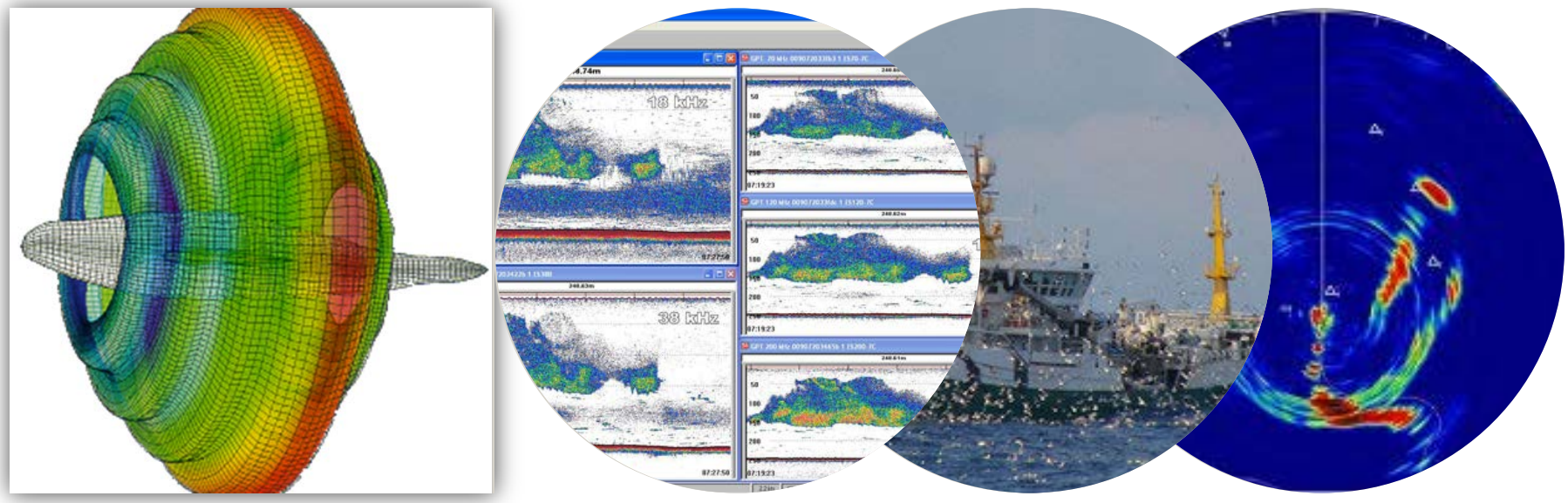
Modelling acoustic reflectivity of fish

Sascha Fässler



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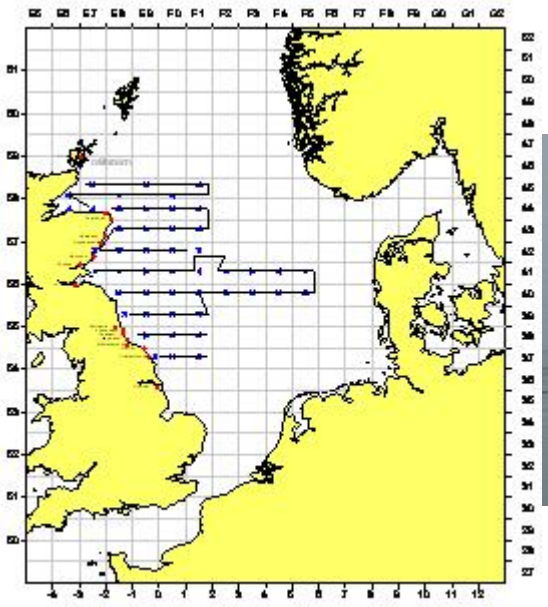
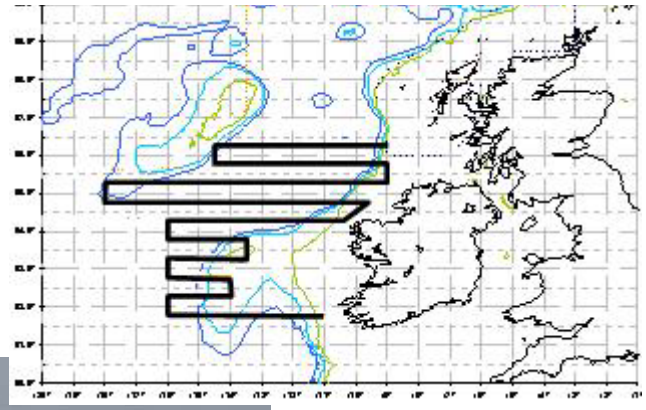
Introduction

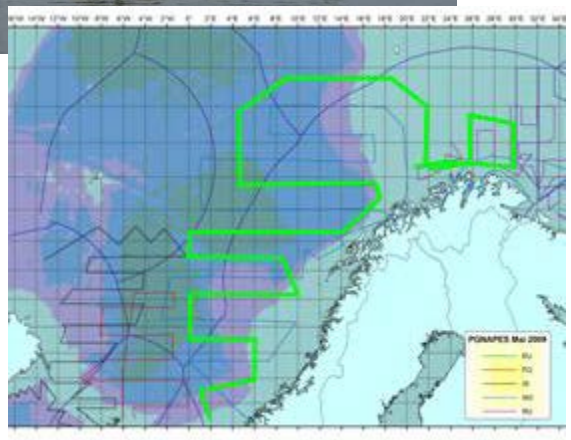
Annual IMARES acoustic surveys



North Sea herring



Blue whiting



Atlanto-Scandian herring

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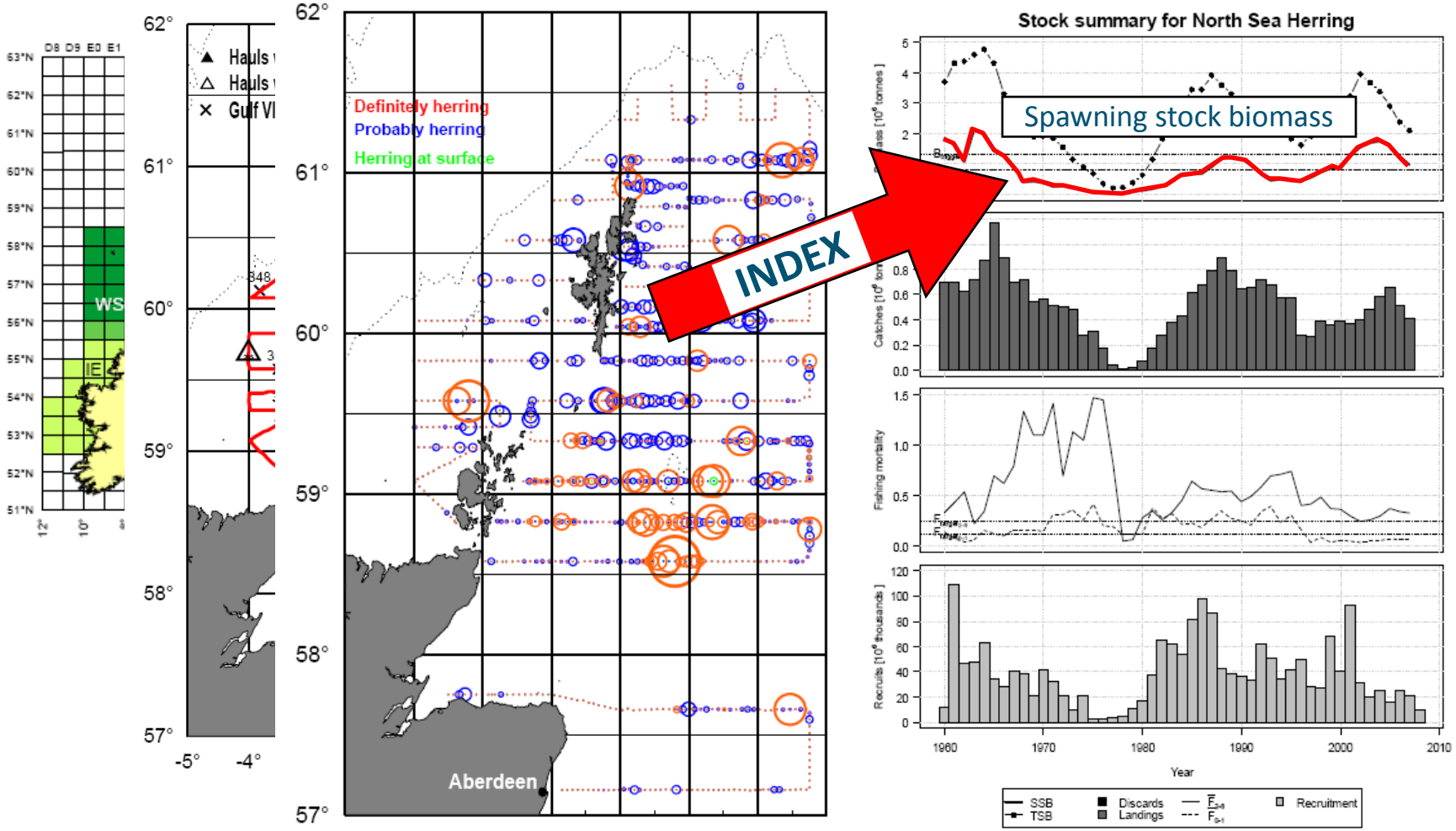
Introduction

North Sea herring abundance estimation



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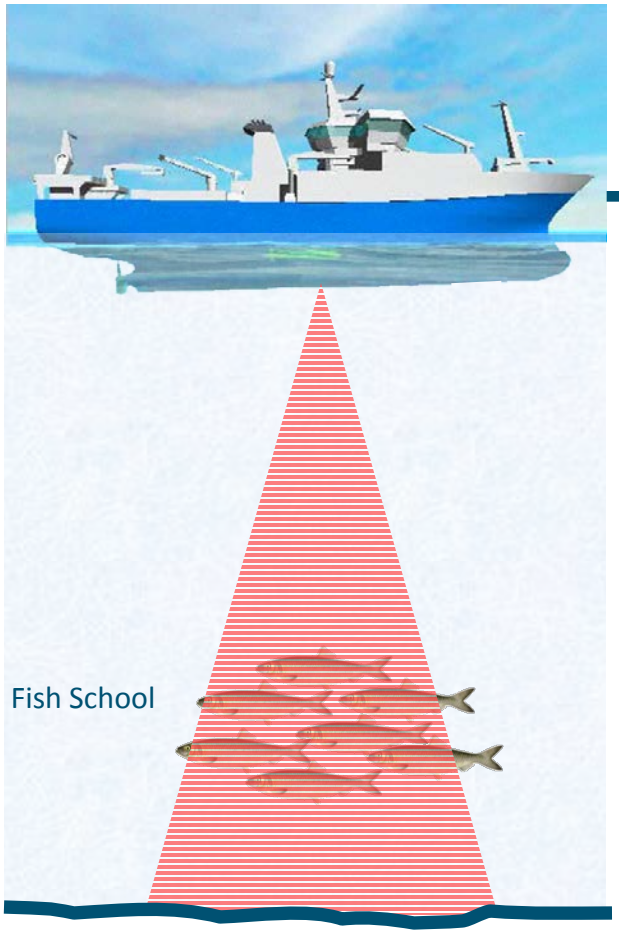
Introduction

acoustic surveys



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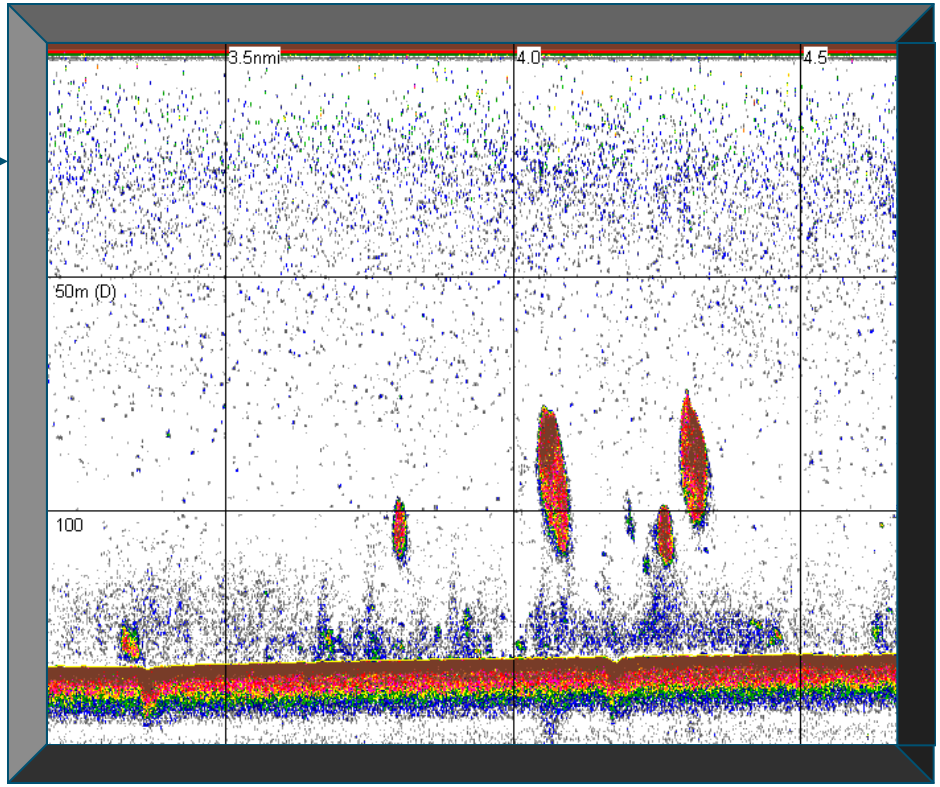

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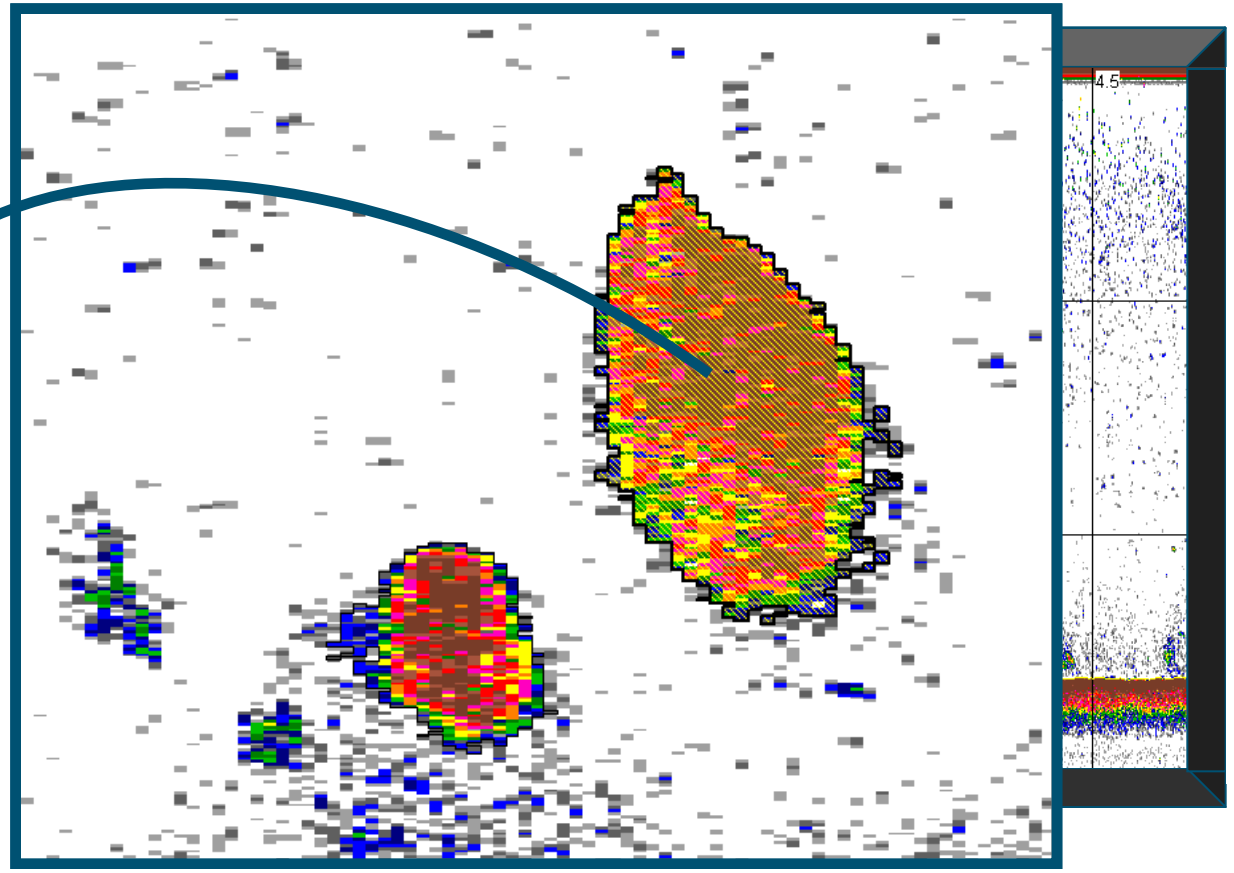
Introduction

acoustic surveys

ρ = fish density

s_A = integrated echo intensity

$$\rho = \frac{s_A}{\langle \sigma_{bs} \rangle}$$

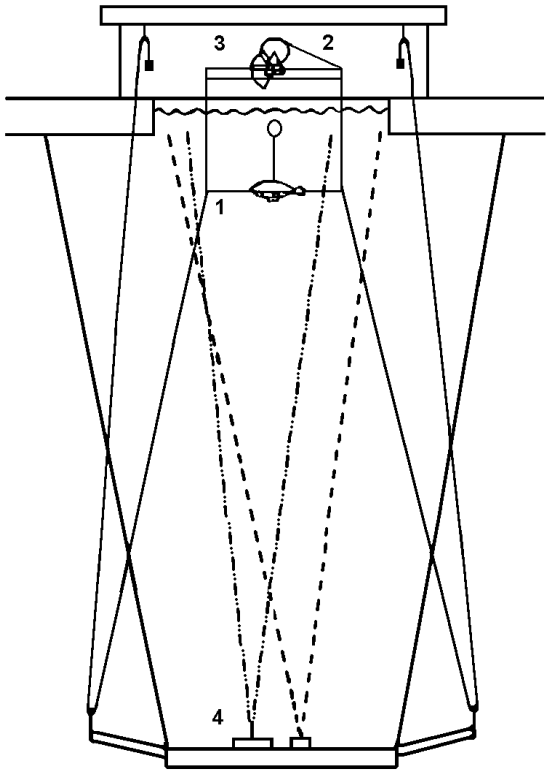


$\langle \sigma_{bs} \rangle \triangleq$ mean acoustic backscatter of one fish

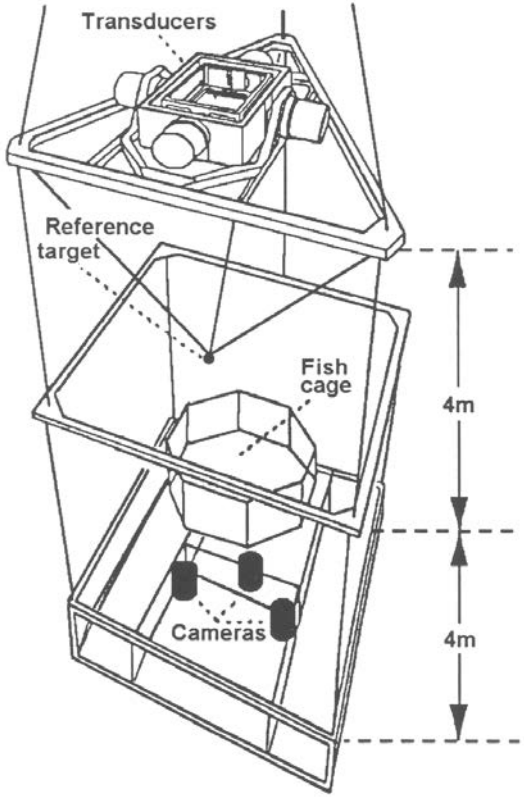
TARGET STRENGTH

Fish Target Strength

herring Target Strength (early measurements)



Nakken and Olsen (1977)



Edwards and Armstrong (1984)

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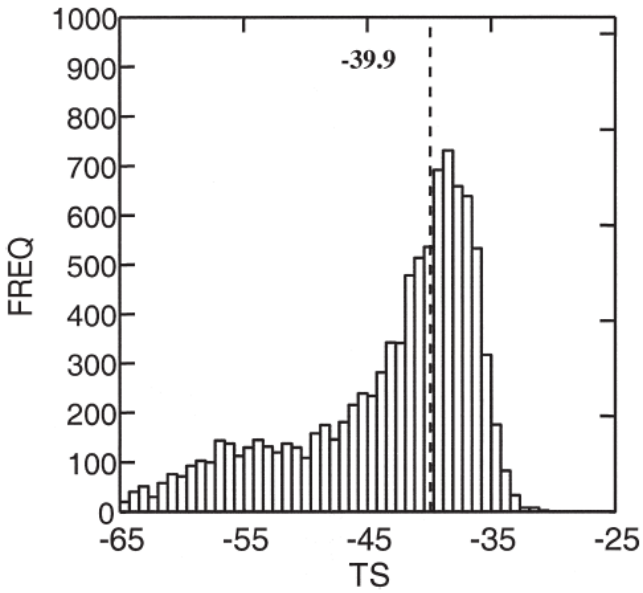
Fish Target Strength

Target Strength (TS)

- TS is very variable! dependent on:

- sounder frequency
- fish size
- fish orientation
- depth
- fat content
- maturity
- stomach content

… swimbladder size!



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Fish Target Strength

Target Strength

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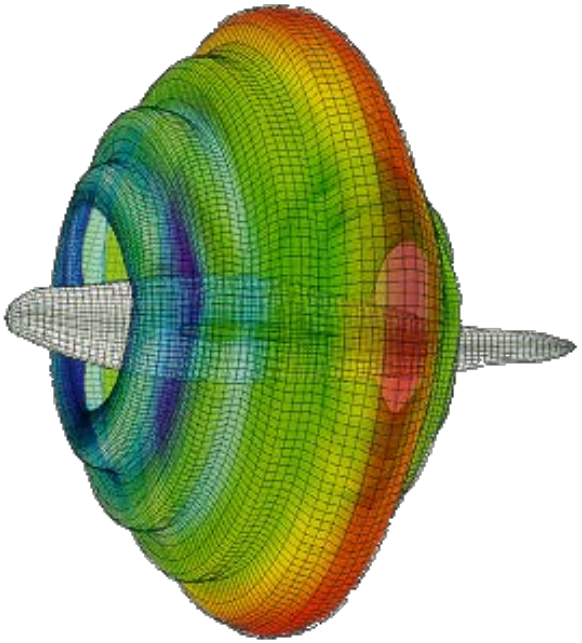
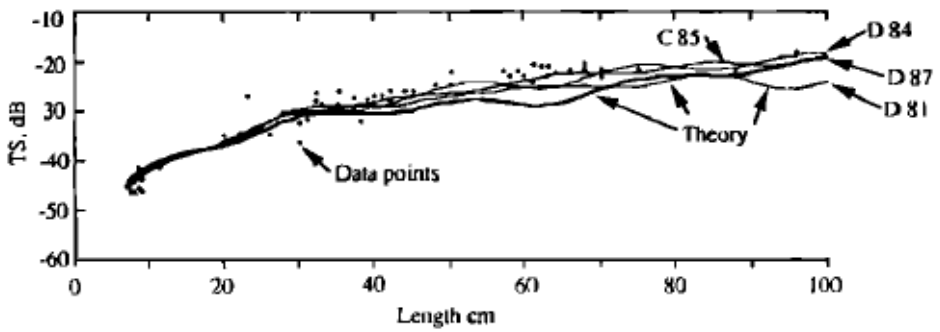
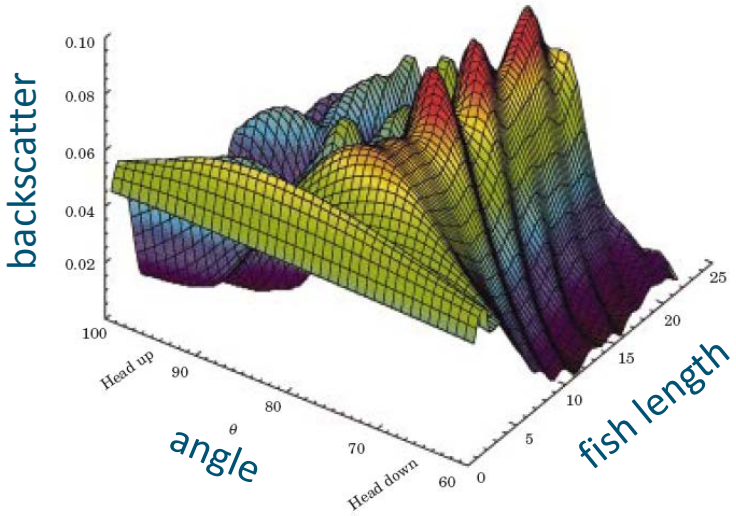


- Models to approximate TS





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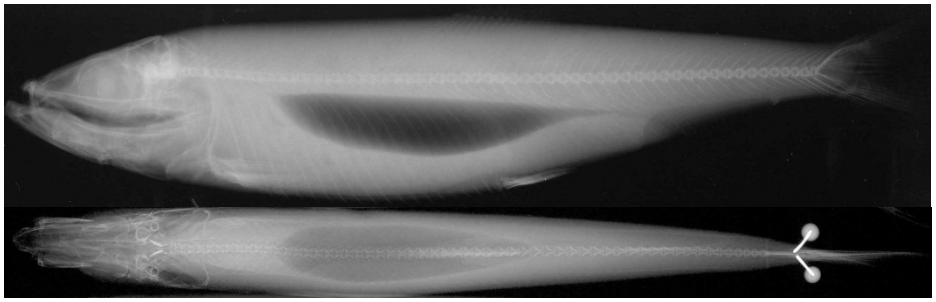
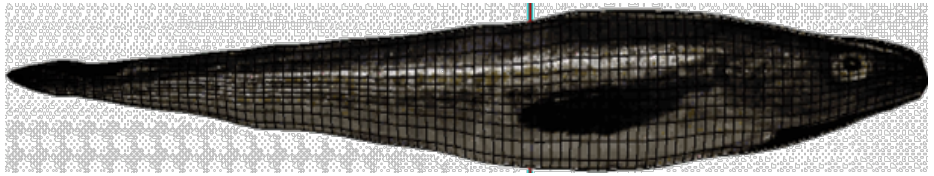
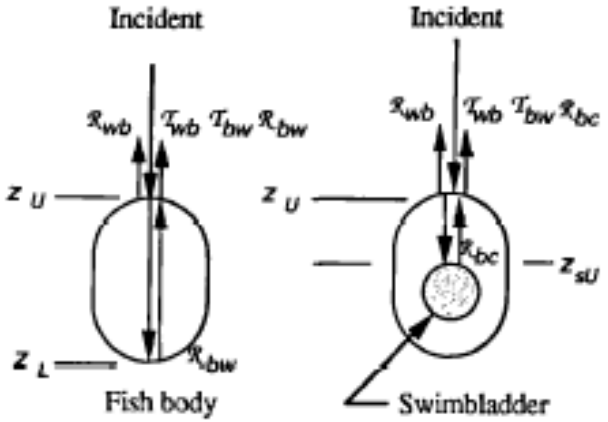
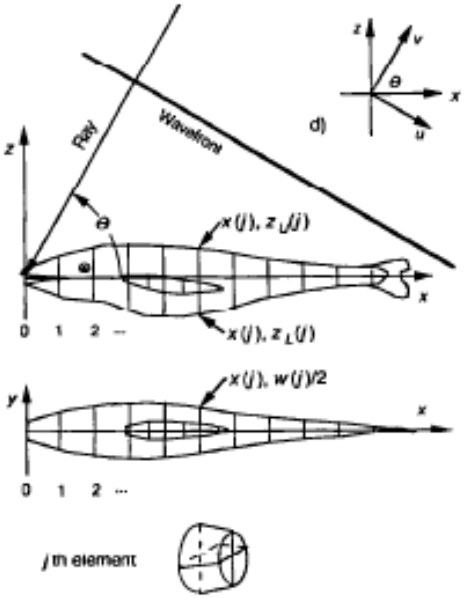
Backscatter modelling

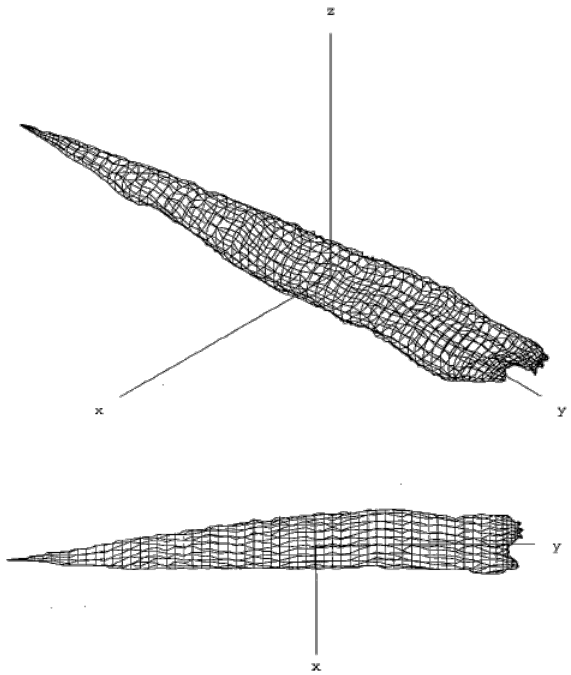
TS model: high resolution representation of shapes











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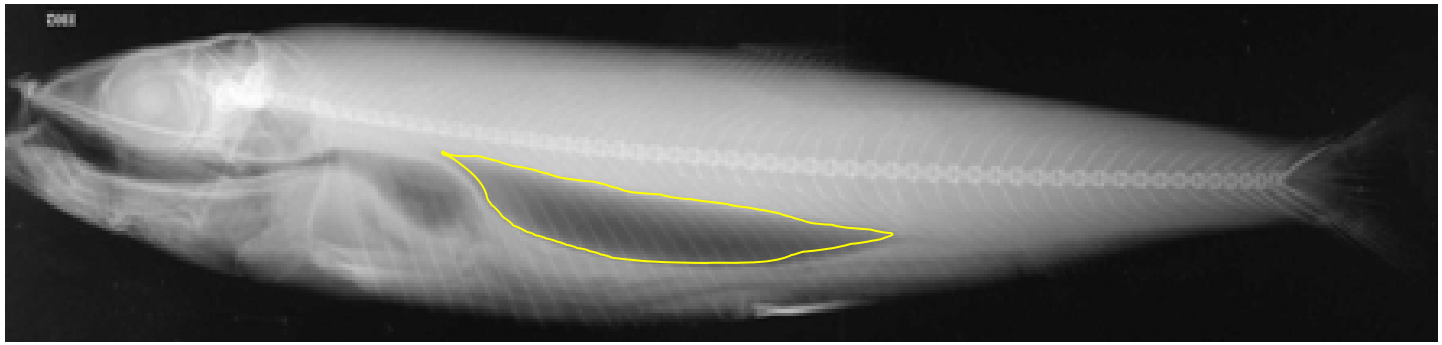
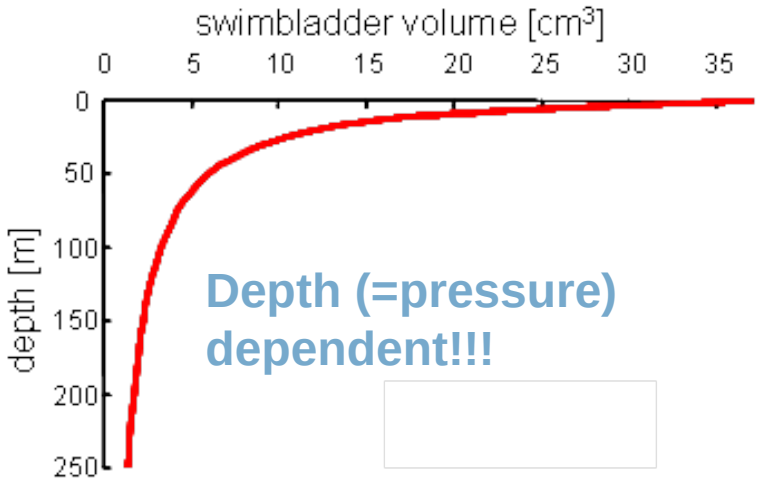
Backscatter modelling

importance of swimbladder

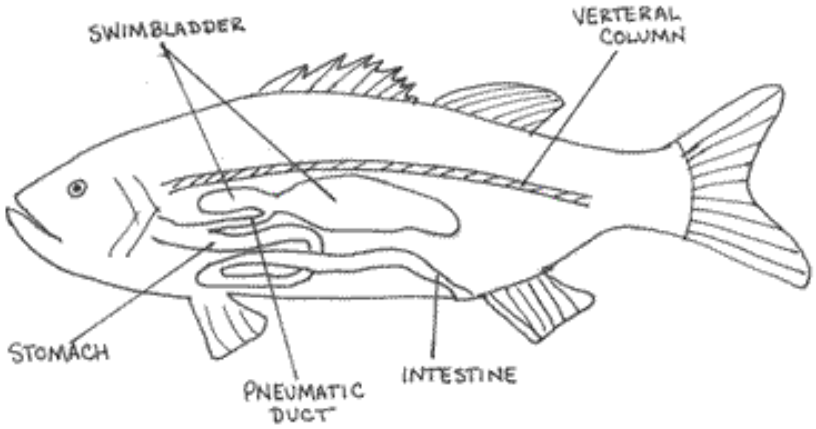
"the swimbladder contribution to backscatter is approximately 90% to 95%" Foote (1980)





Depth (=pressure) dependent!!!

physostome swimbladder



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Backscatter modelling

Journal of Fish Biology (2009) **74,** 296–303
doi:10.1111/j.1095-8649.2008.02130.x, available online at http://www.blackwell-synergy.com

Depth-dependent swimbladder compression in herring *Clupea harengus* observed using magnetic resonance imaging

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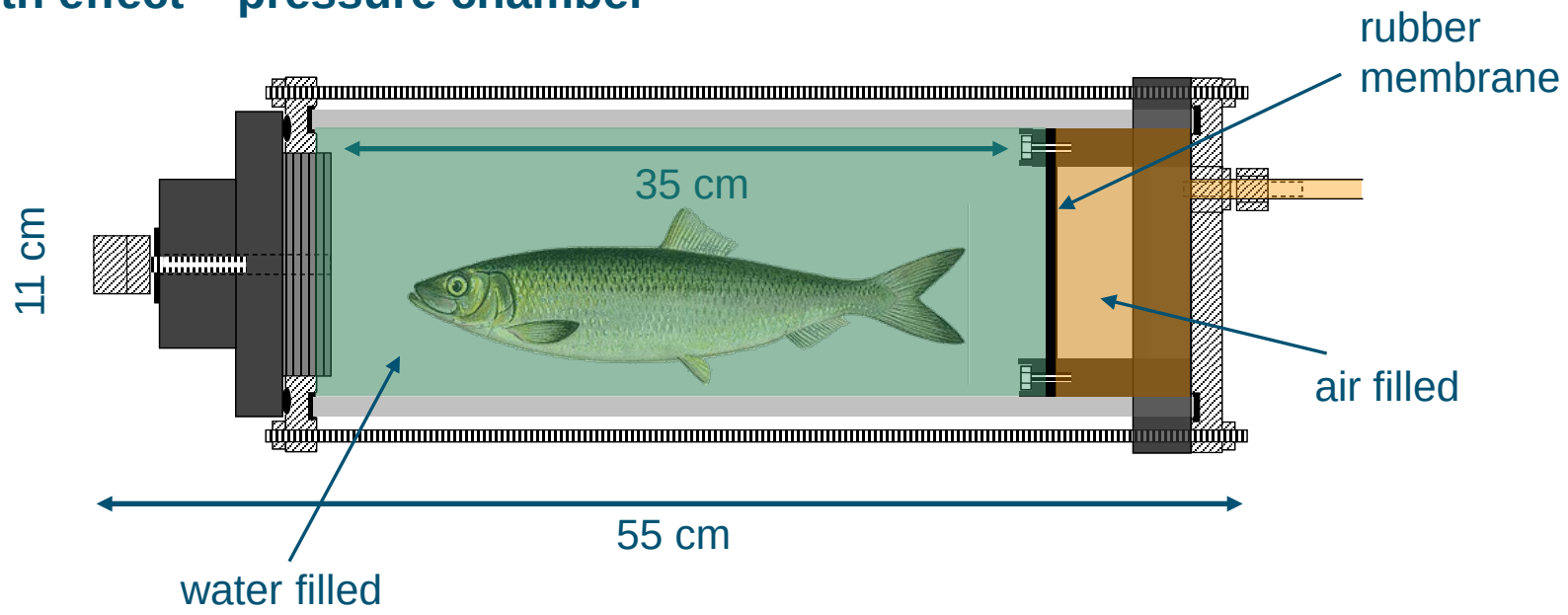
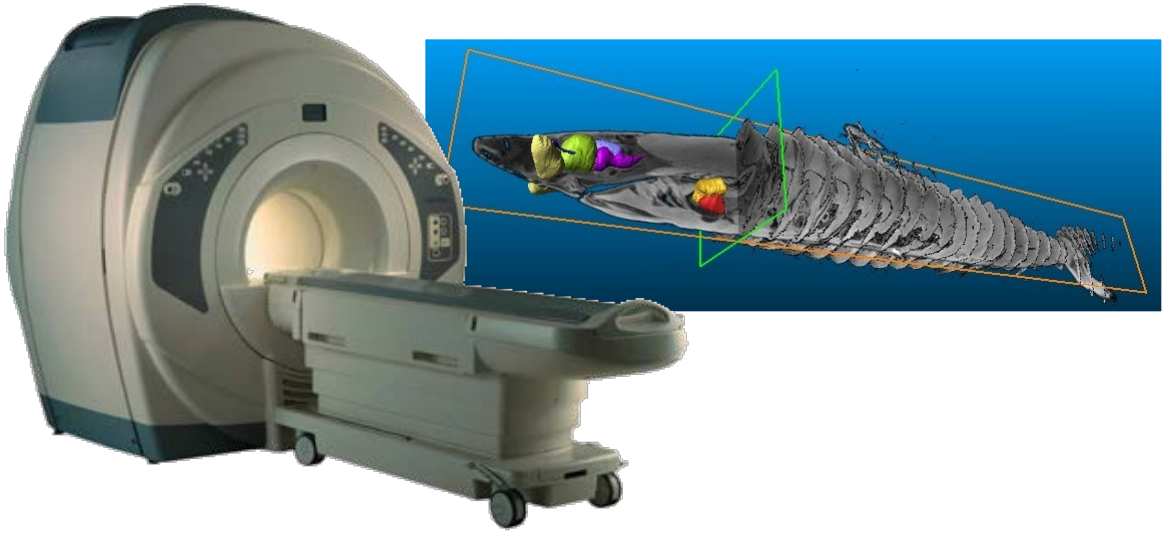
(*Received 30 January 2008, Accepted 13 October 2008*)

Backscatter modelling

Depth effect – pressure chamber

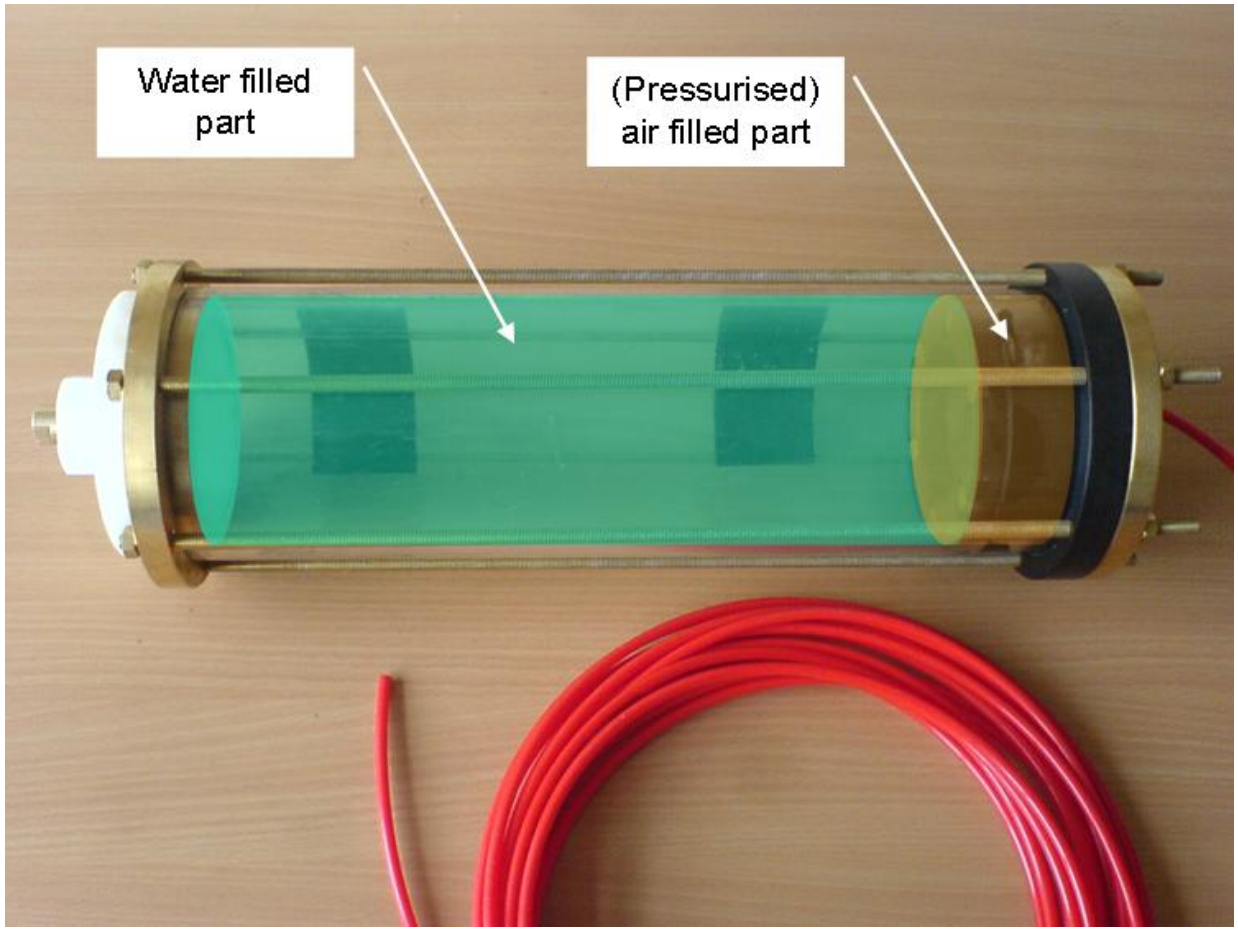


+ MRI scanner!



Backscatter modelling

Pressure chamber



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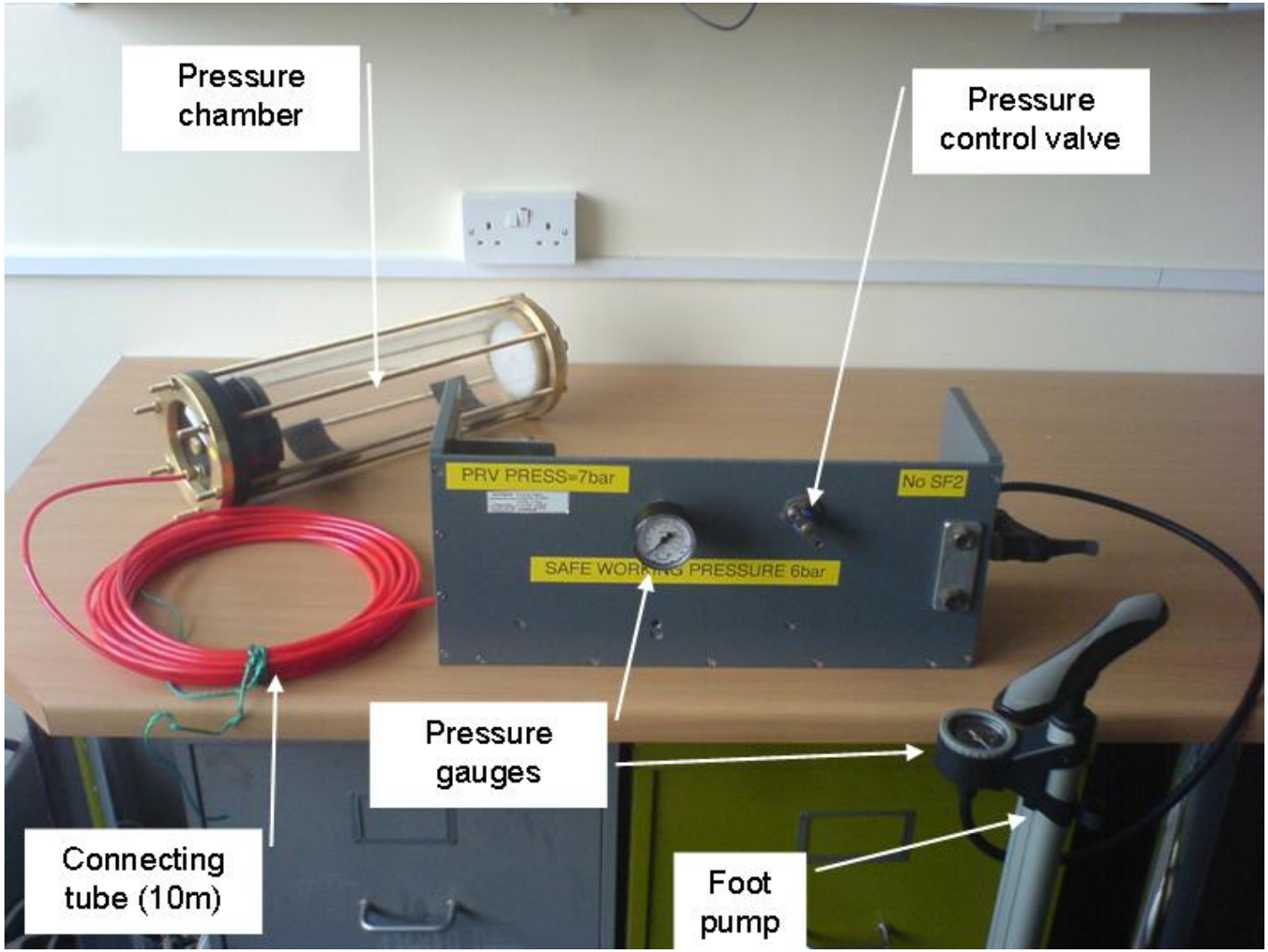

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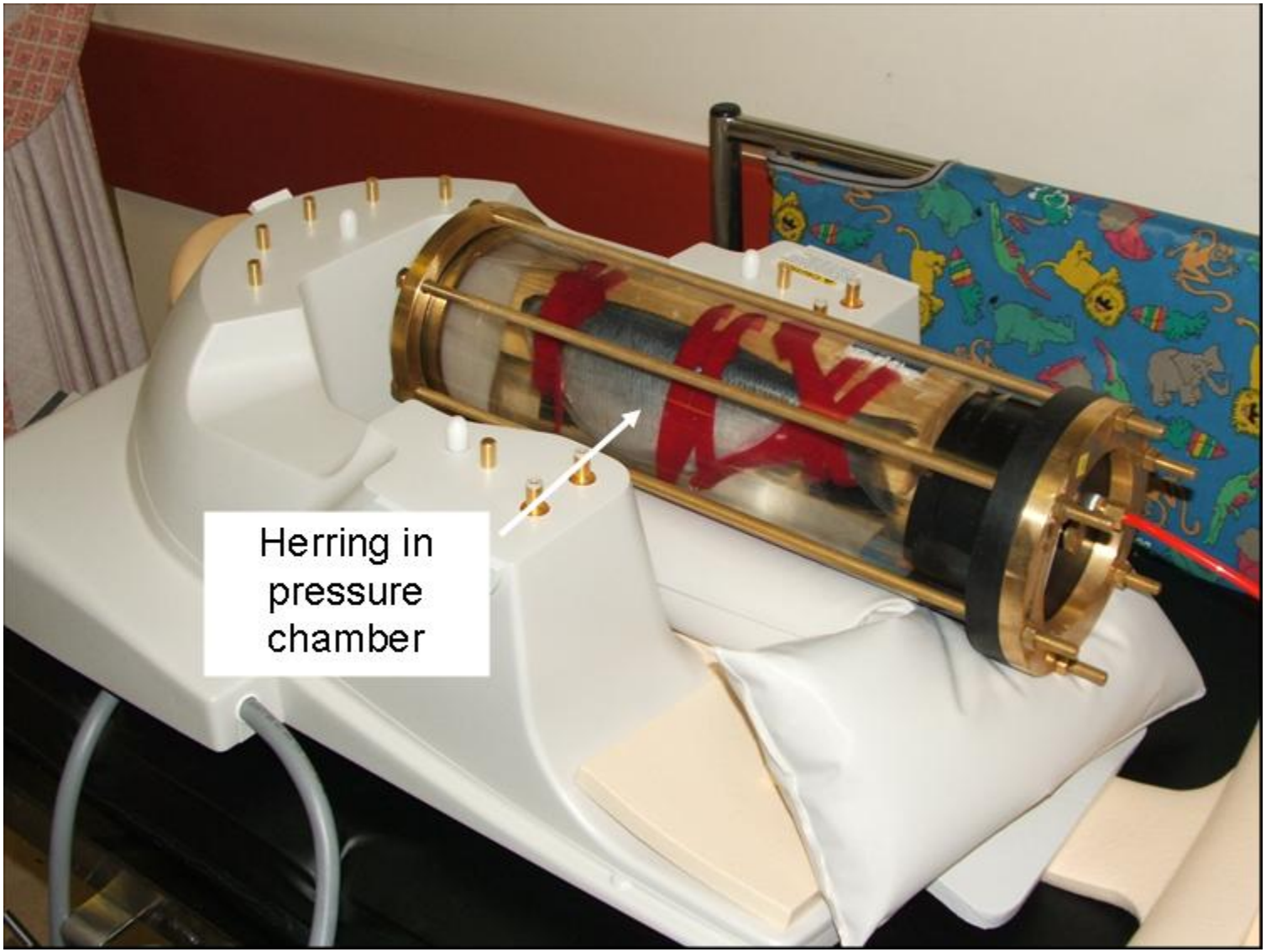

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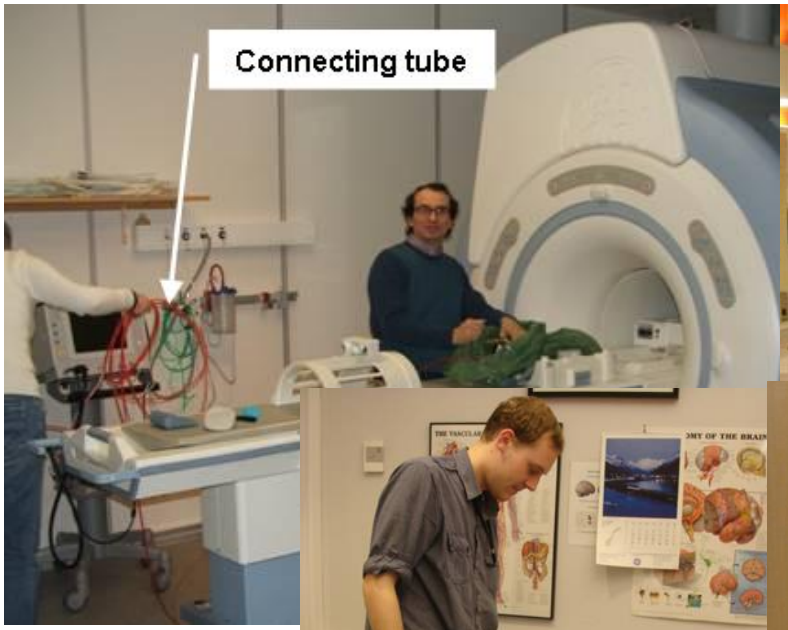

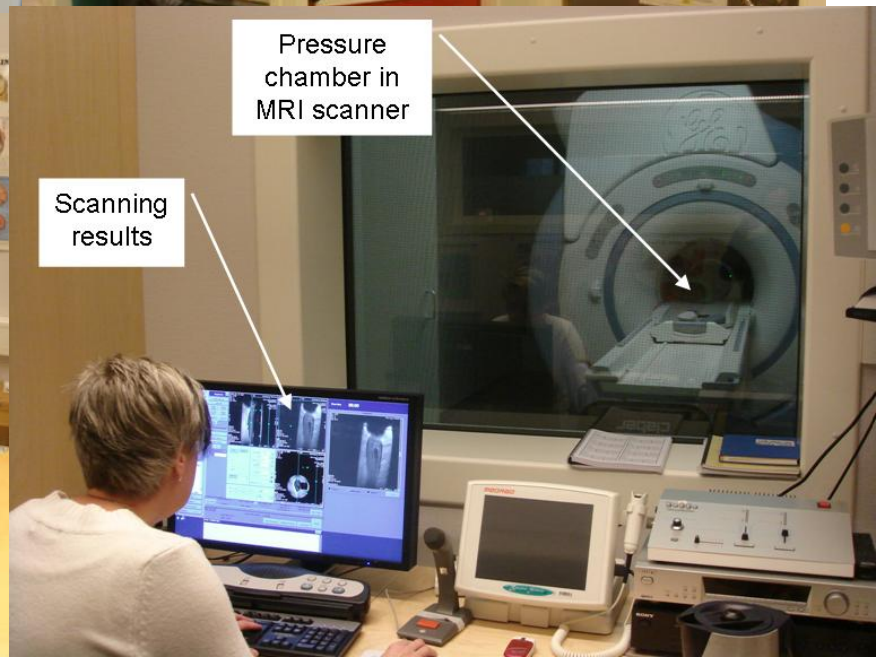

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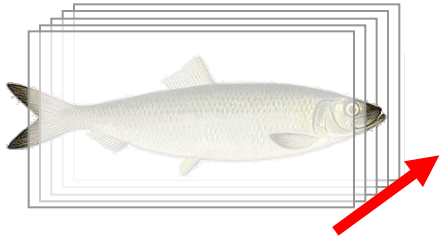
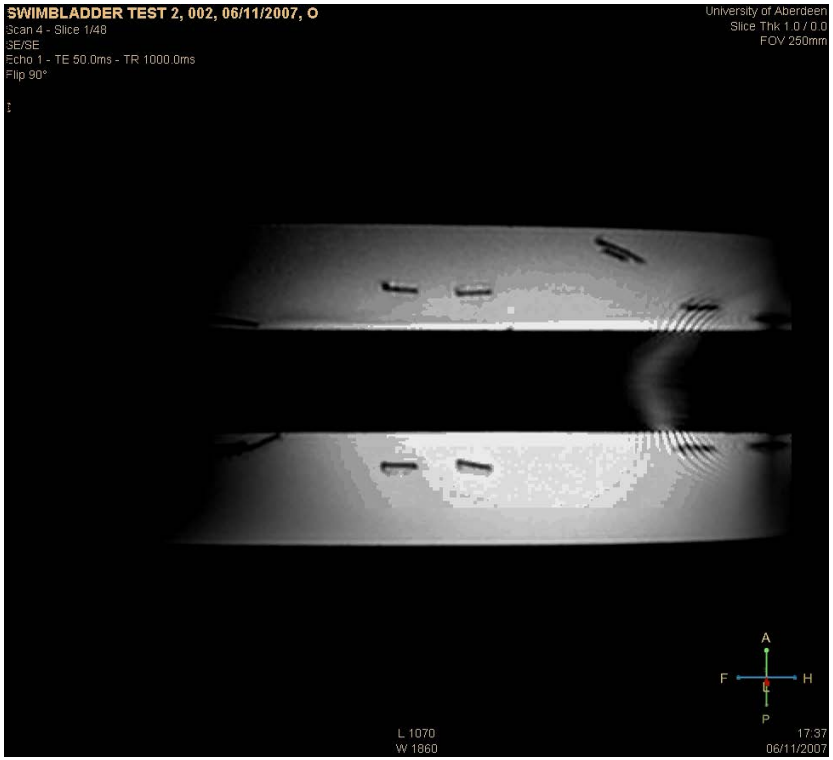
Results





1 bar (= sea surface)

7 bar (= 60m depth)

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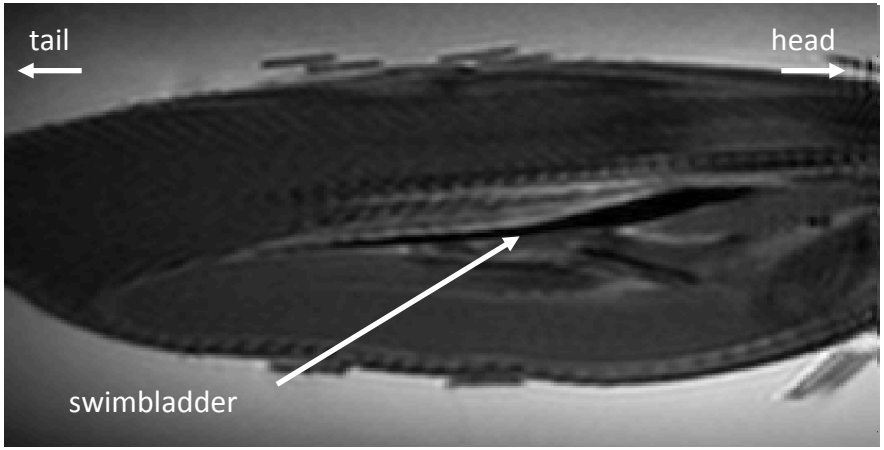
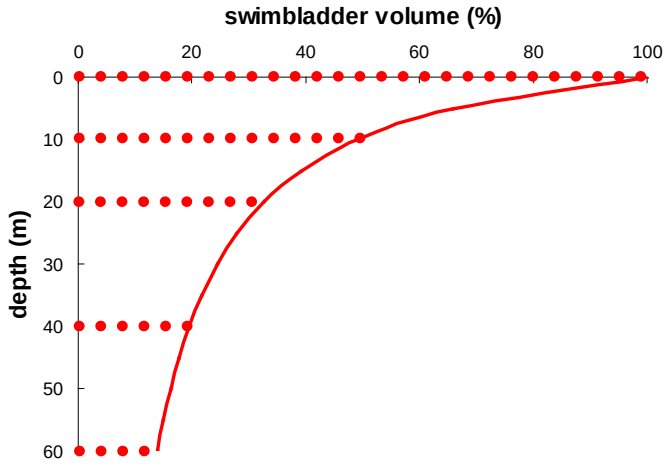
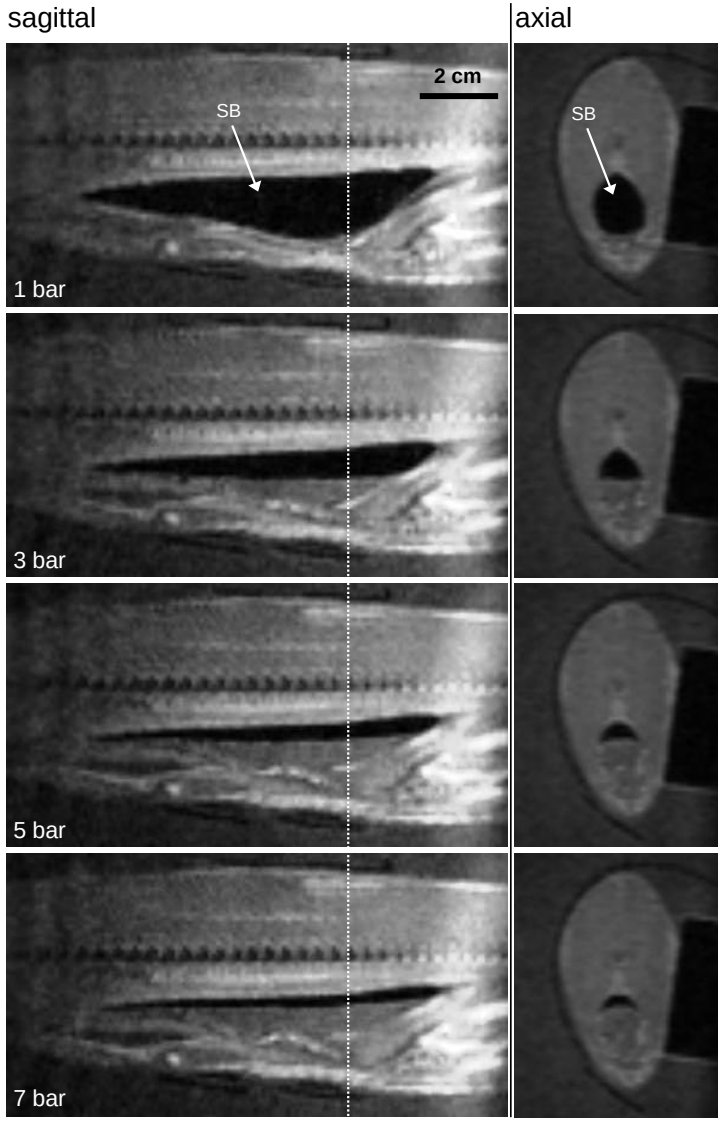
Results







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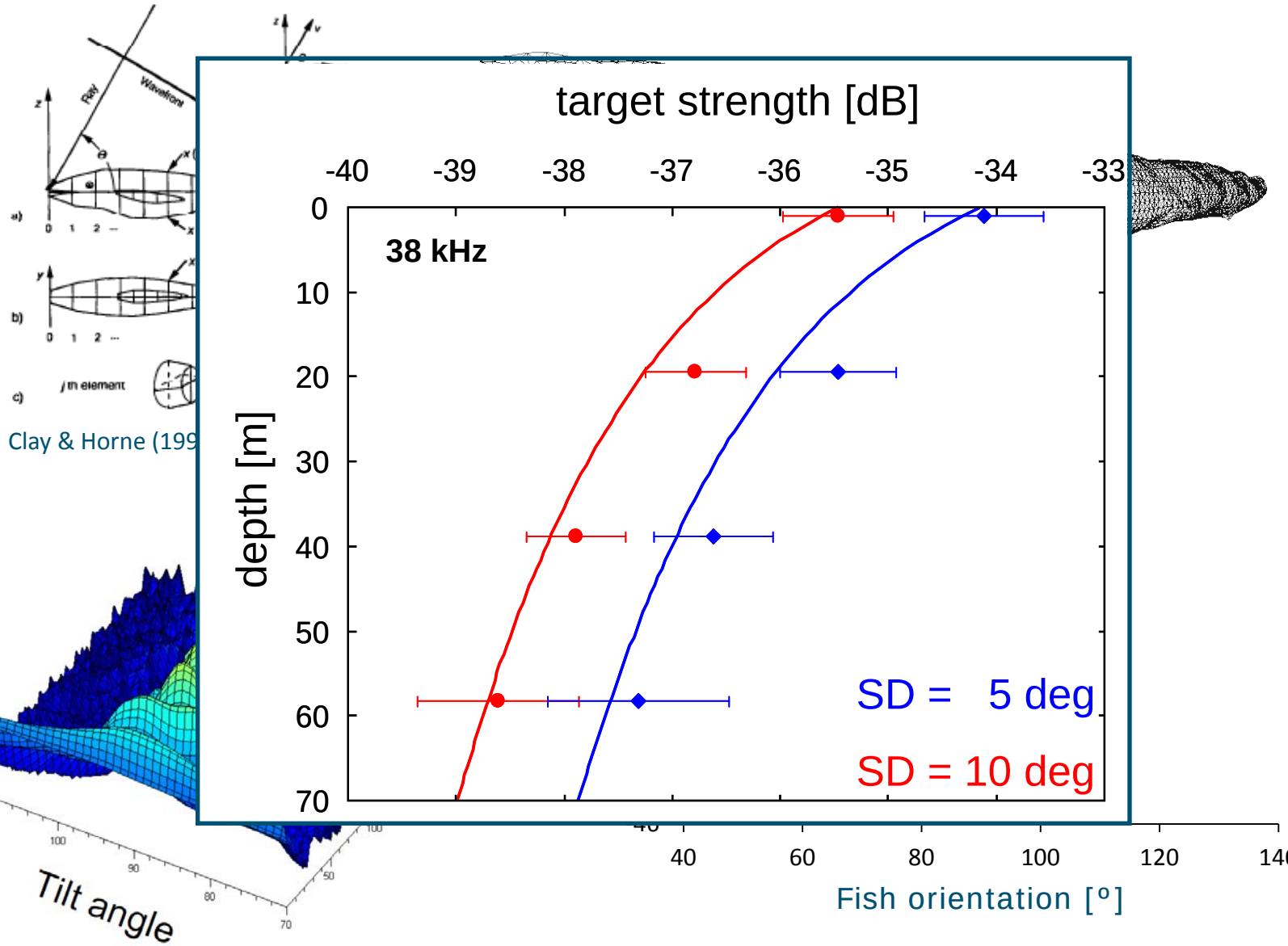
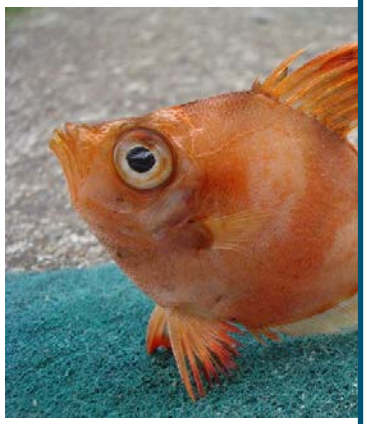
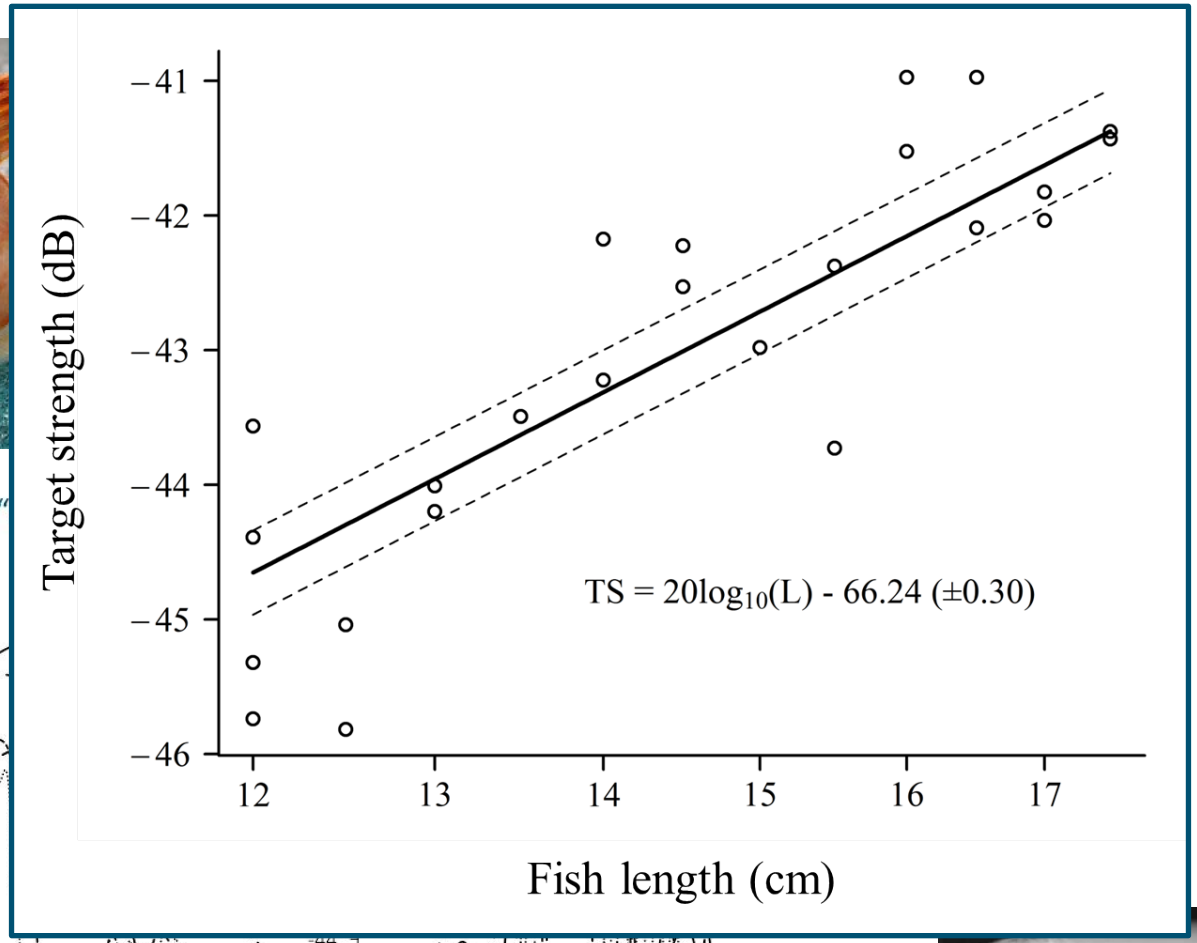
Kirchhoff-ray mode (KRM) approximation

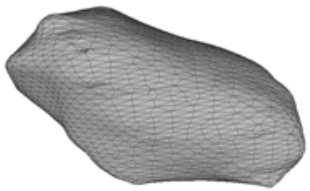


...and for boarfish (*Capros aper*)

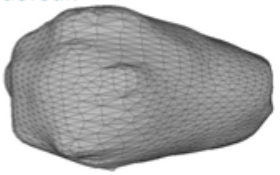




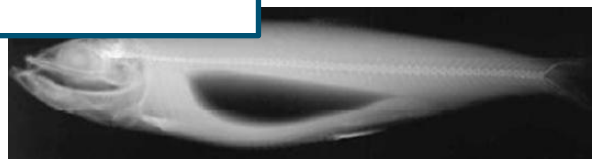
lateral:



dorsal:



boarfish: "



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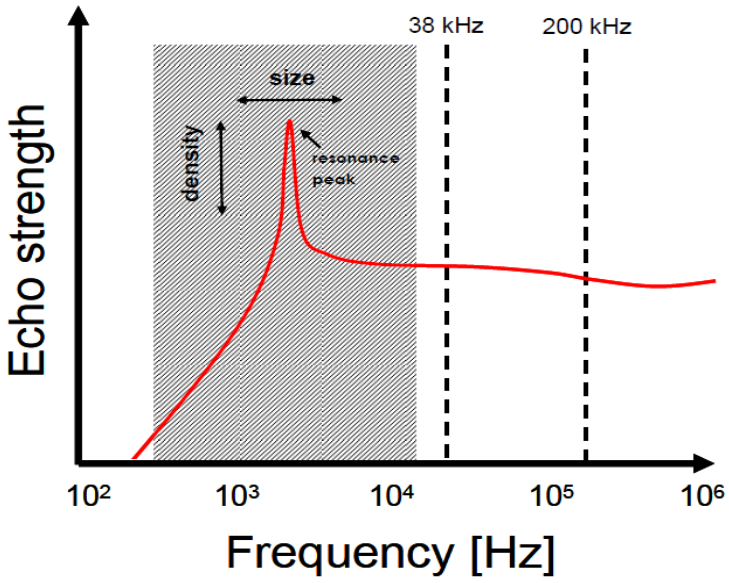
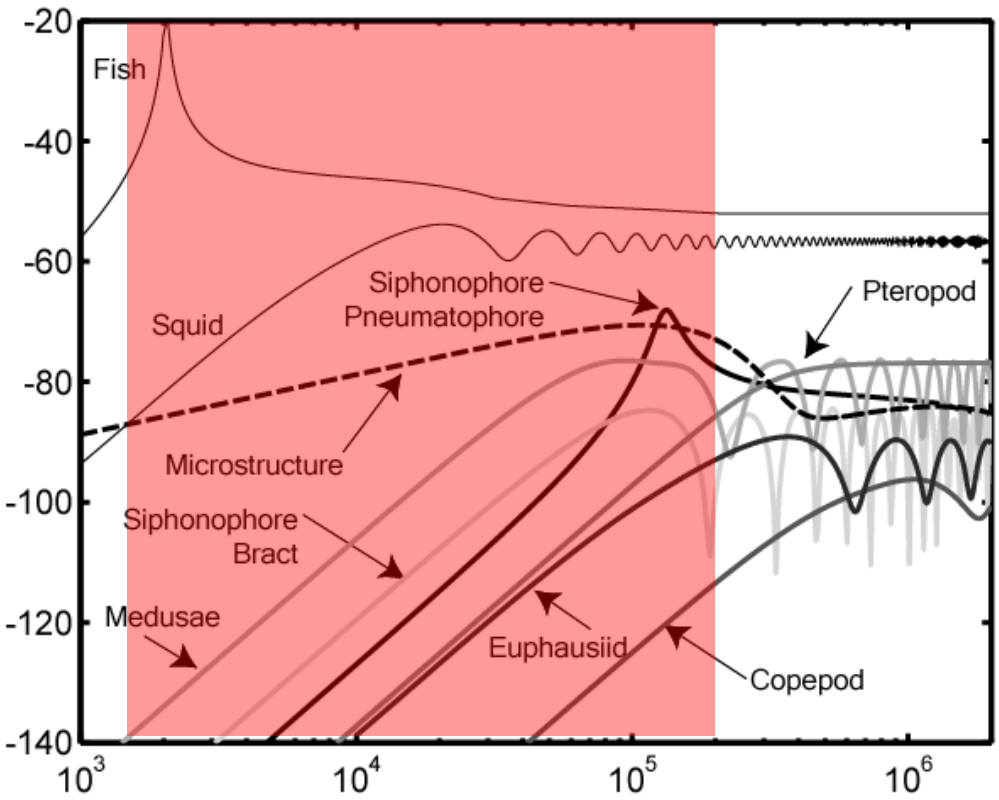
Future...

Broadband acoustics

- Species identification
- Size/density inference





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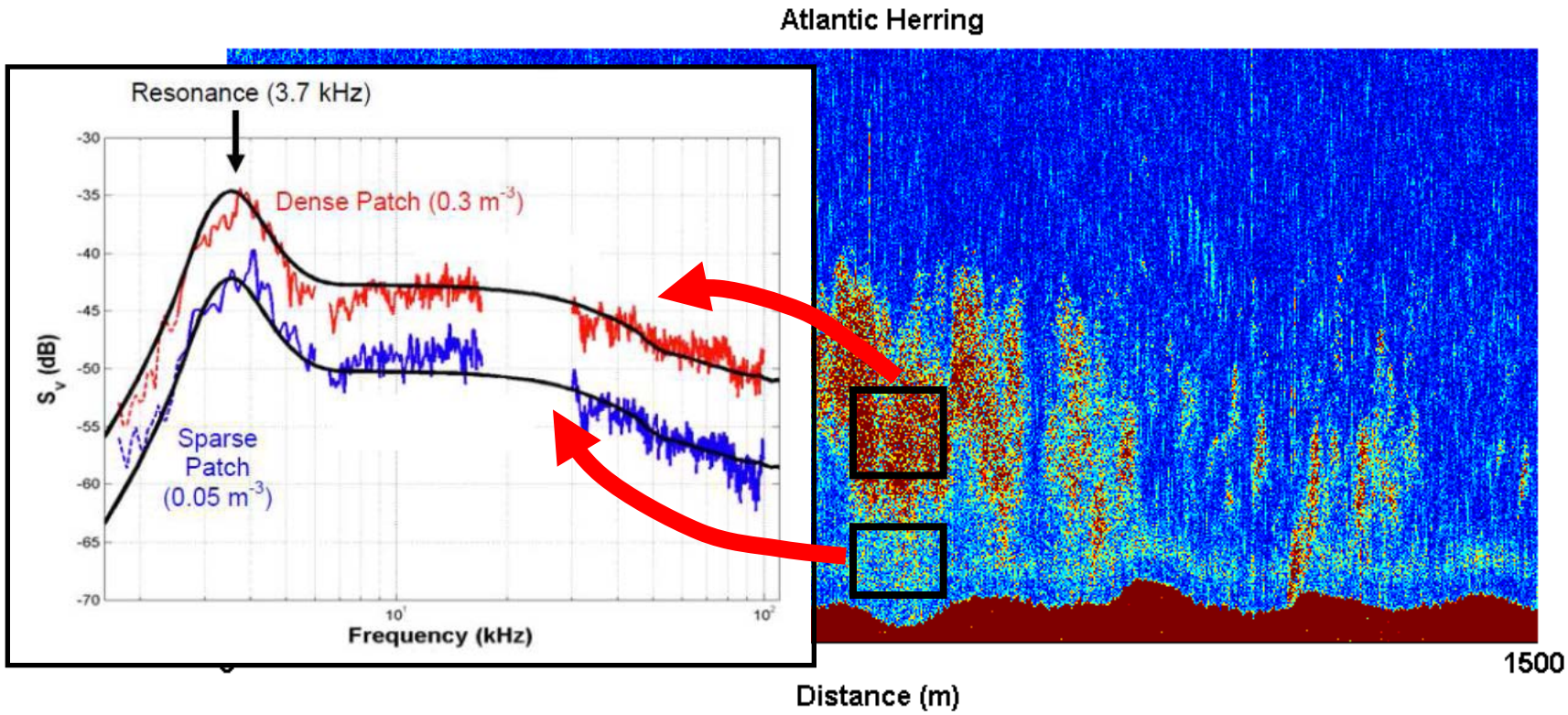
Future...

Broadband acoustics



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Thanks!