JOINT NATURE CONSERVATION COMMITTEE

Marine Monitoring Handbook
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UK Marine SACs Project

Contents

Procedural Guideline No. 3-8 Quantitative sampling of subtidal sediment biotopes and species using driver-operated cores

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Background

This protocol has been adapted from the Marine Nature Conservation Review Rationale and Methods (Connor and Hiscock 1996).

Purpose

Applicable to the following attributes

Core sampling in the sublittoral is appropriate for attributes concerning identification of biotopes and their quality in terms of species richness and the abundance of species. Generic attributes are:

- Measure the species richness in the biotope and/or abundance of target species (rare, fragile, declining, representative) in biotopes.
- Measure the quantity of particular species of conservation importance (rare, fragile, declining species – those for which the site is 'special').

It is also applicable to the following general survey objectives

- Establish/re-establish the species which are present in biotopes at a site including their abundance and/or biomass within statistical limits.
- Establish/re-establish the species which are present along a gradient of change away from a point source of disturbance including their abundance and biomass within statistical limits.

Advantages

This method provides quantitative results which may be appropriate for statistical analysis and interpretation and provide a common standard between a potentially large number of datasets. Additional information is provided by diver observations of sediment type, sediment features and epifauna.

Disadvantages

The collection and subsequent analysis of sediment samples can be very time-consuming and therefore costly. The use of a single pooled sample of cores may not provide an adequate sample for rigorous statistical analyses.

Logistics

Equipment required

1 Plas Penrhos, Ffordd Penrhos, Bangor LL57 2LQ, UK.

- Appropriate vessel from which to operate SCUBA divers, navigation and safety equipment including Differential Global Positioning System (dGPS).
- Complete SCUBA equipment as required under the JNCC diver guidelines (Holt 1998).
- Eight 11cm diameter (approx. 0.01m^2) cylindrical corers and a 5cm diameter corer, with means to seal the corers whilst underwater (caps or bungs); all items to be secured in a carrying basket which is secured to a lifting rope and buoy.
- Preferably a washing system including a puddling hopper, running water hose and sieve stand to ensure effective, gentle sieving of the samples.
- Specimen buckets and pots, notepad, reliable labels for placing into the sample containers (Dymo™ tape proves very effective) and also indelible pen for marking the outside (not the lid) of the sample container; strong plastic bags and labels for particle size samples.
- 10% buffered formal saline (4% formaldehyde) either on the vessel or immediately available after a day's sampling; 70% IMS (industrial methylated spirits) for subsequent storage of samples after initial fixing with formalin.

Staff required

Minimum HSE diving team (four divers with appropriate qualifications, see Holt 1998) plus possible additional boat handling staff with appropriate skills to match the environmental conditions expected.

Best time of year

There is no clearly identifiable time of year to survey sublittoral sediment communities. Summer months, which provide long periods of daylight and favourable weather conditions, are subject to the inclusion of large ephemeral populations of invertebrates and the recruitment of juveniles into adult populations. These factors must be accounted for in any data interpretation. Longer established winter populations are less prone to these seasonal influences. During winter, there are the logistical disadvantages of short daylight hours, potentially disruptive weather conditions and impracticable working conditions.

Of primary importance is that any survey, if the results are to be compared over time, must take place at the same time of year to previous studies. Even then, major weather events between survey dates should be taken note of and included in any interpretation (e.g. dramatic changes in freshwater input in estuaries, storms).

Survey brief

Locate sites and collect the specified number of core samples along with supporting information.

Methods

Field

Site location. Latitude and longitude for sample sites should be determined prior to beginning field work (or should be the same as for sites surveyed in the first monitoring survey). In using the Geographical Positioning System make sure that the correct datum is employed, e.g. WGS84 or OSGB, etc. Positioning should be by dGPS with better than 5m accuracy (offset on the vessel should always be noted) with quality control checks taken from known positions and records of signal quality during the survey.

Sample collection. The corers and corer caps must be clean and secured in their container and a rope attached before the SCUBA divers leave the surface and take the complete assembly to the seabed. Depending upon the sediment type, completion of the coring may take from 5 to 30 minutes. Once a core has been forced into the sediment by a rotating and pushing action, a cap is placed on the top of the corer, the sediment around the corer is manually wafted away and a cap placed on the lower end. This ensures that no material is lost from the corer when it is pulled from the sediment. The whole process should be completed as quickly as possible to avoid loss of animals that would otherwise burrow down and out of the core. A larger scale search of the surrounding seabed is done to look for more widely dispersed, typically larger fauna such as large bivalves, urchins and fish which would not otherwise be recorded using the corers. Notes are made by the divers of sediment features and epifauna. An additional, smaller sample of sediment is also collected for particle size analysis. Additional notes are made by the divers of epifaunal species, sediment features, trace evidence of epifauna (tracks, burrows,

etc.) water depth and time (GMT 24 hr clock). The surface cover lifts the complete assembly with full corers to the surface to begin sieving.

A single sample consists of 8 cores which are pooled and sieved over a 0.5mm mesh and preserved as a single entity.

For the site as a whole the following site features must be recorded:

Score 1–5	Surface relief (even–uneven)
	Firmness (firm–soft)
	Stability (stable–mobile)
	Sorting (well–poor)
Note if present:	Mounds/casts
	Burrows/holes
	Tubes
	Algal mat
	Waves/dunes (>10cm high)
	Ripples (<10cm high)
	Subsurface black layer
	Subsurface coarse layer
	Subsurface clay/mud
	Surface silt/flocculent

On-board processing. The sample should be checked for adequacy. In general a depth of greater than 15cm of sediment in the corer is ideal, although in coarse sediments this may be difficult to achieve on occasions. Samples that are less than 15cm deep are noted.

Additional notes are made on the surface colour, surface texture, change with depth, smell and presence of H_2S-blackened sediments, dominant fauna, presence of dead shells or single large stones, etc. These additional notes can often prove invaluable in the interpretation of data.

The sediment samples should be handled as gently as possible to avoid damage to the infauna. This requires placing the core contents into a receiving hopper. Water is added gently to the receiving hopper to produce a water sediment suspension. The sample is transferred in small quantities to a sieve in a separate water-filled hopper. Sieving should be by puddling (no direct jetting of water on the sieve). The residue on the sieve should be back washed into a pre-labelled specimen container. Back washing should be undertaken over a tray or fish box to avoid accidental loss of the sample. With coarser material (gravel and pebbles) it is advisable to remove material as it builds up in the sieve and place it into the sample pot at regular intervals to avoid damaging the biota in the sieve. The sieve should be checked and cleared of trapped fauna or any sediment impeding its efficiency. A waterproof label with site details should be added to the sample container (adhere to NMBAQC requirements). Fix the sample in 10% formal saline: this may be undertaken on return to the shore, but in all cases it must be done within 24 hours of collection.

Additional sampling. To collect data on the abundance of a named species to a specified level of precision requires prior information on the density and aggregation of the species at the site. In general, the more abundant and less aggregated the species the less replicates will be needed. The procedure for establishing these criteria is described in Holme and McIntyre (1984). When the number of replicates required has been established the sampling procedure can be followed as above. This may require the use of different size corers, number of pooled cores and different sieve mesh sizes depending upon the objectives of the monitoring survey. Clearly, if a targeted species is greater than 5cm diameter but lives further than 15cm down in the sediment, a deeper core will be required, but a mesh size of 2cm would be adequate to collect the specimens.

Laboratory

Adequate wet facilities including a fume cupboard for processing samples are required. Bench space for binocular and compound microscopes and all appropriate taxonomic keys and guides. The requirements are:

- Identify the infauna to the highest taxonomic level practicable (usually to species level).
- Supply a list of taxa, with numbers of individuals for each sample on a standard sediment sample or in a spreadsheet format supplied on computer disc/tape. Taxa should be listed according to Howson and Picton (1997). Species not listed in Howson and Picton should be named according to a recognised authority, which should be cited together with the taxonomic publication used to identify the specimen.

- Provide a voucher collection of specimens. Examples (preferably several) of each taxon identified from the series of samples (each taxon stored separately in IMS in suitable vials or jars, if possible glass) or examples of predetermined target species. These should be properly labelled using specimen labels.

Particle size analysis should be undertaken according to the methods described in Holme and McIntyre (1984) or by more recently developed techniques using laser technology that are supported by research papers as valid and reliable.

Data analysis

A range of data analysis procedures are available and those used will wholly depend on the objectives of the survey work. Data analytical techniques are described in Clarke and Warwick (1994). The techniques most widely accepted in the UK for the definition of faunal assemblages, although by no means the only ones (see Clarke and Warwick 1994), are Bray and Curtis similarity analysis in combination with a hierarchical clustering procedure and ordination by Multidimensional Scaling (MDS). These techniques are available in the Primer package (see Clarke and Warwick 1994). The multivariate analyses TWINSPAN and DECORANA are also useful programs to aid in the identification of biotopes (Hill 1979a, b).

In terms of monitoring it may be necessary to provide a quantitative comparison based on only part of the faunal assemblage (e.g. infauna only). The principal reason for this constraint is finding compatibility between counts of individuals of each species for the infauna and percentage cover or abundance scale data for colonial epifauna. The degree to which manipulation will be necessary is clearly related to the substratum type. Most fine particulate sediments will be comprised almost exclusively of infauna, whereas sediments with a significant gravel content and in relatively sheltered conditions have a diverse and abundant epifauna.

Having defined the faunal assemblage to be examined, the minimum data analysis should comprise a consideration of number of species, total abundance and biomass. These three 'primary variables' may be used to test year-to-year variation (in terms of percentage difference) and can in turn be used to undertake compliance monitoring according to the methods described in the GCSDM (1993). These methods were originally devised for compliance testing at sea disposal sites and have been expanded to include wastewater discharges. They can, therefore, be employed to provide a coarse measure of deviation from the *status quo* with limits applied on a site-by-site basis and may be considered as 'Action Points'.

Where possible the analysis of primary variables should be supported by other univariate (diversity indices and graphical methods) and multivariate analysis techniques (MDS and supporting analyses such as ANOSIM), particularly where any identification from normality is noted. In all cases a broad approach to data analysis should be adopted, without losing site of the species that contribute to the data sets.

Accuracy

The data produced will be quantitative although the heterogeneity of the environment and the number of replicates collected will affect the variability within the data. Inaccuracies can arise due to a range of factors, including the possible lack of experience and conscientiousness of workers and their sample identification skills. The amount of error or variability likely has been established by tests undertaken under the auspices of the NMBAQC and advice has been given on minimising such variability[2].

Information collected on identification and enumeration of species present within samples (in addition to biomass where appropriate) plus ancillary information will require suitable computing software.

Time required

Field

The time constraints for using diver-operated corers are the practical limitations placed on the diver for repeat dives. Under the JNCC diving regulations (Holt 1998), divers are required to remain within no-stop times and to have a surface interval of at least 2 hours for repeat dives. Therefore, realistically, a

2 See National Marine Monitoring Programme Green Book: **http://www.marlab.ac.uk/greenbook/GREEN.htm**

team of 4 divers can complete 4 to 6 sites in a day provided that travel time between sites is not great. In addition to this is the time taken to launch and recover (or moor) the cover boat.

Laboratory

Time required to process samples is usually high depending upon a number of variables and can vary between <1 hour to >1 working day for each sample depending upon sediment type and species richness of the sample.

Data analysis

The input of data into a suitable format should be approximately standard for species, abundance and replicates. The following is copied from the procedural guidelines for sublittoral grab sampling (Thomas 1998): Time taken for data analysis will depend on the extent of the analyses employed. Simple compilation of a spreadsheet including classification using the MCS/Ulster Museum Species Directory codes and full QC checks may take up to two days for a 50-sample/400-species data set. Employing a multistatistical package is very rapid (<1 day) once the data has been adequately formatted, but a time scale for the interpretation of the outputs is dependent on the complexity of the results and may involve several reruns of the data.

QA/QC

- Samples should not be taken from sediment that has been disturbed by the divers' presence.
- Cores must be taken randomly within a defined area (e.g. 25m^2).
- Care should be taken that the corers are inserted to the correct depth (up to 20cm) and removed intact from the sediment, with excess material removed from the outside of the corer before being tipped into the receiving hopper.
- The content of the corer must be checked prior to being tipped into the receiving hopper to ensure that there has been no wash-out of sample through poorly fitted caps to the corers.
- Samples should be washed over a 0.5mm mesh sieve not more than 24 hours after collection and then fixed in formalin solution.
- Samples should be fixed in 10% buffered saline formalin solution (4% formaldehyde). The volume of residual sediment in a container should not exceed one-third to one-half the volume of formalin solution. For samples containing a high volume of clay/water a higher concentration of formalin may be required.
- The guidelines of the NMBAQC should be followed where available.

Health and safety

Qualifications in boat handling must conform to the requirements of contractors for the purposes of safety and insurance. All diving operations are subject to the procedures described in the Diving at Work Regulations 1997[3] and must follow the Scientific and Archaeological Approved Code of Practice.[4] The JNCC guidance notes must be met by all divers (Holt 1998). Risk assessments must be made to provide an analysis of the likely environmental conditions. Poor weather conditions in the shape of high winds or low visibility are particular risks during boating activities. High tidal streams and low underwater visibility have particular health and safety implications to divers. Laboratory safety codes of practice (COSHH approved methods) must be followed.

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3 The Diving at Work Regulations 1997 SI 1997/2776. The Stationery Office 1997. ISBN 0 11 065170 7
See: **http://www.hse.gov.uk/spd/spddivex.htm**

4 Scientific and Archaeological diving projects: The Diving at Work Regulations 1997.Approved Code of Practice and Guidance - L107. HSE Books 1998. ISBN 0 7176 1498 0.
See: **http://www.hse.gov.uk/spd/spdacop.htm - a**

References/further reading

Baker, J M and Wolff, W J (eds) (1987) *Biological surveys of estuaries and coasts*. Estuarine and Brackish-Water Sciences Association Handbook No.3. Cambridge University Press, Cambridge.

Clarke, K R and Warwick, R M (1994) *Change in marine communities: an approach to statistical analysis and interpretation.* Natural Environment Research Council, UK.

Connor, D and Hiscock, K (1996) Data collection methods. In: *Marine Nature Conservation Review: Rationale and Methods* (ed. K. Hiscock), 51–65 and Appendices 5–10, 126–158. Joint Nature Conservation Committee, Peterborough.

Elliott, M (1997) *Benthic techniques, best practice review*. Workshop at Hull University 18/9/97.

GCSDM (1993) Analysis and interpretation of benthic community data at sewage-sludge disposal sites. *Aquatic Environment Monitoring Report No. 37.* Ministry of Agriculture Fisheries and Food, Lowestoft.

Hill, M O (1979). *DECORANA – a FORTRAN program for detrended correspondence analysis and reciprocal aver aging.* Cornell University, Ithaca, New York.

Hill, M O (1979) *TWINSPAN – a FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes.* Cornell University, Ithaca, New York.

Hiscock, K (ed.) (1996) *Marine Nature Conservation Review: rationale and methods.* Coasts and seas of the United Kingdom. MNCR series. Joint Nature Conservation Committee, Peterborough.

Holme, N A and McIntyre, A D (eds) (1984) *Methods for the study of marine benthos*, 2nd ed. IBP Handbook No.16. Blackwell Scientific Publications, Oxford, for International Biological Programme.

Holt, R H F (1998) *Rules and regulations covering diving at work for the statutory Nature Conservation Agencies* (JNCC, EN, SNH, CCW).

Howson, C M and Picton, B E (eds) (1997) *The species directory of the marine fauna and flora of the British isles and the surrounding sea.* Ulster Museum and the Marine Conservation Society, Belfast and Ross-on-Wye.