Bio-acoustic monitoring with the Acoustic Zooplankton Fish Profiler (AZFP)

S. Pearce[1], J. Buermans[1], S. Gauthier[2], A. Rezvanifar[3], T.P. Marques[3], M. Cote[3], A.B. Albu[3] and D. Lemon[1]

[1] ASL Environmental Sciences Inc., Victoria, BC
[2] Fisheries and Oceans Canada, Inst. Ocean Sciences, Sidney, BC
[3] University of Victoria, Victoria, BC

ASL Environmental Sciences
Celebrating 42 Years of Excellence

ASL Environmental Sciences

Presentation Outline

- **Introduce ASL Environmental Sciences**
- Introduce Acoustic Zooplankton Fish Profiler (AZFP)
- AZFP: Highlighted Projects
  - Slocum Glider
  - Computer Vision / Machine Learning, Pacific Herring

ASL: What do we do?

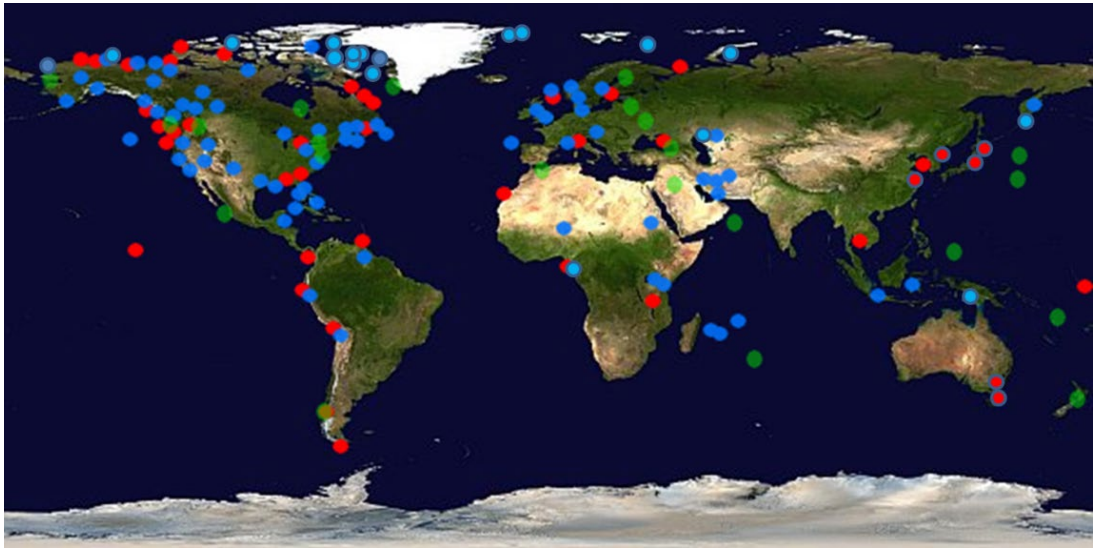
- Over 1200 Projects completed since 1977

- Staff of about 42:
8 Ph.D.s, 13 M.Sc., 2 P.Eng.

David Holland of NYU Disko Bay (W. Greenland)

ASL: What do we do?

- Products
  - e.g. AZFP (Mooring, Glider, Pole-mount)
- Field Services
  - Deployment, Recovery
- Consulting Services
  - Data Processing, Remote Sensing, Modeling



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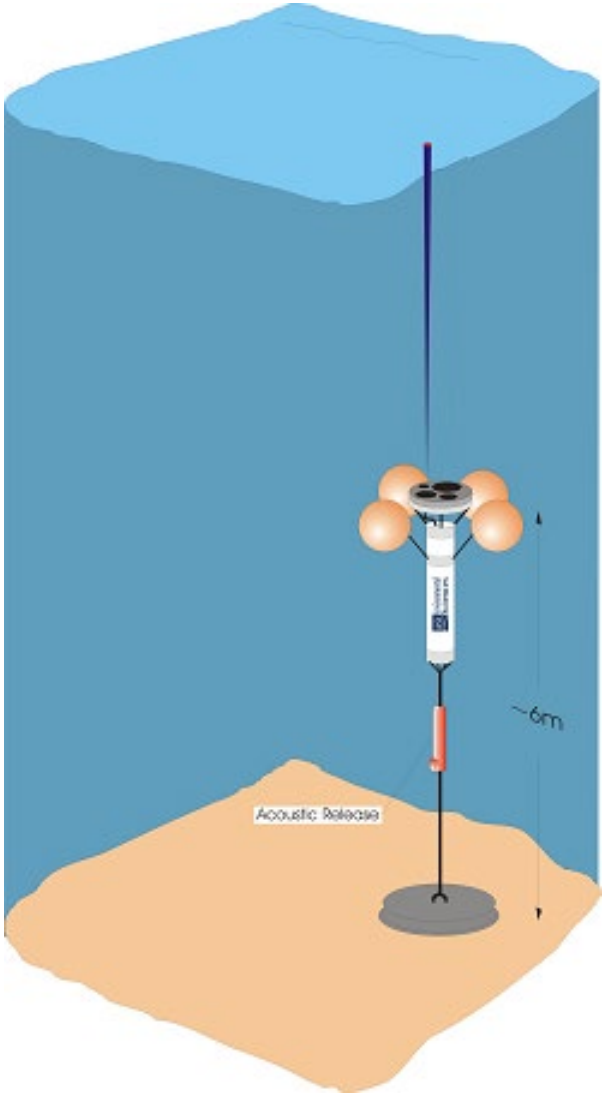
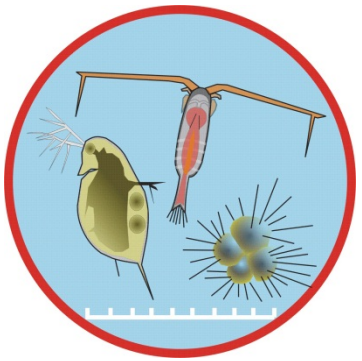
Acoustic Zooplankton Fish Profiler



•An inexpensive way of obtaining reliable, high resolution, **calibrated** acoustic backscatter measurements at several frequencies

- Upward looking or buoy-mounted
- Glider mounted
- CTD cage



Acoustic Zooplankton Fish Profiler

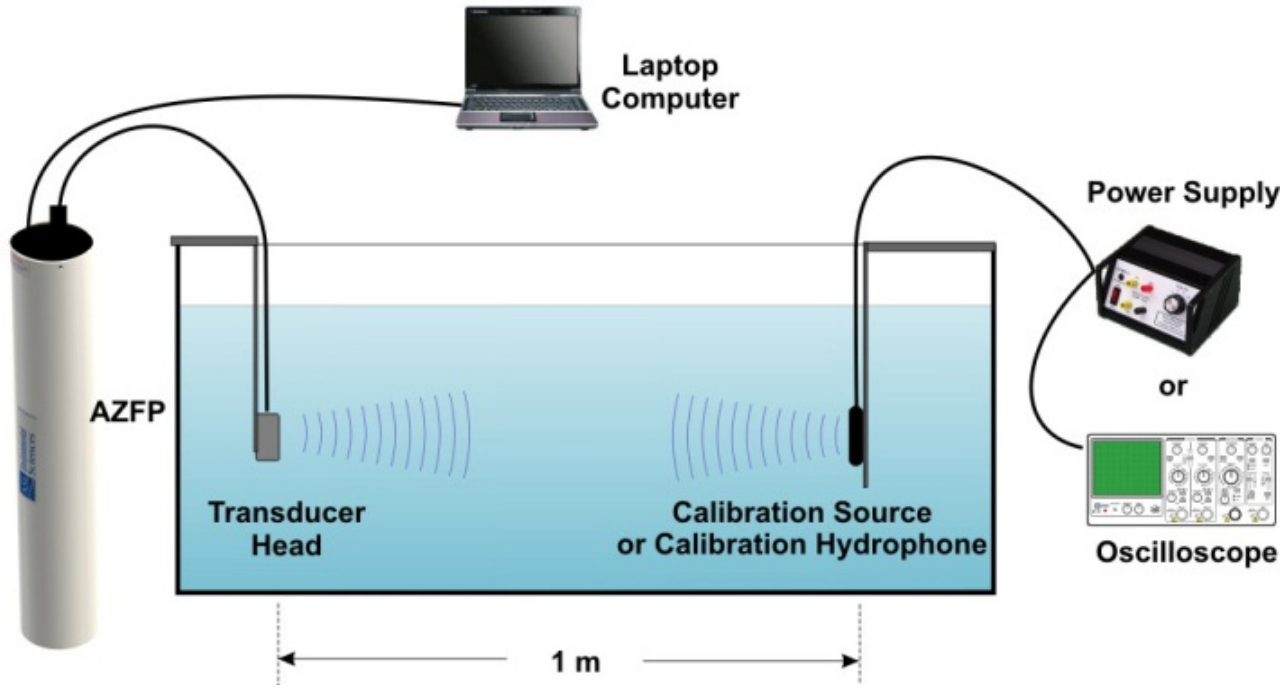
•Up to 4 channels in one instrument

Frequencies available:

- 38 kHz
- 125 kHz
- 333 kHz
- 769 kHz
- 2000 kHz
- 67.5 kHz
- 200 kHz
- 455 kHz
- 1250 kHz

Calibration Procedure (Pt. 1)

- Calibration
  - Calibrated hydrophones (Reson TC4035, Reson 4038, or Onda HCN-1500; ±1 dB stated accuracy)
  - Secondary source, calibrated with our Reson 4035 and HCN-1500
  - Measurements of the on-axis values of the transmitted signal strength and the receiver response as a function of signal strength



Calibration Procedure (Pt. 2)

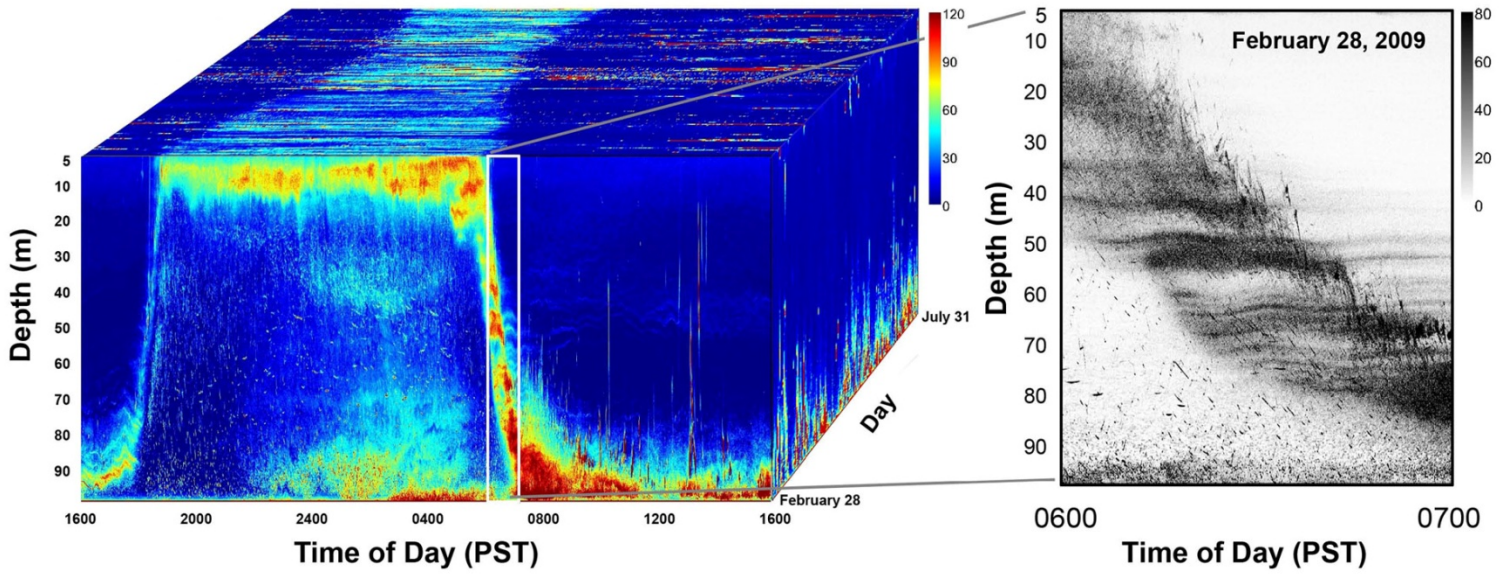
- Verification
  - Tungsten-carbide (WC) sphere suspended via monofilament line
    - Large freshwater tank (~6 m length, ~2.5 m diameter)
    - Measured target strength vs. theoretical target strength
    - Pass/Fail criterion: ±1 dB from theoretical target strength

Acoustic Zooplankton Fish Profiler

Photo credit: Christian Katlein
Alfred-Wegener-Institut

Long Time Series Analysis

- 6 Months of data shown as a ‘cube’
- Days are represented by Z-Dimension



Gray Scale image shows high temporal resolution view of zooplankton descent between 0600 and 0700 PST

- internal waves affect zooplankton distribution
- Some fish follow zooplankton migration
- other fish remain near bottom

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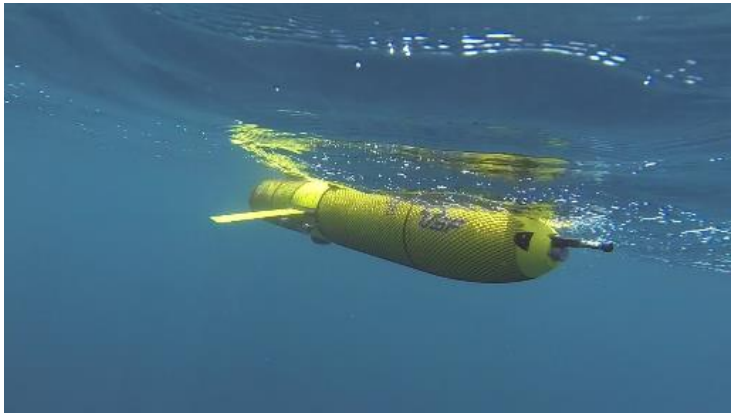
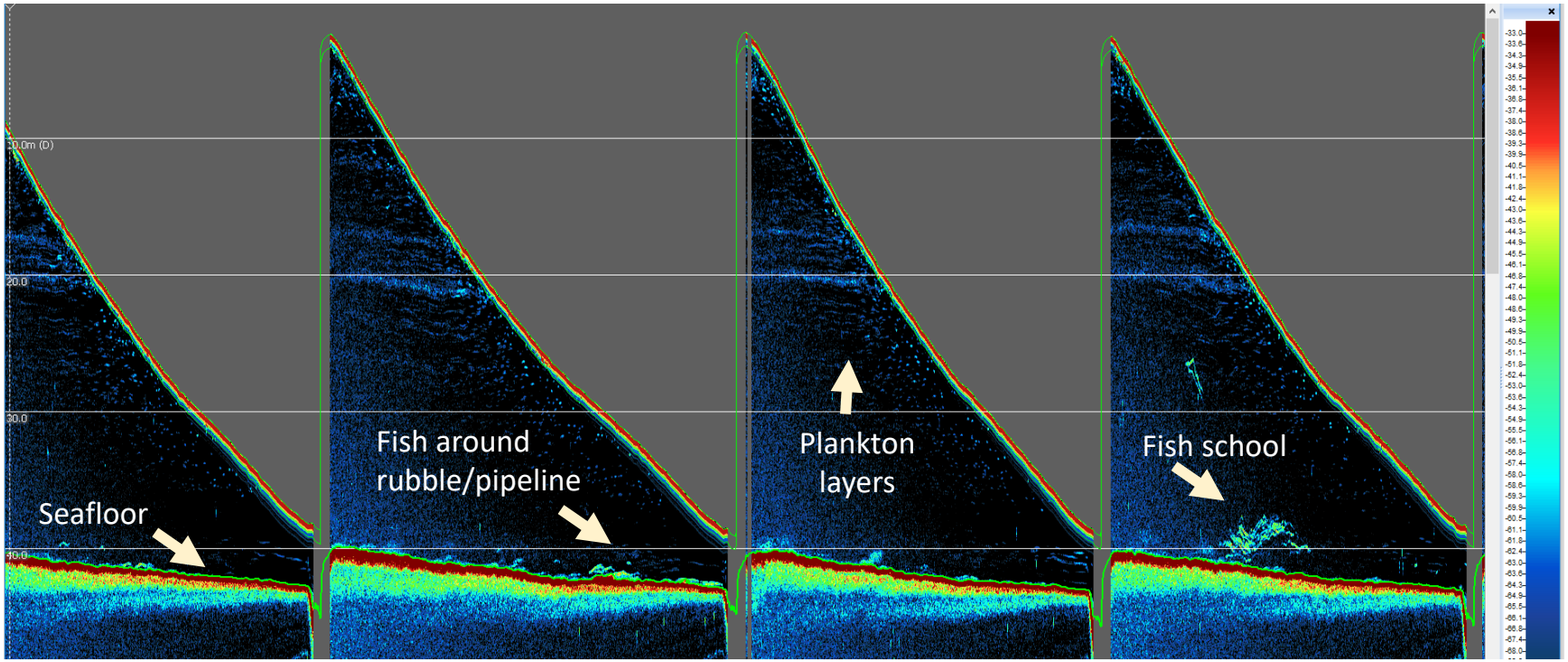
Antarctic
Deployment

- 38, 67, 125 kHz

- 125, 200, 455, 769 kHz

(Photo courtesy of Grace Saba, Rutgers)





Images courtesy of Chad Lembke (USF) and Chris Taylor (NOAA)

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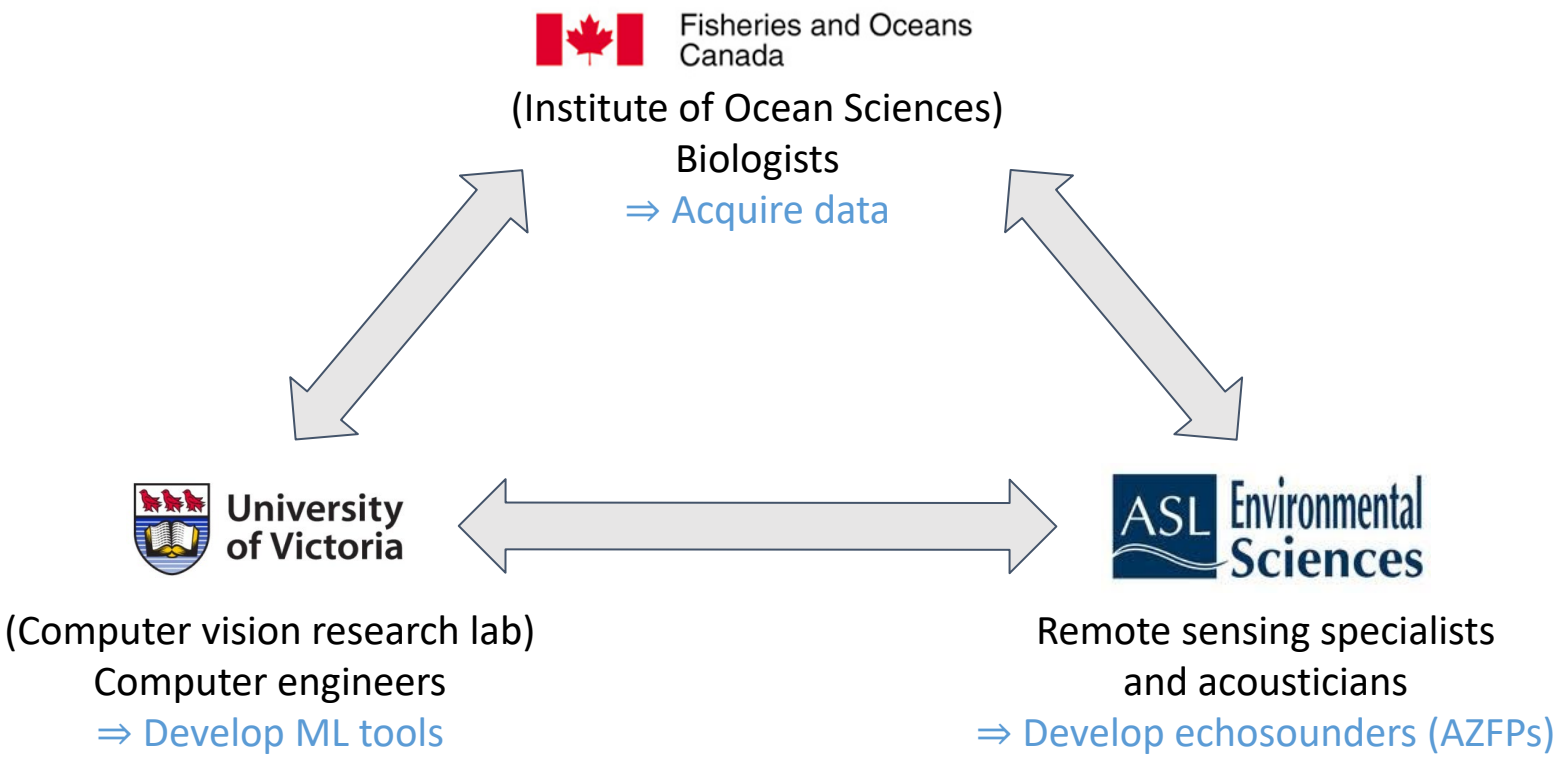
UVic / DFO / ASL Collaboration

- Engage, Engage Plus grants (NSERC)



Machine Learning, Pacific Herring

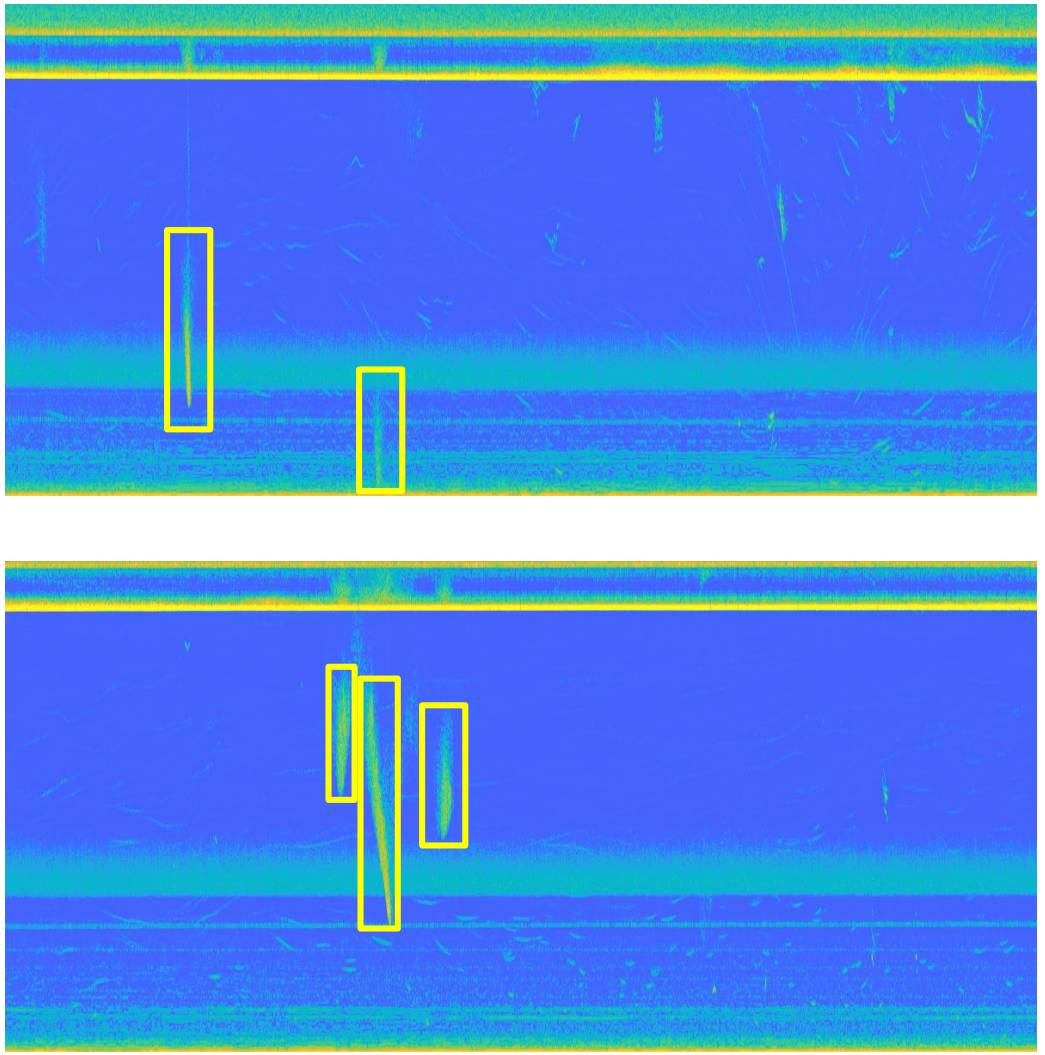
Ground truth dataset

100 echograms

145 samples of Pacific herring schools

Comparison: Support Vector Machine (SVM) vs. Convolutional Neural Network (CNN)

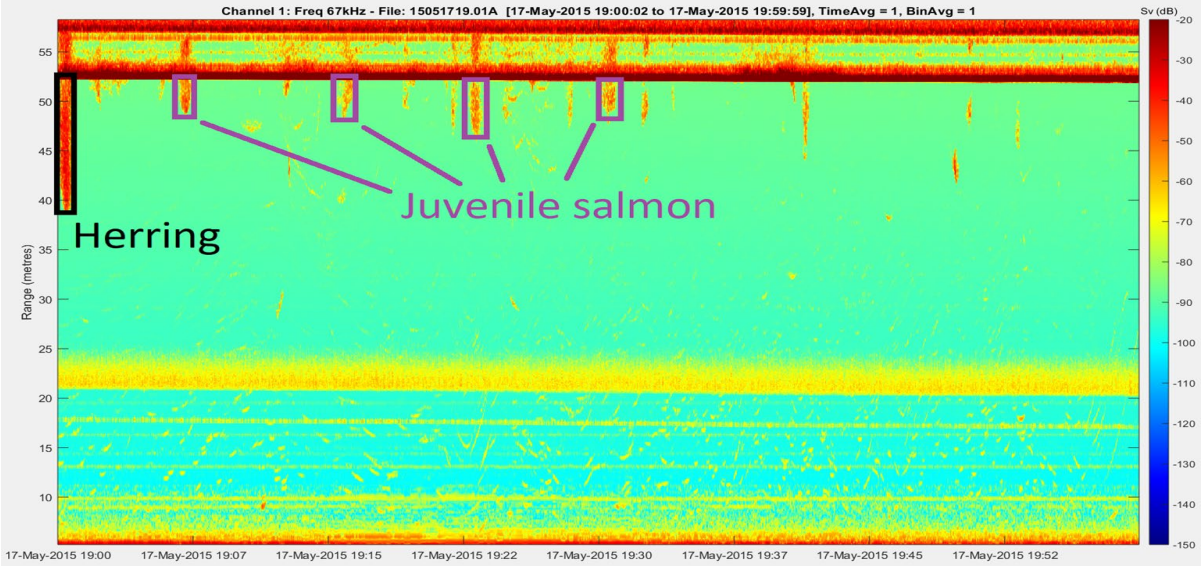
Samples are used for the extraction of features and the training of the deep learning-based classifier.



Echograms with annotated samples (yellow bounding boxes)

Current/Future Work

- Single deep learning detection pipeline:
  - Single network to perform *localization* and *classification*
- Extension to other species, structures, and phenomena that can be monitored with echosounders:
  - Current: salmon, zooplankton
  - Future: suspended sediments, ocean turbulence, etc.



Acknowledgements

- Co-authors
  - DFO/IOS
  - UVic
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- Workshop Participants

Thank you!