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SERPENT Project

UK SERPENT Activity Report: Lincoln 205/26b-14 and Warwick Crestal

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Previous SERPENT observations have revealed the impacts of sedimentation disturbance from the open hole phase of hydrocarbon drilling. This work showed some evidence for different faunal responses over time following the sedimentation event, including evidence for recovery of the abundance and diversity of organisms living within the impacted area. The interpretation of these changes is limited because data only exist over coarse time scales necessary when completing visits pre-drilling, post-drilling and return visits to the sites (e.g. months to years).

The primary aim of the field visits to the Transocean Leader in 2019 were to understand the responses of seafloor organisms to sedimentation disturbance over finer temporal scales (e.g. minutes to hours) within the context of the existing knowledge of the effects of sedimentation at hydrocarbon drilling sites. This was addressed using seafloor video survey techniques and time-lapse photography of seafloor organisms during sedimentation events.

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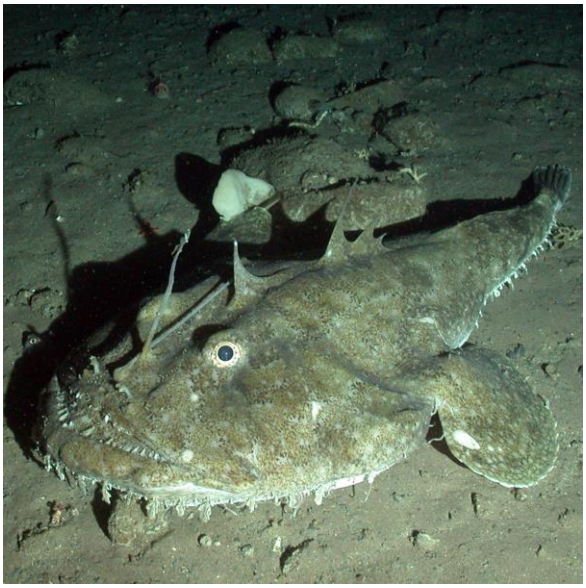

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2019

Andrew Gates & Jennifer Durden

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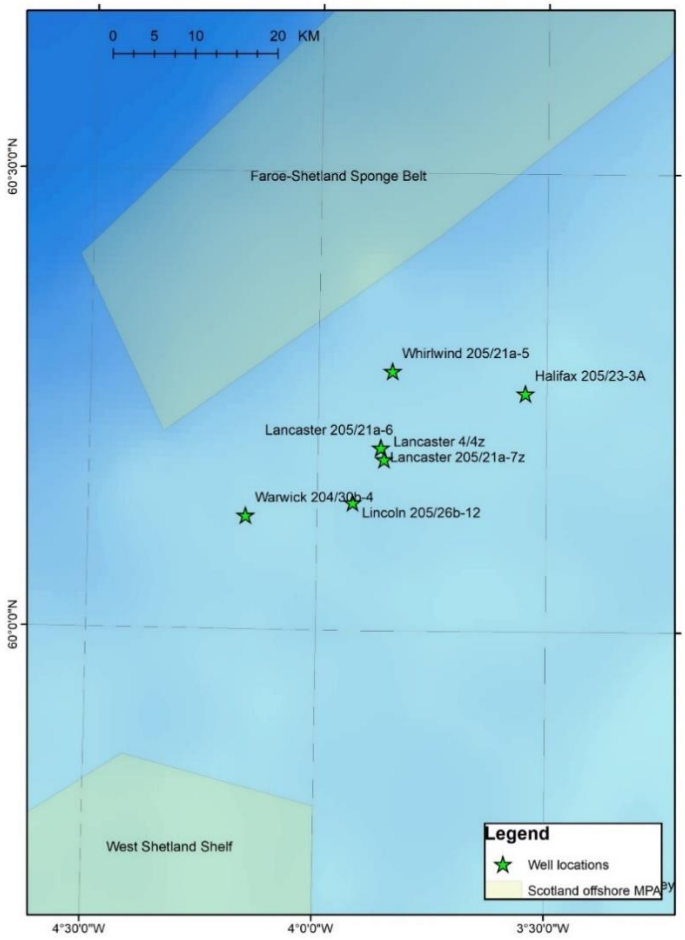


Location of Hurricane sites with SERPENT field data

General information:

Client: Hurricane Energy
Operator: Petrofac
Rig Operator: Transocean
Rig: Transocean Leader
ROV service provider: Oceaneering International
ROV: Magnum 205
ROV Team: Richard Walker, Darren Timperley, Callum McGarrie, Allan McPherson, Ian Cameron

Rig visits:

Visit 1:

SERPENT representative: A Gates
Rig: Transocean Leader
Dates: 25 July – 3 August 2019
Location: Lincoln 205/26b-14
Position: 60° 07' 8.354" N, 003° 54' 58.490" W
Water depth: 160m
Well condition: post open-hole drilling

Visit 2:

SERPENT representative: J Durden
Dates: 15-23 September 2019
Location 1: Lincoln 205/26b-14
Water depth: 160m
Well condition: Complete
Rig heading: 270

Location 2: Warwick Crestal 204/30b-A
Position: 60° 07' 25.476" N, 004° 09' 28.836" W
Water depth: 156 m
Well condition: Pre-spud
Rig heading: 270

Visit 3:

SERPENT representative: A Gates
Location: Warwick Crestal 204/30b-A
Dates: 29 November – 2 December 2019

Gear:

The ROV generally operated well throughout the field campaign. The only major problem occurred during the last dive of the July/August visit to the Transocean Leader. There was a thruster problem and the vehicle was recovered rapidly after deployment of the time-lapse camera.

There was an issue with the Kongsberg OE14 stills camera and flash at various times throughout the visits. The flash would intermittently fail and require restarting to solve. There were some issues with the GUI that prevented re-starting the camera with the vehicle in the water.

The SERPENT time-lapse camera provided some excellent data but we encountered two problems during the visits. Despite testing rigorously before the field visits the first deployment failed after 6 images. On recovery it was clear that the batteries had lost their charge very rapidly (it should hold charge for >1500 pictures). After re-charging, a deck test showed the batteries again failed to hold the charge. All batteries in the flash and camera were changed and the problem was solved.

When the camera was recovered in December after the long deployment at Warwick the flash unit had flooded. This turned out to not affect the data collections because it must have occurred after the battery had drained or the memory filled. Camera fail at end of deployment, flooded flash unit. Subsequently sent for repair.

SERPENT equipment sent to the Transocean Leader.

Box 4 - Aluminium transit case **Weight – 30 kg ; Dimensions: 770 mm x 580 mm x 400 mm** **Estimated value - £1000**	**Description of Goods:** Equipment and consumables for scientific sampling at sea: 4 x 100 plastic sample bags Sample processing gear (cutting plates, slicing rings) Sample labels and pens PPE including robust rubber gloves, eye protection 36 x 1L sample bottles 20 x 1.5 L UN sample bottles 10 x 5 L buckets 2 x wash bottles Stationary and tool-kit Funnel Nitrile gloves 1 x vial flourocin dye Luminophore tracers (coloured sand) Tape Mesh bag ROV quadrat Hand operated siphon pump
Box 2 - Aluminium transit case **Weight – 50 kg ; Dimensions: 770 mm x 580 mm x 400 mm** **Estimated value - £500**	**Description of Goods:** Equipment and consumables for scientific sampling at sea. Packing list: Core sampling equipment: 2 x metal core sampler holders 14 x core tubes 14 x core holsters + spare parts Jubilee clips 1 x core extruder
Box 3 - Aluminium transit case **Weight – 60 kg** **Dimensions – 1160 mm x 580 mm x 400 mm** **Estimated value - £10,000**	**Description of Goods:** Underwater time lapse camera equipment Includes: Scorpio Plus digital time lapse camera with deep-sea housing Flash and deep-sea housing 2 x intellipeak charging units DC power unit Test monitor Software CDs and operating manuals Camera cables and USB adapters, memory cards

	Plastic mounting frame Laptop computer to operate
Aluminium Box **Dimensions – 770 mm x 580 mm x 400 mm** **Estimated value - £200**	**Description of Goods** **2.5 L 37.5% formaldehyde solution (msds included)** **0.5 and 1.5 l UN sample bottles** **2 scientific sediment sieves** **Packing materials**
Peli storm case **Dimensions – 795 x 518 x 310 mm** **Estimated value - £35,000**	**Description of Goods - contains oceanographic equipment:** **Current meter (Seaguard RCM DW rated 3000 m) with salinity sensor** **Serial number 198** **Datalogger Titanium body RBR Model XR-420CTDmTi+pH+DO** **Includes conductivity (Marine Conductivity), temperature, pressure, pH (AMT UT-pH-EM) and Oxygen (Aanderaa AA 3830 Optode) sensors and spare alkaline batteries** **Serial Number 17023**
2 x traffic cone	
Cool box	

Narrative:

Visit 1

Lincoln 205/26b-14
A Gates
25 July – 3 August 2019

25th July 2019

Travel to Aberdeen from Stanhope County Durham by train. Extremely hot weather, train delays predicted but manage to get on an earlier train.

26th July 2019

Check in Bristows 11:45. Helicopter transfer to *Transocean Leader,* change helicopter because of problem with door so some delays. Arrive around 1700.

Meet Richard Walker, ROV supervisor and see ROV (Magnum 203). Allan McPherson and Ian Cameron are the rest of the team.

27th July 2019

Morning meeting 07:15 – ROV is good to go. Stills camera has been set up with the flash.

On inspections it is clear that parallel lasers need re-aligning.

First dive is at 08:29. Operational tasks include GVI and bulls eyes inspection. After this we spend the morning doing some general observations around the south of the BOP reaching about 150 m distance. A wide range of observations including octopus, cup corals, asteroids and *Phycis blennoides.*

On deck at 11:35. Prepare current meter for deployment (15 minute intervals from 14:00 UTC today). Calibrate laser scale – 31 cm. Have some trouble with the flash on the Kongsberg stills camera.

Off deck 16:11 (Oceaneering Dive 83), deploy current meter at 44 m 189° to the BOP at 16:35

Begin video transect survey with 1st & 2nd lines to the E and SE of the well. Recover ROV at 18:00

28th July 2019

07:15 morning meeting followed by 07:30 safety meeting.

Spend the morning preparing the time-lapse camera while ROV team do some maintenance.

ROV off deck 11:09. After routine GVI and Bulls eye checks we complete ROV transect surveys at 180°, 225°, 270°, 316°, 0° and 45° before recovering to deck at 17:40.

29th July 2019

Spend the morning setting up the time lapse camera for a sedimentation experiment with anemones on the seabed. camera set to take images at 1 minute intervals from 14:00 UTC (15:00 BST – ROV and Rig are operating on BST).

Off deck at 14:35 with t/l camera and core sampler and a plan to find anemones or other sessile invertebrates.

15:21 – identify suitable area, 120 m at 289° to the BOP. Empty 4 cores of sediment on anemones. Seems to be a problem with the camera – no flashes observed.

Recover ROV and camera. On deck 1650. Batteries appear to be in poor condition so we change. More fiddly than expected but Ian provides expert assistance.

30th July 2019

ROV at seabed at 14:50 after working on t/l camera in the morning. Camera placed at 114 m 319° to the BOP. After GVI operations we return to camera and see the flashes working. We place 2 sediment loads on anemones in view and temporarily switch on lasers to estimate size.

Carry out a video study of anemone response to sedimentation with the ROV HD camera from 17:00 to 1728.

Recover ROV at 17:30 with a slow ascent to be used as a water column transect (8m/min with heave compensation).

31st July 2019

07:15 morning meeting request for a SERPENT presentation tomorrow.

Plan to continue video sequences of anemone response to sedimentation.

08:48, after completing Operational inspections we recover time lapse camera. Oceaneering Dive 86.

09:21 on deck with camera.

Return to seabed and start another video anemone experiement, this time using drill cuttings. Observe for 1 hour but no sign of emergence. Re-check on several occasions and still buried at 16:17.

Carry out 3 more anemone experiments with mixed results including rolling away and very slow emergence. Complete these operations by 16:00.

TL camera has been set up in parallel for a baited deployment. The bait is in position at 163 m to the south of the BOP by 16:56 and the ROV is recovered to deck.

1st August 2019

06:50 join the pre tour meeting to do SERPENT presentation.

Begin re-packing SERPENT gear and download videos/stills.

10:10 ROV off deck for recovery of t/l camera experiment and back on deck by 11:00.

In the afternoon complete 3 more sedimentation experiments. ROV on deck 16:30.

As discussed with Petrofac prepare to leave t/l camera on seabed for long-duration deployment after SERPENT visit ends. Prepare for images to commence at 08:00 tomorrow at 1 hour intervals, set to infinite images so will continue until batteries fail or memory full.

2nd August 2019

Plan to deploy t/l camera before leaving the TO Leader. We see the first photos at 08:00, confirming the camera is operating correctly. ROV at depth at 09:05 and camera is placed with a large rock in the field of view approximately 50 m N of the BOP (47 m 020° from the BOP, 10 m from the Metrol basket). Current meter is not deployed. Partly because of a problem with the ROV thruster that need repair but partly because of concern of loss on longer deployment.

Due to leave the TO Leader today, do heli-briefing, get into survival suit, hear helicopter circling the rig but fog has come in and it returns to Aberdeen without landing. Spend the afternoon waiting, can't continue work as baggage checked in and not allowed to access. Eventually we are informed the flight is cancelled. Another night on board.

3rd August 2019

Better luck with the fog today and the helicopter flight takes place as planned.

Visit 2

Location 1: Lincoln 205/26b-14
Location 2: Warwick Crestal 204/30b-A
J Durden
15-23 September 2019

15 September 2019

Travel from Southampton to Aberdeen by Flybe via Manchester. Checked luggage (containing PPE) did not arrive in ABZ.

16 September 2019

Recovered checked baggage. Helicopter transfer to rig. Completed rig induction / orientation and health, safety and environment introduction. Met Brian (logistics) about where our current meter was (on a ship in Aberdeen).

17 September 2019

07:15 morning meeting. Met ROV team. Time-lapse camera recovered by the ROV team. On deck at 21:36. Frame grabs of time-lapse camera taken from oblique HD video prior to recovery.

Data obtained: ROV frame grabs, 1111 time-lapse images

Oceaneering dive number: 117

18 September 2019

Began servicing time-lapse camera. Removed strobe and charged. Removed camera with housing and charged.

TL-18092019-001#1-4: Conducted 'as left' seabed survey after BOP was removed, and sonar 'as left' survey was complete. Noted that lasers were not parallel on first attempt (because they were nudged during other operations), so recovered the vehicle, straightened lasers and redeployed ROV. Transects were conducted at each of the cardinal compass headings (0, 90, 180, 270), at ~1 m altitude for ~150 m from the wellhead. Still photos were captured at approximately every 10 m (0-150 m) using an oblique Canon Powershot camera.

Data obtained: 4 video files, 4 x 16 still photos, dive log

Oceaneering dive number: 120

19 September 2019

Ran through Digisnap and camera settings for time-lapse camera on the work bench. Refitted the charged strobe to the frame. Expect to move to next location tonight.

TL-19092019-002: Water column survey at 8 m/min at end of dive where umbilical was untwisted.

Data obtained: 1 video file

Oceaneering dive number: 121

Location 2: Warwick Crestal 204/30b-A

Position: 60 deg 07' 25.476" N, 004 deg 09' 28.836" W

Water depth: 156 m

Well condition: Pre-spud

Rig heading: 270

20 September 2019

07:15 morning meeting. Rig was moved to Warwick Crestal location overnight. Spent the morning gathering / copying previous seabed transects and water column videos completed by Oceaneering. Oceaneering team change at lunchtime. Afternoon troubleshooting of still camera flash.

Other data obtained:

-previous ROV frame grabs of seabed and 2 videos of crabs eating

-4 previous water column survey videos from Lincoln well; 14 (Oceaneering dive 98), 21 (dive 104), 28 August (dive 109)

-15 previous seabed transects from Warwick Deep 205_26b-14 Oceaneering dives 60-61, 4-5 July 2019 – paper logs provided

21 September 2019

0715 meeting. Lots of delays today with power being transferred, could not dive while this was happening. Got flash working on the stills camera, then spent time at the seabed adjusting the flash intensity and still camera settings.

TL-21092019-003: Water column survey from seabed to surface (during 'as found' survey). Seabed water temperature 10.6C

Data obtained: 1 HD video

Oceaneering dive number: 122

TL-21092019-004#1-4: Seabed pre-spud video surveys

West, north, south and east. Engaged downward-facing lights to enhance lighting in video. Adjusted the flash intensity a few times to get reasonable exposure in still cameras. We captured additional video frame grabs of large sponges, urchins, etc.

Data obtained: 4 HD videos, frame grabs, still images

22 September 2019

0715 meeting – still loading/unloading equipment for well spud, which is now scheduled for Monday. Gave a brief talk at the 0730 Sunday safety meeting to show some images of fauna at the Lincoln and Warwick Crestal locations, and one day of time lapse imagery from Lincoln. The time-lapse camera was deployed in the morning. The SERPENT container was put on deck in the afternoon, so the current meter/traffic cone was prepared and set at a 15 minute interval, beginning on Monday at 0900. The case for the current meter was returned to the SERPENT container.

TL-22092019-005: Deployment of time-lapse camera

The time-lapse camera was deployed facing a rock with a large sponge attached to it, ~35 m southeast of the well location. The location was selected to be away from ROV garage and dredging operations to avoid conflict/contact with the camera frame (i.e. not to the east of the well location). Video was taken throughout the seabed location search and placement. The time-lapse camera was deployed with a 1-h interval, and was observed flashing in the water before being placed on the seabed. Water temperature was 10.5C at deployment.

Data obtained: 1 HD video, frame grabs of time lapse camera with target

23 September 2019

The current meter was deployed while I waited for the helicopter (which was cancelled due to bad weather at the rig). The ROV team confirmed that they deployed the current meter ~5 m behind the time-lapse camera.

24 September 2019

Helicopter off the rig to Aberdeen, then flight to Southampton (changing at Newcastle).

Visit 3

Location: Warwick Crestal 204/30b-A
A Gates
29 November - 2 December 2019

29th November 2019

It has proved very challenging to get back out the TOL with terrible weather conditions likely to prevent any ROV dives. Finally there is a weather window for a couple of days so visit is confirmed. We have been on standby to do this visit all of November. Travel Southampton to Aberdeen via Newcastle. Overnight at hotel at ABZ.

30th November 2019

Bristows check-in at 10:45. Arrive on TOL at around 12:00. Out to ROV at 13:45 with plan to recover t/l. Note lots of salp chains in the water column. Operations to recover Metrol equipment (acoustic modems to communicate well test data). T/L recovered at 14:52 (31 m 57.65° to BOP). There were squid eggs on

the camera rope. Collect a series of photos of the seabed the camera had observed and recover to deck at 15:20 with both camera and current meter.
Complete a slow ascent (water column transect). On deck at 16:00.

1st December 2019

07:15 – morning meeting. Need to get SEREPNT gear backloaded in next few days. Gear has become separated with some boxes making round trips to Aberdeen on the supply vessel and the time-lapse gear remaining on board.
Prepare for video transect survey. Check parallel lasers (34 cm). at depth at 08:20 and note high abundance of euphausids (krill) and salp chains. Complete transect survey in 8 main headings by 12:00 then recover and pack SERPENT gear.

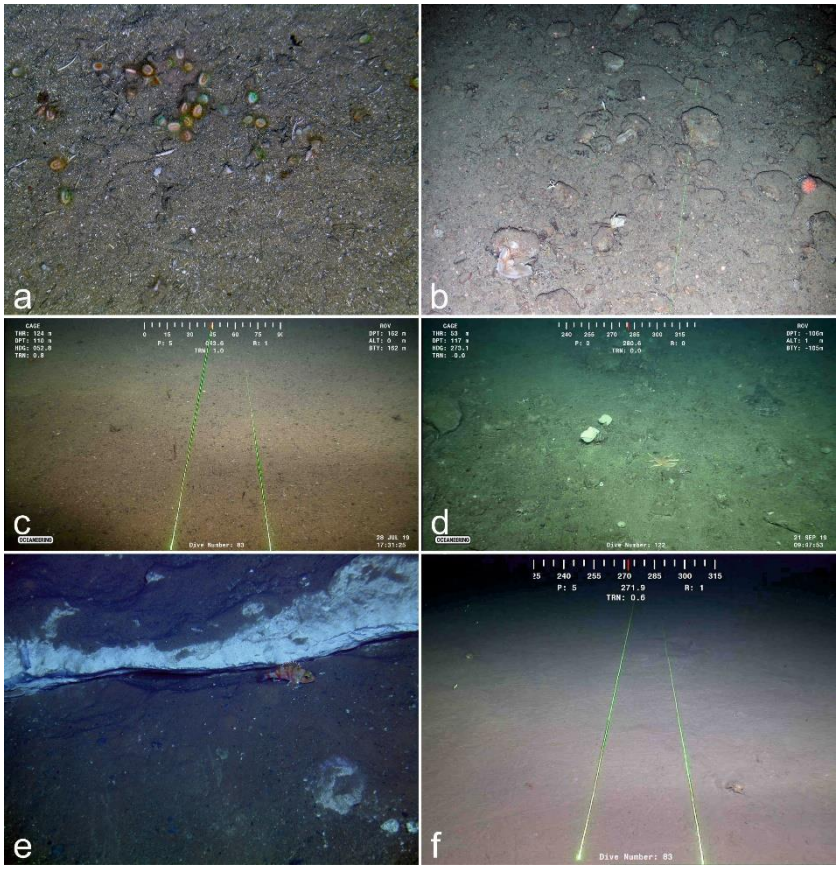
2nd December 2019

Confirm departure today at 07:15 meeting. Need to leave before poor weather returns. Spend the morning with ROV team and complete one more water column survey on ascent after operational dive.
Depart TOL and return travel to Southampton after a productive science campaign in 2019.

Initial seabed observations

The seabed at both Lincoln 205/26b-14 and Warwick Crestal 204/30b-A sites was characterised by heterogeneity. Either coarse sandy sediment, gravel or boulders dominated different areas. These habitats appeared to support different faunal assemblages. More detailed analysis of the fauna will provide evidence but initial observations suggest that the abundance of cup corals (likely *Caryophyllia smithii*) was notably higher at the Lincoln site. Sponges appeared more abundant on hard substratum at Warwick (we could not find any sponges for time-lase deployment at Lincoln).

Both sites were impacted by sedimentation disturbance following open hole drilling. Close to the wells there were areas of cement which appeared cracked in places. With increasing distance from the well there was a gradient of sediment cover. In most transects, seafloor disturbance was no longer visible by the end (150 m from the well).



Examples of seafloor images. a) cup corals within coarse sandy sediment at Lincoln, b) sponges on hard substratum at Warwick, c) sandy sediment at Lincoln, d) heterogeneous seabed at Warwick, e) cement close to the well at Lincoln, f) fine layer of drilling mud smothering the seabed at Lincoln.

ROV video transects carried out

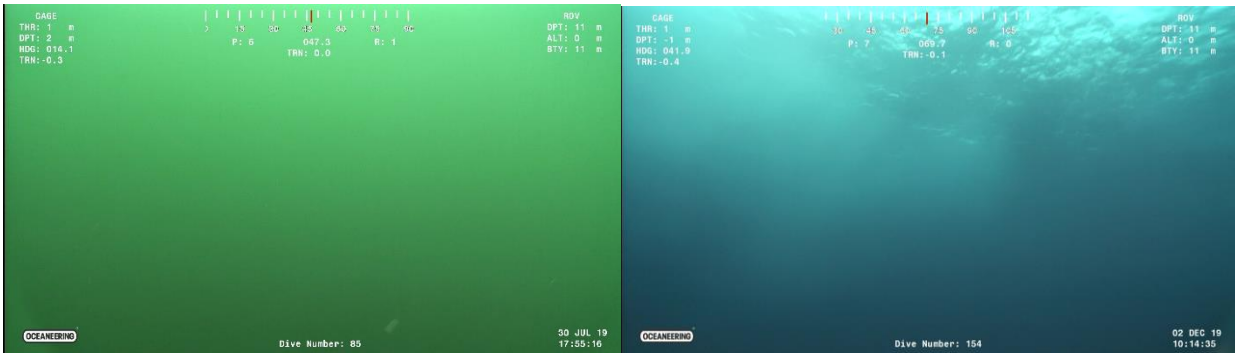
ROV video transects carried out at Warwick Crestal and Lincoln-B in 2019

Date	Site	Phase in drilling	Transect name	Heading	Distance (m)	Laser scale (cm)	Start time	end time
27/07/2019	Lincoln-B	Post_drill	Lincoln-B_Post_drill _T1	90	150	31	16:48:45	17:10:11
27/07/2019	Lincoln-B	Post_drill	Lincoln-B_Post_drill _T2	135	150	31	17:18:00	17:41:39
28/07/2019	Lincoln-B	Post_drill	Lincoln-B_Post_drill _T3a	180	150	31	11:58:11	12:19:35
28/07/2019	Lincoln-B	Post_drill	Lincoln-B_Post_drill _T4	225	150	31	12:28:00	12:51:48
28/07/2019	Lincoln-B	Post_drill	Lincoln-B_Post_drill _T5	270	152	31	14:54:09	15:13:00
28/07/2019	Lincoln-B	Post_drill	Lincoln-B_Post_drill _T6	315	150	31	15:54:19	16:18:36
28/07/2019	Lincoln-B	Post_drill	Lincoln-B_Post_drill _T7	0	150	31	16:31:30	16:48:29
28/07/2019	Lincoln-B	Post_drill	Lincoln-B_Post_drill _T8	45	150	31	17:13:00	17:32:15
18/09/2019	Lincoln-B	As_left	Lincoln-B_As_left_T1	0	150	34	17:22:00	17:38:00
18/09/2019	Lincoln-B	As_left	Lincoln-B_As_left_T2	90	150	34	17:49:00	18:13:00
18/09/2019	Lincoln-B	As_left	Lincoln-B_As_left_T3	180	150	34	18:20:00	18:41:00
18/09/2019	Lincoln-B	As_left	Lincoln-B_As_left_T4	270	150	34	18:48:00	19:05:00
21/09/2019	Warwick Crestal	Pre_drill	Warwick Crestal_Pre_drill_T1	270	150	34	16:03:00	16:28:00
21/09/2019	Warwick Crestal	Pre_drill	Warwick Crestal_Pre_drill_T2	0	150	34	16:48:00	17:06:00
21/09/2019	Warwick Crestal	Pre_drill	Warwick Crestal_Pre_drill_T3	180	150	34	17:15:00	17:33:00
21/09/2019	Warwick Crestal	Pre_drill	Warwick Crestal_Pre_drill_T4	90	150	34	17:55:00	18:17:00
01/12/2019	Warwick Crestal	Post_drill	Warwick Crestal_Post_drill _T1	90	150	34	08:45:23	08:53:20
01/12/2019	Warwick Crestal	Post_drill	Warwick Crestal_Post_drill _T2	45	150	34	08:58:22	09:14:53
01/12/2019	Warwick Crestal	Post_drill	Warwick Crestal_Post_drill _T3	0	132	34	09:20:46	09:34:22
01/12/2019	Warwick Crestal	Post_drill	Warwick Crestal_Post_drill _T4	315	150	34	09:43:03	09:55:26
01/12/2019	Warwick Crestal	Post_drill	Warwick Crestal_Post_drill _T5	270	150	34	10:09:55	10:23:33
01/12/2019	Warwick Crestal	Post_drill	Warwick Crestal_Post_drill _T6	200	150	34	10:50:36	11:09:09
01/12/2019	Warwick Crestal	Post_drill	Warwick Crestal_Post_drill _T7	180	120	34	11:18:07	11:32:50
01/12/2019	Warwick Crestal	Post_drill	Warwick Crestal_Post_drill _T8	135	150	34	11:39:14	11:53:42

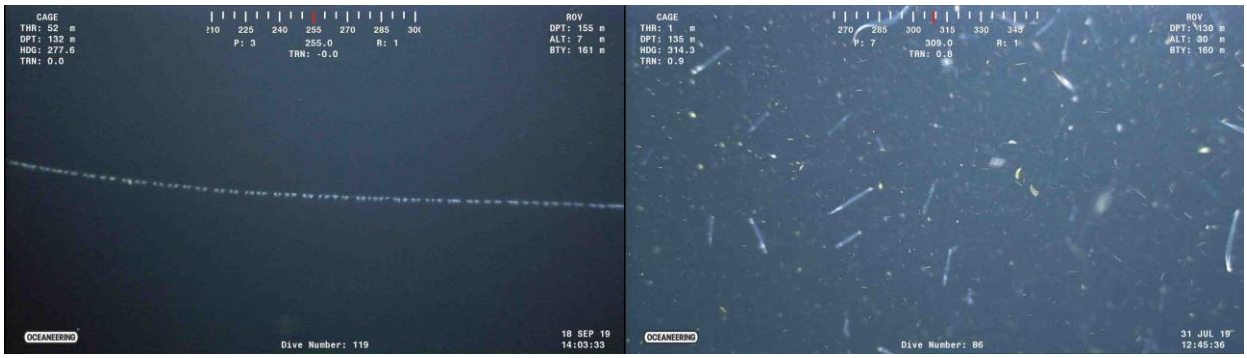
ROV water column video transects:

In 2016 at Lancaster we encountered significant increases in the abundance of fish between surveys and occasional large blooms of gelatinous zooplankton (including jellyfish). The programme over several months offered the opportunity to collect some higher frequency observations to detect when these events might occur. The following table shows water column profile video transcts carried out during the drilling programme. In each case the ROV was recovered slower than normal and the cameras and lights left on. The images below show some of the changes noted. Images of zooplankton are difficult to capture because of the motion blur but a wide variety were noted in the transects. These included a range of jellies, arrow worms and salp chains. Analysis will be carried out on video data rather than stills.

#	File name	File type	Water depth	Dive	Date	start time	end time	Duration (mm:ss)
1	Water column survey Dive 85_30_Jul_19	MTS	161	85	30-Jul-19	17:36:38	17:56:30	19:52
2	Water column survey Dive 93_14_Aug_19	MTS	161	93	14-Aug-19	11:58:22	12:08:19	09:57
3	Water column survey Dive 104_21_Aug_19	MTS	161	104	21-Aug-19	15:20:18	15:40:18	20:00
4	Water column survey Dive 109_28_Aug_19	MTS	161	109	28-Aug-19	11:31:14	11:48:30	17:16
5	Water column survey Dive 121_19_Sep_19	MTS	162	121	19-Sep-19	10:48:24	11:06:04	17:40
6	Water column survey Dive 140_14_Oct_19	MTS	157	140	14-Oct-19	15:26:31	15:49:25	22:54
7	Water column survey Dive 143_18_Oct_19	MTS	158	143	18-Oct-19	11:04:10	11:12:06	07:56
8	Water column survey Dive 147_30_Oct_19	MTS	157	141	30-Oct-19	16:27:45	16:46:24	18:39
9	Water column survey Dive 151_06_Nov_19	MTS	158	151	06-Nov-19	11:23:10	11:42:39	19:29
10	Water column survey Dive 152_30_Nov_19	MTS	157	152	30-Nov-19	15:42:24	15:56:31	14:07
11	Water column survey Dive 154_02_Dec_19	MTS	157	154	02-Dec-19	09:58:12	10:15:37	17:25



Note the different in water column appearance at 11 m depth in July during a phytoplankton bloom and during winter conditions in December 2019.



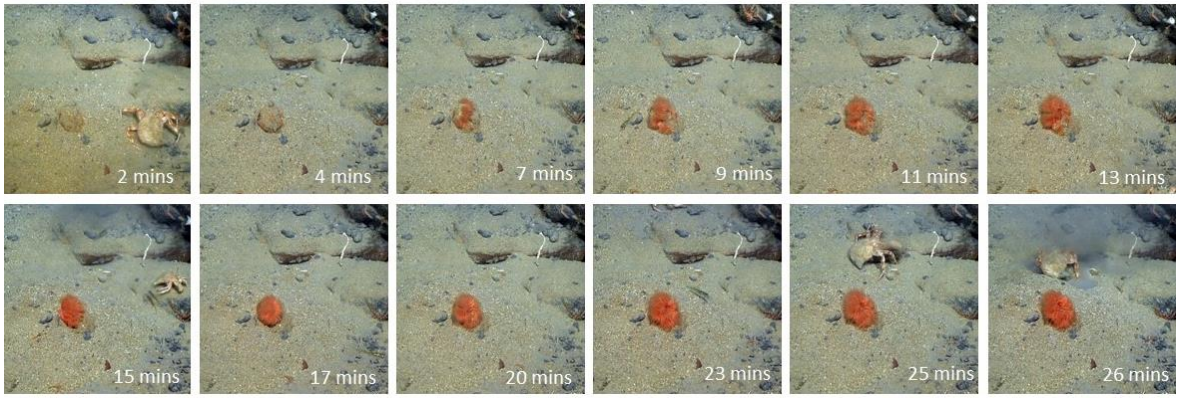
Examples of zooplankton in the water column

Lincoln: Anemone sedimentation experiments

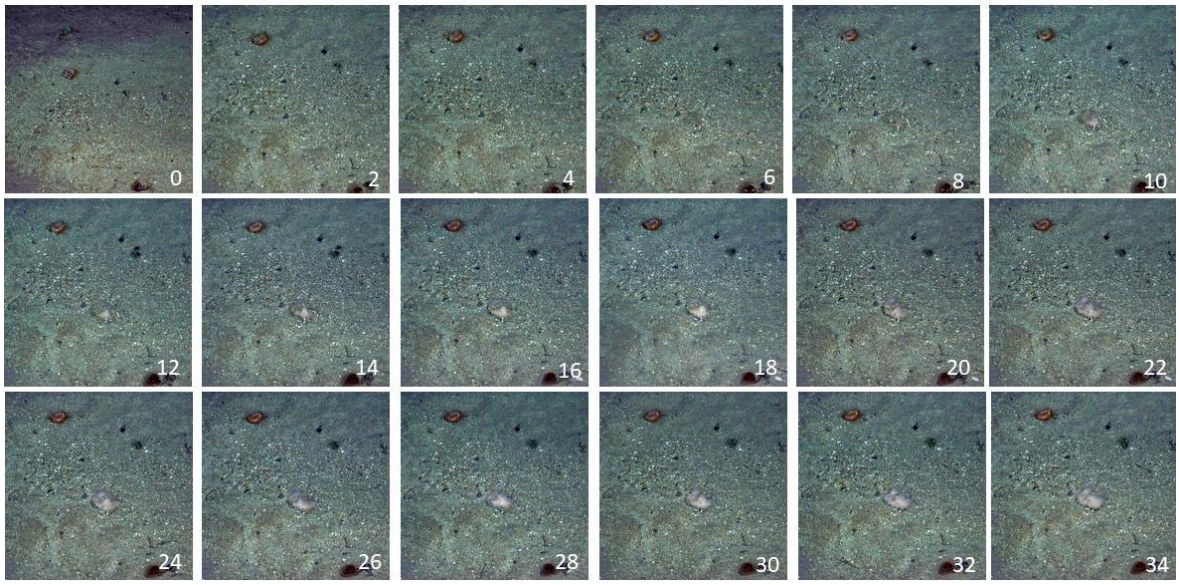
10 *in situ* observation experiments were carried out to explore the ability of abundant components of the megafauna could respond to sedimentation events. In this case sufficient sediment was placed on the anemone to cover the animal and the time required for the animal to clear the sediment was recorded.

No.	Date	Location	Treatment	Camera	Outcome	Notes	Start
1	29/07/2019	Background	Background	T/L	Cleared	Camera failed	14:06 (UTC)
2	30/07/2019	Background	Background	T/L	Cleared		14:19 (UTC)
3	30/07/2019	Background	Background	Video/Stills	Cleared		16:54*
4	31/07/2019	Cuttings	Cuttings	Video/Stills	Failed to clear		11:05
5	31/07/2019	Cuttings	Background	Video/Stills	rolled away	Response to cuttings?	13:21
6	31/07/2019	Cuttings	Background	Video/Stills	rolled away		13:24
7	31/07/2019	Background	Background	Video/Stills	Cleared		13:29
8	01/08/2019	Background	Background	Video/Stills	Cleared		13:51
9	01/08/2019	Cuttings	Background	Video/Stills	rolled away	Response to cuttings?	14:57
10	01/08/2019	Cuttings (fine)	Background	Video/Stills	Partial clear		15:09

*Data collected using ROV HD video time is recorded in BST. Time-lapse deployments in UTC.



Anemone clearing sediment in Experiment



Anemone clearing sediment in Experiment

Anemone clearing sediment in Experiment

Time lapse camera deployments

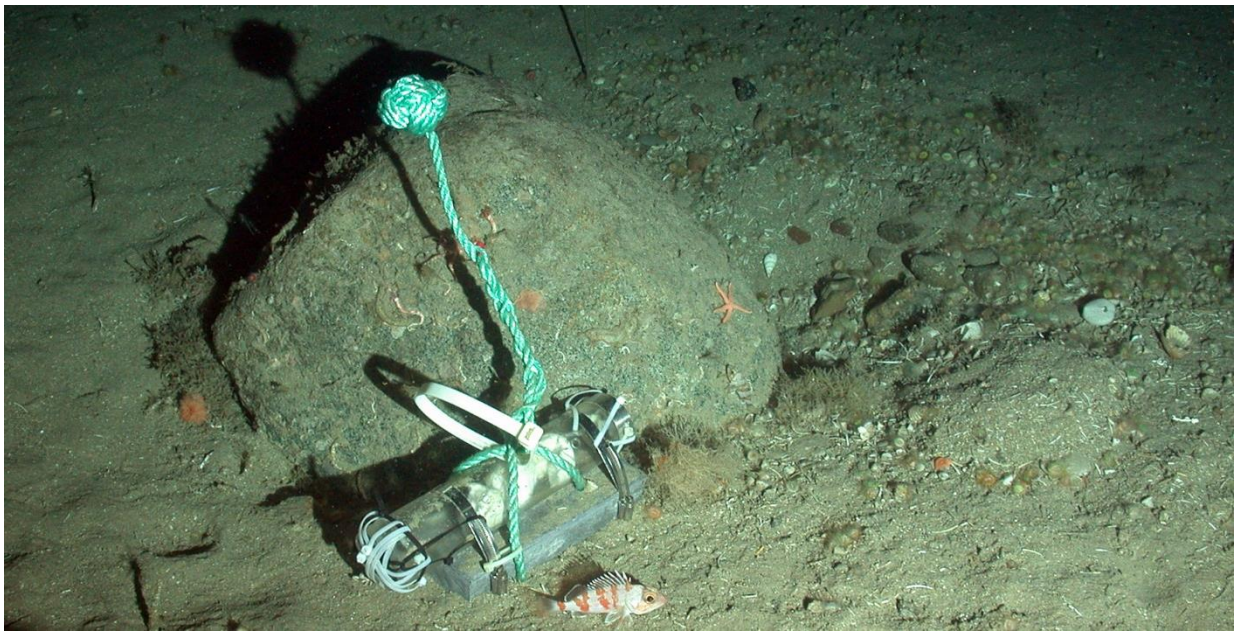
Five time-lapse camera deployments were completed during SERPENT operations at Lincoln and Warwick. They served several purposes. 1) A method for observing sedimentation experiments (above), 2) in baited mode to observe scavenging fauna, and 3) in long-term mode to observe changes in relation to disturbance events and environmental variability. The details of deployments are presented below with more information in subsequent sections.

No.	Experiment type	Interval (mm:ss)	Start date	Start time (UTC)	End Date	End time (UTC)	No. images
1	Sedimentation	01:00	29/07/19	14:06	29/07/19	14:11	6
2	Sedimentation	00:30	30/07/19	14:19	31/07/19	05:50	1820
3	Baited	00:45	31/07/19	16:52	01/08/19	*	1616
4	Long term	60:00	02/08/19	08:59	17/09/19	21:33	1095
5	Spud in	60:00	22/09/19	13:04	09/11/19	00:45	1156

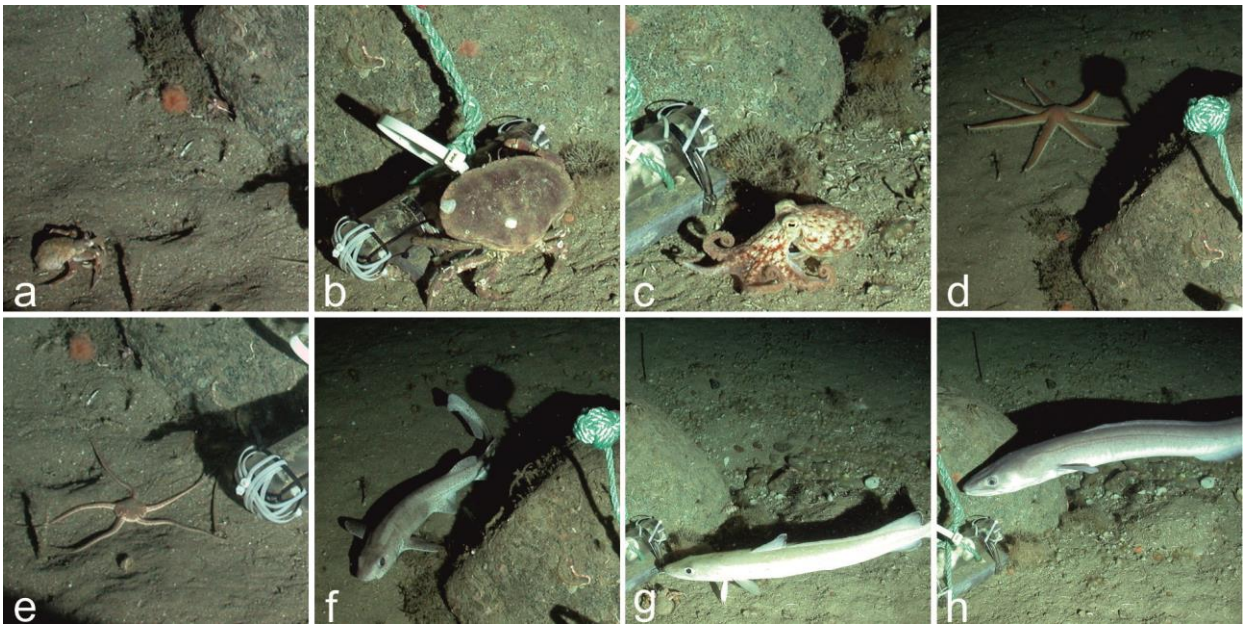
*time reset to 00:00 at start of deployment

Baited Time-Lapse Camera Experiment

A single baited time-lapse camera deployment was completed at Lincoln to compare with similar deployments at other Hurricane sites in recent years. This method allows assessment of components of the fauna that would be missed by other visual survey approaches such are seabed transects and adds value to understanding the faunal assemblages present. Bait used was hake fillets provided by the galley. A single serpent core tube was filled with bait to avoid complete consumption by animals. The time on the camera appears to have re-set to 00:00 on deployment but time of first photograph was observed (16:52) and there were 45 s interval between images. Current data are available in parallel with this deployment.



Field of view of the baited camera experiment at Lincoln-B



Some highlight images from the baited time lapse camera deployment at Lincoln-B: a) hermit crab and commensual anemone (Pagurus priedeaux), b) Brown/Edible Crab (Cancer pagurus), c) Octopus, d) Large 7-armed sea star (Luidia sp.), e) ophiuroid (brittle star), f) catshark, g) Ling, h) Conger eel

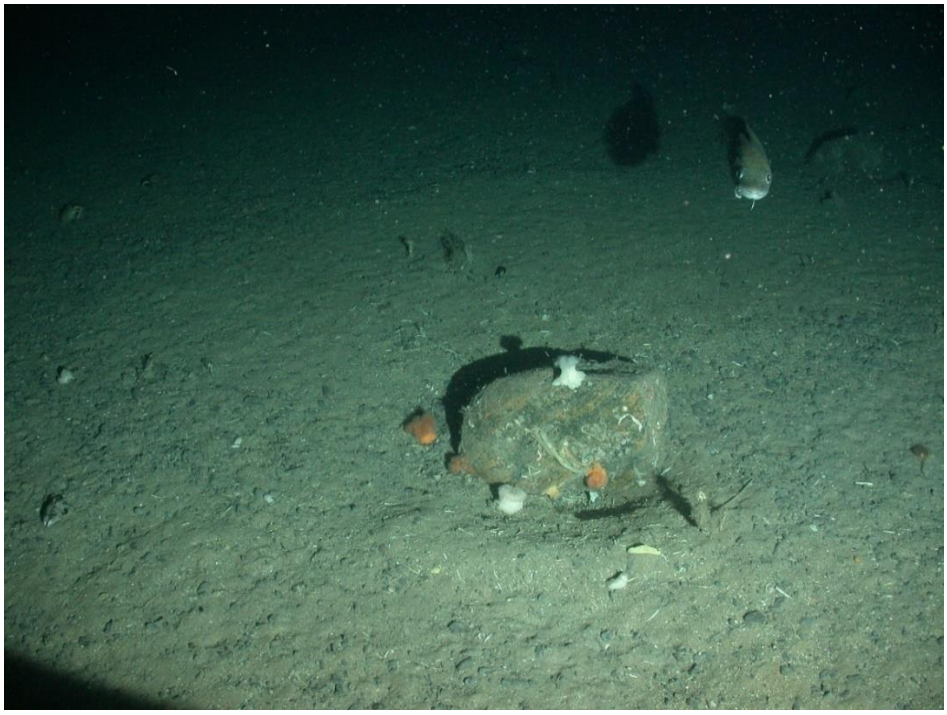
Long time-lapse camera deployments

From SERPENT studies at Hurricane sites to date there are good data sets that demonstrate changes in faunal assemblages at points in time following drilling over time scales of weeks to months to years (e.g. pre, post drilling and recovery studies). There is a significant gap in the scientific literature over finer time scales (e.g. hours to days) following types of disturbace event.

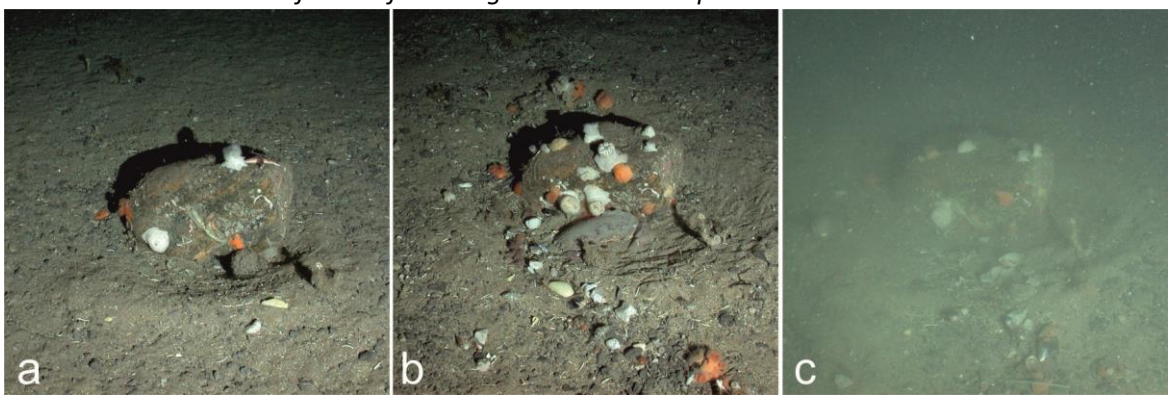
During the 2019 SERPENT field campaign we used the time-lapse camera to address this knowledge gap. After completion of work programmes during the July/August and September visits to the TOL the camera was deployed and set to collect images every hour until either the battery failed or the memory was full in order to capture processes at finer temporal scales.

Lincoln

At Lincoln the long term observations took place after the well had been spudded and continued during the routine operations after the open hole phase had been completed so no major sedimentation events occurred.



Field of view of the long-term camera experiment at Lincoln-B

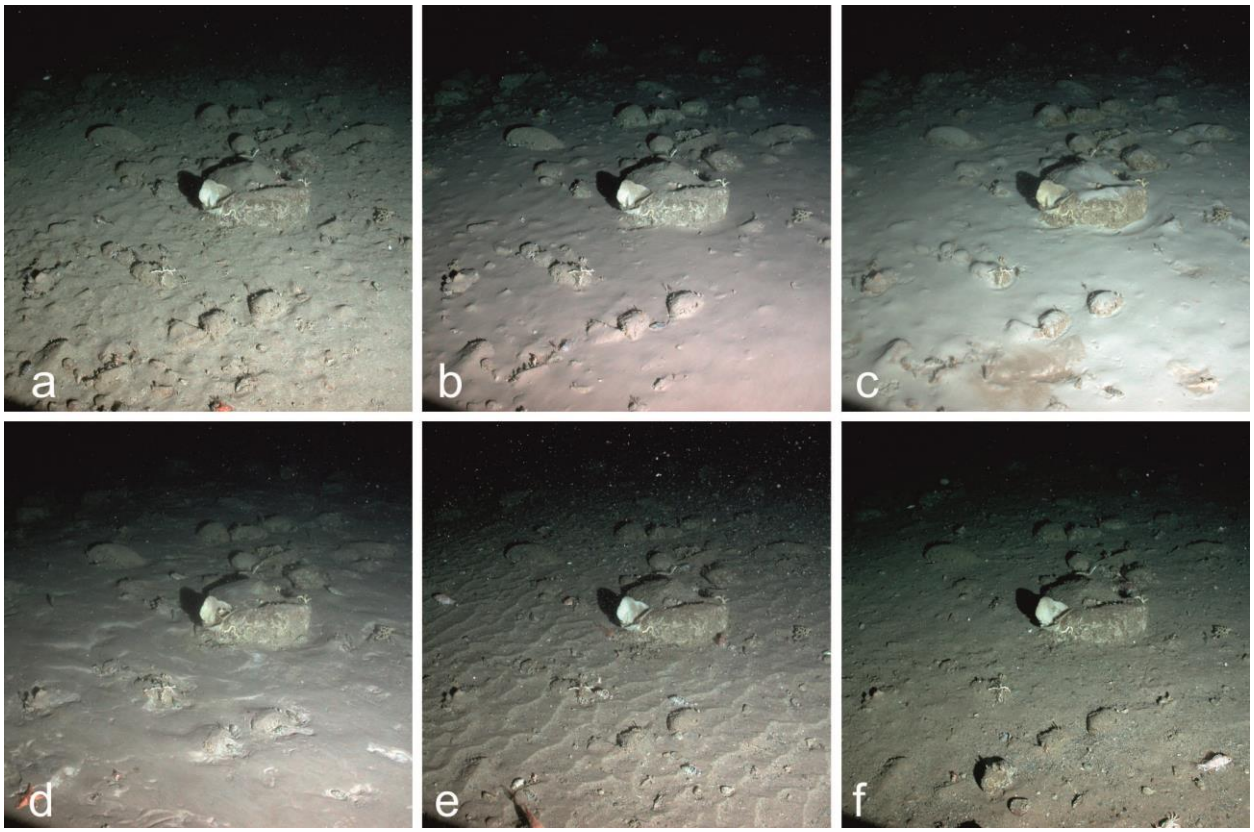


Examples of change in the Lincoln camera deployment. Note the increase in anemone abundance between a) and b). Apparent sedimentation events were also detected c)

Warwick Crestal

At Warwick Crestal the SERPENT visit was combined with the movement of the TOL between sites so it was possible to capture the spud in sedimentation event. This is highly novel and appears to have captured interesting data.

The field of view for the long deployment at Warwick Crestal



Images showing the changes in the appearance of the seabed habitat during the time-lapse camera deployment at Warwick Crestal

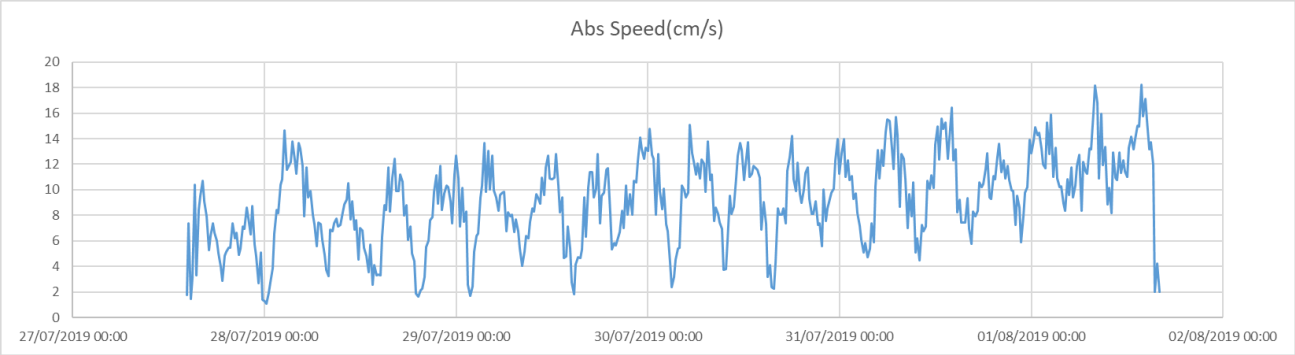
Sensor Data

Supporting environmental data were collected using a sensor package on a Seaguard RCM DW, rated to 3000 m. It was equipped to measure temperature, salinity, current velocity, current direction and backscatter. It was deployed during the visit to Lincoln in 27th July 2019 and recovered at the end of the visit, 1st August 2019. At Warwick Crestal it was deployed 23rd September alongside the time-lapse camera for the long deployment and recovered during the visit in 30th November. The sensors were set to take data every 15 minutes. Example data sets are shown below.

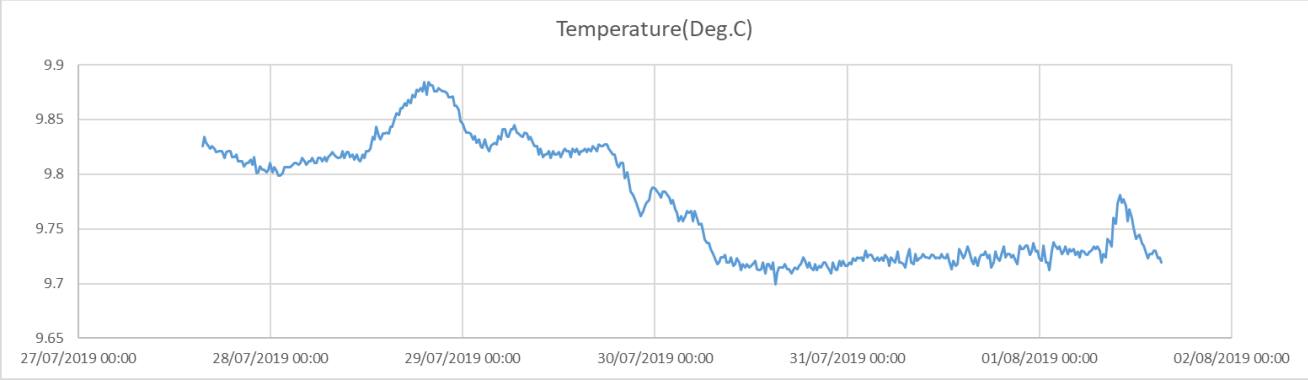
Deployment details:

Site	Start date	Start time	End date	End time	Interval (hh:mm:ss)
Lincoln	27/07/2019	15:30	01/08/2019	15:15	00:15:00
Warwick Crestal	23/09/2019	10:00	30/11/2019	17:00	00:15:00

Lincoln

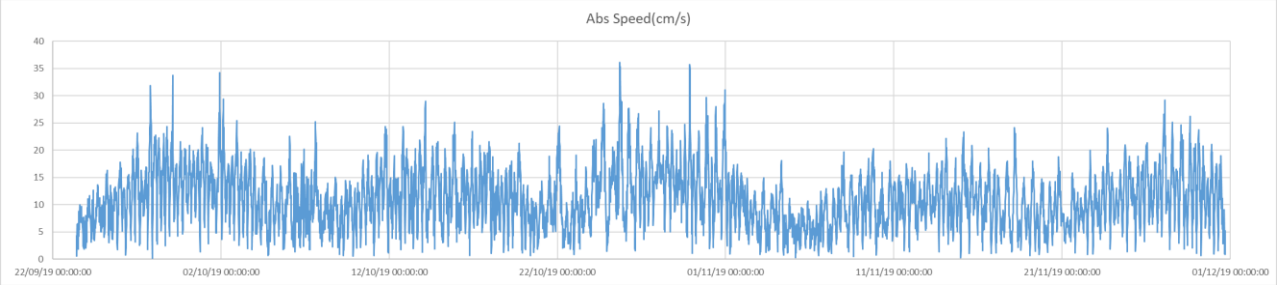


Current velocity data 17th July – 2nd August 2019

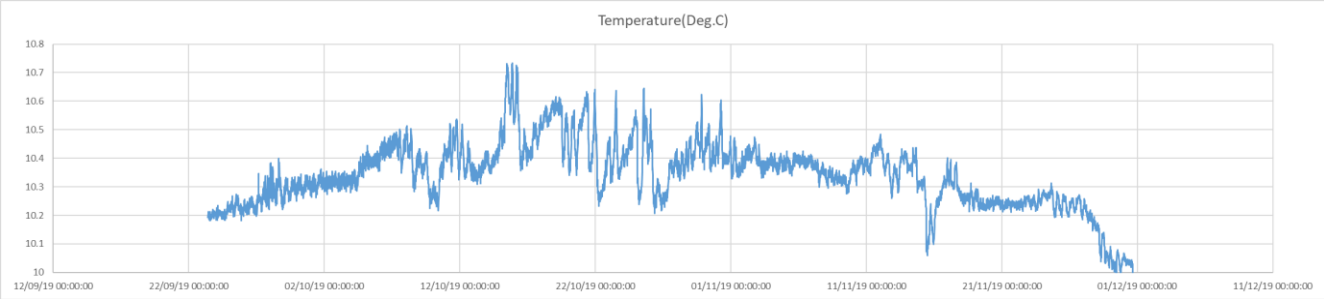


Temperature data 17th July – 2nd August 2019

Warwick Crestal



Current velocity data 22nd September – 1st December 2019



Temperature data 22nd September – 1st December 2019

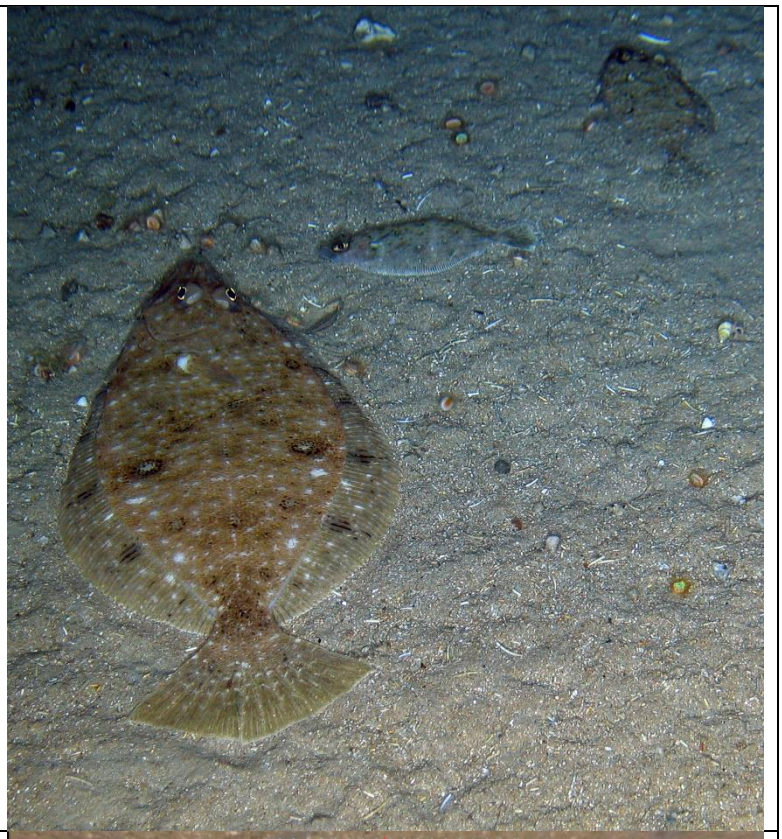
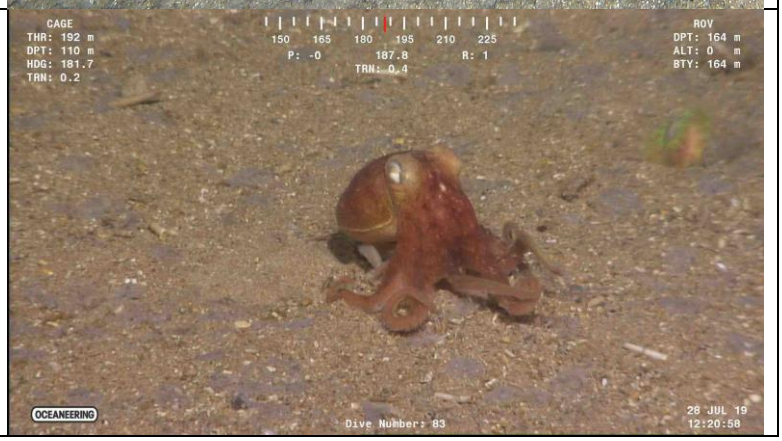
Observations and events

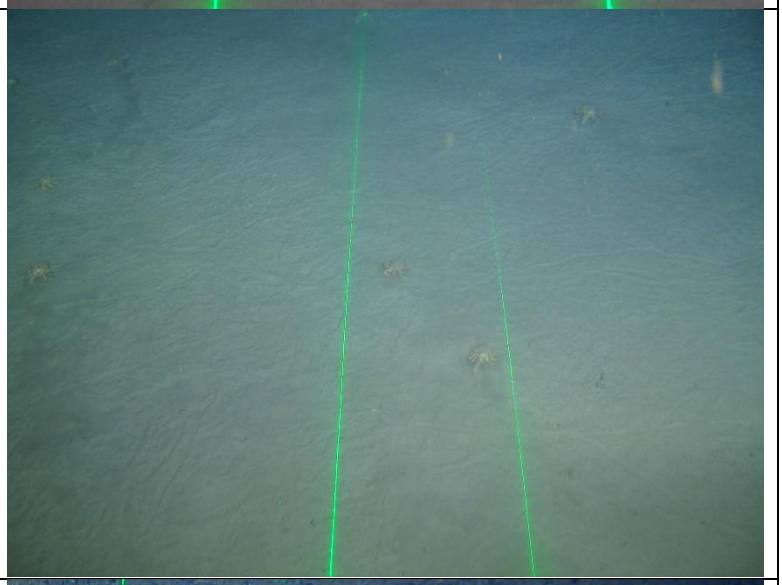
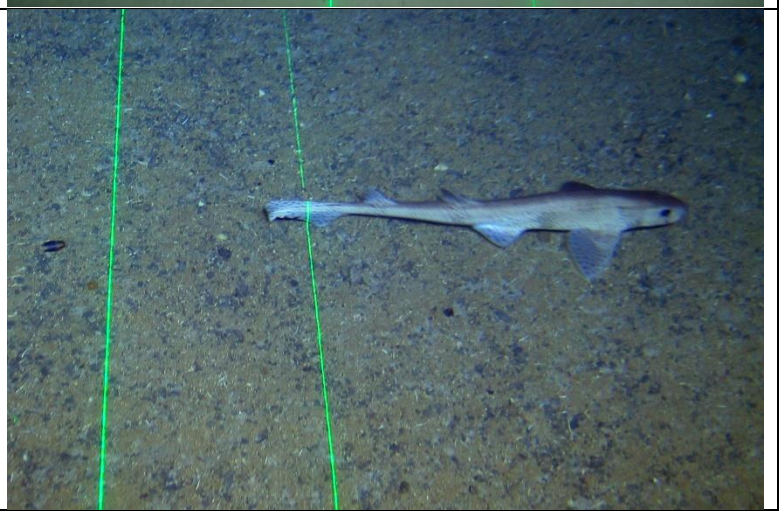
Date/time	Observation	Image
27/07/2019 08:15	*Helicolenus dactylopterus* close to cement near the well head	
27/07/2019 08:17	*Metridium* anemones on mussel shell close to the well head	

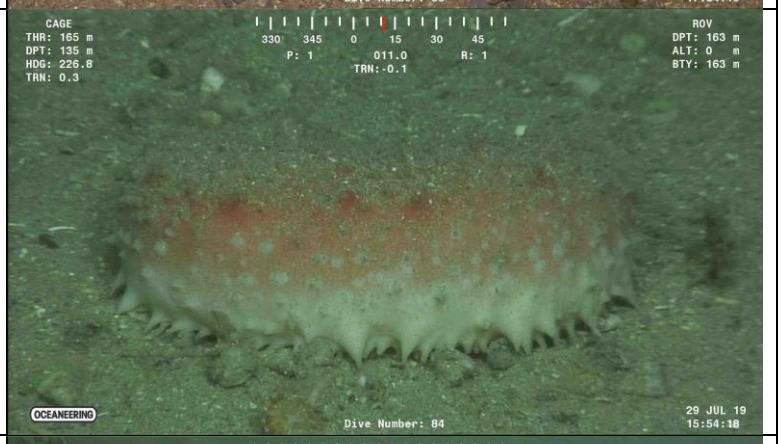
27/07/2019 09:05	*Pagurus priedeaux*	
27/07/2019 09:20	Unidentified hydroid with apparent drill cuttings	
27/07/19 09:48	Megrim (*Lepidorhombus whiffiagonis*)	

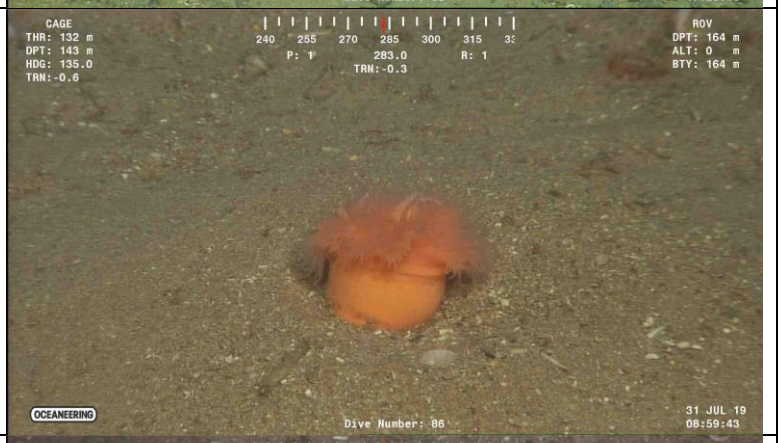
27/07/2019 09:50	Cup coral, resembles Devonshire cup coral (reported in Hurricane Consultancy reports) for which there is a deep water form - *Caryophyllia smithii* var. *clavus*) that is found in water >50-1000 m deep	
27/07/19 09:55	*Porania pulvillus*	
27/07/19 09:59	*Stichastrella rosea*	

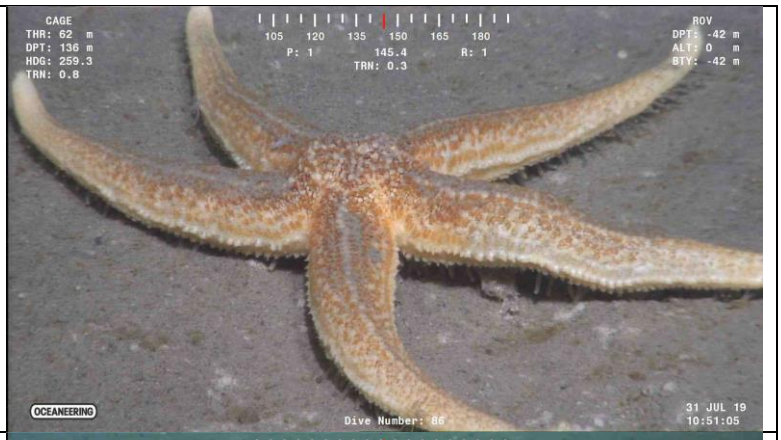
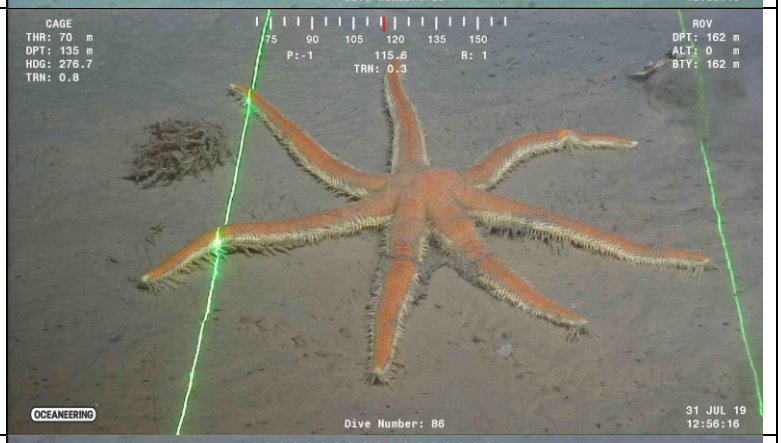
27/07/19 09:59	Greater Forkbeard *Phycis blennoides*	
27/07/19 10:04	7-arm star, *Luidia ciliaris*	
27/07/19 10:09	Asteroid feeding	

27/07/2019 10:22	3 x Flatfish (*Lepidorhombus* XX)	
27/07/2019 12:20	Octopus	

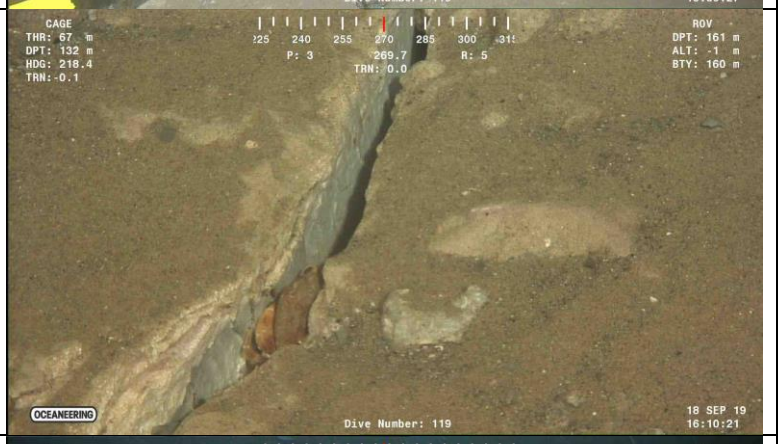
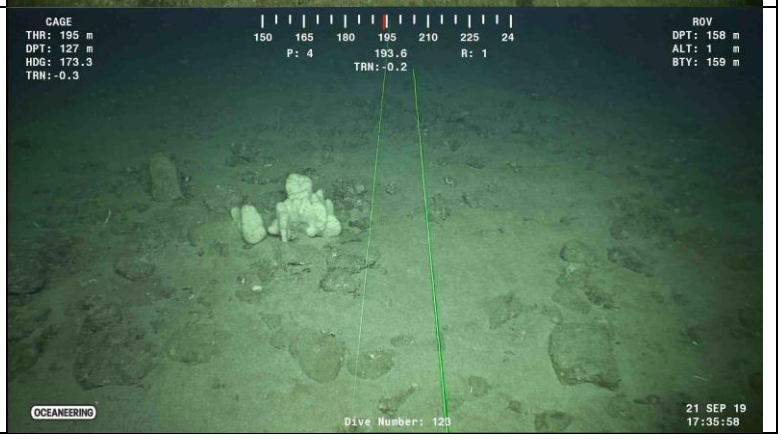
28/07/19 14:15	Cancer pagurus between laser scaling lines on ROV video transect	
28/07/19 15:13	Multiple hermit crabs observed on drill cuttings during ROV video transect	
28/07/19 15:21	Dogfish observed on ROV video transect	

28/07/19 17:34	Ophiuroid and tail of flatfish	
29/07/2019 15:54	Sea cucumber *Parastichopus tremulus*	
30/07/2019 16:22	Dogfish	
30/07/2019 16:35	*Metridium* anemone (white)	

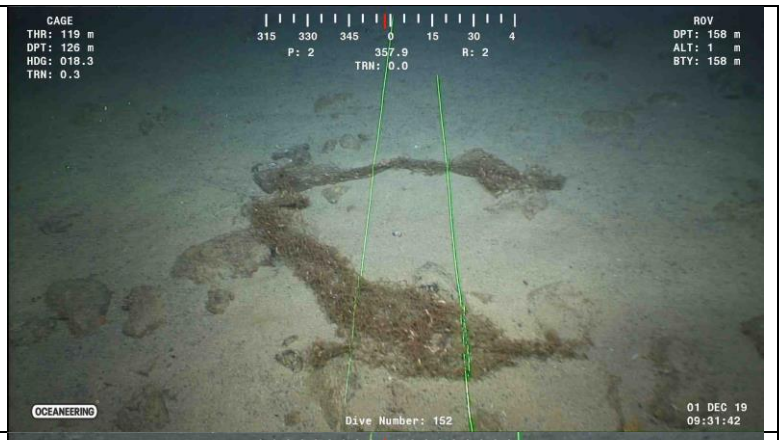
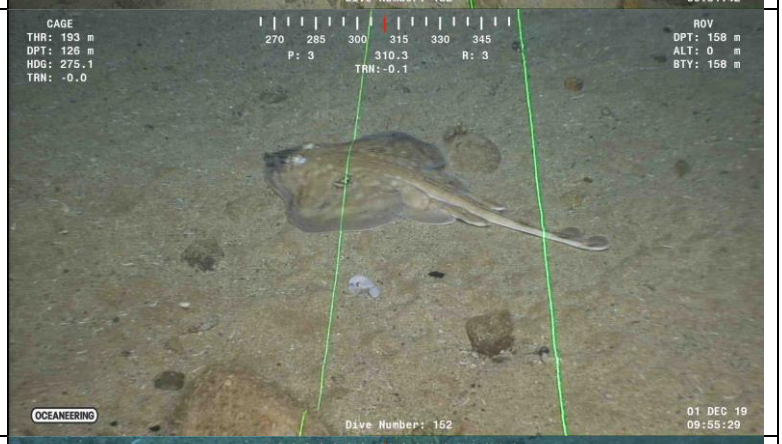
30/07/2019 16:44	Ling under a rock	
30/07/2019 17:26	*Metridium* anemone (orange)	
31/07/2019 08:59	*Metridium* anemone (orange)	
31/07/2019 09:07	Anemone test	

31/07/2019 10:51	*Asterias rubens*	
31/07/2019 12:53	Octopus	
31/07/2019 12:56	*Luidia* in laser scaling lines (34 cm)	
31/07/2019 13:04	Hermit crab with large Hormathiid on its shell	

31/07/2019 13:07	Indet cephalopod	
31/07/2019 16:50	Baited time-lapse camera in position	
02/08/2019 10:25	Time-lapse camera in position observing a rock shortly after deployment at Lincoln B	
28/09/2019 19:50	Brown crab	

18/09/2019 16:09	Cod (*Gadus morhua*) and *Metridium* anemones of different colours closet to the well head.	
18/09/2019 16:10	Brown crab (*Cancer pagurus*) in a crack in the cement around the well head.	
21/09/2019 10:35	Two echinoid morphotypes 1 *Echinus*? and 2 pencil spine urchins (*Cidaris*)	
27/09/2019 17:35	Sponge on hard substratum	

30/11/2019 14:19	Squid eggs on the BOP	
30/11/2019 14:54	*Phakellia* sponge, filled with sediment	
30/11/2019 15:13	Ling (*Molva molva*)	
01/12/2019 09:30	Funnel-shaped sponge, possible *Phakellia* sp. filled with sediment.	

01/12/2019 09:31	Anthropogenic litter. Appears to be discarded fishing net.	
01/12/2019 09:55	Cuckoo Ray (*Leucoraja naevus*)	
01/12/2019 10:02	Monkfish, very dark in colour.