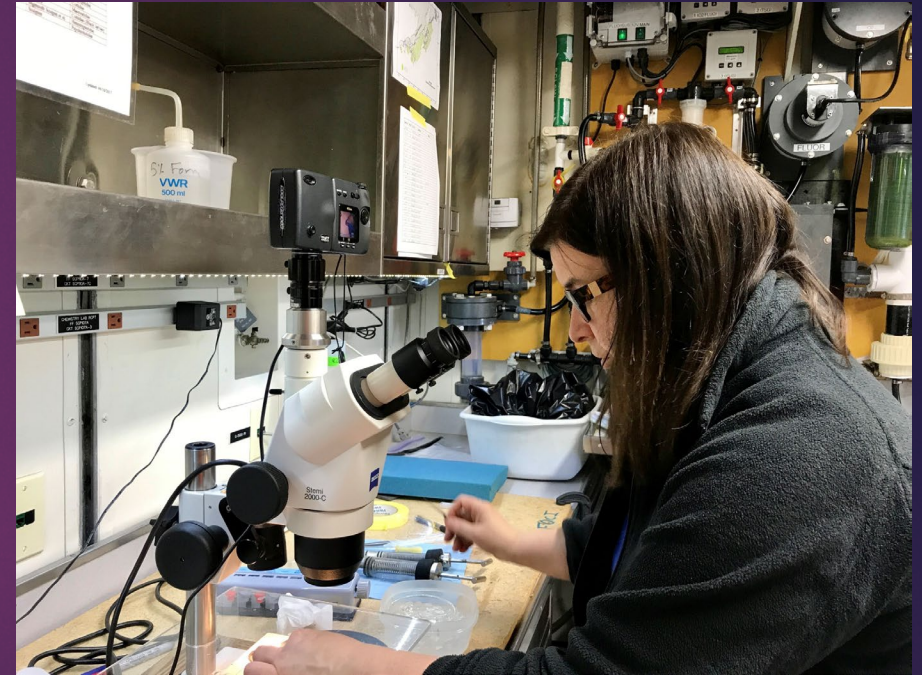# Automation of rapid zooplankton assessment for use in ecosystem based fisheries management

David G. Kimmel, Deana C. Crouser, Paweł Kaźmierczak, Barbara Kłopotowska, Mirosław Ciupiński, and Hongsheng Bi

Outline

- Applying zooplankton information to fisheries management – the problem

- Rapid Zooplankton Assessment (RZA)

- An automated approach to the RZA – a work in progress
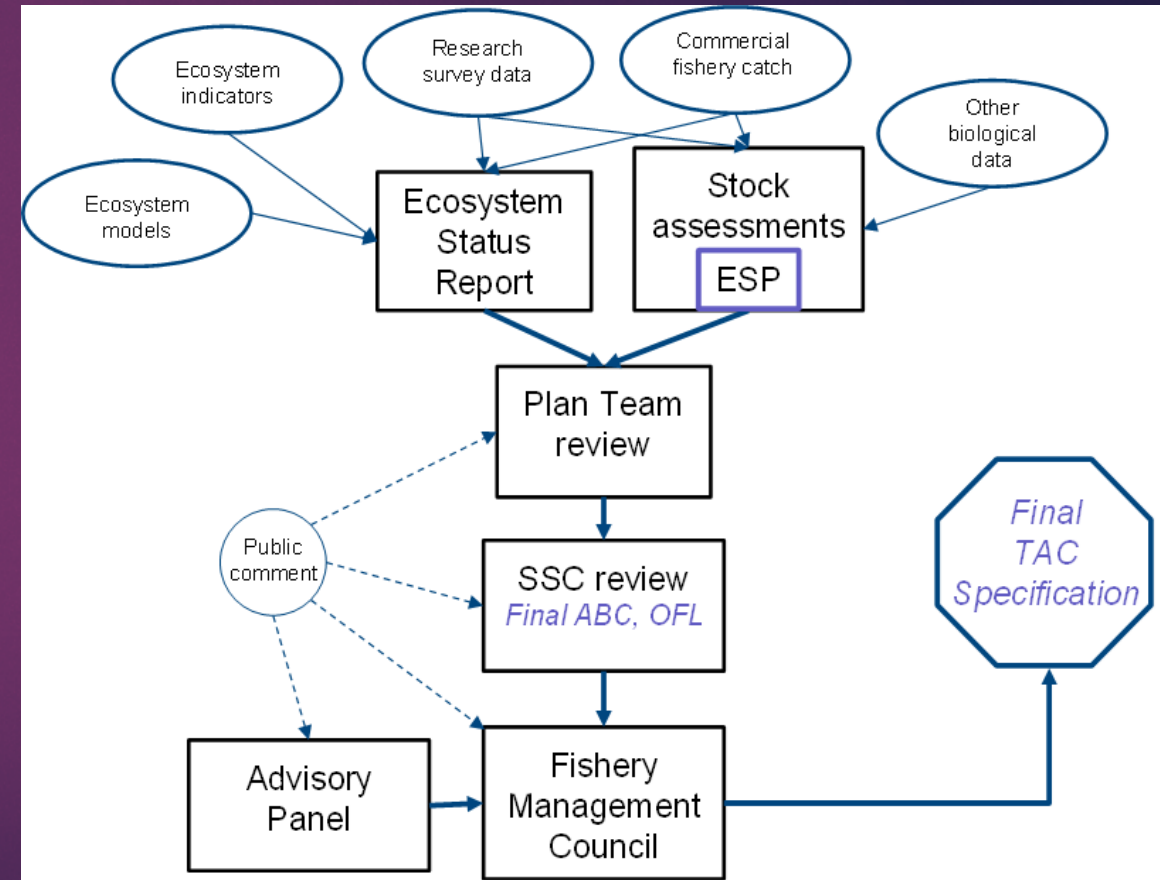
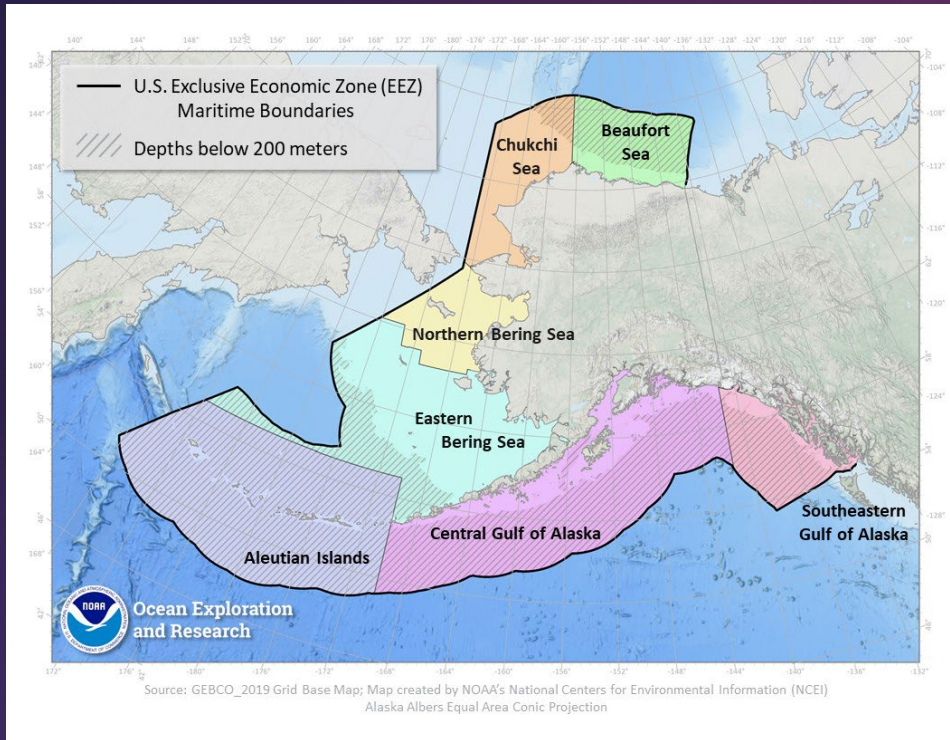- Future work and some parting thoughts

Fisheries management in Alaska

- 60,000 jobs in the seafood industry
- $1.7 billion, 31% of the US total revenue

Annual cycle

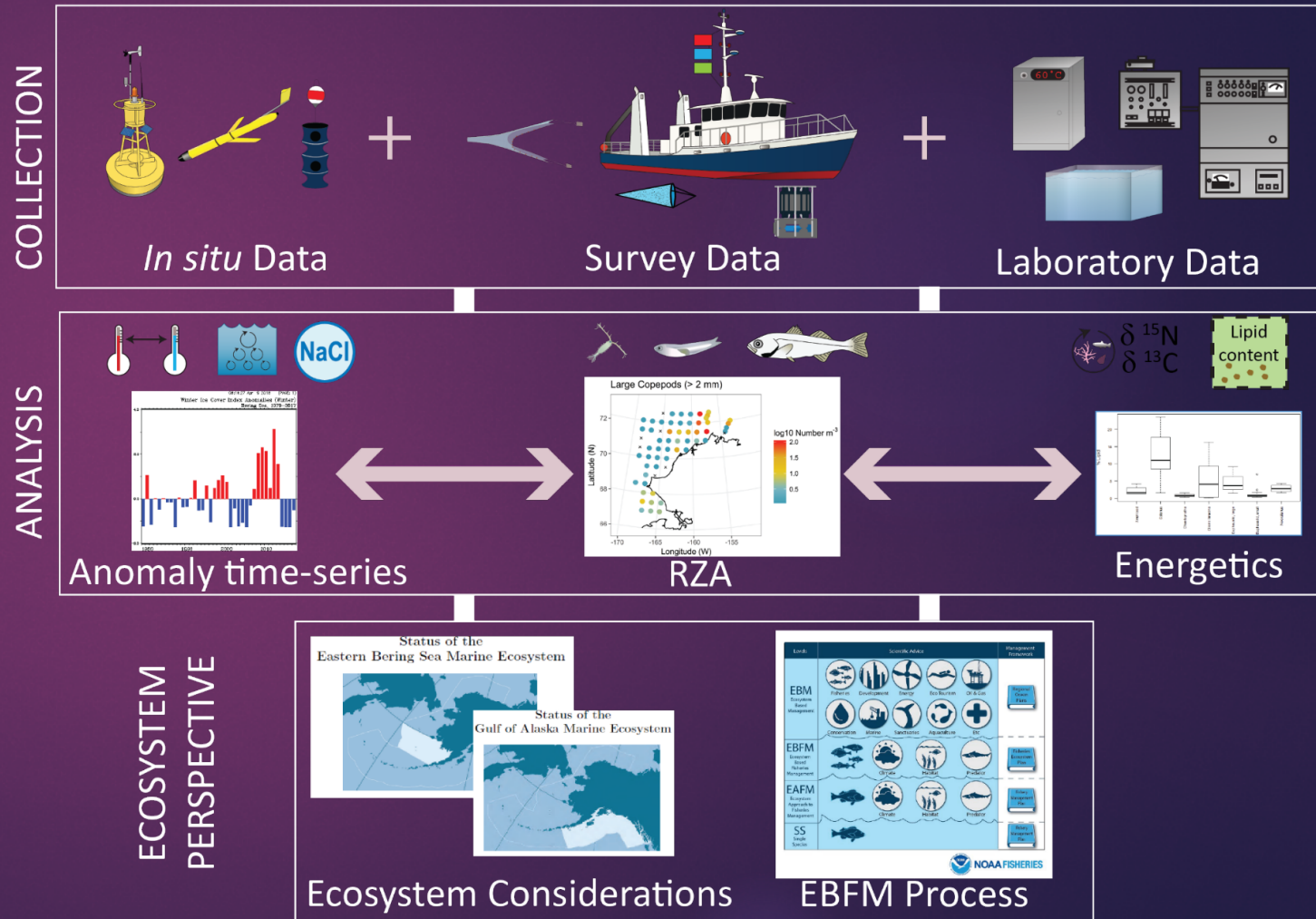# Ecosystem assessment

Source: GEBCO_2019 Grid Base Map; Map created by NOAA's National Centers for Environmental Information (NCEI)
Alaska Albers Equal Area Conic Projection

Recruitment Processes Alliance

COLLECTION

In situ Data + Survey Data + Laboratory Data

ANALYSIS

Anomaly time-series ⟷ RZA ⟷ Energetics

ECOSYSTEM PERSPECTIVE

Ecosystem Considerations   EBFM Process

▶ 5 large marine ecosystems = a lot of samples

Rapid Zooplankton Assessment

- The problem: zooplankton data were not being applied to fishery management during the annual cycle

    - Collecting zooplankton is easy, turning a zooplankton sample into meaningful data is hard

        - Expertise and Time

- The solution

    - A rapid sort on board the ship to approximate the standing stock of important zooplankton groups

RZA methods

Large copepods > 2 mm
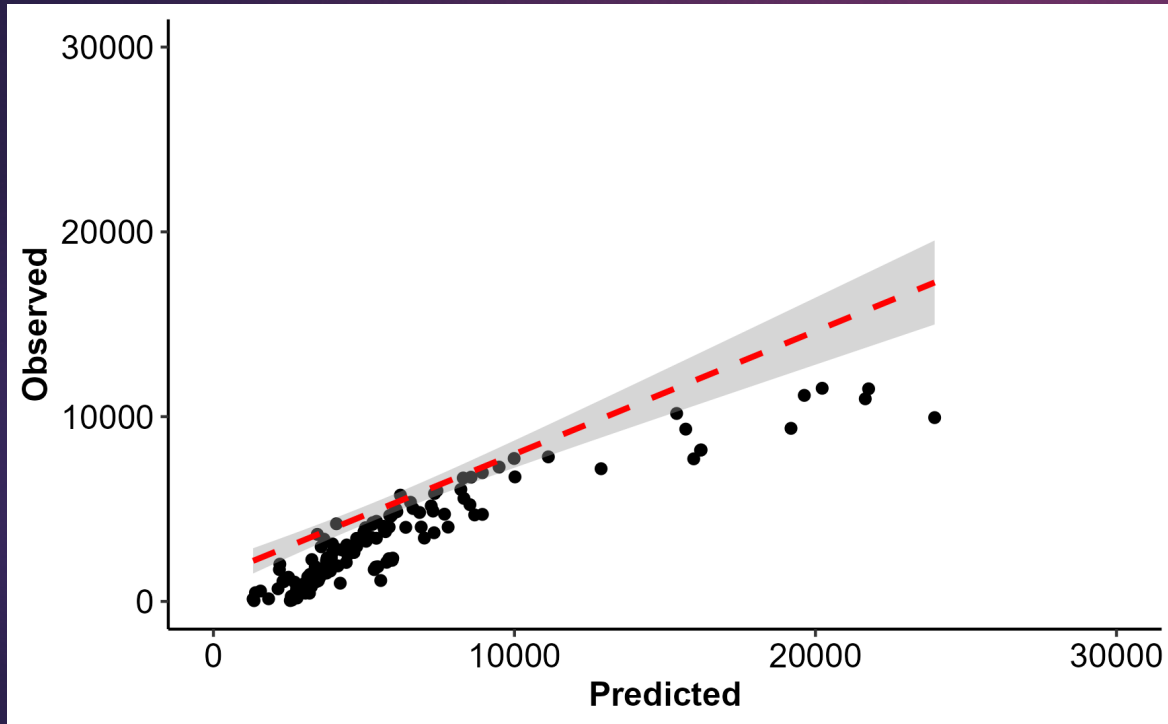
Calanus, Neocalanus

Small copepods < 2 mm
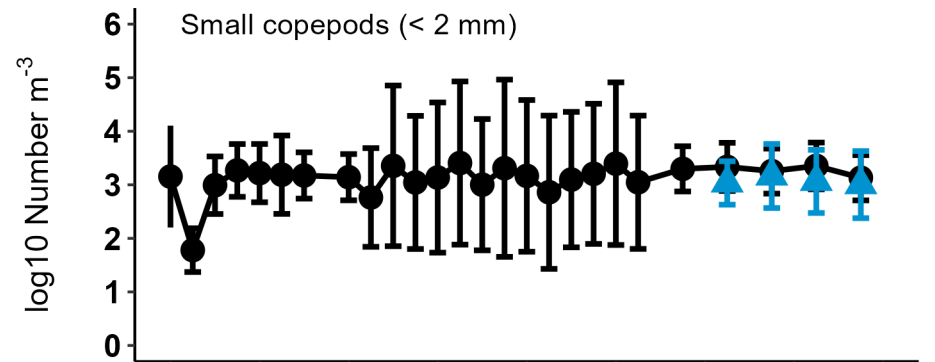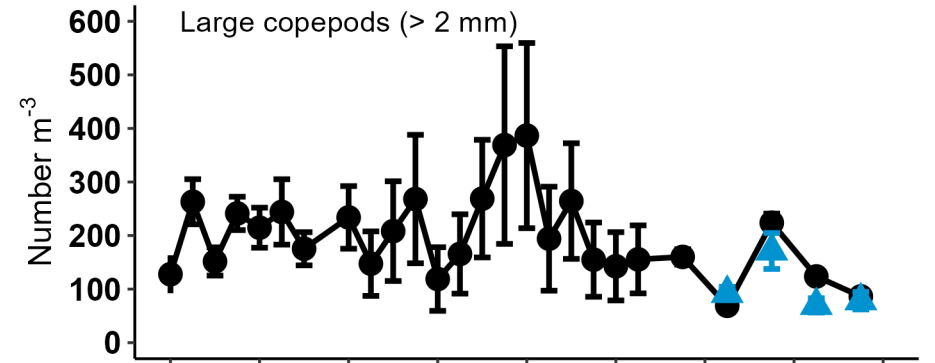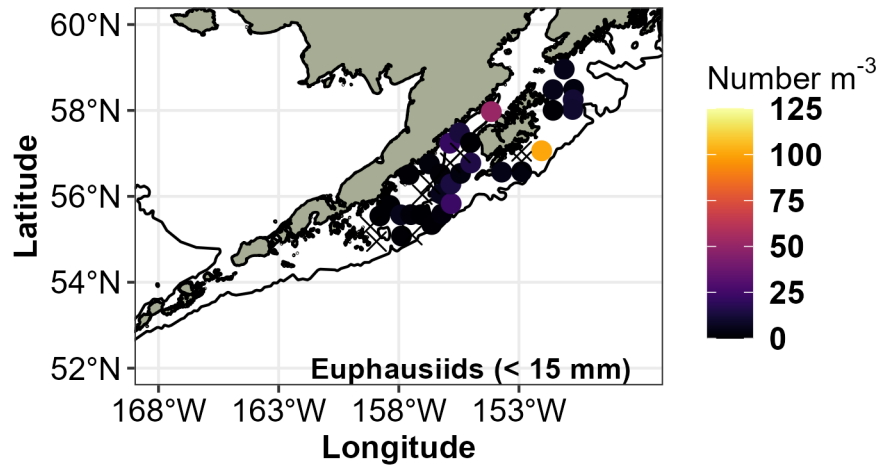
Pseudocalanus, Acartia, Oithona

Euphausiids < 15 mm

Thysanoessa inermis, T. raschii

Bayesian analysis of RZA

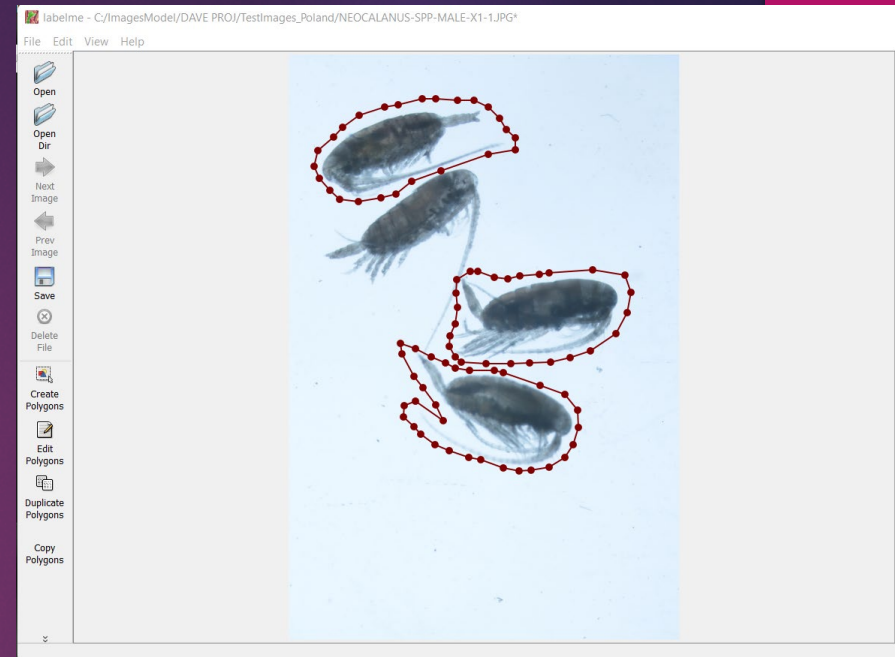| Model	Intercept	Slope	r^2	EPLD
Base + Sorter (Random, Fixed)	**8.33**	**0.65**	**0.63**	**0**
Base + Sorter (Random)	8.27	0.61	0.62	-7.2
Base + LME	8.13	0.64	0.59	-32.7
Base	8.23	0.65	0.59	-33.2
Base + Season	8.26	0.66	0.59	-33.4

RZA Results
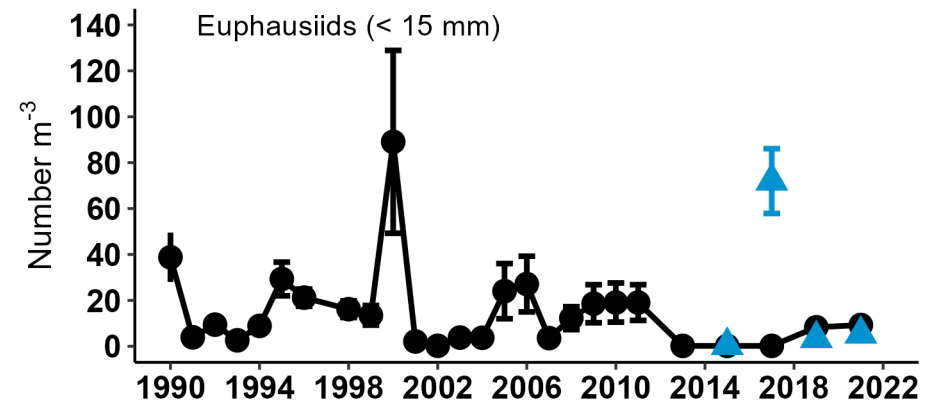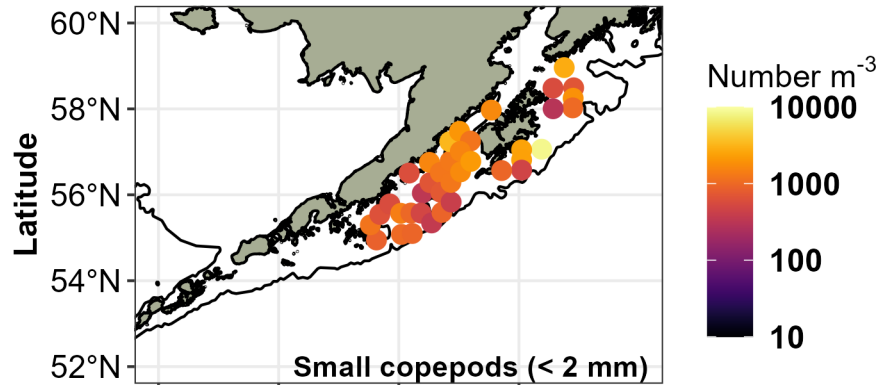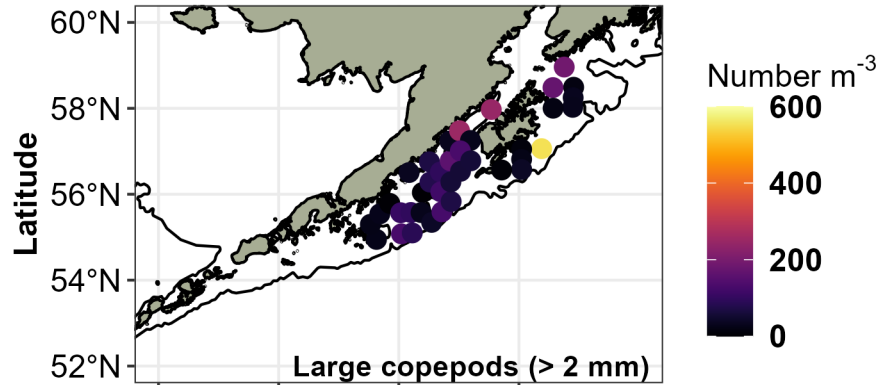
Automating the RZA

- Remove sorter impact on RZA

- Reduce time to produce RZA data

- Provide an easy to use tool to produce RZA in other Large Marine Ecosystems

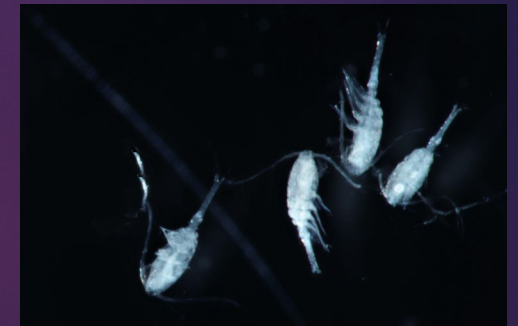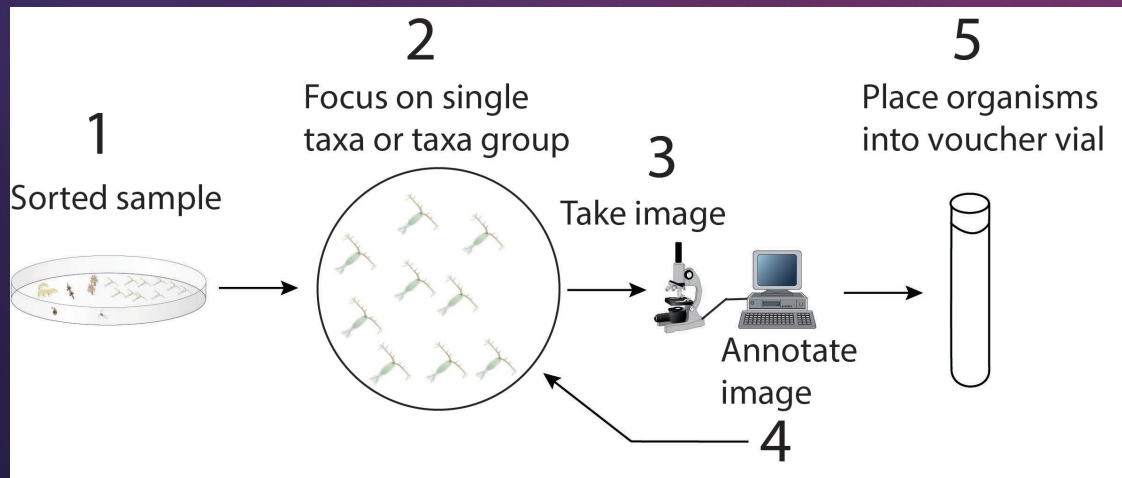- Produce additional information (size, lipid content) for context

The duel was set,
John Henry against the machine.

Training library

LabelMe

Poland Sorting and Identification Center

1 Sorted sample

2 Focus on single taxa or taxa group

3 Take image

4 Annotate image

5 Place organisms into voucher vial

Algorithm flow –Scene model
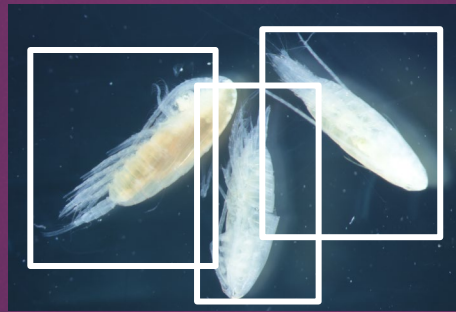

Detect background

→ ShuffleNet

Dark background

Light background

Algorithm flow – Mask R-CNN
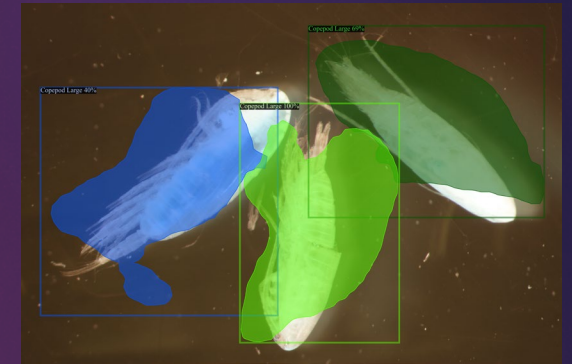
Mask Region Based Convolutional Neural Network

ROI detection

Classification

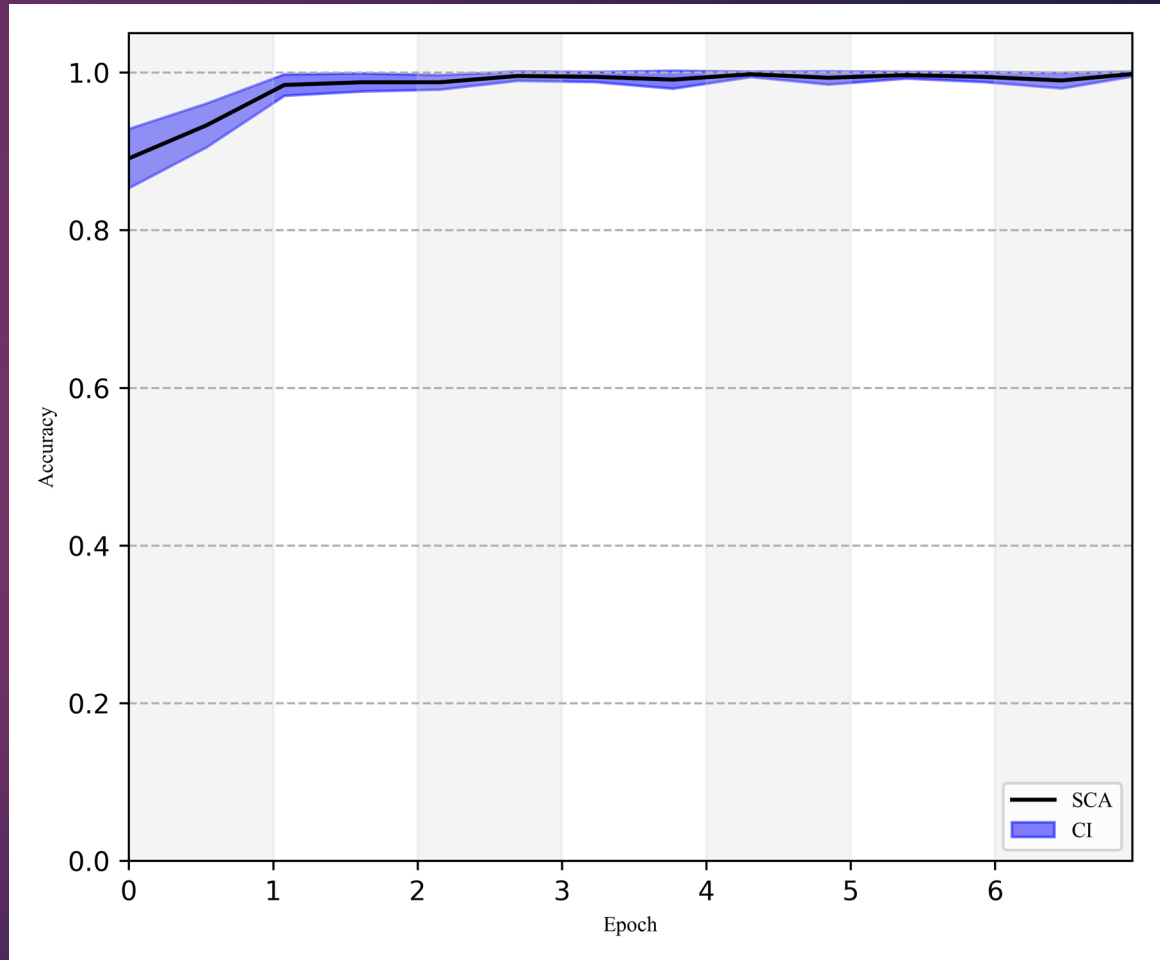Regional Proposal Network
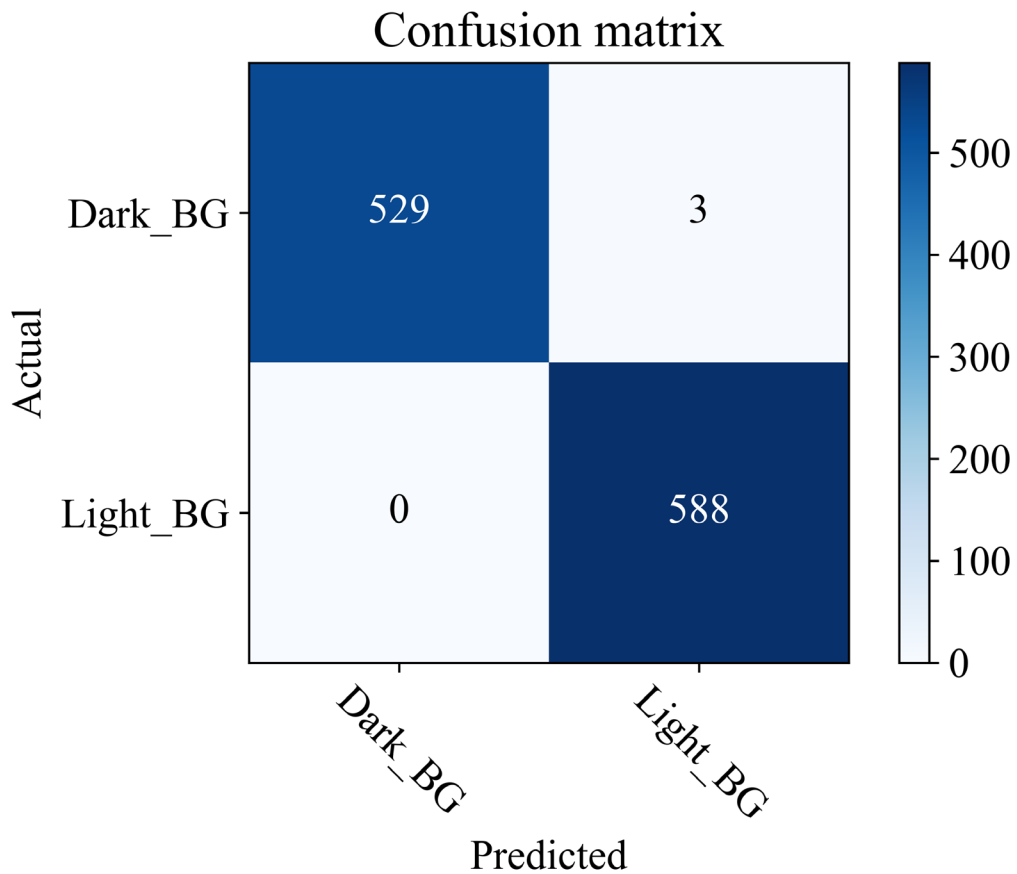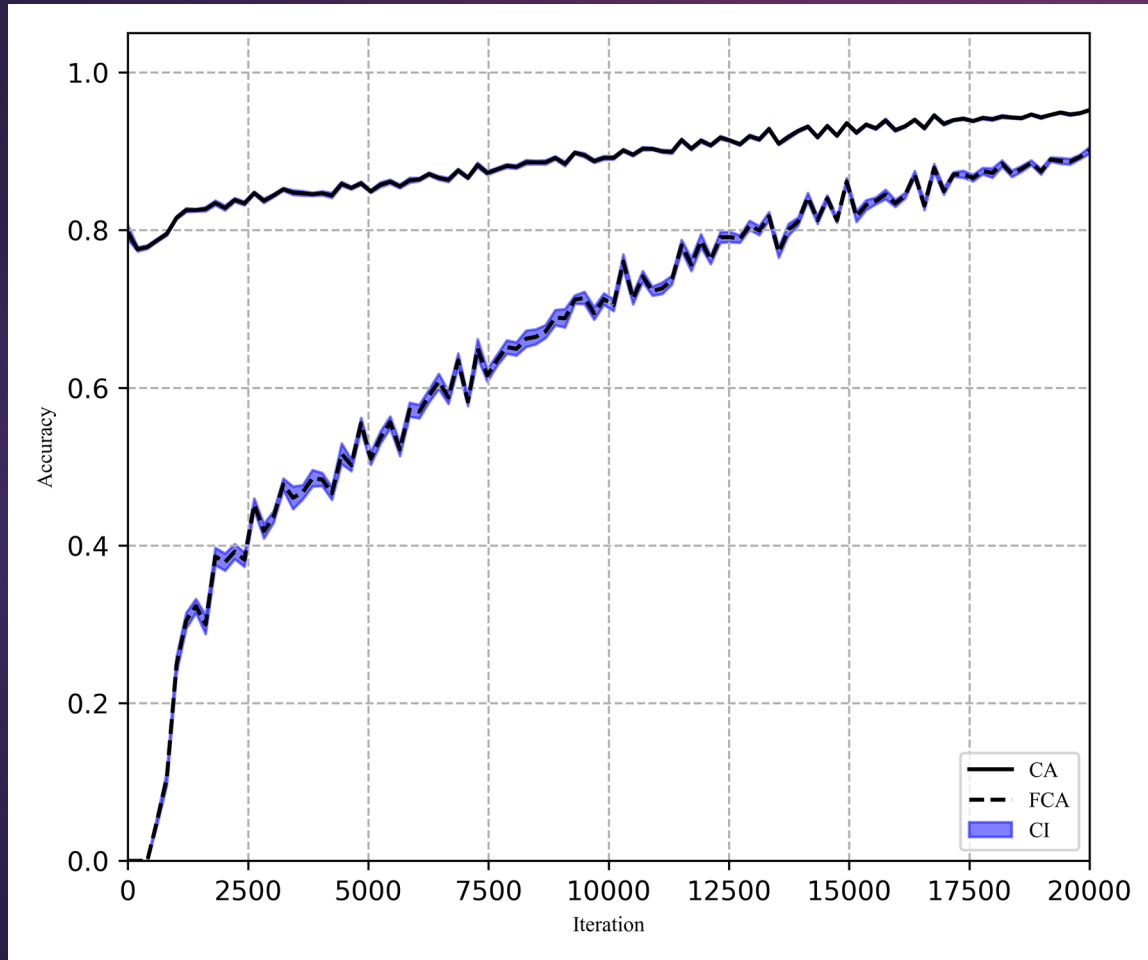
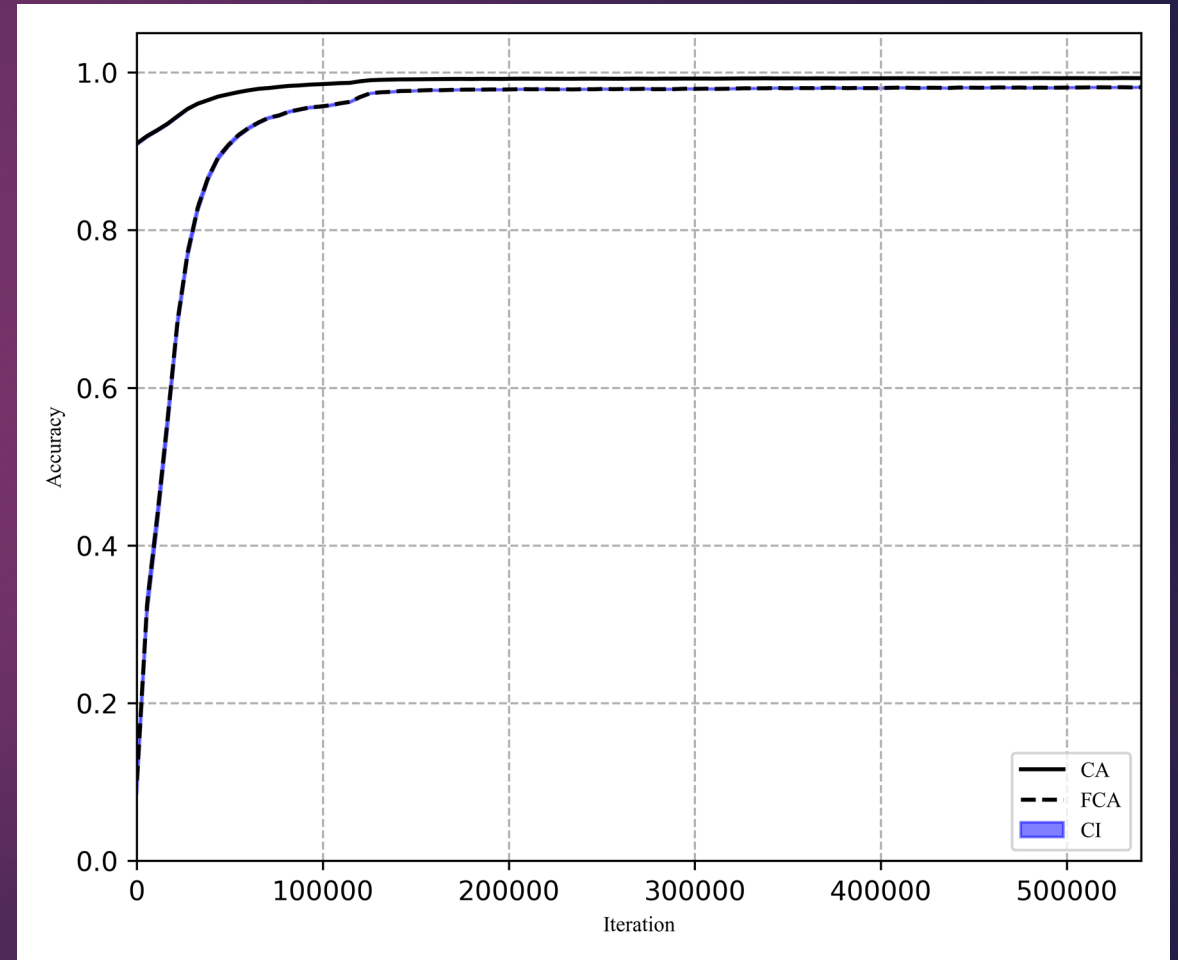Residual Neural Network

Training – Scene classification

Training – Object classification
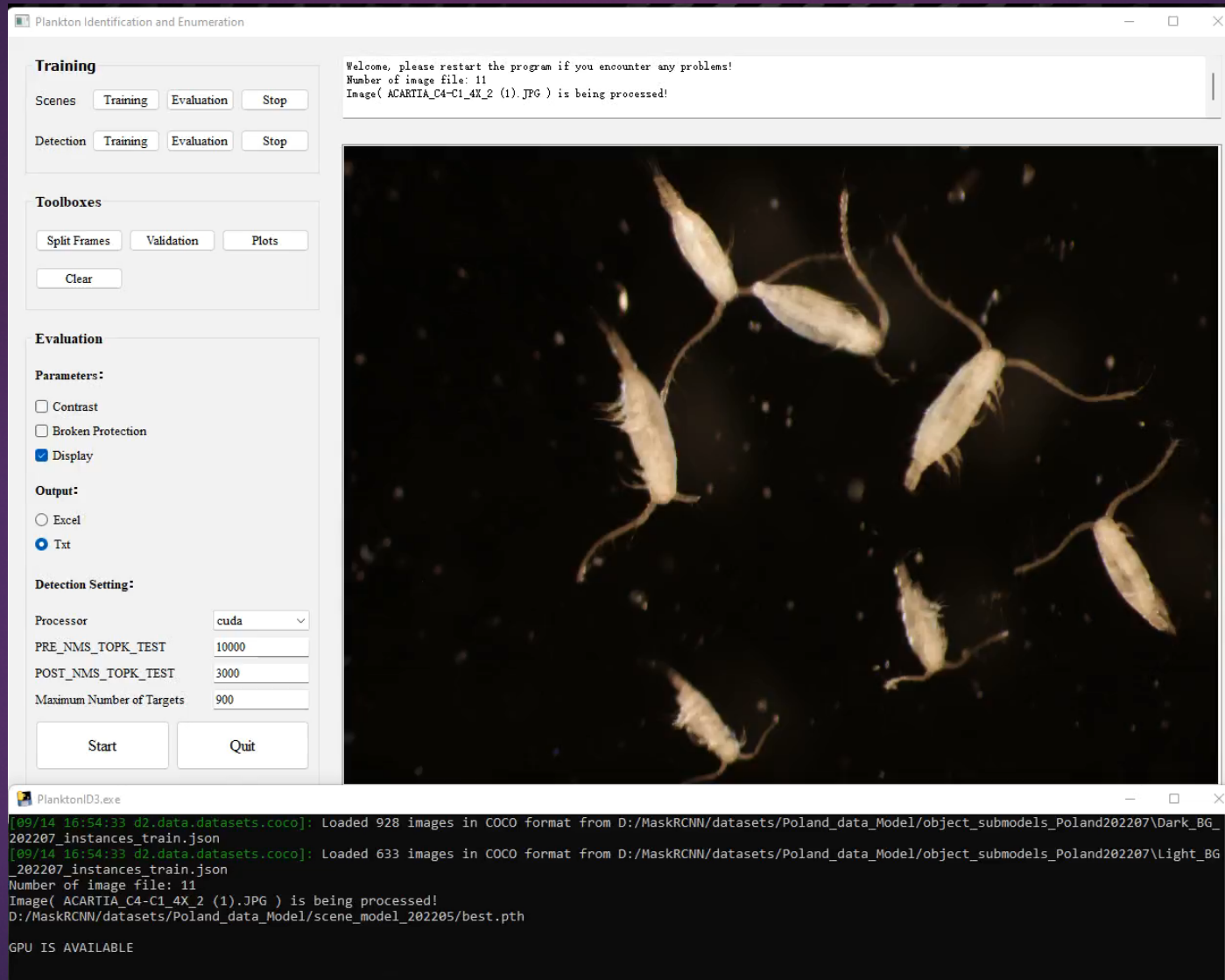

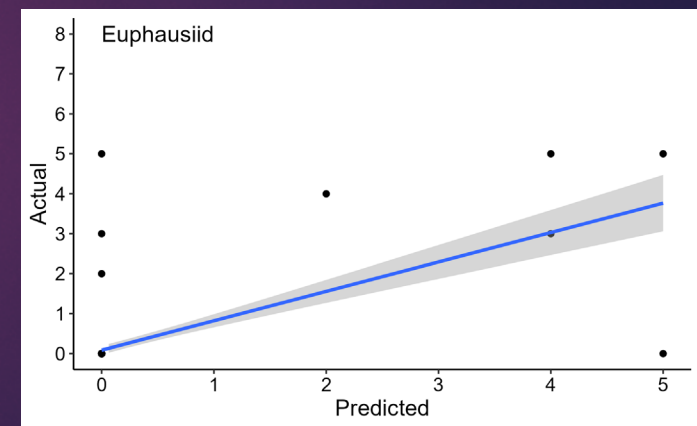Initial training

Current training

Video of software in action

Testing

Classification

Counts
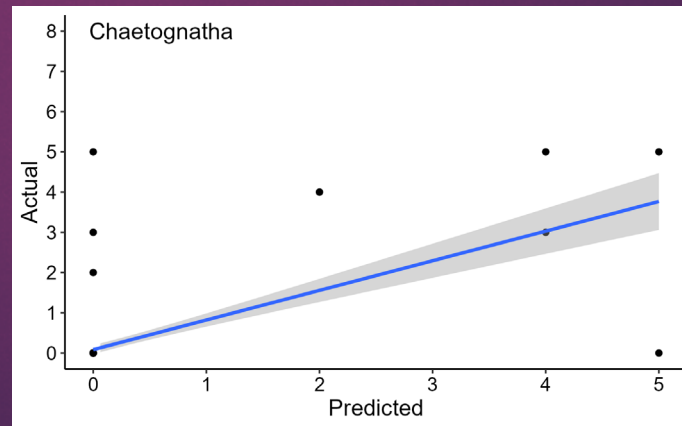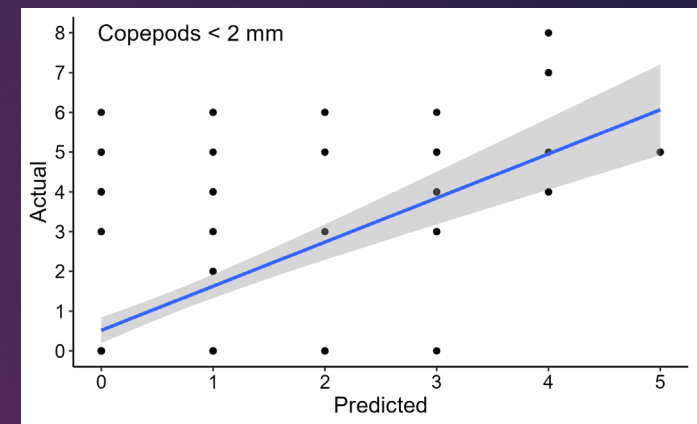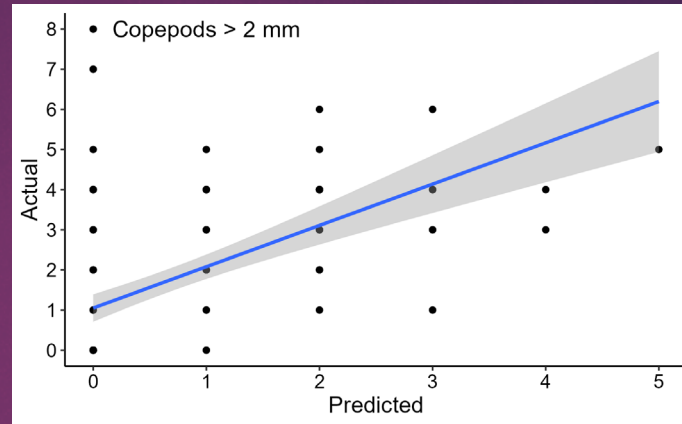
Conclusions and Future Work

- ▶ Based on beginning set of training data we have a viable classifier for the RZA categories
- ▶ Annotate and train, annotate and train, annotate and train…
- ▶ Develop streamlined image generation at sea
  - ▶ Currently, using microscope, but could improve
- ▶ How robust is the algorithm?
  - ▶ We plan to add in field generated images, which will require more training, adjustments, a new algorithm?