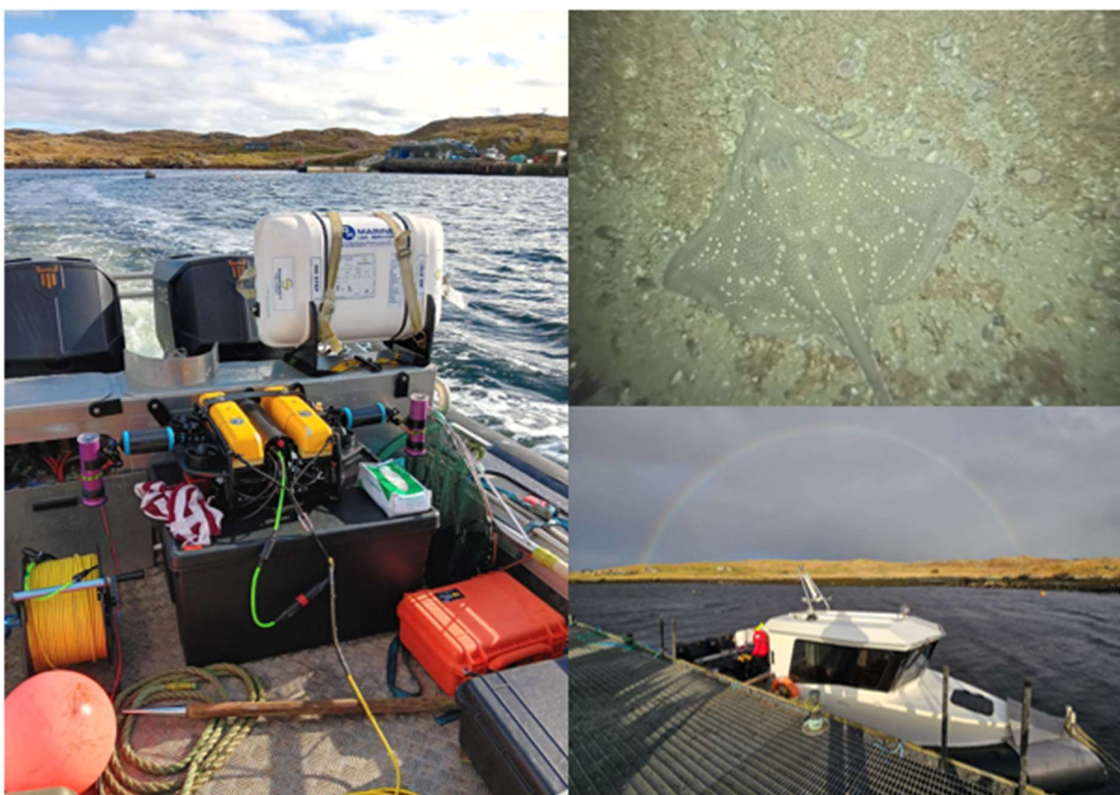


TRITONIA SCIENTIFIC LTD., REPORT No: SSF-105154_1

Survey and analysis report: Fish Holm, Shetland Isles, March 2025.



Prepared for Scottish Sea Farms Ltd. [REDACTED]

[REDACTED] Tritonia, May 2025

REPORT No: SSF-099741

Survey and analysis report: Fish Holm, Shetland Isles, March 2025.

Prepared for Scottish Sea Farms Ltd. [REDACTED]

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Prepared: May 2025

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Background & context

In February 2024, Tritonia carried out a baseline survey for Scottish Sea Farms Ltd (SSF), to fulfil SEPA requirements for a proposed Atlantic salmon fish farm site at Fish Holm, in the Setterness region of NE Mainland Shetland. The survey report noted the presence of horse mussels (*Modiolus modiolus*) at the northern end of the surveyed area, and SEPA and NatureScot subsequently requested the collection of some additional data in this area.

Aims

- The specific aim of the survey was to collect the additional data specified by SSF, comprising three short ROV transects (1 x 150m, 2 x 35m), five 'high priority' spot check dive locations and an additional three 'low priority' spot check locations. For each spot check, the ROV was to be deployed for a maximum of 5-10 metres to establish whether or not horse mussels were present.
- The analytical aims were to establish from the collected data the presence/absence of live horse mussels and/or their empty shells, and to provide an estimate of mussel/shell coverage (% seabed area) and live mussel density (number/m²) for each target area, allowing an assessment to be made of whether any horse mussel bed constituting Priority Marine Feature (PMF) habitat was present.

Survey design

The survey design was produced by SSF following discussion with SEPA and NatureScot, based on the data previously gathered and described in the baseline survey report SSF-077075. Locations of the proposed transects and spot check dives are shown in Figure 1, and co-ordinates are detailed in Table 1.

The survey was carried out on the 13th and 14th March 2025, delayed by a day due to strong (F5-6) winds on the 12th. These decreased to a fairly constant F4 on both survey days, but with strong and increasing tidal currents which presented some challenges in the control and positioning of the ROV.

Actual ROV transects and orthomosaic tracks are shown in Figure 2.

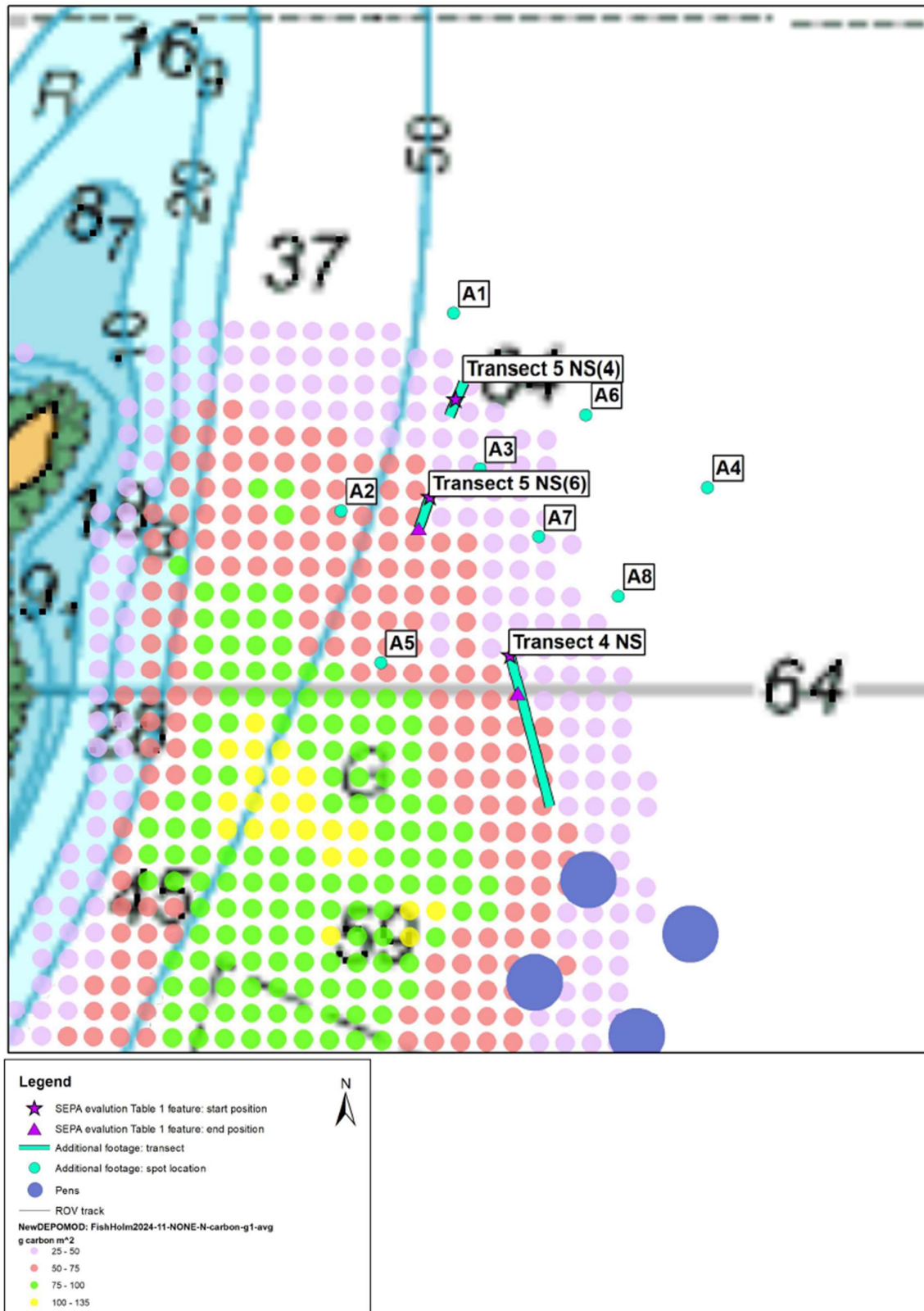


Figure 1 (from SSF). Additional data requested for Fish Holm in March 2025, comprising one long transect (150m), two short transects (35m) and eight spot locations (A1-A8).

Table 1 (from SSF). Proposed ROV transect details

ID	Description	Type	startLatDDM	startLongDDM	endLatDDM	endLongDDM	Transect Length (m)	Transect Bearing (degG)
Transect 4 NS	Aligned with the near-bed major axis, ending at original Transect 4 NS "patchy horse mussel beds"	Transect (partial re-fly)	60°26.942'N	01°07.310'W	60°27.020'N	01°07.350'W	150	345
Transect 5 NS(4)	Transect 5 NS "horse mussel bed". Short transect defined with the SEPA coordinate in the centre.	Transect (re-fly)	60°27.160'N	01°07.398'W	60°27.143'N	01°07.413'W	35	203
Transect 5 NS(6)	Transect 5 NS "patchy horse mussel bed". Transect as per SEPA coordinates.	Transect (re-fly)	60°27.102'N	01°07.433'W	60°27.085'N	01°07.445'W	33	198
A1	Original planned benthic sampling station A1	Spot (orbit)	60°27.196'N	01°07.409'W				
A2	Original planned benthic sampling station A2	Spot (orbit)	60°27.094'N	01°07.526'W				
A3	Original planned benthic sampling station A3	Spot (orbit)	60°27.116'N	01°07.381'W				
A4	Original planned benthic sampling station A4	Spot (orbit)	60°27.106'N	01°07.145'W				
A5	Additional spot location on Transect 5 (instead of A5 which is near Transect 4 NS above)	Spot (orbit)	60°27.016'N	01°07.484'W				
A6	Additional spot location between A1 and A4	Spot (orbit)	60°27.143'N	01°07.271'W				
A7	Additional spot location SE of A3	Spot (orbit)	60°27.081'N	01°07.320'W				
A8	Additional spot location between A4 and Transect 4 NS	Spot (orbit)	60°27.050'N	01°07.237'W				

Note: green shading denotes priority transects & stations, orange are stations to be surveyed only if time permits

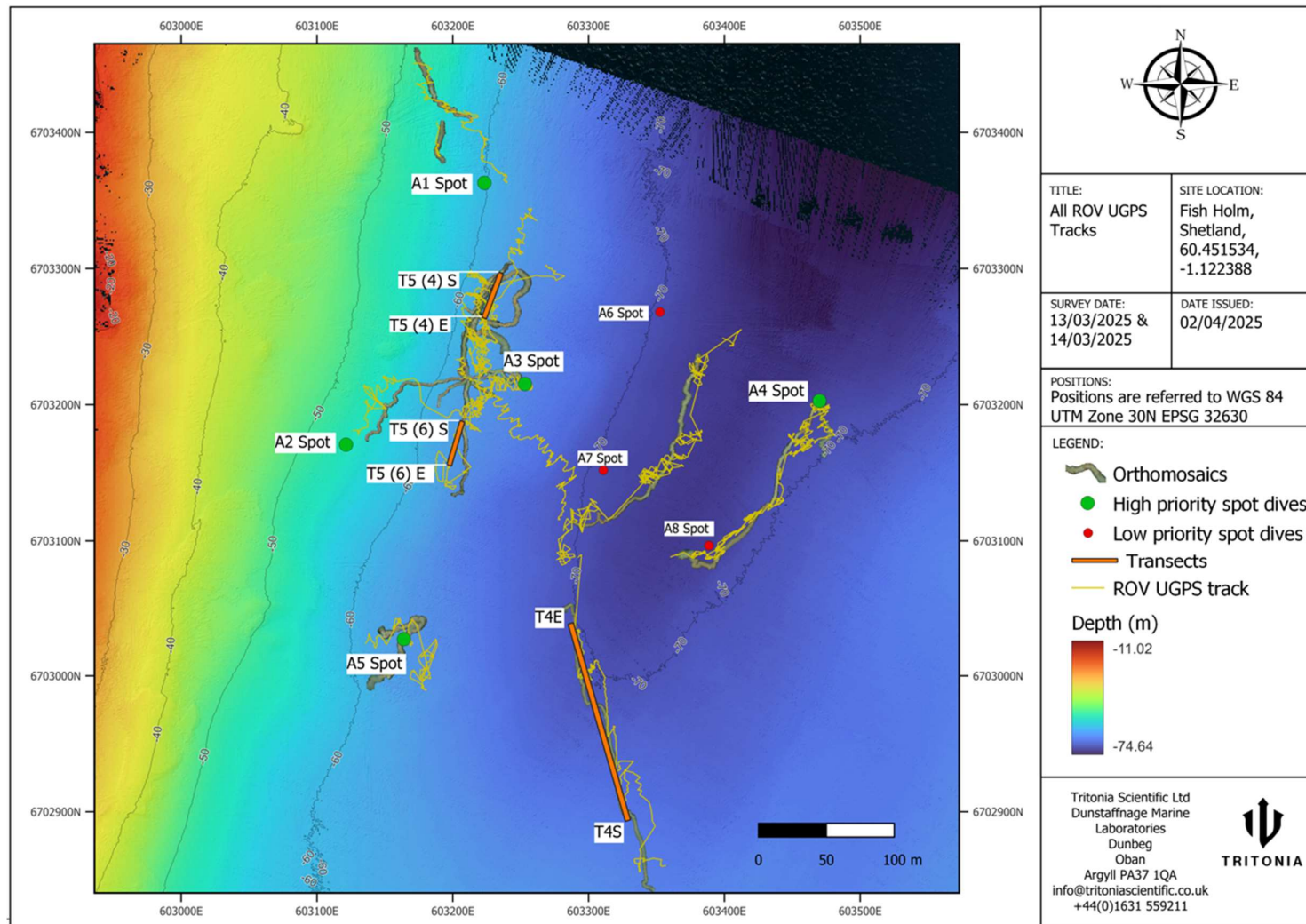


Figure 2: Map displaying the smoothed and cleaned calculated position track of the ROV and resulting photogrammetry orthomosaics, derived from downward facing GoPro imagery.

Methodology- ROV Videography

ROV visual survey transects and plots were run on the 12th and 13th March 2025. A total of 1739m of georeferenced seabed video footage and still (GoPro) images were collected, and used to derive 1489m of seabed orthomosaics (the remainder of the footage was unsuitable for orthomosaic building, due to significant motion across the brittlestar beds).

Georeferenced Video Transects

A BlueROV2™ Heavy Configuration was used to record georeferenced video transects. The ROV foundation comprised an 8 thruster configuration, low-light navigation HD camera, dimmable Lumen Subsea™ lights (4 x 1500 lumens), Pressure Sensor (BlueRobotics™ Bar30) and 6-axis IMU sensors.

Navigation System

The ROV utilised a Short Base Line (SBL) acoustic positioning system, which consisted of a WaterLinked G2™ Topside unit adapted with a heading sensor and Furuno SCX-20 Satellite Compass (NMEA 2000) GPS antenna. A WaterLinked™ Antenna fitted with four D1 acoustic receivers was side mounted at 1m below the waterline, and an A1 locator integrated and mounted on the starboard side of the ROV (but see Appendix 1: Technical notes regarding A1_redo). The system triangulated and calculated the position of the locator based on the acoustic signals received, combined with global coordinates and data from the pressure sensor, achieving accurate geolocation of the ROV.

A Doppler Velocity Log (DVL), WaterLinked™ DVL A50 was integrated into the ROV system, enhancing position-keeping, stabilisation, and velocity computation. This augmented the navigation system and enabled semi-autonomous missions and achieved precise geolocated transects.

Telemetry data was continuously recorded throughout the dive, facilitating precise spatial referencing for the videos and still imagery, thereby enhancing the production of data visualisation.

Video and Imagery Collection

The still images (27.13MP) used for the photogrammetry plots were recorded using two GoPro® HERO 12 cameras, and the video transects with a DeepWater explorerHD™ 3.0 camera for high-definition live streaming and recording. The BlueROV2™ was equipped with 4 x 1500 lumens internal, dimmable lights, and two supplementary external lights (up to 18000 lumens each) used in lower light conditions. Both the cameras and lights were positioned facing downwards for optimal illumination and image capture.

A note on data collection methodology

Previous survey work in the Fish Holm area (Feb 2024) had noted the presence of horse mussels around and in gaps between areas of brittlestar bed, and it was speculated that horse mussel bed (PMF) habitat might potentially underlie the brittlestars in places. During the 2025 campaign, efforts were made to investigate this further by lowering the ROV closer to the seabed (Figure 3), and attempting to displace the brittlestars by abrupt upward acceleration of the ROV. However, while there was some brief displacement, the brittlestars settled immediately back in place and it was not possible to ascertain what was underneath them.

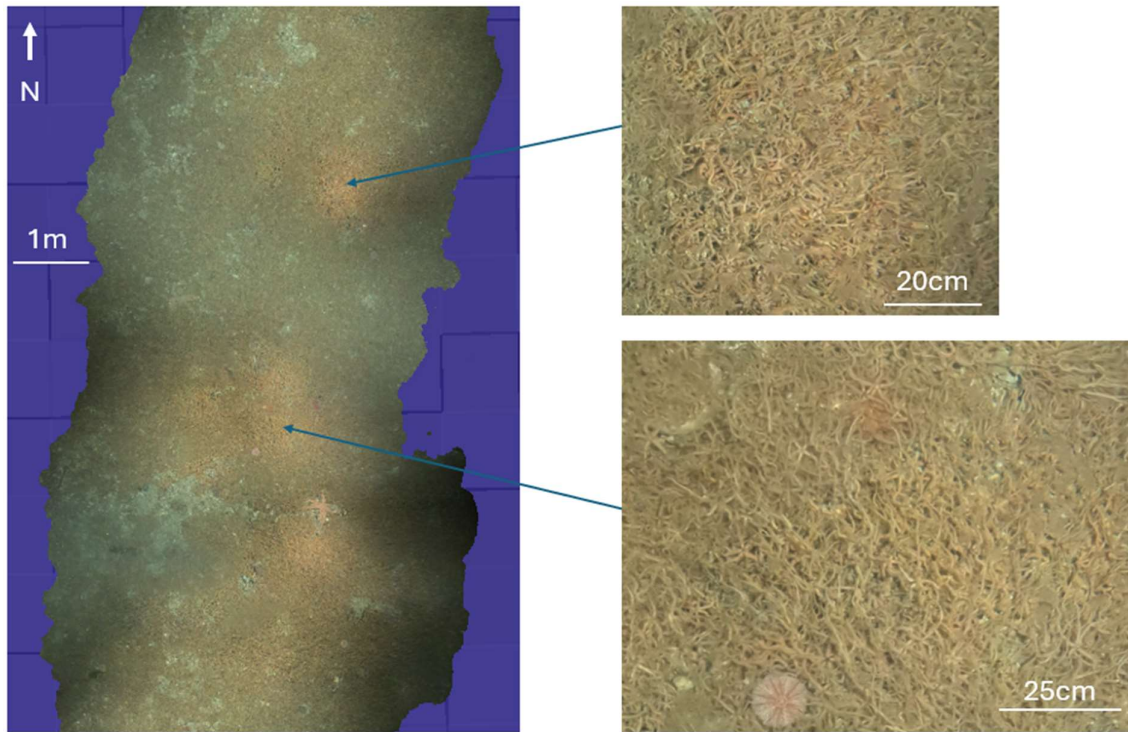


Figure 3: Section of orthomosaic from near spot check location A7. Height of ROV above the seabed was approximately 1m, reducing to 0.2m in the brighter patches. Close inspection of these areas failed to reveal what was underlying the brittlestar bed.

Methodology – Data analysis

Analysis was carried out through examination of the orthomosaics in QGIS, and focused on the target transects and spot check locations identified in Figures 1 and 2. The procedure was as follows.

Boundaries were drawn at either end of the orthomosaic correlating approximately to the target start and end points (Table 1), or nearest available point where the actual ROV line differed from the target. For the spot check locations, the polygon function in QGIS was used to delineate an area of approximately 25m² as close as possible to the target coordinate, and boundaries drawn to enclose this area.

The area between the boundaries was closely and methodically examined, working from one end of the section to the other and moving the field of view back and forth across the transect to ensure the whole section was viewed.

Notes were made of the observed substrate and any fauna present, with a specific focus on the presence/absence of horse mussels (*Modiolus modiolus*) and their shells. Live or possibly live mussels were marked with a red dot, and their density calculated by dividing the total number counted by the transect/spot check area in m², excluding any areas obscured by brittlestar bed. Empty shells were generally too abundant to be enumerated in this way, and were instead quantified as percentage shell cover per m² of seabed, again excluding brittlestar bed. The process was to distribute sample squares over a minimum of 5% of the exposed areas of seabed within each transect/spot check area, using an appropriate number and size of squares. The polygon function was then used to draw around any horse mussels/shells within each square, and the total area of horse mussel coverage within each square was recorded and an average calculated. Distribution of squares was not completely random as they had to be positioned around the brittlestar bed, but care was taken to ensure the locations were broadly representative of the transect/spot check area as a whole.

Following discussion with SSF, spot check locations A1 and A5 were discarded from the analysis as these had already been covered in the 2024 baseline survey report.

Results and interpretations

Transect 4 NS(6)

This section of orthomosaic runs approximately SSE-NNW for 150m, from 60.4490°N, -1.1217°E in the south to 60.4503°N, -1.1224°E in the north (Figure 4). Approximate depth is 68-70m. The substrate is muddy sand, with varying quantities of pebbles and bivalve shells/broken shells including razor clams (*Ensis ensis*), king/queen scallops (*Pecten maximus/Aequipecten opercularis*) and occasional horse mussels (*Modiolus modiolus*). Fauna is relatively sparse along the transect, with abundance tending to positively correlate with pebble/shell content. Scattered clumps of brittlestars are present, but there is no extensive bed formation. Brittlestars also occur individually and make up the majority of the observed fauna, along with other echinoderms including starfish, cushion and sun stars (*Asterina gibbosa*, *Crossaster papposus*) and edible urchins (*Echinus esculentus*). Some live bivalves including king and queen scallops are also present, although not always readily distinguishable from empty shells. A small number of possible live horse mussels were observed and are marked with red dots on Figure 4. Occasional hermit crabs were also observed.

Horse mussel density: 0.01 live/m²

Horse mussel/shell coverage: 0.3%

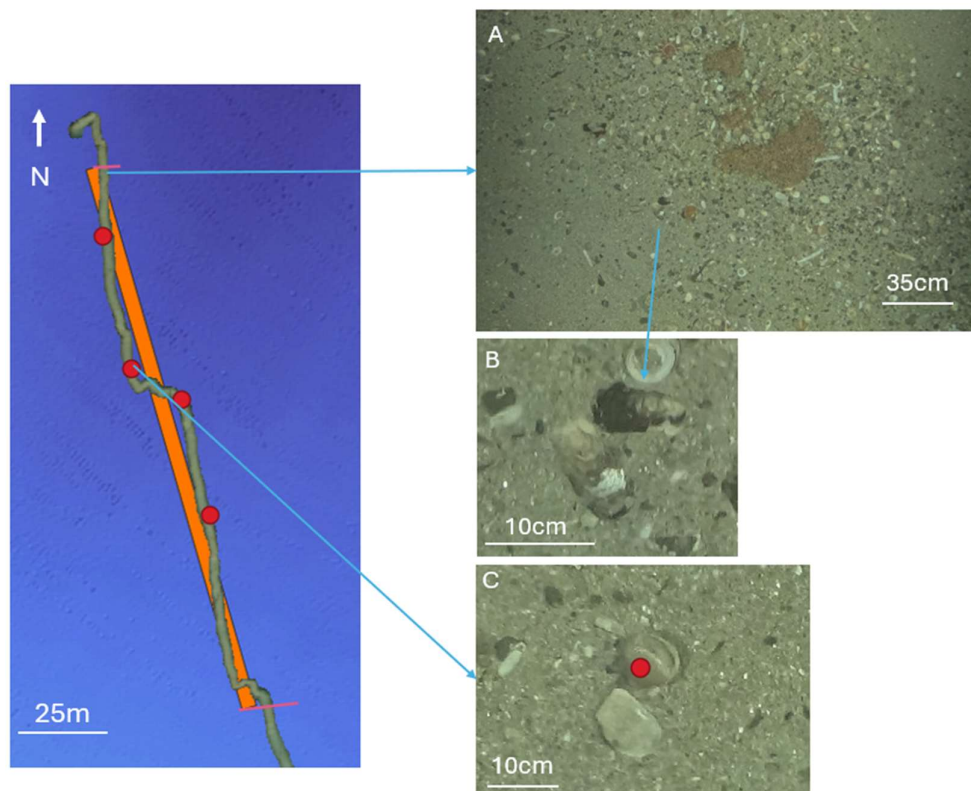


Figure 4: Transect 4 NS, comprising muddy sand with shelly/pebbly patches. A: brittlestar cluster over a shelly/pebbly substrate including B: horse mussel shells. C: Possible live horse mussel.

Transect 5 NS(4)

This section of orthomosaic (Figure 5) runs approximately SSW-NNE for 33m, from 60.4524°N, -1.1236°E in the south to 60.4526°N, -1.1233°E in the north. Approximate depth is 65m. Patchy brittlestar bed covers much of the area (approximately 61%). The remaining substrate is muddy sand with bivalve shells and pebbles, including horse mussel (*M. modiolus*) shells, many of which are worn and/or broken. These are especially abundant at the south end of the transect. Where the cover is thin or absent, bivalve shells including horse mussel are visible, as well as some live king and queen scallops (*P. maximus*, *A. opercularis*). No live horse mussels could be positively identified. Edible urchins (*E. esculentus*), sun stars (*C. papposus*) and anemones occur relatively infrequently, in association with the areas of brittlestar bed.

Horse mussel density: N/A – live individuals not observed.

Horse mussel/shell coverage: 10%

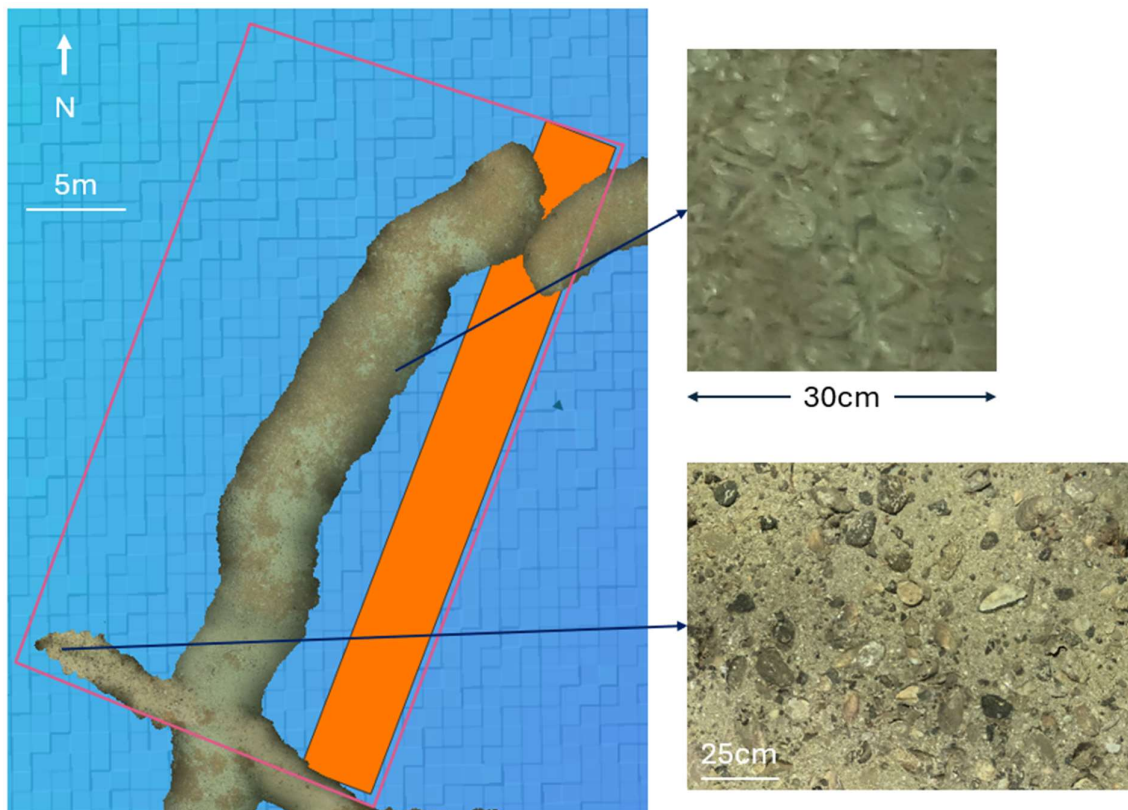


Figure 5: Transect 5 NS(4), comprising muddy sand with shelly/pebbly patches and brittlestar bed. Horse mussel shells are visible beneath the brittlestars in places (above right) and in exposed areas (below right).

Transect 5 NS(6)

This section of transect runs from 60.4514°N, -1.1238°E in the south to 60.4516°N, -1.1238°E in the north (34 m). Approximate depth is 56m. Brittlestar bed covers approximately 64% of the area, with the remainder comprising muddy/sandy sediments with shells/broken shells and pebbles. Horse mussel (*M. modiolus*) shells are abundant where the sea bed is exposed between and within areas of brittlestar bed. Live/possible live specimens also occur relatively frequently, and are marked with red dots on Figure 6. However, overall density is low ($1.6/\text{m}^2$) and individuals are typically separated by $>10\text{cm}$ even where they occur in clusters. No byssal thread connections between mussels are observed, and there is no bed formation.

The fauna is dominated by echinoderms. Besides the bed-forming brittlestars, urchins (*E. esculentus*) occur commonly, with sunstars (*C. papossus*), 7-armed starfish (*Luidia ciliaris*) and anemones also observed.

Horse mussel density: $1.6 \text{ live}/\text{m}^2$

Horse mussel/shell coverage: 16%

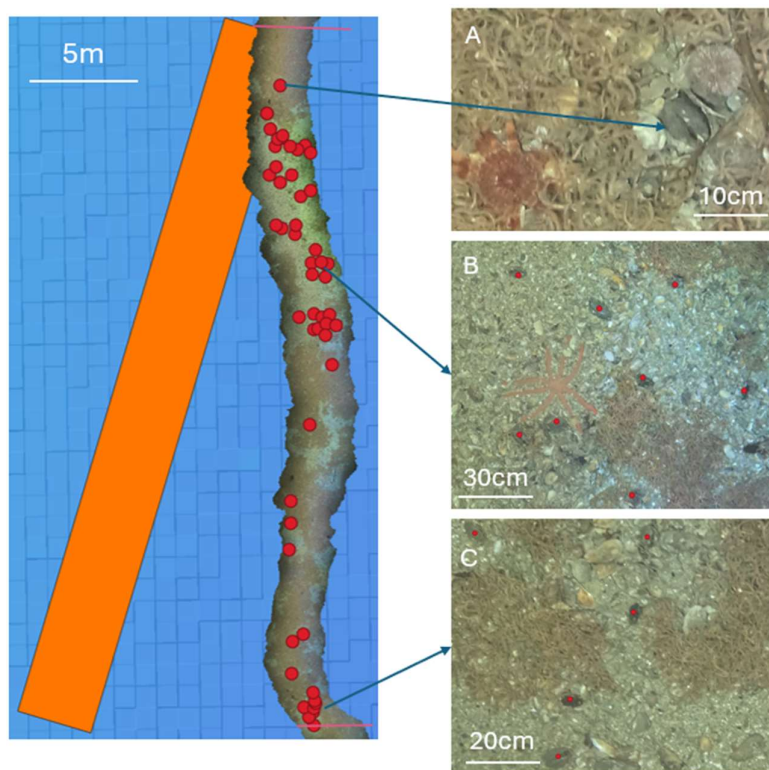


Figure 6: Transect 5 NS(6), comprising coarse/shelly sediments and brittle star bed. A: Possible live horse mussel exposed where brittlestar bed cover is thin, with urchin and sun star. B: Cluster of live horse mussels in exposed area with 7-armed starfish. C: Live horse mussels and shells at south end of transect.

Spot check A2

A2 covers an area of 25.3m² (Figure 7), with approximate centre point at 60.4516°N, -1.1251°E and water depth around 58m. Brittlestar bed covers the entire area but is relatively thin in places, where a sandy/muddy substrate with shells and pebbles can be seen beneath. While it is not generally possible to positively identify the shells beneath the brittlestars, it is likely that they include horse mussel (*M. modiolus*) shells, as these are clearly present in an exposed area just outside the A2 boundary to the northeast (Figure 7). No live horse mussels were identified. Urchins (*E. esculentus*), sun stars (*C. papposus*) and anemones occur relatively infrequently, and occasional kelp fragments were noted.

Horse mussel density: N/A – 100% brittlestar bed

Horse mussel/shell coverage: N/A – 100% brittlestar bed

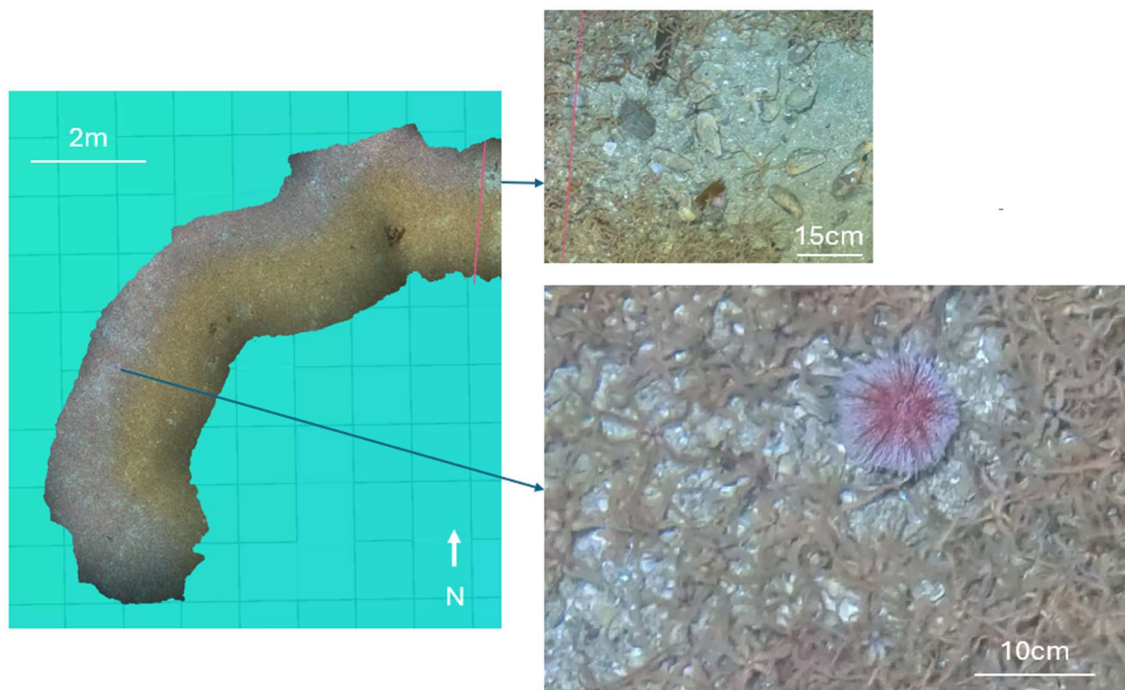


Figure 7: Spot check area A2, characterised by brittlestar bed cover overlying a shelly/pebbly substrate. Above right: horse mussel shells just outwith the NE boundary of the area. Below right: Edible urchin in thin brittlestar bed.

Spot check A3

A3 covers an area of 27.5m² (Figure 8), with approximate centre point at 60.4519°N, -1.1231°E and water depth around 57m. It comprises a muddy/sandy seabed with shells, pebbles, and occasional kelp fragments. Patches of brittlestar bed cover around 33% of the total area. Horse mussel (*M. modiolus*) shells are present in abundance, and occasional possible live specimens occur at relatively low density, marked with red dots (Figure 8). Other fauna observed within A3 include the sun star (*C. papposus*), edible urchin (*E. esculentus*), starfish, anemones and hermit crab.

Horse mussel density: 0.38 live/m²

Horse mussel/shell coverage: 10%

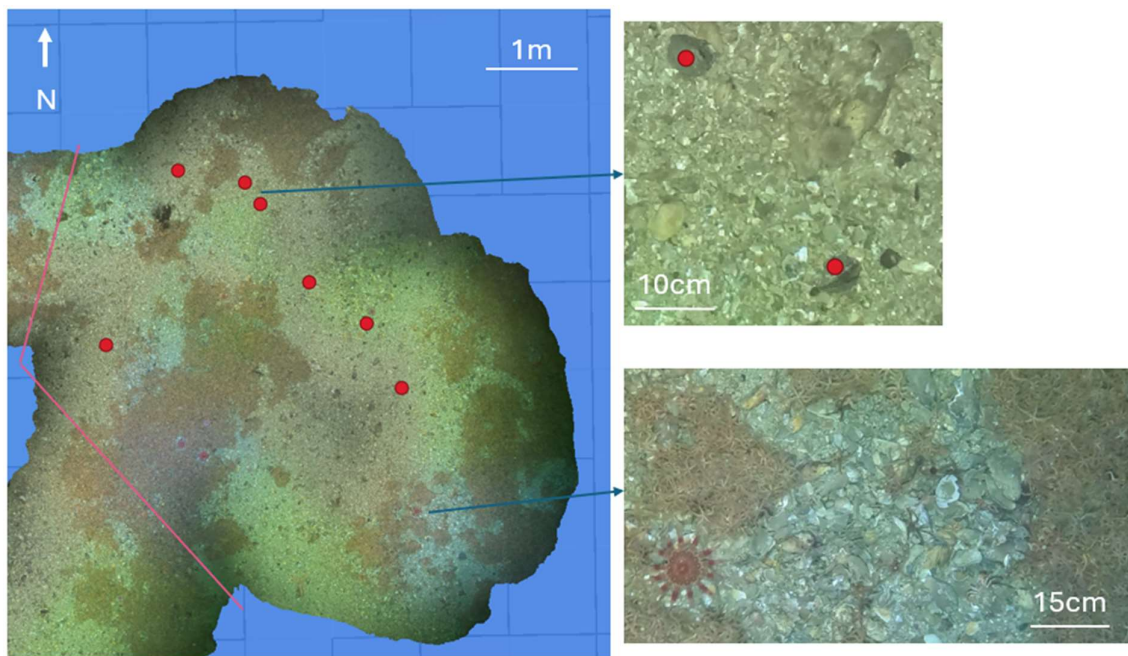


Figure 8: Spot check area A3. Muddy/sandy substrate with pebbles and shells, including abundant horse mussel (*M. modiolus*) shells. Above right: Two possible live horse mussels in the northern part of the survey area. Below right: Sun star on a substrate of horse mussel shell and brittlestar bed.

Spot check A4

A4 covers an area of 25.2m² (Figure 9), with centre point at approximately 60.4517°N, -1.1190°E and water depth around 67m. Brittlestar bed covers about 22% of the total area, with the remainder comprising a muddy/sandy seabed with shells and pebbles. Horse mussel shells are very abundant, with some scallop and other bivalve shells also noted.

The fauna is dominated by echinoderms, including urchins (*E. esculentus*), numerous 7-armed starfish (*L. ciliaris*), and brittlestars occurring as individuals/small clusters outside of the main bed areas. Some possible live horse mussels (*M. modiolus*) were observed at low density, marked as red dots in Figure 9.

Horse mussel density: 0.66 live/m²

Horse mussel/shell coverage: 32%

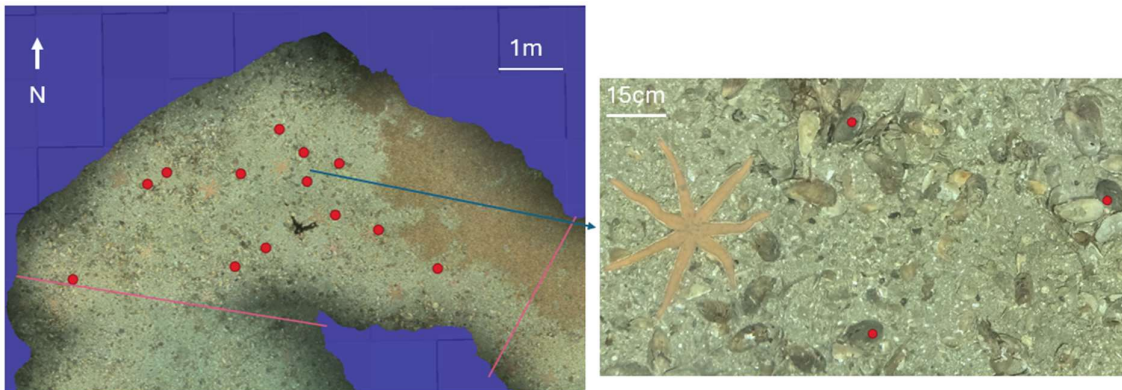


Figure 9: Spot check area A4. Muddy/sandy substrate with pebbles and shells, including abundant horse mussel shells, and brittlestar bed. Right: 7-armed starfish with horse mussel shells and possible live specimens.

Spot check A6

A6 covers an area of 25.8m² (Figure 10), with centre point at approximately 60.4520°N, -1.1206°E and water depth around 68m. Brittlestar bed covers two thirds of the area, with the remaining third comprising a muddy/sandy substrate with shells and pebbles. Horse mussel (*M. modiolus*) shells are very abundant, littering the exposed area and gaps within the brittlestar bed. A small number of possible live specimens were noted, marked with red dots on Figure 10. Other fauna observed include starfish, urchins (*E. esculentus*) and individual/small groups of brittlestars outside the main bed.

Horse mussel density: 0.17 live/m²

Horse mussel/shell coverage: 86%

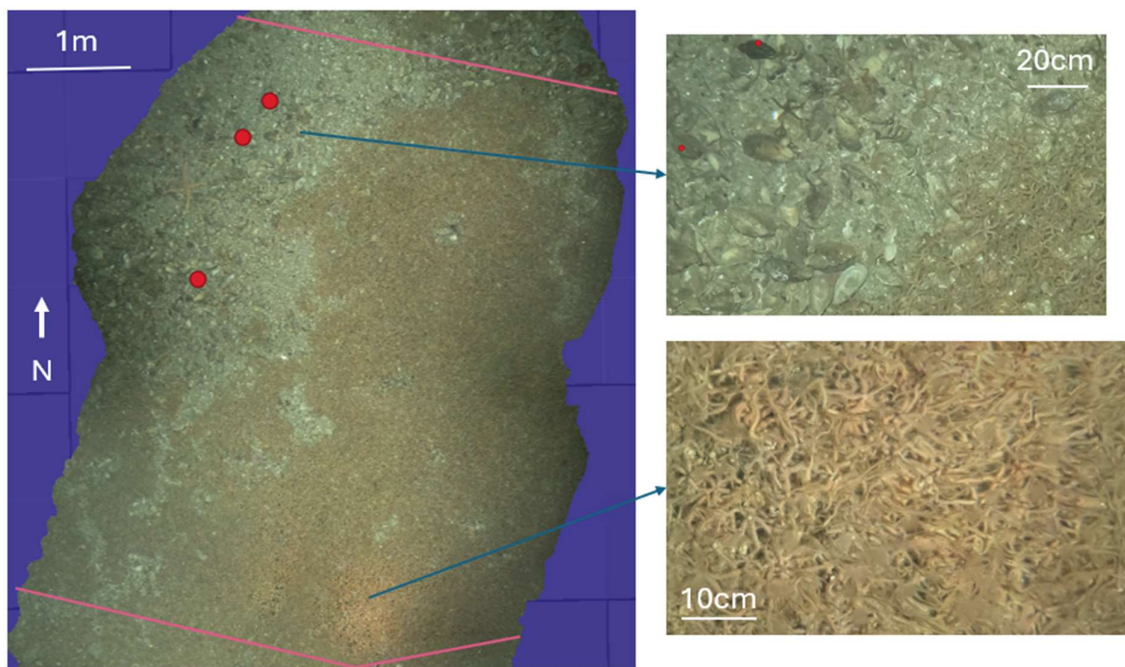


Figure 10: Spot check area A6. Muddy/sandy substrate with pebbles and shells, including abundant horse mussel shells, and brittlestar bed over ~67% of the total area. Above right: Edge of brittlestar bed and exposed substrate with abundant horse mussel shells and possible live specimens. Below right: Closer approach to the seabed (altitude ~0.2m) over brittlestars, confirming it is not possible to discern what lies beneath them.

Spot check A7

A7 covers an area of 25.9m² (Figure 11) with centre point at approximately 60.4511°N, -1.1216°E and water depth around 66m. Most of the area (~86%) is covered by brittlestar bed. The remainder comprises a muddy/sandy substrate with shells and pebbles. Horse mussel (*M. modiolus*) shells are abundant, and small number of possible live specimens were noted. A number of urchins (*E. esculentus*) were observed, and individual brittlestars occur in the exposed areas outwith the main bed.

Horse mussel density: 2.77 live/m²

Horse mussel/shell coverage: 27%

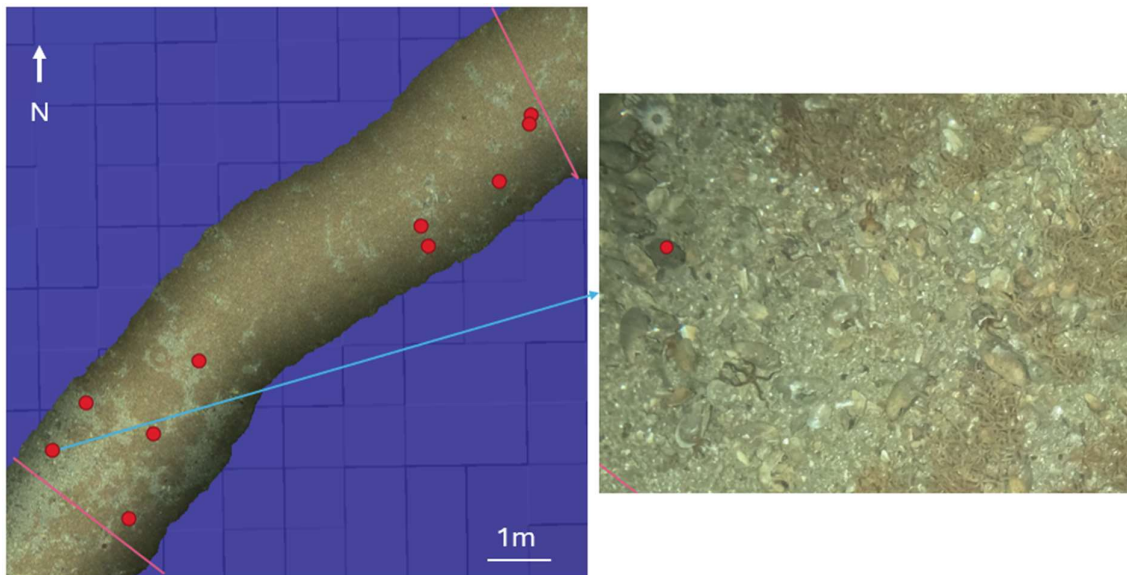


Figure 11: Spot check area A7. Brittlestar bed covers most of the total area. The exposed area comprises a muddy/sandy substrate with pebbles and shells, including abundant horse mussel shells. Right: Horse mussel shells and a possible live specimen in an exposed area, with thin patches of brittlestar bed.

Spot check A8

A8 covers an area of 27.1m² (Figure 12), with centre point at approximately 60.4507°N, -1.1204°E and water depth around 65m. Brittlestar bed covers 93% of the total area. The exposed 7% comprises a muddy/sandy substrate with shells and pebbles. Horse mussel (*M. modiolus*) shells are very abundant at the south end, where the brittle star bed is patchy, and are visible throughout the survey area where the cover is thin or absent. Many of them appear to be worn and/or broken. A possible live specimen occurs within the bed at the south end. Edible urchins (*E. esculentus*) and sunstars (*C. papposus*) are also present.

Horse mussel density: 0.56 live/m²

Horse mussel/shell coverage: 16%

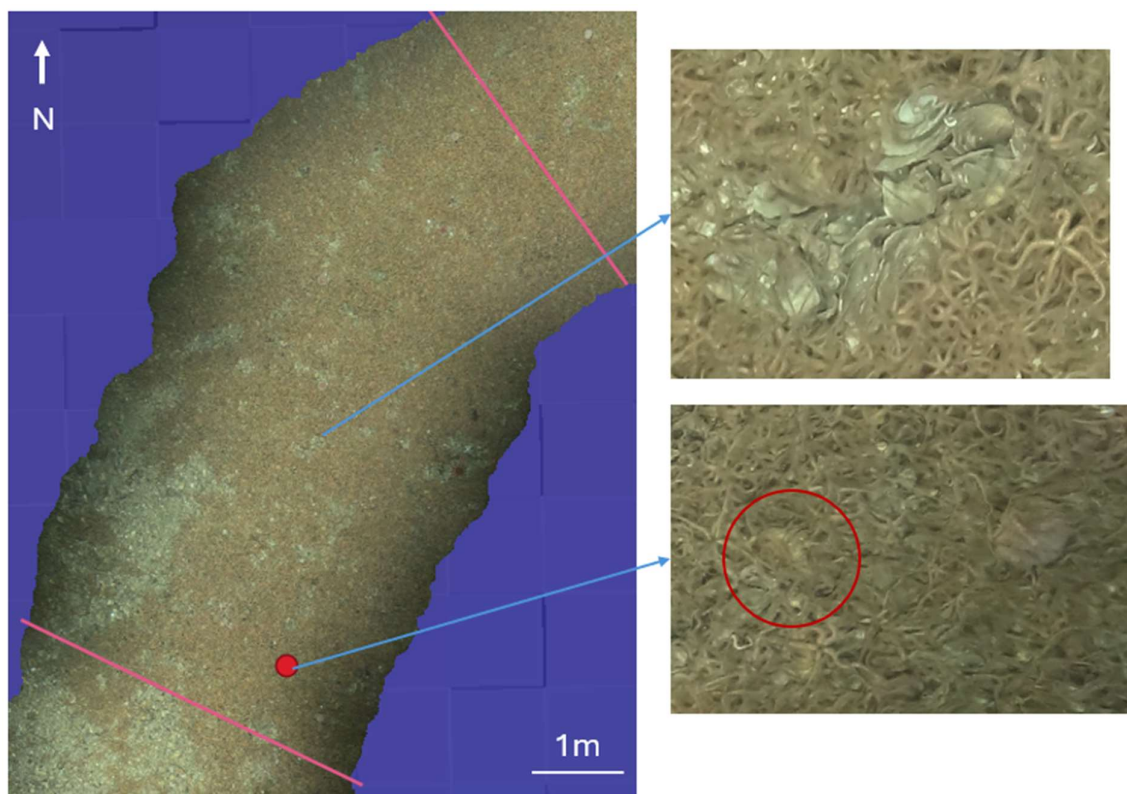


Figure 12: Spot check area A8. Brittlestar bed covers most of the total area. The exposed area comprises a muddy/sandy substrate with pebbles and shells, including abundant horse mussel shells. Above right: Worn/broken horse mussel shells in an exposed patch. Below right: Possible live specimen within the brittlestar bed.

Details of all survey targets (transects and spot check areas) are summarised in Table 2. Note that the horse mussel density and % horse mussel/shell coverage are calculated by exposed area, i.e. excluding any areas obscured by brittlestars, as it has not been possible to establish the presence/extent of any horse mussels that might underlie the brittlestars.

Table 2. Survey target details.

Target ID	Total area (m ²)	Brittlestar bed (m ²)	Brittlestar bed (%)	Exposed area (m ²)	No/size sample squares	Exposed area analysed (%)	Horse mussel/shell coverage per square (%)	Mean horse mussel/shell coverage (%)	Density (live mussels/m ² exposed area)
T4 NS(6)	436	2.2	1	433.8	6 x 2m x 2m = 24m ²	5.5	0.6	0.3	0.01
							0.0		
							0.1		
							0.4		
							0.4		
							0.3		
T5 NS(4)	204	125.1	61	78.9	4 x 1m x 1m = 4m ²	5.1	19.0	10	0.00
							7.8		
							7.2		
							6.6		
T5 NS(6)	97	62.5	64	34.5	7 x 0.5m x 0.5m = 1.75m ²	5	34.8	16	1.60
							11.6		
							8.0		
							6.0		
							19.6		
							13.2		
A2	25.3	25.3	100	0	N/A	N/A	N/A	N/A	N/A
A3	27.5	9.2	33	18.3	4 x 0.5m x 0.5m = 1m ²	5.5	15.2	10	0.38
							2.0		
							12.0		
							8.8		
A4	25.2	5.5	22	19.7	4 x 0.5m x 0.5m = 1m ²	5	32.4	32	0.66
							34.4		
							26.4		
							32.8		
A6	25.8	17.4	67	8.4	2 x 0.5m x 0.5m = 0.5m ²	6	82.4	86	0.17
							89.6		
A7	25.9	22.3	86	3.6	2 x 0.5m x 0.5m = 0.5m ²	12.5	37.6	27	2.77
							16.8		
A8	27.1	25.3	93	1.8	1 x 0.5m x 0.5m = 0.25m ²	13.9	16	16	0.56

Discussion

Horse mussel reef (bed) habitat is defined according to the Joint Nature Conservation Committee (JNCC) as follows:

“*Modiolus modiolus* is the foundation species in biogenic reefs that are characterised by clumped mussels and shell covering more than 30% of the substrate, which may be infaunal or embedded reefs, semi-infaunal (with densities of greater than five live individuals per m²) or form epifaunal mounds (standing clear of the substrate with more than 10 live individuals per clump), all of which support communities with high species richness (or diversity) compared to sediments of the surrounding area” (JNCC Report No. 531, 2015).

A further requirement cited earlier within the same report is that “the distinct region containing *M. modiolus* is greater than 25m² in extent”.

Examination of the target area orthomosaics indicates that habitat qualifying as horse mussel bed (and therefore PMF) is not present within any of them, based on the seabed coverage (%) and densities (live mussels/m²) calculated. Two of the spot-check areas did meet the requirement for coverage to exceed 30% (A4, 32% and A6, 86%), but live mussel densities were far below the 5/m² threshold (0.66 and 0.17/m² respectively). The areas covered by horse mussels/shells were also not characterised by increased species richness compared with the surrounding substrate.

Brittlestar bed was extensive over many of the surveyed areas, and had to be excluded from the horse mussel coverage and density calculations, as it was not possible to see whether horse mussels or shells were present underneath the brittlestars. Care therefore needs to be taken in extrapolating the resulting coverage/density values across the obscured areas.

References

JNCC Report No. 531: Defining Annex I biogenic *Modiolus modiolus* reef habitat under the Habitats Directive: Report of an inter-agency workshop, March 4th & 5th 2014. ISSN 0963-8901. December 2015.

Data access

All data, comprising downward facing georeferenced videos, still images, forward facing navigation camera footage and orthomosaics can be accessed via the link provided separately to SSF by email (03/04/2025).

Appendix 1: Technical notes

Dive log highlights

- **T5 (6) and (4) Redo** - No DWE recorded
- **A1_redo** - U1 Waterlinked locator used (opposed to A1), switched because position was lost
- **A7** - Flapper skate approx. 13min into dive

Positional information

- 'Image_positions' are derived from cleaned gpx files logged from our UGPS system (Waterlinked) and correlated with images using matching timestamps
- 'ROV position track shapefiles' are derived from cleaned gpx files logged from our UGPS system (Waterlinked)
- Considerable positional errors (up to 20m) were experienced during survey periods due to a communication issue between the depth sensor of the ROV and the UGPS system.
- The ability to accurately reach and cover target areas was also compromised by strong spring tidal currents and subsequent drag on the ROV.

CRS information

Orthomosaics and position track files are delivered in WGS 84 EPSG 4326

Orthomosaic scaling

Scaled using the known distance between the Left and Right GoPro of 45cm.

Output summary

1489m of seabed orthomosaics

1739m of seabed georeferenced imagery and footage

Data summary

Total of 93.4Gb of ROV data including:

- 28Gb of DWE downward facing video
- 52.8Gb of GoPro downward facing Imagery
- 12.4Gb of navigation camera forward facing footage