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

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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
- 67.5 kHz
- 125 kHz
- 200 kHz
- 333 kHz
- 455 kHz
- 769 kHz
- 1250 kHz
- 2000 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)
Fish around rubble/pipeline
Plankton layers
Fish school

Images courtesy of Chad Lembke (USF) and Chris Taylor (NOAA)
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UVic / DFO / ASL Collaboration

• Engage, Engage Plus grants (NSERC)

(Fisheries and Oceans Canada) (Institute of Ocean Sciences) Biologists ⇒ Acquire data

University of Victoria (Computer vision research lab) Computer engineers ⇒ Develop ML tools

Remote sensing specialists and acousticians ⇒ Develop echosounders (AZFPs)
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.
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Thank you!