JOINT NATURE CONSERVATION COMMITTEE

Marine Monitoring Handbook
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Contents

Sandbanks which are slightly covered by seawater all the time

Definition

Sublittoral sandbanks, permanently submerged. Water depth is seldom more than 20 m below Chart Datum. Non-vegetated sandbanks or sandbanks with vegetation belonging to the *Zosteretum marinae* and *Cymodoceion nodosae*.

Introduction to the feature's interest

This habitat type occurs widely on the north-east Atlantic coast of Europe and is extensive in the UK. Sites have been selected to represent the main geographical and ecological range of variation of the habitat type and are amongst the most extensive in the UK.

The habitat type consists of soft sediment types that are permanently covered by shallow sea water, typically at depths of less than 20 m below chart datum. Sites have been selected to cover the geographical and ecological range of variation of the following categories:

(i) gravelly and clean sands

(ii) muddy sands

(iii) eelgrass *Zostera marina* beds

(iv) maerl beds

The latter two categories are distinctive communities associated with shallow sublittoral sandy sediments and are of particular value because of the diversity of species they may support.

The diversity of species and communities associated with subtidal sandbanks is determined by sediment type and a variety of other physical factors. These include geographical location reflecting biogeographical trends, the relative exposure of the coast (from wave-exposed open coasts to tide-swept coasts or sheltered inlets and estuaries) and differences in the depth, turbidity and salinity of the surrounding water. The site series includes a range of physiographic types to encompass the variation within the four main sub-types of this Annex I habitat.

Shallow sandy sediments are typically colonised by a burrowing fauna predominantly of worms, crustaceans, bivalve molluscs and echinoderms. Mobile fauna at the surface of the sandbank may include shrimps, prosobranch molluscs, crabs and fish. Sandeels, an important food for birds, live in sandy sediments. Epifaunal organisms such foliose algae, hydroids, bryozoans and ascidians may occur where coarse stable material such as small stones, shells or maerl is present. Mixtures of sand and hard substrata can lead to the presence of very rich communities. Shallow sandy sediments may be important nursery areas for fish and feeding grounds for seabirds (especially puffins *Fratercula arctica*, guillemots *Uria aalge* or razorbills *Alca torda*) and seaduck (for instance common scoter Melanitta nigra).

Typical attributes to define the feature's condition

Generic attributes

Table 3.4-1 lists the generic attributes for subtidal sandbank features and presents examples of the measures proposed for some of the candidate SACs in the UK. This list is not exhaustive and will be further developed as our knowledge improves of the factors that determine the condition of sandbank ecosystems.

Table 3.4-1 Summary of attributes that may define favourable condition of subtidal sandbanks.

Attribute	*Measure*	*Comment*
Extent		
Extent of feature	Area of subtidal sediment	Extent of the feature is a reporting requirement of the Habitats Directive. In dynamic situations, fluctuations in extent may be great, but are attributable to natural coastal processes beyond management control. A full understanding of such variability will only be gained after a number of monitoring cycles.
Extent of a sub-feature	Extent (ha) of seagrass, normally measured during peak growth period (*likely between May-August*)	The extent of seagrass is a key structural component of some sandbanks and provides a long-term integrated measure of environmental conditions across the feature.
	Extent of mussel beds	The extent of mussel beds is a key structural component of the sediments and, depending on the size and distribution of the beds, they may play an important functional role within the feature, e.g. by stabilising the sediment. It should be recognised that mussel beds are a dynamic habitat although in many cases beds tend to remain in the same place in the long term whilst patchiness within them is often much more dynamic.
	Extent of brittlestar beds	The extent of brittlestar beds is a key structural component of the sediments, represents a major concentration of biomass within the feature, and may play an important role in local carbon and nutrient cycles.[b] Fluctuations in brittlestar beds have been shown to relate both to large-scale hydrographic processes and to short-term localised events; thus they will indicate environmental change at a range of scales.
Physical properties		
Sediment character	Particle size analysis: parameters include the percentage sand/silt/gravel, mean and median grain size, and sorting coefficient, used to characterise sediment type	Sediment character defined by particle size analysis is vital to the structure of the feature, and reflects all of the physical processes acting on it. Particle size composition varies across the feature and can be used to indicate spatial distribution of sediment types thus reflecting the stability of the feature and the processes supporting it.
Topography	Depth and distribution of sandbanks	Depth and distribution of the sandbanks reflects the energy conditions and stability of the sediment, which is key to the structure of the feature. Depth of the feature is a major influence on the distribution of communities throughout.
Water density – temperature and salinity	Regular measurement of water temperature and salinity in the subtidal periodically throughout the reporting cycle	Temperature and salinity are characteristic of the overall hydrography of the area. Changes in temperature and salinity influence the presence and distribution of species (along with recruitment processes and spawning behaviour) including those at the edge of their geographic ranges and non-natives.
Nutrient status	Extent (range and area) of macroalgae across whole or parts of the feature, measured during peak growth period (*likely between May-August*)	Nutrient status is a key functional factor that influences the sub-feature as opportunistic macroalgae compete with important biotopes (sub-features) such as seagrass, and affect the associated species. Note that an increase in filamentous green algae may be a related natural phenomenon or may indicate eutrophication
Nutrient enrichment – phytoplankton	Average phytoplankton concentration (ChlA)	Chlorophyll A concentration provides an indication of nutrient levels and their effect on the sediment communities.
Water clarity	Average light attenuation measured periodically throughout the reporting cycle	Water clarity is important for maintaining extent and density of algal and plant dominated communities. Clarity decreases through increases in amounts of suspended organic/inorganic matter.

Attribute	*Measure*	*Comment*
Biotic composition		
Spatial distribution of all or a range of biotopes	Relative distribution of biotopes throughout the feature	The relative distribution of biotopes is an important structural aspect of the feature. Changes in extent and distribution may indicate long term changes in the physical conditions at the site.
Biotope composition	Number and occurrence / frequency of range of characteristic biotopes measured during the summer months, once during reporting cycle.	The number and occurrence/ frequency of characteristic biotopes is an important structural aspect of the feature.
Presence and distribution of a specific biotope	Distribution/ presence-absence/frequency of a typical or notable biotope	The biotopes chosen should be a key structural component of the sediments, and may be important because they are *notable, i.e. of nature conservation importance due to their rarity/scarcity, or region importance;have high species richness;* *an extensive example;* *sensitive to anthropogenic activity .eg introduction of non-native species; and/or* *indicative of changes in the supporting processes of the ecosystem.*
Species composition of specific biotopes	Frequency and occurrence/ diversity index of composite species (total or sub-set)	Species composition is an important contributor to the structure of some biotopes. A measure of species diversity also gives an indication of the quality of a biotope, where any change in diversity may indicate a cyclic change or trend in sediment communities.
Population status of characteristic species	Estimate population size using abundance/occurrence/ frequency/biomass Measure the population structure using for example age structure	The species selected may be of interest in its own right and/or be indicative of the structure of an important biotope. A change in the population status of a species may indicate cyclic change/trend in the host biotope and/or the sediment (sub) feature as a whole.
Zostera marina density	Average density, measured during peak growth period (*likely between May–August*)	An early indicator of seagrass under stress is a reduction in biomass, normally measured by the number and length of leaves. Density is preferred as a surrogate for biomass, being less destructive, based on a baseline survey to establish the relationship between density and biomass at a site.
Sabellaria spinulosa	Measure recruitment from the age structure (see Holt *et al*. 1998).[a]	Recruitment processes are important to the species (or sub-feature) with respect to both the maintenance of the biogenic reef (structure) and then functional role that the sub-feature plays within the feature as a whole.
Status of notable species	Measure the occurrence and frequency of a specified species	A *notable species*: has nature conservation importance due to its rarity/scarcity, or regional importance; has high abundance and contributes to sediment structure; may be used as an indicator of environmental stress if it is a species sensitive to pollution e.g. molluscan sensitivity to TBT.
Biological structure		
Spatial distribution of biotopes or sub-features	Distribution and extent of characteristic biotopes	The relative distribution of biotopes, for instance sand and sandy gravel biotopes, is an important structural aspect of the site. Changes in the extent and distribution may indicate long-term changes in the prevailing physical conditions at the site.
	Relative distribution of different maerl biotopes	The relative distribution of different maerl biotopes, live/dead maerl and patchiness within the maerl bed, are important structural aspects of the sub-feature and therefore feature as a whole. Changes in relative extent and distribution may indicate long-term changes in the physical conditions influencing the feature.
Spatial patterns of characteristic species	Presence/absence and density of different brittlestar species	The sub-feature (subtidal brittlestar beds biotope complex) is defined by the occurrence of brittlestars at high densities. Hence density is critical to the structure of the sub-feature; note that beds usually have a patchy internal structure with localised concentrations of higher density. The main bed-forming species are *Ophiothrix fragilis* (the most common bed-forming species) and *Ophiocomina nigra* (less frequently forming beds on sublittoral sediments). Sometimes the beds comprise mixed populations of both species. The two species have different environmental requirements and feeding strategies, and hence recording which species is relevant to the function of the sub-feature and feature as a whole is necessary.

Suggested techniques for monitoring sandbank attributes

For each of the attributes likely to be selected to monitor the condition of a feature, there are many techniques available to measure its value. To help implement the UK's Common Standards for Monitoring programme, it is necessary to recommend a small number of techniques that are likely to provide comparable measures (Table 3.4-2). The UK Marine SACs project evaluated the inter-comparability of some of these techniques (recording biotope richness, species counts), but further work is required on other techniques (such as measuring extent with remote sensing techniques). The advice presented below will be updated when new information becomes available.

Table 3.4-2 Suggested techniques for measuring sandbank attributes. The terms under *Technique* appear under the heading *Summary title* in the procedural guidelines provided in Section 6. Guidance will be developed for the techniques in italics.

Generic attribute	*Feature attribute*	*Technique*
Extent		AGDS; Side scan sonar; Point sample mapping; Towed video (for shallow areas: *Air photo interpretation; Remote imaging)*
	Biotope extent	AGDS; Side scan sonar; Mosaicing sonar images; Point sample mapping (using grab, ROV or Drop-down video samples
Physical properties	Substratum: sediment character	Particle size analysis; Sediment profile imaging; *Sediment chemical analyses*
	Topography	*Bathymetric mapping* (Depth is recorded by AGDS)
	Tidal regime	*Current meters; Tide gauges; Water chemistry data loggers*
	Water clarity	Measuring water quality; *Water chemistry data loggers; Secchi disk*
	Water chemistry (including salinity, temperature)	Measuring water quality; *Water chemistry data loggers*
	Nutrient status	Measuring water quality; *Water chemistry data loggers*; (Biotope extent techniques for algal mats)
Biotic composition	Biotope richness	Subtidal biotope ID; Grab sampling; Subtidal core sampling
	Species composition/richness	Grab sampling; Subtidal core sampling; Suction sampling; Fish on sediment (Epibiota only: Drop-down video; ROV; Diver-operated video; Towed video; *Epibenthic trawling*)
	Characteristic species	Grab sampling; Subtidal core sampling; Suction sampling; Fish on sediment
Biological structure	Spatial pattern of subtidal biotopes	Point sample mapping (from Grab sampling, ROV or Drop-down video data); AGDS; Side scan sonar (with mosaicing); Towed video

Specific issues affecting the monitoring of sandbanks

Each attribute will have its own inherent source of variability that must be addressed during data collection and subsequent interpretation of the results. However, some generic issues should be considered when planning the whole monitoring study.

Seasonal effects

Marine communities show seasonal patterns that could significantly affect a monitoring programme on subtidal sandbanks. Algal communities show the most obvious seasonal trends and sandbank habitats may support dense ephemeral algal communities during the summer months. Maerl beds support rich algal assemblages with distinct seasonal variation. For instance, a marked change in the abundance of algae in tidal rapids was observed in Loch Maddy between autumn 1998 and summer 1999.[c]

Many marine organisms have seasonal reproductive patterns that can significantly alter the number of individuals present at different times of the year. Some polychaete worms have semelparous or 'boom and bust' life history strategies where the mature adults spawn synchronously and then die. Clearly, the number of adults present in the sediment will depend on the stage in their lifecycle. Larval settlement and recruitment of juveniles to the population can result in a massive increase in the population size at certain times of the year. The presence and number of juveniles should be enumerated separately to the adults in all samples.

Seasonal effects are also prevalent in seagrass communities. The blade density of the eelgrass itself will increase during the summer and then decrease during the autumn and winter – a process known as die-back.[d] Seagrass blades may support dense assemblages of epiphytic algae during the summer months, which then decline during the winter.

Seasonal patterns must be considered when planning a monitoring strategy. Sampling should be undertaken at the same time of year if seasonal variation is likely. It may be necessary to specify the duration of a sampling window – for example, to precede post-reproductive death in polychaete communities. Seasonal changes in seagrass have important consequences for the timing of remote sensing campaigns because the spectral signature[1] of the seagrass will change between summer and winter.[e]

Meteorological changes

Prevailing weather conditions will affect any monitoring study. Periods of calm conditions will improve underwater visibility and improve sampling efficiency and reliability. Subtidal sandbanks are often located in areas of strong tidal streams and therefore sampling should take place at slack water. If possible, sampling exercises should avoid the equinoctial tides when the duration of slack water will be at its shortest.

A change in the strength of prevailing wave action, or a change in the frequency of winter storms, could lead to a gradual change in the topography, or even the location, of a sandbank. Such changes could affect a sampling programme, particularly where a grid sampling strategy was used.

Weather cycles can result in changes in the biotic assemblages. Changes in perennial algae on Loch Maddy maerl beds were possibly due to an unusually warm preceding summer. [See note c above]

Access

Boats are required to sample subtidal sandbanks. Where necessary, sampling should be timed to coincide with slack water and calm conditions.

Sampling issues

Subtidal sandbanks pose a number of logistical and methodological problems to a monitoring study. It is important to establish the extent of the entire feature to plan an effective monitoring strategy. Often, sandbanks will form a mosaic of patches that are distributed throughout an SAC. In such circumstances, it may be necessary to develop a stratified monitoring strategy based on an initial inventory of the entire sandbank resource. Individual sandbanks may be categorised – for example, by topographical structure or sediment type, to stratify a monitoring programme. Such a programme should ensure that all categories are sampled. For individual categories (a single sandbank), sample sites should be spread throughout to ensure adequate consideration of spatial variation. It cannot be assumed that a single sample station will be representative of the habitat as a whole. The actual number of stations necessary to describe the full range of species present should be determined from a pilot study. A sampling strategy should consist of many stations with few replicates per station (even just one) when considering attrib-

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1 See Section 5 for an explanation

utes relating to biological description.

Unfortunately, mapping the extent of sandbanks is difficult, particularly in shallow areas where boat access is difficult, and water clarity is too low to use remote sensing techniques based on electromagnetic spectral radiation. In such conditions, it would be necessary to use a grid sampling technique to map extent. Prevailing hydrodynamic conditions will shape the topographic structure of sandbanks, for instance by creating sand waves on the surface. Small fluctuations in the hydrodynamic regime, often at the scale of metres (or less) will affect the physical structure of the sediment, which in turn may lead to significant differences in the biotic assemblage. A recent investigation into the populations of sandeels on sandbanks in the Firth of Forth recorded considerable fine scale heterogeneity in sediment structure (over tens of metres) that resulted in huge variations in the density of fish present in sediment. It will be necessary to map a subtidal sandbank during each monitoring cycle, both to estimate its extent and to plan more detailed sampling.

Ambient physical conditions, particularly sediment type, determine the precise biotic composition of sediment biotopes. Whilst attributes relating to biotic composition should use the terminology in the national biotope classification, it will be necessary to define carefully the actual species composition recorded locally. Such local descriptions will help to avoid any ambiguities when assigning a future sample to a biotope class.

The choice of actual technique used to sample the sediment within an SAC will be influenced by the type of sediment present, but must be consistent throughout all samples used to monitor an individual attribute. Samples should be processed through a 1mm sieve, unless previous investigations indicate a finer mesh is necessary to sample the target biotic assemblage adequately. Where a finer mesh is necessary, the sample should be subdivided to provide a 1mm mesh fraction. It is important to consider any other established sampling/monitoring studies in an SAC prior to finalising the mesh size. If the data from such studies can contribute to an SAC monitoring programme, it will be necessary to harmonise the mesh size between all subsequent monitoring studies to ensure data are comparable.

Site marking and relocation

Permanent marking of sandbanks may not be possible because of their dynamic nature and their geographic location may move between monitoring events. Site relocation will rely on dGPS,[2] particularly in offshore areas.

For less dynamic habitats, sites may be marked with acoustic transponders[3] or curly whirlies.[4]

Health and safety

All field staff must follow approved safety procedures published by their host institution, or that of the contracting agency, whichever are the more stringent.

Subtidal sandbanks often create shallow shoals that generate rough sea conditions in comparison to adjacent level areas of seabed. Strong tidal streams may also be present which, when combined with strong winds, will create rough sea conditions. Prevailing sea conditions must be assessed prior to any sampling exercise.

Sublittoral sediment sampling often involves heavy equipment (grabs, dredges) and deck machinery (winches) that have specific health and safety requirements which must be followed at all times. Furthermore, sea conditions have a significant effect on the safe use of this equipment – unexpected movement of the vessel due to a boat's wake can result in a grab violently swinging across the deck.

Some sampling on subtidal sandbanks will involve SCUBA diving techniques. All diving operations are subject to the procedures described in the Diving at Work Regulations 1997[5] (see: **http://www.hse.gov.uk/spd/spddivex.htm**) and must follow the Scientific and Archaeological Approved Code of Practice[6] (**http://www.hse.gov.uk/spd/spdacop.htm - a**).

2 See Procedural Guideline 6-1 on dGPS guidance.

3 See Procedural Guideline 6-2 on site marking

4 Plastic corkscrews that are screwed down into the sediment: see Fowler, S L (1992) *Marine monitoring in the Isles of Scilly 1991*, English Nature Research Report No. 9. English Nature, Peterborough.

5 The Diving at Work Regulations 1997 SI 1997/2776. The Stationery Office 1997, ISBN 0 11 065170 7.

6 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.

Bibliography

a Holt, T J, Rees, E I, Hawkins, S J and Reed, R (1998) *Biogenic reefs: an overview of dynamics and sensitivity characteristics for conservation management of marine SACs*. Scottish Association of Marine Sciences, Oban (UK Marine SACs Project).

b Hughes, D J (1998) *Subtidal brittlestar – An overview of dynamic and sensitivity characteristics for conservation management of marine SACs*. Scottish Association for Marine Sciences, Oban (UK Marine SACs Project).

c Howson, C M and Davison, A (2000) *Trials of monitoring techniques using divers and ROV in Loch Maddy cSAC, North Uist*. Scottish Natural Heritage, Edinburgh.

d Short, F T, Ibelings, B W and den Hartog, C (1988) Comparison of a current eelgrass disease to the wasting disease in the 1930s. *Aquatic Botany*, **30**, 295–307.

e Pooley, M and Bamber, R (2000) *Evaluation of aerial and diving techniques to survey vegetation in the Chesil and Fleet European marine site*, unpublished report to English Nature. English Nature, Wareham.

f OSPAR (1997) *JAMP Eutrophication monitoring guidelines: benthos*. (Document reference: 1997-6). London , OSPAR Commission.

g Van der Meer, J (1997) Sampling design of monitoring programmes for marine benthos: a comparison between the use of fixed versus randomly selected stations. *Journal of Sea Research*, **37**, 167–179.