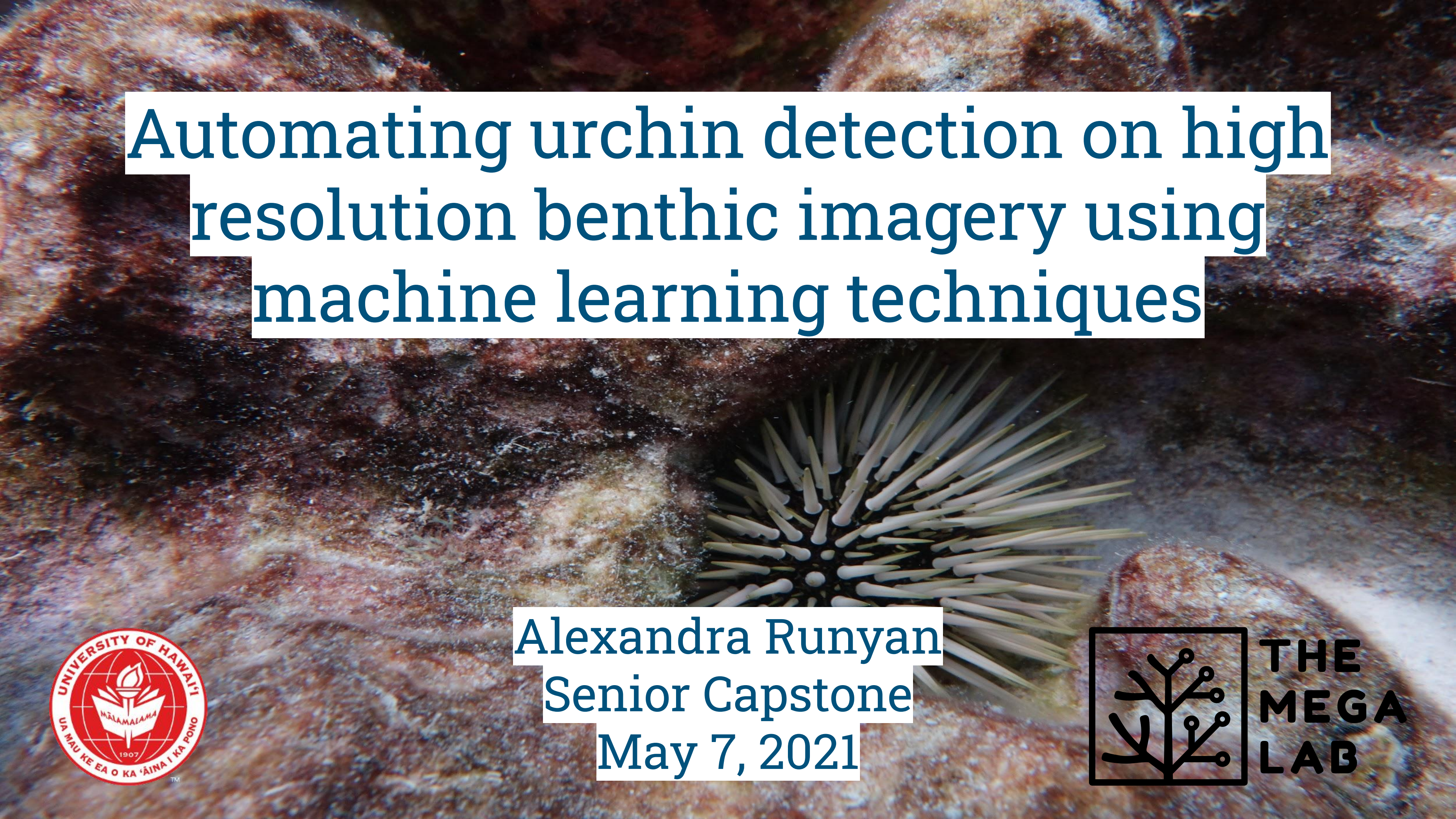
Automating urchin detection on high resolution benthic imagery using machine learning techniques



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May 7, 2021

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THE MEGA LAB

Importance of Herbivores on Coral Reefs

- Herbivory on coral reefs makes hard substrate available for coral settlement
- Overfishing has removed many herbivorous fish from reef ecosystems

Importance of Herbivores on Coral Reefs

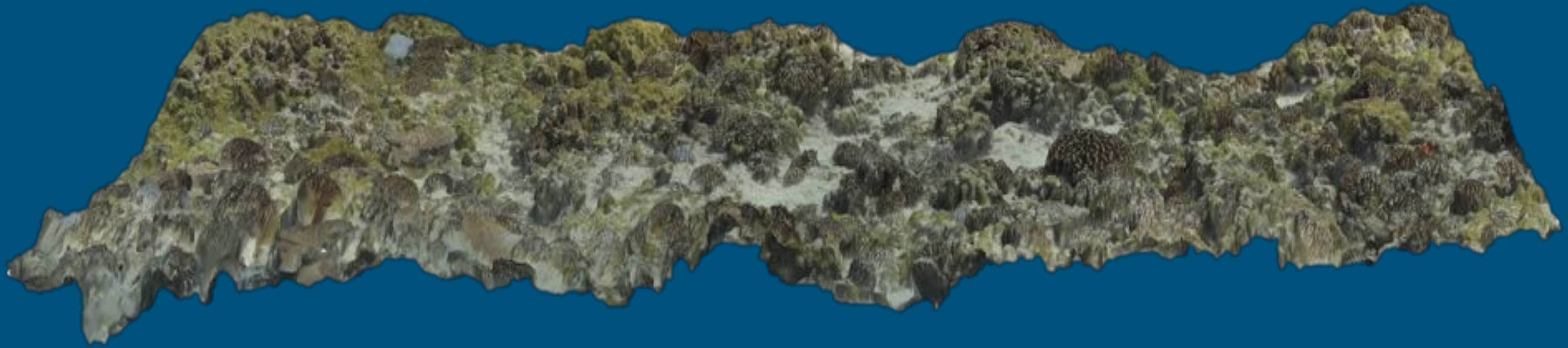
- Herbivorous urchins prevent dramatic ecosystem phase-shifts
- High urchin density → less macroalgae and more juvenile corals
- 1984 mass-mortality of *Diadema antillarum*

Common Sampling Methods

- Transect and quadrat
- Photoquadrats
- Video collection
- Limitations

Structure-from-Motion Photogrammetry

- Images collected in lawn-mower pattern with about 80% overlap
- Process images to create 3D model
- Extract orthomosaic and DEM from model



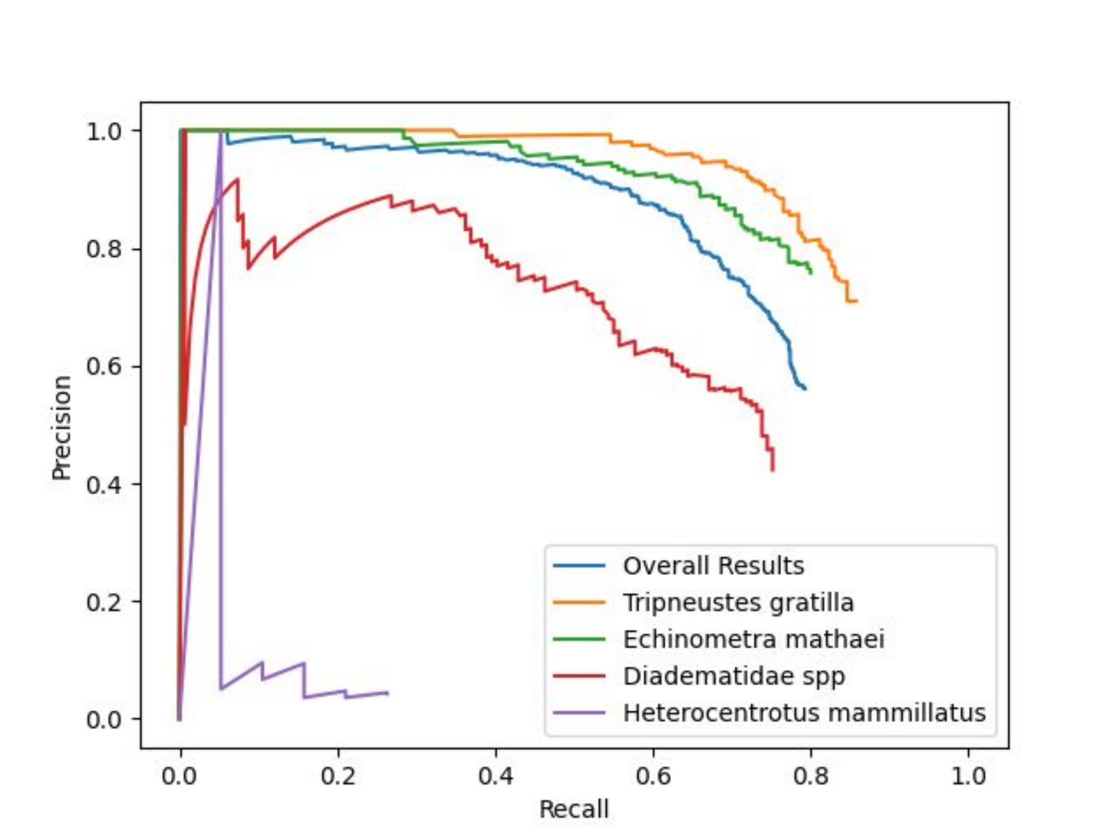
Machine Learning Automation

- Train with manual annotation
- Validate against manual annotation
- Test on new images

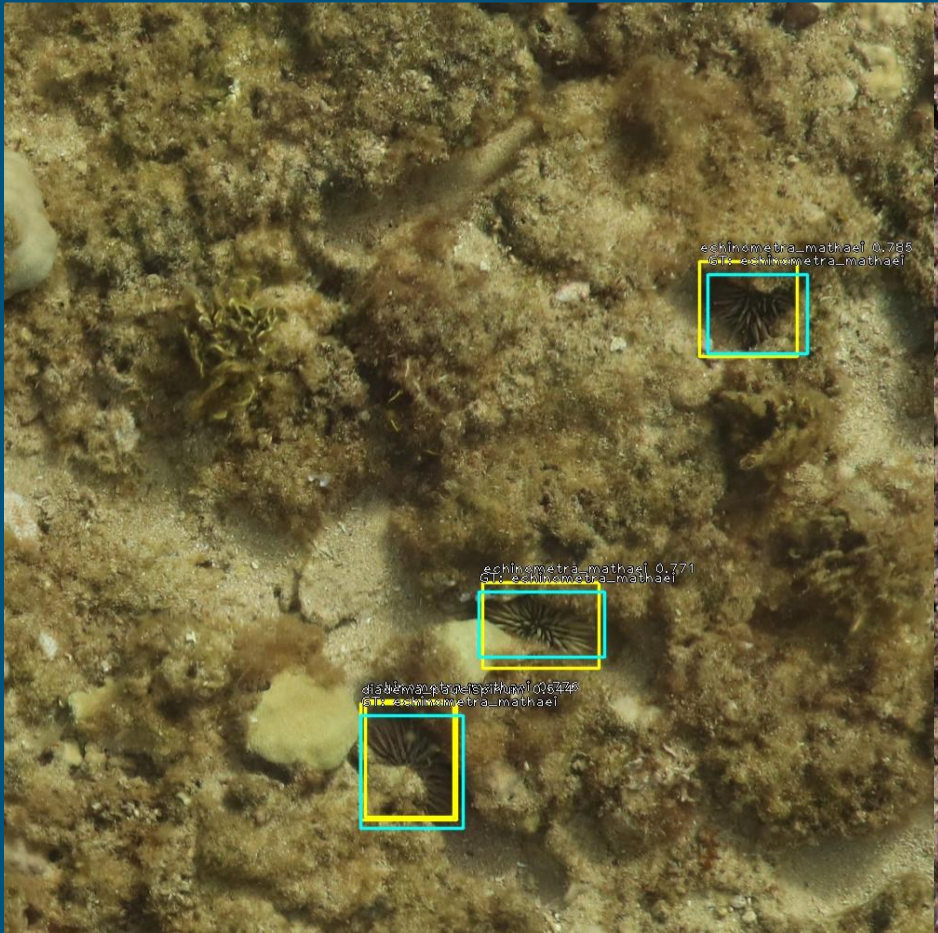
Project Objectives

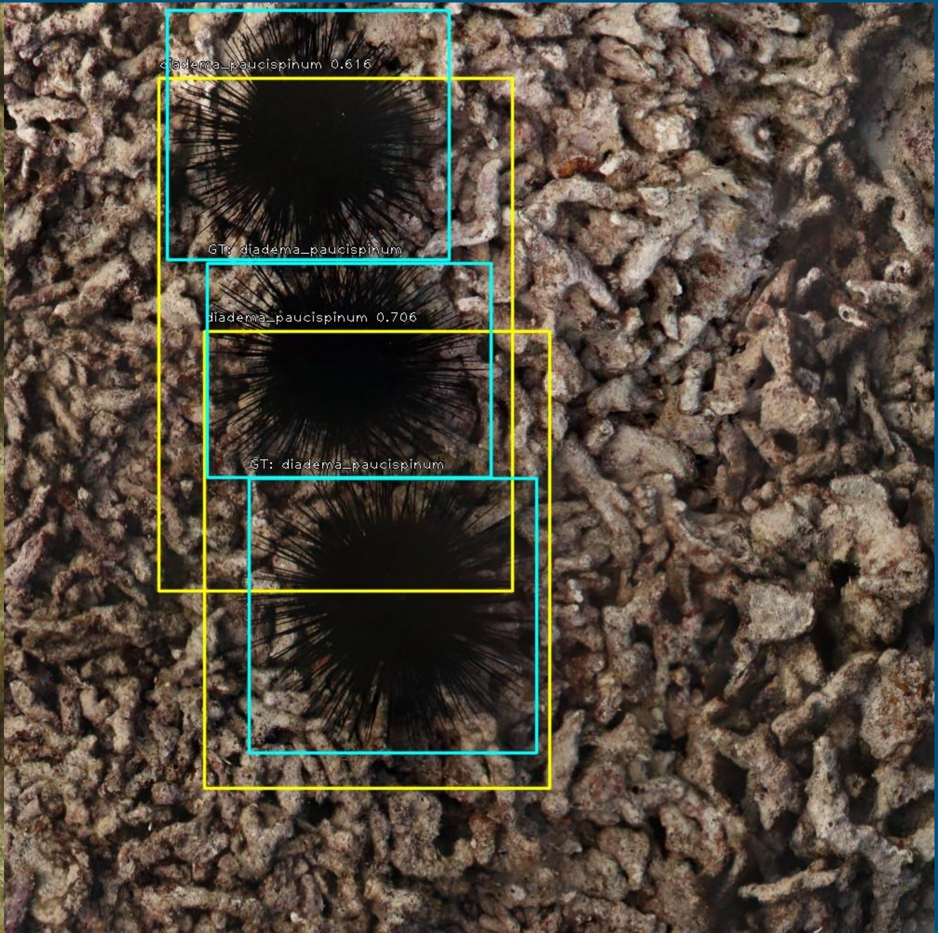
- Develop a machine learning tool to identify urchin species to:
  - Quantify urchin abundance and distributions on Hawaiian reefs
  - Create a more efficient method for long-term monitoring efforts

Precision and Recall



Computers make mistakes too!





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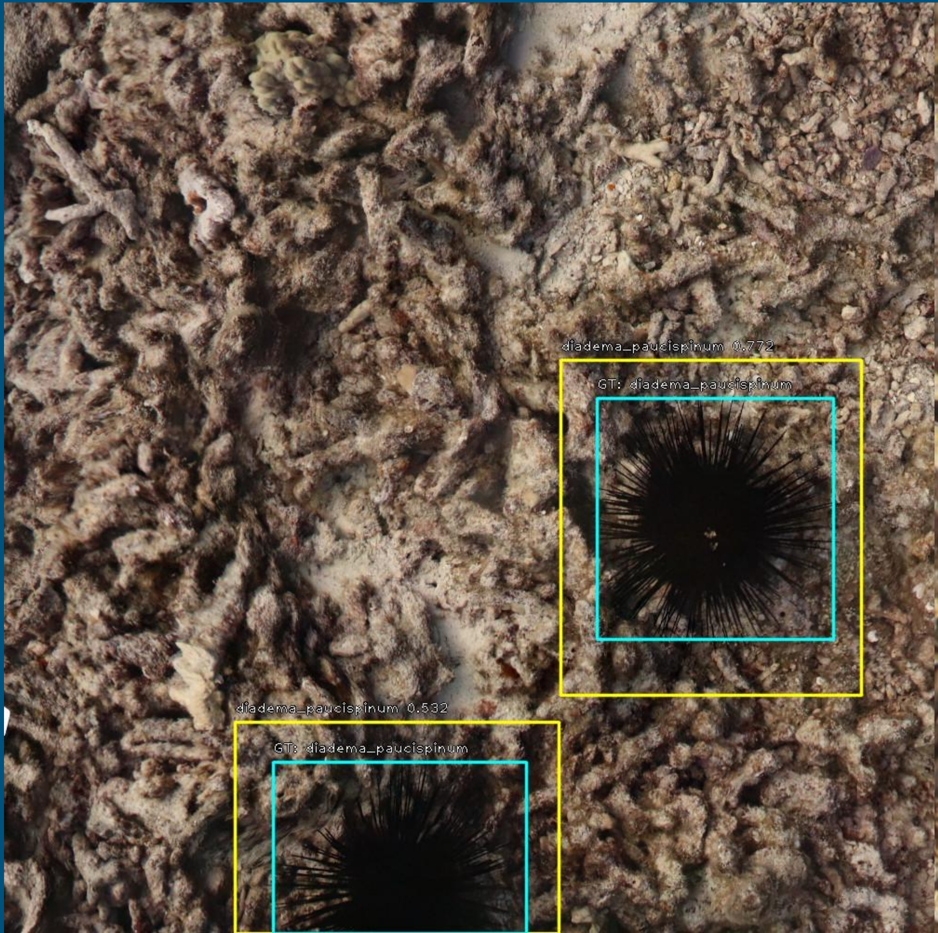
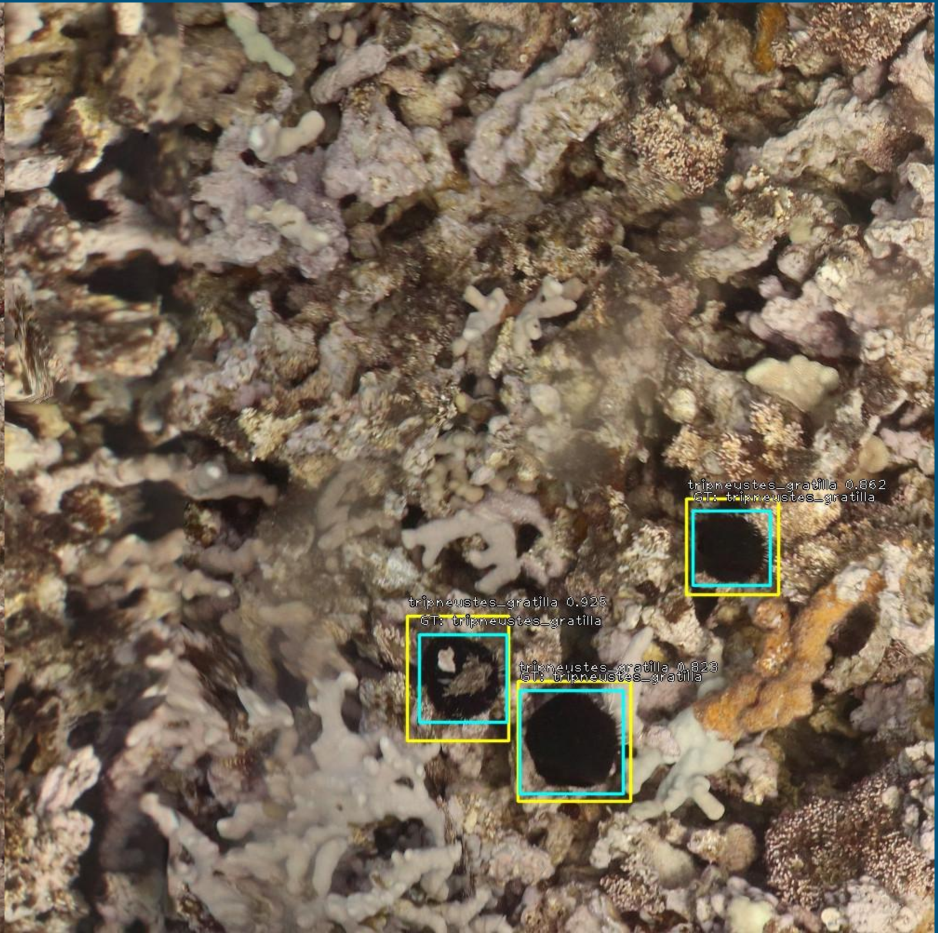
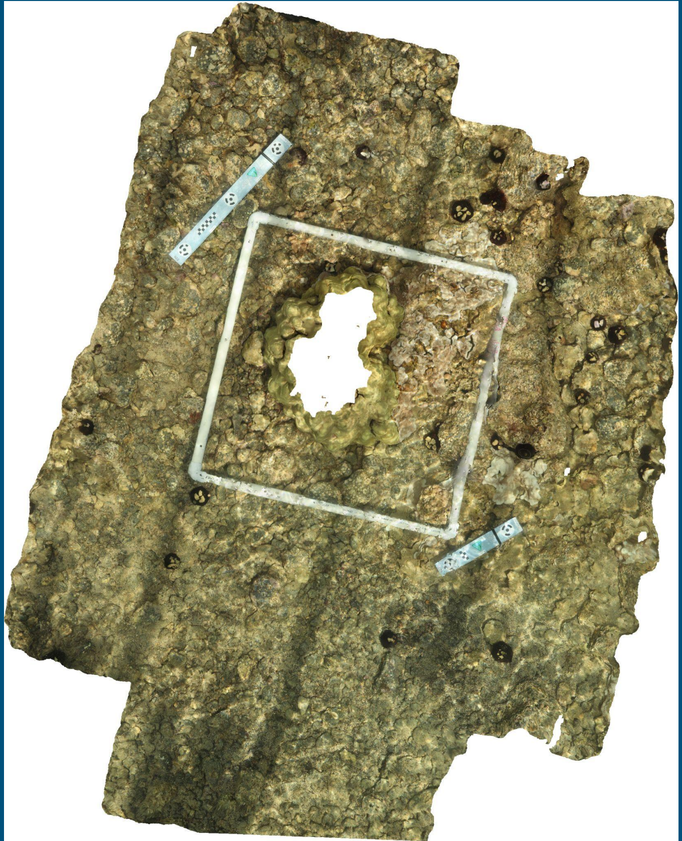
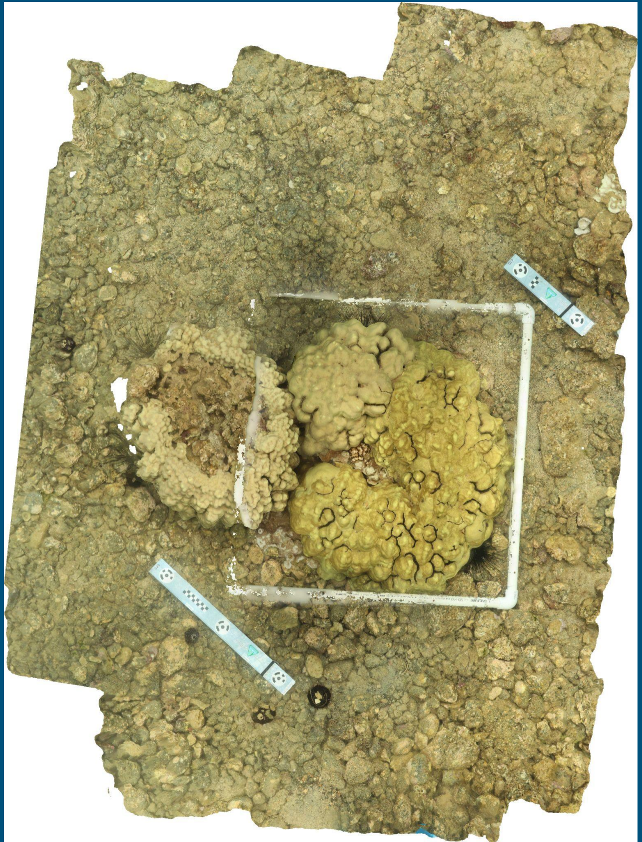




Testing on unannotated data





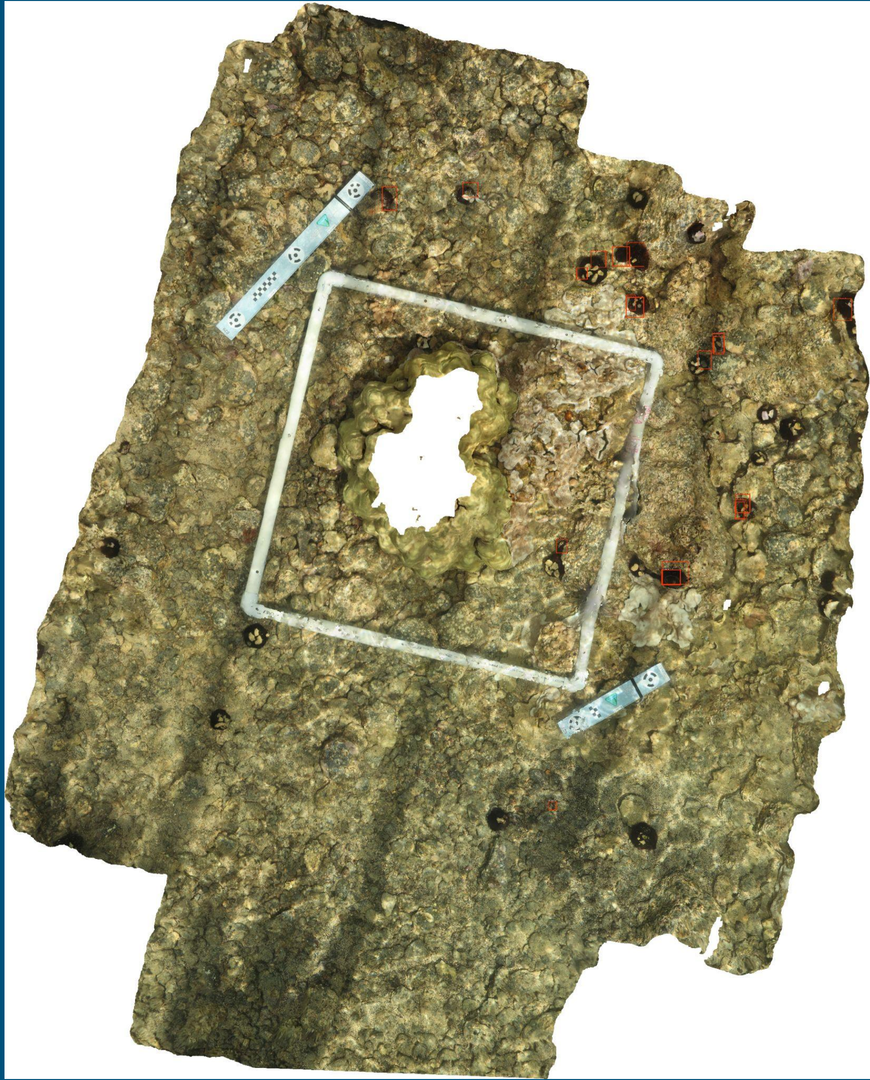
Testing

Average targets found by algorithm:

64.1%

Average correctly labelled species:

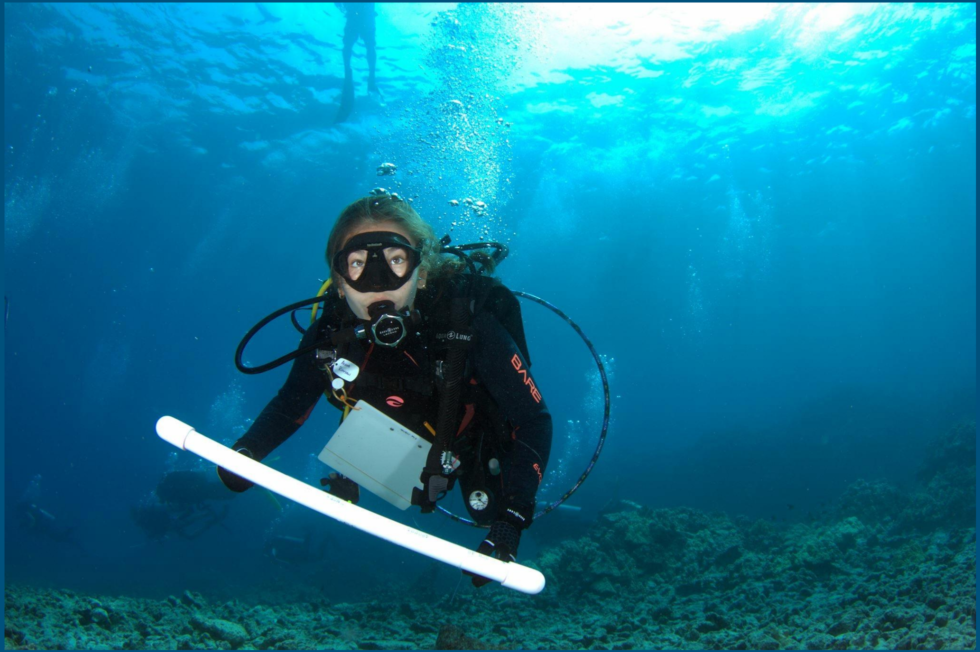
43.8%



Conclusions

- *T. gratilla* and *E. mathaei* were best identified by the ML algorithm
- More data and testing with different conditions needed
- Classifying down to species level exceeded expectations!

Future Directions



- *In-situ* vs computer vision comparison studies
- Real time ML identification
- Optimize the tool for utilization by research groups in HI (NOAA, DAR, UH)

Broader Impacts

Human-in-the-Loop Classification

More efficient long-term monitoring

Track population changes

Resource management

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Mahalo