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Pobie Bank Reef Special Area of Conservation 2020 Cruise Report (1220S)

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This report is compliant with the JNCC **Evidence Quality Assurance Policy** https://jncc.gov.uk/about-jncc/corporate-information/evidence-quality-assurance/ and was reviewed by MSS and JNCC.

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Abbreviations

EOL	End of Line
JNCC	Joint Nature Conservation Committee
MSS	Marine Scotland Science
MPA	Marine Protected Area
MRV	Marine Research Vessel
OppCam	Opportunistic Camera
SAC	Special Area of Conservation
SOL	Start of Line
SVP	Sound Velocity Profile
UTC	Coordinated Universal Time

1 Background and introduction

The survey at Pobie Bank Reef Special Area of Conservation (SAC) was carried out between 22 August – 7 September 2020 on the MRV *Scotia* cruise 1220S. This report describes the survey design and methodology, the events of the survey and the data collected. Results of analyses of the data collected will be reported on separately.

1.1 Pobie Bank Reef Special Area of Conservation

Pobie Bank Reef SAC is in the North Sea, approximately 20 km east of Shetland, Scotland (Figure 1). The site has an area of 966 km^2 and a depth range of 58 m to 137 m. Pobie Bank Reef SAC was designated to protect the seabed within the site, which meets the definition of 'Annex I habitat type 1170: Reef' as described in the EC Habitats Directive (hereafter 'Annex I Reef').

The Annex I Reef at Pobie Bank Reef SAC has a conservation objective of 'maintain or restore the feature in/to favourable condition' (Table 1, JNCC 2013).

JNCC and MSS last visited Pobie Bank Reef SAC in 2013 (Parry & Robertson 2019).

As Pobie Bank Reef SAC crosses the 12 nm boundary, JNCC and NatureScot are jointly responsible for nature conservation in the MPA.

For up-to-date background information on Pobie Bank Reef SAC, see the Site Information Centre[1].

[1] Pobie Bank Reef SAC Site Information Centre. Accessed August 2020; https://jncc.gov.uk/our-work/pobie-bank-reef-mpa/#conservation-advice

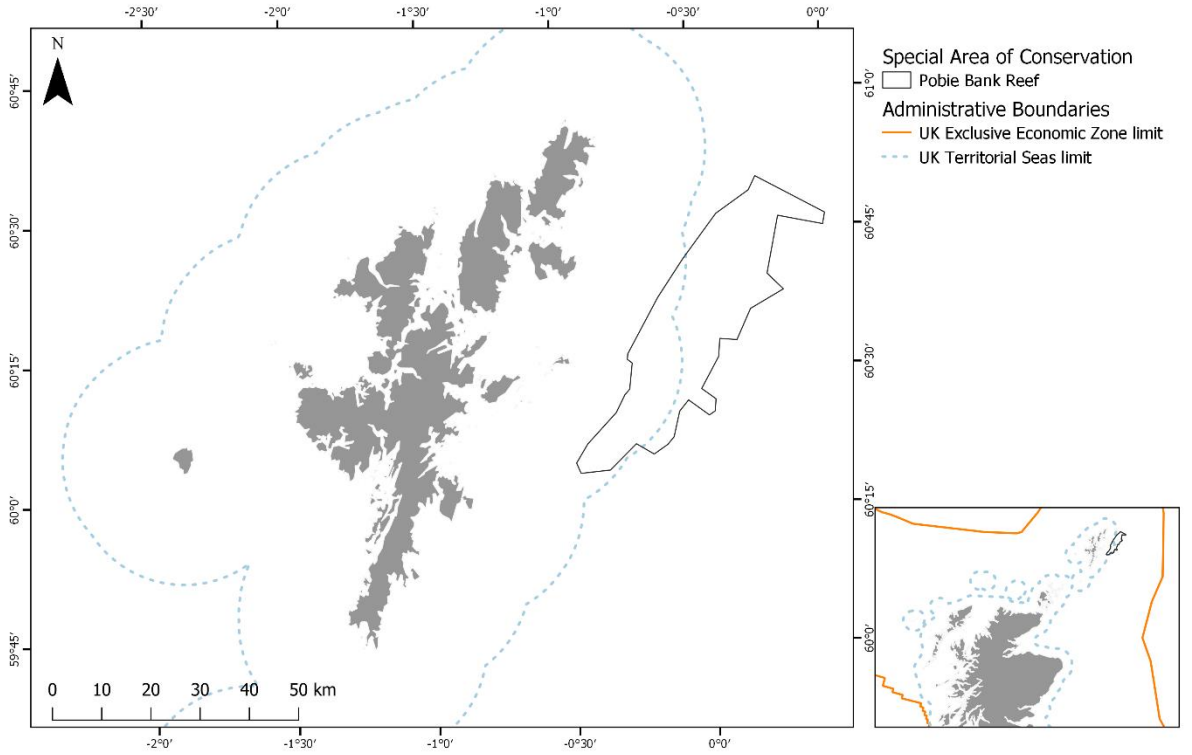

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Figure 1. The Shetland Islands and the boundary of Pobie Bank Reef Special Area of Conservation.

Table 1. Site designations and conservation objectives at Pobie Bank Reef SAC (JNCC & SNH 2013).

Feature	Feature Type	Conservation objectives
Reefs	Annex I Habitat	Subject to natural change, maintain or restore the reef in/to favourable condition, such that: • the natural environmental quality and processes supporting the habitat • the extent of the habitat on site • the physical structure, community structure, function, diversity and distribution of the habitat and typical species representative of the reef in the Northern North Sea regional sea are maintained or restored, thereby ensuring the integrity of the site and also make an appropriate contribution to favourable conservation status of the Annex I habitats.

1.2 Aims and objectives

The aim of the 1220S survey was to acquire a robust initial sentinel monitoring dataset (see Table 2) for Pobie Bank Reef SAC. The dataset will contribute to the development of a monitoring time-series for the site, against which the rate and direction of change in the condition of the site's designated feature can be inferred in the long term. This dataset will

be used to enhance understanding of the extent of Annex I reef in the MPA. Future repeated monitoring and evidence gathering will be required to fully investigate and understand the long-term variability in any parameters measured.

The monitoring objectives of the survey were as follows (listed in order of priority):

- **Monitoring Objective 1**: Collect evidence to inform understanding of the physical extent and distribution of the Annex I Reef within Pobie Bank Reef
- **Monitoring Objective 2**: Collect evidence to inform Type One (sentinel) monitoring of the physical and biological structure and function relating Annex I Reef at Pobie Bank Reef
- **Monitoring Objective 3**: Collect evidence to inform understanding of the extent and distribution of sedimentary habitats within Pobie Bank Reef SAC.

Table 2. The definition of Type One monitoring (Kröger & Johnston 2016).

Sentinel monitoring of long-term trends (Type One monitoring) – Objective: to measure rate and direction of long-term change. This type of monitoring provides the context to distinguish directional trends from short-scale variability in space and time by representing variability across space at any one time and documenting changes over time. To achieve this objective efficiently, a long-term commitment to regular and consistent data collection is necessary; this means time-series must be established as their power in identifying trends is far superior to any combination of independent studies.

The monitoring objectives were used to create more specific survey objectives which also include contingency activities (Table 3).

Table 3. Survey objectives in priority order. The equipment used to complete each survey objective, the monitoring objective the survey objective addresses, and a summary of the extent to which each survey objective was completed during 1220S are also shown.

Priority	Survey objective	Equipment	Monitoring objective	Summary of progress
1	Acquire full coverage sidescan sonar from the prioritised acoustic survey boxes (and ~50% multibeam coverage)	Sidescan sonar (multibeam)	1 and 2	Completed
2	Acquire video and still imagery from sampling stations inside the acoustic survey boxes	Drop camera	1 and 2	Partially completed
3	Acquire video and still imagery from sampling stations outside acoustic survey boxes	Drop camera	1 and 2	Partially completed
4	If time is available, select ground truthing sites inside area of newly acquired acoustic data sample using	Drop camera & mini Hamon	1 and 2	Completed using OppCam

Priority	Survey objective	Equipment	Monitoring objective	Summary of progress
	drop camera & the mini Hamon grab for PSA where possible.			
5	If time is available, acquire full coverage multibeam from the prioritised survey boxes	Multibeam	1 and 2	Partially completed
6 (contingency)	Acquire grab samples from stations where seabed is deemed suitable	Hamon grab	3 and 4	Not attempted
7 (contingency)	Test OppCam system	Git Up camera, lamps and housings	NA	Completed
8 (contingency)	Contingency: improve habitat map of surrounding area by acquiring grab samples from the Unst Basin for PSA and relate this to the Roxann hardness and roughness index	Day grab	NA	Not attempted
9 (contingency)	NatureScot contingency sampling	Drop camera	NA	Attempted, but no data collected

2 Survey design and methods

2.1 Survey design

Six acoustic survey boxes (A-F) were designed to target the areas of Pobie Bank Reef SAC where the existing map of Annex I features could be improved (Figure 2), and address monitoring objective 1. Boxes A – E were the highest priority as they contained limited acoustic survey data. Box F was a lower priority as a habitat map based on multibeam data has previously been produced for this area (Foster-Smith *et al*. 2009), however the resolution and accuracy of this mapped area could be improved. The areas outside of the six survey boxes have full coverage habitat maps produced from sidescan sonar data collected in 2013 (Parry & Robertson 2019; Drawbridge & Betteridge, *in press).*

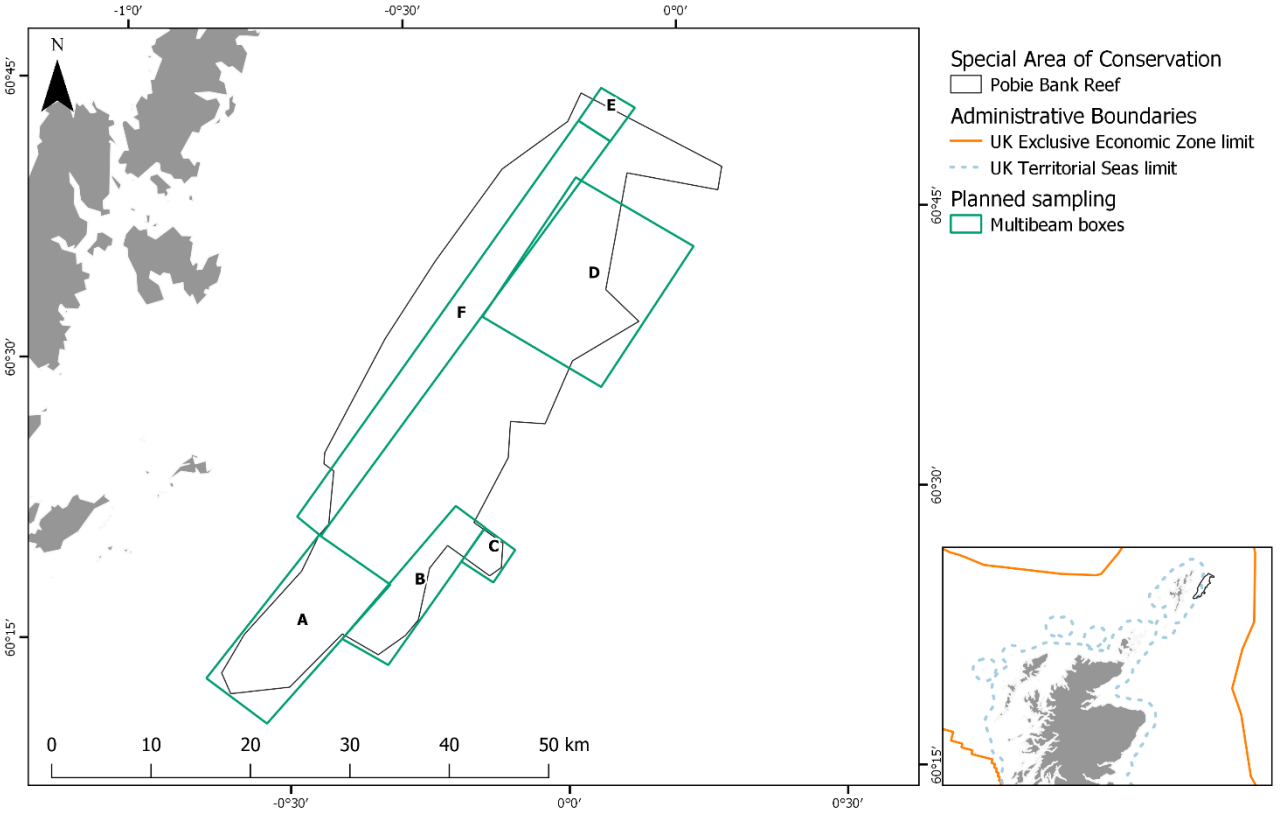

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Figure 2. Pobie Bank Reef SAC 1220S planned acoustic survey boxes.

One hundred monitoring stations were selected across Pobie Bank Reef SAC using an equidistant triangular grid. This resulted in a station spacing of 3.34 km. Stations 001 – 100 were prefixed with an M which stands for monitoring (Figure 3). These stations were selected to address monitoring objectives 1 and 2.

The number of stations chosen was based on a power analysis, which was informed by an analysis of imagery data collected at Pobie Bank Reef SAC in 2013. The power analysis suggested that 70 stations would be required to detect a 20% change in species richness with a statistical power of 0.8 on Annex I Reef. One hundred stations were chosen as a suitable number for the survey as approximately 70 out of the 100 stations were deemed likely to intersect with Annex I Reef based on existing habitat maps of the site. Furthermore, the 70 stations were deemed to be a high estimate as more images were planned per

transect in 2020 than were collected in the 2013 dataset that the power analysis was based on. All stations were planned as drop camera stations. The plan also included an option to collect grab samples from stations where sedimentary habitats were observed to address monitoring objective 3 (Table 3), however, this was not attempted due to time lost to bad weather.

All imagery data collected can be used for ground truthing and improving habitat maps of the site, in addition to monitoring.

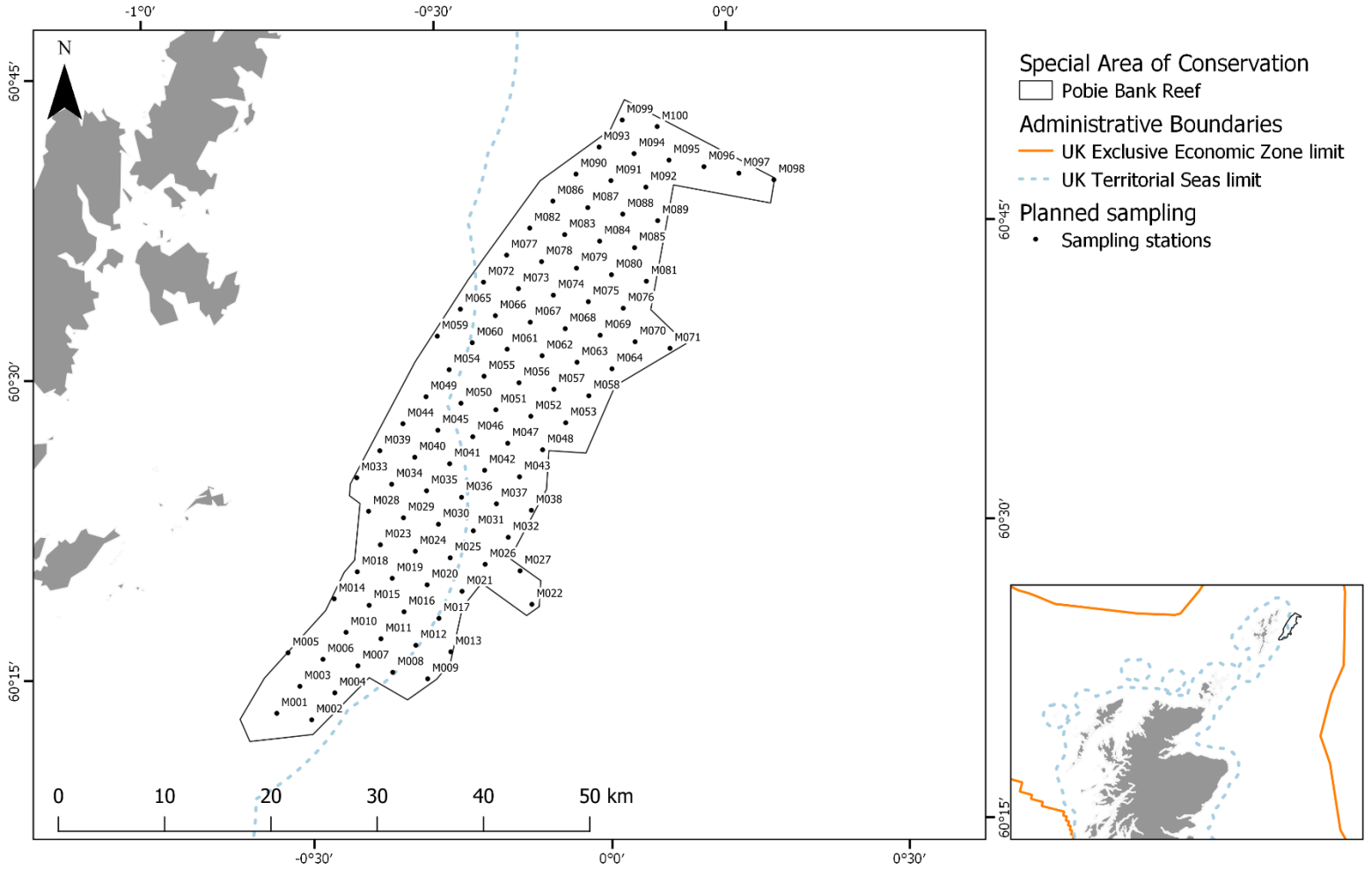

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Figure 3. Pobie Bank Reef SAC 1220S planned sampling stations.

2.1.1 Contingency sampling

A contingency plan was included in case of poor weather or equipment downtime. Four contingency objectives were included to provide options for working in different weather conditions and with different equipment problems, these are listed in (Table 3, objectives 6 - 9).

NatureScot provided coordinates of camera stations in inshore areas of the Shetland Islands. These stations had been planned but not sampled in previous NatureScot surveys. In the event of inclement weather offshore stations could be chosen based on their proximity to Pobie Bank Reef, the amount of shelter provided from prevailing weather, and the length of time conditions at Pobie Bank Reef were forecast to be unsuitable for sampling.

The only contingency objectives addressed were objective 7 and 9, however no data was collected for objective 9 (see the Wednesday 2 September in section 3).

2.2 Methods

The following sampling equipment was used on the survey (data type collected given in brackets):

- Sidescan sonar (acoustic images of the seabed)
- Multibeam echosounder (bathymetry and backscatter)
- Sound Velocity Profile (SVP) probe (multibeam calibration)
- Drop frame camera (still and video imagery)
- Opportunistic camera system (still and video imagery)

Further details of equipment used, and procedures followed are provided in Annex 2.

2.3 Survey project team

The survey team for the duration of the fieldwork included JNCC survey scientists, MSS engineers/technicians, an MSS Scientist in Charge (SIC), and a sidescan engineer contracted in from an external organisation. Risk assessments carried out by JNCC and MSS prior to the survey necessitated fewer staff numbers than previous MPA monitoring surveys to manage the risk of coronavirus transmission.

Roles across the 12 hour working shifts were assigned as follows:

Cross-shifts (06:00 – 18:00)	**Night Shift (00:00 – 12:00**	**Day Shift (12:00 – 24:00)**
MSS scientist in charge JNCC survey scientist	JNCC data manager and survey scientist MSS drop camera engineer Multibeam technician	JNCC survey planning lead and survey scientist MSS drop camera engineer Sidescan engineer

3 Survey Narrative

The survey at Pobie Bank Reef SAC was carried out between 22 August – 7 September 2020 on the MRV *Scotia* cruise 1220S.

All times are UTC and to the nearest 15 minutes. Survey equipment and consumables were loaded onto the survey vessel in advance of sailing.

Saturday 22 August: All survey staff had joined the MRV *Scotia* in Aberdeen by 10:30, and the ship sailed at 12:00. We headed directly to a site at Stonehaven where multibeam patch tests have previously been conducted. During the transit we had a safety briefing on the forecastle deck.

We arrived at Stonehaven and started a wet test of the drop frame camera at 13:15. This test was successful, and we moved on to the multibeam patch test, which was completed at 20:00.

The sidescan towfish (400/900 KHz) had been prepared and was ready to deploy at 20:00, but shortly after deployment at ~20:15 the towfish was lost.

The equipment provider was contacted, and they were able to supply a spare sidescan towfish (300/600 KHz) that had recently returned from a previous job. We headed back to Aberdeen, arriving outside the harbour at ~23:00. MRV *Scotia's* work boat was deployed to collect the towfish from Aberdeen Harbour.

Sunday 23 August: After the replacement sidescan towfish had been collected, the work boat broke down when returning to the MRV *Scotia*. The Harbour Pilot towed the work boat back into the Aberdeen Harbour and MRV *Scotia* returned to the quayside to collect all crew members.

We sailed again from Aberdeen Harbour at 04:00 and arrived at Pobie Bank Reef at 22:15.

The drop frame was deployed at 22:40 (station code 001) but power was not being supplied to the stills camera so it was recovered before starting the transect. A battery was added to the frame and drop camera operations successfully restarted at 23:00 and continued into the next day.

Monday 24 August: Drop frame camera operations continued all day and 23 camera monitoring stations were completed by midnight. Mostly from acoustic boxes A, B, and C.

The procedure for working with just two people in the TV container (where the engineer and survey scientist operate the camera) worked well. The process had been changed slightly, to collect 10-minute tows rather than 150-meter tows. This was to make it easier for the scientist collecting data to monitor progress along the transect whilst taking still images and recording metadata.

The replacement towfish was tested on the deck and was considered ready to use.

Tuesday 25 August: Drop frame camera operations continued until 09:00. Between 9:00 and 11:00 (while the camera was downloading) a toolbox talk was given to the night shift to explain how to deploy the sound velocity profiler (SVP) and enter the results into the multibeam acquisition software, and how to log data in the acquisition software. A review of the patch test data from Stonehaven revealed that the heading calibration should be rerun.

The data collected during this toolbox talk were used to calibrate the heading offsets for the multibeam.

Camera operations restarted at 12:15, when the camera download had finished, and continued to the end of the day. Nineteen camera stations were completed, bringing the total to 42.

Wednesday 26 August: The night shift started the higher priority camera stations at Box D and had completed 12 stations by 09:00 (bringing the total to 54). Night shift then began transiting to the sidescan test site while the camera was downloading.

The test site was positioned between Box D and Box A and had previously been mapped as having a mixture of bedrock reef, stony reef, and sand. This would help us select the best sidescan settings for the survey.

We arrived at the test site at 11:00 at which time the sidescan technician came on shift to begin preparing the sidescan.

The sidescan was deployed at the test site at ~13:00 but had to be recovered due to issues with communication with the equipment. We had equipment downtime between 13:30 and 15:30 while the towing cable was re-terminated.

The sidescan was ready to deploy again at 16:00 and once testing was completed we transited to the deepest area of Box A to do an SVP at 19:00.

Simultaneous multibeam and sidescan data collection began at Box A at 20:15. However, at 20:50 there was again a problem with communication with the sidescan. It was recovered and the cable reterminated, resulting indowntime between 21:00 and 23:00 while the cable was re-terminated.

Thursday 27 August: The night shift completed 13 camera stations by 09:00 (bringing the total to 67) and then began transiting to Box A to do an SVP dip at 10:00.

At 11:00 acoustic survey operations began at Box A, starting with a test of the towfish followed by running of simultaneous multibeam and sidescan survey lines. By 23:00, 4 of the 40 lines at Box A were completed with 100% multibeam coverage and 200% (including overlap) sidescan coverage.

Friday 28 August: Simultaneous multibeam and sidescan operations continued all day. The line spacing was increased to collect 50% multibeam coverage and 100% sidescan coverage. This change was made to improve our coverage of the site, whilst still collecting data that can be used to create habitat maps of the areas surveyed. Day ended ~1/3 of the way through Box A.

Saturday 29 August: Simultaneous multibeam and sidescan operations continued all day. Box A was nearly finished by the end of the day.

Sunday 30 August: Simultaneous multibeam and sidescan operations continued all day. The acoustic survey of Box A was finished, and boxes B1-B3 were nearly finished by the end of the day.

Monday 31 August: Simultaneous multibeam and sidescan operations continued until 11:30. At this point Box B had been completed and Box C was being surveyed. Whilst at Box C, buoys and long lines were spotted close to our area of operation and the sidescan towfish was retrieved. We continued to survey Box C using just the MBES, however by 14:40 we

found we were having to skip multiple survey lines to avoid fishing gear so we left Box C having surveyed approximately half the area.

With the forecast predicted to worsen over the next couple of days the decision was made to try to finish the remaining camera stations, rather than starting a new acoustic box.
We transited to the nearest station and camera operations began at 16:00 and continued until the end of the day, at which point 7 stations had been completed bringing the total to 74.

Tuesday 1 September: Camera operations continued until 08:00 when deteriorating weather impacted the quality of data being collected. At this point 11 stations had been completed, bringing the total to 85.

An SVP dip was collected at 09:45 followed by simultaneous multibeam and sidescan operations at Box D. The data quality was reviewed and deemed suitable despite the deteriorating weather conditions. The sidescan was set to highspeed mode as keeping the vessel speed below 4 knots was difficult.

Simultaneous multibeam and sidescan operations continued at Box D until midnight.

Wednesday 2 September: Multibeam and sidescan operations continued until 12:15 when the deteriorating weather reduced the quality of data being collected to an unacceptable level.

At this point a decision was made to transit to an inshore site to test the OppCam system (mounted on a pyramid frame). By 15:20 we had arrived at the site and began testing the OppCam with multiple different video settings at 120 m depth. Having completed multiple successful tests, we began transit to a nearby NatureScot contingency drop camera station at 22:00. Shortly after arriving at 22:45 it was clear that conditions were still not suitable for using the drop camera, so we started a transit back to a more sheltered location.

Thursday 3 September: The night shift continued to test the OppCam until 4:00, when transit began back to Pobie Bank Reef SAC.

By 06:45, the MRV *Scotia* had arrived at Box D and the sea conditions were suitable for working. An SVP dip was acquired before continuing the simultaneous sidescan and multibeam survey from where we had left it on the 02/09/2020. Initially lines were run in south to north orientation only, but as the weather continued to improvegood quality data was collected in both directions.

Sidescan and multibeam operations continued until midnight, at which point approximately two thirds of Box D had been completed.

Friday 4 September: We continued to collect multibeam and sidescan data until Box D was completed at 14:40 and then began the transit to Box E began. We arrived at 16:00 and collected an SVP followed immediately by the simultaneous multibeam and sidescan survey of Box E. By midnight most of Box E was completed.

Saturday 5 September: The multibeam and sidescan survey of Box E was completed at 01:00 and was followed by a single line of Box F heading south.

This line was finished at 06:40 and was followed by a transit to Box C to check if long liners were still operating in the area. There were no signs of fishing gear in the water so the multibeam and sidescan survey resumed at Box C at 08:30. Box C was completed at 17:30.

After completing Box C, the heading patch test was repeated (as previous attempts had failed to achieve the desired run lines over a sloping seabed). This was completed successfully at 18:45.

With limited time left on the survey site and weather conditions still unsuitable for using the drop camera, the decision was made to attempt some ground truthing stations in Box C using the OppCam deployed from the hanger deck.

This was successful and three groundtruthing stations were completed before we left the site at 21:00 to begin transit back to Aberdeen.

Sunday 6 September: We continued our transit to Aberdeen arriving at 17:00 and bringing 1220S to a close.

Monday 7 September: Vessel demobilisation and unloading.

4 Data acquired

Acoustic data were acquired to address monitoring objectives 1 and 3. Imagery data were acquired to address monitoring objectives 1, 2, and 3.

4.1 Acoustic surveys

Acoustic survey boxes were revised from those planned before the survey during the survey to reduce the survey box area outside the SAC boundary and the survey box area that overlapped previously surveyed areas. This was done to more efficiently cover the area of the site where data needed to be collected. Box B was split into Box B1 - B3 and Box D was split into D1 and D2 (Figure 4). The vertices of all revised survey boxes are provided in Table 5.

Sidescan (100% coverage) and multibeam (50% coverage) was acquired from all high priority acoustic survey boxes (A – E) at a 400 m line spacing. Additionally, at Box A 100% multibeam coverage was acquired from an area in the west of the box at a 200 m line spacing. A single sidescan and multibeam survey line was run along the length of Box F (Figure 4, Table 4).

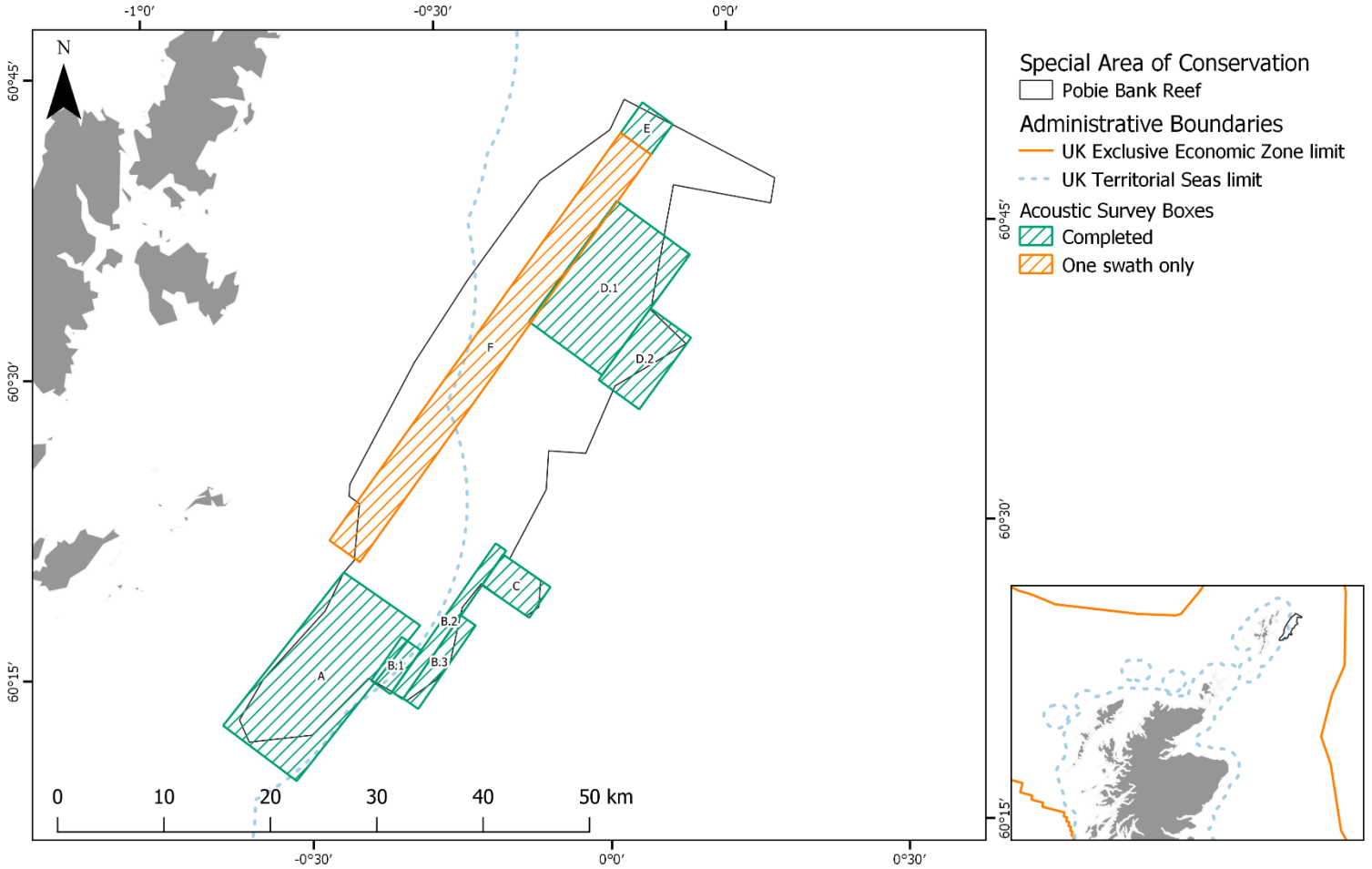

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Figure 4. 1220S survey boxes (A-F). All completed boxes were surveyed to acquire 100% sidescan coverage and at least 50% multibeam coverage, in some areas of Box A 100% multibeam coverage was achieved. One survey line was run in Box F from NE to SW.

Table 4. Summary of acoustic survey boxes at Pobie Bank Reef SAC.

Box	Priority	Box area Km^2	Status
A	High	160.5	Completed
B.1	High	11.0	Completed
B.2	High	20.4	Completed
B.3	High	16.2	Completed
C	High	18.9	Completed
D.1	High	119.0	Completed
D.2	High	39.0	Completed
E	High	12.3	Completed
F	Low	164.5	One swath only

4.2 Imagery samples

Of the 100 planned monitoring stations 85 were visited to collect drop camera samples (Figure 5, Table 6). There was not time to collect grab samples at any stations.

The Opportunistic Camera (OppCam) was tested in an inshore area of the Shetland Islands when weather at the site was not suitable for working, there were 13 test deployments in total. During the survey, five ground truthing stations (GT1 – GT5) were planned to better understand a seabed feature seen on acoustic data at Box C. The OppCam was used to visit three of these ground truthing stations (Figure 6, Table 7).

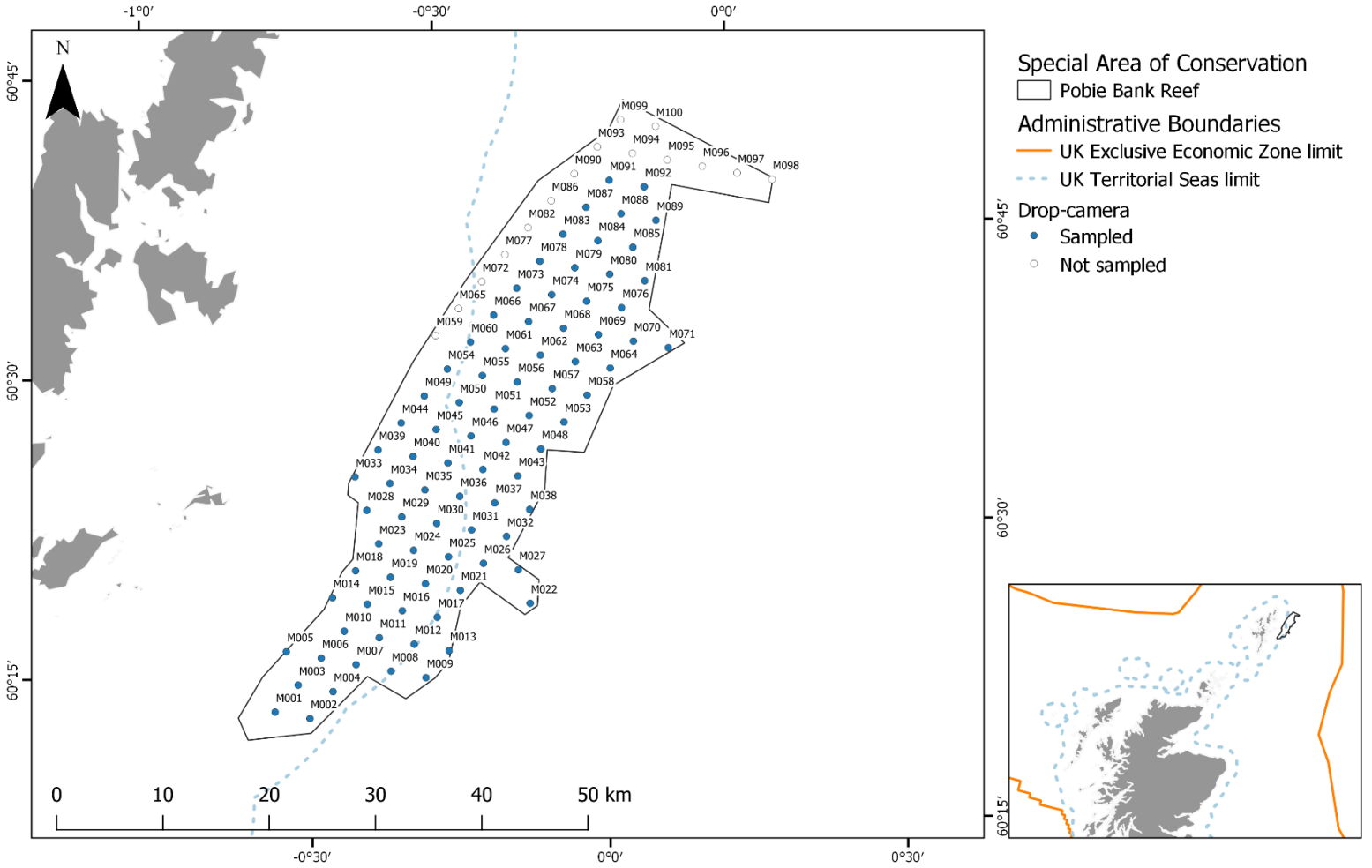

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Figure 5. Summary map showing all sampling stations visited with the drop-camera.

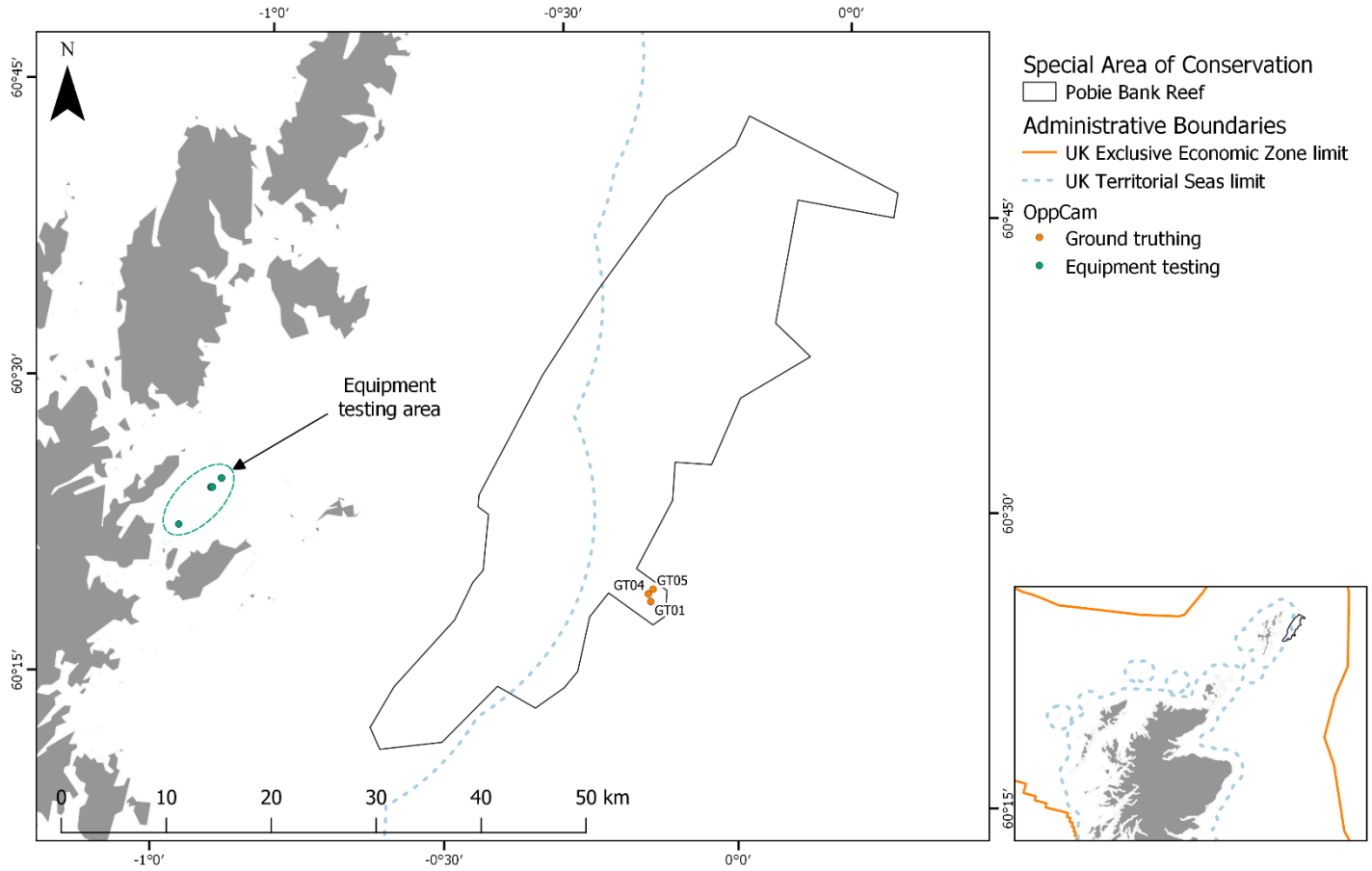

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Figure 6. Summary map showing all sampling stations visited with the OppCam, including the ground truthing stations and the equipment tests near Shetland.

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Annex 1. Glossary

Community	A general term applied to any grouping of populations of different organisms found living together in a particular environment; essentially the biotic component of an ecosystem. The organisms interact and give the community a structure (Allaby 2015).
Conservation Objective	The European Commission (2012) defines conservation objectives as 'the specification of the overall target for the species and/or habitat types for which a site is designated, in order for it to contribute to maintaining or reaching favourable conservation status / condition of the habitats and species concerned at the national, the bio-geographical or the European level'. Conservation objectives set out the broad ecological aims of a site.
EC Habitats Directive	The EC Habitats Directive (Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora) requires Member States to take measures to maintain natural habitats and wild species of European importance at, or restore them to, favourable conservation status.
Favourable Condition	When the ecological condition of a species or habitat is in line with the conservation objectives for that feature. The term 'favourable' encompasses a range of ecological conditions depending on the objectives for individual features.
Feature	A species, habitat, geological or geomorphological entity for which an MPA is identified and managed.
Joint Nature Conservation Committee (JNCC)	JNCC is the public body that advises the UK Government and devolved administrations on UK-wide and international nature conservation. JNCC has responsibility for nature conservation in the offshore marine environment, which begins at the edge of territorial waters and extends to the UK Continental Shelf (UKCS).
Marine Scotland Science (MSS)	Marine Scotland Science is the scientific division of the Marine Scotland Directorate. Its purpose is to provide expert scientific and technical advice on marine and freshwater fisheries, aquaculture, and the protection of the aquatic environment and its wildlife. This advice informs the policies and regulatory activities of the Scottish Government.
Special Area of Conservation	Protected site designated under the European Habitats Directive for species and habitats of European importance, as listed in Annex I and II of the Directive.

Annex 2. Survey equipment and sample processing

Multibeam echosounder bathymetry and backscatter

Multibeam bathymetry and backscatter data were acquired using the RESON Seabat 7125 dual frequency (200 or 400 KHz) multibeam system deployed to the drop keel of MRV *Scotia*. This was used to acquire bathymetry and backscatter data during the survey, set to 200 KHz with the drop keel lowered 7 m below the water surface (2 m below the MRV *Scotia's* hull).

Variations of sound velocity with water depth were determined using an SVP probe and applied during multibeam data acquisition.

Motion and time data were collected from an Applanix POSMV using POSPACK software.

Sidecan sonar

Sidecan sonar acoustic images were acquired using an EdgeTeck 4200 dual frequency (300/600 KHz) towfish and an EdgeTeck 701-DL topside unit.

Sidescan data was recorded using EdgeTeck Discovery 4200-MP software. Multiple equipment settings were tested before acquiring data. For data collection the sidescan system was set up in high-definition mode with a 230 m range on both the port and starboard side (460 m total swath width) using the low frequency setting (300 KHz). Both the high definition and high-speed mode were used during the survey, with the high-speed mode preferred when whether and tides made it difficult to achieve the target speed.

The towfish was towed at a target speed of 4 Knots and at a target altitude above the seabed proportional to 12.5 – 18.5% of the water depth (i.e. at 100 m, the towfish should be between 12.5 and 18.5 m above the seabed).

A High Precision Acoustic Positioning (HiPAP) transponder (see GPS positions and corrections section for more details) was attached to the winch cable directly above the towfish (Figure 7).

Figure 7. Sidescan towfish and HiPAP transponder

Camera (drop frame) sampling

The drop frame used for 1220S is shown in Figure 8.

Figure 8. Drop frame with video and still imaging system.

The stills camera fitted to the drop frame was a standard definition Kongsberg OE 14-408 digital camera (10MP) with dedicated flash unit for still images capture. The stills camera was mounted on the frame to provide a planar (downward facing) view of the seabed and was controlled topside with images (.CR2 and .JPG) recorded internally and downloaded twice daily.

The video footage was shot using a SubC 1 Alpha video camera. HD video was recorded internally and downloaded twice daily. The video camera was also mounted to provide a planar view of the seabed. SD video sent up the line and recorded on DVD as a back-up. The digital stream was captured by the surface PC and recorded direct to MP4 format video files.

Lighting was provided by four SeaLED lamps.

Laser scaling was provided by two red dot laser pointers (set to 120 mm spacing) and two green fan lasers (set to 860 mm spacing) (Figure 9).

The drop frame was also fitted with an altimeter, which recorded the altitude of the frame and GPS time. Additionally, a weight suspended 1 m below the stills camera lens was used as a guide for survey scientists to take images at a consistent altitude.

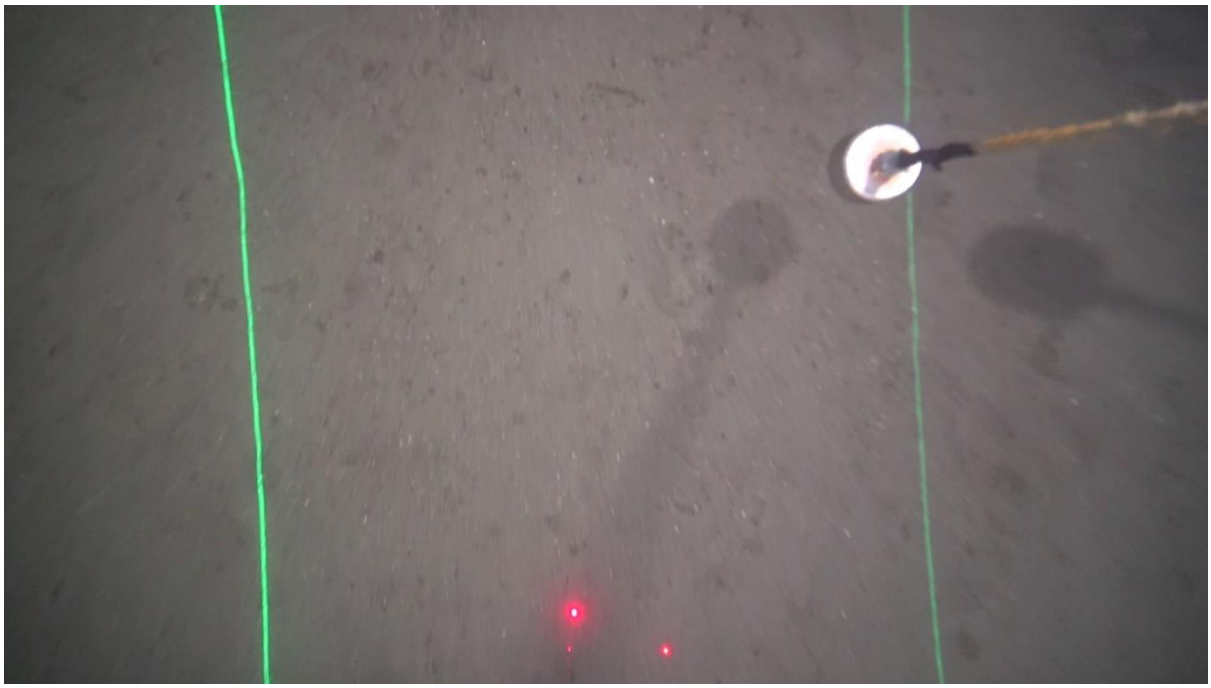

Figure 9. Laser scaling used on 1220S drop-frame. Red point lasers 120 mm spacing. Green line lasers 860 mm spacing.

A HiPAP transponder (see GPS positions and corrections section for more details) was attached to the frame to record its position.

A battery was mounted on the frame to provide additional power.

Field notes were made during each camera deployment, noting station and sample metadata, brief descriptions of substrate, and an assessment of whether the station is suitable for grab sampling.

During drop camera deployments, the vessel executed a controlled drift at a target speed of 0.3 knots through the specified station. The plan had been to collect 150 m video transects; however, this was changed to 10 minute transects at the beginning of the survey. This decision was made as it was easier for a single survey scientist to monitor time rather than distance, along with the rest of the data collection. Stills were captured as frequently as possible during the transect, whenever the following criteria were met:

1. The seabed is clearly visible (no sediment plumes)
2. The camera is at the correct altitude (1 m above the seabed) and in focus
3. The flash has had an opportunity to charge (this will be tested on the first camera deployment but is expected to be 15 – 20 seconds)
4. The camera's field of view has changed since the last image (to avoid pseudoreplication)

Opportunistic Camera (pyramid frame) sampling

The Opportunistic Camera (OppCam) consists of a GitUp action camera in a GroupBinc Scout underwater housing and two Nautilux wide angle lamps in GroupBinc general purpose housings. This system was mounted on a pyramid frame (Figure 10). The pyramid frame was deployed to 1 m above the seabed and held there for 1 minute. Multiple video and still settings were tested during 1220S as a contingency activity.

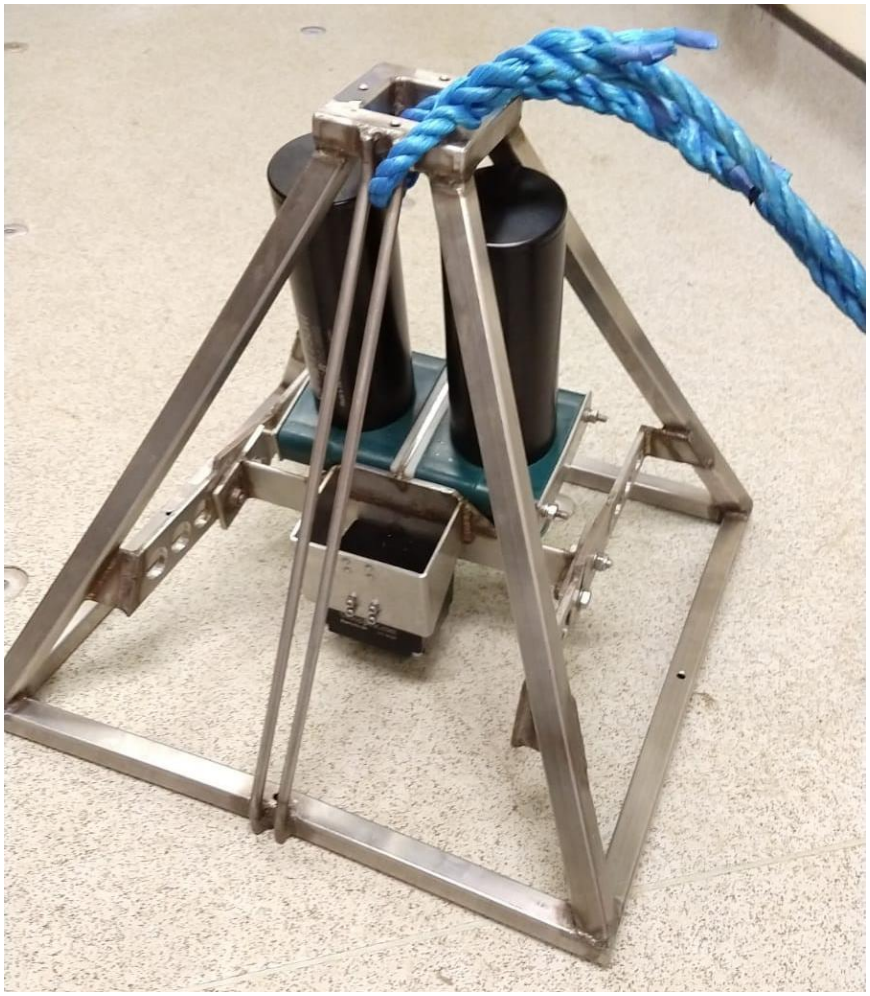

Figure 10. Pyramid frame with two lamp housings and camera housing.

GPS positions and corrections

GPS fixes were recorded using the MRV *Scotia's* data management system, and a backup of each camera tows position was made using ArcGIS. These systems recorded the Lat/Long position of the ships GPS antenna.

Two Kongsberg cNODE miniS model 34 High Precision Acoustic Positioning (HiPAP) transponders were available to mount on equipment during 1220S. One was a 180º omnidirectional and the other a 40º vertical beam transponder. The position of these transponders under water was recorded based on offsets from the ships GPS antenna.

MRV *Scotia*

Full details of the MRV *Scotia* can be found on the MSS website: https://www.gov.scot/publications/marine-science-research-vessels-and-technology/

Annex 3. Survey metadata

Survey box metadata

Table 5. Vertex coordinates (decimal degrees) of the acoustic survey boxes sampled at Pobie Bank Reef SAC during 1220S.

Survey Box	Vertex order	Latitude	Longitude
A	0	60.20047	-0.54335
A	1	60.23749	-0.680475
A	2	60.380182	-0.515823
A	3	60.345265	-0.374179
A	4	60.20047	-0.54335
B.1	0	60.333422	-0.402599
B.1	1	60.32458	-0.366986
B.1	2	60.284447	-0.40748
B.1	3	60.293278	-0.443061
B.1	4	60.333422	-0.402599
B.2	0	60.422808	-0.266863
B.2	1	60.417966	-0.247403
B.2	2	60.281593	-0.38559
B.2	3	60.286415	-0.40499
B.2	4	60.422808	-0.266863
B.3	0	60.351902	-0.280832
B.3	1	60.275472	-0.357077
B.3	2	60.28223	-0.384629
B.3	3	60.358675	-0.308432
B.3	4	60.351902	-0.280832
C	0	60.392901	-0.164011
C	1	60.364774	-0.19228
C	2	60.386329	-0.279965
C	3	60.414474	-0.251752
C	4	60.392901	-0.164011
D.1	0	60.722604	-0.144507
D.1	1	60.686638	-0.007225
D.1	2	60.575826	-0.127841
D.1	3	60.611666	-0.264792
D.1	4	60.722604	-0.144507
D.2	0	60.571324	-0.132135
D.2	1	60.637201	-0.061374
D.2	2	60.61746	0.01451
D.2	3	60.551624	-0.05636
D.2	4	60.571324	-0.132135
E	0	60.793271	-0.067571
E	1	60.765418	-0.097284
E	2	60.779928	-0.154255
E	3	60.807794	-0.124578
E	4	60.793271	-0.067571
F	0	60.779865	-0.154432
F	1	60.765355	-0.09746
F	2	60.390661	-0.491469
F	3	60.405002	-0.547968
F	4	60.779865	-0.154432

Station metadata

Table 6. Drop camera samples taken at Pobie Bank Reef SAC on 1220S. Failed attempts not included. SOL = Start of Line, EOL = End of Line. Latitude and longitude recorded from ship's GPS.

Sample ID	SOL Date Time	SOL Latitude	SOL Longitude	EOL Date Time	EOL Latitude	EOL Longitude
1220S_PBR_M001_S001_A1	23/08/2020 23:13	60.254013	-0.591077	23/08/2020 23:21	60.253843	-0.594107
1220S_PBR_M002_S002_A1	23/08/2020 23:54	60.252697	-0.529525	24/08/2020 23:59	60.252710	-0.531615
1220S_PBR_M003_S003_A1	24/08/2020 00:37	60.278968	-0.560442	24/08/2020 00:45	60.279497	-0.563322
1220S_PBR_M004_S004_A1	24/08/2020 01:19	60.277193	-0.499658	24/08/2020 01:28	60.277883	-0.502983
1220S_PBR_M005_S005_A1	24/08/2020 02:10	60.304508	-0.590587	24/08/2020 02:19	60.306278	-0.591348
1220S_PBR_M006_S006_A1	24/08/2020 02:55	60.303628	-0.530080	24/08/2020 03:06	60.305578	-0.530667
1220S_PBR_M007_S007_A1	24/08/2020 03:53	60.301997	-0.468990	24/08/2020 04:03	60.303942	-0.469672
1220S_PBR_M008_S008_A1	24/08/2020 04:45	60.301898	-0.408937	24/08/2020 04:55	60.303730	-0.410598
1220S_PBR_M009_S009_A1	24/08/2020 05:35	60.300287	-0.348062	24/08/2020 05:44	60.302097	-0.349917
1220S_PBR_M010_S010_A1	24/08/2020 06:47	60.329342	-0.497047	24/08/2020 06:57	60.330977	-0.499367
1220S_PBR_M011_S011_A1	24/08/2020 07:36	60.328585	-0.434973	24/08/2020 07:46	60.329840	-0.437603
1220S_PBR_M012_S012_A1	24/08/2020 08:23	60.326398	-0.374873	24/08/2020 08:33	60.328028	-0.376878
1220S_PBR_M013_S013_A1	24/08/2020 09:15	60.326360	-0.317093	24/08/2020 09:25	60.324577	-0.318693
1220S_PBR_M014_S014_A1	24/08/2020 12:47	60.356710	-0.527563	24/08/2020 12:57	60.356963	-0.531545
1220S_PBR_M015_S015_A1	24/08/2020 13:34	60.355773	-0.463390	24/08/2020 13:45	60.355363	-0.467443
1220S_PBR_M016_S016_A1	24/08/2020 14:20	60.353337	-0.405090	24/08/2020 14:29	60.355178	-0.405327
1220S_PBR_M017_S017_A1	24/08/2020 15:06	60.352225	-0.345110	24/08/2020 15:16	60.354073	-0.345855
1220S_PBR_M018_S018_A1	24/08/2020 16:03	60.380348	-0.493580	24/08/2020 16:13	60.382440	-0.492083
1220S_PBR_M019_S019_A1	24/08/2020 17:38	60.379302	-0.432900	24/08/2020 17:48	60.381705	-0.433562
1220S_PBR_M020_S020_A1	24/08/2020 18:23	60.379423	-0.369652	24/08/2020 18:33	60.379848	-0.374043
1220S_PBR_M021_S021_A1	24/08/2020 19:09	60.378520	-0.310343	24/08/2020 19:20	60.378392	-0.314547
1220S_PBR_M022_S022_A1	24/08/2020 20:14	60.375648	-0.189557	24/08/2020 20:24	60.376175	-0.193425

Sample ID	SOL Date Time	SOL Latitude	SOL Longitude	EOL Date Time	EOL Latitude	EOL Longitude
1220S_PBR_M027_S023_A1	24/08/2020 21:00	60.402780	-0.217197	24/08/2020 21:10	60.402257	-0.220992
1220S_PBR_M026_S024_A1	24/08/2020 23:43	60.403663	-0.278157	24/08/2020 23:53	60.403773	-0.282372
1220S_PBR_M025_S025_A1	25/08/2020 00:29	60.404522	-0.338388	25/08/2020 00:38	60.405173	-0.341737
1220S_PBR_M024_S026_A1	25/08/2020 01:11	60.405332	-0.400095	25/08/2020 01:20	60.406625	-0.402405
1220S_PBR_M023_S027_A1	25/08/2020 02:42	60.405793	-0.461460	25/08/2020 02:52	60.407558	-0.462088
1220S_PBR_M028_S028_A1	25/08/2020 03:31	60.432257	-0.489622	25/08/2020 03:40	60.434073	-0.490123
1220S_PBR_M029_S029_A1	25/08/2020 04:17	60.431557	-0.428863	25/08/2020 04:28	60.433512	-0.429842
1220S_PBR_M030_S030_A1	25/08/2020 05:06	60.430438	-0.368682	25/08/2020 05:16	60.432302	-0.368825
1220S_PBR_M031_S031_A1	25/08/2020 06:24	60.428827	-0.307295	25/08/2020 06:34	60.430613	-0.308477
1220S_PBR_M032_S032_A1	25/08/2020 07:14	60.427682	-0.247952	25/08/2020 07:24	60.429535	-0.247942
1220S_PBR_M033_S033_A1	25/08/2020 12:27	60.460707	-0.518163	25/08/2020 12:37	60.459098	-0.520743
1220S_PBR_M034_S034_A1	25/08/2020 13:23	60.457825	-0.459393	25/08/2020 13:33	60.459722	-0.457748
1220S_PBR_M035_S035_A1	25/08/2020 14:07	60.456568	-0.397367	25/08/2020 14:17	60.458548	-0.397148
1220S_PRR_M036_S036_A1	25/08/2020 15:13	60.454643	-0.336842	25/08/2020 15:23	60.456605	-0.336280
1220S_PBR_M037_S037_A1	25/08/2020 16:02	60.454695	-0.276812	25/08/2020 16:12	60.456337	-0.274700
1220S_PBR_M038_S038_A1	25/08/2020 17:17	60.453553	-0.216310	25/08/2020 17:28	60.455112	-0.213838
1220S_PBR_M043_S039_A1	25/08/2020 18:08	60.479920	-0.245600	25/08/2020 18:19	60.481230	-0.242315
1220S_PBR_M042_S040_A1	25/08/2020 18:55	60.481377	-0.307602	25/08/2020 19:05	60.482163	-0.303903
1220S_PBR_M041_S041_A1	25/08/2020 19:45	60.482507	-0.367142	25/08/2020 19:55	60.483655	-0.363810
1220S_PBR_M040_S042_A1	25/08/2020 20:35	60.483620	-0.427682	25/08/2020 20:45	60.485120	-0.424955
1220S_PBR_M062_S043_A1	25/08/2020 23:33	60.583563	-0.235523	25/08/2020 23:43	60.585383	-0.233703
1220S_PBR_M063_S044_A1	26/08/2020 00:18	60.582112	-0.175125	26/08/2020 00:28	60.583915	-0.173280
1220S_PBR_M064_S045_A1	26/08/2020 01:09	60.581400	-0.113352	26/08/2020 01:19	60.583242	-0.111940
1220S_PBR_M069_S046_A1	26/08/2020 01:55	60.608065	-0.141238	26/08/2020 02:05	60.609898	-0.139440

Sample ID	SOL Date Time	SOL Latitude	SOL Longitude	EOL Date Time	EOL Latitude	EOL Longitude
1220S_PBR_M068_S047_A1	26/08/2020 02:40	60.608410	-0.201815	26/08/2020 02:49	60.610192	-0.201585
1220S_PBR_M067_S048_A1	26/08/2020 03:27	60.610010	-0.261908	26/08/2020 03:36	60.611747	-0.262850
1220S_PBR_M074_S049_A1	26/08/2020 04:09	60.635208	-0.229343	26/08/2020 04:20	60.636567	-0.229775
1220S_PBR_M075_S050_A1	26/08/2020 04:55	60.634343	-0.168453	26/08/2020 05:06	60.636348	-0.169288
1220S_PBR_M076_S051_A1	26/08/2020 05:36	60.632672	-0.107778	26/08/2020 05:46	60.634645	-0.107982
1220S_PBR_M070_S052_A1	26/08/2020 06:55	60.607320	-0.079768	26/08/2020 07:05	60.609285	-0.080128
1220S_PBR_M071_S053_A1	26/08/2020 07:45	60.604778	-0.018573	26/08/2020 07:56	60.606827	-0.019190
1220S_PBR_M081_S054_A1	26/08/2020 08:51	60.658415	-0.075205	26/08/2020 09:02	60.660288	-0.076577
1220S_PBR_M039_S055_A1	26/08/2020 23:29	60.484675	-0.486298	26/08/2020 23:38	60.486522	-0.485857
1220S_PBR_M044_S056_A1	27/08/2020 00:16	60.509613	-0.453205	27/08/2020 00:25	60.511382	-0.453888
1220S_PBR_M045_S057_A1	27/08/2020 00:56	60.508770	-0.392675	27/08/2020 01:06	60.510633	-0.392980
1220S_PBR_M046_S058_A1	27/08/2020 01:36	60.507227	-0.332178	27/08/2020 01:46	60.509065	-0.332548
1220S_PRB_M047_S059_A1	27/08/2020 02:24	60.506760	-0.271640	27/08/2020 02:33	60.508662	-0.271377
1220S_PBR_M048_S060_A1	27/08/2020 03:05	60.504947	-0.210705	27/08/2020 03:14	60.506777	-0.210835
1220S_PBR_M053_S061_A1	27/08/2020 03:53	60.529868	-0.177875	27/08/2020 04:03	60.531758	-0.177873
1220S_PBR_M052_S062_A1	27/08/2020 04:32	60.531585	-0.239140	27/08/2020 04:42	60.533452	-0.238597
1220S_PBR_M051_S063_A1	27/08/2020 05:14	60.532852	-0.299792	27/08/2020 05:24	60.534680	-0.299228
1220S_PBR_M050_S064_A1	27/08/2020 05:50	60.534205	-0.359433	27/08/2020 06:01	60.536108	-0.361087
1220S_PBR_M049_S065_A1	27/08/2020 07:00	60.534932	-0.422730	27/08/2020 07:10	60.536552	-0.420925
1220S_PBR_M054_S066_A1	27/08/2020 07:48	60.560018	-0.390327	27/08/2020 07:58	60.561650	-0.388040
1220S_PBR_M055_S067_A1	27/08/2020 08:29	60.559848	-0.329827	27/08/2020 08:39	60.561037	-0.326507
1220S_PBR_M058_S068_A1	31/08/2020 16:07	60.558935	-0.145015	31/08/2020 16:17	60.556982	-0.145367
1220S_PBR_M057_S069_A1	31/08/2020 17:11	60.559687	-0.205893	31/08/2020 17:24	60.557097	-0.206358
1220S_PBR_M056_S070_A1	31/08/2020 17:57	60.561198	-0.265832	31/08/2020 18:07	60.559323	-0.267080

Sample ID	SOL Date Time	SOL Latitude	SOL Longitude	EOL Date Time	EOL Latitude	EOL Longitude
1220S_PBR_M061_S071_A1	31/08/2020 18:43	60.587507	-0.294280	31/08/2020 18:53	60.585572	-0.295413
1220S_PBR_M060_S072_A1	31/08/2020 19:32	60.588032	-0.355883	31/08/2020 19:43	60.585943	-0.355485
1220S_PBR_M066_S073_A1	31/08/2020 20:33	60.613007	-0.322367	31/08/2020 20:43	60.611085	-0.323520
1220S_PBR_M073_S074_A1	31/08/2020 21:28	60.638908	-0.290978	31/08/2020 21:40	60.636925	-0.292625
1220S_PBR_M078_S075_A1	01/09/2020 00:02	60.663733	-0.258097	01/09/2020 00:12	60.661908	-0.257898
1220S_PBR_M079_S076_A1	01/09/2020 00:46	60.663658	-0.197017	01/09/2020 00:55	60.661915	-0.196993
1220S_PBR_M080_S077_A1	01/09/2020 01:28	60.661918	-0.137000	01/09/2020 01:38	60.659970	-0.136668
1220S_PBR_M085_S078_A1	01/09/2020 02:09	60.687773	-0.103293	01/09/2020 02:19	60.685910	-0.103113
1220S_PBR_M084_S079_A1	01/09/2020 02:49	60.689023	-0.164197	01/09/2020 02:59	60.686935	-0.164305
1220S_PBR_M083_S080_A1	01/09/2020 03:37	60.690262	-0.224542	01/09/2020 03:46	60.688482	-0.225310
1220S_PBR_M087_S081_A1	01/09/2020 04:25	60.715362	-0.192347	01/09/2020 04:34	60.713568	-0.192600
1220S_PBR_M088_S082_A1	01/09/2020 05:02	60.714240	-0.130283	01/09/2020 05:12	60.712300	-0.131342
1220S_PBR_M089_S083_A1	01/09/2020 05:45	60.713520	-0.069720	01/09/2020 05:55	60.711372	-0.070147
1220S_PBR_M092_S084_A1	01/09/2020 06:37	60.739505	-0.097057	01/09/2020 06:47	60.737740	-0.098653
1220S_PBR_M091_S085_A1	01/09/2020 07:20	60.739953	-0.159715	01/09/2020 07:30	60.738028	-0.160663

Table 7. OppCam ground truthing stations sampled at Pobie Bank Reef SAC on 1220S.

Station ID	Date Time	Latitude	Longitude
1220S_PBR_GT01_S095	05/09/2020 20:55	60.396193	-0.206120
1220S_PBR_GT04_S096	05/09/2020 20:28	60.391632	-0.213208
1220S_PBR_GT05_S097	05/09/2020 19:46	60.385447	-0.207197

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