

# Application of machine learning to automated image analysis

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Oregon State University  
Hatfield

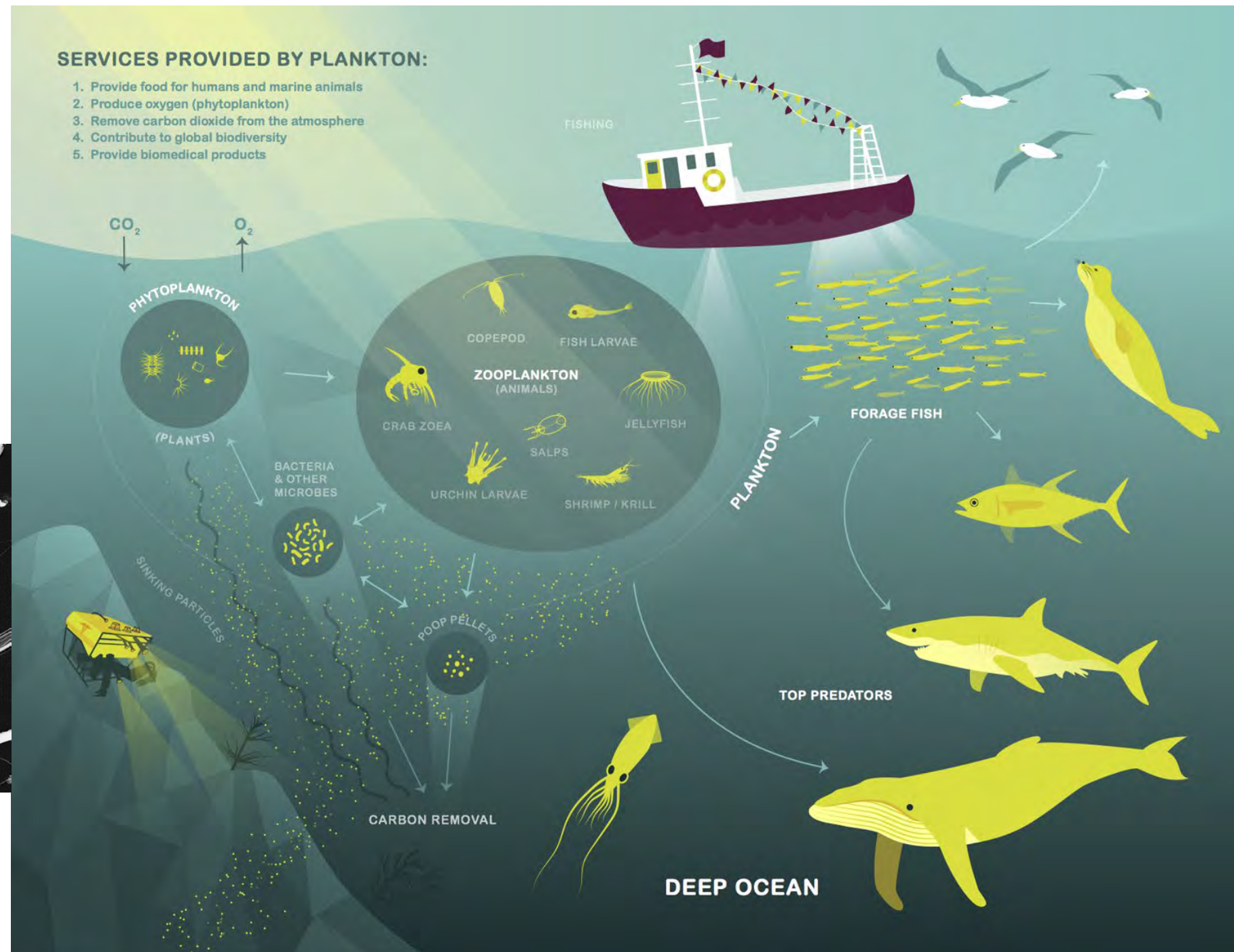
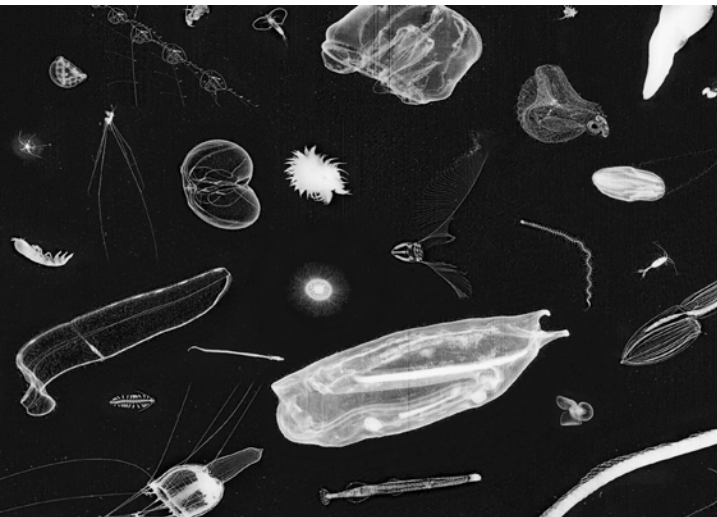


XSEDE

Extreme Science and Engineering  
Discovery Environment

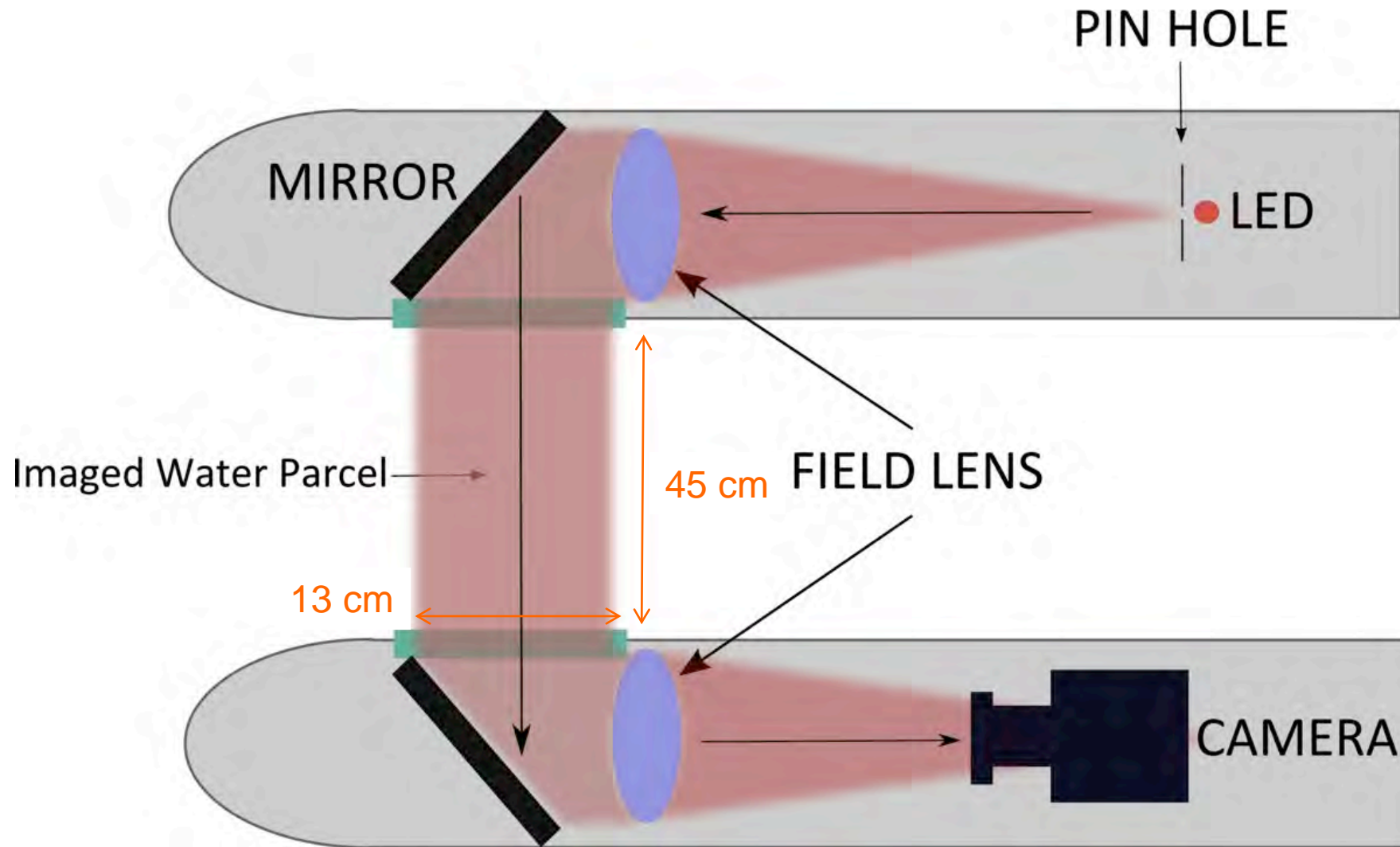


# Plankton: How do we sample it?



# In-situ Ichthyoplankton Imaging System (ISIIS)





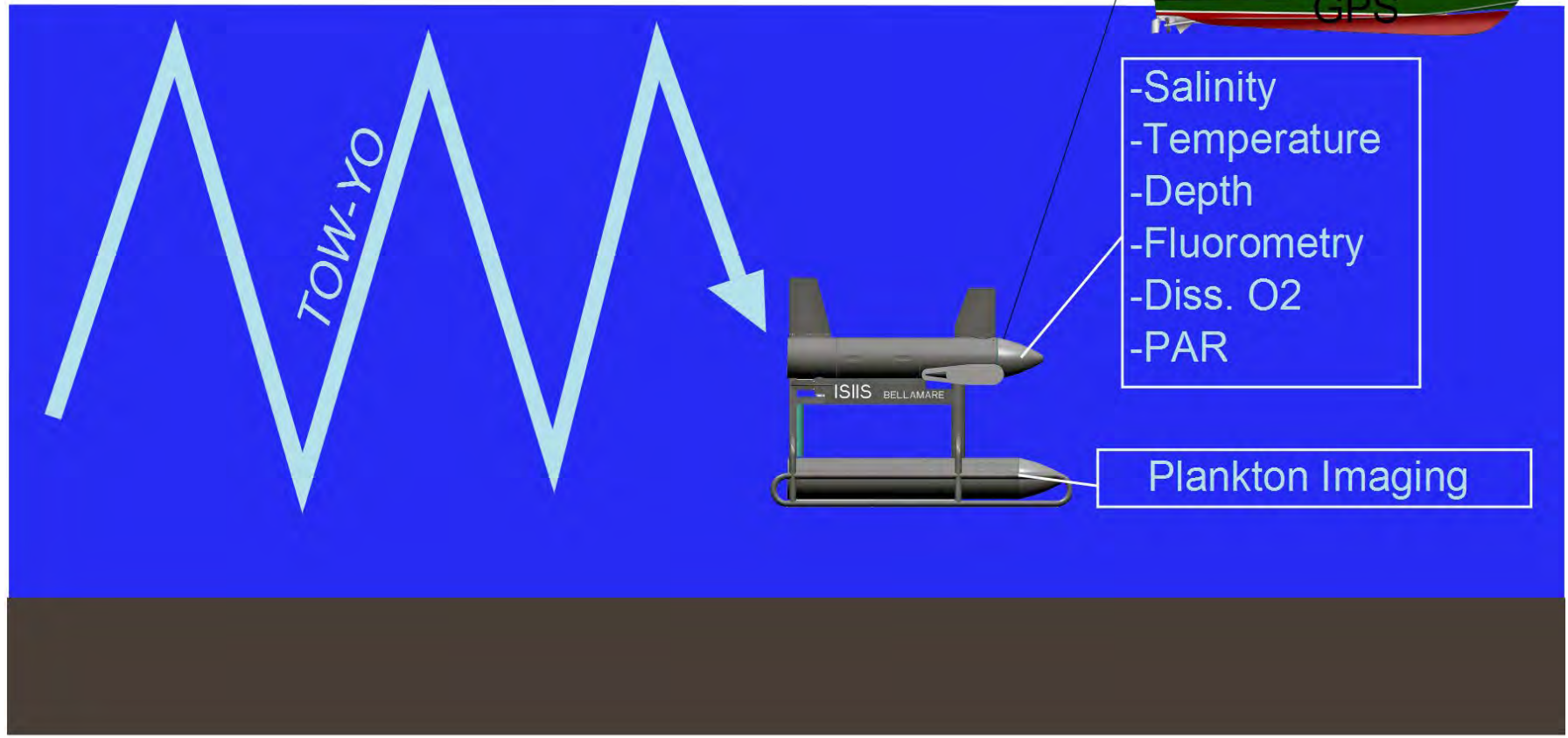
- 13 cm x 13-cm field of view
- 45 cm depth of field
- 2048 pixel line-scan camera
- 66  $\mu\text{m}$  pixel resolution
- 17 frames  $\text{s}^{-1}$
- 180 L  $\text{s}^{-1}$  imaged



5 kts =  $\sim 2.5 \text{ m s}^{-1}$

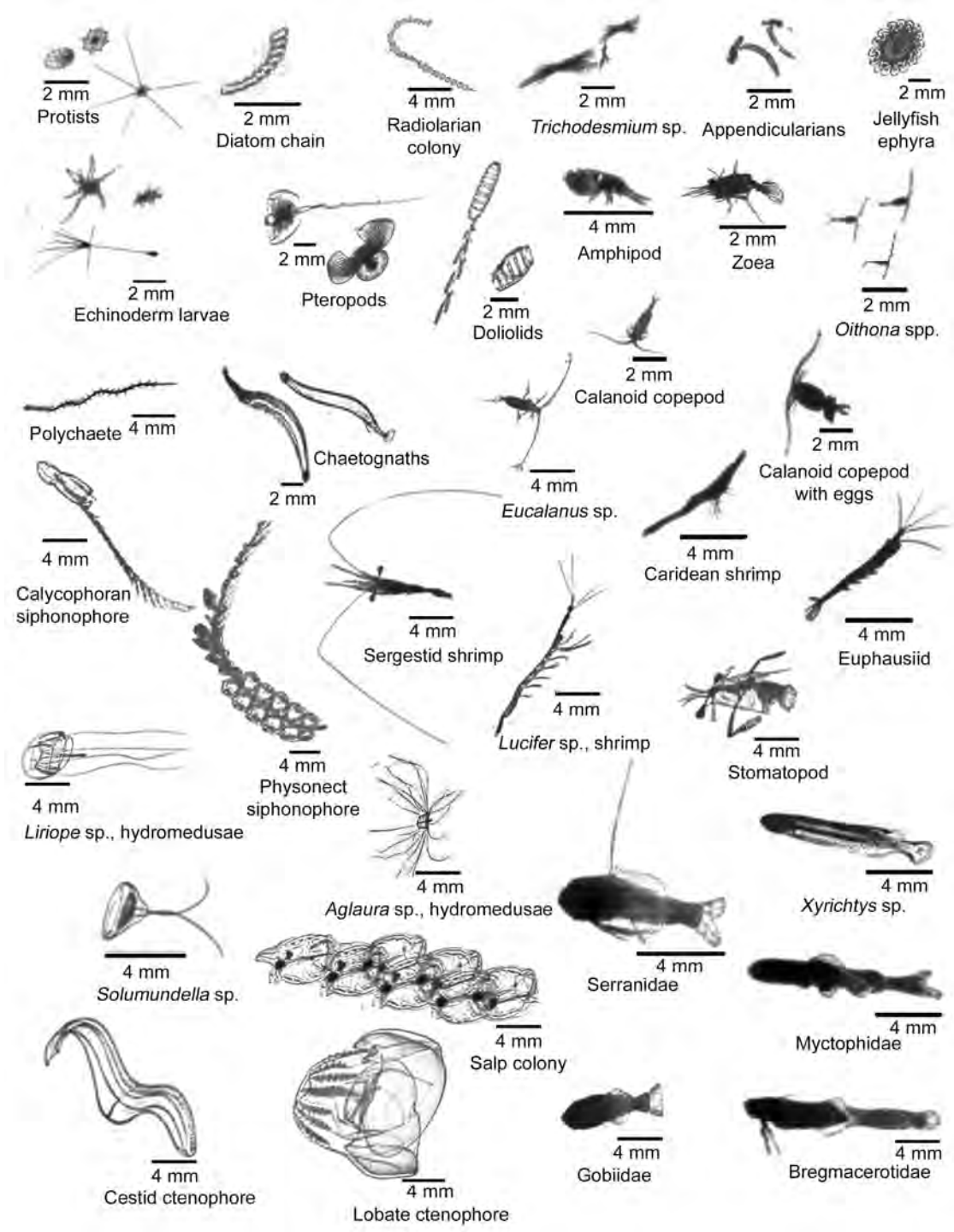


Up to 200 m



- Salinity
- Temperature
- Depth
- Fluorometry
- Diss. O2
- PAR

Plankton Imaging



# What does ISHS see?



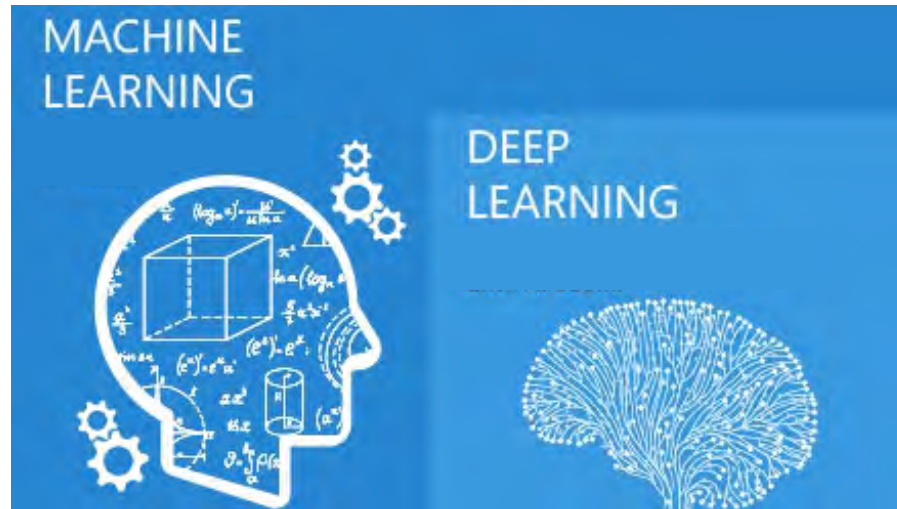
Now imagine that recording going on for several hours



Hundreds of millions to billions of single organisms imaged per cruise



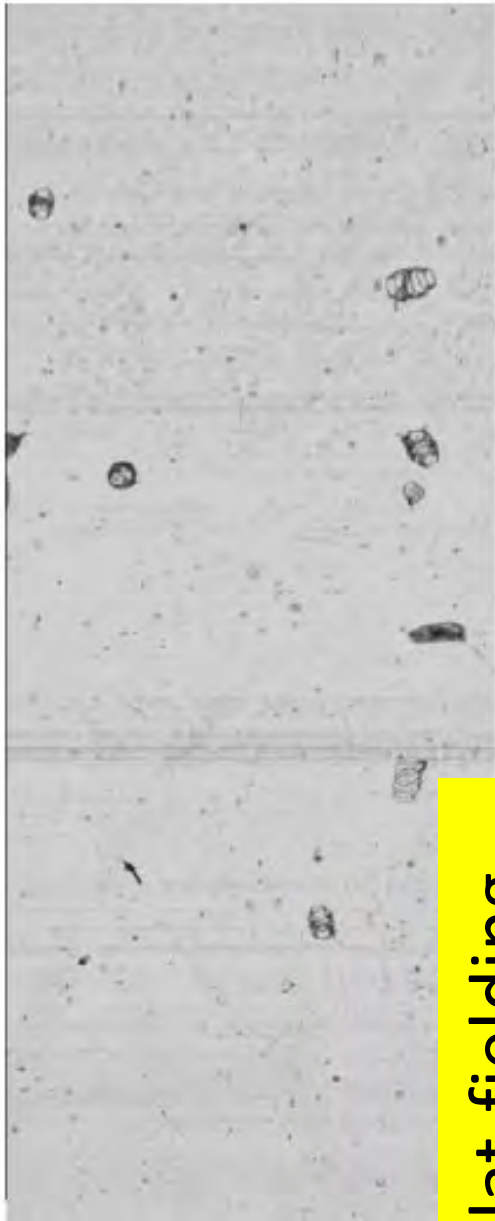
+



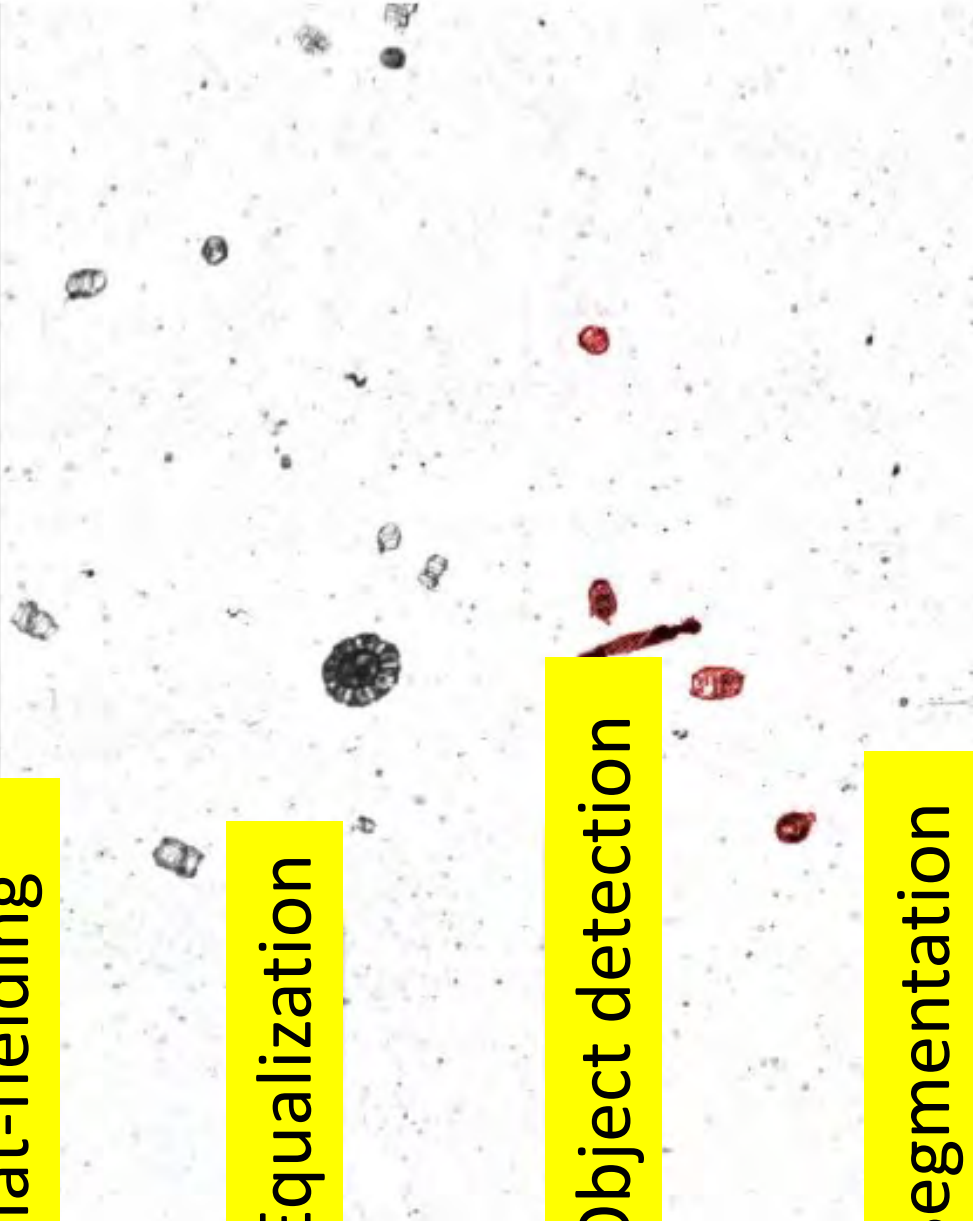




# Segmentation



Flat-fielding



Equalization

Object detection

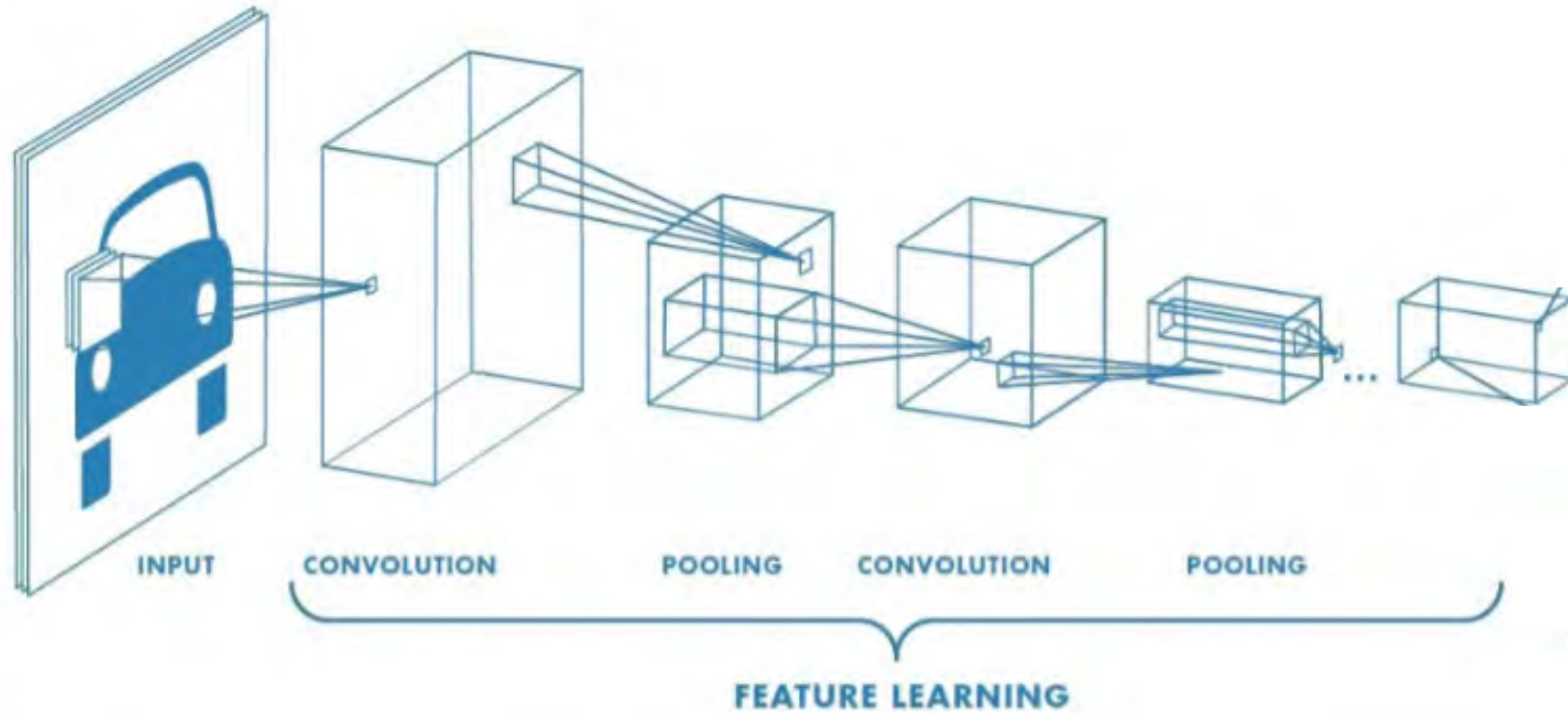
Segmentation



- Unsupervised k-harmonic means clustering
- Bounding box;  $\geq 250$  pixels are retained
- CPU machines (100+ cores)

# Convolutional neural networks (CNNs)

kaggle

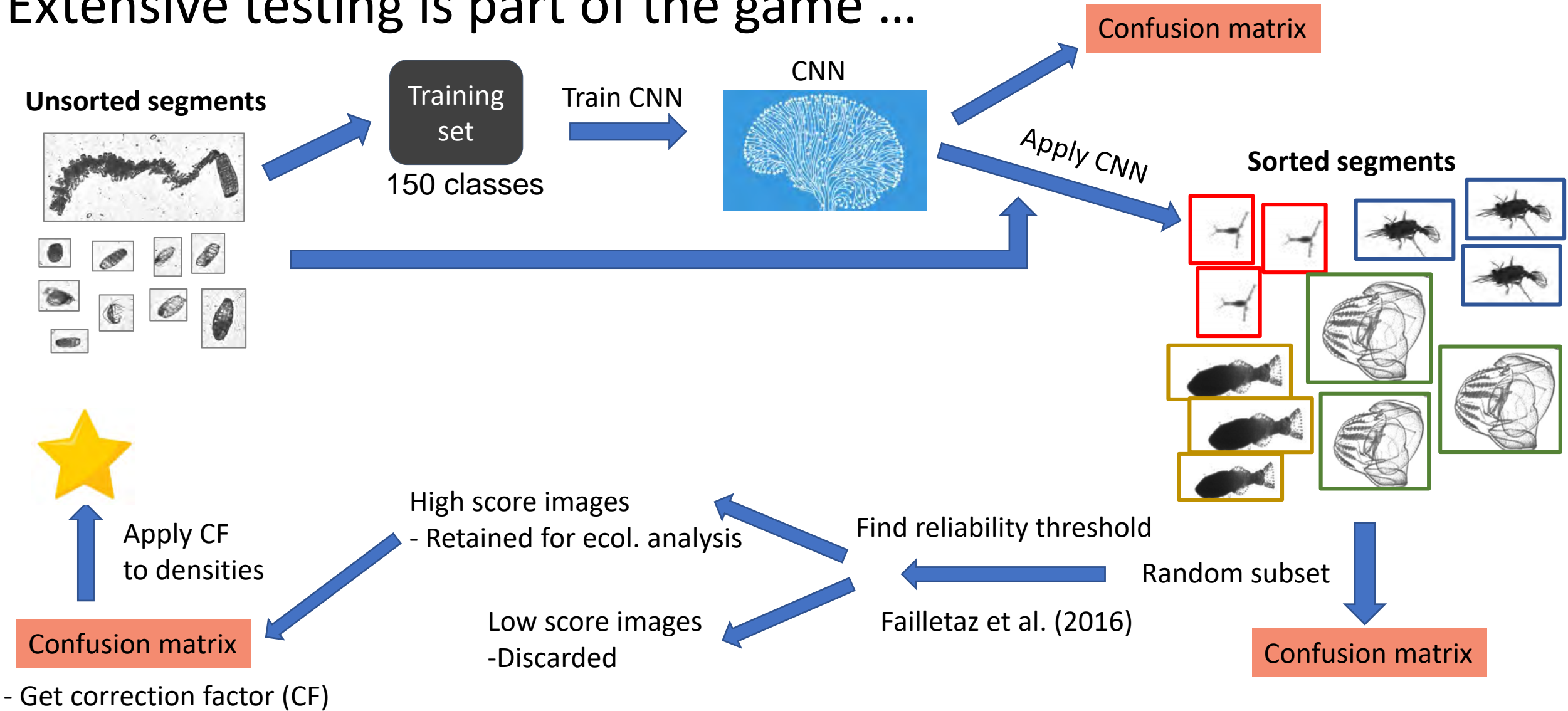


+ Fully connected layer  
- multinomial logistic regression

- Convolution (13x) = detect local combinations of features in images
- Pooling (12x) = merging similar features into one

SparseConvNet with Fractional Max-Pooling (Graham 2015)

# Extensive testing is part of the game ...

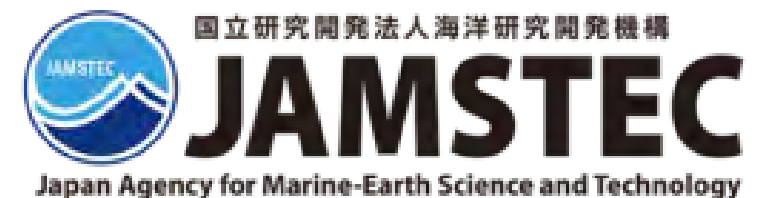


Current learning set: 161 classes

5.5h transect = 115M segments = 55h of processing  
(8 parallel jobs on Nvidia P100 GPUs)

# Efforts to make the pipeline more broadly available to the imaging community

- [www.PIC](http://www.PIC) funded by Belmont Forum
- Streamline steps to library generation
- Optimize CNNs for use across imaging systems (UVP, ISIIS....); transfer learning
- Make pipeline available to others



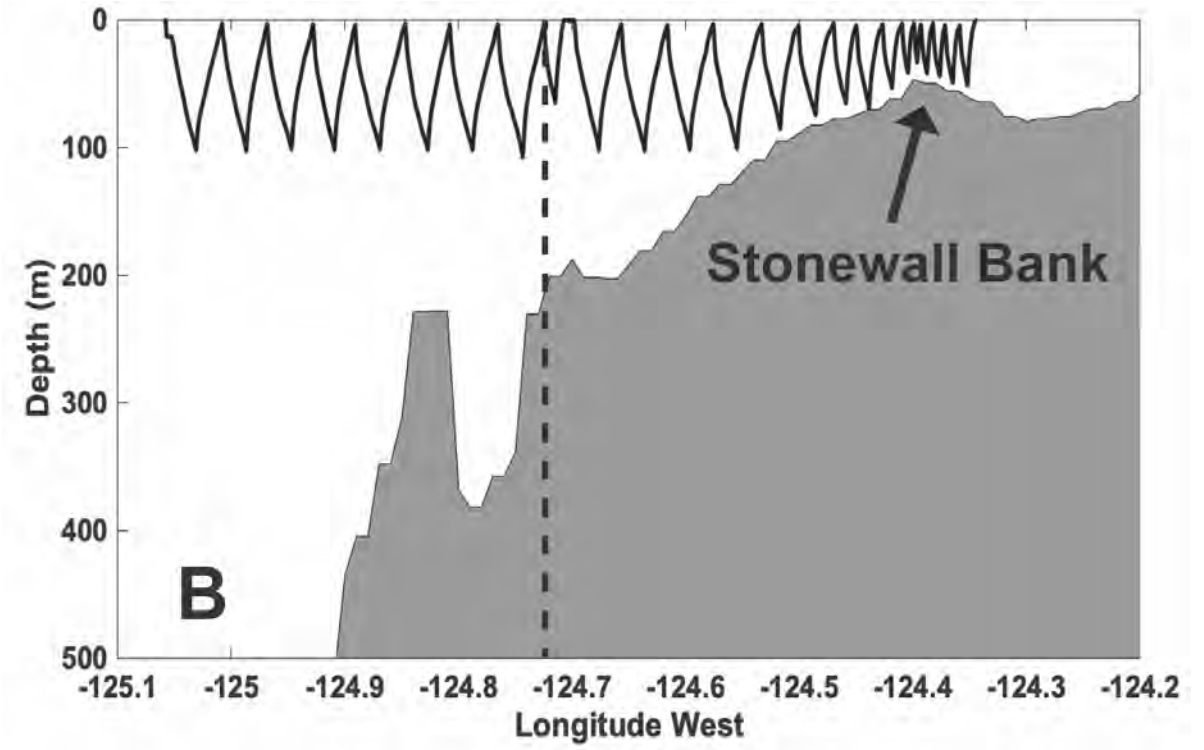
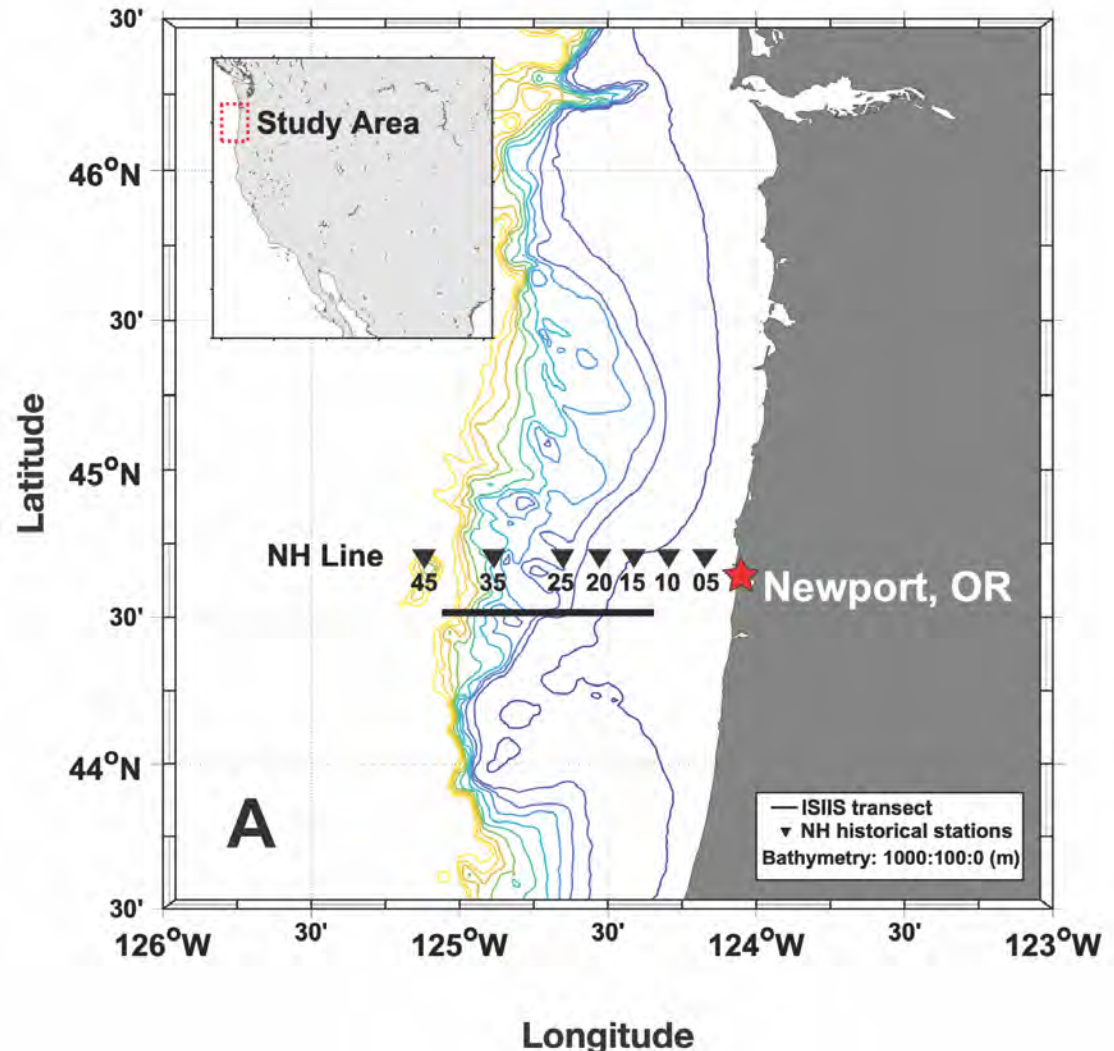
# Three-dimensional cross-shelf zooplankton distributions off the Central Oregon Coast



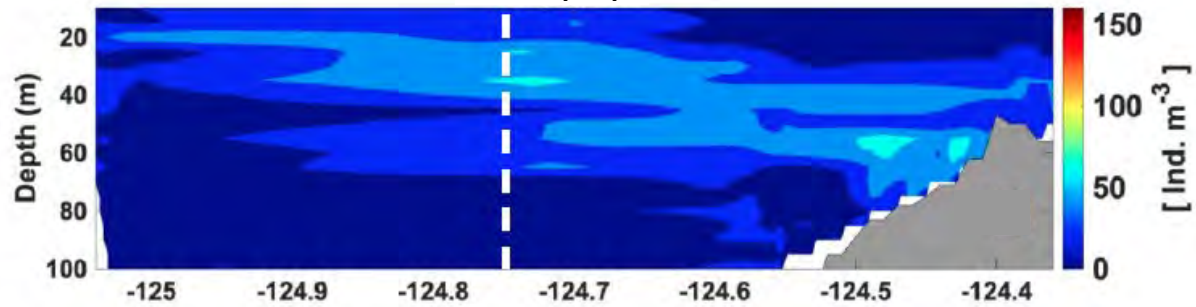
NOAA ship *Bell M. Shimada*

- Newport Hydrographic Line, sampled since 1961
- June 2016

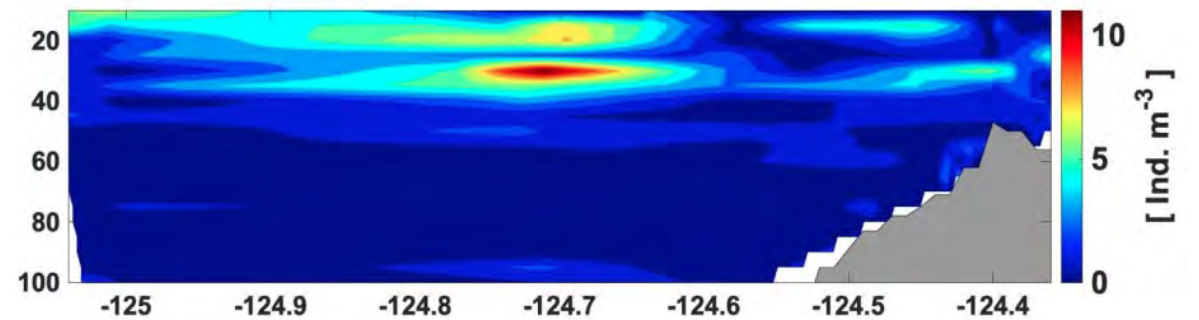
- What could be gained by adding an underwater plankton imager to more traditional deployments?



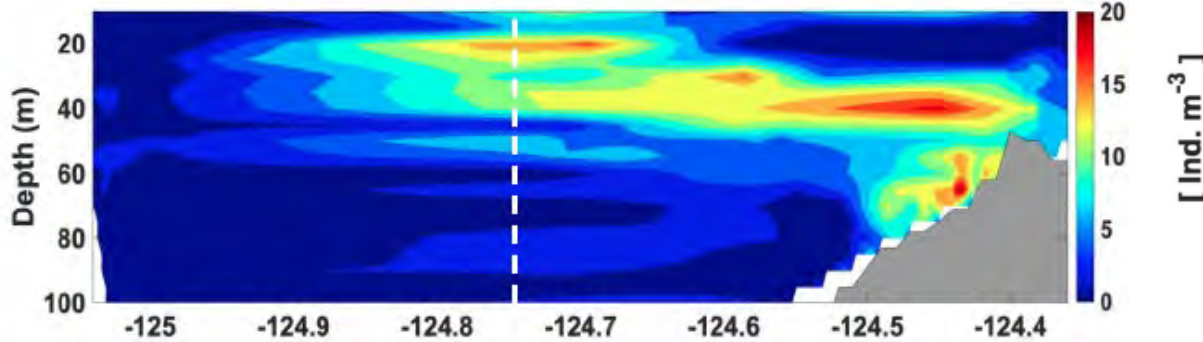
All copepods



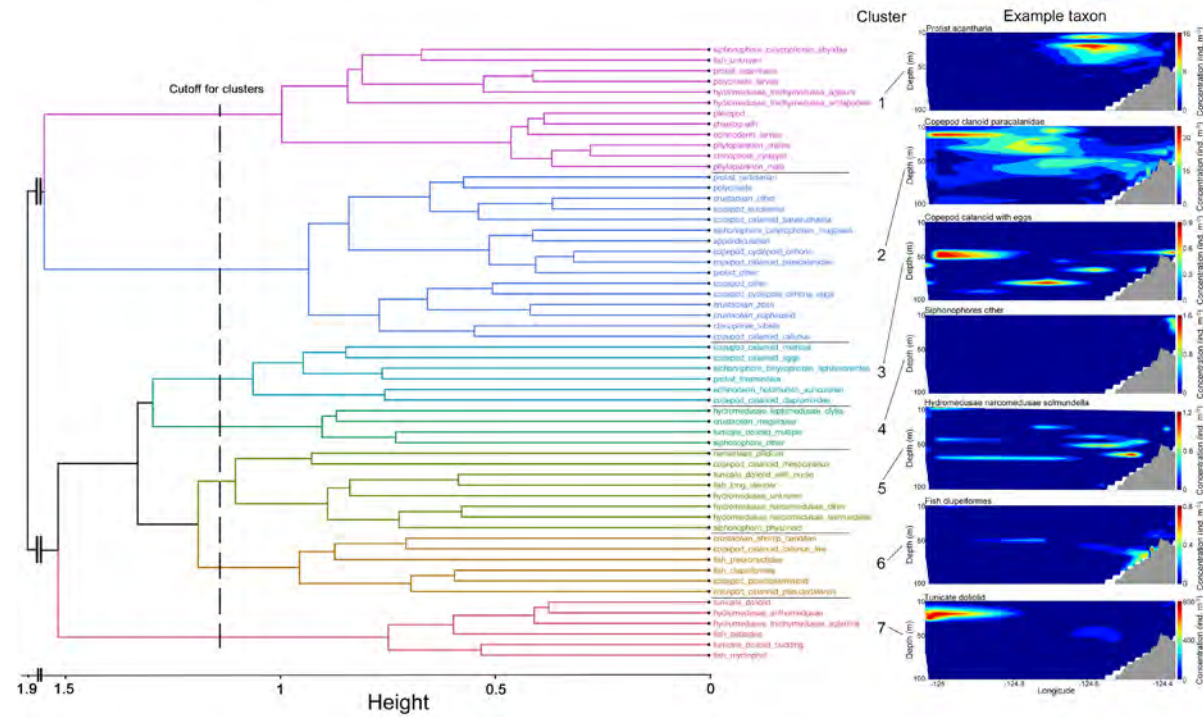
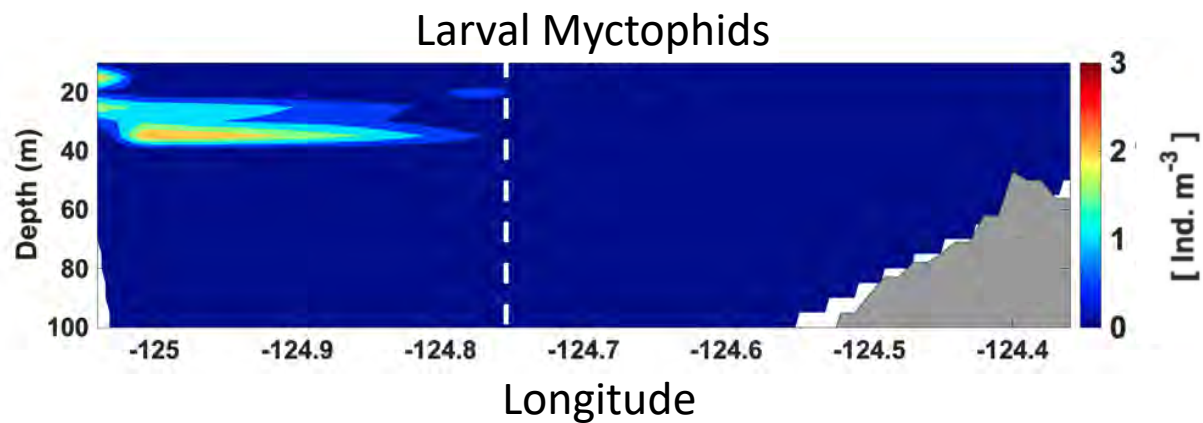
Siphonophores



*Oithona*



Longitude





A photograph of an offshore oil rig deck at sunset or sunrise. The sky is a deep blue with wispy clouds, and the sun is low on the horizon, creating a bright orange glow. The rig's structure, including a crane and various pipes, is visible on the left side. The word "Questions?" is overlaid in large white text in the upper right quadrant.

Questions?