



Marine Monitoring Handbook

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Contents

Preface	7
Acknowledgements	9
Contact points for further advice	9
Preamble	11
Development of the Marine Monitoring Handbook	11
Future progress of the Marine Monitoring Handbook	11
Section 1	
Background	
Malcolm Vincent and Jon Davies	13
Introduction	14
Legislative background for monitoring on SACs	15
The UK approach to SAC monitoring	16
The role of monitoring in judging favourable condition	17
Context of SAC monitoring within the Scheme of Management	22
Using data from existing monitoring programmes	23
Bibliography	25
Section 2	
Establishing monitoring programmes for marine features	
Jon Davies	27
Introduction	28
What do I need to measure?	28
What is the most appropriate method?	37
How do I ensure my monitoring programme will measure any change accurately?	40
Assessing the condition of a feature	51
A checklist of basic errors	53
Bibliography	54
Section 3	
Advice on establishing monitoring programmes for Annex I habitats	
Jon Davies	57
Introduction	60
Reefs	61
Estuaries	70
Sandbanks which are slightly covered by seawater all the time	79
Mudflats and sandflats not covered by seawater at low tide	87

Large shallow inlets and bays	94
Submerged or partly submerged sea caves	101
Lagoons	110

Section 4

Guidance for establishing monitoring programmes for some Annex II species

Jon Davies	119
Introduction	121
Grey seal <i>Halichoerus grypus</i>	122
Common seal <i>Phoca vitulina</i>	125
Bottlenose dolphin <i>Tursiops truncatus</i>	129

Section 5

Advice on selecting appropriate monitoring techniques

Jon Davies	133
Introduction	135
Monitoring spatial patterns	136
Monitoring biological composition	148
Future developments	161
Bibliography	161

Section 6

Procedural guidelines

Caroline Turnbull and Jon Davies	163
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Procedural Guideline No. 2-3

Undertaking a physical survey of littoral and sublittoral sea caves

Caroline Turnbull, Joint Nature Conservation Committee¹

Background

Sea caves are listed on Annex I of the Habitats Directive and SACs have been designated around the British Isles citing them as features. Both intertidal and subtidal habitats need to be monitored and assessed in order to report to the European Commission on the condition of the feature. Assessment and monitoring of the dimensions of the feature are a key attribute in achieving this and provide a structure by which to arrange biological survey data.

Purpose

- (1) To provide detailed sketch maps which can be used to relocate the features in subsequent years for monitoring biological attributes.
- (2) To provide an accurate scale diagram of each individual cave to provide a backdrop for the mapping of biological attributes.

Logistics

Equipment

General

- pitons
- two fibreglass or metal measuring tapes
- calibrated compass (not a sighting compass)
- waterproof paper
- day-glow tags
- white paint
- hard hats with chin strap
- head lamp + two extra reliable light sources
- sturdy clothes and shoes
- GPS unit
- clinometer
- levelling equipment, e.g. theodolite or cross staff
- elbow- and knee-pads – recommended

Specific to sublittoral caves:

- standard SCUBA equipment
 - line and reel
 - surface marker buoys
-

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Personnel

Minimum of two people for surveying of whom at least one must be able to use a compass confidently. Caves must never be entered alone. The drafting of diagrams needs only one person.

Method

The following methods are taken from Environmental and Resource Technology Ltd (2000).

Marking the location

Draw a clear sketch of the location of the cave in relation to its surroundings. Take two bearings from the cave to two separate fixed positions to help with relocation. Take a GPS reading if possible and record the co-ordinates and the projection they are given in. Note the position of the cave on an Ordnance Survey map and take a note of the grid reference. If appropriate, mark the entrance to the cave with a small dash of white or fluorescent paint. A submerged cave once located may be marked with a buoy but this should only be left unattended when it is judged safe to do so and you are returning within the same day. It is not recommended that buoys are left for long periods since they can be a hazard to maritime traffic.

Establishing reference lines

Cave walls are referred to side 1 (left side when looking into the cave) and side 2 (right side when looking into the cave).

Each reference line should be fixed in the side wall of the cave as close to the floor as possible. Hammer pitons into crevices, or drill a hole and then fix a piton using a rawlplug. Start the first reference line as close to the cave entrance as is convenient on side 1. Attach a measuring tape to the first piton and unwind it towards the rear of the cave keeping it close to the wall and taut. Where the wall changes direction (known as a node) attach pitons and affix the tape to them to aid it in keeping close to the wall. To minimise the impact on the environment, only place pitons at nodes when they are needed to hold the tape in. Place the reference line down the length of side 2 in the same way and join both tapes at a common node at the back of the cave if the cavity terminates. Mark the pitons with day-glow tags to aid relocation – these must be removable at the end of the survey. The pitons should remain if possible to aid with subsequent surveying work.

Recording cave dimensions

- Along both sides, starting at node 1, take and record a compass bearing from each node to the next. Also record the distance in metres of each node along the marker tape. Take bearings to the nearest degree.
- Measure cave widths from side 1 only. From each node on side 1, measure and note the distance and bearing across the floor to a recorded point on side 2 (either a node or a noted distance along the tape).
- At each node on both sides, measure and record the height from the floor to the reference line.
- At each node, measure (if possible) or estimate the vertical distance from the floor to the maximum ceiling height.
- Draw a plan view of the floor indicating the position of the reference line tapes, nodes and pitons. Also note major substratum types and discontinuities along the floor on the same plan view.
- On both sides describe the wall profile from floor to maximum height in terms of inclination, i.e. vertical, sloping or overhanging, with estimated heights and clinometer measurements.
- At intertidal sites, determine the height of the cave on the shore (to side 1, piton 1, or to the surface of a rock pool in the entrance) by levelling. Also draw a profile of the cave floor by levelling inside the cave.

For further information please refer to Environmental and Resource Technology Ltd (2000) or Ellis (1988).

Data analysis

A plan view and side 1 and side 2 elevations of caves can be drawn from the dimensions and compass bearings taken during fieldwork (Figures 1 and 2 for examples). In addition, the length to width and length to height ratios can be calculated, which give an indication of the overall form or proportions of the cave.

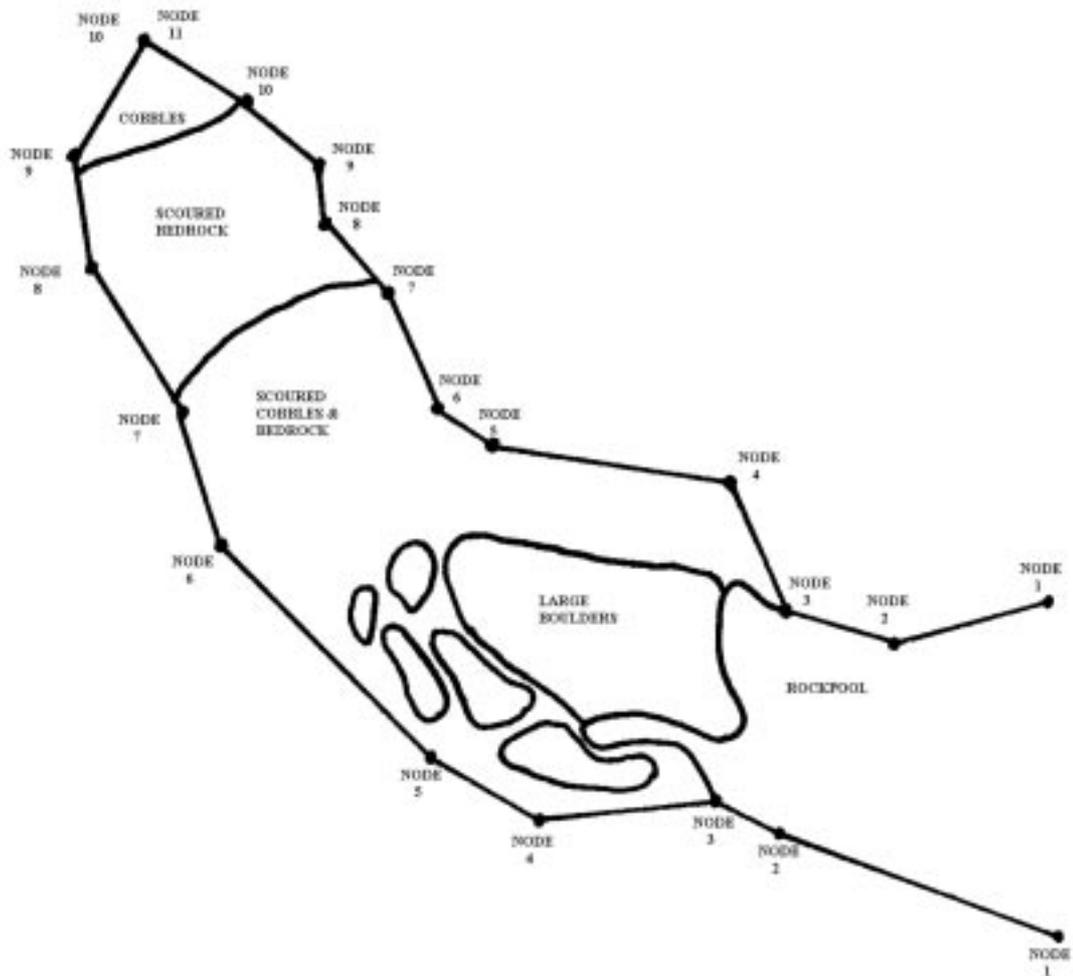


Figure 1 Plan view of a sample cave showing the labelling of nodes and substrate types

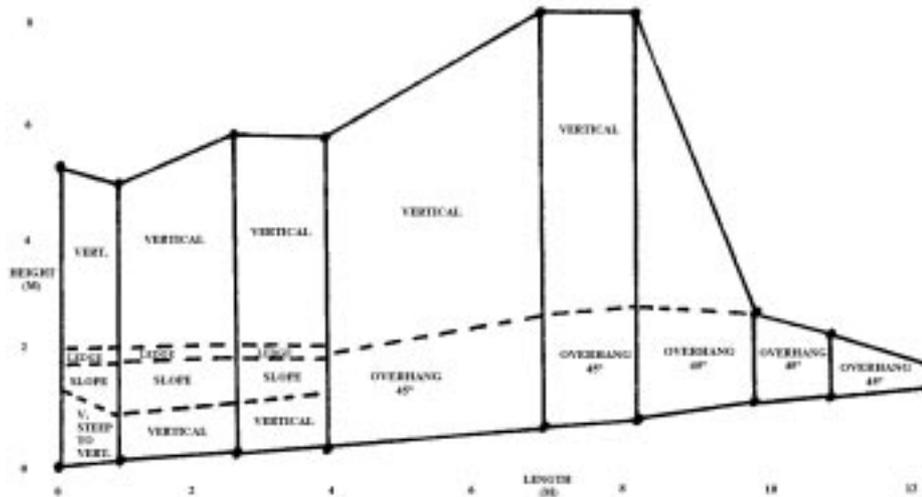


Figure 2 Sample diagram of a cave wall showing changes in elevation and placement of nodes

Accuracy testing

When possible, drawings should be validated by a co-worker with an understanding of the methodology.

QA/QC

Check before leaving for survey work that there are sufficient pitons and length of measuring tape for a range of cave sizes and complexities. Also ensure that all other relevant equipment is present and in working order.

Use local guides or detailed maps to find the correct location of a cave before commencing surveying. This is especially important for sublittoral caves which can be hard to find without specialist local knowledge.

The location of the cave should be recorded along with the projection or geographical coordinates used, e.g. OS grid or latitude and longitude. All locational information should be stored in a safe place with shared access so as to aid returning surveyors in subsequent years.

When laying the reference line ensure that the measuring tape is kept taught and does not stretch, so as to maximise the accuracy of the measurements.

It is worth noting that the minimum survey standards required by the British Cave Research Association and the Australian Speleological Federation are a survey using a compass and tape traverse, direction recording with a calibrated compass, vertical angles recorded with a calibrated Abney level or similar clinometer, and distances measured using metallic or fibreglass tape or tacheometry. This is especially important if details of the survey are to be disseminated for wider use than purely monitoring work.

Always specify which units the cave will be measured in – they should be SI units, i.e. length in metres or centimetres and plane angles in degrees. A suitable scale should be used and noted on the diagram. The ratio of 1:200 is regarded as the common standard scale by speleological groups.

Ensure that drawings and measurements are correctly transposed from field notes and that the positions of the nodes are accurately recorded.

Data products

- plan and elevation views of caves
- records of substrates present
- cave length to height and length to width ratios

Cave dimensions can be entered into cave surveying software which can generate 3D images of caves. For further information please refer to the following websites:

<http://members.aol.com/caverdave/CPHome.html> – Cave Plot homepage

<http://therion.homepage.com/> – Therion homepage

<http://www.survex.com/> – the Survex Project

Cost and time

Individual surveys should only take half a day to execute and require teams of at least two people for both littoral and sublittoral caves. Equipment for surveys may require some investment to provide the more technical pieces such as a clinometer or theodolite. There are also boat costs and diving equipment to be considered when surveying sublittoral caves.

The checking, verifying and drafting of cave plans should only take a few hours so long as the individual is familiar with interpreting compass bearings and able to scale the measurements correctly. The task should not require specialist staff unless there is a substantial cave complex with many changes in inclination, etc.

Health and safety

Personnel working in caves must never work alone and must wear appropriate safety equipment as outlined in the equipment section. Caves are dangerous, and those surveyed for monitoring purposes are unlikely to have been made safe by local authorities. Therefore, care must be taken when entering a cave for the first time and note taken of overhead hazards and the possibility of falling rock.

In addition to this, littoral sea caves are likely to have slippery rock surfaces due to the presence of algae, and extra care must be taken when moving around. Considerable care must particularly be taken in remote areas where tidal immersion could occur before emergency assistance arrives. Field staff should carry a radio/mobile telephone to ensure the emergency services are notified promptly.

Surveying of sublittoral sea caves will involve SCUBA diving techniques. All diving operations are subject to the procedures described in the Diving at Work Regulations 1997² and must follow the Scientific and Archaeological Approved Code of Practice.³ Divers may require specific training in cave-diving procedures to ensure their safety when surveying caves.

References

Environmental and Resource Technology Ltd (2000) *Establishing a monitoring programme on caves in Berwickshire and north Northumberland cSAC*. Unpublished report to the UK Marine SACs project. English Nature, Peterborough.

Further reading

Ellis, B (1988) *An introduction to cave surveying*. British Cave Research Association.

Related websites

<http://www.bcra.org.uk> – British Cave Research Association

<http://www.bcra.org.uk/csg> – British Cave Research Association cave surveying group

<http://rubens.its.unimelb.edu.au/~pgm/asf/stdsurv.html> – Australian Speleological Federation Cave Survey and Map Standards

<http://www.sat.dundee.ac.uk/~arb/speleo/spfseminar96/survey.html> – Expedition surveying guide

2 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>

3 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