Using *in situ* imaging to describe zooplankton communities in the Northern Gulf of Alaska

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Motivation

Traditional towed net sampling presents challenges:

- Species abundance/distribution poorly resolved due to patchiness
- Damages fragile gelatinous zooplankton
- Taxonomic analysis is time/labor intensive
- High resolution sampling limited by ship time, variable weather, sample processing

To resolve this...

- Deploy "*In Situ* Ichthyoplankton Imaging System Deep-Focus Particle Imager" on Spring and Summer Northern Gulf of Alaska Long Term Ecological Research site cruises to describe NGA zooplankton communities

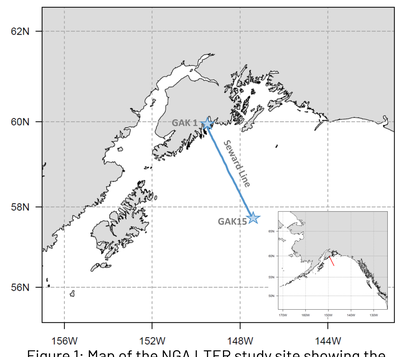


Figure 1: Map of the NGA LTER study site showing the 250 km Seward Line transect

In Situ Ichthyoplankton Imaging System Deep-Focus Particle Imager (ISIIS-DPI)

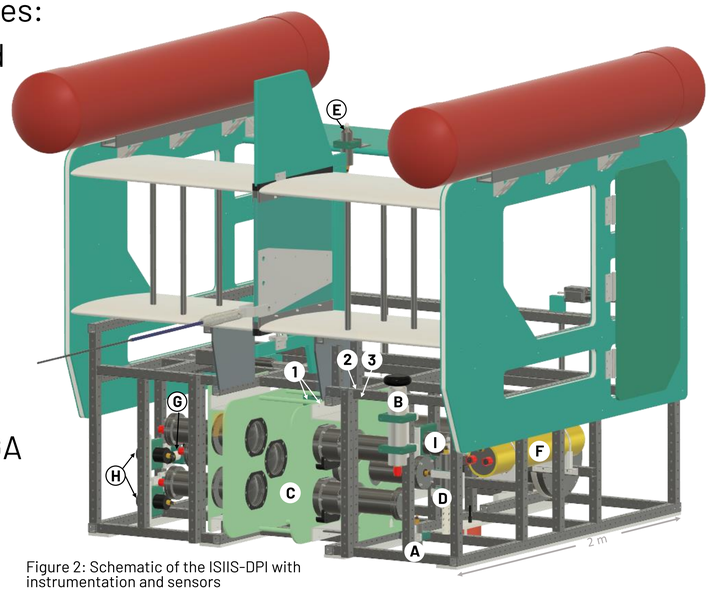
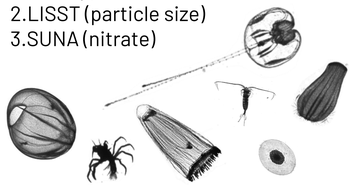


Figure 2: Schematic of the ISIIS-DPI with instrumentation and sensors

A. Altimeter
B. Flowmeter
C. Imaging Parcel
D. pH meter
E. PAR (photosynthetically active radiation)
F. EK80 (acoustics)
G. Oxygen (dissolved oxygen)
H. ECO triplet x2 (fluorescence)
I. AC-S (spectrophotometer)

Obscured in image:
1. FastCat x2 (depth, temperature, salinity)
2. LISST (particle size)
3. SUNA (nitrate)



- Remote Operated Towed Vehicle with fiber optic connections
- *In situ* instrumentation and an imaging array
- Automated and manual flight between the surface and target depths

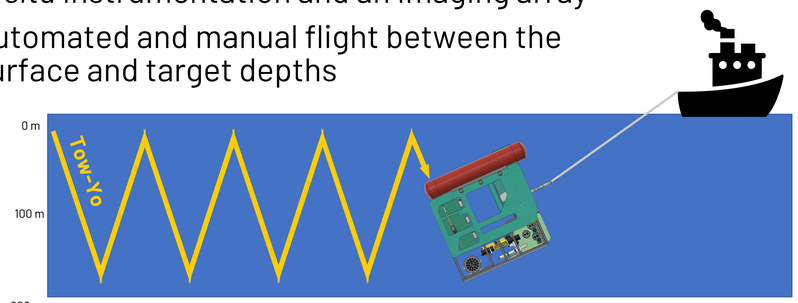


Figure 3: Depicts the "tow-yo" pattern as the ISIIS-DPI is towed behind a research vessel

Imaging System:

- 3 line-scan cameras
- Images ~240 L/sec total (900 GB/hr)
- Conserves scale of particles and plankton

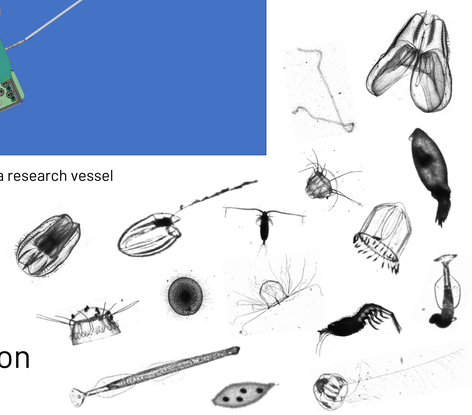


Image Analysis:

- High-performance computing system to automate image segmentation and classification
- Trained sparse Convolutional Neural Network
- 3 cameras processed in parallel
- Seward Line transect collects 28 hours of video (x3 cameras = 25 TB), processed in ~1 day

Preliminary Results

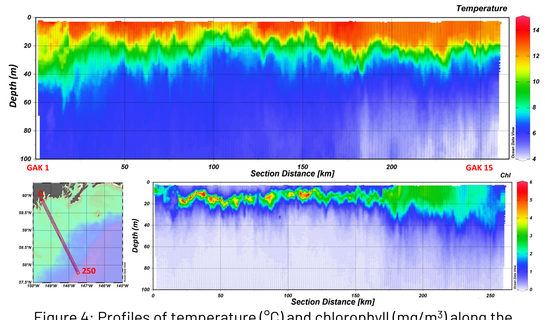


Figure 4: Profiles of temperature (°C) and chlorophyll (mg/m^3) along the July 2022 Seward Line transect (27.6 hr, ~250 km)

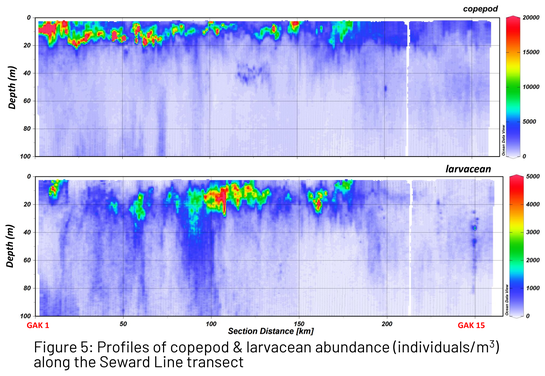


Figure 5: Profiles of copepod & larvacean abundance (individuals/m^3) along the Seward Line transect

- We have deployed the ISIIS-DPI on 3 NGA LTER cruises, collecting over 100 hours of data
- Simultaneous data streams from mounted instruments allow us to collect high-resolution data
- Substantial variability along the transect... compared to lower-resolution data when averaging across stations (Fig. 4)
- We can assign instantaneous physical/environmental conditions to each particle/plankton

Biological patterns

- Copepod abundance reflects the distribution of the subsurface chlorophyll max. in depth and intensity
- Larvacean abundance is offset (slightly deeper) from copepods in the thermocline
- Heatmaps of zooplankton abundance show us how they track biophysical parameters (temp, salinity, chl-a, etc.)
- Relationships are strongest for copepods due to robust abundance estimates (Fig. 5)

Discussion

My MSc project will use datasets generated with the ISIIS-DPI to...

- Describe the fine-scale patterns of gelatinous zooplankton abundance and distribution
- Assess the biophysical drivers behind these spatial patterns
- Identify groups of gelatinous zooplankton that poorly studied with traditional net sampling
- Resolve unknowns to improve our understanding of plankton communities in the NGA

Next steps:

- Refine our NGA specific training sets to optimize zooplankton identification

Acknowledgments

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