MUD, a New Acoustic Echosounder for Sediment Monitoring

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Acknowledgement

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Canada

Fisheries and Oceans Canada

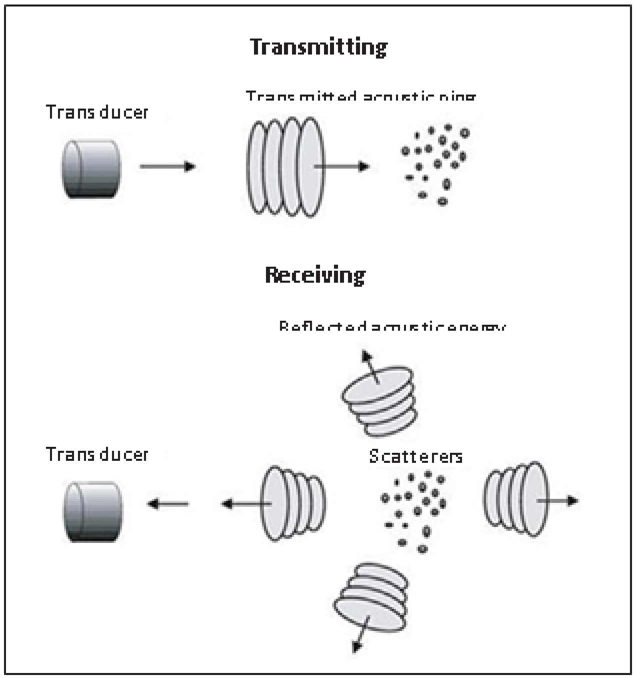
Pêches et Océans Canada

ASL

WEDA Western Dredging Association

Acoustic Backscatter and Sediments

USGS Sediment Acoustic Surrogate



$$\log_{10} SSC = b_0 + b_1 \overline{SCB},$$

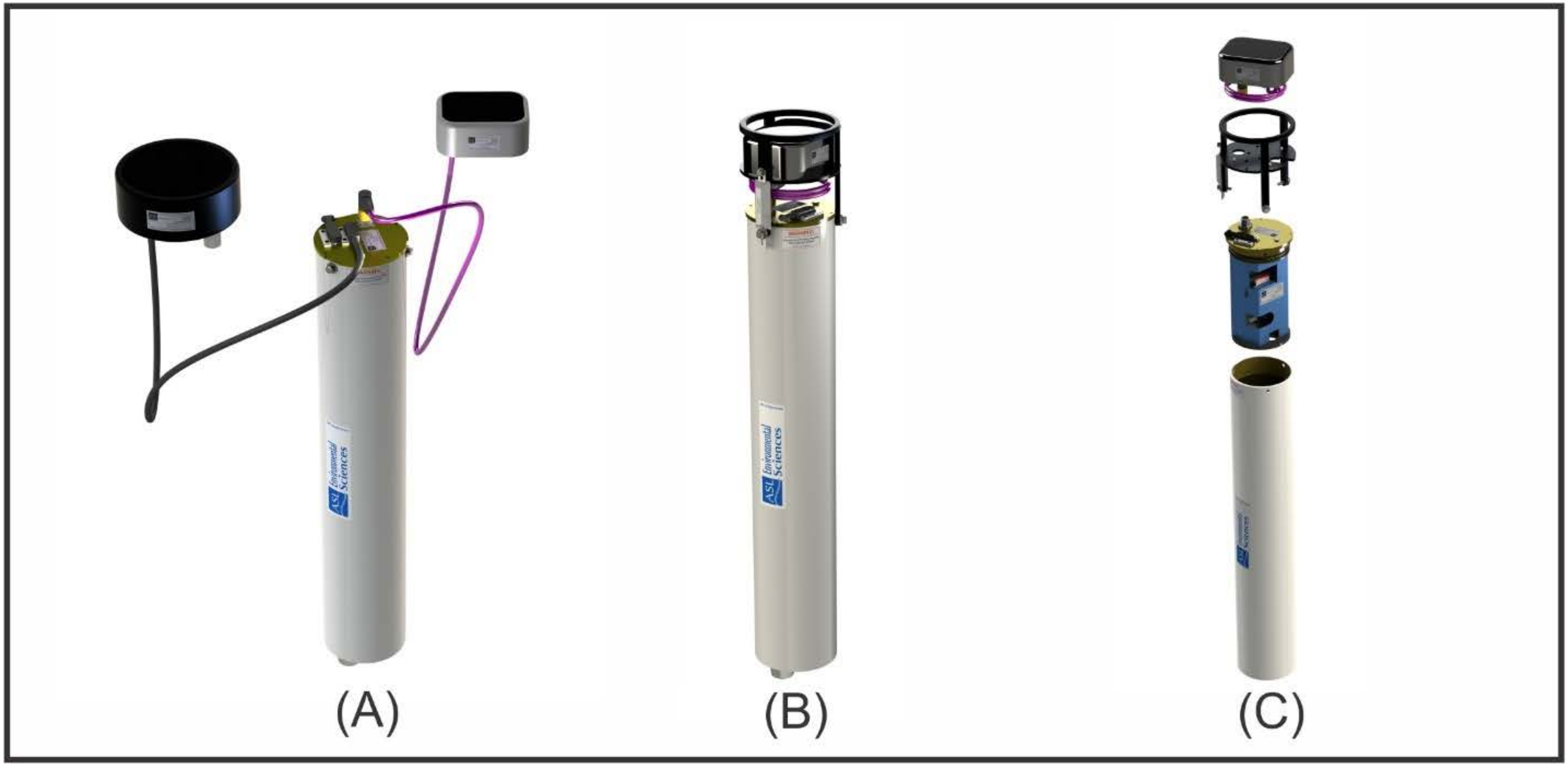
$$SCB = \underbrace{\underbrace{MB}_{I} + \underbrace{20\log_{10}(\Psi r)}_{II} + \underbrace{2r\alpha_w}_{III}}_{WCB} + \underbrace{2r\alpha_s}_{IV},$$

SSC = Suspended Sediment Concentrations
SCB = Sediment-corrected Backscatter
WCB = Water-corrected Backscatter

I. Raw Acoustic Backscatter
II. Beam Spreading
III. Water Absorption
IV. Sediment Attenuation

Landers, M.N., Straub, T.D., Wood, M.S., and Domanski, M.M., 2016, Sediment acoustic index method for computing continuous suspended-sediment concentrations: U.S. Geological Survey Techniques and Methods, book 3, chap. C5, 63 p., http://dx.doi.org/10.3133/tm3C5.

Multifrequency Ultrasonic Device (MUD)

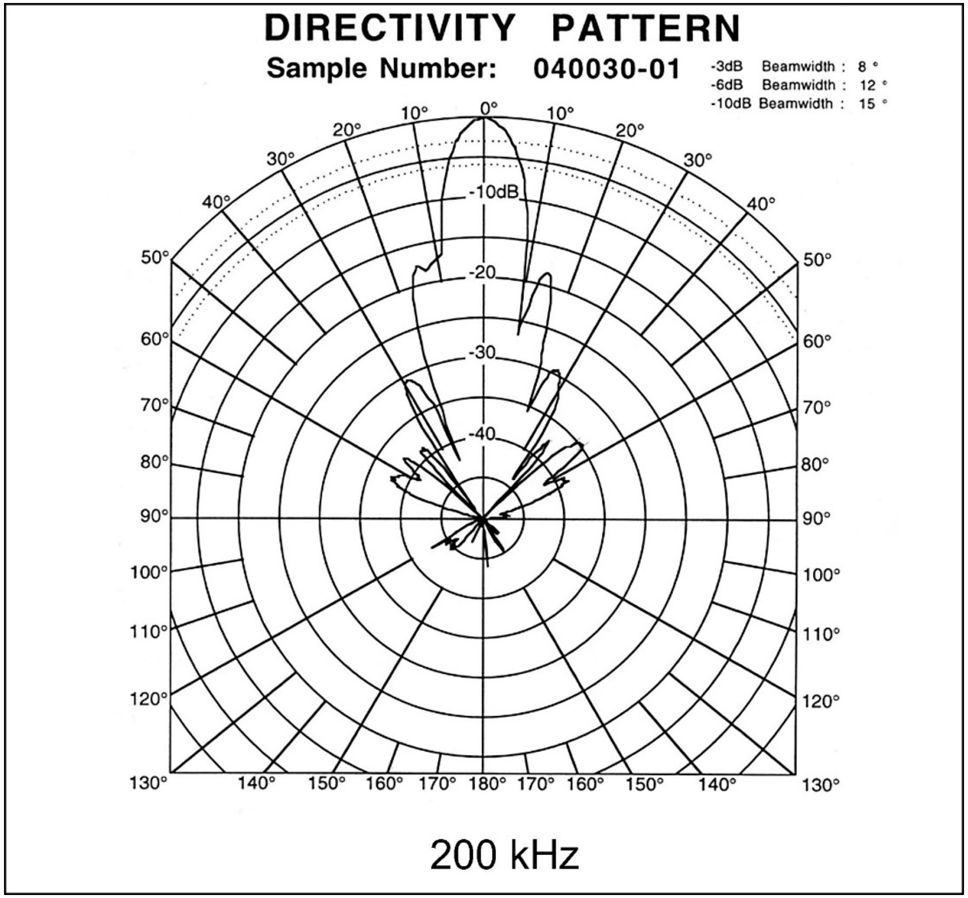


Derivative of the Acoustic Zooplankton Fish Profiler

Frequency choices

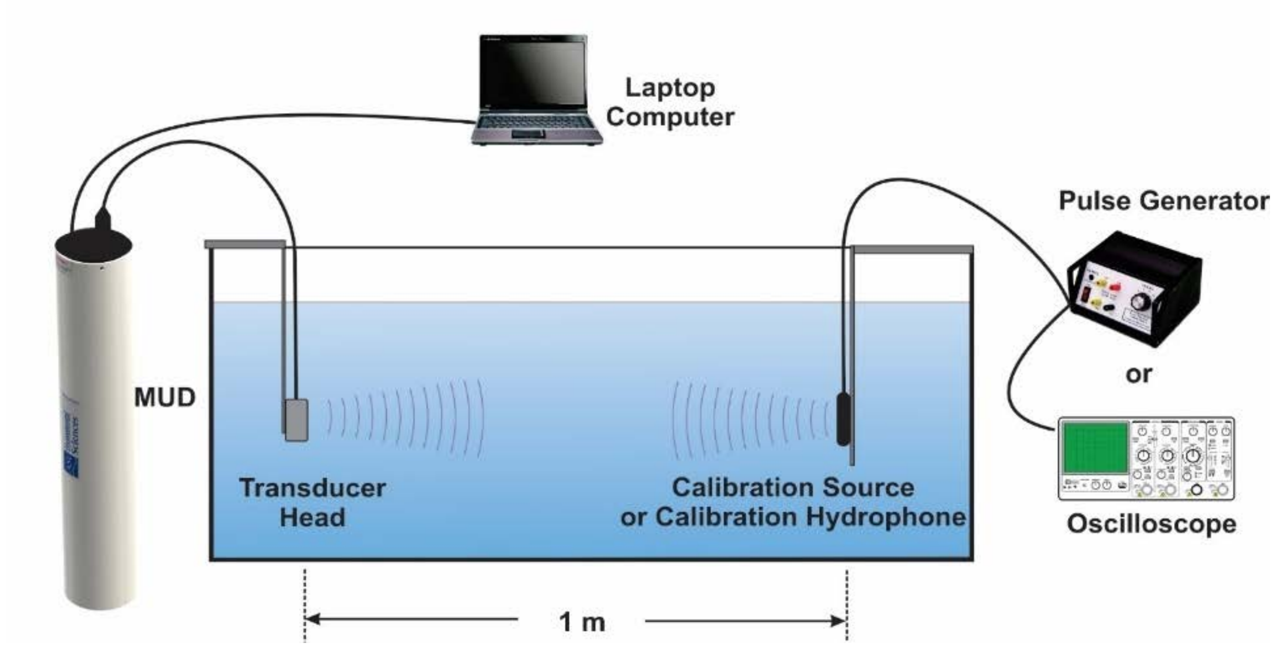
MUD/AZFP		
Frequency (kHz)	Nominal -3 dB Beam Angle (˚)	Nominal Source Level (dB)
2000	7	212*
1200	7	211*
769	7	210*
455	7	210
200	8	210*
125	8	210
67.5	10	205
38	12	208

Beam Spreading



- 200 kHz transducer
- 7° beam angle at -3 dB
- 15° beam angle at -10 dB
- Insignificant near-field

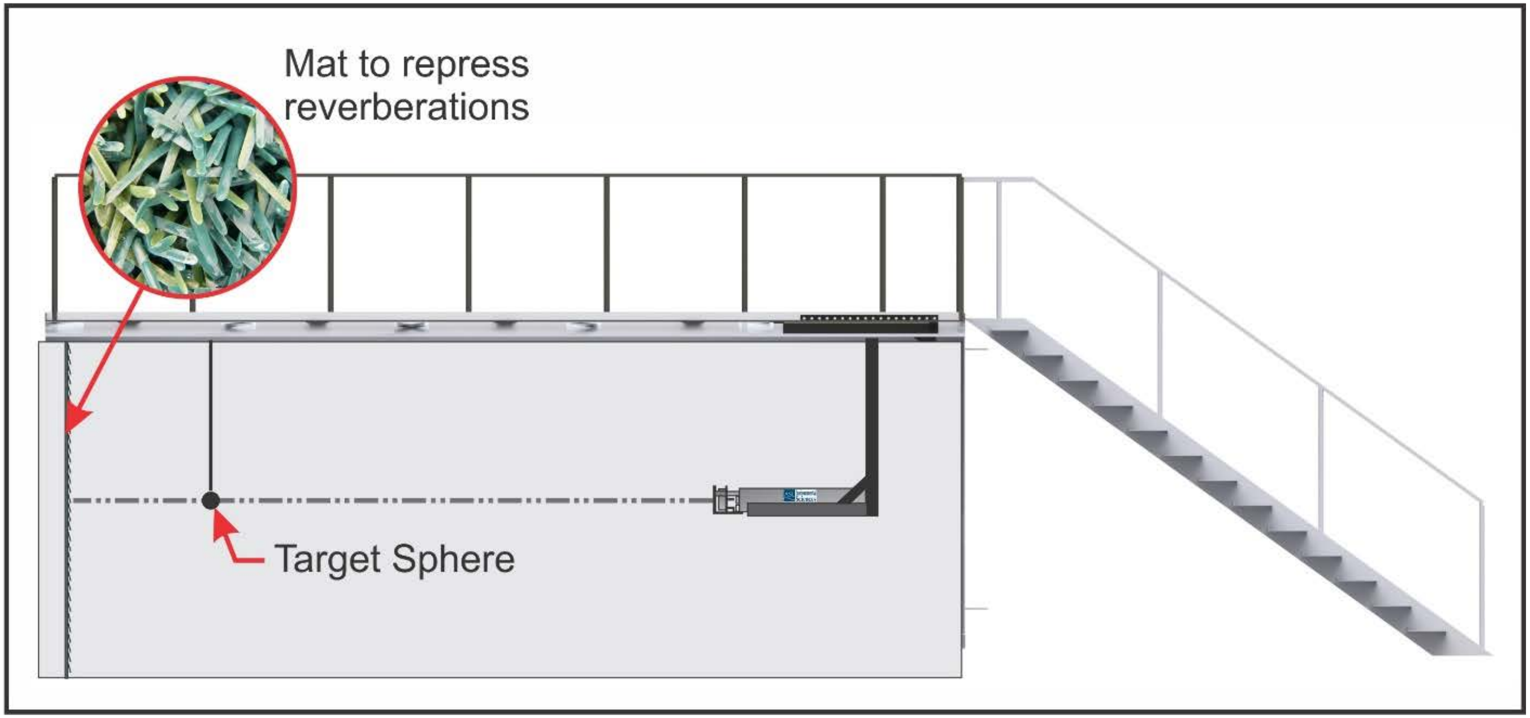
Indoor Calibration



- Calibrated source levels
- Separate calibrated receive levels
- Absolute calibration to within 1 dB

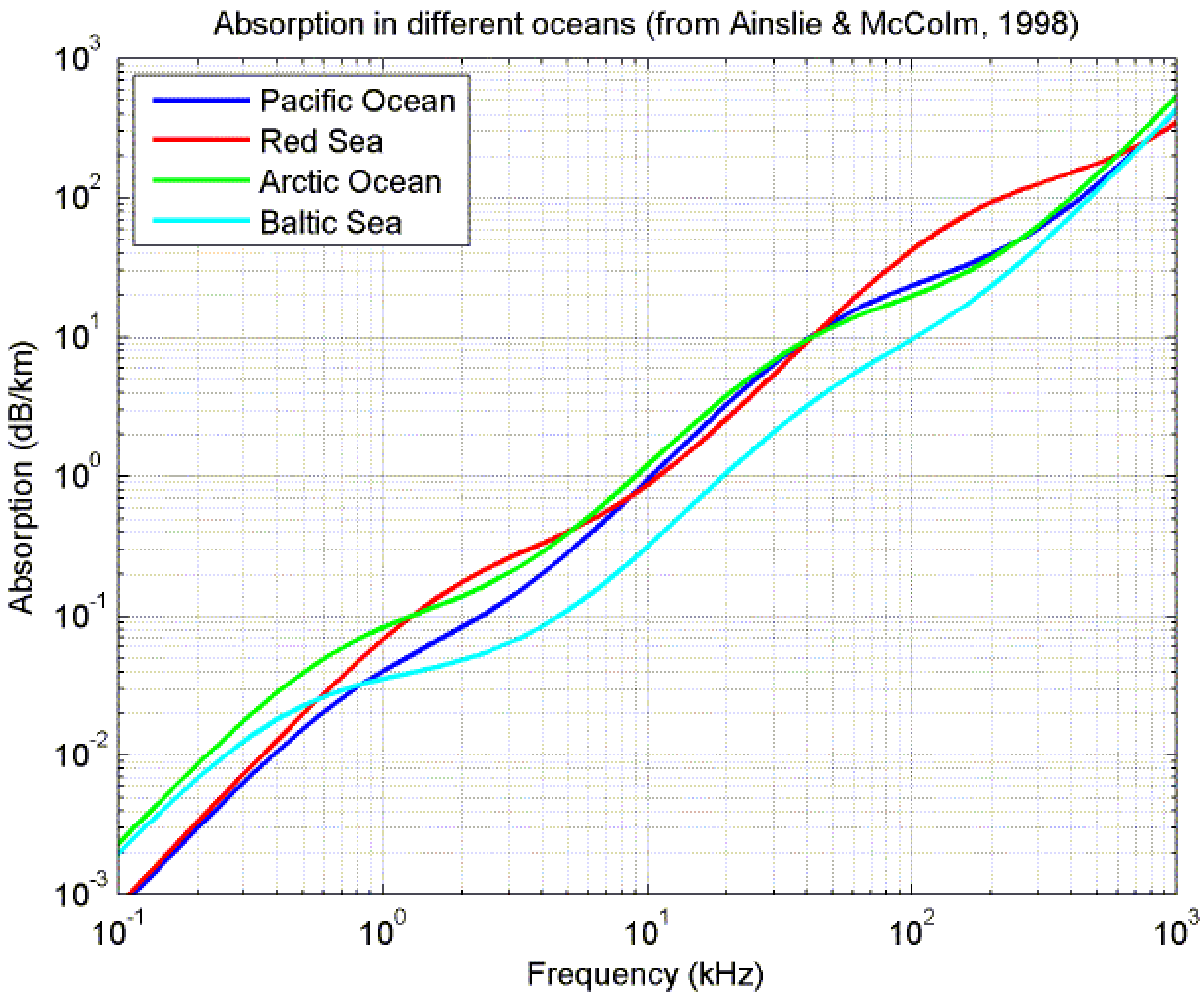
Outdoor Calibration

Calibration with a Target



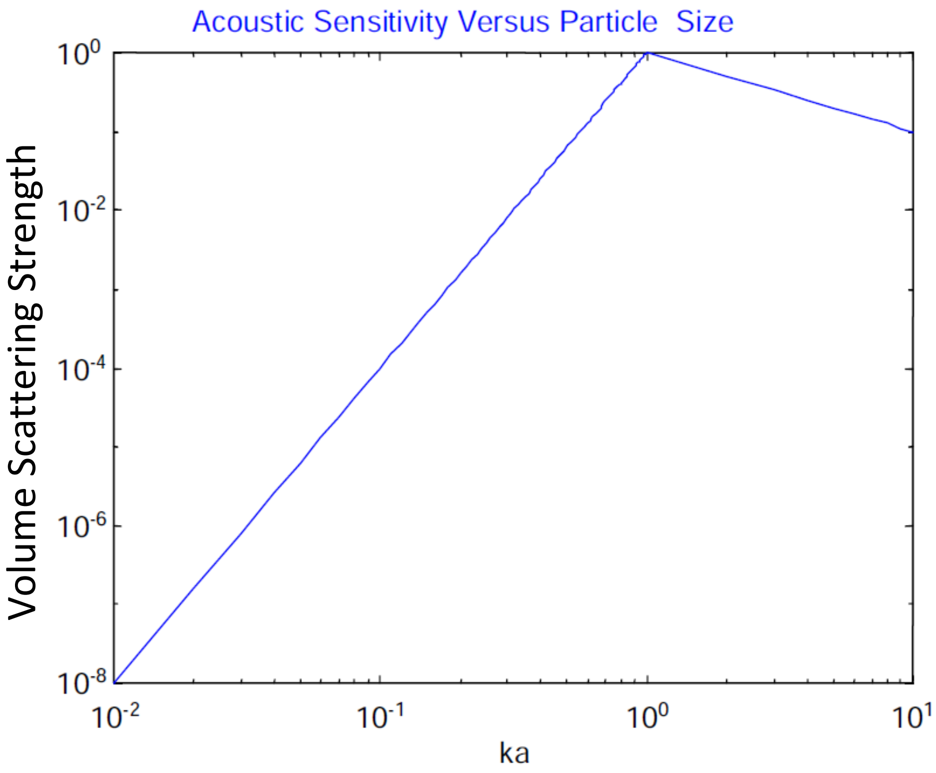
- Secondary calibration with a carbide tungsten sphere
- Stability to 0.5 dB/year

Absorption with Frequency Change



Ainslie M. A., McColm J. G., "A simplified formula for viscous and chemical absorption in sea water", Journal of the Acoustical Society of America, **103**(3), 1671-1672, 1998

Sensitivity to Particle Size

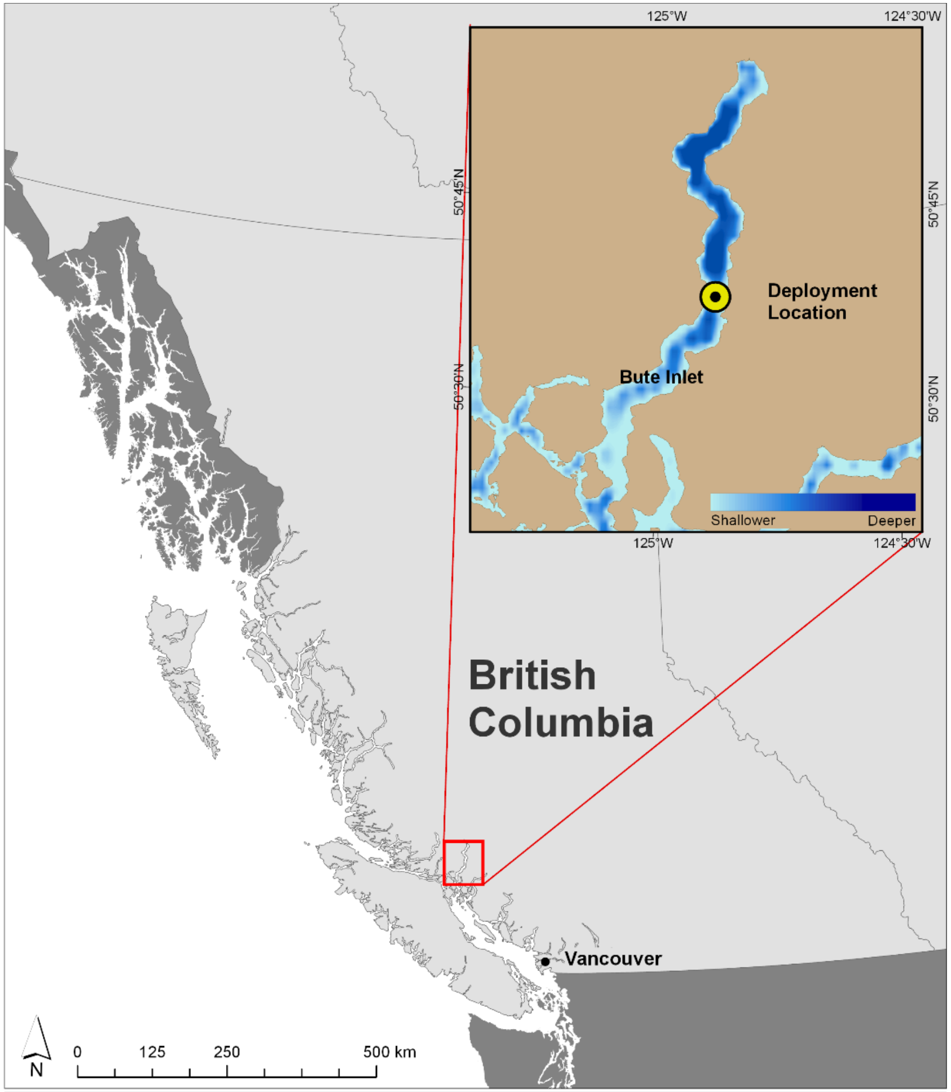


MUD		
Frequency (kHz)	Particle radius [mm] (k*a = 1)	Wentworth terms
2000	0.12	fine sand
1200	0.20	fine sand
769	0.31	medium sand
455	0.52	coarse sand
200	1.19	very coarse sand
125	1.91	very fine pebbles
67.5	3.54	very fine pebbles
38	6.28	fine pebbles

Nortek Technical Note No.: *003*

Atle Lohrmann, October 15, 2001, Monitoring Sediment Concentration with acoustic backscattering instruments

Bute Inlet – May 2018

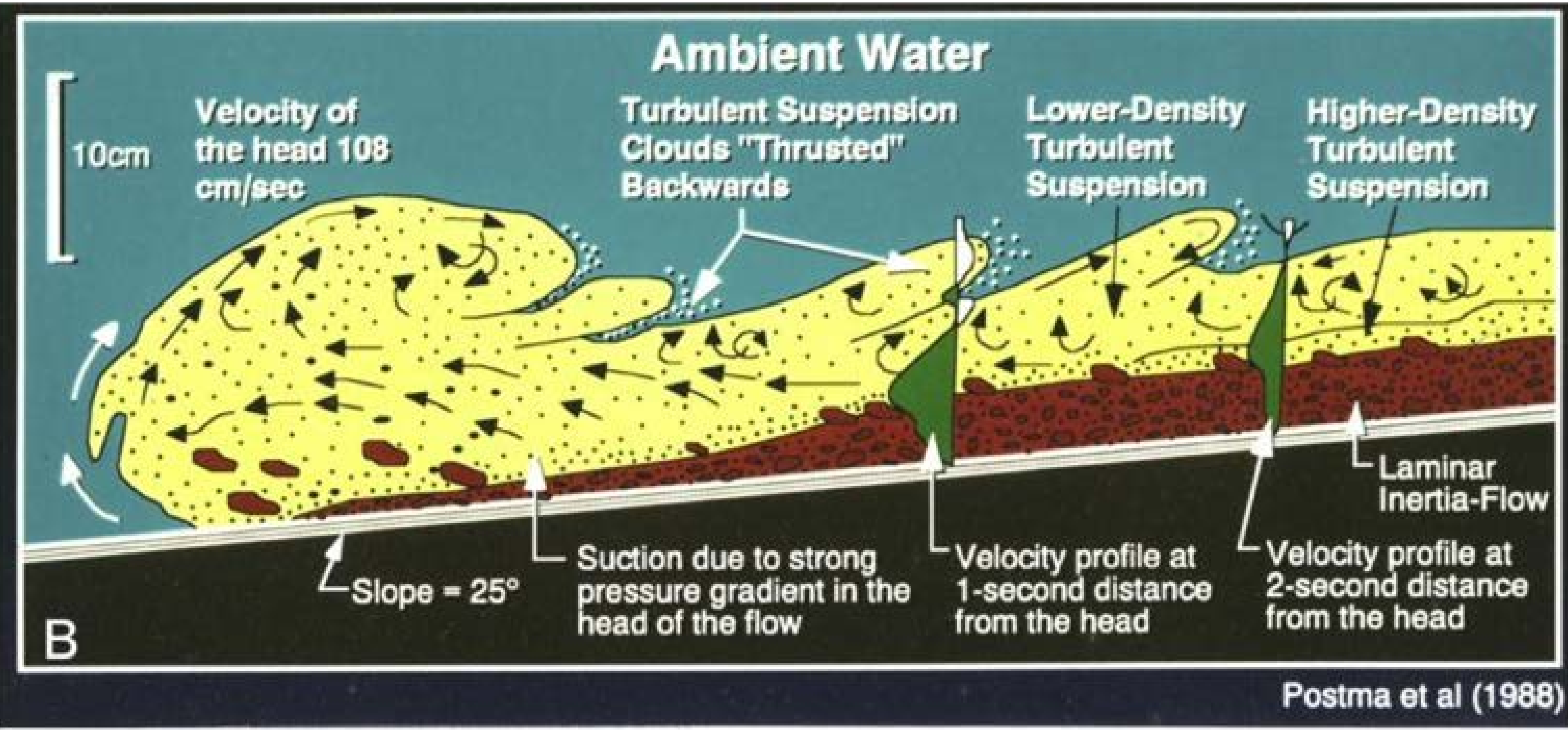


Turbidity Flow Experiment

- NRCan
- NOC
- U. Hull

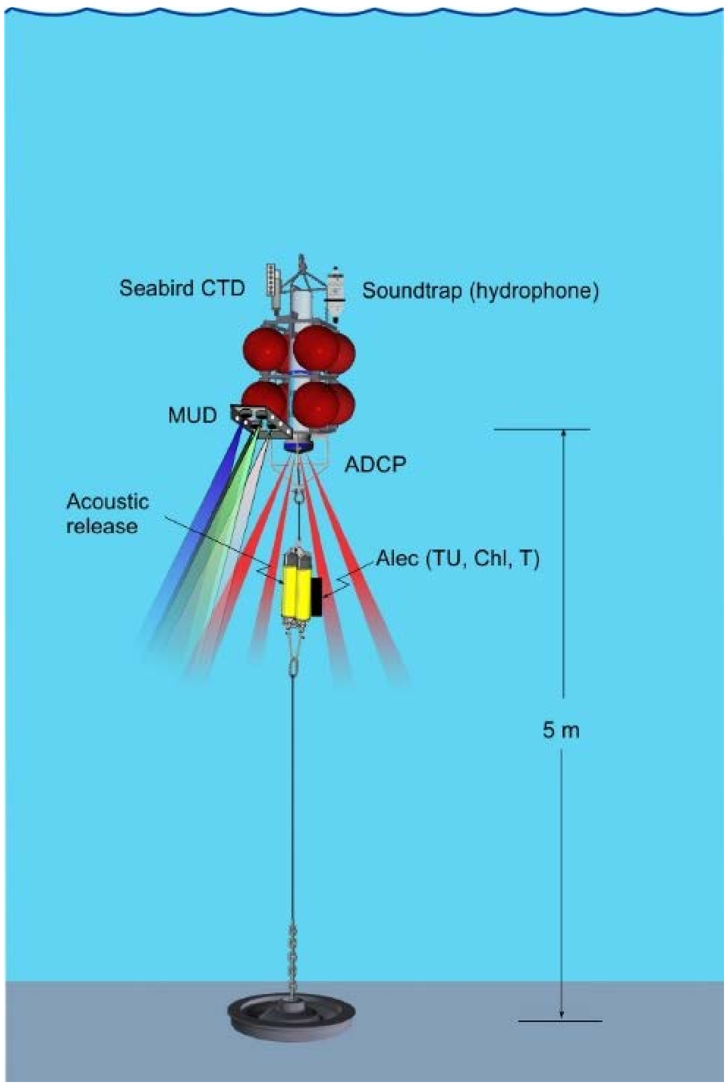
CCGS Vector

Turbidity Flow



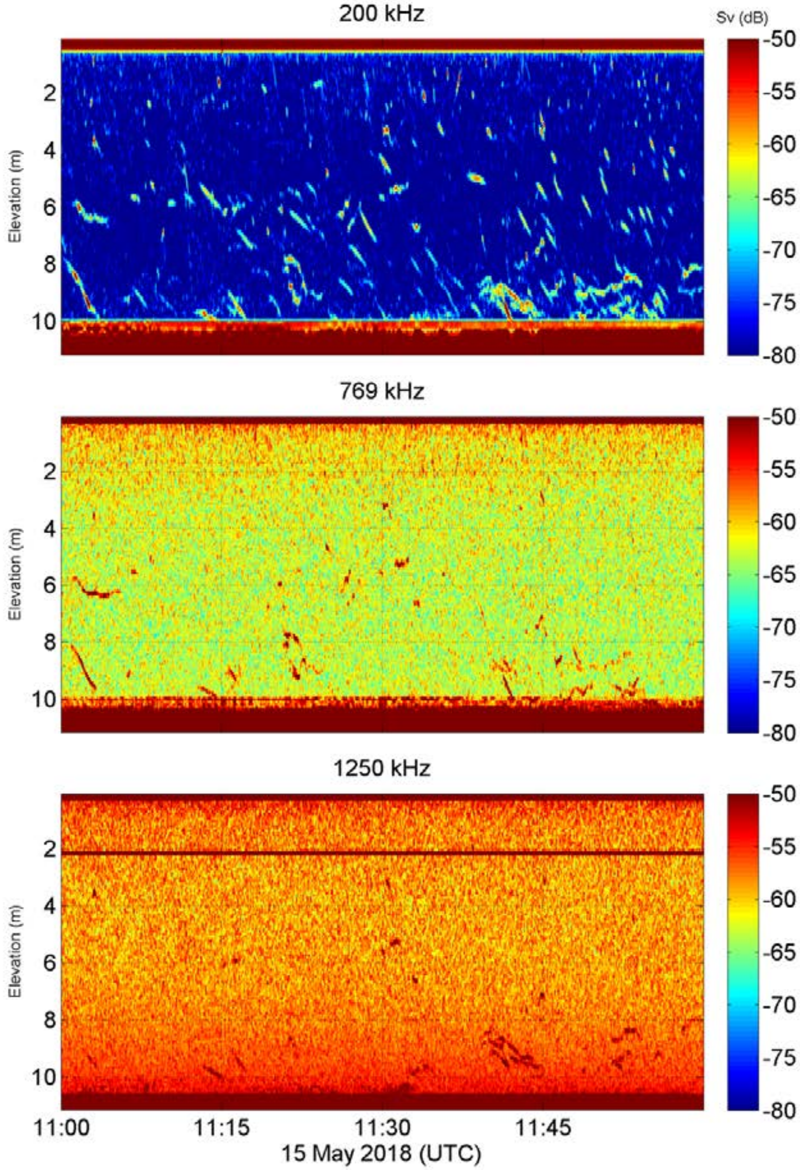
G. Postma, W. Nemec, K.L. Kleinspehn Large floating clasts in turbidites, a mechanism for their emplacement
Sedimentary Geology, 58 (1988), pp. 47-61

Bute Inlet MUD Mooring



- Multifrequency Ultrasonic Device
  - 1200, 768 and 200 kHz
- ADCP – 1200 kHz
- Wiped OBS/Chl-a sensor
- Conductivity/Temperature
- Passive Acoustics (Soundtrap) - UVic

Not Much Suspended Sediment



- Fish swimming into and near bottom
- Likely sand lance

NOAA 2005 Pacific sand lance

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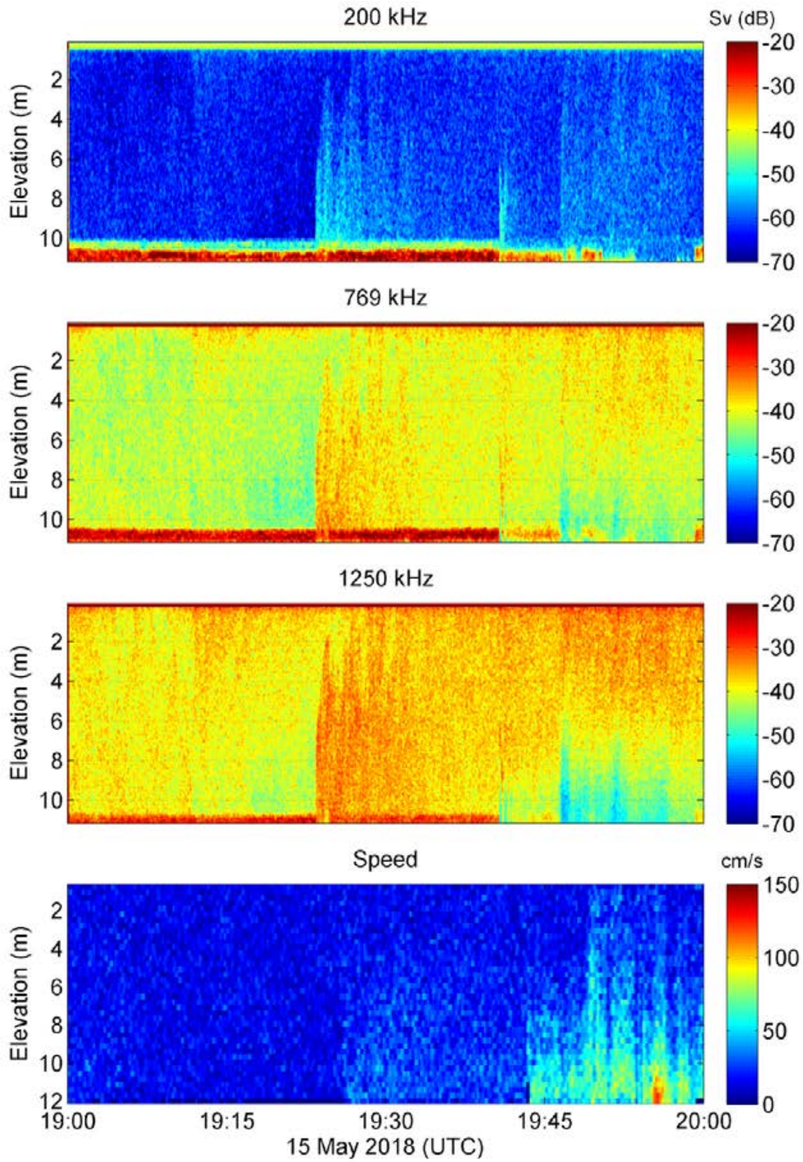
Turbidity Flows



- Three flows
- Fastest at 1.5 m/s
- > 10 m thick
- Sediment attenuation significant

Conclusions

- Multi-use Echosounder
  - Sediments
  - Pacific sand lance
  - Seal-like ABS with passive acoustics detection
  - Gas bubble cloud
- Tuning worked - did not saturate
- SSC estimate still needs to be done
  - 200 kHz can be used for simple inversion
  - Multifrequency can be used to detect particle size distribution changes