Resilience of deep-sea benthic communities to the effects of sedimentation ("ROBES")

Voyage report of Survey 3 (TAN2005): June 2020

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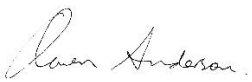	Reviewed by:	Owen Anderson
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1 Voyage background

Uncertainty about the potential environmental effects of deep-sea mining is a major impediment to development of the off-shore mining sector in New Zealand. Two recent applications for seabed mining were declined by the EPA, a key reason being uncertainty about the effects of sediment plumes created by disturbance to the seafloor and discharge of processed waters. Sedimentation effects from bottom trawl fisheries is also an environmental issue of concern for sustainable fisheries certification. Understanding such impacts in the deep ocean is challenging but in 2016, MBIE funded a NIWA-led programme (termed ROBES-"Resilience Of deep-sea Benthos to the Effects of Sedimentation") to investigate the effects of sedimentation from such seabed disturbance using a combination of field survey experimentation with *in situ* observations, and laboratory-based experiments. In combination, the two approaches will provide information on the concentrations and distances over which impacts of suspended sediment on faunal communities become 'ecologically significant'. The work is designed to determine the extent and persistence of sediment plumes, the immediate impact and subsequent recovery of the seafloor environment exposed to these plumes, and the sedimentation effect on the functioning of ecologically significant species.

The survey (Tangaroa voyage TAN2005) discussed in this report was the last of a series of three surveys in a seabed disturbance experiment. Disturbance operations occurred in 2018 (Tangaroa voyage TAN1805) and 2019 (Tangaroa voyage TAN1903) at two different scales (Clark et al. 2018, 2019). The overall plan in 2020 was for benthic communities to be surveyed across the wide area sampled in 2018 and smaller area covered in 2019 to monitor changes over the year and assess recovery and resilience of the seabed communities.

2 Objectives

The main aim of the voyage was:

1. To undertake monitoring of a sediment disturbance experiment to investigate the impacts of sedimentation on deep-sea benthic communities.

This objective had the following sub-components:

A. To repeat sample monitoring sites from a wide area in 2018;

B. To repeat sample monitoring sites from the "Butterknife" feature in 2019;

C. To carry out CTD sampling to monitor oceanographic conditions;

D. To undertake experimental work on selected sediment cores;

E. To monitor trawl disturbance sites from 2019;

F. To undertake further sampling on disturbed/undisturbed sites as time permits;

G. To collect animals for experimental sedimentation studies onshore.

3 Voyage summary

3.1 Voyage Personnel

Name	Organisation	Role
Malcolm Clark	NIWA	Voyage Leader/Biology lead/OFOP
Scott Nodder	NIWA	Watch Leader/Sedimentation lead/filtering
Daniel Leduc	NIWA	Watch Leader/Biology/OFOP/ Chemicals Safety Officer
Steve George	NIWA	DTIS/ CTD
Rob Stewart	NIWA	Biology/OFOP/Deck Safety Officer
Di Tracey	NIWA	Biology/OFOP/Aquaria/Biosecurity
Sarah Searson	NIWA	Mooring/CTD
Chris Ray	NIWA	DTIS/camera & electronics support
Rachel Hale	NIWA	Sedimentation/biogeochemistry
Chris Eager	NIWA	Sedimentation/biogeochemistry
Alan Hart	NIWA	Biology/OFOP/computing support
Lee Rauhina-August	NIWA	Biology/Outreach/Iwi engagement
Campbell Murray	VUW/NIWA	Biology/MSc sampling

3.2 Voyage timeline

The voyage duration was from 8 June 2020 (mobilisation in Wellington) to 22 June 2020 (return to Wellington). Details of daily events are given in Appendix A.

3.3 Voyage and survey area

The research occurred in the central part of the Chatham Rise, on the northern slope at depths of 400-500 m.

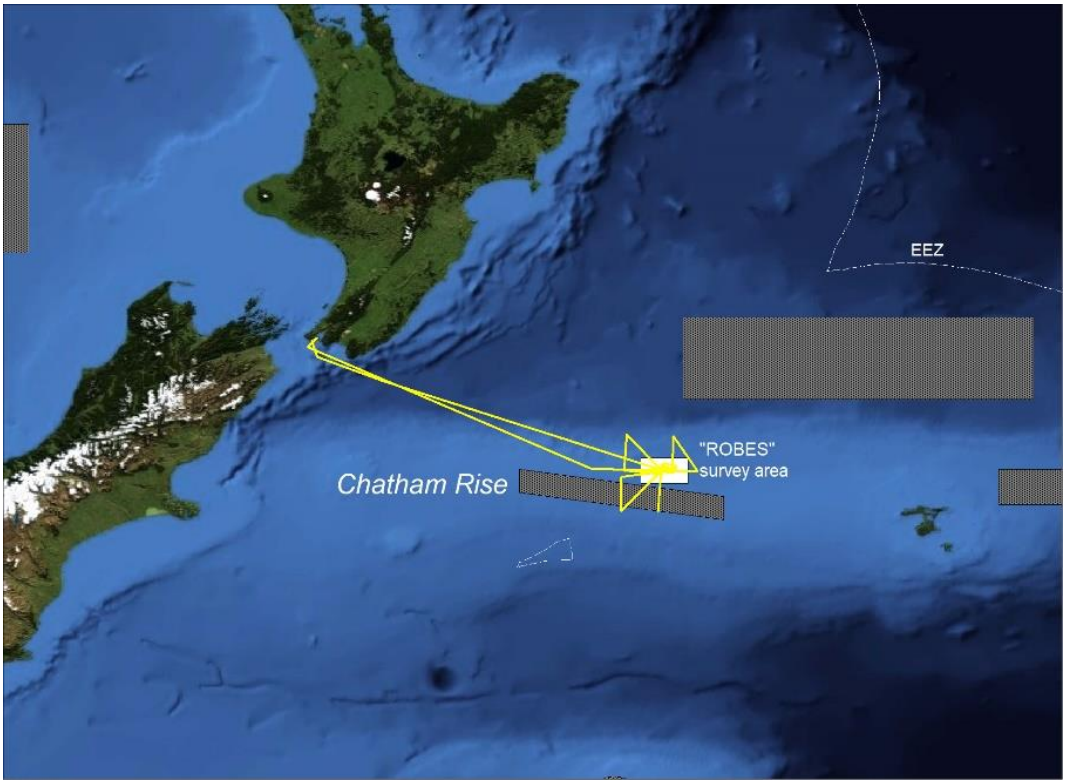

Figure 3-1: The survey area (white box) on the Chatham Rise and approximate voyage track (yellow line). Grey hatched areas are Benthic Protection Areas.

The survey area was the same as covered in 2018 and 2019 (Figure 3-2), with monitoring over the extent of the area surveyed then (Clark et al. 2018), and more concentrated work around the "Butterknife" feature (Clark et al. 2019) (Figure 3-3). Note the backscatter base-map shown in these figures is common to most subsequent figures.

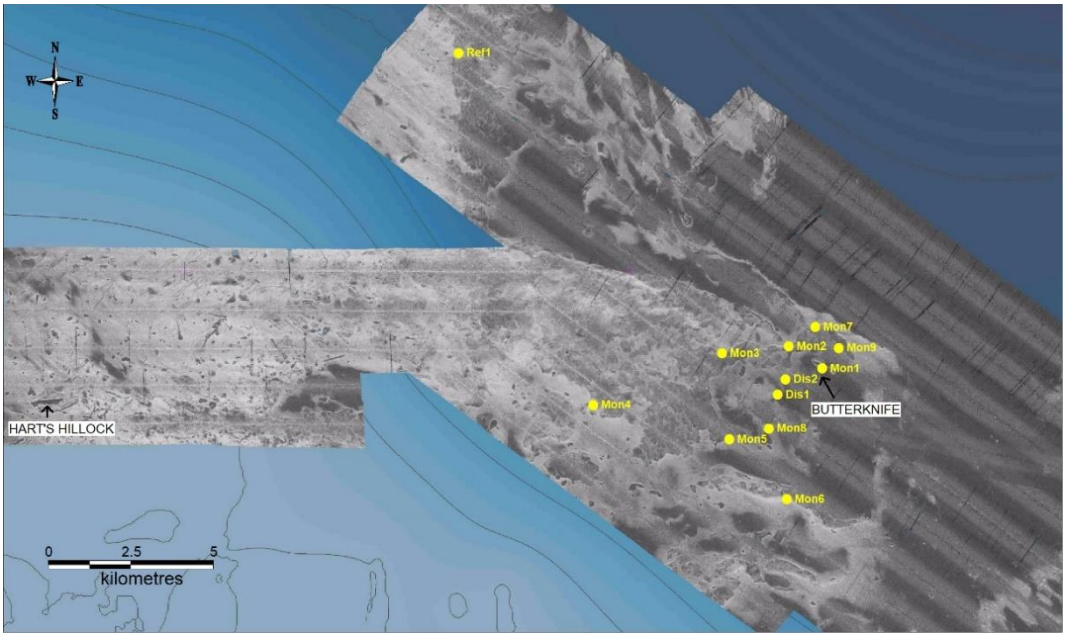

Figure 3-2: The survey area, with multibeam backscatter mosaic and regional bathymetry, showing Monitoring (MON), Disturbance (DIS) and Reference (REF) sites from 2018 (yellow circles), the Butterknife area, and Hart's Hillock for coral collection.

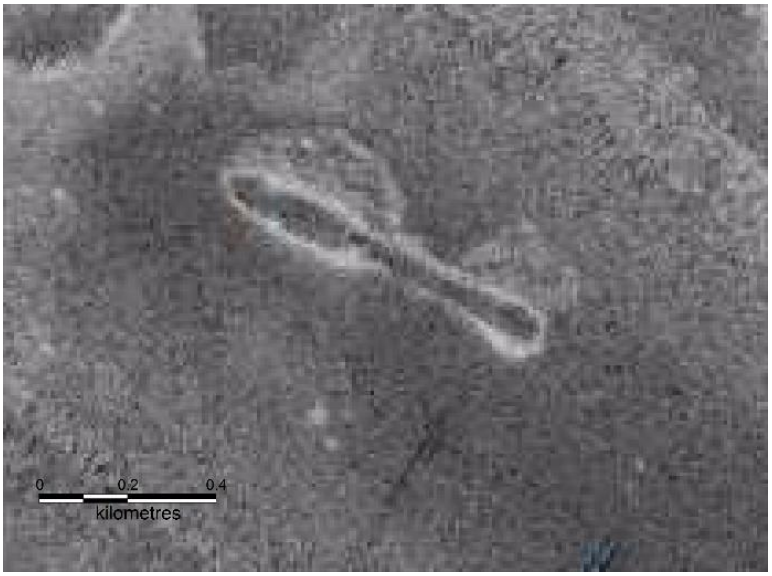

Figure 3-3: The Butterknife feature, showing the high reflectivity rim that is an outcrop with communities of corals, sponges, bryozoans and hydroids.

3.4 Survey approach

The key components of the survey plan were to:

1. Recover the mooring recording oceanographic data deployed in 2019.
2. A survey of the 2018 Monitoring stations with camera and multicorer to describe changes in benthic communities over the wider ROBES study area (based on 2018 disturbance by the Benthic Disturber).
3. A more detailed survey of the Butterknife feature, repeating camera and multicorer stations from 2019 (based on 2019 disturbance by the Sediment Cloud Induction Plough (SCIP)).
4. CTD grid to compare currents and water column characteristics with 2018 and 2019.
5. Capture of live corals for further experimental work back in the laboratory
6. Undertake onboard sediment experiments (community respiration, oxygen profiling, sediment erosion, elutriation).

Lower priority activities where weather, time and conditions allowed:

1. Repeat camera transects over areas of beam trawling in 2019 to evaluate any short-term recovery of epifauna.
2. Investigate immediate impacts on infauna from direct physical disturbance (by a modified beam trawl).
3. Investigate long-term impacts on infauna by sampling inside and outside iceberg scours (common near to the survey area).
4. Collect acoustics and sub-bottom profile data for geological structure and sediment cloud development.

4 Research components

4.1 Details of sampling locations

The main Monitoring (MON) sites from 2018 were repeated, together with a Reference Site (REF), and a Disturbance site (DIS) (as per Figure 3-2). Camera (Deep Towed Imaging System, DTIS/CAM) and multicorer sampling (MUC) was undertaken at each of these locations (Figure 4-1).

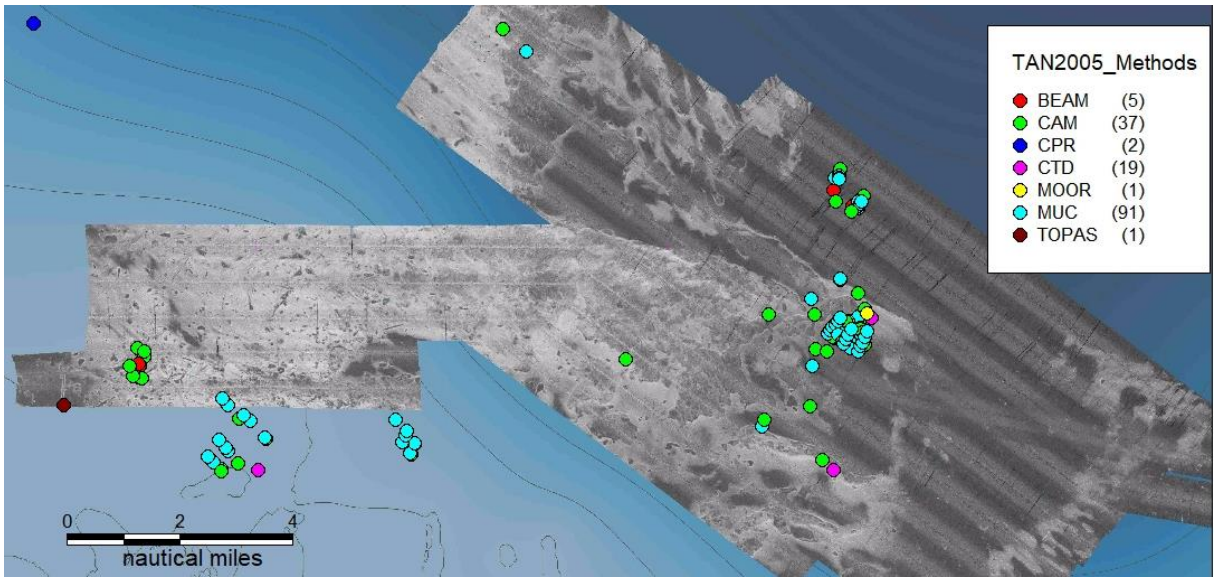

Figure 4-1: The sampling sites of all gear types from TAN2005., BEAM=beam trawl, CAM=DTIS towed camera system, CPR=continuous plankton recorder, CTD=conductivity-temperature-depth probe, MOOR=mooring, MUC=multicorer, TOPAS=sub-bottom profiler.

DTIS and multicore stations were completed on three iceberg scours in the southwest of the area, as well as DTIS and beam trawl work further west at Hart's Hillock and just north of the main sampling around the Butterknife (Figure 4-1). More detailed sampling was carried out in the region of the Butterknife, and Conductivity-Temperature-Depth (CTD) stations were filled over a wider area. These operations are covered in more detail in the sections below.

The total number of stations completed was 156 (Table 4-1), mainly using towed camera, multicorer and CTD equipment. Other operations included various beam trawls for disturbance and specimen capture, recovery of a mooring, an acoustic (sub-bottom profiler) survey, and two deployments of the continuous plankton recorder (CPR) between Wellington and the ROBES survey area, and on the return steam. Many stations were repeat sampling of 2018 monitoring stations using DTIS and/or the multicorer (Table 4-2). There were 9 camera and 30 multicorer deployments around the Butterknife feature that were repeats of 2019 stations (Table 4-2).

Table 4-1: Number of deployments by sampling gear type. CAM = Deep Towed Imaging System (DTIS); MUC = multicorer; CTD = Conductivity-Temperature-Depth; MOOR = Mooring; ACO = Acoustics (TOPAS); BEAM = Beam Trawl, CPR = Continuous Plankton Recorder.

CAM	MUC	CTD	MOOR	ACO	CPR	BEAM
37	**91**	**19**	**1**	**1**	**2**	**5**

Table 4-2: Number of sampling stations of the main gear types during the different phases of the survey. CAM = Deep Towed Imaging System (DTIS); MUC = multicorer; BEAM = beam trawl

Phase	CAM	MUC	BEAM	Total
2018 repeat	**12**	**24**		**36**
2019 repeat	**9**	**30**		**39**
Beam trawl impact	**4**	**15**	**2**	**19**
Iceberg scour	**6**	**22**		**28**
Coral capture			**3**	**3**
Coral disturbance/recovery	**6**			
Total	**37**	**91**	**5**	

Details of all stations are given in Appendix B.

4.2 Physical Oceanography

4.2.1 Methods

A number of gear types and instruments were used to measure and characterise the oceanographic and environmental conditions in the area.

CTD (Conductivity-Temperature-Depth)

The CTD-rosette system was a Seabird Electronics Inc. (SBE) 911plus CTD with a 12 by 10-litre SBE 32 Carousel water sampler. The CTD sensor configuration consisted of primary temperature, primary conductivity, and primary dissolved-oxygen; secondary temperature, secondary conductivity, and secondary dissolved-oxygen; pressure; primary and secondary fluorescence; primary and secondary transmissivity; solar photosynthetically active radiation (PAR); Seapoint turbidity, and sonar altitude. The water sampler carried 12 10-litre external-spring Niskin-type bottles.

Water samples were collected from selected depths for later calibration of salinity and oxygen sensors. Near-bottom water was also taken for onboard experiments.

Moorings

One mooring that had been deployed in TAN1903 was retrieved after a 12 month period between surveys. This consisted of:

- PARFLUX Mark 78H Sediment trap (21 bottles)
- Aqualogger x 2
- Ecotriplet
- MicroCAT CTD sensor
- ADCP Current meter

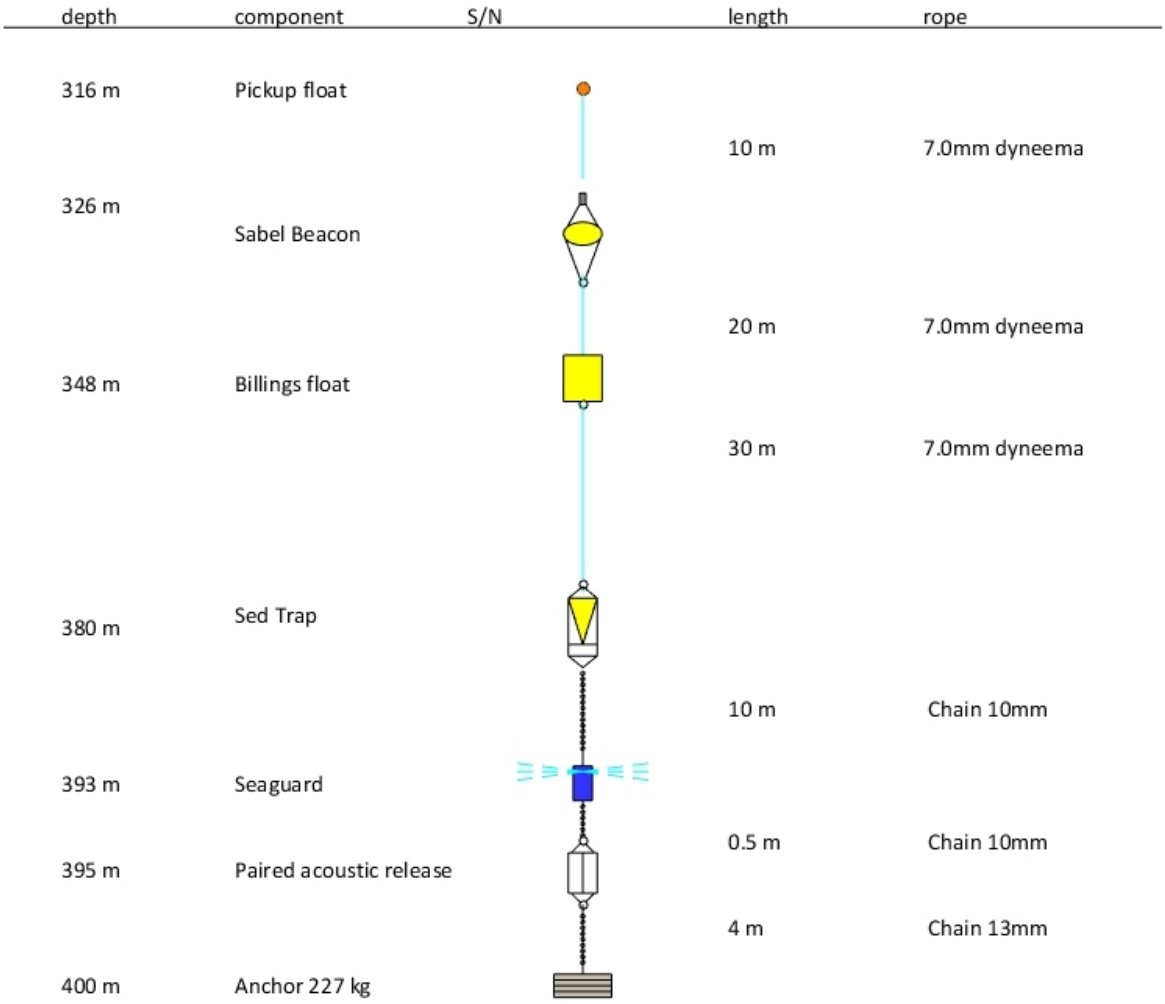

Figure 4-2: Details of the sediment-trap/current meter mooring configuration deployed on TAN1903.

Acoustic systems

Two acoustic sources, including the EK60 Split-beam Echosounder (SpBES), and TOPAS sub-bottom profiler were utilized during the survey. The keel mounted EK60 system on RV *Tangaroa* comprises five frequencies (18, 38, 70, 120, 200 kHz). This was kept running for much of the voyage to collect water column data.

The TOPAS PS 18 Parametric Sub-Bottom Profiler (SBP) is permanently mounted to a pod on the ship's hull and controlled with software in the multibeam laboratory. A linear chirp waveform was used, with chirp frequencies of 2.0 to 6.0 kHz. The TOPAS beam is stabilised for heave, roll and pitch movements via motion data fed from the ship's Position and Orientation System for Marine Vessels (POS MV) system.

4.2.2 Results

CTD

Nineteen CTD casts were completed over the duration of the voyage. These were carried out in a star-shaped grid over a wide area beyond the specific ROBES sampling sites (Figure 4-3). One was

completed at the mooring site before its recovery; the other 18 were part of the grid with about 12 n.miles separation between each.

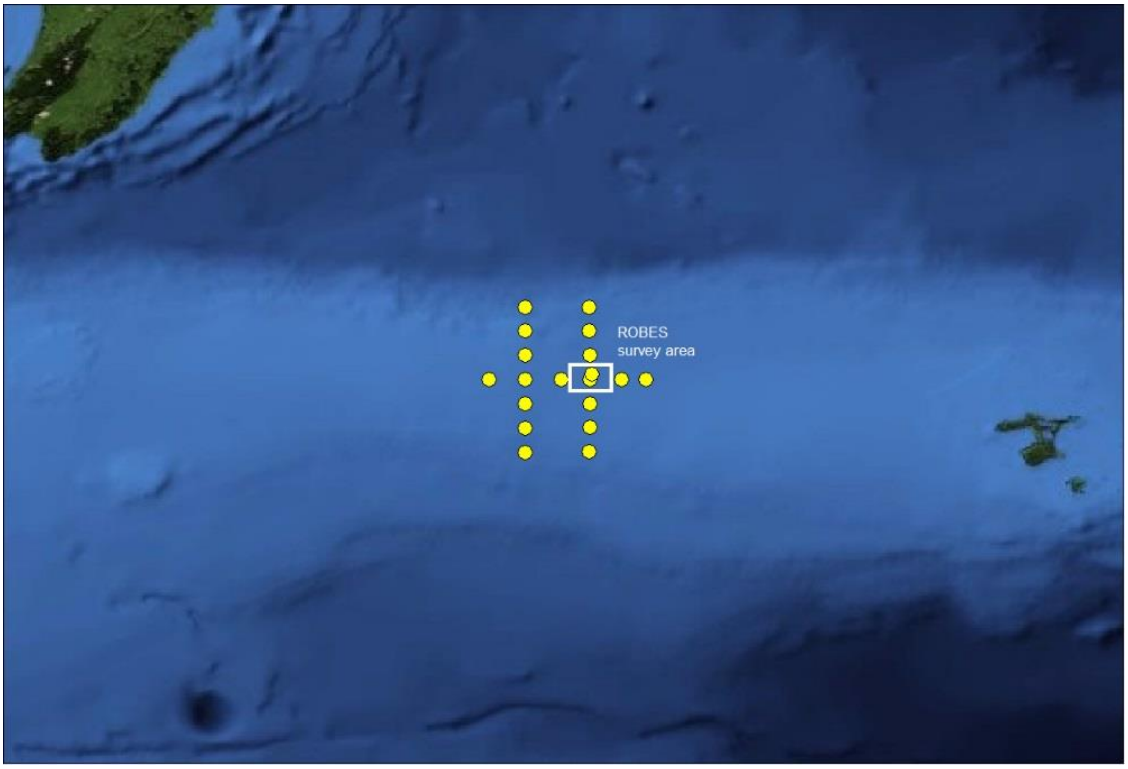

Figure 4-3: The distribution of CTD sites to collect water mass data.

These data will be calibrated and analysed in conjunction with 2018 and 2019 CTD data to examine inter-annual variability in current flows and water mass characteristics, especially the position of the Subtropical Front.

Moorings

The 2019 mooring was recovered successfully. Mooring components and the sediment trap were covered with hydroid growth, and associated fauna that included nudibranchs, anemones, and polychaetes. Samples of the fauna were kept for taxonomic and growth studies.

Figure 4-4: The 2019 mooring sediment trap, showing the extensive growth of hydroids after 12 months.

Acoustic systems

Nine transects using the TOPAS sub-bottom profiler were run across the full ROBES area (Figure 4-5).

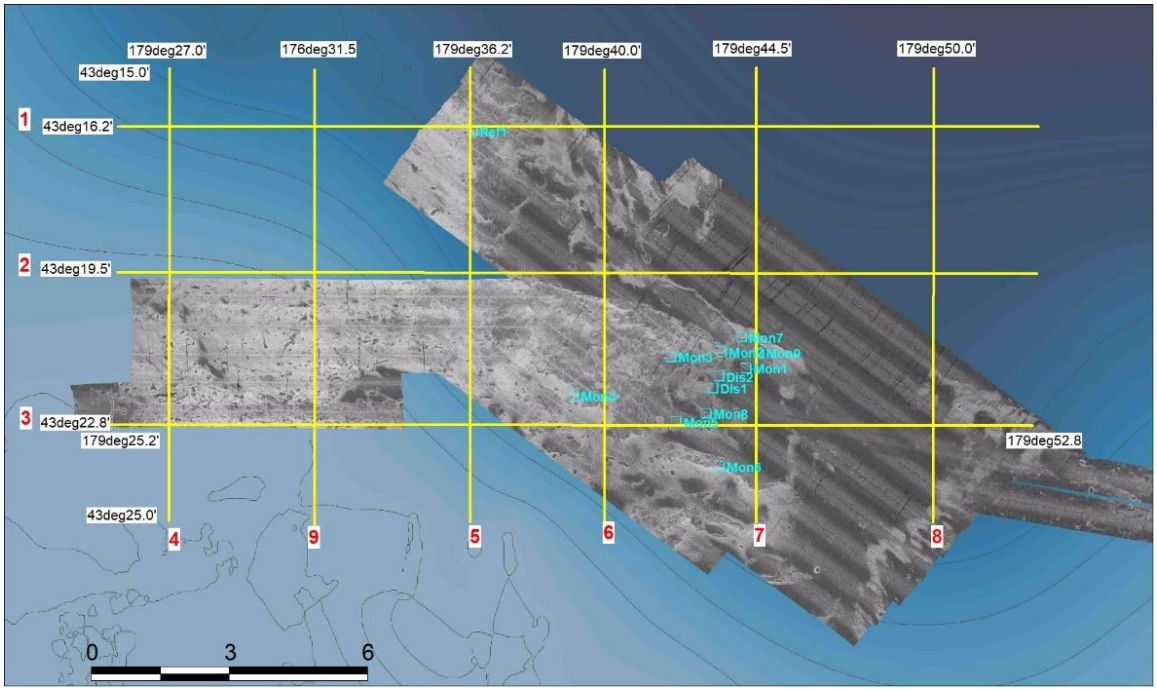

Figure 4-5: Grid lines conducted across the ROBES area with the TOPAS sub-bottom profiler. TOPAS lines are yellow. The core sampling sites are shown in light blue for reference only.

Weather conditions were good, and the quality of the profile data appeared excellent. An example is given in the figure below (Figure 4-6) showing a very strong seafloor reflector indicating hard and/or consolidated substrates at or very close to the seafloor across the central part of the ROBES survey

area. A thin veneer of transparent sediment is noticeable one-third along the transect infilling a shallow depression, with several moderate subsurface reflections.

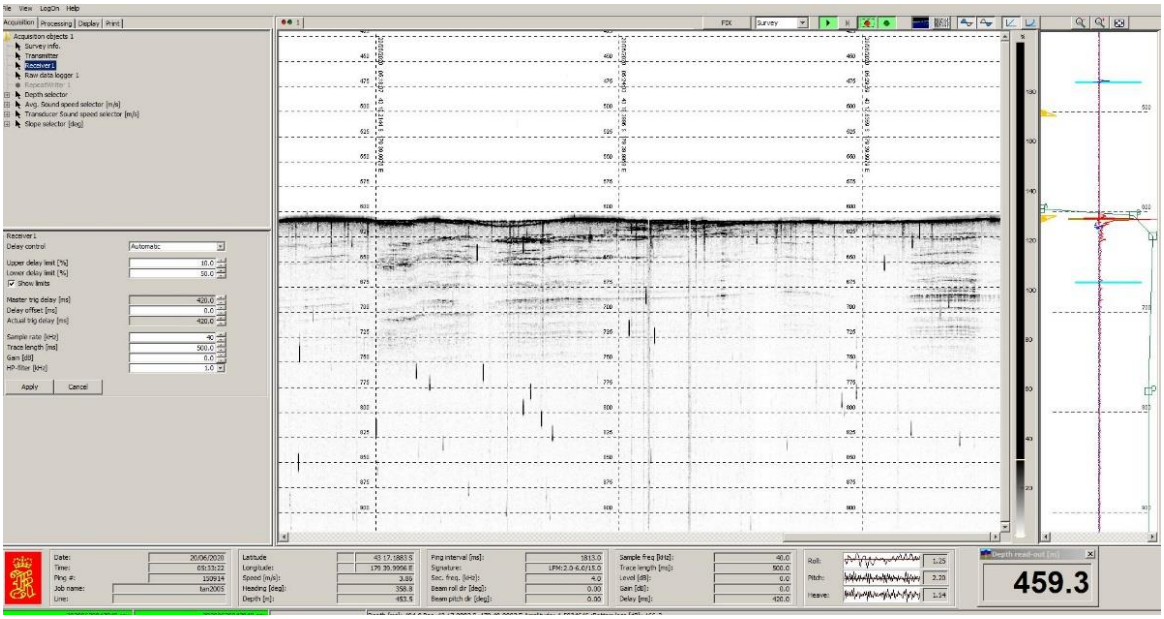

Figure 4-6: Read-out from the TOPAS survey, showing the seabed structure along transect number 6 running to the north across the survey area.

4.3 Sedimentation characteristics

4.3.1 Methods

Multicoring operations

The Ocean Instruments MC-800 multicorer consists of a metal frame with up to eight short 10 cm-diameter core barrels and a coring weight assembly. The weights are triggered when the frame contacts the seabed, pressing the barrels down into the sediment, ensuring that the sediment-water interface is largely preserved. During the voyage, 4 or 6 tubes were mounted onto the frame and most deployments were successful.

A set of idealised sampling schemes was developed for the voyage and employed where practicable at each site to ensure sufficient sediment samples were collected for the range of parameters being measured. The schemes differed between the MON, REF and DIS sites, where three casts were done at each site, and the disturbance grid sites, where one cast was done at each site. The scheme for repeating the core 2018 and 2019 sites is shown below (Figure 4-7).

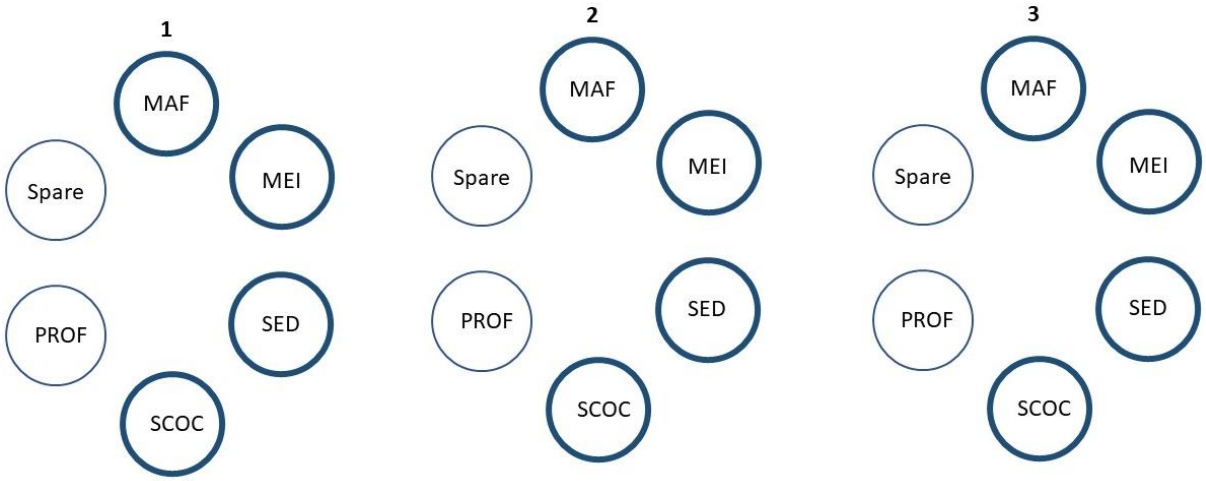

Figure 4-7: Sampling scheme for the core repeat DIS, REF and MON sites, where three multicore deployments (each with 6 cores) took place at each site. MAF = macrofauna, MEI = meiofauna (sub-core), bacteria (surface) and stable isotope/fatty acids (rest of 0-5 cm core), SED = sediment parameters, SCOC = sediment oxygen consumption, PROF = profiling.

Macrofauna (MAF) were sampled by sectioning the core at 0-5, 5-10 and 10-15 cm sediment depth intervals, wet-sieving at 300 µm, and fixation in 10% formalin. Meiofauna (MEI) were sampled by taking a 2.9 cm-diameter sub-core, sectioning at 0-1, 1-2 and 2-5 cm sediment depth intervals and preserving with 10% buffered formalin. Bacteria samples were collected as a surface scrape using a sterilised stainless steel spoon, with sediment placed in a 50 ml Falcon tube and frozen at -80°C. The remaining sediment from around the meiofauna sub-core was placed in a plastic bag and frozen at -20°C for later stable isotope/fatty acid analyses. Sediment (SED) parameter samples were sliced at 0.5, 1.0, 1.5, 2.0, 2-5, 5-10, 10-15, and 15-20 cm. Sediment samples were placed in Whirlpak or Twirl'Em bags, sealed and frozen at -20°C for later analysis for particle grain-size, water content, total organic matter, pigments (chlorophyll a/phaeopigments) and carbonate content.

Three multicore drops were made at the 2018/2019 DIS, REF and MON coring sites:

DIS 1, REF 1, MON 1, MON 2, MON 5, MON 7, MON 9 (refer Clark et al. 2018, 2019)

A regular grid of sampling sites was designed in 2019 to cover the area of the Butterknife. These were regularly spaced in a 5 x 5 station grid to span the range of 2019 disturbance and non-disturbance conditions.

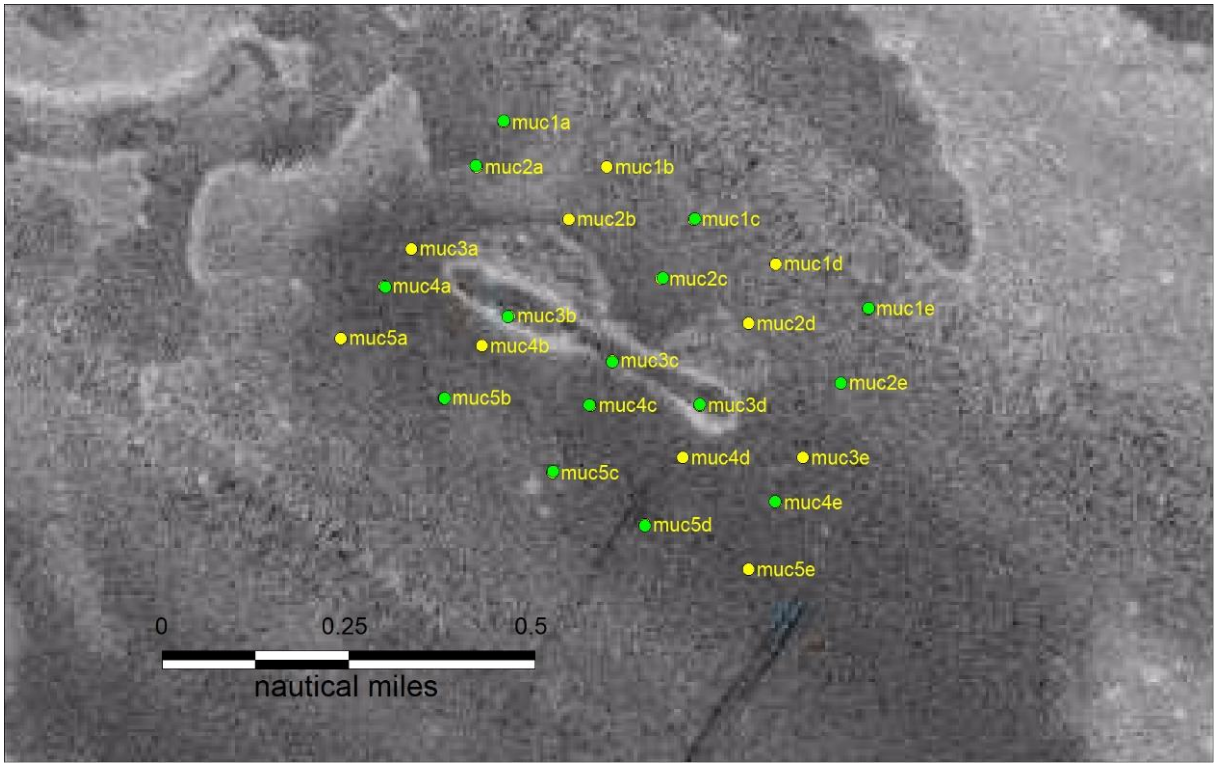

Figure 4-8: The planned grid of Multicorer stations across the Butterknife area (yellow = standard sites, green = SCOC and biogeochemisty sites, see text below).

There was single multicore drop at each site, with six cores.

A subset of these sites (15 of the 25) was selected for more detailed experimental measurements in the onboard laboratories (see next section).

Experimental work

Biogeochemistry of sediments (profile cores)

A subset of sites was selected for oxygen profiling (MON7, MON2, DIS1, MON9, MON1, MON5, REF1, 3b, 5d, 1e, 2e, 4e, 4c, 2c) (Figures 3-2, 4-8). Micro-probes were used for measurement of dissolved oxygen (DO) in the surficial 50 mm, and pore waters removed (using a Rhizome sampler) for chemical analysis and pH, DO and redox measurements at a range of depths down to 10 cm sub-surface. Sediment cores were sectioned for later chemical and particle size analysis.

Sediment Community Oxygen Consumption (SCOC cores)

Sediment incubations were undertaken in order to estimate sediment community oxygen consumption. The upper 13–15 cm of sediment and the overlying water from undisturbed multicore tubes were carefully extruded into incubation chambers (total volume = 2.0 L) with the same internal diameter. Overlying water was sampled for dissolved nutrients. Incubation chambers were then sealed and placed in water baths at ambient bottom water temperature (± 0.1 °C) where they were held in the dark for 12–48 h. An additional chamber containing only near-bottom water was incubated to account for water column respiration. A magnetically driven impeller (60–80 rpm) fitted to the chamber lids gently circulated water during the incubations. Approximately 2 h after chambers were placed in the water bath, O_2 concentrations were measured with a FireSting optode O_2 sensor inserted through a sampling port in the chamber lid. Further O_2 measurements were made during the incubation period, (2hr increments) which was terminated when the initial concentrations had

decreased by 10%–20%. Upon termination of core incubations, dissolved nutrients were sampled. SCOC was estimated from the decline in O_2 concentration with time (linear regression $r^2 > 0.9$) after correcting for water column respiration. Once the incubation was completed, all of the sediments in the core were processed for later macrofauna assessment (sieved on 300 micron mesh and fixed in formalin).

Elutriation

A standard elutriation procedure was undertaken on the 2018 and 2019 voyages. This involved physical agitation of a sediment:water mix (1:4 ratio) for 15 minutes to simulate a dredging and dumping activity. For 2020, an additional, longer (4 h tumbling) was also undertaken to better simulate the mechanical agitation of a deep-sea mining operation (i.e., 2 treatments) (Figure 4-9). These were run using reference site sediments, as well sediments from several specific TAN1903 sites. Elutriate water samples were collected for measurement of dissolved metals, dissolved nutrients, and dissolved organic carbon (DOC). Time series measurements also included sediment particle size to complement the turbidity and fluorescent dissolved organic matter (FDOM) measurements using a YSI EXO 1 handheld multiparameter sonde.

Figure 4-9: Elutriation tumbler used for TAN2005 experiments. 1 litre Schott bottles containing water and sediment were inserted into the plastic tube and tumbled via the motorized rollers.

EROMES

The EROMES apparatus (Figure 4-10) is a useful predictive tool for characterising the nature of the sediments and quantifying the potential resuspension of fine particulate matter. The work in 2020 focused on improved simulations to measure resilience to disturbance following an initial moderate disturbance.

Cores were taken from the multi-corer unit and were extruded into shorter core barrels for EROMES experiments in Tangaroa's temperature-controlled lab.

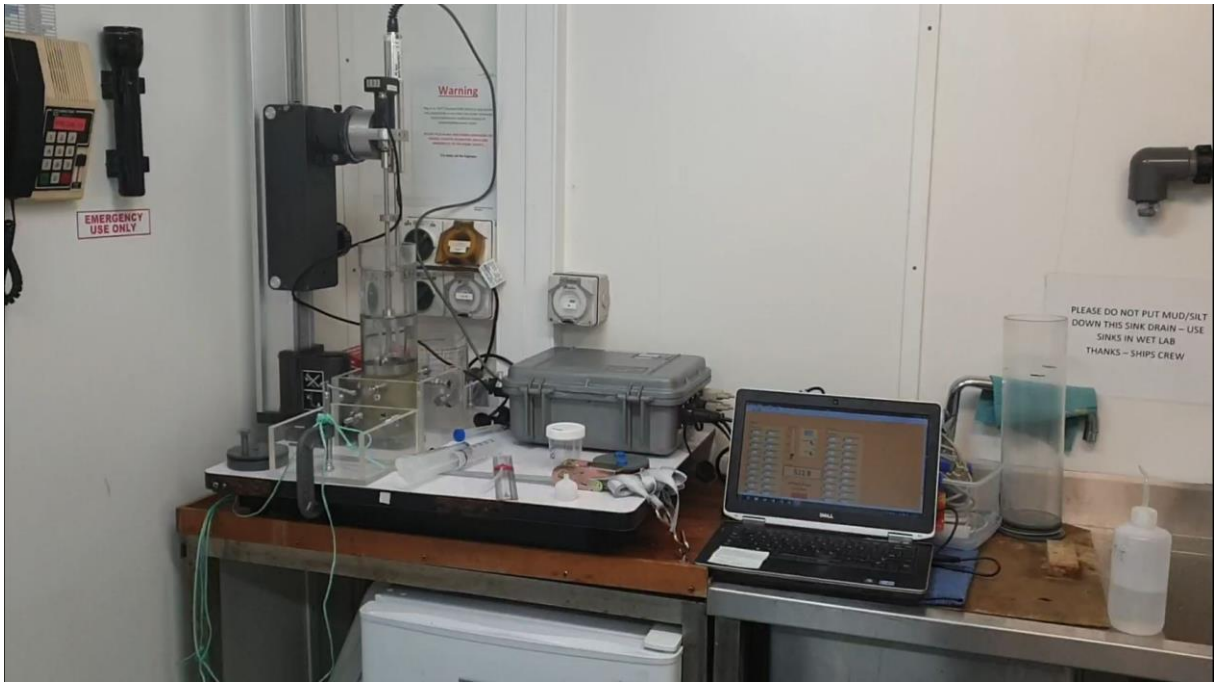

Figure 4-10: EROMES device used for the TAN2005 experiments shown here inserted into a sediment core

There were three experimental approaches:

i. A partial disturbance to half shear strength– followed by a settling period of 24 h to allow capping fines to settle (approximately 2-3 mm of sediment cap) then restart of the shear-stress and turbidity measurements. This tested the effect of bead shear stress and resuspension in a more controlled system than the total mixing of the elutriation procedure. This experiment was designed to improve understanding of the effects of post settlement layers and their resilience to resuspension.

ii. An initial disturbance to full shear strength followed by a settling of 4hrs. At 7 specific timesteps, water for analyses of nutrients, dissolved metals, suspended sediment concentration, sediment particle size, DOC, and FDOM were collected. These samples characterise the impacts of both disturbance and settlement phases on the biogeochemistry of the near benthic boundary layer over time. In addition to the EROMES turbidity meter, a YSI EXO1 handheld sonde was used to continuously record temperature, specific conductance, dissolved oxygen, turbidity, and FDOM throughout the EROMES disturbance and settlement phases. These additional measurements will provide a more dynamic picture of the processes that seabed disturbance has on the settlement of particulate and dissolved material.

iii. Dissolved oxygen core profiles using the Unisense microsensors were taken on cores from both within and outside the beam trawl disturbance area (Figure 5). These cores were then subjected to the EROMES and analytes sampled at 7 specific timesteps for nutrients, dissolved metals, suspended sediment concentration, sediment particle size, DOC, and FDOM were collected. A subsequent dissolved oxygen profile was taken post EROMES experiment.

4.3.2 Results

Multicoring operations

The distribution of stations is shown below (Figure 4-11) for the repeated core 2018-2019 sites, and the 2019 Butterknife survey.

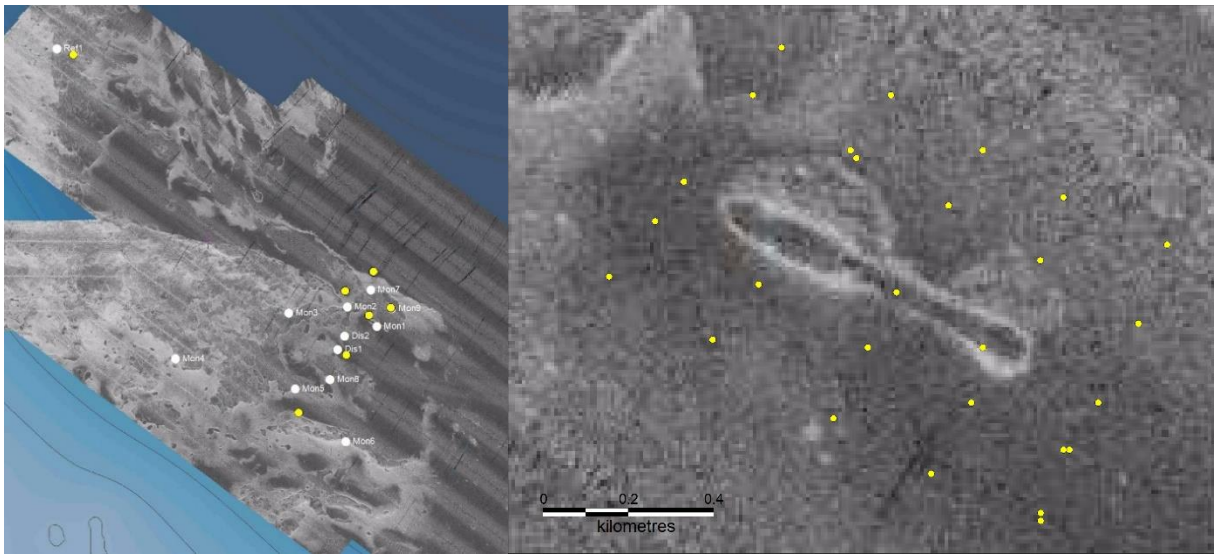

Figure 4-11: The distribution of MUC stations (yellow dots) over the wide area (left), and Butterknife survey area (right).

There were 24 deployments at the core repeat sites, and 29 for the Butterknife grid.

Cores were also obtained from a number of sites to provide sediments for planned sedimentation experiments on land using corals and for calibration of the instruments measuring water column turbidity deployed on the CTD.

Experimental work

Biochemistry and SCOC

Oxygen profile and SCOC experiments (see Figure 4-12) were carried out onboard from four areas:

1. Butterknife: 14 stations (refer Figure 4-8)
   - Transect 1: a, c, e
   - Transect 2: a, c, e
   - Transect 3: c, d
   - Transect 4: a, c, e
   - Transect 5: b, c, d
2. Core sites: 7 stations (refer Figure 3-2)
   - DIS 1, REF 1, MON 1, MON 2, MON 5, MON 7, MON 9.
3. Iceberg scours (see later section) 9 stations:
   - For each of the 3 scours, 2 inside station and 1 outside station.
4. Beam trawl disturbance (see later section) 12 stations:

- TB disturbance 1: 3 inside stations, 3 outside stations
- TB disturbance 2: 4 inside stations, 2 outside stations.

SCOC experiments were run at each of these stations, with a smaller number of sites selected for oxygen profiling (MON7, MON2, DIS1, MON9, MON1, MON5, REF1, 2b, 5d, 1e, 2e, 4e, 4c, 2c).

Figure 4-12: Experimental work: Oxygen probe measurements (left) and respiration experiments (right).

Elutriation/EROMES

The data collected from the elutriate trials and EROMES will be combined with multicore characteristics (e.g., grain size) for analysis. Representative results of elutriation for one site in 2019 are shown in Figure 4-13. The initial very high turbidity declines at a rapid rate for the first 8 hrs and then subsequently at a slower rate. Significantly, there is a marked increase in the level of dissolved organic matter (measured by fDOM) following the 8 hr settling period. This fDOM production is consistent with measurements taken post-disturbance by the glider in 2018, and could signal deoxygenation of near-seabed water because of poor circulatory exchange with the overlying water.

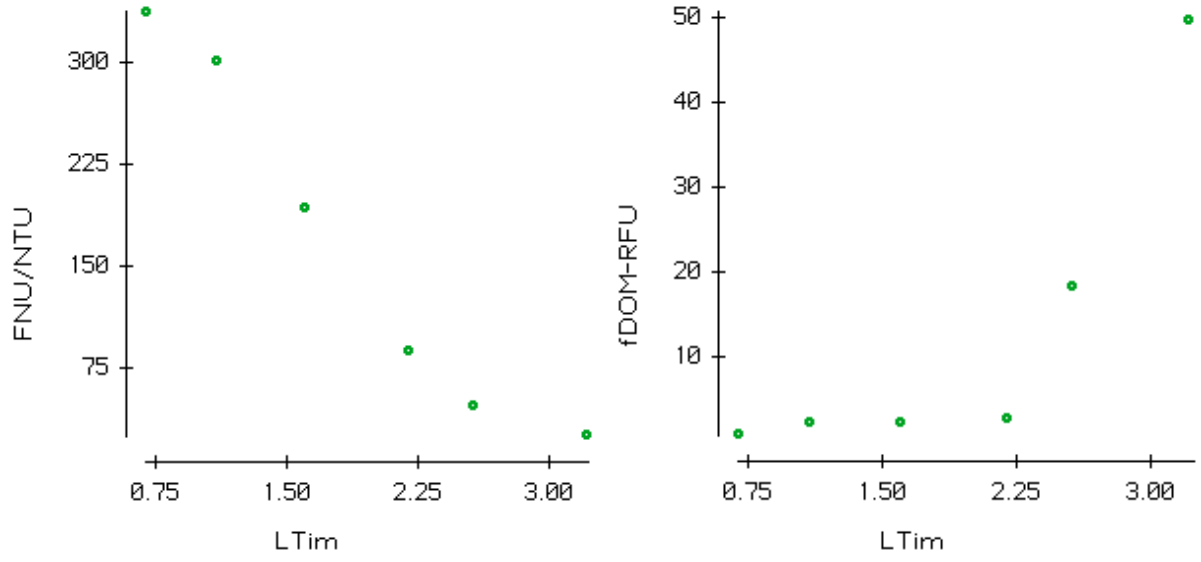

Figure 4-13: Elutriate data for turbidity (NTUs) and dissolved organic matter (DOM) measured by fluorescence (fDOM) from 2019 ROBES voyage. Site MUC3b. Plot of variables against time (LTim = Ln+1 time, 8 hours = 2.2).

4.4 Seabed habitats and fauna

4.4.1 Methods

Photographic survey

The camera gear used was NIWAs "Deep Towed Imaging System" (DTIS). DTIS is a battery-powered towed camera frame which records continuous high definition (HD) digital video and simultaneously takes high definition (10 megapixel) still images at 15 second intervals. Full resolution video and still images were recorded at the seabed and downloaded on return to the surface. A low-resolution video image was transmitted to the surface in real time enabling control of camera altitude and initial evaluation of seabed substratum types and biological assemblages. The seabed position of DTIS was monitored by an acoustic ultra-short baseline (USBL) transponder system and plotted in real time using OFOP (Ocean Floor Observation Protocol) system.

During all deployments spatially-referenced observations on the occurrence of biological assemblages (at relatively coarse taxonomic resolution) and substratum types were recorded by observers using the OFOP system. These initial observations were logged directly to an onboard database. All data were subsequently transferred to the ship's server for storage.

All DTIS transects were run using *Tangaroa*'s Dynamic Positioning System to maintain course and speed and help ensure the winch operator could maintain the optimal height above the seabed. This was successfully done using the main azimuth thruster, and minimising use of bow or stern thrusters. DTIS was towed at 0.5 knots, at a height of 2–3 m above the seafloor.

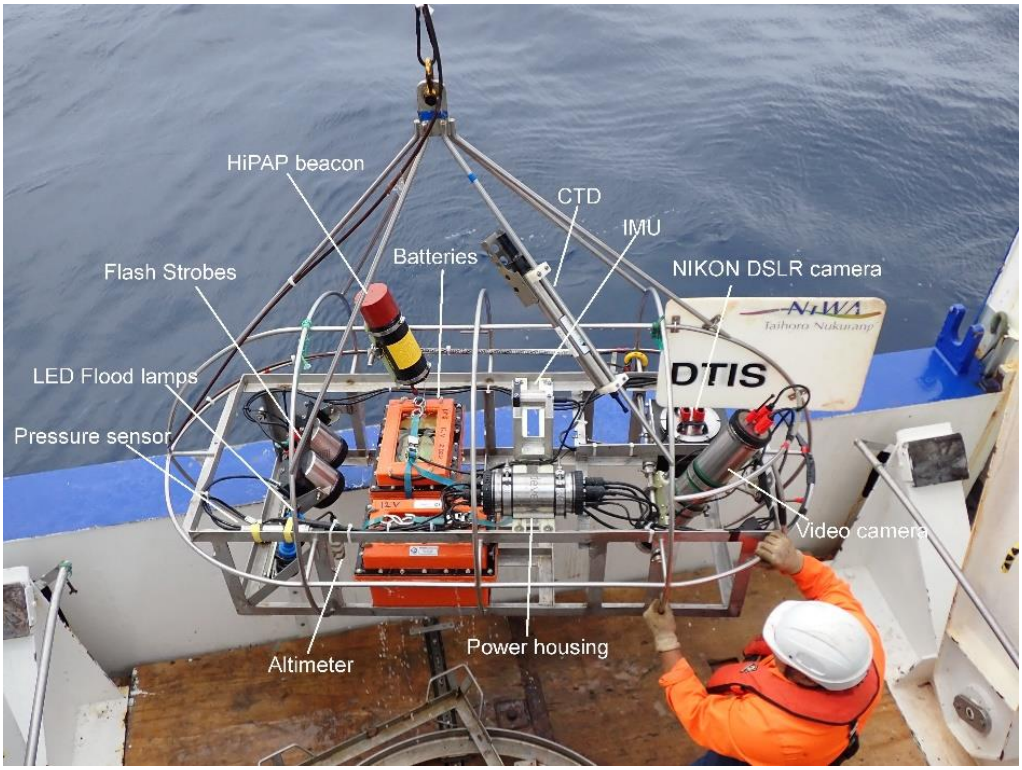

Figure 4-14: NIWAs Deep Towed Imaging System (DTIS) being deployed from *Tangaroa*.

A small CTD unit was attached to DTIS, recording conductivity, temperature, and depth data for the camera transects.

Other Disturbance sampling

In addition to repeating previous sampling sites from the 2018 and 2019 disturbance experiments, if time allowed there were plans to investigate three different spatial and temporal scales of disturbance:

i. Small-scale beam trawl disturbance (soft sediment) with multicore sampling inside and outside the recent beam trawl track. This involved DTIS before and after to examine the imprint of the trawl on the soft sediment. The main sampling was with the multicorer targeting sites inside and outside the beam trawl track.

ii. Iceberg scour disturbance. The Chatham Rise has numerous sites where icebergs have grounded in the past and left strong gouges in the seabed. Three of these were identified from detailed MBES maps made at Greta Point, and paired DTIS and multicorer sampling operations were carried out inside and outside the scours.

iii. Beam trawl disturbance (hard substrate). In 2018 DTIS lines had been run on "Harts Hillock" where there were clumps of *Goniocorella dumosa*. The DTIS lines had been repeated in 2019 to help direct subsequent sled and beam trawl sampling of live coral. The DTIS lines were run again post-trawling operations to provide data on the immediate impact of beam trawls on the epifauna. These lines were repeated again in 2020.

All three options were realised.

Catch sampling

Coral specimens were collected at several sites with a beam trawl. This trawl is a net attached to a 4m wide beam, with a vertical opening of about 30 cm.

Figure 4-15: NIWA's beam trawl, a simple but effective sampling tool for benthic invertebrates.

4.4.2 Results

Photographic survey

A total of 37 DTIS tows was completed. The nature of these varied between "activity" and weather-dependent factors at each site. Repeat transects were followed using the ship's dynamic positioning to cover the same lines as much as possible.

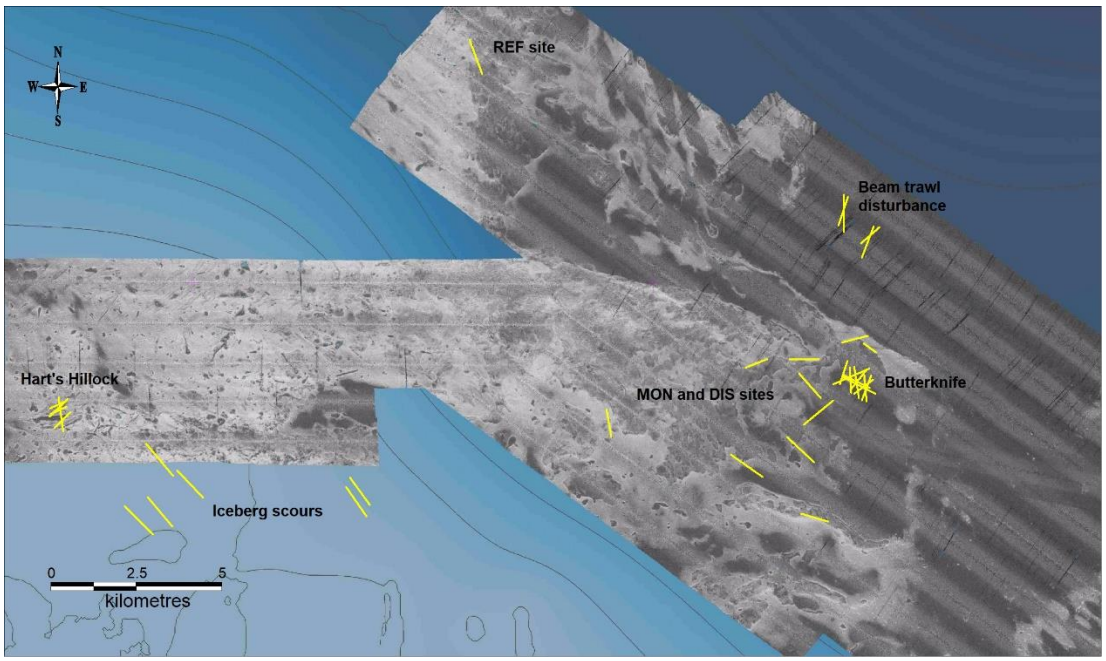

Figure 4-16: Distribution of DTIS tows over the survey area.

Over 30 hours of high definition video were recorded, and over 7 000 still images were taken (240 frames per 1 hr of transect -see the Table 4.3 below). Image quality for both video and stills was generally high, and the use of the *Tangaroa*'s Dynamic Positioning was an important element in this, as it controlled the speed of the ship and enabled a reasonably consistent height above the seafloor to be maintained. DTIS was operated successfully in a range of wind and swell conditions.

Table 4-3: Summary of DTIS data. Duration of video and number of still images taken in the 2020 survey.

Site	No. Stations	No. Stills	Video (HH:MM:SS)
All	37	7 319	30:28:20

DTIS transects were completed on each of the MON, DIS and REF sites. The Butterknife feature was extensively surveyed, and included transects along the northern and southern rims, as well as across the feature – repeating the main lines from 2019. Thickets of *Goniocorella dumosa* occurred mainly on the rims, especially the northwest and southeast sectors, and scattered clumps were also observed on several transects to the north where there was light backscatter (Figure 4-17).

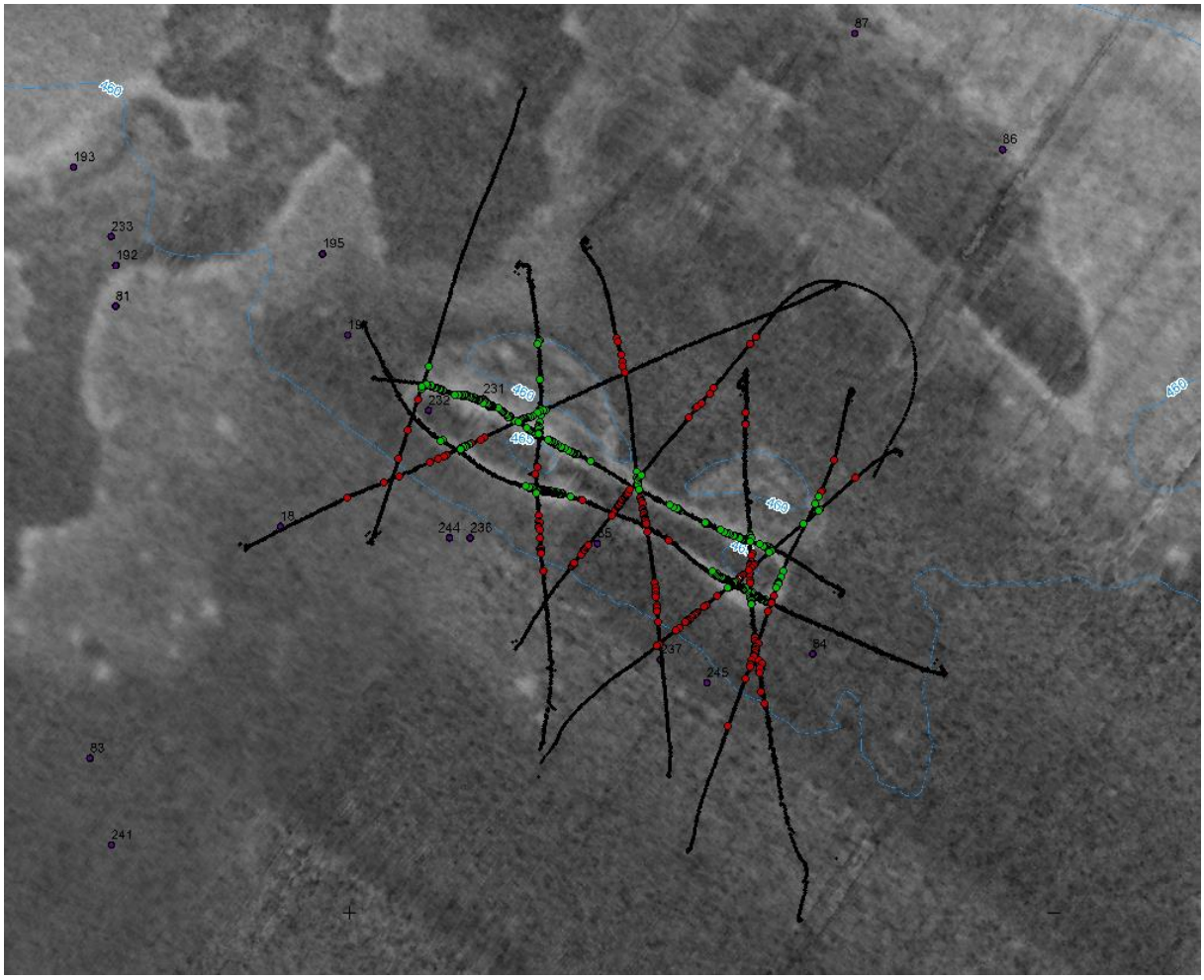

Figure 4-17: DTIS lines across the Butterknife. Green dots indicate records of coral communities, red dots show observations of SCIP marks.

The survey recorded areas of high coral density in the same places as previously observed (2018 and 2019), and widespread distribution of disturbance marks caused by SCIP on the previous survey. This was unexpected as in the 2019 survey very few marks caused by the Benthic Disturber in 2018 were observed.

DTIS station descriptions

An account of each DTIS station, highlighting the main characteristics of the tow, with images of representative or notable fauna or substrate, is given in Appendix C.

Other disturbance sampling

Small-scale beam trawl disturbance

In two locations, multiple beam trawl deployments were made. Station TAN2005/119 was recorded as a single tow, but in effect was 5 short tows over the same ground covering a total area of 8,200m^2. Station TAN2005/145 comprised 7 tows also with a total swept area of 8,200m^2. Trawl position was recorded from a C-node USBL beacon mounted on the headline. Multicorer deployments were made inside and outside the disturbed area, as well as before and after DTIS transects (Figure 4-18). The beam trawl tracks were clearly visible on DTIS, and multicore samples from the inside locations were notable for their very smooth surface (suggesting recent smoothing by the trawl) (Figure 4-19).

Figure 4-18: Beam trawl disturbance sites. Blue lines=DTIS tows before and after; black line=repeated beam trawl lines; green dot=multicorer inside line; red dot=multicorer outside line. Dark black "lines" are artefacts of MBES data.

Figure 4-19: Beam trawl disturbance: DTIS images of trawl tracks (left) and smooth surface of multicorer sample (right).

Iceberg scours disturbance

Three iceberg scours were identified from MBES imagery in the southern-central part of the survey area. Two DTIS transects were run across each of these, and sites for multicorer sampling identified both inside the scour, and on the slope beyond them (Figure 4-20).

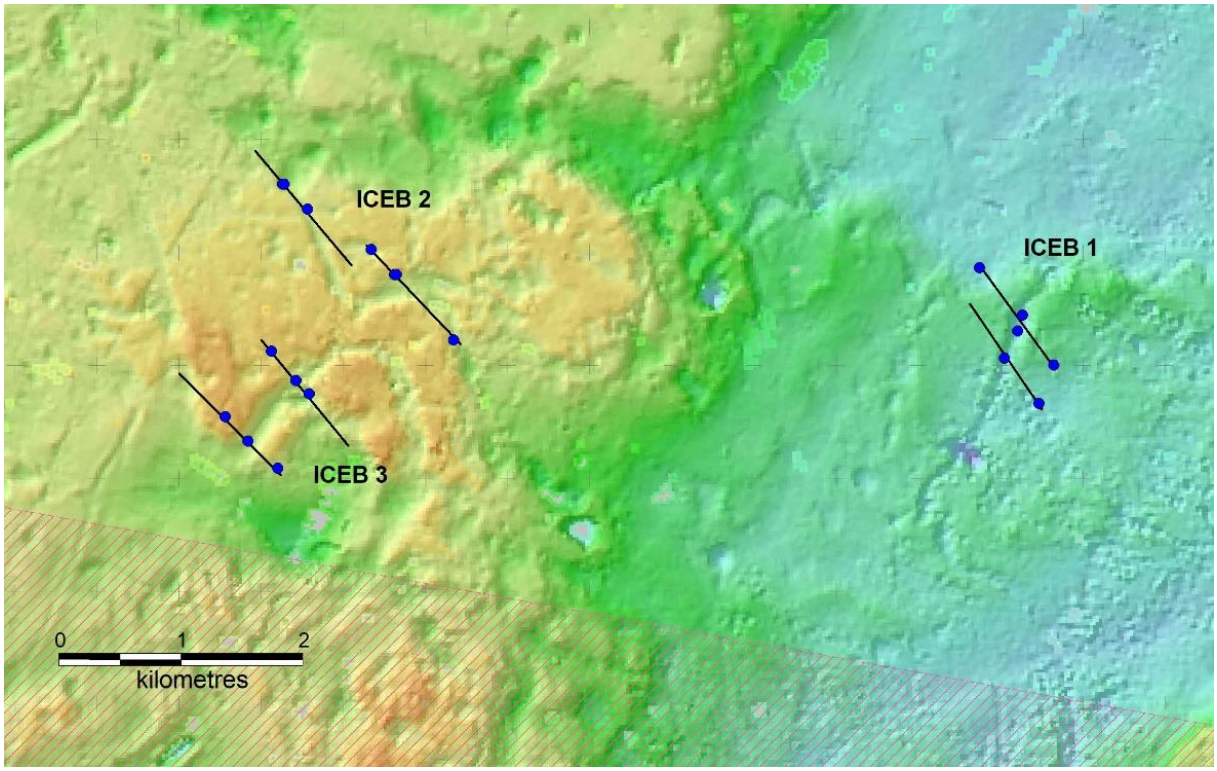

Figure 4-20: Section of the Chatham Rise showing iceberg scours, and location of DTIS transects (black lines) and multicorer stations (blue dots). The red striped area is the Mid-Chatham Rise Benthic Protection Area.

Iceberg scour 1 had three multicore stations inside the scour, and three outside; Scour 2 had three inside and two outside; and scour 3 had three inside and three outside.

These samples and data will provide information on long-term disturbance differences. To an extent this was an opportunistic survey given better weather than expected during the survey, and data might not be able to be analysed by the ROBES project, but be part of a future University post-graduate project.

Beam trawl coral disturbance/recovery

DTIS transects were run both perpendicular to, and along, the beam trawl tow lines used to capture live coral. In 2019 three short beam trawl tows were done, with a single along-tow DTIS transect carried out before trawling, and two perpendicular DTIS runs post-trawling. The three DTIS lines from 2019 were repeated in 2020, prior to carrying out two further beam trawl tows to collect corals (Figure 4-21). The along-trawl line was repeated post-trawling, but weather conditions meant that the transverse DTIS runs had to be at different angles to the previous ones. However, in combination the two years sampling provides a good opportunity to assess the impacts of beam trawling, and the extent of any recovery over a one year period.

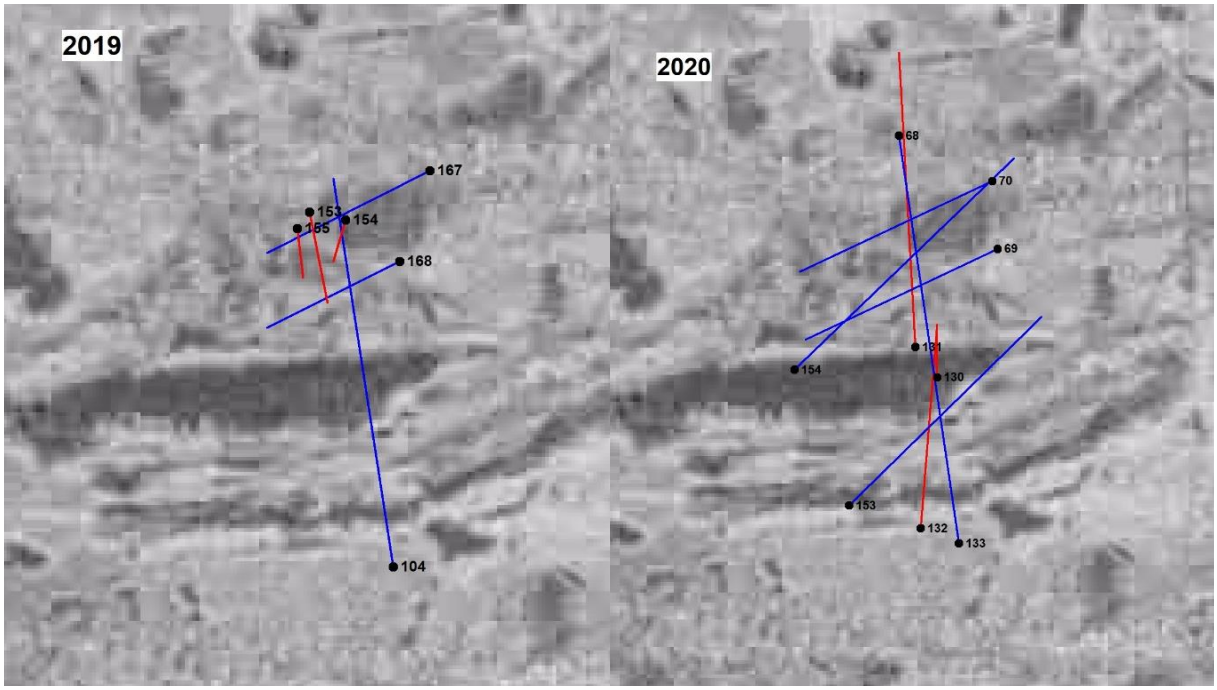

Figure 4-21: Hart's Hillock disturbance tows. Left panel = 2019, Right panel = 2020. Red lines = beam trawl, blue lines = DTIS transects.

Live capture aquarium samples

Two beam trawls were deployed towards the end of the survey to collect live samples of the stony branching coral *Goniocorella dumosa*. This sampling was for additional sedimentation experiments (building on those done in 2019) in NIWA's Marine Environment Manipulation Facility (MEMF) at Greta Point.

Several healthy coral colony samples with large numbers of live polyps, ranging in size from small fist-sized pieces to clumps, were taken from the hauled beam trawl and placed in lidded buckets of seawater chilled down to the *in situ* sampling temperature of ~9°C. The samples were then quickly transferred to baskets in 24 1 Litre containers in the cold-water flow-through aquaria system on board Tangaroa. Daily checks were made to ensure the water temperatures and current flow in the tanks reflected *in situ* conditions– e.g., temperature = 8.8°C. There was no mortality, and condition of the corals appeared very good. In total 241 small colonies or colony branchlets were retained (80 from tow 130, 111 from tow 132) (see Figures 4-22, 4-23).

In addition, tissue samples for a complementary genetic study were collected from the coral samples and placed in RNA/DNA Shield for analysis back at Greta Point.

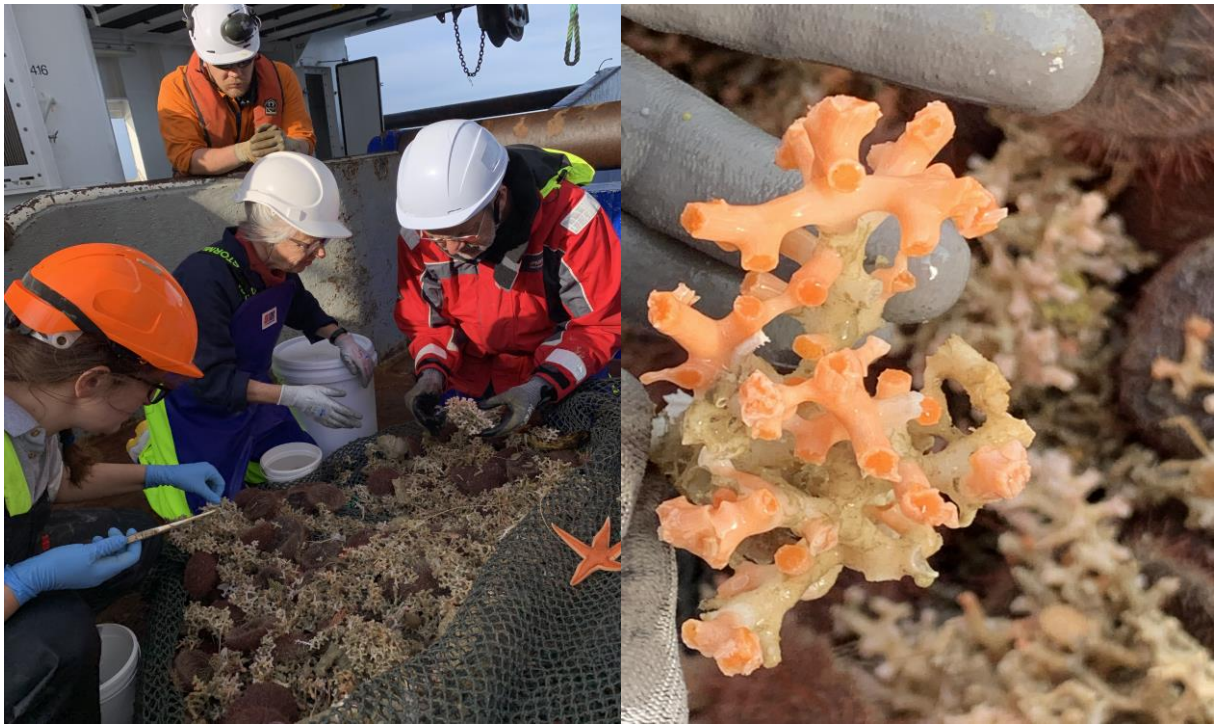

Figure 4-22: Left: collection of corals from the beam trawl. Right: typical clump of live coral retained .

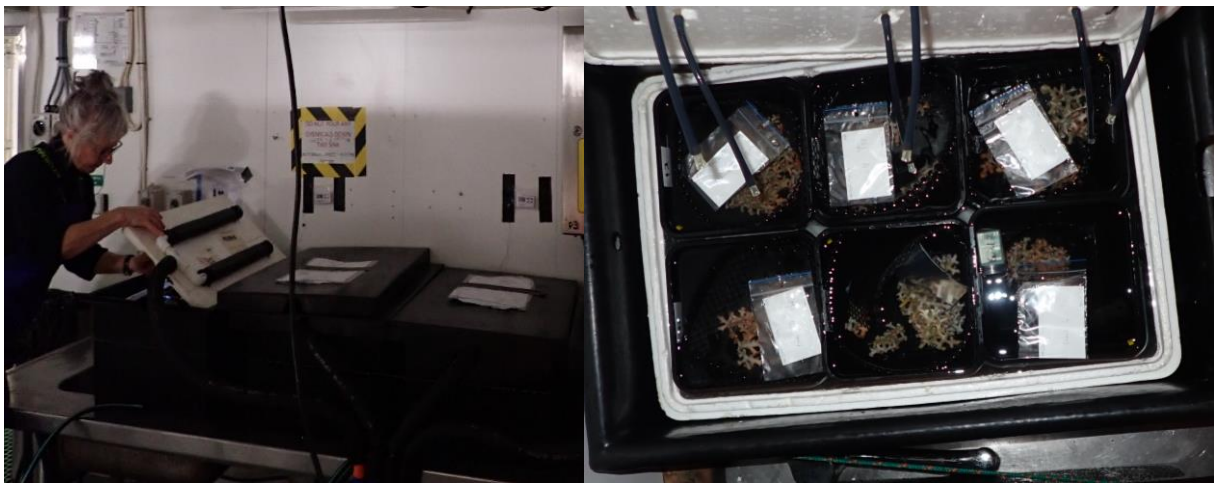

Figure 4-23: The aquarium set-up on board Tangaroa (left) and corals inside the tanks.

5 Acknowledgements

Ngā mihi ki ngā kaimahi katoa me te waka *Tangaroa*! Thanks to all involved!

Thanks to all the scientific staff, officers and crew of RV *Tangaroa* for their enthusiasm and hard work onboard. We also appreciate the efforts made by Vessels shore staff given the challenges imposed by Covid-19.

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Appendix A Summary of daily events during the voyage.

Date	Activity
8 June	Mobilisation
9 June	Mobilisation completed. Sail 0900. Deploy CPR. Head for Chatham Rise.
10 June	Complete 3 CTD (#2-4) casts as run into survey area. Start multicores at MON7 (#5-8), MON2 (#9-11), DIS1 (#12-15).
11 June	DTIS stations at DIS1, MON2, MON7, MON1, with two along Butterknife rims (#16-21). Resume multicores at MON9 (#22-24), MON1 (#25-27), MON5(# 28-30). DTIS at Mon5.
12 June	Complete DTIS runs at MON6 (#32), MON8 (#33), MON9 (#34), DIS2 (#35), head to REF1 with freshening weather to complete MON multicores at REF1 (#36-39) and DTIS at REF1. Fresh SW changes plan to focus DTIS on Butterknife: stations #41, 42. Switch to CTD as swell increases (#43).
13 June	Complete CTD grid (stations 044-051). Swell still too high for DTIS ops, but head towards Butterknife to start multicore grid.
14 June	Wind eases to 20 kn, 3-4 m swells at times, but multicore ops go well, complete lines b and d (10 sites). Resume DTIS on Butterknife (#63,64), two exploratory tows in area of beam trawl disturbance (#65-66), then MON4, and out to Hart's Hillock for repeat tows across area of coral.
15 June	Three DTIS across the coral area and site of previous beam trawling (#068-070). Steam back to complete DTIS at MON3 (#071), then CTD prior to retrieving mooring. Continue DTIS at Butterknife (#74, 75, 76) and start Butterknife core lines a and e.
16 June	Complete Butterknife core line e. Steam SW for iceberg scour work. DTIS Scour1 (#91, 92), Scour2 (#93, 94), and Scour3 (#95, 96). Start multicore Scour3 (#97).
17 June	Continue multicore ops at Scour3 (#98-102), Scour2 (#103-110) and Scour1 (#111-118). Head to area north of Butterknife for beam trawl disturbance trials (#119)
18 June	Undertake multicore sampling inside and outside disturbed area (#120-128), and check with DTIS. Sample Hart's Hillock for live coral capture (#130-132) and run a DTIS line over tracks. Do three CTD stations along line west of previous sampling.
19 June	Complete Butterknife multicore grid (line c, #137-141). Then return to complete CTD line to the north (#142-144). Undertake further beam trawl disturbance tows (#145)
20 June	Sample inside and outside the disturbance area (multicores #146-151). Complete two further DTIS over Harts Hillock (#153, 154). Undertake TOPAS sub-bottom profile survey over the general ROBES area (9 transect lines)
21 June	Complete TOPAS survey 0300. Begin transit towards Wellington.
22 June	Arrive back in Wellington

Appendix B TAN2005 station summary

CAM=DTIS, CTD=conductivity-temperature-depth unit, MUC=multicorer, MOOR=mooring, BEAM=beam trawl, CPR=Continuous Plankton Recorder. Perf=gear performance (1,2=good; 3=poor), depths (s_dep, f_dep) in m, time=NZST.

Stn	Area	Method	Date	Time	lat_d	lat_min	lon_d	lon_min	lon	s_dep	f_dep	n.mile	dir	Perf	Comments
1	Transit	CPR	9-Jun	1141	41	29.47	174	54.06	E	0	0	210.00	123	2	CPR run from Wellington Heads to survey area
2		CTD	10-Jun	822	43	24.06	178	53.9	E	0	0	0.00	289	1	CTD number 8, west end, to 363m
3		CTD	10-Jun	1018	43	24.02	179	12.09	E	0	0	0.00		1	CTD number 9, west line, to 382m
4		CTD	10-Jun	1225	43	23.98	179	30.02	E	0	0	0.00		1	CTD number 10, west line, to 381m
5	MON7	MUC	10-Jun	1610	43	20.58	179	44.22	E	462	462	0.00		1	6 cores: 5 good, 1 OK.
6	MON7	MUC	10-Jun	1705	43	20.58	179	44.22	E	465	465	0.00		2	4 good cores.
7	MON7	MUC	10-Jun	1803	43	20.57	179	44.21	E	465	465	0.00		2	6 good cores
8	MON7	MUC	10-Jun	1831	43	20.57	179	44.22	E	464	464	0.00		2	4 good cores.
9	MON2	MUC	10-Jun	1924	43	20.92	179	43.49	E	459	459	0.00		2	6 good cores
10	MON2	MUC	10-Jun	1953	43	20.92	179	43.5	E	460	460	0.00		2	3 good cores
11	MON2	MUC	10-Jun	2037	43	20.93	179	43.49	E	460	460	0.00		1	6 good cores
12	DIS1	MUC	10-Jun	2134	43	22.11	179	43.53	E	450	450	0.00		1	3 good cores
13	DIS1	MUC	10-Jun	2206	43	22.11	179	43.53	E	450	450	0.00		2	5 good cores
14	DIS1	MUC	10-Jun	2240	43	22.11	179	43.53	E	450	450	0.00		2	6 good cores.
15	DIS1	MUC	10-Jun	2315	43	22.12	179	43.53	E	450	450	0.00		2	5 good cores
16	DIS1	CAM	11-Jun	28	43	21.86	179	43.89	E	450	450	0.60	231	1	Repeat TAN1903/019.
17	MON2	CAM	11-Jun	314	43	21.21	179	43.58	E	451	455	0.46	271	1	Repeat TAN1903/030.
18	MON7	CAM	11-Jun	535	43	20.83	179	44.64	E	466	459	0.42	255	2	Repeat TAN1903/022.
19	MON1	CAM	11-Jun	755	43	21.35	179	44.67	E	460	456	0.60	246	1	Repeat TAN1903/021.
20	BUTT	CAM	11-Jun	1032	43	21.66	179	44.68	E	455	459	0.48	296	1	Repeat TAN1903/009. North rim of Butterknife.

Stn	Area	Method	Date	Time	lat_d	lat_min	lon_d	lon_min	lon	s_dep	f_dep	n.mile	dir	Perf	Comments
21	BUTT	CAM	11-Jun	1320	43	21.75	179	44.81	E	458	452	0.59	297	1	Repeat TAN1903/008. South rim of Butterknife.
22	MON9	MUC	11-Jun	1533	43	21.25	179	44.66	E	455	455	0.00		2	5 good cores
23	MON9	MUC	11-Jun	1603	43	21.25	179	44.67	E	458	458	0.00		1	6 good cores
24	MON9	MUC	11-Jun	1635	43	21.24	179	44.66	E	455	455	0.00		1	5 good cores
25	MON1	MUC	11-Jun	1742	43	21.39	179	44.11	E	453	453	0.00		1	4 good cores
26	MON1	MUC	11-Jun	1815	43	21.38	179	44.1	E	456	456	0.00		2	5 good cores, 1 didn't fire.
27	MON1	MUC	11-Jun	1845	43	21.38	179	44.1	E	454	454	0.00		1	6 good cores
28	MON5	MUC	11-Jun	2035	43	23.19	179	42.31	E	443	443	0.00		2	5 good cores
29	MON5	MUC	11-Jun	2102	43	23.19	179	42.31	E	443	443	0.00		1	6 good cores
30	MON5	MUC	11-Jun	2130	43	23.19	179	42.31	E	443	443	0.00		2	5 good cores
31	MON5	CAM	11-Jun	2227	43	23.07	179	42.36	E	447	439	0.61	305	1	Repeat TAN1903/043.
32	MON6	CAM	12-Jun	105	43	23.78	179	43.79	E	443	439	0.45	287	1	Repeat TAN1805/88.
33	MON8	CAM	12-Jun	321	43	22.84	179	43.47	E	448	448	0.59	313	1	Repeat TAN1903/044.
34	MON9	CAM	12-Jun	545	43	21.1	179	44.82	E	461	461	0.25	307	1	Repeat TAN1903/023.
35	DIS2	CAM	12-Jun	757	43	21.82	179	43.62	E	455	454	0.52	318	1	Repeat TAN1805/83.
36	REF1	MUC	12-Jun	1055	43	16.54	179	36.54	E	456	456	0.00		2	5 good cores, 1 didn't fire.
37	REF1	MUC	12-Jun	1127	43	16.54	179	36.54	E	454	454	0.00		2	6 good cores
38	REF1	MUC	12-Jun	1201	43	16.54	179	36.54	E	452	452	0.00		2	0 useable cores.
39	REF1	MUC	12-Jun	1231	43	16.54	179	36.54	E	449	449	0.00		2	5 good cores
40	REF1	CAM	12-Jun	1338	43	16.14	179	35.98	E	438	441	0.58	160	1	Repeat TAN1903/033 with slight adjustment for weather. Tow down tongue of higher reflectivity.
41	BUTT	CAM	12-Jun	1856	43	21.34	179	44.25	E	459	457	0.40	177	1	Repeat of TAN1903/126; western area of Butterknife

Stn	Area	Method	Date	Time	lat_d	lat_min	lon_d	lon_min	lon	s_dep	f_dep	n.mile	dir	Perf	Comments
42	BUTT	CAM	12-Jun	2123	43	21.46	179	44.56	E	460	458	0.41	175	1	Repeat of TAN1903/125; eastern end of Butterknife.
43		CTD	12-Jun	2251	43	23.96	179	44.06	E	0	0	0.00	118	1	CTD No. 4, central, to 428m.
44		CTD	13-Jun	112	43	23.85	179	59.99	E	0	0	0.00	182	1	CTD No. 11, east line, to 408m
45		CTD	13-Jun	341	43	23.92	179	47.98	W	0	0	0.00		1	CTD No. 12, east line, to 458m
46		CTD	13-Jun	852	42	47.96	179	44.04	E	0	0	0.00	154	1	CTD No.7, north line, to 1038m.
47		CTD	13-Jun	1118	42	59.75	179	43.85	E	0	0	0.00	144	1	CTD No. 6, north line, to 608m
48		CTD	13-Jun	1329	43	11.77	179	44.08	E	0	0	0.00	191	1	CTD No. 5, north line, to 490m.
49		CTD	13-Jun	1745	43	35.87	179	44.13	E	0	0	0.00	173	1	CTD No.3, south line, to 389m
50		CTD	13-Jun	1956	43	47.91	179	44.11	E	0	0	0.00	147	1	CTD No.2, south line, to 429m
51		CTD	13-Jun	2205	43	59.97	179	43.97	E	0	0	0.00	178	1	CTD No.1, south line, to 514m
52	BUTT	MUC	14-Jun	245	43	21.32	179	44.39	E	457	457	0.00		1	MUC1b, 6 good cores
53	BUTT	MUC	14-Jun	329	43	21.39	179	44.32	E	452	452	0.00		2	MUC2b, 5 good cores
54	BUTT	MUC	14-Jun	411	43	21.4	179	44.33	E	458	458	0.00		1	MUC2b, 6 good cores. Station repeated in error.
55	BUTT	MUC	14-Jun	446	43	21.56	179	44.16	E	456	456	0.00		1	MUC4b, 6 good cores
56	BUTT	MUC	14-Jun	545	43	21.63	179	44.08	E	452	452	0.00		2	MUC5b, 5 good cores
57	BUTT	MUC	14-Jun	636	43	21.45	179	44.69	E	458	458	0.00		1	MUC1d, 6 good cores
58	BUTT	MUC	14-Jun	735	43	21.64	179	44.55	E	465	465	0.00		2	MUC3d, 5 good cores
59	BUTT	MUC	14-Jun	810	43	21.71	179	44.53	E	457	457	0.00		1	MUC4d, 6 good cores
60	BUTT	MUC	14-Jun	850	43	21.8	179	44.46	E	457	457	0.00		2	MUC5d, 3 good cores, repeat.
61	BUTT	MUC	14-Jun	922	43	21.8	179	44.46	E	457	457	0.00		1	MUC5d, 6 good cores
62	BUTT	MUC	14-Jun	1014	43	21.53	179	44.65	E	451	451	0.00		1	MUC2d, 6 good cores
63	BUTT	CAM	14-Jun	1137	43	21.46	179	44.71	E	459	458	0.42	200	1	Repeat of TAN1903/164, eastern end of Butterknife.

Stn	Area	Method	Date	Time	lat_d	lat_min	lon_d	lon_min	lon	s_dep	f_dep	n.mile	dir	Perf	Comments
64	BUTT	CAM	14-Jun	1351	43	21.32	179	44.34	E	459	456	0.50	171	1	Repeat of TAN1903/127, central region of Butterknife
65		CAM	14-Jun	1616	43	18.63	179	44.21	E	478	474	0.47	199	1	Check of beam trawl area. Muddy sediment.
66		CAM	14-Jun	1845	43	19.1	179	44.77	E	474	473	0.53	201	1	Check of beam trawl area. Muddy sediment.
67	MON4	CAM	14-Jun	2124	43	22	179	38.97	E	424	425	0.45	171	1	Repeat of TAN1903/032, Mon4.
68	HART	CAM	15-Jun	15	43	21.81	179	27.06	E	389	392	0.55	172	1	Repeat of TAN1903/104 reverse, across Harts Hillock.
69	HART	CAM	15-Jun	315	43	21.96	179	27.24	E	391	391	0.28	245	1	Repeat of TAN1903/167 across TB line, southern of pair.
70	HART	CAM	15-Jun	438	43	21.87	179	27.23	E	386	391	0.28	245	1	Repeat of TAN1903/168 across TB line, northern of pair.
71	MON3	CAM	15-Jun	800	43	21.2	179	42.46	E	448	444	0.38	248	1	Repeat of TAN1903/031. MON3 site.
72	MOOR	CTD	15-Jun	921	43	21.26	179	44.98	E	0	0	0.00	94	1	CTD at MOOR site, to 417m
73	MOOR	MOOR	27-Jun	1012	43	21.19	179	44.87	E	457	464	0.00		1	Recover mooring from TAN1903/166.
74	BUTT	CAM	15-Jun	1258	43	21.53	179	44.76	E	459	457	0.37	234	1	Repeat of TAN1903/165, eastern region of Butterknife.
75	BUTT	CAM	15-Jun	1456	43	21.69	179	44.26	E	457	459	0.40	39	1	Repeat of TAN1903/162 adjusted.
76	BUTT	CAM	15-Jun	1726	43	21.6	179	44.03	E	457	459	0.39	19	1	Repeat of TAN1903/162 adjusted.
77	BUTT	MUC	15-Jun	1905	43	21.55	179	43.9	E	456	456	0.00		1	MUC5A, 6 good cores
78	BUTT	MUC	15-Jun	1943	43	21.48	179	43.98	E	459	459	0.00		1	MUC4A, 6 good cores
79	BUTT	MUC	15-Jun	2022	43	21.43	179	44.03	E	457	457	0.00		2	MUC3A, 4 good cores, repeat
80	BUTT	MUC	15-Jun	2055	43	21.43	179	44.03	E	457	457	0.00		1	MUC3A, 6 good cores.
81	BUTT	MUC	15-Jun	2156	43	21.32	179	44.15	E	457	457	0.00		1	MUC2A, 6 good cores.
82	BUTT	MUC	15-Jun	2234	43	21.26	179	44.2	E	458	458	0.00		2	MUC1A, 5 good cores
83	BUTT	MUC	15-Jun	2333	43	21.86	179	44.65	E	457	457	0.00		2	MUC5E, 4 good cores, repeat.
84	BUTT	MUC	16-Jun	4	43	21.85	179	44.65	E	459	459	0.00		2	MUC5E, 5 good cores

Stn	Area	Method	Date	Time	lat_d	lat_min	lon_d	lon_min	lon	s_dep	f_dep	n.mile	dir	Perf	Comments
85	BUTT	MUC	16-Jun	47	43	21.77	179	44.7	E	453	453	0.00		2	MUC4E, 4 good cores.
86	BUTT	MUC	16-Jun	116	43	21.77	179	44.69	E	451	451	0.00		1	MUC4E, 6 good cores.
87	BUTT	MUC	16-Jun	155	43	21.71	179	44.75	E	457	457	0.00		1	MUC3E, 6 good cores
88	BUTT	MUC	16-Jun	306	43	21.61	179	44.82	E	454	454	0.00		1	MUC2E, 6 good cores
89	BUTT	MUC	16-Jun	347	43	21.51	179	44.87	E	450	450	0.00		2	MUC1E, 4 cores, repeat.
90	BUTT	MUC	16-Jun	416	43	21.51	179	44.87	E	455	455	0.00		1	MUC1E, 6 good cores
91	ICEB	CAM	16-Jun	740	43	23.52	179	33.83	E	414	419	0.54	324	1	Iceberg scour 1 across northern section.
92	ICEB	CAM	16-Jun	1008	43	23.7	179	33.75	E	419	411	0.57	326	1	Iceberg scour 1, southern section.
93	ICEB	CAM	16-Jun	1252	43	23.41	179	30.21	E	394	391	0.60	317	1	Iceberg scour 2, southeastern transect
94	ICEB	CAM	16-Jun	1527	43	23.06	179	29.55	E	391	393	0.67	320	1	Iceberg scour2, northwestern transect
95	ICEB	CAM	16-Jun	1837	43	23.86	179	29.53	E	393	385	0.61	321	1	Iceberg scour 3, eastern transect
96	ICEB	CAM	16-Jun	2126	43	23.99	179	29.12	E	395	389	0.64	315	1	Iceberg scour 3, western transect
97	ICEB	MUC	16-Jun	2324	43	23.96	179	29.1	E	385	385	0.00		2	ICEB3, out3, 4 good cores
98	ICEB	MUC	17-Jun	3	43	23.84	179	28.92	E	385	385	0.00		1	ICEB3, in3, 4 good cores
99	ICEB	MUC	17-Jun	44	43	23.73	179	28.78	E	385	385	0.00		1	ICEB3, out2, 4 good cores
100	ICEB	MUC	17-Jun	125	43	23.63	179	29.29	E	389	389	0.00		1	ICEB3, in1, 4 good cores
101	ICEB	MUC	17-Jun	154	43	23.57	179	29.21	E	392	392	0.00		1	ICEB3, in2, 4 good cores
102	ICEB	MUC	17-Jun	259	43	23.44	179	29.06	E	391	391	0.00		1	ICEB2, out2, 4 good cores
103	ICEB	MUC	17-Jun	344	43	23.39	179	30.17	E	385	385	0.00		1	ICEB2, in3, 3 good cores
104	ICEB	MUC	17-Jun	432	43	23.1	179	29.81	E	393	393	0.00		2	ICEB2, in3, 3 good cores
105	ICEB	MUC	17-Jun	455	43	23.1	179	29.82	E	393	393	0.00		2	ICEB2, in3, repeat, 1 good core
106	ICEB	MUC	17-Jun	545	43	22.99	179	29.67	E	393	393	0.00		1	ICEB2, out1, 4 good cores
107	ICEB	MUC	17-Jun	630	43	22.81	179	29.28	E	387	387	0.00		3	ICEB2, in2, 0 cores
108	ICEB	MUC	17-Jun	735	43	22.81	179	29.28	E	387	387	0.00		3	ICEB2, repeat in2, 0 cores

Stn	Area	Method	Date	Time	lat_d	lat_min	lon_d	lon_min	lon	s_dep	f_dep	n.mile	dir	Perf	Comments
109	ICEB	MUC	17-Jun	815	43	22.7	179	29.13	E	387	387	0.00		2	ICEB2, in1, 3 good cores
110	ICEB	MUC	17-Jun	841	43	22.7	179	29.14	E	387	387	0.00		1	ICEB2, in1 repeat, 4 good cores.
111	ICEB	MUC	17-Jun	957	43	23.67	179	33.73	E	412	412	0.00		2	ICEB1, out2, 3 good cores
112	ICEB	MUC	17-Jun	1021	43	23.67	179	33.73	E	412	412	0.00		1	ICEB1, out2 repeat, 4 good cores
113	ICEB	MUC	17-Jun	1230	43	23.5	179	33.82	E	410	410	0.00		2	ICEB1, out1, 5 good cores
114	ICEB	MUC	17-Jun	1307	43	23.47	179	33.52	E	406	406	0.00		2	ICEB1, in3, 6 good cores
115	ICEB	MUC	17-Jun	1342	43	23.35	179	33.6	E	414	414	0.00		1	ICEB1, in2, 6 good cores
116	ICEB	MUC	17-Jun	1416	43	23.28	179	33.63	E	412	412	0.00		2	ICEB1, in1, 2 short cores, repeat.
117	ICEB	MUC	17-Jun	1442	43	23.28	179	33.63	E	412	412	0.00		2	ICEB1, in1, 3 short cores, chalk
118	ICEB	MUC	17-Jun	1544	43	23.07	179	33.37	E	409	409	0.00		2	ICEB1, out3, 5 good cores
119	DIST	BEAM	17-Jun	1838	43	19	179	44.06	E	475	475	1.10	9	2	Beam trawl trials
120	DIST	MUC	18-Jun	26	43	18.77	179	44.13	E	475	475	0.00		1	DIST, in1, 6 good cores
121	DIST	MUC	18-Jun	56	43	18.77	179	44.12	E	475	475	0.00		1	DIST, in2, 6 good cores
122	DIST	MUC	18-Jun	129	43	18.77	179	44.13	E	475	475	0.00		1	DIST, in3, 6 good cores
123	DIST	MUC	18-Jun	200	43	18.77	179	44.08	E	474	474	0.00		2	DIST, out1, 3 good cores
124	DIST	MUC	18-Jun	303	43	18.77	179	44.07	E	474	474	0.00		2	DIST, out1, 6 good cores
125	DIST	MUC	18-Jun	337	43	18.74	179	44.17	E	469	469	0.00		3	DIST, out2, 2 good cores
126	DIST	MUC	18-Jun	406	43	18.77	179	44.17	E	470	470	0.00		2	DIST, out2, 6 cores.
127	DIST	MUC	18-Jun	438	43	18.8	179	44.17	E	477	477	0.00		2	DIST, out3, 4 good cores
128	DIST	MUC	18-Jun	524	43	18.8	179	44.17	E	476	476	0.00		2	DIST, out3, 6 cores
129	DIST	CAM	18-Jun	709	43	19.19	179	44.11	E	473	475	0.60	1	1	DIST run, clear TB marks on seabed
130	HART	BEAM	18-Jun	1013	43	22.13	179	27.13	E	394	402	0.06		1	Catch 48kg. Live corals, coral matrix, urchins, sponges and mix of invertebrates.
131	HART	BEAM	18-Jun	1238	43	22.09	179	27.09	E	401	395	0.39	357	3	Zero catch, net ripped.

Stn	Area	Method	Date	Time	lat_d	lat_min	lon_d	lon_min	lon	s_dep	f_dep	n.mile	dir	Perf	Comments
132	HART	BEAM	18-Jun	1427	43	22.33	179	27.1	E	395	394	0.27	5	2	Catch 30kg. Live corals, similar composition to #130, dominated by coral matrix, heart urchins.
133	HART	CAM	18-Jun	1557	43	22.35	179	27.17	E	394	395	0.55	352	1	Repeat earlier #068 over area of trawling
134		CTD	18-Jun	1854	43	35.99	179	11.93	E	0	0	0.00	283	1	CTD no. 15, western south line, to 425m
135		CTD	18-Jun	2037	43	48.04	179	12.01	E	0	0	0.00	125	1	CTD no. 14, western south line, to 472m
136		CTD	18-Jun	2223	44	0.08	179	12.03	E	0	0	0.00		1	CTD no.13, western south line, to 602m
137	BUTT	MUC	19-Jun	340	43	21.73	179	44.29	E	454	454	0.00		2	MUC5c, 5 good cores
138	BUTT	MUC	19-Jun	414	43	21.64	179	44.35	E	454	454	0.00		1	MUC4c, 6 good cores
139	BUTT	MUC	19-Jun	444	43	21.57	179	44.4	E	454	454	0.00		2	MUC3c, 5 good cores.
140	BUTT	MUC	19-Jun	518	43	21.46	179	44.49	E	444	444	0.00		1	MUC2c, 6 good cores
141	BUTT	MUC	19-Jun	550	43	21.39	179	44.55	E	455	455	0.00		1	MUC1c, 6 cores.
142		CTD	19-Jun	841	43	12.02	179	11.88	E	0	0	0.00	207	1	CTD no.16, western north line, to 421m
143		CTD	19-Jun	1030	42	59.89	179	11.97	E	0	0	0.00	15	2	CTD no.17, western north line, to 547m
144		CTD	19-Jun	1224	42	48.04	179	12.04	E	0	0	0.00	320	1	CTD no.18, western north line, to 1000m.
145	DIST	BEAM	19-Jun	1755	43	19.27	179	44.51	E	475	476	1.11	63	2	Beam trawl trials
146	DIST	MUC	20-Jun	110	43	19.29	179	44.61	E	475	475	0.00		1	DIST, in4, 6 good cores
147	DIST	MUC	20-Jun	143	43	19.31	179	44.65	E	475	475	0.00		1	DIST, out2, 6 good cores
148	DIST	MUC	20-Jun	213	43	19.27	179	44.64	E	475	475	0.00		1	DIST, in3, 6 good cores
149	DIST	MUC	20-Jun	313	43	19.2	179	44.66	E	475	475	0.00		1	DIST, out1, 6 good cores
150	DIST	MUC	20-Jun	350	43	19.23	179	44.71	E	475	475	0.00		1	DIST, in2, 6 good cores
151	DIST	MUC	20-Jun	423	43	19.2	179	44.74	E	480	480	0.00		1	DIST, in2, 6 good cores
152	DIST	CAM	20-Jun	545	43	19.37	179	44.49	E	475	474	0.39	48	1	DIST, DTIS along beam trawl and MUC line.
153	HART	CAM	20-Jun	840	43	22.3	179	26.97	E	395	391	0.36	46	1	HART, southern tow across beam trawl lines.
154	HART	CAM	20-Jun	949	43	22.12	179	26.87	E	402	392	0.40	46	1	HART, northern tow across beam trawl lines.

Stn	Area	Method	Date	Time	lat_d	lat_min	lon_d	lon_min	lon	s_dep	f_dep	n.mile	dir	Perf	Comments
155		TOPAS	20-Jun	1108	43	22.82	179	25.27	E	396	430	120.00	357	2	Survey lines across ROBES area, sub-bottom profiler
156		CPR	21-Jun	300	43	16.05	179	24.53	E	10	10	225.00	280	2	Transit back to Wellington

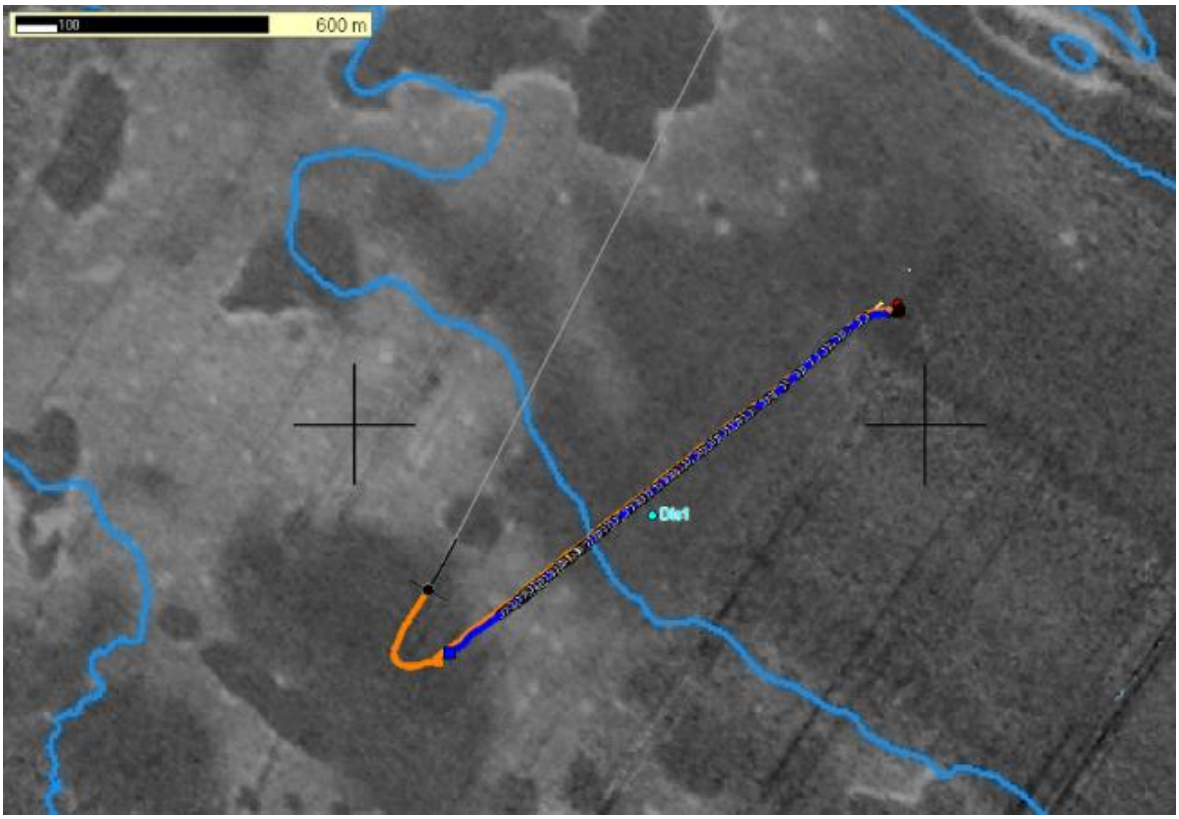
Appendix C DTIS station descriptions TAN2005

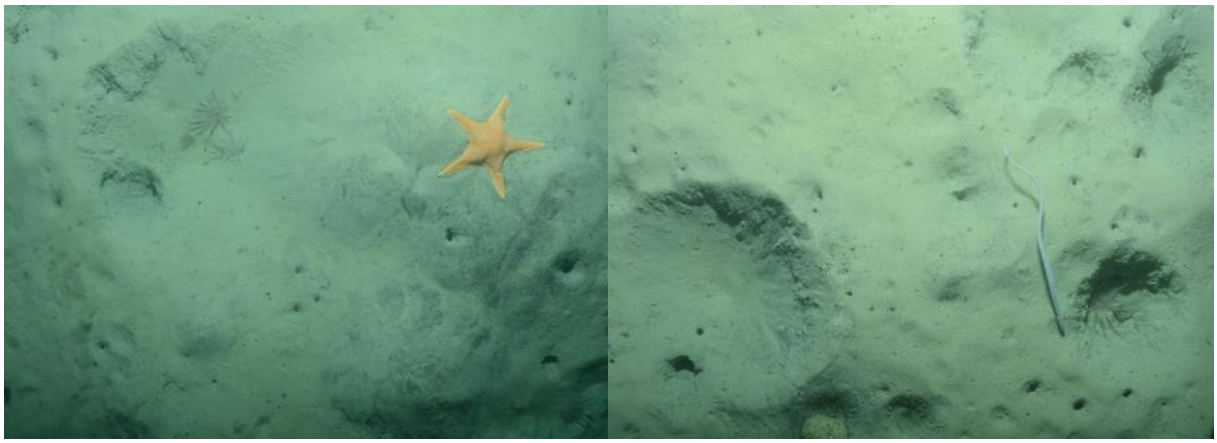
Each station is described with notes on the main substrate and fauna. An image is provided showing the DTIS track on the base backscatter map, as well as representative seabed images.

Station 16, DIS1

Transect repeating TAN1903_19, NE direction.

Seafloor consisted of flat muddy sediments with many burrows, mounds and pits. The most common organisms were cerianthids. Several asteroids, urchins, rattails, eels were also present. No Benthic Disturber marks were seen.



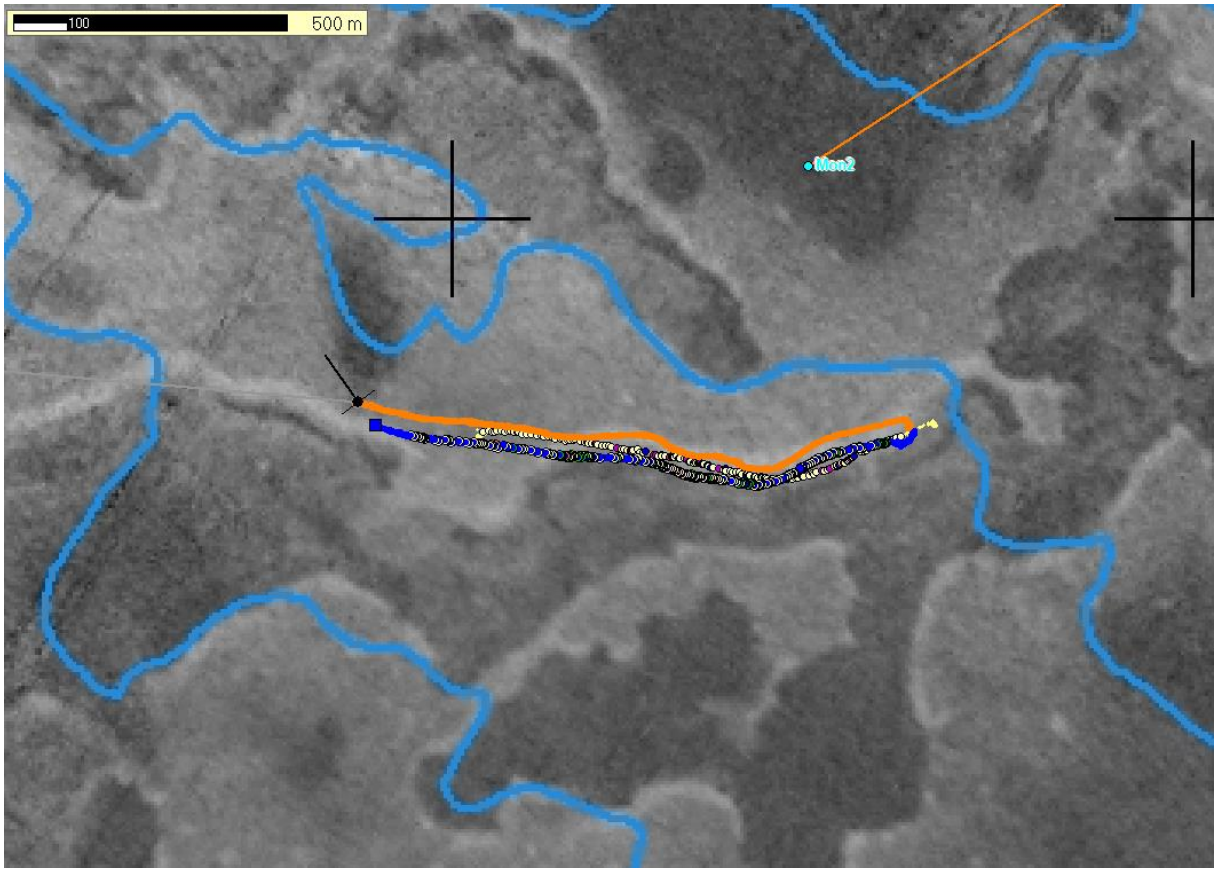


Left: TAN2005_016_166 example of seabed with burrows and mounds. Cerianthids top left hand corner and asteroid to the right. Right: TAN2005_016_118 example of seabed with burrows and mounds. Eel to the right and a cerianthid in the burrow.

Station 17, MON2

Repeat of TAN1903_030.

The transect crossed the TAN1903 transect twice in the first half, then ran mostly parallel to old transect. Initially muddy sediment was followed by a mix of cobbles and pebbles on mud with *Goniocorella* and along the outcrop were some stylasterids and a few large yellow sponges. Lots of fish were present throughout, and some asteroids and cerianthids (particularly near end of transect) and the odd echinoid and cup coral.

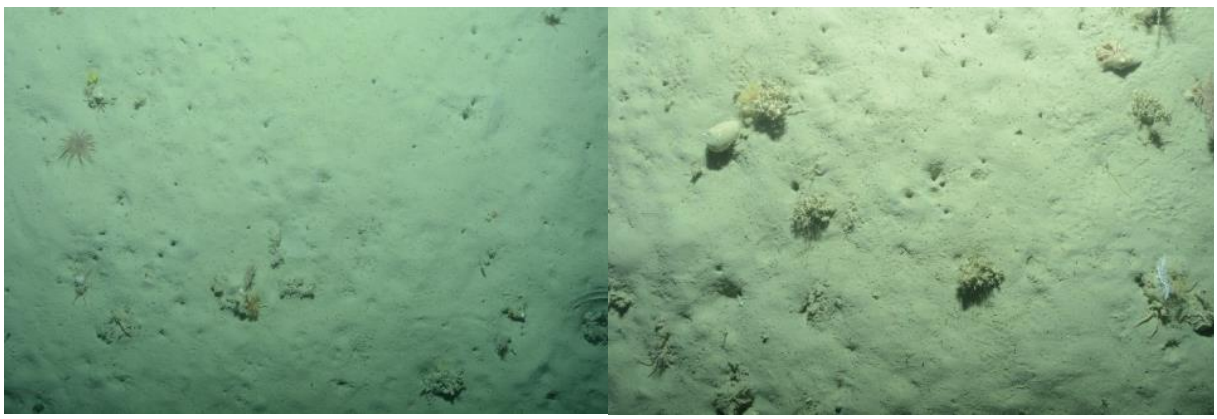


Left: TAN2005_017_139 example of soft sediment with cobbles. A number of squat lobsters and asteroids are seen. Right: TAN2005_017_102 example of the ridge line. Lovely example of *Goniocorella,* with rattails.

Station 18, MON7

DTIS transect along TAN1903_22.

Substrate comprised muddy sediment, burrows, pebbles, with some mounds and cobbles. Fauna included cerianthids, *Radicipes*, *Tairoa tauhou*, squat lobsters, *Goniocorella dumosa*, demosponge, stylasterids, eels, rattails.

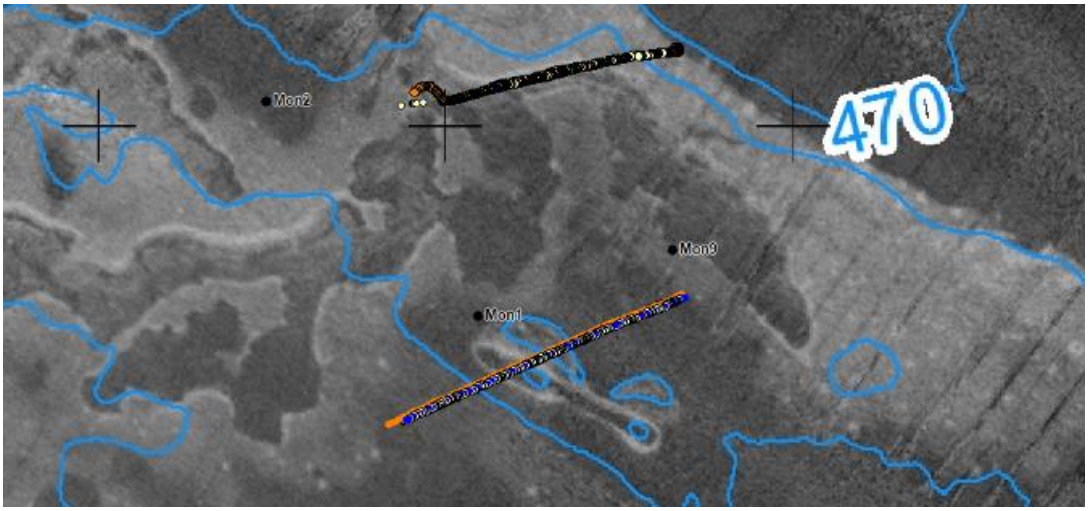


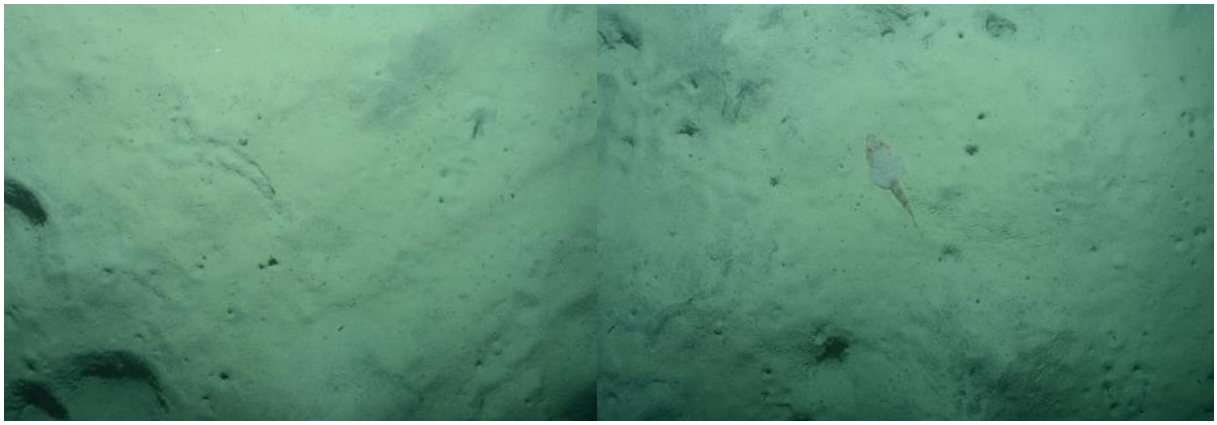
Left: TAN2005_018_78 example of a diverse community containing cerianthids, sponges, corals and squat lobsters. Right: TAN2005_018_159 another example of a diverse community of corals, squat lobsters and a crab.

Station 19, MON1

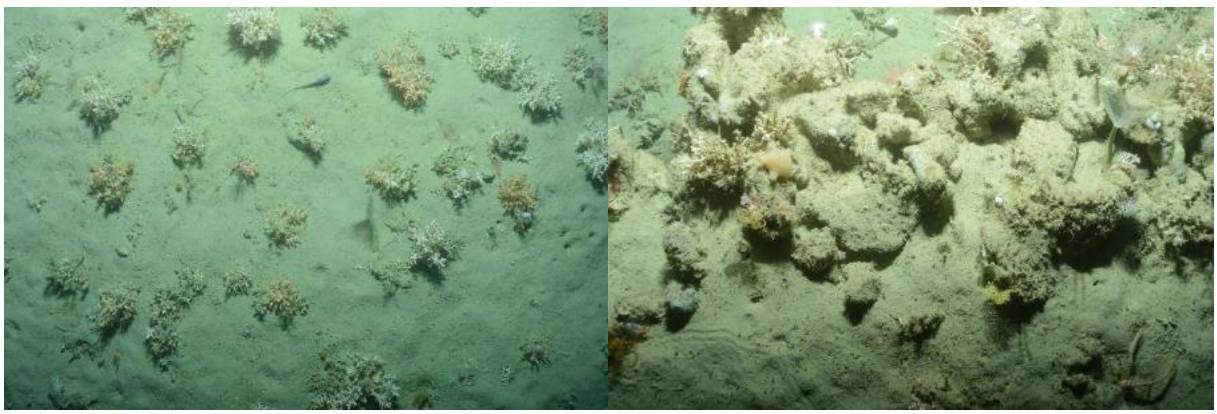
Repeat of TAN1903_21, crossing butterknife feature.

Seabed consists of muddy sediments with burrows, mounds and pits (common fauna were cerianthids, and echinoids), except when crossing the contour of the butterknife (the rim) where the seabed consists of pebbles and cobbles on muddy sediments, and with common *Goniocorella*. Some sea perch and bellowsfish were observed.





Left: TAN 2005_19_097 showing furrow lines in soft sediment and pits. Right: TAN2005_19_032 deepsea flathead on soft sediment.

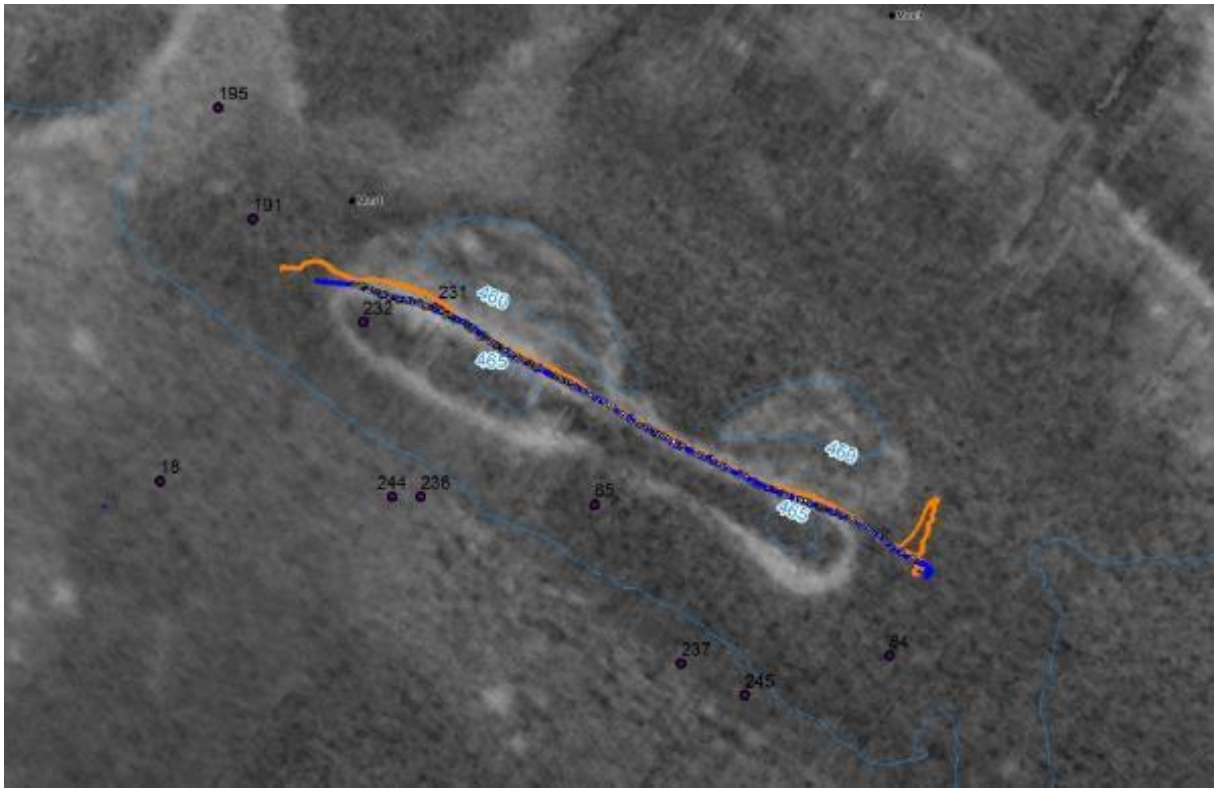


Left: TAN2005_019_151 *Goniocorella dumosa* clumps. Right: TAN2005_019_152 region of high diversity on the Butterknife rim.

Station 20, BUTT northern rim.

Repeat of TAN1903_009 transect along top rim of the Butterknife feature.

Dense *G. dumosa* clumps occurred at the eastern end of transect and in the northeastern region on cobbles, pebbles, boulders, and bedrock, interspersed with muddy sediment, burrows and mounds. Other invertebrates included *Farrea* sponge, demosponge, cup corals, stylasterids, occasional *Radicipes*, primnoid, squat lobsters, and cerianthids. Rattails were common.

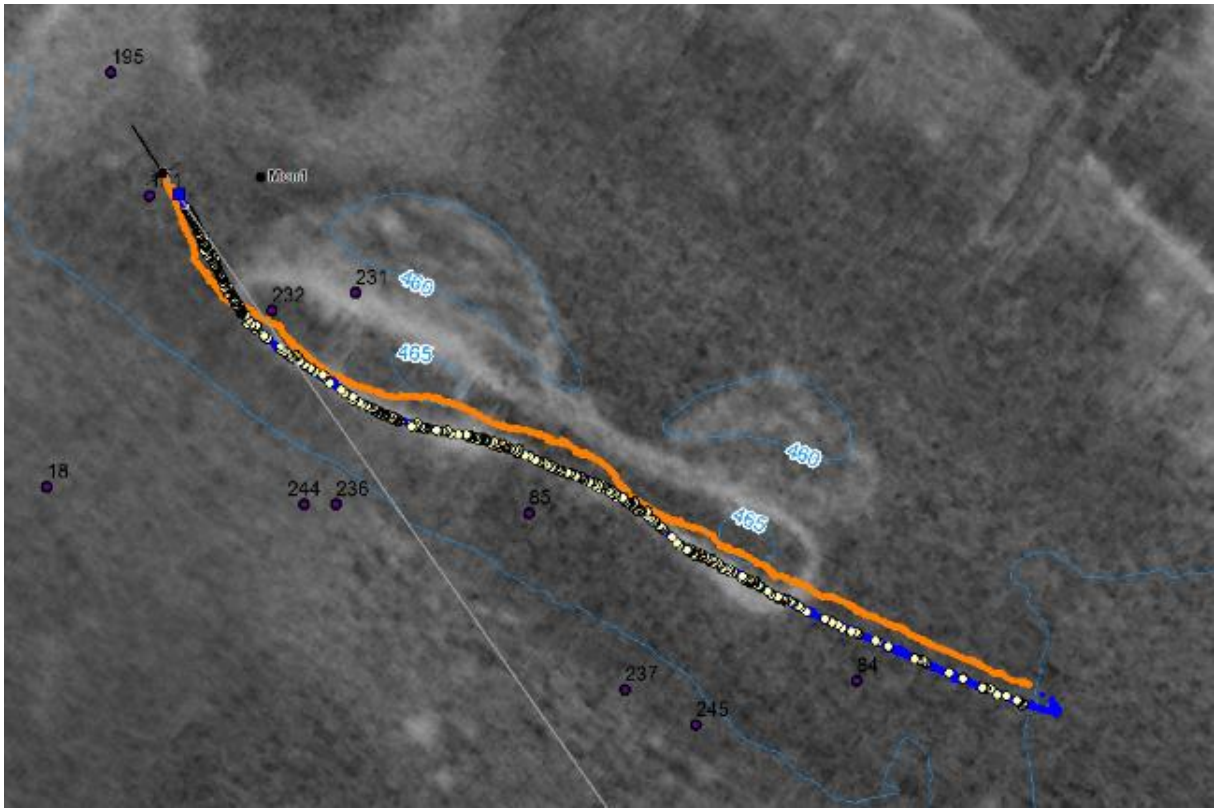


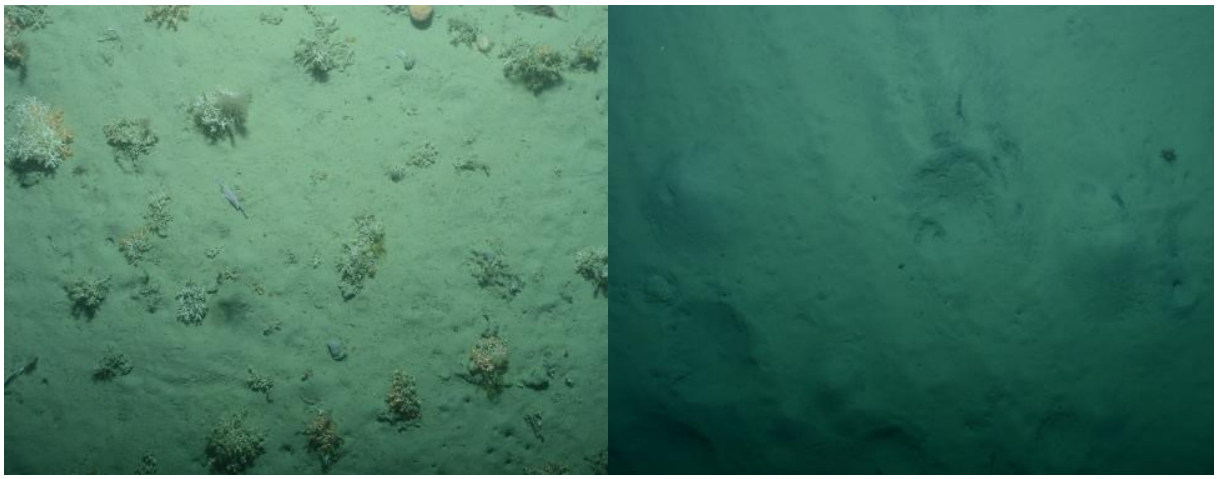
Left: Tan2005_020_195 Coral and molluscs north west corner. Right:TAN2005_020_136 delicate lace stylasterid hydrocorals and cup corals.

Station 21, BUTT, southern rim

Repeat of TAN1903_008 transect along southern rim of the Butterknife from east to west, 554-457m.

The transect started with muddy sediment with mounds and pits, then tracked on to an area of *Goniocorella* clumps with other fauna including sponges, hydroids, *Munida*, stylasterids. It ended in mostly muddy sediment. Mud substrate fauna included anemones, asteroids, *Radicipes*, with fish including eels, rattails and sea perch. Some SCIP tracks were observed.



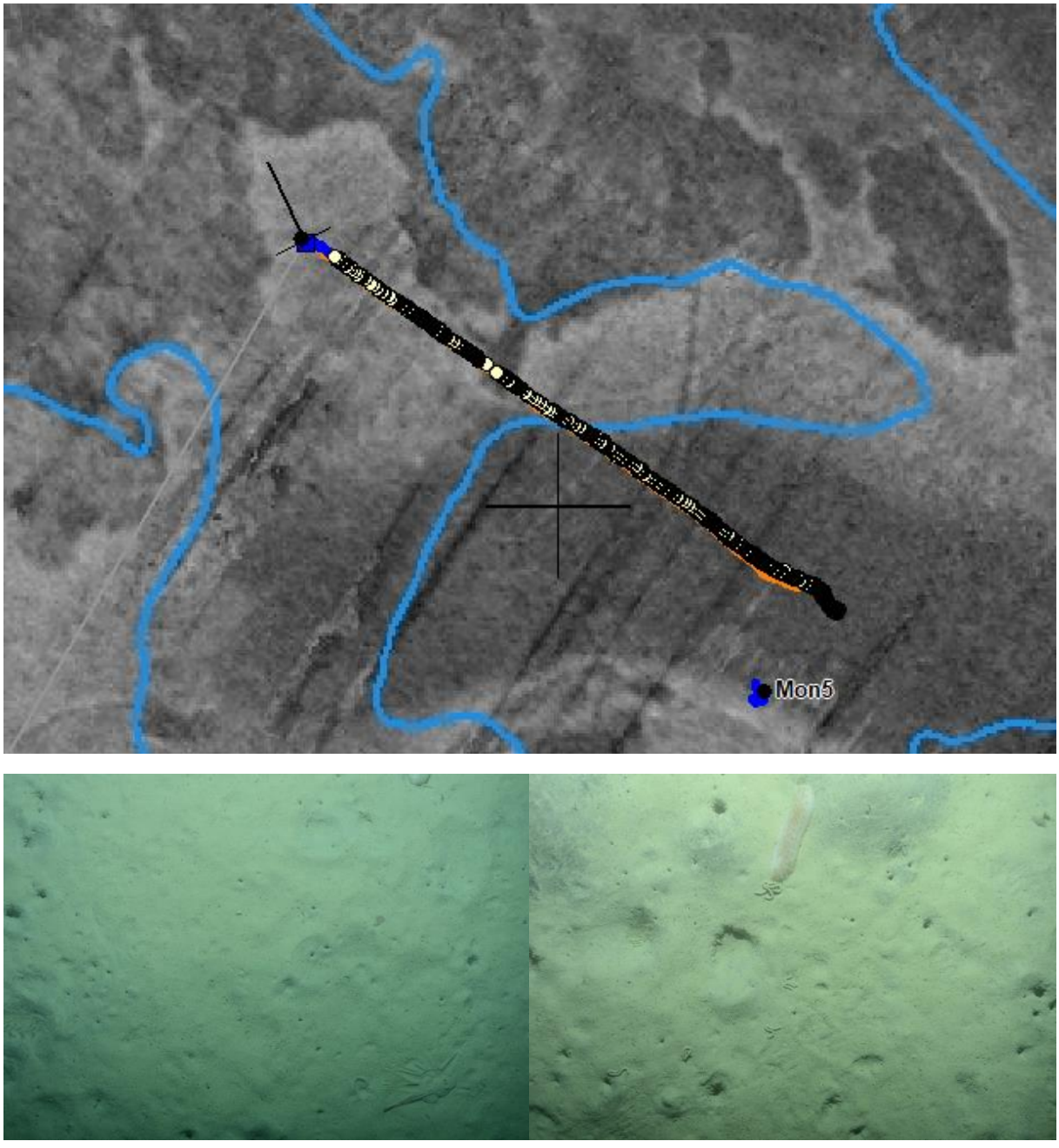


Left: Tan2005_021_080 Coral clumps and associated fauna on the butterknife rim, eastern side. Right: TAN2005_021_131 indication of disturber track.

Station 31, MON 5

Repeating TAN1903_043.

Primary substrate was muddy sediment with burrows, mounds and pits. Fauna within this zone were abundant anemones, fewer echinoids, holothurians and asteroids. Fish included rattails, eels and a lookdown dory. There was one patch of scattered cobbles with encrusting sponges, hydroids, stylasterid corals and clumps of *Goniocorella dumosa*.

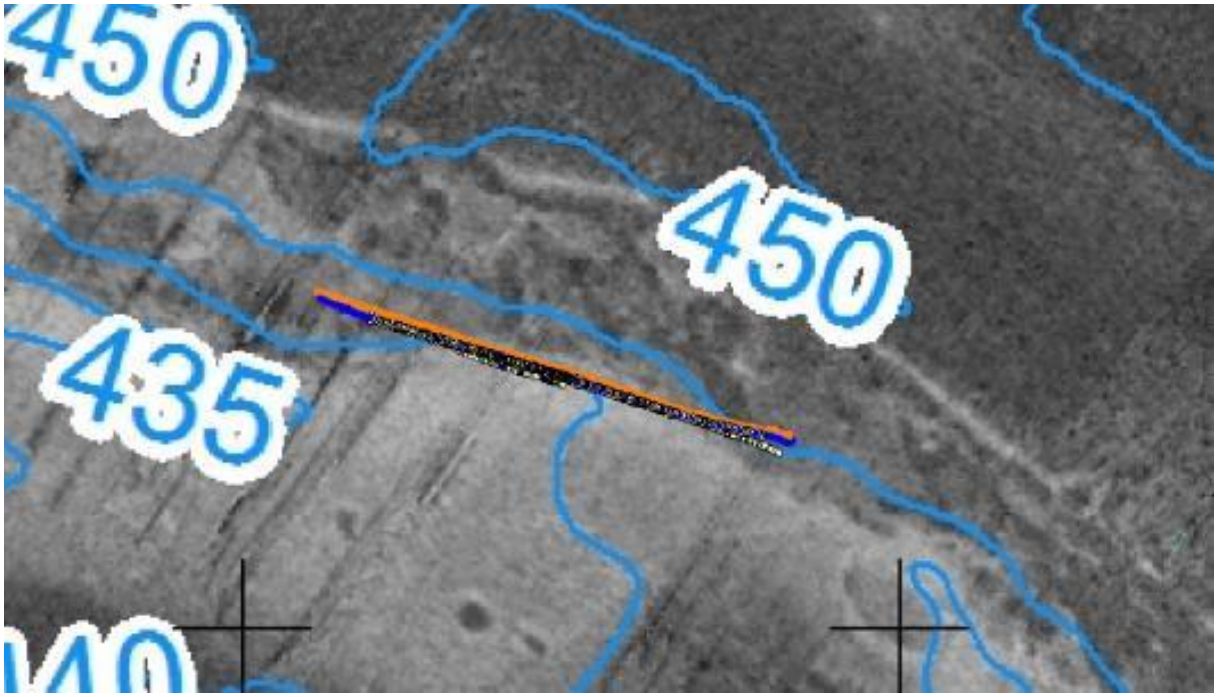


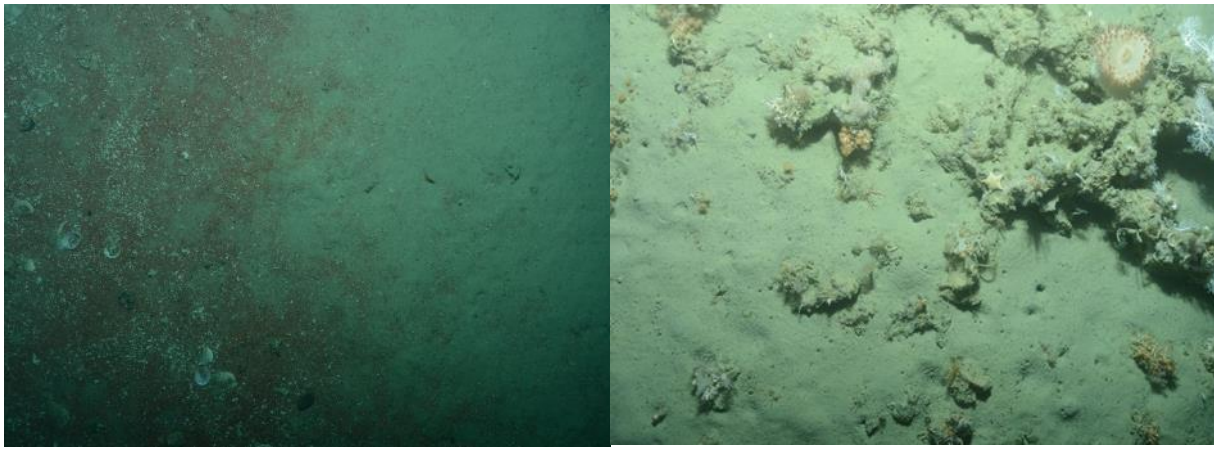
Left: TAN2005_031_215 muddy sediment with pits and burrows; a squat lobster top right, an ocean plants pattern to the left and a deep-sea flat head bottom right. Right: TAN2005_031_90 mud and burrows also show a *Bathyplotes* sp. and its faecal coil.

Station 32, MON 6

Repeat of TAN1903_40 & 41 DTIS transects.

The seabed substrate was variable, at times muddy with burrows and mounds, some asteroids, echinoids, anemone and cerianthids; at times substrate consisted of pebbles and cobbles and bedrock outcrop, with the odd patch of shell hash. Sponges and *Goniocorella* were common on hard substrates, with some stylasterids and a single brisingid.



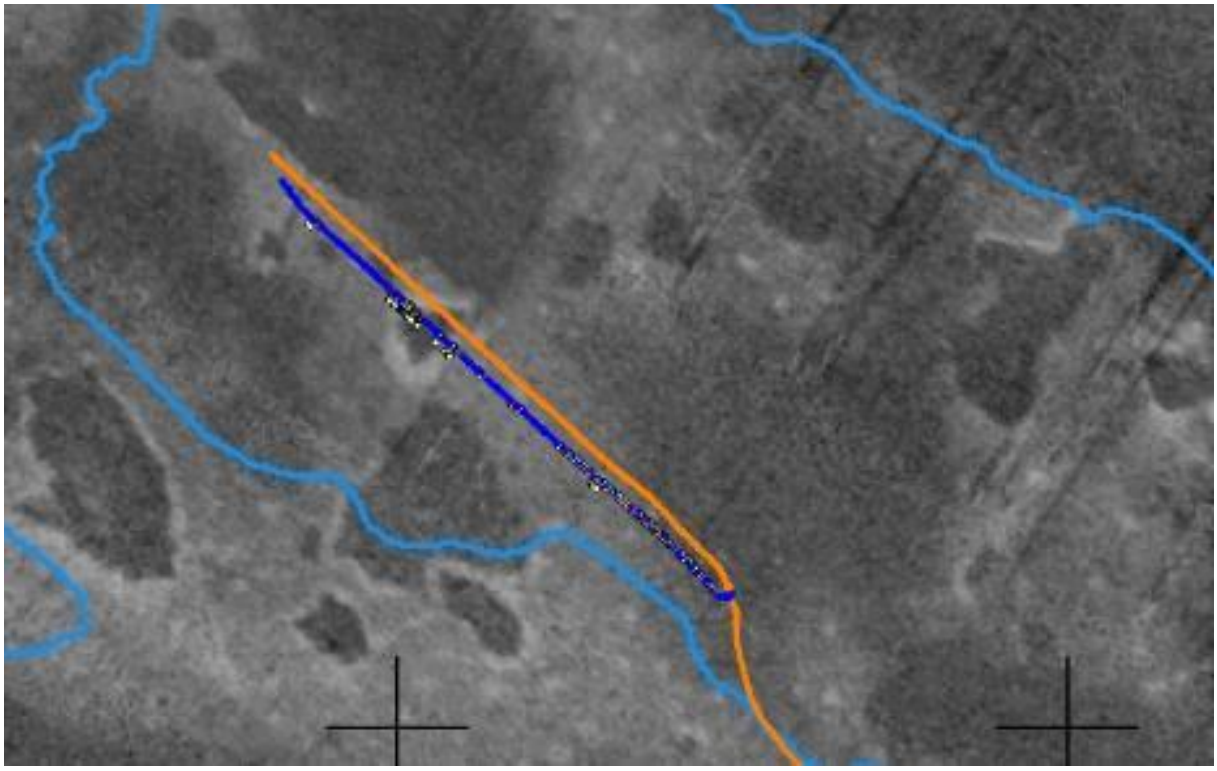


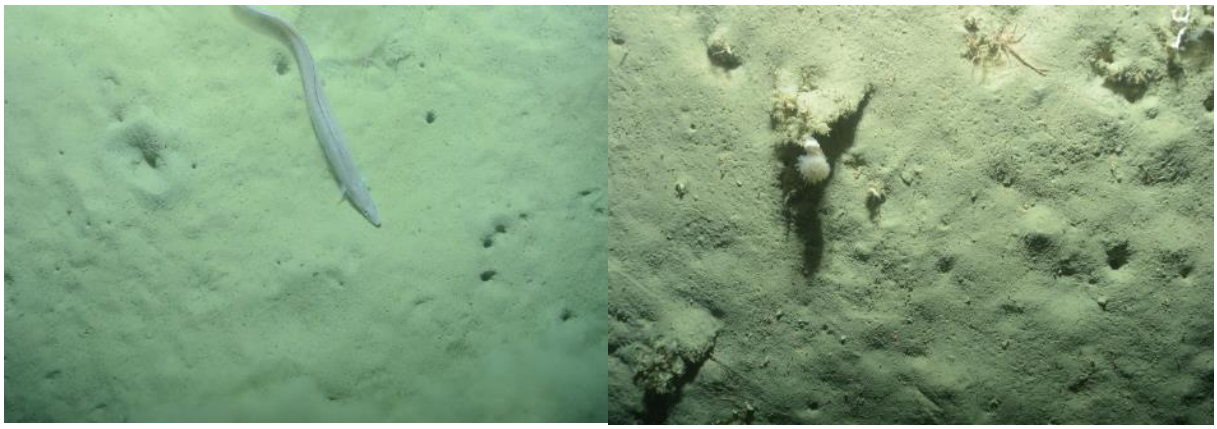
Left: TAN2005_032_70 showing shell hash, with red algal mat(?). Right: TAN2005_032_79 showing a good variety of biodiversity along rocky outcrop including; starfish. *Goniocorella dumosa*, and anemone.

Station 33, MON 8

Repeat of TAN1903_44.

Seabed consisted mostly of soft muddy sediments, burrows, mounds and pits, with common cerianthids and rattails and the occasional starfish. Some pebble and mud substrate occurred in areas of high reflectivity with scattered *Goniocorella* clumps and a few sponges. Some fish were seen – bellowsfish, eels, and a ling.



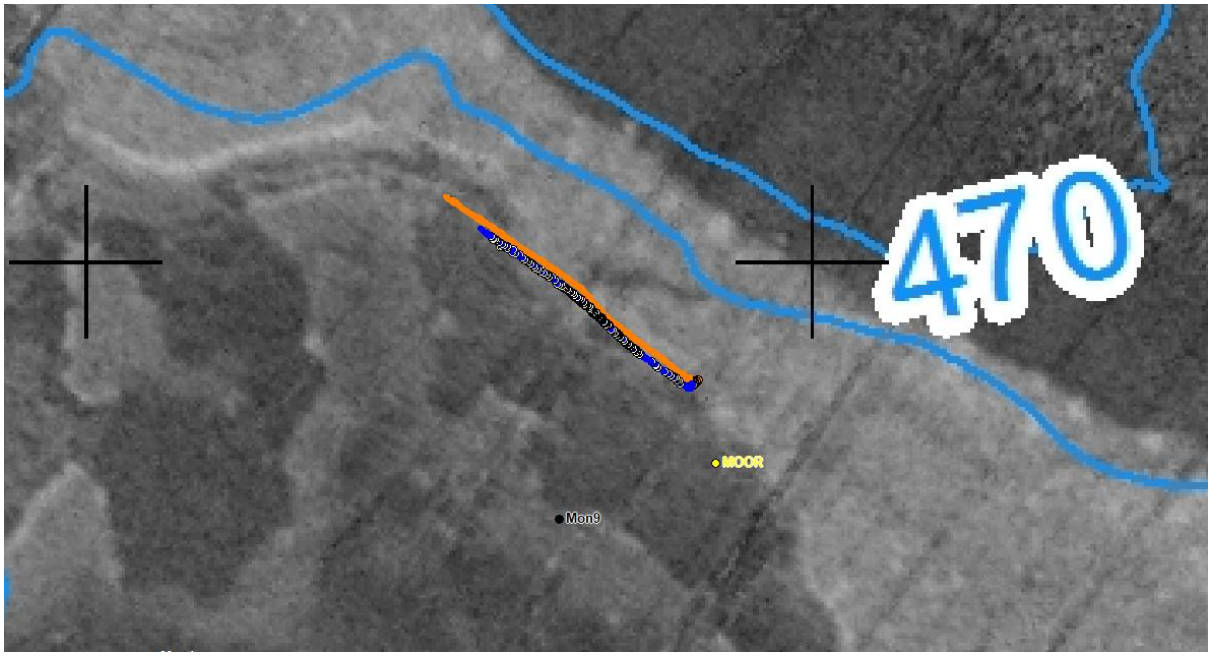


Left: TAN2005_033_202 showing an eel. Right: TAN2005_033_183 showing squat lobsters, corals and anemones.

Station 34, MON 9

Repeat of TAN1903_23.

Substrate was mixed muddy sediment, burrows, occasional boulders, pebbles and cobbles. Invertebrates observed included cerianthids, anemones, echinoids, scampi, a seapen, stylasterids, a few *Goniocorella* and an holothurian. Fish included rattails, banded bellows fish, eel, and a ghost shark.

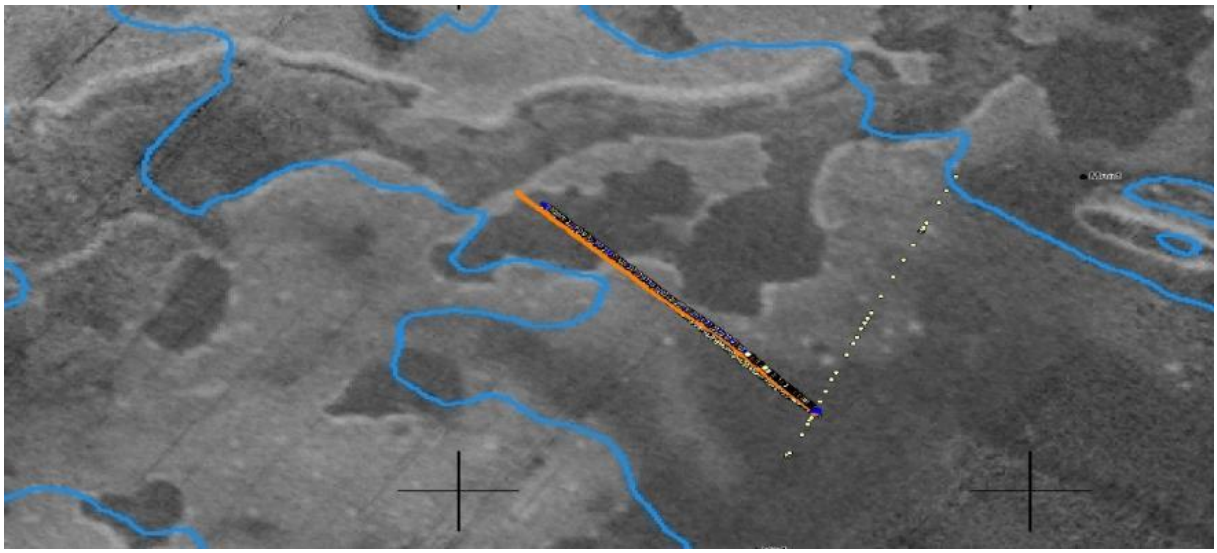


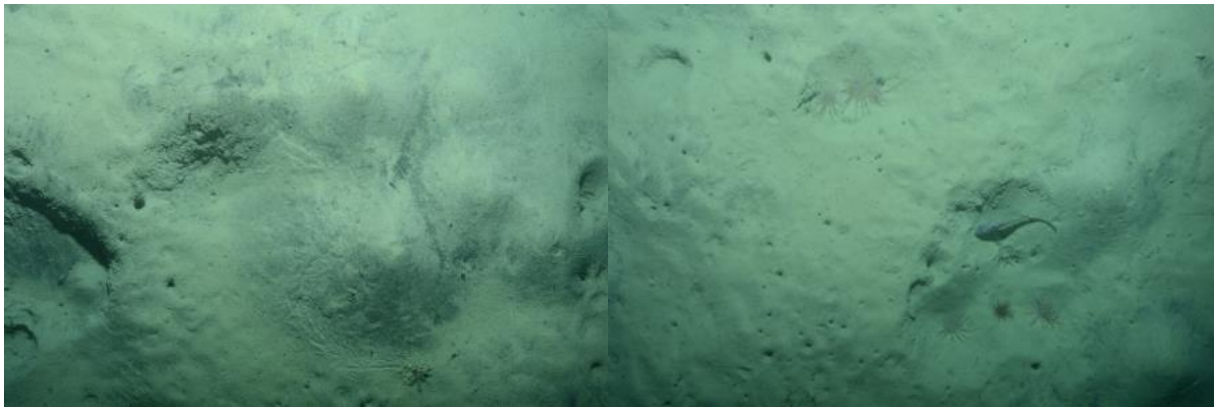
Left: TAN2005_034_13 showing a *Radicipes* on the bottom right hand corner. Right: TAN2005_034_181 showing tail of a ghost shark, a cerianthid top left, an echinoid, and anemone (?) above the shark, two small rattails.

Station 35, DIS 2

Repeat of TAN1805_83 DTIS transect.

Muddy sediment predominated, with mounds and burrows consistent along the transect. Cerianthids, asteroids, echinoids, demosponge, *Taiaroa tauhou*, and pagurids were observed. Fish included rattails, an eel, and deepsea flathead.



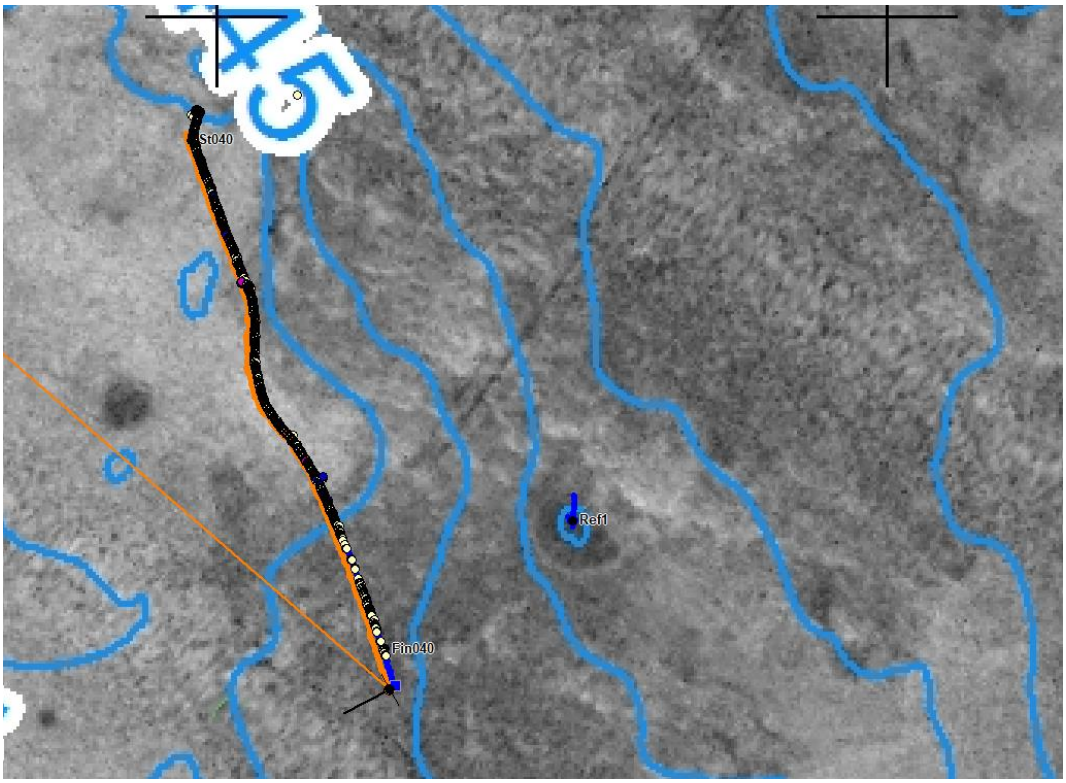


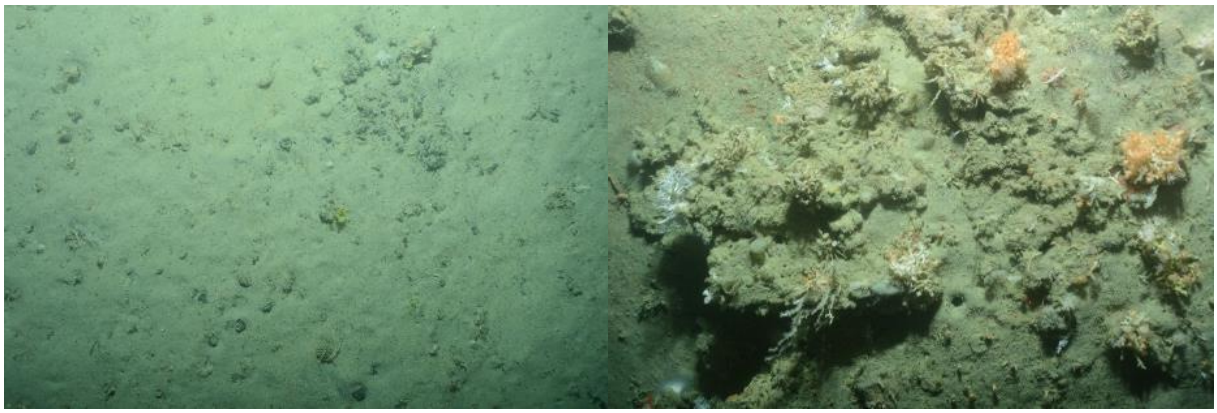
Left: TAN2005_035_34 showing an urchin; coral, and some rattails. Right: TAN2005_035_144 showing different coloured cerianthids, a rattail and squat lobster.

Station 40, REF1

Repeat of TAN1903_33.

The transect was undertaken in ~3m swells which affected camera height at times. Substrate comprised muddy sediment, cobbles pebbles and gravel for two-thirds of the transect, with some outcrops and a possible SCIP track. Fauna on hard substrates was largely cryptic but included Demospongiae sponges, hydroids, brisingid sea stars and some *Goniocorella dumosa* clumps on a distinct outcrop. Invertebrate fauna on mud substrates included; anemones, asteroids, cidarid echinoids and larger echinoids with occasional Alcyonaceae (*c.f Anthomastus*). The latter part of the transect in lower reflectivity backscatter was mostly mud with small burrows and some tracks. Some scampi burrows were also observed. Fish included rattails, eels, possibly a ling, a skate, flathead and sea perch.



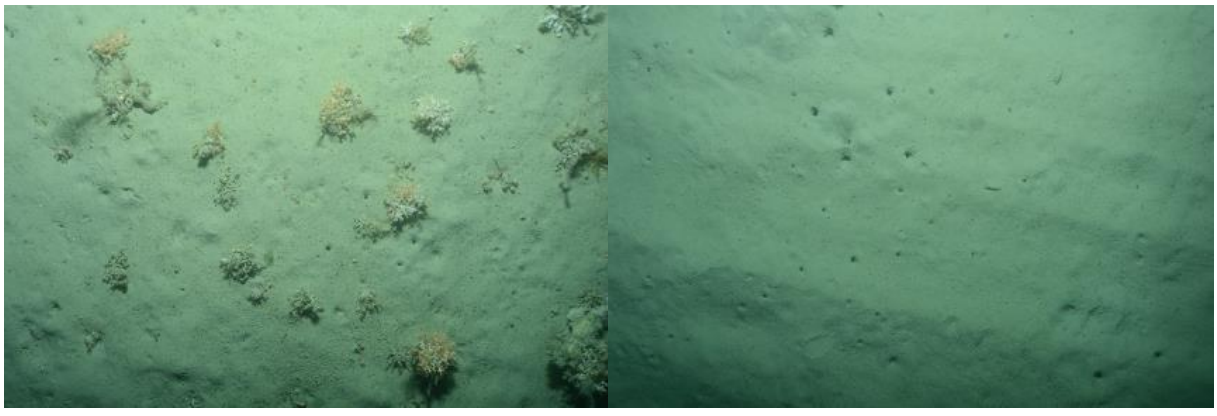


Left: TAN2005_040_126 showing scattered cobbles and pebbles on a mud substrate with sponges, anemones and squat lobsters. Right: TAN2005_040_171 showing a low relief outcrop with *Goniocorella dumosa* clumps and encrusting hydroids, sponges and stylasterid corals.

Station 41, BUTT

Repeat of TAN1903_126 , DTIS tow bisecting the northern edge of the Butterknife.

The transect commenced over a flat mud seafloor with burrows, pits and mounds. It transitioned to cobbles and *Goniocorella dumosa* clumps with hydroids, stylasterids, cup corals, hydroids and bryozoans. In the central zone it reverted to muddy sediment with old eroded SCIP tracks present. An outcrop ledge on the south rim was colonised with *Goniocorella*, stylasterids and hydroids. The latter part of the tow reverted back to muddy sediment with anemones and echinoids.

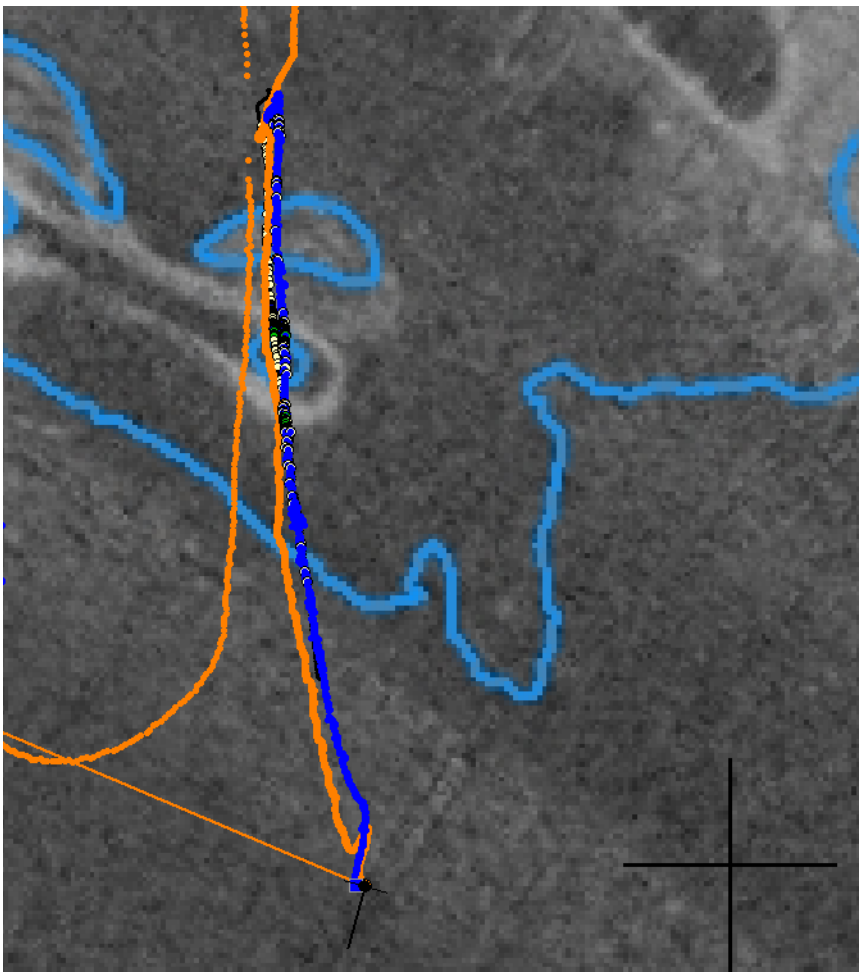


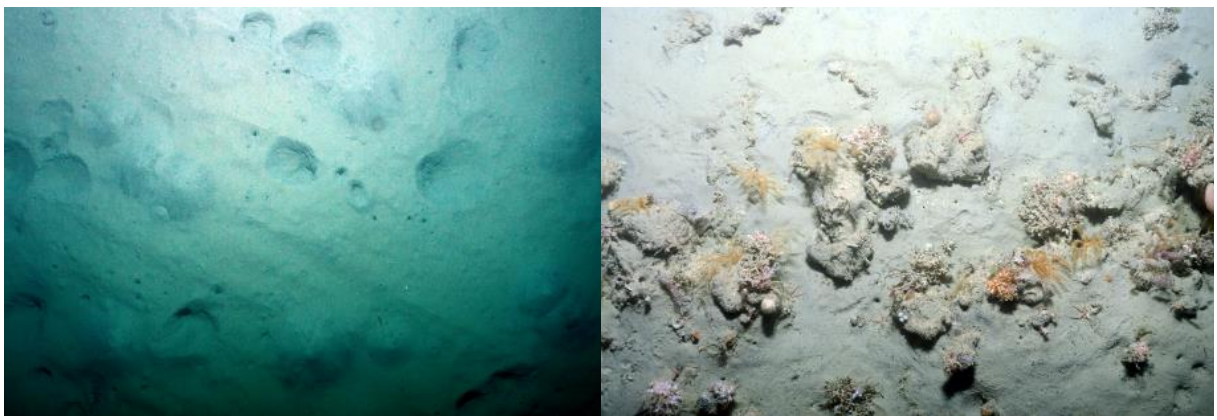
Left: TAN2005_041_070 with scattered *Goniocorella dumosa* clumps on a mud substrate on the north rim of the Butterknife. Right: TAN2005_041_081 showing probable eroded SCIP tracks from TAN1903.

Station 42, BUTT

Repeat of TAN1903_125.

Disturber (SCIP) tracks were observed north of the Butterknife, inside the feature, and to the south of the southern rim. Substrate was mostly muddy sediment with pits, burrows and mounds throughout the transect other than in a narrow area on both the rims that had pebbles, cobbles and outcrops with associated encrusting species including *Goniocorella*, sylasterids, hydroids, bryozoans and other cryptic fauna. Fish included rattails, eels, ghostsharks and a lookdown dory.



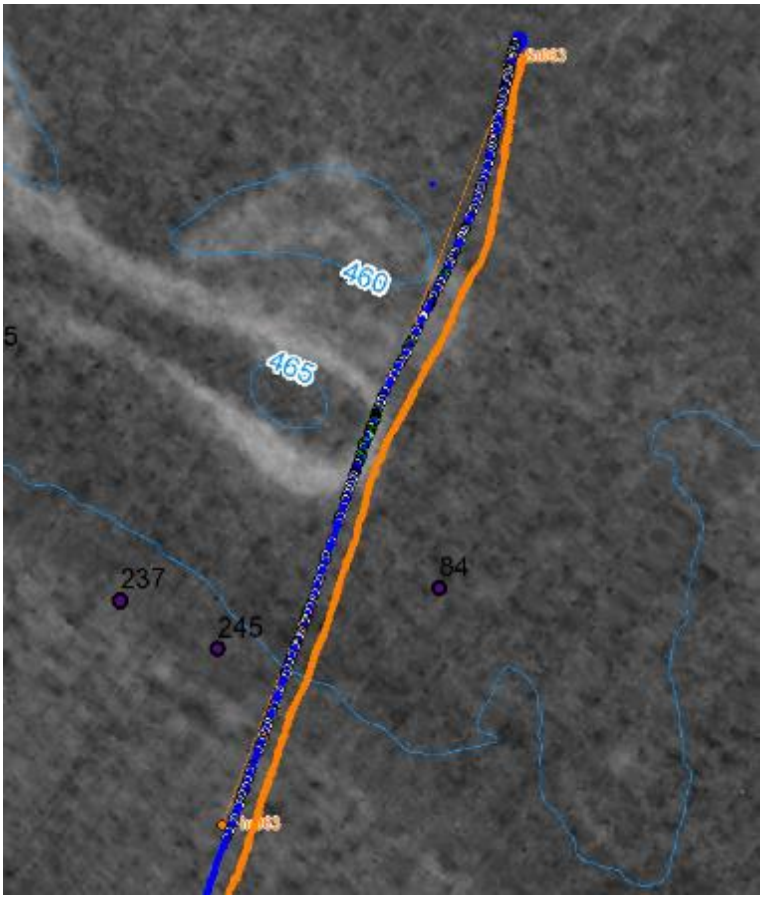


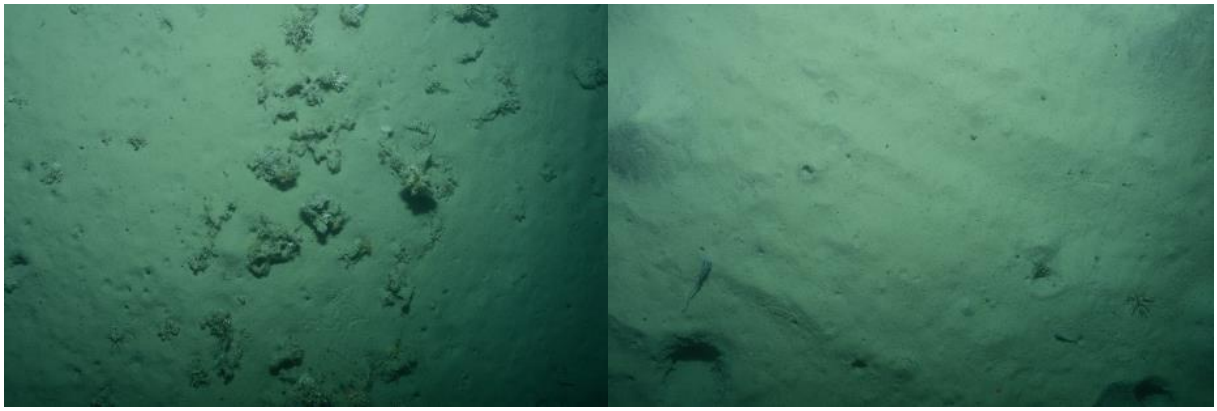
Left: TAN2005_042_031 displaying SCIP tracks north of the northern rim of the Butterknife. Right: TAN2005_042_079 showing fauna on the northern rim.

Station 63, BUTT

Repeat of TAN1903_164 DTIS transect at south-eastern edge of Butterknife.

The transect commenced in an area of muddy sediment with numerous mounds and burrows. At the eastern end of the Butterknife there were scattered cobbles and pebbles and clumps of *Goniocorella dumosa*. Other fauna included demospongiae, stylasterids, cup corals and bryozoans. Beyond this zone the seabed reverted back to mud with burrows, mounds and pits. Relic SCIP tracks were also observed. Invertebrate fauna included anemones, cerianthids and echinoids. Rattails occurred throughout the transect.



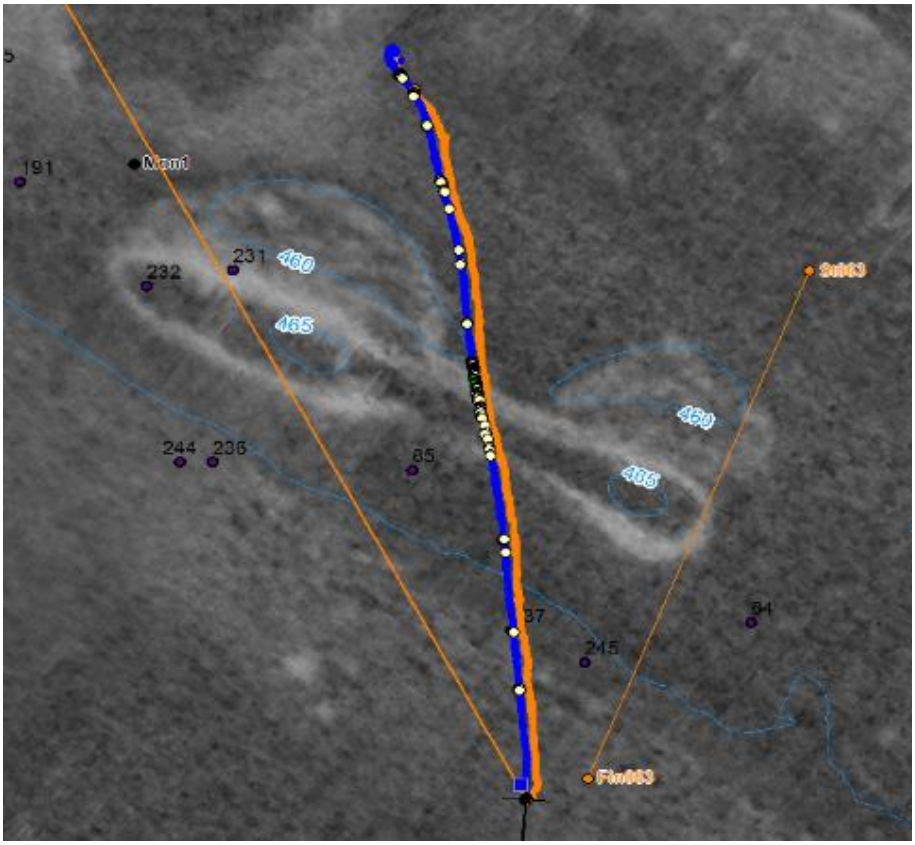


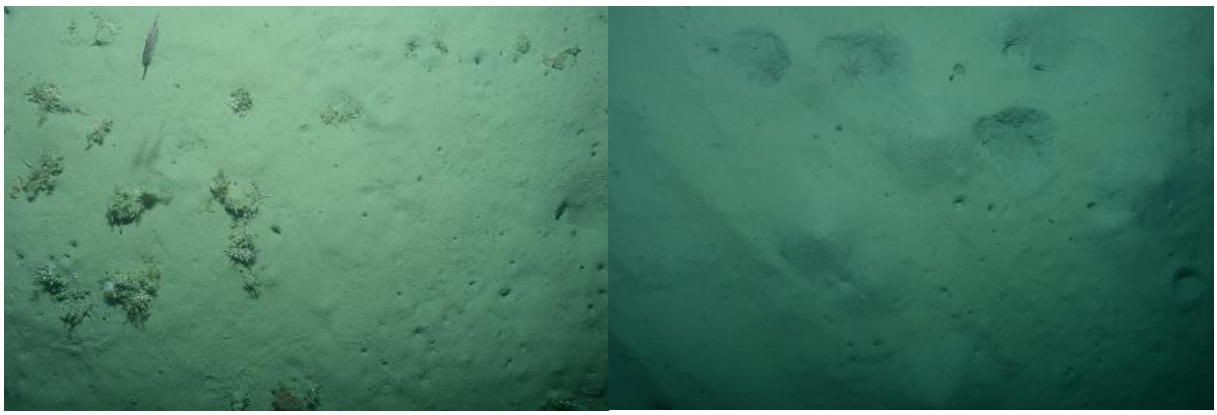
Left: TAN2005_063_092 clumps of fauna on the eastern end of the Butterknife. Right: TAN2005_063_124 relic disturber (SCIP) tracks on a mud-covered seafloor south of the rim.

Station 64, BUTT

Repeat of TAN1903_127 DTIS transect through the centre of the Butterknife.

The transect started in muddy sediment with mounds pits and burrows, disturber (SCIP) tracks were also observed. The northern rim of the Butterknife has hard substrate and cobbles with encrusting fauna including *Goniocorella* and stylasterid corals, hydroids and bryozoans. The central area of the feature had disturber track marks. The southern rim in this area of the Butterknife was muddy sediment. South of the Butterknife the seabed reverted to muddy sediment with pits and burrows. Multiple disturber tracks were seen.

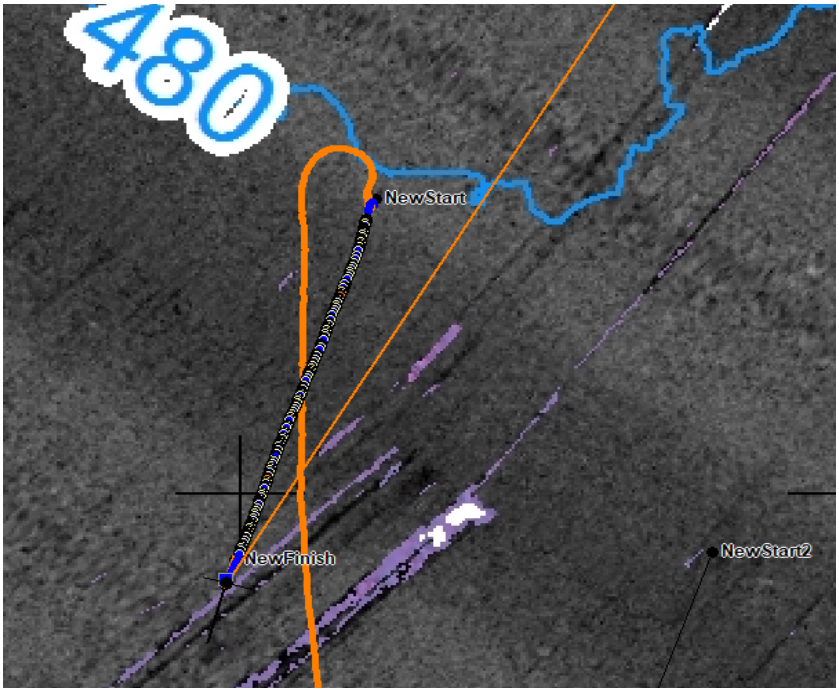


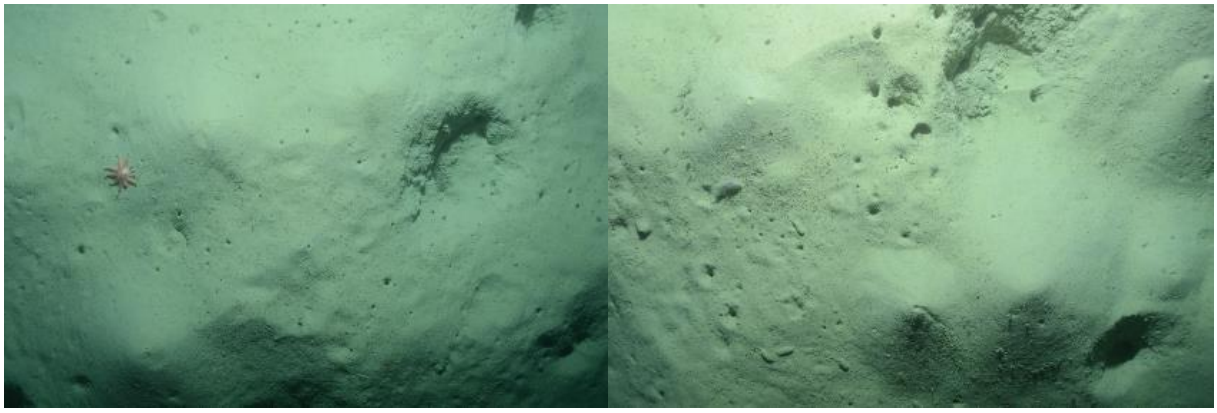


Left: TAN2005_065_096 clumps of invertebrate fauna on the northern rim of the Butterknife. Right: TAN2005_064_109 relic disturber (SCIP) tracks on mud seafloor south of the rim.

Station 65, Beam Trawl Disturbance area 1

The seafloor was entirely mud with burrows, mounds and pits. Invertebrate fauna comprised anemones with a few cerianthids. Other fauna included echinoids and asteroids. Fish included rattails, eels, sea perch and a deep-sea flathead.

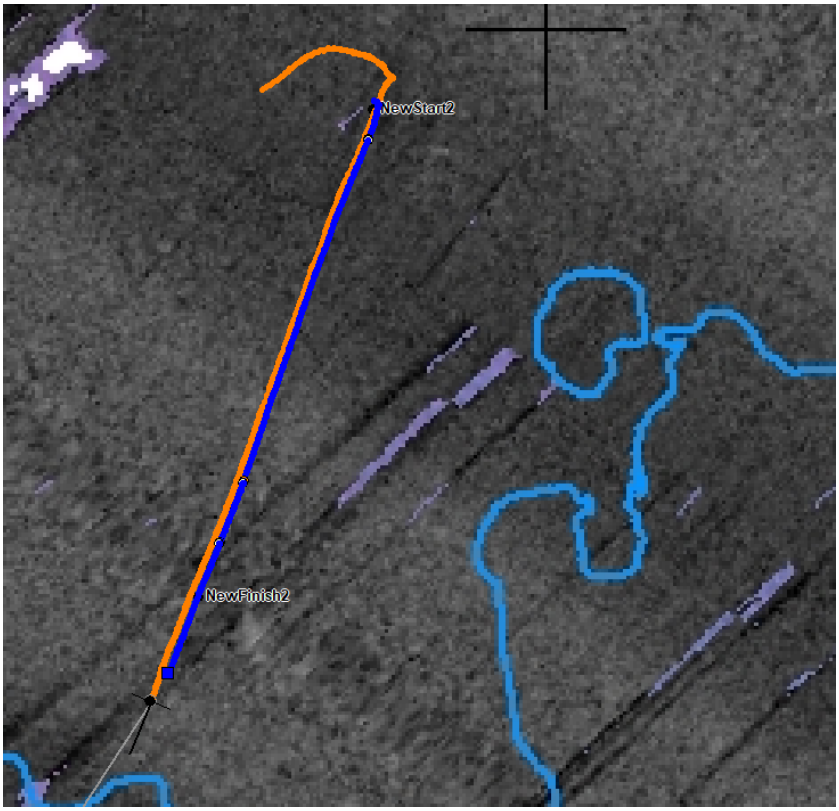


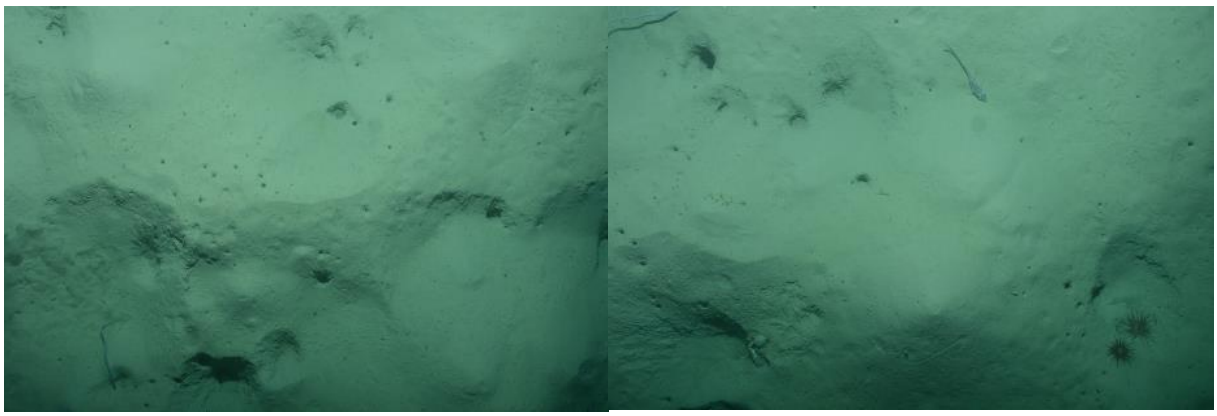


Left: TAN2005_065_023 Solasteridae asteroid on mud sediment substrate Right: TAN2005_063_133 holothurian on mud substrate.

Station 66. Beam trawl Disturbance Area 2

This was a second DTIS run to the north west of the Butterknife in an area where beam trawl disturbance will be conducted. Muddy sediment dominated with mounds pits and burrows. Fish included eels, rattails and several sea perch.



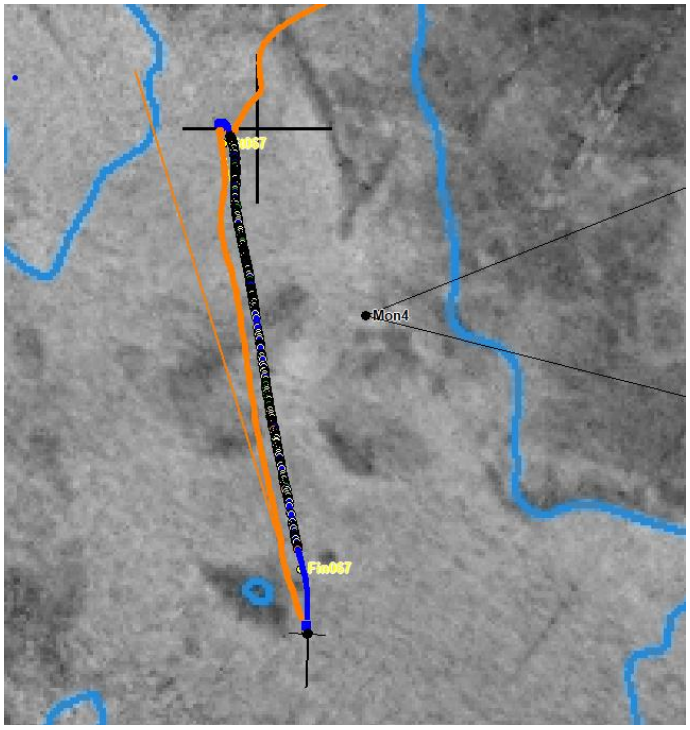


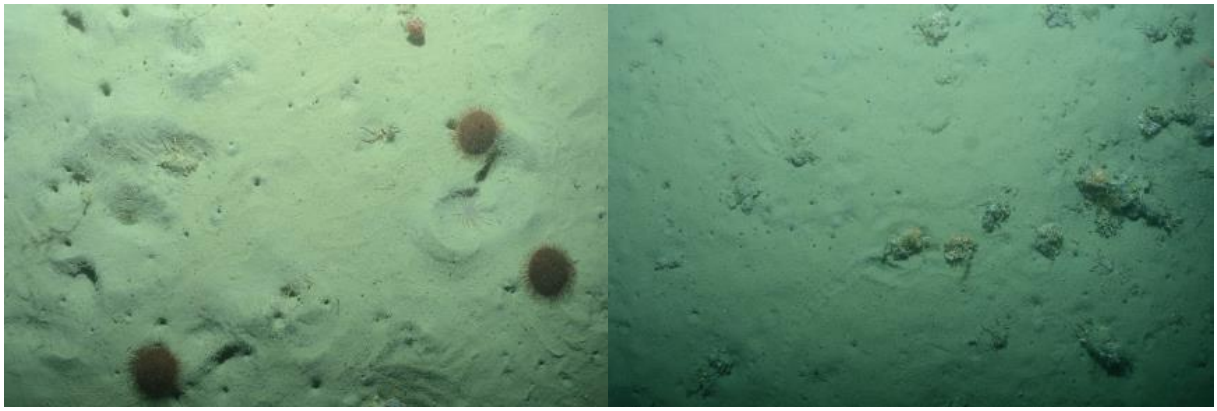
Left: TAN2005_066_100 muddy sediment substrate with pits and burrows. Right: TAN2005_066_185 hydroid, crab and anemones on muddy substrate.

Station 67, MON4

Repeat of TAN1903_032

The transect featured a consistent substrate mix of pebbles, cobbles and muddy sediment. A small patch of just mud with mounds, pits and burrows occurred in the middle of the transect. Fauna on the cobbles and pebbles included sponges, hydroids, galatheids, cup corals and some *Goniocorella dumosa*. Invertebrates on the mud substrate included; hydroids, *Flabellum*, galatheids and the occasional sea pen. There was a dense patch of echinoids over a short distance. Rattails and eels were common on this transect.



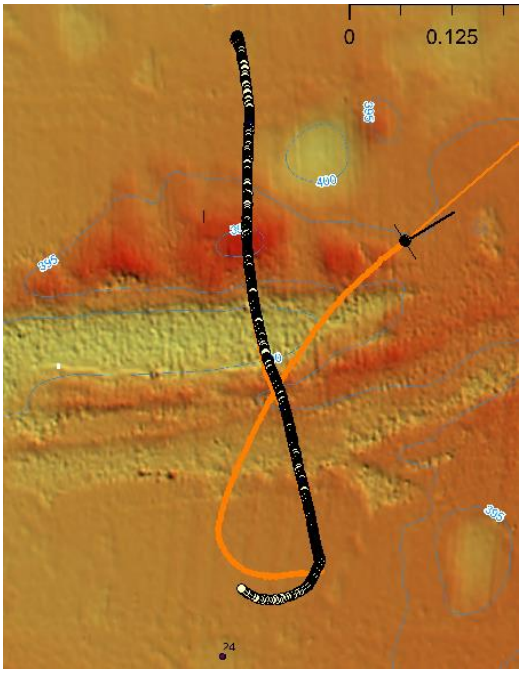


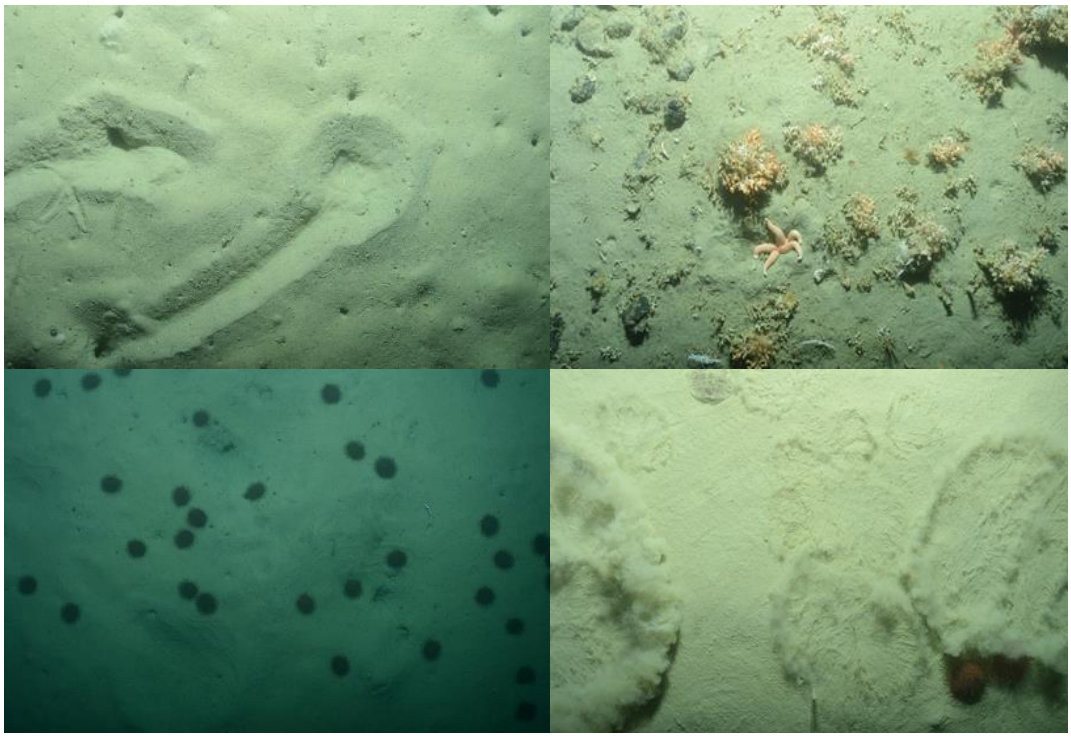
Left: TAN2005_067_046 Group of echinoids on muddy sediment substrate with anemones and burrows. Right: TAN2005_067_068 Scattered cobbles and pebbles encrusted with sponges, ascidians, *Goniocorella*, stylasterids and crinoids.

Station 68, Hart's Hillock

Repeat of TAN1903_0104 (North to south)

The seafloor was a patchwork of muddy sediments and mix of pebbles, cobbles and muddy sediments, with a smattering of bedrock/boulder. Muddy sediments were characterised by dense aggregations of echinoids, a few asteroids and *Radicipes*. The pebble-cobble-mud substrate was dominated by *Goniocorella* clumps, with some sponges and asteroids.



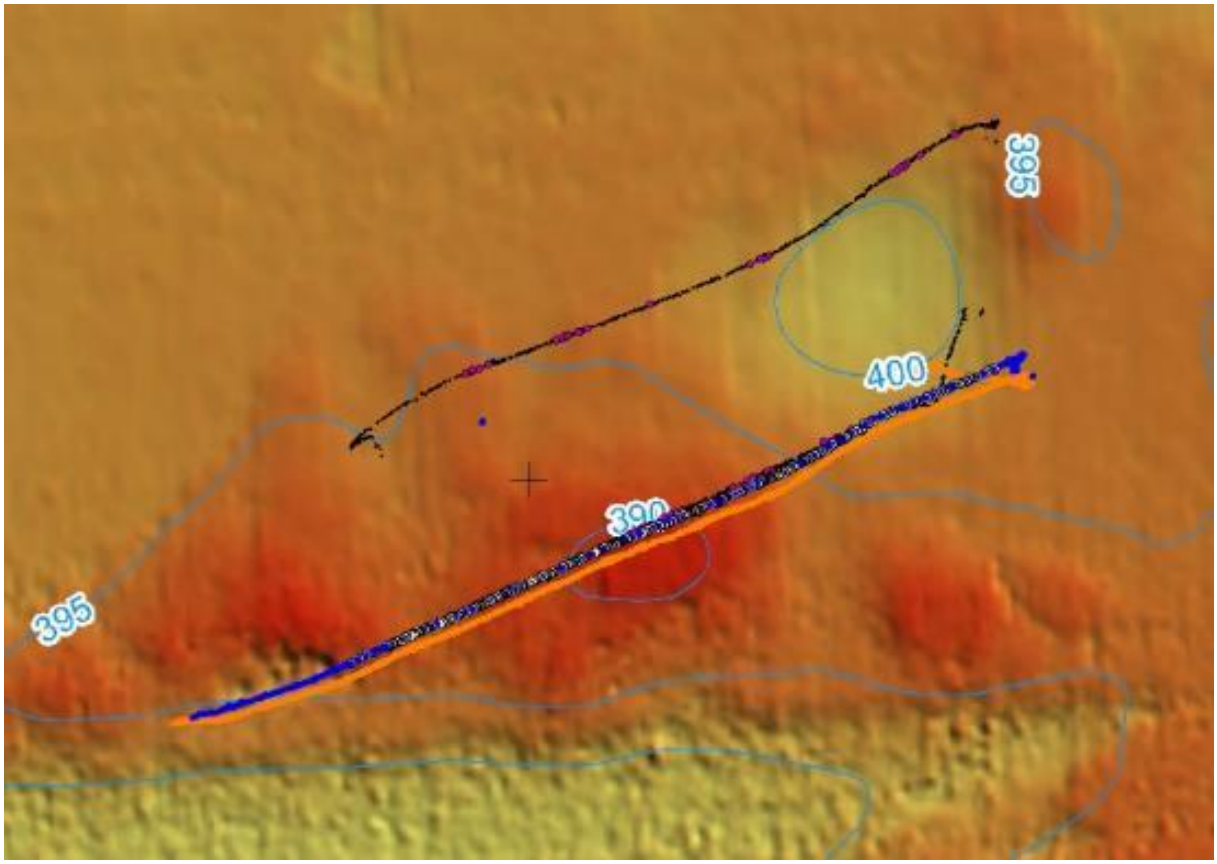


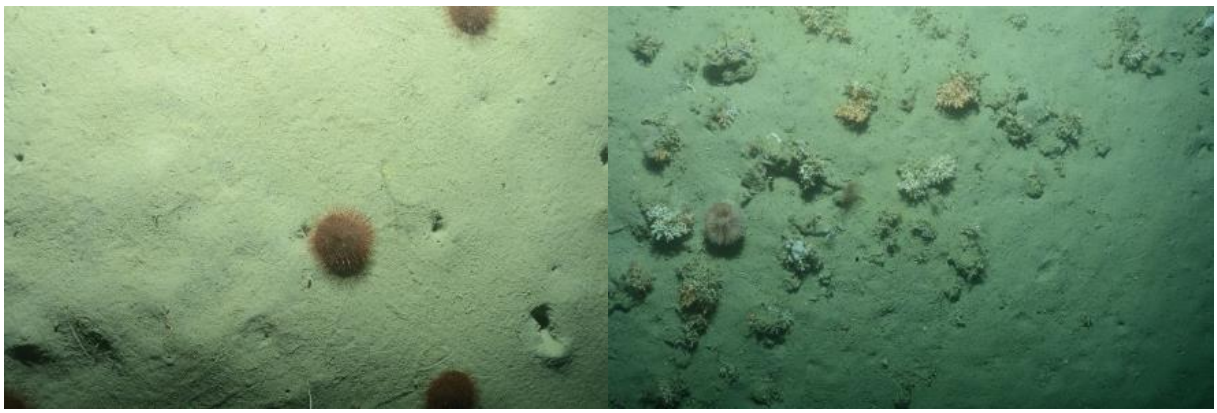
Left: TAN2005_068_090 animal trails to left side and a trail leading to a scampi in its burrow. Right: *Goniocorella dumosa,* a partially buried asteroid and urchin. Lower left and right: echinoid community.

Station 69, Hart's Hillock.

Repeat of TAN1903_0168 (NE to SW).

This transect was a fairly even mix of muddy sediment, burrows, cobbles, pebbles, aggregations of echinoids, and several clumps of *Goniocorella dumosa*. There were patches of chalky sediment towards the end of the transect. Other invertebrates included demosponges, asteroids, and some cidarids. Fish observed were sea perch, banded bellowsfish, and rattails.



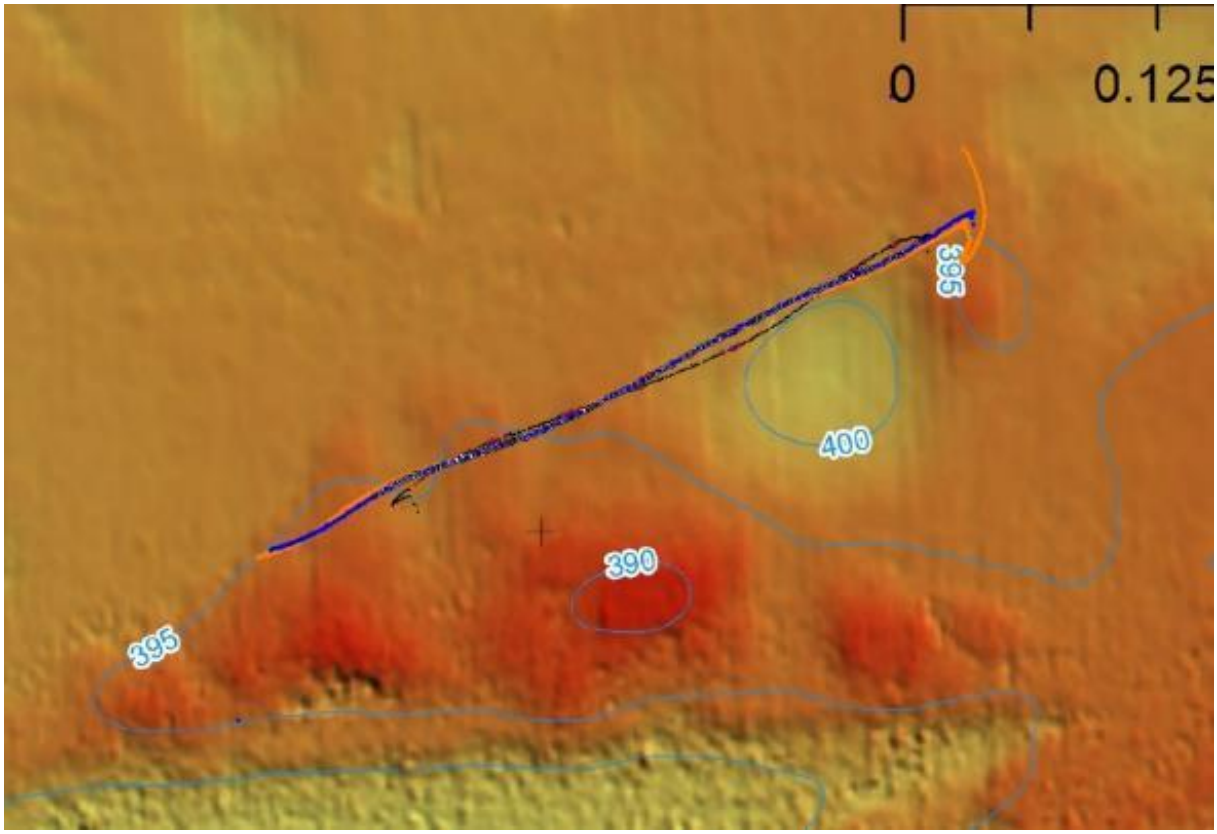


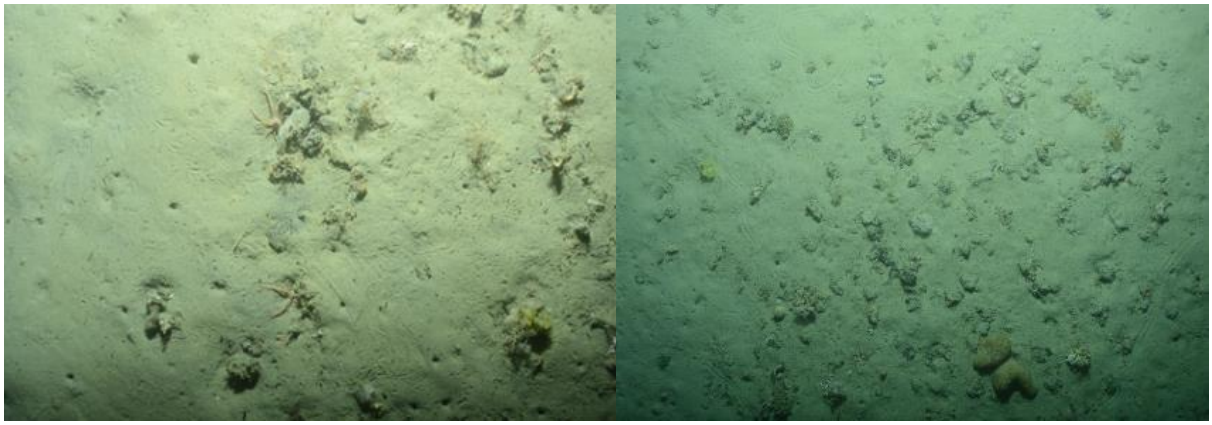
Left: TAN2005_069_25 A small echinoid colony. Right: TAN2005_069_45 An interesting array of biodiversity; anemone, rattail, *Goniocorella dumosa*

Station 70, Hart's Hillock.

Repeat of TAN1903_0167 (NE to SW).

Substrate comprised muddy sediment, burrows, cobbles, and pebbles. There were aggregations of echinoids, and several patches of *Goniocorella dumosa*. Other invertebrates included *Radicipes*, a few demosponges, asteroids, and some cidarids. Fish observed included banded bellowsfish and rattails.



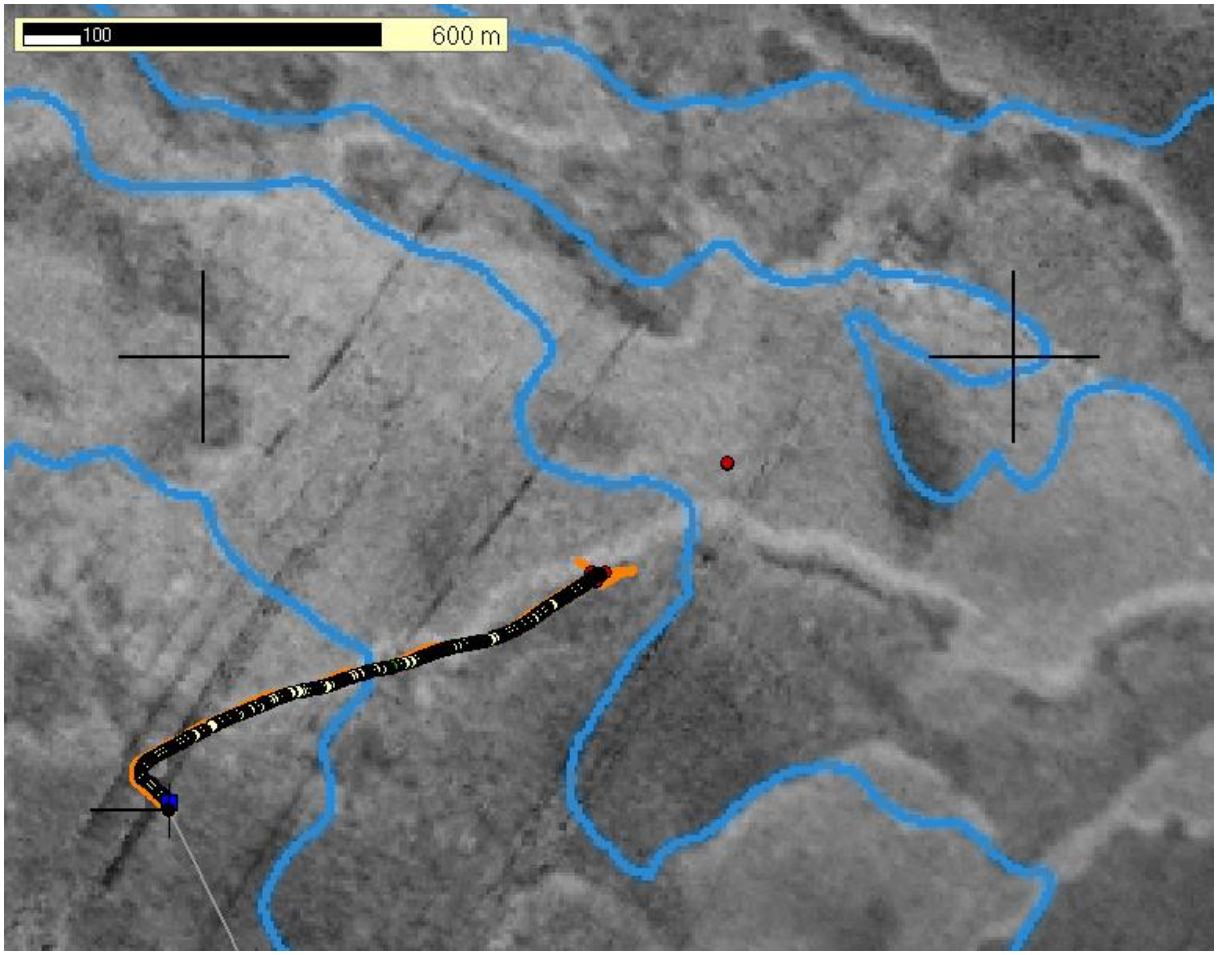


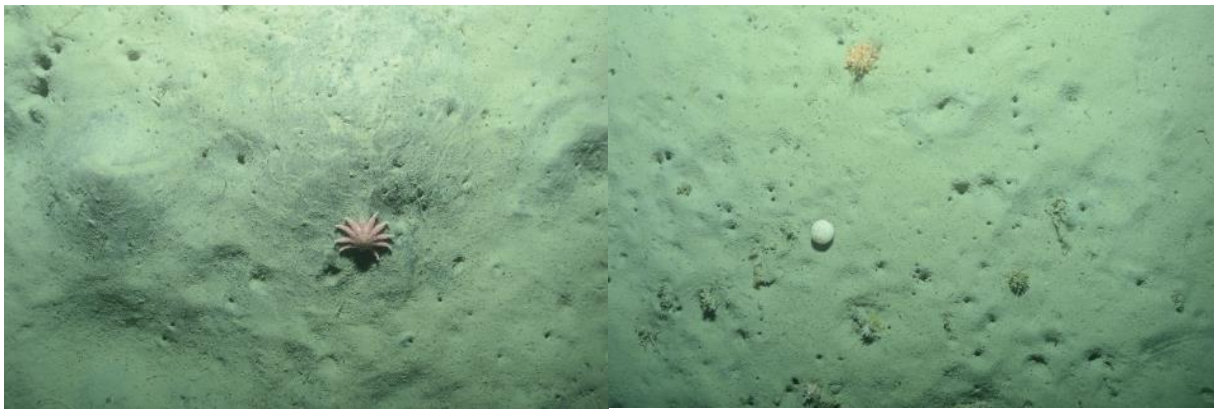
Left: TAN2005_070_014 a community of squat lobsters, ophiuroids, bryozoans and corals. Right: TAN2005_070_73 squat lobsters, bryozoans and ophiuroids making tracks.

Station 071, Mon 3

Repeat of TAN1903/031 (reverse).

Seabed consisted of mainly muddy sediments interspersed by areas of pebble, cobble and/or boulders with mud. Muddy sediments were characterised by the presence of asteroids, with the occasional echinoid, zoanthid and cerianthid. The hard substrate was colonised by sponges, *Goniocorella* and stylasterids.



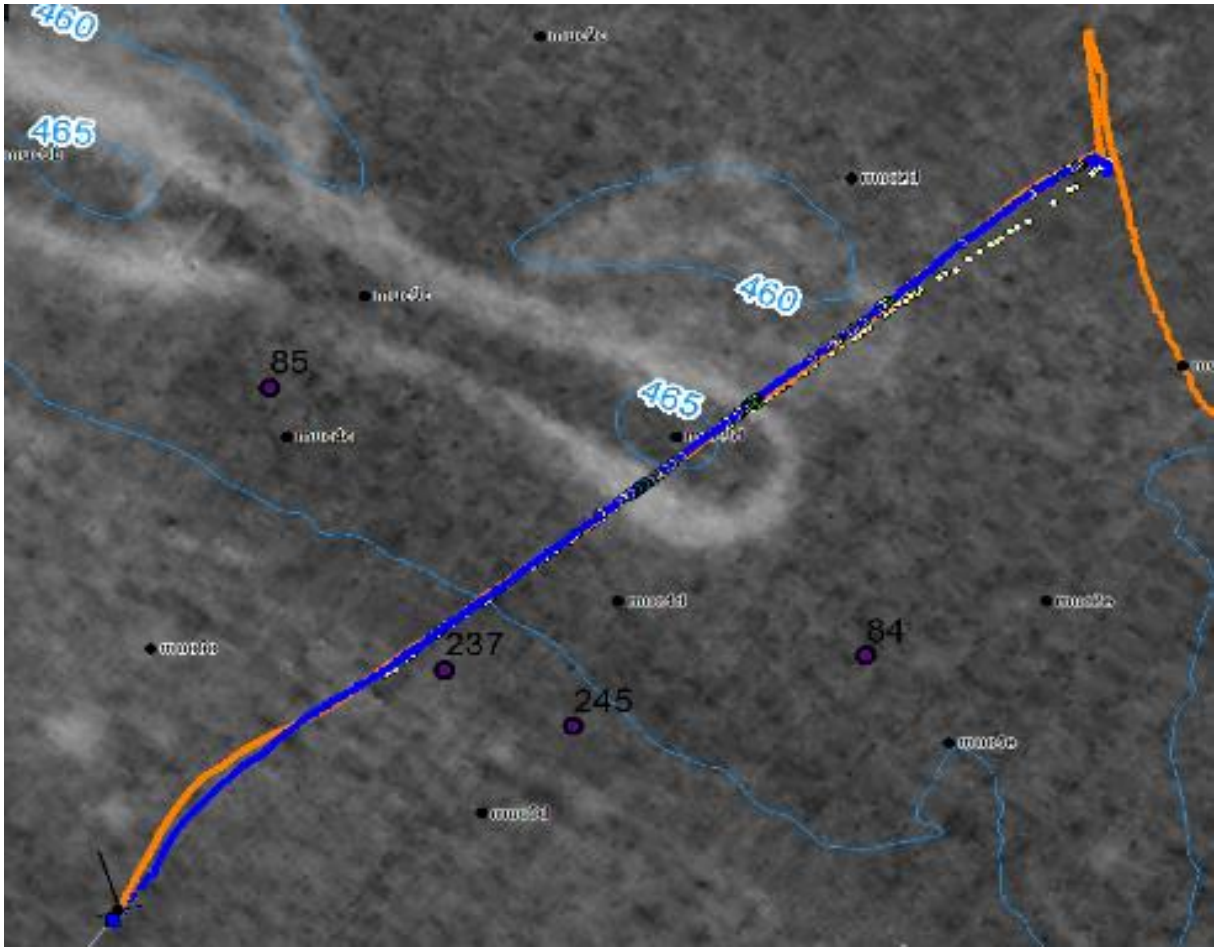


Left: TAN2005_071_078 an asteroid and shrimp. Right: TAN2005_071_150 *Goniocorella dumosa* and demosponge.

Station 74, BUTT

Rerun of TAN1903_165

This transect covered the southeastern area of the Butterknife. Disturber tracks were observed to the north of the eastern rim of the Butterknife and in the centre, and marks were extensive south of the feature. Encrusting fauna were common on the hard outcrop and cobbles of the Butterknife and on cobbles and pebbles to the north. The remainder of the transect was dominated by muddy mounds and burrows with sparse fauna.

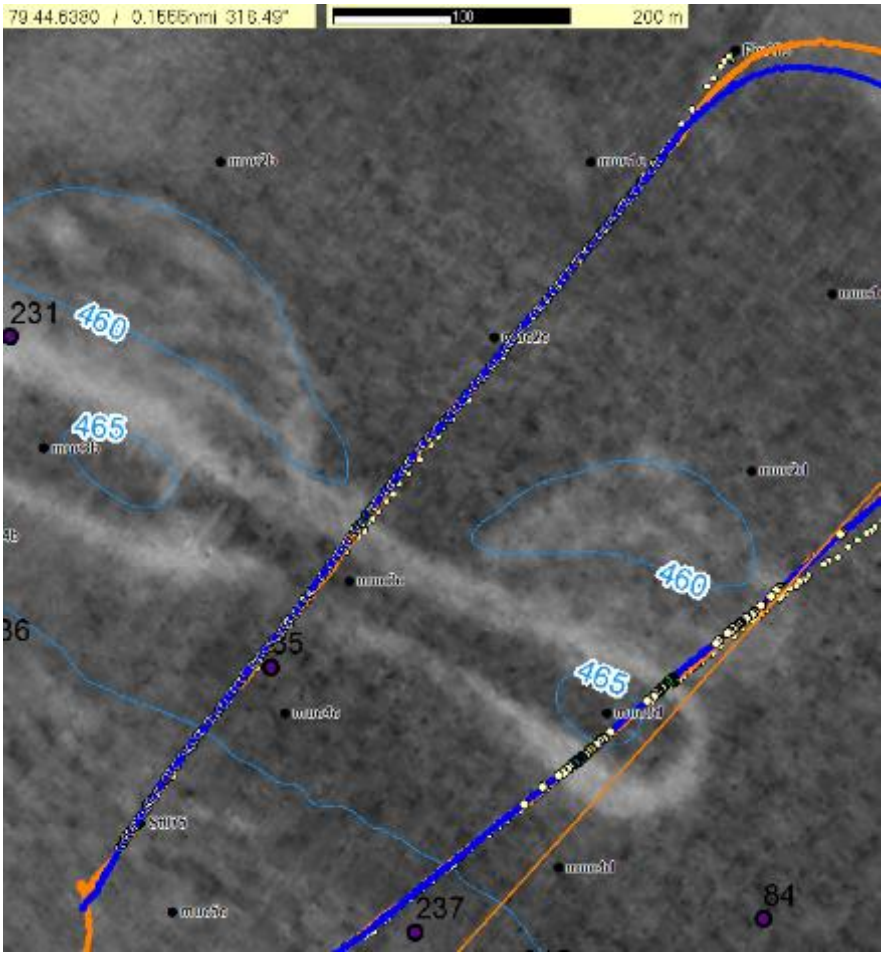


Left: TAN2005_074_082 disturber tracks from the eastern end of the Butterknife. Right: TAN2005_074_91 hard outcrop on the southern rim of the Butterknife with encrusting fauna including stalked cup corals and bivalves.

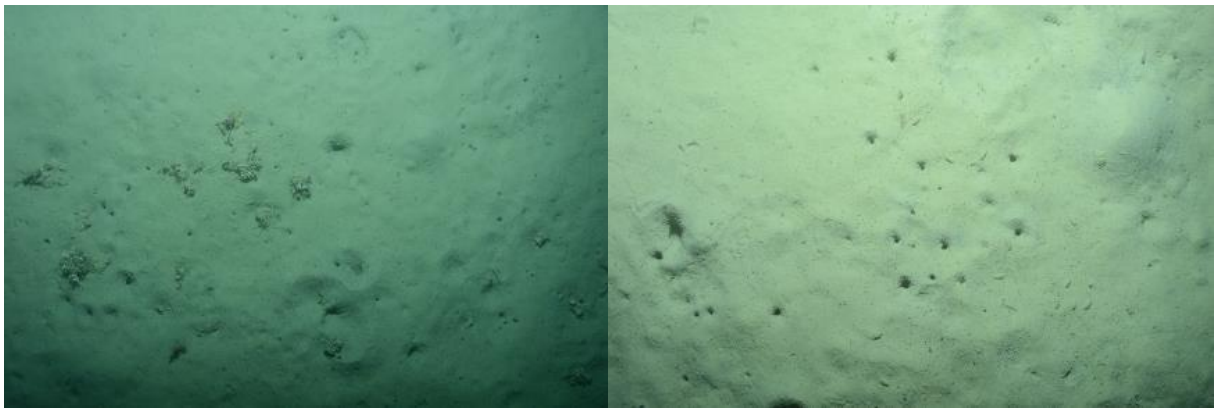
Station 75, BUTT

DTIS tow across mid Butterknife from south to north. Repeat of TAN1903_049.

The area to the south of the feature was mud with burrows, mounds and pits with a band of SCIP tracks. Fauna included anemones, asteroids, echinoids and hydroids. Fish observed included rattails, eels and a deepsea flathead. The narrow rim outcrop had sponges, cup corals, stylasterids, and hydroids. North of the rim the substrate reverted to mud with burrows and the occasional SCIP track.



(DTIS transect TAN2005_075 on the left)

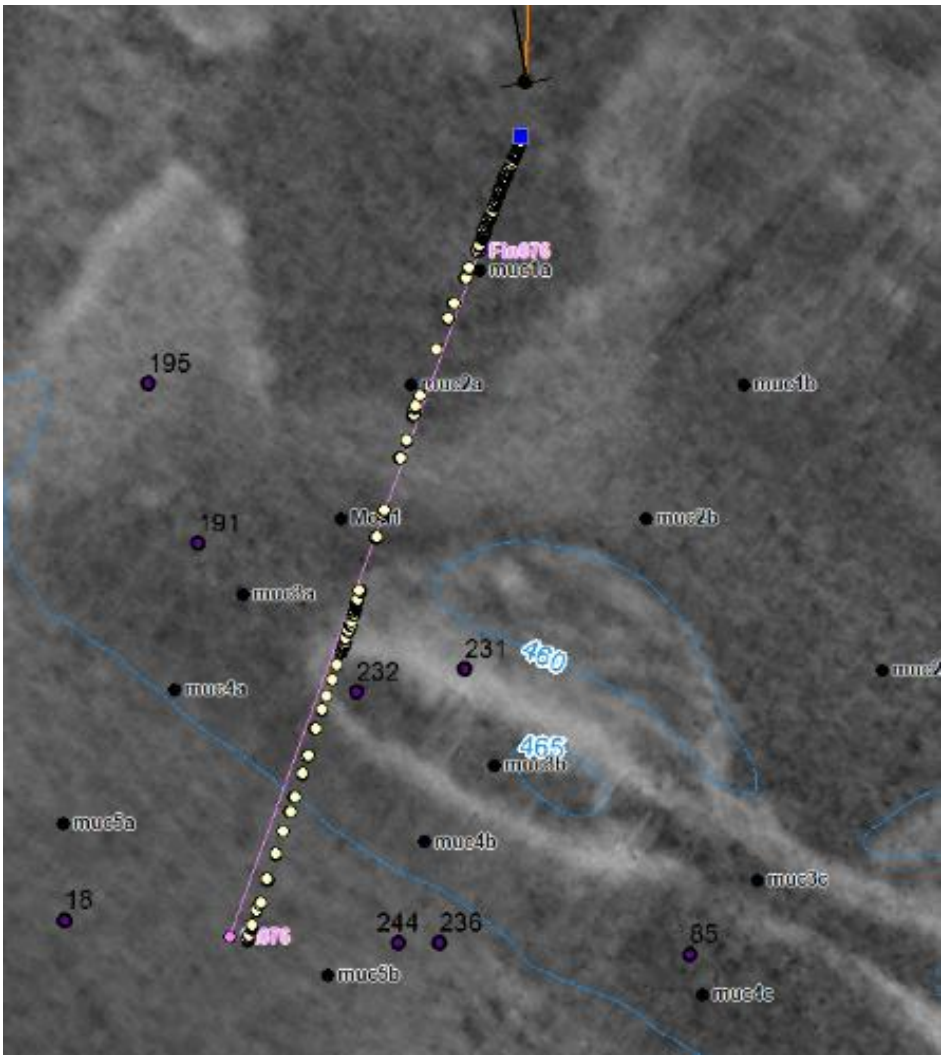


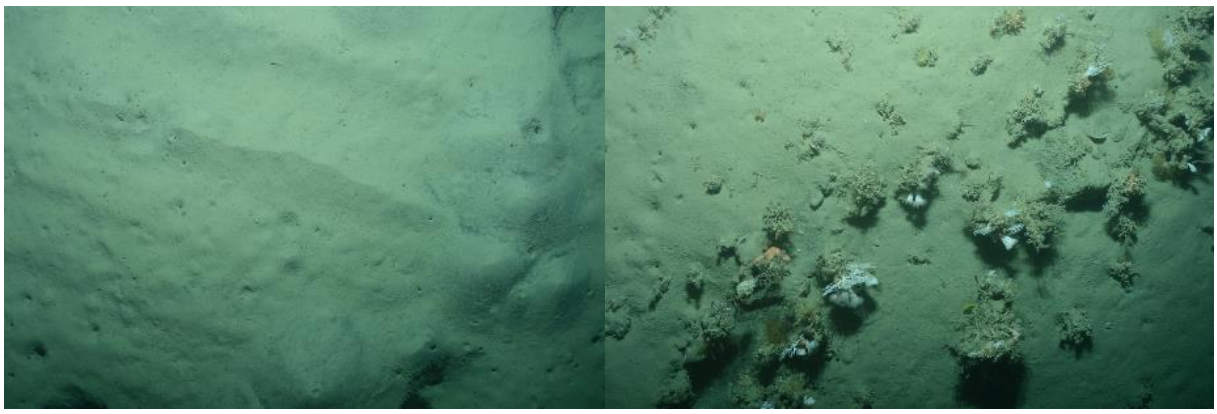
Left: TAN2005_075_083 small cobbles and clumps of *Goniocorella*. Other fauna included ascidians, hydroids and *Munida* squat lobsters Right: TAN2005_075_089 Holothurian with scattered faecal coils on mud substrate.

Station 76, BUTT

Rerun of TAN1903_162. SW area of the Butterknife.

Some SCIP lines were recorded south of the eastern end but were fewer than observed elsewhere. There were some encrusted cobbles on the northern rim, otherwise fauna was sparse throughout the transect, comprising primarily anemones and rattails.



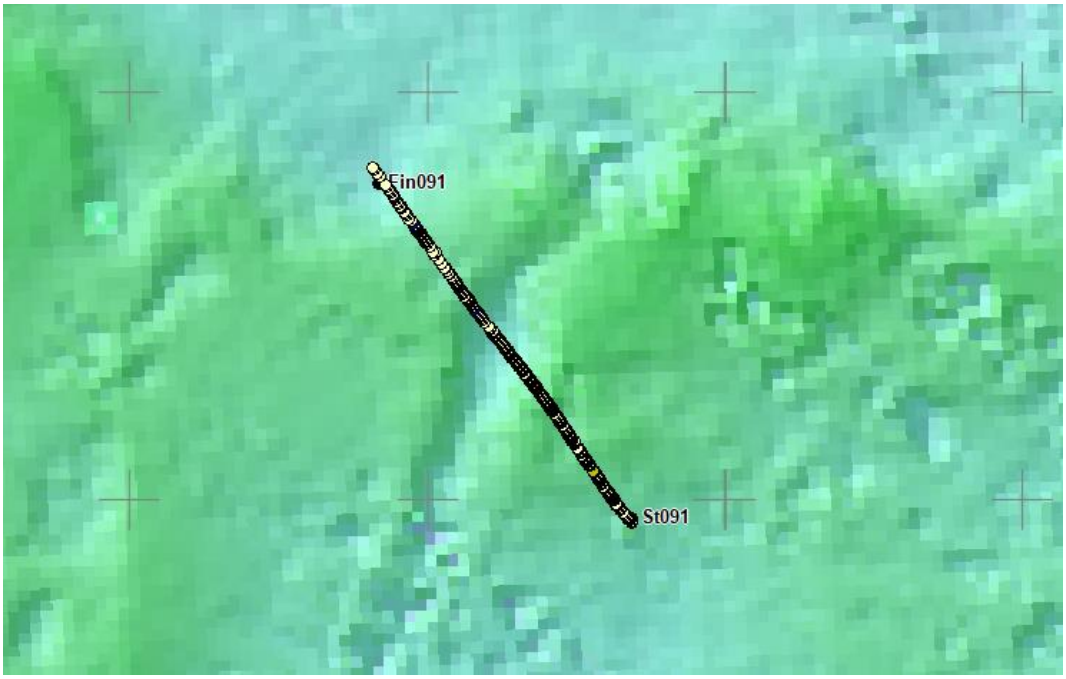


Left: TAN2005_076_041. Disturber tracks south of the Butterknife. Right: TAN2005_076_073 cobbles and clumps of *Goniocorella,* cup corals and other encrusting fauna on the north western rim of the Butterknife.

Station 91, ICEB scour 1

Transect crossing iceberg scour from SE to NW.

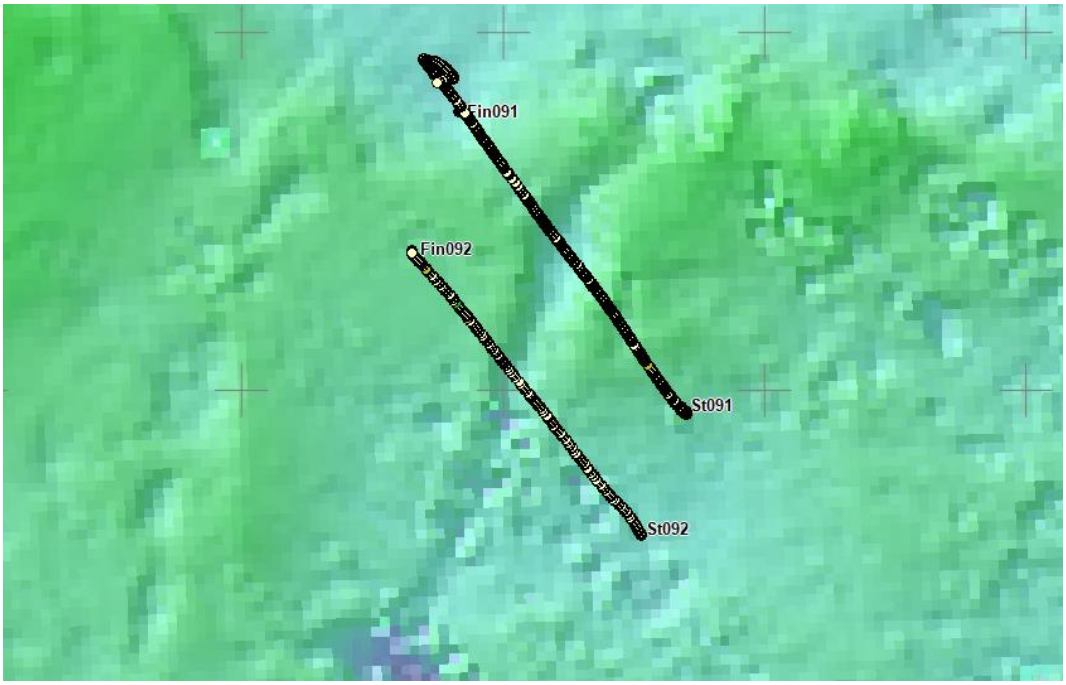
The beginning of the transect consisted of muddy sediments with mud and burrows and hardly any fauna. Then followed a couple of patches of hard substrate, pebbles, cobbles and the occasional boulder (harbouring *Goniocorella*, sponges, and *Flabellum* among other encrusting organisms) as the transect ascended the "lip" of the scour and came down the other side. The centre of the scour consisted of muddy sediments with scattered aggregations of echinoids, and mounds/burrows. Hard substrate was again encountered on the scour "lip" on the other side and some distance beyond it. Substrate was mud near the end of transect with burrows, pits and mounds.

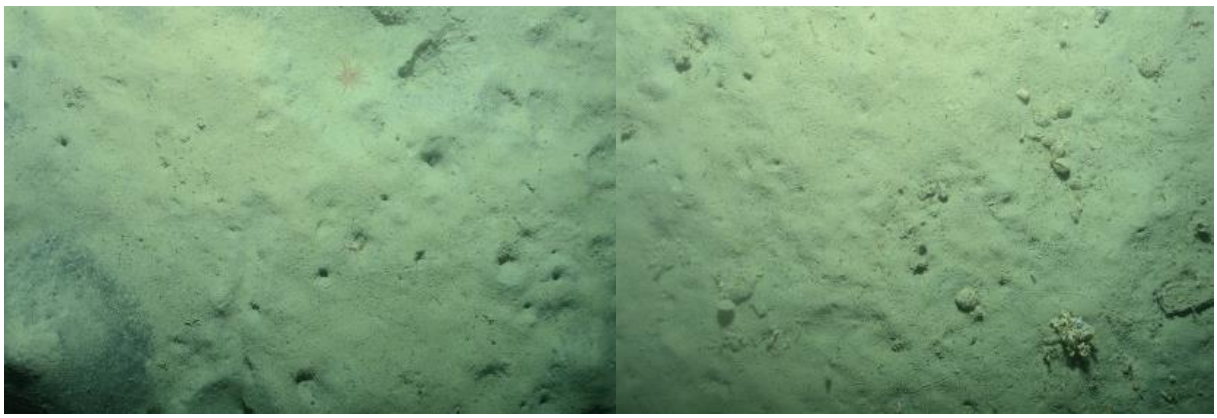


Left: TAN2005_091_038 Muddy sediment with an asteroid southeast of the iceberg scour. Right: TAN2005_091_152 edge of the iceberg scour; many pebbles/hard substrate, corals, sponges, echinoids, fish, etc.

Station 92, ICEB scour 1

This second transect crossed the iceberg scour to the south of the previous DTIS tow. The first half of the transect consisted of muddy sediments with many mounds and burrows. Some patches of harder substrate (pebbles, cobbles, boulder) were encountered on the distal side of the scour with occasional small corals present. The last third of the transect was mostly muddy sediments with patches of pebbles and a few cobbles. Fauna included occasional asteroids and echinoids.



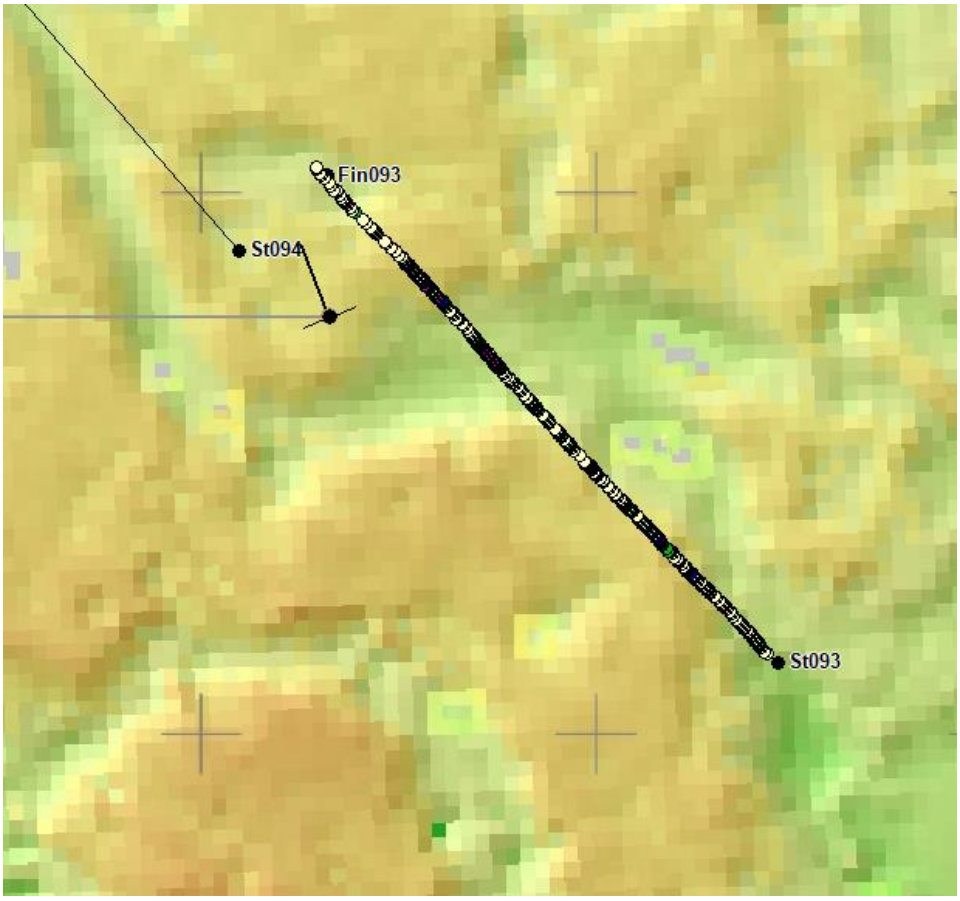


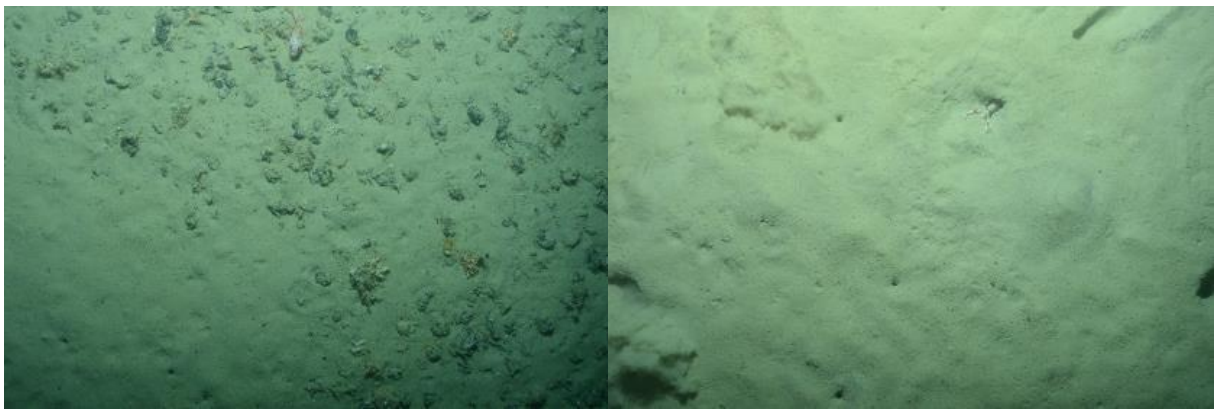
Left: TAN2005_092_10 Muddy sediment and burrows and mounds with an asteroid and squat lobster. Right: TAN2005_092_134 Some pebbles in muddy sediment, brachiopods, gastropods, ophiuroids, and *Goniocorella.*

Station 93, ICEB scour 2

First transect on iceberg scour # 2 (IB2a).

On the south edge the substrate was a mix of mud with scattered cobbles, pebbles and gravel. Invertebrate fauna was varied with demosponges, hydroids, stylasterids, *Goniocorella*, and asteroids including brisingids. On mud substrates, spatangid and cidarid urchins were common throughout. Within the scour the substrate was cobbles, pebbles and mud. Potential coring sites were at the start and end of the transect and on the northern edge of the scour Other areas had scattered pebbles and cobbles.



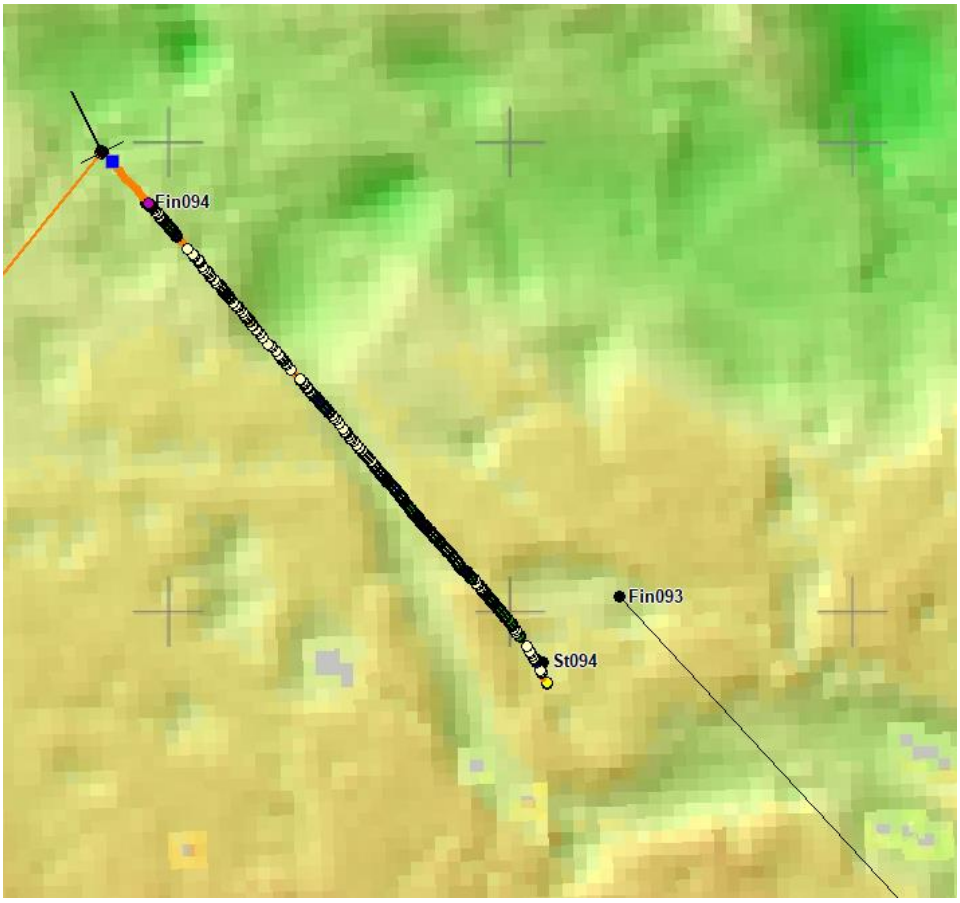


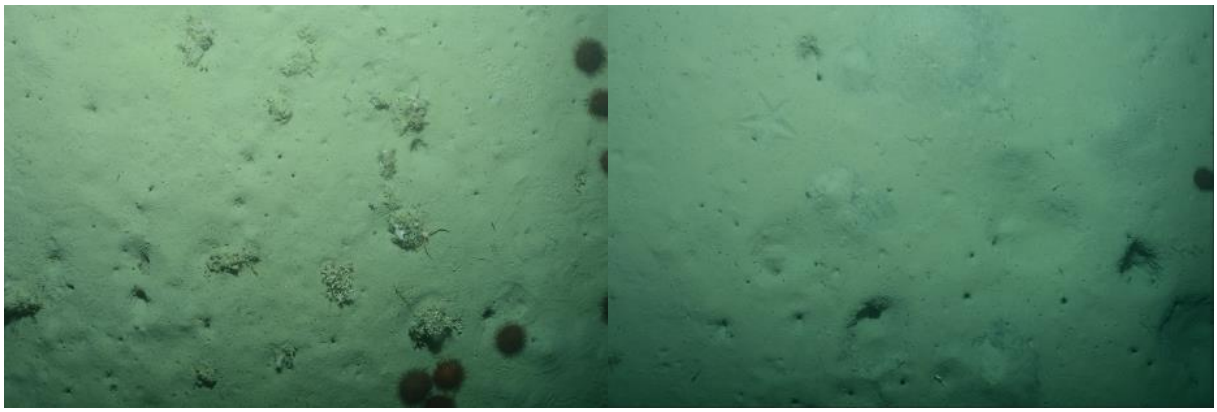
Left: TAN2005_093_115 Cobble and pebble substrate with *Goniocorella*, sponges and stylasterids. Right: TAN2005_093_213 - Muddy sediment with a scampi at a burrow entrance (top right centre).

Station 94, ICEB 2

Second transect on iceberg scour # 2 (IB2b).

The transect started in muddy sediment with pits and mounds, and then ran along the edge of the scour characterised by pebbles and cobbles with encrusting fauna. The middle part of the transect was in the scour where muddy sediment appears deep enough for multicores, especially in regions with mounds and pits. The latter part of the transect ascended the scour into a region of pebbles, cobbles and some small boulders interspersed with muddy depressions that may also be suitable for cores. Large patches of heart urchins occurred in several places. Fishes included rattails, flatfish, scampi, spikey dogfish and a ghost shark.



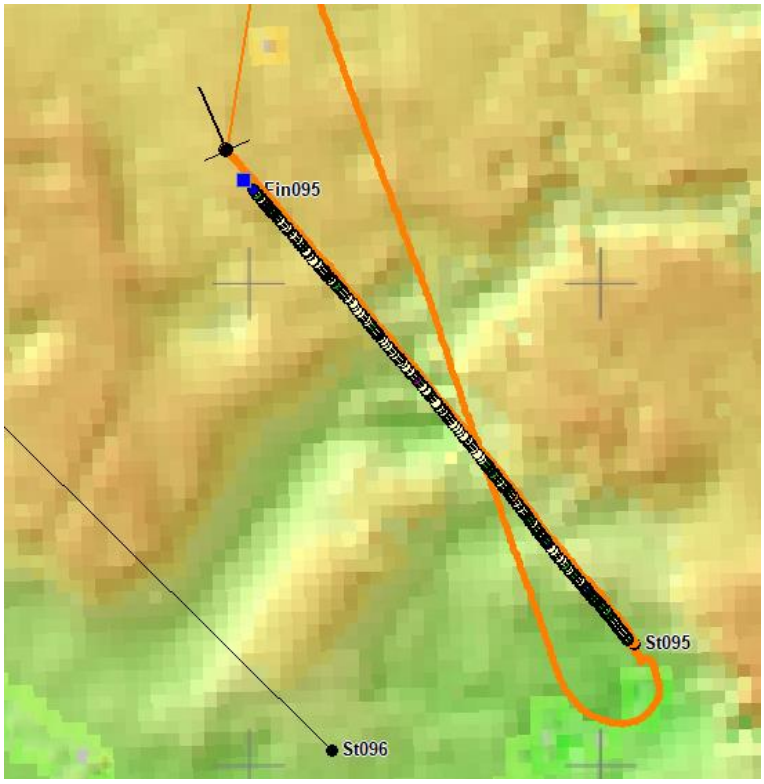


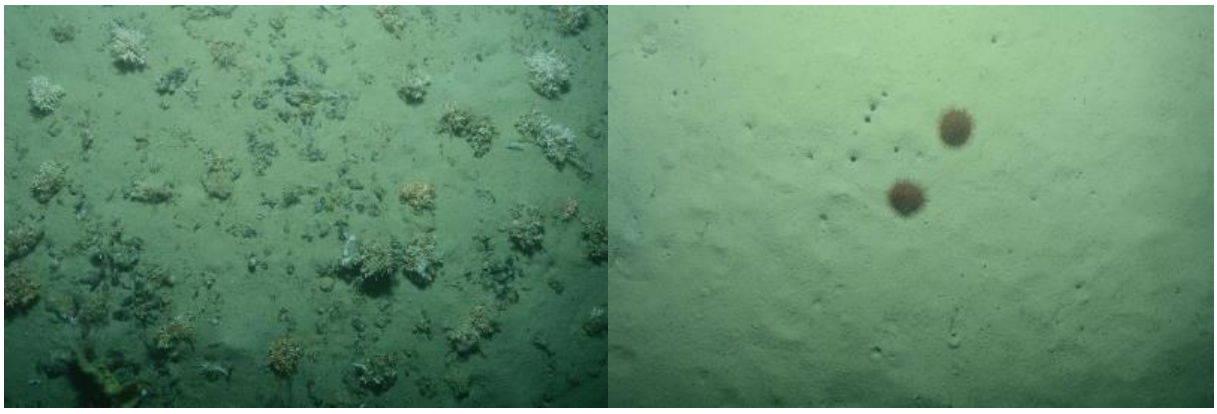
Left: TAN2005_094_45 Cobble and pebble substrate with heart urchins. Right: TAN2005_094_238 Muddy sediment with pits mounds and burrows.

Station 095, ICEB 3

DTIS tow over iceberg scour site IB3a

There was a patchy distribution of cobbles and pebbles with encrusting fauna amongst areas of muddy sediment with pits, mounds and burrows. Typical fauna on hard substrates were demosponges, stylasterids, bryozoans, hydroids, ascidians, brisingids and *Goniocorella* clumps. Species on the soft substrates were abundant groups of spatangids, cidarid echinoids, *Munida*, scampi and occasional gastropods. Fish included rattails and a ghost shark. Potential core sites were observed within the scour and towards the end of the transect on the northern rim outside of the scour.



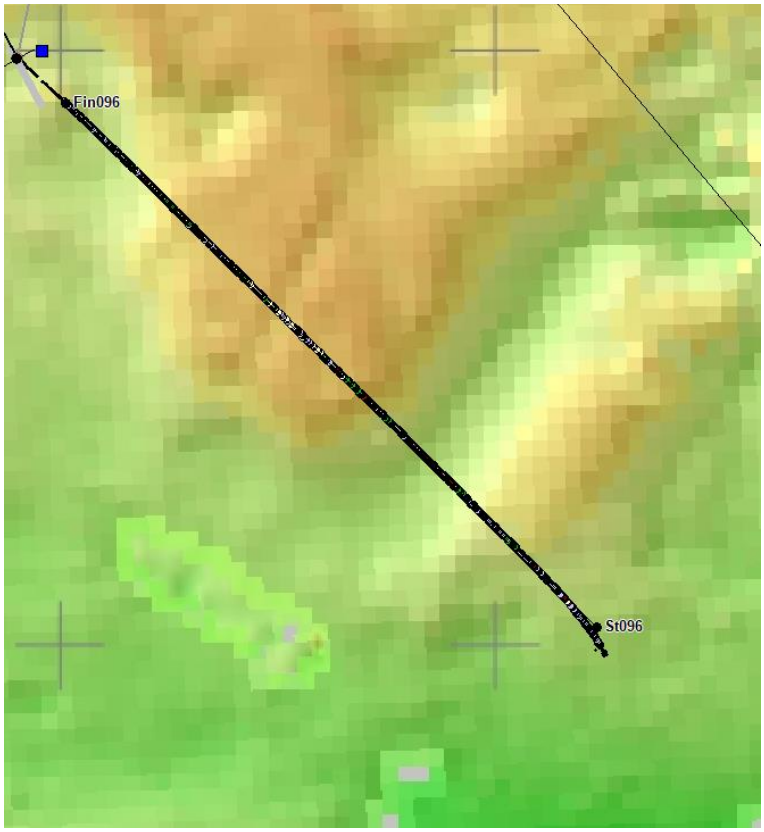


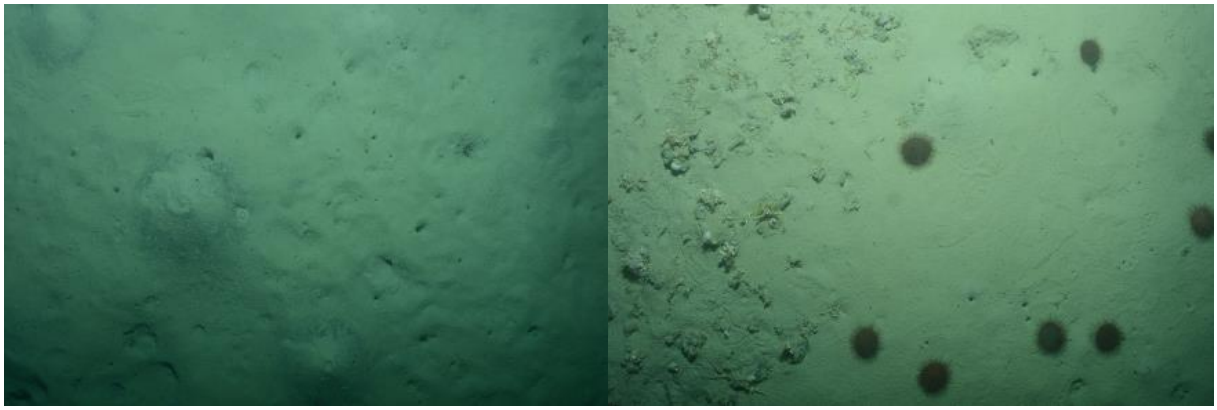
Left: TAN2005_095_174 Cobble and pebble substrate with *Goniocorella*, stylasterid corals and galatheids.
Right: TAN2005_095_225 Spatangid heart urchins on mud substrate.

Station 096, ICEB 3

Second transect on iceberg scour # 3 (IB3b).

Muddy sediment with pits and mounds occurred in deeper parts of the transect including in the iceberg scour. Patches of cobbles, pebbles and gravel, with heart urchins, occurred mainly on the elevated regions. Chalk was observed in places on mounds and around burrows. Encrusting fauna were common on hard substrates, other fauna observed included parasol urchins, sea perch, scampi and ghost sharks.

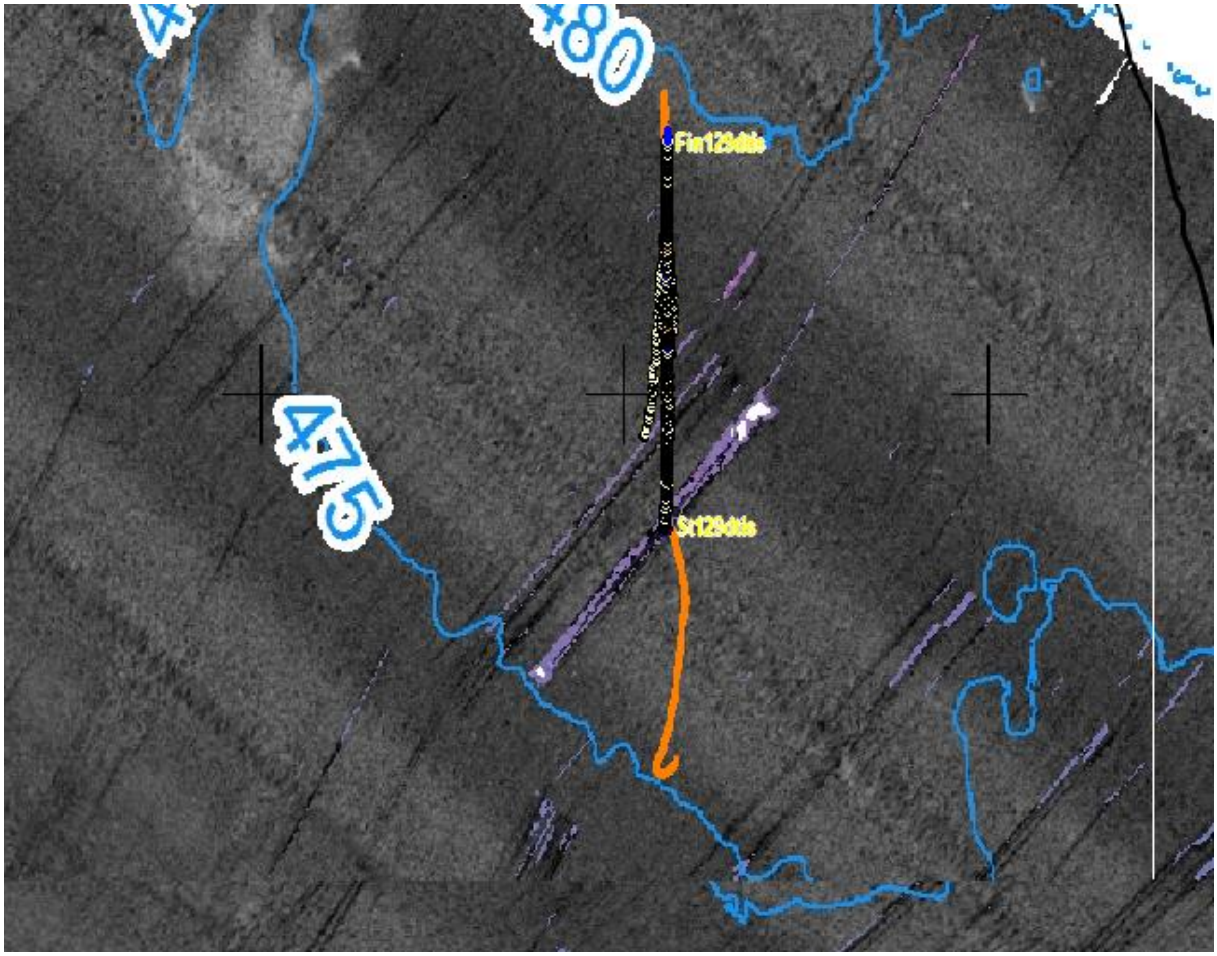


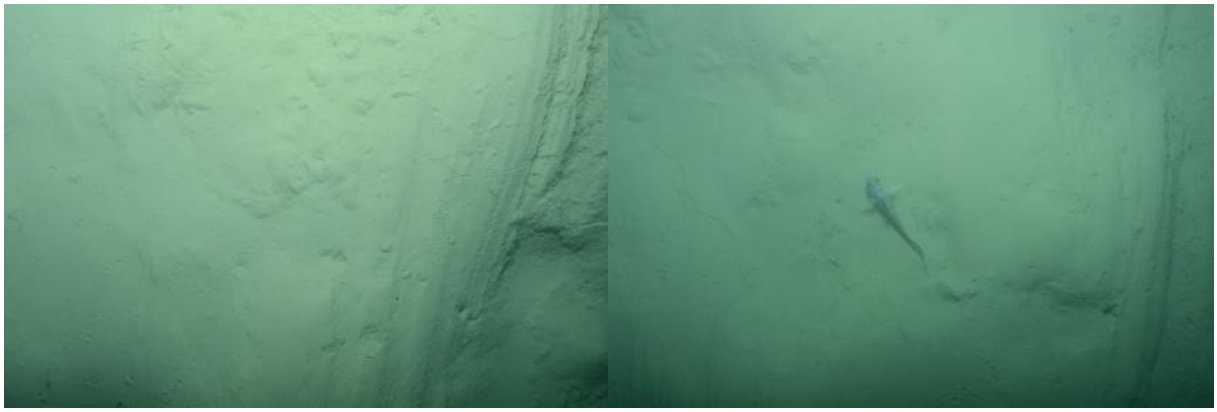


Left: TAN2005_096_020 muddy sediment deemed suitable for coring. Right: TAN2005_096_164 Spatangid heart urchins on flat mud substrate adjacent to hard substrate mid transect.

Station 129 Beam trawl disturbance site 1.

Muddy sediment with burrows dominated initially, then there were obvious trawl tracks over the disturbed area. Trawl tracks extended along the disturbed area, with signs of chain footprint where it was thought the gear landed on bottom. Numerous rattails were observed.



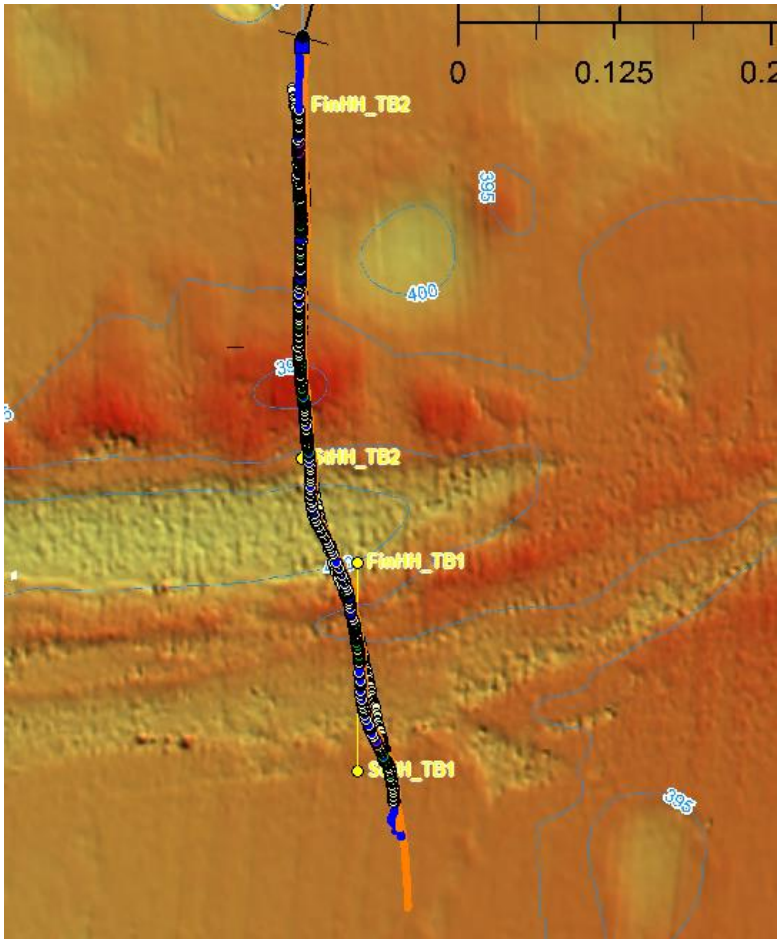


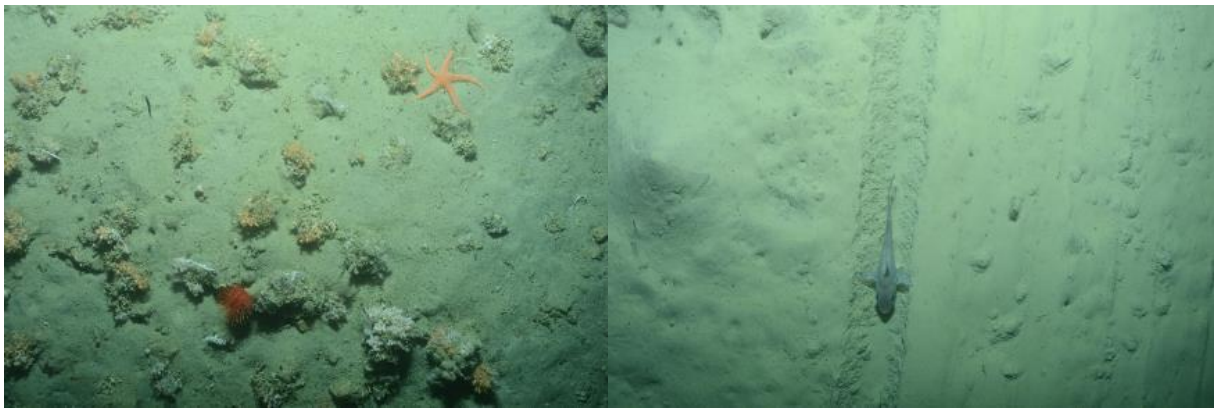
Left: TAN2005_131 signs of chains on the left and tracks to the right of the picture: Right: A lone rattail swimming to the left of the track marks on the right.

Station 133 Hart's Hillock

Repeat of DTIS TAN2005_068 on Hart's hillock

This tow was predominantly on muddy sediment with burrows, mounds and tracks. There were some areas of cobbles, pebbles and gravel. These were colonised with clumps of *Goniocorella*, encrusting demosponges, hydroids, ascidians, stylasterids and cryptic *Munida*. On the softer sediment areas spatangid heart urchins were in very high densities. Trawl tracks were prominent in places from the previous beam trawl station 132.

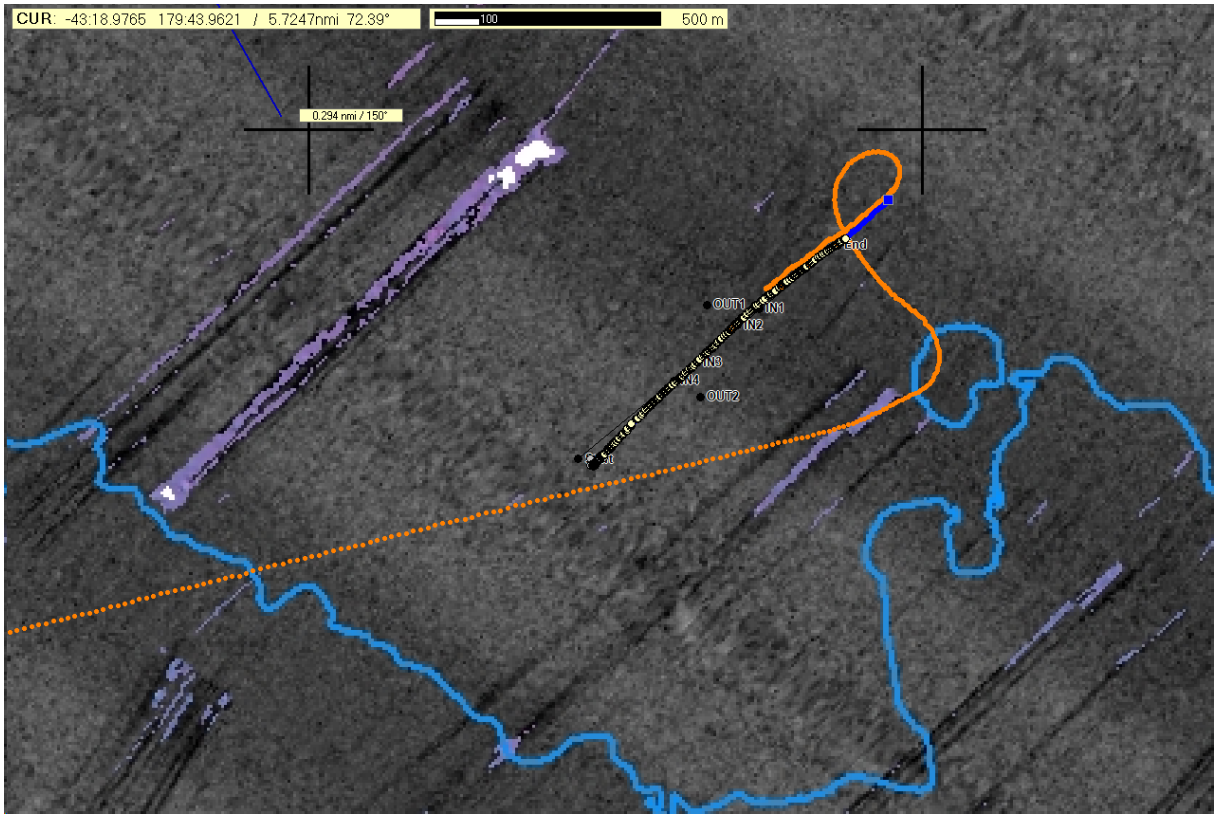


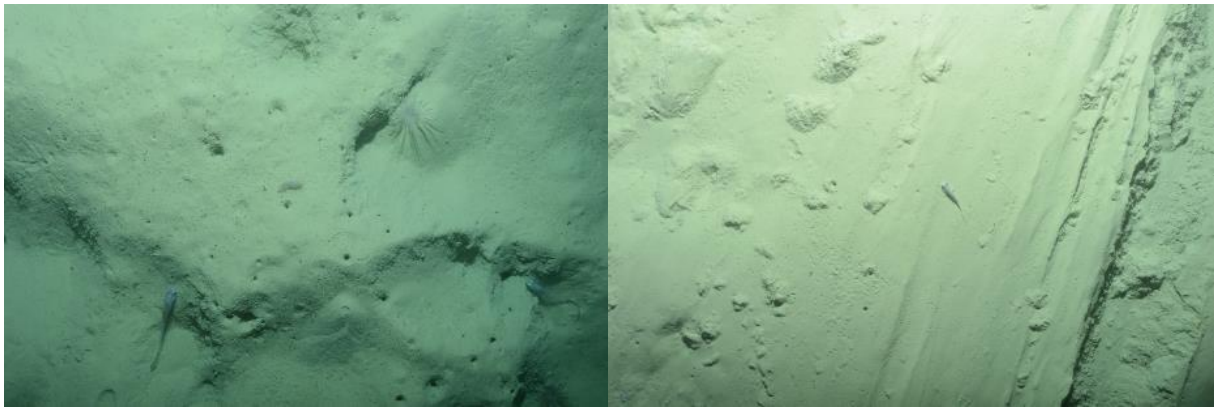


Left: TAN2005_133_053 Isolated clumps of *Goniocorella* corals with encrusting hydroids, sponges and stylasterids on cobbles. A *Dermechinus* urchin in the lower centre. Right: TAN2005_133_046 A rattail forages along trawl marks created by beam trawl station 132. Undisturbed mud substrates lie to the left of the image.

Station 152, Beam Trawl disturbance site 2

This transect ran along beam trawl marks and targeted multicorer sampling sites (IN1-4). Substrate was muddy sediment throughout. The beginning and end of the transect was characterised by dense burrows, pits and mounds and some cerianthids and echinoids. The middle of the transect had many trawl marks with rattails and fish (most were quite small) common and the occasional cerianthid and echinoid. We did not observe any marks made by the multicorer tubes.

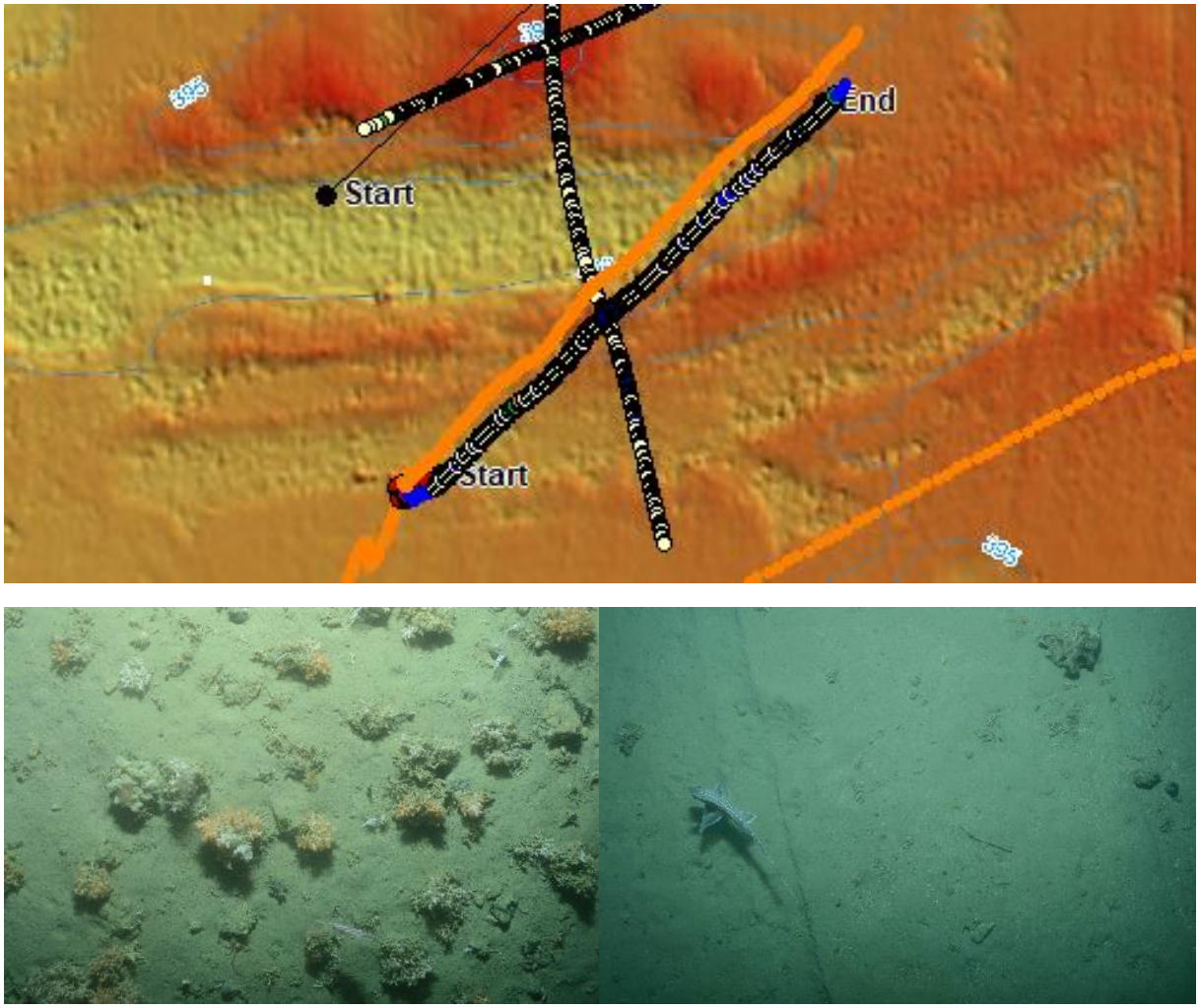




Left: TAN2005_152_014 Muddy sediment with burrows, holothurian rattails and cerianthids. Right: TAN2005_152_038 Trawl marks on muddy sediment, small rattail.

Station 153, Hart's Hillock

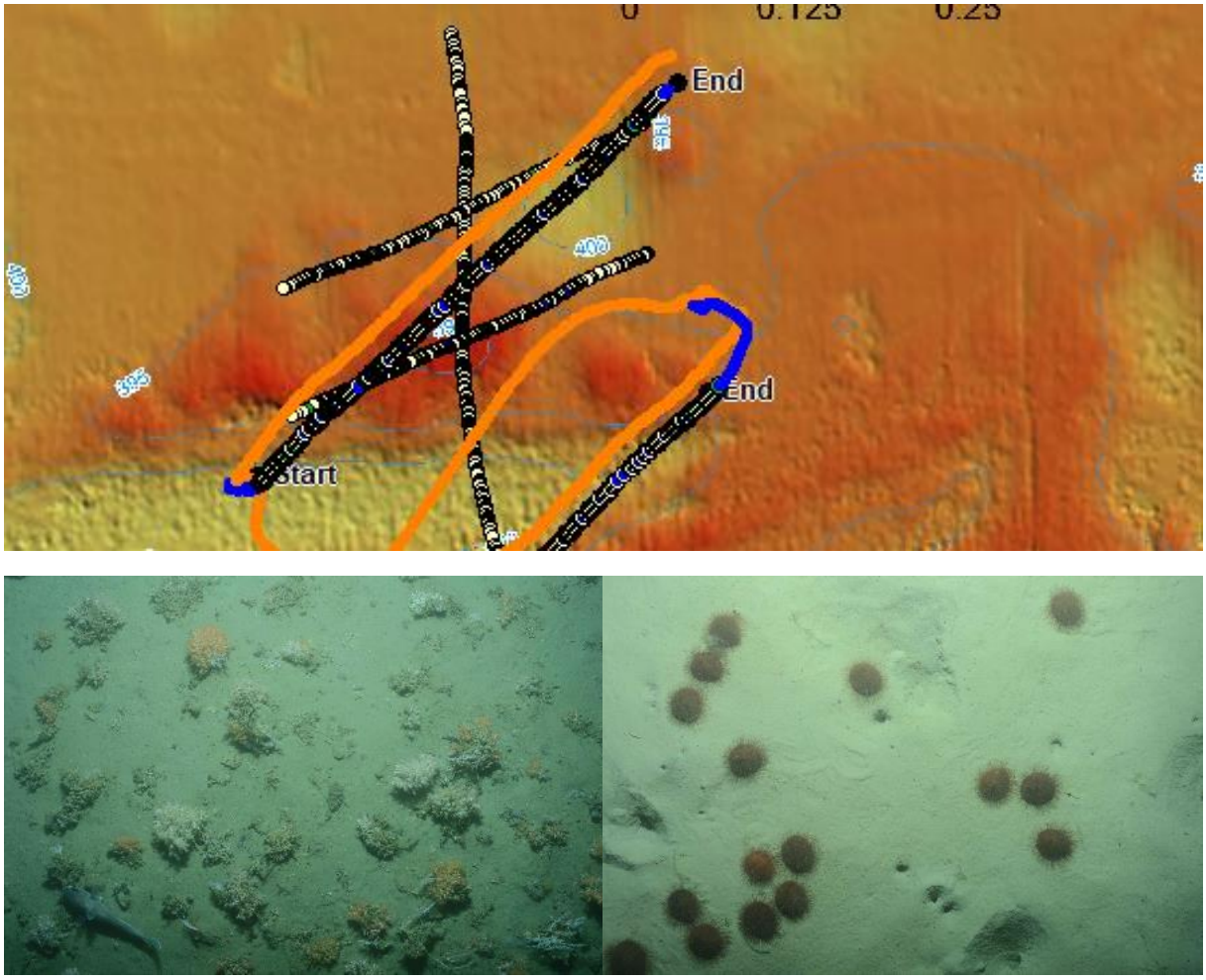
This transect crossed beam trawl tow TAN2005/68. Burrows and muddy sediment were common with numerous trawl tracks observed in places. This was mixed with dense patches of *Goniocorella* and some stylasterids on substrate of pebbles cobbles, and mud. A large *Hyalascus* sponge, aggregations of echinoids, *Radicipes* whip octocoral rattails, ghost shark, toadfish, and eels were observed.



Left: TAN2005_153_066 Patch of *Goniocorella* on cobbles and pebbles. Right: TAN2005_153_072 Beam trawl track in soft sediment, with ghost shark.

Station 154, Hart's Hillock

This was a second transect crossing beam trawl tows to the north. Substrate was mixed, with burrows in muddy sediment and one trawl track; with patches of *Goniocorella* on pebbles and cobbles. There were aggregations of echinoids, and occasional demosponges, *Radicipes*, shark, rattails, sea perch, and bluenose.



Left: TAN2005_054_073 Community of *Goniocorella* on pebble-cobble substrate, with a rattail. Right: TAN2005_054_089 Aggregation of heart urchins.