2018 Bishop Museum & University of Hawai'i Project Team

Project context: Perform collaborative, multi-disciplinary research to determine how predicted environmental stressors will affect key species and habitats at Lalo (French Frigate Shoals) in the Papahānaumokuākea Marine National Monument

Goal is to determine how changing climate conditions will impact:

(1) low-lying sand and coral reef habitats and associated species
(2) mesophotic diversity, and
(3) trophic connections between shallow and mesophotic coral ecosystems

Meet the multi-disciplinary research teams

Theme 1: Understanding the potential impacts of predicted environmental stressors on priority species

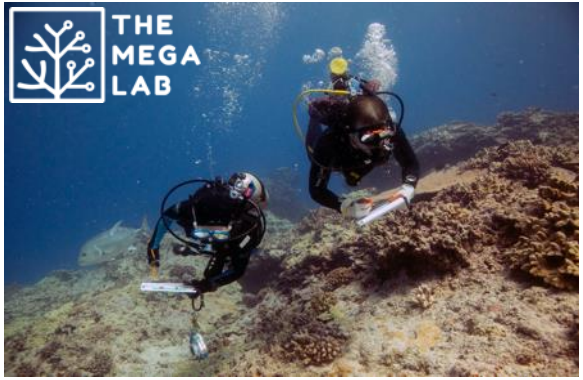
Sea Level Rise:
Historical reconstruction of beach erosion and accretion during the recent Holocene

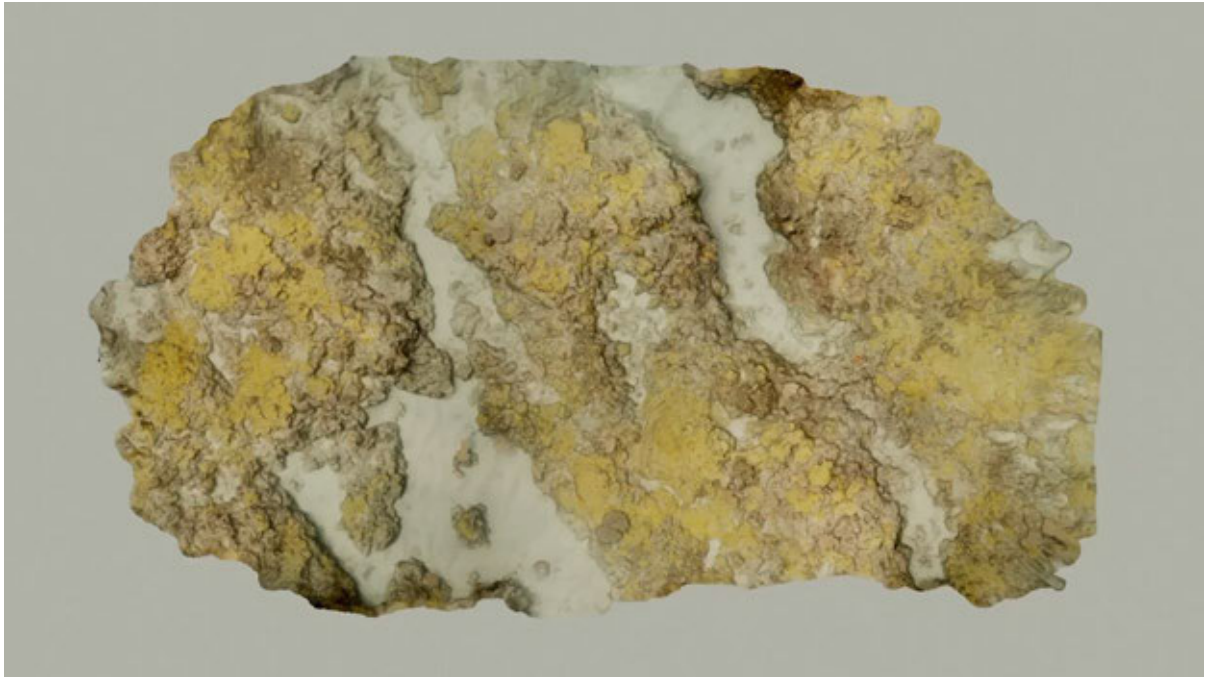
Kammie Tavares, Dr. Chip Fletcher, Dr. Tiffany Anderson, Kristian McDonald, Dr. Haunani Kane

Meet the multi-disciplinary research teams

Theme 1: Understanding the potential impacts of predicted environmental stressors on priority species

Shallow coral reefs:
3D mapping of corals to track changes in community structure associated with environmental perturbations.





Dr. John Burns, Dr. Atsuko Fukunaga, Kailey Pascoe

Meet the multi-disciplinary research teams

Theme 1: Understanding the potential impacts of predicted environmental stressors on priority species

Trophic connections between shallow and deep habitats: Trophic dynamics and the flow of energy and nutrients between shallow and mesophotic coral reef ecosystem habitats

Dr. Brian Popp and Dr. Yannis Papastamatiou

Dr. Carl Meyer

Dr. Mark Royer

Meet the multi-disciplinary research teams

Theme 2: Increasing understanding of the mesophotic zone

MCEs: Characterize abiotic features of mesophotic coral ecosystems and fill gaps in taxonomic research of MCEs (especially fishes and algae)

Dr. Rich Pyle

Dr. Alison Sherwood

Dr. Heather Spalding

Project Approach

- Three ship-based research expeditions conducted on R/V Searcher and NOAA R/V Hi'ialakai
- Aerial drone mapping and coring used to examine evolution of low-lying islands
- Innovative photogrammetry technology used to create high-resolution 3D maps of coral reefs
- Telemetry tagging linked to listening stations to track movement of marine predators

Project Approach

- Deployment of advanced underwater sensor arrays with to characterize physiochemical properties of seawater on mesophotic coral reef ecosystems
- Cutting-edge eDNA analysis of water samples to enhance taxonomic classifications
- Specimen-based research for trophic connections, taxonomy and new species descriptions




Project Products – Sea Level Rise

- Determined 2000-yr old fossil reef was basis for development of dynamic islands at Lalo
- Findings help inform managers about how islands will respond to changing climate conditions

East Island

Gin Island

Project Products – Sea Level Rise

Outreach and Communication:

20 presentations given to the general public at both public and private Hawaiian K-12 schools, University of Hawaiʻi, and international scientific conferences.

Findings have been communicated to the PMNM Board of Directors, PMNM Research Advisory Council, National Marine Sanctuaries Webinar, Haunauma Bay Science Talks, Obama Foundation.

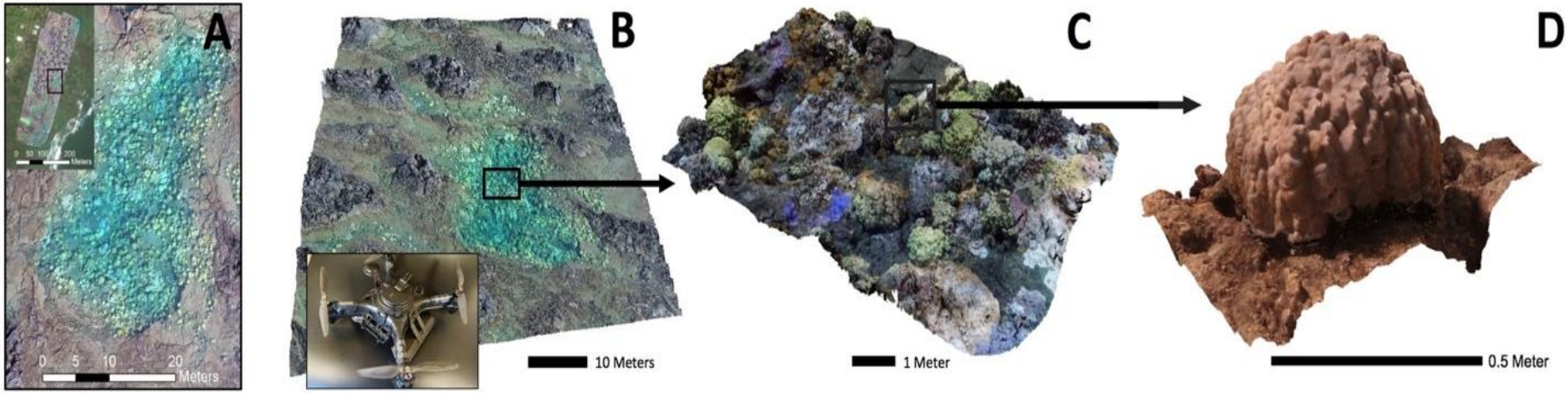
Kammie Tavares created a short documentary video entitled The Kūpuna Islands that was showcased at the 2020 HAWAIʻI CLIMATE CONFERENCE HĀ O KE KAI.

Our research activities received press in outlets such as *STAR Advertiser, Hawaii News Now, Ke Ola Magazine,* and *The Garden island*

In a formal capacity, our research has been shared with thousands of individuals.

Project Products – Coral Reefs

- The 3D approach enhances our ability to monitor changes in coral community structure
- We identified species-specific responses to coral bleaching and quantified how loss of live coral reduces the 3D architectural complexity of coral reefs
- The findings provide managers will useful information for developing targeted conservation strategies to protect corals that disproportionality provide 3D habitat for reef organisms



Project Products – Coral Reefs

Outreach and Communication:

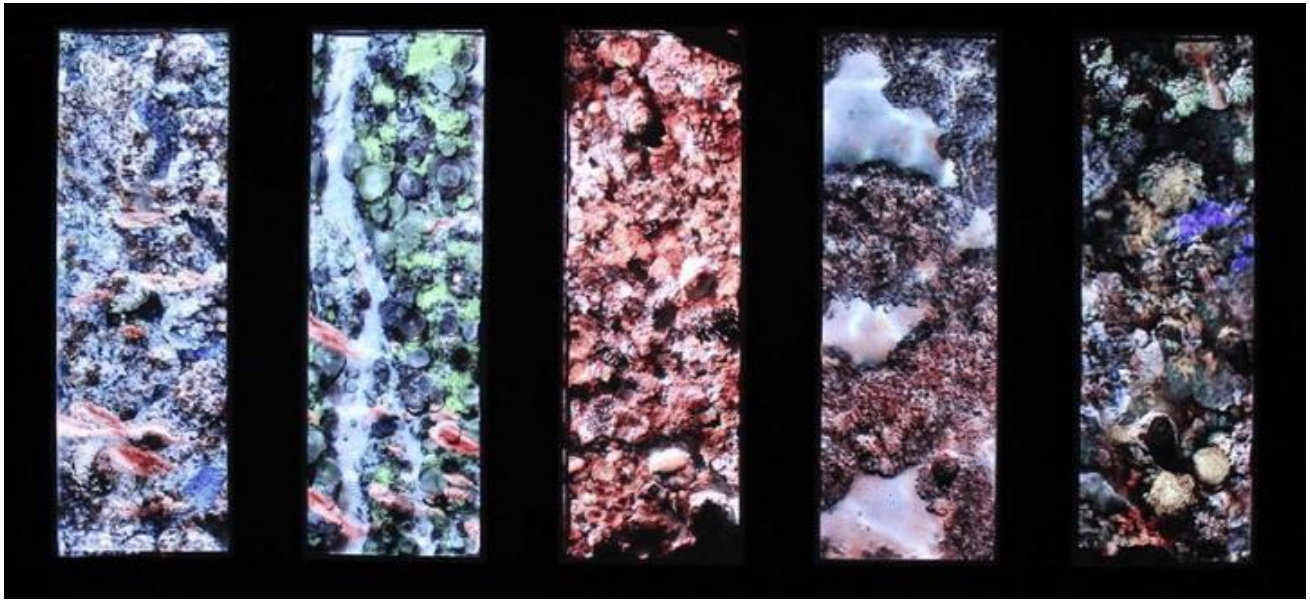
Created a Virtual Reality Exhibit, "Exploration of Coral Reefs in Hawai'i through Virtual Reality: Hawaiian Coral Reef Museum VR" – Won *Best Visualization Showcase Award* at PEARC2020

Project Products – Coral Reefs

Outreach and Communication:

Created a Virtual Reality Exhibit, "Exploration of Coral Reefs in Hawaiʻi through Virtual Reality: Hawaiian Coral Reef Museum VR" – Won *Best Visualization Showcase Award* at PEARC2020

3D printed exhibit at the Aquarium of the Pacific in collaboration with convivial studies



Project Products – Coral Reefs

Outreach and Communication:

Created a Virtual Reality Exhibit, "Exploration of Coral Reefs in Hawaiʻi through Virtual Reality: Hawaiian Coral Reef Museum VR" – Won *Best Visualization Showcase Award* at PEARC2020

3D printed exhibit at the Aquarium of the Pacific in collaboration with convivial studies

Augmented reality application in development, beta version available on Google Play (MEGA Lab)

Coral Health Atlas website displays 3D data, 360 immersive panoramic, and reef information

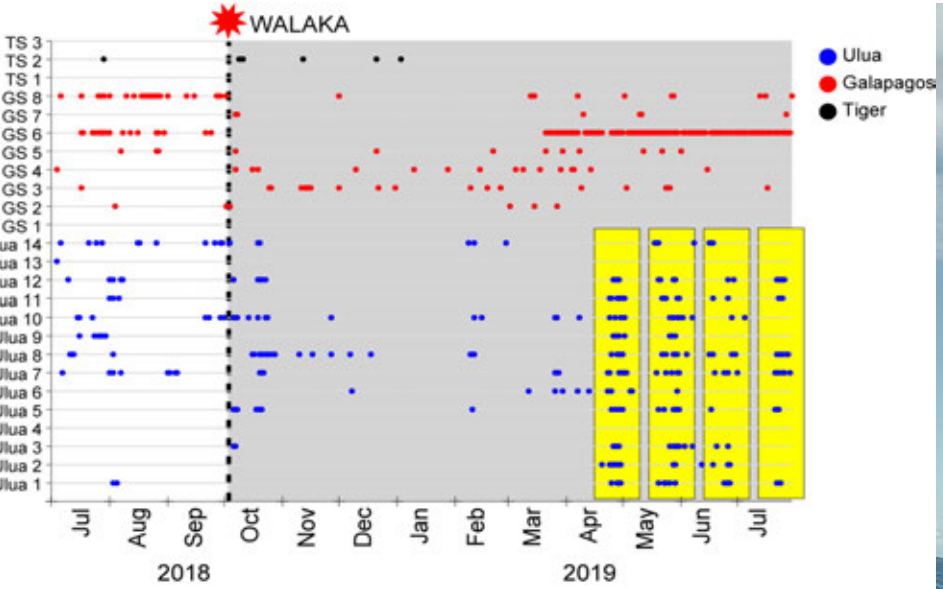
Presentations given to the general public at both public and private Hawaiian K-12 schools, University of Hawaiʻi, Mokupapapa Discovery Center, and international scientific conferences.

Our research activities received press in outlets such as *Science, STAR Advertiser, Hawaii News Now, Ke Ola Magazine,* and *The Garden island*

Four publications in international peer-reviewed scientific journals with several in preparation

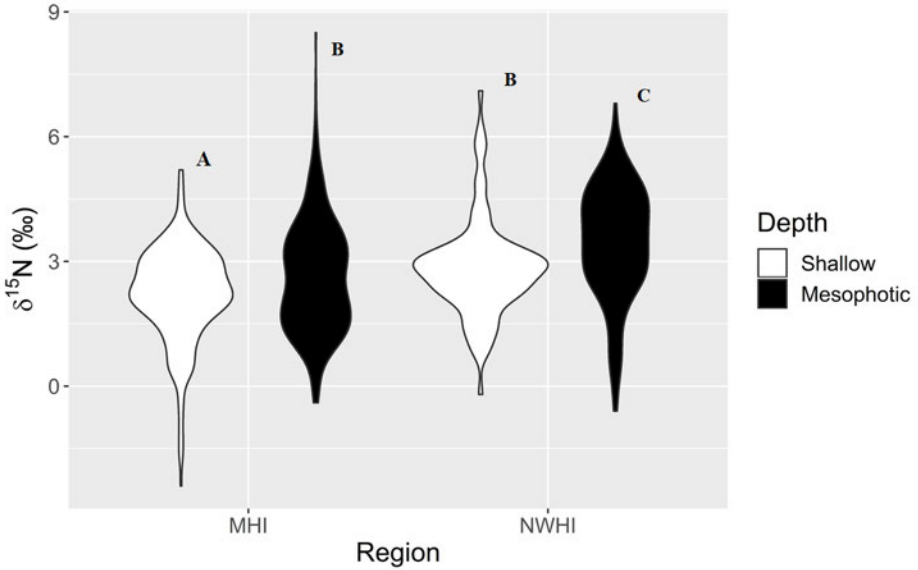
Project Products – Trophic Connections

- Hurricane Walaka impacted our research plans but provided unprecedented insight into hurricane impacts on predators
- Our data show that the Southwest habitats remain populated with predators despite extensive loss in live coral habitats – **predator populations indicate ecosystem resilience**
- The on-going stable isotope and eDNA analyses will provide insight into trophic dynamics



Project Products – Trophic Connections

- Examining connectivity in macroalgal species composition at Pearl and Hermes Atoll between shallow subtidal and mesophotic depths to help explore *Chondria tumulosa* outbreak
- Identify tropic connections in macroalgal tissue nutrients (%N) and stable isotopes (δ15N) between shallow subtidal and mesophotic depths in the NWHI and MHI
- Benthic algae is major food source in shallow reef food webs, this study will inform managers of how much primary productivity is transported between shallow and mesophotic reefs.



Project Products – Trophic Connections

Outreach and Communication:

Findings inform managers on how trophic dynamics and energy flow are connected between mesophotic and shallow reefs, as well as how trophic systems will respond to climate change

Presented findings to the Reserve Advisory Committee and the Mokupapapa Discovery Center

Multiple conference presentations accepted and currently on-hold due to covid19

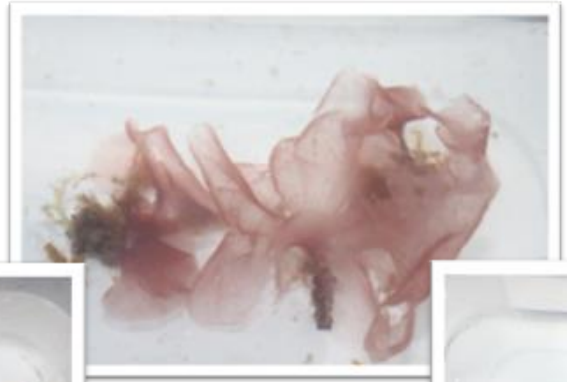
Received press in *Civil Beat* regarding insight into predator movement patterns

Results and activities shared via social media platforms

Scientific manuscripts are in preparation for publication in international peer-reviewed journals

Project Products – Mesophotic Ecosystems

- Collected samples from shallow to deep coral ecosystems to fill in gaps in taxonomic understanding of algae on reefs at Lalo
- Rebreather surveys and sensor deployment provide critical insight into composition and physiochemical characteristics of deep reef habitats
- Results will provide managers with an in-depth taxonomic characterization of marine species



Project Products – Mesophotic Ecosystems

Outreach and Communication:

Algae research featured in *Voice of the Sea* Episode, *College of Charleston Today, Big Biology Podcast,* and *Kilo i'a Magazine*

Participated in Bishop Museum Science Discovery Day, 16 conference presentations, research seminars, and guest lectures

2 new species of algae described using the Cultural Naming Process with PMNM (Martensia lauhiekoeloa and Psaromenia laulamaula). Overall, 11 new algal species named thus far, with many more in progress. 7 manuscripts published or in review with more in preparation.

Results and activities shared via social media platforms

Virtual reality exhibit in development to showcase mesophotic coral reef ecosystems at Bishop Museum and other public venues

Project Takeaways

Hurricane Walaka and unforeseen technical issues created both setbacks and new opportunities

More exciting results to come that will tell us; what is there, how it is connected, and how it is responding to changing environmental conditions

This work supports both scientific discoveries and collection of data that can directly assist managers with developing actionable strategies to protect and conserve resources at Lalo

Examining the Impacts of Hurricane Walaka

Island Habitats

Dr. Haunani Kane (Postdoc at UH Hilo)

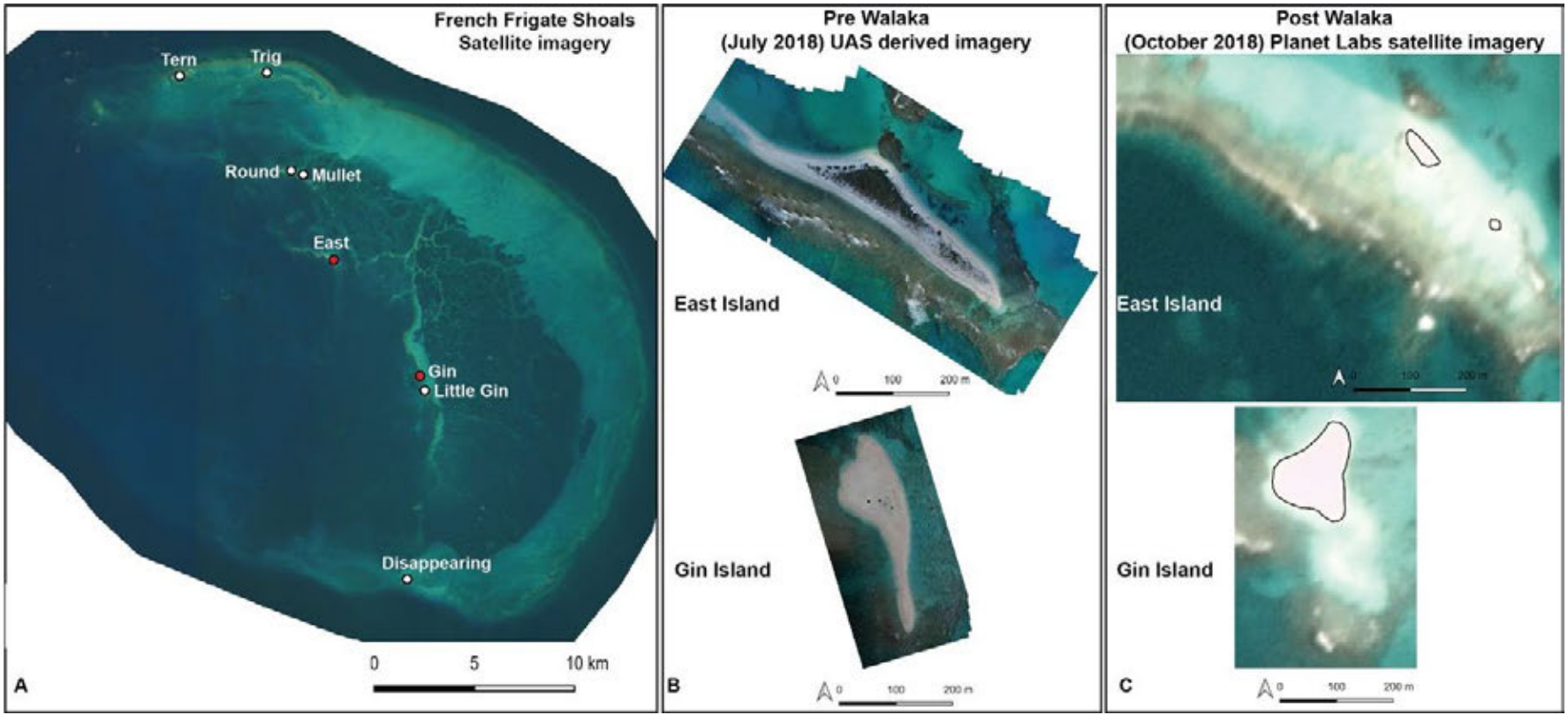
Kainalu Steward (MS student at UH Hilo)

Coral Habitats

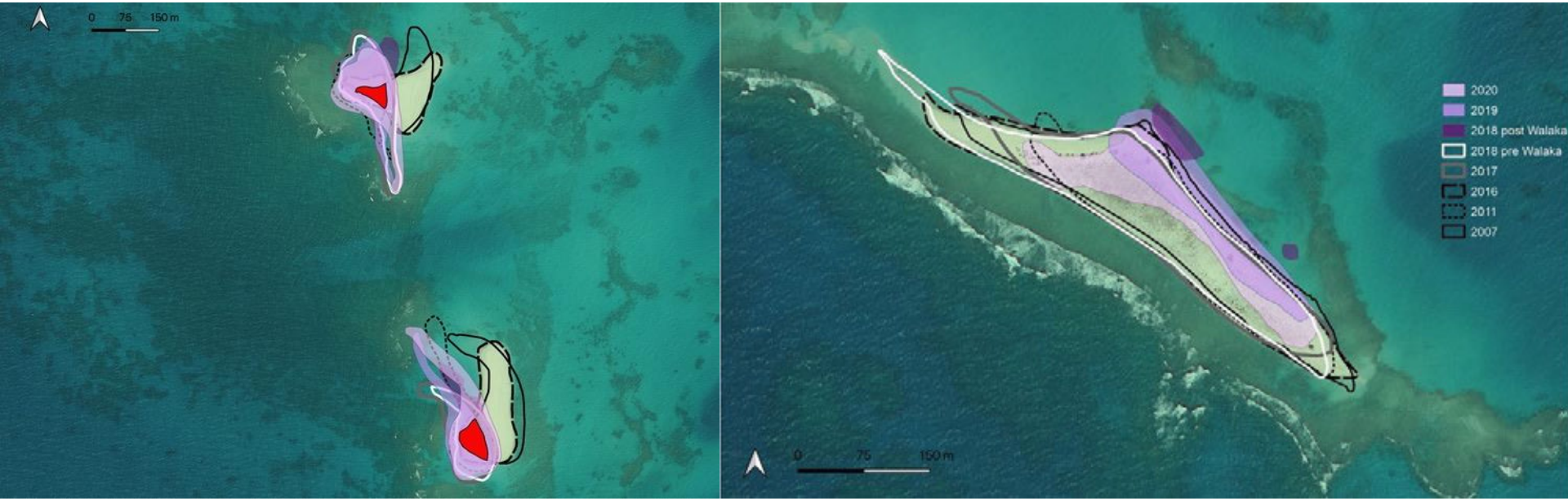
Dr. John Burns (UHH - MEGA Lab)

Kailey Pascoe (UHH - MEGA Lab)

Using satellite imagery and UAS photogrammetry to assess the impacts of Hurricane Walaka upon island habitat



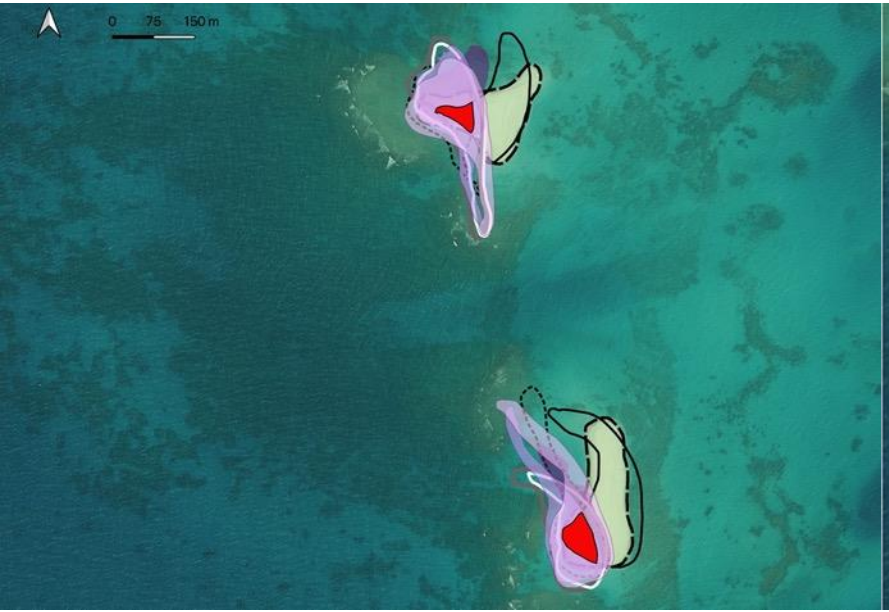
Using satellite imagery and UAS photogrammetry to assess the impacts of Hurricane Walaka upon island habitat



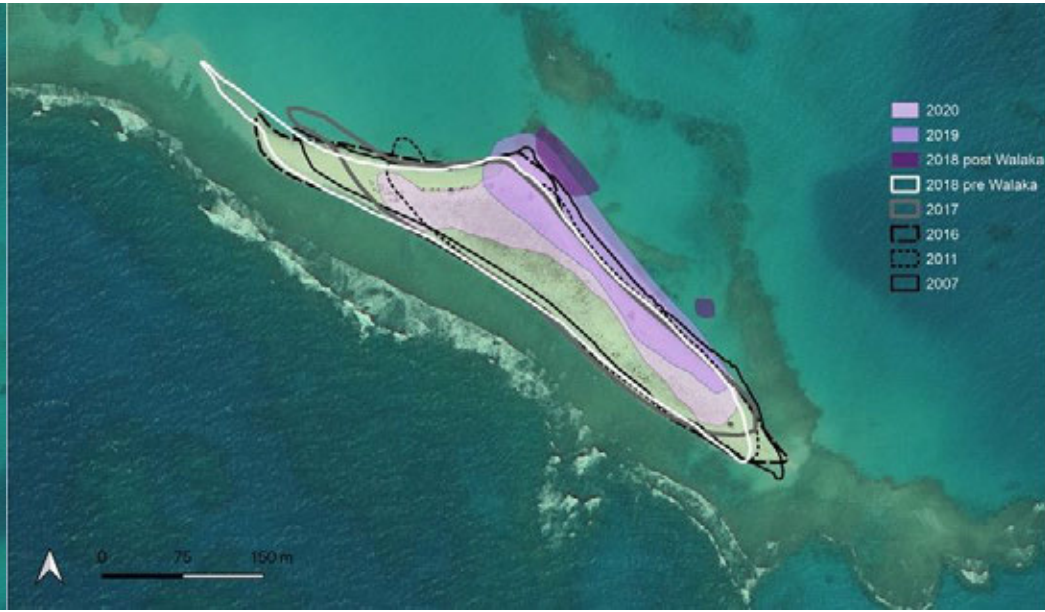
Project Products

- Shoreline erosion & accretion following Walaka will be documented at 4 islands.
- 3D models of at least 2 islands will be created using UAS derived imagery.
- Pre & post Walaka island size and volume will be quantified at at least 2 islands using 3D reconstructions.
- 1 peer reviewed publication

A collaborative process will be used to identify and evaluate gaps in knowledge and management needs related to hurricane impacts



How has historical island migration impacted resources and management?



How has island loss and recovery from Walaka impacted habitat & ecosystem services?

A collaborative process will be used to identify and evaluate gaps in knowledge and management needs related to hurricane impacts

A collaborative process will be used to identify and evaluate gaps in knowledge and management needs related to hurricane impacts

Project Products

Year 1:

PMNM resource monitors, stakeholders, climate scientists will be convened.

Expert discussions will be centered upon Walaka impacts, management needs, and knowledge gaps.

Year 2:

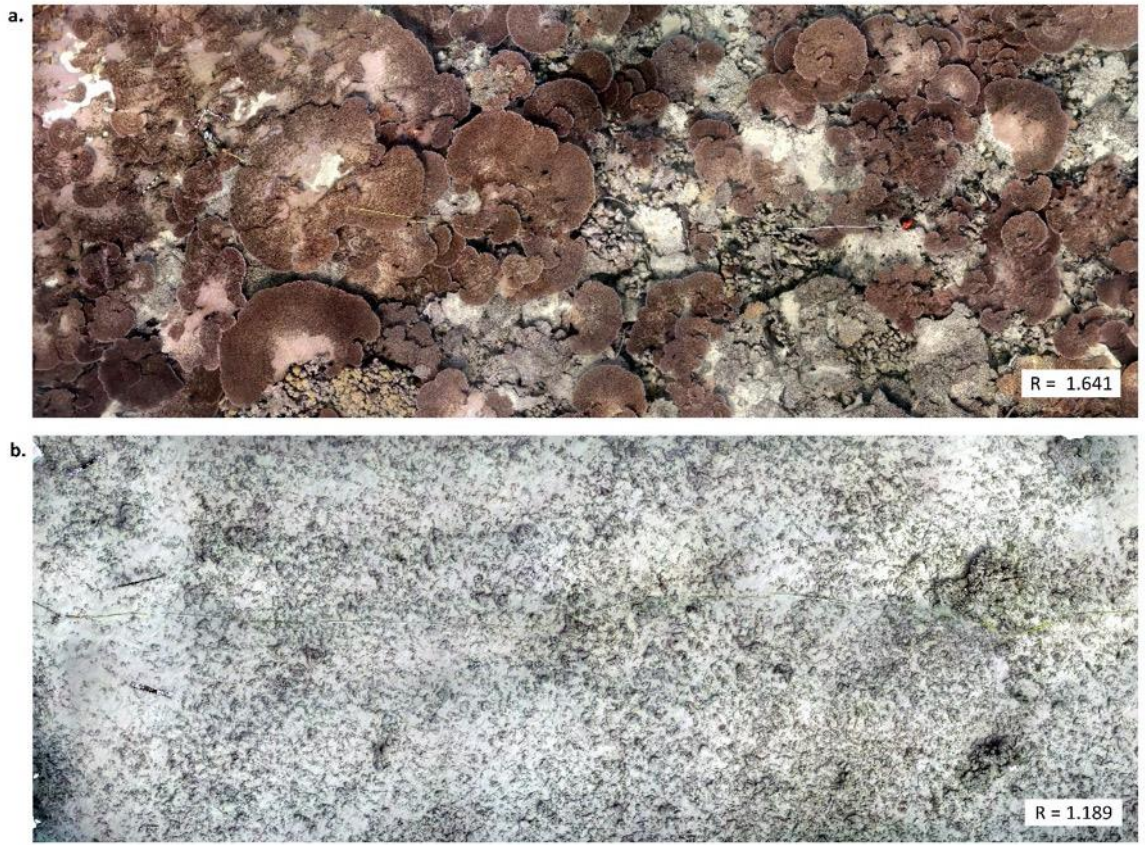
Short (10 yr) and long (100 yr) term impacts and remediation solutions will be summarized and shared with stakeholders at a final meeting.

Hurricane Walaka Impacts to Coral Reefs at Lalo

Use a 3D approach to track changes in habitat architecture caused by Hurricane Walaka

Multiscale Environmental Graphical Analysis (MEGA) Lab at UH Hilo is developing specialized technological tools for tracking changes in reef habitats through time

THE MEGA LAB



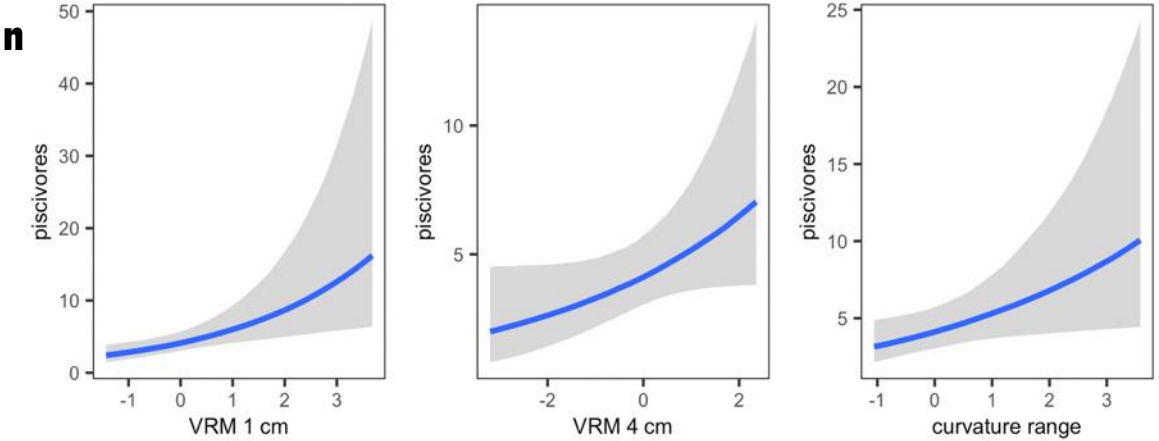
Hurricane Walaka Impacts to Coral Reefs at Lalo

Project products:

Year 1: Identify how changes in coral community composition influence 3D structural complexity

Year 2: Inform managers how changes in habitat complexity affect biodiversity

THE MEGA LAB



Hurricane Walaka Impacts to Coral Reefs at Lalo

Outreach plans:

Continue development of Virtual Reality and Augmented Reality Experiences

Create transformative exhibits to engage audiences with scientists

Present findings at conferences and in scientific publications