Procedural Guideline No. 3-5 Identifying biotopes using video recordings

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Background

Drop-down video recording techniques have been used in a variety of applications (Sanderson *et. al.* 2000) and are appropriate for the identification of seabed habitats/biotopes when multiple deployment has priority over the requirement for fine detail. The technique could be described as 'semi-remote'; the operator of the video camera and recording equipment does have a limited amount of choice over where the camera is directed and what footage is recorded compared to a 'blind' remote technique such as grab sampling or towed video. As the operator has considerable influence over what is recorded he or she must have an appropriate knowledge of benthic communities and a sound understanding of the aims of the survey. The deployment protocol should take into account the variable nature of the seabed but at the same time set minimum requirements for obtaining footage with a combination of images using the camera held both close to the seabed and suspended a few metres above it for each habitat/biotope. It is also advisable, when establishing a programme of monitoring using drop-down video, to ground-truth the video records by either incorporating information from existing *in situ* survey data (through reference to regional or local biotopes) or conducting targeted *in situ* surveys at a similar time of year.

Purpose

To deploy video equipment to record sequences of video to identify biotopes or populations of conspicuous species.

Advantages

- Records are obtained rapidly and are stored in a permanent format that can be reviewed whenever required.
- Video images have a wide variety of uses outside the primary aim of the survey, e.g. selected still images for illustrative purposes or for producing educational and training material.

Disadvantages

Certain groups of species, such as hydroids, bryozoans and fine algae, are particularly difficult to identify from video records (hence the need for ground truthing or prior *in situ* survey and local biotope descriptions). Similarly other cryptic species, such as *Sabellaria spinulosa* and species that are best identified *in situ* by their touch (e.g. some of the sand-coated ascidians) are also missed by video unless good close-up images are obtained. This can lead to misidentification of biotopes unless appropriate measures are taken, such as using experienced surveyors who are familiar with the local area to score video footage.

Applicable to the monitoring of the following attributes

- evaluating biotope richness (i.e. number of biotopes)

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- detecting the presence of certain biotopes
- estimation of the extent of certain biotopes (as represented along a transect, for example)
- presence of conspicuous (key) species

Applicable to the following survey objectives

- inventory of seabed biotopes within a near-shore area
- reconnaissance survey prior to deployment of other methodologies
- ground truth AGDS information
- estimating the distribution and extent of habitats
- estimating the distribution and extent of biotopes (primarily epifauna)
- supplement *in situ* diving surveys by targeting specific habitats or biotopes
- making observations beyond the depth limits of normal scuba diving
- estimating biotope richness within a specified area

Logistics

Equipment

An overview of a typical drop-down video system is shown in Figure 1.

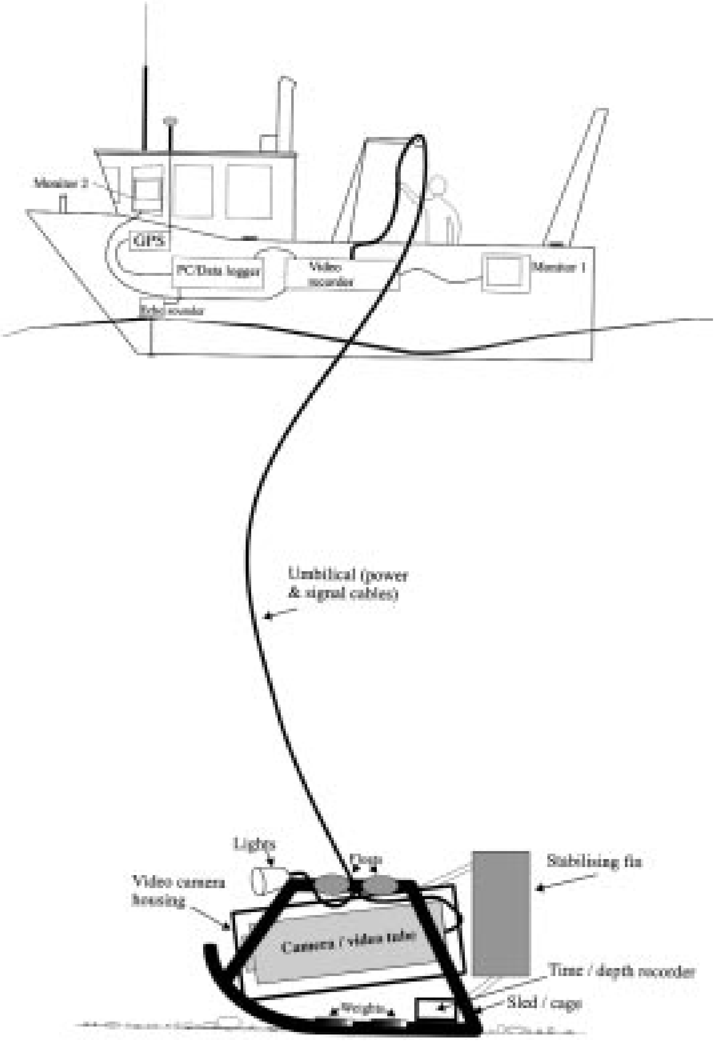

Figure 1 The main components of a drop-down video system (not drawn to scale – the camera and sled are shown at ~6x relative size)

Video format

The choice of recording medium is as important as the choice of video camera equipment, since this has most bearing over post-processing capabilities. There are many different formats of video recording media available at present. The more recently developed digital video systems designed for the domestic market (e.g. mini-DV or digital 8) or professional Digital S far out-perform older systems, such as Hi8, video 8, VHS and SVHS when considering the functions that are required to carefully review biological information on video. The higher cost and larger physical size of professional broadcast quality analogue and digital systems make them less suited for drop-down underwater use. The 'best' systems (in terms of value for money and image clarity and utility) available at present record digital information onto a variety of media including tape, laser disc (writeable digital video discs – DVD) or integrated hard drive. With magnetic tape recording media some degradation of the information on the tape can occur over time and therefore it would be unwise to plan archiving digital images on tape alone. Information stored on laser disc, providing the discs are protected from physical damage, should last indefinitely.

Digital images, in whatever medium, allow the viewer to freeze-frame, play in reverse, slow motion or a frame at a time backwards and forwards, and 'grab' video-stills without most of the distortion, flickering and 'noise' commonly experienced with analogue systems. The rate of image capture will cope with moving images at low light levels, although blurring will occur if the subject or camera moves too quickly.

Video footage can be played from a videotape recorder/player or camera. Whatever system is used the person reviewing the video recording requires as much control over the speed and direction of play of the tape as possible. Digital images can be viewed on a domestic TV (with an SVHS-in socket if possible) or run through a computer or editing suite for simultaneous image-grabbing or editing. Simple and relatively low-cost editing suites are now available that can cope with extracting video clips and stills or making back-up copies of tape sequences.

Video camera

Digital video camcorder and professional broadcast quality video camera technology is moving ahead so quickly that the primary limiting factor for deployment of a drop-down system is obtaining an 'off-the-shelf' underwater housing that will fit a 'state-of-the-art' camera. There are ready made complete drop-down systems available, for example the 'Fishman' series of drop-down cameras and mini-ROVs (remote operated vehicles) made by Q.I. Inc. in Japan (**http://www.qi-inc.com**). Providing these are sufficiently rugged for the conditions likely to be encountered, such systems feature camera pan and tilt options that provide the user with greater control over where the camera is aimed.

The features found on the Sony VX1000 digital colour camcorder (DCC) used by CCW are shown in Table 1. Such features worked well in trials around the North Wales coast (Sanderson *et. al.*2000) and are considered the minimum requirement for a system.

Table 1 Video camera requirements

Features	
Tape format	mini-DV
CCD	800 pixel
Min. illumination	4 lux
Optical zoom	x 15
Digital zoom	x 60
Weight	770g
Power consumption	5W
Operating time	325 min
Audio recording	12/16 bit
DV output	IEEE 1394 (Firewire)

A camera with an infra-red (IR) remote control facility can be utilised for surface control of the main camera functions via an umbilical. By building an infra-red sensor into the surface console the control signals can be converted into RS485 data format, thus allowing control signals to be passed via data wires in the umbilical. Electronics at the camera end of the umbilical convert the electrical signals back to IR pulses.

Lighting

Even in brightly lit, clear, shallow water, colour at the red end of the spectrum is filtered out leaving all images with a blue or green-blue cast. Small inconspicuous species such as fine filamentous algae or well-camouflaged species blend with their background unless artificial lighting is employed.

Colour-balanced quartz halogen lamps or high-intensity dispersion lights provide the principal illumination source for the camera. Two or more lights should be attached to the camera housing or its supporting frame in such a way as to provide even lighting in the majority of the field of view. Most lighting systems can be run from batteries mounted on the video camera housing or frame but far better 'burn-time' is obtained by using a low voltage direct current supply from the surface via the main umbilical.

Underwater housing

For drop-down use the ability to control the camera via signals sent down the umbilical is very important. Indeed, a simple drop-down system need consist of little more than a fixed-focus housed camera tube (i.e. lens and image capturing electronics) on the end of a cable with the power supply and recording facility on the surface. Therefore the specification for a housing can be fairly simple if it is to be 'made-to-measure'. A simple housing could comprise a hollow cylinder with mounting brackets to hold the camcorder, a lens system in addition to that of the camera (normally to widen the angle of view) and control rods/switches to operate the primary camera functions (on/off, record, pause, etc.). There is no requirement for being able to clearly see the viewfinder *in situ* (if using a camcorder) and therefore the back of the housing can simply act as an attachment point for the umbilical.

There are also many makes of underwater video housing on the market, many of which are reasonably easily adapted to working as a drop-down system. Some of the popular models already incorporate connectors for external umbilical cables. Please refer to the end of this guideline for websites where these products are available.

Sled design

The housing and lights should be securely mounted in a framework that both protects them from damage and orientates them to view the seabed when supported by the umbilical. The frame must afford the camera an uninterrupted view but at the same time protect the housing and absorb shock if in collision with underwater obstructions. The video housing and lighting brackets should allow positioning at a variety of angles so that the camera is pitched nose-down to get a close-up view when the frame is resting on the seabed. The frame should have sled-like runners to allow the frame to be dragged smoothly across the seabed, and also a tail fin to orientate the camera to the direction of travel and reduce yaw when suspended in mid-water. Unlike towed camera equipment the frame must also be light enough to deploy by hand, because the ability to react to features underwater as they appear on screen at the surface is fundamental to successful filming. Ideally the frame needs to be constructed from corrosion-resistant stainless steel. The attitude that the frame adopts underwater may require trimming with buoyancy cells (e.g. solid foam or small solid buoys) or small bolt-on lead weights to optimise the field of view.

The umbilical

Any system that requires images to be viewed in real time requires an umbilical. An umbilical is essentially a waterproof multi-core cable for transmitting power to the lights and camera, and passing control signals to the camera and video signals from the camera back to the surface. Waterproof connectors are required at both ends and at junctions in the cable.

The length and weight of the cable are the main factors limiting the maximum depth of deployment. Video housings can be made to withstand the pressure at a depth of hundreds of metres but manually hauling more than 80m of umbilical can create difficulties, although more expensive lightweight fibre-optic cables are more easily handled than conventional cables. The longer the cable the more drag is exerted on it and the greater the signal strength required to and from the camera (see manufacturers' specifications). For a system that is deployed manually the cable must also bear the combined weight of the camera and sled, although a strong point with a reinforced section of cable should form the attachment to the sled so that no strain is placed on the electrical connections. Most sea conditions will prevent a perfectly perpendicular deployment and therefore more cable is required than the depth of water below the boat. The system used in the CCW's surveys had an umbilical of 100m length, but this was difficult to use at depths greater than 60–70m. As a 'rule of thumb' allow 1.5–2 times the cable length to water depth in calm conditions and up to three times more in tidal conditions.

Peripherals

Real-time viewing is necessary for most drop-down applications. A monitor should be positioned so that both the helmsman and the person handling the umbilical have an adequate view, although in some cases an auxiliary output might be necessary for a secondary viewing monitor if the working positions of the members of the team are separated. Monitors tend to be difficult to view in strong daylight and will require some form of shading (and waterproofing) if used in an open boat.

Equipment used on the boat should be mounted in a splash-proof console if the boat is open to the weather. All electrical power must be suitably fused and protected. High voltage supplies must have earth leakage circuit breakers and a sea earth must be used. Power to the whole system can come from multiple twelve-volt DC portable batteries (lead-acid rechargeable batteries), a small portable generator or from the boat's own 12 volt supply (via an inverter for any equipment, such as a PC or video recorder, requiring voltages higher than the boat's supply).

Geo-reference capability

The utility of the video record can be greatly enhanced if the exact location (depth, time and position) of the camera is known. Geographic co-ordinates (from dGPS data) can be recorded simultaneously with depth readings from an echo-sounder and logged by a PC. If this information can be superimposed onto VHS videotape via an external interface the viewer can effectively geo-reference each frame, although attempts to superimpose positional information onto digital video during monitoring trials have so far been unsuccessful (Sanderson *et al.* 2000).

In order for data to be analysed over a time series and to monitor biotope richness, for example, it is necessary to be able to account for or standardise recording effort because the number of biotopes recorded will be linked to effort (see species–effort curves, e.g. Hawkins and Hartnoll 1980). Continuous tracking of the camera's whereabouts on the seabed using dGPS allows the user to restrict recording to a pre-determined distance. Based on previous experience of diving, effort-limited survey (e.g. Brazier *et al.* 1999a; Bunker 1999, Sanderson *et al.* 2000), a total survey area of 150m^2 (50 x 3m) was found to be sufficient for divers to adequately record at least one biotope (probably two) in the tide-swept reefs of Pen Llyn a'r Sarnau. This method, adapted to suit the deployment of a drop-down system, required the deployment of the drop-down camera over a distance of 100m steered in a straight line. This suited the scale of heterogeneity present on this particular site.

In practice this can be achieved by setting a waypoint on the dGPS (which can be a pre-determined buoyed position, for example, chosen at random from within a desired survey area) when the seabed comes into view on the video screen. The boat can then be steered or allowed to drift in a straight line away from the waypoint until 100m has been covered as shown on the DGPS ('distance to waypoint'). If distance over the seabed can in some way be superimposed on the video tape or synchronised with logged positions over time, effort limitation can also be achieved by randomly selecting sections of seabed footage from longer runs.

Alternative measures for recording depth should be considered, particularly if working in shallow water and/or over rugged terrain where the boat's echo-sounder transducer might not be perpendicularly above the camera. A digital time and depth recorder (e.g. an electronic dive timer) mounted in one corner of the camera's view could be a simple but effective way of overcoming this problem, although this will partially obscure the field of view. Alternatively, the camera and the data logged by a dive timer/time-depth recorder (with a computer download facility) attached to the camera frame can be synchronised post-deployment.

Boat requirements

Drop-down video equipment can be adapted for deployment from a wide variety of vessels. The following should be considered when choosing an appropriate boat:

- Is it capable of manoeuvring in shallow restricted waters or wherever the equipment is to be deployed?
- Does the boat have a power supply for running the drop-down equipment? If not, can batteries or a generator be adequately housed on board?
- Is there suitable dry cabin space or is the boat open to the elements?
- Is there a position on board where the sled and video can be easily deployed without long drops to the sea surface or danger from entangling the umbilical with other equipment/propellers etc?
- Can the helmsman and video operator both see the video image in real-time?
- Does the vessel carry sufficient safety equipment and comply with current workboat codes of practice?

Personnel

A drop-down video survey 'team' should comprise three people: a helmsman, someone to deploy the video and a third to aid with navigation, take field notes, control the video recorder and assist with deployment and retrieval of the umbilical, sled and camera. It is distinctly advantageous (if not essential) that the person deploying the video is reasonably familiar with the benthic communities in the area so that he/she can react to the presence of inconspicuous, unusual or diagnostic features.

Method

Deployment of the drop-down equipment

(1) Plan to deploy the drop-down video equipment at or near to slack water if in a tide-swept area and consider carefully how the prevailing wind and tidal flow might influence the direction of travel during deployment. Manoeuvrability of the support vessel will be dictated by its size, engine type, etc., and trying to hold station or move in a straight line might be impractical at certain stages of the tide or if the wind direction is, for example, blowing onshore.

(2) The video recorder, camcorder, GPS/dGPS and data logger/PC all have internal clocks. It necessary to synchronise all time-keeping devices to real time (= GPS time) so that any records made with a time reference attached (whether hand-written or automatically logged) can be easily cross-referenced without having to add or subtract confusing correction factors.

(3) Prior to each deployment the video camera, lights and videotape recorder should all be tested and working to ensure all electrical connections are sound and the recording facility is functioning. Note that some video lights cannot be switched on for more than a minute or so as they overheat when out of water. This is also the best time to label the leader section of each video run with specific information about the site, date, time and operator. A simple 'clapperboard' with the relevant information written in black on a white background held in front of the camera for about five to ten seconds should suffice.

(4) Once the boat is on site (and perhaps anchored if only a small area of seabed is to be investigated) the video is set to record and the camera frame lowered overboard by hand and the cable paid out until the seabed comes into view. If the boat is moving, perhaps drifting with the tide or wind or under power, the operator must then respond to sometimes sudden changes in the seabed profile and raise or lower the equipment to keep the seabed in sight.

(5) To record sufficient detail to characterise epibenthic biotopes a combination of wide-angle and close-up views of the seabed are required, preferably with sufficient pauses to gain good 'still' pictures. This can be achieved by devising a flexible protocol to suit the prevailing conditions. For example, the camera can be 'flown' at half a metre or so above the seabed for ten seconds then lowered to touch bottom where, if stationary, it can focus on objects immediately in front of the lens for five seconds. Repeated cycles of 'hops' along the seabed should record sufficient detail of both the smaller inconspicuous species as well as more widely distributed larger species. An experienced operator in co-ordination with the helmsman may also be able to target and home in, to a limited degree, on new or unusual species. The temptation to repeatedly home in on large, bright and colourful species, such as dahlia anemones *Urticina felina*, should be avoided (Figure 2). Such species are usually readily identified from a quick glance, whereas less conspicuous species can easily be overlooked.

(6) Kelp forest biotopes can be surveyed by slight modification of the above technique (Figure 2). There is an obvious danger of entangling the equipment, but careful deployment in calm conditions should provide adequate views of the canopy, kelp stipes and understory substratum. To penetrate the canopy the camera system must be dropped vertically into the kelp, allowed to record images for a few seconds then extracted vertically again without dragging the camera sideways.

(7) Once the required distance or time sequence has been completed the camera is retrieved. The duration of each deployment can either be pre-determined (see effort-limitation paragraph) or can be dependent on the length of videotape or duration of the battery, particularly if the recording occurs in a housed video camera rather than at the surface.

(8) A handwritten field log should be kept of times and positions of deployment. Even if GPS positions and depths are being logged automatically, basic details of the start and finish of each particular run and how these data correspond to the videotape sequence must be recorded. This guards against loss of electronic data; a very real possibility when dealing with delicate electronic instrumentation on board a constantly moving vessel in a humid salt water environment.

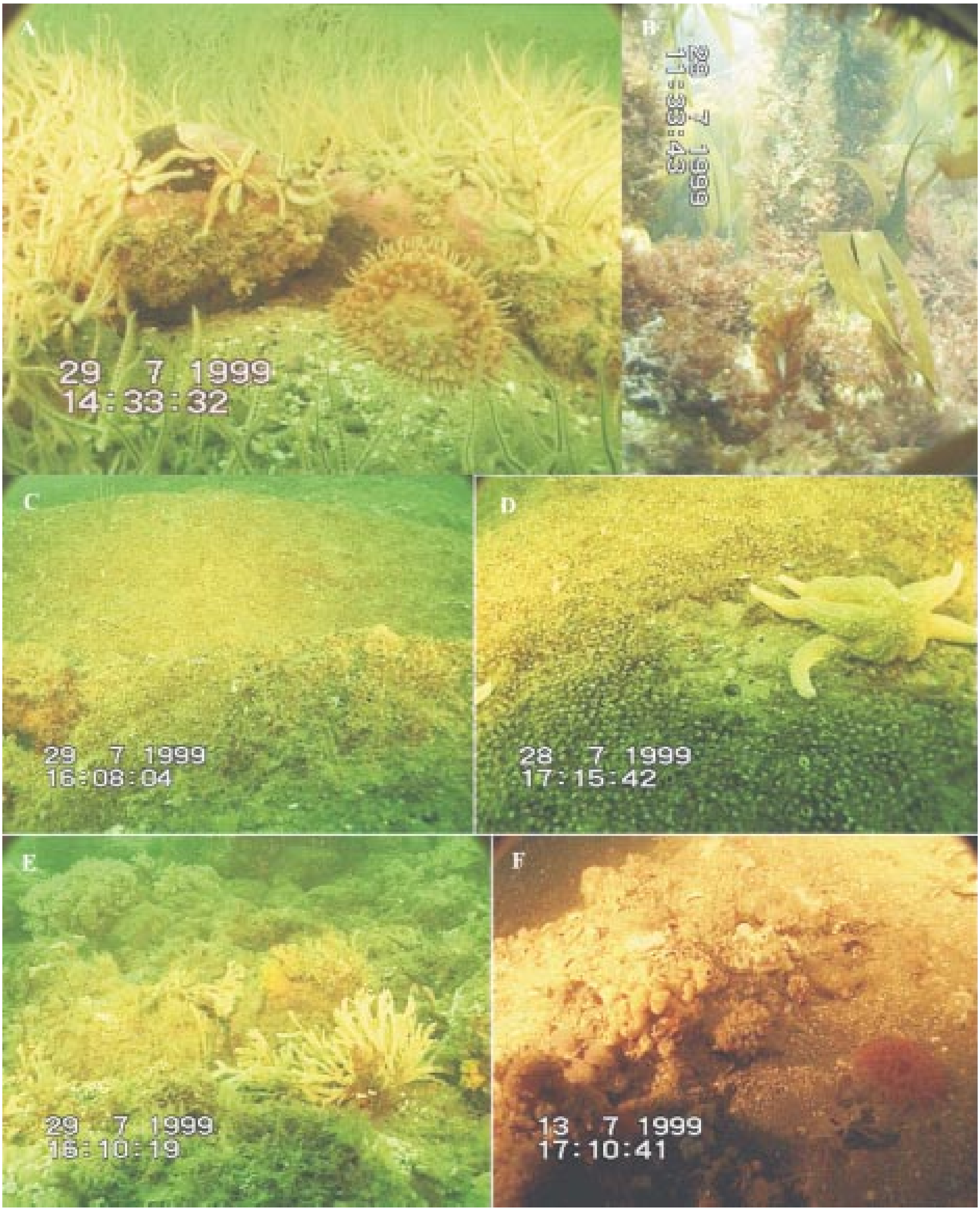

Figure 2 Video stills taken from Pen Llyn monitoring trials. (A) Conspicuous species such as *Urticina felina* and brittlestars *Ophiothrix fragilis* are easily recognised at a glance, although the viewer is tempted to concentrate on them. (B) The camera can be lowered below the kelp canopy (in this case the camera has landed on its side). (C) With the camera held above the seabed, the extent of this mussel *Musculus discors* biotope can be seen. (D) A closer view of the mussel's siphons in the *Musculus discors* biotope is recorded by landing the camera on the seabed. (E) Many of the turf-forming bryozoan species can be identified from this image with practice. (F) Blurred images of these colonial ascidians make them difficult to identify – the camera was travelling quickly with the tide.

Data analysis

Post processing of video

(1) Tapes are scored using freeze-frame, slow motion or standard play speed as required to identify as many species as possible and estimate their abundance (using MNCR SACFOR abundance scales; Hiscock 1996). Each video clip should be viewed by a biologist, preferably with prior experience of identifying species both *in situ* and off video recordings. Estimates of abundance are made by eye using the relative sizes of known features/species to gauge the size of the field of view. Notes should be made on standardised recording sheets (e.g. SNH's video log sheets or Nature Conservation Review (MNCR) recording forms).

(2) Once a complete run has been scored, the data are organised into biotopes (or habitat types if the characterising epifauna/flora could not be identified). For the purposes of an effort-limited drop-down survey methodology a biotope can be defined as having a total lower size limit: $5m^2$ was found to be a workable limit (Sanderson *et al.* 2000) below which the data were not distinguished from the surrounding larger biotope. Sparse or scattered features, such as boulders on sediment plains, were only counted as separate biotopes if their total cumulative area exceeded $5m^2$ although their presence should be noted.

(3) Biotopes recorded from the video are then compared and matched, if possible, with descriptions in the national classification (Connor *et al.* 1997). In many cases a ‘perfect fit’ with the national biotope descriptions will not be found. It will therefore be necessary, particularly for monitoring purposes, to refer to local or regional biotope descriptions that emphasise the key species and habitat features. It may be necessary to review the footage again to search for ‘clues’ of characterising species that are particularly inconspicuous on video images. This applies particularly to encrusting species such as ascidians and small mussels (e.g. *Musculus discors*) and fine species such as hydroids, bryozoans and small algae (Figure 2).

Accuracy testing

Field trials (both diving and drop-down video recording) have shown that in a limited number of cases there are difficulties encountered in appropriately attributing records to biotopes in the national classification (Connor *et al.* 1997). It was concluded that there were three principal reasons for these discrepancies that the recorder should be aware of:

(1) The workers did not examine all of the possible biotope options in the manual.

(2) Difficulties arise in the accurate and repeatable allocation of records to national biotope descriptions. National biotopes are, by their nature, nationally ‘normalised’ in order to account for biogeographic variations in the component species over their range. For this reason it would be highly desirable to match survey descriptions to more tightly described regional descriptions of national biotopes.

(3) The presence of mosaics of biotopes (e.g. vertical and horizontal surfaces that support two biotopes).

QA/QC

Minimum sampling and data analysis requirements

Effort limitation

Drop-down video surveys can be adapted to effort-limit deployments to a distance of, for example, 100m steered in a straight-line over the seabed. This distance was chosen to suite the scale of heterogeneity present on a particular area in North Wales (Sanderson *et al.* 2000) and can be adjusted as required to suite different locations. The greatest accuracy in deploying the equipment in straight lines over a known distance is achieved by allowing the boat to drift with wind and/or tide – perhaps from a pre-determined start point, although not aiming for a pre-determined end point. Attempts to power the boat between two chosen points (starting at one buoy and aiming for another) often resulted in curved runs covering more than 100m of seabed.

The number of drop-down samples required for an area and the pattern of deployment will have to be considered as part of the overall monitoring strategy.

Best time of year to undertake sampling

The best time for collecting video footage is usually related to ensuring the best likelihood of calm conditions and clear water. Although summer is usually the best time for calm seas, the best water clarity may be more specifically late summer or early spring (either side of spring and summer plankton blooms) and during neap tides. Comparative/time series studies should consider how different communities might appear at different times of year as turfs of plants and animals mature – some biotopes may be more easily identified during certain seasons.

Quality assurance measures

- Guidance and training in the recognition of critical components of a biotope is necessary for anyone involved in conducting drop-down surveys or the post-processing phase. Footage from earlier surveys in the same area can be utilised for such purposes to improve familiarity with 'local biotopes'.
- Regional descriptions of national biotopes created through analysis of data from within the survey area (if available) will significantly contribute to the quality assurance of identifying biotopes from video records.
- A second opinion should be sought on the identification of a selection of biotopes (suggest 10% of the records should be double-checked), particularly those outside the specialisation of the person responsible for reviewing the tapes. Significant and consistent discrepancies between two workers must be resolved, perhaps through re-working of local biotope descriptions.
- A reference library of video clips and stills showing variations of confirmed biotopes should be included as part of a regional classification and added to as more information is collected during future survey programmes.

Data products

- video recordings plus written record of content of each videotape
- still images (taken from video) to illustrate biotope descriptions
- position co-ordinates from dGPS related to time code on video and depth readings from echo-sounder or time-depth recording device (electronic files)
- field notes
- list of biotopes at given positions

Cost and time

Time required

Field

Between 10 and 25 deployments can be achieved in a single day, although this is highly variable depending on depth, travel distance between sites, complexity of the sites, duration of slack water if required and duration of the power supply. Effort-limited 100m deployments can take approximately 10–20 minutes (to include the time taken to deploy and retrieve the video equipment), although more time is required to deploy and retrieve buoys if they are used to mark a site.

Post-processing

As a rule of thumb, the time taken to score tapes is usually about two to three times the real-time length of the video footage.

Data analysis

Habitat records can be matched by eye with existing biotope records, 'local' biotope descriptions from the same area or descriptions in the sublittoral biotope manual (Connor *et al.* 1997). Further viewing of video clips may be required to confirm the identification of a selection of biotopes.

Equipment and survey costs

There are two main ways of calculating the cost of carrying out drop-down video surveys:

Option 1: where the survey is carried out using ‘in-house’ staff and equipment

Option 2: where the survey is contracted out to a ready-equipped survey company

The following table lists the items of equipment required for carrying out a drop-down video survey. The cost values given are estimates based on the cheaper end of the market – more sophisticated systems are available at higher costs.

Table 2 Items required and approximate costs (in Autumn 2000) for a drop-down video survey

Extent	*Items*	*Approximate cost*
Option 1#	Video camera*	>£1.5K
	Underwater video housing + umbilical*	>£2.5K
	Video lights*	>£1.5K
	Frame or sled*	>£500
	Surface monitor*	£300 (x 2?)
	Video tape recorder (backup or instead of in-camera recording)	>£500
	dGPS*	>£500
	Echo-sounder (usually part of boat)	>£300
	Time-depth logger	~£250
	Laptop PC (data logging)	>£1K
	Boat* hire or…	~£250 per day
	Boat purchase	~>£30K
	Power source – batteries	~£200
	Power source – generator	~>£1.5K
	Playback facility – e.g. TV and high-end video player (can link camcorder directly to TV)	~>£2K
	Ready-made drop-down systems (submersible camera, cable and surface monitor)	Start at ~£3K for basic system
Option 2	External contract for survey company (including reporting, videotapes and field survey)	~£220 per 100m transect (based on CCW information – Sanderson et al. 2000)**

Many of the Option 1 items can be hired.

* Essential items.

** For an organisation committed to regular drop-down video surveys it is substantially cheaper, in terms of cost per site surveyed (just over £120 per transect), to carry out the survey using in-house staff and equipment. The calculation takes into account estimates of staff time, overheads and equipment based on a comparative study carried out by CCW (Sanderson *et al.* 2000) although costs per site surveyed will vary considerably at different locations around the country.

Health and safety

- Seagoing scientific work should comply with all rules and safety recommendations in force regarding safety at sea and boat use.
- High voltage equipment should be treated with great care in a seawater environment. Circuit breakers

earth connections (to seawater in this case) and measures to protect electrical equipment from coming into contact with seawater and the operators should be used where appropriate.

- Electrical equipment should not be handled with wet hands.
- The weight of the drop-down equipment should be considered with regard to safe manual handling practices.
- There is a risk of falling overboard when handling the drop-down camera – life jackets to be worn!
- There is a risk of snagging the umbilical and trapping the camera on underwater obstructions such as rocks, wreckage and lines. A buoy should be fitted to the surface end of the umbilical should the need arise to ditch it overboard.
- Avoid operating the gear in strong tides or rough weather, or whenever total control of the boat and camera is not possible at all times.

References

Connor, D W, Dalkin, M J, Hill, T O, Holt, R H F, and Sanderson, W G (1997) *Marine Nature Conservation Review: marine biotope classification for Britain and Ireland. Volume 2. Sublittoral biotopes. Version 97.06.* JNCC Report No. 230. Joint Nature Conservation Committee, Peterborough.

Hiscock, K (ed.) (1996) *Marine Nature Conservation Review: Rationale and methods.* Coasts and seas of the United Kingdom. MNCR series. Joint Nature Conservation Committee, Peterborough.

Sanderson, W G, Holt, R H F, Kay, L, Wyn, G and McMath (eds) (2000) *The establishment of an appropriate prgramme of monitoring for the condition of SAC features on Pen Llyn a'r Sarnau: 1998–1999 trials.* Countryside Council for Wales, Contract Science Report No. 380. Countryside Council for Wales, Bangor.

Useful websites

http://www.cameratech.com/Products/Light-Motion-Housing2.html

http://www.videoquip.co.uk/underwat.html

http://www.amphibico.com

http://www.sli.unimelb.edu.au/research/mer/Irene_AMSA/index.html