



# Assessment of Ocean Energy Systems to Power Guam Aquaculture Center

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Fleur de Peralta

Andrea Copping

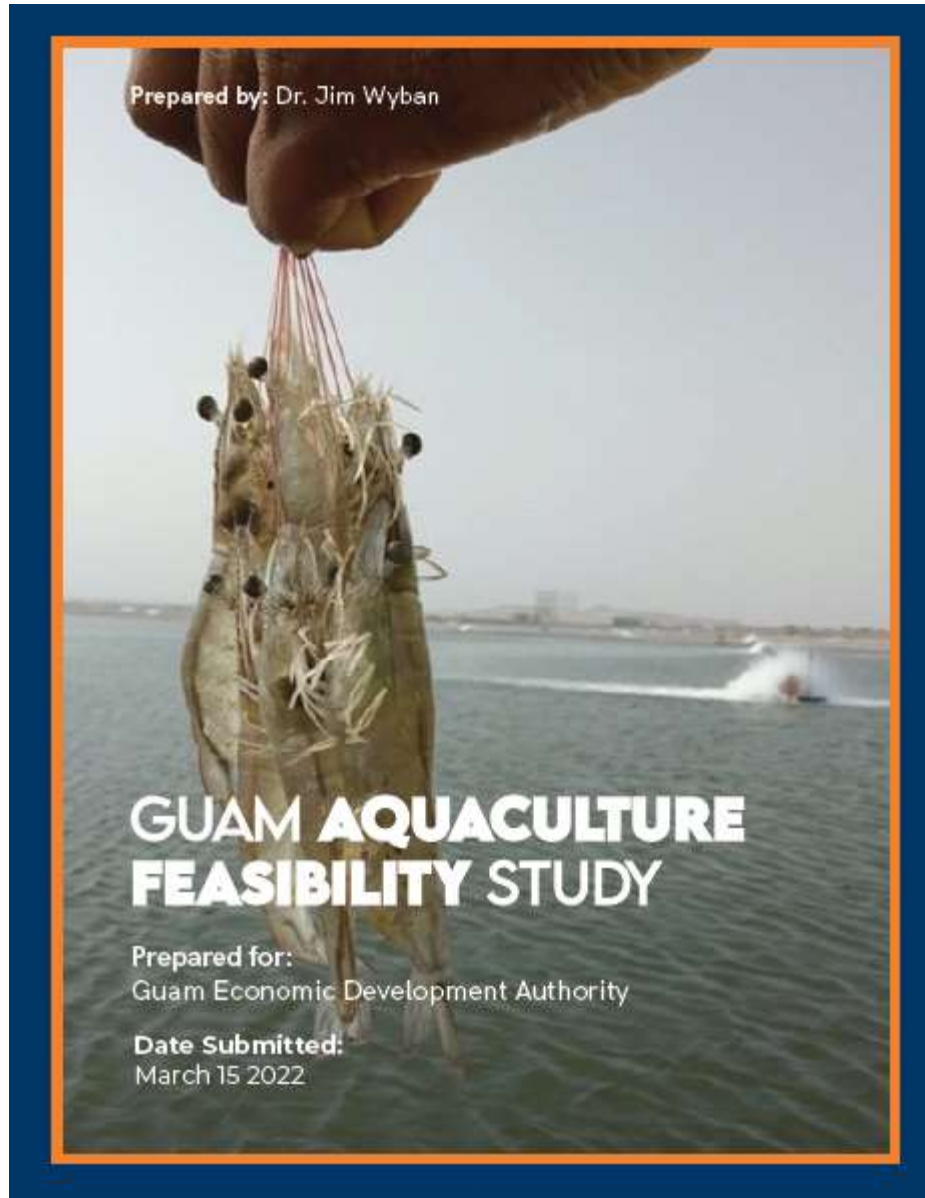


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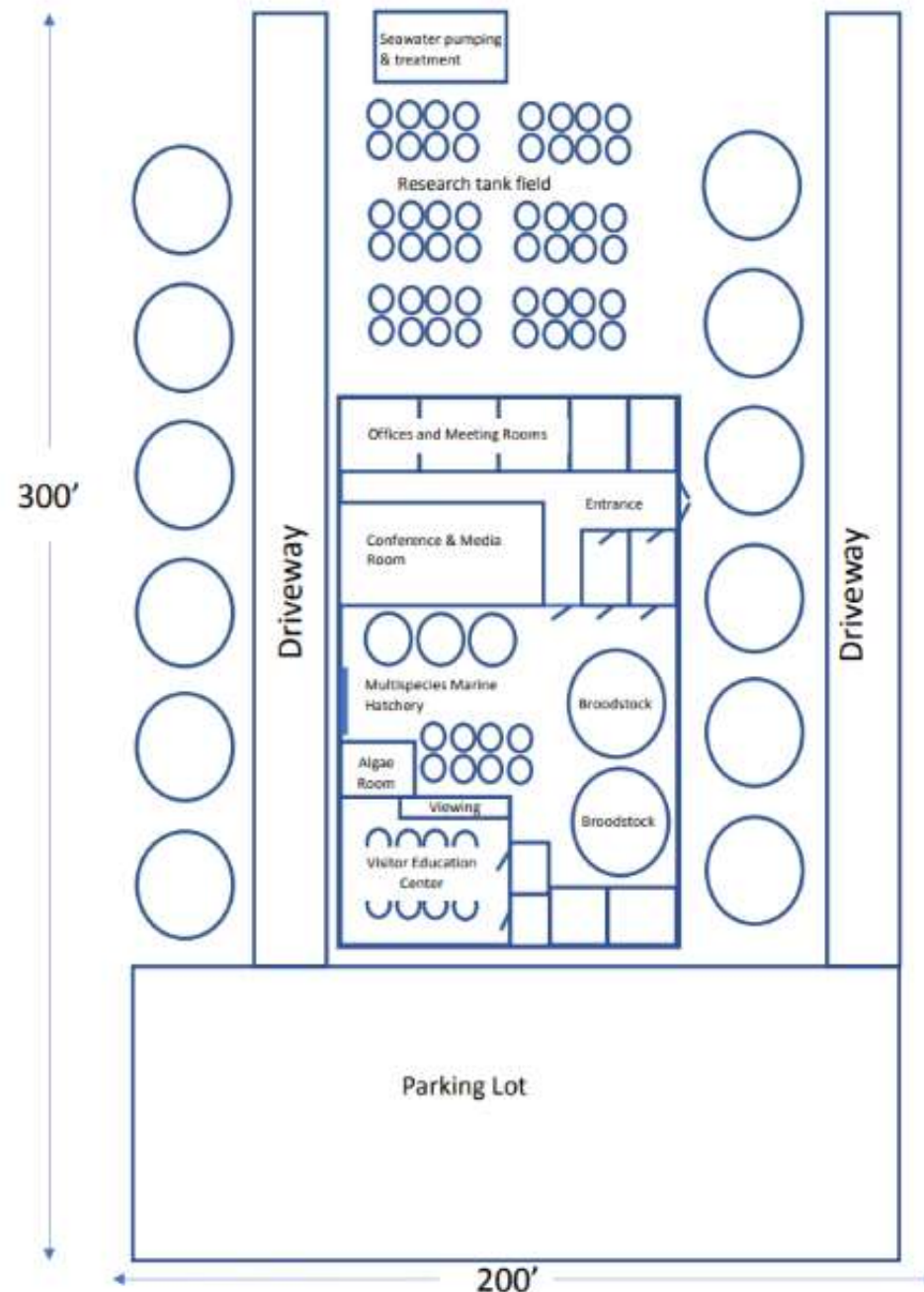
Energy Efficiency & Renewable Energy

# Community Scale Marine Energy Project



- Need to expand aquaculture industry to increase food security and benefit island's community and economy
- Guam Aquaculture Innovation Center (GAIC) as high priority target for island development
- Project specifically assesses ocean energy\* systems as a potential power source
- **Project Team:** PNNL, Sandia National Laboratories and University of Guam

Guam Aquaculture Innovation Center Conceptual Design  
Site Plan 60,000 sq ft – not to scale



# Conceptual Design

- ~ \$3M project
- Planning 10,000 SF building space in 60,000 SF lot
- Water systems: seawater and freshwater
- Offices and conference rooms
- Lecture Hall
- Wet labs (diagnostics and biochemistry)
- Multi-species marine hatcheries
- Digital library space
- Indoor/outdoor tanks
- Visitor Center aquarium and viewing stations of marine hatchery
- Parking lot

Ref: March 2022 GEDA Guam Aquaculture Feasibility Study

# Proposed GAIC Sites



Figure 13. Tanguisson Beach site satellite image.

## NCS/Tanguisson Beach Area:

- 5 acres flat seaside land above NCS Beach
- Total 13.74 acres with steep cliffs
- Site of abandoned power plant and oil spill in 80's, citizen death from eating seaweed harvested
- Documented presence of radon at site

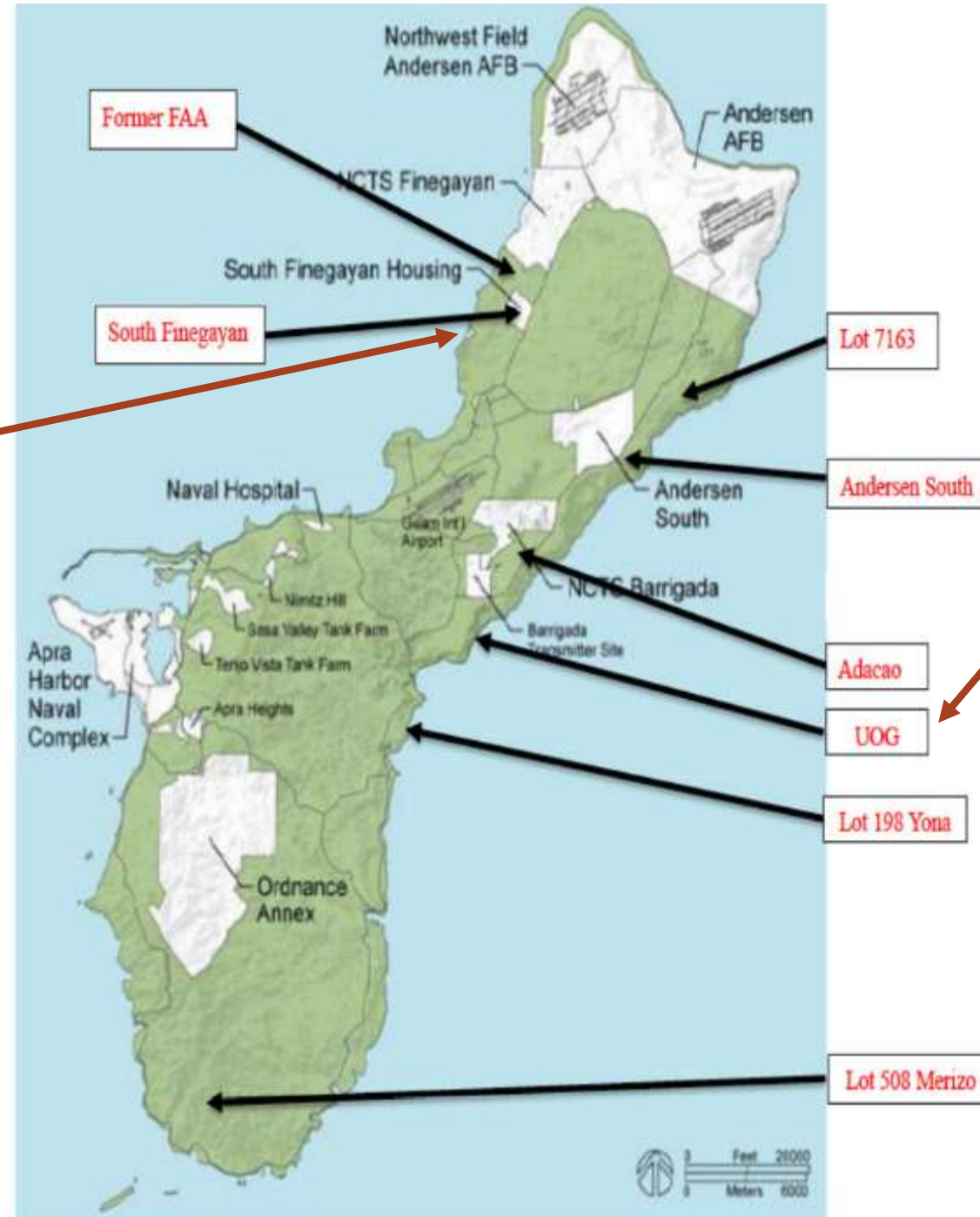


Figure 12. Satellite image of UOG Marine Lab and WERI.

## UOG Marine Lab:

- Limited land (< 5 acres needed)
- Nearby gov't lands with steep cliffs

Source for figures: March 2022 GEDA Guam Aquaculture Feasibility Study

# Infrastructure Considerations

- Framework categories initially evaluated
  - Technical Feasibility
  - Environmental Feasibility
  - Energy Matching Feasibility
  - Resource Matching Feasibility
  - Deployment/capability
- IT/OT System Cybersecurity
- Survivability during Extreme Weather Conditions (e.g., Category 4 Typhoon Mawar May 2023)



Pacific Ocean coastal activity at UOG's Marine Laboratory a day before Typhoon Mawar reached Guam on May 23, 2023. (Source: Guam Power Authority forwarded from a Resident near the Marine Laboratory)

# Community Engagements and Outreach

- Stakeholder Engagement and Outreach Plan – April 2023
- Population 170,000 – Chamoru (37.3%), Filipino (26.3%), and Mix (Caucasians, Chuukese, Korean, Chinese, Japanese and other Pacific Islanders)
- Island Community Targets:
  - Coastal and Inland Villages and Fisheries
  - Government Leadership and Special Interest Groups:
    - ✓ Guam Power Authority, Guam Economic Development Agency, Guam EPA, Guam Green Growth, Science & Technology Steering Committee
  - US Military on Guam
- Science Community Targets:
  - Developers and Consultants
  - Coastal Management organizations



Photo: *Guam convict tang fish and coral* (Courtesy of NOAA/David Burdick)

# Ocean Thermal Energy Converter Assessment

- Infrastructure:
  - Water depths drop off to >1000 meters with a few 100 meters of shore
  - Onshore plant, pipes from depth to shore
  - Offshore plant mounted on floating platform, with flexible attachments to management movement and disconnect during severe storms
- Energy needed:
  - Baseload power with fewer maintenance interruptions compared to solar PV or wind.
  - Reconnect online quickly after power outage or support black start
- Deployment and Maintenance Capacity
  - Transport and deploy long sections of pipe
  - Rely on local rigging capabilities

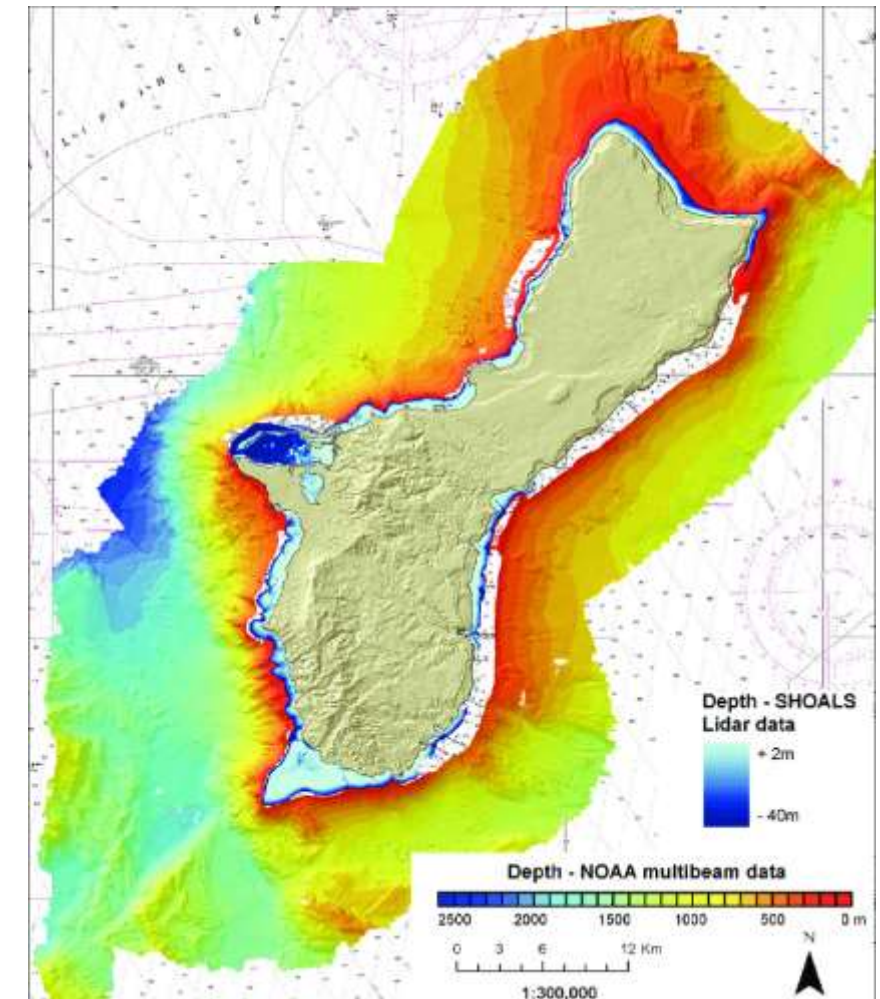


Photo: NOAA

# Wave Energy Assessment

- Infrastructure:
  - Siting based on depth, benthic habitats, coral, military zones, navigation routes, environmental managed areas,
  - Anchor/mooring limitations of coral reef area (31.2% coral and hard bottom and 68.8% unconsolidated sediment) with 10% live coral cover
  - Mooring system dependent on seabed substrates
  - Spatial planning considers other uses (shipping lanes, navigation routes, fishing areas, recreation areas)
  - Erosion and Coastal protection
  - Cabling routes

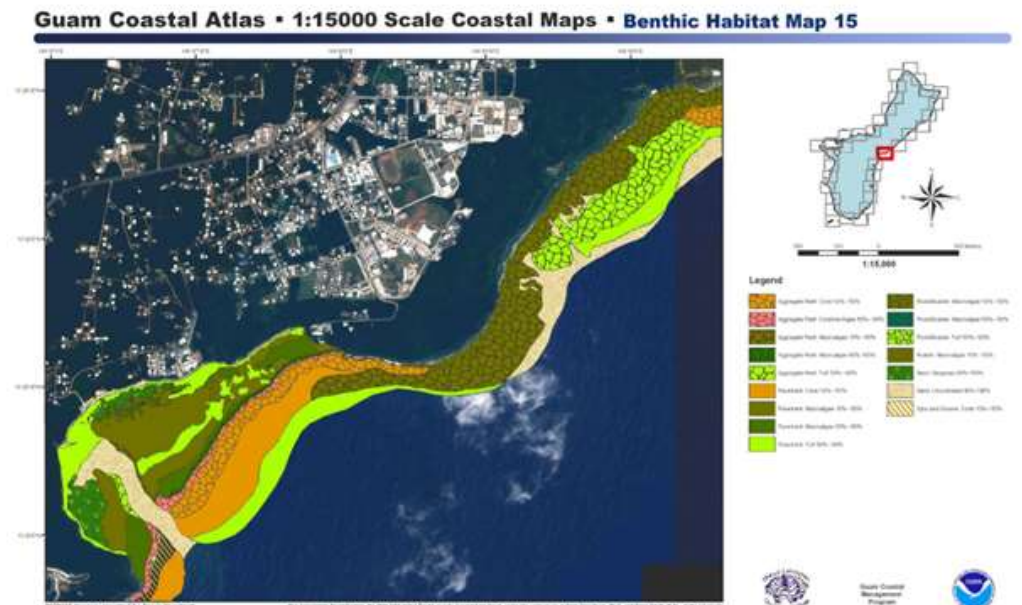
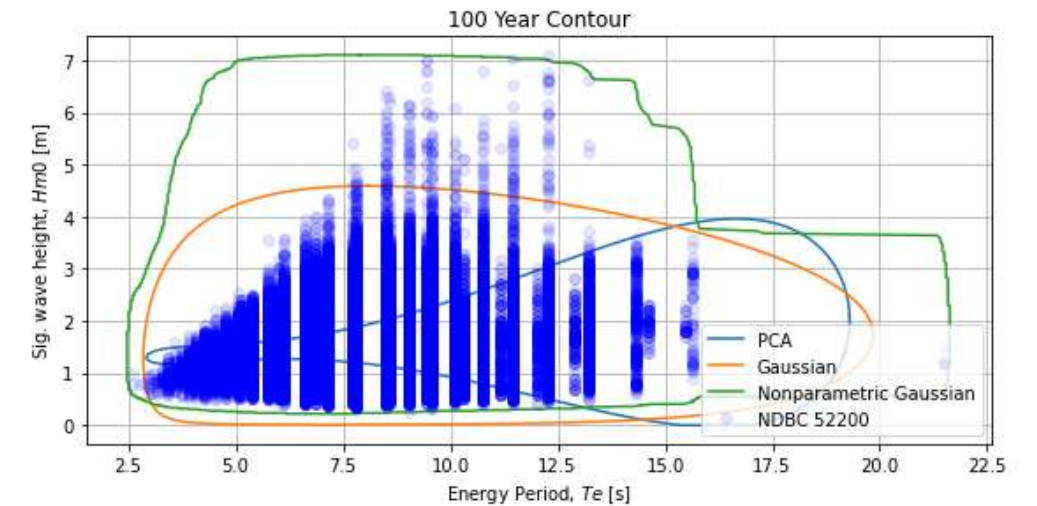
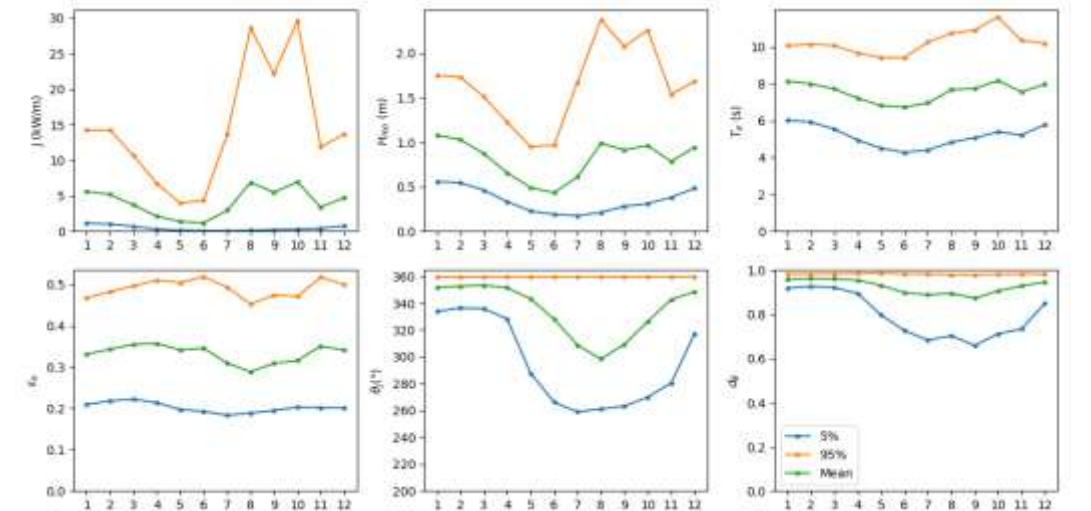


Figure 9. Guam Coastal Atlas - Benthic Habitat and substrate near UOG site [22]

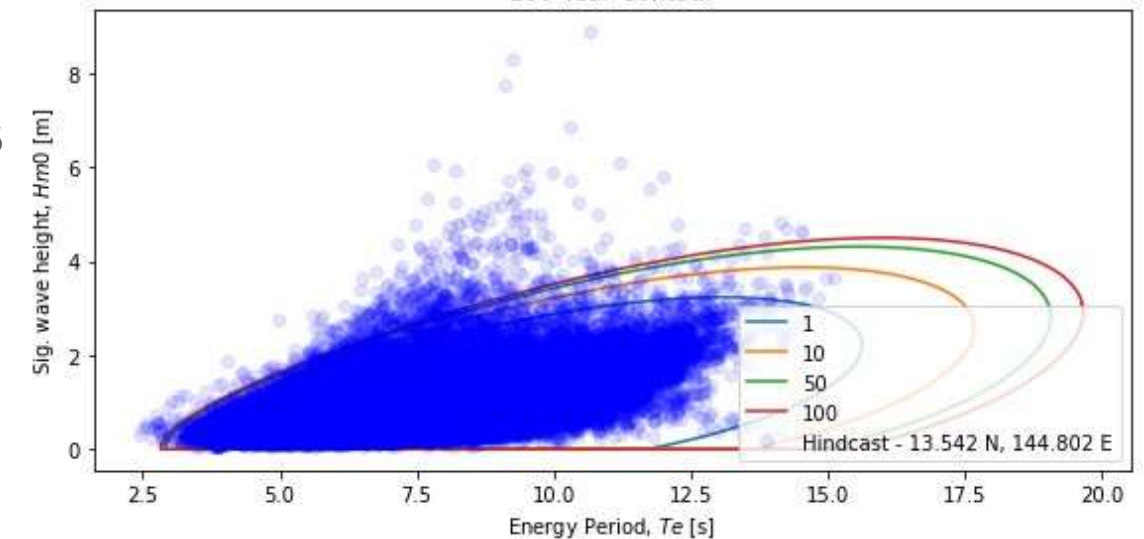


# Wave Energy Assessment (cont'd)

- Energy needed:
  - Wave Resource Analysis (NOAA wave data)
  - Simulating Waves Nearshore (SWAN) models from Pacific Island Ocean Observing System (PacIOOS)
  - Analysis of Hindcast Datasets to assess wave parameters and Sea States (wave resource plots)
- Deployment and Maintenance Capacity
  - Require heavy lift Dynamic Positioning capabilities and vessels for laying cables
  - Challenged with island's modest capabilities for deployment support



100 Year Contour



## Environmental Considerations

- Protection of coral-reef types, algal-dominated hard substrates, and small areas of seagrass
  - Limited mangrove habitat
  - Guam EPA monitors physical, chemical and bacteriological status of marine waters
  - NOAA performs coral-reef condition assessments
  - Lack of quantitative baseline for sediment and tissue pollutant concentrations
  - Guam Coastal Resilience Assessment ranks sites benefiting coastal communities and wildlife



Photo: Fish Focus



Photo: Guam Daily Post

## Environmental Considerations (cont'd)

- Installation for OTEC could threaten to coastal resources
- Other areas to explore:
  - Island's shipping lanes and other maritime activities
  - Changes in oceanographic systems water system from WEC and OTEC (turbidity, temperature)
  - Electromagnetic fields risk to animals from cables
  - Recyclable? Waste Storage? Burial at Sea?



Photo: Aquaman Charters

# Economic Considerations

- Offshore platforms or onshore sites must comply with Guam's Coastal Management Program
  - Specific Policies, rules, responsibilities, obligations, relationships
- Synergistic uses
  - OTEC feasibility study Seawater Air Conditioning (SWAC) from 30 yrs ago
  - Logistics of integrating into electricity grid
  - Ease of deploying for emergency power sources (post-Typhoon Mawar)
  - Use OTEC to support desalination systems
- Scalability of ocean energy systems
  - Capacity to generate power to store in Batter Energy Storage Systems (BESS)
- Comparison of energy OES to other renewable energy sources (solar and wind power)
- Impact on Island's Main Economy – Tourism (aesthetics)



# Thank you

Fleur de Peralta  
[fleurdeliza.deperalta@pnnl.gov](mailto:fleurdeliza.deperalta@pnnl.gov)