NIWA
Taihoro Nukurangi

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

Voyage report of Survey 1: May-June 2018

October 2018

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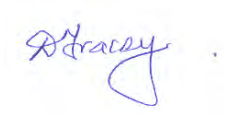
Quality Assurance Statement		
	Reviewed by:	Di Tracey
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1 Voyage background

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 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. The selected area on Chatham Rise is in the vicinity of earlier proposals to mine seafloor phosphorite nodules and is near to bottom trawling and long-lining activities.

This voyage was the first of three surveys designed to determine the effects of sedimentation, and the resilience and potential recovery of impacted benthic communities. This survey was designed to subject an area of seabed to disturbance that will create a sediment plume. The suspended sediment load created by the disturbance would be tracked and monitored, and the data used to refine sediment plume models. The effects on faunal community structure at this site and at increasing distance from the impact was examined by pre-and post-disturbance sampling. The monitoring (post-disturbance survey) will be repeated in 2019 and 2020 to determine the longer-term resilience and recovery dynamics of disturbed communities.

The laboratory-based side of the programme involves holding live deep-sea corals and sponges in tanks, and exposing them to various levels and duration of particle loads in the water (based on the field survey plume) in order to reveal acute thresholds as well as sub-lethal chronic effects of settled and suspended sediment.

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 seafloor exposed to these plumes, and the sedimentation effect on the functioning of ecologically significant species.

2 Objectives:

The main aim of the voyage was:

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

This large objective had a number of sub-components:

a) To carry out a baseline survey of benthic communities on the Chatham Rise crest;
b) To disturb an area of seabed, creating a sediment plume above the seafloor;
c) To monitor the dispersal of the sediment plume;
d) To determine the characteristics of the suspended and settled sediment;
e) To survey benthic communities, post-disturbance; and
f) To collect animals for experimental sedimentation threshold studies onshore.

3 Voyage summary

3.1 Voyage Personnel

Name	Organisation	Role
Arne Pallentin	NIWA	MBES/Acoustics
Joanne O'Callaghan	NIWA	Physics lead/glider
Fiona Elliott	NIWA	Glider/moorings/ADCP/CTD
Pete Gerring	NIWA	Moorings/landers/Disturber
Will Quinn	NIWA	Moorings/landers/Disturber
Olivia Price	NIWA	Glider/moorings/CTD
Rebecca McPherson	NIWA	ADCP/CTD/moorings
Ben Lennard	NIWA	Towfish
Chris Ray	NIWA	Towfish/DTIS
Kolter Larsen	Okeanus	Benthic Disturber
Scott Nodder	NIWA	Watch Leader/Sedimentation lead/filtering
Chris Hickey	NIWA	Ecotoxicology
Rob Stewart	NIWA	Sediment micro-profiling/Deck Safety Officer
Chris Eager	Waikato University	Sedimentation/biogeochemistry
Tim Horst	Delft Technical University	Sediment generation/discharge
Steve George	NIWA	DTIS/ CTD
Malcolm Clark	NIWA	Voyage-Watch Leader/Biology/OFOP
Caroline Chin	NIWA	Biology/OFOP/Chemicals Safety Officer
Daniel Leduc	NIWA	Biology/OFOP
Alan Hart	NIWA	Biology/OFOP
Valeria Mobilia	Victoria University/NIWA	Live capture, general biology support/filtering
Malindi Gammon	Ministry for Primary Industries	Live capture, general biology support/filtering

3.2 Voyage time-line

Date	**Activity**
9 May	Mobilisation
10 May	Mobilisation
11 May	Complete mobilisation. Sail 1530, posmv calibration in harbour, towfish test, SVP, MBES patch test for calibration in Palliser Bay. MBES runs across head of canyon
12 May	Palliser Bay. Deployment trials of benthic landers, #3, 4, 5. Electrical issues with Benthic Disturber. Continue MBES lines of canyon overnight.
13 May	Palliser Bay. Further towfish test. Benthic lander trail #8. Electrical issues resolved, test Benthic Disturber deployment and recovery, short trial on seafloor. 1300 begin transit to Chatham Rise.
14 May	In transit. Trial towfish (#10). MBES over several previous DTIS sites inside BPA to record backscatter as tool to aid site selection for coral communities. Arrive at S129 site. Begin detailed MBES survey work.

15 May	Mix MBES runs with DTIS tows to relate backscatter to seafloor substrate and fauna. 7 DTIS tows (#13,14,15,16, 18,19,20).
16 May	Extend exploration from site S129, west towards CRP area outside the BPA, with further MBES lines, and DTIS (#22,23,24). Further sampling of S129 area (DTIS #26,27).
17 May	One DTIS tow before weather stops sampling operations 0300-0800. Run MBES lines one way. Resume DTIS (#30,31,32), towfish tests (#33,36), and further DTIS (#34,35, 37).)
18 May	Continue with DTIS exploration of features and sites around S129 (#38, 39, 40), glider deployment aborted with increasing weather, trial gravity corer (#41). 1130 head east for trial of Benthic Disturber. MBES small area for test, then two DTIS to check substrate (#42,43). Deploy Benthic Disturber for trial tows to test operation and maneuverability. #45 successful.
19 May	Second trial of Benthic Disturber. Steam back to S129 site for possible glider deployment. Weather increases, not possible. Do ADCP survey to establish current flows. CTD cast for testing equipment and determining bottom boundary layer turbidity. Further tests of towfish (#47,48). Additional DTIS lines to establish reference site (#49,50) and explore further sites for final survey station allocation (#51,52).
20 May	DTIS#52; ADCP survey 2; deploy glider. Steam to reference site, deploy two moorings (ADCP, Sediment trap). Multicorer drops struggle, 6 deployments, some tubes OK, but only one drop successful with 4 good cores. 2330 weather stops operations. Slow dodge, MBES lines with weather.
21 May	Continue slow MBES lines. Monitor glider. As weather eases, switch to CTDs at MON6, MON5 and MON1 sites. Multicorer stations at MON 1 site go well with 6 successful casts (#66-71). Move to NW Reference Site, continue with multicoring (#72-75).
22 May	Reference Site. CTD cast, and DTIS tow. Head back to MON3 with two short DTIS (#78,79) and MON2 (#80-81). Then test potential Disturber site (DTIS #82-83). Weather coming away again, but continue DTIS at MON 1 (#84,85), and MON7 (#86,87).
23 May	Continue DTIS at MON6 (#88). Weather means stop DTIS ops, switch to CTD at MON 3 (#89), casts at MON2, MON7, MON4 and DIS1. Resume DTIS operations later in day, at MON4 (#94,95) and MON5 (#96-98). Deploy three Benthic Landers (#99-101).
24 May	Deploy RAS mooring, complete triangulation of the landers and mooring. Start multicorer sampling, MON7 (6 drops), MON2 (3 drops), MON3 (3 drops), DIS 1 (9 drops), DIS 2 (3 drops), BL2 (3 drops).
25 May	Continue multicorer at BL2 (1 drop), MON5 (3 drops), MON6 (4 drops). DTIS runs over new areas (#138, 139), then two gravity core attempts (#140, 141). Acoustics/MBES survey grid. 2000, start Benthic Disturber (short tow, replace transponder). Then commence continuous towing in “Disturbance box”.
26 May	Continue Benthic Disturber tow (#145) until broken stay, short retrieval and redeploy (#146).
27 May	Complete Disturber tow, in total about 31 hours. Retrieve, to begin CTD survey of Disturbance box and surrounding area to monitor plume. CTD problems, switch to MBES survey. Complete 7 stations (#148-154). Weather deteriorates, steam to sites 15 miles to west for sled shots to sample sponges.
28 May	Complete sled tows, return to box area and resume CTD operations (#160-164) until weather comes away and stops all ops from 1200. Dodging through afternoon.

29 May	Continue dodging. Weather easing, head back to box area to undertake CTD work over grid before disturbance (#165-177)
30 May	Complete CTD grid (#178). Weather eased enough for Benthic Disturber. Tow for 5 hrs, then pump fails. Retrieve. Head to REF1 site while both BDR and CTD fixed, multicores (#182-185), CTD (#186), DTIS (#187). Redeploy BDR, but again fails.
31 May	Undertake exploratory DTIS tows to see post-disturbance 1 effects while BDR pump being replaced (#189-195). BDR ready again 1800, shoot #196 back in Disturbance Box.
1 June	Continue BDR run in Box.
2 June	Haul BDR (30 hrs). Undertake CTD grid over Disturbance area (#197-205). Return to REF site to retrieve ADCP and Sediment Trap moorings. Complete MBES survey of Disturbance box. CTD over area where glider picked up signal. Multicorer stations #207-217.
3 June	Continue multicorer survey (#218-228). Retrieve three landers, and glider while good weather. Redeploy ADCP mooring (#229) and sediment trap mooring (#230). Two DTIS on "butterknife" feature before Benthic Disturber runs. Disturber has slip-ring problem, delayed. Two more DTIS (#233-234)
4 June	Disturber back in action. Deploy on lines to south of "butterknife" feature. Complete 11 lines. DTIS tows through area (#236,237). Continue post-disturbance DTIS survey, MON5, MON3 (#238-239)
5 June	Post disturbance DTIS survey tows on DIS1, DIS2, MON8, MON3, MON1 (#240-245). Multicores to finish post-disturbance survey, MON7 (#246-247) and MON5 (#249-251). Begin steam at 1500 for sponge sampling site.
6 June	Multibeam two lines in sponge site area, deploy DTIS (#252), and then two short beam trawl shots to sample sponges for lab work (#253,254). Begin transit to Wellington.
7 June	Arrive back in Wellington

3.3 Voyage area, track and sites sampled

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

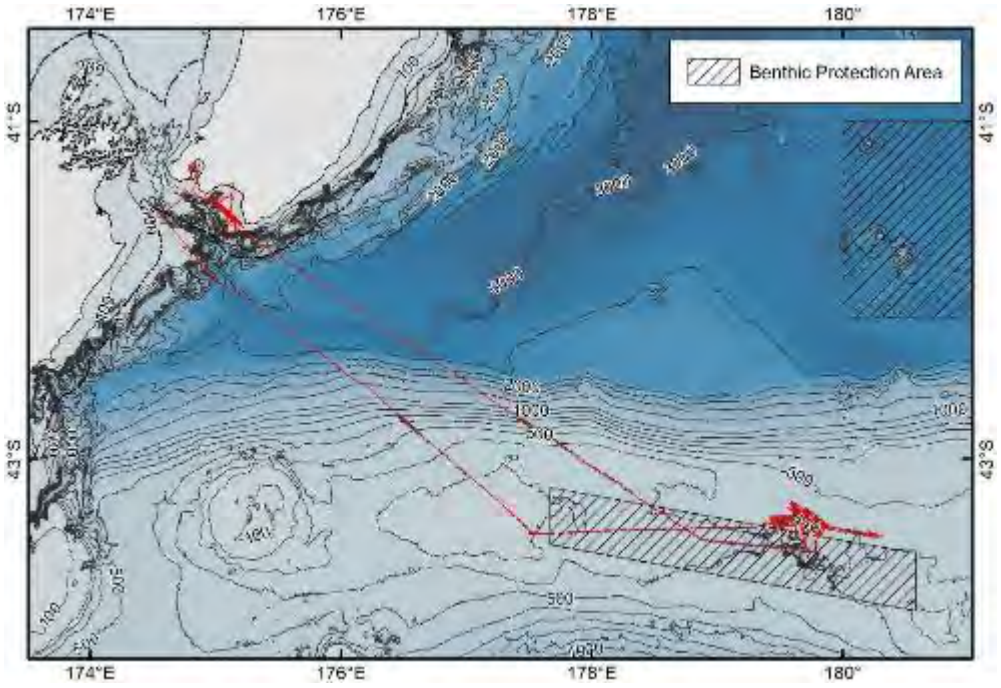


Figure 3-1: The vessel track, showing general location of the main survey (cluster of red track lines.

The area was centred on a station where previous camera work had suggested coral communities could occur. This was an area of relatively uniform slope, with no topographic features, but patches of coral communities on exposed rock and cobble substrate. The survey area was east of the main license area held by Chatham Rock Phosphate, and several nautical miles north of the northern boundary of the Mid-Chatham Benthic Protection Area (BPA).

4 Research components

4.1 Survey approach

The survey design was developed over a number of team meetings prior to the survey, taking into account the experiences from previous deep-sea disturbance experiments (Jones et al. 2017). The general sequence undertaken is given below, which outlines the main structure and components.

Initial work with Multibeam and DTIS will establish the suitability of the site, and take into account a number of factors, including:

- Nature of the seafloor (composition, mud, nodules, cobbles, pebbles etc)
- Topography (flat or gradual slope, clear of possible obstacles for the Disturber)
- Distribution of fauna-appropriate species composition (corals, sponges), abundance (numbers and density), and extent of distribution downstream of the potential disturbance site.

The sampling design was based on a gradient approach, commonly used to monitor seabed environmental changes in the oil and gas industry. The theoretical approach was to sample along two axes of potential plume dispersal to represent overall effects.

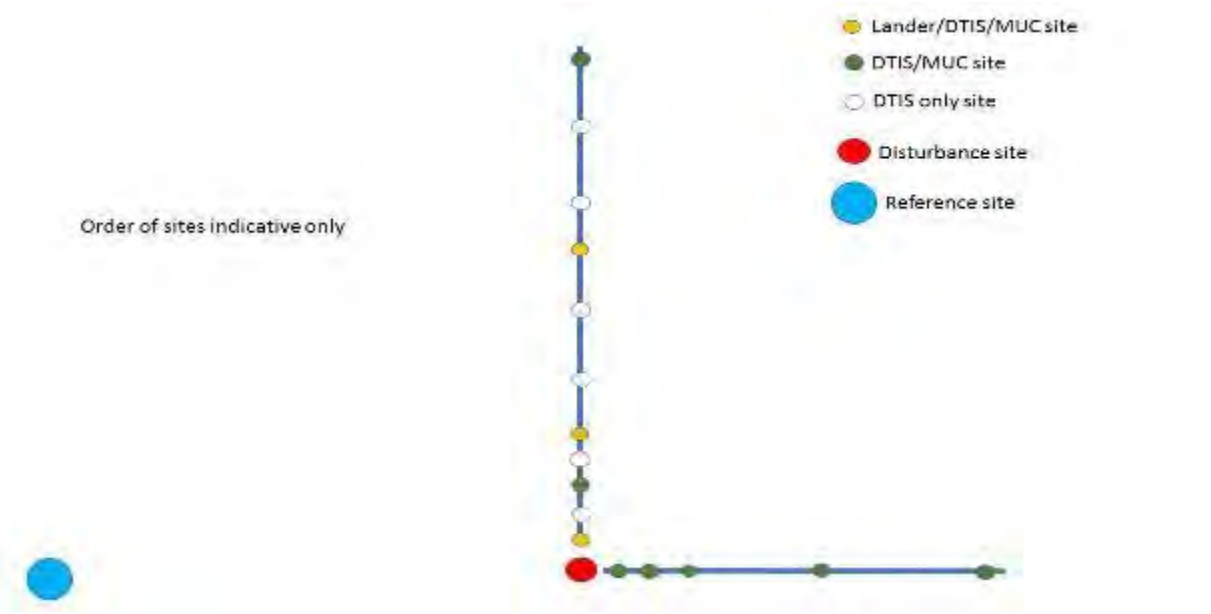


Figure 4-1: Schematic of the general from of the planned 2-axis survey design.

A Reference Site is situated well away from the potential area of plume dispersal, but close enough to be indicative of unimpacted conditions. Then emphasis with sampling is placed along the main axis.

1) Moorings are deployed at the reference site to provide background flow and environmental data clear of any likely passage of the plume.
2) A baseline survey with multibeam, DTIS, CTD and multicorer (MUC) is carried out.
3) Benthic landers are deployed pre-disturbance to measure the plume deposition along the main axis of dispersal during and following disturbance.
4) The seafloor is disturbed over a compact area (red oval), creating a plume of sediment, that disperses down-current.
5) The vessel tracks the plume with a variety of instrumentation (towfish, MBES, acoustic sounders, ADCP).
6) The glider is also programmed to work through the expected area of the plume to help detect and track it.
7) The baseline survey is then repeated post-disturbance.

4.2 Pre-survey hydrodynamic modelling

The dispersal of the plume was the subject of extensive modelling prior to the survey taking place. This took into account factors such as the composition of the sediment from available corer data (and hence settlement rates), height of release (assumed 5 m from the BDR), and tidal modulation.

Results showed a complex plume pattern that varied with lunar cycles, but overall indicated settlement of most particles within 0.5–2.5 km, as shown in the figure below.

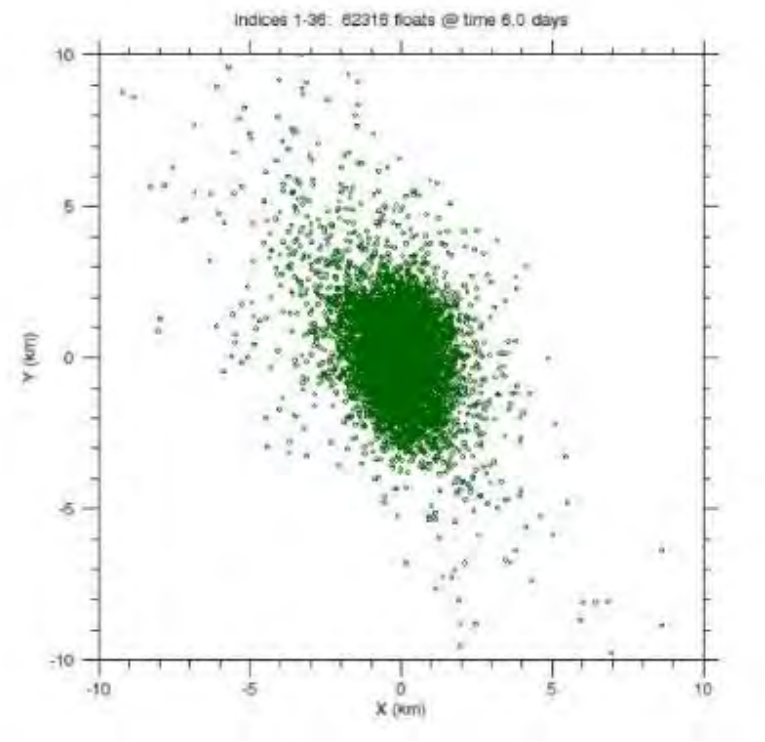


Figure 4-2: Modelled dispersal and settling direction and distances of sediment plume particles.

Specific transect line surveys were run with the ADCP to cover tidal periods, and the glider also provided regular current flow information. These sources were used to evaluate direction of likely dispersal relative to the modelling, and to identify the best position for disturbance

4.3 Survey area

The general area we intended to survey had been identified from an examination of seabed images and benthic sample information held by NIWA. This then needed to be assessed in relation to several criteria:

- Substrate
  - some nodules/sediment combination to be realistic for potential mining or trawling disturbance
- Biology
  - representative faunal composition
  - density high enough to be meaningful for measuring changes, but not high enough for concerns of sensitive habitat, or Vulnerable Marine Ecosystem classification
- Trawling distribution
  - Low effort, keep area clear in future
- Clear of protected or conservation areas
  - Benthic Protection Areas, Seamount Closure Areas

Images from DTIS recorded during TAN1701 (a site termed S129) revealed a small community of corals, sponges and associated benthic invertebrates. This was the focus of our exploration at the start of the survey, undertaking a detailed MBES survey of the area, and DTIS tows to image the seafloor. A second region, extending to the west, was also surveyed if we found S129 to be unsuitable. Each had advantages and disadvantages, but the S129 area was determined overall to be the most appropriate.

The MBES work (described more below) identified a patchwork of backscatter and low topographic relief that was used to plan DTIS tows in the exploratory phase of the voyage.

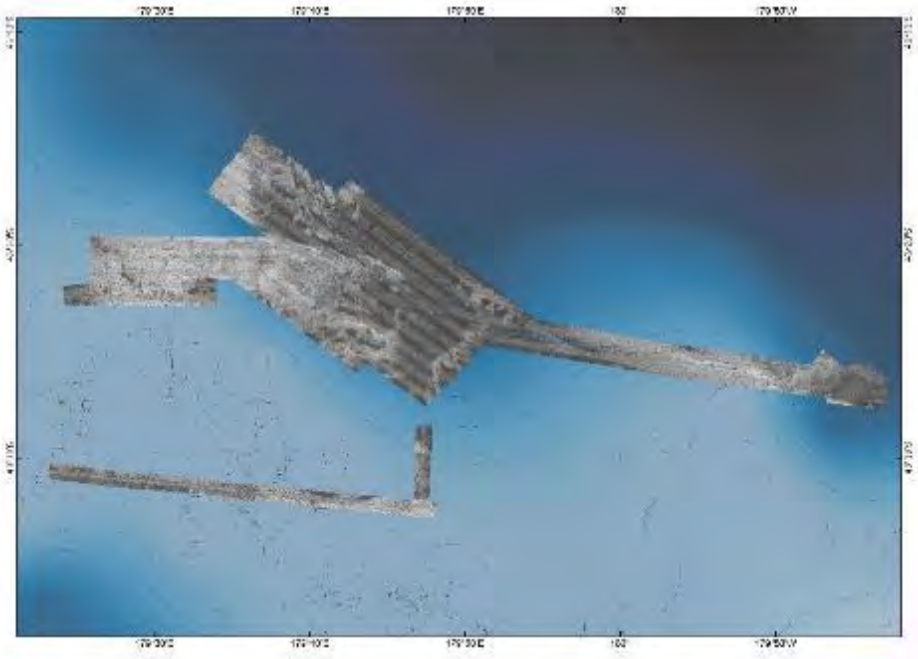


Figure 4-3: The area covered by the survey and multibeam transects, showing the patchiness of substrate composition (backscatter-light is high reflectivity).

The location of the monitoring sites (coded "Mon" in the figure below) was based on where patches of coral-dominated communities were found. These were typically distributed along the ribbons of high reflectivity (light colouration) in the backscatter. This is discussed further on in the report.

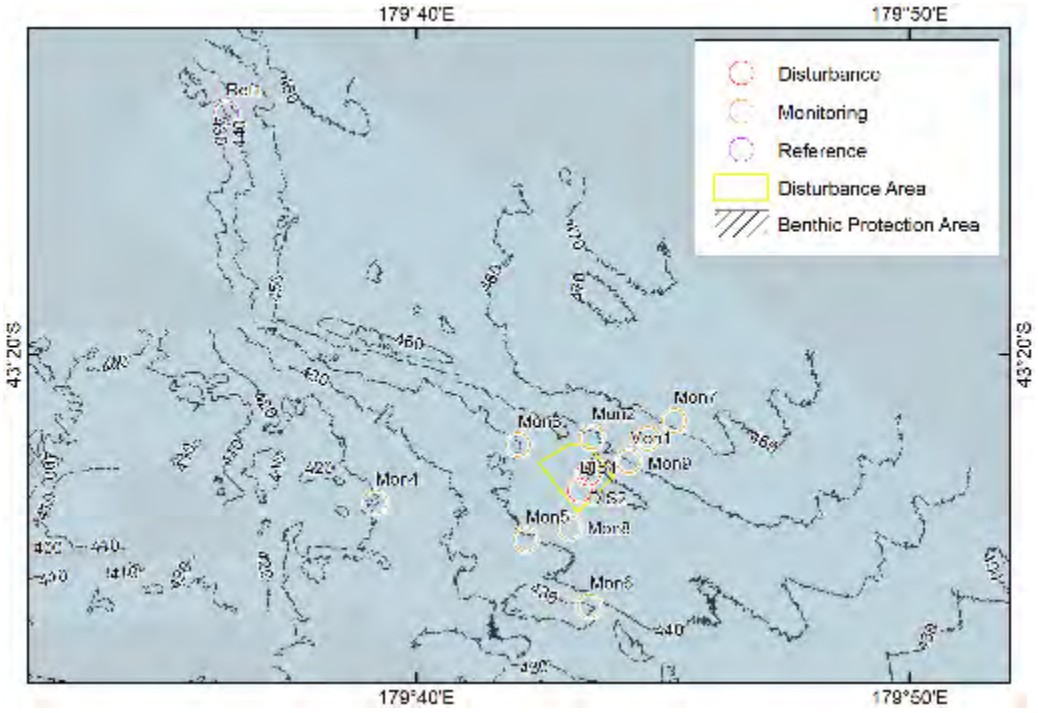


Figure 4-4: The main survey area, showing the location of core sampling sites, and the disturbance box (yellow polygon).

The design ended up being considerably different from the theoretical plan, as the patchiness of the biology meant an axis approach was not possible. Instead, the design became driven by a more circular gradient, with varying distances to Monitoring sites across a number of directions from the disturbance site.

Table 4-1: Summary of distance and direction of sampling sites from the disturbance box.

Site	Distance from edge of Disturbance box (n.miles)	Direction to site
Mon 2	0.13	028
Mon 8	0.28	200
Mon 1	0.33	070
Mon 3	0.50	290
Mon 7	0.67	041
Mon 9	0.76	066
Mon 5	0.86	219
Mon 6	1.40	173
Mon 4	2.64	263
Ref 1	7.0	316

Several DTIS runs around Mon2 and Mon 3 sites were brought closer to the edge of the Disturbance Box when it was realized that any sedimentation might be over a small distance (<2 km).

4.4 Sampling stations

The total number of stations completed was 254 of which 225 were part of the main survey sequence.

Table 4-2: Number of sampling stations of the main gear types during various phases of the survey.

Phase	CAM	MUC	CTD	BDR
Exploratory/testing	25		1	3
Pre-disturbance	20	51	9	
Disturbance phase				8
Post disturbance	22	32	39	

Table 4-3: Number of deployments by sampling gear type.

MUC	CAM	CTD	LAN	TOW	MOOR	SVP	GCR	SLED	BDR	GLR	BEAM
83	70	49	7	7	5	11	3	5	11	1	2

In addition, 11 SVPs, 2 beam trawls, and 5 sled shots were completed. There were 7 test deployments of the towfish.

Details of all stations are given in Appendix A.

4.5 Physical Oceanography

4.5.1 Methods

A number of gear types and instruments were deployed or used to measure and characterise the oceanographic conditions in the area, as well as the plume composition.

CTD

Data acquisition instrumentation combined a Seabird Electronics Inc. (SBE) 911plus CTD and a 24 by 10-litre SBE 32 Carousel water sampler. The CTD sensor configuration consisted of primary temperature (SBE 3plus), primary conductivity (SBE 4), and primary dissolved-oxygen (SBE 43), plumbed horizontally and pumped by a SBE 5T pump; secondary temperature (SBE 3plus), secondary conductivity (SBE 4), and secondary dissolved-oxygen (SBE 43), plumbed horizontally and pumped by a second SBE 5T pump; pressure (Digiquartz); primary and secondary fluorescence (Seapoint SCF); primary and secondary transmissivity (Wetlabs C-Star 25-cm Red); solar photosynthetically active radiation (PAR) (Biospherical Instruments QCP-2300L-HP); and sonar altitude (Tritech PA500/6K8). The water sampler carried 24 10-litre external-spring Niskin-type bottles (Ocean Test Equipment Standard 10 BES). Data acquisition software was SBE Seasave Version 7.22.3. On selected casts, a Wetlabs Ecotriplet was attached to the CTD frame to measure Coloured Dissolved Organic Matter (CDOM), 660 nm fluorescence and particle back-scatter, as a proxy for turbidity. The Ecotriplet logged data internally and required manual setting for each cast.

Water samples were collected from selected depths for processing onboard. Primary sampling depths were 200, 350, 400 and nominally ~440 (i.e., at the bottom of the CTD cast, typically 10 m above the seafloor) metres, with additional sampling undertaken at surface (nominally ~10 m), 100 and 300 m. The seawater was transferred into 10 litre carboys, except for those samples that are taken directly off the Niskin bottles (see below). Details of the methods used for the water column measurements are summarised here.

The water column parameters were:

1) Total Suspended Solids (TSS) – 47 mm-diameter, pre-weighed, 0.45 µm membrane filters; 2 litres of sea-water filtered at each depth; filters rinsed with 0.2 µm filtered seawater and then deionised distilled water to remove sea salts and dried naturally (no heating) in the dark. Total number of samples: 88.
2) TSS - particle size – 250 ml unfiltered water sample was also collected into a polyethylene bottle from each depth and poisoned with one drop of 7% saturated mercuric chloride for later particle grain-size analysis. Total number of samples: 75.
3) Particulate Organic Carbon-Particulate Nitrogen (POCPN) and Total Carbon-Total Nitrogen (TCTN) – 25 mm-diameter, pre-combusted (400°C, 4 hours), GFF glass-fibre filters; 1 litre of sea-water filtered at each depth. POCPN samples were acidified with 4 ml 0.4 N H2SO4 while TCTN samples were not acidified; both filter types were rinsed with 0.2 µm filtered seawater and frozen at -20°C. Total number of samples: 80 POCPN, 75 TCTN.
4) Chlorophyll a (Chla) – 25 mm-diameter, GFF glass-fibre filters; 0.5 litres of sea-water filtered at each depth, rinsed with 0.2 µm filtered seawater and frozen at -80°C. Total number of samples: 84.
5) Nutrients – the filtrate from the Chla samples were collected in 250 ml polyethylene bottles and frozen at -20°C. Total number of samples: 84.
6) Dissolved organic carbon (DOC) – 50 ml samples, filtered directly from the Niskin bottle through a 47 mm, pre-combusted GFF filter, into pre-ashed glass Schott bottles and frozen at -20°C. Total number of samples: 73.

7) Dissolved inorganic carbon/alkalinity (DIC/alk) – 1 litre samples collected into glass Schott bottles directly from the Niskin bottle, poisoned with one drop of 7% saturated mercuric chloride. Total number of samples: 72.
8) Coloured dissolved organic matter (CDOM) – 60 ml samples collected into polycarbonate containers and refrigerated at 4°C. Samples were then processed onboard by measuring the absorption signatures (200-850 nm) using an Ocean Optics DT-MINI UV/VIS light source, liquid waveguide capillary cell (LWCC), and USB4000 spectrophotometer. Total number of samples: 135, including nanopure water blanks and repeats.
9) Trace gases (methane, CH4; nitrous oxide, N2O) – 240 ml samples were collected directly from the Niskin bottle into glass serum bottles; Samples were poisoned with one drop of 7% saturated mercuric chloride, sealed with crimped aluminium caps and rubber stoppers and stored in a chilly bin. Total number of samples: 44.

Water Sample Reference Data

Salinity

A total of 98 salinity water samples were drawn and measured aboard ship according to NOCF protocols. Instrumentation for measuring these samples consisted of a Guildline 8400B Salinometer, an Ocean Scientific International (OSIL) salinometer interface and OSIL Salinometer software. The salinometer was standardised with IAPSO Standard water (Batchs P156 and P157). The water sample containers were 250 ml (nominal) serum bottles with plastic caps and disposable plastic inserts, as supplied by OSIL.

Dissolved Oxygen

A total of 97 dissolved-oxygen water samples were drawn and measured by wholebottle Winkler titration according to NOCF protocols. Instrumentation for measuring these samples consisted of a custom built and adapted automated whole-bottle Winkler titrator with ultraviolet end-point detection, originally based on a design of Scripps Institute of Oceanography. The titrator was standardised with standards made up by precision weighed quantities of potassium iodate (K IO3), diluted in ultrapure deionised water, and made up to volume at a measured temperature in a volumetric flask of measured volume. To allow for the titration of the high oxygen concentrations of cold Antarctic surface water, a more concentrated that normal Sodium Thiosulphate solution was made up; around 70 g/l compared with the normal 50 g/l. The water sample containers were 125-ml (nominal) Pyrex or Kimax brand iodine flasks with glass stoppers and ground glass seals between the flask neck and the stopper. Matched flask and lid combinations were individually numbered and their contained volumes at 20 °C known from previous measurement.

Moorings

A total of three moorings were set-up for deployment during TAN1805. A RD Instruments 600kHz Acoustic Doppler Current Profiler (ADCP) was deployed in 440m at the REF site (43° 16.546’ S, 179° 35.716’ E) for approximately 2 weeks. ADCP bin sizes were 4 m thick, with the first bin 6.2m above the ADCP. There were 25 bins, spanning the lower water column, from 350 to 450m. Current velocities. ADCP sampling interval was 600 seconds.

A McLane PARFLUX Mark 78HW-13 sediment trap (S/N: ML14441-01) was deployed on a single mooring (see Results section). The sediment trap samples will be analysed for total mass flux, POC, PN and chla flux to match the water column measurements, and particle grain-size distribution.

A separate mooring was deployed with a McLane Remote Access Sampler (RAS), with 48 x 500 ml water sample bags.

The final moorings deployed for 12 months beginning June 2018 are shown below.

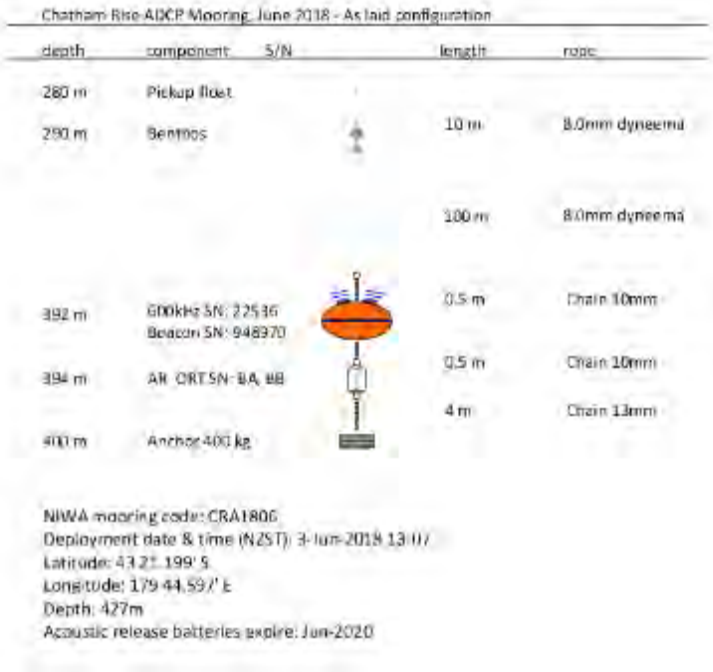


Figure 4-5: Details of the ADCP mooring.

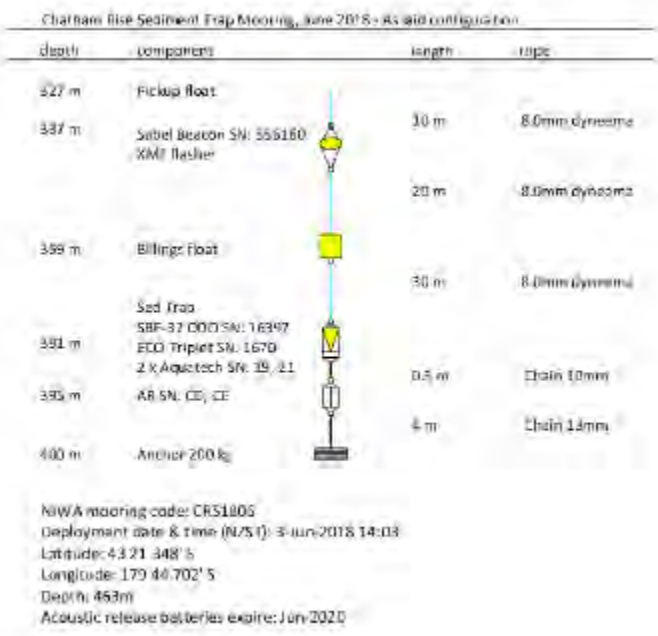


Figure 4-6: Details of the Sediment trap mooring.

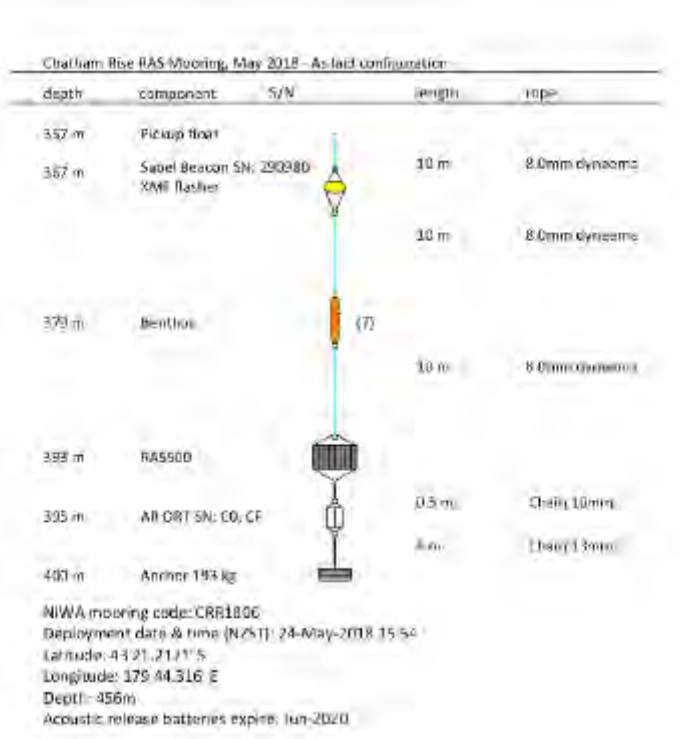


Figure 4-7: Details of the RAS water sampler mooring.

Shipborne acoustic sensors

The ship's acoustic sensor, including the EK60 Split-beam Echosounder (SpBES) (18, 38, 70, 120, 200 kHz), EM302 Multibeam Echosounder (MBES) (30 kHz), EM2040 MBES (200 kHz), TOPAS PS18 Sub-Bottom Profiler (SBP) (2-10 kHz), and Acoustic Doppler Current Profiler (ADCP were utilized during the survey.

MBES

The Kongsberg EM302 is a mid to deep water MBES using frequencies centred on 30 kHz. The system has 288 beams generating up to 432 soundings per swath and has dual-swath capability (two swath in one ping cycle). The system can record bathymetry (water depth), seafloor and water-column backscatter data. All three pieces of information where used for this project, with particular interest in detecting sediment plumes in the water-column and changes in the seafloor backscatter data.

The system's last calibration and determination of transducer misalignment values was done in July 2017 (TAN1707). It is deemed to be still accurate and no off-set errors caused by wrong calibration values or changed transducer alignments were observed in the MBES data

The initial data collection was aimed at locating suitable sites for the benthic disturbance experiment, both for the disturbance itself and for potential monitoring sites. Lines were spaced to allow for relatively overlaps (5-10%) only. The ADCP was run synchronised with the EM302 to provide a more detailed understanding of the currents in this area. Data from these lines provided maps for the DTIS operations.

The Kongsberg EM2040 is a shallow water MBES using frequencies centred on 200, 300, or 400 kHz. The system has 256 beams generating up to 400 soundings per swath and has dual-swath capability (two swath in one ping cycle). The system can record bathymetry (water depth), seafloor and water-column backscatter data. The EM2040 was intended to be used if the experiment site selected had water depth shallower than c 400 m. This would have allowed the use of an additional frequency, an

advantage as reflectance and backscatter are frequency dependent. As the selected site was around 450 m the EM2040 was not used.

EK60

The keel mounted EK60 system on RV *Tangaroa* comprises five frequencies (18, 38, 70, 120, 200 kHz). Calibrations using standard spheres lowered under the ship in position to appear in the four sectors of the split-beam echosounders are run regularly by NIWAs fisheries acoustic scientists. A full calibration is planned for the start of TAN1806, and results from this are transferable to TAN1805 data.

Operation

The EK60 was set for a 1000 m range, but as the depth of the survey area was typically less than 500 m the ping cycle of the EK60 was reduced to 1 sec using the K-Sync unit's setup.

Details of the sounder setup can be found in the figure below

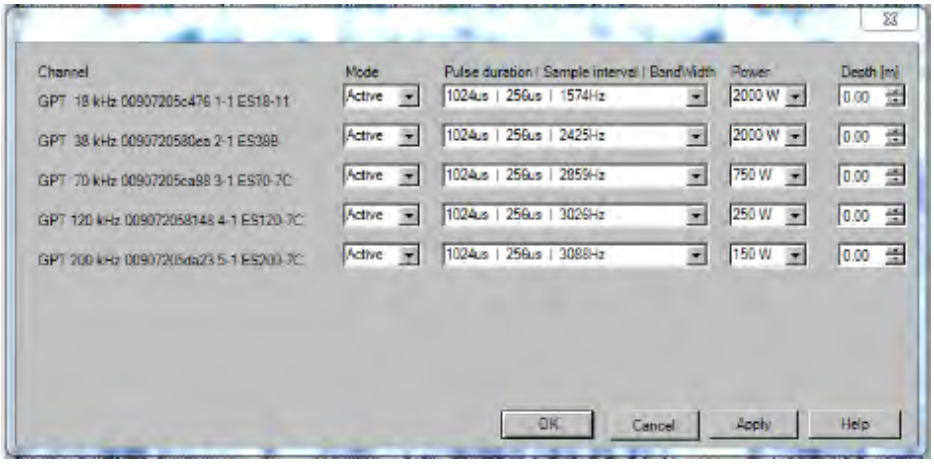


Figure 4-8: Settings for the five EK60 frequencies used during the survey.

ADCP

Tangaroa is fitted with a 75kHz RDI ADCP, which uses acoustics to measure ocean current speed and direction at depth intervals ("bins") through the water column below the ship. The transducer is housed in an acoustic pod, located on the hull slightly port and forward from the ship centre, at a depth of 5m. A blanking distance of 8m applies to all data collected, meaning the first measured depth range starts at 13m.

Data collection is controlled by the software VmDas with short-term-averaged data transmitted across the DAS network for near-real time display. The use of external software KSync allows the ADCP to be further controlled in the timing of transmission to allow simultaneous use of different acoustics transducers which would otherwise interfere. Raw data are recorded in duplicate and are archived at the end of the voyage prior to further quality control cleaning and analysis. Real-time display of currents from the ship ADCP were displayed via endmap on the bridge to aid in plume detection for other ship operations.

Supporting Systems

K-Sync

The K-Sync unit synchronises the ping cycles of all echosounders on-board RV *Tangaroa*. This is necessary as frequencies used by systems overlap and would cause interference in the recorded data.

SVP/CTD

Cast data from an AML x.Change Sound Velocity Profiler (SVP), a Seabird SBE37 Conductivity Temperature Depth (CTD) probe (attached to the DTIS system), and a Seabird SBE911 CTD (attached to the rosette water sampler) were used to generate SVP files formatted for Kongsberg systems. The data cleaning, extending of profiles, and conversion were done utilising the UNH/NOAA "SoundSpeedManager" software.

Glider

The glider used in the voyage was NIWAs 1000m rated underwater Slocum Glider 'Betty'. Slocum gliders are buoyancy driven, autonomous underwater vehicles that move through the ocean in a saw-tooth pattern at a top speed of 0.3ms^{-1} (0.5 knots) and a descent/ascent rate of 0.2ms^{-1}. Science sensors were sampled every 4 seconds during the dive from the sea surface to 13m above the seabed, and the return to the surface.

The glider carried a suite of sensors:

- SeaBird CTD - temperature, conductivity, pressure
- WetLabs FLBBCD - chlorophyll, coloured dissolved organic matter, scattering at 700nm
- WetLabs BB3 - scattering at 470, 532, 660nm
- Biospherical QSP2155 - photosynthetically active radiation
- AADI OXY4831 - dissolved oxygen concentration

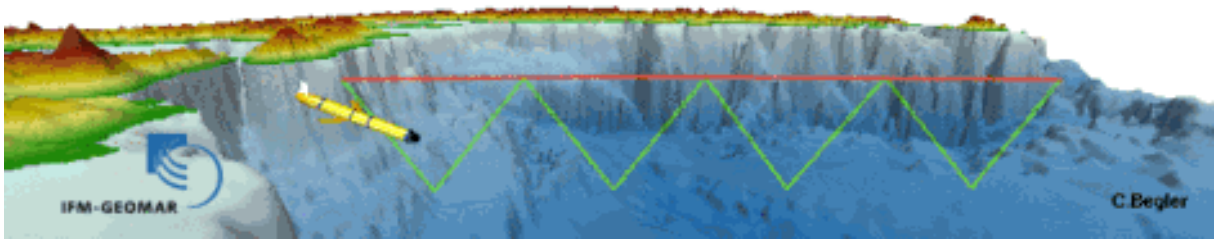


Figure 4-9: Diagram showing saw-tooth pattern of underwater glider and two-way transfers.

Towfish tow body

The Towfish was developed to allow at depth real time turbidity measurements to be observed and recorded over a large area. The main structure for the Towfish came from a small acoustic tow body that was stripped out and re-engineered to accommodate an Aqualogger turbidity sensor, an acoustic altimeter and a fibre interface housing.

The Towfish was deployed from the fantail of RV *Tangaroa* and can be towed by either of the two acoustic winches. The acoustic winches provide communications and power via a fibre optic/copper composite armoured cable.

The fibre interface housing located within Towfish converts the fibre and 230Vac power from the armoured tow cable into 2 x rs232 serial connections, 2 x ethernet connection and 30vdc and 12vdc to power the Aqualogger and altimeter. While the fibre Interface housing has been developed for Towfish it is also intended to be used with other towed instrument platforms.

Towfish specifications:

- Length 1800 mm
- Main body diameter 315 mm
- Width across fins 850 mm
- Weight Towfish 170 kg plus 60 kg Depressor Wing in air and 170 kg in water.
- Max depth 1500 m

4.5.2 Results

CTD

A total of 50 CTD casts was completed over the duration of the voyage. Initially CTD casts were done at each monitoring site. However, most were carried out immediately after a disturbance event in a grid pattern, to detect and take water samples of the near bed plume and water column. Several station sites were repeated due to CTD issues. The majority of issues being water ingress/corrosion on connectors plugs. Cables were replaced on the Seapoint turbidity logger, WETLABS transmissiometer and fluorescence instruments.

Temperatures spanned 8° to 14° C and salinity ranged from 34.5 to 34.95 psu from the T-S plot. An example CTD profile prior to the use of the benthic disturbance shows the presence of several oceanographic features. 1) an upper well-mixed water column with high fluorescence, and 2) a homogeneous bottom boundary layer that had lower transmission (down to 94% light transmission).

The lower light transmission is indicative of higher turbidity in the bottom boundary layer, which during TAN1805 was up to 100 m above the seafloor.

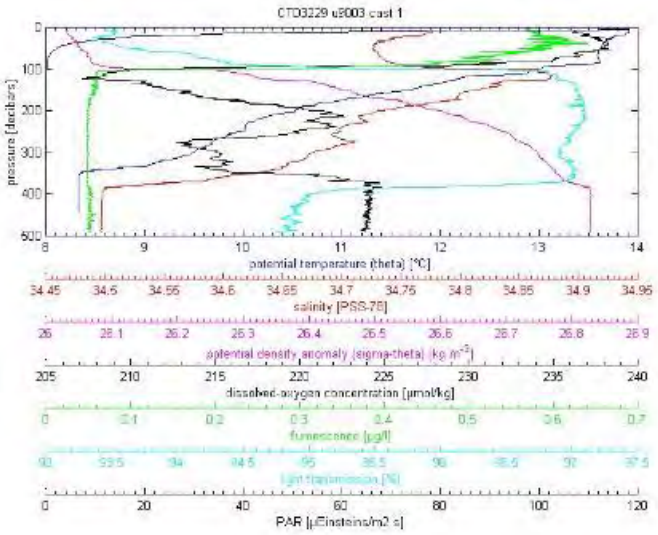


Figure 4-10: Example CTD profile prior to the use of the benthic disturber (u9003).

A CTD profile on June 2 (u9044) from after the second benthic disturbance through the main disturbance box was quite different in the near-seabed region. Light transmission was lower for this profile and down to 93% at 450 m and there were several peaks over the lower 100 m rather than a uniform lower layer. While there was a decrease in light transmission, the reduction was only several percent compared to before any benthic disturbance and suggests that any plume detected by the CTD had low turbidity concentrations.

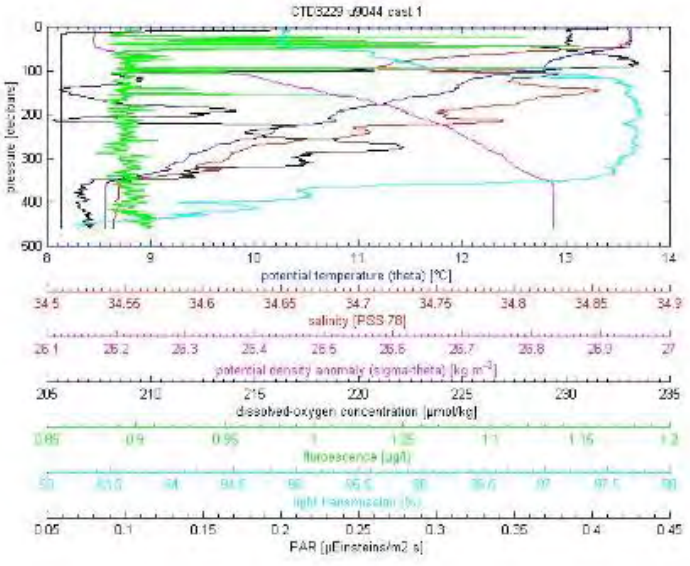


Figure 4-11: Example CTD profile following the use of the benthic disturber (u9044, station 200).

Moorings

Deployment details of the three moorings are given below.

Table 4-4: Deployment location data, and information on sensors attached to the moorings.

Mooring Metadata										Instrument Metadata					
Platform	NIWA Code	TAN1805 station no.	Deployment start date NZST	Deployment start time	Deployment end date	Deployment end time	Latitude	Longitude	Depth	Model	SN	HAB (m)	Nominal depth (m)	Sample interval (s)	Burst sample (s)
ADCP mooring	1805CRA	54	20/05/2018	15:13	2/06/2018	13:37	43 16.546 S	179 35.716 E	440	Xeos Sable	948970	8	432		
										RDI 300kHz	22536	8	432	600	N
										Sonardyne ORT	BA	5	435		
										Sonardyne ORT	BB	5	435		
ADCP mooring	1806CRA	229	3/06/2018	13:07			43 21.199 S	179 44.597 E	427	Xeos Sable	948970	8	419		
										RDI 300kHz	22536	8	419	600	N
										Sonardyne ORT	BA	5	422		
										Sonardyne ORT	BB	5	422		
Sediment Trap Mooring	1805CRS	55	20/05/2018	15:53	2/05/2018	12:00p.m.	43 16.675 S	179 36.187 E	463	Xeos Sable	556160	67	396		
										Xeos XMF		67	396		
										McLane Sediment trap		9	454		
										Sonardyne ORT	CE	5	458		
										Sonardyne ORT	CD	5	458		
Sediment Trap Mooring	1806CRS	230	3/06/2018	14:03			43 21.348 S	179 44.702 E	460	Xeos Sable	556160	67	393		
										Xeos XMF		67	393		
										McLane Sediment trap		9	451		
										Wetlabs BBFLCD2WB	1670	9	451	1800	N
										Aquatec aqualogger	255-4019	9	451	900	10
										Aquatec aqualogger	255-4021	9	451	900	10
										SeaBird SBE37ODO	16397	9	451	1800	N
										Sonardyne ORT	CE	5	455		
										Sonardyne ORT	CD	5	455		
RAS Mooring	1805CRR	102	24/05/2018	3:54			43 21.271 S	179 44.316 E	456	Xeos Sable	290980	33	423		
										Xeos XMF		33	423		
										McLane RAS		7	449		
										Sonardyne ORT	C0	5	451		
										Sonardyne ORT	CF	5	451		

ADCP

Preliminary plots from the ADCP deployed at the REF site for 14 days are shown below Current magnitude and direction span the lower 100 m of the water column from 350 to 450 m. Current magnitudes ranged from 0 to 0.4 ms^{-1}. Faster currents near the beginning and end of the deployment are associated with spring tidal ranges of up to 1.4 m on Chatham Rise. There was an asymmetry in currents due to the duration of an ebb tide exceeding the flood tide. For the shorter tidal stage (flood), current speeds are faster than during the longer tidal stage. Current directions were towards the N/NE and S/SW over the 2 weeks.

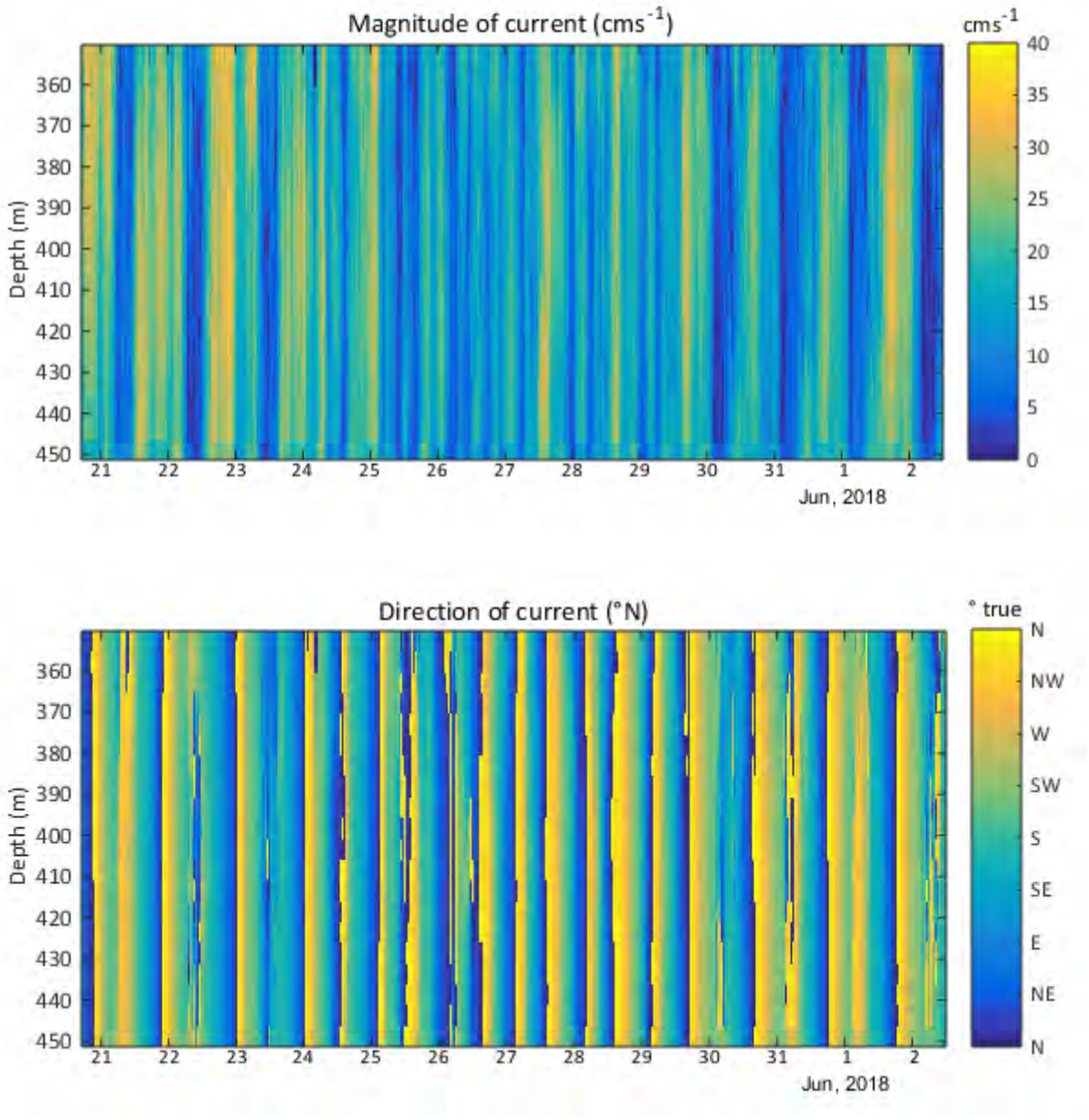


Figure 4-12: Current speed (top) and current direction (bottom panel) from the ADCP at the REF site.

Tidal cycles were also seen in the depth-averaged direction frequency and echo amplitude.

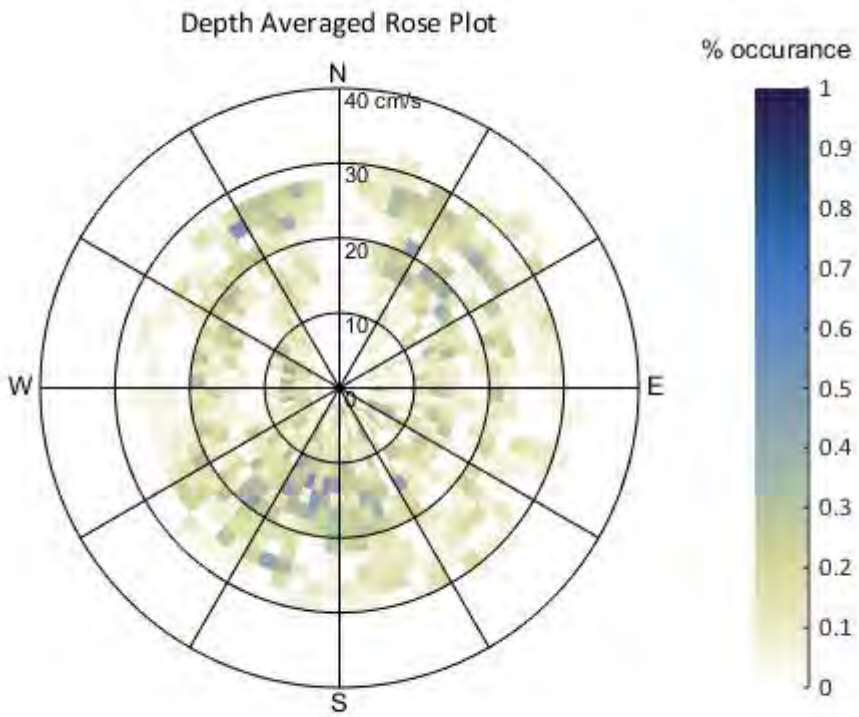


Figure 4-13: Depth-averaged current rose plot from the moored ADCP.

Acoustic backscatter from the upward facing ADCP can be used to indicate sediment resuspension. In the backscatter data from May 23 to June 2 there were regular occurrences from 400 to 450m. The frequency of the larger peaks in backscatter was diurnal rather than semi-diurnal and was due to larger tidal amplitudes on every second tide.

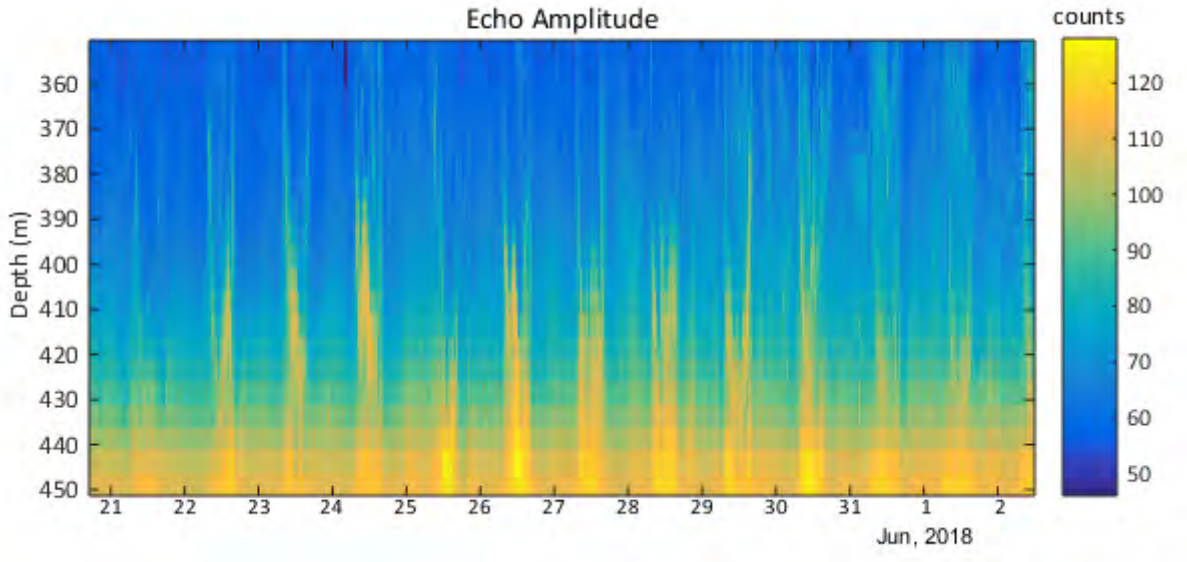


Figure 4-14: Echo Amplitude from the ADCP deployed at the REF site for 14 days.

Sediment trap

The sediment trap deployed at the REF site had a sampling interval of ~ 1 day (13 bottles). Prior to deployment, 500 ml trap bottles were filled with 1.0 µm/0.45 µm filtered seawater collected using the CTD-rosette from near the sea-floor (440 m water depth) that was amended by adding 60 g mercuric chloride, 115 g sodium chloride and 20 g sodium borate to 20 litres of seawater. The trap was deployed about 10 m above the seafloor. The trap collected a full suite of 13 samples. Measured tilts ranged from <0.5° to ~3°. The trap bottles were removed from the sediment trap and stored in a refrigerator at ~4°C.

After this initial deployment, the sediment trap was turned around (batteries replaced, new filled sample bottles installed) and re-deployed on 3 June in the vicinity of the benthic disturbance for a period of one year. The trap was moored about 10 m off the seabed, with the first bottle programmed to be open for 1 week (4-11 June 2018) and then the remaining 12 bottles open for 27 days each for the remaining year-long deployment. Two Aqualoggers, one Ecotriplet and one Seabird MicroCAT/DO sensor were also attached to the sediment trap frame. One Aqualogger was programmed to sample until December 2018, followed by the second Aqualogger (with 1 month overlap) to ensure full sample coverage across the year-long deployment.

The McLane RAS was deployed about 7 m above the seabed on 23 May in the vicinity of the benthic disturbance. The RAS was programmed to sample seawater at 1 day intervals for the first 3 weeks of the deployment period (21 bags), and then every 12 days for the remaining year-long period. The sample bags were pre-poisoned before the voyage by adding 1 ml of 7% saturated mercuric chloride to each 500 ml bag. Before each collected sample in the field, the system was programmed to be flushed with 10% HCl; the sampled seawater was not filtered.

Mooring and lander positions were determined after landing on the seabed by triangulation fixes based on distance and bearing from the ship to an acoustic transponder mounted on the equipment.

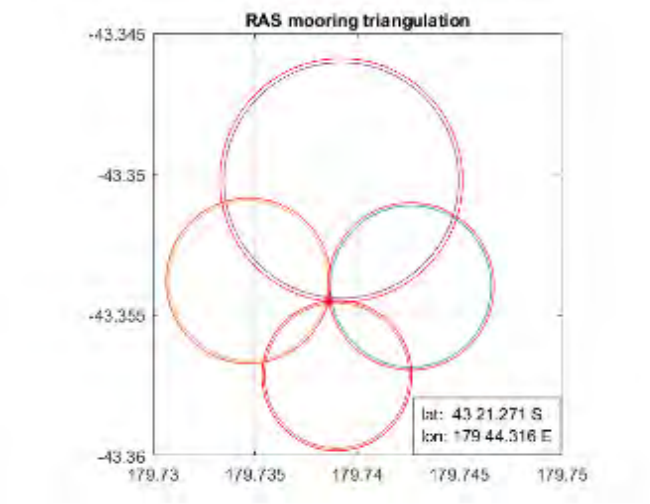


Figure 4-15: Triangulation of the RAS water sampler mooring, showing seafloor location of the mooring.

MBES-Acoustics

All acoustic systems worked well, although a heave artefact in the MBES data was noted during times of heavy, multi-directional, swells. While this does not put the data outside expected tolerances, it will undergo further analysis.

In total 33 SVP/CTD profiles were loaded, cleaned, and exported to Kongsberg 'asvp' format. A concatenated file of all casts was exported into CARIS HIPS compatible format for use in post-processing of the bathymetry data.

All MBES operations followed NIWA standard operating procedures. The swath was reduced to 60° either side of Nadir (120°) as one of the main aims was to collect high quality seafloor and water-column backscatter data. This was best achieved by restraining the swath width.

After a disturbance area was selected further lines were run in this smaller zones. Lines were in parallel to the existing lines run during exploration. This increased the coverage to >200% allowing the generation of seafloor backscatter without use of the specular reflection data at Nadir. These high density data also provide a background dataset for the water-column backscatter up to a depth of about 200m above the seafloor, thus covering the expected plume extent.

Along these lines the EM302 MBES, the EK60 SpBES, and the ADCP were run. The number of systems meant a reduced ship speed of 6 knots, allowing sufficiently small distances between pings of each system.

Post-disturbance lines from the first two parts of the MBES work stretching over the area covered by disturber tracks were repeated, keeping line direction identical.

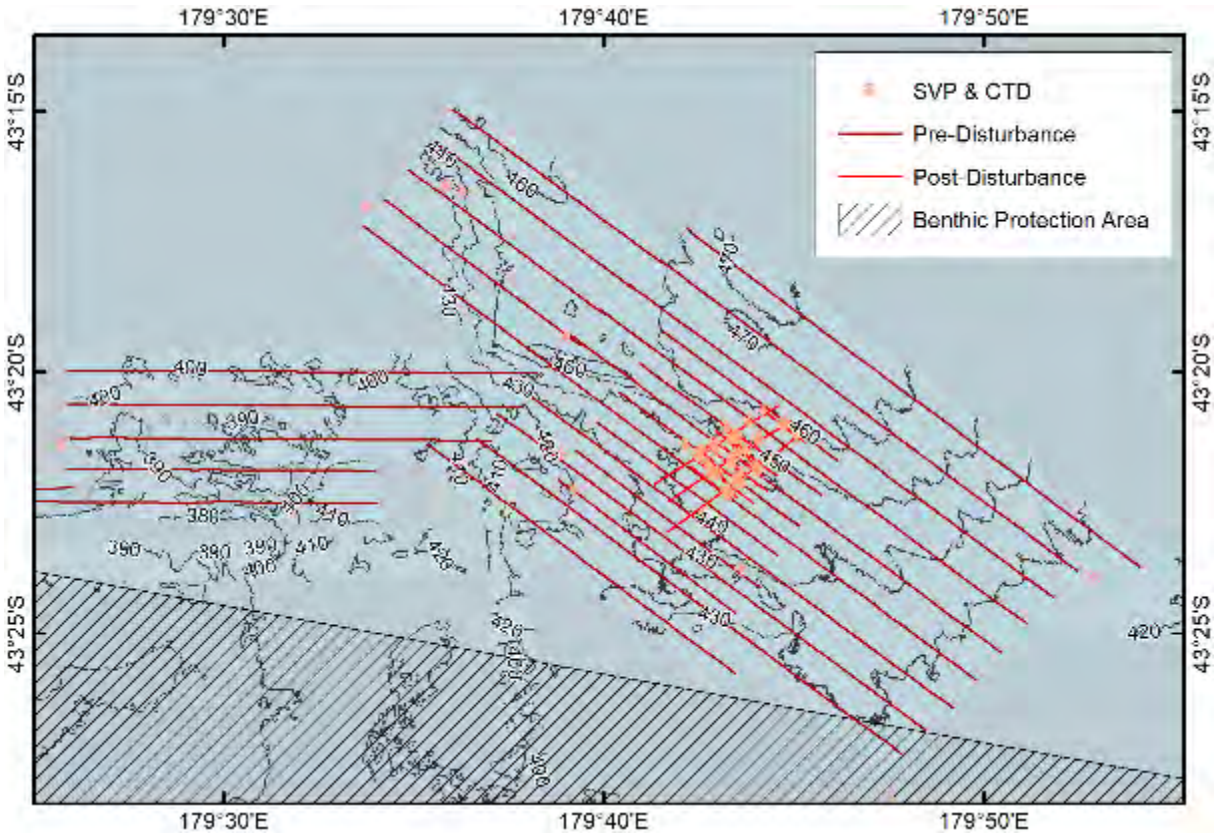


Figure 4-16: Distribution of MBES transect lines in the main survey region.

In addition to the targeted survey lines the acoustic systems were run and data collected during the disturbance runs. While the constant turning and towing of the BDR at slow speeds caused significant cavitation noise effecting the data quality, these lines have the advantage of being closest in time to the disturbance.

Some acoustic reflectors in the first 50 m above the seafloor were noticed, but no clear pre-/ post-disturbance change was noted in the limited processing possible at sea. Further work on this will be carried out.

EK60 data were collected in parallel with EM302 and ADCP data on the target survey lines and during the disturber runs. Pre-processing (loading, bottom tracking) was done using the NIWA ESP3 software. Further processing will be done post-voyage).

Glider

NIWAs ocean glider "Betty" was deployed on May 20 and recovered on June 3 in the survey area. Over the 2 weeks, the glider covered 250 km and completed 484 vertical profiles. The vehicle speed of 0.3 ms^{-1} was, at times, comparable to the current speeds on the Chatham Rise which made glider navigation difficult at the beginning of the mission. The figure below shows the glider track, and surface locations, during the survey.

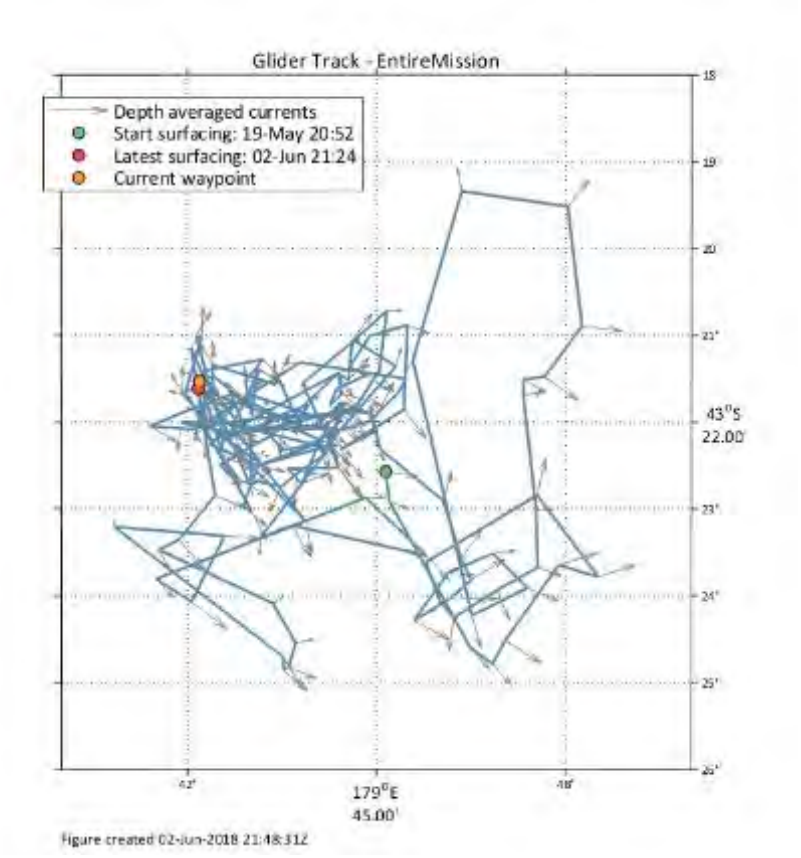


Figure 4-17: Glider track over the 14-days with depth averaged currents from each segment.

The glider collected data on several parameters, but here we illustrate contour profiles of temperature, salinity and coloured dissolved organic matter (CDOM).

Temperatures tended to decrease linearly with depth to a minimum of 8 C at 350 m down to the seabed. Salinity structure was more complicated with subsurface peaks in salinity occurring below the mixed layer depth. This is likely due to horizontal advection of eddies at around 100m. Tidal

fluctuations were seen in both temperature and salinity as twice daily ‘wiggles’ most noticeable at the base of the pycnocline.

Increases in CDOM occurred twice during the glider mission – from late on May 26 with concentrations up to 4.5 ppb seen up until May 30. CDOM was evident well above the bottom boundary layer, with instances of higher CDOM to the surface. From June 1 until the glider was recovered elevated CDOM was again observed inside the benthic disturbance polygon.

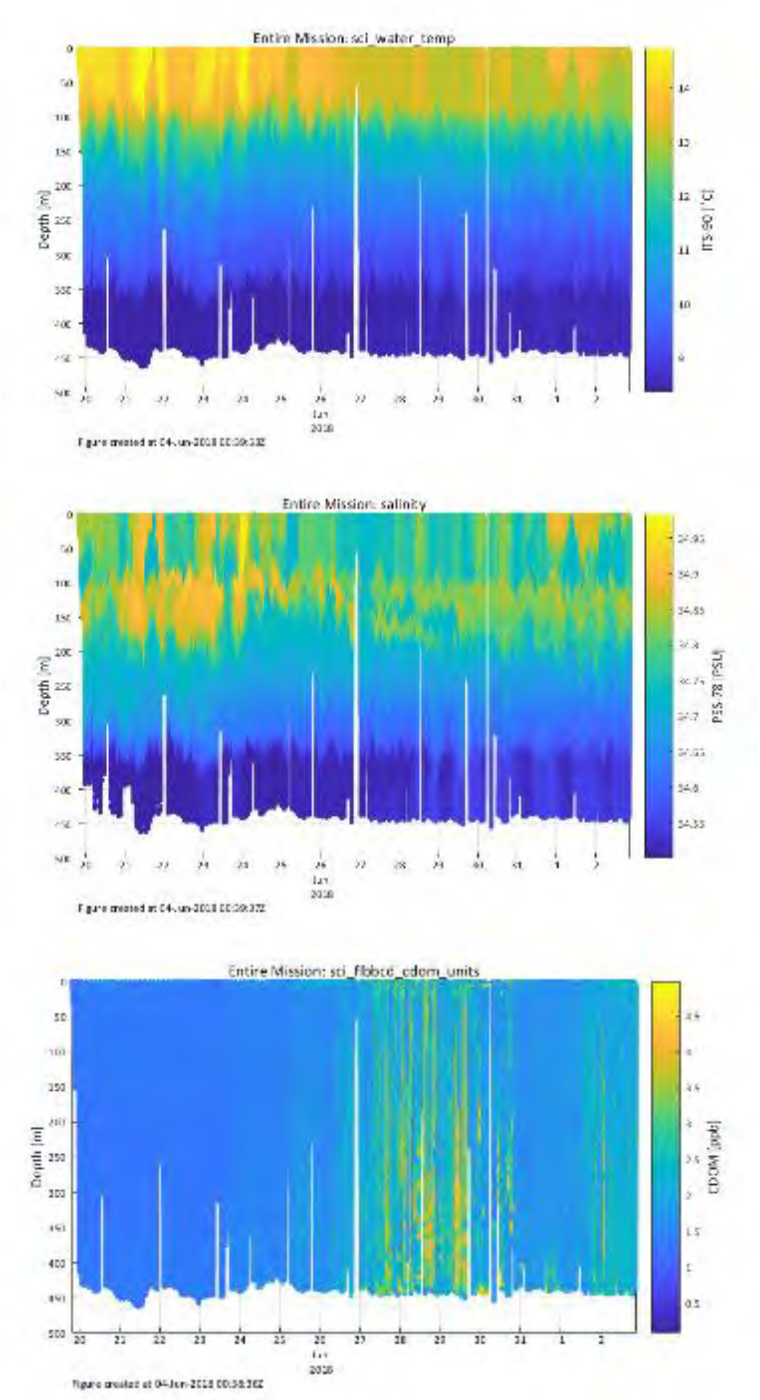


Figure 4-18: Temperature, salinity and Coloured Dissolved Organic Matter (CDOM) observations from ocean glider ‘Betty’ during the survey.

Example profiles from the glider optical backscatter (660nm) show the presence of a plume on several occasions. The first time was around May 30 with peaks concentrated at 435m to possibly 465 m (the glider does not sample the lowest 30 m of the water column as it requires this vertical distance to change direction). The other peak – from June 1 – was much higher in the water column from 300 m down to near the seabed. Increased turbidity was, however, only observed in a single glider profile.

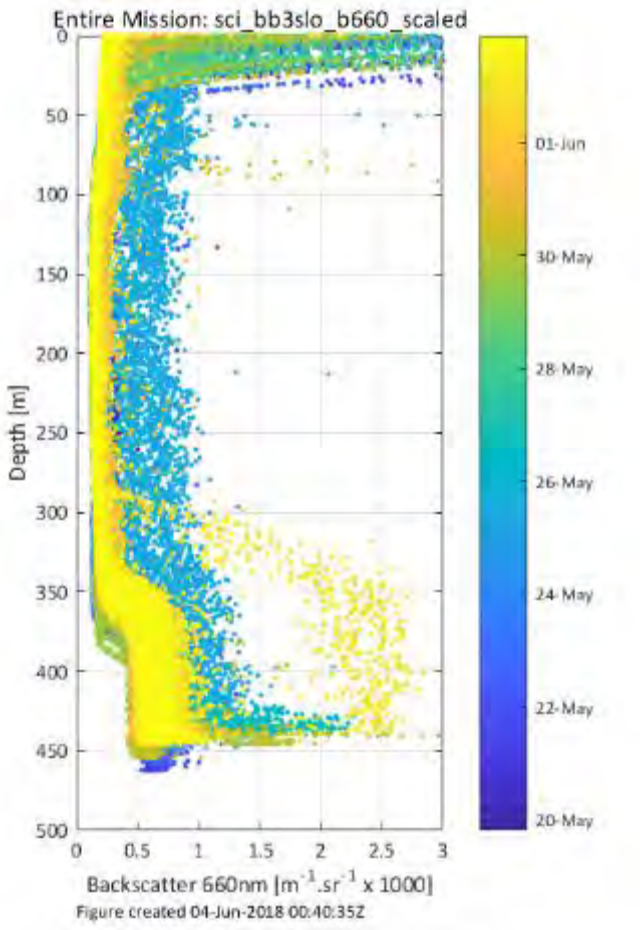


Figure 4-19: Profile of backscatter from the glider with time during the survey.

Towfish

Four trials were carried out with the Towfish in various configurations, with different tow cable lengths and a vessel speed of 3 to 3.5 knots.

An increase in the angle of the wing relative to the Towfish had little to no effect on the Towfish depth relative to tow cable length however it did allow the Towfish to be trimmed for level flight. Moving the tow point 50mm forward of the original tow position increased pitch stability with no adverse effect on depth. Adding weights on the tow cable ahead of the Towfish caused it to pitch nose down by 60 to 70 degrees under tension from the tow cable. In all trials an increase in speed resulted in a reduction in the depth of the Towfish.

In the final trial the Towfish obtained 400 metres depth, 30 metres from the bottom at 3.3 knots with 1200 metres of tow cable. However, because of the slow speed necessary to keep the Towfish deep, and the time needed for turning, it was going to be very time intensive, which was impractical given the time constraints of the survey and likely dispersal rates of the plume. Added to this was that the Aqualogger turbidity sensor was not giving satisfactory results, it was ultimately decided not to use the

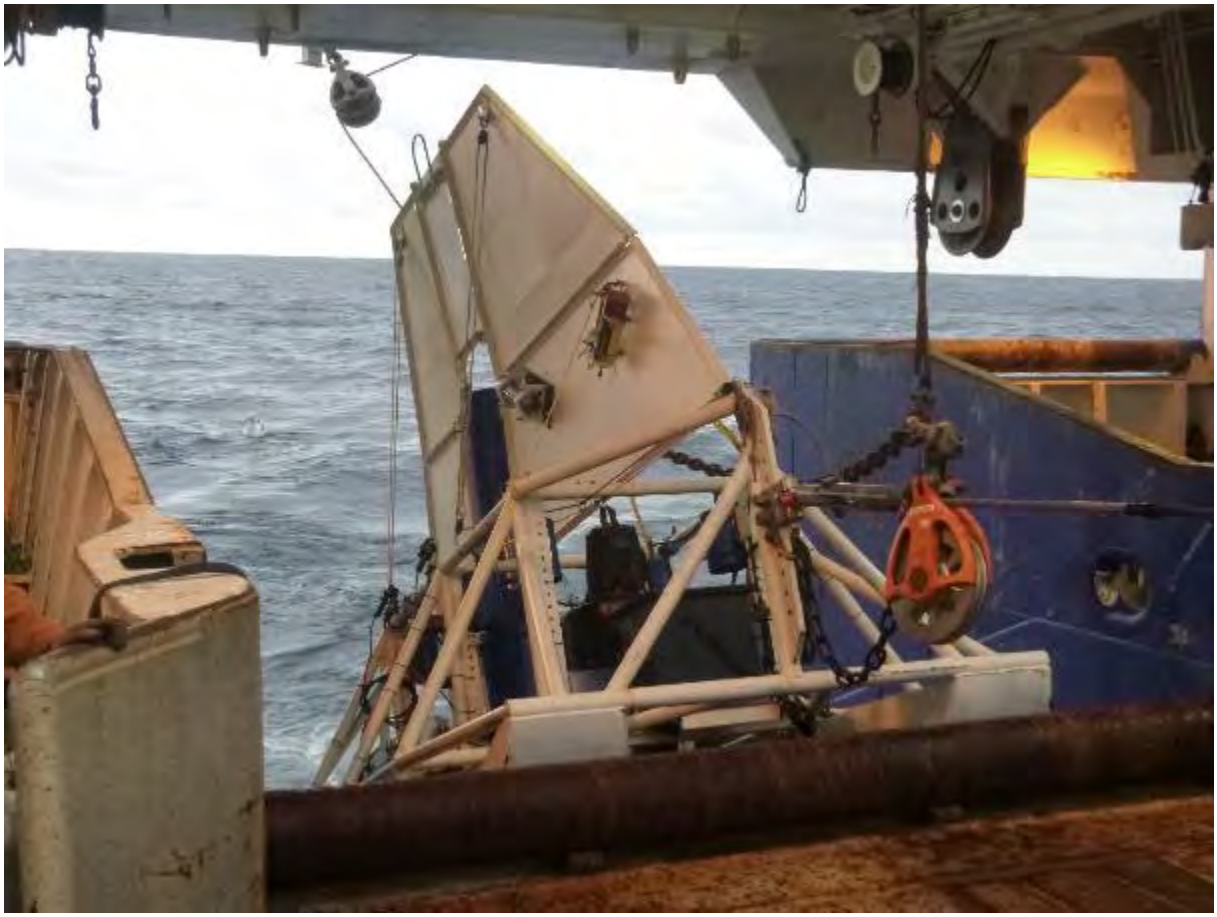
gear. Nevertheless, the development of the Towfish will prove very useful in inshore and shallower applications.

4.6 Seabed disturbance

4.6.1 Methods

Benthic Disturber

The physical disturbance was done with a specially designed "Benthic Disturber" (BDR) (Brockett and Richards 1994). The gear was used in similar disturbance experiments in the 1990s by US, UK, Japanese and Indian research programmes investigating effects on manganese nodule communities on the abyssal plains in the central Pacific and Indian oceans (Jones et al. 2017).



The BDR is approximately 4.5m long, 2.4 m wide, and 3 m overall height (with a collapsible stability sail). It weighs about 2.5 t in air. It was modified for this survey to fit the dimensions and operations off *Tangaroa*. Power supply was adjusted, and the one-piece sail was hinged to accommodate the overhead clearance between the stern ramp and fantail (see photo above).

A pump at the front fluidises the sediment by injecting water, and the resulting slurry is pumped up and out of the central chimney. As the BDR is towed slowly along the seafloor at about 1 knot, it creates a plume about 5-10m high, and the disturbance can penetrate about 10-15 cm into the seabed substrate. Coarse material is screened out and diverted away from the chimney intake.

Additional equipment was added to the BDR:

- A video camera was mounted on the sail close to the top of the chimney, to image the sediment being ejected, to attempt quantification of its velocity and rate.
- A C-node transponder was mounted on the sail, facing forward and angled at 45° so position and depth of the BDR could be recorded.
- A sediment collection tube was strapped to the chimney, with an inlet pipe extending into the chimney to capture sediment being ejected.
- Two altimeters were mounted, at the front and rear of the BDR to measure the orientation of the Disturber and the relative distance of the BDR to the seafloor before and after fluidization- these data help to estimate the sediment production (Tim Horst).

Jet production

Attempts were made to determine the amount the Disturber sank into the seabed, which would aid calculating the production of the jets and amount of material fluidized and released up the chimney.

- A camera was initially mounted low down on the BDR frame to image penetration into the sediment of the Disturber skids. However, the amount of sediment being kicked up by the BDR prevented any useable footage being obtained.
- Some information was gathered by painting the bars at four places on the BDR. Abrasion of the paint by the sediment was indicative of how much it sank into the seafloor.
- A foot was made that would track the ground level at the back of the BDR. It was attached to the frame and with an angle sensor on the bar the distance from frame to sea bed could be calculated. Another foot and bar was attached to the frame in front of the jets. The extent of sinking in could then be calculated by comparing the seabed level in front of the disturber and the known distance to the bottom of the sleds.

Initial trials

There was an initial trial with the BDR in Palliser Bay before commencing the steam to Chatham Rise. Following initial problems with the BDR power shorting electrical systems on the ship, the break in the insulation of a cable to the winch was found and resolved.

Once a potential survey site had been identified, a further trial of the BDR was undertaken in an area 20 n.mi east (to ensure there could be no possible drift of any plume to the survey area).

This test looked at the manoeuvrability of the BDR, and hence what type of oval or figure-of-eight design might be practicable, without hauling in the Disturber after a single straight-line run.

4.6.2 Results

Disturbance area

There were two disturbance areas. The first was in the centre of the survey region, with MON 3, MON2, MON1, MON 7 and MON 9 covering the northern dispersal routes of a sediment plume. MON2, 7, MON9 and MON 7 were particularly relevant, as the ADCP and glider data suggested strong N-NE current flows at times.

The trials had confirmed that the BDR could be towed continuously, with gradual turns over a diameter of 300–400 m being feasible. The disturbance “box” was therefore designed as a polygon in the middle of a number of monitoring sites, and where substrate was predominantly soft based on MBES backscatter and DTIS imagery. The BDR track was targeted to pass through DIS 1 and DIS2 sites, in order to observe the direct impacts. The direction was occasionally changed to even any stress on towing points, and to cover undisturbed sectors in the middle of the area.

The images below show the “Disturbance Box” as a yellow polygon, with the BDR track from the HiPAP system. The Benthic Disturber was kept on the seafloor the whole time, with slow turns creating an oval type of “racetrack” disturbance source. Both these disturbance events lasted about 30 hours.

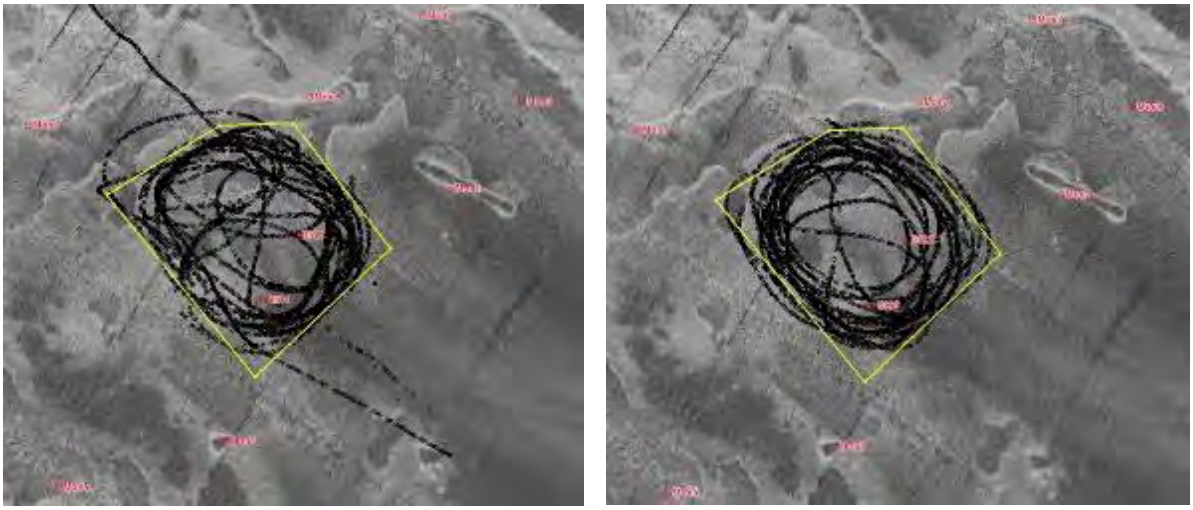


Figure 4-20: Track of the Benthic Disturber inside the disturbance box during the two main disturbance events.

The second area was close along the southern flank of a small part of the survey area termed the “butterknife”. This was not a topographic feature as such, but a part of the general slope with exposed bedrock and cobbles in places that formed a rim of high reflectivity in the shape of a knife. The Disturber was lifted clear of the seafloor at the end of each run, and towed slowly back to the northwest before being lowered again. This resulted in a series of parallel/overlapping lines.

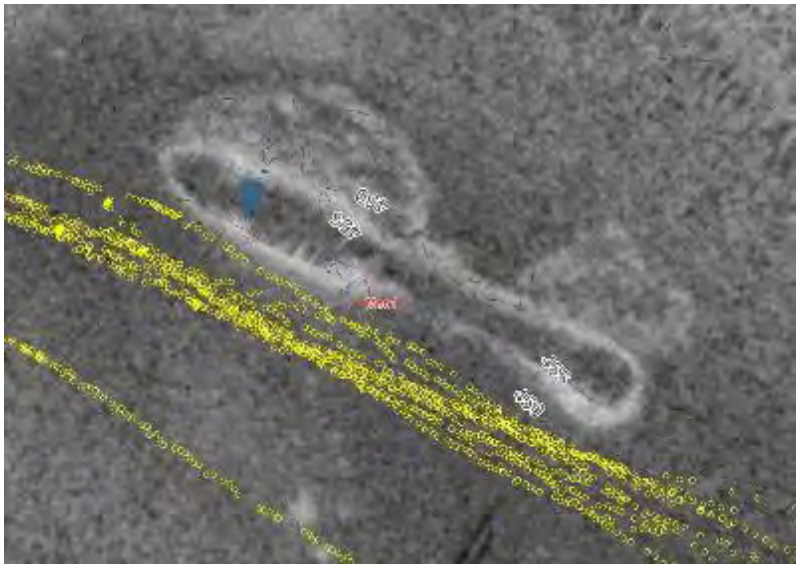


Figure 4-21: The "butterknife" feature within the survey area, showing the parallel tracks of the BDR during the second type of disturbance.

The table below summarises the duration and distance of each deployment of the BDR.

Table 4-5: The duration and distance of each deployment of the BDR.

Stn_no	Hours	Distance (nm)	Distance (km)	Area(km2)
44	1.95	2.69	4.98	0.012
45	0.92	1.26	2.33	0.006
144	1.12	1.55	2.87	0.007
145	19.51	23.98	44.42	0.107
146	10	12.93	23.95	0.057
180	5.47	6.55	12.13	0.029
181	0	0	0.00	0.000
188	0.2	0.17	0.31	0.001
196	30.42	45.65	84.56	0.203
235	5.15	6.99	12.95	0.031
TOTAL	**74.74**	**101.77**	**188.51**	**0.452**

Benthic Disturber performance

The operation of the BDR on the *Tangaroa* worked well. Prior to the trip there were uncertainties and concerns about deployment and retrieval, but the procedures developed were efficient, and the hinged sail enabled use of the stern ramp which ensured the operation was safe and effective in a range of wind and sea conditions.

The BDR produced a good level of sediment "smoke" in its trial runs as well as through the disturbance phases. That can be seen in the live video feed on the left hand monitor in the image below.

However, after the first period of disturbance, DTIS runs over sections of the disturbed track showed less impact than expected-the BDR skid marks were evident, but the fluidising jets were having much less effect. This is seen in the images below, where the skids have been digging in, and the jet effects are seen as shallower ripples. The jets appeared to be fluidising only a few cm, and not the 10-15cm that was expected from the previous operations of the BDR.

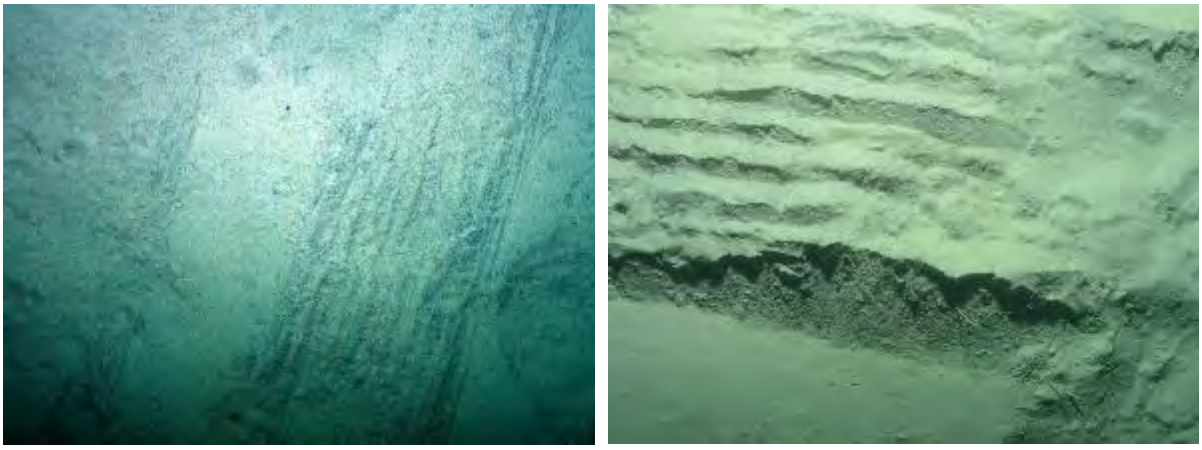


Figure 4-22: Images from DTIS of BDR tracks following disturbance events.

Together with little evidence in camera photographs of any obvious build up of sediment near the BDR runs, or on adjacent coral communities, it seemed the BDR was picking up only very fine sediment from the top few cm of seabed, and this was rapidly being swept away in the near-seafloor currents.

4.7 Sedimentation characteristics

4.7.1 Methods

Benthic landers

Three newly built benthic landers were used for the first time on this voyage. They were designed in house by NIWA Instrument Systems, with input from NIWA Science staff under a Strategic Capex project (WN18CAPEX/18.813). The cube frames were built specifically to accommodate instruments to be deployed on the voyage to measure near-seabed physical processes and to collect samples and data on particle dynamics in the water column close to the seafloor. The three landers have approximate dimensions of 1.5 x 1.5 x 2.5 m (LxWxH) and weigh about 1075 kg in air.

The figure below shows an entire lander-view, ready for deployment, and various close-up shots. The yellow blocks on top of the stainless steel frame are Resinex syntactic foam buoyancy; the top of the frame is about 2 m off the deck; Top right shows the video camera, Seabird MicroCAT-DO sensor (yellow sticker) and orange 12 and 24 V batteries; Bottom left highlights the Technicap sediment trap (white tube) above the orange batteries. Other instruments include the AQUAScat (black cylinder on lower left-side frame) and Ecotriplet (black cylinder with copper front) mounted in front of the batteries; The bottom right image shows a Niskin water sampling bottle (grey) and Nortek Aquadopp ADP mounted on top frame (black cylinder with red mesh cap).

Figure 4-23: NIWA benthic landers: Top left, overall view, and other panels show greater detail (see text for description).

Figure 4-24: Image from the cut-away on RV Tangaroa while deploying a benthic lander.

The three Benthic Landers had a variety of instrumentation that included an acoustic doppler current profiler (Nortek Aquadopp 2 MHz), turbidity sensors (Aquatec AQUAloggers and AQUAscats), temperature-salinity-dissolved oxygen sensor (Seabird MicroCAT), a camera and light, a Niskin water bottle (5 litre), and a sediment trap (Technicap, 12 sample bottles) to measure particle deposition. One lander had a full suite of instrumentation (Lander 2 – "Outlanda"), while the other two had a cut-down number of instruments (Lander 1 – "Yolanda", no AQUAscat, Lander 3 – "Zoolanda", no AQUAscat, no sediment trap). DGTs ("diffusive gradients in thin-films") were also added onto an aerial attached to the top of each lander frame (see section on "Ecotoxicity and Biogeochemistry").

The landers were tested in shallow water in Palliser Bay on 12 May (stations 003-005 Landers 1, 2 and 3) and 13th May (station 008, Lander 2 only), in order to trial deployment and recovery techniques, and to ensure the amount of buoyancy was appropriate (beyond tank tests at Greta Point).

Multicoring operations

The multi-corer consists of a metal frame with a number of 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. A single deployment of the multi-corer results in up to 8 sediment samples each of which can penetrate up to 40-80 cm into the seabed. 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. Whenever possible, samples for analyses of meiofauna (MEI), Macrofauna (MAF) and Sediment (SED) were obtained from different multicorer deployments to provide true replication at the same site. An example of one of the idealised sampling schemes is shown below.

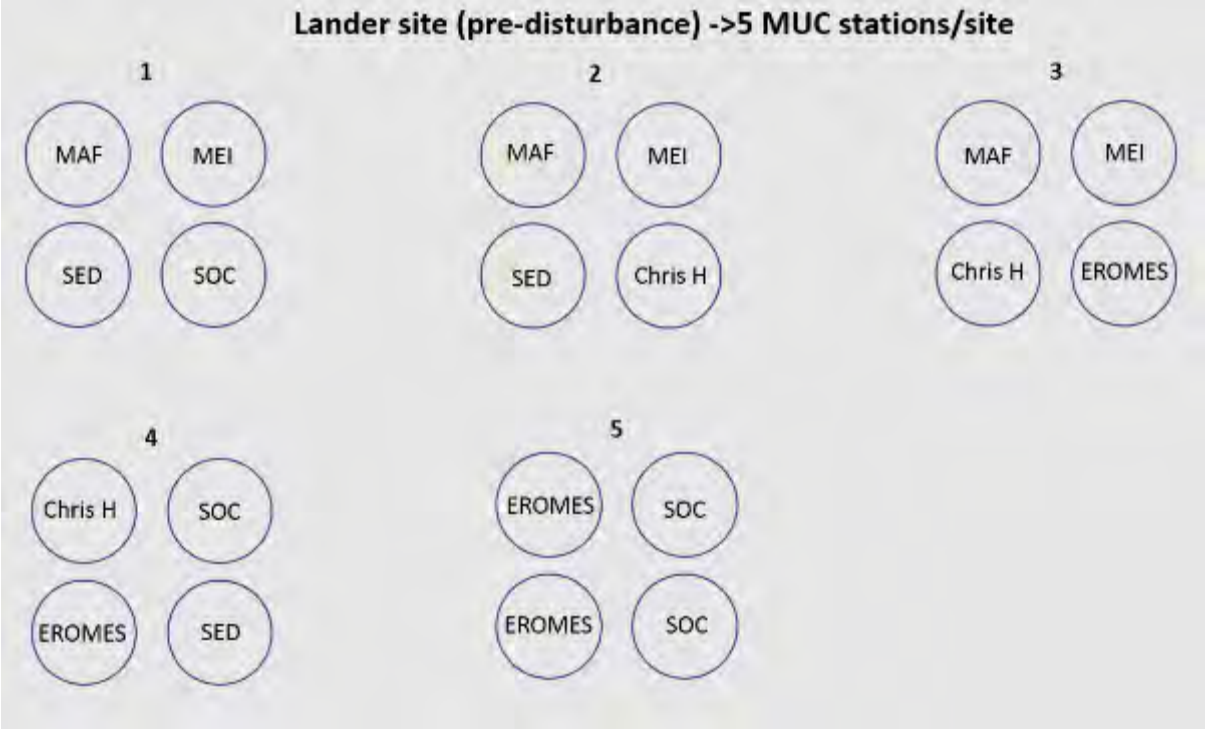


Figure 4-25: Example of an idealised sampling scheme for the Lander site. MUC = multicorer. MAF = macrofaunal, MEI = meiofauna (sub-core), bacteria (surface) and stable isotope/fatty acids (rest of 0-5 cm core), SED = sediment parameters, SOC = sediment oxygen consumption, EROMES = erosion threshold experiments, Chris H = oxygen/metal/nutrient profiling

A box corer was taken as back-up if areas couldn't be found where the multicorer could be used. However, this was unnecessary, and the box corer was not used.

A gravity corer (with 1.5 m barrel) was used in order to sample deeper into the sediment than the multicorer, and establish oxygen profiles over a greater distance. The silty sediments on the Rise, however, meant penetration of the three cores attempted was no greater than achieved by the multicorer.

Experimental work

Passive samplers for metals ('DGTs')

Trace metal concentrations were measured using both direct chemical analyses of water samples for total and dissolved metals and using DGT ("Diffusive Gels in Thin films") passive time-integrating samplers for metals. The DGT samplers accumulate trace metals and provide a time-averaged measure of metal concentrations. The DGTs were mounted on each of the landers and the reference site mooring, deployed in laboratory 'sediment capping' trials and in standardised sediment elutriate tests.

The average in situ concentration of a suite of dissolved metals present either at the field site or in the laboratory simulation are calculated from the chemical analysis of the DGTs.

Biogeochemistry of sediments

Our working hypothesis for the Chatham Rise sediments have deep dissolved oxygen penetration – of the order of 20-50 cm depth. Thus, major biogeochemical transitions – such as nitrate removal, ammoniacal-N increase, manganese/iron increase will occur at significant depth.

Changes in the surface interface caused by deposition of fine material are therefore likely to result in marked changes in sub-surface chemistry and the flux processes (see Sediment capping experiment).

Both multi-corer and gravity corer (with polyethylene plastic liner) samples were collected for sediment characterisation. Micro-probes were used for measurement of dissolved oxygen (DO) and pH profiles 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 20-30 cm sub-surface.

Cores were sectioned for sediment chemical analysis and particle size.

Sediment capping by fine sediments

The sediment disturbance process associated with mining will result in a separation of coarse and fine material which will be deposited at differing distances down-current from the activity. The approach was to measure a gradient of settled fines thicknesses on cores – measuring changes in metals and nutrient fluxes and respiration:

i. Core treatments (replicated): Control, 2mm, 5mm, 10mm fines caps. Settled fines generated from elutriation process from surficial sediments from disturbance site;
ii. DGTs in overlying water;
iii. Respiration rate;
iv. Nutrient flux;
v. Microprobe profiles through capping layer over duration of experiment;
vi. Dissolved metals and nutrients at end of experiment;
vii. Sub-surface pore water chemistry and probe measurements at completion;
viii. Surface erosion measurements at completion;
ix. Visual (photographic) assessment of time course of consolidation of sediment capping layer;
x. Characterisation of sediment capping material (metals, TOC, TN, particle size distribution, density).

The duration of incubations in relation to the time required to establish maximum effects as a result of biogeochemical changes is unknown. In practice, the incubation time was restricted by the time available following collection of the cores. Final core incubations were a total of 6 days.

Core fluxes

Core incubations were carried out from the REF site and impacted DIS sites. The approach involved:

i. DGTs in overlying water;
ii. Respiration rate;
iii. Nutrient flux;
iv. Microprobe profiles at completion of flux;
v. Dissolved metals and nutrients at end of experiment;
vi. Sub-surface pore water chemistry and probe measurements at completion;

Elutriates

Standard elutriate procedures were carried out from the disturbance area (surficial and deep sediment) with measurement of the settling rate of fines and turbidity reduction. The approach involved:

i. Elutriates from surficial sediment and deep sediment (Note: gravity corer was no effective in obtaining sediments deeper than about 40 cm – which was comparable with the multi-corer);
ii. DGTs in overlying water measured over two time periods ('standard' incubation at 15°C for 48h; in situ simulation with incubation at 10°C for 96h);

iii. Dissolved metals, DOC, sulphide and nutrients at end of experiment;
iv. Turbidity and physio-chemical changes with time for surface sediments mixed with overlying water (200x v/v initial dilution).

Sediment Community Oxygen Consumption (SCOC)

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 (n=40, 4 per location) were carefully extruded into incubation chambers (total volume = 2.0 L) with the same internal diameter. Overlying water was sampled for dissolved nutrients and metals (0.45 µm cellulose acetate filter). 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 26–48 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 6 h after chambers were placed in the water bath, O_2 concentrations were measured with a PreSens FIBOX 3 PSt3 optode O_2 sensor inserted through a sampling port in the chamber lid. Further O_2 measurements were made during the incubation period, (6hr increments) which was terminated when the initial concentrations had decreased by 10%–20%. Upon termination of core incubations both dissolved nutrients and metals were taken. SCOC was estimated from the decline in O_2 concentration with time (linear regression r2 > 0.9) after correcting for water column respiration.

Sediment erosion measurement system (EROMES)

The erosion measurement system (EROMES; Schünemann and Kühl 1991) was used to calculate sediment transport parameters from all locations both Pre and Post disturbance. Sample core collection was undertaken using the Multicorer (*n*=3) and cores were then extruded into EROMES cores. Upon extrusion, EROMES cores (*n*=30, three per location) were stored at 10 °C for 2 -12 h and gently filled 20 cm above sediment with seawater collected from overlying cores (salinity 34 psu), temperature 10 °C). Once filled, a rotating propeller increased bed shear stress by 0.1 N m-2 (based on the erosion of quartz sand) every 2 min (Andersen 2001, Andersen and Pejrup 2002). An optical backscatter sensor positioned 6.5 cm above the sediment recorded material in suspension. Water samples were collected at the beginning and end during erosion runs to calibrate the optical backscatter sensor reading to suspended sediment concentration. The resulting time series of suspended sediment concentration was used to derive the erosion rate (*ER*) in (g m^{-2} s^{-1}) for each incremental increase in nominal bed shear stress. From *ER* plotted vs Nominal bed shear stress the following measures of erosion potential can be calculated: erosion threshold (τc), erosion rate (*ER*), and erosion constant (*me*). τc (N m^{-2}) was calculated from the regression between ln(nominal bed shear stress) and erosion rate (n = 3, R2 ≥ 0.9). τc was defined as the nominal bed shear stress needed to produce an erosion rate of 0.1 g m^{-2} s^{-1}. This represents continuous movement of sediment at the surface, and the onset of surface erosion. The *ER* (g m^{-2} s^{-1}) at 0.5 N m^{-2} has been used as a comparison point in previous studies and was chosen here to assess early surface erosion. Finally, m_e (g N^{-1} s^{-1}) highlights the change in erosion rate with increasing bed shear stress between 1.0-1.6 N m^{-2} (n = 6, R2 ≥ 0.9) and denotes latter sub- surface erosion. Thus, a decrease (-) in τ_c and increase (+) in *ER* depict increased surface erosion, whereas an increase (+) in m_e describes an increased change in subsurface erosion.

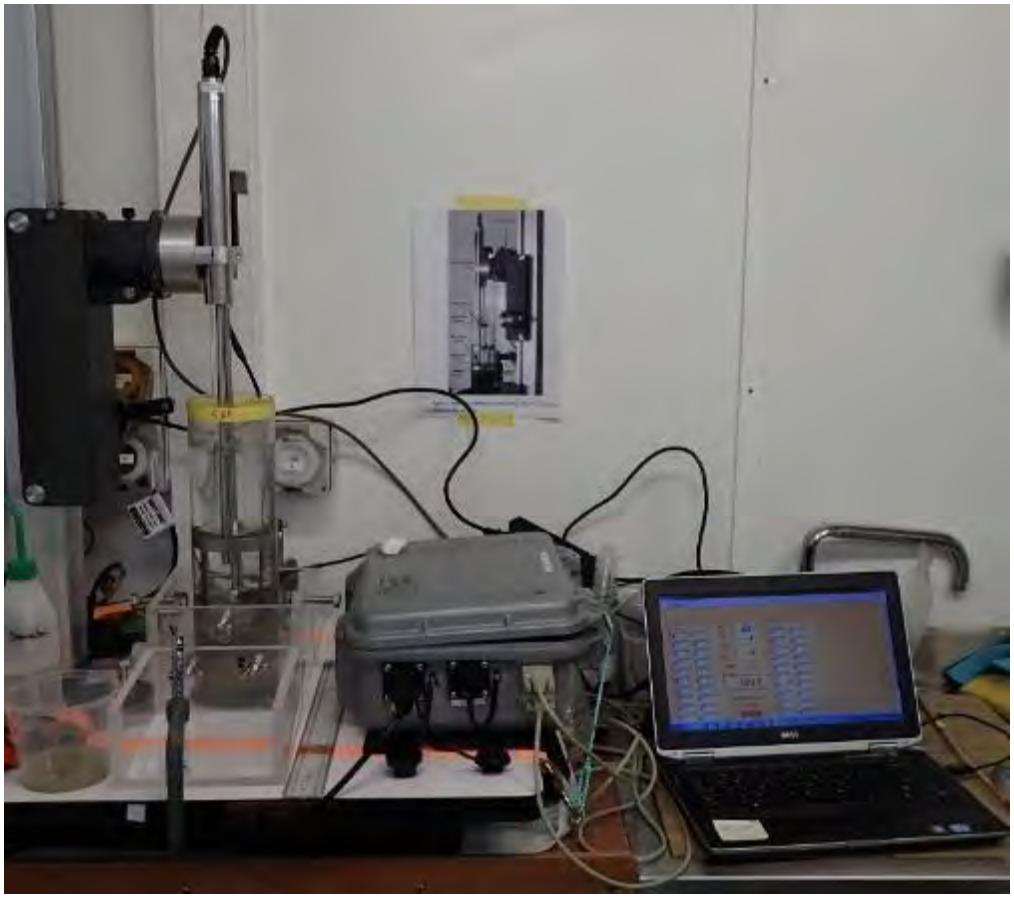


Figure 4-26: Core-based erosion device (EROMES) was used to determine sediment resuspension potential.

4.7.2 Results

Landers

The landers were deployed across an area we expected would cover the sediment plume gradient and measure the size, density and biochemical composition of the particles. Lander 1 was deployed ~500 m outside the area of disturbance, Lander 2 ~2 km away from the disturbance area, on the north side of the "butterknife" (equivalent to the RAS water sampler mooring site) and Lander 3 further to the northeast about 4 km away from the disturbance area. The landers were deployed on 23 May and their exact locations were triangulated using ranging techniques off the acoustic releases: Lander 1 – station 99, 43° 21.524'S 179° 43.927'E, Lander 2 – station 100, 43° 21.381'S 179° 44.643'E and Lander 3 – station 101, 43° 21.005'S 179° 45.464'E. The landers were found to have drifted in the order of a few hundred meters from their release locations at the surface before settling onto the seafloor.

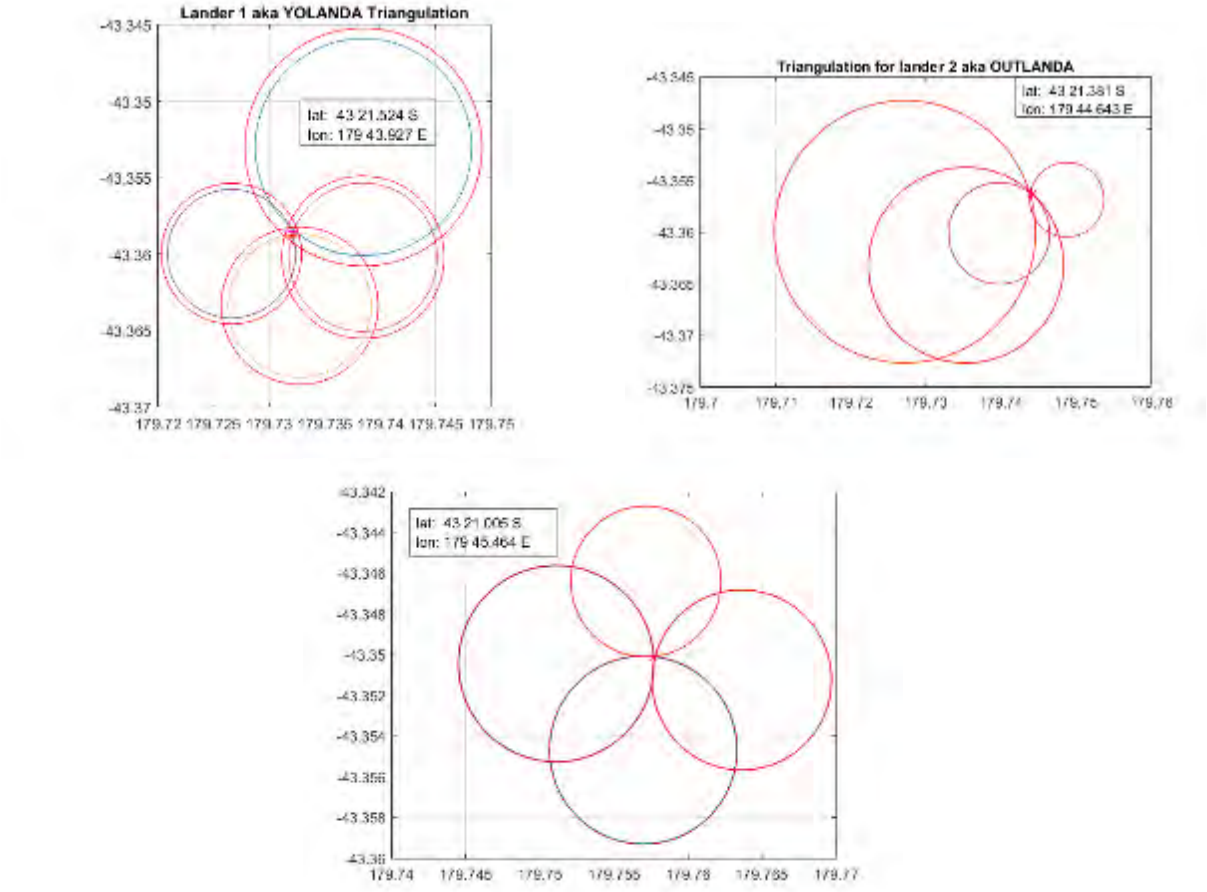


Figure 4-27: Triangulation positions of the three benthic landers (Lander 1 – Yolanda, Lander 2 – Outlanda, Lander 3 – Zoolanda).

The benthic landers were successfully recovered on 3 June and all instruments downloaded, except for the AQUAscat, which was downloaded ashore by Iain Macdonald (NIWA Hamilton). The three Seabird MicroCATs were not programmed correctly and didn't collect any data. The two traps on Landers 1 and 2 provided samples with ~1 day resolution for the duration of the deployment. The water samples from the Niskin bottles were transferred into 10 litre carboys and then subsampled for total suspended solids and POCPN using the methods for processing CTD water samples (see above). Preliminary results from the three AQUAloggers at approximately 1 metre above the seabed are shown below.

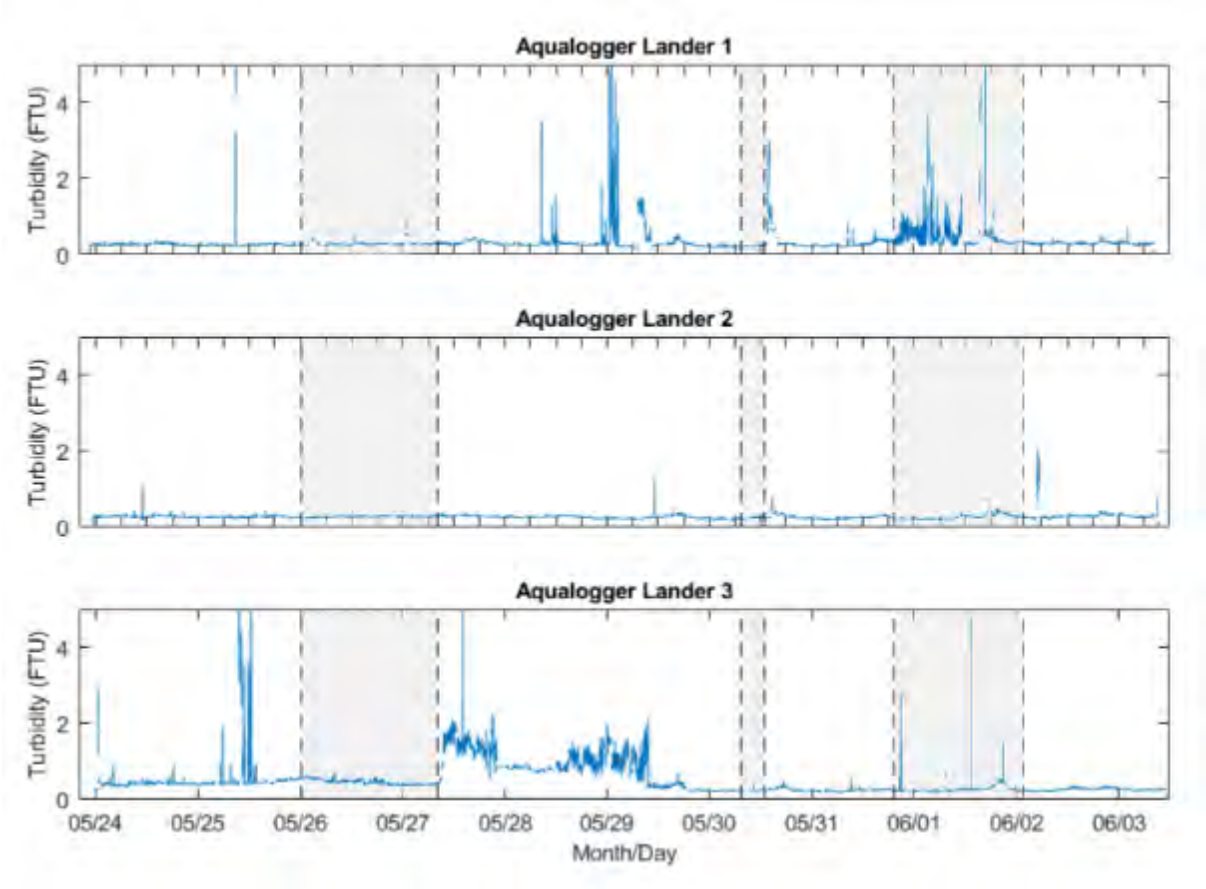


Figure 4-28: Turbidity data from the benthic lander AQUAloggers. Shaded areas are when benthic disturbances were undertaken.

Multicorer

The multi-corer was deployed 83 times, yielding 317 individual cores. The majority of the cores were undisturbed and contained sediment at least 15 cm deep; targeting areas of low backscatter reflectivity from the multibeam echosounder data helped greatly in obtaining deep, undisturbed cores. Ten sites were sampled, including the REF sites, the two disturber (DIS) sites, and seven monitoring (MON) sites. The two disturber sites and five of the monitoring sites were sampled both pre- and post-disturbance.

Table 4-6: Sites sampled with the multicorer, pre- and post-disturbance. Sites in bold are lander sites (Lander1=MON1, Lander2=MON9, Lander3=MON7).

Sites	Pre-disturbance	Post-disturbance
REF1	x	
DIS1	x	x
DIS2	x	x
MON1	x	x
MON2	x	x
MON3	x	
MON5	x	x
MON6	x	
MON7	x	x
MON9	x	x

At all of the sites sampled with the multicorer, cores were obtained for analyses of infauna (meio- and macro-infauna), bacteria, stable isotope/fatty acids, and sediment parameters (e.g., grain size, pigment concentrations). The multicore sampling schemes are summarised below.

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 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 zip-lock plastic bag and frozen at -20°C for later stable isotope/fatty acid analyses. Sediment (SED) parameter samples were sliced at 0.5 cm intervals to 2 cm and then at 1 cm intervals down to either the bottom of the core (1 per site) or to 15 cm sediment depth (2 cores per site). 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.

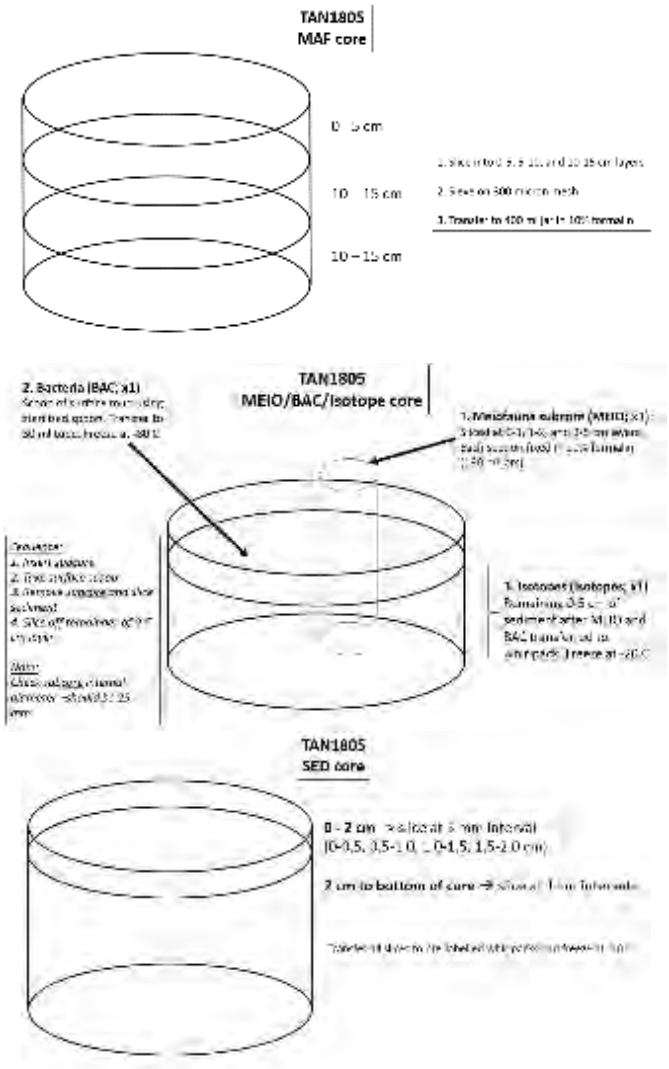


Figure 4-29: Sampling schemes for multicore samples: MAF = macrofaunal, MEIO = meiofauna, BAC = bacteria, SED = sediment parameters. See text for details.

Cores for onboard analyses of sediment community oxygen consumption (SCOC), erosion thresholds (EROMES) and dissolved oxygen, dissolved metals, nutrient, pH and redox profiles, as well as for sediment capping experiments, were obtained from the REF, DIS and lander sites (see details on "Ecotoxicity and Biogeochemistry").

Cores were also obtained from a number of sites to provide sediments for sedimentation experiments on land using sponges (Valeria Mobilia, PhD) and for calibration of the instruments measuring water column turbidity, deployed on the CTD and benthic landers. These samples were generally from cores that were excess to the other sampling at the site or were sufficiently disturbed so were not appropriate for the other analyses; sediment samples were typically collected over the top 5 cm for both the sedimentation experiments and for the turbidity calibration exercises. Several multicores from the disturber sites were also analysed for sediment shear strength and density (Tim Horst, PhD).

Experimental core studies

The trace metal accumulators were deployed on Benthic Landers and in both elutriate and core treatments (Figure 4-30) to determine the release of metals associated with simulated seabed mining activities. The results of these exposures are awaiting chemical analyses.

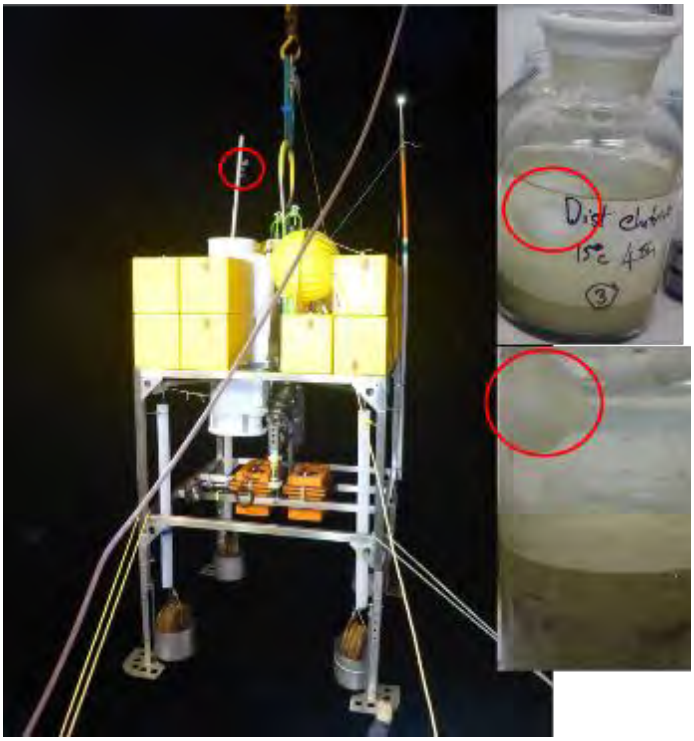


Figure 4-30 Benthic Lander and laboratory treatments showing the deployment of trace metal accumulators ('DGTs', circled).

The biogeochemistry of the phosphorite-containing sediments was characterised using sediment profiling clarke-type microprobes measuring dissolved oxygen (DO), pH and redox conditions. The results showed that the natural sediments had a DO penetration to anoxic conditions of 30-50 mm. Addition of about 5 mm of surficial fine sediment material generated by the Benthic Disturber markedly reduced the DO penetration to about 15 mm.

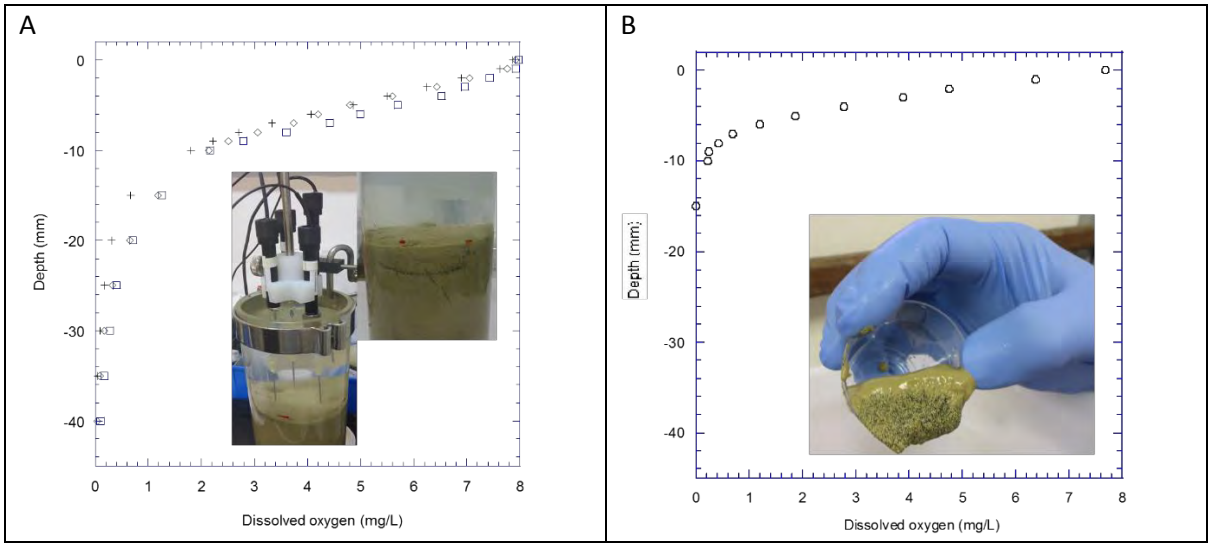


Figure 4-31: Results for DO profiles for natural sediment (A) and sediment capped with fine material (B).

An experimental approach was used to establish potential critical capping thicknesses of fine sediments for adverse effects on biogeochemical processes and for trace metal release. This involved adding a range of fine sediment cap thicknesses (2, 5, and 10 mm) to cores with natural sediments – followed by an incubation period to establish new equilibrium conditions. The fine sediment material was obtained by elutriation (i.e., vigorous agitation of the natural sediments with seawater, ~1:4 v/v) followed by cold settling. The fine sediment slurry was then applied to the natural sediment core to obtain the nominal capping thicknesses. The results showed a marked reduction in the depth to anoxia occurring for the 2 mm thickness sediment – with minimal further reduction for thicker sediment caps.

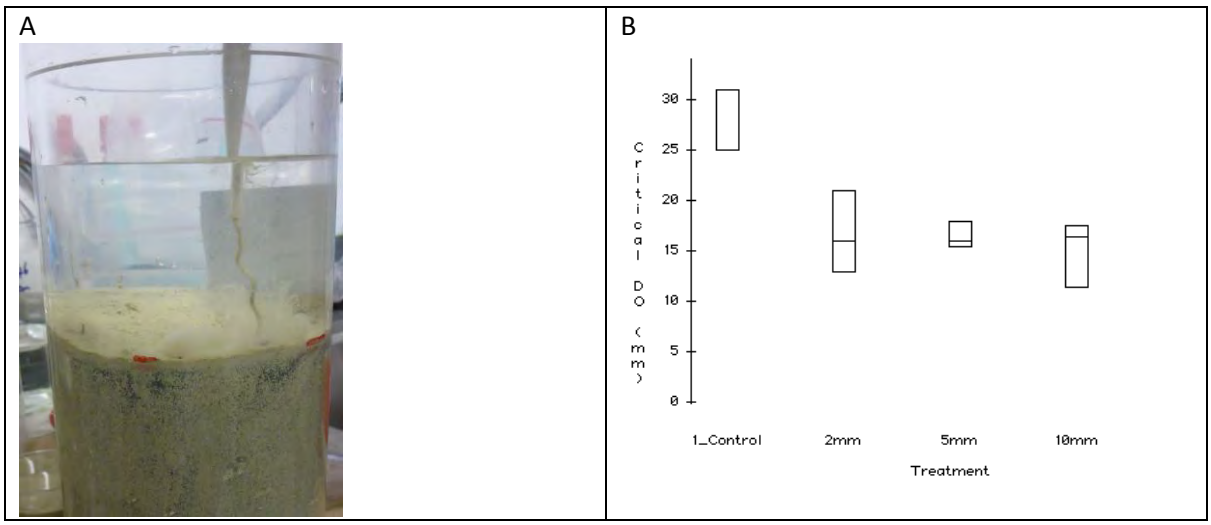


Figure 4-32: Core receiving fine sediment capping layer prior to incubation (A) and summary plot of DO anoxia depth for different nominal capping thicknesses (B).

After 6 days incubation the 10 mm capped cores developed visual signs of subsurface anoxia – blackening below 100 mm depth – which were not evident in the control cores. The sediment DO profiles measured in each of these core treatments will be used to calculate the rate of sediment oxygen demand and determine how this has changed as a result of the fine sediment capping.

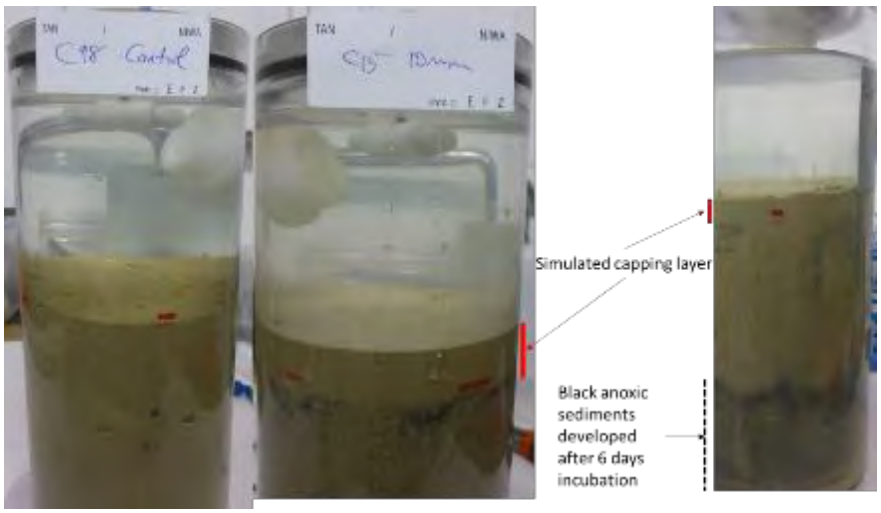


Figure 4-33: Cores showing addition of fine sediment capping layer and generation of black anoxic sediments at about 10 cm sub-surface after 6 days.

The biogeochemical processes occurring in the chemistry of the sediments were also investigated by core incubation to measure the flux of oxygen (i.e., sediment oxygen demand), nutrients and dissolved metals in the overlying water of stirred cores and in sediment pore waters. The pore water samples were obtained from several depths (1, 2, 5, 10 cm sub-surface) using a Rhizome sampler. The results of these analyses are awaiting further chemical and statistical analyses.

Elutriation tests were used as standardised procedures to determine contaminants released from the sediments when mixed with the overlying seawater. There were two approaches: (i) a bottle test with chemical measurements after fixed time periods; and (ii) a stirred core test to determine the rate of recovery of the disturbed sediment. The results of the core test for a 200x dilution of sediment (v/v) show an initial very high turbidity (100 FTU) with a rapid reduction (to 20% of initial value after 2 h) as initial settling occurred. A secondary exponential settling rate occurred over the following 24 h by which time the turbidity had reduced to about 13 FTU (compared to the background water value of 0.8 FTU).

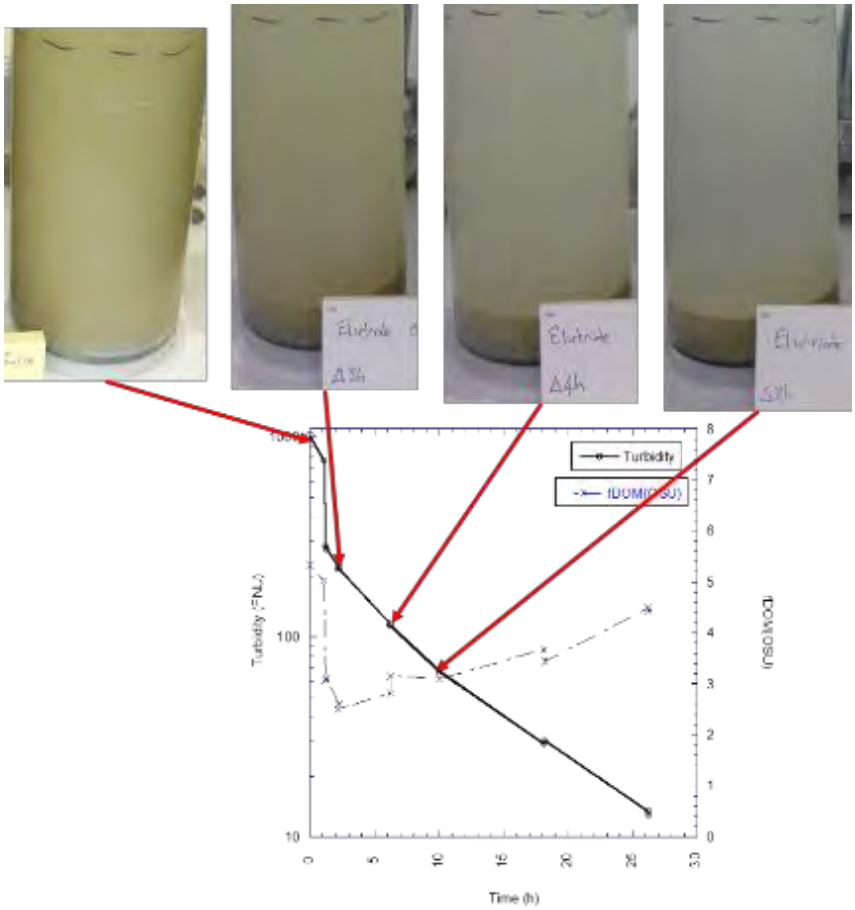


Figure 4-34: Elutriate test with natural reference sediment suspension (200x v/v dilution) and time series of turbidity and dissolved organic matter.

The monitoring also included dissolved organic matter (fDOM) measurements. These data showed a marked initial increase in fDOM to 5.3 OSU (compared with the background 1.7 OSU) followed by a decline and then a progressive further increase during the following 24 h. This release of organic matter is an important factor in reducing potential toxicity of metals and will also result in secondary DO reduction in the water column caused by bacterial metabolism. The glider monitoring showed post-disturber reduction in deep-water DO which would be consistent with the release of DOM from the benthic sediments.

EROMES results will be analysed following calibration with sediment collected during the voyage.

4.8 Seabed habitats and fauna

4.8.1 Methods

Photographic survey

The camera gear used was NIWAs "Deep Towed Imaging System" (DTIS) (Hill 2009) which has been proven on many surveys around New Zealand. 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.

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 for up to one hour at 0.5 knots, at a height of 2–3 m above the seafloor.

A small CTD unit was attached to DTIS, recording conductivity, temperature, and depth data for the first few camera transects. Unfortunately, the unit became flooded and unserviceable. For subsequent tows, an Aqualogger and ecotriplet were mounted on the DTIS frame, recording data on turbidity, CDOM, fluorescence and particle back-scatter

Catch sampling

Specimens were collected at several sites with an epibenthic sled (Clark and Stewart 2016), when weather conditions limited other operations, and where previous DTIS imagery suggested it was worthwhile to sample for sponges to retain for experimental work in the laboratory at Greta Point.

The NIWA "Seamount Sled" (Clark & Stewart 2016) is designed to sample rough seafloor (and used extensively on seamounts around New Zealand as well as on soft seafloor) and catch macro- and mega-epifauna. The sled has a mouth opening of 1 m width, and 0.4 m height. It is towed at 1–1.5 knots.

The NIWA beam trawl was also deployed, at a separate location on the transit back to Wellington, as previous efforts had not recovered sufficient specimens. This trawl is a net attached to a 4m wide beam, with a vertical opening of about 30 cm.

4.8.2 Results

Photographic sampling

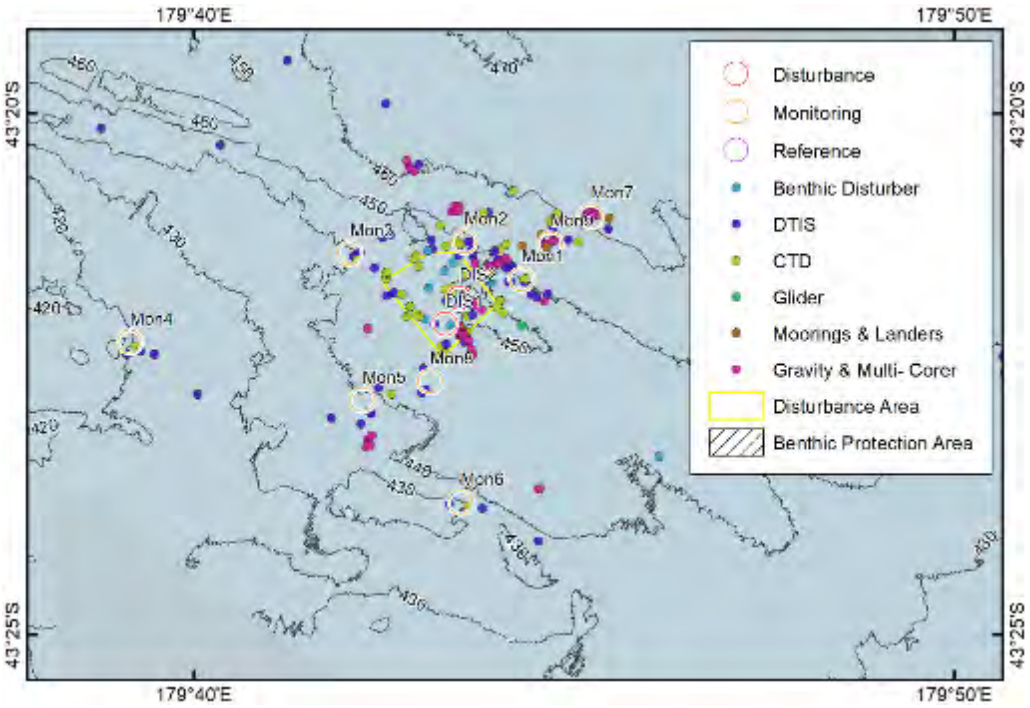
A total of 69 DTIS tows was completed. The nature of these varied between sites depending on weather angles that were possible, as well as whether a longer single tow or multiple short tows were planned. The latter was the preferred option when weather didn't allow a tow along a high reflectivity ribbon, and there was little value in a long tow on soft sediment. Biological communities were patchy, and concentrated along such ribbons, which in places were very narrow strips of harder substrate.

Over 50 hours of high definition video were recorded, and over 12000 still images were taken (240 frames per 1 hr of transect -see the table 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 conditions and swells up to 4–5 m.

Table: **Summary of DTIS data. Duration of video and number of still images per site.**

Site	No. Stations	No. Stills	Stills Data size (GB)	Video (HH:MM:SS)	Video Data (GB)
All	69	12,100	114	50:33:08	566

The location of DTIS stations in the main survey area is shown below.



Descriptions of faunal assemblages and substratum types were recorded in real time from DTIS camera transects and subsequently augmented by observations from high-resolution still images.

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 2.

Coral distribution

One of the main benthic invertebrate communities in the area is dominated by corals. Where bedrock was exposed, or there were patches of cobble and pebble substrate, small patches of stony coral *Goniocorella dumosa* (referred to as *Goniocorella* throughout the text) often occurred, with octocorals, lace corals, and hydrocorals. The *Goniocorella* was of particular interest as a target community for investigating sedimentation effects, given it is one of the commonest coral species on the crest of the Chatham Rise, can form dense thicket structures in places, and is of concern for potential impacts from deep-sea mining.

The coral communities were patchily distributed, with few corals on the softer sediment, and various densities associated with mixed substrate types. The denser coral sites occurred primarily on harder substrate, such as along the ribbons of exposed rock/cobbles.

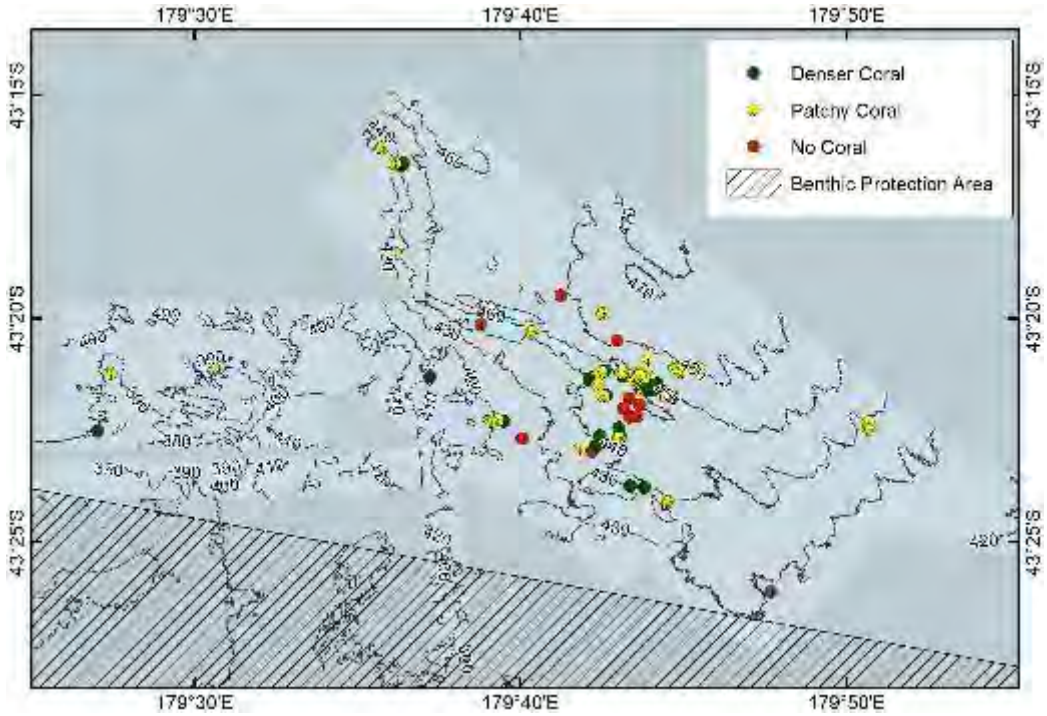


Figure 4-35: The distribution of stony coral communities in the survey area.

Existing sedimentation

Many parts of the survey area in general appear already subjected to natural sedimentation levels. Although bottom trawling is not reported in recent years from here, a section of trawl net was imaged during a DTIS tow across the "butterknife" wedged under a small overhanging outcrop, where the belly

section of the net would have come fast or been damaged. Human activities may, therefore, have an effect on disturbing sediment, although it is likely that relatively strong near-bottom currents may play a major role in naturally mobile sedimentation. Particle densities associated with the Benthic Boundary Layer (BBL) were observed with sensors on the glider and CTD to extend to 50 m or more above the seabed. This means that there are compounded issues to address in what factors affect benthic communities in the region. It is challenging to observe recent settlement, and will require larger volumes of sediment than produced during the survey, and comprise coarser sediment from greater penetration into the substrate. These are aspects to consider in planning the next stages in the survey programme.

Specimen collections

Biological specimens recovered from the sled and trawl were sorted once on deck. Macro-invertebrates were identified to the lowest possible taxon, and data entered directly into Specify software for subsequent uploading into NIWAs "niwainvert" database.

A total of 107 invertebrate "lots" were catalogued from the sled and beam trawl catches during the survey. There were 32 operational taxon units (OTUs) identified from 9 phyla (see Table below).

Table 4-7: Summary of faunal samples catalogued onboard.

NIWA Catalog Number	Phylum	Class	ID Taxon	Count	Total Lot Weight (g)
131002	Cnidaria	Anthozoa	Alcyonacea	1	1
131003	Annelida	Polychaeta	Polychaeta	1	1
131004	Cnidaria	Anthozoa	Alcyonacea	1	200
131005	Brachiopoda		Brachiopoda	60	160
131006	Arthropoda	Malacostraca	Galatheidae	3	10
131007	Arthropoda	Malacostraca	Brachyura	1	1
131008	Cnidaria	Anthozoa	*Goniocorella dumosa*	1	20
131009	Echinodermata	Ophiuroidea	Ophiuroidea	5	5
131010	Annelida	Polychaeta	Polychaeta	2	1
131011	Mollusca	Bivalvia	Bivalvia	1	1
131012	Mollusca	Bivalvia	Bivalvia	1	24
131013	Bryozoa		Bryozoa	1	2
131014	Annelida	Polychaeta	Polychaeta	3	1
131015	Annelida	Polychaeta	Polychaeta	4	32
131016	Porifera		Porifera	3	3
131017	Cnidaria	Anthozoa	Gorgonacea (Alcyonacea)	3	7
131018	Bryozoa		Bryozoa	1	1
131019	Cnidaria	Hydrozoa	Hydrozoa	1	1
131020	Cnidaria	Anthozoa	Alcyonacea	9	3
131021	Porifera		Porifera	1	8
131022	Echinodermata	Echinoidea	Spatangidae	2	200
131023	Bryozoa		Bryozoa	2	18
131024	Arthropoda	Malacostraca	Brachyura	1	4
131025	Brachiopoda		Brachiopoda	5	8
131026	Cnidaria	Anthozoa	Gorgonacea (Alcyonacea)	1	1
131027	Annelida	Polychaeta	Polychaeta	1	1

131028	Cnidaria	Hydrozoa	Hydrozoa	2	12
131029	Echinodermata	Ophiuroidea	Ophiuroidea	1	1
131030	Cnidaria	Anthozoa	Scleractinia	2	2
131031	Porifera		Porifera	1	6
131032	Porifera		Porifera	1	8
131033	Mollusca	Bivalvia	Bivalvia	1	1
131034	Cnidaria	Anthozoa	Gorgonacea (Alcyonacea)	15	20
131035	Echinodermata	Echinoidea	Cidaridae	5	30
131036	Cnidaria	Anthozoa	Actiniaria	1	30
131037	Cnidaria	Hydrozoa	Hydrozoa	12	4
131038	Annelida	Polychaeta	Polychaeta	23	20
131039	Cnidaria	Anthozoa	Gorgonacea (Alcyonacea)	7	2
131040	Echinodermata	Asteroidea	Asteroidea	2	85
131041	Arthropoda	Malacostraca	Brachyura	1	24
131042	Echinodermata	Asteroidea	Brisingidae	1	34
131043	Mollusca	Bivalvia	Bivalvia	6	54
131044	Arthropoda	Malacostraca	Paguridae	15	78
131045	Porifera		Porifera	22	280
131046	Arthropoda	Malacostraca	Munida	13	48
131047	Brachiopoda		Brachiopoda	43	80
131048	Echinodermata	Holothuroidea	Holothuroidea	3	5
131049	Cnidaria	Anthozoa	Actiniaria	2	3
131050	Mollusca	Gastropoda	Gastropoda	1	1
131051	Echinodermata	Ophiuroidea	Ophiuroidea	8	5
131052	Mollusca	Bivalvia	Bivalvia	2	5
131053	Arthropoda	Malacostraca	Munida	3	2
131054	Cnidaria	Anthozoa	*Goniocorella dumosa*	1	50
131055	Arthropoda	Malacostraca	Munida	2	10
131056	Cnidaria	Hydrozoa	Hydrozoa	8	8
131057	Cnidaria	Anthozoa	*Goniocorella dumosa*	2	28
131058	Mollusca	Bivalvia	Bivalvia	3	5
131059	Annelida	Polychaeta	Polychaeta	13	20
131060	Porifera		Porifera	5	18
131061	Cnidaria	Anthozoa	Alcyonacea	2	4
131062	Mollusca	Polyplacophora	Chiton	1	1
131063	Chordata	Ascidiacea	Ascidiacea [Tunicates]	1	2
131064	Echinodermata	Echinoidea	Cidaridae	1	5
131065	Brachiopoda		Brachiopoda	2	3
131066	Echinodermata	Ophiuroidea	Ophiuroidea	1	1
131067	Echinodermata	Echinoidea	Spatangidae	1	94
131068	Arthropoda	Malacostraca	Decapoda	1	1
131069	Annelida	Polychaeta	Polychaeta	1	12
131070	Porifera	Demospongiae	Geodia	1	200
131071	Porifera	Demospongiae	Ecionemia	2	600
131072	Porifera		Porifera	2	110
131073	Mollusca	Gastropoda	Nudibranchia	2	120
131074	Annelida	Polychaeta	Polychaeta	5	20
131075	Echinodermata	Echinoidea	Spatangidae	1	340

131076	Arthropoda	Malacostraca	*Campylonotus rathbunae*	3	14
131077	Chordata	Ascidiacea	Ascidiacea [Tunicates]	2	20
131078	Mollusca	Cephalopoda	Sepiolidae	1	50
131079	Porifera		Porifera	3	12
131080	Arthropoda	Malacostraca	Brachyura	1	6
131081	Echinodermata	Asteroidea	Asteroidea	1	6
131082	Arthropoda	Malacostraca	Brachyura	2	25
131083	Arthropoda	Malacostraca	Decapoda	1	3
131084	Annelida	Polychaeta	Serpulidae	5	42
131085	Arthropoda	Malacostraca	Munida	18	110
131085	Arthropoda	Malacostraca	Munida	25	110
131086	Arthropoda	Malacostraca	Paguridae	1	10
131087	Porifera	Demospongiae	Ecionemia	4	2200
131088	Arthropoda	Malacostraca	Munida	12	100
131088	Arthropoda	Malacostraca	Munida	25	100
131089	Annelida	Polychaeta	Polychaeta	1	60
131090	Cnidaria	Anthozoa	Gorgonacea (Alcyonacea)	1	90
131091	Arthropoda	Malacostraca	Brachyura	4	34
131092	Echinodermata	Echinoidea	Spatangidae	1	390
131093	Chordata	Ascidiacea	Ascidiacea [Tunicates]	9	40
131094	Arthropoda	Malacostraca	Galatheidae	2	6
131095	Cnidaria	Anthozoa	Flabellum	2	20
131096	Arthropoda	Malacostraca	*Campylonotus rathbunae*	6	60
131097	Cnidaria	Anthozoa	Actiniaria	2	200
131098	Cnidaria	Anthozoa	*Goniocorella dumosa*	3	40
131099	Arthropoda	Malacostraca	Paguridae	2	20
131100	Echinodermata	Echinoidea	Cidaridae	9	250
131101	Mollusca	Gastropoda	Nudibranchia	1	80
131102	Echinodermata	Asteroidea	Asteroidea	5	230
131103	Annelida	Polychaeta	Polychaeta	10	40
131104	Arthropoda	Malacostraca	Decapoda	1	3
131105	Brachiopoda		Brachiopoda	1	10
131106	Mollusca	Gastropoda	Gastropoda	1	140

Live capture aquarium system

Sled and /or beam trawl catches were sorted on deck and healthy specimens of sponges were quickly removed and placed in bins with refrigerated water and transferred to an aquarium system in the Fish Factory wet lab.

This comprised a cooling unit which recirculated water at 8–9°C through smaller containers which in turn housed cages to hold the live sponges.

Few sponges were caught in the earlier sled tows. The experimental side of the project is important for determining potential sedimentation threshold levels, and therefore an area of known occurrence of the knobbly sandpiper sponge (*Ecionemia novaezelandiae*) was identified from hoki trawl survey data for sampling on the return to Wellington.

Two lines of MBES were run to map the topography and backscatter, and a high reflectivity slope area was then imaged with a DTIS tow. This confirmed that sponges were present, and the seabed could be

sampled with the beam trawl. Two trawls were completed, the second in particular catching several clumps of *E. novaezelandiae*, that were returned to the Marine Environment Manipulation Facility at Greta Point.

Figure 4-36: A sled catch including Ecionemia sponges (at bottom edge of station number board).

5 Acknowledgements

Thanks to all the scientific staff, officers and crew of RV *Tangaroa* for their enthusiasm and hard work onboard in coping with many challenges raised by the use of new equipment and the deployment of the wide variety of gear deployments.

We appreciate the efforts made by Vessels shore staff, especially Greg Foothead, in helping facilitate the modifications required for the BDR to be operated off *Tangaroa* and the fitting of it and the winch. The ship's engineers are thanked for their help during the voyage in helping sort out various equipment problems. We acknowledge the efforts by Okeanus Science and Technology (especially Ted Brockett) in ensuring the modifications and shipping of the BDR were timely and effective.

The support and advice of members of the project End-User Advisory Group (comprising representatives from MfE, DOC, MPI, MBIE, STRATERRA, Chatham Rock Phosphate, ECO) was appreciated. Discussions were also held prior to the survey between Lee Rauhina-August, NIWA's Pou Ārahi – Māori Development Leader (Te Kuwaha - National Centre of Māori Environmental Research), the Programme Leader, and several tangata whenua groups.

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Appendix A TAN1805 station summary.

CAM=DTIS, CTD=conductivity-temperature-depth unit, MUC=multicorer, SLED=epibenthic sled, SVP =sound velocity probe, LAN=benthic lander, TOW=towfish, BDR=benthic disturber, GLR=glider, MOOR=mooring, BEAM=beam trawl, GCR=gravity corer. Perf=gear performance (1,2=good; 3=poor), depths (s_dep,f_dep) in m. Area "X" = exploratory region

Stn	Area	Method	Date	Time	lat_d	lat_min	lon_d	lon_min		s_dep	f_dep	n.mile	dir	Perf	Comments
1	Test	TOW	11-May	1909	41	27.93	174	58.01	e	100	0	0.75	32	2	Test of Towfish deployment and retrieval, and stability.
2	Test	SVP	11-May	1958	41	28.29	174	57.21	e	0	0	0.00	226	1	SVP to 250m prior to MBES patch test
3	Test	LAN	12-May	952	41	26.18	175	7.47	e	0	22	0.00		2	Test of benthic lander #2
4	Transit	LAN	12-May	1345	41	26.19	175	7.48	e	0	23	0.00		2	Test of benthic lander #1
5	Transit	LAN	12-May	1745	41	26.41	175	7.58	e	0	18	0.00		2	Test of benthic lander #3
6	Transit	SVP	12-May	1932	41	28.23	174	57.1	e	0	0	0.00	148	1	SVP to 300m before MBES patch test
7	Transit	TOW	13-May	529	41	40.24	175	8.54	e	110	180	3.24	234	2	Test of towfish comms and wire-depth-speed combinations
8	Transit	LAN	13-May	838	41	27.38	175	8.43	e	0	22	0.00		2	Further test of instruments on lander #2
9	Transit	BDR	13-May	1158	41	27.6	175	7.59	e	0	33	0.83	177	2	Test of Benthic Disturber. Deployment and retrieval worked well. No altimeter.
10	Transit	TOW	14-May	741	43	11.39	178	18.11	e	5	5	3.97	129	2	Test of towfish with wing added and drogue. Improvement, will change towing point.
11	Transit	SVP	14-May	912	43	14.36	178	23.4	e	0	0	0.00	44	1	SVP cast to 365m prior to MBES
12	Transit	SVP	14-May	1700	43	28.17	179	47.54	e	10	0	0.00	77	1	SVP cast to 400m prior to detailed MBES survey
13	X	CAM	15-May	48	43	26.11	179	47.68	e	420	428	0.62	95	2	DTIS run on soft-hard-soft backscatter.
14	X	CAM	15-May	339	43	23.75	179	43.36	e	435	445	0.59	81	2	DTIS run on hard tending soft. Small patch of corals on an edge.
15	X	CAM	15-May	627	43	22.69	179	40.05	e	430	436	0.59	104	1	DTIS run on hard tending soft backscatter. Soft sediment throughout. Few epifauna
16	X	CAM	15-May	856	43	21.31	179	37.22	e	415	420	0.61	0	2	DTIS run on hard backscatter over small ridge. Some small patches of coral, common heart urchins, *Hyalascus* sponge.
17	X	SVP	15-May	1051	43	19.34	179	39	e	0	0	0.00	71	1	SVP to 440m depth before resuming detailed MBES survey.
18	X	CAM	15-May	1617	43	21.6	179	43.9	e	452	456	0.57	66	2	DTIS run on hard rim substrate. Coral thickets on pebbles and cobbles on rims of small hole.
19	X	CAM	15-May	1847	43	21.3	179	43.14	e	451	456	0.51	70	1	DTIS run along reflective edge. Patches of coral and sponges on pebbles and cobbles. Soft, bioturbated sediment away from edge.
20	X	CAM	15-May	2107	43	20.95	179	43.88	e	456	463	0.63	78	1	DTIS run along linear highly reflective edge in backscatter. Extensive patches of coral and some sponges on pebbles and cobbles. Soft, bioturbated sediment away from edge.

21	X	SVP	16-May	32	43	21.4	179	25.69	e	400	398	0.00	330	1	SVP cast to 396 m prior to 2nd MBES survey over S-CRP area
22	X	CAM	16-May	416	43	21.1	179	30.73	e	392	399	0.60	12	1	DTIS run along edge of hole in western area. Heart urchins common, small patches of coral.
23	X	CAM	16-May	642	43	21.23	179	27.43	e	394	400	0.59	16	1	DTIS run along ridge summit in western area.
24	X	CAM	16-May	1118	43	22.52	179	27.03	e	395	391	0.63	357	1	DTIS run across hole to small rise. There were patches of *Goniocorella* (GDU) thickets.
25	X	SVP	16-May	1623	43	16.81	179	33.76	e	10	10	0.00	48	1	SVP to 400m prior to detailed MBES work.
26	X	CAM	16-May	1857	43	18.55	179	36.15	e	435	441	0.60	18	1	DTIS run across largish, elevated feature, light reflectivity. patchy small corals and pebbles, *Hyalascus* sponges.
27	X	CAM	16-May	2119	43	20.14	179	38.78	e	449	458	0.56	16	1	Soft, bioturbated sediment. No corals, abundant PO4 pebbles on elevated ridge.
28	X	CAM	17-May	202	43	19.9	179	42.52	e	466	465	0.38	309	1	Some patches of small corals, echinoids and *Radicipes*. Soft, bioturbated sediment. Transect aborted due to adverse weather conditions.
29	X	SVP	17-May	625	43	23.92	179	52.9	e	10	5	0.00	202	2	SVP to update MBES survey
30	X	CAM	17-May	941	43	22.33	179	50.65	e	442	440	0.20	195	1	DTIS run across small hole. Mainly soft sediment.
31	X	CAM	17-May	1139	43	20.49	179	42.96	e	463	450	0.59	201	1	DTIS across hard ribbon edge. Few pebbles, no corals.
32	X	CAM	17-May	1334	43	21.16	179	42.59	e	453	444	0.63	246	1	DTIS up small spur. Good diversity, some GDU patches along central part of tow.
33	X	TOW	17-May	1521	43	22.11	179	41.13	e	10	10	1.93	298	3	Tow fish test. Different towing position. Issue with depressor weights.
34	X	CAM	17-May	1712	43	22.63	179	42.43	e	440	439	0.62	239	1	Small, isolated GDU on narrow strip of high reflectivity. Mainly soft, bioturbated sediment.
35	X	CAM	17-May	1945	43	24.1	179	44.53	e	440	441	0.50	244	1	Small, patchy GDU at base and slopes of ridge, reasonable concentrations. Mainly soft, bioturbated sediment on top.
36	X	TOW	17-May	2108	43	24.22	179	24.22	e	420	419	4.29	76	1	Tow fish test. Added more weight.
37	X	CAM	17-May	2326	43	19.49	179	41.23	e	464	454	0.58	254	1	DTIS run across highly reflective ridge feature - soft, bioturbated mud mainly.
38	X	CAM	18-May	202	43	21.11	179	45.45	e	464	455	0.50	245	1	Soft, bioturbated mud mainly; pebble patches on speckled substrate. Very thin strips of GDU
39	X	CAM	18-May	427	43	22.49	179	50.67	e	440	441	0.21	322	1	DTIS tow across small hole with high reflectivity rim. A definite edge, with brisingids, stylasterids, sponges, a few corals.
40	X	CAM	18-May	632	43	22.31	179	39.48	e	427	410	0.62	298	1	DTIS run up a contour extension. A good patch of corals about half way through.
41	D1	GCR	18-May	1058	43	22.31	179	43.67	e	454	454	0.00		2	Gravity corer. One tube. 12cm of sandy sediment.

42	East	CAM	18-May	1602	43	27.24	179	43.26	w	446	448	0.52	314	1	DTIS run across muddy, bioturbated sediment. No corals.
43	East	CAM	18-May	1808	43	26.57	179	44.23	w	447	447	0.49	315	1	DTIS run across muddy, bioturbated sediment. No corals.
44	East	BDR	18-May	2135	43	26.98	179	43.69	w	454	451	2.69	297	2	Benthic disturbance test. No HiPAP. 1 x sediment sample collected from chimney.
45	East	BDR	19-May	403	43	26.66	179	45.06	w	444	445	1.26	109	2	Test of Benthic Disturber. Tow hauled short because of chance to deploy glider.
46	X	CTD	19-May	1324	43	21.91	179	44.07	e	453	0	0.00	297	2	CTD to sample benthic boundary layer
47	X	TOW	19-May	1433	43	21.44	179	43.55	e	0	0	1.50	80	3	Abort shortly after launch. Depth and turbidity data not being received.
48	X	TOW	19-May	1643	43	20.59	179	45.57	e	466	460	3.85	296	2	Second tow. Depth and wire needed a problem. Turbidity sensor values uncertain.
49	X	CAM	19-May	1954	43	16.53	179	36.42	e	440	440	0.05	200	3	DTIS tow aborted due to comms/recording issues.
50	REF1	CAM	19-May	2004	43	16.58	179	36.34	e	444	438	0.60	315	1	DTIS tow onto small rise. Coral, sponges, encrusting on outcrops and small overhangs.
51	X	CAM	19-May	2317	43	20.3	179	40.35	e	445	463	0.55	317	1	DTIS tow. Corals along edge; muddy, bioturbated sediments on either side.
52	X	CAM	20-May	127	43	22.02	179	43.17	e	445	446	0.60	326	1	Muddy, bioturbated sediments.
53	X	GLR	20-May	718	43	22.04	179	44.31	e	0	0	0.00	271	2	Glider operations around site of disturbance
54	REF1	MOOR	20-May	1503	43	16.55	179	35.72	e	427	427	0.00		2	ADCP mooring at REF site. Boxed position.
55	REF1	MOOR	20-May	1553	43	16.67	179	36.18	e	463	463	0.00		2	Sediment trap mooring at REF site
56	REF1	MUC	20-May	1844	43	16.18	179	35.8	e	434	434	0.00		4	No samples
57	REF1	MUC	20-May	1938	43	16.57	179	36.3	e	439	439	0.00		3	1 core sample retained (7 cm long)
58	REF1	MUC	20-May	2014	43	16.54	179	36.23	e	433	433	0.00		3	2 core samples (4-6 cm long)
59	REF1	MUC	20-May	2107	43	16.55	179	36.23	e	435	435	0.00		3	2 core samples (5-7 cm long)
60	REF1	MUC	20-May	2209	43	16.33	179	36.51	e	451	451	0.00		1	4 core samples (25-31 cm long)
61	REF1	MUC	20-May	2252	43	16.29	179	36.2	e	448	448	0.00		3	2 core samples (7-9 cm long)
62	X	SVP	20-May	2339	43	15.9	179	35.76	e	440	441	0.00	320	1	SVP for new MBES lines
63	MON6	CTD	21-May	1106	43	23.76	179	43.62	e	0	0	0.00	260	2	CTD at MON6 site, to 440m. 1 bottle didn't fire.
64	MON5	CTD	21-May	1251	43	22.69	179	42.6	e	0	0	0.00	210	2	CTD at MON5 site, to 437m. 1 bottle didn't fire.
65	MON1	CTD	21-May	1452	43	21.4	179	21.4	e	0	0	0.00	91	2	CTD at MON1 site.
66	MON1	MUC	21-May	1629	43	21.71	179	44.44	e	443	443	0.00		1	MON1. 4 cores (38-44 cm core length)
67	MON1	MUC	21-May	1711	43	21.8	179	44.61	e	453	453	0.00		1	MON1. 4 cores (36-40 cm core length)
68	MON1	MUC	21-May	1838	43	21.45	179	43.97	e	452	452	0.00		3	2 cores, 2 failed (tube foot malfunction) (32-55 cm core length)
69	MON1	MUC	21-May	1911	43	21.46	179	43.89	e	454	454	0.00		2	3 cores (1 turbid), 1 failed (tube foot malfunction) (30-50 cm core length)

70	MON1	MUC	21-May	1943	43	21.46	179	43.93	e	453	453	0.00		2	3 cores (38-44 cm core length)
71	MON1	MUC	21-May	2014	43	21.46	179	43.92	e	454	454	0.00		1	4 cores (31-38 cm core length)
72	REF1	MUC	21-May	2150	43	16.55	179	36.56	e	450	450	0.00		1	4 cores (22-38 cm core length)
73	REF1	MUC	21-May	2250	43	16.39	179	36.81	e	450	450	0.00		4	1 core, 2 failed (tube foot malfunction) (8 cm core length)
74	REF1	MUC	21-May	2250	43	16.35	179	36.51	e	450	450	0.00		1	4 cores (13-16 cm core length)
75	REF1	MUC	22-May	12	43	16.36	179	36.59	e	453	453	0.00		2	CTD to 437m depth
76	REF1	CTD	22-May	112	43	16.54	179	36.3	e	10	10	0.00	293	2	CTD to 437m depth
77	REF1	CAM	22-May	350	43	16.53	179	36.14	e	436	438	0.50	331	1	DTIS across Reference site track. Some small coral patches.
78	MON3	CAM	22-May	656	43	21.33	179	42.19	e	446	443	0.09	329	1	Small clumps of coral
79	MON3	CAM	22-May	737	43	21.37	179	42.1	e	442	441	0.10	321	1	Patchy clumps of coral
80	MON2	CAM	22-May	858	43	21.36	179	43.48	e	453	454	0.19	335	1	Small band of pebbles and cobbles with some corals-GDU and gorgonian corals.
81	MON2	CAM	22-May	1011	43	21.37	179	43.67	e	453	453	0.23	336	1	GDU and gorgonians in thin band
82	DIS1	CAM	22-May	1237	43	21.72	179	42.63	e	449	449	0.35	321	1	Corals and sponges in rim and ridge, with soft, bioturbated sediments elsewhere.
83	DIS2	CAM	22-May	1440	43	21.84	179	43.63	e	453	448	0.65	320	1	Soft sediment, with sparse sponge and occasional GDU.
84	MON1	CAM	22-May	1742	43	21.73	179	44.66	e	451	451	0.22	336	1	GDU and sponges on two crossings of high reflectivity rim; muddy sediments elsewhere.
85	MON1	CAM	22-May	1847	43	21.62	179	44.35	e	454	453	0.25	324	1	GDU and sponges on two crossings of high reflectivity rim; soft muddy sediments elsewhere on transect.
86	MON7	CAM	22-May	2058	43	21.21	179	44.93	e	457	459	0.34	339	1	Mainly soft sediment with bedrock, GDU and sponges on southern rim.
87	MON7	CAM	22-May	2226	43	21.09	179	44.72	e	457	458	0.41	339	1	Soft sediment with bedrock patches, GDU and sponges on southern rim.
88	MON6	CAM	23-May	119	43	23.79	179	43.79	e	438	432	0.43	288	1	Mostly pebbles, cobbles, boulders with encrusting sponges, GDU, stylasterids and bryozoans. Outcrop near start with intact GDU.
89	MON3	CTD	23-May	504	43	21.4	179	42.15	e	15	10	0.00		1	CTD to 425m. Just S+DO calibration water samples.
90	MON2	CTD	23-May	605	43	21.25	179	43.52	e	10	10	0.00	30	1	CTD to 434m. Just S+DO calibration water samples.
91	MON7	CTD	23-May	708	43	20.96	179	44.77	e	10	10	0.00	304	1	CTD to 447m. Just S+DO calibration water samples.
92	MON4	CTD	23-May	823	43	22.23	179	39.23	e	10	10	0.00	329	1	CTD to 410m. Just S+DO calibration water samples.
93	DIS1	CTD	23-May	938	43	21.73	179	42.73	e	10	10	0.00	69	1	DIS1 CTD to 437m. Full water sampling.

94	MON4	CAM	23-May	1304	43	22.28	179	39.3	e	425	422	0.28	313	1	MON4 east DTIS
95	MON4	CAM	23-May	1422	43	22.31	179	39.12	e	420	422	0.31	324	1	MON4 west DTIS
96	MON5	CAM	23-May	1618	43	22.98	179	42.2	e	443	445	0.34	302	1	MON5 west DTIS
97	MON5	CAM	23-May	1850	43	22.88	179	42.33	e	437	434	0.21	299	1	MON5 east DTIS, tow aborted due to comms issues with DTIS.
98	MON5	CAM	23-May	2039	43	22.86	179	42.32	e	446	441	0.22	302	2	Mainly muddy sediment with patches of cobbles and pebbles encrusted with sponges, bryozoans and possibly GDU. t.
99	MON1	LAN	23-May	2228	43	21.52	179	43.93	e	459	459	0.00		1	Benthic lander site BL1, closest to Disturbance area. Lander #1=Yolanda - ADCP, AQlogger, Technicap trap, Microcat/DO.
100	MON9	LAN	23-May	2312	43	21	179	45.46	e	456	456	0.00		1	Benthic lander site BL2, intermediate distance from Disturbance area. Outlanda=most instrumented lander (#2), as above with AQscat.
101	MON7	LAN	23-May	2350	43	21.38	179	44.64	e	465	465	0.00		1	Benthic lander site BL3, greatest distance from Disturbance area. Zoolanda=least instrumented lander (#3), as for #1 but with no trap.
102	MON1	MOOR	24-May	354	43	21.27	179	44.32	e	456	456	0.00		1	4 good cores, 30-40 cm
103	MON7	MUC	24-May	512	43	20.94	179	45.17	e	463	463	0.00		1	4 good cores, 30 - 40 cm
104	MON7	MUC	24-May	545	43	20.98	179	45.16	e	464	464	0.00		1	4 good cores, 30 - 40 cm
105	MON7	MUC	24-May	633	43	21.02	179	45.22	e	464	464	0.00		1	3 good cores, 25-35 cm
106	MON7	MUC	24-May	808	43	21.06	179	45.11	e	461	461	0.00		3	0 cores
107	MON7	MUC	24-May	852	43	20.98	179	45.22	e	470	470	0.00		1	4 good cores (31-45 cm core length).
108	MON7	MUC	24-May	922	43	20.96	179	45.21	e	469	469	0.00		1	4 good cores (39-44 cm core length).
109	MON2	MUC	24-May	1021	43	20.94	179	43.45	e	465	465	0.00		1	4 good cores (24-42 cm core length).
110	MON2	MUC	24-May	1048	43	20.94	179	43.39	e	465	465	0.00		1	4 good cores (38-39 cm core length).
111	MON2	MUC	24-May	1121	43	20.89	179	43.43	e	465	465	0.00		2	3 good cores (24-25 cm core length).
112	MON3	MUC	24-May	1245	43	20.51	179	42.83	e	464	464	0.00		1	4 good cores (18-42 cm core length).
113	MON3	MUC	24-May	1322	43	20.55	179	42.9	e	464	464	0.00		1	4 good cores (23-40 cm core length).
114	MON3	MUC	24-May	1351	43	20.45	179	42.8	e	458	458	0.00		1	4 good cores (25-46 cm core length).
115	DIS1	MUC	24-May	1518	43	22.16	179	43.56	e	450	450	0.00		1	4 good cores (29-37 cm core length).
116	DIS1	MUC	24-May	1547	43	22.09	179	43.51	e	450	450	0.00		1	4 good cores 34-43 cm core length).
117	DIS1	MUC	24-May	1612	43	22.09	179	43.51	e	449	449	0.00		1	4 good cores (30-45 cm core length).
118	DIS1	MUC	24-May	1638	43	22.07	179	43.48	e	451	451	0.00		1	4 good cores (19-30 cm core length).
119	DIS1	MUC	24-May	1704	43	22.04	179	43.48	e	450	450	0.00		1	4 good cores (18-30 cm core length).
120	DIS1	MUC	24-May	1807	43	22.09	179	43.51	e	449	449	0.00		1	4 good cores (29-35 cm core length).
121	DIS1	MUC	24-May	1833	43	22.12	179	43.49	e	450	450	0.00		2	3 good cores (13-32 cm core length).
122	DIS1	MUC	24-May	1906	43	22.1	179	43.51	e	449	449	0.00		2	3 good cores (19-34 cm core length).
123	DIS1	MUC	24-May	1932	43	22.11	179	43.48	e	448	448	0.00		2	3 good cores (36-42 cm core length).
124	DIS2	MUC	24-May	2042	43	21.81	179	43.67	e	457	457	0.00		1	4 good cores (20-45 cm core length).

125	DIS2	MUC	24-May	2109	43	21.8	179	43.71	e	456	456	0.00		1	4 good cores (25-45 cm core length).
126	DIS2	MUC	24-May	2136	43	21.83	179	43.7	e	458	458	0.00		1	4 good cores (26-33 cm core length).
127	BL2	MUC	24-May	2233	43	21.16	179	44.75	e	462	462	0.00		1	4 good cores (31-40 cm core length).
128	BL2	MUC	24-May	2302	43	21.19	179	44.74	e	463	463	0.00		1	4 good cores (38-53 cm core length).
129	BL2	MUC	24-May	2328	43	21.21	179	44.74	e	464	464	0.00		1	4 good cores (34-42 cm core length).
130	BL2	MUC	24-May	2355	43	21.22	179	44.73	e	462	462	0.00		1	4 good cores (18-38 cm core length).
131	MON5	MUC	25-May	126	43	22.06	179	42.29	e	442	442	0.00		1	4 good cores (30-40 cm core length)
132	MON5	MUC	25-May	206	43	23.13	179	42.29	e	444	444	0.00		1	4 good cores (24-36 cm core length)
133	MON5	MUC	25-May	206	43	23.09	179	42.34	e	444	444	0.00		1	4 good cores (25-41 cm core length)
134	MON6	MUC	25-May	234	43	23.09	179	42.34	e	442	442	0.00		1	4 good cores (23-41 cm core length)
135	MON6	MUC	25-May	349	43	23.68	179	44.54	e	443	443	0.00		2	2 good cores (41-43 cm core length)
136	MON6	MUC	25-May	420	43	23.6	179	44.53	e	448	448	0.00		1	4 good cores (20-45 cm core length)
137	MON6	MUC	25-May	451	43	23.6	179	44.55	e	443	443	0.00		1	3 good cores (24-37 cm core length)
138	MON8	CAM	25-May	649	43	22.65	179	43.05	e	445	446	0.14	345	1	New site on southern side of disturber box. Small "rim" of high backscatter. Patches of cobbles and pebbles on each rim with gorgonian, sponge, GDU.
139	DIS1	CAM	25-May	819	43	22.19	179	43.56	e	450	450	0.41	337	1	NW over intended Disturber track
140	DIS1	GCR	25-May	1003	43	22.12	179	43.56	e	454	454	0.00		3	DIS1, gravity core, only 25cm core, poor penetration.
141	DIS1	GCR	25-May	1049	43	22.09	179	43.48	e	457	457	0.00		3	DIS1, gravity core, only 25cm core, poor penetration.
142	DIS1	SVP	25-May	1120	43	22	179	43.45	e	0	0	0.00	79	1	SVP prior to MBES-acoustic survey
143	DIS1	SVP	25-May	1744	43	21.55	179	38.88	e	10	10	0.00	196	1	SVP to update data during MBES survey
144	DIS_BOX	BDR	25-May	2058	43	22.03	179	43.38	e	453	450	1.55	25	3	Deployment aborted due to no signal from HiPAP beacon
145	DIS_BOX	BDR	26-May	16	43	21.97	179	43.04	e	447	452	23.98	48	2	Retrieved after 21 hours due to issues with sail stay; fixed stay
146	DIS_BOX	BDR	26-May	2158	43	21.51	179	43.3	e	452	448	12.93	263	2	Continue disturbance inside Dis-Box
147	DIS_BOX	CTD	27-May	910	43	21.92	179	42.92	e	0	0	0.00	281	3	CTD (code1) to 440m. Two depths, then failed.
148	DIS_BOX	CTD	27-May	1332	43	21.95	179	42.97	e	10	10	0.00	351	1	CTD (code1) repeat. To 435m
149	DIS_BOX	CTD	27-May	1536	43	21.49	179	43.72	e	10	10	0.00	253	1	CTD (code2) to 451m
150	DIS_BOX	CTD	27-May	#REF!	#REF!	#REF!	#REF!	#REF!	##	10	10	0.00	222	1	CTD (code3) to 447m
151	DIS_BOX	CTD	27-May	1609	43	21.79	179	44.04	e	10	10	0.00	242	1	CTD (code4) to 440m
152	DIS_BOX	CTD	27-May	1640	43	22.09	179	43.61	e	10	10	0.00	240	1	CTD (code5) to 440m
153	DIS_BOX	CTD	27-May	1832	43	22.32	179	43.25	e	10	10	0.00	198	1	CTD (code6) to 440m
154	DIS_BOX	CTD	27-May	1912	43	21.57	179	42.53	e	10	10	0.00	200	3	CTD (code7) to 440m; cast aborted

155	S-CRP	SLED	27-May	2328	43	20.4	179	31.03	e	404	401	0.17	206	2	66 kg mud and phosphorite nodules, chert rocks. Small clump of GDU, brachiopods, galatheids.
156	S-CRP	SLED	28-May	51	43	20.8	179	27.6	e	396	392	0.21	200	2	11 kg catch: hydroids, corals, squat lobsters, phosphorite, chert rocks
157	S-CRP	SLED	28-May	210	43	21.03	179	27.49	e	390	389	0.28	268	2	280 kg catch. Little biology: hydroids, asteroids, GDU coral, squat lobsters, spatangid, phosphorite, chert rocks
158	S-CRP	SLED	28-May	500	43	23.67	179	27.69	e	388	387	0.17	14	3	100 g pebbles, a flatfish and two galatheids.
159	S-CRP	SLED	28-May	602	43	23.39	179	27.76	e	386	387	0.29	193	2	Small diverse catch: live GDU, polychaetes, galatheids.
160	DIS_BOX	CTD	28-May	821	43	21.59	179	42.53	e	10	10	0.00	185	2	CTD (code 7) to 440m. No plume, no water samples taken
161	DIS_BOX	CTD	28-May	900	43	21.39	179	42.9	e	10	10	0.00	245	2	CTD (code 8) to 440m. No plume, no water samples.
162	DIS_BOX	CTD	28-May	955	43	21.27	179	43.32	e	10	10	0.00	160	2	CTD (code 9) to 450m. No plume, no water samples.
163	DIS_BOX	CTD	28-May	1042	43	20.96	179	43.81	e	10	10	0.00	128	2	CTD (code 10) to 450m. No plume, no water samples.
164	DIS_BOX	CTD	28-May	1124	43	21.3	179	44.04	e	10	10	0.00	157	2	CTD (code 11) to 450m. Slight near-bottom increase in turbididty, 3 water depths.
165	DIS_BOX	CTD	29-May	1135	43	21.85	179	42.84	e	10	10	0.00	156	1	CTD (code1) to 440m. Water samples taken.
166	DIS_BOX	CTD	29-May	1247	43	21.69	179	43.31	e	10	10	0.00	2	1	CTD (code2) to 440m. Water taken.
167	DIS_BOX	CTD	29-May	1327	43	21.5	179	43.71	e	10	10	0.00	170	1	CTD (code3) to 445m. No water samples.
168	DIS_BOX	CTD	29-May	1414	43	22.08	179	43.55	e	10	10	0.00	138	1	CTD (code5) to 446m; full water sampling
169	DIS_BOX	CTD	29-May	1541	43	21.36	179	42.93	e	10	10	0.00		1	CTD (code8) to 445m
170	DIS_BOX	CTD	29-May	1612	43	21.54	179	42.53	e	10	10	0.00	216	1	CTD (code7) to 440m.
171	DIS_BOX	CTD	29-May	1651	43	22.23	179	43.26	e	10	10	0.00	184	1	CTD (code6) to 440m
172	DIS_BOX	CTD	29-May	1745	43	21.79	179	44.03	e	10	10	0.00	216	1	CTD (code4) to 447m; full water sampling
173	DIS_BOX	CTD	29-May	2032	43	21.21	179	43.44	e	10	10	0.00	204	2	CTD (code9) to 442m; issues with fluorometer
174	DIS_BOX	CTD	29-May	2138	43	21.07	179	43.24	e	10	10	0.00	116	2	CTD (code10) to 455m; issues with fluorometer - new unit swapped in
175	DIS_BOX	CTD	29-May	2218	43	21.26	179	44.11	e	10	10	0.00	193	2	CTD (code11) to 447m; fluorometer u/s
176	DIS_BOX	CTD	29-May	2331	43	21.59	179	44.36	e	10	10	0.00	171	2	CTD (code12) to 448m; fluorometer u/s
177	DIS_BOX	CTD	30-May	19	43	21.23	179	45.06	e	10	10	0.00	164	2	CTD (code13) to 448m; fluorometer u/s
178	DIS_BOX	CTD	30-May	53	43	21.03	179	44.69	e	10	10	0.00	202	2	CTD (code14) to 450m; fluorometer u/s
179	DIS_BOX	CTD	30-May	144	43	20.74	179	44.2	e	10	10	0.00	187	2	CTD (code15) to 450m; fluorometer u/s
180	DIS_BOX	BDR	30-May	723	43	21.67	179	43.09	e	451	453	6.55	56	2	Benthic Disturbance phase 2.
181	DIS_BOX	BDR	30-May	1412	43	23.29	179	46.12	e	10	100	0.00	331	4	Benthic Disturber reshot. Pump failed, retrieve. Gear didn't contact bottom.

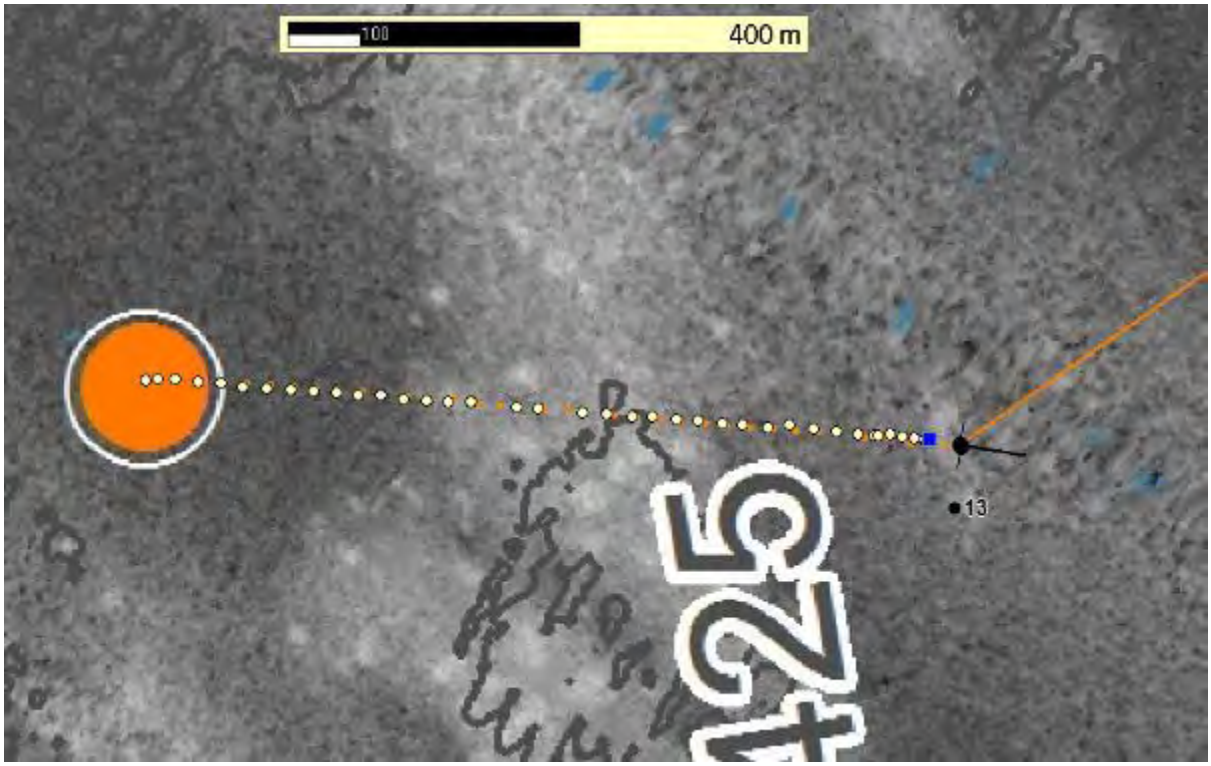
182	REF1	MUC	30-May	1646	43	16.28	179	36.47	e	448	448	0.00	105	4	Multicorer drop on stn 60. 0 cores.
183	REF1	MUC	30-May	1801	43	16.55	179	36.52	e	452	452	0.00		2	Multicorer drop on stn 72. 3 cores
184	REF1	MUC	30-May	1829	43	16.58	179	36.51	e	448	448	0.00		0	Multicorer on stn 72; 3 cores
185	REF1	MUC	30-May	1856	43	16.58	179	36.5	e	449	449	0.00		2	Multicorer drop on stn 72; 3 cores
186	REF1	CTD	30-May	2010	43	16.42	179	35.83	e	10	10	0.00	216	2	CTD (REF1) to 430m; no water samples; issues with comms, DO and salinity sensor
187	REF1	CAM	30-May	2144	43	16.17	179	35.75	e	430	440	0.59	134	1	DTIS transect at REF site; repeat along previous transect.
188	DIS_BOX	BDR	31-May	138	43	21.43	179	43.41	e	450	450	0.17	164	4	Benthic disturber pump 2 failed again after 5 mins on bottom; deployment aborted.
189	MON8	CAM	31-May	448	43	22.45	179	43.02	e	449	445	0.20	172	1	MON8 post-disturbance1. Corals on rim. No obvious sedimentation effect.
190	DIS1	CAM	31-May	633	43	21.79	179	43.32	e	452	449	0.47	155	1	DIS1 post disturbance1. Soft sediment, crossed Disturber path.
191	MON1	CAM	31-May	849	43	21.4	179	44	e	456	455	0.33	136	1	MON1, good run along edge of hard rim. Stylasterids, gorgonians, demosponges and GDU frequent on pebbles and cobbles.
192	MON2	CAM	31-May	1055	43	21.33	179	43.67	e	452	452	0.16	193	1	MON2, rim coral communities
193	MON2	CAM	31-May	1231	43	21.23	179	43.61	e	454	451	0.32	272	1	MON2, followed ribbon of hard backscatter, good cobble-gorgonian/GDU/demosponge communities.
194	MON3	CAM	31-May	1417	43	21.19	179	42.48	e	448	442	0.30	249	1	MON3. Extensive areas of scattered cobbles and pebbles with gorgonians and sponges, small patches of GDU.
195	MON2	CAM	31-May	1631	43	21.32	179	43.96	e	456	450	0.24	261	2	MON2. Ribbon of high backscatter. Some cobbles-pebbles with scattered coral
196	DIS_BOX	BDR	31-May	1914	43	21.31	179	43.08	e	452	448	45.65	199	2	BDR disturbance 2. Disturbance box, 30.42hrs
197	DIS_BOX	CTD	2-Jun	235	43	21.95	179	42.8	e	10	10	0.00	312	2	CTD (code1) to 435m
198	DIS_BOX	CTD	2-Jun	317	43	21.71	179	43.39	e	10	10	0.00	307	2	CTD (code2) to 450m. Some plume sign. Water taken.
199	DIS_BOX	CTD	2-Jun	441	43	21.54	179	43.56	e	10	10	0.00	340	2	CTD (code3) to 445m. No plume, no water.
200	DIS_BOX	CTD	2-Jun	516	43	22.1	179	43.57	e	10	10	0.00	340	2	CTD (code5) to 448m. Good plume signal. Water taken
201	DIS_BOX	CTD	2-Jun	653	43	22.3	179	43.31	e	10	10	0.00	36	2	CTD (code6) to 440m. No plume. No water.
202	DIS_BOX	CTD	2-Jun	727	43	21.86	179	44	e	10	10	0.00	90	2	CTD (code4) to 445m. Slight indication, water samples taken.
203	DIS_BOX	CTD	2-Jun	841	43	21.52	179	42.54	e	10	10	0.00	197	2	CTD (code7) to 440m. No plume indication.
204	DIS_BOX	CTD	2-Jun	929	43	21.46	179	42.96	e	10	10	0.00	172	2	CTD (code8). No plume indication, water samples taken.
205	DIS_BOX	CTD	2-Jun	1025	43	21.25	179	43.47	e	10	10	0.00	188	2	CTD (code9). No plume indication.
206	DIS_BOX	CTD	2-Jun	1740	43	21.94	179	43.6	e	10	10	0.00		2	CTD over glider plume sign. Little indication.
207	DIS1	MUC	2-Jun	1849	43	22.1	179	43.48	e	450	450	0.00		1	4 cores (12-33cm)

208	DIS1	MUC	2-Jun	1914	43	22.1	179	43.53	e	450	450	0.00		1	4 cores (26-45cm)
209	DIS1	MUC	2-Jun	1940	43	22.11	179	43.55	e	450	450	0.00		1	4 cores (21-42cm)
210	DIS1	MUC	2-Jun	2004	43	22.12	179	43.54	e	456	456	0.00		2	3 cores (38-44cm)
211	DIS1	MUC	2-Jun	2031	43	22.18	179	43.62	e	450	450	0.00		2	3 cores (18-42cm)
212	DIS1	MUC	2-Jun	2056	43	22.26	179	43.65	e	456	456	0.00		1	4 cores (36-44cm)
213	MON1	MUC	2-Jun	2157	43	21.47	179	43.94	e	460	460	0.00		1	4 cores (29-34cm)
214	MON1	MUC	2-Jun	2225	43	21.43	179	44.01	e	460	460	0.00		1	4 cores (17-38cm)
215	MON1	MUC	2-Jun	2252	43	21.48	179	44.12	e	460	460	0.00		1	4 cores (30-37cm)
216	MON1	MUC	2-Jun	2316	43	21.43	179	44.14	e	461	461	0.00		2	3 cores (20-39cm)
217	MON1	MUC	2-Jun	2342	43	21.39	179	44.1	e	461	461	0.00		1	4 cores (32-46cm)
218	MON1	MUC	3-Jun	17	43	21.44	179	43.7	e	457	457	0.00		1	6 cores (20-34cm)
219	MON9	MUC	3-Jun	100	43	21.25	179	44.66	e	460	460	0.00		2	6 cores (15-43cm)
220	MON9	MUC	3-Jun	132	43	21.24	179	44.58	e	461	461	0.00		1	6 cores (23-37cm)
221	MON9	MUC	3-Jun	201	43	21.26	179	44.63	e	460	460	0.00		1	6 cores (19-33cm)
222	MON7	MUC	3-Jun	247	43	21.01	179	45.17	e	460	460	0.00		1	6 cores (28-44cm)
223	MON7	MUC	3-Jun	314	43	20.95	179	45.27	e	460	460	0.00		1	6 cores (21-30cm)
224	MON7	MUC	3-Jun	343	43	20.91	179	45.28	e	470	470	0.00		1	6 cores (30-37cm)
225	DIS2	MUC	3-Jun	448	43	21.88	179	43.78	e	450	450	0.00		1	6 cores (23-34cm)
226	DIS2	MUC	3-Jun	516	43	21.84	179	43.71	e	451	451	0.00		1	6 cores (24-41cm)
227	MON2	MUC	3-Jun	604	43	20.94	179	43.49	e	459	459	0.00		1	6 cores (25-34cm)
228	MON2	MUC	3-Jun	632	43	20.89	179	43.49	e	459	459	0.00		2	6 cores (14-37cm)
229	MON9	MOOR	3-Jun	1307	43	21.16	179	44.57	e	460	0	0.00	303	2	Deploy long-term ADCP mooring
230	MON9	MOOR	3-Jun	1403	43	21.28	179	44.64	e	460	0	0.00	303	2	Deploy long-term sediment trap mooring
231	MON1	CAM	3-Jun	1625	43	21.47	179	44.19	e	451	456	0.35	117	2	Run along northern "rim" of harder substrate. Patches of corals, gorgonians and sponges. Good GDU community at start of tow
232	MON1	CAM	3-Jun	1804	43	21.48	179	44.11	e	456	443	0.40	121	2	Run along southern rim. Good coral communities at southeastern end.
233	MON2	CAM	3-Jun	2027	43	21.3	179	43.66	e	451	450	0.19	184	2	Repeat #192. Patches of coral with muddly sediment. Entered Disturbance box at end.
234	MON2	CAM	3-Jun	2150	43	21.21	179	43.12	e	451	449	0.93	93	2	Repeat #193. Mostly muddy sediments, occasional patch of cobbles with coral
235	MON1	BDR	4-Jun	24	43	21.62	179	43.93	e	456	454	6.99	104	2	BDR runs along lines to south of "butterknife". Total of 10 lines run inside 90 m (0.05 NM) wide box, plus 1 trial run southwest of box
236	MON1	CAM	4-Jun	1715	43	21.61	179	44.17	e	452	454	0.18	31	1	DTIS across "Butterknife", no obvious evidence of smothering, BDR tracks observed.

237	MON1	CAM	4-Jun	1817	43	21.74	179	44.44	e	455	455	0.19	43	1	DTIS across "Butterknife", no obvious evidence of smothering, BDR tracks observed. GDU communities at SE end, not as dense as NW corner.
238	MON5	CAM	4-Jun	2036	43	22.92	179	41.81	e	442	440	0.31	49	1	DTIS repeat at MON5. Mostly muddy sediment
239	MON3	CAM	4-Jun	2225	43	21.48	179	42.38	e	444	446	0.23	67	2	DTIS repeat at MON3, following high reflectivity ribbon
240	DIS1	CAM	5-Jun	32	43	22.21	179	43.32	e	445	445	0.30	50	1	DTIS repeat of DIS1, post-disturbance.
241	DIS2	CAM	5-Jun	143	43	21.93	179	43.66	e	448	448	0.31	11	2	DTIS repeat of #83.
242	MON8	CAM	5-Jun	441	43	22.68	179	43	e	448	448	0.20	30	1	Mainly soft sediment, south rim with some sponge, gorgonian, bryozoan and GDU.
243	MON3	CAM	5-Jun	618	43	21.75	179	42.54	e	448	448	0.16	30	1	Patchy cobbles-pebbles with scattered GDU, gorgonians, sponges.
244	MON1	CAM	5-Jun	754	43	21.61	179	44.14	e	453	457	0.23	30	1	NW end of “butterknife”. GDU in patches, strong edge with prominent stylasterids.
245	MON1	CAM	5-Jun	906	43	21.76	179	44.51	e	459	459	0.20	31	1	SE end of “butterknife”. Mostly soft sediment, thin band of GDU community on high reflectivity rim.
246	MON7	MUC	5-Jun	1135	43	20.97	179	45.29	e	465	465	0.00		1	6 cores (22-43cm)
247	MON7	MUC	5-Jun	1203	43	20.99	179	45.35	e	465	465	0.00		2	5 cores (18-43cm)
248	MON5	MUC	5-Jun	1301	43	23.17	179	42.31	e	447	447	0.00		3	1 core (26cm)
249	MON5	MUC	5-Jun	1327	43	23.18	179	42.28	e	448	448	0.00		2	5 cores (21-30cm)
250	MON5	MUC	5-Jun	1358	43	23.2	179	42.27	e	448	448	0.00		1	6 cores (16-37cm)
251	MON5	MUC	5-Jun	1424	43	23.19	179	42.31	e	449	449	0.00		1	6 cores (33-62cm)
252	ANZ	CAM	6-Jun	239	43	25.8	177	33.02	e	305	307	0.28	221	1	Exploration for sponge target
253	ANZ	BEAM	6-Jun	446	43	25.73	177	33.07	e	306	306	0.17	218	2	Short beam trawl tow. Several sponges, with galatheids, heart urchin, some fishes.
254	ANZ	BEAM	6-Jun	605	43	25.61	177	33.17	e	304	306	0.37	206	1	Short beam trawl. Sponges, galatheids, good diverse catch.

Appendix B DTIS station descriptions

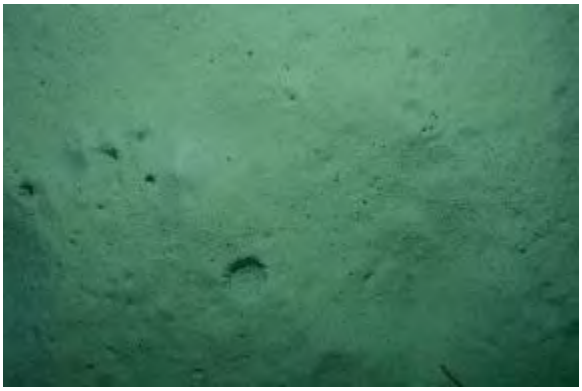
Station 013. Exploratory area



This transect ran across a small ridge with low reflectivity backscatter with pale patches [white dots in graphic above = muddy sediment].

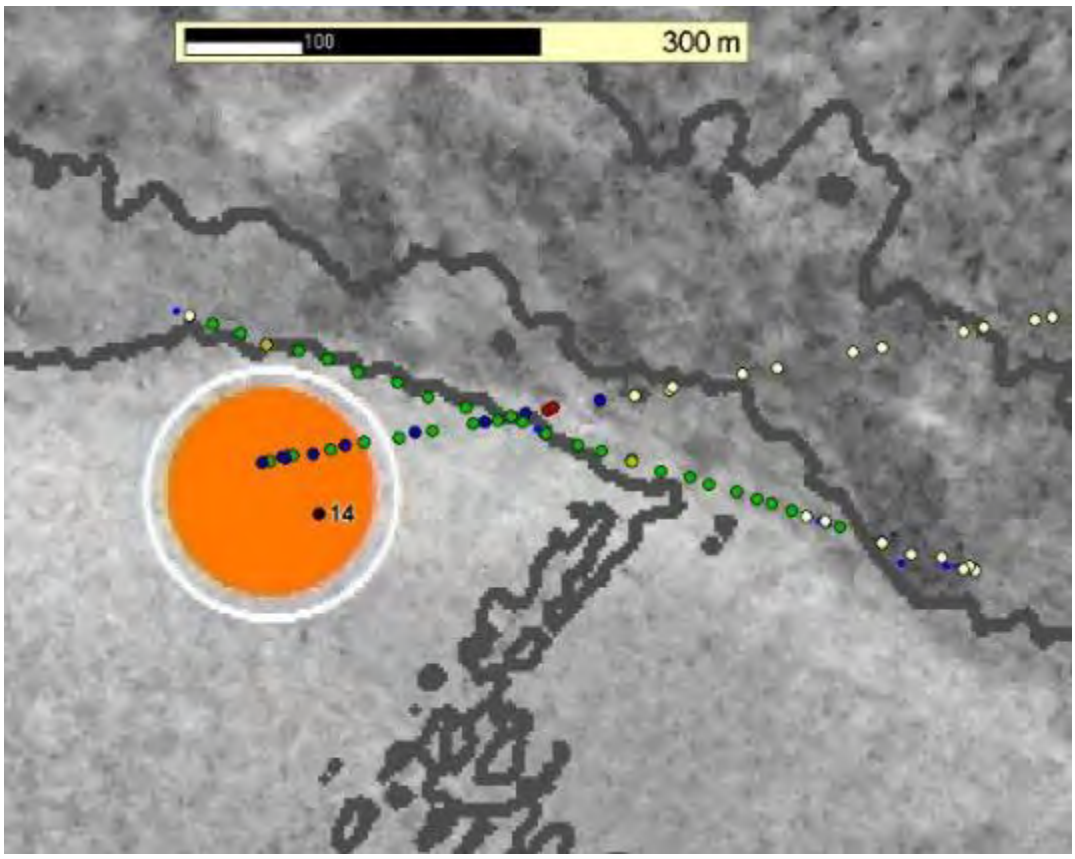
The seafloor was muddy substrate, with pronounced mounds and burrows. There were occasional rattails and asteroid sea stars, holothurians and sea pens. Several locations could be cored.

TAN1805_Stn_013_028.JPG



TAN1805_Stn_013_192.JPG

Station 014: Exploratory area



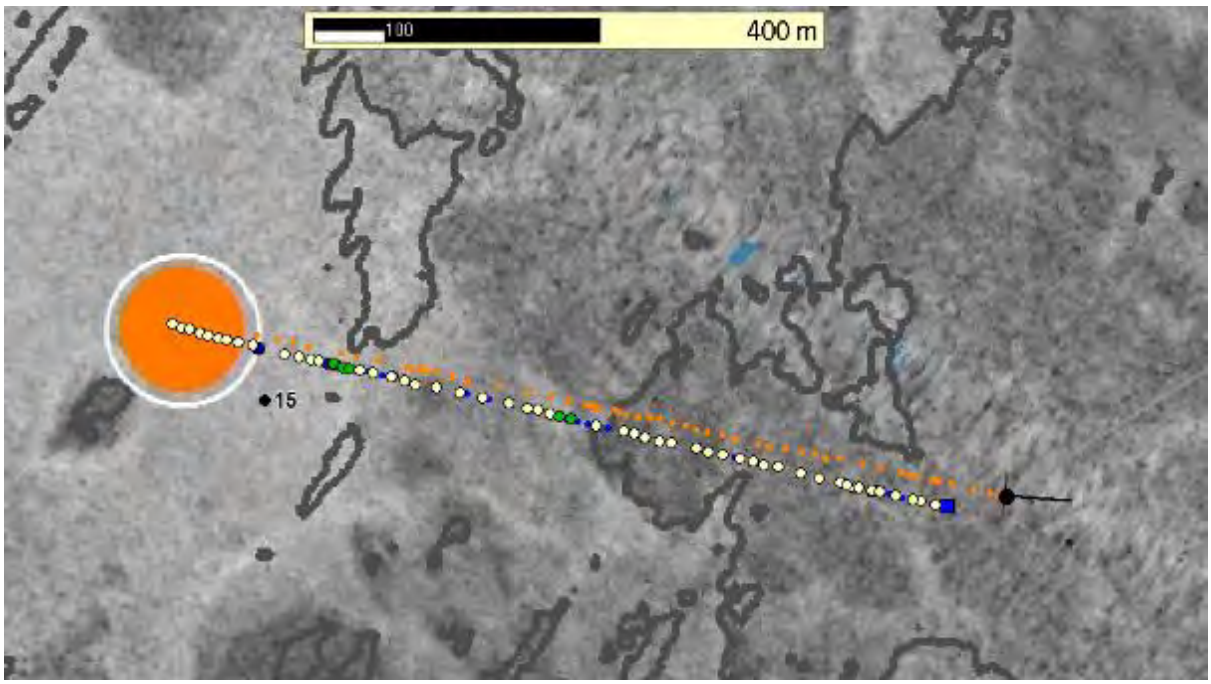
The transect targeted an area of high reflectivity at the start, grading into low reflectivity. Passes over a band of higher reflectivity two third way through. [white dots = muddy sediment, green dots = cobbles/pebbles, blue dots = pebbles, red dots = bedrock, pale green = boulders].

This was a relatively flat tow (435m to 445m). At the start, there was predominantly muddy sediment with pebbles and cobbles, with encrusting sponges and bryozoans. At the edge of a transition in backscatter, a ridge with *Goniocorella* stony corals, the urchin *Dermechinus horridus*, and stylasterid corals. After that substrate was mainly soft muddy sediment with pits and burrows, occasional cidarid and heart urchins (*Paramaretia peloria*) and anemones. The thin area of higher reflectivity was a band of hard substrate, also supporting *Goniocorella*. Several locations could be suitable for coring.

TAN1805_Stn_014_057.JPG

TAN1805_Stn_014_142.JPG

Station 015: Exploratory area



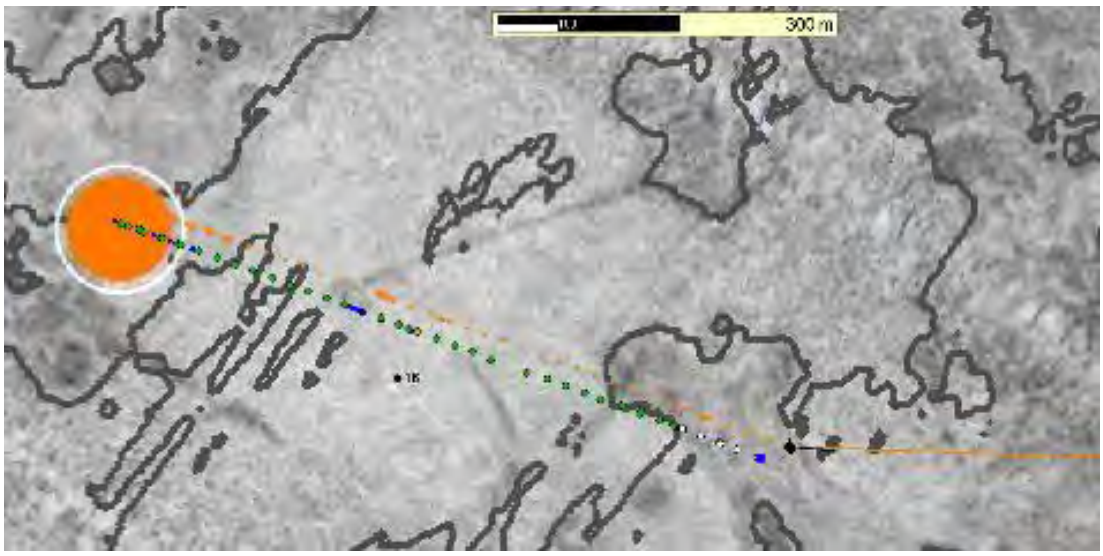
The transect targeted medium reflective backscatter transitioning to darker backscatter.

There was muddy sediment throughout with burrows, a few solitary asteroids, and patches of scattered small cobbles and pebbles in a slightly more reflective band with encrusting fauna including small gorgonians, stylasterids and hydroids, and plate shaped demosponges (possibly *Poecillastra laminaris* possibly *Awhiowhio sepulchrum*). There were more pebbles and some larger isolated cobbles in a patch in the middle of the transect, followed by muddy sediment again.

TAN1805_Stn_015_063.JPG

TAN1805_Stn_015_187.JPG

Station 016: Exploratory area



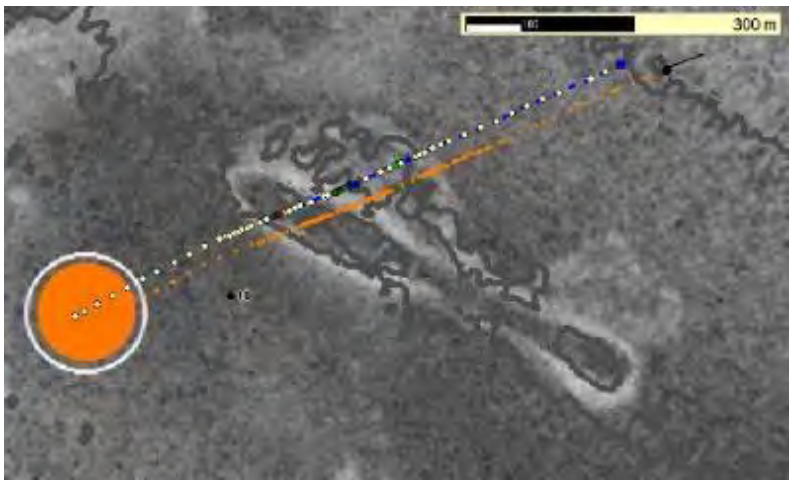
The target area had high reflectivity, and a small rise with lower reflectivity near the end of the transect.

This was another relatively flat transect (415m to 420m). Muddy sediment with no burrows along with encrusted cobbles, nodules and pebbles for most of the transect. The transect finished in a region of low reflectivity, with markedly softer sediment with burrows. The cobbles appear to have film of sediment as an overlay. Encrusting fauna includes fragments of live *Goniocorella* and apparently dead stony coral rubble. Heart urchins were common in patches, especially in the middle, and at the end of the tow. Demosponges occurred throughout, on pebbles and cobbles in ball and plate forms. There were numerous lanternfish and shrimps along the length of the transect. In places there were *Hyalascus* glass sponges. Overall this was a more fauna-rich area than other transects to date.

TAN1805_Stn_016_009.jpg

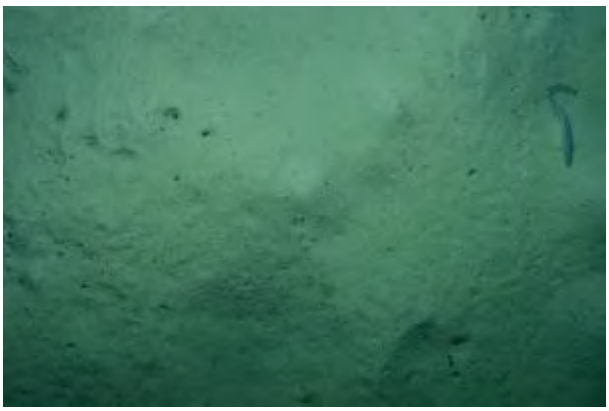
TAN1805_Stn_016_201.jpg

Station 018: S129 site (“the butterknife”)



The target was an area of medium reflectivity with a central ~4m depression surrounded by high reflectivity substrate bordered by low reflectivity background starting at 452m and ending in 455m.

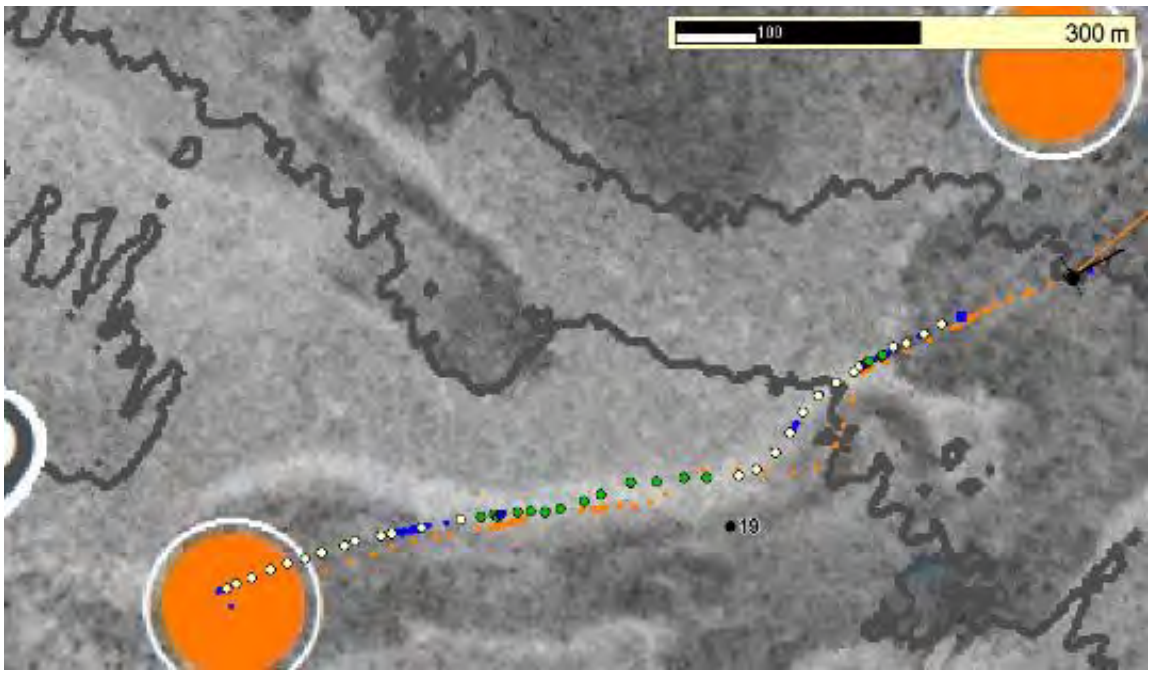
This transect was near site S129 which sampled the same bottom feature. The central part of the transect features two elevated ledges of hard substrate and exposed encrusted cobbles bordering a central depression containing soft sediment, one ledge has a section of lost trawl netting. The beginning of the transect was relatively flat but with lumpy muddy sediment pocketed with burrows, pits and mounds. Sea stars, echinoids, and rattails were common throughout the transect. Towards the edge of the depression, *Goniocorella* stony corals started to appear in small clusters including bryozoans. In the centre of the depression, sediment was similar to the rest of the transect. Coming to the other side of the depression, there were small to medium clusters of intact *Goniocorella*, solitary stalked cup corals, anemones and other fauna in a thin band. As the transect passed over less reflective backscatter it reverted back to soft sediments similar to the beginning of the transect.


TAN1805_Stn_018_026.jpg


TAN1805_Stn_018_121.jpg


Clip from video showing a piece of trawl net

Station 019: Exploratory area



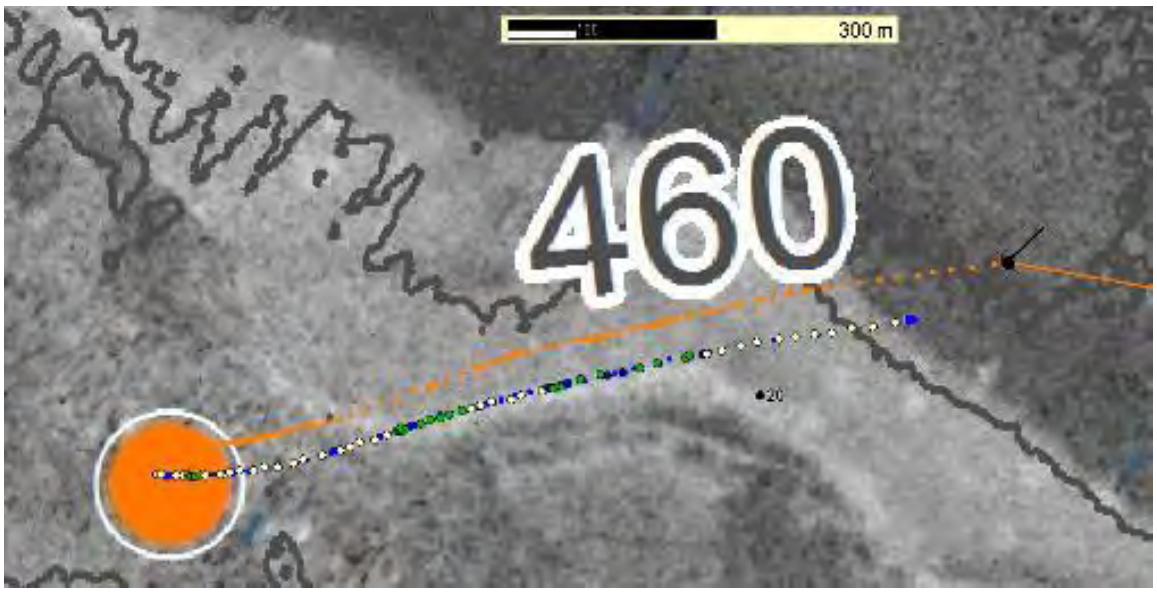
The transect targeted a narrow wavy band of medium reflectivity backscatter.

The transect started off as muddy sediment with burrows, and then turned to mud and pebbles with two areas characterised by patches of small encrusted cobbles and pebbles, mainly with branching small gorgonians or hydroids but also with some fragments of *Goniocorella* in places. The transect attempted to follow the higher reflectivity backscatter which appeared to be in a narrow band. The medium backscatter appeared as mud and the end of the transect over darker backscatter gradually reverted back to mud with burrows until the end. One patch of hard substrate was as a low ledge recorded as bedrock. Echinoids, asteroids, rattails and anemones were present throughout the transect.

TAN1805_Stn_019_002.jpg

TAN1805_Stn_019_155.jpg

Station 020: Exploratory area



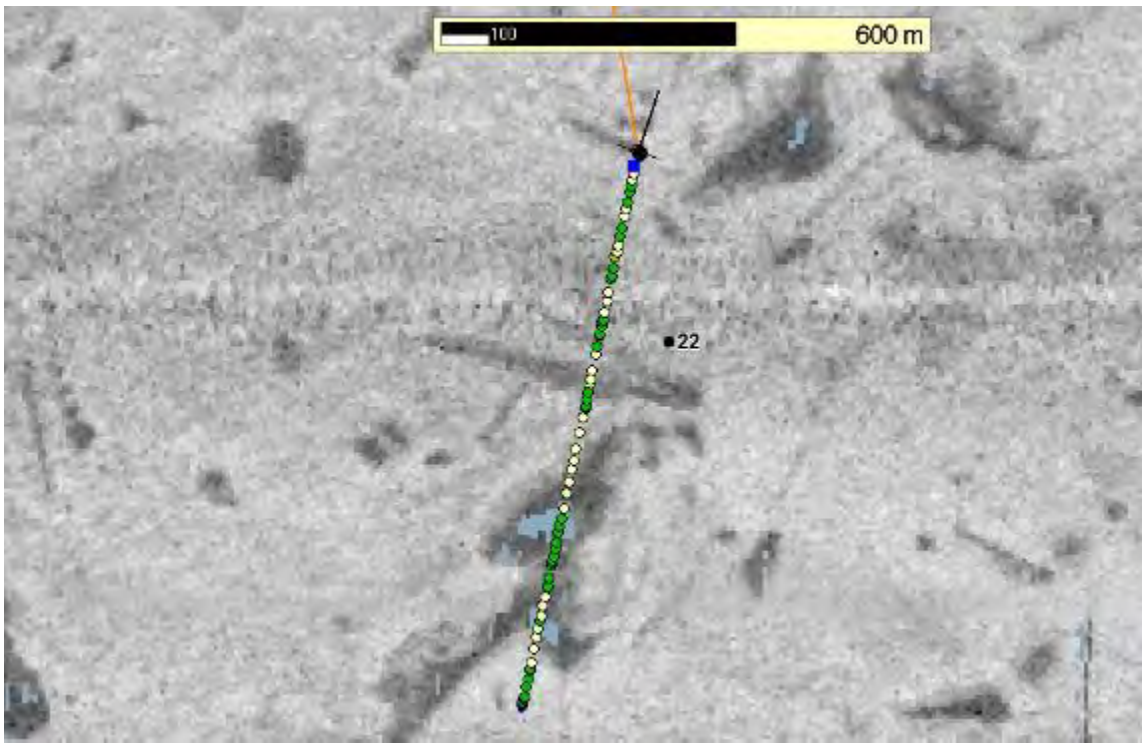
The target area started off on low-medium reflectivity seabed and the middle third followed the crest of high reflectivity, ending on low-medium reflectivity backscatter.

The beginning and end of the transect were mainly muddy sediment and burrows, whereas the central crest portion of the transect consisted of a mix pebbles and encrusted cobbles often with a overlay of sediment. There was also a ledge of hard substrate coded as bedrock. Gorgonians, hydroids and stylasterids were more commonly observed on cobbles than fragments of *Goniocorella* which occurred in places. Common non-encrusting fauna along the transect were asteroids, echinoids, rattails, squat lobsters and anemones.

TAN1805_Stn_020_108.jpg

TAN1805_Stn_020_165.jpg

Station 022: S-CRP area



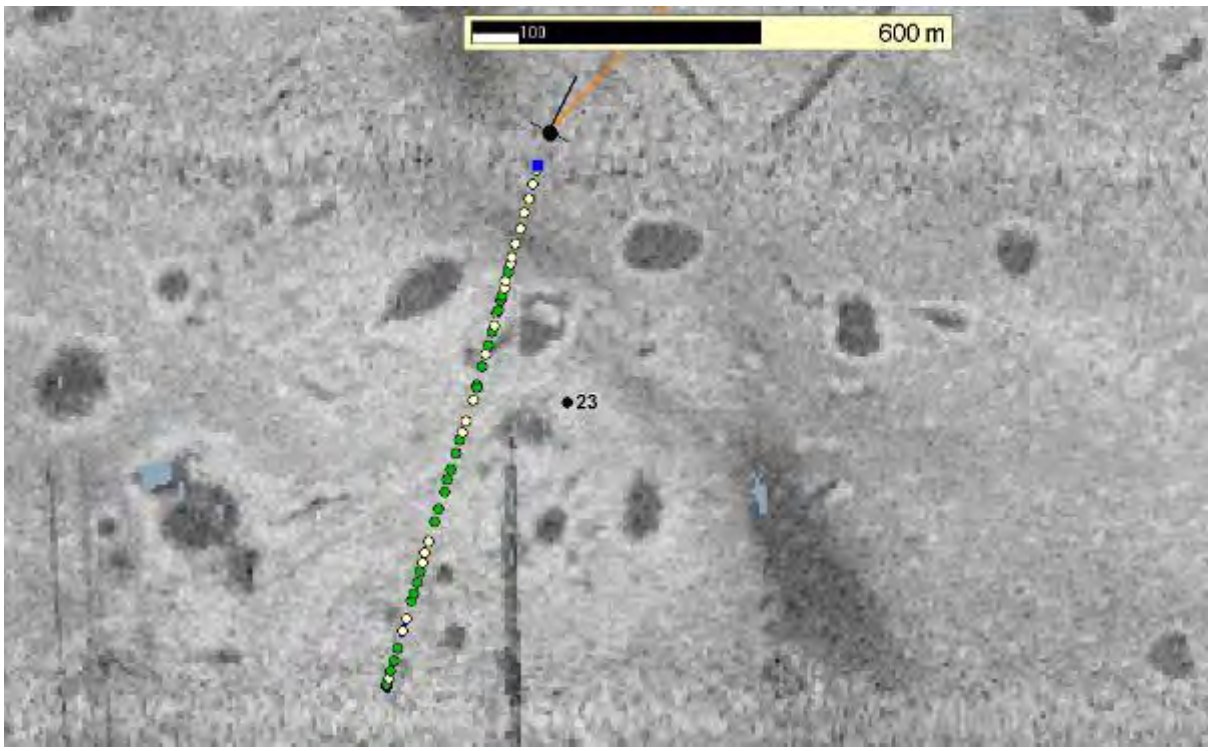
This transect transversed a small low backscatter depression within an area of slightly elevated (8-10m) high reflectivity backscatter.

The transect alternated between patches of encrusted cobbles and pebbles, and some boulders, with patches of muddy sediment with burrows, with infrequent chalk sign (possibly expelled from burrows). Many cobbles were already heavily sedimented. Encrusting fauna included *Goniocorella* fragments, demosponges (plate and white ball) and small gorgonians and hydroids. There were several areas of dense heart urchins (in the middle of the transect and towards the end). Scattered rattails and conger eels occurred throughout the transect, and some other non-encrusting invertebrate fauna including *Radicipes*.

TAN1805_Stn_022_011.JPG

TAN1805_Stn_022_162.JPG

Station 023. S-CRP area



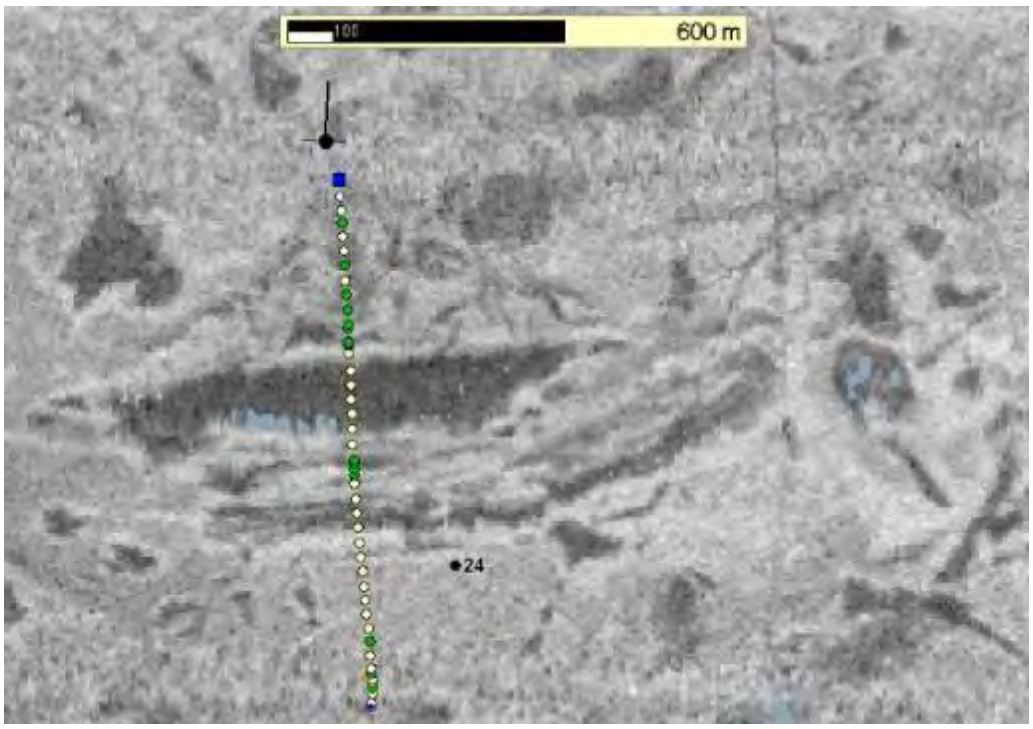
This transect covered a mix of high and mid-low backscatter - predominantly high backscatter, with several small depressions (~7m deep) with low reflectivity backscatter, dropping 9m from the start to an area of low backscatter at the end.

The substrate was mainly muddy sediment and pebbles and cobbles, with patches of muddy sediment. *Goniocorella* occurred in patches and were associated with the pebbles and cobbles (*Goniocorella* was sparse and not in dense thickets). The areas of muddy sediment had burrows and pits and there were several patches of dense heart urchins and some demosponges. Fish, primarily rattails, were also seen on the muddy sediment.

TAN1805_Stn_023_040.JPG

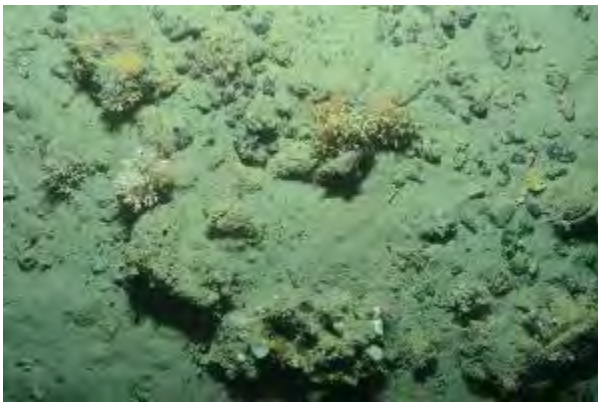
TAN1805_Stn_023_107.JPG

Station 024. S-CRP area



This transect was west of the “CRP” area, running across a 12m depression then up an elevated mound ~7m high with high reflectivity backscatter.

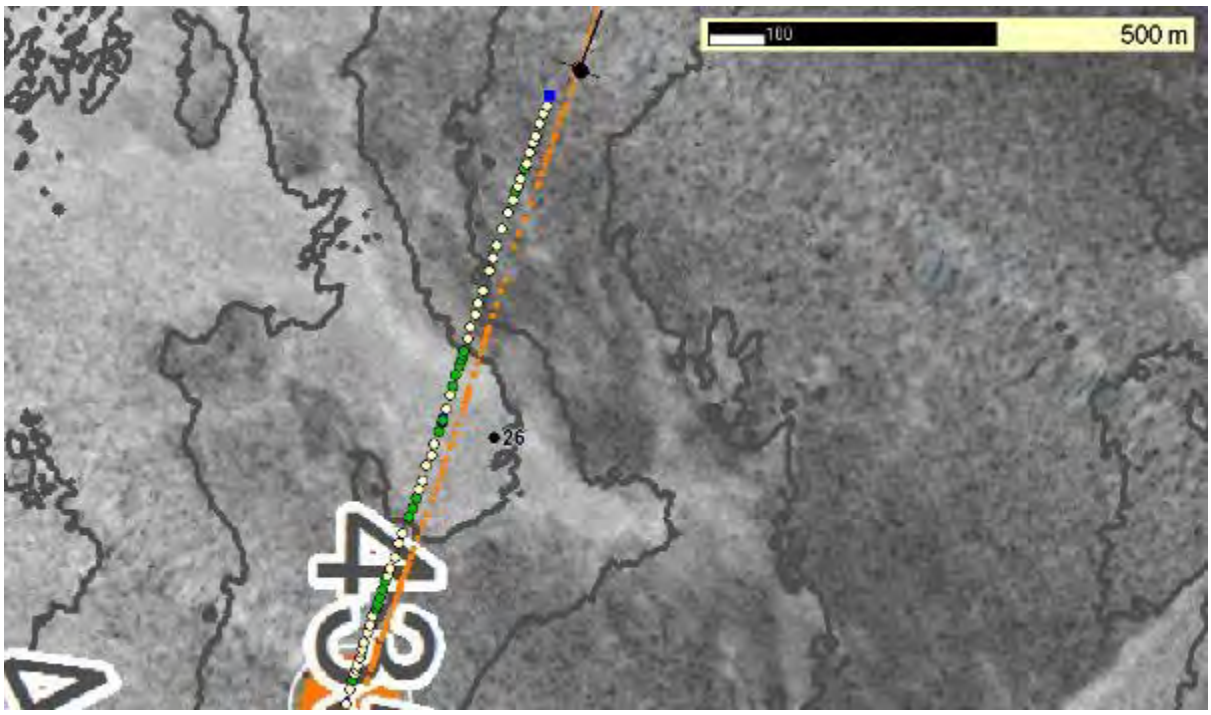
The substrate comprised patchy bands of muddy sediment, and mud with cobbles, nodules and pebbles, and a hard ‘bedrock’ substrate around the rim of the depression. The depression corresponded with dark backscatter and was muddy, the transect then rose to patches of heavily encrusted cobbles on the raised section of the transect near the end. This corresponded to a variable distribution of mostly buried heart urchins, *Radicipes*, scampi and other soft sediment fauna in places, with *Goniocorella,* stylasterids, gorgonians, demosponges and other encrusting fauna on hard substrates. Patches of intact *Goniocorella* were more common on the small rise towards the end of the transect. Other fauna included parasol urchins, sea perch and eels Rattails were the main fish observed.



TAN1805_Stn_024_140.jpg

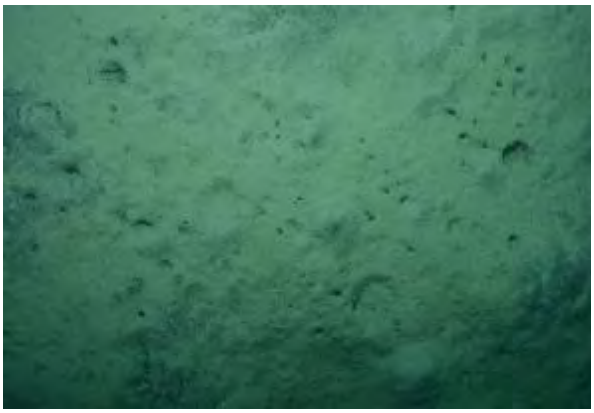
TAN1805_Stn_024_210.jpg

Station 026: Exploratory area



This transect targeted a central plateau of high reflectivity with a crest on its eastern edge, bordered by flat areas of low reflectivity.

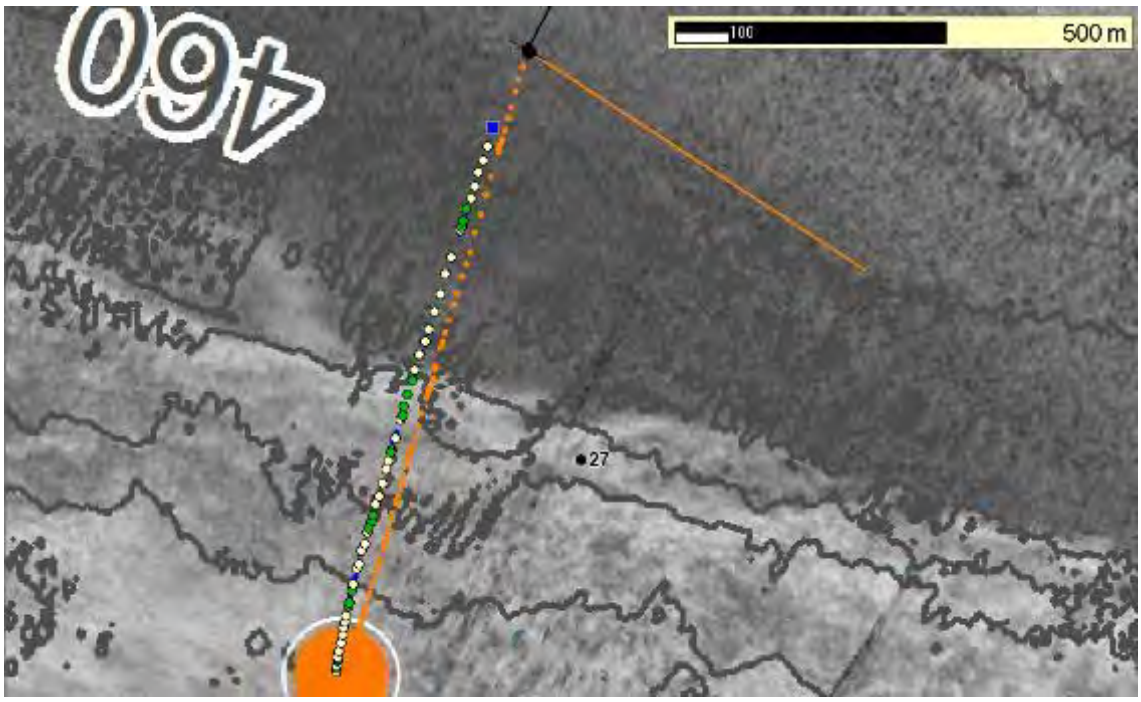
There were areas with lower reflectivity in the beginning and end of the transect. This mainly corresponded to muddy sediment with burrows, some mounds, grey anoxic areas and occasional patches of dense urchins. The centre of the transect was a high reflectivity "plateau" with sparse patches of small *Goniocorella* corals, sponges, bryozoans, pebbles and cobbles. *Hyalascus* sponges were found on the edge of the central plateau and on muddy sediment.



TAN1805_stn_26_193.jpg

TAN1805_stn_26_137.jpg

Station 027: Exploratory area



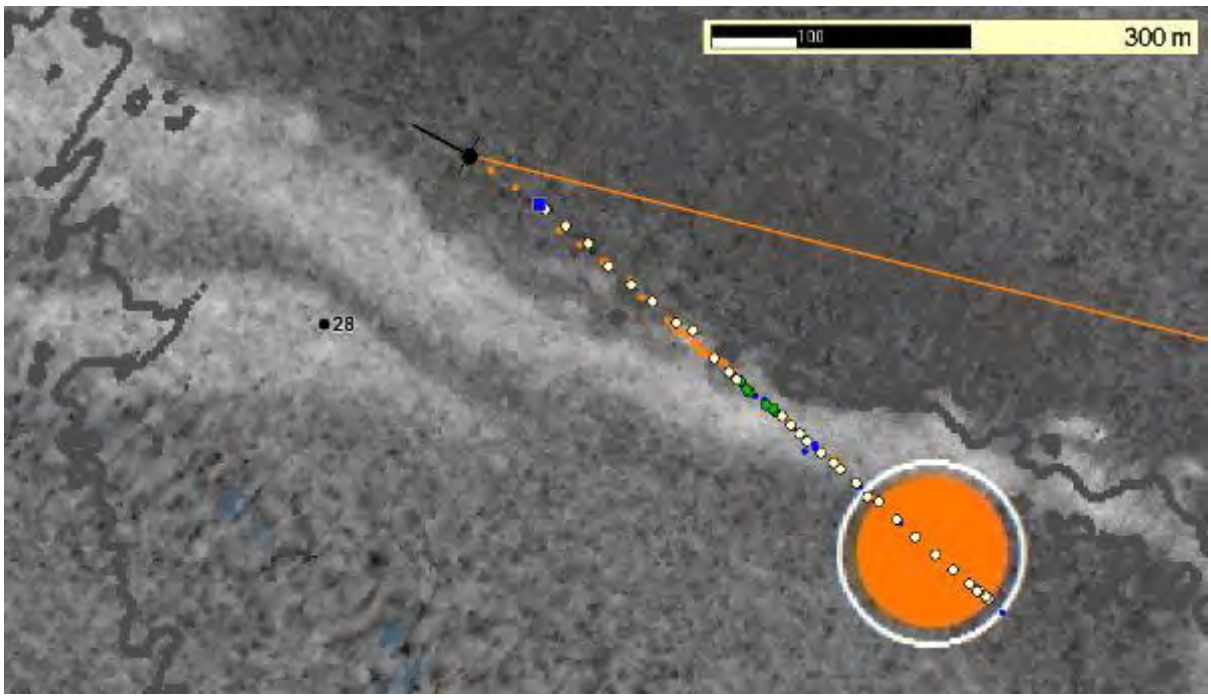
A southwest-northeast transect, the first half of which consisted of high reflectivity seabed bounded by a slight crest; second half consisting of low reflectivity seabed. Depth ranged from 448m to 460m over light backscatter then rose to 441m towards the end of the transect.

There were areas of high density nodule pebbles (phosphorite?) and small bryozoan and hydroid encrusted cobbles largely devoid of conspicuous epifauna. Some dead *Goniocorella* was observed. There were some small gorgonians, sponges (white balls) and other encrusting fauna, though these were low or sparse, the hard surfaces appeared sedimented. The cobbles and pebbles occurred in patches mainly in the high reflectivity half of the transect, the muddy sediment in this area was flat with few burrows. In the low reflectivity half, the seabed consisted of muddy sediments with extensive areas of burrows, pits and mounds. Common non-encrusting fauna included asteroids, rattails and there were some live, and several dead, *Hyalascus* glass sponges and a brisingid.

TAN1805_stn_27_002.jpg

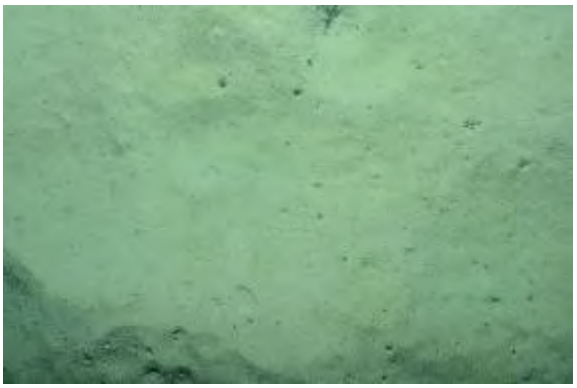
TAN1805_stn_27_039.jpg

Station 028: Exploratory area



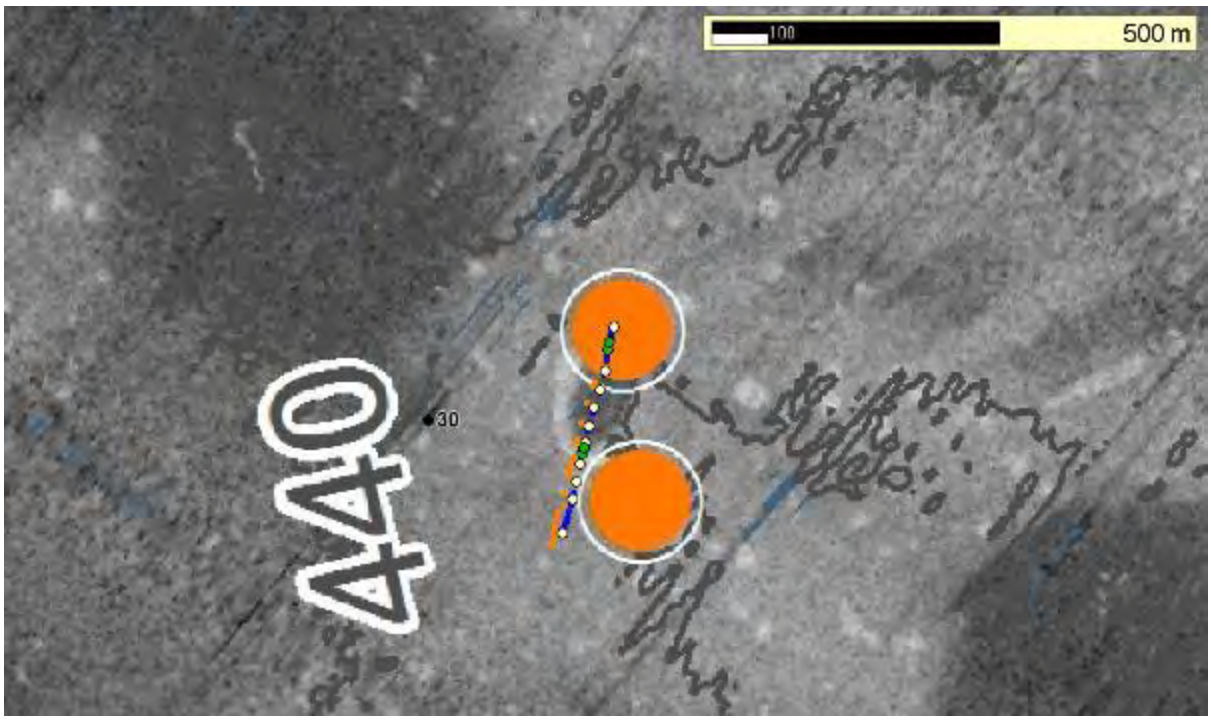
This tow targeted an isolated strip of high backscatter to the northeast of the exploratory area. The tow was shortened to 40 minutes due to rough weather. Direction was from the southeast to northwest.

This was a flat transect (464 m depth start, 463 m depth end), with little change over the slight ridge feature. It was mostly muddy sediment with burrows, with a very brief patch of pebbles and small *Goniocorella* stony coral clusters along the highly reflective strip. There was sparse fauna – a few rattails, asteroids, echinoids and one anemone.


TAN1805_Stn_028_015.JPG


TAN1805_Stn_028_143.JPG

Station 030: Exploratory area



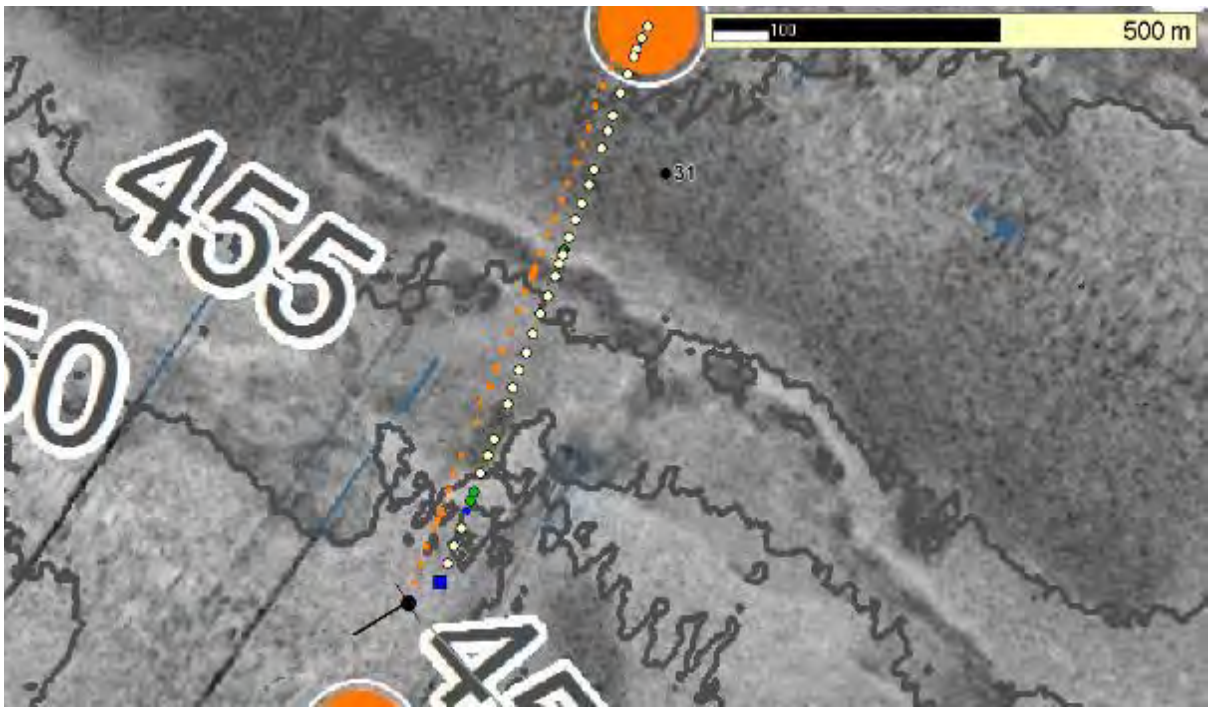
This tow was targeting a small hole with a high backscatter rim. The transect direction was not ideal because of bad weather.

The transect was short (20 minutes of DTIS video) because the targeted high backscatter hole was small. The transect passed over the northern and southern rims which were comprised of encrusted cobbles and pebbles, the centre of the small depression and the surrounding substrates were mounded muddy sediment. There were a few scattered gorgonians recorded at the beginning of this transect. Two-thirds of the way along was a patch of cobbles and pebbles, and one live clump of *Goniocorella*, and a few demosponges and encrusting bryozoans. Cidirids were scattered throughout the transect. There were also numerous bony fish, notably myctophids and hoki, with the occasional rattail and a banded bellowsfish.

TAN1805_Stn_030_015.JPG

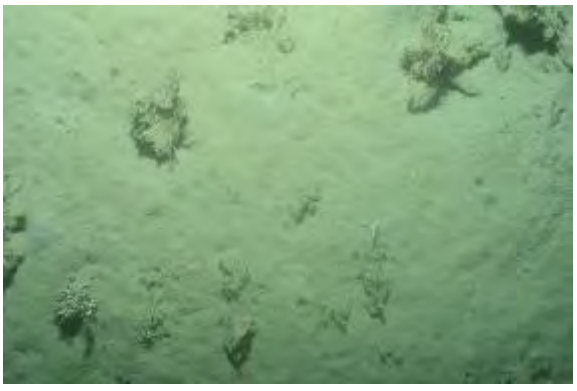
TAN1805_Stn_030_049.JPG

Station 031: Exploratory area

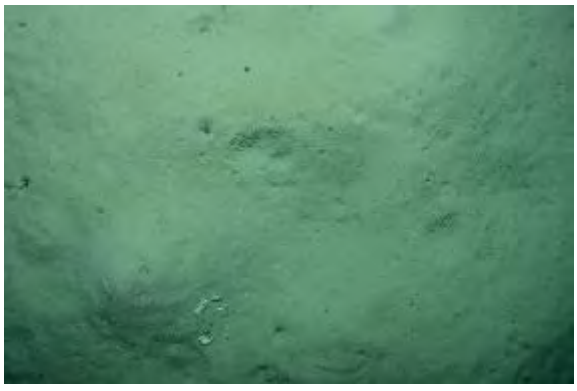


This transect ran across a small ribbon of high backscatter and a slightly elevated area of higher reflectivity backscatter.

The substrate was predominantly muddy bioturbated sediment throughout, with a few cobbles and pebbles along the ribbon of high reflectivity with some boulders near the end. Encrusting fauna mainly comprised bryozoans, hydroids, small gorgonians, stylasterids, ascidians and some *Goniocorella* fragments. Other sparse fauna included: scampi, asteroid and rattails. A skate was seen halfway through the transect.

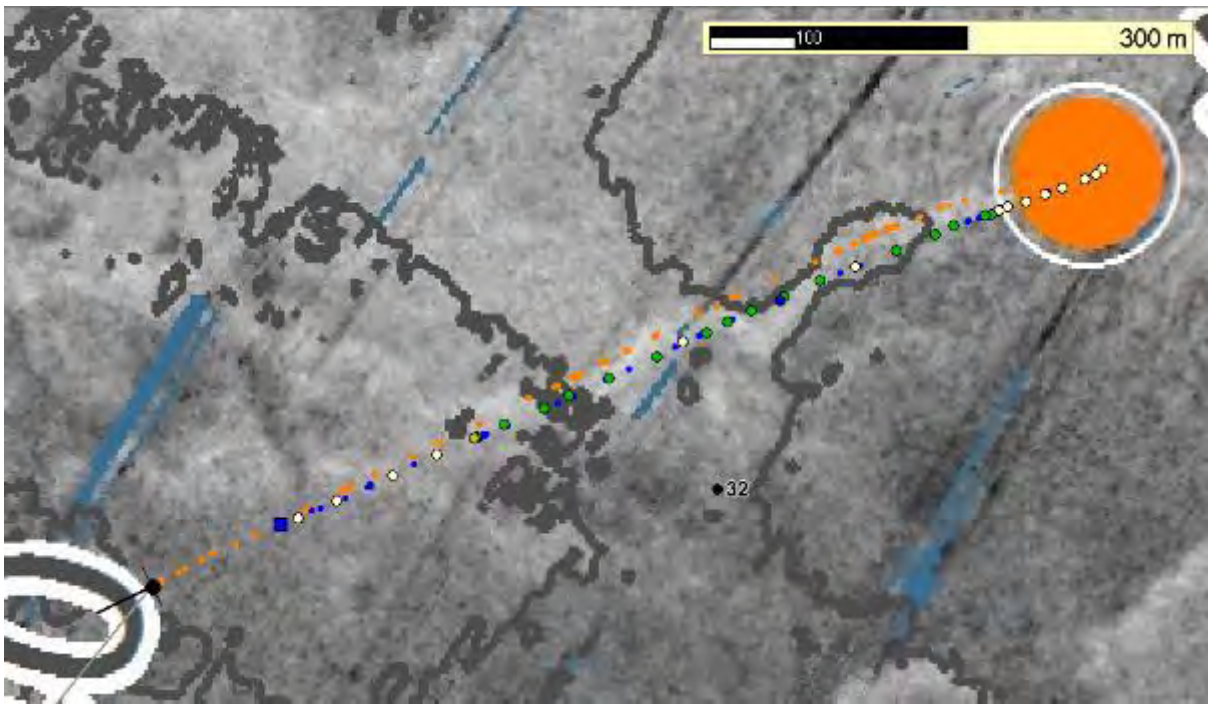


TAN1805_Stn_031_187.JPG



TAN1805_Stn_031_023.JPG

Station 032: Exploratory area



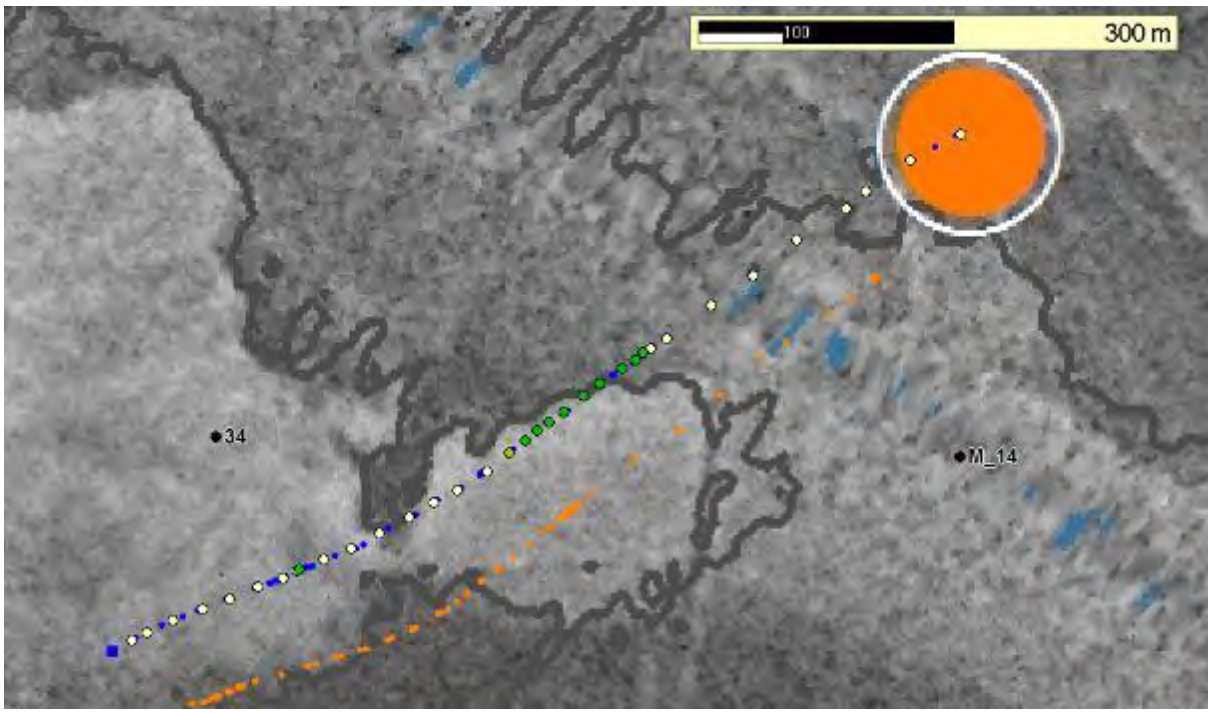
This tow targeted a ribbon of high backscatter and followed a narrow low ridge rising from 448 to 444 m.

The substrate was initially muddy sediment and then transitioned to mud with scattered pebbles and cobbles. Halfway through the transect there was some bedrock with sandy overlay, and patches of numerous pebbles. Encrusting fauna included stylasterids, small gorgonians and ball and encrusting sponges, fragments of *Goniocorella* and some intact coral substrate. The *Goniocorella* occurred in patches until near the end of the transect; the substrate ended in muddy sediment and burrows. Other fauna seen during the transect included brisingid seastars, cidarids, holothurians, flabellum, and the soft coral *Anthomastus*.

TAN1805_stn_32_132.jpg

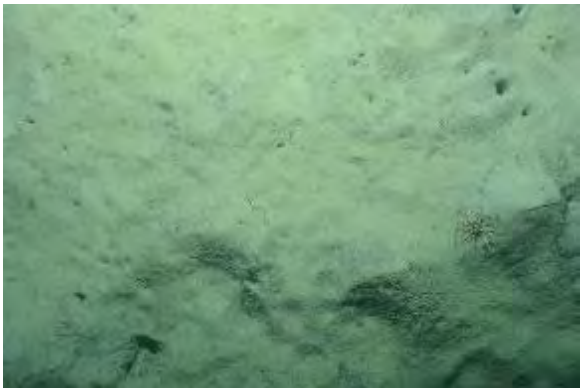
TAN1805_stn_32_153.jpg

Station 034: Exploratory area



The transect crossed narrow bands of high reflectivity as well as slight depressions with low reflectivity, over a depth range of 437-442 m.

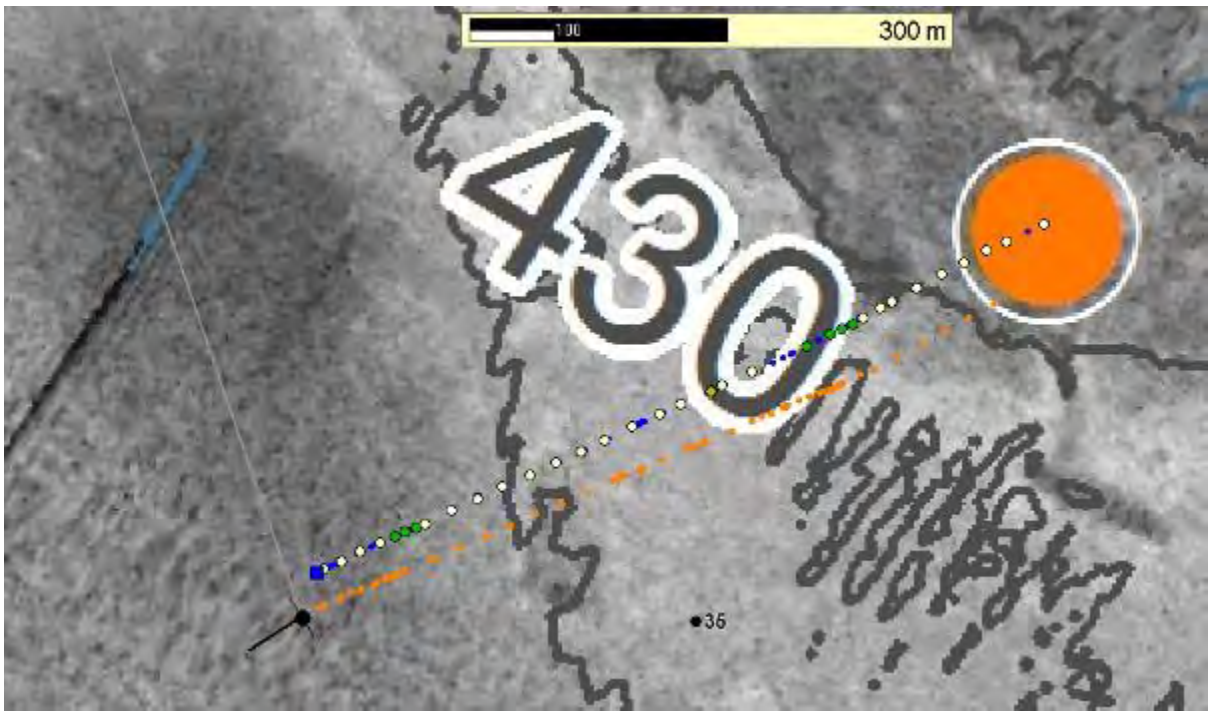
The tow transitioned from a region of lower reflectivity backscatter characterised by muddy sediment with burrows, mounds, and heart urchin tracks; to a slightly elevated area of higher reflectivity, the later substrate comprising pebble/cobbles heavily encrusted with fauna, including gorgonians, stylasterids, hydroids, plate form demosponges and some fragments of *Goniocorella*. The last third of the transect also crossed a region of high-reflectivity backscatter but had few patches of scattered cobbles and appeared to be mainly muddy sediments with burrows and mounds. Common non-encrusting fauna included asteroids, cidarids, spatangids, holothurians. Problems with data recording mean the plot above may not accurately reflect the DTIS position.



TAN1805_stn_34_018.jpg

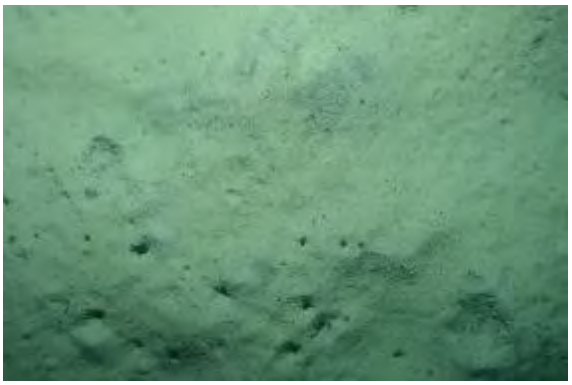
TAN1805_stn_34_026.jpg

Station 035: Exploratory area



This transect crossed a central plateau with high reflectivity narrow bands.

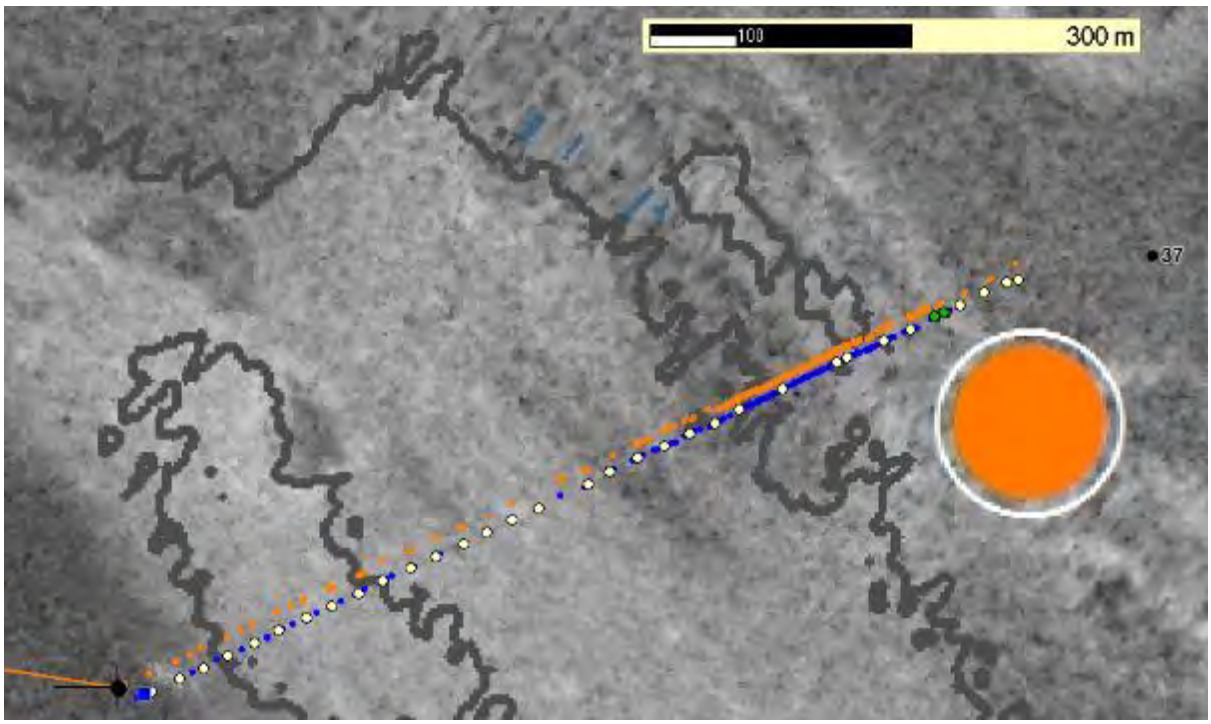
Encrusting fauna included some intact coral in addition to fragments of *Goniocorella* , with some plate form demosponges on patches of pebbles and cobbles on both flanks of the elevated plateau. There were some isolated small boulders. Other areas were soft sediment with burrows, mounds, grey patches (possibly indicative of sediment turnover from bioturbation). Common fauna here included spatangid urchins, *Hyalascus*, asteroids, and small white sponges.



TAN1805_stn_035_018.jpg

TAN1805_stn_035_067.jpg

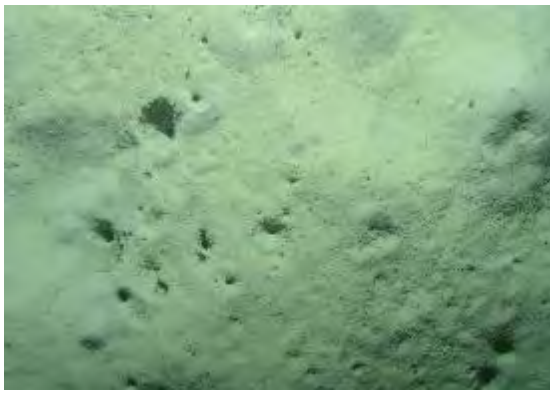
Station 037: Exploratory area



This transect crossed low-mid reflectivity; low at the beginning and end of the transect.

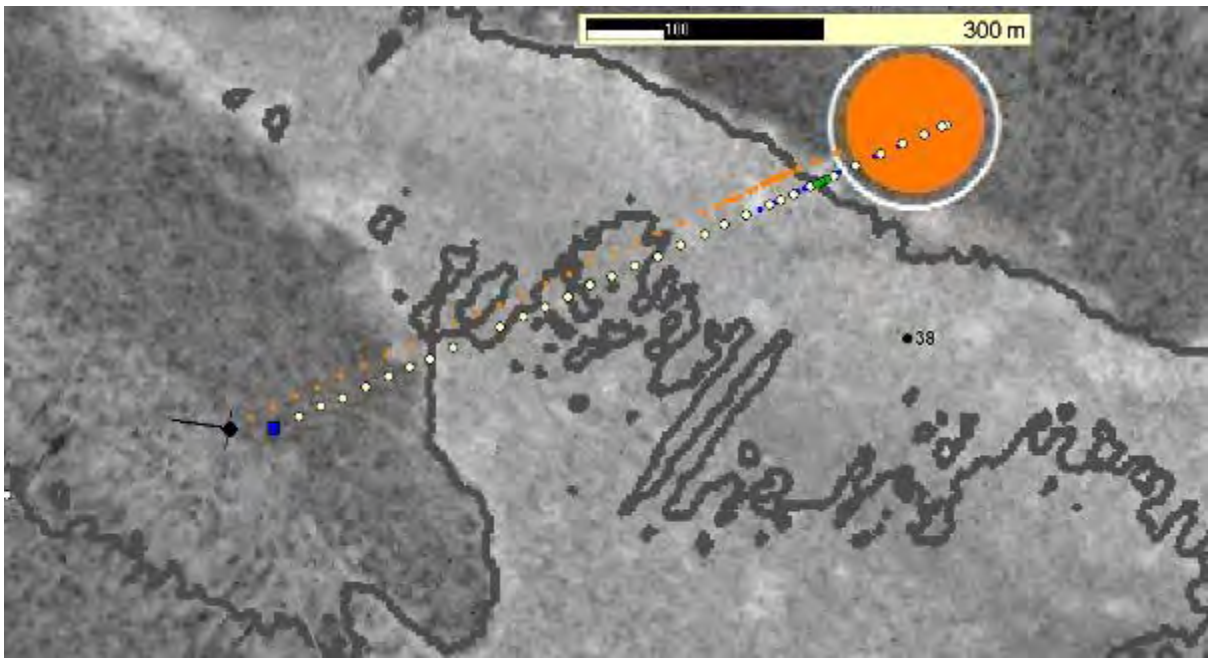
The seabed comprised muddy sediment for most of the transect, with burrows, mounds and grey patches. There was one small patch of encrusted cobbles on a small ribbon of medium reflectivity backscatter. The tow started in 458 m and ended in 452 m, the small patch of pebbles and cobbles near the start was over a slight 2 m high rise. Similar shaded backscatter later in the transect appeared muddy. Encrusting fauna did not include *Gonicorella*, one plate form of demosponge was seen. Common fauna included spatangid urchins, rattails and a large number of mysids/ euphausiids.

TAN1805_video_screen_grab_037_0278.jpg



TAN1805_stn_037_016.jpg

Station 038: Exploratory area



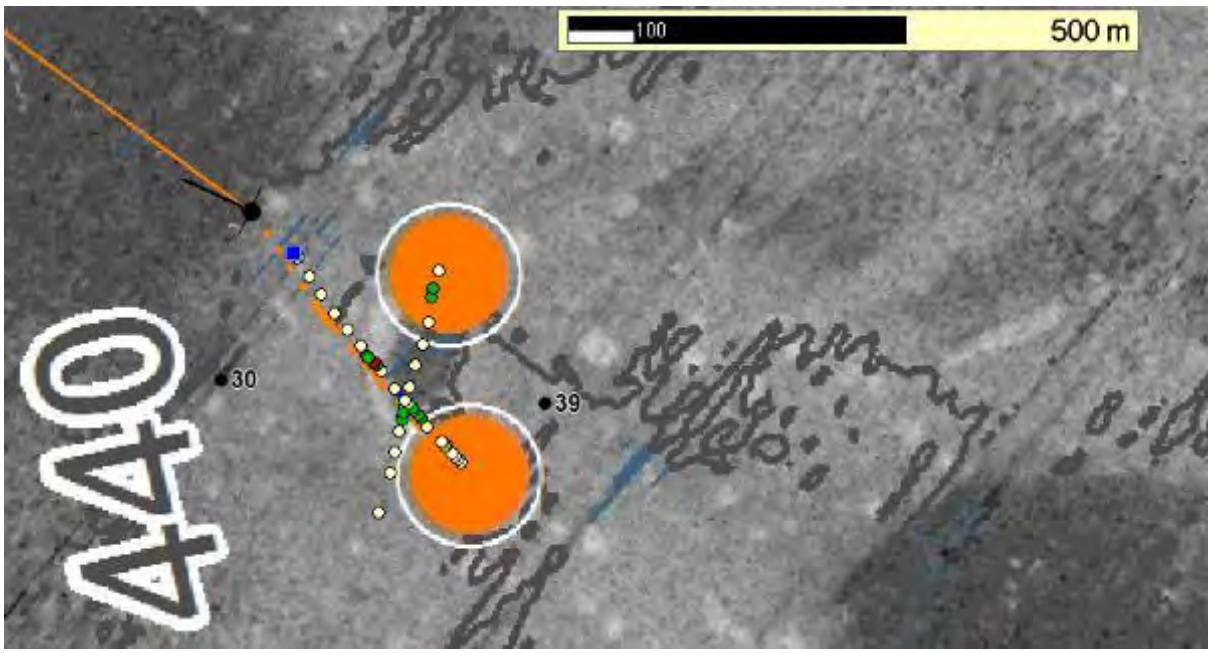
This transect crossed an area of mid-intensity reflectivity north east of the 'butterknife' towards the edge of the multibeam area.

The substrate was mostly muddy sediment with burrows and mounds, except for the edges of higher reflectivity where pebbles were present. Small gorgonians and ascidians were the main encrusting fauna with some plate form sponge and bryozoans in a round form similar in appearance to giant foraminiferans. Non-encrusting fauna elsewhere included spatangids, parasol urchins, rattails, anemones, and asteroids.

tan1805_stn_038_042.jpg

tan1805_stn_038_164.jpg

Station 039: Exploratory area



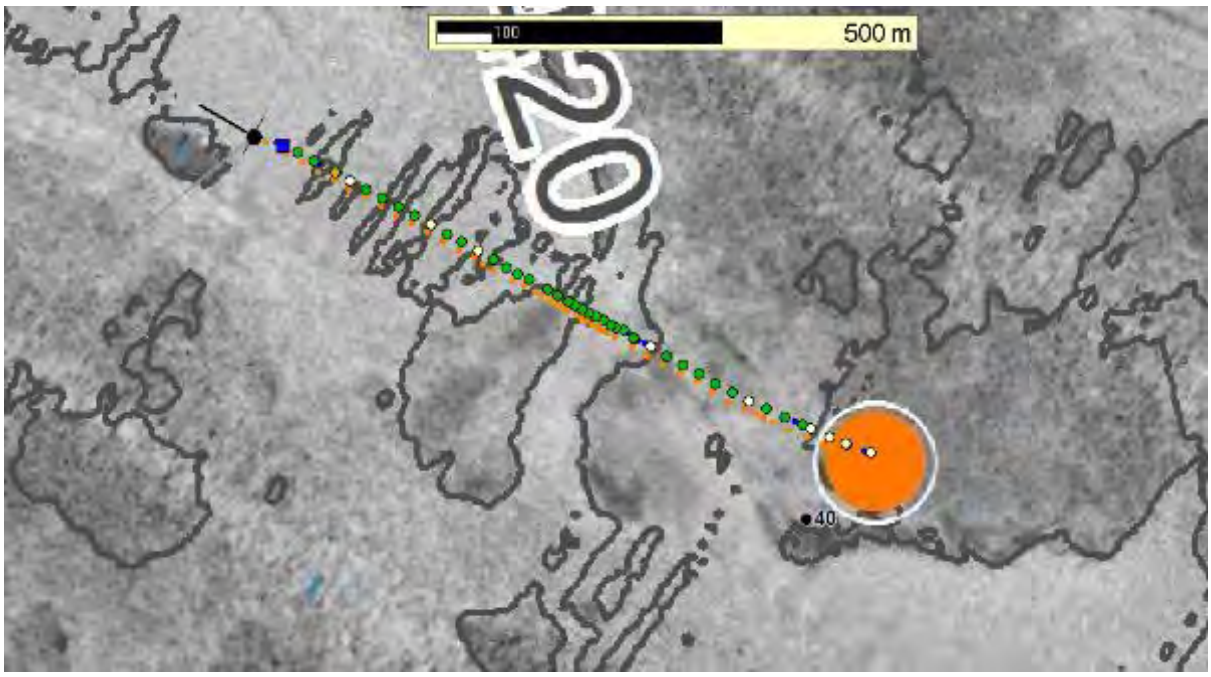
This transect targeted a small depression (also sampled on transect 30) with a rim of high back scatter.

The tow was only 20 minutes long. The transect transitioned from mud to encrusted pebbles, cobbles and a boulder on the southern edge of the rim. This ridge had a patchy distribution of *Goniocorella,* but was mainly small gorgonians with stylasterids, ball and plate-form demosponges, encrusting sponges, brisingids and cidarid urchins. A similar pattern occurred when the transect intersected the ridge a second time but also included some hard ledge 'bedrock' with stalked cup corals, stylasterids and lacey bryozoans. The background substrate was predominantly muddy sediment with burrows and mounds, with scattered scampi and sea pens.

tan1805_stn_039_047.jpg

tan1805_stn_039_028.jpg

Station 040: Exploratory area



This tow covered a ridge-tongue feature on the western side mostly in mid-highly reflective backscatter. Depth changed slightly, from 427 m to 417 m over the course of the transect.

Substrate was predominantly cobbles and pebbles, sometimes in dense patches. Associated with these were encrusting fauna, dense at times, including some *Goniocorella* and intact coral, gorgonians, stylasterids, demosponges and several *Hylascus.* One quarter of the way along the transect was a dense patch of heart urchins, associated with muddy sediment and burrows.

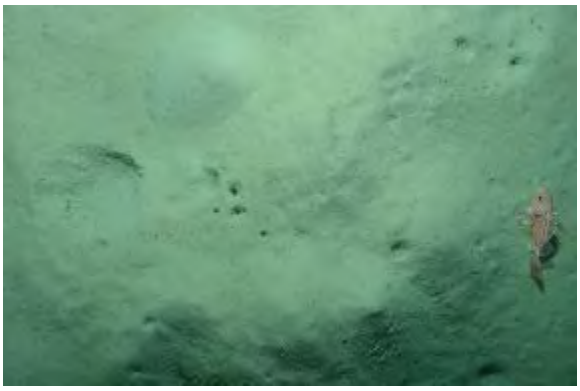
TAN1805_stn_40_043.jpg

TAN1805_stn_40_081.jpg

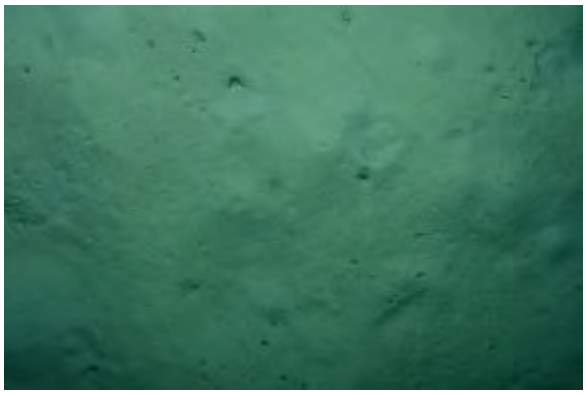
Station 042: Pilot Disturbance area (East)

This tow was in an area 20 n.mi to the east of the main survey region. It covered an homogeneous, low reflectivity area in order to test the BDR.

The seabed was very flat (449 m to 448 m depth). The substrate was entirely muddy sediments with mounds and burrows. Some fish, scampi, and spatangid urchins were present.



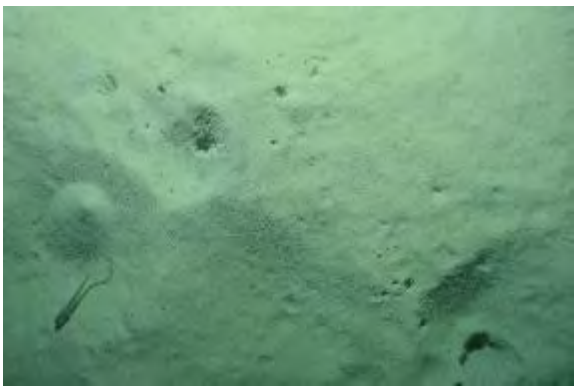
TAN1805_stn_42_42.jpg



TAN0805_stn_42_93.jpg

Station 043: Pilot disturbance area (East)

This was in the same area as #042. It was a relatively flat transect (449 m start, 447 m end) with low reflectivity backscatter. The substrate was mostly muddy sediment, burrows and mounds apart from one small patch of sand. Common fauna were scampi, sea perch, rattails, asteroids, and spatangid urchins. There was also a small dense patch of juvenile spatangids. Clumps of dead (?), half-buried coral were visible in some still images.



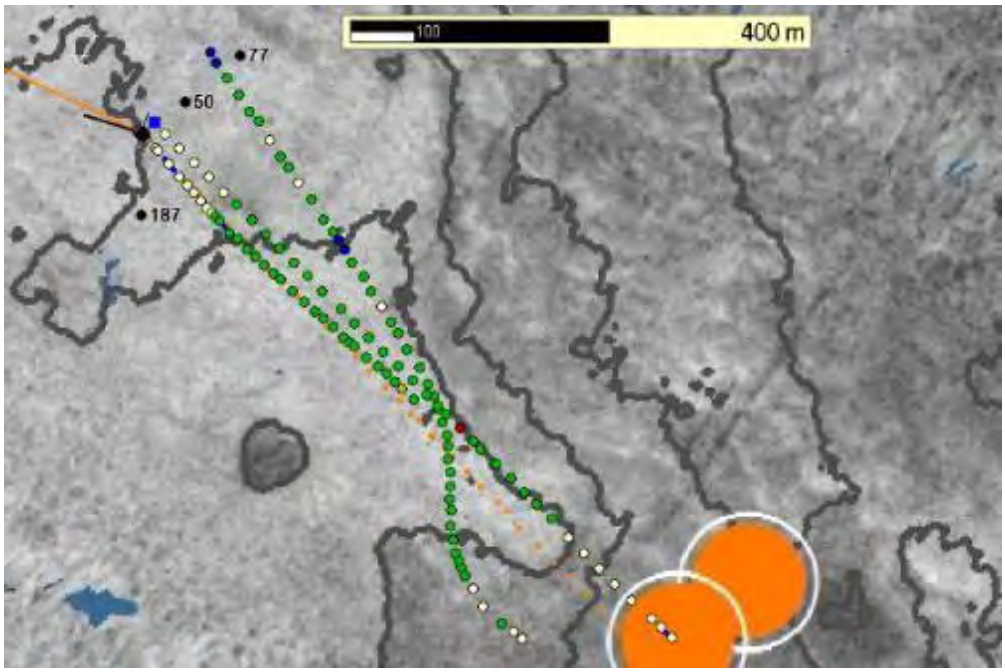
TAN1805_stn_43_075.jpg

TAN1805_stn_43_081.jpg

Station 49: REF site

The transect was aborted early on due to communication problems with DTIS, but it was eventually relowered without bringing back on-board, and was recorded as station 50 at the same location.

Station 50: REF site



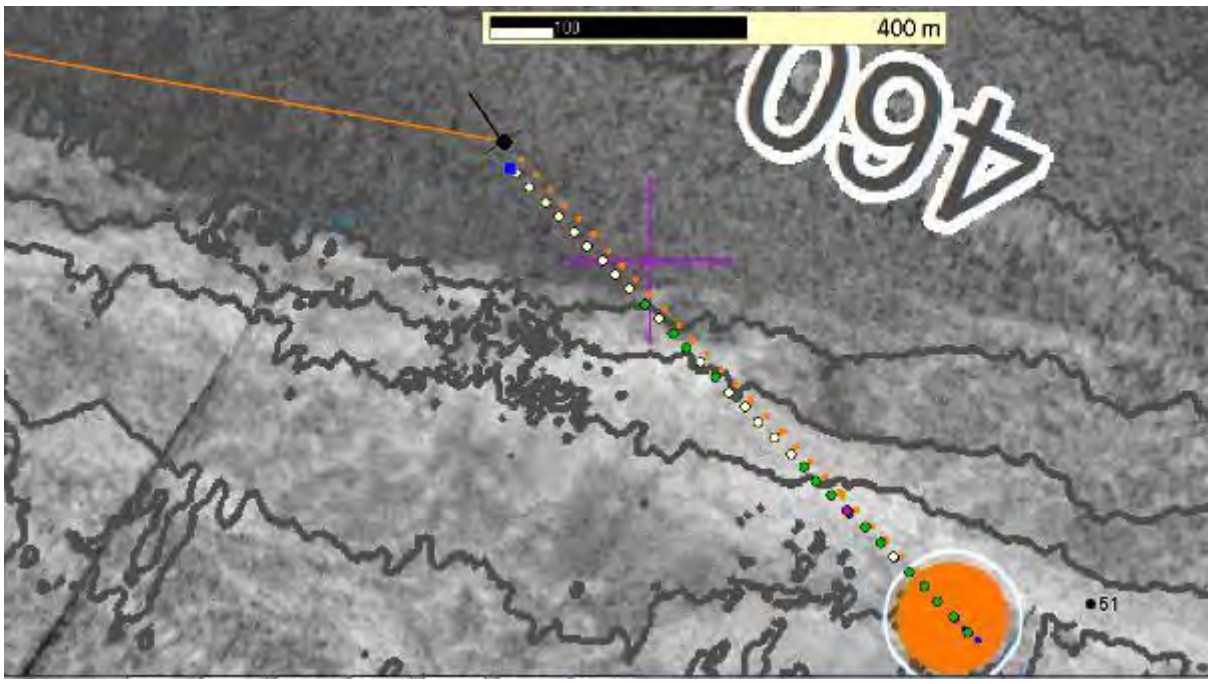
The Reference site was on a low relief plateau of mid-high reflective backscatter.

The transect initially crossed flat low reflectivity ground consisting of muddy sediments and burrows; as it climbed a ridge of high reflectivity sediment turned to pebble/cobble substrate with small gorgonians, *Goniocorella* and sponges; substrate then changed to cobbles, boulders and bedrock overlain with sediments where intact coral, brisingid, and stylasterids were present. When the plateau was reached, the substrate comprised mixed sediment and pebbles; and on the other side of the plateau substrate changed to sediment and burrows/mounds. Common fauna included spatangid urchins, asteroids, *Hyalascus* sponge, and rattails.

Tan1805_STN_50_107.jpg

TAN1805_stn_50_007.jpg

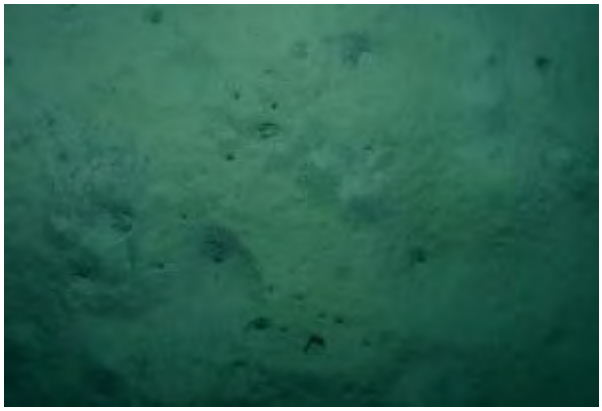
Station 51: Exploratory area



The transect was a descending slope (445 m start, 461 m end) from high reflectivity to low reflectivity.

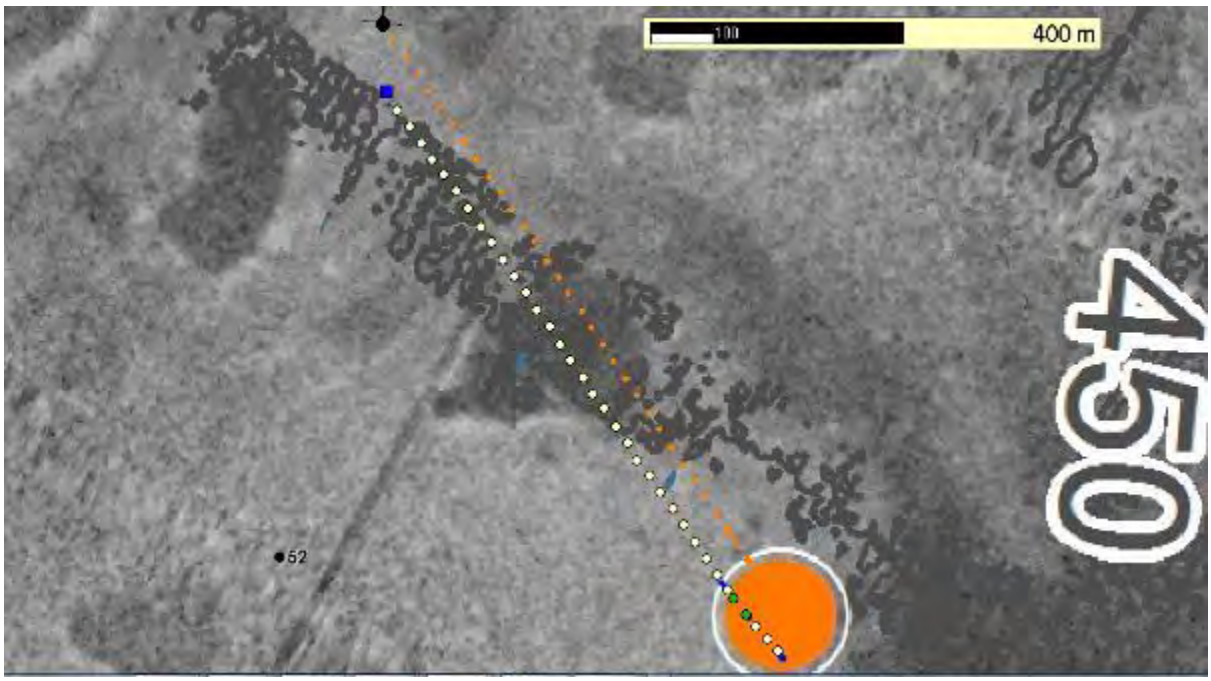
Seabed at the start consisted of mud with dark patches of fine gravel, and encrusted pebbles and cobbles of varying density. There was a patch of hard substrate in the middle of the transect with intact coral, brisingids and stylasterids. Other fauna included demosponges, *Psolus* sp holothurian, ascidians and stalked cup coral. Towards the end of the transect, substrate reverted to muddy sediment, mounds and burrows. Common non-encrusting fauna were spatangids, asteroids, rattails, Corallimorpharia, and sponges.

TAN1805_stn_51_045.jpg



TAN1805_stn_51_185.jpg

Station 52: Exploratory area



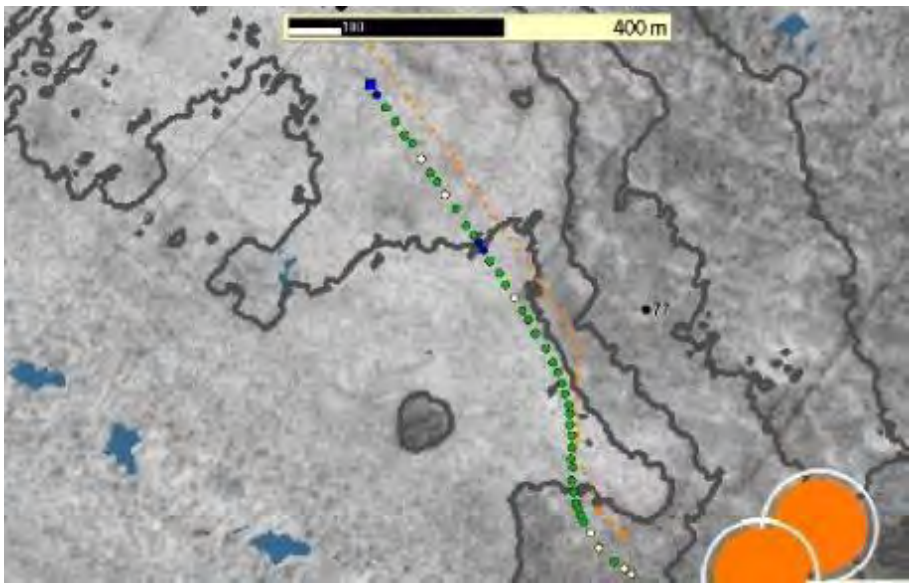
This was a flat transect of low to medium reflectivity.

One patch of encrusted cobbles occurred early in the transect over medium intensity backscatter, but mud dominated elsewhere, often heavily bioturbated. The cobbles were encrusted primarily with bryozoans and small gorgonians, There was no apparent *Goniocorella* but some sedimented plate sponges were noted (probably *Awhiowhio sepulchrum*). There were several patches of spatangid heart urchins, rattails, one *Hyalascus* glass sponge and a purple fleshy sea pen.

tan1805_stn_052_129.jpg

tan1805_stn_052_134.jpg

Station 077: REF site



This transect was the second at the reference site, on the ridge extension of medium to high backscatter. The tow started on the southern side at 438 m and came over the crest of the small ridge and along the edge to the northwest at depths of 435-436 m.

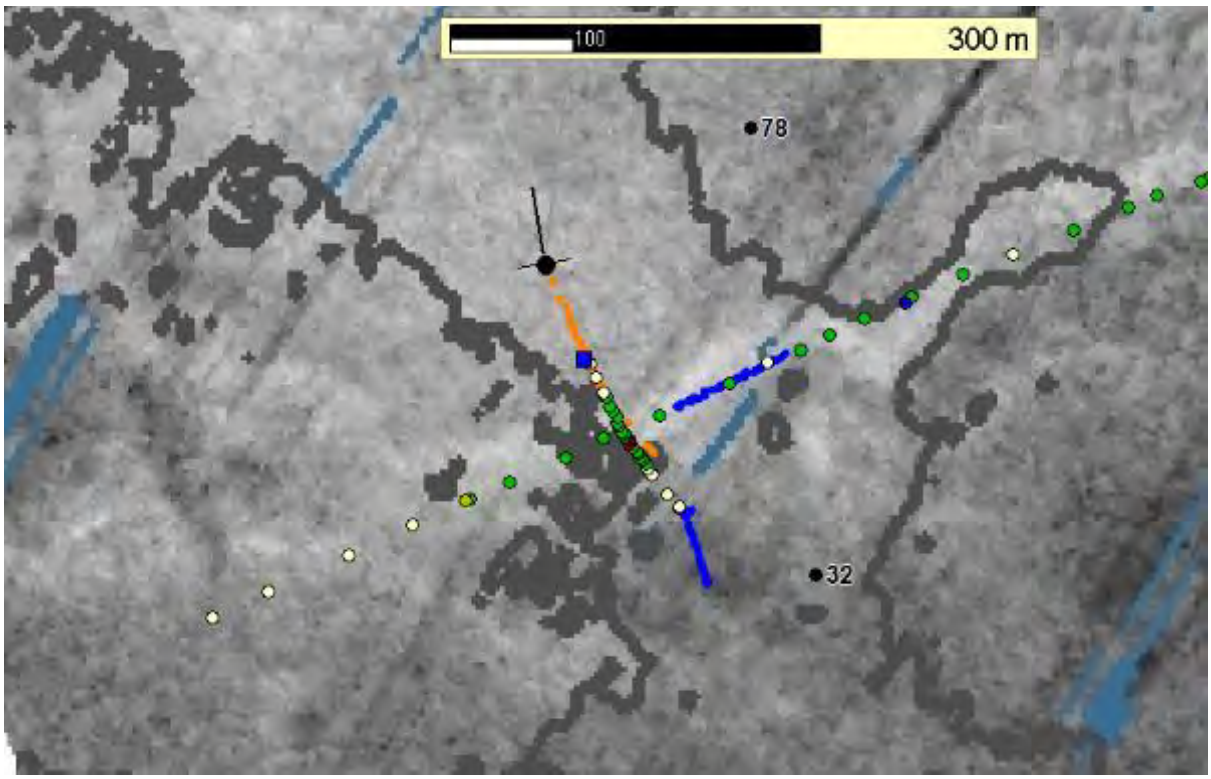
Substrate was initially mud with burrows, and then harder with encrusted pebbles and cobbles and some small nodules coming over the ridge. There were scattered patches of intact and fragmented *Goniocorella*, and occasional *Hyalscus* sponges. Small round demosponges and other low encrusting fauna were frequent on pebbles. Along the edge were occasional rocky outcrops with sponges and stylasterids. There were several large plate form sponge species in cobble rich areas. In softer substrate patches asteroids were frequent, heart urchins were abundant in several places, and some *Radicipes* were observed. Rattails, sea perch, eels and small sharks were the main fish observed.


tan1805_stn_077_150.jpg


tan1805_stn_077_075.jpg


clip of 077_0639

Station 078: MON 3 site



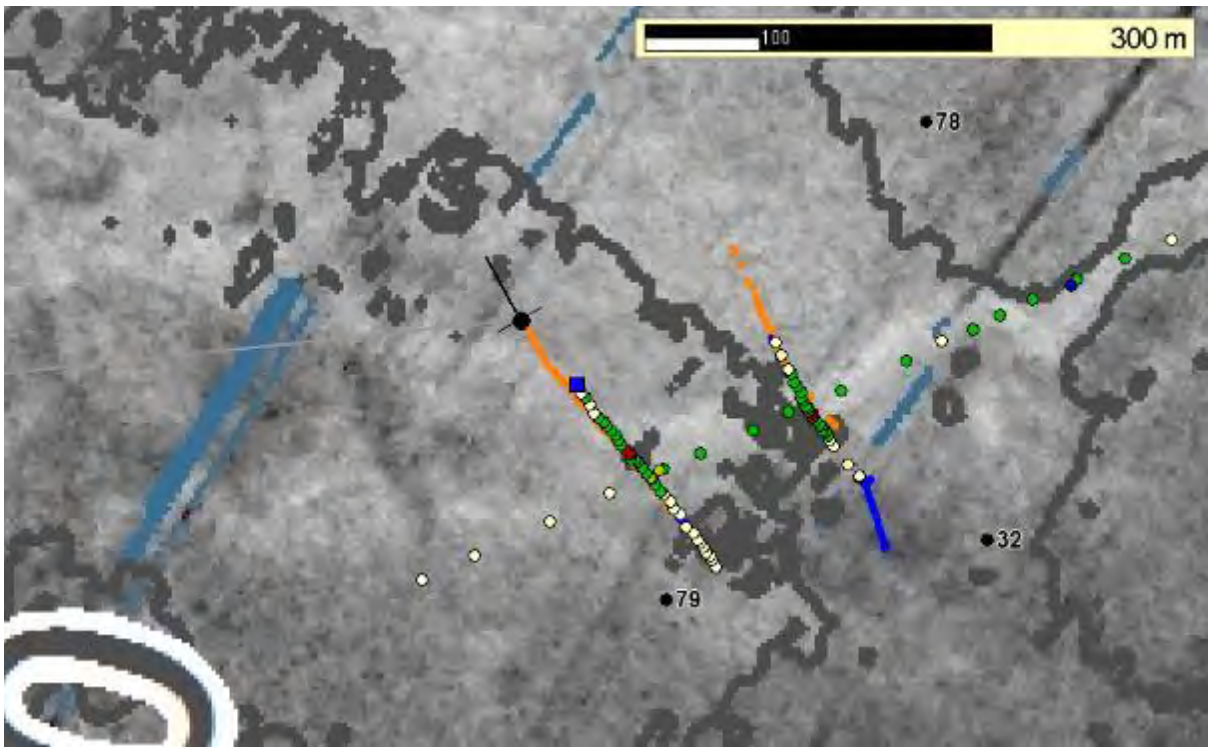
This transect (448 – 445 m) followed a northeast line on Monitoring site 3. This was a short tow over a low ridge with medium backscatter.

The substrate was initially mud with some burrows. It transitioned to pebbles, cobbles and some "bedrock" where the transect intersected pale backscatter. There were patches of *Goniocorella,* demosponges, gorgonians and encrusting fauna on the hard substrate including stylasterids, alcyonacea and *Desmophyllum*. After the ridge, the substrate was mainly mud with no burrows.

tan1805_stn_078_030.jpg

tan1805_stn_078_034.jpg

Station 079: MON 3 site



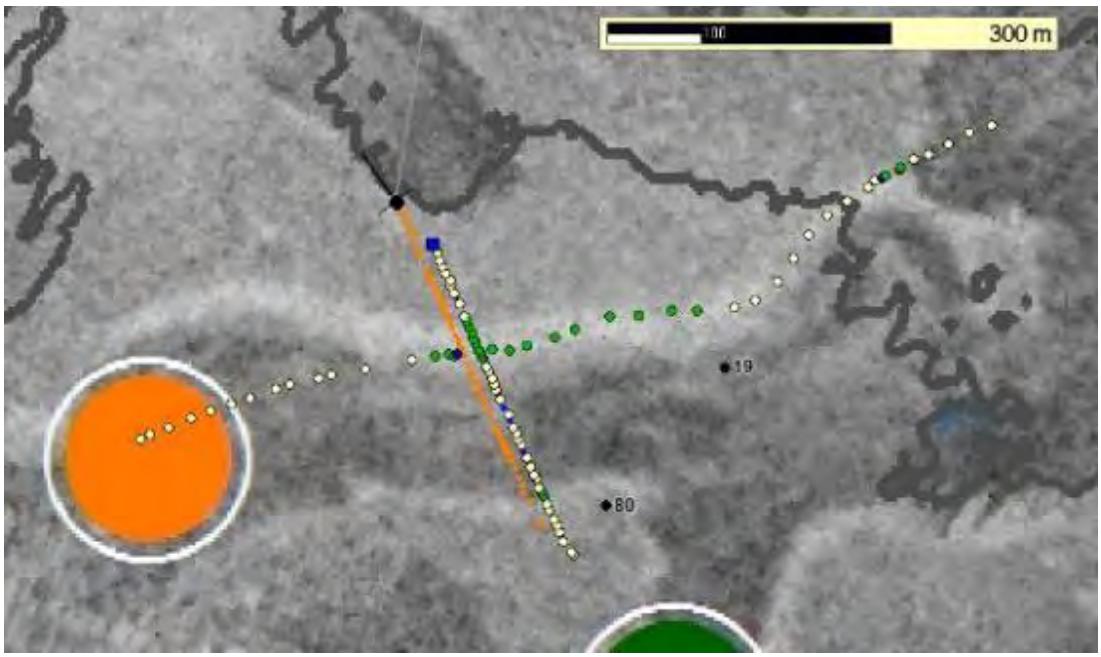
This transect (446 – 443 m) followed a northwest line on Monitoring site 3. This was a short tow following #078 and bisecting the low ridge with pale medium reflectivity backscatter (the site identified from tow 32).

The substrate was initially mud with some burrows and then transitioned to pebbles and cobbles in the sections of pale backscatter and a hard substrate ledge where there were patches of *Goniocorella,* gorgonians and low encrusting fauna including ascidians, anemones and some cup coral . After the ridge, the substrate was mud with no burrows and scattered cobbles. Fauna here included conger eels, a cod, bellows fish, asteroids and *Flabellum*.

tan1805_stn_079_038.jpg

tan1805_stn_079_003.jpg

Station 080: MON 2 Site

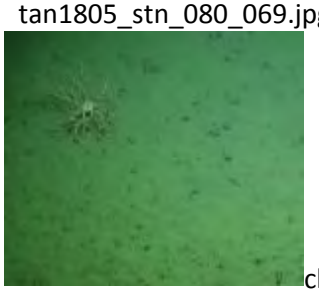


This transect (445 – 456 m) followed a northwest line on Monitoring site 2. This was a short DTIS tow, running over two ridges and bisecting DTIS transect 19.

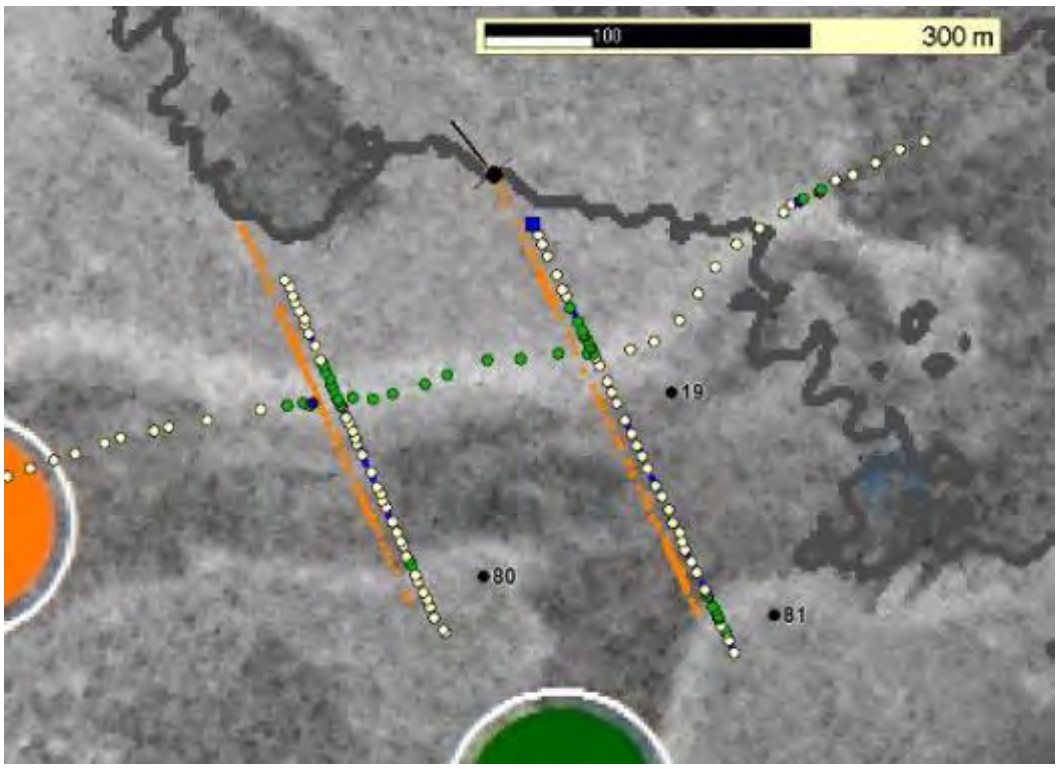
The substrate was predominantly mud and burrows, transitioning to pebbles and cobbles at the two ridges of pale backscatter. The first ridge had a smaller patch of cobbles and pebbles than the second, both had low encrusted cobbles, the second area also contained small un-encrusted nodules. At both ridges common fauna were small round demosponges, gorgonians, ascidians and round bryozoans. *Goniocorella* was not present. A single basket star was noted (Gorgonocephalidae).


tan1805_stn_080_069.jpg


tan1805_stn_080_094.jpg


clip from video

Station 081: MON 2 Site



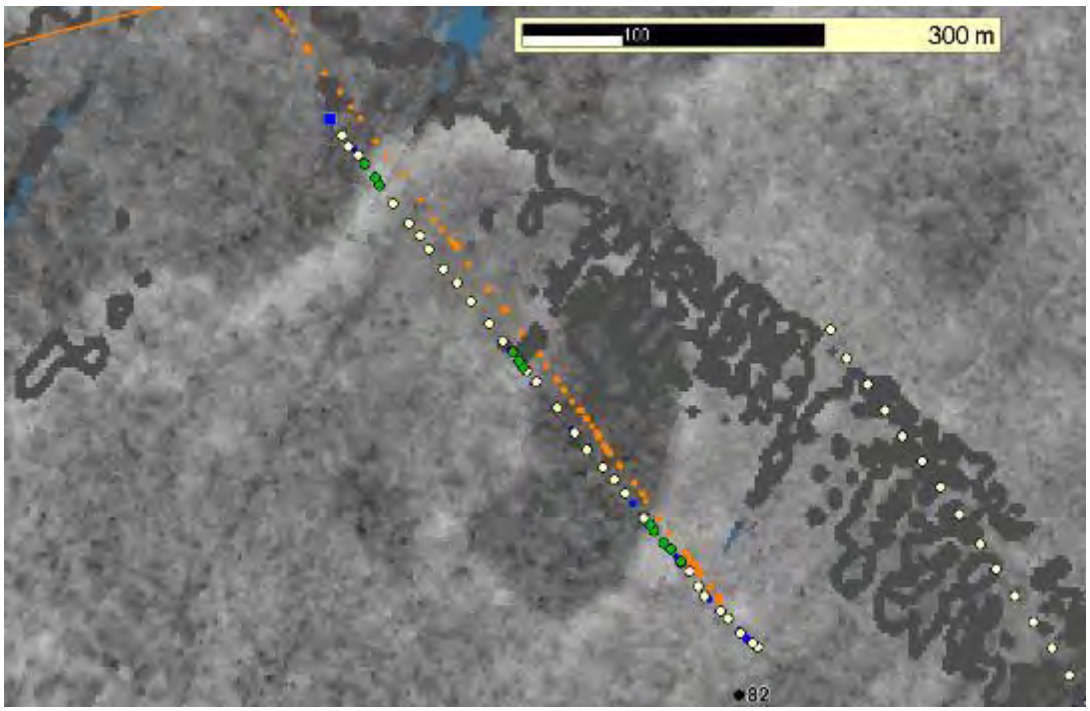
This transect (456m – 456m) followed a northwest line on monitoring site 2 to the west of 'the butterknife'. This was a short tow, running over the same two ridges as station 080, bisecting DTIS transect 19.

The transect started with a patch of cobbles and pebbles at the first ridge. Encrusting fauna included ball demosponges, gorgonians and probable *Goniocorella* fragments. The substrate then transitioned back to mud and burrows, with mounds. On the second ridge of medium-high backscatter encrusted cobbles and pebbles occurred with small nodules and a hard bedrock outcrop. There were similar encrusting fauna here with the addition of *Desmophyllum* and stylasterids on the larger sized hard substrate. The transect ended in mud and burrows. Other common fauna seen throughout the transect included anemones and asteroids, fishes included rattails and lanternfishes. Less common fauna noted were Coralimorpharia, holothurians, scampi and spotted flounder.

tan1805_stn_081_082.jpg

tan1805_stn_081_085.jpg

Station 082: DIS 1 Site



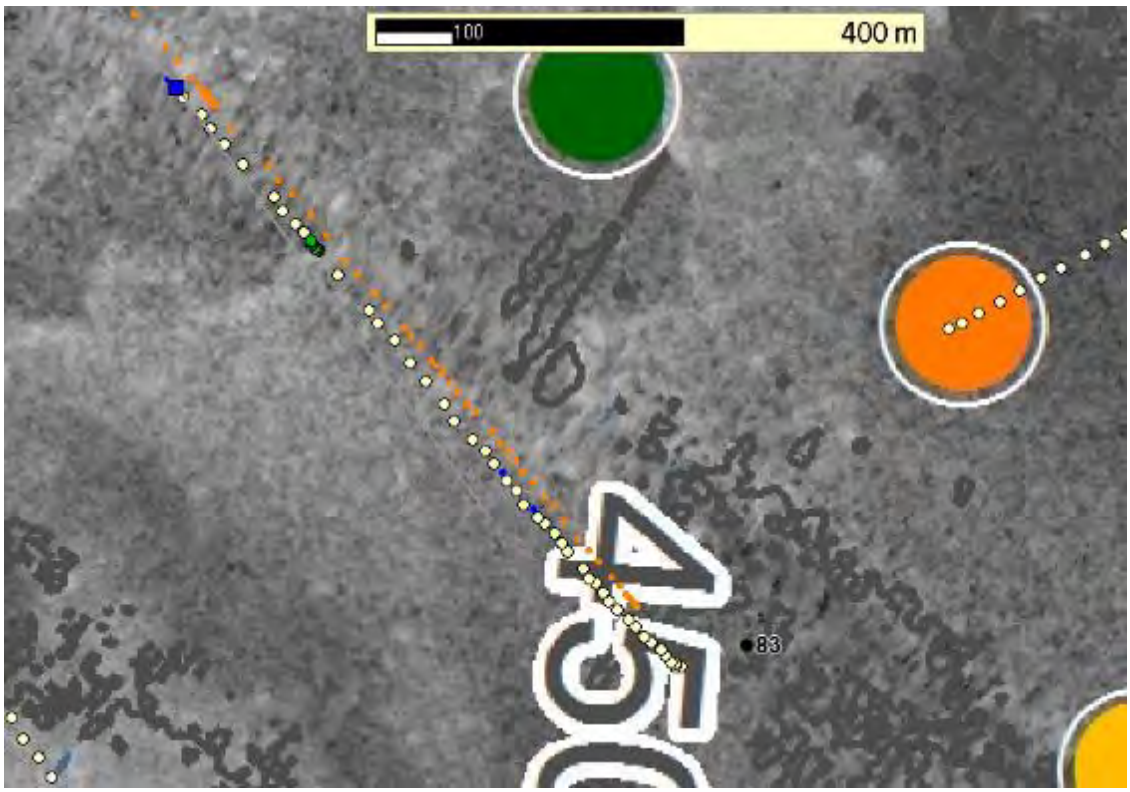
This was the first transect on Disturbance site 1.

This transect started on flat soft muddy sediment and intersected several bands of medium reflectivity back scatter. At the rim of the tongue of soft sediment was a small area of pebbles and cobbles with demosponges, gorgonians and the occasional clump of *Goniocorella*. The substrate reverted to muddy bioturbated sediments with little fauna, and the occasional rattail. On the opposite rim was a narrower but similar band of cobbles with *Goniocorella* and demosponges (including a displaced yellow sponge, probably *Awhiowhio sepulchrum*). Towards the end of the tow was another patch of pebbles and cobbles with *Goniocorella*, gorgonians and demosponges. Non-encrusting fauna included *Munida*, corallimorpharians, *Radicipes*, bellowsfish, holothurians, and a dwarf cod. The observed patterns of fauna and cobbles and pebbles were a good match with the backscatter.

tan1805_stn_082_043.jpg

tan1805_stn_082_094.jpg

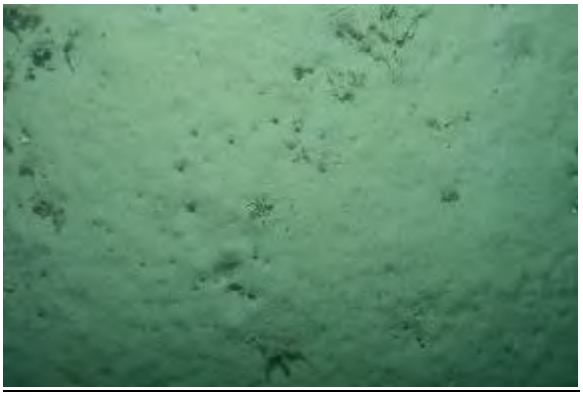
Station 083: DIS 2 Site



This was the first transect on Disturbance site 2.

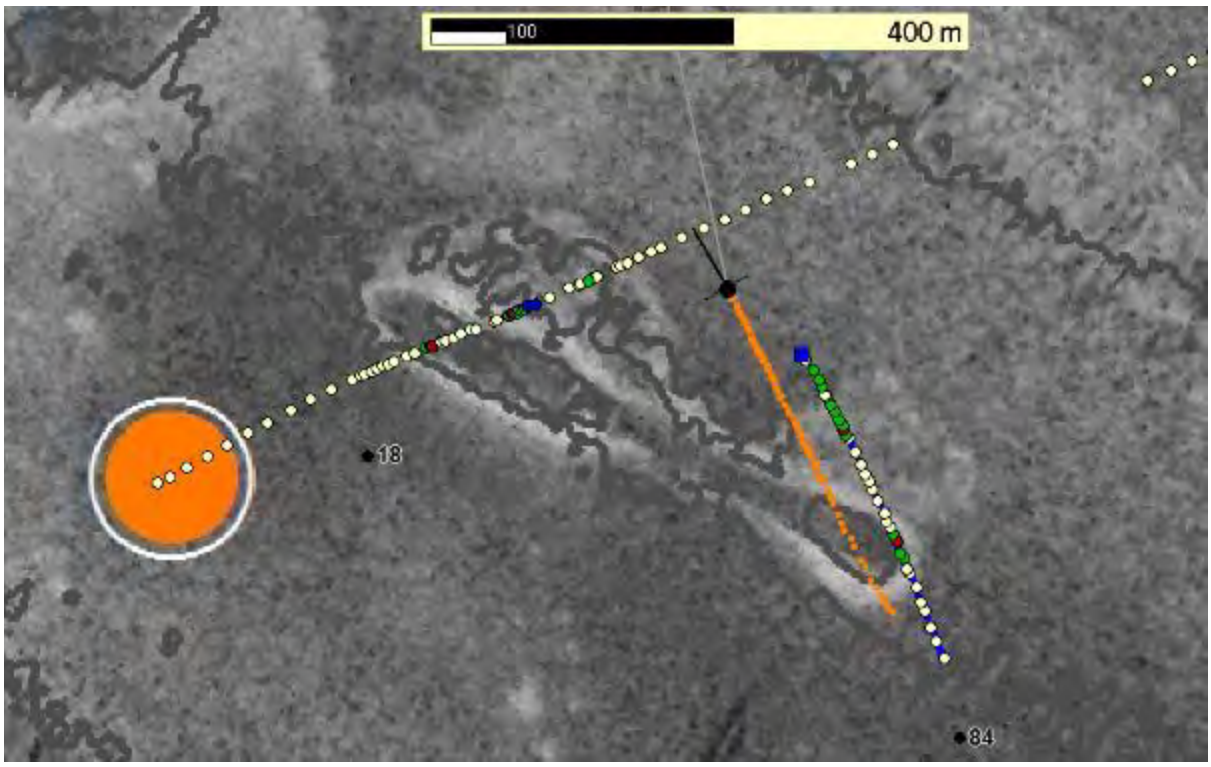
This was a flat transect (455 m – 452 m) with mainly muddy bioturbated sediment except for one small patch of pebbles and cobbles in a region of more reflective backscatter. The cobbles were encrusted with gorgonians, ball sponges and other common encrusting fauna but without conspicuous *Goniocorella*. Away from this small patch the seabed reverted back to muddy sediments with burrows and mounds. Other fauna included asteroids, spatangid urchins, rattails, and coralimorpharians.

TAN1805_stn_83_080.jpg



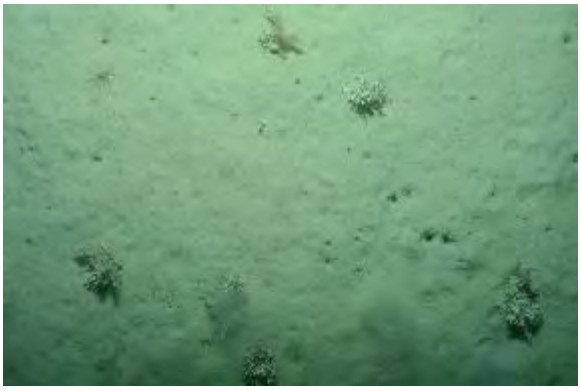
TAN1805_stn_83_185.jpg

Station 84: MON 1 site

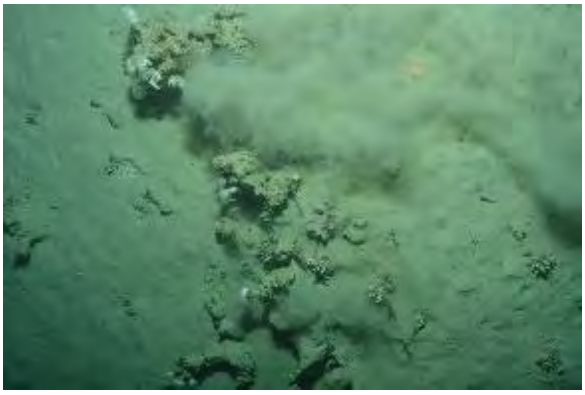


This was the first of two transects crossing the “butterknife”, a narrow, elongated and shallow depression with a well-defined rim of high reflectivity backscatter.

The rim was characterised by a mix of pebbles/cobbles/boulders with an outcrop of bedrock. There was also another region of cobbles and hard substrate to the north of the depression. Encrusting organisms included intact *Goniocorella* heads, stalked cup corals, stylasterids and lacey bryozoans. The middle, low reflectivity region of “butterknife”, consisted of soft sediments as did the surrounding area beyond the rim. Non-encrusting fauna included anemones, spatangids, sea pens and rattails.

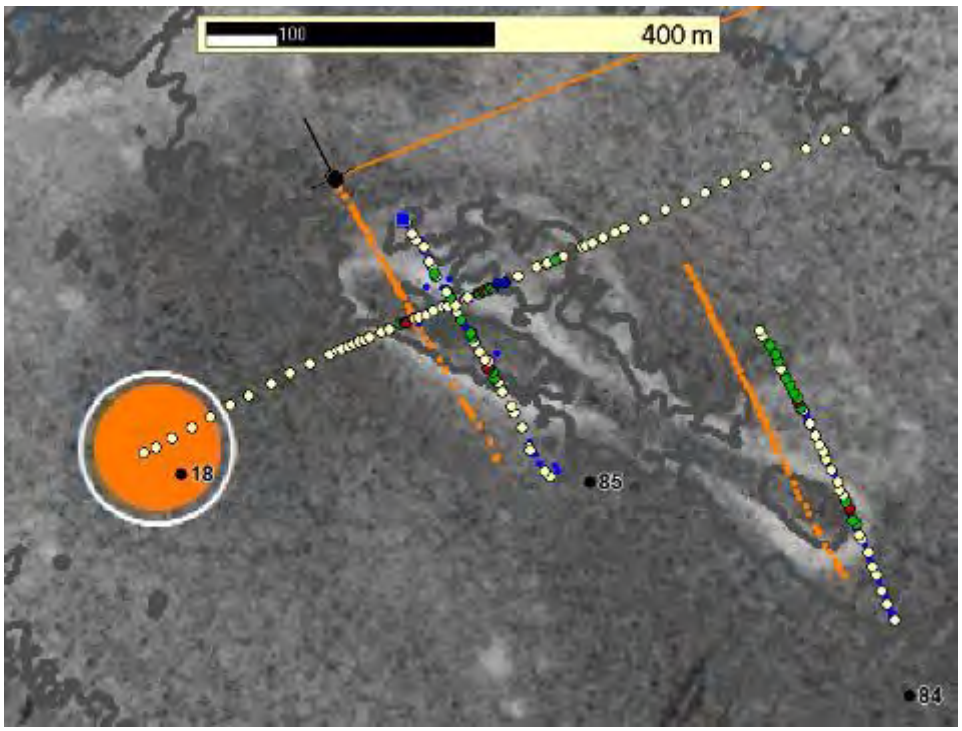


TAN1805_stn_84_075.jpg



TAN1805_stn_84_072.jpg

Station 85: MON 1 site



This was the second of two transects crossing the “butterknife”, this one west of #84.

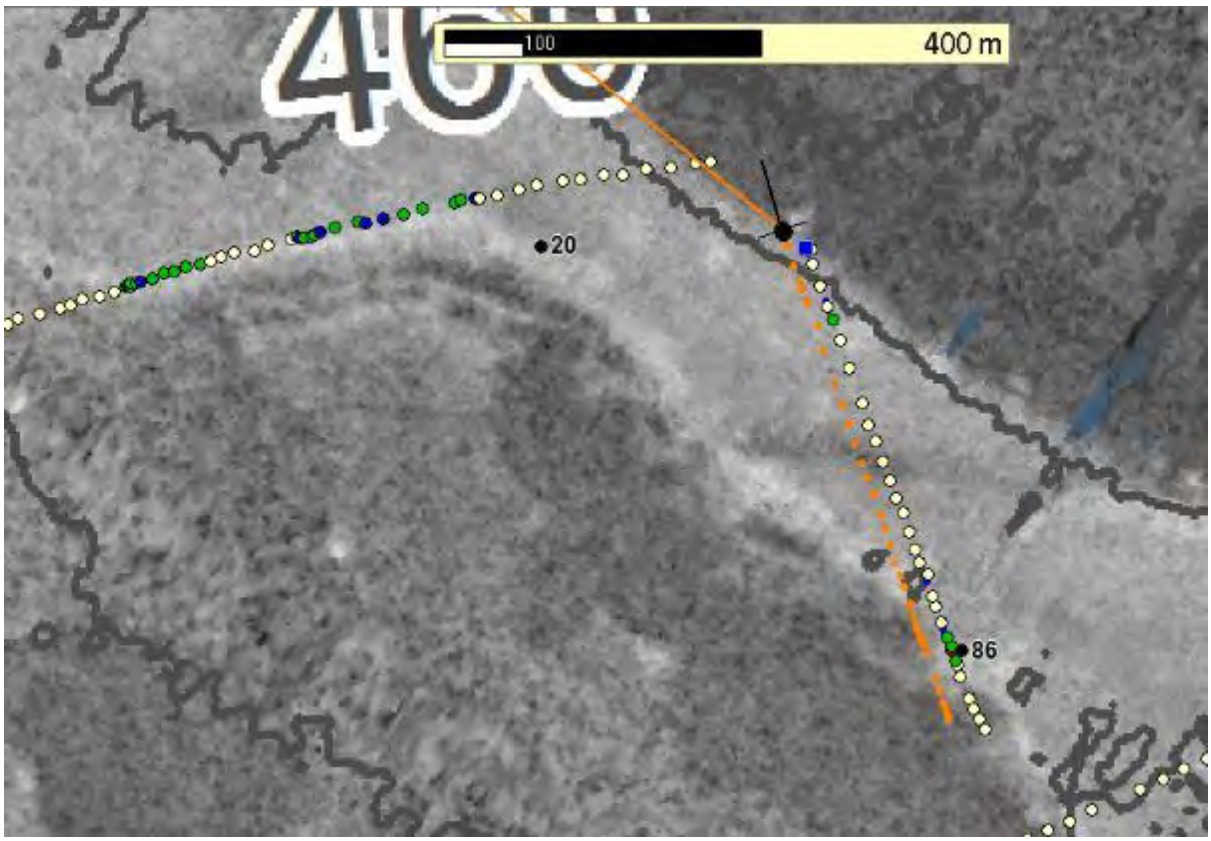
As with #84, the high reflectivity rim was characterised by pebbles/cobbles/boulders with encrusting organisms including stalked cup corals, sponges and intact *Goniocorella*. The middle and low reflectivity regions consisted of soft bioturbated sediment. Non-encrusting fauna included anemones, tam-o-shanter urchins (*Phormosoma bursarium), Flabellum* and rattails.

TAN1805_stn_85_062.jpg

TAN1805_stn_85_106.jpg

Clip from still 055

Station 86: MON 7 site



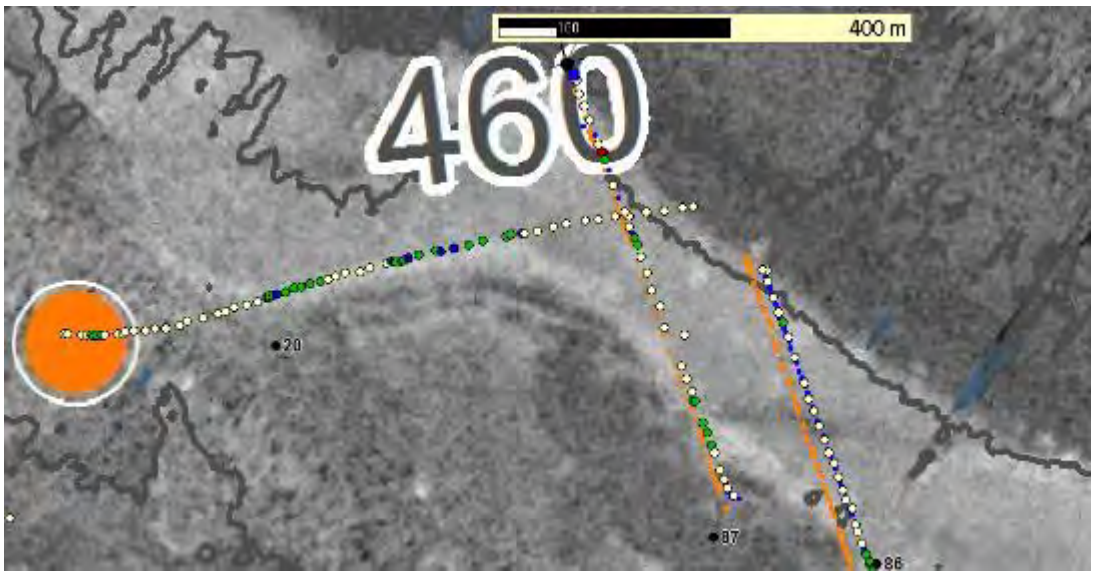
This was the first of two transects crossing a low plateau with a moderately well-defined southern rim of high reflectivity.

There were patches of pebbles and a bedrock edge near the beginning of the transect and a small patch of pebbles and cobbles at the northern end. However, there were no *Goniocorella*, but stylasterids and gorgonians were common in small patches. Most of the transect was muddy sediment with pits and mounds. Small purple and large ball sponges were common on mud. Other species recorded included sea perch, euphausiids and hoki.

Video clip

TAN1805_stn_86_033.jpg

Station 87: MON 7 site



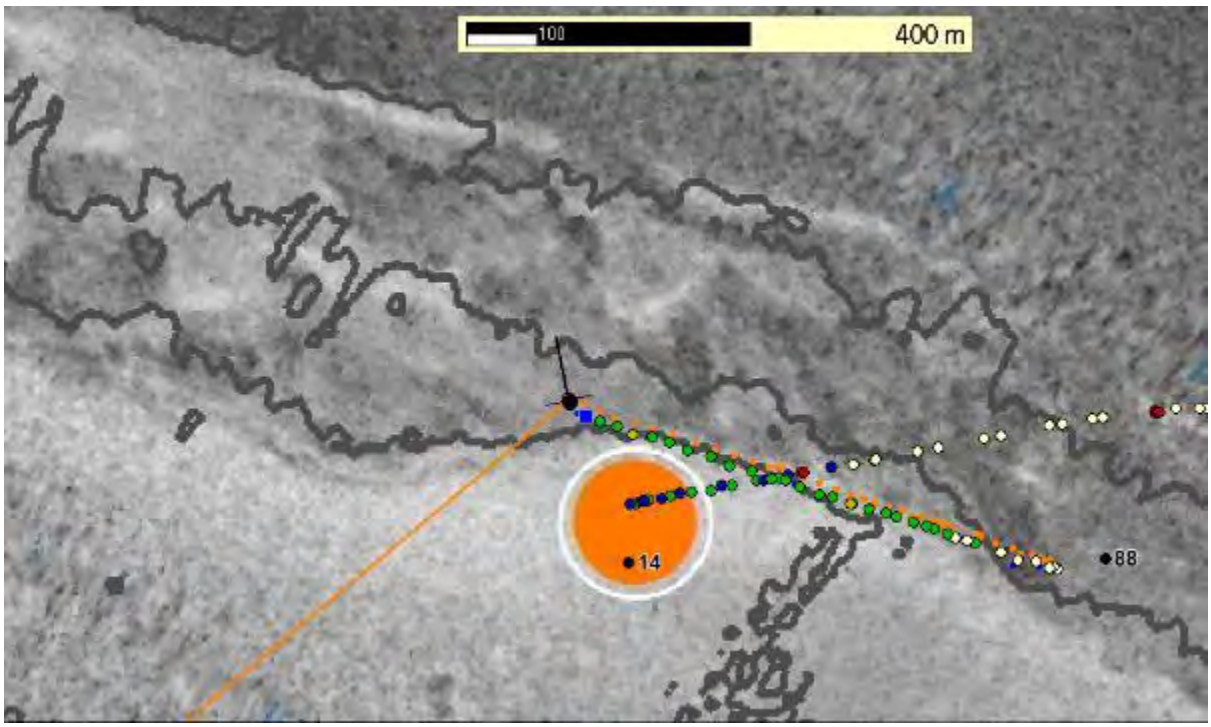
This was the second of two transects at MON 7.

Several patches of cobbles and an area of exposed hard substrate occurred in the sections of the transect with higher reflectivity backscatter. Gorgonians and bryozoans were the main encrusting fauna, other species included a ball form bryozoan or giant foram, soft corals and solitary ascidians. *Goniocorella* were rare, small and inconspicuous. Several dead plate form demosponges were also observed. Anemones, spatangid urchins, asteroids and euphausiids were common fauna, with fish species including a longnosed chimera, a ribaldo, deepsea flatheads and several species of rattail.

TAN1805_stn_87_043.jpg

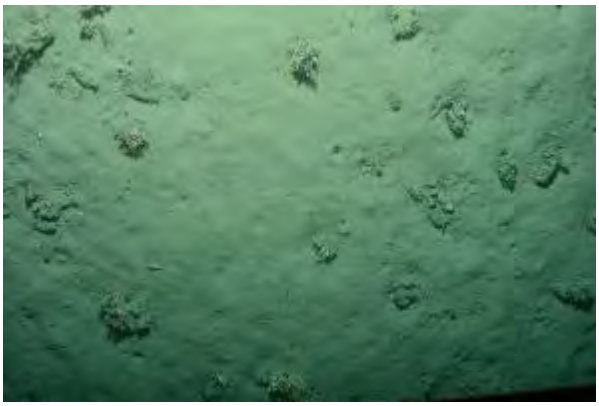
TAN1805_stn_87_014.jpg

Station 88: MON 6 site



This was the first of two transects following a northeastern-facing flank of high reflectivity previously samples in DTIS station 14.

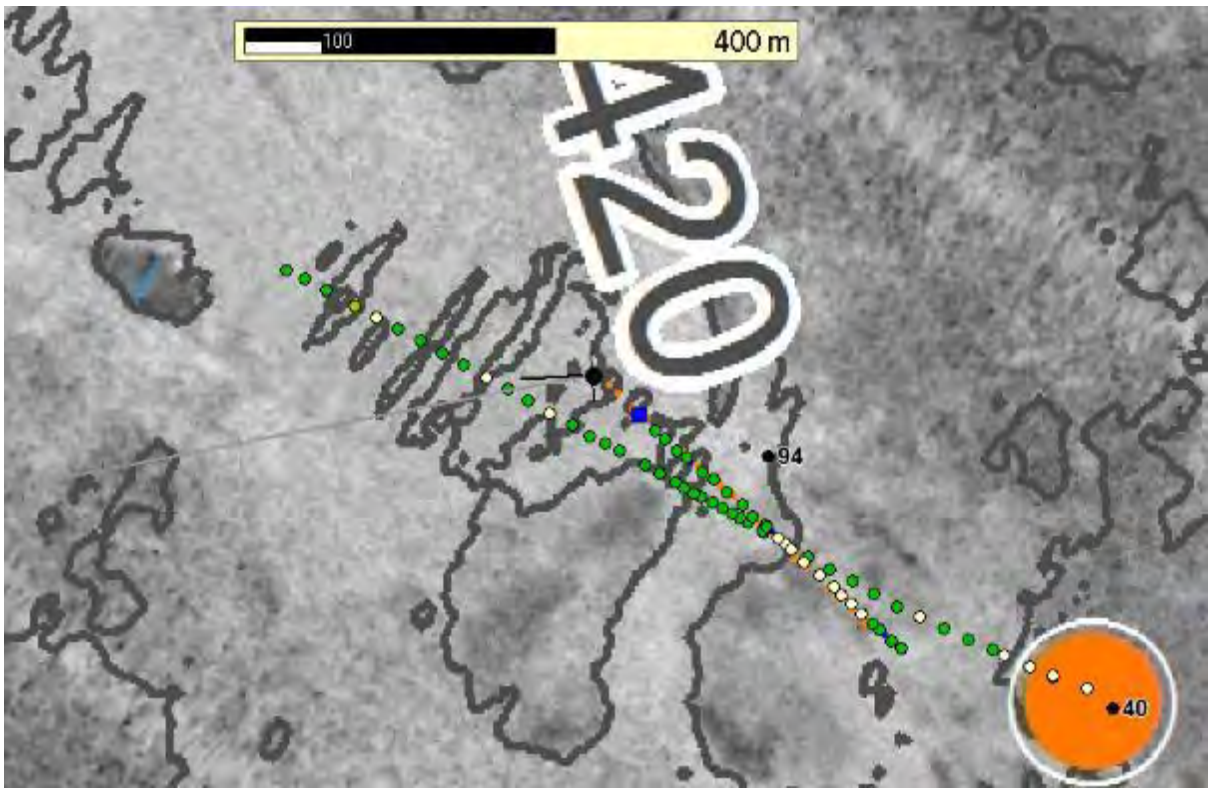
This transect mostly consisted of pebbles, cobbles, boulders with encrusting sponges, intact heads and fragments of *Goniocorella*, and other encrusting fauna including small gorgonians, stylasterids and bryozoans. The last part of the transect consisted of muddy sediment and burrows. Some large sponges and anemones were present.



TAN1805_stn_088_124.jpg

TAN1805_stn_088_143.jpg

Station 94: MON 4 site



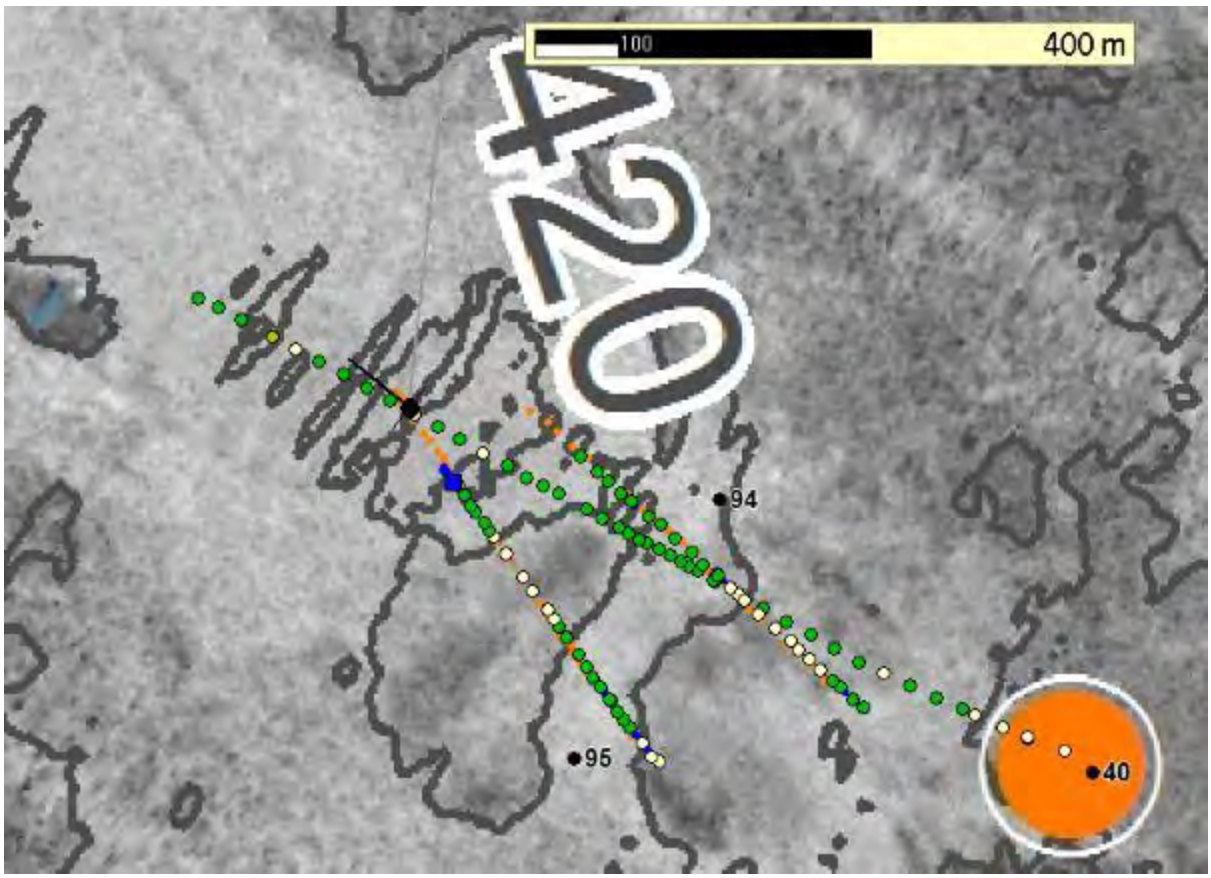
The transect headed northwestwards across a tongue of slightly elevated medium-high reflectivity sampled by DTIS station 40.

The substrate alternated between encrusted pebbles and cobbles to soft mud with burrows back to firmer mud with dark pebbles and cobbles, and some dark sediment patches on the slight rise. Pebbles and cobbles had ball demosponges, encrusting sponge and other fauna, small gorgonians, and some small fragments of *Goniocorella* in places. Rattails and lanternfish were frequent. On the softer sediment there were dense areas of heart urchins, some *Phormosoma bursarium* urchins, regular occurrence of parasol urchins, and an *Anthomastus* soft coral. Asteroids were scattered throughout.

TAN1805_stn_094_020.jpg

TAN1805_stn_094_032.jpg

Station 95: MON 4 site



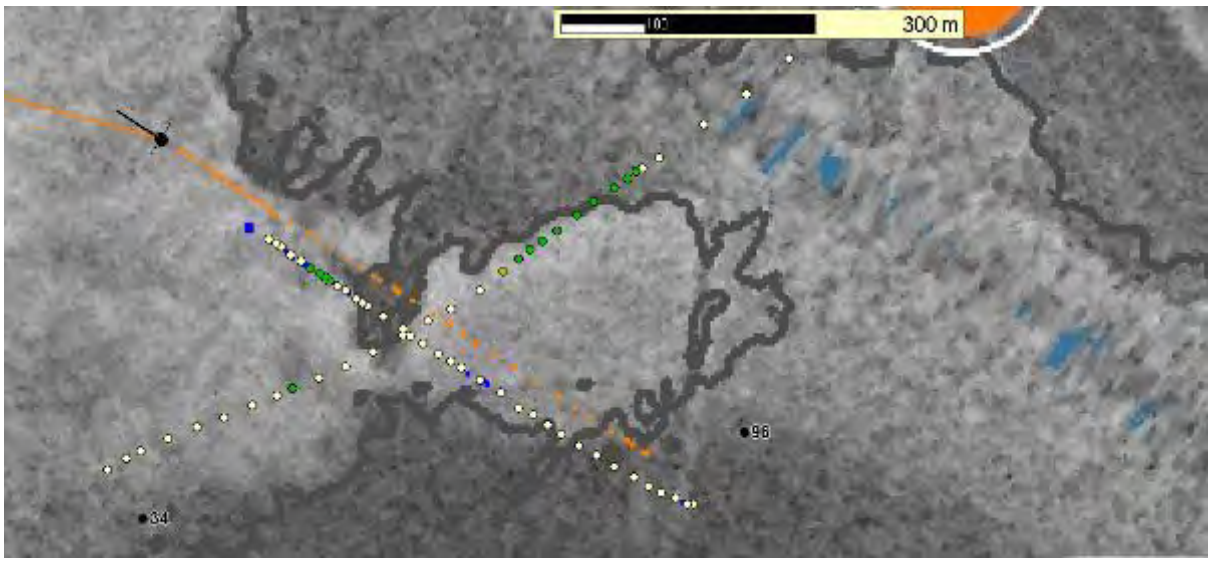
This transect was northwest across a tongue of medium-high slightly elevated backscatter and a shallow depression with lower backscatter previously sampled in DTIS stations 40 and 94.

Substrate alternated between encrusted pebbles and cobbles, sometimes with some nodule gravel, and soft bioturbated muddy sediment. Cobbles and pebbles were heavily encrusted with small gorgonians, stylasterids, ascidians, encrusting hydroids and bryozoans, ball demosponges and small clumps of *Goniocorella*. Other fauna included cidarid urchins, squat lobsters and several species of asteroid sea stars.

TAN1805_Stn_095_033.jpg

TAN1805_Stn_095_063.jpg

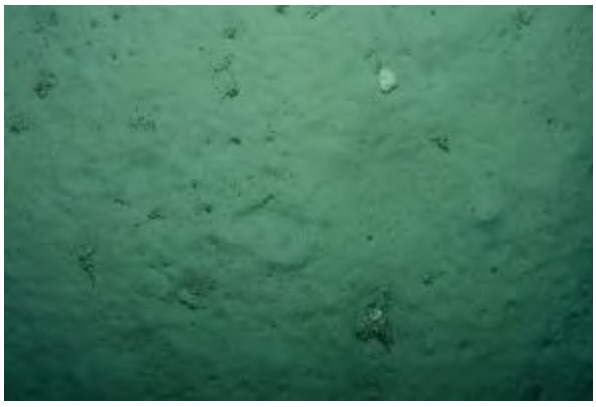
Station 96: MON 5 site



This transect headed northwest over the medium-high reflectivity site with a central slightly elevated ridge also sampled on DTIS station 34.

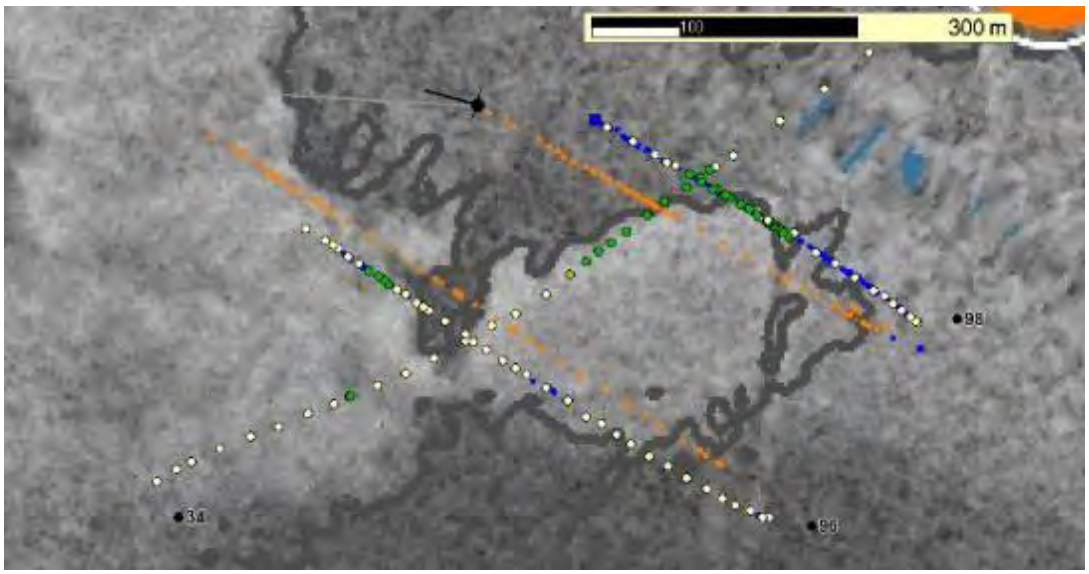
The transect was mostly muddy sediment with burrows, tracks, mounds and dark grey patches. There was a small area of encrusted cobbles and pebbles, sponges and bryozoans, and then substrate reverted back to muddy sediment, with less bioturbation. Other fauna included a seapen, *Radicipes* and parasol urchins.

TAN1805_Stn_096_125.jpg



TAN1805_Stn_096_127.jpg

Station 98: MON 5 site



The transect crossed a plateau of medium-high reflectivity also sampled on DTIS stations 34 and 96.

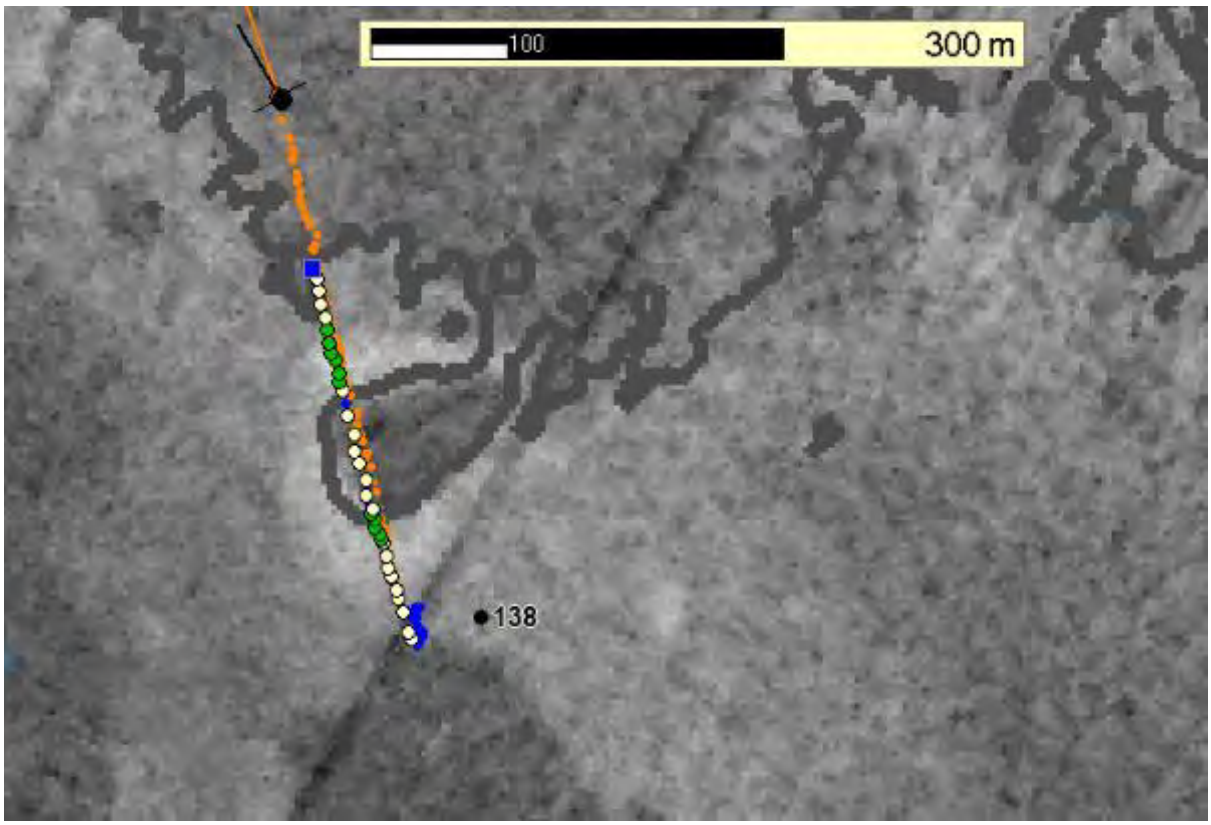
The transect started with muddy sediment with burrows, mounds and extensive heart urchin tracks, but most of the plateau had heavily encrusted cobbles and pebbles. Encrusting fauna included gorgonians, ball and encrusting sponges, lacey bryozoans and large clumps of *Goniocorella*. The transect reverted back to muddy sediment with burrows and mounds close to the end. Other common fauna were asteroids, spatangid urchins, cidarid urchins, and rattails.

TAN1805_Stn_098a_076.jpg

TAN1805_Stn_098a_080.jpg

Unusual unknown fauna from video clip

Station 138: MON 8 site



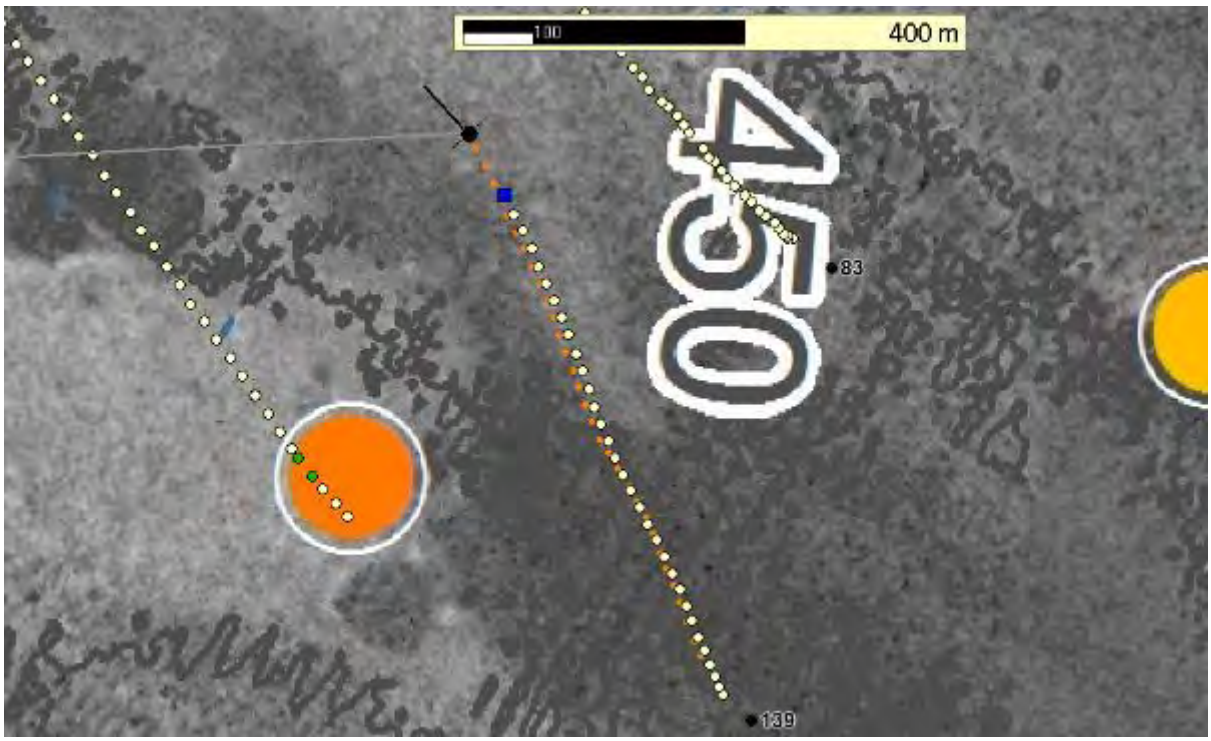
This transect (448 – 449 m) was a short tow, targeting a small hole with a rim of pale backscatter.

Substrate was initially muddy sediment with burrows, pits and the occasional mound. This then transitioned to mud with pebbles and cobbles at the rim of pale backscatter. Here there were stylasterids, gorgonians, *Goniocorella* clumps and demosponges. There were muddy sediments and burrows in the centre of the hole, and then cobbles and pebbles again at the rim of pale backscatter. Here the same fauna (stylasterids, gorgonians, *Goniocorella* and demosponges) was seen. The occasional bony fish occurred throughout the transect, mainly rattails.

tan1805_stn_138_066.jpg

tan1805_stn_138_068.jpg

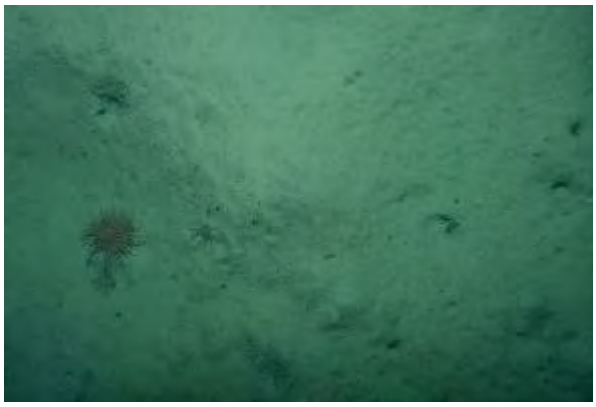
Station 139: DIS 1 site



This was a very flat transect (452 m) over dark backscatter.

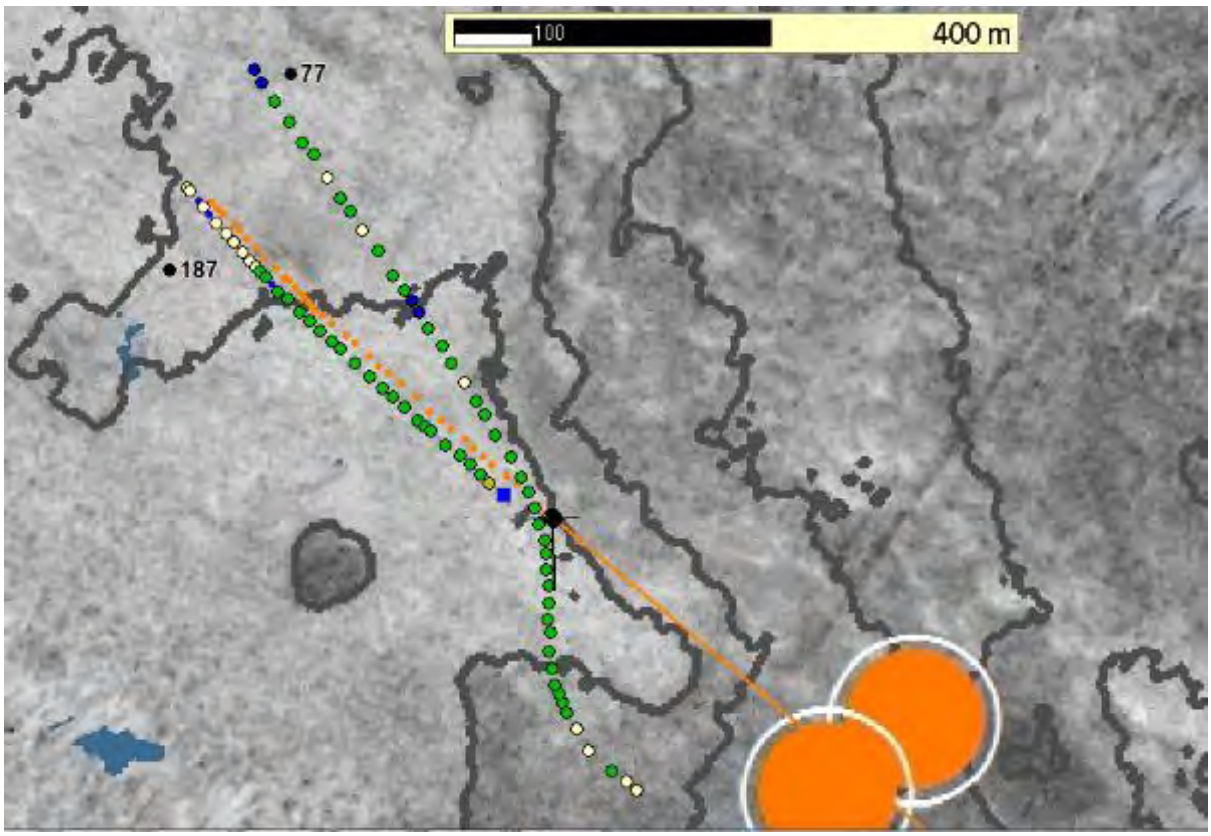
The sediment was muddy throughout, with burrows, pits and mounds. Anemones, rattails, asteroids, eels and heart-urchins were seen along the transect, together with the occassional dark ghost shark, *Taiaroa tauhou* soft coral, holothurians, crabs and squat lobsters.

tan1805_stn_139_015.jpg



tan1805_stn_139_082.jpg

Station 187: REF 1 site



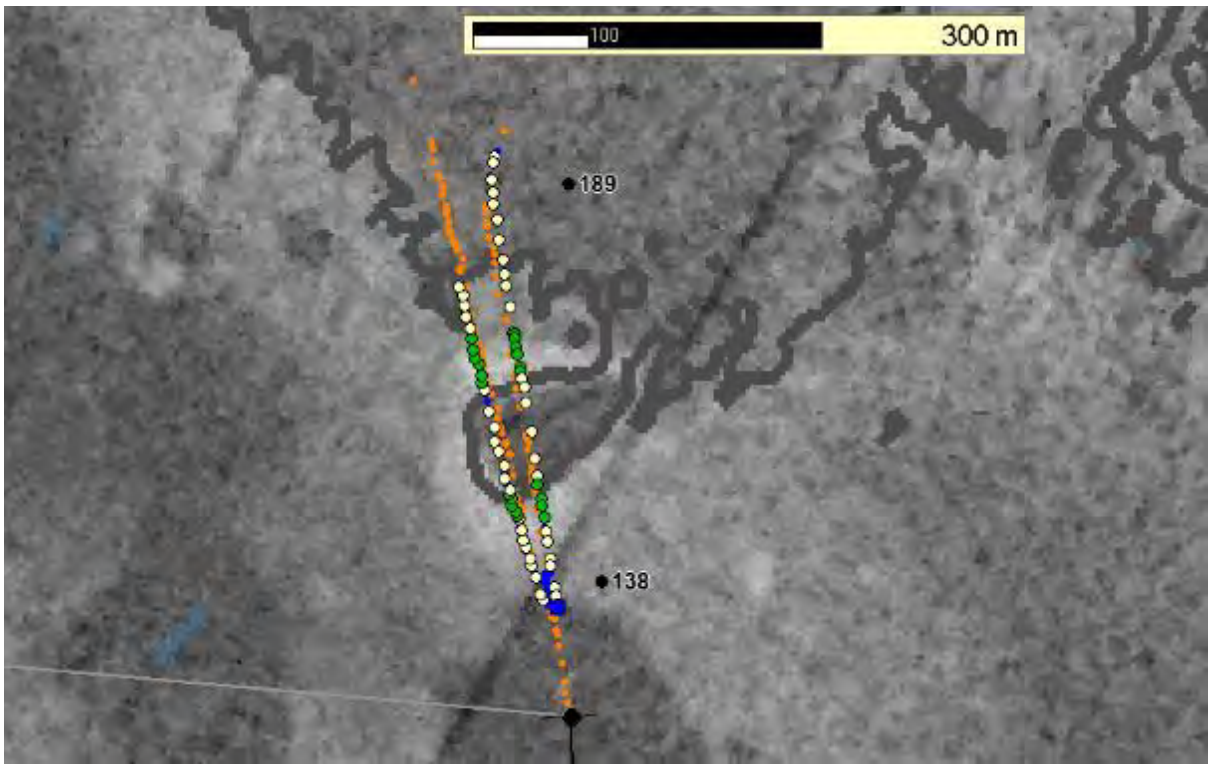
This was a repeat tow post-disturbance at the Reference site previously covered in DTIS transects 50 and 77

The transect had varying densities of pebbles, encrusted cobbles and isolated boulders throughout, as well as some nodule gravel and slabs of hard substrate. Muddy sediment was generally flat with small burrows and numerous tracks. Encrusting fauna was mostly encrusting ascidians, sponges and bryozoans/hydroids. *Goniocorella* were rare and usually small. Heart urchins were common over both mud and pebbles. Additional fauna included *Radicipes,* coralimorphia, a small *Hyalascus* glass sponge, *Psolus* sp holothurian and various rattails and fish.

tan1805_stn_187_035.jpg

tan1805_stn_187_082.jpg

Station 189: MON 8 site



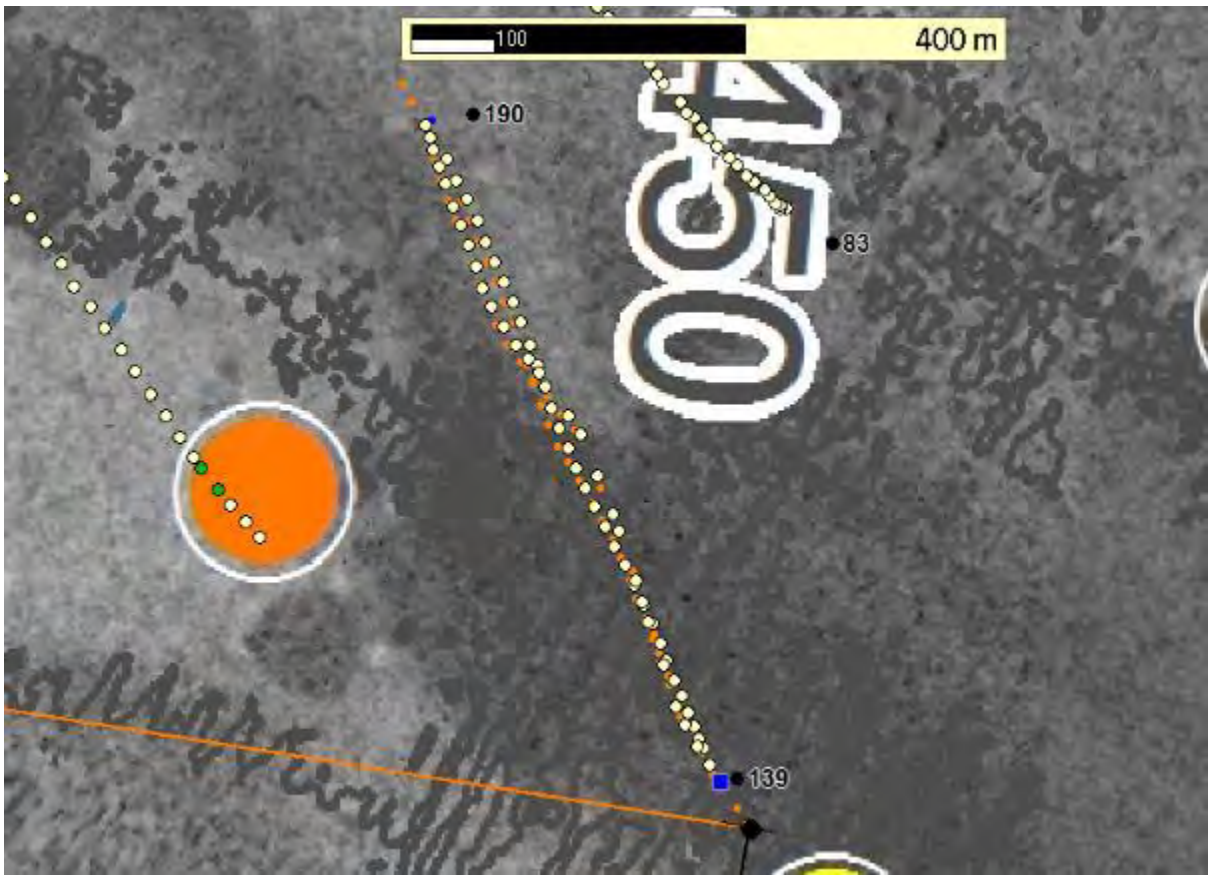
This tow was a repeat of DTIS station 138, run to the south over small depression surrounded by high reflectivity backscatter.

The transect started on soft muddy sediment, with moderate bioturbation. On the high reflectivity northern and southern rims substrate changed to pebbles and cobbles, with gorgonians, stylasterids, clonal ascidians, and patches of intact *Goniocorella*. In between, and at the southern end of the transect, muddy sediment with burrows dominated. There was no evidence of sedimentation having increased.

Video clip

TAN1805_stn189_053.jpg

Station 190: DIS 1 site



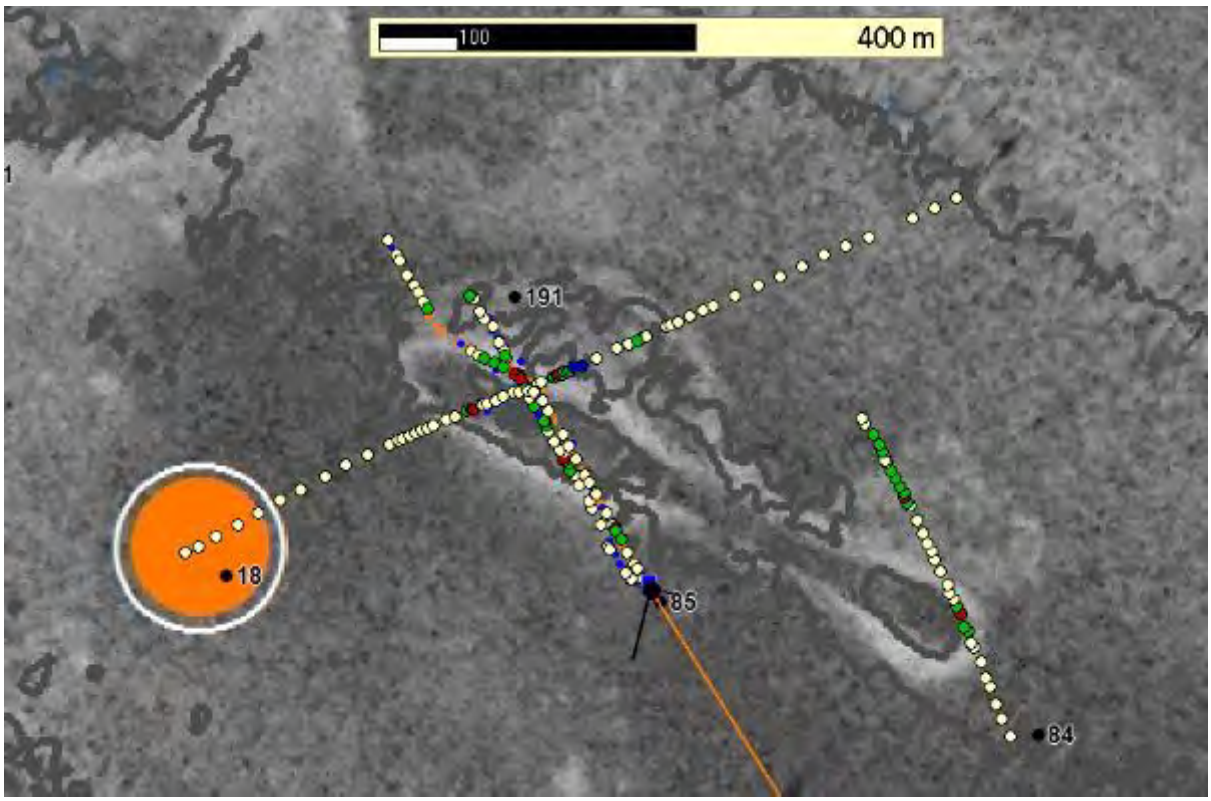
This tow was a post-disturbance repeat of #139 in the area of low reflectivity chosen for BDR operations.

The sediment was mud with burrows, mounds and pits throughout this transect. Disturber tracks were observed within the disturber box area. These were clearly skid tracks, but depressions from the fluidising jets in between the skids were not obvious and tended to be shallow.

TAN1805_stn_190_151.jpg

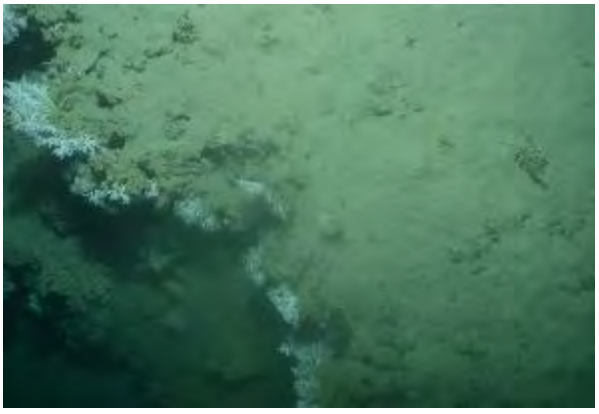
TAN1805_stn_190_159.jpg

Station 191: MON 1 site



This tow was a repeat of DTIS transect 85 from northwest to southeast across the rim of high reflectivity backscatter on the “butterknife”.

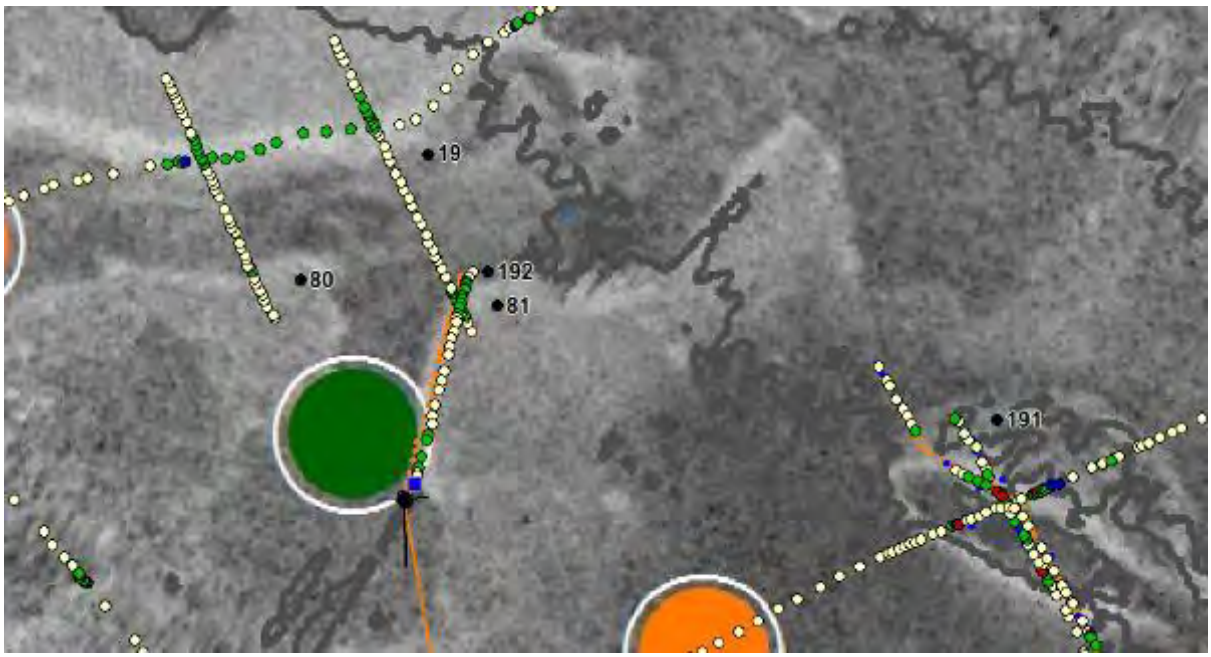
The sediment was initially mud with burrows pits, mounds and tracks. At the pale backscatter, the sediment transitioned to mud with some cobbles and pebbles. Here there was a “bedrock “ledge with stylasterids, stalked cup corals, intact *Goniocorella,* and gorgoneans. Bony fish (predominantly rattails), holothurians and urchins were seen occasionally throughout the transect. There were no obvious signs of sedimentation following disturbance.



TAN1805_stn_191_107.jpg

TAN1805_stn_191_108.jpg

Station 192: MON 2 site



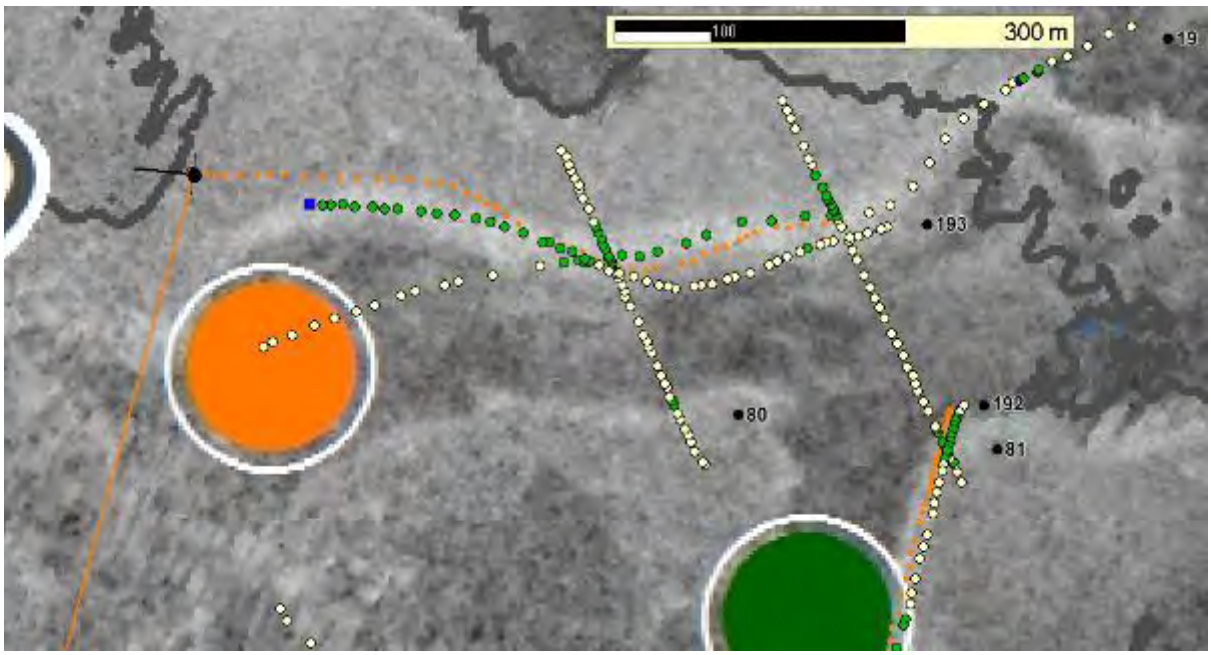
The tow traversed a band of medium-high reflectivity backscatter close to the disturbance box and west of the “butterknife” feature.

The transect started on soft sediment with burrows, and then passed over a ribbon of higher reflectivity comprising cobbles and pebbles, with demosponges (including a sedimented plate species), gorgonians, hydroids, bryozoans, ascidians and the occasional *Goniocorella* clump. Substrate after that was soft sediment and burrows, until towards the end of the tow there were pebble-cobble patches with gorgonian-demosponges. Fish included lookdown dory and rattails

TAN1805_stn_192_009.jpg

TAN1805_stn_192_074.jpg

Station 193: MON 2 site



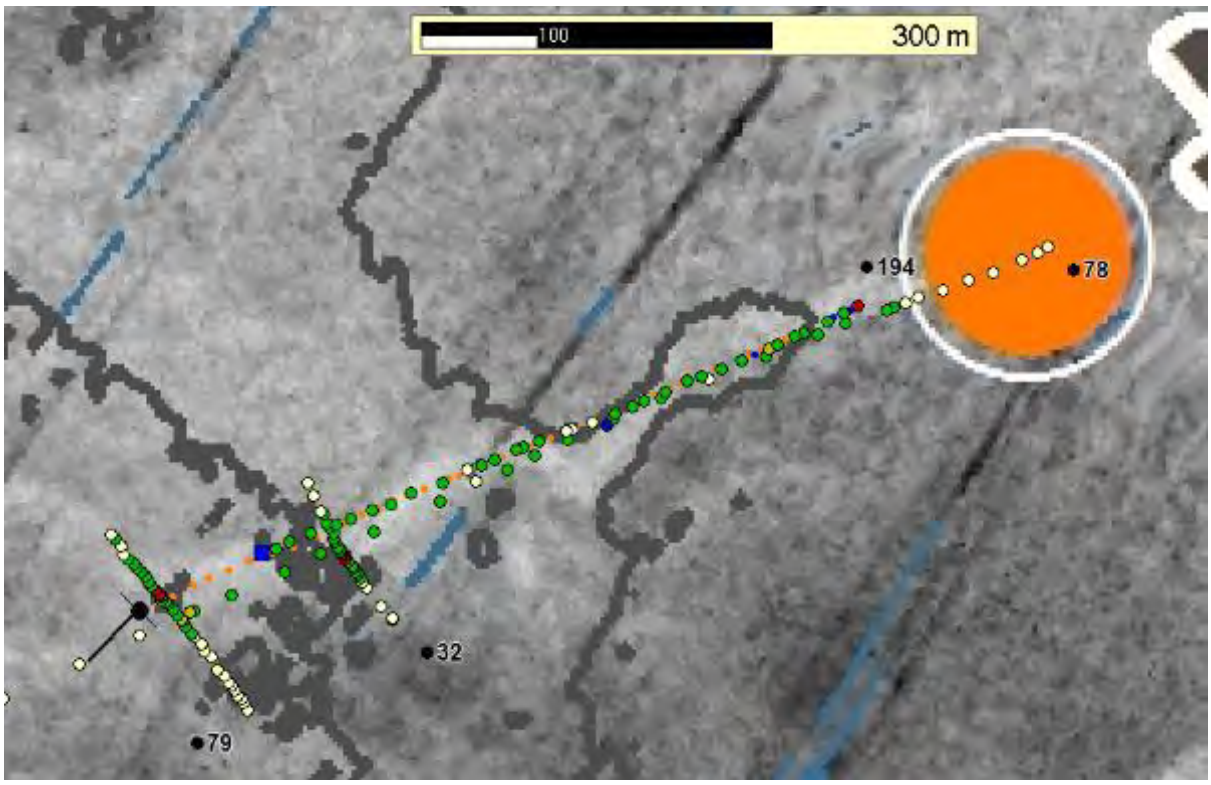
This transect followed a similar line to DTIS transect 19. It didn't exactly follow the original transect, but targeted a ridge of pale back scatter in the second half).

Substrate was initially mud with burrows, pits and mounds. The sediment then transitioned to mud with cobbles and pebbles (and some patchy areas of nodule gravel) at the ridge of pale back scatter. Here there were gorgonians, hydroids and bryozoans, some *Goniocorella*, stylasterids, ball sponges and a plate demosponge. The density of this fauna was patchy and decreased towards the end of the "ridge" of pale backscatter. Some rattails, asteroids, anemones, and squat lobsters were seen occasionally throughout the transect.

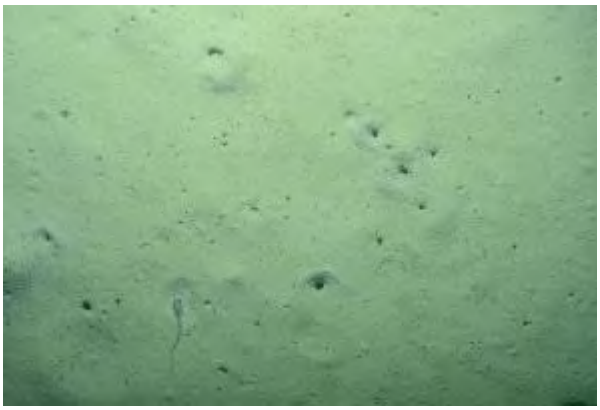
TAN1805_Stn_193_103.jpg

TAN1805_Stn_193_121.jpg

Station 194: MON 3 site



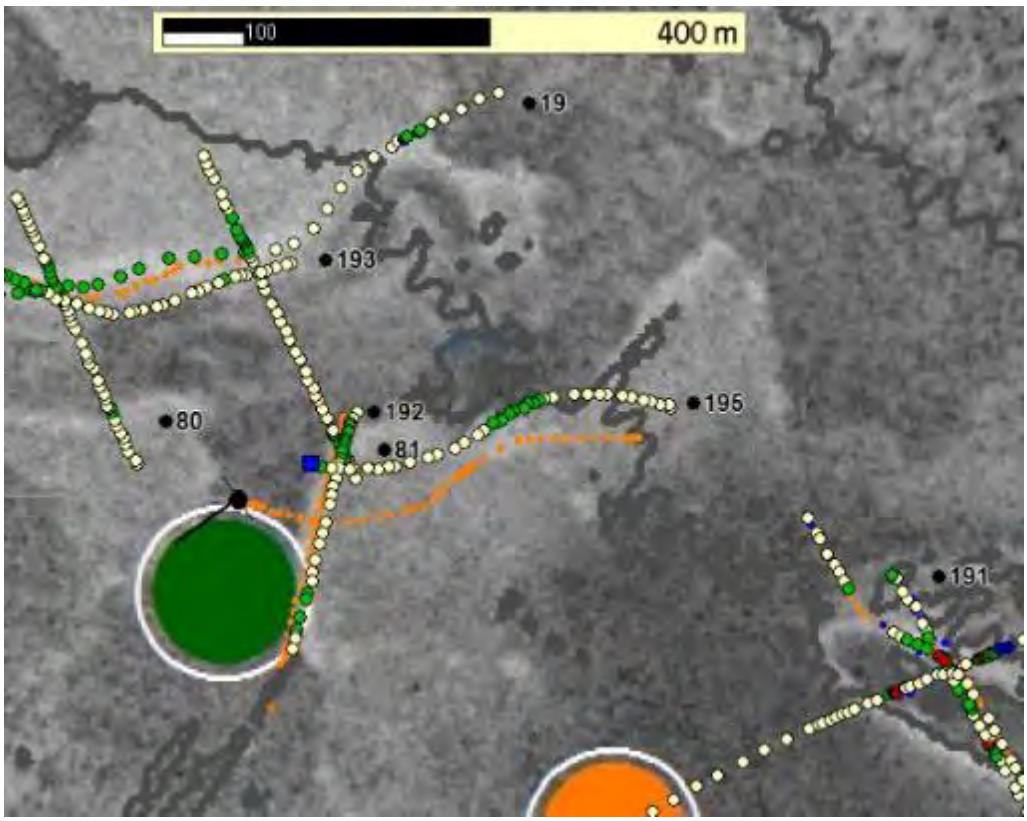
The substrate was mud with pebbles and cobbles throughout, encrusted and dense in some patches. Fauna associated with the harder substrate included several *Goniocorella* clumps, gorgonians, demosponges, other common encrusting fauna and some stalked cup corals. Buried heart urchins, along with faunal tracks, were observed throughout in the softer sediment. Demosponges increased in density towards the end of the transect, while the *Goniocorella* and gorgonians decreased. Other fauna observed included a basket star, some asteroids, and various rattails. There was a hint of recent sediment dusting on some images (see still 083-096).



TAN1805_Stn_194_086.jpg

TAN1805_Stn_194_066.jpg

Station 195: MON 2 site



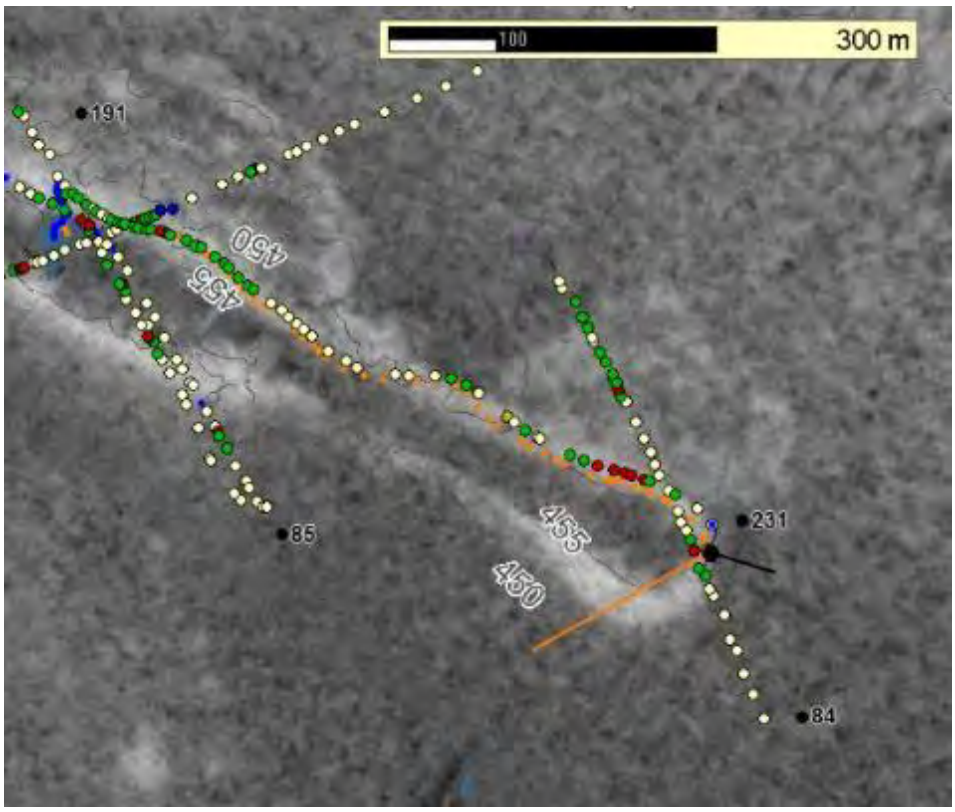
The transect followed a ridge of high reflectivity at MON 2, on the edge of the Disturbance Box.

The substrate was initially mud and burrows, with small area of pebbles/cobbles/mud crossing the band of higher reflectivity, and ended with similar muddy substrate. Cobbles were heavily encrusted with gorgonians and sponges, with some small patches of *Goniocorella*. There were scattered spatangid urchins, asteroids, cidarid urchins, anemones and *Taiaroa tauhou* soft corals.

TAN1805_Stn_195_039.jpg

TAN1805_Stn_195_132.jpg

Station 231: MON 1 site (“The butterknife”)



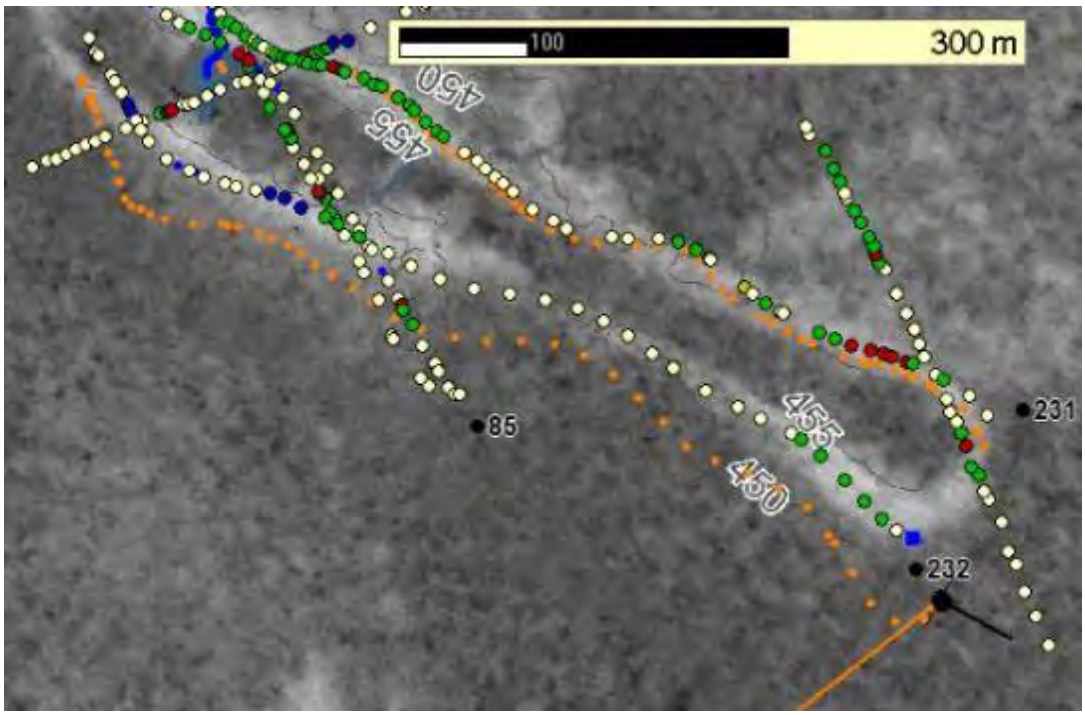
This transect targeted the northern ridge of the butterknife feature post-disturbance, and ran along the band of medium-high reflectivity backscatter on the rim of the depression.

The transect managed to keep mostly within the area of higher reflectivity. In several places there was exposed bedrock on the rim edge which hosted stalked cup corals, *Dermichinus* urchins, large stylasterids, bivalves and intact *Goniocorella*. Along much of the transect the substrate was characterised by mud with patches of pebbles, cobbles-the latter with live *Goniocorella*.

TAN1805_stn_231_025.jpg

TAN1805_stn_231_151.jpg

Station 232: MON 1 site



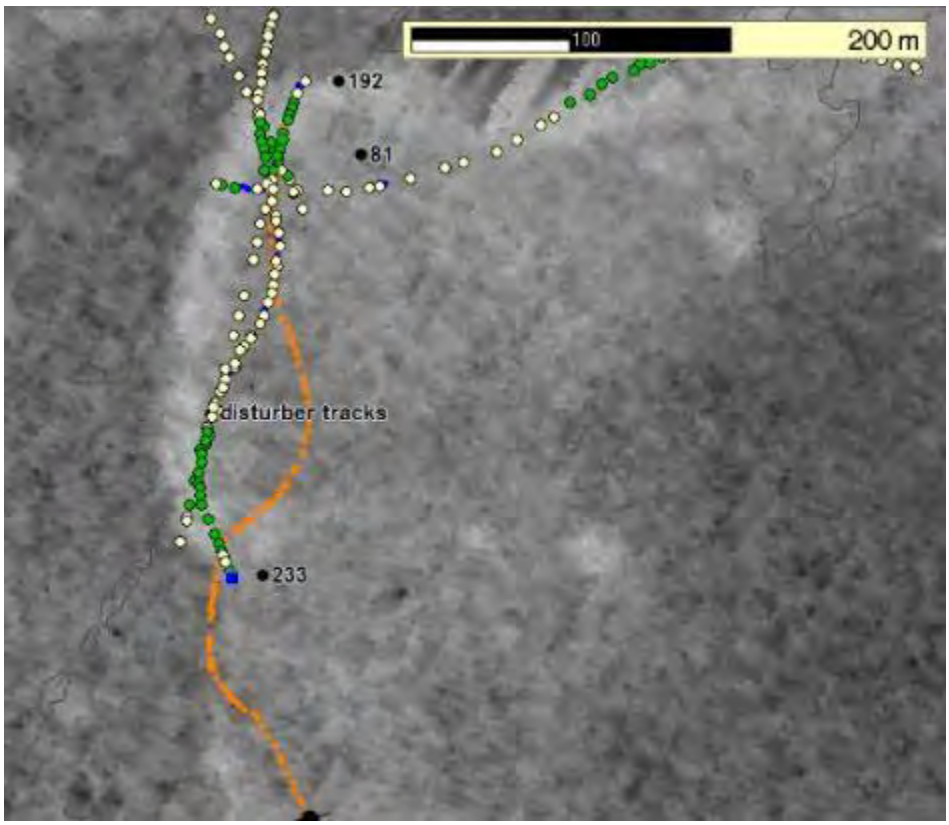
This tow was a companion to #231, but targeted the southern rim of medium-high reflectivity backscatter on the butterknife feature.

The first half of the transect skirted the area of higher backscatter and went over muddy sediment, bioturbated with mounds and burrows at the beginning. Much of the transect was flat with occasional patches of pebbles-and near the end there were denser patches of cobbles and pebbles characterised by intact *Goniocorella* coral, sponges, stylasterids and other encrusting fauna.

TAN1805_stn_232_085.jpg

TAN1805_stn_232_197.jpg

Station 233: MON 2 site



This was a replicate of station 192 post disturbance, which targeted a band of medium-high reflectivity backscatter close to the disturbance box. Much of the mid transect skirted the area of highest reflectivity. This was prior to more detailed disturbance.

The beginning and mid-section of the transect was over muddy bioturbated sediment. On the higher reflectivity backscatter the mud was flat with patches of cobbles and pebbles encrusted with gorgonians, *Goniocorella*, stylasterids and other encrusting fauna. There was a disturber track close to the end of the transect. Muddy sediment appeared to be slightly rippled in places suggesting high current flow. Some gorgonians and other encrusting fauna near the disturber tracks showed no obvious signs of recent added sedimentation.

TAN1805_stn_233_056.jpg

TAN1805_stn_233_093.jpg

Station 234: MON 2 site

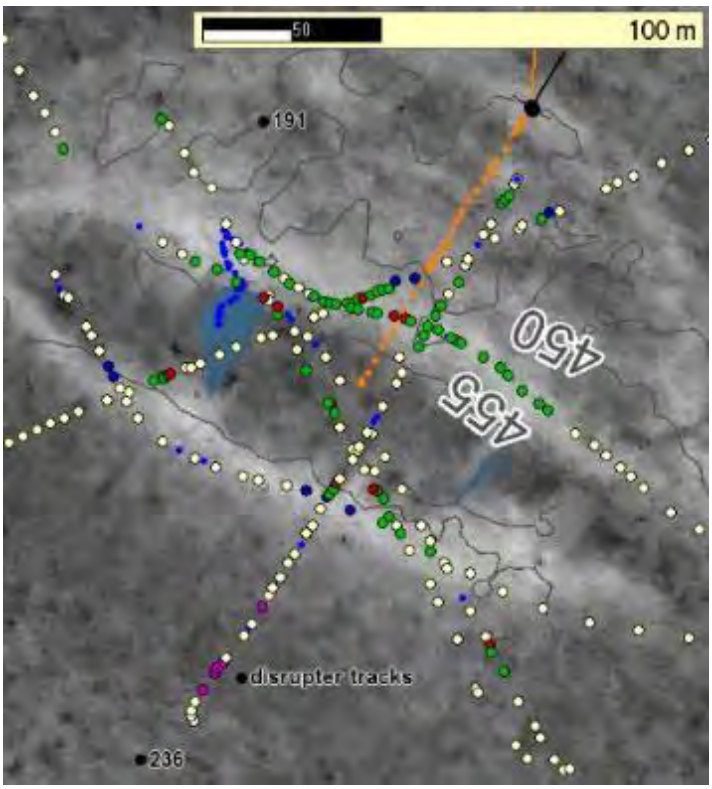
This was a replicate tow of station 193 on the western side pf MON 2 and bisecting station 19, which went along a band of medium-high reflectivity backscatter.

The transcect was mostly muddy sediments with occasional pebbles and scattered *Goniocorella*.

TAN0805_stn_234_039.jpg

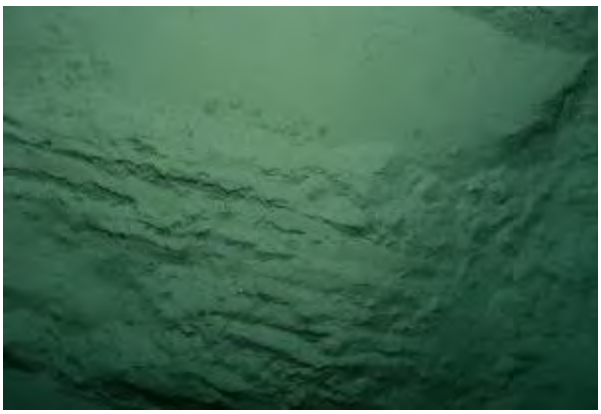
TAN1805_stn_234_039.jpg

Station 236: MON 1 site



This transect crossed the parallel lines disturbance area and western section of the butterknife feature following the disturbance survey done to the immediate south. Disturber track observations are shown here by purple dots.

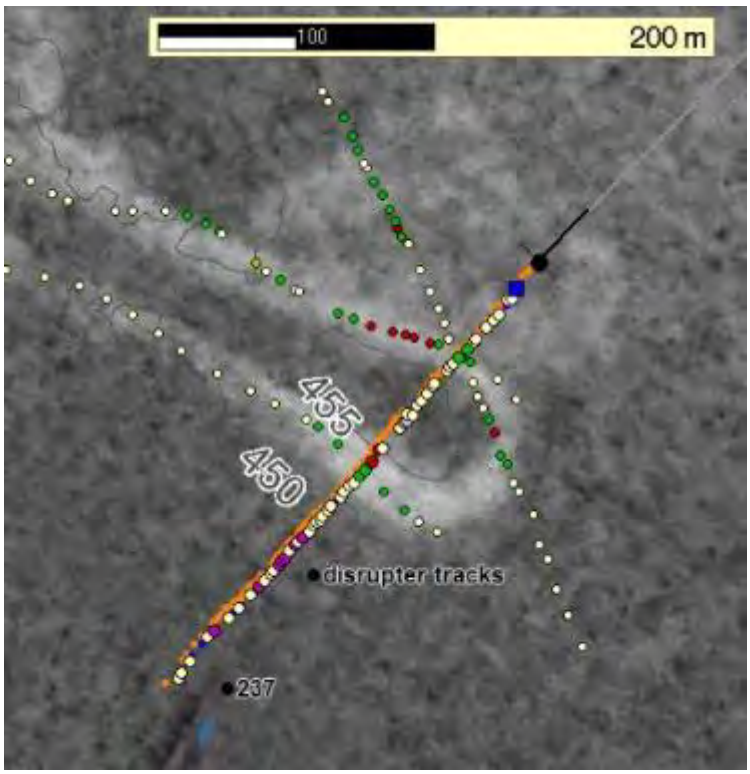
Substrate was initially soft sediment with burrows and mounds with some disturber tracks, then changed to pebbles/cobble substrate with some clumps of *Goniocorella* on the rim. The middle of the feature consisted of soft sediment with burrows and mounds until reaching the northern bedrock rim, with intact coral, stylasterids and sponges. Further north, substrate became patchier with cobble/pebbles with small *Goniocorella* clumps, and eventually soft sediments. There were no signs of suspended sediments, or obvious smothering of benthic fauna.



TAN1805_stn_236_013.jpg

TAN1805_stn_236_073.jpg

Station 237: MON 1 site



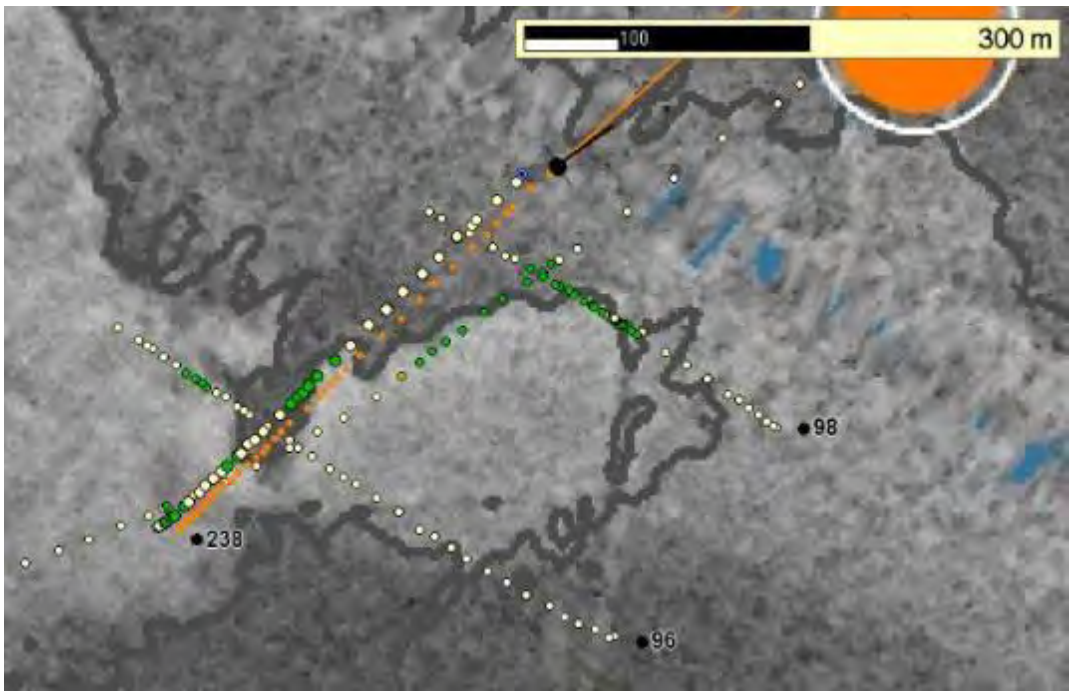
This transect, like the previous DTIS shot, crossed the disturbance lines area and eastern section of the butterknife feature.

Substrate was initially soft sediment with burrows and mounds with some disturber tracks, then changed to pebble/cobble substrate with some clumps of *Goniocorella* on the southern rim. The middle of the transect consisted of soft sediment with burrows and mounds until reaching the northern rim with a low bedrock ridge with intact coral, stylasterids and sponges. Clear of the high reflectivity strip, substrate became patchier cobble/pebbles with small *Goniocorella* clumps, and eventually soft sediments. There were no signs of suspended sediments, or obvious smothering of benthic fauna.

TAN1805_stn_237_035.jpg

TAN1805_stn237_059.jpg

Station 238: MON 5 site



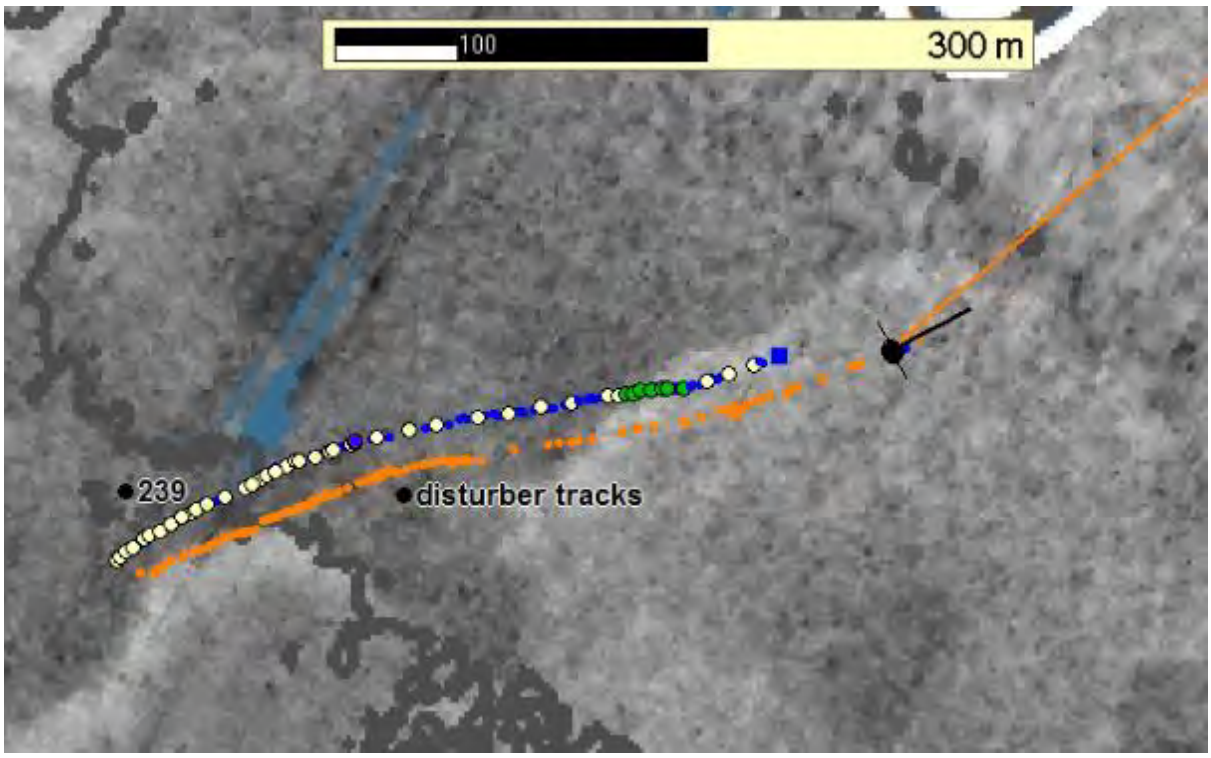
The tow crossed the mid-high reflectivity area of MON 5 also sampled on stations 34, 96 and 98.

Substrate was a mix of mud/pebble/cobble sediments with occasional patches of *Goniocorella*. As the tow moved down into a slight depression, the seabed was characterised by muddy sediment with burrows/mounds/grey patches. There were few fauna on the soft sediment.

TAN1805_stn_238_047.jpg

TAN1805_stn_238_072.jpg

Station 239: MON 3 site



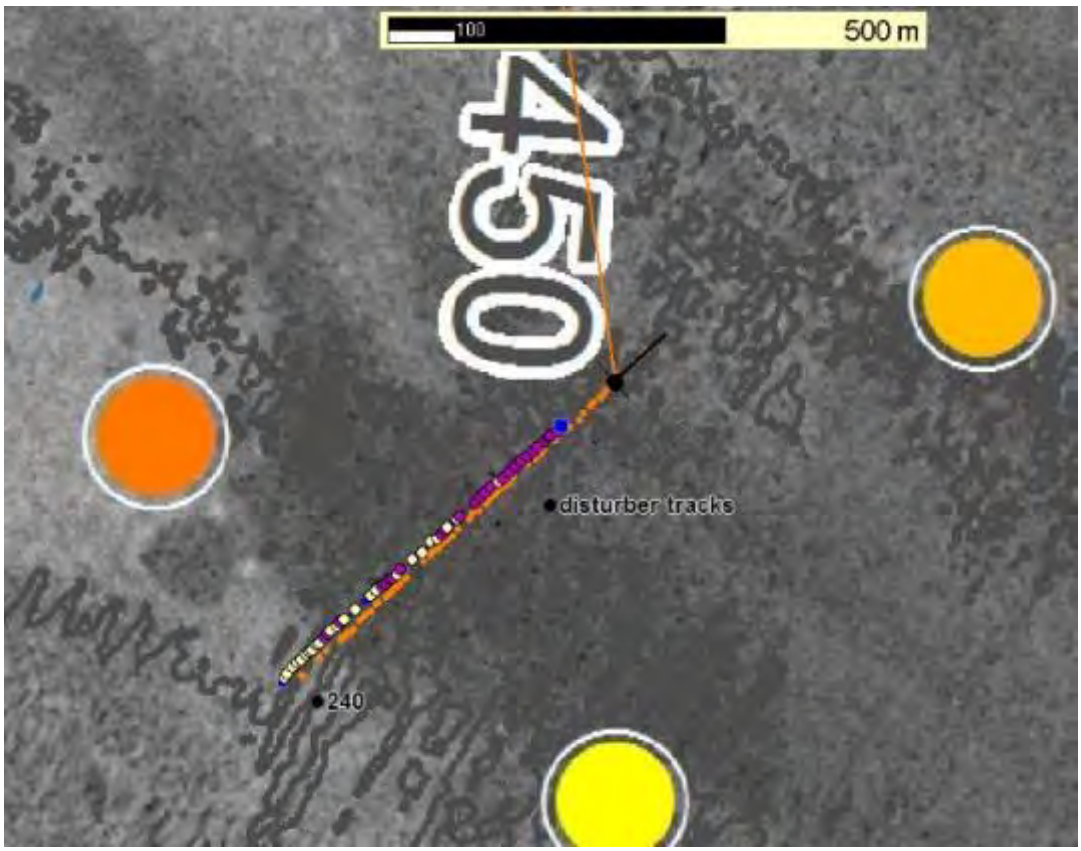
This tow repeated station 82, targeting a band of medium-high reflectivity, although the DTIS track ran north of the intended line for much of the time due to near-seafloor currents. A disturber track was crossed near the middle of this transect.

The transect substrate consisted mainly of soft sediment with burrows and mounds. As it crossed the band of higher reflectivity the substrate turned from bioturbated mud to encrusted cobbles. The main fauna were gorgonians, ball sponges and low encrusting bryozoans and hydroids. *Goniocorella* may have been present but as small fragments. Other fauna included *Radicipes,* anemones and a red cod. Camera height was often > 3m off the bottom and consequently images were dim for periods of time.

TAN1805_stn_239_071.jpg

TAN1805_stn_239_130.jpg

Station 240: DIS 1 site



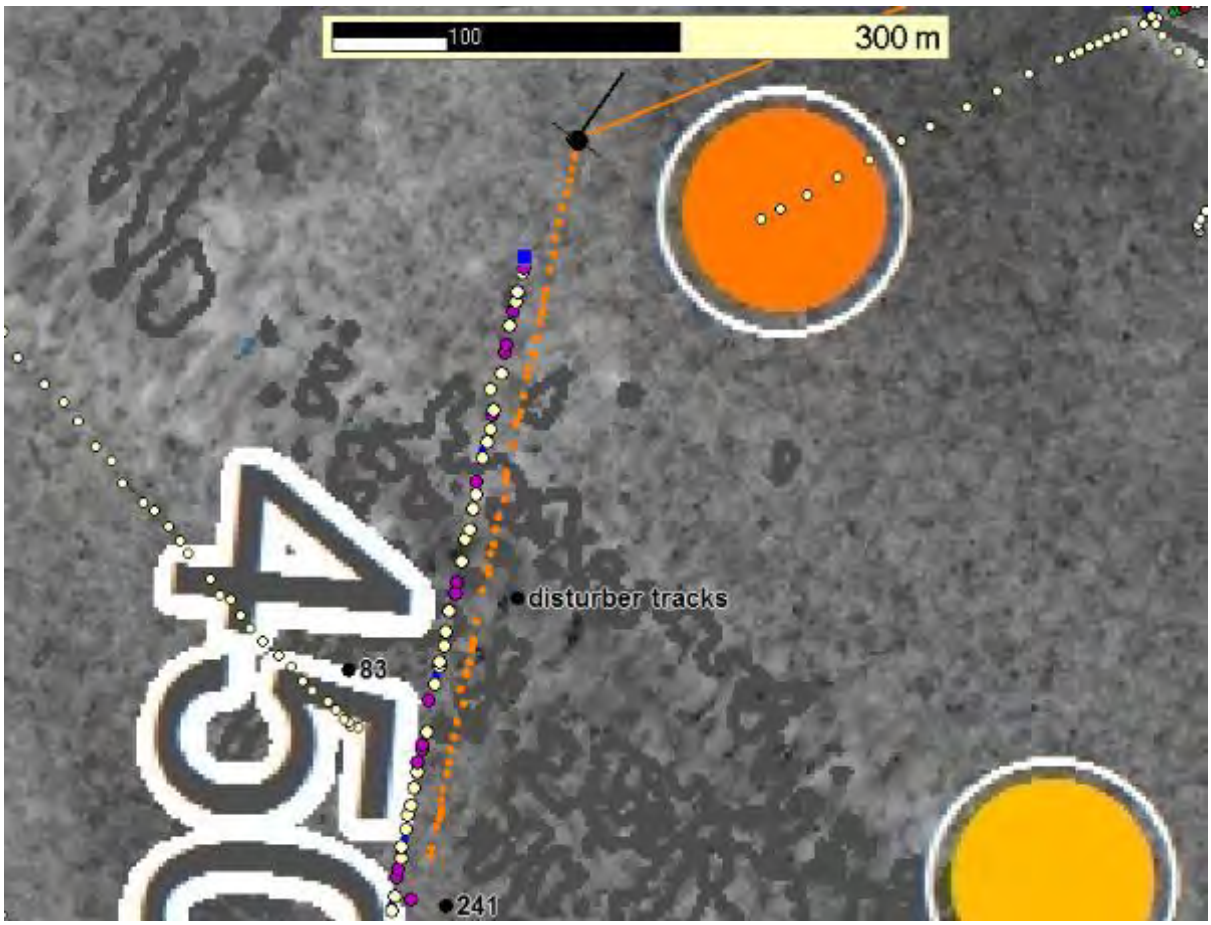
This site is in the southeastern corner of the disturber box. The tow crossed stations 139 and 190, in an area of low reflectivity (purple dots).

The transect was soft sediment with burrows and mounds. There were frequent disturber tracks throughout the transect, and few fauna.

TAN1805_Stn_240_061

TAN1805_Stn_240_104

Station 241: DIS 2 site



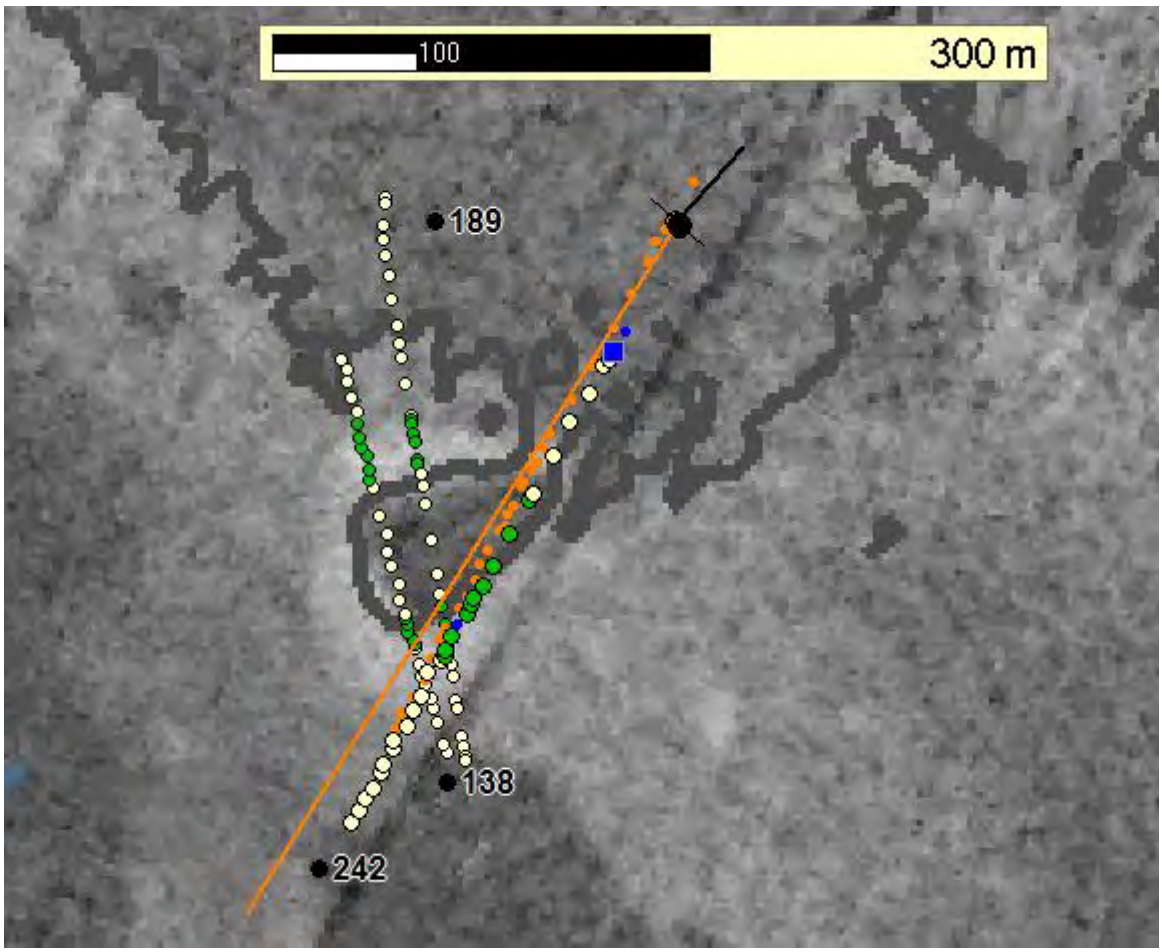
This tow, at DIS 2 which is north of DIS 1, was a repeat (following disturbance) of station 83, crossing an area of low reflectivity in the eastern part of the disturbance box.

The transect was soft sediment with burrows and mounds with occasional disturber track marks (purple dots). There were few epifauna.

tan1805_stn_241_050.jpg

tan1805_stn_241_151.jpg

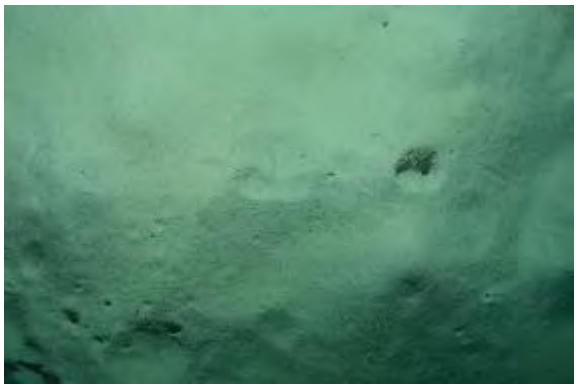
Station 242: MON 8 site



This tow was a repeat of stations 138 (pre-disturbance), and 185 (first post-disturbance) on a small depression of low reflectivity backscatter surrounded by a band of medium reflectivity.

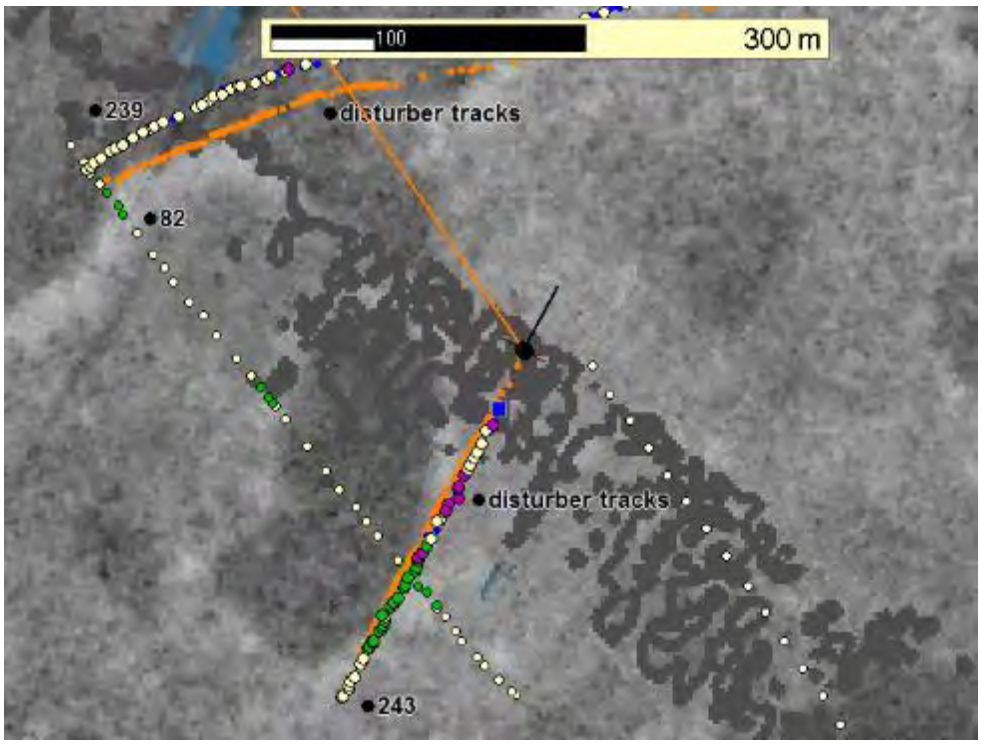
The sediment was predominantly mud and burrows, transitioning to cobbles and pebbles at the band of higher back scatter. Here there were gorgonians, some *Goniocorella*, demosponges, and encrusting sponges and bryozoans. Occasional rattails, holothurian, heart urchins, some squat lobsters and cidarid urchins were also observed throughout the transect.

tan1805_stn_242_152.jpg



tan1805_stn_242_103.jpg

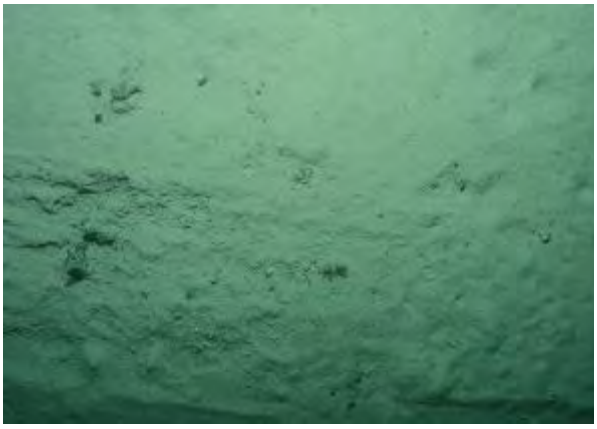
Station 243: MON 3 site



This transect was close to the disturbance box, with a band of pale medium backscatter surrounding a patch of low backscatter. It was slightly south of station 82.

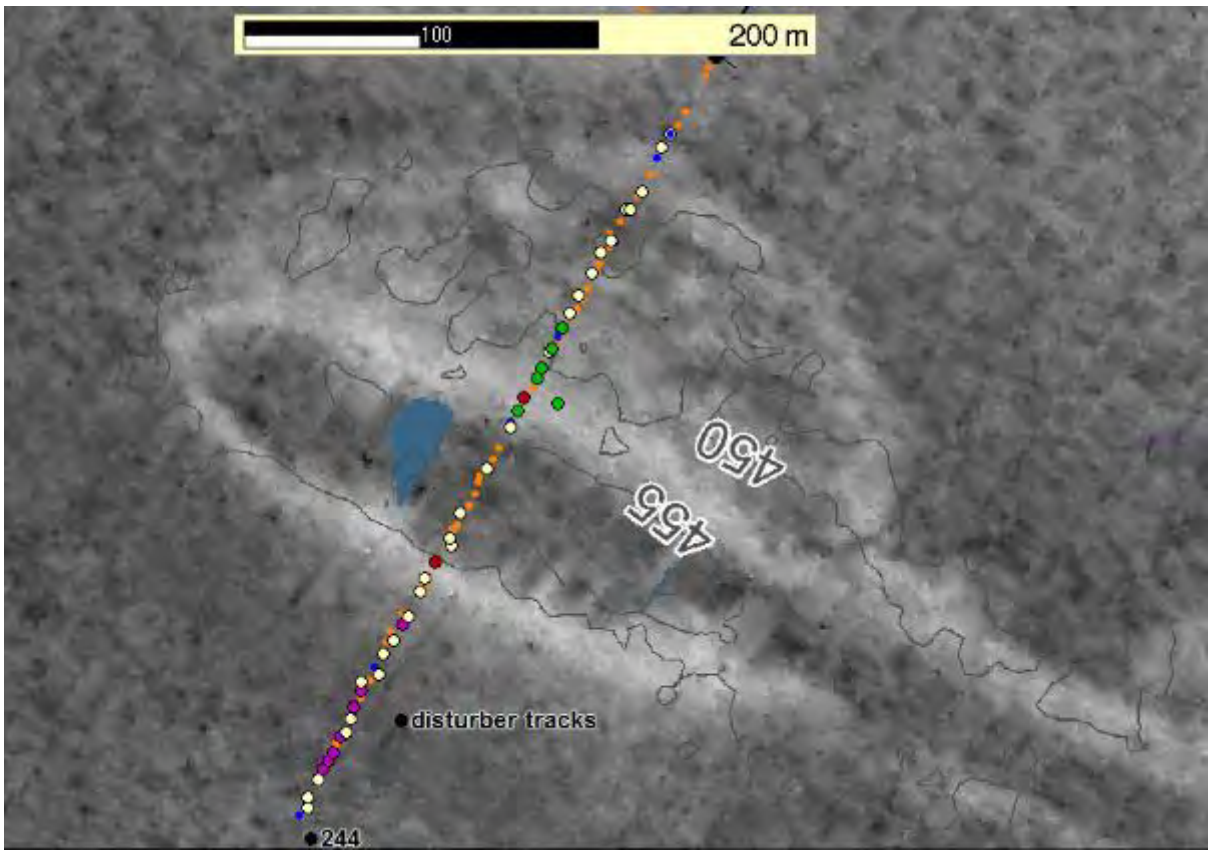
The sediment was initially mud with burrows and mounds, transitioning to cobbles and pebbles at the pale backscatter, and then back to mud with burrows and mounds. Several disturber tracks occurred in the middle part of the transect. Fauna associated with the cobbles included gorgonians, some *Goniocorella*, bryozoans, ascidians, *Psolus* holothurians, demosponges (including some large plate forms) and encrusting sponges. Disturber tracks were observed during the second half of the transect, although there appeared to be little evidence of sedimentation adjacent to the tracks. Bony fish, primarily rattails but including lookdown dory, and heart urchins were observed throughout the transect.

tan1805_stn_243_035.jpg



tan1805_stn_243_046.jpg

Station 244: MON 1 site



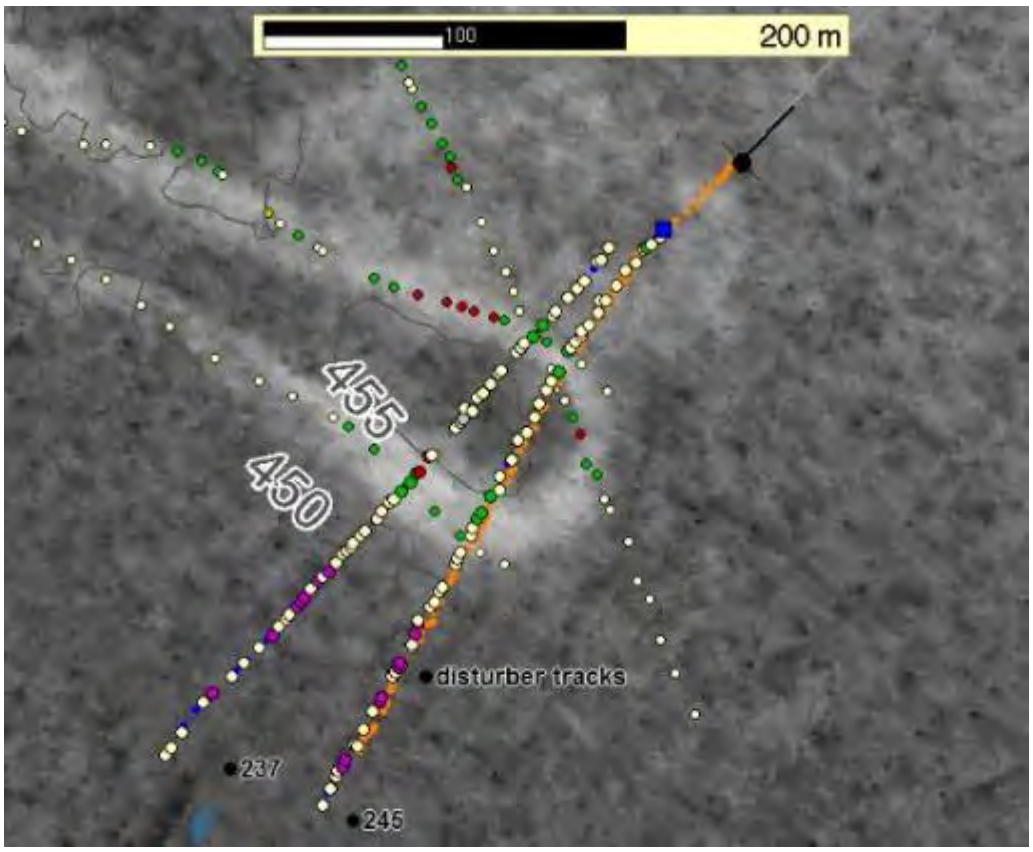
This transect ran northwards across the northwestern end of the 'butterknife'

The transect began in the parallel lines disturber area, where the sediment was mud and burrows with disturber tracks evident. The sediment then transitioned to mud with cobbles and pebbles at the pale back scatter rim of the feature. Here, *Goniocorella,* gorgoneans, stylasterids, bryozoans, demosponges and encrusting sponges were observed. The sediment then reverted back to mud and burrows at the end of the transect. Some rattails and cidarid urchins were observed throughout.

tan1805_stn_244_016.jpg

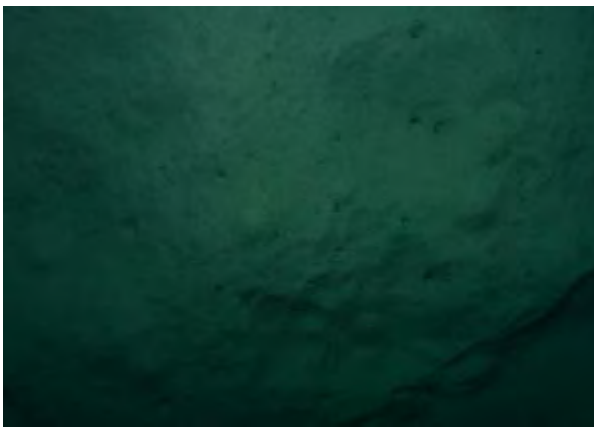
tan1805_stn_244_047.jpg

Station 245: MON 1 site



This transect crossed the parallel lines disturbance area and eastern end of the butterknife feature, similar to DTIS station 237.

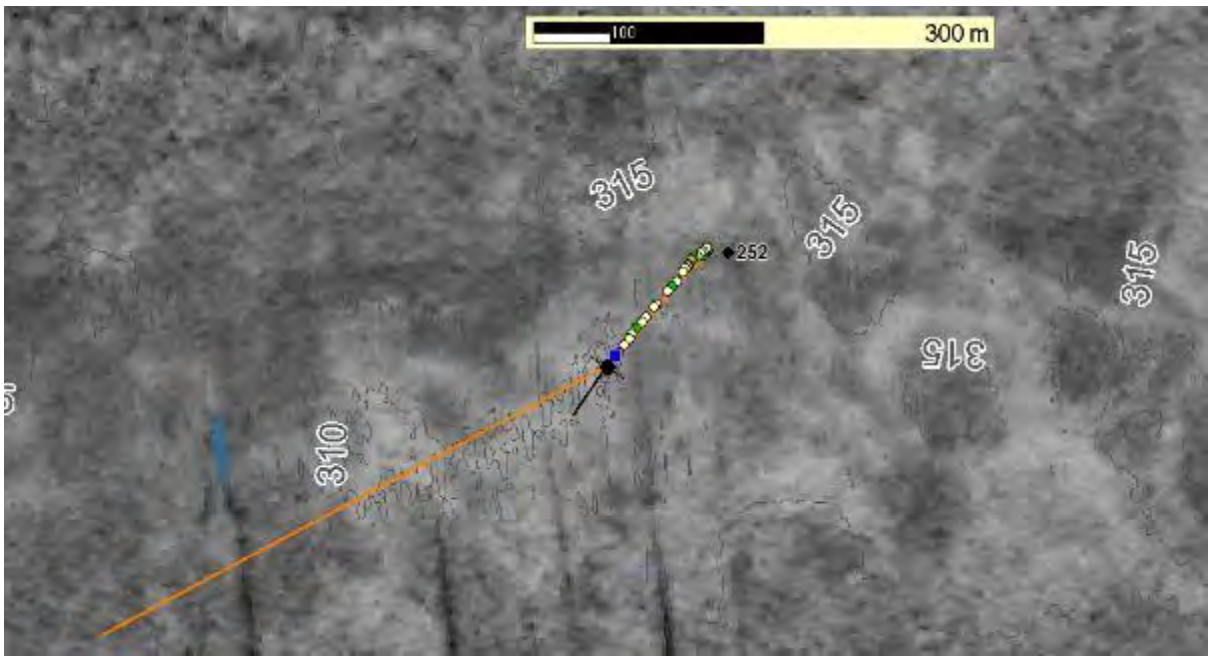
Substrate initially comprised soft sediments with burrows and mounds with some disturber tracks, then changed to encrusted pebbles and cobbles in the band of high reflectivity backscatter. Fauna included some clumps of *Goniocorella* and other common fauna seen on previous passes over the feature. A red cod was noted.



TAN1805_stn_245_032.jpg

TAN1805_stn245_057.jpg

Station 252: ANZ area to the west



This transect occurred well to the west of the main survey area-on the transit back to Wellington. It was done to check substrate and fauna prior to beam trawls aimed at collecting sponges for experimental studies. Transect targets were of higher reflective backscatter more likely to have sponges.

Substrate was generally dark soft ?sandy sediment with green sediment overlay and some burrows. There were scattered encrusted cobbles and occasional boulders. Encrusting fauna included several species of sponge as well as colonial and solitary ascidians, gorgonians, hydroids and tube worms. Other fauna observed were *Munida*, scampi, a mysid swarm, flatheads and dark ghost sharks.

TAN1805_stn_252_037.jpg

TAN1805_stn252_107.jpg