

Procedural Guideline No. 3-11

Littoral monitoring using fixed quadrat photography

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Background

Fixed quadrat monitoring

Photographic monitoring using fixed quadrats has long been established as an efficient, repeatable method for long-term monitoring studies. This paper is based on experiences from Wembury Voluntary Marine Conservation Area (VMCA) in Devon, but this type of survey has also been used at the Skomer Marine Nature Reserve (MNR) and, sublittorally, at Lundy Island. It involves the photographing of permanently marked quadrats along broad belt transects. Supported by standard MNCR recording, it can provide a valuable record of the condition of an area of coastline.

The method is very simple and therefore ideal for use by volunteers or non-professional surveyors. Quadrat locations are decided according to the survey objectives, but will generally be representative of the entire area. The simplicity of the method lies in the fact that, after initial site selection, minimum expertise is required to carry out the survey. The design of the quadrat and camera support (see Figure 1) obviates even the need for highly skilled photographers.

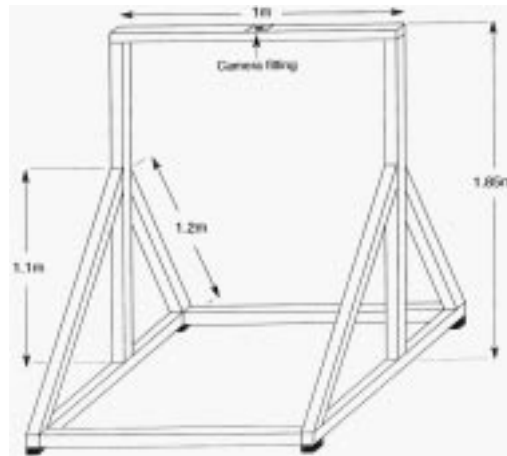


Figure 1 Quadrat design for photographic biotope survey. The height of the camera above the quadrat depends on the lens length – 1700mm for a 35mm lens, 1400mm for a 28mm lens. For certain types of survey, for instance monitoring growth rates of covering species, it is useful to divide the quadrat into smaller units using cross-hairs.

Quadrats are photographed at regular intervals and the photographs scanned into a Geographical Information System (GIS) and digitised to show area cover of key species. Yearly data is then overlaid and area cover compared.

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Purpose

Monitoring the population of characteristic, important or indicator species on:

- rocky shores/seabed
- *Zostera* beds
- saltmarsh

Monitoring growth/expansion rates of solitary and colonial species such as:

- *Eunicella verrucosa* (pink sea fan)
- *Sabellaria* spp.
- composition of characteristic biotopes

Advantages

- Low maintenance
- Minimum equipment
- Minimum training needed
- Can be carried out by non-specialist staff after initial site selection
- Low cost (after initial outlay for equipment)
- Non-destructive sampling technique

The simplicity of data collection also reduces the likelihood of error in the analysis. As technology (e.g. digital cameras, image analysis software) improves, data processing will become easier and will have less margin for error.

Disadvantages

- Restricted area covered
- May not reflect wider changes
- Restricted to predominantly bedrock/hard substrata biotopes (but can be used with care for sediment biotopes such as *Zostera* beds)
- Site selection/marketing and data processing can be labour-intensive

Logistics

Equipment

There is a long list of equipment for the initial site location and marking, but once that has been completed, much less equipment is required.

Set-up phase

- Map, sighting compass and GPS
- Tide tables
- Drill with fuel and spare drill bits
- Hartnoll and Hawkins (1980) suggest using an air-drill powered by a SCUBA tank to mark quadrats. However, there are several petrol-driven drills available that are powerful enough to drill rock and infinitely more portable. Note, even the most modern battery-driven drills are not powerful enough to drill hard rock

- **Quadrat** It is particularly important to try the quadrat in awkward-to-reach habitats, such as overhangs, to make sure the surroundings do not obstruct the camera's view of the quadrat. For smaller biotopes, such as overhang turfs, it is useful to have a 0.25m square quadrat specifically designed to get into small places
- Marker bolts and resin for setting them
- High visibility caps and/or paint for bolts
- Camera (SLR or digital) – a 35mm lens will work, but with a 28mm or 24mm the quadrat camera support can be lower, with negligible distortion (Figure 2)
- Chinagraph pencil and slate/weatherwriter
- Safety equipment, including:
 - protective eyewear
 - heavy duty gloves
 - non-slip boots
 - first aid kit
 - radio/mobile phone for remote sites
 - life jackets for exposed sites

Survey

- Map, sighting compass and GPS
- Tide tables
- Directions/site guide to relocate stations
- Quadrat and associated equipment, such as spare nuts for camera supports (see Figure 1)
- Survey camera and spare films
- Snapshot camera and spare films
- Numbered identity cards/slates for each quadrat
- Chinagraph pencil and slate/weatherwriter
- Survey forms
- Paint to remark sites if necessary
- Safety equipment, including:
 - first aid kit
 - radio/mobile phone for remote sites
 - life jackets for exposed sites

Equipment for data processing

- Personal computer
- Scanner
- Geographical information system/image analysis software



Figure 2 Quadrat *in situ* at Wembury VMCA during a survey. The lens used here was a 35mm, hence the height of the cross-bar camera supports.

Personnel

Set-up and data processing are the most time-consuming parts of this type of project. A considerable amount of time is needed to research the entire survey area so that transects and quadrats are located so as to best fulfil the survey objectives. Manual data entry and digitising is slow and labour-intensive.

Initial site selection and marking

At least two experienced littoral surveyors are required to carry out biotope mapping. If the survey area is large, this will take several days and may have to be carried out over an extended period of time because of tidal restrictions.²

For quadrat marking, when power tools are being used, an absolute minimum team of three is recommended, ideally with a fourth person to help carry heavy equipment. At least one of the team should be an experienced littoral surveyor and, for continuity, preferably one who carried out the initial site selection. Duration of site marking will depend on several factors, in particular the accessibility of the survey site and the hardness of the rock. Allow about 20 minutes per quadrat.

Survey

A team of three is recommended for the survey, mainly to help carry equipment. Specialist biologists are not necessary, but at least one of the team should be a competent photographer. Allow about 15 minutes per quadrat. Two transects close together can be surveyed on the same falling and rising tide.

Data processing

This is more time-consuming without the use of a digital camera. Photographs are scanned into a standard GIS package and manually digitised. This involves digitising areas of main species cover and assigning scaled points to individual species such as limpets. Quadrats with algal canopies are digitised with and without the algae. Overlays for successive years can then be directly compared for area and individual species cover. Photographs of quadrats can be linked via the GIS to maps of the whole survey area.

At the time of writing (2000), digital cameras and image analysis software are becoming much more affordable and easy to use and it is anticipated that this technology will dramatically reduce the time required to process data from this type of survey.

² See PG 1-1 for the guidance on biotope mapping.

Method

Site selection and marking

- (1) Map whole survey area to biotope level (or obtain previously prepared maps).
- (2) Select transect locations according to survey objectives.
If the survey is aimed at monitoring a large area, transects should be located to cover as many features of that area as possible. For instance, where the survey area is at the mouth of an estuary, transects should be located to survey all levels of salinity and physical exposure.
- (3) Select quadrat locations to provide a representative sample of entire transect/survey area.
Quadrats should be located so as to provide a representative picture of the survey area. At Wembury, representativeness was decided by carrying out a biotope survey of each of the five transects. A matrix of all biotopes found was then drawn; if a biotope was found in three or more of the transects, it was deemed to be representative.
Where possible, care should be taken to locate quadrats away from the biotope margins.
- (4) Mark quadrat locations with bolts – marking diagonal corners as in Figure 3. Occasionally, an additional bolt to mark the general location of a quadrat may be necessary, e.g. for overhang or boulder biotopes, where a bolt in a prominent place will help relocation.
Bolts should be set so that the legs of the quadrat sit directly on top of them, to ensure exact repositioning. It is good practice to mark the same corners on each quadrat, to ensure that the photographs are always orientated in the same way.
- (5) Photograph quadrat *in situ*.
- (6) Produce field locating guide using a combination of field notes, photographs and bearings/transits or differential GPS readings for each quadrat.

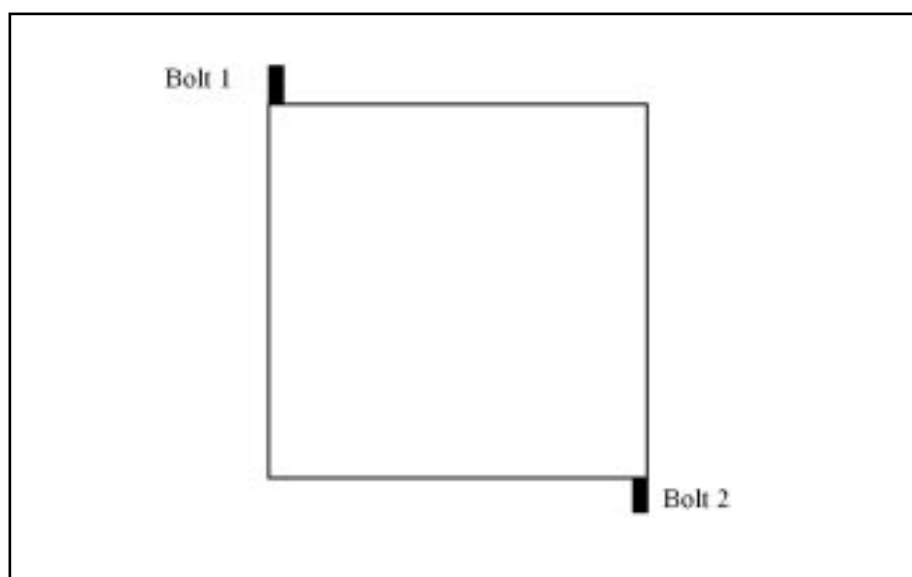


Figure 3 Showing position of marker bolts relative to the quadrat. An additional position indicator bolt can also be set – for instance, if the quadrat is under an overhang, a locator bolt could be placed on top of the ledge.

Survey

Fieldwork down the shore

- Follow the falling tide.
- Ensure that the quadrat, and hence camera, is orientated in exactly the same way each time it is photographed.
- Ensure that the inside edges of the quadrat are within the photograph frame.
- Ensure that the quadrat identity slate is within the photograph frame but not obscuring important features.

- Photograph quadrat, recording the camera settings. Pictures should be bracketed.³ If using a camera with automatic settings, it is possible to standardise light levels by using a diffused flash for all photographs.
- For biotopes with an algal canopy, photograph the quadrat with and without the algae in place.
- Support the photographic data with a detailed habitat survey every 3–5 years. The easiest way to do this is to complete a Marine Nature Conservation Review (MNCR) habitat survey form for each quadrat.
- Sample difficult to identify species with care, for subsequent identification preferably from adjacent areas.

Laboratory/field base

- Ensure all films are correctly labelled and that numbers of photographs correspond to the field notes.
- Check photographs against notes once developed.
- Identify all samples and add data to survey forms.
- Scan photographs into GIS package and digitise areas of main cover. Manual scanning of photographs is very time-consuming and produces large files. A scanning resolution of 300dpi gives images of sufficient quality for digitising, as well as reasonably sized files for most PCs. Figure 4 shows an example of a quadrat picture and digitised overlay.
- Assign large individuals with points.
- Compare overlay with previous years' data.

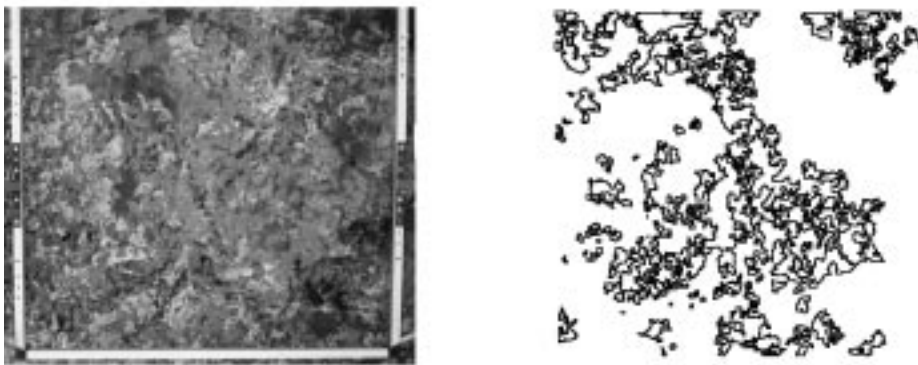


Figure 4 Example of quadrat of a yellow and grey lichen biotope (left) and its associated digitised overlay of main species cover (right)

Data analysis

The principal data analysis consists of direct comparison of area cover, abundance and/or size of individuals/colonies (e.g. *Eunicella verrucosa*). Where surveys are aimed at area cover, as opposed to growth of an individual species, statistical analysis of data can be done, but the method is designed to be as simple as possible and direct comparison is more relevant.

QA/QC

- Relocation – at the beginning of a survey, the directions for quadrat location are tested by new surveyors.
- The surveys take place at the same time each year.
- To standardise the photography, camera settings are not adjusted during the survey.
- At the beginning of each data entry phase, comparative exercises in digitising are carried out to determine the variability of data processors.
- Surveys are backed up by detailed habitat surveys (MNCR survey forms) every 3 years (DWT).
- ID for 5–10% of records should be cross-checked by an independent individual.

³ Author's note – experience has shown us that lightly overcast days are better for surveying than sunny days, when any cloud dramatically affects the light levels.

Data products

This type of survey will produce a detailed pictorial image of the study area over a set period of time. The images can be linked to base maps of the survey area where appropriate, or simply kept as a direct comparative record. Whilst the linked maps and photographs can be reproduced in report form, they are much better displayed using a computer. Habitat survey form data can also be linked electronically, either directly or via an external database, such as the MNCR Database or Recorder 2000.

Images and overlays can be stored on CD. Prints and slides should be carefully archived and stored in appropriate conditions according to manufacturers' instructions.

Cost and time

Table 1 Typical costs and timing of a survey of sixty quadrats in five transects (DWT 2000). The costs shown do not include basic survey equipment, such as slates, compass, writing materials, etc. Comparative figures for a digital camera survey are shown in brackets.

<i>Resource</i>	<i>Cost</i>	<i>Time</i>
Quadrat construction	£25 for materials	0.5 days
Biotope mapping	Personnel time	5 days
Quadrat location and marking	Personnel time	7 days
Bolts and fixative	£40	
Drill hire/fuel	£15 per day	
Survey	Personnel time	5 days
Good SLR camera	£300+	(1 tide per transect)
Film	£25	
[Digital camera]	[£500+]	
Data processing		
Development of photographs	£35	
[or CDs for digital image storage]	[£1 per CD]	
	Personnel time	30 days
	Manual scanning/digitising	[8–10 days]
	[Digital photography and image analysis]	
Reporting	Personnel time	4–5 days

Health and safety

Survey team

The usual conditions for a shore survey apply:

- A team of at least two should carry out any shore survey.
- At least one member of the team should be qualified in first aid.
- A first aid kit must be carried and all members of the team must be made aware of its location.
- Always inform someone of the survey details – location and estimated time of return.
- Carry a mobile phone/VHF radio (though the remoteness or topography of many shore locations often renders one or both of these unusable).
- A good knowledge of the tides and the shoreline (i.e. the potential for being cut off) is essential.

In addition to the generic risk assessment for survey work, a site-specific risk assessment should be completed for each survey.

A separate risk assessment should be carried out when using power tools.

Public risk

In addition to the risks to those carrying out the survey, there is the danger to the public that may be caused by leaving bolts sticking out of rocks on a busy seashore. Ensure that quadrat markers project as little as possible from the rock face and protect them with a high visibility cap.

The Health and Safety Executive produce various free guides to help people assess risks and prevent accidents. These can be obtained from HSE Books (telephone 01787 881165).

References

Hawkins, S J and Hartnoll, R G (1980) A compressed air drill powered by SCUBA cylinders for use on rocky shores. *Estuarine and Coastal Marine Science*, 9, 819–820.