IDENTIFICATION OF SEABED INDICATOR SPECIES TO SUPPORT IMPLEMENTATION OF THE EU HABITATS AND WATER FRAMEWORK DIRECTIVES

Second edition

Keith Hiscock
Olivia Langmead
Richard Warwick
Anna Smith

This report completes literature reviews. Additions, errors and omissions should be drawn to the attention of the first author: khis@mba.ac.uk

Report to the Joint Nature Conservation Committee and the Environment Agency

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The species included in this report and the environmental pressures (factors) linked to them can be selectively accessed from http://www.marlin.ac.uk/indicatorsp

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Reference:

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SUMMARY

Significant progress has been made in recent years to identify indices of pollution in the marine environment based on reviews of information in published papers and reports. The EU Water Framework Directive has provided a recent imperative to identify biological (as well as physical and chemical) data that will inform the development of measures of quality. The measures need to relate to a range of ‘Pressures’ so that cause and effect can be assessed. It is the matching of information sources to different Pressures (Environmental factors) which has been at the centre of the study described here.

The area included is the north-east Atlantic, predominantly estuarine and nearshore habitats.

The seabed Indicators research was undertaken as a follow-on to the review of time-series studies (Hiscock & Kimmance 2004: see http://www.marlin.ac.uk/time_series_metadata for report and interactive access to the database).

One hundred and twenty-five papers or reports have been identified that list species which increase or decrease or that are considered intolerant to or favoured by different pressures/environmental factors. The publications have been inspected and the results tabulated for each of the main Pressures identified by the Environment Agency. Those Pressures have been matched to ‘Environmental factors’ used in the Marine Life Information Network (*MarLIN*) programme to assess sensitivity of species to perturbation and the *MarLIN* database has been queried to provide tabulated information on intolerance and sensitivity (sensitivity = intolerance and recovery potential) for species that have been researched by *MarLIN*. The various terms and measures used to record degree of tolerance/intolerance for each species against researched pressures/factors have been rationalised into ‘Highly Intolerant’, ‘Intolerant’, ‘Neutral’, ‘Favoured’, ‘Highly Favoured’.

The information located in the literature has been entered to a Microsoft Access database identifying the response of 533 taxa to seven Pressures, 15 Environmental factors and a general category for industrial effluents including sewage and metals. A Web ‘front-end’ has been designed to provide selective access to the information in the database (http://www.marlin.ac.uk/indicatorspp).

Whilst adding significantly to the availability of information about likely indicator species in relation to particular Pressures, few species are identified more than once or twice as responding to a particular Pressure and few Pressures have a large number of potential indicators identified. However, there is a significant amount of information available for physical disturbance, organic enrichment and hydrocarbon contamination.

Information should continue to be added to the database.

Some ‘Pressures’ need better definition so that they relate more precisely to particular factors or so that there is clarification for increases and decreases.

The *MarLIN* database fields (and associated Web pages) should be modified to make them more relevant to the Water Framework Directive and to take advantage of information obtained in the course of undertaking the work described in this report.

Readers of the report are invited to draw attention to relevant publications not included or to information about potential indicators based on their own knowledge.

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1. INTRODUCTION

This report is adapted from Hiscock *et al.* (2004) following further research especially into hard substratum species and the development of the database to access information.

Box 1

Terms used in this report

1. Terms used by OSPAR and ICES in relation to biological indicators:

The terms have been developed especially in relation to ecosystem effects of fisheries.

EcoQ: Ecological Quality. EcoQ of surface waters is an overall expression of the structure and function of aquatic systems, taking account of the biological community and natural physiographic and climatic factors as well as physical and chemical conditions including those resulting from human activities.

EcoQO: Ecological Quality Objective. EcoQO is the desired level of EcoQ relative to the EcoQ reference level (the level of EcoQ where anthropogenic influence on the ecological system is minimal).

Fragile species: Sessile and slow-moving species, often characterised by rigid bodies or tubes that are particularly sensitive [*sic*] to physical damage.

Sensitive species: A species easily depleted by a human activity, and/or if affected is expected to only recover over a very long period, or not at all.

Opportunistic species: Species with early maturation, high fecundity and a high colonisation potential achieved through intrinsic long-distance dispersal and a high reproductive rate. These characteristics allow for colonising habitats of a temporary nature often created through physical disturbance.

Scavenger species (invertebrates): Opportunistic feeders that respond to chemical signals and are mobile over scales of tens of metres.

2. The following definition of 'intolerance' is from the *MarLIN* Web pages:

Intolerance is the susceptibility of a habitat, community or species (i.e. the components of a biotope) to damage, or death, from an external factor. Intolerance must be assessed relative to change in a specific factor.

This introduction draws attention to existing and known forthcoming information resources that can be used to identify marine indicator species. In freshwater biology, there has long been a tradition of using species composition to indicate water quality. The 'RIVPACS' programme is a commercially available methodology for identifying water quality from the organisms present in a stream (see, for instance, Wright *et al*., 2000). In marine biology, the idea that indicator species could be used to identify pollution-induced change has been discussed for many years (see, for instance, Gray & Pearson, 1982). The indicator species approach was greatly encouraged by the work of Pearson & Rosenberg (1978) on organic pollution gradients (Figure 1) but identifying a sound suite of indicator species for marine water quality in general, let-alone developing something like RIVPACS has proved difficult. COASTPACS/MARINPACS (Allen, in press) is similar to RIVPACS for sediment benthos and aims to identify predicted community at a location and compare it to the actual community present.

Nevertheless, significant progress has been made in recent years especially by Ángel Borja and colleagues (see, for instance Borja *et al.*, 2000; 2004) in developing the AZTI Marine Biotic Index (AMBI). Borja *et al*. (2000) identified five ecological groups related to the degree of sensitivity/tolerance to an environmental stress gradient (Figure 2) and, by analysing data from a wide range of soft-bottom benthos in a variety of locations including polluted or disturbed situations, listed a large number of species assigned with their ecological group. AMBI is also available on the Internet to enable analysis of any suitable dataset to identify degree of 'pollution'. The Marine Life Information Network (*MarLIN*) Web pages provide an assessment of intolerance and of sensitivity for species based on a review of literature. Sensitivity is assessed in relation to 24 environmental factors. A new index (the Swedish 'Species Tolerance Values' (E5O $_{0.05}$)) was made available at the ICES Study Group on EcoQO's for Sensitive and for Opportunistic Benthos Species (SGSOBS) workshop in Copenhagen on 22-24 March 2004 (see Box 2).

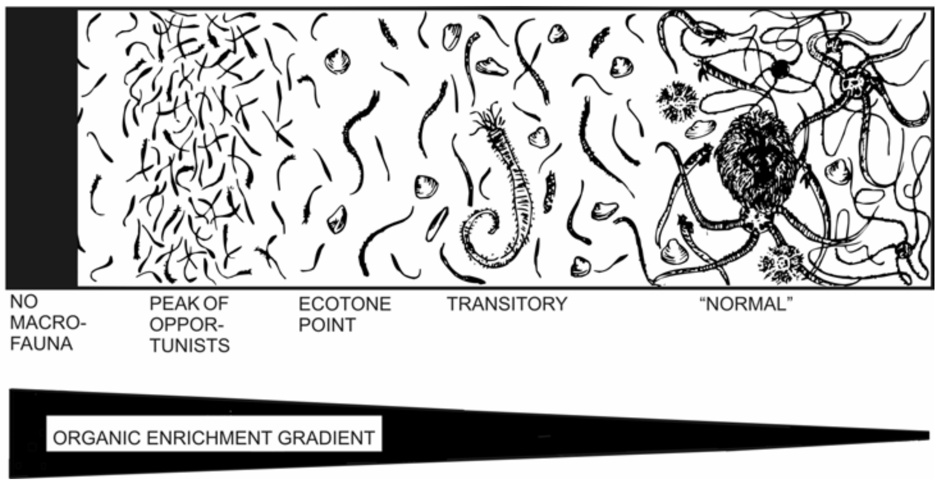

Figure 1. Diagrammatic representation of changes in abundance and species types along a generalised organic enrichment gradient (from Pearson & Rosenberg, 1978).

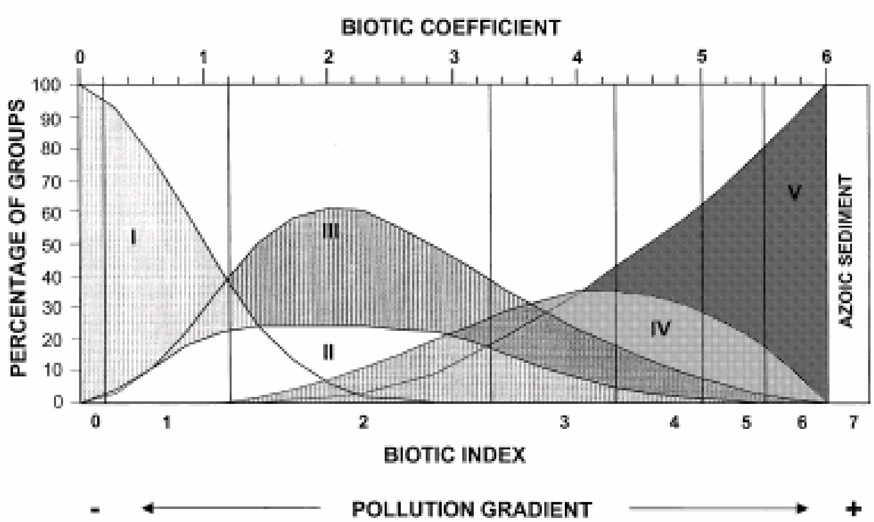

Figure 2. Theoretical model from Borja *et al.* 2000) that divides the ordination of soft-bottom macrofauna species into five ecological groups (Group I: very sensitive species; Group II: indifferent species; Group III: tolerant species; Group IV: second-order opportunistic species; Group V: first-order opportunistic species), according to their sensitivity to an increasing pollution gradient.

The study described in this report identifies potential indicator species from published literature. The basic presumption in undertaking the work is that the presence of species at a location is encouraged or discouraged by the environmental factors prevalent at that location. Those factors may be:

1. natural, resulting in the presence of a particular community and a certain species richness, and
2. unnatural (brought about by human activities), resulting in a modification of the expected natural communities.

For the purposes of identifying the ‘quality’ or ‘health’ of a community, it will be any effects of chronic (frequent or continuous) disturbance and pollution that are most important to assess. Studies are often of one-off events such as oil spills or of experimental trawling and extrapolating to likely long-term impacts or to frequent or continuous disturbance or pollution is usually difficult. However, sensitive indicators may only require single or episodic exposure; for instance to cause imposex. In the case of frequent or continuous application of a factor, *MarLIN* Biology and Sensitivity Key Information research should identify potential indicator species as ‘High’ Intolerance (i.e. likely to be killed by the factor). In the case of one-off events that cause long-lasting adverse effects, *MarLIN* Biology and Sensitivity Key Information research should identify potential indicator species as ‘High’ or ‘Very High’ Sensitivity (i.e. likely to be killed and unlikely to recover for in excess of respectively ten or 25 years or not at all).

However, variability in environmental conditions from day-to-day, season-to-season and year-to-year creates fluctuations in the abundance and distribution of component species in a community – resulting in what is sometimes called “dynamic stability”. Such variability can result in temporary absence or low abundance of a species for natural reasons.

Furthermore, although communities are now classified within biotopes, predicting what biotope will be present under defined environmental conditions is difficult outside of extreme situations where only a few species are likely to be able to survive (for instance, extreme wave exposure, low salinity, extreme organic enrichment). Separating natural variability from change brought about by human activities is therefore often difficult. Nevertheless, several types of studies can point to those species that react to human-induced change. For instance:

1. time-series studies where an environment has been degraded or a factor changed;
2. studies of gradients of effect away from point source perturbations (especially contaminants input), and
3. studies following extreme events and pollution or disturbance.

In undertaking the review described here, we have identified from the literature examples of the above types of study in order to determine likely indicator species.

2. MARINE ENVIRONMENTAL PROTECTION INITIATIVES

There are several marine environmental protection initiatives currently being developed that require or would benefit from identification of those species that might indicate the quality of water masses or the degree of contamination or disturbance of seabed habitats.

The EC Water Framework Directive (WFD) addresses the full range of potential human impacts on aquatic systems. It includes identification of targets (subject to various qualifications) for coastal and transitional (estuarine) waters in terms of achieving “good surface water status” by 2015. “Good surface water status” is defined in terms of “good ecological status”, coupled with “good surface water chemical status” and achievement of protected area objectives which includes those of the Habitats Directive. Status is assessed in relation to type-specific reference conditions representing the conditions to be expected in undisturbed water bodies with no or very minor anthropogenic alterations, which in consequence are to be regarded as having “High Ecological Quality”. The WFD defines High Ecological Quality as “All the disturbance sensitive taxa associated with undisturbed conditions are present”.

Box 2

International Council for the Exploration of the Seas (ICES) Study Group on EcoQO’s for Sensitive and for Opportunistic Benthos Species (SGSOBS). Copenhagen on 22-24 March 2004.

Summarised brief for the meeting.

Continue development of EcoQ element (o) Density of sensitive species and EcoQ element (p) Density of opportunistic species to:

1. identify possible [sensitive and opportunistic] species, taking into account developments in implementing the Water Framework Directive;
2. commence development, for species identified , and on the basis of the criteria for sound EcoQOs established by ICES in 2001, of related metrics, objectives and reference levels for this EcoQO;
3. for these [the above] EcoQ elements, to consider further spatial scale requirements of sampling and the adequacy of existing monitoring activities;
4. where possible and appropriate, reconstruct the historic trajectory of the metric and determine its historic performance;
5. taking into account all potential sources of relevant information, determine what information it will be possible to collect in future to assess whether the EcoQO is being met;
6. develop draft guidelines, including monitoring protocols and assessment methods, for evaluating the status of, and compliance with, the EcoQO.

Summarised recommendations.

1. The above [reviewed in full report] information resources and any others readily available should be combined to identify tolerant, sensitive, and opportunistic species.
2. Sensitive taxa should be related to the EcoRegion and habitat type (e.g. EUNIS habitat type) in which they occur.
3. Lists of species from analysis of survey data should be presented so that rare or uncommon species are not included (may be EcoRegion dependent). Rare species cannot be used reliably to identify the presence of adverse effects.
4. The identification of key structural and functional sensitive species that are intolerant and/or sensitive to stressors needs to be given priority because of their high ecological significance.
5. Sensitive species that are normally in high abundance in a biotope are preferred over low density species as potential indicators.
6. Sensitive species that are conspicuous, easily identified, and readily observed or surveyed should be identified as “Sentinel species”.

(From: http://www.ices.dk/iceswork/wgdetailace.asp?wg=SGSOBS**)**

The factors, under the Water Framework Directive, to be assessed for coastal waters and transitional waters cover:

1. **biological quality elements** (phytoplankton, macroalgae and angiosperms, benthic invertebrate fauna and, additionally in transitional waters, fish);

2. **hydromorphological elements** (tidal regime, morphological conditions);
3. **physico-chemical elements:** general conditions (temperature, oxygenation, transparency, nutrient concentrations, salinity), specific synthetic pollutants and specific non-synthetic pollutants.

The resulting classification scheme which is required to assess the status of biological elements (plants, macroinvertebrates and transitional fish) is expressed in terms of High, Good, Moderate, Poor and Bad status and is expressed numerically as an Ecological Quality Ratio (EQR) which is a "ratio representing the relationship between the values of the biological parameters observed for a given body of surface water and values for these parameters in the reference conditions applicable to that body. The ratio shall be represented as a numerical value between zero and one, with high ecological status represented by values close to one and bad ecological status by values close to zero" (see: www.wfduk.org/wfd_concepts/cis_Glossary). The classification scheme is required to be in place for the commencement of monitoring in 2007

The Oslo and Paris Commissions (OSPAR) Convention on the Protection of the Marine Environment of the north-east Atlantic has adopted an 'Ecological Quality Objectives' (EcoQO) approach in implementing Annex V of the Convention. It is probably possible to interpret the ecological quality that would result from achieving the EcoQOs as being in line with the "good ecological status" which the Water Framework Directive sets as the goal for coastal waters and transitional waters in general.

The Habitats Directive requires the maintenance of 'favourable conservation status' within Special Areas of Conservation. That requirement should be informed by a knowledge of what communities and what species richness should be present in an area against the communities that are present. Change in communities needs to be recorded and interpreted including separation of natural variability and change brought about by anthropogenic activities (over-and-above sample variability). Where possible, features assessed for the Habitats Directive will be related to the biological elements of the WFD using the same metric scales. For example, for macroinvertebrates in an intertidal mudflat, the same metrics may be used to assess favourable condition and ecological status.

The International Council for the Exploration of the Seas (ICES) has, perhaps, the longest history of working to identify benthic indicator species. Their work is now closely linked to OSPAR. The ICES Advisory Committee on Ecosystems (www.ices.dk/iceswork/ace.asp) has recommended properties of good indicators (from political to scientific) of environmental quality:

- Relatively easy to understand by non-scientists and those who will decide on their use.
- Sensitive to a manageable human activity.
- Relatively tightly linked in space and time to that activity.
- Easily and accurately measured, with a low error rate.
- Responsive primarily to human activity, with low responsiveness to other causes of change.
- Measurable over a large proportion of the area in which the indicator is likely to be used.
- Based on an existing body of time-series of data to allow a realistic setting of objectives.

The ICES 'Study Group on EcoQO's for Sensitive and for Opportunistic Benthos Species (SGSOBS)' met in Copenhagen on 22-24 March 2004 (see Box 2). That meeting provided the opportunity for one of the project team (KH) to contribute initial results from this

JNCC/EA exercise and to ensure that this report takes account of most up-to-date information and approaches to identifying indicator species.

The UK Biodiversity Indicators Forum (16 June 2003) considered the value of indicator species as a part of a wide-ranging appraisal of ‘indicators’.

In all of the various initiatives aimed at environmental protection, interpreting the results of biological monitoring or of sudden observed change requires an ability to separate likely natural variability or response to natural extreme events from change brought about by human activities: another area of interpretation that should be informed by the study described here. This study provides the start of an evidence base to support the setting of numerical boundaries essential to interpreting changes in biological communities when setting objectives for ecological status assessments for WFD or favourable condition assessments for Habitats. The study will also help to identify gaps in our knowledge with respect to key sensitive species and help to focus ecological research into the effects of anthropogenic pressures on the marine environment.

3. SOURCES OF INFORMATION

JNCC Time-series study. The review of time-series studies undertaken for JNCC by the Marine Biological Association (Hiscock & Kimmance 2003) identified some changes in species abundances that could be interpreted as related to changes in environmental factors including as a result of human activities.

Pollution studies. The wide range of papers describing results of studies of pollution events and of studies of gradients of effect from point source discharges were especially useful in identifying species that were affected by certain contaminants.

***MarLIN* sensitivity reviews.** The Marine Life Information Network (*MarLIN*) Biology and Sensitivity Key Information sub-programme has used a wide range of literature to identify degree of intolerance and likely recoverability of species to environmental factors. The assessments of intolerance to a factor and likely recovery are brought together into an index of sensitivity (see Hiscock & Tyler-Walters, in press). Information is held in a Microsoft Access database. Two queries were undertaken with the following interpretation.

1. **Intolerant species.** ‘High’ or ‘Intermediate’ intolerance to selected factors. Degree of intolerance will reflect recent events that have affected a community as well as events that may have taken place a year or more ago and result in absence of sensitive species as well. Intolerant species will be absent from severely affected locations.
2. **Sensitive species.** Species with a ‘Very High’ or ‘High’ sensitivity will be affected in the long term. Their absence may indicate an event that happened several years before the survey or that happens intermittently. Sensitive species are likely to be excluded from a community where an adverse factor is present continuously but not necessarily at a severe level.

Expert opinion. The review described here has benefited from experience of contributors in undertaking studies related to pollution and/or analysing data sets to identify species ‘driving’ change.

4. DATA LOGGING AND INTERPRETATION

Data logging was undertaken on a Microsoft excel spreadsheet. The information was separated into tables for the following factors:

- Diffuse nutrients
- Organic enrichment
- 'Priority substances'
- Thermal discharge
- Change in turbidity
- Change in emersion regime
- Physical removal (dredging)
- Physical disturbance (trawl fishing)
- Physical abrasion and disturbance (dredge fishing)
- Pesticides and medicines (fish farming)
- Temperature change (climate change)

Records were identified according to:

- Habitat
- Species
- Change
- Exposure pressure
- Source reference
- Method used
- Notes

The above information was further interpreted and collated into a spreadsheet that related to activities and to the habitat types separated into European Union Nature Information System (EUNIS) types. Species identified as indicator species or that were demonstrated to change significantly in abundance in relation to change in a factor were recorded within each habitat type. A measure of 'confidence' was given depending on the number of publications in which a particular species featured.

Change in salinity was not included in the data logging exercise although one relevant paper (Mucha *et al.,* 2004) is noted below.

5. SUMMARY OF RESULTS

5.1 Introduction

The earlier report (Hiscock *et al.* 2004) tabulated results of the literature review from Microsoft Excel spreadsheets in an appendix and presented a summary of reactions of species to factors using the terms that the authors of separate papers used. The report also included tabulated information from the *MarLIN* database of species intolerance and sensitivity to different factors. Since that report was completed, we have translated the different terms and scales used by different authors into one set of terms and entered the information to a Microsoft Access database. That database has been used to produce Appendix 1 in this report and to support Web pages (www.marlin.ac.uk/indicator_species) that provide the opportunity to undertake selective searches. Appendix 1 summarizes the full list of papers and sources that yielded information. Some case studies are also included (in boxes) below.

5.2 Results of the literature review

5.2.1 Introduction

The terms used in headings (5.2.2 to 5.2.13) below are those listed by the Environment Agency as 'Source pressure' followed by the 'Exposure pressure' with *MarLIN* equivalent or closest match factors in parenthesis. Source and Exposure pressures are human activity-based and do not include natural variability in environmental factors that might be driving change, although may be linked. It is therefore important to identify potential indicators related especially to lowered salinity and to decrease in temperature. Also, change in physical substratum and oxygen concentration (deoxygenation) might result from natural events and, if change is to be interpreted according to major drivers, such natural factors need to be acknowledged.

5.2.2 Dredging – Suspended sediment / change in physical substrate (Substratum removal)

Dredging includes activities such as aggregate extraction and pipeline burial and all species on and in the seabed, except some highly mobile species, will have a high intolerance. Degree of recoverability and therefore sensitivity depends on cessation of activity and the same sort of substratum being present after dredging. The available literature reviewed here takes little account of recovery and results given in this report may not identify good indicator species for long-term impacts.

5.2.3 Commercial fishing including oyster, mussel and cockle dredging and trawling – Change in physical substrate, Change in habitat, Removal of fish / invertebrates (Abrasion and physical disturbance)

Abrasion and physical disturbance is likely to result from the use of mobile fishing gear that penetrates the seabed, mooring chains that scrape the seabed, propeller wash, vessels stranding and storms that disturb sediments or cause abrasion by mobilising sand, cobbles etc. There is a large body of information describing effects of mobile fishing gear (see, for instance, the volume edited by Kaiser & de Groot, 2000). Physical disturbance attracts a small range of opportunistic species such as *Capitella capitata* and *Mediomastus fragilis* (May & Pearson, 1995). Commercial fishing activites particularly impact upon bivalve molluscs and more generally lead to increases in scavenging and predatory crustaceans, gastropods and sea stars (Rumohr and Kujowski, 2000). The likely impact of fishing on habitats and species in Special Areas of Conservation has recently been updated by Sewell & Hiscock (2005).

5.2.4 Nets, traps and pots - Removal of fish / invertebrates (Removal of this species/removal of other species)

Static fishing gear will remove target species (intolerance of target species) but may also catch non-target species and may crush or detach fragile sessile invertebrates. (See Eno *et al.*, 2001.)

5.2.5 Discharge of contaminated water / use and disposal of other chemicals – Priority substances / other synthetic / non-synthetic chemicals, heavy metals (Synthetic chemicals, Heavy metals)

The Water Framework Directive introduces a new categorisation for prioritising the assessment and control of contaminants released to the environment which is explained in more detail in the Directive and Common Implementation Strategy Guidance links to which can be found on the UK WFD website. For simplicity, contaminants have been considered under the headings of synthetic chemicals, metals and their compounds and persistent hydrocarbons.

Synthetic chemicals

Box 3

Species likely to have been intolerant of Tributyl Tin compounds. Species present in significant (over 2 or 3 per grab or at several stations) numbers at upper estuary sites in the River Crouch in 1991 or 1997 but not 1987. (Interpreted from Matthiesen *et al*. 1987.)

Eteone longa	*Achelia echinata*	*Corophium volutator*
Exogone spp	*Anoplodactylus pygmaeus*	*Caprella linearis*
Aphelochaeta multibranchis	Ostracods	*Hydrobia ulvae*
Tharyx killariensis	*Diastylis* sp.	*Retusa obtusa*
Melinna palmata	*Parajassa pelagica*	*Cerastoderma edule*

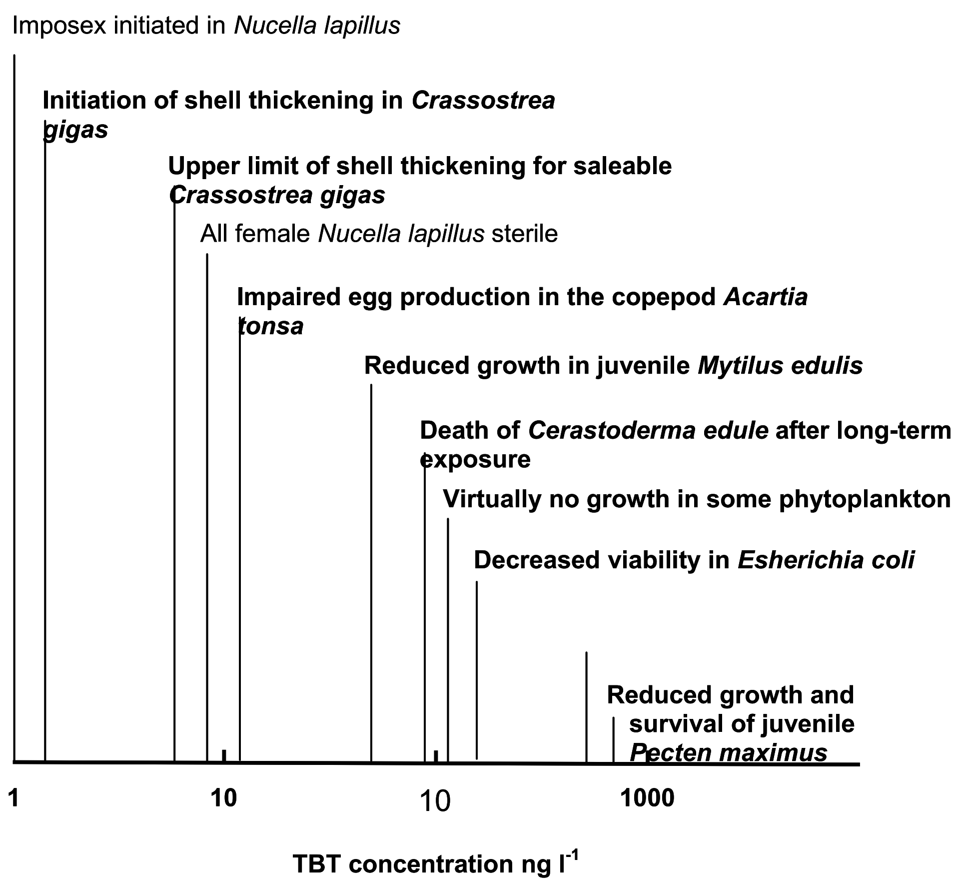

Figure 3. Sensitivity to tributyltin contamination (ng l^{-1}) of various marine organisms. The responses range from subtle effects on individuals to acute effects on species populations (from Hawkins *et al*., 1994 based on Gibbs *et al.* 1991).

A wide range of substances fall under the category 'Synthetic chemicals'. They include "Organohalogen compounds and substances", "Organophosphorous compounds" and "Organotin compounds" at least in Annex VIII of the WFD. Establishing cause and effect in relation to what is often a cocktail of chemical in water is often difficult and the impact of Tributyl Tin (TBT) contamination may be one of the few clear examples of effects that have not been confused with other stressors. Matthiessen *et al.* (1999) provide an account of changes in the Crouch Estuary following the prohibition of TBT use on small vessels in 1987. Whilst a definite link to TBT could not be established, the increase in number of infaunal taxa from 15 in 1987 to 40 in 1991 and 47 in 1997 (and from 29 in 1987 to 39 in 1997 for epifauna) at the most inland site suggests that it should be possible to identify taxa that are likely to have been sensitive to TBT. For infaunal species, those that were not recorded in 1987 but were present in 1991 and 1997 are listed in Box 3.

For epifaunal species, many occurred as single records and an increase in numbers of individuals may be a better basis for assessing improvement since TBT was banned. The number and abundance of species of molluscs, crustaceans and ascidians especially increased.

TBT has also been shown to affect various species in different ways and to have a variety of sublethal effects. Whilst sublethal effects are outside the scope of the current study,

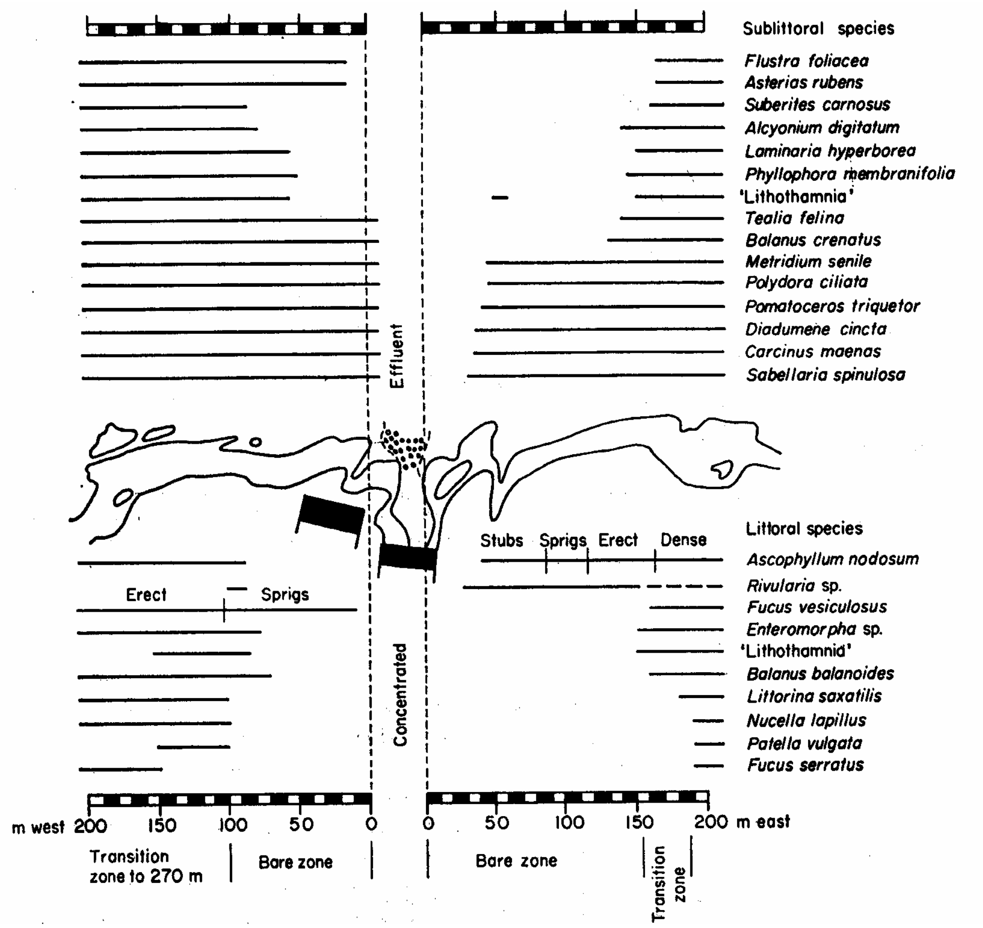

Figure 4. Distribution of conspicuous intertidal and subtidal species for a distance 200m west and east of an acidified halogenated effluent. (From Hoare & Hiscock, 1974.)

they can trigger higher order effects. Figure 3 illustrates the range of sublethal effects that can be found.

The study by Hoare & Hiscock (1974) of the impact of a bromine extraction plant effluent on intertidal and subtidal hard substratum communities provides the largest dataset found for impacts of a chemical (acidified halogenated) effluent on hard substratum benthos. Degree of intolerance for that effluent was assessed as follows:

- Highly intolerant species were those not found within about 200m east of the effluent on the shore and, for sublittoral species including fauna from kelp holdfasts, within Amlwch Bay (except that some were found near Amlwch Harbour);
- Intolerant species were those not found within about 150 m east of the effluent on the shore and underwater but, for kelp holdfast stations, include species found within the bay but only at the sampling station about 500 m east of the outfall
- Tolerant species occurred near to the outfall although not directly adjacent;
- Favoured species had increased abundance near to the outfall although did not occur under its immediate influence;
- Highly favoured species occurred in increased abundance near to the outfall.

Figure 4 summarises the area of effect of the effluent on some of the most conspicuous affected species. Taxonomic groups that were found to be most intolerant to tolerant of the effluent were, in order of intolerance: amphipod crustacea, red algae, echinoderms, ascidians, decapod crustaceans, bryozoans to polychaetes.

Box 4

Tolerance of sediment species to copper. Tolerance is assessed in relation to concentrations of > 200 ppm. From Rygg (1985). * = negatively correlated with increased sediment copper concentration in experimental studies by Olsgard (1999). [1] = Possibly *Minuspio cirrifera* in Howson & Picton (1997). [ ] = Not recorded from UK waters.

Non-tolerant (absent)	Non-tolerant but occasionally found	Moderately tolerant. Present at some stations	Highly tolerant. Common at the most polluted stations
Annelida	**Annelida**	**Annelida**	**Annelida**
Glycera rouxii	*Paramphinome jeffreysii*	*Ceratocephale loveni*	*Phloe minuta*
[*Phylo norvegica*]	*Lumbrineris* spp.	*Nephtys paradoxa*	*Eteone longa*
Laonice cirrata	*Paraonis gracilis*	*Nephtys ciliata*	*Anaitides groenlandica*
Diplocirrus glaucus	*Prionospio cirrifera**[1]	*Prionospio malmgreni*	*Nereimyra punctata*
Polyphysia crassa	*Spiophanes kroyeri*	*Tharyx marioni*	*Ophiodromus flexuosus*
Scalibregma inflatum	*Melinna cristata*	**Mollusca**	*Glycera alba*
Ophelina cylindricaudata	**Mollusca**	*Thyasira flexuosa*	*Goniada maculata*
Ophelina norvegica	*Thyasira equalis*	*Thyasira sarsi**	*Polydora* spp.
Ophelina modesta	**Echinodermata**	*Corbula gibba*	*Scoloplos armiger*
Ophelina acuminata	*Amphiura chiajei*		*Cirratulus cirratus**
Rhodine loveni	*Amphiura filiformis*		*Chaetozone setosa**
Rhodine gracilior			*Cossura longocirrata*
Sosane gracilis			*Capitella capitata**
Terebellides stroemi			*Heteromastus filiformis*
Crustacea			*Tubificoides* spp.
Eudorella emarginata			
Eriopisa elongata			
Calocaris macandreae			
Mollusca			
Nucula sulcata			
Ennucula tenuis			
Abra nitida			

Metals and their compounds

Metals are most often addressed as 'heavy metals' although the term is rarely defined. Many metals are essential as trace elements to organisms and include aluminium, arsenic, chromium, cobalt, copper, iron, manganese, molybdenum, nickel, selenium, tin, vanadium and zinc. Non-essential heavy metals include cadmium, gold, lead, mercury and silver (Furness & Rainbow, 1990). Langston (1990) describes sublethal effects of metals especially from experimental studies and specifically effects of copper and zinc in Restronguet Creek, Cornwall.The species effects in terms of increase or decrease are described in Bryan *et al.* (1987). The paper by Rygg (1985) of the effect of copper is particularly valuable in specifying non-tolerant species in relation to a specified concentration in sediment (Box 4).

Persistent hydrocarbons

Hydrocarbons include a wide range of substances ranging in toxicity from very high (for instance, fresh petroleum) to very low (for instance, weathered crude oil).

The hydrocarbons most likely to affect water quality and be entrained into seabed habitats are from effluents that, at source, might have concentrations up to 25 ppm oil. Studies of point source discharges including refinery effluents and from oil based drilling muds have identified tolerant and intolerant species along gradients away from those point sources. Those studies that clearly identify intolerant and favoured (possible indicator) species are included in Appendix 1. However, many studies are descriptive in nature. For instance, work carried out on sublittoral sediments in Sullom Voe (May & Pearson, 1995) draws attention to the occurrence of species characteristic of enriched sediments in areas of

Box 5

Hydrocarbon contamination

Elevated levels of hydrocarbons in sediments may cause mortality of species and make space available to tolerant opportunistic species. Levell *et al.* (1989) catalogue some of the species whose abundance appears to be affected by hydrocarbon contamination and disturbance along gradients away from oil platforms. The following species are identified as affected:

Taxa that are present in high abundance (extremely tolerant species)

Capitella capitata (a polychaete worm)*
Phloe inornata (a polychaete worm)
'Rhaphidrilus nemasoma' (a polychaete worm)*
Ophryotrocha spp. (a polychaete worm)*

Very tolerant taxa (enhanced abundances in transitional zones along disturbance/pollution gradient)

Chaetozone setosa species complex (a polychaete worm)*
Cauleriella sp. (a polychaete worm)
Tharyx marioni (a polychaete worm)
Cirratulus cirratus (a polychaete worm)*
Heteromastus filiformis (a polychaete worm)
Capitomastus minimus (a polychaete worm)
Notomastus latericeus (a polychaete worm)
Eteone sp. (a polychaete worm)
Anaitides mucosa (a polychaete worm)
Hesionid worms such as *Nerimyra punctata* & *Ophiodromus flexuosa*
Glycerid worms such as *Glycera ?alba* & *Goniada maculata*
Polydora sp. (a polychaete worm)
Diplocirrus glaucus (a polychaete worm)
Philine scabra (a mollusc)
Thyasira flexuosa/gouldii (a mollusc)
* = also listed by Olsgard & Gray (1995) as 'most tolerant'.

enhanced hydrocarbons: *Capitella capitata*, *Thyasira flexuosa*, *Prionospio fallax*, *Chaetozone setosa* and *Abra nitida*. Conclusions from Levell *et al*. (1989) in relation to the impacts of North Sea oil platforms are shown in Box 5. Daan *et al*. (1994) also list species most abundant and least abundant near to oil platforms where oil-based drilling muds were used. Olsgard & Gray (1995) analysing results from Norwegian sector North Sea oil production platforms list 32 'most sensitive' and 10 'most tolerant' species.

Oil spills have also revealed species that are tolerant or intolerant of oiling although oil on the surface of the sea rarely affects subtidal species unless dispersed into the water column by chemicals or by strong wave action. The Braer oil spill in Shetland in 1993 provided an opportunity to identify species that increased or declined in abundance where oiling occurred. Severe weather conditions meant that oil was incorporated into sediments. Kingston *et al.* (1995) note the following:

- **Species reaching maximum abundance at contaminated sites:** *Capitella capitata*; *Chaetozone setosa*; *Phloe inornata*; *Diplocirrus glaucus*; *Paramphinome jeffreysi*; *Spiophanes kroyeri*.
- **Species with significantly lower abundances at oiled stations**: *Aonides paucibranchiata*; *Glycera lapidum*; *Lumbrineris gracilis*.

Amphipods were completely absent from the worst affected areas, consistent with other known impacts of oil spills (for instance, loss of ampheliscid amphipods after the *Amoco Cadiz* oil spill: Cabioch *et al*., 1980).

5.2.6 Use and disposal of synthetic / non—synthetic chemicals (e.g. addition of medication-synthetic chemicals) - Priority substances / other synthetic / non-synthetic chemicals, heavy metals (Synthetic chemicals)

This category relates specifically to the pharmaceutical chemicals and biocides used in the aquaculture industry**.** A study undertaken by the Scottish Association for Marine Science and others (SAMS, 2005) investigated the effects of pharmaceutical products on benthic fauna and flora in sea lochs. With regard to seabed macrofaunal communities, the report concludes "There was no change in species composition that could be attributed to treatment with sea lice medicines". For intertidal species the only possible disturbance-related impact was the low frequency of developed egg-masses of the barnacle *Semibalanus balanoides* at the predicted high impact station at Loch Diabaig. Whilst there may be sublethal effects, such as disruption of chiton production, the prospect of identifying indicator species for pharmaceutical chemicals seems poor.

5.2.7 Physical structure / Physical alteration by .... engineering modification – Change in physical substrate, Oxygen concentration, Flow / flow direction, Suspended sediment / Increased turbidity (Increase/Decrease in suspended sediment)

Levels of suspended sediments vary greatly in transitional waters and less so in coastal waters. Increases in suspended sediments may occur naturally because of freshwater run-off or following storms that disturb seabed sediments. Sediments being dumped as a part of capital and maintenance dredging will also increase suspended sediment levels which might clog feeding structures and smother organisms. Turbidity may also increase as a result of algal blooms.

5.2.8 Surface water run-off, Process water discharge, Disposal of wastes - Nitrate/Phosphate (Changes in nutrients)

Increased nutrients are most likely to affect abundance of phytoplankton which may include toxic algae. The abundance of foliose benthic algae may also increase where nutrients are high. Both of these primary effects resulting from elevated nutrients will impact upon other biological elements or features (e.g. toxins produced by phytoplankton blooms or deoxygenation of sediments from coverage of algal mats) and may lead to "undesirable disturbance" to the structure and functioning of the ecosystem.

5.2.9 Abstraction of water - Salinity (Increase in salinity)

Marine species will usually survive in salinities as low as 30 with progressively more being unable to survive as salinity drops towards freshwater levels. Increased salinity (as might happen where fresh water is being abstracted upstream) is likely to result in the appearance of many species that require a higher salinity than previously existed at a location. Studies of species distributions along a salinity gradient will reveal those species likely to occur in an area after salinity has risen. Few such studies exist and the species that would indicate a rise in salinity is dependent on the salinity that existed prior to change and that after change. The most useful approach to identifying potential indicator species would be to tabulate non-rare species according to the salinity ranges in which they occur or are absent. Such an approach was used by Laffoley & Hiscock (1993).

5.2.10 (Decrease in salinity)

Decrease in salinity is not included within 'Pressures' but results from natural events such as prolonged rainfall. Tidal barrages and water extraction from rivers will also affect salinity in transitional waters. In situations where there is continuous input of freshwater (for instance the outfall from a hydroelectric plant), species that might survive occasional low salinity, might succumb to continuous low salinity near the surface. All marine species are ultimately intolerant of decrease in salinity and the comment for information sources is as above.

Some species appear to have a very high tolerance of variable salinity. The Douro Estuary, Portugal has "dramatic" salinity fluctuations (0-35) not only seasonally but within the tidal cycle. Mucha *et al.* (2004) found only 14 taxa there – taxa that are highly tolerant of fluctuations in salinity (Box 6).

Box 6

Taxa highly tolerant of salinity changes in the Douro Estuary, Portugal where salinity ranges from 0 to 35 (Mucha *et al.*, 2004).

Hediste diversicolor	Nadiidae	*Cyathura carinata*
Streblospio benedicti	Tubificidae	*Corophium volutator*
Melina palmata	*Tubifex costatus*	*Scrobicularia plana*
Polygordius sp.	Nematoda indet.	Chironomidae indet.
Enchytraeidae indet.		Collembola indet.

5.2.11 Process water discharge – Oxygen concentration / Organic matter (Deoxygenation)

Organic matter is included here as organic enrichment causes de-oxygenation. Annex VIII of the WFD refers to "Substances which have an unfavourable influence on the oxygen balance". There have been many studies of the impact on benthic communities of organic enrichment causing hypoxia and many are reviewed by Diaz & Rosenberg (1995). Box 7 gives examples of species found to be resistant to moderate and severe hypoxia and species that seem to be eliminated by such conditions.

Box 7

Examples of species found to be resistant to moderate and severe hypoxia and species that seem to be eliminated by such conditions. (Species not recorded from Britain and Ireland have not been included). From Diaz & Rosenberg (1995). The number of source references for a species conclusion is given in brackets.

Species resistant to severe hypoxia	Species resistent to moderate hypoxia	Species sensitive to hypoxia
Arctica islandica (2)	*Capitella capitata* (3)	*Diastylis rathkei* (1)
Astarte borealis (2)	*Abra alba* (2)	*Nephrops norvegicus* (1)
Corbula gibba (5)	*Abra nitida* (2)	*Brissopsis lyrifera* (1)
Ophiura albida (2)	*Amphiura filiformis* (3)	*Ampharete grubei* (1)
Halicryptus spinulosus (2)	*Amphiura chiajei* (2)	*Macoma calcarea* (1)
Malacoceros fuliginosus (2)	*Streblospio benedicti* (1)	*Gammarus tirinus* (1)
Metridium senile (1)	*Mercenaria mercenaria* (1)	*Spisula solida* (1)
Phoronis mülleri (2)	*Spisula solidissima* (2)	*Crangon crangon* (1)
Ophiodromus flexuosus (1)	*Lumbrineris verilli* (1)	*Carcinus maenas* (1)
Pseudopolydora pulchra (1)	*Scoloplos armiger* (1)	*Nereis pelagica* (1)
Paraprionospio pinnata (2)	*Nereis diversicolor* (1)	
Loimia medusa (2)	*Pectinaria koreni* (1)	
Modiolus phaseolina (1)		
Nephtys hombergi (2)		
Calliactis parasitica (1)		
Streblospio benedicti (1)		
Goniadella gracilis (1)		
Mytilus edulis (1)		
Heteromastus filiformis (3)		
Arenicola marina (1)		
Magelona sp. (1)		

5.2.12 Process water discharge - Thermal range (Increase in temperature)

Increase in temperature can be a cause for concern and is related to heated effluents from power stations. Only a few papers describe impacts from such heated effluents. In the long-term, climate change and seawater temperature rise may be affect some key structural or key functional species. Such potential long-term impacts are not included here but are reviewed in Hiscock *et al*. (2004).

5.2.13 Thermal range (Decrease in temperature)

Decrease in temperature is most likely to be a natural event as a result of, for instance, a very cold winter. The most consistently useful source of information on the effects of very cold weather on marine life is the summary edited by Crisp (1964) of the impact of the 1962/63 winter on marine life in Britain.

5.3 Meiobenthos

This section of the report is included to address the status of knowledge of meiobenthos as potential indicators. Because of perceived taxonomic difficulties, meiobenthos are not usually considered as practical indicators of disturbance. Also, no reliable indicators of pressures other than organic enrichment have been identified. Nevertheless, the meiofaunal taxa that favour habitats that are highly enriched with organic matter are remarkable in two respects; first they are virtually confined to a few groups of nematodes and copepods that are relatively easy to recognise at taxonomic levels above that of species, and second these same groups are of ubiquitous occurrence in such situations, at least in temperate latitudes where they have been most studied. The suite of species is small, but differs rather consistently between intertidal or shallow estuarine sites and those sites that are subtidal and more or less fully marine.

Intertidally on a wide range of sediment types including muds, muddy sands and sands, nematodes are found in very high densities in organic material such as decomposing macroalgae and terrestrially derived plants. Decomposing wrack beds are usually dominated (worldwide) by a single species, *Rabditis marina* (Inglis & Coles, 1961; Inglis, 1966), whereas decaying marsh vegetation and sewage effluent is usually dominated by two related genera of the nematode family Monhysteridae, namely *Diplolaimella* and *Diplolaimelloides* (Lorenzen, 1969; Hopper, 1970; Hopper *et al.*, 1973, Austen *et al.*, 1989). A wide variety of environments enriched by particulate organic material are also characterised by the predominance of a limited number of copepod species. Notable among these are members of the genus *Tisbe* (Fava & Volkmann, 1975). This genus comprises a number of very closely related and morphologically similar species (Volkmann, 1979), which are often found in multispecies guilds in organically enriched habitats (Bergmans, 1979). For example, Gee *et al.* (1985) found that sediments enriched with organic detritus became dominated by a guild of five *Tisbe* species, even in situations where a *Beggiatoa* mat formed on the sediment surface, indicating at least periodic anoxia in the overlying water as well as the sediment. Species in this genus are exceptionally large relative to other harpacticoid copepods, and quite easy to identify to genus level.

Subtidally, the nematodes that typically predominate in organically enriched sediments are not the small Monhysterids and Rhabditids, but abnormally large Oncholaimids, which as a group are also easy to identify. In situations where disturbance is not necessarily associated with organic enrichment, these species are more often members of the genus *Metoncholaimus*, in Britain particularly *M. scanicus* and *M. albidus* (Richard Warwick, personal observations). However, in organically enriched situations *Pononema* may become enormously abundant (Warwick & Robinson, 2000). Bett & Moore (1988) for example found a wet weight of 50 $g.m^{-2}$ of *P. alaeospicula* in the centre of the Garroch Head (Firth of Clyde) sewage sludge dumping ground. They also report dense populations of this species from a sublittoral sewage outfall in the Firth of Forth and surrounding the outfall of an alginates factory in Loch Creran, W. Scotland. The commoner, closely related and morphologically similar *P. vulgare* was found in dense matted aggregations often comprising millions of individuals and easily visible to the naked eye in organically enriched habitats in the Kiel and Flensberg inner fjords (Lorenzen *et al.*, 1987; Prein, 1988). The harpacticoid copepod species most commonly associated with subtidal organically enriched habitats is the large Diosaccid *Bulbamphiascus imus* (Marcotte & Coull, 1974; Keller, 1986; Moore & Pearson, 1986; Sandulli & Nicola-Guidici, 1990), to such an extent that it has come to be regarded as an indicator species of organic pollution. Marcotte & Coull (1974) found that this species was dominant near a sewage outfall in the Mediterranean in the summer, but that a species of *Tisbe* dominated in winter.

6. CONCLUSIONS

The information included in the database that supports the Web pages has identified a large number of species that might respond positively (increased abundance or appearance where not previously present) or negatively (decreased abundance or loss) to certain environmental factors and human activities. In order to produce practical guidance that might assist in interpreting change, the various results have been brought together in Appendix 1 (presented following References). The list whilst large cannot be exhaustive and there will be references that still await discovery.

Certain species or taxa occur frequently in lists of species that decline in abundance or tolerant species that thrive where significant pressures of different types occur. The taxa are ones that are likely to occur in many surveys because they are common and widespread. They include:

Various amphipods. Sensitive to physical disturbace and hydrocarbons.

Amphiura filiformis. Sensitive to physical disturbance, hydrocarbons and to organic input (increased nutrients).

Capitella capitata. Typically increases in abundance as a result of hydrocarbons and organic input.

Cardium edule. Sensitive to physical disturbance.

Chaetozone setosa. Typically increases in abundance as a result of hydrocarbons and organic input.

Echinocardium cordatum. Sensitive to physical disturbance and to organic input (increased nutrients).

Eteone longa. Typically increases as a result of organic input.

Heteromastus filiformis. Tolerant of or increased abundance in relation to heavy metals and organic input including nutrients.

Macoma balthica. Typically increases as a result of organic input.

Mya arenaria. Typically increases as a result of organic input.

Nephtys hombergii. Sensitive to physical disturbance.

Phloe minuta. Typically increases as a result of organic input.

Scalibregma inflatum. Typically increases as a result of organic input.

Scolelepis fuliginosa. Typically increases as a result of organic input.

Scoloplos armiger. Typically increases as a result of organic input.

Reviews that bring-together results from several different studies to look for consistent trends in presence or absence of species in relation to specific pressures are few. Rygg (1985) compares his observations from Norwegian fjords of effects of copper pollution with three other studies whilst Borja (2000) has used a wide range of studies but where the pressure is different from study-to-study, thus not identifying pressure-specific indicator taxa. If pressure-specific taxa exist, they would be particularly valuable in identifying reasons for decline or increase in those species at a location. Organic enrichment gradients and TBT contaminant effects do, however, have pressure-specific taxa.

The results of the study described here confirm that many of the species that have been identified as ‘tolerant’ of a wide range of pressures (and therefore of ‘low’ sensitivity to that pressure) are r-strategists – species that have a high rate of reproduction and will colonise habitats quickly. Such r-strategists may be killed by the factors resulting from pressures but have a high turn-over rate and so return rapidly. In conditions of severe impact, not even the r-strategists survive. Some K-strategists (species that have low fecundity, are slow-growing and long-lived) may be tolerant of pressures. For instance, horse mussels, *Modiolus modiolus,* have continued to thrive in the vicinity of an oily effluent in Shetland (ERT (Scotland) Ltd, 2002). However, it is usually K-strategists that constitute the majority of indicators of adverse effects from a pressure.

The identification of species as either ‘r-strategists’ or ‘K-strategists’ is simplistic and there are many species that have a reproductive strategy, growth rate and longevity that is intermediate. Those species are often ‘moderately sensitive’ to a factor and occur at in intermediate position along a pollution/disturbance gradient or along a time gradient to recovery following removal of a pressure. In the context of 'intermediate' species, it is difficult to better the diagram in Figure 1 although similar diagrams should be produced for other substrata especially hard substrata and for particular sampling units such as kelp holdfasts.

In concentrating on identifying species or particular taxa as indicators, this study may have missed the opportunity to look at broader indicators of pressures affecting marine life. For instance, the occurrence of large patches of intertidal green algae or epiphytes on subtidal plants may indicate eutrophication.

Appendix 1 produced as a part of this contract will now be used in Biology and Sensitivity Key Information reviews being produced by the *MarLIN* programme. At present, new species being researched will include reference to the conclusions of this review in the 'Additional Information' section of sensitivity reviews. However, presentation of the *MarLIN* reviews to make them as useful as possible to personnel implementing the WFD, interpreting the results of SAC monitoring etc. requires the development of additional tools and searches, some re-structuring of the Web-site and using terminology employed for 'Pressures' in the WFD.

In interpreting the results of surveys by reference to 'indicator' species identified by the survey, it is important to take account of the natural stability or instability of the environment in which the samples were taken. The presence of disturbance-tolerant species and the absence of long-lived slow-growing species may merely indicate that the habitat is naturally unstable (through wave disturbance of sediments, scour effects during storms, low salinity events during high river flow etc.). However, in situations where measures have been taken to improve water quality or to reduce habitat disturbance, the appearance of K-strategists not previously present will be a good sign.

Climate change effects may also need to be taken into account in identifying potential indicator species. Some edge-of-range species may increase (southern species) or decrease (northern species) as temperature rises. Interestingly, many species with calcified skeletons (increased CO_2 bring absorbed in seawater is predicted to cause acidification with adverse effects on calcified organisms), survived and even thrived in the acidified effluent at Amlwch (Hoare & Hiscock, 1974).

We are aware of several papers that have been submitted for publication that relate to human impacts on the marine environment and identify potential indicator species. We have been unsuccessful in obtaining 'in submission' papers describing changes in the Bay of Biscay and off the coast of Belgium in relation to fishing activities. We have not been able to spend time 'screening' the CEFAS report on aggregate extraction (Boyd *et al*., 2004) which identifies many species that characterise dredged and undredged areas. Other relevant papers such as on macroalgae and gradients of nutrient enrichment (Karez *et al*., 2004) are appearing at frequent intervals. Such papers can be used to expand or refine conclusions in this report and on *MarLIN* Web pages at some later revision.

7. RECOMMENDATIONS

1. The conclusions from this study brought together in Appendix 1 should be scrutinized by experienced marine ecologists and attention drawn to additional sources of information and improvements to the contents of the table.
2. Validation of the AMBI index and its categorisation of sensitivity for macroinvertebrate species (i.e. abundant and sensitive taxa which will determine status boundaries) should be further undertaken to provide a firmer evidence base to support the development of the index.

3. There should be particular effort to mobilise information from monitoring studies of fish farms: such information has been only sparsely found in available literature.
4. More effort needs to be made to identify sources of information about effects of nutrients on intertidal sediment flats: for instance, Rafaelli *et al.* (1989).
5. Information on 'Substratum removal' (Mineral extraction: aggregates) should be carefully scrutinized and conclusions about potential indicator species improved to take account of speed of recovery wherever possible.
6. A greater range of faunal and floral groups should be assessed to broaden the scope of for determining indicator species such as macroalgae and angiosperms (such as sea grasses) and fish species to provide a similar evidence base for other biological elements considered by the Habitats and Water Framework Directives.
7. The exercise undertaken at the ICES Workshop (for species beginning with 'A') (see Hiscock *et al* to bring-together results of various studies that have produced indices should be completed but using only common/widespread species from the AMBI work and adding information from the current study.
8. The *MarLIN* database should be interrogated to identify biotopes that are registered as high or very high sensitivity to factors where these relate to Habitats Directive water related features or WFD biological elements and classification tools.
9. A series of diagrammatic representations of the 'health' of communities in different habitats in relation to a gradient of 'pressure' should be developed as a training aid. The diagrams will be similar in style to those produced by Pearson & Rosenberg (1978).
10. Further research should be undertaken to identify species and biotopes affected by natural variability and extremes to provide a context to change brought about by human activities and to provide additional supporting evidence where misclassifications occur from assessment schemes being developed for Habitats Directive and WFD.
11. More clarity is needed in the application of Pressures and *MarLIN* factors of "Suspended sediment" and "Turbidity" as the two are closely linked and any impacts are difficult to disentangle between the two categories. [for the moment, 'Decreased turbidity' (Warwick *et al.*, 1991) has not been included in Appendix 1].
12. *MarLIN* Biology and Sensitivity Key Information research should be undertaken on (potential) indicator species to ensure that information for interpretation of change is available.
13. Using the information collated in the current exercise and existing research on the *MarLIN* database, produce "Reduced abundance may be due to:" and "Increased abundance may be due to:" on the *MarLIN* database and Web pages (cross-references to recommendation in 9.1 of SGSOBS report).
14. Keep the *MarLIN* database and Web pages up-to-date as new literature and interpretation of existing information becomes available.
15. There should be greater integration of initiatives to improve consistency of approach to the assessment of sensitivity of species and reduce confusion in terminology. The *MarLIN* website should be further developed to provide a consistent glosssary of terms for relating pressures and impacts on the marine environment as well as helping to validate classification schemes used for regulatory monitoring and EU Directives.

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9. REFERENCES

Allen, J.H. in press. *Derivation of Numerical Predictive Models from the NMP dataset*. SNIFFER research report SR(02)38. Scotland and Northern Ireland Forum for Environmental Research. 100 pp.

Anger, K., 1975. On the influence of sewage pollution on inshore benthic communities in the south of Kiel Bay. Part 2. Quantitative studies on community structure. *Helgolander Wissenschaftliche Meeresuntersuchungen*, **27**, 408-458.

Atkinson, R.J.A., 1989. Baseline survey of the burrowing megafauna of Loch Sween pMNR and an investigation of the effects of trawling on the benthic megafauna. (Contractor: University Marine Biological Station, Millport.) *Nature Conservancy Council*, *CSD Report*, No. 909. 59 pp.

Austen, M.C., Warwick, R.M. & Rosado, M.C. 1989. Meiobenthic and macrobenthic community structure along a putative pollution gradient in southern Portugal. *Marine Pollution Bulletin*, **20**, 398-405.

Bagge, P., 1969. Effects of pollution on estuarine ecosystems. I. The succession of the polluted estuarine habitats in the Baltic-Skaggerak region. *Meerentutkimuslait. julk.*, **228**, 3-118.

Ball, B., Munday, B. & Tuck, I., 2000. Effects of otter trawling on the benthos and environment in muddy sediments. In *Effects of fishing on non-target species and habitats: biological, conservation and socio-economic issues* (ed. M.J. Kaiser & S.J. Groot), pp. 69-82. Oxford: Blackwell Science Limited.

Bamber, R. N. (1989). A comparison of surveys of the CEGB'S Blyth fly-ash dumping ground. Research Reports. Central Electricity Generating Board. **RD/L/3425/R88:** [85].

Bamber, R.N. & Spencer, J.F., 1984. The benthos of a coastal power station thermal discharge canal. *Journal of the Marine Biological Association of the United Kingdom*, **64**, 603-623.

Barnett, P.R.O. & Watson, J., 1986. Long-term changes in some benthic species in the Firth of Clyde, with particular reference to *Tellina tenuis* da Costa. *Proceedings of the Royal Society of Edinburgh*, **90B**, 287-302.

Bergman, M.J.N. & Hup, M., 1992. Direct effects of beam trawling on macrofauna in a sandy sediment in the southern North Sea. *ICES Journal of Marine Science*, **49**, 5-11.

Bergmans, M., 1979. Taxonomic notes on species of *Tisbe* (Copepoda: Harpacticoida) from a Belgian sluice dock. *Zoologica Scripta*, **8**, 211-220.

Bellan, G., 1980. 'Relationship of Pollution to Rocky Substratum Polychaetes on the French Mediterranean Coast' *Marine Pollution Bulletin*, **11**, 318-321

Bett, B.J. & Moore, C.G., 1988. The taxonomy and biology of a new species of *Pontonema* (Nematoda, Oncholaimidae) dominant in organically polluted sublittoral sediments around Scotland, with a review of the genus. *Journal of Natural History*, **22**, 1363-1377.

Beukema, J.J., 1989. Long-term changes in macrozoobenthic abundance on the tidal flats of the western part of the Dutch Wadden Sea. *Helgolander Meeresuntersuchungen*, **43**, 405-415.

Beukema, J.J., 1991. Changes in composition of bottom fauna of a tidal-flat area during a period of eutrophication. *Marine Biology*, **111**, 293-301.

Beukema, J.J., 1995. Long-term effects of mechanical harvesting of lugworms *Arenicola marina* on the zoobenthic community of a tidal flat in the Wadden Sea. *Netherlands Journal of Sea Research*, **33**, 219-227.

Beyer, F., 1968. Zooplankton, zoobenthos and bottom sediments as related to pollution and water exchange in the Oslofjord. *Helgolanders wiss Meeresunters*, **17**, 496-509.

Black, K.D., Fleming, S., Nickell, T.D. & Pereira , P.M.F., 1997. The effects of ivermectin, used to control sea lice on caged farmed salmonids, on infaunal polychaetes. *ICES Journal of Marine Science*, **54**, 276-279.

Borja, A., Franco, J. & Perez, V., 2000. A marine biotic index to establish the ecological quality of soft-bottom benthos within European estuarine and coastal environments. *Marine Pollution Bulletin*, **40**, 1100-1114.

Borja, A., Franco, J., Valencia, V., Bald, J., Muxika, I., Belzunce, M.J. & Solaun, O., 2004. Implementation of the European water framework directive from the Basque country (northern Spain): a methodological approach. *Marine Pollution Bulletin*, **48**, 209-218.

Boyd, S.E., Limpenny, D.S., Rees, H.L., Cooper, K.M. & Campbell, S., 2003. Preliminary observations of the effects of dredging intensity on the re-colonisation of dredged sediments off the southeast coast of England (Area 222). *Estuarine, Coastal and Shelf Science*, **57**, 209-223.

Boyd, S.E., Cooper, K.M., Limpenny, D.S., Kilbride, R., Rees, H.L., Dearnaley, M.P., Stevenson, J., Meadows, W.J., & Morris, C.D., 2004. Assessment of the re-habilitation of the seabed following marien aggregate dredging. Lowestoft: Centre for Environment, Fisheries & Aquaculture Science. (CEFAS Science Series Technical Report No. 121.)

Bradshaw, C., Veale, L.O. & Brand, A.R., 2002. The role of scallop-dredge disturbance in long-term changes in Irish Sea benthic communities: a re-analysis of an historical dataset. *Journal of Sea Research*, **47**, 161-184.

Brown, J.R., Gowen, R.J. & McLusky, D.S., 1987. The effect of salmon farming on the benthos of a Scottish sea loch. *Journal of Experimental Marine Biology and Ecology*, **109**, 39-51.

Bryan, G.W., Gibbs, P.E., Hummerstone, L.G. & Burt, G.R., 1987. Copper, zinc, and organotin as long-term factors governing the distribution of organisms in the Fal Estuary in southwest England. *Estuaries*, **10**, 208-219.

Bustos-Baez, S. & Frid, C., 2003. Using indicator species to assess the state of macrobenthic communities. *Hydrobiologia*, **496**, 299-309.

Cabioch, L., Dauvin, J.C., Bermudez, J.M. & Babio, C.R., 1980. Effets de la maree noire de l' "Amoco Cadiz" sur le benthos sublittoral du nord de la Bretagne. *Helgolander Meeresuntersuchungen*, **33**, 192-208.

Cole, S., Codling, I.D., Parr, W. & Zabel, T., 1999. *Guidelines for managing water quality impacts within UK European Marine sites*. Natura 2000 report prepared for the UK Marine SACs Project. 441 pp.

Collier, L.M. & Pinn, E.H., 1998. An assessment of the acute impact of the sea lice treatment ivermectin on a benthic community. *Journal of Experimental Marine Biology and Ecology*, **230**, 131-147.

Cowie, P.R., Widdicombe, S. & Austen, M.C., 2000. Effects of physical disturbance on an estuarine intertidal community: field and mesocosm results compared. *Marine Biology*, **136**, 485-495.

Craeymeersch, J.A., Piet, G.J., Rijnsdorp, A.D. & Buijs, J., 2000. Distribution of macrofauna in relation to the micro-distribution of trawling effort. In *Effects of fishing on non-target species and habitats: biological, conservation and socio-economic issues* (ed. M.J. Kaiser and S.J. Groot), pp. 187-197. Oxford: Blackwell Science Limited.

Crisp, D.J. (ed.), 1964. The effects of the severe winter of 1962-1963 on marine life in Britain. *Journal of Animal Ecology*, **33**, 165-210.

Crump, R.G., Morley, H.S. & Williams, A.D., 1998. West Angle Bay, a case study. Littoral monitoring of permanent quadrats before and after the "Sea Empress" oil spill. In *The Sea Empress oil spill* (ed. R. Edwards & H. Sime), pp. 207-225. Lavenham, Suffolk: Chartered Institution of Water and Environmental Management.

Daan, R., Mulder, M. & Leeuwen, A.V., 1994. Differential sensitivity of macrozoobenthic species to discharges of oil-contaminated drill cuttings in the North Sea. *Netherlands Journal of Sea Research*, **33**, 113-127.

Dauvin, J. C. (1998). The fine sand *Abra alba* community of the Bay of Morlaix twenty years after the Amoco Cadiz oil spill. *Marine Pollution Bulletin*, **36**, 669-676.

Davies, J.M., Addy, J.M., Blackman, R.A., Blanchard, J.R., Ferbrache, J.E., Moore, D.C., Somerville, H.J., Whitehead, A. & Wilkinson, T., 1984. Environmental effects of the use of oil-based drilling muds in the North Sea. *Marine Pollution Bulletin*, **15**, 363-370.

Desgarrado Pereira, C., Gaudencio, M.J., Guerra, M.T. & Lopes, M.T., 1997. Intertidal macrozoobenthos of the Tagus estuary (Portugal): The Expo '98 area. *Publicaciones Especiales. Instituto Espanol de Oceanografia*, **23**, 107-120.

Desprez, M., 2000. Physical and biological impact of marine aggregate extraction along the French coast of the Eastern English Channel: short- and long-term post-dredging restoration. *ICES Journal of Marine Science*, **57**, 1428-1438.

Devon Wildlife Trust, 1993. Lyme Bay. A report on the nature conservation importance of the inshore reefs of Lyme Bay and the effects of mobile fishing gear. Exeter: Devon Wildlife Trust.

Diaz, R.J. & Rosenberg, R., 1995. Marine benthic hypoxia: a review of its ecological effects and the behavioural responses of benthic macrofauna. *Oceanography and Marine Biology: an Annual Review*, **33**, 245-303.

Dicks, B. & Levell, D., 1989. Refinery-effluent discharges into Milford Haven and Southampton Water. In *Ecological impacts of the oil industry* (ed. B. Dicks), pp. 287-316. London: Wiley.

Dixon, I.M.T., 1987. Experimental application of oil-based muds and cuttings to seabed sediments. In *Fate and Effects of Oil in Marine Ecosystems* (ed. J. Kuiper & W.J. Van den Brink), pp. 338. Dordrecht: Martinius Nijhoff Publishers.

Dybern, B.I., 1972. Ideforden – En Forstord Marin Miljo. *Fauna och Flora*, **67**, 90-103.

Eagle, R.A., 1973. Benthic studies in the south east of Liverpool Bay. *Estuarine and Coastal Marine Science*, **1**, 285-299.

Eleftheriou, A. & Robertson, M.R., 1992. The effects of experimental scallop dredging on the fauna and physical environment of a shallow sandy community. *Netherlands Journal of Sea Research*, **30**, 289-299.

Eno, N.C., Donald, D.S., Kinnear, J.A.M., Amos, S.C., Chapman, C.J., Clark, C.A., Bunder, F.S.P.D. & Munro, C., 2001. Effects of crustacean traps on benthic fauna. *ICES Journal of Marine Science*, **58**, 11-20.

ERT (Scotland) Ltd., 2002. Sullom Voe oil terminal effluent discharge site chemical and biological monitoring. April 2002 survey. *Report to BP Exploration Operating Company Ltd, Sullom Voe Terminal*.

Fava, G. & Volkmann, B., 1975. *Tisbe* (Copepoda: Harpacticoida) species from the lagoon of Venice 1. Seasonal fluctuations and ecology. *Marine Biology*, **30**, 151-166.

Ferns, P.N., Rostron, D.M. & Siman, H.Y., 2000. Effects of mechanical cockle harvesting on intertidal communities. *Journal of Applied Ecology*, **37**, 464-474.

Fulton, C., 1962. Environmental factors influencing the growth of Cordylophora. *Journal of Experimental Zoology*, **151**, 61-78.

Furness, R.W. & Rainbow, P.S., 1990. *Heavy metals in the marine environment.* Florida: CRC Press.

Gee, J.M., Warwick, R.M., Schanning, M., Berge, J.A. & Ambrose Jr., W.G. 1985. Effects of organic enrichment on meiofaunal abundance and community structure in sublittoral soft sediments. *Journal of Experimental Marine Biology and Ecology*, **91**, 247-262.

Gibbs, P., Bryan, G, & Spence, S., 1991. The impact of tributyltin (TBT) pollution on *Nucella lapillus* (Gastropoda) populations around the coast of south-east England. *Oceanologica Acta, Special Issue*, **11**, 257-261

Gomez Gesteira, J.L. & Dauvin, J.C., 2000. Amphipods are good bioindicators of the impact of oil spills on soft-bottom macrobenthic communities. *Marine Pollution Bulletin*, **40**, 1017-1027.

Grant, A. & Briggs, A.D., 1998. Toxicity of Ivermectin to estuarine and marine invertebrates. *Marine Pollution Bulletin*, **36**, 540-541.

Gray, J.S. & Pearson, T.H., 1982. Objective selection of sensitive species indicative of pollution-induced change in benthic communities .1. Comparative methodology. *Marine Ecology Progress Series*, **9**, 111-119.

Gray, J.S., 1976. The fauna of the polluted river Tees estuary. *Estuarine and Coastal Marine Science*, **4**, 653-676.

Gray, J.S., Clarke, K.R., Warwick, R.M. & Hobbs, G., 1990. Detection of initial effects of pollution on marine benthos: an example from the Ekofisk and Eldfisk oilfields, North Sea. *Marine Ecology Progress Series*, **66**, 285-299.

Halcrow, W., Mackay, D.W. & Thornton, I., 1973. The distribution of trace metals and fauna in the Firth of Clyde in relation to the disposal of sewage sludge. *Journal of the Marine Biological Association of the United Kingdom*, **53**, 721-739.

Hall, J.A., Frid, C.L.J. & Gill, M.E., 1997. The response of estuarine fish and benthos to an increasing discharge of sewage effluent. *Marine Pollution Bulletin*, **34**, 527-535.

Hall, S.J., Basford, D.J. & Robertson, M.R., 1990. The impact of hydraulic dredging for razor clams *Ensis sp*. on an infaunal community. *Netherlands Journal of Sea Research*, **27**, 119-125.

Hall-Spencer, J.M. & Moore, P.G., 2000a. Scallop dredging has profound, long-term impacts on maerl habitats. *ICES Journal of Marine Science*, **57**, 1407-1415.

Hall-Spencer, J.M. & Moore, P.G., 2000b. Impact of scallop dredging on maerl grounds. In *Effects of fishing on non-target species and habitats*. (ed. M.J. Kaiser & S.J., de Groot) 105-117. Oxford: Blackwell Science.

Hardy, F.G., Evans, S.M. & Tremayne, M.A., 1993. Long-term changes in the marine macroalgae of three polluted estuaries in north-east England. *Journal of Experimental Marine Biology and Ecology*, **172**, 81-92.

Hauton, C., Hall-Spencer, J.M. & Moore, P.G., 2003. An experimental study of the ecological impacts of hydraulic bivalve dredging on maerl. *ICES Journal of Marine Science*, **60**, 381-392.

Hawkins, S.J., Proud, S.V., Spence, S.K. & Southward, A.J., 1994. From the individual to the community and beyond: water quality, stress indicators and key species in coastal systems. In *Water quality and stress indicators in marine and freshwater ecosystems: linking levels of organisation (individuals, populations, communities)* (ed. D.W. Sutcliffe), 35-62. Ambleside, UK: Freshwater Biological Association.

Henriksson, R., 1969. Influence of pollution on the bottom fauna of the Sound (Öresund). *Oikos*, **20**, 507-523.

Hiscock, K., Langmead, O. & Warwick, R. 2004. Identification of seabed indicator species from time-series and other studies to support implementation of the EU Habitats and Water Framework Directives. *Report to the Joint Nature Conservation Committee and the Environment Agency from the Marine Biological Association.* Plymouth: Marine Biological Association. JNCC Contract F90-01-705. 109 pp.

Hiscock, K. & Kimmance, S., 2003. Review of current and historical seabed biological time-series in the UK and near Europe. *Report from the Marine Biological Association to the Joint Nature Conservation Committee*. JNCC Contract: F90-01-563, 55 pp.

Hiscock, K., Southward, A.J., Tittley, I. & Hawkins, S.J.A. 2004. Effect of changing temperature on benthic marine life in Britain and Ireland. *Aquatic Conservation*, **14**, 333-362.

Hiscock, K. & Tyler-Walters, H., in press. Assessing sensitivity of seabed species and biotopes – the Marine Life Information Network (*MarLIN*). *Hydrobiologia* (38th European Marine Biology Symposium proceedings).

Hartnoll, R.G., 1998. *Volume VIII. Circalittoral faunal turf biotopes: An overview of dynamics and sensitivity characteristics for conservation management of marine SACs*. Scottish Association of Marine Sciences, Oban, Scotland. [UK Marine SAC Project. Natura 2000 reports.]

Hoare, R. & Hiscock, K., 1974. An ecological survey of the rocky coast adjacent to a bromine extraction works. *Estuarine and Coastal Marine Science*, **2**, 329-348.

Holt, T.J., Rees, E.I., Hawkins, S.J. & Seed, R., 1998. *Biogenic reefs (Volume IX). An overview of dynamic and sensitivity characteristics for conservation management of marine SACs*. Scottish Association for Marine Science (UK Marine SACs Project), 174

Hopper, B.E. 1970. *Diplolaimelloides bruciei*: n.sp. (Monysteridae: Nematoda), prevalent in marsh grass, *Spartina alterniflora* Loisel. *Canadian Journal of Zoology*, **48**, 573-575.

Hopper, B.E., Fell, J.W. & Cefalu, R.C., 1973. Effects of temperature on the life cycles of nematodes associated with the mangrove (*Rhizophora mangle*) detrital system. *Marine Biology*, **23**, 293-296.

Howson, C.M. & Picton, B.E. (ed.), 1997. *The species directory of the marine fauna and flora of the British Isles and surrounding seas.* Ulster Museum and The Marine Conservation Society, Belfast and Ross-on-Wye. Belfast: Ulster Museum. [Ulster Museum publication, no. 276.]

Hyslop, B. T., M. S. Davies, *et al*. (1997). Effects of colliery waste on littoral communities in north-east England. *Environmental Pollution*, **96,** 383-400.

Inglis, W.G. & Coles, J.W., 1961. The species of *Rabditis* (Nematoda) found in rotting seaweed on British beaches. *Bulletin British Museum Natural History (Zoology),* **7**, 320-333.

Inglis, W.G., 1966. The occurrence of *Rhabditis marina* on Western Australian beaches. *Nematologica*, **12**, 643.

Johnson, L. J. and C. L. J. Frid (1995). The recovery of benthic communities along the County Durham coast after cessation of colliery spoil dumping. *Marine Pollution Bulletin*, **30**, 215-220.

Johnston, E & Keough, M.J., 2002. Direct and indirect effects of repeated pollution events on marine hard-substrate assemblages. *Ecological Applications*, **12**, 1212–1228.

Jones, D.J., 1973. Variation in the trophic structure and species composition of some invertebrate communities in polluted kelp forests in the North Sea. *Marine Biology*, **20**, 351-365.

Kaiser, M.J. & de Groot, S.J., 2000. *Effects of fishing on non-target species and habitats*. Oxford: Blackwell.

Kaiser, M.J. & Spencer, B.E., 1996. The effects of beam-trawl disturbance on infaunal communities in different habitats. *Journal of Animal Ecology*, **65**, 348-358.

Kaiser, M.J., Edwards, D.B., Armstrong, P.J., Radford, K., Lough, N.E.L., Flatt, R.P. & Jones, H.D., 1998. Changes in megafaunal benthic communities in different habitats after trawling disturbance. *ICES Journal of Marine Science*, **55**, 353-361.

Kaiser, M.J., Ramsay, K., Richardson, C.A., Spence, F.E. & Brand, A.R., 2000. Chronic fishing disturbance has changed shelf sea benthic community structure. *Journal of Animal Ecology*, **69**, 494-503.

Karez, R., Engelbert, S., Kraufvelin, P., Pedersen, M.F., & Sommer, U., 2004. Biomass responses and changes in composition of ephemeral macroalgal assembalges along an experimental gradient of nutrient enrichment. *Aquatic Botany*, **78**, 103-117.

Keller, M., 1986. Structure des peuplements meiobenthiques dans le secteur pollue par le reject en mer de l'egout de Marseille. *Annals of the Institute of Oceanography (Paris),* **62**, 13-36.

Kenny, A.J. & Rees, H.L., 1994. The effects of marine gravel extraction on the macrobenthos: early post-dredging recolonization. *Marine Pollution Bulletin*, **28**, 442-447.

Kenny, A.J. & Rees, H.L., 1996. The effects of marine gravel extraction on the macrobenthos: results 2 years post-dredging. *Marine Pollution Bulletin*, **32**, 615-622.

Kingston, P.F., 1987. Field effects of platform discharges on benthic macrofauna. *Philosophical Transactions of the Royal Society of London, Series B*, **316**, 545-565.

Kingston, P.F., Dixon, I.M.T., Hamilton, S. & Moore, D.C., 1995. The impact of the *Braer* oil spill on the macrobenthic infauna of the sediments off the Shetland Islands. *Marine Pollution Bulletin*, **30**, 445-459.

Konnecker, G., 1977. Epibenthic assemblages as indicators of environmental condition. In *Biology of benthic organisms* (ed. B.F. Keegan, P. O Ceidigh & P.J.S. Broaden), pp. 391-395. Oxford: Pergamon Press.

Kraufvelin, P, Christie, H, Olsen, M., 2002. Littoral macrofauna (secondary) responses to experimental nutrient addition to rocky shore mesocosms and a coastal lagoon. *Hydrobiologica*, **484**, 149-166.

Laffoley, D. & Hiscock, K., 1993. The classification of benthic estuarine communities for nature conservation assessments in Great Britain. *Netherlands Journal of Aquatic Ecology*, **27**, 181-187.

Langston, W.J., 1990. Toxic effects of metals and the incidence of metal pollution in marine ecosystems. In *Heavy metals in the marine environment* (ed. R.W. Furness and P.S. Rainbow), pp. 101-122. Florida: CRC Press.

Leppakoski, E., 1973. Effects of an oil spill in the northern Baltic. *Marine Pollution Bulletin*, **4**, 93-94.

Leppakoski, E., 1975. *Meerentutkimuslait. julk.*, **239**, 280-288.

Levell, D., Rostron, D. & Dixon, I.M.T., 1989. Sediment macrobenthic communities from oil ports to offshore oilfields. In *Ecological impacts of the oil industry* (ed. B. Dicks), pp. 97-134. London: Wiley.

Lindeboom, H.J. & De Groot, S.J., 1998. The effects of different types of fisheries on the North Sea and Irish Sea benthic ecosystems. *NIOZ-Rapport*, 404 pp.

Lorenzen, S. 1969. Freilebende meeresnematoden aus dem Schlikwatt and den Salzwiesen der Nordseekuste. *Veroff. Institut Meeresforsch. Bremerhaven*, **11**, 195-238.

Lorenzen, S., Prein, M., & Valentin, C., 1987. Mass aggregations of the free-living marine nematode *Pontonema vulgare* (Oncholaimidae) in organically polluted fjords. *Marine Ecology Progress Series,* **37**, 27-34.

Macdonald, D.S., Little, M., Eno, N.C. & Hiscock, K., 1996. Disturbance of benthic species by fishing activities: a sensitivity index. *Aquatic Conservation: Marine and Freshwater Ecosystems*, **6**, 257-268.

Magorrian, B.H. & Service, M., 1998. Analysis of underwater visual data to identify the impact of physical disturbance on horse mussel (*Modiolus modiolus*) beds. *Marine Pollution Bulletin*, **36**, 354-359.

Marcott, B.M. & Coull, B.C. 1974. Pollution, diversity and meiobenthic communities in the North Adriatic (Bay of Piran, Yugoslavia). *Vie Milieu*, **24B**, 281-330.

Matthiessen, P., Kilbride, R., Mason, C., Pendle, M., Rees, H.L. & Waldock, R., 1999. Monitoring the recovery of the benthic community in the River Crouch following TBT contamination. *Final Report for the Department of the Environment, Transport and the Regions (DETR). Centre for Environment, Fisheries and Aquaculture Science*, 51 pp.

Mattsson, J. & Linden, O., 1983. Benthic macrofauna succession under mussels, *Mytilus edulis* L. (Bivalvia), cultured on long-lines. *Sarsia*, **68**, 97-102.

May, S.J. & Pearson, T.H., 1995. Effects of oil-industry operations on the macrobenthos of Sullom Voe. *Proceedings of the Royal Society of Edinburgh, series B*, **103**, 69-97.

McLusky, D.S., Bryant, V. & Campbell, R., 1986. The effects of temperature and salinity on the toxicity of heavy metals to marine and estuarine invertebrates. *Oceanography and Marine Biology: an Annual Review*, **24**, 481-520.

Meire, P.M., Seys, J., Buijs, J. & Coosen, J., 1994. Spatial and temporal patterns of intertidal macrobenthic populations in the Oosterschelde: are they influenced by the construction of the storm-surge barrier? *Hydrobiologia*, **282/283**, 157-182.

Millner, R. S., R. R. Dickson, *et al*. (1977). Physical and biological studies of a dredging ground off the east coast of England, ICES Committee Meeting Papers and Reports. **C.M.1977/E:48:** 11.

Moore, C.G., 1996. *The distribution of serpulid reefs in Loch Creran, Argyll*. Scottish Natural Heritage Research, Survey and Monitoring Report No 53.

Moore, C.G. & Pearson, T.H., 1986. Response of a marine benthic copepod assemblage to organic enrichment. In *Proceedings of the Second International Conference on Copepoda, Ottowa, Canada, 13-17 August 1984* (ed. G. Schriever *et al.*), pp. 369-373. Ottowa: National Museum of Canada.

Moore, J., 1991. Studies on the impact of hydraulic cockle dredging on intertidal sediment flat communities. *Final report. Field Studies Council Research Centre Oil Pollution Research Unit.* 46 pp.

Moore, J., 1997. Rocky shore transect monitoring in Milford Haven, October 1996. *Impacts of the Sea Empress oil spill*. Countryside Council for Wales Sea Empress Contract Report, 241, 90pp.

Moore, J.J., 1998. Sea Empress oil spill: impacts on rocky and sedimentary shores. In *The Sea Empress Oil Spill* (ed. R. Edwards & H. Sime), pp. 173-187. Lavenham, Suffolk: Chartered Institution of Water and Environmental Management.

Mucha, A.P., Vasconcelos, M.T.S.D. & Bordalo, A.A., 2004. Vertical distribution of the macrobenthic community and its relationships to trace metals and natural sediment characteristics in the lower Douro estuary, Portugal. *Estuarine, Coastal and Shelf Science*, **59**, 663-673.

Naylor, E., 1965. Effects of heated effluents upon marine and estuarine organisms. *Advances in Marine Biology*, **3**, 63-103.

Newell, R.C., 1985. A survey of the benthos in the lower Humber estuary in the vicinity of the Tioxide UK outfall at Grimsby, October 1983. *Tioxide UK Limited*, 105 pp.

Newell, R.C., Newell, P.F. & Trett, M.W., 1984. Benthic communities in Seaton Channel (Teesmouth): a survey of macro- and microbenthos in relation to the Tioxide UK outfall. *Tioxide UK Ltd and Marine Ecological Surveys Ltd*, 64 pp.

Nikitik, C.C.S. & Robinson, A.W., 2003. Patterns in benthic populations in the Milford Haven waterway following the 'Sea Empress' oil spill with special reference to amphipods. *Marine Pollution Bulletin*, **46**, 1125-1141.

Olesen, T.M.E., & Weeks, J.M., 1994. Accumulation of Cd by the Marine Sponge *Halichondria panica* Pallas: Effects upon Filtration Rate and Its Relevance for Biomonitoring. *Bulletin of Environmental Contamination and Toxicology*, **52**, 722-728.

Olsgard, F. & Gray, J.S., 1995. A comprehensive analysis of the effects of offshore oil and gas exploration and production on the benthic communities of the Norwegian continental shelf. *Marine Ecology Progress Series*, **122**, 277-306.

Olsgard, F., 1999. Effects of copper contamination on recolonisation of subtidal marine soft sediments - an experimental field study. *Marine Pollution Bulletin*, **38**, 448-462.

Oug, E., Naes, K. & Rygg, B., 1998. Relationship between soft bottom macrofauna and polycyclic aromatic hydrocarbons (PAH) from smelter discharge in Norwegian fjords and coastal waters. *Marine Ecology Progress Series*, **173**, 39-52.

Pearson, T.H. & Black, K.D., 2001. The environmental impacts of marine fish cage culture. In *Environmental impacts of aquaculture* (ed. K.D. Black), pp. 1-31. Sheffield: Academic Press.

Pearson, T.H. & Rosenberg, R., 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. *Oceanography and Marine Biology. Annual Review*, **16**, 229-311.

Pearson, T.H., 1975. The benthic ecology of Loch Linnhe and Loch Eil, a sea-loch system on the west coast of Scotland. IV. Changes in the benthic fauna attributable to organic enrichment. *Journal of Experimental Marine Biology and Ecology*, **20**, 1-41.

Pearson, T.H., Josefson, A.B. & Rosenberg, R., 1985. Petersen's benthic stations revisited. I. Is the Kattegatt becoming eutrophic? *Journal of Experimental Marine Biology and Ecology*, **92**, 157-206.

Prein M., 1988. Evidence for a scavenging lifestyle in the freeliving nematode *Pontonema vulgare* (Enoplida, Oncholaimidae). *Kieler Meeresforsch*, **6**, 389-394.

Raffaelli, D., Hull, S., & Milne, H., 1989. Long-term changes in nutrients, weed mats and shorebirds in an estuarine system. *Cahiers de Biologie Marine*, **30**, 259-270.

Read, P., 1987. The intertidal benthos and sediments of particulate shores in the Firth of Forth, Scotland, with particular reference to waste water discharges. *Proceedings of the Royal Society of Edinburgh*, **93B**, 401-413.

Rees, H.L., Rowlatt, M.A., Lambert, M.A., Lees, R.G. & Limpenny, D.S., 1992. Spatial and temporal trends in the benthos and sediments in relation to sewage sludge disposal off the northeast coast of England. *ICES Journal of Marine Science*, **49**, 55-64.

Ringelband, U., & Karbe L., 1996. Effects of Vanadium on Population Growth and Na-K-ATPase Activity of the Brackish Water Hydroid Cordylophora caspia. *Bulletin of Environmental Contamination Toxicology*, **57**,118-124.

Rosenberg, R., 1977. Effects of dredging operations on esturine benthic macrofauna. *Marine Pollution Bulletin*, **8**, 102-104.

Rosenberg, R., 1972. Benthic faunal recovery in a Swedish fjord following the closure of a sulphite pulp mill. *Oikos*, **23**, 92-108.

Rumohr, H. & Kujawski, T., 2000. The impact of trawl fishery on the epifauna of the southern North Sea. *ICES Journal of Marine Science*, **57**, 1389-1394.

Rutt, G.P., Levell, D., Hobbs, G., Rostron, D.M., Bullimore, B., Law, R.J. & Robinson, A.W., 1998. The effects on the marine benthos. In *The Sea Empress oil spill* (ed. R. Edwards & H. Sime), pp. 189-206. Lavenham, Suffolk: Chartered Institution of Water and Environmental Management.

Rygg, B., 1985. Effect of sediment copper on benthic fauna. *Marine Ecology Progress Series*, **25**, 83-89.

Saiz Salinas, J.I. & Urdangarin, I., 1994. Response of sublittoral hard substrate invertebrates to estuarine sedimentation in the outer harbour of Bilbao (N. Spain). *Marine Ecology*, **15**, 105-131.

SAMS (Scottish Association for Marine Science), 2005. Ecological effects of sea lice medicines in Scittish sea lochs. Funal Report. Oban: Scottish Assocaition for Marine Science. Available from: www.sams.ac.uk/research/coastal%20imapcts/ecol.htm (*sic*).

Sandulli, R. & Nicola-Giudici, M. de, 1989. Effects of organic enrichment on meiofauna: a laboratory study. *Marine Pollution Bulletin*, **20**, 223-227.

Service, M. & Magorrian, B.H., 1997. The extent and temporal variation of disturbance to epibenthic communities in Strangford Lough, Northern Ireland. *Journal of the Marine Biological Association of the United Kingdom*, **77**, 1151-1164.

Sewell, J. & Hiscock, K., 2005. Effects of fishing within UK European Marine Sites: guidance for nature conservation agencies. *Report to the Countryside Council for Wales, English Nature and Scottish Natural Heritage from the Marine Biological Association.* Plymouth: Marine Biological Association. CCW Contract FC 73-03-214A. 195 pp.

Sheader, M., 1986. The effect of intensive dredging on benthic community structure. *University of Southampton*. Report to the Nature Conservancy Council, Peterborough (CST Report 679) 61 pp.

Shelton, R. G. J. and M. S. Rolfe 1972. The biological implications of aggregate extraction: recent studies in the English Channel, ICES Committee Meetings Papers and Reports**:** 12.

Shillabeer, N. & Tapp, J.F., 1990. Long-term studies of the benthic biology of Tees bay and the Tees estuary. *Hydrobiologia*, **195**, 63-78.

Smith, J.E. (ed.), 1968. *'Torrey Canyon'. Pollution and marine life. A report by the Plymouth Laboratory of the Marine Biological Association of the United Kingdom*. Cambridge: Cambridge University Press.

Smyth, J.C., 1968. The fauna of a polluted site in the Firth of Forth. *Helgolander Wissenschaftliche Meeresuntersuchungen*, **17**, 216-233.

Southern Science, 1992. An experimental study on the impact of clam dredging on soft sediment macroinvertebrates. *English Nature Research Reports*, 79 pp.

Spencer, B.E., Kaiser, M.J. & Edwards, D.B., 1997. Ecological effects of intertidal Manila clam cultivation: observations at the end of the cultivation phase. *Journal of Applied Ecology*, **34**, 444-452.

Spencer, B.E., Kaiser, M.J. & Edwards, D.B., 1998. Intertidal clam harvesting: benthic community change and recovery. *Aquaculture Research*, **29**, 429-437.

Thain, J.E., Davies, I.M., Rae, G.H. & Allen, Y.T., 1997. Acute toxicity of Ivermectin to the lugworm *Arenicola marina*. *Aquaculture*, **159**, 47-52.

Tuck, I.D., Hall, S.J., Robertson, M.R., Armstrong, E. & Basford, D.J., 1998. Effects of physical trawling disturbance in a previously unfished sheltered Scottish sea loch. *Marine Ecology Progress Series*, **162**, 227-242.

Van Dalfsen, J.A., Essink, K., Toxvig Madsen, H., Birklund, J., Romero, J. & Manzanera, M., 2000. Differential response of macrozoobenthos to marine sand extraction in the North Sea and the Western Mediterranean. *ICES Journal of Marine Science*, **57**, 1439-1445.

Van Moorsel, N. T. 1994. Geomorphology, macrobenthic ecology and the effects of gravel extraction, Rapport Bureau Waardenberg and the North Sea Directorate (DNZ), Ministry of Transport, Public Works and Water Management, The Netherlands.

Veale, L.O., Hill, A.S., Hawkins, S.J. & Brand, A.R., 2000. Effects of long-term physical disturbance by commercial scallop fishing on subtidal epifaunal assemblages and habitats. *Marine Biology*, **137**, 325-337.

Volkmann, B., 1979. A revision of the genus *Tisbe* (Copepoda: Harpacticoida). Part 1. *Archo. Oceanogr. Limnol. Suppl*., **19**, 121-284.

Wahl, M., 1984. The fluffy sea anemone Metridium senile in periodically oxygen depleted surroundings. *Marine Biology*, **81**, 81-86.

Walker, A.J.M. & Rees, E.I.S., 1980. Benthic ecology of Dublin Bay in relation to sludge dumping: fauna. *Irish Fisheries Investigation Series B (Marine),* **22**, 1-59.

Warwick, R.M. & Robinson, J. 2000. Sibling species in the marine pollution indicator genus *Pontonema* Leidy (Nematoda: Oncholaimidae), with a description of *P. mediterranea* sp. nov. *Journal of Natural History*, **34**, 641-662.

Warwick, R.M., 2001. Evidence for the effects of metal contamination on the intertidal macrobenthic assemblages of the Fal estuary. *Marine Pollution Bulletin*, **42**, 145-148.

Warwick, R.M., Goss-Custard, J.D., Kirby, R., George, C.L., Pope, N.D. & Rowden, A.A., 1991. Static and dynamic environmental factors determining the community structure of estuarine macrobenthos in SW Britain: why is the Severn Estuary different? *Journal of Applied Ecology*, **28**, 329-345.

Wright, J.F., Sutcliffe, D.W., & Furse, M.T., 2000. Assessing the biological quality of fresh waters. RIVPACS and other techniques. Ambleside: The Freshwater Biological Association.

APPENDIX 1. Species likely to respond to exposure pressures (environmental factors) and that might be identified as indicator species.

Annotations are: HI = Highly Intolerant; I = Intolerant; T= Tolerant; F = Favoured; HF = Highly Favoured.

Sources of information are:

HI [no superscript number] *MarLIN* reviews. See www.marlin.ac.uk for sources and interpretation.

[1] Table 1 (Post-TBT Crouch Estuary infauna: Matthiessen *et al.*, 1999)

[2] Box 3 (Tolerance of sediment species to copper: Rygg, 1985) (Not including species not listed in Howson & Picton 1997)

[3] Box 5 (Salinity variation: Mucha *et al.*, 2004)

[4] Appendix 2 of Hiscock *et al.* (2004) (Results of the literature review.) (Most references are identified precisely but for those indicated [4], the reader will need to refer to Appendix 2 in Hiscock *et al.*, 2004)

[5] (Redundant)

[6] Hardy *et al*. , 1993	[10] Newell,1985	[14] Bamber & Spencer, 1984	[18] Moore, 1991	[22] Veale *et al*., 2000	[26] Southern Sciences, 1992
[7] Desgarrado Periera *et al.,* 1997	[11] Meire *et al.*, 1994	[15] Hall *et al*., 1990	[19] Cowie *et al*., 2000	[23] Kaiser *et al*., 2000	[27] Hauton *et al.*, 2003
[8] Gray, 1976	[12] Warwick *et al.*, 1991	[16] Ferns, 2000	[20] Shaeder, 1986	[24] Bradshaw *et al*., 2002	[28] Hall-Spencer & Moore, 2000
[9] Newell *et al*., 1984	[13] Barnett & Watson, 1986	[17] Beukema, 1995	[21] Devon Wildlife Trust ,1994	[25] Eleftheriou & Robertson, 1992	[29] MacDonald *et al*., 1996
					[30] Eno *et al*., 2001

[31.] Read, 1987	[35] Bagge, 1969	[39] Pearson, 1975	[43] Henriksson, 1969	[47] Desprez, 2000	[51] Kenny & Rees, 1994
[32] Shillabeer & Tapp, 1990	[36] Eagle, 1973	[40] Rosenberg, 1972	[44] Leppakoski, 1975	[48] Boyd *et al*., 2003	[52] Kenny & Rees, 1996
[33] Bustos-Baez & Frid, 2003	[37] Rees *et al*., 1992	[41] Dybern, 1972	[45] Beyer, 1968	[49] Shelton & Rolfe, 1972	[53] Millner *et al*., 1977

[34] Anger, 1975

[38] Hall *et al*., 1997

[42] Halcrow *et al*., 1973

[46] Diaz & Rosenberg, 1995

[50] Van Moorsel, 1994

[54] van Dalfsen *et al*., 2000

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[55] Hyslop *et al*., 1997

[56] Johnson & Frid, 1995

[57]Bergman & Hup, 1992

[58] Lindeboom & De Groot, 1998

[59] Rumohr & Kujawski, 2000

[60] Craeymeersch *et al*., 2000

[61] Kaiser *et al*., 1998

[62] Kaiser & Spencer, 1996

[63] Atkinson, 1989

[64] Ball *et al*., 2000

[65] Tuck *et al*., 1998

[66] Brown *et al*., 1987

[67] Pearson & Black, 2001

[68] Mattson & Linden, 1983

[69] Black *et al*., 1997

[70] Collier & Pinn, 1998

[71] Grant & Briggs, 1998

[72] Thain *et al*., 1997

[73] Spencer *et al*., 1997

[74] Spencer *et al*., 1998

[75] Beukema, 1989

[76] Beukema, 1991

[77] Pearson et al., 1985

[78] Crump *et al*., 1998

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[79] Dicks & Levell, 1989

[80] Moore, 1998

[81] Nikitik & Robinson, 2003

[82] Olsgard & Gray, 1995

[83] Gray et al., 1990

[84] Kingston, 1987

[85] Kingston *et al*., 1995

[86] Davies *et al*., 1984

[87] Levell *et al*., 1989

[88] Rutt *et al*., 1998

[89] Gomez Gesteira & Dauvin, 2000

[90] Oug *et al*., 1998

[91] Daan *et al*., 1994

[92] Dixon, 1987

[93] Bryan *et al*., 1987

[94] (Redundant)

[95] Olsgard, 1999

[96] Dauvin, 1998

[97] Bamber, 1989

[98] Leppakowski, 1973

[99] Rosenberg, 1977

[100] Warwick, 2001

[101] Jones, 1973

[102] Smith (ed.), 1968

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[103] Cole *et al*., 1999

[104] Ringleband Karbe, 1996

[105] Johnston & Keough, 2002

[106] Karez *et al*., 2004

[107] Kraufvelin *et al*., 2002

[108] Moore, 1996

[109] Saiz Salinas & Urdangarin, 1994

[110] Moore, 1997

[111] Hall-Spencer & Moore, 2000a

[112] Belan, 1990

[113] Oleson & Weeks, 1994

[114] Fulton, 1962

[115] Magorrian & Service, 1998

[116] Service & Magorrian, 1997

[117] Hartnoll, 1998

[118] Holt *et al*., 1998

[119] Konnecker, 1997

[120] McLusky *et al*., 1986

[121] Naylor, 1965

[122] Smyth, 1968

[123] Wahl, 1984

[124] Walker & Rees, 1980

[125] Hoare & Hiscock, 1974

Species	EA 'Exposure pressure'																Habitat(s) (where specified)	Notes
	[None]	[None]	Suspended sediment		Increased turbidity	[None]	Priority substances			Nitrate / Phosphate	Salinity		Oxygen concentration	Thermal range/heat		Industrial effluents (gen.) incl. sewage & metals		
	Equivalent *MarLIN* environmental factor																	
	Substratum loss	Smothering	Increased suspended sediment	Decreased suspended sediment	Increased turbidity	Physical disturbance [* = dredging - fishery]	Synthetic chemicals [Tox =chemotherap.]	Heavy metals	Hydrocarbons	Changes in nutrients [* =. Org. enrich. mari.]	Increased salinity	Decreased Salinity	Deoxygenation	Increased temperature	Decreased temperature			

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Abra alba	F[49]	F[4]				HI[18*] [27]	HI		HI[92] F[88]	HI[33*] I[46*]			I[4]([2])			F[9]	A2.2 Litt. sands & muddy sands; A4.1 Sub. cob., grav., cse snd; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds; A4.6 Biogenic structs over sublitt. sed. Various (Diaz & Rosen.)	Intermediate to organic enrichment [45]
Abra nitida	HI	HI[99]				HI[20*]		HI[2]		HI[40]*			I[46]([2])				A2.3 Litt. mudsA4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds Various (Diaz & Rosen.)	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Abra prismatica									HI[82, 83]								A4.2 Sublitt. sands & muddy sands	
Abra sp.						HI[64*]											A4.2 Sublitt. sands & muddy sands	
Abra tenuis						HI[20*, 26*]											A2.3 Litt. muds; A4.4 Sublitt. combi. seds	
Achelia echinata							HI[1]											[1] = TBT
Actinia equina																HI[125]	A1.2 Litt. Rk mod. Exp waves	[125] = acidified-halogenated
Actinothoe sphyrodeta			T[109]															
Aequipecten opercularis						HI[22*]											A4.1 Sub. cob., grav., cse snd	
Ahnfeltia plicata							HI		HI									
Alaria esculenta											HI			HI				
Alentia gelatinosa						I[27*]											A4.6 Biogenic structs over sublitt. Sed.	
Alcyonidium mytili																HI[125]	A.3.2 Infralitt. rock mod. exp. wave act..	[125] = acidified-halogenated
Alcyonium digitatum	HI[49]					HI[21*, 22*, 23] I[117]	HI[102]						HI			I[125]	A3.6 Circalitt. rk mod. exp. wave act..; A4.1 Sub. cob., grav., cse snd	[125] = acidified-halogenated
Alkmaria romijni	HI	HI				HI												
Ampelisca brevicornis						HI[60*]			HI[80]								A2.2 Litt. Sands & muddy sands; A4.2 Sublitt. sands & muddy sands	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Ampelisca spinipes		F[4]															A4.2 Sub. Sands & muddy sands	
Ampelisca spp.						HI[62*]			HI[96] [89] [83] [88]								A4.2 Sublitt. sands & muddy sands	
Ampharete grubei	F[49]					HI[73] [26*] F[73]				F[33*]			HI[46]				A4.1 Sub. cob., grav., cse snd; A4.2 Sublitt. sands & muddy sands; A4.4 Sublitt. combi. Seds; Various (Diaz & Rosen.)	In some papers as *A. acutifrons*
Ampharete sp.										F[38*] [39*]							[4]A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. Muds	
Amphianthus dohrnii	HI					HI												
Amphipholis squamata	HI[47] [48]																A4.1 Sub. cob., grav., cse snd	
Amphipoda indet.	HI[51] [52]								HI[85]	HI[45*]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds; A.4.1 Sub. cob., grav., cse snd	
Amphiura chiajei						HI[64*]		I[2]	HI	HI[45*]([2]) [68*]		HI	I[4]([2])				A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds; Various (Diaz & Rosen.)	[2] = Copper
Amphiura filiformis		I[97]				I[58*] [59*] F[24*]	HI	I[2]		** missing			I[4]([3])				A4.1 Sub. cob., grav., cse snd; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds Various (Diaz & Rosen.)	[2] = Copper Intermediate to organic enrichment [45]
Amphiura sp.										F[39*]							A4.3 Sublitt. Muds	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Amythasides macroglossum									I[82]								A4.2 Sublitt. sands & muddy sands	
Anaitides groenlandica								T[2]		F[35*] [40*]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. Muds	[2] = Copper
Anaitides sp.										F[75]								
Anoplodactylus pygmaeus							HI[1]											[1] = TBT
Antedon bifida		HI				HI	HI		HI		HI	HI				HI[125]	A3.6 Circalitt. rk mod. exp. wave act.;	[125] = acidified-halogenated
Aonides paucibranchiata									I[82, 85]								A4.2 Sublitt. Sands & muddy sands	
Aora typica																HI[125]	A.3.2 Infralitt. rock mod. exp. Wave act.;	[125] = acidified-halogenated
Aphelochaeta marioni							HI[1]	I[93]								F[10]	A2.3 Litt. Muds; A4.3 Sublitt muds	
Aphelochaeta multibranchis							HI[1]											
Aphelochaeta sp.		F[4]																
Aphrodita aculeata						I[61*] [22]					HI	HI					A4.1 Sub. Cob., grav., cse snd; A4.2 Sublitt. Sands & muddy sands	
Apistobranchus paucibranchiata										I[77] F[67*]							A4.3 Sublitt. Muds	
Arctica islandica	I[50]	I[99]				I[59*] [60*]	HI						T[46]([2])	HI			A4.2 Sublitt sands & muddy sands; Various (Diaz & Rosen.)	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
																	A4.1 Sub. Cob., grav., cse snd; A4.3 Sublitt. Muds	
Arenicola marina							HI[82]			F[31]* [75]			T[46]				A2.2 Litt. Sands & muddy sands; A2.3 Littoral muds; A4.3 Sublitt. Muds Various (Diaz & Rosen.)	
Aricidea wassi									I[82]								A4.2 Sublitt. Sands & muddy sands	
Armandia cirrhosa	HI										HI							Rapid colonizer
Ascidiella scabra						HI										HI[125]	A.3.2 Infralitt. rock mod. exp. Wave act.;	[125] = acidified-halogenated
Ascophyllum nodosum	HI	HI				HI	HI											
Astarte borealis													T[46]([2])				Various (Diaz & Rosen.)	
Asterias rubens	I[49]					I[57*] F[24*]			HI		HI		HI	HI		T[125]	A3.6 Circalitt. Rk mod. exp. Wave act.; A4.2 Sublitt. Sands & muddy sands; A4.1 Sub. Cob., grav., cse snd	[125] = acidified-halogenated
Atrina fragilis	HI	HI				HI								HI				
Atylus swammerdami						F[60*]											A4.2 Sublitt. Sands & muddy sands	
Audouinella purpurea																HI[6]	A1.3 Litt. Rock shelt. Wave act.	
Axinella dissimilis	HI[119]	HI	HI			HI[119]					HI		HI	HI				
Balanus crenatus	I[51] [52]	HI					HI						HI	HI I[121]		T[125]	A3.6 Circalitt. Rk mod. exp. Wave act.; Sub. Cob., grav., cse snd	[125] = acidified-halogenated
Balanus improvisus																T[7]	A2.3 Litt muds (on stones?)	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Bangia atropurpurea																HI[6]	A1.3 Litt. Rock shelt. Wave act.	
Bathyporeia elegans						I[15*]											A2.2 Litt sands & muddy sands	
Bathyporeia pelagica		I[55]					HI		HI	HI	HI		HI				A2.2 Litt. Sands & muddy sands	
Bathyporeia pilosa						I[16*]											A2.2 Litt. Sands & muddy sands	
Bathyporeia sp.									I[80]								A2.2 Litt. Sands & muddy sands	
Berthella plumula																HI[101]		
Botryllus schlosseri		HI	HI													HI[125]	A3.6 Circalitt. Rk mod. exp. Wave act.;	[125] = acidified-halogenated
Brada villosa								HI[2]									A4.3 Sublitt. Muds	
Bradyidius armatus										F[45*]							A4.3 Sublitt. Muds	
Branchiostoma lanceolatum	I[47]																A4.1 Sub. Cob., grav., cse snd	
Brissopsis lyrifera						I[64*]	HI			F[40*]			I[46]				A4.3 Sublitt. Muds; Various (Diaz & Rosen.)	
Buccinum undatum						I[23*] [65*] F[24*] [59*]											A4.1 Sub. Cob., grav., cse snd; A4.2 Sublitt. Sands & muddy sands; A4.3 Sublitt. Muds	
Bugula turbinata		HI					HI		HI									
Caecum armoricum	HI					HI					HI							
Callianassa subterranea						I[58*]	HI		I[91]		HI						A4.2 Sublitt. Sands & muddy sands	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Calliostoma zizyphinum						F[24*]											A4.1 Sub. Cob., grav., cse snd	
Callithamnion sepositum																HI[6]	A1.3 Litt. Rock shelt. Wave act.	
Calocaris macandreae								HI[2]										[2] = Copper
Campanulariidae indet.						I[24*]											A4.1 Sub. cob., grav., cse snd	
Cancer pagurus		HI				I[25*] F[22*]	HI		HI							T[125]	A3.6 Circalitt. rk mod. exp. wave act.; A4.1 Sub. cob., grav., cse snd; A4.2 Sublitt. sands & muddy sands	[125] = acidified-halogenated
Capitella capitata							HI[69]	T[95] F[86]	F[82 83 84 85 86 88]	F[8* 31* 32* 33* 34* 35* 36* 39* 40* 41* 42* 43* 44* 66* 67* 68*]			I[46(3)]			T[7 8]	A2.3 Littoral muds; A4.2 Sub. Sands & muddy sands; A4.3 Sublitt. muds Various (Diaz & Rosen.)	[2] = Copper
Capitella sp.									F[80]								A2.2 Litt. sands & muddy sands	
Capitellides giardi																F[9]	A4.3 Sublitt. mud	
Capitomastus minimus						I[64]				F[32*]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Capitomastus sp.										F[39*]							A4.3 Sublitt. muds	
Caprella linearis							HI[1]											[1] = TBT

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Caprellidae indet.																HI[125]		[125] = acidified-halogenated
Carcinus maenas							HI[71]		HI				I[46]			HF[7]	A2.3 Litt. muds; Various (Diaz & Rosen.)	
Caryophyllia smithii						I[21*]											A3.6 Circalitt. rk mod. exp. wave act.	
Caulleriella killariensis						I[74]											A4.2 Sublitt. sands & muddy sands	
Caulleriella sp.								HI[93]	F[86 88]	F[67]*						T[8]	A2.3 Litt. muds; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Caulleriella zetlandica						F[65* 58*]								F[14]			A2.2 Litt . sands & muddy sands; A4.3 Sublitt. muds	
Cellaria sp.																HI[125]	A3.6 Circalitt. rk mod. exp. wave act.	[125] = acidified-halogenated
Cellepora hyalina																HF[125]	A3.6 Circalitt. rk mod. exp. wave act.	[125] = acidified-halogenated
Ceramium rubrum																HI[6]	A1.3 Litt. rock shelt. wave act.	
Ceramium shuttleworthianum																HI[6]	A1.3 Litt. rock shelt. wave act.	
Ceramium tenuissimum																HI[6]	A1.3 Litt. rock shelt. wave act.	
Ceramium virgatum							HI		HI									
Cerastoderma edule						I[16* 18* 26* 74]	I[1]	HI[93]	I[88]				HI	HI[14]		T[7] I[8]	A2.2 Litt. sands & muddy sands; A2.3 Litt. muds; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds; A4.4 Sublitt. combi. seds	[1] = TBT

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
						F[20*]												
Cerastoderma glaucum	HI	HI			I[12]					HI			HI					
Ceratocephale loveni								F[2]										[2] = Copper
Cerianthus lloydii						I[27*]											A4.6 Biogenic structs over sublitt. sed.	
Chaetopterus variopedatus						I[27*]											A4.6 Biogenic structs over sublitt. sed.	
Chaetozone gibber									F[80 81 88]								A2.2 Litt. sands & muddy sands; A4.2 Sublitt. sands & muddy sands	
Chaetozone setosa		F[98]				I[64*] F[65* 58* 83]		T[2] I[95]	F[82 89 83 85 88]	F[32* 40*] F [68*]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	[2] = Copper
Chaetozone sp.									F[86]								A4.2 Sublitt. sands & muddy sands	
Chironomidae indet.											T[3]	T[3]						
Chlamys varia																T[125]	A3.6 Circalitt. rk mod. exp. wave act	[125] = acidified-halogenated
Chondrus crispus							HI											
Chthamalus montagui												HI	HI		HI			
Chthamalus sp.									I[78]									
Chthamalus stellatus							I[102]					HI	HI		HI			
Cingula vitrea						I[58*]											A4.2 Sublitt. sands & muddy sands	
Ciona intestinalis						HI		I[105]										
Cirratulidae indet.					I[12]					F[32*]							A4.2 Sublitt. sands & muddy sands ;	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
										37* 67*							A4.3 Sublitt. muds	
Cirratulus cirratus		HI					HI	T[2]	F[82]	F[112]							A4.2 Sublitt. sands & muddy sands	[2] = Copper
Cirriformia sp.						I[20*]											A2.3 Litt. muds	
Cirriformia tentaculata								I[93]		F[32*]						F[9]	A2.3 Litt. muds; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Clausinella fasciata						I[22*]											A4.1 Sub. cob., grav., cse snd	
Clavelina lepadiformis		HI				HI												
Clavopsella navis	HI	HI	HI			HI												
Clitellio arenaria										F[31*]							A2.3 Littoral muds	
Collembola indet.											T[3]	T[3]						
Conopeum reticulum		HI							HI									
Corallina officinalis																HI[125]	A1.2 Litt. Rk mod. Exp waves	[125] = acidified-halogenated
Corbula gibba						I[64] 65		F[2]		F[35*] 39* 41*			T[46(5)]				A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds Various (Diaz & Rosen.)	[2] = Copper
Corophium arenarium					I[12]	I[16*]											A2.2 Litt. sands & muddy sands	
Corophium crassicorne						I[15*]											A2.2 Litt. sands & muddy sands	
Corophium sp.																T[7]	A2.3 Litt. muds	
Corophium bonelli																HI[125]	A3.6 Circalitt. rk mod. exp. wave act	[125] = acidified-halogenated
Corophium volutator		HI			I[12]		I[1]	T[93]	HI	F[8*]	T[3]	T[3]	HI			F[9]	A2.3 Littoral muds; A4.3 Sublitt. muds	[1] = TBT

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
							HI[70]	HI[100]		[31*] [41*]								
Corystes cassivelaunus						I[29*] F[59*]											A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Cossura longocirrata								T[95]									A4.3 Sublitt. muds	
Cossura sp.										F[67*]							A4.3 Sublitt. muds	
Crangon allemani	I[53]																A4.1 Sub. cob., grav., cse snd	
Crangon crangon	I[53]									I[77]			HI[46]			F[10]	A4.3 Sublitt. mids; Various (Diaz & Rosen.);A4.1 Sub. cob., grav., cse snd	
Crangonidae indet.										I[45*]							A4.3 Sublitt. muds	
Crepidula fornicata							HI											
Crisia denticulata																HI[125]	A3.6 Circalitt. rk mod. exp. wave act.	[125] = acidified-halogenated
Crisia sp.						I[24*]											A4.1 Sub. cob., grav., cse snd	
Crustacea indet.								HI[2]									A4.3 Sublitt. Muds	
Ctenodrilus sp.									F[84]								A4.2 Sublitt. Sands & muddy sands	
Cumacea indet.										I[45*]							A4.3 Sublitt. muds	
Cyathura carinata					I[12]			HI[100]			T[3]	T[3]					A2.3 Litt. muds	
Cylichna cylindracea						I[58*,64*]			I[91]								A4.3 Sublitt. muds	
Delesseria sanguinea							HI		HI				HI			HI[6]	A1.3 Litt. rock shelt. wave act.; A.3.2 Infralitt. rock mod. exp. wave action	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
																[125]		
Dendrodoa grossularia																HI[101]		
Diastylis bradyi										I[32*]							A4.2 Sublitt. sands & muddy sands	
Diastylis rathkei													I[46]				Various (Diaz & Rosen.)	
Diastylis sp.							HI[1]											[1] = TBT
Didemnidae indet.																T[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Diplocirrus glaucus						I[64*]		HI[2]		F[67*]							A4.3 Sublitt. muds	[2] = Copper
Donax vittatus	I[54]																A4.2 Sub. Snds & muddy snds	
Dosinia exoleta	I[50]					I[27*]											4.1 Sub. cob., grav., cse snd; A4.6 Biogenic structs over sublitt. sed.	
Dosinia lupinus						I[64*]											A4.3 Sublitt. muds	
Echinocardium cordatum	I[54]					HI I[25*, 29*, 57*, 58*, 64*] F[59*]	HI		I[91]	I[40*, 68*, 77]			HI				A4.2 Sub. Sands & muddy sands; A4.3 Sublitt. muds	
Echinocardium flavescens									I[82]								A4.2 Sub. Sands & muddy sands	
Echinocyamus pusillus	I[47]					I[59*]			I[82]								A4.2 Sublitt. sands & muddy sands; A4.1 Sub. Cob., grav., cse snd	
Echinodermata indet.								HI[2]									A4.3 Sublitt. muds	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Echinus esculentus						I[23*] HI[111]	HI[102]	HI	HI[102]								A4.1 Sub. cob., grav., cse snd	
Eclysippe vanelli									I[82]								A4.2 Sublitt. sands & muddy sands	
Edwardsia ivelli	HI	HI				HI												
Edwardsia sp.									I[82]								A4.2 Sub. sands & muddy sands	
Electra pilosa		HI														T[125]	A3.2 Infralitt. Rk mod. exp. Wave act.	[125] = acidified-halogenated
Elminius modestus									I[79]							T[7]	A2.3 Litt. Muds (on stones?)	
Enchytraeidae indet.							HI[1]				T[3]	T[3]						[1] = TBT
Enipo kinbergi						I[58*]											A4.2 Sublitt. sands & muddy sands	
Ennucula tenuis								HI[2]										[2] = Copper
Ensis arcuatus						I[27*]											A4.6 Biogenic structs over sublitt. sed.	
Ensis ensis						I[25*]											A4.2 Sublitt. sands & muddy sands	
Ensis siliqua									I[88]								A4.2 Sublitt. sands & muddy sands	
Ensis spp.	I[50]					I[29*]	HI		HI								A4.2 Sublitt. sands & muddy sands; A4.1 Sub. cob., grav., cse snd	
Enteromorpha sp.		HI							F[78]								A1.2 Litt. Rk mod. Exp waves	
Ericthonius brasiliensis																HI[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Eriopisa elongata						I[4]		HI[2]									A4.2 Sublitt. sands & muddy sands	[2] = Copper
Escharoides coccineus																T[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Eteone longa						I[26*]	HI[1]	T[95]		F[42*] [31*] [35*] [36*] [39*] [41*] [75]							A2.3 Littoral muds; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds ; A4.4 Sublitt. combi. seds	[1] = TBT, [2] = copper;
Euclymene lumbricoides						F[83]											A4.2 Sublitt. sands & muddy sands	
Eudorella emarginata								HI[2]										[2] = Copper
Eulalia sanguinea																T[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Eulalia virdis																F[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Eulalia sp.										F[39*] [76]							A4.3 Sublitt. muds	
Eumida sp.										I[67*]								
Eunicella verrucosa	HI					I[21*]						HI	HI				A3.6 Circalitt. rk mod. exp. wave act.	
Eurydice pulchra		HI					HI			HI			HI					
Eurystheus maculatus																I[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Exogone naidina							HI[1]											[1] = TBT
Exogone sp.							HI[1]											[1] = TBT
Fabricia sabella								F[100]									A.2.3 Littoral muds	
Fabulina fabula		F[4]				I[57*]	HI			I[32*]							A4.2 Sublitt. sands & muddy sands	
Flustra foliacea			F[117]				HI					HI				T[125]	A3.6 Circalitt. rk mod. exp. wave act.	[125] = acidified-halogenated

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Fucus ceranoides		HI																
Fucus distichus		HI												HI				
Fucus serratus		HI					HI									HI[6]	A1.3 Litt. rock shelt. wave act.	
Fucus spiralis		HI						HI										
Fucus vesiculosus		HI																
Funiculina quadrangularis	HI					I[29*]											A4.3 Sublitt. muds	
Furcellaria lumbricalis						I	HI		HI									
Galathea intermedia						F[24*]											A4.1 Sub. cob., grav., cse snd	
Gammarus insensibilis	HI				HI		HI		HI									
Gammarus salinus									HI									
Gammarus tigrinus													I[46]				Various (Diaz & Rosen.)	
Gari fervensis	I[50]																A4.1 Sub. cob., grav., cse snd	
Gattyana cirrosa									I[91]								A4.2 Sublitt. sands & muddy sands	
Giffordia granulosa																HI[6]	A1.3 Litt. rock shelt. wave act.	
Glycera alba								T[95]		I[67*] F[40*]							A4.3 Sublitt. muds	[2] = Copper
Glycera lapidum									I[85]	I[4]							A4.2 Sublitt. sands & muddy sands	
Glycera rouxii								HI[2]										[2] = Copper
Glycera spp.	I[47]																A4.1 Sub. cob., grav., cse snd	
Glycinde nordmanni		F[97]							I[91]	I[4]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Glycymeris glycymeris						I[23*]											A4.1 Sub. cob., grav., cse snd	
Gobius cobitis								HI										
Gobius couchi								HI										
Golfingia vulgaris									I[82]								A4.2 Sublitt. sands & muddy sands	
Goniada maculata	F[49]	I[97]						T	F[86]	I[33*] T[35*]							A.2.2 Littoral muds; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt.muds A4.1 Sub. cob., grav., cse snd	[2] = Copper
Halichondria panicea		HI				I		HI[113]								I[101]		
Harmothoe ljungmani	I[47]																A4.1 Sub. cob., grav., cse snd	
Harmothoe sp.								HI[95]		F[76]							A4.3 Sublitt. muds	
Harpinia antennaria						I[64*]			I[82] [91 92]								A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Harpinia sp.									HI[81] [88]								A4.2 Sublitt. sands & muddy sands	
Haustorius areanius	I[4]	I[55]							I[80]								A2.2 Litt sands & muddy sands	
Hediste diversicolor							HI[70] [71]	T[93]		F[8*] [31* 44*]	T[3]	T[3]				T[7]	A.2.3 Littoral muds; A4.3 Sublitt. muds	
Helcion pellucidum										I[67*]						HI[125]	A.3.2 Infralitt. rock mod. exp. wave action	[125] = acidified-halogenated
Henricia oculata														HI				
Henricea sp.																HI[125]	A3.6 Circalitt. rk mod. exp. wave act.	[125] = acidified-

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
																		halogenated
Hesionidae										F[45*]							A4.3 Sublitt. muds	
Hesionura elongata	F[48]																A4.1 Sub. cob., grav., cse snd	
Heteromastus filiformis		F[97]				I[17*] 73 74 F[4]		T[95]		F[35*] 37* 40* 75 76			T[46]				A2.2 Litt. sands & muddy sands; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds Various (Diaz & Rosen.)	[2] = Copper
Hiatella arctica																T[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Himanthalia elongata		HI									HI							
Hippolyte varians																HI[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Hippolytidae indet.										I[45*]							A4.3 Sublitt. muds	
Hyale prevostii									HI									
Hyas coarctus						I[22*] F[59*]											A4.1 Sub. cob., grav., cse snd; A4.2 Sublitt. sands & muddy sands	
Hydrobia ulvae						I[16*] 18	HI[71] I[1]	HI[93]		F[31*]						T[7]	A2.2 Litt sands & muddy sands; A.2.3 Littoral muds	[1] = TBT
Hydroides norvegica																F[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Hymeniacidon perleve																HI[101]	A4.2 Sub. Snds & muddy snds	
Iphinoe trispinosa		F[4]															A4.2 Sublitt.sands & muddy sands	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Isaeidae indet.									I[81]								A4.2 Sublitt. sands & muddy sands;	
Jasmineira elegans																F[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Jassa falcata			HI[109]					I[120]	HI				HI			HI[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Jassa marmorata									F[83]								A4.2 Sublitt. sands & muddy sands;	
Jassa pusilla																T[7]	A2.3 Litt. muds	
Kefersteinia cirrata																T[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Labidoplax sp.										F[39*]							A4.3 Sublitt. muds	
Lacuna parva																HI[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Lacuna vincta						HI										HI[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Lafoea dumosa						I[24*]											A4.1 Sub. cob., grav., cse snd	
Lagis koreni						I[62*]											A4.2 Sublitt.sands & muddy sands	
Lagisca extenuata																I[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Laminaria digitata																HI[6] I[125]	A1.2 Litt. Rk mod. Exp waves; A1.3 Litt. rock shelt. wave act.	[125] = acidified-halogenated
Laminaria hyperborea							T[102]							HI		T[125]	A.3.2 Infralitt. rock mod. exp. wave action	[125] = acidified-halogenated
Laminaria saccharina		HI									HI					HI[6]	A1.3 Litt. rock shelt. wave act.	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Lanice conchilega		F[4] 56				I[57*] F[73*]	HI			I[67*] F[39*]					HI		A4.2 Sub. sands & muddy sands; A4.3 Sublitt. muds	
Laonice cirrata								HI[2]										
Lepidonotus squamatus																T[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Leptognathia brevirostris										F[67*]							A4.3 Sublitt. muds	
Leptopsammia pruvoti	HI	HI	HI			HI					HI		HI	HI				
Leptosynapta bergensis		F[97]															A4.3 Sublitt. muds	
Leptosynapta inhaerens						I[58*]											A4.2 Sublitt. sands & muddy sands	
Levinsenia gracilis										F[37*(2)]							A4.2 Sublitt. sands & muddy sands	
Limaria hians						I[28*]											A4.6 Biogenic structs over sublitt. sed.	
Limaria loscombi						I[24*]											A4.1 Sub. cob., grav., cse snd	
Limatula subauriculata									I[82]								A4.2 Sublitt. sands & muddy sands	
Liocarcinus depurator						HI							HI					
Liocarcinus holsatus						F[59*]											A4.2 Sublitt. sands & muddy sands	
Liocarcinus sp.						I[22*] 27											A4.1 Sub. cob., grav., cse snd; A4.6 Biogenic structs over sublitt. sed.	
Lithophyllum incrustans	HI						HI		HI									
Lithothamnion corallioides	HI	HI	HI			HI					HI							
Lithothamnion glaciale	HI	HI	HI		HI	HI				HI				HI				

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Littorina littorea		HI					HI[71]		HI[110]	F[106] [107]								
Littorina obtusata/mariae																HI[125]	A1.2 Litt. Rk mod. Exp waves	[125] = acidified-halogenated
Littorina saxatilus																HI[125]	A1.2 Litt. Rk mod. Exp waves	[125] = acidified-halogenated
Lumbrinereis gracilis	I[48]	F[97]					HI		I[85]								A4.1 Sub. cob., grav., cse snd; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Lumbrinereis sp(p).								HI[2] [94]		F[37*]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	[2] = Copper
Lunatia montagui									F[82]								A4.2 Sublitt. sands & muddy sands	
Lutraria angustior						I[27*]											A4.6 Biogenic structs over sublitt. sed.	
Macandrevia cranium									I[82]								A4.2 Sublitt. sands & muddy sands	
Macoma balthica						I[18*]	HI[1]	HI[93]	HI	F[31*] [35*] [43*] [44*] [76*] [75*]						I[8] F[10]	A2.2 Litt. sands & muddy sands; A2.3 Littoral muds; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	[1] = TBT;
Macoma calcarea													I[46]				Various (Diaz & Rosen.)	
Macropodia rostrata						F[24*]											A4.1 Sub. cob., grav., cse snd	
Macropodia sp.						I[22*]											A4.1 Sub. cob., grav., cse snd	
Magelona mirabilis							HI		HI									

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Magelona pappillicornis						I[57*]											A4.2 Sublitt. Sands & muddy sands	
Magelona sp.		F[4]								I[67*]							A4.2 Sublitt. Sands & muddy sands	
Malacoceros fuliginosus									I[82]	F[67*]			T[46]				A4.2 Sublitt. Sands & muddy sands; A4.3 Sublitt. muds; Various (Diaz & Rosen.)	
Maldanidae indet.										F[37*]							A4.2 Sublitt. sands & muddy sands	
Manayunkia aestuarina						I[19*] [26*]		F[100]		F[31*]							A2.3 Litt. muds; A4.4 Sublitt. combi. seds	
Marphysa bellii	I[48]																A4.1 Sub. cob., grav., cse snd	
Marphysa sanguinea	I[48]																A4.1 Sub. cob., grav., cse snd	
Mastocarpus stellatus																HI[6]	A1.3 Litt. rock shelt. wave act.	
Mediomastus fragilis						F[58*]				F[31*]							A.2.3 Littoral muds; A4.3 Sublitt. muds	
Melarhaphe neritoides									F[78]								A1.2 Litt. Rk mod. Exp waves	
Melinna cristata								I[2]										[2] = Copper
Melinna palmata					I[12]	I[26*] F[73]	HI[1]	HI[93]		F[67*]	T[3]	T[3]					A2.3 Litt. muds; A4.3 Sublitt. muds; A4.4 Sublitt. combi. seds	[1] = TBT
Membranipora membranacea																T[125]	A.3.2 Infralitt. rock mod. exp. wave action	[125] = acidified-halogenated
Membranoptera alata																HI[6]	A1.3 Litt. rock shelt. wave act.	
Mercenaria mercenaria						I[20*]											A2.3 Litt. muds	
Metridium senile						I[65*]							T[46] [123]			T[125]	A3.6 Circalitt. rk mod. exp. wave act.; A4.3 Sublitt. muds; Various (Diaz &	[125] = acidified-halogenated

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
																	Rosen.)	
Micropthalmus sczelkowii										F[68*]							A4.3 Sublitt. muds	
Microspio sp.										F[67*]							A4.3 Sublitt. muds	
Modiolus modiolus	I[51, 52]	HI				HI I[24*]				F[68*]		HI	T[46]	HI			Various (Diaz & Rosen.)	
Modiolula phaseolina													T[46]				A4.1 Sub. cob., grav., cse snd	
Molgula manhattensis						HI												
Monia squama																HF[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Montacuta ferruginosa									I[91]								A4.2 Sublitt. sands & muddy sands	
Montacuta substriata									I[82, 83]								A4.2 Sublitt. sands & muddy sands	
Morchellium argus		HI																
Mugga wahlbergi										I[67*]								
Musculus discors		HI																
Mya arenaria		I[99]			I[12]	I[17*, 26*]			HI	F[31*, 35*, 43*]						I[8]	A2.2 Litt. sands & muddy sands; A2.3 Littoral muds; Sublitt. sands & muddy sands; A4.3 Sublitt. muds; A4.4 Sublitt. combi. seds	
Mya truncata						I[27*]				F[47*]							A4.3 Sublitt. muds; A4.6 Biogenic structs over sublitt. sed.	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Myriochele oculata									I[82]	F[37*]							A4.2 Sublitt. sands & muddy sands	
Mysella bidentata		I[97] F[4]				I[58*] [64*] F[73]			I[82 91]	F[37*]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Mytilus edulis		I[99]						HI[93]		F[32*] [41*]			I[46]			I[8]	A2.3 Litt. muds; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds Various (Diaz & Rosen.)	
Naididae											T[3]	T[3]						
Nais communis										F[31*]							A2.3 Littoral muds	
Necora puber																I[125]	A3.6 Circalitt. rk mod. exp. wave act	[125] = acidified-halogenated
Nematoda indet.											T[3]	T[3]						
Nematostella vectensis	HI					HI												
Nemertea indet.		F[4]							F[4]							T[125]	A.3.2 Infralitt. rock mod. exp. wave act.; A4.2 Sub. Snds & muddy snds; A4.3 Sublitt. muds	[125] = acidified-halogenated
Nemertesia ramosa						I[115] [116]												
Nemertesia sp.						I[21*]											A3.6 Circalitt. rk mod. exp. wave act.	Likely to recolonise rapidly
Nemertina indet.						I[27*]			F[82]								A4.6 Biogenic structs over sublitt. sed.	
Neocrania anomala		HI																
Neomysis integer											HI							

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Neopentadactyla mixta	HI	HI	HI			HI					HI			HI				
Nephrops norvegicus						I[63]							I[46]				A4.3 Sublitt. muds; Various (Diaz & Rosen.)	
Nephtys ciliata								F[2]		F[44*]							A4.3 Sublitt. muds	[2] = Copper
Nephtys cirrosa	F[15, 58]					I[47*, 49, 65]											A2.2 Litt. sands & muddy sands; A4.3 Sublitt. muds; A4.1 Sub. cob., grav., cse snd	
Nephtys hombergii		I[16, 97]				I[16*, 20*, 26*, 73, 74]	HI[1]	T[93, 100]	HI I[91]				T[46 (2)]			T[7] F[9, 10]	A2.2 Litt. Sands & muddy sands; A2.3 Litt. Muds; A4..2 Sublitt. Sands & muddy sands; A4.3 Sublitt. Muds; A4.4 Sublitt. Combi. Seds; Various (Diaz & Rosen.)	[1] = TBT
Nephtys incisa										F[37*]							A4.2 Sublitt. Sands & muddy sands	
Nephtys paradoxa								F[2]										[2] = Copper
Nephtys sp.						I[61*]											A4.2 Sublitt. Sands & muddy sands	
Nepthys longosetosa									I[82]								A4.2 Sublitt. Sands & muddy sands	
Neptunea antiqua						F[24*]											A4.1 Sub. Cob., grav., cse snd	
Nereimyra punctata								T[2, 95]	F[90]								A4.2 Sublitt. Sands & muddy sands; A4.3 Sublitt. Muds	[2] = Copper
Nereis diversicolor					I[12]	I[19*]				F[75, 76]			I[46]			F[9]	A2.3 Litt. Muds; A4.3 Sublitt.muds; Various (Diaz & Rosen.)	
Nereis pelagica													I[46]			T[125]	A.3.2 Infralitt. rock mod. exp. wave act.; Various (Diaz & Rosen.)	[125] = acidified-halogenated
Notomastus latericeus	I[47]								F[87]								A4.2 Sublitt. Sands & muddy sands;	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
																	Sub. Cob., grav., cse snd	
Notomastus sp.		F[4]															A4.2 Sub. Snds & muddy snds	
Nucella lapillus	HI						HI		I[102]		HI					HI[125]		[125] = acidified-halogenated
Nucula hanleyi	F[49]																A4.1 Sub. Cob., grav., cse snd	
Nucula nitidosa		F[4]				I[58*] [59*] [65*]				I[68*] [77] F[33*]							A4.2 Sublitt. Sands & muddy sands; A4.3 Sublitt. Muds	
Nucula sulcata								HI[2]									A4.3 Sublitt. Muds	[2] = Copper
Nucula tenuis						I[64*] [59*]		HI[2]									A4.2 Sublitt. Sands & muddy sands; A4.3 Sublitt. Muds	
Obelia geniculata																I[125]	A.3.2 Infralitt. Rock mod. Exp. Wave action	[125] = acidified-halogenated
Obelia longissima														HI				
Oligochaeta indet.									F[81]	F[32*]						T[7]	A2.3 Litt. Muds; A4.2 Sublitt. Sands & muddy sands	
Ophelia bicornis	F[4(2)]																Sub. Cob., grav., cse snd	
Ophelina acuminata						F[4] [58*]		HI[2]		F[31*] [37*]							A4.2 Sublitt. Sands & muddy sands A2.3 Littoral muds; A4.2 Sublitt. Sands & muddy sands	[2] = Copper
Ophelina cylindricaudata								HI[2]										
Ophelina modesta								HI[2]										[2] = Copper

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Ophelina norvegica								HI[2]										[2] = Copper
Ophelina sp.										I[67*]								[2] = Copper
Ophiocomina nigra						F[23*] [24]											A4.1 Sub. Cob., grav., cse snd	
Ophiodromis flexuosus								T[2]		F[35*] [40*]			T[46]				A4.2 Sublitt. Sands & muddy sands; A4.3 Sublitt. Muds Various (Diaz & Rosen.)	
Ophiopholis aculeata						I[24*]											A4.1 Sub. Cob., grav., cse snd	
Ophiothrix fragilis	I[49]	HI				I[24*]			HI				HI			I[125]	A3.6 Circalitt. Rk mod. Exp. Wave act. A4.1 Sub. Cob., grav., cse snd	[125] = acidified-halogenated
Ophiura affinis								I[95]	I[82] F[83]								A4.2 Sublitt. Sands & muddy sands; A4.3 Sublitt. Muds	
Ophiura albida	I[53] F[49]					F[23*] [24] [59*]				I[40*] [67*]			T[46 (2)]				A4.2 Sublitt. Sands & muddy sands; A4.3 Sublitt. Muds Various (Diaz & Rosen.) A4.1 Sub. Cob., grav., cse snd	
Ophiura ophiura						I[59*]											A4.2 Sublitt. Sands & muddy sands	
Ophiura sp.		F[4]				F[58*]				I[45*]							A4.3 Sublitt. Muds; A4.2 Sub. Sands & muddy sands	
Ophiura texturata										I[40*]							A4.3 Sublitt. Muds	
Ophyrotrocha sp.									F[82] [84] [49]	F[4*] [38*] [67*]								

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Osilinus lineatus		HI											HI		HI			
Ostracoda indet.							HI[1]											
Ostrea edulis	HI	HI				HI	HI	I[93]					HI		HI			[1] = TBT
Owenia fusiformis	I	F[4]							I[82] 91	I[67*]							A4.2 Sublitt. Sands & muddy sands	
Pachycerianthus multiplicatus						I[29*]											A4.3 Sublitt. Muds	
Pagurus bernhardus	I[53]					F[61*]											A4.2 Sublitt. Sands & muddy sands; A4.1 Sub. Cob., grav., cse snd	
Pagurus sp.						F[22*]											A4.1 Sub. Cob., grav., cse snd	
Palmaria palmata							HI		HI[99]									
Paludinella litorina		HI				HI												
Pandalidae indet.										I[45*]							A4.3 Sublitt. muds	
Pandalina brevirostris						F[24*]											A4.1 Sub. cob., grav., cse snd	
Panoplea minuta																HI[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Parajassa pelagica							HI[1]											
Paramphinome jeffreysii								I[2]	F[82]								A4.2 Sublitt. sands & muddy sands	[1] = TBT
Paranais littoralis										F[31*]							A2.3 Littoral muds	[2] = Copper
Paranais sp.						I[19*]											A2.3 Litt. muds	
Paraonis gracilis								I[2]										
Parougia caeca										I[67*]								[2] = Copper

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Patella sp.									F[78] [79]								A1.2 Litt. Rk mod. Exp waves	
Patella ulyssiponensis		HI					HI		HI[67]									
Patella vulgata		HI					HI[102]		HI[110]							HI[125]	A1.2 Litt. Rk mod. Exp waves	[125] = acidified-halogenated
Pectinaria koreni								I[95]					I[46]				A4.3 Sublitt. muds; Various (Diaz & Rosen.)	
Pectinaria sp.						I[58*]											A4.2 Sublitt. sands & muddy sands	
Peloscolex benedeni										F[8*] [35*] [39*] [41*] [42*]							[4]A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt.muds	
Pelvetia canaliculata		HI							HI							HI[125]	A1.2 Litt. Rk mod. Exp waves	[125] = acidified-halogenated
Pentapora fascialis						I[21*] [29] [30]					HI						A3.6 Circalitt. rk mod. exp. wave act.	
Perugia caeca										I[67*]								
Petricola pholadiformis					HI[14]									HI[14]				
Phascolion strombi									I[82]								A2.2 Litt. sands & muddy sands	
Phaxas pellucidus						I[59*] [64*]				I[77]							A4.2 Sublitt. sands & muddy sands	
Philine aperta										F[40*]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Phloe inornata									F[83]	F[67*]							A4.3 Sublitt. muds	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
									[85,87]									
Phloe minuta		I[97]					HI[1]	T[2,95]	I[91] F[84]	F[32*,35*,37*,39*,40*,45*]							A4.2 Sublitt. sands & muddy sands	[1] = TBT [2] = Copper
Pholas dactylus							HI										A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Phoronis hippocrepia			F[109]															
Phoronis mulleri													F[46 (2)]				Various (Diaz & Rosen.)	
Phoronis sp.						F[58*]											A4.2 Sublitt. sands & muddy sands	
Photis longicaudata									I[88]								A4.2 Sublitt.sands & muddy sands	
Phycodrys rubens																HI[125]	A1.2 Litt. Rk mod. Exp waves	[125] = acidified-halogenated
Phyllodoce groenlandica									F[90]								A4.2 Sublitt. sands & muddy sands	
Phyllodoce maculata																F[9]	A4.3 Sublitt. muds	
Phyllodoce sp.	F[47]					I[26*]				F[39*]							A4.3 Sublitt. muds A4.1 Sub. cob., grav., cse snd	
Phymatolithon calcareum	HI	HI	HI			I[28*]								I			A4.6 Biogenic structs over sublitt. sed.	
Pilumnus hirtellus																I[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Pisidia longicornis	I[48,49]					HI			I[88]			HI				HI[125]	A.3.2 Infralitt. rock mod. exp. wave act.; A4.1 Sub. cob., grav., cse snd	[125] = acidified-halogenated

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Plumaria elegans																HI[6]	A1.3 Litt. rock shelt. wave act.	
Podoceropsis nitida											I[82]						A4.2 Sublitt. sands & muddy sands	
Poecilochaetus serpens		F[4]															A4.2 Sublitt. sands & muddy sands	
Polychaeta indet.						F[21*]											A3.6 Circalitt. rk mod. exp. wave act.	
Polycirrus denticulatus																T[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Polycirrus medusa	I[47]																A4.1 Sub. cob., grav., cse snd	
Polycirrus plumosus										I[67*]								
Polycirrus sp.		F[4]							I[82]								A4.2 Sublitt. sands & muddy sands	
Polydora benedeni																F[8]	A4.3 Sublitt. muds	
Polydora caulleryi								T[95]									A4.3 Sublitt. muds	
Polydora ciliata								T[120]	F[87]	F[8*, 35*, 41*, 122*]						F[8] HF[125]	A3.2 Infralitt. rk mod. exp. wave act.; A3.6 Circalitt. rk mod. exp. wave act.; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	[125] = acidified-halogenated
Polydora polybranchiata																F[9]	A4.3 Sublitt. muds	
Polydora sp.								T[2]		I[32] F[39*]						T[7]	A2.3 Litt. muds; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	[2] = Copper
Polygordius lacteus						I[27*]											A4.6 Biogenic structs over sublitt. sed.	
Polygordius sp.											T[3]	T[3]						
Polyphysia crassa								HI[2]		F[40*, 77]							A4.3 Sublitt. muds	[2] = Copper

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Polysiphonia urceolata																HI[6]	A1.3 Litt. rock shelt. wave act.	
Pomatoceros triqueter	I[47, 48, 49]	HI										HI				HF[125]	A3.2 Infralitt. rk mod. exp. wave act.; A3.6 Circalitt. rk mod. exp. wave act.; Sub. cob., grav., cse snd	[125] = acidified-halogenated
Pomatoschistus microps								HI										
Pomatoschistus minutus								HI										
Porifera indet. (encr.)						F[21*]											A3.6 Circalitt. rk mod. exp. wave act.	
Porphyra umbilicalis									F[78]							HI[125]	A1.2 Litt. Rk mod. Exp waves	[125] = acidified-halogenated
Portlandia phillippiana									I[82]								A4.2 Sublitt. sands & muddy sands	
Potamopygyrgus jenkensii							HI[71]										A4.3 Sublitt. muds	
Praxillura sp.										F[39*]							A4.3 Sublitt. muds	
Prionospio cerrifera								HI[2, 4, 95]		F[39*]							A4.2 Sublitt. sands & muddy sands A4.3 Sublitt. muds	[2] = Copper
Prionospio fallax										F[67*]							A4.3 Sublitt. muds	[2] = Copper
Prionospio malmgreni								F[2]										
Prionospio sp.										F[37*, 39*]						T[7]	A2.3 Litt. muds; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Protanthea simplex		HI				HI								HI				
Protodorvillea kefersteini									F[90]	F[67*]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Protodorvillea sp.										F[39*]							A4.3 Sublitt. muds	
Psammechinus miliaris	I[49] [53]	HI				HI F[59*]	HI[102]		HI[102]								A4.2 Sublitt. sands & muddy sands; A4.1 Sub. cob., grav., cse snd	
Psammodrilus balanoglossoides									F[80]								A2.2 Litt. sands & muddy sands	
Pseudocuma longicornis						F[60*]			I[88]								A4.2 Sublitt. sands & muddy sands	
Pseudopolydora paucibranchiata								I[95]	F[84]	F[67*]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Pseudopolydora pulchra													T[46]				Various (Diaz & Rosen.)	
Ptilota plumosa																HI[6]	A1.3 Litt. rock shelt. wave act.	
Pycnogonum littorale																T[125]	A3.6 Circalitt. rk mod. exp. wave act	[125] = acidified-halogenated
Pygospio elegans						I[16* 18] F[73]				F[8*] [31* 35*] [42* 44*]						F[9]	A2.2 Litt. sands & muddy sands; A2.3 Littoral muds; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Pygospio sp.								F[93] [100]									A2.3 Littoral muds	
Raricirrus berylii									F[82]								A4.2 Sublitt. sands & muddy sands	
Retusa obtusa							I[1]											
Rhaphidrilus sp.									F[82]								A4.2 Sublitt. sands & muddy sands	
Rhodine gracilior								HI[2]										[1] = TBT
Rhodine loveni								HI[2]										

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Rhodothamniella floridula		HI					HI		HI			HI						[2] = Copper
Rissoa parva																HI[125]	A3.6 Circalitt. rk mod. exp. wave act	[125] = acidified-halogenated
Sabellaria alveolata					T[124]													[2] = Copper
Sabellaria spinulosa	I[48 51 52]				T[124]							T[124]				T[7] F[125]	A2.3 Litt. muds; A3.6 Circalitt. rk mod. exp. wave act; Sub. cob., grav., cse snd	[125] = acidified-halogenated
Semibalanus balanoides						I	I		I					I		I[125]	A1.2 Litt. Rk mod. Exp waves	[125] = acidified-halogenated
Scalibregma inflatum		F[4]						HI[2]		F[32* 33* 40* 67]							[4]A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Sclerocheilus minutus																F[125]	A3.6 Circalitt. rk mod. exp. wave act	[125] = acidified-halogenated
Scolelepis fuliginosa										F[31 35 39 40 42 66 68]							A2.3 Littoral muds; Sublitt. sands & muddy sands; A4.3 Sublitt. muds	[2] = Copper
Scolelepis squamata		I[55]								F[31*]							A2.2 Litt. Sands & muddy sands, A2.3 Littoral muds	
Scolelepis tridentata						I[64*]											A4.3 Sublitt. muds	
Scoloplos armiger		I[99] F[4]				I[16* 58* 65* 83]		HF[2]	I[82 86]	F[35* 36* 43*]			I[46]				A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
									F[83, 88]	[44*, 85, 86]							Various (Diaz & Rosen.)	
Scoloplos sp.										F[4*]							A4.3 Sublitt. muds	[2] = Copper
Scoloplos squamata										F[67*]							A2.3 Littoral muds	
Scrobicularia plana					I[12]			T[93]			T[3]	T[3]				T[8]	A2.3 Littoral muds	
Scrupocellaria sp.						I[24]											A4.1 Sub. cob., grav., cse snd	
Scrupocellaria reptans																I[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Scrupocellaria scrupea																HI[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Semibalanus balanoides							I[102]		I[78 79]								A1.2 Litt. rk mod. exp waves	
Serpula vermicularis	HI[108, 118]									I[108]								
Serpulidae indet.						I[24*]											A4.1 Sub. cob., grav., cse snd	
Sertularella sp.						I[24*]										T[125]	A3.6 Circalitt. rk mod. exp. wave act.; A4.1 Sub. cob., grav., cse snd	[125] = acidified-halogenated
Sertularella polyzonias																F[125]	A3.6 Circalitt. rk mod. exp. wave act.	[125] = acidified-halogenated
Sosane gracilis								HI[2]										
Sphaeodorum gracilis		F[97]															A4.3 Sublitt. muds	
Sphaeodorum sp.										F[39*]							A4.3 Sublitt. muds	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Sphaerosyllis tetralix										F[67]*								
Spio armata		F[4]															A4.2 Sub. Snds & muddy snds	
Spio decorata										F[67*]							A4.3 Sublitt. muds	
Spio filicornis	F[48] [54]	F[4]				I[15*] F[58*]				I[31*] [32*]							A2.2 Littt. sands & muddy sands; A2.3 Littoral muds; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. Muds; Sub. cob., grav., cse snd;	
Spionidae indet.					I[12]					F[45*]							A4.3 Sublitt. muds	
Spiophanes bombyx	F[47] [48 54]	F[4]				I[57] F[58*]			I[82]	I[32*]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. Muds; Sub. cob., grav., cse snd	
Spiophanes kroyeri								T[95] HI[2] [94]									A2.3 Sublitt. muds	
Spiophanes sp.									F[84]	F[39*]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	
Spiratella retroversa									I[82]								A4.2 Sublitt. sands & muddy sands	[2] = Copper
Spirorbidae indet.						I[24*]										T[125]	A.3.2 Infralitt. rock mod. exp. wave act.; A4.1 Sub. cob., grav., cse snd	[125] = acidified-halogenated
Spisula elliptica									I[82]								A4.2 Sublitt. sands & muddy sands	
Spisula solida						I[59*]							HI I[46]				A4.2 Sublitt. sands & muddy sands; Various (Diaz & Rosen.)	
Spisula subtruncata		I[99]															A4.2 Sub. sands & muddy sands; A4.3 Sublitt. muds	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
		F[4]																
Stenothoe marina																T[7]	A2.3 Litt. muds	
Sthenelais limicola									I[82 83]								A4.2 Sub. sands & muddy sands	
Streblospio benedicti											T[3]	T[3]	T[46]				Various (Diaz & Rosen.)	
Streblospio shrubsoli						I[19*]				F[8*]						F[8]	A2.3 Litt. muds; A4.3 Sublitt. muds	
Streblospio sp.								F[100]									A2.3 Littoral muds	
Syllis sp.	I[47]					I[26*]											A4.1 Sub. cob., grav., cse snd; A4.4 Sublitt. combi. seds	
Syllis hyalina																I[125]	A3.6 Circalitt. rk mod. exp. wave act.;	[125] = acidified-halogenated
Synelmis klatti										I[67*]								
Telimya ferruginosa						I[58*]											A4.2 Sublitt. sands & muddy sands	
Tellina crassa	I[50]																Sub. cob., grav., cse snd	
Tellina pygmaea	F[47]																Sub. cob., grav., cse snd	
Tellina spp.	I[4]																A4.2 Sub. sands & muddy asnds	
Tellina tenuis														F[13]		I[8]	A2.2 Litt. sands & muddy sands; A4.3 Sublitt. muds	[2] = Copper
Tenellia adspersa	HI	HI																
Terebellides stroemi						I[65*]		HI[2]		I[40*]							A4.3 Sublitt. muds	[1] = TBT
Tetrastemma sp.						I[16*]											A2.2 Litt. sands & muddy sands	[2] = Copper
Tharyx killariensis							HI											
Tharyx marioni						I[26*]		F[2]									A4.4 Sublitt. combi. seds	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Tharyx sp.																T[7]	A2.3 Litt. muds	[1] = TBT
Thracia phaseolina										F[31*]							[4]A2.3 Littoral muds	[2] = Copper
Thracia sp.							HI[1]											
Thyasira equalis								I[2]										[2] = Copper
Thyasira ferruginea										F[67*]							A4.3 Sublitt. muds	
Thyasira flexuosa						I[58*, 64]		F[2]		F[35*]							A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt. muds	[2] = Copper
Thyasira gouldi	HI					HI				HI				HI				
Thyasira sarsi								I[2, 95]	I[82, 85]								A4.3 Sublitt. muds	
Thyasira sp.									F[84]	F[39*, 40*]							A4.3 Sublitt. muds (2)	
Trachythyone elongata						I[58*]											A4.2 Sublitt. sands & muddy sands	
Tricolia pullus																HI[125]	A.3.2 Infralitt. rock mod. exp. wave act.	[125] = acidified-halogenated
Truncatella subcylindrica	HI	HI				HI	HI											
Tubificoides amplivisatus										F[31*]				F[14]			A2.2 Litt. sands & muddy sands; A2.3 Littoral muds	

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Tubificoides benedini						I[19*, 26*] F[31*, 83]	HI[1]									F[9, 10]	A2.3 Litt. muds; A4.3 Sublitt muds; A4.4 Sublitt. combi. seds	
Tubificoides sp(p).					I[12]			T[2] F[100]		F32* 38*		T[3]	T[3]				A2.3 Littoral muds; A4.2 Sublitt. sands & muddy sands; A4.3 Sublitt.muds	[1] = TBT
Tubularia indivisa																I[125]	A3.6 Circalitt. rk mod. exp. wave act.	[125] = acidified-halogenated
Unciola planipes									I[82]								A4.2 Sublitt. sands & muddy sands	
Upogebia sp.						I[58*]											A4.2 Sublitt. sands & muddy sands	
Urothoe brevicornis						F[60*]											A4.2 Sublitt. sands & muddy sands	
Urothoe poseidonis						F[60*]			I[80]								A2.2 Litt. sands & muddy sands; A4.2 Sublitt. sands & muddy sands	
Urothoe sp.		I[55]				I[62*]											A2.2 Litt. sands & muddy sands; A4.2 Sublitt. sands & muddy sands	
Urticina felina						I[22*]										T[125]	A3.6 Circalitt. rk mod. exp. wave act.; A4.1 Sub. cob., grav., cse snd	[125] = acidified-halogenated
Venerupis rhomboides	I[50]					I[28*]				F[31*]							A2.3 Littoral muds A4.1 Sub. cob., grav., cse snd; A4.6 Biogenic structs over sublitt. sed.	Also known as *Tapes rhomboides*
Venerupis senegalensis																I[8]	A4.3 Sublitt. muds	[8] as *V. pullastra*

Species	Sub. loss	Smother.	Incr. sus.	Decr. sus.	Incr. turb.	Phys. dist.	Syn. chem.	Heavy met.	Hydrocarb.	Nutrients	Incr. salin.	Decr. salin.	Deoxy.	Incr. temp.	Decr. temp	Ind. eff.gen	Habitat(s) (where specified)	Notes
Virgularia mirabilis						I[29 63]											A4.3 Sublitt. muds	
Zostera marina	HI	HI								HI								
Zostera noltii	HI	HI																