Cruise Report ZDLM3-10-2019

Finfish SED trials

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DESIRE THE RIGHT

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Previous related reports:

Iriarte V, Arkhipkin A, Blake D (2018). License X-2017 Pinniped Bycatch Mitigation Report: Implementation of seal exclusion devices (SEDs) in the Loligo (*Doryteuthis gahi*) fishing fleet during the 2nd season 2017. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 28 pp.

Iriarte V., Pompert J. (2016). Pinniped Bycatch Report: Squid & Finfish Trawlers. Preliminary information on the bycatch of pinnipeds in the Falkland Islands. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 13 pp.

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1. Introduction

In the Falkland Islands, the South American fur seal (*Arctocephalus australis*, ARA) and the South American sea lion (*Otaria flavescens*, OTB) spatially overlap and interact with bottom-trawl fishing (Thompson et al., 2003; Baylis et al., 2015; Iriarte & Pompert, 2016; Baylis et al., 2018). Falkland Islands fisheries target either finfish (e.g. hake *Merluccius hubbsi*, HAK; hoki *Macruronus magellanicus*, WHI; blue whiting *Micromesistius australis*, BLU) or squid species (i.e. *Illex argentinus*, ILL; *Doryteuthis gahi*, LOL) which constitute important prey items for both seal species (Thompson et al., 1998; Koen Alonso et al., 2000; Baylis et al., 2014). Until 2014, seal-trawler interactions in the LOL fishery in the Falklands remained uncommon. However, a steady increase in seal interactions with a dramatic increase in fur seal mortality resulted in the implementation of seal exclusion devices (SEDs) in the LOL fishery in 2017 (Iriarte et al., submitted). Precautionary measures were also established for the finfish fleet, with vessels required to have a SED aboard and the delineation of a SED compulsory area for finfish west of the southern LOL fishing grounds. This SED compulsory area for finfish comprises eight grid squares (XTAG, XTAH, XUAG, XUAH, XVAG, XVAH, XWAG, XWAH; Fig.1) and includes the ARA foraging grounds (Thompson et al., 2003) where most of observed seal incidental mortalities had historically occurred in the BLU fishery (Iriarte & Pompert, 2016).

Since the delineation of the SED compulsory area the fishing effort within its boundaries has maintained (Table 1). However, crew from vessels that had worked there mentioned problems related to the use of approved SED models for LOL, particularly grid clogging and the loss of catch through the SED's hatch (Fig.2). In consequence, it was decided to carry out trials of different SED models in search of a device that could both minimize the failures mentioned above and allow the safe escape of seals.

Table 1. Fishing effort within the SED compulsory area from 08/2015.
As vessel positions correspond to midday, effort in adjacent grids is also included.

Year	SED area effort (days)	Adjacent grid effort (days)
2015	10	5
2016	63	29
2017	312*	65
2018	73	17
2019	92	1

*206 fishing days after SED implementation.

2. Objectives

The principal objective was to develop, test, and achieve a suitable SED for finfish (i.e. HAK, WHI, BLU), departing from the already implemented SED model for the LOL fishery.
Secondary objectives included to record behaviour and escapement of seals; observe escapement of commercial species, and evaluate water flow conditions within the SED and grid blockage.

3. Methods

3.1 Study area

During the first four days, trials took place in the License A (HAK) fishing area (Fig.1). The cruise was focused in the zone where the vessel had been fishing some days before the cruise, where HAK had concentrated. Following that, sampling effort also occurred within the LOL Box, with one day in the surroundings of Beauchêne Island, and the last one on the east (Fig.1).

3.2 Itinerary

On 3 October 2019 the *F/V Monteferro* picked FIFD personnel in Port San Carlos and steamed northwest, where it fished during four days (4-7 October). It then moved towards the SED mandatory area, however on 8 October weather conditions prevented sampling. In consequence, it was decided to steam east and on the next two days work in more protected waters within the LOL Box. Due logistical problems with the underwater footage equipment, on 10 October the survey was cancelled after one trawl, arriving to Port William in the afternoon.

3.3 Fishing gear

The net used had an opening of 180m and a cod-end mesh size of 110 mm with a 40mm square mesh panel on the top and a lower outer strengthening bag of 165 mm.
A 4m SED net extension was attached in between the body of the net and the cod-end. All the trialled SED models had a 200x223 cm internal 90mm mesh panel (final version size), with its proximal side attached 3m from the grid and its distal side left lose (Fig.3a). From 7 October (St.450) a modification occurred, with the internal mesh panel also distally attached to the sides of the net extension initially by a string (Fig.3b). Consequently, panel dimension was reduced and a PVC tube in the border of the panel was added (Fig.3c). The stainless

steel grid had an octagonal shape with an overall height of 200 cm and width of 140 cm, mounted at an angle of 45º-50º. The frame was built of 21mm diameter bars, with one central horizontal bar reinforcing the grid. Ten 16mm vertical bars spaced at a distance of 15 cm completed the grid. Location and number of 300mm buoys varied depending on the SED model and underwater camera location. The escape hatch had a semi-circular shape, was constructed out of 30mm rope and had a diameter of 140 cm and a radius of 100 cm. All scientific and commercial trawls were carried out with the same net, the latter without the SED net extension.

3.3.1. SED prototypes

The only difference between the three SEDs tested relied on the type of coverage of the external escape hatch. All the SED prototypes were built aboard the *Monteferro*.

3.3.1.1 *Hood model*

This model is based on the sea lion escape device used in the squid fishery in New Zealand, also trialled in their hoki fishery (Cleal et al., 2009; Hamilton & Baker, 2015). The hood was made of 90 mm mesh and its length was 168cm. The escape hatch had a width of 227 cm and a height of 114 cm. Conveyor belt material was attached to its edge that worked as a kite. Three 300 mm buoys maintained the hood opened while the gear was submerged (Fig.4, 5).

3.3.1.2 *Visor model*

A piece of rectangular semi-flexible plastic covering 1/2 of the SED's external hatch was attached to the distal side of the SED top's hatch. Netting covered the visor and a PVC tube with floats on its proximal edge gave it rigidity. Ropes were added to its proximal sides to attach them to the net extension and keep the visor on position while trawling (Fig.6, 7).

3.3.1.3 *Streamer model*

Seven double 130 cm red *mazzerpur* streamers were attached to the proximal side of the SED's escape hatch, partially covering it (Fig.8, 9).

3.4 Underwater cameras

Two kits of GitUp2 camera and torch were used to obtain information of SED performance.

Each kit consisted in two separated aluminium cylinders, one of them containing a camera plugged to a master timer, while the second cylinder contained the torch, the system's battery

and a secondary timer. An external cable connected the cylinders, allowing the energy of the battery to flow to both sides (Fig.10). The master timer was programmed to start 10min after connecting the external cable, with the light's timer programmed to initiate 20 min later.
One of the torches had two LED white lights, while the other had one red and one white LED. During the trials the latter (with only the red light activated) was fitted to the external part of the SED, while the former was usually fitted inside the SED and during the first four stations had a red cellophane filter. Both underwater footage kits were fitted inside protective housing constructed aboard (Fig.11). Location of the housings varied depending on the SED model, its operational performance and footage equipment efficiency (Fig.12). Protective housings were attached to the net by ropes and the external footage kit was also covered by netting at all times (Fig.13).

3.5 Cruise procedure

3.5.1 *Stations*

Except on the last day (10 October), four trawls of 2h of duration were daily conducted. Transects were selected based on the echo-sounder and Captain's experience and were mostly focused in the north of FOCZ (Table 2; Fig.1). Trawl operations daily commenced at around 07:00 each day. During the first three days an optional commercial trawl took place (Table 2).

3.5.2 *Underwater cameras & surface SED monitoring*

Before the morning shoot, housings were daily installed in the gear with the help of the deck boson and crew. In order to preserve the system's energy, in every single haul the external cable was unplugged and connected back after 30 sec, which made the system's recording cycle to be reseted. Gantry observations took place in every shoot and haul, with the aim of monitoring the SED, record pinniped presence/absence, estimate seabird abundance, observe seabird behaviour and film the gear during shooting and hauling. All footage data was extracted every day and stored in a 4TB external hard drive. Footage from the underwater cameras was quickly inspected in order to discuss with the captain modifications to be made. Trawl specific data by station was kindly recorded by bridge personnel (e.g. vessel positions every 15 min, depth, trawl width and height, etc.).

3.5.3 *Biological sampling*

HAK length-frequency was sampled in all scientific and commercial trawls. Size of the catch was estimated by eye during the haul and catch composition and discards proportions were estimated in the factory, while the catch was being processed.

4. Results

A total of 24 trawls were carried out, 21 of them corresponding to SED trials and three to commercial trawls, in which only fish biological sampling took place (Table 2). The first three days of the cruise were focused in evaluating which of the SED models had better efficiency, specifically regarding the loss of catch and escapement of seals. As no pinnipeds were sighted in the FOCZ, the evaluation relied mostly on fish escapement recorded by the underwater cameras and SED surface behaviour observed during hauling.

Table 2. SED and commercial trawls carried out along the cruise.

Date	SED model	#Trawls	Stations	Commercial station
04/10/2019	Hood	4	433-436	437
05/10/2019	Visor	4	438-441	442
06/10/2019	Streamer	4	443-446	447
07/10/2019	Hood	4	448-451	NA
08/10/2019	NA	NA	NA	NA
09/10/2019	Hood	4	452-455	NA
10/10/2019	Hood	1	456	NA

4.1. Underwater cameras and surface SED monitoring

A total of 657 GB of underwater recordings were obtained, together with 4GB of surface video recordings of shoots and hauls. Several problems were encountered with the underwater equipment. Difficulties arose as timers were fragile and connections too breakable for the rough manoeuvring aboard a bottom trawler. The setting of the underwater gear resulted neither adequate nor practical for our research purposes (Fig.10). Modifications to be made include: making camera and torch to work independently, eliminate timers, and attach batteries to the walls of the cylinder. Besides the technical problems, another issue that affected the quality of the data was the camera placement, however this was successively improved (Fig.12).

4.2 SED prototypes

Throughout the first three evaluation days, the hood model resulted to be the most promising and it was decided to continue the survey fishing with it (Table 3). Although the data analysis is preliminary, the most remarkable characteristic of the SED hood model is its capacity to retain escaping fish during trawling (Fig.14), however some fish may escape in the early stages of the haul, when the vessel diminishes its speed and tension of the fishing gear is reduced. Fish escapement during trawling was observed for both the visor and streamer models; however the former did not work appropriately (Table 3, Fig.7, 8). No difference was recorded in HAK length, whether fished with or without any SED model (Table 3). Along the cruise it was noticed the importance of the internal design of the SED, as the net panel configuration successfully proved for targeting LOL had to be modified (Fig.3). This is mostly related to the different swimming behaviour of these species, as finfish (i.e. HAK, KIN) have the capacity to swim against the water current and escape.

Regarding the SED hood model, its hood expanded after being deployed and maintained its position at all times when submerged, while in the surface it was seen to collapse, which may potentially represent a problem for escaping seals during hauling (Fig.16). Pinnipeds were sighted during the haul of five stations; however entrance into the net was neither observed nor recorded in the underwater footage (Table 4, Fig.17).

Table 3. Information from trawls carried out in the FOCZ (grids XEAG, XFAG).

SED	# Trawls	Echo-sounder inputs	HAK catch average (kg)	HAK TL average (cm)	SED fish loss	Advantages	Disadvantages	Comments
Hood	8	HAK catches corresponded to signal; however small HAK presumably escaping through net's square panel	3492	49.44	Only during hauling;	Hood retains escaping fish	Surface collapsing hood in haul	Observation of escaping seals needed
Visor	4	On 3rd station catch did not correspond to mark; apparently fish lost through cod-end.	4000	48.49	YES but not dramatic	NA	Visor distally entangled.	Hatch 100% open
Streamer	4	HAK catches matching mark.	4701	48.23	YES but not dramatic	NA	Streamers do not discourage fish from escaping and could entangle seals	NA
NA	3	------------------	2722	49.17	NA	NA	NA	Night trawling

Table 4. Pinniped sightings along the cruise.

Date	Station	Grid	Species	#Individuals	Behaviour
07/10/19	450	XEAG	ARA	1	Scavenging astern
07/10/19	451	XFAG	ARA	2	Porpoising astern
09/10/19	452	XVAK	ARA	1	Swimming astern
09/10/19	454	XUAM	ARA, OTB	2	Milling around the net
10/10/19	456	XRAP	OTB	2	Milling around the net

4.3 Catch and biological data

In general, catches were consistent to the echo-sounder signal, however it was presumed on some occasions small HAK was escaping through the cod-end's square mesh panel. Catches previous to the research cruise were higher but trawling time was longer. According to the Captain, bigger HAK could have functioned as a clog in the cod-end, preventing small HAK from escaping. Whichever the case, HAK biomass available during the cruise was smaller than previous weeks, when very high CPUE was recorded (Derbyshire, 2019). During the research cruise catches in the north averaged 3,732 kg, being the minimum of 1229.3 kg (St.450) and the maximum of 6526.5 kg (St.446). The maximum CPUE observed was of 3263 kg/h, being the minimum 266 kg/h (commercial station 437) and the mean 1724 kg/h (Fig.18).

4.3.1 HAK population characteristics

A total of 1908 HAK individuals were sampled, of which 1729 (91%) were female. HAK mean lengths recorded were bigger from the vessel's latest trip, which were 46.2 cm for females and 38.7 cm for males (Derbyshire, 2019). This supports Captain's theory mentioned above.

HAK

Sex	I	II	III	IV	V	VI	VII	VIII
Female	0%	26%	59%	5%	0%	0%	3%	8%
Male	0%	3%	11%	3%	3%	0%	39%	40%

Sex	Min. Total Length (cm)	Max. Total Length (cm)	Modal Total Length (cm)	Mean Total Length (cm)
Female	37	77	46	49.5
Male	35	53	42	42.3

5. Conclusions and perspectives

Despite the challenges faced with the underwater footage equipment, the outcomes of the cruise were positive as most of the objectives were accomplished:

✓ The hooded SED proved to be the best model to mitigate catch loss, however pinniped escapement data is still needed;

✓ SED efficiency varies depending on the behaviour of target species. The wide experience of Captain and crew regarding SEDs played a key role in constructing and improving SED’s performance;

✓ Behaviour of three commercial species (LOL, HAK, KIN) within the SED was recorded in different manoeuvrings (i.e. trawling and hauling), supporting previous thoughts that internal SED adjustments (e.g. size, position, type of mesh panel/high-speed funnel; length of net extension; etc.) should be trialled depending on the target species.

✓ Neither grid blockage nor seal bycatch was observed.

It is expected to carry out a 2nd finfish SED cruise in 2020 after the 2nd LOL season, with the aim of obtaining information on pinniped escapement, fish behaviour, and improving SED performance.

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Figures

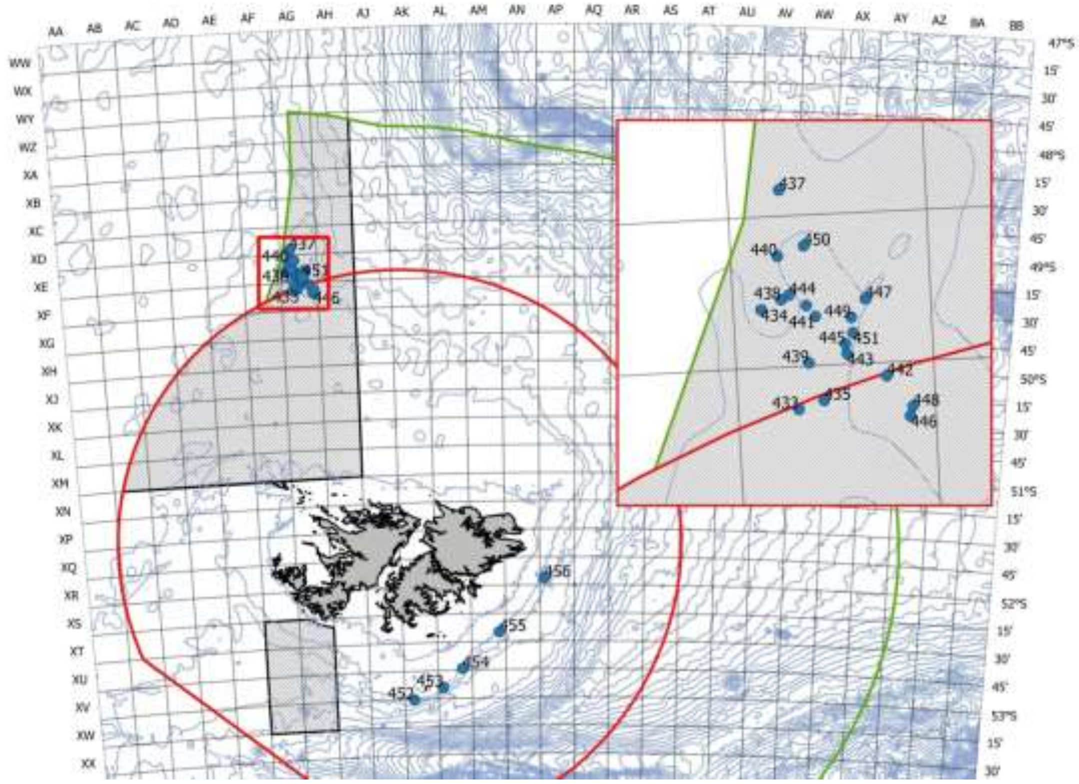


Fig.1. Research stations. Delimited areas indicate HAK fishing grounds (triangle in the north) and SED compulsory area (rectangle in the south).

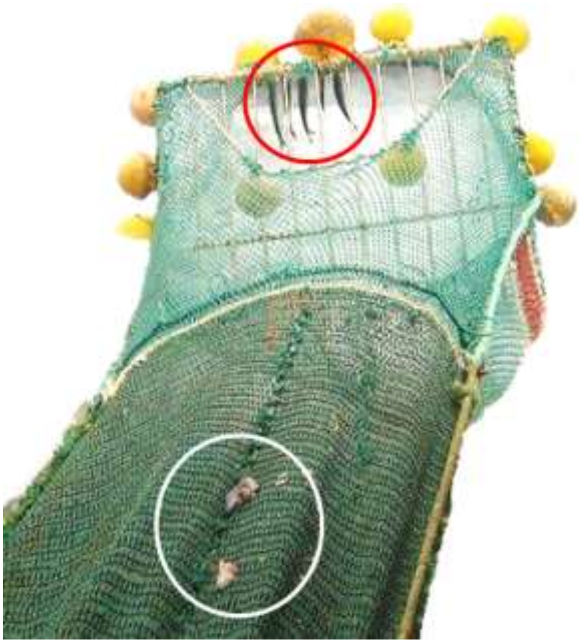


Fig.2. Fish loss through SED in a finfish vessel. The position of the enmeshed fish indicates an upward current flew through the hatch. Note the short SED's next extension; it is unknown whether this SED had either a mesh panel or a high-speed funnel to canalise the water flow through the grid towards the cod-end.

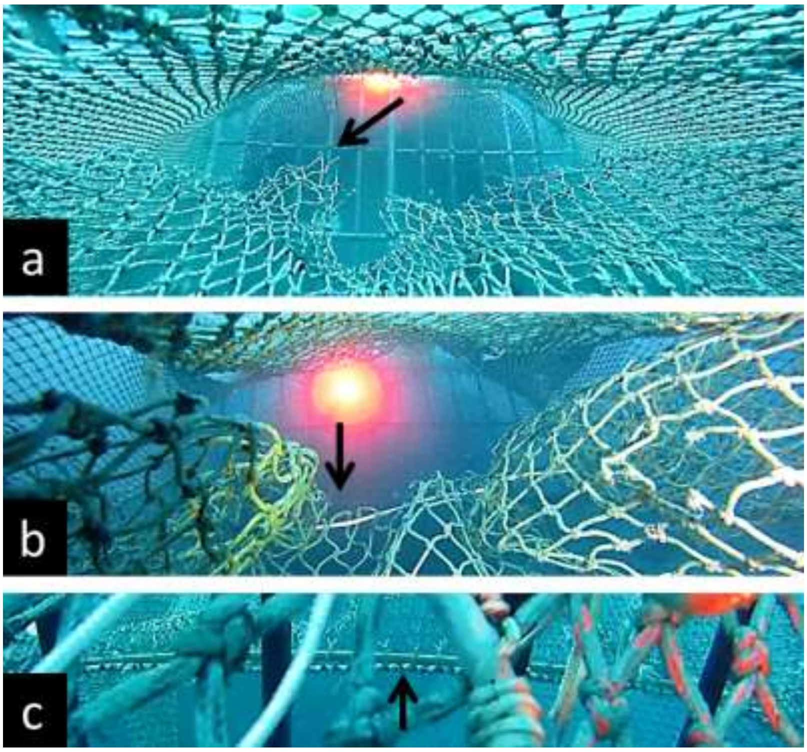


Fig.3. Internal mesh panel. Original lose configuration (a), early modified version with a string (b), final configuration with a rope inside a PVC tube that connected the mesh panel to the sides of the net extension (c).

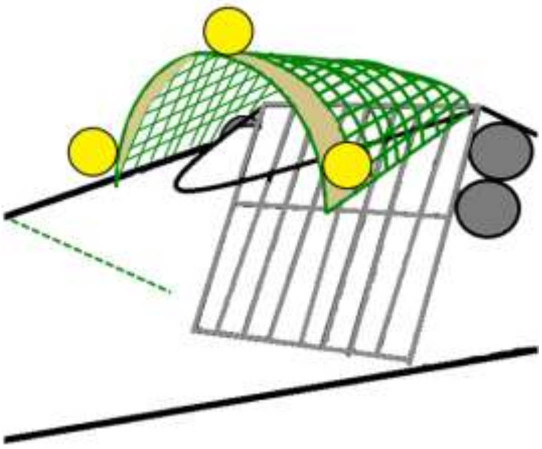


Fig.4. Diagram of hood SED. The hood is made by 90mm mesh; conveyor belt material is attached to its edge to work as a kite. Three 30mm buoys maintained the hood in position and the escape hatch open. The green dotted line represents the internal mesh panel.

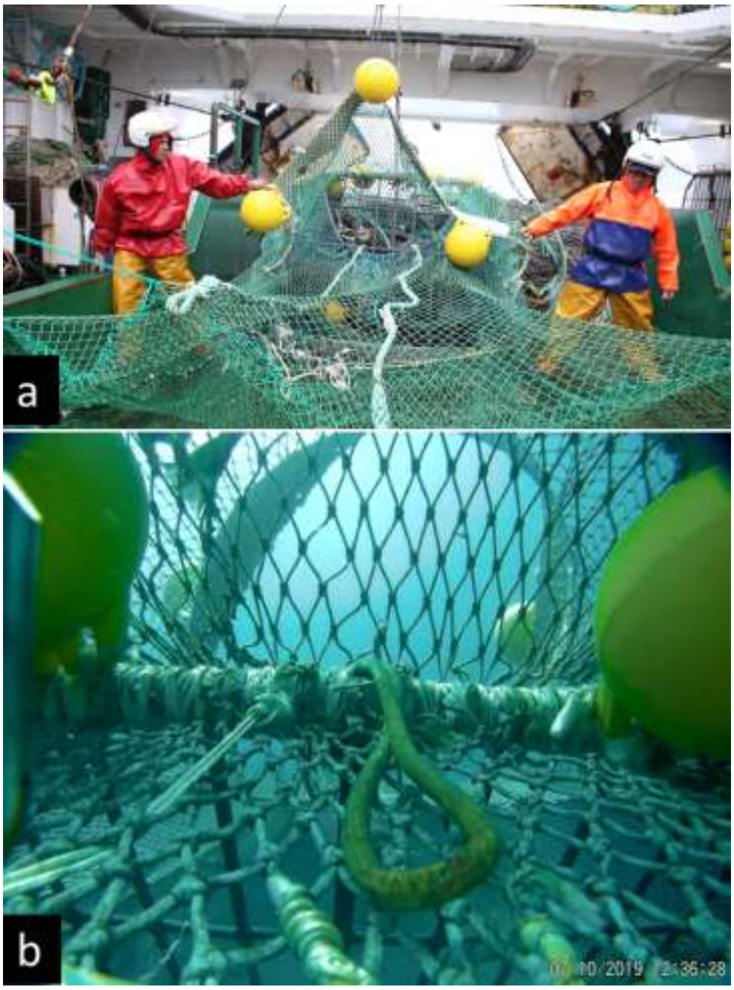


Fig.5. Hood SED. Open up on deck (a) and hood's rear view after being deployed (b).

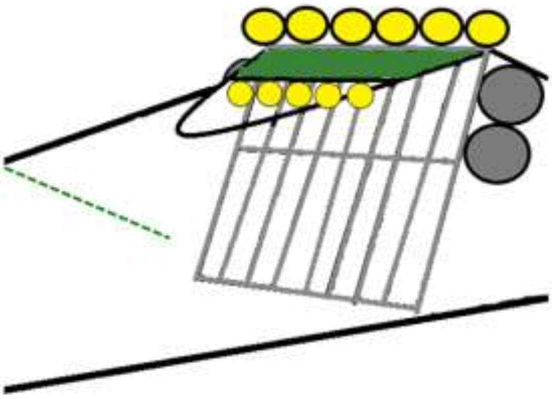


Fig.6. Diagram of visor SED. The visor is made of conveyor belt material and covered by netting. The green dotted line represents the internal mesh panel.

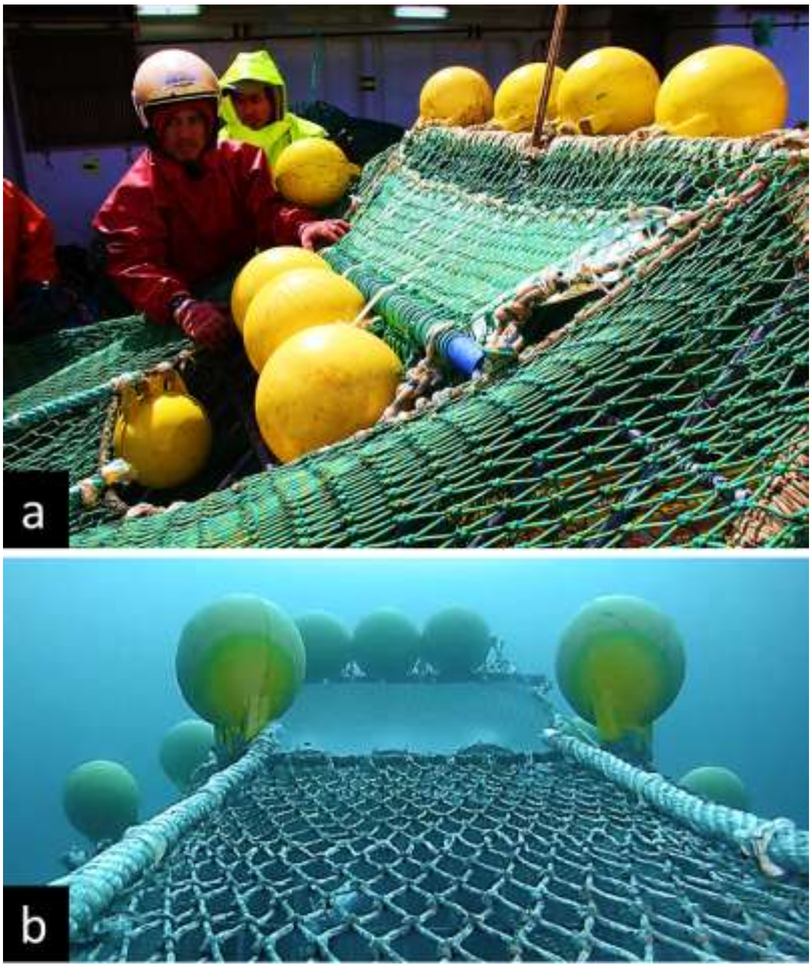


Fig.7. Visor SED. On deck view (a) and after deployment (b), with visor's buoys entangled with SED's top flotation.

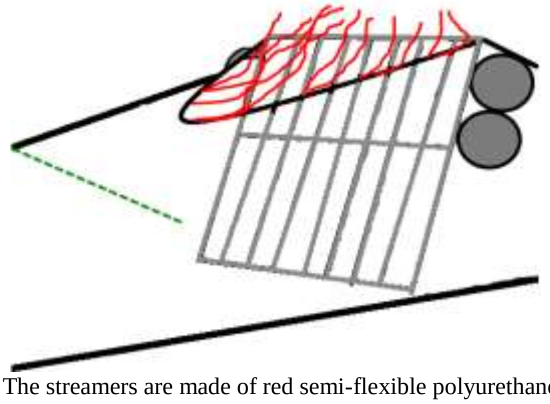


Fig.8. Diagram of streamer SED. The streamers are made of red semi-flexible polyurethane 10 mm tubing. The green dotted line represents the internal mesh panel.

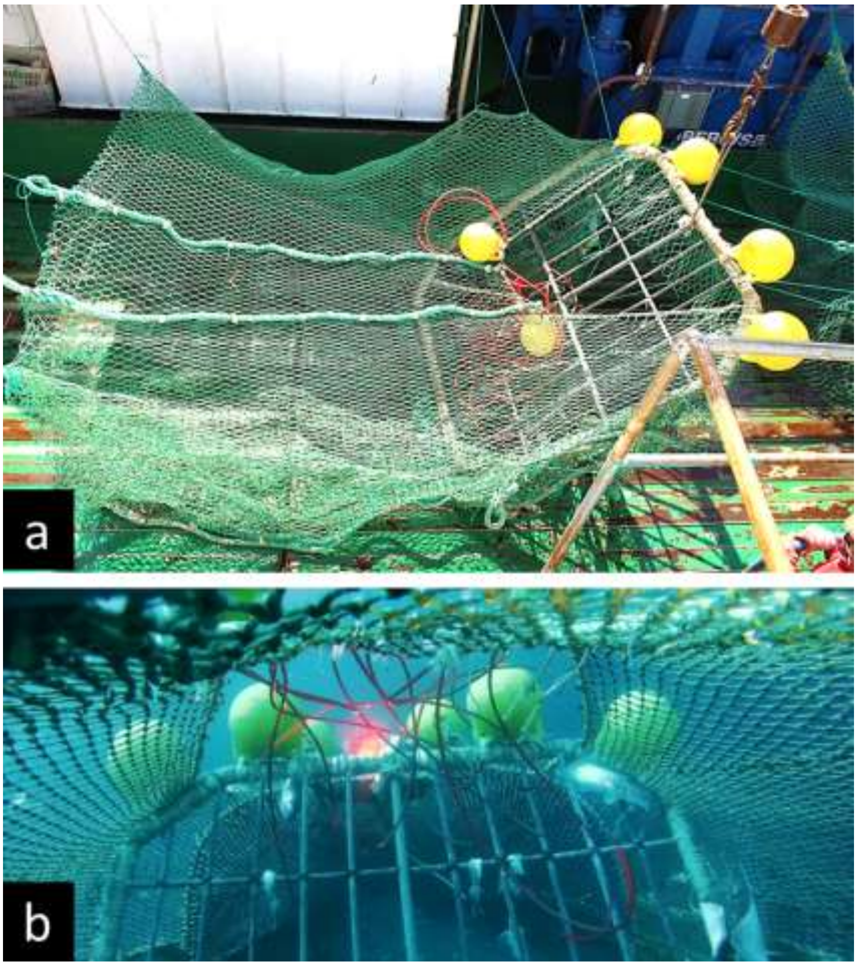


Fig.9. Streamer model. On deck view (a) and after deployment (b).

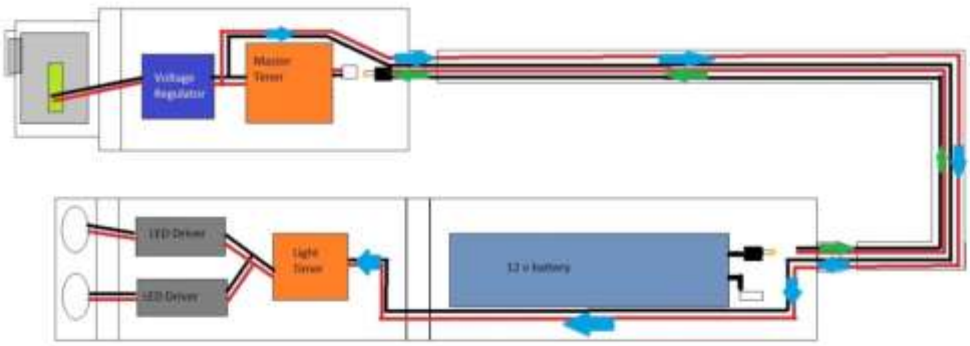


Fig.10. Setting of underwater footage.

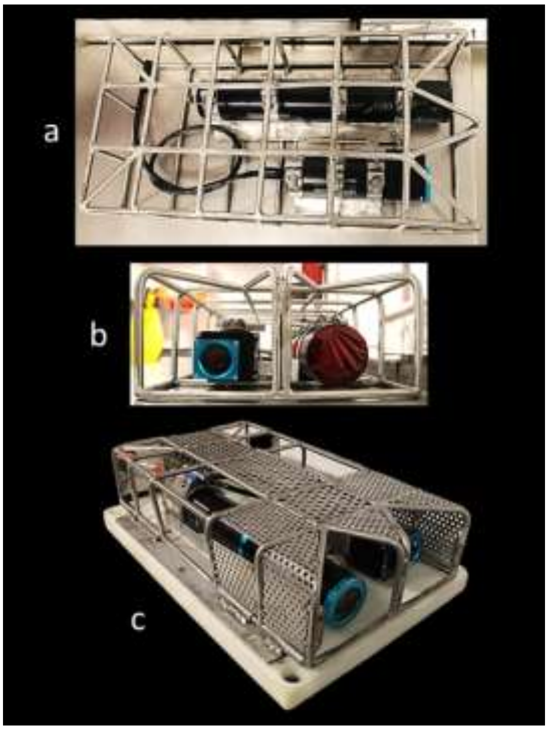
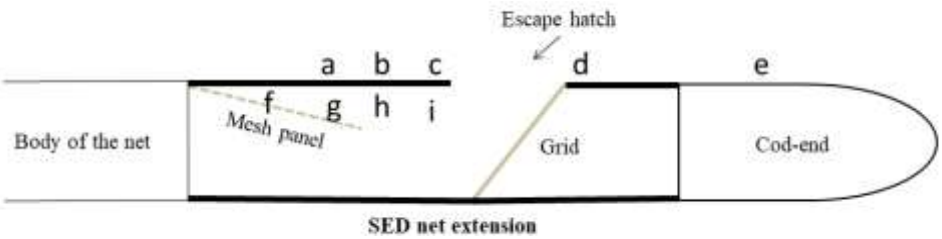


Fig.11. Trawl housings. Protective structure mostly used inside the SED (a, b). Note the cellophane filter in torch (b). Protective footage kit housing used on top of the net (c). Note the higher coverage of the cylinders and the Teflon base.



Date	SED model	Camera 1	Distance grid (m)	Camera 2 (red LED)	Distance hatch (m)	Camera problems encountered
04/10/19	Hood	g	2	b	1.5	St. 433-434: battery of kit 2 disconnected; camera 1's view blocked due weight of camera 2. St. 434-435: kit 1 moved to position b.
05/10/19	Visor	a	2.5	e	NA	Camera 1 too far away from hatch; visor entangled in top grid's flotation; rope blocking view of camera 2.
06/10/19	Streamer	h	1.5	d	0.3	St.445-446: timer connector of white torch disconnected; footage too dark.
07/10/19	Hood	f	3	d	0.5	During first station (448) a broken wire caused a fault in camera 1 plus water leakage; connectors becoming rusty. Torch of kit 2 also with wire problems, worked intermittently and only in stations 448-449.
09/10/19	Hood	i	1	d	0.5	On first station (452) master timer of kit 1 stopped functioning; only data from kit 2 available.
10/10/19	Hood	i	1	NA	NA	Battery connector of kit 2 broke, no energy released to the system.

Fig.12. Camera placement configuration and problems encountered along the trials.

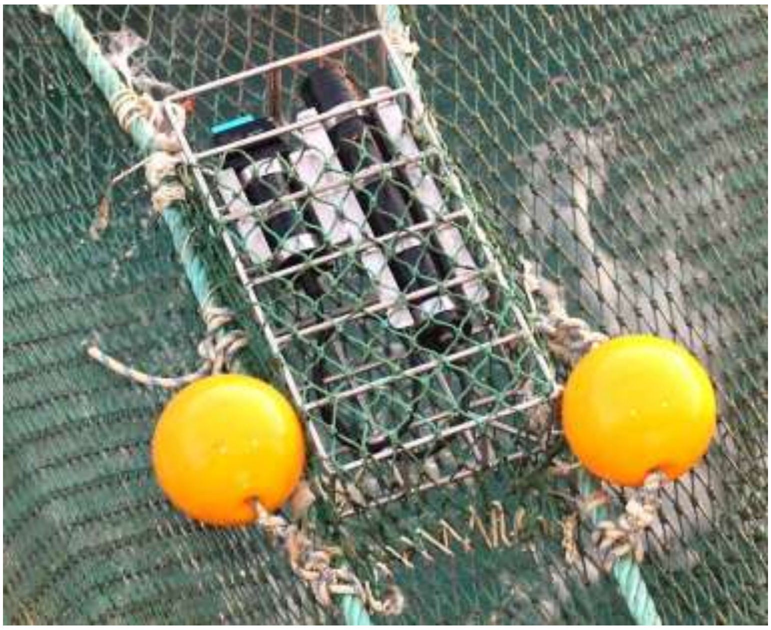


Fig.13. Protective netting on top of the external housing.

Fig.14. HAK retained in hood.

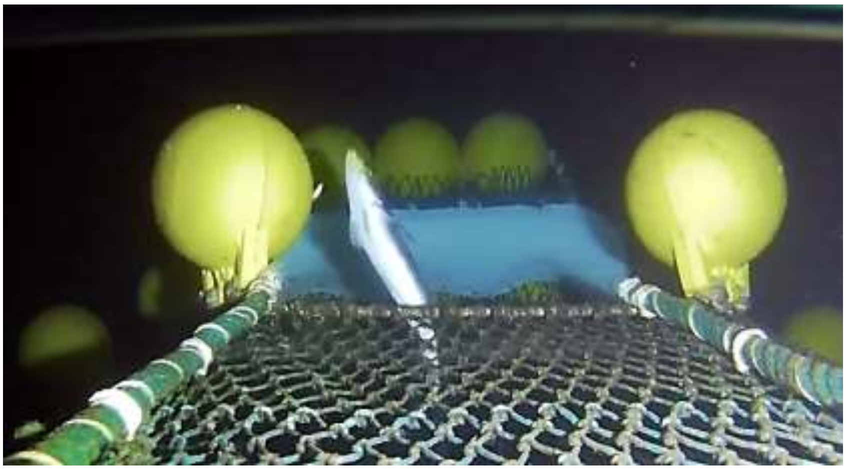


Fig.15. Escaping HAK during trawling (visor SED)

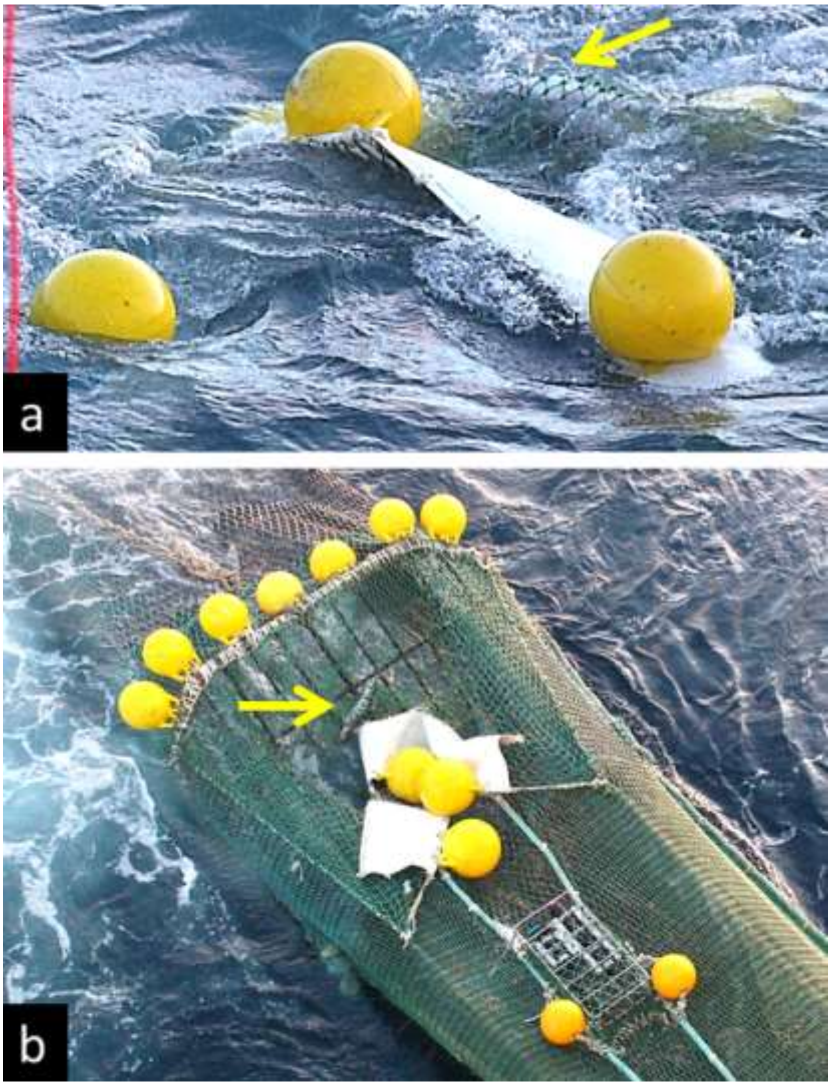


Fig.16. Hood behaviour in the surface during hauling. During manoeuvring the hood mostly remains open (a). While being close to the vessel and outside the water, the hood collapses (b). The yellow arrows indicate HAK retained in the hood.

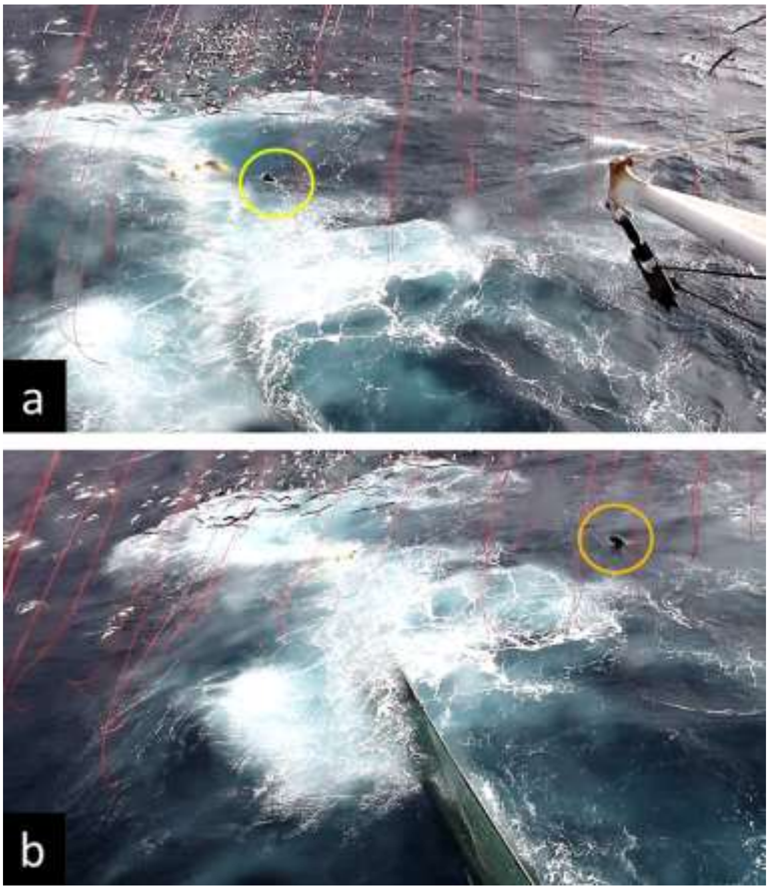


Fig.17. Pinnipeds sighted in haul of St. 454. Immediately after one ARA was seen porpoising next to the SED (a) an OTB was seen on the surface (b).

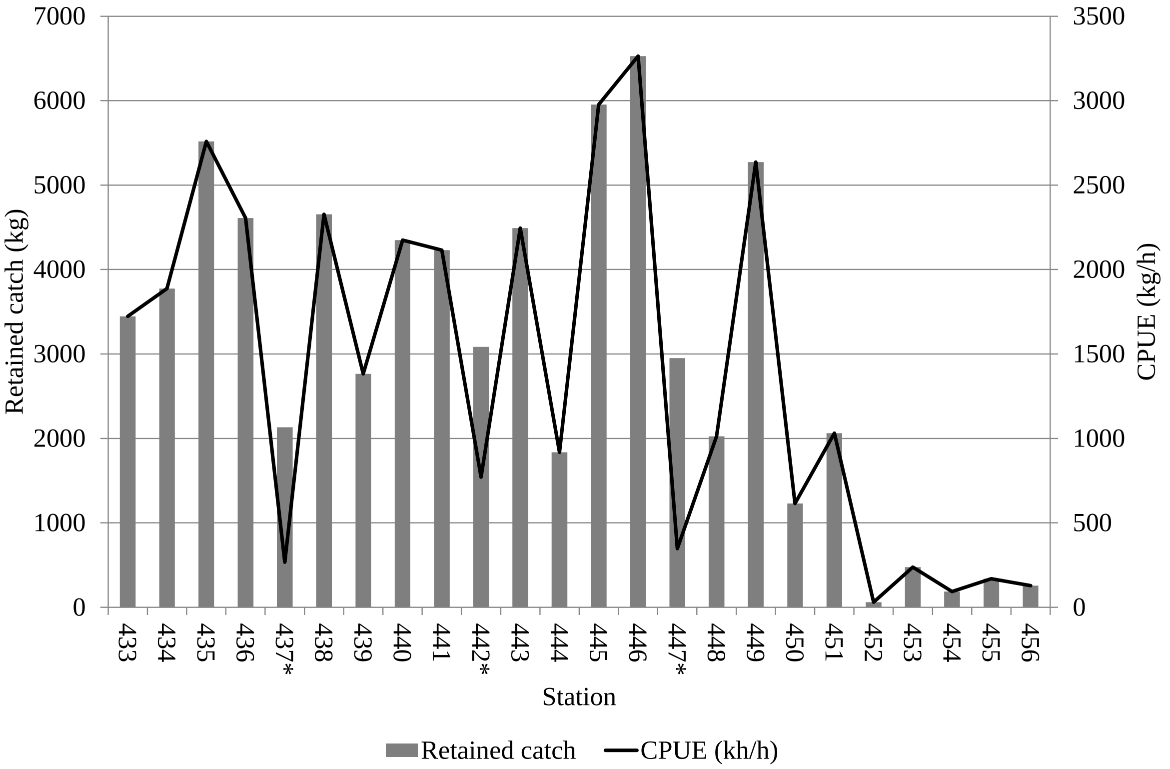


Fig.18. CPUE along the research cruise. The star indicates commercial stations. Stations 452-456 were carried out in the LOL Box, where no fish was available.