A practical method for quantification of impact of environmental changes to coastal biotopes

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DELOS Deliverables 33 and 49
February 2003

Contents

1 Introduction

1.1 Scientific background

Species and species communities are impacted by (man-made) changes in the environment. These changes may lead to reduction of abundance of some species while other species might benefit. Predicting these changes based on expected impact on the environment is complex.

Based on the available data from literature, field observations and model results, the present study aims at achieving progress in the prediction of changes caused by environmental changes. For this a case study has been executed representing a macro-tidal site on the South-East coast of the U.K., the Elmer area.

1.2 DELOS framework

Within the framework of the DELOS project, the aim of project research is to elaborate the impact of low-crested breakwaters on the near-field and mid-field hard- and soft substrate ecosystems. The role of Delft Hydraulics is to provide a quantitative link between the quantification of hydro-morpho-dynamic changes and the impact on the local species and species communities. This report reflects this task, defined as Deliverable … in the DELOS contract. The report is a follow-up of the Deliverables 27 and 42, where the approach to hydro-morpho dynamic modelling has been described in detail.

2 Methodology development

2.1 Aim of the methodology

The aim of the methodology is to create a practical and generic linkage, possibly quantitative, between changes in the physical environment and changes in local ecology, on a scale of a few km2 with sufficient spatial detail to allow for habitat identification.

2.2 Requirements

It is assumed that the physical environment is the main cause defining the characteristics of the local ecology. This leads to the need for the following information:

1) Well defined physical variables that can be used to describe the local physical environment.
2) Well defined definition of local ecology, for instance through species lists or biotope definitions.
3) A suitable definition of physical requirements for each species or biotope linking to governing physical variables.
4) A method to produce values of governing physical variables for designed or expected changes in the local environment.

Furthermore, to be practical, the method requires the use of as much as possible generic and existing information and tools.

2.3 Available information and tools

Given the above requirements, a search has been executed into existing systems that link local species occurrence to the characteristics of the physical environment. This has been the subject of some European funded studies. The following examples can be given:

The EUNIS Habitat classification system

The EUNIS Habitat classification has been developed to facilitate harmonised description and collection of data across Europe through the use of criteria for habitat identification. It is a comprehensive pan-European system, covering all types of habitats from natural to artificial, from terrestrial to freshwater and marine habitats types. It is built to link to and correspond with other major habitat systems in Europe:

- It cross-references to all EU Habitat Directive habitat types used for EU Member States and can be used as a basis for EU Habitat Directive extension for Accession Countries
- It builds on the CORINE and Palaearctic Habitat classifications. It will continue to include the Palaearctic Habitat classification's most detailed units as they are further developed over Europe for the Bern Convention EMERALD network (Resolution No.4)
- It contains and will continue to include relevant marine habitat types as they are developed in collaboration with the OSPARCOM marine work
- It cross-references to the Corine Land Cover classification, to some regional and national classifications, and to other systems such as the European Vegetation Survey.

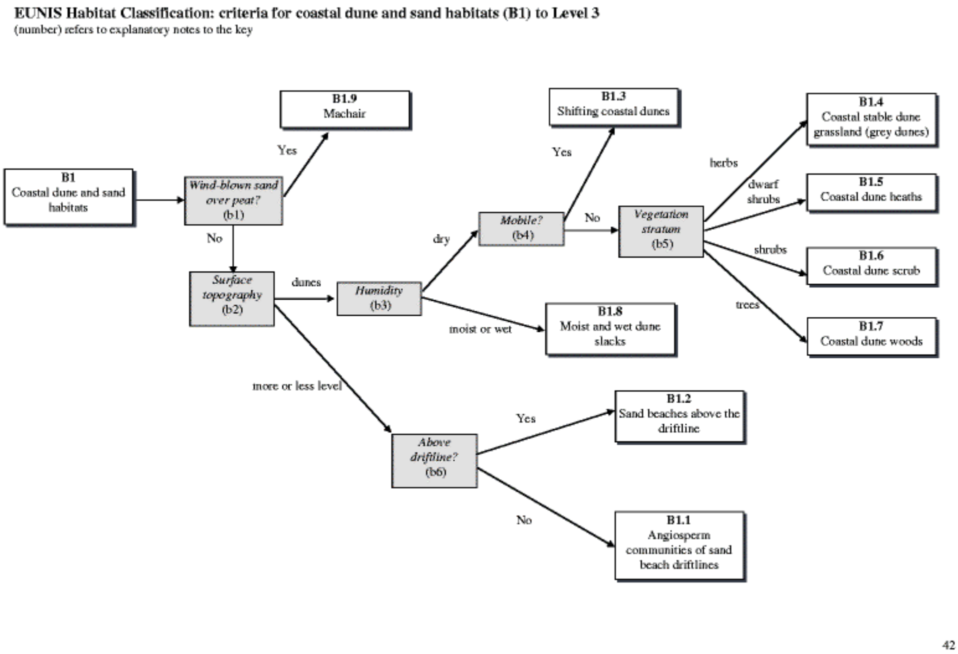


Figure 1 Example of EUNIS Habitat classification scheme.

(source:http://mrw.wallonie.be/dgrne/sibw/EUNIS/home.html, http://eunis.eea.eu.int/eunis3/eunis.jsp)

The BioMar Project. "Marine coastal zone management: identification, description and mapping of biotopes" .

Aims of the program were:

- To develop a system for surveying marine biotopes (i.e. habitats, fauna, and flora), and storing, analysing and presenting this data for conservation management.

- To survey marine biotopes of the Republic of Ireland (TCD)
- To map and review coast-land biotopes of Ireland (NPW)
- To provide list of coastal sites in Ireland for inclusion in NATURA 2000 (sites to be protected under the EC Habitats Directive) (NPW)
- To assess remote survey methods for marine biotopes (Newcastle)
- To develop computerised databases and mapping systems for marine conservation management (TCD and JNCC)
- To develop a classification system for marine biotopes of the North East Atlantic (JNCC)
- To provide an inventory of marine protected areas in Europe (AIDEnvironment)

BioMar was part-funded by the Commission of the European Union LIFE programme. (Picton, 1998).

As a third tool we can identify available mathematical model systems that can predict the present and future values of physical variables, that are affected by (man-made) changes to the environment. Within the framework of the EU DELOS project, the Delft3D modelling systems is selected for this goal. However, other systems are available and could be used to achieve comparable results.

Selection

If we evaluate the above two classification systems, it is relevant to judge the applicability of the system to the selected case (Elmer, S.E. England coast) but more if there is a linkage between physical variables and local ecology. The EUNIS system strives for a comprehensive pan-European classification system. It is a system that also links its classification to other existing systems. However, it provides no clear physical criteria to make a coupling to the local environment. The BioMar system uses in that sense a very clear setup, with an a priori list of physical variables for coastal ecosystems. However, it relates to Irish coasts and need not to be applicable to other situations. From above arguments, the BioMar system is selected as a basis for the remainder of the methodology development.

It is relevant to note that both systems are hierarchical. For instance BioMar utilises the following structure from large scale systems (km2) toward very local sub-biotopes (m2):

A - Major habitat
B - Habitat complex
C – Biotope complex
D – Biotope
E - Sub-biotope

On the level of biotopes and sub-biotopes, species lists are available, giving expected abundance and the level of faithfulness of the prediction.

(see Annexes 1 and 2 for examples of the BIOMAR output)
(see Annexes 3 for examples of the EUNIS output)

2.4 Field data

A test case is selected for this application that provides both physical and biological data to analyse the performance of the methodology. However, prediction of distribution of biotopes is not identical to prediction of the occurrence of certain species in a certain location. The latter task is much more complicated due to the natural variability (in time and space) of species occurrence and the extensive datasets that are required to perform such a task. Biotope distribution is somewhat easier because a biotope is already defined as a physical entity. A biotope is linked to occurrence of key species (communities). It could be interpreted as an area that provides opportunities for certain key species (communities) to occur without necessarily having to find a certain species all the time in a certain biotope.

2.5 Implementation

In order to implement the methodology on the basis of available tools a test-case has been selected. For this test-case the methodology will be evaluated. Important aspects will be the sensitivity to environmental changes, the availability and quality of required input, the validity for use as a (quantitative) prediction tool.

2.5.1 Biotopes definition

The methodology will use either biotope complexes or biotope definitions from the BioMar classification. Due to the nature of the case, the more detailed sub-biotopes are expected to be too local for any sensible prediction and the habitat complexes are considered to global to show much sensitivity to expected changes in the environment. The methodology therefore will not predict the occurrence or disappearance of specific species. Relevant species information can however be derived from the species lists, given for each biotope.

2.5.2 Physical variables

The BioMar system uses a set of 5 physical parameters to define the environment for each biotope or biotope complex. It follows that the definitions are less restricted for the latter.

Example for biotope ELR.BPat. Barnacles and *Patella* spp. on exposed or moderately exposed, or vertical sheltered, eulittoral rock.

Salinity:	Full
Wave exposure:	Exposed, Moderately exposed
Tidal streams:	Moderately strong, Weak
Substratum:	Bedrock; large boulders

Zone: Eulittoral - upper, Eulittoral - mid
Height band: Mid shore
Other features: Also on sheltered vertical bedrock

The ‘Zone’ is defined biologically and gives no physical information that can’t be derived from the parameter ‘Height band’. Other features that are mentioned are not useable for modelling purposes. Each other parameter is defined as a series of classes. Any biotope can be defined with a combination of parameters, using one or more selected classes per parameter. See Annexes 4 and 5 for a list of biotopes included in the BioMar system.

2.5.3 Link to model output

It is a challenge to create a link of classification parameters to model output. This challenge is twofold, 1) model output is not necessarily defined in the same way as the classification parameters and 2) parameter classes have to be extracted from continuous model output.

Salinity

The following classification table and references are listed in the BioMar website:

Coastal areas in Ireland are subject to variable salinities depending on local rainfall and freshwater runoff. The categories presented are based on the 'Venice' system (Carricker 1967) and the work of Kinne 1971)

1	High salinity	> 40 ‰
2	Normal/full salinity	30 to 40 ‰
3	Variable salinity	18 to 30 ‰
4	Low salinity	< 18 ‰

It is unclear how salinity-classes are numerically defined. Are the given values based on yearly averages, maxima or otherwise? For the test-case presented in this report, salinity will be assumed ‘normal’, without influence of rainfall or run-off.

Wave exposure

BioMar wave exposure is defined as follows:

1	EXTREMELY EXPOSED	Open coastlines facing the prevailing winds subject to oceanic swell with an extensive fetch of several 1000 km. with deep water (>50 metres) close offshore (<300 metres).
2	VERY EXPOSED	Open coastlines facing the prevailing winds subject to oceanic swell with a fetch of several 100 km. but with no deep water (>50 metres) close offshore (<300 metres).
3	EXPOSED	Open coast sites with the prevailing wind onshore but where the are offshore shallows and obstructions (such as reefs or islands) or where there is a restricted (>90º) window to the open sea. This can include sites facing away from the prevailing wind but with regular onshore winds and a long fetch.
4	MODERATELY EXPOSED	Sites facing away from the prevailing wind but subject to periods of strong winds without a long fetch
5	SHELTERED	Sites with a restricted fetch and/or open water window. Coasts facing the prevailing wind but with a short fetch (>20 km.) or extensive offshore shallows.

6	VERY SHELTERED	Unlikely to have a prevailing wind fetch extending beyond 20 km. unless the open water wind is >30º, the are extensive shallows and obstructions offshore or they facing away from the prevailing wind.
7	EXTREMELY SHELTERED	Fully enclosed sites with a fetch no greater the about 3 km.
8	ULTRA SHELTERED	Fully enclosed sites with a fetch of a few tens of metres or at most 100s of metres.

This type of definition can easily be extracted from GIS-maps of any study site. In this project, the Elmer case will be classified as a exposed to sheltered location. The D3D wave model (SWAN) does not recognize this type of definition. The model generates wave or current induced bottom shearstress or characteristic wave heights such as the HM0. To utilise model results, the model output should be superimposed on the given list of definitions.

As a first approximation we use the following conversion table that gives a classification result distributed mostly in the classes ‘exposed’ to ‘sheltered’ (based on maximum shearstress values during normal wind conditions. This conversion is tentative and should be checked for storm conditions.

	Wave exposure	**Tau-max**
1	EXTREMELY EXPOSED	>2.5
2	VERY EXPOSED	2.0
3	EXPOSED	1.5
4	MODERATELY EXPOSED	1.0
5	SHELTERED	0.5
6	VERY SHELTERED	0.3
7	EXTREMELY SHELTERED	0.1
8	ULTRA SHELTERED	0

Tidal stream

BioMar uses the maximum values as basis for classification. The categories are as follows:

1	Very strong	> 6 knots	> 3 m/s
2	Strong	3 to 6 knots	1.5 to 3 m/s
3	Moderately strong	1 to 3knots	0.5 to 1.5 m/s
4	Weak	< 1 knot	< 0.5 m/s
5	Very weak	negligable	< 0.1 m/s *

(* this value was nor provided by BioMar, and is based on expert judgement)

Substratum

The substrate list is extensive in BioMar. Biotopes are very sensitive to the substratum parameter. The model will not provide this information. It should be derived from field surveys. In the test-case, the breakwaters could be defined as bedrock or boulders. The surrounding area was investigated and resulted in a D50 corresponding to medium and fine sands with little mud. The BioMar substratum scale:

1	Bedrock		
2	Boulders		
3		very large	>1024 mm
4		large	512-1024 mm
5		small	256-512 mm
6	Cobbles		64-256 mm
7	Pebbles		16-64 mm
8	Gravel		4-16 mm
9		stone	
10		shell	
11		dead maerl	
12		live maerl	
13	Sand		
14		coarse	1-4 mm
15		medium	0.25-1 mm
16		fine	0.063-0.25 mm
17	Mud		<0.063 mm
18	Shells (empty)		
19	Artificial		
20		metal	

21		concrete
22		wood
23	Trees/branches	
24	Algae	
25	Others	

Height band

The height band consists of a combination of drying areas and subtidal zones. This requires a depth map of the study area and information on the tidal range. The following classification is used by BioMar:

	Zone in tidal range	Definition
1	Splash zone, above highest astronomical tide	Strandline (more then 95% dry)
2	Around MHWS	Upper shore (more then 80% dry)
3	Around MTL	Middle shore (more then 20% dry)
4	Around LWN	Lower shore (less then 20% dry)
5	Below lowest astronomical tide (=Chart Datum)	0-5 metres BCD
6		5-10 metres BCD
7		10-20 metres BCD
8		20-30 metres BCD
9		30-50 metres BCD
10		>50 metres BCD

Translation of inundation time from model output has lead to the definition of the below classification table for the drying zones:

	Zone	**Inundation time (% of tidal cycle)**
5	Subtidal	>1
4	Lower shore	0.8
3	Middle shore	0.2
2	Upper shore	0.05
1	Strandline	0

3 Delft3D sediment-online model calibration

3.1 Introduction

To perform morphodynamic calculations on coastal areas the following modules of the Delft3D system have to be used: Delft3D-sediment-online and Delft3D-MOR. With these modules one can simulate wave propagation, currents, sediment transport, morphological developments and water quality aspects in coastal, river and estuarine areas (Bos, 1996).

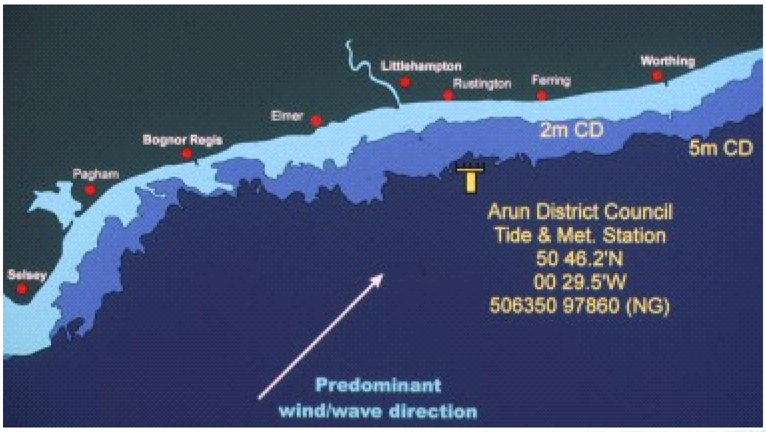
The newest version of the Delft3D package is called Delft3D-sediment-online. In this version the modules FLOW, SED and MOR are not seen as separate entities anymore. The Delft3D-sediment-on-line version allows for the simulation of flow, transport of sediment (as bed and suspended load) and bed level changes, at the same time step. The effects of density currents, due to suspended sediment concentration, can be implicitly taken into account. This formulation is suited especially for high dynamic processes, where short-term bed level changes affect the local hydrodynamics (Lesser, 2002).

The wave module is based on the ‘HISWA concept’ (Holthuijsen et al., 1989, 1993). This module solves the spectral wave action balance equation assuming a frequency spectrum of fixed shape, allowed to propagate within a directional sector of less than 150°, on a two-dimensional rectangular grid. The model takes into account the effects of shoaling and refraction, dissipation by bottom friction and wave breaking, current refraction and wave blocking. Recently, the HISWA successor SWAN has been integrated into the Delft3D-MOR model. In contrast to its predecessor HISWA, SWAN is fully spectral over the total range of wave frequencies, over the complete directional sector of 360°. The latter implies that short-crested random wave fields propagating from widely different directions (or ‘multi-modal wave fields’) can now be accommodated.

3.2 The Elmer case

3.2.1 Introduction

Much of the coastline is composed of a shingle upper beach and a sandy lower foreshore. Shingle is a very good absorber of wave energy and is restrained from excessive movement along the beach (littoral drift) by the shore parallel breakwaters. Eight rock islands have been constructed, four each by the Council and the Environment Agency (formerly the National Rivers Authority), in a jointly promoted scheme to protect a very vulnerable stretch of coast that suffered badly in the storms of 1989/90. The scheme, completed in 1993, was designed by consultants, Robert West & Partners, with model testing at HR Wallingford. The total cost of the main scheme (split approximately 50-50, Arun/EA) amounted to some £4m. and was grant aided by the Ministry of Agriculture, Fisheries and Food (MAFF) with additional money coming from West Sussex County Council (WSCC).



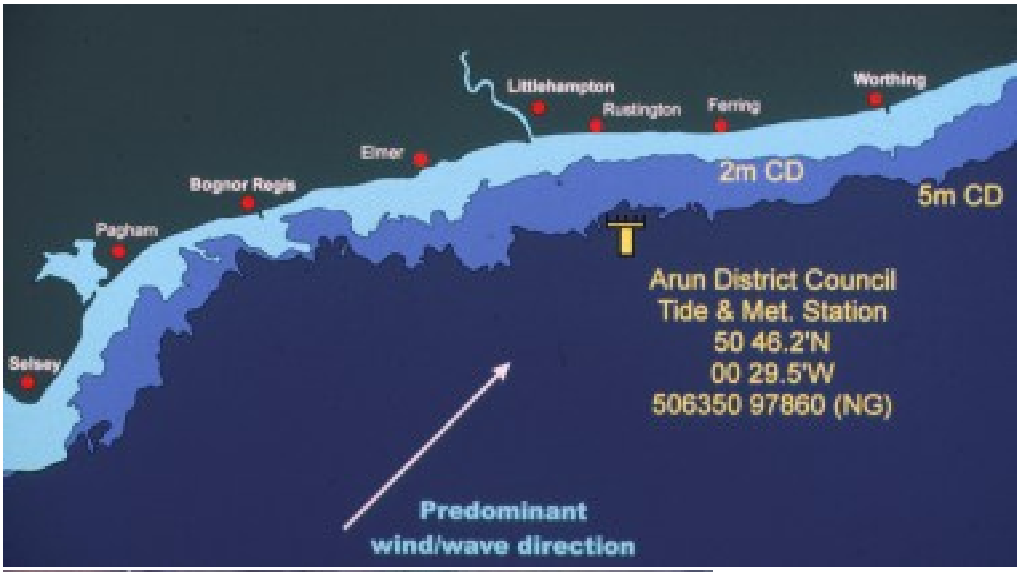


Figure 3.1 The Elmer area.

Source: http://www.arun.gov.uk/cgi-bin/buildpage.cgi?mysql=90. The Arun Civic Centre Maltravers Road, Littlehampton, West Sussex, BN17 5LF.

This model was set up to simulate the currents around the detached breakwaters constructed along the Elmer coast in southern England. The currents along this coast are driven by a semi-diurnal tide and waves. The sediment concentrations due to these currents are also given as model output. Since measurements were carried out in and behind the gap between breakwater 3 and 4, the study is focused on this area.

3.2.2 Data

Survey data were provided within the framework of the DELOS project by Southampton Oceanography Centre (M. Collins et al.).

Bathymetry

The bottom samples that were available described the bathymetry around all the 8 detached breakwaters and reached a depth of about 5 m offshore. The samples are given with the mean sea level (MSL) as a reference level.

Tide

The tidal constituents of two water level stations were used to determine the tidal elevation at the Elmer coast. The two stations are Bognor Regis (west of Elmer) and Littlehampton (east of Elmer).

Table 3.1 Tidal components from two stations

	M2		S2		K1		O1	
	phase	amp	phase	amp	phase	amp	phase	amp
Bognor Regis	323	1.82	10	0.6	154	0.05	15	0.08
Littlehampton	323	1.97	16	0.54	108	0.06	10	0.03

Waves

In July 2001 measurements were carried out around the gap between breakwater 3 and 4. During the rising period of three tidal cycles the water level elevation and the waves were measured. Since no offshore wave data was available, these wave measurements outside breakwater 3 (see figure 1) were used for estimating the wave height and direction to force the wave model. The wave heights and directions measured during each of the three tidal cycles were averaged and then used as input for the SWAN model. Averaging the wave height, peak period and direction in a tidal cycle gives the following values:

Table 3.2 Measured wave characteristics, July 2001

tidal cycle	9	10	11

mean Hs	0.63	0.54	0.43
mean Tp	3.7	4	3.3
Mean Dir	229	228	239

This case was used a basis for calibration of the model. To produce a case with more biological relevance (high tidal currents and high wave exposure), a situation with mean Hs of 2.5m during a spring tide was used.

Sediment

Grain size data of the sediment in and behind the measured gap was also available. The grain sizes (d_{50}) vary from 100 um to 160 um. The sediment behind the gap can be classified as fine sand. Close to the highwater level medium sand can be found with a d_{50} of 300 um. Data were provided by Southampton Oceanography Centre (M. Collins et al.)

3.2.3 Model setup

Grid and bathymetry

A curvilinear grid was constructed for an area of 800 m cross-shore and 750 m alongshore. The grid has a maximum resolution of 10 x 6 m and consists of 5500 active cells. By interpolation of the samples a bathymetry was generated.

Water level

The amplitudes and phases were found by interpolation of the amplitudes and phases of these two stations. Besides this, the phase and amplitude difference along the offshore boundary were derived and applied on the model boundary.

Table 3.3 Tidal components estimated for the study site

	M2		S2		K1		O1	
	phase	amp	phase	amp	phase	amp	phase	amp
western bnd	323	1.8950	13.000	0.5700	131.000	0.0550	12.500	0.0550
eastern bnd	323	1.9035	13.342	0.5666	128.382	0.0556	12.215	0.0522

To smooth the inflow on the boundaries Neumann boundaries are applied on the western and eastern boundary. This Neumann boundary applies a water level gradient as a boundary condition.

Waves

After some sensitivity runs, one characteristic wave condition is determined for each tidal cycle to be applied on the sea boundary. These wave conditions are presented as:

Table 3.4 Wave characteristics for model application

tidal cycle	9	10	11
mean Hs	1.00	0.90	0.80
mean Tp	3.7	4	3.3
mean Dir	240	240	250

Since the tidal range is more than 5 m and the bathymetry is rather shallow, the wave patterns during the tidal cycle are significantly changing. Therefore, the water level variation is also given as variable in the wave model (SWAN). During the period with no measurements in a tidal cycle, the wave height is set on 0.5 m with a direction of 230 degrees.

3.2.4 Calibration results

Calibration run

No other parameters of the Delft3D model were changed from the default values other then boundary conditions described above. This led to a simulation of the 2 day period in July 2001.

In the figure 3.2 below, the simulated depth averaged currents are presented in red together with the measured velocity at 30 cm above the bed (blue). The currents are in m/s. The survey location was just outside the gap between both breakwaters

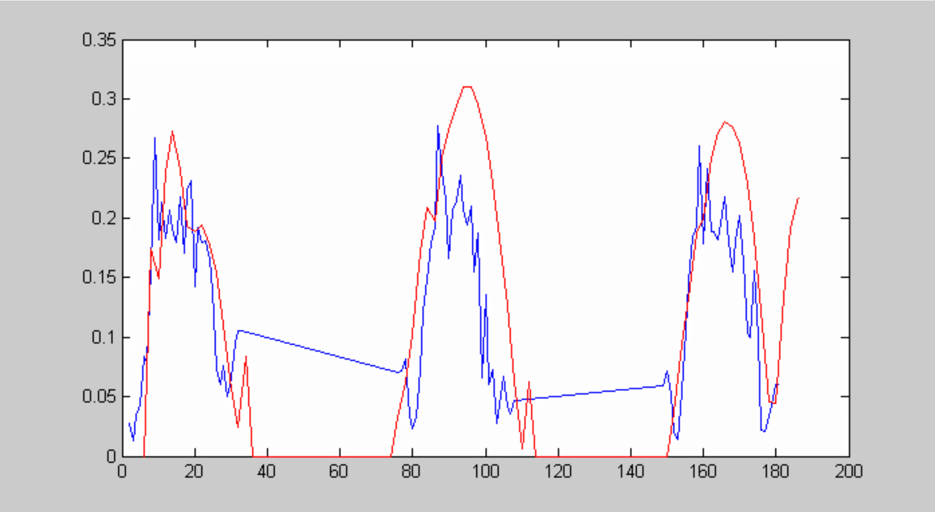


Figure 3.2 Model calibration on data from the DELOS survey at the Elmer site.

No breakwaters run

In order to allow analysis of the impact of a breakwater on the local biotope distribution, the present situation with breakwaters was modified to a hypothetical 'historic' situation without breakwaters.

Model results: velocity

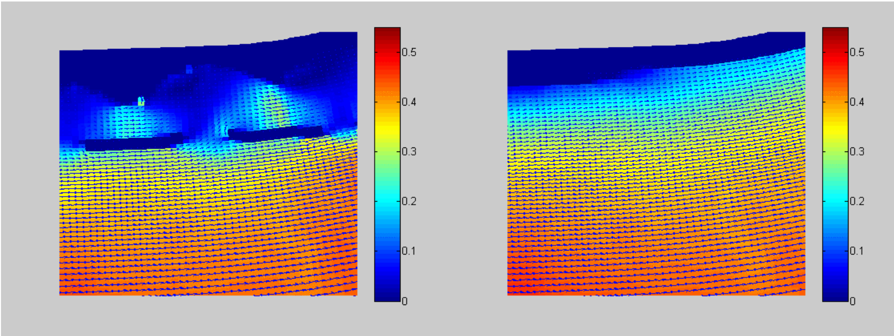


Figure 3.3 Depth averaged velocities near high water in layout with and without the breakwaters (July 2001, DELOS survey, wind and tide)

The impact of the breakwaters is clearly shown in the figures 3.3. Behind the breakwater the local shallows cause increased current speeds.

Bed shear stress

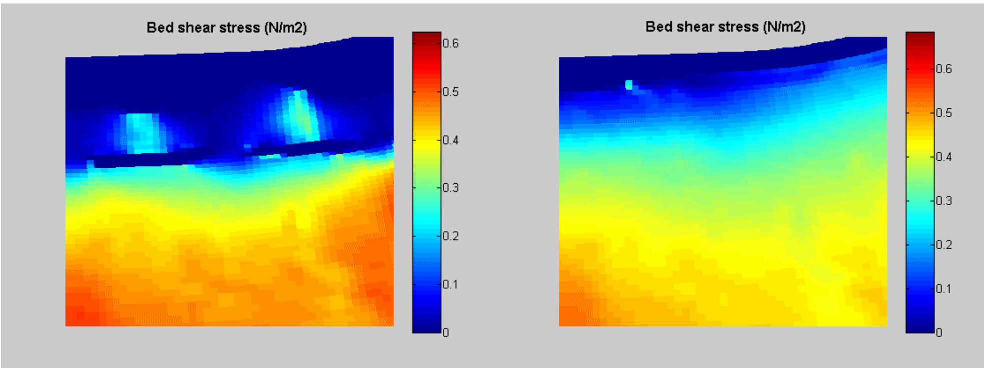


Figure 3.4 Bed shear stress distributions near high water with and without breakwaters (July 2001, DELOS survey, wind and tide)

4 Delft3D model runs for biotope mapping

For both lay-outs (with and without breakwaters) a run was performed representing limiting conditions for the local species communities. In essence this run aims for an extreme in wave exposure and currents that still occurs yearly and therefore could limit the suitability of local habitats for species with lifespans of more then a year. The results of these runs are used for biotope analysis.

4.1 Velocity

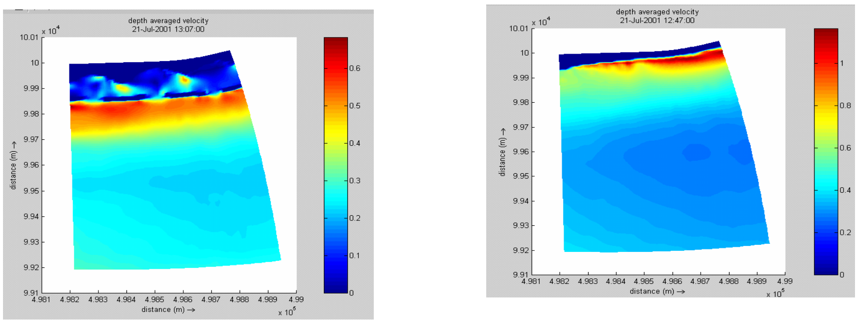


Figure 4.1 Velocity distributions near high water with and without breakwaters (Hs =2.5 m)

From Figure 4.1 the influence of wave breaking on current velocity in front of the breakwater is clearly seen.

4.2 Bed shear stress

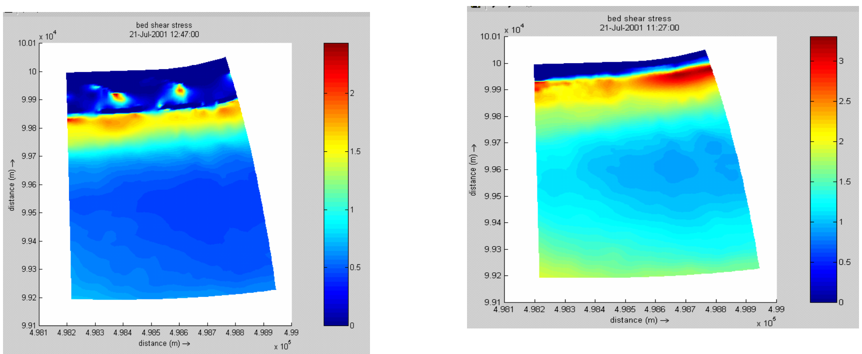


Figure 4.2 Bed shear stress distributions near high water with and without breakwaters (Hs =2.5 m). Note the different scaling.

Bed shear stress is a combination of current and wave conditions.

4.3 Height and Depth

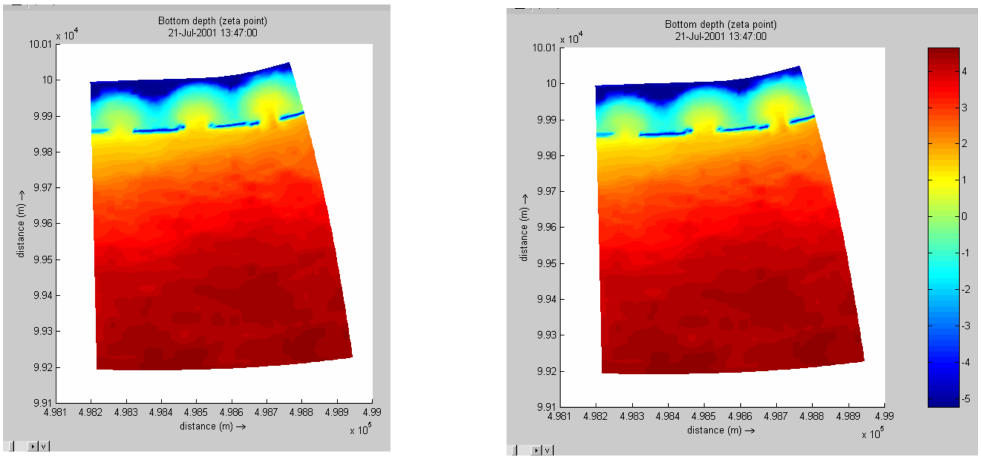


Figure 4.3 Bottom depth distributions relative to MSL with and without breakwaters (negative values are above MSL).

4.4 Additional parameters

4.4.1 Substrate

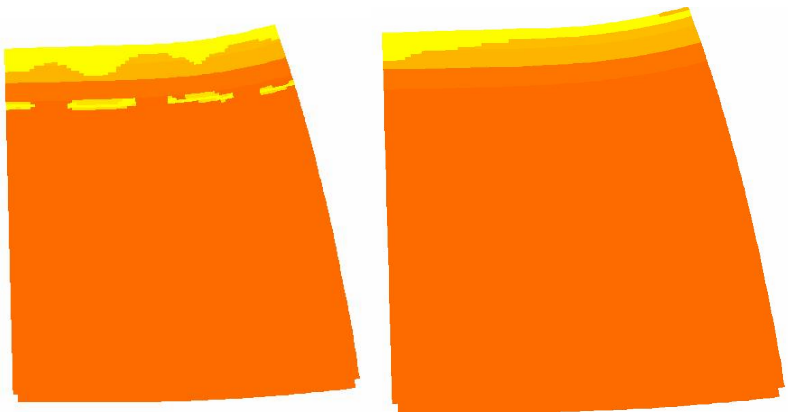


Figure 4.4 Substrate map of the study area (orange = fine sand, yellow = boulders and pebbles)

This map has been composed on the basis of some sediment samples that are available for the area. Sediment composition is assumed to become coarser (from fine sand to pebbles) going from subtidal to strandline depths-zones.

4.4.2 Salinity

Salinity was assumed 'Full', constant and equal in the study area, leading to a class-value of 2.

5 Coupling physical environment to ecology; biotope prediction for a coastal ecosystem

5.1 Approach

WL | delft hydraulics uses a generic classification methodology for hard and soft-bottom communities, which can be used to describe the changes in the community compositions resulting from the construction of an LCS. This classification is based on linking environmental conditions to biotope or species habitat definitions. The environment could potentially be influenced by construction of an LCS. For the DELOS project the BioMar biotope classification system (partly developed through Europese funding) was adopted as basis for the analysis.

These classifications can be translated into habitat suitability curves, which are defined as linear functions. Or in the case of biotopes, the methodology translates biotope classifications in discrete classes. In the latter case, the physical parameters will be defined as discrete functions (as is the case in the BioMar system). The output of the morpho-hydrodynamical model generates the required physical parameters that are used to select the suitable biotopes for each location. Subsequently the distribution patterns of the various biotopes in the area surrounding the LCS will totalled into biotope areas. The performance of the method can be improved iteratively, based on the sensitivity of the model to describe the different biotope distributions imposed by constructions of LCS and input from ecological experts within the project. For example if the model does not predict any changes in the distribution patterns as a result of a LCS, the classifications could be to general and should be more refined. Data from specific sites can be used to test the model performance.

5.2 Coupling to hydrodynamics model output

The following physical parameters were derived from the Delft3D model set-up:

- Tidal range (5.0 m, LLW - HHW)
- Depth (meters relative to Mean Sea Level)
- Maximum bottom shear stress: Taumax (N m-2)
- Maximum current velocity: Umax (m s-1)

From Tidal range and Depth, the input for the required Height and Depth classification was derived with the following formula:

Height classes (above subtidal): H = 1-(CD+Depth)/T-range
Depth classes (subtidal and lower): D = CD+Depth

Where:
CD = 2.50 m (Chart Datum) and
T-range = 5.0 m (Tidal range)

Salinity was kept constant at class-value 2 for all model runs. Substratum was derived from some local sediment sampling information. Given the classification definitions as described in Chapter 3, model output was recalculated into the discrete class-values as required for the biotope selection.

5.3 Running the model

The biotope-model uses a selection of biotopes and the required class-values per parameter (see the list in Annex 3). Columns in figure 5.1 indicate the required class-values of each physical parameter. If a location satisfies at least one requirement for each parameter, the location is selected as a suitable environment for the relevant biotope. With the biotope model, this process is repeated for each biotope for each gridcell. As the area of each gridcell is known, the biotope-model will calculate a total biotope-area within the study area. It is possible that one gridcell is suitable for more then one biotope. In those cases, the model will allocate the area of the gridcell to more biotopes. In the case that no biotope could be selected for a gridcell, the model will not include the gridcell area. However, this problem is an artefact of the definition of biotopes and biotopes requirements, in nature every location will be occupied by a biotope by definitions.

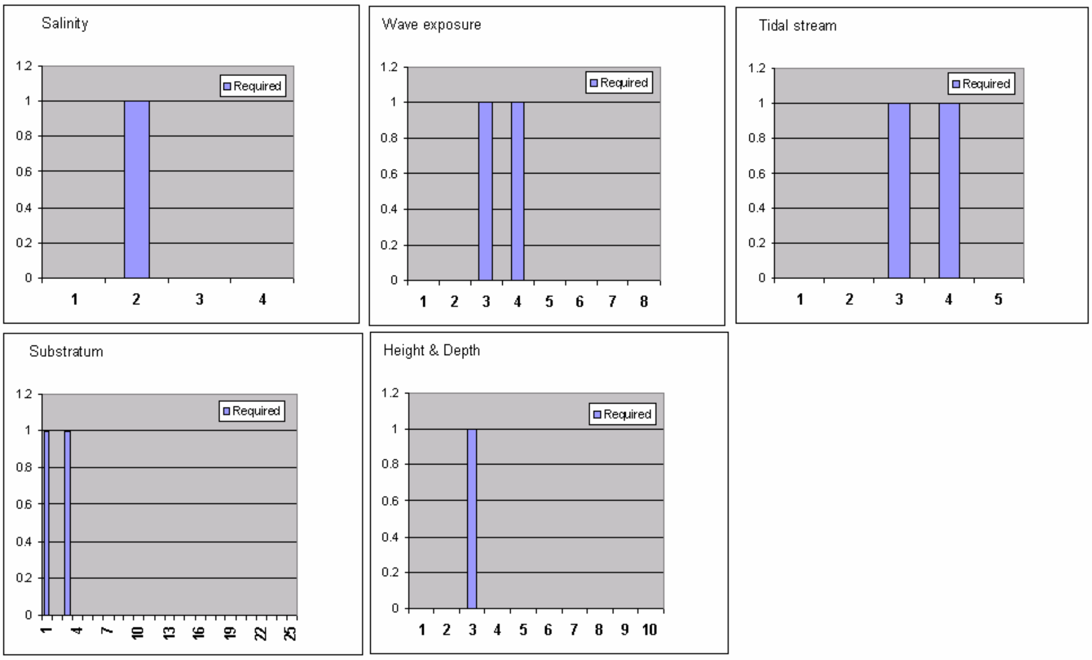


Figure 5.1 Biotope requirements for biotope ELR.BPat

5.4 Results

In order to test the performance of the BioMar biotope classification system, runs have been performed on both the more global biotope-complex level and the biotope level.
For each condition, distributions have been calculated. These results are based on two runs of the morpho-hydrodynamic model, (1) storm weather situation (Hs=2.5m) with breakwater present and (2) storm weather present situation without a breakwater. Figure 5.2 shows both biotope and biotope-complex distributions for hard and soft substrates for the situation with the breakwater. The summation of areas gives a total biotope area per run in the tables 5.1 and 5.2 below. It can be seen that not all gridcells have been included in the classification (bright yellow colour). Especially the more detailed biotope system leaves areas unclassified.

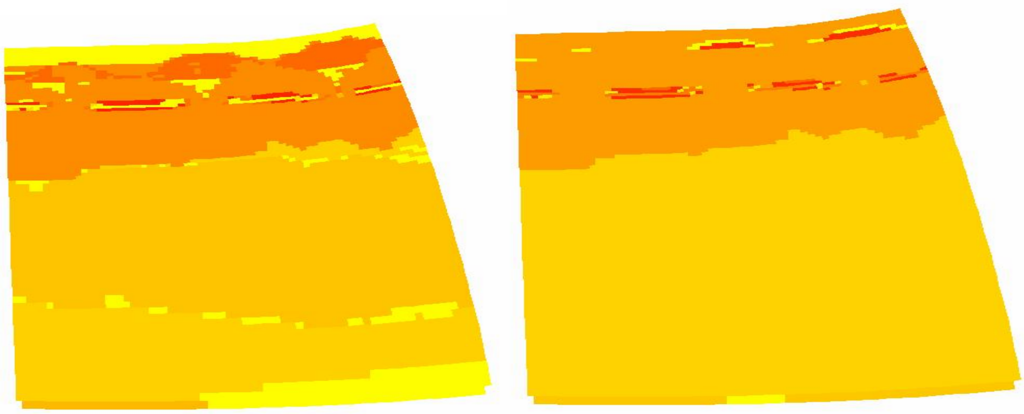
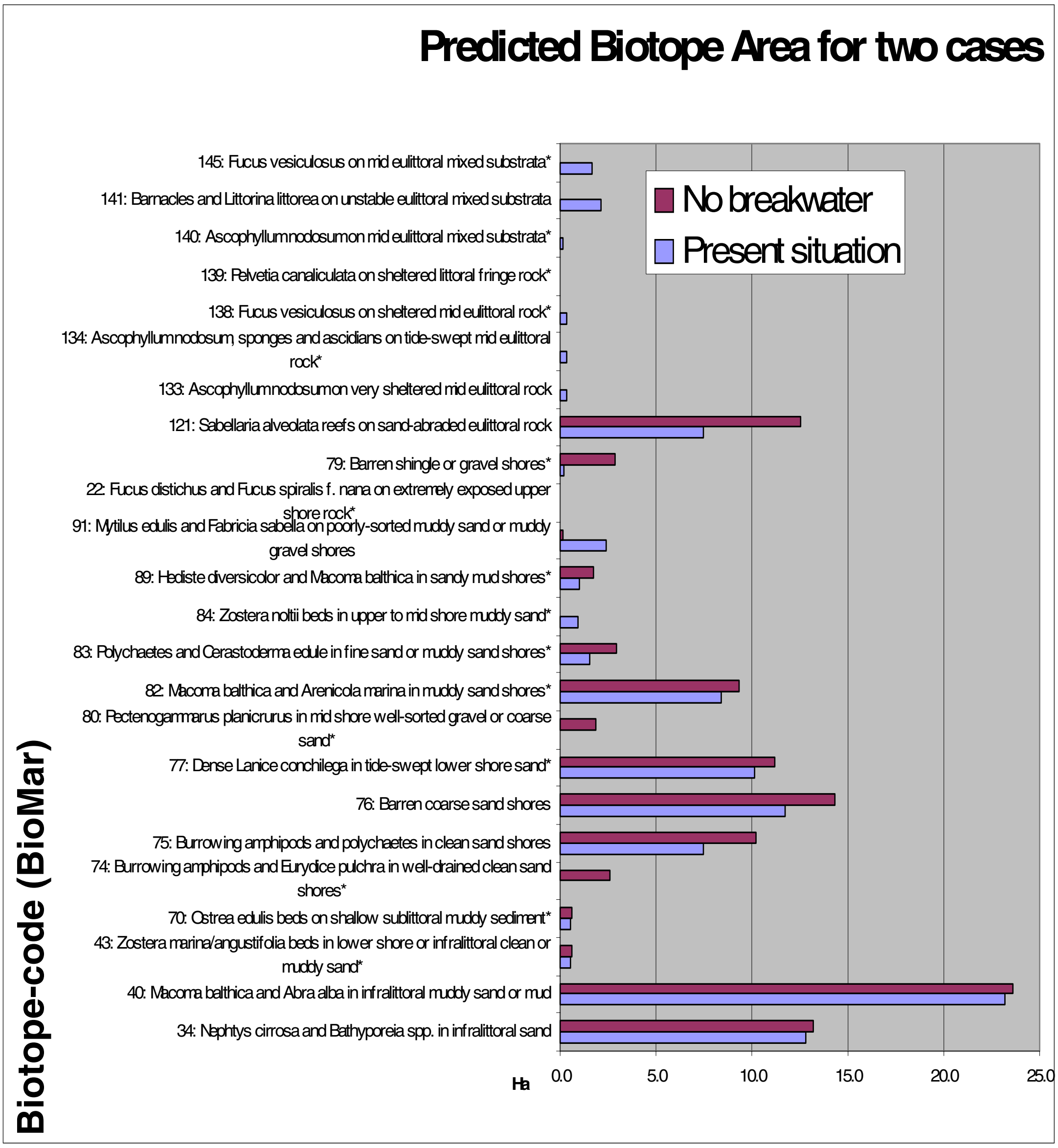


Figure 5.2 Biotope and biotope-complex results for present situation (Hs=2.5m)

Table 5.1 Biotope distributions for a run with and without breakwater.



The biotope description gives information on species to be expected in the environment of the study area. Figure 5.3 show a detail with number of biotopes that link to numbers in Table 5.1.

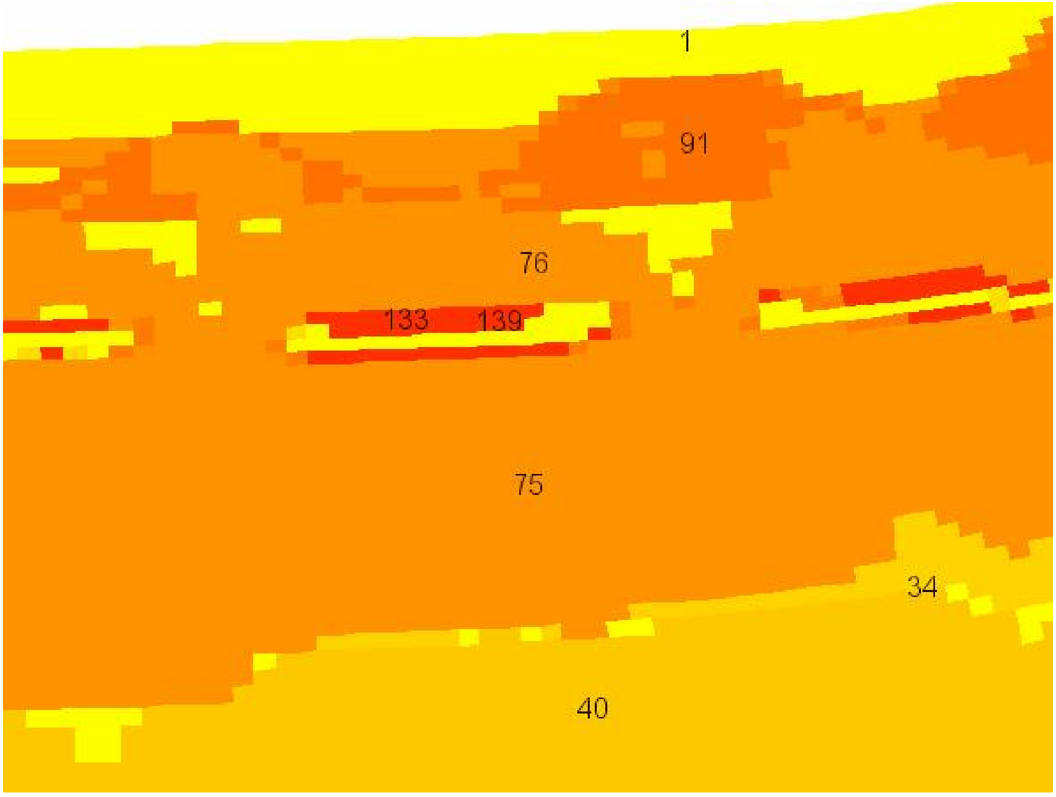
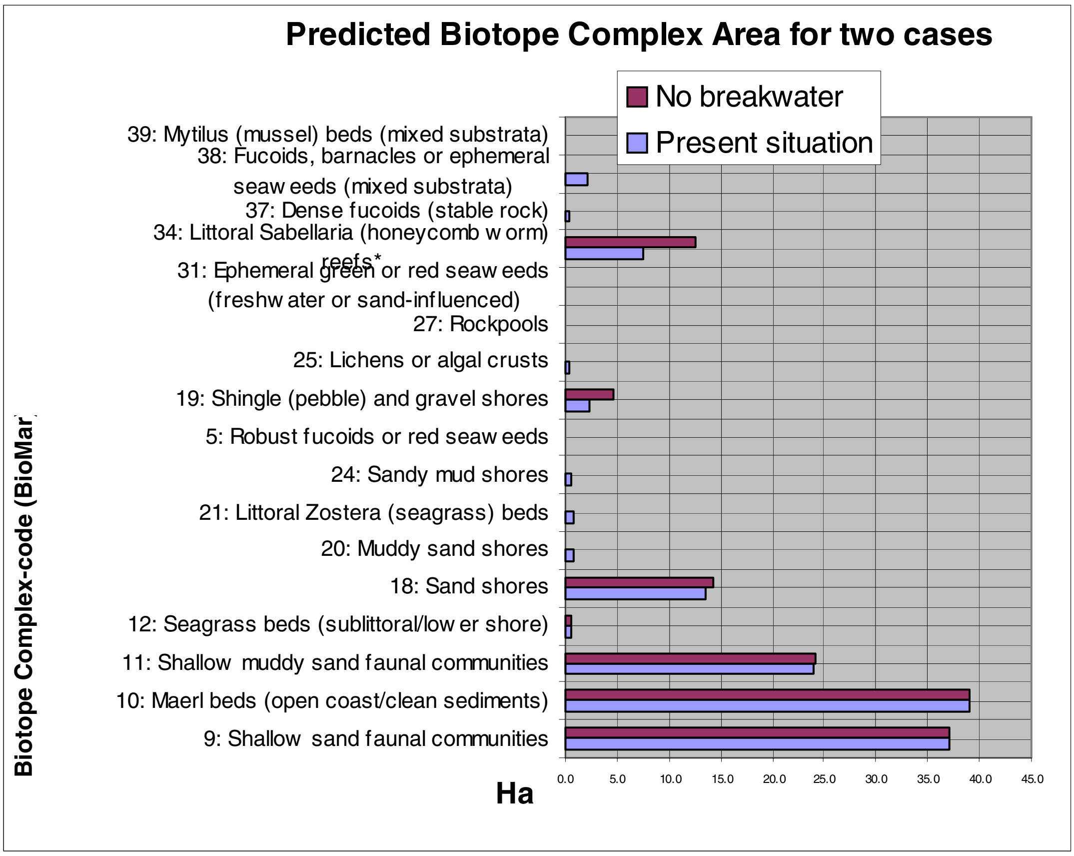


Figure 5.3 A detail of the study area showing biotope distributions (value 1 indicates missing data).

Table 5.2 Biotope-complex distributions for a run with and without breakwater



The biotope-complex description gives global information on species to be expected in the environment of the study area. Figure 5.4 shows a detail with number of biotopes that link to numbers in Table 5.2.

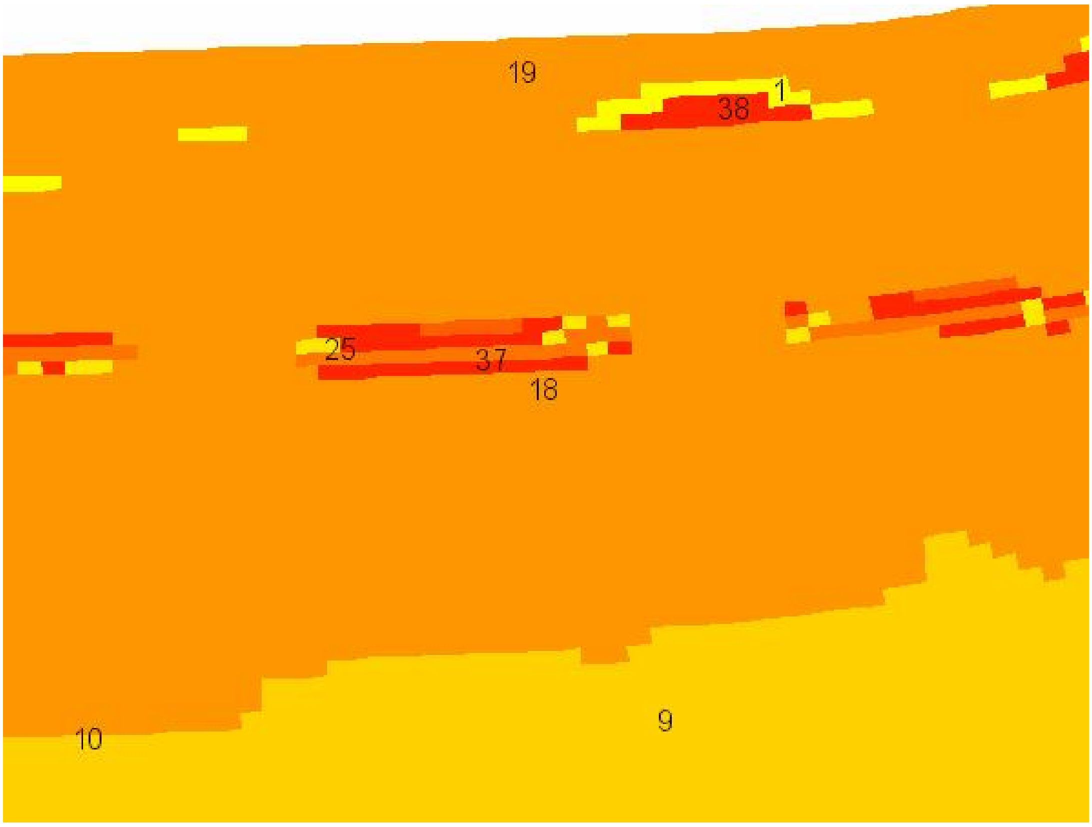


Figure 5.4 A detail of the study area showing biotope-complex distributions (value 1 indicates missing data).

5.5 Species list

The BioMar dataset includes for most of the biotopes a list of species that are occurring in that biotope. In the table 5.3, this list is presented for 5 most common biotopes in the study area. In grey entries, species are listed that were also found by Southampton Oceanography Centre (P. Moschella et al.) in soft sediment sample site near (but not in) the study area.

Table 5.3 List of species potentially occurring in characteristic biotopes

IGS.FaS.NcirBat	IMS.FaMS.MacAbr	LGS.S.AP	LMS.MS.MacAre	MLR.Sab.Salv
34	40	75	82	121
Nephtys	Nephtys cirrosa	Nephtys cirrosa	Nephtys hombergii	Sabellaria alveolata
Nephtys cirrosa	Nephtys hombergii	Scolelepis squamata	Scoloplos armiger	Semibalanus balanoides
Scolelepis squamata	Scalibregma inflatum	Pontocrates	Pygospio elegans	Balanus crenatus

Spio filicornis	Lagis koreni	Bathyporeia	Arenicola marina	Balanus perforatus
Capitella capitata	Ampelisca spinipes	Eurydice pulchra	Ventrosia ventrosa	Elminius modestus
Pontocrates arenarius	Crangon crangon		Cerastoderma edule	Patella vulgata
Bathyporeia	Nucula nitidosa		Macoma balthica	Littorina littorea
Haustorius arenarius	Fabulina fabula			Nucella lapillus
Eurydice pulchra	Macoma balthica			Mytilus edulis
	Abra alba			Porphyra
	Echinocardium cordatum			Palmaria palmata
				Mastocarpus stellatus
				Ceramium
Ammodytes tobianus	Mya			Cladostephus spongiosus
	Corbula gibba			Fucus serratus
				Fucus vesiculosus
				Enteromorpha
				Ulva

5.6 Discussion and Conclusions

This application to Elmer, although only roughly-calibrated, illustrates the sensitivity of the biotope approach for man-made changes in the environment. It could be therefore, after calibration and validation, a valuable tool for analysis of impacts to the ecology of an impacted site. Some major limitations apply to the methodology:

1) The BioMar biotope system is only developed for the Irish and British coastlines. For other applications, for instance in the Mediterranean, possibly other biotopes and certainly other species lists will be found. This aspect could be less dramatic when biotope complexes are considered. In this case the more broad definition could apply for other systems.

2) The BioMar system does not contain mutually excluding biotope definitions. This means that an expert has to use local knowledge to sort the most probable set of biotopes from the predicted total set.

3) Other factors then the parameters used will be relevant. For instance, nutrient availability is an important governing parameter. These are not included in this approach. Including this means that an adaptation to the present BioMar system is required.

4) The translation of model parameters into the required BioMar parameters is not defined in detail in the BioMar system. It is unclear if averages or maximum values should be used, and over what time period these values should be extracted.

5) Comparing species lists of most common predicted soft substrate biotopes with a species list that was obtained from a nearby area, shows that many listed species were not found in samples. This result should be used to become aware that the prediction of species occurrence and even more so, species abundance, is not possible with this method.

6) Further data-analysis of this and other sites should be needed to confirm the usefulness of this approach.

6 References

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ANNEX 1, BIOMAR littoral hard substrates biotope listing

Littoral rock (and other hard substrata)	LR	B - Habitat complex
Lichens or algal crusts	LR.L	C - Biotope complex
Yellow and grey lichens on supralittoral rock*	LR.L.YG	D - Biotope
Prasiola stipitata on nitrate-enriched supralittoral or littoral fringe rock*	LR.L.Pra	D - Biotope
Verrucaria maura on littoral fringe rock	LR.L.Ver	D - Biotope
Verrucaria maura and *Porphyra umbilicalis* on very exposed littoral fringe rock*	LR.L.Ver.Por	E - Sub-biotope
Verrucaria maura and sparse barnacles on exposed littoral fringe rock*	LR.L.Ver.B	E - Sub-biotope
Verrucaria maura on very exposed to very sheltered upper littoral fringe rock*	LR.L.Ver.Ver	E - Sub-biotope
Chrysophyceae on vertical upper littoral fringe soft rock*	LR.L.Chr	D - Biotope
Blidingia spp. on vertical littoral fringe soft rock	LR.L.Bli	D - Biotope
Ulothrix flacca and *Urospora* spp. on freshwater-influenced vertical littoral fringe soft rock	LR.L.UloUro	D - Biotope

Exposed littoral rock (mussel/barnacle shores)	ELR	B - Habitat complex
***Mytilus* (mussels) and barnacles**	ELR.MB	C - Biotope complex
Mytilus edulis and barnacles on very exposed eulittoral rock*	ELR.MB.MytB	D - Biotope
Barnacles and *Patella* spp. on exposed or moderately exposed, or vertical sheltered, eulittoral rock*	ELR.MB.BPat	D - Biotope
Chthamalus spp. on exposed upper eulittoral rock*	ELR.MB.BPat.Cht	E - Sub-biotope
Barnacles and *Lichina pygmaea* on steep exposed upper eulittoral rock	ELR.MB.BPat.Lic	E - Sub-biotope
Catenella caespitosa on overhanging, or shaded vertical, upper eulittoral rock*	ELR.MB.BPat.Cat	E - Sub-biotope
Barnacles, *Patella* spp. and *Fucus vesiculosus* f. *linearis* on exposed eulittoral rock	ELR.MB.BPat.Fvesl	E - Sub-biotope
Semibalanus balanoides on exposed or moderately exposed, or vertical sheltered, eulittoral rock*	ELR.MB.BPat.Sem	E - Sub-biotope
Robust fucoids or red seaweeds	ELR.FR	C - Biotope complex
Fucus distichus and *Fucus spiralis* f. *nana* on extremely exposed upper shore rock*	ELR.FR.Fdis	D - Biotope
Corallina officinalis on very exposed lower eulittoral rock*	ELR.FR.Coff	D - Biotope

Himanthalia elongata and red seaweeds on exposed lower eulittoral rock*	ELR.FR.Him	D - Biotope

Moderately exposed littoral rock (barnacle/fucoid shores)	MLR	B - Habitat complex
Barnacles and fucoids (moderately exposed shores)	MLR.BF	C - Biotope complex
Pelvetia canaliculata and barnacles on moderately exposed littoral fringe rock*	MLR.BF.PelB	D - Biotope
Fucus vesiculosus and barnacle mosaics on moderately exposed mid eulittoral rock*	MLR.BF.FvesB	D - Biotope
Fucus serratus on moderately exposed lower eulittoral rock	MLR.BF.Fser	D - Biotope
Fucus serratus and red seaweeds on moderately exposed lower eulittoral rock*	MLR.BF.Fser.R	E - Sub-biotope
Dense *Fucus serratus* on moderately exposed to very sheltered lower eulittoral rock*	MLR.BF.Fser.Fser	E - Sub-biotope
Fucus serratus and under-boulder fauna on lower eulittoral boulders*	MLR.BF.Fser.Fser.Bo	E - Sub-biotope
Fucus serratus and piddocks on lower eulittoral soft rock	MLR.BF.Fser.Pid	E - Sub-biotope
Red seaweeds (moderately exposed shores)*	MLR.R	C - Biotope complex
Mixed red seaweeds on moderately exposed lower eulittoral rock	MLR.R.XR	D - Biotope
Palmaria palmata on very to moderately exposed lower eulittoral rock*	MLR.R.Pal	D - Biotope
Mastocarpus stellatus and *Chondrus crispus* on very to moderately exposed lower eulittoral rock*	MLR.R.Mas	D - Biotope
Osmundea (Laurencia) pinnatifida and *Gelidium pusillum* on moderately exposed mid eulittoral rock*	MLR.R.Osm	D - Biotope
Ceramium sp. and piddocks on eulittoral fossilised peat*	MLR.R.RPid	D - Biotope
Ephemeral green or red seaweeds (freshwater or sand-influenced)	MLR.Eph	C - Biotope complex
Enteromorpha spp. on freshwater-influenced or unstable upper eulittoral rock*	MLR.Eph.Ent	D - Biotope
Porphyra purpurea or *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock*	MLR.Eph.EntPor	D - Biotope
Rhodothamniella floridula on sand-scoured lower eulittoral rock*	MLR.Eph.Rho	D - Biotope
Mytilus* (mussels) and fucoids (moderately exposed shores)	MLR.MF	C - Biotope complex

Mytilus edulis and *Fucus vesiculosus* on moderately exposed mid eulittoral rock	MLR.MF.MytFves	D - Biotope
Mytilus edulis, *Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock	MLR.MF.MytFR	D - Biotope
Mytilus edulis and piddocks on eulittoral firm clay	MLR.MF.MytPid	D - Biotope
Littoral *Sabellaria* (honeycomb worm) reefs*	MLR.Sab	C - Biotope complex
Sabellaria alveolata reefs on sand-abraded eulittoral rock	MLR.Sab.Salv	D - Biotope

Sheltered littoral rock (fucoid shores)	SLR	B - Habitat complex
Dense fucoids (stable rock)	SLR.F	C - Biotope complex
Pelvetia canaliculata on sheltered littoral fringe rock*	SLR.F.Pel	D - Biotope
Fucus spiralis on moderately exposed to very sheltered upper eulittoral rock*	SLR.F.Fspi	D - Biotope
Fucus vesiculosus on sheltered mid eulittoral rock*	SLR.F.Fves	D - Biotope
Ascophyllum nodosum on very sheltered mid eulittoral rock	SLR.F.Asc	D - Biotope
Ascophyllum nodosum on full salinity mid eulittoral rock*	SLR.F.Asc.Asc	E - Sub-biotope
Ascophyllum nodosum, sponges and ascidians on tide-swept mid eulittoral rock*	SLR.F.Asc.T	D - Biotope
Ascophyllum nodosum and *Fucus vesiculosus* on variable salinity mid eulittoral rock*	SLR.F.Asc.VS	E - Sub-biotope
Fucus serratus on sheltered lower eulittoral rock	SLR.F.Fserr	D - Biotope
Fucus serratus, sponges and ascidians on tide-swept lower eulittoral rock	SLR.F.Fserr.T	E - Sub-biotope
Fucus serratus and large *Mytilus edulis* on variable salinity lower eulittoral rock	SLR.F.Fserr.VS	E - Sub-biotope
Fucus ceranoides on reduced salinity eulittoral rock*	SLR.F.Fcer	D - Biotope
Fucoids, barnacles or ephemeral seaweeds (mixed substrata)	SLR.FX	C - Biotope complex
Barnacles and *Littorina littorea* on unstable eulittoral mixed substrata	SLR.FX.BLlit	D - Biotope
Fucus vesiculosus on mid eulittoral mixed substrata*	SLR.FX.FvesX	D - Biotope
Ascophyllum nodosum on mid eulittoral mixed substrata*	SLR.FX.AscX	D - Biotope
Ascophyllum nodosum ecad *mackaii* beds on extremely sheltered mid eulittoral mixed substrata*	SLR.FX.AscX.mac	E - Sub-biotope
Fucus serratus on lower eulittoral mixed substrata	SLR.FX.FserX	D - Biotope
Fucus serratus with sponges, ascidians and red seaweeds on tide-swept lower eulittoral mixed substrata*	SLR.FX.FserX.T	E - Sub-biotope
Ephemeral green and red seaweeds on variable salinity or	SLR.FX.EphX	D - Biotope

disturbed eulittoral mixed substrata		
Fucus ceranoides on reduced salinity eulittoral mixed substrata*	SLR.FX.FcerX	D - Biotope
***Mytilus* (mussel) beds (mixed substrata)**	SLR.MX	C - Biotope complex
Mytilus edulis beds on eulittoral mixed substrata*	SLR.MX.MytX	D - Biotope
Rockpools	LR.Rkp	C - Biotope complex
Green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in upper shore rockpools*	LR.Rkp.G	D - Biotope
Corallina officinalis and coralline crusts in shallow eulittoral rockpools*	LR.Rkp.Cor	D - Biotope
Coralline crusts and *Paracentrotus lividus* in shallow eulittoral rockpools	LR.Rkp.Cor.Par	D - Biotope
Bifurcaria bifurcata in shallow eulittoral rockpools*	LR.Rkp.Cor.Bif	E - Sub-biotope
Cystoseira spp. in shallow eulittoral rockpools*	LR.Rkp.Cor.Cys	E - Sub-biotope
Fucoids and kelps in deep eulittoral rockpools*	LR.Rkp.FK	D - Biotope
Sargassum muticum in eulittoral rockpools*	LR.Rkp.FK.Sar	E - Sub-biotope
Seaweeds in sediment (sand or gravel)-floored eulittoral rockpools	LR.Rkp.SwSed	D - Biotope
Hydroids, ephemeral seaweeds and *Littorina littorea* in shallow eulittoral mixed substrata pools*	LR.Rkp.H	D - Biotope
Overhangs and caves	LR.Ov	C - Biotope complex
Rhodothamniella floridula in upper littoral fringe soft rock caves	LR.Ov.RhoCv	D - Biotope
Sponges and shade-tolerant red seaweeds on overhanging lower eulittoral bedrock	LR.Ov.SR	D - Biotope
Sponges, bryozoans and ascidians on deeply overhanging lower shore bedrock	LR.Ov.SByAs	D - Biotope

ANNEX 2, BIOMAR biotope sheet

Barnacles and fucoids (moderately exposed shores)		
Code: MLR.BF	Habitat complex: Moderately exposed littoral rock	C - Biotope complex

Habitat classification

Salinity:	Full
Wave exposure:	Moderately exposed
Substratum:	Bedrock; boulders
Zone:	Eulittoral
Height band:	Upper shore, Mid shore, Lower shore

Biotope description

On moderately exposed rocky shores the extent of fucoid cover is typically less than that found on sheltered shores (SLR.F). The fucoids form a mosaic with barnacles on bedrock and boulders, rather than the blanket cover associated with sheltered shores, except for on the lower shore where there may be dense *Fucus serratus* (MLR.Fser). Beneath the band of lichens at the top of the shore (LR.YG and LR.Ver) the channel wrack *Pelvetia canaliculata* typically occurs overgrowing the black lichen *Verrucaria* spp. with sparse barnacles (MLR.PelB). Below, barnacles and limpets *Patella* may cover extensive areas of rock (ELR.BPat), particularly on steep or vertical rock. In the absence of ELR.BPat, the spiral wrack *Fucus spiralis* may occur (SLR.Fspi). On the mid shore the bladder wrack *Fucus vesiculosus* generally forms a mosaic with barnacles (MLR.FvesB). Finally, the serrated wrack *Fucus serratus*, dominates the lower shore (MLR.Fser); a number of sub-biotopes have been described: lower shore bedrock and boulders may be characterised by mosaics of *F. serratus* and turf-forming red algae (MLR.Fser.R); where the density of *F. serratus* is greater (typically common - superabundant) and the abundance of red algae less MLR.Fser.Fser should be recorded. The presence of boulders and cobbles on the shore can increase the micro-habitat diversity which often results in a greater species richness. Although the upper surface of the boulders may bear very similar communities to MLR.Fser.Fser there is often an increase in fauna (crabs, tube-worms, sponges and bryozoans) and MLR.Fser.Fser.Bo should be recorded.

Characterising species

Species	Typical abundance	Frequency	Faithfulness
Chthamalus montagui	Frequent	*	***
Semibalanus balanoides	Frequent	****	*

Patella vulgata	Frequent	****	*
Gibbula umbilicalis	Occasional	*	**
Melarhaphe neritoides	Frequent	*	**
Flustrellidra hispida	Occasional	*	**
Lomentaria articulata	Occasional	**	**
Membranoptera alata	Occasional	*	**
Leathesia difformis	Occasional	*	**
Ascophyllum nodosum	Occasional	*	**
Fucus serratus	Abundant	****	*
Pelvetia canaliculata	Frequent	*	**
Verrucaria maura	Common	*	**

Annex 3 EUNIS classification example

EUNIS Habitat classification : key

Program version : 2.2 : 08/03/2002 - **Data version** : 28/02/2002 for the key file - **Search date** : 30-06-2003

Search criteria :

- **Key level :** B - Coastal habitats

Search results :

Coastal habitats (B)

Note: coastal saltmarshes are categorised under A2.6

023 - Underlying substrate type Non-aquatic coastal habitats are divided on the basis of underlying substrate (which may be overlain with superficial deposits): *sand* substrates form coastal dune and sand habitats; *shingle* substrates form mobile or stable shingle beaches and banks; *rock* substrates (which include non-mobile boulders) comprise sea and coastal lagoon cliffs and rocky sea shores including the supra-littoral spray zone.		
sand = B1 - Coastal dune and sand habitats	*shingle* = B2 - Coastal shingle habitats	*rock* = B3 - Rock cliffs, ledges and shores, including the supralittoral

b01 - Wind-blown sand over peat? Machair (characterised by wind-blown calcareous sand with a predominance of shell fragments usually over peat, a low proportion of sand-binding vegetation and a long history of agricultural use) (path = *Yes*), is distinguished from other coastal sand habitats. Note that a machair complex is defined comprising units from B1, C and I.	
Yes = B1.9 - Machair	*No* = b02

b02 - Surface topography The topography of the surface distinguishes the abrupt mounds and hollows of sand *dunes* from *more or less level* sand beach habitats.	
dunes = b03	*more or less level* = b06

b03 - Humidity *Dry* sand dunes are distinguished from *moist or wet* dune slacks. Note that dune slack pools are categorised under C.	
dry = b04	*moist or wet* = B1.8 - Moist and wet dune slacks

b04 - Mobile?
Unvegetated mobile sand dunes (path = *Yes*) are separated from dunes which have become stabilised by vegetation.

Yes = B1.3 - Shifting coastal dunes	*No* = b05

b05 - Vegetation stratum
Predominant vegetation type is used to distinguish between: dune grassland (*herbs*); dune heath (predominantly ericaceous *dwarf shrubs*); dune scrub (*shrubs*); and dune woodland (*trees*).

herbs = B1.4 - Coastal stable dune grassland (grey dunes)	*dwarf shrubs* = B1.5 - Coastal dune heaths	*shrubs* = B1.6 - Coastal dune scrub	*trees* = B1.7 - Coastal dune woods

b06 - Above driftline?
Driftline habitats characterised by lines of wave-deposited organic material colonised by annual angiosperms are distinguished (path = *No*) from mobile sand beaches above the driftline. Note that freshly deposited driftlines characterised by marine invertebrates and without annual vegetation are included in A2.

Yes = B1.2 - Sand beaches above the driftline	*No* = B1.1 - Angiosperm communities of sand beach driftlines

b07 - Driftline?
Driftline habitats characterised by lines of wave-deposited organic material are distinguished (path = *Yes*) from mobile or stabilised shingle beaches above the driftline.

Yes = B2.1 - Shingle beach driftline habitats	*No* = b08

b08 - Vegetated?
Unvegetated mobile shingle beaches (path = *No*) are separated from more stable vegetated coastal shingle habitats.

Yes = b09	*No* = B2.2 - Unvegetated mobile shingle beaches above the driftline

b09 - Shingle fixed by vegetation?
Fixed shingle habitats with vegetation of grasses or heaths (path = *Yes*) are distinguished from more open communities dominated by other herbaceous species on substrates which may be more mobile.

Yes = b10	*No* = B2.3 - Upper shingle beaches with open vegetation

b10 - Vegetation stratum
Predominant vegetation type is used to distinguish between: shingle and gravel beach grassland, (*herbs*); shingle and gravel beach scrub (*shrubs*); and shingle and gravel beach woodland (*trees*).

herbs = B2.4 - Fixed shingle beaches, with herbaceous vegetation	*shrubs* = B2.5 - Shingle and gravel beaches with scrub vegetation	*trees* = B2.6 - Shingle and gravel beach woodland

b11 - Spray zone?
The lichen or spray zone above the high tide mark (or above the mean water level where non-tidal) (path = *Yes*) is distinguished from rock habitats not regularly affected by spray. Note that rock pools in the supralittoral are classified as enclaves of littoral rock pools.

Yes = B3.1 - Supralittoral rock (lichen or	*No* = b12

splash zone)	

b12 - Hard rock? Hard rock cliffs and ledges (path = *Yes*) are distinguished from cliffs of relatively soft, unconsolidated material.	
Yes = b13	*No* = B3.4 - Soft sea-cliffs, often vegetated

b13 - Vegetated? Unvegetated coastal hard rock cliffs and ledges (path =No) are separated from rocky habitats with halophytic angiosperms (path = *Yes*).	
Yes = B3.3 - Rock cliffs, ledges and shores, with halophytic angiosperms	*No* = B3.2 - Unvegetated rock cliffs, ledges, shores and islets

f24 - Usage Shrub plantations are separated on the basis of their usage: for *whole plant* harvesting, such as horticultural shrub nurseries; for *leaf or branch* harvest, such as osiers or tea; for ornamental purposes e.g. flowers, or fruit other than vines (path = *other fruit or ornamental*); vines, usually for wine production (path = *viticulture*).			
whole plant = FB.1 - Shrub plantations for whole-plant harvesting	*leaf or branch* = FB.2 - Shrub plantations for leaf or branch harvest	*other fruit or ornamental* = FB.3 - Shrub plantations for ornamental purposes or for fruit, other than vineyards	*viticulture* = FB.4 - Vineyards

Search criteria :

- **Habitat code :** B2

Search results :

B2 - Coastal shingle habitats

Beaches of the oceans, of their connected seas and of their associated coastal lagoons, covered by pebbles, or sometimes boulders, usually formed by wave action. (Source: Devillers, P., Devillers-Terschuren, J. and Vander Linden, C. (2001))

Higher level(s) : [B]

Relationship to other classifications

CORINE Land Cover

	3.3.1.	Beaches, dunes, and sand plains

HELCOM Baltic Sea Marine and Coastal Biotopes 1996

<	03.03.02	Beach ridges: beach ridges consisting of gravel pebbles and/or boulders

Ramsar wetland types

>	E	Sand, shingle or pebble shores

Barcelona Convention, December 1998

=	I.3.	(SUPRALITTORAL) STONES AND PEBBLES

Biodiversity Broad Habitat Classification (UK)

>	19	Supralittoral sediment
Palaearctic classification, 10 December 2001		
=	17	Shingle beaches
Lower levels :		
Access to the key :		

Search results :

Levels displayed on the list : [2] [3] [4] [5] [6] [all levels]

Higher level(s) : [B]

B2 - Coastal shingle habitats
B2.1 - Shingle beach driftline habitats
B2.2 - Unvegetated mobile shingle beaches above the driftline
B2.3 - Upper shingle beaches with open vegetation
B2.4 - Fixed shingle beaches, with herbaceous vegetation
B2.5 - Shingle and gravel beaches with scrub vegetation
B2.6 - Shingle and gravel beach woodland
Access to hierarchy for : [A] [B] [C] [D] [E] [F] [G] [H] [I] [J]

Search criteria :

- **Habitat code :** B2.1

Search results :

Levels displayed on the list : [3] [4] [5] [6] [all levels]

Higher level(s) : [B] [B2]

B2.1 - Shingle beach driftline habitats
B2.11 - Boreo-arctic gravel beach annual communities
B2.12 - Atlantic and Baltic shingle beach drift lines
B2.13 - Gravel beach communities of the mediterranean region
B2.14 - Biocenosis of slowly drying wracks
Access to hierarchy for : [A] [B] [C] [D] [E] [F] [G] [H] [I] [J]

Search criteria :

- **Habitat code :** B2.12

Search results :

B2.12/P-17.22 - Atlantic and Baltic shingle beach drift lines

"Formations, predominantly of annuals, occupying accumulations of drift material and gravels rich in nitrogenous organic matter on nemoral and boreonemoral beaches of the Atlantic, the North Sea and the Baltic; characteristic are [Cakile maritima] ssp. [maritima], [Cakile maritima] ssp. [baltica], [Salsola kali], [Atriplex spp.] (particularly [Atriplex glabriuscula]), [Polygonum spp.], [Euphorbia peplis], [Mertensia maritima], [Glaucium flavum]. " (Source: Devillers, P., Devillers-Terschuren, J. and Vander Linden, C. (2001))

Higher level(s) : [B] [B2] [B2.1]

Relationship to other classifications

Nordic classification 1994

	4.2.1.4	Orache-Knotgrass type

CORINE Land Cover

	3.3.1.	Beaches, dunes, and sand plains

Palaearctic classification, 10 December 2001

=	17.22	Atlantic shingle beach drift lines

Legal status

1210	**Habitats Directive/FFH** - Annual vegetation of drift lines

ANNEX 4 Description of BioMar biotope complexes	**Biotope complex**	**Salinity**	**Wave exposure**	**Tidal stream**	**Substratum**	**Bio-subzone**	**Height& Depth**
Alcyonium-dominated communities (tide-swept/vertical)	ECR.Alc	2	3,4	2,3	1,3	10,11	7,8,9
Barnacle, cushion sponge and Tubularia communities (very tide-swept/sh	ECR.BS	2,3	3,4,5,6	1,2	1,3	10,11	6,7,8
Faunal crusts or short turfs (wave-exposed rock)	ECR.EFa	2	1,2,3	3,4,5	1,3	10,11	7,8,9
Robust faunal cushions and crusts (surge gullies and caves)	EIR.SG	2	1,2,3	4,5	1,2,6,7	7,8,9	5,6
Robust fucoids or red seaweeds	ELR.FR	2	1,2,3		1	4,5,6	2,3,4
Mytilus (mussels) and barnacles	ELR.MB	2	4		1,3,4	4,5,6	2,3,4
Estuarine sublittoral gravels and sands	IGS.EstGS	3,4	5,6,7	1,2,3	8,13	8,9	5,6,7
Shallow gravel faunal communities	IGS.FaG	2	3,4,5	2,3,4	8	8,9	5,6,7
Shallow sand faunal communities	IGS.FaS	2	2,3,4,5	2,3,4,5	13	8,9	5,6,7
Maerl beds (open coast/clean sediments)	IGS.Mrl	2,3	3,4,5	1,2,3,4,5	8,13	8,9	5,6,7
Shallow muddy sand faunal communities	IMS.FaMS	2,3	4,5,6	4,5	16,17	8,9	5,6,7
Seagrass beds (sublittoral/lower shore)	IMS.Sgr	2,3,4	4,5,6,7	4,5	16,17	8,9	4,5,6
Angiosperm communities (lagoons)	IMU.Ang	4	7	4,5	17	8,9	5
Estuarine sublittoral muds	IMU.EstMu	3,4	5,6,7	3,4,5	17	8,9	5,6,7
Shallow marine mud communities	IMU.MarMu	2	6,7	4,5	17	8,9	5,6,7
Laminaria saccharina (sugar kelp) and filamentous seaweeds (mixed sedi	IMX.KSwMx	2,3,4	5,6,7	3,4,5	25	8,9	5,6
Estuarine coarse sediment shores	LGS.Est	3,4	6,7	1,2,3	7,8,14	1,2,3,4,5,	1,2,3,4
Sand shores	LGS.S	2,3	3,4,5		13	1,2,3,4,5,6	1,2,3,4
Shingle (pebble) and gravel shores	LGS.Sh	2	2,3,4		7,8	1,2,3,4,5,6	1,2,3,4
Muddy sand shores	LMS.MS	2,3	5,6		16,17	1,2,3,4,5,6	1,2,3
Littoral Zostera (seagrass) beds	LMS.Zos	2,3	5,6		16,17	4,5,6	2,3
Soft mud shores	LMU.Mu	3,4	5,6,7		17	1,2,3,4,5,6	1,2,3,4
Saltmarsh	LMU.Sm	3,4	6,7		16,17	1,2,3	1
Sandy mud shores	LMU.SMu	2,3,4	6,7		16,17	1,2,3,4,5,6	1,2,3,4
Lichens or algal crusts	LR.L	2,3	2,3,4,5,6		1,2,6	1,2,3	2
Overhangs and caves	LR.Ov	2,3	2,3,4		1	2,3,4,5,6	2,3,4
Rockpools	LR.Rkp	2,3	2,3,4,5		1	1,2,3,4,5,6	2,3,4

Grazed kelp with algal crusts	MIR.GzK	2	4,5	4,5	1,3,4,5,6	7,8,9	5,6,7
Kelp with red seaweeds (moderately exposed rock)	MIR.KR	2	3,4,5	3,4,5	1,3,4	7	4,5
Barnacles and fucoids (moderately exposed shores)	MLR.BF	2	4		1,3,4	4,5,6	2,3,4
Ephemeral green or red seaweeds (freshwater or sand-influenced)	MLR.Eph	2	4,5		1,3,4	3,4,5,6	2,3,4
Mytilus (mussels) and fucoids (moderately exposed shores)*	MLR.MF	2	4	3,4	1,3,4	5,6	3,4
Red seaweeds (moderately exposed shores)*	MLR.R	2	4		1,3,4	5,6	3,4
Littoral Sabellaria (honeycomb worm) reefs*	MLR.Sab	2	3,4		1,2,6,7,8,1	5,6	3,4
Silted kelp (stable rock)	SIR.K	2,3	5,6,7	3,4,5	1,2,6,25	7,8,9	5,6,7
Submerged fucoids, green and red seaweeds (lagoonal rock)	SIR.Lag	4	7	4,5	25	8,9	5
Dense fucoids (stable rock)	SLR.F	2,3	5,6,7		1,2,6	4,5,6	2,3,4
Fucoids, barnacles or ephemeral seaweeds (mixed substrata)	SLR.FX	2,3	5,6,7		2,6,7	4,5,6	3,4
Mytilus (mussel) beds (mixed substrata)	SLR.MX	2,3	4,5,6		2,6,7	5,6	3,4

Yellow cells indicate originally missing data, values that are filled in are based on expert judgement

ANNEX 5 Description of BioMar biotopes	Biotope	Salinity	Wave exposre	Tidal stream	Substratu m	Bio-subzone	Height& Depth
Venerid bivalves in circalittoral coarse sand or	CGS.Ven	2	3,4	3,4	8,14,18	10,11	8,9
Balanus crenatus, Halichondria panicea and Al	ECR.BS.BalHpan	3	5,6	1	1	10,11	6,7
Balanus crenatus and Tubularia indivisa on ext	ECR.BS.BalTub	2	4,5	1	1	10,11	6,7
Cushion sponges, hydroids and ascidians on ti	ECR.BS.CuSH	3	6,7	2,3	1,3	10,11	5,6,7
Halichondria bowerbanki, Eudendrium arbuscul	ECR.BS.HbowEud	4	6	2,3	1,2,6,7	10,11	6,7
Tubularia indivisa, sponges and other hydroids	ECR.BS.TubS	2	3	1,2	1,3	10,11	7
Coralline crusts, Parasmittina trispinosa, Cary	ECR.EFa.CCParCar	2	2,3	3,4,5	1,3	10,11	8,9
Corynactis viridis and a crisiid/Bugula/Cellaria t	ECR.EFa.CorCri	2	2,3	2,3,4	1,3	10,11	8,9
Pomatoceros triqueter, Balanus crenatus and	ECR.EFa.PomByC	2	2,3,4	2,3,4.5	6,7,13	10,11	8,9
Alaria esculenta on exposed sublittoral fringe b	EIR.KFaR.Ala	2	1,2,3	3,4	1,3	7	4,5
Alaria esculenta forest with dense anemones a	EIR.KFaR.AlaAnSC	2	1	4	1	8,9	7,8,9
Foliose red seaweeds on exposed or moderate	EIR.KFaR.FoR	1	2,3,4	3,4	1,3	9	6,7,8
Laminaria hyperborea forest with a faunal cushi	EIR.KFaR.LhypFa	2	1,2,3	3,4	1,3	8	5,6,7
Sparse Laminaria hyperborea and dense Parac	EIR.KFaR.LhypPar	2	2	5	1	8	5,6
Laminaria hyperborea with dense foliose red se	EIR.KFaR.LhypR	2	2,3	3,4	1,3	8,9	5,6,7
Laminaria saccharina and/or Saccorhiza polys	EIR.KFaR.LsacSac	1	2,3,4	3,4	1,2,6	8,9	5,6,7,8
Foliose seaweeds and coralline crusts in surge	EIR.SG.FoSwCC	2	1,2,3	5	1,2,6	8,9	5,6
Sponge crusts on extremely wave-surged infral	EIR.SG.SC	2	2,3	4,5	1,3	7,8	5,6
Sponge crusts and anemones on wave-surged	EIR.SG.SCAn	2	2,3		1	8,9	5,6
Sponge crusts and colonial ascidians on wave-	EIR.SG.SCAs	2	2,3,4	4,5	1	8	5
Corallina officinalis on very exposed lower eulitt	ELR.FR.Coff	2	2,3,4	3,4,5	1	6	3,4
Fucus distichus and Fucus spiralis f. nana on	ELR.FR.Fdis	2	1		1	3,4	2
Himanthalia elongata and red seaweeds on ex	ELR.FR.Him	2	3,4		1	6	3,4
Barnacles and Patella spp. on exposed or mod	ELR.MB.BPat	2	3,4	3,4	1,3	4,5	3
Mytilus edulis and barnacles on very exposed	ELR.MB.MytB	2	4	3	1,3,4	6	3,4
Sparse fauna in reduced salinity infralittoral mo	IGS.EstGS.MobRS	4	5,6,7	1,2,3	16	8,9	5,6
Nephtys cirrosa and fluctuating salinity-tolerant	IGS.EstGS.Ncir	4	4,5	2,3	13	8,9	5,6

Neomysis integer and Gammarus spp. in low s	IGS.EstGS.NeoGam	4	6,7	2,3	13	8,9	5,6
Halcampa chrysanthellum and Edwardsia timid	IGS.FaG.HalEdw	2	4,5	3,4	7,9	8,9	6,7
Spisula elliptica and venerid bivalves in infralitto	IGS.FaG.Sell	2	3	2,3,4	10,14	8,9	5,6,7,8
Fabulina fabula and Magelona mirabilis with ve	IGS.FaS.FabMag	2	4,5	4	16	8,9	5,6,7,8
Dense Lanice conchilega and other polychaete	IGS.FaS.Lcon	2	5,6,7	2,3	14	8,9	5,6,7
Sparse fauna in infralittoral mobile clean sand	IGS.FaS.Mob	2	2,3	3,4	14	8,9	5,6
Nephtys cirrosa and Bathyporeia spp. in infralit	IGS.FaS.NcirBat	2	2,3,4	2,3,4	15,16	8,9	5,6,7,8
Sertularia cupressina and Hydrallmania falcata	IGS.FaS.ScupHyd	2	4,5	2,3	7,14	8,9	7,8,9
Lithothamnion glaciale maerl beds in tide-swep	IGS.Mrl.Lgla	3	5,6	3	9,11,12	8,9	5,6
Phymatolithon calcareum maerl beds in infralitt	IGS.Mrl.Phy	2	4	3,4	11,14	8,9	5,6,7,8
Capitella capitata in enriched sublittoral muddy	IMS.FaMS.Cap	2,3	5,6,7	4	17	8,9,10,11	5,6,7,8,9,1
Echinocardium cordatum and Ensis spp. in lo	IMS.FaMS.EcorEns	2	4,5	4,5	15,16,17	8,9	4,5,6,7
Macoma balthica and Abra alba in infralittoral	IMS.FaMS.MacAbr	2	5	4	16,17	8,9	5,6,7,8
Spio filicornis and Spiophanes bombyx in infral	IMS.FaMS.SpiSpi	2	4,5	4	16,17	8,9	6,7,8
Ruppia maritima in reduced salinity infralittoral	IMS.Sgr.Rup	3,4	7	5	16,17	8,9	5
Zostera marina/angustifolia beds in lower shore	IMS.Sgr.Zmar	2	5,6,7	4,5	13,17	8,9	4,5
Potamogeton pectinatus community*	IMU.Ang.NVC A12	4	7,8	5	17	7,8,9	5
Phragmites australis swamp and reed beds	IMU.Ang.NVC S4	4	7,8	5	15,13,25	8	5
Aphelochaeta marioni and Tubificoides spp. in	IMU.EstMu.AphTub	3	5,6,7	3,4	17	8,9	5,6
Capitella capitata and Tubificoides spp. in redu	IMU.EstMu.CapTub	4	5,6,7	3,4,5	17	8,9	5,6
Limnodrilus hoffmeisteri, Tubifex tubifex and G	IMU.EstMu.LimTtub	4	6,7	4,5	17	8,9	5
Infralittoral fluid mobile mud	IMU.EstMu.MobMud	3,4	5,6,7	2,3	17	8,9	5,6
Nephtys hombergii and Tubificoides spp. in vari	IMU.EstMu.NhomTub	3	5,6,7	3,4,5	16,17	8,9	5,6,7
Polydora ciliata in variable salinity infralittoral fi	IMU.EstMu.PolVS	3	4,5,6	3,4	25	8,9	5,6
Tubificoides spp. in reduced salinity infralittoral	IMU.EstMu.Tub	4	5,6,7	3,4	17	8,9	5,6
Arenicola marina and synaptid holothurians in	IMU.MarMu.AreSyn	2	7	4,5	17	8,9	5
Ocnus planci aggregations on sheltered sublitt	IMU.MarMu.Ocn	2	6	4,5	9,10	8,9,10	5,6,7
Philine aperta and Virgularia mirabilis in soft st	IMU.MarMu.PhiVir	2	6,7	5	17	8,9	6,7
Semi-permanent tube-building amphipods and	IMU.MarMu.TubeAP	2,3	5,6	4	16,17	8,9,10,11	6,7,8,9,10
Crepidula fornicata and Aphelochaeta marioni i	IMX.EstMx.CreAph	3	6,7	3,4,5	25	8,9	5,6,7

Mytilus edulis beds on variable salinity infralitto	IMX.EstMx.MytV	3	5	3,4	25	8,9	5,6
Polydora ciliata, Mya truncata and solitary asc	IMX.EstMx.PolMtru	3	5,6	3	25	8,9	5,6,7
Burrowing anemones in sublittoral muddy grav	IMX.FaMx.An	2	5,6	3,4	8	8,9	7,8
Limaria hians beds in tide-swept sublittoral mu	IMX.FaMx.Lim	2	5,6	3,4	8,13	8,9,10,11	6,7,8
Venerupis senegalensis and Mya truncata in lo	IMX.FaMx.VsenMtru	2,3	5,6,7	4	8	8,9	4,5
Filamentous green seaweeds on low salinity in	IMX.KSwMx.FiG	4	7	5	8,13	8,9	5
Laminaria saccharina, Chorda filum and filame	IMX.KSwMx.LsacX	2,3	5,6,7	3,4,5	17	8,9	5,6
Loose-lying mats of Phyllophora crispa on infra	IMX.KSwMx.Pcri	2	5,6	5	8,13	8,9	7
Mats of Trailliella on infralittoral muddy gravel	IMX.KSwMx.Tra	2	6,7	5	8,13	8,9	5,6
Lithothamnion corallioides maerl beds on infrali	IMX.MrlMx.Lcor	2	5,6	4	11,12	8,9	5,6
Lithophyllum dentatum maerl beds on infralittor	IMX.MrlMx.Lden	2	5,6	4,5	11,12,17	8,9	5
Lithophyllum fasciculatum maerl beds with Chl	IMX.MrlMx.Lfas	2	5	4	8,17	8,9	5,6
Ostrea edulis beds on shallow sublittoral mudd	IMX.Oy.Ost	2	5,6,7	4,5	10,16	8,9	5,6
Alcyonium digitatum with a bryozoan, hydroid	IR.FaSwV.AlcByH	2	3,4	3,4	1	8,9	5,6
Corynactis viridis, Metridium senile and Alcyon	IR.FaSwV.CorMetAlc	2	2,3,4	3,4	1	8,9	6,7
Oligochaetes in reduced or low salinity gravel o	LGS.Est.Ol	4	5,6,7	2,3	8,14	4,5,6	3,4
Burrowing amphipods and Eurydice pulchra in	LGS.S.AEur	2	3,4		15	4,5,6	2,3,4
Burrowing amphipods and polychaetes in clea	LGS.S.AP	2	3,4		15,16	4,5,6	3,4
Barren coarse sand shores	LGS.S.BarSnd	2	3,4		14,15	1.2.3.4.5.6	1,2,3,4
Dense Lanice conchilega in tide-swept lower s	LGS.S.Lan	2,3	4,5,6	2,3	15,16	4,5,6	3,4
Talitrid amphipods in decomposing seaweed o	LGS.S.Tal	2	3,4,5,6		8,13	1	1
Barren shingle or gravel shores*	LGS.Sh.BarSh	2	3,4		6,7,8	1,2,3,4,5,6	2,3,4
Pectenogammarus planicrurus in mid shore we	LGS.Sh.Pec	2,3	4		8,14	4,5,6	2,3
Bathyporeia pilosa and Corophium spp. in upp	LMS.MS.BatCor	3	4,5,6		16,17	4,5,6	2,3
Macoma balthica and Arenicola marina in mud	LMS.MS.MacAre	2,3	4,5,6		16,17	4,5,6	2,3,4
Polychaetes and Cerastoderma edule in fine s	LMS.MS.PCer	2	4,5		16,17	4,5,6	2,3
Zostera noltii beds in upper to mid shore mudd	LMS.Zos.Znol	2,3	5,6,7		16,17	4,5,6	2,3
Hediste diversicolor and oligochaetes in low sa	LMU.Mu.HedOl	4	7		17	2,3,4,5,6	2,3,4
Hediste diversicolor and Scrobicularia plana in	LMU.Mu.HedScr	3,4	5,6,7		17	4,5,6	2,3,4
Hediste diversicolor and Streblospio shrubsolii	LMU.Mu.HedStr	3,4	6,7		17	4,5,6	3,4

Salicornia spp.*	LMU.Sm.NVC SM8	3,4	6,7		17	1,2,3	1,2
Hediste diversicolor and Macoma balthica in s	LMU.SMu.HedMac	2,3	5,6		16,17	4,5,6	3,4
Mya arenaria and polychaetes in muddy gravel	LMX.Mare	4	6		25	4,5,6	3,4
Mytilus edulis and Fabricia sabella on poorly-s	LMX.MytFab	2	5,6,7		7,8,14	2,3,4,5,6	2,3,4
Blidingia spp. on vertical littoral fringe soft rock	LR.L.Bli	2	4	3	1	2,3	2
Chrysophyceae on vertical upper littoral fringe	LR.L.Chr	2,3	4	3	1	2,3	2
Prasiola stipitata on nitrate-enriched supralittor	LR.L.Pra	2	3,4		1	1,2,3	2
Ulothrix flacca and Urospora spp. on freshwate	LR.L.UloUro	2	4		1	2,3	2
Verrucaria maura on littoral fringe rock	LR.L.Ver	2,3	2,3,4,5,6		1,3	2,3	2
Yellow and grey lichens on supralittoral rock*	LR.L.YG	2,3	2,3,4,5,6		1,3	1	1
Laminaria digitata on moderately exposed or ti	MIR.KR.Ldig	2	3,4,5	3,4,5	1,2	7	5
Laminaria hyperborea and foliose red seaweed	MIR.KR.Lhyp	2	3		1,2	8,9	5,6,7
Ephemeral red seaweeds and kelps on tide-sw	MIR.SedK.EphR	2	3,4	3	5,6,7,8	8,9	6,7
Halidrys siliquosa and mixed kelps on tide-swe	MIR.SedK.HalXK	2	4	3,4	1,2,6	8,9	5,6,7
Laminaria saccharina, Chorda filum and dense	MIR.SedK.LsacChoR	2	4	3	2,6,7	8	5
Polyides rotundus, Ahnfeltia plicata and Chond	MIR.SedK.PolAhn	2	3,4	3,4	1,6,7	8,9	6
Sabellaria spinulosa with kelp and red seawee	MIR.SedK.SabKR	2	4,5,6	3,4	1,2	8,9	6
Saccorhiza polyschides and other opportunisti	MIR.SedK.Sac	2	4,5	3,4	1,2	7,8	5
Mixed kelps with scour-tolerant and opportunis	MIR.SedK.XKScrR	2	3,4	3,4	1,2	8,9	5,6,7
Fucus serratus on moderately exposed lower e	MLR.BF.Fser	2	4	3,4	1,3,4	6	4
Fucus vesiculosus and barnacle mosaics on m	MLR.BF.FvesB	2	3,4		1,3,4	5	4
Pelvetia canaliculata and barnacles on modera	MLR.BF.PelB	2	4		1,3,4	3	2
Enteromorpha spp. on freshwater-influenced or	MLR.Eph.Ent	2	2,3,4,5	4	1,2,17	3,4	2
Porphyra purpurea or Enteromorpha spp. on sa	MLR.Eph.EntPor	2,3	4		1,3,4	4,5,6	3
Rhodothamniella floridula on sand-scoured low	MLR.Eph.Rho	2	4,5,6	3,4	1,3,4	6	4
Mytilus edulis, Fucus serratus and red seawee	MLR.MF.MytFR	2	4		1,3,4	6	4
Mytilus edulis and Fucus vesiculosus on mode	MLR.MF.MytFves	2	3,4		1,3,4	5	3
Mytilus edulis and piddocks on eulittoral firm cl	MLR.MF.MytPid	2	3,4		25	4,5,6	4
Mastocarpus stellatus and Chondrus crispus o	MLR.R.Mas	2	2,3,4		1,3,4	6	4
Osmundea (Laurencia) pinnatifida and Gelidiu	MLR.R.Osm	2	3,4		1,3,4	5	4

Palmaria palmata on very to moderately expos	MLR.R.Pal	2	2,3,4		1,3,4	6	4
Ceramium sp. and piddocks on eulittoral fossili	MLR.R.RPid	2	4		25	4,5,6	4
Mixed red seaweeds on moderately exposed l	MLR.R.XR	2	3,4		1,3,4	6	3,4
Sabellaria alveolata reefs on sand-abraded eulit	MLR.Sab.Salv	2	3,4		2,6,7,8,13	5,6	3,4
Cordylophora caspia and Electra crustulenta o	SIR.EstFa.CorEle	4	6,7	2,3	1,2	8,9	5
Hartlaubella gelatinosa and Conopeum reticulu	SIR.EstFa.HarCon	4	6,7	3	1,2,25	8,9	5
Mytilus edulis beds on reduced salinity tide-sw	SIR.EstFa.MytT	4	6,7	2	1,2	8,9	5
Echinus, brittlestars and coralline crusts on gr	SIR.K.EchBriCC	2	5,6	3,4,5	1,2,6	9	6,7
Mixed Laminaria hyperborea and Laminaria sa	SIR.K.LhypLsac	2	5	4,5	1,2	8,9	5
Laminaria saccharina on very sheltered infralitt	SIR.K.Lsac	2,3	6	4,5	1,2	8,9	5
Laminaria saccharina on reduced or low salinit	SIR.K.LsacRS	4	6,7	4,5	1,2	8,9	5
Ascophyllum nodosum with epiphytic sponges	SIR.Lag.AscSAs	4	7	4,5	1,2,6	8,9	5
Fucus ceranoides and Enteromorpha spp. on l	SIR.Lag.FcerEnt	4	7	5	1,2,6,25	8,9	5
Mixed fucoids, Chorda filum and green seawee	SIR.Lag.FChoG	4	7	5	1,2,6,7	8,9	5
Polyides rotundus and/or Furcellaria lumbricali	SIR.Lag.PolFur	4	6,7	5	1,2,6,7	8,9	5
Ascophyllum nodosum on very sheltered mid e	SLR.F.Asc	2,3	5,6,7		1,3	5	3
Ascophyllum nodosum, sponges and ascidian	SLR.F.Asc.T	2,3	5,6,7		1,2,6	5	3
Fucus ceranoides on reduced salinity eulittoral	SLR.F.Fcer	3,4	6,7		1,3	2,3,4	3,4
Fucus serratus on sheltered lower eulittoral roc	SLR.F.Fserr	2,3	5,6,7		1,3	6	4
Fucus spiralis on moderately exposed to very	SLR.F.Fspi	2,3	4,5,6,7		1,2,6	4	4
Fucus vesiculosus on sheltered mid eulittoral r	SLR.F.Fves	2,3	5,6,7		1,3	5	3
Pelvetia canaliculata on sheltered littoral fringe	SLR.F.Pel	2,3	5,6,7		1,2,6	3	2
Ascophyllum nodosum on mid eulittoral mixed	SLR.FX.AscX	2,3	5,6		2,6,7	5	3
Barnacles and Littorina littorea on unstable euli	SLR.FX.BLlit	2,3	5,6,7		2,6,7	4,5,6	3,4
Ephemeral green and red seaweeds on variabl	SLR.FX.EphX	3	5,6,7		2,6,7	4,5,6	3
Fucus ceranoides on reduced salinity eulittoral	SLR.FX.FcerX	3,4	5,6,7	3,4,5	25	3,4,5,6	2,3,4
Fucus serratus on lower eulittoral mixed substr	SLR.FX.FserX	2,3	5,6,7		2,6,7	6	4
Fucus vesiculosus on mid eulittoral mixed sub	SLR.FX.FvesX	2,3	5,6,7	4,5	2,6,7	4,5,6	3,4
Mytilus edulis beds on eulittoral mixed substra	SLR.MX.MytX	2,3	5,6,7	2,3,4	2,6,7	5,6	4

Yellow cells indicate originally missing data, values that are filled in are based on expert judgement