
INSTITUTE OF MARINE RESEARCH
HAVFORSKNINGSINSTITUTTET

Observing zooplankton layers with acoustics at close range

Egil Ona

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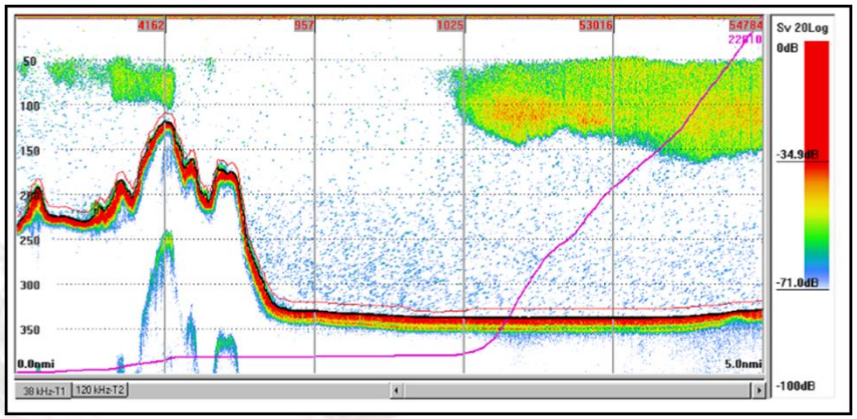
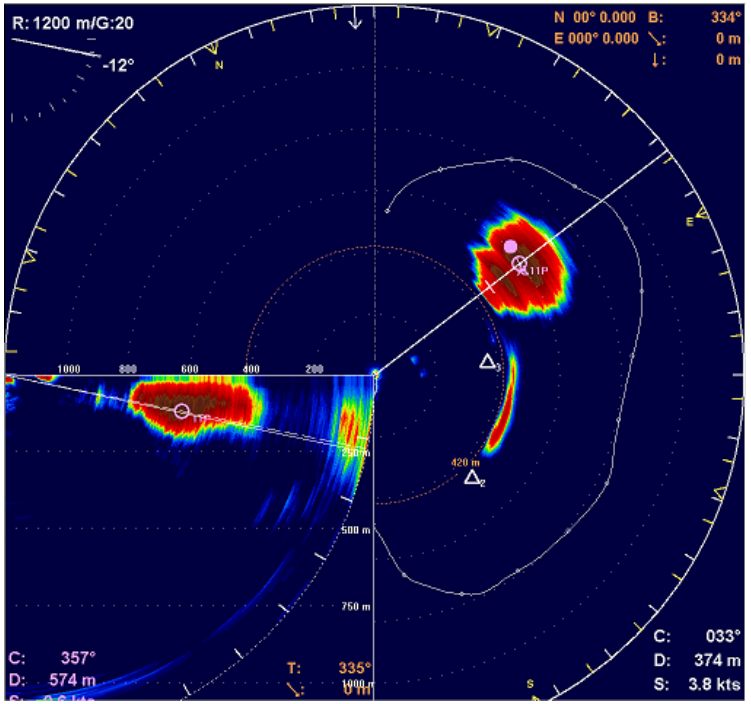
My regular work

ECHO SOUNDER



SONAR

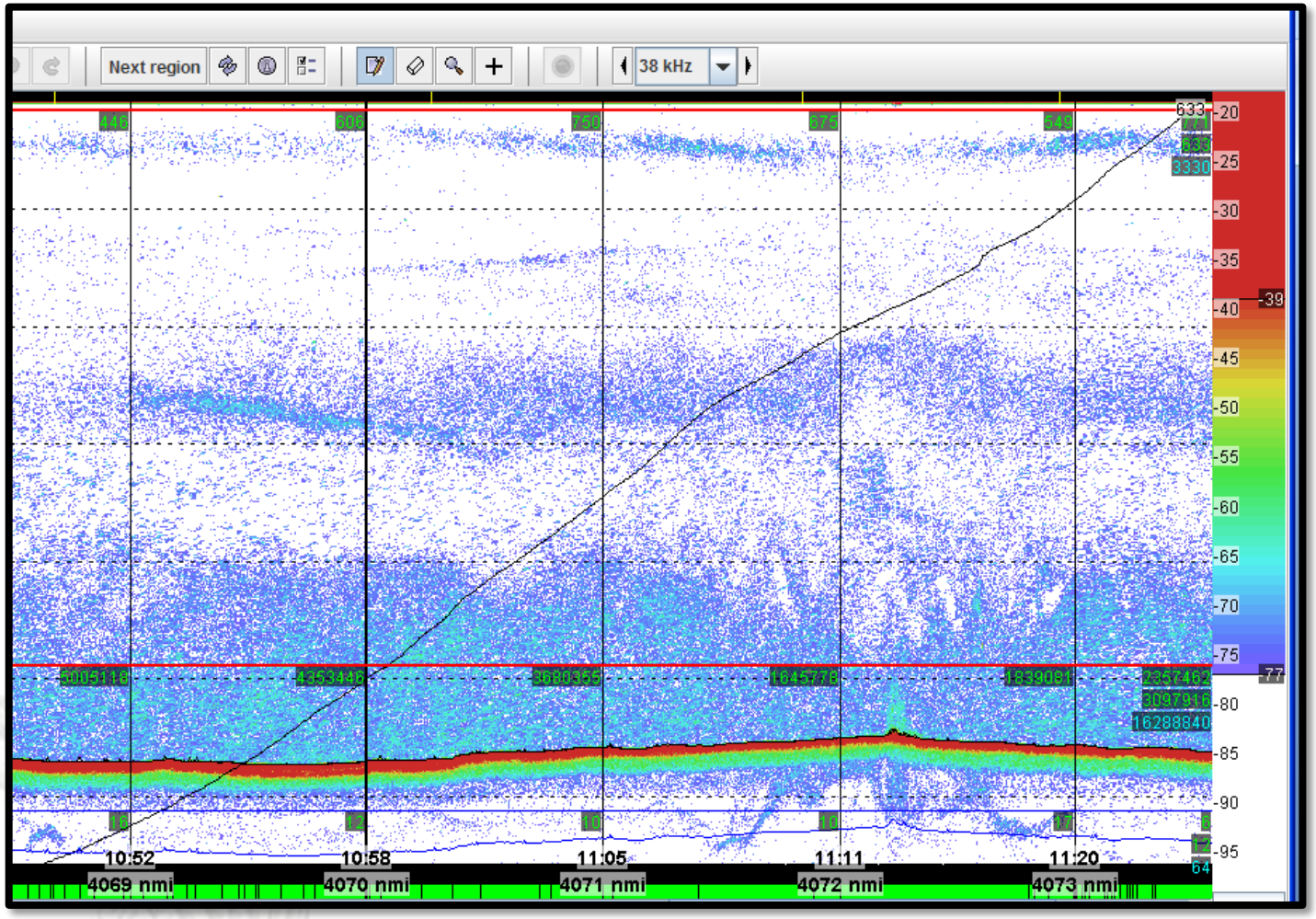


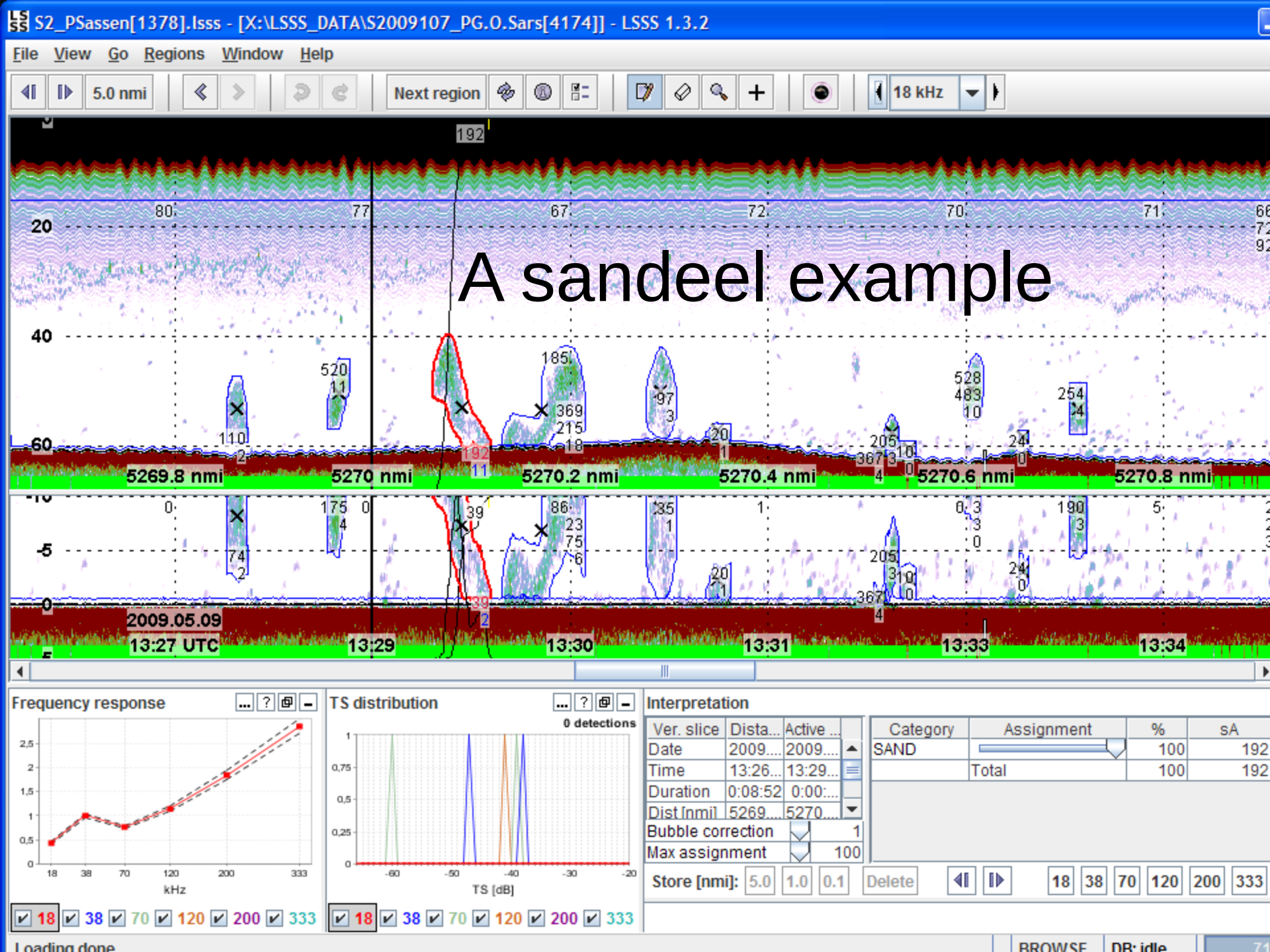
Contents

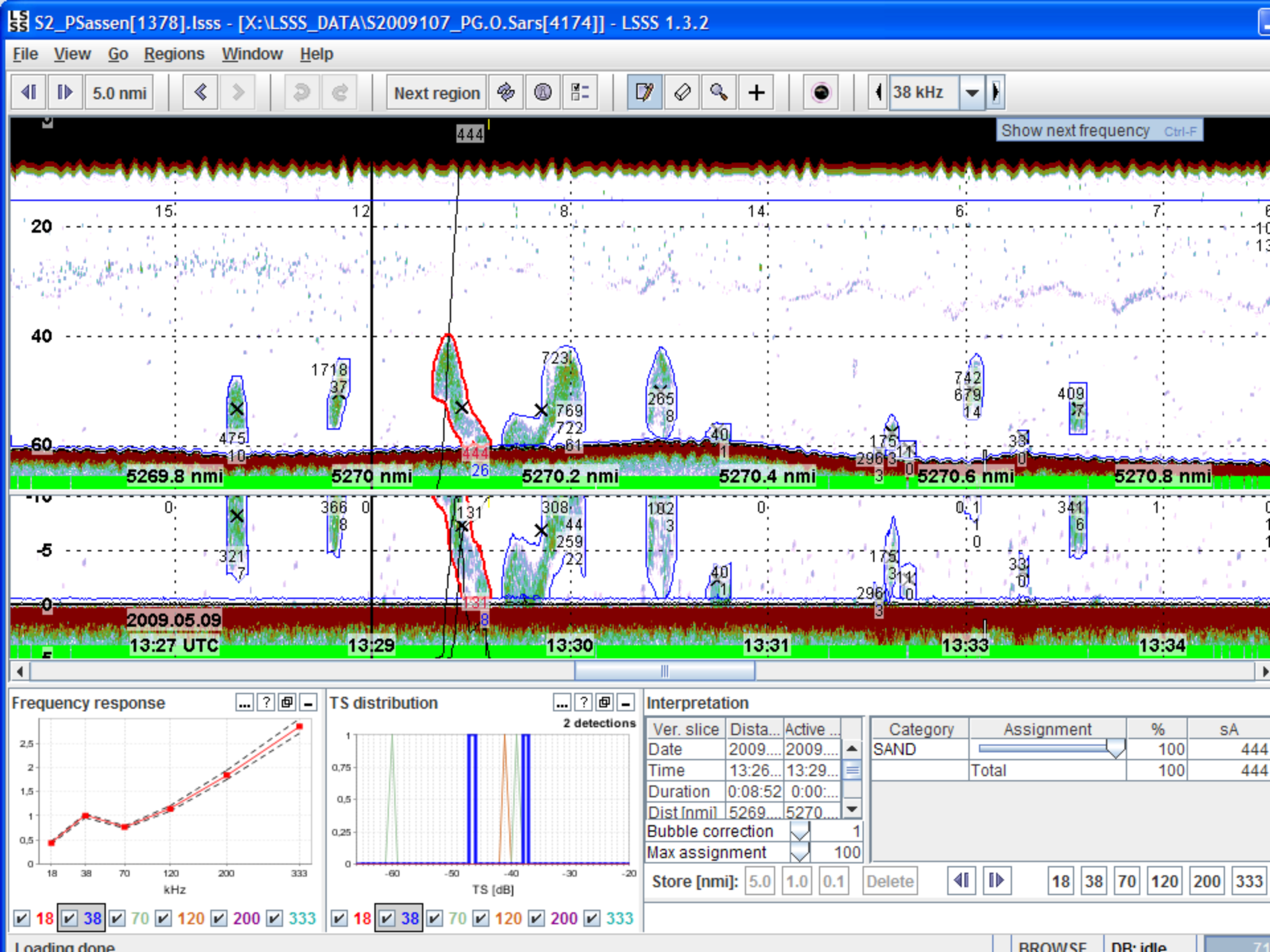
- Standard acoustic surveys (fish and zooplankton)
- Multifrequency limitations
- Probing and calibration
- Some zooplankton examples
- Present and future acoustic methods

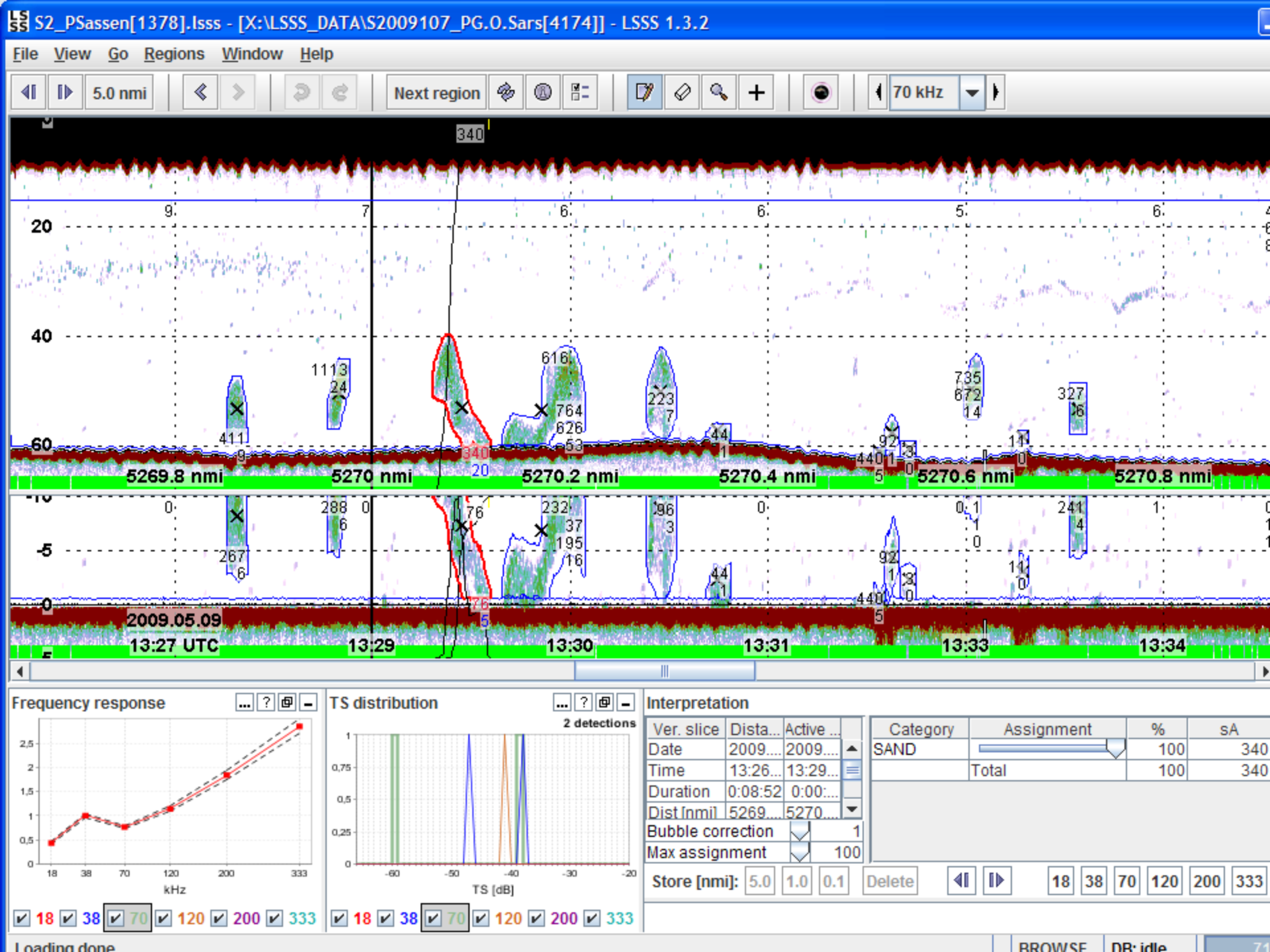
The problem

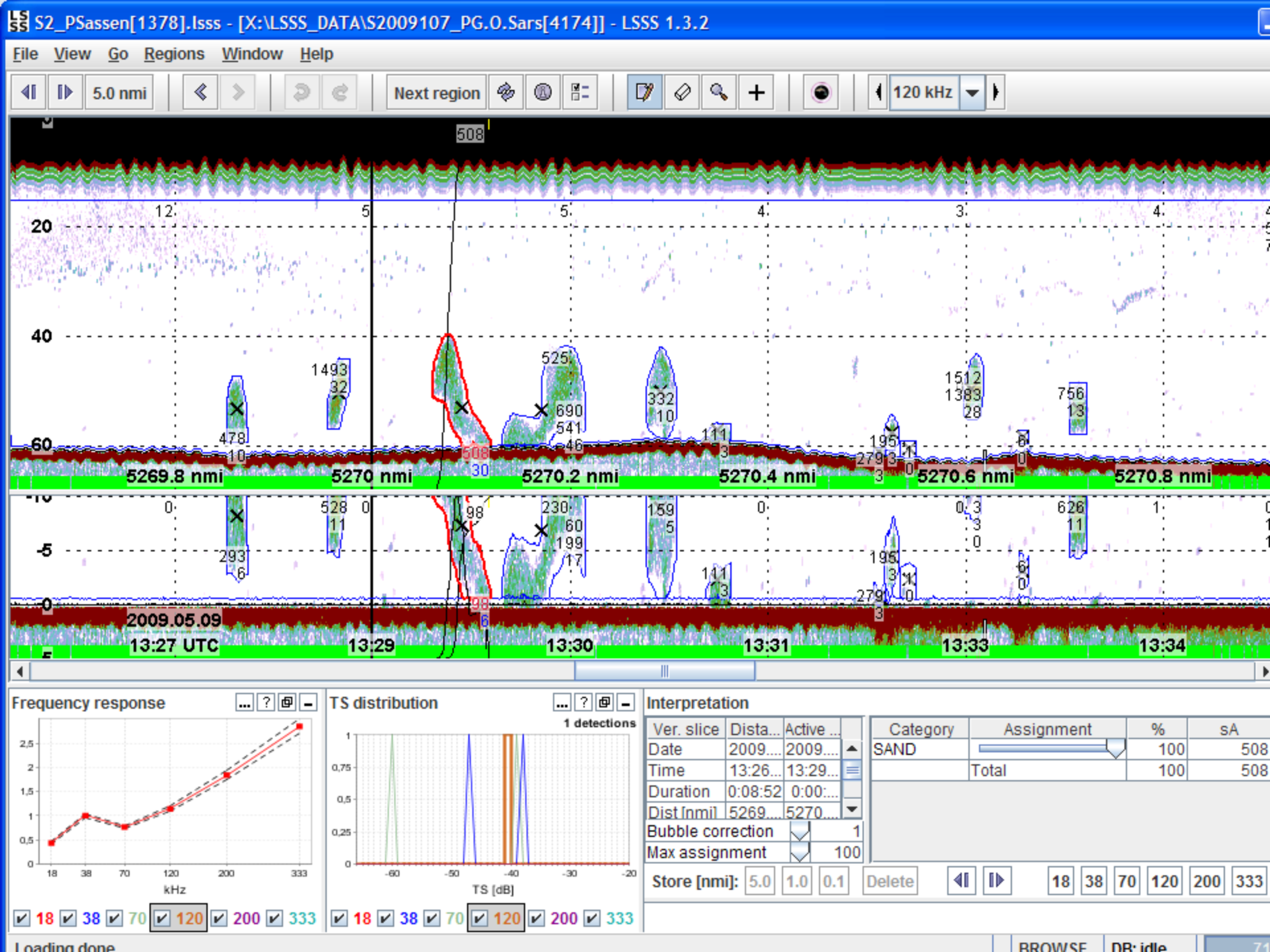
Who lives here and who eats whom

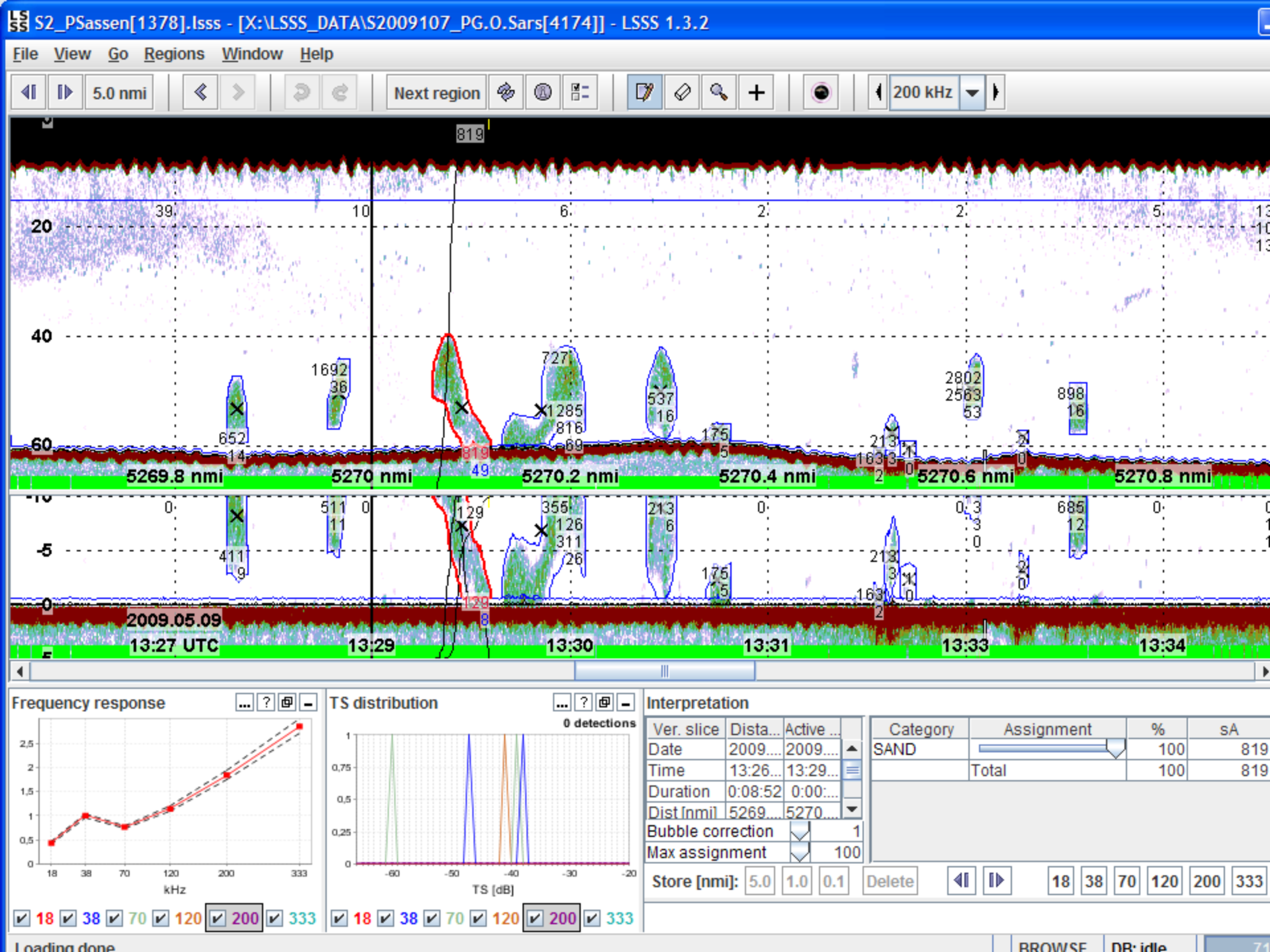


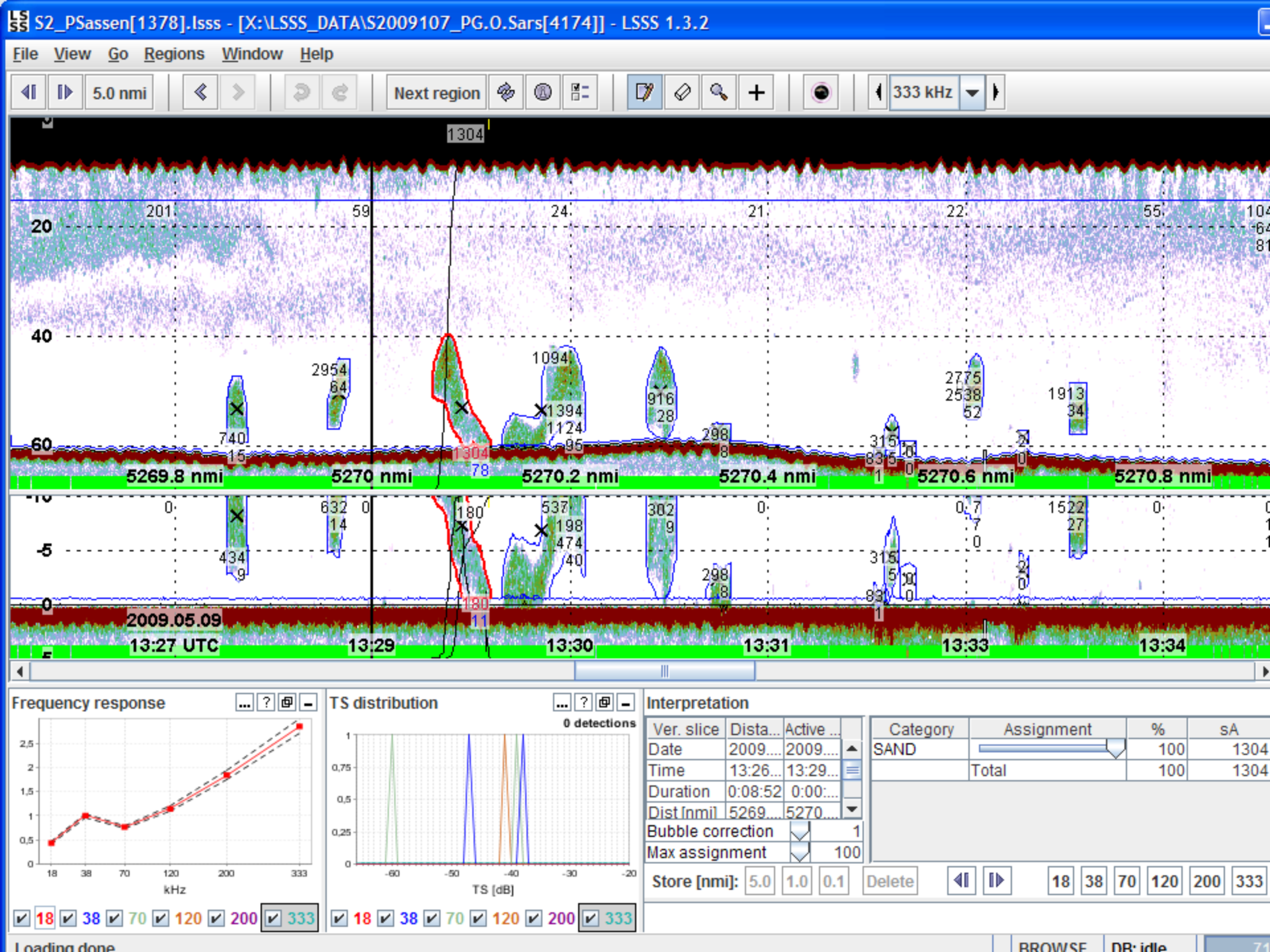

S2_PSassen[1378].lsss - [X:\LSSS_DATA\S2009107_PG.O.Sars[4174]] - LSSS 1.3.2
File View Go Regions Window Help
5.0 nmi
Next region
18 kHz
A sandeel example
5269.8 nmi
5270 nmi
5270.2 nmi
5270.4 nmi
5270.6 nmi
5270.8 nmi
2009.05.09
13:27 UTC
13:29
13:30
13:31
13:33
13:34
Frequency response
kHz
TS distribution
0 detections
TS [dB]
Interpretation
Ver. slice
Dista...
Active ...
Date
Time
Duration
Dist [nmi]
Bubble correction
Max assignment
Category
Assignment
%
sA
SAND
Total
Store [nmi]:
5.0
1.0
0.1
Delete
18 38 70 120 200 333
Loading done
BROWSE
DB: idle

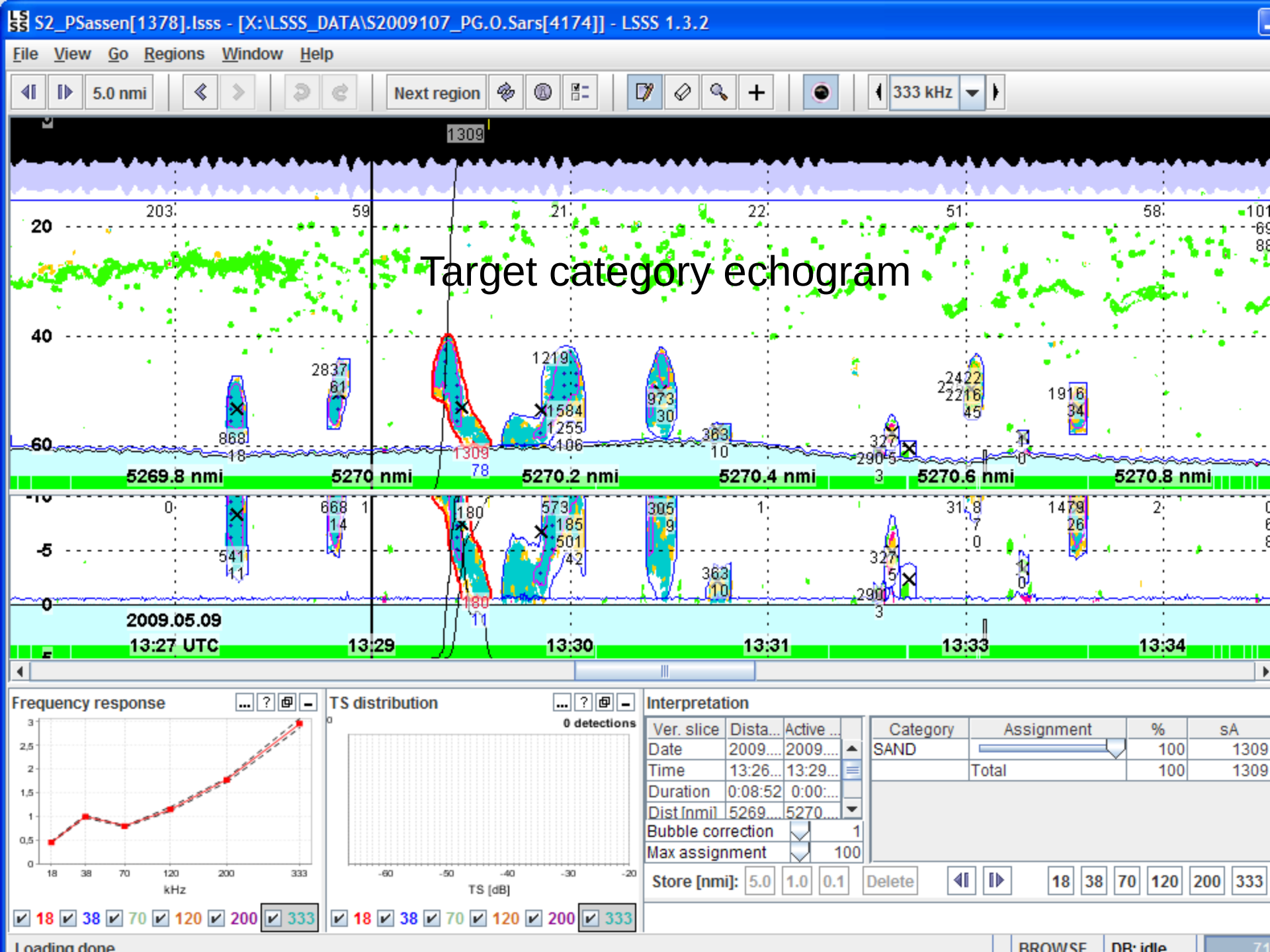

S2_PSassen[1378].lsss - [X:\LSSS_DATA\S2009107_PG.O.Sars[4174]] - LSSS 1.3.2
File View Go Regions Window Help
5.0 nmi
Next region
38 kHz
Show next frequency Ctrl-F
444
20
40
60
-10
-5
0
5269.8 nmi
5270 nmi
5270.2 nmi
5270.4 nmi
5270.6 nmi
5270.8 nmi
2009.05.09
13:27 UTC
13:29
13:30
13:31
13:33
13:34
Frequency response
kHz
TS distribution
2 detections
TS [dB]
18 38 70 120 200 333
Interpretation
Ver. slice
Dista...
Active ...
Date
Time
Duration
Dist [nmi]
Bubble correction
Max assignment
Category
Assignment
%
sA
SAND
Total
Store [nmi]:
5.0
1.0
0.1
Delete
Loading done
BROWSE
DB: idle


S2_PSassen[1378].lsss - [X:\LSSS_DATA\S2009107_PG.O.Sars[4174]] - LSSS 1.3.2
File View Go Regions Window Help
5.0 nmi
Next region
70 kHz
5269.8 nmi
5270 nmi
5270.2 nmi
5270.4 nmi
5270.6 nmi
5270.8 nmi
2009.05.09
13:27 UTC
13:29
13:30
13:31
13:33
13:34
Frequency response
kHz
TS distribution
2 detections
TS [dB]
Interpretation
Ver. slice
Dista...
Active ...
Date
Time
Duration
Dist [nmi]
Bubble correction
Max assignment
Category
Assignment
%
sA
SAND
Total
Store [nmi]:
Delete
18 38 70 120 200 333
Loading done
BROWSE
DB: idle

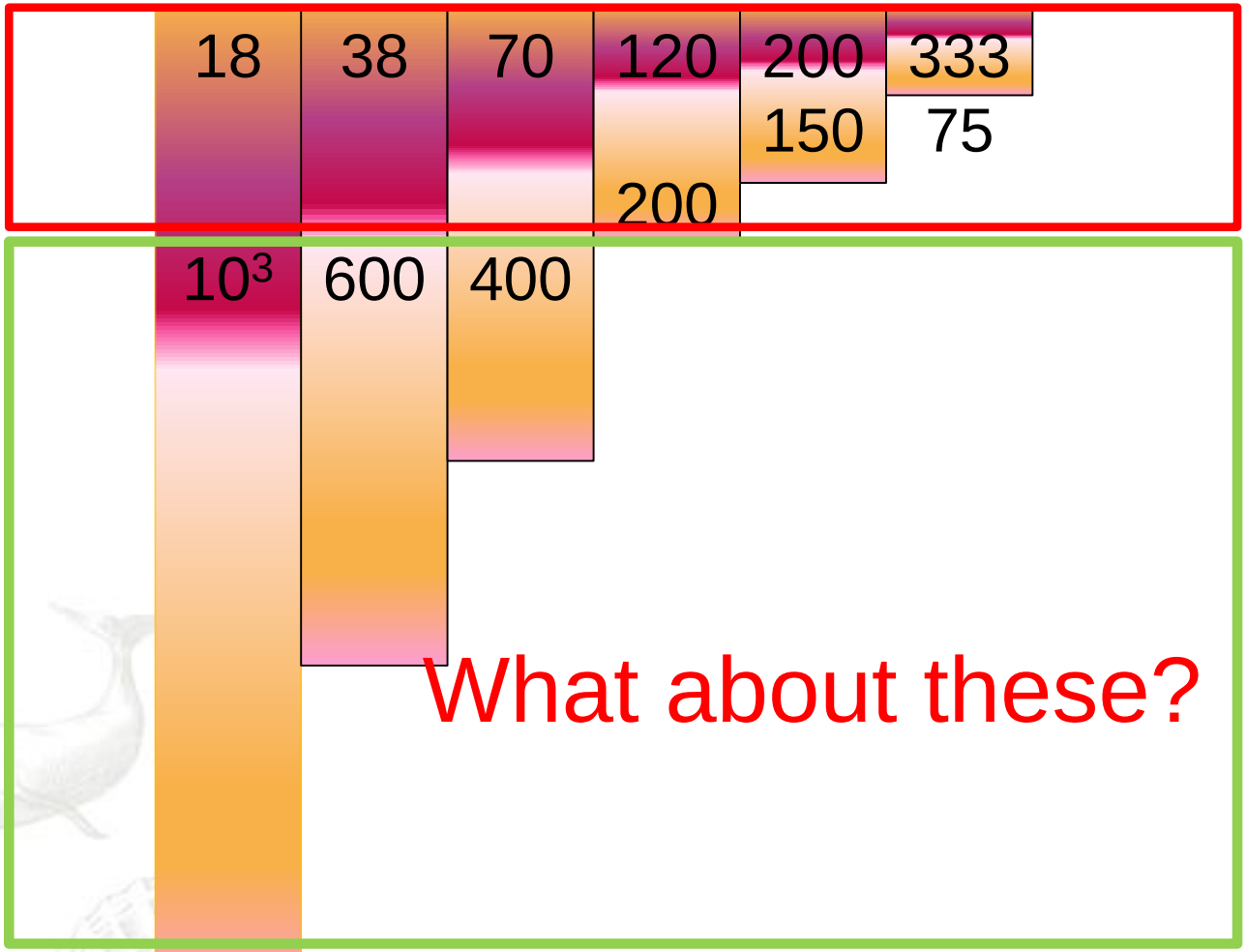

S2_PSassen[1378].lsss - [X:\LSSS_DATA\S2009107_PG.O.Sars[4174]] - LSSS 1.3.2
File View Go Regions Window Help
5.0 nmi
Next region
120 kHz
5269.8 nmi
5270 nmi
5270.2 nmi
5270.4 nmi
5270.6 nmi
5270.8 nmi
2009.05.09
13:27 UTC
13:29
13:30
13:31
13:33
13:34
Frequency response
kHz
TS distribution
1 detections
TS [dB]
Interpretation
Ver. slice
Dista...
Active ...
Date
Time
Duration
Dist [nmi]
Bubble correction
Max assignment
Category
Assignment
%
sA
SAND
Total
Store [nmi]:
5.0
1.0
0.1
Delete
18 38 70 120 200 333
Loading done
BROWSE
DB: idle


S2_PSassen[1378].lsss - [X:\LSSS_DATA\S2009107_PG.O.Sars[4174]] - LSSS 1.3.2
File View Go Regions Window Help
5.0 nmi
Next region
200 kHz
819
20
40
60
-10
-5
0
5269.8 nmi
5270 nmi
5270.2 nmi
5270.4 nmi
5270.6 nmi
5270.8 nmi
2009.05.09
13:27 UTC
13:29
13:30
13:31
13:33
13:34
Frequency response
kHz
TS distribution
0 detections
TS [dB]
Interpretation
Ver. slice
Dista...
Active ...
Date
Time
Duration
Dist [nmi]
Bubble correction
Max assignment
Category
Assignment
%
sA
SAND
Total
Store [nmi]:
5.0
1.0
0.1
Delete
18 38 70 120 200 333
Loading done
BROWSE
DB: idle


S2_PSassen[1378].lsss - [X:\LSSS_DATA\S2009107_PG.O.Sars[4174]] - LSSS 1.3.2
File View Go Regions Window Help
5.0 nmi
Next region
333 kHz
1304
5269.8 nmi
5270 nmi
5270.2 nmi
5270.4 nmi
5270.6 nmi
5270.8 nmi
2009.05.09
13:27 UTC
13:29
13:30
13:31
13:33
13:34
Frequency response
kHz
TS distribution
0 detections
TS [dB]
Interpretation
Ver. slice
Dista...
Active ...
Date
Time
Duration
Dist [nmi]
Bubble correction
Max assignment
Category
Assignment
%
sA
SAND
Total
Store [nmi]:
5.0
1.0
0.1
Delete
18 38 70 120 200 333
Loading done
BROWSE
DB: idle


S2_PSassen[1378].lsss - [X:\LSSS_DATA\S2009107_PG.O.Sars[4174]] - LSSS 1.3.2
File View Go Regions Window Help
5.0 nmi
Next region
333 kHz
Target category echogram
5269.8 nmi
5270 nmi
5270.2 nmi
5270.4 nmi
5270.6 nmi
5270.8 nmi
2009.05.09
13:27 UTC
13:29
13:30
13:31
13:33
13:34
Frequency response
kHz
TS distribution
0 detections
TS [dB]
Interpretation
Ver. slice
Dista...
Active ...
Date
Time
Duration
Dist [nmi]
Bubble correction
Max assignment
Category
Assignment
%
sA
SAND
Total
Store [nmi]:
Delete
18 38 70 120 200 333
Loading done
BROWSE
DB: idle

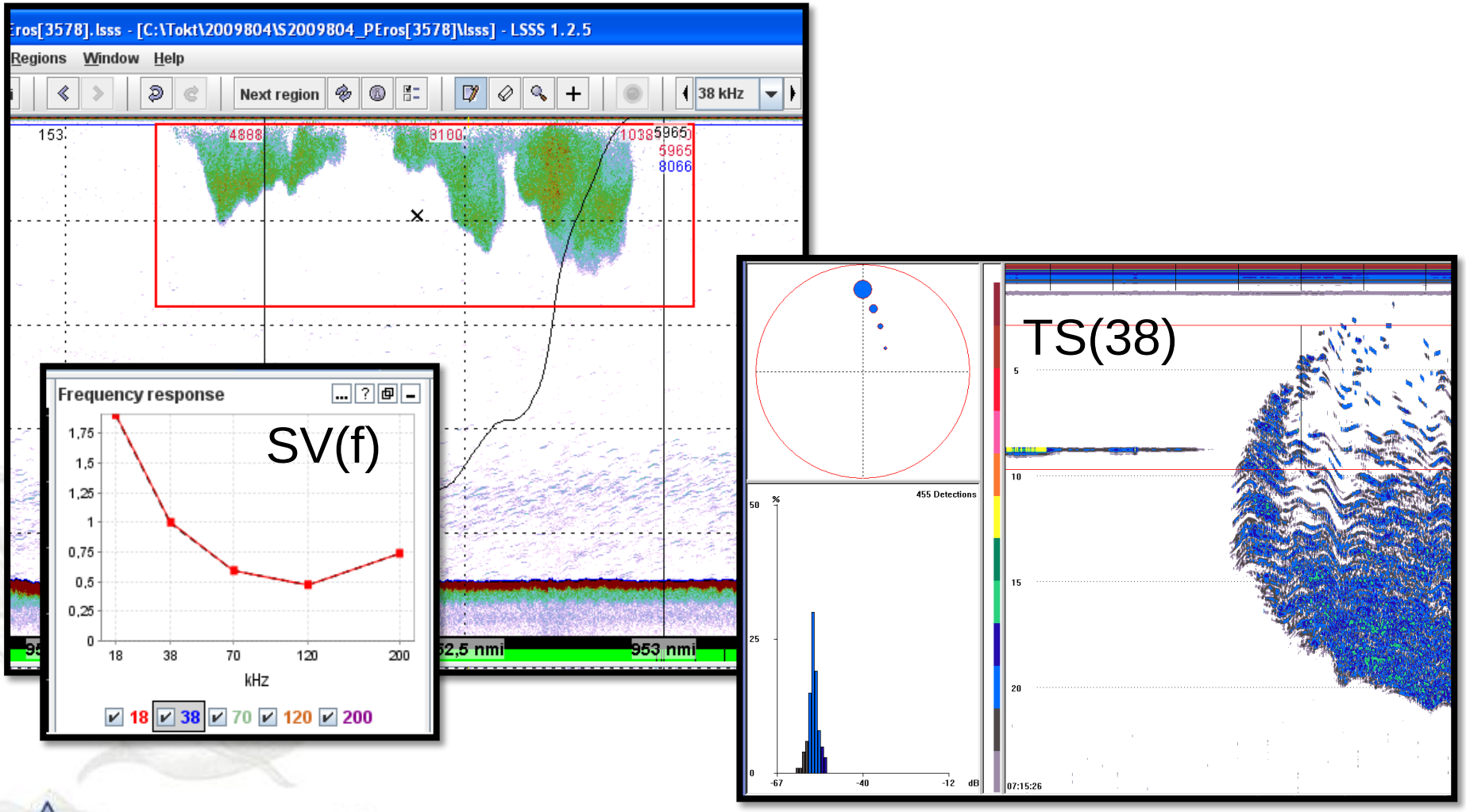
Multi-frequency capacity from vessel



The ”TS probe”

(Originally made for TS measurements of fish)

Example Capelin schools
(probing inside school for <TS>)



Re-arranged as (AOS)

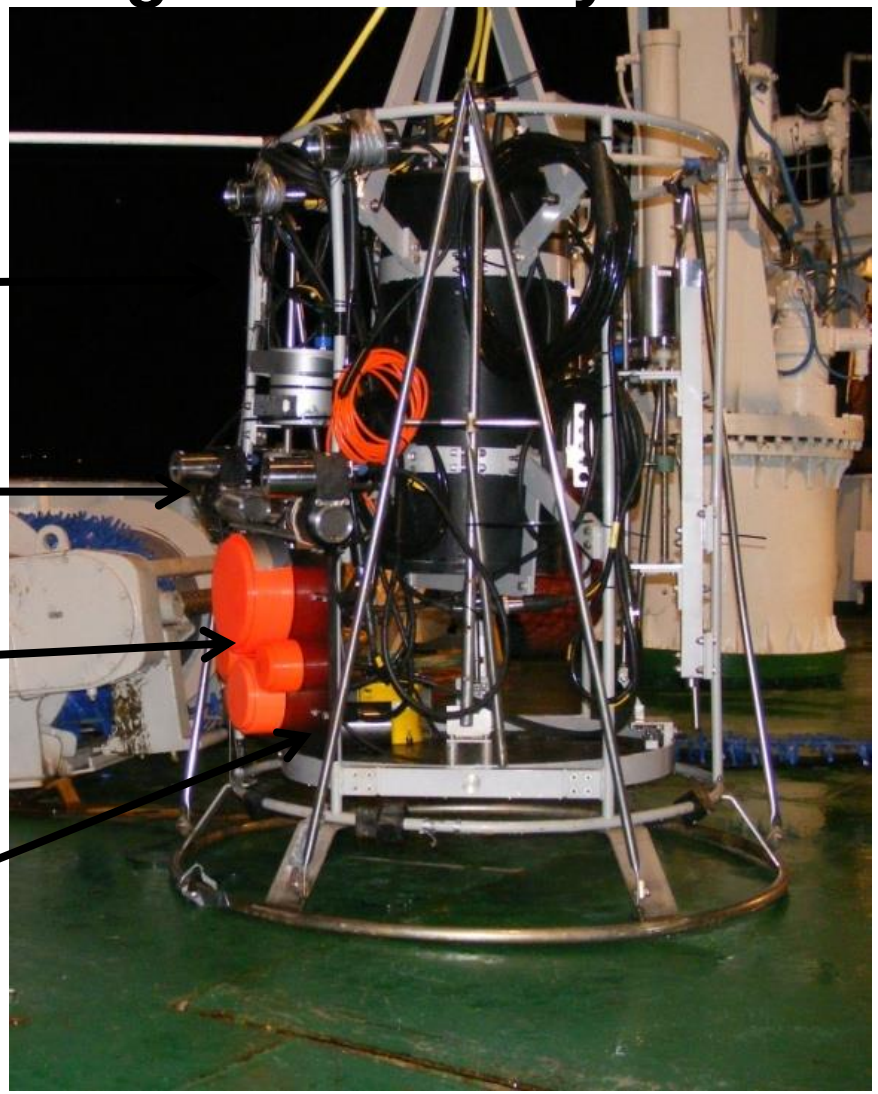
Transducers observing horisontally

CTD (Seabird microcat)

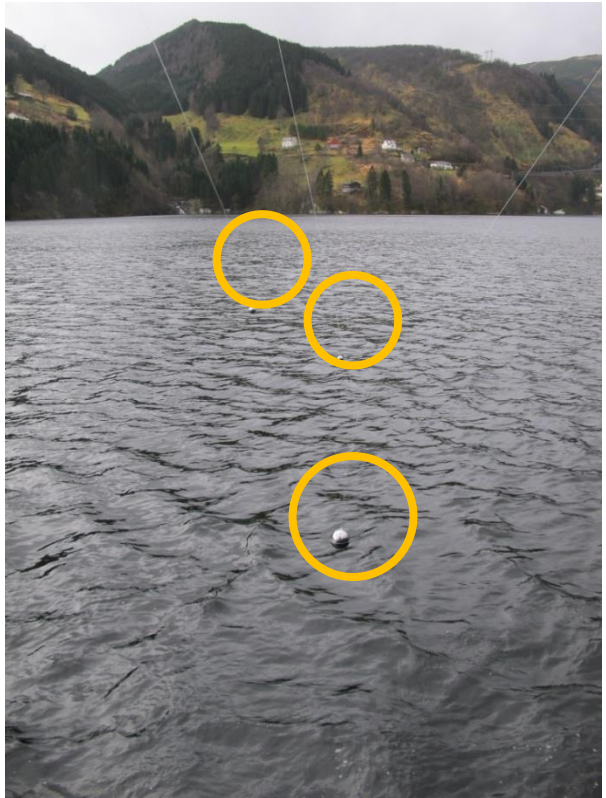
IMENCO Stereo-camera

4 Simrad DD transducers
70, 120, 200, 300 kHz

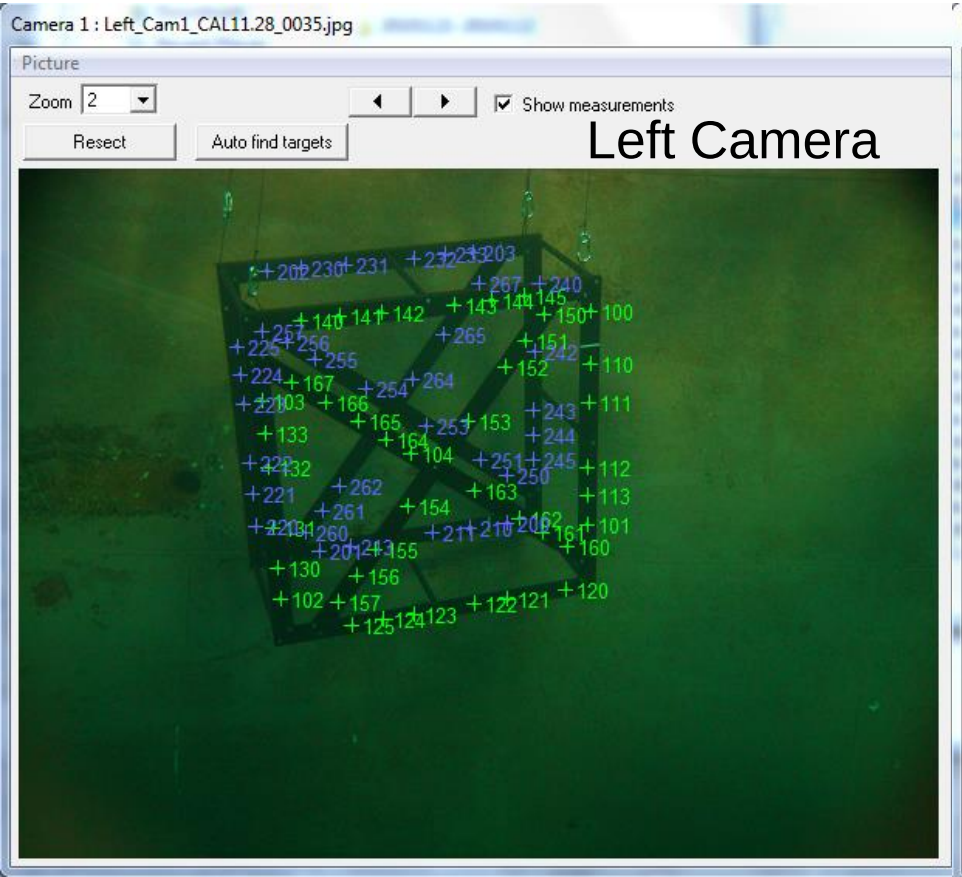
ADCP (RDI, 600 kHz)

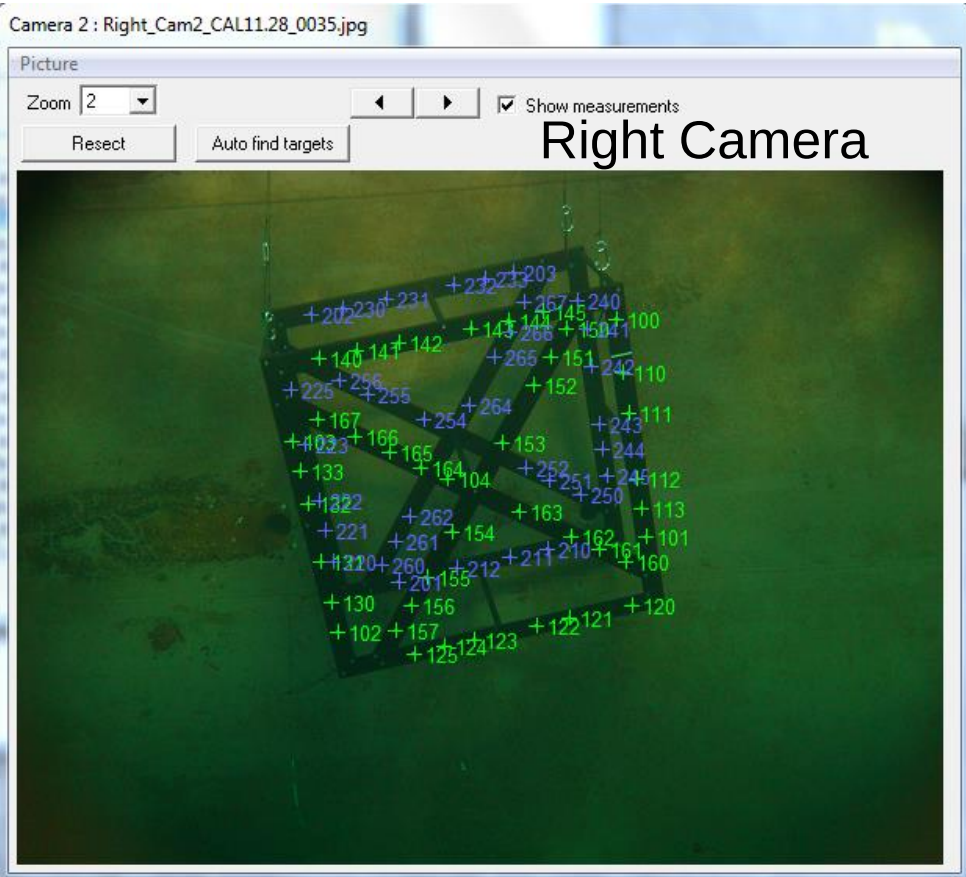


Calibration 1

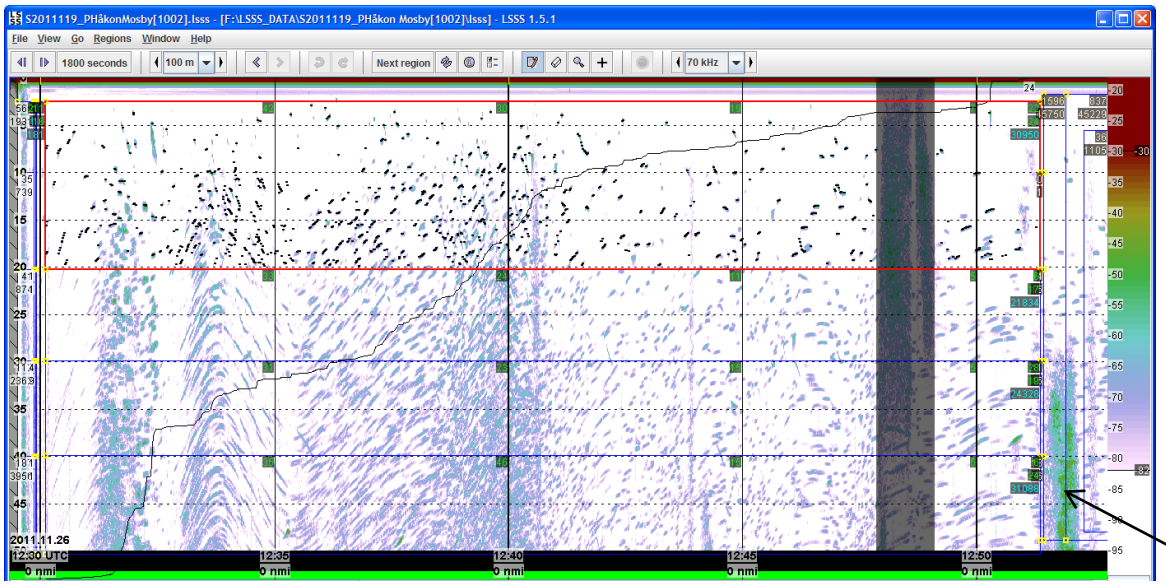


Calibration 2 (stereogrammetry)





AOS echogram, 0 - 440 m (Pinging to 50 m)

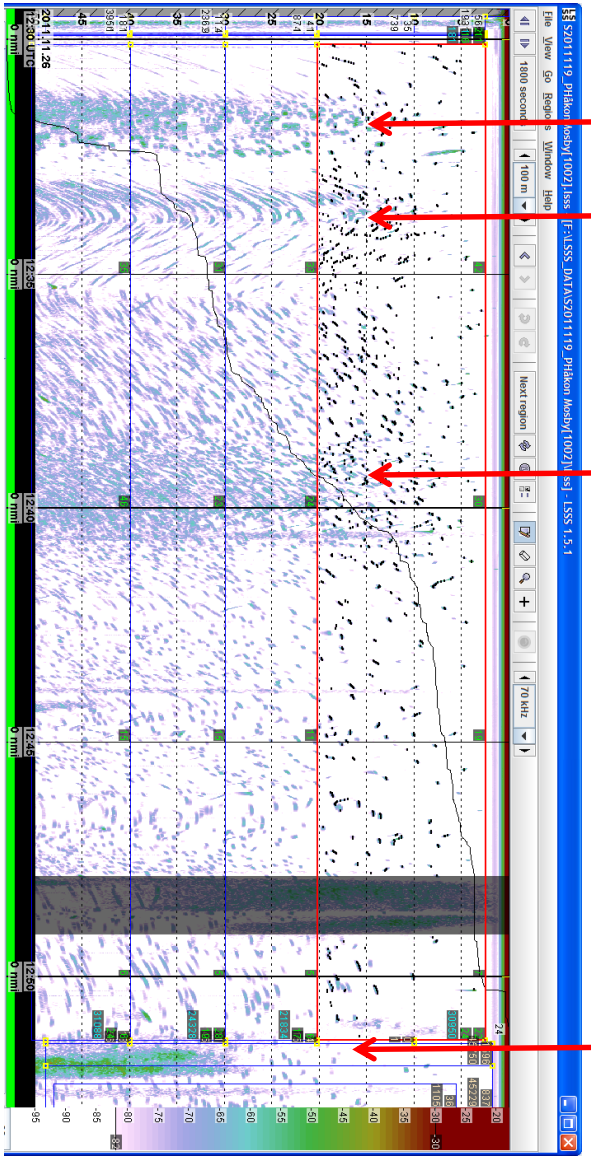


Range (m)

Bottom echo

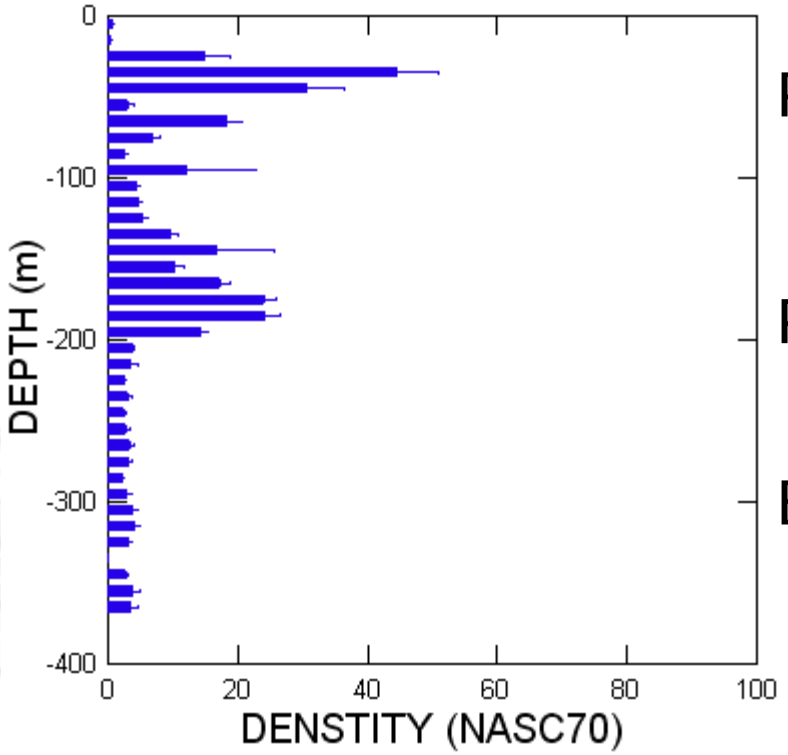
DEPTH (M)

Rotated



Vertical volume density profile

Pearlside and Bentosema

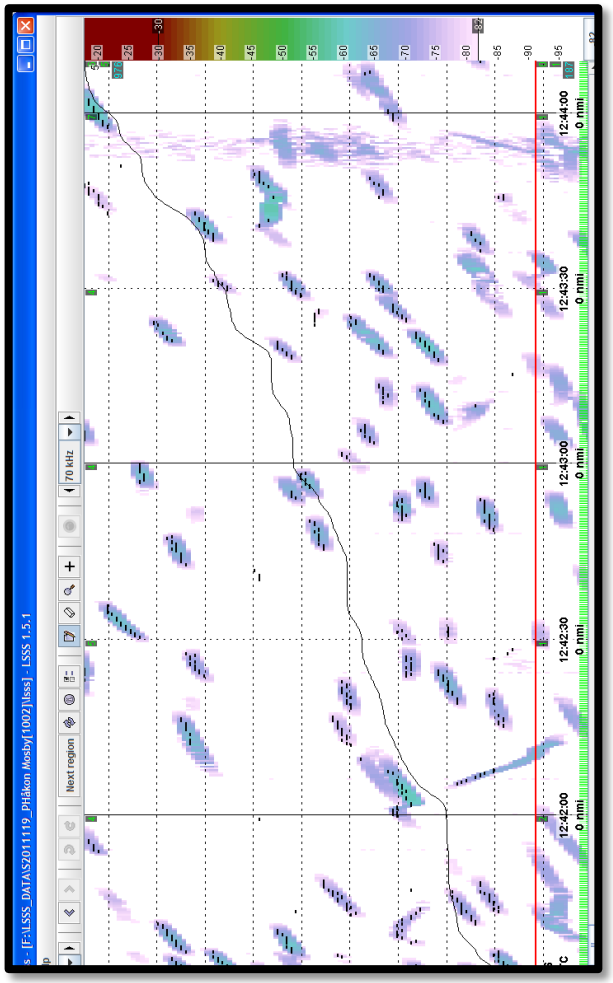


Analysis:

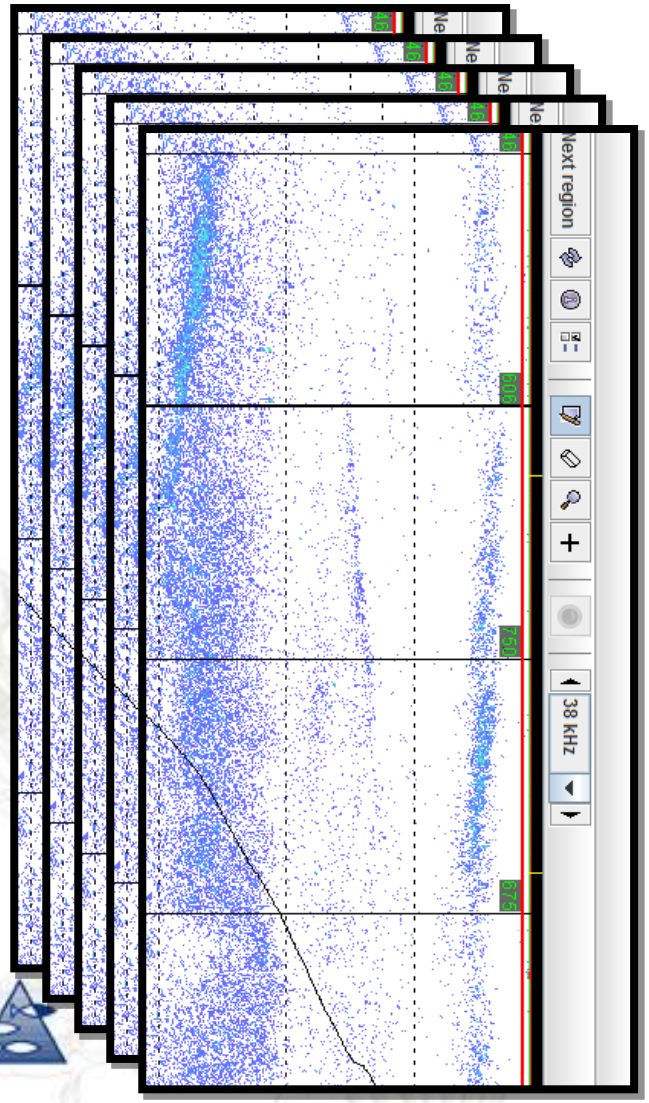
$$\rho_v = \frac{s_A}{\sigma_{sp}(1852)\Delta z}$$

$$10\log(\rho_v) = SV - TS$$

Measure $TS_H(f)$
(zoomed previous recording)

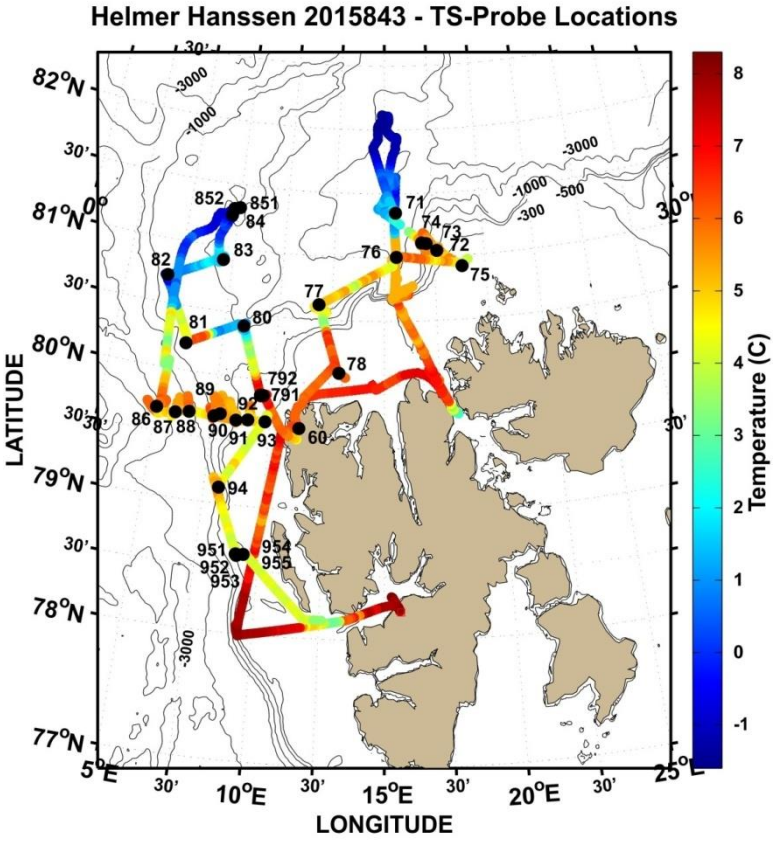


Target ID



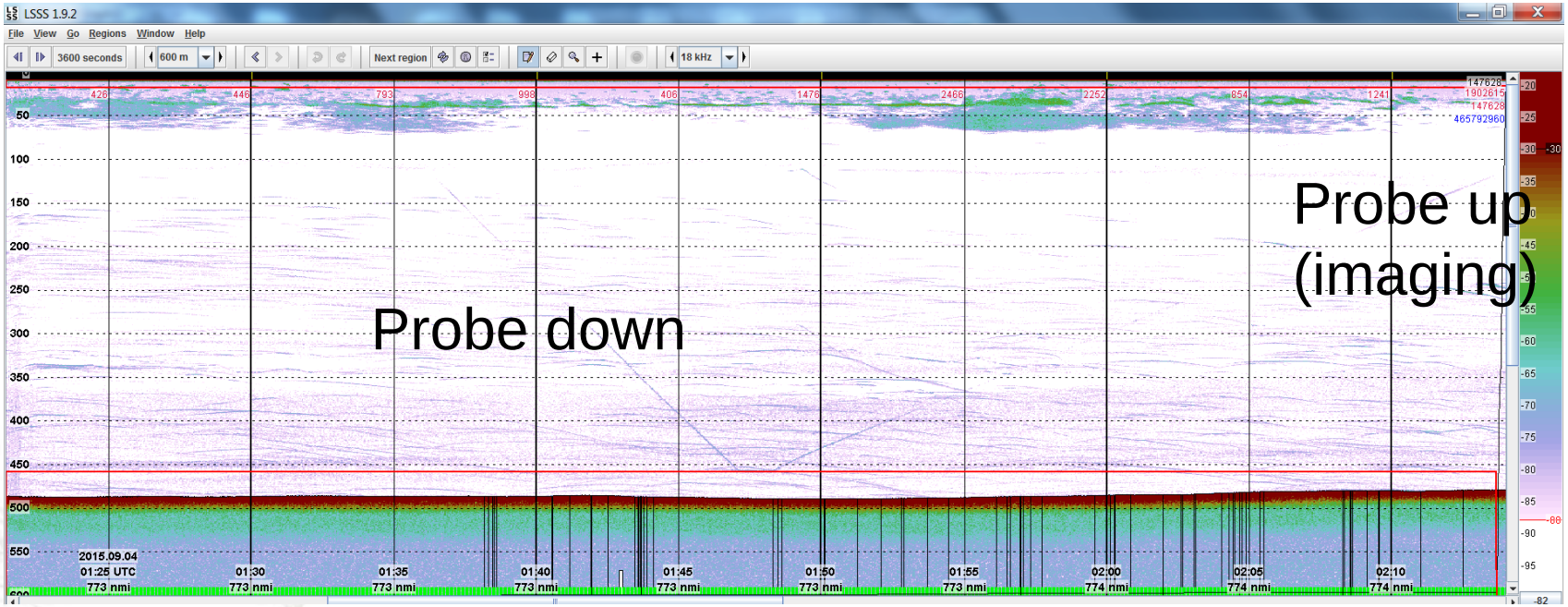
Standard
Multi-frequency
analysis

Zooplankton examples

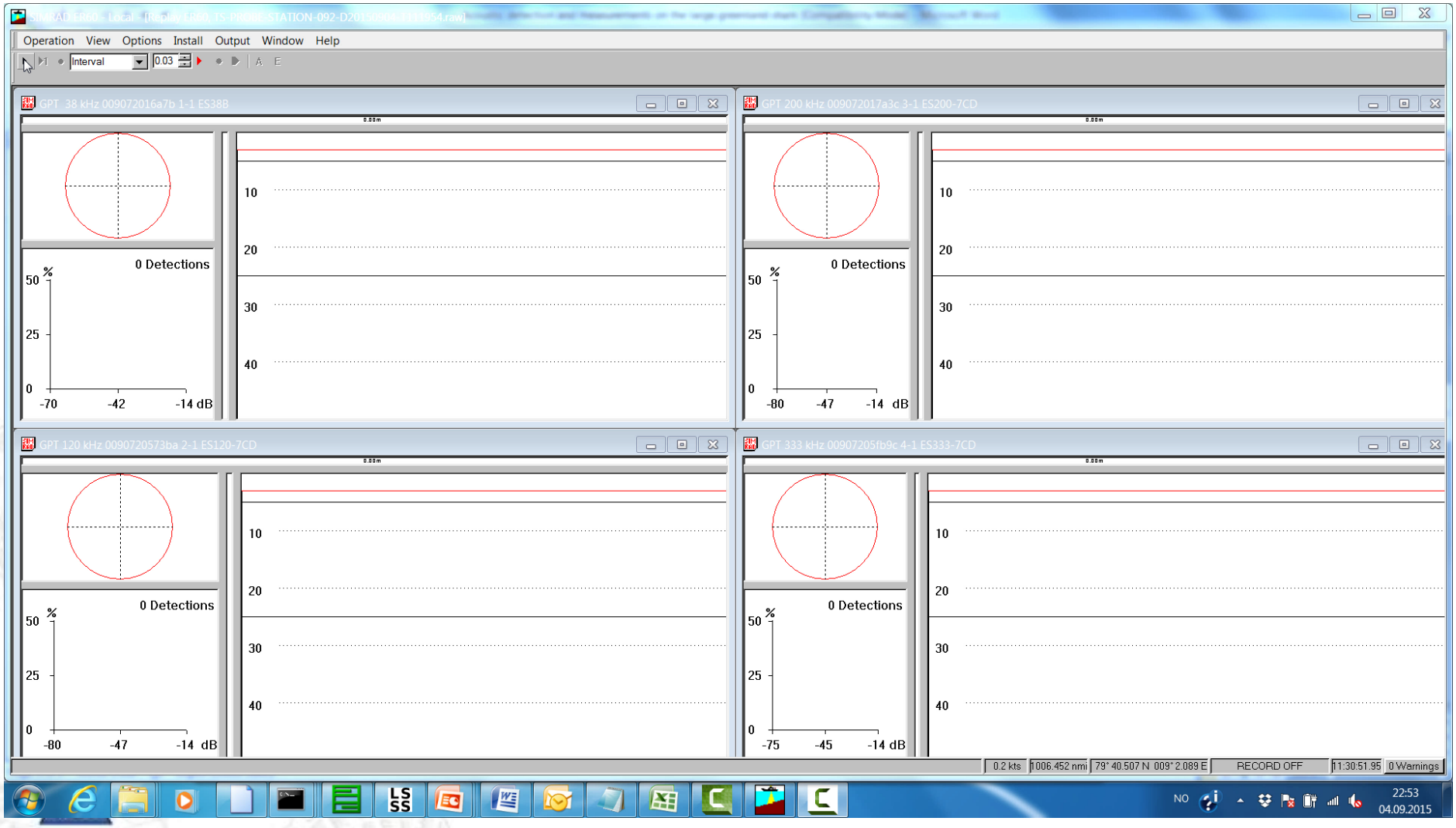


One station, no 91

(only 18 kHz running, no disturbance on Probe)

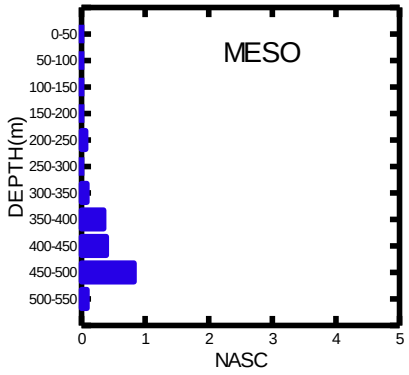


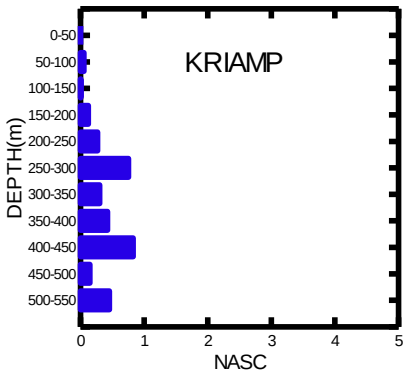
Station91

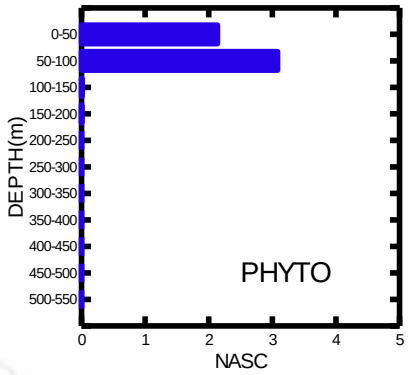

Operation View Options Install Output Window Help
Interval
0.03
GPT 38 kHz 009072016a7b 1-1 ES38B
0 Detections
50
25
0
%
-70 -42 -14 dB
10
20
30
40
GPT 200 kHz 009072017a3c 3-1 ES200-7CD
0 Detections
-80 -47 -14 dB
GPT 120 kHz 0090720573ba 2-1 ES120-7CD
0 Detections
-80 -47 -14 dB
GPT 333 kHz 00907205fb9c 4-1 ES333-7CD
0 Detections
-75 -45 -14 dB
0.2 kts
1006.452 nmi
79° 40.507 N 009° 2.089 E
RECORD OFF
11:30:51.95
0 Warnings
NO
22:53
04.09.2015

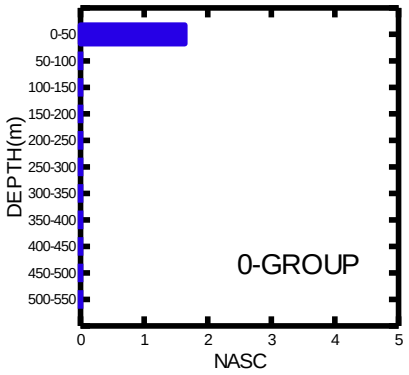
Typical output, categories each station

VERTICAL DISTRIBUTION OF TARGET CATEGORIES



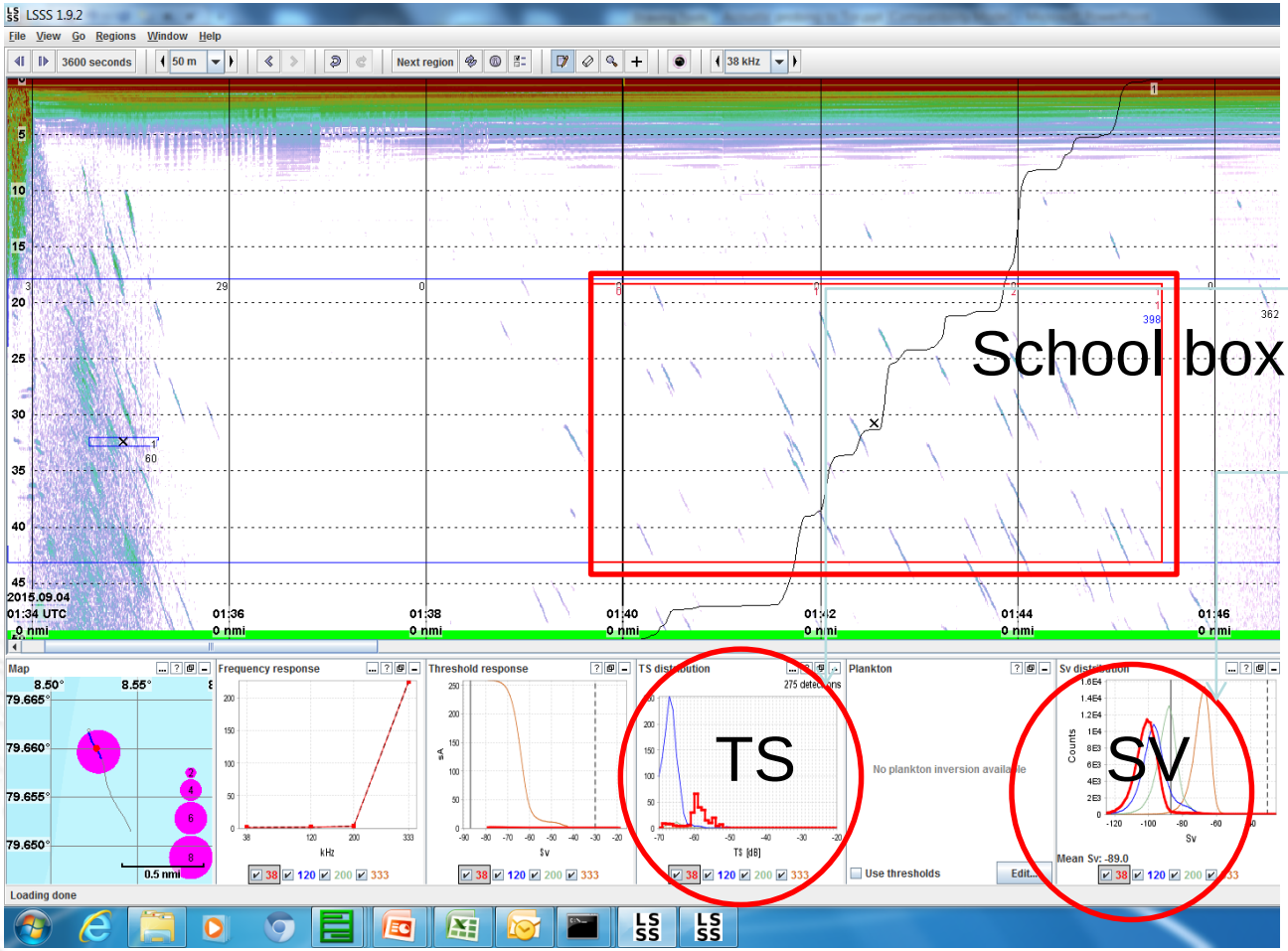






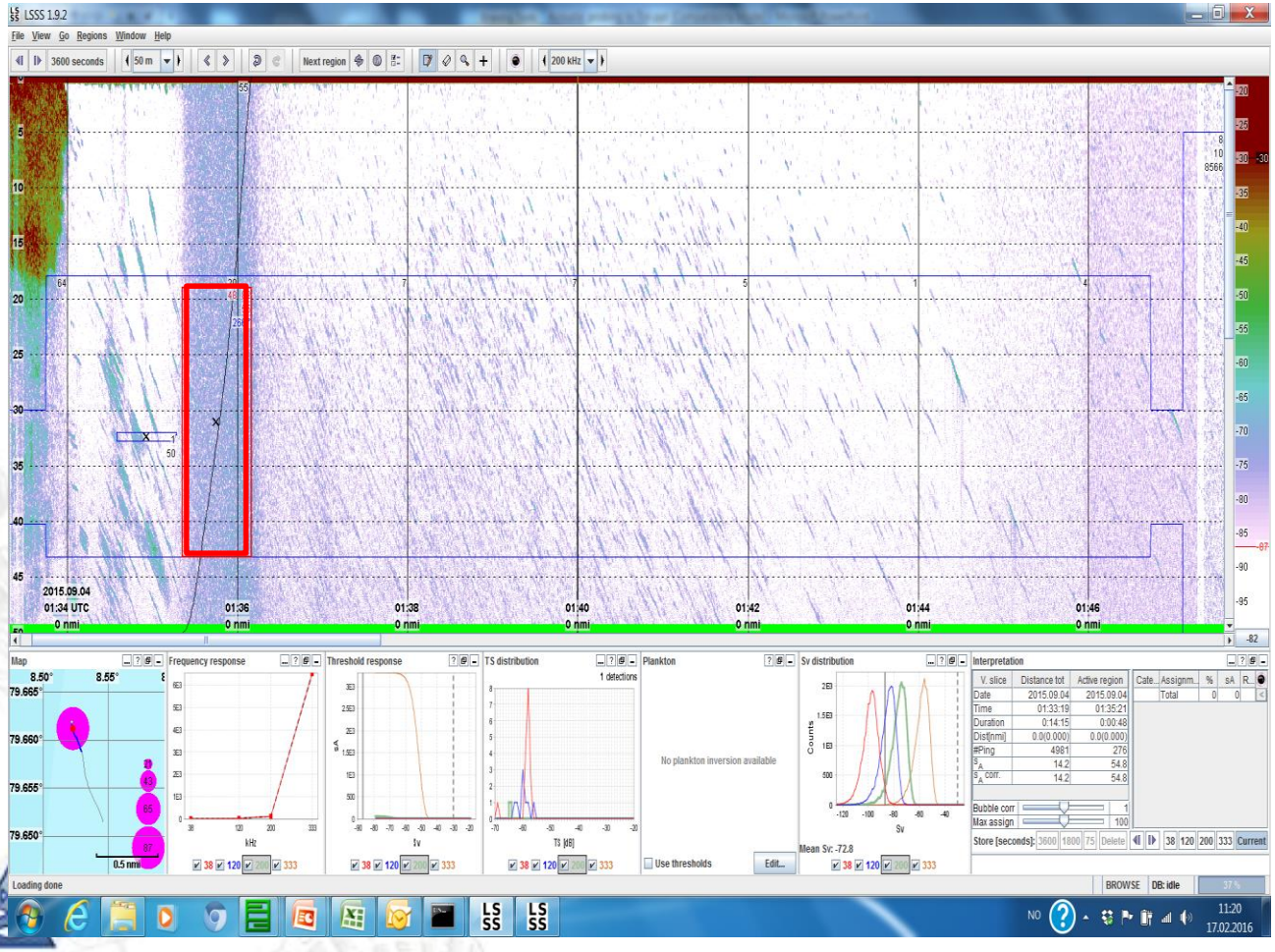
Easy Example MESO,

absolute mean animal density, measured, 20-40 m from the AOS



MESO	MEASURED
MEAN SV	-88
MEAN TS	-59
SV-TS	-29
VOL-DENSITY	0.001258925
M^3/FISH	794
F/1000M^3	1.259

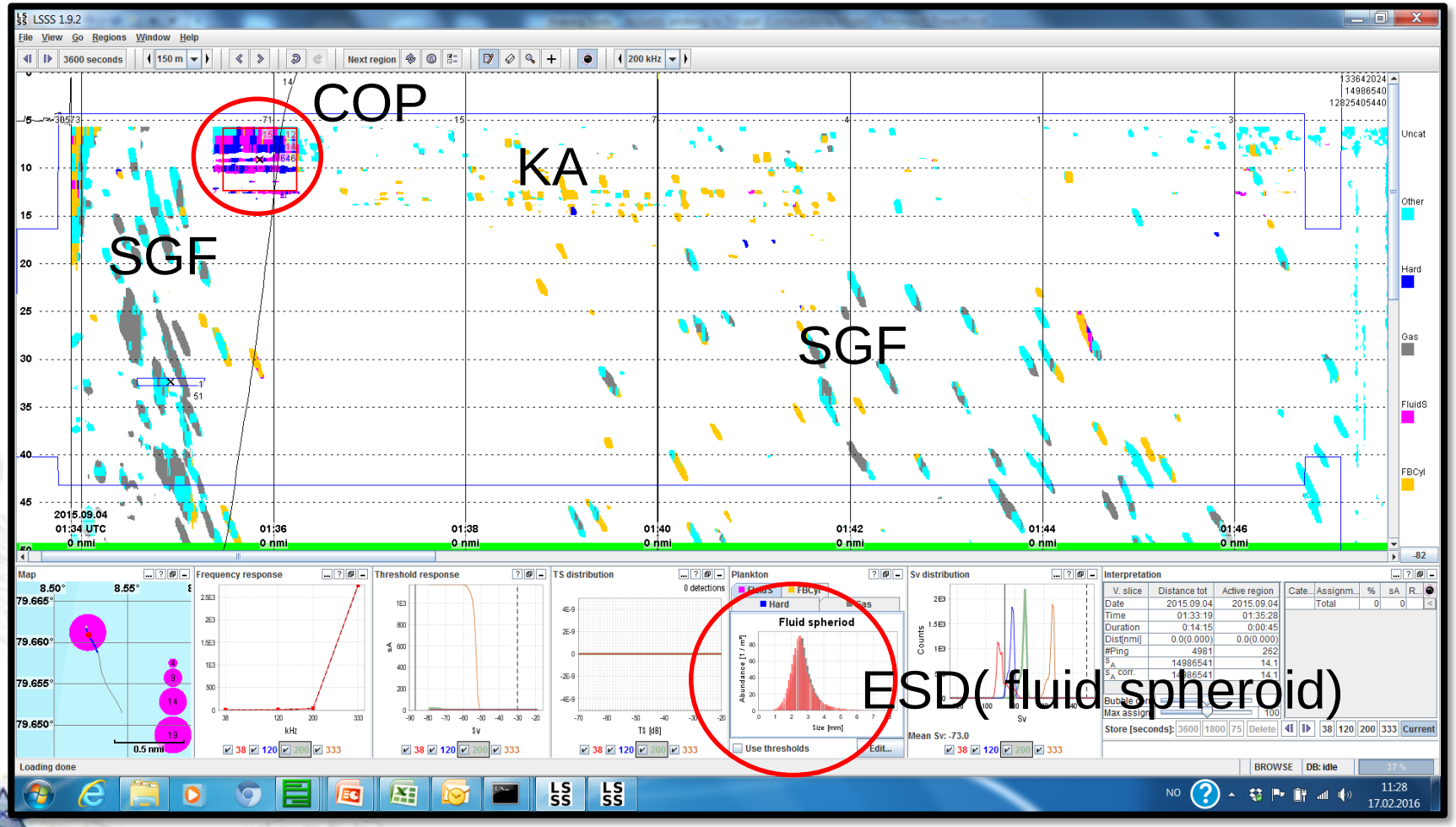
Copepod layer,
200 kHz, 50 – 80 m depth



COPEPODES	MEASURED
MEAN SV	-75
MEAN TS	-93
SV-TS	18
VOL-DENSITY (N/M^3)	63
M^3 /ANIMAL	1.58E-02
$n/1000M^3$	63096

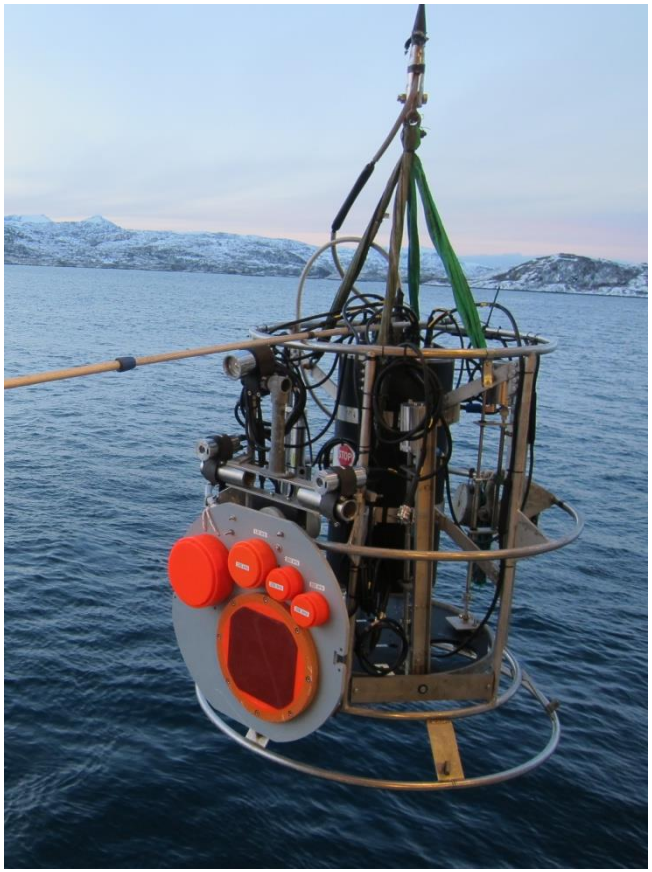
Auto-ID help-(KORONA)

Inversion methods (see Holliday et al.)



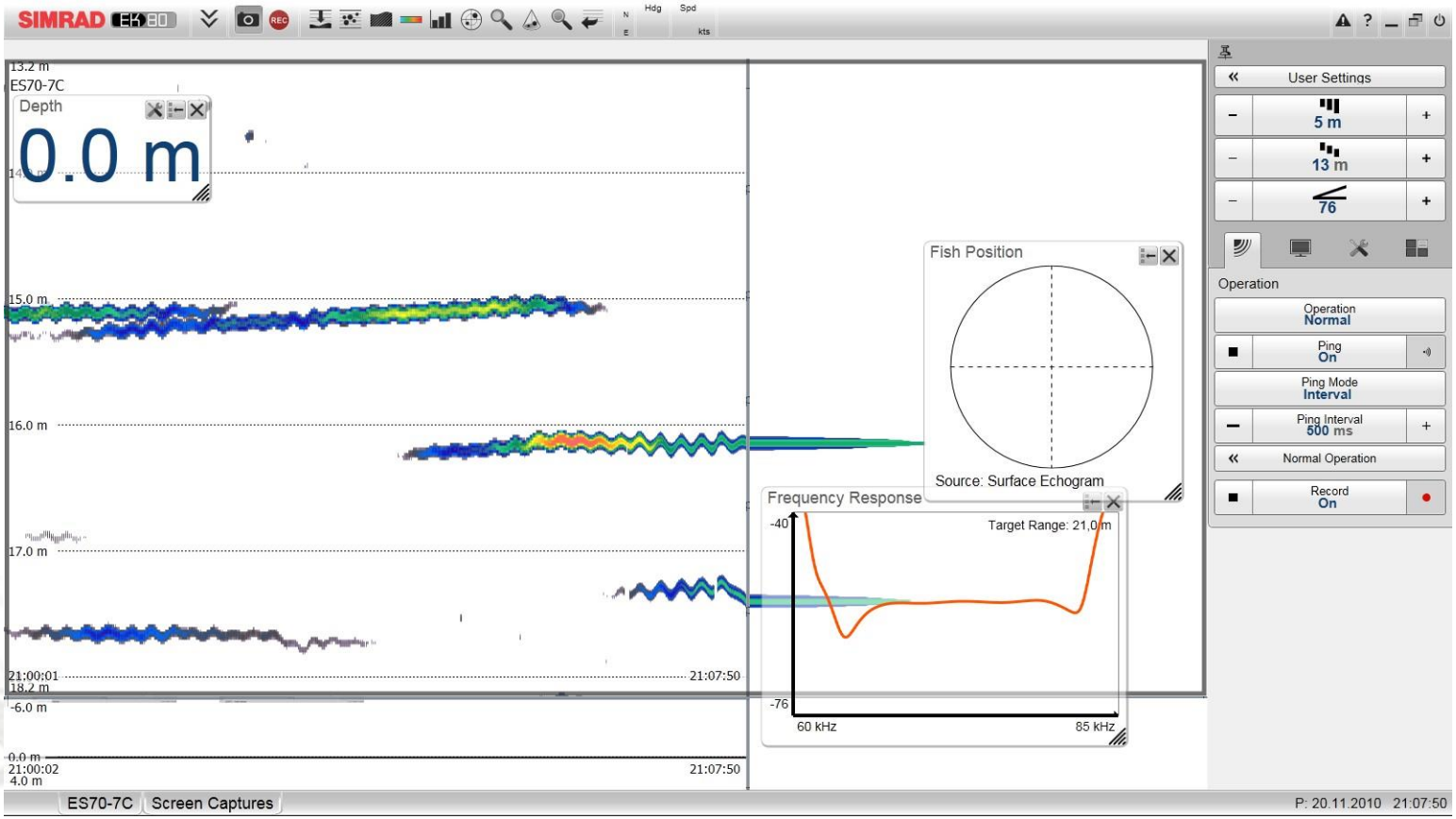
Leave 1984 - 2010

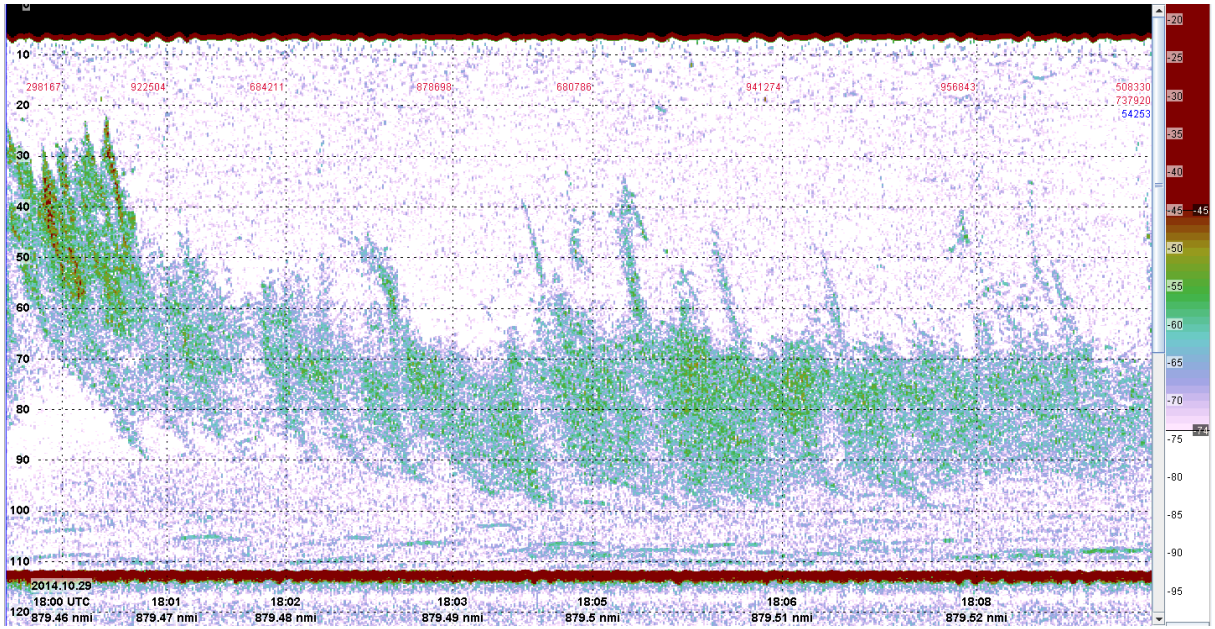
2010 – 2016
Broadband system Simrad EK80



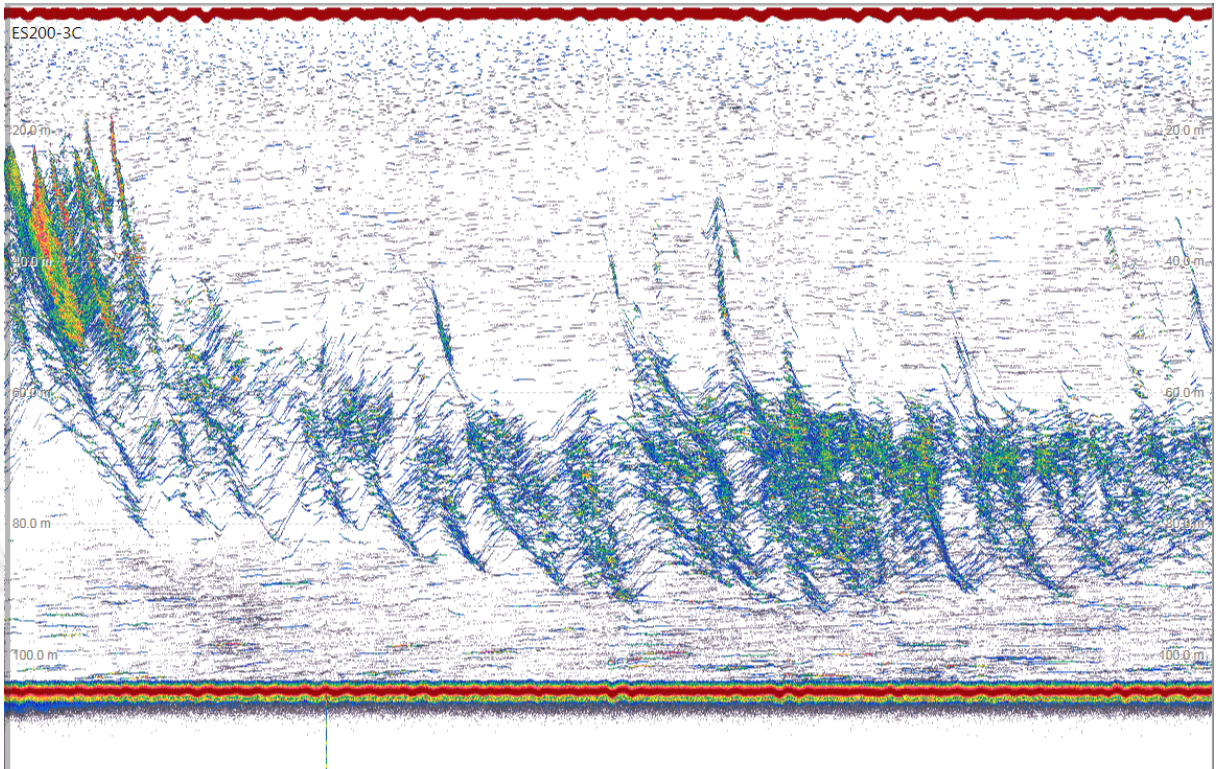
Resolution !

TS(f), *Bentosema glaciale* 400 m




2014.10.29
18:00 UTC
879.46 nmi
18:01
879.47 nmi
18:02
879.48 nmi
18:03
879.49 nmi
18:05
879.5 nmi
18:06
879.51 nmi
18:08
879.52 nmi

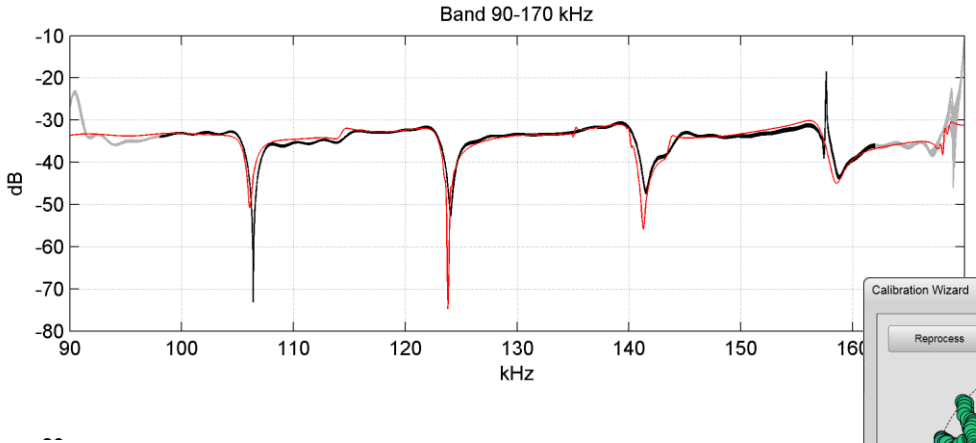
EK60


ES200-3C
20.0 m
40.0 m
60.0 m
80.0 m
100.0 m

EK80

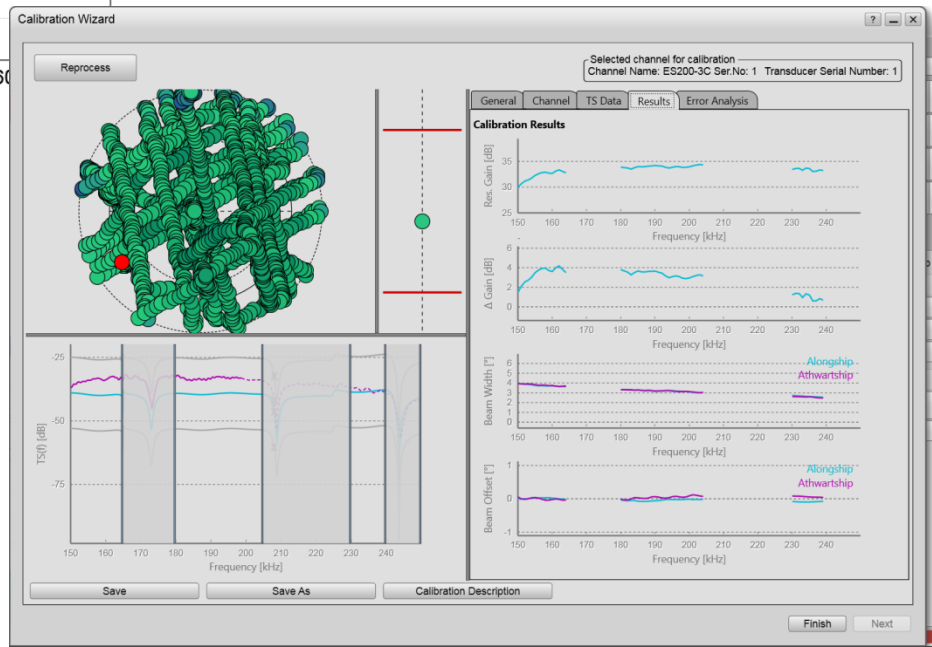
Calibration accuracy

Wideband calibration WC 75,
90 -170 kHz

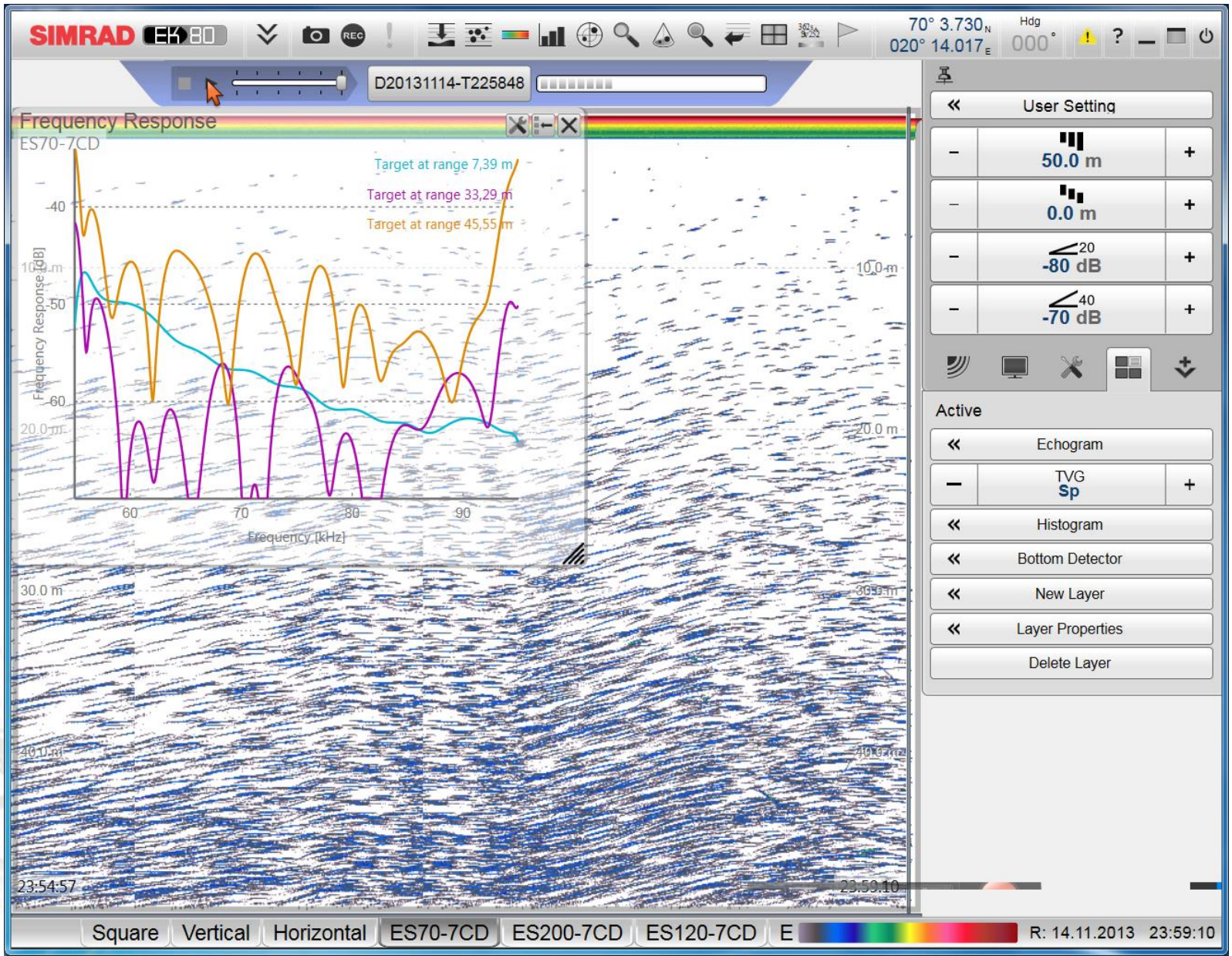


Measured TS(f)

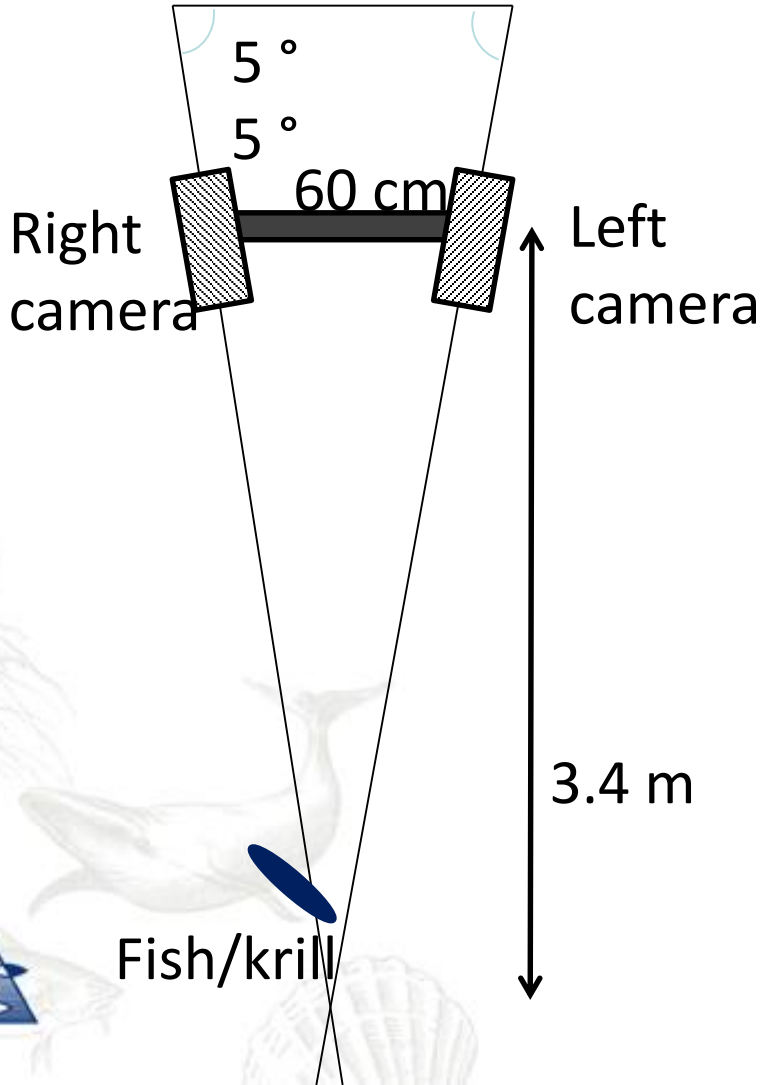
Theory

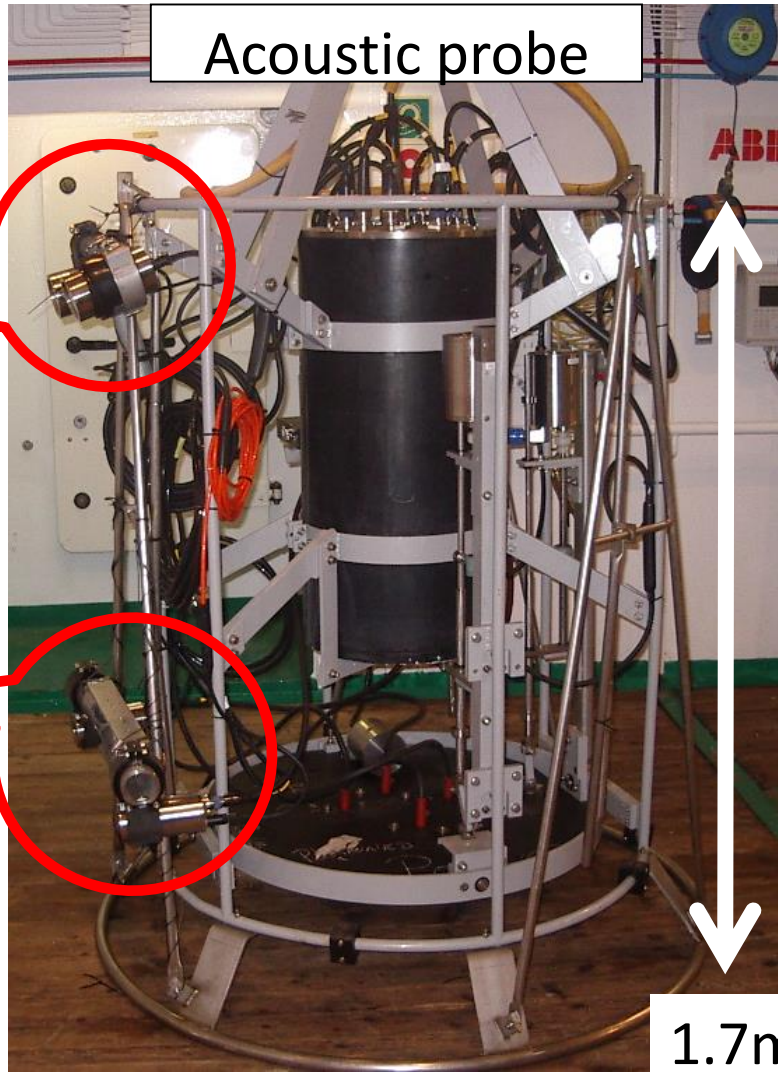


SALPS WB x 4


SIMRAD EK80
70° 3.730 N
020° 14.017 E
Hdg
000°
D20131114-T225848
Frequency Response
ES70-7CD
Target at range 7,39 m
Target at range 33,29 m
Target at range 45,55 m
Frequency Response [dB]
Frequency [kHz]
User Setting
50.0 m
0.0 m
-80 dB
-70 dB
Active
Echogram
TVG
Sp
Histogram
Bottom Detector
New Layer
Layer Properties
Delete Layer
23:54:57
Square
Vertical
Horizontal
ES70-7CD
ES200-7CD
ES120-7CD
R: 14.11.2013
23:59:10

Optical ID og measurements

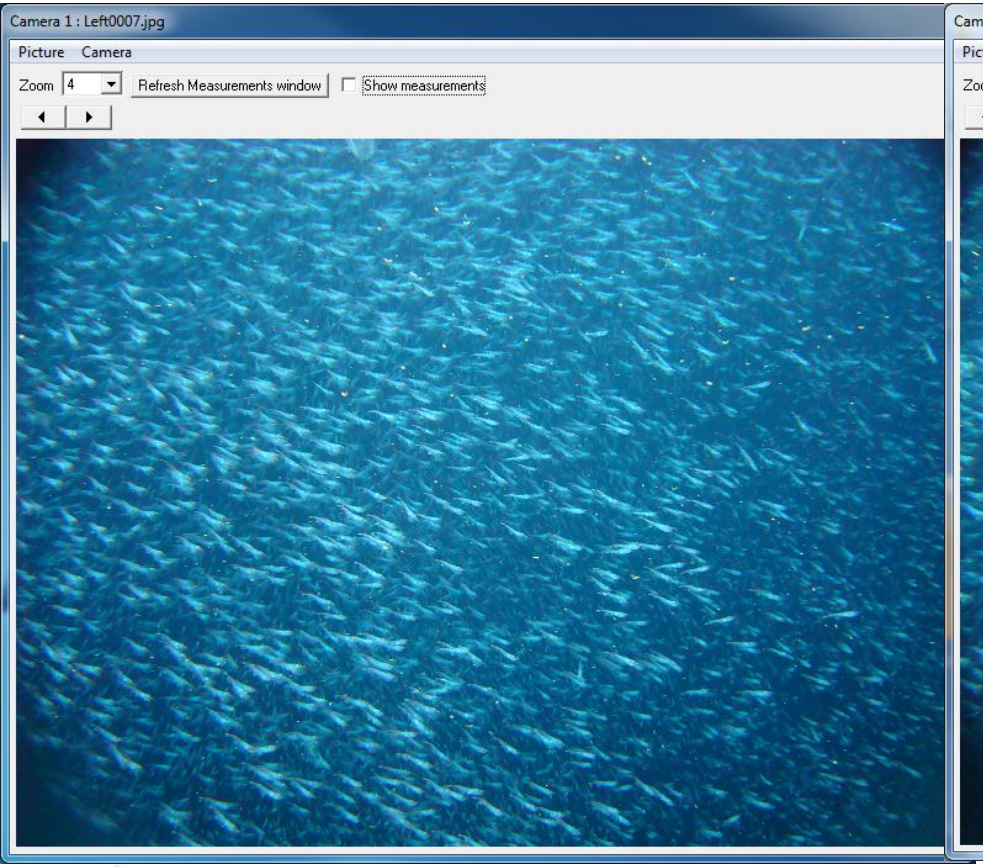




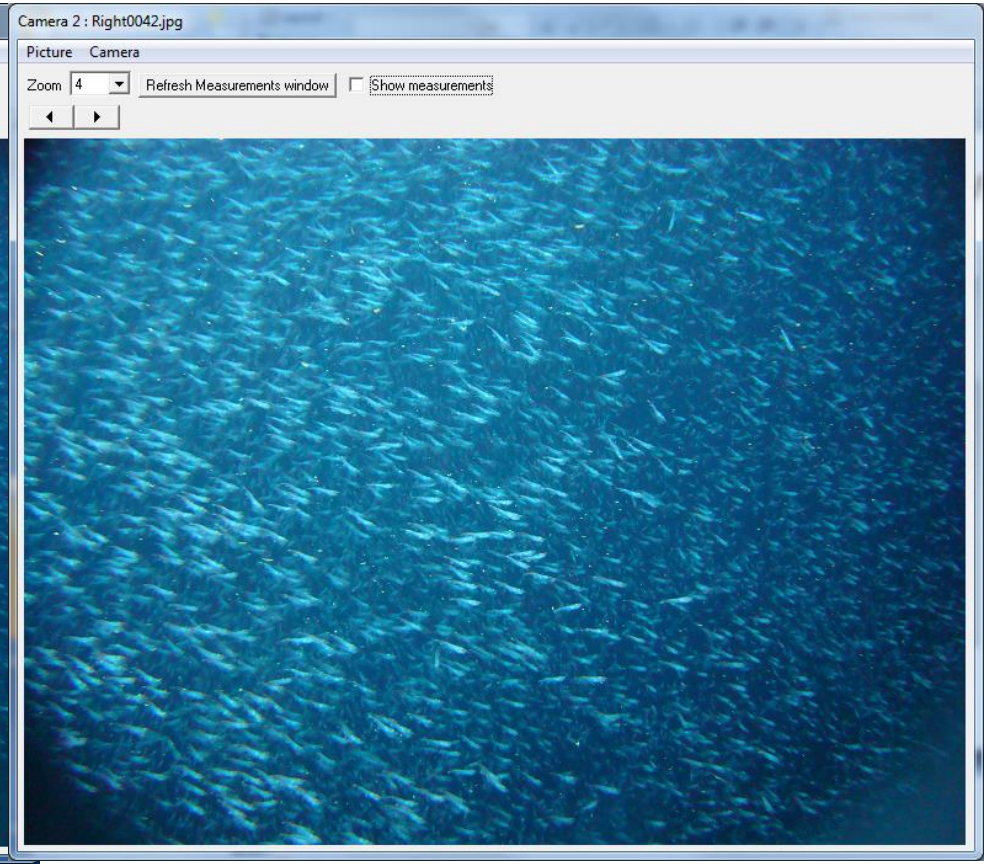
Volume density - Antarctic krill

(example)

Left Camera



Right Camera

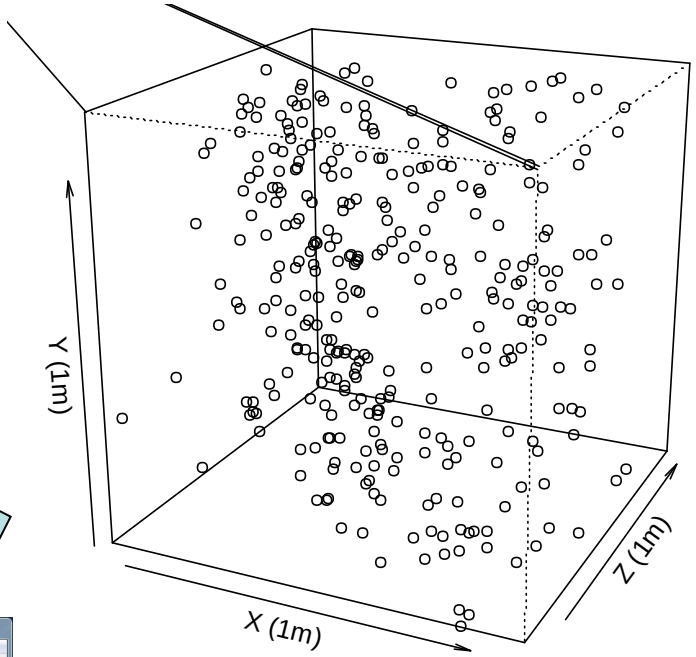


R/V G.O.Sars (2008)

Antarctic ocean (~30m depth)

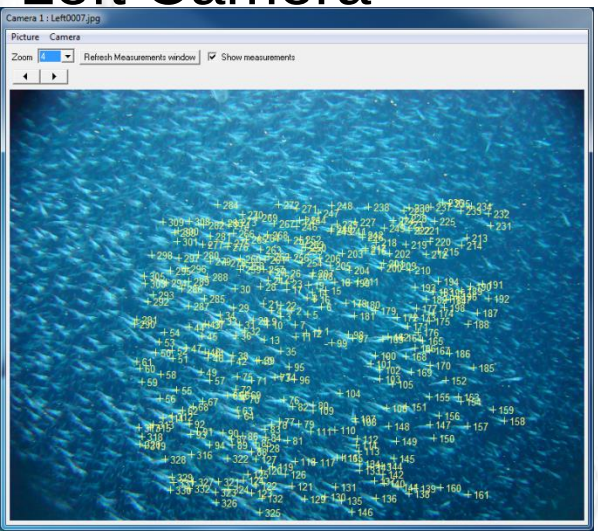
Volume density - Antarctic krill

(example)

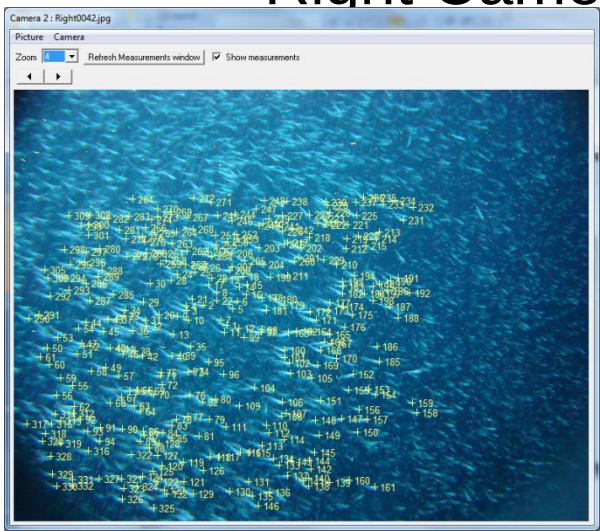


326/m³

Left Camera



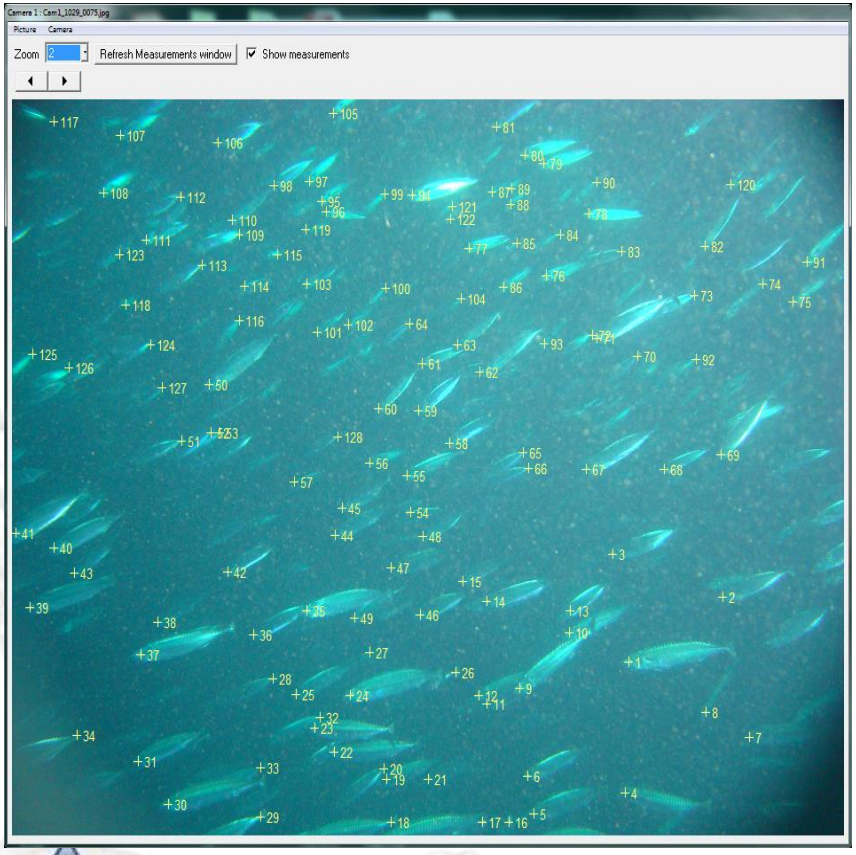
Right Came



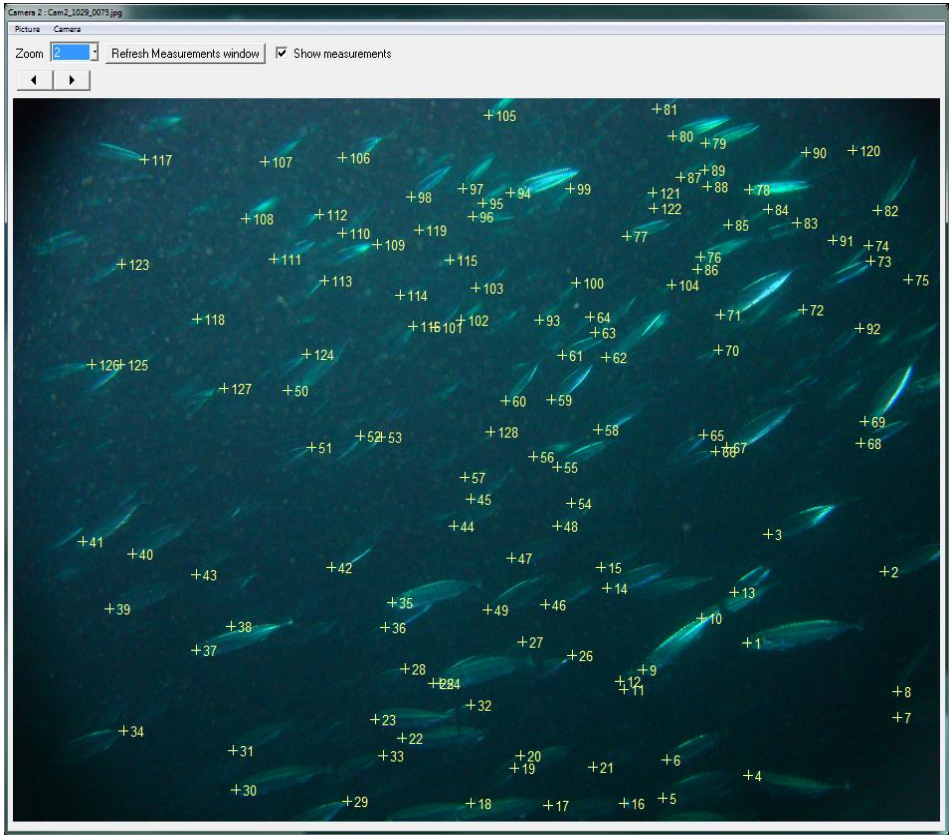
R/V G.O.Sars (2008)
Antarctic ocean (~30m depth)

Or mackerel

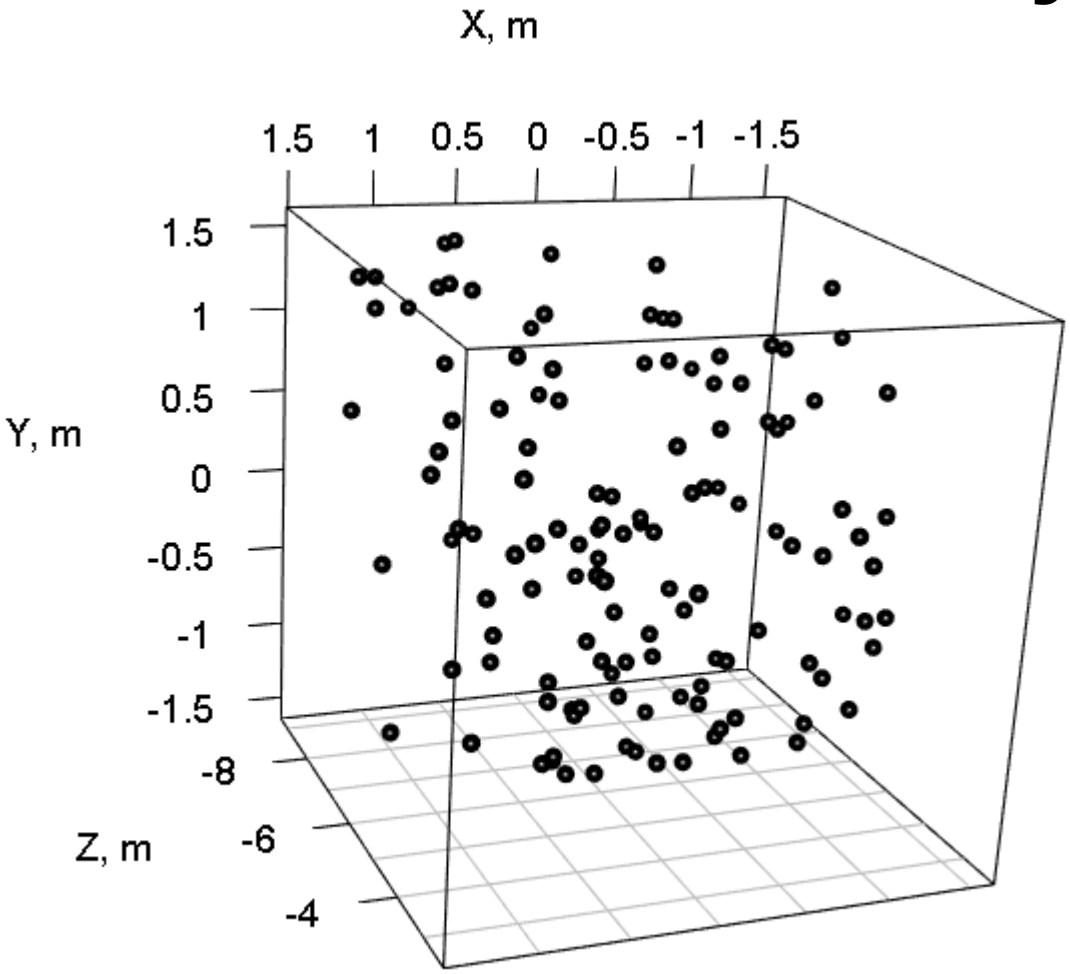
Left camera



Right camera



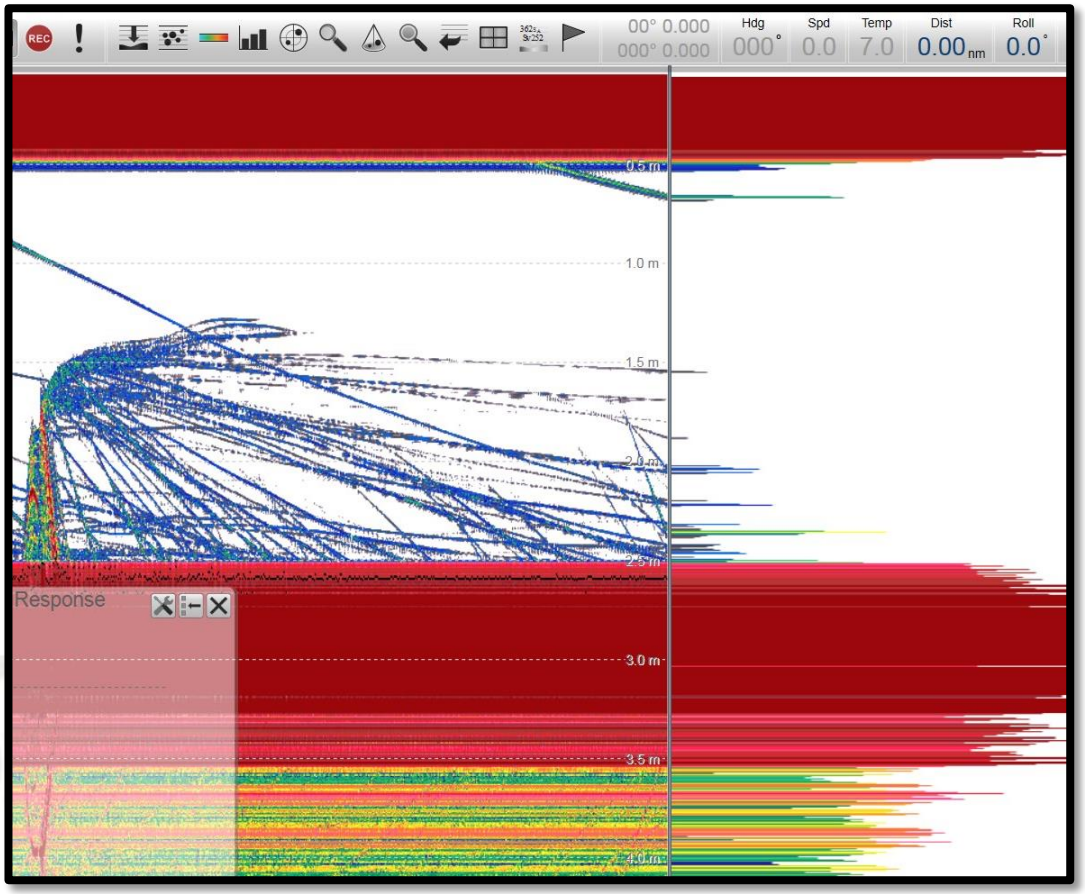
Volume density (n/V)



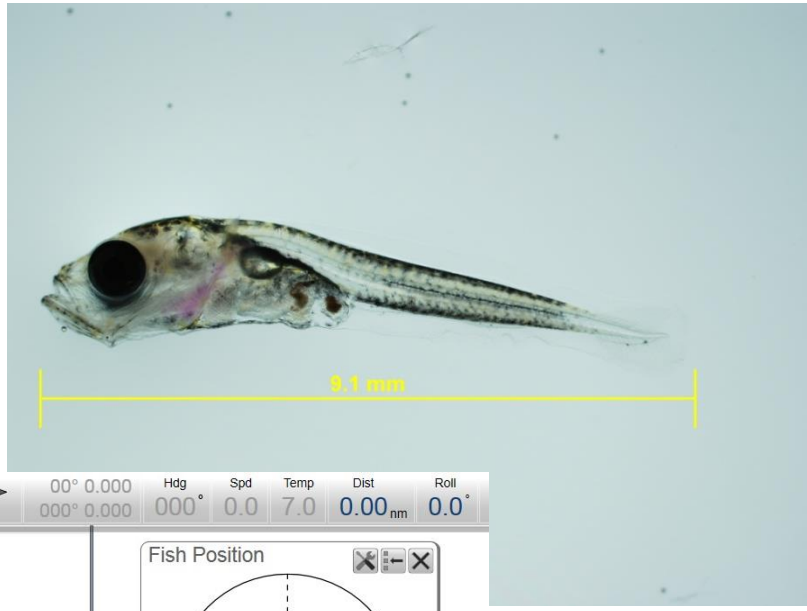
=128/(3*3*6)

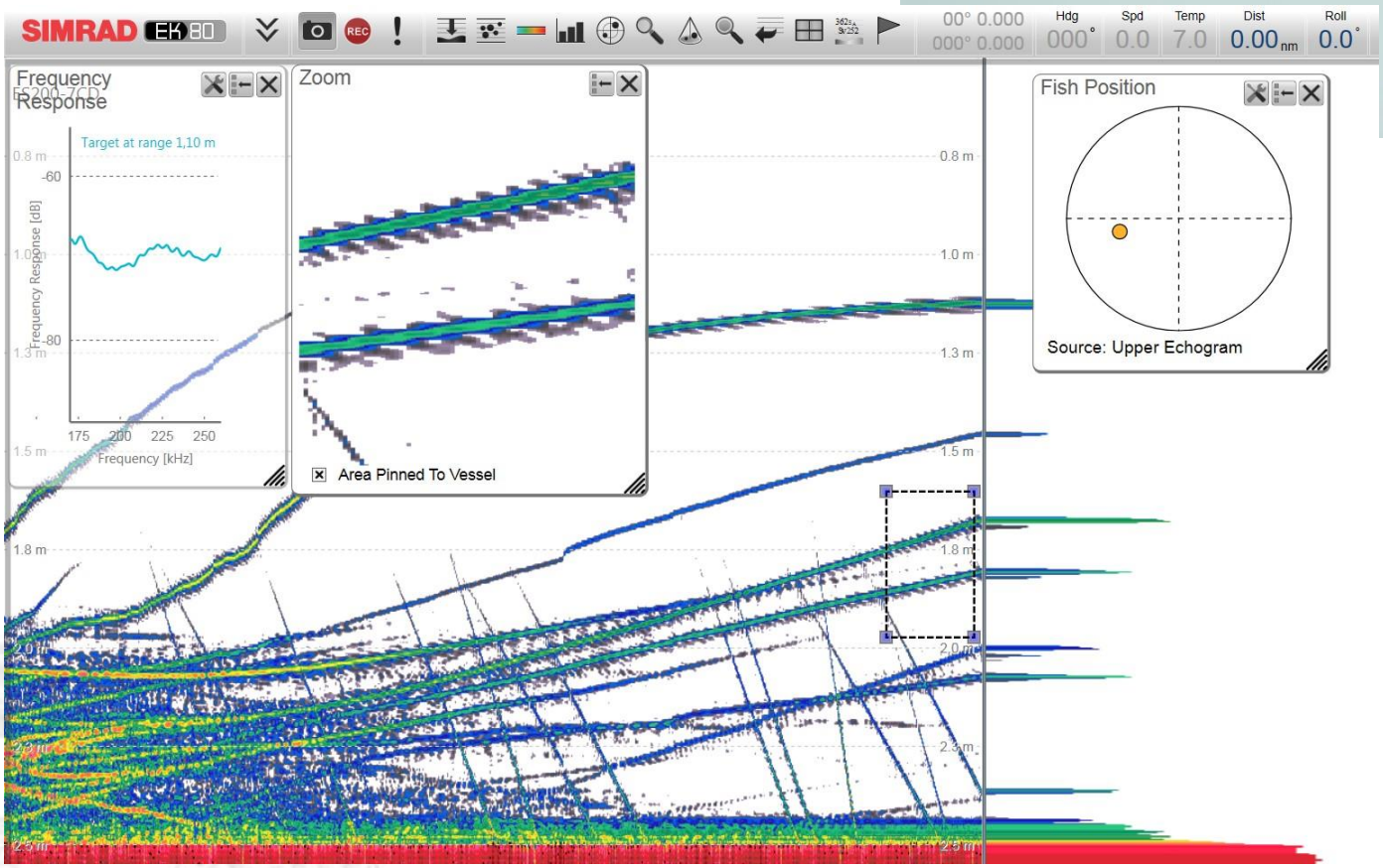
=2.37 mackerel/m^3

Smaller targets, cod eggs

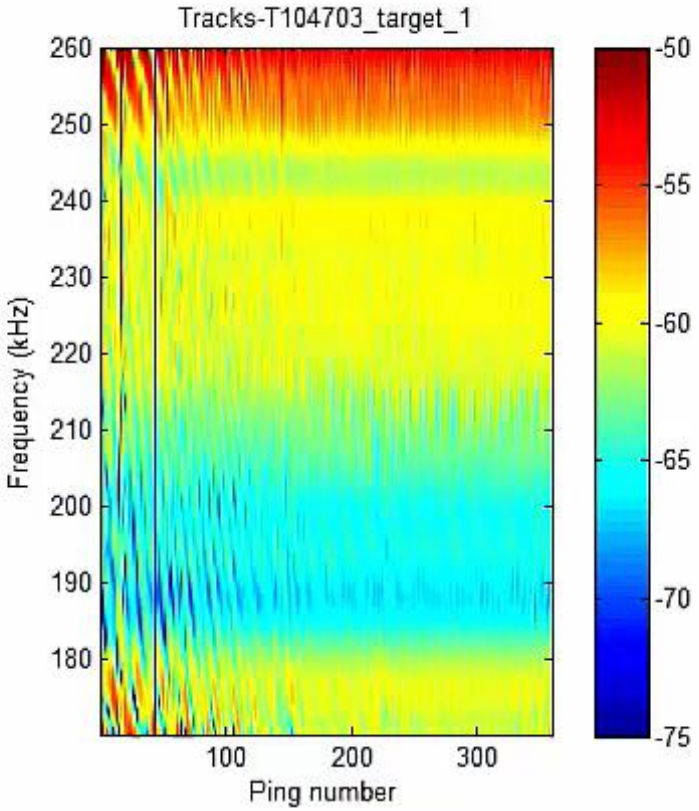


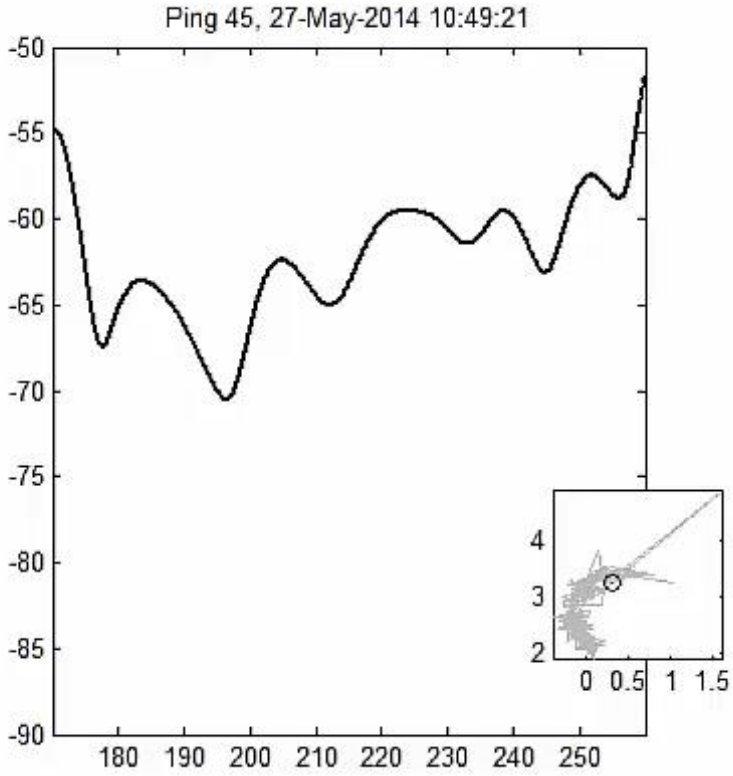
Larva 2


9.1 mm

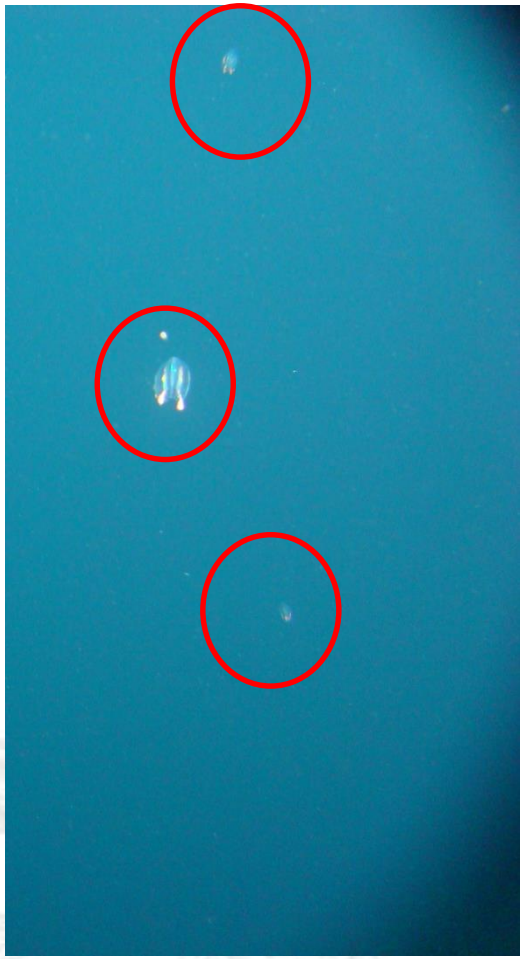

SIMRAD EK80
Hdg
Spd
Temp
Dist
Roll
Frequency Response
Target at range 1,10 m
Frequency Response [dB]
Frequency [kHz]
Zoom
Area Pinned To Vessel
Fish Position
Source: Upper Echogram

Spectral analysis and position(x,y,z,t)





Example, 5000 pictures
(under analysis)



Towards ”iPhone” acoustics ?

-History

1960’s:
Room
size

1980’s:
rack
mount

2000:
Windows

2015:
Stand
alone

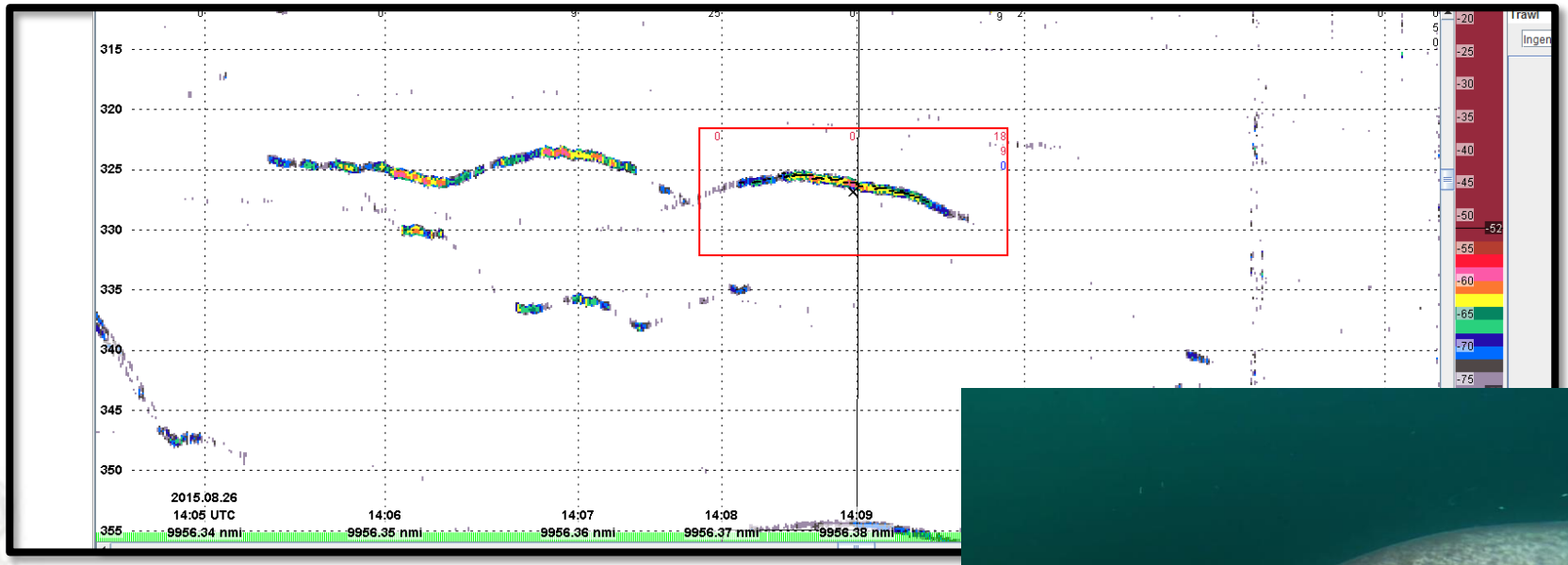
Future?

1970

2000

2030

THANK YOU !


315
320
325
330
335
340
345
350
355
2015.08.26
14:05 UTC
9956.34 nmi
14:06
9956.35 nmi
14:07
9956.36 nmi
14:08
9956.37 nmi
14:09
9956.38 nmi
-20
-25
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-45
-50
-52
-55
-60
-65
-70
-75