

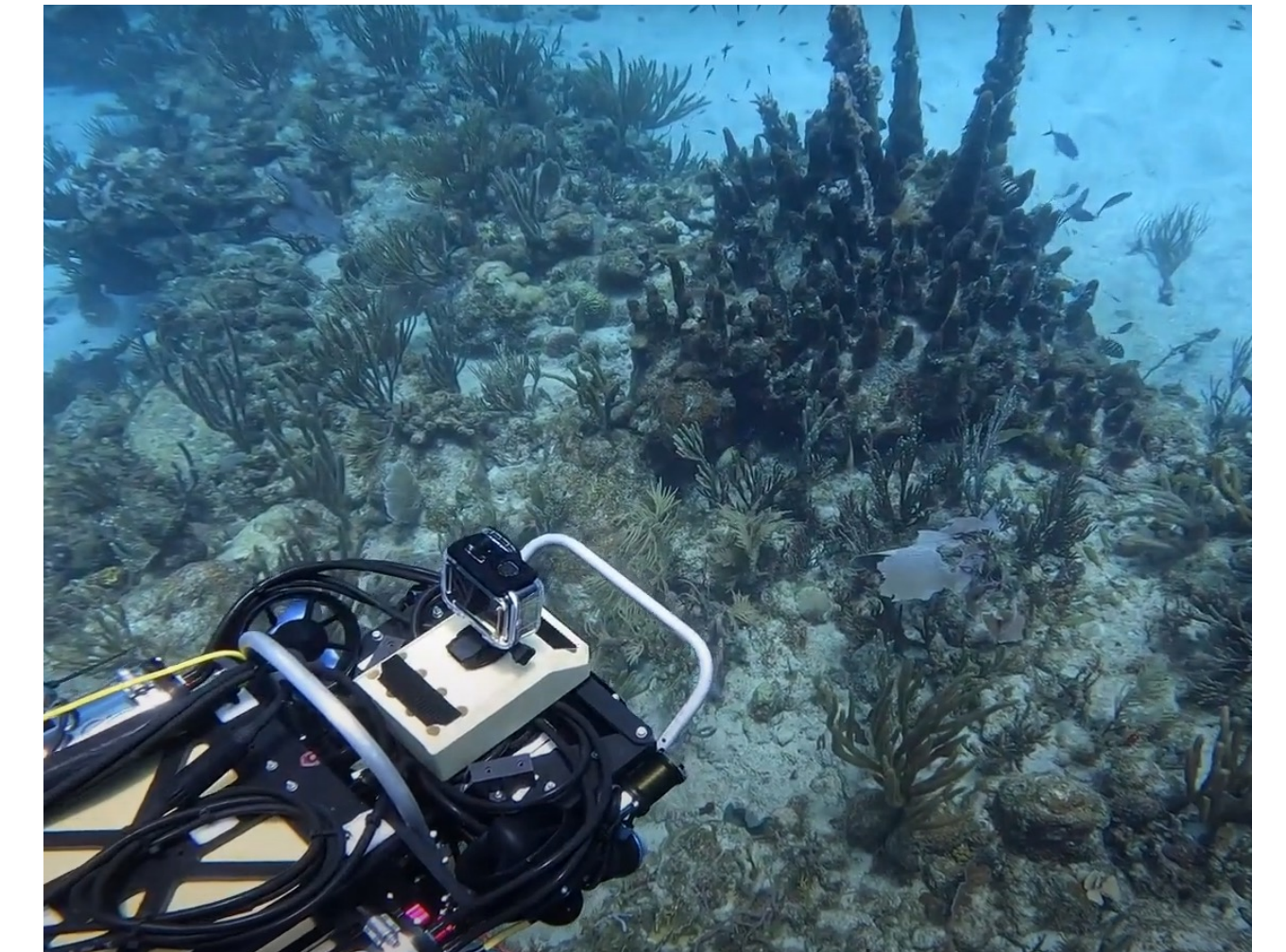
NRI: An Ecologically Curious Robot for Monitoring Coral Reef Biodiversity

Yogesh Girdhar, Frants Jensen, Seth McCammon, Aran Mooney

Woods Hole Oceanographic Institution.

<https://warp.whoi.edu/curee/>

Coral reefs worldwide are threatened by anthropogenic disturbances and climate change. New tools are needed to scale up monitoring of coral reefs to understand reef ecosystems, rapidly assess biodiversity, and measure the efficacy of interventions. This interdisciplinary project addresses this need by creating an autonomous robotic system that can navigate a complex ecosystem and intelligently sample its environment to estimate local biodiversity and ecosystem health.



Challenges:

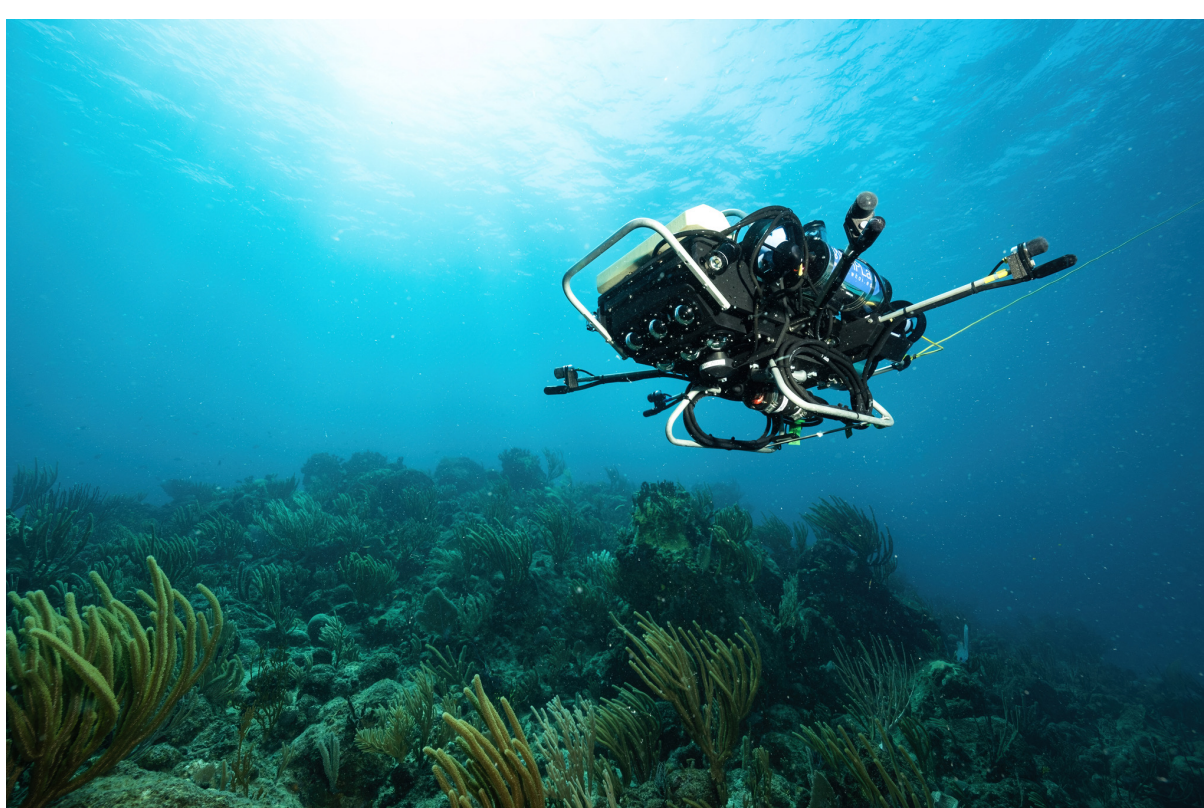
Benthic Monitoring: high resolution surveys needed to characterize benthic cover (coral and algae), and detect anomalies (diseases) require operation close to seafloor with complex geometry.

Animal Monitoring: animals change their behavior in presence of robots (and divers). Furthermore animal hotspots are temporally and spatially varying. Quantifying their abundance is non-trivial.

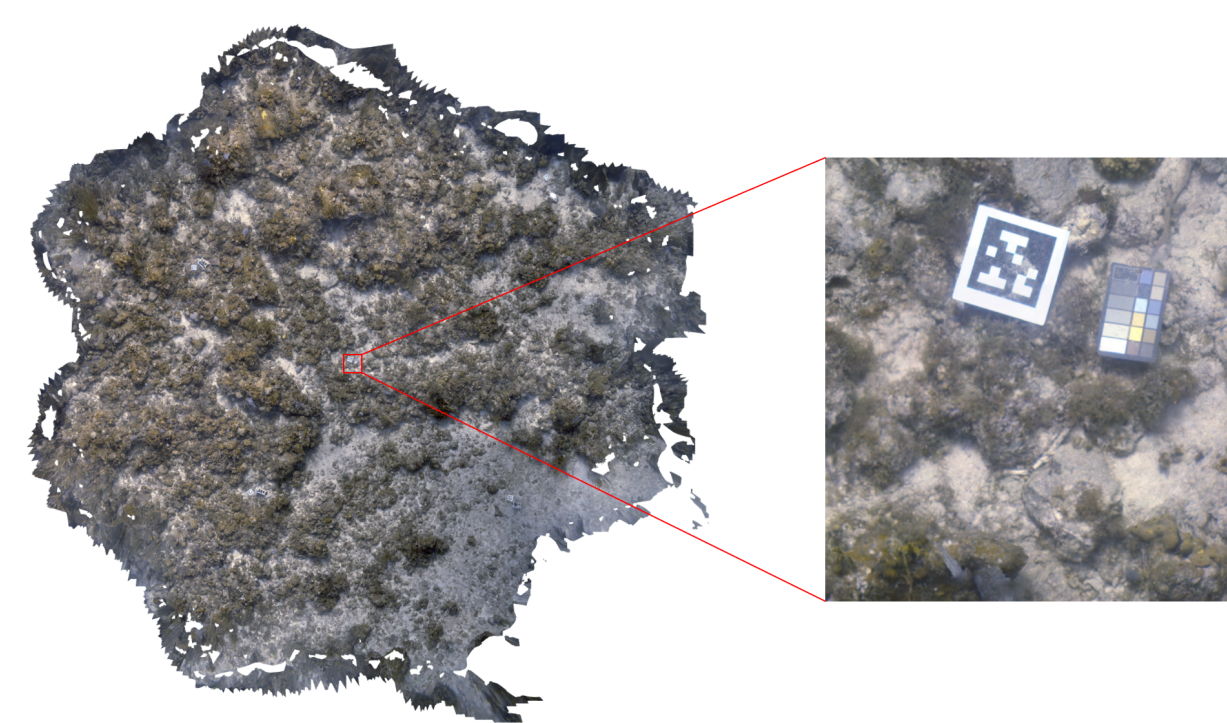
Scientific Impact:

- Novel informative path planning algorithms for adaptive sampling of periodic phenomena (such as diurnal animal activity)
- Planning with multi-modal (visual and acoustic) sensing to characterize hotspots
- Semi-supervised approach for visually tracking and monitoring arbitrary animals.

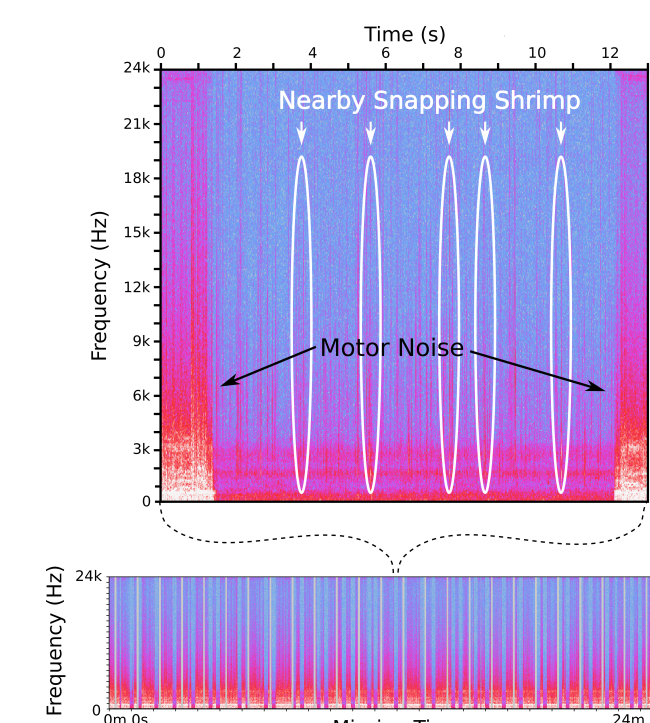
Solution:



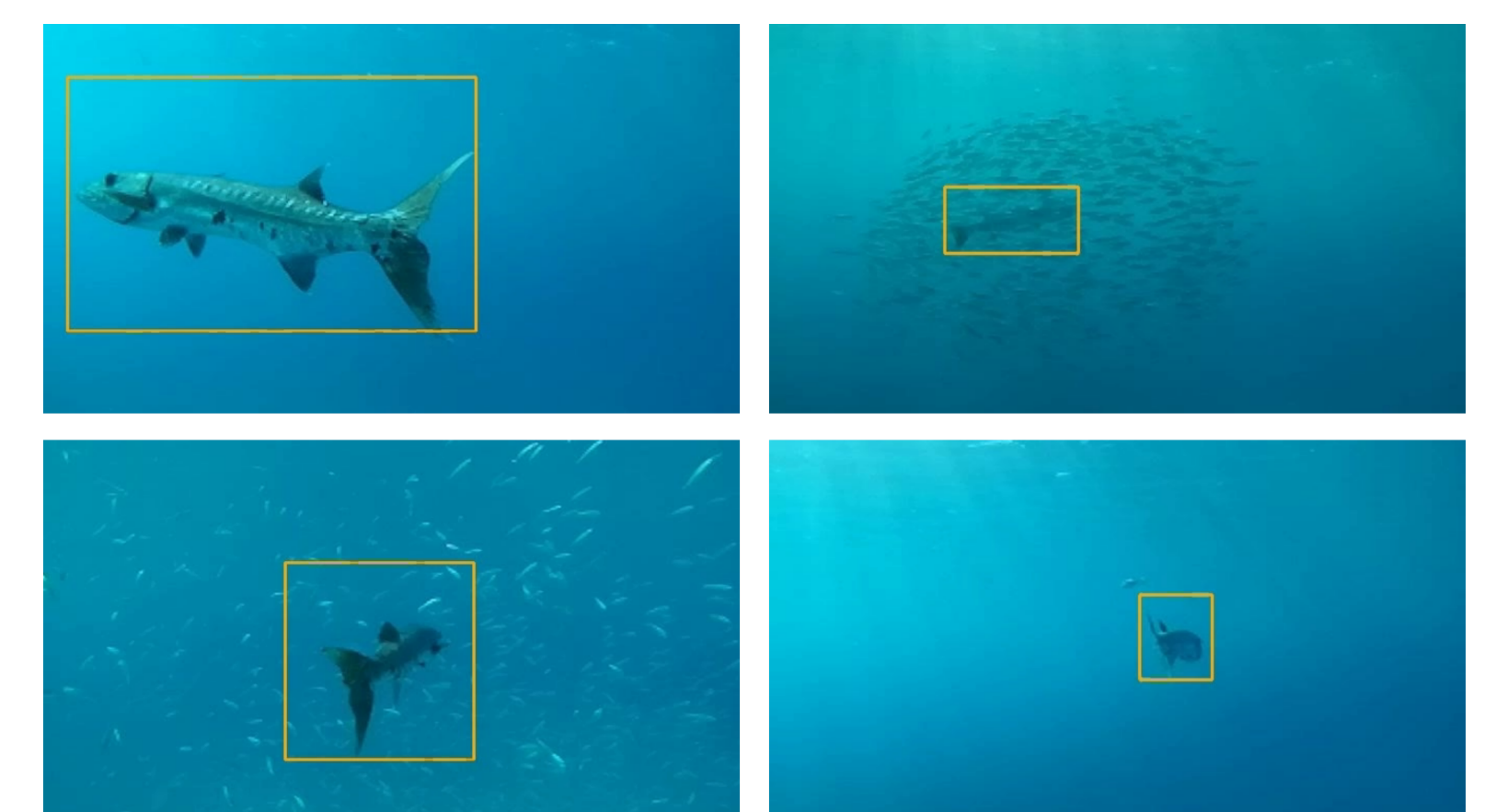
Developed CUREE: a novel robot for visually and acoustically guided missions in coral reef like environments



Low altitude visual surveys for characterizing substrate types



Listen to the reef chatter while drifting to detect animal hotspots



Track apex predators (barracudas) and quantify their behavior as a proxy for ecosystem functioning

Broader Impact:

- Interdisciplinary training of postdocs, graduate students, undergraduate students, K12, and preschoolers in field robotics, AI, and machine learning, and coral reef ecology.
- The developed technology will lower the cost of monitoring and enable more targeted reef restoration actions.



Products:

- McCammon, Seth and Aoki, Nadege and Mooney, T. Aran and Girdhar, Yogesh. (2022). Adaptive Online Sampling of Periodic Processes with Application to Coral Reef Acoustic Abundance Monitoring. 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). 11671 to 11678. doi:<https://doi.org/10.1109/IROS47612.2022.9982217>
- Cai, L., McGuire, N., Hanlon, R., Mooney, T. A., & Girdhar, Y. (2023). Semi-Supervised Visual Tracking of Marine Animals using Autonomous Underwater Vehicles. International Journal of Computer Vision(IJCV).
- Girdhar, Y., McGuire, N., Cai, L., Jamieson, S., McCammon, S., Claus, B., San Soucie, J. E., Todd, J. E., Mooney, T. A. (2023). CUREE: A Curious Underwater Robot for Ecosystem Exploration. IEEE International Conference on Robotics and Automation.