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Defining and managing *Sabellaria spinulosa* reefs:
Report of an inter-agency workshop
1-2 May, 2007

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EXECUTIVE SUMMARY

JNCC invited representatives from a range of organisations working on *Sabellaria spinulosa* to a workshop in Peterborough on the 1-2 May, 2007. The aims of the workshop were to:

- Exchange information on current research relating to *Sabellaria spinulosa* reefs and the requirements for their conservation under the Habitats Directive.
- Elaborate a definition of *Sabellaria spinulosa* reefs which can be used by JNCC and the Country Agencies in relation to implementing the Habitats Directive in UK waters.
- Discuss issues relevant to the management of *Sabellaria spinulosa* reefs and identify potential areas of future research to support the definition, management and monitoring of *Sabellaria spinulosa* reefs in the context of the Habitats Directive.

The simplest definition of *Sabellaria spinulosa* reef in the context of the Habitats Directive was considered to be an area of *Sabellaria spinulosa* which is elevated from the seabed and has a large spatial extent. Colonies may be patchy within an area defined as reef and show a range of elevations. In UK waters elevations created by worm tubes of up to 30cm have been recorded and spatial extents of more than 1km^2.

In seeking to provide greater guidance, workshop participants tried to put some figures on the characteristics of elevation, area and patchiness which could be used in combination to determine whether an area might qualify as a reef (Table 4). **NB. These figures are presented as a starting point for wider discussion rather than accepted and fully agreed thresholds for *Sabellaria spinulosa* reef identification.**

Further appreciation of the quality of the reef can be determined by using a scoring system for a range of characteristics. These characteristics include elevation, extent and patchiness but could also cover sediment consolidation, density, associated biodiversity and longevity. Development of this approach, for example, with supporting guidance or perhaps an indication of relative weighting of the different characteristics, could be very useful as a second stage in the process of identifying suitable areas of *Sabellaria spinulosa* reef for protection within *Natura 2000* sites.

A variety of survey methodologies and tools can be used to detect, map, sample and monitor *Sabellaria spinulosa* reefs. Guidance on what is most appropriate will depend on the definition (and therefore parameters which need to be measured) and what is practical under particular environmental conditions.

The focus of management is likely to be on the activities which could have an impact on *Sabellaria spinulosa* reefs; however, given that environmental conditions are a major influence (e.g. sediment loads, presence of sand waves and drop offs), a holistic approach to management will be required. Management proposals also need to reflect the dynamic nature of reefs which can colonise, evolve and degrade rapidly. This is well illustrated by studies showing their natural temporal and spatial variation. Risk

assessments and management plans can be used to set out the procedures which will assist with the management of *Sabellaria spinulosa* reefs.

There are many potential areas for future research on *Sabellaria spinulosa* to inform *Natura 2000* work. Of the list drawn up at the workshop the highest priority was considered to be work on:

- How reefs form, evolve and decay and a better understanding of the environmental conditions under which they do so.
- Controlled experiments to inform management decisions such as the establishment of closed areas.
- Creating an inventory of possible areas of *Sabellaria spinulosa* reef in UK waters.

CONTENTS

1   Background

Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (The Habitats Directive) is a European agreement that sets out a number of actions to be taken for nature conservation. This includes the requirement that Member States designate Special Areas of Conservation (SACs) that support certain habitats and species.

A series of marine SACs have already been designated around the coast of the UK as a contribution to the *Natura 2000* network. The Joint Nature Conservation Committee (JNCC) and the Country Conservation Agencies are now working towards the identification of a second tranche of SACs 'away from the coast' (both within territorial waters and offshore waters).

One of the habitats listed for protection within SACs (in Annex II of the Directive) is reefs. This includes bedrock, cobble and biogenic variants. Reefs formed by the ross worm *Sabellaria spinulosa* are one of the biogenic reef sub-types identified by the European Commission. This is a species which is widely distributed and common in UK waters, occurring as individuals but also forming 'crusts' or 'reefs' of many individuals on sandy and mixed coarser sediments.

JNCC invited representatives from a range of organisations working on *Sabellaria spinulosa* to a workshop in Peterborough on the 1-2 May, 2007. The aims of the workshop were to:

- Exchange information on current research relating to *Sabellaria spinulosa* reefs and the requirements for their conservation under the Habitats Directive.
- Elaborate a definition of *Sabellaria spinulosa* reefs which can be used by JNCC and the Country Agencies in relation to implementing the Habitats Directive in UK waters.
- Discuss issues relevant to the management of *Sabellaria spinulosa* reefs and identify potential areas of future research to support the definition, management and monitoring of *Sabellaria spinulosa* reefs in the context of the Habitats Directive.

The agenda and participants' list are included as Annex 1.

2   Defining *Sabellaria spinulosa* reefs

The objective of the first session of the workshop was to reach a shared understanding on what constitutes *Sabellaria spinulosa* reef and, if possible, to agree on a definition which could be used by the JNCC and Country Conservation Agencies for their *Natura 2000* work e.g. for identifying, proposing and advising on the management of *Natura 2000* sites to ensure the favourable conservation status of *Sabellaria spinulosa* reefs within them. The definition would therefore be linked to a potential management response.

A number of short presentations provided background for the subsequent discussions on defining *Sabellaria spinulosa* reefs.

Ian Reach (Natural England) described some of the existing definitions of *Sabellaria spinulosa* reefs which are being used for conservation purposes. They include definitions in guidelines relating to the Habitats Directive, the OSPAR Commission work on habitats and species conservation and the UK Biodiversity Action Plan process. He provided an overview of current understanding and key questions in relation to of the stages in development of *Sabellaria spinulosa* reefs, associated species, potential role as refuge and the likely pressures and impacts on them.

Charlotte Johnston (JNCC) described the Annex III criteria set out in the Habitats Directive for selecting *Natura 2000* sites for Annex I habitats. These are: representativity, area of coverage, conservation of structure and function (including restoration possibilities) and a global assessment. Reefs are defined in the interpretation manual prepared by the Commission and most recently updated in May 2007. This latest elaboration of the definition of reefs makes specific mention of topography and substratum and although it includes examples of animals forming biogenic reefs (such as Sabellaria *spinulosa*), there is no reference to associated biodiversity (Box 1).

BOX 1: Definition of Reefs from the Updated Interpretation Manual [From: DOC.HAB.06-09/03]

Reefs can be either biogenic concretions or geogenic origin. They are hard compact substrata on solid and soft bottoms, which arise from the sea floor in the sublittoral and littoral zone. Reefs may support a zonation of benthic communities of algae and animal species as well as concretions and corallogenic concretions.

Clarifications:

- *Hard compact substrata* are: rocks (including soft rock, e.g. chalk), boulders and cobbles (generally >64mm in diameter).
- *Biogenic concretions* are defined as: concretions, encrustations, corallogenic concretions and bivalve mussel beds originating from dead or living animals, i.e. biogenic hard bottoms which supply habitats for epibiotic species.
- *Geogenic origin* means: reefs formed by non biogenic substrata.
- *Arise from the seafloor* means: the reef is topographically distinct from the surrounding seafloor.
- *Sublittoral and littoral zone* means: the reefs may extend from the sublittoral uninterrupted into the intertidal (littoral) zone or may only occur in the sublittoral zone, including deep water areas such as the bathyal.
- Such hard substrata that are covered by a thin and mobile veneer of sediment are classed as reefs if the associated biota is dependent on the hard substratum rather than the overlying sediment.
- Where an uninterrupted zonation of sublittoral and littoral communities exist, the integrity of the ecological unit should be respected in the selection of sites.
- A variety of subtidal topographic features are included in this habitat complex such as: hydrothermal vent habitats, sea mounts, vertical rock walls, horizontal ledges, overhangs, pinnacles, gullies, ridges, sloping or flat bedrock, broken rock and boulder and cobble fields.

Examples of animals forming biogenic reefs in the North Atlantic include North Sea: Polychaetes (e.g. *Sabellaria spinulosa, Sabellaria alveolata, Serpula vermicularis*), bivalves (eg. *Modiolus modiolus, Mytilus* sp.) and cold water corals (e.g. *Lophelia pertusa*).

Issues highlighted in this presentation were the need to define *Sabellaria spinulosa* reefs more precisely, limitations of the methods used to identify presence and spatial extent of reefs, difficulties of assessing reef quality, and limitations in our understanding reef structure and function including the longevity/persistence of reef structures.

Vicki Hendrick (Newcastle University) described a multi-criteria scoring system which can be used to given an overview of various characteristics considered important to the 'reefiness' of *Sabellaria spinulosa* aggregations (Annex 2). Each of the characteristics can be scored as Low, Medium or High, and be weighted according to the perceived importance of that characteristic. Confidence limits can also be attached to the scores. The suggested scales are a starting point for discussion and the characteristics can be modified to reflect any future accepted definition of *Sabellaria spinulosa* reefs including that applied for the purposes of the Habitats Directive. Whilst an overall score is an oversimplification, the approach encourages a structured

consideration of each characteristic, as well as being a systematic and transparent tool to support decision-making when describing and comparing reefs. The methodology is described in detail in Hendrick & Foster-Smith (2006)[1]. Table 1 shows how it was applied to an area of *Sabellaria spinulosa* reef off the coast of East Anglia., whilst the presentation detailed an assessment of various physical characteristics assessed for the BBL pipeline case study.

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[1] Hendrick & Foster-Smith (2006) *Sabellaria spinulosa* reef: a scoring system for evaluating 'reefiness' in the context of the Habitats Directive. J.Mar.Biol.Ass.UK. 86: 665-677.

Table 1. Summary of example application of scoring protocol to the Saturn reef. Reef-characteristics, confidence of score and perceived importance of feature are all scored on a sliding scale of low-medium-high. (Table 5 from Hendrick & Foster-Smith, 2006)

Characteristic reef feature	Score from assessment against criteria			Subjective confidence of data & methodology to support assessment score			Subjective value of the importance of each criteria as a contribution to total score			Basis of score
	Low	Med	High	Low	Med	High	Low	Med	High	
Elevation										Score based on video and still imagery providing good coverage of the colony.
Consolidation										As above
Spatial extent										Score based on mapped extent of reef derived from ROV route by BMT Cordah Ltd. (2003) – see Figure 2
Patchiness										Score based on video and still imagery providing good coverage of the core area of colony.
S. spinulosa density										No quantitative *Sabellaria* density data is available.
Biodiversity										Infaunal assessment of grabs samples is indicative of a high biodiversity, but is limited to two samples.
Community composition										Species counts from the two infaunal samples were not included in the reports.
Temporal stability										Two surveys by Envision Mapping in 2004 and 2005 found no sign of the *Sabellaria* reef at this site. Anecdotal accounts from surveys undertaken by CEFAS, however, suggest a degree of persistence at this site (D. Limpenny, pers. comm.).
Overall weighted scores as a percentage of maximum possible score.	58%			55%						

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These presentations were followed by a "show & tell" session for participants to view examples of *Sabellaria spinulosa* aggregations and discuss whether they might be categorised as reefs, as well as to tease out issues surrounding the definition of *Sabellaria spinulosa* reef. The material presented included underwater photographs (stills and stills from video footage), photographs of samples collected by grabs, trawls and other sampling devices, and side scan sonar traces (Figure 1).

Figure 1. Examples of *Sabellaria spinulosa* images, presented at the workshop [provided by CEFAS]

(a) Still image grabbed from sledge mounted video camera footage

(b) Vertical profile through the reef/sediment interface taken using a Sediment Profile Imaging camera

(c) Paper record showing isolated *Sabellaria spinulosa* reef features alongside aggregate suction trailer dredge tracks, collected using an analog sonar system.

(d) Still image grabbed from ROV video

2.1 Issues relevant to reef definition

The workshop discussions on defining *Sabellaria spinulosa* reefs covered many topics but focused on the following:

- Spatial extent and patchiness of what might constitute a reef.
- What constitutes topographic distinctiveness of a reef.
- Range of forms which might/should be included within the definition of a reef.
- Biodiversity interest of reefs.
- Longevity of reefs and the potential for restoration.
- The environmental context in which reefs develop.
- A scoring system to support the definition process.

2.1.1 Spatial extent and patchiness

Typical spatial extents of what might be considered *Sabellaria spinulosa* reef in UK waters are difficult to determine as high densities of *Sabellaria spinulosa* are known to occur in patches of a few square metres as well as large areas[2] of more than 1km^2. Furthermore, regardless of extent, patchiness appears to be a feature of reefs and therefore 100% coverage should not to be expected within an area defined as a *Sabellaria spinulosa* reef. The extent of patchiness is therefore related to defining the size of the reef and the cut off point between what constitutes a series of reefs or a single larger reef.

Based on their experience, participants were asked to indicate what they believed would be suitable cut off points for grading an area on a scale of low-medium-high for 'reefiness' in relation to extent and patchiness and also what would not be considered a reef (Table 2).

Table 2. Range of figures proposed by participants as a measure of 'reefiness'.
[Where more than one participant proposed a particular figure the number is shown in brackets]

Measure of 'reefiness'	NOT a REEF	LOW	MEDIUM	HIGH
Area (m^2)	< 25 (3) <100 (4) ≤ 100 100 <500 <200 <1000 (2)	<10 25-2500 100 (2) 100-200 100-500 (2) 200-500 500 1000-3000 2500	10-100 200-1000 500-1000 (2) 500-1500 900 (2) 1000 2500-5000 3000-5000	>100 1000 (2) >1000 (2) >1500 >2500 (3) >5000
Patchiness (% cover)	<5 <10 (4) <20 <25 (5) <30	5-15 10-25 (2) 10-30 25-50 (5) <25	15-40 25-50 (3) 30-50 50-75 (6)	>40 >50 (4) ≥75 (5)

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[2] E.g. Marine Ecological Surveys Ltd (2006) Hastings Shingle Bank Area 366-370: Benthic Monitoring Report. Technical report prepared for the Resource Management Association. February 2006. 86pp.

2.1.2 Topographic distinctiveness

Topographic distinctiveness was considered to be an essential part of the definition of a *Sabellaria spinulosa* reef. Elevation could be taken as a proxy for this and the scoring system presented by Vicki Hendrick described a range of possible scores for average tube height, maximum tube height and indications from remote sensing which together would give an indication of elevation. The extent to which elevation is associated with diversity is not known.

Most of the discussion focused on what might be a suitable measure of tube height although it was also recognised that elevation could be the result of an underlying feature, such as a sandwave, on which the *Sabellaria spinulosa* had settled. Tube heights of 30cm have been reported in UK waters[3].

Based on their experience, participants were asked to indicate what they believed would be suitable cut off points for grading an area on a scale of low-medium-high for 'reefiness' in relation to average tube height and also what would *not* be considered a reef (Table 3).

Table 3. Range of figures proposed by participants as a measure of 'reefiness'.
[Where more than one participant proposed a particular figure the number is shown in brackets]

Measure of 'reefiness'	NOT a REEF	LOW	MEDIUM	HIGH
Elevation (average tube height)	Not visible (2) <1cm (1) <2cm (6) <5cm (5)	<2cm (4) 2-5cm (5) <5 (1) 5-10 (4)	≥ 5 (1) 2-5 (2) 5-10 (6) 10-20 (4)	>5 (3) >10 (7) >20 (4)

The ability to measure tube height will depend on the survey methods used and it may therefore be necessary to recommend certain techniques (for example, sidescan sweeps and forward looking cameras) to improve the chances of making such measurements.

2.1.3 Range of forms

The known life history characteristics of *Sabellaria spinulosa* point to a species which can colonise areas - such as an area previously subject to aggregate dredging - and have an initial rapid growth rate.

High densities of *Sabellaria spinulosa* have been observed in a variety of forms. In some locations tubes do not stand particularly proud of the surface even though the worm is abundant. These have been described a crusts or sheets. In others where there is significant elevation, they are more often described as reefs. It is not known whether these different forms should be considered stages in reef development or

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[3] Foster-Smith R & White W (2001). *Sabellaria spinulosa* in the Wash and north Norfolk cSAC and its approaches: Part I: Mapping techniques and ecological assessment. A report for the Eastern Sea Fisheries Joint Committee and English Nature. English Nature Research Report No. 545. 43pp.

whether they are the result of growth in different environmental conditions and on different substrata.

2.1.4 Biodiversity value

Preliminary analysis of records of *Sabellaria spinulosa* presented to the meeting (**BFS**) shows that although this species is widely distributed in UK waters, locations where it is found at high densities are where a significant proportion of the total population occur (more than 50%) and cover a relatively small geographic area. The conservation and management of *Sabellaria spinulosa* reefs is therefore an important part of biodiversity conservation in UK waters.

The Habitats Directive is aimed at the conservation of flora and fauna however the definition of reef makes no specific mention of biodiversity value. During discussions it was apparent that this may nevertheless be relevant when it comes to comparing potential locations for SACs.

Surveys have revealed that the diversity of associated species appears to vary depending on the form of the *Sabellaria spinulosa* aggregations. Areas with crusts, for example, have been shown in some cases to have a higher diversity than areas with erect worm tubes. Some studies have also examined the associated fauna in dead and living reefs and suggest there may be no significant difference.

For offshore locations data on the species associated with high densities of *Sabellaria spinulosa*, and also areas of low-lying or elevated *Sabellaria spinulosa* tubes is limited to a few locations. Associated species appear to be different in different locations, however work on areas recovering following aggregate extraction shows a sudden dramatic shift to supporting large numbers of crustaceans (Figure 2). While the species reaching such high numbers is not the same from area to area, a huge increase in their biomass may be evident e.g. 4,000 individuals /msq.[4]
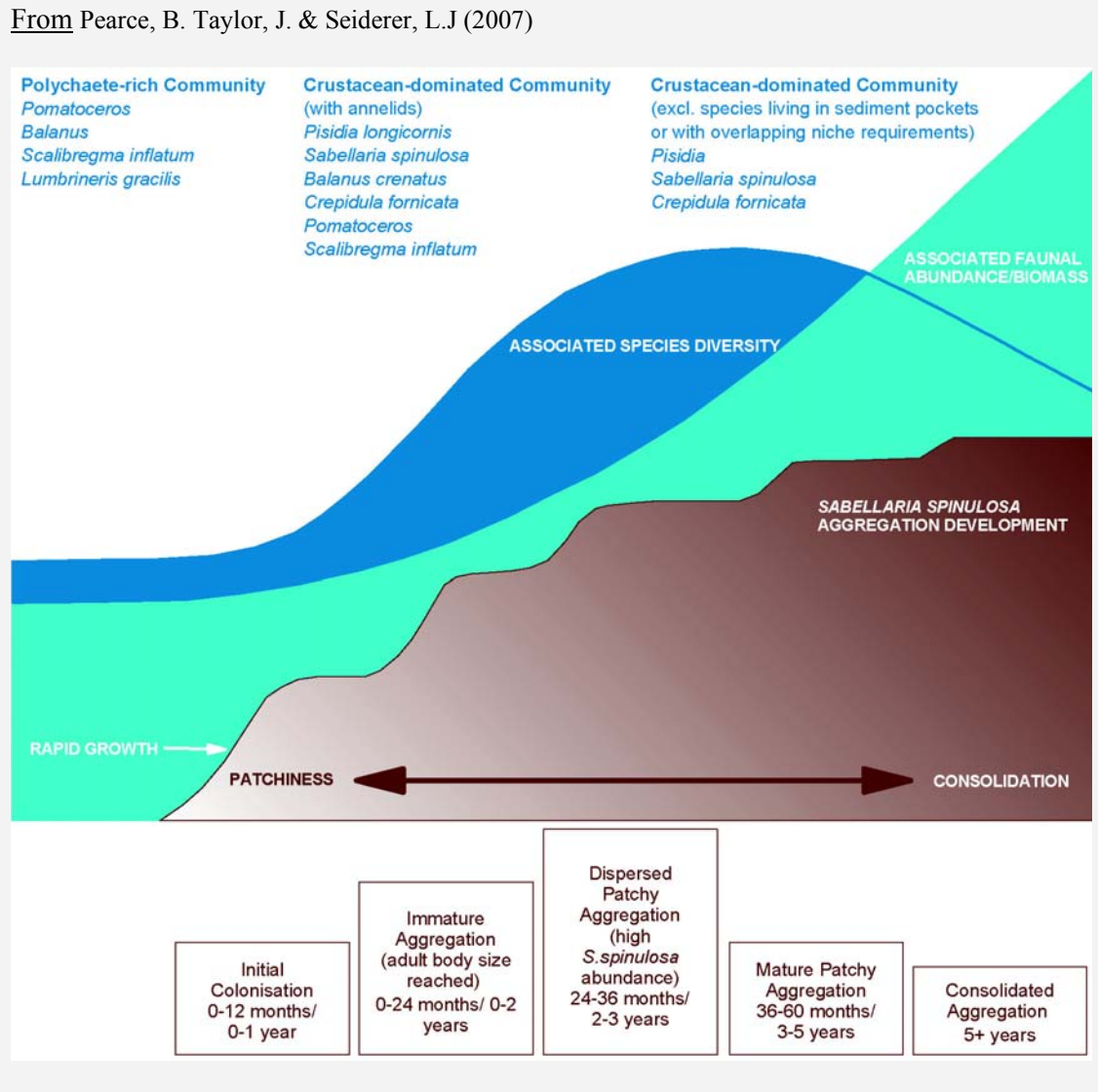
2.1.5 Longevity and restoration potential

Sabellaria spinulosa reefs are not necessarily long lived features which will be problematic in terms of management. Nevertheless there is evidence from some locations of a pattern of development of reefs and for the community structure of reefs to become relatively stable after an initial period of rapid growth (see Figure 2).

While it was concluded the potential for development of *Sabellaria spinulosa* reefs was not sufficient justification for proposing an area as an SAC, areas of degraded reef or where reef formation was previously known could usefully be considered.

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[4] Pearce, B. Taylor, J. & Seiderer, L.J. 2007. Recoverability of *Sabellaria spinulosa* Following Aggregate Extraction. Aggregate Levy Sustainability Fund MAL0027. Marine Ecological Surveys Limited, 24a Monmouth Place, Bath, BA1 2AY. 87pp.

Figure 2. Stages in recolonisation of previously dredged area by *Sabellaria spinulosa.*

From Pearce, B. Taylor, J. & Seiderer, L.J (2007)

2.1.6 Context

The worms settle on varied habitats including sand, shell debris and cobble. This is relevant in terms of management as it may affect their sensitivity to particular impacts. Little is known about the ecosystem function role of *Sabellaria spinulosa* reefs, however this is certainly likely to be different from that of the surrounding uncolonised habitat, particular in areas of bare sand.

2.1.7 Scoring System

There was much interest in the potential role and detail of the scoring system described by Vicki Hendrick. The list of characteristics was discussed, as were ways in which they might be measured or weighted to better reflect particular definitions of a reef.

Identified benefits of using such a system included providing a structure for decision making which would be consistent and comparable between sites as well as showing where data were lacking. There would also be value in using it as an interactive process bringing people together to reach a common view on particular features which may be defined as reefs. In a similar way, the system could act as a focus for reaching scientific consensus on the different characteristics of *Sabellaria spinulosa* reefs.

Further development of this approach, for example, with supporting guidance or perhaps an indication of relative weighting of the different characteristics, could be very useful as a second stage in the process of identifying suitable areas of *Sabellaria spinulosa* reef for protection within *Natura 2000* sites.

KEY MESSAGES

A consistent, agreed definition for *Sabellaria spinulosa* reefs is needed at a UK level to relation to ***Natura 2000*** sites.

The definition of reefs in the EU Guidelines specifies that they arise from the seafloor (meaning the reef is topographically distinct from the surrounding seafloor). Elevation is therefore a necessary consideration.

The EU Guidelines need further elaboration to provide something which can be identified and measured in the field. In doing so the definition could (and should) reflect UK aspirations for conservation of *Sabellaria spinulosa* reefs within the framework of the Habitats Directive

The key consideration is "reefiness" i.e. this is not a species conservation measure.

A number of potential characteristics of *Sabellaria spinulosa* reefs were discussed, however it was concluded that the definition should be kept simple and clear rather than listing all potential characteristics.

The key elements of any definition in relation to *Natura 2000* were considered to be geographic extent (including patchiness) and topographic distinctiveness.

At its simplest, a definition of *Sabellaria spinulosa* reef in the context of the Habitats Directive was considered to be an area of *Sabellaria spinulosa* which is elevated from the seabed and has a large geographic extent. Colonies may be patchy within an area defined as reef and show a range of elevations. In UK waters elevations created by ross worm tubes of up to 30cm have been recorded and geographic extents of more than 1km^2. Potential guideline figures for these elements of the definition were discussed and are a starting point for further refinement and clarification of the definition.

Additional characteristics should be considered when describing the particular qualities of a reef and comparing different reefs. A scoring system, such as that described at the meeting, would be a useful tool for this task. Advantages of using such a system include the provision of a clear structure to support decision making as well as being useable with limited and varied data sets as well as pointing to further data needs.

3   Management and monitoring *Sabellaria spinulosa* reefs

A second theme of the workshop was future management and monitoring of *Sabellaria spinulosa* reefs. This will be influenced by the definition of *Sabellaria spinulosa* reefs, objectives for *Sabellaria spinulosa* reefs within SACs and survey techniques available.

David Limpenny (CEFAS) described the results of a study which compared a range of survey techniques for detecting, mapping and sampling *Sabellaria spinulosa* reef (Limpenny et al., in prep). These were acoustic remote sensing, digital imaging scanning sonar, visual observation with video and still photography, diver observation and sampling using a variety of grabs, small epibenthic beam trawls and collection by divers. The appropriate survey methodology will be influenced by the definition of a reef. For example, if it only relates to elevation and patchiness or whether additional characteristics such as associated biodiversity and temporal stability need to be assessed.

Decisions on survey techniques will also depend on the type of environment being surveyed and rather than a single approach a suite of tools are likely to be useful, each helping with a number of the elements which need to be examined. The results of this work will inform the development of best practice guidelines for the conduct of survey work on *Sabellaria spinulosa*.

Zoë Crutchfield (JNCC) described the legislative requirements for management of reefs and an overview of the various controls available.

There are regulations under development for application of the Habitats Directive in offshore areas, however until these are introduced current legal measures to safeguard areas of *Sabellaria spinulosa* reef are limited to the requirements of Environmental Impact Assessment and 'appropriate assessment' under the Petroleum Offshore regulations. The latter are concerned with activities likely to have a significant effect on a "relevant site" which include areas which could potentially be SACs for *Sabellaria spinulosa* reefs. Neither of these current legal measures applies to ongoing activities but rather to plans or projects.

Ian Reach (Natural England) described the conservation objectives and management implications of SACs for *Sabellaria spinulosa* reefs.

Sabellaria spinulosa reefs are present in some existing SACs (e.g. The Wash and North Norfolk) and management requirements will therefore be guided by the existing conservation objectives albeit set some years ago. These state that the features of interest within the SAC should be maintained in favourable condition, subject to natural change. This is elaborated further into ensuring that biotope presence and abundance should not deviate significantly from the established baseline. Developing objectives for potential offshore SACs also refer to ecological processes and characteristic species composition of biogenic reef communities.

Common standards for reef monitoring developed by JNCC and the Country Conservation Agencies currently refer to extent, biotope composition, distribution and spatial patterns of biotopes, presence of notable biotopes, presence of specified species and others.

Bryony Pearce (Marine Ecological Surveys Ltd) described work carried out at Hastings Shingle Bank on *Sabellaria spinulosa* in an area previously subject to aggregate dredging[5]. The study was conducted to establish rates of recovery, map extent and quality, and investigate the biological and physical factors influence the recovery or colonisation following cessation of aggregate dredging. The data shows that rapid colonisation began almost instantly after dredging ceased and that growth rates of *Sabellaria spinulosa* for the first 18 months were fast. The process of colonisation in the surrounding area suggests mature patches were around 3-5 yrs old.

In terms of the associated biodiversity there was no particular difference in the species characterising the reef and the surrounding habitat. However, elevated abundances of many species were found in association with the reefs. This may be very significant in terms of food web interactions. For example the porcelain crab *Pisidia longicornis* was found in abundances of 3,000-4,000 per square metre, and is therefore likely to be an important food resource for fish in the area.

Rob Blyth-Skyrme (Natural England) introduced the subject of fishing and potential impacts on *Sabellaria spinulosa* reefs. There is historic evidence of reefs which have disappeared or being much reduced and anecdotal reports about links with fishing activity. In the Wash a survey by the Eastern Sea Fisheries Committee has revealed extensive occurrence of areas of *Sabellaria spinulosa* with elevations of up to 6.5cm from the seabed. They are considering an annual monitoring strategy to record the presence of reefs or reef precursor to inform management decisions within the SACs.

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[5] Pearce, B. Taylor, J. & Seiderer, L.J. 2007. Recoverability of *Sabellaria spinulosa* Following Aggregate Extraction. Aggregate Levy Sustainability Fund MAL0027. Marine Ecological Surveys Limited, 24a Monmouth Place, Bath, BA1 2AY. 87pp.

KEY MESSAGES

A variety of survey methodologies and tools can be used to detect, map, sample and monitor *Sabellaria spinulosa* reefs. Guidance on what is most appropriate will depend of the definition (and therefore parameters which need to be measured) and what is practical under particular environmental conditions.

The focus of management is likely to be on the activities which could have an impact on *Sabellaria spinulosa* reefs, however given that environmental conditions are a major influence (e.g. sediment loads, presence of sand waves and drop offs), a holistic approach to management will be required.

Management could usefully be carried out in synergy with the requirements for other features such as large marine inlets or sandbanks which are also subject to SAC designation.

Management proposals need to reflect the dynamic nature of reefs which can colonise, evolve and degrade rapidly. This is well illustrated by studies showing their natural temporal and spatial variation.

Risk assessments and management plans can be used to set out the procedures which will assist with the management of *Sabellaria spinulosa* reefs.

4   Research and data needs

The workshop concluded with a brief discussion of data needs and identifying areas for future research relating to *Sabellaria spinulosa* reefs. These were:

- How reefs form, evolve and decay and a better understanding of the environmental conditions under which they do so. This would include consideration of the longevity of reef structures, larval supply and larval settlement in UK waters and what constitutes natural change of reefs.
- Relative importance of different characteristics of reef structure e.g. crusts vs. elevated tubes, dead/alive, associated fauna as a potential food source in terms the structure and function of the reef.
- The role of predation on reef structure and function.
- Mesocosm experiments.
- Impacts of single and repeated fishing/activities.
- Sub-lethal effects of fishing (and other activities).
- Generic effects e.g. turbidity, water quality, sediment supply.
- Controlled experiments to inform management decisions e.g. closed areas.
- Scouring effects of structures.
- How to do condition monitoring and what would this involve (power analysis-improving confidence limits).
- How to monitor *Sabellaria spinulosa* reef quality in light of current monitoring protocols.
- Designing a cost effective ground-truthing tool which measures parameters for assessing reefs.

Putting together an inventory of possible reefs based on current knowledge and an agreed definition developed at the workshop would also be very valuable. This could draw on a number of existing databases such as those put together by CEFAS as part of their work ASLF work. This would be useful, for example, for putting sites in context although the required metadata to carry out such analysis may not always be available.

KEY MESSAGES

There are many potential areas for future research on *Sabellaria spinulosa* to inform *Natura 2000* work. Of the list drawn up at the workshop the highest priority was considered to be work on:

- How reefs form, evolve and decay and a better understanding of the environmental conditions under which they do so. This would include; investigations into the longevity of reef structures; larval supply and larval settlement in UK waters identifying sources and sinks; and what constitutes natural change of reefs.

- Controlled experiments to inform management decisions such as the establishment of closed areas.

- Creating an inventory of possible areas of *Sabellaria spinulosa* reef in UK waters.

5   Conclusions

The main focus of the workshop was seeking agreement on a definition of *Sabellaria spinulosa* reefs.

The simplest definition of *Sabellaria spinulosa* reef in the context of the Habitats Directive was considered to be an area of *Sabellaria spinulosa* which is elevated from the seabed and has a large spatial extent. Colonies may be patchy within an area defined as reef and show a range of elevations. In UK waters elevations created by worm tubes of up to 30cm have been recorded and spatial extents of more than 1km^2.

In seeking to provide greater guidance, workshop participants tried to put some figures on the characteristics of elevation, area and patchiness which could be used in combination to determine whether an area might qualify as a reef. The best, but not unanimous, agreement which could be reached on the day is given below in Table 4.

<u>Note that the figures are presented as a starting point for wider discussion rather than accepted and fully agreed thresholds for *Sabellaria spinulosa* reef identification.</u>

Table 4. Range of figures proposed by participants which could be used together as a measure of 'reefiness'.

Measure of 'reefiness'	NOT a REEF	LOW	MEDIUM	HIGH
Elevation (cm) (average tube height)	<2	2-5	5-10	>10
Area (m^2)	<25	25-10,000	10,000 – 1,000,000	> 1,000,000
Patchiness (% cover)	<10%	10-20	20-30	>30

Further appreciation of the quality of the reef can be determined by using a broad scoring system for a range of characteristics. These characteristics include elevation, extent and patchiness but could also cover sediment consolidation, density, associated biodiversity and longevity. Development of this approach, for example with supporting guidance or perhaps an indication of relative weighting of the different characteristics, could be a very useful as a second stage in the process of identifying suitable areas of *Sabellaria spinulosa* reef for protection within *Natura 2000* sites.

ANNEX 1   Agenda and participants list

Inter-agency workshop on *Sabellaria spinulosa* reefs
AGENDA
JNCC, Monkstone House, Peterborough
12:00 – 17:00 1 May; 9:30 – 16:15 2 May 2007

Day 1 (1 May): Defining *Sabellaria spinulosa* reefs

12:00   Lunch (provided)

12:50 **1**   **Ian Reach: Introduction - the conservation interest of *Sabellaria spinulosa* reefs
(Natura 2000, BAP, OSPAR and other MPAs)**

12:50 **2**   **Charlotte Johnston: *Sabellaria spinulosa* reefs in the context of the Habitats Directive - limitations of existing definition in SAC selection**

13:10 **3**   **Interactive session on defining *Sabellaria spinulosa* reef (chaired by Zoë Crutchfield):**
- Vicki Hendrick: a scoring system for *Sabellaria spinulosa* reef identification

14:50   Coffee break

15:05 **4**   **Group 'show and tell': examples of UK *Sabellaria spinulosa* aggregations** (photos and descriptions); which should be categorised as reefs and why? Group to note difficulties of and possible solutions to *Sabellaria spinulosa* reef identification.

17:00   **Close**

19:00   Dinner at local restaurant

Day 2 (2 May): Management of *Sabellaria spinulosa* reefs

9:30 **1**   **Summary of key points from previous day's discussion (Sue Gubbay) and further group discussion**

10:15 **2**   **Zoë Crutchfield: Conclusions on approaches to *Sabellaria spinulosa* reef identification**

11:00   Coffee Break

11:20 **3**   **Dave Limpenny/Bob Foster-Smith: Overview of survey techniques for *Sabellaria spinulosa* reefs; outcomes from MAL008 project**

11:45 **4**   **Zoë Crutchfield: Legislative requirements for management of**

Sabellaria **reefs and overview of controls available**

12:05 **5**   Lunch (provided)

12:35 **6**   **Ian Reach: Conservation objectives for *Sabellaria spinulosa* reefs**
- Group discussion on conservation objectives and favourable condition/conservation status

13:15 **7**   **Interactive session on managing *Sabellaria spinulosa* reefs (chaired by Charlotte Johnston)**
- Bryony Pearce: Impacts of aggregate dredging on *Sabellaria* and development of *Sabellaria* post aggregate-dredging
- Rob Blyth-Skyrme/Conor Donnelly: Impacts of fishing on *Sabellaria spinulosa* reefs and potential management measures (to be confirmed)

13:55   Coffee break

14:10 **8**   Group discussion on management of *Sabellaria spinulosa* reefs: Best practice

15:15 **9**   **Research priorities (Sue Gubbay to sum up; Charlotte Johnston to chair)**

15:40 **10**   **Final conclusions**

16:15   **End**

Participants contact details

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ANNEX 2

Reef characteristics for a potential scoring system

Scoring system for a variety of reef characteristics developed by Hendrick & Foster-Smith as a basis for discussion. Table 2 From Hendrick & Foster-Smith (2006) *Sabellaria spinulosa* reef: a scoring system for evaluating 'reefiness' in the context of the Habitats Directive. J.Mar.Biol.Ass.UK. 86: 665-677.

	Characteristic score		
	Low ….....................	**Medium** …......................	**High**
	0 …….........................…	**50** ….........................……	**100**
a. Elevation score			
Average tube height	~ 10 cm	~ 15 cm	~ 20 cm
Maximum tube height	~ 15 cm	~ 20 cm	~ 30 cm
Indications from remote sensing	Undetectable	Colony produces an indistinct image	Colony produces a distinct image
b. Sediment consolidation score			
Percentage cover of substratum by consolidated *Sabellaria* tubes.	~ 30 % cover	~ 45 % cover	~ 60 % cover
Degree of consolidation	Consolidation of sediment primarily an encrusting veneer of *Sabellaria* tubes, little concretion of substratum.	Sediment consolidation by upright *Sabellaria* tubes, some concretion of underlying substratum.	Substratum well consolidated by intertwined matrix of *Sabellaria* tubes.
c. Area score			
Extent of total area	Area ~ 600m^2	Area ~ 900m^2	Area ~ 1200m^2
Extent of core area	Area ~ 200m^2	Area ~ 350m^2	Area ~ 500m^2
Extent of peripheral area	Area ~ 500m^2	Area ~ 750m^2	Area ~ 1000m^2
d. Patchiness score			
Percentage cover of consolidated tubes within overall spatial extent of reef	~ 10 % cover	~ 20 % cover	~ 30 % cover
e. *S. spinulosa* density score			
Av. density of *S. spinulosa* (/m^2)	~ 800 individuals	~ 1,500 individuals	~ 3,000 individuals
Maximum density (/m^2)	~ 500 individuals	~ 1,700 individuals	~ 3,500 individuals
f. Biodiversity score			
Margalef's species richness	~ 5.0	~ 6.5	~ 8.0
Shannon diversity index	~ 2.5	~ 2.7	~ 3.0
Simpson's diversity index	~ 0.85	~ 0.87	~ 0.90
g. Biotope score			
MNCR biotope code (see Table 3)	Other biotopes	CR.MCR.CSab.Sspi	SS.SBR.PoR.SspiMx
h. Longevity score			
	No evidence for longevity of colony	Evidence of dense *S. spinulosa* aggregations found *repeatedly* but not *persistently* over time	Evidence of dense *S. spinulosa* aggregations found *persistently* over time

Summary of reef-like characteristics considered important to the interpretation of the Habitats Directive definition of reef, together with proposed methods of measurement/detection on which to base a categorisation of *Sabellaria spinulosa* reef.

N.B. Whilst grab sampling has been listed as a possible methodology for scoring many of the reef characteristics discussed, its use should be limited due to the destructive nature of this technique. However, where information derived from this technique is pre-existing, it can provide a valuable insight into the nature of the colonial structure.

Table 6. From Hendrick & Foster-Smith (2006) *Sabellaria spinulosa* reef: a scoring system for evaluating 'reefiness' in the context of the Habitats Directive. J.Mar.Biol.Ass.UK. 86: 665-677.

Feature / Characteristic	Basis of definition	Potential means of measurement / detection
Elevation	Average or maximum tube heights	Video & laser, Stereo imaging, sidescan, imaging sonar Grab – retrieval of reef fabric
Sediment coalescence and stability	Colony should bind sediment and smother or replace existing substratum with new one	Vertical photography: drift or 'lander' & Video Grab

Spatial extent	Area covered by aggregation	Acoustic techniques:
		    Sidescan; AGDS; Swath
		Sampling:
		    Towed video; Grabs

Cover / patchiness	Percentage cover of substratum by aggregation Dispersion:- Scattered vs. clumped	As above
S. spinulosa density	Average or maximum density of *S. spinulosa* / m^2	Grab sampling
Biodiversity and species richness	Elevated relative to similar non-*Sabellaria* habitats in vicinity Qualitatively different (multivariate & randomisation null models)	Video Grab Trapping/baited traps
Characteristic species	Contains species considered characteristic of the MNCR *Sabellaria* biotopes	As above
Temporal stability	Coarse:- presence or absence Degree of presence: - Resolution and repeatability of detection important. Statistical power to discriminate	Repeat sampling Size-cohort analysis