

# Target strength of chub mackerel (*Scomber japonicus*) in Moroccan waters measured *in situ*

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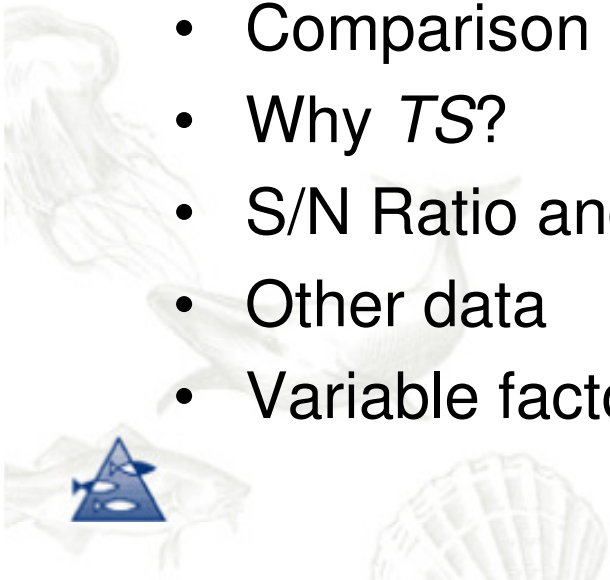
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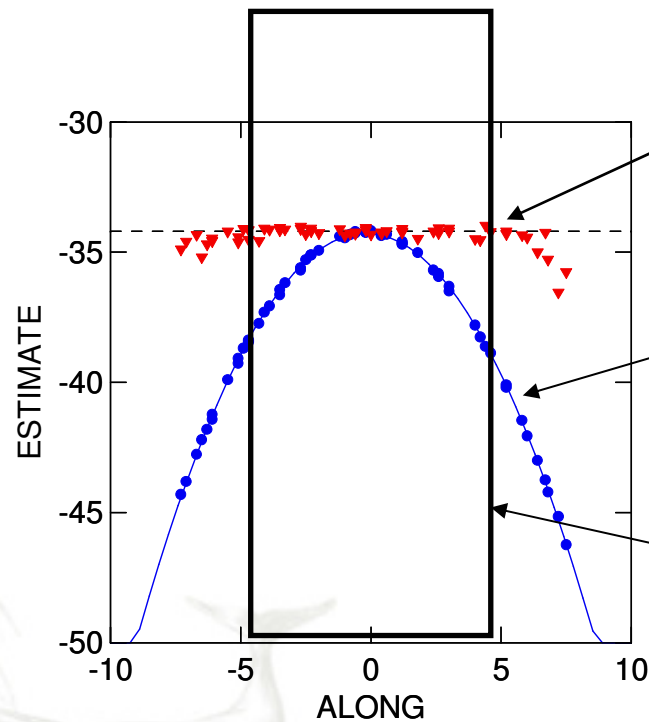


# Content of the talk

- Calibration
- Measurement area
- Example of echogram
- *TS* distribution
- Swimming angle
- Main results
- Comparison of *TS*-To-Length relations
- Why *TS*?
- S/N Ratio and Density
- Other data
- Variable factors that influence the *TS*



# Calibration results, CU 60 sphere

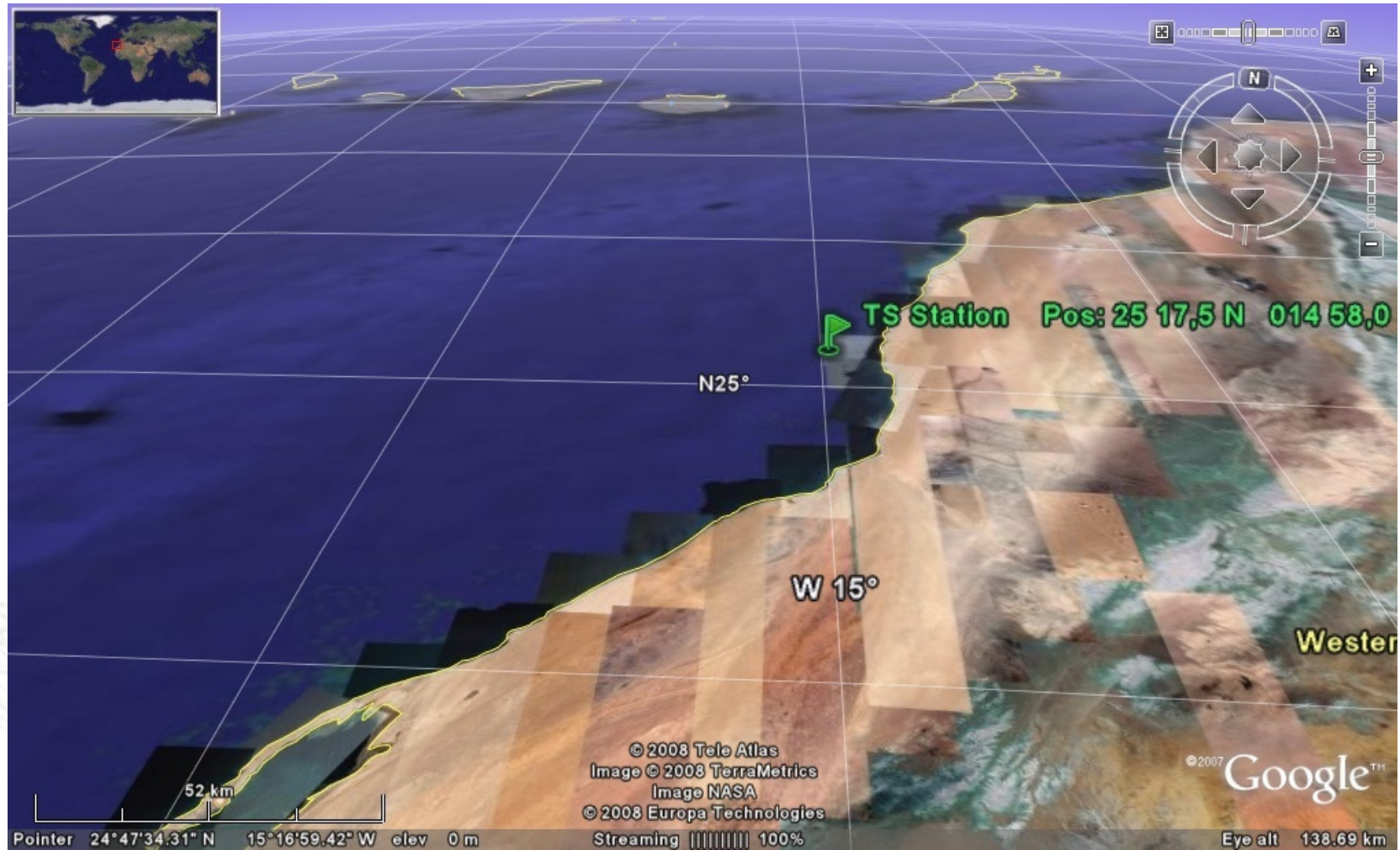


Compensated TS = -33.6 dB

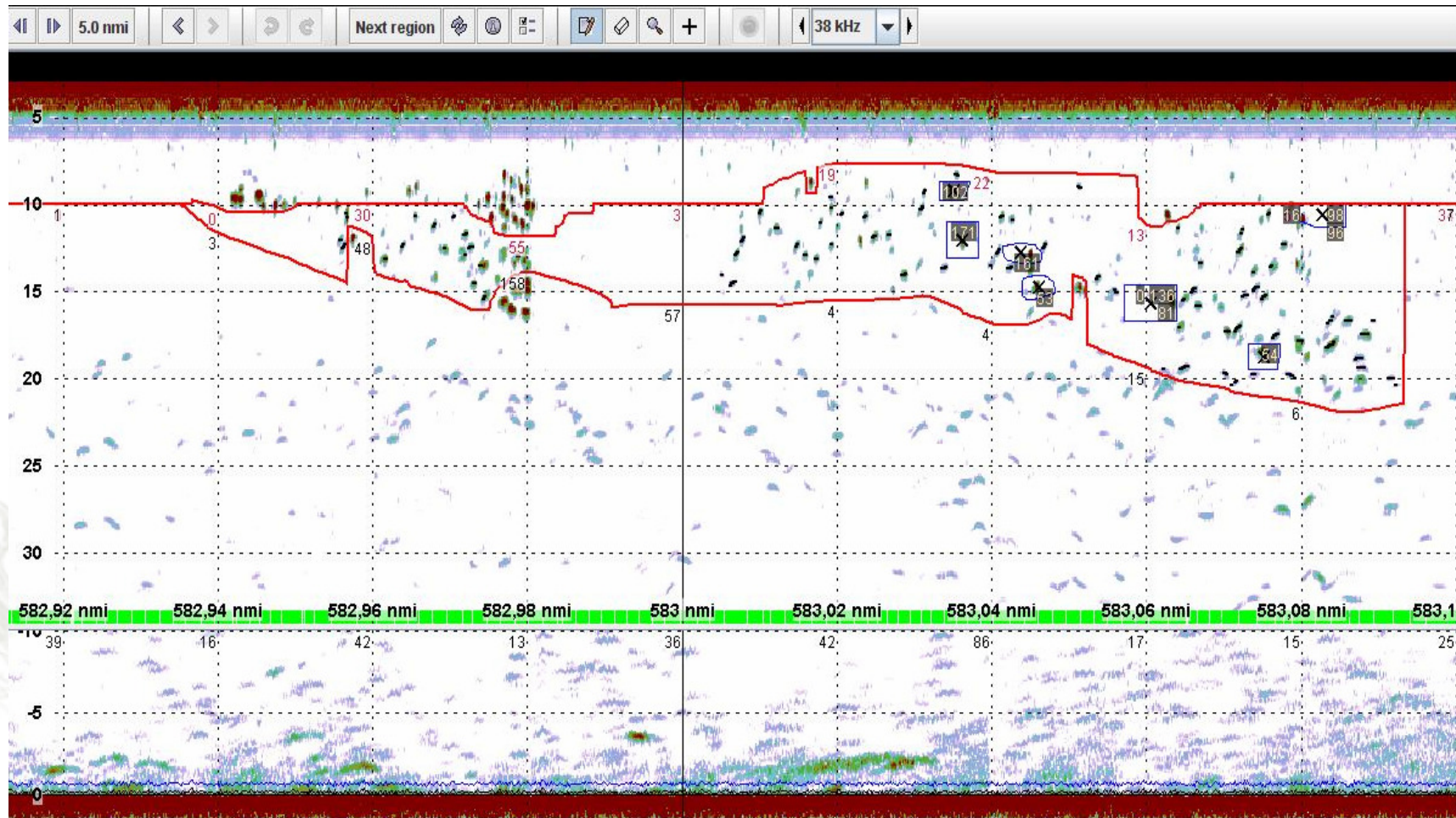
Measured beam pattern

Part of acoustic beam used for fish target strength analysis ( $\theta < 5$  deg.)

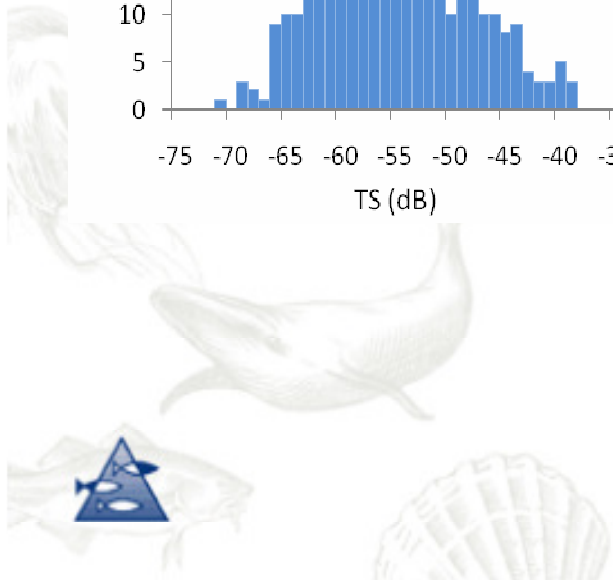
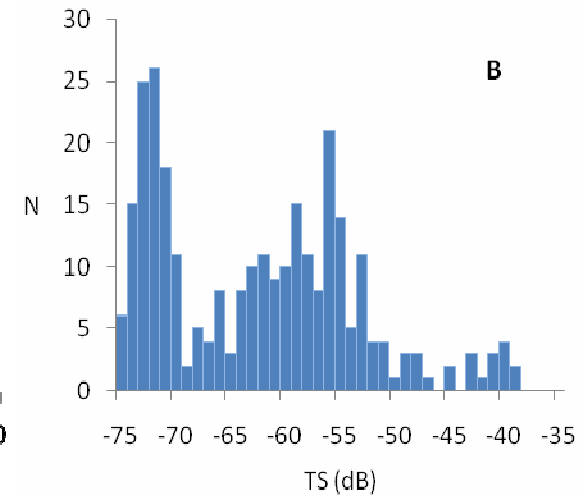
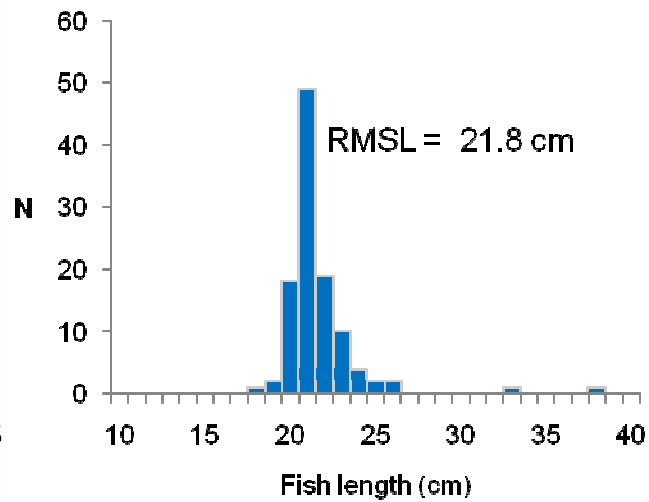
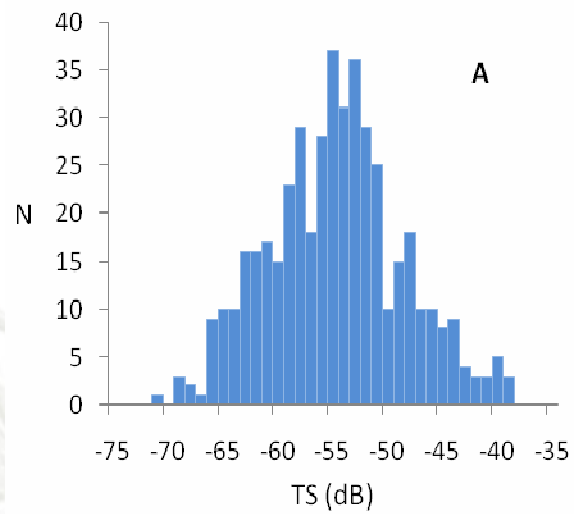
# Target strength station



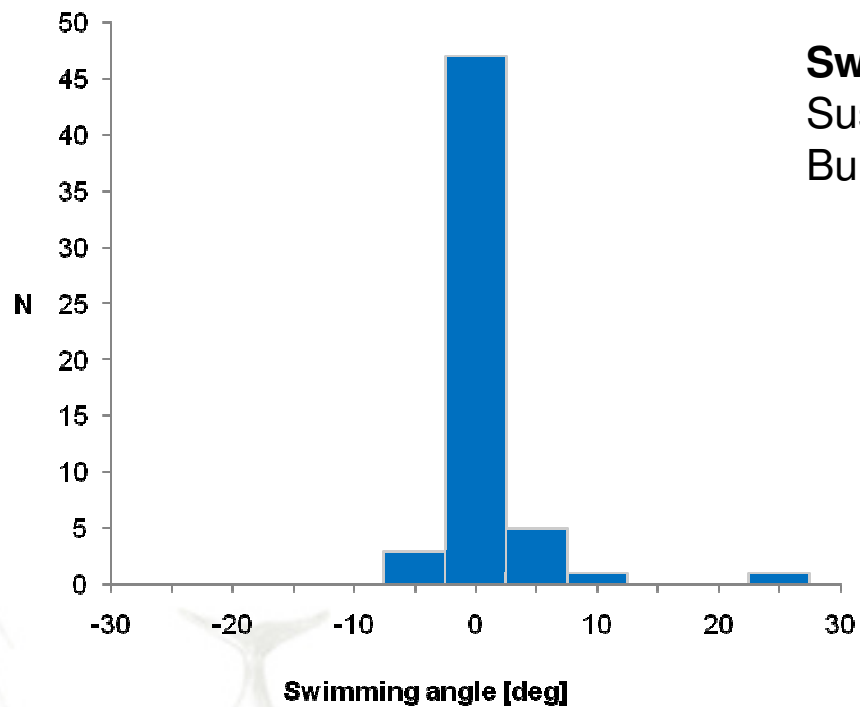
# Example from echogram



# TS distribution and fish length



# Swimming angle from tracking



## Swimming speed of chub mackerel:

Sustained mode: 0.9 m/s or 2.7 bl

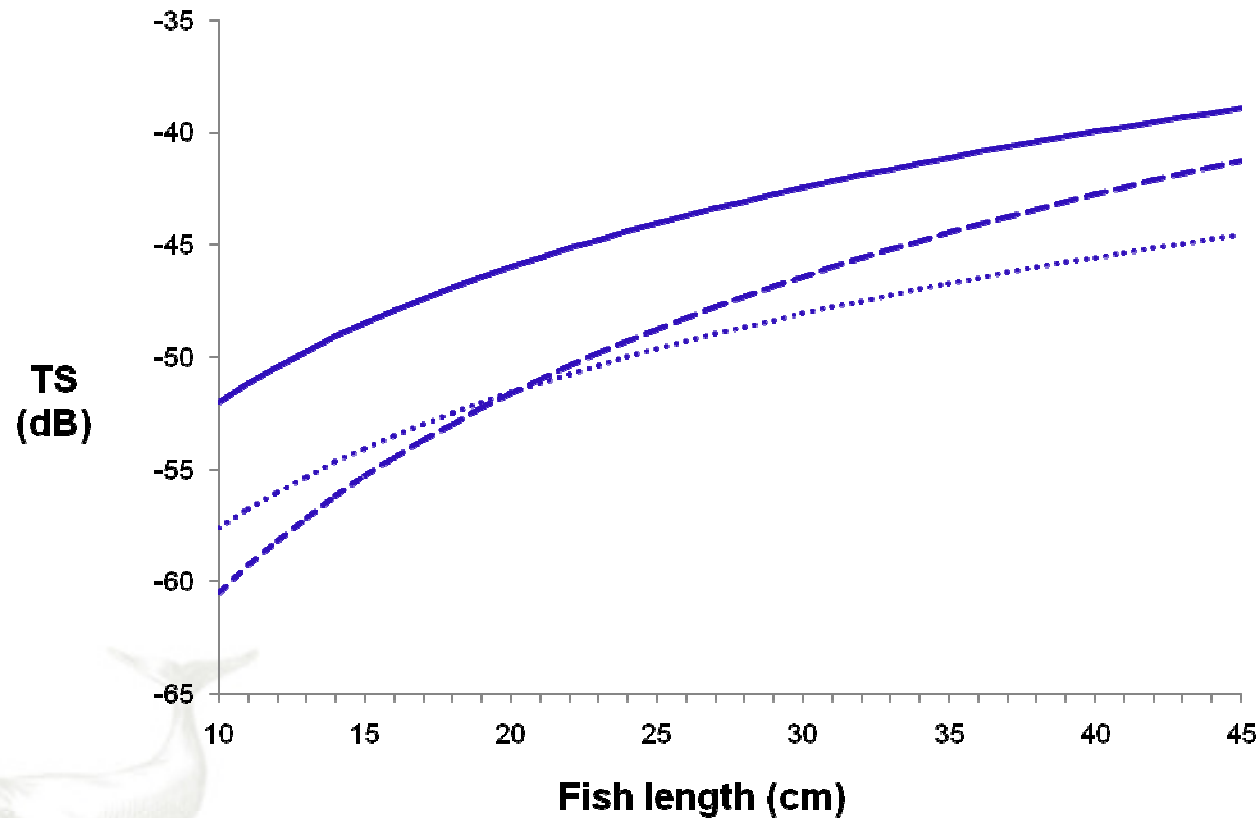
Burst mode: 2.5 m/s or 8.3 bl

# Main results

Date	Hour	Depth (m)	Freq (kHz)	N	Mean L (cm)	SD(L)	Catch (kg)	%	Mean TS (dB)	b <sub>20</sub>
30.11.07	15-16	10-30	38	465	21.8	1.4	27.9	99.6	-50.9	-77.6
30.11.07	15-16	10-30	120	287	21.8	1.4	27.9	99.6	-53.1	-79.8



# Comparison of *TS*-to-Length Relations



--- 29.5 log L - 90

..... 20 log L - 77.6

— 20 log L - 72

# Why *TS*?

- To obtain absolute density estimates from echo integration

Area density of fish [ #/nmi<sup>2</sup>]

$$\rho_A = \frac{s_A}{\langle \sigma \rangle}$$

Area backscattering coefficient [m<sup>2</sup>/nmi<sup>2</sup>]

Mean acoustic cross section of the targets [m<sup>2</sup>]

An unbiased measure of  $\langle \sigma \rangle$  is needed



# S/N Ratio and Density

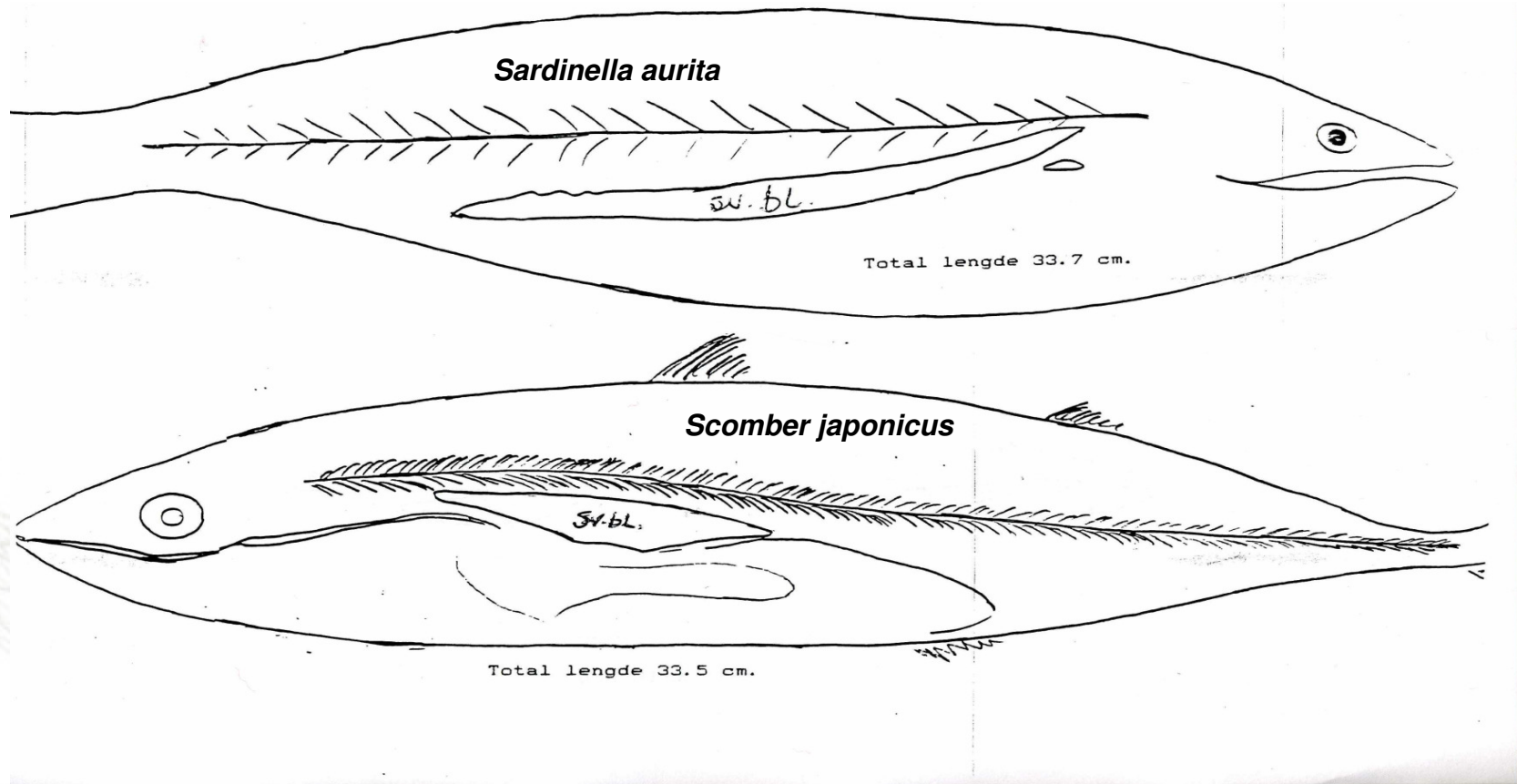
- S/N Ratio 38 kHz: 41.1 dB
- S/N Ratio 120 kHz: 24.9 dB

$$N = \frac{s_A (c\tau/2) r^2 \Omega_D}{4\pi 10^{TS/10} \Delta z (1852)^2} \quad (2)$$

## *Probability of multiple targets*

- Less than 5% in selected area
- About 25% in the more dense area

# Fish and swimbladder



# Swimbladder vs Fish length

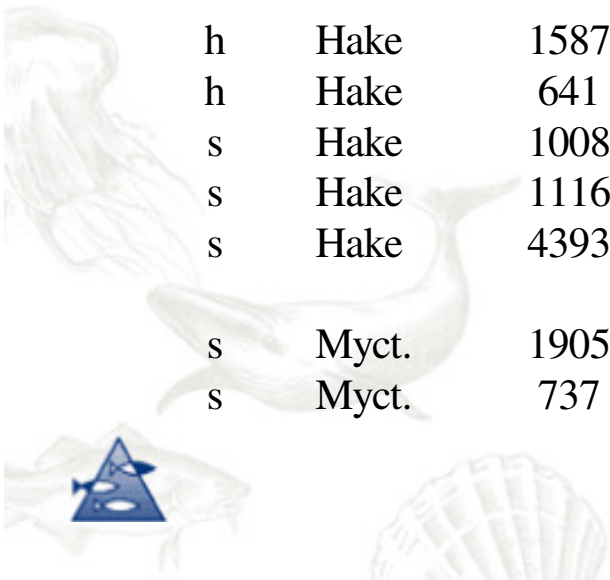
Species	Lsb/Lf	sb in % of fish vol
<i>Sardina pilchardus</i>	0.31	1.42
<i>Sardinella aurita</i>	0.32	1.8
<i>Trachurus sp.</i>	0.25	1.84
<i>Scomber japonicus</i>	0.19	1.96

$$TS = 20\log(0.23)^{-1} * Lsb - b$$

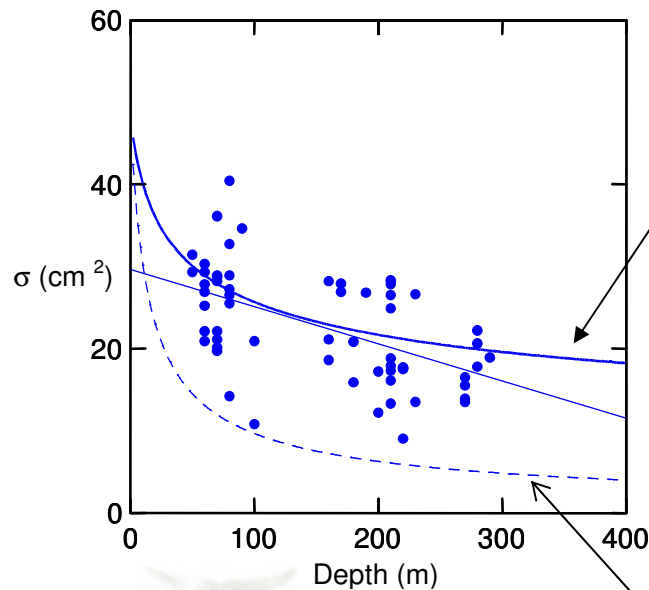
<i>Sardina pilchardus</i>	20logL - 69.9
<i>Sardinella aurita</i>	20logL - 69.9
<i>Trachurus sp.</i>	20logL - 71.8
<i>Scomber japonicus</i>	20logL - 73.8

# A summary of *TS* observations

Transd	Species	N	Mean L (cm)	SD(L)	Catch (kg)	%	Mean TS	b <sub>20</sub>
h	Pilchard	2003	20.9	1.4	480	97	-41.1	-67.2
h	Pilchard	1401	20.2	2.2	1500	99	-40.0	-66.4
h	Pilchard	1648	17.0	1.2	528	100	-40.9	-65.6
h	Pilchard	2100	17.4	0.8	682	99	-41.6	-66.4
h	Horse	576	17.2	1.5	507	99	-42.1	-66.8
h	Horse	4483	15.8	0.8	624	96	-41.4	-65.2
h	Hake	1587	30.1	5.1	168	100	-36.8	-66.5
h	Hake	641	20.9	2.4	91	58	-42.1	-68.5
s	Hake	1008	16.5	4.5	39	99	-45.9	-70.0
s	Hake	1116	50.0	5.4	541	82	-33.7	-67.7
s	Hake	4393	42.1	4.0	1122	66	-35.3	-67.8
s	Myct.	1905	6.21	0.7	9	88	-54.3	-70.2
s	Myct.	737	7.33	0.7	1186	41	-55.8	-73.1



# Measured depth (pressure) dependency herring (32 cm) backscattering cross section, (2000 TS data in each point)



Fitted curve:

$$\sigma_z = \sigma_0(1+z/10)^\gamma$$

$$TS = 20 \log L - 2.3 \log(1+z/10) - 65.4$$

Expected curve if swimbladder  
attained "bubble" compression

# On the End

- The idea of a 'standard', fixed target strength relation with a precision level of  $0.1 \text{ dB}$  for each species has no biological foundation and should be used as a reference or guideline. (*Ona 1990*)

*Thank you for your attention!*

