JOINT SURVEY REPORT FOR CRIMAC SFI AND IMR SAMPLING GEAR PROJECT

GO Sars 1. - 21.11.2021

Editor(s): and (IMR)
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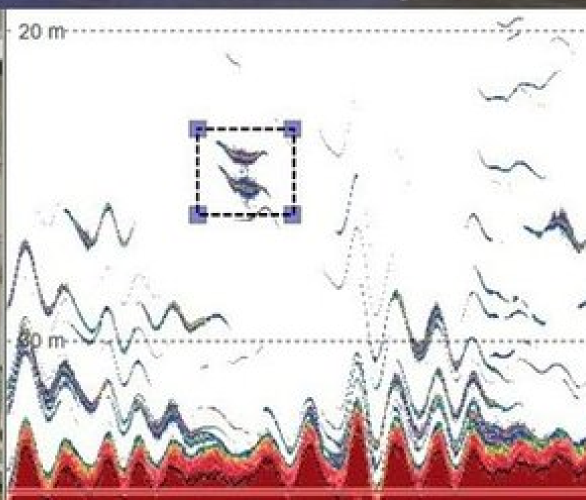

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Summary (English):

In this report we present main activities and preliminary results from the joint survey for the CRIMAC sfi and IMR sampling gear project. The survey was conducted on board RV G.O. Sars between 1. and 21. November and the survey area covered the coasts of Troms and Finmark and the area south and south-west of Bjørnøya. The overall aims were to test IMRs sampling trawls (sampling gear project), obtain optical and broadbanded acoustical measurements of demersal fish (CRIMAC) and test and develop new optic and acoustic instruments and methods (CRIMAC). Most of the sampling stations were based on a fixed protocol consisting of an acoustic transect, a TS probe deployment, trawling (with the Deep Vision camera system) and CTD. In addition to these stations several other tasks, such as developing the commercial DV, ADCP testing, and data collection for FM conversion to CW, were conducted sequentially.

Summary (Norwegian):

I denne rapporten presenterer vi aktiviteter og foreløpige resultat fra felles tokt mellom CRIMAC SFI og HIs «Bedre sampling redskaper» prosjekt. Toktet ble gjennomført om bord på G.O. Sars mellom 1. og 21. november og toktområdet dekket kysten av Troms og Finnmark samt området sør og sør-vest for Bjørnøya. De overordnede målene med toktet var å teste HIs prøvetakingstrål, Harstadtrålen (sampling redskaper prosjekt), samle optiske og bredbånds akustiske målinger av bunnfisk (CRIMAC) og utvikle og teste nye akustiske og optiske metoder og instrumenter (CRIMAC). Hoveddelen av datainnsamlingen var basert på et fast opplegg der man etter å ha identifisert et trålbart område med fiskeregistreringer, 1; gjennomførte et akustisk transekt (med båtens ekkolodd), 2; senket ned TS proben for akustiske målinger av fisk på kort avstand, 3; trålte tilbake med Deep Vision kamera system og 4; CTD måling. Denne datainnsamlingsprotokollen ble repetert flere ganger i ulike områder. I tillegg ble det gjennomført mange andre forsøk samt testing og utvikling av instrumenter som ikke var del av den systematiske datainnsamlingen, f.eks. utvikling av DV til kommersielt fiske, testing av ny ADCP og datainnsamling for FM (bredbånd) konvertering til CW (enkel frekvens).

Content

1 - Introduction

This survey was a joint survey between the CRIMAC SFI and the Trawl methodology project at IMR (“ bedre samplingredskaper” #15566) . The overall objectives were to test IMRs sampling trawls (Trawl methodology project) and to obtain optical and broad banded acoustical measurements of demersal fish (CRIMAC).

The trawl methodology project provides guidance and tests the performance of IMRs sampling trawls. The project is funded by the Norwegian ministry of trade, industry and fisheries. The experiments are important for maintaining the integrity of time series based on net sampling for IMRs fisheries advisory process.

CRIMAC is a center of research-based innovation funded by the research council of Norway through their center for research-based innovation program (SFI). Sustainable, healthy food production and clean energy production for a growing population are important global goals, and CRIMAC will contribute to these by obtaining accurate underwater observations of gas, fish, nekton and other targets. The data will be used in conjunction with CRIMAC data from other surveys to build a reference data set for optical and acoustic target classification. The classification libraries will be used for developing methods and products toward the fishing industry and marine science.

The survey had a range of different objectives, including:

- Development of demersal video trawling. This included developing and testing new trawl design, trawl created sand cloud measurements to ensure clear images over different bottom substrates, imaging of demersal catches using the Deep Vision (DV) system and test various approaches for DV for commercial fisheries.
- Training operators for the FOCUS vehicle for monitoring trawl performance and fish behaviour.
- Test new and existing sensors for trawl positioning and geometry measurements.
- Investigate and improve the performance of IMRs standard Harstad sampling trawl.
- Collect broad-banded acoustic data from demersal fish; from both hull-mounted and probing platforms.
- Collect data to estimate crosstalk between frequencies using standard settings.
- Collect data to validate acoustic FM to CW conversions.
- Collect data to provide optimal settings for near-seafloor acoustic measurements.
- Collect broadband data from near sea floor for classification.
- Collect data for comparing the combined Simrad EC150 Echosounder and ADCP against the standard onboard ADCP were conducted.

2 - Survey overview

2.1 - Time period and area

The first part of the survey was conducted between November 2nd (Tromsø) and November 9th 2021 (Kirkenes), and the second part was between November 10th (Kirkenes) and November 21st (Tromsø). The work during the first part was performed along the coast of Troms and Finmark, approximately between longitude 20.1° and 30.9° and latitude 70.7° and 70.6° (WGS84). The second part was performed south and south-west of Bjørnøya, between longitude 17.5° and 18.7° and latitude 74.2° and 73.6° (WGS84) as well as the coast of Finmark and Troms, between longitude 31.9° and 20.0° and latitude 70.6° and 69.9° (WGS84).

The major sampling stations, including TS probe, demersal and pelagic trawls and CTD as well as the survey track is shown in Figure 1 .

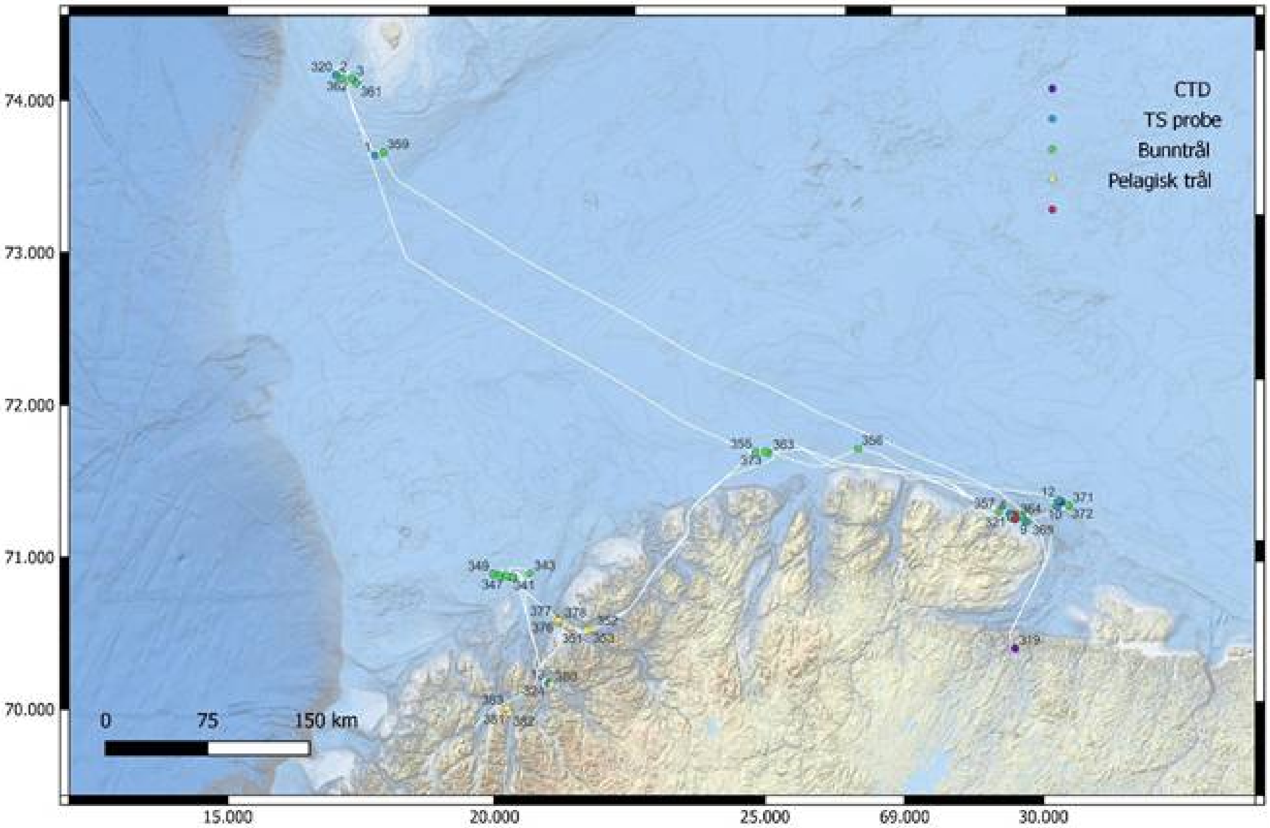


Figure 1 . Cruise track and stations (CTD, TS probe, demersal and pelagic trawls).

2.2 - Vessel details

The cruise was conducted with RV G.O. Sars (Figure 2) operated by the Institute of Marine Research. The vessel is 77.5 m length overall, has a m aximum speed of 17 knots and a c rew of 15 in addition to space for 30 scientific crew members including instrument technicians. The vessel is equipped with Kongsberg Maritime EK80 scientific broadband echosounders (operating at 18, 38, 70, 120, 200, and 333 kHz centre frequency) and a range of other sensors (sonars, ADCPs). The vessel is equipped to deploy a wide range of additional equipment (e.g. probes, towed vehicles, pelagic and demersal trawls). More information about the vessel can be found online (https://www.hi.no/resources/brosjyre-g.o.sars.pdf).

Figure 2 . G. O. Sars (image credit: Institute of Marine Research).

2.3 - Cruise participants

The scientific crew in the first part consisted of 13 people and in the second part of 21 people representing IMR, KM, Scantrol, UiB and NORCE (Table 1 and Figure 3).

Table 1 . Scientific crew.

Scientific crew 1 st part (1. – 9. November)		**Scientific crew 2 nd part (10. – 21. November)**	
Arill Engås (cruise leader)	IMR	**Arill Engås (cruise leader)**	IMR
Jan Tore Øvredal	IMR	Asbjørn Aasen	IMR
Nils Naterstad	IMR	Liz Beate Kolstad Kvalvik	IMR
Sigurd Hannaas	IMR	Jostein Saltskår	IMR
Shale Pettit Rosen	IMR	Martin Dahl	IMR
Martin Dahl	IMR	Erik Schuster	IMR
Erik Schuster	IMR	Nils Olav Handegard	IMR
Asbjørn Aasen	IMR	Rolf Korneliussen	IMR
Liz Beate Kolstad Kvalvik	IMR	Geir Pedersen	IMR
Jostein Saltskår	IMR	Ronald Pedersen	IMR
Henrik Berg	IMR	Rokas Kubilius	IMR
Åsta Øvernes	Avonova	Maria Tenningen	IMR
Thor Bærhaugen	KM	Thor Bærhaugen	KM
		Jon Even Corneliussen	KM
		Antonio Palermino	IMR
		Eirik Svoren Osborg	Scantrol

Scientific crew 1 part (1. – 9. November)		Scientific crew 2 part (10. – 21. November)	
		Ahmed Pala	UiB
		Taraneh Westergerling	UiB
		Ivar Wangen	KM
		Rune Øyerhamn	NORCE
		Anna Oleynik	UiB

Figure 3 . Scientific crew in the second part of the survey. From left Nils Olav Handegard, Geir Pedersen, Eirik Svoren Osborg, Rolf Korneliussen, Rune Øyerhamn, Antonio Palermino, Thor Bærhaugen, Rokas Kubilius, Taraneh Westergerling, Jostein Saltskår, Ahmed Pala, Ivar Wangen, Maria Tenningen, Asbjørn Aasen, Anna Oleynik, Jon Even Corneliussen, Liz Kvalvik, Arill Engås, Erik Schuster.

3 - Activities

This chapter provides an overview of the activities carried out during the survey. Each activity has a stated objective, method description and a short description of the preliminary results. Some of the activities were carried out sequentially, but several tasks were carried out as part of a protocol that covered several objectives, combining experiments for ship acoustic, TS probe and trawling. The protocol included 1) finding fish aggregations over different bottom substrates, 2) do an acoustic transect over the trawlable area, 3) deploy the trawl equipped with scientific DV, 4) CTD cast, and finally 5) a TS probe station. Other tasks, such as developing the commercial DV, ADCP testing, and data collection for FM conversion to CW, were conducted sequentially.

3.1 - Develop trawl design for demersal video trawling

3.1.1 - Overview of trawl hauls and monitoring sensors

During the survey 29 trawl hauls were made to develop and test a trawl design that lifts in-trawl camera system off the seabed and above the sand cloud (Table 2). In each haul, trawl performance including, door behaviour, bottom contact, trawl geometry and waterflow was monitored using a range of Simrad PX catch monitoring sensors (Kongsberg Maritime AS) (Figure 4), GO Pro cameras and in some of the hauls the Focus underwater towed vehicle (section 3.3). In addition to Simrad sensors, in some of the hauls Star-Oddi tilt sensors were used to monitor bottom contact and RBR depth sensors were used to monitor the dimensions inside the tunnel. A detailed description of each trawl haul is presented in annex1.

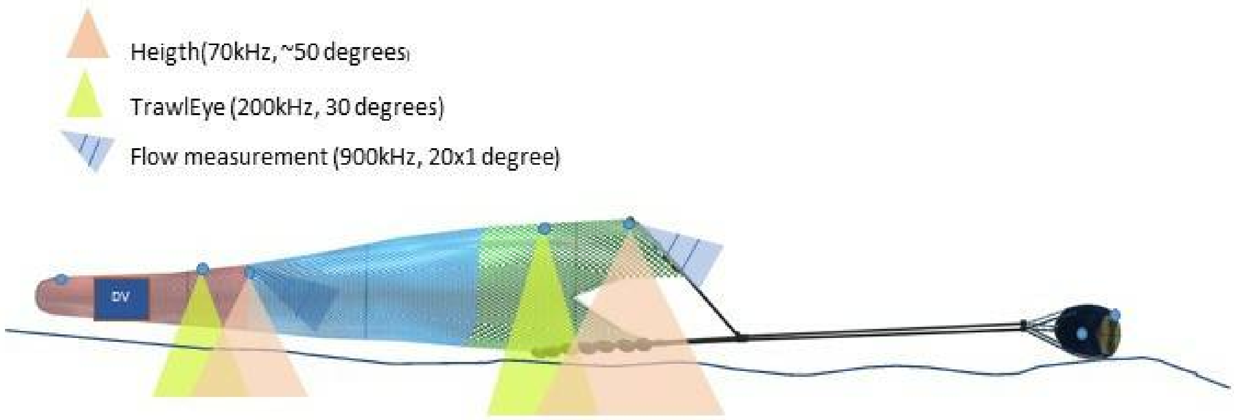


Figure 4 . Overview of main trawl monitoring sensors. Two PX Trawl Eyes measured the height of the trawl opening, depth, distance to seabed (bottom contact) and monitored fish entering the trawl. One sensor was placed in the upper panel above the ground gear and the other in the tunnel about 1 m in front of the DV (deep vision camera system). Two flow sensors were used to measure waterflow in the trawl opening and in the tunnel. The sensors also measured height, roll, pitch and depth. A PX MiniCatch sensor was mounted in the cod end. Door performance was monitored with PX MultiSensors. The sensors monitored door spread, height, roll and pitch.

Table 2 . Overview of trawl stations including station number, haul date and time, duration and position and main instrumentation. Trawl instrumentation includes Deep vision camera system (DV, Sci = scientific version and Fi = commercial fishery version), Focus underwater vehicle, GO Pro cameras, Simrad trawl eyes and flow sensors with approximate positions. More detailed information of the trawl hauls can be found in annex 1.

Station	Start time (UTC)	Tow time (min)	Start Lat (°)	Start Lon (°)	DV	Focus	GO Pro cameras	Simrad TrawlEye	Simrad flow sensor
341	02.11.2021 09:45	31	20.66	70.81	-	X	Extension	Ground gear and extension	-
342	02.11.2021 14:12	148	20.56	70.82	-	X	Extension	Ground gear and extension	headline
343	02.11.2021 18:14	30	21.08	70.82	-	-	-	Ground gear and extension	headline
344	03.11.2021 07:34	102	20.45	70.83	-	X	Extension	Ground gear	headline
345	03.11.2021 10:50	105	20.72	70.80	-	X	Extension	Ground gear and extension	headline
346	03.11.2021 14:38	50	20.34	70.84	-	X	Extension	Ground gear and extension	headline
347	03.11.2021 16:56	98	20.61	70.82	-	X	Extension	Ground gear and extension	headline
348	04.11.2021 13:09	97	20.75	70.80	Sci	X	Extension	Ground gear and extension	headline
349	04.11.2021 17:26	99	20.33	70.84	Sci	X	Chafing gear	Ground gear and extension	headline
350	05.11.2021 09:10	91	20.73	70.81	Sci	X	Chafing gear	Ground gear and extension	headline
355	07.11.2021 08:27	117	25.97	71.40	Sci	X	Fish lock	Ground gear and extension	Headline and end of trawl
356	07.11.2021 16:08	31	28.04	71.29	Sci	X	Fish lock	Ground gear and extension	Headline and end of trawl
357	08.11.2021 10:03	8	30.51	70.67	Sci	-	Chafing gear	Ground gear and extension	Headline and extension
358	08.11.2021 12:30	31	30.82	70.61	Sci	X	Chafing gear	Ground gear and extension	Headline
359	12-11-2021 20:47	29	73.66	18.65	Sci	-	Stereo rig and chafing gear	Ground gear and extension	Headline and extension
360	13-11-2021 07:50	23	74.16	17.75	Sci	-	Stereo rig	Ground gear and extension	Headline and extension
361	13-11-2021 15:24	82	74.12	18.11	Fi	X	Stone release and toward DV	Ground gear and extension	Headline and extension
362	13-11-2021 20:52	81	74.16	17.99	Fi	X	Stone release and toward DV	Ground gear and extension	Headline and extension
363	14-11-2021 23:20	32	71.38	26.24	Fi	-	Toward DV and inside DV	Ground gear and extension	Headline and chafing gear
364	15-11-2021 12:42	34	70.61	30.82	Sci	-	-	Ground gear	Headline and chafing gear
365	15-11-2021 18:25	26	70.62	30.80	Sci	-	-	Ground gear and extension	Headline and chafing gear
366	15-11-2021 23:43	46	70.60	30.94	Sci	X	-	Ground gear and extension	Headline and chafing gear
367	16-11-2021 04:54	30	70.61	30.89	Sci	-	-	Ground gear and extension	Headline and chafing gear
368	16-11-2021 10:32	33	70.61	30.74	Sci	X	-	Ground gear and extension	Headline and chafing gear

Station	Start time (UTC)	Tow time (min)	Start Lat (°)	Start Lon (°)	DV	Focus	GO Pro cameras	Simrad TrawlEye	Simrad flow sensor
369	16-11-2021 20:45	33	70.56	31.02	Sci	-	-	Ground gear and extension	Headline and chafing gear
370	16-11-2021 03:37	30	70.61	31.64	Sci	-	-	Ground gear and extension	Headline and chafing gear
371	17-11-2021 10:09	83	70.59	31.88	Sci	X	-	Ground gear and extension	Headline and chafing gear
372	17-11-2021 18:10	31	70.59	31.86	Sci	-	-	Ground gear and extension	Headline and chafing gear
373	18-11-2021 12:28	22	71.39	26.17	Fi	-	Toward and inside DV	Ground gear and DV	Headline and chafing gear

3.1.2 - Set up the Selstad 630 trawl

3.1.2.1 - Objective

Rig the trawl for the first time and ensure that the performance is optimal. The Selstad 630 demersal trawl is used by the commercial fleet and is much larger than the sampling trawls commonly used on board G.O. Sars and another important objective was to make sure the crew and vessel could efficiently handle the trawl.

3.1.2.2 - Method

A Selstad Streamline 630 demersal trawl with Thyborøn 23 VFG (8 m^2) trawl doors was rigged for the purpose of developing video-trawling methods for demersal trawls (Figure 5) . The trawl was mounted on a rockhopper ground gear with 60 pcs of 14 mm quick links. A fine meshed cod end (24 mm Åkra codend used in scientific surveys at IMR) was used to ensure that all fish passing through the DV camera system would be caught. A 2-4 panel transition was attached to the back of the trawl to connect the 4-panel DV to the 2-panel trawl. A stone release to prevent large stones from entering and damaging Deep Vision was placed in front of the 2-4 panel transition. The stone release was created by removing a 1 m wide triangle from the under panel of the trawl. The underside was covered with a mat with hanging short ropes to prevent fish from escaping («Labbetuss» or «chafing gear»). Trawl performance was monitored as described in section 3.1.1 and annex 1.

3.1.2.3 - Preliminary results

G.O. Sars and the crew were able to handle the trawl very well. The performance was good. Door spread was stable at about 115 – 120 m and trawl opening at 6-7 m. Trawling speed was kept at 3.5 knots to use the same speed as the commercial fleet. Bottom contact was good (Figure 6) and stone release with chafing gear worked well after some modifications. The transition (2 to 4 panel) also looked good.

Figure 5 . The Selstad trawl and DV are prepared for deployment.

Figure 6 . Screen shot from TV80 (KM) software. Showing the TrawlEye echograms (bottom contact and height over seabed and data from door and flow sensors on the right.

3.1.3 - Trawl configuration that lifts DV above sand cloud

3.1.3.1 - Objective

Develop trawl configuration that lifts the deep vision camera system above the sand cloud without affecting trawl performance.

3.1.3.2 - Method

Different configurations were tested to identify a design that lifts the camera system high enough to avoid the sand cloud (Table 3). The configurations that were tested consisted of different combinations of extensions (attached to the 2-4 panel transition) with different lengths, mesh types and buoyancy. The height of the camera system above the sand cloud was measured with a Simrad PX trawleye (KM) mounted in front of the DV extension and in some hauls with the scanning sonar and echosounder on the Focus. Trawl geometry and performance were monitored with Simrad trawl sensors, GO Pro cameras and the FOCUS underwater vehicle (section 3.1.1 and Annex 1: Trawling - log and instrumentation).

Table 3 . Different trawl configurations (extensions with different mesh types, lengths and buoyancy attached to the 2-4 panel section) that were tested aiming to get deep vision 8-10 m above seabed. The selected configuration is marked in green.

Mesh type	Length (m)	Number extra floats on extension *	Trawl hauls	Codend/Deep Vision height over seabed (clearance, m)
Diamond	10.7	0	341; 342	3.5
Diamond	10.7	22	343	5.5
Square	15	0	344	3
Square	15	22	345	4
Square / diamond	15 /22	44	346; 347; 348	8.5
Diamond	22	30	349	6
Diamond	22	44	350; 355+	8

* Floats were 240 mm diameter Selstad Isfell hydrodynamic with buoyancy of 4.9 kg. Floats were added to upper laces of both 2-4 panel section and any additional sections, with roughly 2 m spacing.

3.1.3.3 - Preliminary results

Trawl rigging with a 2-4 panel transition (10.7m), 22 m diamond mesh extension and 44 extra floats resulted in a 7-9-meter clearance over seabed for deep vision (Figure 7). The angle of the trawl extension was between 7-9°.

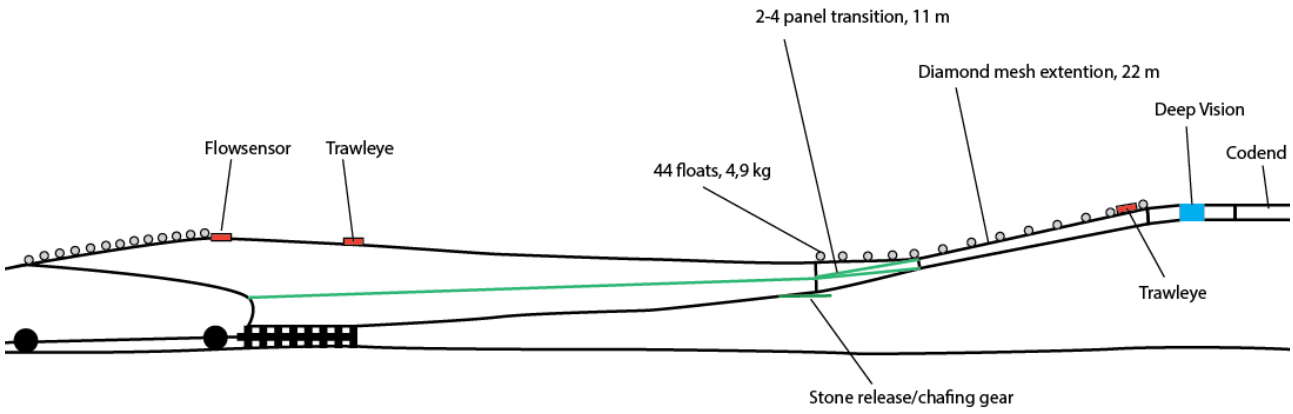


Figure 7 . Trawl rigging that achieved 7-9-meter clearance above sand cloud.

3.1.4 - Trawl geometry measurements with Scientific and prototype fishery DV

3.1.4.1 - Objective

Document the performance of the new trawl design that lifts Deep Vision camera system above the sand cloud.

3.1.4.2 - Method

Twenty trawl hauls were made with the new design that lifts the DV off the seabed (Table 3). Fourteen of these were with the scientific deep vision and three with a prototype fishery version. The trawl hauls were made in the area between Southwest of Bjørnøya and the eastern Finnmarkskyst (Figure 1) and the performance was monitored and measured with Simrad catch sensors (Figure 4), GO Pro cameras and FOCUS underwater vehicle (Table 2).

3.1.4.3 - Preliminary results

A preliminary analyses of the Simrad catch sensor data (TrawlEyes on headline and in the extension) in hauls 359 – 370 show that door spread varied mainly between 110 and 120 m (Figure 8 a). Trawl vertical opening was mainly between 6 and 7 m (Figure 8 b). The DV camera unit was at a consistent height between 8 and 10 m above seabed (Figure 8 c). The hauls were between 30 and 80 minutes long and towing speed was between 3 and 4 knots (Figure 8 d). Variation in data was partly caused by sensor movement (not properly attached to the trawl in some of the hauls). The preliminary results indicate that the trawl geometry was stable. There were no obvious differences in trawl geometry in hauls with the fishery DV and scientific DV. Height and width in the extension (measured with depth sensors and PX sensors) have not yet been fully analysed, but there are indications of collapse in the trawl extension in front of the fishery version of the Deep Vision camera system. We also lack good flow measurements in the trawl extension and fish behavioural data. These need to be considered in future experiments.

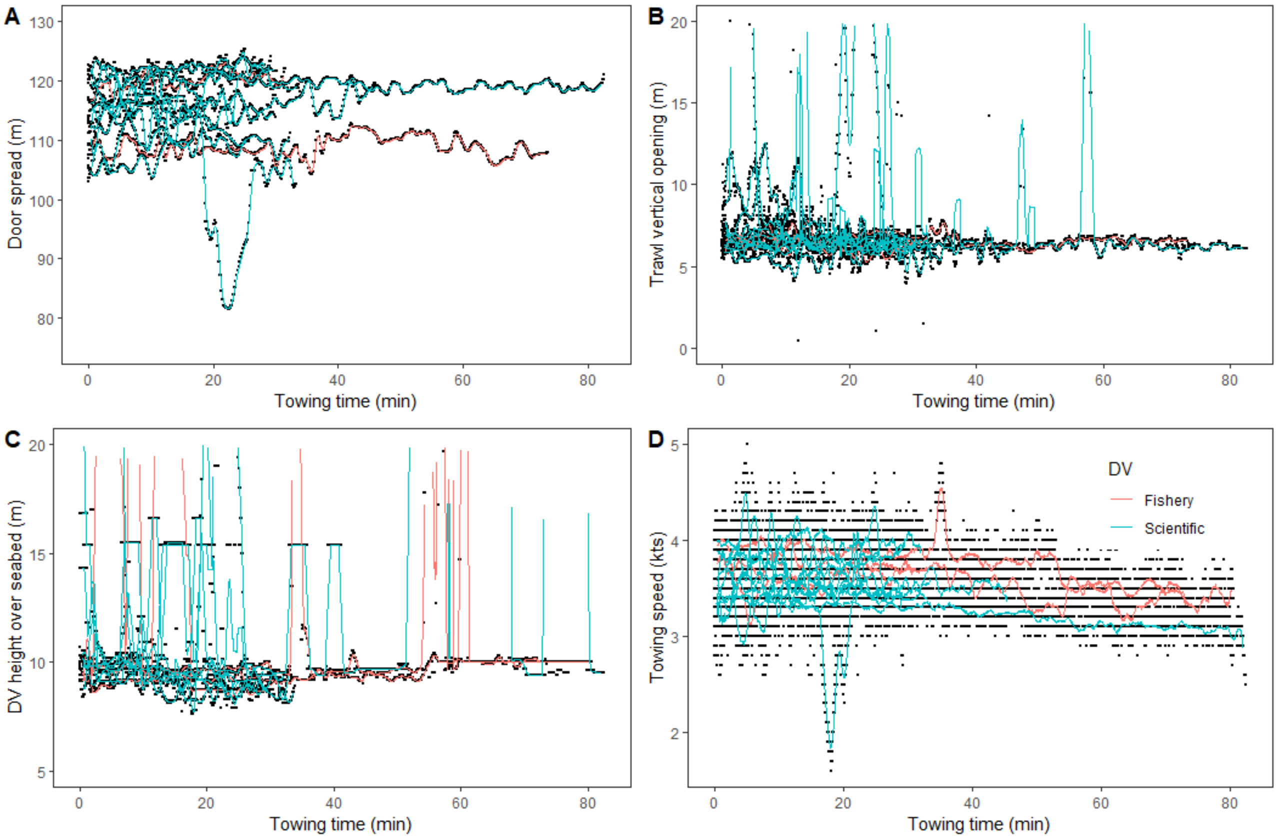


Figure 8 Trawl geometry measurements with Simrad catch monitoring sensors, A. Door spread, B. Trawl vertical opening, C. Deep vision height over seabed and D. towing speed. The data is shown as measured points (black points) and running averages by station (red lines=hauls with fishery version DV; blue lines=hauls with scientific DV).

3.2 - Measure trawl sand cloud over different bottom substrates

3.2.1.1 - Objective

Measure the height of the sand cloud created by the trawl ground gear in different seafloor types and investigate the effects on image quality on in trawl camera system. How high above seafloor do we need to get the camera system for clear images?

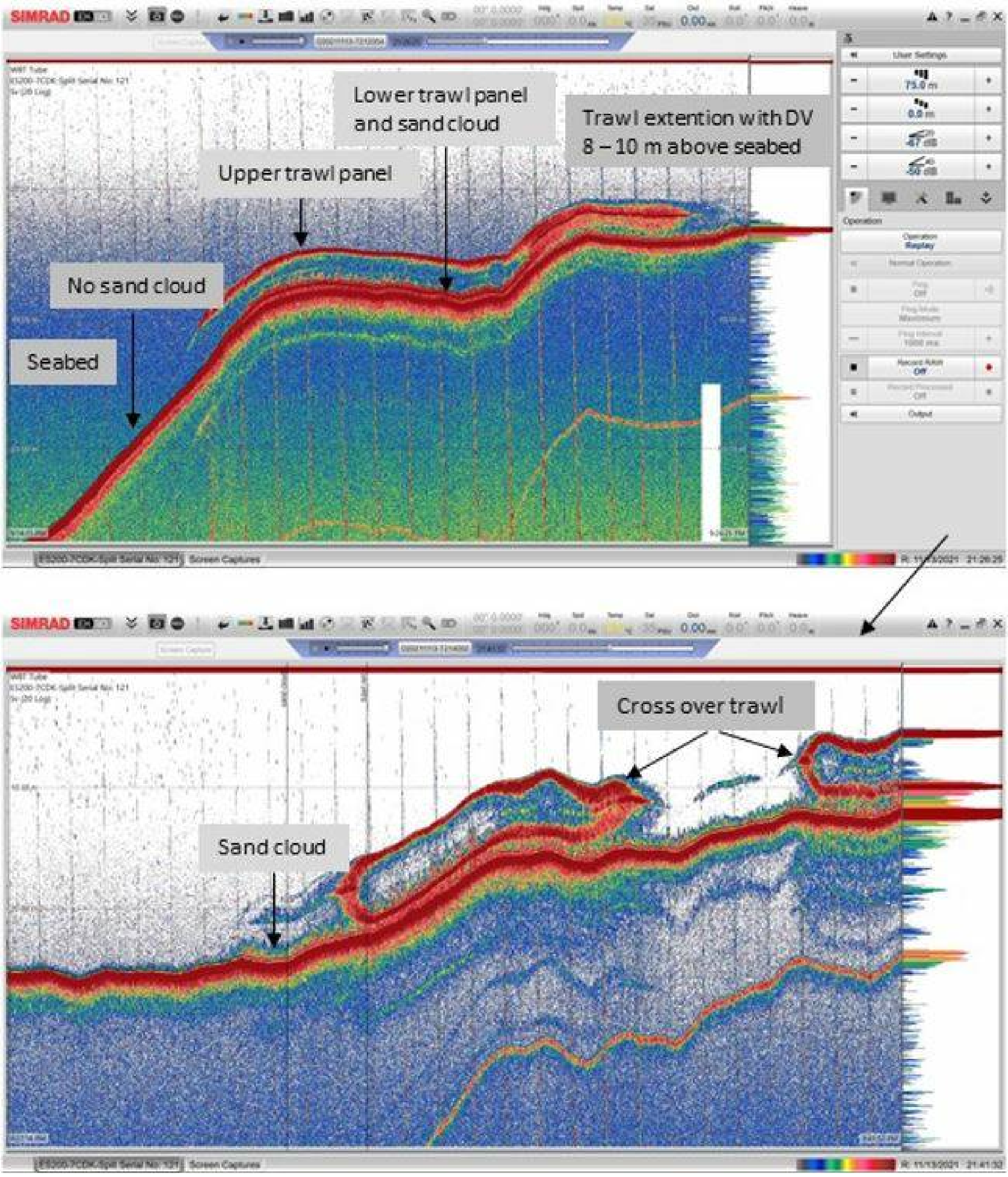
3.2.1.2 - Method

The sand cloud created by the trawl ground gear was monitored in two trawl stations, 363 and 371 (Figure 1). The seafloor in station 363 was sand with gravel and in station 371 sand with gravel and sludge. The sand cloud was measured using a wide band echosounder (WBAT tube with a Simrad ES200-7CDK transducer, Kongsberg Maritime AS). The echosounder was mounted on the towed underwater vehicle Focus (section 3.3). The echosounder was operated in CW mode, with a 0.512 ms pulse duration and 1 – 2 pings per second. In addition, a Go Pro camera facing upward and toward a reference board was attached to the Focus. The purpose of the camera was to compare backscatter strength with image clarity. A similar reference board was mounted in the DV system.

When the trawl was in position Focus was deployed. The Focus was navigated along the trawl wires to the trawl opening and further back toward the codend and the deep vision camera system. Once on top of the DV the focus moved slightly to the side of the trawl, stayed in position and data were collected. The aim was to then lower down and into the sand cloud to obtain images that could be related to the acoustic data, but this was too risky and could not be done.

3.2.1.3 - Preliminary results

The data have not yet been analysed, but based on visual investigation of the echosounder data, the sand cloud is clearly observed below and inside the trawl (Figure 9). The data further indicate that the sand cloud height ranged between 1 and 8 meters above seabed. However, the acoustic data is very noisy (electric noise) that makes data at ranges > 20 m difficult to analyse. Also, at close range echoes weaker than -70 dB cannot be distinguished from the background noise. This means that the weakest backscatter from the sand cloud cannot be detected and the results will only provide estimates of minimum extents of the sand clouds. The data will be analysed in LSSS and sand cloud echo strengths will be compared with image quality. We will also attempt to identify and remove the noise source in the echosounder and repeat the experiment in 2022.



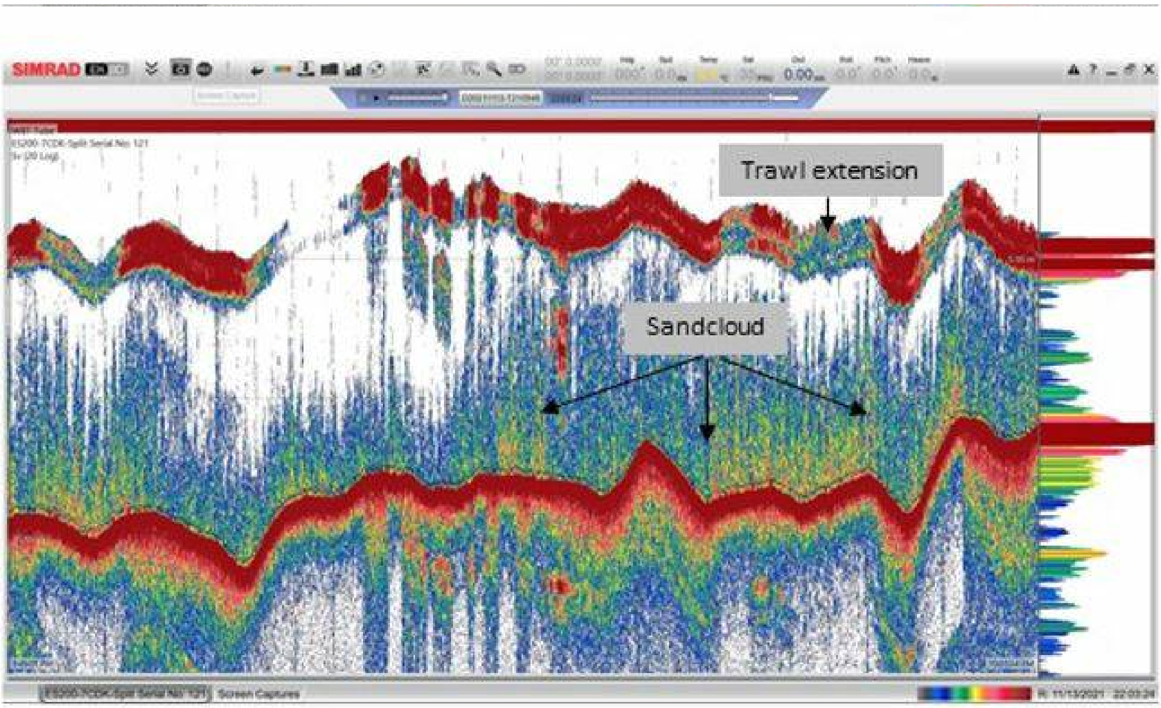


Figure 9 . Examples of EK80 data from echosounder mounted under the FOCUS-2 vehicle. The FOCUS was 2 – 30 m above the trawl and the sand cloud can be observed below and inside the trawl. The first image is from approaching the trawl and measuring the first part of the trawl. Range is 70 m. The image in the middle is showing cross sections of the trawl middle part and sand cloud under and inside the trawl. The range is 40 m. In the image on the bottom FOCUS is 2 – 5 m above the trawl extension which is about 10 meters above the seafloor. The sand cloud can be seen below the trawl extension. Range is 20m.

3.3 - Training of Focus operators

3.3.1.1 - Objective

The Focus is a towed underwater vehicle (Figure 10) and is used for observations on towed fishing gear. The objective of this task was to train two operators that could operate the vehicles, as well as observations on DV in conjunction with bottom trawling.

3.3.1.2 - Method

The focus is equipped with a Mesotech scanning sonar. This is crucial for navigational purposes. The payload on the vehicle was two video cameras, a wide band echosounder (WBAT tube with 200KHz transducer), and a GoPro camera with a reference figure to observe the sand cloud formation around DV.

The system consists of a vessel and a winch system. The winch system was bolted onto a dedicated location behind the instrument room at the 5th deck. An adaptation frame (green color) was used between the winch and the deck to fit the bolt holes. The winch was recently serviced at Macartney, and, among other things, the main motor and gears were replaced.

The winch was connected to dedicated 440V 3phase outlet on 5 deck. When shooting wire to the Z-lifting frame astern, the winch's drive went into overload protection and after a restart it was not possible to drive the winch. Macartney was contacted and it was discovered that a phase in the power supply to the winch was missing. A conductor was broken in the ship’s electrical cable, and we had to pull a cable to the winch from the hangar where it was connected to the main 440V outlets. The winch worked fine after this change.

The rest of the system was connected, function tested and found operational. Before the first deployment, cables for the camera rig and lights on board the Focus had to be reorganized and fastened. During this operation the plug on the pan and tilt unit for camera and light was switched on and off with power still on the vessel. This was needed because the pitch and tilt device had to be driven back and forth to get enough slack in the cables during fastening. This operation caused the pitch and tilt device to fail. The cause was a fault in the serial communication channel. We were not able to address this before leaving last port in Kirkenes for the second leg of the cruise.

During the last part of the cruise a fault was experienced on the Focus electrical safety system which measures the electrical isolation of the system. Station 371 was aborted, and faultfinding did not successfully reveal any faults so further use was suspended rest of cruise.

3.3.1.3 - Result

In total 12 Focus hauls were successfully conducted. Experience and results from the deployments during the cruise showed that the Focus underwater vehicle is an excellent platform for *in situ* investigations of towed fishing gear, both by optics and acoustics. Enough resources must be allocated to ensure proper training and maintenance of the vehicle.

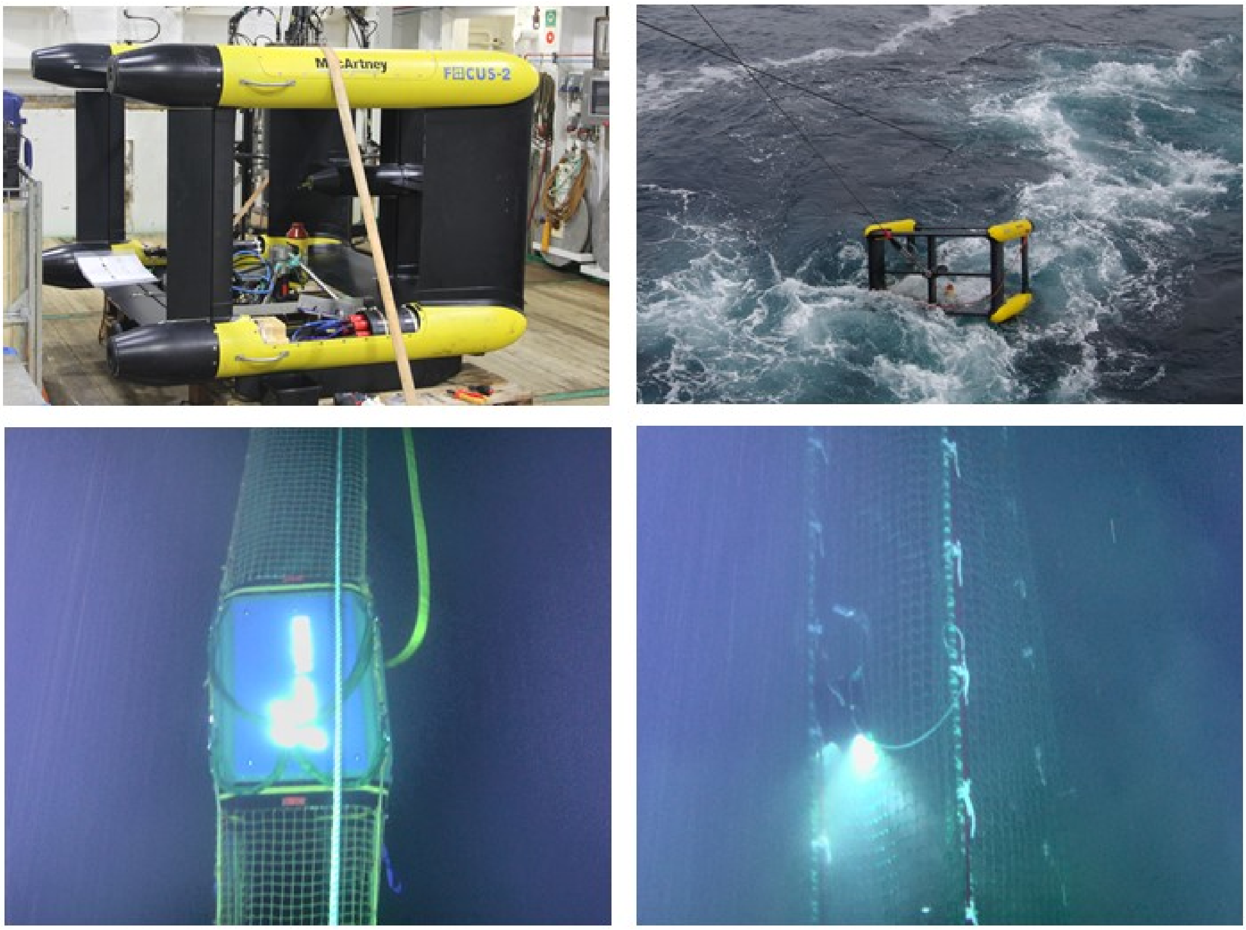


Figure 10 . FOCUS-2 underwater vehicle (MacArtney) used to monitor the trawl, fish behaviour and the sand cloud created by the trawl ground gear. The focus was equipped with a mesotech sonar, cameras and a 200 KhZ echosounder (Kongsberg Maritime AS).

3.4 - Scientific deep vision

3.4.1.1 - Objective

To collect in-trawl images of demersal fish for training and testing an automated identification algorithm and improve the estimation of automated individual counts trough the comparison with the catch.

3.4.1.2 - Method

The Deep Vision in-trawl camera system (Scantrol Deep Vision, Bergen, Norway, Figure 11) was mounted in front of the codend of the adapted Selstad630 bottom trawl. The camera-unit was set to take 5.1MP (2456x2054 Pixels) images with a frequency of 10 frames/second. Aside from collecting more than 18.000 images, each trawl catch was processed following the “Manual for sampling of fish, crustaceans and other invertebrates” (Mjanger *et al.* , 2019). The catch data containing individual length and weight samples by species and total count and weight by species were recorded (Figure 12). During the survey both the picture files and the catch data were loaded into the LSSS system to assist with the selection and scrutinization of acoustic data.

3.4.1.3 - Preliminary results

The DV was used on ten trawl stations (Table 2). Two of these stations were located 20-40 Nm southwest of Bear Island, whereas the other 8 stations were positioned 20 Nm east of Berlevåg (Figure 1). The images were clear with no interference with the sand cloud (Figure 13). The images will be compared to the catch data and provide the starting point for developing DV algorithms on demersal trawl surveys. Bottom trawl catch sizes ranged between 100 and 3000 kg and consisted mainly of haddock, redfish, cod and saith (Table 4).

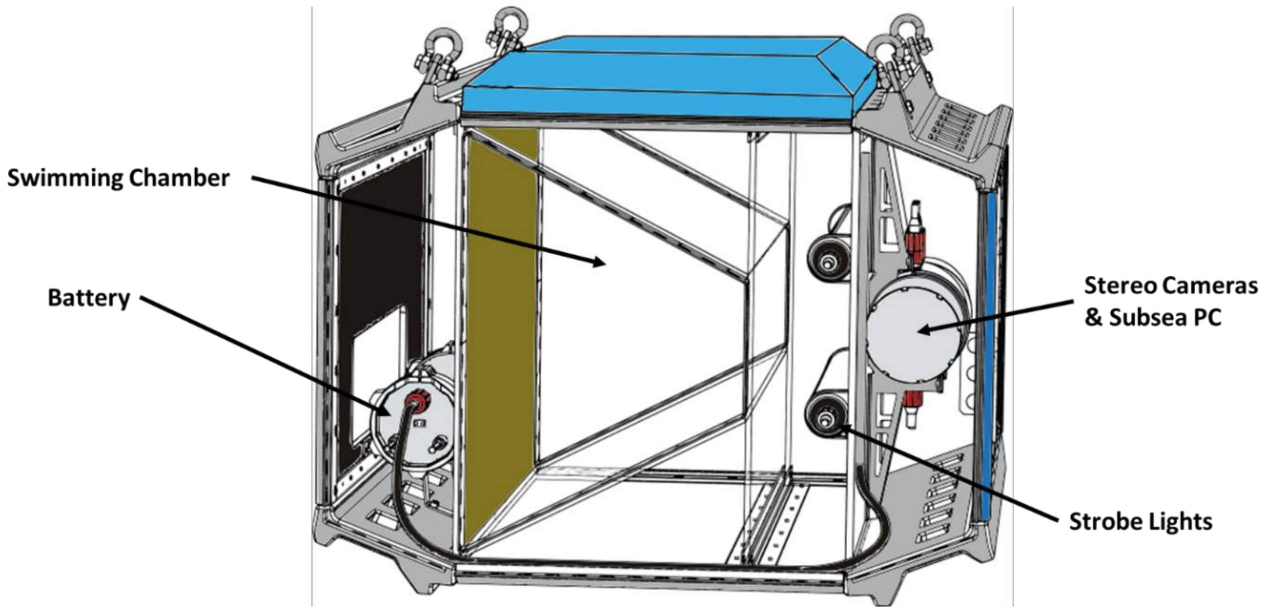


Figure 11 . Anatomy of the Deep Vision Subsea Unit (DVSU) used during the 2021 CRIMAC survey.

Figure 12 Biological sampling. Taraneh Westergerling (left), Anna Oleynik (right) and Ahmet Pala (behind) are working up the catches (Image credit: Rokas Kubilius/Institute of Marine Research)

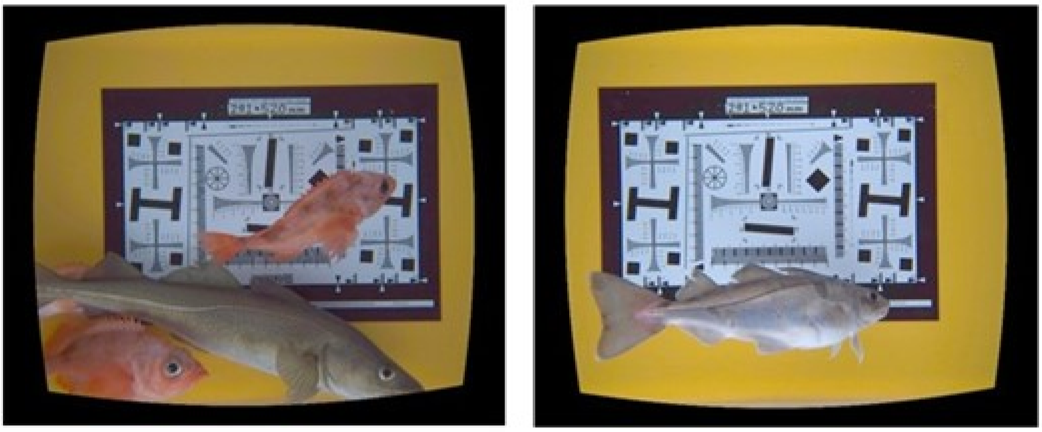


Figure 13 . Deep Vision in-trawl Images of the three dominant demersal fish species Gadus morhua (Cod, Torsk), Melanogrammus aeglefinus (Haddock, Hyse), Sebastes mentella (Deepwater redfish, Snabeluer).

Table 4 . Total catch and main species in trawl stations.

Station no.	Date	Latitude	Longitude	Trawl	Total catch (kg)	Main species
359	12.11.2021	73.65983	18.65333	Test	319	Redfish
360	13.11.2021	74.16017	17.74717	Bottom trawl, Selstad 630.	118	Haddoc
361	13.11.2021	74.12417	18.10550	Bottom trawl, Selstad 630.	399	Haddoc
362	13.11.2021	74.16117	17.99183	Bottom trawl, Selstad 630.	252	Haddoc
364	15.11.2021	70.60783	30.81900	Bottom trawl, Selstad 630.	481	Haddoc
365	15.11.2021	70.61733	30.80233	Bottom trawl, Selstad 630.	204	Haddoc
366	15.11.2021	70.60067	30.93867	Bottom trawl, Selstad 630.	579	Haddoc
367	16.11.2021	70.60583	30.89317	Bottom trawl, Selstad 630.	191	Haddoc
368	16.11.2021	70.61433	30.73633	Bottom trawl, Selstad 630.	2700	Haddoc
369	16.11.2021	70.55850	31.02317	Bottom trawl, Selstad 630.	2400	Haddoc
370	17.11.2021	70.61449	31.63527	Bottom trawl, Selstad 630.	392	Redfish
371	17.11.2021	70.58860	31.87931	Bottom trawl, Selstad 630.	1910	Haddoc
372	17.11.2021	70.59268	31.86211	Bottom trawl, Selstad 630.	249	Haddoc/Cod
373	18.11.2021	71.38999	26.16882	Bottom trawl, Selstad 630.	223	Saith
380	20.11.2021	70.07862	21.27837	Pelagic trawl, Harstad.	NA	Herring

3.5 - Develop and test the Deep Vision fisheries version

3.5.1.1 - Objective

A prototype for the Deep Vision Fisheries version was made ready for the CRIMAC survey in the Barent Sea . The aim was to collect in-trawl images with a modified Deep Vision system for knowledge and testing to the coming Deep Vision system for commercial fisheries. In addition to image collection, Scantrol Deep Vision AS were also gathering information about how such a system can be designed for easy handling when shooting and heaving.

3.5.1.2 - Method

The Deep Vision Fisheries prototype camera system was first mounted right behind the 11m extension of the Selstad 630 bottom trawl. After these experiments, the system was mounted in front of the codend of the VITO pelagic trawl. The system was modified with a special kind of settings compared to the scientific Deep Vision system. Furthermore, the amount and angle of light was adjusted between hauls.

3.5.1.3 - Preliminary results

Having tested the prototype on different trawls indicates that the system that is currently under development can be adaptable for several types of trawls. The prototype was used to collect images on six trawl stations. Three of these were with a white background, and three without any addition to the trawl. The images have been collected and will be further compared. However, a brief look through the images tells us that we have images of Atlantic Herring that can be compared to images from the scientific Deep Vision model.

3.6 - Trawl door positioning

3.6.1.1 - Objective

Information about the horizontal position of the trawl allows the operator to avoid wrecks and other obstacles on the seabed. If combined with information from echosounders and sonars the fishers can also target fishing grounds more efficiently. The objective of this task was to test trawl positioning using the existing ITI transducers and new PX POS sensors, providing information about the range and bearing to each sensor and thus the position of the sensors.

3.6.1.2 - Methods

The vessels existing ITI system combined with new PX POS sensors were used to test the trawl positioning features.

3.6.1.3 - Preliminary results

Spread, depth and temperature data were stable and correct using TP90 and test client. Range measurement also looked stable while bearing measurement were not good. When using the ITI transceiver everything was working smooth.

In the future we will investigate possibilities of combining the door positioning system with sonar system, by visualizing door positions on the sonar. This could improve precision in both pelagic trawling for scientific and commercial purposes.

3.7 - Testing the Harstad trawl

3.7.1.1 - Objective

Fish has been observed to escape the Harstad-trawl during haul back. In addition, damage to the front top webbing of the trawl has been observed when the trawl is taken in on the net drum due to floats penetrating the webbing. The objective of the trawl testing with the Harstad-trawl was to identify if a fish flap webbing panel or a conical webbing panel mounted in the front of the codend could reduce escapement during haul-back.

3.7.1.2 - Methods

Trawl tests to verify if thicker twine in the front top panel of the trawl would affect the trawl performance. The performance was monitored using two GoPro cameras positioned at both sides of the fish lock.

3.7.1.3 - Results

The underwater observations showed that the fish flap webbing panel did not flap down during haul-back, preventing fish for escaping. The conical webbing panel observations indicated that this system could increase fish retention during haul-back by trapping the fish after they passed through it. Thicker webbing in the front top panel of the trawl did not affect the trawl performance.

3.8 - Calibration of acoustic instruments

3.8.1.1 - Objective

The objective of this activity was to ensure proper calibration of the acoustic instrumentation used in the survey.

G.O. Sars is equipped with six drop-keel mounted echosounders (Simrad EK80) capable of continuous wave (CW) (narrowband) or frequency modulated (FM) pulse generation, except the 18 kHz transducer operating in CW only. These have nominal frequencies at 18, 38, 70, 120, 200, and 333 kHz. The TS-Probe is equipped with same type of echosounders (Simrad EK80) with nominal frequencies at 38, 70, 120, 200, and 333 kHz. TS-Probe mounted 38 kHz echosounder is capable of CW pulse generation only and 333 kHz echosounder was not used on this survey.

3.8.1.2 - Echosounder settings

Ship and TS-Probe echosounders were operated with both CW and FM acoustic pulses. Settings for these were chosen to fit survey objectives and to avoid undesirable effects such as acoustic “cross-talk” in broadband data. This influenced the choice of the acoustic bandwidth, power, and pulse duration settings for broadband pulse operation (Table 5). The ship EK80 data were collected using two sets of echosounder settings (setting No.1 and No.2 in Table 5)

Table 5 . Ship and TS-Probe fisheries echosounder settings used during the survey. Ship EK80 echosounder setting No.2 consisted of two ping groups with alternating pinging.

Channel	Pulse shape	Bandwidth [kHz]	Taper	Pulse duration [ms]	Power [W]
A. Ship EK80 echosounder setting No.1					
18-CW	CW	-	Fast	1.024	800
38-CW	CW	-	Fast	1.024	400
70-FM	FM-Up	50-85	Fast	2.048	225
120-FM	FM-Up	90-170	Fast	4.096	100
200-FM	FM-Up	170-260	Fast	4.096	105
333-FM	FM-Up	280-380	Fast	4.096	40
B. Ship EK80 echosounder setting No.2					
Ping group 1					
18-CW	CW	-	Fast	1.024	800
38-CW	CW	-	Fast	1.024	400
70-CW	CW	-	Fast	1.024	225
120-CW	CW	-	Fast	1.024	100
200-CW	CW	-	Fast	1.024	105
333-CW	CW	-	Fast	1.024	40
Ping group 2					
18-CW	CW	-	Fast	1.024	800
38-FM	FM-Up	34-45	Fast	2.048	400
70-FM	FM-Up	50-85	Fast	2.048	225
120-FM	FM-Up	90-170	Fast	4.096	100
200-FM	FM-Up	170-260	Fast	4.096	105
333-FM	FM-Up	280-380	Fast	4.096	40
C. TS-Probe EK80 echosounder settings					
38-CW	CW	-	Fast	0.512	200
70-FM	FM-Up	50-85	Fast	2.048	75
120-FM	FM-Up	90-170	Fast	4.096	100
200-FM	FM-Up	170-260	Fast	4.096	105

The reason for using these specific EK80 settings:

- Up-sweep frequency modulation was used for all channels to make between-channel comparison easier. This is even if combined use of up-sweep and down-sweep on every second channel is known to reduce crosstalk.
- Power choice. Reduction of the power by 3 dB on the fundamental frequency reduces the power on the second harmonic by 6 dB and third harmonic by 9 dB. Thus, reduction of power reduces crosstalk, although it may also reduce the range at the fundamental frequency (not an issue on this survey, depth generally under

300 m).

- Pulse duration choice for frequency modulated pulses (FM). Longer pulses transfer more energy into water. A doubling of pulse-duration doubles the energy in the signal, but the energy increases equally much at the fundamental frequency and its harmonic frequencies. Therefore, increasing pulse-duration for increasing frequency would reduce crosstalk. It is therefore desirable to use long pulses especially on high acoustic frequency channels such as those with nominal frequencies 120, 200, and 333 kHz. These channels were set to 4 ms pulse duration, while 70 kHz and 38 kHz were operated at 2 ms pulse duration.
- High bandwidth and short pulse duration may be negative for the digitized signal, although this is merely speculations.
- A combination of reducing power and increasing pulse-duration at high frequencies is beneficial to avoid crosstalk.
- The 70 kHz system used on the TS-probe should not use frequencies below 55 kHz (ES70-7CD), and the ship 70kHz system (ES70-7C) has poor performance below 50 kHz in general. The ship 70 kHz channel, therefore, use 50 kHz as the lowest frequency. To avoid crosstalk with higher frequencies, the highest frequency is set to 85 kHz.
- It is desirable to change as few settings as possible for data to be directly comparable to previous work (e.g. CRIMAC survey 2020116).
- For some channels the exact setting does not matter much but it is important to stick to the same settings on this and future surveys.

3.8.1.3 - Calibration

Ship drop-keel mounted (2021.11.10, Kirkenes) and TS-Probe mounted (2021.11.20, Kvænangen) echosounders were calibrated using standard methods (Demer *et al.* , 2015) and metallic spheres of various sizes made of tungsten carbide with 6 percent cobalt binder. The calibration sphere diameter was chosen based on the best fit for the bandwidth in question in terms of the “null” positions in the frequency response of the sphere (Table 6 and Figure 14). Both narrowband and broadband pulses were calibrated for the ship and TS-Probe echosounders and the calibration data collection log is presented in Table 7 and Table 8 , respectively. Example calibration results are shown in Figure 15 .

A second calibration target of a different size was used where needed to ensure calibration data across the entire bandwidth of the chosen acoustic pulse (Figure 14) and the two calibration results were merged following the EK80 software procedures. Calibration target diameters used were: 57.2 mm, 38.1 mm, 35 mm, 25 mm, 22 mm, and 20 mm (henceforth referred to in the format “WC57.2” indicating tungsten carbide sphere of 57.2 mm diameter).

The EC150-3C ADCP is mounted on the drop keel along with the fisheries echosounders and is capable of operating as an ADCP and as a split-beam echosounder with a narrow beam width (about 2.5°) with both narrow- and broad-band acoustic pulses. It was calibrated with WC38.1.

An additional weight (900g led) was used to stabilize spheres of smaller size (WC38.1, WC22, and WC20) when calibrating ship echosounders. The weight was suspended 8 m below the calibration target by 0.4mm diameter nylon line. WC57.2 was used alone with no additional weights.

TS-Probe was calibrated when suspended in water by ship crane at 150m depth with additional centre calibrations at 250 and 100 m depth (sphere suspended at the acoustic axis of the chosen echosounder but no movement for beam pattern mapping). The sphere was suspended by a single line (0.4 mm diameter nylon) 8 m below the probe.

Ship EK80 and EC150-3C calibration conditions and calibration quality were good to excellent. TS-Probe calibration was influenced by abundant fish targets that were interfering with the calibration procedure. Calibration result text files may benefit from check-up and calibration re-run from acoustic raw data files before these are used to scale fish and bottom acoustic frequency response data.

Table 6 . Calibration target choice for narrowband (CW) and broadband (FM) pulses of indicated nominal frequency echosounder (e.g. "70CW" - continuous wave pulses at 70 kHz nominal frequency). "Gap" indicates that bandwidth is not fully covered by use of two calibration targets.

	18CW	**38CW**	**38FM**	**70CW**	**70FM**	**120CW**	**120FM**	**200CW**	**200FM**	**333CW**	**333FM**
BW (kHz)	**-**	**-**	**34-45**	**-**	**50(55)-85**	**-**	**90-170**	**-**	**170-260**	**-**	**280-380**
Ship EK80 echosounder calibration targets											
WC57.2	X	X	X	X		X					
WC38.1					X		X	X	X (gap)		
WC35							X		X (gap)		
WC22										X	X
WC20											X
TS-Probe EK80 echosounder calibration targets											
WC35		X		X	X	X	X	X	X (gap)		
WC25					X		X		X (gap)		

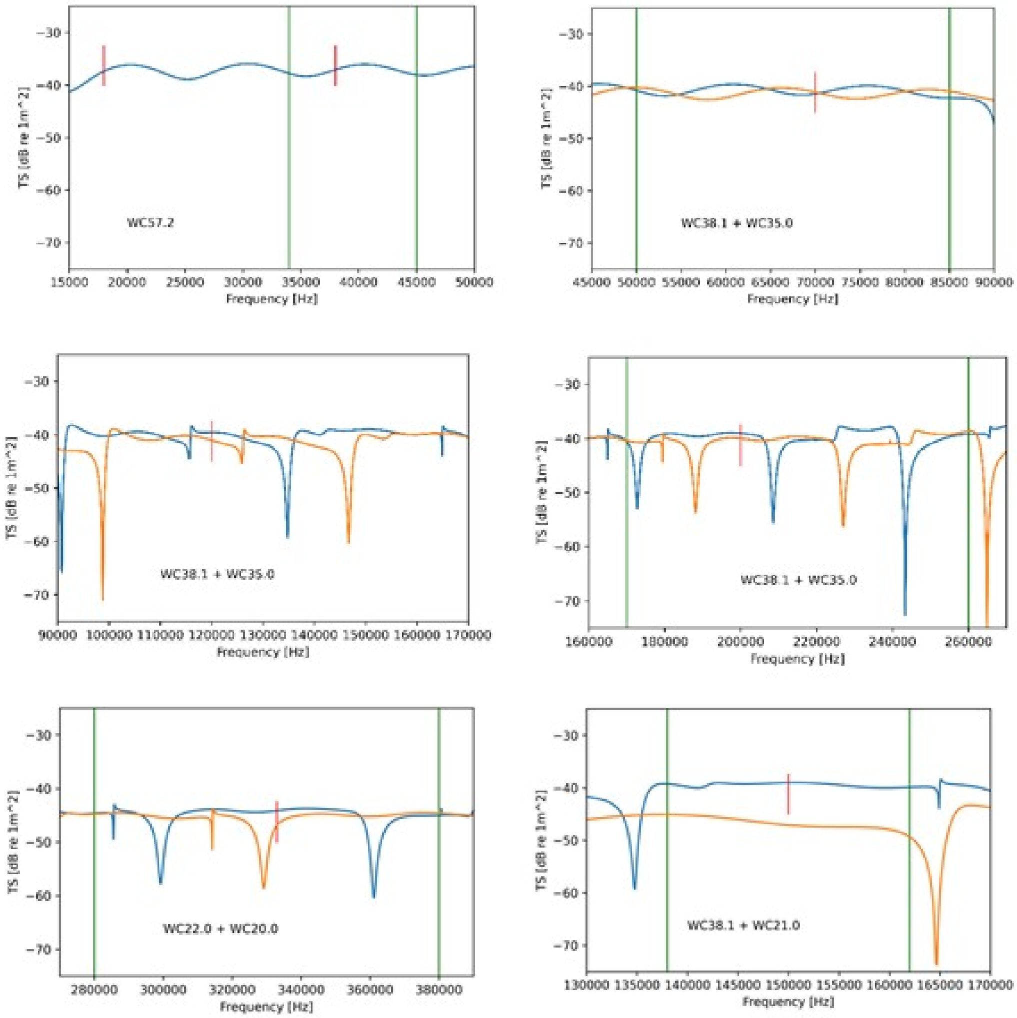


Figure 14 . The expected tungsten carbide calibration sphere acoustic target strength versus acoustic frequency. Calibration targets and target acoustic frequency response for the narrow and broadband pulse calibration of nominal frequencies: (a) 18 and 38 kHz, (b) 70 kHz, (c) 120 kHz, (d) 200 kHz, (e) 333 kHz, and (f) 150 kHz of EC150-3C unit. Dual-sphere calibration was necessary for certain pulses of broad bandwidth. This is to bridge the gaps over "nulls" in the acoustic frequency response of one sphere with data from another sized sphere. "WC57.2" refers to sphere diameter (in mm) and material (tungsten carbide). Blue lines are for the larger of the two spheres in one graph. Vertical red lines indicate nominal "CW" frequencies. Vertical green lines indicate limits of broadband pulse bandwidth.

Table 7 . Ship EK80 and EC150-3C calibration data collection log (2021.11.10/11) in Kirkenes fjord. Data collection sequence is based on calibration target deployment. Calibration sphere ID: WC57.2 - IMR 109, WC38.1 – unmarked (G.O. Sars kit ball), WC35 – IMR129, WC22 – IMR068, WC20 – IMR008. WC38.1 IMR119 was also tested and some data recorded but it was not used to update the echosounder with new calibration results.

Frequency [kHz]	Pulse shape	Pulse duration [ms]	Power [W]	Power taper	Beam mapping	Calibration target	EK80 Updated
EK80 - Ship							
18	CW	1.024	800	Fast	Full	WC57.2	Yes, replace
38	CW	1.024	400	Fast	Full	WC57.2	Yes, replace
38	CW	0.512	400	Fast	Centre	WC57.2	No
38	CW	0.256	400	Fast	Centre	WC57.2	No
34-45	FM-Up	**2.048**	400	Fast	Full	WC57.2	Yes, replace
70	CW	1.024	225	Fast	Full	WC57.2	Yes, replace
70	CW	0.512	225	Fast	Centre	WC57.2	No
70	CW	0.256	225	Fast	Centre	WC57.2	No
70	CW	0.128	225	Fast	Centre	WC57.2	No
50-85	FM-Up	**2.048**	225	Fast	Full	WC57.2	No
120	CW	1.024	100	Fast	Full	WC57.2	Yes, replace
120	CW	0.512	100	Fast	Centre	WC57.2	No
120	CW	0.256	100	Fast	Centre	WC57.2	No
120	CW	0.128	100	Fast	Centre	WC57.2	No
90-170	FM-Up	**4.096**	100	Fast	Full	WC57.2	No
50-85	FM-Up	**2.048**	225	Fast	Full	WC38.1	No, IMR 119
50-85	FM-Up	**2.048**	225	Fast	Full	WC38.1	Yes, replace
90-170	FM-Up	**4.096**	100	Fast	Full	WC38.1	Yes, replace
120	CW	1.024	100	Fast	Centre	WC38.1	No
200	CW	1.024	105	Fast	Full	WC38.1	Yes, replace
200	CW	0.512	105	Fast	Centre	WC38.1	No
200	CW	0.256	105	Fast	Centre	WC38.1	No
200	CW	0.128	105	Fast	Centre	WC38.1	No
170-260	FM-Up	**4.096**	105	Fast	Full	WC38.1	Yes, replace
EC150-3C							
150	CW	1.024	90	Fast	Full	WC38.1	Yes, replace
150	CW	0.512	90	Fast	Centre	WC38.1	No
150	CW	0.256	90	Fast	Centre	WC38.1	No
138-162	FM-Up	**2.048**	90	Fast	Full	WC38.1	Yes, replace

Frequency [kHz]	Pulse shape	Pulse duration [ms]	Power [W]	Power taper	Beam mapping	Calibration target	EK80 Updated
EK80 - Ship							
90-170	FM-Up	**4.096**	100	Fast	Full	WC35	Yes, MERGE
170-260	FM-Up	**4.096**	105	Fast	Full	WC35	Yes, MERGE
333	CW	1.024	40	Fast	Full	WC22	Yes, replace
280-380	FM-Up	**4.096**	40	Fast	Full	WC22	Yes, replace
280-380	FM-Up	**4.096**	40	Fast	Full	WC20	Yes, MERGE

Table 8 . TS-Probe EK80 calibration data collection log (2021.11.20) in Kvænangen fjord. Data collection sequence is based on calibration target deployment. Calibration sphere ID: WC35 – IMR129, WC25 – IMR139.

Frequency [kHz]	**Pulse shape**	**Pulse duration [ms]**	**Power [W]**	**Power taper**	**Beam mapping**	**Calibration target**	**EK80 Updated**
TS-Probe at 150m depth							
38	CW	0.512	200	Fast	Full	WC35	Yes, replace
50-85	FM-Up	**2.048**	75	Fast	Full	WC35	Yes, replace
90-170	FM-Up	**4.096**	100	Fast	Full	WC35	Yes, replace
170-260	FM-Up	**4.096**	105	Fast	Full	WC35	Yes, replace
TS-Probe at 250m depth							
38	CW	0.512	200	Fast	Centre	WC35	No
50-85	FM-Up	**2.048**	75	Fast	Centre	WC35	No
90-170	FM-Up	**4.096**	100	Fast	Centre	WC35	No
170-260	FM-Up	**4.096**	105	Fast	Centre	WC35	No
TS-Probe at 100m depth							
38	CW	0.512	200	Fast	Centre	WC35	No
50-85	FM-Up	**2.048**	75	Fast	Centre	WC35	No
90-170	FM-Up	**4.096**	100	Fast	Centre	WC35	No
170-260	FM-Up	**4.096**	105	Fast	Centre	WC35	No
TS-Probe at 150m depth							
50-85	FM-Up	**2.048**	75	Fast	Full	WC25	No
90-170	FM-Up	**4.096**	100	Fast	Full	WC25	Yes, MERGE
170-260	FM-Up	**4.096**	105	Fast	Full	WC25	Yes, MERGE

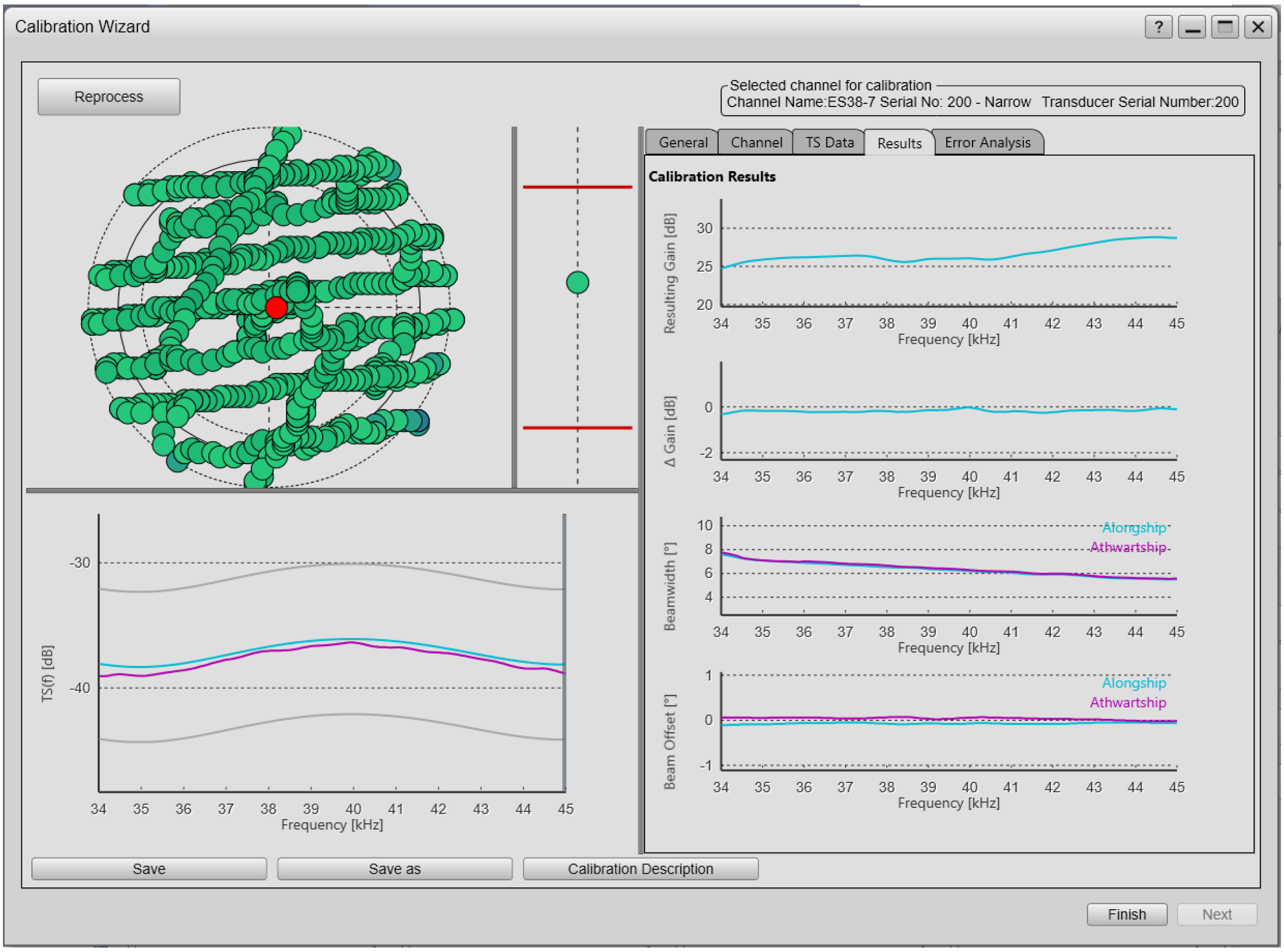


Figure 15 . Representative ship EK80 echosounder calibration example (34-45 kHz pulses, WC57.2) with full beam mapping exercise (left) and calibration results (right) displayed.

3.9 - Broadband echosounder measurements of demersal fish

3.9.1.1 - Objective

The objective of this task was to collect broadband data from demersal fish and validate with trawl sampling and the DV system. Demersal fish is expected to primarily be measured as individual specimens that may be organized as track, so that the broadband acoustic track data can be organized in an acoustic feature library. The broadband data may at any later stage be processed in several different ways, of which one is to split the data into sub-bands.

3.9.1.2 - Method

The data were collected using the standard settings as shown in section 3.8 . The target species were cod and haddock.

When the hull mounted echosounder channels were used in (primarily) FM mode, the settings in Table 5 A were used: this is the settings targeting to be used on standard surveys. The 18 kHz transducer is not broadband, so the EK80/18-kHz channel had to be run in CW. Abundance estimation is primarily done using 38 kHz s data, and to maintain the time-series the EK80/38-kHz channel is suggested to be run in CW still for some time. The other EK80 channels are suggested to be run in FM. When in CW mode, the settings in Table 5 B, Ping group 1, were used.

Both ship-bound and TS-probe EK80 data were processed by KORONA and then scrutinized. There were different KORONA setups depending on their purpose. The ship-bound data were selected from a straight cruise line immediately prior to the collection of Deep vision data. The data were analyzed as follows:

- Data not to be used in this analysis were excluded. This includes data from start of Deep vision data collection and TS probe. The ship-speed echogram noise was used to exclude data slightly before the Deep vision data. The cruise line and ship speed were then used to select approximately 30 minutes of data prior to Deep vision. These data were used for further analysis.
- Results from the catch were inspected (Table 4). Most catches contained more than 90% of cod and haddock combined.
- Data in a depth range from bottom to 40 m above bottom were allocated to Cod/Haddock. The data prior to Deep vision in general did not show clear tracks of fish. The data were attempted tracked, but the preliminary attempts were not very successful. The scrutiny is therefore to be perceived as an indicator in the LSSS Work files and database where to look for data to analyze further after the survey.

3.9.1.3 - Preliminary results

Deep Vision identified several stations that contained primarily cod (*Gadus morhua*) and haddock (*Malenogrammus aeglifinus*) (see section 3.4). Results of the trawl catches from those stations contained typically 20% cod and 70% haddock. Acoustically, there were not much fish to see, neither from hull mounted echosounder -system, nor from the TS-probe (see section 3.11).

3.10 - Crosstalk estimation for broad band echosounders

3.10.1.1 - Objective

The echosounder channels are known to interfere, primarily due to generation of sound at higher harmonic frequencies. This is also known as crosstalk. Theoretical calculations have been done with the purpose of reducing the crosstalk to an ignorable level. The objective here is to verify that the new suggested settings (Table 5 A) are appropriate as standard settings for acoustic surveys.

3.10.1.2 - Method

Data to investigate crosstalk were collected on a similar CRIMAC survey in 2020. Those were used to verify a model for non-linear sound propagation, which in turn were used to suggest new standard settings as found in Table 5 A. Data to investigate crosstalk were collected as backscatter from the bottom at two different locations, with flat bottom at 300 m, and at 100 m. Maximum range for 200 kHz echosounder systems is usually slightly less than 300 m, but for a large and strong target as the bottom 300 m is reasonable. For the 333 kHz channel, only the bottom at 100 kHz is usable. Data for crosstalk were also collected during calibration of TS probe.

The echosounder used the settings as in Table 5 A, but only one channel was active at a time.

3.10.1.3 - Results

Table 9 shows crosstalk between echosounder channels using the recommended settings as found in Table 5 A. Only one channel was active at a time, but NASC from the bottom were measured at all frequencies. Each NASC at a channel was normalized to its active value. As an example for line 3 of Table 9 below: 70 kHz was active, no backscatter was measured at 18 or 38 kHz, but significant backscatter (2.2% of active value) was found at the 120 kHz channel, and little backscatter at 200 kHz (0.2%) and 333 kHz (0.1%). Data from the TS probe will be analyzed later. A preliminary conclusion is that the settings used (Table 5 A) seems to be sufficient, although further investigations will be done.

Table 9 . Crosstalk. Thick black numbers (=1.000) indicates active frequency. Other numbers indicate measurement when frequency

is passive relative to its active state. Red numbers indicate significant crosstalk.

18 kHz	38 kHz	70 kHz	120 kHz	200 kHz	333 kHz
1,000	0,011	0,000	0,000	0,000	0,000
0,000	**1,000**	0,016	0,001	0,000	0,000
0,000	0,000	**1,000**	0,022	0,002	0,001
0,000	0,000	0,001	**1,000**	0,022	0,046
0,000	0,000	0,000	0,002	**1,000**	0,048
0,000	0,000	0,000	0,000	0,000	**1,000**

3.11 - TS Probe

The TS probe is a vertical profiler equipped with echosounders and motion sensors (Figure 16). The probe was equipped with four wideband transceivers (Simrad EK80) coupled to four split-beam transducers (ES38D, ES70-7CD, ES120-7CD, ES200-7CD). The transducers were fastened on a single plastic plate the orientation of which is motor controlled. The probe was also equipped with pitch, roll and pressure sensors. The settings of the WBTs installed on the TS-probe are given in Table 10 .

Table 10 The WBT settings used by the TS probe.

WBT name	Frequency range	Power	Pulse duration
WBT 747008-15 ES38D_ES	38 kHz	200 W	0.512 ms
WBT 747015-15 ES70-7CD_ES	55-85 kHz	75 W	2.048 ms
WBT 747022-15 ES120-7CD_ES	90-170 kHz	100 W	4.096 ms
WBT 747019-15 ES200-7CD_ES	170-260 kHz	105 W	4.096 ms

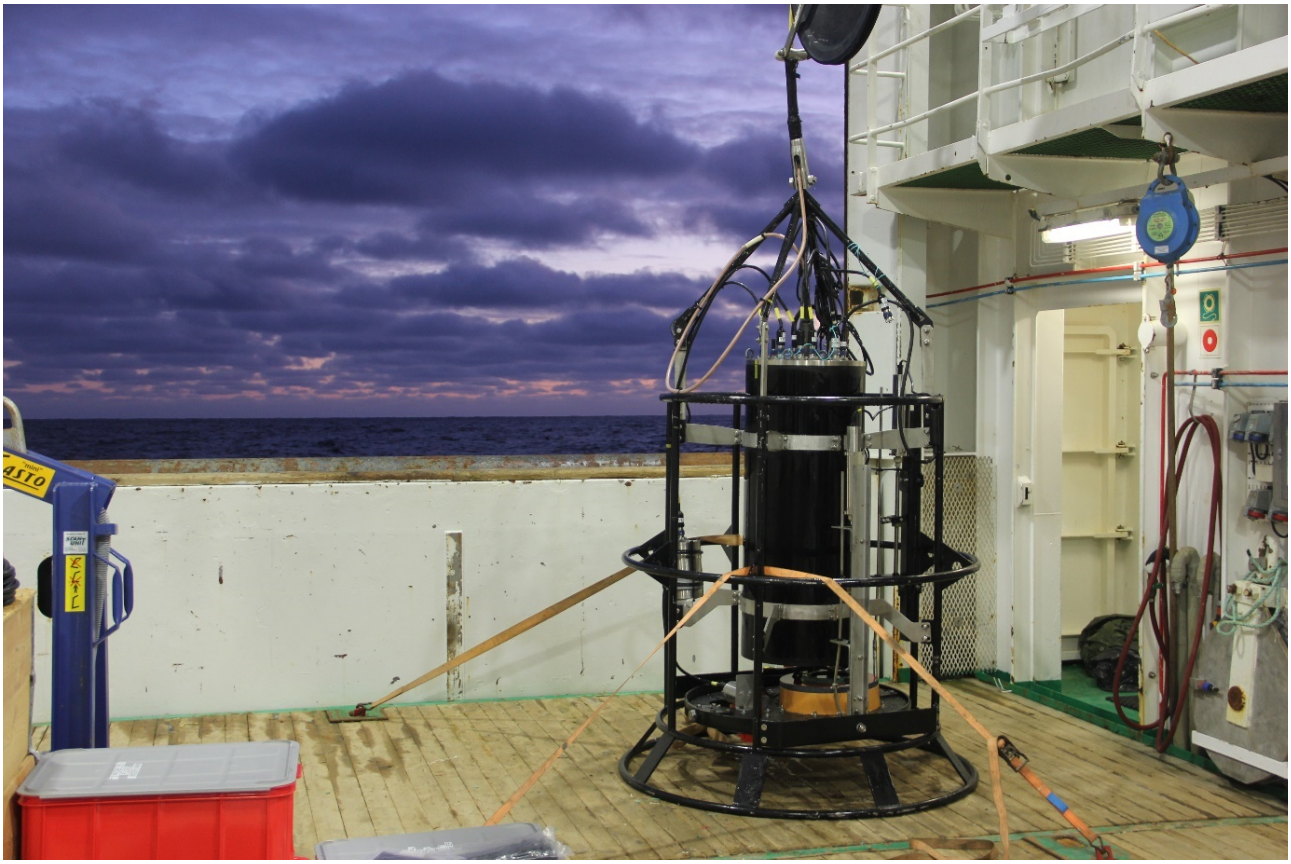


Figure 16 .1. Acoustics-equipped probe ('TS-probe') as suspended by a reinforced electric-optic wire for live communication and data viewing.

Figure 16 .2. Acoustics-equipped probe ('TS-probe') as suspended by a reinforced electric-optic wire for live communication and data viewing. TS-probe contains four broadband transceivers (black cylinder in the middle) that are coupled to the transducers mounted on a motorized plate (bottom). Probe was operated at 100-300 m depth (Image credit: Rokas Kubilius/Institute of Marine Research).

The probe was deployed 14 times (13 measurements and one calibration). Narrowband (38 kHz) and broadband (70, 120, 200 kHz) acoustic recordings were obtained on demersal fishes (all 13 deployments) and the seafloor (10 deployments). Seafloor measurements were performed with different incidence angles by moving the orientation of the plate with the transducers. The echosounder data was collected in simultaneous ping mode, i.e. all transducers transmitted a pulse simultaneously. The probe was calibrated using standard methods (Demer, 2015), and the sets of calibrations were performed at the end of the survey (see calibration chapter). The data collection log is shown in Table 11 . The TS-probe was also used to conduct sequential FM and CW measurements of a sphere.

Table 11 . TS-probe TS(f) data collection log.

TS-probe station number	Date [yyyy.mm.dd]	Time [hh:mm]	Probe depth [m]	Comment
Station 1	2021.11.12	22:49	276	Not much fish, some single targets (small gadoids).
Station 2	2021.11.13	10:07	140	Few fish, mostly mesopelagic organisms.
Station 3	2021.11.13	17:59	100-126	Weak targets.
Station 4	2021.11.15	14:28	100-115	Good number of targets, mostly smaller but some large targets.
Station 5	2021.11.15	20:00	120-137	Mostly weak targets, some stronger targets.
Station 6	2021.11.16	01:42	110-138	Many weak targets.
Station 7	2021.11.16	01:52	80	Interesting registrations (stronger targets).
Station 8	2021.11.16	12:47	107-137	Large targets and many weak targets.
Station 9	2021.11.16	22:14	100	Mostly weak targets.
Station 10	2021.11.17	05:20	100	Similar as previous (mostly weak targets).
Station 11	2021.11.17	13:06	230	Similar as previous (mostly weak targets).
Station 12	2021.11.17	19:40	237	Mostly weak targets
Station 13	2021.11.17	17:57	250	Mostly weak targets
Calibration	2021.11.19	22:15	150	Calibration of TS probe

3.11.1 - TS probe measurements fish

3.11.1.1 - The objective

The objective of using the TS probe was to measure dorsal aspect TS(f) at 38 CW and 55-260 kHz FM of individually separated demersal/semi-demersal fish (cod, haddock) and other targets of interest. The data will be part of the CRIMAC acoustic library.

3.11.1.2 - Method

13 deployments of the probe were performed. The probe was generally lowered to 50-30 m above seafloor (dependent on fish height above seafloor) and collect data until enough single target detections (500 fish targets). Duration of the data collection depended on the density of fish (number of successful registrations). Trawl stations were performed prior to each TS probe station.

3.11.1.3 - Preliminary results

Most single fish detections consisted of smaller targets, with some stations also containing larger targets (large cod or haddock). In general, there were low densities, and the number of successful registrations were limited. A few examples of small (Figure 17) and large (Figure 18) targets were successfully recorded. Broadband responses of the different cases are given in Figure 19 .

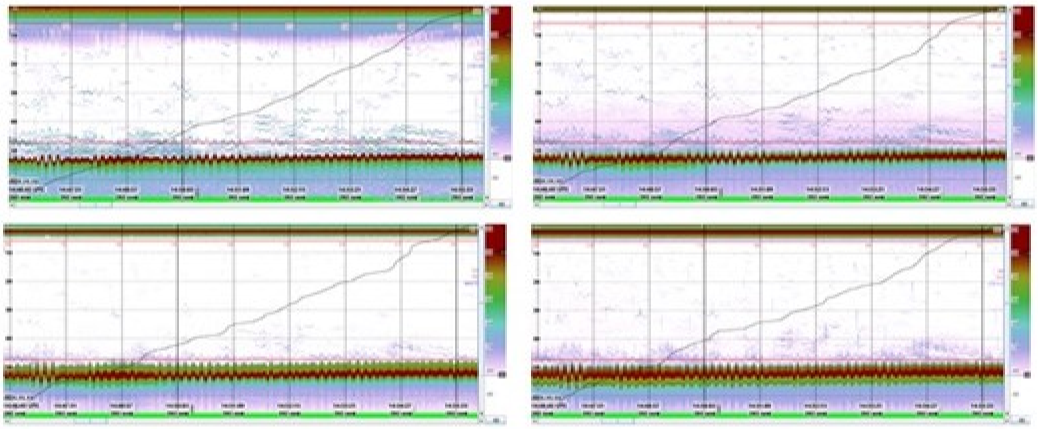


Figure 17 . Example of smaller targets. Pulse compressed echograms for 38, 70, 120 and 200 kHz.

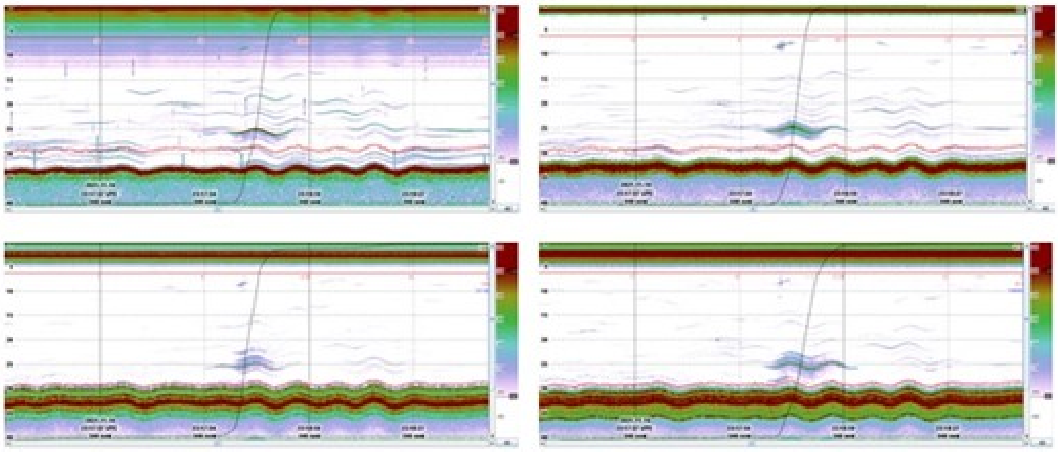


Figure 18 . Example of larger target. Pulse compressed echograms for 38, 70, 120 and 200 kHz.

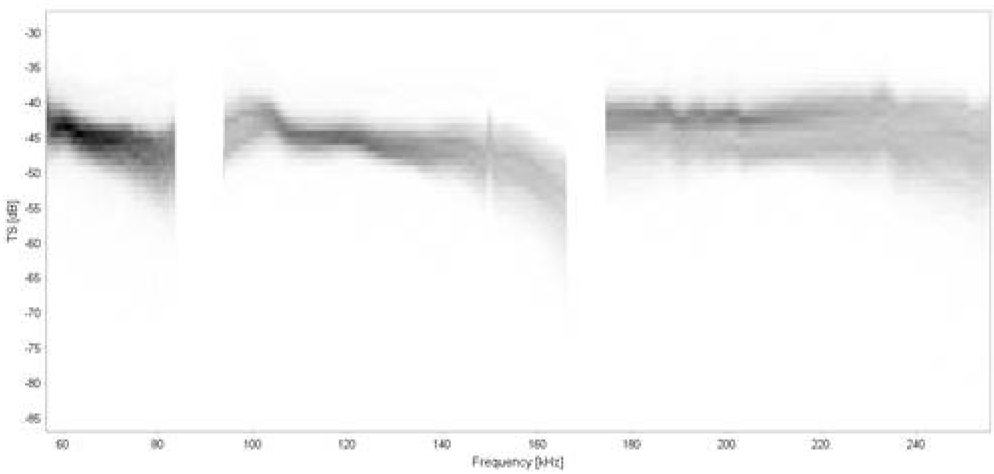


Figure 19 .1. Broadband frequency response (TS(f)) for multiple small targets in Figure 17 .

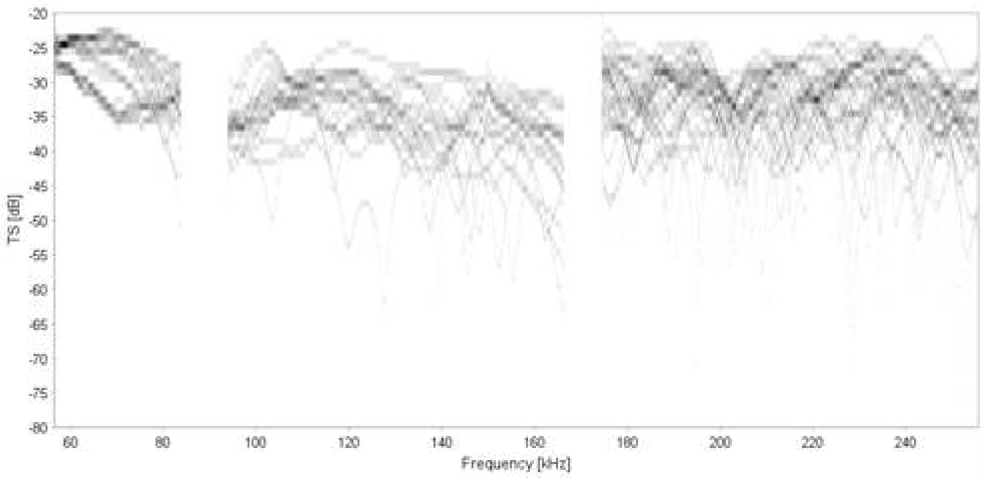


Figure 19 .2. Broadband frequency response (TS(f)) for multiple large target in Figure 18 .

TS probe data has separate LSSS projects, with the same categories as for the shipboard acoustic data. After collection of fish TS(f) the protocol for broadband measurements of seafloor was followed (see next section).

3.11.2 - Broad band signatures of seafloor substrates using the TS probe

3.11.2.1 - Objective

The objective of this task was to gather information on the frequency response of different seafloor substrates from the TS-probe at short range and 0-15° incident angles. The measurements will provide data for further improvements of bottom detectors as well as bottom classification algorithms.

3.11.2.2 - Method

Acoustic backscatter from the seafloor was collected at 10 TS probe stations at 30 m range and with 0-15° incidence angle.

The TS-probe was positioned approximately 30 m above the seafloor with the echosounders at 0° incidence angle to the seafloor. The echosounder data were then recorded for approximately 300 pings/90 seconds at each discrete step of 0°, 5°, 10°, and 15° incidence angle. This procedure was repeated 5 times at each station, except at station 1 and 2, where 3 and 4 repetitions were performed, respectively. The motors for tilting the transducers in the pitch and roll direction were controlled by a LabView program.

The heave of the ship was translated to the TS-probe through the winch cable. The pressure at the TS-probe was measured continuously and included in the raw acoustic files as NME0 datagrams. The raw files were processed to include the depth information as heave in the MRU0 instead of the NME0 datagrams. For each file, the mean depth was calculated, and the deviations from the mean depth were interpreted as heave and included in the MRU0. The heave compensation routine compensates the heave partially – but not completely – as seen in Figure 20 .

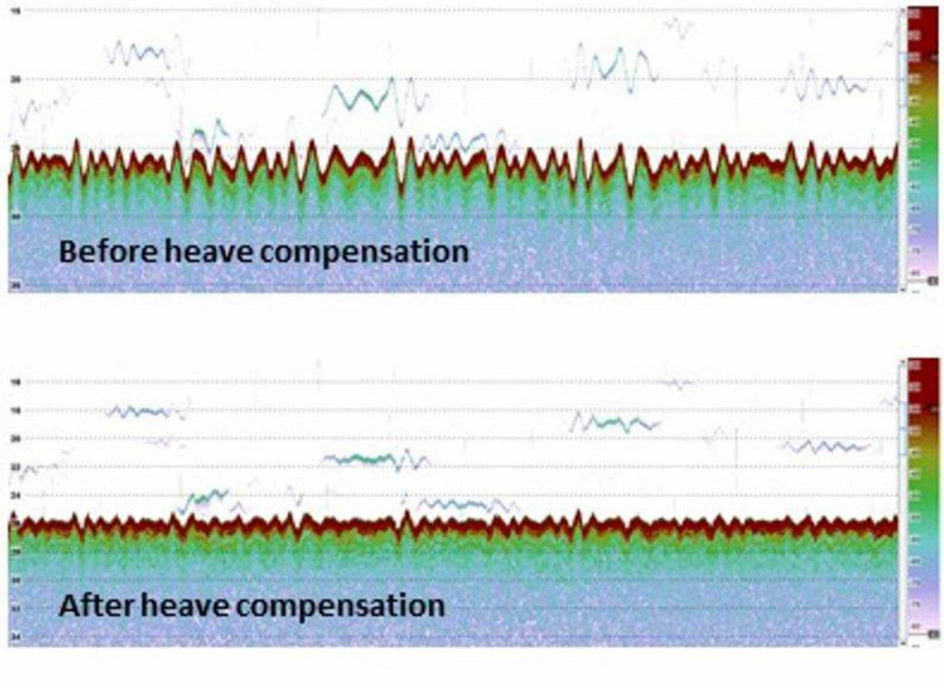


Figure 20 . Heave compensation using pressure data.

3.11.2.3 - Preliminary results

Ten stations of bottom measurement were conducted (Table 12). Five different bottom substrate categories are covered during the survey, with grain size code 115, 120, 130, 150, and 160.

Table 12 . TS probe stations for bottom,

Name	Start time	Stop Time	Latitude	Longitude	Grain size	Grain size code
TS probe 1	2021-11-12T23:40:36.927Z	2021-11-13T00:39:00.887Z	73.644520	18.447928	Slamholdig sandholdig grus	150
TS probe 2	2021-11-13T11:13:59.154Z	2021-11-13T12:08:03.393Z	74.181527	17.573757	Grusholdig sandholdig slam	115
TS probe 3	2021-11-13T18:49:36.745Z	2021-11-13T19:48:33.032Z	74.157051	18.018790	Slamholdig sandholdig grus	150
TS probe 4	2021-11-15T15:37:38.211Z	2021-11-15T16:43:46.473Z	70.637755	30.705793	Sandholdig grus	160
TS probe 5	2021-11-15T21:08:37.392Z	2021-11-15T22:12:50.434Z	70.622857	30.792795	Sandholdig grus/Grusholdig slamholdig sand	160/120
TS probe 6	2021-11-16T02:23:10.150Z	2021-11-16T03:21:58.528Z	70.619629	30.824483	Sandholdig grus/Grusholdig sand	160/130
TS probe 7	2021-11-16T13:56:03.953Z	2021-11-16T14:58:40.688Z	70.599902	30.783005	Sandholdig grus/Grusholdig sand	160/130
TS probe 8	2021-11-16T23:38:40.949Z	2021-11-17T00:42:53.724Z	70.575867	30.935603	Sandholdig grus	160
TS probe 9	2021-11-17T14:21:56.757Z	2021-11-17T15:28:09.309Z	70.633064	31.738373	Grusholdig slamholdig sand	120

Name	Start time	Stop Time	Latitude	Longitude	Grain size	Grain size code
TS probe 10	2021-11-17T20:16:58.876Z	2021-11-17T21:11:55.584Z	70.652139	31.701720	Grusholdig slamholdig sand	120

The frequency response of the acoustic data is calculated for each TS-probe deployment (Figure 22), and each deployment is linked to a sediment type (Figure 21). The results indicate a frequency dependence on the incident angle, which is to be investigated further in future work on this data.

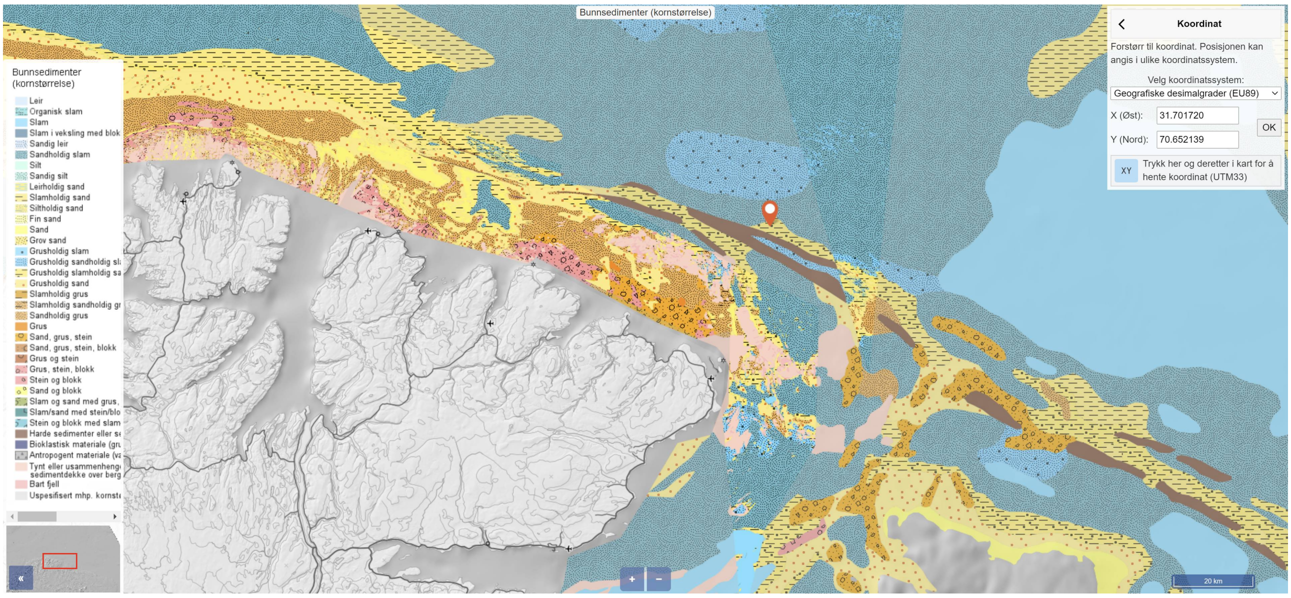


Figure 21 . Each deployment is linked with the sediment types documented by NGU.

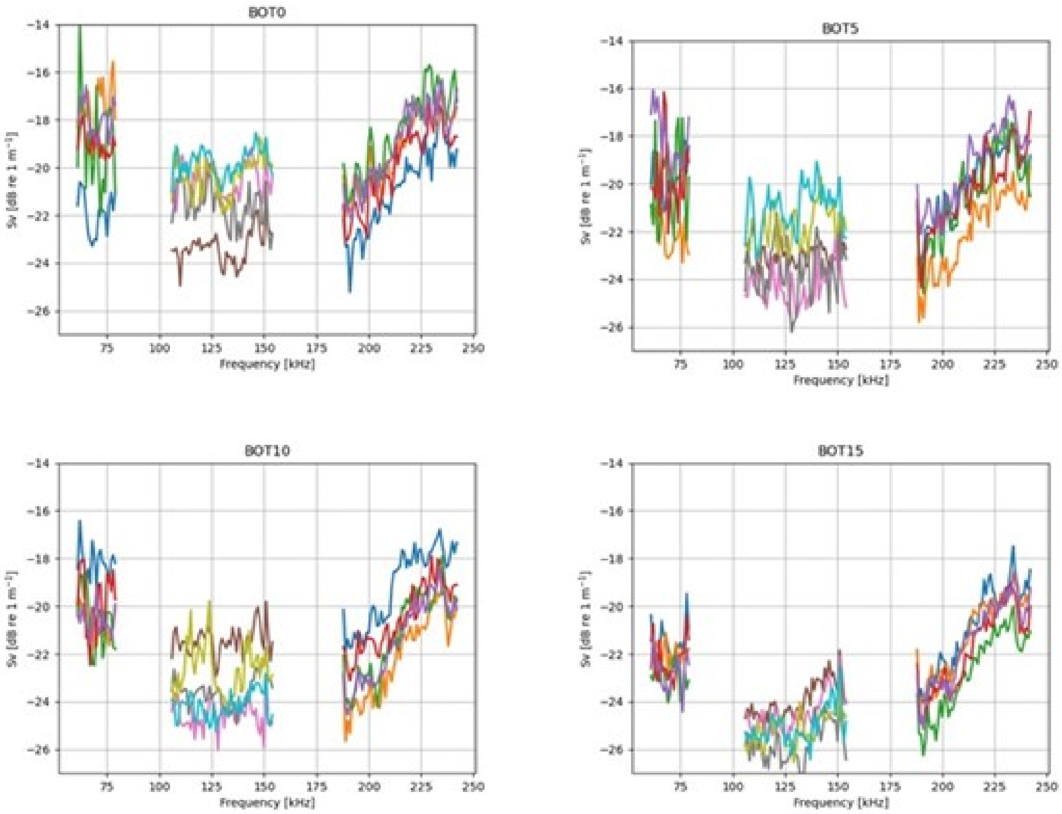


Figure 22 . The frequency response results for TS-probe.

3.11.3 - Optimal settings for near-seafloor broad band measurements

3.11.3.1 - Objective

The objective was to investigate settings that could be used to measure fish closer to the bottom.

3.11.3.2 - Method

Preliminary investigations have indicated that short CW-pulses make it possible to measure fish closer to the bottom than long CW pulses or even longer FM pulses. Although pulse-compression of FM signals give a very fine spatial resolution of pelagic targets, the temporal side-lobes of the pulse-compression results in difficulty in getting close to the bottom. Therefore, a sequence of shorter CW pulses was used to attempt seeing fish closer to the bottom. This experiment was, however, not carefully planned, and was carried out in an area where there were not many fish-tracks close to the bottom. Ideally it should have been done in an area with many clear tracks close to the bottom, and then compare the results of the different settings. Thus, this is a typical ad-hoc experiment that should be made when fish-registrations allow for such investigations. Still, this require the echosounder systems to be calibrated a prepared for this experiment.

3.11.3.3 - Preliminary results

No results

3.12 - Verification of extraction of CW (narrowband) from FM (broadband)

3.12.1.1 - Objective

Multifrequency data are currently used to aid manual acoustic target classification. A natural extension from using multifrequency to broadband data would be to apply the same functionality. Broadband data could be split into many more frequencies than previous multifrequency systems. Furthermore, each pulse-compressed nominal frequency is based on a wider bandwidth (10 - 25 kHz) than the existing multifrequency system (3 kHz for the previous echosounder EK60, thought to be similar for EK80). An acoustic feature library and belonging functionality to process data already exists in LSSS. The objective is to verify that conversion of FM (broadband) data gives the same acoustic abundance as CW (narrowband) data.

3.12.1.2 - Methods

Based on previous work, settings for echosounder power and pulse durations to minimize crosstalk was suggested (section 3.10). EK80 was calibrated (section 3.8) for those settings, that were intended to be used during this and future surveys at IMR using broadband. Furthermore, EK80 was also calibrated for CW mode for the same power settings, and with 1 ms pulse durations on all frequencies. Data of EK80 alternating between pinging FM (broadband) pulses and CW (narrowband) pulses by means of EK80 mission planner. All channels were used in CW mode every second ping, and as many channels as possible were used in FM every second ping. Currently the channels are 38, 70, 120, 200 and 333 kHz. The 18 kHz channel was always run in CW mode as the 18 kHz transducer did not have enough bandwidth to be used in FM mode.

Ideally, the data to be used should contain some schools 50 – 100 m below the sea surface. The reason for this is that such shallow schools do not require noise quantification and noise removal. Although noise-corrected data should also be good to verify this, noise removal is done in independent processes and therefore introduce an additional uncertainty in the processing that should be avoided if possible. In addition to data from single individuals of fish and schools of fish, data from spheres were collected.

Prior to the survey, the implementation of the equations for extracting CW components from FM data were verified. The equations were implemented both in LSSS, and independently in Python. The extraction of CW components of FM data will be verified further with that setup.

Comparison of several schools and single individuals give generally the same result as those reported in Figure 23 and Figure 24 : the points at the right side of the curve (as Figure 24 – right panel) are most like CW, but not exactly the same. Sometimes the FM points are slightly stronger than CW, sometimes they are weaker, but on average the impression is that they are close to those from CW pulses. Note that the energy of a 3 kHz section of a 4 ms FM pulse is less than 15% that of a 1 ms CW pulse that is also expected to be 3 kHz, while a pulse with 20 kHz bandwidth has comparable energy.

3.12.1.3 - Preliminary results

CW data and CW components extracted from FM data will not give exactly the same result, but it is expected that they will be on average similar when made as comparable as possible. The comparison is done in the following way:

1. The first point in the comparison (as seen in the figure below) is CW data, the second is the whole bandwidth of FM data pulse compressed, i.e. the same as EK80 shows.
2. The second point is cut by 1 kHz at each end just to see if there is any difference with LSSS using a different bandwidth.
3. Third point is the widest symmetric bandwidth around the (120 kHz) frequency.
4. Following points are all symmetric at decreasing bandwidths until the final point of 3 kHz.

Figure 23 shows an example of comparison between CW and extracted CW components of the FM band, and

Figure 24 shows the broadband spectre used to generate the CW components in Figure 23 .

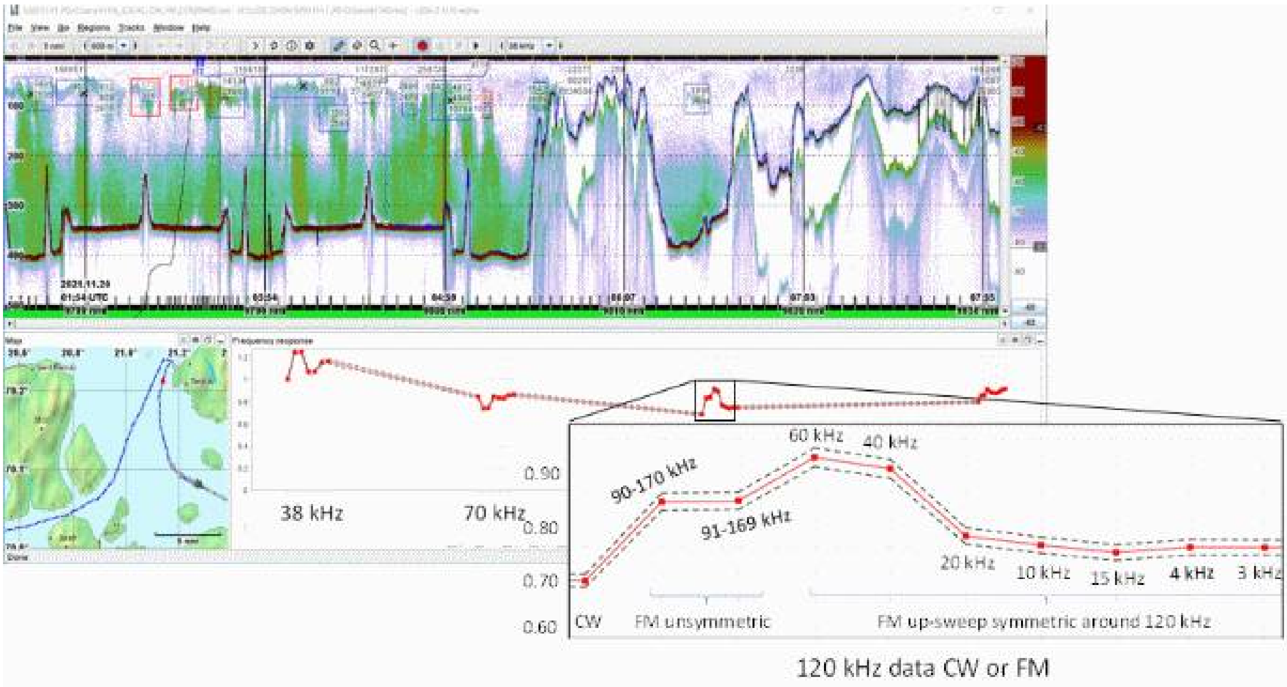


Figure 23 . Schools of herring used to compare CW data and CW components extracted from FM data. The upper panel shows the echogram, and the schools encircled in red that are used to make the frequency response. A section of the frequency response at 120 kHz is enlarged. First point is EK80 CW data, second point shows the complete EK80 band of the 120-kHz channel used in the pulse-compression. The following points show decreasing bands used in the pulse-compression until the final that contains only 3 kHz that is expected to be the bandwidth used by the CW signal.

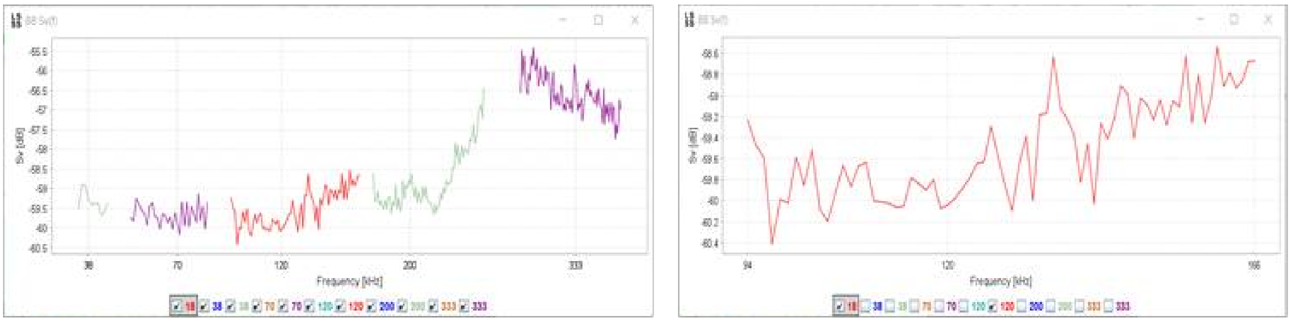


Figure 24 . Broadband frequency specter of whole band (left) and the 120 kHz EK80-channel (right) at 1 kHz resolution. The broadband specter shows that the averaged value depends on the used bandwidth.

3.14 - Test and verification of the Simrad EC150-3C combined echo sounder and ADCP

3.14.1.1 - Objective

The objective was to further test and characterize the Simard EC150 combined echo sounder and ADCP. The instrument was made commercially available in 2020, and further testing in open waters, at varying conditions with and without targets like fish in the water column, is desired. The test includes comparing the estimates from the Ocean Surveyor 150 kHz ADCP with the EC150-3C. KONGSBERG is also exploring new ways to calibrate the EC150 as ADCP.

3.14.1.2 - Methods

Several experiments have been conducted to meet the objectives. These are:

1. General testing. Data has been collected throughout the cruise, changing between CW and FM as well as different cell sizes.
2. Calibration. Two different patterns were tested. In the first the vessel went in circles, first clockwise, then counterclockwise. Speed was 5-10 knots and data were collected for two full rounds in each direction. The second pattern was to run a straight line, making sharp turns, almost like a “drunk man walking”. The ship went in one direction for about 30 minutes, then turned and tried to follow the same track in the reverse direction.
3. Comparison with Ocean Surveyor 150. Data were collected with EC150 and OS150 pinging alternately. Data were collected with CW/NB mode as well as FM/BB, using different cell sizes.
4. Data were collected with the EC150 alternating between ADCP mode and echo sounder mode for every other ping. This is a unique feature for this instrument and gathering data under varying conditions is valuable for characterisation and verification of the operation.

3.14.1.3 - Results

Data sets for testing the system were secured. The preliminary data analysis indicates that the data collection has been successful (Figure 25), but more in-depth analysis will be needed. The EC150 was also used for determining speed and direction of water currents during trawling, c.f. the trawling activities above.

Figure 25 . Screenshot showing the EC150 alternating between ADCP and echosounder modes.

4 - Data organization

The data is organized in accordance with the IMR data organization procedure. In this section the placement of each data set it described as well as a short description of each individual data set. The headings are equal to the folders in the data structure.

4.1 - OBSERVATION_PLATFORM

4.1.1 - TS_PROBE

The EK80 echosounder channels on the TS probe were calibrated 2021.11.20 *after* the collection of TS data for the bottom and demersal fish. TS-probe was stored at:

\S2021111_PGOSARS_4174\OBSERVATION_PLATFORMS\TS_PROBE\TS_PROBE_EK80_RAWDATA

The folders are organized by activity (TS-PROBE), TS station number as recorded in the “Toktlogger” (e.g. STATION-1), date (e.g. 20211112) and optionally running number (e.g. 1) if there are multiple stations in one day.

TS-PROBE-STATION-1-20211112

TS-PROBE-STATION-2-20211113-1

…

Pitch, roll, heave measurements are stored in

*\S2021111_PGOSARS_4174\OBSERVATION_PLATFORMS\TS_PROBE\TS_PROBE_EK80_RAWDATA\PITCH-
ROLL*

File name convention follows

TS-PROBE-STATION-1-EZ-PITCH-ROLL-DATA-20211112224153.TXT

TS-PROBE-STATION-2-EZ-PITCH-ROLL-DATA-20211112224153.TXT

…

4.1.2 - FOCUS

\S2021111_PGOSARS_4174\OBSERVATION_PLATFORMS\FOCUS2\

The data are arranged into subfolders including echosounder, video and scanning sonardata:

EK80\

MESOTECH\

VIDEO\

Within these subfolders data are organized in folders by station number

361

362

…

Timestamps for each haul is calculated by an .PY script and put into “tidsstempler.txt” file.

4.2 - ACOUSTIC

The shipboard EK80 echosounder channels were calibrated 2021.11.10-11. The acoustic data are located at \S2021111_PGOSARS_4174\ACOUSTIC\. Under that directory, the echosounder raw-data, the LSSS work-files, and the pre-processing setups are located. Ship-borne EK80 data was stored at \EK80\EK80_RAWDATA. The LSSS work-files are found at \LSSS\WORK.

The LSSS survey/project files should normally be located at \LSSS\LSSS_FILES. However, in this case the survey files are not stored but can be re-generated at will.

The setup for processing EK80_RAWDATA to processed KORONA files are most easily found at \LSSS\LSSS_FILES\SETUP_FOR_KORONA_PROCESSING. There are several directories containing setups for processing there, of which each contain the - setup itself and the reference files. The directories are:

- copiedConfigFiles_CROSSTALK,
- copiedConfigFiles_DeepVision,
- copiedConfigFiles_FM_CW_comparison,
- copiedConfigFiles_KORONA_KLOSER_TO_BOTTOM

The KORONA files itself (i.e. processed EK80 files) are not stored but can be generated using the setup above. The IMR data directory storage structure did not allow for a data organizing containing several versions of KORONA processing.

4.3 - BIOLOGY

4.3.1 - CATCH_MEASUREMENTS

4.3.1.1 - BIOTIC

Catch data are stored by station number:

\S2021111_PGOSARS_4174\BIOLOGY\CATCH_MEASUREMENTS\BIOTIC\

4-2021-4174-11_359_73124

4-2021-4174-11_360_73125

…

4.3.1.2 - GOPRO VIDEOS

\S2021111_PGOSARS_4174\BIOLOGY\CATCH_MEASUREMENTS\OTHER_MULTIMEDIA\TRAWL_VIDEO\

The data is organized into subfolders by station number

341

342

…

Within each folder there is a ### Readme.txt file containing video description for the haul (this folder also includes GoPro camera attached on FOCUS). A detailed description of the position of each camera can be found in Annex 1: Trawling - log and instrumentation .

358\358 Readme.txt

359\359 Readme.txt

…

4.3.1.3 - DEEP_VISION

\S2021111_PGOSARS_4174\BIOLOGY\CATCH_MEASUREMENTS\DEEP_VISION\

Deep vision data are organized into subfolders by timestamp (yyyymmddThhmmZ). Within each subfolder are separate folders for the right and left stereo camera.

20211104T1237Z

20211108T0938Z

…

4.3.2 - TRAWL_SENSORS

4.3.2.1 - TRAWL_SONAR

\S2021111_PGOSARS_4174\BIOLOGY\TRAWL_SENSORS\SIMRAD\PX\

The data are stored by station number (same name as in toktlogger). Witihin each station folder are; .csv and .dat files with the measurements and screen shots that were taken occasionally. Time on display is in UTC.

Bunntrål 342

Bunntrål 343

…

4.4 - CRUISE_DOCUMENTS

4.4.1 - MULTIMEDIA_FILES

4.4.1.1 - IMAGES

T:\S2021111_PGOSARS_4174\CRUISE_DOCUMENTS\MULTIMEDIA_FILES\IMAGES\

Images are stored in folders with the name of the person who took the photos. Under the name folder pictures are either stored in folders named after the camera that was used and / or in folders named “public” and “nonpublic”.

NAME1

NAME2

…

4.4.1.2 - VIDEOS

T:\S2021111_PGOSARS_4174\CRUISE_DOCUMENTS\MULTIMEDIA_FILES\VIDEOS

Annex 1: Trawling - log and instrumentation

In this document each trawl haul is described in detail, including instrumentation used and where on the trawl it was positioned, how the trawl was rigged and any other important information about the haul. Trawl logs with measurements registered during the hauls are presented in Tables 1 – 3.

PART I

Date: *02.11.2021*

4.4.1.3 - Haul 1, station 341

Trawl: Selstad 630

Selstad 630 trawl mounted on ground gear with 60 pcs of 14 mm quick links.

Thyborøn 23 VFG, 8.0 m ² trawl doors.

- 10.7 m 2-4 panel transition
- 10.7 m diamond mesh extension
- Åkra cod end
- Simrad Trawl eye above ground gear
- 2 x rbr depth sensors in the middle of ground gear for intercalibration
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- Simrad Trawl eye 1.2 m from aft of extension
- Go-pro camera 3.2 m aft of extension

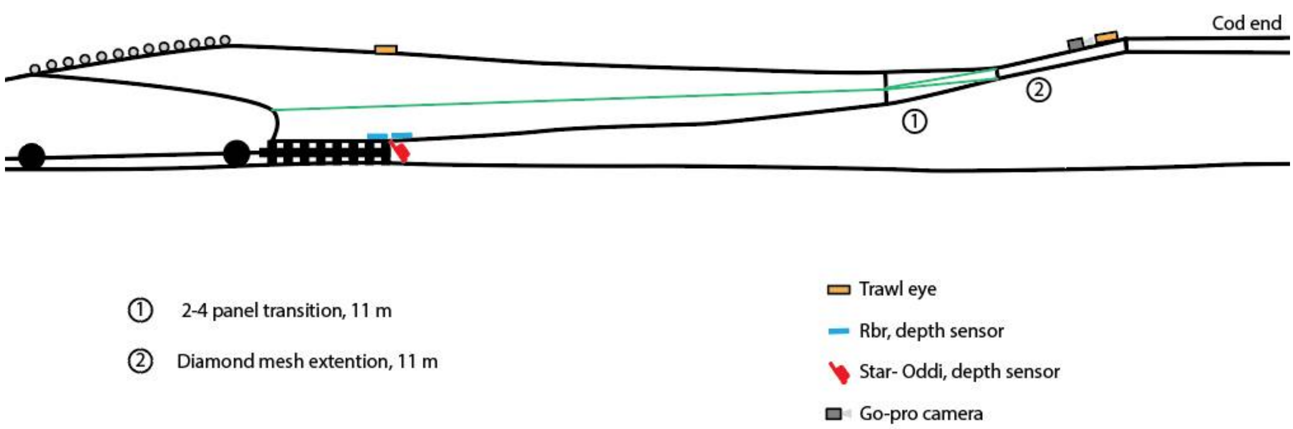


Figure 1. Selstad 630 trawl with instrumentation

Mount the 2-4 panel transition to the back of the trawl, it stays mounted throughout the whole cruise. The first test is with the 10.7 m diamond mesh extension to get an idea of what the height over bottom will be.

Door spread looks good ~115 m, and the opening of the trawl is about 6.5-7 m. Cannot get clear signals from the trawl eye at the end of the extension, but it seems like it is around 4 m from trawl eye to bottom. It may not be mounted correctly, and we get this confirmed by the Go-pro video: the netting is a bit slack and there is a slight twist in the extension such that the trawl eye is not pointed directly down towards the seabed.

Measure the exact length of transition panel and extension, both are 10.7 m.

Examine 2-4 panel transition, extension, and cod end to see if there is anything wrong, it does not appear so, but the large meshes in the front of the cod end are removed to be on the safe side.

The FOCUS gets a little dip in the sea, but not all the way down to look at the trawl.

4.4.1.4 - Haul 2, station 342

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 10.7 m diamond mesh extension
- **Simrad Flow sensor on headline**
- Simrad Trawl eye above ground gear
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- Simrad Trawl eye 1.2 m from aft of extension, upper panel
- **1 x rbr depth sensor next to trawl eye, upper panel**
- **1 x rbr depth sensor below trawl eye, lower panel**
- Go-pro camera 3.2 m from aft of extension
- FOCUS

The FOCUS goes out and down to the trawl, measures width and height from end of the extension and all the way forward to the wingtips.

The extension is measured to have an opening cross-section of 0.6 x 0.6 m.

There are some waves in the netting in the aft section of the trawl, may have been a bit misaligned when mounted to starboard rib line.

Height over bottom from trawl eye: ~ 6 m.

4.4.1.5 - Haul 3, station 343

Trawl: *Selstad 630 trawl*

- 10.7 m 2-4 panel transition
- 10.7 m diamond mesh extension

- **22 x floats**
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- Simrad Trawl eye 1.2 m from aft of extension, upper panel
- 1x rbr depth sensor next to trawl eye, upper panel
- 1x rbr depth sensor next to trawl eye, lower panel

Mounts 22 pcs. of 9.5'' floats with a buoyancy of 4.9 kg each, on the top rib lines of transition panel and extension, 2 m between each float.

Height over bottom from trawl eye: 6-7 m.

Date: *03.11.2021*

4.4.1.6 - Haul 4, station 344

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- **15 m square mesh extension**
- **0 x floats**
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- 1 x rbr depth sensor next to trawl eye, upper panel
- 1 x rbr depth sensor below trawl eye, lower panel
- Go-pro camera 6.0 m from aft of extension
- FOCUS

During the night, the crew has removed the diamond mesh extension and mounted the square mesh extension, 15 m, to the trawl. To make sure that the different measurements are the same as before with the 10.7 m long extension, the trawl eye is mounted on the upper panel, 11 m from front of extension. Go-pro 2 m in front of trawl eye looking back. Floats are taken of.

The FOCUS measures from extension and forward. The extension is still slightly twisted, and there are some waves in the aft section of the trawl.

Measures the diamond mesh extension: 15 m.

Height over bottom from trawl eye: approx. 4 m.

4.4.1.7 - Haul 5, station 345

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 15 m square mesh extension
- **22 x floats**
- **Simrad distance sensors on wing tips**
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- Simrad Trawl eye 4.0 m from aft of extension, upper panel
- 1 x rbr depth sensor next to trawl eye, upper panel
- 1 x rbr depth sensor below trawl eye, lower panel
- Go-pro camera 7.0 m from aft of extension
- FOCUS

Attach floats, 22 pcs, from front end of transition and backward to around 3 m from aft of extension (to get same measurements as with the 10.7 m extension). Distance sensors attached to wing tips to get the horizontal distance from wing to wing. Don't get clear signals, but around 34-35 m it seems.

The FOCUS measures from extension and forward.

The rib lines on the trawl are compared, there does not seem to be any big differences.

Height over bottom from trawl eye: approx. 6.5 m.

4.4.1.8 - Haul 6, station 346

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 15 m square mesh extension
- **22 m diamond mesh extension**
- **44 x floats**
- Simrad distance sensors on wing tips
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear

- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- **Simrad Trawl eye 1.0 m from aft of extension, upper panel**
- **1 x rbr depth sensor next to trawl eye, upper panel**
- **1 x rbr depth sensor below trawl eye, lower panel**
- **Go-pro camera 3.0 m from aft of extension**
- FOCUS

Mount another extension, 22 m diamond mesh, to the trawl and more floats.

10 floats on 2-4 panel transition, 10.7 m

14 floats on square mesh extension, 15.0 m

20 floats on diamond mesh extension, 22.0 m

44 floats in total

Move Trawl Eye, rbr depth sensors and Go-pro to the aft of the last extension.

FOCUS goes out, the extension is all twisted, but it does not appear to be twisted when it is hauled back in. The bottom panel is torn by the bottom contact case, the tear is fixed, but we need to have an eye on that when the trawl goes in and out.

Height over bottom from trawl eye: approx. 12 m.

4.4.1.9 - Haul 7, station 347

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 15 m square mesh extension
- 22 m diamond mesh extension
- 44 x floats
- Simrad distance sensors on wing tips
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- Simrad Trawl eye 1.0 m from aft of extension, upper panel
- 1 x rbr depth sensor next to trawl eye, upper panel
- 1 x rbr depth sensor below trawl eye, lower panel

- Go-pro camera 3.0 m from aft of extension
- FOCUS

The FOCUS measures from extension and forward, goes all the way forward to look at the starboard trawl door.

Height over bottom from trawl eye: 11-12 m.

Date: *04.11.2021*

4.4.1.10 - Haul 8, station 348

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 15 m square mesh extension
- 22 m diamond mesh extension
- 44 x floats
- **Stone release/chafing gear**
- **Deep Vision, scientific**
- Simrad Flow sensor on headline
- **Simrad distance sensor on headline**
- Simrad Trawl eye above ground gear
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- **Simrad distance sensor at the front of 2-4 panel transition**
- Simrad Trawl eye 1.0 m from aft of extension, upper panel
- 1 x rbr depth sensor next to trawl eye, upper panel
- 1 x rbr depth sensor below trawl eye, lower panel
- Go-pro camera 3.0 m from aft of extension
- FOCUS

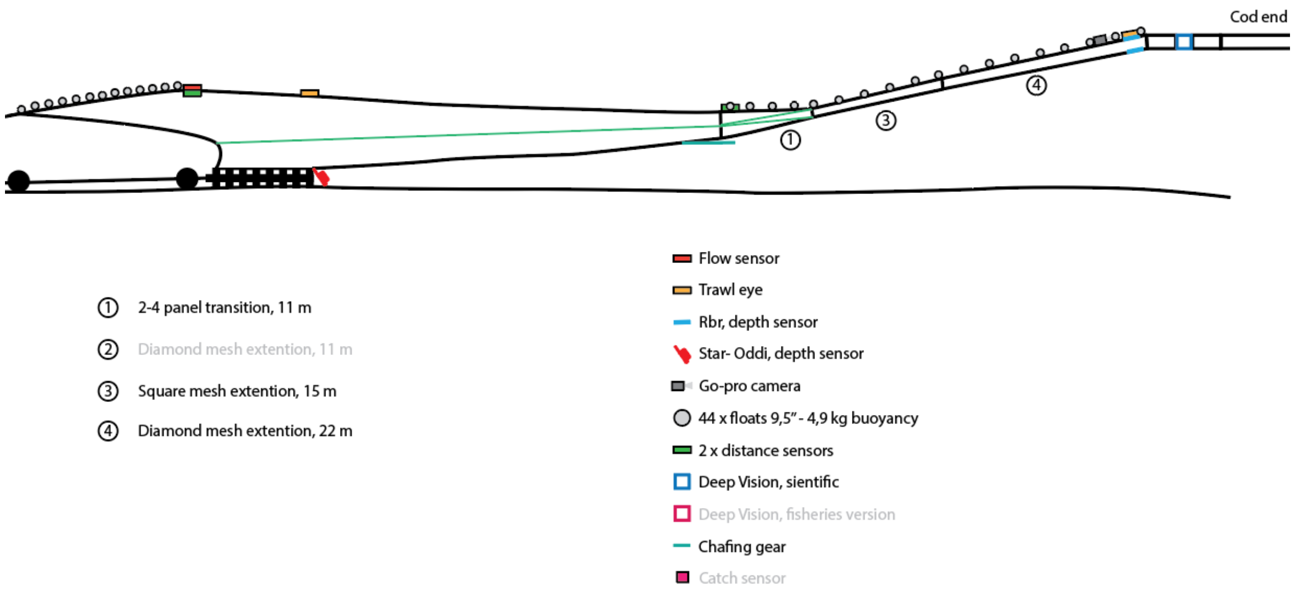


Figure 2. Selstad 630 trawl with extensions, instrumentation and Deep Vision.

A triangle in the aft bottom panel of the trawl is cut out to make the stone release, this section is made of double 5 mm p.e. twine, figure 28. A rope is thread around the hole and sewn to the netting. The chafing gear is mounted mesh by mesh in front of the triangle and attached 8 meshes down on each side. The back corners of the chafing gear are attached to the trawl with two rubber bands on each side.

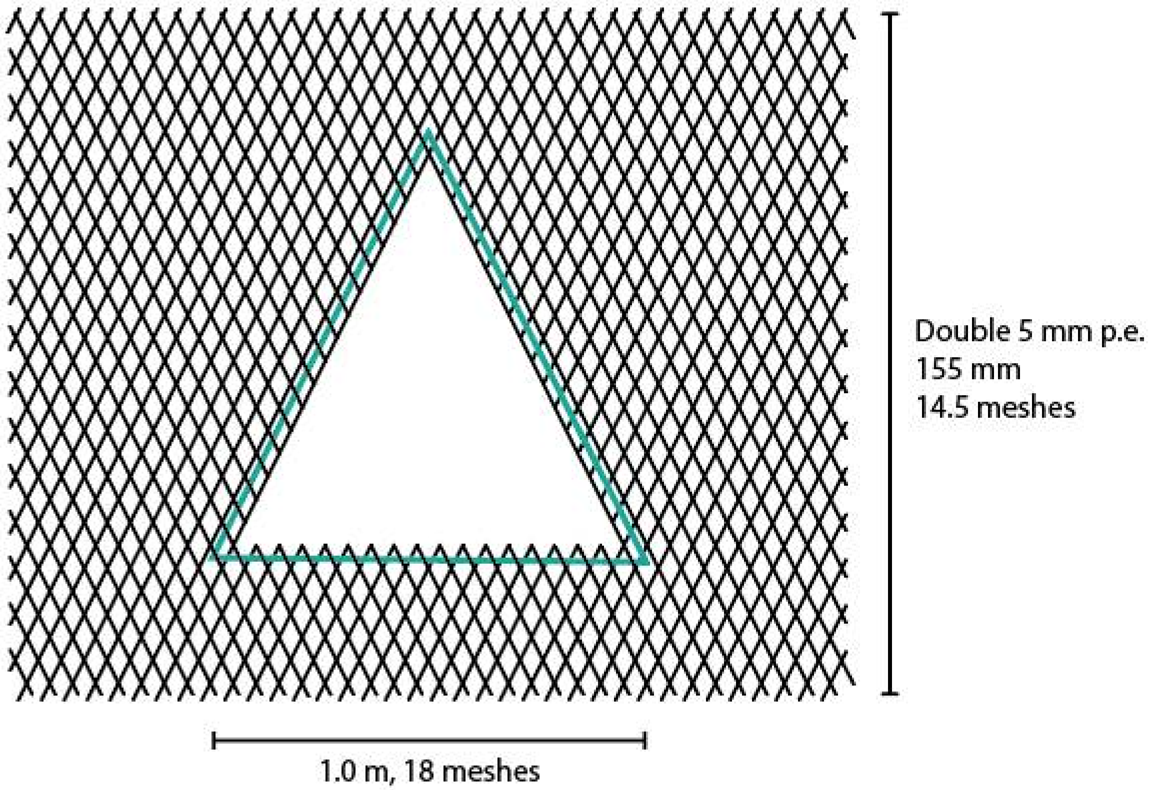


Figure 3. Stone release in bottom panel of trawl.

Figure 4. Chafing gear.

Large meshes are made at the aft end of the diamond mesh extension to easily attach the Deep Vision frame. The cod end is attached to aft section of DV.

Simrad distance sensors are mounted on headline and at the front of the 2-4 panel transition to measure the length, we do not get very clear signals, but it seems like it is around 51 m.

Height over bottom from trawl eye: 10.5 m.

4.4.1.11 - Haul 9, station 349

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- **30 x floats**
- Stone release/chafing gear

- Deep Vision, scientific
- Simrad Flow sensor on headline
- **Simrad distance sensor above gear**
- Simrad Trawl eye above ground gear
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- Simrad Trawl eye 1.0 m from aft of extension, upper panel
- 1 x rbr depth sensor next to trawl eye, upper panel
- 1 x rbr depth sensor below trawl eye, lower panel
- **Simrad distance sensor at front of DV-extension**
- Go-pro camera 1.5 m behind chafing gear
- FOCUS

The 15 m square mesh extension and its floats, 30 floats left are removed. Distance sensors are moved to get distance from ground gear to end of extension/DV.

DV is about 6 m over bottom, that is not enough to get over the sand cloud.

Date: *05.11.2021*

4.4.1.12 - Haul 10, station 350

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- **44 x floats**
- Stone release/chafing gear
- Deep Vision, scientific
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- Simrad Trawl eye 1.0 m from aft of extension, upper panel
- 1 x rbr depth sensor next to trawl eye, upper panel
- 1 x rbr depth sensor below trawl eye, lower panel
- Go-pro camera 1.0 m behind chafing gear

- FOCUS

14 additional floats are mounted to get higher over the bottom.

Height over bottom from trawl eye: 9.0 – 9.5 m.

The bull rope is tangled around the extension.

The bottom contact sensor holder was damaged: one bolt and bushing holding roller in place missing. Taken off and repaired (new bushings milled and bolts holding roller replaced). Mesh bag placed over top of sensor holder to reduce chance of meshes getting snagged and torn during shooting.

Date: *06.11.2021*

4.4.1.13 - Haul 11, station 351-352

Trawl: *Harstad-trawl* (with new stronger netting in top panel and an inclined-panel fish lock in cod end.)

- 2 x Scanmar distance sensor on the wings
- Scanmar speed sensor on headline
- Scanmar trawl eye on headline
- Scanmar distance sensor on headline
- 1 x rbr depth sensor on headline
- 1 x rbr depth sensor on fishing line
- Go-pro camera in front of fish lock looking back
- Go-pro camera aft of fish lock looking forward

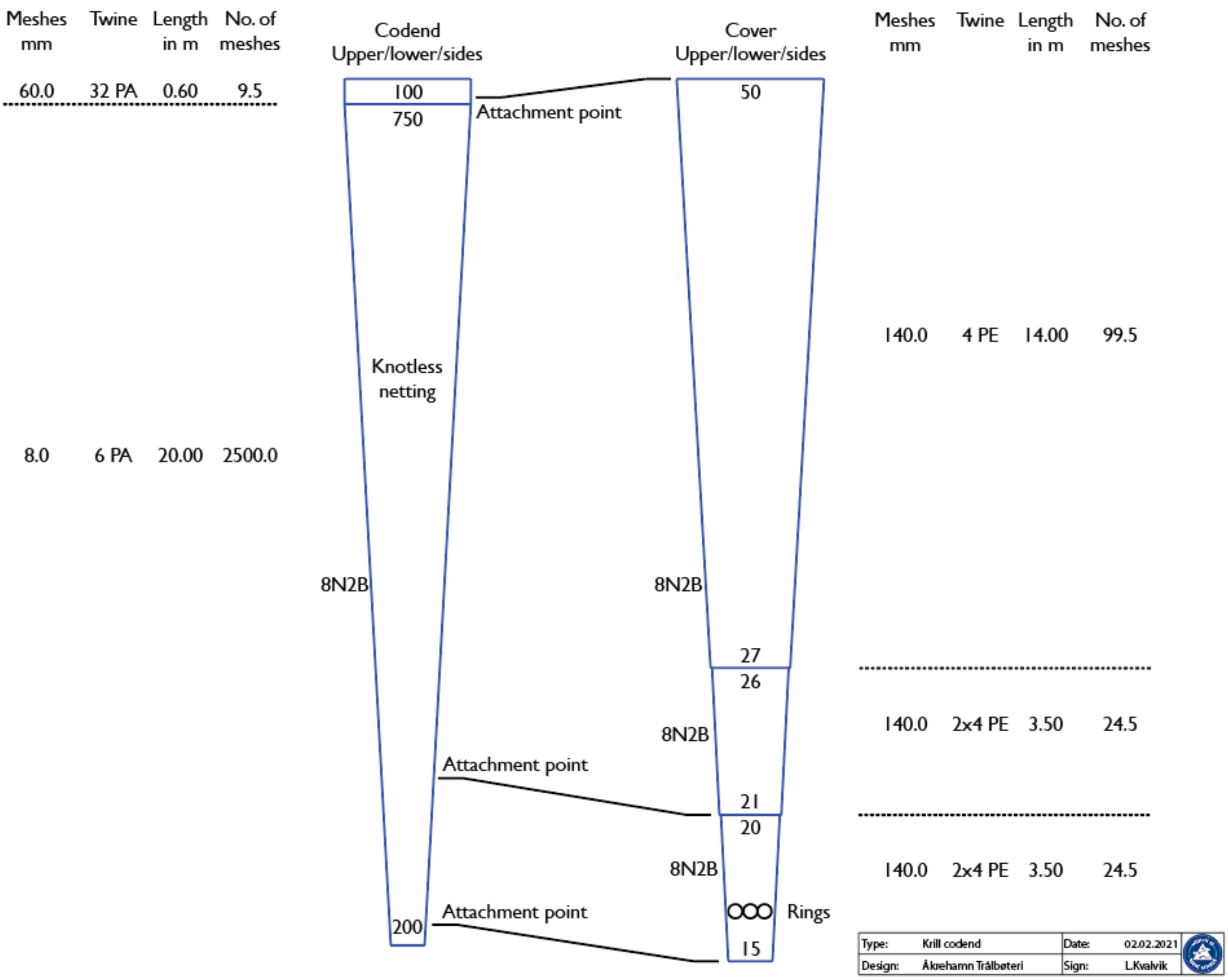


Figure 5. Drawing of small mesh, 8 mm cod end.

There is no movement in the fish lock, even when the cod end is almost lying still and there is little water flow the fish lock stays open.

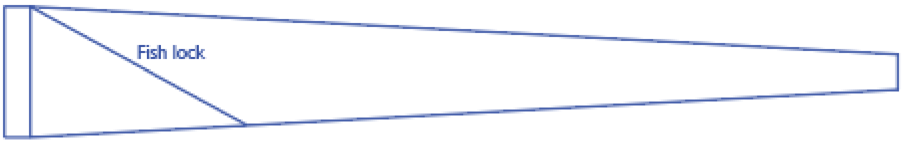


Figure 31 : Inclined-panel fish lock.

4.4.1.14 - Haul 12, station 353-354

Trawl: *Harstad-trawl*

- 2 x Scanmar distance sensor on the wings
- Scanmar speed sensor on headline

- Scanmar trawl eye on headline
- Scanmar distance sensor on headline
- 1 x rbr depth sensor on headline
- 1 x rbr depth sensor on fishing line
- Simrad flow sensor in upper panel in front of cod end.
- Go-pro camera in front of fish lock looking back
- Go-pro camera aft of fish lock looking forward

12 kg of extra lead rope is mounted at the top of the fish lock to see if it will help in getting it to close, but the go-pro video shows us that there is almost no change, it still stays open.

Simrad flow sensor is mounted in the top panel just ahead of cod end to see if we can get a measurement of the speed inside the trawl, it measures lower speed inside and we are not sure if the readings are correct.

Date: *07.11.2021*

4.4.1.15 - Haul 13, station 355

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific
- Simrad Flows sensor on headline
- Simrad Trawl eye above ground gear
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- **Simrad Flow sensor, end of trawl**
- Simrad Trawl eye 1,0 m from the end of the extension, top panel
- **1 x rbr depth sensor in the middle of the 22 m extension, top panel**
- **1 x rbr depth sensor in the middle of the 22 m extension, bottom panel**
- **Simrad catch sensor on cod end**
- 2 x Go-pro camera in front of chafing gear
- FOCUS

Changing the position of some sensors to get more data on flow and extension opening. The flow sensor at the end of the trawl is not correctly mounted so the data may not be reliable.

4.4.1.16 - Haul 14, station 356

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- Simrad Flow sensor, end of trawl
- **1 x rbr depth sensor, end of trawl, top panel**
- **1 x rbr depth sensor, end of trawl, bottom panel**
- Simrad Trawl eye 1,0 m from the end of the extension, top panel
- Simrad catch sensor on cod end
- 2 x Go-pro camera in front of chafing gear
- Go-pro on top panel of DV extension
- FOCUS

2 x rbr depth sensors moved to end of trawl.

Date: *08.11.2021*

4.4.1.17 - Haul 15, station 357

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific
- Simrad Flow sensor on headline

- Simrad Trawl eye above ground gear
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- **Simrad Flow sensor, between 2-4 panel transition and 22 m extension**
- **1 x rbr depth sensor, between 2-4 panel transition and 22 m extension, top panel**
- **1 x rbr depth sensor, between 2-4 panel transition and 22 m extension, bottom panel**
- **Simrad distance sensor on each side of 22 m extension, in the middle**
- Simrad Trawl eye 1,0 m from the end of the extension, top panel
- Simrad catch sensor on cod end
- 2 x Go-pro camera in front and back of chafing gear

The geometry of the trawl does not seem right, heave the trawl back in and the sweeps are tangled. Flow sensor does not send signals.

Distance sensors measure 0,5-0,6 m opening width in the extension.

Short haul.

4.4.1.18 - Haul 16, station 358

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear
- 1 x Star-Oddi depth sensor mounted in a bottom contact case on ground gear
- 1 x Star-Oddi Starmon TD depth/temperature/pitch sensor mounted in Scanmar bottom contact sensor holder in the middle of ground gear
- 1 x rbr depth sensor, between 2-4 panel transition and 22 m extension, top panel
- 1 x rbr depth sensor, between 2-4 panel transition and 22 m extension, bottom panel
- Simrad distance sensor on each side of 22 m extension, in the middle
- Simrad Trawl eye 1,0 m from the end of the extension, top panel
- Simrad catch sensor on cod end

- 2 x Go-pro camera in front and back of chafing gear

Same set-up as last haul.

PART II

Date: *12.11.2021*

4.4.1.19 - Haul 17, station 359

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear
- **1 x rbr depth sensor, in the middle of the 22 m extension, top panel**
- **1 x rbr depth sensor, in the middle of the 22 m extension, bottom panel**
- Simrad distance sensor on each side of 22 m extension, in the middle
- **Go-pro stereo camera rig, side panel, 3 m from end of extension.** The left camera was not turned on.
- **Simrad flow sensor 87 cm from middle of Go-pro rig**
- Simrad Trawl eye 1,0 m from the end of the extension, top panel
- 2 x Go-pro camera in front and back of chafing gear

Note, bottom contact sensor has been removed and will not be used for the remainder of the cruise. We are confident that bottom contact is good and the fishing master is concerned about meshes getting snagged on the sensor holder and torn during shooting.

Catch 300 kg: Blue whiting 54 kg, American Plaice 26 kg, Jellyfish 21 kg, Redfish (113 kg), Haddock (52 kg), A few shrimp and mesopelagic fish.

Date: *13.11.2021*

4.4.1.20 - Haul 18, station 360

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension

- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.
- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel
- Simrad distance sensor on each side of 22 m extension, in the middle
- Go-pro stereo camera rig, side panel, 3 m from end of extension
- Simrad flow sensor 87 cm from middle of Go-pro rig
- Simrad Trawl eye 1.0 m from the end of the extension, top panel

We lost one of the distance sensors on the extension. The flow sensor in the extension shows water flow at 0.1 kts, may be hitting the net wall? The ground is a bit bumpy, so the trawl is heaved and set back down a couple of times. Range of trawl eye over ground gear was increased from 15 to 30 m after haul so that the navigator can observe the bottom and the trawl ground gear.

4.4.1.21 - Haul 19, station 361

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- **Deep Vision, Fishery frame and rubber sheet attached with 7-meter 155 mm square mesh extension**
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.
- Go Pro camera upper panel toward stone release
- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel
- Simrad Trawl eye 1.0 m from the end of the extension, top panel
- **Simrad flow sensor attached on the outside the upper panel of the square mesh DV extension about 2 m from DV**
- Go Pro camera 2.0 m ahead of DV rubber plate pointing toward DV. Mounted on the lower panel on the

square mesh DV extension.

- FOCUS

FOCUS is deployed at 03.34. At 03.44 the trawl wire is observed on the sonar and at 04.03 the light from camera monitoring the stone release is observed on the camera. At 04.06 the FOCUS hits the bottom, and is brought back to deck. DV fishery rubber frame collapsed.

Figure 6. Deep Vision, Fishery frame and rubber sheet attached with 7-meter 155 mm square mesh extension.

4.4.1.22 - Haul 20, station 362

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, Fishery frame and rubber sheet attached with 7-meter 155 mm square mesh extension

- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.
- Go Pro camera upper panel toward stone release
- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel
- GO Pro camera toward 22 m extension attached on lower panel
- Simrad Trawl eye 0.5 m from the end of the extension, top panel
- Simrad flow sensor attached on the outside the upper panel of the square mesh DV extension about 2 m from DV
- Go Pro camera 0.5 m ahead of DV rubber plate pointing toward DV. Mounted on the lower panel on the square mesh DV extension.
- FOCUS (EK80 and GO Pro with 1 image per second.

DV fishery frame was made more rigid by attaching four wooden planks across the opening ends in the upper and lower panels and additional floats on the top. Echoes from trawl eye in headline become very weak when trawl hits the seabed. Data from the trawl eye in the back is lost because of empty battery. At 08.55 FOCUS is deployed, 9:17: headline, 10:07:05 over headline. We get very nice images of the trawl and fish inside. The fish seem to stop in front of the cod end entrance. The catch is about 1 ton and consists of a mixture of haddock, cod, wolf fish, place and some redfish and arctic skate.

Fishery deep vision was much better. Camera toward extension did not give any useful information.

Date: *14.11.2021*

4.4.1.23 - Haul 22, station 363

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- 7-meter 155 mm square mesh extension with Deep Vision Fishery frame and rubber plate attached.
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.
- Simrad flow sensor upper panel above chafing gear
- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel

- Simrad Trawl eye 0.5 m from the end of the extension, top panel
- Go Pro camera 0.5 m ahead of DV rubber plate pointing toward DV. Mounted on the lower panel on the square mesh DV extension.
- **Go Pro camera and light inside DV fishery frame pointing horizontal**

In the beginning of the haul the contact with trawl sensors was very poor. Separation of range 0-10 (high resolution) and 10 – 100 m was not good. Seabed and trawl ground gear were at 10 meters and in the change of range when the trawl was on seabed making it difficult to get a good clear image of the seabed and trawl.

Pelagic registrations on echo sounder and some fish close to bottom.

Date: *15.11.2021*

4.4.1.24 - Haul 23, station 364

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.
- Simrad flow sensor upper panel above chafing gear
- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel

Trawl eye above ground gear: range was changed to 0-30 m. Better contact with trawl eye but still weak echoes. Need to be attached better for correct and stable direction. Test increasing wire length 20 m at a time for best possible bottom contact (0-20° roll on doors is optimal, more than 45° risk of collapsing). Trawl eye in extension was not mounted. It was not possible to find the bag for it.

4.4.1.25 - Haul 24, station 365

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific

- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.
- Simrad flow sensor upper panel above chafing gear
- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel
- Simrad Trawl eye 0.5 m from the end of the extension, top panel

No signals from Flow sensor mounted in upper panel above chafing gear.

4.4.1.26 - Haul 25, station 366

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.
- Simrad flow sensor upper panel above chafing gear
- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel
- Simrad Trawl eye 0.5 m from the end of the extension, top panel
- FOCUS

Trawl eye above ground gear is still loose. FOCUS problems with power supply and abort.

Date: *16.11.2021*

4.4.1.27 - Haul 26, station 367

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific

- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.
- Simrad flow sensor upper panel above chafing gear
- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel
- Simrad Trawl eye 0.5 m from the end of the extension, top panel

4.4.1.28 - Haul 27, station 368

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision (scientific)
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.
- Simrad flow sensor upper panel above chafing gear
- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel
- Simrad Trawl eye 0.5 m from the end of the extension, top panel
- FOCUS

FOCUS problems with power supply and abort.

4.4.1.29 - Haul 28, station 369

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.

- Simrad flow sensor upper panel above chafing gear
- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel
- Simrad Trawl eye 0.5 m from the end of the extension, top panel

Still poor data with trawl eye above ground gear. Experienced some problems with deploying the trawl and at the end of the haul the bottom gets bumpier. The skipper lifts the trawl from bottom for 5 – 10 minutes. The catch is about 90% 40 – 50 cm haddock. We move about 15 nm more North.

Date: *17.11.2021*

4.4.1.30 - Haul 29, station 370

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.
- Simrad flow sensor upper panel above chafing gear
- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel
- Simrad Trawl eye 0.5 m from the end of the extension, top panel

4.4.1.31 - Haul 30, station 371

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.
- Simrad flow sensor upper panel above chafing gear

- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel
- Simrad Trawl eye 0.5 m from the end of the extension, top panel
- FOCUS

Larger fish at 150 m depth and smaller registrations close to bottom. Trawl eye above ground gear is properly attached and the data are good. FOCUS: 10:53:24 light from DV, 10:44:29 stay on top of DV, 11:00 on the side of DV. Experience several alarms on FOCUS and start bringing back.

4.4.1.32 - Haul 31, station 372

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 22 m diamond mesh extension
- 44 x floats
- Stone release/chafing gear
- Deep Vision, scientific
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.
- Simrad flow sensor upper panel above chafing gear
- 1 x rbr depth sensor, in the middle of the 22 m extension, top panel
- 1 x rbr depth sensor, in the middle of the and 22 m extension, bottom panel
- Simrad Trawl eye 0.5 m from the end of the extension, top panel

Date: *18.11.2021*

4.4.1.33 - Haul 32, station 373

Trawl: *Selstad 630*

- 10.7 m 2-4 panel transition
- 14 x floats
- Stone release/chafing gear
- **Deep Vision fishery version, 3 m-155 mm square mesh extension with DV-frame and rubber plate attached.**
- Simrad Flow sensor on headline
- Simrad Trawl eye above ground gear.

- Simrad flow sensor upper panel above chafing gear
- **Simrad distance sensors on each side of the 2-4 panel transition, just ahead of DV**
- **Simrad Trawl eye at a 45 ° angle pointing horizontal, front of DV-frame**
- **Go Pro camera 1.5 m ahead of DV rubber plate pointing toward DV**
- **Go Pro camera and light inside DV fishery frame pointing horizontal**

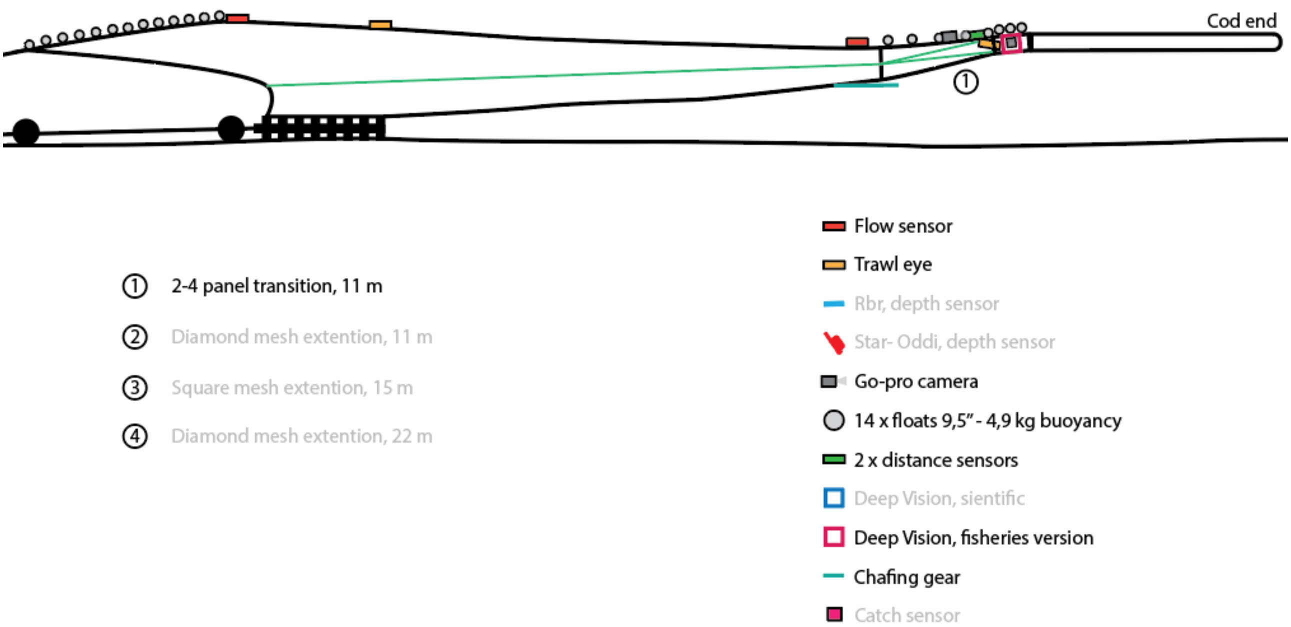


Figure 7. Selstad trawl with Deep Vision, fishery version and instrumentation. Equipment labelled in grey was not mounted to the trawl.

We remove the 22 m long extension. Cut down the DV extension from 7 m to 3 m and then mount the DV extension directly on the 2-4 panel transition. Hoping to see that when the DV is mounted to a tapered extension it will have a nice and open shape, and this gets verified by the Go pro cameras. The distance sensors on each side of the transition panel also show the same result (0.9-1.1 m).

The Trawl eye mounted in front of The DV frame points horizontal and shows if fish is entering the DV.

The sweep winches stop working when the trawl is back on deck, and the rest of the hauls with the bottom trawl are cancelled.

Date: *19.11.2021*

4.4.1.34 - Haul 33, station 374

Trawl: *Vito*

- Simrad Flow sensor on headline
- Simrad Trawl eye on headline
- Simrad Flow sensor 8 m from end of trawl

- Simrad distance sensors on each side of trawl, 2 m from end
- Simrad Trawl eye at a 45 ° angle pointing horizontal, front of DV-frame
- Deep Vision fishery version, 3 m-155 mm square mesh extension with DV-frame and rubber plate attached.
- Deep vision components: camera, lights, battery

The DV fishery version is mounted directly to the Vito trawl with all the DV components in the frame. Lights are mounted in an upward (upper light) and downward (bottom light) position with 100% brightness. Get good pictures from the DV camera. The skirt at the end of the trawl is showing in the pictures.

The trawl opening is a bit low; it may be the kite that is not working as it should.

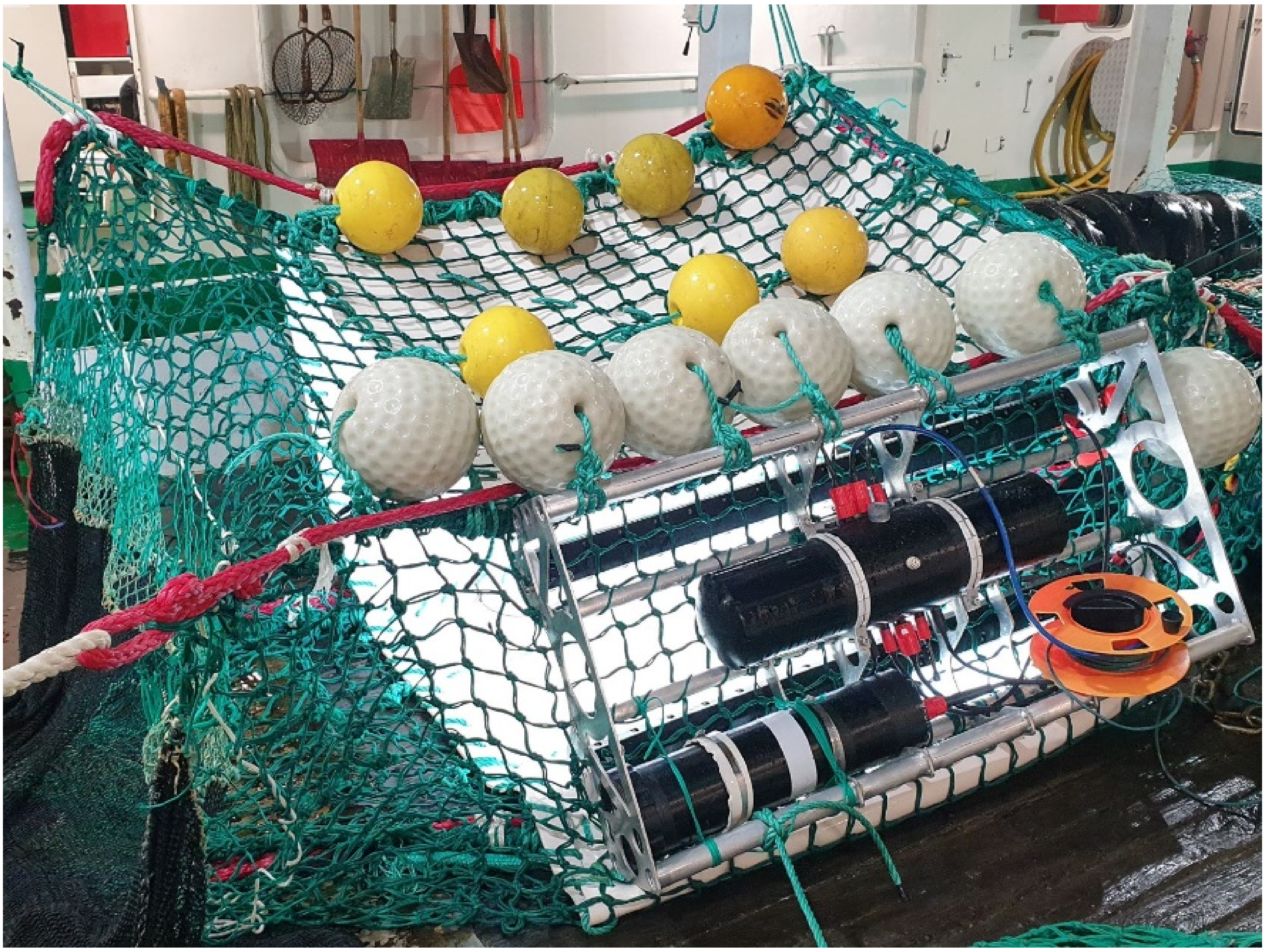


Figure 8. Deep Vision fishery version, 3 m-155 mm square mesh extension with DV-frame, rubber plate and camera components.

4.4.1.35 - Haul 34, station 375

Trawl: *Vito*

- Simrad Flow sensor on headline
- Simrad Trawl eye on headline

- Simrad Flow sensor 8 m from end of trawl
- Simrad distance sensors on each side of trawl, 2 m from end
- Simrad Trawl eye at a 45 ° angle pointing horizontal, front of DV-frame
- Deep Vision fishery version, 3 m-155 mm square mesh extension with DV-frame and rubber plate attached.
- Deep vision components: camera, lights, battery
- Go pro camera back of DV pointing forward

Lights are still mounted in a tilted upward (upper light) and downward (bottom Light) position, but are now covered with some rubber, so that the brightness is about 25%.

The DV shuts down after about 20 min, empty battery. But the Go pro camera shows fantastic pictures of the trawl opening. Both the netting and the DV rubber plate are all stretched out.

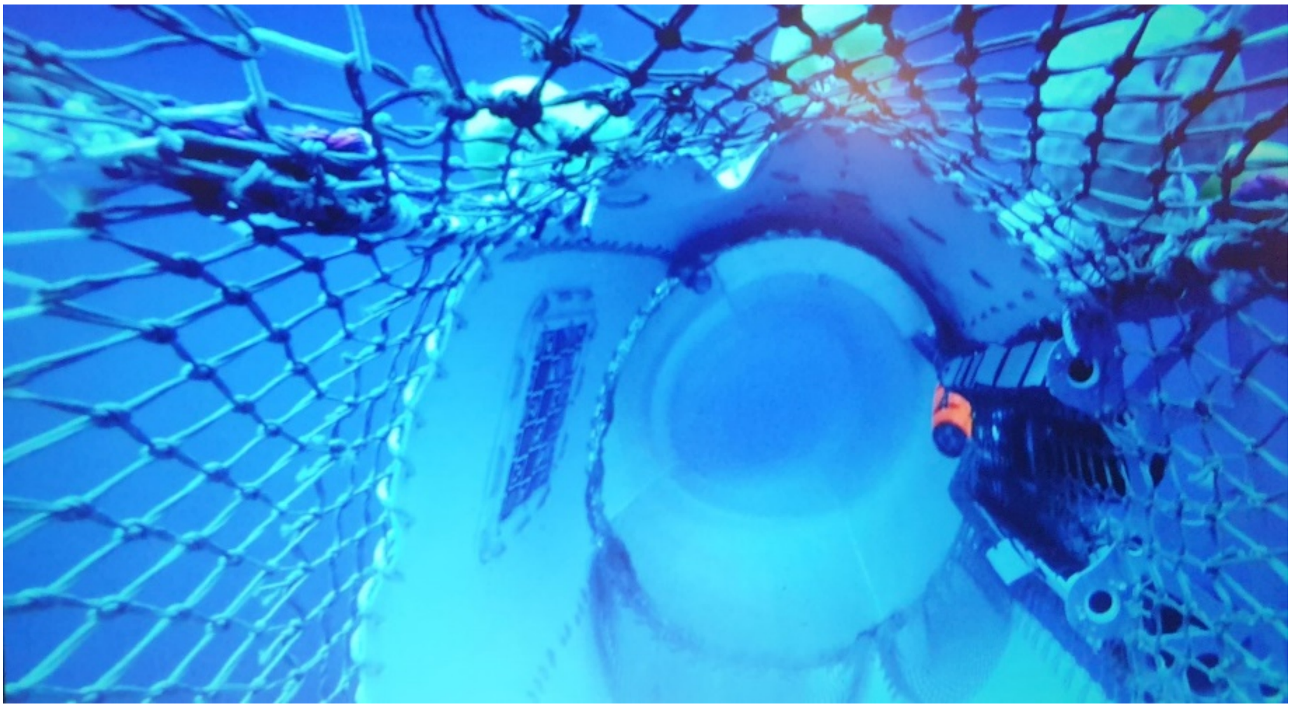


Figure 9. Deep Vision, fishery version; inside the Vito trawl.

4.4.1.36 - Haul 35, station 376

Trawl: *Vito*

- Simrad Flow sensor on headline
- Simrad Trawl eye on headline
- Simrad Flow sensor 8 m from end of trawl
- Simrad distance sensors on each side of trawl, 2 m from end

- Simrad Trawl eye at a 45 ° angle pointing horizontal, front of DV-frame
- Deep Vision fishery version, 3 m-155 mm square mesh extension with DV-frame and rubber plate attached.
- Deep vision components: camera, lights, battery
- Go pro camera in front of DV pointing backward

Measure the difference between the upper kite rope and headline, it should be a 10-15 cm difference, but there is more so a quick link is connected to the kite rope on each side to make it a bit shorter. It seems to help a bit with the low trawl opening.

DV lights are turned straight forward, 25 % brightness.

The DV shuts down after about 12 min, can't see anything on the Go pro camera without lights.

4.4.1.37 - Haul 36, station 377

Trawl: *Vito*

- Simrad Flow sensor on headline
- Simrad Trawl eye on headline
- Simrad Flow sensor 8 m from end of trawl
- Simrad distance sensors on each side of trawl, 2 m from end
- Simrad Trawl eye at a 45 ° angle pointing horizontal, front of DV-frame
- Deep Vision fishery version, 3 m-155 mm square mesh extension with DV frame.
- Deep vision components: camera, lights, battery
- Go pro camera in front of DV pointing backward

The rubber plate inside DV extension is removed.

DV lights straight forward, 25 % brightness.

4.4.1.38 - Haul 37, station 378

Trawl: *Vito*

- Simrad Flow sensor on headline
- Simrad Trawl eye on headline
- Simrad Flow sensor 8 m from end of trawl
- Simrad distance sensors on each side of trawl, 2 m from end
- Simrad Trawl eye at a 45 ° angle pointing horizontal, front of DV-frame
- Deep Vision fishery version, 3 m-155 mm square mesh extension with DV frame.
- Deep vision components: camera, lights, battery
- Go pro camera in front of DV pointing backward

Lights in a tilted upward (upper light) and downward (bottom Light) position, 25% brightness.

4.4.1.39 - Haul 38, station 379

Trawl: *Vito*

- Simrad Flow sensor on headline
- Simrad Trawl eye on headline
- Simrad Flow sensor 8 m from end of trawl
- Simrad distance sensors on each side of trawl, 2 m from end
- Simrad Trawl eye at a 45 ° angle pointing horizontal, front of DV-frame
- Deep Vision fishery version, 3 m-155 mm square mesh extension with DV frame.
- Deep vision components: camera, lights, battery
- Go pro camera in front of DV pointing backward

Lights in a tilted upward (upper light) and downward (bottom Light) position, 25% brightness.

Date: *20.11.2021*

4.4.1.40 - Haul 39, station 380

Trawl: *Harstad-trawl (* with new stronger netting in top panel and a fish lock funnel in cod end.)

- Regular Scanmar instrumentation
- 2x Go pro cameras front and back of fish lock

Nice footage of fish lock, and fish standing outside the fish lock close to the cod end netting not finding their way forward and out of the cod end.

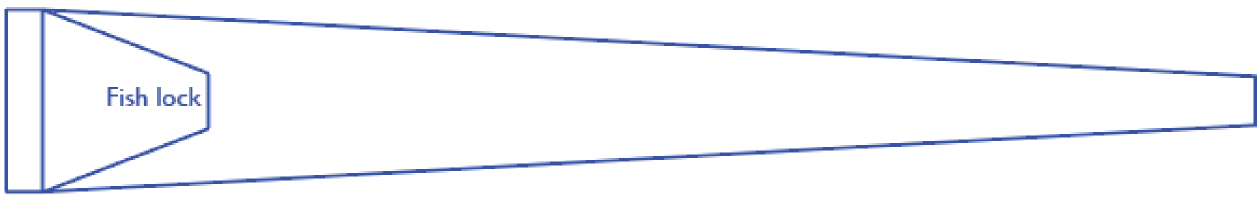


Figure 10. Fish lock funnel in cod end.

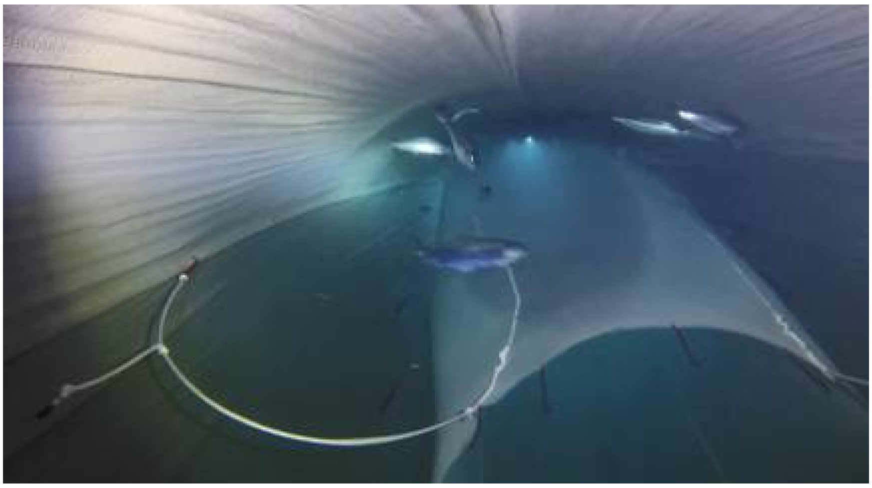


Figure 11. Fish lock funnel from inside the cod end.

4.4.1.41 - Haul 40, station 381

Trawl: *Harstad-trawl*

- Regular Scanmar instrumentation
- 2x Go pro cameras front and back of fish lock

Nice footage of fish lock, but not a lot of fish.

Date: *20.11.2021*

4.4.1.42 - Haul 41, station 382

Trawl: *Vito trawl*

- Thyborøn 7a trawl doors
- Regular Scanmar instrumentation
- Go-pro camera pointed toward kite

Thyborøn 23 VFG trawl doors (8 m^2) were used throughout the whole cruise, it seems like they may be a bit big and heavy for the Vito trawl, so we wanted to check if using the smaller Thyborøn 125” 7a trawl doors would give us the trawl opening height that we expect. It helps a bit, we gain a meter or two, but it’s still not where we want it to be. A Go-pro camera is placed to look at the kite. The video shows that the kite does not have the right shape and the netting is “galloping” up and down. We take a closer look at the kite and find that it is skewed, and there is something wrong with the small meshed netting in the center of the headline.

4.4.1.43 - Haul 42, station 383

Trawl: *Vito trawl*

- Thyborøn 7a trawl doors
- Regular Scanmar instrumentation
- Go-pro camera pointed toward kite

To make sure that the “galloping kite” was not a one-off we took another haul, it shows the exact same result. There is something wrong, and it must be looked at.

Table 1. *Trawl haul log for Selsatd 630 trawl.*

Stasjon	Wire (m)	speed sensor headline	gps speed (kts)	bunndyp (m, fra kjøl)	høyde overtelne (m)	Tråløye1 over gir (m)	tråløye2 på forlengelse (m)	dyp tråløye (m)	dør spredning (m)	vinge spredning (m)	pitch bb (°)	pitch sb (°)	roll bb (°)	roll sb (°)	ton bb (°)	ton sb (°)	flow bakerst i trål cell2 (kts)	avstand forlengelse (m)
341	495					7,40			113									
	"					6,4	4 ish		114		11,2	5,8	9,8					
		3,3		229		6,5												
342	555	3,3		228,3		6	3,7		119		2,1	3,7	5,4	2,8				
	560	3,1		227,6	6,8	6,1	3,7		118		4,3	5	2,1	2,3				
	560	3,3	3,6	227,7	6,9	7	4,1		120		6,1	7,2	-1	16				
	560	3,4	3,5	225,8	7,7	5,9	4,1	229	117		3,7	4,8	3,4	1,4				
343	480	2,9	3,7	182,8	7,4	7,3	7,2		112		6,2	5,1	-1	-3				
	"	2,7	3,3	184	8,1	5,1	7,2	181	111									
	"	2,9	3,8	184,4	7,8	6,5	7,2	181	112		9,3	6	-6	-6				
	"	2,5	3,7	187	7,4	7,7	7,2	181	112									
344	540	3,4	3,5	217	7,3	7,8	3,5	215	115		7,3	8,2	-4	-3				
	"	3,2	3,3	222,8	6,5	6	4	218	118									
	"	3,3	3,6	224	7,4	6,3	4,9	222	116		5	5	1,2	-0				
	550	3	3,7	225,6	7,3	6,1	4,2	224	116		2,8	5,6	-4	-1				
	"	3,2	3,8	228,5	7,3	6,5	4,7	227	116									
	"	3	4	228,2	7,5	6,4	3,7	229	115									
		3,1	3,6	225,5	7,1	6,1	4,1	229	117						8	8,3		
345	570	3,1	3,2	226,5	7	7,2	6,4	226	116	33,6	17,2	7,5	-12	-5	8,2	8,6		
	"	3,2	3,2	227	7,1	6,5	6,3	225	117		5	7,8	-1	-0	7,8	8,3		
	"	3,2	3,4	228,7	7,4	6,5	6,7	225	118		13,6	7,1	-17	-8	7,8	8,2		

Stasjon	Wire (m)	speed sensor headline	gps speed (kts)	bunndyp (m, fra kjøl)	høyde overtelne (m)	Tråløye1 over gir (m)	tråløye2 på forlengelse (m)	dyp tråløye (m)	dør spredning (m)	vinge spredning (m)	pitch bb (°)	pitch sb (°)	roll bb (°)	roll sb (°)	ton bb (°)	ton sb (°)	flow bakerst i trål cell2 (kts)	avstand forlengelse (m)
		3,3	3	225,1	7	6,3	6,5	225	119		10,8	7,8	-8	9,6	8,3	8,4		
346	570	3,1	3,7	217,8	6,8	6,1	12,4	212	118	34	16,4	4,4	-18	-2	8,2	8,5		
	"	3,1	3,3	217,8	7	6,4	12,4	212	118	33,7	7	6,8	-3	-3	8,5	8,8		
347	570	3,3	3,3	25,9	6,7	6,7			120	35	5,1	6	0,8	-0				
	"	3,3	3,4	225,1	7	5,1	10,2*	220	117	34,2	4,6	3,4	-2	2,6	8,6	8,9		
	"	3,5	3,4	227	7	6,1	11,9	224	118	33,9	4,9	5	-1	0,4	8,5	8,9		
348	620	3	3,4	228,3	6,7	5,9	10*	221	120		15,4	4,5	-19	1,1	8,1	8,4		
	"	3,2	3,5	228,2	7	6,4	10,5*		118		6,6	4,5	-14	1,1	8,5	8,4		
	"	3,1	3,7	227,5	6,6	6,1	10,5		118		9,5	7	-12	-8	8,4	8,4		
349	620	3,5	3,4	218,4	6,7	6	7,7	215	119		11,8	7,5	-7	-3	8,9	8,4		
	"	3,5	3,5	216,9	6,7	6,3	7,4	216	120		13,8	8	-13	-9				
	"	3,4	3,6	216,4	6,2	6,2	7,8	215	119									
350	620	3,5	3,6	229,4	6,7	6,1	8,8*		120		3,2	3,5	-2	-10	8,2	8,6		
	"	3,5	3,3	230,9	6,8	6,1	9,3	224	119		4,4	7,8	-4	-8	8,1	8,6		
	"	3,4	3,1	233,8	6,8	6,3	9,5		120						8,9	8,6		
	"	3,2	3,2	227,6	7	5,9	9,1	224	119				-10	-1				
355	666	*	3	261,5	7,2	6,5	9,5	268	121		11,9	5,8	-5	-1	8,3	8,6		
	670		2,9	262,7	7	5,6	10*		121		5,1	4,4	-6	-9			1,7	
	668		3,5	254,4	7	5,9	9*		120				-1	2			0,9	
	665		3,3	255,4	7,2	5,7	9*		124						9,7	9,2	0,5	
	667	3,8	3,3	254,9	6,8	7,2	9*		123		9,4	10,5	2	-2	9,9	9,6	1,4	
	667	4	3,7	254,5	8,2	7,7	9*											

Stasjon	Wire (m)	speed sensor headline	gps speed (kts)	bunndyp (m, fra kjøl)	høyde overtelne (m)	Tråløye1 over gir (m)	tråløye2 på forlengelse (m)	dyp tråløye (m)	dør spredning (m)	vinge spredning (m)	pitch bb (°)	pitch sb (°)	roll bb (°)	roll sb (°)	ton bb (°)	ton sb (°)	flow bakerst i trål cell2 (kts)	avstand forlengelse (m)
356	880	2,8	3,5	389,9	7,6	6,7	10,2	388	118		12,4	12,9	-20	-8	8,2	8,5	2,3	
	880	3	3,7	388,5	7,5	6,8	10,6	387	118		6	7	-7	-3			2,7	
357	250		3,7	74,33	5,5	4,9	9*		97,5		9,4	24,8	-16	-9	7	7,5		0,8
	260		3,6	73,8	5,4	5,3	10*		93,3		16,3	8	-44	-22	5,8	6,5		0,6
358	435	3,6	3,2	171,4	6,6	7,3	10*		108		7,4	8,9	-9	-10	7	7,4		0,5
	435	3,2	3,7	167,5	8,3	6,8	10*		105		16,7	10,1	-19	-9	7,2	7,7		1
	435	2,7	3,6	170	8,8	5,7	10*		103		1,1	9,3	-1	-16	6,5	7		0,6
359	691		4,2	318	9,2	8,5	10,3	309	114		11	9,5	-4	-2	8,1	7,6	0,2	0,8
	782	3,6	3,2	316	7,2	6,2	9,2	311	122		6,1	7	-5	-4	9,4	8,9	0,1	0,8
	802	3,6	3,9	316	7	6,8	9,1	312	125		5,8	7	-3	-5	9,3	8,7	-0,1	1,1
360	440	3,4	3	187,7	7,2	6,8	9	180	118		4,4	5,6	-0	-3	7,5	8		
	440	3,4	3,9	193,7	7,1	6,3	9		116		7,2	4,8	0,5	-3	7,5	8,4		
361	340	3,8	3,7	123,2	7	6,7	9,6	118	111		6,6	2,6	-2	-4	8,7	8,8		
	340	3,4	4	130,4	7,1	6,6	9,4	115	110		5,4	4,8	-3	-2	8,3	8,6		
	340	3,6	3,8	139,5	7,8	7,2	9,8	137	109		7,7	4,9	-1	-2	8,8	9,1		
	390	3,8	3,7	139,2	6,9	6,2	9,4	110	109		8,7	4,8	-8	-5	8,9	8,8		
362	375	3,9	3,9	139	6,5	6,2	8,5	128	112		5,7	4,6	-0	-1	9,9	9,5		
	350	3,8	3,8	139	7,5	6,6	9,6	131	108		6,3	5,1	-1	-3	8,7	8,5		
363	650	4	3,4	256		7,2	9	255	120		7	8,7	0,1	-3	9,9	9,4		
	660	3,9	3,7	252	6,2	5,8	8,8	255	119		5,9	3,5	1	-1	9,1	9,3		
	660	3,8	3,8	257	5,2	5,6	8,5	255	122									
364	450	3,2	3,3	178	7,6	10	11,4	170	115		13,8	4,9	-5	-1	9	8,5		

Stasjon	Wire (m)	speed sensor headline	gps speed (kts)	bunndyp (m, fra kjøl)	høyde overtelne (m)	Tråløye1 over gir (m)	tråløye2 på forlengelse (m)	dyp tråløye (m)	dør spredning (m)	vinge spredning (m)	pitch bb (°)	pitch sb (°)	roll bb (°)	roll sb (°)	ton bb (°)	ton sb (°)	flow bakerst i trål cell2 (kts)	avstand forlengelse (m)
	520	3,3	3,2	173	5,6	6,6	8,3	172	117		10,7	2,4	-4	-4	9,3	8,9		
	572	3,5	3,2	173	6	6,2	8,7	173	118		14,4	7,4	-16	-11	10,2	10		
	571	4,1	3,6	170	5,6	6,4	8,4	172	122		8,9	4,9	-8	-7	9,7	9,2		
365	520	3,4	3,9	172,1	6,3	6,4	9,3	169	115		8,7	7,3	-10	-29	8,6	9		
	520	3,8	3,9	173,8	6,5	6,4	8,6	166	115		8	3,6	-6	-3	8,5	8,9		
	520	3,3	3,8	168,1	7	6	9,1	166	114		8,6	8,4	-16	-10	7,5	8		
366	475	3,5	3,3	179	7,3	6,9		174	111		6,1	6,2	-3	-3	8,6	8,2		
	485	4,1	4,1	179	7,3	7		177	114		8,6	5,7	-2	-2	9,2	8,6		
	500	3,6	3,6	170	6,8	6,5		170	117		7,8	6,8	-6	-5	9,1	8,8		
	500	3,7	3,6	169	7,3	6,6		168	115		2,9	5,8	-0	-11	9	8,5		
367	425	3,4	3,8	170,1	6,9	6,8	9,2	171	115		7,6	8,2	-5	-4	8,1	8,4	2,8	
	425	3,4	3,8	168,9	8,2	6,1	9,4	171	112		7,6	5,5	-4	-0	8,1	8,6	2,1	
	450	3,6	3,7	171,2	7,4	5,4	9,2	170	115		12,8	4,4	-10	-2	8	8,3	2,7	
	450	3,4	3,7	168,1	6,5	6,2	8,3	166	113		5,3	3,8	-0	-4	8,4	8,7	3,2	
368	350	3,4	4,1	132,9	7,2	6,9	10,1	122	109		4,4	2,9	-1	-12	7,3	7,9	3,1	
	350	3,4	3,8	143	6,8	6,2	9,5	134	109		4,6	2,3	-5	0,8	8,2	7,6	3,1	
369	350	3	3,5	129	6,8	6	10	125	104		14,4	5,7	-13	-10	7,1	6,6	2,7	
	351	2,7	3,3	128	5,8	4,7	8,7	125	109		5,6	7,1	-6	-11	9,7	11	2,1	
	296	3,5	3,5	125	5,3	6,1	9,3	121	101		3,2	1,4	0,5	-2	8,1	7,6	2,8	
370	700	3,5	3,6	281	7	6,2	9,3	275	123		6,6	4,2	2	-1	8,5	8,7	3,4	
	700	3,6	3,1	279,8	6,8	6,6	9,1	273	121		14,6	8,5	-20	-17	7	7,5	2,6	
	700	3,6	3,6	284,2	7,2	5,9	9,3	281	122		3,3	7,6	0,9	-5	7,8	8,5	3,2	

Stasjon	Wire (m)	speed sensor headline	gps speed (kts)	bunndyp (m, fra kjøl)	høyde overtelne (m)	Tråløye1 over gir (m)	tråløye2 på forlengelse (m)	dyp tråløye (m)	dør spredning (m)	vinge spredning (m)	pitch bb (°)	pitch sb (°)	roll bb (°)	roll sb (°)	ton bb (°)	ton sb (°)	flow bakerst i trål cell2 (kts)	avstand forlengelse (m)
371	660	3,3	3,4	251,6	7,3	6,5	9,9	248	119		13,4	12,2	-13	-16	7,6	8,1	3	
	660	3,3	3,3	252,8	7,7	6,9	10	245	119		9,9	5,2	-17	-7	7,9	8,3	3	
	660	3,4	3,4	255	7,9	6,3	10		120		8,2	8,6	7,6	6,6	-4,2	-12	2,9	
372	625	3,4	3,5	252,4	7,3	6,2	9,6	247	119		8,3	2,8	-12	-3	8,2	8,5	3,1	
	625	3,4	3,6	251,7	7	6,5	10		120		7	2	-8	-6	7,7	8,2	3,1	
	625	3,4	3,5	255,4	7,3	6,5	9		118		11,2	4,2	-12	-5	7,4	8,1	3	
373	650	4,1	3	252	8,4	6,8			122		8,8	5,4	1,6	1	9	9,6	3,4	0,9
	710	4,3	3,5	256,8	6,8	6,3			123		3,1	1,8	4,5	1,3	10,3	10	3,4	1,1
	705	4	3,8	256,1	6,4	6,8		257	123		6,2	3,7	-1	-4	8,9	9,4	3,2	0,9

Table 2. *Harstad trawl log.*

Hal	Dyp	Wire	GPS	trål speed	tråløye	dyp overtelne	vinge avstand	dør avstand	bb dør tilt	sb dør tilt	bb dør dyp	sb dør dyp	kommentar
351	388,3	180	3,2	3,2	16,2	20,4	25,3	52,4	17	14	44,6	38,8	Standard rigging
	387,1	180	3,4	3	15	20,1	25,5	53,7	16	15	41	35	2x vingesensor
	386,1	180	3,4	3,1	15,3	19,4	25,7	53,3	16	14	41	35	overtelne: tråløye, dybde, speed, rbr- dybde
													undertelne: rbr dybde
352	368,2	230	3,2	2,7	16,5	38,3	26,5	56,5	16	15	52	55	2x Go-pro i overpanel foran og bak nymontert fiskelås (24mm).
	360,9	230	3,2	2,7	16,2	41,5	26,3	55,9	15	14	64	56	
	349,9	230	3,4	2,8	15,9	39,9	26,3	61,8	16	14	61	54	
	348,3	230	3,2	2,7	16,5	38,1	26,4	56,2	17	14	63	55	

Hal	Dyp	Wire	GPS	trål speed	tråløye	dyp overtelne	vinge avstand	dør avstand	bb dør tilt	sb dør tilt	bb dør dyp	sb dør dyp	kommentar
	347,8	230	3,3	2,6	16,5	40,9	26,6	56,4	16	14	65	57	
353	389,8	205	2,7	3,1	12,6	22,4	26,2	56,9	17	13	39	35	simrsd flowsensor rett framfor sekk
	390,2	195	2,6	2,8	14,7	22,1	26,3	55,9	14	13	43	37	flytter bakerste kamera litt bak
	394,5	195	2,7	3,3	13,5	19,9	26,4	56,6	17	15	39	34	12 kg ekstra bly
	399,6	195	2,6	3,4	13,5	19,9	26,4	56,3	16	15	39	34	
354	397,9	276	2,6	3,1	12,9	41,1	27,6	61,1	17	15	61	55	"
	387,3	376	2,6	3	13,5	42,1	27,6	61,2	17	15	63	56	
	385,1	268	2,6	3,2	13,2	40,2	27,4	60,4	18	14	59	54	
	386,6	862	2,6	3,1	13,5	42,2	27,5	60,2	16	15	62	56	
381	328,4	200	2,9		16,8	40*		54,6	19,2	15,2	59,2	58,3	
	325,9	299	3		15,6	75*		60,9	18,3	16,2	86	88	
	325,7	399	2,8		17,1	125*		61,9	20,2	17,2	138	140	

Table 3. *Vito trawl log.*

stasjon	wire	speed sensor headline	gps speed	bunndyp (fra kjøl)	dyp overtelne	tråløye 1 på overtelne	tråløye2 framfor dv	dør spredning	pitch bb	pitch sb	roll bb	roll sb	ton bb	ton sb	flow bakerst i trål cell2	høyde	avstand rett framfor dv	kommentar
374	200		3,6	459		10,8	1	100	5	4,1	2,7	1,4			3,5		1,8	med dv komersiell, glømt go pro
	200		3,7			10,6	1	100							3,4		1,8	litt lav åpning, kite? Tråldører
375	200		2,9	454		17	1,25	100	3,4	4,6	3,3	-0,5			3,6		1,9	

stasjon	wire	speed sensor headline	gps speed	bunndyp (fra kjøl)	dyp overtelne	tråløye 1 på overtelne	tråløye2 framfor dv	dør spredning	pitch bb	pitch sb	roll bb	roll sb	ton bb	ton sb	flow bakerst i trål cell2	høyde	avstand rett framfor dv	kommentar
	200		3,4	445		13	1,25	99	5,4	6,8	2,3	-1,3	8,3	7,9	3,7		1,8	
376	200	3,3	3,2	435	87	17	1,25	96	6,2	5	3,7	1,4	7,8	7,2	3,3	2,9	2	
377	200	3,1	3,4	437	86	19	1,25	96	1,6	2,3	6,7	0,8	6,8	6,1	3,2	2,9	2	
378	200	3,3	3,2	438	77	14	1	100	5,8	4,4	2,2	-0,8	8	7,8	3,5	2,9	1,9	
379	200	3,4	3,7	440	79	18	1,25	95	4,9	3,2	0,7	1,1	7,6	7,3	3,2	2,8	1,9	
382			3,4		52	20		73										med HI dører
	375		3,2	330	98,8	20,4		78,9	10	9	22	18	7,1	7,2				
	375		3,2			21,3		79,2										
	460		3,2	330	151	23,7		79,3										
	460		3,3	323	154	21,9		81,6										
	460		3,3	320	154	21,3		82,9										
	460		3,3	316	154	20,4		83,1										
383	300		3,3	306	57,8	20,4		77,4										
	400		3,3	327	86,7	20,1		82										
	400		3,1	326	87,5	20,4		81,4										

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