# CRIMAC CRUISE REPORT 2025

## GO Sars 2025001018

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Cruise leader(s): Maria Tenningen (IMR)

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**Summary (English):**

This years CRIMAC cruise was conducted in the fjords in Troms between November 14th and 20th. The cruise objective was to support the CRIMAC project by carrying out experiments, collect data and test new instrumentation and methods for improved acoustic and optic marine monitoring. The weather conditions were variable but did not affect the experiments and data collection. Herring were distributed in large dense layers that moved closer to surface at night and deeper down and packed more densely during the day. Large numbers of whales were also present in the area.

Our main activities and findings included:

1. An experiment with the calibration sphere suspended in two different methods. The results indicate that suspension may affect the calibration results.
2. Measurements of noise level in the 333 kHz broadband transducer. The results suggest that noise is little affected by vessel speed and active vs passive transmission, but the level was 4.5 times (6.5 dB) stronger in 2025 than in 2023.
3. Data collection with the CamSounder in-trawl camera system for evaluation of image quality and developmnt of automated image analyses. The system worked well and there were no technical issues, but the images were too dark to develop reliable image analyses algorithms.
4. The ActSel, active selection device that automatically opens and closes the trawl, was tested on the Harstad survey trawl. The system was successfully adapted to the survey trawl and demonstrated that it operates as designed. However, we experienced some leaking of fish and challenges with the 3rd wire on board Go Sars.
5. Passive acoustic monitoring with hull (drop keel) mounted hydrophone showed that vessel noise dominates below ~100 Hz making detection of low frequency vocalizing mammals challenging, especially at high cruising speeds. However, detections are possible when the vessel is drifting and vocalization above ~3000 Hz (e.g. by killer whales) is clearly observable at all cruising speeds.
6. The broadband frequency response of herring schools was measured with ADCP and EK80 and the results will be compared with CRIMAC backscatter modelling of schools with similar length distribution.

**Summary (Norwegian):**

Dette årets CRIMAC-tokt ble gjennomført i fjordene i Troms mellom 14. og 20. november. Hensikten med toktet var å støtte CRIMAC-prosjektet ved å utføre eksperimenter, samle data og teste nytt utstyr og metoder for bedre akustisk og optisk marin overvåkning. Værforholdene var variable, men påvirket ikke eksperimentene eller datainnsamlingen. Sild forekom i store lag som beveget seg nærmere overflaten om natten og dypere — og tettere — om dagen. Store antall hval var også til stede i området.

Våre hovedaktiviteter og funn inkluderte:

1. Et eksperiment med kalibreringskule suspendert på to forskjellige måter. Resultatene tyder på at opphengingsmetode kan påvirke kalibreringsresultatene.
2. Målinger av støynivå i 333 kHz bredebåndstransduceren. Resultatene antyder at støy i liten grad påvirkes av fartøyhastighet eller aktiv vs. passiv transmisjon, men nivået var 4,5 ganger (6,5 dB) høyere i 2025 enn i 2023.
3. Datainnsamling med CamSounder trålkamerasystem for evaluering av bildekvalitet og utvikling av automatiserte bildeanalyser. Systemet fungerte godt uten tekniske problemer, men bildene var for mørke til å utvikle pålitelige bildeanalysealgoritmer.
4. ActSel, et seleksjonssystem som automatisk åpner og lukker trålen, ble testet på Harstad trålen. Systemet ble tilpasset trålen og vi fikk demonstrert at systemet fungerer som tenkt. Vi erfarte imidlertid noe lekkasje av fisk og utfordringer med sondekabelen om bord på G.O. Sars.
5. Passiv akustisk overvåking med hydrofon montert i skroget (drop-keel) viste at fartøystøy dominerer under ~100 Hz, noe som gjør det utfordrende å detektere lavfrekvente vokaliserende pattedyr, spesielt ved høy fart. Deteksjoner er imidlertid mulig når fartøyet driver, og vokaliseringer over ~3000 Hz (f.eks. fra spekkhoggere) er klart observerbare ved alle hasigheter.
6. Bredbåndsresponsen fra sildestimer ble målt med ADCP og EK80, og resultatene vil bli sammenlignet med CRIMACs tilbakespredningsmodellering av stimer med tilsvarende lengdefordeling.

Content

# 1 - Introduction

CRIMAC is a centre of research-based innovation funded by the research council of Norway through their program for research-based innovation (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. This cruise supported CRIMAC by providing a platform for data collection and testing new and improved instrumentation and methods for sampling the marine environment. The data collected on the cruise 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. This year the cruise also supported the NEMO project WP9 – New trawl sampling. This is and internal IMR project financed by the Norwegian ministry of Trade, Industry and Fisheries. The project aims to implement new efficient and automated methods for IMR monitoring activities. WP9 aim is to implement in-trawl camera-based sampling for scientific surveys. The cruise was conducted between November 14th and 20th in the Fjords in Troms ( Figure 1 ).

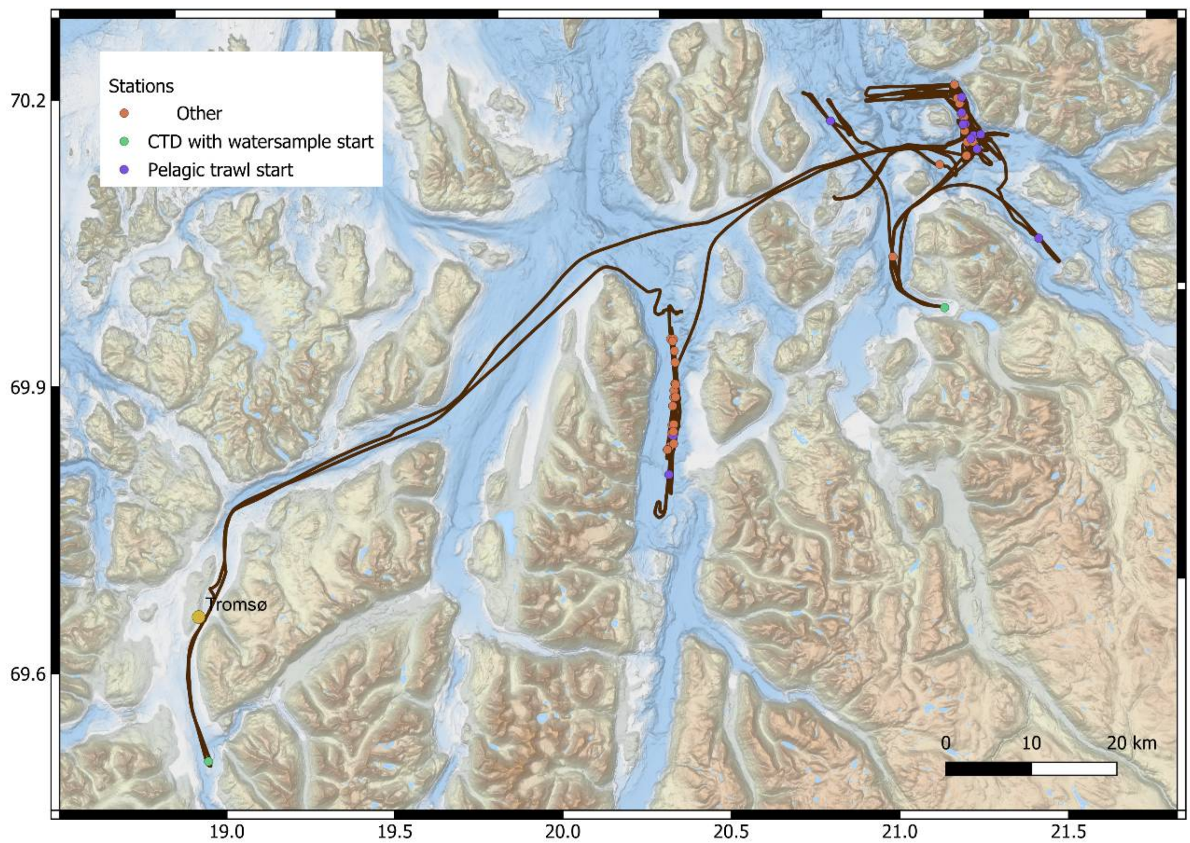



*Figure 1 . CRIMAC 2025 cruise – Experimental area, tracks and trawl stations.*

## 1.1 - Survey objectives

The survey had the following main objectives:

1. Calibration: (i) calibrate the ship keel-mounted echosounders for the purposes of this survey and (ii) conduct an experiment testing two methods of a calibration sphere suspension under the vessel and its effect upon calibration results
2. Measure noise levels in the 333 kHz broadband transducer
3. T est the CamSounder in-trawl camera system and collect data to evaluate image quality and develop filtering, tracking and length measurement algorithms for herring.
4. Implement and test methods for remotely opening and closing the Harstad trawl for selective sampling
5. Passive acoustic monitoring with hull (drop keel) mounted hydrophone (vessel noise and marine mammal detection)
6. Measure the broadband frequency response of herring schools to compare with CRIMAC backscatter modelling of schools with similar length distribution (acoustic estimation of fish size).

## 1.2 - Vessel details

The cruise was conducted with RV G. O. Sars ( Figure 2 ) operated by the Institute of Marine Research.

RV G.O. Sars is 77.5 m length overall, has a m aximum speed of 17 knots and a c rew of 15 in addition to accommodation 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).*

## 1.3 - Cruise participants

The scientific crew consisted of 17 researchers, technicians and students from the Institute of Marine Research, Norway (IMR), Kongsberg Discovery (KD), FishNext Research, University of Bergen (UoB) and the French National Research Institute for Sustainable Development (IRD) ( Table 1 ; Figure 3 )

*Table 1 . Scientific crew for the survey.*

| Name | Institute / Company |
|---|---|
| Maria Tenningen | IMR |
| Jan Frode Wilhelmsen | IMR |
| Jostein Saltskår | IMR |
| Rolf Korneliussen | IMR |
| Ketil Malde | IMR |
| Geir Pedersen | IMR |
| Vaneeda Allken | IMR |
| Rokas Kubilius | IMR |
| Ivan Platonov | KD |
| Robert Sørhagen | KD |

| | |
|---|---|
| Christoffer Aaseth | KD |
| Yoann Ladroit | KD |
| Craig Rose | FishNext Research |
| Jaroslav Kamrla | UoB |
| Ghjuvan Santoni-Guychard | IRD |
| Johannes Wåhlberg-Thorsen | Student / TrawlTech |
| Alexander Muthanna | Student / TrawlTech |

*Figure 3 . Scientific crew*

# 2 - Calibration of acoustic instruments

Author(s): Rokas Kubilius (IMR), Robert Sørhagen (KD) and Geir Pedersen (IMR)

RV G.O. Sars is equipped with six drop-keel mounted echosounders (Simrad EK80) capable of continuous wave (CW)/narrowband or frequency modulated (FM)/broadband pulse generation. These have nominal frequencies at 18, 38, 70, 120, 200, and 333 kHz.

The Simrad EC150-3C ADCP / echosounder is also installed on the ship drop-keel and is capable of CW and FM pulse generation both when operated as an ADCP and as a scientific fisheries echosounder of rather narrow beamwidth (2.5 ° ).

## 2.1 - Echosounder calibration

Ship echosounders were operated with 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 acoustic bandwidth, power, and pulse duration settings ( Table 2 ). Standard CW pulse settings (Korneliussen et al 2008) were used but with reduced power (this is to match power setting of alternating CW / FM pulses that were used during parts of this survey). The standard IMR FM pulse settings for broadband acoustic backscatter data collection were used (except that the broadband pulse bandwidth was wider on some of the channels). See:

https://kvalitet.hi.no/Portal/1/Search?q=ek80&search_class=-99#rpShowDynamicModalDocument-8071

*Table 2 . The ship drop keel-mounted echo sounder (Simrad EK80) setting configurations during the backscatter data collection of this survey (CRIMAC settings). “CW” - continuous wave pulses (narrowband). “FM” – frequency modulated pulses (broadband). “FM-Up” – frequency modulated up-sweep pulse.*

| Chanel | Tr. type | Pulse shape | Bandwidth [kHz] | Taper | Pulse duration [ms] | Power [W] |
|---|---|---|---|---|---|---|
| **CW (Continuous Wave)** | | | | | | |
| 18-CW | ES18-11mk2 | CW | - | Fast | 1.024 | 800 |
| 38-CW | ES38-7 | CW | - | Fast | 1.024 | 400 |
| 70-CW | ES70-7C | CW | - | Fast | 1.024 | 225 |
| 120-CW | ES120-7C | CW | - | Fast | 1.024 | 100 |
| 200-CW | ES200-7C | CW | - | Fast | 1.024 | 105 |
| 333-CW | ES333-7C | CW | - | Fast | 1.024 | 40 |
| **FM (Frequency Modulated)** | | | | | | |
| 18-CW | ES18-11mk2 | FM-Up | - | Fast | 2.048 | 800 |
| 38-FM | ES38-7 | FM-Up | 34-45 | Fast | 2.048 | 400 |
| 70-FM | ES70-7C | FM-Up | 50-85 | Fast | 2.048 | 225 |
| 120-FM | ES120-7C | FM-Up | 95-165 | Fast | 4.096 | 100 |
| 200-FM | ES200-7C | FM-Up | 170-260 | Fast | 4.096 | 105 |
| 333-FM | ES333-7C | FM-Up | 280-380 | Fast | 4.096 | 40 |

Ship drop-keel mounted echosounders (2025.11.15, Tromsø) 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 3 ; Figure 4 ). Both narrowband and broadband pulses were calibrated; calibration data log in Table 4. Example calibration results are shown in Figure 5. CTD cast was performed prior to the start of the calibration procedures and echosounder environment updated accordingly.

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 4 ) and the two calibration results merged as per EK80 software procedures for it. Calibration target diameters used: 57.2 mm, 38.1 mm, 35 mm, and 25 mm (henceforth referred to in the format “WC57.2” indicating tungsten carbide sphere of 57.2 mm diameter). Calibration targets are traceable, and laser engraved with an ID number.

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

An additional weight (400g shackle) was used to stabilize spheres of smaller size (WC35 and WC25) when calibrating ship echosounders. It was suspended 8 m below the calibration target by 0.50 mm diameter nylon line. WC57.2 and WC38.1 were used alone with no additional weights. All spheres had nylon line netting with 2 m long loop to ensure the calibration target is removed in range from the three winch-line suspension rig line and knot echoes that are present just above the calibration target.

Ship EK80 and EC150-3C echosounder calibration conditions and quality were good to excellent. Calibration results text files (*.xml) may benefit from check-up and calibration re-run from acoustic raw data files before these are used to scale fish acoustic frequency response data. The 333kHz nominal frequency echosounder was not calibrated on this survey due to lack of available time.

*Table 3 . 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). Yellow marked calibrations are not used to update EK80 (additional experimentation data for CRIMAC WP2).*

| | | **18CW** | **18FM** | **38CW** | **38FM** | **70CW** | **70FM** | **120CW** | **120FM** | **200CW** | **200FM** | **333CW** | **333FM** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **G. O. Sars keel-mounted echosounders** | | | | | | | | | | | | | |
| Sphere ID | BW (kHz) | **-** | **14-22** | **-** | **34-45** | **-** | **45-95** | **-** | **90-170** | **-** | **160-260** | **-** | **280-450** |
| IMR106 | WC57.2 | X | X | X | X | X | | X | | X | | | |
| IMR003 | WC38.1 | X | X | X | X | X | X | X | X | X | X | | |
| IMR123 | WC35 | | | | | | X | | X | | X | | |
| IMR132 | WC25 | | | | | | | | | X | X | | |
| IMR002 | WC38.1 | | | X | X | | | | | X | X | | |
| IMR023 | WC38.1 | | | X | X | | | | | X | X | | |
| | WC22 | | | | | | | | | | | Skipped | Skipped |
| | WC20 | | | | | | | | | | | | Skipped |

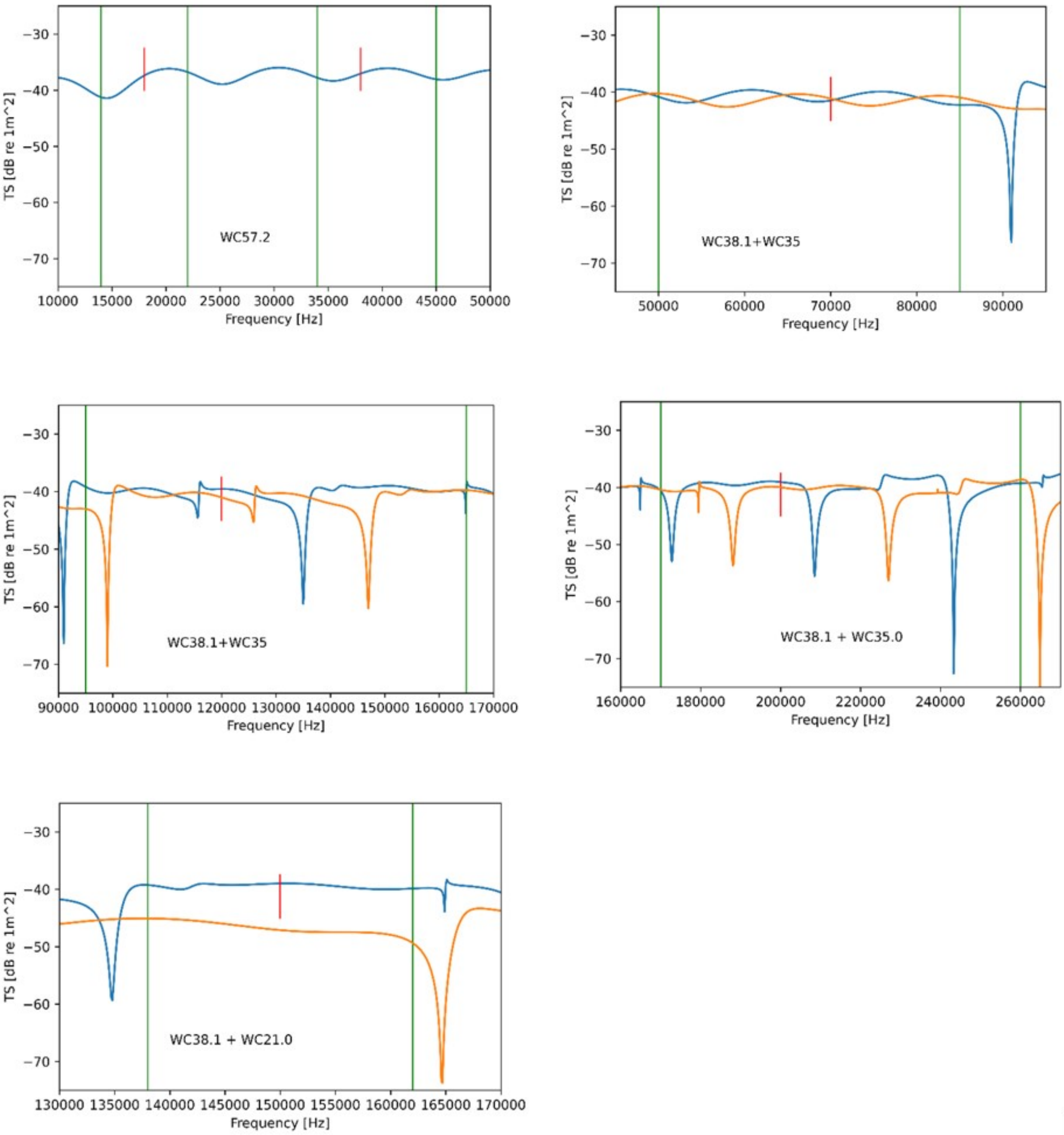



*Figure 4 . The expected tungsten carbide calibration sphere acoustic target strength versus acoustic frequency. Calibration targets and target acoustic frequency response for the narrow- and broadband pulse calibration of nominal frequencies: (a) 18 and 38 kHz, (b) 70 kHz, (c) 120 kHz, (d) 200 kHz, (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 when using CRIMAC settings.*

*Table 4 . Ship EK80 and EC150-3C calibration data collection log (2025.11.15) at calibration site near Tromsø. Data collection sequence is based on calibration target deployment. Suffix "-T" indicates test datasets that were not used to update the echosounder calibration parameters.*

| Chanel | Frequency [kHz] | Pulse shape | Pulse duration [ms] | Power [W] | Power taper | Beam mapping | Calibration target | EK80 Updated | Comment |
|---|---|---|---|---|---|---|---|---|---|

| G. O. Sars keel-mounted echosounders | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 18-CW | 18 | CW | 1.024 | 800 | Fast | Full | WC57.2 | Yes, replace | |
| **18-FM** | **14-22** | FM-Up | **2.048** | 800 | Fast | Full | WC57.2 | Yes, replace | |
| 38-CW | 38 | CW | 1.024 | 400 | Fast | Full | WC57.2 | Yes, replace | |
| **38-FM** | **34-45** | FM-Up | **2.048** | 400 | Fast | Full | WC57.2 | Yes, replace | |
| 70-CW-T | 70 | CW | 1.024 | 225 | Fast | Full | WC57.2 | No | |
| 120-CW-T | 120 | CW | 1.024 | 100 | Fast | Full | WC57.2 | No | |
| 200-CW-T | 200 | CW | 1.024 | 105 | Fast | Full | WC57.2 | No | |
| | | | | | | | | | |
| 18-CW-T | 18 | CW | 1.024 | 800 | Fast | Full | WC38.1 | No | |
| **18-FM-T** | **14-22** | FM-Up | **2.048** | 800 | Fast | Full | WC38.1 | No | |
| 38-CW-T | 38 | CW | 1.024 | 400 | Fast | Full | WC38.1 | No | |
| **38-FM-T** | **34-45** | FM-Up | **2.048** | 400 | Fast | Full | WC38.1 | No | |
| 70-CW | 70 | CW | 1.024 | 225 | Fast | Full | WC38.1 | Yes, replace | |
| **70-FM-T** | **45-95** | FM-Up | **2.048** | 225 | Fast | Full | WC38.1 | No | |
| 120-CW | 120 | CW | 1.024 | 100 | Fast | Full | WC38.1 | Yes, replace | |
| **120-FM** | **90-170** | FM-Up | **4.096** | 100 | Fast | Full | WC38.1 | Yes, replace | |
| 200-CW | 200 | CW | 1.024 | 105 | Fast | Full | WC38.1 | Yes, replace | |
| **200-FM** | **160-260** | FM-Up | **4.096** | 105 | Fast | Full | WC38.1 | Yes, replace | |
| **EC-150-3C** | 150 | CW | 1.024 | 90 | Fast | Full | WC38.1 | Yes, replace | |
| **EC-150-3C** | **138-162** | FM-Up | **2.048** | 90 | Fast | Full | WC38.1 | Yes, replace | |
| All EK80 channels active, simultaneous ping, FM-Up settings Sphere recorded on-acoustic-axis on all channels | | | | | Fast | Centre | WC38.1 | No | |
| **70-FM** | **45-95** | FM-Up | **2.048** | 225 | Fast | Full | WC35 | Yes, replace | |
| **120-FM** | **90-170** | FM-Up | **4.096** | 100 | Fast | Full | WC35 | Yes, MERGE | |
| **200-FM** | **160-260** | FM-Up | **4.096** | 105 | Fast | Full | WC35 | Yes, MERGE | |
| **200-FM** | **160-260** | FM-Up | **4.096** | 105 | Fast | Full | WC25 | Yes, MERGE | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 200-CW-T | 200 | CW | 1.024 | 105 | Fast | Full | WC25 | No | |
| | | | | **Calibration target suspention experiment** | | | | | |
| 38-CW | 38 | CW | 1.024 | 400 | Fast | Full | WC38.1 | Single susp. | IMR002 |
| **38-FM** | **34-45** | FM-Up | **2.048** | 400 | Fast | Full | WC38.1 | Single susp. | IMR002 |
| 200-CW | 200 | CW | 1.024 | 105 | Fast | Full | WC38.1 | Single susp. | IMR002 |
| **200-FM** | **160-260** | FM-Up | **4.096** | 105 | Fast | Full | WC38.1 | Single susp. | IMR002 |
| | | | | | | | | | |
| 38-CW | 38 | CW | 1.024 | 400 | Fast | Full | WC38.1 | Tripple susp. | IMR002 |
| **38-FM** | **34-45** | FM-Up | **2.048** | 400 | Fast | Full | WC38.1 | Tripple susp. | IMR002 |
| 200-CW | 200 | CW | 1.024 | 105 | Fast | Full | WC38.1 | Tripple susp. | IMR002 |
| **200-FM** | **160-260** | FM-Up | **4.096** | 105 | Fast | Full | WC38.1 | Tripple susp. | IMR002 |
| | | | | | | | | | |
| 38-CW | 38 | CW | 1.024 | 400 | Fast | Full | WC38.1 | Single susp. | IMR023 |
| **38-FM** | **34-45** | FM-Up | **2.048** | 400 | Fast | Full | WC38.1 | Single susp. | IMR023 |
| 200-CW | 200 | CW | 1.024 | 105 | Fast | Full | WC38.1 | Single susp. | IMR023 |
| **200-FM** | **160-260** | FM-Up | **4.096** | 105 | Fast | Full | WC38.1 | Single susp. | IMR023 |
| | | | | | | | | | |
| 38-CW | 38 | CW | 1.024 | 400 | Fast | Full | WC38.1 | Tripple susp. | IMR023 |
| **38-FM** | **34-45** | FM-Up | **2.048** | 400 | Fast | Full | WC38.1 | Tripple susp. | IMR023 |
| 200-CW | 200 | CW | 1.024 | 105 | Fast | Full | WC38.1 | Tripple susp. | IMR023 |
| **200-FM** | **160-260** | FM-Up | **4.096** | 105 | Fast | Full | WC38.1 | Tripple susp. | IMR023 |
| | | | | | | | | | |
| | **All FM in PASSIVE** | FM-Up | | | | PASSIVE record. 200pings. 700m record range. Ping rate 1/sec. | | | |

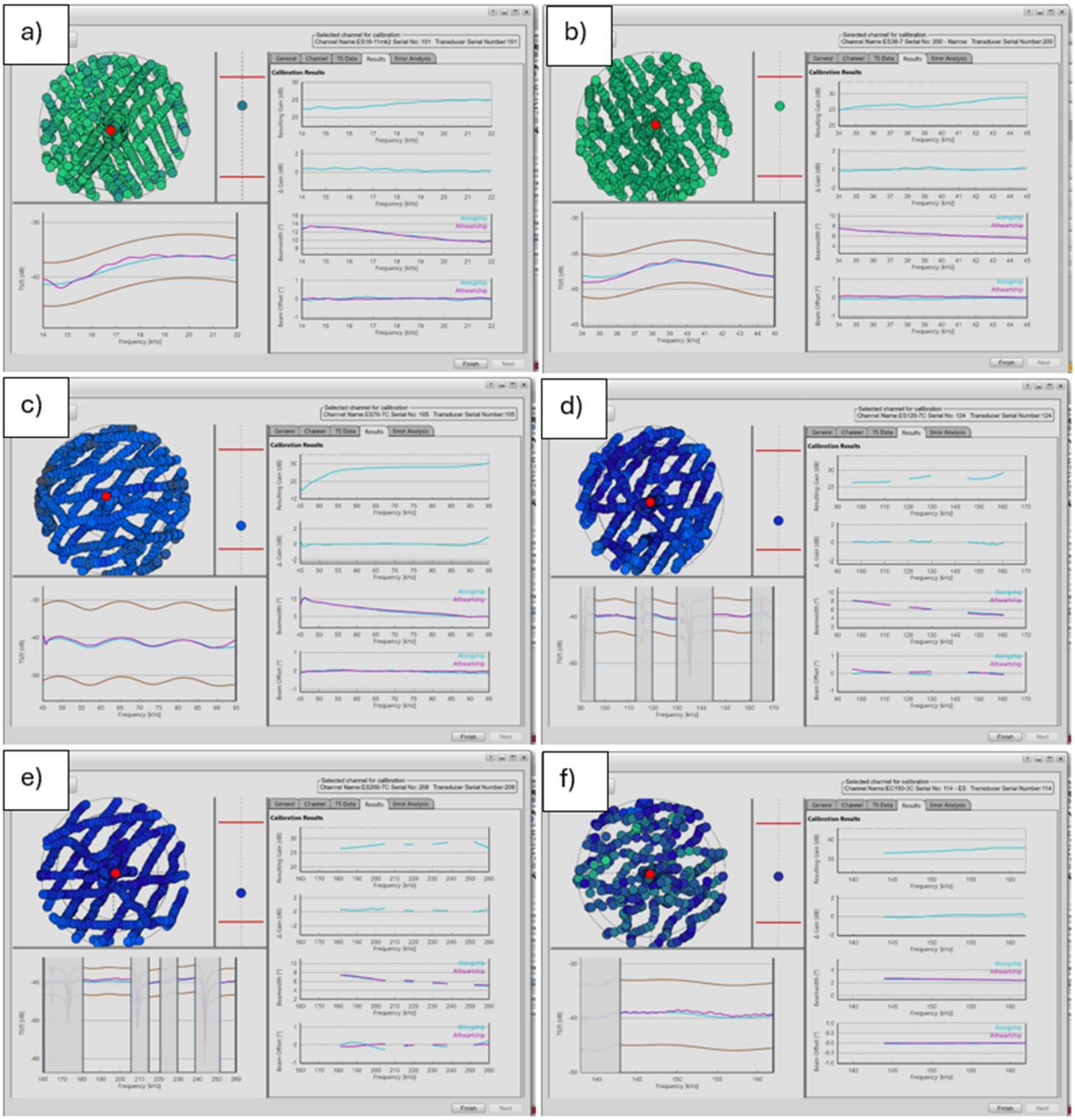



*Figure 5 . Representative ship EK80 echosounder calibration examples with full beam mapping exercise (left) and calibration results (right) displayed. Five EK80 calibrations are shown: (a) 12-22 kHz, (b) 34-45 kHz, (c) 45-95 kHz, (d) 90-170 kHz, (e) 160-260 kHz pulses. (f) show EC150-3C ADCP / echosounder system calibration. Operated as echosounder with 138-162 kHz broadband pulses. WC57.2 is used for (a) and (b), WC35 is used for (c), WC38.1 is used for (d), (e), (f).*

## 2.2 - Calibration target suspension experiment

Experiment was conducted with the WC38.1 target being suspended in two different methods : with one-line suspention where the target is hung by its own nettting and a tripple-attachment suspention where there are 3 different lines threaded through the calibration sphere netting at 3 different points ( Figure 6 ). Only two spheres were tested in this way on this survey ( Table 5 ). The two WC38.1 spheres were produced by Spherical-Trafalgar:

- IMR002, Batch no. 73763, grade 10, date of manufacture - 20140327
- IMR 028, Batch no. 73031, grade 10, date of manufacture - 20140611

The spheres were netted in 0.40mm diameter nylon line, the tripple suspention was also made of same line.

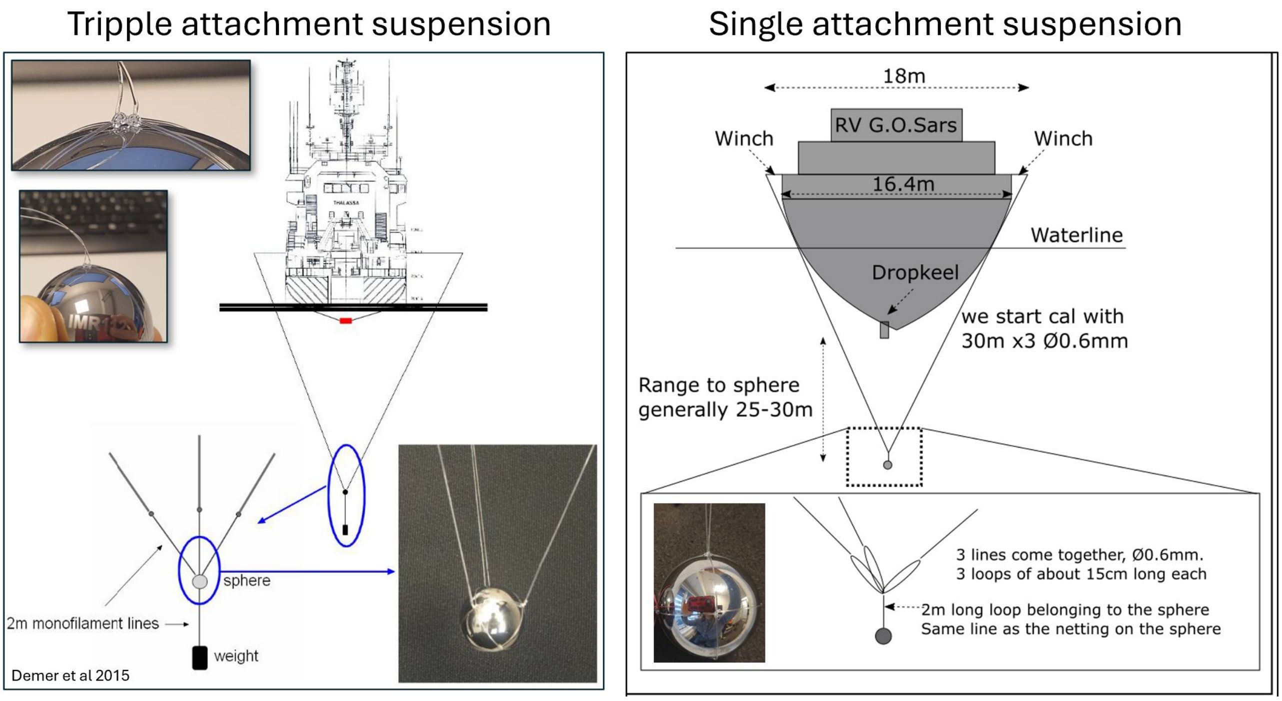



*Figure 6 . Calibration target suspention experiment sketch. Left: tripple-point suspension, except for that we did not use additional weights (adapted after Demer et al 2015). Right: single-point suspention.*

*Table 5 . Data collection*

| Sphere type | Sphere no. | Channel | Suspension | Pulse type | Filename |
|---|---|---|---|---|---|
| WC38.1 | IMR002 | 200 | Single | CW | 200-CW-WC381-IMR002-SINGLE-CalibrationDataFile-D20251115-T174632 |
| WC38.1 | IMR002 | 200 | Single | FM | 200-FM-WC381-IMR002-SINGLE-CalibrationDataFile-D20251115-T175441 |
| WC38.1 | IMR002 | 200 | Triple | CW | 200-CW-IMR002-TRIPLE-CalibrationDataFile-D20251115-T183953 |
| WC38.1 | IMR002 | 200 | Triple | FM | 200-FM-IMR002-TRIPLE-CalibrationDataFile-D20251115-T185232 |
| WC38.1 | IMR002 | 38 | Single | CW | 38-CW-WC381-IMR002-SINGLE-CalibrationDataFile-D20251115-T172857 |
| WC38.1 | IMR002 | 38 | Single | FM | 38-FM-WC381-IMR002-SINGLE-CalibrationDataFile-D20251115-T173753 |
| WC38.1 | IMR002 | 38 | Triple | CW | 38-CW-IMR002-TRIPLE-CalibrationDataFile-D20251115-T182156 |
| WC38.1 | IMR023 | 200 | Single | CW | 200-CW-IMR023-SINGLE-CalibrationDataFile-D20251115-T201324 |
| WC38.1 | IMR023 | 200 | Single | FM | 200-FM-IMR023-SINGLE-CalibrationDataFile-D20251115-T202101 |

| | | | | | |
|---|---|---|---|---|---|
| WC38.1 | IMR023 | 200 | Triple | CW | 200-CW-IMR023-TRIPLE-CalibrationDataFile-D20251115-T194453 |
| WC38.1 | IMR023 | 200 | Triple | FM | 200-FM-IMR023-TRIPLE-CalibrationDataFile-D20251115-T195346 |
| WC38.1 | IMR023 | 38 | Single | CW | 38-CW-IMR023-SINGLE-CalibrationDataFile-D20251115-T202758 |
| WC38.1 | IMR023 | 38 | Single | FM | 38-FM-IMR023-SINGLE-CalibrationDataFile-D20251115-T203402 |
| WC38.1 | IMR023 | 38 | Triple | CW | 38-CW-IMR023-TRIPLE-CalibrationDataFile-D20251115-T193047 |
| WC38.1 | IMR023 | 38 | Triple | FM | 38-FM-IMR023-TRIPLE-CalibrationDataFile-D20251115-T193725 |
| WC38.1 | WO13099 | 200 | Single | CW | 200-CW-WO13099-SINGLE-CalibrationDataFile-D20251119-T195643 |
| WC38.1 | WO13099 | 200 | Single | FM | 200-FM-WO13099-SINGLE-CalibrationDataFile-D20251119-T200524 |
| WC38.1 | WO13099 | 200 | Triple | CW | 200-CW-WO13099-TRIPLE-CalibrationDataFile-D20251119-T185233 |
| WC38.1 | WO13099 | 200 | Triple | FM | 200-FM-WO13099-TRIPLE-CalibrationDataFile-D20251119-T184504 |
| WC38.1 | WO13099 | 38 | Single | CW | 38-CW-WO13099-SINGLE-CalibrationDataFile-D20251119-T193847 |
| WC38.1 | WO13099 | 38 | Single | FM | 38-FM-WO13099-SINGLE-CalibrationDataFile-D20251119-T194509 |
| WC38.1 | WO13099 | 38 | Triple | CW | 38-CW-WO13099-TRIPLE-CalibrationDataFile-D20251119-T191534 |
| WC38.1 | WO13099 | 38 | Triple | FM | 38-FM-WO13099-TRIPLE-CalibrationDataFile-D20251119-T190056 |
| WC38.1 | WO17850 | 200 | Single | CW | 200-CW-WO17850-SINGLE-CalibrationDataFile-D20251119-T175951 |
| WC38.1 | WO17850 | 200 | Single | FM | 200-FM-WO17850-SINGLE-CalibrationDataFile-D20251119-T181316 |
| WC38.1 | WO17850 | 200 | Triple | CW | 200-CW-WO17850-TRIPLE-CalibrationDataFile-D20251119-T165055 |
| WC38.1 | WO17850 | 200 | Triple | FM | 200-FM-WO17850-TRIPLE-CalibrationDataFile-D20251119-T162258 |
| WC38.1 | WO17850 | 38 | Single | CW | 38-CW-WO17850-SINGLE-CalibrationDataFile-D20251119-T174446 |
| WC38.1 | WO17850 | 38 | Single | FM | 38-FM-WO17850-SINGLE-CalibrationDataFile-D20251119-T175331 |
| WC38.1 | WO17850 | 38 | Triple | CW | 38-CW-WO17850-TRIPLE-CalibrationDataFile-D20251115-T202758 |
| WC38.1 | WO17850 | 38 | Triple | CW | 38-CW-WO17850-TRIPLE-CalibrationDataFile-D20251119-T170106 |

For all experiments the difference between resulting calibration gain and TS RSM error, and theoretical predictions ( MacLennan, 1981), for 38 and 200 kHz FM using single and triple suspension were visualized and quantified. Additionally, the sensitivity to angle of incidence was explored. Below we show examples of for selected spheres of the corresponding estimated gain values.

### 2.2.1 - IMR023 - 38kHz FM

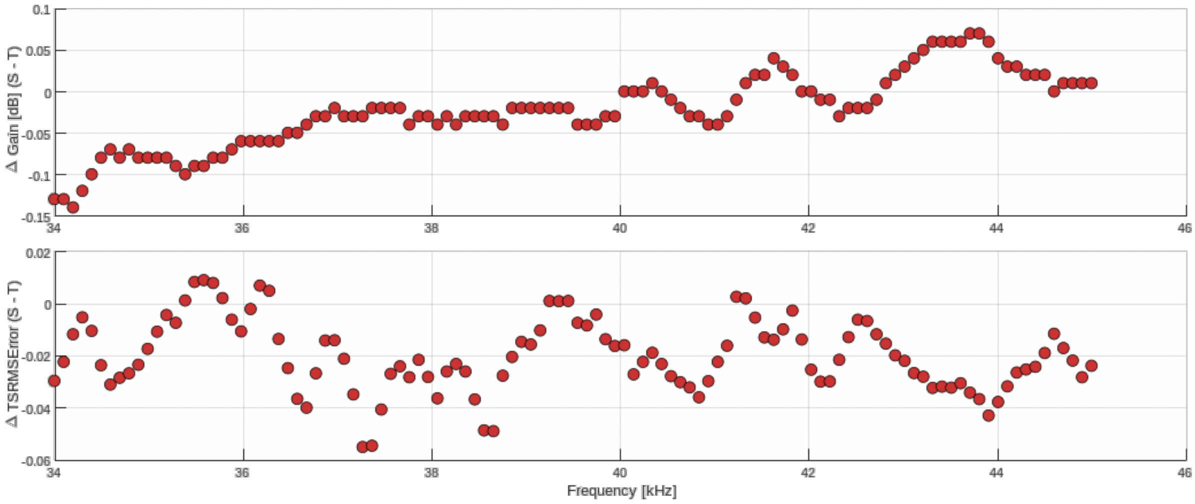



*Figure 7 . Difference between estimated gain and TS RMS error for single and triple suspension using 38 kHz FM (WC38.1-IMR023).*

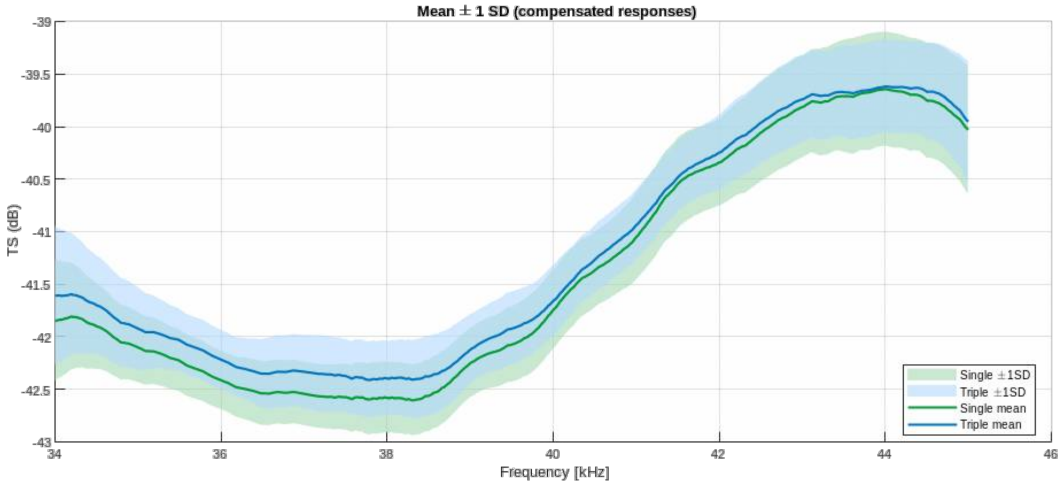



*Figure 8 . Estimated TS as a function of frequency for WC38.1-IMR023 with single and triple suspension using 38 kHz FM.*

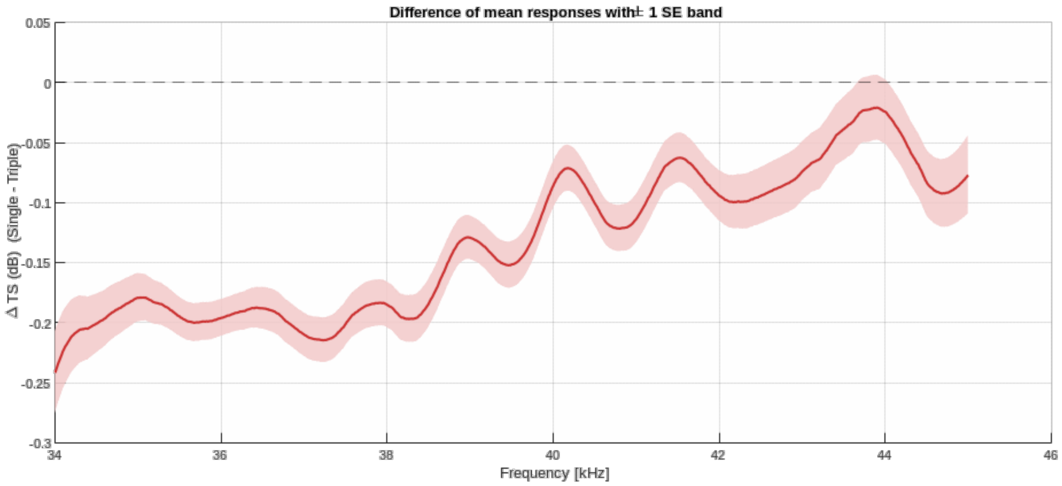



*Figure 9 . Difference between estimated TS as a function of frequency for WC38.1-IMR023 for single and triple suspension using 38 kHz FM.*

### 2.2.2 - IMR023 - 200kHz FM

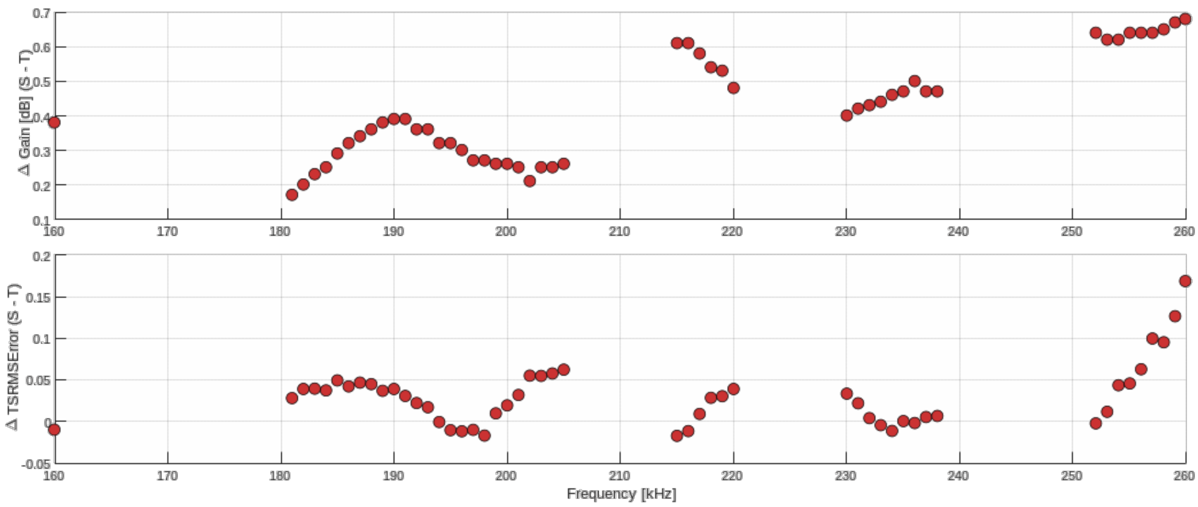



*Figure 10 . Difference between estimated gain and TS RMS error for single and triple suspension using 200 kHz FM (WC38.1-IMR023).*

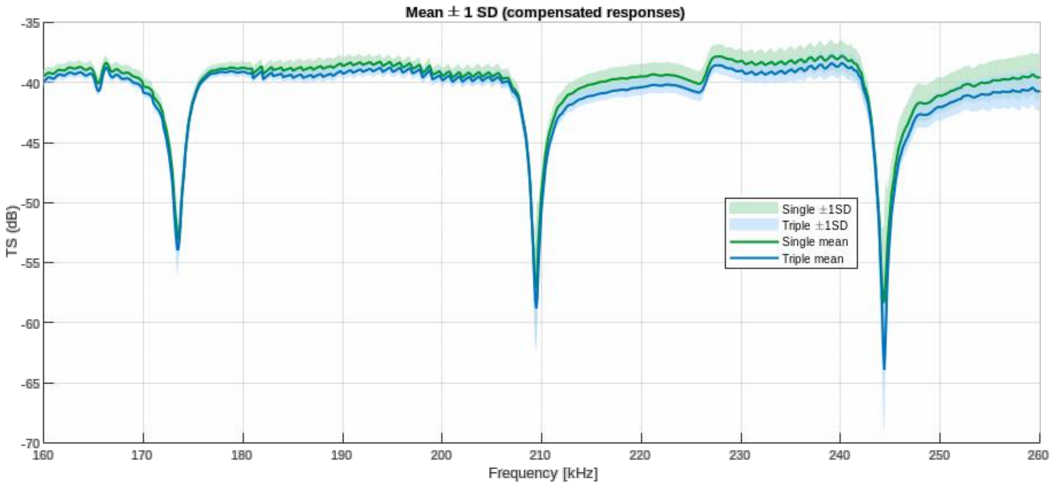



*Figure 11 . Estimated TS as a function of frequency for WC38.1-IMR023 with single and triple suspension using 38 kHz FM.*

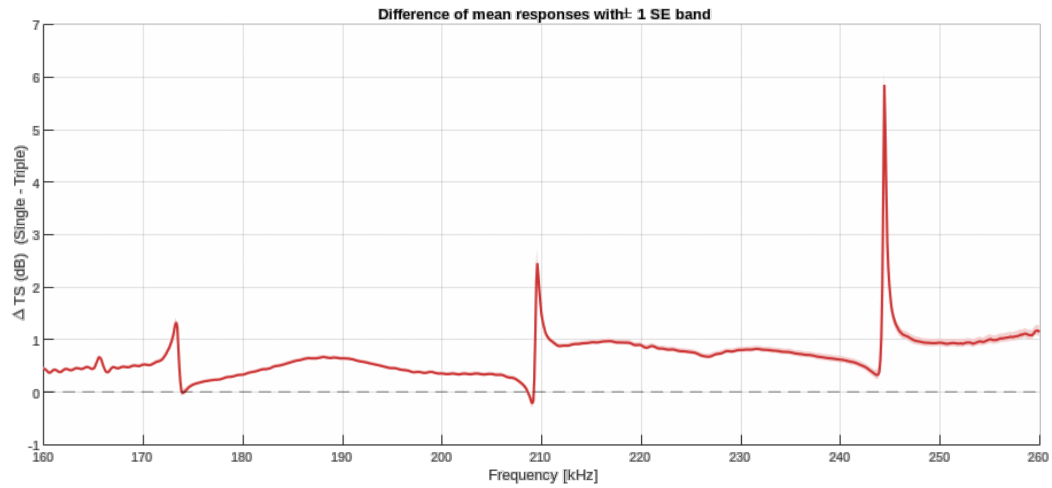



*Figure 12 . Difference between estimated TS as a function of frequency for WC38.1-IMR023 for single and triple suspension using 200 kHz FM.*

### 2.2.3 - WC25-WO14583 - 38kHz FM

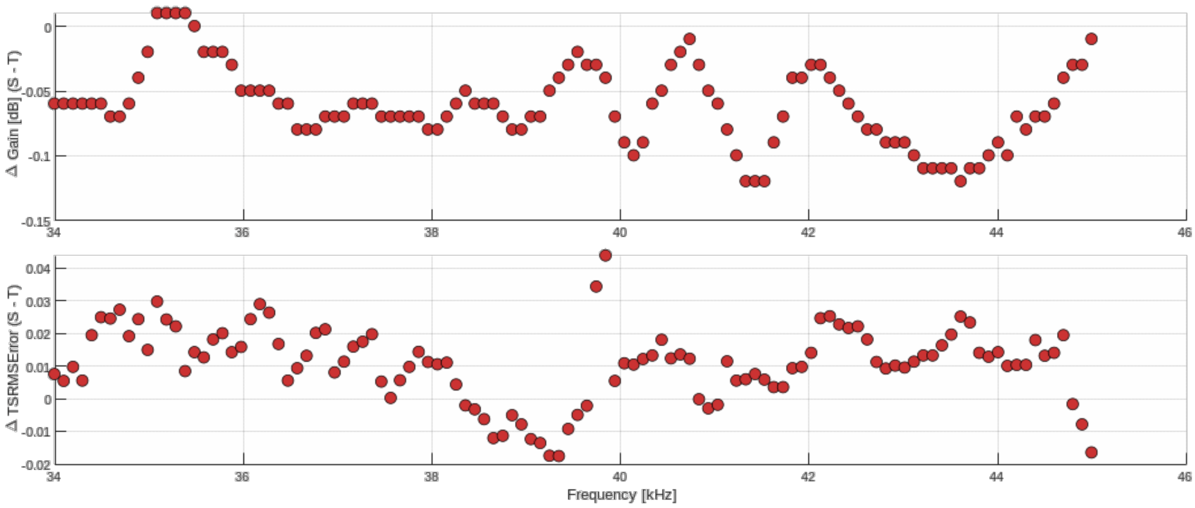



*Figure 13 . Difference between estimated gain and TS RMS error for single and triple suspension using 38 kHz FM (WC25-WO14583).*

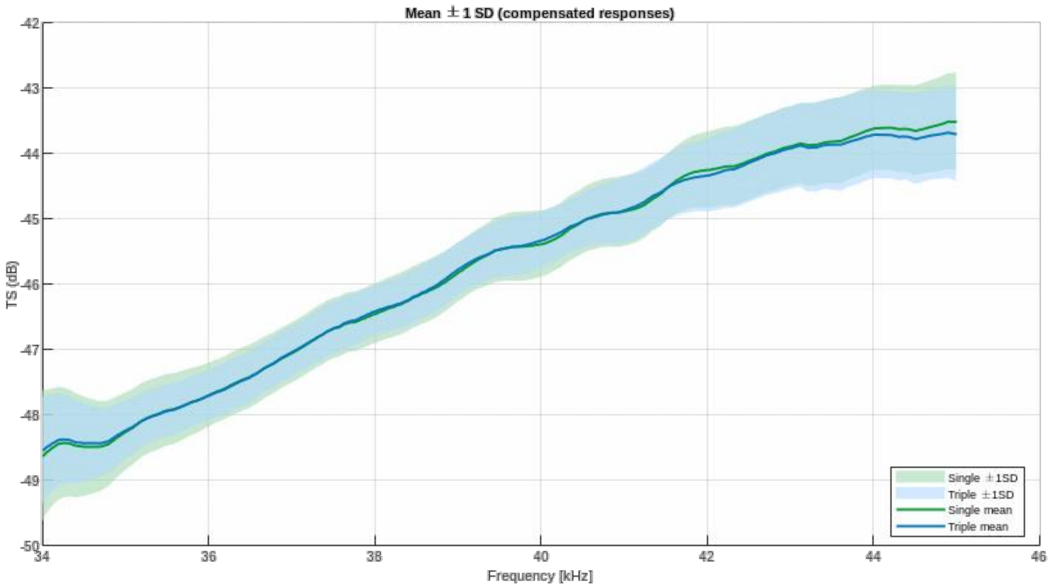



*Figure 14 . Estimated TS as a function of frequency for WC25-WO14583 with single and triple suspension using 38 kHz FM.*

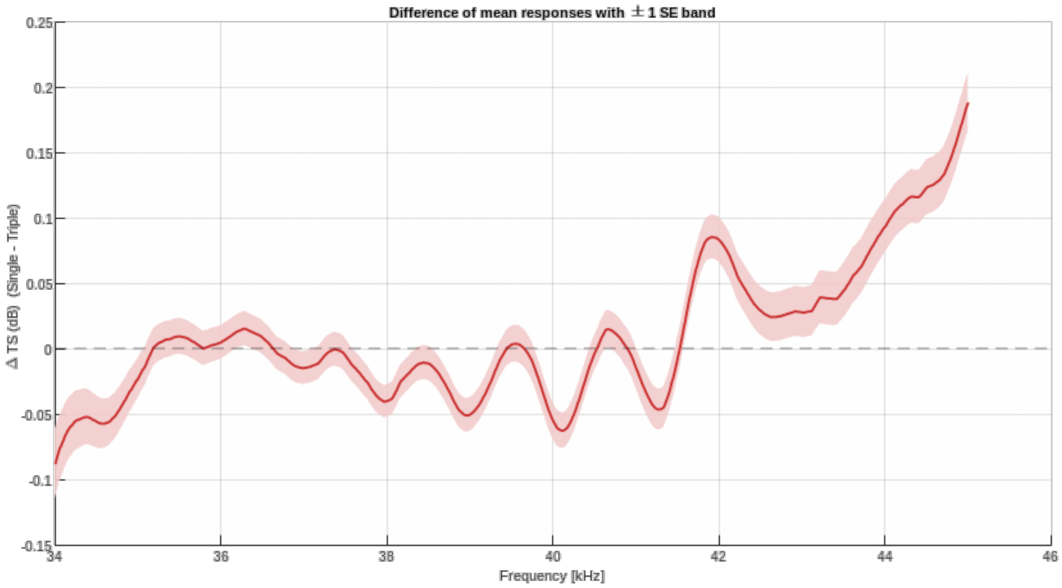



*Figure 15 . Difference between estimated TS as a function of frequency for WC25-WO14583 for single and triple suspension using 38 kHz FM.*

### 2.2.4 - WC25-WO14583 – 200 kHz FM

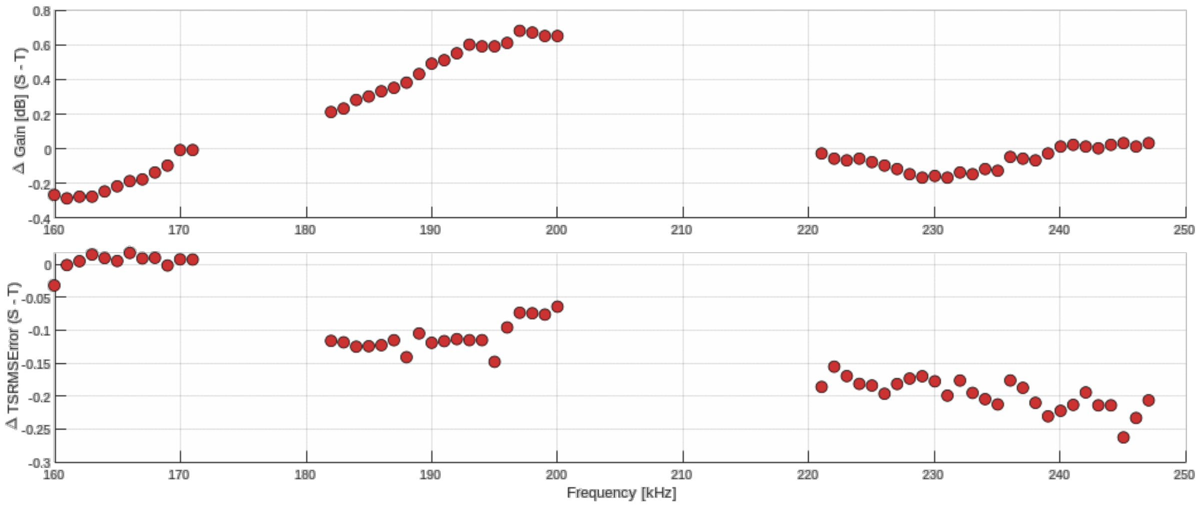



*Figure 16 . Difference between estimated gain and TS RMS error for single and triple suspension using 200 kHz FM (WC25-WO14583).*

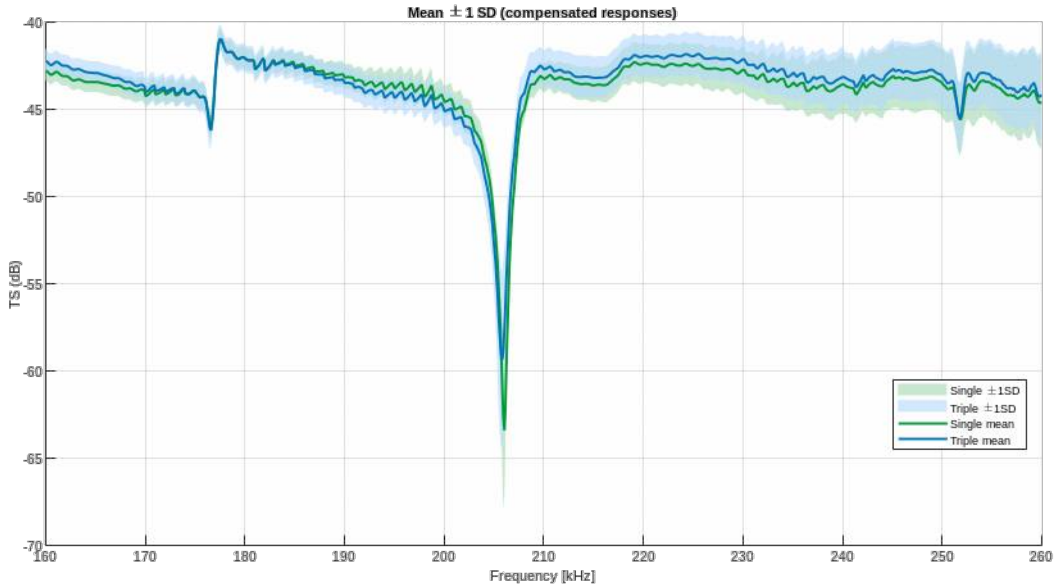



*Figure 17 . Estimated TS as a function of frequency for WC25-WO14583 with single and triple suspension using 200 kHz FM.*

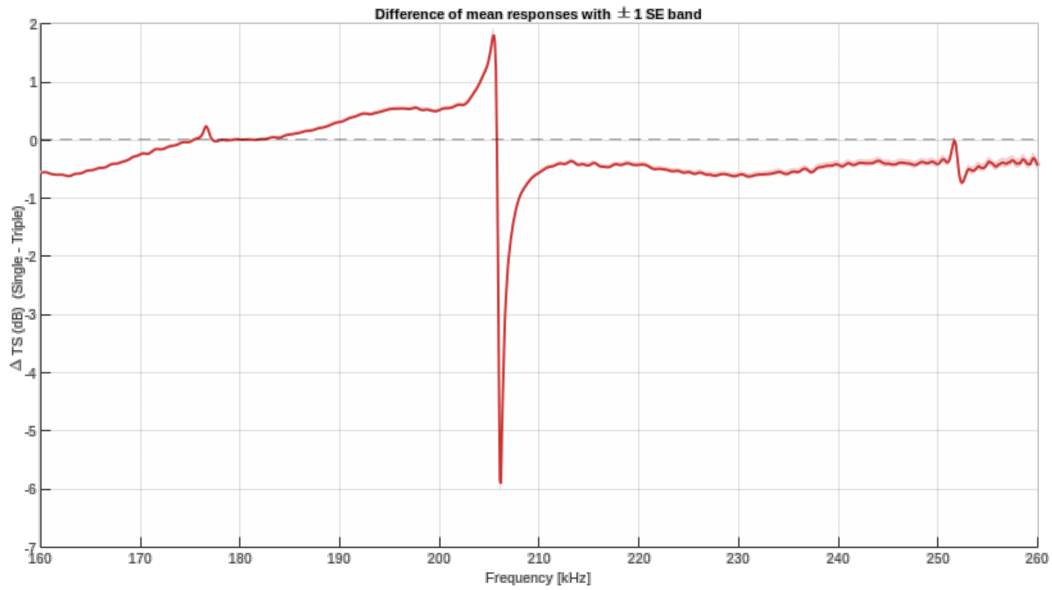



*Figure 18 . Difference between estimated TS as a function of frequency for WC25-WO14583 for single and triple suspension using 200 kHz FM.*

# 3 - Noise measurements in 333-kHz echosounder

**Author(s): Rolf Korneliussen (IMR)**

Noise was investigated during the 2025-CRIMAC survey (2025001018) for comparison with similar survey in 2023. Prior to the 2023 survey (2023001016) a new 333-kHz broadband transducer was installed. The transducer had a new type of earthing that led to much lower noise as compared to the same type of transducer with a different type of earthing. For this reason, it was especially the noise-comparison of the 333-kHz channel in FM-modus that was of interest.

Noise was investigated in FM-modus with both active transmission of sound and passive recordings, and at both 4+ and 9.5+ knots. Averaged noise in FM-modus was essentially equal in all these four situations, although nose was slightly stronger at 9.5+ knots. Similarly, noise was quantified for similar speeds (5 knots and 10 knots) for data collected at the 2023001016 survey for both active transmission and passive recording of sound. As for the 2025 survey, quantified noise was essentially equal in all four situations, although slightly stronger at 10 knots (as expected). One situation was selected for further comparison: active transmission of sound at approximately 10 knots for the surveys in 2023 and 2025.

Figure 19 (upper panel) shows that noise averaged over the whole bandwidth in FM-mode was 4.5 times (6.5 dB) stronger in 2025 than in 2023. Lower panel shows that the noise was stonger over the whole bandwidth in 2025 except for 300 and 312 kHz.

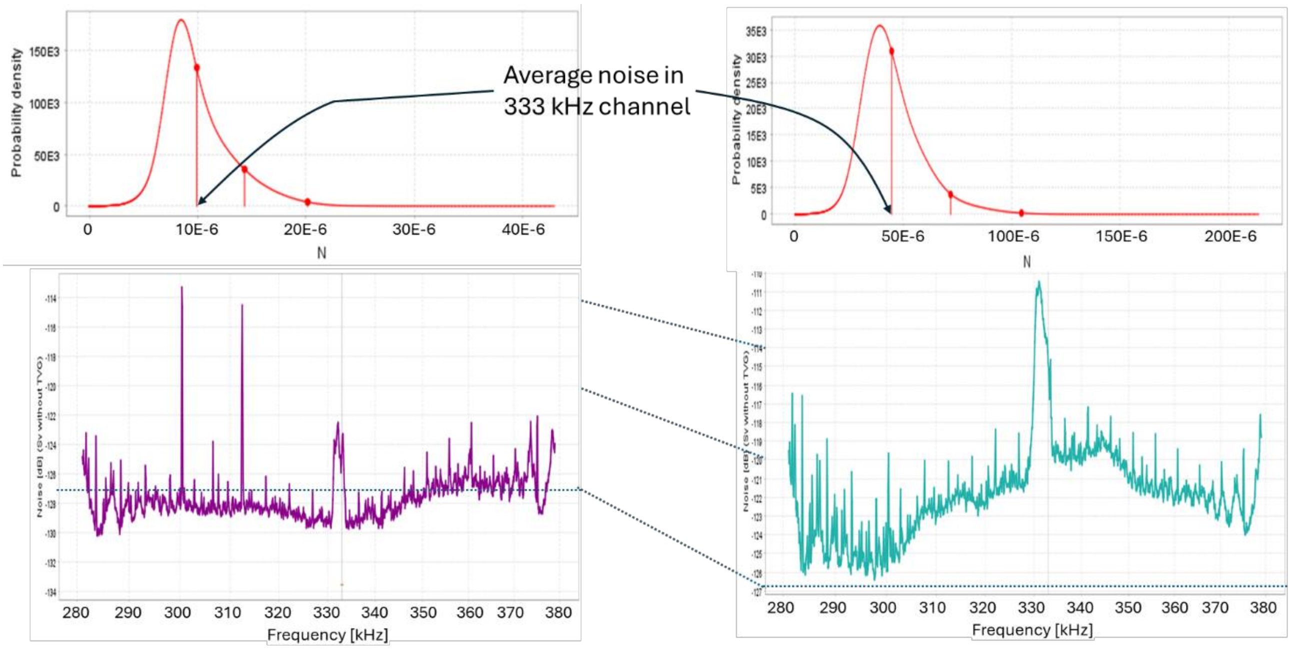



*Figure 19 . Noise in 333-kHz EK80 channel in FM-modus in 2023 (to the left) and in 2025 (to the right). Upper panel shows noise averaged over the whole bandwidth Lower panel shows how noise in all of the frequency-band 280 – 380 kHz.*

# 4 - CamSounder – in-trawl camera system (Scantrol DV)

**Author(s): Ketil Malde, Vaneeda Shalini Devi Allken, Jostein Saltskår (IMR), Jaroslav Kamrla (UoB) and Maria Tenningen (IMR)**

Ketil Malde, Vaneeda Allken, Jostein SaltskÃ¥r, Jaroslav Kamrla, Maria Tenningen.

## 4.1 - Objective

CamSounder (Scantrol Deep Vision) is a new trawl camera system designed to provide real time information on species and length composition in the catch. The objective was to test the system and collect data to evaluate image quality and develop filtering, tracking and length measurement algorithms for herring.

## 4.2 - Method

The CamSounder was mounted in a steel frame to protect and stabilize the system during trawling ( Figure 20 ). The camera frame was attached in the middle of the starboard side panel (60 mm meshes), either in the last trawl section ahead of the selection extension ( Figure 21 a) or in the extension ( Figure 21 b). The distance to the opposite side was either about 2.8 m or 1.5 m. The frame weight in air was 20 kg and buoyancy was adjusted with 8 floats (2.49 kg netto buoyancy per float). Data were collected with default settings. Frame rate was 10 images per second with 100 ms exposure and the system used strobing led light.

Data can be downloaded from the CamSounder using the built-in web interface, after first packing the images into a zip file. We found that using the system's SSH interface to copy files using rsync was at least as fast (speed being limited by the often poor wifi connection quality) and allowed us to view partially transferred data and resume incomplete transfers. A Python script was written to sync data from CamSounder, GoPro, and DarkVision, available here: https://git.imr.no/ketilm/camserver-scripts

The images as produced by the camera are quite dark, and their size makes them slow to transfer and work with. To this effect, scripts were written to produce scaled down image sizes and to automatically adjust image parameters (brightness, contrast, etc), using the ImageMagick software package. These scripts are stored together with the image data.

An object detection algorithm (YOLO) developed by IMR, trained on images collected with another camera system, was applied to the data. The aim was to convert the fish detections into preliminary annotations for the CamSounder images and use it to train a new model. Herring length was measured in the deep vision analyses software (DVAS, Scantrol DV AS).

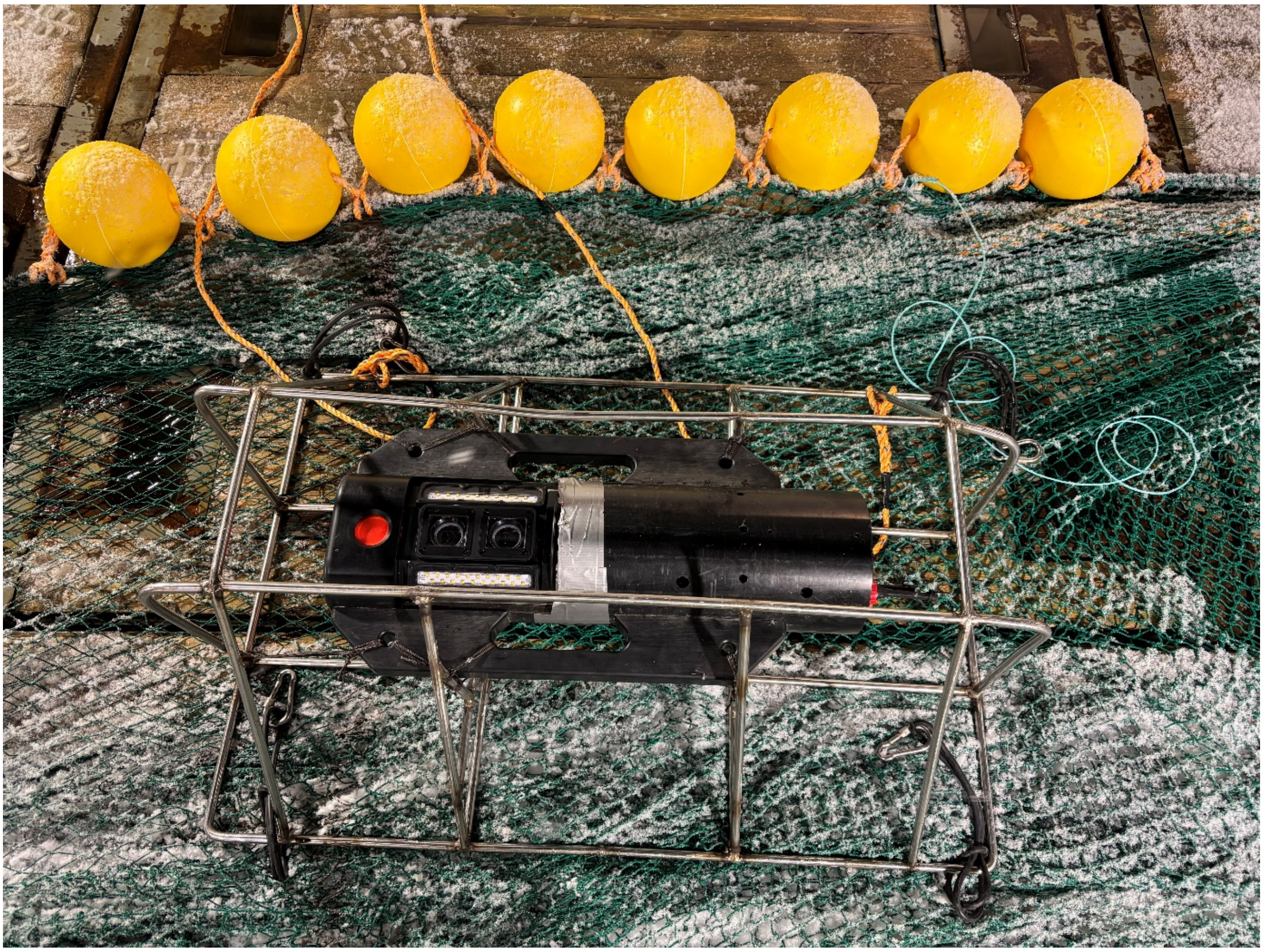


*Figure 20 . The CamSounder was mounted in a protective steel frame on the starboard side panel of the trawl.*

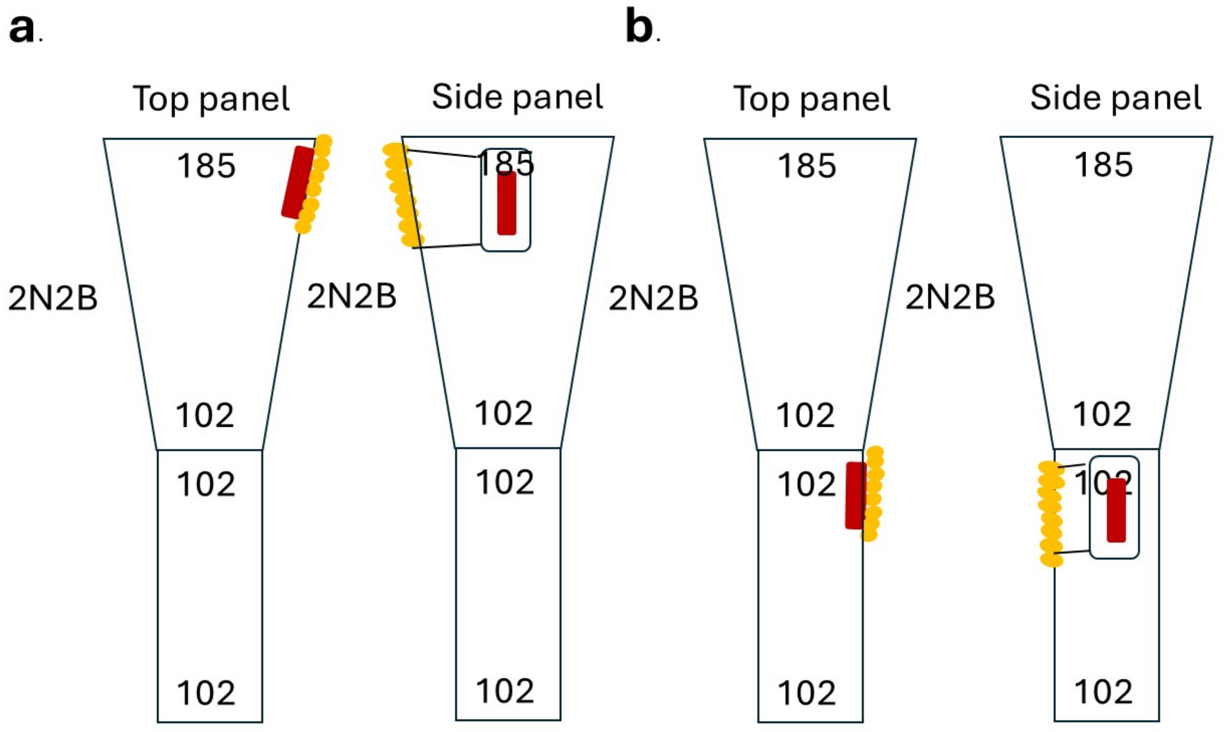



*Figure 21 . The CamSounder was either mounted in the last section before the extension (a) or in the extension section of the trawl (b).*

## 4.3 - Preliminary results

CamSounder data were collected successfully in 6 trawl hauls (for more details see Appendix 1).

**Image quality**

Images obtained from the CamSounder appeared generally dark. However, simple post-processing adjustments in image-editing program enhanced visibility and revealed some of the missing details such as the net, its meshes and fish features relevant for length measurements. Below is an example of enhanced image in comparison to the original ( Figure 22 ).

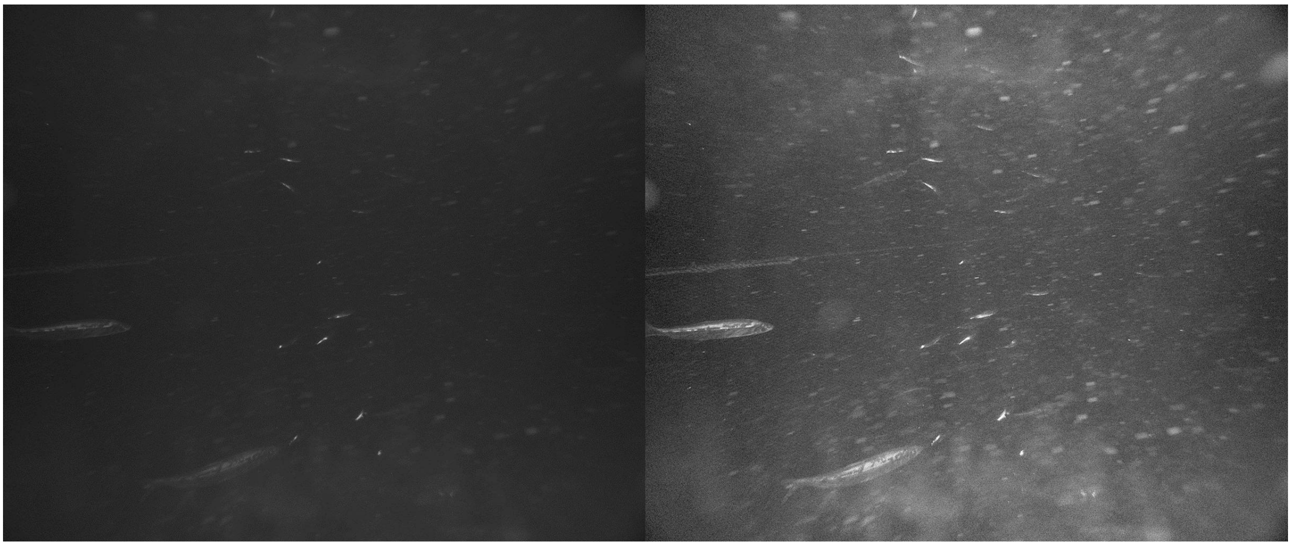


*Figure 22 . Image from before is on the left and the enhanced image is on the right*

**Object detection**

The object detection algorithm performed poorly on the CamSounder images and the model missed a large proportion of the fish. The images were dark and it was in many cases difficult also for humans to count the number of fish present in an image ( Figure 23 ).

*Figure 23 . Example of object detection algorithm applied to the CamSounder data.*

**Length measurements**

Deep Vision analysis software (DVAS) was utilized to length measure the herring from station 671 (haul number 5). Due to the darkness of the images, the fish further from the camera often lacked necessary details, especially the caudal fin, required for the measurements. Furthermore, presumably due to the calibration, measurements of the herring in the background were highly sensitive to where the pointer was placed and resulted in uncertain measuremenets. Therefore, only fish positioned closer to the camera were included in the analysis ( Figure 24 ). A total of 101 randomly selected herring were length measured. The average size of herring in this school was 34.6 cm ( Figure 25 ).

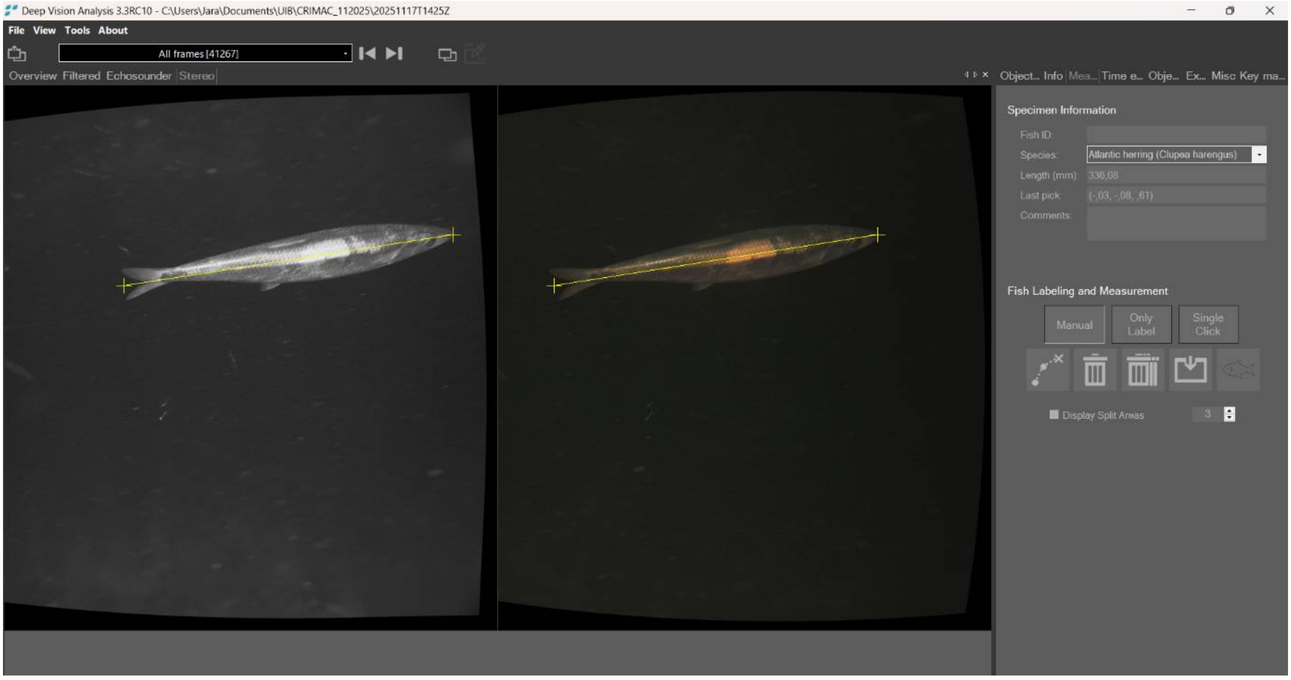



*Figure 24 . Length measurement in DVAS .*

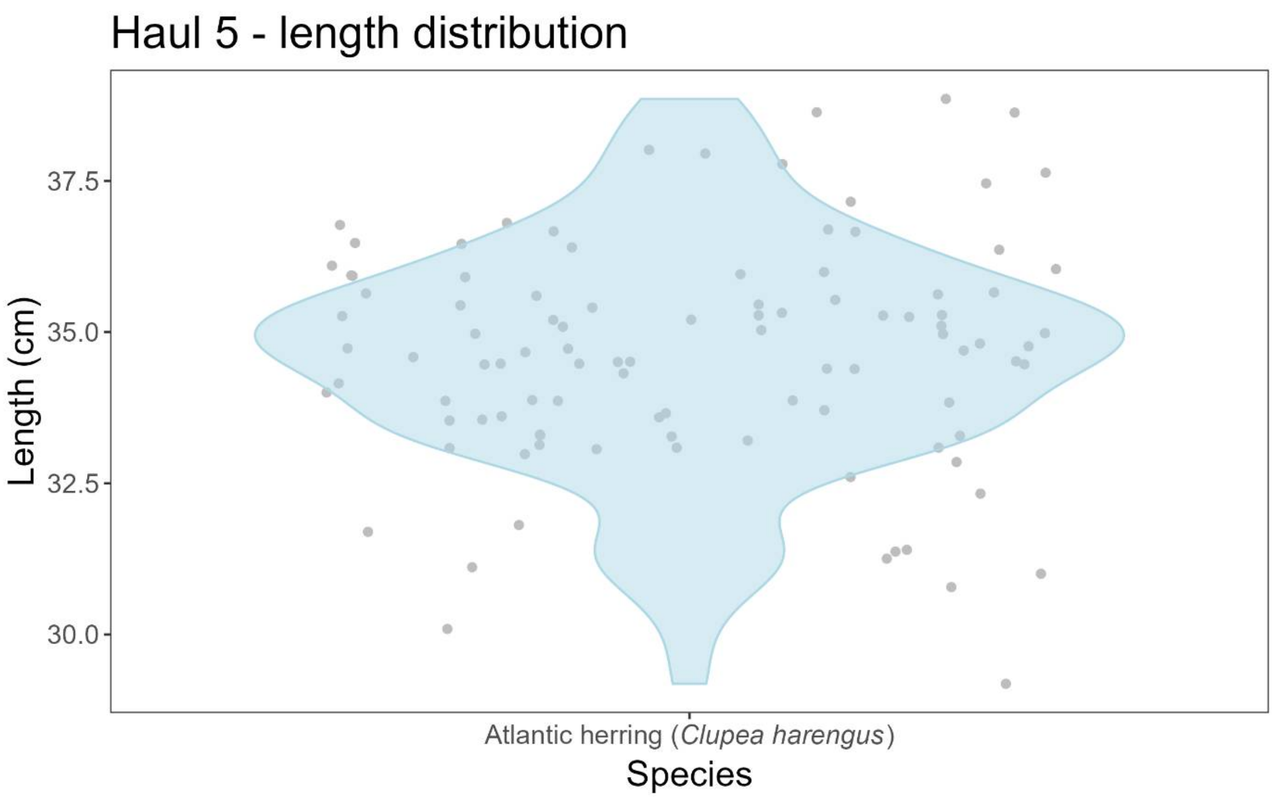



*Figure 25 . Length distribution of herring at station 671.*

# 5 - Remote opening and closing of the trawl for selective sampling

Author(s): Craig Rose (FishNext Research), Jostein Saltskår and Maria Tenningen (IMR)

FishNext Research in collaboration with Kongsberg Discovery have developed an active selection device that automatically opens and closes the trawl (ActSel). The system operates together with the Simrad FX80 system with live cameras (Kongsberg Discovery). ActSel is primarily developed to detect and avoid salmon by-catch in the Alaska pollock and West Coast hake fisheries. On this cruise we wanted to investigate whether the system could be used on IMR survey trawls for selective sampling. IMR aims to develop camera-based sampling methods for trawl surveys. The concept is that species specific counts and length distributions are obtained with an in-trawl camera system and only the fish needed for physical sampling are brought on deck allowing the remaining fish to swim out of the net after imaged.

## 5.1 - Objective

The objectives in this cruise were to test and optimize ActSel for the Harstad trawl, evaluate practicality and reliability and monitor herring behaviour in relation to the selection panel in red and white light conditions. As an alternative to the ActSel a simple grid-based system was also tested.

## 5.2 - Method

Two Harstad trawls were rigged on GO Sars, one with the ActSel system ( Figure 26 ) and one with the grid-based system ( Figure 27 ; appendix 2). A 4-panel section was attached between the trawl and the codend (102 60 mm meshes per panel) containing the selection systems. To maintain mesh stability 30 mm Danline lacing rope with 5% slack were attached.

The ActSel consists of a panel in the aft end of the trawl that either covers an escape opening or uncovers it and guides fish out. The system is composed of a mesh panel, which is moved by a hydrodynamic kite controlled by lines adjusted by a small, remote winch (actuator). Control and telemetry of the actuator, as well as live video from the trawl is provided by the Kongsberg/Simrad FX system, using a cable from the vessel to the net (third wire). The FX hub was attached to the trawl top panel in the extension section with ActSel. Control of the third wire requires significant drag at the trawl end. While commercial trawls have codends with enough drag to handle the third wire directly connected to the aft end of the net, the survey trawl's codend is so light that the tension in the third wire would disable the net by folding it forward. This was solved by affixing the cable to the trawl's headrope and securing it along the net to extension containing the FX hub. A stretch release (16 mm dynema ca 5 m long) was attached in the headline and additional stretch release on the cable by the hub ( Figure 28 ).

As an alternative method we tested a grid-based was system. The system consisted of a steel frame (160 cm high and 120 cm wide) covered with 30 mm mesh netting. The frame was attached in a 45 degree angle in the extension section. The upper half of the frame was not attached and could be moved between catch mode (lifted toward the trawl roof covering the fish release opening) and release mode (lowered down covering the entrance to the codend and allowing fish to escape through the opening in the trawl roof. Hauls were alternated between catch and release modes.

In addition to the FX live cameras, GoPro and Dark Vision cameras (IMR) were used to monitor the selection systems and fish behaviour. A detailed haul-by-haul description of camera positions is available in Appendix 1.

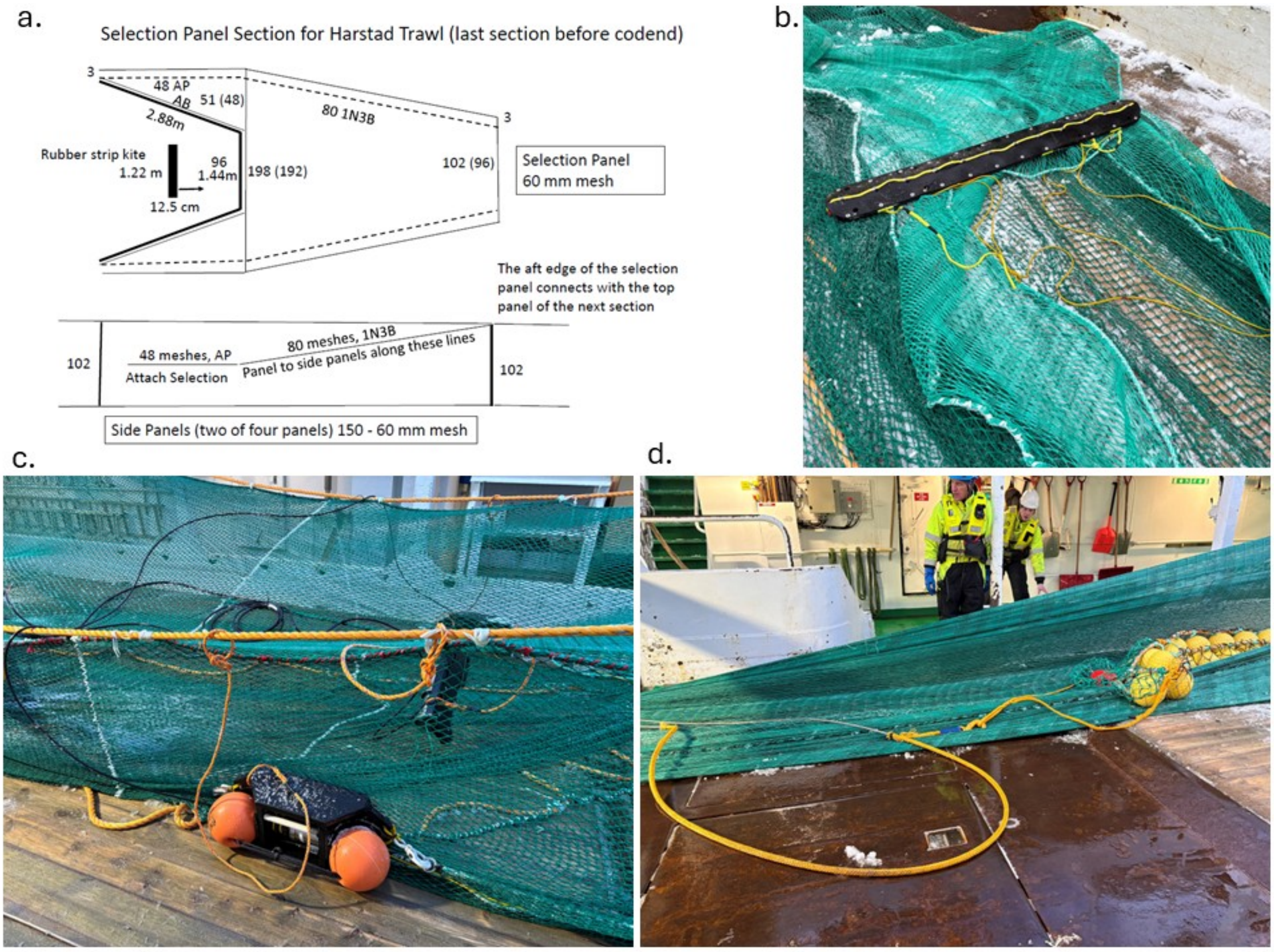



*Figure 26. ActSel (Rose and Barbee, 2022) is a by-catch reduction device that can quickly be altered between capture and release configurations with real-time triggering. An electric actuator controls a water kite that moves a fish-guiding net panel. Panel design (a), kite (b), actuator (c) and the stretch release used to reduce load on the 3rd wire (d).*

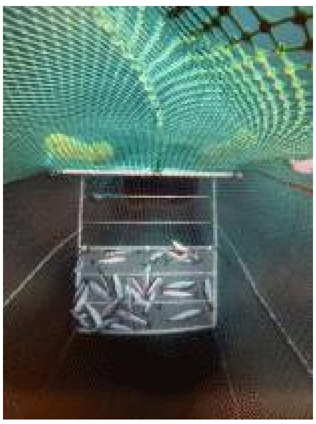


*Figure 27 . A selection system based on the design of a selection grid.*

*Figure 28 . Extension section with the ActSel system showing the actuators, kites, lines going from the actuator to the kite, Simrad live cameras, the FX hub and CamSounder.*

## 5.3 - Preliminary results

**ActSel**

A detailed report written by Craig Rose is available in Appendix 3. In summary:

- The ActSel system was successfully adapted to the survey trawl and demonstrated that it operates as designed. The net panel was efficiently moved between release and capture modes ( Figure 29 ).
- We collected data that allows us to study herring behaviour with the ActSel in capture and release configurations under both red and white lighting.
- The ability to deploy two live-feed cameras and two actuators was very beneficial to this trip's experiments.

Some of the issues that we experienced included:

- Even though this was a new process and the third wire and its winch had rarely been used, this operation was well established after the first days, but required additional time and personnel to operate.
- Significant quantities of herring were observed to escape over the top of the ActSel panel when it was in the capture configuration.
- In some of the hauls the ActSel section was tangled during setting.

In conclusion, the Simrad FX system and its ActSel components performed well. There is however some concern related to the many components of the ActSel and the risk of entanglement. If IMR in the future intends to use systems requiring the 3rd wire, there is a need to upgrade the system and build procedures for routine use.

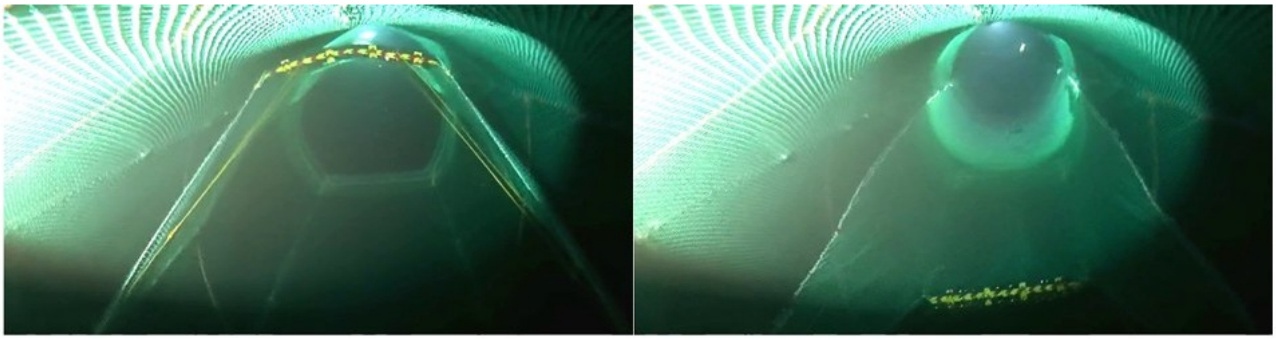


*Figure 29 . Underwater images of ActSel. To the right the kite and panel are up and fish are guided into the codend. To the left the kite and panel are down and fish are guided out through the top panel that is open.*

**Grid system**

The grid-based system was tested in 7 hauls (5 release mode and 2 catch mode). The idea of this system was that the haul starts with the grid open, i.e. catch configuration and once enough fish are caught (registered by the in-trawl camera system) the top panel of the grid is released down with an acoustic releaser and the entrance to the codend is closed. Fish are released out through the opening in the trawl ceiling. We observed that fish were getting stuck on the closed part of the frame and in the netting around the frame both when in catch and release configurations. The reason for this may be that the angle of the grid was not optimal, the opening into the codend and out of the trawl were not large enough and / or that there was too much netting around the grid that “bags were created”.

# 6 - Passive acoustic monitoring with hull (drop keel) mounted hydrophone (WP1 task)

**Author(s): Geir Pedersen (IMR) and Robert Sørhagen (KD)**

A Kongsberg Discovery hydrophone system was installed temporarily on GO Sars, comprising of a single hydrophone mounted in the hull of the GO Sars, with a hardware system to collect, store, and visualize wave data.

Continuous monitoring of vessel generated noise can facilitate improved vessel operations (condition monitoring) and provide data on underwater radiated noise. Continuous monitoring of marine mammals for research or warning are other potential applications of hull mounted hydrophones.

## 6.1 - Objective

The objective of the PAM experiment was to gain experiences with running the KD hull mounted system. To observe differences in near field noise measurements by the hull mounted system and far field measurements with external hydrophone. Additionally, to evaluate feasibility of detecting marine mammals.

## 6.2 - Method

The hydrophone module was installed in the vessel's drop keel to enable near-field measurements of vessel noise and detection of marine mammals. The system was cabled to a dedicated PC equipped with software for real-time monitoring and recording of acoustic data. Data was collected at sampling frequency 768 kHz.

Noise measurements focused on characterising the vessel's self-noise under a range of operating conditions ( Table 6 ). First, self-noise was recorded with the vessel stationary. In addition, self-noise was recorded with the vessel stationary using a separate hydrophone deployed in the far field (via CTD), with a recording duration of approximately 60 minutes.

Self-noise was then recorded at various speeds, following the identification of a suitable area for steaming with minimal external acoustic interference. Data were collected both without excess operational noise (i.e. with echosounders, trawl gear and other systems turned off) and under normal operational conditions (with echosounders and other standard equipment running).

For both configurations, the vessel steamed at 3, 7, and 11 knots, with approximately 15 minutes of recording per transect and for each of three drop keel positions (fully retracted, half-extended, and fully extended).

Marine mammal measurements aimed to evaluate the capability of the hydrophone system to detect biologically generated sound. Areas with likely marine mammal presence were identified, typically regions associated with herring aggregations, with night-time conditions generally preferred. Recordings were made with the vessel stationary in an area where marine mammals had been sighted, using a separate hydrophone deployed in the far field (via CTD) for at least 60 minutes. Further recordings were obtained while the vessel was underway at speeds of 3, 7, and 11 knots, with approximately 30 minutes of data collected per transect in each speed category.

Additional ad hoc measurements were conducted under a variety of conditions and vessel operations, including during trawling, to broaden the dataset across realistic working scenarios. To further assess whether marine mammal detection was feasible using the hull-mounted hydrophone system, the vessel was allowed to drift for approximately three hours during the night of 16–17 and 17-18 November. This drift period, during which passive acoustic monitoring was conducted. After drifting the vessel steamed at three knots over the same are to determine whether detections are still possible.

*Table 6 . Experiments with the hull mounted hydrophone.*

| Date | Time | Operation | Speed | Drop-keel |
|---|---|---|---|---|
| **16.11.2025** | 09:06:42-09:21:44 | Steam | 3 knots | 0 m |
| **16.11.2025** | 08:43:59-08:59:01 | Steam | 7 knots | 0 m |
| **16.11.2025** | 08:22:28-08:37:30 | Steam | 11 knots | 0 m |
| **16.11.2025** | 10:37:22-10:52:26 | Steam | 3 knots | 1.25 m |
| **16.11.2025** | 10:12:21-10:27:24 | Steam | 7 knots | 1.25 m |
| **16.11.2025** | 09:49:36-10:04:37 | Steam | 11 knots | 1.25 m |
| **16.11.2025** | 20:36:39-20:51:40 | Steam | 3 knots | 2.5 m |
| **16.11.2025** | 20:14:39-20:29:40 | Steam | 7 knots | 2.5 m |
| **16.11.2025** | 19:53:34-20:08:35 | Steam | 11 knots | 2.5 m |
| **17.11.2025** | 00:01:36 | Drift | 0 knots | 2.5 m |
| **17.11.2025** | 01:49:59 | Drift | 0 knots | 2.5 m |
| **17.11.2025** | 18:11:37 | Drift | 0 knots | 2.5 m |
| **18.11.2025** | 20:36:39-20:51:40 | Steam | 3 knots | 2.5 m |
| **18.11.2025** | 20:08:44-20:23:46 | Steam | 7 knots | 2.5 m |
| **18.11.2025** | 19:38:14-19:38:14 | Steam | 11 knots | 2.5 m |

## 6.3 - Preliminary results

During initial data exploration the acoustic data were resampled to 48 kHz. Power Spectral Density was estimated with 1s Hann Window with 50% overlap, and 10 s average, with GO Sars cruising at 3, 7, and 11 knots ( Figure 30 ). At 11 knots saturation and additional noise related to flow is observed which is not found at lower cruising speeds.

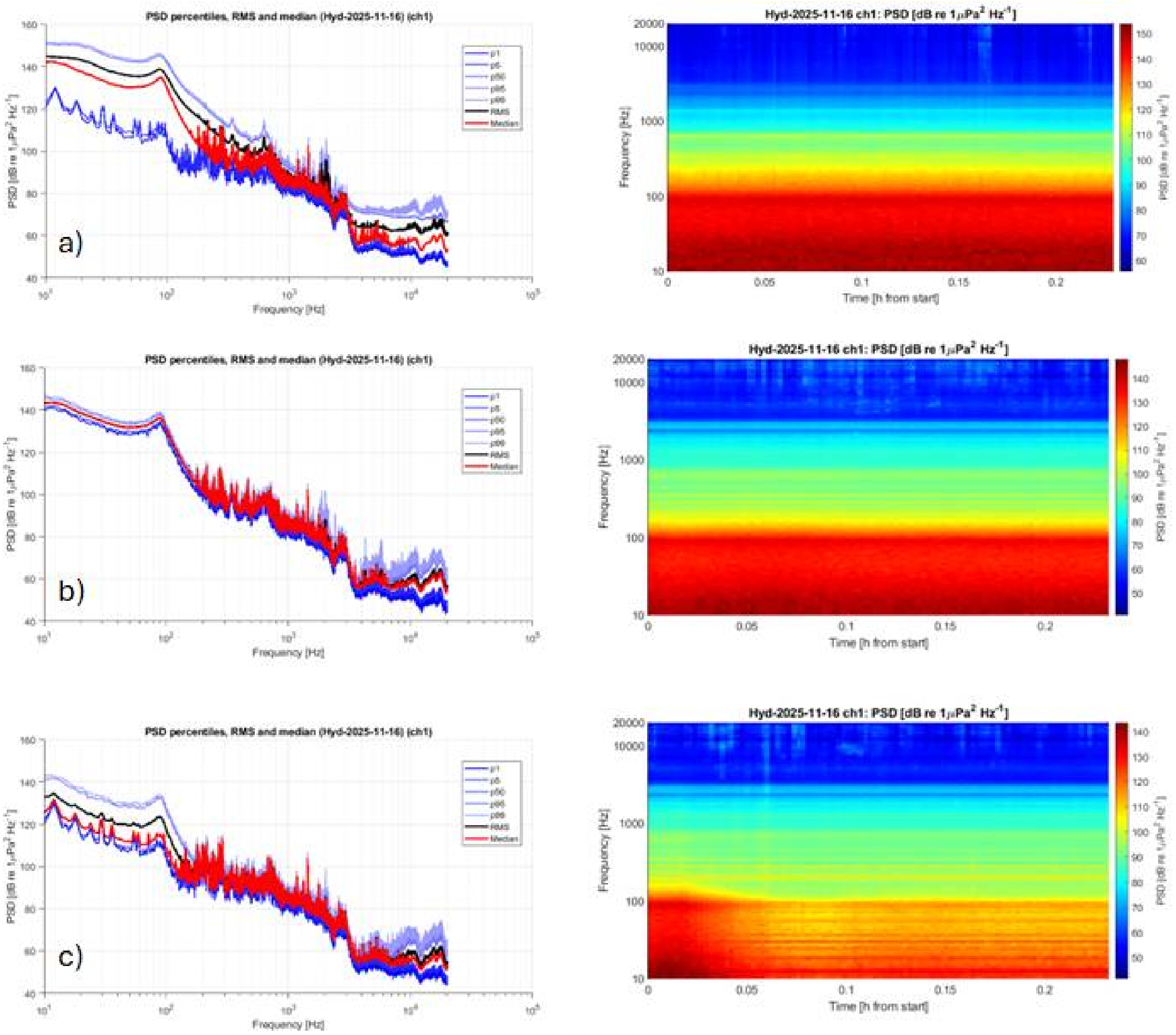



*Figure 30 . PSD at three cruising speeds 11 knots (a), 7 knots (b), and 3 knots (c).*

Vessel noise dominates below ~100 Hz making detection of low frequency vocalizing mammals challenging, especially at high cruising speeds. Detections are possible when the vessel is drifting ( Figure 31 ).

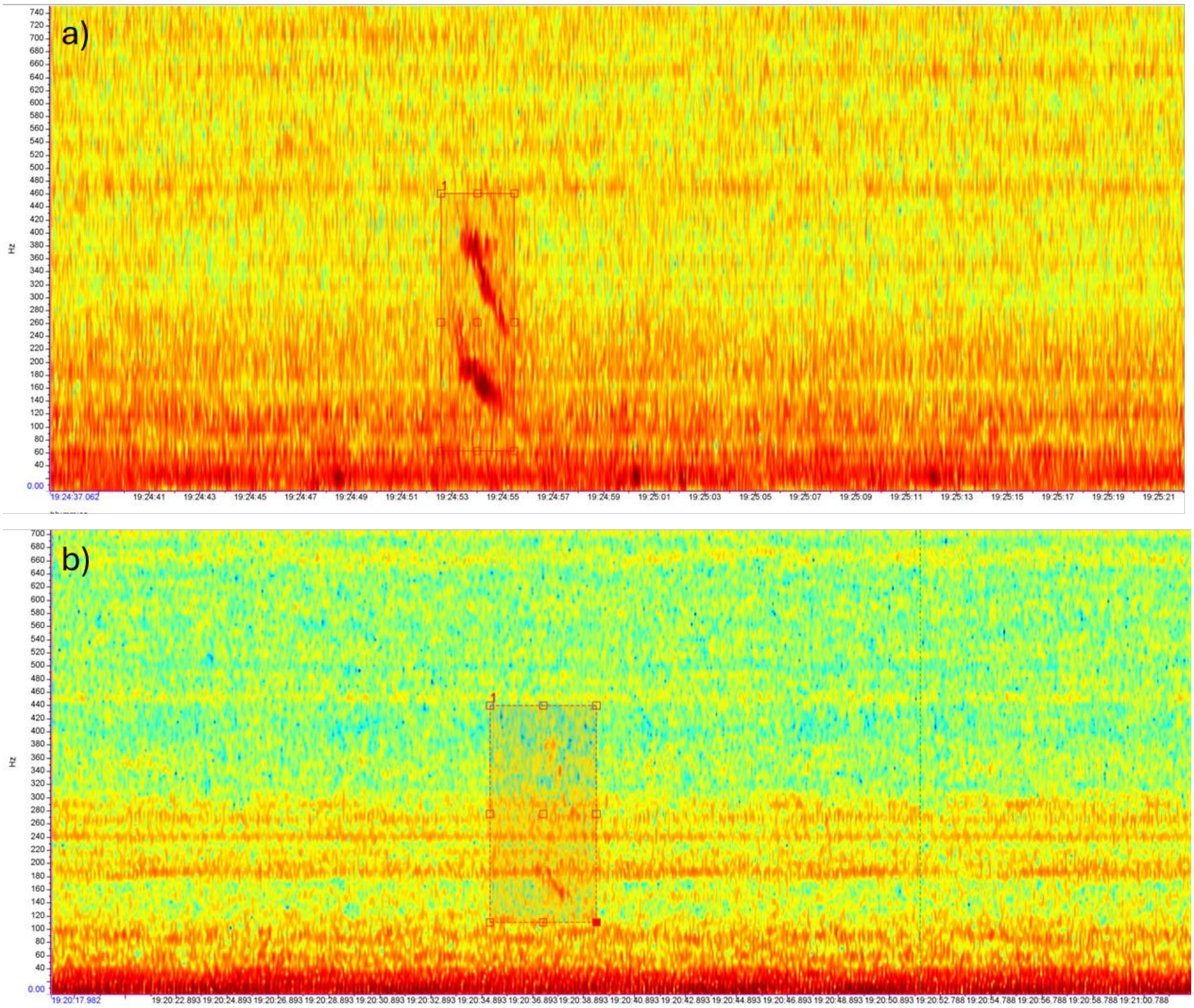
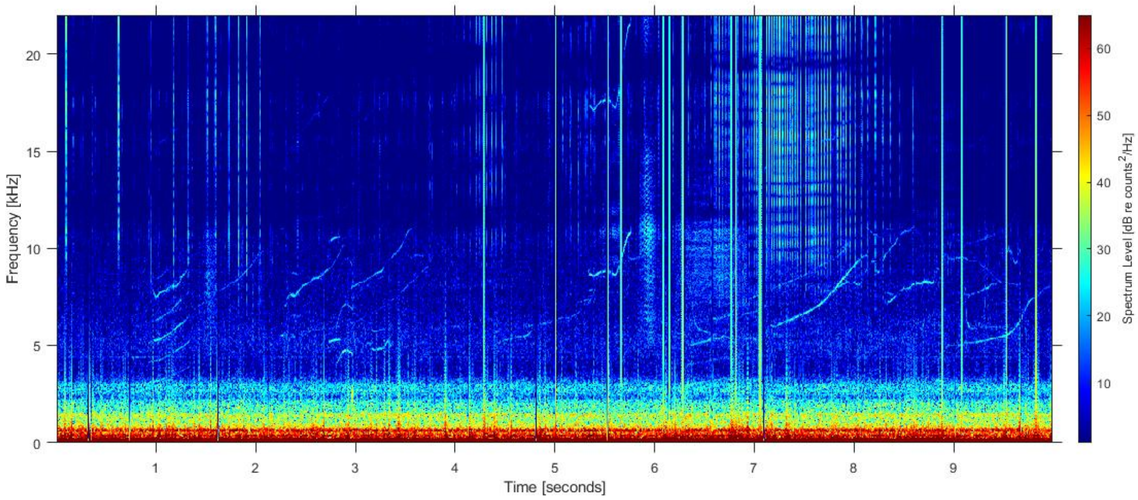



*Figure 31 . Vessel drifting with additional hydrophone on CTD (a). Low frequency vocalization (humpback whale) is within the low frequency noise band due to the vessel and is less clearly visible on the hull mounted system (b).*

Vocalization (e.g. by killer whales) is clearly observable at all cruising speeds above ~3000 Hz ( Figure 32 ).



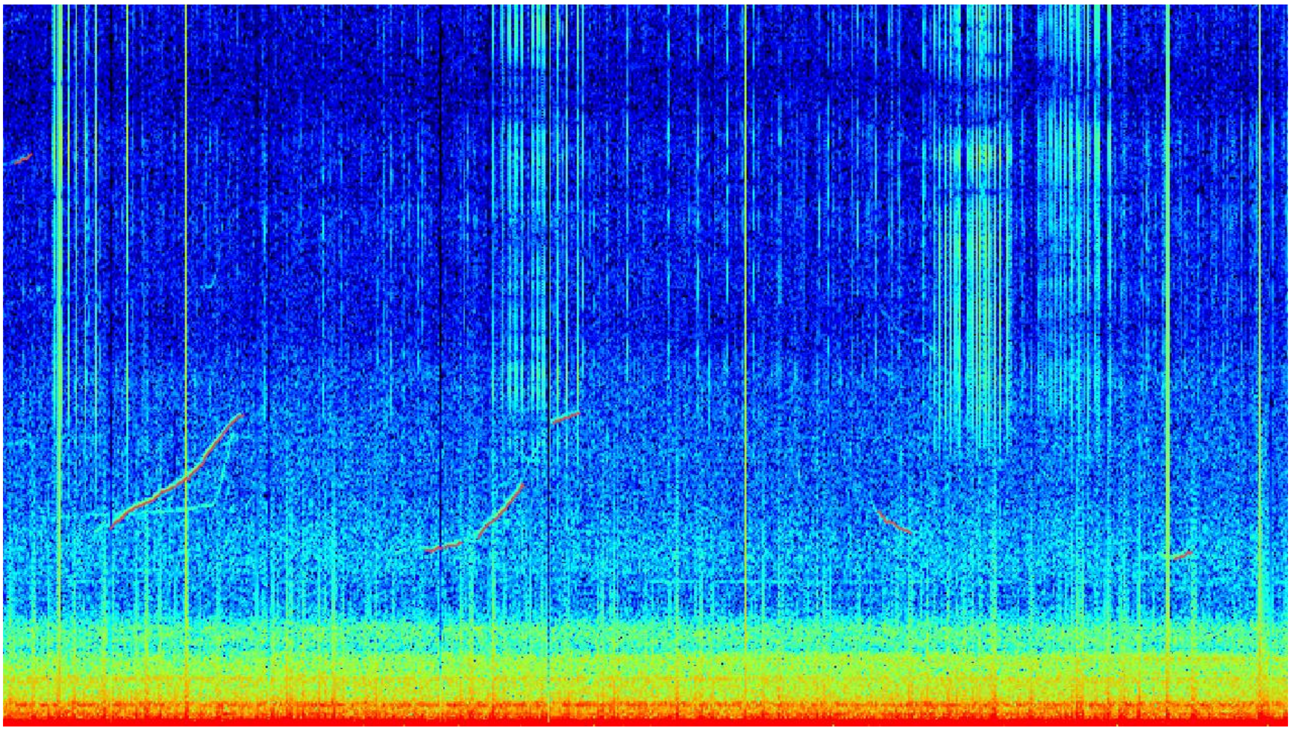


*Figure 32 . Clearly visible killer whale clicks and FM calls observed on the hull mounted system while steaming 11 knots (upper figure) and example of a simple call detector used on the data (lower figure) where detected calls are marked with red colour.*

# 7 - Broadband EK80 and EC150 measurements of herring layers (WP1 task)

**Author(s): Geir Pedersen (IMR)**

## 7.1 - Objective

The objective of this study was to collect broadband frequency responses from herring schools and compare these with CRIMAC backscatter simulations of schools with similar length distributions. Specifically, we aimed to examine whether the modeled frequency responses that indicate size groups correspond to the measured responses at sea, and, where possible, to support this comparison with target tracking from the Kongsberg Discovery ADCP EC150 narrow-beam echosounder.

In addition, we aim to explore the potential for single-target detection of herring using the narrow-beam system (EC150), in terms of density and range limits, and to assess whether this is a feasible method for estimating size distributions based on single-target data. Finally, we aimed to collect independent size distribution data on herring using the CamSounder system to link acoustic responses to fish size.

The main objectives were to:

- Collect frequency responses of herring layers across the full frequency range of the EK80 broadband echosounder, for schools with different size distributions.
- Collect single-target detections of herring within layers using the narrow-beam EC150, and map the conditions (densities and ranges) under which reliable single-target detection is possible.
- Collect independent herring size distribution data using CamSounder for validation and interpretation of the acoustic data.

## 7.2 - Method

Data was collected along a series of acoustic transects across herring layers in the survey area. For each experiment, a straight-line transect was run over a herring layer with the vessel maintaining a constant speed suitable for both broadband acoustic sampling and subsequent trawling operations. Each acoustic transect had a minimum effective duration of approximately 30 minutes to ensure sufficient sampling of the herring layer.

On each transect, the vessel will first conduct the acoustic survey pass and then perform a trawl on the return track over the same herring layer. During the acoustic pass, the EK80 broadband echosounder was operated over its full available frequency range to record frequency responses of the herring layers. Simultaneously, the EC150 narrow-beam echosounder was operated to collect high-resolution data aimed at detecting and tracking single herring targets within the layer. For the EC150 data, particular attention will be given to documenting the ranges and densities at which single targets can be reliably resolved, in order to evaluate the feasibility of using this approach for size estimation.

During the return leg of each transect, a trawl equipped with a CamSounder system was deployed to sample the same herring aggregation that was insonified acoustically. The CamSounder was used to obtain *in situ* measurements of fish length distribution within the trawl. These size distribution data will be used to characterize the length composition of the herring schools sampled on each transect.

The acoustic data from the EK80 and EC150 will subsequently be linked to the corresponding CamSounderderived size distributions from the associated trawl haul. This will allow comparison of measured broadband frequency responses with CRIMAC model outputs for schools with similar length distributions, and assessment of the correspondence between modelled size-group indicators and observed acoustic responses. The EC150 single-target data will be used to explore the conditions under which single-target sizing of herring is feasible and to evaluate its potential for future operational use.

*Table 7 . Trawl hauls with CamSounder and associated data collection with EK80 and EC150.*

| Date | Time | Haul | Station | Trawl Depth | Comment |
|---|---|---|---|---|---|
| **17.11.2025** | 14:49:47-15:42:38 | 5 | 671 | 84 m | Dense layer of herring. |
| **18.11.2025** | 07:53:46-08:04:20 | 7 | 673 | 152 m | Layer of herring. |
| **19.11.2025** | 06:46:4-07:16:47 | 9 | 675 | 125 m | Dense layer of herring (trawled top of layer). |
| **19.11.2025** | 08:02:53-08:27:54 | 10 | 676 | 141 m | Dense layer of herring (trawled top of layer). |
| **19.11.2025** | 09:54:52-10:31:31 | 11 | 677 | 141 m | Dense layer of herring (trawled top of layer). |
| **19.11.2025** | 11:13:41-11:32:30 | 12 | 678 | 120 m | Dense layer of herring (trawled top of layer). |

## 7.3 - Preliminary results

ADCP and EK80 data will be analysed and compared with backscatter models when results from the CamSounder (herring length distribution) are available. Figure 33 shows an example of data collected by the EK80 with corresponding frequency response for parts of the herring school. The school was sampled using trawl and CamSounder (station 671).

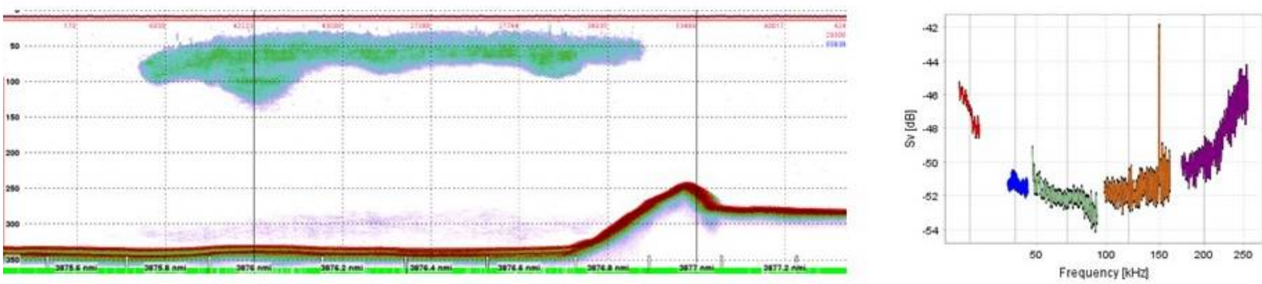



*Figure 33 . Example data showing a herring school also sampled with trawl and CamSounder.*

# 8 - Data organization

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

The data from GO Sars is stored at IMRs secure data storage system under \cruise_data\2025\S2025001018_PGOSARS_4174. All data placements below refer to this directory as the top-level directory.

## 8.1 - ACOUSTIC DATA

The ship-borne EK80 echosounders and 150 kHz ADCP/echosounder were calibrated prior to data acquisition and the subsequent files contain the updated calibration settings. The calibration files are located under:

- ACOUSTIC\EK80\EK80_CALIBRATION
- PHYSICS\ADCP\150_KHZ

Ship-borne unprocessed EK80 data from FF G.O. was stored in accordance with the IMR data storage structure under \ACOUSTIC\EK80\EK80_RAWDATA.

The overall organizing of data from the survey is stored in the survey file localized at \ACOUSTIC\LSSS\LSSS_FILES. A survey-file keeps track of how the directories are organized, e.g. which Work-files to use, which KORONA-files to use and which preprocessing setup to use.

## 8.2 - BIOLOGY

**Trawl sensors**

Door sensors registered door depth and spread and a trawl eye in the headline registered headline depth and vertical door opening. Trawl speed and wire length were also registered. The data are stored by haul here:

- BIOLOGY\TRAWL_SENSORS\SCANMAR

**Image data**

Image data were collected with the CamSounder, DarkVision, GoPro camera and SIMRAD FX live cameras. Information about the camera systems used in the different hauls, mounting of the systems and file names are available in appendix 1. Trawl log. The data form the different systems are stored here:

- \BIOLOGY\CATCH_MEASUREMENTS\OTTHER_MULTIMEDIA\CAMSOUNDER.
- \BIOLOGY\CATCH_MEASUREMENTS\OTTHER_MULTIMEDIA\DARKVISION.
- \BIOLOGY\CATCH_MEASUREMENTS\OTTHER_MULTIMEDIA\GOPRO.
- \BIOLOGY\CATCH_MEASUREMENTS\OTTHER_MULTIMEDIA\SIMRADFX.

# 09 - Appendix 1. Trawl log

*Table 1. Overview of trawl hauls, start and stop times and selection system that was used.*

| Station | Start | End | Selection system |
|---|---|---|---|
| 667 | 2025-11-16T13:09:40.150Z | 2025-11-16T13:15:40.548Z | ActSel |
| 668 | 2025-11-16T17:06:22.622Z | 2025-11-16T17:43:26.249Z | ActSel |
| 669 | 2025-11-17T06:28:56.017Z | 2025-11-17T06:59:33.738Z | Grid |
| 670 | 2025-11-17T11:14:18.729Z | 2025-11-17T12:16:11.402Z | ActSel |
| 671 | 2025-11-17T14:49:47.779Z | 2025-11-17T15:42:38.800Z | ActSel |
| 672 | 2025-11-18T06:28:20.620Z | 2025-11-18T07:00:13.515Z | Grid |
| 673 | 2025-11-18T07:53:46.680Z | 2025-11-18T08:04:20.834Z | Grid |
| 674 | 2025-11-18T13:31:12.086Z | 2025-11-18T13:51:45.262Z | ActSel |
| 675 | 2025-11-19T06:46:45.892Z | 2025-11-19T07:16:47.941Z | Grid |
| 676 | 2025-11-19T08:02:53.308Z | 2025-11-19T08:27:54.996Z | Grid |
| 677 | 2025-11-19T09:54:52.618Z | 2025-11-19T10:31:31.040Z | Grid |
| 678 | 2025-11-19T11:13:41.220Z | 2025-11-19T11:32:30.555Z | Grid |

*Table 2. Overview of trawl hauls with information of camera systems that were used and the file names.*

| Station | CamSounder | Simrad camera 1 | Simrad camera 2 | GoPro | DarkVision |
|---|---|---|---|---|---|
| 667 | NA | Simrad_2025-11-16_12-48 | NA | X (concat012?) | 2025-11-16-12-49-53_crimac-2025_dv2 |
| 668 | 20251116T1631Z | Simrad_2025-11-16_16-48 | NA | 2016-11-16T14:13:49:0024 | 2025-11-16-17-20-36_crimac-2025_dv2 |
| 669 | 20251117T0603Z | NA | NA | 2025-11-17_05:25:53:0011 | 2025-11-17-06-58-25_crimac-2025-dv1 |
| 670 | NA | Simrad_2025-11-17_11-08; Simrad_2025-11-17_11-33 | Simrad_2025-11-17_11-08; Simrad_2025-11-17_11-33 | | 2025-11-17-11-30-47_crimac-2025-dv2 |
| 671 | 20251117T1425Z | Simrad_2025-11-17_14-49 | Simrad_2025-11-17_14-49 | | 2025-11-17-14-25-21_crimac-2025_dv1 |
| 672 | 20251118T0606Z | NA | NA | 2025-11-18_06:23:20:0013 | 2025-11-18-05-54-21_crimac-2025_dv2 |
| 673 | 20251118T0606Z | NA | NA | 2025-11-18_06:23:20:0013 | 2025-11-18-05-54-21_crimac-2025_dv2 |
| 674 | 20251118T0945Z | X | x | | 2025-11-18-09-44-41_crimac-2025_dv2 |
| 675 | 20251119T0622Z | NA | NA | 2025-11-19T06:09:15:0002 | 2025-11-19-06-17-37_crimac-2025_dv2 |

| | | | | | |
|---|---|---|---|---|---|
| 676 | 20251119T0622Z | NA | NA | 2025-11-19T06:09:15:0002 | 2025-11-19-06-17-37_crimac-2025_dv2 |
| 677 | 20251119T0929Z | NA | NA | 2025-11-19T09:08:36:0014 | 2025-11-19-09-30-30_crimac-2025_dv2 |
| 678 | 20251119T0929Z | NA | NA | 2025-11-19T09:08:36:0014 | 2025-11-19-09-30-30_crimac-2025_dv2 |

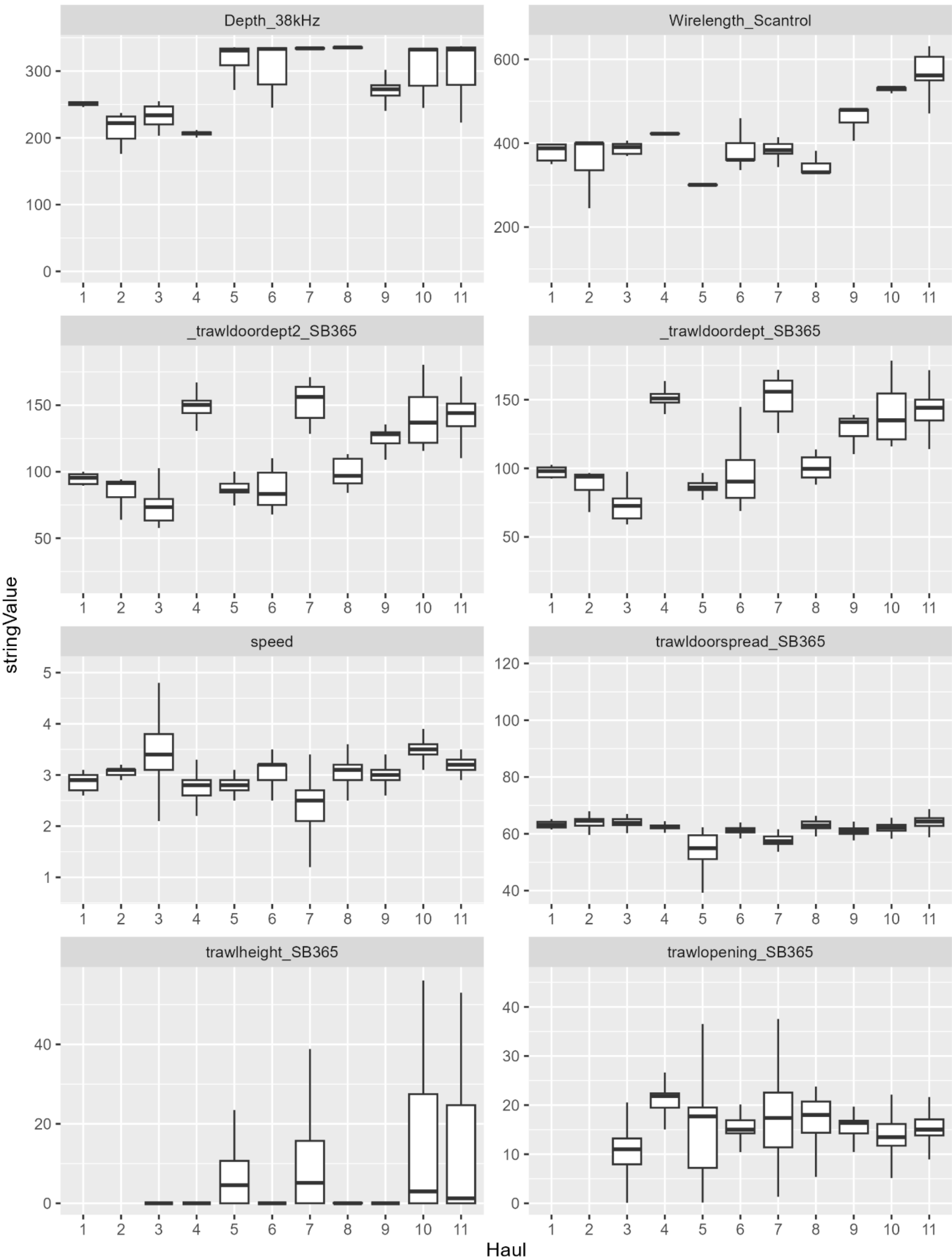
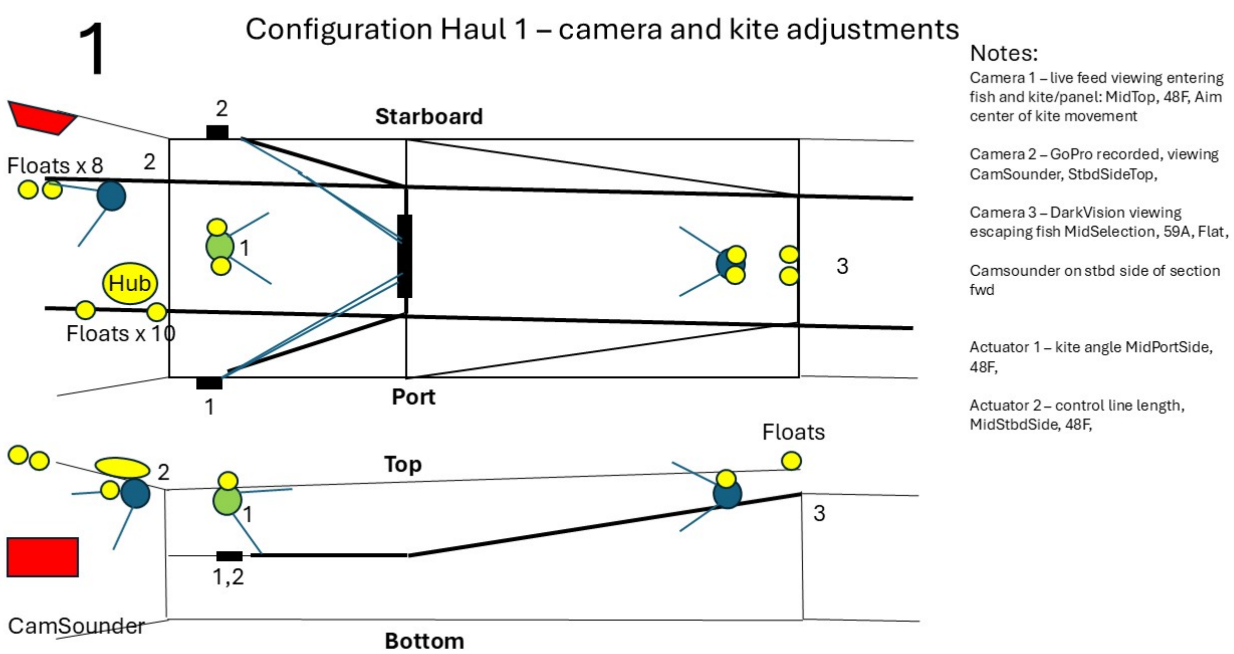



*Figure 1. Trawl information. Bottom depth (m), wire length (m), door depths (m), speed (kts), door spread (m), and trawl opening (m).*

**Haul 1; Station 667**

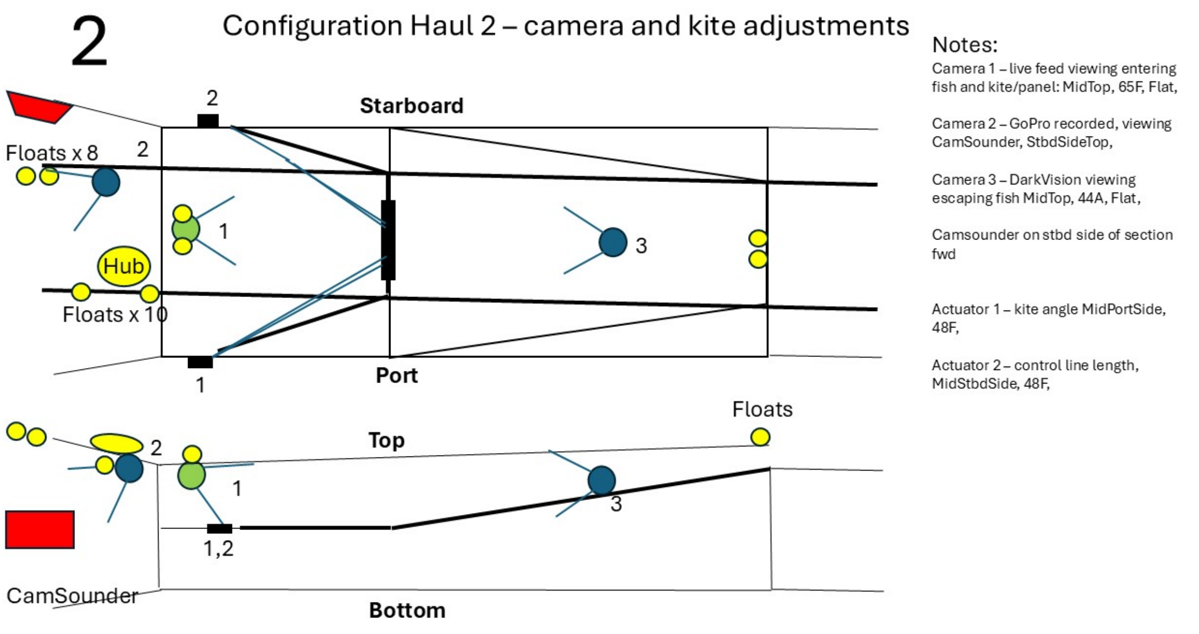
- Start time: 2025-11-16T13:09:40.150Z
- End time: 2025-11-16T13:15:40.548Z
- Trawl depth: 95m
- Trawl speed: 2.9 kt
- Area: Lyngenfjord
- Catch: nothing
- Selection section: ActSel
- Hub on port side, top panel with 10 floats a 2.7 kg.
- Simrad FX camera (image upside down and slightly too much toward top panel, light from DarkVision is disturbing)
- CamSounder mounted, but battery is empty. 8 2.6 kg floats. 185 60 mm meshes ~2.8 m to opposite side
- GoPro toward CamSounder too far away, not enough light and slightly wrong direction. Added a light, moved closer and changed angle for next haul.
- Dark Vision good images of ActSel, but FX camera light was disturbing
- Some difficulties to set the 3rd wire winch tension, the trawl is light, the system is old and has not been used in many years.
- 3rd wire entangled in the winch when hauled in, too much loose wire.




**Haul 2; Station 668**

- Start time: 2025-11-16T17:06:22.622Z

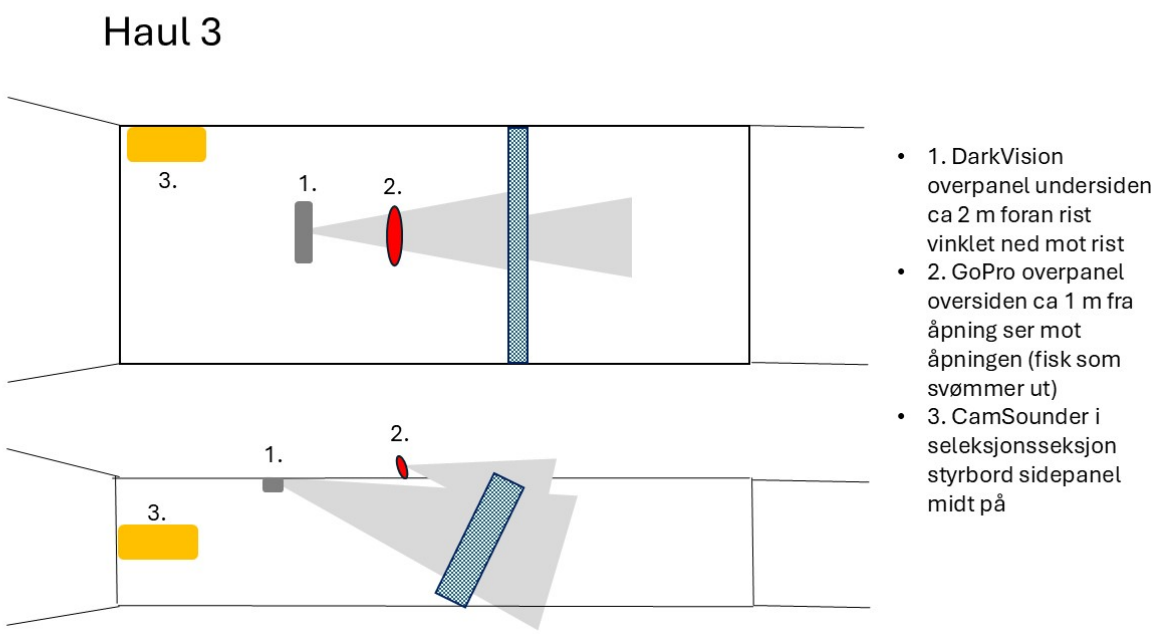
- End time: 2025-11-16T17:43:26.249Z
- Trawl depth: 87m
- Trawl speed: 3.0 kt
- Area: Lyngenfjord
- Catch: nothig
- Selection section: ActSel (works well)
- Simrad FX camera (image upside down and slightly too much toward top panel, light from DarkVision is disturbing)
- CamSounder (same mounting as in haul 1) recording with three different settings (10 minutes with each setting and 2 min between each setting)
- GoPro monitoring CamSounder moved closer and adjusted tilt angle from previous haul. CamSounder seems to be well positioned
- Dark Vision was moved slightly closer to kite (21 meshes from codend in haul 1 to 36 in hauls 2). Good images of the selection panel
- 3rd wire operation was good




## Haul 3; Station 669

- Start time: 2025-11-17T06:28:56.017Z
- End time: 2025-11-17T06:59:33.738Z
- Trawl depth: 74 m

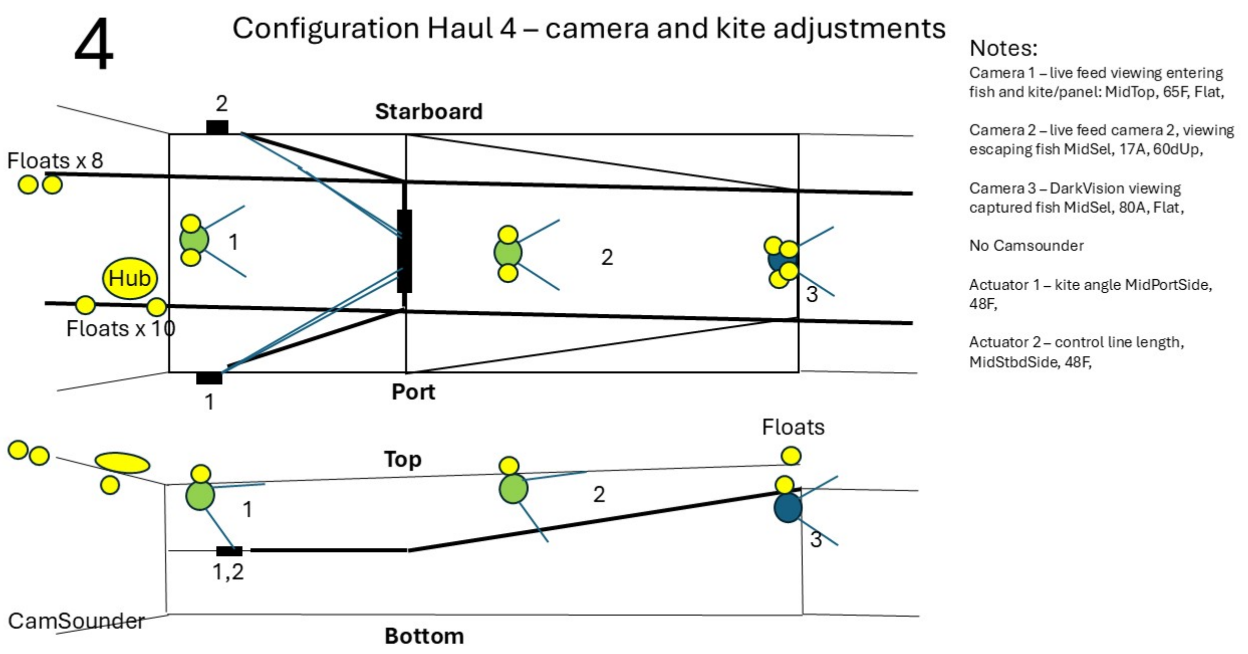
- Trawl speed: 3.4 kt
- Area: Kvænangen deep
- Catch: krill, mesopelagic fish and some saith.
- Selection section: Grid (release mode)
- Saith partly stuck on the grid panel
- GoPro on the top panel, outside of trawl about 1 m in front of the opening pointing toward the opening. Could have been closer to the opening
- DarkVision about 2 m ahead of the opening in the top panel tilted toward the grid. Could have been slightly further away.
- CamSounder recording with three different settings (10 minutes with each setting and 2 min between each setting)




**Haul 4; Station 670**

- Start time: 2025-11-17T11:14:18.729Z
- End time: 2025-11-17T12:16:11.402Z
- Trawl depth: 144 m
- Trawl speed: 2.8 kt
- Area: south of Spildra
- Catch: Some fish observed at 150 m depth. Saith observed on cameras. Lost fish between top panel and kite when in catch mode.

- Selection section: ActSel
- Two Simrad cameras; top panel ahead of kite tilted toward the kite, the other in the top panel pointed backward to monitor fish swimming out
- DarkVision mounted in upper panel of the section just ahead of codend facing the codend (monitoring fish swimming into codend)
- One of the actuator lines was caught but managed to get it released. Mye sei og mye som svømte ut også når i fiskemodus.
- CamSounder is not attached, but the floats are on
- No GoPro
- Problem with 3rd wire

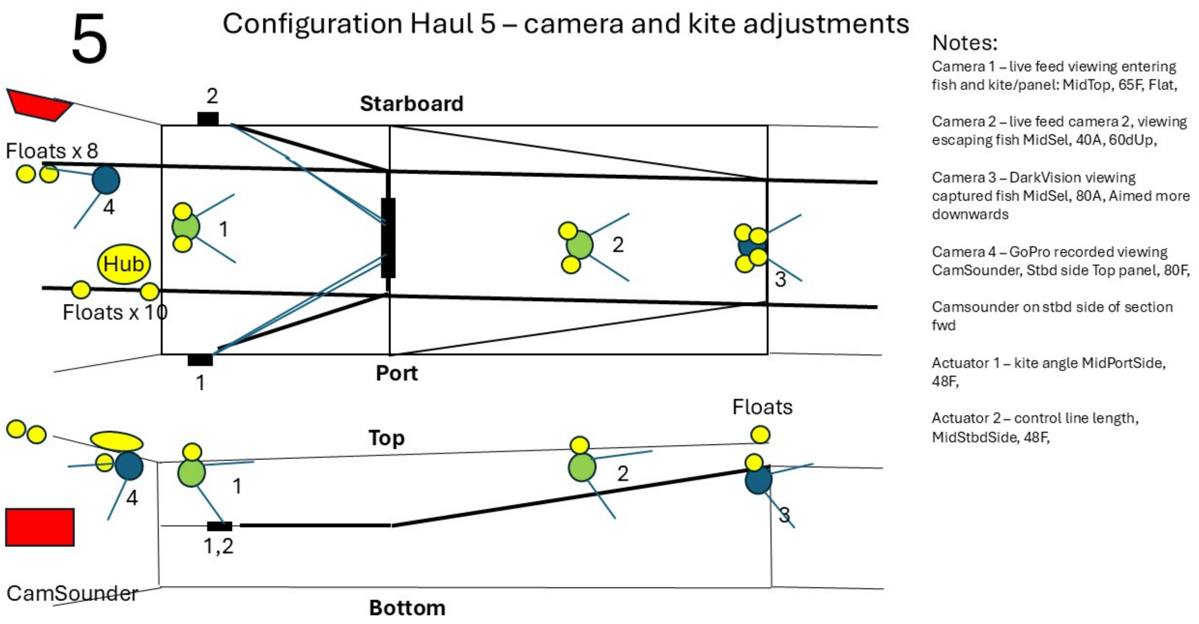



**Haul 5; Station 671**

- Start time: 2025-11-17T14:49:47.779Z
- End time: 2025-11-17T15:42:38.800Z
- Trawl depth: 84 m
- Trawl speed: 2.8 kt
- Area: East of Rødøya
- Catch: large quantities of herring in a layer at 50 – 100 m depth
- Selection section: ActSel. Initially challenges to get the kite up.
- Two Simrad cameras; top panel ahead of kite tilted toward the kite, the other in the top panel pointed

backward to monitor fish swimming out

- DarkVision mounted in upper panel of the section just ahead of codend facing the codend (monitoring fish swimming into codend)
- Some initial challenges with ActSel, butt hen working well. Loosing fish beetween kite and top panel when in catch mode
- Experiments with red and white light. Herring seem to be attracted to the ligh
- CamSounder recording continuosly
- GoPro not attached
- Large quantities of herring caught in the meshes, most likely due to too slow hauling speed

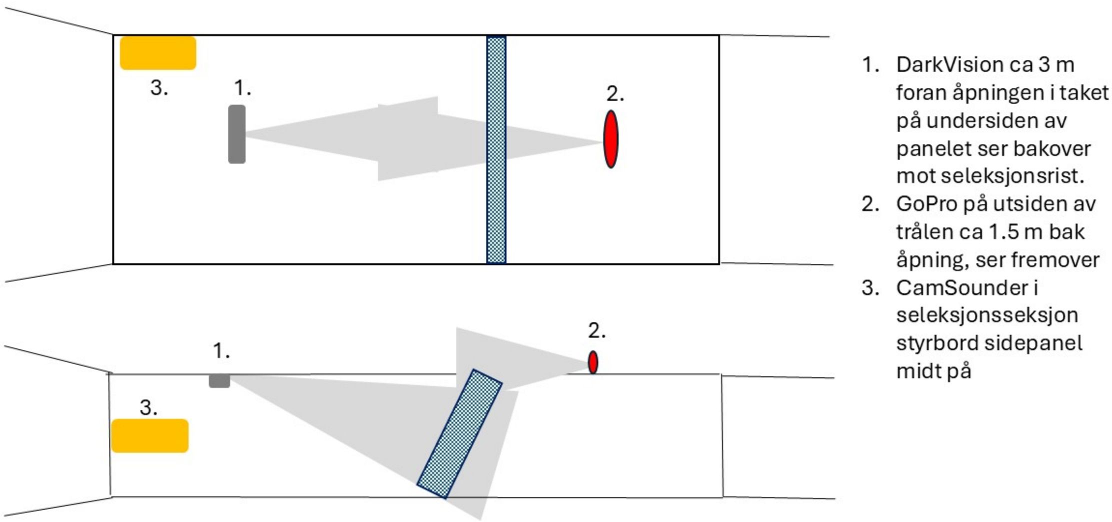



**Haul 6; Station 672**

- Start time: 2025-11-18T06:28:20.620Z
- End time: 2025-11-18T07:00:13.515Z
- Trawl depth: 88 m
- Trawl speed: 3.0 kt
- Area: East of Rødøya
- Catch: Litle fish observed on the echosounder, a school of herring in the end of the haul, but due to very slow trawl speed little fish passed to the codend.
- Selection section: Grid
- GoPro on top panel attache on the outside of the trawl about 1.5 m behind opening poiting toward opening (good images may be moved closer to opening)

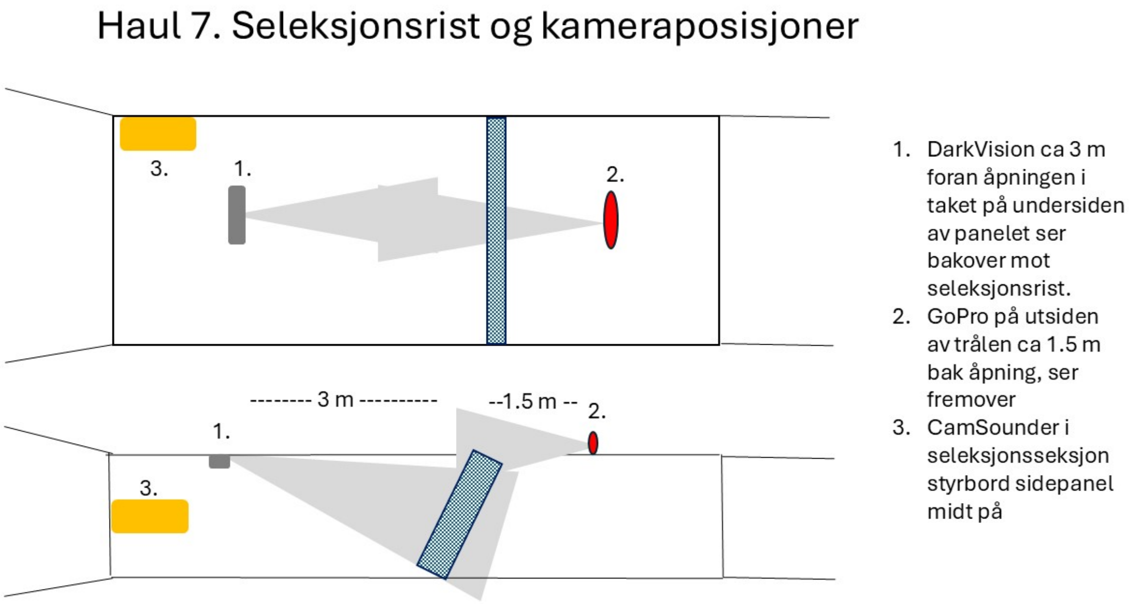
- DarkVision ca 3 m ahead of grid in the top panel tilted down and backward toward grid. Some disturbanc from GoPro light, need to be tilted more down
- Camsounder recording continuously

Haul 6. Seleksjonsrist og kameraposisjoner




**Haul 7; Station 673**

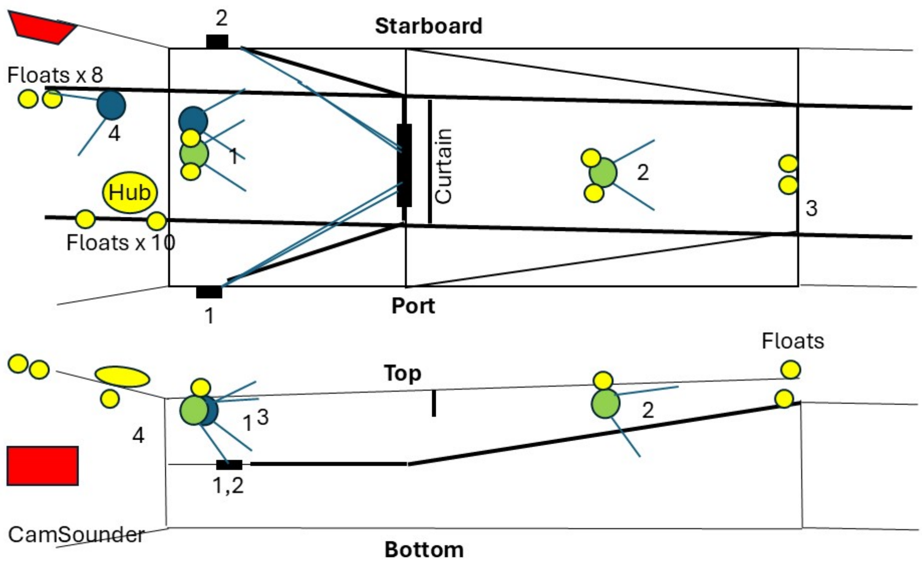
- Start time: 2025-11-18T07:53:46.680Z
- End time: 2025-11-18T08:04:20.834Z
- Trawl depth: 152 m
- Trawl speed:2.4 kt
- Area: East of Rødøya
- Catch: Layer of herring
- Selection section: Grid (release mode)
- Turned and set the trawl out again – all same settings as in haul 6.




**Haul 8; Station 674**

- Start time: 2025-11-18T13:31:12.086Z
- End time: 2025-11-18T13:51:45.262Z
- Trawl depth: 99 m
- Trawl speed: 3.1 kt
- Area: East of Rødøya
- Catch: No fish
- Selection section: ActSel (problems with one of the actuator lines getting caught in one of the floats. Had to bring in the trawl two times before fixing the problem
- Two Simrad cameras; top panel ahead of kite tilted toward the kite, the other in the top panel pointed backward to monitor fish swimming out
- DarkVision mounted in upper panel of the section just ahead of codend facing the codend (monitoring fish swimming into codend)
- CamSounder recording continuously
- No GoPro

## 8a Configuration Haul 8a – camera and kite adjustments




Notes:

Camera 1 – live feed viewing entering fish and kite/panel: MidTop, 65F, Flat,

Camera 2 – live feed camera 2, viewing escaping fish MidSel, 40A, 60dUp,

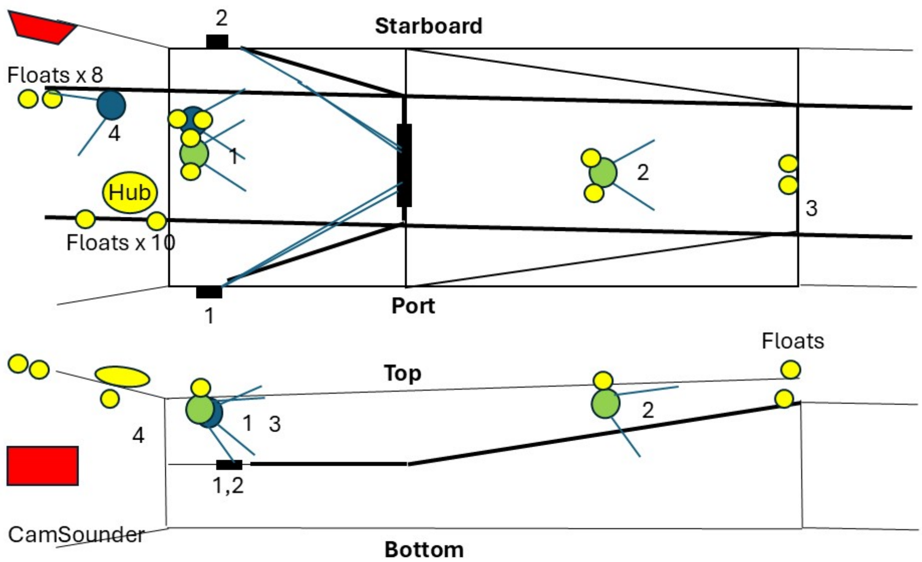
Camera 3 – DarkVision parallel view to main camera - MidTop, 65F, Flat, No floats

Camsounder on stbd side of section fwd

Actuator 1 – kite angle MidPortSide, 48F,

Actuator 2 – control line length, MidStbdSide, 48F,

## 8b Configuration Haul 8b – camera and kite adjustments




Notes:

Camera 1 – live feed viewing entering fish and kite/panel: MidTop, 65F, Flat,

Camera 2 – live feed camera 2, viewing escaping fish MidSel, 40A, 60dUp,

Camera 3 – DarkVision parallel view to main camera - MidTop, 65F, Flat, floats added

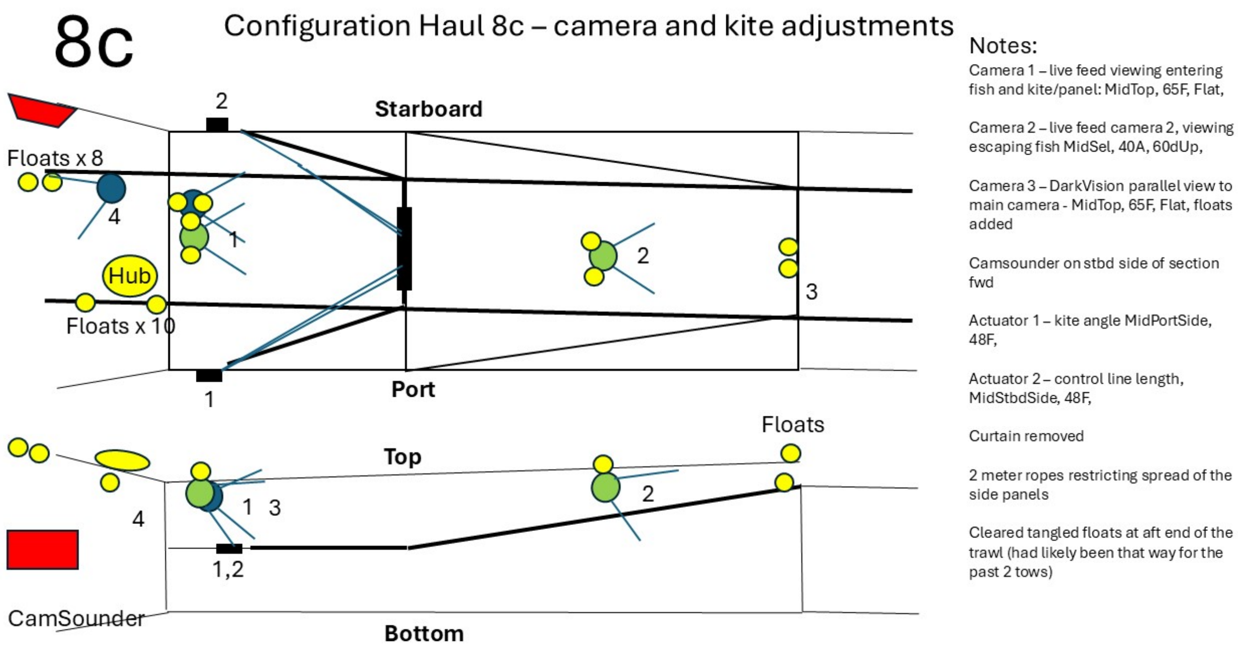
Camsounder on stbd side of section fwd

Actuator 1 – kite angle MidPortSide, 48F,

Actuator 2 – control line length, MidStbdSide, 48F,

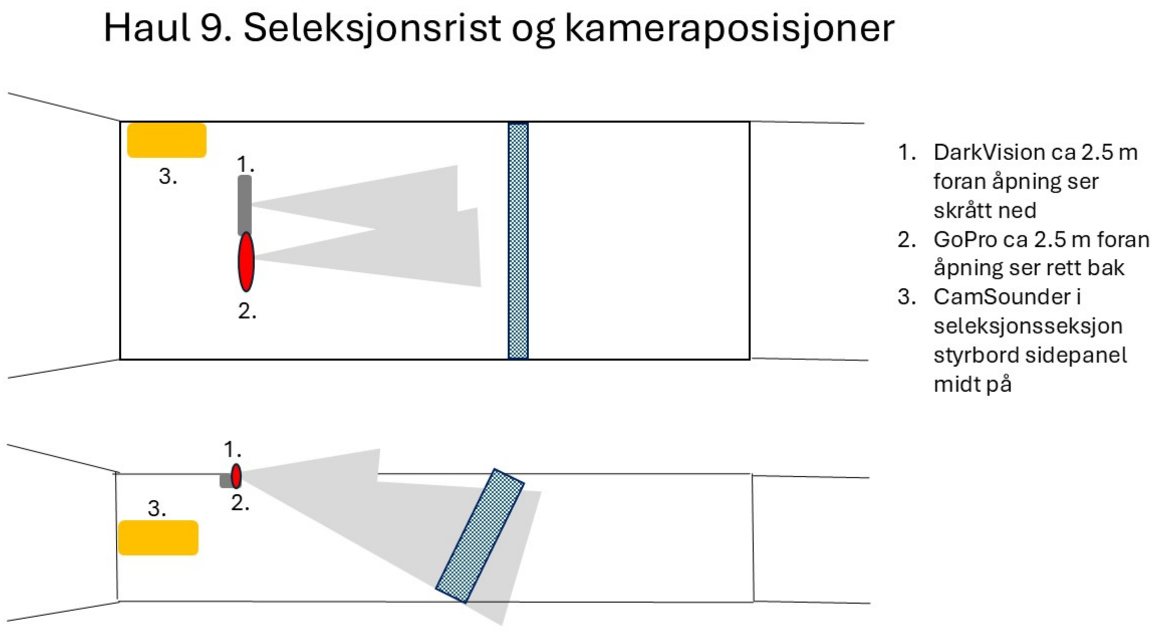
Curtain removed

2 meter ropes restricting spread of the side panels



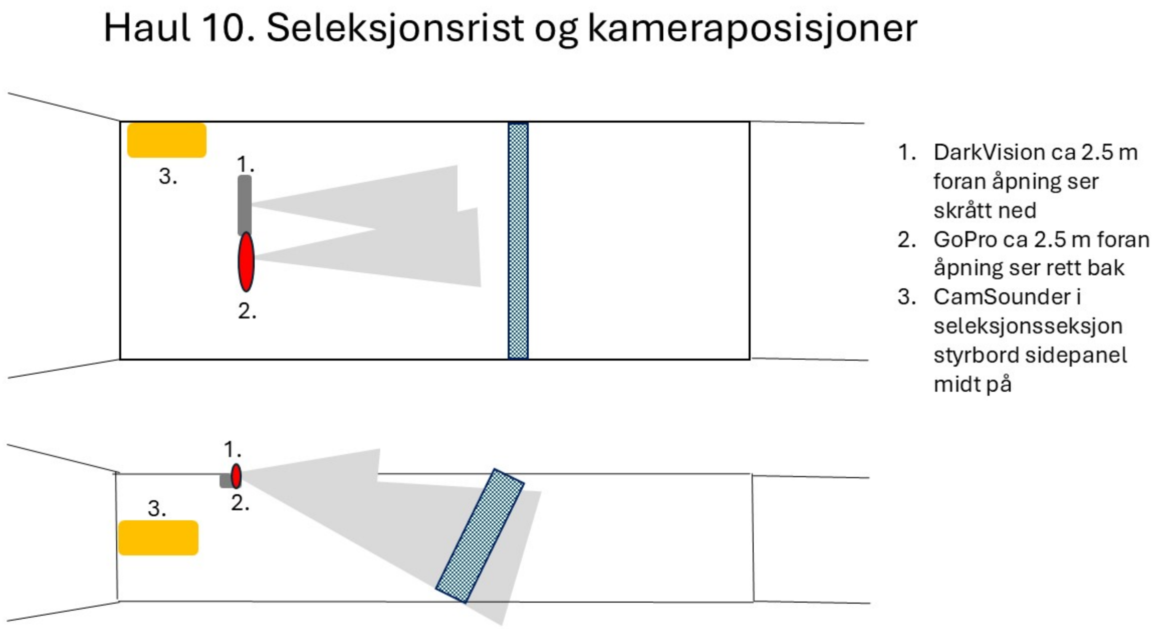

**Haul 9 Station 675**

- Start time: 2025-11-19T06:46:45.892Z
- End time: 2025-11-19T07:16:47.941Z
- Trawl depth: 125 m
- Trawl speed: 3.0 kt
- Area: East of Rødøya
- Catch: Dense layers of herring that mov deeper during day. Take a small slice of the top of the layer
- Selection section: Grid (release mode)
- GoPro about 2.5 m ahead of opening / grid facing backward
- DarkVision about 2.5 m ahead of opening / grid tilted down
- Camsounder recording continuously
- Take trawl partly in turn and out again same trawl path back (Haul 10)




**Haul 10 Station 676**

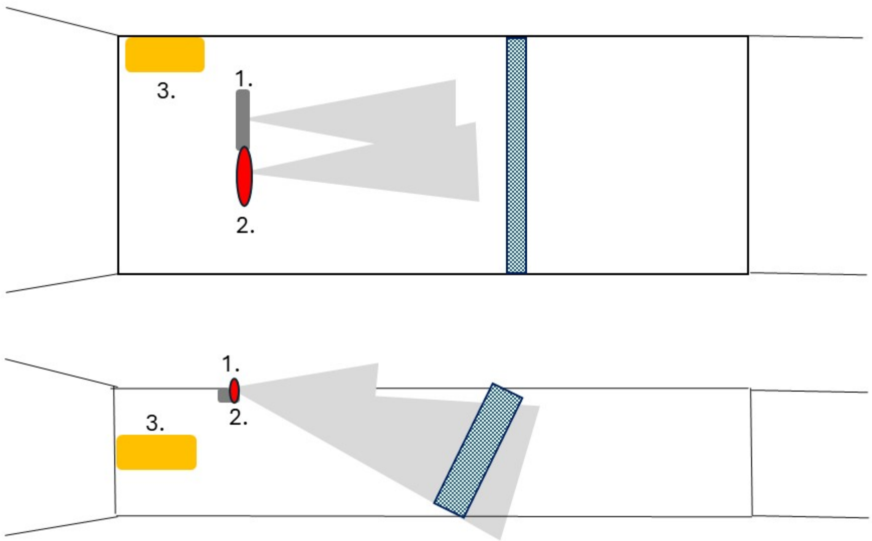
- Start time: 2025-11-19T08:02:53.308Z
- End time: 2025-11-19T08:27:54.996Z
- Trawl depth: 141
- Trawl speed: 3.4 kt
- Area: East of Rødøya
- Catch: Dense layers of herring that mov deeper during day. Take a small slice of the top of the layer
- Selection section: Grid (release mode)
- Same settings for GoPro, Dark Vision and CamSounder as in haul 9.



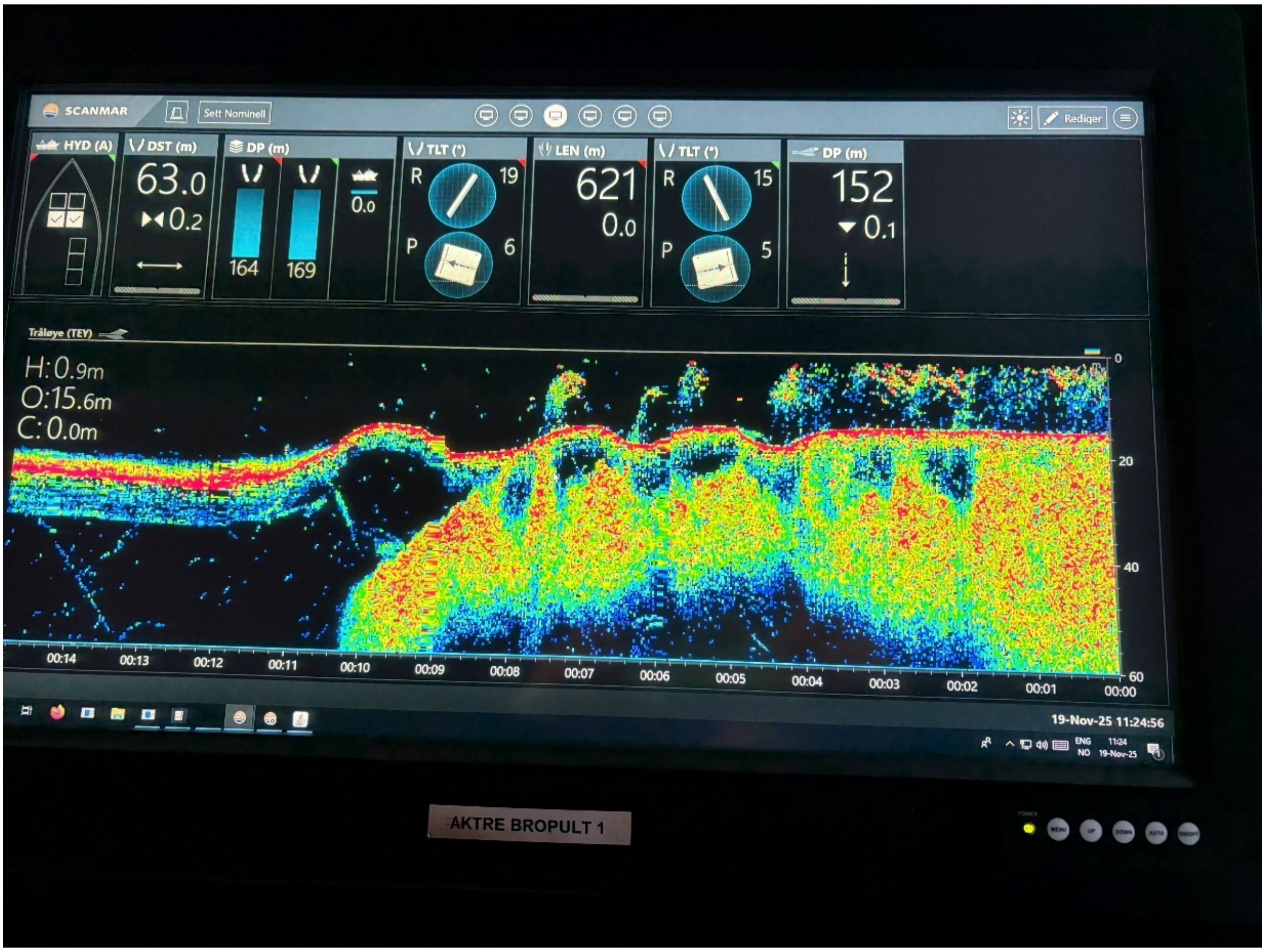

**Haul 11 Station 677**

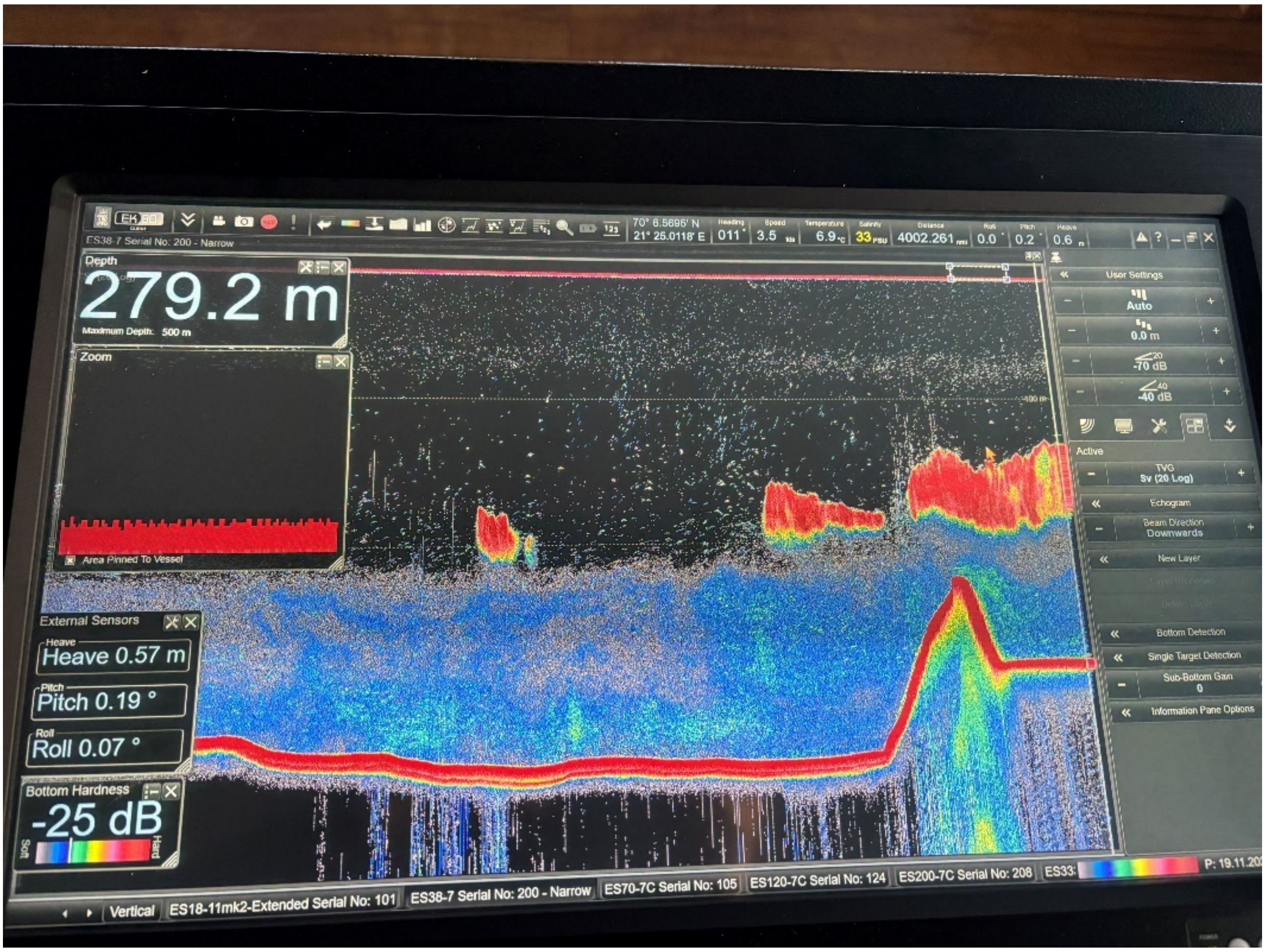
- Start time: 2025-11-19T09:54:52.618Z
- End time: 2025-11-19T10:31:31.040Z
- Trawl depth: 141
- Trawl speed: 3.3 kt
- Area: East of Rødøya
- Catch: Dense layers of herring that mov deeper during day. Take a small slice of the top of the layer
- Selection section: Grid (capture mode)
- Same settings for GoPro, Dark Vision and CamSounder as in haul 9.

# Haul 11. Seleksjonsrist og kameraposisjoner




1. DarkVision ca 2.5 m foran åpning ser skrått ned
2. GoPro ca 2.5 m foran åpning ser rett bak
3. CamSounder i seleksjonsseksjon styrbord sidepanel midt på

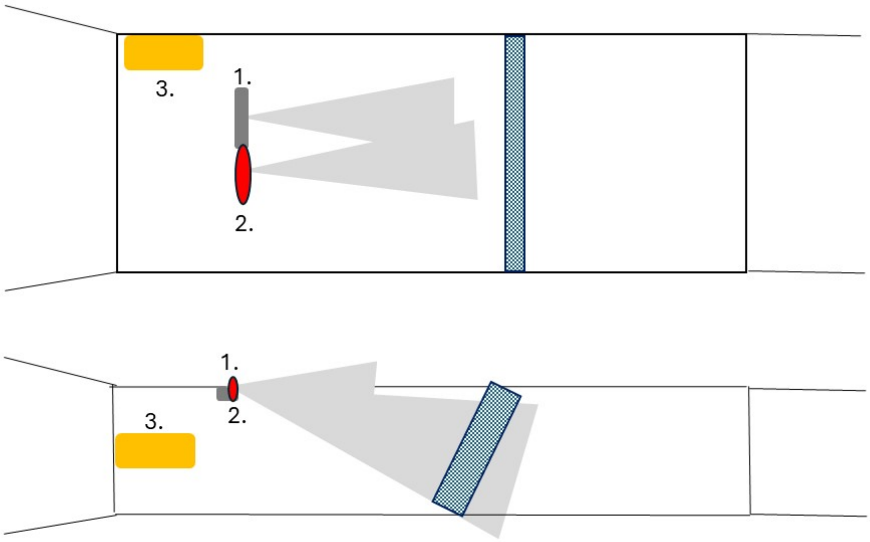




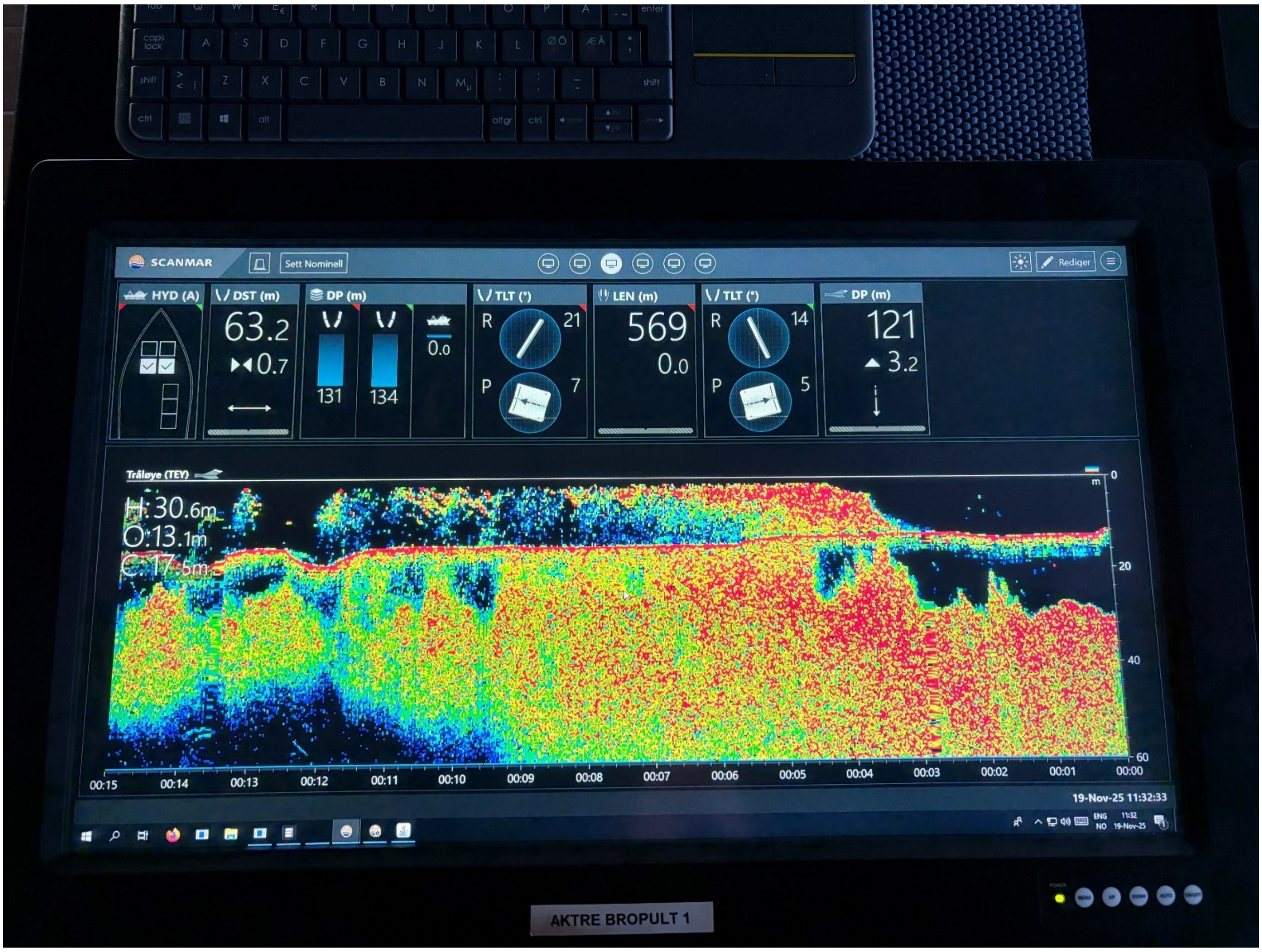

**Haul 12 Station 678**

- Start time: 2025-11-19T11:13:41.220Z
- End time: 2025-11-19T11:32:30.555Z
- Trawl depth: 120 m
- Trawl speed: 3 – 3.5 knop
- Area: East of Rødøya
- Catch: Dense layers of herring that mov deeper during day. Take a small slice of the top of the layer
- Selection section: Grid (capture mode)
- Same settings for GoPro, Dark Vision and CamSounder as in haul 9.

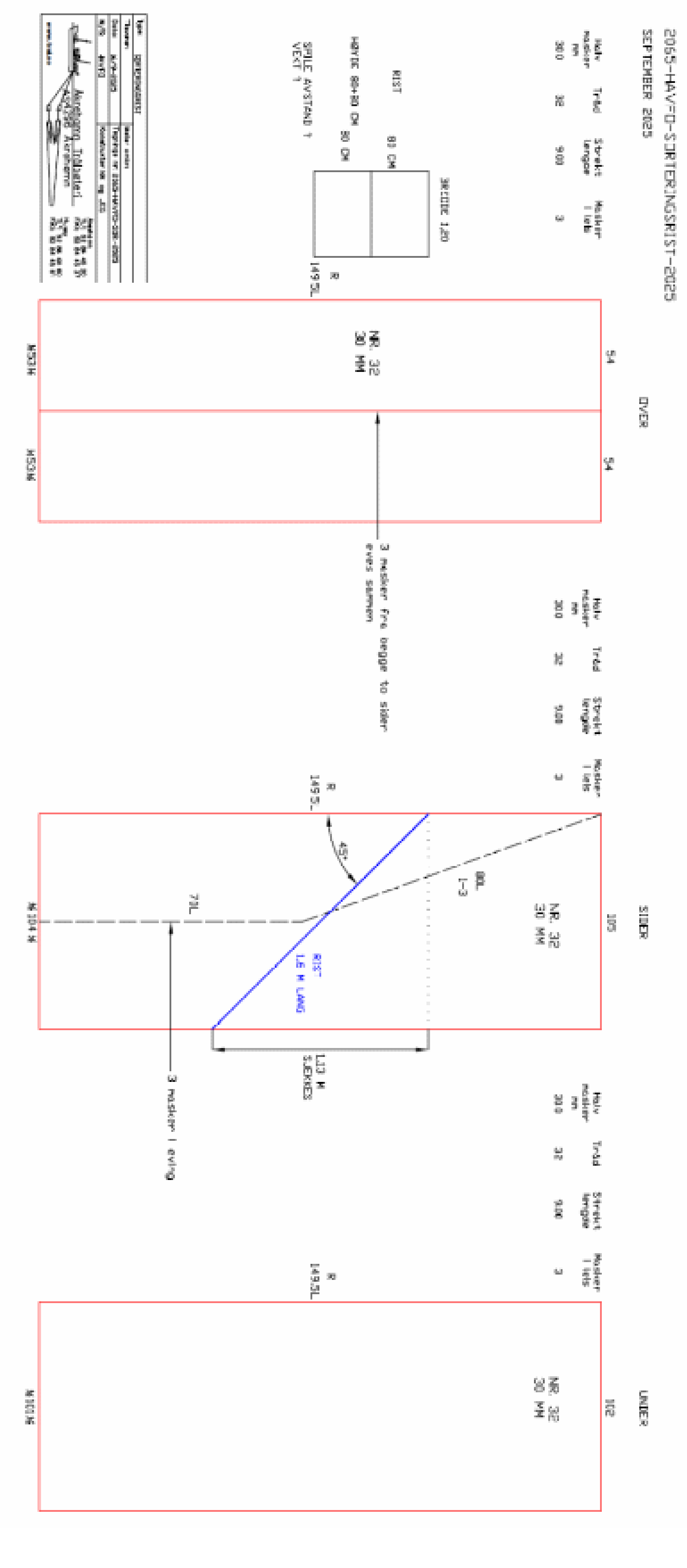
# Haul 12. Seleksjonsrist og kameraposisjoner




1. DarkVision ca 2.5 m foran åpning ser skrått ned
2. GoPro ca 2.5 m foran åpning ser rett bak
3. CamSounder i seleksjonsseksjon styrbord sidepanel midt på



# 10 - Appendix 2. Drawing of the extension section and the grid



# 11 - Appendix 3. Report ActSel by Craig Rose

**Summary report on the application of ActSel system for CRIMAC survey use**

Contract #NEMO 15977-09 with FishNext Research LLC

Dr. Craig Rose, of FishNext Research, joined the G.O. Sars during a trip out of Tromso from 14.11 to 18.11, 2025, providing expertise and work to assess the potential of the Active Selection (ActSel) system to provide selective physical samples from survey trawl hauls where most fish encounters are quantified by means other than bringing them aboard. The ActSel system allows vessel personnel to alternate trawl functions between retaining fish in the codend and releasing them. It consists of a panel in the aft end of the trawl that either covers an escape opening or uncovers it and guides fish out.

The system is composed of that mesh panel, which is moved by a hydrodynamic kite controlled by lines adjusted by a small, remote winch (actuator). Control and telemetry of the actuator, as well as live video from the trawl is provided by the Kongsberg/Simrad FX system, using a cable from the vessel to the net (third wire).

The specific services that FishNext Research LLC delivered to IMR were:

- *Consultation during the planning phase and providing drawings of the trawl section*

> Dr. Rose participated in a number of video calls and email exchanges to plan the field work and provided trawl section drawings and formatted templates for recording gear and monitoring configurations during the research.

- *Providing the kite and its control lines for the trials on board GO Sars*

These components were shipped, received and used during the research trip.

- *Participating in the expedition from November 14th at 12:30 (P.M.) - November 18th 18:00 (06 P.M.) and contributing with guidance and practical help setting up and carrying out the experiments on board GO Sars*

> Dr. Rose travelled to Tromso on November Nov 11-12, obtained the required Medical Clearance on Nov. 13 and boarded the G. O. Sars on Sars on the morning of November 14$^{th}$. Dr. Rose and others set up equipment on Nov 14-15 and departed Tromso the evening of the 15$^{th}$. Dr. Rose contributed to experiments conducted from Nov 16-18 and left the vessel at Sverjoy late on the 18$^{th}$ .

- *A written report summarizing the experiments and providing recommendations for further development and implementation of the ActSel system on IMR sampling trawls.*

> While this report provides an overall summary of the experiments and resulting recommendations, the detailed results are more fully communicated in research documents provided to the Chief Scientist, including:

1. underwater videos from the trawl, including visible control actions,
2. trawl diagrams for each haul, detailing locations and orientations of observation equipment,
3. a time-coded listing of observations and actions during each trawl haul, and
4. a general log of observations and their interpretations.

**Research Activities**

Over the three days of trawling, we conducted seven trawl hauls with the ActSel system in the net. On the first day, trial hauls focused on locating and orienting observation cameras to observe ActSel performance and fish responses, as well as determining the best control settings for operating the ActSel system in this net.

The ActSel system uses the vessel’s ‘third wire’ telemetry cable to transmit real-time video and control the motors that operate the actuators. Control of that cable requires significant drag at the trawl end. While commercial trawls have codends with enough drag to handle the third wire directly connected to the aft end of the net, the survey trawl’s codend is so light that the tension in the third wire would disable the net by folding it forward. Institute scientists and the crew solved this issue by affixing the cable to the trawl’s headrope and securing it along the net to the area under study. Even though this was a new process and the third wire and its winch had rarely been used, this operation was well established after the first days, albeit taking additional time and personnel.

Experiments on the second day observed interactions between fish and the system, particularly one tow that encountered schooling herring long enough to observe their behavior with the ActSel in capture and release configurations under both red and white lighting. Different cameras recorded movements of the ActSel kite and panel, fish moving out of the system towards the codend, and fish moving out of the net through the escape portal. Many of those herring escaped over the top of the ActSel panel when it was in the capture configuration. aThe last day’s hauls explored a modification to address that problem. Unfortunately, the ActSel section was tangled during setting and the first attempt to correct it was unsuccessful. The problem was identified and corrected for the third tow, but the modification did not stop the escapes when the system was in it’s capture configuration.

**Interpretations and Recommendations**

We successfully adapted the ActSel system to the survey trawl and demonstrated that it operates as designed, directing fish in most of the trawl’s cross-section either to be retained in the codend or released from the net. A good preliminary solution was developed for Issues with handling the necessary telemetry cable, but effective future use will be enhanced with more experience. The Simrad FX system and its ActSel components performed well. Improvements can still be made in panel and kite designs and actuator reliability. The ability to deploy two live-feed cameras and two actuators was very beneficial to this trip’s experiments. Having a dedicated platform allowed us to achieve in only three days what would have taken much longer during commercial operations.

However, putting herring through the system showed that some fish got through in the wrong direction. The survey trawl’s cross section formed an oval with its longer axis in the vertical direction and the ActSel panel did not move far enough up to prevent fish escapes near the top of the net when the ActSel panel was up.

The ActSel system shows promise for selectively collecting small fish samples from survey hauls where most fish are released. The main remaining issue with the ActSel system itself is the need to better seal the kite against the top panel in its capture position and potentially against the bottom in the release position. The leakage observed in these initial tests could thwart the intended survey application. Several avenues are available to resolve this issue, but they need to be tried, developed, implemented, and demonstrated. These include:

1. Reducing the vertical opening of the trawl where the kite is operating
2. Attaching a weighted net panel to the top of the net to block the remaining opening (possibly also a

floated panel at the bottom of the net).

3. Changing kite and panel designs to allow a wider range of movement, e.g., longer wings.

This sealing issue is also important to other ActSel applications and resolving it will be part of our ongoing ActSel development project that ranges well beyond the survey application studied here. FishNext Research will keep CRIMAC personnel at the IMR informed of progress in this area.

FishNext Research appreciates the opportunity to work with IMR’s CRIMAC scientists and the G. O. Sars crew on this project. We learned a lot in a short amount of time and substantially improved the understanding of the potential for using ActSel system for open-net surveys. We should have developed and tested solutions for the leakage issues that we detected by the time that the other technologies necessary for open-net surveys have emerged.t

# 12 - References

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