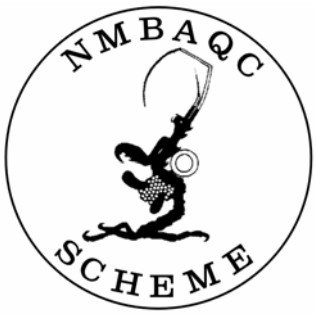

NMBAQC Epibiota Questionnaire Summary
A review of current video analysis techniques in the UK

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Cover Note:

The following report provides a review of results collated from the NMBAQC scheme's 'Review of Analysis of Video and Still Images' Questionnaire. This report highlights the wide range of purposes and functions for which video work is conducted by government agencies and private organisations in the UK. In conjunction with this, the report also shows that there are inconsistent and variable image capture and analysis procedures currently used by different organisations in the UK.

The recommendation from this report is that there is a need to standardise (or set minimum standards for) certain aspects of video and stills image analysis techniques in the UK, as no national or international standards currently exist for this aspect of video work. We recommend that this should be in the form of an NMBAQC best practice guidance document which makes recommendations for image analysis procedures.

By developing a best practice guidance document for image analysis procedures, we will help ensure the quality and consistency of video data collected in the UK which is now integral to work carried out for many European directives such as the Water Framework, Habitats and Marine Strategy Framework Directives.

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Introduction

From 2008 – 2009 the National Marine Biological Analytical Quality Control (NMBAQC) scheme trialled a national quality assurance programme for its Epibiota component which consisted of three trial ring tests and a workshop. The trial ring tests and workshop revealed that participants (from Competent Monitoring Authorities, Conservation Agencies, Fisheries Laboratories, Universities and Consultancies) have many different purposes for collecting video footage and still images of subtidal marine habitats and also have many different ways in which they conduct image analysis (Envision, 2010a). It was clear from the trial ring tests and workshop that before any further ring tests are implemented through the NMBAQC there is a need to conduct a review of existing video analysis procedures used in the UK.

In January 2010, a questionnaire was sent out to 32 organisations known to be involved in subtidal epibiota video/stills work in the UK (see Appendix 1 for a copy of the questionnaire). This included the 17 participating organisations from the NMBAQC Epibiota Video Ring Test Trial, and two additional participants. The organisations who responded to the questionnaire included four of the UK's Competent Monitoring Authorities (CMAs), all four of the UK's Conservation Agencies, one Museum and ten private organisations (see Table 1). The participating museum was the Ulster Museum, and this will be considered a 'private organisation' for the purposes of this review. The private organisations shall remain anonymous for the purposes of this questionnaire review.

Table 1. Participating government agencies of the questionnaire

Competent Monitoring Authorities
Agri-Food and Biosciences Institute (AFBI)
Centre for Environment, Fisheries & Aquaculture Science (Cefas)
Marine Scotland Science (MSS)
Northern Ireland Environment Agency, Water Management Unit (NIEA)
Conservation Agencies
Countryside Council for Wales (CCW)
Joint Nature Conservation Committee (JNCC) (via Plymouth University)
Natural England (NE) (via Cefas)
Northern Ireland Environment Agency (NIEA)
Scottish Natural Heritage (SNH)

The primary aim of the NMBAQC's epibiota questionnaire was to review the current procedures used in video and stills image analysis in the UK. The questionnaire focused on this aspect of video work as the NMBAQC trial ring tests highlighted the lack of standard approach to image analysis and because no national or international standard methods currently exist for image analysis. However, in order to understand and attempt to standardise image analysis techniques, the entire process of video work (from the monitoring purpose through to Quality Assurance procedures) was explored through the questionnaire.

This review is intended to help inform the production of a best practice guidance document for video and stills image analysis, which will ensure the consistency and quality of video data collected in the UK.

Review of Questionnaire Results

1 Purpose of video work

The aim of this section of the questionnaire was to gather further details about the purpose of video work in order to better understand the wide range in video analysis techniques used by government agencies and private organisations.

1.1 The main purpose of subtidal video work

Table 2 shows that government agencies and private organisations conduct video work for a wide range of purposes. The majority of work done by both government agencies and private organisations includes site monitoring, habitat/substrate exploration, assessment of impacts and ground truthing of acoustic data.

Table 2. Video work purposes

Video work purposes	Government Agencies (Total: 8)	Private Organisations (Total: 11)
Site monitoring (e.g. for MPA or SAC monitoring)	5	6
Habitat/Substrate identification/exploration	7	10
Ground truthing of acoustic data (e.g. for habitat mapping)	6	8
Fisheries stock assessment (e.g. *Nephrops* burrows)	3	0
Individual species distribution assessment	5	6
Fish surveys	2	0
Assessment of impacts (e.g. aggregate extraction, dredging, outfalls, trawling, anchoring, EIA, cable inspections and assessment of aquaculture)	7	7

1.2 Biological elements focused on in subtidal video work

Table 3 shows the number of government agencies and private organisations who focus on different biological elements for their video work. Generally the majority of video work is focused on biotopes, invertebrates (both sessile and mobile) and algae/angiosperms found on hard substrates and soft sediment. Most government agencies and private organisations also assess the sea floor geology/sediment characteristics as supporting information to the biological information they collect. Fewer government agencies and private organisations assess fish and fisheries related biological elements in their video work. Although not captured in this questionnaire, it is likely that many government agencies and private organisations already do (or soon will) estimate the presence of marine litter as a supporting parameter which is a Marine Strategy Framework Directive descriptor.

Table 3. Biological elements focused on in subtidal video/stills work

Biological Element	Government Agencies (Total: 8)	Private Organisations (Total: 11)
Hard Substrate (Geological or Biogenic Reef)		
Sessile invertebrates	8	11
Mobile invertebrates	8	11
Algae	5	6
Demersal fish	4	6
Pelagic fish	1	1
Biotopes	8	11
Soft Sediment		
Sessile invertebrates	8	10
Mobile invertebrates	7	11
Algae	4	6
Seagrass	5	9
Burrows (non-fisheries species)	6	7
Demersal fish	5	6
Pelagic fish	1	1
Biotopes	7	11
Fisheries related		
Seed mussels	1	1
Herring spawning grounds	2	2
Particular fish species	3	0
Invertebrate burrows (e.g. *Nephrops*)	3	1
Physical		
Sea floor geology/sediment characteristics	6	7
Archaeology	0	0
Condition of installed infrastructure (e.g. outfalls, cables, wind turbines etc)	2	1
Environmental impact		
Beggiatoa (anaerobic) bacterial mat	1	1
Sewage solids	1	1
Effluent colour	0	0
Other: dredge material disposal and aggregate extraction	1	0

1.3 Locations where subtidal video work is conducted

All government agencies conduct their video work within their geographical jurisdiction in the UK (e.g. NIEA conservation covers the Northern Ireland inshore waters -within 12 nm). All agencies conduct their video work in waters within 12nm, except for JNCC which conducts their video surveys outside 12nm, for example in the NE Atlantic deep-

sea (off the shelf) and Faroe-Shetland Channel. AFBI also conduct video work outside of UK waters in Ireland and NW Europe.

Private organisations conduct their video work around all of the UK, and various other locations around the world such as Ireland, the Middle East, West Africa, the Mediterranean and Australia.

1.4 Sediment types where subtidal video work is conducted

All government agencies and private organisations generally conduct their video work over the entire range of sediment types: Geological Reef (Bedrock, boulders, cobbles, pebbles, and gravel), Biogenic Reef, Sand, mud, and silt/clay.

1.5 Maximum water depth for video work

Government agencies and private organisations conduct video work to a range of water depths, with the majority of work being conducted above 500 m (Table 4). However, some work is conducted as deep as 5000 m, which is by JNCC (on behalf of Plymouth University) who are the only agency who conduct deep-water video surveys in the UK.

Table 4. Depth at which subtidal video work is conducted

Maximum Depth	Government Agencies (Total: 8)	Private Organisations (Total: 11)
< 100 m	3	6
< 500 m	3	2
< 2000 m	1	3
Up to 5000 m	1	0

2 Image capture procedure

The aim of this section of the questionnaire was to gather details about image capture procedure in order to better understand the wide range in video analysis techniques used by government agencies and private organisations.

Please note, only 10 private organisations filled in this section of the questionnaire as one organisation is only involved in video analysis (not capture). Some participants did not provide answers to all questions in this section. Where no answer was provided, an attempt was made to clarify this with participants. If no response was received by participants it was assumed that the answers to these questions was ‘no’ (if this was an option).

2.1 Standard Operating Procedure for image capture/collection procedure

Of the government agencies, only three have formal Standard Operating Procedures (SOPs) and one has a SOP in development (Table 5). Half of the government agencies do not have formal Standard Operating Procedures for their video collection procedure.

None of the private organisations have their own in-house SOPs for their video collection procedure (Table 5). Many organisations commented that the purpose for their contracted work varies, therefore SOPs are not written. Two of the private organisations use a third party or their client's SOPs or their video collection procedure.

Table 5. The existence of SOPs for image capture/collection

Existence of Standard Operating Procedures	Government Agencies (Total: 8)	Private Organisations (Total: 10)
Yes	3	0
No	4	8
In development	1	0
Third party or client SOP used	N/A	2

2.2 Adherence to national or internationally recognised standards relating to image capture procedure

Half of the government agencies follow the MESH guidelines (Mitchell and Coggan, 2007; White et al, 2007; Coggan et al, 2006), one follows the ICES Nephrops Survey guidelines and three do not adhere to any standards for image capture procedure (Table 6). Interestingly none of the Conservation Agencies acknowledged adhering to the video capture procedures laid out in the Marine Monitoring Handbook.

Over half of the private organisations did not acknowledge following any of the recognised standards for image capture procedure, while two organisations follow the MESH guidelines and two organisations follow the procedural guidelines in the Marine Monitoring Handbook (Moore and Bunker, 2005; Sotheran and Foster-Smith, 2004; Service and Golding, 2001) (Table 6).

Table 6. Adherence to standards for image capture procedure

Adherence to standards	Government Agencies (Total: 8)	Private Organisations (Total: 10)
MESH guidelines	4	2
JNCC Marine Monitoring Handbook guidelines	0	2
ICES (SGNEPS) - Study Group on Nephrops Survey	1	0
None	3	6

2.3 Deployment equipment used

The government agencies and private organisations use various types of deployment equipment, with the majority using drop-down cameras followed by towed cameras, handheld diver cameras and ROV cameras (Table 7).

Table 7. Deployment equipment used

Deployment equipment used	Government Agencies (Total: 8)	Private Organisations (Total: 10)
Towed camera (e.g. mounted on a sledge)	4	6
Drop-down camera	6	8
Hand-held diver camera	5	5
Hand-held camera from boat	0	0
ROV camera – small scientific	4	5
ROV camera – large industrial	3	1
SPI/REMOT camera (Sediment profile imagery)	1	0

2.4 Video and/or stills camera(s) used

Table 8 lists the various video and stills cameras used by the government agencies and private organisations. Please note this is not a complete list as not all participants specified their cameras in the questionnaire.

Table 8. Video and stills cameras used for video/stills image collection

Video cameras	Sills cameras
Kongsberg OE14-120	Kongsberg OE14-208 (digital)
Kongsberg OE14-366	Nikon D300 (digital)
Kongsberg Simrad OE1362	Photosea 1000 (35mm)
Sony DCR-TRV900	
Sony DCR-TRV950	
Sony HDR-HC7	
Sony HDR-HC9	
Sony HDV-1080i	
Sony HVR-A1E	
Tritech Laser Video	

2.5 Lighting used when collecting images

Table 9 lists the wide range of lighting configurations used by the different government agencies and private organisations. Please note this is not a complete list as not all participants specified their lighting configuration in response to this question.

Table 9. Lighting configurations for collecting video and still images

Lighting configuration	Government Agencies (Total: 8)	Private Organisations (Total: 10)
Bulb type	Halogen: 5 LED: 3 HID: 3	Halogen: 2 LED: 2 HID: 2
Wattage	10 – 100W	10 – 100W

Table 9 continued. Lighting configurations for collecting video and still images

Lighting configuration	Government Agencies (Total: 8)	Private Organisations (Total: 10)
White balance	Automatic: 4 Manual: 3	Automatic: 3 Manual: 1
Light source	Single: 1 Dual: 4 Quadruple: 1	Single: 2 Dual: 5

2.6 Method of recording video footage

Five of the government agencies record their footage both directly onto the camera and 'top side' via a cable, with one agency stating they use both methods simultaneously and for other agencies the method used is dependent on the type of video equipment they are using (Table 10). The remaining two agencies that only use 'top side' do so because of the great depth of their surveys. There is only one agency which solely records video footage directly onto their video camera.

The majority of private organisations record their video footage 'top side' on their boat via cable, with three organisations also indicating they also record their footage directly onto cameras (Table 10). There is only one private organisation which solely records video footage directly onto their video camera.

This questionnaire did not capture whether people who use top side recording actually review the live streamed footage, which is an important consideration to how much control they have over the footage collected (e.g. this allows real time targeting of certain areas of interest).

Table 10. Ways in which video footage is recorded

Footage recording method	Government Agencies (Total: 8)	Private Organisations (Total: 10)
Directly onto the camera	6	4
'Top side' (on your boat via cable)	7	9

The type of cable used for 'top side' recording

Table 11 shows that a variety of cable types are used for 'top side' recording, with government agencies using a wider selection of cables compared to private organisations.

Table 11. Type of cables used for 'top side' recording

Government Agencies	Private Organisations
Standard core	Standard core
Fibre optic	Fibre optic
Coaxial cable	Special TV cable Type 6013/B
Copper core	
Combination copper core with fibre optic capabilities	
Multicore polyurethane sheathed cable	

2.7 Collected image format

Table 12 shows that government agencies and private organisations use a range of video footage and stills formats, however the most common video footage format is tape format and the most common still image format is '.jpeg'.

Table 12. Video footage and stills formats

Format	Government Agencies (Total: 8)	Private Organisations (Total: 10)
Video footage formats		
Tape (hd mini, vhs, high 8)	6	10
Direct to disc burner (e.g. blu-ray dvd, hd dvd, dvd)	4	5
Hard Disk Drive/Flash Drive	3	3
Still image formats		
.jpeg	7	8
.tiff	2	4
.pdf	0	1
Photographic film (35mm)	2	0

2.8 Video camera resolution

This question caused a lot of confusion with many participants not knowing the resolution of their video cameras. As a result an internet search was conducted to compare the resolution (horizontal lines) of each of the different video cameras used by participants. Table 13 shows that there is substantial variation in the resolution of video camera used by participants, which ranges from 470 – 1080 horizontal lines.

Table 13. Video camera resolution

Video cameras	Resolution (Horizontal Lines)
Kongsberg OE14-120	1000
Kongsberg OE14-366	470
Kongsberg Simrad OE1362	460
Sony DCR-TRV900	500
Sony DCR-TRV950	530
Sony HDR-HC7	530
Sony HDR-HC9	480
Sony HDV-1080i	530
Sony HVR-A1E	1080
Tritech Laser Video	470

2.9 Still images camera resolution

The resolution of camera stills ranged from 2 – 12 mega pixels for the government agencies, and 3 – 10 mega pixels for the private organisations.

2.10 Supporting information collected

All government agencies and private organisations collect waypoints or tracks from a GPS on a vessel and/or from a GPS/transponder on the camera to georeference their footage (Table 14). Table 14 shows that there is a range of other supporting information collected by some agencies and organisations.

Table 14. Supporting information collected with video/stills

Supporting information collected	Government Agencies (Total: 8)	Private Organisations (Total: 10)
Waypoints or tracks from GPS on vessel (to georeference image)	7	10
Waypoints or tracks from GPS/transponder on the camera (to georeference image)	4	5
Environmental data (e.g. salinity, dissolved oxygen)	2	2
Trawl, dredge or grabs used in conjunction with video (to ground-truth biology)	4	5
Trawl, dredge or grabs deployed in a separate process to the video collection (to ground-truth biology)	6	5
Specimens collected by ROV arms or divers (to ground-truth biology)	0	2
Sediment grab (to ground-truth sediment classification)	5	6
Sediment Profile Imagery	1	0

3 Image analysis procedure

The purpose of this section of the questionnaire was to establish what current techniques are used in the UK to analyse video/stills.

Please note, when no answer was provided, an attempt was made to clarify this with participants. If no response was received by participants it was assumed that the answers to these questions was ‘no’ (if this was an option).

3.1 Existence of Standard Operating Procedures for image analysis procedure

The level of existence of SOPs for image analysis procedures is a similar to the existence of SOPs for image capture procedure (outlined in Section 2.1). Of the government agencies, only two have formal SOPs for their image analysis procedure, and another has standard methods documented in scientific publications (Table 15). Only two private organisations have SOPs for their image analysis procedure. A number of private organisations stated that variable contract work meant that no SOPs exist for their for image analysis procedures.

Table 15. The existence of Standard Operating Procedures for image analysis procedure

Existence of Standard Operating Procedures	Government Agencies (Total: 8)	Private Organisations (Total: 11)
Yes	2	2
Methods written in publications	1	0
No	5	9

3.2 Adherence to national or internationally recognised standards relating to image analysis procedure

The level of adherence to standards for image analysis is similar to the level of adherence to standards for image capture techniques (outlined in Section 2.2). Only three of the government agencies follow the MESH guidelines (Mitchell and Coggan, 2007; White et al, 2007; Coggan et al, 2006), one follows the ICES Nephrops Survey guidelines and four do not adhere to any standards for image analysis procedure (Table 16). As with image capture procedure, interestingly none of the Conservation Agencies acknowledge adhering to the procedures laid out in the Marine Monitoring Handbook.

The majority of the private organisations do not acknowledge following any of the recognised standards for image analysis procedure, while two organisations follow the MESH guidelines and one organisation follows the procedural guidelines in the Marine Monitoring Handbook (Moore and Bunker, 2005; Sotheran and Foster-Smith, R., 2004; Service and Golding, 2001).

Table 16. Adherence to standards for image analysis procedure

Adherence to standards	Government Agencies (Total: 8)	Private Organisations (Total: 11)
MESH guidelines	3	2
JNCC Marine Monitoring Handbook guidelines	0	1
ICES (SGNEPS) - Study Group on Nephrops Survey	1	0
None	4	8

3.3 Image viewing hardware used

The response to this question was varied, with some participants providing the detailed answers, whilst others provided the comment ‘various’ and others left this section blank. Table 17 summarises the specific responses provided by half of the participants, and shows that mainly PCs and laptops (of varying brands) are used to view and analyse video footage. The specifications of these range from 17 to 24 inch screens with 1024x768 to 1920x1200 pixel screen resolutions. Only two government agencies have a video monitor which is used exclusively for viewing video footage.

Table 17. Image viewing hardware used

Screen Make	Screen Model	Screen Size	Screen Resolution (pixels)
Personal Computers			
Acer	AL2016W	20 inch	1680 x 1050
Apple	Apple Cinema Display	20 inch	1680 x 1050
Dell	E172FPT	17 inch	1280 x 1024
Dell	E177FP	17 inch	1280 x 1024
Dell	IN2010NB	20 inch	1600 x 900
Dell	2407WFPb	24 inch	1920 x 1200
Dell	2407 WFP-HC	24 inch	1920 x 1200
DGM	L-2231WD	22 inch	1680 x 1050
Fujitsu Siemens	Scenicview P20W-5 ECO	20 inch	1680 x 1050
HP	No details given	No details given	1920 x 1200
Laptops			
Sony	Vaio	17 inch	1920 x 1080
Dell	Latitude D610	No details given	1024 x 768
Toshiba	No details given	No details given	1600 x 1200
Television / Video Monitor			
JVC	TM-H150CG	15 inch	> 750 TV lines
Sony	KX-20PS1	20 inch	No details given

3.4 Hardware and software you use to play/view video/stills for analysis

The response to this question was varied, with many participants not detailing their DVD/CD/Hard drive/Tape player hardware make and model. This is because the majority of participants use computers to view their images, and these details are controlled by the specific type of PC or laptop which they have (as detailed in Table 17). As a result only the video and stills image viewing software will be reviewed here.

Table 18 shows that a range of image viewing programmes used by government agencies and private organisations.

Table 18. Video and still image viewing software

Video image viewing software	Still image viewing software
Adobe Premier	Adobe Photoshop
Avid Liquid Pro	Aperture
Final Cut Pro	CorelDraw
Intervideo WinDVD 8	Irfanview
Nero (e.g. Nero 9, Nero Playback)	Matlab
Pinnacle (e.g. Studio 10)	Microsoft Photo Editor
PowerDVD	Microsoft Office Picture Manager
Windows Fax Viewer	Paint Shop Pro
Windows Media Player	Pinnacle
Quicktime	ThumbsPlus
Ulead	Windows Picture and Fax Viewer

3.5 The use of different image types for different purposes

Table 19 summarises the various uses of video footage, frame grab stills and camera stills. The government agencies and private organisations all generally use video footage for biotope/habitat classification and identification and enumeration of large/mobile epibiota. Not all government agencies and private organisations make use of stills from video frame grabs. Those who do, appear to use frame grabs for a variety of purposes ranging from biotope/habitat classification to identification and enumeration of epibiota. Some organisations also claim to use video frame grabs as backups where still images are missing. All government agencies use camera stills to compliment their video footage and these stills are generally used for epibiota identification and enumeration. Not all private organisations make use of separate camera stills with only 7 of the 10 using separate stills for biotope/habitat classification and epibiota identification and enumeration. The lack of use of a separate stills camera is acceptable for two of the three private organisations as they generally only conduct habitat surveys, however the other private organisation does conduct species identification and enumeration therefore the lack of higher resolution camera stills to aid in species identification and enumeration is concerning.

Table 19. Summary of the uses of video footage and stills (video frame grabs and camera stills)

Footage/Stills	Government Agencies (Total: 8)	Private Organisations (Total: 10)
Video footage (i.e. continuous)	8 use video footage for: - Biotope/habitat classification, - Sediment classification, - Identification and enumeration of large epibiota - Detection of anthropogenic impacts	10 use footage for: - Characterisation and ground truthing, - Biotope/habitat classification, - Identification of mobile epifauna
Still images (frame grabs from continuous video)	6 use frame grabs for: - Biotope/habitat classification, - Detection of anthropogenic impacts, - Presentation/illustration, - Training	8 use frame grabs for: - Biotope/habitat classification, - Identification and enumeration of epibiota, - Backups where still images are missing
Still images (from a separate stills camera)	8 use camera stills for: - Epibiota identification and enumeration	7 use camera stills for: - Biotope/habitat classification, - Epibiota identification and enumeration

3.6 Video/stills analysis procedure:

3.6.1 Initial scan of video footage

The majority of government agencies (six out of eight) and private organisations (seven out of eleven) conduct and initial scan of their video footage to assess image quality and to get a general impression of the habitats/species which will be encountered.

3.6.2 Rating the quality of video footage

The response to this question was varied, with four of the government agencies and five of the private organisations indicating that they do not rate the image quality of their video footage before they begin analysis.

The other four government agencies and six private organisations who do rate the quality of their video, do so by following a wide range of criteria. Some examples of the different criteria used include:

- Camera distance from the seabed is too great, therefore unable to identify and enumerate target object.
- The angle of the field of view of the camera is not optimal to permit target object identification and enumeration.
- Camera moving too fast over ground to permit target object identification and enumeration.
- Camera distance from the seabed and/or movement/speed along the seafloor is inconsistent, therefore occasionally unable to identify and enumerate target object.
- High turbidity masking the image, therefore unable to identify and enumerate target object.
- Lasers scaling is not ON (therefore scale can not be confidently assessed).
- Lighting is insufficient to permit target object identification and enumeration.

Video quality is ranked by the four government agencies and six private organisations to various degrees. For example:

- Excellent - Crystal clear footage; Good- Seabed easily observed, small amounts of suspended matter but this does not effect the visibility; Poor- Suspended matter, dense fauna or disturbed sediment results in a partially obscured view of the seabed. A little uncertain if all target objects can be accounted for; Very Poor- Suspended matter, dense fauna or disturbed sediment is present in such volume that only unidentifiable shadows can be seen on the screen, resulting in uncertain estimations; Zero- For whatever reason (sledge flying, sediment disturbance, dense gathering of fauna, effects of trawling, etc) there is no view of the seabed at all. No counts can be provided.
- Good, Average, Poor. No hard and fast rules on how video quality is rated.
- Good, Medium and Poor. Analysis of some sort is always done, if the footage is of particularly poor quality stills are grabbed from the video to illustrate the limits of the analysis.
- Usable or Not usable.

3.6.3 Use of a scale bar in footage

Two government agencies and three private organisations do not use any form of scaling on their video footage (Table 20). All other government agencies and private organisations use at least one form of scaling, with laser scaling and the use of a physical scale bar being most common.

Table 20. Type of scaling used for video footage

Type of scaling used	Government Agencies (Total: 8)	Private Organisations (Total: 11)
None used	1	3
Laser scaling on footage/images	5	5
Presence of a physical scale bar in the field of view of footage	2	6
Fixed field of view (with pre-defined scale) of footage and/or images	3	3

The following are examples of the different types of scaling used by government agencies and private organisations:

Laser scaling

- Five laser integrated (using a Tritech Laser camera).
- Four fixed lasers in a square.
- Four radially mounted laser scalar pointers (using a Kongsberg-camera: Class 3b, 635nm, 3.5mW).
- Four point laser (built into the underwater housing with a Sony camera).
- Two lasers (10cm apart) centred in the middle of the image.

Physical scale bar

- 10 cm scale bar (attached to the bottom of a fresh (clean) water camera housing).
- 1 cm marked metal rod suspended just below the frame.
- ROV has a scale bar at the bottom of the field of view.
- Sometimes quadrats of known size are recorded.

Field of view

- With the camera in a freshwater housing, the camera is a known distance from the seabed and therefore the field of view is known.
- Field of view is determined by attaching a mesh to the base of the system, so it lies flush with the seabed when the camera frame is landed. The grid is wider than the field of view so that aberrations towards the edge of the view can be noted. The 'calibration' is photographed and recorded to video with the camera landed on the seabed. The camera is also calibrated with the mesh at 1m, 2m and 3m from the camera. The altimeter for the system only records to the nearest meter, so this is all that is required. In general we only take images when the camera is landed on the seabed thus the size of the field of view is constant for the stills images.
- The field of view across the bottom of the monitor screen is known when the camera is a certain distance from the seabed. A range finder records the varying

height the camera is off the seabed and so that the field of view can be calculated at any particular point of the recording.

3.6.4 Image sampling unit

All participants responded to this question, however varying levels of detail were provided. Table 21 outlines the various types of image sampling units used by the government agencies, and shows that the most common sampling units are continuous video footage over a specific time (often 10 minutes, but one participant stated up to 1 hour) and continuous video footage over a specific distance (often 100 metres). Biotope/habitat classification is what all types of image sampling units were most commonly used for. Those agencies who provided details of when the identification and enumeration of epibiota took place indicated that the sampling units 'continuous over a specific time' and 'freeze frames at specific time intervals' are used. This is complimented by camera stills which all government agencies use for epibiota identification and enumeration (Table 19).

Table 21. Types of image sampling units used by government agencies

Image Sampling unit	Government Agencies (Total: 8)	Details	Purpose
Continuous (e.g. record everything encountered) over a specific time	6	- e.g. 10 minute to 1 hour tows	- Anthropogenic impact assessment - Biotope / habitat classification - Standardisation - Stock assessment
Continuous over a specific distance	3	- e.g. 100m tows	- Biotope / habitat classification - Identification and enumeration of megafauna
Continuous over a geo-referenced area	1	no details given	- Biotope / habitat classification
Freeze frames at specific time intervals	2	e.g. stills at 1 min intervals	- Biotope / habitat classification - Identification and enumeration of epibiota
Freeze frames at specific distance intervals	1	no details given	- Biotope / habitat classification
Biological/Habitat units	2	e.g. sub-divisions of the 10 min tows to assess points of interest	- Anthropogenic impact assessment - Biotope / habitat classification

Table 22 outlines the various types of sampling units used by the private organisations, and shows that all sampling units are commonly used except for freeze frames at specific time or distance intervals. Biotope/habitat classification is what all types of image

sampling units were most commonly used for. Generally the same details were provided by the private organisations about the types of sampling units they use (e.g. 10 min tow / 100m tow / subdivisions of footage at habitats or biological units of interest). This is complimented by camera stills which 7 out of 10 private organisations use for epibiota identification and enumeration (Table 19).

Table 22. Types of image sampling units used by private organisations

Image Sampling unit	Private Organisations (Total: 11)	Details	Purpose
Continuous (e.g. record everything encountered) over a specific time	6	- e.g. 10 min tow either side of target point / sampling station	- Biotope / habitat classification - Ground-truthing -
Continuous over a specific distance	7	- e.g. 100 m tow, or within a defined survey area	- Biotope / habitat classification - Ground-truthing
Continuous over a geo-referenced area	5	e.g. within a defined survey area	- Biotope / habitat classification - Diversity monitoring - Ground-truthing
Freeze frames at specific time intervals	0	-	-
Freeze frames at specific distance intervals	1	e.g. 3 freeze fames taken from a 10 minute DDV drift	- Biotope / habitat classification
Biological/Habitat units	7	e.g. sub-divisions of footage into habitats / biological units of interest	- Biotope / habitat classification - Diversity monitoring - Identification and enumeration of epibiota

3.6.5 Counting and identification strategy within each image sampling unit

The majority of government agencies and private organisations use the entire frame of an image (video or stills) to classify biotopes or identify and enumerate taxa (Table 23). Some government agencies and private organisations use a combination of the strategies outlined in Table 23, depending on the type and purpose of contracted work they undertake. Fewer government agencies and private organisations use a restricted field of view to count and identify biological units, and this tended to be the case for more targeted monitoring for example counting *Nephrops* in burrows. For this example, only *Nephrops* which are recorded that pass over the bottom of the monitor screen.

Two private organisations did not provide a response to this question as they said it depends entirely on the type and purpose of contracted work they undertake.

Table 23. Counting and identification strategy used

Counting and identification strategy	Government Agencies (Total: 8)	Private Organisations (Total: 11)	Details
Count and identify all biological units present within the entire frame	7	9	- Used for video and stills - Biotope/habitat classification - Identification and enumeration of taxa
Only count and identify biological units which pass a line on the screen	3	1	- Used for video footage - Only count and record that pass over the bottom of the monitor screen
Only count and identify biological units from a set area within the frame	1	1	- No details given

3.7 Taxonomic identification procedure

3.7.1 Minimum level of taxonomic experience/training required for staff undertaking image analysis

Generally all government agencies and private organisations have no specified minimum taxonomic experience required for their staff to undertake image analysis. Instead, there is a focus on providing initial and ongoing training (internal and external) to ensure staff are competent in video analysis.

Only two private organisations specified that minimum taxonomic experience required for their staff to undertake image analysis. For one organisation, they expected staff to have a minimum of Marine Biology BSc and two years benthic experience. The other organisation stipulated that only their most senior taxonomists undertake video analysis, and their experience generally consisted of at least four years benthic taxonomy training (in-house) and considerable experience in the field (preferably including dive experience).

3.7.2 Level of taxonomic detail for identification

All government agencies and private organisations attempt to identify species down to the lowest taxonomic level (Table 24). In conjunction with this, some types of video work only require the identification of biotopes/habitats or targeted species. Some participants commented that identification to lowest taxonomic level is only attempted when the quality or resolution of video/stills is adequate.

Table 24. Taxonomic level of identification

Taxonomic level of identification	Government Agencies (Total: 8)	Private Organisations (Total: 11)
Lowest taxonomic level possible	8	11
Biotope/Habitat type only	5	4
Targeted species only	4	4

3.7.3 Minimum size of biological units which are identified and counted

The minimum size of biological units which are identified and counted by government agencies and private organisations varied substantially. Two government agencies and seven private organisations had no minimum size specified, with some stating this is dependent on the quality of the video and the type of work. For the government agencies who provided details of the minimum size of biological units, the minimum size ranged from 2mm – 5cm. For the private organisations who provided details of the minimum size of biological, the minimum size ranged from 2mm – 1cm. Interestingly some of these organisations who mentioned that they do have a minimum size of biological units stated that they do not use a scale bar, therefore it is questionable how they would determine the size of biological units in their video footage or stills.

3.7.4 Resources used to help with taxonomic identification?

All government agencies and private organisations use a range of resources used to assist with taxonomic identification. Such resources include in house identification/reference catalogues, standard species lists, scientific papers, identification guides and books, online species databases (e.g. WoRMS) and biotope keys. A complete list of taxonomic resources utilised by government agencies and private organisations is summarised on the NMBAQC website.

3.7.5 The level of confidence recorded in biological identifications

All of the government agencies and six of the private organisations do not record the level of confidence in their identification, as only positive identification is accepted (i.e. no guessing is allowed). One of the government agencies stated that if there is any uncertainty, then an identification is moved up to a taxonomic level (i.e. genus or higher) where the identification is certain.

The five remaining private organisations do record the certainty as ‘certain’, ‘uncertain’ or ‘?’ in a comments box.

3.7.6 Procedure for dealing with un-identified taxa or uncertain taxa identifications

All government agencies and private organisations have a way of dealing with un-identified taxa or uncertain taxa identifications (Table 25). Six of each of the government agencies and private organisations attempt to resolve the taxa identification by sending an image to an expert. It should be noted that experts such as those at Ulster Museum have made comments that identifying anything other than large/conspicuous/common species from video or stills is often not possible without any form of ground truthing or supporting samples (see Appendix 2).

Slightly more participants opt to use a description instead (e.g. white encrusting sponge), and only one of each of the government agencies and private organisations opt not to record or count the un-identified taxa.

Table 25. How unidentified taxa are dealt with

Dealing with unidentified taxa	Government Agencies (Total: 8)	Private Organisations (Total: 11)
Take a still image of taxa and send to an expert for identification	6	6
Use a description instead (e.g. white encrusting sponge)	7	8
Not recorded or counted (e.g. ignored)	1	1

3.8 Enumeration procedure:

Please note, one of the private organisations only does identification, therefore only ten private organisations are assessed for the Enumeration section of the questionnaire.

3.8.1 Counting strategies used for different types of taxa

The government agencies and private organisations use variable counting strategies used for different types of taxa (Table 26). The SACFOR abundance scale (see the JNCC website) is the most common counting strategy for counting solitary epifauna, colonial invertebrates and algae, however participants can use any combination of other counting strategies (individual counts, % cover or presence/absence). Individual counts are more common for counting highly mobile species. Many participants highlighted that the counting strategy used is variable as it is very much dependent on type of video work being done.

Table 26. Counting strategies used for different types of taxa

Counting strategy	Government Agencies (Total: 8)	Private Organisations (Total: 9)
Solitary epifauna (e.g. polychaetes tube worms)	- Individual counts: 3 - SACFOR: 5	- Individual counts: 5 - % cover: 2 - SACFOR: 8
Colonial invertebrates (e.g. sponges, colonial ascidians)	- % cover: 2 - SACFOR: 5 - Presence/absence: 1	- % cover: 5 - SACFOR: 9
Algae	- % cover: 2 - SACFOR: 3 - Presence/absence: 2	- % cover: 5 - SACFOR: 6
Highly mobile species (e.g. demersal fish)	- Individual counts: 4 - SACFOR: 2	- Individual counts: 2 - SACFOR: 1

3.8.2 Different counting strategy used for highly abundant species

All but one of the government agencies said they do not employ a sub-sampling strategy for highly abundant species. The one government agency that does use sub-sampling only stated that this was site specific and provided no further details.

All but two of the private organisations said they do not employ a sub-sampling strategy for highly abundant species. The two private organisations that do use sub-sampling both conduct individual counts over a reduced section of area or time of footage and this is multiplied up for a total count.

3.9 Biotope/habitat classification procedure:

Please note, one of the private organisations only conducts species (not biotope) identification, therefore only ten private organisations are assessed for the biotope/habitat section of the questionnaire.

3.9.1 Keys used to classify your biotope/habitat

All of the government agencies and private organisations who conduct biotope/habitat monitoring use a combination of the following keys to assist in biotope/habitat classification:

- European Nature Information Systems (EUNIS).
- JNCC website (biotope search facility).
- Marine Life Information Network.
- Marine Monitoring Handbook.
- Marine Nature Conservation Review.

3.9.2 Level of certainty recorded in biotope/habitat classification

Six of the government agencies and five of the private organisations do not record a level of certainty with their biotope/habitat classification. The other two government agencies and six private organisations take note of their uncertainty (e.g. there may be a mismatch of species and habitats) and what the alternative biotope may be. Generally these organisations provide just comments, but some private organisations provide a level of certainty (e.g. Highly certain, Certain, Uncertain, and Slight possibility).

3.9.3 Procedure for determining the start and end point of biotope/habitat

All government agencies and private organisations determine the start and end point of biotopes/habitats visually based on video footage and occasionally associated side-scan or bathymetric data.

3.9.4 Procedure for estimating the area of biotope/habitat estimated?

Four of the government agencies and three of the private organisations do not estimate the area of biotopes/habitats from their video work. The remaining government agencies and private organisations do estimate the area of biotopes/habitats using a combination of

the time/distance travelled along the geo-referenced video, associated side-scan and bathymetric data.

3.10 Assessment of physical features

3.10.1 Level of detail (e.g. categories used) used to classify the sea floor geology/sediment characteristics

Most government agencies and private organisations use the Wentworth scale (e.g. boulder, cobble, pebble, gravel, sand, mud) to describe the seafloor sediment characteristics. However some organisations use more detail, for example:

- Rock outcropping, Boulders, Cobbles, Gravel, Sand, Mixed sediments, Mud.
- Bedrock, Large boulders, Medium boulders, Small boulders, Cobbles pebbles, Empty shells, *Modiolus* shells, Gravel, Sand, and Mud.

3.10.2 Resources used to help in the classification of sea floor geology/sediment characteristics

Four of the government agencies and six of the private organisations use a scale bar or fixed field of view in their video footage to help classify the seafloor sediment characteristics. Generally all government agencies and private organisations use the Wentworth scale as a reference to help classify the seafloor sediment characteristics, however the MNCR and JNCC Habitat Forms are also used by some private organisations.

3.11 Assessment of environmental impact features:

3.11.1 Quantitative/qualitative methods are used

Only four government agencies responded to this question. The details were provided as quantitative/qualitative methods used to assess environmental impacts:

- Site specific,
- The observer records any impact features but not to any predefined standard,
- Presence/absence and number,
- The location of anchor scar damage to soft sediments is noted.

4 Data interpretation, reporting and storage

4.1 Methods of data (from video/stills analysis) interpretation

Tables 27 to 30 show the various ways in which video/stills data are interpreted. Some private organisations commented that the way in which data are interpreted is either beyond the scope of their contracted work or depends very much on their contracted work. Generally most government agencies and private organisations present their data in pictures/stills and text and tables (Table 27). Very few government agencies and private organisations conduct univariate analyses compared to multivariate analyses (Table 28 and Table 29). Most government agencies and private organisations present their interpreted data through GIS maps of individual species distributions and habitat/biotope distributions (Table 30).

Table 27. Descriptive summary of video/stills data

Summary used	Government Agencies (Total: 8)	Private Organisations (Total: 11)
Pictures/stills and text	7	11
Tables	6	9
Graphs	2	4

Table 28. Univariate statistics used

Univariate statistics	Government Agencies (Total: 8)	Private Organisations (Total: 11)
ANOVA	3	3
ANCOVA	1	0
Regression	1	1

Table 29. Multivariate statistics used

Multivariate statistics	Government Agencies (Total: 8)	Private Organisations (Total: 11)
MDS plots	5	5
ANOSIM	4	3
SIMPER analysis	4	4
Principle components analysis	2	4
Permanova	1	0

Table 30. GIS maps produced

GIS data reporting	Government Agencies (Total: 8)	Private Organisations (Total: 11)
Individual species distributions	5	8
Functional groups distributions	2	4
Habitat/Biotope distributions	5	10

4.2 Data reporting

Video/stills data and analysis is reported by all government agencies and private organisations in the form of written reports (Table 31). These are generally grey literature (government agency reports or private organisation reports), and occasionally peer reviewed publications. Fewer government agencies and private organisation report their data in the form of SAC/SSSI Condition Assessment and online maps.

The majority of government agency reports (detailing data and analyses) are publicly available, whereas the public availability of private organisation reports is dependent on their contracted work (Table 32).

Table 31. Format of reporting

Format of reporting	Government Agencies (Total: 8)	Private Organisations (Total: 11)
Written report	8	11
SAC/SSSI Condition Assessment	4	1
Online maps	2	1

Table 32. Public availability for data and analyses

Public availability for data and analyses	Government Agencies (Total: 8)	Private Organisations (Total: 11)
Yes	6	0
No	1	1
Dependent on contract	1	10

4.3 Archiving system for images and image interpretation data

A wide variety of archiving systems are used by government agencies and private organisations for their images and image interpretation data (Table 33 and Table 34). Most private organisations tend to use a combination of DVDs, external hard drives, networked drives and tapes to archive their video footage and still images (Table 33). Whereas most government agencies tend to only use networked drives and tapes to archive their video footage and still images. One government agency highlighted that they also store their tapes in a fireproof safe for extra security. Some of the private organisations mentioned that tapes were given to their clients who are presumed to archive these appropriately.

Most private organisations and some of the government agencies retain their original data sheets and spreadsheets as an archive of their interpretation data (Table 34). Approximately half of the government agencies and private organisations store their data on Marine Recorder and/or the NBN or DASHH databases.

Table 33. Archiving system for images

Archiving system for images	Government Agencies (Total: 8)	Private Organisations (Total: 11)
CD	2	5
DVD	4	10
External hard drive/memory stick	1	7
Local hard drive	2	3
Networked drive	5	8
Tape (e.g. Mini HD, High 8, HD, VHS)	6	8

Table 34. Archiving system for interpretation data

Archiving system for interpretation data	Government Agencies (Total: 8)	Private Organisations (Total: 11)
Original data sheets (hand written)	4	10
Spreadsheet	6	10
Marine Recorder Database	4	5
Online database (NBN)	2: NBN or DASHH	3

5 Quality Assurance

There is a range of internal Quality Assurance (QA) procedures used by government agencies and private organisations (Table 35). Generally most of the government agencies follow a SOP (or standard method), have a second (expert) opinion to confirm identification of taxa, have internal identification training and agreement between two workers assessing video footage. Whereas private organisations internal QA focuses mainly on having a second (expert) opinion to confirm identification of taxa, and agreement between two workers assessing video footage.

The external QA which government agencies are involved in is predominantly through their involvement in the NMBAQC Epibiota Video Ring Test Trial (Table 36). Fewer (approximately half) of the private organisations have participated in the various types of external QA in place for video analysis.

A complete system of QA for marine biological monitoring is outlined in Addison (2010).

Table 35. Internal QA in place

Internal QA	Government Agencies (Total: 8)	Private Organisations (Total: 11)
Follow a SOP (i.e. standard methods)	6	4
10% repeat video analysis (check of identification and enumeration)	3	5
10% check of data entry (check of transcription errors)	2	4
Second (expert) opinion to confirm identification of taxa	8	9
Internal identification training	7	4
Agreement between two workers assessing video footage	7	11

Table 36. External QA in place

External QA	Government Agencies (Total: 8)	Private Organisations (Total: 11)
Attend national identification training workshops	5	5
Participation in NMBAQC online stills image ring test (no longer running) or equivalent (e.g. weedseen website) – *please specify below*	3	4
Participation in NMBAQC Epibiota Video Ring Test Trial (2007-2009)	6	6

6 Comments from questionnaire participants

Appendix 2 outlines the participants' comments from Sections 6 and 7 of the questionnaire (Lessons learnt and Additional information, comments or questions). These comments provide valuable advice to all organisations involved in video work on equipment, techniques and methods for image capture, viewing and analysis. Comments were also made on the NMBAQC's Epibiota Video Ring Test Trial, supporting the need for external QA but also highlighting the likely financial restrictions of small private organisations in participating in potentially expensive ring tests in the future. We thank those participants who provided these extra comments, and the NMBAQC will be taking these on board in future work for its Epibiota component.

Discussion

This report has highlighted the wide variety of monitoring purposes, equipment, techniques and methods used for video work by government agencies and private organisations in the UK. The NMBAQC remains primarily concerned with the variation in video and stills image analysis techniques, as no national or international standards currently exist for this aspect of video work. In order to understand and attempt to standardise image analysis techniques, the entire process of video work (from the monitoring purpose through to Quality Assurance procedures) was explored through the questionnaire.

The following sections of this discussion highlights the key findings from the questionnaire and outline the NMBAQC's main concerns related to these variable aspects of video work. It is these aspects that we believe require best practice guidance, which would make recommendations (outlining pros and cons of methods or setting standard methods) for the appropriate equipment, technology and methods to use for different types of image analysis procedures.

1 Purpose of video work

The response to this section of the questionnaire demonstrates the wide range of purposes for which video work is conducted by government agencies and private organisations in

the UK. Other factors which also vary greatly include the geographic location and water depths at which video work is conducted. In conjunction to this, there is a wide range of biological elements which are monitored through video work, although the majority of video work appears to be focused on biotopes, invertebrates (both sessile and mobile) and algae/angiosperms found on hard substrates and soft sediment.

The variation in the purpose of video work in the UK will clearly have an influence on the variation in image capture and analysis procedures. This variation will have to be considered in any best practice guidance, as not all purposes of video work will be able to be adequately addressed. Instead, the most common purposes of video work (monitoring, habitat/substrate exploration, assessment of impacts and ground truthing of acoustic data) should be focussed on.

2 Image capture procedure

A substantial amount of work has been dedicated to reviewing and recommending best practice image capture procedures (field collection of video) in the UK (Rees, 2009; Mitchell and Coggan, 2007; White *et al*., 2007; Coggan et al, 2006; Moore and Bunker, 2005; Sotheran and Foster-Smith, R., 2004; Service and Golding, 2001). It is therefore very concerning that over half of the government agencies and private organisations do not acknowledge following any of these recognised standards for their image capture procedure. It is equally as concerning that over half of the questionnaire participants do not have Standard Operating Procedures for their video collection procedure (which should demonstrate consistency in their image capture procedure and their adherence to these recognised standards).

This questionnaire also highlighted the various deployment equipment, video and stills cameras, lighting configurations, recorded image formats and supporting information which all make up image capture procedures in the UK. Once again many private organisations stated that the image capture procedure is entirely dependent on their contracted work, which highlights the variable nature of video work.

Some of the variation in image capture procedures highlighted in this questionnaire will have an impact on the quality of video footage obtained and the scope for image analysis. For example:

- The wide range in video camera and stills camera resolutions (470 – 1080 lines, and 2-12 mega pixels respectively; see Section 2.8 and 2.9) will have a significant effect on image clarity and the minimum size of objects which can be confidently identified.
- The wide range in lighting configurations (bulb types, wattage white balance and light source configuration; see Section 2.5) will have a significant effect on the colour and brightness of footage and still images. For example Halogen bulbs generally cast a yellow light, which will in turn affect the perceived colour of objects seen and could cause issues if colour of taxa is used as a taxonomic indicator.
- The variation in ‘top side’ recording (including the type of cable, length of cable, use of a signal booster, and the video camera used; see Section 2.6) will have a significant effect on image clarity and the minimum size of objects which can be confidently identified.

- There are issues associate with the variable recording formats of video footage and stills (see Section 2.7) which are likely to impact the image quality.

The choice of image capture procedure is clearly dependent on the purpose for the video work. Despite the variable purposes for video work, the NMBAQC believe that there is scope for providing best practice guidance which would outline the pros and cons and make recommendations for the appropriate equipment, technology and methods for different types of monitoring. These recommendations would be made by giving primary consideration to best practice image analysis procedures, which should be used for different purposes of video work.

3 Image analysis procedure

This section of the questionnaire has revealed that the image analysis procedure for video footage and stills is even less consistent than image capture procedures, as even fewer participants (only two government agencies and two private organisations) have SOPs for their image analysis procedures. Similarly only half of the government agencies and three of the private organisations follow recognised standardised methods such as the MESH (Coggan et al., 2006, White et al, 2007; Coggan et al, 2006) and the Marine Monitoring Handbook (Moore and Bunker, 2005; Sotheran and Foster-Smith, 2004; Service and Golding, 2001). However, adherence to these standard methods does not mean a great deal for image analysis procedures, as they are primarily focused on image collection procedures and do not go into detail about image analysis.

This questionnaire has also highlighted the substantial variation in many aspects of the image analysis procedure. Some of this variation is to be expected, given the wide range of purposes for which video work is conducted. Nevertheless, there are some concerning variations in image analysis procedure which are likely to contribute to variable interpretation of video and stills images:

- The variation in PC and laptop specifications (17 to 24 inch screens and 1024x768 to 1920x1200 pixel screen resolutions; see Section 3.3) used to view images will have a noticeable effect on image clarity and the minimum size of objects which can be confidently identified. Also, current technology means that television/video monitors are still better for viewing video footage compared to PCs and laptops. Interestingly only two of the 19 participating organisations currently use television/video monitors for their image analysis.
- The various types of image viewing software are unlikely to affect how video footage and still images can be viewed and interpreted, however they do vary in their editing capabilities for different tasks associated with image analysis (e.g. quality of screen grabs taken and image editing capabilities; see Section 3.4).
- The use of different image types (continuous video footage, frame grabs from video footage, or still images from a separate camera) and sampling units (e.g. continuous footage over time or freeze frames at distance intervals) for different types of image analysis (e.g. biotope/habitat classification or identification and enumeration of epibiota) is variable (see Section 3.5 and 3.6.4). There are some particular image analysis procedures (e.g. using still images, which are of higher quality, to conduct identification and enumeration of epibiota) which should be introduced as standard best practice methods to ensure a more consistent approach to video interpretation.

- There are a number of variable criteria and ranking options used to rate the quality of video footage (see Section 3.6.2). A best practice standard could be developed based on what some organisations currently do to ensure a more consistent approach to video interpretation.
- The inconsistency in the use of a scale bar in video footage by some organisations is concerning (see Section 3.6.3). Mitchell and Coggan (2007) highlight the necessity of a visible reference to scale in an image which is vital to determine to scale, extent and identity of features - both biological and geological - within an image.
- The procedures for identification and enumeration of epibiota are variable (see Section 3.7 and 3.8) and are likely to influence the data obtained from video analysis. Of particular concern is the variation counting strategies used for different types of taxa. It appears that all types of counting strategies (individual counts, % cover, SACFOR categories or presence/absence) are used for all types of taxa (solitary epifauna, colonial invertebrates, algae and highly mobile species) despite their potential lack of suitability in some cases. For example % cover is used to estimate solitary epifauna, when really SACFOR or individual counts are more appropriate.
- The level of detail for describing the seafloor sediment characteristics is variable (see Section 3.10), and a standard approach could easily be recommended based on the commonly used (but differently interpreted) Wentworth scale.

The choice of image analysis procedure is ultimately dependent on the purpose for video work. Despite the variable purposes for video work, the NMBAQC believe that there is scope for providing best practice guidance which would outline the pros and cons and make recommendations for different equipment, technology and methods for different types image analysis procedures which would lead to more consistent image analysis and interpretation in the UK.

4 Data interpretation, reporting and storage

The purpose of this section of the questionnaire was to share with participants the different ways in which data are currently interpreted, reported and stored. Once again, there is substantial variation seen between government agencies and private organisations, with the most concerning example being that of the archiving systems used for images and image interpretation data (see Section 4.3). The NMBAQC recommend that the participants of this questionnaire consider whether their system of archiving is sufficient given the examples of other participants.

5 Quality Assurance

The purpose of this section of the questionnaire was to share with participants the different aspects of QA that government agencies and private organisations currently have in place. Table 35 outlines a complete system of internal QA which the NMBAQC advocate as best practice (also see Addison, 2010). The NMBAQC recommend that the participants of this questionnaire consider whether their internal QA system is adequate. The external QA options currently available to questionnaire participants is the NMBAQC Epibiota video ring test which will be advertised and run in Autumn 2010.

Concluding Remarks

This report highlights the wide range of purposes and functions for which video work is conducted by government agencies and private organisations in the UK. In conjunction with this, the report also shows that there are inconsistent and variable image capture and analysis procedures currently used by different organisations in the UK.

There is a clear need to standardise (or set minimum standards for) certain aspects of video and stills image analysis techniques in the UK, as no national or international standards currently exist for this aspect of video work. We recommend that this should be in the form of an NMBAQC best practice guidance document, which makes recommendations (outlining pros and cons of methods or setting standard methods) for image analysis procedures. This will not include recommending standard equipment, but will set minimum standards for equipment specifications.

By developing best practice guidance for image analysis procedures, we will help ensure the quality and consistency of video data collected in the UK which is now integral to work carried out for many European directives such as the Water Framework, Habitats and Marine Strategy Framework Directives.

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Appendix 1: NMBAQC Epibiota Questionnaire

ıiota Component
ıis of Video and Still Images
ıuary 2010

From 2008 – 2009 the National Marine Biological Analytical Quality Control (NMBAQC) scheme trialled a national quality assurance programme for its Epibiota component which consisted of three ring tests and a workshop. The trial ring tests and workshop revealed that participants (from competent monitoring authorities, conservation agencies, fisheries laboratories, universities and consultancies) have many different purposes and ways in which they conduct video analysis of subtidal marine habitats, and before any further ring tests are implemented through the NMBAQC there is a need to collate and review existing video analysis procedures used in the UK. This review will help inform the production of standard monitoring protocols and will lead to further work in the Epibiota component of the NMBAQC which will ensure the consistency and quality of video data collected in the UK (which is now integral to work carried out for many European directives such as the Water Framework and Marine Strategy Framework Directives). For details of the findings of the NMBAQC's Trial Video Ring Tests, please refer to the NMBAQC Epibiota Workshop Proceedings (attached in the email with this questionnaire).

This questionnaire is designed to collect information about current video analysis procedures. It has been sent out to all government agencies, universities and consultancies known to be currently involved in video analysis of subtidal marine habitats in the UK.

If you use different video analysis methods for different surveys then please answer this questionnaire in relation to your most frequent method used, and list any exceptions which you think would be useful for us to know!

Please return your completed questionnaire and supporting Standard Operating Procedure(s) (for video capture and analysis) to Prue Addison (prue.addison@environment-agency.gov.uk) by Friday the 19th of February, 2010.

1 Purpose of video work

1.1 What is the main purpose(s) of your subtidal video work (tick all that apply)?

	✓
Site monitoring (eg. for MPA or SAC monitoring)	
Habitat/Substrate identification/exploration	
Ground truthing of acoustic data (eg. for habitat mapping)	
Fisheries stock assessment (eg. nephrops burrows)	
Individual species distribution assessment	
Fish surveys	
Assessment of impacts (eg. aggregate extraction, dredging, outfalls, trawling, anchoring, EIA, cable inspections)	

Other, please specify:

1.2 What biological/physical element(s) do you focus on in your subtidal video work (tick all that apply)?

	✓
Hard Substrate (Geological or Biogenic Reef)	
Sessile invertebrates	
Mobile invertebrates	
Algae	
Demersal fish	
Pelagic fish	
Biotopes	
Soft Sediment	
Sessile invertebrates	
Mobile invertebrates	
Algae	
Seagrass	
Burrows (non-fisheries species)	
Demersal fish	
Pelagic fish	
Biotopes	
Fisheries related	
Seed mussels	
Herring spawning grounds	
Particular fish species – *please specify*	
Invertebrate burrows (e.g. *Nephrops*)	
Physical	
Sea floor geology/sediment characteristics	
Archaeology	
Condition of installed infrastructure (e.g. outfalls, cables, wind turbines etc)	

Environmental impact	
Beggiatoa (anaerobic) bacterial mat	
Sewage solids	
Effluent colour	

Other, please specify:

1.3 What location(s) in the UK or rest of the world do you conduct your subtidal video work?

	Please specify general location and/or oceans:
UK	
Rest of the world	

Other, please specify:

1.4 What sediment type(s) do you conduct your subtidal video work on (tick all that apply)?

Sediment type	✓
Geological Reef (Bedrock, boulders, cobbles, pebbles, gravel)	
Biogenic Reef	
Sand	
Mud	
Silt/Clay	

Other, please specify:

1.5 Please indicate the depth at which you conduct your subtidal video work:

	Minimum (m)	Maximum (m)
Depth		

2 Image capture procedure

2.1 Do you have a Standard Operating Procedure (SOP) for your image capture/ collection method in the field? If yes, could you please attach a copy with your completed questionnaire?

2.2 Do you adhere to national or internationally recognised standards relating to your image capture procedure (e.g. by British Standards (BSi), International Council for the Exploration of the Sea (ICES) or Mapping European Seabed Habitats (MESH))? If yes, please list the standards which you work to:

2.3 What type(s) of deployment equipment do you use (tick all that apply)?

	✓
Towed camera (e.g. mounted on a sledge)	
Drop-down camera	
Hand-held diver camera	
Hand-held camera from boat	
ROV camera – small scientific	
ROV camera – large industrial	
SPI/REMOT camera (Sediment profile imagery)	

Other, please specify:

2.4 What type of video and/or stills camera(s) do you use? Please specify make and model for each:

2.5 What type of lighting do you use when collecting images?

	Provide details:
Bulb type (e.g. LED, halogen etc)	
Wattage	
Burn temperature	
White balance (e.g. automatically or manually set)	
Single or dual light source	

Additional information, please specify:

2.6 What type(s) of images do you collect, and do you use different image types for different purposes (e.g. stills only for identification)?

	✓	Purpose?
Video footage (i.e. continuous)		
Still images (frame grabs from continuous video)		
Still images (from a separate stills camera)		

2.7 How do you record your footage?

	✓
Directly onto the camera	
'Top side' (on your boat via cable)	

2.8 If you record your footage via a cable, please specify the type of cable used (e.g. fibre optic or standard core cable)?

2.9 What recording format do you collect your images in (tick all that apply)?

	✓
Video footage formats	
Tape (hd mini, vhs, high 8)	
Direct to disc burner (e.g. blu-ray hd dvd, dvd, cd)	
Hard Disk Drive/Flash Drive (e.g. .avi, .jpeg, .wmv, .mov)	
Still image formats	
.jpeg	
.tiff	
.pdf	
Slides (please indicate dimensions)	
Photographic film (please indicate dimensions)	

Other, please specify:

2.10 What is the resolution of the video camera (eg. number of lines)?

2.11 What is the resolution of the camera used to collect the still images (e.g. number of mega pixels)?

2.12 Do you collect any supporting information (tick all that apply)?

	✓
Waypoints or tracks from GPS on vessel (to georeference image)	
Waypoints or tracks from GPS/transponder on the camera (to georeference image)	
Environmental data (e.g salinity, dissolved oxygen) – *please specify below*	
Trawl, dredge or grabs used in conjunction with video (to ground-truth biology)	
Trawl, dredge or grabs deployed in a separate process to the video collection (to ground-truth biology)	
Sediment grab (to ground-truth sediment classification)	
Specimens collected by ROV arms (to ground-truth biology)	

Other, please specify:

3 Image analysis procedure

3.1 Do you have a SOP for your video/stills image analysis procedure? If yes, could you please attach a copy with your completed questionnaire?

3.2 Do you adhere to national or internationally recognised standards relating to your image analysis procedure or data standards (e.g. by British Standards (BSi), International Council for the Exploration of the Sea (ICES) or Mapping European Seabed Habitats (MESH))? If yes, please list the standards which you work to:

3.3 Please give details of the image viewing hardware you use:

	Screen Make	Screen Model	Screen Resolution
Laptop monitor			
PC monitor			
Television monitor			

Other, please specify:

3.4 Please give details of the hardware and software you use to play/view your video/stills for analysis:

	DVD/CD/Hard drive/Tape player Make	DVD/CD/Hard drive/Tape player Model	Image viewing software (if a computer is used)
Video			
Still Images			

Other, please specify:

3.5 Please explain your video/stills analysis procedure:

3.5.1 Do you conduct an initial scan of your video footage to decide on your analysis technique?

3.5.2 Do you rate the quality of your video footage (to help explain the level of detail of your analysis)? If so, please describe the video quality cut-off point where detailed analysis is not done.

3.5.3 Does your footage have a scale bar (i.e. is a field of view determined) to allow you to estimate size of taxa and sediment? If so, please indicate which set up you use:

	✓
Laser scaling on footage/images. Please indicate you laser set up below	
Presence of a physical scale bar in the field of view of footage - p*lease indicate your set up below*	
Fixed field of view (with pre-defined scale) of footage and/or images - p*lease indicate you set up below*	

Please provide additional details:

Other, please specify:

3.5.4 What is your image sampling unit (tick all that apply)? If you use multiple sampling units for difference purposes, please indicate your purpose.

	✓	Purpose
Continuous (e.g. record everything encountered) over a specific time – *please indicate below*		
Continuous over a specific distance – *please indicate below*		
Continuous over a geo-referenced area – *please indicate below*		
Freeze frames at specific time intervals – *please indicate below*		
Freeze frames at specific distance intervals – *please indicate below*		
Biological/Habitat units – *please indicate below*		

Please provide additional details:

Other, please specify:

3.5.5 What is your counting and identification strategy within each image sampling unit?

	✓
Count and identify all biological units present within the entire frame	
Only count and identify biological units which pass a line on the screen– *please describe procedure below*	
Only count and identify biological units from a set area within the frame– *please describe procedure below*	

Please provide additional details:

Other, please specify:

3.6 Please explain your taxonomic identification procedure:

3.6.1 Do you require a minimum level of taxonomic experience/training for staff undertaking image analysis, and do you maintain this in a staff training log/manual? Please provide details:

3.6.2 What taxonomic level do you identify the biological units in your video/stills?

	✓
Lowest taxonomic level possible	
Genus only	
Class/Family only	

Biotope/Habitat type only	
Targeted species only	

Other, please specify:

3.6.3 What is the minimum size of biological units which are identified and counted (e.g. 5cm)?

3.6.4 What resources do you use to help in your taxonomic identification (tick all that apply)?

	✓
Identification/Reference catalogue (utilising images/specimens from previous surveys) – *please indicate below*	
Standard species lists – *please indicate below*	
Scientific papers – please indicate below	
Identification guides or books - *please indicate below*	
Online species database (e.g. WoRMS) – *please indicate below*	
Biotope keys– please indicate below	

Please provide additional details:

Other, please specify:

3.6.5 Does the video analyst record the level of confidence in the identification of individual record (e.g. certain/uncertain)? And is a reason given for this level of certainty (eg. Is this confidence level tied to a record of the video quality if it hindered certain identification)?

3.6.6 What is the procedure for dealing with un-identified taxa or uncertain taxa identifications?

	✓
Take a still image of taxa and send to an expert for identification	
Use a description instead (e.g. white encrusting sponge)	
Not recorded or counted (e.g. ignored)	

Other, please specify:

3.7 Please explain your enumeration procedure:

3.7.1 What counting strategies are used for different types of taxa (e.g. individual counts, rounded counts (e.g 10's, 100's), % cover, SACFOR, presence/absence, other – please describe)?

	Counting strategy?
Solitary epifauna (e.g. polychaetes tube worms)	
Colonial invertebrates (e.g. sponges, colonial ascidians)	

Algae	
Highly mobile species (e.g. demersal fish)	

Other, please specify:

3.7.2 Do you employ a different counting strategy for highly abundant species (e.g. sub-sampling)? If so, please describe:

3.8 Please explain your biotope/habitat type identification procedure:

3.8.1 Do you use keys to identify your biotope/habitat type? If so, please indicate which keys:

3.8.2 Do you provide a level of certainty in your biotope/habitat type identification?

3.8.3 How do you determine the start and end point of your biotope/habitat type?

3.8.4 Do you estimate the area of your biotope/habitat type?

3.9 Please explain your assessment of physical features:

3.9.1 What level of detail (e.g. categories used) do you classify the sea floor geology/sediment characteristics?

3.9.2 What resources do you use to help in your classification of sea floor geology/sediment characteristics (tick all that apply)?

	✓
Scale bar on video footage – *please provide details*	
Sediment Identification/Classification guides (e.g. Wentworth Scale or Munsell Soil Color Chart) – *please indicate below*	

Please provide additional details:

Other, please specify:

3.9.3 What resources do you use to help in your recording of archaeology and or the condition of installed infrastructure?

3.10 Please explain your assessment of environmental impact features (e.g. Beggiatoa (anaerobic) bacterial mats, sewage solids and effluent colour):

3.10.1 What quantitative/qualitative methods are used?

4 Data interpretation, reporting and storage

4.1 How is your interpreted data (from video/stills analysis) used?

4.1.1 Please give details of any descriptive (non-statistical) summary used (tick all that apply):

	✓
Pictures/stills and text	
Tables	
Graphs	

Other, please specify:

4.1.2 Please give details of any univariate statistics used (tick all that apply):

	✓
ANOVA	
ANCOVA	
Regression	

Other, please specify:

4.1.3 Please give details of multivariate statistics used (tick all that apply):

	✓
MDS plots	
ANOSIM	
SIMPER analysis	
Principle components analysis	

Other, please specify:

4.1.4 Please give details of GIS techniques used (tick all that apply):

	✓
Individual species distributions	
Functional groups of spp distributions	
Habitat/Biotope distributions	

Other, please specify:

4.2 How is your data reported?

4.2.1 Please indicate in what format your data is reported (tick all that apply):

	✓
Written report	
SAC/SSSI Condition Assessment	
Online maps	

Other, please specify:

4.2.2 Are your data and analyses publicly available?

4.3 How/where you archive your *video footage or stills* (tick all that apply)?

	✓
CD	
DVD	
Blu-Ray Disc	
High definition DVD (now no longer supported)	
External hard drive/memory stick	
Local hard drive	
Networked drive	
Tape (e.g. Mini HD, High 8, HD, VHS)	

Other, please specify:

4.4 How are your *image interpretation data* stored (tick all that apply)?

	✓
Original data sheets (hand written)	
Excel spreadsheet (or other spreadsheet format)	
Agency/consultancy database – please indicate type/name below	
Online database (e.g. NBN) – please indicate type/name below	

Please provide details:

Other, please specify:

5 Quality Assurance / Quality Control

5.1 What internal quality assurance system do you have in place for your video analysis work (tick all that apply)?

	✓
Follow a SOP (i.e. standard methods)	
10% repeat video analysis (check of identification and enumeration)	
10% check of data entry (check of transcription errors)	
Second (expert) opinion to confirm identification of taxa	
Internal identification training	

Agreement between two workers assessing video footage	

Other, please specify:

5.2 What external quality assurance system do you have in place for your video analysis work (tick all that apply)?

	✓
Attend national identification training workshops	
Obtained an identification qualification awarded by a professionally recognised institute	
Participation in NMBAQC online stills image ring test (no longer running) or equivalent (e.g. weedseen website) – *please specify below*	
Participation in NMBAQC Epibiota Video Ring Test Trial (2007-2009)	

Please provide additional details:
Other, please specify:

6 Lessons learnt

6.1 Please describe any approaches to video analysis which you have attempted but have not worked in the past (e.g. compatibility issues between video formats and editing software / enumeration strategies that have been difficult to apply in practice):

7 Additional information, comments or questions?

7.1 Please write any additional information, comments or questions below:

Thank you for taking the time to complete this questionnaire.

Please return to:
Prue Addison, Environment Agency, Marine Monitoring Service
Email: **prue.addison@environment-agency.gov.uk**
Ph: 01733 464283
Deadline: February 19th 2010

Appendix 2: Comments from questionnaire participants

The following section outlines the comments from questionnaire participants, relating to approaches to video analysis, the need for standardised methods and other general comments about Quality Assurance in video analysis.

1 Image Capture

CCW: The CCW lighting system fitted to the prototype use filament bulbs (contrary to the design brief) and when the system was used on rugged grounds the filaments broke, causing both loss of lighting and problems with the surface electronics due to voltage and current changes. It was decided to replace the lights with High Intensity Discharge (HID) lamps.

CCW: In deeper water we tend to clip/tape the umbilical to the towing cable because of increased drag in different directions from boat and current can knock the sledge over.

Cefas - Have found that long video tows (20 minutes) are boring and inefficient. We have cut down to 10-minute tows which capture a similar amount of information about the environment as you would get on a 20-minute tow. This allows for greater replication in sampling design.

Private Organisation: Most of our stills camera work is carried out with a camera in a freshwater housing and its purpose is to provide information for EIA or environmental monitoring and to support information provided by grabs by increasing sample density without increasing the number of grab samples that require analysis.

2 Image Viewing

Cefas - Use of a non-linear editor makes the video analysis a much more pleasant task – being able to scroll through the video at will, rather than wait for tapes to play. Use of a jog-shuttle to move video frame-by-frame is also helpful. It can also capture screen shots to populate a reference library.

MSS - Recording to PC H/drive using flat screens to review – quality of playback was too poor on the available equipment.

3 Image Analysis

AFBI - Need to further develop techniques for quantitative analysis if video is to go forward as a monitoring tool. It doesn't seem likely that we can down the role of recommending standard equipment but perhaps minimum standards of resolution for different tasks is possible. Form experience in the original benthos task team it may require one group to lay down the standards and defend them.

AFBI - More good could be done for geo-referencing and linking with GIS;

AFBI - Look at offshore industry standards for recording and storage;

AFBI - Remember it is Government Policy to develop evidence based science! i.e. not good enough to rely on opinion.

Cefas - Cefas use an adapted SACFOR scale for video & stills analysis. Essentially this boils down to assessing abundance by orders of magnitude for different growth forms (crust/meadow or massive/turf) or size of individuals or colonies (<1cm, 1-3 cm, 3-15 cm, >15 cm).

Cefas - The greatest difficulty is in getting consistency across different analysts, especially in the biotopes classes they assign to the video clips. Some tend to find a few 'favourite' classes and use these repeatedly. Biotope assignment is very subjective. Assignments may change radically when data from associated grab samples becomes available.

Cefas - The MNCR & EUNSI habitat/biotope classification is poorly developed for sub-littoral habitats and there are many cases of near rather than complete matching between your observations and the existing classes. In some cases we have to erect new, unofficial biotope classes.

MSS - Two reviewers assessing the same data at the same time – results can be biased.

MSS - Electronic real time assessment of species/points of interest – leads to poor results and inaccurate data.

Private Organisation 1 - Coral Point Count with Excel extensions (CPCe) - The random point count method is commonly used on still images or frame-grabbed video to estimate the community statistics of benthos. A matrix of randomly distributed points is overlaid on an image, and the species or substrate-type lying beneath each point is visually identified. Coral Point Count with Excel extensions (CPCe) is a standalone Visual Basic program which automates, facilitates, and speeds the random point count analysis process. CPCe includes automatic frame-image sequencing, single-click species/substrate labelling, auto-advancement of data point focus, zoom in/out, zoom hold, and specification of random point number, distribution type, and frame border location. Customization options include user-specified substrate codes and data point shape, size, and colour. CPCe can also perform image calibration and planar area and length calculation of benthic features. The ability to automatically generate analysis spreadsheets in Microsoft Excel based upon the supplied species/substrate codes is a significant feature. Data from individual frames can be combined to produce both inter- and intra-site comparisons. Spreadsheet contents include header information, statistical parameters of each species/substrate type (relative abundance, mean, standard deviation, standard error) and the calculation of the Shannon–Weaver diversity index for each species. Additional information can be found at http:// www.nova.edu/ocean/cpce/.
The Coral Point Count with Excel extensions, although originally designed for analysis of coral may be a useful tool for the analysis of temperate Atlantic benthic habitats.
Strengths -The data can be assessed in PRIMER. Weaknesses- Does not identify all species captured within stills.

Private Organisation - When using different computers for analysis do not rely on frame numbers as a guide for QA. Unfortunately a bad import of data can mean that frame number can vary between imports.

Private Organisation - There are a plethora of guidelines and procedures available, some more detailed than others. A consistent, widely used SOP is needed.

Private Organisation - Some of the guidelines in use require two or three or four scientists to review the data on the vessel or on shore. This is unlikely to be commercially viable unless the procedure is mandatory from the regulators that inspect the final reports.

Private Organisation - Training to encourage a consistent approach to seabed physical type, % coverage and video analyses techniques would be welcome.

Private Organisation - Training on megafauna identification would be welcome.

Private Organisation – Any standard monitoring protocols which are produced MUST allow for the wide diversity of ways in which video data could be collected and used. It must be possible to select appropriate criteria for a given project, while still following a flexible suite of guidelines without being tied to a detailed procedure which would be unsuitable for a particular study.

Private Organisation – Many video surveys need to be properly geo-referenced with a method of mapping data (images) taken from the video, to a specified level of accuracy. Often this is obtained from an overlay of a GPS output on the video image. Most easy to use, but often it obscures vital information contained in the image and would be better placed elsewhere.

Ulster Museum - I am asked frequently to identify species in video taken for the purposes that this questionnaire relates to. Much of the video is taken at too great a distance and too low a resolution for anything other than the largest species to be identified. Little attention seems to be paid to sampling or ground truthing the species within the areas being studied, with video often being seen as ground truthing itself. It also leads to a dumbing down of the work, by only recording large, conspicuous, common species rather than the differences which it purports to discover.

Ulster Museum - My own expertise is in photographically documenting the external appearance of species, which are often currently only identifiable using existing keys and handbooks if a sample is available. Unfortunately this is leading to a perception that species in the sea can be accurately identified without sampling, in areas and habitats which have not been ground truthed with specimens.

4 Data entry

Cefas - Entering data into Marine Recorder remains a difficult and laborious task.

5 Ring test comments

Private Organisation - I think that any video QA tools are very useful. The ones developed by Envision as part of the video trials proved useful discussion points to highlight inter-surveyor variability both in the workshop and within our company. As a result we now undertake 'team training' prior to most jobs (particularly when it comes to substrate analysis), which has undoubtedly increased consistency in our work. We regularly work with CCW on diving projects, as well as occasionally on video, and they are constantly striving to ensure QC through training and developing their own tools, as we do our own. It would be nice to see national standards brought in, and I think courses for individuals, rather than accreditations per organisations, would be useful. We do a lot of training with Seasearch and Ulster museum courses as divers, but other than that there is little in the way of nationally recognised training schemes, particularly for any non-divers trying to interpret subtidal video.

Private Organisation - Unfortunately as in situ identification of the epibenthos is not the main stay of most people's work I am not sure whether you would have subscription levels that would warrant their development. Most in situ specialists in this country are small consultancies and freelancers who would struggle to pay into an expensive QA scheme, despite their willingness to join.

6 General comments

Cefas - We put a lot of this information into the NMBAQC Epibiota Video Ring Test Trial. It is a pity that we now have to waste time duplicating information already submitted to the NMBAQC.

Private Organisation - Difficult to complete some part of questionnaire as we used video and stills in a large variety of roles from a rapid visual assessment to producing species counts and lists so there are no standard video system or approach and often new technology is incorporated to achieve specific tasks.