



RESEARCH EXPEDITION REPORT

RRS *Discovery* Expedition DY200

**AtlantiS, PISCES, REDRESS, RISC, MARS and JNCC survey
at Greater Haig Fras and The Canyons MCZs**

23 September – 12 October 2025

Principal Scientists

V A I Huvenne & M Kingsland

Shadowing Principal Scientists

L Skein & G Salavasidis

Report Number 88

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National Oceanography Centre, Southampton
Cruise Report No. 88
RRS *Discovery* Cruise DY200

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DOCUMENT DATA SHEET

AUTHOR HUVENNE, V.A.I., Kingsland M., Skein, L. & Salavasidis, G.	PUBLICATION DATE April 2026
TITLE RRS Discovery DY200, 23 September – 12 October 2025. AtlantiS, PISCES, REDRESS, RISC, MARS and JNCC survey at Greater Haig Fras and The Canyons MCZs	
REFERENCE Southampton, UK: National Oceanography Centre, Southampton, 200pp (National Oceanography Centre Cruise Report, No. 88)	
ABSTRACT <p>Expedition DY200 combined at-sea activities and observations for a series of funded projects with equipment trials for the Marine Autonomous and Robotics (MARS) facility at the National Oceanography Centre in Southampton. The work was part of a wider effort to increase our understanding of deep-water benthic habitats of conservation interest, particularly of their long-term variability and their resilience to anthropogenic impacts.</p> <p>For the NERC-funded National Capability programme AtlantiS (“Atlantic Climate and Environmental Strategic Science”, NE/Y005589/1), AUV and towed camera surveys were carried out at two of the programme’s long-term benthic observation sites: the Greater Haig Fras and The Canyons Marine Conservation Zones (MCZs). For the Horizon Europe-funded project REDRESS (“Restoration of Deep-sea habitats to Rebuild European Seas”; GAP No 101135492), 15 artificial reefs were deployed in The Canyons MCZ. They will be revisited in the coming years. To support this future monitoring effort, and to aid the already ongoing monitoring effort in the MCZ in general, an extensive programme of towed camera deployments was carried out for the Joint Nature Conservation Committee (JNCC).</p> <p>In parallel, the expedition enabled a range of more technical operations: the recovery of two moorings deployed during DY196 in the area for the NERC-funded PISCES project (Processes driving Submarine Canyon fluxES; NE/W005441/1), the recovery of a hydrophone lander deployed during JC278 for a NOC-internally funded project, and most importantly, extensive trials with the Autosub5 AUV, with the aim to train several new members of the team in the deployment, recovery, mission planning and execution of the Autosub5 missions. In addition, a new AUV anchoring system was tested as well.</p> <p>Wherever possible, the AUV trials were planned in a way that the data obtained added value to the projects mentioned. Overall, the team completed 14 AUV missions, 29 SeaSpyder camera tows, 9 CTD casts and 8 anchor tests, as well as recovering the requested equipment successfully and deploying the 15 ecoreefs. EM710 multibeam echosounder data were also collected on the transits. The new data provide once again a new time-point in the long-term time-series of the Greater Haig Fras MCZ and The Canyons MCZ and will enable the evaluation of long-term changes in those areas, particularly in The Canyons MCZ that was closed to bottom fishing just 3 years prior in 2022.</p> KEYWORDS Submarine Canyon, cold-water corals, shelf mosaic habitats The Canyons Marine Conservation Zone, Greater Haig Fras Marine Conservation Zone, Autosub 5 AUV, deep-sea habitat restoration	
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PARTICIPANTS

1.1. SCIENTIFIC PERSONNEL

name	surname	institute	Role
Veerle	Huvenne	NOC	PSO
Lisa	Skein	NOC	Shadowing PSO
Brian	Bett	NOC	Benthic ecologist
Timothy	Le Bas	NOC	Habitat mapper/watch leader
Andrew	Gates	NOC	Benthic Ecologist/watch leader
Sara	Driscoll	NOC	Biogeochemist
Lisa	Skein	NOC	Benthic Ecologist/shadow PSO
Angus	Rees	USoton	PhD student, benthic ecologist
Sophie	Cottam	USoton	MSc student, benthic ecologist
Dara	Farrell	NOC	Underwater acoustics
Fionnuala	McBreen	JNCC	MPA monitoring
Michaela	Vieser	Independent	Writer in residence
Matthew	Kingsland	NMF-MARS	MARS Dev/co-PSO/TLO
Enrico	Anderlini	NMF-MARS	AUV operations lead
Owain	Shepherd	NMF-MARS	AUV operations
Eoin	O'hObáin	NMF-MARS	AUV operations
Ollie	Williams	NMF-MARS	AUV operations
Trishna	Saeharaseelan	NMF-MARS	AUV C2
Tia	Burden	NMF-MARS	AUV Trainee
Francesco	Fanelli	NMF-MARS	AUV OAS/FLS tuning
Callum	Duguid	NMF-MARS	AUV Anchor System
Konrad	Ciaramella	NMF-MARS	AUV Anchor System
Georgios	Salavasidis	NMF-MARS	MARS/shadow PSO
Timothy	Powell	NMF	CTD/moorings
Christian	Crowe	NMF	CTD/moorings
Martin	Bridger	NMF	IT/systems
Benjamin	Poole	NMF	Ocean Engineering
Rory	O'Brien	NMF-MARS	MARS
Joseph	Young	Ocean Ecology	Camera operator

1.2. SHIPS OFFICERS AND CREW

Stewart	Mackay	Master
Andrew	Mahon	Chief Officer
Graham	Stringfellow	2 nd Officer
Jonathan	Brown	3 rd Officer
Gary	McCoy	Chief Engineer
Derek	Hay	2 nd Engineer
Jonathan	Gheisari-Miandoab	3 rd Engineer
Benjamin	Fowler	3 rd Engineer
William	Hicks	ETO
Graham	Bullimore	Purser

Stephen	Smith	Chief Petty Officer - Scientific
Stuart	Cook	Chief Petty Officer - Deck
Kevin	Riley	Petty Officer – Deck
Luke	Stalker	Petty Officer - Scientific
Glyndor	Henry	Engine Room Petty Officer
Christopher	Peppin	Seaman Grade 1A
Martin	Wright	Seaman Grade 1A
John	Melville	Seaman Grade 1A
Peter	Lynch	Head Chef
Neil	Burgess	Chef
Marius	Constantin	Steward
Sergio	Pires Constantino	Assistant Steward
Valeria	Brown	Purser

2. ITINERARY

Departure Southampton: 23 September 2025, time: 11:00 BST
Arrival Southampton: 12 October 2025, time: 11:00 BST

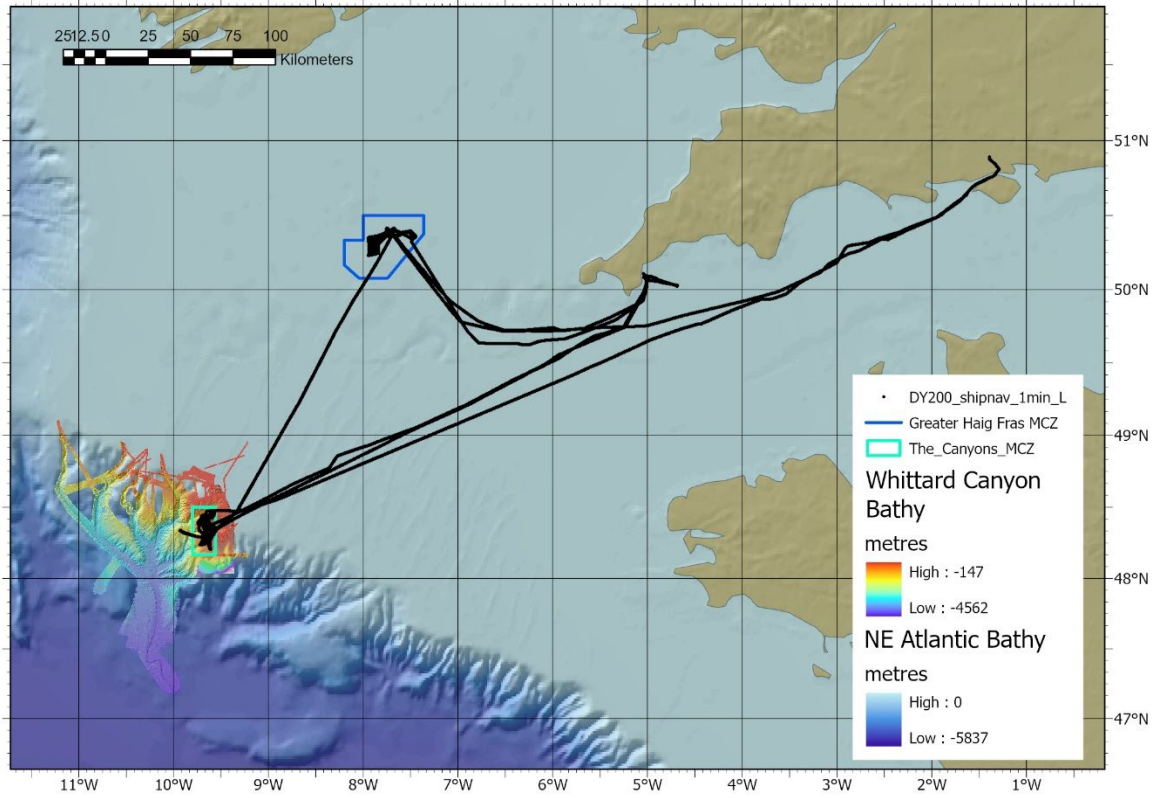


Fig. 2.1 Cruise track chart

3. BACKGROUND AND SCIENTIFIC RATIONALE

Expedition DY200 combined work for several research projects with technical trials for the NOC Marine Autonomous and Robotic Systems facility. A short summary of the research projects and their overarching aims is listed below, while the specific cruise objectives are presented in section 4.

3.1. Research projects

3.1.1. *AtlantiS (Veerle Huvenne)*

The Atlantis project (“Atlantic Climate and Environmental Strategic Science”, NE/Y005589/1) is the NERC single centre National Capability programme supporting the UK’s strategic marine research. The aim of the programme is to provide evidence, tools and knowledge to support the UK’s ambitions for a healthy, biologically diverse and resilient marine environment, a sustainable blue economy and coastal communities safe from natural hazards. The objectives of the programme are to strengthen the capacity of UK marine science to observe, model and predict the ocean through a step change in capability to maximise the value inherent in marine data, to transform the ocean from being data poor to data rich; to provide global syntheses of iconic climate change indicators; to lead an increase in public and government understanding of the role of the ocean in climate; and to communicate actionable knowledge effectively.

The project is delivered through an integrated research programme, including data and evidence gathering from sustained observations to support national and international research and policy. One of the sustained observation programmes includes regular repeat visits to a series of locations on the UK margin, to study the spatial and temporal dynamics of different benthic ecosystems. It particularly focuses on the impacts of human activities and basin/decadal scale oceanographic processes on the benthic environment. The sites are chosen for their presence of Vulnerable Marine Ecosystems (VMEs, as defined by the FAO; ICES, 2020, Annex 6) and other features of conservation interest. As such they are located in, or near to, Marine Protected Areas (MPAs). Two of our regular observational sites were the target of this expedition: the Greater Haig Fras Marine Conservation Zone (MCZ) and The Canyons MCZ. They are presented in more detail in section 3.2.

At the Greater Haig Fras MCZ, the aim for Atlantis was to continue the time-series of repeat AUV surveys that was started in 2012 to record long-term change in the MCZ. In parallel, any additional multibeam bathymetry or other data that could be collected while the AUV was carrying out its missions would add to the site characterisation.

In Whittard Canyon, and more specifically at The Canyons MCZ, the main target was to repeat AUV mapping missions carried out on canyon interfluves during previous cruises (JC125 and JC237) in order to evaluate changes in benthic habitat and human pressures (bottom trawling intensity). Furthermore, the aim was to extend the surveys with additional AUV-based photography to obtain better ground-truthing. Other than that, any additional repeat AUV surveys inside the canyon system would augment the long-term observational dataset in the wider Whittard Canyon system.

3.1.2. *PISCES (Rob Hall)*

Exchange of water masses, nutrients and carbon between the deep open ocean and shallow shelf seas is of fundamental importance to shelf sea ecosystem function and global climate. Nutrients upwelled onto continental shelves drive new primary production, support commercial fisheries, and allow

continental margins to contribute a disproportionately large amount of carbon sequestration through the biological pump (>40% globally). The transport of carbon off the shelves to the deep ocean, where residence times are order 100 years rather than order 1 year, is also essential for long-term climate stability. However, free exchange across the shelf break is markedly restricted by the tendency for slope currents to flow along isobaths, rather than across them. This tendency stems from a well-known dynamical constraint (Taylor-Proudman theorem), which requires purely geostrophic flows to follow isobaths because vertical velocity must be zero at all depths. Any cross-slope flows must therefore be ageostrophic in nature, either through flow acceleration, nonlinearity or turbulent stresses. As a result, shelf break exchange is limited where the continental slope is straight and smooth, but is dramatically enhanced over abrupt and complex bathymetric features that allow the slope current to break from geostrophy. Submarine canyons are key locations of enhanced shelf break exchange, but their complexity also makes the processes within them challenging to observe, understand and predict.

Ubiquitous along continental margins worldwide, submarine canyons feature steep convergent walls – an ideal environment for the development of two crucial cross-slope exchange processes:

Upwelling and downwelling. Rossby numbers ($Ro = U/Lf$) are typically higher within canyons than over smooth continental slopes, due to their shorter bathymetric length scales (L) and steeper slope gradients with convergent isobaths that accelerate flows (U). Thus, the presence of a canyon often results in an unstable, ageostrophic slope current that is deflected onto (upwelling) – or off (downwelling) – the continental shelf, depending on the canyon's geometry and flow direction.

Internal tides and turbulent mixing. Canyons cut across oscillating tidal currents, which typically flow parallel to the shelf break, and generate energetic internal tides. These, and other remotely-generated internal waves, are trapped within canyons by reflection from their steep walls and gently sloping floor. This focusing of internal wave energy towards the head of canyons causes breaking, scattering, and drives elevated levels of diapycnal mixing. In turn, this allows upwelling of nutrients and other deep ocean tracers above the canyon rim.

These two exchange processes are expected to transport substantial quantities of deep ocean nitrate across the shelf break and so facilitate enhanced primary production over the outer shelf. In addition, the associated cross-slope fluxes of heat and salt drive entrainment of sloping boundary layer waters into the deep ocean interior and allow canyons to contribute a disproportionately large amount of diapycnal transport to the global ocean mixing budget. Despite this, the total cross-slope transports of heat, salt and nitrate have never been assessed for a whole submarine canyon system and the relative importance of **advective processes** to **diffusive processes** is unknown.

Fluxes of heat, salt and nitrate through any particular canyon are likely driven by a combination of advective and diffusive processes, so to fully understand canyon exchange, they must be considered together. Due to the complexity of canyon dynamics, their diagnosis requires fine-resolution numerical models validated against intensive observations. Processes driving Submarine Canyon fluxES (PISCES; NE/W005441/1) is the first integrated observational-modelling study of both advective and diffusive exchange processes in a submarine canyon. The project focuses on exchange through canyons incising the European northwest shelf, but the results are applicable to canyons worldwide. Whittard Canyon is our exemplar case study and we are leveraging ongoing fine-scale modelling efforts with NEMO through the UK JMMP.

3.1.3. REDRESS (*Veerle Huvenne*)

REDRESS (“Restoration of Deep-sea habitats to Rebuild European Seas”; GAP No 101135492) is a Horizon Europe project that aims to demonstrate the feasibility, sustainability and value of deep-sea ecosystem restoration, while providing public authorities with solutions to plan and upscale restoration operations. The project focuses on a variety of deep-sea habitats, including cold-water coral reefs, coral gardens, methane seeps and bioturbated muddy grounds. It will identify suitable locations for future restoration actions, demonstrate a number of restoration solutions (including the deployment of artificial reefs, or the re-positioning of corals brought up as fisheries bycatch), develop the optimal approaches for monitoring of restoration sites, and evaluate the socio-economic impacts of deep-sea restoration.

NOC’s contribution to REDRESS is to deploy a series of artificial reefs in an area that previously hosted cold-water coral reefs, and to demonstrate its latest technological solutions for monitoring the effect of these ecoreefs on the benthic ecosystem. For DY200 specifically, this meant the deployment of 15 artificial reef structures on the interflaves of The Canyons MCZ, together with the collection of imagery and water column property data to be used as baseline for future monitoring.

3.1.4. RISC (*Dara Farrell*)

The measurement of ocean noise, or ‘underwater soundscaping’, is a powerful tool for understanding and monitoring the ocean (Bayrakci et al. 2023). Applications include biodiversity monitoring, measurements of anthropogenic noise (Farrell et al. 2017), as well as detection of atmospheric, cryospheric, and geospheric events (such as storms, iceberg calving, and underwater landslides, respectively). Marine life activity (e.g. marine mammals, fishes) can be monitored and linked to temporal dynamics (e.g. diel, seasonal), hence providing fundamental ecological knowledge of underwater ecosystems and how they may be impacted by human activities and climate change. The importance of underwater sound has been underscored by the relatively recent adoption of Ocean Sound as a GOOS Essential Ocean Variable (EOV; Tyack, 2018; 2023) alongside more traditional physical and biochemical oceanographic parameters.

However, long-term measurements of ocean sound are rare, especially in deep water environments away from coastlines. The project “Soundscapes of the Porcupine Abyssal Plain and Whittard Canyon”, funded by the NOC RISC programme aims to collect and analyse an initial, pilot acoustic dataset from both sites by adding hydrophones to an array of instruments at PAP-SO and Whittard Canyon, taking advantage of regular CLASS/ATLANTIS expeditions and additional funded cruises to deploy and recover the equipment.

As a result, eight hydrophones were deployed during expedition JC278 to record the ocean soundscape and marine mammal activity at both Whittard Canyon and the Porcupine Abyssal Plain Sustained Observatory (PAP-SO): the Whittard Canyon mooring (one in-line hydrophone), the PISCES 2 mooring (one in-line hydrophone), a standalone acoustic lander (four hydrophones), the PAP 3 mooring (one in-line hydrophone), and one hydrophone mounted on a lander at the PAP site in partnership with Ifremer.

The hydrophone deployments from JC278 were expected to provide first-of-their-kind measurements of deep-water soundscapes at both sites, presenting opportunities to explore different (but complementary) scientific questions. The PAP-SO site offers a very well characterised location to provide baseline monitoring of deep-sea soundscapes, analogous to deep-sea mining locations, and a unique opportunity to tie noise levels to a wide array of other meteorological and oceanographic measurements. Whittard Canyon is a dynamic shelf edge and continental margin environment, which

is a hub for ocean life across trophic levels, enabling the detection and monitoring of soniferous wildlife from crabs to fish to marine mammals. As a popular fishing ground, the detection of marine noise pollution from vessels and its impact on marine life can also be investigated, especially in relation to the mooring's location adjacent to The Canyons and South-West Deeps Marine Conservation Zones. Furthermore, the canyon system hosts large turbidity currents which will generate an acoustic signature.

The primary objective for the Soundscapes of the Porcupine Abyssal Plain and Whittard Canyon project during DY200 therefore was the recovery of the acoustic lander and acoustic recorder mounted on one of the PISCES moorings, deployed during expedition JC278.

3.1.5. MARS trials (*Matt Kingsland*)

The NOCs Marine Autonomous Robotics group (MARS) operates and maintains an extensive number of advanced towed, autonomous and remotely operated vehicles for ocean exploration and scientific research. A major proportion of those vehicles are designed and developed in-house, and in order to ensure their accurate, robust and reliable operation, regular equipment trials are necessary. Testing of particularly the deep-water vehicles is challenging, as the NOC is located relatively far away from deeper waters (>200m water depth). Dedicated expeditions to the nearest deep-water research site, such as Whittard Canyon, that combine a series of tests and trials, are the most cost-efficient way to answer this challenge.

For DY200, the MARS team brought two main pieces of engineering equipment on board, Autosub5 and an AUV mooring test system. Autosub5 is a 6m long work-class AUV designed to be launched and recovered from a ship. It comes with specialist launch and recovery equipment as well as a dedicated team to operate it. Autosub5's primary purpose is imaging using both acoustic (sidescan and multibeam) and optical (camera) sensors. There were two main objectives for Autosub 5 on this cruise, firstly team training, as there has been significant turnover in the team since it last went on a science cruise. Thus, a significant portion of the cruise was dedicated to training the new team. Secondly, Autosub5 has always struggled to take low altitude (3-3.5m) camera pictures in any non-flat terrain. A new obstacle avoidance system (OAS) was installed pre-cruise along with an upgraded camera system. The OAS system had already been tested in Loch Ness, but this cruise was to provide more realistic testing conditions, primarily the coral mini-mounds located on the Whittard Canyon interflaves. Previous attempts to take AUV camera pictures on the mini-mounds resulted in the submarine aborting due to getting too close and in some cases touching the seabed.

The AUV mooring test system is a novel way to temporarily moor AUVs to the seabed. The system has been wholly developed by the NOC's MARS team in preparation for the Drivers of Oceanic Change in the Amundsen Sea (DeCAdeS) NERC funded project (NE/T012803/1). The objective of that project is to have an AUV repeatedly moor under ice for up to 1 month at a time over a total period of 12 months. MARS had previously tested the system on AUVs in Loch Ness but have not yet tested it in the ocean at a representative depth. Thus, the aim for DY200 was to conduct tests at varying depths, with the deepest being 1500m. MARS brought a test rig which could hold 3 mooring systems at a time thus allowing to build confidence in the reliability of the system. To document the tests they were recorded with a camera and passive acoustic monitoring system (PAM).

3.1.6. JNCC MCZ evidence gathering (Fionnuala McBreen)

The Joint Nature Conservation Committee (JNCC) is a UK Statutory Nature Conservation Body. JNCC provides advice to UK Governments on offshore, UK-wide and international nature conservation issues. The UK offshore marine environment extends from the edge of territorial waters to the UK Continental Shelf and covers an area of 722,134 km², 3 times the size of the UK. The 78 UK offshore MPAs cover an area 1.1 times the size of the UK. JNCC has responsibility for monitoring and assessing the condition of these offshore MPAs and their designated features, 64 of which are designated for seabed habitats and species. Due to the cost of monitoring offshore MPAs, it is not feasible to monitor every site and JNCC focus their direct monitoring efforts on a subset of MPAs. At the time of the DY200 survey, the subset of offshore MPAs to be monitored included The Canyons MCZ but did not include Greater Haig Fras MCZ. Where possible, additional data is collected in MPAs through collaborative opportunities.

NOC invited JNCC to collaborate on the DY200 survey on the RRS *Discovery* as the survey was planning to visit two UK offshore MPAs – Greater Haig Fras MCZ and The Canyons MCZ. JNCC provided funds to hire a SeaSpyder drop camera to collect video and still imagery data in the Canyons MCZ and provided a list of priority areas for ship multibeam data collection in Greater Haig Fras MCZ which could take place while Autosub was on its missions.

3.2. Work areas

The DY200 survey took place in two UK offshore Marine Conservation Zones, Greater Haig Fras and The Canyons (Fig. 3.1).

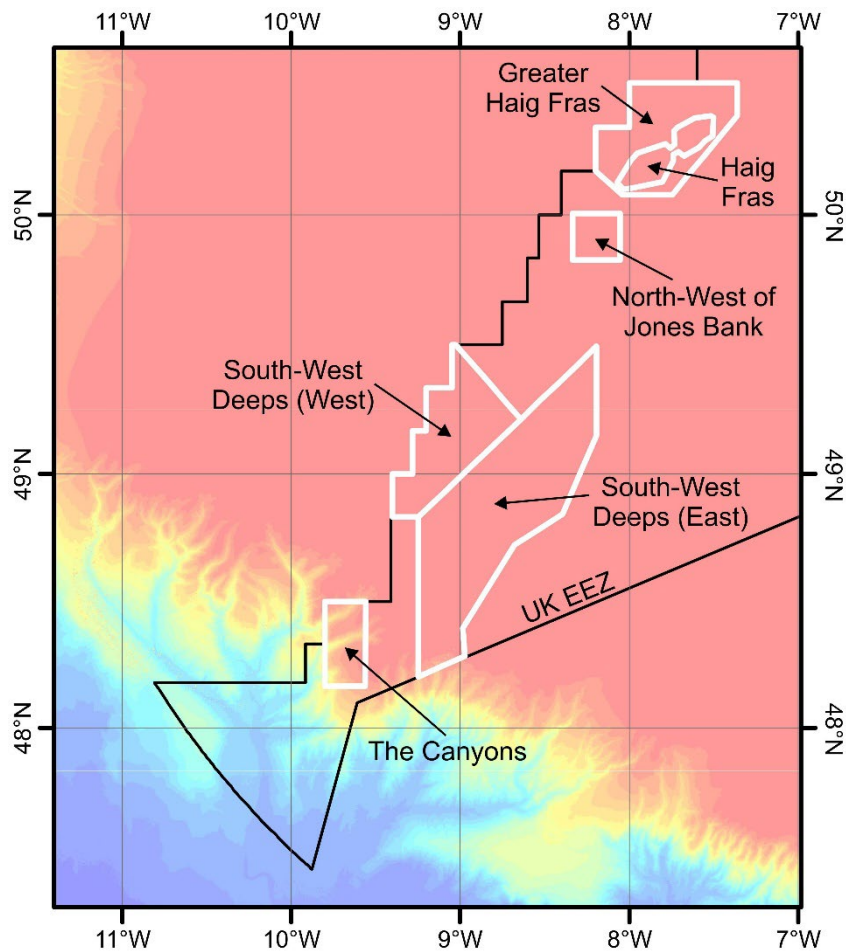


Fig. 3.1: Greater Haig Fras and The Canyons Marine Conservation Zones and nearby UK MPAs.

3.2.1. Greater Haig Fras MCZ (*Fionnuala McBreen, Brian Bett*)

The Greater Haig Fras Marine Conservation Zone (MCZ)¹ was designated in January 2016 under the Marine and Coastal Access Act 2009. It protects 2,041km² of continental shelf habitats surrounding a fully submarine granite outcrop (the Haig Fras Rock Complex) with depths ranging between 50m and 200m. The subtidal rocky complex within the site is a designated feature (Annex I reef) of the Haig Fras Special Area of Conservation (SAC) (see Fig 3.2). It is the only rocky reef on the Celtic Shelf, west of Cornwall.

¹ For more information on the Greater Haig Fras MCZ visit the site information centre: <http://jncc.defra.gov.uk/our-work/greater-haig-fras-mpa/>

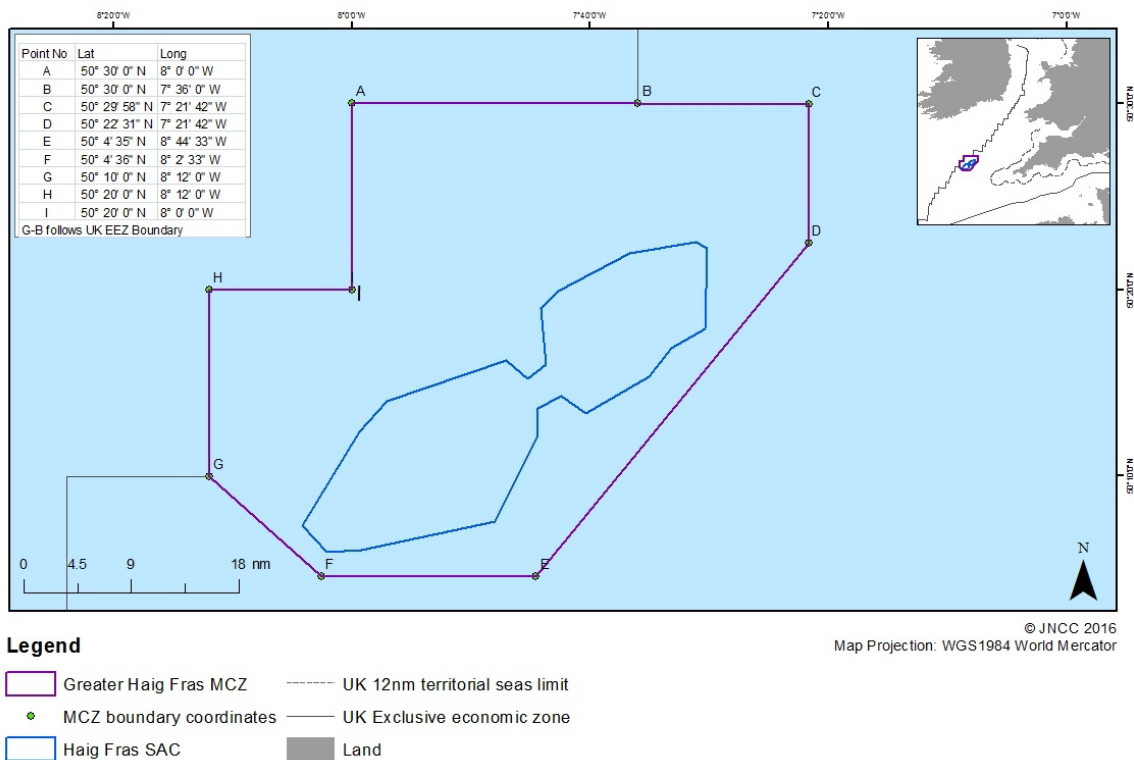


Fig. 3.2. Site boundary for Greater Haig Fras MCZ

The MCZ has six designated features: Subtidal coarse sediment, Subtidal sand, Subtidal mud, Subtidal mixed sediments, the MCZ Feature of Conservation Importance (FOCI) Sea-pen and burrowing megafauna communities, and the Haig Fras rock complex geological feature. The variety of subtidal sediments present at the MCZ supports a range of organisms including many species of polychaete worm and bivalve mollusc that live within the sediment, and epifaunal species such as sea urchins and starfish. Sea-pen and burrowing megafauna communities, an OSPAR Threatened and/or Declining habitat, are found in the deeper areas of the site.

On 24 March 2024, a Marine Protected Areas Bottom Towed Fishing Gear Byelaw 2023 came into force which prohibits the use of bottom towed gear on the rocky reefs in Haig Fras SAC. A draft Byelaw was proposed by the Marine Management Organisation (MMO) in June 2025 which would prohibit bottom towed gear in the entire Greater Haig Fras MCZ.

In 2019, JNCC and the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) conducted a baseline monitoring survey of Greater Haig Fras MCZ on the RV *Cefas Endeavour* (CEND0719) (Wood, et al 2020). The survey used a drop camera to collect video and still images and a 0.1 m² Hamon grab to collect infauna and particle size data.

NOC operations in the Greater Haig Fras Marine Conservation Zone were initiated in 2012 from RRS *Discovery* III cruise 377/8 (Ruhl, 2013). That work was undertaken as part of the Defra (Department for Environment, Food and Rural Affairs) funded project "Investigating the feasibility of utilizing AUV and Glider technology for mapping and monitoring of the UK MPA network (MB0118)", specifically Case Study 2: Shallow-water AUV mapping off SW UK. The aim of the original survey was to undertake high-resolution mapping (multibeam echo sounding, and sidescan sonar) and colour photography ("AESAs" camera) over the then recommended Marine Conservation Zone (rMCZ) using Autosub6000.

Following discussions with Defra, JNCC, and CEFAS, the Greater Haig Fras area was selected for the Autosub6000 mission. The specific location of the survey area was chosen to correspond with an area of ship-based seabed survey (multibeam bathymetry and backscatter) carried out from the RV *Cefas Endeavour* just prior to the arrival of RRS *Discovery* III cruise 377/8. Autosub6000 carried out the planned survey in a single mission (Mission 58; 25-26 July; NOC station number D377-062) comprised of four dives: (1) vehicle sensor test; (2) swath bathymetry survey from 50 mab; (3) photographic survey from 3 mab; and (4) sidescan sonar survey from 15 mab.

The mission was very successful, with the preliminary results reported to Defra by Wynn et al. (2013) and later published in Wynn et al. (2014). Given the effectiveness of this approach to seafloor mapping and biological assessment, the site and the technique were encompassed in the CLASS (Climate Linked Atlantic Section Science) project in Theme 1.4 Seafloor Disturbance and Recovery, and Task 4.1 Marine Protected Area related fixed point observatories, jointly with the Darwin Mounds Special Area of Conservation and The Canyons Marine Conservation Zone.

Follow-up time-series studies were subsequently conducted from RRS *James Cook* Cruise 124/5/6 in 2015 (Huvenne, et al., 2016) and RRS *James Cook* cruise 166/7 in 2018 (Huvenne & Furlong, 2019), in both cases using Autosub6000. In 2022 a subsequent follow-up survey was carried out with the new Autosub5 AUV during expedition DY152. Detailed analysis of the seafloor photographs from the first survey (2012) were published by Benoist et al. (2019) who noted that they were able to distinguish seven biotopes, detect statistically significant variations in standing stocks, species density, species diversity, and faunal composition, and identify significant indicator species for each habitat. They further noted that, without a cost-effective method, applicable across multiple habitat types, it would be difficult to develop a coherent classification of biotopes or to routinely assess their conservation status in the rapidly expanding global extent of MPAs.

A comparative analysis of the seafloor mapping undertaken in 2012 and 2015 was carried out by Zelada Leon et al. (2020) that highlighted the need for sidescan sonar derived backscatter textural features in the objective and repeatable mapping of the different seafloor habitats present. Similarly, a comparative analysis of the seafloor photography undertaken in 2012, 2015, and 2018 has been undertaken and is being prepared for publication (Benoist et al., in prep.), of note, day-night variation was detected in the composition of faunal communities recorded.

3.2.2. The Canyons MCZ and Whittard Canyon (Veerle Huvenne, Fionnuala McBreen)

Submarine canyons are the main pathways between the continental shelf and the deep sea, funnelling the transport of sediments and nutrients, but also litter and pollutants (Fernandez-Arcaya et al., 2017; Huvenne and Davies, 2014; Heijnen et al., 2022). Their presence on the margin leads to modified local shelf circulation and sedimentation (Fernandez-Arcaya et al., 2017). At the same time, irregular topography within the canyon can induce and modify hydrodynamic regimes resulting in internal tide and bore generation (Hall et al., 2017). This high environmental heterogeneity can lead to enhanced productivity, biodiversity, and faunal abundance (De Leo et al., 2010; Vetter et al., 2010, Robert et al., 2015).

Submarine canyons are under increasing anthropogenic pressures, including from offshore exploration, fishing, pollution and climate change (Fernandez-Arcaya et al., 2017; Pierdomenico et al., 2023), but increasing numbers of canyons are being protected.

Whittard Canyon is a large dendritic canyon system comprised of four main branches that runs from the shelf edge to the outflow channel at >4200 m water depth (Amaro et al., 2016). It hosts a wide

range of habitat types (Robert et al., 2015), including cold-water coral reefs, some of which are vertical (Huvenne et al., 2011). Increased diversity has been observed within the canyon (Pearman et al., 2023; Robert et al., 2015), and several features of conservation interest have been identified (e.g. Davies et al., 2014).

The Whittard Canyon system includes the Dangaard and Explorer Canyons, which are included within The Canyons MCZ², the only deep-sea MCZ in English waters. The Canyons Marine Conservation Zone was designated in November 2013. The Canyons MCZ protects the only known area of cold-water coral reef in English waters and is one of two English MCZs that protect deep-water habitats. It comprises the upper reaches of two canyon limbs (Dangaard and Explorer Canyon) that feed into the Whittard Canyon system (Stewart et al., 2014). The shallower areas between the canyons are referred to as the interfluves. The MCZ is designated to protect Deep-seabed, Cold-water coral reefs, Coral gardens and Seapen and Burrowing Megafauna communities. On the 13 June 2022, The Canyons Marine Conservation Zone (Specified Area) Prohibited Fishing Gears Byelaw prohibiting the use of “bottom towed fishing gear” came into force in parts of the MCZ (see Fig. 3.3).

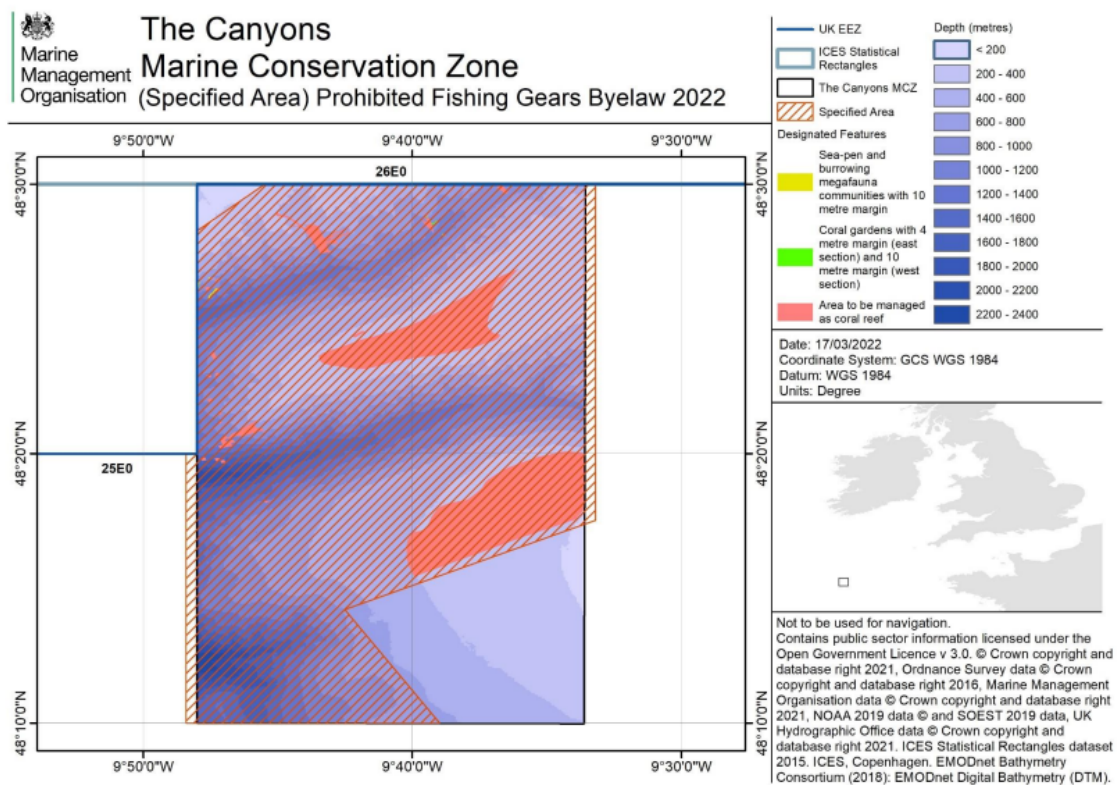


Fig. 3.3: The Canyons Marine Conservation Zone Prohibited Fishing Gears Byelaw 2022

In 2017, JNCC & Cefas undertook a baseline monitoring survey on the RV *Cefas Endeavour* to The Canyons MCZ (CEND0917) (Eggett et al, 2018; Savage et al, 2025). The survey focussed on the collection of drop camera video and still imagery and NIOZ boxcore samples across the MCZ. A new habitat map for The Canyons MCZ was created after this survey (Savage et al, 2025). It updated the Marine Habitat Classification of Britain and Ireland habitat map based on an analysis of existing ship-

² For more information on The Canyons MCZ visit the site information centre: <http://jncc.defra.gov.uk/our-work/the-canyons-mpa/>

based multibeam bathymetry and backscatter data from the Mapping European Seabed Habitats (MESH) project, NOC and the UK Hydrographic Office, in addition to particle size data and seabed imagery (Fig. 3.4). The interfluves are characterised by soft sediment, with depth primarily driving the distinction between the mud and sand habitats, with mud being more prevalent in the deeper areas of the site. The interfluves also had areas of ‘Squat lobster assemblage on Atlantic upper and mid bathyal coarse sediment (*Lophelia* rubble)’ (M.) and ‘Coarse sediment’ characterised by the presence of coral rubble. Rock within higher energy environments in the canyons was found to be predominantly surrounded by sand, whereas areas of rock with lower energy levels were more likely to be surrounded by mud.

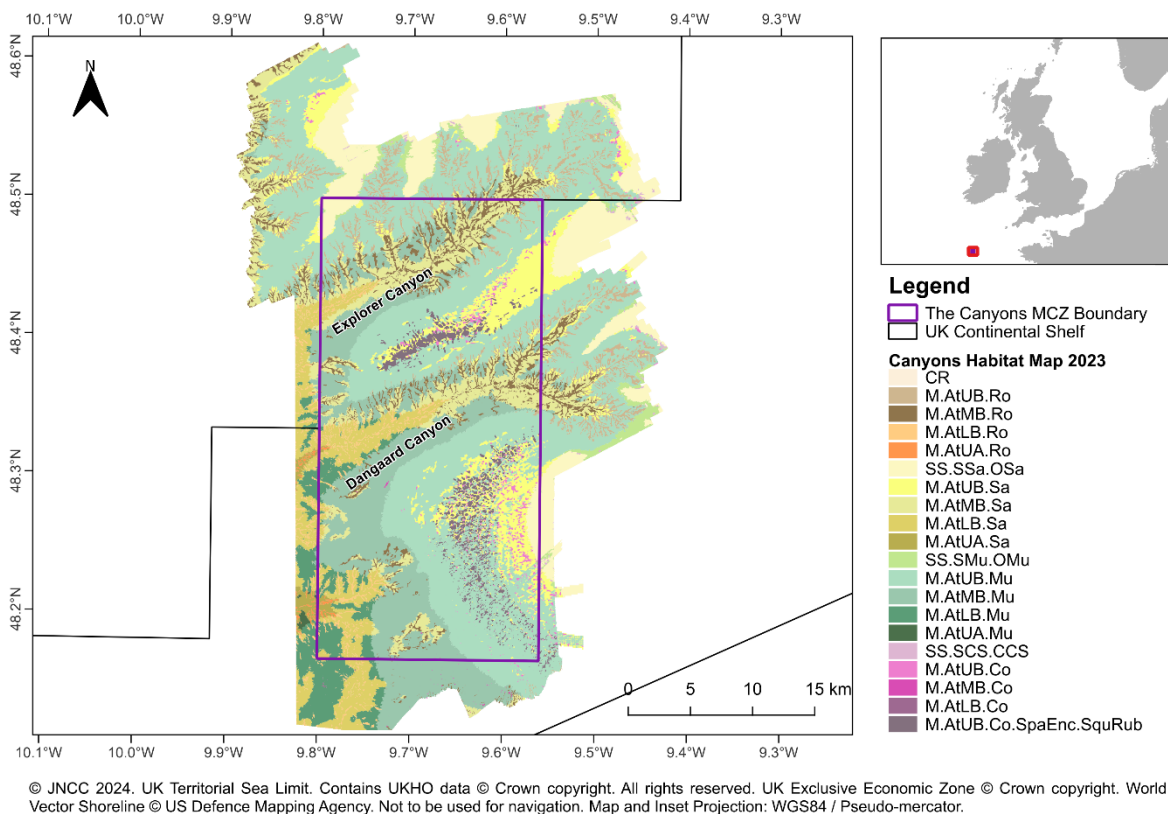


Fig. 3.4: The Canyons MCZ habitat map 2023 (Savage et al, 2025)

In 2018 expedition JC166 acquired ROV transect and MBES data within The Canyons MCZ, allowing ground truthing of areas previously un-surveyed (Huvenne & Furlong, 2019). As a result of the additional evidence gathered from this survey, two further features were added to the site designation in 2019, ‘Coral gardens’ and ‘Sea-pen and burrowing megafauna communities’.

4. OBJECTIVES

Based on the wider aims of the projects listed above, the DY200 specific objectives for each project could be formulated as follows:

4.1. AtlantiS

4.1.1. Haig Fras

- Carry out the 24h Haig Fras AUV Mission, repeat of previous missions in 2012, 2015, 2018, and 2022, acquiring MBES, sidescan Sonar and photography data to add to the CLASS and AtlantiS time series of this site.
- Extend shipboard MBES cover in the Greater Haig Fras area to improve understanding of the wider context of the time series site

4.1.2. Whittard Canyon area

- Repeat the AUV-based sidescan sonar survey from JC125 and JC237 over the Dangaard interfluvial mini-mound area to add to the time-series illustrating trawling impacts
- Add an AUV MBES survey to the same Dangaard interfluvial site to obtain good insight in the local (micro)bathymetry and to enable safe AUV operation close to the seabed
- Add an AUV camera survey to the Dangaard interfluvial site to map out habitat distribution and assess benthic assemblages
- Repeat the AUV-based sidescan sonar survey from JC237 over the Explorer interfluvial minimound area to add to the time-series evaluating trawling impacts
- Add an AUV camera survey over the Explorer interfluvial site to map out habitat distribution and assess benthic assemblages
- If time allows: extend the JC125/JC237 AUV MBES dataset in Explorer Canyon, and collect AUV MBES data in Dangaard Canyon to enable fine-scale species distribution modelling over a wider area within the canyons
- If time allows: repeat the DY152 AS5 trials AUV MBES survey over an area of large scours in the deep outflow channel of Whittard Canyon (>4000m) to evaluate recent large-scale erosion in the area as a result of turbidity current activity
- If time allows: carry out SeaSpyder towed camera surveys in terrains less suitable for AUV missions to evaluate the presence of Vulnerable Marine Ecosystems.

4.2. PISCES

- Recover two short ADCP moorings, from Dangaard Canyon (PISCES 1) and Explorer Canyon (PISCES 2), both deployed during JC278. Each mooring has a low-frequency, long-range ADCP with current meters and CTD loggers beneath it. During DY196 (PISCES Process Cruise) both moorings were augmented with a Seaglider operating as a virtual mooring above it, in effect acting as a virtual chain of CTD loggers. The combined mooring-glider dataset will yield near-full-depth month-long timeseries temperature, salinity (thus density) and horizontal velocity. This will allow semi-diurnal internal tide energetics (available potential energy, horizontal kinetic energy and energy flux) to be calculated for each canyon over two spring-neap cycles.

- Recover MARS Seaglider SG605. This glider is equipped with a Lab-on-Chip (LoC) nitrate sensor, along with conventional CTD, dissolved oxygen, chlorophyll fluorescence and optical scatter sensors. After DY196, this glider operated as a virtual mooring above the PISCES 1 and PISCES 2 moorings alternately, extending the internal tide energetics timeseries and measuring any upwelling of nitrate-rich deep water through the canyons.
- Complete a CTD cast near the recovery location of SG605 to calibrate the LoC sensor. Water samples will be taken every 50 m from 1000 m to the surface then frozen onboard for later nutrient analysis.

4.3. REDRESS

- Deploy 15 ecoreefs: 6 ecoreefs of two models on the Explorer interfluve, and 9 ecoreefs of 3 models on the Dangaard interfluve, aiming to place them in locations with high density of coral rubble or framework on top of coral mini-mounds
- Carry out 'before', and possibly 'after', baseline camera surveys to characterise the habitat and benthic assemblage before placing the ecoreefs, and to confirm their position and correct deployment
- Carry out CTD casts at both interfluves to characterise the watercolumn, including water sampling for the carbonate system (and if possible for nutrients)
- If time permits, attempt to revisit with the towed camera a small settling experiment deployed in 2022 on JC237 on the Dangaard interfluve to evaluate potential coral/faunal colonisation and any potential changes in benthic assemblage at the experiment, or in the wider area.

4.4. RISC

- Recover the hydrophone lander from the Explorer interfluve and recover all data collected on its instruments to enable analysis of the soundscape in the area, including cetacean presence and distribution, potential ship noise, sounds produced by the benthic community etc.
- Recover the additional hydrophone attached to the PISCES2 mooring to support the wider study of the soundscape within the canyon

4.5. MARS trials

- Training of the new team members in the entire Autosub5 mission process (mission planning, preparation, mobilisation, deployment, recovery, data download & organisation, data delivery to the science team, in addition to trouble shooting and AUV maintenance on board) in a realistic setting & scenario
- Testing of the obstacle avoidance system (OAS) in a realistic setting (cold-water coral mini-mounds on the canyon interfluves)
- Successful camera missions in the mini-mound areas on the canyon interfluves
- Testing of the new Localisation Package (navigation system) of Autosub5 and ALR
- Testing of the new thrusters
- Testing of the ALR anchoring system

4.6. JNCC

- Collect drop camera video and imagery to verify the presence of coral rubble and mini-mounds in the area of the Dangeard Interfluve that is inside The Canyons MCZ but outside the fisheries management area
- Collect AUV and drop camera still imagery from The Canyons MCZ over the same area so the two methods can be compared
- Collect drop camera video and imagery on the Explorer and Dangeard Interfluves to contribute to a long-time monitoring time series of The Canyons MCZ. Camera locations will be stratified by terrain type (mini-mound/non-mini-mound), interfluve, and 100-m depth band
- Collect ship-based bathymetry and backscatter multibeam data in Greater Haig Fras MCZ to improve the habitat maps for the MCZ.
- If time allows, collect further drop camera video and imagery in other locations of the Greater Haig Fras MCZ to add to the habitat mapping effort

5. NARRATIVE

Monday 22 September 2025

Final day of mobilisation: last items brought on board, bunkering, last pieces of equipment being installed. Integration of the external SeaSpyder camera system with the RRS Discovery deep-tow cable being completed with the help of the ROV Isis team.

Science party joined the vessel by mid-day. Science meeting at 12:45 BST, sign-on and safety briefing took place at 15:00 BST.

Tuesday 23 September 2025

Sunny & calm, increasing to slight/moderate later in the day

An unforeseen issue with the SeaSpyder camera (loss of signal) nearly delayed the ship, but was fixed just in time, again with help of the ROV Isis team. The gangplank was lifted at 09:45 GMT and we set sail at 10:00 GMT. The transit progressed smoothly past the Needles, and a safety walk around the deck was organised by the TLO at 12:30 BST, followed by a safety drill (muster station) at 13:00 BST.

At 15:30 BST, just south of Portland, the ship halted for a few tests: first of all, the SeaSpyder camera was tested (**DY200-001-CAM01**). The currents were very strong and the camera was instantaneously swept backwards. Adjusting the ship speed over the ground, a safe cable angle could be ensured, but this resulted in the camera moving too fast over the seabed for safe operation (and decent image quality). The tow was aborted, but the system was tested with positive outcome.

This test was followed by a test of the Active Heave Compensation (AHC) on the 2nd CTD winch, which had been adjusted by Kongsberg engineers just before the cruise. This test was also successful. The ship continued its passage to Haig Fras.

Wednesday 24 September 2025

Sunny and calm seas

Overnight, the clocks were changed to GMT to avoid confusion and make sure all logging and note-taking is carried out in the same time zone. From this point, all times in the narrative are in GMT, unless stated otherwise.

The transit to Haig Fras continued until 13:07 GMT, and the ship set up for the first CTD (**DY200-002-CTD01**). The rosette was deployed at 13:39, reached the seabed at 13:46 and was back on deck at 14:04. All bottles were tested, one failed. Some of the water was sampled for DIC and alkalinity, as a practice run for the team who will do the sampling in The Canyons MCZ later.

With the CTD on deck, the ship moved to the AUV launch position, and Autosub5 was prepared for deployment. It was in the water by 15:07 (**DY200-003-AUV01-M122**), and started diving at 15:20. The first phase of the deployment consisted of a test, which unfortunately was not successful: the mission was aborted. The vehicle was recovered with some difficulty, and was back on deck by 16:26.

The fault was investigated and found to be a problem with the ascent phase in the initial 10 min test dive. The AUV team worked on it until approximately 21:15 when they were out of hours.

In the meantime, the 2nd Sea Spyder camera survey was attempted (**DY200-004-CAM02**). We decided on doing some transects over the Haig Fras AUV survey area to collect images from three main substrates for comparison with AUV images. Several other sites of interest for JNCC were also planned for later. On arrival at the seabed at 20:33 there was some trouble with the AHC, which was soon resolved. Several images were taken when a water droplet was noticed in the frame of the stills camera images. The dive was immediately aborted and the Sea Spyder brought to the surface. It was on deck at 20:52.

Investigation showed water ingress into the dome. It was not clear if this was just the outer glass dome of the camera housing or the larger part of the titanium housing. This needed support from shore and a longer investigation, hence camera work was cancelled for the rest of the night.

As this could not be fixed immediately we decided to proceed to a ship-board multibeam survey with the EM710 (**DY200-005-MBES01**), extending further west the previously collected data in this area. They survey began at 22:08.

At 00:00 the ship moved east of the northern end of the 2nd MBES line. On the next line, to avoid a gap in the data the maximum angle was increased from 60° to 65° on the starboard side and 70° on port. The port angle was changed back to 65° when the overlap between lines was sufficient.

Thursday 25 September 2025

Sunny and calm seas

We continued the multibeam survey with swath angles of 65° until 10:30, at which time the ship returned to the AUV launch position. We arrived at the waypoint just before lunch, so after a quick bite the AUV team went through the last pre-dive checks, and the AUV was launched at 12:40. The team took the system through four test missions, keeping it in the water to avoid having to recover each time. The tests were successful, and by 15:40 the vehicle was sent on its way for the traditional Haig Fras mission (**DY200-006-AUV02-M124**). The AUV team monitored the vehicle on the USB until 16:45, after which the USBL pole was recovered and the ship set off for another multibeam survey (**DY200-007-MBES02**).

The multibeam survey was interrupted at 21:12 by a message on C2 from the AUV, which had surfaced. The survey was stopped and the ship began heading to the AUV location for investigation. We were alongside the vehicle at 22:30. A strong following current had reduced the water flow over the vehicle, meaning it wasn't moving through the water, and therefore could not be controlled, causing it to surface. The AUV was programmed to dive again and continue the survey, with some adjustments to counter the effect of following current. The ship remained nearby to monitor the dive until 23:25 before heading back to resume the MBES survey.

Friday 26 September 2025

Sunny, with a light breeze and slight seas, increasing to moderate later

We re-started the multibeam acquisition at 00:29 (**DY200-008-MBES03**), slightly south of where we broke off. We continued without any interruption until 09:32, when we halted the survey to take a

fresh sound velocity profile, using the CTD rosette as a carrier frame. The CTD was deployed at 09:57 (**DY200-009-CTD02**) and recovered at 10:04. After this, multibeam surveying resumed (**DY200-010-MBES04**) till 11:56 when the AUV team received a message that the Autosub was at the surface.

We broke off the survey and travelled over to the AUV location, where the vehicle was picked up quickly: it was on board by 14:00.

In the meantime, extensive discussions had been had between the Ocean Ecology SeaSpyder operator and his shore-based support team, and a port call in Falmouth was planned to pick up a spare stills camera. We had a few more hours before we had to set off on the transit, so we spent the time doing a test dip with the ALR anchor frame (**DY200-011-AF01**, 14:43-15:35) and then carried out another short multibeam survey (**DY200-012-MBES05**) before starting the passage to Falmouth at 20:00.

Saturday 27 September 2025

Overcast with moderate winds and sea state, increasing to a strong breeze overnight

The transit continued till 09:00, when we reached the agreed rendez-vous point outside Falmouth. The spare parts were delivered by 11:00, and were straightaway installed in the SeaSpyder frame. An initial deck test confirmed that the new system was operational, and the green light was given to leave for the Whittard Canyon. We set sail at 12:35, on our way to the glider rendez-vous location. Once we were out of view of land, we carried out the necessary MMO survey before switching on the sub-bottom profiler as underway data collection system. The EM710 multibeam was already pinging, but not always recording.

Sunday 28 September 2025

Sunny with moderate winds and sea state, reducing to a gentle breeze in the evening

The transit progressed well overnight, and we reached the working area by 10:30. In the course of the morning, we received a message that the glider would not re-surface until 15:20 in the afternoon, so we adjusted the plan and decided to start with a deployment of the anchor frame first (**DY200-013-AF02**). The system was deployed at 10:41, and stayed at depth for ca. 20 min. Some mackerel bait was attached to it in front of the camera, to create an ad-hoc baited camera frame. It was brought back on deck by 11:29. At that point the AUV team discovered a small bug in the control software, so the AUV deployment was delayed a bit until 13:59. The initial test phase was successful, but when the AUV eventually went to carry out its mission at 14:13, it aborted at 14:49 (**DY200-014-AUV03-M125**). Unfortunately, the maximum dive depth had not been set correctly. The vehicle was recovered quickly, and the ship set off at 15:40 to recover the glider.

As the glider had moved into the Irish EEZ, and we had not had the chance to obtain a MARA license in time, we switched off the recording of any underway data as soon as we crossed the EEZ boundary. The glider was spotted quickly at 17:05, and with a couple of attempts, was recovered at 17:39 (**DY196-EC**).

We then moved back into the UK EEZ to do a CTD cast (**DY200-015-CTD03**) to collect a 1000 m water column profile with nutrient samples from 24 depths. As the water was deeper than 1000 m we profiled the full water column (+SVP), then sampled from 1000 m to the surface, as requested by Rob Hall.

From the CTD station we transited back to the southern interfluvial area in the study area (Dangeard interfluvial) for an AUV deployment (**DY200-016-AUV04-M127**). The AUV was in the water at 22:01, and started its dive at 22:19. The descent was smooth, and the vehicle could start its survey operations without problems. With the AUV well underway, we transited to the Explorer interfluvial for our first set of SeaSpyder tows, to obtain baseline video data over the deployment sites for the REDRESS ecocreefs.

Monday 29th September

Flat seas and no wind (Beaufort F1) at the start of the day, with a slight increase later on

The SeaSpyder was launched at 00:13 (**DY200-017-CAM03**). We did one ship move (200 m at 007deg), passing over the first mini-mound, observing a range of coral rubble and sandy seabed and several different species of animal (hormathiids, chimaera, holothurians and hermit crabs). We then paused to review the images as we suspected the flash was not working every time. We found that this was the case and a significant number of images were very dark. After the second ship movement over the next mound we lost comms with the camera. A re-start solved this issue and we continued to the end of the line.

The second SeaSpyder deployment of the night was launched at 03:30 (**DY200-018-CAM04**). At the bottom we immediately encountered Boarfish (*Capros aper*), Redfish (*Helicolenus* sp.) and Ling (*Molva* sp.). The tow lasted till 05:12. A third tow was carried out (**DY200-019-CAM05**), starting from 05:41 till 07:30.

In general, the SeaSpyder tows went very smoothly; this was helped by the sea state. Unfortunately, during the last tow, the OFOP logging software was not started correctly, and some of the observations were not saved correctly. After quality-checking the data, it also transpired that the EXIF files of the stills images had a different time (close to UTC+2). This may need attention in post-processing.

In between, at 04:07 Autosub5 surfaced unexpectedly for a safety check. The AUV engineers on call diagnosed the issue, which was related to the ballasting problem that had occurred before. With a new command being sent to the vehicle, the issue could be solved, and she dived again at 04:52 for the second part of her mission.

The SeaSpyder was back on deck at 07:30, and the ship repositioned to the location of the RISC lander (**JC278-007**). The system was interrogated at 08:15, and was found to still be in the right location. After the captain's 08:30 morning meeting the acoustic release was triggered and the lander was sighted at 08:44. It was on deck at 09:15.

After a short transit, the recovery of the PISCES2 mooring (**JC278-005**) was next. The mooring was released at 10:02, and was spotted at 10:15. It had risen very quickly, and was clumped together at the surface, which made it difficult to grapple and recover. A few items were somewhat entangled, but eventually everything could be recovered safely by 11:44.

This gave us plenty of time to add another recovery, so we moved to the location of the PISCES1 mooring (**JC278-006**) and released that at 12:56. When it reached the surface it was also slightly entangled. It came on deck by 13:53.

Given that all recovery operations had happened so smoothly, an additional dip with the ALR anchor frame was possible (**DY200-020-AF03**). It was deployed at 14:34 and lowered to 500m water depth. It

was back on board by 15:43 with all anchors released. However, review of the camera data afterwards indicated that two of the anchors only released on the ascent.

With all the equipment that needed recovery safely on board, we travelled back to the AUV survey site on the Dangeard interfluve. The vehicle had been travelling slower than expected, and although she only finished the MBES part of her survey, it was decided to finish the mission so that she could be recovered in daylight. She was on deck by 18:50.

The next operation was a series of SeaSpyder tows across the Dangeard interfluve, to obtain baseline data before deploying the REDRESS ecoreefs. The first, starting at 19:48 was a long camera tow (**DY200-021-CAM06**) that passed over 8 mini-mounds in a single dive. There were varying amounts of coral rubble associated with the different mounds, interspersed with areas of sandy, rippled sediment and occasional dropstones. Ecological highlights included chimaera, macrourids, holothurians and catsharks/dogfish. Small lengths of fishing gear (long lines) were frequently observed. On two occasions the SeaSpyder had to be re-booted underwater after the camera software froze. We also started to have an issue with the flash running hot, and had to wait longer for it to charge up (up to 25s). A few pauses were added into the tows to let the flash cool down before continuing. In the end the tow was quite long, and for one section, expected to be sandy, the camera was lifted 15m off the seabed and taken on a mid-water tow to move a bit quicker. The station finished at 01:32.

Tuesday 30 September 2025

Light cloud cover, sea state slight and moderate winds

Observations were similar on the second tow of the night (**DY200-022-CAM07**), which started at 02:25. This tow was shorter and the camera was back on deck at 05:03. Overall, it appeared that the AUV sidescan sonar map from JC237 did not correspond well with the visual observations on the camera.

A third tow was added to the night (**DY200-023-CAM08**), focusing on one of the JNCC monitoring sites (CNYN023). The SeaSpyder was deployed at 05:51, and was back on deck for 06:57. This finished the camera work for the night and the ship set off to do the calibration CTD for the microcat CTDs recovered from the moorings. With a bit of confusion about which mooring location to go to for this, we arrived at the location of the PISCES1 mooring just after breakfast. However, the microcat batteries needed extra charging, and it was decided to do a test with the ALR anchor frame first (**DY200-024-AF04**). Initially the winch had some issues, but at 08:51 the frame was in the water and deployed till 800m. It was recovered by 10:20. By that time the CTD was ready, but it was established that the chosen mooring location was the shallower one, and would not give enough depth to calibrate all of the microcats correctly. Therefore the ship moved further down the Dangeard Canyon until a location with 1200m water depth was reached. The CTD was in the water at 11:28 (**DY200-025-CTD04**), and was recovered at 12:53. The microcat that was recovered from the lander frame was not calibrated as no spare batteries were available.

From the CTD location we went back to the Dangeard interfluve to deploy the first of the REDRESS Ecoreefs (**DY200-026-ERF01**). As we had not been able to map the area with AUV bathymetry yet, we established a deployment location based on the observations of dense coral rubble fields on the SeaSpyder tows. To confirm if we were aiming for the top of a coral mound, we attempted to cross it slowly (~2kts) with the sub-bottom profiler running. However, it was a challenge for the officers to cross the mound exactly, so this took a bit of time. Eventually it was decided to place the ecoreef at a

location where dense coral rubble was confirmed. The reef module (large wedding cake model) was lifted into the water at 14:58 and carefully placed on the seabed at 15:20. The operation went smoothly, with the deployment cable carefully recovered.

Unfortunately, there was no time for more ecoreef deployments, and we proceeded to the launch site of the AUV (**DY200-027-AUV05-M128**). She was in the water at 16:04, diving at 16:21. After following her to the seabed and along her first track for a while, the ship was repositioned to the next SeaSpyder location. We arrived there at 18:30ish, but delayed the start time of the tow because the camera operator was not yet on shift. By 19:00 he started his watch and the camera was prepared for launch. However, exactly at that time we received the message that the AUV had surfaced, and it was decided to turn around and approach her with the ship so wifi communication could be established. By the time we arrived there, at ca. 20:15, it was established she had surfaced because of the same issues with speed through the water. While she was at the surface, problems with the thrusters developed, something which later turned out to be caused by the front recovery rope having come loose and entangling itself around the antenna and propellers. The abort command was given, and the vehicle was followed by the ship for the rest of the night.

Wednesday 1 October 2025

Light cloud, moderate winds and slight seas, increasing to moderate later

At first light, the whole Autosub team was up to assist with the unusual recovery of the vehicle. The ship was carefully and skilfully manoeuvred closer to the vehicle until the loose rope could be grappled with a long stick created for ALR, and once the ropes were on board the rest of the recovery was swift, and the AUV was on board by 08:00. The damage was limited, but the vehicle was subjected to an extensive set of detailed checks to ensure the next deployment would be smooth.

With the vehicle rescued, the team set out to deploy ecreefs. We started on the Dangeard interfluvial at all mounds where we had been able to confirm dense coral rubble with the SeaSpyder. Reefs were deployed at 10:02 (LifeLophelia star shape, **DY200-028-ERF02**), at 11:02 (small wedding cake, **DY200-029-ERF03**) and 11:59 (large wedding cake, **DY200-030-ERF04**). Because re-deployment of Autosub was not yet possible, the ship moved to the Explorer interfluvial for further deployments at 13:59 (large wedding cake, **DY200-031-ERF05**), 14:47 (small wedding cake, **DY200-032-ERF06**), 15:35 (large wedding cake, **DY200-033-ERF07**), 16:33 (small wedding cake, **DY200-034-ERF08**), 17:26 (small wedding cake, **DY200-035-ERF09**), and 18:21 (large wedding cake, **DY200-036-ERF10**).

In the meantime any further Autosub work was cancelled until after the upcoming storm Amy, also because some issues with the software still had to be sorted out. We therefore proceeded with SeaSpyder work, particularly to continue the baseline video work on the Dangeard interfluvial, before deploying more ecreefs there. In the meantime we also had received the AUV MBES bathymetry data from Autosub5 Mission 127, which gave us a much better control of the mound positions, and hence a much better idea of where to plan the ecreef placement and hence the baseline video surveys.

The SeaSpyder was deployed at 19:56 for the first tow (**DY200-037-CAM09**). The terrain was similar to the previous night, and some dense patches of coral rubble were found. From time to time we stopped taking pictures because the flash of the stills camera overheated. At 21:25 the tow was halted for 5 mins to enable the bosun to correct the scrolling on the winch. The system was back on deck by 22:24.

The second tow (**DY200-038-CAM10**) started at 23:01 with an attempt to find one of the ecoreefs deployed that morning. The SeaSpyder was kept at a safe altitude of 4m, and the ship was slowly brought into position. The reef was sighted at 23:40, to great delight of the whole team! After that the tow continued the normal way, but some sections were not recorded as the camera frame was lifted off the seabed and towed faster to speed up the operation.

Thursday 02 October 2025

Overcast, strong breeze with occasional gusts up to 32kn. Moderate to rough seas with increasing swell throughout the day

At 00:09 the SeaSpyder tow had to be halted to restart the camera, but the tow could be continued and the frame was back on deck by 02:23. The next tow (**DY200-039-CAM11**) started at 03:09, took in two planned ecoreef deployment sites and finished at 05:11 and, towards the end of the tow, a high density of crinoids was spotted, reminiscent of a HyBIS deployment on JC278 earlier in the year. The ship set off to the next site, but had to stop (05:20-05:44) while a thruster problem had to be solved. The night's camera tows revealed coral rubble as expected on each mound, confirming that all the remaining sites selected were suitable for ecoreef deployments.

For the last survey of the night (**DY200-039-CAM12**), the ship moved to one of the camera locations suggested by JNCC (CNYN177), inside the MCZ but outside the current bottom fishing ban. The SeaSpyder was deployed at 06:06. Coral rubble was identified on the footage here as well. The camera was recovered at 07:38, and secured on the deck.

With all planned ecoreef locations confirmed to be good, the next round of deployments could start. The first ecoreef (star, **DY200-041-ERF11**) was placed on the seabed at 08:57, followed by further reefs at 10:09 (large wedding cake, **DY200-042-ERF12**), 10:55 (star, **DY200-043-ERF13**), 11:37 (small wedding cake, **DY200-044-ERF14**) and 12:20 (small wedding cake, **DY200-045-ERF15**). All deployments went smoothly and with high precision both in the horizontal and vertical.

After completion of the ecoreef deployments, CTDs were carried out to collect background water column data, carbonate chemistry and nutrient samples from the Dangeard (**DY200-046-CTD05**) and the Explorer (**DY200-047-CTD07**) interfluves. An anchor frame test in deeper water (**DY200-048-AF05**) was the final science activity before the ship is turned around to return to Falmouth to avoid storm Amy at 18:30.

Friday 3 October 2025

Cloudy with light rain and a strong breeze, rough seas. Increasing to near-gale force winds later

We continued our passage to Falmouth throughout the night. Luckily the sea and wind were mainly behind the vessel so the transit was reasonably smooth. We arrived in Falmouth Bay around 15:30 and the ship went on DP to keep position until conditions would improve enough to sail out again.

Saturday 4 October 2025

Patchy cloud, showers with gale force winds and a moderate sea in Falmouth Bay

The ship stayed on DP in Falmouth Bay for the whole day, moving slightly further offshore overnight. Science work mainly consisted of data processing, backups, and planning for the next week.

Sunday 5 October 2025

Sunny with a moderate to fresh breeze and moderate seas in Falmouth Bay, but rough seas further in the English Channel and on transit to Haig Fras

By 10:00 the ship was back closer to Falmouth, ready for a boat transfer of one of the crew, with a new crew member taking their place. The exchange happened at 10:35, and by 10:55 the ship had swung around and was underway to Haig Fras. Following the required time interval of mammal observation, the SBP was switched on at 13:15. The EM710 multibeam system was not yet switched on because there was a problem with the transmission of the signal between the MBES hardware and the SIS software.

Later in the afternoon, at 14:00, we held a science and engineering meeting, exchanging the first results from the cruise so far.

Later in the evening, the ship systems tech managed to solve the issue with the EM710, and we started recording at 20:25.

Monday 6 October 2025

Sunny start, gradually becoming overcast; slight to moderate seas with a moderate to fresh breeze

After the delays to the science programme for the weather the team were excited to restart data collection as we approached Haig Fras in calmer seas. On arrival at around 01:30 we set up for a SeaSpyder photographic survey in the area previously studied by AUV. The planned transect to the north was in the same direction as a northward current so we were cautious watching the wire. **DY200-049-CAM13** moved steadily northward encountering different types of seabed and a wide variety of fauna, as previously seen in studies at this site. During the tow, a pod of common dolphins feeding on small fish / squid attracted to the ship's light entertained us. We continued the tow until the morning, and by 05:46 the SeaSpyder was brought back on deck to enable the ship to reposition to the AUV launch site for a short mission to collect the traditional Haig Fras photo data set.

The ship was in position shortly after 6am, but the pre-dive checks on Autosub5 had returned an error which had to be resolved before the deployment could go ahead. By 08:17 the vehicle was finally in the water for **DY200-050-AUV06-M129**. After a short while of monitoring the sub, the USBL pole was brought up at 08:57 and the ship could leave the site to carry out some multibeam mapping (**DY200-051-MBES06**). The ship had to travel for nearly an hour to reach the start of the survey at 09:49.

We broke off at 14:22 to meet the AUV at the rendez-vous point. The vehicle surfaced at 15:33, just as the ship had set up on the waypoint, and was recovered back on deck by 16:50. Unfortunately once again no good pictures were recorded: while the AUV had completed the mission correctly, she had stayed 2m too high above the seabed, and with all the sediment stirred up by Storm Amy, visibility was too low. Once everything was secured on deck, we set sail for The Canyons MCZ again.

Tuesday 7 October 2025

Light cloud, a gentle breeze over slight seas turning smooth to calm, but with a long swell

The ship arrived at the Dangeard interfluvium for the next AUV mission just before 08:00. The aim of **DY200-052-AUV07-M130**, after a series of engineering tests, was to carry out a photo mission before completing the multibeam and sidescan sonar mapping in the area. The AUV was deployed at 08:39, but consecutive tests took much longer than planned, and by 14:30 it was decided to complete the tests and shift to the multibeam and sidescan sonar mapping, leaving the photography till the next day.

Once the AUV had dived on mission 131, the ship proceeded to deeper water for an anchor frame deployment (**DY200-53-AF06**) to 800 m depth. This was largely successful (2/3 units behaving as they should). Back on deck by 19:30 it was time for a night of SeaSpyder photography at JNCC stations (and monitoring C2 for any AUV updates). The sea surface was very still, with an underlying long period swell. A 'super moon' was spectacular in the night sky but the spring tide currents were strong, requiring extra vigilance on the wire. At the start of the first deployment (**DY200-054-CAM14**) the wire was beginning to go aft of the vessel so the ship movement was slowed to 0.1 knots. This seemed to solve the problem and the tow continued, observations confirming coral rubble, quite dense in patches, in the area where these data are limited and therefore not under the fishing regulations. The second deployment, in slightly deeper water, the deepest of the cruise so far, (**DY200-055-CAM15**) also revealed evidence of coral rubble at the start of the tow but this was sparser as the tow continued. The wire was not such an issue and 0.2 knots was fine.

Wednesday 8 October 2025

Cloudy with occasional drizzle or rain, calm sea increasing to slight, wind increasing from light to moderate

The camera was back on deck by 00:45. A longer ship move of around 5 nautical miles to the north to reach a JNCC station in the 200-300 m depth band (**DY200-056-CAM16**) revealed similar seabed with dropstones, sand ripples and occasional coral rubble. Some highlight fauna included seapens and yellow coral. A short ship move to **DY200-057-CAM17** to another JNCC site in the same depth band followed. The SeaSpyder was on deck at 05:24, so there was time for a fifth camera tow. **DY200-058-CAM18** was in the water at 05:57, and reached the deepest camera depth of the cruise so far: 449m at the start, increasing to 511m by the end. The seabed was mainly sandy with a few dropstones, plenty of ripple formations and occasional burrows. The camera frame was secured on deck by 07:27, so the ship could move to a deeper location in the Dangeard Canyon, close to where cold-water coral had been observed on JC237. We deployed the CTD (**DY200-059-CTD07**) at 08:24 to obtain water samples for the characterisation of the carbonate system close to the corals (and took a nutrient sample at the bottom). This took just over an hour (09:37), and was followed by another anchor frame test at 800 m (**DY200-060-AF07**). This time all anchors released correctly. We left the site shortly after recovery at 11:43, and steamed to the location where Autosub5 was still surveying. We managed to contact the vehicle via the USBL, and learnt that she had just finished the sidescan mapping, and was gradually stepping closer to the seafloor to start the photo part of the mission. Unfortunately, at that point she had used up all her batteries, and she had to abort her mission. She surfaced at 12:43, close to the ship, and was recovered by 13:55.

With the AUV back on board earlier than expected, we quickly re-scheduled the afternoon's activities. The CTD team sprung into action and **DY200-061-CTD08** was in the water by 14:16, at the same location as CTD05, close to one of the ecoreefs on the Dangaard interfluve. An error had been noticed with the sampling protocol, and we decided that the samples had to be repeated. The system was back on board by 14:49.

With enough spare time before the SeaSpyder could go back into the water, we sailed to a deeper section of the Dangaard Canyon for another anchor frame test, this time at 1500m depth (**DY200-062-AF08**). The frame was deployed at 15:55 and recovered at 18:27, but unfortunately the system had not worked correctly. Clearly the additional pressure/lower temperature affected the release mechanism.

By then it was more than time to move to our first SeaSpyder station of the day on the Explorer interfluve. In windier weather than the previous night, **DY200-063-CAM19** was deployed at 19:18 and focused on an area of relict trawl marks around the 400m contour. The sand appeared to have a slightly different appearance to previous tows, the ripples possibly more degraded. In one area the camera was brought up to 3 m altitude to assess whether a feature in view may be a trawl mark, but this was inconclusive on first inspection. Hormathiid anemones were the most abundant fauna, characteristically facing into the current. The second tow of the night (**DY200-064-CAM20**) started at 21:53 and was in the same depth band and constituted one of the JNCC repeat observation / monitoring stations (CNYN106).

Thursday 9 October 2025

Overcast, with slight seas and light winds

A third station on Explorer interfluve, started at 00:19, revealed similar appearance (**DY200-065-CAM21**) and once sufficient photos were collected for JNCC's monitoring, we departed at 02:00 for the next SeaSpyder tows at Dangaard Canyon interfluve.

Once arrived, the camera went into the water at 03:22 (**DY200-066-CAM22**) for a tow over the lower end of the AUV-mapped area. The seabed was mainly muddy sand with ripples and several burrows. A limited amount of (fossil?) coral rubble was observed on a mound top. The camera was brought up at 05:33, and we moved to another location on the AUV map where a high concentration of crinoids had been seen on HyBIS data from JC278. **DY200-067-CAM23** was deployed at 06:14, and crinoids were spotted as soon as the seafloor came into view. The tow was only short, as the SeaSpyder had to be on deck in time to enable the next AUV launch. By 07:35 everything was secured on deck and the ship repositioned to the AUV launch site.

DY200-068-AUV08-M132 was deployed at 08:38. The initial phase of the mission was critical, as the vehicle gradually dived closer to the seabed and started its photographic work. The first legs of the mission were the most critical, going across mounds, including mounds with ecoreefs. The AUV held out well, and managed to continue its entire mission. Even when the abort command was sent after lunch, to enable her to be picked up before 14:00, the AUV was too far out of range to capture the message and continued the mission to the end. The recovery was difficult, and it took until 15:06 before the AUV was on deck.

With that delay, it was decided that the CTD which was planned next was cancelled, and the ship went straightaway to the next AUV deployment site. The Autosub team turned the vehicle around quickly, and by 16:58 she was back into the water (**DY200-069-AUV09-M133**).

By 18:30 the ship repositioned and set up for a series of camera surveys of JNCC monitoring sites on Explorer Canyon interfluve. The first SeaSpyder survey of the night (**DY200-070-CAM24**) was in slightly shallower water and unexpectedly revealed relatively high abundance of crinoids. These were seen on sandier sediment than those observed on the mounds of coral rubble at Dangeard earlier. Accompanied by a small shoal of boarfish, we found occasional sea-pens of at least two species at the next station (**DY200-071-CAM25**), another JNCC monitoring site in the same depth band. There was a lot of krill in the water column for the third (**DY200-072-CAM26**) and fourth stations (**DY200-073-CAM27**), where sea-pens were more common than we had seen during DY200 to date.

Friday 10 October

Overcast, moderate winds and slight to moderate seas

DY200_073_CAM27 started at 00:30 and ran till 01:58. The next station, **DY200-074-CAM28**, began with trouble from the wire angle. Changing the heading a couple of times soon solved this and the tow continued. Boarfish and crinoids were the first observations on this tow, and the camera was brought back on board by 04:01.

The next and final tow followed soon after (**DY200-075-CAM29**), at 04:49, although there was a slight delay in the start because a French fishing vessel was close to the site and appeared to come in our way. One of the science party spoke to them, and they agreed to move off the site so the camera could be deployed. It was back on board by 06:13.

From there, we made our way towards the area where the AUV was surveying, to call it up and change some of the camera settings. The pictures so far had been very red, and while the initial interpretation was that this was caused by too high an altitude above the seabed, further analysis overnight had shown that inappropriate settings were to blame. The AUV was spotted by the USBL and a surfacing command was given. The vehicle was spotted at the surface and changes to the camera configuration were sent via WiFi, after which the AUV was sent on a new, shorter camera mission to test if those changes brought any improvement. This second mission timed out, and the team quickly downloaded a few images to check the results. They were much more balanced, but still a little bit overexposed, so another tweak was made to the settings and another mission sent. After a rather lengthy recovery, the AUV was back on board at 15:51.

That freed up the ship for the final station. After a short move, we deployed the CTD for station **DY200-076-CTD09**, over the Explorer Canyon coral reef. The system came back on deck at 17:55, and once that was secure, we set off for our long transit home. We left the MBES and SBP running along our transit.

Saturday 11 October

Overcast, moderate to fresh breeze with moderate seas

The transit home continued, while the science and engineering party were busy packing up, cleaning the labs and getting ready for the demob once arrived in Southampton. Clocks were changed back to BST overnight.

Sunday 12 October

Overcast, moderate breeze with moderate seas

The transit continued smoothly, and the pilot was picked up at 09:30BST. We sailed into Southampton Water and the ship docked alongside NOC at 11:00BST. Demob was started immediately and was largely completed by the end of the day.

6. TECHNICAL and OPERATIONAL REPORTS

6.1. Autosub5

Operational Team: Enrico Anderlini, Eoin Ó hÓbain, Trishna Saeharaseelan, Owain Shepherd, Ollie Williams, Konrad Ciaramella, Francesco Fanelli, Matthew Kingsland

6.1.1. Autosub5 introduction

Autosub5 (previously Autosub 2000 Under Ice, Phillips et al. 2020) is a high-power work-class AUV, measuring 6 m in length and weighing 2 tonnes. It consists of a free-flooded nose section containing sensors, a centre section of syntactic foam (the buoyancy) and batteries, and a free-flooded aft section containing navigation and additional sensors. Vehicle control is achieved through twin thrusters and four independently-actuated control planes. Autosub5 is mainly launched from a ship such as the RRS Discovery, as for DY200. The primary objectives of Autosub5 are to gather acoustic imaging of the seabed in high resolution by operating multi-beam and sidescan sonars for topographic mapping, use of sub-bottom profilers to see what is in the first few meters under the seabed and high-resolution camera systems for imaging of the seabed. Other standard sensors include an ADCP for water column tracking and CTD (conductivity temperature depth). Furthermore, for this cruise and upcoming cruises the AUV has also been fitted with a single channel fluorometer. The vehicle has been designed by the NOC's Marine Autonomous and Robotic Systems (MARS) division to suit the needs of UK science, with the primary goal being modularity so new experimental sensors can be accommodated.

DY200 served as a recommissioning trial for the AUV after the (battery thermal and electric shocks) events of JC257, and as an engineering trial for several updates to the onboard control software (OCS) and other new features. Specifically, the main updates on Autosub5 (AS5) are:

- Replacement of the Bridges thrusters with new 400W thrusters (same propellers),
- New, improved battery boxes (decoupling of boxes into individual units with lifting bars for easier lifting, removal of corrosive rubber seal, enhanced leak detection, improved bulkhead connectors),
- Addition of an altimeter (ISA500) for improved obstacle avoidance (forward-looking sonar still on board),
- Enhancement of the ground-fault monitoring system.

Autosub 5 was running an initial configuration of 6000m rated foam and five 5 kWhr Batteries which at present allow for ~100 km and ~24 hour operations with all sensors running.

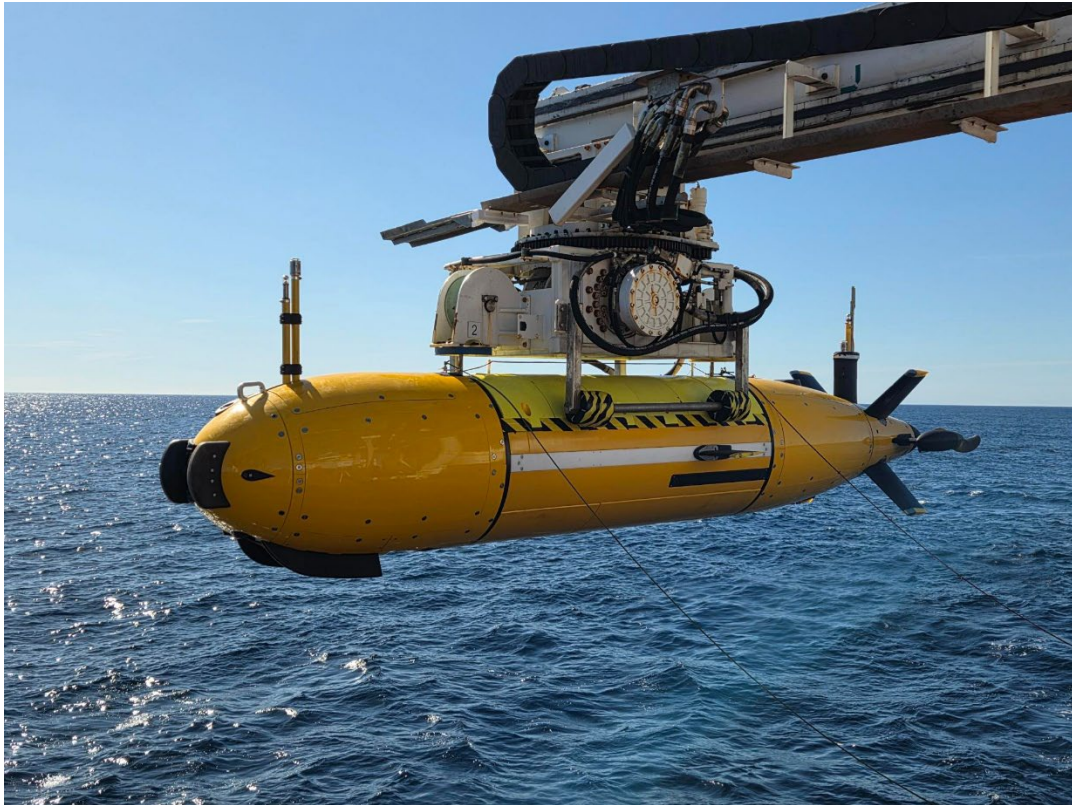


Fig. 6.1. Autosub 5 vehicle on the gantry before launch.

6.1.2. Autosub5 Operations Team

Table 6.1. AUV Ops team for DY200.

Name	Surname	Institute	Role
Enrico	Anderlini	NOC/MARS	AUV Ops Engineering Manager / trainee
Eoin	Ó hÓbáin	NOC/MARS	AUV Ops Engineer - Software
Trishna	Saeharaseelan	NOC/MARS	AUV Ops Engineer – Software / trainee
Owain	Shepherd	NOC/MARS	AUV Ops Engineer - Mechanical
Ollie	Williams	NOC/MARS	AUV Ops Engineer – Electrical / trainee

Table 6.2. Support team from experienced MARS Development personnel.

Name	Surname	Institute	Role
Konrad	Ciaramella	NOC/MARS	Robotic systems electronics engineer
Francesco	Fanelli	NOC/MARS	OCS theme lead
Matthew	Kingsland	NOC/MARS	Senior robotic systems engineer / principal investigator

6.1.3. AUV configuration

- Initial AUV hydrostatic configuration (changed during the cruise, check Section 6.2.)
 - Buoyancy (water density 1,024 kg/m³) 192N
 - Heel/roll moment (water density 1,024 kg/m³) 0.4 Nm (starboard down)
 - Trim/pitch moment (water density 1,024 kg/m³) -1,1 Nm (by the bow)
 - Righting/BG Stiffness (water density 1,024 kg/m³) 90.6 Nm/Rad
- Wings Front position @3°
- Autosub5 recovery line retention system with nylon springer lines
- 2m Springer lines
- 25m Onboard rope box recovery lines
- 30m LARS recovery lines
- AIS Beacon Front
- Light flasher Rear double Blink every 30 seconds
- Front Iridium Beacon (Asub5-Fwd) on 5min interval
- Aft Iridium Beacon H01-057 on 30min interval
- Avtrak Address 2409
- Marker 6 Address 2204

Table 6.3. Autosub5 Sensor Fit

Sensor	Manufacturer	Operating parameters	Purpose	BODC Sensor #	Serial Number
2205 Sidescan Sonar	Edgetech	120kHz 400kHz	Dual frequency side-scan imaging	TOOL1819	45562
2205 Sub Bottom Profiler	Edgetech	2-16kHz	Sub-surface acoustic data	TOOL1819	45562
WBMS Multibeam	Norbit	200kHz 400- 700kHz	Bathymetry mapping, water column data and snippet data.	TOOL1850	448520
WBMS Speed of Sound	Norbit		Speed of sound sensor		
WBMS Forwards looking Sonar	Norbit	200kHz 400- 700kHz	Obstacle avoidance system		1802
ISA 500-L altimeter	Impact Subsea	500 kHz Max range 120 m	Obstacle avoidance system		1338.0227
Seabird 9+ Dual CTD	Seabird		2 x Conductivity sensors 1 x pressure sensor	TOOL1508 TOOL0416 TOOL0417	09P69497- 1124

Sensor	Manufacturer	Operating parameters	Purpose	BODC Sensor #	Serial Number
			2 x temperature sensors		
CTD 9+ Dissolved Oxygen sensor	Seabird			TOOL0036	43C-2451
AESA 2.5 Downwards Cameras	NOC	See below	3m Altitude camera surveys dual flash.	TOOL1201	
BRAIN	NOC	-	Image recognition system		
Chip scale Atomic Clock	Microsemi	1pps & NTP	Timing & triggering co-ordination	N/A	N/A
Sprint Nav 700	Sonardyne	600Khz DVL	Navigation & ADCP Data	TOOL1786	322108-001
Mini SVS	Valeport		Speed of sound sensor – into SprintNAV		96533
BDRT Ecopuck	Seabird	Single Channel	Single Channel Fluorometer	TOOL0060	1560

Table 6.4. Ancillary Equipment

Sensor	Serial	Purpose
Workshop container	NMFU 3274996	Container with spares and tools
Control Container	PSSU3687308	Container with QNAP & Piloting Equipment
LAWSON LARS	ASO-LG-6001	Launch & Recover System (LARS)

6.1.3.1. AEASA2.5 settings

The camera settings were adjusted during the cruise as follows.

Table 6.5. Camera system settings using during DY200.

Mission	AS5M129	AS5M131	AS5M132	AS5M133	AS5M134	AS5M135
Lens focal length in air [mm] / approx. water [mm]	16 / 21	16 / 21	16 / 21	16 / 21	16 / 21	16 / 21
F Stop (F-number)	8	8	8	8	8	8
Depth of field in air [near cm/far cm]	148 / 413	148 / 413	148 / 413	148 / 413	148 / 413	148 / 413
Depth of field in water approx. [near/far cm]	157 / 350	157 / 350	157 / 350	157 / 350	157 / 350	157 / 350

Shutter [ms]	2994	2994	2994	2994	2994	2994
Gain [dB]	16.04	16.04	16.04	16.04	16.04	14.02
Frame Rate [fps]	1	1	1	1	1	1
W.B.R [red/green]	4.0	4.0	4.0	4.0	2.0	2.0
W.B.R [blue/green]	1.6	1.6	1.6	1.6	1.6	1.6
Trigger Delay [μs]	124	124	124	124	124	124

6.1.4. DY200 summary

- 9 Deployments
- 14 Missions
- 28 Dives
- 2 full MBES surveys at 50 m altitude (1 new site, 1 repeat site)
- 3 full SSS & SBP surveys at 15 m altitude (3 repeat sites)
- 2 full camera, SSS & SBP surveys at 3.5 m altitude (2 new sites, mini mounds)
- 431.2 km of missions completed
- 113.6 hr total mission duration
- 508.3 m maximum depth
- 1.8 m minimum altitude
- 1.8 m/s fastest speed over ground
- 100.7 km longest mission distance
- 26 hr longest mission duration
- 01:40 shortest time between recovery & launch
- Maintenance / spares used: 1 Xeos beacon cable, 1 actuator cable, 1 camera logger to forward payload tube cable
- Vehicle successfully recommissioned after upgrades
- Several new upgrades tested including:
 - OAS with forward looking altimeter
 - Improved batteries
 - Improved ground fault detection system
 - Higher-power thrusters
 - AESA 2.5 Camera system prototype
 - LP navigation software (offline)

6.1.5. Faults/Issues

There were a small number of issues and faults associated with this campaign. All faults are recorded in NOC's JIRA fault recording system with a unique number NOCSUB2KUI-xxx, with the numbers recorded below. The faults and issues listed below are those relevant to operation and collection of science data on DY200.

Table 6.6. Recorded issues during DY200.

Jira Number	Title
NOCSUB2KUI-909	Incomplete acoustic status messages received

NOCSUB2KUI-910	SBD status does not support greater than 64 health events. Prevents battery monitoring
NOCSUB2KUI-911	Aesa Camera 2.5 Prototype Tripping fwd Payload Tube – resolved on 27/09/2025
NOCSUB2KUI-912	AS5 Battery Equalization Faulty
NOCSUB2KUI-913	400W Thrusters Seizing
NOCSUB2KUI-914	Ropebox Covers Failing
NOCSUB2KUI-915	C2 commands break down after new OCS config (& hash)
NOCSUB2KUI-916	C2 commands in mission script break down after new OCS config without warning if mission is sent
NOCSUB2KUI-917	DGO Bulkhead adapter loose on Endcap of Aft Payload Tube
NOCSUB2KUI-918	Autosub 5 presents 2 m (higher) altitude offset during camera survey
NOCSUB2KUI-919	Autosub 5 surfaces 100 m from RRS Discovery
NOCSUB2KUI-920	lat/lon missing from edgetech data from AS5M129
NOCSUB2KUI-921	Edgetech connection issue. SBP file "not found".
NOCSUB2KUI-922	Building OCS software for AUV on different devices cause dccl library issue
NOCSUB2KUI-923	OCS: DCCL library mismanaged causes User Interface to not run
NOCSUB2KUI-924	No backup for WSL ubuntu image leads to OCS build server downtime
NOCSUB2KUI-925	OCS: Edgetech in stuck in ReadyToBeOff after rostopic does not update
NOCSUB2KUI-926	High pressure in aft tube due to failed water cooling. Props start spinning while people were working on the vehicle
NOCSUB2KUI-927	OAS ISA500 false returns
NOCSUB2KUI-928	Sprint Nav time sync is still an issue
NOCSUB2KUI-929	Orientation of the yellow ship wrong on piloting.c2/live/tracking
NOCSUB2KUI-930	During dive Autosub5 pitch isn't getting to demand
NOCSUB2KUI-931	Camera Ground faults on Forward tube
NOCSUB2KUI-932	Vbatt Ground fault
NOCSUB2KUI-933	Edgetech stuck in preparing to be off
NOCSUB2KUI-934	AS5M131 Possibly missing MBES data

<u>NOCSUB2KUI-935</u>	Vehicle idle, Helm unable to process missions
<u>NOCSUB2KUI-936</u>	Pin Holes Discovered in AS5 Power tube - Aft payload tube potting
<u>NOCSUB2KUI-937</u>	Autosub 5 misballasted before the cruise
<u>NOCSUB2KUI-938</u>	OAS - including memory to avoid strong oscillations in uphill OAS legs

6.1.6. Mission summaries

Table 6.7. Mission summaries for DY200.

Mission	Start Time	Start Date	Duration [hr]	Distance [km]	Start Lat	Start Lon	End Lat	End Lon	Max Depth [m]	Min Alt. [m]	End State of Charge	Main Sensors			Mission Summary
												MBES	SSS & SBP	Cam.	
AS5M122	15:17	24/09/25	0.24	0.48	50.392	-7.723	50.390	-7.719	72.7	37.1	91%				Test dive to 10m. Ended in abort (stuck trying to ascend) due to incorrect ballasting (bow-down pitch moment)
AS5M123A	12:52	25/09/25	0.31	0.42	50.389	-7.727	50.384	-7.729	26.0	78.0	89.5%				Test dive to 10m to check new ballasting (+72.4 Nm bow up). Safety stop due to stuck trying to ascend (abort criteria changed)
AS5M123B	13:12	25/09/25	0.28	0.44	50.384	-7.729	50.380	-7.729	29.9	76.7	89.5%				Test dive to 10m with higher surge thrust (revs from 42 to 46 rad/s). Safety stop due

Mission	Start Time	Start Date	Duration [hr]	Distance [km]	Start Lat	Start Lon	End Lat	End Lon	Max Depth [m]	Min Alt. [m]	End State of Charge	Main Sensors			Mission Summary
												MBES	SSS & SBP	Cam.	
															to stuck trying to ascend.
AS5M123C	13:37	25/09/25	0.14	0.49	50.381	-7.732	50.376	-7.730	22.9	79.1	88.5%				Test dive to 10m with pitch & yaw demand limits increased by 20%. Surfaced upon timeout.
AS5M123D	14:00	25/09/25	1.07	1.86	50.378	-7.733	50.36	-7.730	42.6	63.9	88%				Test dive to 10m, 20m, 40m, 10m. Surfaced upon timeout.
AS5M124	15:17	25/09/25	26	77.77	50.372	-7.730	50.375	-7.465	110.5	1.9	38%	yes	yes	yes	Haig Fras standard MBES, SSS & SBP, and camera survey. AS5 safety surfaced due to being stuck trying to descend in a following current. Minimum speed through water raised from 0.9 to 1.0 m/s and mission

Mission	Start Time	Start Date	Duration [hr]	Distance [km]	Start Lat	Start Lon	End Lat	End Lon	Max Depth [m]	Min Alt. [m]	End State of Charge	Main Sensors			Mission Summary
												MBES	SSS & SBP	Cam.	
															successfully completed. No camera images, as the system malfunctioned.
AS5M125	13:30	28/09/25	0.39	1.22	48.291	-9.645	48.282	-9.642	19.6	>300	85.5%				Test dive to 10m (300s) and 20m (300s) to check new ballasting configuration
AS5M126	14:11	28/09/25	0.8	2.0	48.281	-9.632	42.290	-9.638	264.2	71.4	85%	yes			50m-altitude MBES survey of Dangaard Interfluve. AS5 aborted on the dive after passing a depth of 260 m due to the incorrect depth threshold parameter being set.
AS5M127	22:07	28/09/25	21.5	75.3	48.292	-9.648	48.281	-9.634	485.2	18.5	46%	yes			50m-altitude MBES survey of Dangaard Interfluve. AS5

Mission	Start Time	Start Date	Duration [hr]	Distance [km]	Start Lat	Start Lon	End Lat	End Lon	Max Depth [m]	Min Alt. [m]	End State of Charge	Main Sensors			Mission Summary
												MBES	SSS & SBP	Cam.	
															safety surfaced due to being stuck trying to descend along the 4 th track (uphill). The survey was then split into two additional parts sent via Iridium, with large positioning error after each dive due to the currents.
AS5M128	16:15	29/09/25	3.3	10.9	48.289	-9.64	48.269	-9.689	497.6	14.6	80%		yes		15m-altitude SSS & SBP survey of Dangaard Interfluve. AS5 safety surfaced due to being stuck trying to descend along the 2 nd track (uphill). When trying to resend

Mission	Start Time	Start Date	Duration [hr]	Distance [km]	Start Lat	Start Lon	End Lat	End Lon	Max Depth [m]	Min Alt. [m]	End State of Charge	Main Sensors			Mission Summary
												MBES	SSS & SBP	Cam.	
															the AUV down to complete the survey, the forward recovery line got entangled into the propellers and an emergency recovery was successfully accomplished on 01/10.
AS5M129	08:26	06/10/25	7.4	31.0	50.413	-7.749	50.409	-7.695	106.9	4.3	68%		yes	yes	3.5m-altitude camera, SSS and SBP survey of Haig Fras. Due to errors with the depth controller, the AUV followed the sea floor at an altitude of 5.5m instead of 3.5m.
AS5M130A	08:45	07/10/25	0.2	1.1	48.296	-9.628	48.292	-9.639	17.9	-	66.5%				Dive to 20m depth westwards

Mission	Start Time	Start Date	Duration [hr]	Distance [km]	Start Lat	Start Lon	End Lat	End Lon	Max Depth [m]	Min Alt. [m]	End State of Charge	Main Sensors			Mission Summary
												MBES	SSS & SBP	Cam.	
															with timeout of 400 s and no changes – baseline
AS5M130B	09:12	07/10/25	0.5	1.1	48.292	-9.639	48.290	-9.622	18.3	-	66.5%				Dive to 20m depth eastwards with timeout of 400 s and no changes – check for current effects
AS5M130C	09:53	07/10/25	0.2	1.1	48.289	-9.621	48.298	-9.622	19.2	-	66.5%				Dive to 20m depth northwards with timeout of 400 s after setting the lower anti-wind-up limit of the depth PID controller to – 0.04 (from –0.02)
AS5M130D	10:10	07/10/25	0.5	1.1	48.296	-9.620	48.283	-9.614	18.8	-	66.5%				Dive to 20m depth southwards with a timeout of 400s

Mission	Start Time	Start Date	Duration [hr]	Distance [km]	Start Lat	Start Lon	End Lat	End Lon	Max Depth [m]	Min Alt. [m]	End State of Charge	Main Sensors			Mission Summary
												MBES	SSS & SBP	Cam.	
															after no further changes – check for current effects
AS5M130E	10:45	07/10/25	0.2	1.0	48.282	-9.614	48.291	-9.616	19.7	-	66.5%				Dive to 20m depth northwards with timeout of 400 s after setting the lower anti-wind-up limit of the depth PID controller to – 0.06
AS5M130F	11:04	07/10/25	0.2	1.1	48.289	-9.616	48.278	-9.613	20.7	-	66.5%				Dive to 20m depth southwards with timeout of 400 s after setting the lower anti-wind-up limit of the depth PID controller to – 0.08

Mission	Start Time	Start Date	Duration [hr]	Distance [km]	Start Lat	Start Lon	End Lat	End Lon	Max Depth [m]	Min Alt. [m]	End State of Charge	Main Sensors			Mission Summary
												MBES	SSS & SBP	Cam.	
AS5M130G	11:37	07/10/25	0.6	2.7	48.276	-9.612	48.294	-9.624	82.1	-	66.5%				Running the AUV northwards on a longer mission with depth steps at 80 m (400 s), 81.5 m (400 s), 40 m (400 s), and 38.5 m (400 s) after no further changes
AS5M130H	12:34	07/10/25	1.0	2.7	48.292	-9.629	48.268	-9.627	82.5	-	66.5%				Running the AUV southwards on a longer mission with depth steps at 80 m (400 s), 81.5 m (400 s), 40 m (400 s), and 38.5 m (400 s) after no further changes
AS5M130I	13:56	07/10/25	0.7	1.4	48.268	-9.632	48.286	-9.648	50.7	-	66.5%				Running the AUV northwards with a dive to 50 m and a timeout of 600 s after

Mission	Start Time	Start Date	Duration [hr]	Distance [km]	Start Lat	Start Lon	End Lat	End Lon	Max Depth [m]	Min Alt. [m]	End State of Charge	Main Sensors			Mission Summary
												MBES	SSS & SBP	Cam.	
															updating the downward anti-wind-up limit of the pitch PID controller to -65 (from -50)
AS5M131	15:06	07/10/25	22.1	100.7	48.291	-9.656	48.282	-9.628	508.3	4.3	9.5%	yes	yes	yes	Dangaard Interfluve: 3 legs of 50m-altitude MBES survey, full 15m-altitude SSS survey and short camera survey straight after the M130 tests. AS5 aborted once the voltage dropped below the threshold, as it ran out of energy.
AS5M132	08:51	09/10/25	5.3	23.8	48.288	-9.627	48.281	-9.627	484.8	1.8	71%		yes	yes	3.5m-altitude camera, SSS and SBP survey of Dangaard

Mission	Start Time	Start Date	Duration [hr]	Distance [km]	Start Lat	Start Lon	End Lat	End Lon	Max Depth [m]	Min Alt. [m]	End State of Charge	Main Sensors			Mission Summary
												MBES	SSS & SBP	Cam.	
															Interfluve. During the mission, skip commands were sent to AS5 via acoustics for training.
AS5M133	17:05	09/10/25	15.3	71.1	48.424	-9.653	48.397	-9.724	413.6	2.1	29%		yes	yes	15m-altitude SSS and partial 3.5m-altitude camera, SSS & SBP survey of Explorer Interfluve. Mission finished early with a stop via acoustics to adjust camera settings.
AS5M134	08:49	10/10/25	2.4	9.7	48.396	-9.728	48.399	-9.726	374.4	2.7	19.5%			yes	3.5m-altitude camera survey of Explorer Interfluve testing updated camera settings (white balance ratio Red:Green from

Mission	Start Time	Start Date	Duration [hr]	Distance [km]	Start Lat	Start Lon	End Lat	End Lon	Max Depth [m]	Min Alt. [m]	End State of Charge	Main Sensors			Mission Summary
												MBES	SSS & SBP	Cam.	
															4 to 2). AS5 stopped with timeout.
AS5M135	11:44	10/10/25	3.0	10.7	48.397	-9.728	48.394	-9.725	358.9	2.3	10%			yes	3.5m-altitude camera survey of Explorer Interfluve testing updated camera settings (gain of 14 from 16). AUV stopped through acoustic message.

6.1.7. AUV data

6.1.7.1. Hard Drive Structure

At the end of the cruise a hard drive was presented to the PI containing all the collected data. These data are also hosted on the NOC network and are available from the MARS AUV Ops team UNIX system. The final copies will be uploaded to the British Oceanographic Data Centre (BODC).

The file structure contains a folder for each mission with the relevant mission number and date, e.g., AS5M122_20250924. Within each folder are the data sub-folders:

- AS5MXXX_camera,
- AS5MXXX_ctd,
- AS5MXXX_edgetech,
- AS5MXXX_figures (from the engineering log plots),
- AS5MXXX_mbes,
- AS5MXXX_ocs-logs,
- AS5MXXX_syrinx_dvl.

In case any data is missing because the payload sensor was intentionally not switched on during the mission, an empty datafile stating that the data is missing is included instead.

6.1.7.1.1. Figures folder

The figures folder contains 80+ plots as .fig, a MATLAB format. These figures present the engineering data for the mission for all the devices and the missions itself.

6.1.7.1.2. Navigation / Janus

The AUV runs two navigation systems, the Localizer and the SprintNav. The Localizer is a navigation algorithm created by MARS and used live by the vehicle during the mission and can be found in the .CSV as the latitudes and longitudes given. The SprintNav navigation is logging throughout the mission. Once the mission is complete, this SprintNave navigation is re-run through the JANUS software and gives the best post-processed navigation which is needed for the multibeam processing. You can find the JANUS navigation in the Sprint nav folder or Janus folder.

6.1.7.1.3. OCS-logs folder

This contains all the OCS (onboard control system) logs from the log folder on the front and back payload tubes. It includes raw communication with each device. Within this folder is the sensor raw logs folder which contains all the raw logged sensor data. A new log folder is created when the OCS reboots.

The mission CSV file contains the engineering log of the mission, which is 1s records logging all diagnostics coming from the vehicle. The Localizer navigation can be found in this file along with when devices are powered on and off along with settings. This file is used to create the figures folder.

The configuration YAML file contains a definition of the AUV and its configuration during the mission. This file rarely changes.

The GeoJson files contain the mission(s) which were sent from the C2 web-based control system. It includes everything including way points, speed, depths, etc., which were requested of the AUV for the mission.

6.1.7.1.4. Syrinx/ADCP/DVL

The syrinx folder contains the ADCP & DVL data collected by the 600kHz DVL/ADCP. This is output in a PDO format. Specific ADCP settings can be found in the mission logs. The device alternates pings between DVL and ADCP, how often it pings is controlled by the trigger settings which is usually a function of altitude and primary sensor device.

6.1.7.1.5. CTD

The CTD folder contains the processed data using the seabird 9+ tool. The raw CTD data can be found in the data folder. The device logs data at 10hz.

6.1.7.1.6. Edgetech

The .JSF files are stored on the Edgetech 2205 itself and are broken up by track. These files can be found in the Edgetech folder. Most of the missions were run using the 2-13kHz 16ms sub-bottom chirp; however, the exact setting for each mission can be found in the mission summary. These logs contain the localizer navigation as it is fed in live during the mission.

The system malfunctioned during the last week of the cruise. Hence, the separate navigation files from the SprintNav / Janus postprocessing may be used in case the navigation has not been copied into the Edgetech files.

6.1.7.1.7. AESA camera folder

This folder contains .DNG files for AESA 2.5.

6.1.7.1.8. Multibeam

The Nortek Multibeam produces 3 main files: a Multibeam file, a side scan/snippet data file and a water column data file. In the raw folder these files are stored as a raw binary output from the vehicle and must be converted to .s7k and merged with the navigation data as a post processing exercise, which is what can be found in the post Norbit folder.

The multibeam files are split based on time. The name of the file indicates whether Janus nav is being used, and if the file contains the BC back scatter or WC water column data, too.

All the missions with multibeam on were run with the 400kHz 80kHz bandwidth at maximum power.

The multibeam also has the speed of sound sensor embedded with it. These data are recorded in the 3 multibeam files but can also be found in the Engineering CSV.

Within the files you can find the follow 7K Records:

7000 – System Configuration Data

7004 – Beam Geometry Data

7027 – Bathymetry Data

7007 – Sidescan Data3

7028 - Snippet

7042 – Water column Data

7610 – Speed of Sound data

6.1.7.2. **Triggering**

Every acoustic device on the AUV is triggered to be in sync with each other, thus reducing the interference between devices. The trigger rate is set around the highest priority data. For example, if the low frequency 120kHz sidescan is the primary data product, the ping rate is slowed down to 2 Hz to allow the maximum range data to be collected. If a 3 m camera survey is the primary operation, the ping rate is set to 6 Hz to allow the vehicle to detect the bottom from ~130m away but also have a rapid update rate while at 3 m. The mission's initial triggering setting used can be found in that mission's summary. The trigger setting can be changed during the mission (and has been done so during DY200 to transition from MBES to SSS to camera surveys). Details of any changes during mission can be found in the GeoJson file or the engineering log.

6.1.7.3. **Timing**

All devices on the AUV are synchronised to an NTP server running on the aft payload tube. This NTP server gets its time from GPS and is stabilized by a 1pps coming from a chip scale atomic clock embedded in the aft tube. The 1pps is fed around the system to devices to increase the accuracy of their timing.

6.1.8. **LP testing** (*Georgios Salavasidis*)

6.1.8.1. **Introduction**

The Localisation Package (LP) is the new navigation system designed to replace the Localiser. The LP has been tested several times on the Autosub Long Range (ALR) vehicles, but no full integration tests have been performed onboard Autosub5.

The LP consists of two main components:

- The Dead Reckoning (DR) node, which uses a 3D kinematic model to propagate an initialised navigation state over time.
- The Fuser node, which updates and corrects the navigation state produced by the DR node whenever additional navigation aids become available.

The main goal of this cruise, from the navigation perspective, was to test the integration and performance of the LP onboard Autosub5. For safety reasons, the vehicle's control loop remained closed using the Localiser, while the LP ran in parallel to provide comparative navigation data.

To start producing navigation information, the LP needs a few fundamental inputs: vehicle velocity estimates/measurements, attitude data (pitch, roll, and yaw), and an initial estimate of the vehicle's navigation state (position and associated covariance). Once these are available, the DR and Fuser nodes can run. Any additional navigation sources are then fed to the Fuser, which corrects the DR-estimated navigation state accordingly.

6.1.8.2. **Configuration / Parameter setup**

For DY200, the LP was configured as follows:

The DR node was provided with:

- Outputs from the 3D velocity model, which translates the propeller RPM into surge, sway, and heave components.

- Attitude data (pitch, roll, and yaw) from the SprintNav.
- An initialised navigation state supplied by the Initialisation node.

Note, the Initialisation node records valid LP outputs in a log file. When the vehicle is next powered on, this node reads the most recent entry and provides the LP with the latest logged navigation state (latitude, longitude, and depth) along with the associated variance for each component.

The Fuser node was configured to use the following navigation aids:

- GPS position measurements, when available
- Syrinx BT velocity data, when available
- SprintNav depth estimates

Midway through the cruise, the Fuser was also enabled to incorporate USBL measurements.

The initial Fuser configuration parameters were:

- `disable_velocity_fusion_on_surface = false`
- `is_bottom_lock_aiding_enabled = true`
- `is_water_track_aiding_enabled = false`
- `P_b_dive = [0.01, 0.01, 0.0004]`
- `Q_b_dive = [0.0001, 0.0001, 0.000025]`
- `P_c_dive = [0.0025, 0.0025, 0.0004]`
- `Q_c_dive = [0.0009, 0.0009, 0.000025]`
- Correction saturation on depth only - 5m

Mid-cruise, the following adjustments were made to test whether dives without bottom lock were over-sensitive to depth measurements:

- `P_b_dive = [0.01, 0.01, 0.0004]`
- `Q_b_dive = [0.000025, 0.000001, 0.00000025]`
- `P_c_dive = [0.0025, 0.0025, 0.0004]`
- `Q_c_dive = [0.000025, 0.000025, 0.00000025]`

No decay mechanism for bias and current estimates was implemented or applied.

6.1.8.3. Performance assessment

The LP performance was broadly consistent with the expectations of the LP development team. To summarise the results, we considered two distinct operating scenarios:

- Shallow-water missions, where the vehicle maintains continuous bottom lock, including during dive and surfacing phases;
- Deep-water missions, where the vehicle operates without bottom lock (and without water-tracking velocity measurements) at least during dive/surfacing phases.

It is worth noting that LP had never previously been tested under the latter conditions, as the Nortek sensors on the ALRs typically provide water-tracking velocity data.

For evaluation purposes, we present position estimates from the *SprintNav*, *Localiser*, LP and USBL (when available). Two LP instances are shown: LP RT (in red), representing the real-time LP solution computed onboard the vehicle, and LP Sim, which is a MATLAB-based replica of LP RT used in post-

mission replay and evaluation under different configurations and conditions. Post-cruise analysis indicated that the LP performance could have been improved with some tuning, which has been implemented in LP Sim. It should also be noted that LP Sim does not fuse USBL data, whereas LP RT does so for missions conducted after 30 September (M128 onwards).

A detailed evaluation of the LP performance for each mission is provided in the MARS DY200 operational report (Anderlini et al., 2025). A summary of the issues identified and conclusions/way forward is listed below.

6.1.8.4. Issues identified / Discussion points

- During the early experiments (prior to M125), the LP system was not provided with depth measurements, resulting in unrealistic depth estimates. During this period, depth was inferred solely from the 3D kinematic model, with no correction applied, even after system reboots. This issue was resolved from M125 onwards.
- It was observed for the first time that the Fuser's performance is directly influenced by its configuration setup. Historically, the filter had been robust and required minimal tuning. However, for Autosub5, particularly during deep missions and in the absence of both water-tracking and bottom-track data, the filter appeared oversensitive to depth measurements and initial estimation performed while the vehicle was still at the surface. Future tuning can significantly improve both robustness and accuracy.
- The untuned LP system can be affected negatively by depth measurements during long missions where the state uncertainty has grown significantly. This occurs because depth updates are further injected into the horizontal plane through correlations (when the vehicle exhibits substantial pitch), leading to noticeable jumps in the estimated position.
- Deep missions relying solely on propeller-based velocity estimates can accumulate significant navigation errors. This behaviour is not new and has been observed across all tested navigation solutions.
- On 9 October, the LP system reported initialization errors. Investigation revealed that, on the previous day, during a brief reboot on the ship's deck, the Fuser had received depth values with zero variance. This caused the initialiser to log extremely small depth uncertainty values, rendering the covariance matrix ill-conditioned.
- When the vehicle is commanded to abort and surface rapidly, navigation performance degrades because the vehicle lacks control authority. Improved performance could be achieved by informing the LP system of the sub's current operating phase (e.g., via Helm). Alternatively, the LP system could incorporate intelligence to infer the vehicle state using the velocity model derived from propeller speed measurements.

6.1.8.5. Conclusion / Future steps

DY200 contributed valuable datasets for evaluating the performance of the LP system under specific platform (Autosub5) and environmental conditions (deep dives). The key benefits include:

- a) Integrating LP into Autosub5 and performing navigation without DVL water-track measurements.
- b) Conducting dives/surfacing entirely without DVL data.
- c) Understanding the peculiarities of the filter and performing initial tuning efforts.
- d) Observing the importance of maintaining correlations between states (e.g. during DVL-based position correction) while also recognising the need to mitigate the impact of outliers.
- e) Fusing USBL data effectively (pre-filtering)

- f) Highlighting the necessity of safeguarding the Fuser from unrealistic measurements and enhancing the initialisation node to improve robustness.

Future steps include:

- a) Pre-filtering USBL measurements to avoid fusing outliers, as observed in Fig. 6.2.

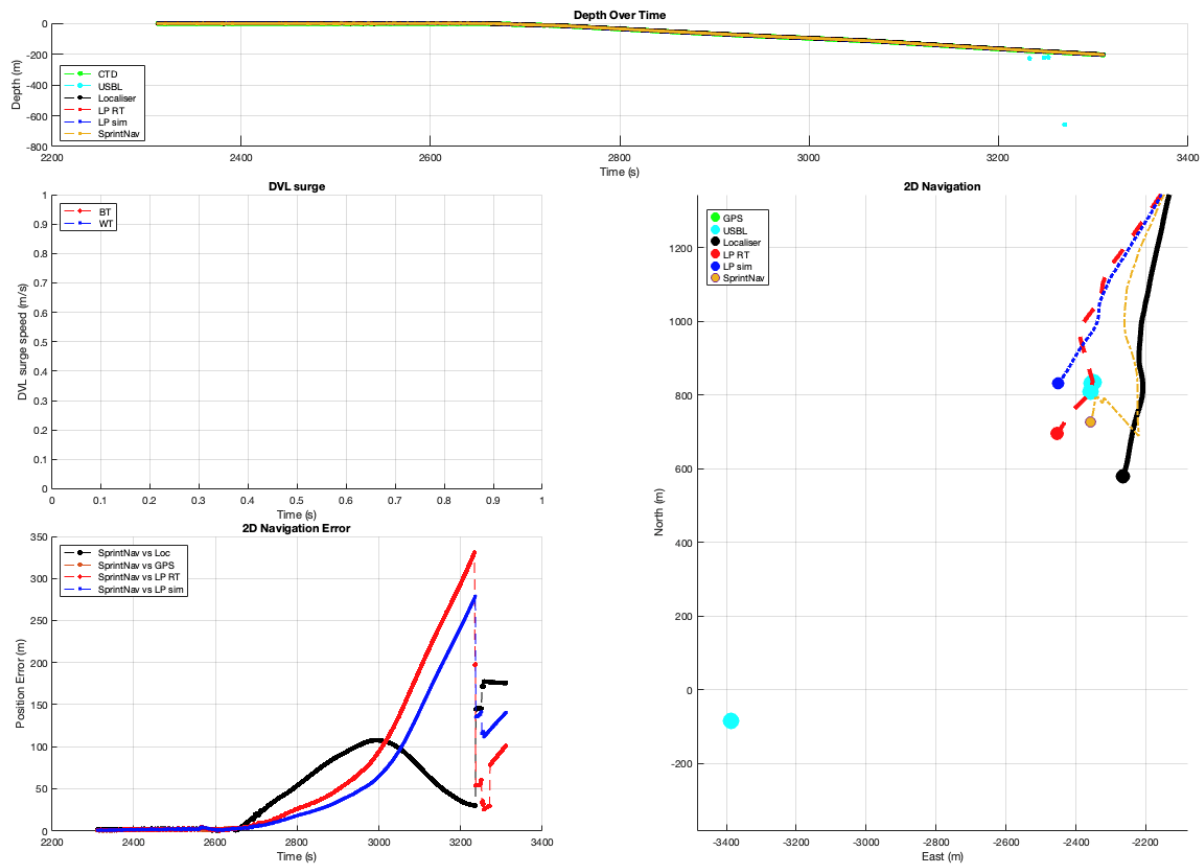


Fig. 6.2. USBL outlier being fused by the LP RT, demonstrating the need for USBL pre-filtering (M131).

- b) Implement a higher level of DVL pre-filtering. High-quality DVL data is essential not only for accurate filtering but also for smoothing and correcting past errors. Fig. 6.3 illustrates the importance of removing potentially invalid DVL measurements. The same issue is highlighted in Fig. 6.4.

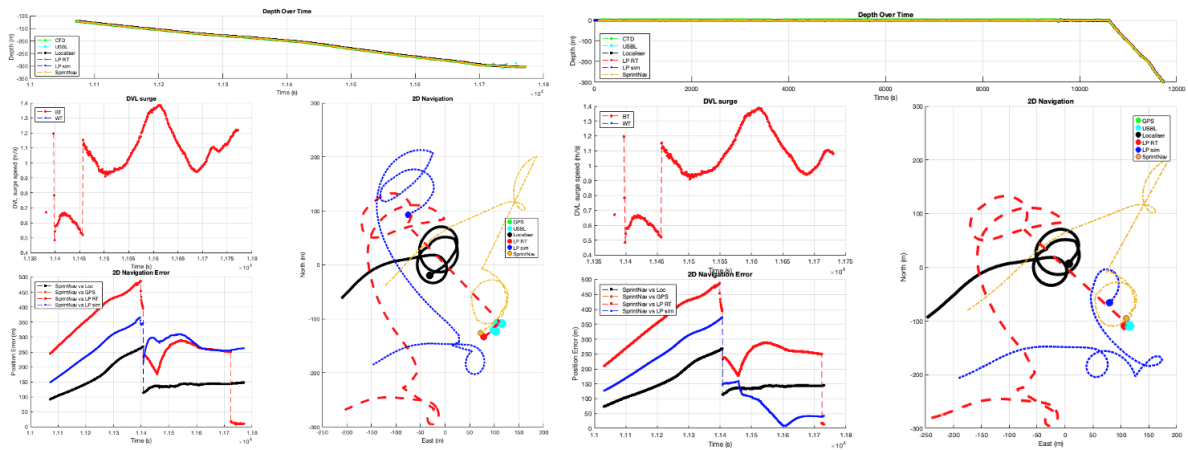


Fig. 6.3. (Left) Initial DVL bottom-track velocities introducing position corrections that degrade performance (M128). (Right) The same mission is replayed with the initial DVL data excluded from fusion by LP sim. The LP sim is now able to correct for past velocity errors and achieve good agreement with USBL.

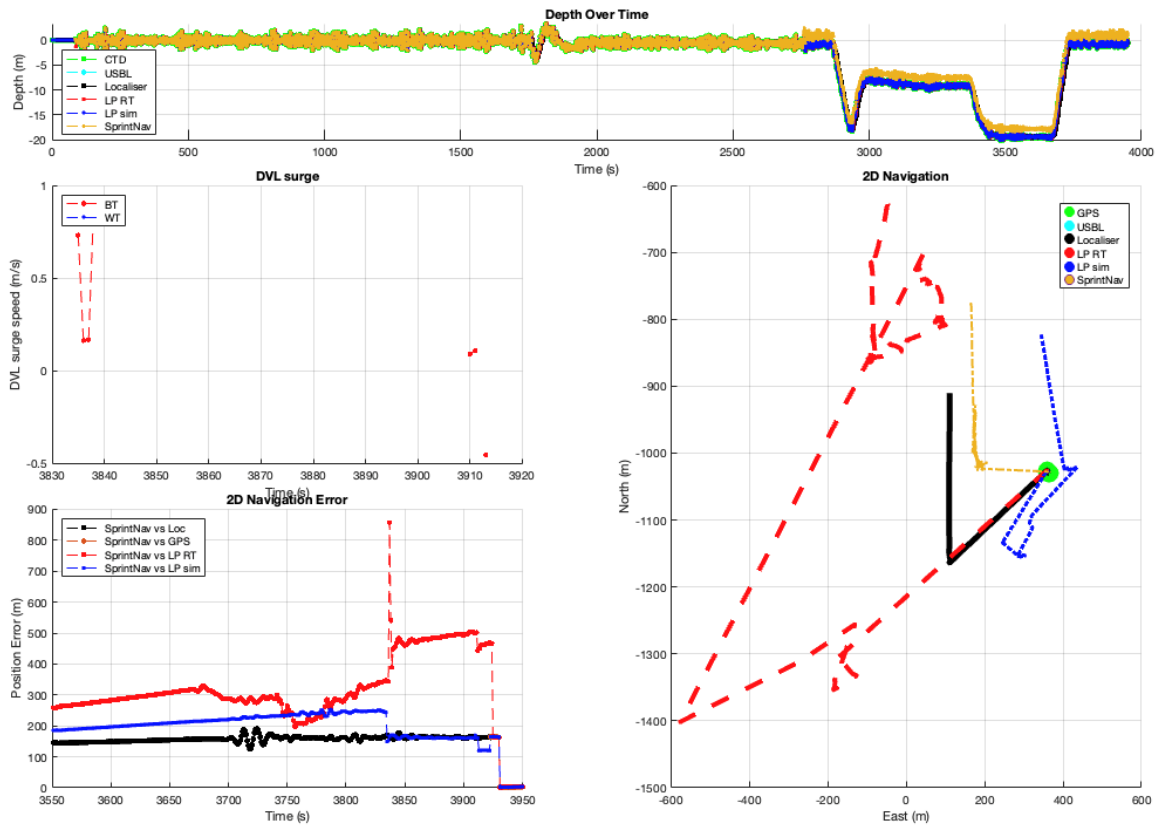


Fig. 6.4. Spurious DVL data cause the LP to make large horizontal position jumps, leading to degraded performance (M125).

- c) Fuser tuning – improve multi-platform robustness rather than optimizing solely for platform-specific performance.
- d) Safeguarding the *Fuser* – prevent it from being fed erroneous measurements, such as unrealistic variances or invalid measurement values.
- e) Default minimum variance/covariance – enforce minimum uncertainty for each data source. If a source reports lower uncertainty, either discard the measurement or replace the reported uncertainty with the default minimum.

- f) Improving the *Initialiser* node – enhance both performance and robustness by initialising the full state and incorporating a mechanism to propagate uncertainty over time. Ensure that initialization can always be successfully performed (resolve potential numerical issues when saving into a log file).
- g) Evaluate options that improve the performance for dives and surfacings when both bottom-track and water-track data are unavailable. Special attention is needed for scenarios such as aborted surfacings to maintain reliable navigation (required?).
- h) Standard MATLAB tools for LP performance evaluation – continue developing tools to evaluate LP performance efficiently, an effort initiated within the team.

6.1.9. Obstacle avoidance system testing

One of the MARS objectives for the cruise was testing the Onboard Control System (OCS) Obstacle Avoidance System (OAS) using measurements from an Impact Subsea ISA500-L single-beam altimeter mounted in the bow of the vehicle.

The need to use a forwards-looking sensor in the onboard avoidance system is associated with the requirement to perform low-altitude flight (e.g. camera missions) over rough terrain; in such scenarios, relying only on the downwards-looking DVL to avoid the seabed is too risky (and confirmed hard to achieve during previous failed attempts), especially since the DVL is located towards the stern of the vehicle, which further increases the overall reaction time of the AUV. The main reason for integrating a forward-looking avoidance sensor is to sense and react to obstacles ahead before the vehicle reaches them.

Since approximately 2022, opportunistic tests have been carried out with a NORBIT FLS mounted vertically in the bow of the vehicle and used as avoidance sensor (mostly data-gathering, with a few missions where it was used online); however, the performance of such sensor for avoidance purposes has been deemed not satisfactory, which led to it being replaced by an ISA500 for the first time during this expedition. The ISA500 altimeter has been used on several occasions on an Autosub Long Range (ALR), throughout 2025, where it showed encouraging performance.

Summary of the main results:

Overall, the OCS Obstacle Avoidance System performed well during the cruise, showing repeatable behaviour and allowing the vehicle to successfully perform (on the first try) low-altitude camera surveys in areas where multiple failed attempts had been made in the past; the ISA500 proves to be a simple and reliable sensor for short-range detection of obstacles. Further improvements can be made to the system – some already suggested in the MARS operational report – however the results achieved during DY200 give us confidence in the system ahead of future science expeditions. Further technical details of the OAS tests are provided in the MARS DY200 operational report (Anderlini et al., 2025)

6.1.10. Testing of the new thrusters

Up-rated 400W thrusters were fitted to the AUV and tested prior to the DY200 commissioning trials. Overall, the thrusters have performed well during trials but field testing has resulted in modifications being required to the depth controller PID tuning as well as updates to the post-recovery SOP, specifically procedural updates for flushing the bearings post-deployment.

Summary of the main results:

- Operationally, the two sets of thruster bearings should be flushed with warm, fresh water after each dive. This will inhibit the build-up of salt crystals in the ceramic bearings.
- The updated 400W thrusters are ~ 10% more efficient than the previous generation. Given that the thrusters are the most significant power demand of the AUV, the upgrade can greatly increase endurance.
- If required, the max angular velocity of the thrusters could safely be increased to 52rad/s for increased AUV speed.

Further technical details of the thruster tests are available in the MARS DY200 operational report (Anderlini et al., 2025).

6.1.11. Mobilisation

Mobilisation started on the morning of Saturday 20/09/2025, but the workshop container was taken to RRS Discovery only at 12:00 due to late de-mobilisation from the previous cruise. However, mobilisation went well, and the mobilisation checks were completed on Monday 22/09/2025 successfully. The following lessons may be useful for future cruises:

1. Challenges were experienced in setting up the WiFi antennas on the monkey island and networking on the ship due to new hardware being installed. Daniel Matterson helped us update the configuration on 22/09/2025 and his presence would be useful at the start of future mobilisations if the antennas are updated.
2. The LARS will need oiling and maintenance at the end of the previous cruise.
3. The deck arrangement on DY200 should be used as an example, as we had good space around the LARS, AUV and workshop container, the quarantined battery box is nearby as is the AUV trolley for emergency recoveries.
4. During the dunk test, the ISA500 altimeter did not return readings potentially due to silt.
5. Using the dunk test to check the AUV's ballasting is very deceiving, as a problem with trim when the AUV is underwater was not detected.

After the dunk test, it was decided to remove mass from the vehicle to make her more buoyant. To avoid causing a list/heel/roll moment to port, 0.5 kg mass blocks were removed from the forward port & starboard lower points, and 1 kg mass blocks from the aft port & starboard lower points (thus causing a 37 Nm pitch moment bow down) (DY200(B) drawing).

During the cruise, upon request from the ship's captain, AS5's forward mast was taken down after each recovery and the LARS stowed away from the AUV. This provides free access to the top of the AUV in case the lithium-ion fire blanket has to be applied, as well as providing better access for AUV Ops to do maintenance tasks.



Fig. 6.5. Autosub 5 on the aft deck during non-operational times. The LARS is stowed away so that the top of AUV can be accessed with ease.

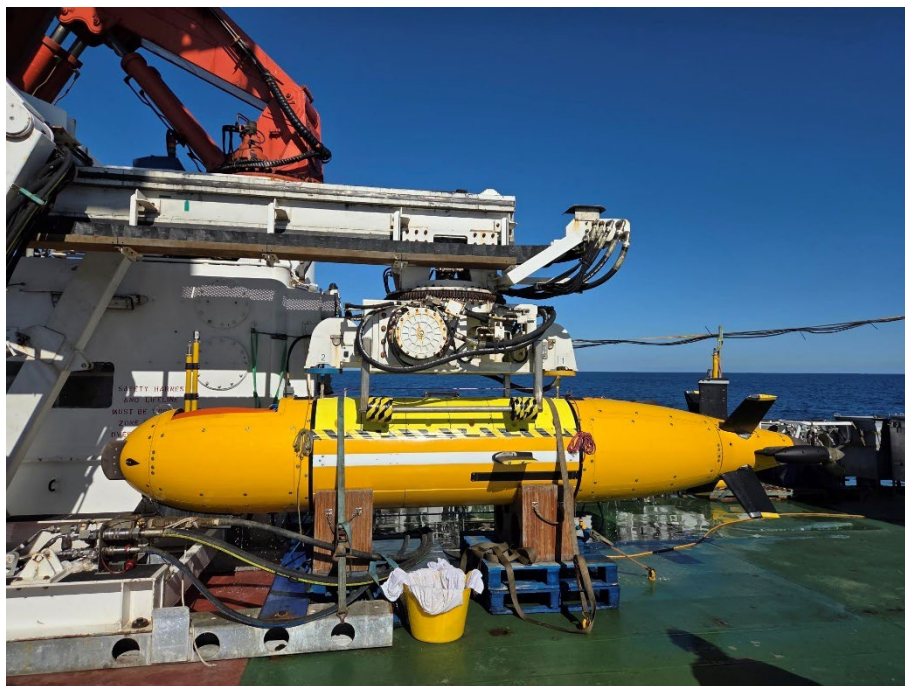


Fig. 6.6. Autosub 5 rigged for launch or recovery on deck.

6.1.12. Demobilisation

After the last recovery, Autosub 5 was deposited immediately onto its trolley from the LARS and then towed as far forward as possible, next to the aft end of the workshop container. This solution enabled the team to start taking down the LARS and preparing it for transfer (in safe conditions with mild waves), thus speeding up de-mobilisation significantly once in port.



Fig. 6.7. Autosub 5 on its trolley after the last recovery, with the LARS already taken down to its storage configuration, on the afternoon of the second last day of the cruise.

6.1.13. AUV missions

For the purpose of DY200 (and probably any cruises following DY200), an “Autosub5 mission” is defined as the AUV operation lasting from one to the next period at the sea surface. This means that, contrary to previous nomenclature, a single AUV deployment (operation between launch and recovery from the ship, previously called “mission”) now can include several missions, in those cases where the AUV surfaces between separate operations.

During DY200, some of the AUV missions were purely aimed at engineering trials and testing, while other missions, sometimes part of the same ‘station’ or deployment, were focused on acquiring scientific data.

In the Mission Summaries below, the basic information (specifications, settings, aim) is listed for all missions, but engineering review data and further engineering test results are omitted. They can be found in the MARS DY200 operational report (Anderlini et al., 2025). Details of scientific data collection are provided.

6.1.13.1. Autosub5 Mission AS5M122 summary

This was an engineering test mission:

Details

Mission Identifier:M122
 Start Time:24-Sep-2025 15:17:50
 Time Elapsed:0.23722 Hrs
 Distance Traveled:0.48137 km
 Start Coordinates:50.392 deg N, -7.723 deg E
 End Coordinates:50.39 deg N, -7.7194 deg E
 Max Depth:72.6729 meters
 Minimum Altitude Recorded:37.071m
 Start Battery Voltage: 57.558V End Battery Voltage: 57.516V
 Start State of Charge: 92% End State of Charge: 91%

6.1.13.2. Autosub5 Missions AS5M123A-D summary

These too were test missions. As the nomenclature of missions and deployments was not finalised yet, the deployment consisted of 4 missions, they were distinguished with letters A-D.

Details

M123A

Mission Identifier:M123A
Start Time:25-Sep-2025 12:52:21
Time Elapsed:0.31111 Hrs
Distance Traveled:0.41674 Km
Start Coordinates:50.3892 deg N, -7.727 deg E
End Coordinates:NaN deg N, NaN deg E
Max Depth:26.0295 meters
Minimum Altitude Recorded:77.9877m
Start Battery Voltage: 57.628V End Battery Voltage: 57.58V
Start State of Charge: 89.5% End State of Charge: 89.5%

M123B

Mission Identifier:M123B
Start Time:25-Sep-2025 13:12:42
Time Elapsed:0.28472 Hrs
Distance Traveled:0.4444 Km
Start Coordinates:50.3841 deg N, -7.7293 deg E
End Coordinates:50.38 deg N, -7.7295 deg E
Max Depth:29.9353 meters
Minimum Altitude Recorded:76.6971m
Start Battery Voltage: 57.572V End Battery Voltage: 57.514V
Start State of Charge: 89.5% End State of Charge: 89.5%

M123C

Mission Identifier:M123C
Start Time:25-Sep-2025 13:37:22
Time Elapsed:0.13556 Hrs
Distance Traveled:0.49449 Km
Start Coordinates:50.3805 deg N, -7.7315 deg E
End Coordinates:50.3762 deg N, -7.7303 deg E
Max Depth:22.8665 meters
Minimum Altitude Recorded:79.1065m
Start Battery Voltage: 57.464V End Battery Voltage: 57.456V
Start State of Charge: 88.5% End State of Charge: 89%

M123D

Mission Identifier:M123D
Start Time:25-Sep-2025 14:00:16
Time Elapsed:1.0686 Hrs
Distance Traveled:1.8623 Km
Start Coordinates:50.3776 deg N, -7.7329 deg E
End Coordinates:50.3673 deg N, -7.7292 deg E
Max Depth:42.5658 meters
Minimum Altitude Recorded:63.8767m
Start Battery Voltage: 57.416V End Battery Voltage: 57.318V
Start State of Charge: 88% End State of Charge: 88%

At the end of these missions, the sub was not recovered, moving directly to M124, as AS5 was deemed safe for operations in the shallow waters with flat terrain in Haig Frs.

6.1.13.3. Autosub5 Mission AS5M124 summary

Details

Mission Identifier:M124
Start Time:25-Sep-2025 15:17:38
Time Elapsed:28.1103 Hrs
Distance Traveled:77.7749 Km
Start Coordinates:NaN deg N, NaN deg E
End Coordinates:50.3752 deg N, -7.4645 deg E
Max Depth:110.4762 meters
Minimum Altitude Recorded:1.9463m
Start Battery Voltage: 57.308V End Battery Voltage: 55.704V
Start State of Charge: 88% End State of Charge: 70%

The actual state of charge was 38% after the mission, with the higher value of 70% coming from charging on deck before the mission logs were created.

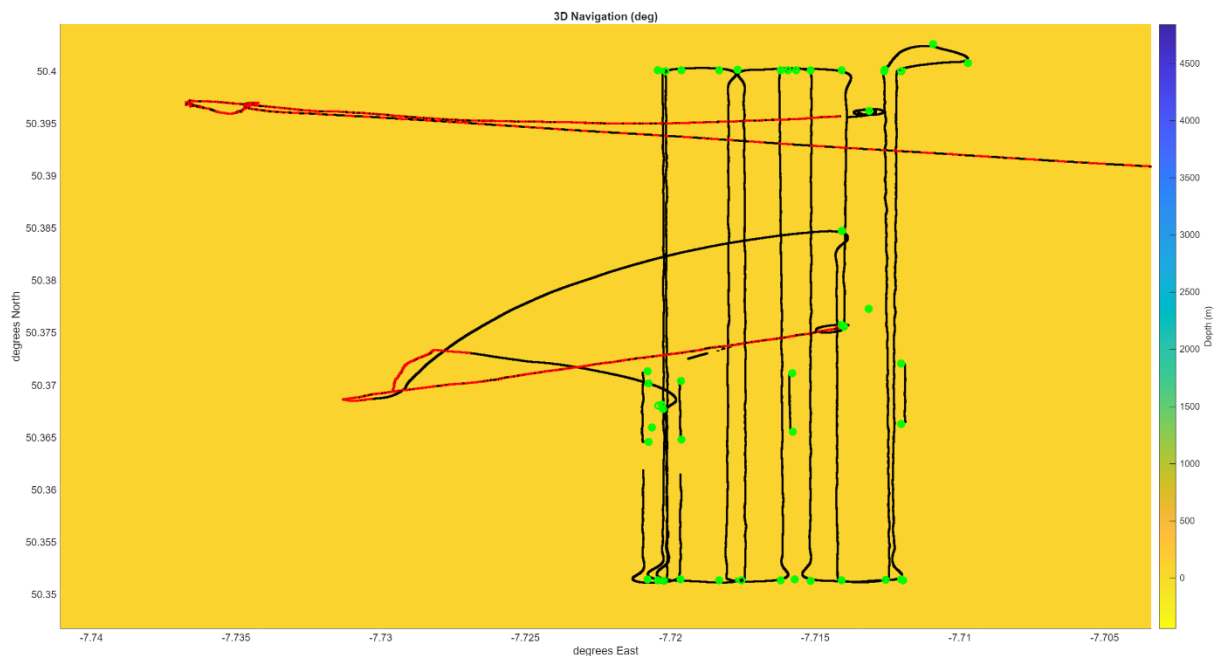


Fig. 6.8. Basic track plot of AS5M124, carried out at Haig Frs

Narrative

This mission ([plan 1-11](#)) was the standard MBES, SSS + SBP and camera survey of Haig Frs. Before sending the AUV onto the mission after M123D, the following configuration changes to the OCS were made via WiFi:

- Under_min_alt = 1 m,
- No_contact_timer = 28 hr.

Additionally, the CTD was turned off to save energy. The “stuck trying to ascend” behaviour was returned to result in a safety abort. Despite the camera showing problems, it was left within the mission plan anyway to acquire low-altitude data for the ISA 500 altimeter.

The AUV was tracked with the ranger2 USBL system as part of a training session, with the ship travelling South tracking the AUV travelling Northwards along the first MBES track.

The AUV emerged at 21:05:58 after being stuck on descent. The ship was undertaking an MBES survey at another location at that time. As the C2 message via Iridium was not completely informative (the AUV was on safety surface and it could be resumed back to idle helm status, the mission was stopped on command/behaviour 14 (half of the fourth leg of the MBES survey), the minimum depth was 1.9 m (safe), and the MBES was still on), it was decided to go back to the AUV to check the engineering logs via WiFi to understand the cause for the safety stop (excluding causes more worrying than stuck on descent).

Whilst tracking AS5 on the surface with the ship, AS5 kept on drifting in a South-West direction at 0.6 m/s.

Upon checking the logs, it was clear that AS5 encountered a large following current during the track, meaning that it was travelling at only 0.9 m/s through the water. Although this speed is higher than the lower minimum speed through water for AS5 to be controllable, the AUV could not keep control authority due to its incorrect ballasting. Hence, it surfaced in safety stop after being stuck in descent.

The mission was edited so that the target speed over ground was 1.2 m/s, the minimum speed through water 1 m/s and the maximum speed through water 1.4 m/s. Afterwards, AS5 was sent to complete the second part of the mission ([plan 30-6](#)), which it completed successfully, surfacing on 26/09/2025.

Scientific data review

The MBES plot shows an AUV angle of list/heel/roll of 1.8° and a crabbing of the vehicle towards port so that the starboard side of the MBES line is less defined and thus present a small gap between neighbouring track legs. The SSS and SBP data were as expected (the SBP data are not particularly useful due to the rocky terrain). No photos could be taken due to a malfunction with the camera.

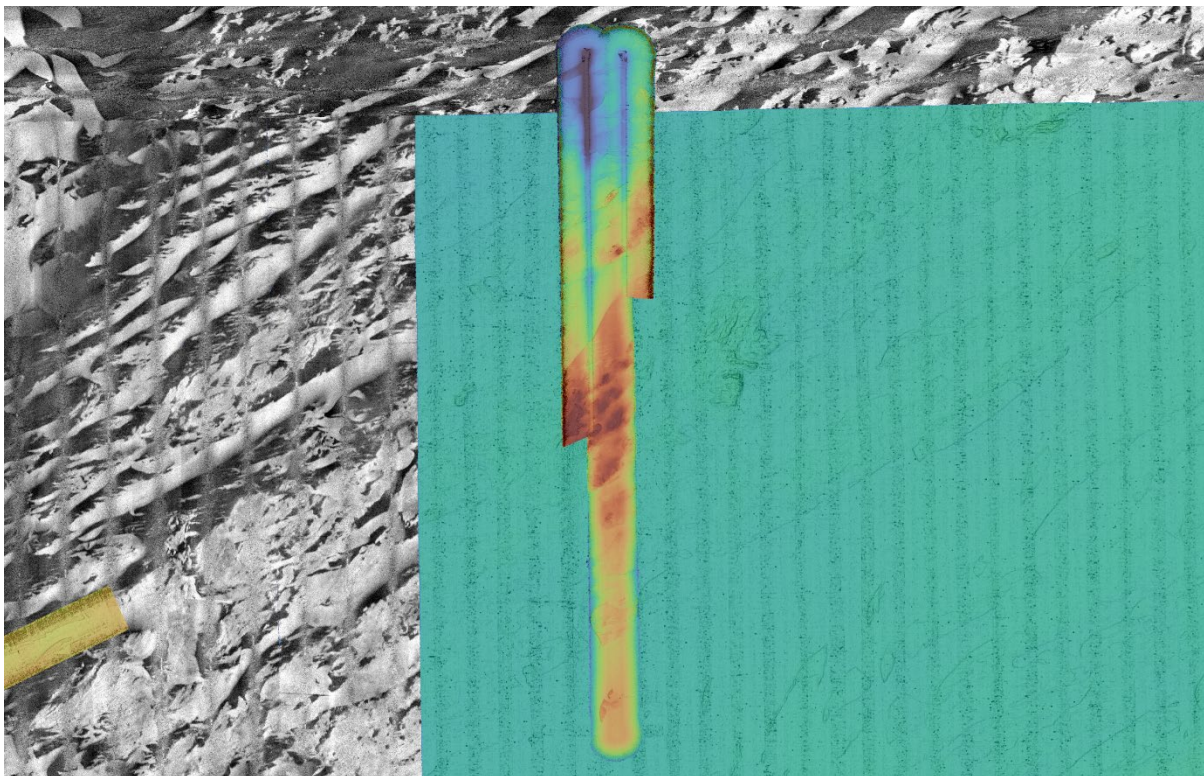


Fig. 6.9. Preliminary MBES data from the first part of AS5M124, against background of shipboard EM710 MBES data and backscatter data in the area

System specifications

Wings	-486 mm from the centre of pressure (aft position) 3° tail-tip up
Estimated Battery Use	14.2 kWh

Navigation

Navigation Solution	Localiser
USBL Telemetry	Telemetry aiding during the first dive

OCS Critical Parameters Spec

Parameter	Value
No_contact_timer	28 h
Safety_min_alt	3 m
Safety_max_depth	6,000 m
Iridium_period	5 mins

Safety & Monitor Parameters Spec

Parameter	Value
Over_max_depth	5,000 m
Under_min_alt	1 m
Safety_max_depth	6,000 m
Iridium_period	5 mins
Stuck-trying-to-a/descend depth threshold	3 m

Obstacle Avoidance Parameters Spec

ISA 500	Sensor on, but offline
Avoidance strategy	Not required
ISA 500 quality threshold	Not required
Look-ahead normalization threshold	Not required
Demands transition filter coefficients	Not required

Payload Settings

Device	Required (Y/N)	Mode
9+ CTD	Optional	Switched on on the surface, but turned off during mission
AESA Camera	Yes	N/A - camera malfunctioned
Norbit Bathy	Yes	Bathy_400kHz_Swath140_Range170 at 50m altitude; Bathy_700kHz_Swath110_Range55 at 15m altitude
Edgetech 2205	Yes	SSH_410_SBP_2_8_40ms_Gain10

Wetlabs BBRT	Optional	N/A
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ADCP/DVL Settings

Setting	Requested Values
Bins	6
Depth cell width (cm)	433
Pings to average	4
Transducer depth (cm)	0
Depth range (m)	25.98
Velocity (m/s)	2.79
Velocity error (cm/s)	0.19

6.1.13.4. Autosub5 Mission AS5M125 summary

This was a technical test after corrections to the ballasting

Details

Mission Identifier:M125
 Start Time:28-Sep-2025 13:13:20
 Time Elapsed: 0.38556 Hrs
 Distance Traveled: 1.2243 Km
 Start Coordinates:48.2914 deg N, -9.6453 deg E
 End Coordinates:48.2822 deg N, -9.6416 deg E
 Max Depth: 19.6417 meters
 Minimum Altitude Recorded: **1.3473m**
 Start Battery Voltage: 57.726V End Battery Voltage: 57.59V
 Start State of Charge: 85.5% End State of Charge: 85.5%

6.1.13.5. Autosub5 Mission AS5M126 summary

This mission was aimed at collecting bathymetry data, but was aborted early due to a technical fault.

Details

Mission Identifier:M126
 Start Time:28-Sep-2025 14:11:50
 Time Elapsed:4.0811 Hrs
 Distance Traveled:2.0172 Km
 Start Coordinates:48.2808 deg N, -9.632 deg E
 End Coordinates:NaN deg N, NaN deg E
 Max Depth:264.2497 meters
 Minimum Altitude Recorded:71.4245m
 Start Battery Voltage: 57.488V End Battery Voltage: 58.076V
 Start State of Charge: 85% End State of Charge: 85%

Mission Narrative

After downloading the engineering logs of mission AS5M125 and checking that the AUV could fly levelly after the ballast change, the OCS configuration file was changed to set no_contact_timer = 28 hr via WiFi. The AUV was then sent onto the MBES and camera survey of Dangaard Interfluve ([plan 31-7](#)) via WiFi whilst she was still in the water.

For training, the AUV Ops team tracked the AUV during diving via acoustics by having the ship lowering the Ranger2 mast (ship speed limited to 4 knots). Unfortunately, during the tracking it became obvious

that AS5 aborted before reaching 270 m of depth. The root cause was over_max_depth = 260 m in the AUV's configuration file (when in fact water up to 600 m deep was expected on the site).

The AUV surfaced in safety abort behaviour, and the team recovered AS5 successfully in mild waves (significant wave height < 2 m). On deck, the team prepared quickly for a second launch from 20:00 onwards depending on the end of the other planned activities (glider recovery and CTD sampling).

The following issues were experienced on this short mission:

- Mistake by the engineering manager during training in checking the “over_max_depth” parameters,
- Oversight of the error on C2 where commands in the mission script are no longer accepted after an OCS update that results in a change in the hash – if the AUV had not aborted, the sensors would not have been switched on or off during the mission (Norbit switched on & mode set by the pilot on the surface),
- Problem with the acoustic message interchange with the Ranger2 and C2 (<https://jira.noc.ac.uk/browse/NOCSUB2KUI-909>).

System specifications

Wings	-486 mm from the centre of pressure (aft position) 3° tail-tip up
Estimated Battery Use	0.42 kWh

Navigation

Navigation Solution	Localiser
USBL Telemetry	Telemetry aiding during the first dive

OCS Critical Parameters Spec

Parameter	Value
No_contact_timer	2 h
Safety_min_alt	3 m
Safety_max_depth	6,000 m
Iridium_period	5 mins

Safety & Monitor Parameters Spec

Parameter	Value
Over_max_depth	260 m – error: in fact, the depth at the dive site > 330 m
Under_min_alt	1 m
Safety_max_depth	6,000 m
Iridium_period	5 mins
Stuck-trying-to-a/descend depth threshold	3 m

Obstacle Avoidance Parameters Spec

Avoidance strategy	Not required
ISA 500 quality threshold	Not required
Look-ahead normalization threshold	Not required
Demands transition filter coefficients	Not required

Payload Settings

Device	Required (Y/N)	Mode
9+ CTD	Optional	On
AESA Camera	Yes	N/A
Norbit Bathy	Yes	Bathy_400kHz_Swath140_Range170
Edgetech 2205	No	N/A
Wetlabs BBRT	Optional	N/A

ADCP/DVL Settings

Setting	Requested Values
Bins	6
Depth cell width (cm)	433
Pings to average	4
Transducer depth (cm)	0
Depth range (m)	25.98
Velocity (m/s)	2.79
Velocity error (cm/s)	0.19

6.1.13.6. Autosub5 Mission AS5M127 summary

AS5M127 completed the plan that was attempted in AS5M126.

Details

Mission Identifier:M127

Start Time:28-Sep-2025 18:17:12

Time Elapsed:25.3278 Hrs

Distance Traveled:75.3428 Km

Start Coordinates: NaN deg N, NaN deg E

End Coordinates:48.2814 deg N, -9.6342 deg E

Max Depth:485.2537 meters

Minimum Altitude Recorded:**0.81087m**

Start Battery Voltage: 58.076V End Battery Voltage: 51.756V

Start State of Charge: 85% End State of Charge: 46%

Note that the mission was actually sent at 22:07, with the AUV diving at 22:19 on 28/09/2025. The actual minimum altitude recorded was 18.5 m due to a mistake in the planning of the last track, whose minimum altitude was set at 20 m instead of 50 m (otherwise the minimum altitude reached was 45.8 m).

The actual start location from the mission plan was 48.2923102 latitude and -9.6480717 longitude.

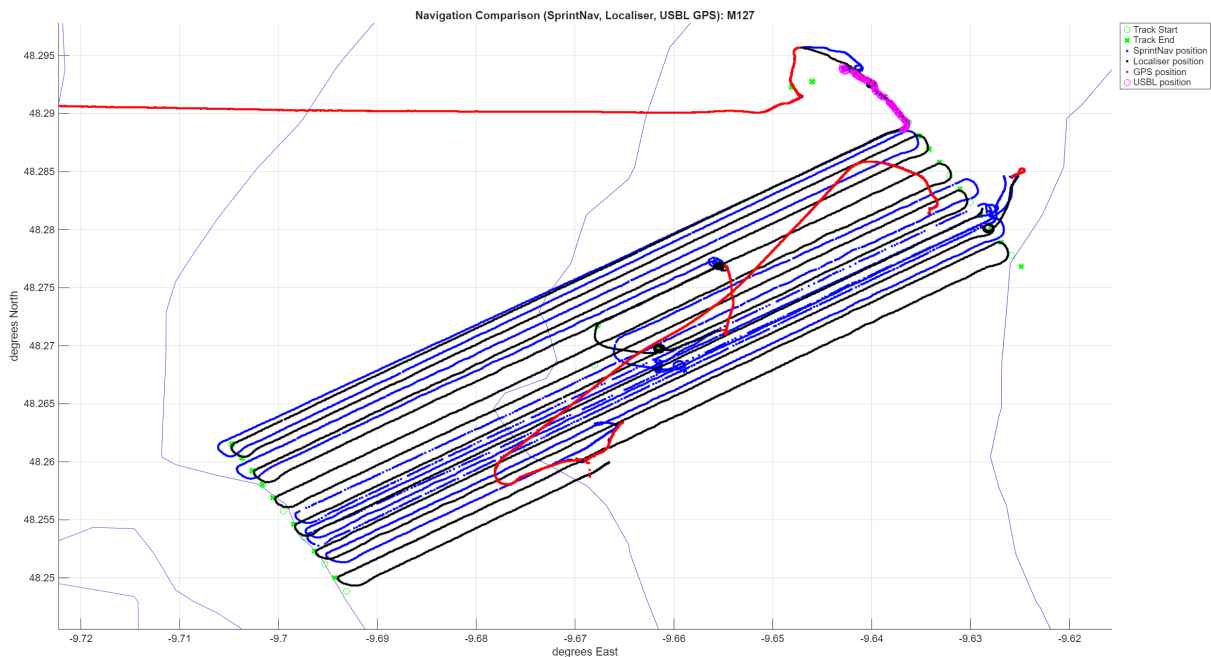


Fig. 6.10. Track plot of the different navigation solutions for AS5M127

Mission narrative

The launch was undertaken at night successfully. The MBES mode was set on the surface manually because the first loitering of 5 mins was not long enough for the system to fully turn on.

After launch, the AUV Ops team trained with tracking the AUV with acoustics by using the Ranger2 pole in the water (ship speed limited to 4 knots). During this phase, the AUV's localisation was aided via USBL telemetry.

The AUV resurfaced towards the end of the fourth MBES survey track at approximately 04:00 with a safety surface. After checking that the system was OK via Iridium and that the MBES was still on, the plausible event causing the safety surface was assumed a stuck-trying-to-descend due to currents. Hence, the MBES survey was split into two additional parts (there is a limit of 7 behaviours that can be sent via Iridium), with the second part being sent via Iridium (email) immediately. After observing the AUV being on the first new mission, the third part of the MBES survey was sent via email to the Iridium queue.

The AUV resurfaced at 12:00, received the new mission via Iridium and autonomously dived for the new mission.

From 17:00, AUV Ops started tracking the AUV's position via the Ranger2 pole which was lowered in the water once the ship reached the mission's end point.

The AUV resurfaced at 17:30 in an unexpected position (towards 1/3 of the last leg). By reinspecting the mission plan, the last leg was given an incorrect minimum altitude of 20 m and a timeout of 3,600 s meaning that the AUV reached the timeout. The ship travelled approximately 2 km to start the recovery procedure in daylight. The AUV was difficult to spot and initially seemed deeper in the water due to the waves. The waves' spread also meant that the AUV's direction kept changing between two headings.

The AUV was successfully recovered on the deck at 18:52.

After connecting the charging cables to the charger, it was clear that there was a problem with two unequalised cells in module 4 of battery box 2 in string 2 (difference > 100 mA with respect to the other cells), and two cells in module 4 of battery box 1 in string 2 also started to show equalization problems.

Scientific data review

Due to the two surfacing events, the AUV ended up having a large error when diving which resulted in a gap in the MBES survey. However, the quality of the MBES bathymetric map is extremely high, showing interesting lines potentially caused by the current at the site.

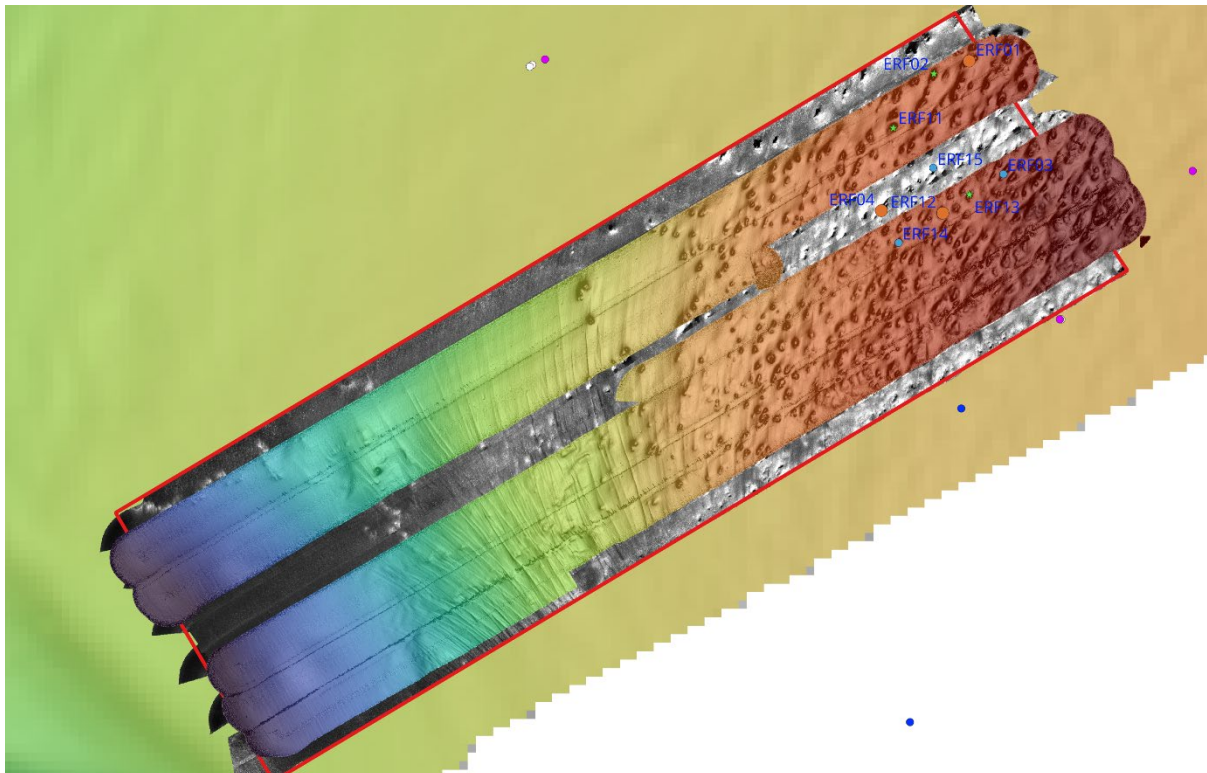


Fig. 6.11. Initial MBES bathymetry map based on the data collected during AS5M127. Note the gap in the data caused by the different parts of the mission and the drift of the vehicle during ascent and descent.

System specifications

Wings	-486 mm from the centre of pressure (aft position) 3° tail-tip up
Estimated Battery Use	14.2 kWh

Navigation

Navigation Solution	Localiser
USBL Telemetry	Telemetry aiding during the first dive

OCS Critical Parameters Spec

Parameter	Value
No_contact_timer	28 h

Safety_min_alt	3 m
Safety_max_depth	6,000 m
Iridium_period	5 mins

Safety & Monitor Parameters Spec

Parameter	Value
Over_max_depth	5,000 m
Under_min_alt	1 m
Safety_max_depth	6,000 m
Iridium_period	5 mins
Stuck-trying-to-a/descend depth threshold	3 m

Obstacle Avoidance Parameters Spec

Avoidance strategy	Not required
ISA 500 quality threshold	Not required
Look-ahead normalization threshold	Not required
Demands transition filter coefficients	Not required

Payload Settings

Device	Required (Y/N)	Mode
9+ CTD	Optional	Switched on on the surface, but turned off during mission
AESA Camera	Yes	N/A
Norbit Bathy	Yes	Bathy_400kHz_Swath140_Range170
Edgetech 2205	No	N/A
Wetlabs BBRT	Optional	N/A

ADCP/DVL Settings

Setting	Requested Values
Bins	6
Depth cell width (cm)	433
Pings to average	4
Transducer depth (cm)	0
Depth range (m)	25.98
Velocity (m/s)	2.79
Velocity error (cm/s)	0.19

6.1.13.7. Autosub5 Mission AS5M128 summary

Details

Mission Identifier: M128
 Start Time:30-Sep-2025 16:15:30
 Time Elapsed:3.2556 Hrs

Distance Traveled: 10.9264 Km
 Start Coordinates: 48.2886 deg N, -9.6382 deg E
 End Coordinates: 48.2695 deg N, -9.6887 deg E
 Max Depth: 497.6188 meters
 Minimum Altitude Recorded: 0.73386m
 Start Battery Voltage: 57.734V End Battery Voltage: 56.804V
 Start State of Charge: 82.5% End State of Charge: 80%

The actual minimum altitude during the mission was 14.6 m (removing time at the surface, where spurious data is given by the wave action).

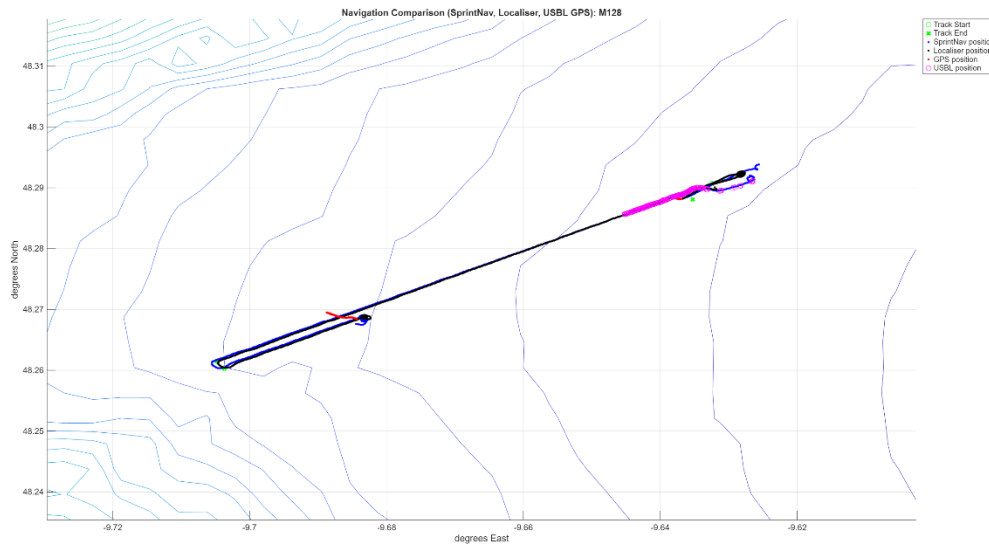


Fig. 6.12. Track plot of AS5M128

Mission narrative

In the morning, the AUV's ballasting was further corrected by moving 2 kg from the forward port lower to the aft port lower ballast points (effective change of 72.4 Nm pitch moment bow up; drawing: [AUTOSUB5_DY200\(E\).pdf](#)).

The AUV was sent on the SSS & SBP survey of Dangaard Interfluve ([plan 41-8](#)) after raising the minimum speed through water to 1.1 m/s (speed over ground 1.2 m/s and maximum speed through water 1.4 m/s).

Before disconnecting the batteries' charging cable, the charger page was inspected (192.168.10.200) to check the status of the modules on string 2. Two cells on battery box 2 on the string still presented a charge difference > 100 mA, indicating that the equalization of the battery management system (BMS) is not working as expected. However, the battery string was still deemed safe for the remainder of the short cruise.

After completing the launch checklist, the AUV was sent on the mission, diving at 16:15. As part of the training, AS5 was tracked via acoustics until 17:30 (the spiral dive was clear from the tracking), and its positioning was aided via USBL telemetry until the start point of the first SSS track leg.

Autosub 5 safety surfaced at 19:00. As the ship was still nearby, the decision was taken to approach her and resend her on her mission via WiFi and to aid her positioning with acoustics to avoid the positioning problems experienced with the second and third part of AS5M127.

After downloading the engineering logs, she was sent on the second part of the mission, but she was unable to dive, and safety surfaced again. After increasing the speed target and limits within the

mission script and raising the AUV's depth change threshold to trigger STTD/A from 3 m to 5 m, the new mission was resent. However, the AUV was still unable to dive. The changes were reversed and the thrusters toggled, but it became clear that AS5 was stuck in the water, with the thrusters drawing current but not rotating. At this point, the most plausible hypothesis was a net or line getting stuck in her propellers, but with a net buoyancy < 23 kg, as the AUV was floating on the surface. The abort weight was dropped for precaution at 21:30. Upon getting closer to the AUV with the search lights (< 250 m), AS5's recovery lines could be seen entangled into the aft of the vehicle at 22:07. The decision was made to attempt an emergency recovery in daylight.

After dawn and an emergency recovery toolbox talk, RRS Discovery approached AS5 slowly in a swell with a significant wave height < 2.5 m. From the bridge, it was clear that the forward rope box had become loose, and the line was out and entangled on the AUV's starboard side, with a loop around the aft antenna mast. The aft rope box looked intact.



Fig. 6.13. Autosub 5 with its forward recovery line wrapped around the aft antenna mast.

By using ALR's long Templeton pole, the line was grappled and the two recovery lines brought aboard for a standard recovery with the LARS. During the recovery, the aft Xeos beacon became dislodged from its position, but was still hanging from the cable and the antenna mast was undamaged. The forward line was damaged, presenting bumps and stretched parts, but the recovery was smooth and successful, although extra time was needed in removing the forward line from the LARS.

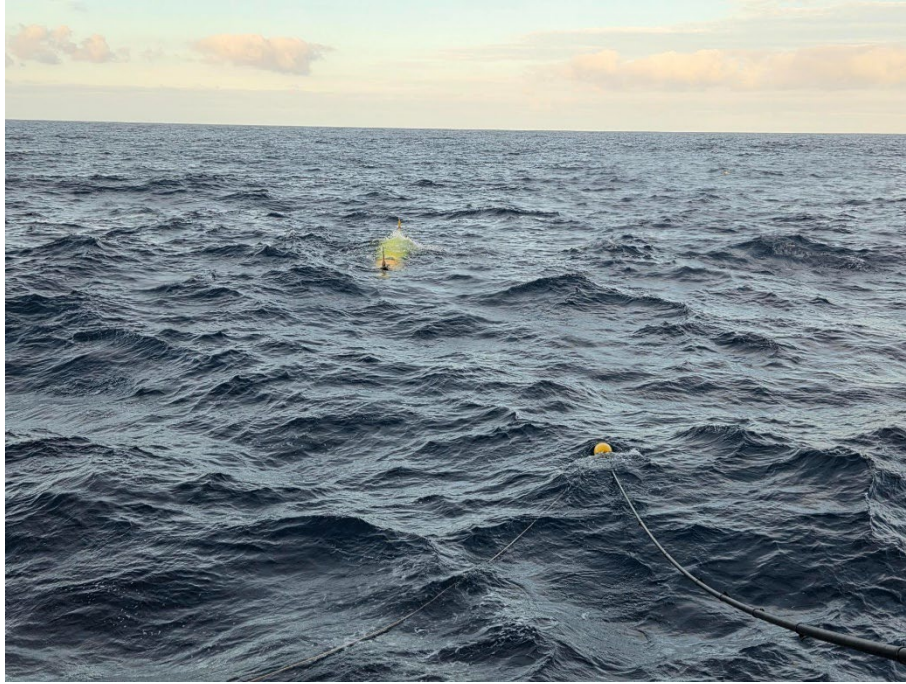


Fig. 6.14. Autosub 5 near RRS Discovery being grappled with the Templeton pole.

After inspection of AS5 on deck, the only damaged items that needed replacing were the forward line, the forward rope box cover and the cable for the aft Xeos beacon.

For future missions, a revised design was implemented for the recovery line rope boxes, which uses small snap ties, and which was improved throughout the cruise.

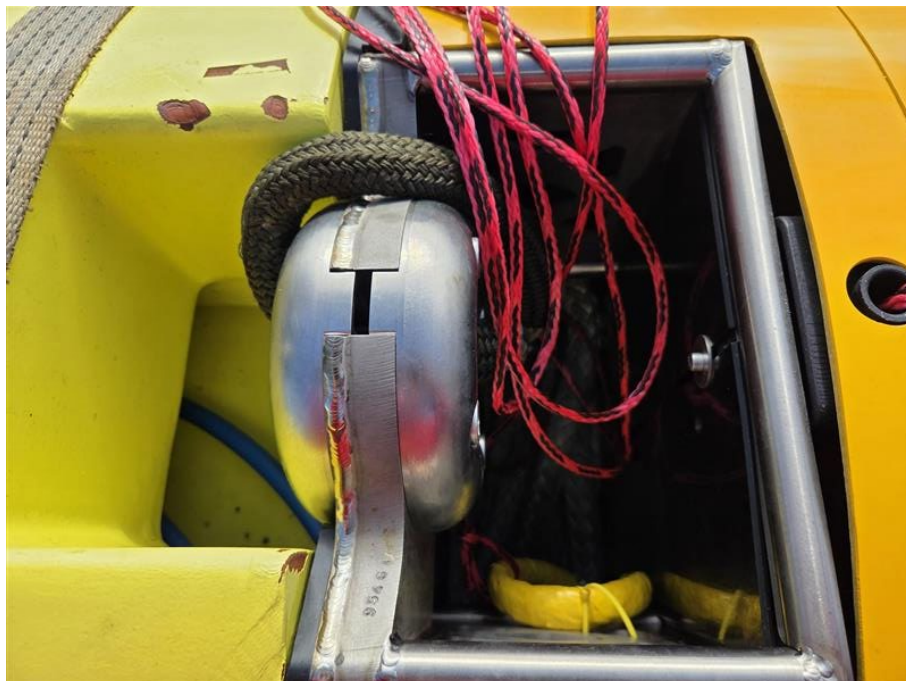


Fig. 6.15. Preliminary new design for the rope boxes with small yellow snap ties.

Scientific data review

The SSS and SBP data from the partial survey was analysed by the scientific team and the SBP data found to be of particular interest, showing unknown features in the site's underground terrain's composition.

System specifications

Wings	-486 mm from the centre of pressure (aft position) 3° tail-tip up
Estimated Battery Use	2.1 kWh

Navigation

Navigation Solution	Localiser
USBL Telemetry	Telemetry aiding during the first dive

OCS Critical Parameters Spec

Parameter	Value
No_contact_timer	28 h
Safety_min_alt	3 m
Safety_max_depth	6,000 m
Iridium_period	5 mins

Safety & Monitor Parameters Spec

Parameter	Value
Over_max_depth	5,000 m
Under_min_alt	1 m
Safety_max_depth	6,000 m
Iridium_period	5 mins
Stuck-trying-to-a/descend depth threshold	3 m

Obstacle Avoidance Parameters Spec

Avoidance strategy	Not required
ISA 500 quality threshold	Not required
Look-ahead normalization threshold	Not required
Demands transition filter coefficients	Not required

Payload Settings

Device	Required (Y/N)	Mode
9+ CTD	Optional	On
AESA Camera	Yes	N/A
Norbit Bathy	No	N/A

Edgetech 2205	Yes	SSH_410_SBP_2_13_16ms_SS8E
Wetlabs BBRT	Optional	On

ADCP/DVL Settings

Setting	Requested Values
Bins	6
Depth cell width (cm)	433
Pings to average	4
Transducer depth (cm)	0
Depth range (m)	25.98
Velocity (m/s)	2.79
Velocity error (cm/s)	0.19

6.1.13.8. Autosub5 Mission AS5M129 summary

Details

Mission Identifier:M129
 Start Time:06-Oct-2025 08:26:01
 Time Elapsed:7.3936 Hrs
 Distance Traveled:31.0495 Km
 Start Coordinates:50.413 deg N, -7.7491 deg E
 End Coordinates:50.4087 deg N, -7.6946 deg E
 Max Depth:106.8656 meters
 Minimum Altitude Recorded:4.2767m
 Start Battery voltage: 57.754V End Battery Voltage: 55.012V
 Start State of Charge: 78% End State of Charge: 68%

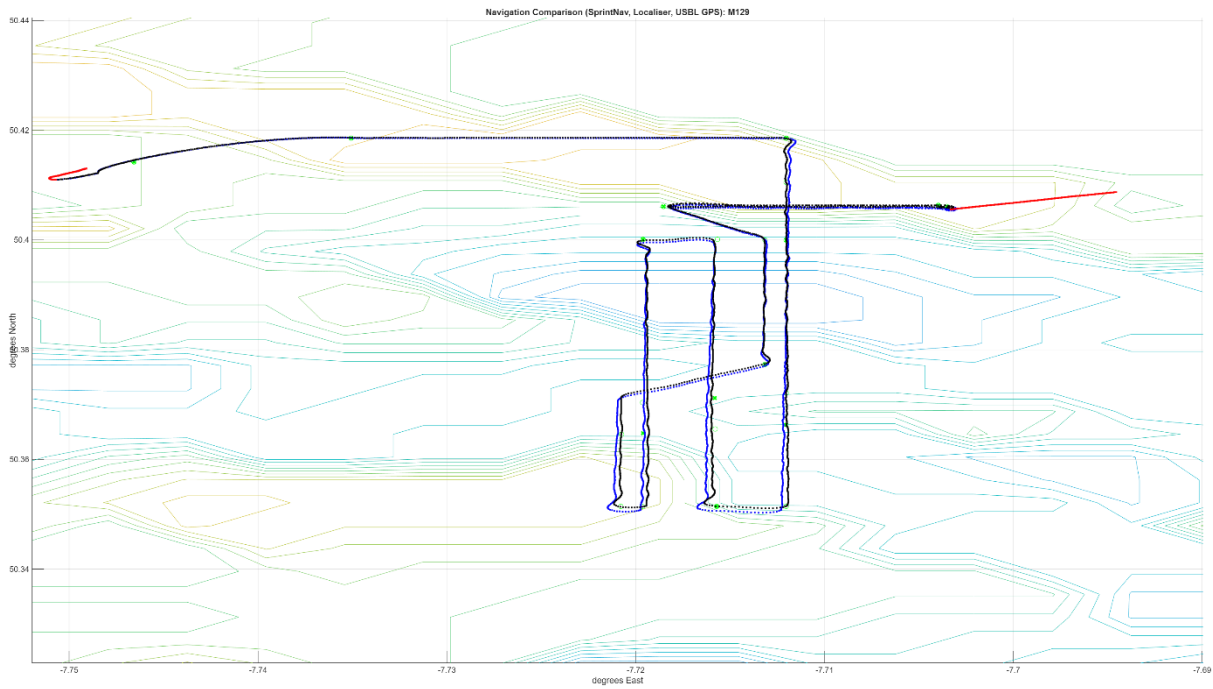


Fig. 6.16. Track plot of AS5M129 at Haig Fras

Mission narrative

Prior to the mission, the following maintenance tasks were undertaken on 04/10/2025:

1. Replacing the cable connecting the camera logger to the forward payload tube after detecting ground faults with Megger testing,
2. Replacing the cable connecting the starboard lower actuator (actuator #2) to the power tube after detecting ground faults with Megger testing (and observing higher corrosion levels on the anodes for the top port and starboard bottom actuators),
3. Replacing the WiFi and Iridium antennas with the latest Trident antennas with DGO connectors,
4. Flushing the thrusters' bearings after finding the starboard thruster had seized up on 04/10/2025,
5. Updating the code on the charger to be able to manually charge each module individually to reduce the equalisation problems in the battery boxes in string 2,
6. Updating the trigger manager profile (configuration) removing the FLS and correcting the ISA 500 triggers.

Preparations for the launch of the repeat camera survey at Haig Fras started at 05:30 am, but launch was delayed until after 08:00 due to two errors:

1. AS5 stuck in safety surface due to DVL down, as the Syrinx DVL was not publishing any data: the problem was caused by the baseline trigger for the DVL being removed by accident from the new trigger manager configuration file,
2. Camera time not synchronizing with the AUV's ROS time (stuck at 27/05/2025). The time was synchronized manually on deck during the pre-launch checks and once the AUV was in the water before being sent onto the mission.

Autosub 5 was successfully launched in a moderate swell, with the Haig Fras camera survey mission ([plan 48-8](#)) sent at 08:25. The AUV safety-surfaced at 15:32 during the slow-speed part of the speed test at the end of the survey, as it lost control authority in the strong currents. Autosub 5 was safely recovered on deck at 16:30 after a difficult approach in waves. When the AUV was grappled, the recovery lines came out from the rope boxes with difficulty and great force due to the strength of the snap-ties. Hence, the design was revised before the next deployment, with weaker cable ties being used.

Scientific data review

Although approximately 20,000 images were taken, they are expected to be unusable due to the altitude of the vehicle throughout the mission (> 5 m).

System specifications

Wings	-486 mm from the centre of pressure (aft position) 3° tail-tip up
Estimated Battery Use	2.1 kWh

Navigation

Navigation Solution	Localiser
USBL Telemetry	Telemetry aiding during the first dive

OCS Critical Parameters Spec

Parameter	Value
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No_contact_timer	28 h
Safety_min_alt	3 m
Safety_max_depth	6,000 m
Iridium_period	5 mins

Safety & Monitor Parameters Spec

Parameter	Value
Over_max_depth	5,000 m
Under_min_alt	1 m
Safety_max_depth	6,000 m
Iridium_period	5 mins
Stuck-trying-to-a/descend depth threshold	5 m

Obstacle Avoidance Parameters Spec

Avoidance strategy	simple_down_checks
ISA 500 quality threshold	N/A
Look-ahead normalization threshold	N/A
Demands transition filter coefficients	N/A

Payload Settings

Device	Required (Y/N)	Mode
9+ CTD	Optional	On
AESA Camera	Yes	On
Norbit Bathy	No	N/A
Edgetech 2205	Yes	SSH_410_SBP_2_13_16ms_SS8E
Wetlabs BBRT	Optional	On

ADCP/DVL Settings

Setting	Requested Values
Bins	6
Depth cell width (cm)	433
Pings to average	4
Transducer depth (cm)	0
Depth range (m)	25.98
Velocity (m/s)	2.79
Velocity error (cm/s)	0.19

6.1.13.9. Autosub5 Missions AS5M130A-I summary

This was a series of test missions to finally get all the settings right for the ballasting. Based on the results of AS5M129 where Autosub 5 had a depth offset of 2 m during the camera survey, it was decided to run a series of engineering tests to try to empirically update the coefficients of the depth and pitch controllers before a full analysis over the winter.

Details

M130A

Mission Identifier:M130A
Start Time:07-Oct-2025 08:45:31
Time Elapsed:0.23806 Hrs
Distance Traveled:1.0657 Km
Start Coordinates:48.2961 deg N, -9.6284 deg E
End Coordinates:48.292 deg N, -9.6386 deg E
Max Depth:17.8829 meters
Minimum Altitude Recorded:919.4466m
Start Battery Voltage: 57.812V End Battery Voltage: 57.724V
Start State of Charge: 66.5% End State of Charge: 66.5%

M130B

Mission Identifier:M130B
Start Time:07-Oct-2025 09:12:35
Time Elapsed:0.51333 Hrs
Distance Traveled:1.0758 Km
Start Coordinates:48.2917 deg N, -9.6386 deg E
End Coordinates:48.2899 deg N, -9.622 deg E
Max Depth:18.3339 meters
Minimum Altitude Recorded:0.80435m
Start Battery Voltage: 57.656V End Battery Voltage: 57.574V
Start State of Charge: 66.5% End State of Charge: 66.5%

M130C

Mission Identifier:M130C
Start Time:07-Oct-2025 09:53:31
Time Elapsed:0.22528 Hrs
Distance Traveled:1.0545 Km
Start Coordinates:48.2894 deg N, -9.6211 deg E
End Coordinates:48.2976 deg N, -9.6223 deg E
Max Depth:19.2229 meters
Minimum Altitude Recorded:924.9726m
Start Battery Voltage: 57.52V End Battery Voltage: 57.474V
Start State of Charge: 66.5% End State of Charge: 66.5%

M130D

Mission Identifier:M130D
Start Time:07-Oct-2025 10:10:55
Time Elapsed:0.46472 Hrs
Distance Traveled:1.0787 Km
Start Coordinates:48.2963 deg N, -9.6201 deg E
End Coordinates:48.2833 deg N, -9.614 deg E
Max Depth:18.7811 meters
Minimum Altitude Recorded:1.0003m
Start Battery Voltage: 57.458V End Battery Voltage: 57.414V
Start State of Charge: 66.5% End State of Charge: 66.5%

M130E

Mission Identifier:M130E
Start Time:07-Oct-2025 10:45:22
Time Elapsed:0.21889 Hrs
Distance Traveled:1.042 Km
Start Coordinates:48.2823 deg N, -9.6138 deg E
End Coordinates:48.2907 deg N, -9.6163 deg E
Max Depth:19.7051 meters
Minimum Altitude Recorded:942.8236m
Start Battery Voltage: 57.372V End Battery Voltage: 57.342V
Start State of Charge: 66.5% End State of Charge: 66.5%

M130F

Mission Identifier:M130F
Start Time:07-Oct-2025 11:04:13
Time Elapsed:0.24861 Hrs
Distance Traveled:1.0618 Km
Start Coordinates:48.2889 deg N, -9.6161 deg E
End Coordinates:48.2784 deg N, -9.6126 deg E
Max Depth:20.6987 meters
Minimum Altitude Recorded:866.3161m
Start Battery Voltage: 57.326V End Battery Voltage: 57.312V
Start State of Charge: 66.5% End State of Charge: 66.5%

M130G

Mission Identifier:M130G
Start Time:07-Oct-2025 11:37:11
Time Elapsed:0.61806 Hrs
Distance Traveled:2.6885 Km
Start Coordinates:48.2758 deg N, -9.6123 deg E
End Coordinates:48.2935 deg N, -9.6242 deg E
Max Depth:82.1339 meters
Minimum Altitude Recorded:839.7382m
Start Battery Voltage: 57.274V End Battery Voltage: 57.22V
Start State of Charge: 66.5% End State of Charge: 66.5%

M130H

Mission Identifier:M130H
Start Time:07-Oct-2025 12:34:17
Time Elapsed:0.95667 Hrs
Distance Traveled:2.703 Km
Start Coordinates:48.2919 deg N, -9.6288 deg E
End Coordinates:48.268 deg N, -9.6265 deg E
Max Depth:82.4922 meters
Minimum Altitude Recorded:864.5857m
Start Battery Voltage: 57.18V End Battery Voltage: 57.088V
Start State of Charge: 66.5% End State of Charge: 66.5%

M130I

Mission Identifier:M130I
Start Time:07-Oct-2025 13:56:04
Time Elapsed:0.69667 Hrs
Distance Traveled:1.4434 Km
Start Coordinates:48.2684 deg N, -9.6324 deg E
End Coordinates:48.2855 deg N, -9.6475 deg E

Max Depth:50.6888 meters
Minimum Altitude Recorded:948.5096m
Start Battery Voltage: 57.026V End Battery Voltage: 56.926V
Start State of Charge: 66.5% End State of Charge: 66.5%

6.1.13.10. Autosub5 Mission AS5M131 summary

Details

Mission Identifier:M131
Start Time:07-Oct-2025 15:06:12
Time Elapsed:22.1403 Hrs
Distance Traveled:100.6713 Km
Start Coordinates:48.2905 deg N, -9.6555 deg E
End Coordinates:48.2819 deg N, -9.6284 deg E
Max Depth:508.3396 meters
Minimum Altitude Recorded:4.3166m
Start Battery Voltage: 56.848V End Battery Voltage: 47.87V
Start State of Charge: 66.5% End State of Charge: 9.5%

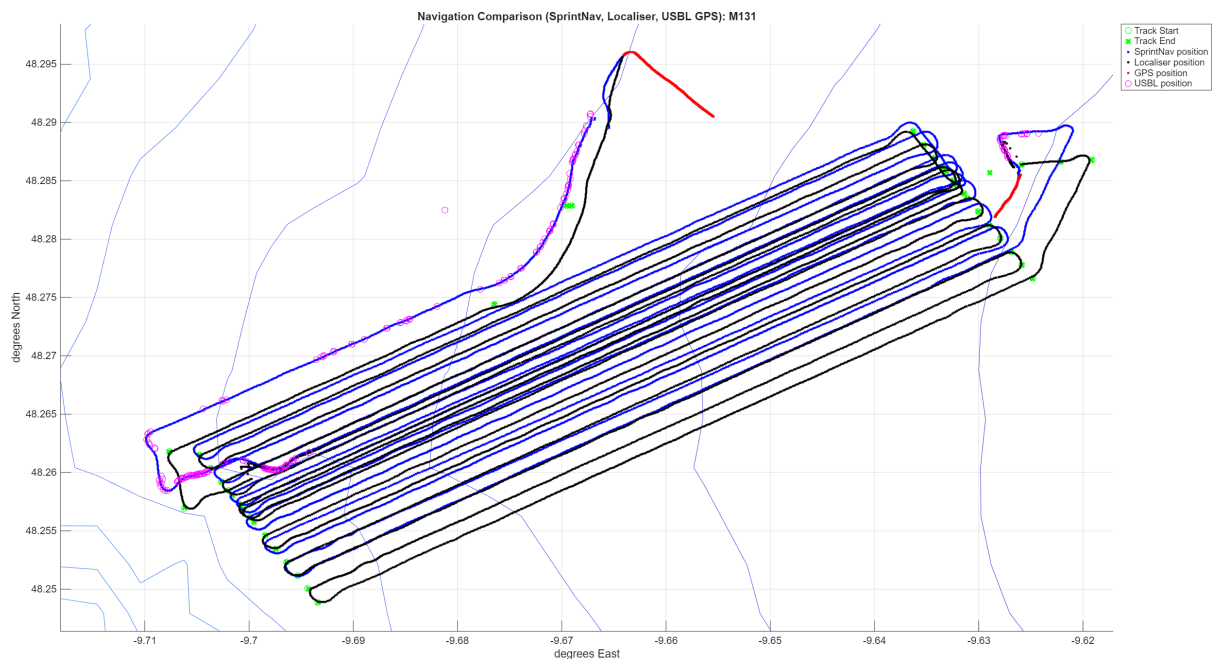


Fig. 6.17. Track plot of AS5M131 on the Dangeard interfluve

Mission narrative

The mission was launched with AS5 still in the water after surfacing from M130I.

The new mission, involving a very long MBES, SSS & SBP and camera survey of Dangeard Interfluve ([plan 59-10](#)), was then sent via WiFi at 15:00 after updating the start position to reflect the updated position of the AUV due to the strong currents. The long loiters on the surface were not skipped because of attempts to sync the time of the camera logger with the AUV before the dive, which happened at 15:38.

After the dive, the AUV was tracked via acoustics until 17:10. RRS Discovery rendezvoused with AS5 towards the start of the first MBES survey leg to aid its positioning with USBL telemetry after detecting a large positioning error due to the current during the dive to approximately 450 m depth.

RRS Discovery went back to the survey area on the next day (08/10/2025) from 12:00 to track AS5. Upon approaching the start of the camera survey, it was possible to track AS5 transitioning from the SSS to the camera surveys. At the time, AS5 had a significant positioning error so USBL telemetry was used for position aiding. Just after the acoustic communications AS5 was observed to ascend fast, hinting an abort. Upon recovery on the surface, it became clear that the mission had ended due to the AUV hitting the under_min_threshold safety check, as it was running low on energy.

Autosub 5 was recovered safely on the deck at 13:56, 00:40 after the end of the recovery checklist within the control container.

Scientific data review

The MBES survey at Dangaard Interfluve was successfully completed, filling the gap from AS5M127. However, one section of the survey was initially missing from the data provided to the science party. An investigation is underway to avoid this problem in the future.

The SSS and SBP surveys were also completed successfully although the navigation error by the end of the survey meant that the AUV was actually further Northwest from the target position. However, as an additional leg had been added to the survey, the full target area was covered.

The camera survey had only started for 10 minutes and the AUV was still at 4.5 m from the seafloor by the time the AUV ran out of energy and aborted.

System specifications

Wings	-486 mm from the centre of pressure (aft position) 3° tail-tip up
Estimated Battery Use	2.1 kWh

Navigation

Navigation Solution	Localiser
USBL Telemetry	Telemetry aiding during the first dive

OCS Critical Parameters Spec

Parameter	Value
No_contact_timer	31 h
Safety_min_alt	3 m
Safety_max_depth	6,000 m
Iridium_period	5 mins

Safety & Monitor Parameters Spec

Parameter	Value
Over_max_depth	5,000 m
Under_min_alt	1 m
Safety_max_depth	6,000 m

Iridium_period	5 mins
Stuck-trying-to-a/descend depth threshold	5 m

Obstacle Avoidance Parameters Spec

Avoidance strategy	simple_lookahead – although altimeter only switched on shortly before end of mission
ISA 500 quality threshold	0.3
Look-ahead normalization threshold	30 m – intentionally higher than how far we were expecting to see things (we did not want to normalise any obstacle and be as aggressive as we could since we did not know if the vehicle was going to make it)
Demands transition filter coefficients	0 – filter not enabled

Payload Settings

Device	Required (Y/N)	Mode
9+ CTD	Optional	On
AESA Camera	Yes	On
Norbit Bathy	Yes	Bathy_400kHz_Swath140_Range170
Edgetech 2205	Yes	SSH_410_SBP_2_13_16ms_SS8E
Wetlabs BBRT	Optional	On

ADCP/DVL Settings

Setting	Requested Values
Bins	6
Depth cell width (cm)	433
Pings to average	4
Transducer depth (cm)	0
Depth range (m)	25.98
Velocity (m/s)	2.79
Velocity error (cm/s)	0.19

6.1.13.11. Autosub5 Mission AS5M132 summary

Details

Mission Identifier:M132

Start Time:09-Oct-2025 08:51:53

Time Elapsed:5.3419 Hrs

Distance Traveled:23.766 Km

Start Coordinates:48.2881 deg N, -9.6032 deg E

End Coordinates:48.2805 deg N, -9.6267 deg E

Max Depth:484.798 meters

Minimum Altitude Recorded:0.81843m

Start Battery Voltage: 57.59V End Battery Voltage: 55.428V

Start State of Charge: 79% End State of Charge: 71%

The minimum actual altitude recorded during the dive (i.e., removing wave effects) was 1.75 m.

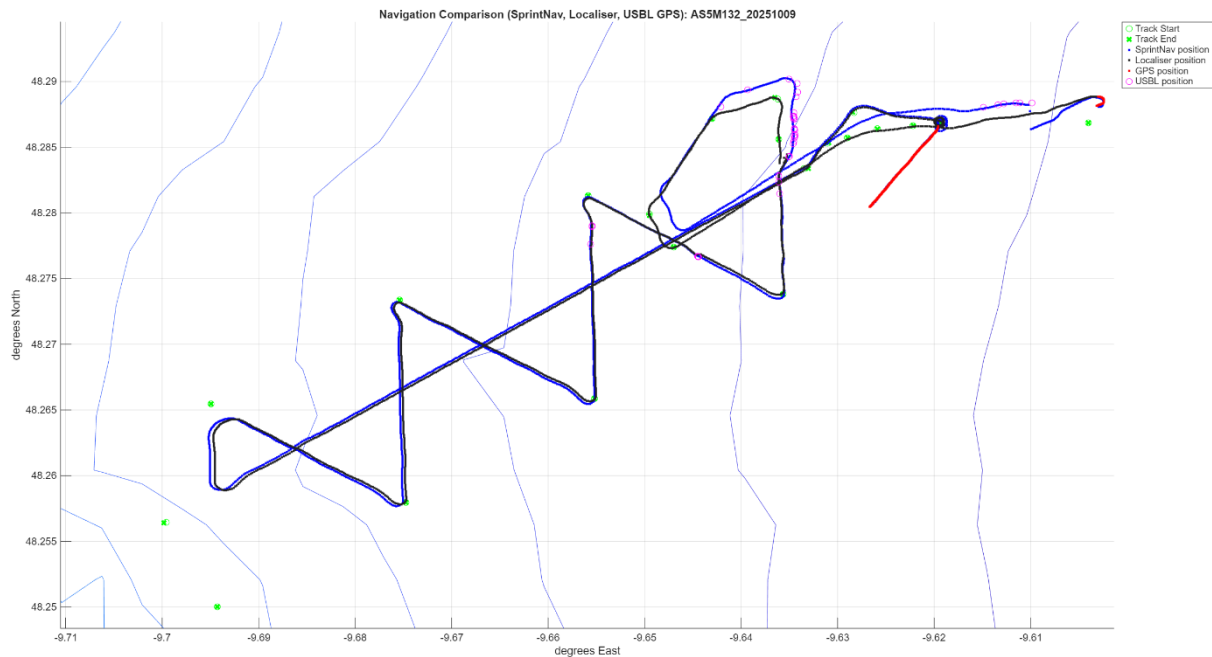


Fig. 6.18. Track plot of Mission AS5M132 on the Dangeard interfluve

Mission narrative

During the pre-launch checklist for AS5M132:

1. The Edgetech SSS and SBP did not start up correctly. The device status topic was too slow and was not updating with real data. The Edgetech got stuck in preparing to be off. The team used the Ethernet client to manually turn off the Edgetech, and then restarted the OCS. At the time, the data download cable was connected.
2. The startup log shows that the Avtrak comms manager failed.
3. The nocs_ initialiser process died.
4. There were communication issues via WiFi. The data processing PC lost ssh terminal with AS5 over .10 ethernet, whereas the laptops were still able to connect to sub over WiFi. Additionally, C2 stopped seeing status updates over WiFi.

Despite these challenges, all pre-launch checks were completed and AS5 was successfully deployed at 08:49, with the mission sent at 08:54. The team checked that the camera was correctly triggering and that the Edgetech was pinging before sending a skip command to start the dive at 08:58.

The team followed AS5 via acoustics through the Ranger 2 pole and trained with aiding positioning via USBL telemetry. Unfortunately, AS5 was faster than the ship due to extra caution in following AS5 on the mini-mounds terrain. Hence, the position aiding could be achieved only after the first loop on the track.

The team tried to finish the mission early by first sending skip commands towards the end of the downhill legs, which were accepted, and then by sending safety abort commands, which were never received due to the AUV range from the ship. Hence, the team spent the remainder of the mission tracking AS5 until its surfacing at 13:42.

Recovery was difficult because of the weather conditions, with moderate wind perpendicular to small waves. RRS Discovery was positioned facing the wind, but this meant that AS5 was facing the ship perpendicularly. Hence, grappling the AUV proved to be difficult and took many efforts over 45 mins, with the crew twice hooking on the fixed planes and once entangling two lines on the sternplanes. After the AUV was finally grappled and taken to the stern quarter, the hammerlock on the aft recovery line seized in one direction. Hence, the line was secured to the LARS momentarily, while reapplying the hammerlock.

Autosub 5 was finally recovered on the deck at 15:17, and inspected for damage, with none present. Afterwards, AUV Ops moved quickly through starting the preparations for the next launch.

Scientific data review

Almost 16,000 images were collected during the low-altitude survey of Dangaard Interfluve, as well as the data from the Edgetech SSS and SBP. The AUV passed close to some of the artificial reefs during the survey.

System specifications

Wings	-486 mm from the centre of pressure (aft position) 3° tail-tip up
Estimated Battery Use	2.1 kWh

Navigation

Navigation Solution	Localiser
USBL Telemetry	Telemetry aiding during the first dive

OCS Critical Parameters Spec

Parameter	Value
No_contact_timer	31 h
Safety_min_alt	3 m
Safety_max_depth	6,000 m
Iridium_period	5 mins

Safety & Monitor Parameters Spec

Parameter	Value
Over_max_depth	5,000 m
Under_min_alt	1 m
Safety_max_depth	6,000 m
Iridium_period	5 mins
Stuck-trying-to-a/descend depth threshold	5 m

Obstacle Avoidance Parameters Spec

Avoidance strategy	simple_lookahead
ISA 500 quality threshold	0.3
Look-ahead normalization threshold	30 m – intentionally higher than how far we were expecting to see things (we did not want to normalise any obstacle and be as aggressive as we could since we did not know if the vehicle was going to make it)
Demands transition filter coefficients	0 – filter not enabled

Payload Settings

Device	Required (Y/N)	Mode
9+ CTD	Optional	On
AESA Camera	Yes	On
Norbit Bathy	No	N/A
Edgetech 2205	Yes	SSH_410_SBP_2_13_16ms_SS8E
Wetlabs BBRT	Optional	On

ADCP/DVL Settings

Setting	Requested Values
Bins	6
Depth cell width (cm)	433
Pings to average	4
Transducer depth (cm)	0
Depth range (m)	25.98
Velocity (m/s)	2.79
Velocity error (cm/s)	0.19

6.1.13.12. Autosub5 Mission AS5M133 summary

Details

Mission Identifier:M133

Start Time:09-Oct-2025 17:05:32

Time Elapsed:15.2819 Hrs

Distance Traveled:71.0688 Km

Start Coordinates:48.424 deg N, -9.6531 deg E

End Coordinates:48.3971 deg N, -9.7239 deg E

Max Depth:413.5517 meters

Minimum Altitude Recorded:2.109m

Start Battery Voltage: 56.376V End Battery Voltage: 50.288V

Start State of Charge: 78.5% End State of Charge: 29%

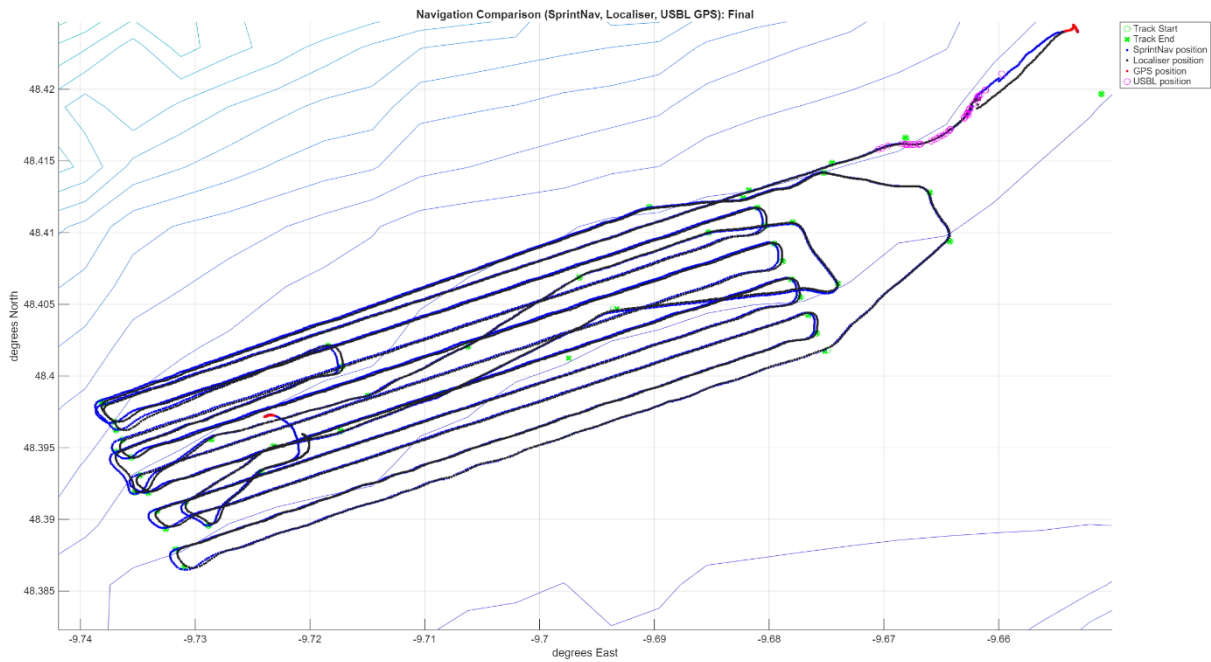


Fig. 6.19. Track plot of Mission AS5M133 over the Explorer interflue

Mission narrative

After quick but thorough pre-launch checks and a transfer from Dangeard to Explorer Interflue, AS5 was redeployed for an overnight mission, with the mission being sent at 17:05 and the AUV diving at 17:12.

Scientific data review

The Edgetech SSS and SBP were run both at 15 m altitude (for the full survey) and 3.5 m altitude (for the partial camera survey). The SprintNav navigation files are also available to postprocess the data (with position information) if needed.

The camera survey was interrupted to change the set-up of the AESA camera system.

Autosub 5 ran close to the artificial reefs during both surveys.

System specifications

Wings	-486 mm from the centre of pressure (aft position) 3° tail-tip up
Estimated Battery Use	2.1 kWh

Navigation

Navigation Solution	Localiser
USBL Telemetry	Telemetry aiding during the first dive

OCS Critical Parameters Spec

Parameter	Value
No_contact_timer	31 h
Safety_min_alt	3 m
Safety_max_depth	6,000 m
Iridium_period	5 mins

Safety & Monitor Parameters Spec

Parameter	Value
Over_max_depth	5,000 m
Under_min_alt	1 m
Safety_max_depth	6,000 m
Iridium_period	5 mins
Stuck-trying-to-a/descend depth threshold	5 m

Obstacle Avoidance Parameters Spec

Avoidance strategy	simple_lookahead
ISA 500 quality threshold	0.3
Look-ahead normalization threshold	30 m – intentionally higher than how far we were expecting to see things (we did not want to normalise any obstacle and be as aggressive as we could since we did not know if the vehicle was going to make it)
Demands transition filter coefficients	0 – filter not enabled

Payload Settings

Device	Required (Y/N)	Mode
9+ CTD	Optional	On
AESA Camera	Yes	On
Norbit Bathy	No	N/A
Edgetech 2205	Yes	SSH_410_SBP_2_13_16ms_SS8E
Wetlabs BBRT	Optional	On

ADCP/DVL Settings

Setting	Requested Values
Bins	6
Depth cell width (cm)	433
Pings to average	4
Transducer depth (cm)	0
Depth range (m)	25.98
Velocity (m/s)	2.79
Velocity error (cm/s)	0.19

6.1.13.13. Autosub5 Mission AS5M134 summary

Details

Mission Identifier:M134

Start Time:10-Oct-2025 08:49:24

Time Elapsed:2.3689 Hrs

Distance Traveled:9.7081 Km

Start Coordinates:48.3964 deg N, -9.7278 deg E

End Coordinates:48.3988 deg N, -9.7256 deg E

Max Depth:374.4186 meters

Minimum Altitude Recorded:**0.8932m**

Start Battery Voltage: 50.232V End Battery Voltage: 49.406V

Start State of Charge: 28.5% End State of Charge: 19.5%

The minimum actual altitude recorded during the dive (i.e., removing wave effects) was 2.67 m.

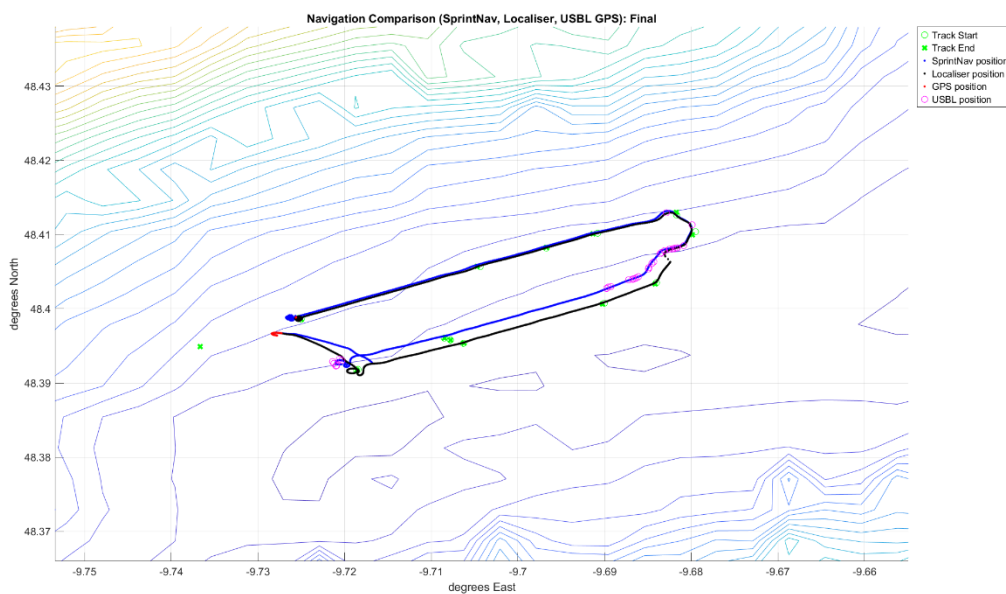


Fig. 6.20. Track plot of Mission AS5M134 over the Explorer interfluvium

Mission narrative

After inspecting the images from M132, the scientific team decided to try to change the settings for the AESA camera. Hence, RRS Discovery rendezvoused with AS5 and after tracking the AUV via acoustics, a stop command was sent at 08:05. After downloading a few random images and the engineering log files, checking the remaining state of charge at 32%, and updating the parameters on the surface (white balance ratio Red:Green from 4 to 2, fixing the time stamps and creating a new folder AS5M134), a new mission was sent via WiFi at 08:49 and the AUV diving at 08:58. As a glitch was identified with the Edgetech, it was decided to turn the sensor off for the next mission.

Scientific data review

The camera survey was undertaken successfully with the updated setting up to the system's timeout.

System specifications

Wings	-486 mm from the centre of pressure (aft position) 3° tail-tip up
Estimated Battery Use	2.1 kWh

Navigation

Navigation Solution	Localiser
USBL Telemetry	Telemetry aiding during the first dive

OCS Critical Parameters Spec

Parameter	Value
No_contact_timer	31 h
Safety_min_alt	3 m
Safety_max_depth	6,000 m
Iridium_period	5 mins

Safety & Monitor Parameters Spec

Parameter	Value
Over_max_depth	5,000 m
Under_min_alt	1 m
Safety_max_depth	6,000 m
Iridium_period	5 mins
Stuck-trying-to-a/descend depth threshold	5 m

Obstacle Avoidance Parameters Spec

Avoidance strategy	simple_lookahead
ISA 500 quality threshold	0.3
Look-ahead normalization threshold	30 m – intentionally higher than how far we were expecting to see things (we did not want to normalise any obstacle and be as aggressive as we could since we did not know if the vehicle was going to make it)
Demands transition filter coefficients	0 – filter not enabled

Payload Settings

Device	Required (Y/N)	Mode
9+ CTD	Optional	On
AESA Camera	Yes	On (white balance ratio Red:Green from 4 to 2)
Norbit Bathy	No	N/A
Edgetech 2205	Yes	N/A
Wetlabs BBRT	Optional	On

ADCP/DVL Settings

Setting	Requested Values
Bins	6
Depth cell width (cm)	433
Pings to average	4
Transducer depth (cm)	0
Depth range (m)	25.98
Velocity (m/s)	2.79
Velocity error (cm/s)	0.19

6.1.13.14. Autosub5 Mission AS5M135 summary Details

Mission Identifier:M135

Start Time:10-Oct-2025 11:44:56

Time Elapsed:2.9822 Hrs

Distance Traveled:10.7301 Km

Start Coordinates:48.397 deg N, -9.7275 deg E

End Coordinates:48.3938 deg N, -9.7251 deg E

Max Depth:358.8728 meters

Minimum Altitude Recorded:2.3205m

Start Battery Voltage: 49.274V End Battery Voltage: 47.906V

Start State of Charge: 18.5% End State of Charge: 10%

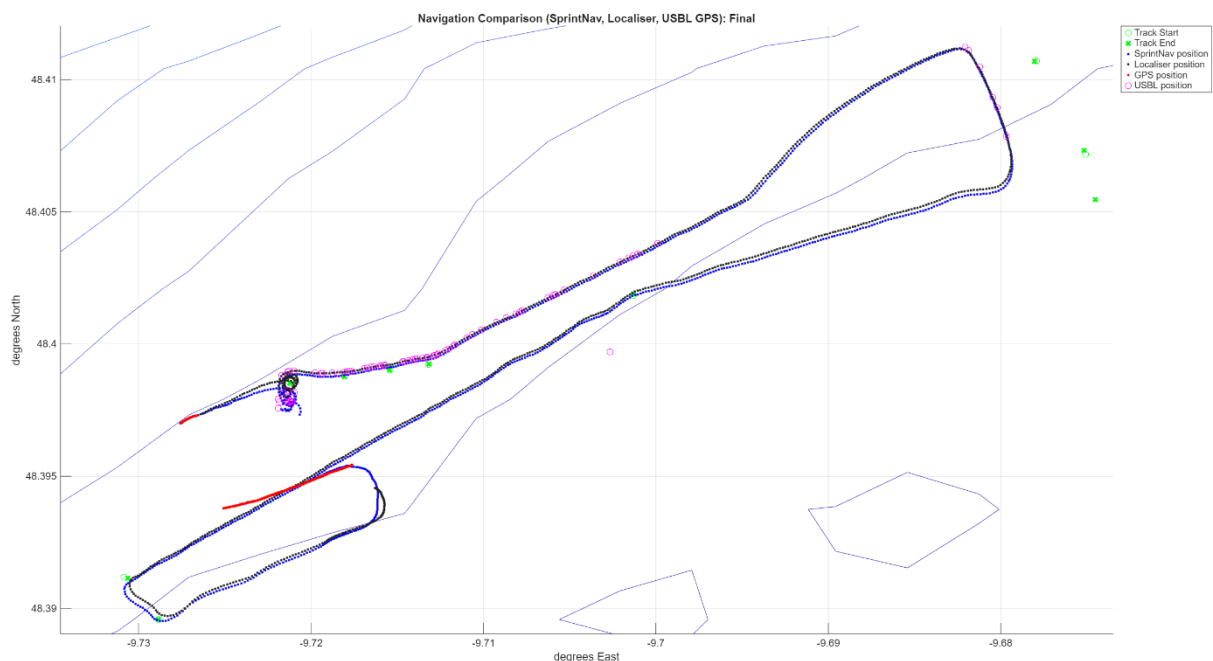


Fig. 6.21. Track plot of Mission AS5M135 over the Explorer interflue

Mission narrative

The AUV resurfaced at 11:05, with a remaining state of charge of 23%. The camera configuration was updated to a gain of 14 from 16. The new mission was resent at 11:32. Unfortunately, due to a problem with the Autosub radio on the bridge, the message stating that the mission had been sent was not

received. At the time, the ship was still between AS5 and the dive point to offer the best WiFi signal on the starboard side. Additionally, the orientation of the ship on C2 was broken so that the team in the control container could not see the relative position of the vehicles. The AUV started proceeding towards RRS Discovery, but a stop command was sent after a radio call from the bridge (that went through) and the AUV stopped 200 m short of the ship. At the same time, RRS Discovery took evasive manoeuvres and did a horseshoe turn around the AUV to position itself away from the dive point. As a lesson-learned outcome, AUV Ops will wait for positive confirmation that the message has been received before proceeding with sending missions in the future, as per the pre-launch checklist.

After resending the mission at 11:46, the AUV dived at 11:47.

RRS Discovery tracked AS5 via acoustics from 13:40 and sent a new stop command at 14:16 with the AUV safely next to RRS Discovery but travelling in the opposite direction. After catching up with the AUV on the starboard side to establish a WiFi connection, the AUV was ready for recovery from 14:38 but could only be recovered on the deck by 16:08 due to the difficulty in grappling it, as the ship was still placed perpendicularly to the AUV in wind and waves with different directions.

Upon recovery, AUV Ops realized that the Y connector for the aft non-toxic water supply was left on and it was still dangling below the AUV.

Scientific data review

The camera survey was undertaken successfully with the updated setting to the system's timeout.

Autosub 5 ran close to the artificial reefs during the survey.

System specifications

Wings	-486 mm from the centre of pressure (aft position) 3° tail-tip up
Estimated Battery Use	2.1 kWh

Navigation

Navigation Solution	Localiser
USBL Telemetry	Telemetry aiding during the first dive

OCS Critical Parameters Spec

Parameter	Value
No_contact_timer	31 h
Safety_min_alt	3 m
Safety_max_depth	6,000 m
Iridium_period	5 mins

Safety & Monitor Parameters Spec

Parameter	Value
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Over_max_depth	5,000 m
Under_min_alt	1 m
Safety_max_depth	6,000 m
Iridium_period	5 mins
Stuck-trying-to-a/descend depth threshold	5 m

Obstacle Avoidance Parameters Spec

Avoidance strategy	simple_lookahead
ISA 500 quality threshold	0.3
Look-ahead normalization threshold	30 m – intentionally higher than how far we were expecting to see things (we did not want to normalise any obstacle and be as aggressive as we could since we did not know if the vehicle was going to make it)
Demands transition filter coefficients	0 – filter not enabled

Payload Settings

Device	Required (Y/N)	Mode
9+ CTD	Optional	On
AESA Camera	Yes	On (gain of 14 from 16)
Norbit Bathy	No	N/A
Edgetech 2205	Yes	N/A
Wetlabs BBRT	Optional	On

ADCP/DVL Settings

Setting	Requested Values
Bins	6
Depth cell width (cm)	433
Pings to average	4
Transducer depth (cm)	0
Depth range (m)	25.98
Velocity (m/s)	2.79
Velocity error (cm/s)	0.19

6.2. SeaSpyder technical report

Operational Team: Joseph Young

6.2.1. SeaSpyder introduction

The STR SeaSpyder, provided by Ocean Ecology Ltd (OEL), is a modular, underwater Drop-Down Camera (DDC) system used during the DY200 cruise for High Definition (HD) video and stills capture at survey stations within The Canyons MCZ and Greater Haig Fras MCZ.

A STR SeaSpyder HDFO 3000 m system was mobilised to the RRS Discovery on the 20th of September 2025. The SeaSpyder was set up to obtain still images and video footage on separate cameras to increase quality of imagery obtained. This system contained a SeaSpectrum Mini IP Video Camera (Model: SP-MIP-4000T) as a robust 720 – 1080p video camera angled obliquely at 30°. The camera utilises Internet Protocol Interface for high performance vs bandwidth ratio. A SeaSpyder telemetry 24-megapixel (MP) Cannon EOS 250D Digital Stills Camera mounted vertically (downward facing) was mobilised to collect still images and also interfaced with four downward facing 2000lm light emitting diode (LED) lights (model: STR Sealight LED-2-DC), four downward facing category 3 lasers (model: STR SeaDot Green Laser Pointer, MP-GLP2-6000A-0°/5mW), an STR high powered flash (model: 50705-MP-FT) mounted at 34°, altimeter, combined depth compass and multiplexer. The lasers were mounted to the housing of the stills camera and calibrated to achieve a 17 cm x 17cm square box.



Fig. 6.22. STR SeaSpyder HDFO 3000m DDC system mobilised to the RRS Discovery

6.2.2. SeaSpyder mobilisation

On Saturday 20 September, the SeaSpyder was connected to the Evergrip termination on the 10km long Deep Tow fibre optic winch via a five-tonne shackle. The winch, located on the starboard side mid-ship P-frame of the RRS Discovery, was subsequently load tested by the chief petty officer to one Tonne holding for 5 minutes on 21 September 2025.

Following the successful load test, new fibre optic tails were fusion spliced onto the winch cable. Both the electrical and fibre optic terminations were tested to ensure successful termination. The results of the electrical and optical testing are displayed in Table 6.8. The STR SeaSpyder required a db value

for optical transmission of less than 12 db to ensure appropriate data transfer and operation as per the manufacturer's guidance.

Table 6.8. Optical and electrical readings taken from the main lab to the terminated end of the deep tow winch.

Fibre Cable	1310 nm	1550 nm
Red	8	
Black	12	
Grey		
Continuity and Conductors and Earth	Test Results (GΩ)	
L1 – L2		
L1 – L3		
L2 – L3		
L1 – Earth		
L2 – Earth		
L3 - Earth		
Insulation Resistance Test	Test Results Ω	
L1 – L2		
L1 – L3		
L2 – L3		
L1 – Earth		
L2 – Earth		
L3 - Earth		

The electrical and fibre optic tails were then connected to the SeaSpyder with the black fibre used for telemetry and the red fibre used for the Mini IP Video camera. The connection was undertaken within a subsea silicon oil filled junction box fitted with an oil filled compensator mounted on the top of the SeaSpyder frame.



Fig. 6.23. Connection of the SeaSpyder to the ship's winch system: Deep tow winch termination showing fusion spliced fibre optic tails and STR SeaSpyder junction box (left). Mounted silicon oil filled junction box with oil filled pressure compensator on the SeaSpyder (right).

On 21 and 22 September 2025, the STR SeaSpyder topside multiplexer and topside computer station were set up on the second bay of the main laboratory allowing space for the winch operator to set up a station with clear view of the CLAM and CCTV monitors mounted at the winch control station as shown in Fig. 6.24.



Fig. 6.24. Lab set-up: SeaSpyder topside station in the main lab (left). LEMO connectors (middle). LEMO connectors with earthing procedure (right)

A 10m SeaSpyder HDFO Power Cable was purpose manufactured to carry power from the SeaSpyder topside mux processor located in the main laboratory to LEMO connectors also located in the main laboratory. These LEMO connectors were routed via the ships internal wiring to the deep tow winch as shown in Fig. 6.24.

6.2.3. SeaSpyder Operations

The SeaSpyder was operated by OEL personnel via a topside computer station set up in the main laboratory of the RRS Discovery with a Petty Officer present to control the deep tow winch ensuring the SeaSpyder was kept at a constant altitude of 1.4m to achieve a field of view of at least 1.2m².

6.2.3.1. Deep tow winch and active heave compensation

During DY200, the SeaSpyder was the only piece of equipment attached to the deep tow cable underneath the P-frame, so no wire swapping was required.

The deep tow winch was interfaced with an Active Heave Compensation (ACH) system to enable compensation for the heave of the vessel during operations. The AHC compensated well for the heave of the ship and maintained a constant altitude off the seabed (± 0.5 m) providing stable video footage and reducing the amount of winch adjustment required.

For the AHC operation, the SeaSpyder was deployed to an approximate altitude of 30m from the seabed where the deployment was paused and the AHC turned on. The deployment then continued to the seabed. At the end of each dive, the SeaSpyder was recovered to a depth of 30m, where the AHC was then turned off ready for recovery. All decent and ascent was undertaken at a constant speed of 0.5 m/s (30m/min).

6.2.3.2. High-voltage operations

When operational, the SeaSpyder topside multiplexer delivers 340 v to the SeaSpyder vehicle. During the mobilisation of DY200, operations were discussed with the Chief Engineer and ETO and it was decided that all operations were to be treated as high voltage (HV) to prevent the risk of electric shock.

During deployment, the SeaSpyder vehicle was powered off and any voltage remaining within the winch line was removed using the earthing system shown in Fig. 6.24. At an approximate depth of 10m, the vehicle was then powered on for the remainder of the operations.

During recovery, the SeaSpyder was brought to a depth of 10m where the system was then powered off and any voltage remaining within the winch line was removed using the earthing system shown in Fig. 6.24.

Whilst the SeaSpyder was on deck, the metal frame was earthed to the deck earthing point via an earthing lanyard as visible in Fig. 6.22.

6.2.3.3. Subsea positioning

Interfaced with the mobilised camera system was a subsea positioning system linked to the vessels ultra short baseline (USBL) transponder by the attachment of a USBL beacon to the camera frame as shown in Fig. 6.22. The beacon positioning software was interfaced with the video software to provide an overlay of positioning and second by second logging file containing camera position along with other sensor information.

6.2.3.4. Data storage and processing

Continuous video was obtained at each station including the period of water column as the camera descended to an altitude of 1.4 m above the seabed. Digital stills were acquired between every 15 and 25 seconds allowing enough time for the STR high-powered flash to re-charge prior to the next still. Video files were captured as .avi files with stills captured as both .jpeg and .CR3 (RAW) image files.

After each dive, stills data were recovered from the subsea camera SD card onto the subsea computer. The data were then transferred from the subsea computer to the topside PC where they could then be transferred, along with the video files, onto the Seafloor Ecosystems QNAPS archive system.

6.2.3.5. Operational Issues

On the first day of operations, at 20:42, as the SeaSpyder approached the working depth of ~100m, water ingress in the pressure housing was visible within the stills camera. Owing to this, the SeaSpyder was recovered immediately and an assessment to understand the cause was undertaken. Unfortunately, the issue was perceived to be terminal and arrangements were made for a new camera to be delivered to Falmouth, UK for collection by the vessel on 27 September. Once the new camera and housing were onboard, they were fitted to the SeaSpyder frame and no further issues for the remainder of the DY200 cruise were noted.

During station DY200_017 (SeaSpyder_003), one laser stopped working and the remainder of the dive was completed with only three working lasers. The faulty laser was replaced upon recovery with a spare and the remainder of the cruise was completed with no issues.

6.3. Mooring & Lander recovery

Operational Team: Tim Powell & Chris Crowe

The two moorings deployed during DY196 (PISCES cruise) were released using an IXSEA TT801 deck unit via the ships drop keep mounted moorings transducer. All moorings released on the first attempt with good return signals achieved.

Recoveries were carried out using a 5t deck winch and wide mouthed block hanging from an aft pedestal crane.

PISCES 2 was slightly tangled upon recovery.

6.3.1. PISCES1 recovery

Instrument	Serial Number
Light Beacon	A08-018
Iridium Beacon	M10-043
RDI 75KHZ ADCP	15519
Nortek CM	9975
Sea-Bird SBE 37	7294
Nortek CM	9989
Sea-bird SBE 37	7295
TURBIDITY	93657
Nortek CM	13569
Ixsea Release	1494
Ixsea Release	2302

Nortek CM sn: 9975 stopped 29/09/25 1432 gmt 1.6Mb

Sn:9989 stopped 29/09/25 1444 gmt 1.6Mb both still logging on recovery

SBE 37 SN: 7294 sample number 95206 +5 secs gmt

Sn:7295 sample number 72908 +3secs gmt both stopped logging before recovery

Turbidity sn:93657 stopped 1418 gmt 01/10/25 logging on recovery

RDI 75khz ADCP SN:15519 stopped 02/10/25 0840 gmt 20.4MB +2m 33s gmt logging on recovery

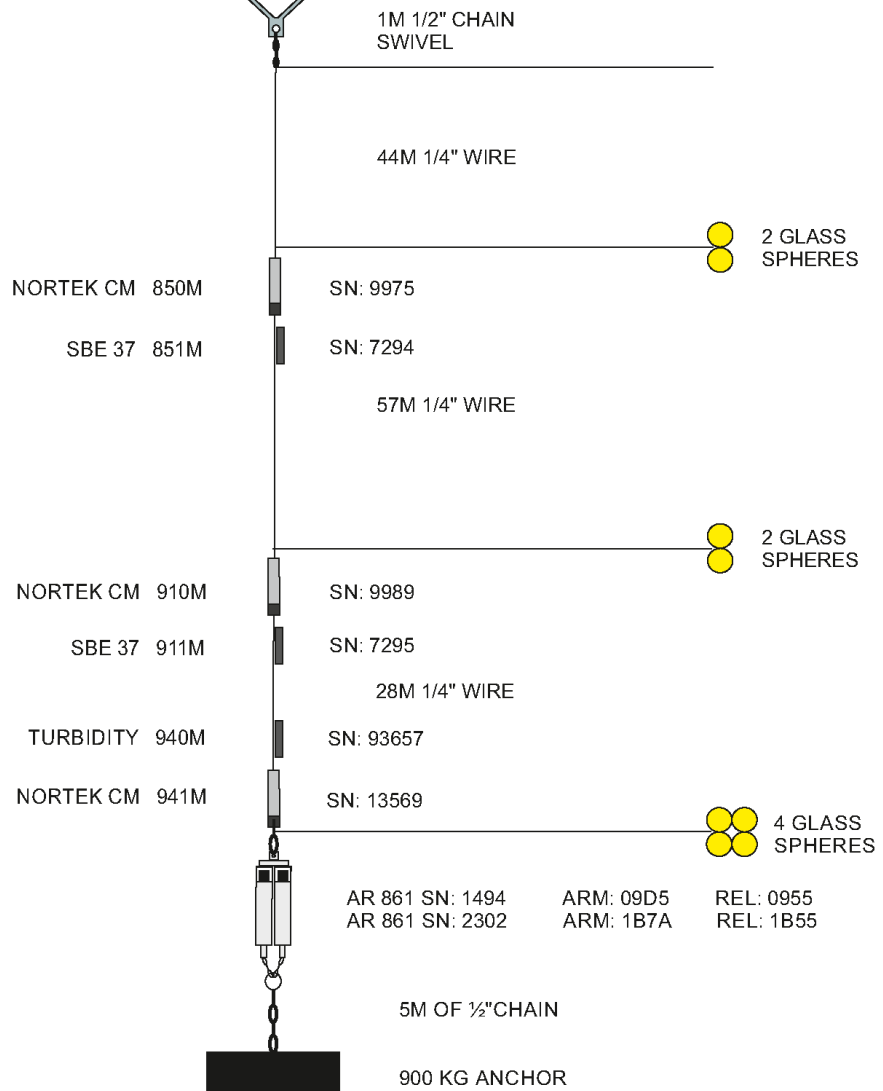
PISCES 1 DANGEARD CANYON (DC) AS RECOVERED DY200 2025

Latitude: 48° 21.41'N
Longitude: 9° 32.61'W
Depth: 955m

ADCP 75kHz 800M
44" SPHERE

RECOVERY FLOAT
15M POLYPROP
RECOVERY LINE

ADCP SN: 15519 IRIIDIUM SN: M10-043
BUOY SN: J16297-002 LIGHT SN: A08-018



SENSORS & MOORINGS

Fig. 6.25 Schematic of the PISCES1 mooring upon recovery

6.3.2. PISCES2 recovery

Instrument	Serial Number
Light Beacon	B08-027
Iridium Beacon	H07-055
Nortek sig 55 ADCP	200113
Nortek CM	13585
Sea-Bird SBE 37	7289
Porpoise	TR-12-1R4-504
Nortek CM	13585
Sea-bird SBE 37	7300
Turbidity	93656
Nortek CM	12119
Ixsea Release	1751
Ixsea Release	2333

Nortek CM SN:13585 stopped 29/09/25 1417 gmt 1.6mb

Sn:12119 stopped 29/09/25 1423 gmt 1.6mb

Sbe 37 sn: 7289 samplenum 77022 +2s gmt

Sn:7300 samplenum 96001 -2s gmt

Turbidity sn:93656 stopped 01/10/25 1508 gmt logging on recovery

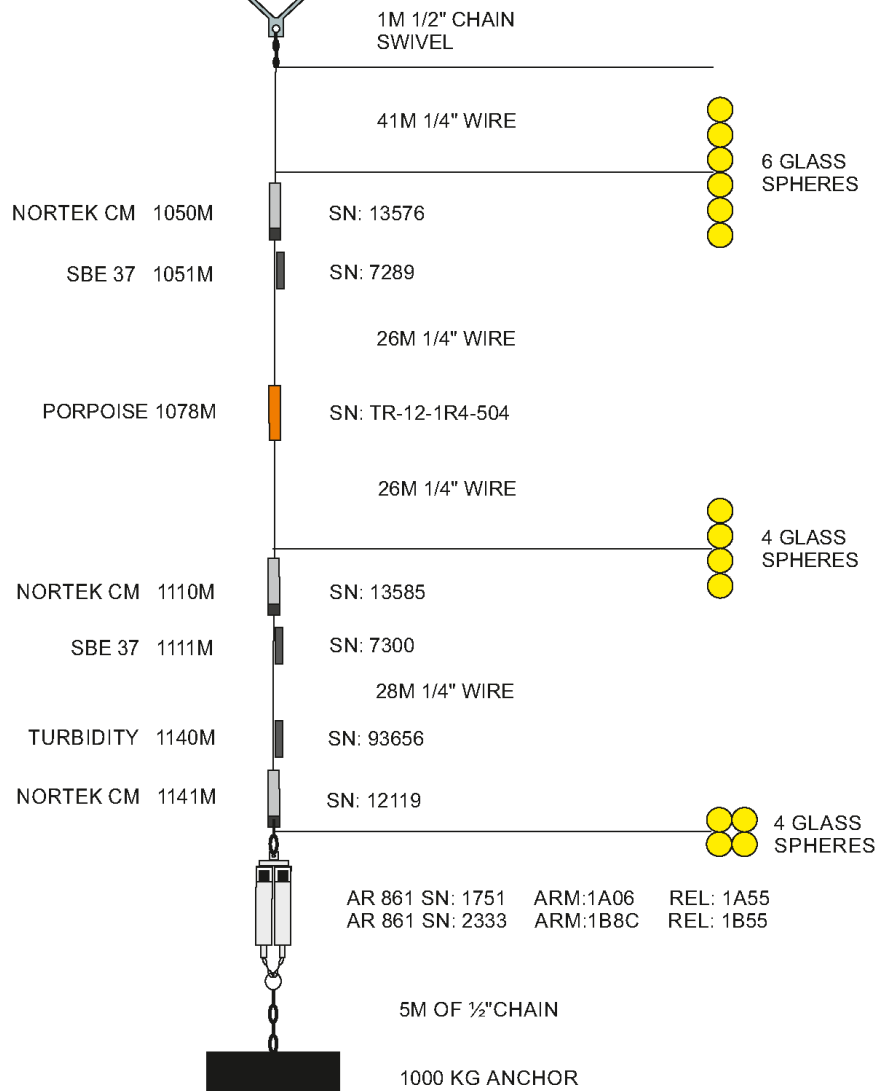
Nortek sig 55 sn:200113 stopped 30/09/25 1523gmt 0 clock drift recorder space 14.31/14.83GB

PISCES 2 EXPLORER CANYON (EC) AS RECOVERED DY200 2025

Latitude: 48° 26.9' N
Longitude: 9° 41.16' W
Depth: 1165 m

ADCP 55kHz 1000M
40" SPHERE

RECOVERY FLOAT
15M POLYPROP
RECOVERY LINE
ADCP SN: 200113 IRIDIUM SN: H07-055
BUOY SN: J20268-002 LIGHT SN: B08-027



SENSORS & MOORINGS

Fig. 6.26 Schematic of the PISCES2 mooring upon recovery

6.3.3. Hydrophone lander recovery

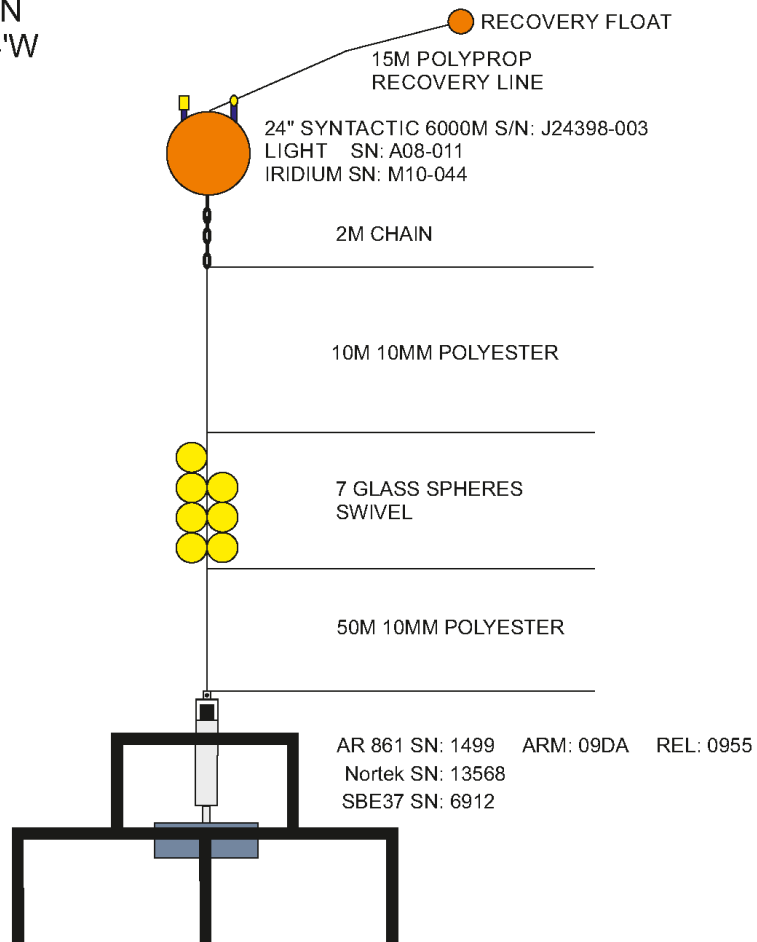
Instrument	Serial Number
Light Beacon	A08-011
Iridium Beacon	M10-044
Nortek CM	13568
Sea-Bird SBE 37	6912
Ixsea Release	1499

Nortek cm sn: 13568 stopped 29/09/25 1025 gmt 1.6mb

Sbe 37 sn:6912 not downloaded as inductive unit and will need a re battery and download at noc Southampton.

HYDROPHONE LANDER AS RECOVERED DY200 2025

Latitude: 48° 23.02'N
Longitude: 9° 44.24'W
Depth: 360m



SENSORS & MOORINGS

Fig. 6.27 Schematic of the hydrophone lander upon recovery

6.4. CTD

Operational Team: Tim Powell & Chris Crowe

6.4.1. CTD cast summary

Total number of casts: 9

Deepest cast: 1749m

6.4.2. Stainless steel CTD wire

CTD Wire 1 was used for all casts and was routed via the bullhorn as the deep tow cable was in use on the P-frame for the SeaSpyder camera system. The wire was mechanically and electrically terminated during the mobilisation and load tested to 2 tonnes.

CTD wire 1 had not been used for a long period and as Kongsberg had recently been aboard to carry out some work on the active heave system, a test dip using a clump weight was carried out prior to the first CTD cast.

Resistance and insulation of the cable were checked periodically. The fasteners of the mechanical termination were checked throughout and re-torqued, no slippage was noted. The termination was left on at the end of the DY200.

CTD Wire 1 before cast 001 readings:

Resistance 74 Ohms, Insulation >999 MOhms @500 VDC

CTD Wire 1 readings after cast 009:

Resistance 74 Ohms, >999 MOhms @500 VDC

6.4.3. Stainless steel CTD sensor set-up

The CTD frame was setup for DY200 with primary conductivity, temperature, and dissolved oxygen sensors on the 9plus and secondary conductivity and temperature sensors on the vane.

Additional sensors on the frame were altimeter, fluorometer, transmissometer & backscatter.

Full sensors information can be found on the Sensor information sheet – appendix 1.

CTD data was viewed and recorded using Seasave V7.26.7.121.

Configuration reports for the SeaSave setup can be found in Appendix 2

6.4.4. Active heave compensation

Following recent work carried out by Kongsberg to the active heave system on the bullhorn the CPOS requested evidence that the system was now working as expected.

The below plot shows the effect on the CTD pressure readings with active heave turned on, off and then back on again.

DY200_CTD_003.hex: Descent Rate

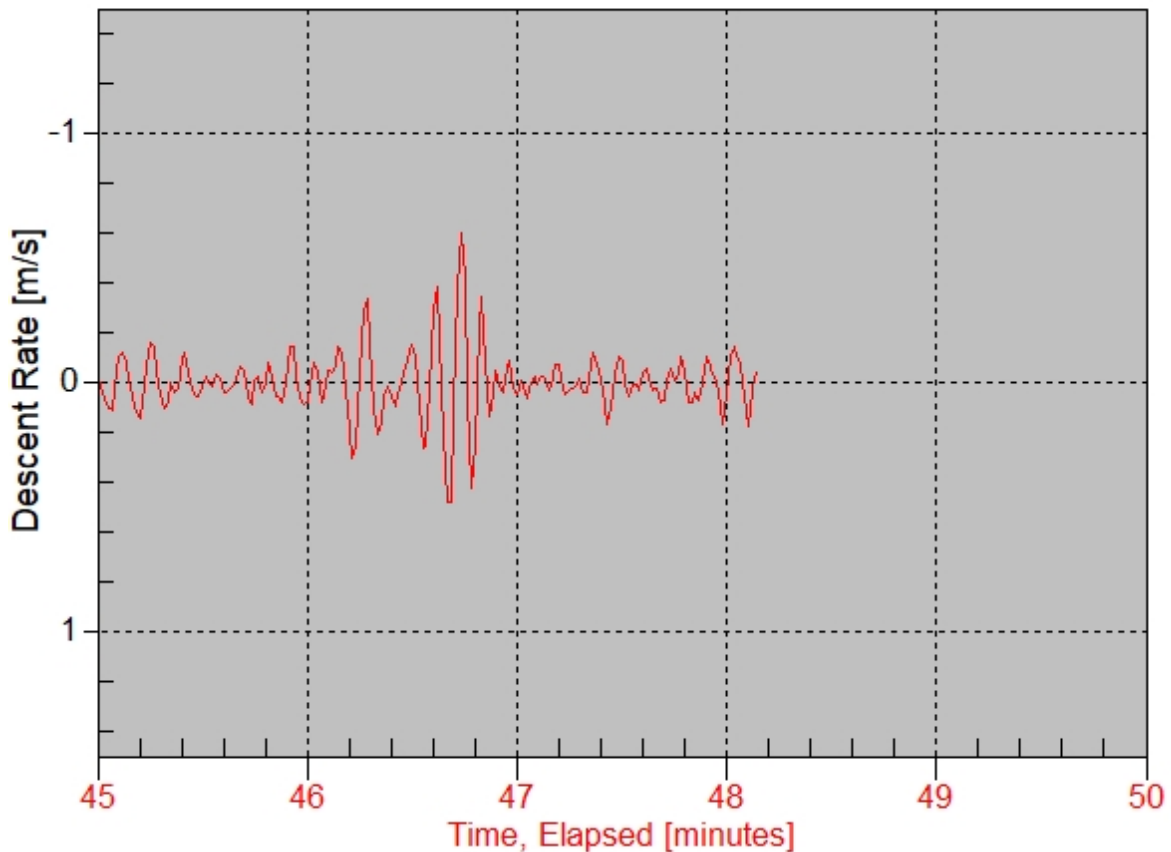


Fig. 6.28 Illustration of the effect of the Active Heave Compensation on the CTD descent rate (AHC taken off at 46 mins and put back on at 47 min).

6.4.5. Seabird data processing

Basic post-processing of the CTD cast data was carried out following guidelines established with BODC (ref. Moncoiffe 7th July 2010).

The CTD casts were processed using SBE Data Processing, V7.26.7. The following modules were used to process the data:

- Data Conversion
- Bottle Summary
- Align
- Cell Thermal Mass
- Derive
- Bin Average
- Strip

6.4.6. Autosal

Salinity samples were collected during the cruise and analysed using a Guildline 8400B Autosal S/N 68958.

6.5. Glider recovery

Operational Team: Rory O'Brian, Matt Kingsland

Seaglider SG605, deployed on DY196 (PISCES cruise) was recovered successfully on 28 September 2025 using the standard operating procedures for the recovery of Kongsberg Seaglider (lasso-loop; Fig. 6.29). Upon recovery, the system was washed with fresh water and transferred into its storage box ready for demob and transport onshore.



Fig. 6.29 Seaglider recovery using pole with lasso loop (left); Seaglider on board (right)

6.6. Ship-fitted Systems

Operational team: Martin Bridger

6.6.1. Scientific computer systems

6.6.1.1. Underway data acquisition

Data from the suite of ship-fitted scientific instrumentation was aggregated onto a network drive on the ship's file server. This was available throughout the voyage in read-only mode to permit scientists to work with the data as it was acquired. A Public network folder was also available for scientists to share files.

A copy of these two drives are written to the end-of-cruise disks that are provided to the Principal Scientist and the designated data centre.

The designated data centre for this cruise is: British Oceanographic Data Centre

List of logged ship-fitted scientific systems:

`/Ship_Systems/[Keywords]_Ship_fitted_information_sheet.docx`

The ship Systems portion of the cruise disk is split into three directories; **Data**, **Metadata** and **Documentation**.

Table 6.9 Description of the main data directories for ship system data logging

Directory	Explanation
Data	<p>Folder: /Ship_Systems/Data/</p> <p>Purpose: All raw and processed datasets, including structured metadata.</p> <p>Examples;</p> <ul style="list-style-type: none"> • Raw sensor time series data (.txt) • Structured sensor metadata (.json) • Processed sensor time series data (.nc) <p>Example file formats: .txt, .nc, .csv, .json, .all, .raw, .log</p>
Metadata	<p>Folder: /Ship_Systems/Metadata/</p> <p>Purpose: All non-structured metadata. This helps to explain some of the datasets.</p> <p>Examples;</p> <ul style="list-style-type: none"> • Data description documentation (.docx) • Sensor calibration documentation (.pdf). • Ship survey documentation (.pdf). <p>Example file formats: .docx, .pdf</p>
Documentation	<p>Folder: /Ship_Systems/Documentation/</p> <p>Purpose: All non-metadata documentation. As an example, PDF documentation for sensor operation.</p> <p>Examples;</p> <ul style="list-style-type: none"> • Instrument manuals (.pdf). <p>Example file formats: .docx, .pdf</p>

The data acquisition systems used on this cruise are detailed in the table below. The data and data description documents are filed per system in the *Data* and *Metadata* directories respectively within Ship Systems folder on the cruise data disk.

Table 6.10: Data acquisition systems used DY200.

Data acquisition system	Usage	Data products	Directory system name
Ifremer TechSAS	Continuous.	NetCDF ASCII pseudo-NMEA	/TechSAS/
NMF RVDAS	Continuous.	ASCII Raw NMEA SeaDataNet NetCDF (Testing)	/RVDAS/
Kongsberg SIS (EM122)	Continuous/ Discrete/Unused.	Kongsberg .all	/Acoustics/EM-122/
Kongsberg SIS (EM710)	Continuous/ Discrete/Unused.	Kongsberg .all	/Acoustics/EM-710/
Kongsberg SBP	Continuous/ Discrete/Unused.	None	/Acoustics/SBP-27/
Kongsberg EA640	Continuous/ Discrete/Unused.	None, redirected to Techsas/RVDAS RAM	/Acoustics/EA-640/
Kongsberg EK80	Continuous/ Discrete/Unused.		/Acoustics/EK-80/
UHDAS (ADCPs)	Continuous/ Discrete/Unused.	ASCII raw, RBIN, GBIN, CODAS files	/Acoustics/ADCP/
VMDAS (ADCPs)	Continuous/ Discrete/Unused.		/Acoustics/ADCP/
Sonardyne Ranger2	Continuous/ Discrete/Unused.	None, redirected to Techsas/RVDAS RAM	/Acoustics/USBL/
Rutter WAMOS	Continuous/ Discrete/Unused.	None, redirected to Techsas/RVDAS RAM	/Wamos/

Data description documents per system:

/Ship_Systems/Metadata/[systemName]/

Data directories per system:

```
/Ship_Systems/Data/[systemName]/
```

6.6.1.2. Significant acquisition events and gaps

On this cruise, the RVDAS event logger was used with CSV records of events saved to the cruise data directory.

Path and pattern to event log CSV files:

```
/Ship_Systems/Data/RVDAS/Event_logs/[logName]/*.csv
```

Table 6.11 Data acquisition times During DY200

Date	Time start*	Time end*	Event
23-09-2025	10:17		Logs Started
12-10-2025		08:56	Logs Saved as CSV

6.6.1.3. Internet provision

Satellite communications were provided with Starlink, OneWeb, VSat and Iridium Certus.

The ship operated with bandwidth controls to prioritise business use.

6.6.2. Data acquisition systems

NMF operated two central acquisition systems; **TechSAS** and **RVDAS**.

6.6.2.1. TechSAS

TechSAS (Technical and Scientific Acquisition System) is a central acquisition system developed by the oceanographic institute Ifremer. TechSAS has been used on the RRS James Cook and RRS Discovery since ~2007/2013 and is currently the primary acquisition system.

TechSAS produced two file types; NetCDF and NMEA (ASCII).

Table 6.12 Description of file types used by the TECHSAS logging system

File type	Explanation
NetCDF	<p>Data: /Ship_Systems/Data/TechSAS/NetCDF/[SENSOR]/</p> <p>Filename format: YYYYMMDD-HHMMSS-[SENSOR]-[SENSOR].[SENSOR]</p> <p>Source: Written in real time by system.</p> <p>Data description: /Ship_Systems/Metadata/Techsas/Data_Description</p>

	<p>Collection: All data at acquisition resolution.</p> <p>Purpose: Standard NetCDF format with global attribute metadata, variable metadata and 1D variable timeseries data.</p>
NMEA	<p>Data: /Ship_Systems/Data/TechSAS/NMEA/[SENSOR]/</p> <p>Filename format: YYYYMMDD-HHMMSS-[SENSOR].[SENSOR]</p> <p>Source: Written in real time by system.</p> <p>Data description: /Ship_Systems/Metadata/Techsas/Data_Description</p> <p>Collection: All data at acquisition resolution.</p> <p>Purpose: ASCII data format with pseudo-NMEA data sentences in 1D timeseries.</p>

System	Quick reference
Primary GPS	<p>NetCDF: /Ship_Systems/Data/TechSAS/NetCDF/GPS/YYYYMMDD-HHMMSS-[TYPE]-POSMV_GPS.gps</p> <p>NMEA: /Ship_Systems/Data/TechSAS/NMEA/mvpos/YYYYMMDD-HHMMSS-POSMV_GPS.mvpos</p> <p>Data description: /Ship_Systems/Metadata/TechSAS/Data_Description/Posmv Data Description.docx</p>
Biogeochemical, meteorological and solar irradiance sensors	<p>NetCDF: /Ship_Systems/Data/TechSAS/NetCDF/SURFMETV3/YYYYMMDD-HHMMSS-[TYPE]-SURFMET.SURFMETv3</p> <p>NMEA: /Ship_Systems/Data/TechSAS/NMEA/surfm/YYYYMMDD-HHMMSS-SURFMET.surfm</p> <p>Data description: /Ship_Systems/Metadata/TechSAS/Data_Description/Surfm Data Description_v5_DY.docx</p>
Thermosalinograph	<p>NetCDF: /Ship_Systems/Data/TechSAS/NetCDF/SURFMETV3/YYYYMMDD-HHMMSS-[TYPE]-SURFMET.SURFMETv3</p> <p>NMEA: /Ship_Systems/Data/TechSAS/NMEA/surfm/YYYYMMDD-HHMMSS-SURFMET.surfm</p>

	<p>Data description: /Ship_Systems/Metadata/TechSAS/Data_Description/Sur fmet Data Description_v5_DY.docx</p>
Windsonic	<p>NetCDF: /Ship_Systems/Data/TechSAS/NetCDF/SURFMETV3/YYYYMMDD- HHMMSS-WINDSONIC-WINDSONIC.WINDSONIC</p> <p>NMEA: /Ship_Systems/Data/TechSAS/NMEA/winds/YYYYMMDD- HHMMSS-WINDSONIC.winds</p> <p>Data description: /Ship_Systems/Metadata/TechSAS/Data_Description/Win dsonic Data Description.docx</p>

6.6.2.2. RVDAS

RVDAS (Research Vessel Data Acquisition System) is a central acquisition system developed by NMF and the British Antarctic Survey. RVDAS has been used since ~2018 and is currently the common data acquisition format across the NERC research ships RRS Discovery, RRS James Cook and RRS Sir David Attenborough.

RVDAS produced one real-time data file (raw ASCII), one real-time PostgreSQL database, one post-cruise PostgreSQL dump, six post-processed data files (NetCDF and CSV), structured metadata files (JSON) and eventlog files (CSV).

Table 6.13 Data types logged by the RVDAS system

File type	Explanation
Raw text	<p>Data: /Ship_Systems/Data/RVDAS/Raw_TXT/ Filename format: [Keywords]_[SENSOR]_YYYY_MM_DD.nmea.txt Source: Written in real time by acquisition module (v2.7.0). Data description: /Ship_Systems/Data/RVDAS/Sensor_metadata/ Collection: All data at acquisition resolution. Purpose: ASCII data format with NMEA-0183 standardised or pseudo-NMEA data sentences in 1D timeseries. Status: Production data product.</p>
PostgreSQL database	<p>Data: Only available onboard ship. Source: Written in real time by database module (v1.0.0). Data description: /Ship_Systems/Data/RVDAS/Sensor_metadata/ Collection: All data at acquisition resolution. Purpose: Advanced querying of timeseries data on ship.</p>

	<p>Status: Production data product.</p>
PostgreSQL database dump	<p>Data: /Ship_Systems/Data/RVDAS/Database_SQL_dump/ Filename format: Source: Written on demand by NetCDF module (v1.0.0) at cruise stop. Data description: /Ship_Systems/Data/RVDAS/Sensor_metadata/ Collection: All data at acquisition resolution. Purpose: Advanced querying of timeseries data off ship. Status: Production data product.</p>
Sensor metadata	<p>Data: /Ship_Systems/Data/RVDAS/Sensor_metadata/ Filename format: [SENSOR]_[SHIP]_YYYY-MM-DDTHHMMSSZ-YYYY-MM-DDTHHMMSSZ.json Source: Written on demand by metadata module (v1.0.0). Collection: Manual entries of structured sensor and acquisition metadata. Status: Production data product.</p>
Event logs	<p>Data: /Ship_Systems/Data/RVDAS/Event_logs/[LOG TYPE]/ Filename format: [LOG TYPE].csv Source: Written in real time by eventlogging module (v1.0.0). Collection: Entries of acquisition and science event history. Status: Production data product.</p>
NetCDF (Raw)	<p>Data: /Ship_Systems/Data/RVDAS/Database_NetCDF/Raw/ Filename format: metocean-[Keywords]-[SENSOR]_[SENTENCE]-raw-YYMMDD-HHMMSS.nc Source: Written by NetCDF module (v1.0.0) as post-processing from database. Data description: /Ship_Systems/Data/RVDAS/Sensor_metadata/ Collection: All data at acquisition frequency. Status: Work-in-progress data product.</p>
NetCDF (SAMOS)	<p>Data: /Ship_Systems/Data/RVDAS/Database_NetCDF/SAMOS/ Filename format: samos_YYMMDD-HHMMSS.nc</p>

	<p>Source: Written by NetCDF module (v1.0.0) as post-processing from database.</p> <p>Collection: SAMOS data variables at 1 min resolution (bin averaged).</p> <p>Data description: https://samos.coaps.fsu.edu/html/documentation.php</p> <p>Status: Work-in-progress data product.</p>
NetCDF (METOCEAN)	<p>Data: /Ship_Systems/Data/RVDAS/Database_NetCDF/METOCEAN/</p> <p>Filename format: metocean_YYYYMMDD-HHMMSS.nc</p> <p>Source: Written by NetCDF module (v1.0.0) as post-processing from database.</p> <p>Collection: All data at 5 min resolution (bin averaged).</p> <p>Data description: /Ship_Systems/Data/RVDAS/Sensor_metadata/</p> <p>Status: Work-in-progress data product.</p>
CSV (Raw)	<p>Data: /Ship_Systems/Data/RVDAS/Database_CSV/Raw/</p> <p>Filename format: metocean-[Keywords]-[SENSOR]_[SENTENCE]-raw-YYYYMMDD-HHMMSS.csv</p> <p>Source: Written by NetCDF module (v1.0.0) as post-processing from database.</p> <p>Data description: /Ship_Systems/Data/RVDAS/Sensor_metadata/</p> <p>Collection: All data at acquisition frequency.</p> <p>Status: Work-in-progress data product.</p>
CSV (SAMOS)	<p>Data: /Ship_Systems/Data/RVDAS/Database_CSV/SAMOS/</p> <p>Filename format: samos_YYYYMMDD-HHMMSS.csv</p> <p>Source: Written by NetCDF module (v1.0.0) as post-processing from database.</p> <p>Collection: SAMOS data variables at 1 min resolution (bin averaged).</p> <p>Data description: https://samos.coaps.fsu.edu/html/documentation.php</p> <p>Status: Work-in-progress data product.</p>
CSV (METOCEAN)	<p>Data: /Ship_Systems/Data/RVDAS/Database_CSV/METOCEAN/</p> <p>Filename format: metocean_YYYYMMDD-HHMMSS.csv</p>

	<p>Source: Written by NetCDF module (v1.0.0) as post-processing from database.</p> <p>Collection: All data at 5 min resolution (bin averaged).</p> <p>Column header format: [VARIABLE] - [SENSOR]_[SENTENCE]</p> <p>Data description: /Ship_Systems/Data/RVDAS/Sensor_metadata/</p> <p>Status: Work-in-progress data product.</p>
--	---

System	Quick reference
Primary GPS	<p>Raw data: /Ship_Systems/Data/RVDAS/Raw_TXT/[Keywords]_POSMV_YYY Y_MM_DD.nmea.txt</p> <p>Data description: /Ship_Systems/Data/RVDAS/Sensor_metadata/posmv- [SHIP]-YYYY-MM-DDTHMMSSZ-YYYY-MM-DDTHMMSSZ.json</p>
Seawater biogeochemical sensors	<p>Raw data: /Ship_Systems/Data/RVDAS/Raw_TXT/[Keywords]_NUDAMUWY_YYYY_MM_DD.nmea.txt</p> <p>Data description: /Ship_Systems/Data/RVDAS/Sensor_metadata/nudamuwy- [SHIP]-YYYY-MM-DDTHMMSSZ-YYYY-MM-DDTHMMSSZ.json</p>
Meteorological sensors	<p>Raw data: /Ship_Systems/Data/RVDAS/Raw_TXT/[Keywords]_NUDAMMET_YYYY_MM_DD.nmea.txt</p> <p>Data description: /Ship_Systems/Data/RVDAS/Sensor_metadata/nudammet- [SHIP]-YYYY-MM-DDTHMMSSZ-YYYY-MM-DDTHMMSSZ.json</p>
Solar irradiance sensors	<p>Raw data: /Ship_Systems/Data/RVDAS/Raw_TXT/[Keywords]_NUDAMLGT_YYYY_MM_DD.nmea.txt</p> <p>Data description: /Ship_Systems/Data/RVDAS/Sensor_metadata/nudamlgt- [SHIP]-YYYY-MM-DDTHMMSSZ-YYYY-MM-DDTHMMSSZ.json</p>
Windsonic	<p>Raw data: /Ship_Systems/Data/RVDAS/Raw_TXT/[Keywords]_WINDSONIC_YYYY_MM_DD.nmea.txt</p> <p>Data description: /Ship_Systems/Data/RVDAS/Sensor_metadata/windsonic- [SHIP]-YYYY-MM-DDTHMMSSZ-YYYY-MM-DDTHMMSSZ.json</p>

6.6.3. Instrumentation

6.6.3.1. Coordinate reference

Path to ship survey files:

```
/Ship_Systems/Documentation/Vessel_Survey
```

6.6.3.2. Origin

All coordinates, unless otherwise specified, use the following convention:

Central reference point (0,0,0) at Frame 44, centreline, main deck with sense (X+ fwd, Y+ stbd, Z+ down). This CRP is at (32.4m, 0m, -7.4m) with respect to the ship's absolute stern, centreline, baseline.

The ship's survey (Parker Maritime, 2013) defines two systems of reference point using two different central reference points (CRPs):

1. (0,0,0) at Frame 0 (aft-most frame, 6m forward from stern), centreline (centre of keel), baseline (ship's bottom-most longitudinal).
2. (0,0,0) at ship's centre of gravity (CG), Frame 44 (26.4m forward from Frame 0 at 0.6m framespacing), centreline (centre of keel), main deck (7.4m up from baseline).

The survey coordinate sense is X is positive forward, Y positive starboard, and Z positive down. The coordinate order in the survey is (Y,X,Z), but unless otherwise noted, all coordinates are given elsewhere as (X,Y,Z).

For all scientific purposes, unless otherwise stated, the coordinate system is referenced using the second system, with the CRP at the CG.

6.6.3.3. Multibeam

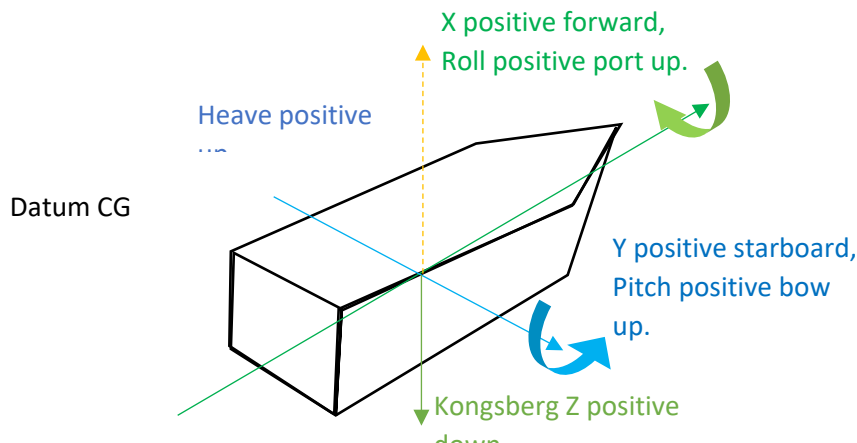


Fig. 6.30 Conventions used for position and attitude. On the Discovery, the Datum is the CRP at the CG.

The Kongsberg axes reference conventions are (see Fig. 6.30) as follows:

1. X positive forward,
2. Y positive starboard,
3. Z positive downward.

The rotational sense for the multibeam systems and Seapath is set to follow the convention of Applanix PosMV (the primary scientific position and attitude system), as per Figure 1.

6.6.3.4. Primary scientific position and altitude system

The translations and rotations provided by this system (Applanix PosMV) have the following convention:

1. Roll positive port up,
2. Pitch positive bow up,
3. Heading true positive to starboard,
4. Heave positive up.

Table 6.14 Position, altitude and time

System	Navigation (Position, attitude, time)
Data product(s)	<p>NMEA (mvpos, mvatt, spat, sppos, cnpos): /Ship_Systems/Data/TechSAS/NMEA/</p> <p>NetCDF (GPS): /Ship_Systems/Data/TechSAS/NetCDF/</p> <p>Raw NMEA (POSMV, SEAPATH, CNAV): /Ship_Systems/Data/RVDAS/Raw_TXT</p> <p>Raw & processed NetCDF (POSMV, SEAPATH, CNAV): /Ship_Systems/Data/RVDAS/Database_NetCDF</p>

	Raw NMEA (POSMV, SEAPATH, CNAV): /Ship_Systems/Data/RVDAS/Database_CSV		
Data description	/Ship_Systems/Data/RVDAS/Sensor_metadata /Ship_Systems/Metadata/Techsas/Data_Description /Ship_Systems/Metadata/RVDAS/Data_Description		
Other documentation	/Ship_Systems/Documentation/GPS_and_Attitude		
Component	Purpose	Outputs	Headline Specifications
Applanix PosMV	Primary GPS and attitude.	Serial NMEA to acquisition systems and multibeam	Positional accuracy within 0.15 m.
Kongsberg Seapath 330	Secondary GPS and attitude.	Serial and UDP NMEA to acquisition systems and multibeam	Positional accuracy within 1 m.
Oceaneering CNav 3050	Correction service for primary and secondary GPS and dynamic positioning.	RTCM to primary and secondary GPS	Positional accuracy within 0.15 m.
Meinberg NTP Clock	Provide network time	NTP protocol over the local network.	

Table 6.15 Significant position, altitude or time events or losses

Date	Time start*	Time end*	Event
-	-	-	Seapath Offline for entire cruise.

6.6.3.5. Ocean and atmosphere monitoring systems

6.6.3.5.1. Surfmet

Table 6.16 Details of Surfmet recordings

System	SURFMET (Surface water and atmospheric monitoring)
Data product(s)	NMEA (surfm, sbe38, sbe45, winds): /Ship_Systems/Data/TechSAS/NMEA/

	<p>NetCDF (SURFMETV3, SBE38, TSG, WINDSONIC): /Ship_Systems/Data/TechSAS/NetCDF/</p> <p>Raw NMEA (NUDAM***, SF***, SBE38DK, SBE45, WINDSONIC): /Ship_Systems/Data/RVDAS/Raw_TXT</p> <p>Raw & processed NetCDF (NUDAM***, SF***, SBE38DK, SBE45, WINDSONIC): /Ship_Systems/Data/RVDAS/Database_NetCDF</p> <p>Raw NMEA (NUDAM***, SBE38DK, SBE45, WINDSONIC): /Ship_Systems/Data/RVDAS/Database_CSV</p>	
Data description	<p>/Ship_Systems/Data/RVDAS/Sensor_metadata</p> <p>/Ship_Systems/Metadata/Techsas/Data_Description</p> <p>/Ship_Systems/Metadata/RVDAS/Data_Description</p>	
Other documentation	/Ship_Systems/Documentation/SURFMET	
Calibration info	<p>See [Keywords]_Ship_fitted_information_sheet.docx for calibration information for each sensor.</p> <p>Calibration documents: /Ship_Systems/Metadata/SURFMET/Calibration_Files</p>	
Component	Purpose	Outputs
Inlet temperature probe (SBE38)	Measure temperature of water at hull inlet.	Serial to Interface Box.
Drop keel temperature probe (SBE38)	Measure temperature of water flush to hull at the drop keel.	Serial to Interface Box.
Thermosalinograph (SBE45)	Measure temp. and conductivity at sampling board. Salinity is calculated.	Serial to Interface Box.
Interface Box (SBE90402)	Signals management.	Serial to Moxa.
Debubbler	Reduces bubbles through instruments.	None.
Transmissometer (CST)	Measure of transmittance.	Analogue to NUDAM.
Fluorometer (WS3S)	Measure of fluorescence.	Analogue to NUDAM.

Air temperature and humidity probe (HMP45A, HMP155)	Temperature and humidity at met. platform.	Analogue to NUDAM.
Ambient light sensors (PAR, SKE510; TIR, CMP6)	Ambient light at met. platform.	Analogue to NUDAM.
Barometer (PTB110, PTB210)	Atmospheric pressure at met. platform.	Analogue to NUDAM.
Anemometer (Windsonic)	Wind speed and direction at met. platform.	Serial to Moxa.
NUDAM	A/D converter.	Serial NMEA to Moxa.
Moxa	Serial to UDP converter.	UDP NMEA to Surfmet VM.
Surfmet Virtual Machine	Data management.	UDP NMEA to TechSAS, RVDAS.

The calibration functions below refer to both the TechSAS and RVDAS data products.

Table 6.17 Calibration functions applied to both the TECHSAS and RVDAS products

Component	Calibrated product steps
SBE38: Temperature (°C)	No calibration to apply because the residuals are below uncertainty.
SBE45: Temperature (°C)	No calibration to apply because the residuals are below uncertainty.
SBE45: Conductivity ($S\ m^{-1}$)	No calibration to apply because the residuals are below uncertainty.
HMP155: Temperature (°C)	
HMP155: Relative humidity (%)	No calibration to apply because the residuals are below uncertainty.
PTB110 / PTB210: Pressure (hPa)	No calibration to apply because the residuals are below uncertainty.
Windsonic: Wind speed ($m\ s^{-1}$)	No calibration to apply.
Windsonic: Wind direction ($m\ s^{-1}$)	

The calibration functions below refer to the TechSAS data products only.

Table 6.18 Calibration functions applied to the TECHSAS data products

Component	Calibrated product steps	
	TechSAS NetCDF	TechSAS NMEA
CST: Transmission (%)	Product = $(\text{Data} - V_{\text{dark}})/(V_{\text{ref}} - V_{\text{dark}})$. Here product has units % and data, V_{dark} and V_{ref} have units V.	
WS3S: Fluorescence ($\mu\text{g L}^{-1}$)	Product = Coefficient \times (Data – Offset). Here product has units $\mu\text{g L}^{-1}$, coefficient has units $\mu\text{g L}^{-1} \text{V}^{-1}$, and data and offset have units V.	
SKE510: PAR (W m^{-2})	Product = $\text{Data} \times \left(\frac{10^6}{\text{Coefficient}}\right)$. Here product has units W m^2 , data has units 10^{-5}V , the 10^6 scalar has units $\mu\text{V V}^{-1}$, and coefficient has units $\mu\text{V m}^2 \text{W}^{-1}$.	Product = $\text{Data} \times \left(\frac{10}{\text{Coefficient}}\right)$. Here product has units W m^2 , data has units W m^2 , the 10 scalar has units $\mu\text{V m}^2 \text{W}^{-1}$, and coefficient has units $\mu\text{V m}^2 \text{W}^{-1}$.
CMP6: TIR (W m^{-2})	Product = $\text{Data} \times \left(\frac{10^6}{\text{Coefficient}}\right)$. Here product has units W m^2 , data has units 10^{-5}V , the 10^6 scalar has units $\mu\text{V V}^{-1}$, and coefficient has units $\mu\text{V m}^2 \text{W}^{-1}$.	Product = $\text{Data} \times \left(\frac{10}{\text{Coefficient}}\right)$. Here product has units W m^2 , data has units W m^2 , the 10 scalar has units $\mu\text{V m}^2 \text{W}^{-1}$, and coefficient has units $\mu\text{V m}^2 \text{W}^{-1}$.

The calibration functions below refer to the RVDAS data products only.

Table 6.19 Calibration functions applied to the RVDAS data products

Component	Calibrated product steps	
	RVDAS raw text	RVDAS NetCDF & CSV
CST: Transmission (%)	Product = $(\text{Data} - V_{\text{dark}})/(V_{\text{ref}} - V_{\text{dark}})$. Here product has units % and data, V_{dark} and V_{ref} have units V.	
WS3S: Fluorescence ($\mu\text{g L}^{-1}$)	Product = Coefficient \times (Data – Offset). Here product has units $\mu\text{g L}^{-1}$, coefficient has units $\mu\text{g L}^{-1} \text{V}^{-1}$, and data and offset have units V.	
SKE510: PAR (W m^{-2})	Product = $\text{Data} \times \left(\frac{1000}{\text{Coefficient}}\right)$. Here product has units W m^2 , data has units mV, the 1000 scalar has units $\mu\text{V mV}^{-1}$, and coefficient has units $\mu\text{V m}^2 \text{W}^{-1}$.	Product = $\text{Data} \times \left(\frac{10}{\text{Coefficient}}\right)$. Here product has units W m^2 , data has units W m^2 , the 10 scalar has units $\mu\text{V m}^2 \text{W}^{-1}$, and coefficient has units $\mu\text{V m}^2 \text{W}^{-1}$.
CMP6: TIR (W m^{-2})	Product = $\text{Data} \times \left(\frac{1000}{\text{Coefficient}}\right)$.	Product = $\text{Data} \times \left(\frac{10}{\text{Coefficient}}\right)$.

	Here product has units $W m^2$, data has units mV , the 1000 scalar has units $\mu V mV^{-1}$, and coefficient has units $\mu V m^2 W^{-1}$.	Here product has units $W m^2$, data has units $W m^2$, the 10 scalar has units $\mu V m^2 W^{-1}$, and coefficient has units $\mu V m^2 W^{-1}$.
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The NMF Surfmet system was run throughout the cruise, excepting times for cleaning, entering and leaving port, and whilst alongside. Please see the separate information sheet (Appendix 6) for details of the sensors used and whether their recorded data have calibrations applied or not.

Table 6.20 Surface water sampling board maintenance

Date	Time start*	Time end*	Event	Trans high (V)	Trans low (V)	Fluoro (V)	Salinity (PSU)
23-09-2025	17:53		Water On				
24-09-2025	08:17		SBE38+45 On				
28-09-2025	16:41		Water Off				
28-09-2025	18:20		Water On				
04-10-2025	09:11	09:34	Maintenance	4.7525	0.0058	-	-

The system was cleaned before and after the cruise.

6.6.3.5.2. Wave radar

Table 6.21 Details of the WAMOS wave radar settings

System	WAMOS Wave Radar
Data product(s)	<p>NMEA (wamos, rexwr): /Ship_Systems/Data/TechSAS/NMEA/</p> <p>NetCDF: /Ship_Systems/Data/TechSAS/NetCDF/NC</p> <p>Raw NMEA (WAMOS, REX2): /Ship_Systems/Data/RVDAS/Raw_TXT</p>

	Raw & processed NetCDF (WAMOS, REX2): /Ship_Systems/Data/RVDAS/Database_NetCDF	
	Raw NMEA (WAMOS, REX2): /Ship_Systems/Data/RVDAS/Database_CSV	
Data description	/Ship_Systems/Metadata/WAMOS /Ship_Systems/Data/RVDAS/Sensor_metadata /Ship_Systems/Metadata/Techsas/Data_Description /Ship_Systems/Metadata/RVDAS/Data_Description	
Other documentation	/Ship_Systems/Documentation/WAMOS	
Component	Purpose	Outputs
Rutter OceanWaves WAMOS	Measure wave height, direction, period and spectra.	Summary statistics in NMEA to TechSAS and RVDAS. Spectra files.
RsAqua Rex2 Wave Height Sensor	Measure wave height at bow to provide calibration reference dataset.	Wave height NMEA, UDP to TechSAS, RVDAS.
Furuno Radar	Measures radar reflection on sea surface.	Radar data to WAMOS.

The wave radar magnetron requires annual replacement. Following replacement, WAMOS needs to collect wave data within 5 km of another wave height sensor over the full range of sea-states in order to derive wave height calibration coefficients for the new magnetron. This reference dataset can be derived by examining the ship's track for wave buoys and downloading their data, or by using the onboard RsAqua Wave Height sensor fitted on the ship's bow.

6.6.3.6. Hydroacoustic systems

Table 6.22 Details of the hydroacoustic data delivered on DY200

System	Acoustics
Data product(s)	Raw (EA-640, EM-122): /Ship_Systems/Data/Acoustics NMEA (eadep, emdep): /Ship_Systems/Data/TechSAS/NMEA NetCDF (EA600, DEPTH): /Ship_Systems/Data/TechSAS/NetCDF Raw NMEA (EA640, EM122): /Ship_Systems/Data/RVDAS/Raw_TXT Raw & processed NetCDF (EA640, EM122): /Ship_Systems/Data/RVDAS/Database_NetCDF

	Raw NMEA (EA640, EM122): /Ship_Systems/Data/RVDAS/Database_CSV	
Data description	/Ship_Systems/Metadata/Acoustics /Ship_Systems/Data/RVDAS/Sensor_metadata /Ship_Systems/Metadata/Techsas/Data_Description /Ship_Systems/Metadata/RVDAS/Data_Description	
Other documentation	/Ship_Systems/Documentation/Acoustics	
Component	Purpose	Operation and Outputs
10/12 kHz Single beam (Kongsberg EA-640)	Primary depth sounder	Continuous, free running/ Discrete / Unused NMEA over serial, raw files
12 kHz Multibeam (Kongsberg EM-122)	Full-ocean-depth multibeam swath.	Continuous, free running/ Discrete / Unused Binary swath, centre-beam NMEA, *.all files, optional water column data
70 kHz Multibeam (Kongsberg EM-710)	Coastal/shallow multibeam swath.	Continuous, free running/ Discrete / Unused Binary swath, centre-beam NMEA, *.all files.
Sub-bottom Profiler (Kongsberg SBP-27)	Multi-frequency echogram to provide along-track sub-bottom imagery.	Continuous, free running/ Discrete / Unused BMP, raw files, optional water column data.
Drop keel sound velocity sensor	Provide sound velocity at transducer depth	Continuous, free running/ Discrete / Unused Value over serial to Kongsberg SIS.
Sound velocity profilers (Valeport Midas, Lockheed XBT)	Direct measurement of sound velocity in water column.	Continuous, free running/ Discrete / Unused ASCII pressure vs sound velocity files. Manually loaded into Kongsberg SIS or Sonardyne Ranger2.

75 kHz ADCP (Teledyne OS75)	Along-track ocean current profiler	Continuous, free running/Discrete/Unused (via UHDAS)
150 kHz ADCP (Teledyne OS150)	Along-track ocean current profiler	Continuous, free running/Discrete/Unused (via UHDAS)
USBL (Sonardyne Ranger2)	Underwater positioning system to track deployed packages or vehicles.	Continuous, free running/Discrete/Unused NMEA over serial
CARIS	Post-processing	Continuous, free running/Discrete/Unused CARIS Project file. CARIS Vessel files
MB-System	Post-processing	Continuous, free running/Discrete/Unused XYZ, SegY files

6.6.3.6.1. Marine mammal protection

Table 6.23 Marine Mammal Observation activities

Date	System	Obs. Start Time	Sys. Start Time Full Power	Notes (inc. any observations or actions)
27-09-2025	SBP27	15:00-15:00	15:33, soft start	Power was increased to -19 at deeper water, and reduced back to -29 in shallow
05-10-2025	SBP27	12:30- 13:13	13:13, soft start	Power was increased to -19 at deeper water, and reduced

				back to -29 in shallow
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6.6.3.6.2. Sound velocity profiles

Sound velocity profiles were measured directly with a Midas SVP, derived from CTD or calculated from the WOA13 model using Ifremer DORIS.

Serial number of instrument used: #034=41603

Path of sound velocity profile data on the cruise datastore:

`/Ship_Systems/Data/Acoustics/Sound_Velocity`

Details of when sound velocity profiles were taken and applied are shown in the table below:

Table 6.24 Sound velocity profiles.

Datetime	Method	Location (Lat/Lon)	Filename	Datetime SVP applied to SIS / Ranger2
24/09/2025 13:39	SVP Deployed SVP Recovered	50.39611 7.72322	WP001	2025-09-24
24/09/2025 14:04	SVP Deployed SVP Recovered	50.3961 7.72322	WP001 WP058	18:23:11
24/09/2025 15:47	SVP Deployed SVP Recovered	50.39352 7.71746	WP058	2025-09-26
26/09/2025 09:53		50.24017 7.93609	WP036	11:53:02
26/09/2025 10:04		50.24018 7.93608	WP036	
28/09/2025 18:25		48.31915 9.89648		2025-09-28
28/09/2025 20:15		48.31915 9.89649		20:33:47

6.6.3.7. Equipment-specific comments

6.6.3.7.1. ADCPs

Table 6.25 ADCP settings

Attribute	Value
Acquisition software	UHDAS
Frequencies used	75 kHz, 150 kHz
Running mode	Free-running (untriggered)

6.6.3.7.2. EM-122 configuration and surveys

Path of Multibeam data on the cruise datastore:

/Ship_Systems/Data/Acoustics/EM-122

Path of EM122 CARIS Vessel Configuration File:

/Ship_Systems/Data/Acoustics/EM-122/CARIS_Processed/VesselConfig

Table 6.26 EM122 specifications

Attribute	Value			
Number of surveys	(TBC)			
Date of patch test	Not undertaken.			
Offsets and rotations	Item	X (m, + Forward)	Y (m, + Starboard)	Z (m, + Down)
	Tx transducer	19.205	1.830	6.934
	Rx transducer	14.094	0.950	6.932
	Item	Roll (deg)	Pitch (deg)	Yaw (deg)
	Tx transducer	-0.35	-0.1	0.19
	Rx transducer	-0.06	0.1	0.15
Post-processing undertaken	None.			

6.6.3.7.3. EM-710 configuration and surveys

Path of Multibeam data on the cruise datastore:

`/Ship_Systems/Data/Acoustics/EM-710`

Path of EM122 CARIS Vessel Configuration File:

`/Ship_Systems/Data/Acoustics/EM-710/CARIS_Processed/VesselConfig`

Table 6.27 EM710 specifications

Attribute	Value			
Number of surveys	(TBC)			
Date of patch test	Not undertaken.			
Offsets and rotations	Item	X (m, + Forward)	Y (m, + Starboard)	Z (m, + Down)
	Tx transducer	37.570	-1.994	7.425
	Rx transducer	36.819	-2.051	7.427
	Item	Roll (deg)	Pitch (deg)	Yaw (deg)
	Tx transducer	-0.07	-0.33	0.22
	Rx transducer	-0.01	0.12	359.7
Post-processing undertaken	None.			

6.6.3.7.4. USBL configuration and deployments

Path of Multibeam data on the cruise datastore:

NMEA: `/Ship_Systems/Data/TechSaS/NMEA/usblp`

NetCDF: `/Ship_Systems/Data/TechSaS/NetCDF/USBL`

\$PERSONLLD ASCII:

`/Ship_Systems/Data/RVDAS/rawdata/*RANGER2USBL*.txt`

Table 6.28 USBL specifications

Attribute	Value
Number of deployments	16
Heads used for operations	1 - Starboard
Datetime of last CASIUS	N/A
Port Head 1DRMS	
Starboard Head 1DRMS	

6.6.3.7.4. Cable logging and monitoring

Winch activity is monitored and logged using the CLAM system.

6.7. Ecoreef deployment

Operational team: Tim Powell, Ben Poole

In total 15 Ecoreefs were deployed during DY200. Twelve were of the “cake” type which had narrow holes through which steel lifting strops were threaded. The other 3 were of the “star” type with threaded U-shaped steel bar lifting points.

The 12 “cake” type reefs were prepared by routing 5m long, 6mm 7x19 galvanised steel lifting strops through the holes within the body of the reef. This wire was chosen as it was the thinnest and therefore most flexible wire easily available that would be strong enough to lift the reefs whilst complying with lifting regulations.

Both ends of the wire strops were attached to the acoustic release hook. One end of each strop was attached with 1.8mm polypropylene line to the shackle above the acoustic release to act as a weak link should a strop become snagged.

The setup for the “star” type reefs was similar except that a webbing strop was used instead of the steel wires as the risk of snagging was much less. The strop was routed through the lifting point, one end was attached to the acoustic release hook and the other end attached to the shackle connecting the acoustic release to the ships wire.

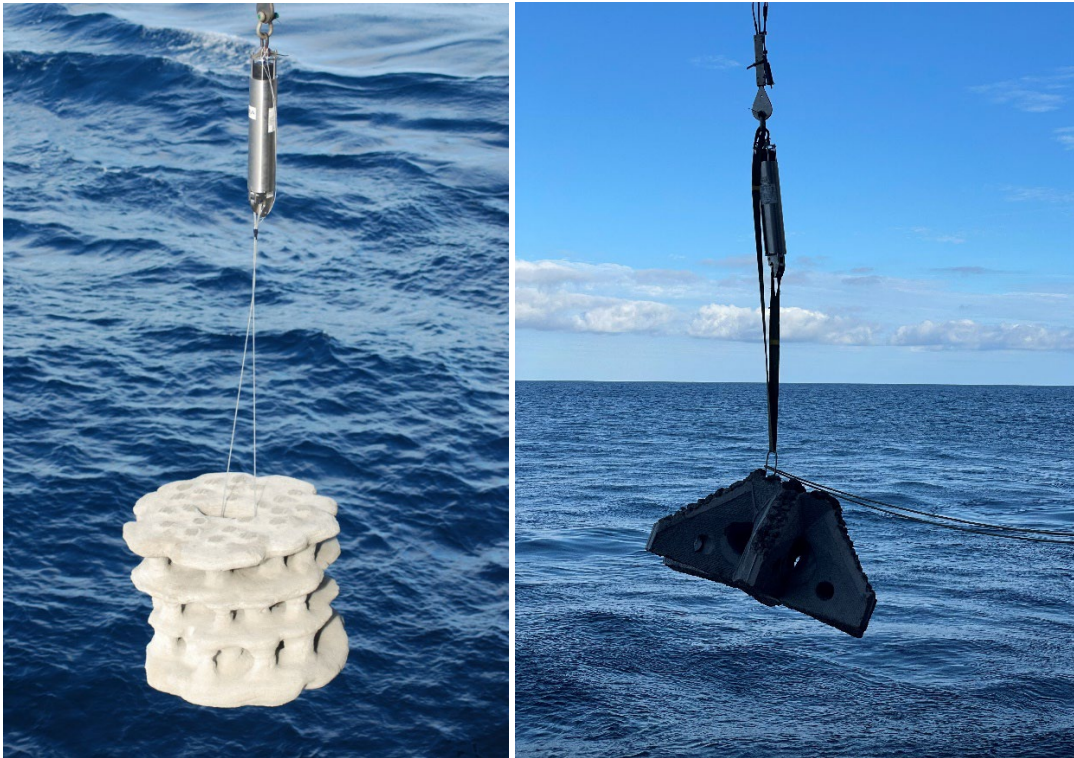


Fig. 6.31 Deployment setup for the ecoreefs: Large wedding cake (left) and star shape (right)

The reefs were lowered to the seabed using the CTD1 wire routed over the bullhorn and released using an Ixsea AR861 acoustic release. A USBL beacon was clamped to the wire 20m up from the end to provide accurate deployment position information. Active heave compensation was used to ensure a gentle landing on the seafloor.

All the reefs were successfully deployed with no hardware being left on the seabed.

6.8. Anchor Frame

Operational team: Callum Duguid & Konrad Ciaramella

An anchor system has been designed and developed to go on Autosub Long Range (ALR), to enable the vehicle to anchor on the sea floor. This is a part of the DECADES project, where it is intended for the ALR to monitor a transect below the Antarctic ice shelf for a year, repeatedly anchoring and hibernating between transects to conserve energy.

Each anchor comprises of a cylindrical pressure vessel held by vacuum against a top plate – in this state the AUV is positively buoyant for normal operation. When it is time for hibernation, an electrically activated valve opens allowing water to enter the cylinder and release it. In this state, the AUV has negative buoyancy - the cylinder falls to the sea floor keeping the AUV stationary by a tether. Once hibernation is completed, a second mechanism releases the tether - returning the AUV to normal buoyance for the next transect. Both anchor deployment and anchor release mechanisms are controlled by fizzlelinks – short loops of Inconel wire which erode in sea water via galvanic corrosion when exposed to voltage.

The anchor system is designed to operate in depths up to 1500m, and individual components have been tested in the NOCs pressure pot. However, due to the nature of the design it is difficult to test the complete system.

The aim on DY200 was to test the anchor systems independently of the ALR, at full operational depth. The testing frame consisted of:

- Three anchor systems - ACT-000151(G)
- An anchor control electronics pod
- Two lights to illuminate the anchors
- 4K camera
- Acoustic recorder to record how the anchors operate during each test.

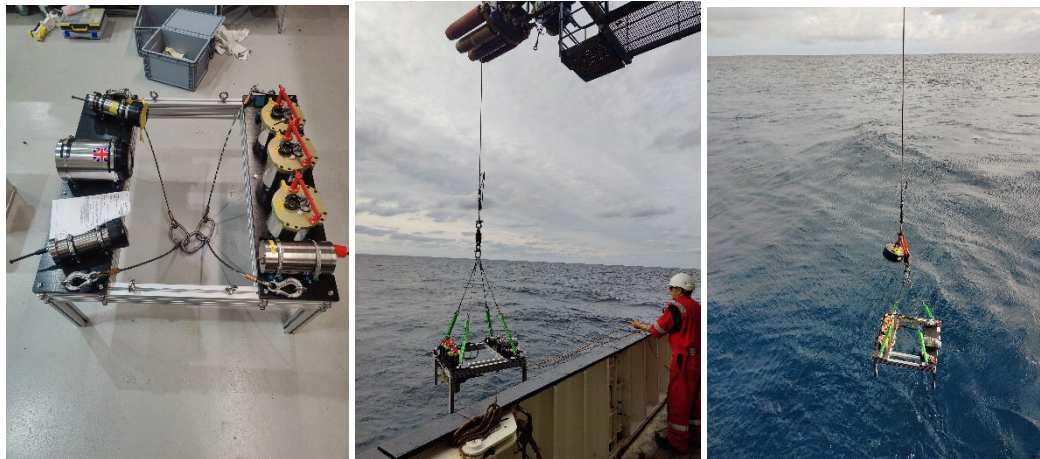


Fig 6.32 Anchor test frame (left), deploying the test frame (middle and right)

Table 6.29 Summary of Anchor Frame Tests

Test #	Depth	# of Successes	Comments
1	50m	3/3	-
2	200m	3/3	<ul style="list-style-type: none"> • 90kg mass added to maintain tension on the wire.
3	500m	1/3	<ul style="list-style-type: none"> • Pos3 anchor deployed at ~95m depth • Pos1 anchor deployed at ~70m depth
4	800m	0/3	<ul style="list-style-type: none"> • All anchors failed to deploy, one remained attached and only detached while being lowered to the deck. None of the secondary links were fized • Sign that descent rate was too high – video shows lifting strop tangling with the Rightmost lever arm for several minutes when the frame is jostled during descent
5	800m	2/3	<ul style="list-style-type: none"> • Modified the lever arm position to ensure the flood valve quad-rings are equidistant from the outlet orifices • Pos3 anchor failed to deploy, damage to quad-ring was observed where it slides over the outlet orifices. quad-ring was replaced.

6	800m	2/3	<ul style="list-style-type: none"> • Lever arms were observed to be flexing, so they were replaced with new stiffened 3D Printed versions. • Pos3 anchor failed to deploy. Scoring noted on the valve internals, signs of possible rubbing and added friction.
7	800m	3/3	<ul style="list-style-type: none"> • Pos3 anchor mechanism was swapped out with a spare due to the observed internal scoring. • An additional 40kg was added to the frame to maintain tension on the wire.
8	1500m	0/3	<ul style="list-style-type: none"> • Deeper test with new style fizzlinks. Fizzing took longer than the allowed time with all first links half eroding, meaning the arms were not fully released within the 2.5mins allowed. It is possible that a longer duration fizz energisation would have fully depleted the fizzlink allowing the valve to open fully. • Pos1 and Pos2 anchors failed to deploy • Pos2 anchor flooded, but ~10mins late

Future Work:

A number of issues were identified from the tests conducted during the cruise, which will need to be addressed before the final under ice deployment. This are:

- Redesign lever arm to reduce flex
- Update piston valve to optimise valve travel and prevent bushing collision
- Consider stronger spring and/or higher lever ratio
- Redesign valve
 - More resilient material selection
 - Investigate larger ports to improve filling rate
 - Reshaped internals to reduce quad-ring wear
- Long term vacuum hold tests
- Testing of redesigned mechanism at NOC

7. SCIENTIFIC METHODS AND INITIAL RESULTS

7.1. Acoustic mapping & profiling (*Tim Le Bas*)

7.1.1. Shipboard Multibeam Systems: EM122 and EM710 Bathymetry & Backscatter

Data were collected throughout the time but only data for the specific survey areas were processed. Survey at Haig Fras was set to 65/65 degree swath and line spacing of 320m, although in some cases this was adjusted to ensure full cover. The survey was carried out in 4 parts:

Files 0072 – 0101 Haig Fras – North of MCZ

Files 0111 – 0149 Haig Fras – West of area above

Files 0150 – 0159 Haig Fras – East of MCZ (infill track)

An old SIS configuration was required when the current configuration ceased to work. This was done by using an old computer.

Files 0026 – 0038 Haig Fras – East of MCZ (more infill tracks)

It took some time to conclude that the absorption coefficients had been corrupted on the original system and when corrected allowed further data to be collected. Data was collected on transit to Whittard Canyon and during other operations there. Whittard Canyon area data were not processed during the cruise.

7.1.1.1. Shipboard bathymetry data processing

All the bathymetry processing was done using QPS Qimera v2.7.3. The import and basic input for the 2 bathymetry systems is listed below. Once within the Qimera program, the data were trimmed using the across-track filter to remove the far range soundings which were increasing in uncertainty. Following this a significant amount of time was spent cleaning the overlap areas. In much of the far range overlap areas it was extremely difficult to discern where the true seafloor signature was located. However, the difference between points was within a few metres and therefore not deemed to be excessive. CUBE processing of the final mosaic was done and exported to QGIS with a 2.5m resolution pixel size. Within QGIS a slope map was created from this. This highlighted the far range overlap areas having high slopes and any locations of anomalous values. To correct these, a “tree filter” was applied. This is a median filter of a small area and then any pixels that are more than a threshold height away from the median are replaced by the median value. It was found that an area of 7 x7 pixels and a threshold height of 0.1m was optimal for the Haig Fras area. It removes a lot of the jitter from the far range overlap areas without noticeably changing any of the actual seafloor features previously seen in the map.

Processing steps:

Qimera

1. New Project
 - i. Import raw data
 - ii. Add tide
 - iii. Add Sound Velocity Profile .asvp
2. Process data
3. Create New Dynamic Grid – Cube 2.5m resolution
4. Filter - Across track -180 to +180 (as lines were planned 320m apart)
5. 2D and 3D editing of spurious values

6. Export Dynamic Grid
 - a. Export to ASCII/Grid
 - b. Export Floating Point GeoTIFF Grid

7.1.1.2. Shipboard backscatter data processing

Backscatter processing was done in FMGT v7.10.1. Input of data is very easy, with any cross lines being removed to aid interpretation. Processing can take the computer considerable time (hours) depending on the number of datafiles and their size. Creation of a backscatter mosaic was done at 1m resolution and exported to QGIS as a GeoTif.

FMGT

1. Create new project
 - a. Single projected coordinate system
 - b. select appropriate UTM zone e.g. Zone 29 is -12° to -6° Longitude)
2. File – Add Source Files
3. Pixel Size window – Edit - Mosaic 1.000 m
4. Mosaic
5. Export (on Visual Objects Tab right click)
 - a. Surface
 - b. Export Floating Point GeoTIFF Grid

Table 7.1 EM710 offsets

EM710	Forward (X)	Starboard (Y)	Downward (Z)
Tx Transducer	37.57	-1.994	7.425
Rx Transducer	36.819	-2.051	7.427
Waterline			1.00

EM710	Roll	Pitch	Heading
Tx Transducer	-0.07	0.33	0.22
Rx Transducer	0.01	0.12	359.7
Attitude 1 COM2/UDP5	-0.14	-0.4	-1.00
Attitude 2 COM3/UDP6	0.00	0.00	0.00

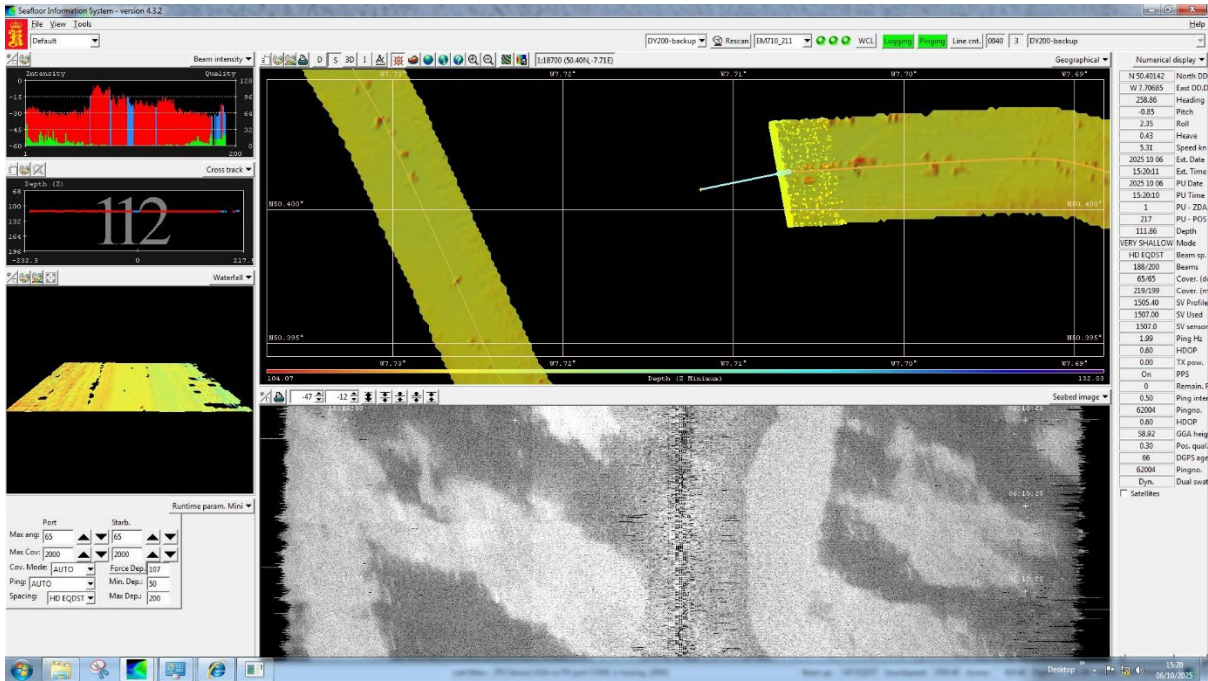


Fig. 7.1 Screenshot of EM710 data acquisition using the SIS software

7.1.1.3. Tide corrections

The polpred online application website was utilised to get tide values to correct the multibeam systems. This is a licensed software application and requires a login id (tlb@noc.ac.uk) password (Sev*****21) and MAP product key: gjp*****. Its address is <https://apps.noc-innovations.co.uk/app/polpred-offshore/>. We used the model GTM_16HC GTM whole domain which can be used for the period: Jan 2018 to end Aug 2030

The software outputs .csv files which can be easily imported in Qimera using the following conversion criteria:

```
header-line-count="5"
encoding="UTF-8"
1st field date-time-field format="yyyy_MM_ddThh:mm:ssZ" mapping="time"
2nd field numeric "tide"
3rd field numeric " none "
4th field numeric " none "
```

Two tide files were created for the two survey areas:

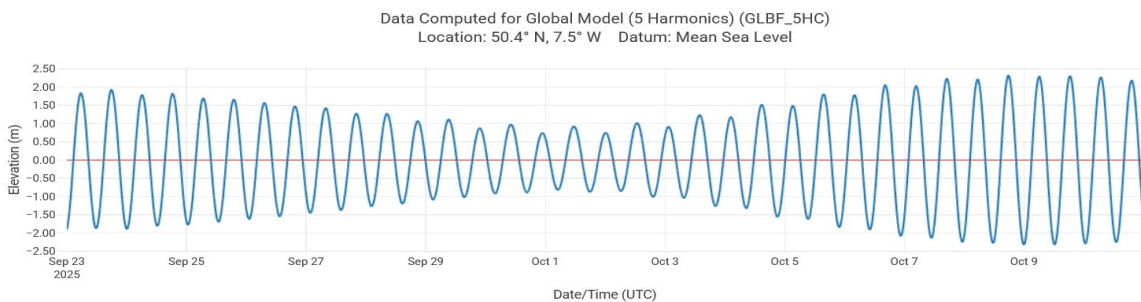


Fig. 7.2 Tidal correction file for Haig Fras

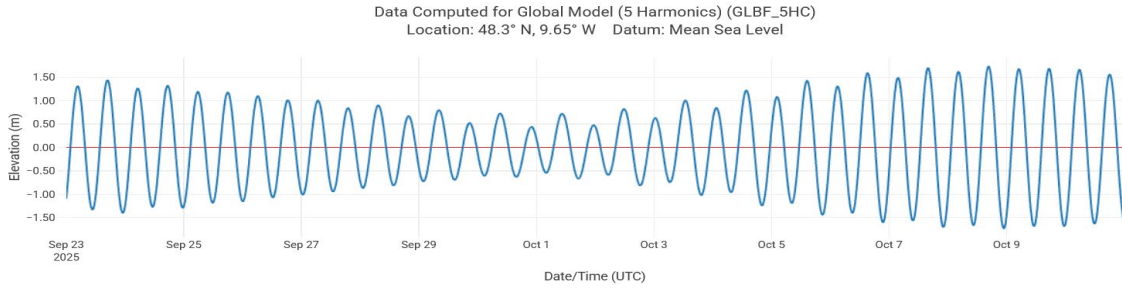


Fig. 7.3 Tidal correction file for Whittard Canyon

7.1.1.4. Sound velocity profiles

Sound velocity profiles were taken either from the CTD system and calculated or by using the SV probe attached to the CTD frame. Example datasets:

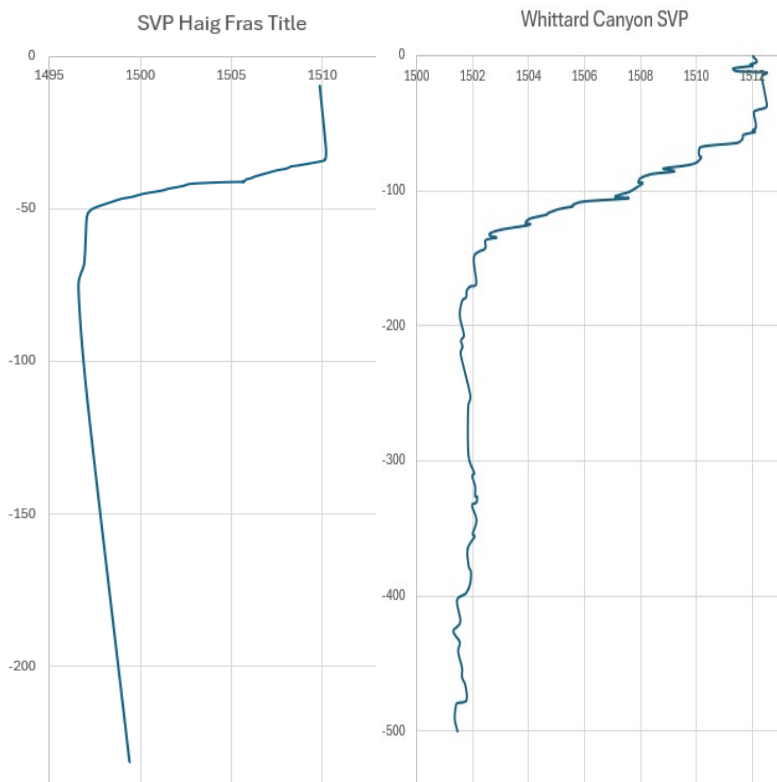


Fig. 7.4 Example sound velocity profiles for the two main study sites. Note the different range for the Y-axis

7.1.2. Shipboard SBP System

The sub-bottom profiler (SBP 27) comprises a linear transmitter array and a linear hydrophone array shared with the shipboard EM122 multibeam system. It is a narrow beam system (3°) that was operated with a linear chirp (2.5-6.5 kHz).

The SBP was switched on for most of the cruise (following MMO observations), but only for selected transits or ecoreef pre-deployment surveys were the data collected and monitored.

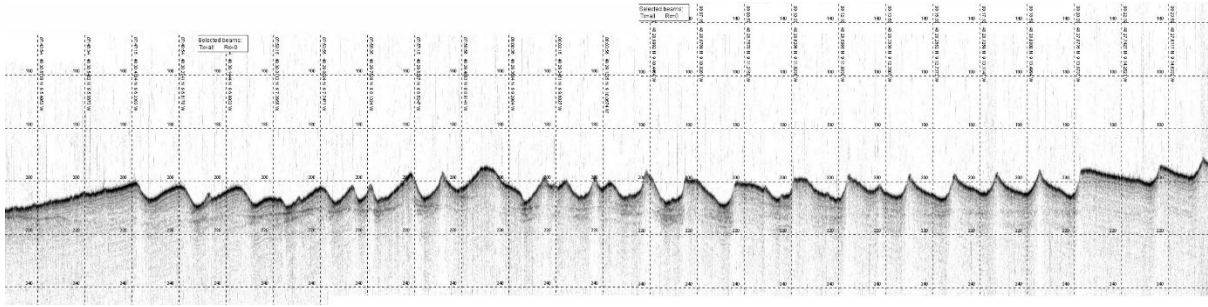


Fig. 7.5 Example of DY200 SBP 27 record, illustrating sediment waves on the flank of a relict Celtic Sea sandbank.

7.1.3. Autosub5 Multibeam Bathymetry & Backscatter

There are several data formats available from this system, at different levels of pre-processing. The formats are sequential and will end with .s7k files which have the Sprintnav navigation inserted (type 4). The types, and required processing steps, are:

1. .log
 - a. "cmd" and cd to Multibeam directory
 - b. `wbm_tool -c < NorbitBathyRaw....log> <NorbitBathyRawData_Sidescan....log>`
2. .wbm
 - a. WBMS_GUI application
 - b. Playback Tab – Browse to Multibeam Directory and the "0" directory
 - c. Select sonarFile.wbm
 - d. Export to s7k...
 - e. Check numbers of pings and export to a s7k file(s)
3. .s7k (large)
 - a. "cmd" and cd to Multibeam directory
 - b. `s7knavmerge -d 600 -a <Output.s7k> <Autosub_Norbit_Janus_Nav.asc>`
4. .s7k (with navigation) ...navmerge-janus.s7k

Table 7.2 Autosub5 Mapping surveys conducted on DY200

Mission No	MBES	Sidescan	Location	Comments
124	✓	✓	Haig Fras	
127	✓		Dangeard Interfluve	3 parts to survey
128		✓	Dangeard Interfluve	
129		✓	Haig Fras	5m altitude
131	✓	✓	Dangeard Interfluve	
133	✓		Explorer Interfluve	

Multibeam surveys were set to 50m altitude giving a swath width of about 250m. Lines were programmed for 150m spacing and so an across track filter of +/- 100m was applied.

For Backscatter imagery the bathymetry data must be processed before creation of a backscatter mosaic. Once the bathymetry data is processed a set of .gsf files must be created. It is the pairing of the .s7k and .gsf files that is required for backscatter processing in FMGT.

Qimera v2.7.5

1. New project
 - a. Single projected coordinate system
 - b. Import raw data (...navmerge-janus.s7k)
 - c. Add tide
 - d. Add SVP
2. Select Source files – Edit Vessel Configuration
 - a. Vessel Type AUV
 - b. NORBIT WBMS Bathy 400kHz
 - i. Tx Transducer Offsets
 - ii. Forward 1.502
 - iii. Up 0.441
 - iv. Rx Transducer Offsets
 - v. Forward 1.502
 - vi. Up 0.441
3. Process data
4. Create New Dynamic Grid – Cube
5. Patch Test for roll
 - a. Select Source files – Edit Vessel Configuration
 - i. Roll 1.8°
6. Process data
7. Create New Dynamic Grid – Cube
8. Wobble Test for latency
 - a. Select Source files – Edit Vessel Configuration
 - i. Motion 1 -1.0 or 0.0 (determined from the wobble test)
 - ii. Position 1 -1.0
 - iii. Depth -1.0
9. Process data
10. Create New Dynamic Grid – Cube
11. Edit Processing Settings
 - a. Select Blocking
 - i. Across track -100 to 100
12. Process data
13. Create New Dynamic Grid – Cube
14. Export Dynamic Grid
 - a. Export to ASCII/Grid
 - b. Export Floating Point GeoTIFF Grid
15. Export Raw Sonar Files
 - a. Export to GSF (for backscatter processing in FMGT)

FMGT v7.10.1

1. Create new project
 - a. Single projected coordinate system
 - i. select appropriate UTM zone e.g. Zone 29 is -12° to -6° Longitude)
2. File – Add Source/Paired Files
 - a. Select s7k files

- b. Select gsf files
- 3. Mosaic
 - a. Pixel Size window – Edit - Mosaic 1.000 m
 - b. Mosaic
- 4. Export
 - a. On Visual Objects Tab right click
 - b. Surface
 - i. Export Floating Point GeoTIFF Grid

7.1.4. Autosub5 Sidescan

Data import of .jsf files into SonarWiz v8.0. This requires a license which is available on the NOC network so requiring VPN connection (via Global Connect). Network IP for the license server is currently 192.168.168.12

On acquisition the Edgetech sidescan is given the standard navigation which can then be improved by incorporating the SprintNav navigation data. This is provided separately as a single ASCII file and needs to be “injected” into the .jsf files. This is done with the NavInjector application and needs the SonarWiz license to be active. A new Navigation File Template needs to be created for data input.

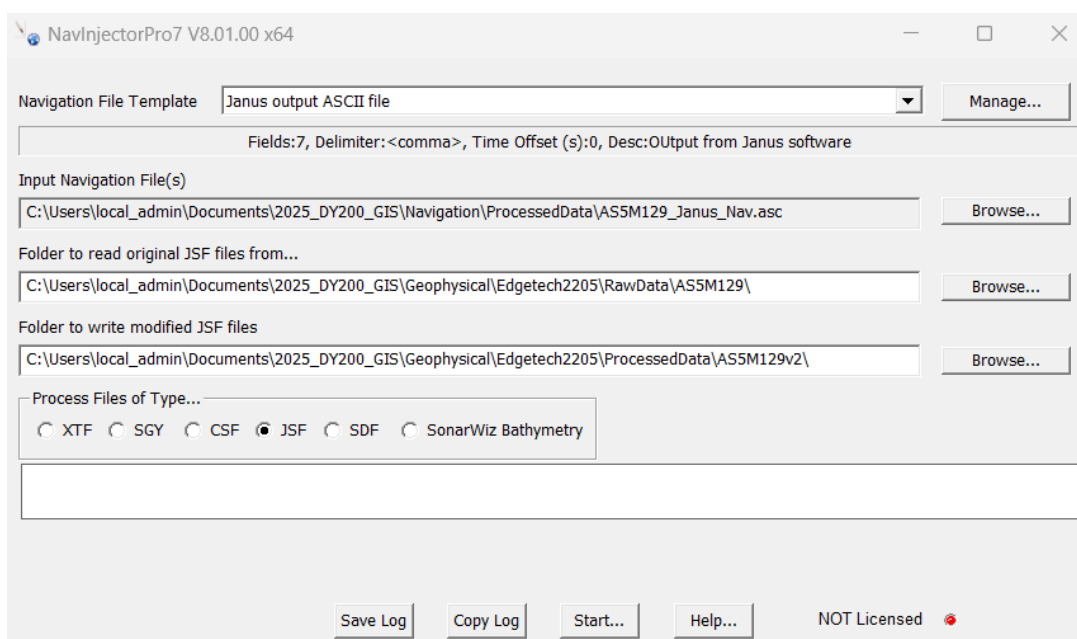


Fig. 7.6 Screenshot of the navinjector in SonarWiz

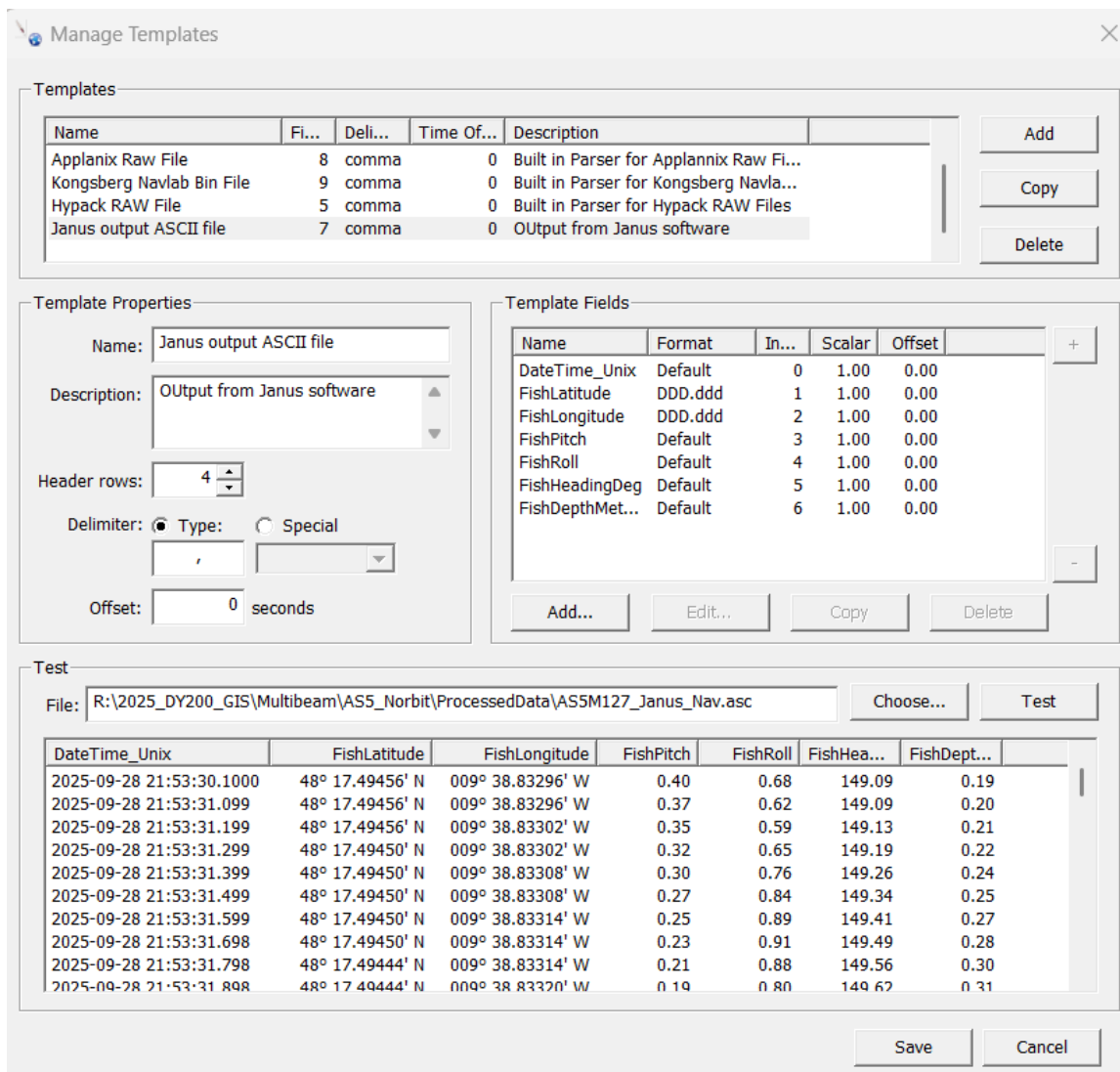


Fig. 7.7 Screenshot of settings for the navinjector in SonarWiz

SonarWiz v8.0

1. Data import
 - a. Set import projection system to UTM zone 29N
 - b. Import of Sidescan (Channels 3 & 4)
 - c. Import of Sub-bottom profiler data (Channel1)
2. Bottom and Far Field track each sidescan file
 - a. Change Threshold if required and Remove any spikes
3. Settings of one file
 - a. Enable EGN
 - b. Rebuild EGN Table
 - i. Check All – or all with same bottom altitudes
 - ii. Start
 - c. Apply (to single file)
4. File Manager
 - a. Select same file

- b. Make Like Selected...
- c. SSS Only: tick EGN
- 5. Set Mapping Color scale
 - a. Gray (smooth and invert)
 - b. Scale Mode – Manual
 - c. Set the minimum to be lower than the lowest actual value (so background value of 0 is not deep shadow)
- 6. Export
 - a. Save Project as Geo Image
 - i. Output filename
 - ii. 8 bit grayscale
 - iii. Tick “Make Background color transparent”
 - iv.
 - v. Specify image resolution 0.25Metres/pixel – check image size is acceptable

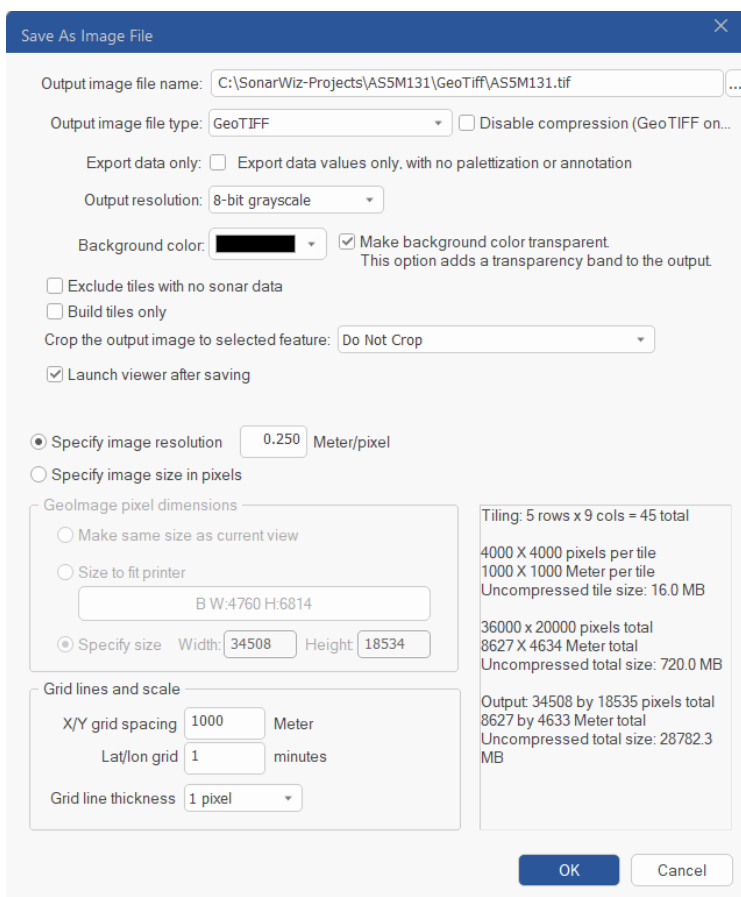


Fig. 7.8 Screenshot of the export function of Sonarwiz used for the AUV sidescan sonar data.

7.1.5. Autosub5 SBP

All sidescan sonar surveys also collected subbottom profiler data simultaneously. Some of those datasets were quickly processed in Sonarwiz for a first look:

- 1. Select one Sub-bottom file
 - a. Properties Window
 - i. Gain

1. Enable (tick) Automatic gain control
 2. Enable (tick) AutoTVG
 3. Save (click icon)
- ii. Display
1. Displayed Range
 - a. Tick Display in 3D View
 - b. Mode – Specified Range
 - c. SBP range 75m
- iii. Bottom Track...
1. Appearance
 - a. Gain Settings – Blank water column – Apply
 - b. Histo Equalise
 - c. Vertical Exaggeration about 2
- b. View Menu Item
- i. Tick Enable 3D View

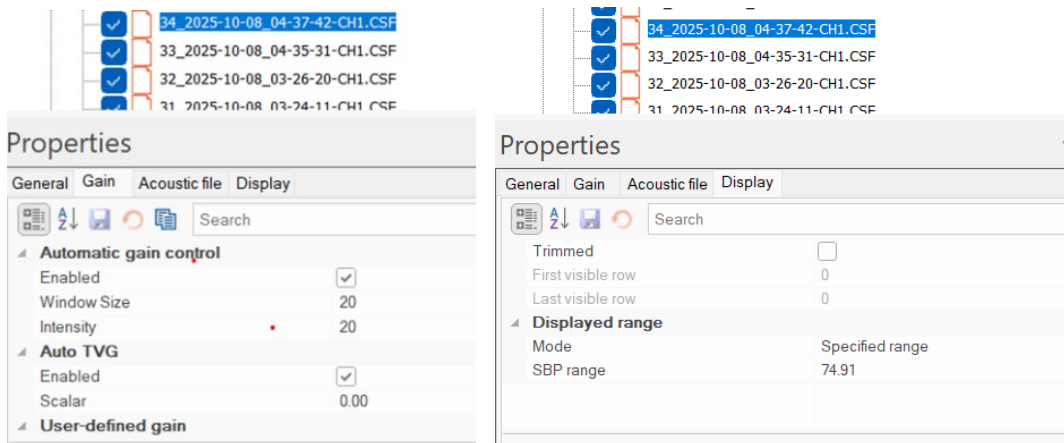


Fig. 7.9 Screenshots of the basic properties settings used to visualise the AUV sidescan sonar data

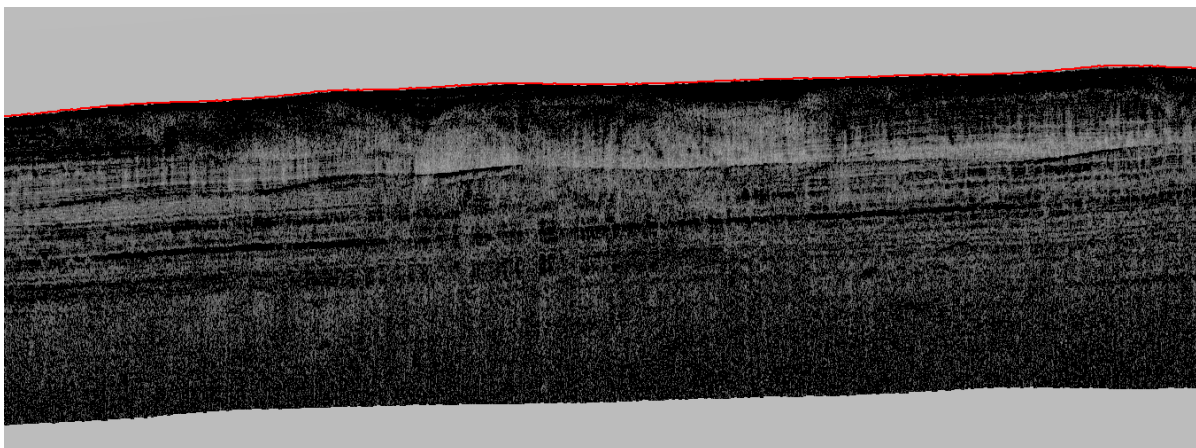


Fig. 7.10 Example AUV subbottom profile

Manipulation in 3D viewer is possible but with limited capabilities. Output can be created of 3D flythroughs or static PDF imagery. Bathymetry grids can be added to the SonarWiz project, remembering that depths in SonarWiz are positive, and negative in DEMs.

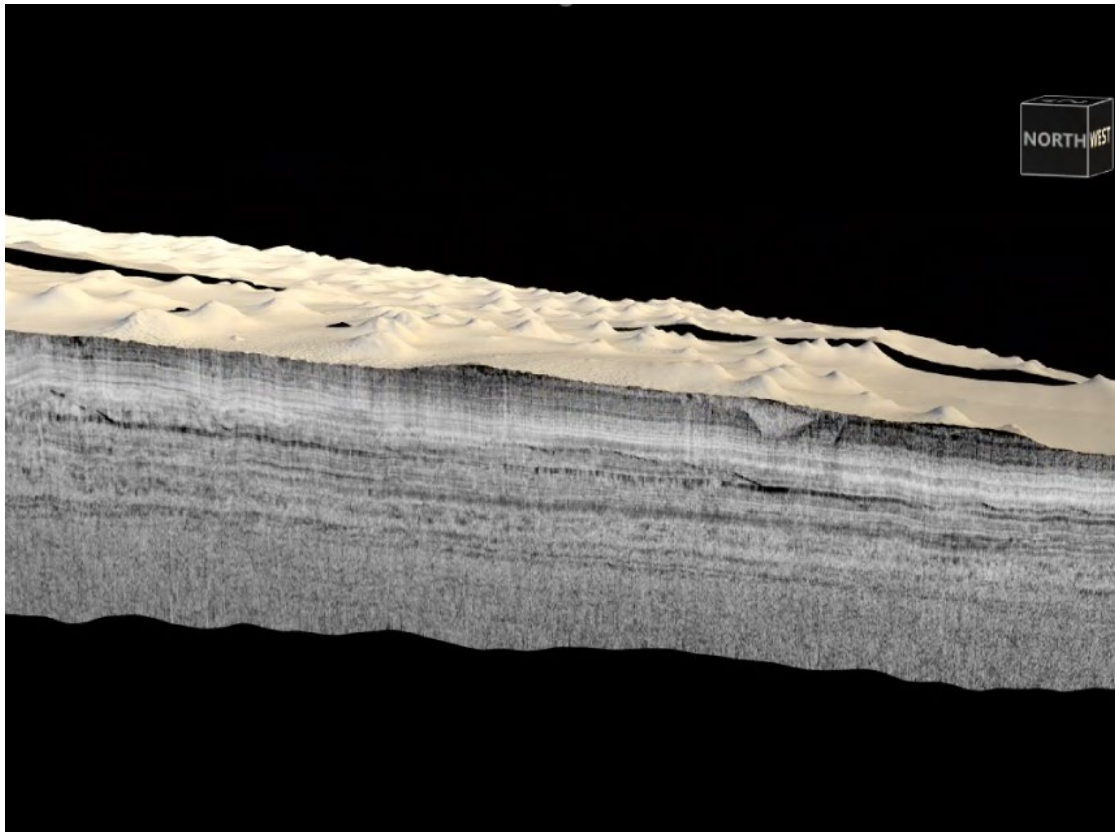


Fig. 7.11 Example of 3D visualisation of AUV bathymetry and sub-bottom profiler data.

7.2. Video surveying and photography (Brian Bett, Lisa Skein, Andy Gates, Fionnuala McBreen)

7.2.1. SeaSpyder imagery

7.2.1.1. General set-up

An off-bottom towed camera platform, STR SeaSpyder from Ocean Ecology Ltd, was used throughout the cruise, being deployed in both the Greater Haig Fras and The Canyons MCZs. The system is fitted with a digital stills camera SeaSpyder Deepwater 4000 m (SP-TC-4000T; Canon EOS 250D), SeaSpyder high power flashgun (50705-MP-FT), four scaling lasers (STR SeaDot Green Laser Pointer; MP-GLP2-6000A-0°/5mW), video camera (SeaSpectrum – Mini IP Camera; SP-MIP-4000T), four LED video lamps (STR LED – 2 – DC), altimeter and an attitude and pressure sensor. During the cruise the vehicle was also fitted with an NMF-supplied USBL beacon (Sonardyne WSM6 / 6+).

The digital stills camera was placed in a vertical orientation within the vehicle, having nominal acceptance angles of $64^\circ \times 45^\circ$ (74° diagonal) in water (via BK7 corrected dome port). Images were shot manually at c. 10-25 s intervals (apparently required flash recharge time?), in both .jpg and .CR3 formats, having dimensions of 6000×4000 px. Note that only .jpg images were reviewed at sea. Four scaling lasers were mounted in a square arrangement surrounding the digital stills camera pressure case; on deck calibration gave the laser dot side length as 17.08 cm, with a diagonal distance of 24.16

cm. Nominal camera altitude for seafloor photography was 1.2 m, with a 0.2 m offset to the altimeter, the winch operator aimed at a target telemetered altitude of 1.4 m. Telemetered altimetry was recorded. The camera platform was operated on the ship's deep-tow system and active heave compensation during all near-seabed operations.

The video camera was mounted externally on the digital stills pressure case at a down-angle of approximately 60°. Note that no vehicle attitude data were recorded, such that camera angle to the seafloor is unknown / variable. Video files, typically 1 × water column descent, 1 × seafloor transect and 1 × water column ascent, were recorded in .avi format at 1920 × 1080 px resolution and a frame rate of 25 s⁻¹.

Post-deployment, the .jpg images were briefly reviewed and 'highlight' images selected to summarise seafloor fabric variation, fauna of interest and any evidence of human impact / debris. Image Exif data from the .jpg images were stripped using the R package 'exiftoolr' with date / time manipulation carried out with the R package 'lubridate'. SeaSpyder (.txt) data files were concatenated in Windows PowerShell then manipulated in MS Excel; these data files primarily provide altitude and temperature data. OFOP 'posi' files were manipulated with base R functions to remove empty fields and edited to the time period where USBL data was recorded. These OFOP files were further edited to seafloor transit sections only (labelled UBT, USBL bottom track).

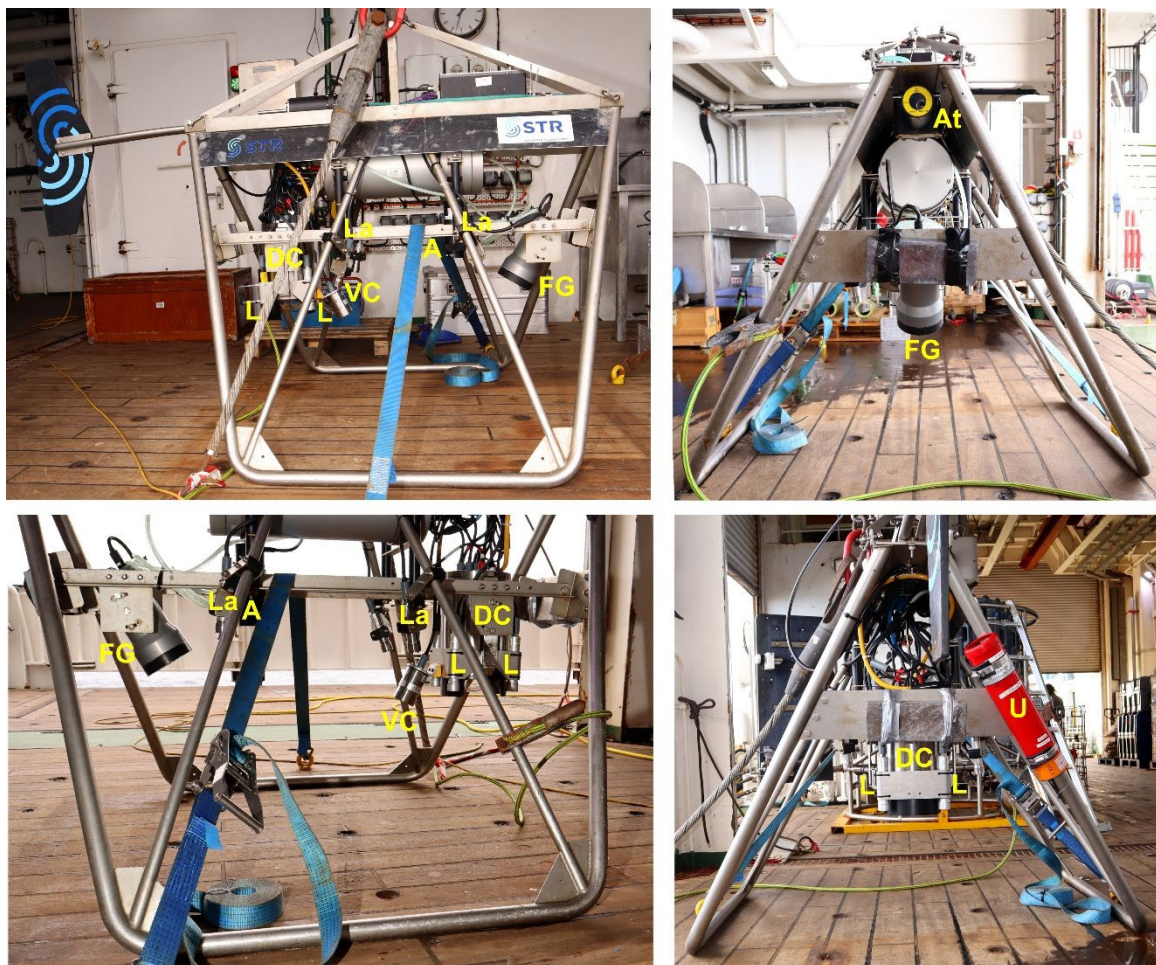


Fig. 7.12 SeaSpyder camera platform illustrating general layout of instrument payload (DC, digital [stills] camera; VC, video camera; L, laser; LA, [video] lamp; A, altimeter; FG, flashgun; At, attitude and pressure sensor (?no data); U, NMF-supplied USBL beacon.

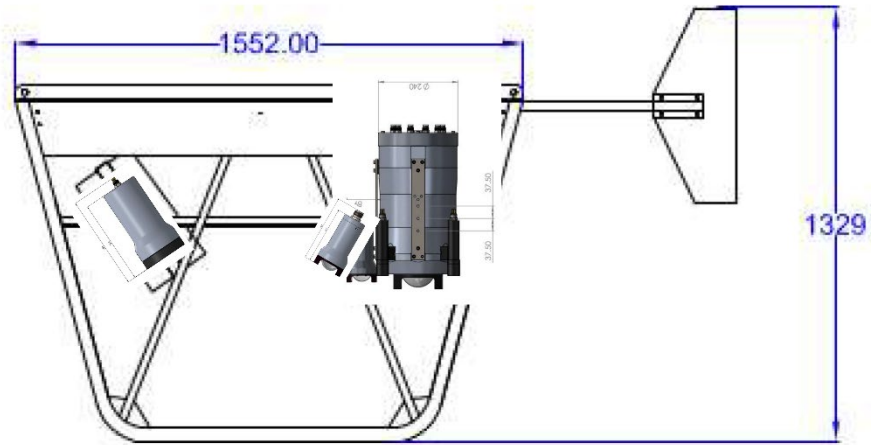


Fig. 7.13 General dimensions of the SeaSpyder platform and its major components.

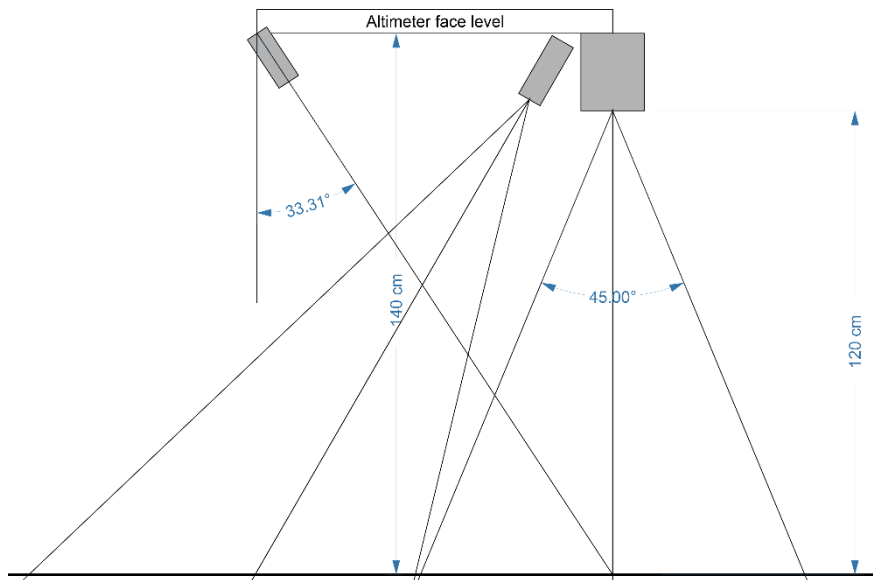


Fig. 7.14 Nominal camera geometry at the seafloor, vertical stills camera, high oblique video camera, flashgun approximately targeted at centre of nominal seafloor image area.

Table 7.3 SeaSpyder datafile inventory

Scanned rough log (.pdf)	Station DY200-	JNCC station	Clapper image	u/w images (first, last)	Exif data file (.csv)	SeaSpyder data file (.xlsx)	OFOP file (.csv)	Bottom tracks (.csv, .shp, etc.)
DY200-017-CAM03	017		IMG_0040.jpg IMG_0042.jpg IMG_0043.jpg IMG_0044.jpg	IMG_0045.jpg IMG_0380.jpg (n = 336)	DY200-017-exif	DY200-017-merged	DY200-017-OFOP	DY200-017-OFOP DY200-017-UBT
DY200-018-CAM04	018		IMG_0381.jpg	IMG_0382.jpg IMG_0515.jpg (n = 134)	DY200-018-exif	DY200-018-merged	DY200-018-OFOP	DY200-018-OFOP DY200-018-UBT
DY200-019-CAM05	019		IMG_0516.jpg	IMG_0517.jpg IMG_0684.jpg (n = 168)	DY200-019-exif	DY200-019-merged	DY200-019-OFOP	DY200-019-OFOP DY200-019-UBT
DY200-021-CAM06	021		IMG_0685.jpg	IMG_0686.jpg IMG_1401.jpg (n = 716)	DY200-021-exif	DY200-021-merged	DY200-021-OFOP	DY200-021-OFOP DY200-021-UBT
DY200-022-CAM07	022		IMG_1402.jpg	IMG_1403.jpg IMG_1679.jpg (n = 277)	DY200-022-exif	DY200-022-merged	DY200-022-OFOP	DY200-022-OFOP DY200-022-UBT
DY200-023-CAM08	023	CNYN023	IMG_1681.jpg	IMG_1682.jpg IMG_1803.jpg (n = 122)	DY200-023-exif	DY200-023-merged	DY200-023-OFOP	DY200-023-OFOP DY200-023-UBT
DY200-037-CAM09	037		IMG_1805.JPG	IMG_1806.JPG IMG_2050.JPG (n = 250)	DY200-037-exif	DY200-037-merged	DY200-037-OFOP	DY200-037-OFOP DY200-037-UBT
DY200-038-CAM10	038		IMG_2051.JPG	IMG_2052.JPG IMG_2301.JPG (n = 249)	DY200-038-exif	DY200-038-merged	DY200-038-OFOP	DY200-038-OFOP DY200-038-UBT
DY200-039-CAM11	039		IMG_2302.CR3	IMG_2303.JPG IMG_2435.JPG (n = 133)	DY200-039-exif	DY200-039-merged	DY200-039-OFOP	DY200-039-OFOP DY200-039-UBT
DY200-040-CAM12	040	CNYN177	IMG_2436.JPG	IMG_2437.JPG IMG_2559.JPG (n = 123)	DY200-040-exif	DY200-040-merged	DY200-040-OFOP	DY200-040-OFOP DY200-040-UBT
DY200-049-CAM13	049		IMG_2564.JPG	IMG_2656.JPG IMG_3061.JPG (n = 490)	DY200-049-exif	DY200-049-merged	DY200-049-OFOP	DY200-049-OFOP DY200-049-UBT

Scanned rough log (.pdf)	Station DY200-	JNCC station	Clapper image	u/w images (first, last)	Exif data file (.csv)	SeaSpyder data file (.xlsx)	OFOP file (.csv)	Bottom tracks (.csv, .shp, etc.)
DY200-054-CAM14	054	CNYN180	IMG_3062.JPG IMG_3360.JPG	IMG_3063.JPG IMG_3219.JPG (n = 157)	DY200-054-exif	DY200-054-merged	DY200-054-OFOP	DY200-054-OFOP DY200-054-UBT
DY200-055-CAM15	055	CNYN181	IMG_3220.JPG	IMG_3221.JPG IMG_3359.JPG (n = 139)	DY200-055-exif	DY200-055-merged	DY200-055-OFOP	DY200-055-OFOP DY200-055-UBT
DY200-056-CAM16	056	CNYN078	IMG_3361.JPG	IMG_3362.JPG IMG_3485.JPG (n = 122)	DY200-056-exif	DY200-056-merged	DY200-056-OFOP	DY200-056-OFOP DY200-049-UBT
DY200-057-CAM17	057	CNYN077	IMG_3486.JPG	IMG_3487.JPG IMG_3603.JPG (n = 117)	DY200-057-exif	DY200-057-merged	DY200-057-OFOP	DY200-057-OFOP DY200-057-UBT
DY200-058-CAM18	058	CNYN100	IMG_3604.JPG	IMG_3605.JPG IMG_3720.JPG (n = 116)	DY200-058-exif	DY200-058-merged	DY200-058-OFOP	DY200-058-OFOP DY200-058-UBT
DY200-063-CAM19	063	CNYN069	IMG_3721.JPG	IMG_3722.JPG IMG_3873.JPG (n = 152)	DY200-063-exif	DY200-063-merged	DY200-063-OFOP	DY200-063-OFOP DY200-063-UBT
DY200-064-CAM20	064	CNYN106	IMG_3874.JPG	IMG_3875.JPG IMG_4027.JPG (n = 153)	DY200-064-exif	DY200-064-merged	DY200-064-OFOP	DY200-064-OFOP DY200-064-UBT
DY200-065-CAM21	065	CNYN017	IMG_4028.JPG	IMG_4029.JPG IMG_4159.JPG (n = 130)	DY200-065-exif	DY200-065-merged	DY200-065-OFOP	DY200-065-OFOP DY200-065-UBT
DY200-066-CAM22	066	CNYN 091	IMG_4160.JPG	IMG_4162.JPG IMG_4362.JPG (n = 201)	DY200-066-exif	DY200-066-merged	DY200-066-OFOP	DY200-066-OFOP DY200-066-UBT
DY200-067-CAM23	067		IMG_4363.JPG	IMG_4364.JPG IMG_4490.JPG (n = 127)	DY200-067-exif	DY200-067-merged	DY200-067-OFOP	DY200-067-OFOP DY200-067-UBT
DY200-070-CAM24	070	CNYN048	IMG_4491.JPG	IMG_4492.JPG IMG_4613.JPG (n = 122)	DY200-070-exif	DY200-070-merged	DY200-070-OFOP	DY200-070-OFOP DY200-070-UBT

Scanned rough log (.pdf)	Station DY200-	JNCC station	Clapper image	u/w images (first, last)	Exif data file (.csv)	SeaSpyder data file (.xlsx)	OFOP file (.csv)	Bottom tracks (.csv, .shp, etc.)
DY200-071-CAM25	071	CNYN041	IMG_4614.JPG	IMG_4615.JPG IMG_4741.JPG (n = 127)	DY200-071-exif	DY200-071-merged	DY200-071-USBL	DY200-071-USBL DY200-071-UBT
DY200-072-CAM26	072	CNYN046?	IMG_4742.JPG	IMG_4743.JPG IMG_4869.JPG (n = 127)	DY200-072-exif	DY200-072-merged	DY200-072-OFOP	DY200-072-OFOP DY200-072-UBT
DY200-073-CAM27	073	CNYN105	IMG_4870.JPG	IMG_4871.JPG IMG_5012.JPG (n = 142)	DY200-073-exif	DY200-073-merged	DY200-073-OFOP	DY200-073-OFOP DY200-073-UBT
DY200-074-CAM28	074	CNYN002	IMG_5013.JPG	IMG_5014.JPG IMG_5134.JPG (n = 121)	DY200-074-exif	DY200-074-merged	DY200-074-OFOP	DY200-074-OFOP DY200-074-UBT
DY200-075-CAM29	075	CNYN006	IMG_5135.JPG	IMG_5136.JPG IMG_5259.JPG (n = 124)	DY200-075-exif	DY200-075-merged	DY200-075-OFOP	DY200-075-OFOP DY200-075-UBT

General caution: beware date / time mismatches

- SeaSpyder stills camera running on UTC+2; OFOP reporting both UTC and UTC+1 (refer to Rough Logs / Station List to confirm UTC date / time of operations)
- The recorded SeaSpyder videos had an inconsistency in their timekeeping. While the overlay of the videos was providing the time of data collection in UTC, the duration of the video files was not consistent with the time elapsed according to the overlay (e.g. a video of 15mins duration might only cover the time span from 02:32-02:37). The cause of this discrepancy is not clear, but may have been related to delays in data transfer. Based on comparisons with stills and with navigation data, the time-stamps on the overlay appear to be correct, rather than the length (time elapsed) during the video fragments.

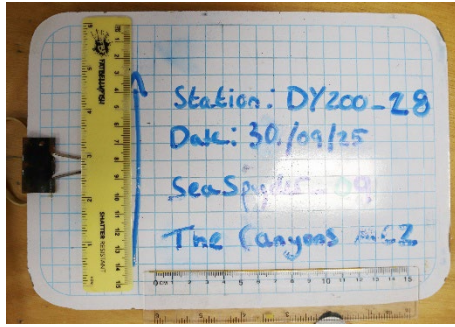


Fig. 7.15 For general reference the scaling of the clapperboard is shown here, i.e. a 1×1 cm grid (note maximum extent of grid box is 23.5×15.8 cm).

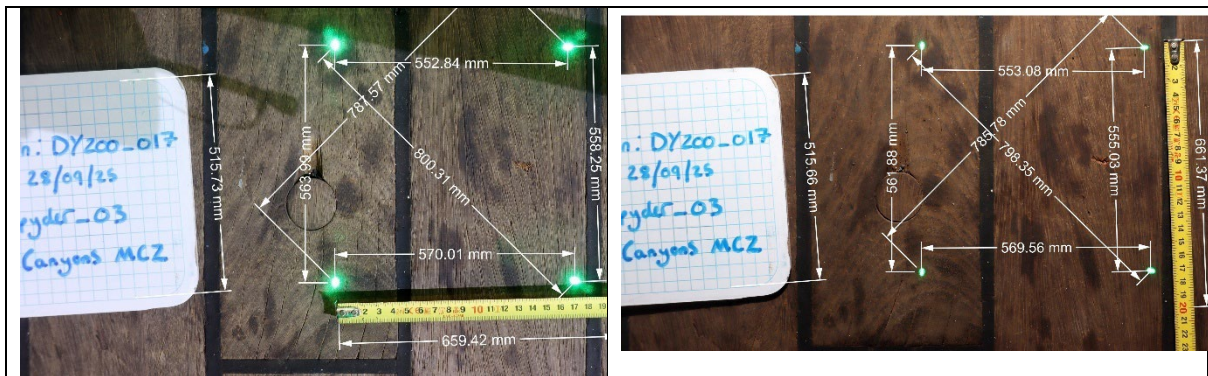


Fig. 7.16 SeaSpyder laser scaling calibration. Averaged from these two deck images, laser dot side length = 17.08 cm, diagonal distance = 24.16 cm.

7.2.1.2. JNCC interest/Requirements from SeaSpyder data

JNCC joined DY200 to gather background and monitoring data for the Canyons MCZ (and Haig Frs if possible) and to better understand the potential role of autonomous underwater vehicles such as AS5 in monitoring of offshore MPAs. A prioritised set of stations was provided for camera surveys, which were considered in planning SeaSpyder deployments.

Eighty good images per were required per JNCC drop camera station. A target of 120 images per station was recommended to allow for quality filtering. The target was higher than the number of images needed as not all images will be of sufficient quality or taken at the right altitude, especially in bad weather. Sufficient replication of stations was required inside a region for it to be used in statistical comparisons both within, and between years. The target was 4 replicate stations per region but due to the limited time available to use the drop camera on the survey, this was reduced to 3 per region on the survey.

NOC completed several long drop camera transects on both the Explorer and Dangeard interfluves in the 300 – 400 m mini mounds area to collect data prior to the deployment of the ecoreefs. High resolution AUV bathymetry was used to ensure the camera transects targeted multiple individual mini mounds. These stations were longer than the intended JNCC station in these regions and the decision was made that due to the limited time available to collect SeaSpyder drop camera data that images from these stations could be used in place of the JNCC stations. Table 7.4 shows the number of drop camera stations collected on the DY200 survey in each JNCC region.

Table 7.4 Number of DY200 camera stations in each JNCC region

Region	Inside fisheries management area	Inside Mini Mounds area	No of DY200 drop camera stations
Explorer Interfluve 200-300 m	✓		3
Explorer Interfluve 200-300 m	✓	✓	3
Explorer Interfluve 300 - 400 m	✓	✓	3
Explorer Interfluve 300 - 400m	✓		3
Dangeard Interfluve 200 - 300m	✓	✓	3
Dangeard Interfluve 300 - 400m	✓	✓	6
Dangeard Interfluve 400 - 500m	✓		2
Dangeard Interfluve Outside Closure 300-400m		✓	3
		Total	26

7.2.1.3. General SeaSpyder Observations

In total 27 successful SeaSpyder seafloor visual surveys were undertaken during the cruise, one within the Greater Haig Frs MCZ and 26 within The Canyons MCZ: 12 on the northern (Explorer) interfluve and 14 on the southern (Dangeard) interfluve. Within The Canyons MCZ near-continuous bathymetric coverage was obtained from 220-530 m water depths, with the bulk of coverage in the 270-390 m range, particularly within the 330-350 m range of the ecoreef deployments.

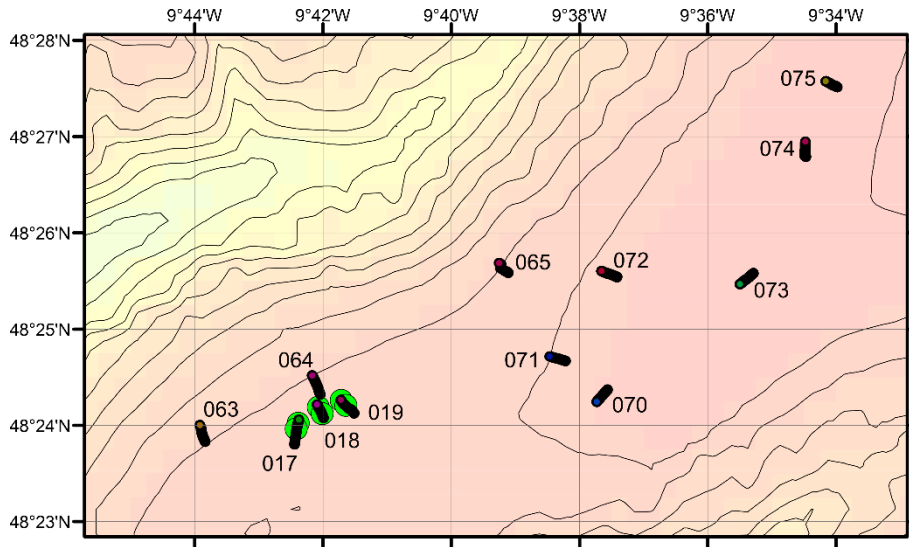


Fig. 7.17 Disposition of SeaSpyder deployments (Stations DY200-xxx) on the Explorer interfluvial; ecocoreef deployment locations are also shown (green circles).

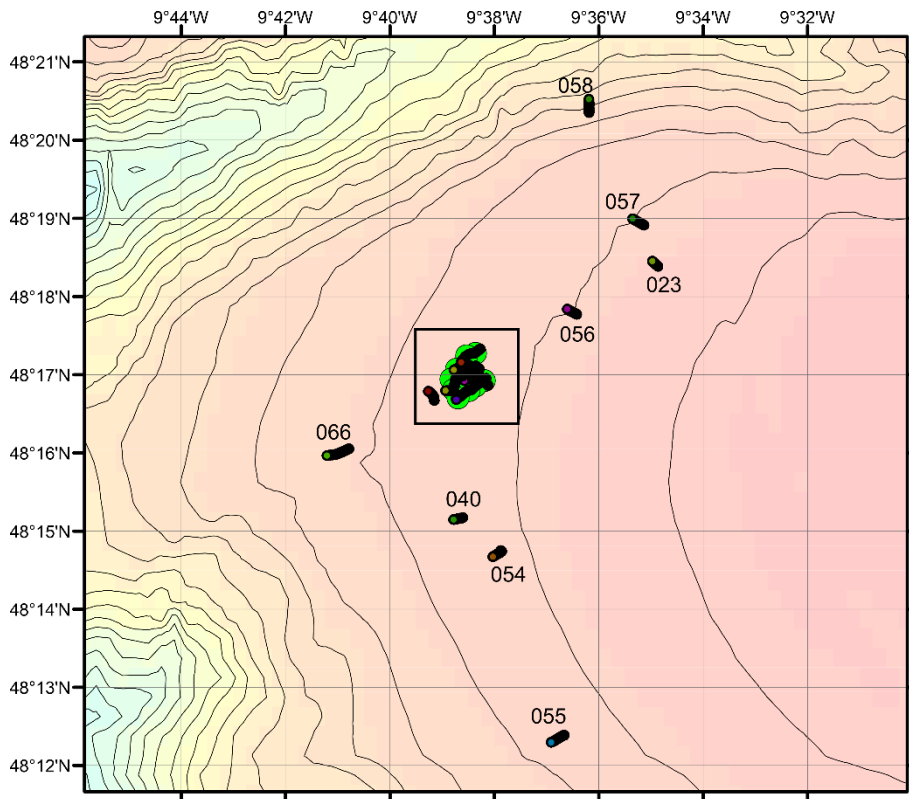


Fig. 7.18 Disposition of SeaSpyder deployments (Stations DY200-xxx) on the Dangeard interfluvial; ecocoreef deployment locations are also shown (green circles); see subsequent figure for crowded central region.

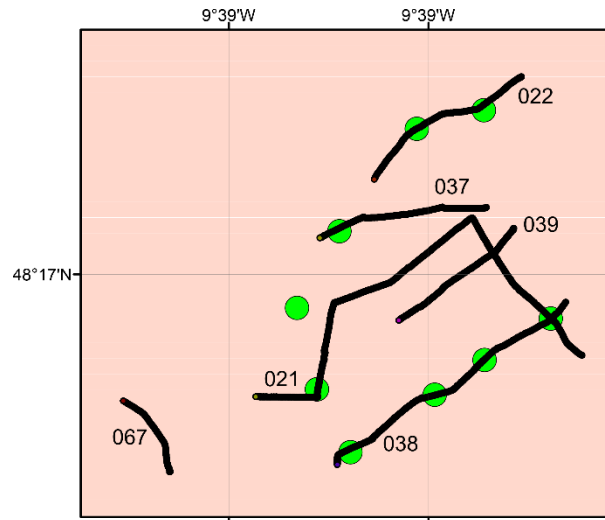


Fig. 7.19 Disposition of SeaSpyder deployments (Stations DY200-xxx) in the central area of the Dangeard interfluvial reef; ecoreef deployment locations are also shown (green circles).

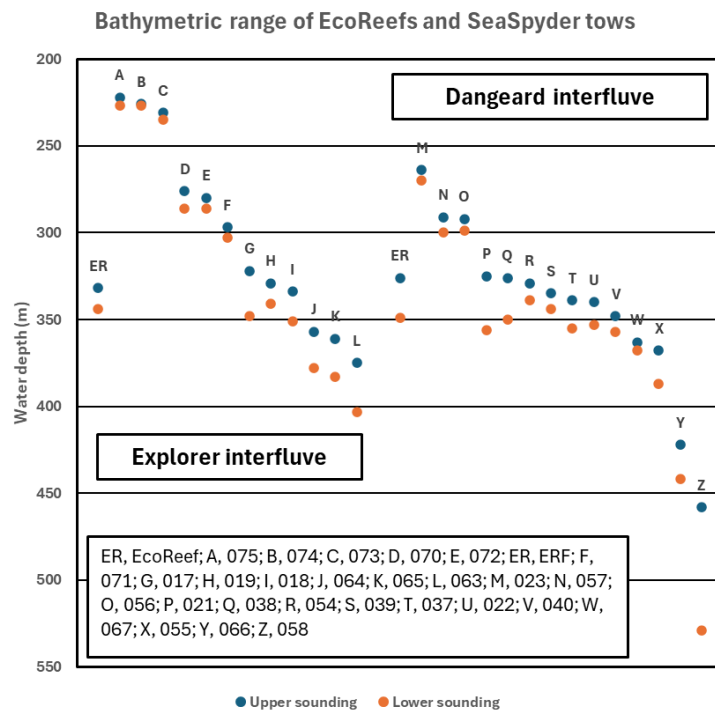
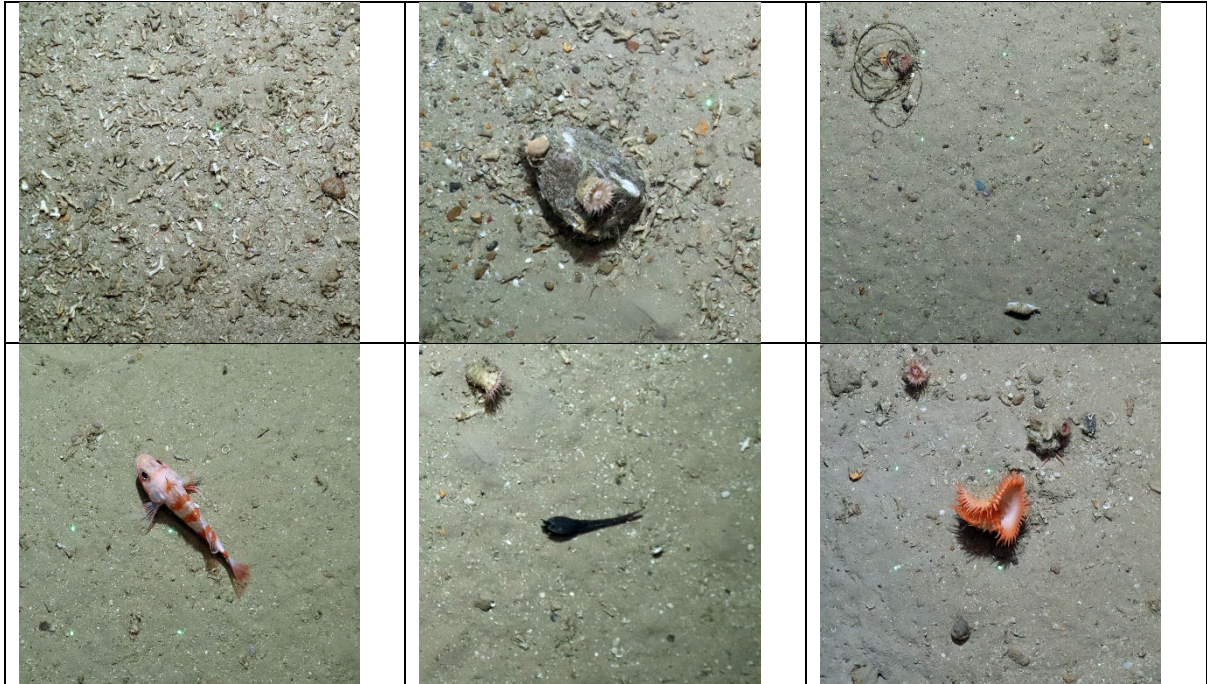


Fig. 7.20 Bathymetric distribution of SeaSpyder deployments shown with bathymetric distribution of ecoreefs.

Short station summaries:

Station: DY200-017 (CAM03) – The Canyons MCZ



Objectives / targets: Northern interfluve of study area (Explorer Interfluve) - photographic survey of Mini-mounds for background data and to assess suitability for REDRESS artificial reefs

Soundings covered: 322-348 m.

Seafloor types: Coral rubble, sand, dropstones

Fauna observed: *Phycis*, *Helicolenus dactylopterus* ('bluemouth'), Chimaera egg cases, Venus flytrap anemone (*Actinoscyphia?*), *Parastichopus*, *Mesothuria*, cerianthids

Artefacts observed: Longline fishing gear.

Video obtained: 1 × descent, 8 × seafloor, 1 × ascent

Images obtained: 344

Station DY200-018 (CAM04) – The Canyons MCZ





Objectives / targets: Northern interfluvial study area (Explorer Interfluvial) - photographic survey of Mini-mounds for background data and to assess suitability for REDRESS artificial reefs

Soundings covered: 334-351 m

Seafloor types: Coral rubble, sand, dropstones

Fauna observed: *Capros aper* (Boarfish), Asteroids (e.g. *Ceramaster?*), Ling (*Molva molva*), *Helicolenus*, Chimaera egg cases, cerianthids, *Mesothuria*.

Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 134

Station DY200-019 (CAM05) – The Canyons MCZ



Objectives / targets: Northern interfluvial study area (Explorer Interfluvial) - photographic survey of Mini-mounds for background data and to assess suitability for REDRESS artificial reefs

Soundings covered: 329-341 m

Seafloor types: Sand, coral rubble, dropstones

Fauna observed: *Helicolenus*, *Nephrops* and burrows, Holothurians (*Parastichopus*), chimaera egg

cases, saddle oysters, *Parazoanthus*, cushion star, Megrim, cerianthids, red asteroid

Artefacts observed: Long-line fishing gear, plastic / fabric.

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 168

Station DY200-021 (CAM06) – The Canyons MCZ



Objectives / targets: Southern interfluvial of study area (Dangeard Interfluvial) - photographic survey of Mini-mounds for background data and to assess suitability for REDRESS artificial reefs

Soundings covered: 325-356 m

Seafloor types: Rippled sand, coral debris, dropstones

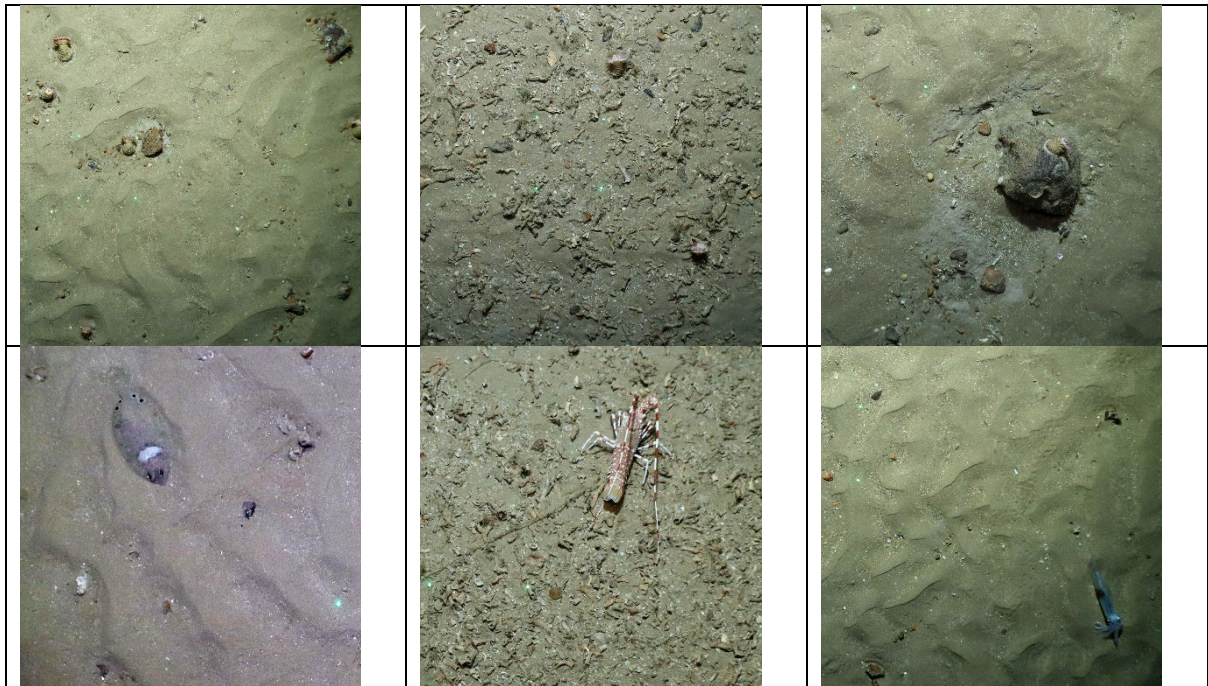
Fauna observed: *Munida*, Conger, megrim, red asteroid, *Pennatula*, *Helicolenus*, small rattail, Yellow Coral, *Pennatula*, *Parastichopus*, chimera egg case, *Cidaris*

Artefacts observed: longline

Video obtained: 1 × descent, 5 × seafloor, 1 × ascent

Images obtained: 716

Station DY200-022 (CAM07) – The Canyons MCZ



Objectives / targets: Southern interfluvial study area (Dangard Interfluvial) - photographic survey of Mini-mounds for background data and to assess suitability for REDRESS artificial reefs

Soundings covered: 340-353 m

Seafloor types: Rippled sand, coral debris, dropstones

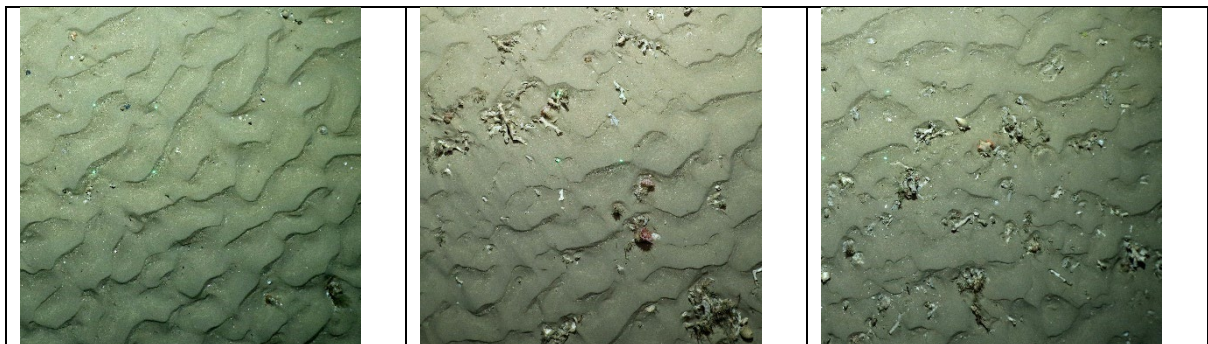
Fauna observed: megrim, *Palinurus*, squid (on seabed), *Munida*

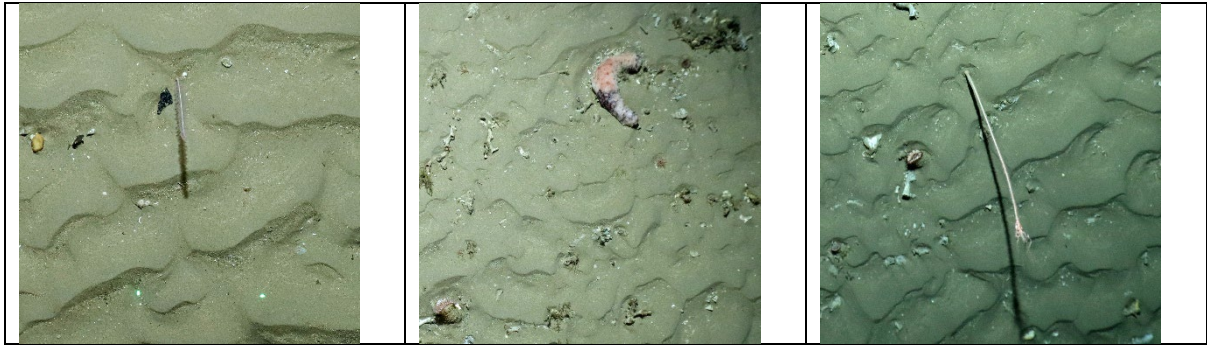
Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 277

Station DY200-023 (CAM08) – The Canyons MCZ





Objectives / targets: JNCC station CNYN023

Soundings covered: 264-270 m

Seafloor types: variously rippled sand, sparse coral rubble.

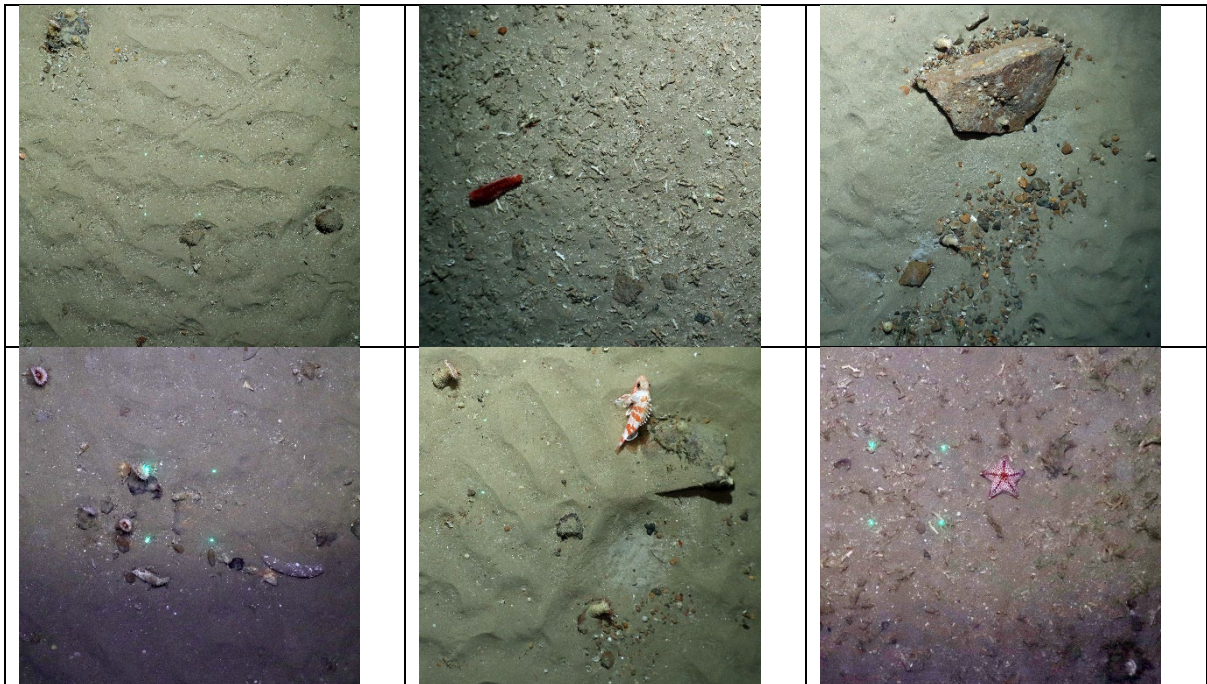
Fauna observed: boar fish, ?*Virgularia*, *Parazoanthus*, cerianthids, megrim, *Funiculina*, *Parastichopus*, necrotised *Parastichopus*

Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 122

Station DY200-037 (CAM09) – The Canyons MCZ



Objectives / targets: Southern interfluvial of study area (Dangeard Interfluvial) - photographic survey of Mini-mounds for background data and to assess suitability for REDRESS artificial reefs

Soundings covered: 339-355 m

Seafloor types: Rippled sand, coral debris, cropstones

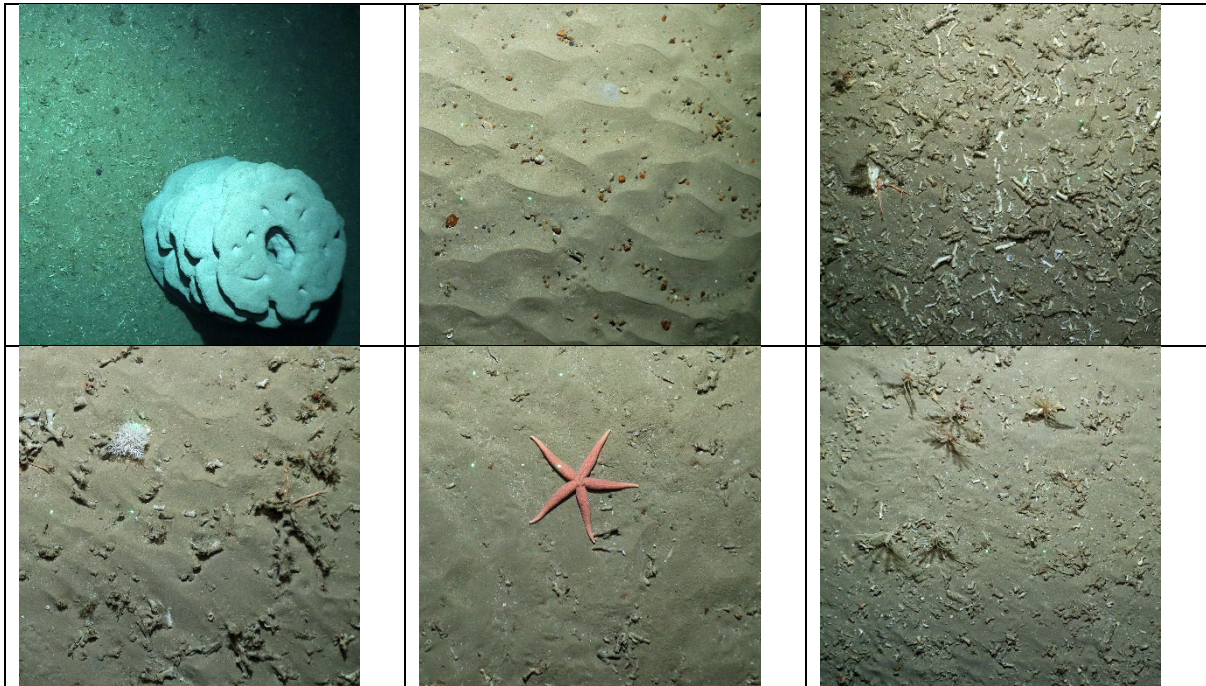
Fauna observed: *Munida*, *Parastichopus*, cerianthids, small rattail, *Mesothuria*, Ling, *Helicolenus*, comatulids, *Poriana*, ?live *Desmophyllum pertusum* (IMG_1977.jpg)

Artefacts observed: none noted

Video obtained: 1 × descent, 2 × seafloor, 1 × ascent

Images obtained: 245

Station DY200-038 (CAM10) – The Canyons MCZ



Objectives / targets: Southern interfluvial study area (Dangeard Interfluvial). Inspect ecoreef site. Photographic survey of Mini-mounds for background data and to assess suitability for REDRESS artificial reefs

Soundings covered: 326-350 m

Seafloor types: ecoreef, rippled sand, coral debris

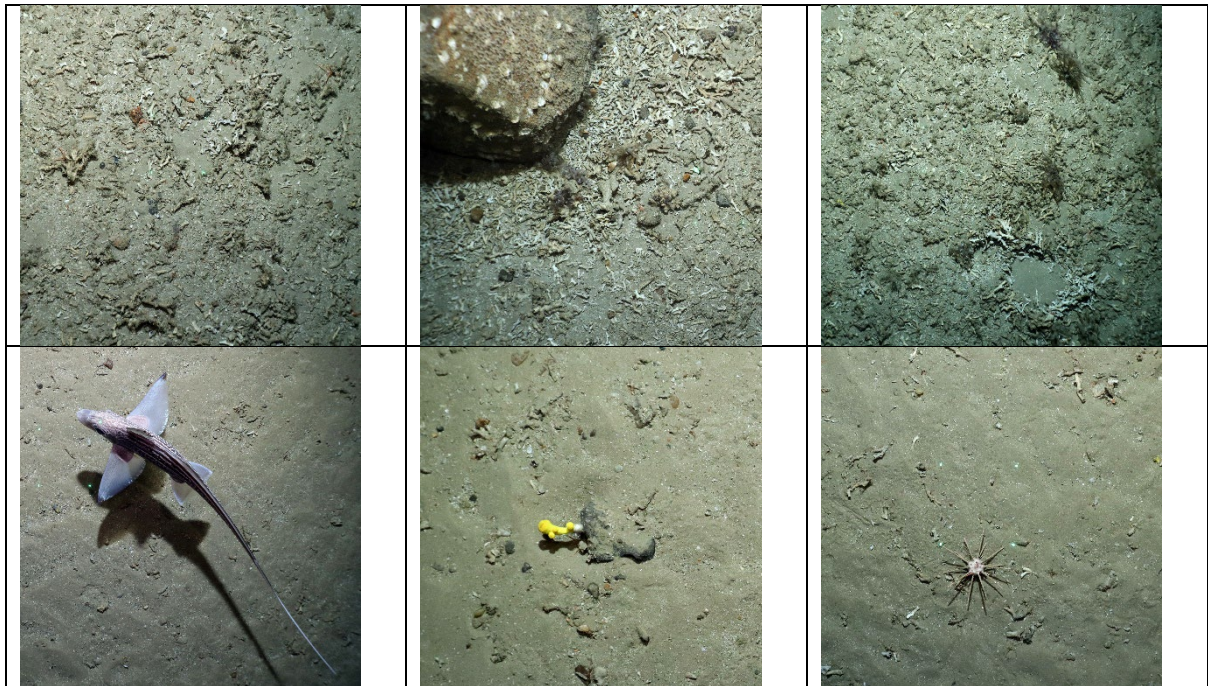
Fauna observed: *Munida*, megrim, *Helicolenus*, small rattail, *Parastichopus*, cerianthids, red asteroid, [abundant] comatulids, *Cancer*, *Mesothuria*, Yellow Coral,

Artefacts observed: longline dropper

Video obtained: 1 × descent, 4 × seafloor, 1 × ascent

Images obtained: 249

Station DY200-039 (CAM11) – The Canyons MCZ



Objectives / targets: Southern interfluvial study area (Dangeard Interfluvial). Pre-survey ecoreef and ecoreef control sites

Soundings covered: 335-344 m

Seafloor types: rippled sand, coral debris, dropstones

Fauna observed: Chimaera (Rabbitfish), *Dendrophyllia cornigera* (Yellow coral), boar fish, *Parastichopus*, *Munida*, Conger, *Cidaris*, ?live *Desmophyllum* (IMG_2363.jpg), [abundant] comatulids,

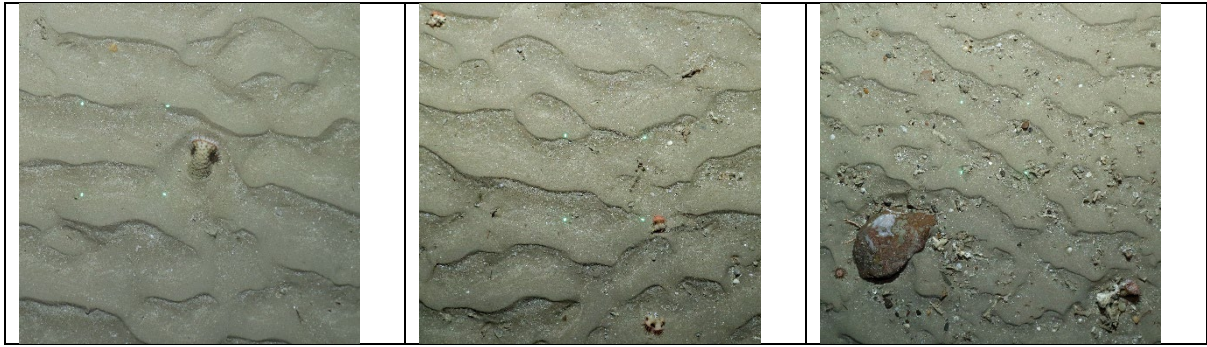
Artefacts observed: Long-line fishing gear

Video obtained: 1 × descent, 2 × seafloor, 1 × ascent

Images obtained: 133

Station DY200-040 (CAM12) – The Canyons MCZ





Objectives / targets: JNCC station CNYN177

Soundings covered: 348-357 m

Seafloor types: rippled sand, sparse coral debris, dropstones

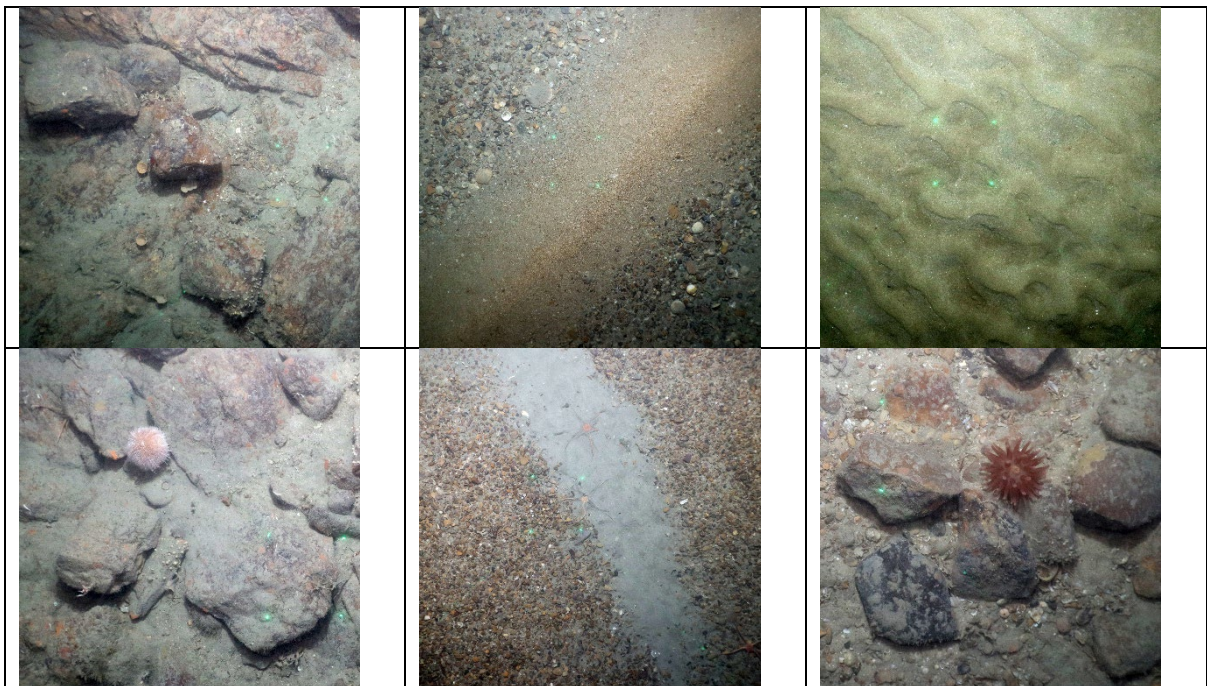
Fauna observed: *Munida*, fauna seems sparse

Artefacts observed: Metal bar (?stanchion)

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 123

Station DY200-049 (CAM13) – Greater Haig Fras MCZ



Objectives / targets: Image data collection for time series and comparison with AUV

Soundings covered: 110-112 m

Seafloor types: Bedrock and boulders, megaripples, rippled sand

Fauna observed: *Munida*, *Echinus*, *Diazona*, *Poriana*, cup and hedgehog sponges, ophiuroids, *Parazoanthus*, *Bolocera*, fragmented *Atrina* shells, Ross Coral, megrim

Artefacts observed:

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 490

Station DY200-054 The Canyons MCZ



Objectives / targets: JNCC site CNYN180

Soundings covered: 329-339 m

Seafloor types: rippled sand, coral debris

Fauna observed: [abundant] *Capros aper* (boarfish), small rattail, *Cidaris*, *Mesothuria*, *Parastichopus*

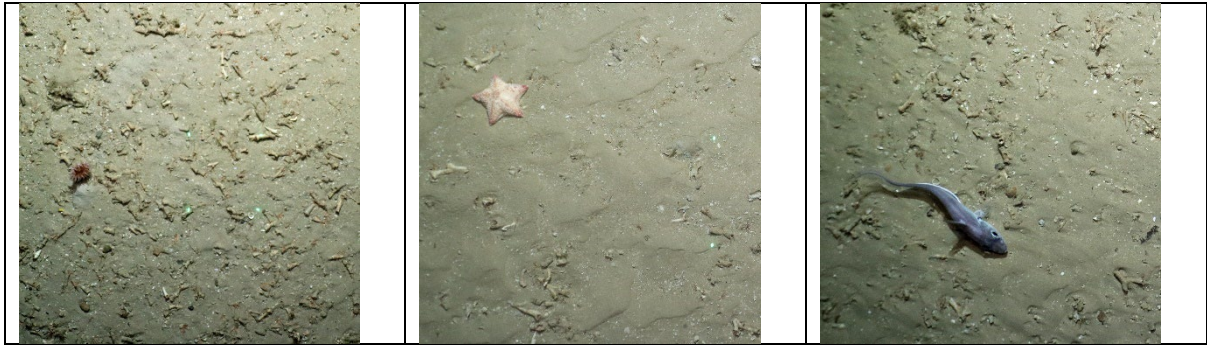
Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 157

Station DY200-055 The Canyons MCZ





Objectives / targets: JNCC site CNYN181

Soundings covered: 368-387 m

Seafloor types: rippled sand, coral debris, dropstones

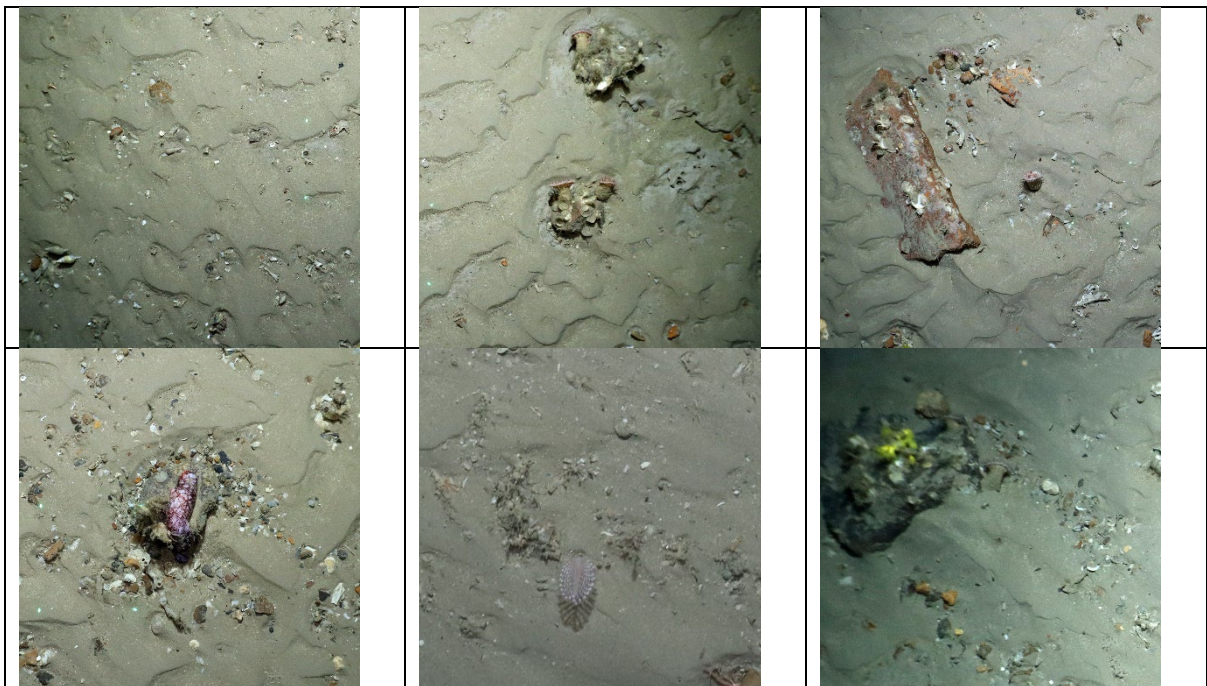
Fauna observed: small rattail, *Porania*

Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 139

Station DY200-056 The Canyons MCZ



Objectives / targets: JNCC station CNYN78

Soundings covered: 292-299 m

Seafloor types: rippled sand, dropstones, sparse coral debris

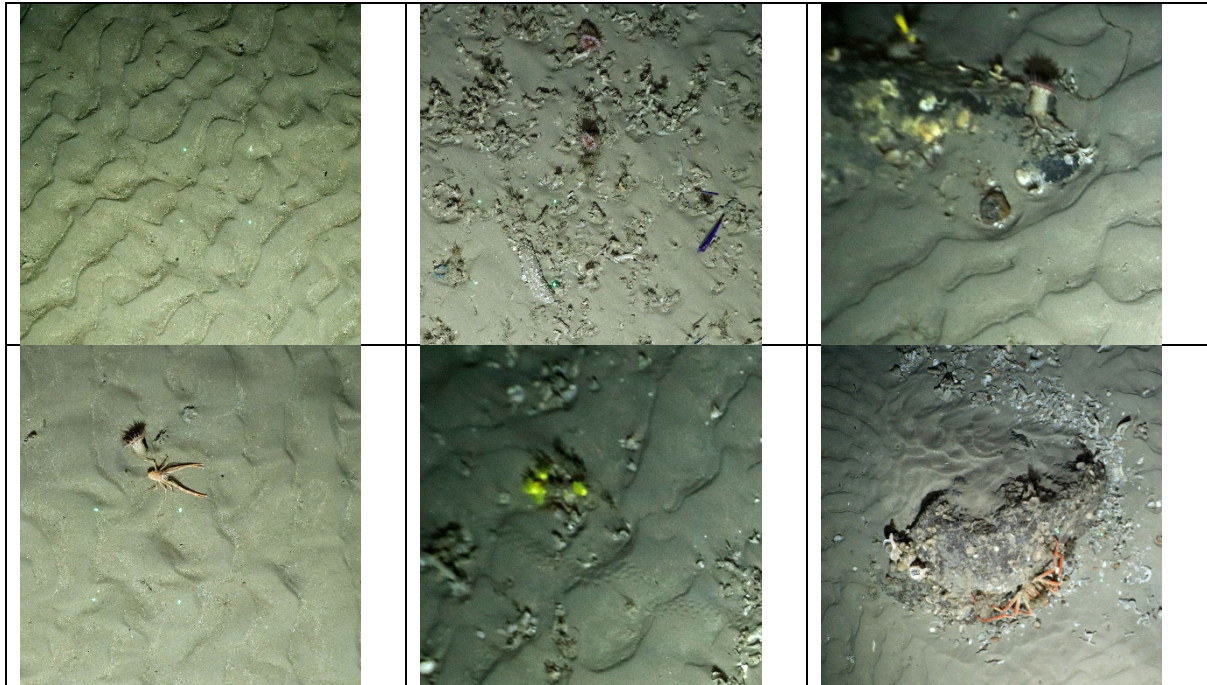
Fauna observed: comatulids, saddle oysters, *Parastichopus*, necrotised *Parastichopus*, *Dendrophyllia cornigera* (Yellow Coral)

Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 122

Station DY200-057 The Canyons MCZ



Objectives / targets: JNCC station CNYN77

Soundings covered: 291-300 m

Seafloor types: rippled sand, coral debris, dropstones.

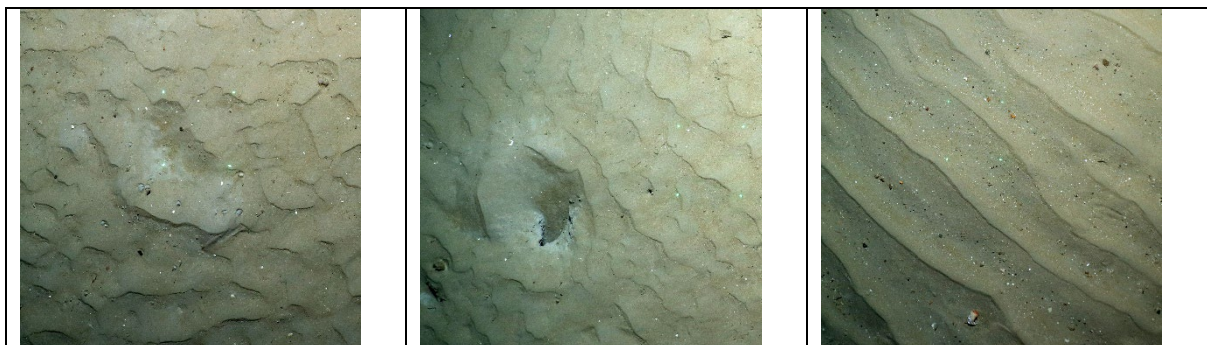
Fauna observed: *Munida*, *Dendrophyllia cornigera*, *Mesothuria*, *Paromola*

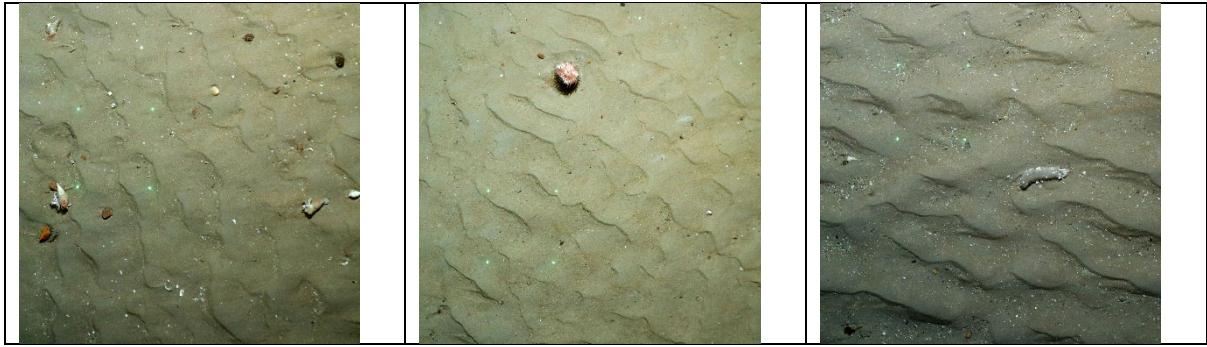
Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 117

Station DY200-058 The Canyons MCZ





Objectives / targets: JNCC station CNYN100

Soundings covered: 458-529 m

Seafloor types: variously rippled sand

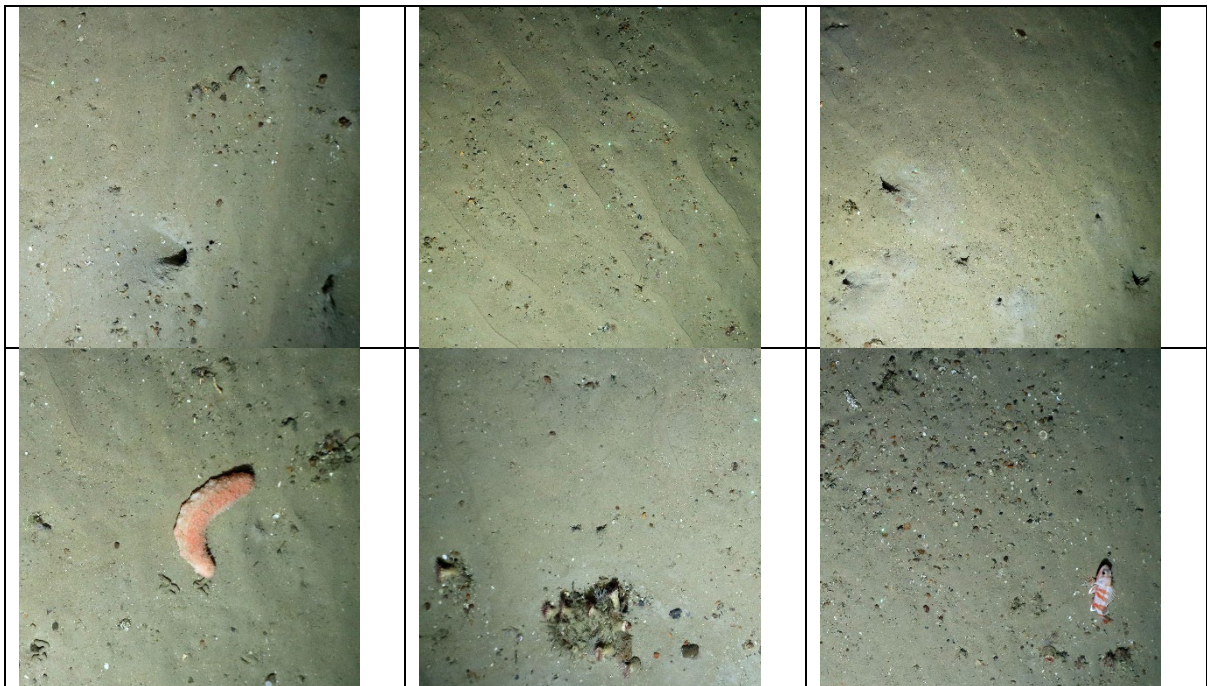
Fauna observed: large burrows (*Nephrops*), *Mesothuria*

Artefacts observed: Longline fishing gear

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 116

Station DY200-063 The Canyons MCZ



Objectives / targets: JNCC Station CNYN069 (close)

Soundings covered: 375-403 m

Seafloor types: variously rippled sand, dropstones

Fauna observed: *Parastichopus*, large burrows (*Nephrops*), *Mesothuria*, megrim, small rattail, *Parazoanthus*, *Helocolenus*

Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 152

Station DY200-064 The Canyons MCZ



Objectives / targets: Close to JNCC Station CNYN106

Soundings covered: 357-378 m

Seafloor types: Rippled sand, gravel / pebble / shell debris, muddy patch with burrows?, coral rubble.

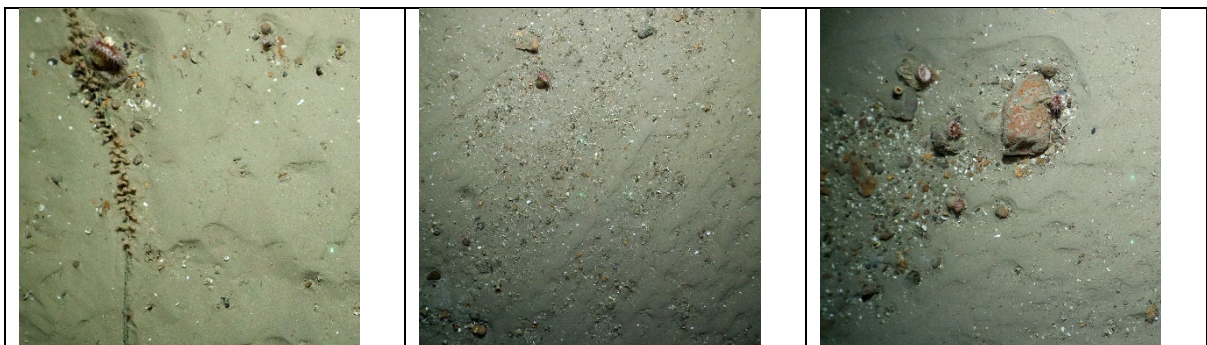
Fauna observed: *Mesothuria*, *Parasitichopus*, *Helicolenus*, red asteroid, *Parazoanthus*, saddle oysters

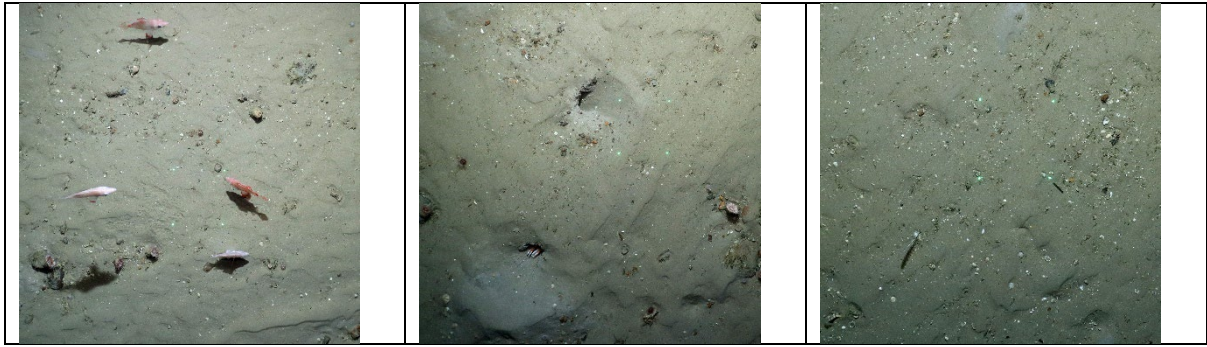
Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 153

Station DY200-065 The Canyons MCZ





Objectives / targets: JNCC station CNYN017

Soundings covered: 361-383 m

Seafloor types: rippled sand, dropstones (scour / comet marks)

Fauna observed: *Capros aper* (boarfish), *Pennatula*, large burrows (*Nephrops*), *Nephrops*, *Mesothuria*, *Parazoanthus*, chimera egg case, red asteroid (damaged), ?*Virgularia*, *Helicolenus*

Artefacts observed: longline gear

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 130

Station DY200-066 The Canyons MCZ



Objectives / targets: JNCC Reference CNYN 091

Soundings covered: 422-442 m

Seafloor types: variously rippled sand, coral debris, dropstones

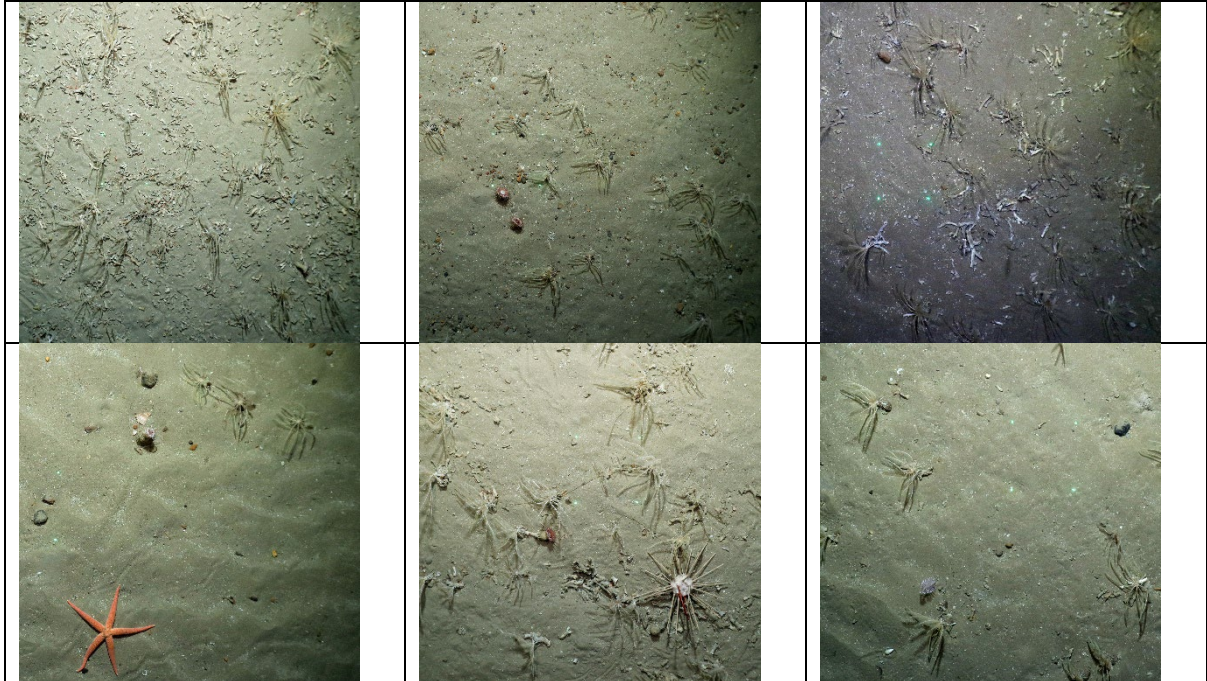
Fauna observed: small rattail, large burrows (*Nephrops*), flabellid cup coral, *Parazoanthus*, *Helicolenus*, *Aequipecten*

Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 201

Station DY200-067 The Canyons MCZ



Objectives / targets: Investigate location previously identified as having high comatulid abundance (JC278)

Soundings covered: 363-368 m

Seafloor types: rippled sand, coral debris

Fauna observed: [very abundant] comatulids (*Leptometra celtica*), *Mesothuria*, *Cidaris*, *Helicolenus*, *Pennatula*, red asteroid, small rattail, megrim, (*Stichastrealla rosea*), *cidaris*

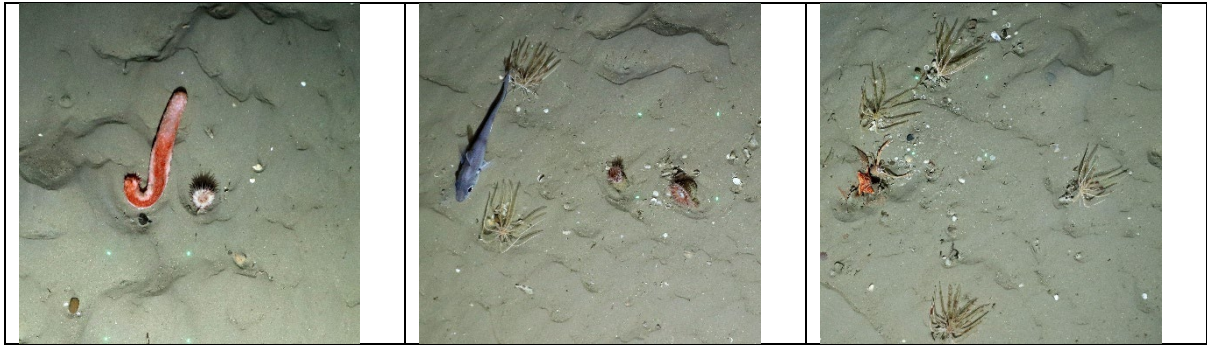
Artefacts observed: long-line fishing gear.

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 127

Station DY200-070 The Canyons MCZ





Objectives / targets: JNCC station CNYN 048.

Soundings covered: 276-286 m

Seafloor types: rippled sand

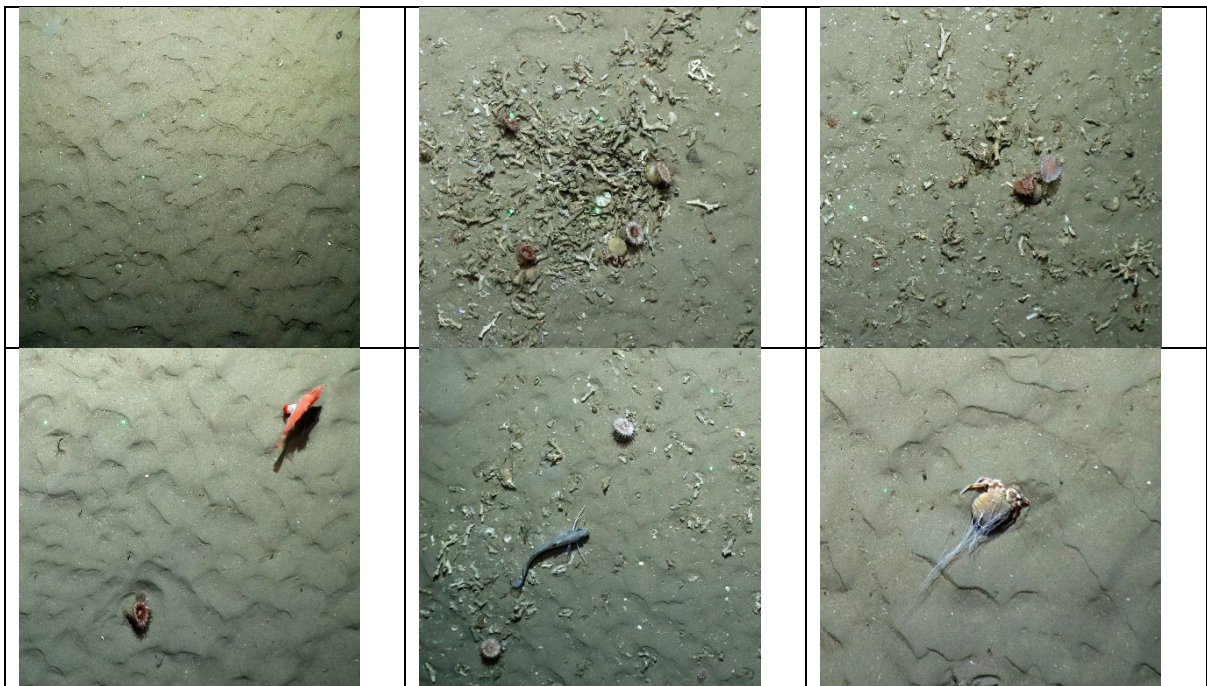
Fauna observed: [very abundant] comatulids, small rattail, *Parastichopus*, cerianthids,

Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 122

Station DY200-071 The Canyons MCZ



Objectives / targets: JNCC Station CNYN041

Soundings covered: 297-303 m

Seafloor types: rippled sand, coral debris,

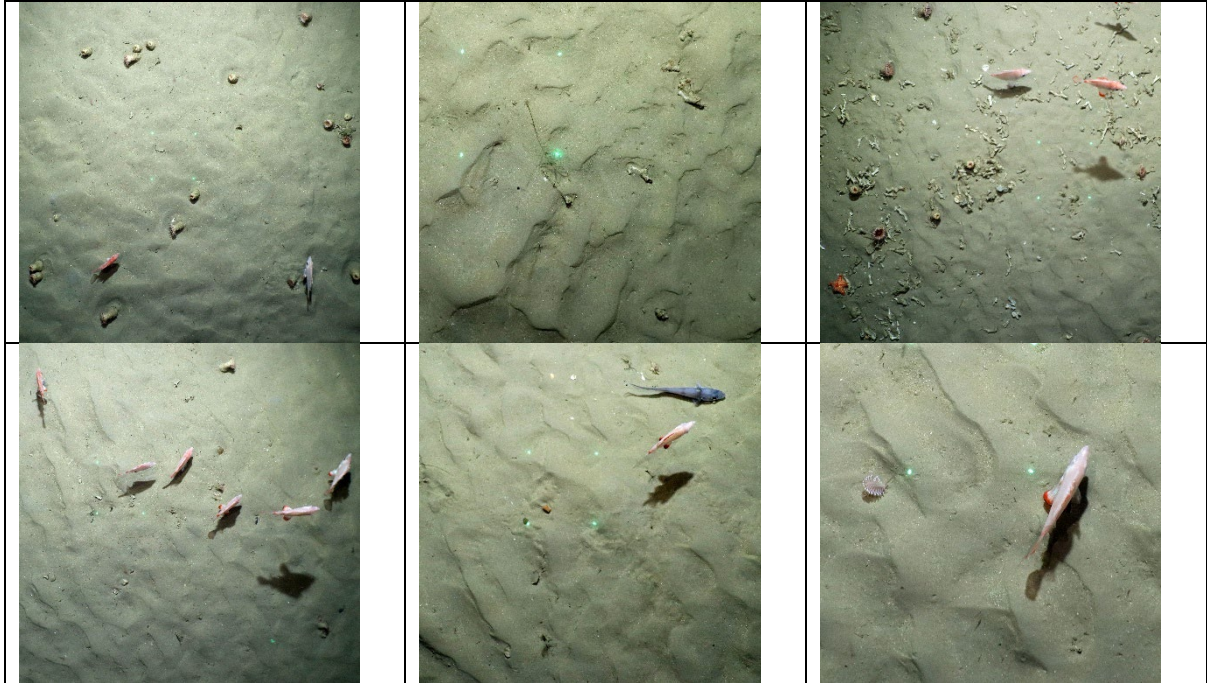
Fauna observed: boar fish, *Parastichopus*, ?*Funiculina*, small rattail, *Phycis*, *Pennatula*, ?*Virgularia*, *Helicolenus*

Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 127

Station DY200-072 The Canyons MCZ



Objectives / targets: JNCC Station CNYN002

Soundings covered: 280-286 m

Seafloor types: variously rippled sand, coral debris

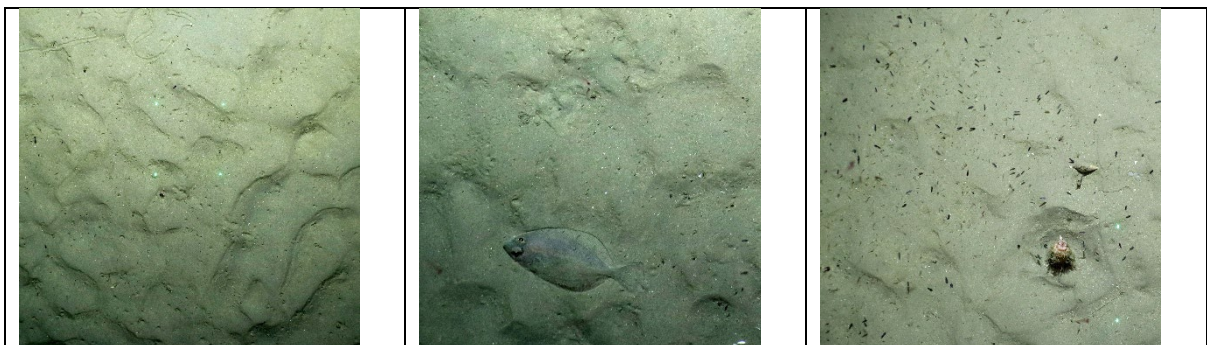
Fauna observed: boar fish, small rattail, *Pennatula*, *Poriana*, *Parastichopus*, megrim,

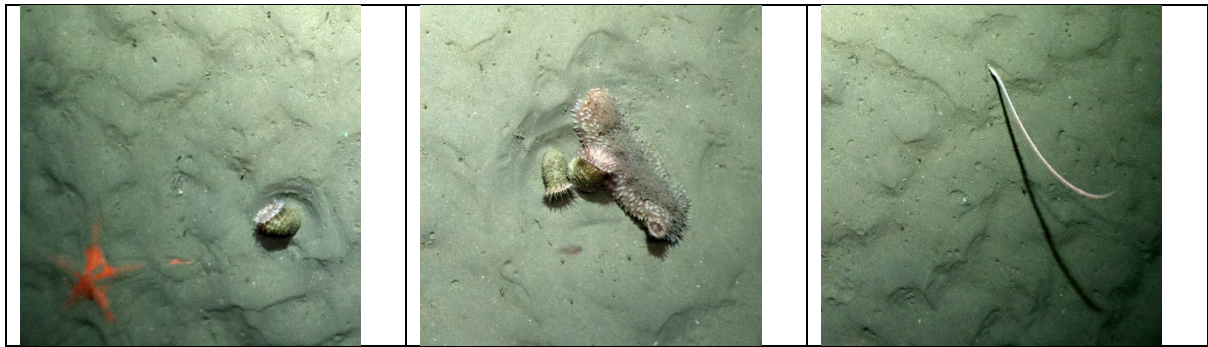
Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 127

Station DY200-073 The Canyons MCZ





Objectives / targets: JNCC Station CNYN105

Soundings covered: 231-235 m

Seafloor types: variously rippled sand

Fauna observed: [abundant] boar fish, *Funiculina*, [odd, ?necrotised] *Parastichopus*, comatulids, *Pennatula*, *Helicolenus*, megrim, burying starfish, small rattail, [dense zooplankton / micronekton]

Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 142

Station DY200-074 The Canyons MCZ



Objectives / targets: JNCC Station CNYN002

Soundings covered: 226-227 m

Seafloor types: variously rippled sand

Fauna observed: [abundant] boar fish, comatulids, [benthic feeding] squid, megrim, [dense zooplankton / micronekton], *Pennatula*, a n other flatfish, [feeding] blue whiting

Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 121

Station DY200-075 The Canyons MCZ



Objectives / targets: JNCC Station CNYN006

Soundings covered: 222-227 m

Seafloor types: variously rippled sand

Fauna observed: [abundant] boar fish, [benthic feeding] squid, megrim, [abundant] *Pennatula*,

Artefacts observed: none noted

Video obtained: 1 × descent, 1 × seafloor, 1 × ascent

Images obtained: 124

7.2.1.4. Taxon note: *Dendrophyllia cornigera* (Lamarck, 1816)

Prior occurrences of this taxon (from OBIS, accessed 03 October 2025, and supplement to Castellan et al., 2019) indicate three records in the Whittard Canyon system, a fourth immediately adjacent to the west, and three records in the Porcupine Seabight, potentially associated with the Gollum Channel system (see, e.g., Verweirder et al., 2023). There are multiple records on the shelf and shelf edge periphery of the Biscay region (see also Oceana, 2011). The Porcupine Seabight records appear to mark the northern limit of the species – a taxon that may expand its distribution as the North Atlantic continues to warm. Currently, *D. cornigera* does not appear in the UK definition of “coral gardens” (Henry & Roberts JM, 2014) but does appear as a representative taxon under proposed VME habitat type “coral garden” subtype “Hard bottom coral garden: Non-reefal scleractinian aggregations” in the ICES (2020) classification.

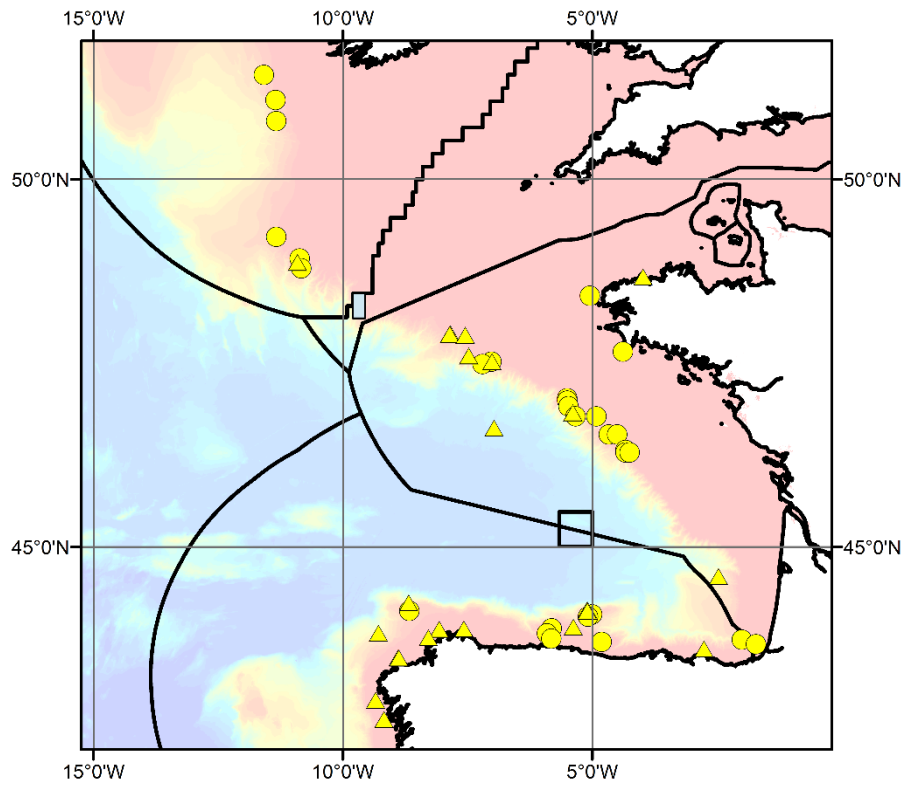


Fig. 7.21 *Dendrophyllia cornigera* distribution in the Porcupine and Biscay area based on records available in OBIS (triangles) and Castellan et al. (2019; circles).

First / new UK records for Dendrophyllia cornigera observed within The Canyons Marine Conservation Zone

Table 7.5 Records from JNCC cruise CEND0917, RV Cefas Endeavour, 20 May-15 June 2017 (Eggett et al., 2018; Savage et., 2025). (Date time and geolocation refer to transect start).

Date time	Cruise	Platform	LAT	LONG	Station	Region
04/06/2017 04:27	CEND09 17	SeaSpy der	48.31492 727	- 9.5860454 55	CNYNO 77	Dangard Interfluve 200-300m mini mound
04/06/2017 00:13	CEND09 17	SeaSpy der	48.29614 167	- 9.6073583 33	CNYNO 78	Dangard Interfluve 200-300m mini mound
01/06/2017 15:31	CEND09 17	SeaSpy der	48.2748	-9.63695	CNYNO 82	Dangard Interfluve 300-400m MESH mini mound
02/06/2017 21:24	CEND09 17	SeaSpy der	48.30405 714	- 9.6232285 71	CNYNO 85	Dangard Interfluve 300-400m MESH mini mound
04/06/2017 09:07	CEND09 17	SeaSpy der	48.33156 154	- 9.5719692 31	CNYNO 90	Dangard Interfluve 300-400m MESH mini mound
01/06/2017 19:33	CEND09 17	SeaSpy der	48.29433 75	- 9.6420625	CNYN1 01	Dangard Interfluve 300-400m MESH mini mound
04/06/2017 10:05	CEND09 17	SeaSpy der	48.33404 167	-9.560425	CNYNO 39	Dangard Interfluve 300-400m MESH non mini mound
04/06/2017 11:22	CEND09 17	SeaSpy der	48.33697 5	- 9.5678833 33	CNYNO 40	Dangard Interfluve 300-400m MESH non mini mound
30/05/2017 19:14	CEND09 17	SeaSpy der	48.4276	- 9.6338833 33	CNYNO 42	Explorer Interfluve 200-300m MESH mini mound
31/05/2017 08:52	CEND09 17	SeaSpy der	48.4129	-9.6945	CNYNO 19	Explorer Interfluve 300-400m non mini mound
31/05/2017 05:08	CEND09 17	SeaSpy der	48.37922 5	-9.68812	CNYNO 64	Explorer Interfluve 200-300m MESH mini mound
31/05/2017 08:52	CEND09 17	SeaSpy der	48.37922 5	- 9.6881166 67	CNYNO 64	Explorer Interfluve 400-500m non mini mound

Table 7.6 Records from JC237 and DY200 (Huvenne, 2024; present cruise). (Date time, geolocation and depth refer to images).

Cr op	Date time	Cruise	Platform	LAT	LONG	Sounding (m)	Image file(s)
A, B	09/08/2022 07:41:32	JC237	AS5	48.2930 8551	- 9.63641 2947	346	JC237-003- Mission31_11370385_13304504491868.r aw, JC237-003- Mission31_11370385_13304504492868.r aw
C	09/08/2022 07:46:18	JC237	AS5	48.2914 3917	- 9.63862 6438	346	JC237-003- Mission31_11370385_13304504777761.r aw
D, E	09/08/2022 07:46:46	JC237	AS5	48.2911 5547	- 9.63845 8839	344	JC237-003- Mission31_11370385_13304504805750.r aw, JC237-003- Mission31_11370385_13304504806749.r aw

Cr op	Date time	Cruise	Platfo rm	LAT	LONG	Soundin g (m)	Image file(s)
F, G	09/08/2022 07:47:03	JC237	AS5	48.2909 8578	- 9.63835 3033	344	JC237-003- Mission31_11370385_13304504822743.r aw, JC237-003- Mission31_11370385_13304504823743.r aw
H, I	24/08/2022 14:10:42	JC237	AS5	48.4121 8394	- 9.68610 148	374	JC237-049-camera-asea- m41_11370385_13305823841929.raw, JC237-049-camera-asea- m41_11370385_13305823842928.raw
J, K	2025/06/02 02:53:00	JC278	HyBIS	48.4040 981	- 9.70191 4	325	JC278_009_20250602025250.JPG, JC278_009_20250602025300.JPG
L	29/09/2025 22:04:34	DY200	SeaSp yder	48.2846 372	- 9.64040 62	341	DY200-021-IMG_0948.JPG
M	29/09/2025 22:13:53	DY200	SeaSp yder	48.2843 352	- 9.64094 48	344	DY200-021-IMG_0981.JPG
N	30/09/2025 00:20:21	DY200	SeaSp yder	48.2808 563	- 9.64607 45	348	DY200-021-IMG_1201.JPG
O	02/10/2025 02:00:30	DY200	SeaSp yder	48.2782 91	- 9.64544 45	350	DY200-038-video-clip
P	02/10/2025 02:02:36	DY200	SeaSp yder	48.2782 255	- 9.64545 55	349	DY200-038-IMG_2288.JPG
Q	02/10/2025 03:41:03	DY200	SeaSp yder	48.2845 12	- 9.63820 28	335	DY200-039-IMG_2315.JPG
R	08/10/2025 02:24:52	DY200	SeaSp yder	48.2964 128	- 9.60749 95	293	DY200-056-IMG_3386.JPG
S	08/10/2025 04:23:01	DY200	SeaSp yder	48.3152 47	- 9.58564 92	292	DY200-057-IMG_3495.JPG
T	08/10/2025 05:07:34	DY200	SeaSp yder	48.3164 672	- 9.58890 4	299	DY200-057-IMG_3598.JPG

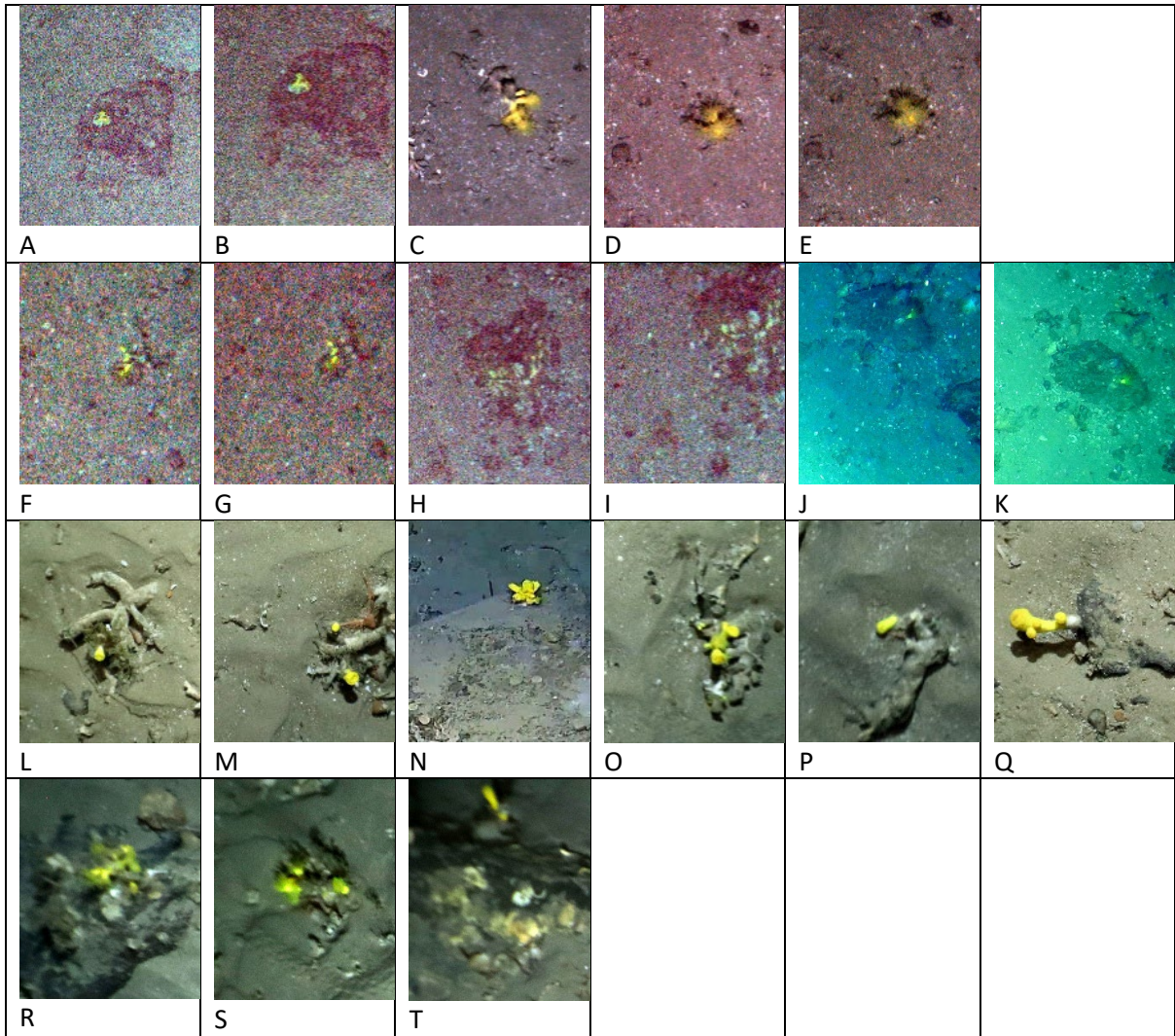


Fig. 7. 22 Cropped images of putative *Dendrophyllia cornigera* specimens

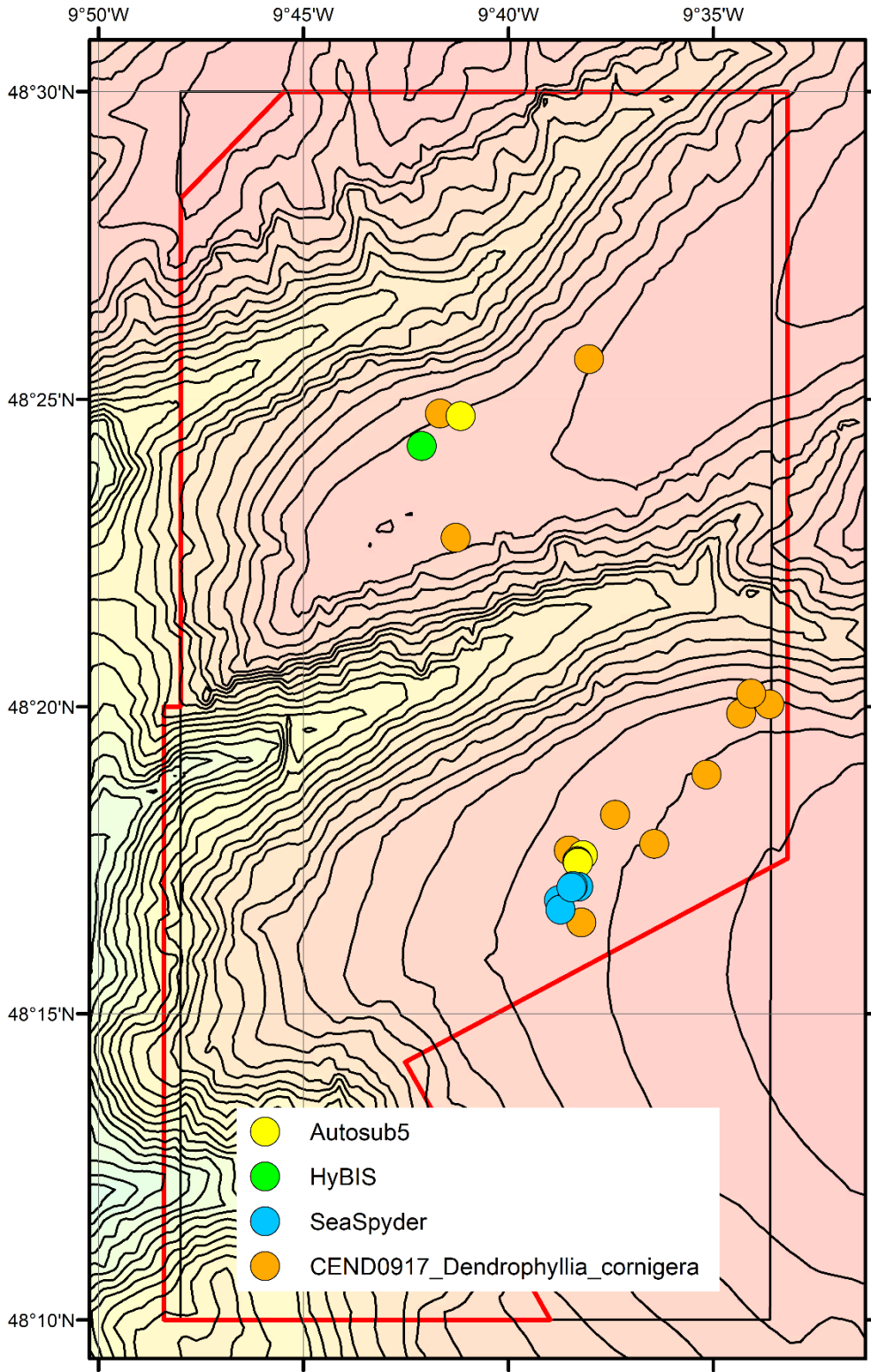


Fig. 7.23 Existing and new records for *Dendrophyllia cornigera* in the vicinity of The Canyons Marine Conservation Zone.

7.2.2. Autosub5-based photography

Six AUV missions included camera trials (see Tables 6.5 and 7.7). The AESA2.5 camera on Autosub5 is a Blackfly BFS_PGE_200S6C with a Sony IMX183 sensor. The system takes images of 5472x3648 pixels over a horizontal and vertical angle of 43.8° and 33.6° respectively, and stored in a RAW16 format. Its angle of view (in air) is 1°. Its lens is a V1624-MPZ set at 16 mm focal length, and with a variable aperture (see Table 6.5, F-stop). While not all of these were successful (see mission descriptions in section 6.1.13), some missions delivered extensive image datasets (Table 7.7). However, as a result of the challenging terrain, large proportions of these images were collected too high above the seafloor. Furthermore, the initial settings of the AESA camera were sub-optimal (see section 6.1.3.1). Adjustments were made in the last two missions, but even then, the red channel stayed over-exposed. As those image datasets were only collected on the last day on site, only a few images were converted from their native .RAW format into .dng and .jpg for initial quality control (using the DarkTable software). Full image processing and analysis was left for the post-cruise phase.

Table 7.7 Autosub5 image datasets. Note the number of images is the total collected on the mission, irrespective of the altitude and including any ascent/descent if the camera was running)

Mission number	Site	No images	Comments
AS5M129	Haig Fras	21,401	Images taken too high above the seabed
AS5M131	Dangeard interfluve	2,840	Very short camera run at end of mission, too high
AS5M132	Dangeard interfluve	17,747	Camera settings not optimal. Automated naming of image files uses wrong date and time
AS5M133	Explorer interfluve	18,417	Camera settings not optimal. Automated naming of image files uses wrong date and time
AS5M134	Explorer interfluve	9,766	Red/green balance adjusted. 1342 images at <4m altitude
AS5M135	Explorer interfluve	11,026	Red/green balance and gain adjusted. 3055 images at <4m altitude

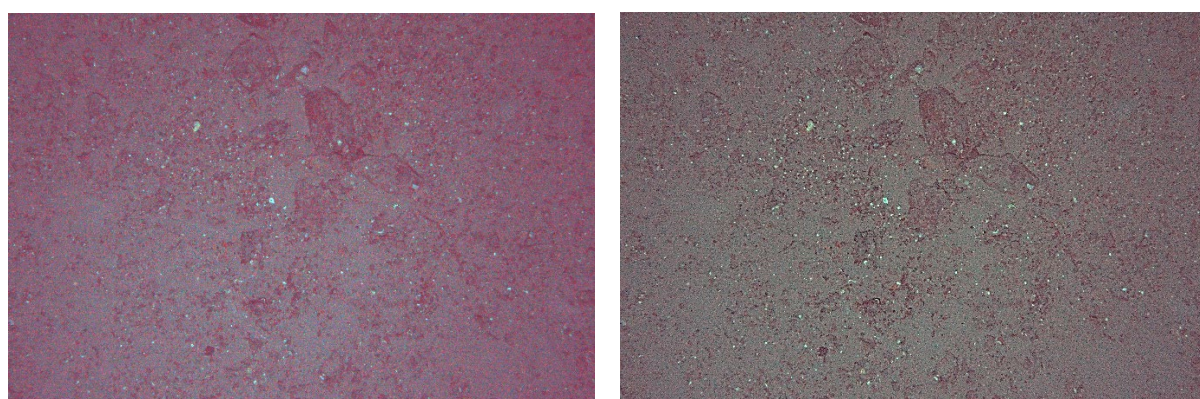


Fig. 7.24 Illustration of initial Autosub5 image quality: non-corrected image from AS5M134, ca. 3.8 m altitude (left); corrected image after application of a colour balance filter, vignetting correction and Exposure correction applied in the freeware software DarkTable (right)

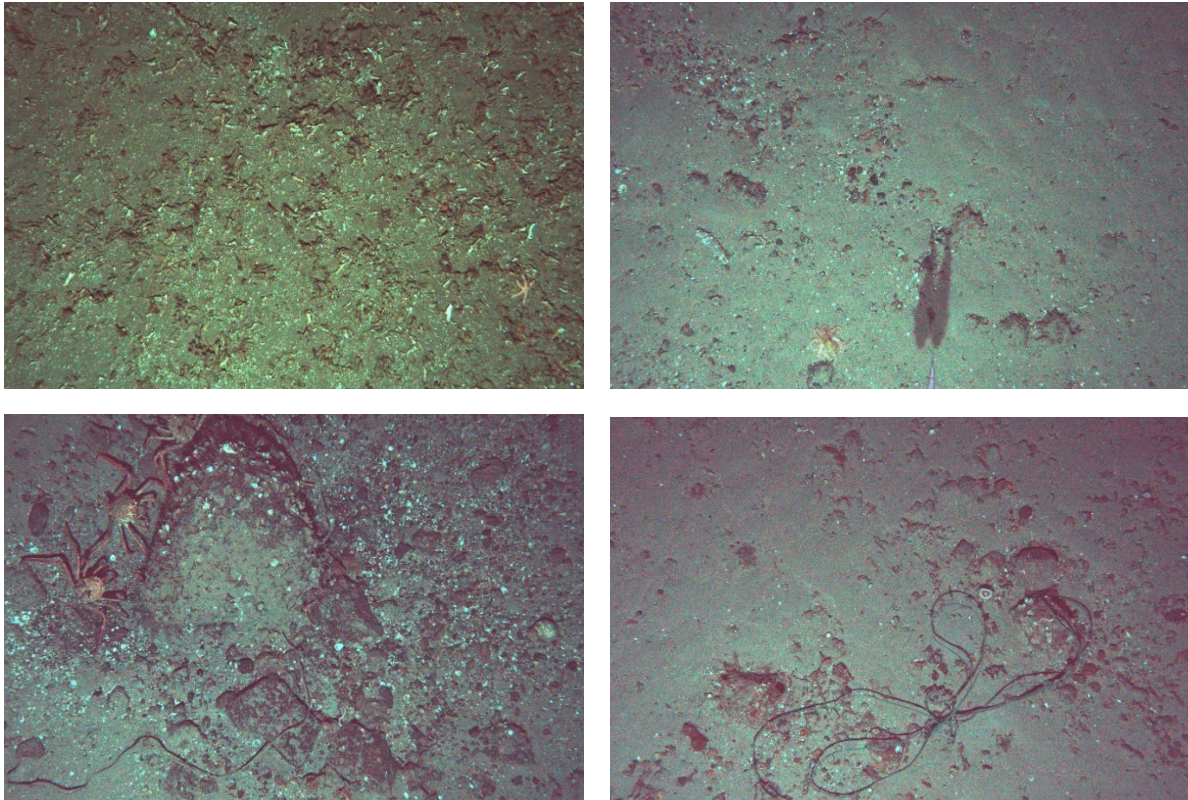


Fig. 7.25 Autosub5 example photographs from the cold-water coral mounds of the Dagaard Interfluvium, including coral rubble on top of a coral mound (upper left), octopus and the double shadow of a boarfish (upper right), large and smaller dropstones forming a habitat for spider crabs (lower left) and the ubiquitous lost fishing gear and litter (lower right).

7.3. Water sampling (Andy Gates & Sara Driscoll)

On DY200 a total of 9 Conductivity Temperature Depth (CTD) casts (Table 7.8) were completed for the following purposes:

- Discrete samples for carbonate chemistry – including total alkalinity (TA), dissolved inorganic carbon (DIC) at ecoreef deployment locations and at confirmed live coral reef sites within canyons
- Dissolved inorganic nutrients for validation of the recovered PISCES glider and spatial variability in bottom waters of The Canyons MCZ
- Validation of the recovered microCATs on the PISCES-1, PISCES-2 moorings and the RISC lander. These casts had long stops (5-10 min)

7.3.1. Carbonate chemistry sampling

For CTD Total alkalinity (TA) and dissolved inorganic carbon (DIC), samples were collected in 250 mL borosilicate glass bottles following Dickson et al. (2007); after a 1% by-volume headspace was created the sample was poisoned by addition of 50 μ L of saturated mercuric chloride solution (HgCl_2) and made air-tight by sealing with greased (Apiezon L) ground-glass stoppers secured with a clip and rubber band. The samples were stored in the dark at room temperature. Samples will be analysed at the National Oceanography Centre, Southampton, UK.

7.3.2. Dissolved nutrient sampling

Nutrient samples were taken from DY200-025-CTD04 for validation of the PISCES glider, shortly after it was recovered (25 samples at 24 depths) and from the two REDRESS CTDs. Samples were filled into 60 ml HDPE Nalgene bottles (acid-washed and rinsed with MilliQ). Seawater was run out of the Niskin bottles for five seconds prior to sample collection. Then sample bottle and cap were rinsed 3 times with sample before taking the final sample. Non-nitrile gloves (Semperguard) were used during sampling. The samples were then immediately frozen (-20 °C) upright and will be analysed by the PISCES team.

Table 7.8 Details of CTD casts

stn no.	Cast no.	Date	LAT (N)	LON (W)	cast depth (m)	Notes	Samples
DY200-02	1	24/09/2025	50° 23.767	7° 50.396	95	SVP and test CTD	TA/DIC at 5 depths
DY200-009	2	26/09/2025	50° 14.410	7° 56.165	103	SVP	
DY200-015	3	28/09/2025	48° 19.149	9° 53.789	1749	SVP for AS-5. Validation CTD for PISCES glider.	25 x Nutrients samples at 24 depths from 1000-0 m. 1 x duplicate
DY200-025	4	30/09/2025	48° 21.749	9° 38.347	1201	MicroCAT validation CTD for PISCES-1, PISCES-2 & RISC lander	
DY200-046	5	02/10/2025	48° 16.949	9° 38.507	330	CTD for ecoreefs deployed at Dangeart interfluve. TA/DIC samples to be discarded because improperly sealed upon collection.	(10 x TA/DIC at 5 depths 5 depths) 1 x nutrient from bottom
DY200-047	6	02/10/2025	48° 24.184	9° 42.092	338	CTD for ecoreefs deployed at Explorer interfluve	10 x TA/DIC at 5 depths 1 x nutrient from bottom
DY200-059	7	08/10/2025	48° 21.069	9° 40.232	330	CTD for spatial carbonate chemistry and bottom nutrient variability	10 x TA/DIC at 5 depths 1 x nutrient from bottom
DY200-061	8	08/10/2025	48° 16.919	9° 38.526	340	Re-collect carbonate samples for CTD05.	10 x TA/DIC at 5 depths
DY200-076	9	10/10/2025	48° 28.339	9° 38.924	1055	CTD for spatial carbonate chemistry at known coral reef location, and bottom nutrient variability	10 x TA/DIC at 8 depths. 2 x bottom nutrients.

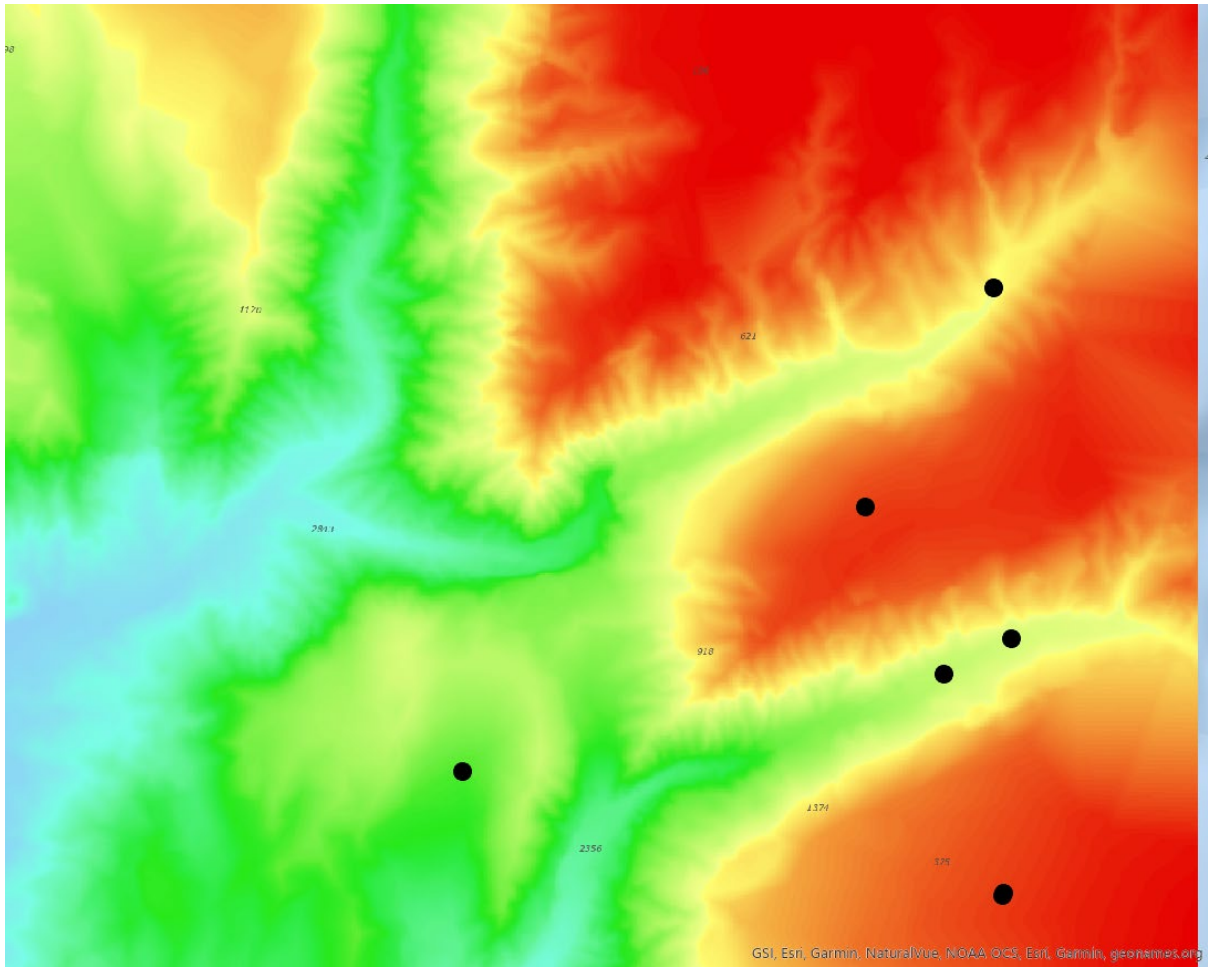


Fig. 7.26 CTD locations in Whittard Canyon

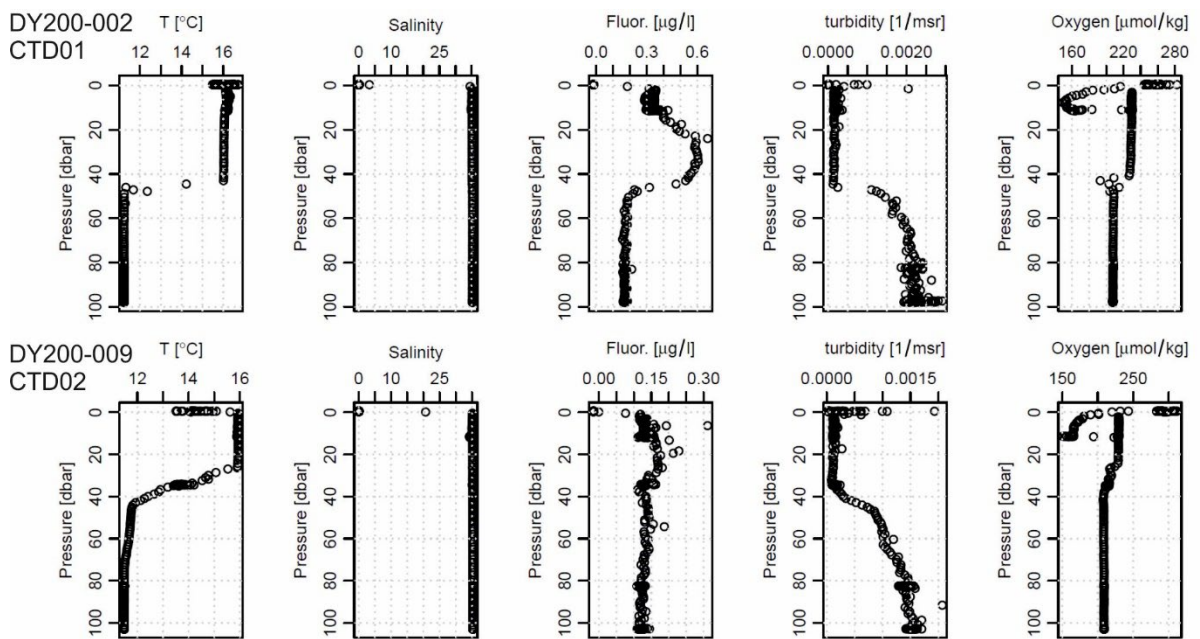


Fig. 7.27 Example CTD profiles, here from Haig Fras

7.4. REDRESS Ecoreefs (*Lisa Skein, Andy Gates, Veerle Huvenne & Sara Driscoll*)

Fifteen ecoreefs of three different models were deployed in The Canyons MCZ, split over the Dangeard and Explorer interfluves. Twelve ecoreefs were of the “wedding cake” type from the company D-shape funded by Project REDRESS and three were ‘star’ shaped donated by the Life Lophelia project (Fig. 7.28).



Fig. 7.28 Ecoreef models. Left and middle are the D-shape “wedding cake” type, AG900-3-REDRESS and AG800-5 , respectively, and right shows “star” type of the Life Lophelia project.

Deployment sites were carefully selected using the Autosub5 high-resolution bathymetry and side-scan sonar. We used a stratified random design with 3 reefs of each type deployed on the Dangeard interfluve, and 3 each of the D-shape reef models on the Explorer interfluve (Table 7.9). Candidate mini-mounds for ecoreef deployment on the Dangeard and Explorer interfluves were first identified using the AUV maps (Fig. 7.29). Baseline imagery surveys were then conducted along transects over the candidate mini-mounds using the SeaSpyder to characterise current conditions and communities before reefs were deployed. The mini-mounds were specifically targeted as they indicate past coral growth and their height above the surrounding seafloor makes them better locations for promoting coral recruitment. The baseline imagery surveys also included comparable coral mounds where no ecoreefs were deployed, so that future studies can compare their benthic communities and the effects of such restoration efforts in the deep-sea.

Table 7.9 – Ecoreef positions

Interfluve	Station number	Model	Deploy date	Lat	Long	Depth	Comments
Dangeard	DY200-026-ERF01/	ERF1rg	30/09/2025	48.2881	-9.6394	341.0	Large wedding cake (flat top) 900kg, USBL position
Dangeard	DY200-028-ERF02/	ERFstr	01/10/2025	48.2874	-9.6422	346.0	Star shape, USBL position
Dangeard	DY200-029-ERF03/	ERFsml	01/10/2025	48.2821	-9.6366	326.0	Small wedding cake (beehive) 800kg, USBL position
Dangeard	DY200-030-ERF04/	ERF1rg	01/10/2025	48.2801	-9.6463	347.0	Large wedding cake 900kg, USBL position
Explorer	DY200-031-ERF05/	ERF1rg	01/10/2025	48.4035	-9.6941	332.0	Large wedding cake 900kg, USBL position, Explorer01

Explorer	DY200-032-ERF06/	ERFsmI	01/10/2025	48.4043	-9.6953	335.0	Small wedding cake 800kg, USBL position, Explorer02
Explorer	DY200-033-ERF07/	ERFIrg	01/10/2025	48.4020	-9.7004	335.0	Large wedding cake 900kg, USBL position, Explorer03
Explorer	DY200-034-ERF08/	ERFsmI	01/10/2025	48.4032	-9.7012	344.0	Small wedding cake 800kg, USBL position, Explorer04
Explorer	DY200-035-ERF09/	ERFsmI	01/10/2025	48.3994	-9.7070	332.0	Small wedding cake 800kg, USBL position, Explorer05
Explorer	DY200-036-ERF10/	ERFIrg	01/10/2025	48.4004	-9.7064	340.0	Large wedding cake 900kg, USBL position, Explorer06
Dangeard	DY200-041-ERF11/	ERFstr	02/10/2025	48.2845	-9.6454	349.0	Star shape, USBL position
Dangeard	DY200-042-ERF12/	ERFIrg	02/10/2025	48.2800	-9.6414	339.0	Large wedding cake 900kg, USBL position Dang.06
Dangeard	DY200-043-ERF13/	ERFstr	02/10/2025	48.2810	-9.6393	338.0	Star shape, USBL position, Dang 07
Dangeard	DY200-044-ERF14/	ERFsmI	02/10/2025	48.2784	-9.6449	346.0	Small wedding cake, 800kg, USBL position, Dang08
Dangeard	DY200-045-ERF15/	ERFsmI	02/10/2025	48.2824	-9.6422	340.0	Small wedding cake, 800kg, USBL position, Dang09
Dangeard		ERFctr		48.2850	-9.6423		Control site
Dangeard		ERFctr		48.2852	-9.6403		Control site
Dangeard		ERFctr		48.2842	-9.6385		Control site
Explorer		ERFctr		48.4060	-9.6928		Control site
Explorer		ERFctr		48.4026	-9.6928		Control site
Explorer		ERFctr		48.4038	-9.6947		Control site

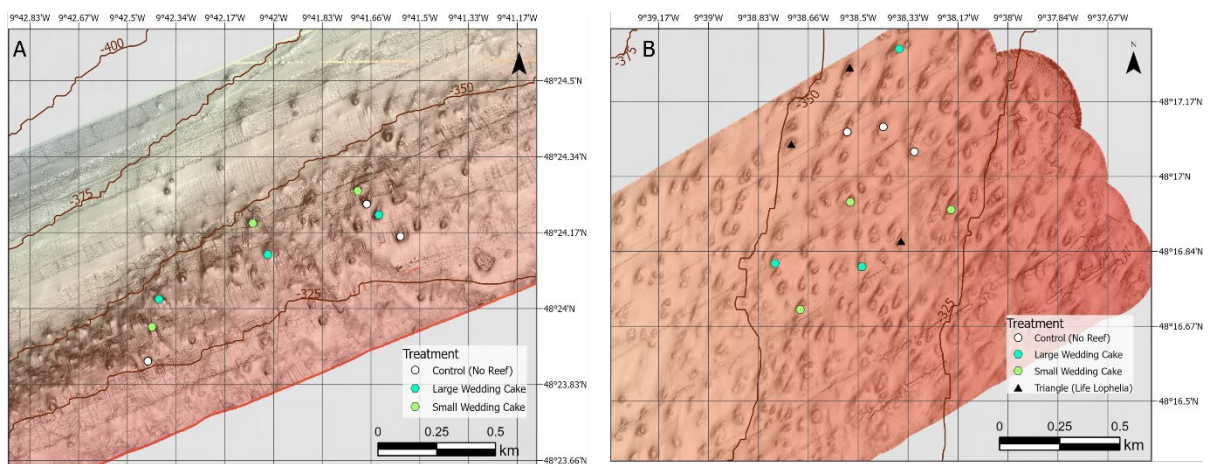


Fig. 7.29 Ecoreef deployment sites at coral mini-mounds of the (A) Explorer and (B) Dangeard interfluves of the Whittard Canyon System. Baseline imagery surveys were conducted across all mounds prior to reef deployment, including control sites where no reefs were deployed to enable future comparative studies. Underlying high-resolution bathymetry was collected with the Autosub-5 AUV at (A) 2 m and (B) 1 m resolution.

Once the ecoreefs were deployed, one reef was checked out with the SeaSpyder camera to ensure the deployment approach had worked successfully and the ecoreef was upright (station DY200-038-CAM10, see section 7.2.1.3).

The ecoreefs will now be left in situ, and will be monitored in the coming years through a combination of opportunistic surveys (ad-hoc towed camera surveys on cruises of opportunity) and dedicated ROV-based surveys every 3 to 6 years, starting in 2028, as part of the NERC-funded National Capability programme AtlantIS and its successors.

7.5. Passive acoustic observations (*Dara Farrell*)

The primary objective for the Soundscapes of the Porcupine Abyssal Plain and Whittard Canyon project during the DY200 cruise was the recovery of the acoustic lander and the acoustic recorder mounted inline on the PISCES 2 mooring, which were deployed during the JC278 cruise in June, 2025. The lander was outfitted with four Geospectrum hydrophones connected to an RS Aqua ORCA 72 D recorder and an RS Aqua PORPOISE 84-D recorder, whereas the RS Aqua PORPOISE 84-D recorder was outfitted with a single hydrophone. Both deployed gear were sited the Whittard Canyon, and their locations are shown in Fig. 7.30 and detailed in Tables 7.10 and 7.11 below.

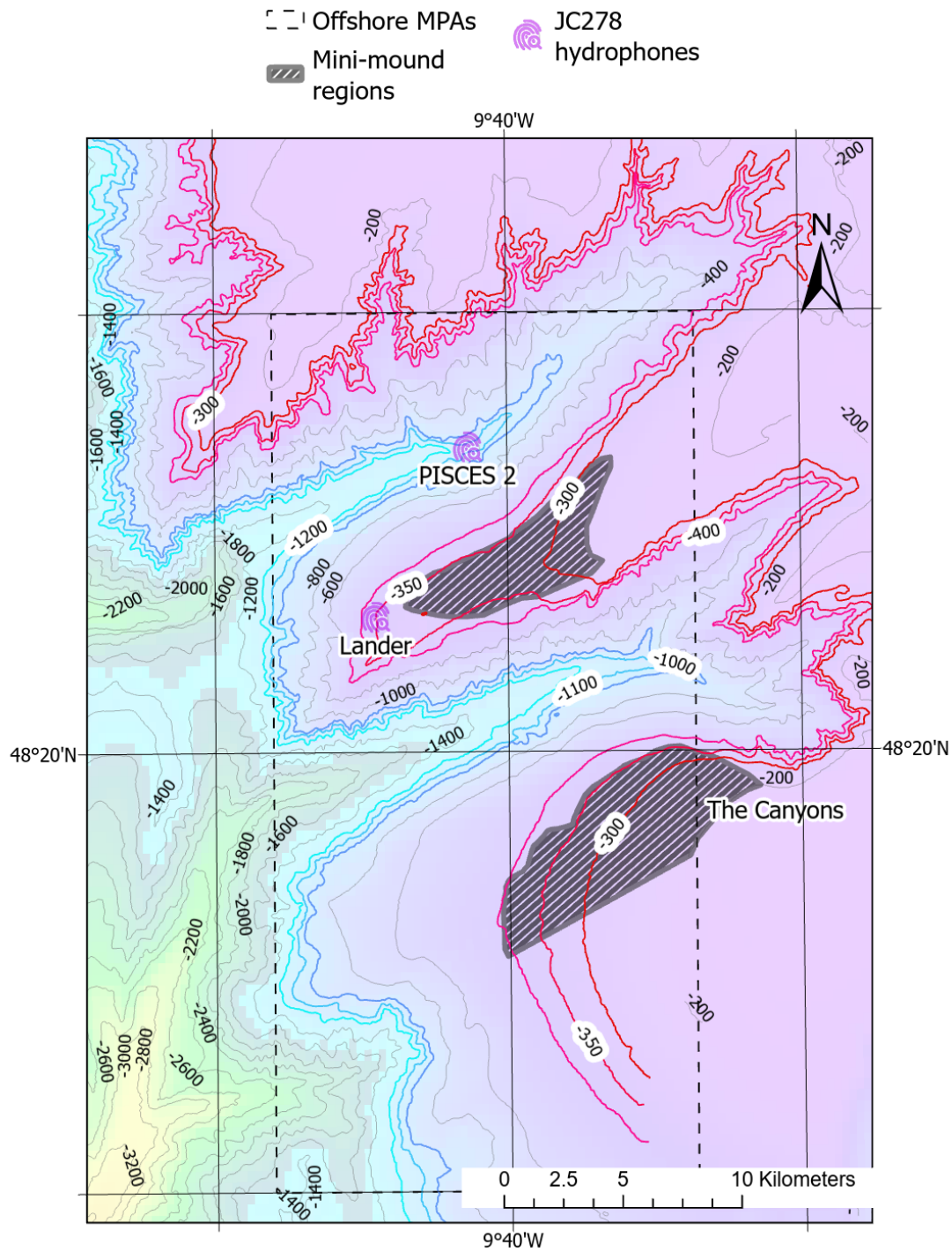


Fig. 7.30 Overview map of hydrophone deployment and recovery locations within The Canyons marine protected area.

Table 7.10 Hydrophone deployment locations. The lander and PISCES 2 recorders were recovered during the DY200 cruise.

Gear (Location)	Station Number	Latitude	Longitude	Instrument Depth (m)	Water Depth (m)
PISCES 2 (Whittard Canyon)	JC278-005	48.44845	-9.68764	1078	1165
Lander (Whittard Canyon)	JC278-007	48.38416	-9.7406	350	350
Whittard mooring (Whittard Canyon)	JC278-011	48.61682	-9.99064	1565	1585
PAP3 mooring (Porcupine Abyssal Plain)	JC278-020	48.97232	-16.49888	3033	4812
EGIM (Porcupine Abyssal Plain)	JC278-031	49.01334	-16.45479	4844	4844

Table 7.11 Summary of settings for all acoustic recorders deployed during JC278. The lander and PISCES 2 recorders were recovered during DY200

Acoustic Recorder and Site	Instr. Depth (m)	Hydrophone type	Set system sensitivity (dB re V/ μ Pa)	Sampling rate (kHz)	Sampling schedule	Deployment date and time (UTC)	Planned deployment duration
		Geospectrum					
RS AQUA ORCA 72-D 6000 m rated LANDER; TR-3-1R0-128 WHITTARD CANYON	350	Ch 1: M36-600 (sync); K000073 Ch 2: M36-900; C001534 Ch 3: M36-900; D000716 Ch 4: M36-900; D000714	Ch 1: nom -178.7+15 dB gain = -163.7 Ch 2: nom -164.7 +15 dB gain = 149.7 Ch 3: nom -165.1 + 15 dB gain = 150.1 Ch 4: nom -165.0 +15 dB gain = 150	96	30 mins on 30 mins off	2025-06-01 16:09:07	3 to 4 months
RS AQUA PORPOISE 84-D 750 m rated LANDER; TR-12-1R4-492 WHITTARD CANYON	350	M36-600 (sync); K000073	-173.7	192	Continuous	2025-06-01 16:09:07	3 to 4 months
RS AQUA PORPOISE 84-D 7 SERIES TITANIUM-2500 m rated PISCES 2; TR-12-1R4-504 WHITTARD CANYON	1078	M36-600; J004849	-162.1	192	Continuous	2025-06-01 10:18:18	3 to 4 months
RS AQUA PORPOISE 84-D 6000 m rated WHITTARD; TR-12-1R4-232 WHITTARD CANYON	1565	M36-600; J004848	-162.6	Dual SR 96/64	Alternate days (1 min off)	2025-06-02 12:42:06	1 year
RS AQUA PORPOISE 84-D 6000 m rated PAP 3; TR-12-1R4-231 PORCUPINE ABYSSAL PLAIN	3033	M36-600; K000074	-161.6	Dual SR 96/64	Alternate days (1 min off)	2025-06-06 14:35:56	1 year
EGIM icListen HF PORCUPINE ABYSSAL PLAIN	4844	icListen HF	-171	256	Continuous	12/06/2025 08:47:47	1 year

7.5.1. PISCES 2 mooring: Station JC278-005

The PISCES 2 mooring was sited in the Explorer Canyon, and included one hydrophone connected to one acoustic recorder (RS Aqua PORPOISE-84D). The recorder was secured in a bespoke stainless-steel frame and mounted vertically in line with the other instruments on the mooring at a depth of 1078 m. Fig. 7.31 shows a preliminary schematic of the mooring as well as a picture of the recorder unit in its mounting frame prior to deployment. The choice of positioning on the mooring was dependent on logistical considerations of the size and weight of the unit, as well as the other jointly mounted instruments (e.g., ADCPs). This location was expected to enable capture of sediment flow in the canyon along with general characterisation of the underwater ambient noise environment over the deployment period.

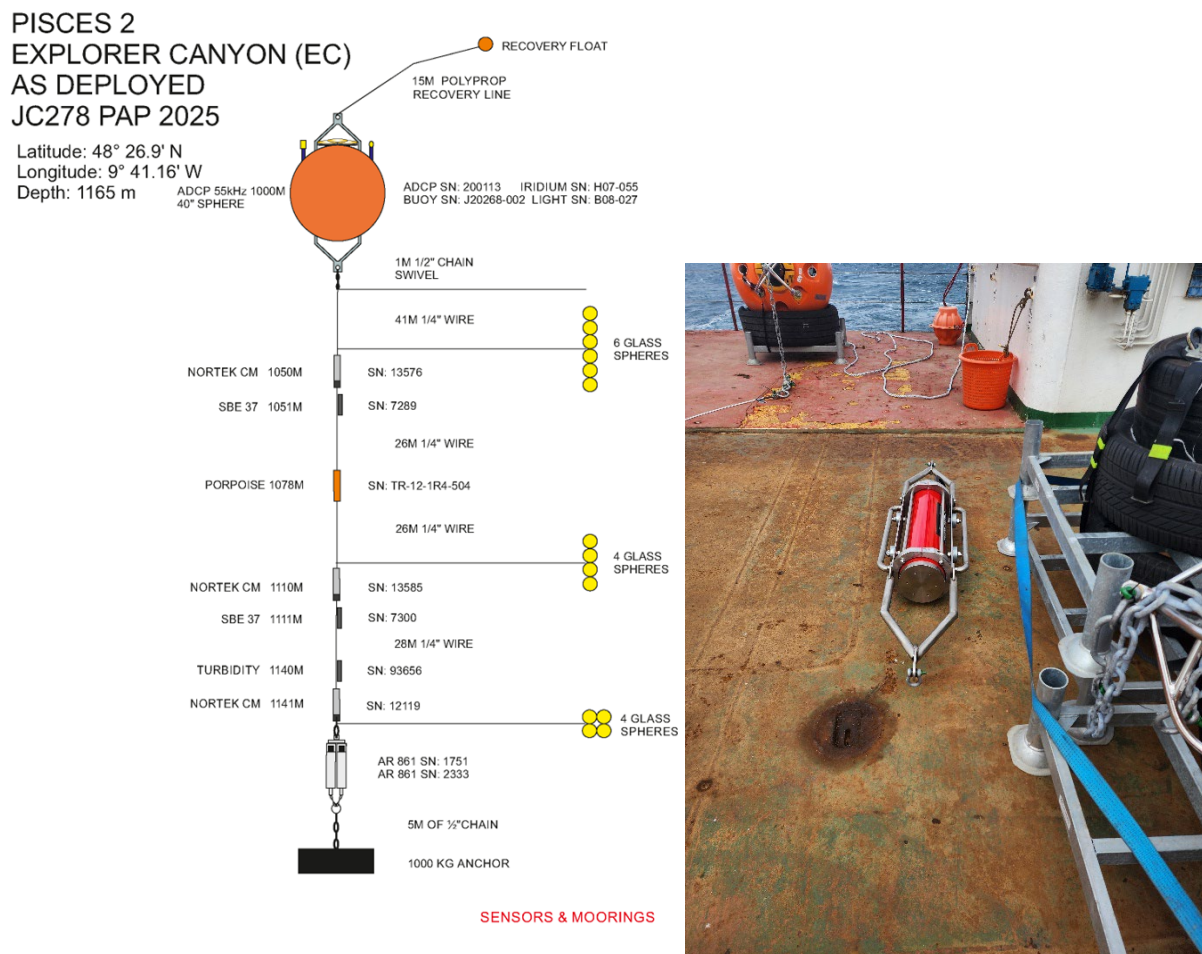


Fig. 7.31 PISCES 2 mooring: initial schematic of planned mooring—not to scale and (left); picture of recorder mounted in frame (contracted by RS Aqua from MC Engineering) prior to deployment (right)

Recovered data

Water ingress occurred in the Porpoise recorder during its deployment. As a result, the instrument did not record during the entire deployment period. The last .WAV file was written to the internal SD card on 22/08/2025. This ingress was coupled with the suspected failure of the in-built pressure relief valve,

which resulted in a build-up of pressure within the instrument that was released upon opening. The root causes of these failures are currently unknown and will be investigated in conjunction with the manufacturer post cruise.

Initial investigation of the recorded files revealed significant saturation consistent with recorder overload, elevated ambient noise, and/or mooring-related noise. This saturation likely precludes adequate capture of the full dynamic range of the soundscape; however, the data captured will be reviewed to assess the utility of any recordings of good fidelity. The settings and the deployment configuration will also be used to inform/improve the settings for future inline moorings of this type.

7.5.2. Whittard Lander: Station JC278-007

The lander was sited on the Explorer Interfluve and hosted four hydrophones connected to two acoustic recorders (RS Aqua PORPOISE-84D And RS Aqua ORCA 72D). Two hydrophones (recording to channels 2 and 4 on the ORCA) were mounted diagonally at an approximately 1.5 m vertical offset from the two hydrophones (recording to channels 1 and 3 on the ORCA) that were mounted diagonally at the corners of the main frame. The channel 1 hydrophone mounted on the main frame was connected to both the PORPOISE and the ORCA recorders to enable synchronisation across instruments since the ORCA was configured for a 30 min on/30 min off duty cycle (see Fig. 7.32). Its configuration was designed to enable exploration of localisation of signals.

This relatively shallow and flat (<4° slope) location for the lander was chosen to enable measurement of surface phenomena, such as wind and wave activity, potential marine mammal vocalisations, and parallel observations of sediment flow with the hydrophone mounted on the PISCES 2 mooring at a depth of 1078 m. Additionally, its placement near the coral mini-mound region may allow capture of features of the ambient environment that may impact coral ecosystems. Deployment on the seafloor within the canyons' thalwegs was considered to be too high-risk considering the shape of the lander and the powerful turbidity currents in this area.

In addition to the hydrophones and their accompanying recorders, the lander was outfitted with a current meter (Nortek) and a CTD (SBE 37-SM MicroCat, Sea-Bird Scientific), as shown in Fig. 7.32.

HYDROPHONE LANDER AS DEPLOYED JC278 PAP 2025

Latitude: 48° 23.02'N
Longitude: 9° 44.24'W
Depth: 350m

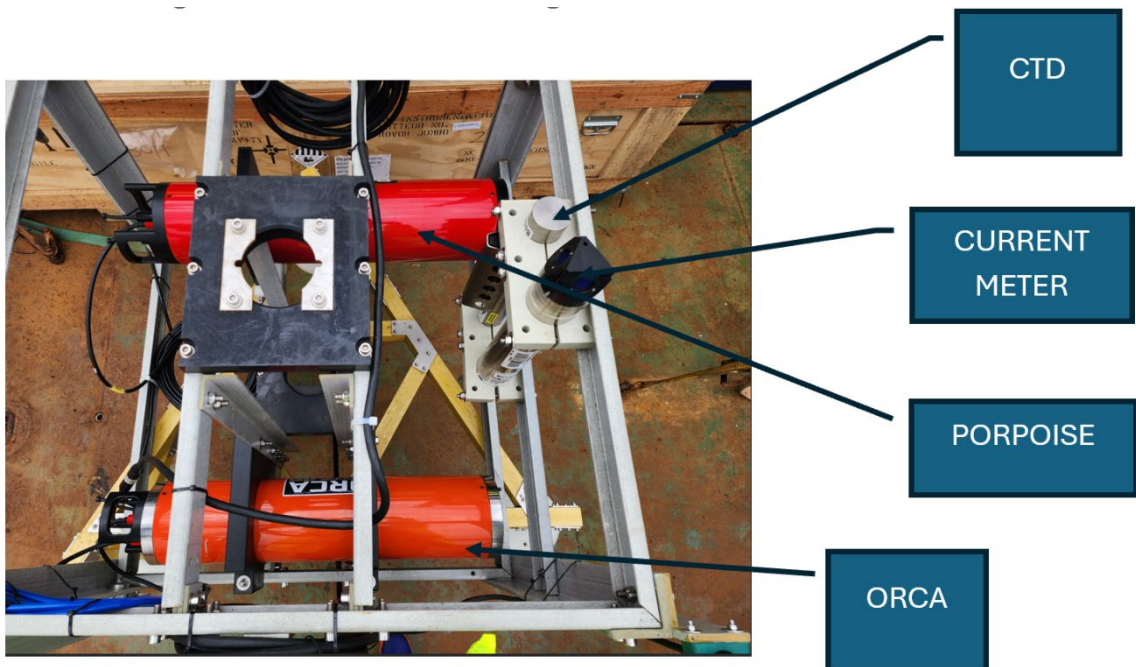
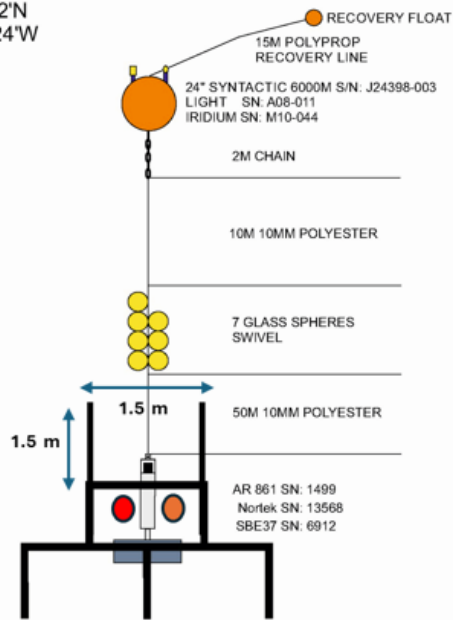


Fig. 7.32 Whittard lander: schematic of the planned lander (top left), channel mapping (top right), and layout of instruments on the acoustic lander (bottom). The vertically mounted hydrophones were approximately 1.5 m above the hydrophones on the main frame (diagonal distance ~1.5 m).

Recovered data

Water ingress occurred in the ORCA recorder during its deployment. The instrument did not record during its deployment period. The root causes of the equipment failure are currently unknown and will be investigated in conjunction with the manufacturer post cruise.

The Porpoise recorder successfully recorded until its recovery on 29/09/2025. Initial investigation of the recorded files revealed files of good fidelity, showing indications of marine mammal activity in the area. Fig. 7.33 is a spectrogram showing an example of suspected common dolphin vocalisations captured by the Porpoise recorder recorded on 18/07/2025 after 22:00 UTC; the overlapping of the signatures in the spectrogram indicates the presence of several mammals.

These data have been earmarked for analysis as part of a PhD dissertation by a student from the University of Southampton.

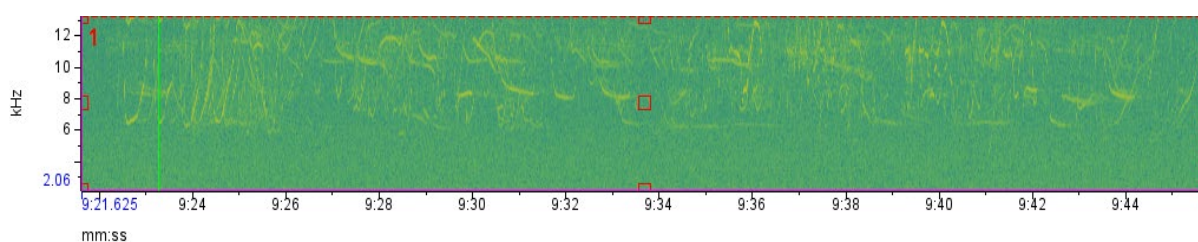


Fig. 7.33 Spectrogram showing suspected common dolphin vocalisations captured by the Porpoise 84-D recorder mounted on the acoustic lander at a depth of 350 m.

7.6. Outreach activities (Michaela Vieser)

7.6.1. Writer in residence

Michaela Vieser (www.michaelavieser.com) joined DY200 as writer in residence, to record her experiences and convey them to a wider audience.

7.6.1.1. Outreach and science communication activities

In addition to her role as an onboard observer, she was also engaged in multiple publication and outreach efforts that document and communicate the scientific and human dimensions of this research expedition.

7.6.1.2. Cruise documentation

A detailed cruise journal was compiled, comprising over 80 pages and exceeding 27,000 words. This private log captures day-to-day operations, observations, and personal reflections, offering a comprehensive narrative of the expedition from an embedded perspective.

7.6.1.3. Feature publication

Michaela was commissioned to write a feature article for the German *Science Notes Magazin* (www.sciencenotes.de), scheduled as the lead story for the January online edition. The article, exceeding 20,000 characters in length, will be supported by four related articles highlighting parallel research projects. The central theme of the lead feature is *“What Does It Take to Look into the Ocean”*, with a focus on the human infrastructure underpinning oceanographic research. The piece will explore how each individual on board—across all roles—contributes to the scientific mission.

To support this work, Michaela conducted in-depth interviews with 37 cruise participants, representing a cross-section of shipboard professions. Interview questions addressed both their formal duties and their personal experiences of the ship as a combined workplace and living environment. Interview durations ranged from approximately 4.5 to 45 minutes.

7.6.1.4. Multimedia collection

Complementing the written materials, Michaela assembled a library of audiovisual documentation. This includes sound recordings and photographs capturing key scientific operations (e.g., deployment of the AUV, anchor platform, and lander recovery), as well as informal moments of life on board, such as recreational and social activities.

7.6.1.5. Scientific shift participation

Michaela participated in the day shift alongside the scientific team, generally from 04:00 to 16:00. During this time, she contributed primarily to data logging during SeaSpyder deployments, gaining firsthand insight into the operational side of deep-sea research.

7.6.1.6. Digital outreach

In collaboration with the National Oceanography Centre (NOC) and the chief scientist, Michaela is produced a series of Instagram outreach posts documenting the cruise. These posts aim to communicate the scope, significance, and human stories of the expedition to a broader public audience.

7.6.1.7. Future projects

The cruise has also enabled Michaela to initiate contact and gather preliminary material from several scientists for her forthcoming non-fiction book, currently under the working title *“The Atlas of Deep Sea Features”* together with Isaac Yuen scheduled for spring 2025 by German publisher Ullstein Verlag.

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9. STATION LIST

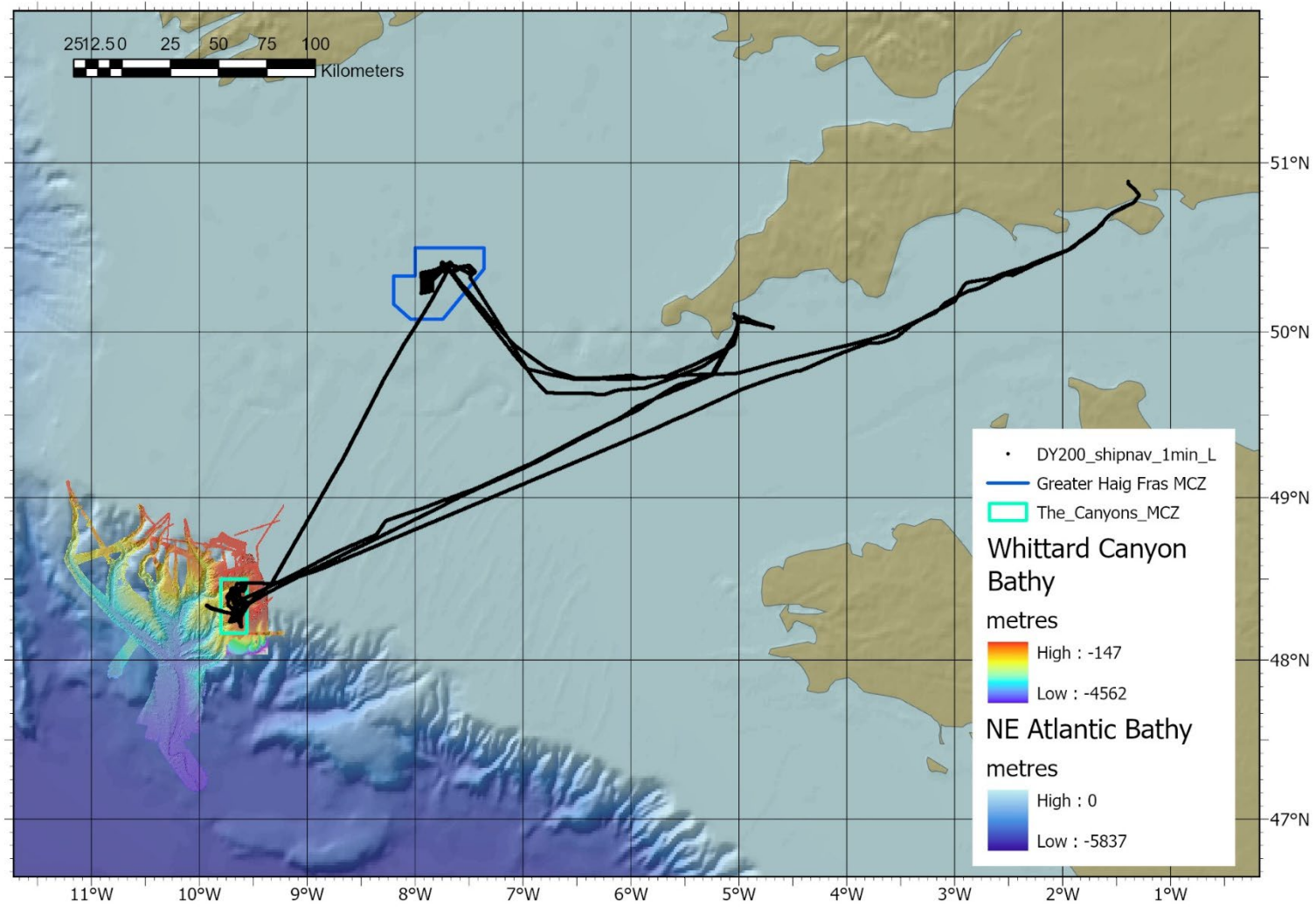
Cruis	Site	Final sample number	Start Date	GMT	Start Time	Start Lat Degr	Start Lat Min N	Start Lat W	Start Long Degr	Start Long Min W	Start Water depth	Equip ment	End Date	GMT	End Time	End Lat Degr	End Lat Min N	End Lat W	End Long Degr	End Long Min V	End water depth	Comments
JC278	The Canyons	JC278-005-PISCES-2/	01/06/2025		10:17	48	26.90000		9	41.1600	1165		29/09/2025		11:44:00	48	26.2820		9	42.4100		Triangulated position, recovered on DY200 (end position is position when on deck)
JC278	The Canyons	JC278-006-PISCES-1/	01/06/2025		13:52	48	21.41000		9	32.6100	955		29/09/2025		13:53:00							Triangulated position, recovered on DY200
JC278	The Canyons	JC278-007-HYDR/	01/06/2025		16:47	48	23.03800		9	44.3990	350		29/09/2025		09:15:00	48	23.3450		9	44.5660	372	deployed without incident, recovered on DY200
DY196	Whittard Canyon	DY196-EC-Glider/											28/09/2025		17:39:00	48	20.2120		9	55.8000	1349	Recovered without incident.
DY200	Test area	DY200-001-CAM01/tow01	23/09/2025		14:54:00	50	20.3370		2	28.2980	55.0		23/09/2025		15:27:00	50	20.3170		2	30.3030		Test deployment of SeaSpyder. Successful. Cable rate descent 0.2m/s, 1.5 Te. Strong current with camera at 2.9kts, ship move slowed to minimum 2 kts. Some test stills taken in water column.
DY200	Haig Fras	DY200-002-CTD01/p01	24/09/2025		13:39:00	50	23.7670		7	43.3940	109.0	95.0	24/09/2025		14:04:00	50	23.7660		7	43.3930	0.0	Test CTD. Carbonate sampling at 5 depths.
DY200	Haig Fras	DY200-002-CTD01/svp01	24/09/2025		13:39:00	50	23.7670		7	43.3940	109.0	95.0	24/09/2025		14:04:00	50	23.7660		7	43.3930	0.0	SVP for ASS.
DY200	Haig Fras	DY200-003-AS5M122/	24/09/2025		15:07:00	50	23.5160		7	43.4480	109.0		24/09/2025		16:26:00	50	23.9480		7	42.1170		Test dive. Aborted during 10 min test dive.
DY200	Haig Fras	DY200-004-CAM02/tow01	24/09/2025		20:14:00	50	22.6313		7	43.2396	108.1		24/09/2025		20:52:00	50	22.6315		7	43.2395	107.8	First image no. 0014. Laser distance to be checked. Dive aborted before transect start due to bubbles on lens.
DY200	Haig Fras	DY200-005-MBES01/EM710	24/09/2025		22:08:00	50	20.3710		7	50.2130	110.0		25/09/2025		10:29:00	50	21.3450		7	53.0750	111.0	ship speed 6 kts
DY200	Haig Fras	DY200-006-AS5M123/	25/09/2025		12:40:00	50	23.4130		7	43.4660	108.0		25/09/2025		15:20:00	50	22.4840		7	43.6970		test dives M123A-D
DY200	Haig Fras	DY200-006-AS5M124/	25/09/2025		15:20:00	50	22.4840		7	43.6970	107.0		26/09/2025		14:00:00	50	22.5120		7	27.8700	107.0	Vehicle surfaced 21:23 25Sep. Naming confusion - on paper this is listed still as M123, but in AUV notes as M124. End station location from AUV report so AUV location instead of ship
DY200	Haig Fras	DY200-007-MBES02/EM710	25/09/2025		17:37:00	50	20.9300		7	53.2800	113.0		25/09/2025		21:31:00	50	17.8606		7	54.0931	115.0	Ship speed 6 kts. MBES survey stopped when AUV surfaced.
DY200	Haig Fras	DY200-008-MBES03/EM710	26/09/2025		00:29:00	50	16.3345		7	54.2890	110.0		26/09/2025		09:32:00	50	13.8910		7	56.3980	90.0	
DY200	Haig Fras	DY200-009-CTD02/p01	26/09/2025		09:57:00	50	14.4100		7	56.1650	114.0	103.0	26/09/2025		10:04:00	50	14.4100		7	56.1650	113.0	10 meters above bottom
DY200	Haig Fras	DY200-009-CTD02/SVP02	26/09/2025		09:57:00	50	14.4100		7	56.1650	114.0	103.0	26/09/2025		10:04:00	50	14.4100		7	56.1650	113.0	10 meters above bottom
DY200	Haig Fras	DY200-010-MBES04/MBES04	26/09/2015		10:36:00	50	13.8870		7	56.5910	109.0		26/09/2025		12:08:00	50	19.5150		7	56.4650	113.0	breaking off for AUV rendezvous
DY200	Haig Fras	DY200-011-AF01/	26/09/2025		14:43:00	50	23.7569		7	44.0961	110.1	50.0	26/09/2025		15:35:00	50	23.7560		7	44.0950	111.0	all three anchors successfully deployed
DY200	Haig Fras	DY200-012-MBES05/MBES05	26/09/2025		16:34:00	50	22.6500		7	37.2520	107.0		26/09/2025		19:59:00	50	19.5420		7	29.4660	101.0	Ship speed 6 kts. Ending at 20:00 to head to Falmouth
DY200	The Canyons	DY200-013-AF02/	28/09/2025		10:41:00	48	17.8990		9	39.0360	385.0	200.0	28/09/2025		11:29:00	48	17.8990		9	39.0360	385.0	
DY200	The Canyons	DY200-014-AS5M125/	28/09/2025		13:56:00	48	17.5460		9	38.8990	369.0		28/09/2025		13:36:00	48	16.9320		9	38.4960	324.0	short ballasting test
DY200	The Canyons	DY200-014-AS5M126/	28/09/2025		14:11:50	48	16.8480		9	37.9200	369.0		28/09/2025		15:35:00	48	17.0290		9	38.0240	324.0	Abort weight dropped, max depth exceeded
DY200	Whittard Canyon	DY200-015-CTD03/p01	28/09/2025		18:25:00	48	19.1488		9	53.7880	1761.0	#####	28/09/2025		20:14:00	48	19.1490		9	53.7890	1762.0	24 bottles at 24 depths to 1000m 25 samples for Nuts. 1 x duplicate at 1000 m
DY200	Whittard Canyon	DY200-015-CTD03/SVP03	28/09/2025		18:25:00	48	19.1488		9	53.7880	1761.0	#####	28/09/2025		20:14:00	48	19.1490		9	53.7890	1762.0	SVP for ASS.
DY200	The Canyons	DY200-016-AS5M127/	28/09/2025		22:01:00	48	17.5850		9	38.9050	367.0		29/09/2025		18:50:00	48	15.5790		9	40.3470	414.0	Surfaced at 04:07 but sent back down.
DY200	The Canyons	DY200-017-CAM03/tow01	29/09/2025		00:13:00	48	23.7940		9	42.4410	322.0	322.0	29/09/2025		02:58:00	48	24.0470		9	42.3750	346.0	issues with camera flash. Camera freeze and required restart. Loss of bottom right laser. 3 mini-mounds covered.
DY200	The Canyons	DY200-018-CAM04/tow01	29/09/2025		03:34:00	48	24.0650		9	41.9980	325.0	325.0	29/09/2025		05:12:00	48	24.2080		9	42.1120	352.0	
DY200	The Canyons	DY200-019-CAM05/tow01	29/09/2025		05:41:00	48	24.1210		9	41.5200	331.0	331.0	29/09/2025		07:30:00	48	24.2680		9	41.7420	NR	start clapperboard image 516
DY200	The Canyons	DY200-020-AF03/	29/09/2025		14:34:00	48	21.4500		9	31.7640	897.0	500.0	29/09/2025		15:43:00	48	21.4500		9	31.7640	897.0	

Cruise	Site	Final sample number	Start Date	Start Time GMT	Start Lat Degr N	Start Lat Min N	Start Long Degr W	Start Long Min W	Start Water depth meter	Equip ment depth	End Date	End Time GMT	End Lat Degr N	End Lat Min N	End Long Degr W	End Long Min W	End water depth meter	Comments
DY200	The Canyons	DY200-021-CAM06/tow01	29/09/2025	19:50:00	48	16.8680	9	38.1070	326.0		30/09/2025	01:32:00	48	16.7870	9	38.9180	353.0	Stopped twice to restart camera. possible sequence going over
DY200	The Canyons	DY200-022-CAM07/tow01	30/09/2025	02:25:00	48	17.3190	9	38.2570	342.0	342.0	30/09/2025	05:03:00	48	17.1410	9	38.6550	351.0	mound...rubble...sand...rubble??
DY200	The Canyons	DY200-023-CAM08/tow01	30/09/2025	05:51:00	48	18.3790	9	34.8660	262.0	262.0	30/09/2025	06:57:00	48	18.4530	9	34.9846	268.0	JNCC reference CNYN023, DY200 WP105
DY200	The Canyons	DY200-024-AF04/	30/09/2025	08:51:00	48	21.4480	9	32.6580	975.0	800.0	30/09/2025	10:20:00	48	21.4480	9	32.6570		1 fail - dropped on deck
DY200	The Canyons	DY200-025-CTD04/p01	30/09/2025	11:28:00	48	21.7490	9	38.3470	1210.0		30/09/2025	12:53:00	48	21.7479	9	38.3720	1201.0	CTD+MCATS
DY200	The Canyons	DY200-026-ERF01/	30/09/2025	15:20:00	48	17.2840	9	38.3630	341.0	341.0								Large wedding cake (flat top) 900kg, USBL position AUV surfaced, wrapped recovery rope around one thruster. Eventually recovered, appears to be minimal damage to AS5
DY200	The Canyons	DY200-027-AS5M128/	30/09/2025	16:04:00	48	17.2720	9	38.3980	341.0		01/10/2025	08:00:00	48	21.9500	9	38.9250	274.0	
DY200	The Canyons	DY200-028-ERF02/	01/10/2025	10:02:00	48	17.2430	9	38.5290	346.0	346.0								Star shape, USBL position
DY200	The Canyons	DY200-029-ERF03/	01/10/2025	11:02:00	48	16.9260	9	38.1930	326.0	326.0								Small wedding cake (beehive) 800kg, USBL position
DY200	The Canyons	DY200-030-ERF04/	01/10/2025	11:59:00	48	16.8080	9	38.7790	347.0	347.0								Large wedding cake 900kg, USBL position
DY200	The Canyons	DY200-031-ERF05/	01/10/2025	13:59:00	48	24.2070	9	41.6430	332.0	332.0								Large wedding cake 900kg, USBL position, Explorer01
DY200	The Canyons	DY200-032-ERF06/	01/10/2025	14:47:00	48	24.2600	9	41.7160		335.0								Small wedding cake 800kg, USBL position, Explorer02
DY200	The Canyons	DY200-033-ERF07/	01/10/2025	15:35:00	48	24.1210	9	42.0210	335.0	335.0								Large wedding cake 900kg, USBL position, Explorer03
DY200	The Canyons	DY200-034-ERF08/	01/10/2025	16:33:00	48	24.1890	9	42.0720	344.0	344.0								Small wedding cake 800kg, USBL position, Explorer04
DY200	The Canyons	DY200-035-ERF09/	01/10/2025	17:26:00	48	23.9630	9	42.4170	332.0	332.0								Small wedding cake 800kg, USBL position, Explorer05
DY200	The Canyons	DY200-036-ERF10/	01/10/2025	18:21:00	48	24.0220	9	42.3860	340.0	340.0								Large wedding cake 900kg, USBL position, Explorer06 Survey covered 4 mounds. Had to stop mid-tow to check winch scrolling.
DY200	The Canyons	DY200-037-CAM09/tow01	01/10/2025	19:56:00	48	17.1090	9	38.3570	340.0	340.0	01/10/2025	22:24:00	48	17.0590	9	38.7670	354.0	
DY200	The Canyons	DY200-038-CAM10/tow01	01/10/2025	23:01:00	48	16.9540	9	38.1390	329.0	326.0	02/10/2025	02:23:00	48	16.6630	9	38.7060	345.0	EcoReef observed. 5 mounds surveyed. altitude mistakenly adjusted over one of the mounds. Coordinates at end are off bottom, time is on deck
DY200	The Canyons	DY200-039-CAM11/tow01	02/10/2025	03:09:00	48	17.0680	9	38.2720	334.0	334.0	02/10/2025	05:11:00	48	16.9230	9	38.5760	337.0	
DY200	The Canyons	DY200-040-CAM12/tow01	02/10/2025	06:06:00	48	15.1720	9	38.6010	347.0	347.0	02/10/2025	07:38:00	48	15.1500	9	38.7830	356.0	
DY200	The Canyons	DY200-041-ERF11/	02/10/2025	08:57:00	48	17.0720	9	38.7230	349.0	349.0								Star shape, USBL position
DY200	The Canyons	DY200-042-ERF12/	02/10/2025	10:09:00	48	16.7990	9	38.4840	339.0	339.0								Large wedding cake 900kg, USBL position Dang.06
DY200	The Canyons	DY200-043-ERF13/	02/10/2025	10:55:00	48	16.8570	9	38.3590	338.0	338.0								Star shape, USBL position, Dang 07
DY200	The Canyons	DY200-044-ERF14/	02/10/2025	11:37:00	48	16.7030	9	38.6950	346.0	346.0								Small wedding cake, 800kg, USBL position, Dang08
DY200	The Canyons	DY200-045-ERF15/	02/10/2025	12:20:00	48	16.9440	9	38.5290	340.0	340.0								Small wedding cake, 800kg, USBL position, Dang09
DY200	The Canyons	DY200-046-CTD05/	02/10/2025	12:48:00	48	16.9490	9	38.5070	339.0	330.0	02/10/2025	13:23:00	48	16.9490	9	38.5070	339.0	discrete carbonate chemistry profile and bottom nutrient sample
DY200	The Canyons	DY200-047-CTD06/	02/10/2025	14:48:00	48	24.1840	9	42.0920	346.0	338.0	02/10/2025	15:26:00	48	24.1830	9	42.0910	345.0	discrete carbonate chemistry profile and bottom nutrient sample
DY200	The Canyons	DY200-048-AF05/	02/10/2025	16:30:00	48	21.6940	9	38.2540	1203.0	800.0	02/10/2025	18:03:00	48	21.6470	9	38.1300	1178.0	Anchor test, 3 dropped.
DY200	Haig Fras	DY200-049-CAM13/tow01	06/10/2025	01:52:00	50	22.4380	7	42.9240	109.0	109.0	06/10/2025	05:46:00	50	23.1030	7	42.9660	111.0	
DY200	Haig Fras	DY200-050-AS5M129/	06/10/2025	08:17:00	50	24.8000	7	44.9450	111.0		06/10/2025	16:50:00	50	24.6800	7	40.2260	112.0	Sub altitude higher than programmed.

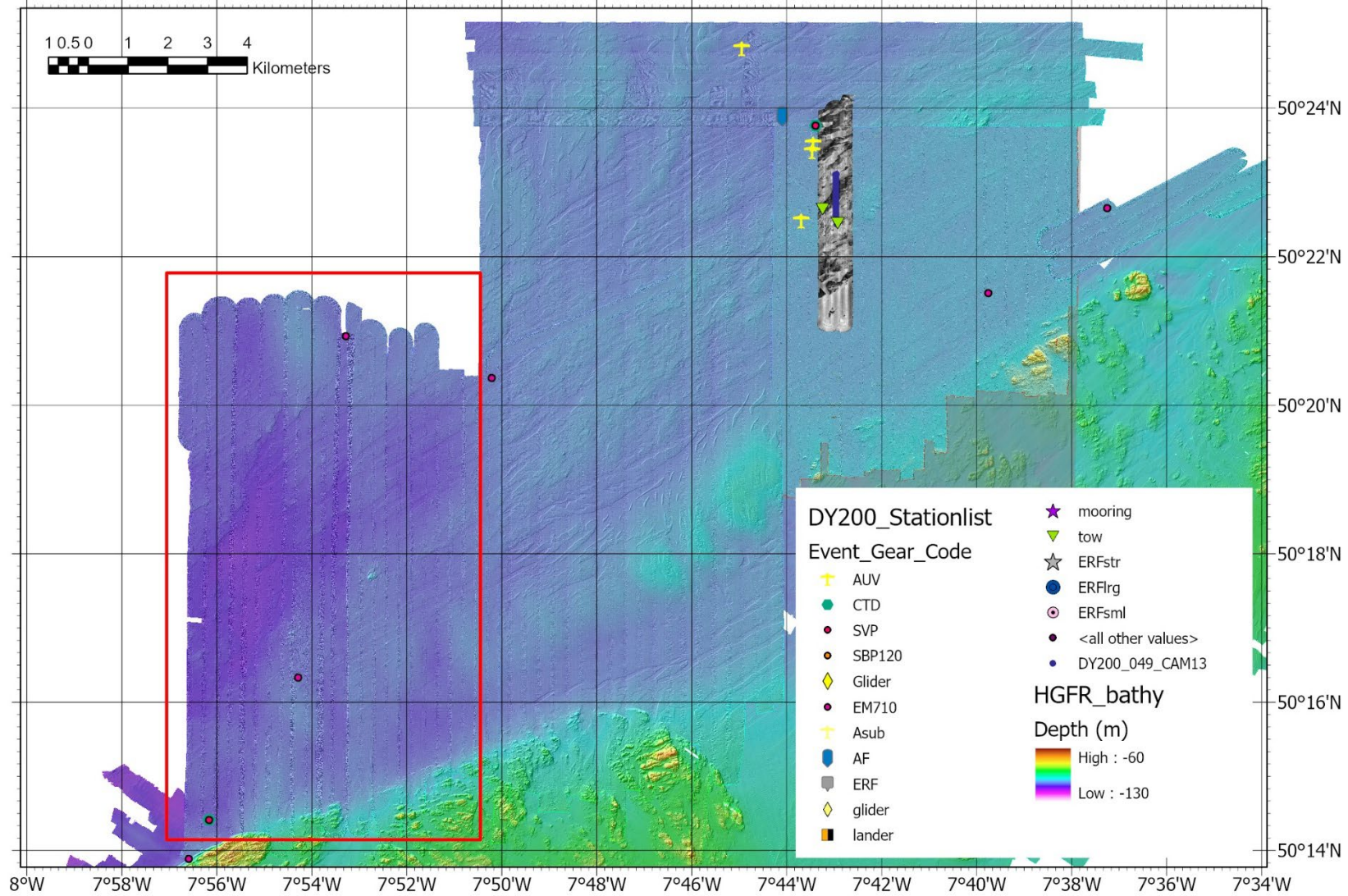
Cruise	Site	Final sample number	Start Date	Start Time GMT	Start Lat Degr N	Start Lat Min N	Start Long Degr W	Start Long Min W	Start Water depth meter	Equip ment depth	End Date	End Time GMT	End Lat Degr N	End Lat Min N	End Long Degr W	End Long Min W	End water depth meter	Comments
DY200	Haig Fras	DY200-051-MBES06/	06/10/2025	09:49:00	50	21.5100	7	39.7500	105.0		06/10/2025	14:22:00	50	21.1160	7	30.8010	93.0	
DY200	The Canyons	DY200-052-AS5M130/	07/10/2025	08:39:00	48	17.8220	9	37.7860	337.0		07/10/2025	15:40:00	48	17.6860	9	39.9220	398.0	Started with depth tests
DY201	The Canyons	DY201-052-AS5N131/	07/10/2025	15:40:00	48	17.6860	9	39.9220	398.0		08/10/2025	13:55:00	48	17.8020	9	38.3290	330.0	
DY200	The Canyons	DY200-053-AF06/	07/10/2025	17:56:00	48	14.1920	9	43.2880	917.0	800.0	07/10/2025	19:30:00	48	14.1380	9	43.1920	916.0	2/3 worked as expected.
DY200	The Canyons	DY200-054-CAM14/tow01	07/10/2025	20:24:00	48	14.7450	9	37.8790	342.0	330.0	07/10/2025	22:13:00	48	14.6010	9	38.0410	339.0	JNCC reference CNYN180 DY200 WP162
DY200	The Canyons	DY200-055-CAM15/tow01	07/10/2025	23:07:00	48	12.3950	9	36.6690	367.0	367.0	08/10/2025	00:44:00	48	12.2970	9	36.9140	380.0	JNCC reference CNYN181 DY200 WP113
DY200	The Canyons	DY200-056-CAM16/tow01	08/10/2025	01:58:00	48	17.7620	9	36.4310	291.0	290.0	08/10/2025	03:18:00	48	17.8370	9	36.6270	299.0	JNCC reference CNYN078 DY200 WP107
DY200	The Canyons	DY200-057-CAM17/tow01	08/10/2025	03:58:00	48	18.9030	9	35.1350	290.0	290.0	08/10/2025	05:24:00	48	19.0700	9	35.2840	301.0	JNCC reference CNYN077 DY200 WP106
DY200	The Canyons	DY200-058-CAM18/tow01	08/10/2025	05:57:00	48	20.3370	9	36.1750	449.0	450.0	08/10/2025	07:27:00	48	20.5100	9	36.1760	511.0	JNCC reference CNYN100 DY200 WP163
DY200	The Canyons	DY200-059-CTD07/	08/10/2025	08:24:00	48	21.0690	9	40.2320	1307.0	#####	08/10/2025	09:37:00	48	21.0690	9	40.2320	1310.0	DIC/TA and bottom nutrient samples collected
DY200	The Canyons	DY200-060-AF07/	08/10/2025	10:15:00	48	21.0640	9	40.2390	1306.0	800.0	08/10/2025	11:43:00	48	21.0610	9	40.2440	1306.0	
DY200	The Canyons	DY200-061-CTD08/	08/10/2025	14:16:00	48	16.9190	9	38.5260	340.0	330.0	08/10/2025	14:49:00	48	16.9220	9	38.5200	340.0	re-do cast CTD05, DIC/TA samples collected, nuts not collected
DY200	The Canyons	DY200-062-AF08/	08/10/2025	15:55:00	48	20.2450	9	43.8050	1555.0	#####	08/10/2025	18:27:00	48	20.3260	9	43.7130	1556.0	Anchor test, 3 dropped.
DY200	The Canyons	DY200-063-CAM19/tow01	08/10/2025	19:18:00	48	23.8300	9	43.8320	375.0	374.0	08/10/2025	21:18:00	48	23.9990	9	43.9120	401.0	Close to JNCC Station CNYN069
DY200	The Canyons	DY200-064-CAM20/tow01	08/10/2025	21:53:00	48	24.3140	9	42.0430	357.0	357.0	08/10/2025	23:30:00	48	24.5120	9	12.1830	373.0	Close to JNCC Station CNYN106, Station no. incorrectly reported in OFOP. Labelled as Stn 65
DY200	The Canyons	DY200-065-CAM21/tow01	09/10/2025	00:19:00	48	25.5680	9	39.1220	360.0	384.0	09/10/2025	01:57:00	48	25.6690	9	39.2910	384.0	JNCC Reference CNYN017
DY200	The Canyons	DY200-066-CAM22/tow01	09/10/2025	03:22:00	48	16.0470	9	40.7940	421.0	422.0	09/10/2025	05:33:00	48	15.9660	9	41.2050	441.0	JNCC Reference 091. End time is on deck, end coordinates off bottom
DY200	The Canyons	DY200-067-CAM23/tow01	09/10/2025	06:14:00	48	16.6620	9	39.1400	364.0	364.0	09/10/2025	07:35:00	48	16.7820	9	39.2630	366.0	DY200 WP177, crinoid city! End time is on deck, end coordinates off bottom
DY200	The Canyons	DY200-068-AS5M132/	09/10/2025	08:38:00	48	17.2860	9	36.2240	271.0		09/10/2025	15:06:00	48	16.5430	9	38.7070	346.0	
DY200	The Canyons	DY200-069-AS5M133/	09/10/2025	16:58:00	48	25.4370	9	39.1130	348.0		10/10/2025	08:22:00	48	23.8260	9	43.4340		end coordinates from vehicle
DY200	The Canyons	DY200-069-AS5M134/	10/10/2025	08:49:24	48	23.7840	9	43.6680			10/10/2025	11:11:00	48	23.9280	9	43.5360		start and end coordinates from vehicle
DY200	The Canyons	DY200-069-AS5M135/	10/10/2025	11:44:56	48	23.8200	9	43.6500			10/10/2025	15:51:00	48	23.4296	9	44.5723		start coordinates from vehicle
DY200	The Canyons	DY200-070-CAM24/tow01	09/10/2025	18:24:00	48	24.3800	9	37.5680	274.0	274.0	09/10/2025	20:04:00	48	24.2470	9	37.7330	291.0	JNCC station 048. CNYN Crinoids.
DY200	The Canyons	DY200-071-CAM25/tow01	09/10/2025	20:26:00	48	24.6680	9	38.2060	296.0	296.0	09/10/2025	21:57:00	48	24.7140	9	38.4660	303.0	JNCC Station CNYN041.
DY200	The Canyons	DY200-072-CAM26/tow01	09/10/2025	22:29:00	48	25.5330	9	37.4070	279.0	279.0	09/10/2025	23:53:00	48	25.5940	9	37.6590	285.0	JNCC Station CNYN002 - correction, seems to be CNYN046
DY200	The Canyons	DY200-073-CAM27/tow01	10/10/2025	00:30:00	48	25.5690	9	35.2880	230.0	230.0	10/10/2025	01:58:00	48	25.4470	9	35.5060	232.0	JNCC Station CNYN105
DY200	The Canyons	DY200-074-CAM28/tow01	10/10/2025	02:36:00	48	26.7690	9	34.4850	224.0	225.0	10/10/2025	04:01:00	48	26.9460	9	34.4760	225.0	JNCC Station CNYN002. End time is on deck, end coordinates off bottom
DY200	The Canyons	DY200-075-CAM29/tow01	10/10/2025	04:49:00	48	27.4980	9	34.0070	222.0	221.0	10/10/2025	06:13:00	48	27.5660	9	34.1820	227.0	JNCC Station CNYN006
DY200	The Canyons	DY200-076-CTD09/p01	10/10/2025	16:48:00	48	28.3396	9	38.9239	1059.0	#####	10/10/2025	17:55:00	48	28.4080	9	38.8600	1060.0	

10. MAPS

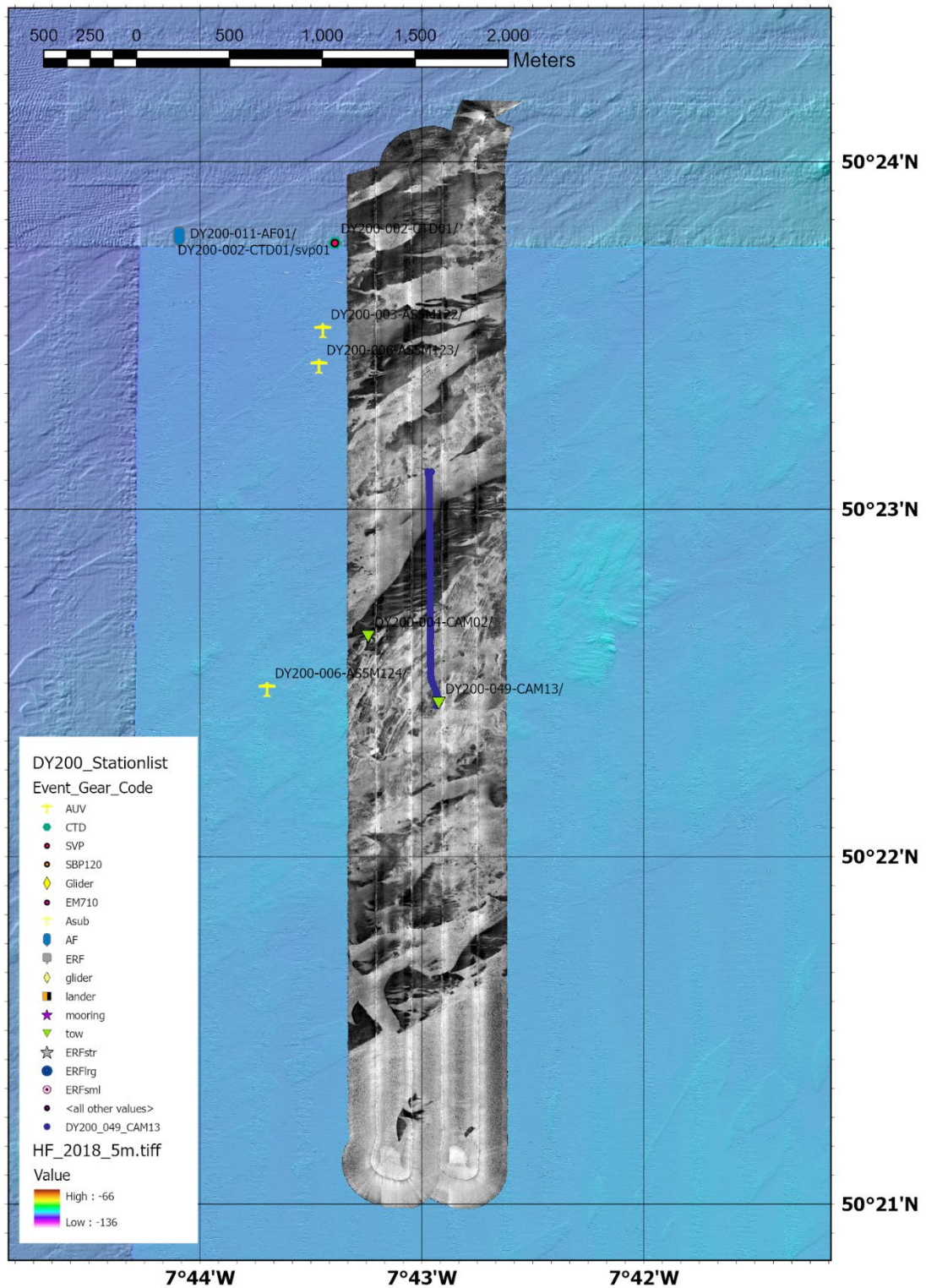
General cruise track:



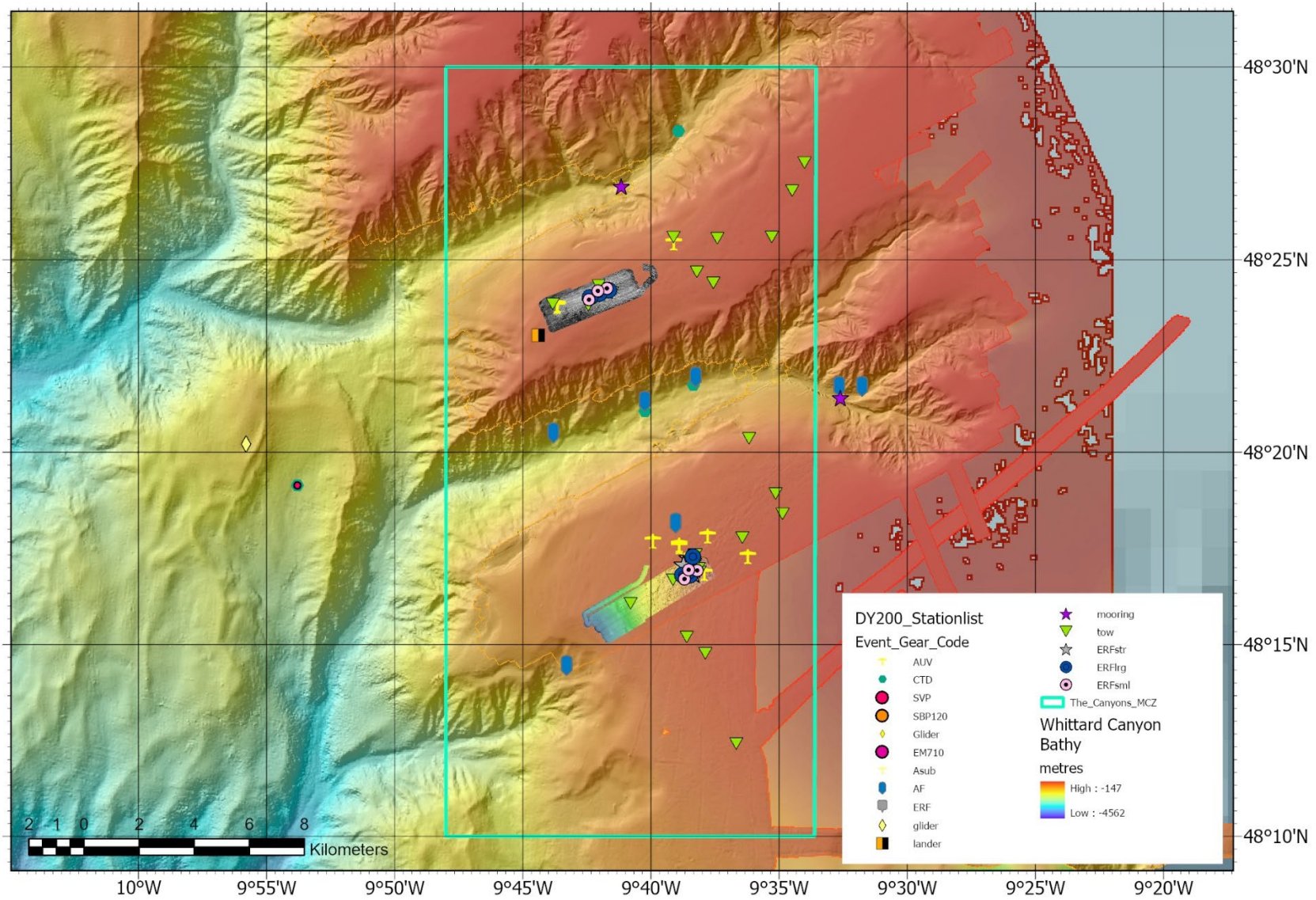
Haig Fras additional mapping:

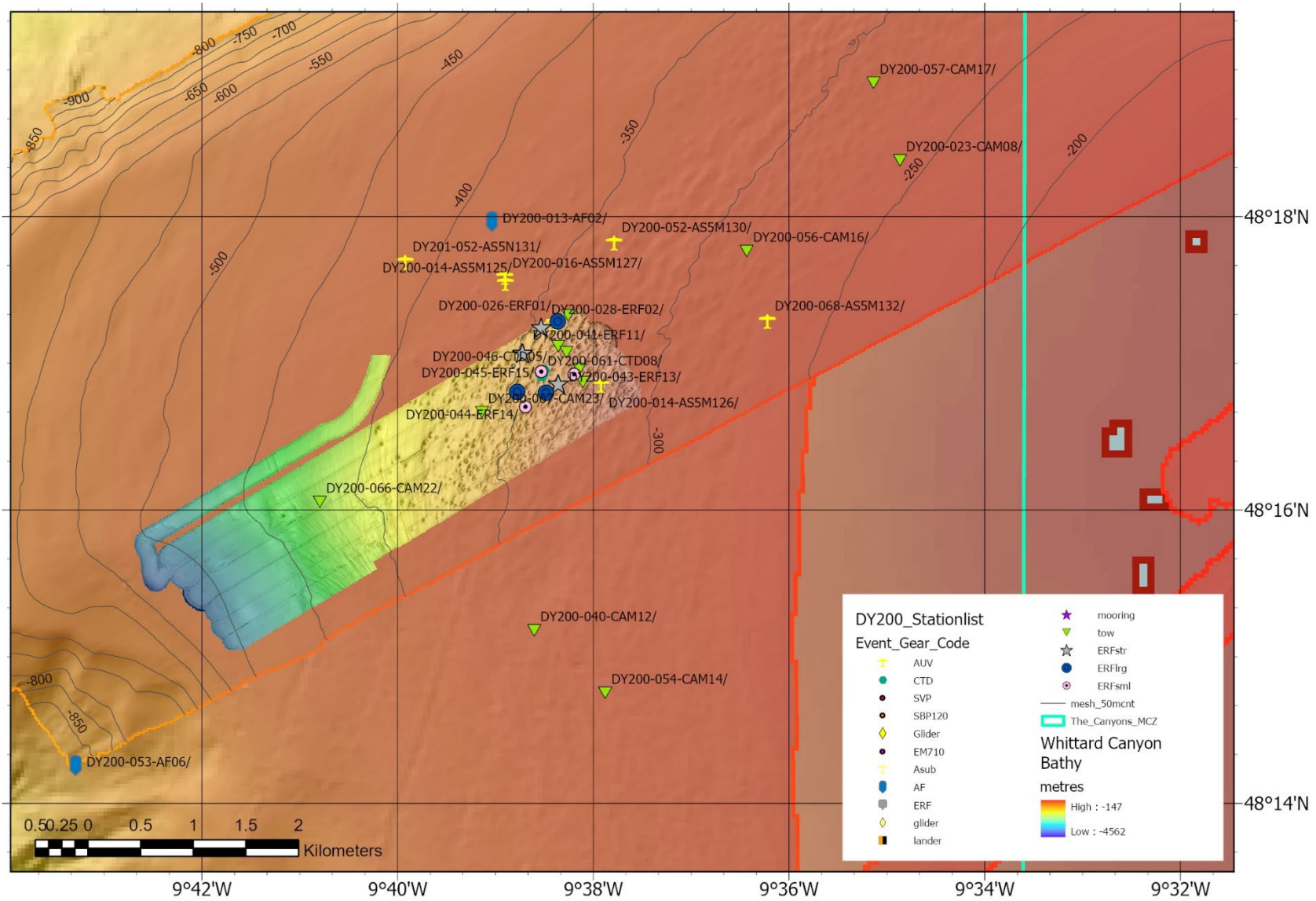


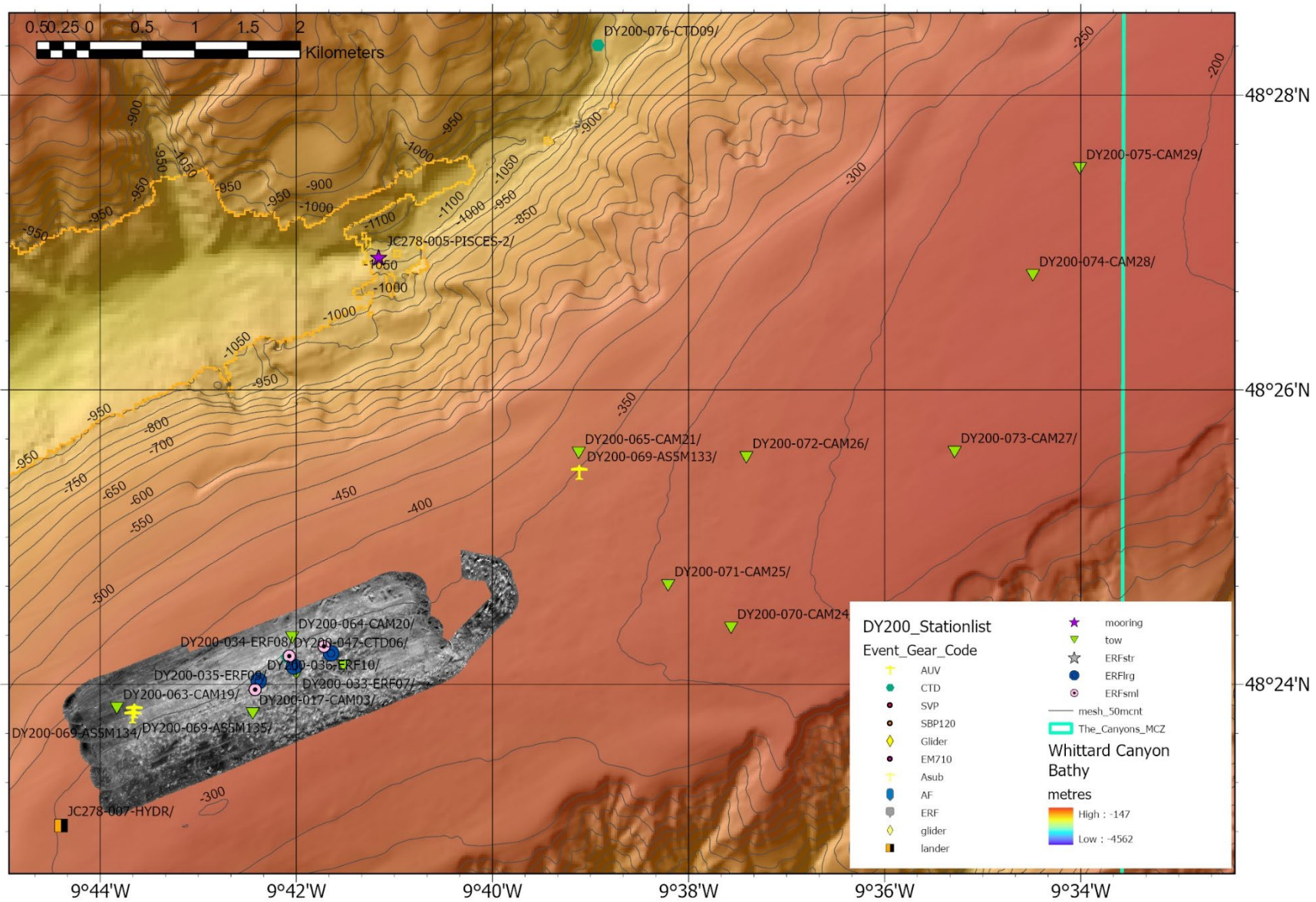
Haig Fras data collection:

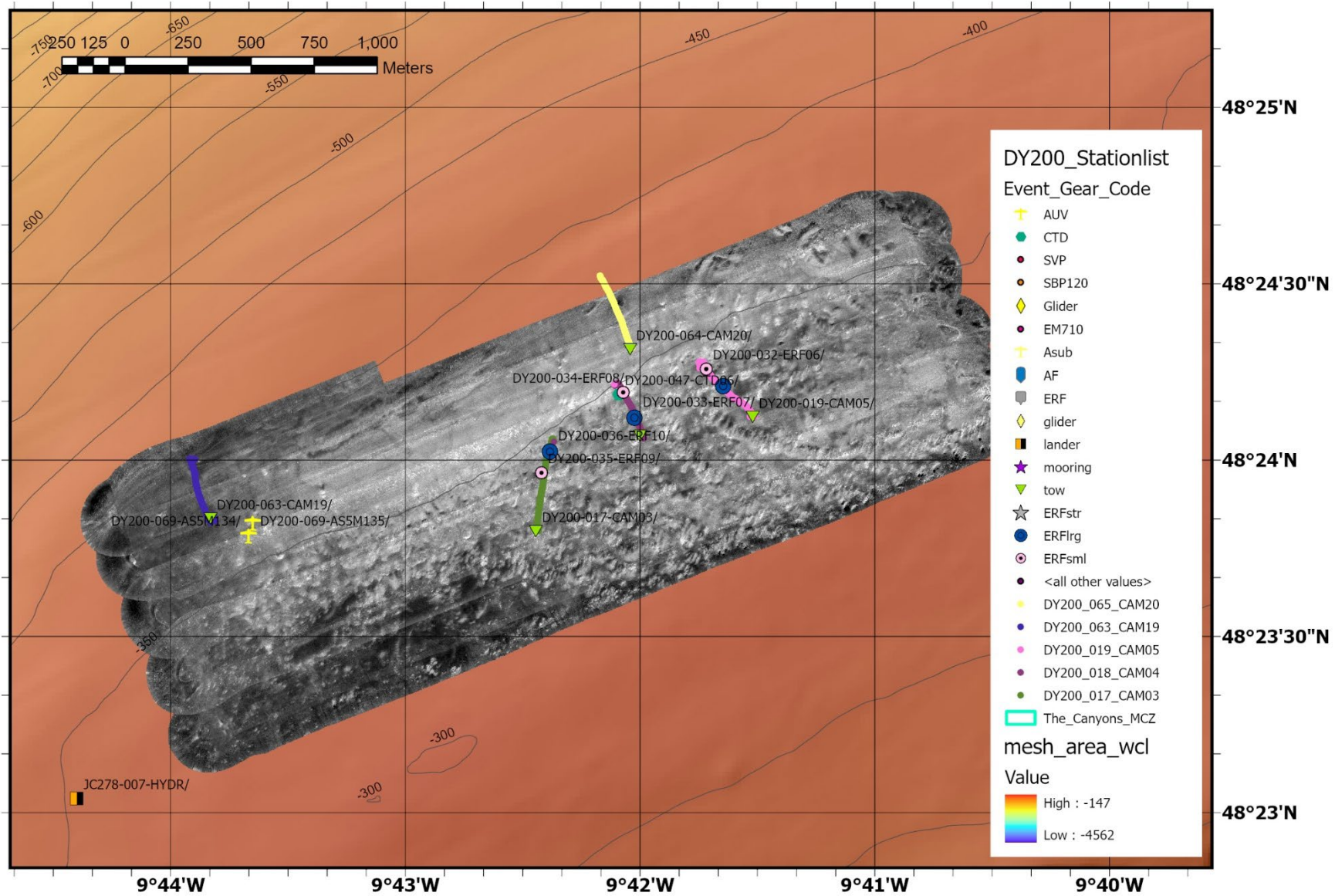


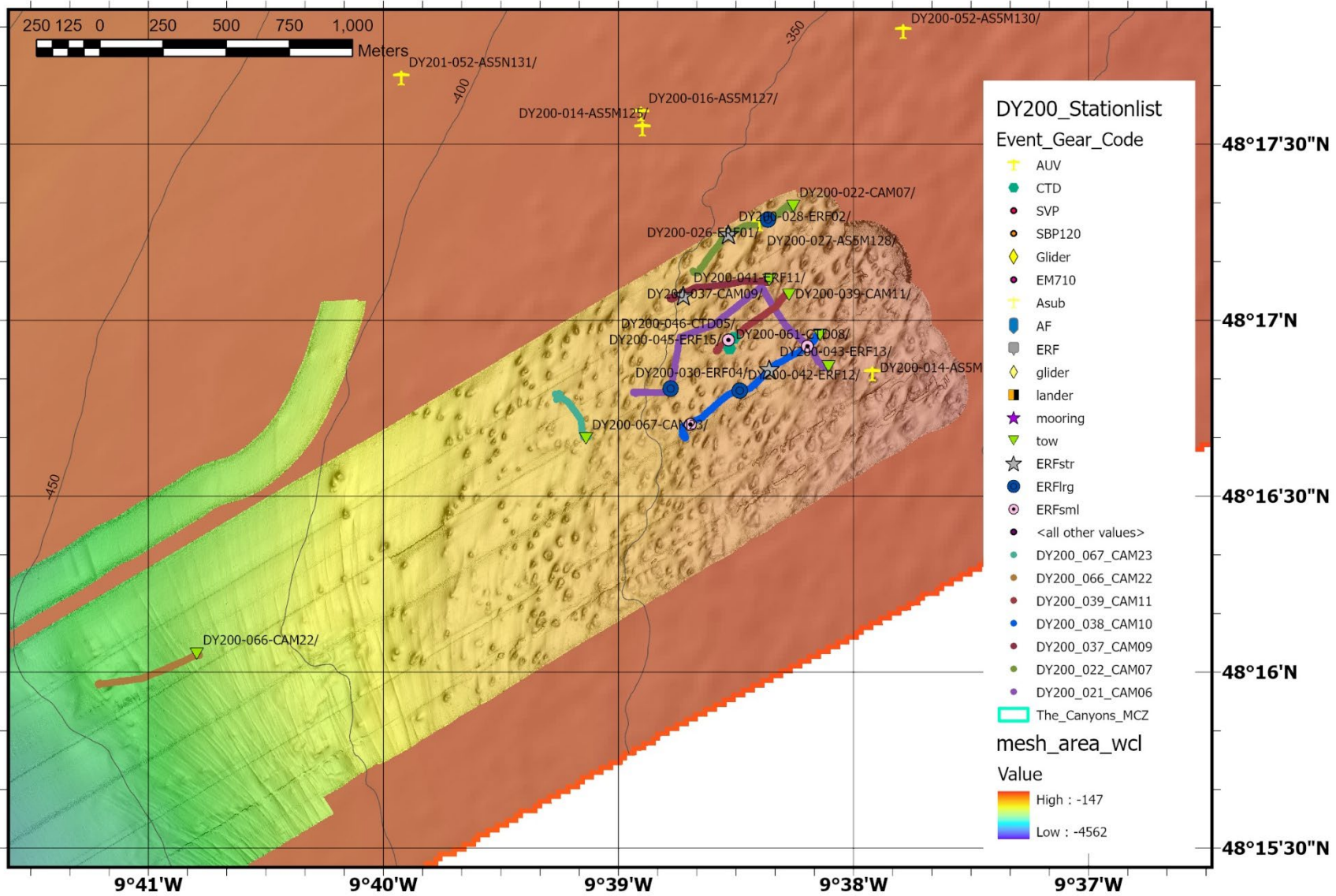
Winchester data collection:











APPENDICES

APPENDIX 1: CTD Sensor Information Sheet – Setup of Stainless Steel 24-way CTD frame for DY200

Instrument / Sensor	Manufacturer/Model	Serial Number	Channel	Casts Used
Stainless steel 24-way frame	NOCS	SBE CTD 6	N/A	All casts
EM CTD Swivel	Machinery Development Services ST6003-2E2-Ti	1246-2	N/A	All casts
Primary CTD deck unit	SBE 11plus	11P-24680-0588	N/A	All casts
CTD Underwater Unit	SBE 9plus	09P-34173-0758	N/A	All casts
24-way Carousel	SBE 32	32-60380-0805	N/A	All casts
Primary Temperature Sensor	SBE 3P	03P-6976	F0	All casts
Primary Conductivity Sensor	SBE 4C	04C-4065	F1	All casts
Digiquartz Pressure sensor	Paroscientific	90074	F2	All casts
Secondary Temperature Sensor	SBE 3P	03P-6981	F3	All casts
Secondary Conductivity Sensor	SBE 4C	04C-4138	F4	All casts
Primary Pump	SBE 5T	05T-3085	N/A	All casts
Secondary Pump	SBE 5T	05T-6320	N/A	All casts
Primary Dissolved Oxygen Sensor	SBE 43	43-2061	V0	All casts
Free	Free	Free	V1	All casts
Light Scattering Sensor	WETLabs Light Scattering	BBRTD -759R	V2	All casts
Altimeter	Valeport VA500	96098	V3	All casts
Transmissometer	WETLabs C-Star	CST-2150DR	V4	All casts
Fluorometer	CTG Aquatracka MKIII	88-2050-095	V5	All casts
Free	Free	Free	V6	All casts
Free	Free	Free	V7	All casts
10L water samplers	Ocean Test Equipment	Set B	N/A	All casts

APPENDIX 2: Seasave Configuration File

PSA file: N:\DY200\SeaSave Setup files\DY200_0758_SS_nmea.psa

Date: 10/09/2025

Instrument configuration file: C:\Users\sandm\Documents\Cruises\DY200\Data\SeaSave Setup files\DY200_0758_SS_nmea.xmlcon

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Deck unit : SBE11plus Firmware Version >= 5.0
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : Yes
NMEA device connected to : PC
Surface PAR voltage added : No
Scan time added : Yes

1) Frequency 0, Temperature

Serial number : 3P-6976
Calibrated on : 5th Sept 2024
G : 4.38968330e-003
H : 6.38127861e-004
I : 2.22000895e-005
J : 2.04293966e-006
FO : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 4C-4065
Calibrated on : 25th July 2024
G : -9.86626453e+000
H : 1.48911737e+000
I : -2.73136895e-003
J : 2.85026137e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 90074
Calibrated on : 23-Sep-22
C1 : -6.571123e+004
C2 : 2.050504e-001
C3 : 1.612220e-002
D1 : 2.883800e-002
D2 : 0.000000e+000
T1 : 2.986693e+001
T2 : -2.678465e-004
T3 : 3.986390e-006
T4 : 7.472100e-010
T5 : 0.000000e+000
Slope : 1.00012000
Offset : 0.01710
AD590M : 1.283700e-002

AD590B : -8.642460e+000

4) Frequency 3, Temperature, 2

Serial number : 6981
Calibrated on : 15th Oct 2024
G : 4.39636982e-003
H : 6.37871319e-004
I : 2.22832255e-005
J : 2.07384354e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 4C-4138
Calibrated on : 25th July 2024
G : -9.84936528e+000
H : 1.45622727e+000
I : -3.00801865e-003
J : 3.30181006e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

Serial number : 43-2061
Calibrated on : 27 Sept 2024
Equation : Sea-Bird
Soc : 4.98100e-001
Offset : -4.95500e-001
A : -3.02870e-003
B : 1.20240e-004
C : -2.28470e-006
E : 3.60000e-002
Tau20 : 1.04000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

7) A/D voltage 1, Free

8) A/D voltage 2, OBS, WET Labs, ECO-BB

Serial number : 759
Calibrated on : 5th Jan 2023
ScaleFactor : 0.003171
Dark output : 0.051300

9) A/D voltage 3, Altimeter

Serial number : 96098
Calibrated on : 13/06/2025
Scale factor : 15.000
Offset : 0.000

10) A/D voltage 4, Transmissometer, WET Labs C-Star

Serial number : CST-2150DR
Calibrated on : 22/09/2025
M : 20.9591

B : -0.1027
Path length : 0.250

11) A/D voltage 5, Fluorometer, Chelsea Aqua 3

Serial number : 088-2050-095
Calibrated on : 8th Oct 2024
VB : 0.299000
V1 : 1.822340
Vacetone : 0.547630
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

12) A/D voltage 6, Free

13) A/D voltage 7, Free

APPENDIX 3: Hydrophone calibration

An M351 field calibrator (GTI Inc.) was used to perform a post-recovery field calibration of the recovered hydrophones while onboard the ship while in motion. **These calibration results are included for completeness only and should not be used in analyses.** Two rounds of calibration were completed for each hydrophone by following the instructions outlined in the instruction manual for field calibration operation in automatic mode:

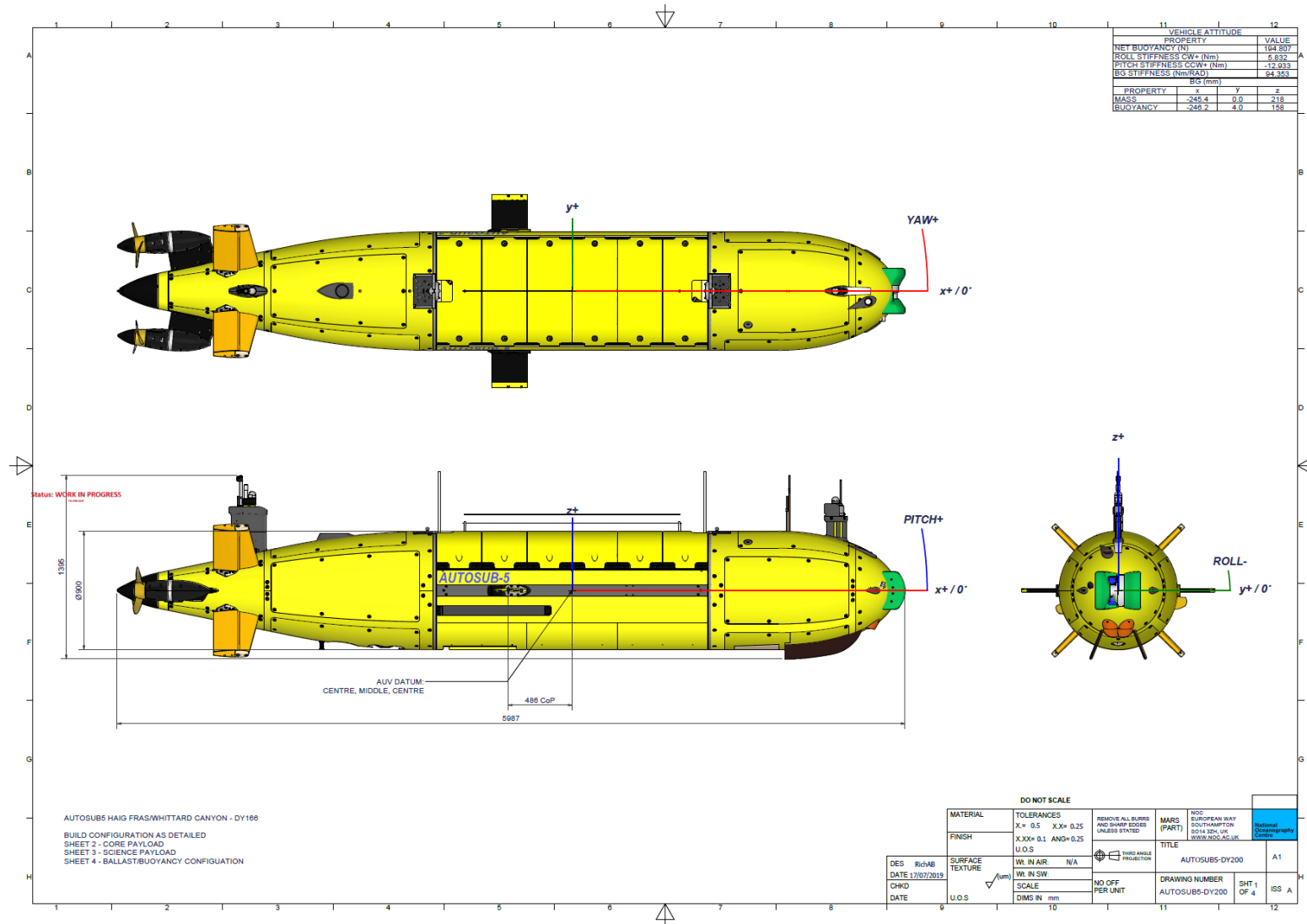
1. The mode switch was set to "Auto"
2. A gain setting of 20 dB was selected
3. The V/C switch was set to V (volts)
4. The Start button was then pressed to begin the calibration
5. When prompted to save to the EEPROM when calibration was completed, a numerical ID for each hydrophone was entered using the frequency/gain dial and the Start button was pressed to save the measurements to the internal memory of the calibrator.
6. Then calibrator was then set to administration mode by holding down the Start button while pushing the power switch to the "On" position. The provided USB-A to USB-B cable was used to connect the calibrator to a computer where the GTI Connection software provided by the manufacturer was installed. After clicking "Connect" the measurements were obtained from the screen (shown in the screenshot below).

As indicated below, variability in the measurements reported from the calibrator was observed; however, there is a degree of consistency with the pre-deployment field calibration carried out under similar conditions during the JC278 cruise. In the field, it may be necessary to perform calibrations several times if conditions are unfavourable. These field measurements from both cruises will be compared with measurements in the lab (on land).

The screenshot shows the 'GTI HFC Connection v1.5' software window. It features a 'Connect' button and an 'Update Firmware...' button. Below these buttons is a table displaying calibration data for a 'COM4 - USB Serial Device (COM4)'. The table consists of 28 columns and 28 rows of numerical data, representing various calibration parameters and results for different hydrophones.

25	1	27	17	23	V	35	44444	25	1	-200.57	-200.33	-200.31	-200.29	-201.72	-200.64	-200.66
25	1	27	17	24	V	35	44444	25	1	-200.57	-200.31	-200.31	-200.30	-201.72	-200.64	-200.66
25	1	27	17	25	V	35	44444	25	1	-200.58	-200.33	-200.31	-200.28	-201.71	-200.64	-200.65
25	1	27	17	25	V	35	44444	25	1	-200.57	-200.33	-200.30	-200.30	-201.72	-200.64	-200.66
25	1	27	17	26	V	35	44444	25	1	-200.56	-200.30	-200.30	-200.28	-201.71	-200.63	-200.64
25	1	27	17	27	V	35	44444	25	1	-200.58	-200.28	-200.30	-200.29	-201.70	-200.63	-200.64
25	1	27	17	28	V	35	44444	25	1	-200.56	-200.31	-200.31	-200.28	-201.73	-200.64	-200.65
25	1	27	17	29	V	35	44444	25	1	-200.58	-200.33	-200.31	-200.29	-201.73	-200.65	-200.66
25	1	27	17	30	V	35	44444	25	1	-200.57	-200.35	-200.32	-200.29	-201.70	-200.65	-200.66
25	1	27	17	31	V	35	44444	25	1	-200.57	-200.37	-200.30	-200.31	-201.72	-200.65	-200.67
25	1	27	17	31	V	35	44444	25	1	-200.56	-200.31	-200.33	-200.30	-201.71	-200.64	-200.66
25	5	31	19	4	V	20	73	25	5	-182.05	-182.33	-183.23	-183.31	-180.16	-182.22	-182.25
25	5	31	19	12	V	20	153	25	5	-176.55	-176.40	-177.85	-177.89	-178.62	-177.46	-177.64
25	5	31	19	17	V	20	1534	25	5	-176.61	-176.40	-177.84	-177.88	-178.63	-177.47	-177.64
25	5	31	19	23	V	20	716	25	5	-176.53	-176.43	-177.87	-177.91	-178.64	-177.48	-177.67
25	5	31	19	27	V	20	714	25	5	-176.38	-176.40	-177.88	-177.93	-178.61	-177.44	-177.65
25	5	31	19	53	V	35	714	25	5	-172.29	-168.07	-167.47	-167.42	-167.03	-168.46	-167.69
25	5	31	19	56	V	35	1534	25	5	-172.57	-168.31	-167.64	-167.57	-167.03	-168.62	-167.83
25	5	31	19	59	V	35	716	25	5	-172.30	-168.11	-167.55	-167.44	-167.03	-168.49	-167.72
25	5	31	20	26	V	20	4849	25	5	-183.71	-183.84	-184.75	-184.87	-180.99	-183.63	-183.62
25	6	2	6	43	V	20	74	25	6	-181.79	-182.40	-183.27	-183.24	-180.05	-182.15	-182.22
25	6	2	7	49	V	20	4848	25	6	-183.60	-183.88	-184.78	-184.81	-181.00	-183.61	-183.62
25	10	11	14	36	V	20	716	25	10	-240.45	-234.88	-228.62	-227.34	-228.87	-232.03	-230.35
25	10	11	14	38	V	20	714	25	10	-239.84	-234.77	-228.11	-226.60	-227.61	-231.39	-229.70
25	10	11	14	40	V	20	1534	25	10	-239.73	-234.66	-228.45	-228.01	-228.71	-231.91	-230.35
25	10	11	14	42	V	20	73	25	10	-239.86	-234.16	-228.64	-227.62	-229.40	-231.94	-230.35
25	10	11	14	44	V	20	4849	25	10	-182.93	-183.72	-184.72	-184.82	-180.91	-183.42	-183.52
25	10	11	14	48	V	20	716	25	10	-177.07	-176.76	-178.16	-178.18	-178.75	-177.78	-177.93
25	10	11	14	50	V	20	714	25	10	-176.64	-176.68	-178.14	-178.18	-178.75	-177.68	-177.89
25	10	11	14	53	V	20	1534	25	10	-199.10	-176.64	-178.15	-178.18	-178.73	-182.16	-178.77
25	10	11	14	57	V	20	73	25	10	-182.30	-182.46	-183.39	-183.51	-180.33	-182.40	-182.42

APPENDIX 4: AUV measurements



VEHICLE ATTITUDE			
PROPERTY	VALUE		
NET BUOYANCY (N)	164.807		
ROLL STIFFNESS C_{RW} (Nm)	5.832		
PITCH STIFFNESS C_{PW} (Nm)	-12.833		
YAW STIFFNESS (Nm/deg)	64.383		
BIC (mm)			
PROPERTY	x	y	z
MASS	-245.4	0.0	215
BUOYANCY	-245.2	4.0	155

Status: WORK IN PROGRESS

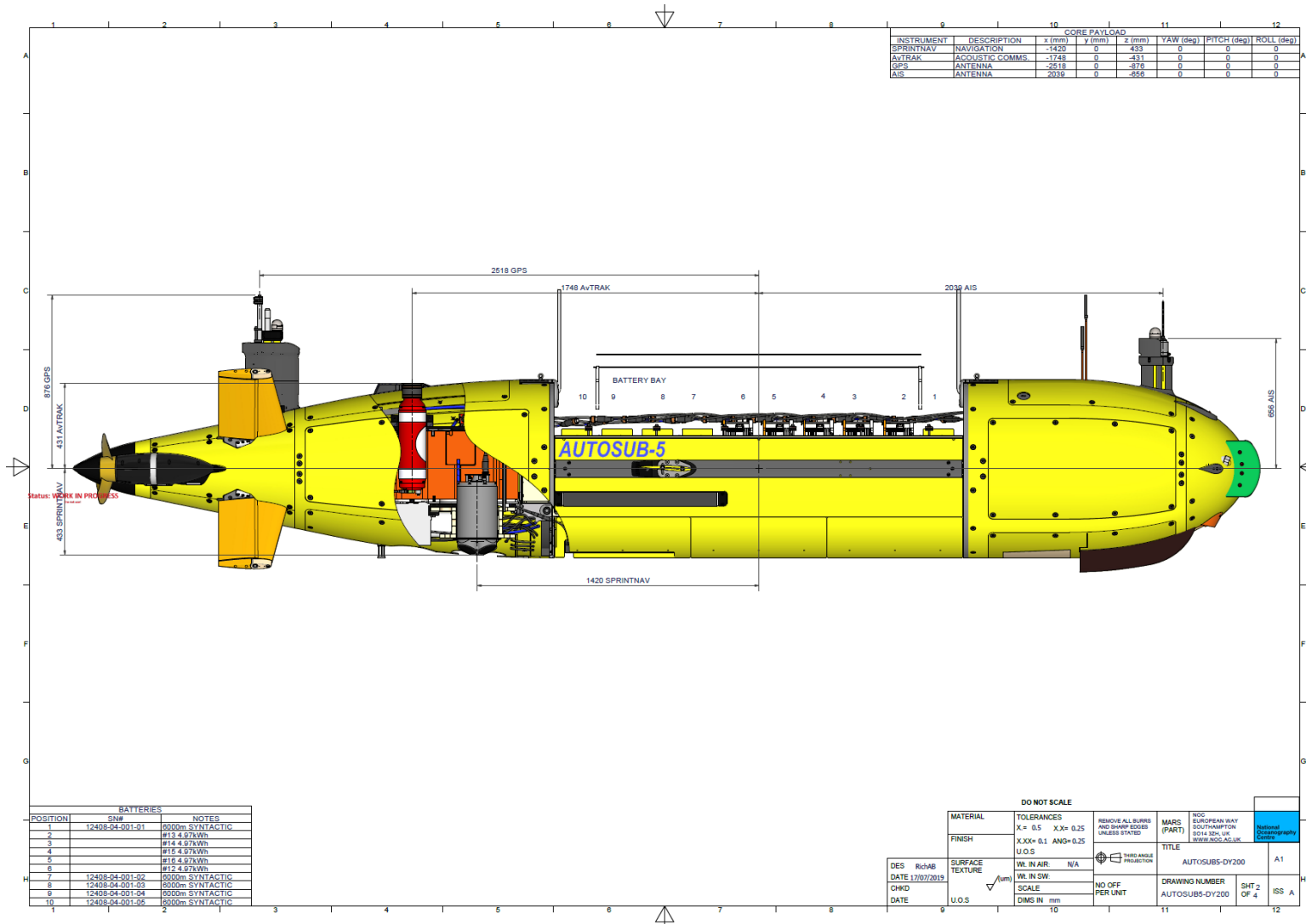
1395
Ø2000

AUV DATUM:
CENTRE, MIDDLE, CENTRE

486 CoP
5987

AUTOSUBS HAIG FRASWHITTARD CANYON - DY168
BUILD CONFIGURATION AS DETAILED
SHEET 2 - CORE PAYLOAD
SHEET 3 - SCIENCE PAYLOAD
SHEET 4 - BALLAST/BUOYANCY CONFIGURATION

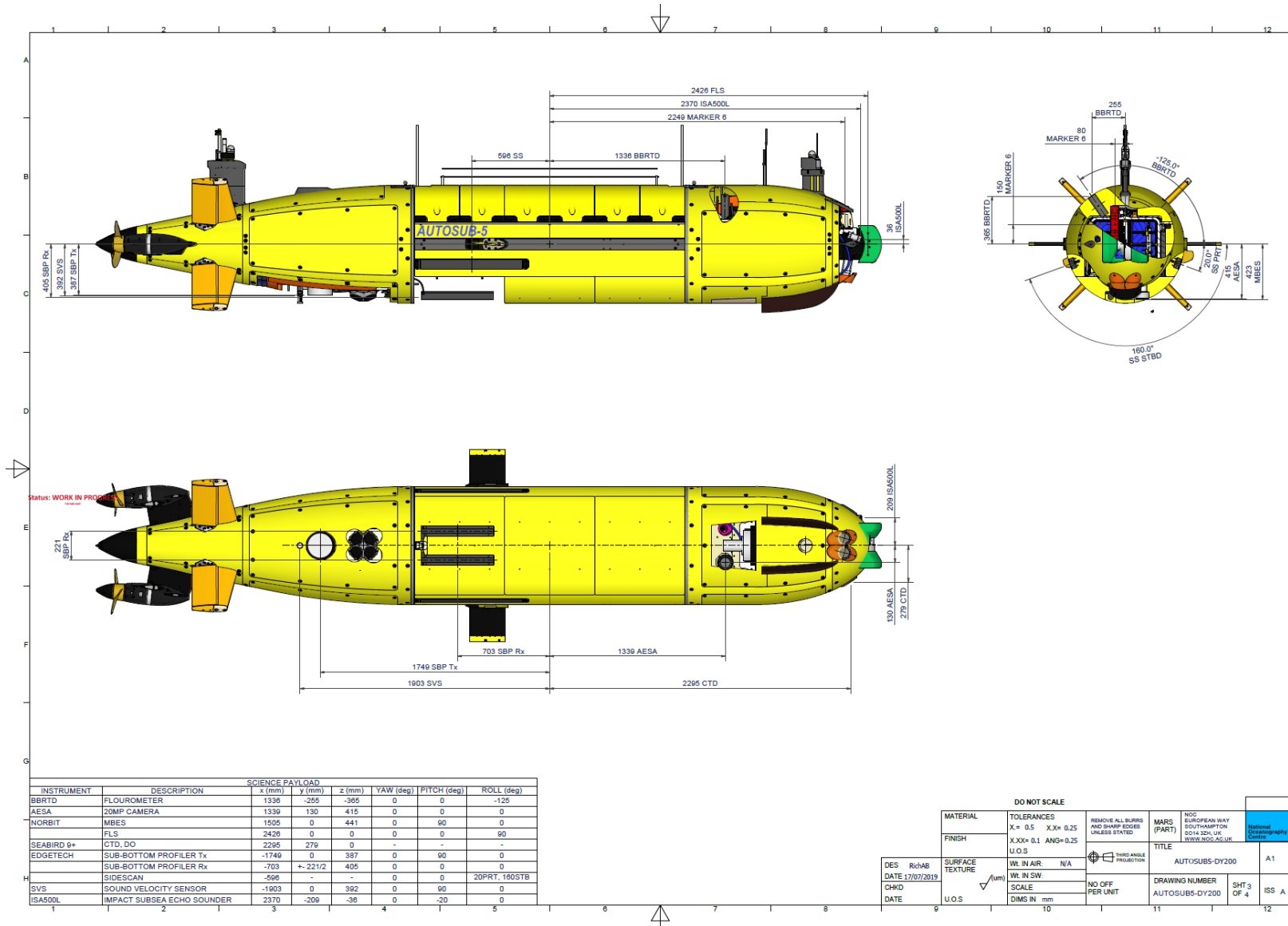
DO NOT SCALE			
MATERIAL	TOLERANCES	REMOVE ALL BURRS AND SHARP EDGES UNLESS STATED	MARS (PART)
FINISH	X _s = 0.5 X _X = 0.25 X _{XX} = 0.1 ANG = 0.25 U.O.S		HQS EUROPEAN WAY SOUTHAMPTON RD14 32H, UK WWW.HQS.SC.UK
SURFACE TEXTURE	W ₁ IN AIR N/A W ₂ IN SW	THIRD ANGLE PERSPECTIVE	TITLE
CHKD DATE	SCALE	NO OFF PER UNIT	AUTOSUBS-DY200
DATE	DIMS IN mm		DRAWING NUMBER AUTOSUBS-DY200
			SHT 1 OF 4
			ISS A



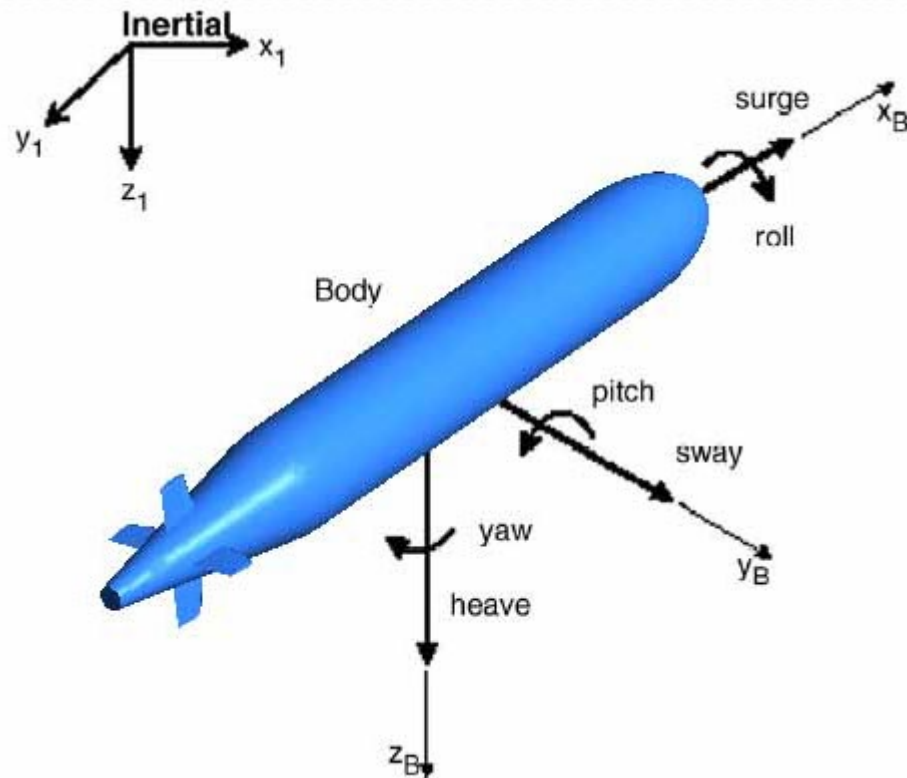
INSTRUMENT	DESCRIPTION	CORE PAYLOAD			YAW (deg)	PITCH (deg)	ROLL (deg)
		x (mm)	y (mm)	z (mm)			
SPRINTNAV	NAVIGATION	-1420	0	433	0	0	0
AvTRAK	ACOUSTIC COMMS.	-1748	0	-431	0	0	0
GPS	ANTENNA	-2618	0	-870	0	0	0
AIS	ANTENNA	2030	0	-856	0	0	0

BATTERIES		
POSITION	SN#	NOTES
2	12408-04-001-01	6000m SYNFACTIC
3		#13 4.07kWh
4		#14 4.07kWh
5		#15 4.07kWh
6		#16 4.07kWh
7		#17 4.07kWh
8	12408-04-001-02	6000m SYNFACTIC
9	12408-04-001-03	6000m SYNFACTIC
10	12408-04-001-04	6000m SYNFACTIC
11	12408-04-001-05	6000m SYNFACTIC

DO NOT SCALE					
MATERIAL	TOLERANCES	REMOVE ALL BURRS AND SHARP EDGES UNLESS STATED	MARS (PART)	NOC EUROPEAN WAY SOUTHAMPTON SO14 5ZK, UK WWW.NOC.AC.UK	
FINISH	X± 0.5 X/± 0.25 X-XX± 0.1 ANG-0.25 U.O.S.		TITLE	AUTOSUBS-DY200 A1	
DES Rich-B DATE 17/07/2019	SURFACE TEXTURE	VL IN AIR: N/A	PROJECTION	AUTOSUBS-DY200	
CHKD DATE	√(µm)	VL IN SW: SCALE DIMS IN mm	NO OFF PER UNIT	DRAWING NUMBER	SHT 2 OF 4
				AUTOSUBS-DY200	ISS A



APPENDIX 5: Vehicle co-ordinate frame



On-board control system - Axis System

Inertial Z - Depth Positive Down

Body Fixed x - positive towards the bow

Body Fixed y - positive to starboard

Body Fixed z - positive down

ϕ Roll clockwise looking forwards

ψ - Yaw clockwise looking downwards

θ - Pitch positive nose up

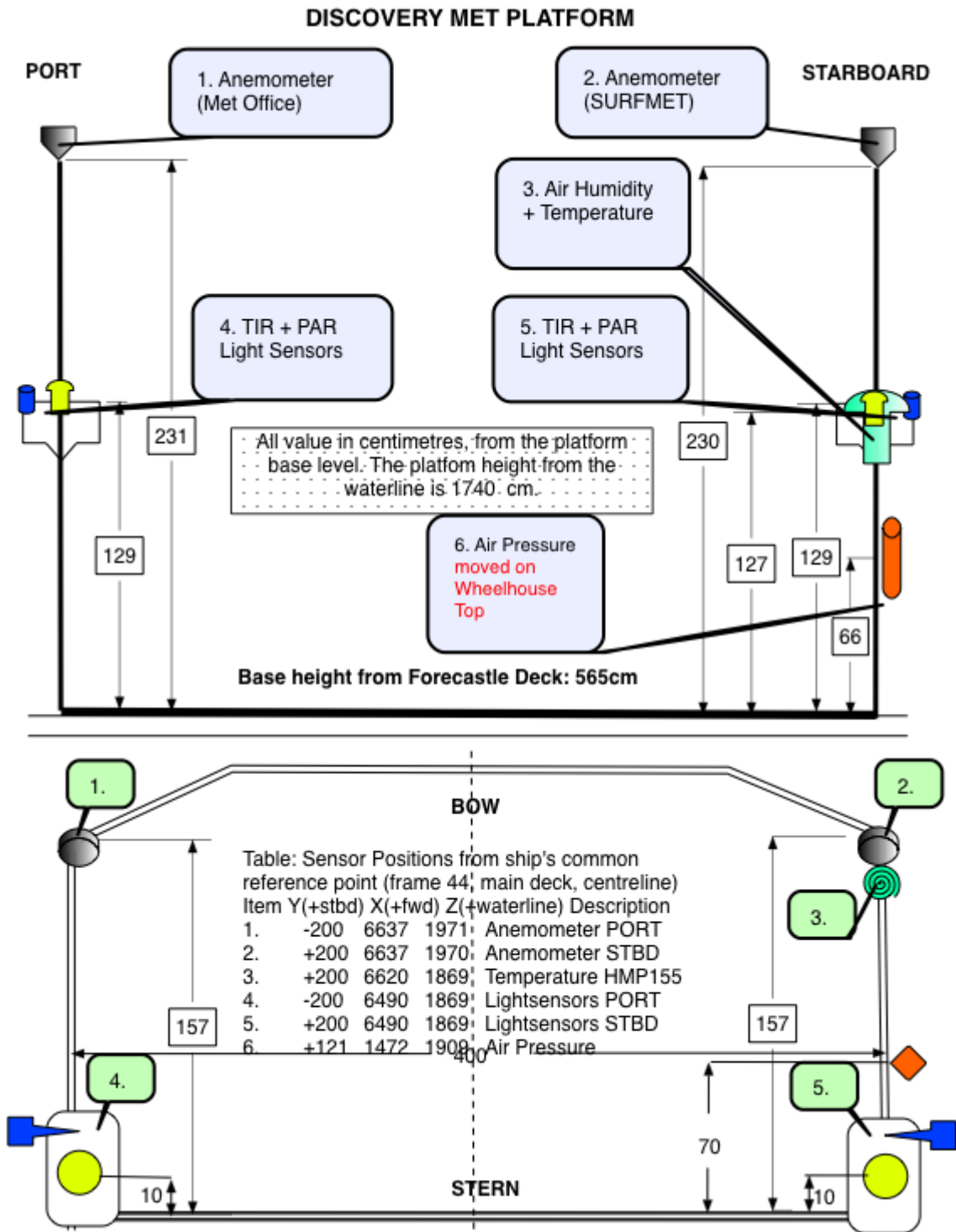
Position - Latitude: positive North

Position - Longitude: positive East

ALL Control Surfaces Trailing edge up is +ve (generates a nose up pitching moment)

APPENDIX 6: Surfmet information sheet

Cruise	DY200
SST	Martin Bridger
Date	2025-09-23 – 2025-10-12



Fitted Sensors:

Manufacturer	Sensor	Comments (e.g. port)	Calibration applied?
Skye	PAR SKE510	(Starboard)	No
Skye	PAR SKE510	(Port)	No
Kipp & Zonen	TIR CM6B	(Port)	No
Kipp & Zonen	TIR CM6B	(Starboard)	No
Gill	Windsonic Option 3	(Starboard)	Yes
Vaisala	HMP155 Temp./Hum.		No
Vaisala	PTB210 Air Pres.		No
Wet Labs	WS3S Fluorimeter		No
Wet Labs	CST Transmissometer		No
Sea-Bird	SBE45 TSG		Yes
Sea-Bird	SBE38 Water Temperature		Yes
Sea-Bird	SBE38 Drop-Keel Temperature		Yes

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