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UK Marine
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Contents

Procedural Guideline 1-1 Intertidal resource mapping using aerial photographs

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Background

Shore mapping aims to create maps showing the distribution of biotopes along with associated information, such as the occurrence of rare species, details of habitat, etc. Biotopes are located on the shore and matched to features shown on recent colour aerial photographs (corrected to allow an Ordnance Survey grid overlay). The biotope boundaries are then defined on the photograph (as 'polygons') and target notes made on biotopes and features of interest together with detailed quantitative data if required. Integral to the methodology is the collating of the biological data, together with aerial photographs and digitised 1:10,000 OS maps on a PC-based Geographical Information System (GIS) such as MapInfo™ or ArcView™ (ideally linked to a database).

The precise methodology varies slightly between workers, but generally follows that described in Foster-Smith and Bunker (1997) and Wyn *et al.* (2000). Shore biotopes are classified according to the national classification (Connor *et al.* 1997); however, it is important to recognise and properly describe the regional character and variants of biotopes in each area of study. Maps may be displayed in a variety of ways, depending on the end-user requirements, either using life form colours (Foster-Smith and Bunker 1997) or biotope complex colours (Connor *et al.* 1997). Perrins and Bunker (1998) discuss the merits of presenting the same map in different ways.

Shore mapping is primarily designed to record the broad-scale distribution of biotopes for baseline mapping. However, following trials on rocky shores oiled by the *Sea Empress* spill, Bunker and Bunker (1998) concluded that the method also has a useful role in surveillance studies and in the planning of monitoring strategies. A useful discussion of the limitations of shore mapping in monitoring sediment biotopes is given in Perrins and Bunker (1998).

A study of shores in Pembrokeshire, Wales affected by the *Sea Empress* oil spill provided examples of how large-scale changes over time were detected by detailed shore mapping and target noting (Bunker and Bunker 1998). Figure 1 shows biotope maps of a limestone shore approximately 6 months and 17 months after the spill. These maps are coloured according to life form (Foster-Smith and Bunker 1997) and show biotopes classified according to Connor *et al.* (1997). Local variants of biotopes were recognised in order to describe particular characteristics of the shore, and subtle changes that took place. Many of the subtle changes that occurred on the shore were not easily shown on a map. Examples of these included the bleaching and subsequent recovery of crustose coralline algae in some kelp biotopes and growths of *Pelvetia canaliculata,* which appeared in the ELR.MB.BPat.Cht (*Chthamalus montagui* and *Lichina pygmaea*) biotope. Such details were recorded as target notes and subsequently discussed in the report.

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Purpose

Attributes measurable by shore mapping

- distribution of individual or groups of biotopes, biotope complexes and life forms present in an area
- extent of individual or groups of biotopes, biotope complexes and life forms present in an area
- diversity of biotopes present in an area
- other attributes attached to polygons in the form of target notes, such as species information, condition of biotopes (Bunker and Bunker 1998) and sensitivity (Cooke and McMath 2000)

Although not essential, the use of GIS, especially when linked to a database, greatly facilitates measuring of various attributes of shore mapping, including the following.

Applicability of shore mapping to other survey objectives

Compile an inventory / re-inventory biotopes or biotope complexes present in a defined area.

Advantages

- The maps can show the overall distribution of biotopes over large areas of shoreline and can be invaluable for developing resource management and monitoring strategies.
- The maps can highlight and help quantify large-scale changes in biotope distribution.
- Aerial photograph interpretation is a tried and tested technique.
- Data stored in a GIS are more flexible and can be interrogated in a number of ways. Entering field data directly to a PC has several advantages. As well as being quick, it cuts out sources of error which can be created by in-between paper stages.

Disadvantages

- It is important that the limitations are fully understood. The colour maps produced on a GIS can appear impressive, but their accuracy together with the biotope boundaries must always be scrutinised. Many shore species and communities occur along a continuum and therefore biotope boundaries are often artificial and subjective.
- Mapping biotopes with strict adherence to the present national classification (Connor *et al.* 1997a, b) may not take account of regional characteristics. So it is essential that proper local descriptions are prepared.
- Small features or species of interest may be overlooked where a large area is being studied. For example, intertidal *Zostera* plants may virtually disappear from sediment flats due to winter die-back and grazing by wildfowl (Perrins and Bunker 1998) and the low density may be missed by ground validation.
- It is difficult to represent the quality of a biotope. The importance of target notes and quantitative studies associated with mapped biotopes is stressed.
- An important biotope may not be a mappable unit resolved by the aerial photograph.
- Photographs may not be taken at the same time as the survey, particularly at low water. However, it is important to use recent aerial photographs. On sediment shores, features can shift over short time scales (between tides in some cases) and this will affect the accuracy of maps produced (see discussion in Perrins and Bunker 1998).

The aerial photographs available to a study may not be of high enough resolution or quality for shore mapping.

Logistics

Pre-survey

Time should be allowed before the survey to obtain aerial pictures, scan, digitise and orthorectify[4] them prior to incorporation into a GIS. If data are to be collated electronically at the time of the survey, aerial photographs for annotation must be prepared prior to the work commencing. Photos must be recorded/analysed at the start, prior to planning fieldwork.

Proper planning of fieldwork is essential for efficient use of the limited time the whole shore is uncovered. As a guide, effective shore mapping work can be carried out for a maximum of 4 hours (2 hours either side of low water) in any period of one low water. Fieldwork should only be carried out during the two to three days either side of spring tides.

Field

The amount of shore that can be covered during a single low tide by a pair of surveyors will vary depending on a number of factors. These include the quantity of information required as well as the complexity and accessibility of the coastline. Wyn *et al.* (2000) discuss survey speeds on different shore types and quote an average speed of 0.6 km/hour or 2.4 km/tide assuming four hours of survey per tide.

The precise equipment to be taken into the field depends upon the information required, but as a guide, a list is given below. Most of the items for general shore work are self-explanatory. A dGPS is essential, especially where points of reference are unclear in the field, e.g. in the middle of an extensive sediment area or positioning or the confirmation of boundaries.

Biotopes on hard substrata do not generally require specialised equipment for sampling. However, for sediment habitats some sampling of the infauna is needed to identify the biotope. A general description of sediment biotopes can be obtained by digging over an area for conspicuous macrofauna and sieving for smaller macrofauna; voucher specimens should be kept for detailed laboratory examination.

A small boat (e.g. an RIB or inflatable) can be useful, even essential along inaccessible rocky coasts and in areas of extensive sediment. (Flat-bottomed boats are most suitable for use on sediment flats.)

Equipment

- clipboard (weather-writers are good for fieldwork)
- printouts of scanned aerial photographs for annotating (laminated copies are most sturdy)
- space pen or 4B pencils for annotating colour photographs
- A4 copies of Ordnance Survey maps (enlarged if necessary)[5]
- field notebook for recording biotopes, target notes and shore profiles
- Site Forms (the MNCR site record form)
- MNCR Biotope Forms (for new biotopes)
- collecting equipment for voucher specimens
- camera (for transparencies/prints and preferably weatherproof) or digital camera/video (or Polaroid camera)
- compass and hand-held differential Global Position System (GPS) (tracking facilities and an interface to download to a PC are desirable features)
- hand lens
- safety equipment including mobile phone, VHF radio, personal protective clothing, first aid kit, life jacket
- tide tables

Extra equipment needed for sediment shores

- spade
- sieve (1mm mesh size)
- sample containers (if voucher specimens are to be kept)

Optional equipment

- hard-hat (for working under cliffs or in caves)

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4 Otho-rectification removes all the camera distortions, and also corrects what is known as relief displacement (the fact that the top of a hill is closer to the camera and so appears artificially enlarged).

5 N.B. A licence is required to copy OS maps.

- hand held flares
- binoculars
- MNCR Biotopes Manual (where a good working knowledge is lacking)
- *Field Guide to Seashore Mapping* (Bunker and Foster-Smith 1996)

Personnel/time

Each field recording team requires at least one marine biologist, skilled in the recognition of biotopes in the field. Other skills required are the ability to operate a GPS, and to interpret maps and aerial photographs. When a boat is used, appropriate seamanship skills are required. For lab-based work, basic skills in the use of GIS are required.

Writing up field data

A day's worth of data from a pair of field workers will take four to six hours to 'write up'. This includes the downloading of GPS information, digitising of polygons (or preparing fair maps), writing up target notes, drawing profiles and logging of photographs. All target notes, descriptions and photographs should be clearly geo-referenced either to polygons or to known locations (e.g. a GPS waypoint). If a PC is not available to field workers, all data should be transposed onto paper and a neat map drawn and clearly labelled. It is essential that all the information is collated in such a way that it can be readily entered into a GIS at a later date. If producing a paper copy it is particularly important that polygon boundaries are made clear. Surveyors must keep up with the task of writing up as the survey progresses and sufficient personnel and time should be allowed for this on survey.

Data collation and analysis

Where more than one field team has been entering data into a GIS and database, time must be allowed for amalgamation of data. The more thoroughly data collation is carried out following each field work session, the less arduous the task of producing the final maps and data output.

Method

Preparation

Good quality colour aerial photographs taken at low water of spring tides at a scale of 1:10,000 provide the best information for shore mapping. Photographs taken at a larger scale may not show enough detail to be useful. If the photographs are loaded into a GIS on a computer prior to the fieldwork, they can be printed out at any required scale for field annotation. Additional background maps (available from the Ordnance Survey), and grid lines can also be overlain prior to printing. The more information that can be made available to the field surveyor, the easier the job of locating one's position in the field becomes.

There are a number of methods for loading aerial photographs into a GIS system:

(1) scanning and registering
(2) scanning, warping (or rubber sheeting) and registering
(3) scanning and ortho-rectification

For each of the above methods, the photographs should be scanned (ideally at a resolution of 300dpi or higher) and registered (i.e. identify points on the photograph – sometimes called *control points* – and obtain the co-ordinates for the same point from a map). Registration is normally done using about 5 control points.

Warping (sometimes referred to as rubber sheeting) requires an additional software tool. By using additional control points, the aerial photograph is fitted more closely to the real map. 'Rubber sheeting' is a term used to describe the technique, as it is analogous to printing the aerial photograph on a sheet of rubber, and then using pins to hold each of the control points in the correct position. The end result is that all the control points are correctly located, and the photograph is stretched between these points. In practice it means that the further you are from a control point, the greater the inaccuracies.

The only truly accurate method for loading an aerial photograph into a GIS is through ortho-rectification. The inaccuracies may seem small, but they tend to be cumulative, especially if you are trying to 'mosaic together' a number of aerial photographs. Without ortho-rectification it becomes virtually impossible to line up neighbouring photographs. This again requires additional software such as OrthoPhoto by exeGesIS SDM Ltd. It also requires the digital terrain model (DTM), which can be purchased from the Ordnance Survey for about £50 for a 20 x 20km tile (at the time of writing). This is used to remove the relief displacement errors.

Colour maps for use in the field should then be printed at a scale of 1:5000 or greater (depending on the detail required by the survey). By printing them from a properly corrected set of aerial photographs, any area can be printed regardless of whether it was originally split between two or more photographs. It is useful to print grid lines on top of the aerial photographs. Problems of orientation on the shore can occur, for example, when working below cliffs or far from shore on sediment flats where land features cannot be seen. The availability of grid lines and a GPS that gives read-outs in OS co-ordinates can be invaluable in such instances.

Wyn *et al.* (2000) describe a technique of producing 'wire frames' by tracing recognisable features from aerial photographs prior to the field survey. This can be useful when copies of aerial photographs are not available for annotation in the field. Visible polygon boundaries are traced by laying a clear acetate sheet over an aerial photograph or by using a GIS. Other visible features, which will be useful for orientation in the field, can also be included, such as field boundaries, roads, groynes, streams, houses and access points. The wire frame map can then be transferred onto waterproof paper and annotated in the field with biotope information and polygon boundaries adjusted as required.

Field recording

Prior to beginning any fieldwork, it is important that the whole survey team gets together to agree recording procedures and biotope identification. Biotope recording is not an exact science and biotopes in the National Classification (Connor *et al.* 1997) can vary visibly from region to region. A 'training session' may take most of one working tide but is essential in order to ensure consistency in recording between team pairs.

When taking aerial photographs into the field, recorders must match biological features with those identified from aerial photographs. These features are then labelled with dominant biotopes and their extents marked on the printed aerial photographs as polygons. It is important for later data handling that each polygon is given its unique field identification code (e.g. FB12).

In particular, on rocky shores, polygons may contain more than one biotope, e.g. algal/faunal dominated zones interspersed with rock pools, overhangs, gullies, etc. Guidelines for recording/mapping mixed biotopes are given in Foster-Smith and Bunker (1997); see Figure 1. Notes on subordinate biotopes in polygons together with any features of importance should also be recorded, together with positional information where possible (e.g. GPS waypoints). Profiles of shores or sketches of important features should be completed in field notebooks whenever a major change is encountered. These profiles are especially important to give information on zonation patterns on steep or vertical shores. It is important that estimates (or measurements) of horizontal and vertical scale should be included on all diagrams and that these should be geo-referenced.

If required, biotope boundaries and the positions of particular features, such as gullies, can be recorded precisely using differential GPS. This may be useful for recording changes of features such as intertidal *Zostera* beds. Biotope boundaries can be difficult to interpret from aerial photographs of sediment shores. It is important to make decisions over biotope boundaries in the field and complete polygon maps as fully as possible. Delaying difficult decisions simply results in further inaccuracies. As it is impossible to cover every square metre of shore, it is important to record how much of the shore area has been visited during the survey. If the GPS has a tracking function, it can be useful to show exactly where surveyors have been. The GPS tracks can later be downloaded to a PC with appropriate software. A map of tracks can then be produced which will give future surveyors a guide as to the intensity of survey undertaken to produce the field maps.

If a biotope is encountered which does not match the national biotope classification, full JNCC marine habitat and site forms should be completed. The data obtained should then be discussed with the JNCC's Marine Information Team.

Photography is an important adjunct to the field surveys. This gives visual information on the condition of the biotope against which gross change can be measured. A mixture of viewpoint and close-up photography is useful. Photographs can be scanned (alternatively a digital camera can be used) and images attached electronically to polygons (with the aid of appropriate software). Video is also a useful medium for recording and can be used as a visual notebook and as an aid to provide relocation information for features of interest. Video files can be incorporated into the GIS and geo-referenced if desired. This method was trialled during the monitoring of biotopes on shores oiled by the *Sea Empress* oil spill in Pembrokeshire; see Bunker and Bunker (1997) for further information on the use of video.

A distinction is made between *polygon attributes* and *target notes* depending upon the type of information and the way in which the notes are geo-referenced.

Polygon attributes

Polygon attributes are information attached to a polygon and recorded as standard. This information would include (where relevant):

- dominant biotope(s);
- substrata and important modifying features;
- species/community information pertaining to the polygon, particularly if this represents a significant variation on the standard biotope description;
- rare species or species of conservation significance;
- information on the quality of the biotope, e.g. if it is scoured or perhaps a particularly good example;
- subsidiary biotopes, which are too small to be mapped individually, e.g. shallow coralline pools, which are widespread over the polygon;
- any other relevant information relating specifically to a particular polygon, e.g. any anthropogenic activities such as bait digging.

Additionally, some surveys may require specific fields for recording data such as the degree of oiling, bait digging or other anthropogenic effects that apply to the polygon.

These data will be stored in a spreadsheet or database linked directly to the polygons through the unique polygon ID reference code. Note that all these data are mappable either by creating a thematic map based on the polygons or as points taken as the centroid of the polyons.

Target notes

Target notes contain information not collected as standard for the polygons, which can be located on the map. This information will be displayed as at least one separate layer within a GIS. The number of layers will be dictated by the nature of the data. The target notes may refer to points, lines or polygons, and it is good GIS practice to have separate layers for each of these data types. The information may also be separated by category (e.g. biological and anthropogenic). Although the creation of too many layers within a GIS may not be desirable, it is extremely difficult to disentangle different types of information once they have been amalgamated into a single layer.

The data may contain:

- information on biotopes smaller than 5 x 5m which cannot be regarded as typifying the whole polygon, e.g. a significant small pool or gully in a large polygon;
- information on impacts within a localised area of a polygon (but which can encompass more than one polygon);
- artificial substrata, e.g. sewage pipes which may be represented as lines that may cross more than one polygon;
- shore profiles showing zonation and biotope extents (especially important on steep or vertical shores);
- features outside the limits of the survey (dunes, land falls, etc);
- locations where photographs and /or video were recorded;
- location of sampling stations (e.g. where quadrats or sediment samples were recorded).

Note that the target notes might refer to very small features as point data (e.g. location of a photograph), or features that are large enough to encompass more than one polygon (e.g. a long sewer pipe). The positions of the target notes can be estimated visually or located more precisely using GPS; the method used and its accuracy must be recorded in the data file for future reference. All target notes must be geo-referenced to display on a map.

Often where there is a large area of shore to cover, it is not possible to visit every polygon and any map should make a distinction between those polygons actually visited and those mapped by extrapolation or using binoculars. The associated data file should include a field to indicate how the data were recorded (direct observation or extrapolation).

Writing up field data

Ideally, surveyors should aim to transcribe field maps, target notes, etc. directly to a PC following the survey. The availability of powerful notebook PCs has made this option easily achievable for field survey teams. Failing this, a neat paper copy of all field survey data should be made. Whatever method is used, it is important that information is transcribed carefully and that target notes, photo logs and other information are cross-referenced both to each other and to the shore map (or GPS waypoints if appropriate). It can be useful to collate the information gathered every day by a team of field workers within MNCR or CCW Site Forms (especially if it is not being entered directly into a PC).

Fair maps should be prepared by drawing out the polygon boundaries, elucidated in the field from aerial photographs. This can be achieved either on a GIS (i.e. digitising the polygons) or by making a neat copy by hand. Either way the polygons should be numbered and labelled with biotopes. Polygon attribute and target note information should be referenced to the numbered polygons and/or waypoints from the GPS (on a PC this is achieved by creating data files which are either tagged to polygons or geo-referenced to waypoints). Photographs should be logged and also geo-referenced (any digital images being downloaded onto a PC). Sketches from field notebooks should be copied out in neat and geo-referenced (these can be scanned in at a later date and incorporated into the GIS if desired).

Any GPS waypoints should be accurately copied out on paper, entered, or downloaded directly onto the PC for display on maps.

Field teams may find it useful to write out the descriptions and target notes and transcribe shore profiles for stretches of coast on standard forms such as the MNCR Site Form or those produced for Phase 1 mapping by CCW (Wyn *et al.* 2000).

Data analysis

All data should be entered into a database such as Recorder 2000. The GIS and associated database can be interrogated for required information. However, it is important that the requirements be decided upon prior to the survey and data entry.

Accuracy testing

Independent checks need to be made at all stages to ensure accuracy.

QA/QC

Photography is a useful supplementary recording method, for instance where examples of biotopes (particularly new, provisional biotopes) need to be referred to during the course of the survey to ensure consistency of recording. This is especially so when there are more than one pair of surveyors involved with the survey work. The use of digital cameras is recommended, as images are instantly available and can be readily downloaded, attributed to OS co-ordinates (geo-referenced) and then entered onto the GIS.

Where more than one field team is operating, it is important that agreement is reached on the naming of biotopes, target noting and other procedural matters before the survey begins. Agreeing the naming of biotopes between survey teams is especially important as there can be difficulties matching the habitats and communities seen in the field with the biotope classification. Training prior to a survey is essential and such procedures are covered in Wyn *et al.* (2000).

Within the context of monitoring it is important to ensure that changes observed are due to factors other than inaccurate recording or variability between workers and it is therefore important to embrace control methods. Completed biotope maps should be taken into the field and checked for accuracy; checks could be made on the identification of biotopes and species. Special attention should be paid to the marking of polygon boundaries. Where extrapolation has been used to complete areas of the photographs not surveyed, some of these areas should be checked.

Wyn *et al.* (2000) describe quality control methods adopted by CCW, where it is recommended that 5% of sites be checked in house and 2% by experienced external surveyors.

The accuracy of field maps will depend on a variety of factors; in particular, the quality of aerial photographs, accuracy of photo registration, intensity of survey, consistency in biotope identification, weather and tidal conditions during time of survey and whether differential or ordinary GPS is used.

Data products

End products by necessity depend on study requirements. It is important to ensure that the GIS and associated database can be interrogated for required information prior to entering data. Commonly required products include printouts of biotope maps (Figure 1), together with data tables of associated information (e.g. target notes) and a written discussion. For monitoring purposes, precise details of the methodology will be required for future surveys.

Electronic copies of the maps, database, etc. are perhaps the most important data products.

Cost and time

The costs of a particular project will depend on location, extent and detail of survey required, ease of access and many other factors depending on the specifications of the project. When in the field, rate of progress will depend not only on these factors but also the prevailing weather conditions, especially if boats are needed for access. It is essential in every survey to cost in time for training and agreement of procedures and biotopes by the field team. Wyn *et al.* (2000) provide a useful guide to estimating the time required to undertake fieldwork in a variety of situations (Table 1).

Table 1 Examples of variations in survey speed on different shore types (from Wyn *et al.*, 2000)

Shore type	*Survey method*	*Survey time (hrs) (4hrs/tide)*	*Site length (km)*	*Site area (km2)*	*km/hr*	*km2/hr*
Sandy shore	foot	8	8.2	3.64	1.025	0.5
Bedrock cliff	boat	3	5.1	0.11	1.7	0.04
Sandy mud inlet	foot	8	4	2.23	0.5	03
Thick mud estuary	boat and foot	15	33.5	4.3	2.2	0.3
Muddy gravel inlet	foot	8	4.3	0.81	0.5	0.1
Complex mixed shore	foot	8.5	7	0.65	0.8	0.08
Complex bedrock platform	foot	7	3.6	0.6	0.5	0.08
Complex shelving platform	boat and foot	9	13	0.52	1.4	0.06

Wide rocky shores (such as those 200m wide found along much of the Northumberland coast) are very difficult to explore by foot and require more survey time than the narrow shores found around much of the Shetland Isles. A boat can be useful for wide rocky shores where one team records the lower shore while a land-based team records the middle and upper shore.

Table 2 provides a framework, which can be used as a guide to planning for costs and time to complete a project. This assumes the team involved has the necessary tools to carry out the job (see ‘Equipment’ above) together with one or more computers with GIS software.

Table 2 A suggested framework to assist the planning of a mapping project

Item	*Cost per unit*	*No. of units*	*Total*	*Notes*
Pre-survey	Desk rate for experienced staff	Estimate number of days to complete task		Obtaining of maps and aerial photographs. Scanning and ortho-rectification of aerials together with preparation of the PC system for data entry and interrogation. Printing out maps and aerial photographs for field use. General survey preparation.
Transport	Mileage cost	Estimate distances		Two vehicles desirable, one to deposit a team, the other to leave at a pick-up point for after the survey.
Field team (worker 1)	Field day rate for experienced biologist	Estimate number of days to complete task		A team of two would be a minimum. Most surveys use two pairs of surveyors.
Field team (worker 2)	Field day rate for person with mapping/GPS experience	Estimate number of days to complete task		
Boat	Hire charge	Negotiate daily or weekly rate		Does cost include fuel? Always try and view boat to ensure it is suitable for the job.
Accommodation and Food	Rate per day / week			Ensure adequate space available to spread out maps, photographs, etc. and instal PCs and printers. Self-catering can be an advantage.

Health and safety

Codes of safe conduct for shore and boat work must be followed at all times and risk assessments must be prepared for the specific locations where the study is being undertaken. The fieldwork often involves exploring coastlines not known to the surveyors. A proper risk assessment prior to fieldwork is essential, especially regarding access and tide times to prevent surveyors being stranded by a rising tide.

Appropriate field survey clothing and safety equipment should be carried, along with a VHF radio or mobile telephone, first aid kits, tide tables and hats and sunscreen (also immersion suits, life jackets and/or hard hats where appropriate).

Surveyors should always work in pairs and adopt lone-worker policies in case both surveyors become trapped or incapacitated (e.g. adhere to predetermined routes and agree details for rendezvous following the survey).

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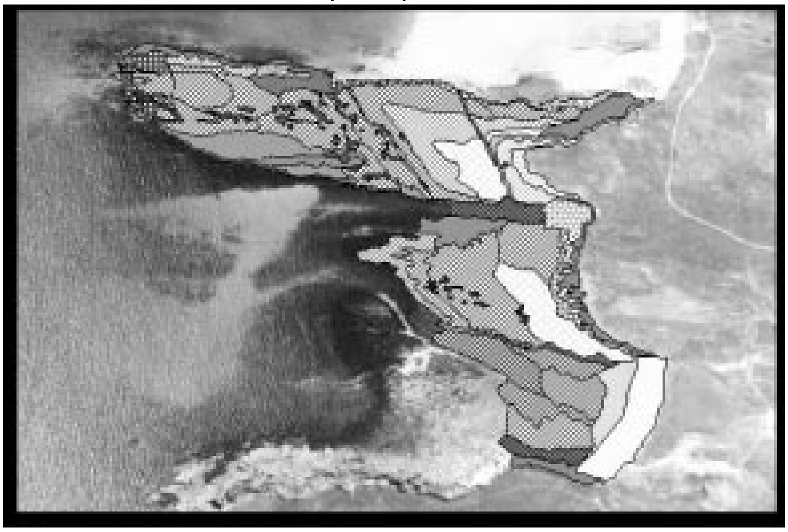
Figure 1 Typical outputs from a biotope mapping exercise (from Bunker and Bunker, 1997; aerial photograph printed with permission from the Countryside Council for Wales)

Aerial photograph

Biotope map in 1996



Biotope map in 1997

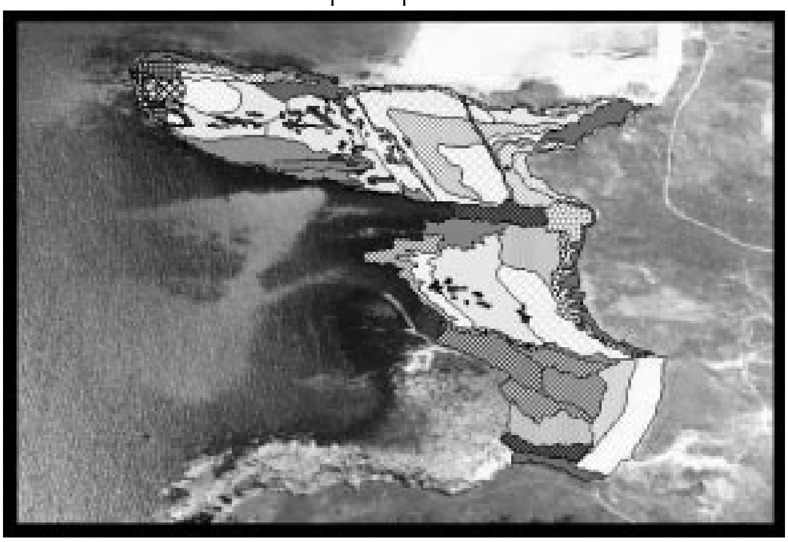
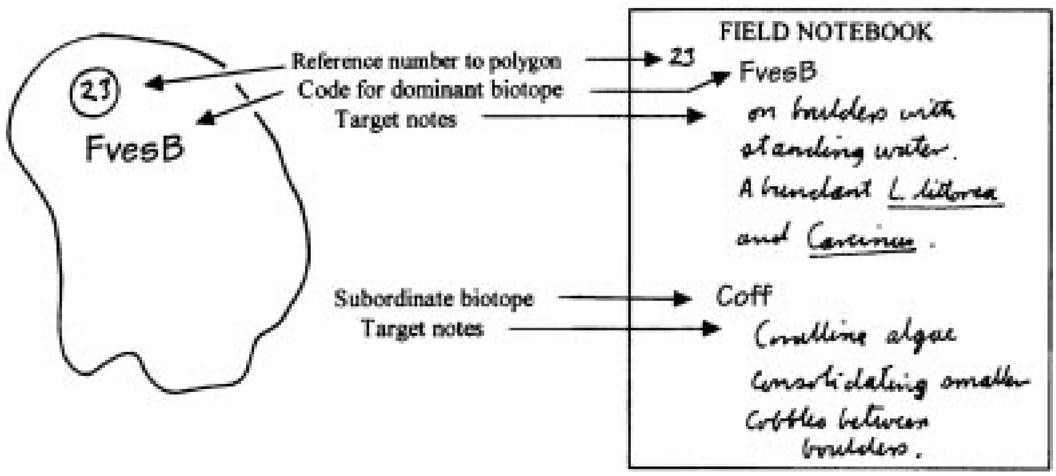


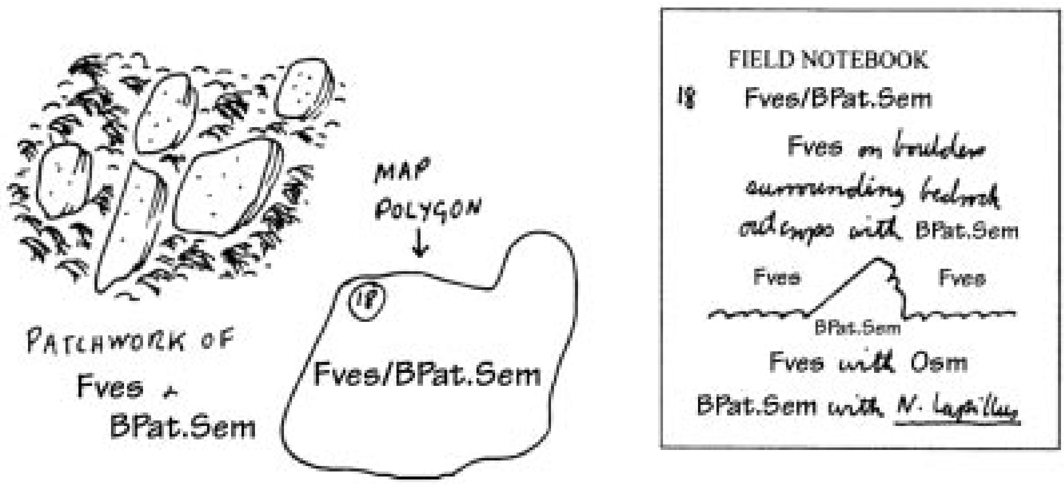
Figure 2. Different methods of recording and representing biotope mixes (after Foster-Smith and Bunker, 1997)

A. Homogeneous areas (polygons) illustrating the format for recording biotope information as codes and target notes

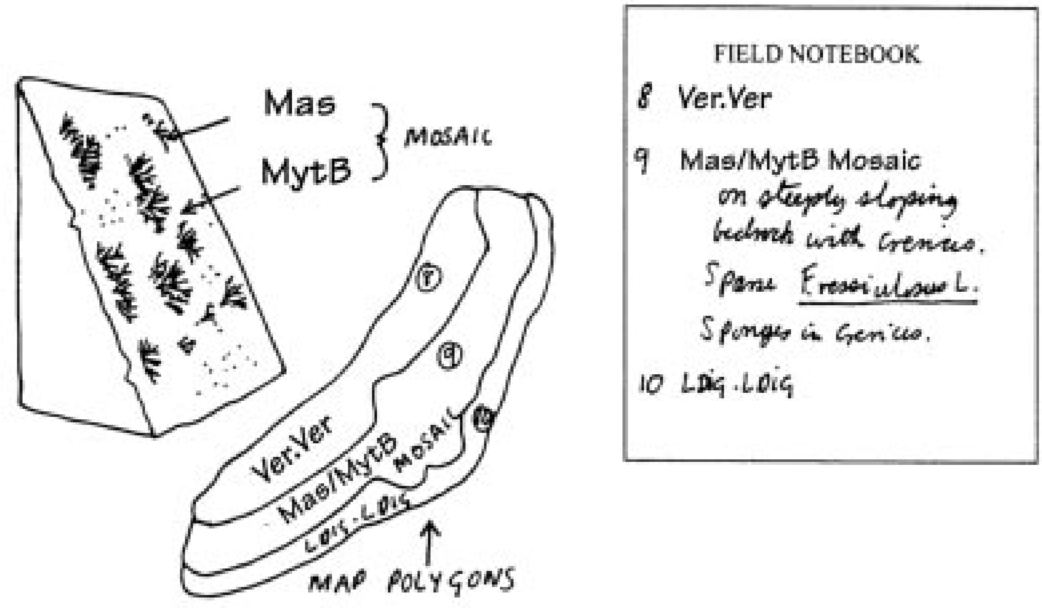


B. Areas dominated by one biotope but with a major division in a key habitat feature and/or presence of subordinate biotope

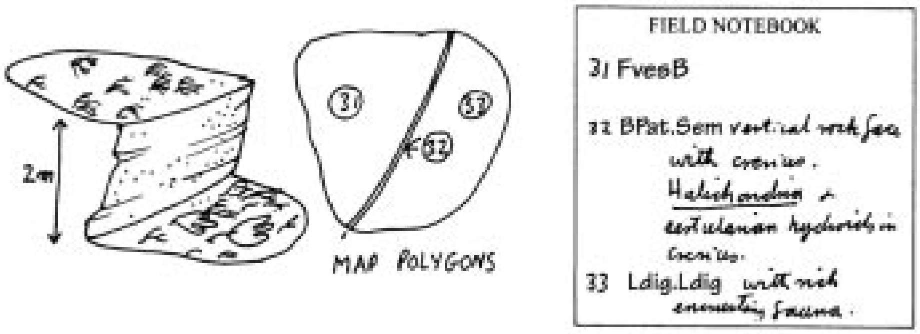
C. Biotopes form a patchwork where each patch falls below the minimum mappable size and where there is no clear predominant biotope. The biotopes are likely to be distributed according to obvious structural differences in the habitat.



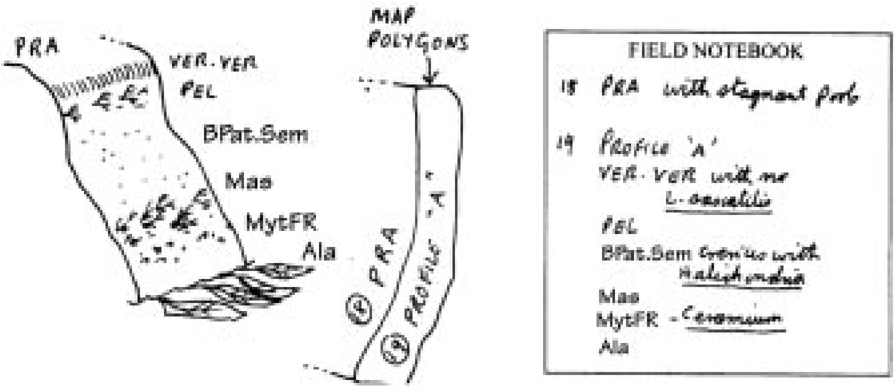
D. Biotopes form a mosaic of small patches below 1m^2. Often, these mosaics are the result of biological interactions leading to changes in patch distribution over time and are not directly related to structural differences in the habitat.



E. Biotope forming a linear feature with no mappable width



F. Biotopes forming a zonation pattern where each biotope is a linear feature of no mappable width



G. Cryptic biotopes as a component of more conspicuous biotopes