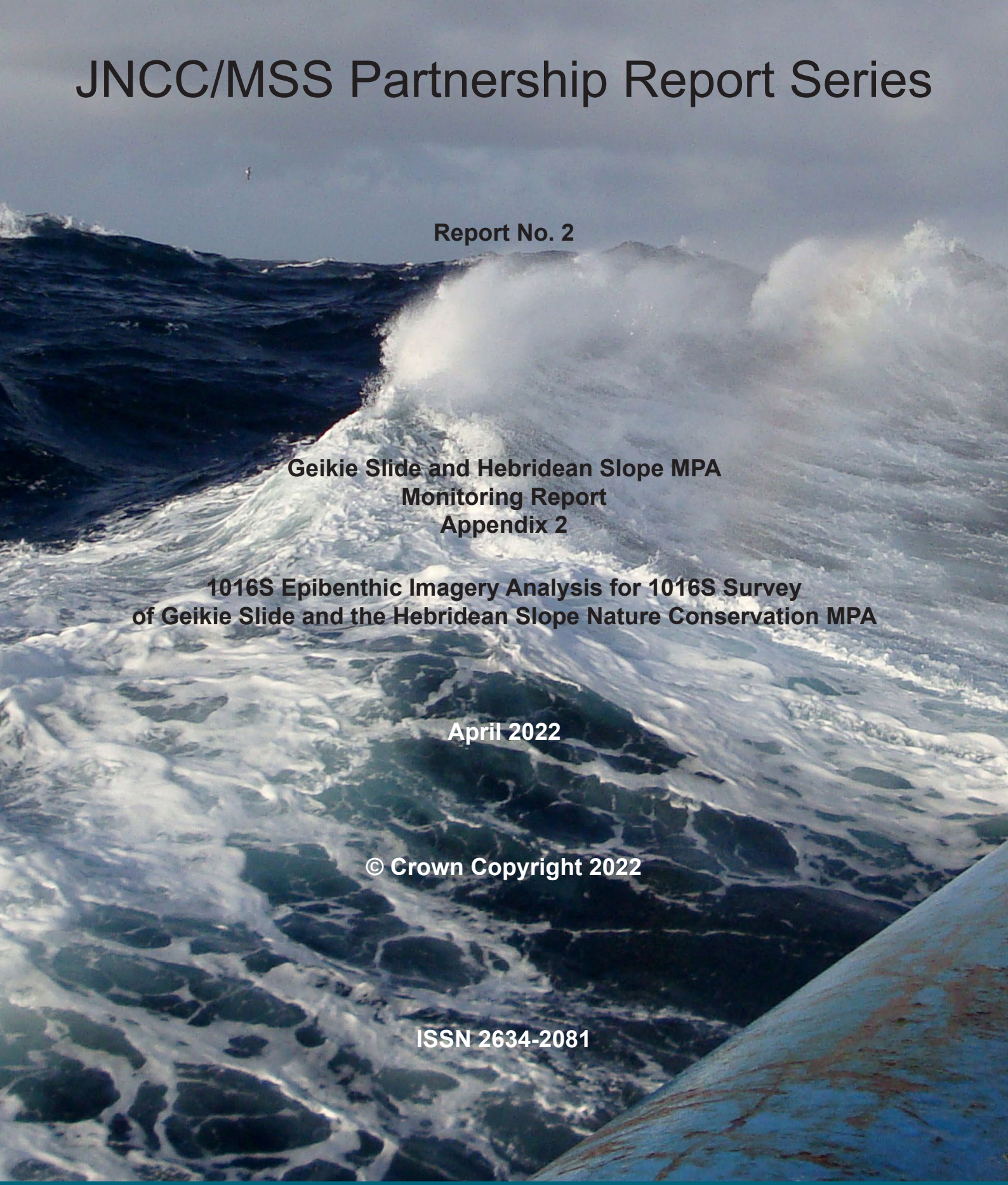

JNCC/MSS Partnership Report Series

Report No. 2

Geikie Slide and Hebridean Slope MPA Monitoring Report Appendix 2

1016S Epibenthic Imagery Analysis for 1016S Survey of Geikie Slide and the Hebridean Slope Nature Conservation MPA

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Appendix 2

Epibenthic Imagery Analysis for 1016S Survey of Geikie Slide and the Hebridean Slope Nature Conservation MPA

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Executive Summary

Envision Mapping Ltd. were contracted to undertake the analysis of offshore seabed video and still images collected on the 1016S survey in 2016 of the Geikie Slide and Hebridean Slope (GSH) Scottish Nature Conservation Marine Protected Areas (NCMPA) to identify the habitats and epifauna present.

Video and still images were reviewed, processed and analysed in accordance with national guidelines, including Coggan *et al*. (2007), BS EN 16260:2012 and Turner *et al*. (2016). The purpose of the analysis of the video/stills was to identify the broadscale habitats which exist in each video record, provide semi-quantitative data on their physical and biological characteristics, to note where one substrate type changes to another and to record any visible impacts or modifiers.

In addition to taxonomic identification and quantification, sea pen abundance and condition were also to be assessed, but no sea pens were found. Nephrops burrows were also counted following the techniques described within the most recent guidance (Turner *et al.* 2016; ICES 2008). The information from the video and stills was recorded on separate spreadsheets, along with broadscale habitat types, Scottish MPA features and biotopes, assigned according to "The Marine Habitat Classification for Britain and Ireland Version 15.03", Parry *et al.* (2015) and Parry (2015).

A total of 58 video tows, one longer chariot video tow and 951 still images were analysed, and for quality control (QC) purposes, six video tows and the associated 102 stills were re-analysed by both internal and external analysts to substantiate results, along with two five-minute sections of the chariot video tow. The video footage analysed was generally of 'good' to 'poor' quality with occasional issues of reduced visibility due to disturbed sediment, or a restricted view of the sediment when the camera system was 'hopped' forwards as it was towed, resulting in fast moving sections of footage further away from the substrate where identification of the fauna was more difficult. The stills were of variable quality, often too far from the substrate for detailed identification of taxa, especially cryptic fauna.

Twelve habitat types / biotopes were identified from the 59 video tows, with the majority of video tows (39) assigned to coarse sediments (M.AtLB.Co (three), M.AtMB.Co (eight), M.AtUB.Co (28). A further eight video tows were allocated as a sand habitat (M.AtLB.Sa (two), M.AtMB.Sa (five), M.AtUB.Sa (one), and only one was allocated a mud habitat (M.AtLB.Mu). Of the remaining 10 video tows, four were thought to be 'Urchin dominated community on Atlantic upper bathyal coarse sediment' (M.AtUB.Co.UrcCom), three were allocated as 'Xenophyophore dominated community on Atlantic lower bathyal coarse sediment' (M.AtLB.Co.XenCom), and two were suggested as 'Xenophyophore dominated community on Atlantic lower bathyal coarse sand' (M.AtLB.Sa[XenCom]) as this biotope only exists for coarse, muddy or mixed sediments. One video tow was allocated 'Surface dwelling ophiuroid community on Atlantic lower bathyal mixed sediment' (M.AtLB.Mx.SurOph), and the final sampling station was given a suggested biotope of M.AtUB.Co[Ditrupa]. Two further mixed sediment habitat types (M.AtMB.Mx and M.AtUB.Mx) were allocated to stills only, but weren't observed for sufficient duration to be allocated to the video footage.

'Deep Seabed' (A6) was the only broadscale habitat allocated to the footage from the 1016S survey area (Table 4), and two Scottish MPA Priority Marine Feature habitats were observed within the Geikie Slide and Hebridean Slope NCMPA: 'Offshore deep sea muds' were seen at sampling station BoxA_A02_S80, which could potentially also be allocated the 'Burrowed Mud' feature due to a high number of burrows observed during the video tow. All of the remaining sampling stations were assigned the 'Offshore subtidal sands and gravels' Priority Marine Feature, apart from a single sampling station, BoxA_A03_S78, which was allocated a mixed sediment biotope. Trawl marks were recorded at one sampling station,

BoxC_C03_S18, and anthropogenic materials were observed in seven video tows in Boxes A, C and D.

Several species were observed that could be considered 'features of interest' in terms of protection or conservation status, including the Scottish Priority Marine Features: *Lophius piscatorius* (monkfish, seen twice) and *Molva dypterygia* (Blue Ling) which was seen in two video tows. There were also potential sightings of *Coryphaenoides rupestris* (round nose grenadier fish) at four sampling stations and Clupeidae (potentially *Clupea harengus)* at one station in Boxes A and C. Hard and soft corals were also recorded throughout Box A and Box F, generally these occurred as solitary individuals.

Nephrops norvegicus (and their burrow systems) and Pachycerianthus were also recorded which are component taxa of burrowed mud, however no sea pens were observed. Most stations were identified as sand or coarse sediments, however, at some stations, relatively high numbers of burrows were recorded within these substrates which could be indicative of a muddier underlying substrate. With seabed sediments being difficult to identify from video and images, we suggest sediment sample data should be used to verify the precise nature of the seabed and an assessment made as to whether the Priority Marine Feature 'burrowed mud' is present.

In general, internal quality assurance of the video and stills analysis showed good agreement between the original analyst and internal QC analyst, however, some minor discrepancies were noted which were thought to be due to the quality of the footage preventing clear identification and counts, and the cryptic and often camouflaged nature of some of the taxa observed throughout this site. However, none of the discrepancies affected SACFOR scores notably, or the subsequent habitat type or protected feature allocations. As such, the levels of confidence within the data analysis were acceptable for the nature of this work, and with the quality of imagery provided.

Comparison of the external QC data and original data showed greater discrepancies than the internal QC in the recording of taxa and substrates observed. Although the larger sediment fractions showed general agreement, a significantly higher amount of silt was recorded within the external QC data which affected assignment of the Scottish MPA feature and habitat/biotope types for all but one of the video tows (tows recorded as a sand and coarse habitat by the original analyst were recorded as muds and mixed habitats in the external QC). It should be noted substrate identification from seabed imagery is a subjective assessment which should be verified with particle size analysis data. Other discrepancies were seen between the original and QC analysts with regards to burrow counts and taxa recorded, and these differences are discussed below. Results have been compared using Bray Curtis similarity tests, and the outcome of these tests are reported on, along with any amendments or remedial action taken in the QC or original data.

The locations of the stations along with habitat type/biotope allocations and the presence of Scottish Priority Marine Feature habitats were mapped and shapefiles provided with associated metadata in a GIS package, and all data entered into Marine Recorder.

A reference collection of still images was compiled to provide examples of the epifauna observed: the collection included 160 images of 98 taxa in total, and 15 images and 12 video clips as examples of the 14 biotopes identified (two biotopes were only seen in the still images and not in the video footage).

Contents

1 Introduction

The Joint Nature Conservation Committee (JNCC) and Marine Scotland (MS) conducted an offshore seabed survey of Geikie Slide and the Hebridean Slope (GSH) Scottish Nature Conservation Marine Protected Area (NCMPA) in July/August 2016.

Located to the north-west of Scotland, the GSH site follows the descent of the seabed from a depth of 200 m on the Hebridean continental shelf, into the Rockall Trough to a depth of 1700 m.

This NCMPA is designated to protect a range of sedimentary habitat types that are home to a diverse array of marine animals, which vary in composition over the range of depths encountered on this area of slope. The continental slope is believed to be significant for the health of Scotland's seas because of the way it influences the movement of water currents, which bring a plentiful supply of food to the area.

The survey departed Aberdeen on 18 July 2016 and arrived back in Aberdeen on 3 August 2016. A drop-frame camera system was used to collect HD video and high resolution still images. The typical duration of video tows captured is a minimum of 10 minutes (minimum distance 150 m).

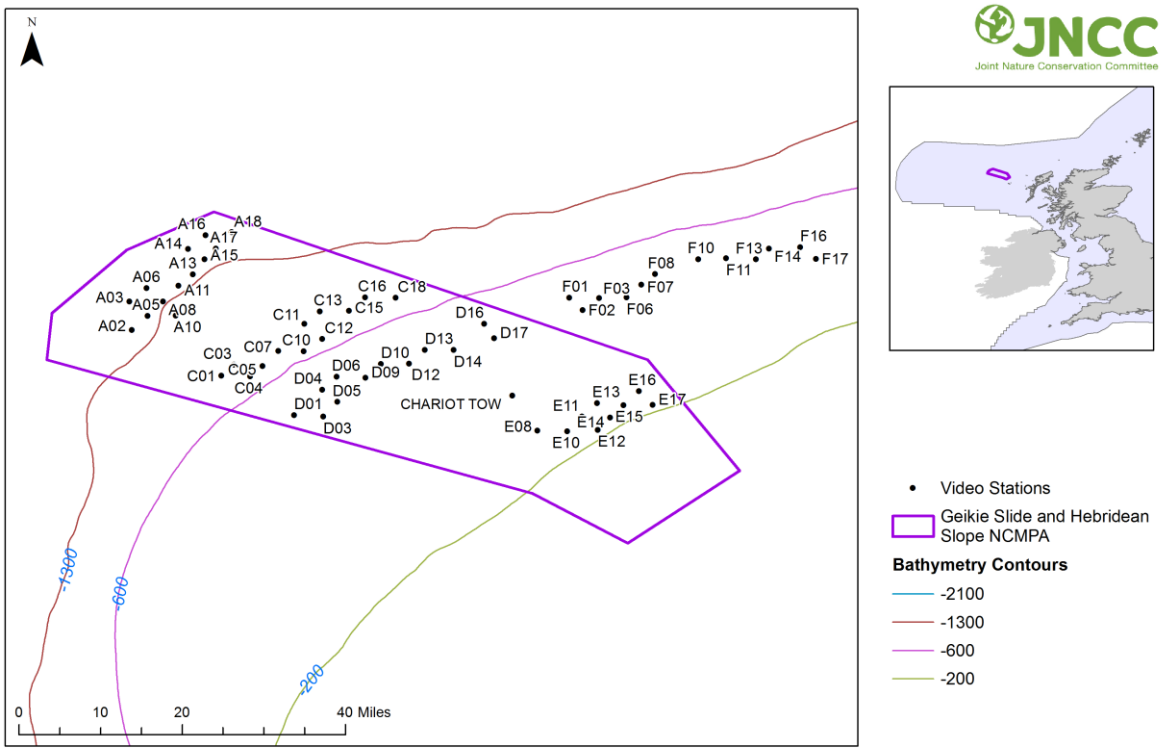


Figure 1. 1016S survey location and boundary of the Geikie Slide and Hebridean Slope (GSH) NCMPA.

Envision Mapping Ltd. were contracted to undertake the analysis of offshore seabed video and stills collected in the Geikie Slide and the Hebridean Slope (GSH) NCMPA on the 1016S survey (Figure 1) to identify the habitats and epifauna present. The purpose of the analysis of the video/stills was to identify habitats, provide semi-quantitative data on the

characteristics of the physical habitat and species composition and to note where one substrate type changed to another. The specific objectives were:

- To review video tows and sub-divide into separate segments as necessary on the basis of changes in habitat, treating each segment as a separate record.
- To describe the substrate and habitat present for each segment and record the presence and location of NCMPA Priority Marine Features.
- To allocate biotope codes at as high a level as possible, depending on information available.
- To analyse all stills associated with each video tow.
- To identify organisms to genus and species level where this can be done with confidence. Higher taxa and life forms are to be used where identification could not be achieved to this level with confidence.
- To record abundance counts for erect epifaunal species, percentage cover for colonial/encrusting species and a semi-quantitative SACFOR abundance for each taxon.
- To record any visible impacts or modifiers.
- To assess all video and stills for image quality.
- To create an image reference collection for each species and biotope recorded in the analysis.
- To record the total number of each species of sea pens (*Virgularia mirabilis*, *Pennatula phosphorea* and *Funiculina quadrangularis*) observed in the video segment or still.
- To record the number of all species of sea pens which are lying flat on the seabed and/or which are visibly broken.
- To assign a value (1 – 3) for the amount of fouling observed on the seapens in each video segment or still.
- To record the number of Nephrops burrows observed either in the video segment or still.
- To record the morphology of any sponges observed either in the video segment or still.

2 Methodology

Video and still images are reviewed, processed and analysed in accordance with national guidelines, such as the standards for analysis in Visual Seabed Surveys (BS EN 16260:2012), Coggan *et al*. (2007), and the NMBAQC Epibiota interpretation guidelines (Turner *et al*. 2016), and in line with the updated species lists in Marine Recorder and the World Register of Marine Species (WoRMS). The purpose of the analysis of the video/stills was to identify what broadscale habitats exist in each video record, provide semi-quantitative data on their physical and biological characteristics, to note where one substrate type changes to another and to record any visible impacts or modifiers. Where appropriate, recommended tools to aid analysis were employed, such as percent cover tools, grid overlay and sediment size guides, and the information from the video and stills was recorded on separate spreadsheets.

Guidelines provided in the JNCC Biotope Report 546 (Parry 2015) and the 'Epibiota Remote Monitoring from Digital Imagery: Interpretation Guidelines' document (Turner *et al.* 2016) were followed when assigning biotopes. The guidance advice specified in the 'Counting Burrows' section of Turner *et al*. (2016), with additional reference to the ICES (2008) report, was adhered to regarding Nephrops burrow identification and burrow counts.

2.1 Quality Control (QC) of incoming data

All video footage was provided digitally and the original data were copied to internal network drives to ensure no data were lost or corrupted and backup copies were kept.

Incoming data initially underwent a QC process whereby data was checked to ensure all stills were present that were listed in the metadata, and vice versa that all stills and video received had associated metadata accompanying them. This required manipulation and processing of the data to match metadata with the time stamp properties (EXIF) of the still images. Files were sequentially and consistently named according to survey box, station codes and numbers. QC of all the amalgamated data was undertaken during finalisation of all the outputs. Details of the substrate (Video Form and Stills Form) was carried out by checking for consistency in all biotopes, Scottish MPA features and Annex 1 habitats allocation, and that the substrate categories all summed to 100% and that substrate type groupings were in line with biotope code allocations for those videos or stills. For the species data, quality assurance checks were made to identify duplicates, any missing values, and inconsistencies in naming and assignment of abundance values.

2.2 Analysis of video

During analysis, each video tow was initially observed rapidly (x4) to get an overview of the sample station in order to segment the video into sections based upon changes in substrate type, if applicable, and each section was treated as a separate record. Start/end times and start/end latitudes and longitudes were taken from the metadata provided for each video tow.

The video was then viewed at normal, or slower than normal, speed to obtain species and substrate data. The data obtained from the video tows were then entered into a Video Analysis spreadsheet based upon those developed by JNCC and Cefas. When each video had been analysed it was possible to assign broadscale habitat types, Scottish MPA features and biotopes. Biotopes were assigned according to "The Marine Habitat Classification for Britain and Ireland Version 15.03"[1] with additional reference to guidance provided in JNCC report 530 (Parry *et al.* 2015) and 546 (Parry 2015).

[1] (http://jncc.gov.uk/marine/biotopes/hierarchy.aspx), accessed January 2017

Where biota could not be identified to species (e.g. because they would need to be collected and closely examined to be certain; or where only a small portion is visible on the video or still) then they were assigned a higher taxonomic category or lifeform within which they are definitely contained. Reference was also made to the Deep Sea Species Image Catalogue (Howell & Davies 2010), and if a taxa was uncertain but identified using images from this catalogue, the Operational Taxonomic Unit (OTU) number was referenced in the qualifier column. Every attempt was made to record cover/abundance of features and species systematically.

2.3 Analysis of stills

All the stills were analysed and assigned to their parent video. The time and position of each still was taken from the metadata provided by JNCC, and recorded in the Stills Analysis spreadsheet, also based upon those developed by JNCC and Cefas.

The physical and biological characteristics were viewed at normal and greater than normal magnification, noting details of substrate types and species present.

A broadscale habitat type, Scottish MPA feature (where present) and biotope was then assigned to each still, again according to "The Marine Habitat Classification for Britain and Ireland Version 15.03" and guidance notes provided by JNCC report 530 (Parry *et al.* 2015) and 546 (Parry 2015).

An actual abundance and a semi-quantitative SACFOR abundance was allocated to each taxon recorded. The results were entered into the prepared stills spreadsheet.

2.4 Sea pen and Nephrops / burrows assessment

In addition to taxonomic identification and quantification in both video and still images, sea pen condition was also to be assessed, by counting the number of sea pens which were lying down or broken within each still or video tow or segment, and a score given to represent the level of fouling with mucus/sediment on a scale of 1-3 (1: none, 2: light, 3: heavy). Infaunal burrows were also counted, with Nephrops burrow systems identified separately following techniques within Turner *et al.* (2016) and the ICES 2008 workshop paper.

2.5 Reference collections

A reference collection was built as the analysis progressed, with good quality images noted and collated for each taxon or species identified. Where possible still images were used preferentially as examples but where a taxon or species was only visible in video footage an image capture from the video footage was used.

Each image was then reviewed and the taxon/species was highlighted (Figure 2) with a box or circle. The file was then saved with the species taxon name and the site identification forming the filename structure
(e.g. Lophius piscatorius_Video_GSH_1016S_BoxE_E15_S106_S1.jpg).
A spreadsheet was then collated which records the species/taxon name, the image file reference and file metadata such as time, data, position, depth and survey / station code.

In addition to a species/taxon reference collection, a biotope/habitat reference collection was also built with good images of each biotope/habitat recorded selected in the same manner as species/taxon with the addition of a best quality, representative, short (1 minute) video clip also selected and extracted for reference purposes. Again, the files were saved and

named with biotope/habitat and station reference as part of the filename and a spreadsheet entry recorded detailing the files and metadata.

2.6 QC of video and stills analysis

A representative set of six of the 58 GSH video tows and associated stills were selected to encompass the range of habitats and analysts, this imagery was then re-assessed for QC purposes by both external and internal QC analysts, which amounted to 102 stills and just over 80 minutes of video (over 10% of footage), along with two five-minute sections of the additional chariot video tow.

The quality checked video and stills data were then entered into a spreadsheet, again using the layout of the Video and Stills Analysis spreadsheets based upon those developed by JNCC and Cefas, so that the data from the original analysis and those of the quality checked analysis were set side by side (given in purple and black font respectively). These include information on who carried out the original analysis as well as the QC procedure.

Upon completion of the analysis a resemblance analysis using Bray Curtis similarity was carried out using:

- Similarity scores for presence/absence of taxon;
- Similarity scores for taxon with abundance counts.

Each still image and video segment was attributed with the Bray-Curtis similarity scores and the results were reported to MS/JNCC. Where image or video segments showed lower levels of similarity, the data recorded between the external and internal analysts was reviewed to identify where the differences occurred and remedial action discussed with MS/JNCC. All reconciliation methods are documented within this final report.

3 Results

3.1 Video and stills

A total of 59 video tows (including one longer chariot video tow), and 956 still images were provided for analysis, however five of the still images had no metadata associated with them and were not processed. Of the remaining 951 images, 31 were not analysed, or only partially analysed, due to the images being too dark or the substrate not visible (allocated a 'zero' or 'very poor' visual quality score). Of the 920 images analysed, 655 (71%) were allocated an 'excellent' or 'good' visual quality, but a further 265 images (29%) were thought to be of 'poor' or 'very poor' quality. The quality scores of 'poor' or 'very poor' are assigned when images are in darkness, the substrate is obscured with disturbed sediment, or the angle or height of the camera system result in a very restricted view of the substrate. These issues affect analysis, potentially limiting the level of taxonomic identification possible and introducing uncertainty. The full results of the analyses are provided in Appendices 1 and 2.

The video footage analysed was generally of good quality (79%) with occasional issues of reduced visibility due to disturbed sediment, or a restricted view of the sediment where the camera system was raised too high above the substrate. The camera system was 'hopped' as it was towed, which also resulted in fast moving sections of footage further away from the substrate where identification of the fauna was more difficult, followed by slower moving sections with a good view of the seabed. 11 of the video tows were allocated 'poor' quality where these issues affected 20-50% of the tow. One video tow was allocated 'very poor' quality, where the video was truncated and only the surface recording of the footage was available for most of the tow. The longer chariot video tow was allocated 'poor' quality, as the footage was unclear due to the camera system being towed too fast and too far away from the substrate for clear viewing, particularly towards the end of the tow.

A reference collection of still images was compiled to provide examples of the epifauna observed: the collection included 160 images of 98 taxa in total, and 15 images and 12 video clips as examples of the 14 biotopes identified (two biotopes were only seen in the still images and not in the video footage). Biota observed, which were very unclear due to the quality of the footage or the angle/speed of the video, were assigned a name (Species A, B etc.) and recorded in the reference collection for information. Please note that in the reference collection, where only higher taxa have been used, then an example of each taxon has been provided, e.g. Actinopterygii. However, this taxon can cover a wide range of species, and it should not be considered as the only potential example.

3.1.1 Sea pens and burrow counts

No sea pens were observed in any of the footage received from the 1016S survey. Every effort was made to count Nephrops using available guidance in Turner *et al.* (2016) and the ICES (2008) workshop paper, however unless the characteristic T-shaped burrow or large enough, crescentic openings and track marks were observed, all other holes, small and large (including uncertain Nephrops burrows) were recorded separately as 'other burrow openings'. It may well be worth noting that also in some of the muddy sand tows in Box C where large Brachyura were seen (possible Chaceon) these were observed digging into the sand making large depressions that could be mistaken for burrows from a distance.

3.1.2 Visible impacts or modifiers

At one station, BoxC_C03_S18, it was thought evidence of trawling could be seen, where mounds of broken clumps of muddy sand were observed in lines. These broken clumps of muddy sand were also seen at the end of BoxC_C01_S20, but the lines were not obvious so

were not recorded as trawl marks. Non-natural materials were also thought to be observed in several tows, including several possible discarded lengths of rope, see Table 1.

Table 1. Visual impacts or modifiers.

Video tow	Time	Non-natural materials / litter
BoxC_C03_S18	Throughout	Possible trawl marks
BoxA_A03_S78 (still 01)	00:35	Uncertain (plastic cuff?)
BoxA_A05_S79	02:42	Uncertain (green objects)
BoxC_C03_S18	08:38	Possible rope
BoxC_C04_S19	10:54	Possible rope
BoxC_C11_S05	01:29	Glass
BoxD_D03_S22	06:42	Possible rope
BoxD_D09_S30 (still 09)	07:28	Possible metal spring/cable

3.2 Habitat type allocation

3.2.1 Video habitat biotope allocation

All of the stations were found to consist of only one 'segment' as there were no significant changes in substrate throughout the video tows.

Twelve habitat types / biotopes were identified from the 59 video tows, with the majority of video tows assigned to habitat type only, including 39 allocated to coarse sediments (M.AtLB.Co (three), M.AtMB.Co (eight), M.AtUB.Co (28)). A further eight video tows were allocated as a sand habitat (M.AtLB.Sa (two), M.AtMB.Sa (five), M.AtUB.Sa (one) biotope, and only one station was allocated a mud habitat (M.AtLB.Mu).

The remaining video tows were allocated biotopes according to the biology observed there, including four video tows which were thought to be 'Urchin dominated community on Atlantic upper bathyal coarse sediment' (M.AtUB.Co.UrcCom) where *Cidaris cidaris* were recorded in higher numbers, often alongside holothurians (*Parastichopus tremulus*). Three video tows were allocated as 'Xenophyophore dominated community on Atlantic lower bathyal coarse sediment' (M.AtLB.Co.XenCom). Two video tows were suggested as 'Xenophyophore dominated community on Atlantic lower bathyal coarse sand' (M.AtLB.Sa[XenCom]) as this biotope only exists for coarse, muddy or mixed sediments, however xenophyophores were common. Another video tow was given a suggested biotope of M.AtUB.Co[Ditrupa] due to the presence of considerable numbers of Ditrupa shells (superabundant) on coarse sediment. A final video tow was allocated 'Surface dwelling ophiuroid community on Atlantic lower bathyal mixed sediment' (M.AtLB.Mx.SurOph) due to the many large Ophiuroids (possibly *Ophiomusium lymani*) which were common.

A summary of these biotopes is given in Table 2 and the distribution of these habitats and biotopes are shown in Figure 2, and the broadscale habitats, Scottish MPA features, MNCR and EUNIS Codes summarised in Table 4. Example images of habitats and biotopes are shown in Table 3.

Table 2. Habitat types identified from video analysis of the 1016S (EGM) survey area.

Biotope (MNCR Code)	EUNIS Code	MNCR Classification	No. of Video Segments
M.AtLB.Co	A6.2	Atlantic lower bathyal coarse sediment	3
M.AtLB.Co.XenCom	A6.2	Xenophyophore dominated community on Atlantic lower bathyal coarse sediment	3
M.AtMB.Co	A6.2	Atlantic mid bathyal coarse sediment	8
M.AtUB.Co	A6.2	Atlantic upper bathyal coarse sediment	28
M.AtUB.Co[Ditrupa]	A6.2	(Suggested) Ditrupa dominated community on Atlantic upper bathyal coarse sediment	1
M.AtUB.Co.UrcCom	A6.2	Urchin dominated community on Atlantic upper bathyal coarse sediment	4
M.AtLB.Mx.SurOph	A6.2	Surface dwelling ophiuroid community on Atlantic lower bathyal mixed sediment	1
M.AtMB.Mx	A6.2	Atlantic mid bathyal mixed sediment	[2 stills only]
M.AtUB.Mx	A6.2	Atlantic upper bathyal mixed sediment	[1 still only]
M.AtLB.Sa	A6.3/6.4	Atlantic lower bathyal sand	2
M.AtLB.Sa[XenCom]	A6.3/6.4	(Suggested) Xenophyophore dominated community on Atlantic lower bathyal sand	2
M.AtMB.Sa	A6.3/6.4	Atlantic mid bathyal sand	5
M.AtUB.Sa	A6.3/6.4	Atlantic upper bathyal sand	1
M.AtLB.Mu	A6.5	Atlantic lower bathyal mud	1

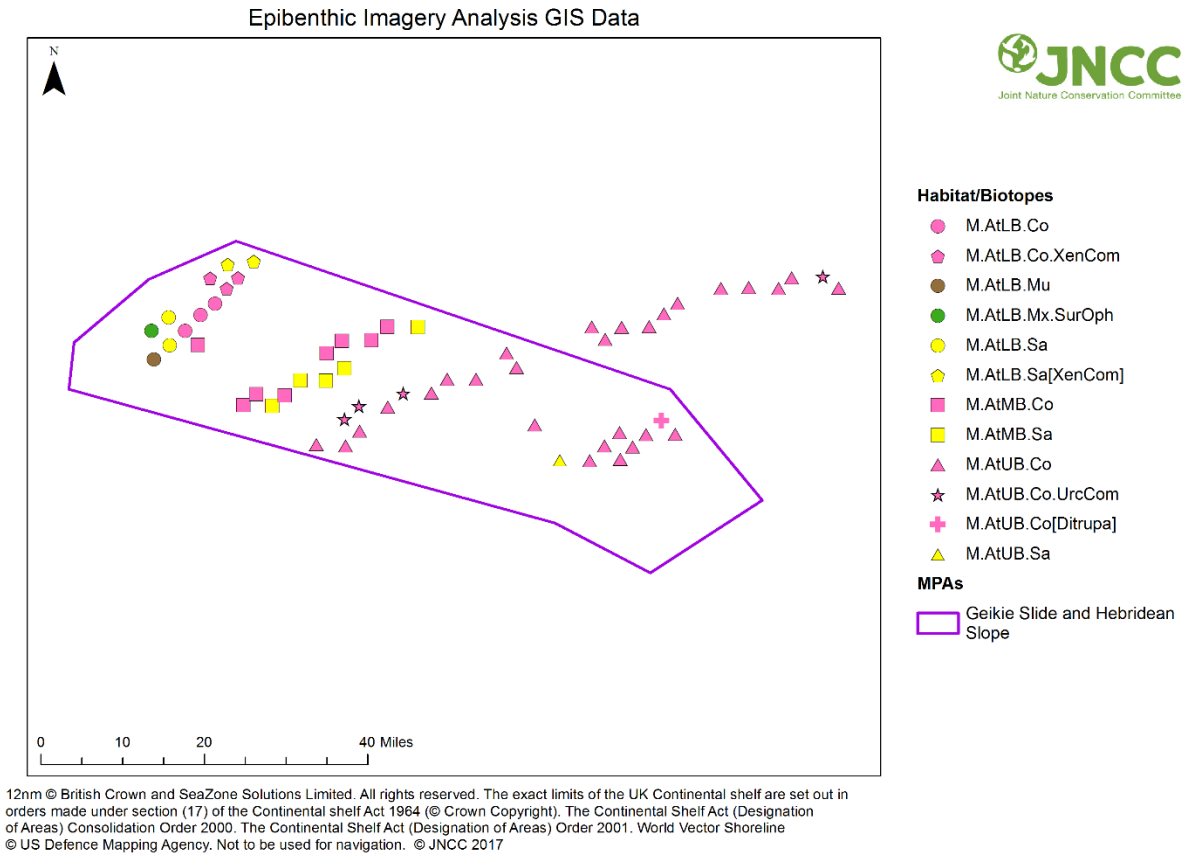
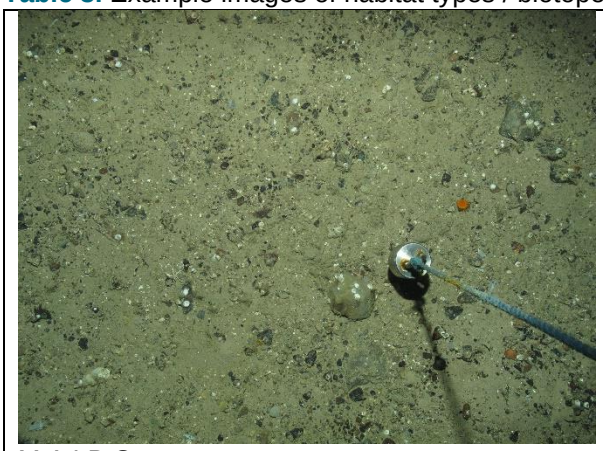
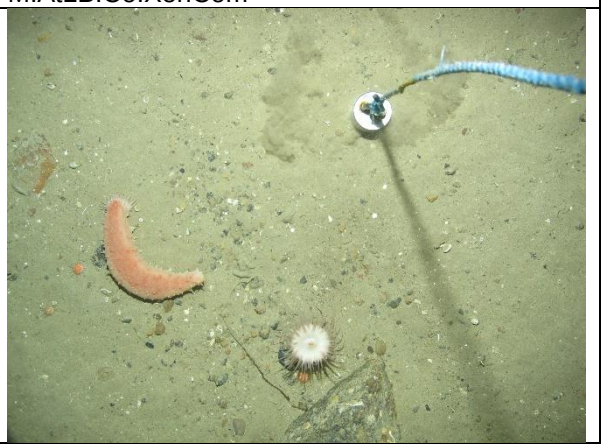
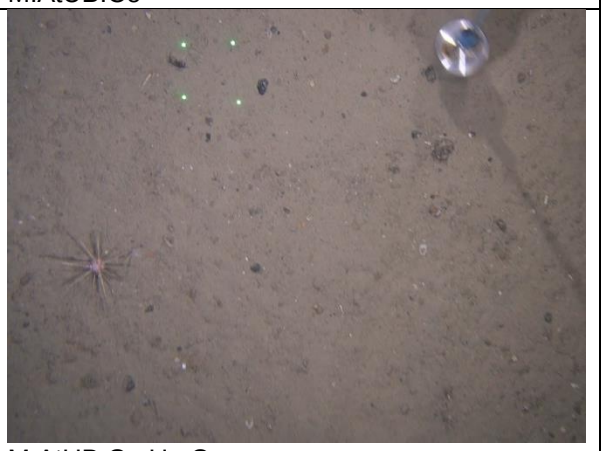
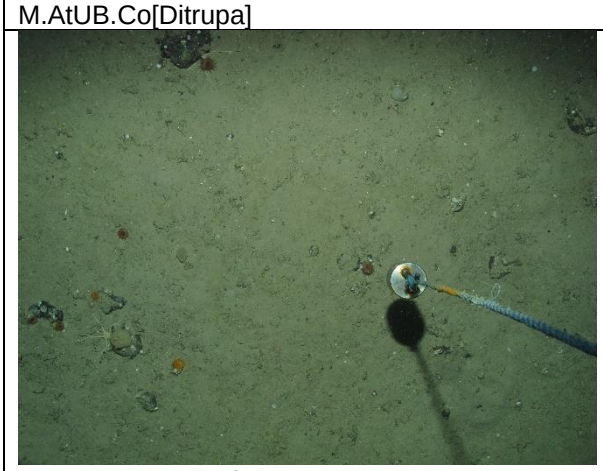
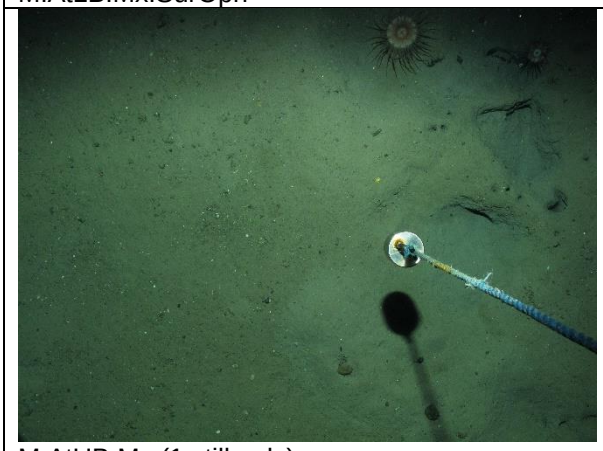
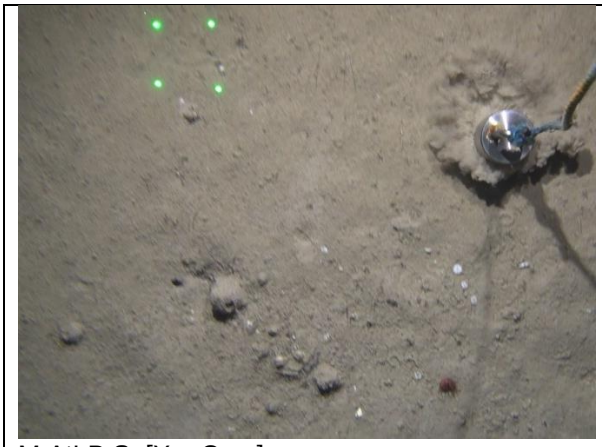


Figure 2. Distribution of biotopes and habitat types throughout the GSH NCMPA.

Table 3. Example images of habitat types / biotopes observed from the 1016S survey imagery.

	
M.AtLB.Co	M.AtLB.Co.XenCom
	

M.AtMB.Co	M.AtUB.Co
	
M.AtUB.Co[Ditrupa]	M.AtUB.Co.UrcCom
	
M.AtLB.Mx.SurOph	M.AtMB.Mx (2 stills only)
	
M.AtUB.Mx (1 still only)	M.AtLB.Sa


M.AtLB.Sa[XenCom]


M.AtMB.Sa


M.AtUB.Sa

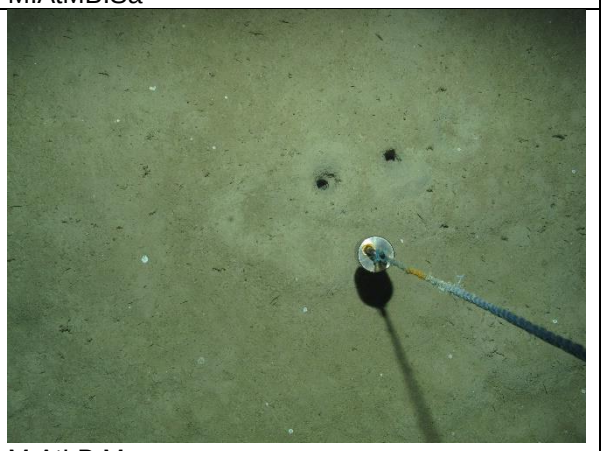

M.AtLB.Mu

Table 4. Summary of stations from the 1016S survey, their broadscale habitats, Scottish MPA features, MNCR and EUNIS codes.

Video sample ref	Broadscale habitat	Scottish MPA feature	MNCR code	EUNIS code
BoxA_A02_S80_S1	A6 - Deep Seabed	Offshore deep sea muds / Burrowed Mud	M.AtLB.Mu	A6.5
BoxA_A03_S78_S1	A6 - Deep Seabed		M.AtLB.Mx.SurOph	A6.2
BoxA_A05_S79_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtLB.Sa	A6.3/6.4
BoxA_A06_S73_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtLB.Sa	A6.3/6.4
BoxA_A08_S77_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtLB.Co	A6.2
BoxA_A10_S81_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Co	A6.2
BoxA_A11_S72_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtLB.Co	A6.2
BoxA_A13_S74_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtLB.Co	A6.2
BoxA_A14_S66_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtLB.Co.XenCom	A6.2
BoxA_A15_S67_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtLB.Co.XenCom	A6.2

Video sample ref	Broadscale habitat	Scottish MPA feature	MNCR code	EUNIS code
BoxA_A16_S64_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtLB.Sa[XenCom]	A6.3/6.4
BoxA_A17_S65_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtLB.Co.XenCom	A6.2
BoxA_A18_S63_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtLB.Sa[XenCom]	A6.3/6.4
BoxC_C01_S20_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Co	A6.2
BoxC_C03_S18_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Co	A6.2
BoxC_C04_S19_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Sa	A6.3/6.4
BoxC_C05_S17_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Co	A6.2
BoxC_C07_S12_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Sa	A6.3/6.4
BoxC_C10_S11_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Sa	A6.3/6.4
BoxC_C11_S05_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Co	A6.2
BoxC_C12_S10_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Sa	A6.3/6.4
BoxC_C13_S04_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Co	A6.2
BoxC_C15_S03_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Co	A6.2
BoxC_C16_S02_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Co	A6.2
BoxC_C18_S01_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtMB.Sa	A6.3/6.4
BoxD_D01_S21_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxD_D03_S22_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxD_D04_S28_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co.UrcCom	A6.2
BoxD_D05_S23_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxD_D06_S29_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co.UrcCom	A6.2
BoxD_D09_S30_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxD_D10_S31_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co.UrcCom	A6.2
BoxD_D12_S32_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxD_D13_S33_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2

Video sample ref	Broadscale habitat	Scottish MPA feature	MNCR code	EUNIS code
BoxD_D14_S36_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxD_D16_S34_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxD_D17_S35_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxE_E08_S112_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Sa	A6.3/6.4
BoxE_E10_S111_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxE_E11_S109_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxE_E12_S110_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxE_E13_S108_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxE_E14_S107_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxE_E15_S106_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxE_E16_S104_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co[Ditrupa]	A6.2
BoxE_E17_S105_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxF_F01_S43_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxF_F02_S45_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxF_F03_S44_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxF_F06_S58_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxF_F07_S57_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxF_F08_S56_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxF_F10_S55_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxF_F11_S54_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxF_F13_S53_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxF_F14_S52_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2
BoxF_F16_S51_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co.UrcCom	A6.2
BoxF_F17_S50_S1	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2

Video sample ref	Broadscale habitat	Scottish MPA feature	MNCR code	EUNIS code
TOW2	A6 - Deep Seabed	Offshore subtidal sands and gravels	M.AtUB.Co	A6.2

3.2.2 Stills biotope allocation

For the majority of the stations the broadscale habitats and biotope classifications of the videos and associated stills broadly agreed with one another (*cf.* Appendix 1 and Appendix 2). The majority of stills (596) were allocated as coarse sediment (M.AtLB.Co (81), M.AtMB.Co (98), M.AtUB.Co (417)). A further 265 stills were allocated as a sand habitat (M.AtLB.Sa (79), M.AtMB.Sa (92), M.AtUB.Sa (94)), 20 stills were allocated a mud habitat (M.AtLB.Mu) and only three stills were allocated to mixed sediments (M.AtMB.Mx (two) and M.AtUB.Mx (one)).

The remaining still images were allocated biotopes according to the biology observed there, including 15 still images which were given the biotope of 'Xenophyophore dominated community on Atlantic lower bathyal coarse sediment' (M.AtLB.Co.XenCom), where three or more xenophyophores were observed in a still. Six still images were allocated the suggested biotope of M.AtUB.Co[Ditrupa] due to the presence of considerable numbers of Ditrupa shells on coarse sediment. Four still images were allocated 'Surface dwelling ophiuroid community on Atlantic lower bathyal mixed sediment' (M.AtLB.Mx.SurOph) due to the presence of 5 or more Ophiuroids, many of which were large (possibly *Ophiomusium lymani*).

None of the still images were allocated to the 'Urchin dominated community on Atlantic upper bathyal coarse sediment' (M.AtUB.Co.UrcCom) as only single individuals were observed in any one still, however collectively the number observed throughout the videos tow was felt sufficient for the allocation of this biotope.

3.3 Features of importance or conservation significance

'Deep Seabed' (A6) was the only broadscale habitat allocated to the footage from the 1016S survey area (Table 4).

Two Scottish MPA Priority Marine Features were observed within the Geikie Slide and Hebridean Slope NCMPA: 'Offshore deep sea muds' were seen at sampling station BoxA_A02_S80, which could potentially also be the 'Burrowed Mud' feature due to a high number of burrows (a Nephrops burrow and 296 other burrow openings) observed during the video tow, however none of the specific component species or habitats were observed there (see also section 3.3.1 below). All of the remaining sampling stations were assigned the 'Offshore subtidal sands and gravels' Priority Marine Feature, apart from a single sampling station, BoxA_A03_S78, which was allocated a mixed sediment biotope. Figure 3 shows the sample stations and associated Priority Marine Features.

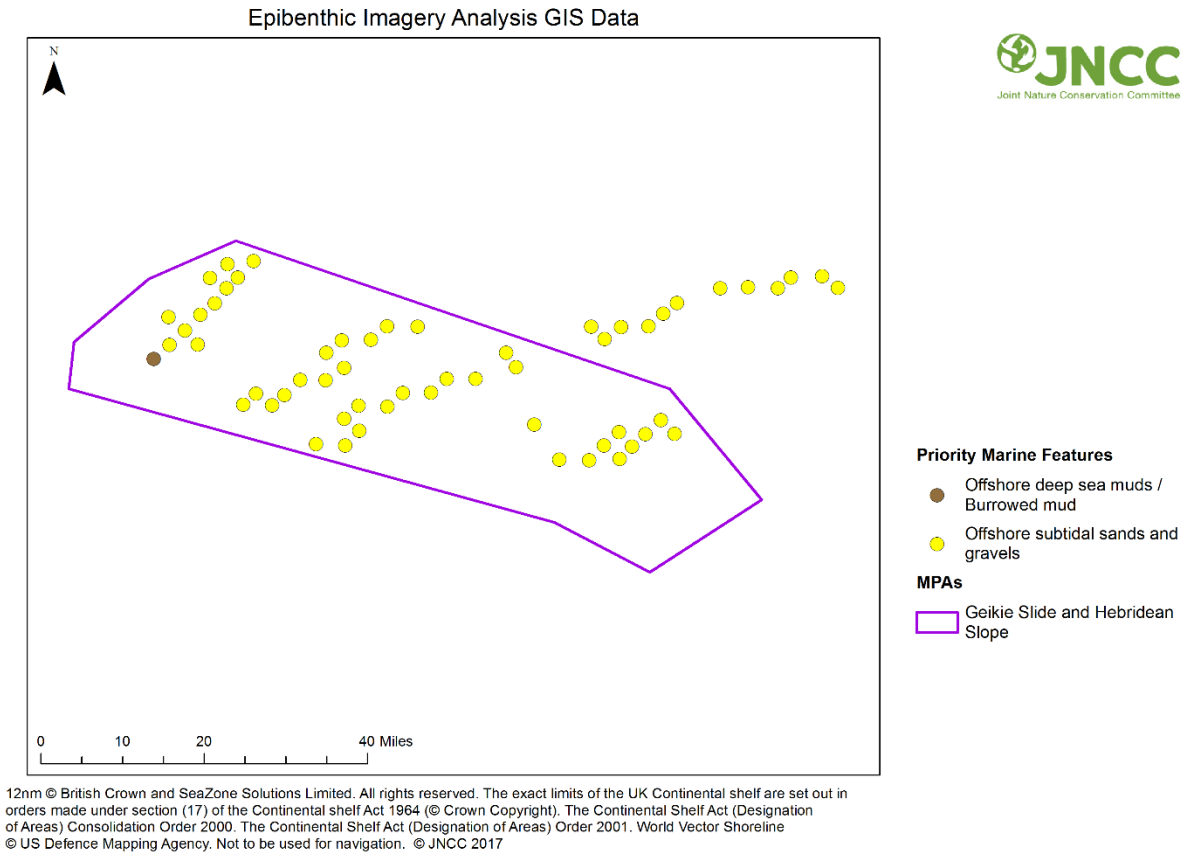


Figure 3. Distribution of Priority Marine Features observed throughout the GSH NCMPA.

Several species were observed that could be considered 'features of interest' in terms of protection or conservation status. A monkfish (*Lophius piscatorius*) was seen in still image BoxC_C11_S05_S1, and in the video tow BoxE_E15_S106, which is a Priority Marine Feature, as is '*Molva dypterygia*' (Blue Ling) which was seen in the video tow BoxF_F14_S52 (and in still images 6, 11 and 13) and in the last 10 minutes of Tow 2 (chariot tow).

Of the other fish recorded within the epibenthic imagery, those worthy of note are where ID was uncertain to species level but could have been mobile species listed as Priority Marine Features. The Round-nose Grenadier *Coryphaenoides rupestris* was possibly sighted but only recorded as Actinopterygii/Macrouridae with 'Coryphaenoides' as a suggestion in the qualifier column in video tows BoxA_A11_S72 and BoxC_C04_S19 and still images in station BoxA_A03_S78 (images 12, 15 and 19) and BoxA_A14_S66 (images 03, 13 and 16). Similarly, a fish sighted in video tow BoxC_C07_S12 (and in still image 06) was identified as Clupeidae as only sighted from above but could possibly have been an Atlantic Herring *Clupea harengus*.

'*Nephrops norvegicus*' (Norwegian lobster) was observed in the second 10 minutes of Tow 2 (chariot tow), and potentially in BoxC_C16_S02 (claw tips only), with Nephrops being one of the 'burrowing megafauna' species that are a component species of the Burrowed Mud Priority Marine Feature. Nephrops burrows were also counted in 14 of the video tows (including the majority of tows in Box C – 9 of 12 stations), in combination with a mixture of other large and small burrow openings at many more of the sites. However, sea pens were not observed at any of the sampling stations.

'*Pachycerianthus multiplicatus'* (firework anemone) is also a component species of the burrowed mud feature. Pachycerianthus was identified to genus level in video tows BoxD_D04_S28 (still image 17), BoxD_D09_S30 (still image 07), BoxD_D10_S31,

BoxD_D13_S33 (still image 10), BoxF_F01_S43, BoxF_F07_S57, and potentially in video tow BoxC_C18_S01 and still images BoxD_D06_S29_06 and BoxF_F02_S45_04, but whether this species was '*Pachycerianthus multiplicatus'* could not be confidently determined from the footage.

Corals are found within several priority marine feature habitats that may occur in these depths ('Seamount communities', 'Continental Slope', 'Carbonate Mounds', 'Coral Gardens', 'Northern Sea Fan and Sponge Communities', 'Deep Sea Sponge Communities') and at the GSH site, Caryophyllia (similar to OTU584 in the Deep Sea Species Image Catalogue) was identified to genus level in several stills in Box A (BoxA_A02_S80, stills 03, 06 and 08 and BoxA_A16_S64, still 08) and seen in video tows BoxA_A02_S80 , BoxA_A06_S73, BoxA_A13_S74, BoxA_A14_S66, BoxA_A16_S64, BoxA_A18 and BoxF_F08_S56. Other Scleractinia were seen in video tows BoxA_A03_S78, BoxA_A08_S77, BoxA_A13_S74 (potentially Lophelia, seen in still image 07) and BoxF_F08_S56, and in still image BoxA_A17_S65_12. Other Anthozoa were observed that could possibly have been Scleractinia, throughout the stills and video from Box A, in particular those specified as 'anemone 1' in the qualifier column, which was thought could have been an uncertain identification of Caryophyllia (OTU584) from a greater distance.

Soft corals may also have been recorded on some occasions, although due to small size or uncertainty due to video quality, these were recorded as 'Alcyonacea' (possible Antipatharians) in video tows BoxA_A14_S66, BoxA_A17_S65 and BoxA_A18_S63, and in stills BoxA_A05_S79_13 and BoxA_A11_S72_11 (possibly *Anthomastus*), as Cnidaria (possible *Stichopathes*) in still image BoxA_A15_S67_09 and Octocorallia in BoxA_A14_S66_09. Other more uncertain lifeforms which could potentially have been soft corals were Species H (possible Nephtheidae/Hexactinallid) seen in BoxA_A17_S65 and Species L in BoxA_A14_S66_03 (recorded as Cnidaria, but possibly just a hydroid).

Also recorded, but only in the comment column, were possible disc shaped foraminiferans which were not thought to be alive, but seen in significant quantities at several sampling stations, in particular BoxA_A02_S80, BoxA_A03_S78, BoxA_A06_S73 and BoxA_A18_S63.

3.3.1 Burrowed mud

The Scottish Priority Marine Feature 'Burrowed mud' reflects a number of component habitats and species that are considered to be of particular relevance in a Scottish context (http://www.gov.scot/Resource/0039/00394205.doc, accessed 17 February 2017) and it was felt that the 'burrowed mud' feature could potentially have been assigned as a 'Scottish MPA feature' in some instances within the video imagery from the Geikie Slide and Hebridean Slope NCMPA.

Nephrops burrows were counted in 14 of the video tows (including the majority of tows in Box C – 9 of 12 stations), in combination with a mixture of other large and small burrow openings at many more of the sites. Sea pens were not observed at any of the sampling stations. Additionally, the majority of stations were considered to be sand or coarse sediments, however, at some stations, the relatively high numbers of burrows recorded within these substrates could be indicative of a muddier underlying substrate.

Only one station, video tow BoxA_A02_S80, was allocated a mud habitat, and had a significant number of other burrow openings (296), as well as one possible Nephrops burrow system, and could potentially be considered 'burrowed mud'.

From the footage at the GSH site it was felt that the identification of silt content within the substrate was subjective (see QC section 3.4), where often the surface appeared to be

composed of coarser sediments (with shell, pebbles and gravel evident in the imagery) but potentially muddier sediment lying underneath (evident in bioturbated muddier patches with burrows). At a number of sampling stations which were allocated sand habitats (Atlantic mid bathyal Sand, M.AtMB.Sa) where higher numbers of burrows were observed, these potentially could have been allocated the 'Burrowed Mud' feature (BoxC_C04_S19, BoxC_C07_S12, BoxC_C10_S11, BoxC_C12_S10 and BoxC_C18_S01). One of the component species of burrowed mud was also potentially observed at BoxC_C18_S01, but only identified as Ceriantharia (possibly Pachycerianthus).

It should be noted that uncertainty in the identification of Nephrops burrows (if the large crescentic openings with track marks, or the characteristic T-shaped burrows were not seen) resulted in most burrow openings being classed as 'other burrows' and Nephrops burrows were not recorded in numbers of over 10 at any of the sampling stations.

3.4 QC of video and stills analysis

A total of 102 stills and just over 80 minutes of video (over 10% of footage), along with two five-minute sections of the additional chariot video tow were reanalysed for QC purposes. The sampling stations were BoxA_A02_S80, BoxC_C12_S10, BoxD_D01_S21, BoxE_E15_S106, BoxF_F10_S55, BoxE_E08_S112 and TOW2 - 9-14mins and 40-45mins. The results are summarised below in Table 6 and given in full detail in Appendices 3, 4, 5 and 6.

3.4.1 Internal QC analysis

An examination of the internal QC data shows that there was some disparity between the data produced by the original analyser and the QC analyser. However, there was 100% agreement between the conclusions of the original analyser and the QC analyser with regard to the assignment of broadscale habitat, Scottish MPA feature and habitat types (see Table 5 and Appendices 3 & 4) in both the video and the stills data.

Table 5. A comparison of broadscale habitats, Scottish MPA features and habitat codes allocated by the original analyser & QC analyser (shaded) for the internal quality control video tows.

Video sample ref	Broadscale habitat	Scottish MPA feature	MNCR code	EUNIS code
BoxA_A02_S80_S1	A6 - Deep Seabed	Offshore deep sea muds / Burrowed mud	M.AtLB.Mu	A6.5
BoxA_A02_S80_S1	A6 - Deep Seabed	Offshore deep sea muds / Burrowed mud	M.AtLB.Mu	A6.5
BoxC_C12_S10_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtMB.Sa	A6.3/6.4
BoxC_C12_S10_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtMB.Sa	A6.3/6.4
BoxD_D01_S21_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
BoxD_D01_S21_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
BoxE_E15_S106_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
BoxE_E15_S106_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
BoxF_F10_S55_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
BoxF_F10_S55_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
BoxE_E08_S112_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Sa	A6.3/6.4
BoxE_E08_S112_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Sa	A6.3/6.4
TOW2 - 9-14mins	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
TOW2 - 9-14mins	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
TOW2 - 40-45mins	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2

Video sample ref	Broadscale habitat	Scottish MPA feature	MNCR code	EUNIS code
TOW2 - 40-45mins	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2

Substrate composition

The substrate composition assessment in both the video and stills data were not always exactly the same, but as it is very difficult to discern substrates, especially silt and sand fractions, from video/still imagery, the proportions are estimated from the nature of the sediment observed in the video (rippled, burrowed, the way the silt behaves in the water column when disturbed, etc.), and should be verified with the PSA data for a more accurate analysis of the sediment. The percent coverages of the larger sediment fractions were also sometimes attributed slightly differently between analyser and QC analyser, however the overall agreement between analysers was good and reflected a confidence in the observations of habitat type and substrate composition.

Quality

Two of the video tows showed disagreement between quality grading, with one analyst allocating ‘poor’ and the other allocating ‘good’ to both tows. These categories are subjective, but also both analysers may have found similar issues with the quality, albeit judging them to be on the borderline of the ‘good’ and ‘poor’ categories, with 5-20% and 20-50% of the tow being affected respectively. Again, within the stills data, there was some variation between allocation of quality categories by the original and QC analyser, but this can be attributed to subjectivity in allocation of these categories and was never more than one category out.

Burrow counts

Some slight differences were also noted in the burrow counts in both video and stills data, but due to the uncertainty with this technique, discussed in sections 3.1.1 and 3.3.1, these were not thought to be of note. A greater difference was seen in BoxD_D01_S21, where three Nephrops burrows and 25+ ‘other’ burrows were recorded originally, whereas the QC analyst counted one Nephrops burrow and 51 ‘other’ burrow openings. At this station, most burrows were seen in one very large mound of burrowed mud, with some larger openings, but many smaller indistinct openings, which were difficult to count precisely. The large mound of muddier substrate also made it difficult to estimate the exact number of burrow systems, and whether this was in fact one large system, or several distinct systems.

Taxa recording

There were also some minor discrepancies between the original analyser and the QC analyser in terms of taxa recorded within both the video and the stills data. The majority of the taxonomic records had been given the same names by both the original analyser and the QC analyser, with some differences occurring where the same taxa were defined at different taxonomic levels by the analysers, e.g. Holothuroidea or *Parastichopus tremulus* and Macrouridae or Trachyrincus. For some of the video tows undergoing QC, some specimens of taxa were missed by either the reviewer or analyst, however these discrepancies often lay where the species were either small, inconspicuous (e.g. Echinoidea, Caridea) or cryptic (e.g. small Galatheoidea under rocks, Ophiuroidea buried in sand). Again, the nature of the footage frequently made identification of the fauna unclear, especially where silt covered the individuals, or sediment was disturbed and obscured the view of the seabed, or where the camera system was higher above the substrate, or moving at a much faster speed during the ‘hops’ forward.

Similar issues were seen within the stills QC data, with additional discrepancies arising in allocation of very sparse and uncertain faunal turfs and crusts of less than 1% cover, where occasionally these were recorded by one analyst and not the other. However, none of the discrepancies in the video or stills data have affected the subsequent biotope allocations and are again considered to be within acceptable levels for the nature of this work and with the quality of imagery provided.

Remedial Actions

From the QC process some amendments were made throughout the data to improve standardisation of how individuals were recorded and remove uncertainty of observations by using a broader taxonomic level e.g.:

- All *Cidaris* was recorded as *Cidaris cidaris*
- All Actiniaria were recorded as Anthozoa (with anemone in qualifier)
- All brittle stars (*Ophiura* and Ophiurida) were recorded as Ophiuroidea (with suggestions in qualifiers)
- Nephrops SACFOR allocation was checked and made consistent (>15 cm)
- Ophiuroidea SACFOR allocation was checked and made consistent throughout (3-15 cm)
- All Porifera were recorded as % cover (rather than counts)
- All whips recorded as Cnidaria in 3-15 cm category
- Sparse and uncertain hydrozoans, bryozoans and Porifera to be recorded as U. faunal turf or U. faunal crust where appropriate

3.4.2 External QC analysis

Comparison of the external QC data and original data showed greater discrepancies than the internal QC in the recording of species and substrates observed.

Assignment of Scottish MPA feature and habitat types were different in both the video and the stills data for all sampling stations except for BoxA_A02_S80, in which both analysts agreed that the habitat should be allocated as ‘Atlantic lower bathyal mud’ (M.AtLB.Mu). However, in the remaining sampling stations the significantly greater silt content given by the external QC analyst meant that all tows originally allocated ‘Atlantic mid bathyal sand’ and ‘Atlantic upper bathyal sand’ (M.AtMB.Sa or M.AtUB.Sa) were recorded as ‘Atlantic mid bathyal mud’ or ‘Atlantic upper bathyal mud’ (M.AtMB.Mu or M.AtUB.Mu) by the external QC analyst. Likewise, ‘Atlantic upper bathyal coarse sediment’ (M.AtUB.Co) recorded by the original analysts was identified as ‘Atlantic upper bathyal mixed sediment’ by the external analyst (see Table 6, Appendix 5 and Appendix 6). This determination of silt content is discussed in the internal QC (3.4.1) and sections 3.3.1 and 3.5.

Table 6. A comparison of broadscale habitats, Scottish MPA features and habitat codes allocated by original & external QC analyser (shaded) for the quality controlled video tows.

Video Sample Ref	Broadscale habitat	Scottish MPA feature	MNCR Code	EUNIS Code
BoxA_A02_S80_S1	A6 - Deep Seabed	Offshore deep sea muds / Burrowed mud	M.AtLB.Mu	A6.5
BoxA_A02_S80_S1	A6 - Deep Seabed	Offshore deep sea muds / Burrowed mud	M.AtLB.Mu	A6.5
BoxC_C12_S10_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtMB.Sa	A6.3/6.4
BoxC_C12_S10_S1	A6 - Deep Seabed	Offshore deep sea muds	M.AtMB.Mu	A6.5
BoxD_D01_S21_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
BoxD_D01_S21_S1	A6 - Deep Seabed		M.AtUB.Mx	A6.2

Video Sample Ref	Broadscale habitat	Scottish MPA feature	MNCR Code	EUNIS Code
BoxE_E15_S106_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
BoxE_E15_S106_S1	A6 - Deep Seabed		M.AtUB.Mx	A6.2
BoxF_F10_S55_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
BoxF_F10_S55_S1	A6 - Deep Seabed		M.AtUB.Mx	A6.2
BoxE_E08_S112_S1	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Sa	A6.3/6.4
BoxE_E08_S112_S1	A6 - Deep Seabed	Offshore deep sea muds	M.AtUB.Mu	A6.5
TOW2 - 9-14mins	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
TOW2 - 9-14mins	A6 - Deep Seabed		M.AtUB.Mx	A6.2
TOW2 - 40-45mins	A6 - Deep Seabed	Offshore sands and gravels	M.AtUB.Co	A6.2
TOW2 - 40-45mins	A6 - Deep Seabed		M.AtUB.Mx	A6.2

Substrate composition

Aside from the mud content (discussed above), the substrate composition scores in the video data did not show major differences between the original and QC analyst. Within the stills data, there was a reasonable level of agreement within the allocation of the larger fractions of the sediment, however in three sampling stations, D01, E15 and F10, the external QC analyser had recorded less in the coarse sediment categories, giving an allocation of mud habitats where the original analyser had recorded coarse sediments (and where the video tows had been recorded as mixed sediments by the external QC analyst). The actual percent cover of coarse sediments was only 1-2% below the level required to constitute a mixed sediment, and after reviewing the data by both parties, a consensus was reached that the coarse sediment percentages should be increased for these tows in the QC data.

Quality

Two of the video tows showed disagreement between quality grading, with the original analyst allocating ‘poor’ and the external QC analyst allocating ‘good’ to both tows. These categories are subjective, and both analysers may have found similar issues with the quality, just judging them to be on the borderline of the ‘good’ and ‘poor’ categories, with 5-20% and 20-50% of the tow being affected respectively. Again, within the stills data, there was some variation between allocation of quality categories by the original and QC analyser, but this can be attributed to subjectivity in allocation of these categories and was never more than one category out.

Burrow Counts

Variations were noted in the burrow counts in both video and stills data, but due to the uncertainty with this technique, discussed in sections 3.1.1 and 3.3.1, these were not thought to be of note. As with the internal QC process, a greater difference was seen in BoxD_D01_S21 (and still 06), where the majority of burrows were seen in a very large mound of burrowed mud and muddier patches, which made it difficult to identify and count the exact number of distinct burrow systems. Another video tow showing a greater difference was in BoxA_A02_S80, where the external QC analyst had counted many more Nephrops burrow systems, while the original analyst counted these as separate burrow openings. This highlights that the original analysts used more caution when identifying Nephrops burrows if there was any uncertainty.

Taxa Recording

For both the taxa recorded from both video and the stills data there were greater discrepancies between the original analyst and the external QC analyst than between internal analysts.

Some differences occurred where the same taxa were defined at different taxonomic levels by the analysers due to uncertainty of identification, e.g. Holothuroidea or *Parastichopus tremulus* and Actiniaria or Anthozoa. For some of the video tows undergoing QC, some specimens of taxa were missed by either the reviewer or analyst, however these discrepancies most often lay where the species were either small, inconspicuous (e.g. Echinoidea, Caridea) or cryptic (e.g. small Galatheoidea under rocks, Ophiuroidea buried in sand). Again, the nature of the footage frequently made identification of the fauna uncertain, especially where silt covered the individuals, or sediment was disturbed and obscured the view of the seabed, or where the camera system was higher above the substrate or moving at a much faster speed during the 'hops' forward. In general, where there was uncertainty of identification of taxa due to quality of the footage, the original analysts tended to show more caution in level of taxonomic ID and abundance counts, whereas the external QC analyst was more likely to record uncertain observations and in more taxonomic detail.

Similar issues were seen within the stills QC data, with additional discrepancies arising in allocation of very sparse and uncertain faunal turfs and crusts of less than 1% cover, which the external QC analyst tended to record more frequently, and in more detail (e.g. original analysts recorded some U. faunal turfs and crusts, external QC analyst recorded various bryozoans and hydroids, as well as more incidences of U. faunal turfs and crusts). As these were observed only in very sparse amounts (<1%) it was considered that the discrepancies in the video or stills data have not affected the subsequent biotope allocations and are again considered to be within acceptable levels for the nature of this work, and with the quality of data provided.

Remedial action

- The Reference Collection was sent to the external QC analyst to agree identification and naming of taxa observed. The external QC analyst was in agreement with the identification of all the specimens in the reference collection and only reported differences in use of taxonomic levels, which were aggregated for comparison of the data, so these differences are not thought to represent significant issues:
    - Internal: *Parastichopus tremulus* - External: Holothuroidea
    - Internal: Aphroditidae - External: *Aphrodita aculeata*

- Video data were reviewed using statistical comparison and where distinct dissimilarities occurred recounts of taxa were undertaken and amended throughout the datasets (Appendix 2), and also in the QC data, where the changes made to the taxa have been highlighted in red font (Appendix 6).
    - A02 – Species B counts: these were recorded as percent cover by the external QC, and counts by the internal analysts, and were difficult to count due to their small size and uncertainty of identification, therefore this species has been removed from the aggregated data which was compared statistically.
    - D01 – Echinoidea counts (Original 1, Internal QC 13, External QC 9): recounts resulted in original analyser counting 8 (and a further 5 uncertain). Original data changed.
    - E15 – Paguridae counts (Original 33, Internal QC 39, External QC 60): recounts resulted in external analyser confirming his previous count, data remains same. No data changed.

- F10 – Echinoidea counts (Original 0, Internal QC 2, External QC 11): recounts made and external QC analyst changed count to 7. External QC data changed.
- Chariot TowB 9-14mins – Paguridae counts (Original 1, Internal QC 0, External 14): recounts made and external QC analyst changed count to 5. External QC data changed.
- Chariot Tow2 40-45 mins – Anthozoa (*Actinauge richardi*) counts (Original 105, Internal QC 99, External QC 165): recounts made and external QC analyst changed count to 112, original analyst changed count to 115 and agreed name change to Anthozoa due to uncertainty of majority of individuals. Original and external QC data changed.
- Chariot Tow2 40-45mins – Paguridae counts (Original 1, Internal QC 6, External QC 10): recounts made and original analyst counted 2 due to a timing issue (and a further 6 uncertain). Original data changed.

- Still imagery data was reviewed to highlight dissimilarities – still images were then reviewed and taxa recounted, and amended throughout the dataset (Appendix 1), and also in the QC data spreadsheet, where the changes made to the taxa have been highlighted in red font (Appendix 5).
    - The majority of discrepancies lay in the recording of species, which were either small and inconspicuous (e.g. Caridea, Ascidia, small Paguridae) or cryptic (e.g. small Galatheoidea under rocks, Ophiuroidea buried in sand), where either the original or external QC analyst missed certain organisms. These were recounted and adjusted in the original and QC data (either removed if uncertain or added if missed).
    - Any discrepancies between recording of hydroids/bryozoans and U. faunal turfs and crusts were left unchanged in the original and QC data, as these were observed only in very sparse amounts (<1%) and are unlikely to have affected the subsequent biotope allocations.
    - In D01, E15 and F10, the percentage coverages of the coarser sediment fractions were increased in the external QC stills data by 1-2% in order to bring the stills substrate data in line with the external QC video data.

NB. Any changes made to the original data as a result of remedial action from the external QC process have also been recorded within the internal QC data spreadsheets (Appendices 3 and 4) by indicating changes with emboldened notes in the qualifier column.

Statistical tests

Bray Curtis tests were carried out to compare the original and external QC video data, and because of the discrepancies in recording biota at different taxonomic levels etc., results initially showed low similarities (all below 63% similarity). To improve standardisation of the species recording for statistical analysis, taxa were aggregated into broader taxonomic groups e.g. **Holothuroidea** (*Parastichopus tremulus*), **Crustacea** (Decapoda, Galatheoidea, Caridea, Brachura), **Actinopterygii** (*Chelidonichthys cuculus, Helicolenus dactylopterus*, Macrouridae, *Phycis blennoides*, Scorpaeniformes, *Trachyrincus*), **Pleuronectiformes** (*Lepidorhombus whiffiagonis*), **Anthozoa** (*Actinauge richardi*, Actiniaria, Anthozoa, Ceriantharia, Zoantharia), etc. and other less certain or inappropriate taxa were removed (Species B, Hormathiidae (*Adamsia palliata*), Gymnosomata), and the process recorded in the external QC data spreadsheets.

Bray Curtis results for the aggregated data returned results of higher than 80% similarity for five out of the eight video tows/segments. After remedial action (described above) the similarity results improved, but only slightly, with the highest similarity in data from the non-aggregated data reaching only 65% for one tow, and Bray Curtis results for the aggregated

data returned results of higher than 80% similarity for six out of the eight video tows/segments (see Table 7).

Table 7. Bray Curtis results for the comparison of original and external QC data, for aggregated and non-aggregated data, and before and after remedial action (increases in bold, above 80% shaded blue).

Video Tow	Non-Aggregated Data Similarities (%)		Aggregated Data Similarities (%)	
	Pre-remedial action	Post-remedial action	Pre-remedial action	Post-remedial action
BoxA_A02_S80_S1	13.48	13.48	87.50	87.50
BoxC_C12_S10_S1	63.01	63.01	83.33	83.33
BoxD_D01_S21_S1	59.89	**64.95**	85.56	**89.69**
BoxE_E15_S106_S1	39.76	39.76	80.85	80.85
BoxF_F10_S55_S1	55.35	55.35	66.67	66.67
BoxE_E08_S112_S1	44.07	**47.27**	58.62	**62.96**
TOW2 - 9-14mins	5.91	**6.14**	81.01	**84.21**
TOW2 - 40-45mins	3.73	**5.00**	74.53	**92.14**

3.5 Discussion

During the analysis, some issues with the quality of the footage and limitations of the analysis approach were noted, some of which are also discussed previously in the QC section (3.4) and in the habitat type allocation results (3.2). In summary:

The quality of the video and stills footage was generally good, however as the camera system was towed it was 'hopped' over the substrate, and a significant percentage of the imagery was high above the substrate, poorly lit and faster moving, of all of which made description of the substrate characteristics and identification of the fauna more difficult and less confident. In particular, where fauna or burrows were observed at the periphery of the field of view, the counts became less certain and harder to identify individuals. Where the full criteria for Nephrops burrow identification (such as the T-shaped burrow, or necessary burrow entrance size or nature) were not clearly observed, burrows were counted as 'other burrow openings', but this was also open to subjectivity.

Due to the nature of the substrate, when the camera system rested on the seafloor, sometimes the sediment was disturbed and obscured the view of substrate and fauna, especially in muddier areas.

Much of the fauna living in the habitats observed at GSH NCMPA are cryptic (small or covered or hidden in sediment) or were of a similar colour and size to the substrate. Recounts showed that internal analysts used more caution in their identification of small, uncertain taxa, and tended to only record taxa where certain. The external QC analyst used less caution in this regard. Current guidance (Turner *et al.* 2016) advises the use of caution where certainty is not high, therefore this gives confidence to the original data. However, employing a cautious approach could result in under-representation of small or cryptic taxa such as Echinoids, Ophiurids and small Paguridae and other Crustacea. Additionally, video quality influences the certainty of identification and where quality is poor there may be under-representation of all taxa.

The recording of sparse and uncertain faunal turfs and crusts introduced some ambiguity into the analysis, particularly within the QC process where these were recorded in much greater detail than in the original analysis (e.g. specific hydroids and bryozoans). It is felt that grouping these records into more general lifeforms such as U. faunal crusts and turfs gives more confidence to results, and it should be stressed that these terms are used for video analysis where uncertainty is high. However, it should also be noted that these lifeforms cannot be entered into Marine Recorder, and where the analyst is certain of observation, broad taxonomic groups such as 'Porifera' or 'Hydrozoa' may also be used.

It is very difficult to discern between the silt and sand fractions from video/still imagery, an issue which was highlighted by the external QC process (section 3.4.2), and the proportions are estimated from the nature of the sediment observed in the video (rippled, burrowed, the way the silt behaves in the water column when disturbed, etc.). These should be verified with the PSA data for a more accurate analysis of the sediment, but it should also be noted that larger fractions of the sediment, which lie at the surface of the substrate, may be under-represented in the PSA data.

Two new biotopes have been suggested for this site, including 'Ditrupa dominated community on Atlantic upper bathyal coarse sediment' (M.AtUB.Co[Ditrupa]) due to the presence of considerable numbers of ditrupa shells (superabundant) on coarse sediment, and 'Xenophyophore dominated community on Atlantic lower bathyal coarse sand' (M.AtLB.Sa[XenCom]) as this biotope currently only exists for coarse, muddy or mixed sediments, however xenophyophores were observed to be common on a sandy substrate. It should also be noted that at some sampling stations, xenophyophores were recorded in lower numbers as the video footage did not allow for confident identification, however it was thought that they did occur in similar abundances to other stations (BoxA_A16_S64).

3.6 Recommendations for video and stills data analysis QC

The Bray Curtis test was used for comparison of QC data, the results of which can be seen in more detail in Appendices 5 and 6. The percentage similarity between results for the video tows that were re-analysed was lowered, often as the result of small differences in taxonomic naming for the same taxa, or different counts for small, inconspicuous and cryptic species (where the level of certainty for recording taxa can be subjective and vary significantly between different analysts). Using the Bray Curtis similarity test did highlight where discrepancies lay in the video analysis, however remedial action did not improve the results significantly, and there is a limit to what can be implied/inferred from the discrepancies noted within the QC process to the rest of the data, or any changes that can be made across the board (i.e. uncertainty in identification due to quality of footage is not necessarily the same for all observations of each taxa, or all video tows or still images). The most significant improvements in results are seen through the aggregation of the data into broader taxonomic categories, but recording the data only at these levels would simplify the detail of diversity observed within the data, and would mean the loss of a lot of potentially relevant information (e.g. specific species seen of conservation importance, etc.).

The Bray Curtis test is less useful for highlighting discrepancies in the stills data, where often low numbers of taxa are being observed in each still, and where anything but an exact match in recording of these taxa will result in very low similarity scores.

We would recommend that for the use of Bray Curtis tests to compare underwater imagery analysis:

- Statistical comparison should only be undertaken for video analysis

- Data should be aggregated into broader taxonomic categories to avoid discrepancies in taxonomic naming (but initially recorded at the highest taxonomic level possible with certainty noted).
- Similarities of over 70% are very good, and acceptable over 60%. Similarities lower than 60% should be reviewed to identify where mismatches or issues occur and considered for remedial action or used to highlight issues within the data or analysis techniques.
- Comparison of SACFOR allocations might be more appropriate, removing the small differences between counts, and highlighting the kind of larger differences that might have an impact on biotope allocation.
- Further studies into how best to compare and assess quality checked data sets should be undertaken.

4 Appendices

Appendix 1: 1016S_stills_ analysis_final_20170303.xlsx (attached as separate file).
Appendix 2: 1016S_video_analysis_final_20170303.xlsx (attached as separate file).
Appendix 3: 1016S_stills_internal_QC_20170303.xlsx (attached as separate file).
Appendix 4: 1016S_video_internal_QC_20170303.xlsx (attached as separate file).
Appendix 5: 1016S_stills_external_QC_20170303.xlsx (attached as separate file).
Appendix 6: 1016S_video_external_QC_20170303.xlsx (attached as separate file).

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