EMFF - Protecting Our Seas

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Final Report

Site

Severn Estuary/ Môr Hafren SAC, Cardiff

Prepared for

WFA-CPC
WG
NRW

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1. Executive Summary

The Welsh Government, in partnership with its statutory nature conservation advisors Natural Resource Wales (NRW), is evaluating the interaction of fishing activities with features of Welsh Marine Protected Areas (MPAs). Mobile fishing gears interacting with *Sabellaria alveolata* reefs within the Severn Estuary / Môr Hafren SAC were categorised as a 'high' risk, 'purple' interaction within the Assessing Welsh Fishing Activities (AWFA)[1] project matrix. The objectives of the project were to produce seabed maps of Sabellaria reef to better understand the extent and distribution of the habitat in relation to current fishing activity.

Fishing activity was assessed through a combined approach of consultative mapping and use of plotter data. A participating fisher and researcher plotted key tows and fishing grounds on hard copies of charts with annotations and notes, guided by reference to the chart plotter screen. A series of start and end waypoints were recorded, transcribed to GIS and verified by the fisher to map mobile gear activity off Cardiff.

Mapping survey effort was focused specifically on areas of overlap between towed gear activity and potential feature presence. The mapped fished area was overlain with sample points showing presence of Sabellaria from existing datasets. Where sample points occurred in the fished area, a 500m envelope was applied to each point to capture potential extent of feature presence, and four survey areas were selected to be surveyed using broadscale techniques. A ten-day survey was undertaken in July 2020 to collect broad-scale acoustic data using an interferometric swath bathymetric system (GeoSwath Plus) and Acoustic Ground Discrimination System (RoxAnn™ AGDS).

Results of the broadscale survey (bathymetric grids, mosaics of the sidescan sonar data, and roughness and hardness values from the AGDS data) were reviewed to identify any potential features or areas of variable ground within the four survey areas. Twelve secondary survey areas were selected to be investigated in greater detail using high frequency sidescan sonar and an Acoustic Resonance Inspection System (ARIS Explorer 3000) camera in a second ten-day survey conducted in August 2020.

The ARIS data were analysed to assess the nature of the seabed and the presence of reflective material within each tow, as well as its elevation, abundance, and distribution, Tows were split into sections where changes in appearance/seabed were observed. The percentage cover of elevated material of ≥2cm (calculated using trigonometric computations) in these sections was recorded and used to determine the presence or absence of Sabellaria reef, as elevation is a key determining factor within the full condition assessment.

The high frequency sidescan data were presented as mosaics for each of the secondary survey areas and shown in relation to sample points showing presence of Sabellaria.

[1] *https://naturalresources.wales/about-us/our-projects/marine-projects/assessing-welsh-fishing-activities/*

This data were then overlain with the ARIS data category for each section of the camera tows to explore the spatial relationship between the analysis results.

The high frequency sidescan sonar showed some areas of variable seabed including ripples/waves and linear features, but no distinctive patterns of reflectance clearly indicative of reef features. Some linear features that were thought to be consistent with marks left by trawling broadly supported the areas recorded in the fishing activity surveys, but may also have been representative of tidal movement or currents.

Review of the ARIS sonar camera system footage showed some variation of seabed types, including areas with no reflective material, areas with possible wave features and areas of rough ground with no elevated material. In other areas of rough ground reflective material was observed which was elevated from the rest of the seabed (≥ 2cm) and ranged in height to over 10cm. Elevated material was not observed with a percentage cover greater than 10%, indicating a potential absence of reef features in the areas surveyed.

2. Background

The Welsh Government, in partnership with its statutory nature conservation advisors Natural Resource Wales, is evaluating the interaction of fishing activities with features of Welsh Marine Protected Areas. Referred to as the Assessing Welsh Fishing Activities Project, a generic 'Welsh Matrix' has identified the risk of each fishing gear/feature interaction and prioritised the interactions for further assessment. In some cases, there are varying levels of confidence in feature distribution and condition within MPAs which potentially risks precautionary restrictions on fishing activities.

Guided by NRW and the AWFA Project, this work aimed to focus on areas where the interaction between fishing and conservation interest had been highlighted as a potential issue. Specifically, the project aimed to survey the seabed to identify the presence of benthic features and to consult with fishers to confirm where fishing activity is taking place. An advisory group was established comprising representatives from the Welsh Fishermen's Association - Cymdeithas Pysgotwyr Cymru (WFA-CPC), Welsh Government and Natural Resources Wales.

The key project area and habitat type to be focused on was prioritised as *Sabellaria spp.* reefs within the Severn Estuary/ Môr Hafren SAC, near Cardiff (Figure 1).

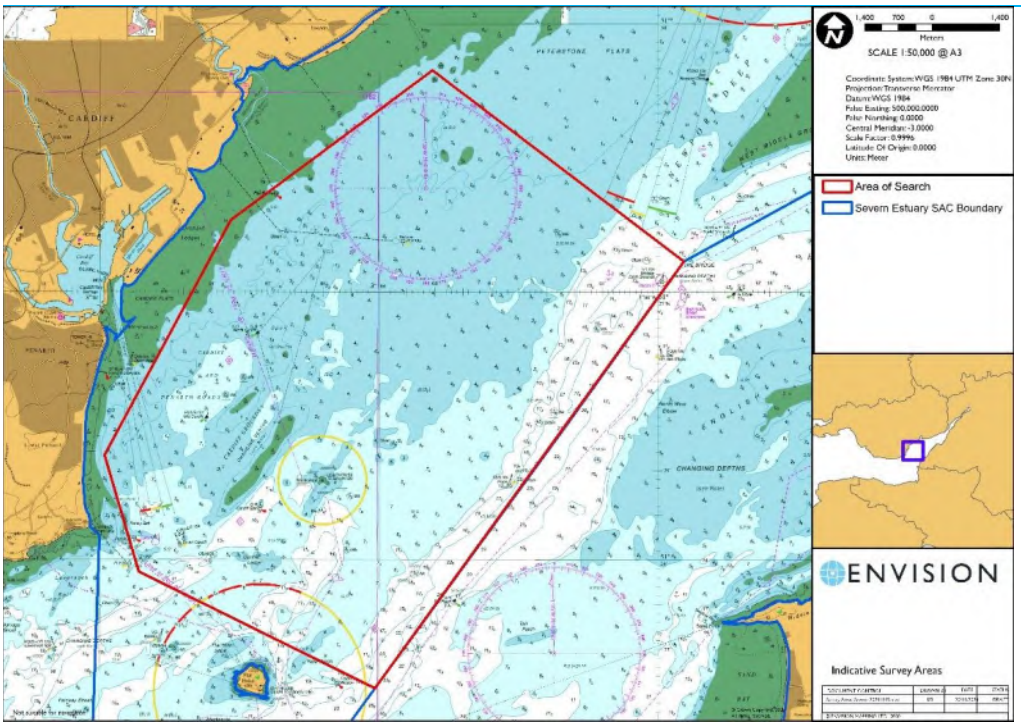


Figure 1.
Area of interest in Severn Estuary/ Môr Hafren SAC, near Cardiff

2.1. Sabellaria in Severn Estuary/ Môr Hafren SAC

Through discussion with the advisory group, it was established that trawling for mixed demersal fish occurs within the Severn Estuary / Môr Hafren SAC with potential for interaction with *Sabellaria spp.* reef. This is considered as a 'high' risk, 'purple' interaction within the AWFA matrix. Two vessels were identified as being active in the area with contact being made through the WFA-CPC.

NRW recently reviewed available data within the Severn Estuary/ Môr Hafren SAC (NRW, pers. comm, Dec 2019) and produced an updated map of sample stations which are considered to have *Sabellaria spp.* reef present (Figure 2), with age and biotope for each station shown (circles decrease in size with age, and multiple circles reflect samples from several years). The majority of the records are from failed grab records, with biotope assignment based on epifaunal community presence. The sample point data also provides insufficient information on extent of Sabellaria habitats for decision making processes. NRW have assessed the confidence in how the point data relates to the habitat description in the data, which is presented in Figure 2.

2.2. Objectives

The objectives of the project were to produce seabed maps at a range of scales to allow for the extent and distribution of Sabellaria reef habitat to be better understood in relation to current fishing activity.

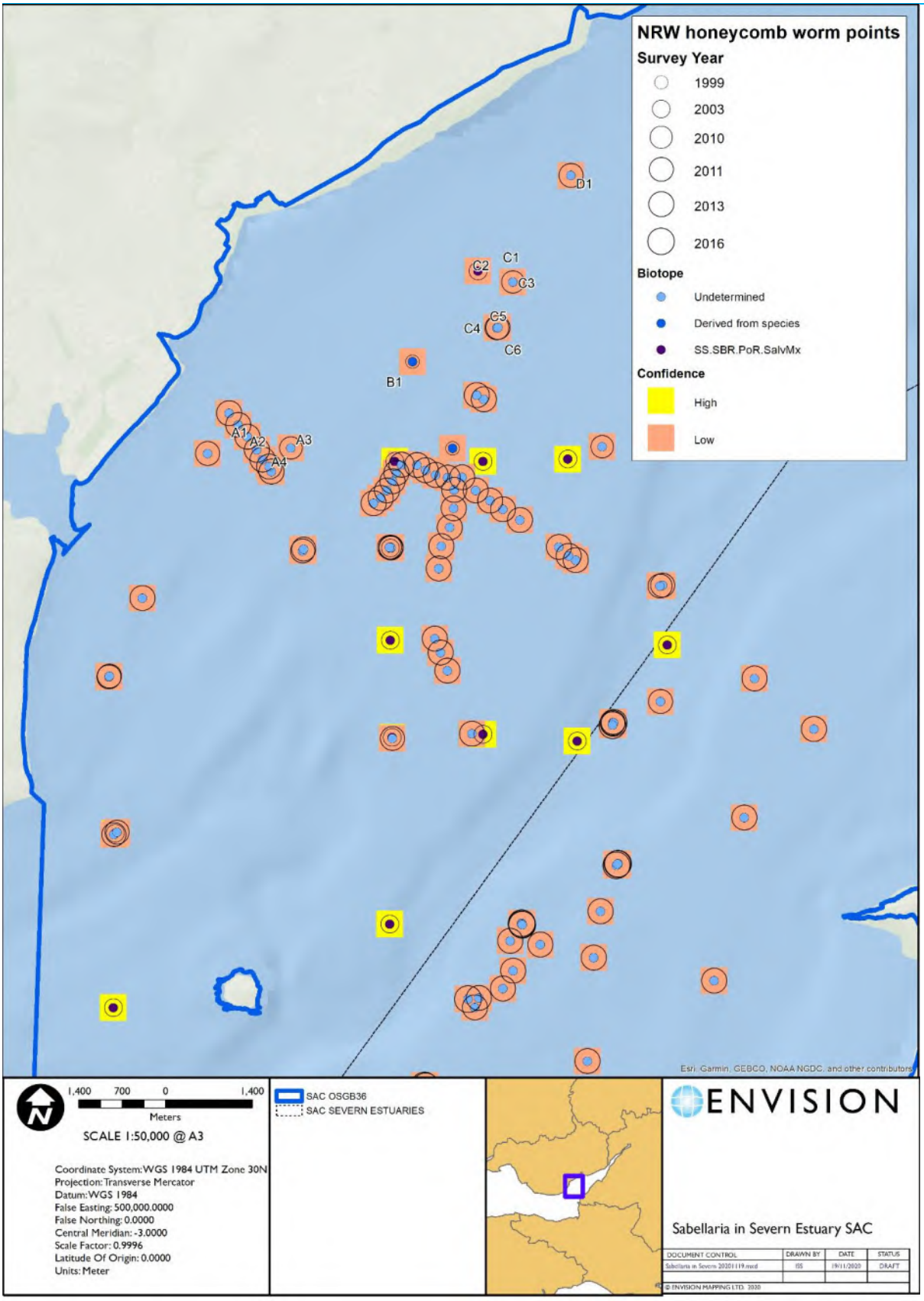


Figure 2.

Sample stations with presence of Sabellaria collated by NRW, showing confidence along with sample age and type of records, in the Severn Estuary/ Môr Hafren SAC

3. Methods

Surveys were undertaken in order to assess areas of seabed which are potentially areas of sublittoral *Sabellaria alveolata* reef habitat and better determine the extent of these features in relation to fishing activity within the Severn Estuary/ Môr Hafren SAC.

3.1. Fishing Activity Survey

The roll-out for inshore Vessel Monitoring Systems (iVMS) in Wales is scheduled to occur within the near future. The current lack of this type of high-resolution spatial fishing activity information necessitates an alternative approach. Previous fishing activity mapping studies have employed a combination of approaches, including consultative mapping and use of plotter data.

3.1.1. Consultative Mapping

Consultative mapping, an increasingly used tool in fisheries and conservation spatial management, is a combination of stakeholder engagement and GIS mapping techniques. A participative fishing activity mapping study collects information on fishing grounds, seasonal activity, gears used and species targeted, alongside contextual information including the location of particular features of interest such as nursery areas or as in this case, specific habitats. The process is centred on a mapping exercise where fishermen draw different fishing grounds onto maps guided either by a structured questionnaire or researcher. Mapping can be undertaken using basic tools from sketch maps drawn on a blackboard to complex on-line data collection and mapping using GIS platforms.

The advantages of this technique are that participatory mapping is an intuitive and easily implemented graphical approach to information gathering, which forms a means of engagement and building relationships with stakeholders across sectors, provides the opportunity to access traditional knowledge and establishes a dialogue on key issues.

This approach has previously been used in Wales by Natural Resources Wales (NRW) in their Fishmap Môn project and by both the Shellfish Association of Great Britain (SAGB) and South and West Wales Fishing Communities Ltd. (SWWFC), the local fishermen's association, to map broadscale fishing activity.

3.1.2. Plotter Data

Where iVMS data is absent and when fishers are willing to share their chart plotter track data and waypoints, this information can represent a high quality and high-resolution information source.

Previous analytical comparisons between data derived from iVMS and onboard plotter track data have shown that polling or recording frequency is very often significantly higher in onboard plotter systems, and where speed data is recorded on the track file, analysis of fishing activity is possible. Locational accuracy is similar, and little variation

is found between fishing grounds identified from plotter data with those from VMS data (Lee, 2012).

However, plotter data can represent large datasets which require significant pre-processing and analysis to extract useful information from, and each system and fisher have different configurations and may not routinely record tracks. Data is often held in a proprietary format which cannot easily be exported to use in other/GIS systems and manual extraction, or transfer is required.

3.1.3. Adopted Approach

Without prior information on the plotter system onboard the vessels fishing within the Welsh sector of the Severn Estuary/ Môr Hafren SAC, a combination of approaches was planned for. A series of small charts derived from the UK Hydrographic Office (UKHO) charts of the survey areas off Cardiff were produced, and copies printed out, to aid discussion and appending by the participating fishers and researcher. A laptop, card reader and blank SD and microSD cards were carried for the meeting with fishers.

For discussion with the Cardiff fishers it was agreed that, as there were only two trawlers working the grounds which share the same tows, that mapping would rely on one fishers' data to reduce disruption to their time and reduce the risk of Covid-19 transmission.

Post-interview, the appended charts were transcribed to GIS along with the waypoints and a series of activity layers produced. These were verified by the fisher to ensure that there were no omissions and that the areas of mobile gear activity off Cardiff were captured accurately.

Results of the fishing activity survey were then used to explore the overlap between areas of fishing and suspected *S. alveolata* reef habitat. This information was used to better focus survey effort and design, which was developed through discussion with the advisory group.

3.2. Benthic & Geophysics Survey

The primary goal of the survey was to determine the presence of priority features (Sabellaria reef habitat) and identify extents of the feature using sidescan sonar and underwater camera systems in relation to current fishing activity. A nested survey design was planned within the Severn Estuary/ Môr Hafren SAC, with relatively large areas being surveyed at a broad-scale / lower resolution to provide contextual information which enabled areas for mid-scale and fine-scale surveys to be selected.

3.2.1. Broadscale Survey Design

After consultation with the advisory group, survey effort was focused specifically on areas of overlap between towed gear activity and potential feature presence. In order to establish survey areas of interest, the mapped fished area was overlain with the map of sample points showing presence of Sabellaria. Where the sample points occurred in the fished area, a 500m envelope was applied to each point to capture potential

extent of feature presence, and survey areas were selected to encompass these points and the areas around them. This resulted in four survey areas to be surveyed using broadscale techniques, which are shown in Figure 3.

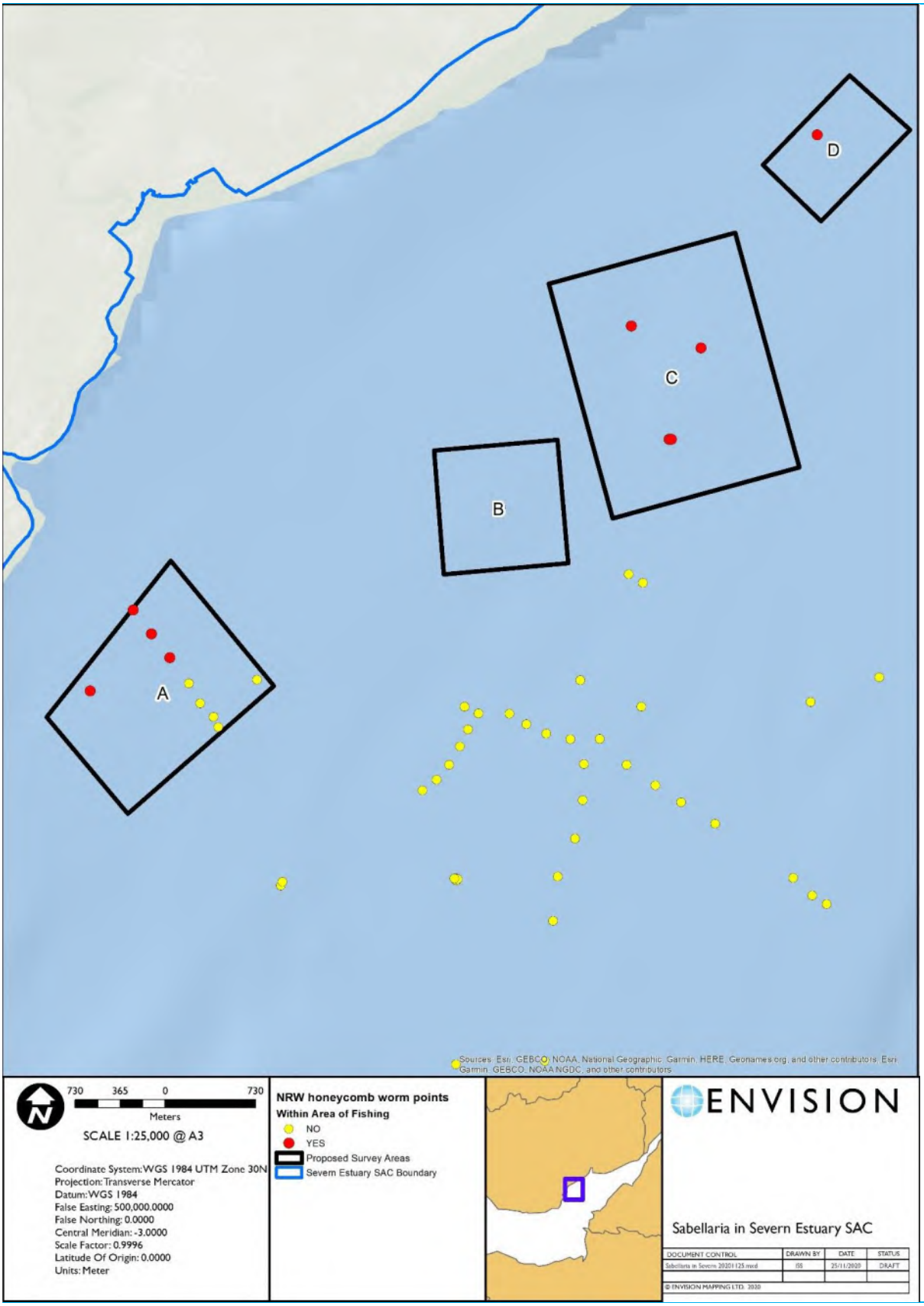


Figure 3.

Broadscale survey areas selected to encompass sample points with presence of Sabellaria in fished areas (including 500m envelope), with sample points occurring in areas of towed gear activity shown as red dots and those outside of fished areas shown as yellow dots

3.2.2. Broadscale Survey Methodology

An initial ten-day survey was undertaken in July 2020 (Severn Survey 01) to collect broad-scale acoustic data using the interferometric swath bathymetric system (GeoSwath Plus) and an Acoustic Ground Discrimination System (RoxAnn™ AGDS), as well as high frequency sidescan data (ENVISION, 2020a). Surveys were conducted from the charter vessel *Celtic Wildcat*, working out of Penarth Harbour, Cardiff.

A series of survey lines were planned to incorporate the four survey blocks, traversing parallel survey lines throughout each block. The line spacing was 50m and infill line spacing was 25m, with infill used in shallow areas where needed. Survey lines were run to a navigable safe depth and no shallower. Survey vessel speed was targeted at 4knts.

Swath bathymetry and AGDS data were collected for all four survey areas.

3.2.3. Technical Specifications

Swath Bathymetric System

A Kongsberg GeoSwath Plus Interferometric system was used, as shown in Figure 4, to provide simultaneous true sidescan sonar and bathymetric data which are geographically coincident and corrected for vessel movement and position. The bathymetric/sidescan survey collects full and continuous coverage of swath bathymetry and sidescan sonar, with contours shown at 1.0 metre intervals, vertically reduced to UK Chart Datum (or Lowest Astronomical Tide) using predicted tides adjusted with logged tide data at a close harbour.

Figure 4.
Kongsberg GeoSwath+ Transducer Head and Topside unit.

Peripherals

A suite of peripheral equipment was required to provide information for quality control and to allow for parameters such as tide and speed of sound through the water column to be accounted for. A sound velocity reading was measured using a Valeport miniSVS at the transducer head and through the water column using an Odum Digibar pro sound velocity profiler. These data enable corrections to be applied to account

for variations in the speed of sound through the water column during survey operations. The table below shows a summary of the peripheral equipment deployed.

ODUM Digibar Pro – A sound velocity profiler used to correct for changes in the velocity of sound through water at various depths in the water column.	
PA200/20 Digital Precision Altimeter – Used as a quality control this apparatus measures accurate height from the seabed in order to verify the readings from the swath transducers.	
MiniSVS (Model # 0652006) – This is attached closed to the transducer to take real time readings of the velocity of sound through water. The readings are applied to the data during processing.	

Acoustic Ground Discrimination System (AGDS)

ENVISION used a RoxAnn™ GroundMaster AGDS operating at 200 kHz. The addition of an AGDS does not compromise the bathymetric data collected by the swath system and provides additional details on the nature of the seabed by measuring its acoustic reflectance properties. The acoustic data, together with GPS data, are logged onto a laptop (Figure 5).

Figure 5.
RoxAnn AGDS, GPS and data acquisition laptop installed on a survey vessel.

This system was deployed by mounting a suitable pole to the vessel and attaching a transducer array to the bottom of the pole approximately 1m below the water surface. The vessel was then manoeuvred along a series of parallel survey lines, data was collected and saved onto a laptop computer at regular intervals of one second.

The data were then backed up and any erroneous data points removed/cleaned, which can result from mid water echoes or data collected whilst the vessel was manoeuvring and causing turbulence or aeration under the transducer.

Once all the data were collected and cleaned then information of the depth, roughness and hardness of the seabed can be processed to detect boundaries for seabed features.

Positioning

A Hemisphere Vector sensor was used for precise positioning and heading. The Vector Sensor provides accurate headings with GPS signals, and also delivers sub-metre DGPS positioning accuracy.

3.2.4. Fine-scale Survey Design

Results of the broadscale survey (bathymetric grids, mosaics of the sidescan sonar data, and roughness and hardness values from the AGDS data) were reviewed to identify any potential features or areas of variable ground within the four survey areas.

After inspection of this data, 12 secondary survey areas of interest were selected (Figure 6) to investigate in further detail using high frequency sidescan sonar and an Acoustic Resonance Inspection System (ARIS Explorer 3000) acoustic imaging camera,

to provide further information to help determine the potential presence of Sabellaria reef habitat.

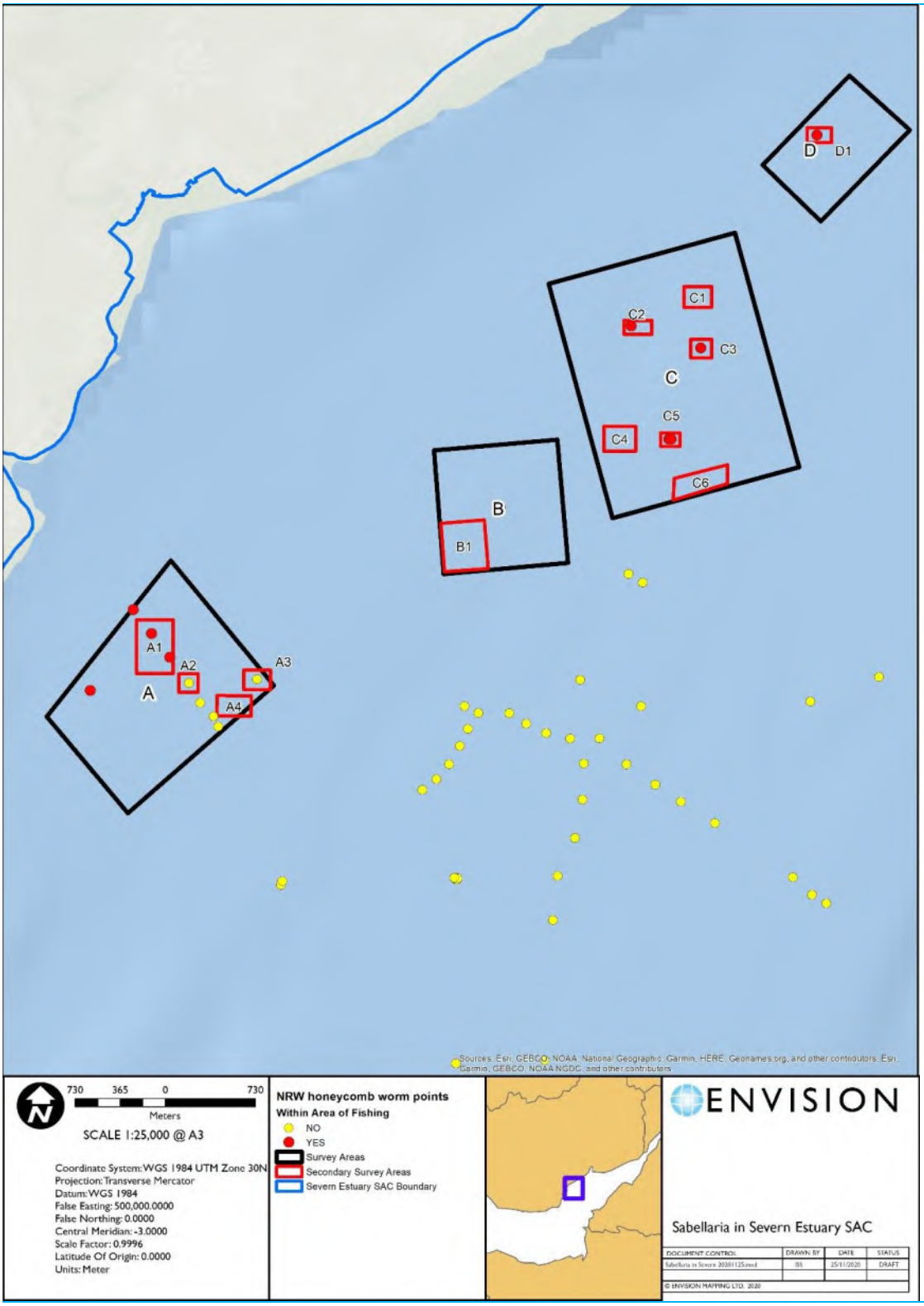


Figure 6.

Secondary survey areas for underwater sonar camera and high frequency sonar survey within the Severn Estuary/ Môr Hafren SAC

3.2.5. Fine-scale Survey Methodology

A second ten-day survey in the Severn (Severn Survey 02) was conducted in August 2020 using the underwater sonar camera system (ARIS 3000) and high frequency (1 MHz) sidescan sonar to collect further information to identify the presence of Sabellaria reef habitat. Surveys were conducted from the charter vessel Celtic Wildcat, working out of Penarth Harbour, Cardiff. Footage (at least two camera tows) was collected with the ARIS sonar camera system from all 12 secondary survey areas, along with high frequency sidescan sonar data.

High frequency sidescan data were collected by deploying the tow fish from the stern of the vessel and traversing parallel lines at a constant speed over the 12 secondary survey areas. The sonar camera system was towed whilst allowing the vessel to drift over a survey area with the current/wind at periods of slack tides. When the tide was flowing too fast outside of this slack water period, the camera system moved too fast to record useful information. Positions were fixed at the start and end of each deployment and a continuous log of GPS data were recorded whilst the system was deployed. Additionally, a log was kept noting the position, depth and appearance of the seabed and any other notable features during each tow.

3.2.6. Technical Specifications

ARIS 3000 Sonar Camera System

The ARIS camera system is comprised of a surface unit which is operated from the wheelhouse and a sub-surface unit which is operated by deck crew and lowered to the sea floor in a manner which has minimal impact on the seabed. The ARIS sonar camera was mounted on a steel frame adapted from a drop-camera frame (Figure 7), (recommended in Griffin *et al.* (2020), as opposed to a pole-mounted system) and lowered to the seafloor using an umbilical to ensure that the system was stable yet had minimal impact on the seabed using buoys and plastic skids to stabilise and correct for attitude of the system when operated. The image can be viewed and recorded at the surface along with GPS time and position, as well as the depth and attitude of the camera system.

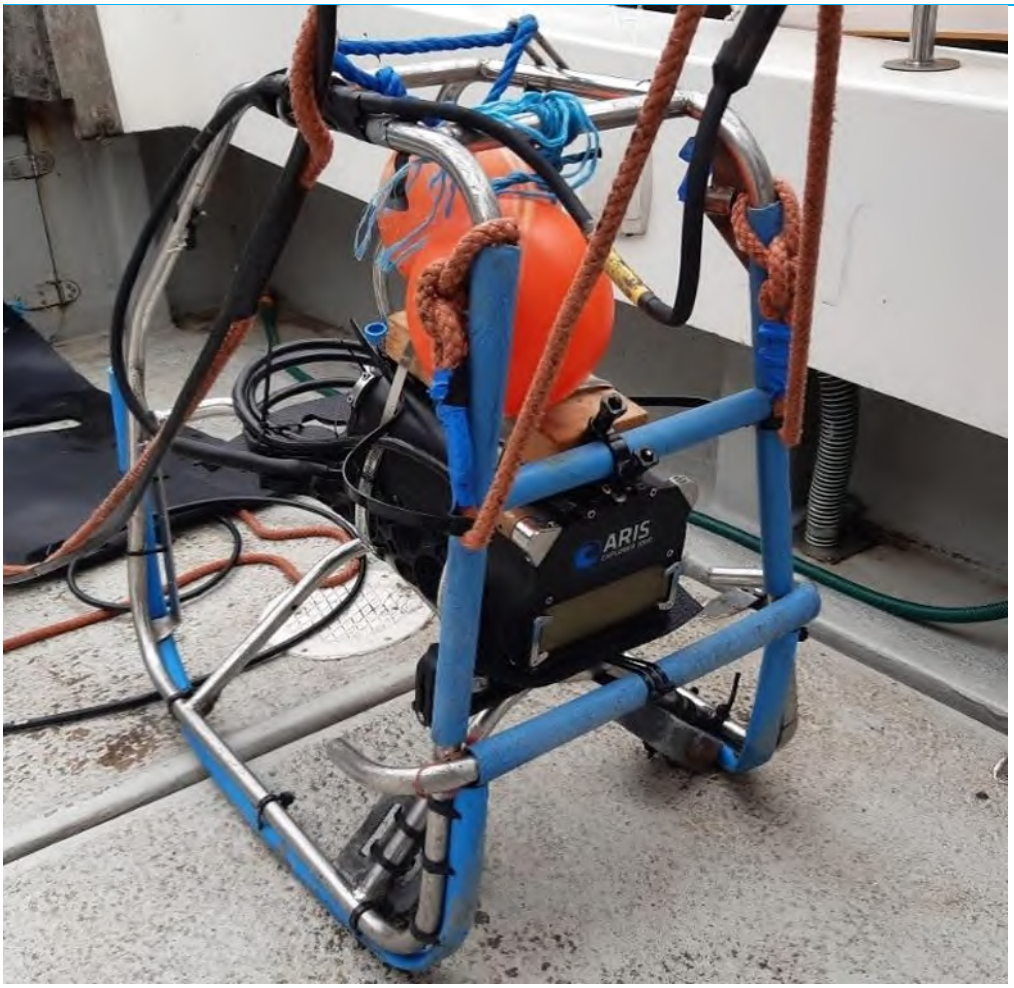


Figure 7.
ARIS 3000 sonar camera system on a stainless steel frame

High Frequency Sidescan Sonar

A high frequency sidescan sonar system (Tritech StarFish 990F XD), as shown in Figure 8, was deployed with the aim of achieving full and continuous coverage high frequency (1MHz) sidescan sonar for mid-scale resolution. Data was collected by traversing parallel lines over the survey areas at a constant slow speed, using a line spacing of 25m.

Figure 8.
Tritech StarFish 990F XD

3.3. Data Analysis

3.3.1. Swath Bathymetry, AGDS and Sidescan Data

The swath bathymetric data was processed to account for calibration & offsets, tidal variations and the speed of sound through the water column. The data were then processed to a grid resolution of 0.5 to 1 meter and presented as grids for the purpose of planning for finer-scale surveys.

AGDS Data were processed to remove any spikes and inconsistencies within the data caused by errors in position logging or from mid water echoes and interference which can introduce anomalies to the dataset.

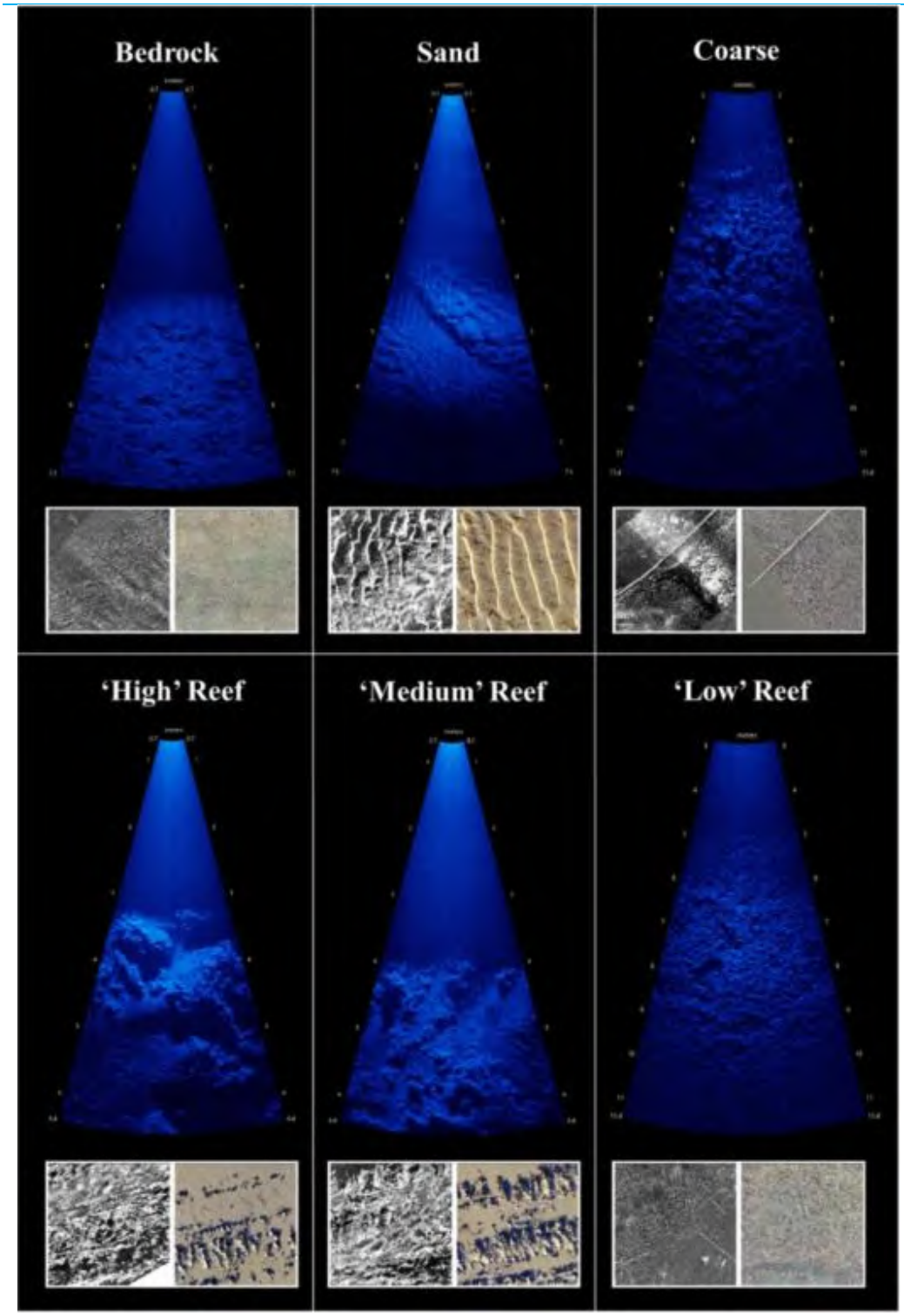
The high frequency sidescan sonar data underwent processing to enable the data to be presented as mosaics for each secondary survey area. For this purpose, a mosaic at a resolution of 5cm was produced for the 12 secondary survey areas.

3.3.2. ARIS Data

Research using acoustic cameras as tools for ground truthing sidescan sonar interpretation and assessing the status of Sabellaria bioconstructions in low-visibility environments has shown that acoustic camera imagery match well with backscatter signatures of seabed features and allowed for reef defining attributes to be assessed (Griffin *et al.*, 2020). The study concluded that colony formation type was distinguishable in the acoustic camera imagery (Table 1), although confidence in differentiating between low-lying Sabellaria formations and surrounding substrates was low, particularly when using a pole-mounted configuration.

Table 1

Acoustic camera imagery (ACI) representative of key non-reef substrates (top) and each Sabellaria reef 'status' (bottom). Corresponding side-scan sonar (SSS, greyscale) and unmanned aerial vehicle (UAV) imagery is also presented for each location. Taken from Griffin et al., 2020.



The ARIS footage from the current study was analysed to assess the presence of reflective material within each tow, as well as its elevation, abundance, and distribution. Initially, a minimum of 3 frame captures were obtained for each tow to present example images of the seabed imagery recorded by the ARIS sonar camera.

ARIS data were then analysed further to record the nature of the seabed and tows were split into sections where changes in appearance/seabed were observed, taking into account layback of the camera system position behind the vessel. Detail on the elevation and abundance of the reflective material was recorded based on categories used in Jenkins *et al.*, (2018), which were proposed by Gubbay (2007), and are presented in Figure 9. These categories are part of a matrix which is used to assess subtidal *S. spinulosa* reef characteristics (Gubbay, 2007) as part of a more comprehensive set of characteristics, such as sediment consolidation and biodiversity scores, which cannot be determined from Aris footage.

			Elevation (cm)			
			<2	2–5	5–10	>10
Reef structure matrix			**Not a reef**	**Low**	**Medium**	**High**
Patchiness (% cover)	<10	Not a reef	Not a reef	Not a reef	Not a reef	Not a reef
	10–20	Low	Not a reef	Low	Low	Low
	20–30	Medium	Not a reef	Low	Medium	Medium
	>30	High	Not a reef	Low	Medium	High

Figure 9.
Sabellaria reef structure matrix modified by Jenkins et al. (2018) from the elevation and percentage cover categories proposed by Gubbay (2007), from Griffin et al. (2020)

The percentage cover of elevated material of ≥2cm in these sections was recorded to determine the presence or absence of Sabellaria reef, as elevation is a key determining factor within the full condition assessment, an approach used by Griffin *et al.* (2020). Elevation of reflective material was calculated using trigonometric computations, and categories (Table 2) were assigned to the data based on percentage cover of elevated material for the purposes of describing and characterisation of the ARIS data visually along each of the tows. Examples of these categories from the ARIS footage imagery are shown in Table 3.

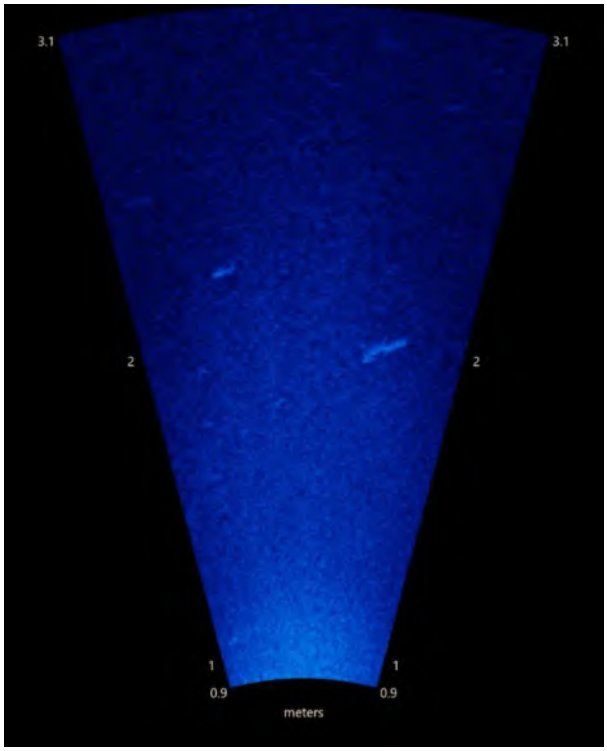
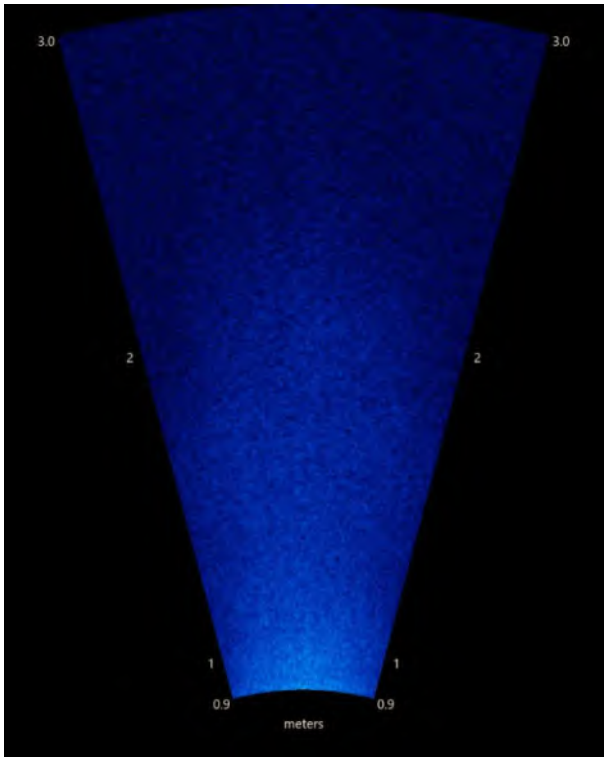
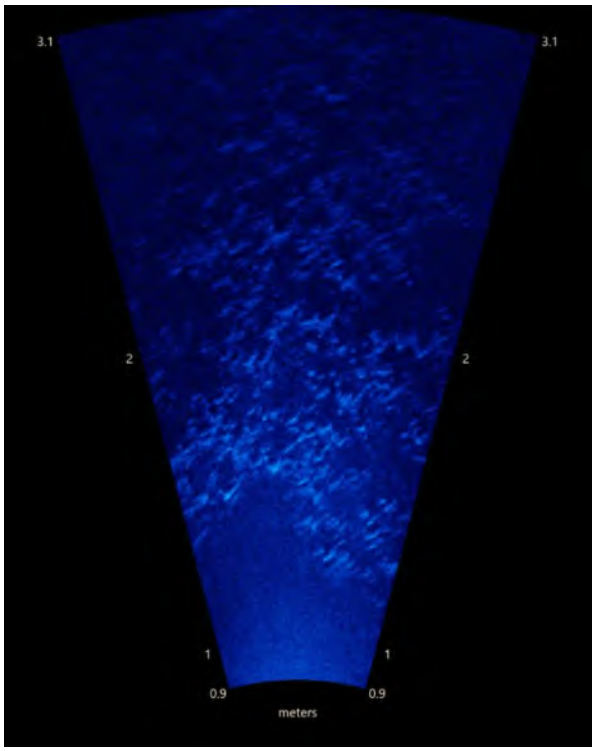
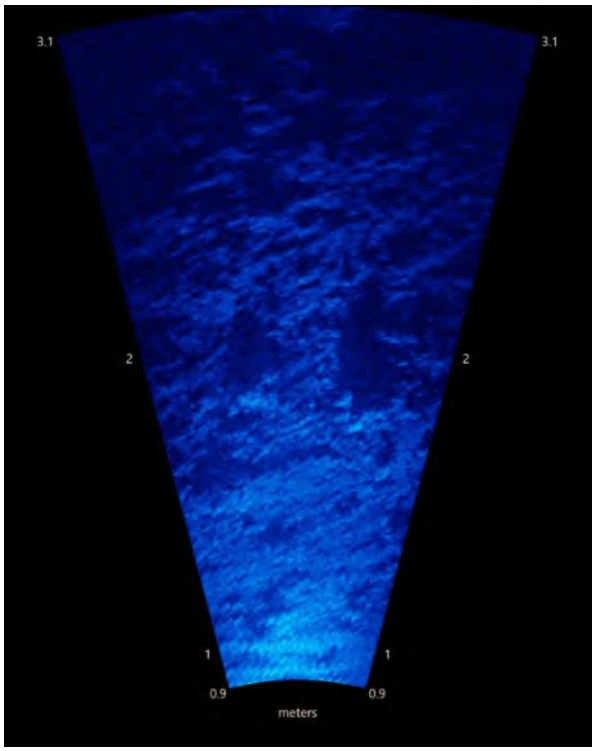
Table 2
Categories allocated to ARIS data based on percentage covers of elevated material

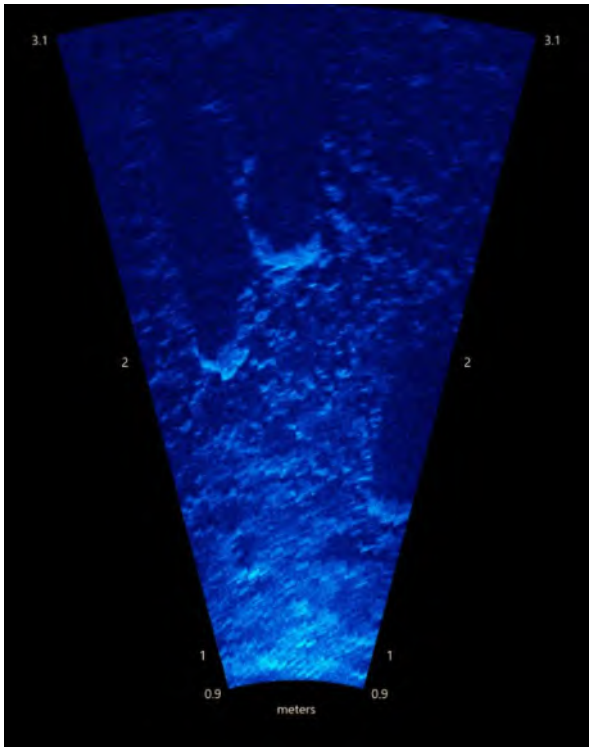
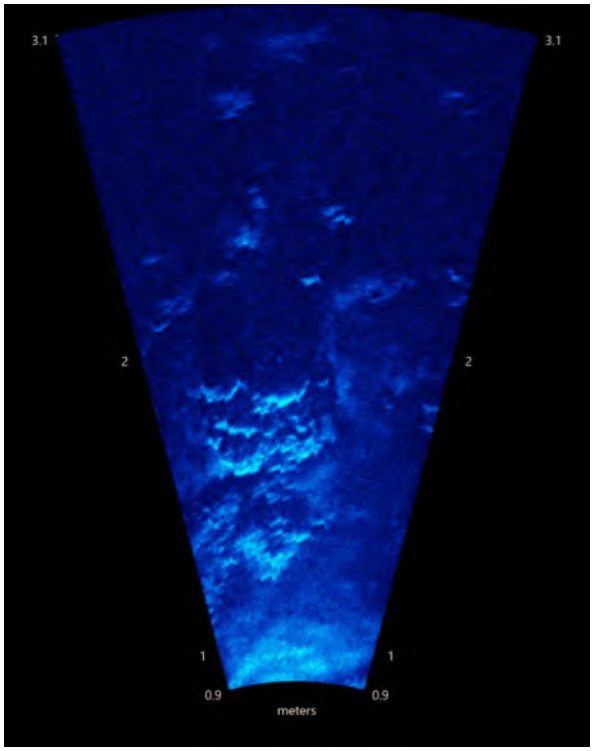
Brief description	**Elevated Material ≥2cm**	
	Frequency	**Abundance**
majority featureless	none	0-4%
majority featureless, ripples present	none	0-4%
smooth	sparse	0-4%

Brief description	Elevated Material ≥2cm	
	Frequency	Abundance
smooth, ripples present	sparse	0-4%
smooth and rough ground	sparse	0-4%
rough ground	sparse	0-4%
smooth and rough ground, ripples present	occasional	5-7%
smooth and rough ground	occasional	5-7%
rough ground	occasional	5-7%
smooth, ripples present	some	8-10%
smooth and rough ground	some	8-10%
rough ground	some	8-10%

Table 3

Example images of analysis categories allocated to ARIS footage from current study

0 – 4 % elevated material	0 – 4 % elevated material
	
5 – 7 % elevated material	5 – 7 % elevated material
	

8 – 10 % elevated material	8 – 10 % elevated material
	

4. Fishing Activity Results

As two trawlers operate from Cardiff, working the same grounds and sharing the same tows, an interview was conducted with one of the fishers to reduce disruption to their time and reduce the risk of Covid-19 transmission.

It was established that extracting the plotter data would have been difficult, if at all possible, at interview in one day. The fisher did not routinely record his tracks as he used a relatively small number of safe tows avoiding seabed obstruction which he could identify by his position on the chart plotter. The Cardiff fishers shared locations of "snags" and "hangers" which have constrained their activity to their habitual tows and grounds.

A hybrid approach was adopted on the day of the visit and key tows and grounds were plotted on hard copies of charts with annotations and notes. These plots were guided by reference to the chart plotter screen and a series of start-end waypoints recorded for the purpose. Further reference was provided by a UKHO chart displayed on the laptop at various magnifications.

Local knowledge on the location of Sabellaria in the area of interest was also recorded.

This information was then mapped in a GIS, resulting in polygon shapefiles representing the outer boundaries of the trawl grounds utilised by the two vessels in inshore and intertidal areas. Due to the small number of fishers operating in the area, this information cannot be presented here without raising confidentiality issues, but the information can be summarised as follows:

4.1. Key Information Recorded

- Gear types used are French rigged otter trawls with light doors to accommodate working soft grounds.
- The polygons encompass a small number of tows which are constrained by a large number of seabed obstructions.
    - Many of the obstructions appear to be a result of the construction of the barrage and are large boulders.
- Actual swept areas of tows are significantly smaller than mapped areas, which could be mapped using GPS loggers or iVMS if necessary, to inform management.
- Trawling activity off Cardiff is constrained by the powerful tidal streams that are prevalent offshore and in deeper water.
- An area off Penarth was also indicated by the fishers and mapped, where they believe that Sabellaria is present, known locally as the "Coral" and which is targeted by recreational anglers as a site known to hold fish, however this information is anecdotal and as such is not presented in this report.

5. Benthic Survey Results

5.1. Area A

The data from the broadscale surveys for area A are presented in Figure 10 to Figure 12, including bathymetry, roughness values (AGDS) and sidescan sonar.

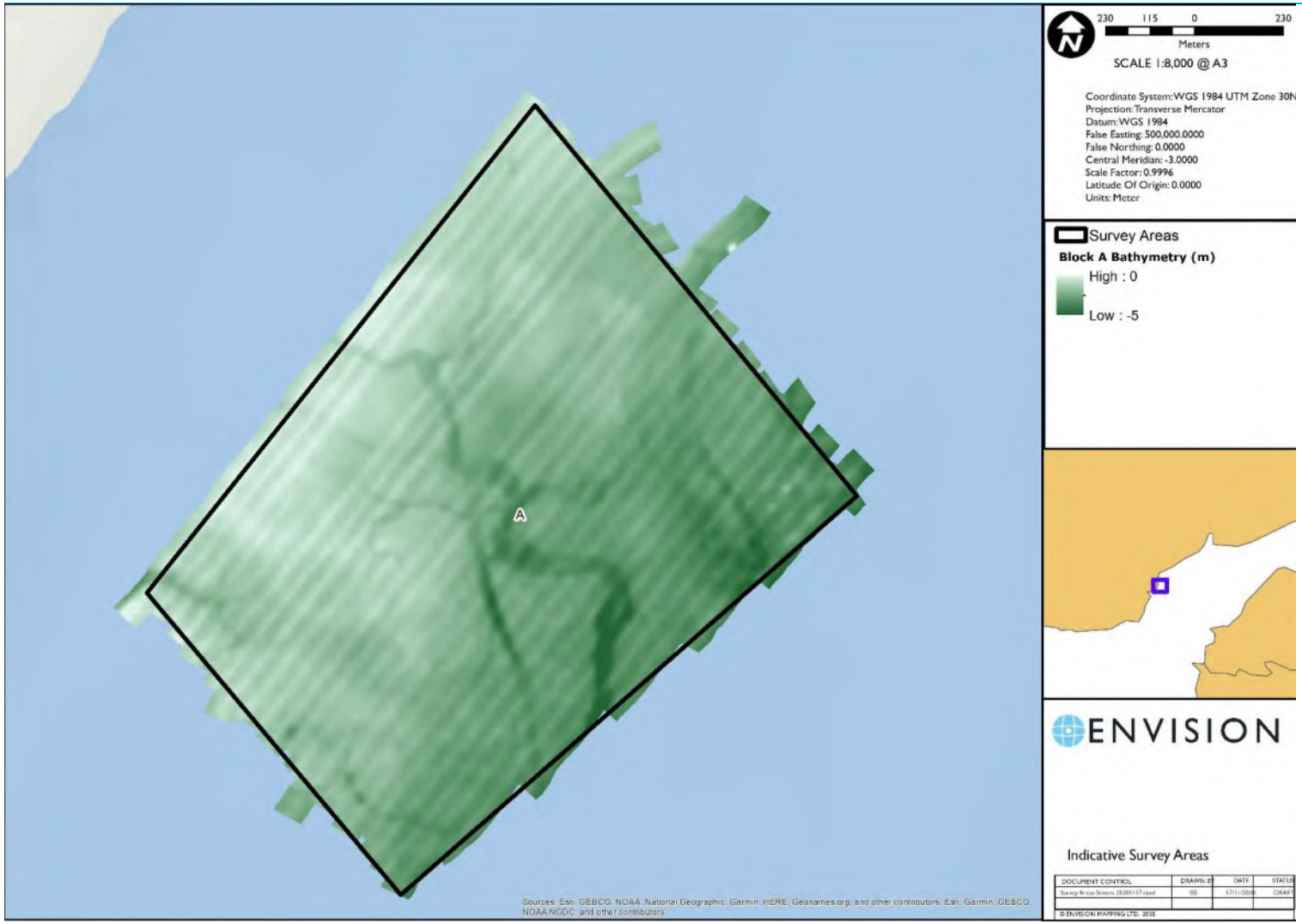


Figure 10.
Bathymetric data for survey area A

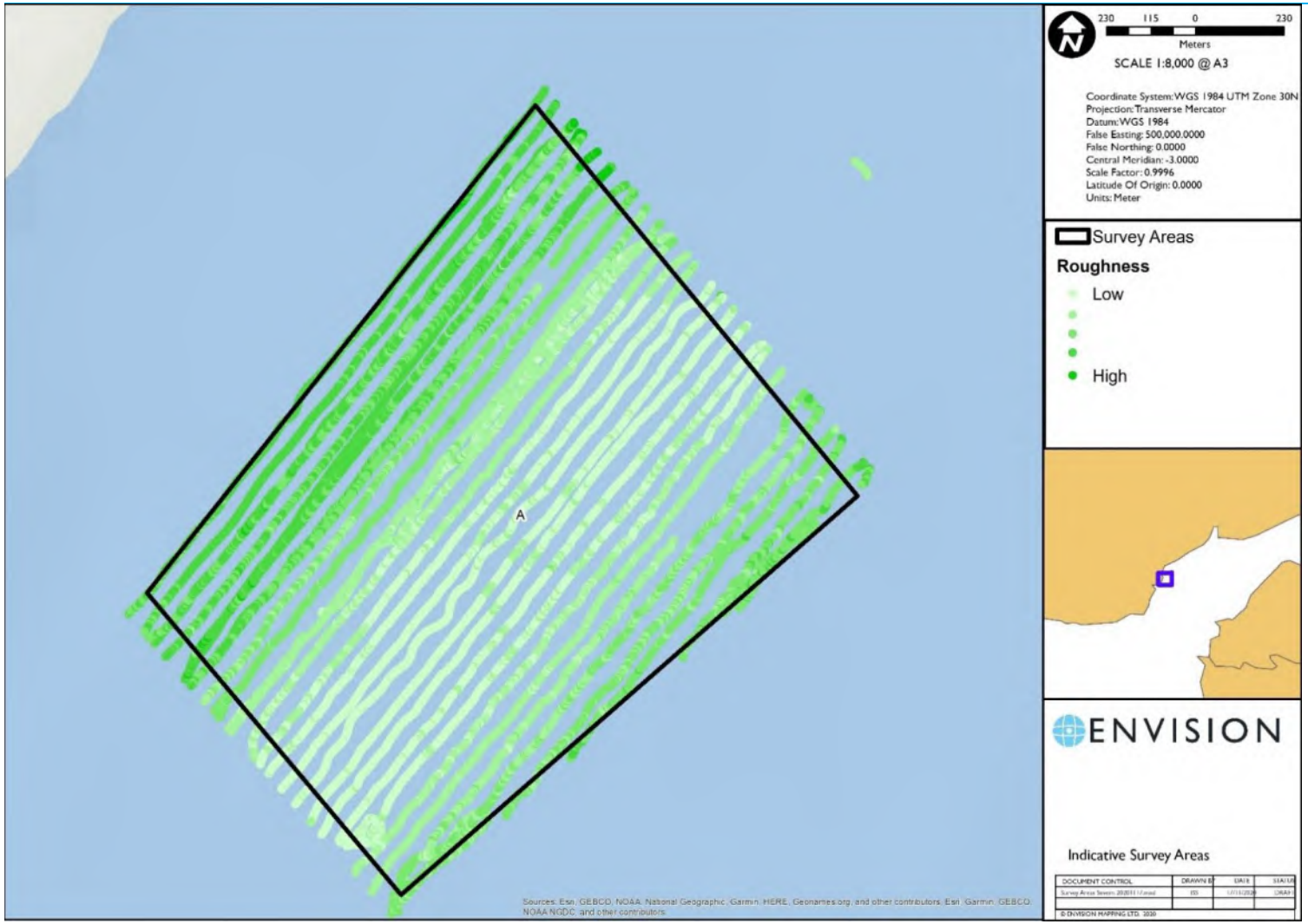


Figure 11.
AGDS data showing roughness values for survey area A

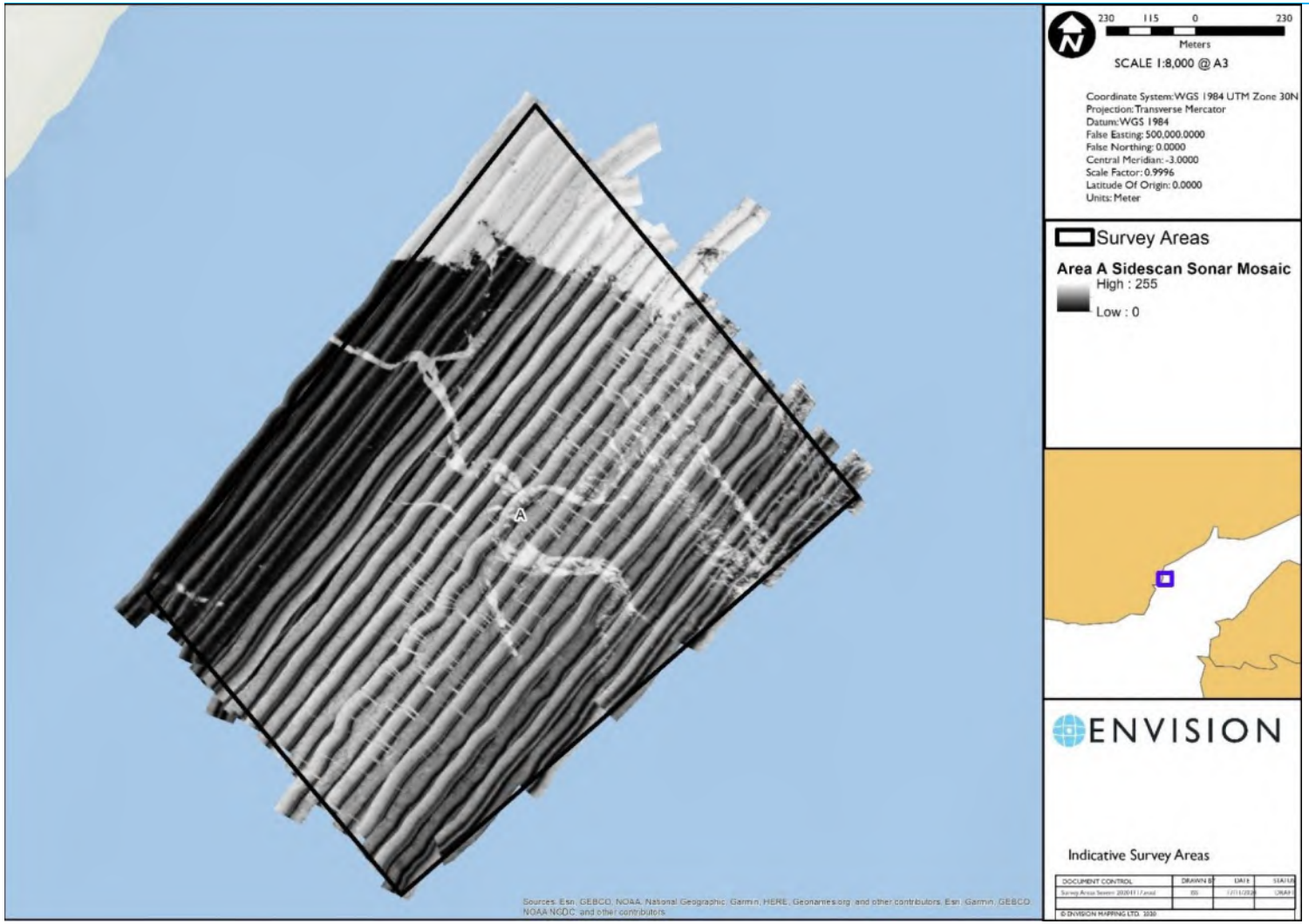


Figure 12.
Sidescan sonar mosaic for survey area A

After examination of the acoustic data from initial surveys and the location of NRW sample points showing presence of Sabellaria, secondary survey areas were selected to investigate potential features or areas of variable ground, which are shown as red boxes in Figure 13.

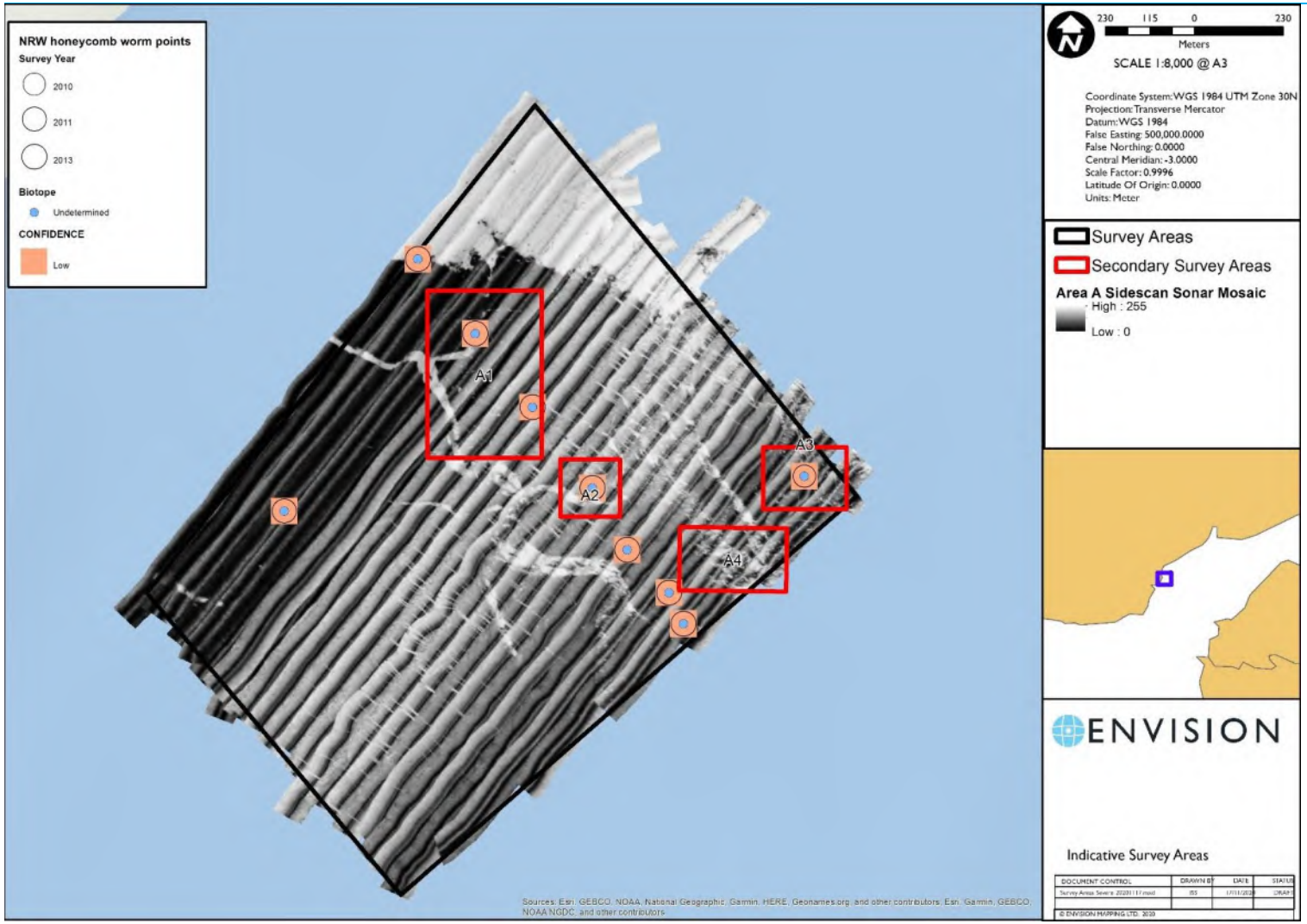


Figure 13.
Sidescan sonar mosaic for survey Area A, with NRW sample points showing presence of Sabellaria overlain, and secondary survey areas

5.1.1. Area A1

The high frequency sidescan data for survey area A1 (Figure 14) shows that there are potential channels in the substrate to the west of the survey area and ripples/waves in the southeast. There appears to be some variation in the seabed reflectance in the central part of the secondary survey area from north to south, but no distinctive patterns of reflectance indicative of reef.

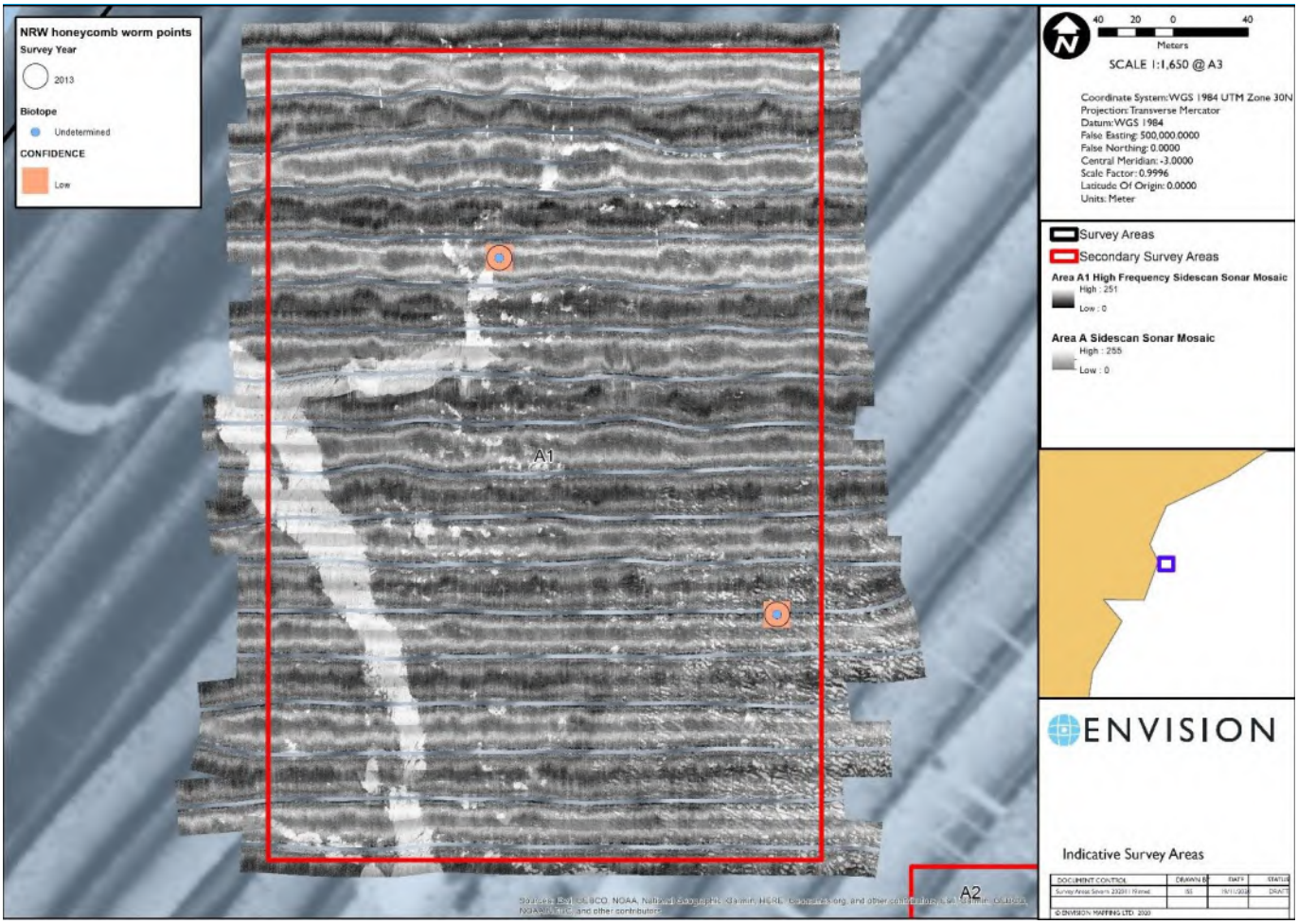


Figure 14.
High frequency sidescan sonar mosaic for survey area A1, with sample points of Sabellaria presence overlain

The ARIS sonar camera imagery for secondary survey area A1 was taken over five tows, and during analysis categories were allocated according to its appearance and the abundance of elevated material (≥2cm), which are presented in Table 4 and in Figure 15.

Whilst elevated material was present in all of the tows, this was not observed at a percentage cover greater than 10%. The sections where elevated material was most frequently observed, with 8-10% cover (in tows 3, 4 and 5), are dispersed and not consistent between tows, and do not appear to be supported by any consistent patterns of reflectance in the sidescan data.

The full analysis results, as well as metadata for each secondary survey area and tow, with brief descriptions and categories of percentage cover of elevated material, are presented in Table 16, Table 17, and Table 18, and example images shown in Table 19 in the Appendices.

Table 4
Categories allocated to ARIS tows for Area A1

Area	Tow	Section	Notes	Brief description	Elevated Material ≥2cm	
					Frequency	Abundance
A1	Tow 1	Section 1	rough seabed and occasional elevated material throughout	rough ground	occasional	5-7%
A1	Tow 2	Section 1	some smooth, some rough ground, little elevated material throughout	smooth and rough ground	sparse	0-4%
A1	Tow 3	Section 1	smooth at beginning, some rough areas	smooth and rough ground	sparse	0-4%
A1	Tow 3	Section 2	rough ground with occasional elevated material	rough ground	occasional	5-7%
A1	Tow 3	Section 3	rough ground with very occasional elevated material	rough ground	sparse	0-4%
A1	Tow 3	Section 4	rough ground with elevated material	rough ground	some	8-10%
A1	Tow 4	Section 1	rough ground with low and high elevated material	rough ground	some	8-10%
A1	Tow 4	Section 2	rough ground with occasional low elevated material, smooth areas	smooth and rough ground	occasional	5-7%
A1	Tow 5	Section 1	rough ground with low and high elevated material	rough ground	some	8-10%
A1	Tow 5	Section 2	smooth, rough at end	majority featureless	none	0-4%
A1	Tow 5	Section 3	rough ground with low and high elevated material	rough ground	some	8-10%
A1	Tow 5	Section 4	rough ground with occasional elevated material, smooth areas	smooth and rough ground	occasional	5-7%

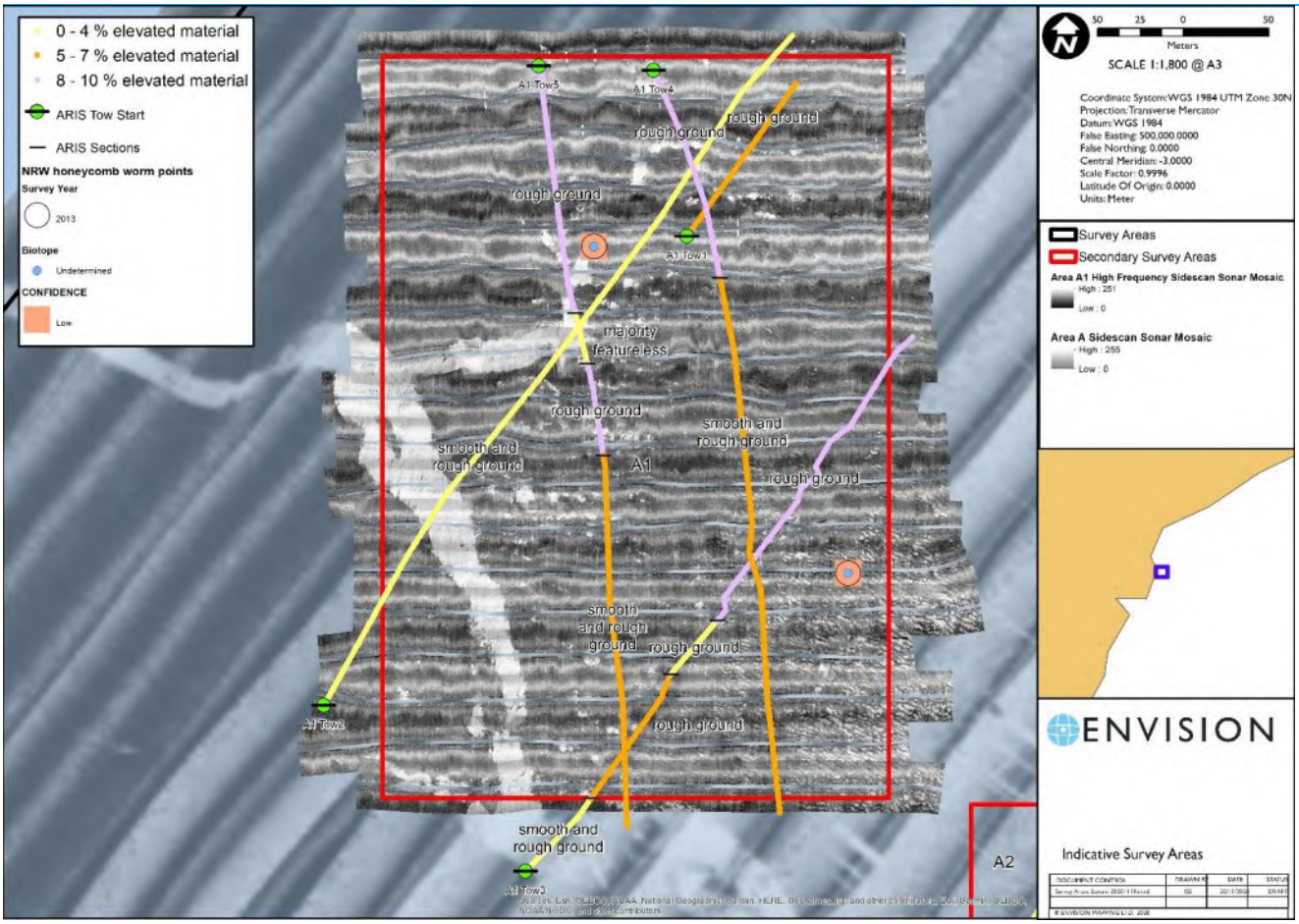


Figure 15.

High frequency sidescan sonar mosaic for survey area A1, with sample points of Sabellaria presence and ARIS sonar camera data overlain

5.1.2. Area A2

The high frequency sidescan data for survey area A2 (Figure 16) shows the majority of the area with a rippled/wave pattern, similar to the southeast corner of secondary survey area A1 (Figure 16), as well as a channel or pockets of featureless areas running northwest to southeast in the southern section of the area.

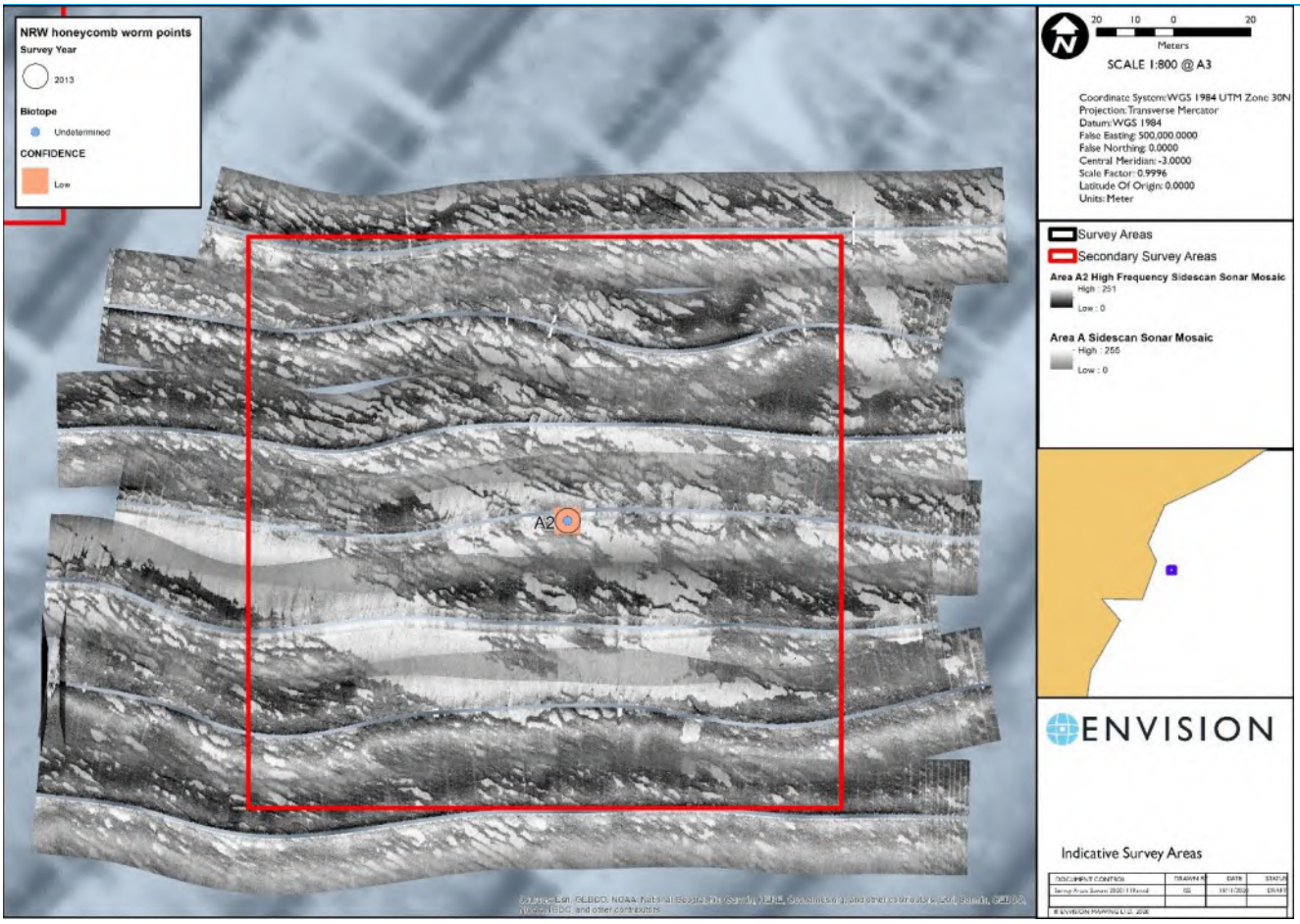


Figure 16.
High frequency sidescan sonar mosaic for survey area A2, with sample points of Sabellaria presence overlain

The ARIS sonar camera imagery for secondary survey area A2 was taken over two tows, and during analysis categories were allocated according to its appearance and the abundance of elevated material (≥2cm), which are presented in Table 5 and in Figure 17.

The seabed in this area appeared to have little reflective material that was elevated, and showed a pattern of smooth areas interspersed with rougher ground, which may be indicative of the ripple or wave features that are visible in the sidescan data (with some coarse material potentially gathering in the troughs of waves).

A featureless area was observed in the middle section of both tows which appears to coincide with the band or channel which can be seen in the sidescan data running from northwest to southeast in the southern section of this survey area.

The full analysis results, including filenames and positions for each secondary survey area and tow, with brief descriptions and categories of percentage cover of elevated material are presented in Table 16, Table 17, and Table 18, and example images shown in Table 19 in the Appendices.

Table 5
Categories allocated to ARIS tows for Area A2

Area	Tow	Section	Notes	Brief description	Elevated Material ≥2cm	
					Frequency	Abundance
A2	Tow 1	Section 1	smooth areas interspersed with rough but sparse reflective material, no elevation	smooth and rough ground	sparse	0-4%
A2	Tow 1	Section 2	smooth, no reflective material	majority featureless	none	0-4%
A2	Tow 1	Section 3	smooth areas interspersed with rough but sparse reflective material, no elevation	smooth and rough ground	sparse	0-4%
A2	Tow 2	Section 1	smooth areas interspersed with rough, not elevated, silt visible	smooth and rough ground	sparse	0-4%
A2	Tow 2	Section 2	smooth, no reflective material	majority featureless	none	0-4%
A2	Tow 2	Section 3	smooth areas interspersed with rough, not elevated, silt visible	smooth and rough ground	sparse	0-4%

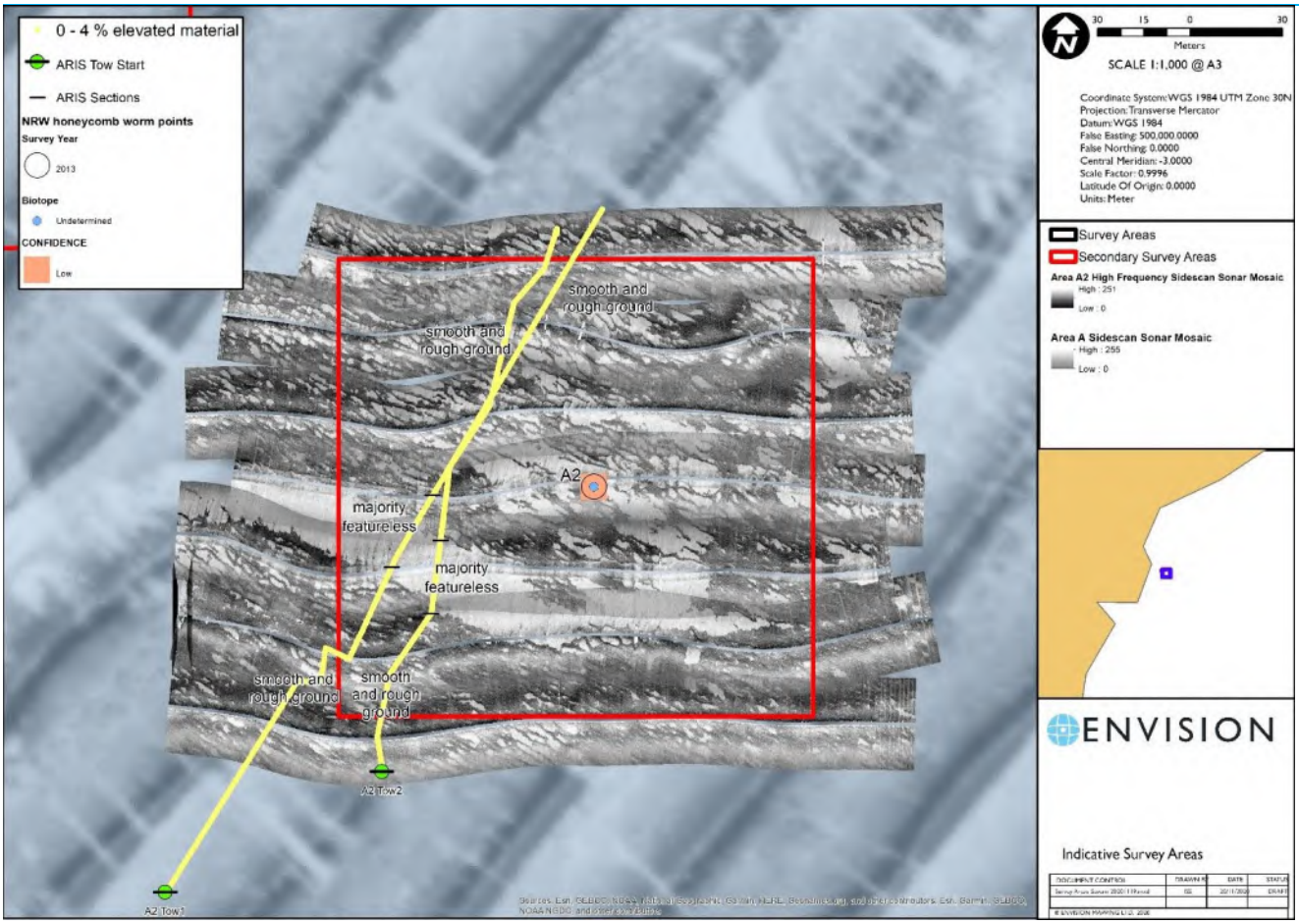


Figure 17.

High frequency sidescan sonar mosaic for survey area A2, with sample points of Sabellaria presence and ARIS sonar camera data overlain

5.1.3. Area A3

The high frequency sidescan data for survey area A3 (Figure 18) shows no distinctive patterns in reflectance, apart from some linear features running north to south which may be consistent with marks left by trawling.

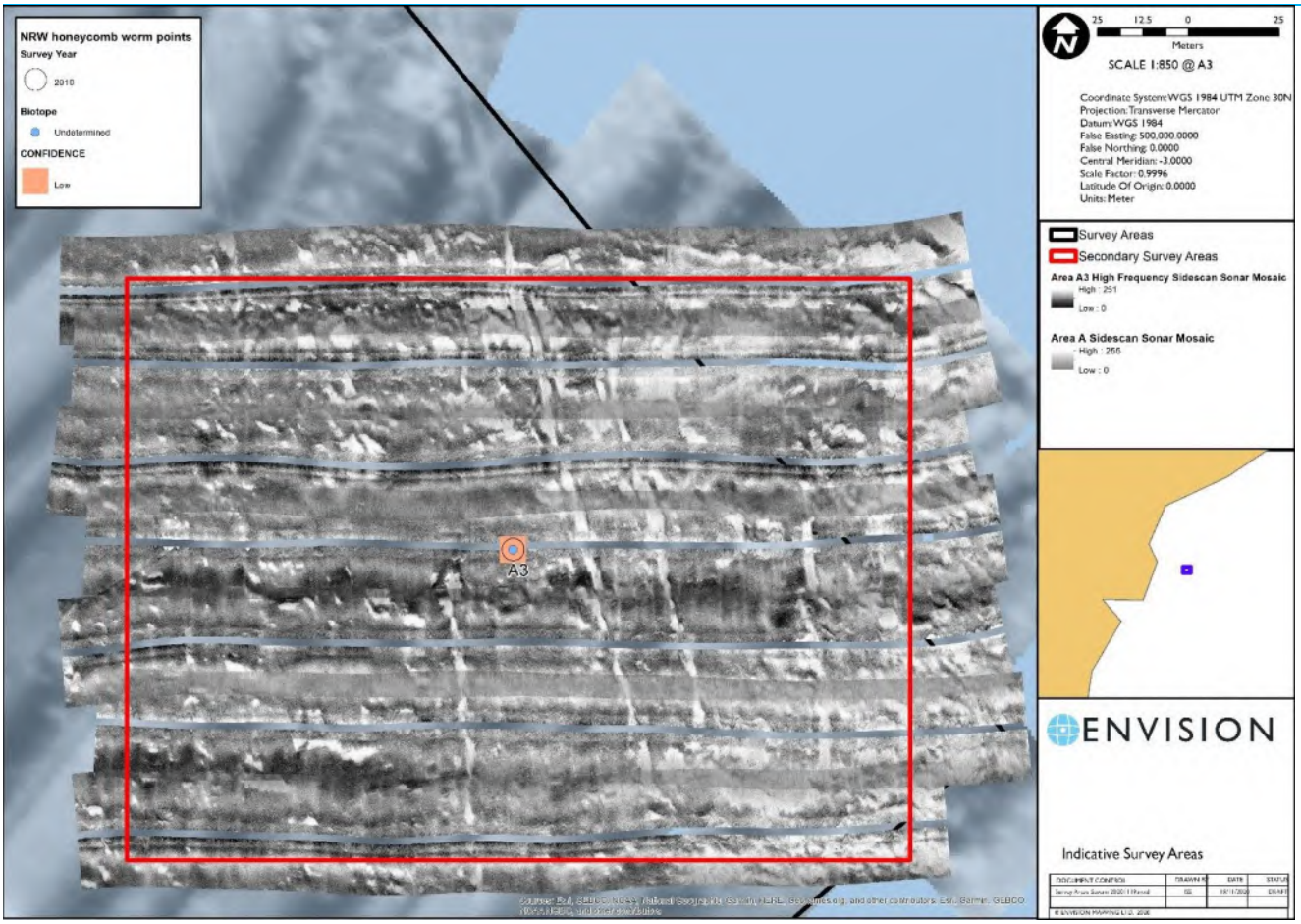


Figure 18.
High frequency sidescan sonar mosaic for survey area A3, with sample points of Sabellaria presence overlain

The ARIS sonar camera imagery for secondary survey area A3 was taken over two tows, and during analysis categories were allocated according to its appearance and the abundance of elevated material (≥2cm), which are presented in Table 6 and in Figure 19.

The seabed appeared in the imagery to be comprised of areas of both rough and smooth ground, with sparse reflective material ranging in elevation but with low percentage cover (0-4%).

The full analysis results, including filenames and positions for each secondary survey area and tow, with brief descriptions and categories of percentage cover of elevated material are presented in Table 16, Table 17, and Table 18, and example images shown in Table 19 in the Appendices.

Table 6
Categories allocated to ARIS tows for Area A3

Area	Tow	Section	Notes	Brief description	Elevated Material ≥2cm	
					Frequency	Abundance
A3	Tow 1	Section 1	rough ground, smooth areas, occasional low elevated material	smooth and rough ground	sparse	0-4%
A3	Tow 2	Section 1	rough ground and smooth areas, occasional low/high elevated material	smooth and rough ground	sparse	0-4%

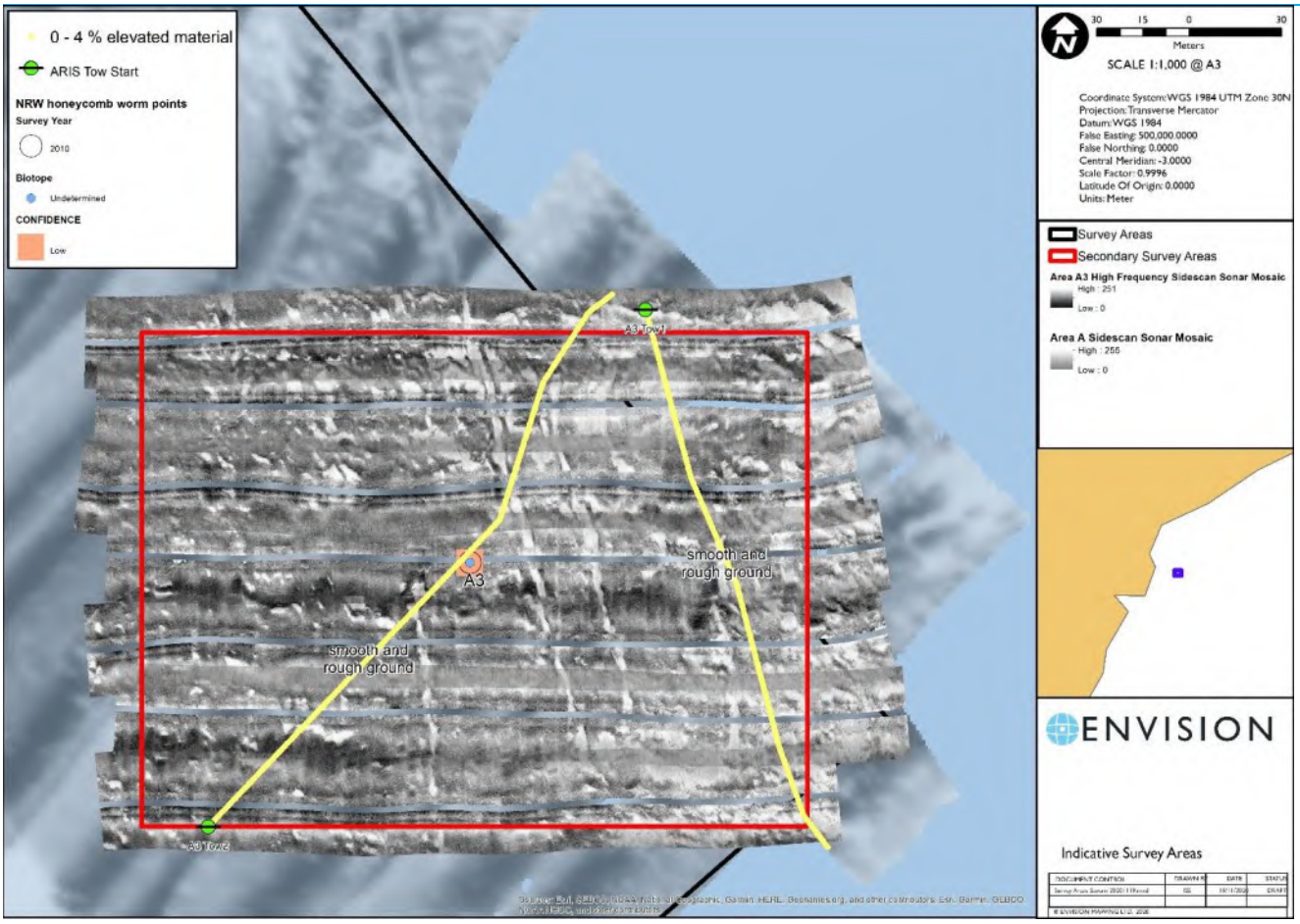


Figure 19.
High frequency sidescan sonar mosaic for survey area A3, with sample points of Sabellaria presence and ARIS sonar camera data overlain

5.1.4. Area A4

The high frequency sidescan data for survey area A4 (Figure 20) is variable without any clear features apparent, however potentially shows some channels or pockets of featureless areas running northwest to southeast.

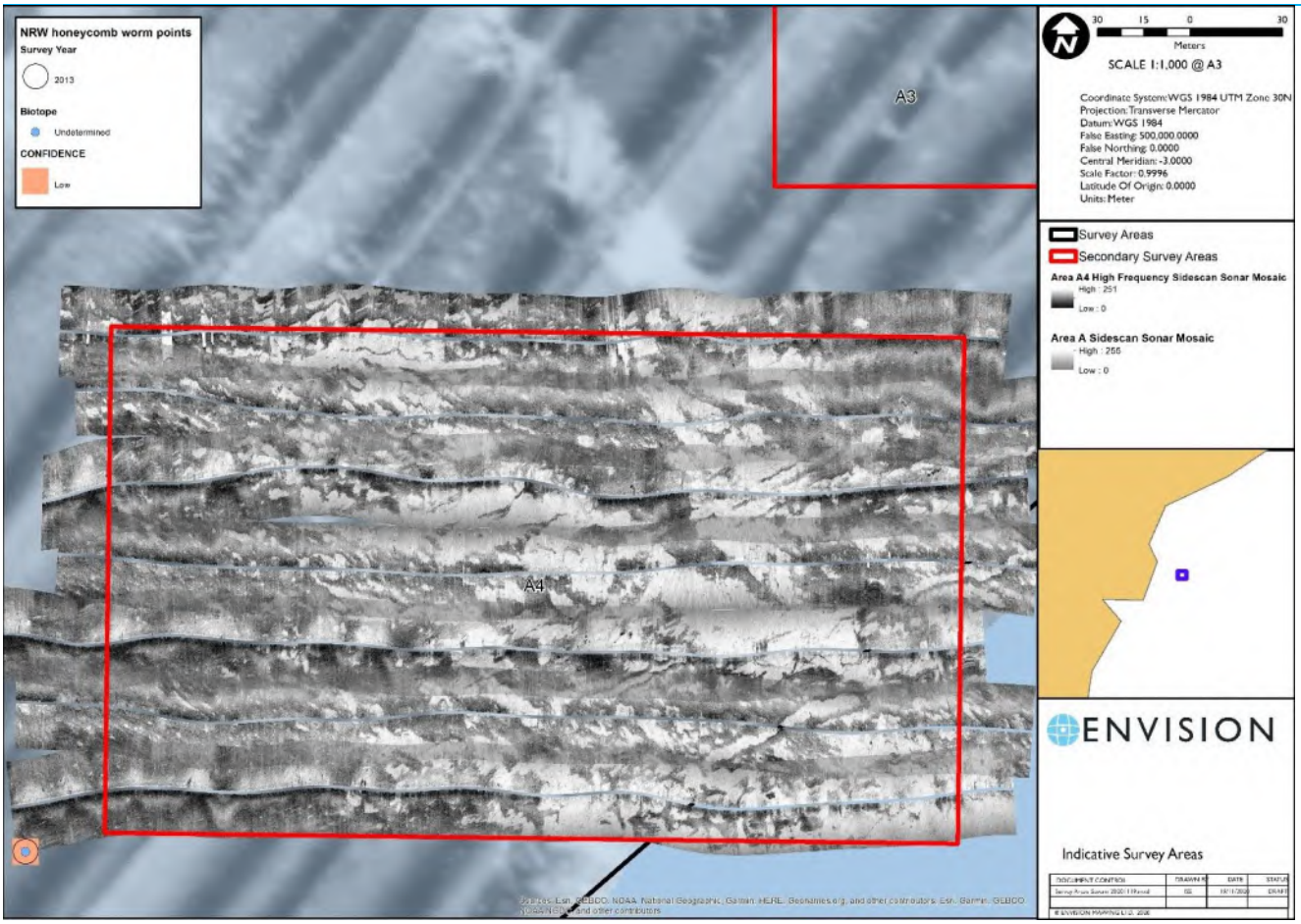


Figure 20.
High frequency sidescan sonar mosaic for survey area A4, with sample points of Sabellaria presence overlain

The ARIS sonar camera imagery for secondary survey area A4 was taken over two tows, and during analysis categories were allocated according to its appearance and the abundance of elevated material (≥2cm), which are presented in the following Table 7 and in Figure 21.

The seabed appeared in the imagery to be comprised of rough ground and intermittent smooth areas, with sparse reflective material of low elevation and low percentage cover (0-4%).

The full analysis results, including filenames and positions for each secondary survey area and tow, with brief descriptions and categories of percentage cover of elevated material are presented in Table 16, Table 17, and Table 18, and example images shown in Table 19 in the Appendices.

Table 7
Categories allocated to ARIS tows for Area A4

Area	Tow	Section	Notes	Brief description	Elevated Material ≥2cm	
					Frequency	Abundance
A4	Tow 1	Section 1	ground appears rough, very occasional elevated material, smooth areas at middle to end	smooth and rough ground	sparse	0-4%
A4	Tow 2	Section 1	little reflective material (low elevation), smooth areas throughout	smooth and rough ground	sparse	0-4%

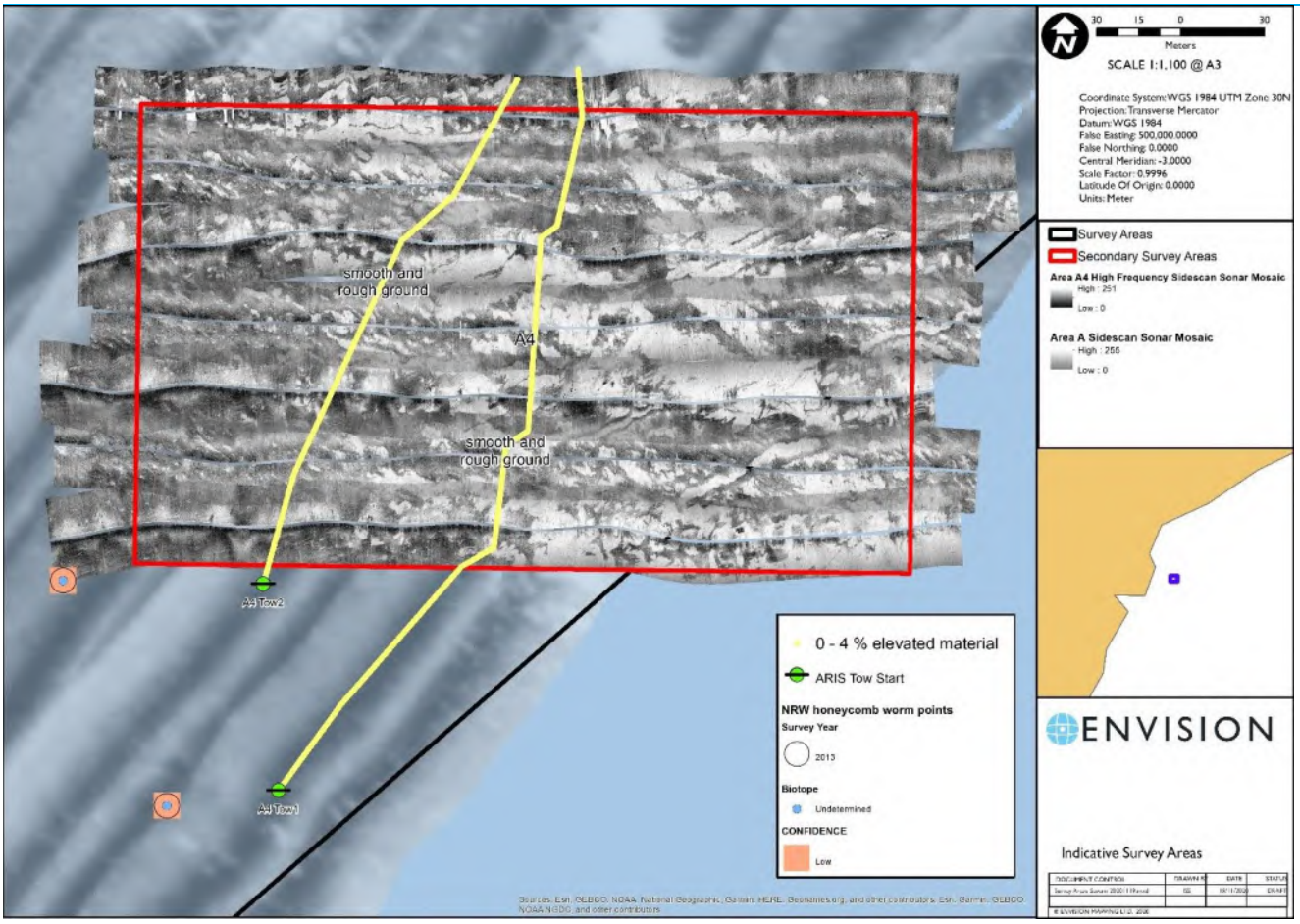


Figure 21.
High frequency sidescan sonar mosaic for survey area A4, with sample points of Sabellaria presence and ARIS sonar camera data overlain

5.2. Area B

The data from the broadscale surveys for area B are presented in Figure 22 to Figure 24, including bathymetry, roughness values (AGDS) and sidescan sonar.

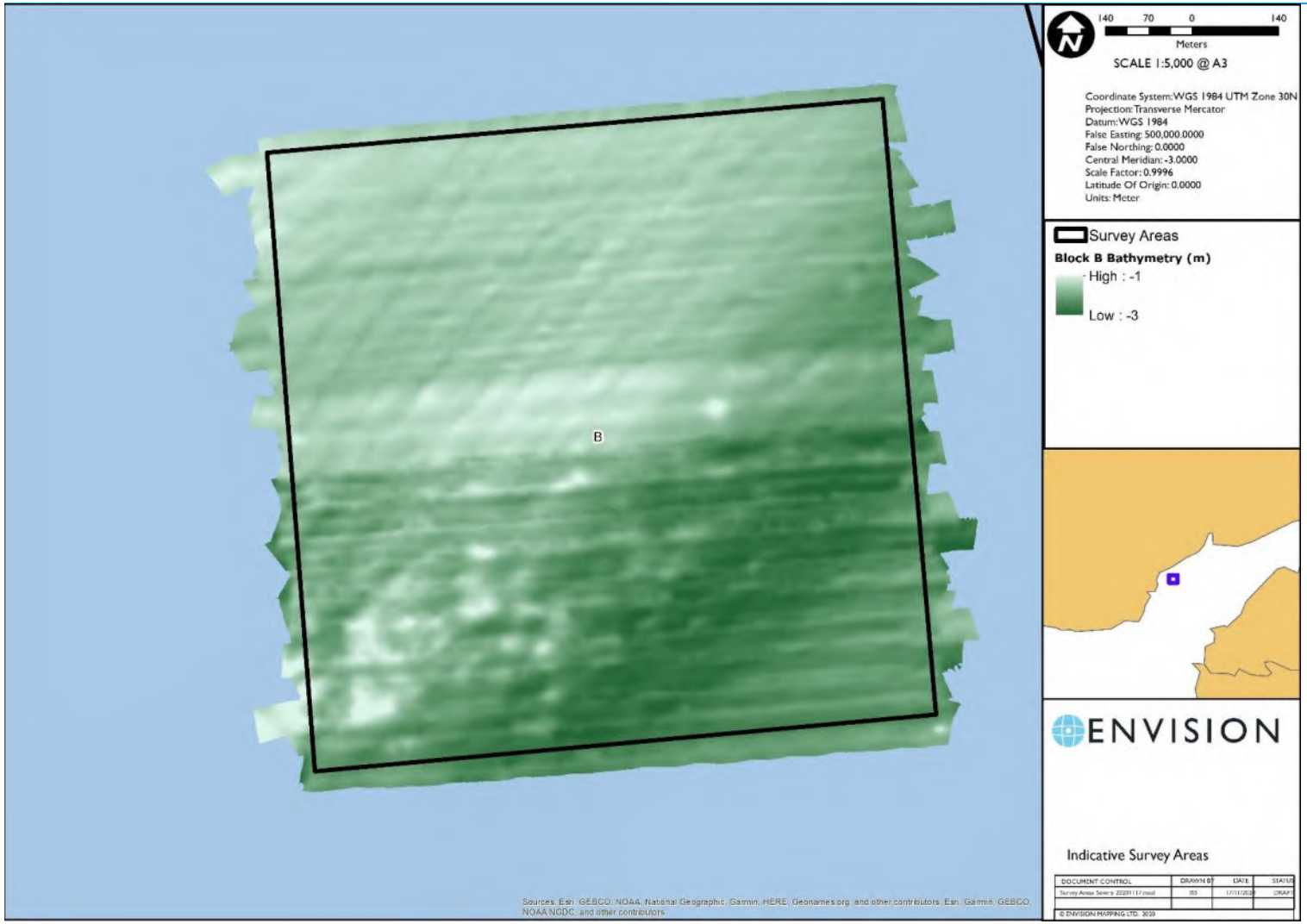


Figure 22.
Bathymetric data for survey area B

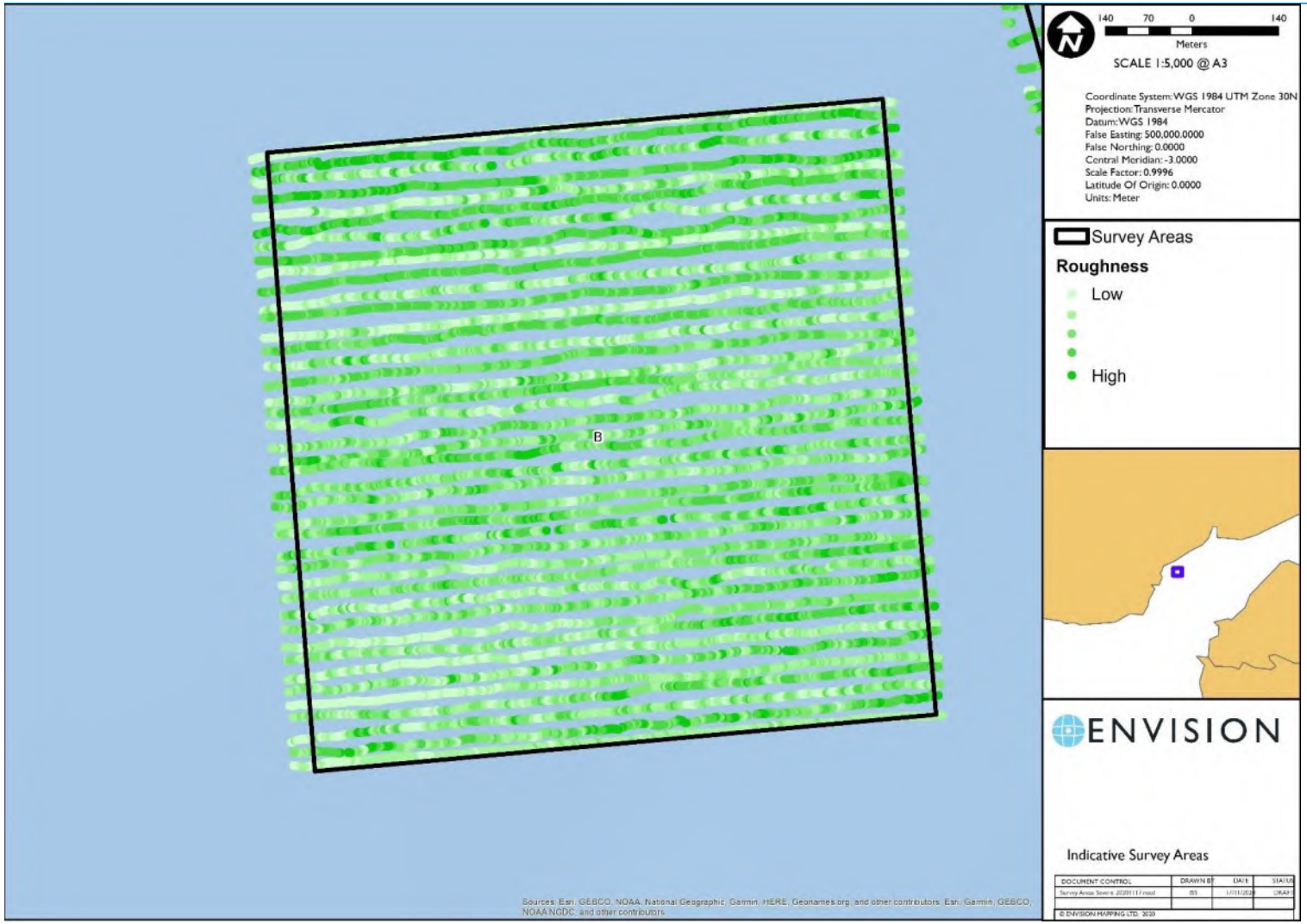


Figure 23.
AGDS data showing roughness values for survey area B

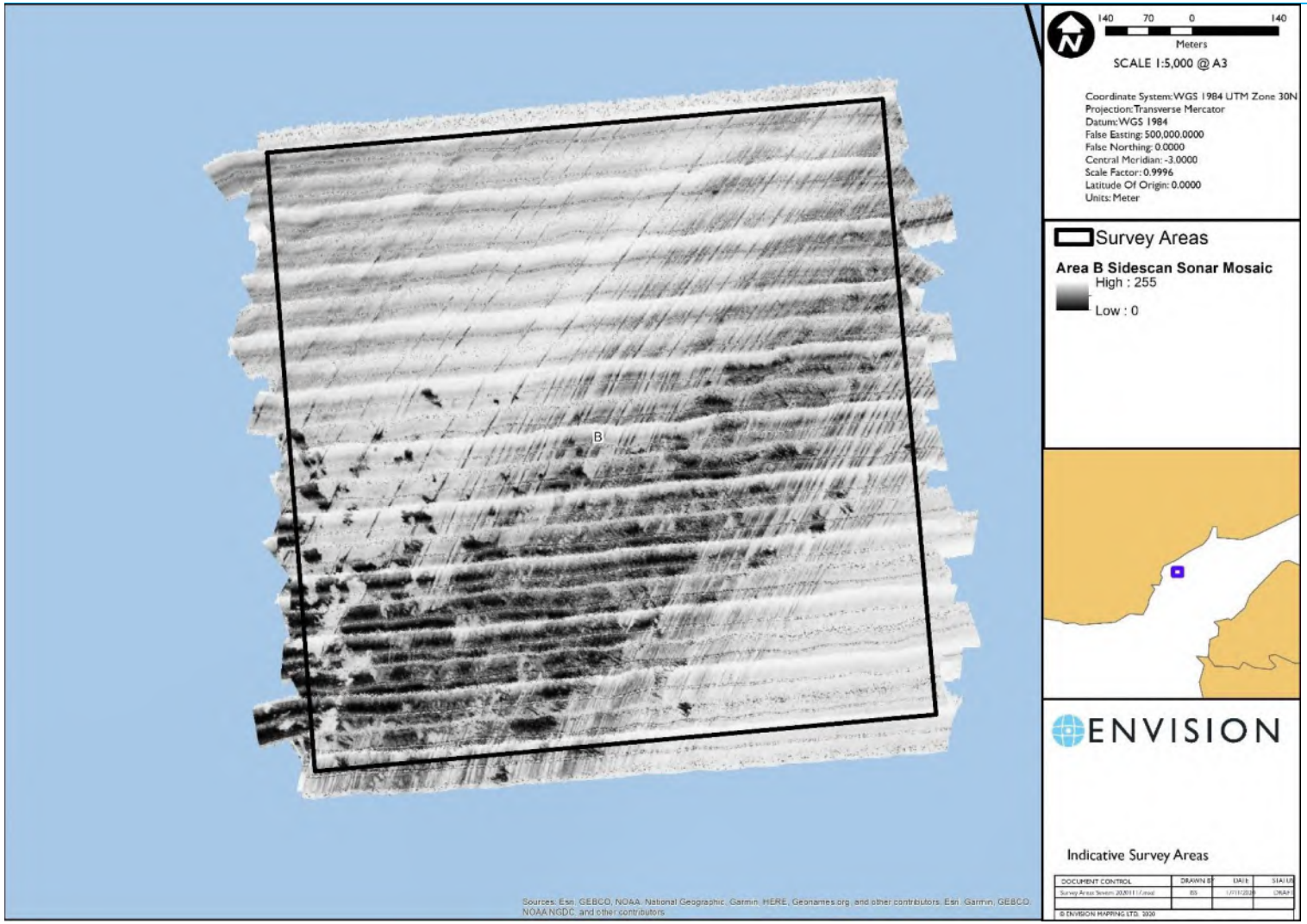


Figure 24.
Sidescan sonar mosaic for survey area B

After examination of the acoustic data from initial surveys and the location of NRW sample points showing presence of Sabellaria, secondary survey areas were selected to investigate potential features or areas of variable ground, which are shown as red boxes in Figure 25.

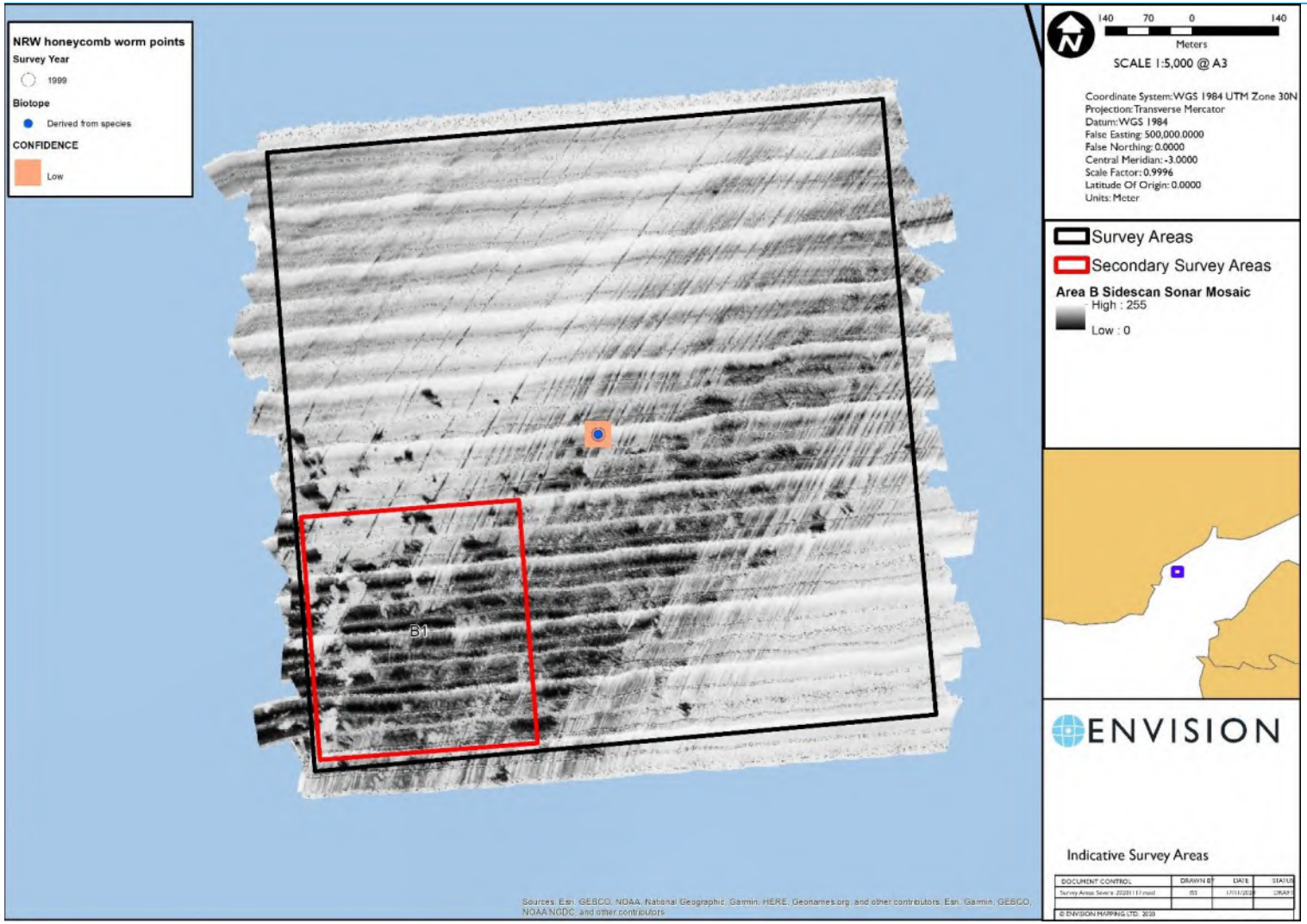


Figure 25.
Sidescan sonar mosaic for survey Area B, with NRW sample points showing presence of Sabellaria overlain, and secondary survey area

5.2.1. Area B1

The high frequency sidescan data for survey area B1 (Figure 26) shows largely smooth seabed with some linear features running northeast to southwest in the northeast part of the survey area, which may be consistent with marks left by trawling. The remainder of the survey area shows some variation in the seabed reflectance, with darker bands also running northeast to southwest, but no distinctive patterns of reflectance indicative of reef.

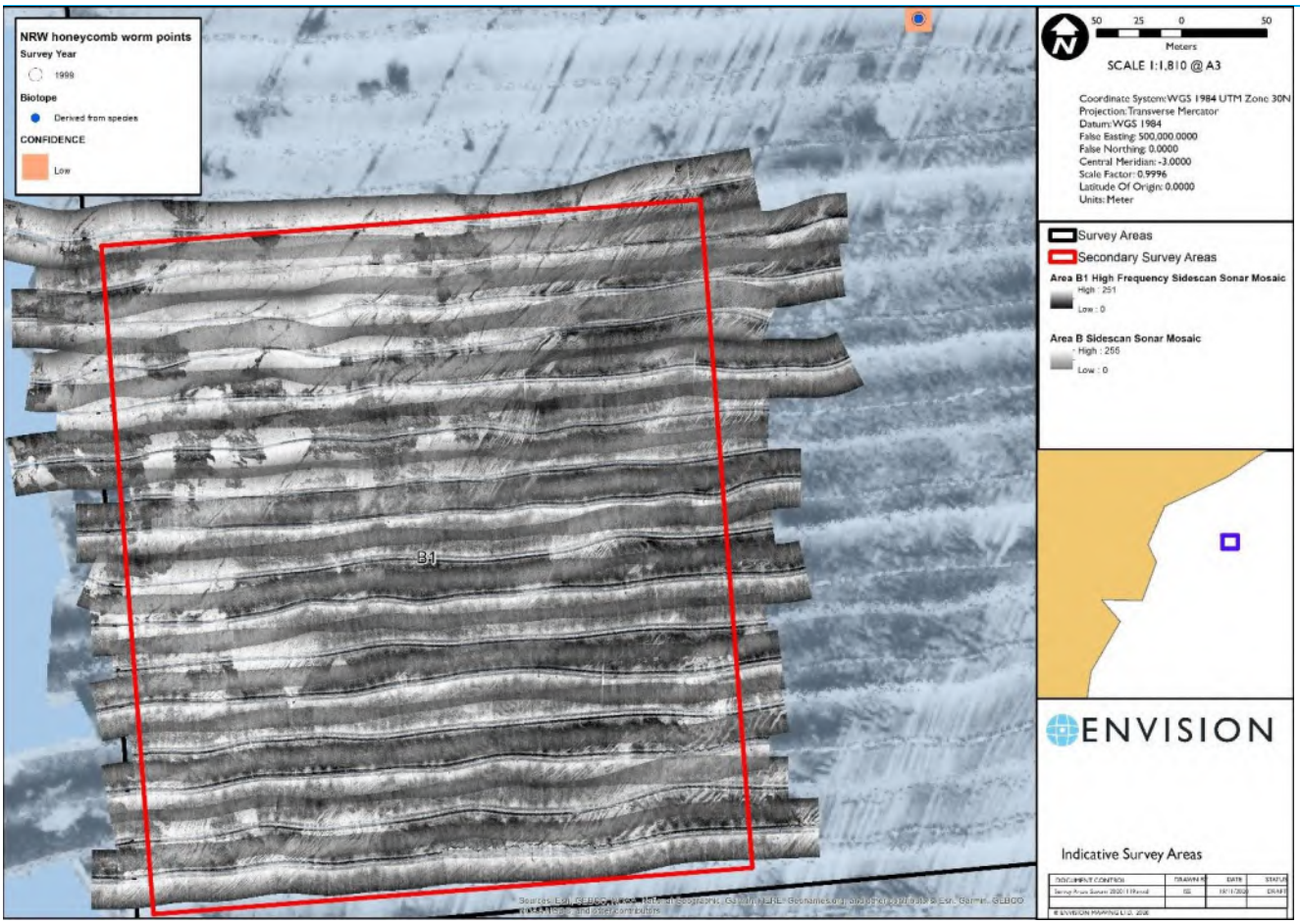


Figure 26.
High frequency sidescan sonar mosaic for survey area B1, with sample points of Sabellaria presence overlain

The ARIS sonar camera imagery for secondary survey area B1 was taken over two tows, and during analysis categories were allocated according to its appearance and the abundance of elevated material (≥2cm), which are presented in the following Table 8 and in Figure 27.

The seabed in area B1 did show variability within the imagery, with Tow 1 appearing largely featureless at either end with potential ripples present, and rougher ground in the central sections (Section 2 and 3) with occasional elevated material observed. Tow 2 showed a lot of variability, with featureless and smooth areas with little reflective material interspersed with areas of rough ground with elevated material present. The

smooth and featureless areas with little elevated material observed in the ARIS imagery appear to coincide with blank or featureless areas of the high frequency sidescan.

The full analysis results, including filenames and positions for each secondary survey area and tow, with brief descriptions and categories of percentage cover of elevated material, are presented in Table 16, Table 17, and Table 18, and example images shown in Table 19 in the Appendices.

Table 8
Categories allocated to ARIS tows for Area B1

Area	Tow	Section	Notes	Brief description	Elevated Material ≥2cm	
					Frequency	Abundance
B1	Tow 1	Section 1	smooth, featureless, some reflective material at end - no shadow, possible ripples	majority featureless, ripples present	none	0-4%
B1	Tow 1	Section 2	rough ground with low and high elevated material	rough ground	occasional	5-7%
B1	Tow 1	Section 3	smooth and rough areas, with some low elevated material, tyre/objects present	smooth and rough ground	occasional	5-7%
B1	Tow 1	Section 4	majority featureless, little reflective material, ripples at end	majority featureless, ripples present	none	0-4%
B1	Tow 2	Section 1	smooth, little reflective material, possible Lanice, ripples present	smooth, ripples present	sparse	0-4%
B1	Tow 2	Section 2	rough, with low and high elevated material common	rough ground	some	8-10%
B1	Tow 2	Section 3	rough with some low elevated material	rough ground	occasional	5-7%
B1	Tow 2	Section 4	little reflective material, majority smooth, ripples present	majority featureless, ripples present	none	0-4%
B1	Tow 2	Section 5	rough, with low and high elevated material common	rough ground	some	8-10%
B1	Tow 2	Section 6	rough and smooth areas, with little low elevated material	smooth and rough ground	sparse	0-4%
B1	Tow 2	Section 7	smooth, featureless, very occasional high elevated material	smooth ground	sparse	0-4%

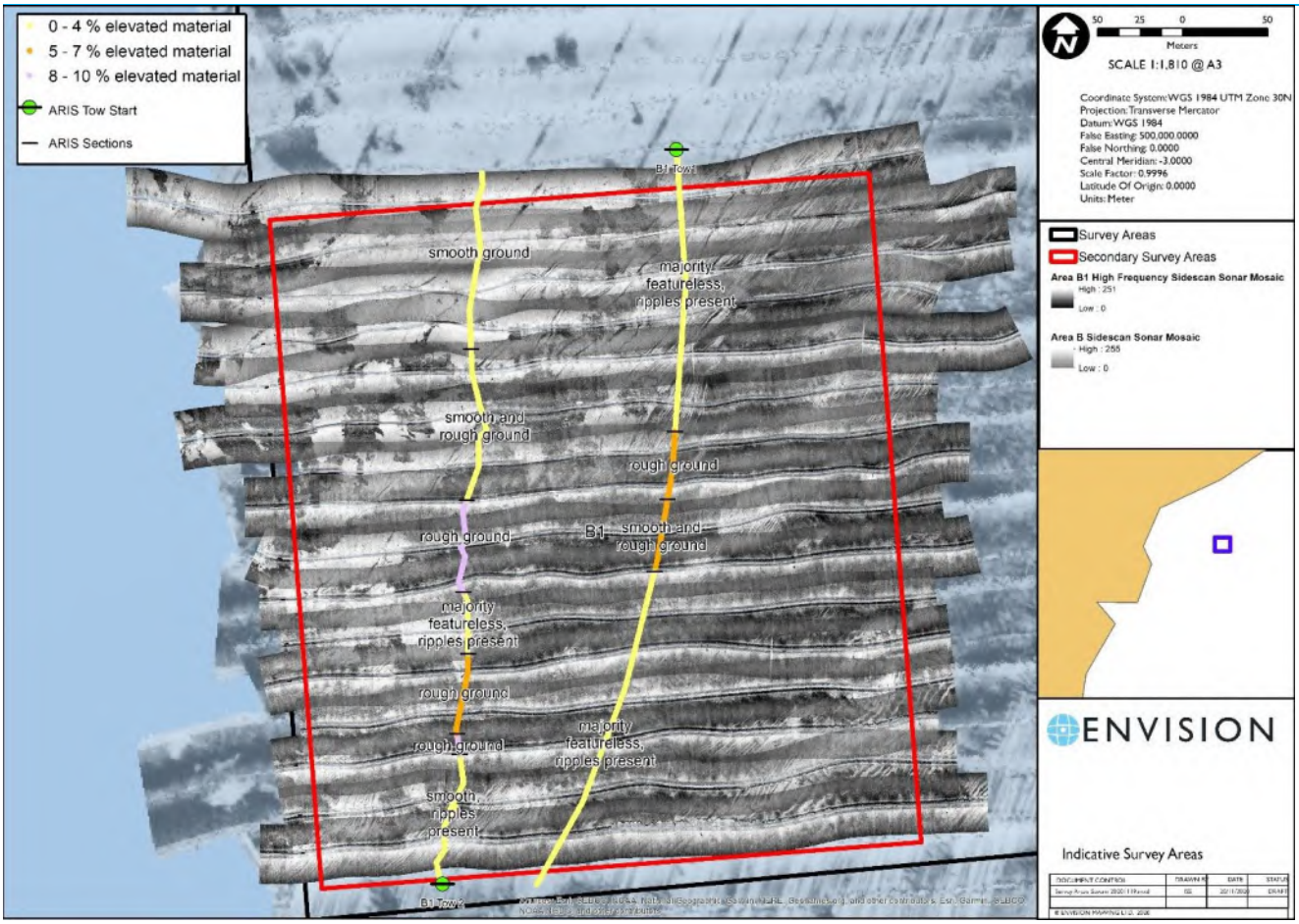


Figure 27.

High frequency sidescan sonar mosaic for survey area B1, with sample points of Sabellaria presence and ARIS sonar camera data overlain

5.3. Area C

The data from the broadscale surveys for area C are presented in Figure 28 to Figure 30, including bathymetry, roughness values (AGDS) and sidescan sonar.

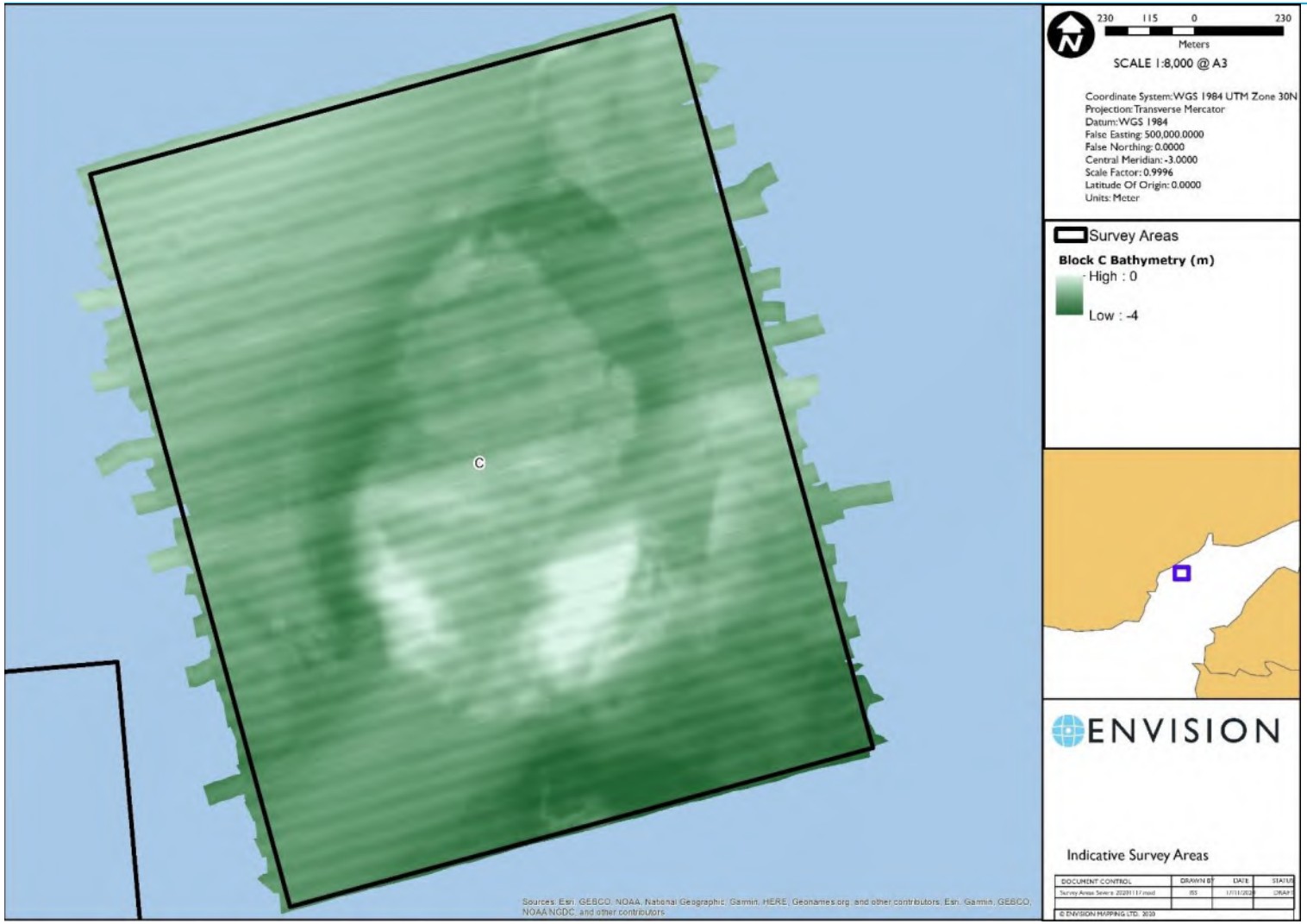


Figure 28.
Bathymetric data for survey area C

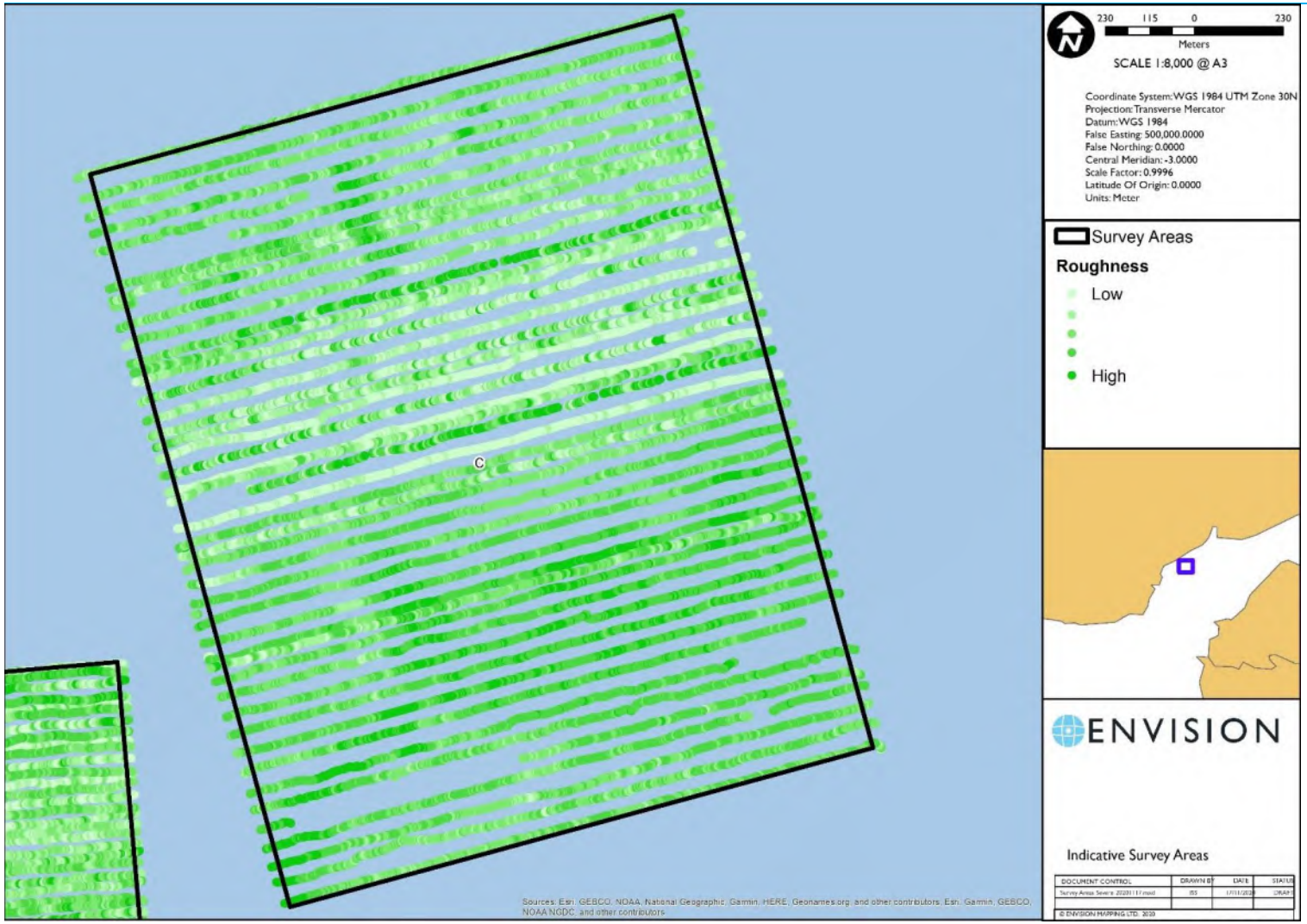


Figure 29.
AGDS data showing roughness values for survey area C

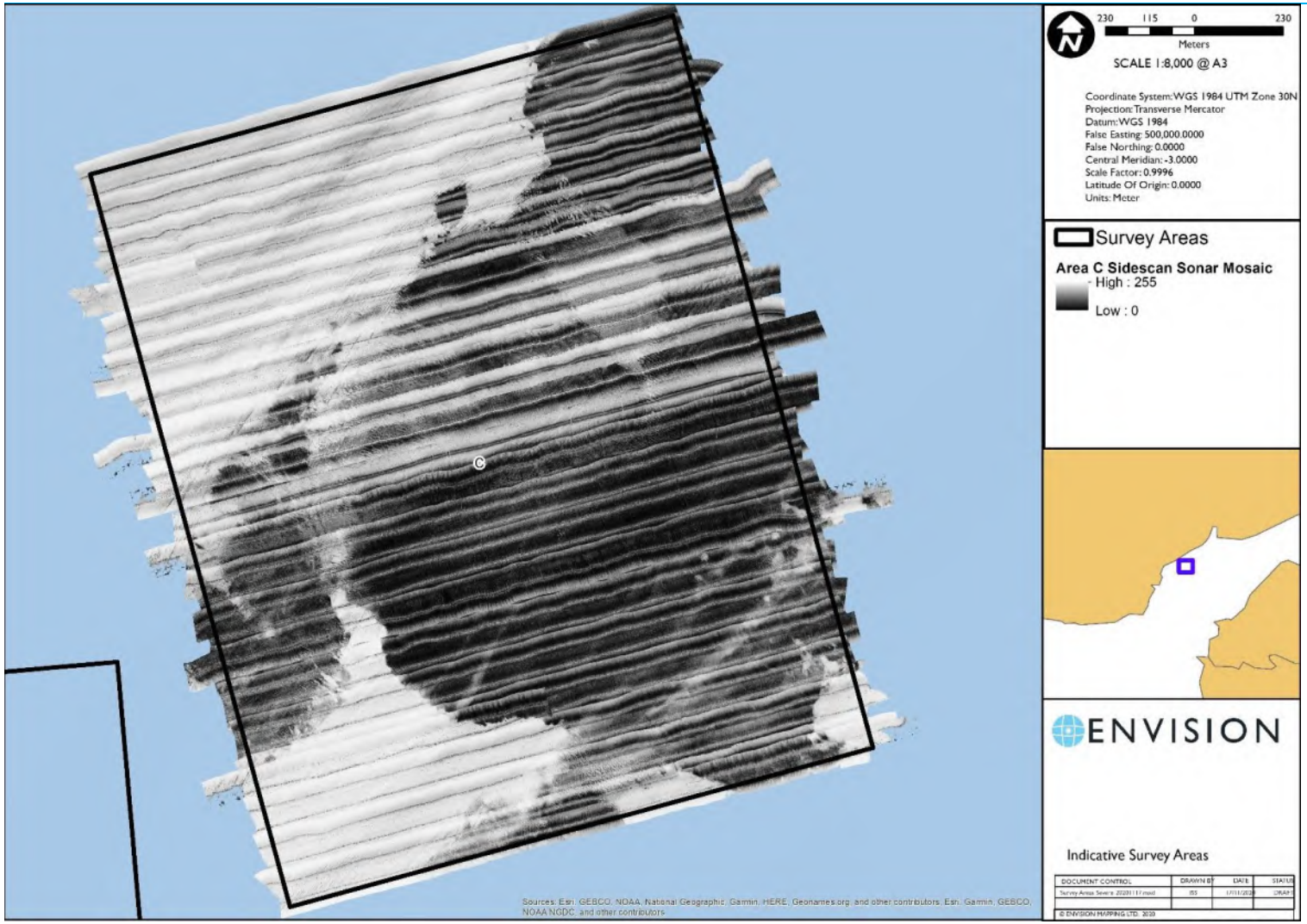


Figure 30.
Sidescan sonar mosaic for survey area C

After examination of the acoustic data from initial surveys and the location of NRW sample points showing presence of Sabellaria, secondary survey areas were selected to investigate potential features or areas of variable ground, which are shown as red boxes in Figure 31.

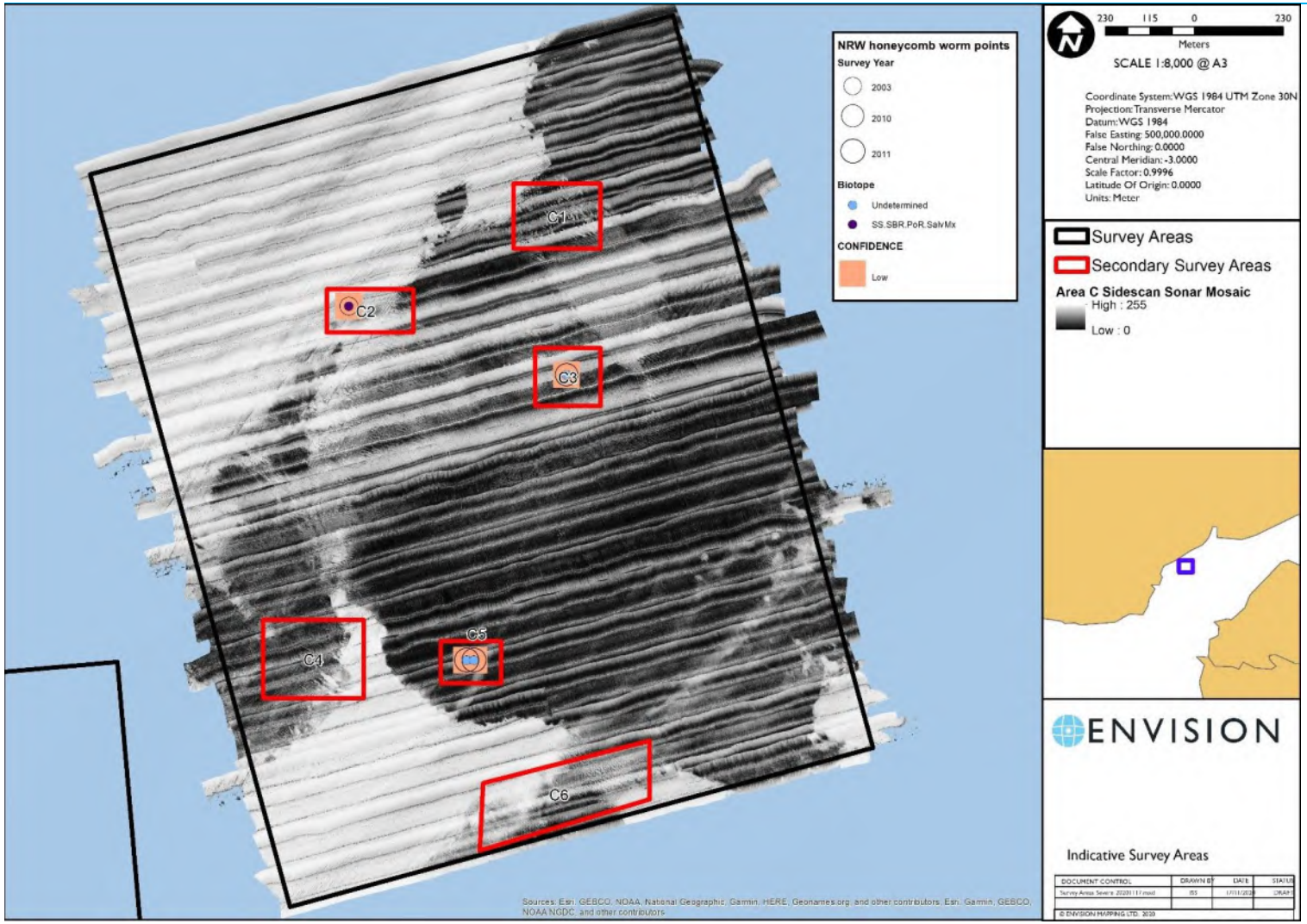


Figure 31.
Sidescan sonar mosaic for survey area C, with NRW sample points showing presence of Sabellaria overlain, and secondary survey areas

5.3.1. Area C1

The high frequency sidescan data for survey area C1 (Figure 32) shows some linear features in the very northwest corner running northeast to southwest which may be consistent with marks left by trawling or winnowing of the sediment by tidal movements. The majority of the area appears to be comprised of dark and light bands which may indicate waves or the effect of tides or currents on sediment.

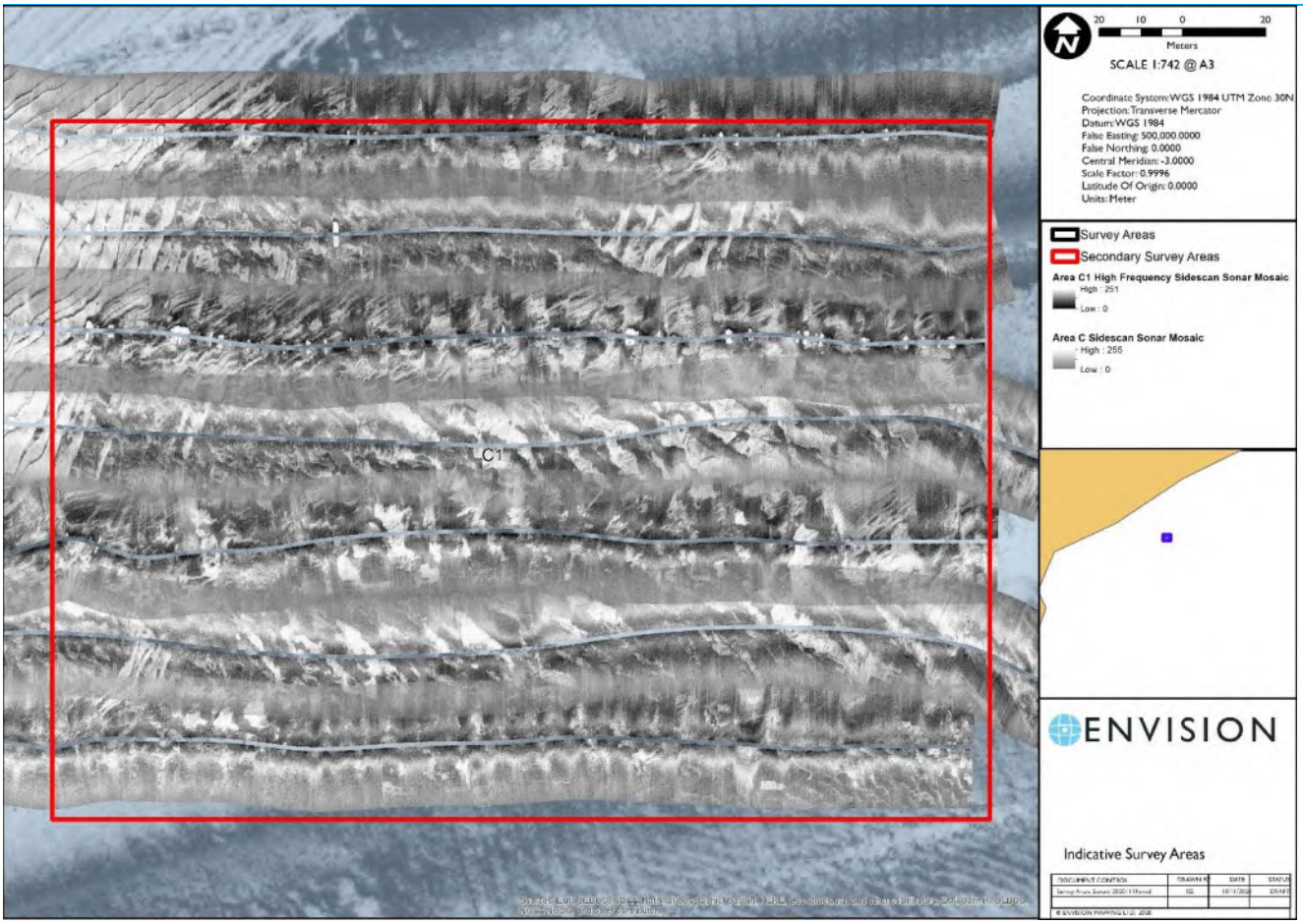


Figure 32.
High frequency sidescan sonar mosaic for survey area C1, with sample points of Sabellaria presence overlain (none present in area)

The ARIS sonar camera imagery for secondary survey area C1 was taken over two tows, and during analysis categories were allocated according to its appearance and the abundance of elevated material (≥2cm), which are presented in the following Table 9 and in Figure 33.

The seabed appeared in the imagery to be comprised of smooth ground and intermittent areas of rough ground, with sparse reflective material of low elevation and low percentage cover (0-4%) throughout.

The full analysis results, including filenames and positions for each secondary survey area and tow, with brief descriptions and categories of percentage cover of elevated

material, are presented in Table 16, Table 17, and Table 18, and example images shown in Table 19 in the Appendices.

Table 9
Categories allocated to ARIS tows for Area C1

Area	Tow	Section	Notes	Brief description	Elevated Material ≥2cm	
					Frequency	Abundance
C1	Tow 1	Section 1	little reflective material, occasional low elevation, second half mostly featureless	smooth ground	sparse	0-4%
C1	Tow 2	Section 1	smooth areas, interspersed with rough (waves?), not much reflective material (low)	smooth and rough ground	sparse	0-4%

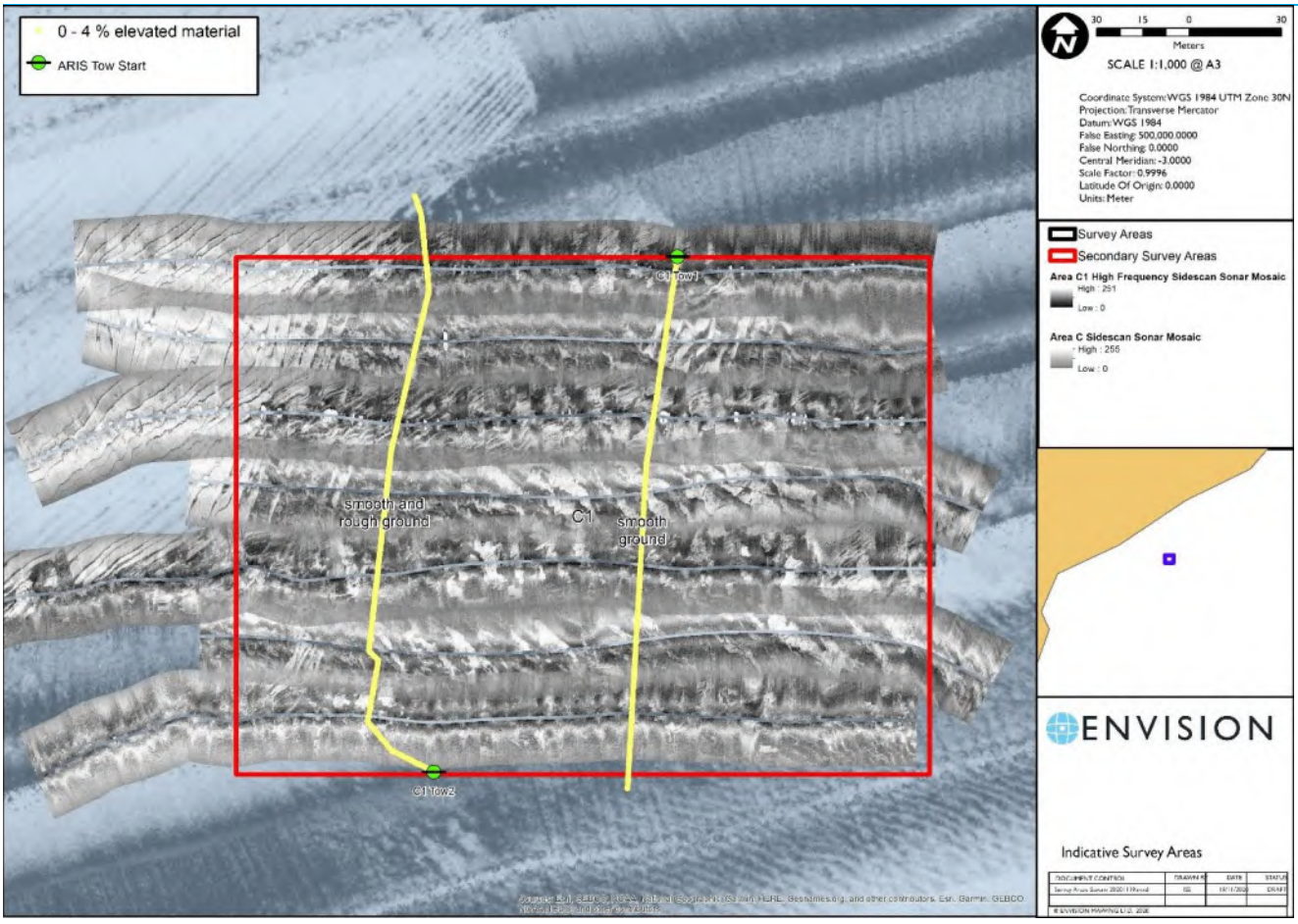


Figure 33.
High frequency sidescan sonar mosaic for survey area C1, with sample points of Sabellaria presence (none present in area) and ARIS sonar camera data overlain

5.3.2. Area C2

The high frequency sidescan data for survey area C2 (Figure 34) appears to be largely featureless, with only a faint indication of linear features. The eastern section of the survey area is darker in the sidescan and may be indicative of more variable ground.

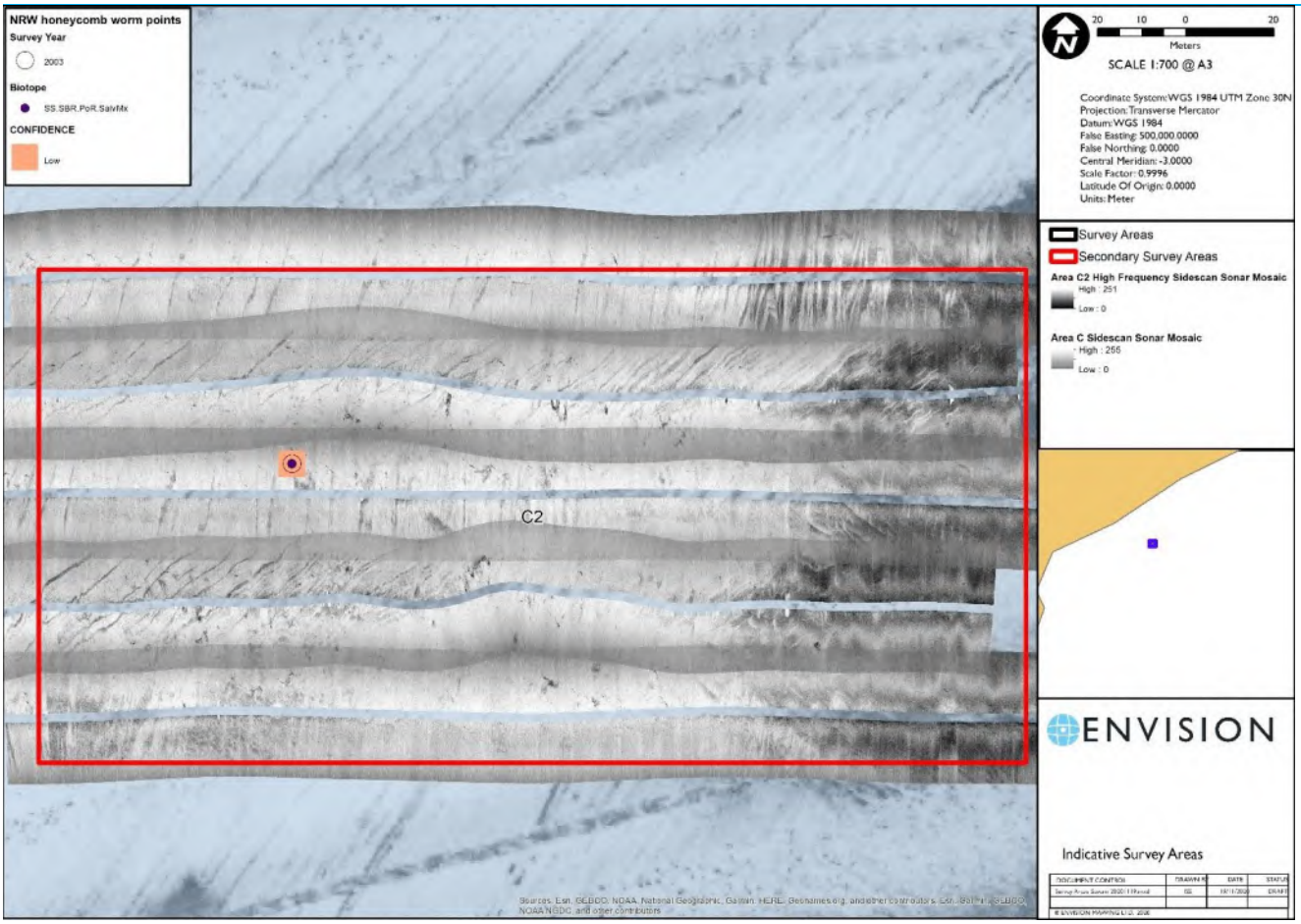


Figure 34.
High frequency sidescan sonar mosaic for survey area C2, with sample points of Sabellaria presence overlain (none present in area)

The ARIS sonar camera imagery for secondary survey area C2 was taken over two tows, and during analysis categories were allocated according to its appearance and the abundance of elevated material (≥2cm), which are presented in the following Table 10 and in Figure 35.

The seabed appeared in the imagery to be largely featureless, with no reflective material. Rippled sediment was observed in bands which may be indicative of ripples on waves or potential evidence of trawling activity. Non-linear (3D) ripples were present at the start of Tow 2, but the remainder was featureless.

The full analysis results, including filenames and positions for each secondary survey area and tow, with brief descriptions and categories of percentage cover of elevated

material, are presented in Table 16, Table 17, and Table 18, and example images shown in Table 19 in the Appendices.

Table 10
Categories allocated to ARIS tows for Area C2

Area	Tow	Section	Notes	Brief description	Elevated Material ≥2cm	
					Frequency	Abundance
C2	Tow 1	Section 1	linear features and ripples, but no reflective material (ripples on waves?)	majority featureless, ripples present	none	0-4%
C2	Tow 2	Section 1	mostly featureless, some 3d ripples near the start	majority featureless, ripples present	none	0-4%

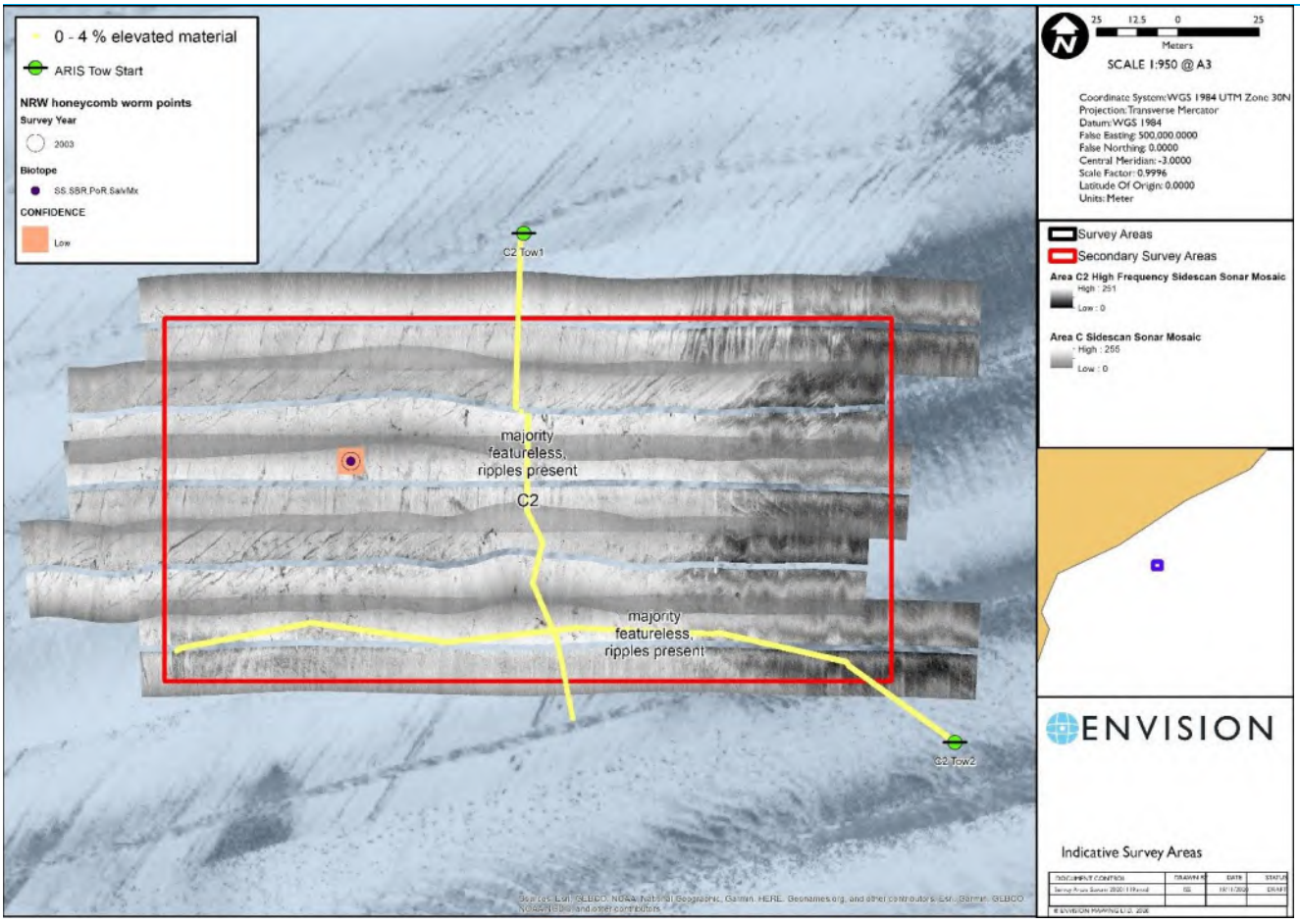


Figure 35.
High frequency sidescan sonar mosaic for survey area C2, with sample points of Sabellaria presence and ARIS sonar camera data overlain

5.3.3. Area C3

The high frequency sidescan data for survey area C3 (Figure 36) shows no distinctive patterns in reflectance, apart from some variability in the southeastern corner of the survey area.

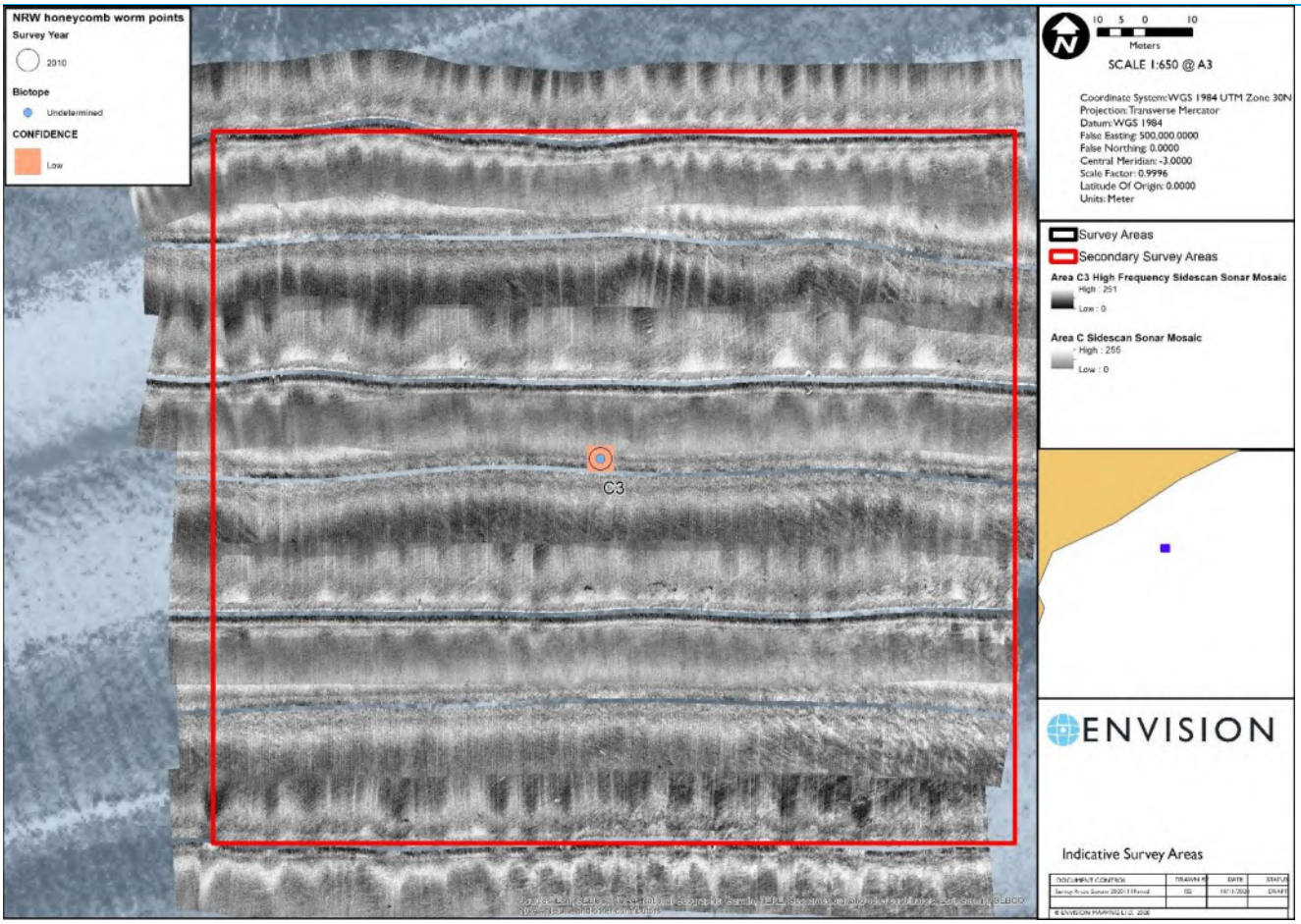


Figure 36.
High frequency sidescan sonar mosaic for survey area C3, with sample points of Sabellaria presence overlain

The ARIS sonar camera imagery for secondary survey area C3 was taken over two tows, and during analysis categories were allocated according to its appearance and the abundance of elevated material (≥2cm), which are presented in the following Table 11 and in Figure 37.

The majority of seabed in this area was rippled, regularly interspersed with areas of rough ground (possible troughs of waves) and reflective material with a range of elevation, sometimes high. Whilst the elevated material was regularly observed in the areas of rough ground, the seabed was largely rippled sediment with no elevated material, making the overall abundance of elevated material sparse. One section at the start of C3 Tow 3 had more elevated material, which coincides with the more variable looking area of sidescan in the southeast corner.

The full analysis results, including filenames and positions for each secondary survey area and tow, with brief descriptions and categories of percentage cover of elevated material, are presented in Table 16, Table 17, and Table 18, and example images shown in Table 19 in the Appendices.

Table 11
Categories allocated to ARIS tows for Area C3

Area	Tow	Section	Notes	Brief description	Elevated Material ≥2cm	
					Frequency	Abundance
C3	Tow 2	Section 1	mostly rippled sediment, interspersed with areas of rough ground with some elevated material	smooth and rough ground, ripples present	sparse	0-4%
C3	Tow 3	Section 1	rough ground and smooth/rippled areas with occasional elevated material, some high	smooth and rough ground, ripples present	occasional	5-7%
C3	Tow 3	Section 2	mostly rippled sediment, interspersed with areas of rough ground with some elevated material	majority featureless, ripples present	sparse	0-4%

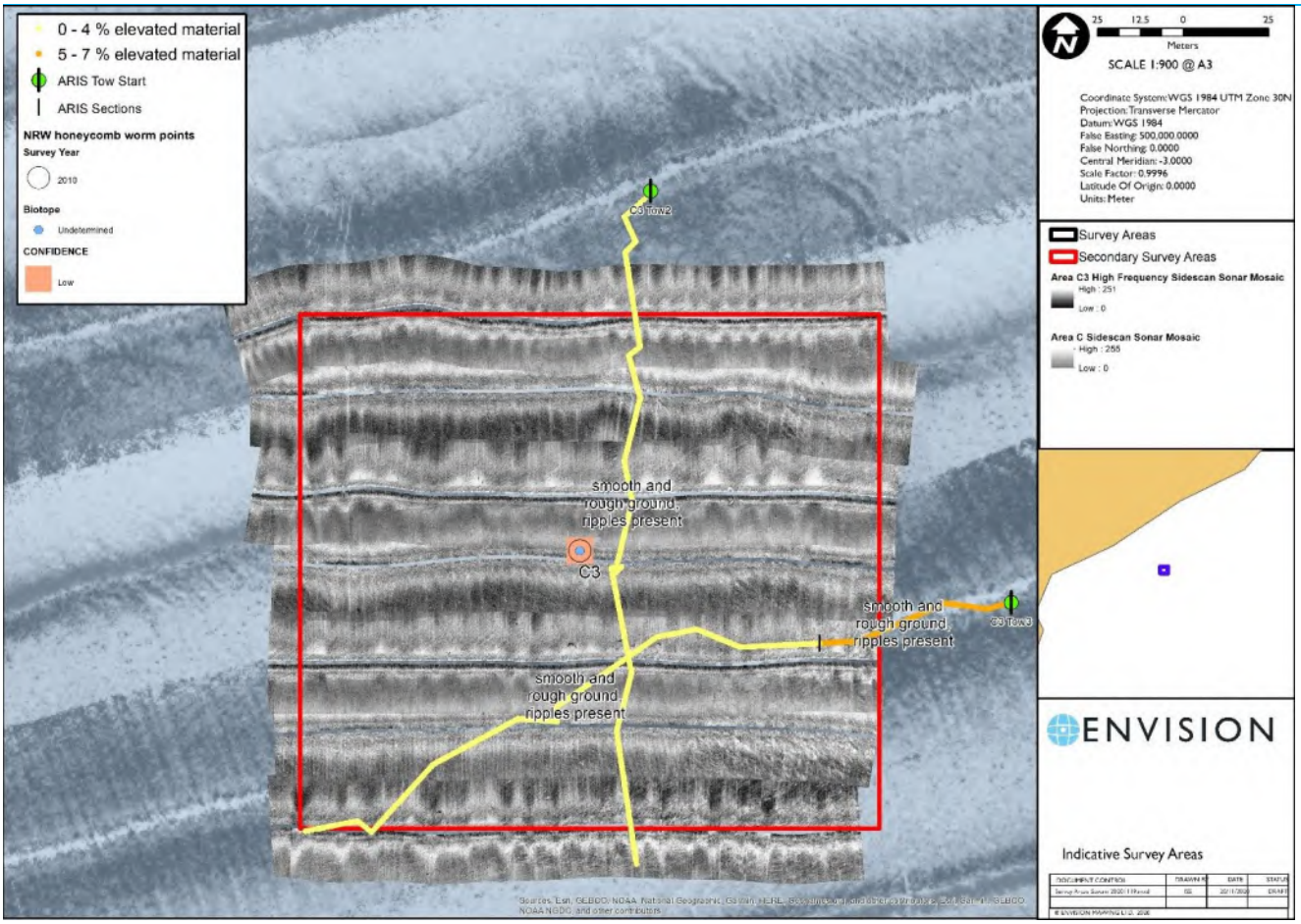


Figure 37.

High frequency sidescan sonar mosaic for survey area C3, with sample points of Sabellaria presence and ARIS sonar camera data overlain

5.3.4. Area C4

The high frequency sidescan data for C4 (Figure 38) shows featureless areas to the east of the survey area and in the northwest corner, with a darker area running northeast to southwest which may indicate an area of seabed with greater variability.

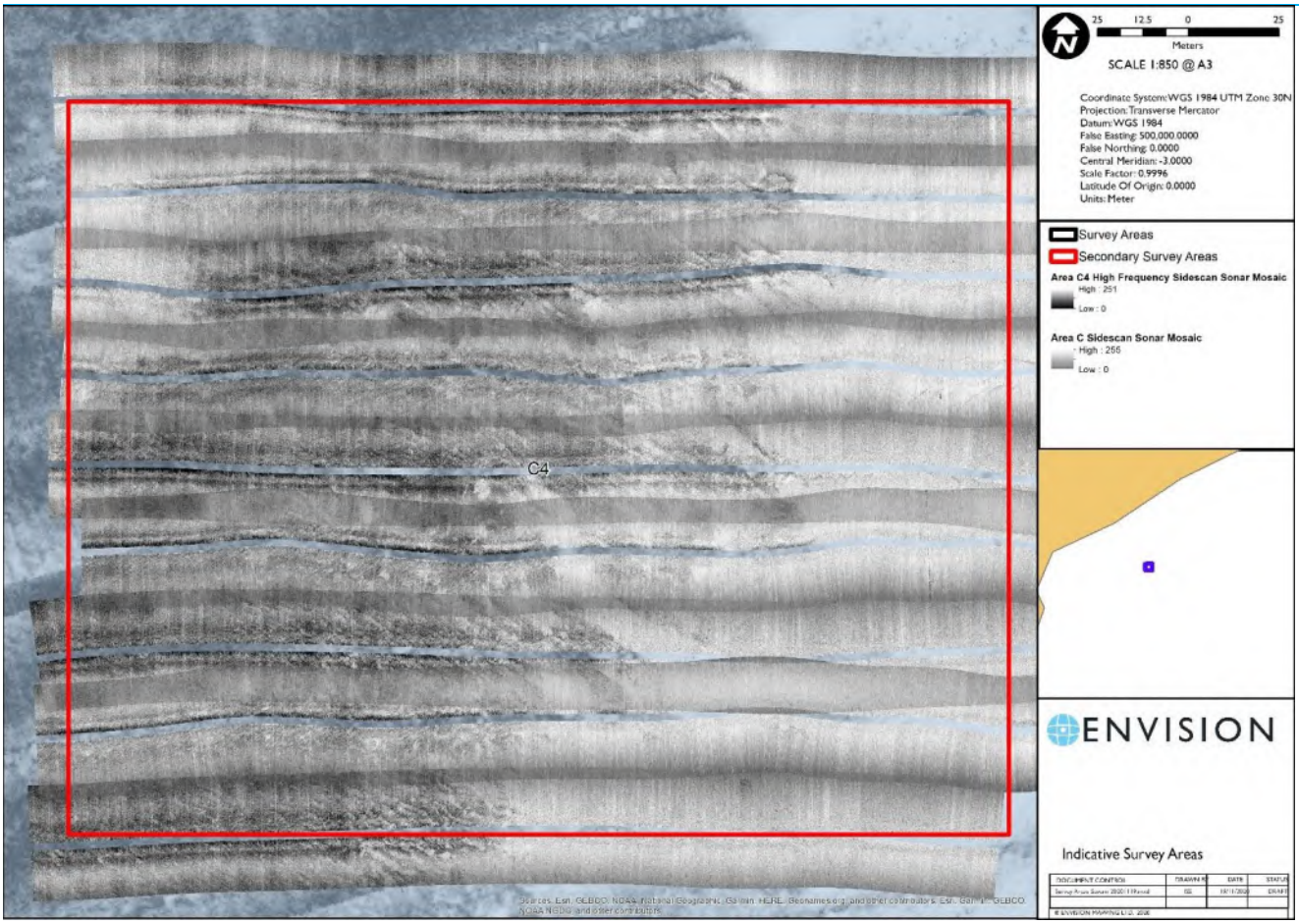


Figure 38.
High frequency sidescan sonar mosaic for survey area C4, with sample points of Sabellaria presence overlain (none present in area)

The ARIS sonar camera imagery for secondary survey area C4 was taken over two tows, and during analysis categories were allocated according to its appearance and the abundance of elevated material (≥2cm), which are presented in the following Table 12 and in Figure 39.

The seabed observed in the ARIS imagery supported the pattern visible in the high frequency sidescan data, appearing featureless, or smooth with some areas of rough ground, but little elevated material in the eastern part of the survey area. The first section of Tow 1 showed smooth and rough ground with more elevated material, coinciding with the darker band visible in the sidescan data, but elevated material was never observed at a percentage cover greater than 10%. The data in Tow 2 in this area was invalid due to the camera system being angled upwards.

The full analysis results, including filenames and positions for each secondary survey area and tow, with brief descriptions and categories of percentage cover of elevated material, are presented in Table 16, Table 17, and Table 18, and example images shown in Table 19 in the Appendices.

Table 12
Categories allocated to ARIS tows for Area C4

Area	Tow	Section	Notes	Brief description	Elevated Material ≥2cm	
					Frequency	Abundance
C4	Tow 1	Section 1	rough ground, some smooth areas, with elevated material	smooth and rough ground	some	8-10%
C4	Tow 1	Section 2	not much reflective material, some rougher ground in areas but reflective material not distinct or elevated, featureless towards end	smooth and rough ground	sparse	0-4%
C4	Tow 2	Section 1	featureless at start, then some rougher ground in areas but indistinctive reflective material and no elevation	majority featureless	none	0-4%
C4	Tow 2	Section 2	camera angled upwards for majority	N/A	N/A	N/A

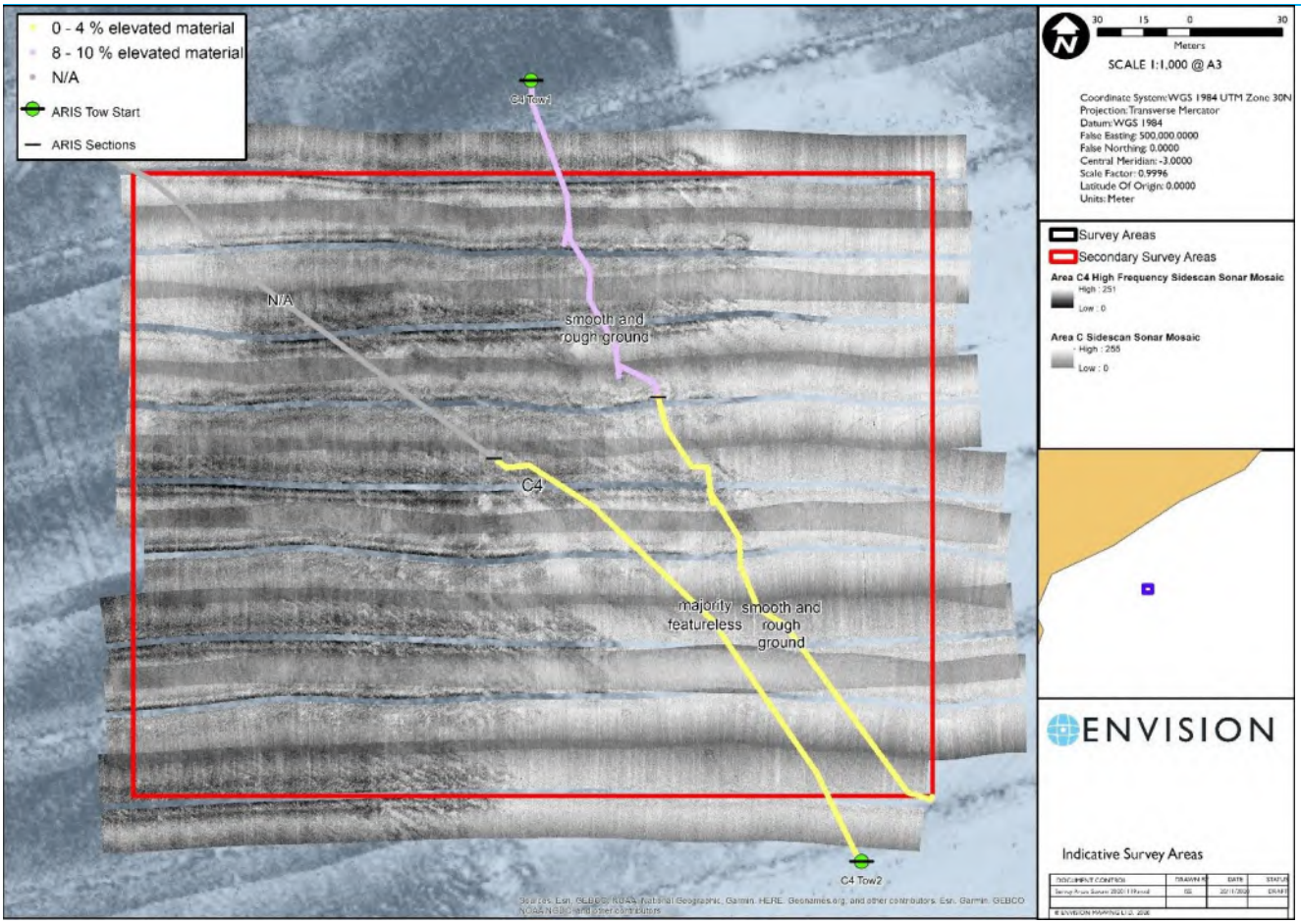


Figure 39.

High frequency sidescan sonar mosaic for survey area C4, with sample points of Sabellaria presence (none present in area) and ARIS sonar camera data overlain

5.3.5. Area C5

The high frequency sidescan data for survey area C5 (Figure 40) shows no distinctive patterns in reflectance, although some darker areas may indicate seabed of greater variability in the area.

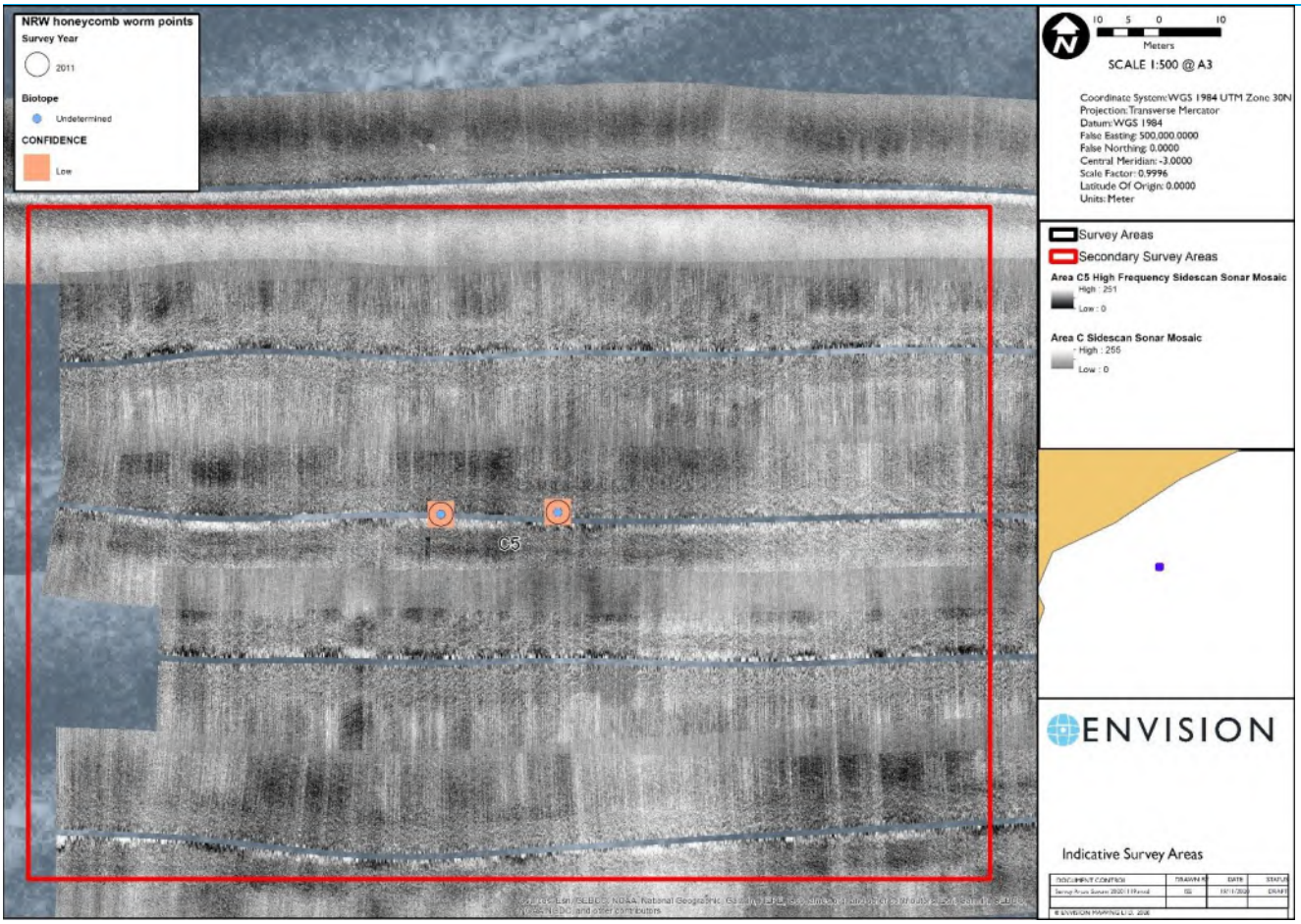


Figure 40.
High frequency sidescan sonar mosaic for survey area C5, with sample points of Sabellaria presence overlain

The ARIS sonar camera imagery for secondary survey area C5 was taken over two tows, and during analysis categories were allocated according to its appearance and the abundance of elevated material (≥2cm), which are presented in the following Table 13 and in Figure 41.

The seabed appeared in the imagery to be comprised of consistent rough ground with little elevation, with elevated material of ≥2cm sparsely distributed throughout both tows.

The full analysis results, including filenames and positions for each secondary survey area and tow, with brief descriptions and categories of percentage cover of elevated material, are presented in Table 16, Table 17, and Table 18, and example images shown in Table 19 in the Appendices.

Table 13
Categories allocated to ARIS tows for Area C5

Area	Tow	Section	Notes		Elevated Material ≥2cm

				Brief description	Frequency	Abundance
C5	Tow 1	Section 1	rough ground but low elevation and very consistent, little variability	rough ground	sparse	0-4%
C5	Tow 2	Section 1	rough ground but low elevation and very consistent, little variability	rough ground	sparse	0-4%

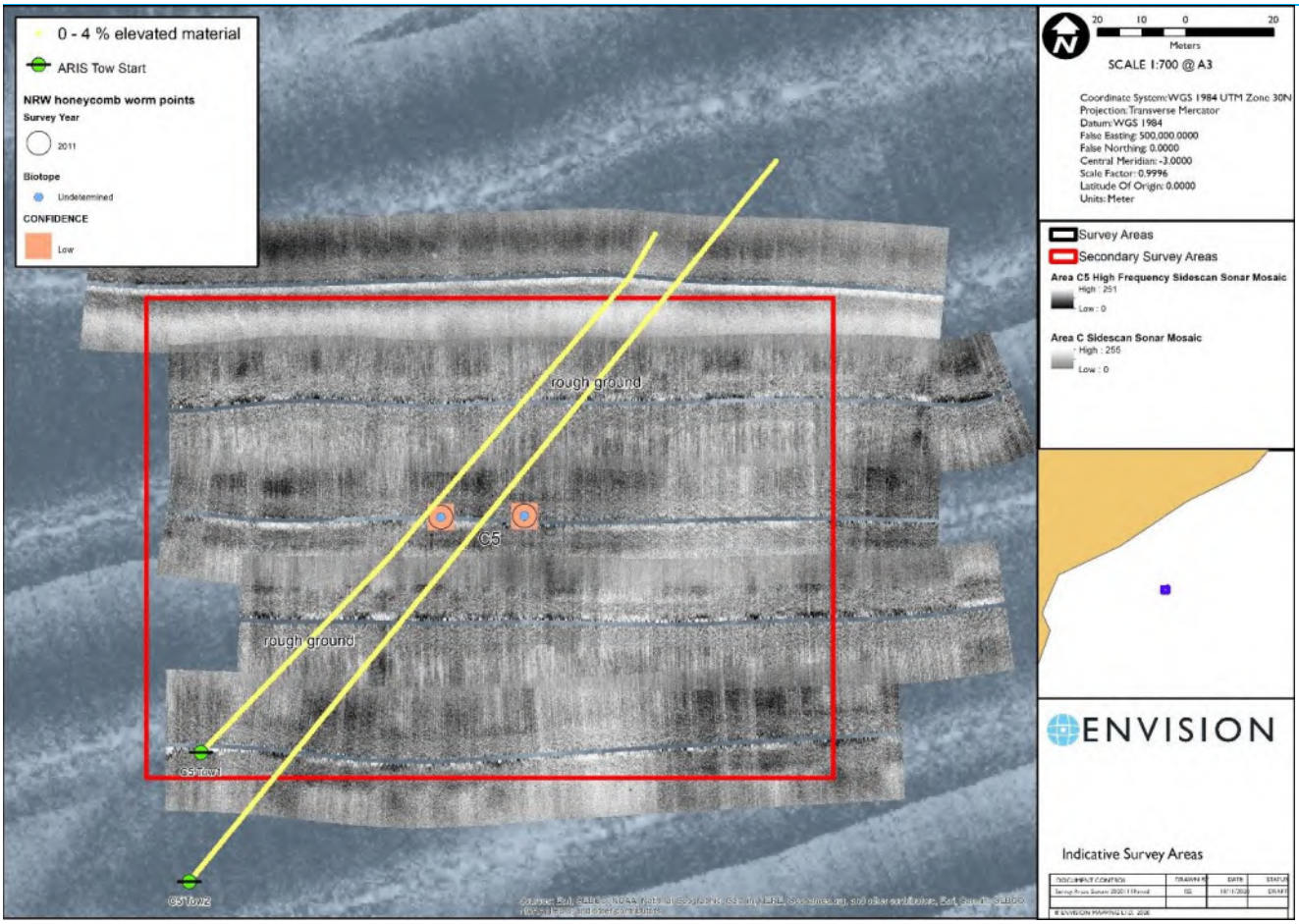


Figure 41.

High frequency sidescan sonar mosaic for survey area C5, with sample points of Sabellaria presence and ARIS sonar camera data overlain

5.3.6. Area C6

The high frequency sidescan data for survey area C6 (Figure 42) shows featureless areas in the northwest and southeastern corners, with a darker area centrally potentially with ripples or waves.

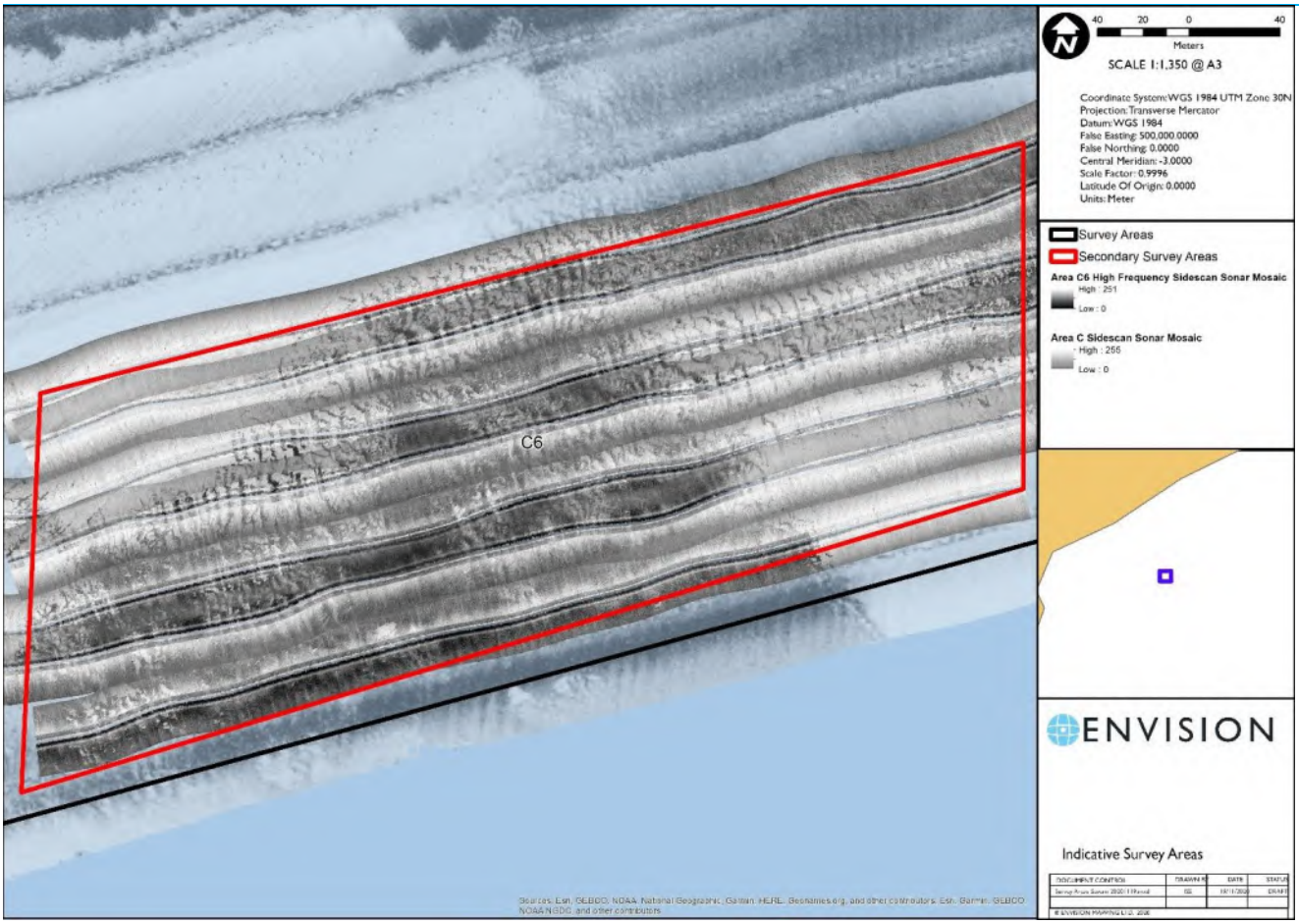


Figure 42.
High frequency sidescan sonar mosaic for survey area C6, with sample points of Sabellaria presence overlain (none present in area)

The ARIS sonar camera imagery for secondary survey area C6 was taken over two tows, and during analysis categories were allocated according to its appearance and the abundance of elevated material (≥2cm), which are presented in the following Table 14 and Figure 43.

The seabed appeared in the imagery to be largely featureless with only very occasional elevated material in Tow 2.

The full analysis results, including filenames and positions for each secondary survey area and tow, with brief descriptions and categories of percentage cover of elevated material, are presented in Table 16, Table 17, and Table 18, and example images shown in Table 19 in the Appendices.

Table 14
Categories allocated to ARIS tows for Area C6

Area	Tow	Section	Notes	Brief description	Elevated Material ≥2cm	
					Frequency	Abundance
C6	Tow 1	Section 1	featureless	majority featureless	none	0-4%
C6	Tow 2	Section 1	Featureless, except for very occasional elevated material	smooth ground	sparse	0-4%

Figure 43.
High frequency sidescan sonar mosaic for survey area C6, with sample points of Sabellaria presence (none present in area) and ARIS sonar camera data overlain

5.4. Area D

The data from the broadscale surveys for area D are presented in Figure 44 to Figure 46, including bathymetry, roughness values (AGDS) and sidescan sonar.

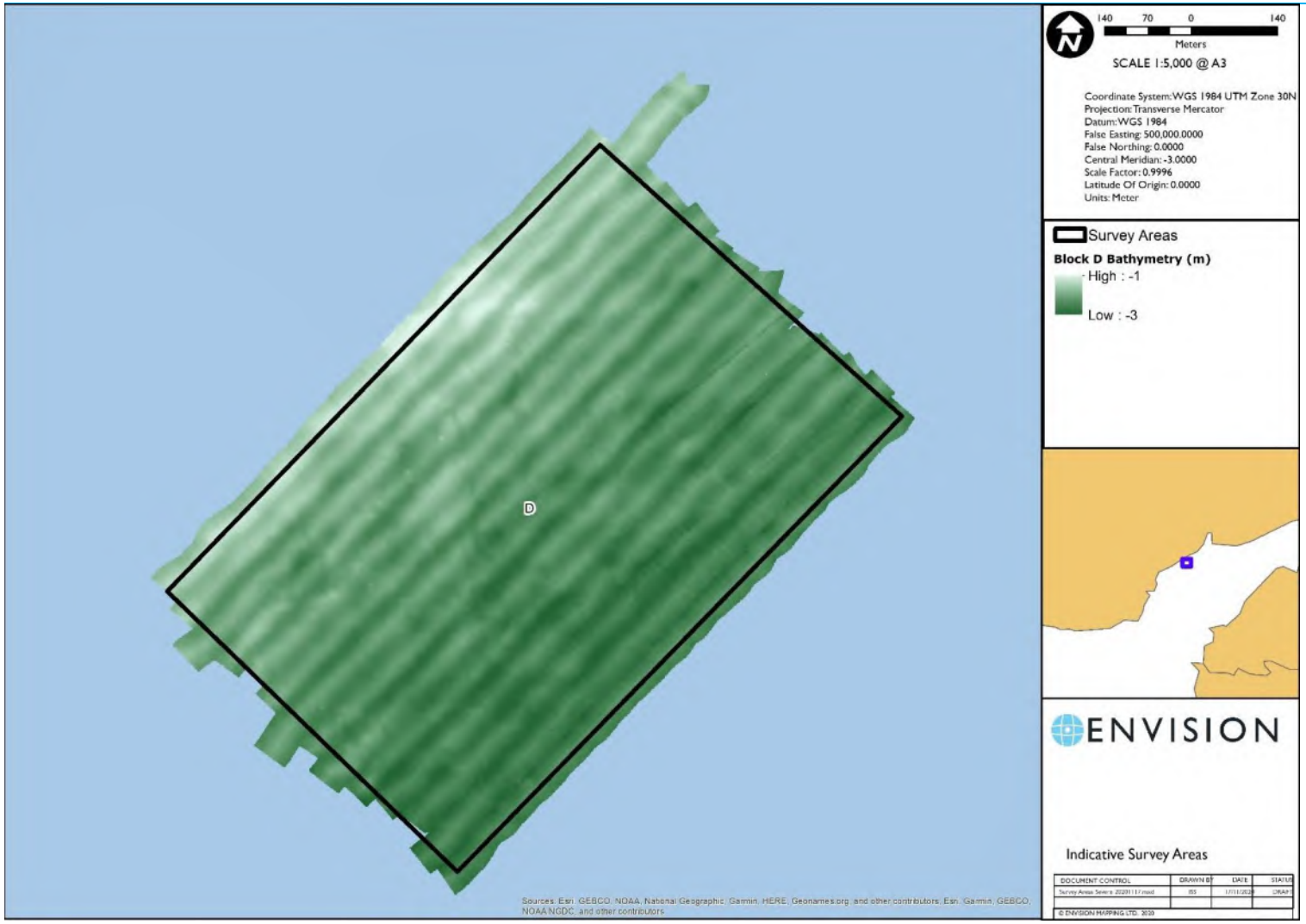


Figure 44.
Bathymetric data for survey area D

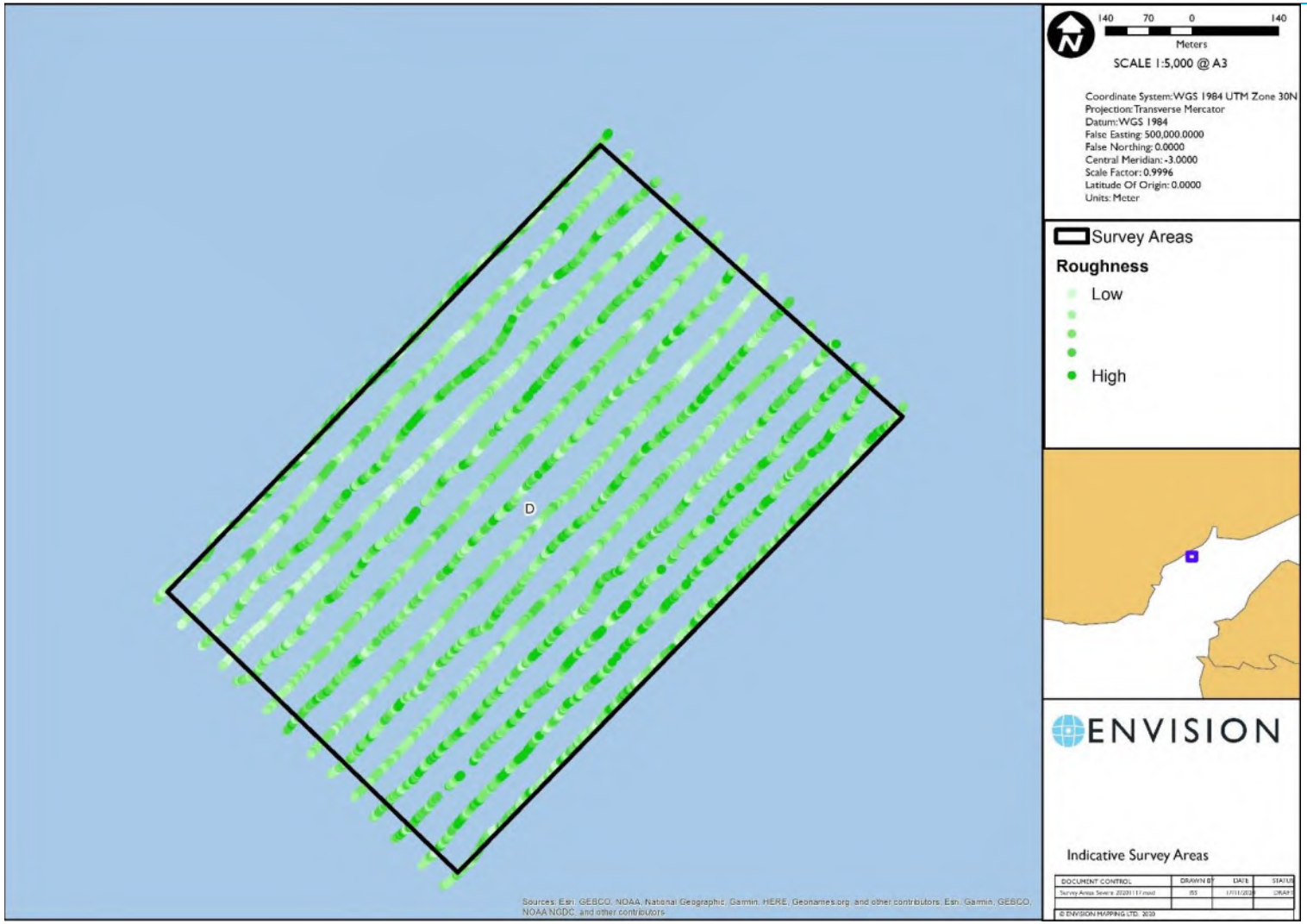


Figure 45.
AGDS data showing roughness values for survey area D

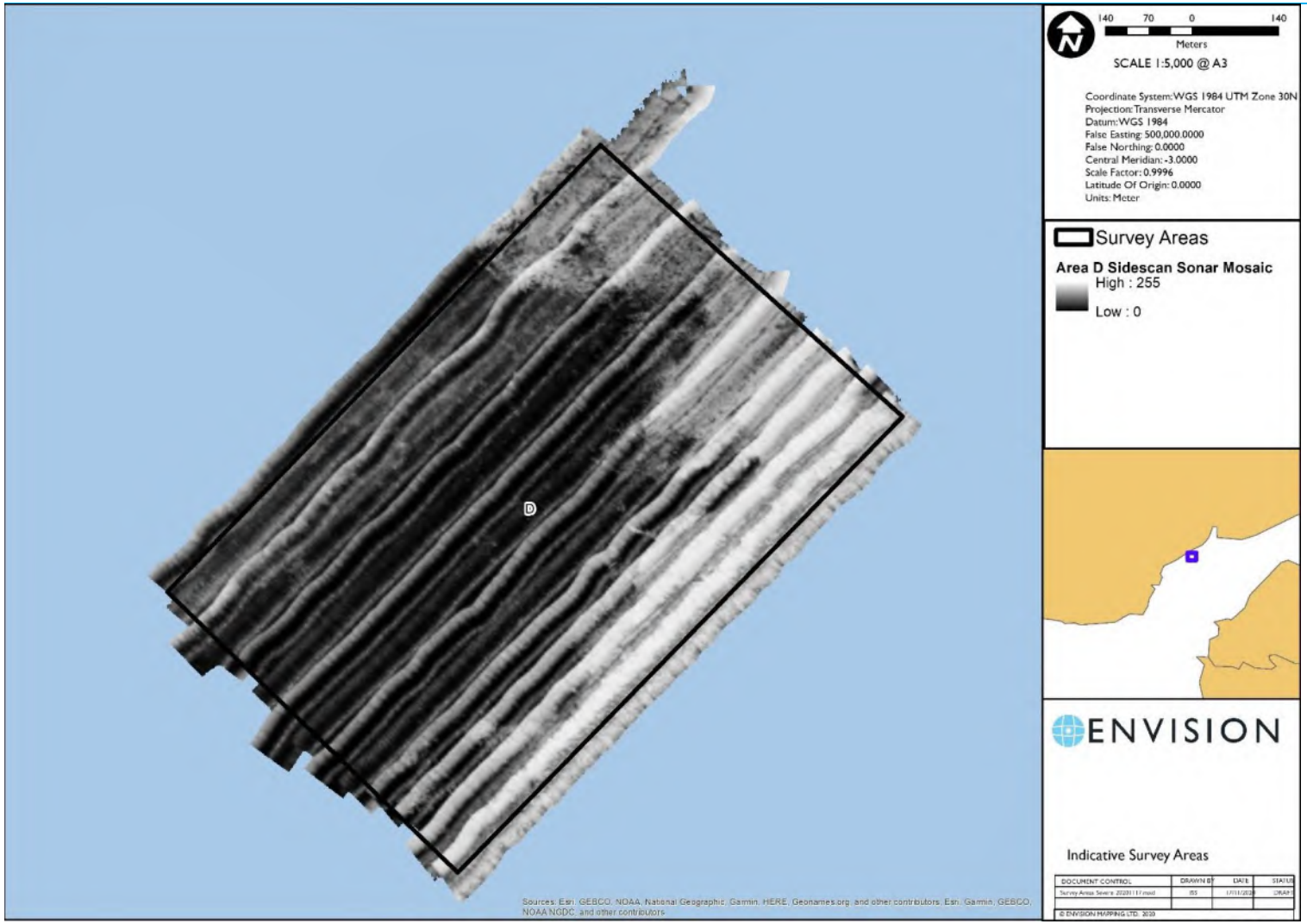


Figure 46.
Sidescan sonar mosaic for survey area D

After examination of the acoustic data from initial surveys and the location of NRW sample points showing presence of Sabellaria, secondary survey areas were selected to investigate potential features or areas of variable ground, which are shown as red boxes in Figure 47.

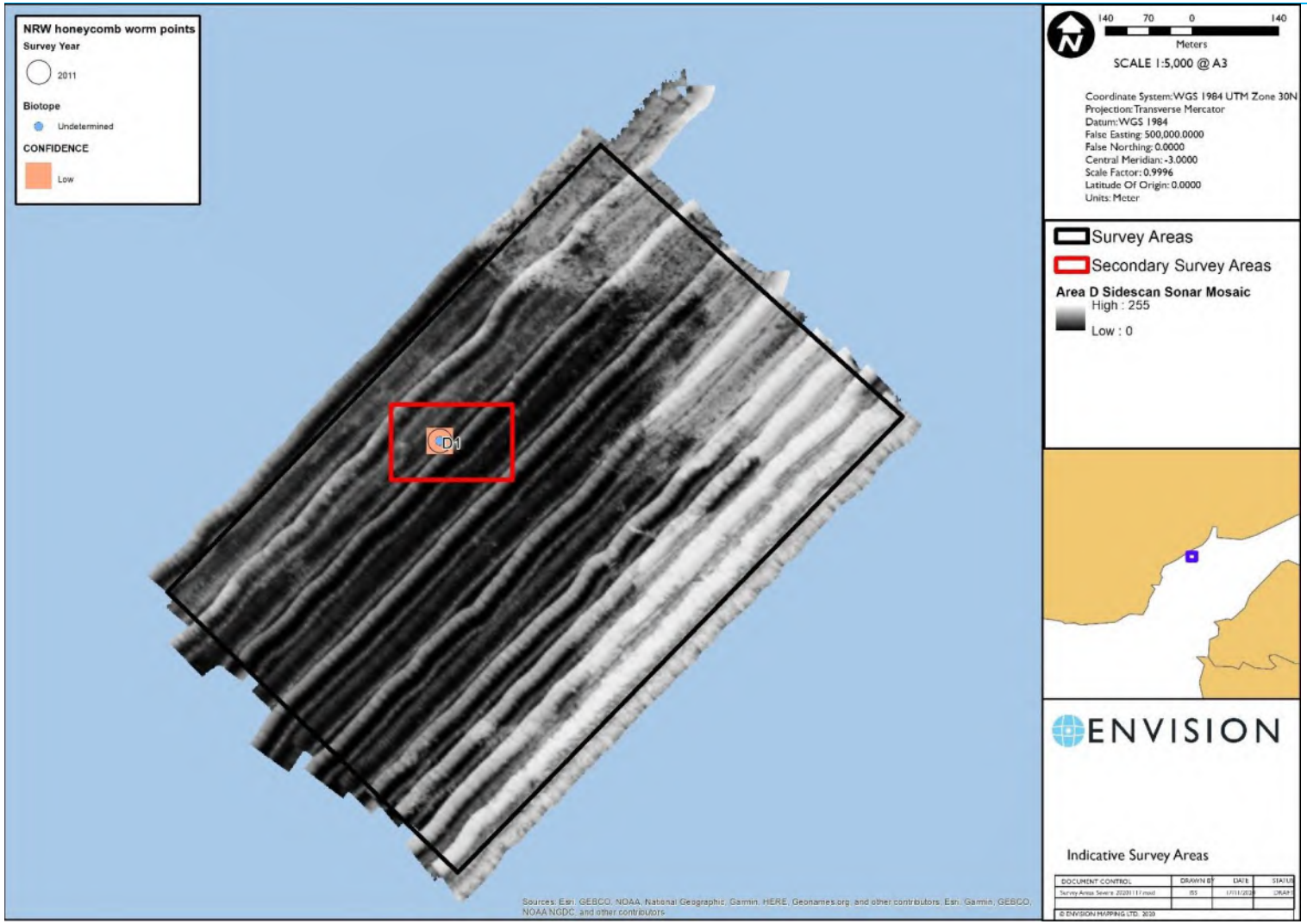


Figure 47.
Sidescan sonar mosaic for survey area D, with NRW sample points showing presence of Sabellaria overlain, and secondary survey areas

5.4.1. Area D1

The high frequency sidescan data for survey area D1 (Figure 48) shows no distinctive patterns in reflectance, apart from some areas of potential variability in the southern section of the survey area.

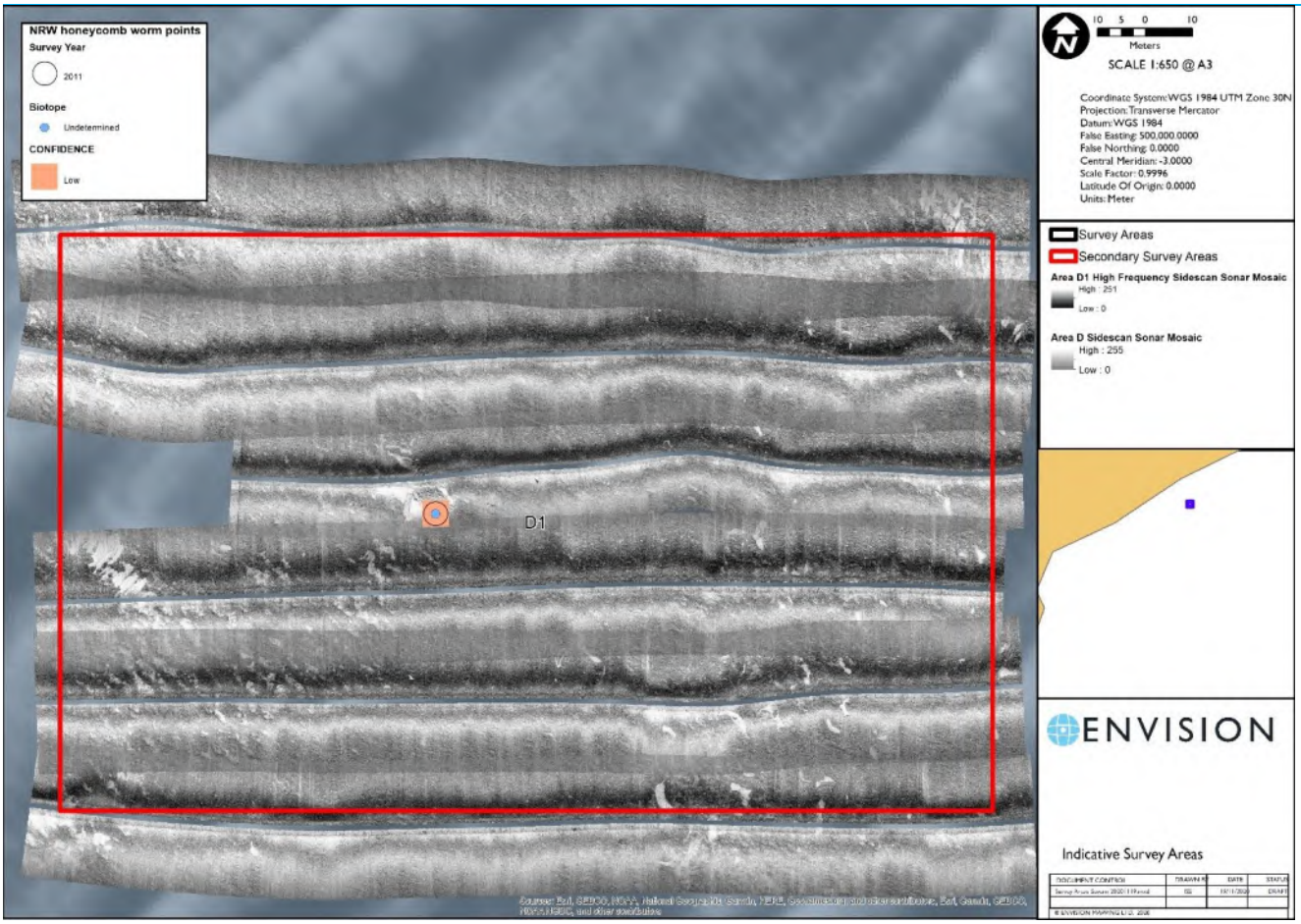


Figure 48.
High frequency sidescan sonar mosaic for survey area D1, with sample points of Sabellaria presence overlain

The ARIS sonar camera imagery for secondary survey area D1 was taken over two tows, and during analysis categories were allocated according to its appearance and the abundance of elevated material (≥2cm), which are presented in the following Table 15 and in Figure 49.

The seabed appeared in the imagery to be comprised of smooth or featureless ground with sparse but large smooth reflective material of no apparent elevation, which may be indicative of larger particles such as cobbles embedded in sediment.

The full analysis results, including filenames and positions for each secondary survey area and tow, with brief descriptions and categories of percentage cover of elevated material, are presented in Table 16, Table 17, and Table 18, and example images shown in Table 19 in the Appendices.

Table 15
Categories allocated to ARIS tows for Area D1

Area	Tow	Section	Notes	Brief description	Elevated Material ≥2cm	
					Frequency	Abundance
D1	Tow 1	Section 1	smooth with sparse but large smooth reflective material (cobbles?), no apparent elevation (in sediment?)	smooth ground	sparse	0-4%
D1	Tow 2	Section 1	smooth with sparse but large smooth reflective material (cobbles?), little apparent elevation, occasional elevated material) in sediment? Some featureless areas in second half	smooth ground	sparse	0-4%

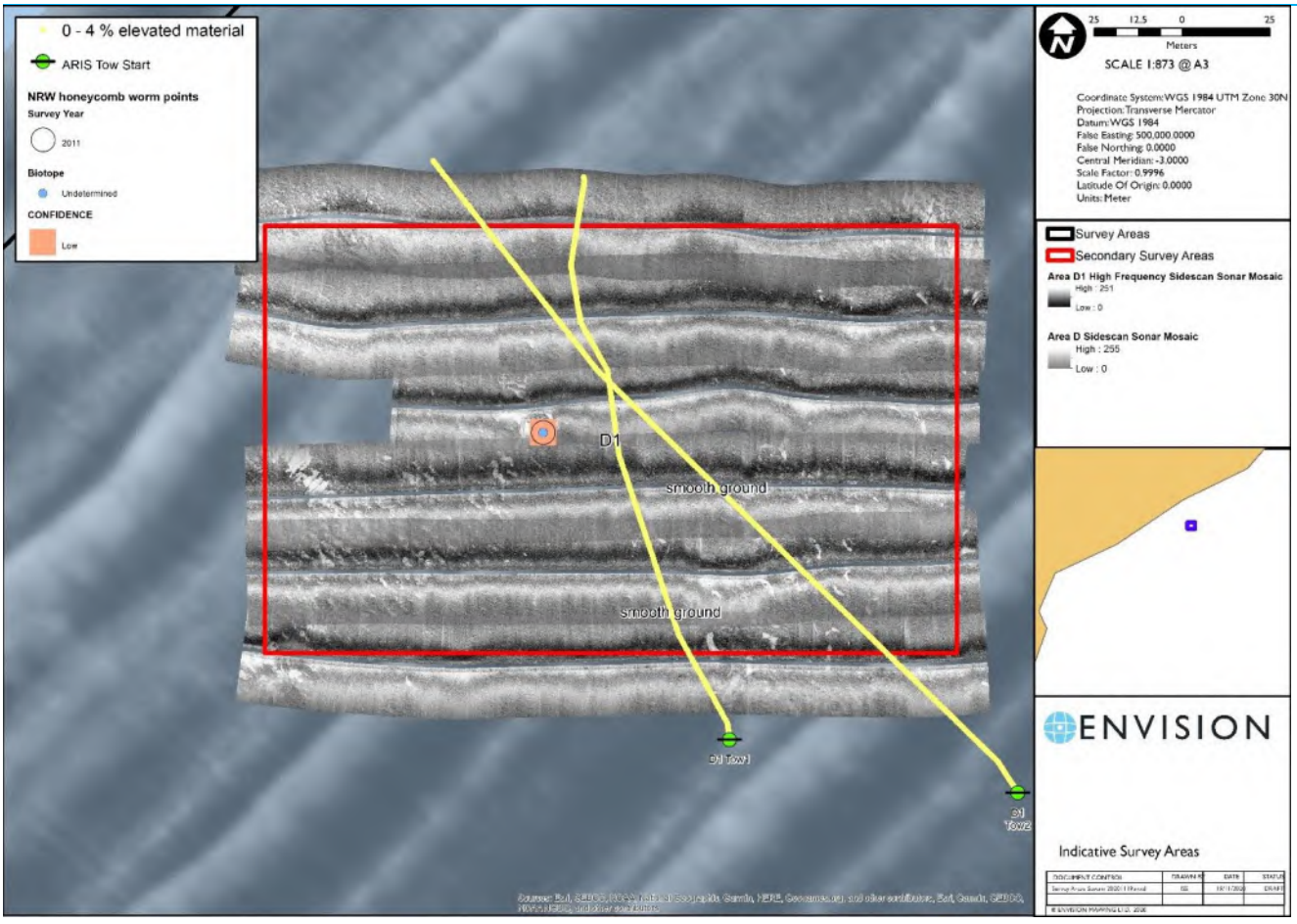


Figure 49.
High frequency sidescan sonar mosaic for survey area D1, with sample points of Sabellaria presence and ARIS sonar camera data overlain

5.5. Summary of Area Features

Area	Description
Area A1	The area is characterised by a channel running through the area from the western edge to the southern edge of the area, which contains reflective material, likely to be coarser sediments. To the south eastern corner is an area of variable seabed which appears to be sand in small waves, with this seabed type continuing to the north western corner of the adjacent area A2. The remainder of A1 has low reflectance and small areas of variability.
Area A2	Small sand waves dominate the area and show alternating patterns of coarser (more reflective) and softer (less reflective) sediments with a larger 'channel' encroaching from the west, likely to be a tidal drainage channel.
Area A3	A relatively homogenous area of seabed with no distinct areas or structures other than linear features which run north to south and are likely to be marks left in the seabed by trawled fishing gear.
Area A4	The area is influenced by what appear to be two channels, likely to be tidal drainage channels running north west to south east, with the remaining seabed consisting of patchy sediments
Area B1	The area is largely smooth seabed with some linear features running northeast to southwest in the northeast part of the survey area, which may be consistent with marks left by trawled fishing gear. The remainder of the survey area is patchy sediments with no indication of reef.
Area C1	The area consists of sand waves over the vast majority of the area with some linear features running northeast to southwest which may be consistent with marks left by trawling in the north western quarter.
Area C2	A relatively featureless area with slight indications of linear features in the western part of the area suggesting the area is trawled. The eastern section of the survey area is softer sand or muds with low returns form sidescan sonar.
Area C3	An homogenous area with no distinct or discernible features on the seabed.
Area C4	The area is characterised by a linear future running northeast to southwest with sand waves and ripples along the edges, after which the seabed is featureless to the east and west.
Area C5	An homogenous area with no distinct or discernible features on the seabed and showing small variations in sediment types.
Area C6	The area is characterised by a feature in the central section of the area indicating an area of sand waves and ripples. To the east and west of the area the seabed becomes featureless and homogeneous.
Area D1	A relatively homogenous area of seabed with no discernible features over most of the area. Some small sand waves/ripples observed to the south west.

5.6. Potential Indication of Fishing Effort

During review of the broadscale and high frequency sidescan data collected during survey work, certain linear features were noted in the survey areas that were thought to be consistent with marks left by trawling and may potentially indicate evidence of fishing. It is also possible that these linear features could be result from winnowing of the sediment by tidal movements or currents, and therefore these areas are presented in this section (Figure 50 to Figure 53) but intended only as an informative measure, rather than formal evidence of fishing activity.

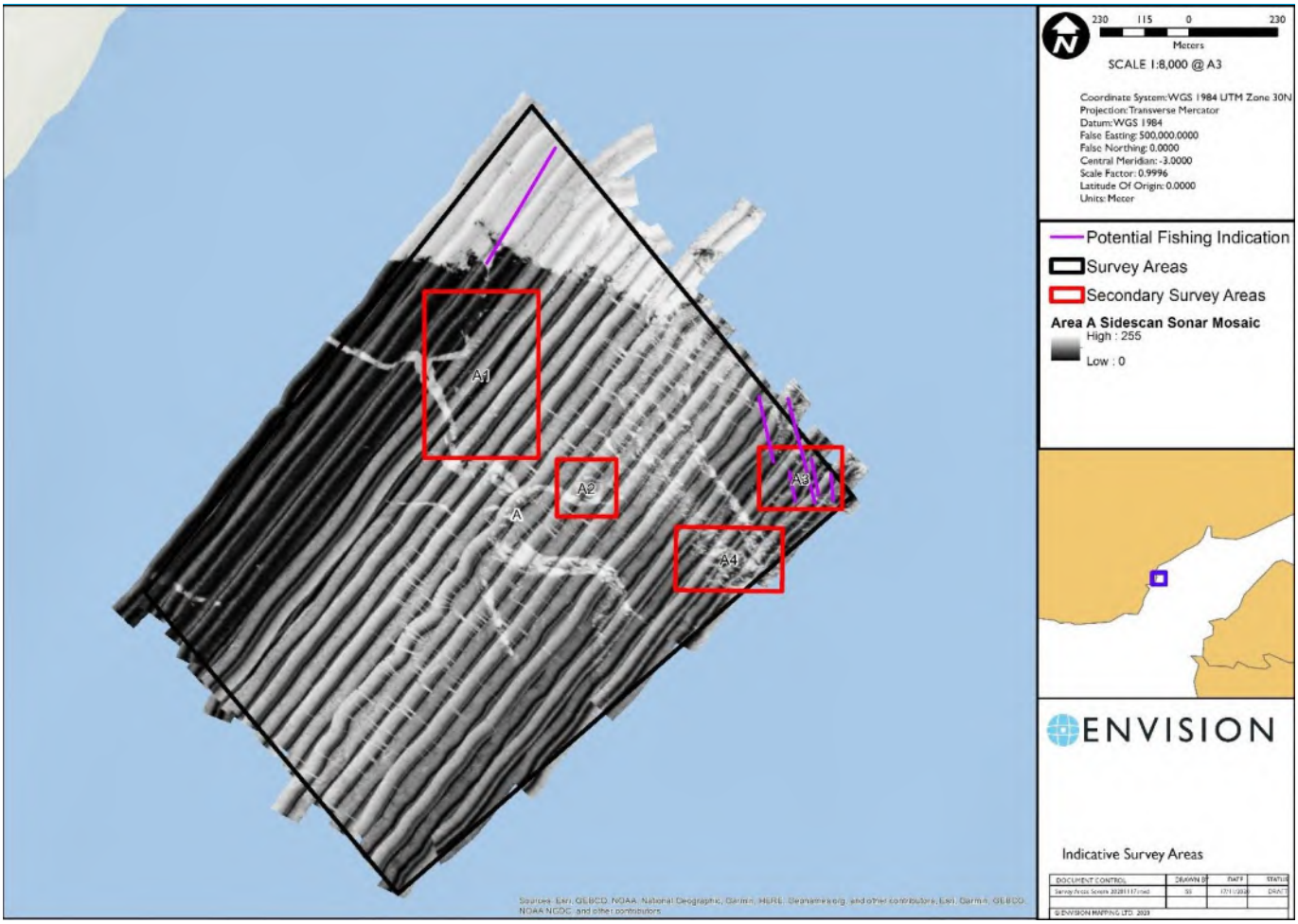


Figure 50.

Potential indication of fishing in survey area A (purple lines). (Please refer also to these areas in sidescan data in Figure 12 and Figure 18).

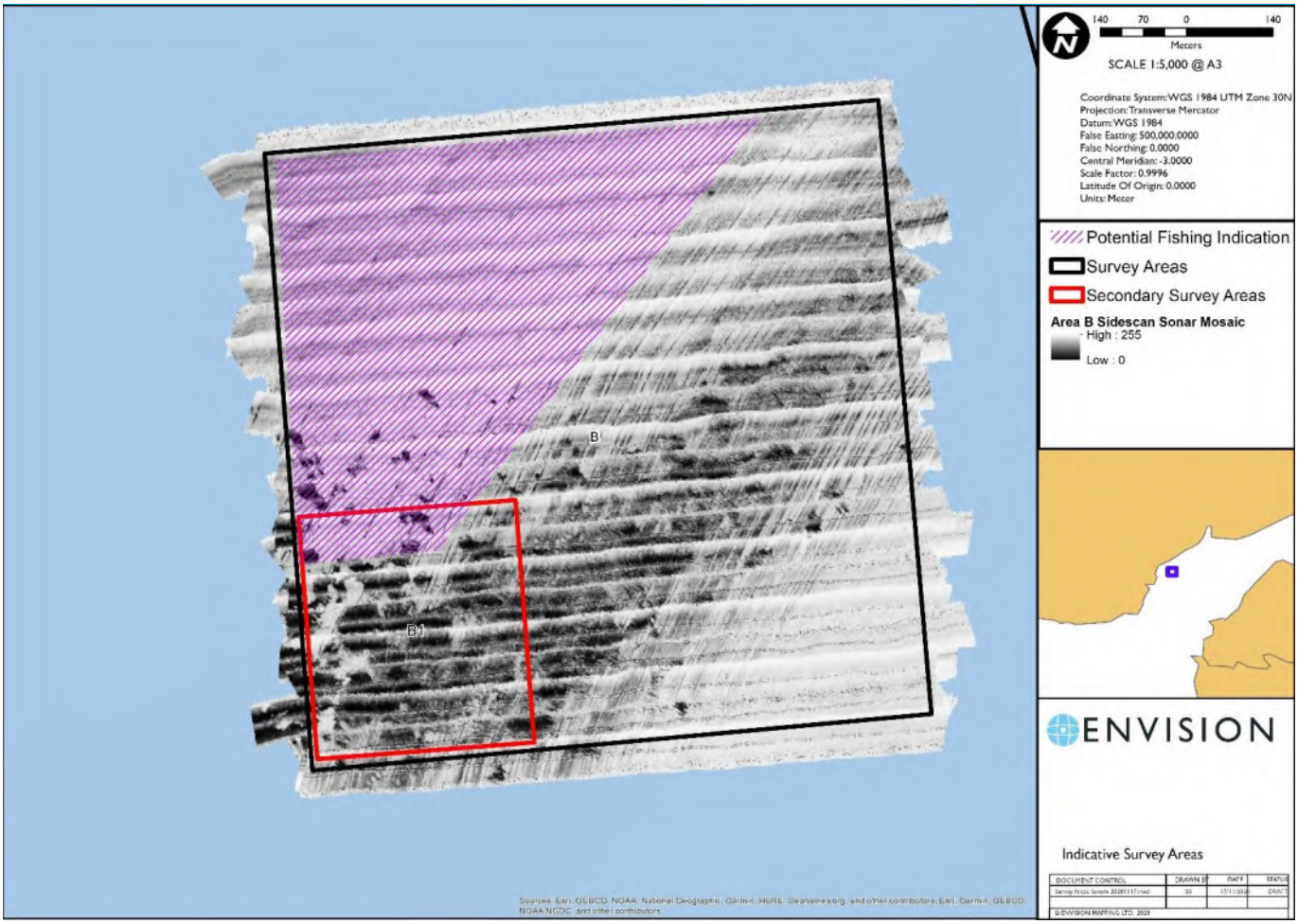


Figure 51.

Potential indication of fishing in survey area B (purple lines). (Please refer also to these areas in sidescan data in Figure 24 and Figure 25).

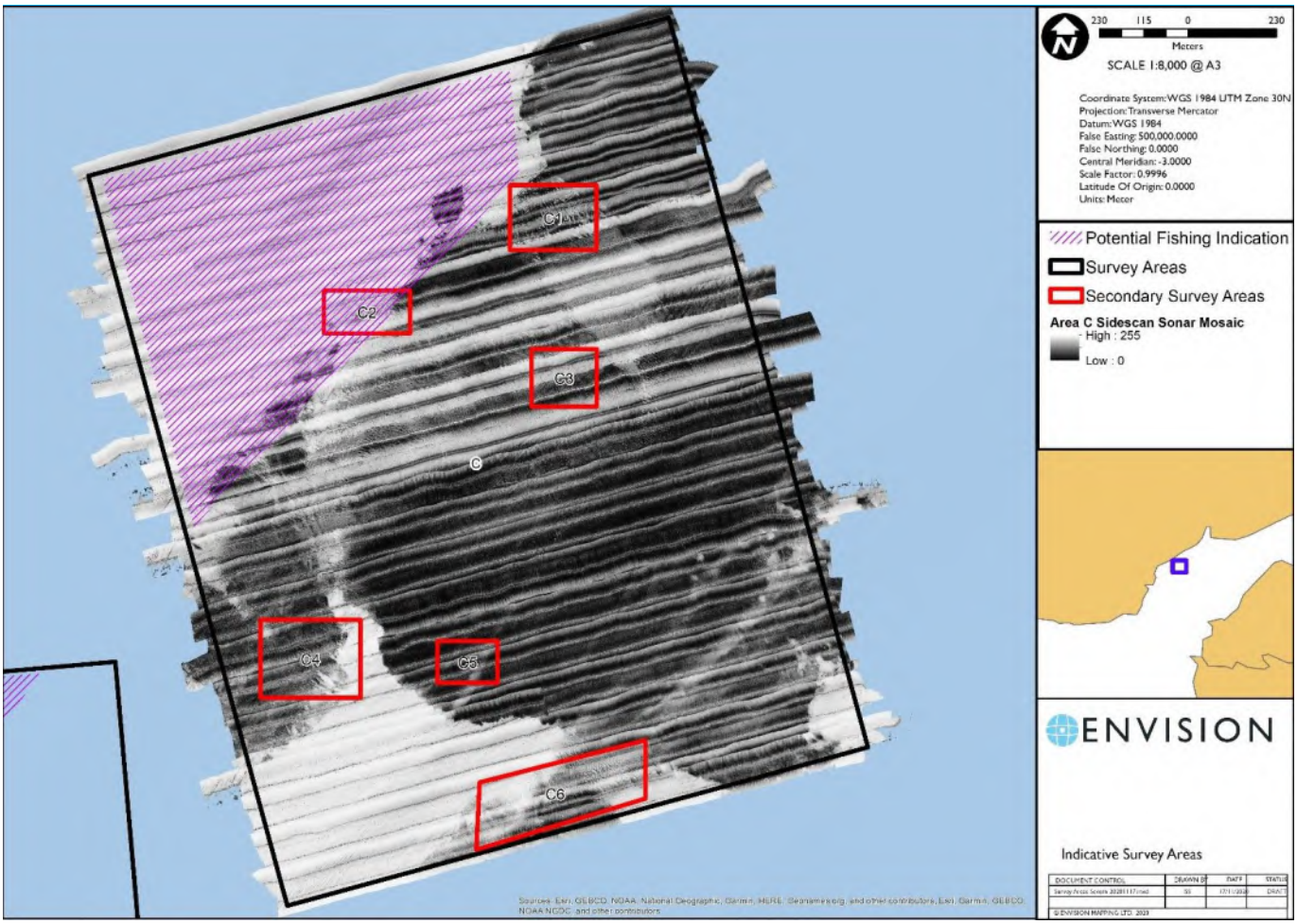


Figure 52.

Potential indication of fishing in survey area C (purple lines). (Please refer also to these areas in sidescan data in Figure 30, Figure 32 and Figure 34).

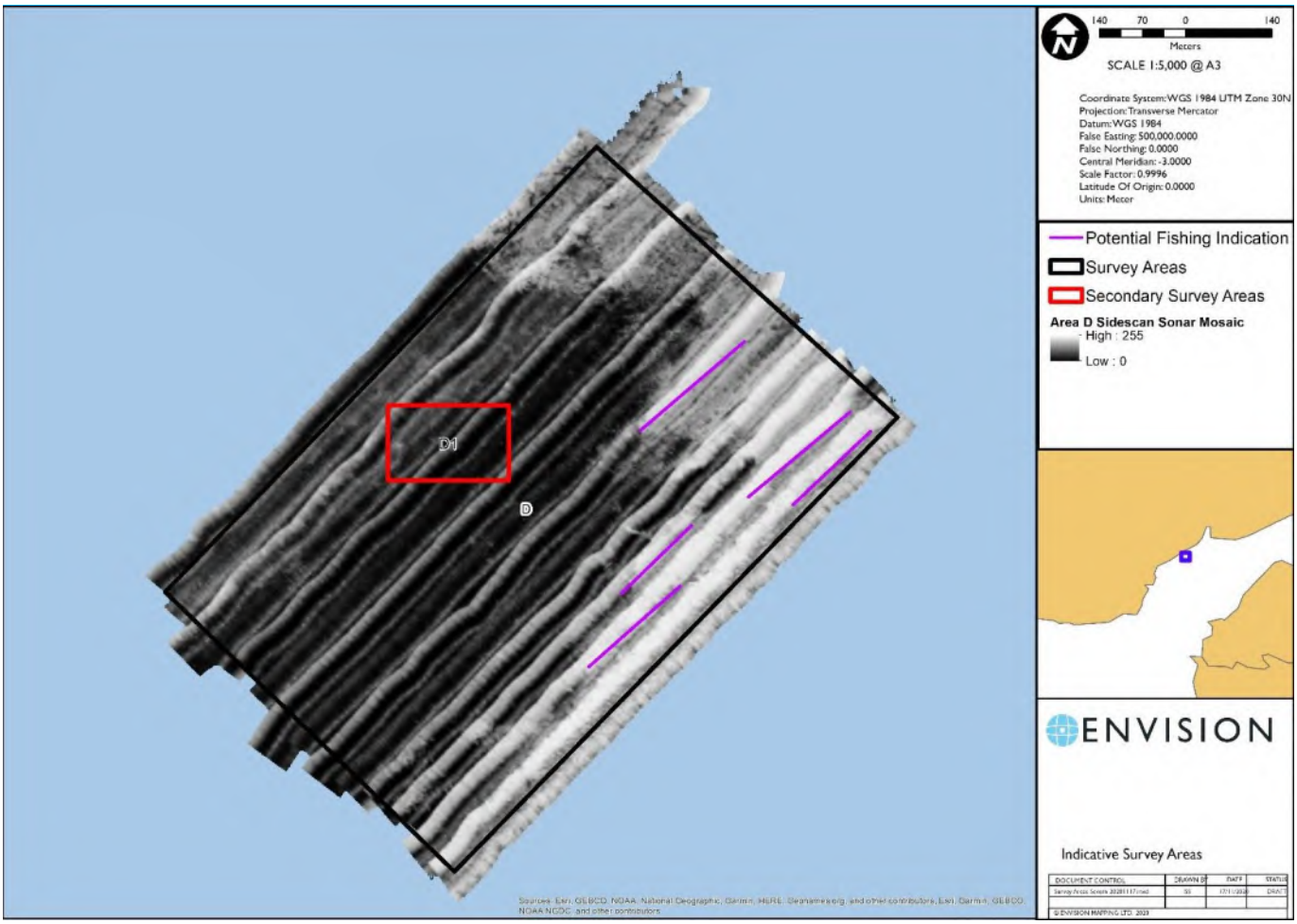


Figure 53.

Potential indication of fishing in survey area D (purple lines). (Please refer also to this area in sidescan data in Figure 46).

6. Discussion

The high frequency sidescan sonar data collected showed some areas of variable seabed including ripples/waves and linear features, but no distinctive patterns of reflectance clearly indicative of reef features. The sidescan also showed areas with linear features that were thought to be consistent with marks left by trawling and may potentially indicate evidence of fishing, which broadly supports the areas recorded in the fishing activity surveys within this study. However, these linear features may also have been caused by winnowing of the sediment by tidal movement or currents.

Review of the ARIS sonar camera system footage showed some variation of seabed types. Featureless areas with no, or very little, reflective material often coincided with blank areas in the sidescan data which may have been indicative of channels or pockets of featureless seabed. Seabed that appeared smooth or rippled was often interspersed with areas of rougher ground with some elevated material and was often present in areas shown in the sidescan data to have a wavelike or banded pattern.

Also identified in the footage were areas of rough ground with no elevated material, and other areas of rough ground with reflective material which was elevated from the rest of the seabed and ranging in height to over 10cm. Elevated material of ≥ 2cm was not observed to occur with a percentage cover of greater than 10% for any extent, indicating a potential absence of reef features in the areas surveyed.

Previous studies elsewhere in the Severn which identified Sabellaria colonies in 'clump' formation (Griffin *et al.*, 2020) also acknowledged that confidence in areas of low-lying Sabellaria reef were reduced as shadows in the ACI in these areas could not be confidently attributed to Sabellaria colonies rather than other substrates such as cobbles.

The survey areas in this study were located where trawling activity had been mapped in the Severn Estuary/ Môr Hafren SAC, and sample data showing presence of Sabellaria in this area was of 'undetermined' nature and low confidence. The seabed that was observed as rough, or mixed, ground with elevated material present in low percentage covers (less than 10%) was not identifiable as any of the classified types of Sabellaria colonies such as 'clumps', 'hummocks' or 'platform' formations and did not show characteristics that were indicative of reef features.

The objectives of the project were to produce seabed maps at a range of scales to allow for the extent and distribution of Sabellaria reef habitat to be better understood in relation to current fishing activity. Surveys using high frequency sidescan sonar in conjunction with ARIS acoustic camera imagery were undertaken within the areas of interest, and proved to be a satisfactory method for detecting the presence or absence of Sabellaria reef in the Severn Estuary. The method has been effective in terms of proving the absence of reef features in the area surveyed using elevation as a determining characteristic. A combination of ARIS and high frequency sidescan sonar should be capable of identifying reef elevation and extent but cannot be fully appraised from the data collected as no reef features were found.

7. References

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8. APPENDICES

Table 16
Metadata from ARIS tows recorded from survey logs and plotter

Survey Area	Tow No.	Tow Name	Depth (m)	Date	Time	Start Lat	Start Long	End Lat	End Long
A1	1	A1.T1	11	23/08/2020	9:20:58	51.457792	-3.12357	51.460555	-3.1200067
A1	2	A1.T2	12.5	23/08/2020	10:17:43	51.4573033	-3.1239683	51.4608267	-3.1200667
A1	3	A1.T3	2.4	23/08/2020	17:49:49	51.45644	-3.12227	51.4592317	-3.119035
A1	4	A1.T4	10.6	26/08/2020	13:51:48	51.4606383	-3.1212	51.4567417	-3.1201217
A1	5	A1.T5	10	26/08/2020	14:16:16	51.4606567	-3.1221733	51.456672	-3.1214127
A2	1	A2.T1	9.7	23/08/2020	10:38:58	51.4549367	-3.11933	51.4569367	-3.1173167
A2	2	A2.T2	12	26/08/2020	13:24:53	51.4552883	-3.11832	51.4568567	-3.11751
A3	1	A3.T1	14.8	23/08/2020	11:18:15	51.45714	-3.1086083	51.45557	-3.10777
A3	2	A3.T2	12	26/08/2020	12:50:10	51.45564	-3.11066	51.4571917	-3.1087833
A4	1	A4.T1	14.8	23/08/2020	10:54:11	51.4530067	-3.113335	51.4553283	-3.1118183
A4	2	A4.T2	12	26/08/2020	13:09:29	51.45368	-3.113425	51.4552967	-3.11213
B1	1	B1.T1	13.7	23/08/2020	11:34:28	51.4681417	-3.0846283	51.4642617	-3.08577
B1	2	B1.T2	10.5	27/08/2020	14:11:29	51.464265	-3.0865817	51.468015	-3.0862633
C1	1	C1.T1	12	23/08/2020	12:09:25	51.4850083	-3.057675	51.48346	-3.05794
C1	2	C1.T2	11.2	27/08/2020	13:49:03	51.4835083	-3.0588433	51.4851867	-3.0589367
C2	1	C2.T1	2.2	23/08/2020	16:51:57	51.482785	-3.0651383	51.481437	-3.064918
C2	2	C2.T2	12	24/08/2020	12:40:07	51.4814217	-3.0634167	51.481806	-3.067014
C3	2	C3.T2	2.3	23/08/2020	16:37:44	51.4815083	-3.05748	51.4797417	-3.0575617
C3	3	C3.T3	11.3	24/08/2020	12:54:55	51.4804417	-3.0559667	51.4798267	-3.0589317
C4	1	C4.T1	2.7	23/08/2020	17:02:53	51.4751167	-3.0672	51.4730283	-3.0653483
C4	2	C4.T2	12.9	24/08/2020	12:19:37	51.4728417	-3.0656783	51.4749067	-3.0692833
C5	1	C5.T1	12.3	24/08/2020	11:02:33	51.47343	-3.0622767	51.4744817	-3.0607883
C5	2	C5.T2	12.6	24/08/2020	11:09:20	51.473175	-3.0623133	51.47464	-3.0604017
C6	1	C6.T1	2.5	23/08/2020	17:23:00	51.471535	-3.060315	51.4698933	-3.0589217
C6	2	C6.T2	14.3	24/08/2020	11:19:01	51.468835	-3.0608617	51.4717067	-3.0574317
D1	1	D1.T1	12.5	24/08/2020	11:43:45	51.49528	-3.0434933	51.4967117	-3.0440967
D1	2	D1.T2	12.7	24/08/2020	11:55:33	51.49514	-3.0423317	51.4967533	-3.0447133

Table 17.
Results from analysis of ARIS imagery, viewed with ARIScope software

Area	Tow	Section	Notes	Elevated Material (cm)				Elevated Material ≥ 2cm			Brief Description
				<2 cm	2-5 cm	5-10 cm	>10 cm	Total ≥ 2cm	Frequency	Abundance	
A1	Tow1	Section1	rough seabed and occasional elevated material throughout	94%	5%	<1	<1	6%	occasional	5-7%	rough ground
A1	Tow2	Section1	some smooth, some rough ground, little elevated material throughout	97%	2%	1%	0%	3%	sparse	0-4%	smooth and rough ground
A1	Tow3	Section1	smooth at beginning, some rough areas	96%	4%	0%	0%	4%	sparse	0-4%	smooth and rough ground
A1	Tow3	Section2	rough ground with occasional elevated material	93%	5%	1%	1%	7%	occasional	5-7%	rough ground
A1	Tow3	Section3	rough ground with very occasional elevated material	97%	2%	1%	0%	3%	sparse	0-4%	rough ground
A1	Tow3	Section4	rough ground with elevated material	90%	7%	2%	1%	10%	some	8-10%	rough ground
A1	Tow4	Section1	rough ground with low and high elevated material	90%	7%	2%	1%	10%	some	8-10%	rough ground
A1	Tow4	Section2	rough ground with occasional low elevated material, smooth areas	94%	4%	1%	<1	6%	occasional	5-7%	smooth and rough ground
A1	Tow5	Section1	rough ground with low and high elevated material	91%	7%	2%	<1	9%	some	8-10%	rough ground
A1	Tow5	Section2	smooth, rough at end	100%	0%	0%	0%	0%	none	0-4%	majority featureless
A1	Tow5	Section3	rough ground with low and high elevated material	90%	6%	3%	1%	10%	some	8-10%	rough ground
A1	Tow5	Section4	rough ground with occasional elevated material, smooth areas	93%	5%	1%	<1	7%	occasional	5-7%	smooth and rough ground
A2	Tow1	Section1	smooth areas interspersed with rough but sparse reflective material, no elevation	99%	1%	0%	0%	1%	sparse	0-4%	smooth and rough ground

Area	Tow	Section	Notes	Elevated Material (cm)				Elevated Material ≥ 2cm			Brief Description
				<2 cm	2-5 cm	5-10 cm	>10 cm	Total ≥ 2cm	Frequency	Abundance	
A2	Tow1	Section2	smooth, no reflective material	100%	0%	0%	0%	0%	none	0-4%	majority featureless
A2	Tow1	Section3	smooth areas interspersed with rough but sparse reflective material, no elevation	99%	1%	0%	0%	1%	sparse	0-4%	smooth and rough ground
A2	Tow2	Section1	smooth areas interspersed with rough, not elevated, silt visible	99%	<1	0%	0%	1%	sparse	0-4%	smooth and rough ground
A2	Tow2	Section2	smooth, no reflective material	100%	0%	0%	0%	0%	none	0-4%	majority featureless
A2	Tow2	Section3	smooth areas interspersed with rough, not elevated, silt visible	98%	1%	<1	0%	2%	sparse	0-4%	smooth and rough ground
A3	Tow1	Section1	rough ground, smooth areas, occasional low elevated material	97%	3%	<1	0%	3%	sparse	0-4%	smooth and rough ground
A3	Tow2	Section1	rough ground and smooth areas, occasional low/high elevated material	96%	3%	<1	<1	4%	sparse	0-4%	smooth and rough ground
A4	Tow1	Section1	ground appears rough, very occasional elevated material, smooth areas at middle to end	98%	1%	<1	<1	2%	sparse	0-4%	smooth and rough ground
A4	Tow2	Section1	little reflective material (low elevation), smooth areas throughout	99%	<1	<1	0%	1%	sparse	0-4%	smooth and rough ground
B1	Tow1	Section1	smooth, featureless, some reflective material at end - no shadow, possible ripples	100%	0%	0%	0%	0%	none	0-4%	majority featureless, ripples present
B1	Tow1	Section2	rough ground with low and high elevated material	93%	4%	3%	<1	7%	occasional	5-7%	rough ground
B1	Tow1	Section3	smooth and rough areas, with some low elevated material, tyre/objects present	95%	4%	<1	0%	5%	occasional	5-7%	smooth and rough ground

Area	Tow	Section	Notes	Elevated Material (cm)				Elevated Material ≥ 2cm			Brief Description
				<2 cm	2-5 cm	5-10 cm	>10 cm	Total ≥ 2cm	Frequency	Abundance	
B1	Tow1	Section4	majority featureless, little reflective material, ripples at end	99%	<1	<1	0%	1%	none	0-4%	majority featureless, ripples present
B1	Tow2	Section1	smooth, little reflective material, possible Lanice, ripples present	99%	<1	0%	0%	1%	sparse	0-4%	smooth, ripples present
B1	Tow2	Section2	rough, with low and high elevated material common	90%	5%	4%	1%	10%	some	8-10%	rough ground
B1	Tow2	Section3	rough with some low elevated material	95%	4%	1%	0%	5%	occasional	5-7%	rough ground
B1	Tow2	Section4	little reflective material, majority smooth, ripples present	99%	<1	0%	0%	1%	none	0-4%	majority featureless, ripples present
B1	Tow2	Section5	rough, with low and high elevated material common	90%	5%	4%	1%	10%	some	8-10%	rough ground
B1	Tow2	Section6	rough and smooth areas, with little low elevated material	97%	2%	1%	0%	3%	sparse	0-4%	smooth and rough ground
B1	Tow2	Section7	smooth, featureless, very occasional high elevated material	99%	<1	0%	0%	1%	sparse	0-4%	smooth ground
C1	Tow1	Section1	little reflective material, occasional low elevation, latterly mostly featureless	99%	<1	0%	0%	1%	sparse	0-4%	smooth ground
C1	Tow2	Section1	smooth areas, interspersed with rough (waves?), not much reflective material (low)	97%	2%	<1		3%	sparse	0-4%	smooth and rough ground
C2	Tow1	Section1	linear features and ripples, but no reflective material (ripples on waves?)	100%	0%	0%	0%	0%	none	0-4%	majority featureless, ripples present

Area	Tow	Section	Notes	Elevated Material (cm)				Elevated Material ≥ 2cm			Brief Description
				<2 cm	2-5 cm	5-10 cm	>10 cm	Total ≥ 2cm	Frequency	Abundance	
C2	Tow2	Section1	mostly featureless, some 3d ripples near the start	100%	0%	0%	0%	0%	none	0-4%	majority featureless, ripples present
C3	Tow2	Section1	mostly rippled sediment, interspersed with areas of rough ground with some elevated material	97%	1%	1%	<1	3%	sparse	0-4%	smooth and rough ground, ripples present
C3	Tow3	Section1	rough ground and smooth/rippled areas with frequent elevated material, some high	93%	4%	2%	1%	7%	occasional	5-7%	smooth and rough ground, ripples present
C3	Tow3	Section2	mostly rippled sediment, interspersed with areas of rough ground with some elevated material	97%	1%	1%	1%	3%	sparse	0-4%	smooth and rough ground, ripples present
C4	Tow1	Section1	rough ground, some smooth areas, with elevated material	91%	6%	2%	<1	9%	some	8-10%	smooth and rough ground
C4	Tow1	Section2	not much reflective material, some rougher ground in areas but reflective material not distinct or elevated, featureless towards end	99%	<1	<1	0%	1%	sparse	0-4%	smooth and rough ground
C4	Tow2	Section1	featureless at start, then some rougher ground in areas but indistinctive reflective material and no elevation	100%	<1	0%	0%	0%	none	0-4%	majority featureless
C4	Tow2	Section2	camera angled upwards for majority	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C5	Tow1	Section1	rough ground but low elevation and very consistent, little variability	97%	2%	<1	0%	3%	sparse	0-4%	rough ground
C5	Tow2	Section1	rough ground but low elevation and very consistent, little variability	97%	2%	<1	0%	3%	sparse	0-4%	rough ground

Area	Tow	Section	Notes	Elevated Material (cm)				Elevated Material ≥ 2cm			Brief Description
				<2 cm	2-5 cm	5-10 cm	>10 cm	Total ≥ 2cm	Frequency	Abundance	
C6	Tow1	Section1	featureless	100%	0%	0%	0%	0%	none	0-4%	majority featureless
C6	Tow2	Section1	featureless, except for very occasional elevated material	99%	<1	<1		1%	sparse	0-4%	smooth ground
D1	Tow1	Section1	smooth with sparse but large smooth reflective material (cobbles?) throughout, no apparent elevation (in sediment?)	98%	1%	<1	<1	2%	sparse	0-4%	smooth ground
D1	Tow2	Section1	smooth with sparse but large smooth reflective material (cobbles?), little apparent elevation, occasional elevated material) in sediment? Some featureless areas in second half	98%	1%	<1	<1	2%	sparse	0-4%	smooth ground

Table 18.
Metadata extracted from ARIS imagery, viewed with ARIScope software, taking into account layback of camera system

Area	Tow	Section	Start Time	End Time	Start Frame	Start Lat	Start Long	End Lat	End Long	Filename
A1	Tow1	Section1	9:21:41	9:23:12	1	51.45977	-3.12092	51.46055	-3.12001	ARIS_2020-08-23_092141_ A1.T1_F30_B128_S470_T06_R0-3.aris
A1	Tow2	Section1	10:17:59	10:27:55	1	51.45730	-3.12397	51.46083	-3.12007	ARIS_2020-08-23_101800_ A1.T2_F30_B128_S470_T06_R0-3.aris
A1	Tow3	Section1	17:50:03	17:52:20	1	51.45643	-3.12227	51.45681	-3.12173	ARIS_2020-08-23_175003_ A1.T3_F30_B128_S726_T06_R0-3.aris
A1	Tow3	Section2	17:52:20	17:53:42	2013	51.45681	-3.12173	51.45746	-3.12106	ARIS_2020-08-23_175003_ A1.T3_F30_B128_S726_T06_R0-3.aris

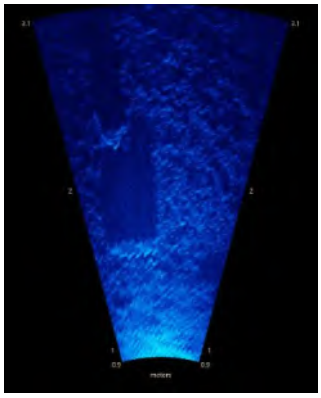
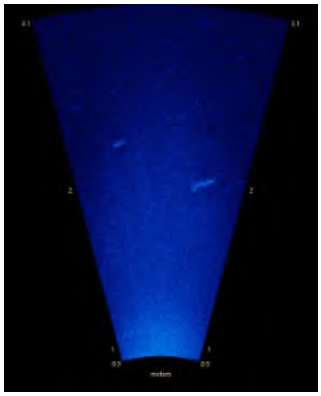
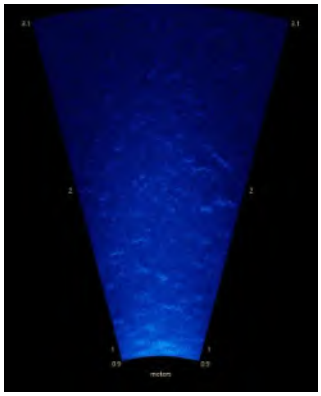
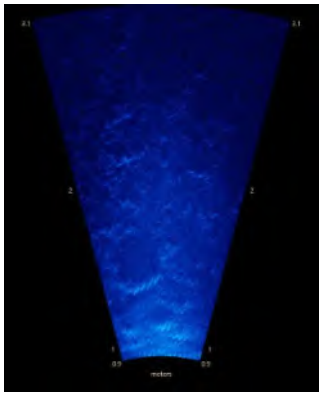
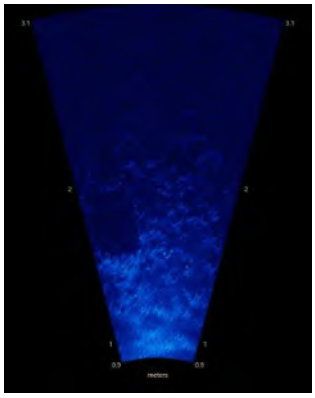
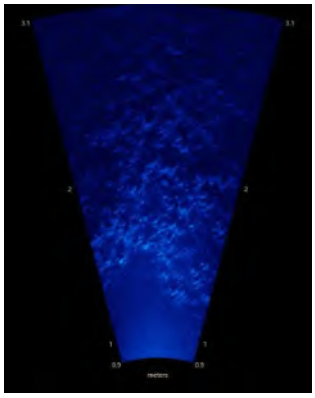
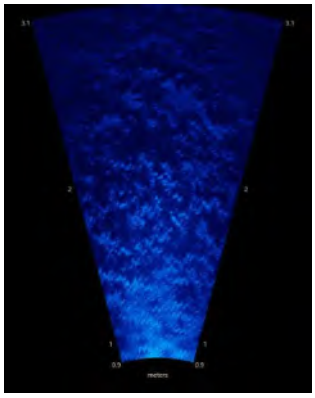
Area	Tow	Section	Start Time	End Time	Start Frame	Start Lat	Start Long	End Lat	End Long	Filename
A1	Tow1	Section1	9:21:41	9:23:12	1	51.45977	-3.12092	51.46055	-3.12001	ARIS_2020-08-23_092141_ A1.T1_F30_B128_S470_T06_R0-3.aris
A1	Tow3	Section3	17:53:42	17:54:18	3224	51.45746	-3.12106	51.45775	-3.12067	ARIS_2020-08-23_175003_ A1.T3_F30_B128_S726_T06_R0-3.aris
A1	Tow3	Section4	17:54:18	17:57:31	3751	51.45775	-3.12067	51.45923	-3.11904	ARIS_2020-08-23_175003_ A1.T3_F30_B128_S726_T06_R0-3.aris
A1	Tow4	Section1	13:52:01	13:57:46	1	51.46064	-3.12121	51.45955	-3.12065	ARIS_2020-08-26_135200_ A1.T4_F30_B128_S734_T06_R0-3.aris
A1	Tow4	Section2	13:57:46	14:09:43	5043	51.45955	-3.12065	51.45674	-3.12012	ARIS_2020-08-26_135200_ A1.T4_F30_B128_S734_T06_R0-3.aris
A1	Tow5	Section1	14:16:34	14:22:46	1	51.46066	-3.12217	51.45936	-3.12186	ARIS_2020-08-26_141634_ A1.T5_F30_B128_S733_T06_R0-3.aris
A1	Tow5	Section2	14:22:46	14:23:51	5451	51.45936	-3.12186	51.45910	-3.12176	ARIS_2020-08-26_141634_ A1.T5_F30_B128_S733_T06_R0-3.aris
A1	Tow5	Section3	14:23:51	14:25:53	6410	51.45910	-3.12176	51.45861	-3.12163	ARIS_2020-08-26_141634_ A1.T5_F30_B128_S733_T06_R0-3.aris
A1	Tow5	Section4	14:25:53	14:31:41	8201	51.45861	-3.12163	51.45667	-3.12141	ARIS_2020-08-26_141634_ A1.T5_F30_B128_S733_T06_R0-3.aris
A2	Tow1	Section1	10:38:56	10:44:20	1	51.45493	-3.11933	51.45588	-3.11828	ARIS_2020-08-23_103856_ A2.T1_F30_B128_S470_T06_R0-3.aris
A2	Tow1	Section2	10:44:20	10:45:19	4767	51.45588	-3.11828	51.45609	-3.11808	ARIS_2020-08-23_103856_ A2.T1_F30_B128_S470_T06_R0-3.aris
A2	Tow1	Section3	10:45:19	10:49:04	5647	51.45609	-3.11808	51.45694	-3.11732	ARIS_2020-08-23_103856_ A2.T1_F30_B128_S470_T06_R0-3.aris
A2	Tow2	Section1	13:25:11	13:29:44	1	51.45529	-3.11832	51.45575	-3.11809	ARIS_2020-08-26_132511_ A2.T2_F30_B128_S734_T06_R0-3.aris
A2	Tow2	Section2	13:29:44	13:31:15	4007	51.45575	-3.11809	51.45596	-3.11805	ARIS_2020-08-26_132511_ A2.T2_F30_B128_S734_T06_R0-3.aris
A2	Tow2	Section3	13:31:15	13:39:59	5346	51.45596	-3.11805	51.45686	-3.11751	ARIS_2020-08-26_132511_ A2.T2_F30_B128_S734_T06_R0-3.aris

Area	Tow	Section	Start Time	End Time	Start Frame	Start Lat	Start Long	End Lat	End Long	Filename
A1	Tow1	Section1	9:21:41	9:23:12	1	51.45977	-3.12092	51.46055	-3.12001	ARIS_2020-08-23_092141_ A1.T1_F30_B128_S470_T06_R0-3.aris
A3	Tow1	Section1	11:18:30	11:25:01	1	51.45714	-3.10862	51.45557	-3.10777	ARIS_2020-08-23_111830_ A3.T1_F30_B128_S475_T06_R0-3.aris
A3	Tow2	Section1	12:50:27	13:00:44	1	51.45563	-3.11066	51.45719	-3.10878	ARIS_2020-08-23_111830_ A3.T1_F30_B128_S475_T06_R0-3.aris
A4	Tow1	Section1	10:54:26	11:11:01	1	51.45301	-3.11335	51.45533	-3.11182	ARIS_2020-08-23_105426_ A4.T1_F30_B128_S475_T06_R0-3.aris
A4	Tow2	Section1	13:09:47	13:19:06	1	51.45368	-3.11343	51.45530	-3.11213	ARIS_2020-08-26_130947_ A4.T2_F30_B128_S734_T06_R0-3.aris
B1	Tow1	Section1	11:34:40	11:42:51	1	51.46814	-3.08462	51.46665	-3.08463	ARIS_2020-08-23_113440_ B1.T1_F30_B128_S475_T06_R0-3.aris
B1	Tow1	Section2	11:42:51	11:43:49	7248	51.46665	-3.08463	51.46630	-3.08469	ARIS_2020-08-23_113440_ B1.T1_F30_B128_S475_T06_R0-3.aris
B1	Tow1	Section3	11:43:49	11:44:53	8107	51.46630	-3.08469	51.46591	-3.08480	ARIS_2020-08-23_113440_ B1.T1_F30_B128_S475_T06_R0-3.aris
B1	Tow1	Section4	11:44:53	11:50:20	9056	51.46591	-3.08480	51.46426	-3.08577	ARIS_2020-08-23_113440_ B1.T1_F30_B128_S475_T06_R0-3.aris
B1	Tow2	Section1	14:11:46	14:16:30	1	51.46426	-3.08659	51.46494	-3.08645	ARIS_2020-08-27_141146_ B1.T2_F30_B128_S732_T06_R0-3.aris
B1	Tow2	Section2	14:16:30	14:17:58	3890	51.46494	-3.08645	51.46505	-3.08647	ARIS_2020-08-27_141146_ B1.T2_F30_B128_S732_T06_R0-3.aris
B1	Tow2	Section3	14:17:58	14:19:27	5100	51.46505	-3.08647	51.46548	-3.08638	ARIS_2020-08-27_141146_ B1.T2_F30_B128_S732_T06_R0-3.aris
B1	Tow2	Section4	14:19:27	14:20:50	6334	51.46548	-3.08638	51.46580	-3.08642	ARIS_2020-08-27_141146_ B1.T2_F30_B128_S732_T06_R0-3.aris
B1	Tow2	Section5	14:20:50	14:23:45	7479	51.46580	-3.08642	51.46629	-3.08639	ARIS_2020-08-27_141146_ B1.T2_F30_B128_S732_T06_R0-3.aris
B1	Tow2	Section6	14:23:45	14:27:47	9870	51.46629	-3.08639	51.46709	-3.08635	ARIS_2020-08-27_141146_ B1.T2_F30_B128_S732_T06_R0-3.aris

Area	Tow	Section	Start Time	End Time	Start Frame	Start Lat	Start Long	End Lat	End Long	Filename
A1	Tow1	Section1	9:21:41	9:23:12	1	51.45977	-3.12092	51.46055	-3.12001	ARIS_2020-08-23_092141_ A1.T1_F30_B128_S470_T06_R0-3.aris
B1	Tow2	Section7	14:27:47	14:31:10	13215	51.46709	-3.08635	51.46802	-3.08626	ARIS_2020-08-27_141146_ B1.T2_F30_B128_S732_T06_R0-3.aris
C1	Tow1	Section1	12:09:40	12:14:40	1	51.48501	-3.05770	51.48346	-3.05794	ARIS_2020-08-23_120940_ C1.T1_F30_B128_S475_T06_R0-3.aris
C1	Tow2	Section1	13:49:23	13:57:42	1	51.48351	-3.05884	51.48519	-3.05894	ARIS_2020-08-27_134923_ C1.T2_F30_B128_S731_T06_R0-3.aris
C2	Tow1	Section1	16:52:11	16:58:07	1	51.48279	-3.06513	51.48144	-3.06492	ARIS_2020-08-23_165211_ C2.T1_F30_B128_S726_T06_R0-3.aris
C2	Tow2	Section1	12:40:22	12:48:41	1	51.48138	-3.06321	51.48181	-3.06701	ARIS_2020-08-24_124022_ C2.T2_F30_B128_S735_T06_R0-3.aris
C3	Tow2	Section1	16:37:50	16:46:16	1	51.48151	-3.05748	51.47974	-3.05756	ARIS_2020-08-23_163750_ C3.T2_F30_B128_S726_T06_R0-3.aris
C3	Tow3	Section1	12:55:08	12:58:56	1	51.48043	-3.05596	51.48032	-3.05677	ARIS_2020-08-24_125508_ C3.T3_F30_B128_S734_T06_R0-3.aris
C3	Tow3	Section2	12:58:56	13:02:50	3351	51.48032	-3.05677	51.47983	-3.05893	ARIS_2020-08-24_125508_ C3.T3_F30_B128_S734_T06_R0-3.aris
C4	Tow1	Section1	17:03:09	17:08:09	1	51.47512	-3.06722	51.47420	-3.06663	ARIS_2020-08-23_170309_ C4.T1_F30_B128_S726_T06_R0-3.aris
C4	Tow1	Section2	17:08:09	17:13:08	4412	51.47420	-3.06663	51.47303	-3.06535	ARIS_2020-08-23_170309_ C4.T1_F30_B128_S726_T06_R0-3.aris
C4	Tow2	Section1	12:19:51	12:28:21	1	51.47284	-3.06567	51.47401	-3.06739	ARIS_2020-08-24_121951_ C4.T2_F30_B128_S736_T06_R0-3.aris
C4	Tow2	Section2	12:28:21	12:32:38	7494	51.47401	-3.06739	51.47491	-3.06928	ARIS_2020-08-24_121951_ C4.T2_F30_B128_S736_T06_R0-3.aris
C5	Tow1	Section1	11:02:49	11:05:51	1	51.47343	-3.06228	51.47448	-3.06079	ARIS_2020-08-24_110249_ C5.T1_F30_B128_S739_T06_R0-3.aris

Area	Tow	Section	Start Time	End Time	Start Frame	Start Lat	Start Long	End Lat	End Long	Filename
A1	Tow1	Section1	9:21:41	9:23:12	1	51.45977	-3.12092	51.46055	-3.12001	ARIS_2020-08-23_092141_ A1.T1_F30_B128_S470_T06_R0-3.aris
C5	Tow2	Section1	11:09:34	11:14:03	1	51.47317	-3.06232	51.47464	-3.06040	ARIS_2020-08-24_110934_ C5.T2_F30_B128_S738_T06_R0-3.aris
C6	Tow1	Section1	17:23:16	17:30:35	1	51.47156	-3.06031	51.46989	-3.05892	ARIS_2020-08-23_172316_ C6.T1_F30_B128_S726_T06_R0-3.aris
C6	Tow2	Section1	11:19:16	11:28:00	1	51.46882	-3.06086	51.47171	-3.05743	ARIS_2020-08-24_111916_ C6.T2_F30_B128_S737_T06_R0-3.aris
D1	Tow1	Section1	11:43:59	11:50:15	1	51.49528	-3.04350	51.49671	-3.04410	ARIS_2020-08-24_114400_ D1.T1_F30_B128_S736_T06_R0-3.aris
D1	Tow2	Section1	11:55:48	12:04:31	1	51.49514	-3.04232	51.49675	-3.04471	ARIS_2020-08-24_115548_ D1.T2_F30_B128_S736_T06_R0-3.aris

Table 19
Example images from ARIS footage for each Tow and each secondary survey area

Area A1, Tow 1 (Image 1)	Area A1, Tow 1 (Image 2)	Area A1, Tow 1 (Image 3)
		
Area A1, Tow 2 (Image 1)	Area A1, Tow 2 (Image 2)	Area A1, Tow 2 (Image 3)
		
Area A1, Tow 3 (Image 1)	Area A1, Tow 3 (Image 2)	Area A1, Tow 3 (Image 3)
		
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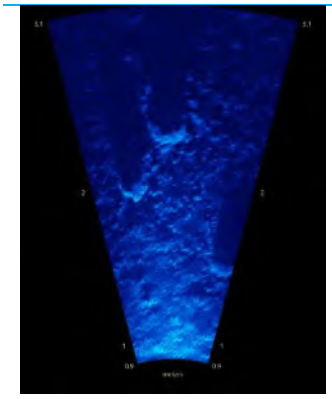
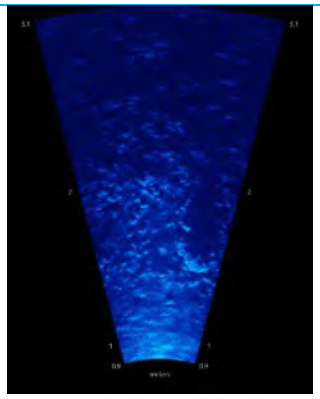
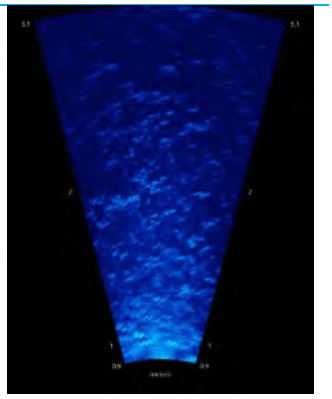
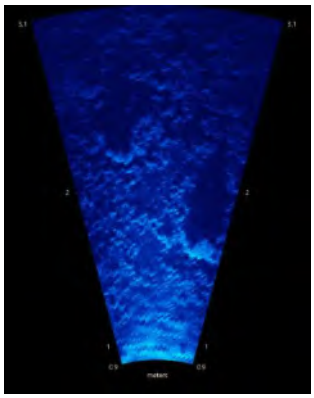
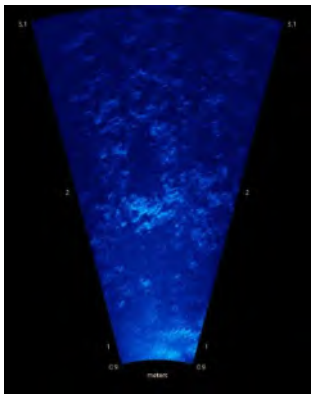
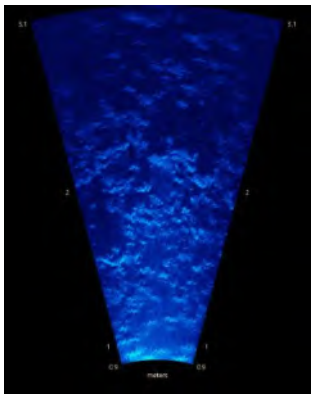
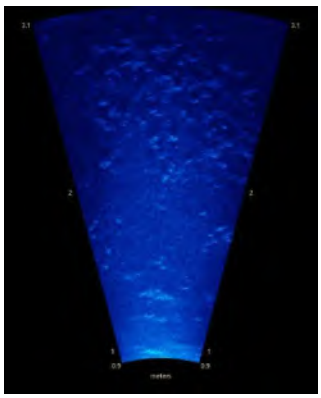
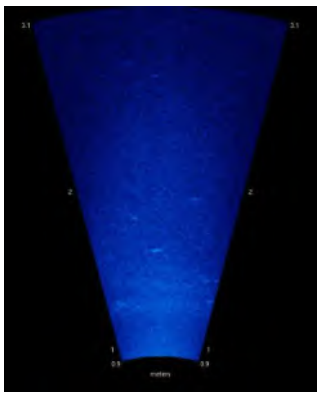
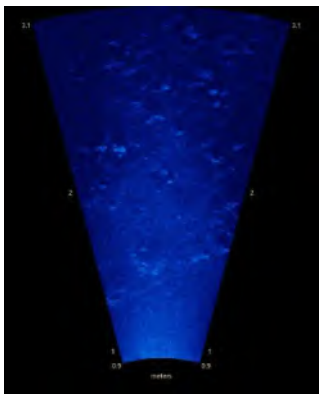
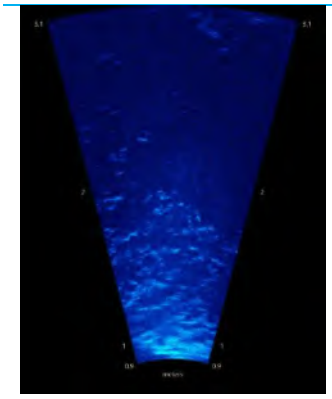
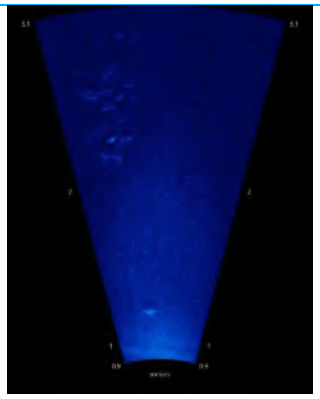
		
Area A1, Tow 5 (Image 1)	Area A1, Tow 5 (Image 2)	Area A1, Tow 5 (Image 3)
		
Area A2, Tow 1 (Image 1)	Area A2, Tow 1 (Image 2)	Area A2, Tow 1 (Image 3)
		
Area A2, Tow 2 (Image 1)	Area A2, Tow 2 (Image 2)	Area A2, Tow 2 (Image 3)



Area A3, Tow 1 (Image 1)



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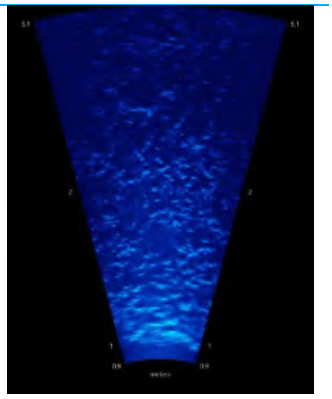
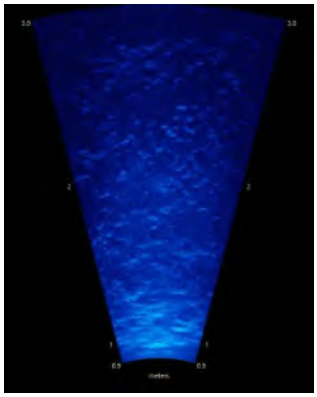
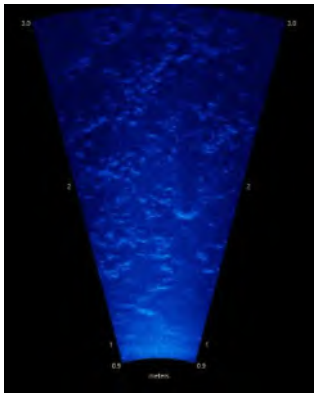


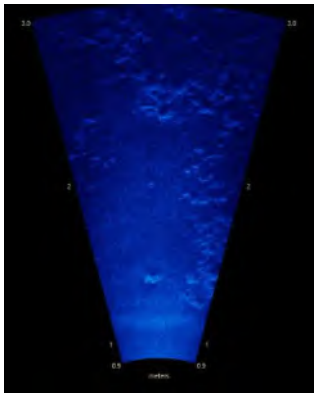
Area A3, Tow 1 (Image 3)



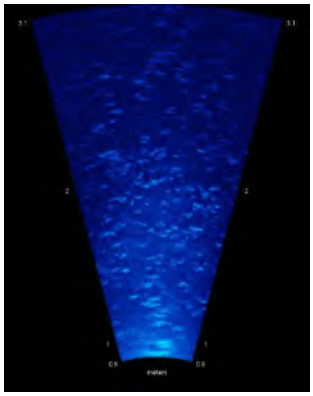
Area A3, Tow 2 (Image 1)



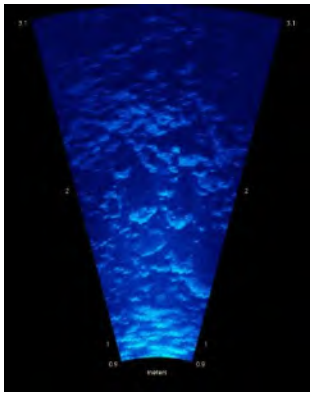
Area A3, Tow 2 (Image 2)



Area A3, Tow 2 (Image 3)

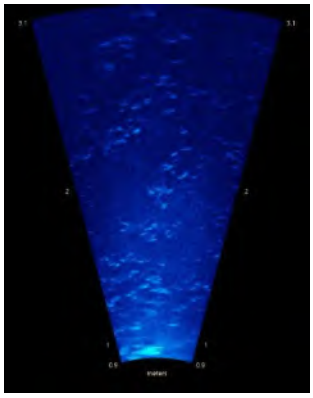
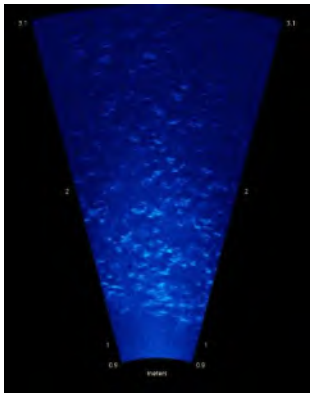
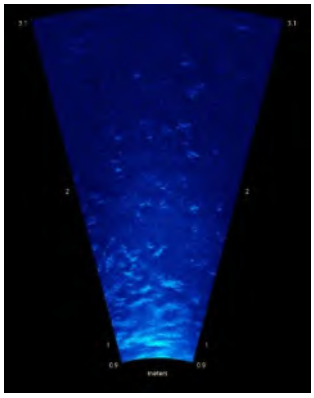
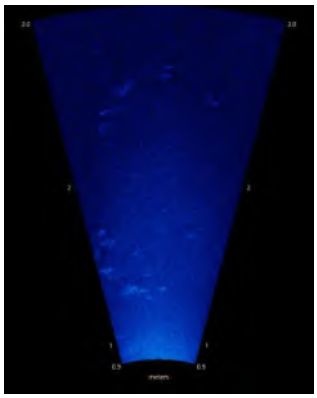
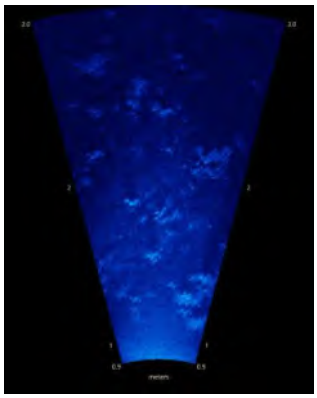
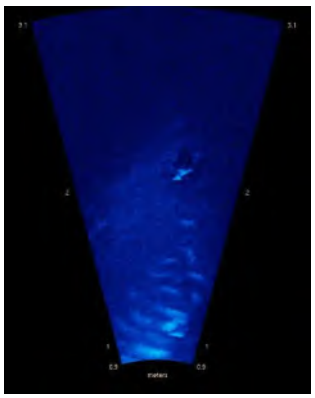
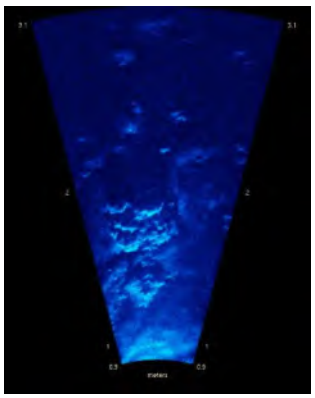
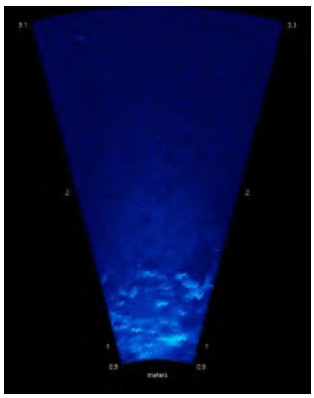


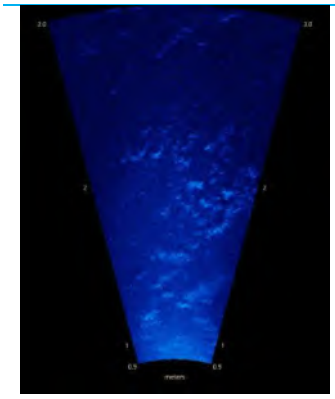
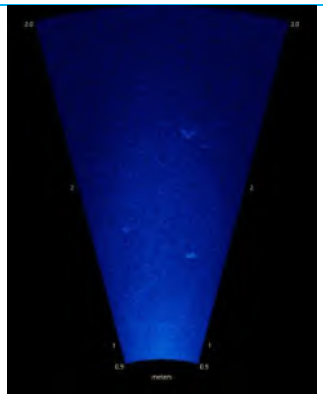
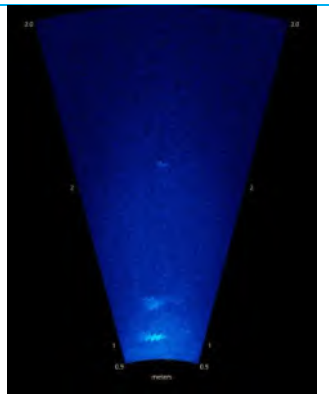
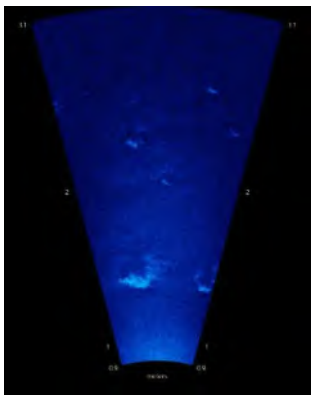
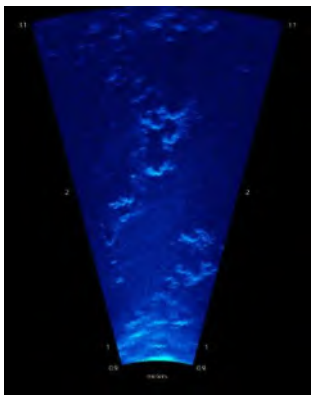
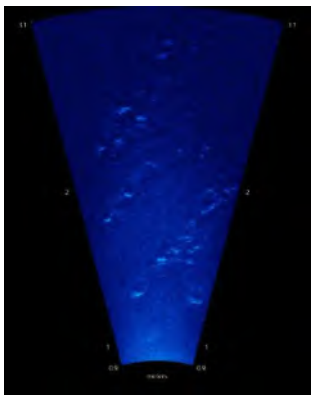
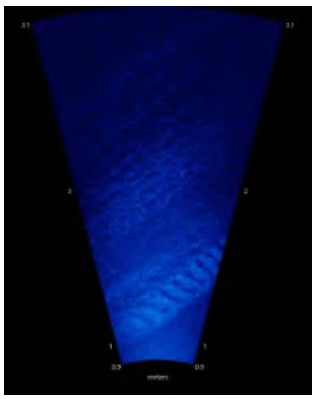
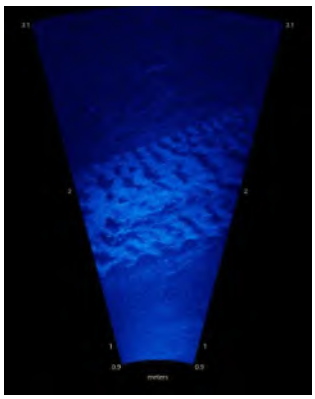
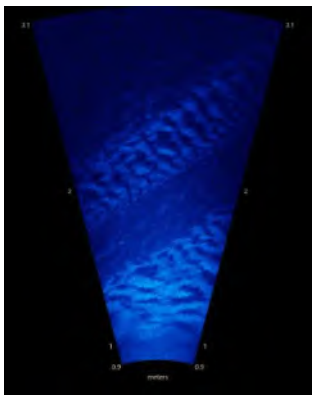
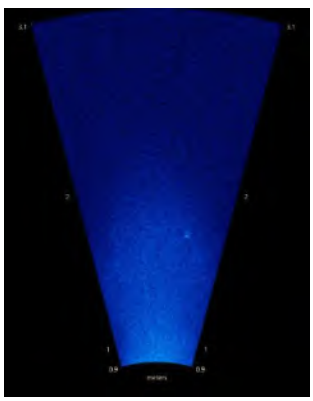
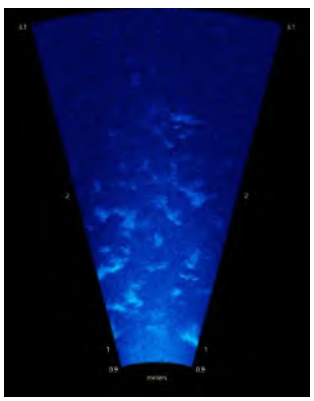
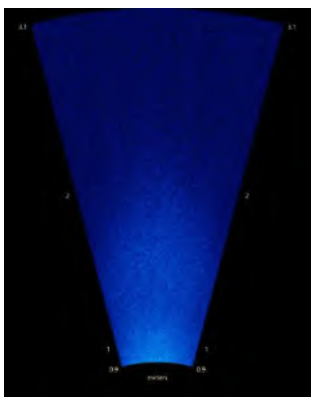
Area A4, Tow 1 (Image 1)

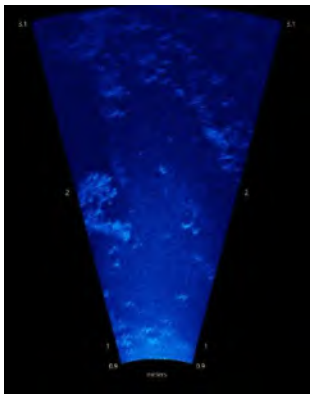
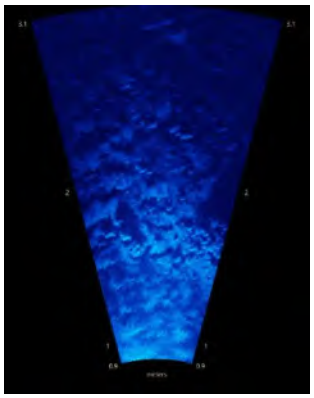
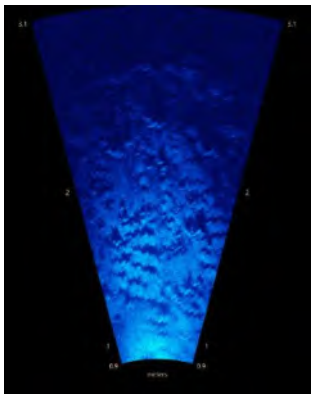


Area A4, Tow 1 (Image 2)

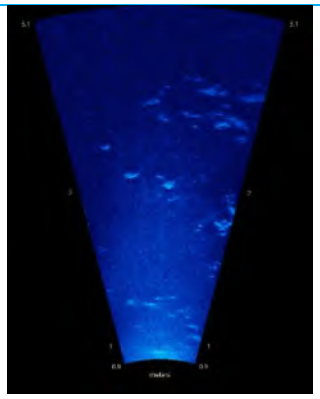
Area A4, Tow 1 (Image 3)

Area A4, Tow 2 (Image 1)	Area A4, Tow 2 (Image 2)	Area A4, Tow 2 (Image 3)
		
Area B1, Tow 1 (Image 1)	Area B1, Tow 1 (Image 2)	Area B1, Tow 1 (Image 3)
		
Area B1, Tow 2 (Image 1)	Area B1, Tow 2 (Image 2)	Area B1, Tow 2 (Image 3)
		
Area C1, Tow 1 (Image 1)	Area C1, Tow 1 (Image 2)	Area C1, Tow 1 (Image 3)

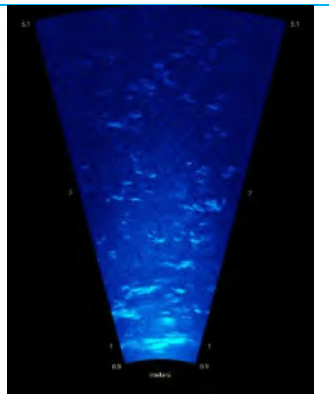
		
Area C1, Tow 2 (Image 1)	Area C1, Tow 2 (Image 2)	Area C1, Tow 2 (Image 3)
		
Area C2, Tow 1 (Image 1)	Area C2, Tow 1 (Image 2)	Area C2, Tow 1 (Image 3)
		
Area C2, Tow 2 (Image 1)	Area C2, Tow 2 (Image 2)	Area C2, Tow 2 (Image 3)
		

Area C3, Tow 2 (Image 1)	Area C3, Tow 2 (Image 2)	Area C3, Tow 2 (Image 3)
		
Area C3, Tow 3 (Image 1)	Area C3, Tow 3 (Image 2)	Area C3, Tow 3 (Image 3)
		
Area C4, Tow 1 (Image 1)	Area C4, Tow 1 (Image 2)	Area C4, Tow 1 (Image 3)
		
Area C4, Tow 2 (Image 1)	Area C4, Tow 2 (Image 2)	Area C4, Tow 2 (Image 3)

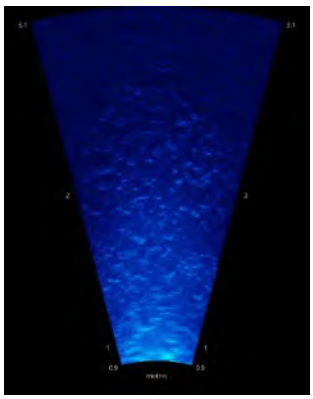
Area C5, Tow 1 (Image 1)



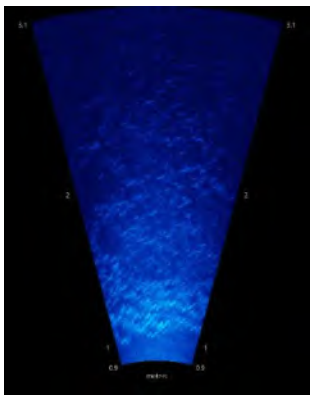
Area C5, Tow 1 (Image 2)



Area C5, Tow 1 (Image 3)

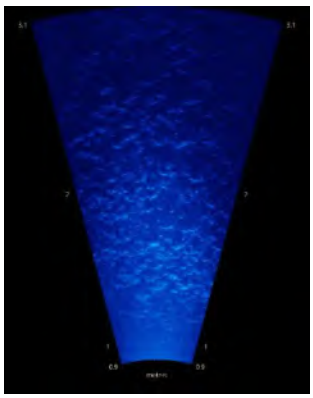


Area C5, Tow 2 (Image 1)



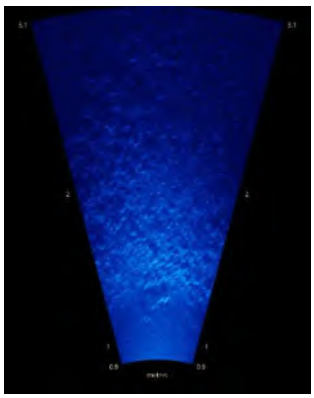
Area C5, Tow 2 (Image 2)

Area C5, Tow 2 (Image 3)

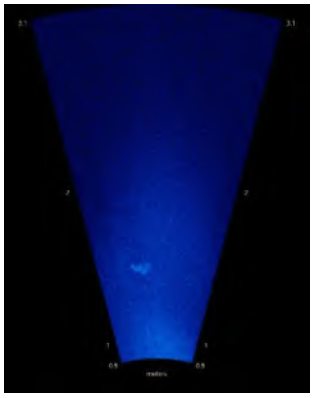
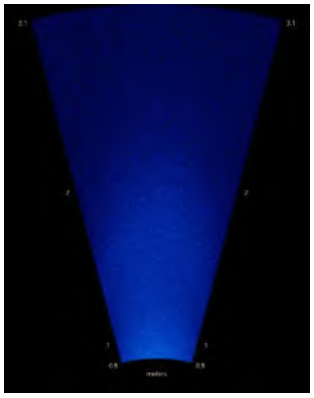
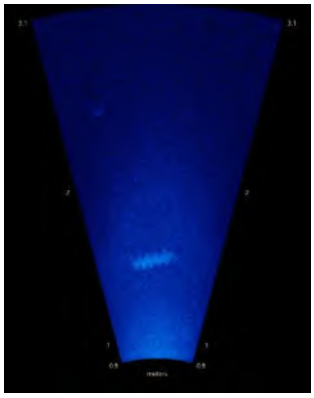
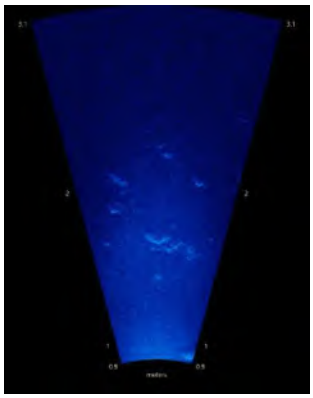
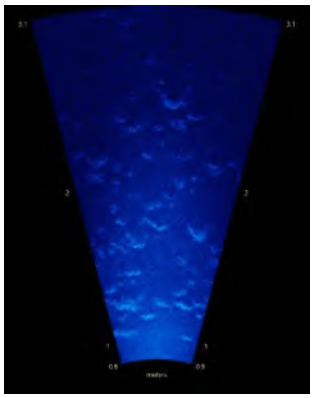
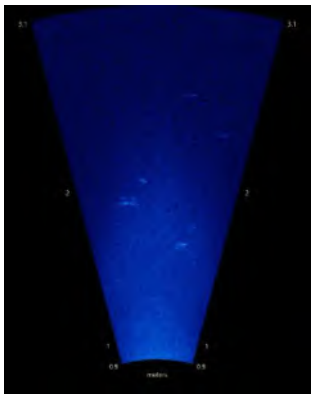


Area C6, Tow 1 (Image 1)

Area C6, Tow 1 (Image 2)



Area C6, Tow 1 (Image 3)

Area C6, Tow 2 (Image 1)	Area C6, Tow 2 (Image 2)	Area C6, Tow 2 (Image 3)
		
Area D1, Tow 1 (Image 1)	Area D1, Tow 1 (Image 2)	Area D1, Tow 1 (Image 3)
		
Area D1, Tow 2 (Image 1)	Area D1, Tow 2 (Image 2)	Area D1, Tow 2 (Image 3)