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Abstract:

Throughout exploratory longline fishing within Division 58.4.1 Australian vessel *FV Antarctic Discovery* deployed benthic video camera systems 15 times and environmental data loggers 33 times. Substrate was generally soft sediments or a combination of soft sediments and cobble stones. Vulnerable Marine Ecosystem indicator species were seen in low numbers within videos. The data collected during the 2015/16 season provides the beginnings of a dataset to allow for spatially-explicit habitat-use models for toothfish.

Introduction:

The 2015/16 CCAMLR season was the first year of a three-year research plan by Australia (WG-FSA-15/47 Rev. 1) in which Australia plans to collect and utilise environmental data to inform spatial management approaches for the conservation of toothfish, bycatch species and representative areas of benthic biodiversity (Objective 2).

In order to achieve objective 2 of the Australian research plan, environmental data was collected using environmental sensors (CTD) and video cameras to record or infer:

- Conductivity and salinity
- Water temperature
- Depth of longline deployments
- Substrate composition
- Density and species composition of benthic invertebrates
- Three-dimensional structure of benthic communities
- Seafloor relief

The collection of this data can be used for a range of things. Firstly the mapping of benthic biodiversity and the determination of presence/absence of Vulnerable Marine Ecosystems (VMEs) and VME indicator species as described in Conservation Measures 22-06 and 22-07. Following this these data can be used as input data for spatially-explicit habitat-use models for toothfish (e.g. Mormede et al. 2014; Péron et al. 2016; Robinson & Reid 2014; Welsford 2011).

Developments in technology allow for ever increasing capability for scientists to research and collect data in difficult to sample locations such as deep sea habitats (Brandt *et al*. 2016). A large amount of work has been done on customising sampling gear for specific data uses, however Kilpatrick *et al*. (2011) defined the five key features of camera systems being attached to longlines for scientific purposes as:

1. Autonomous, as lines are detached from the vessel once deployed;
2. Compact, as the line is generally deployed through a small shooting window (typically 500 mm square) in the stern of the vessel and to ensure that it does not influence the behaviour of the line in strong currents or increase the risk of snags;
3. Robust, as the line is deployed at around 1–2 ms^{-1}, during which the camera has a high likelihood of Impact with the side of the vessel;
4. Provide long battery life and high image storage capacity, as a longline deployment typically Exceeds 24h; and
5. Relatively inexpensive, as longlines are routinely lost due to snags and sea ice cover.

Since 2011, camera technology has developed rapidly. A state of the art benthic impacts camera system as described by Kilpatrick *et al*. (2011) seem large and bulky in comparison to some 'off the shelf' technology available now. Other recording systems such as environmental loggers have also become much more advanced and are available at the size of approximately one AA battery. These advances allow for the possibility to satisfy the five key feature requirements more easily, and for more frequent deployment of data collection equipment during fishing operations.

In this paper, we provide an update on the status of Objective 2 as it relates to the deployments of video cameras and environmental sensors.

Methods:

Benthic Video Cameras:

<u>Design Specifications:</u>

The Benthic Video Camera systems (BVCs) developed by the Australian Antarctic Division have been designed with the five key features outlined by Kilpatrick *et al*. (2011) in mind.

- A large amount of time has gone into the design to allow for observers to set up the BVCs easily and to avoid the disturbance of operations during deployment and retrieval of long lines.
- The aim was to keep the BVCs inexpensive to allow for vessels to have multiple cameras.
- Camera frames are compact and robust, made of rod and being only 660 mm long and ≈150 mm in diameter for easy deployment.
- Once deployed the cameras trigger through the use of a salt water switch, and use 64 GB micro SD cards which can record approximately 6 hours of footage.

<u>Deployment:</u>

BVCs were deployed 15 times during exploratory fishing operations as described in Yates *et al*. 2016. Briefly, a research plan (WG-FSA-15/47 Rev. 1) was developed under Conservation Measure CM 41–01 for an Australian vessel, the *Antarctic Chieftain* (which was later replaced with the Australian vessel *Antarctic Discovery* in accordance with CM21-02), to participate in exploratory fishing and research in Divisions 58.4.2 (SSRU E) and 58.4.1 (SSRUs C, E, G). A total of 82 research lines were completed over 27 fishing days between 29th January and 4th March 2016 within SSRUs 58.4.1E and 58.4.1G. BVCs were attached to a floating line between the anchor and main line (Figures 1 – 3). Depths of deployments ranged from ca. 660 – 2150

m. BVCs were programmed to record for 20 minute periods every 1 hour (20 minutes recording 40 minutes stand-by) once in contact with the water (activated by a salt water switch).

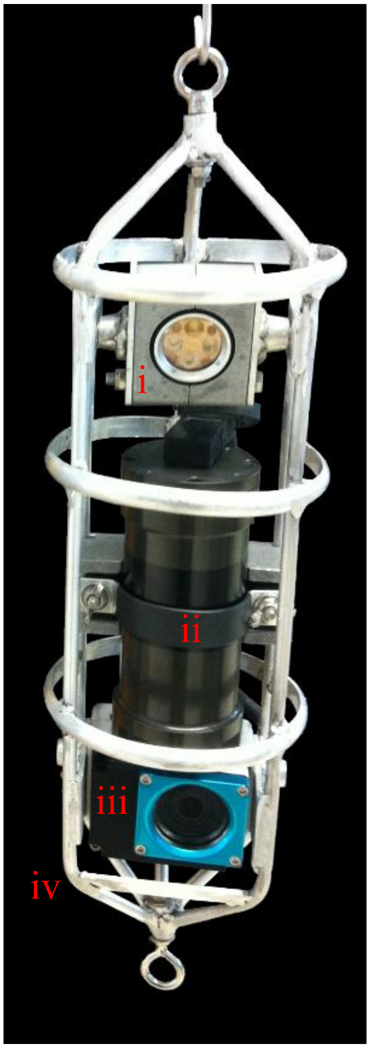

Figure 1: A) Benthic Video Camera system containing light (i), battery housing (ii) and camera (iii) in crash frame (iv). B) Benthic Video Camera system on deployment setup.

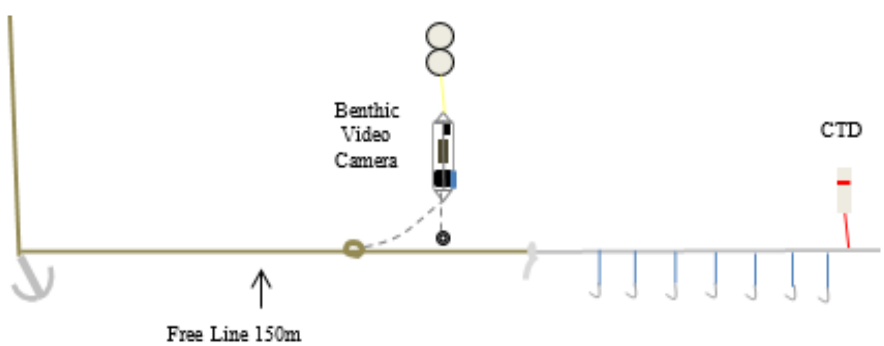

Figure 2: Deployment setup for Benthic Video Camera systems on *FV Antarctic Discovery*.

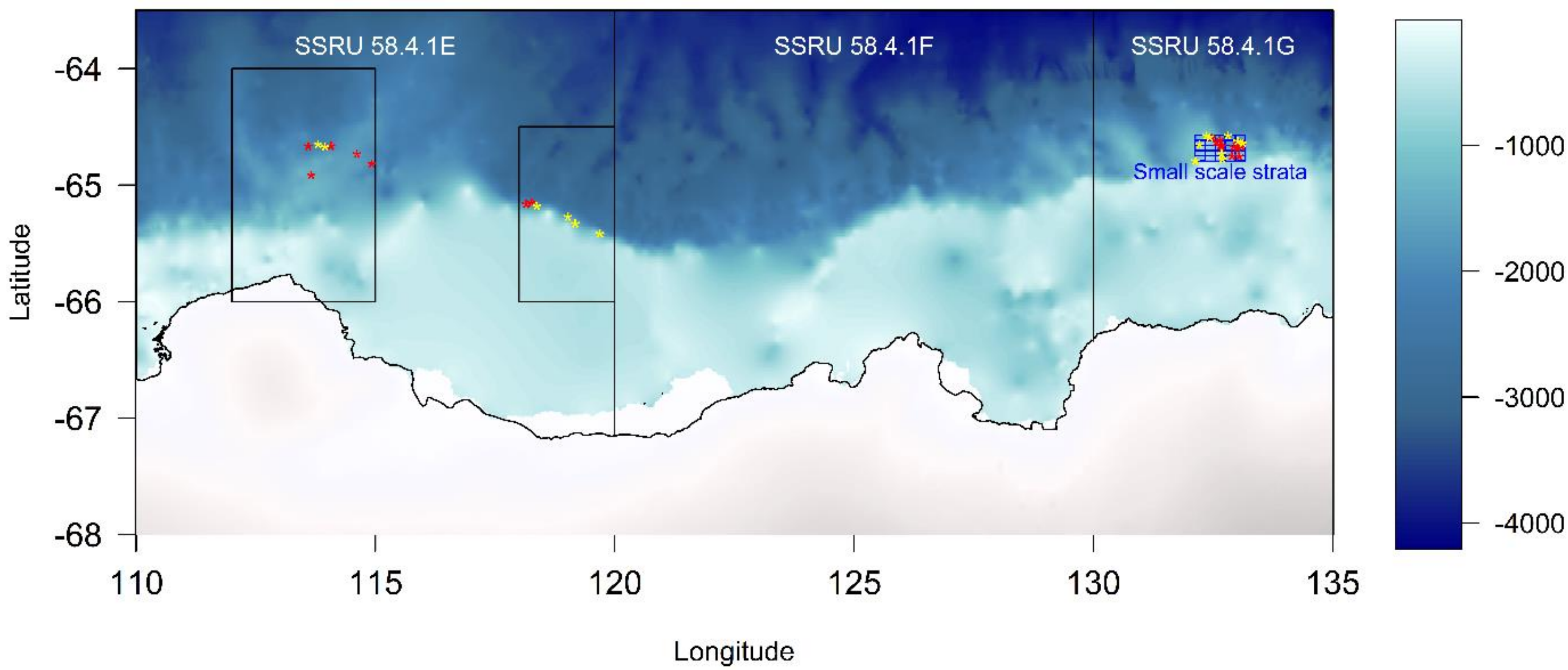

Figure 3: Distribution of Benthic Video Camera systems (yellow) and *Star-Oddi* CTD loggers (red) deployed on *FV Antarctic Discovery* longlines within SSRUs 58.4.1E and 58.4.1G. Note: CTD loggers were deployed with all Benthic Video Camera systems.

Video Processing:

Videos were processed using a combination of R (V3.2.2; R Core Team, 2014) and VLC media player (V2.2.3; VideoLan, 2016) to extract 1 frame per second from all videos. One frame from each deployment was used to classify the substrate composition and benthic biota seen within research blocks. Videos were scored on ability to be used based upon lighting and quality of image.

Biota was identified to the lowest possible taxonomic level (usually family) and substrate characterized using the CATAMI (Collaborative and Annotation Tools for Analysis of Marine Imagery and video) classification system (Althaus et al., 2013).

Conductivity, Temperature and Depth Sensors:

Star-Oddi CTD loggers were deployed a total of 33 times across the three research boxes, 15 were deployed with BVCs and 18 individually (Figure 3). Depths of deployments ranged from ca. 660 – 2200 m. CTD loggers were programed to take readings every 5 seconds once initialized.

Results:

Benthic Video Cameras:

Of the 15 BVCs deployments, 13 were successful in recording the sea floor. The substrate recorded was predominately soft sediments (7 deployments), however a combination of soft sediments, cobbles and rocks were also recorded (Table 1, Figure 4).

While sparsely spread, VME indicator species were seen in 9 of the 13 successful BVC deployments. Three of these deployments also retained indicator species as bycatch on the associated longline. One longline did catch an indicator species (in this case a hydroid), despite none being seen in the associated video (Table 2).

Across the 13 locations where BVCs were deployed, there was no evidence of areas which would be defined as a VME under Conservation Measure 22-06. VME indicator organisms as defined in Conservation Measure 22-07 were seen in low densities (generally 1 individual) and substrate composition and morphology was generally soft and flat.

A range of non-VME organisms were observed in videos with ophiuroidea, pycnogonida and sediment tube worms being most prevalent (Table 3).

Conductivity, Temperature and Depth Sensors:

A CTD example profile is shown in Figure 5 and depth-profile for temperature during setting and hauling is shown in Figure 6. Figure 5 also shows pulses of water coming through with low levels of salinity (I and II). We are currently in discussions with oceanographers on the most appropriate use for the CTD data.

Table 1: Characteristics of substrates observed from Benthic Video Camera systems (BVCs) deployed on longlines within SSRUs 58.4.1E and 58.4.1G.

Type	Characteristic	Photo
1	Unconsolidated soft sediment	
2	Unconsolidated soft sediment with large rocks present	
3	Predominantly cobbles	
4	Consolidated rocks	

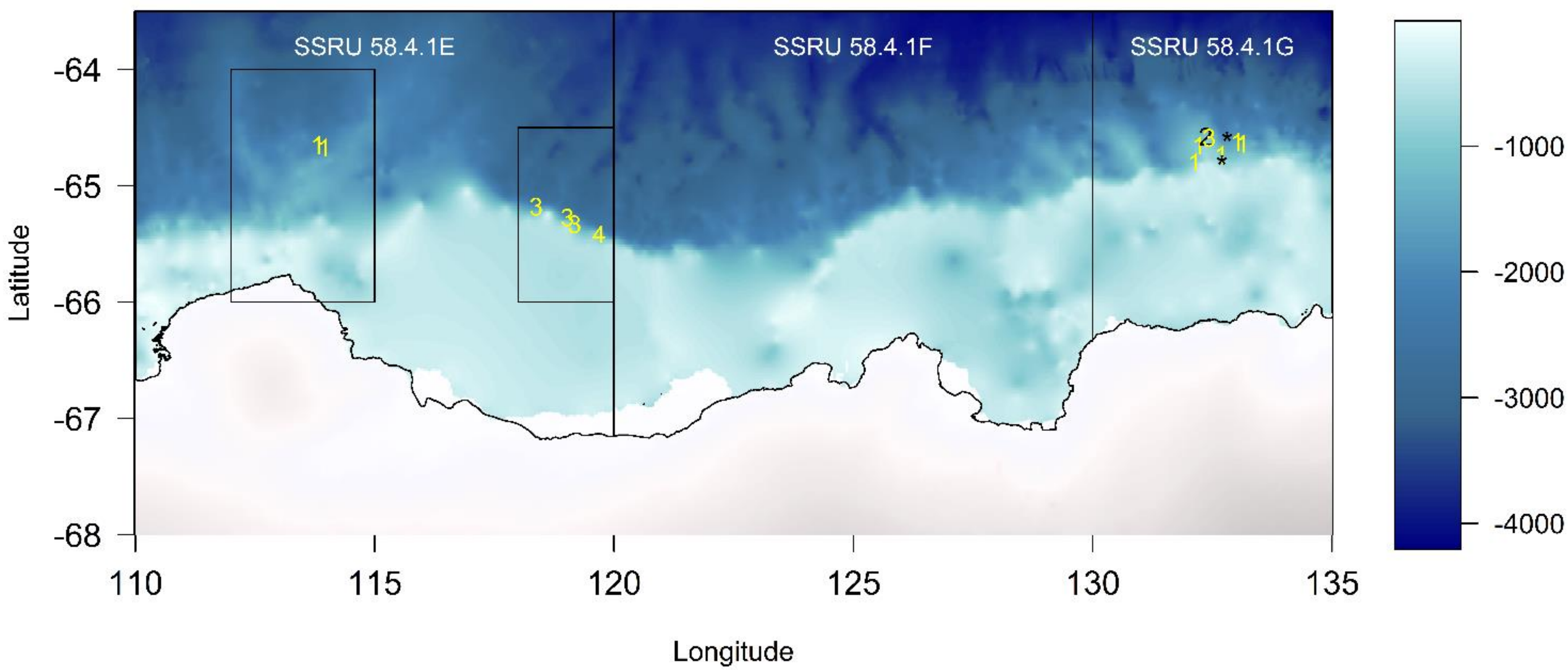

Figure 4: Distribution of substrates observed from Benthic Video Camera systems (BVCs) deployed on longlines within SSRUs 58.4.1E and 58.4.1G. 1: Unconsolidated soft sediment, 2: Unconsolidated soft sediment with large rocks present, 3: Predominantly cobbles, 4: Consolidated rocks (Table). ★ indicates BVCs which malfunctioned and did not record.

Table 2: Presence/Absence of Vulnerable Marine Ecosystem indicator species observed on; Benthic Video Camera systems (C) and caught as longline bycatch (L) on *FV Antarctic Discovery* operating within Division 58.4.1.

		Gorgonians	Anemones	Crinoids	Sea Lily	Urchins	Serpulid Worms	Antarctic Scallop	Hydroids
	Deployment	GGW	ATX	CWD	CWD	URX	SZS	DMK	HQZ
58.4.1 G	3					C			
	4		C			C			
	5		L			C			
	6	C	C		C	C	C,L		L
	7								
	8		C,L				L		
	9							C	
58.4.1_3	10								
	11		C		C				
58.4.1_4	12				C				
	13								
	14								L
	15			C					

Table 3: Presence/Absence of Non - Vulnerable Marine Ecosystem indicator species observed on Benthic Video Camera systems operating within Division 58.4.1.

		Gastropods	Cephalopods	Holothurian (Sea Pigs)	Sea Spiders	Unidentified fish	*Trematomus sp.*	Macrourids	Eelpout	Starfish	Brittle Stars	Worms
	Deployment	GAS	CEP	CUX	PWJ	UNF	TRT	RTX	ELZ	STF	OOY	WOR
58.4.1 G	3											
	4			C	C	C	C			C	C	C
	5				C						C	C
	6				C	C			C		C	C
	7	C			C					C	C	
	8			C	C			C		C	C	C
	9				C				C		C	
58.4.1_3	10			C								
	11			C	C				C	C		
58.4.1_4	12				C		C				C	
	13										C	C
	14								C		C	
	15		C					C		C	C	C

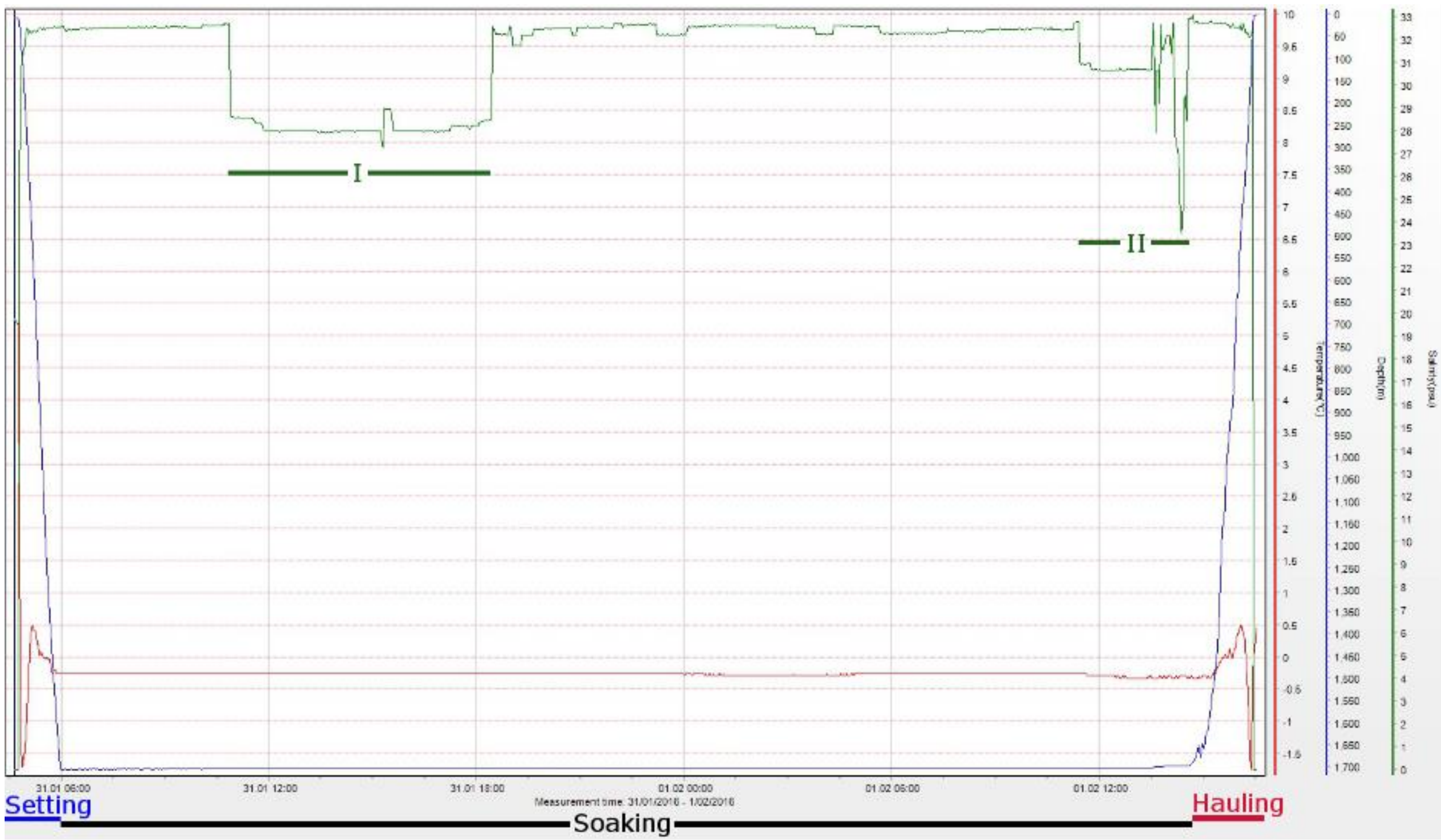

Figure 5: Example conductivity, temperature and depth profile from *Star-Oddi* CTD loggers deployed by *FV Antarctic Discovery* within Division 58.4.1. I and II indicate apparent pulses of water coming with low levels of salinity.

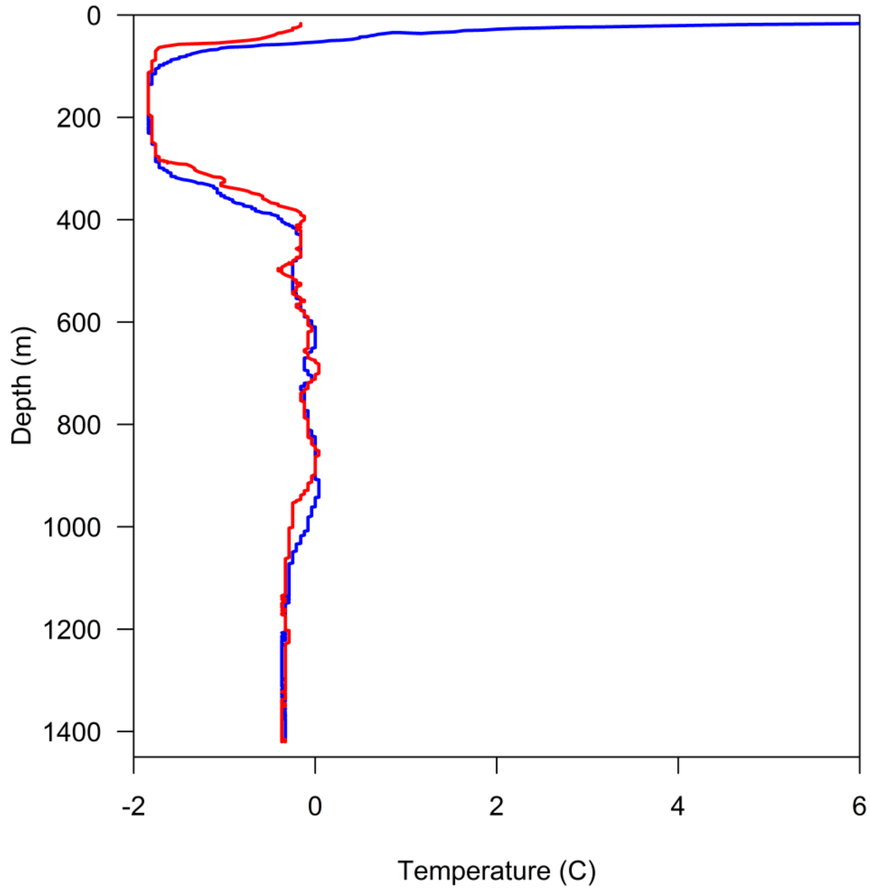

Figure 6: Example temperature and depth profile during setting (blue) and hauling (red) from *Star-Oddi* CTD loggers deployed by *FV Antarctic Discovery* within Division 58.4.1.

Discussion:

We have shown that we can deploy BVCs and environmental loggers as part of normal longline fishing operations to collect data to fulfil Objective 2 of the Australian research plan (WG-FSA-15/47 Rev. 1) as well as to look for presence/absence of VMEs and VME indicator species. Due to some operational issues with LED lights on camera systems, we were unable to achieve the 50% of line sets outlined within the research plan. We were also unable to achieve 50% of line sets outlined within the research plan for environmental logger sets as there was a limited number of loggers placed on the vessel and only the Australian observer conducted the deployment of equipment.

The data collected during the 2015/16 season provides the basis of a data set which can be used in combination with other fisheries data for incorporation into spatially-explicit habitat-use models for toothfish. Relatively low costs and ease of use means there is less obstacles to routine deployment across the CCAMLR Area.

BVCs also have the potential to be deployed on drop lines in areas which have been designated as VMEs to gain an understanding of the extent of the VME distribution and characteristics. BVCs may eventually be used to compare differences between benthic habitat and bycatch on longlines in order to estimate biases of using longlines bycatch as proxy for benthic habitats. In addition to being deployed on longlines the BVCs have the potential to be removed from the crash frame and mounted to trawl gear.

BVCs have the potential to become the equivalent of underwater observers allowing for the creation of habitat maps and tools to assist in the management of VMEs. We welcome expressions of interest from other members regarding deploying BVCs and environmental loggers during their own fishing operations.

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