



Offshore Aquaculture and Wave Energy in Puerto Rico

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**Lysel Garavelli, Mikaela Freeman,
Molly Grear, Candace Briggs**



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Why wave energy for offshore aquaculture?

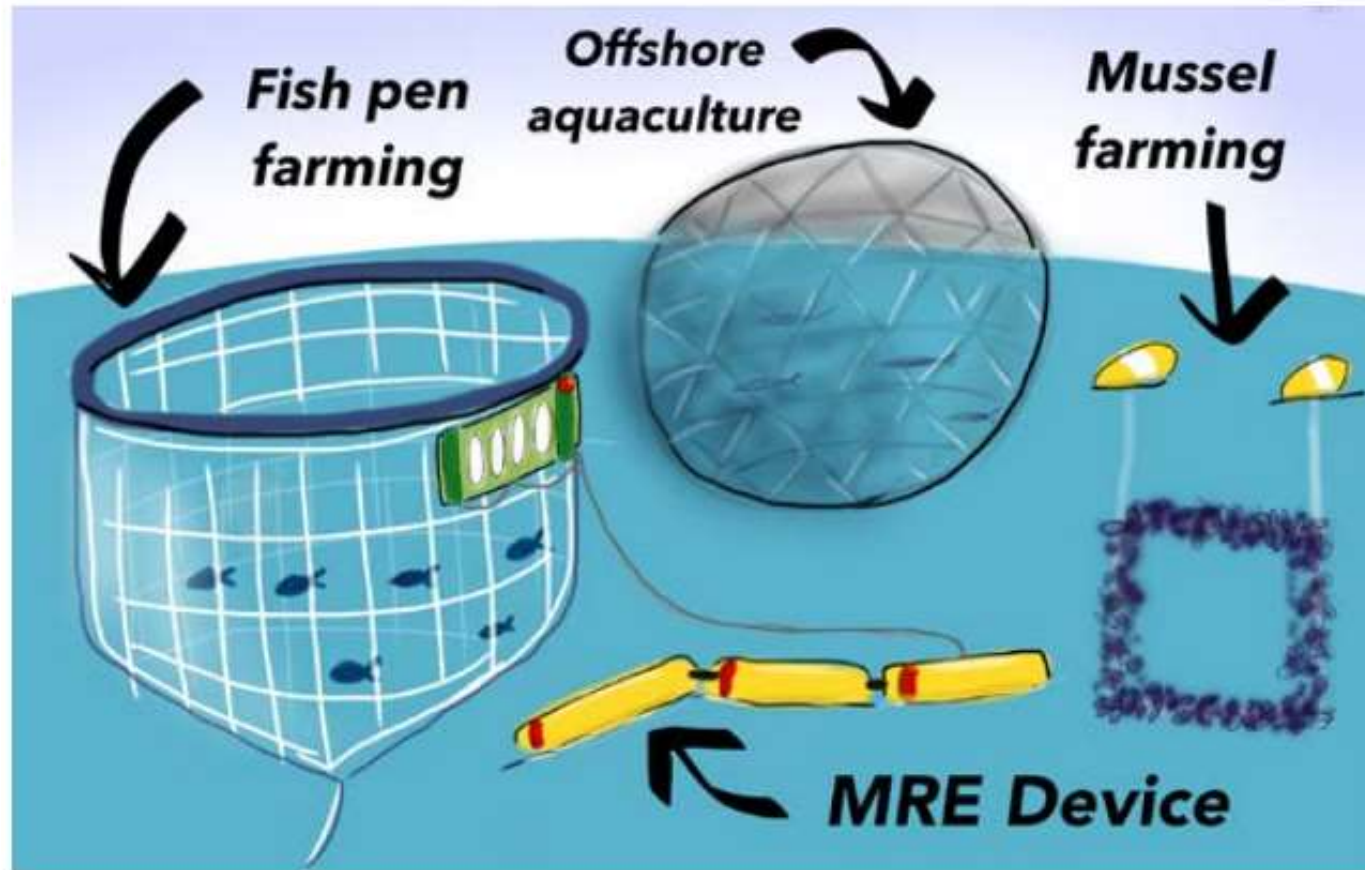


Illustration by Molly Gear (LiVecchi et al. 2019)

- Aquaculture sector is growing and moving further offshore
 - High energy environments well suited for wave energy
- Energy required to power aquaculture operations (vessels, maintenance, monitoring, fish feeders, etc.)
- Potential to provide power-at-sea for offshore aquaculture with wave energy that should be explored

Co-location of offshore aquaculture and wave energy

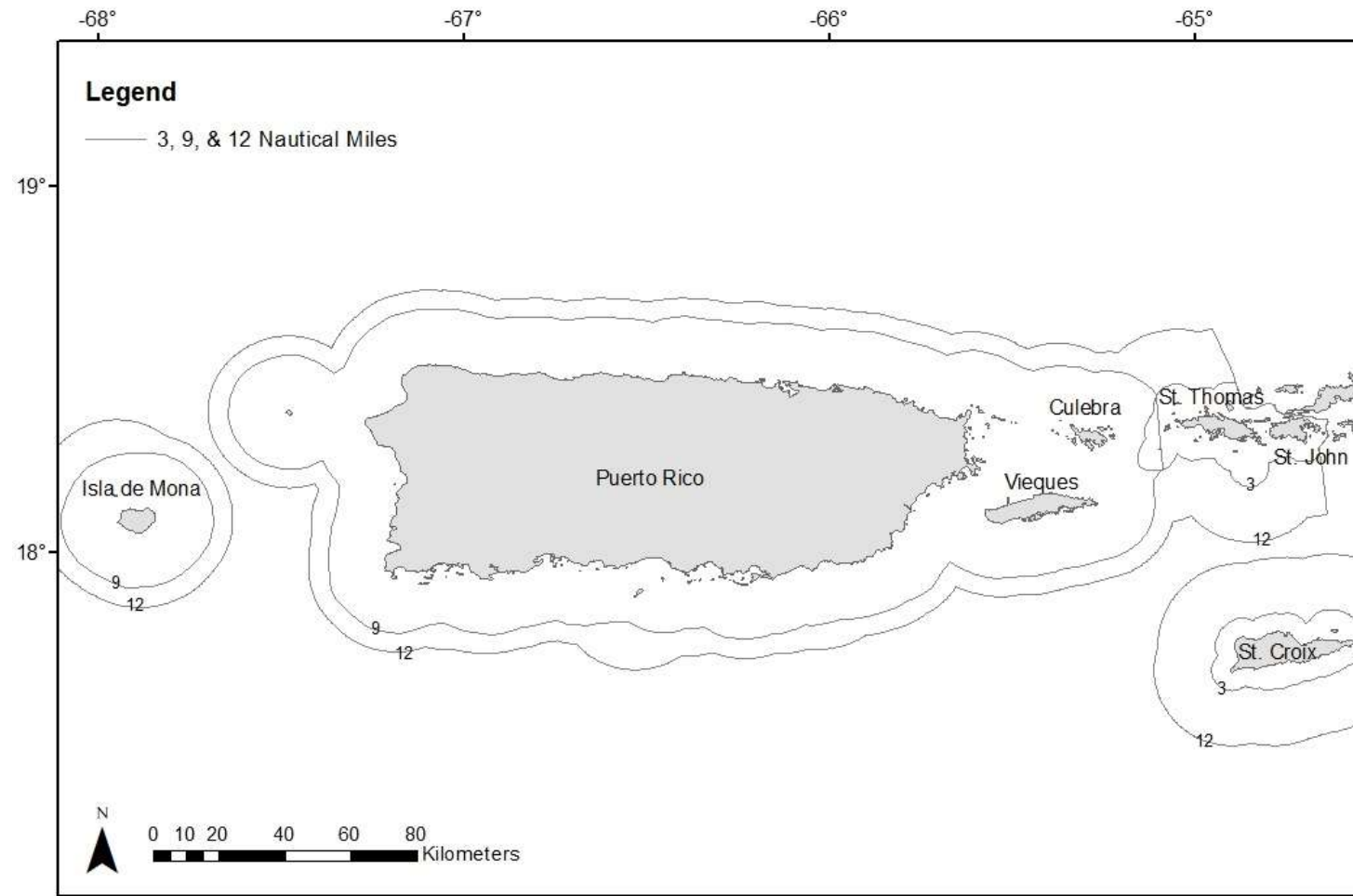
Co-location: marine uses developed within the same space and time scales; specifically focuses on integrating and powering aquaculture with marine energy

- Provides opportunities for sustainable marine development through co-location of activities
- In situ projects have demonstrated success and overall viability to deliver power for aquaculture operations



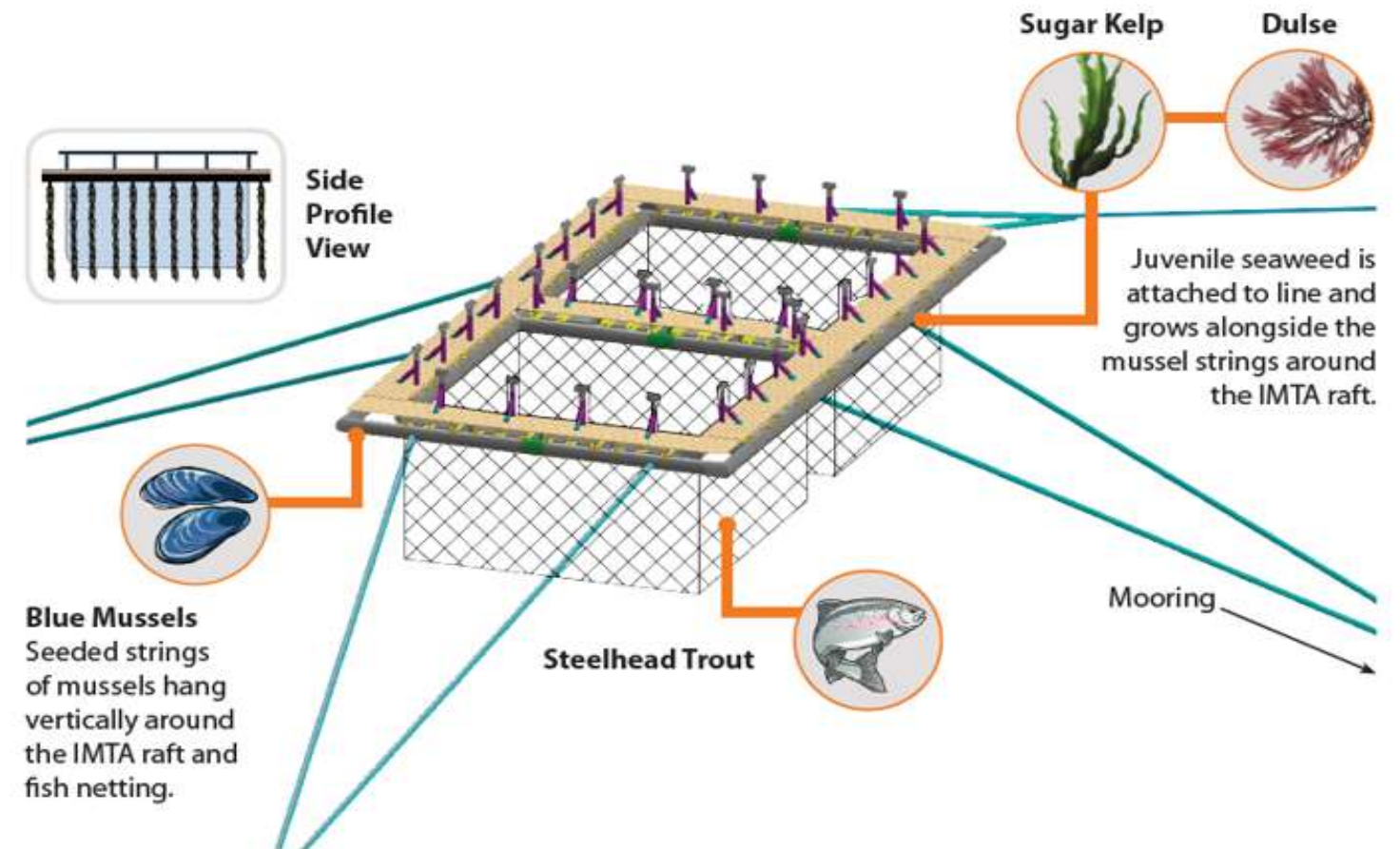
Co-location of offshore aquaculture and wave energy Puerto Rico

- Electricity infrastructure mainly uses fossil fuels
 - Shift to renewable energy sources
- Marine energy = opportunity to increase renewable energy usage
 - Can deliver power-at-sea to offshore industries



Co-location of offshore aquaculture and wave energy Puerto Rico

Assess the ability to co-locate an offshore integrated multi-trophic aquaculture (IMTA) system with wave energy in a real-world application



Outreach & Engagement

- Goals:
 - Gather feedback from stakeholders and local community throughout project
 - Understand local perspectives and needs
 - Identify barriers/challenges and opportunities for co-location



San Juan workshop – February 2023

Spatial Analysis

- Assess suitability for co-location of wave energy and offshore IMTA off Puerto Rico
- Defined parameters and ideal conditions for co-location to use in the analysis based on current research and interviews with experts (Garavelli et al. 2022)

Key Parameters for Identifying Suitable Areas

Parameter	Ideal Conditions
Wave height	0 – 2.5 m
Wave power density	5 – 30 kW/m
Current velocities	0 – 1 m/s
Bathymetry	15 – 80 m
Benthic habitat	Soft bottom habitat (sand & mud)
Distance to Ports	0 – 40 km

Spatial Analysis



Other parameters included in spatial analysis:

- **Regulatory considerations**

- Marine protected areas
- Essential fish habitats
- Species and critical habitat (coral, sea turtle)

- **Maritime activities**

- Navigation routes (> 10 vessels)
- Aids to navigation
- Anchorage areas
- Submarine cables

- **Military activities**

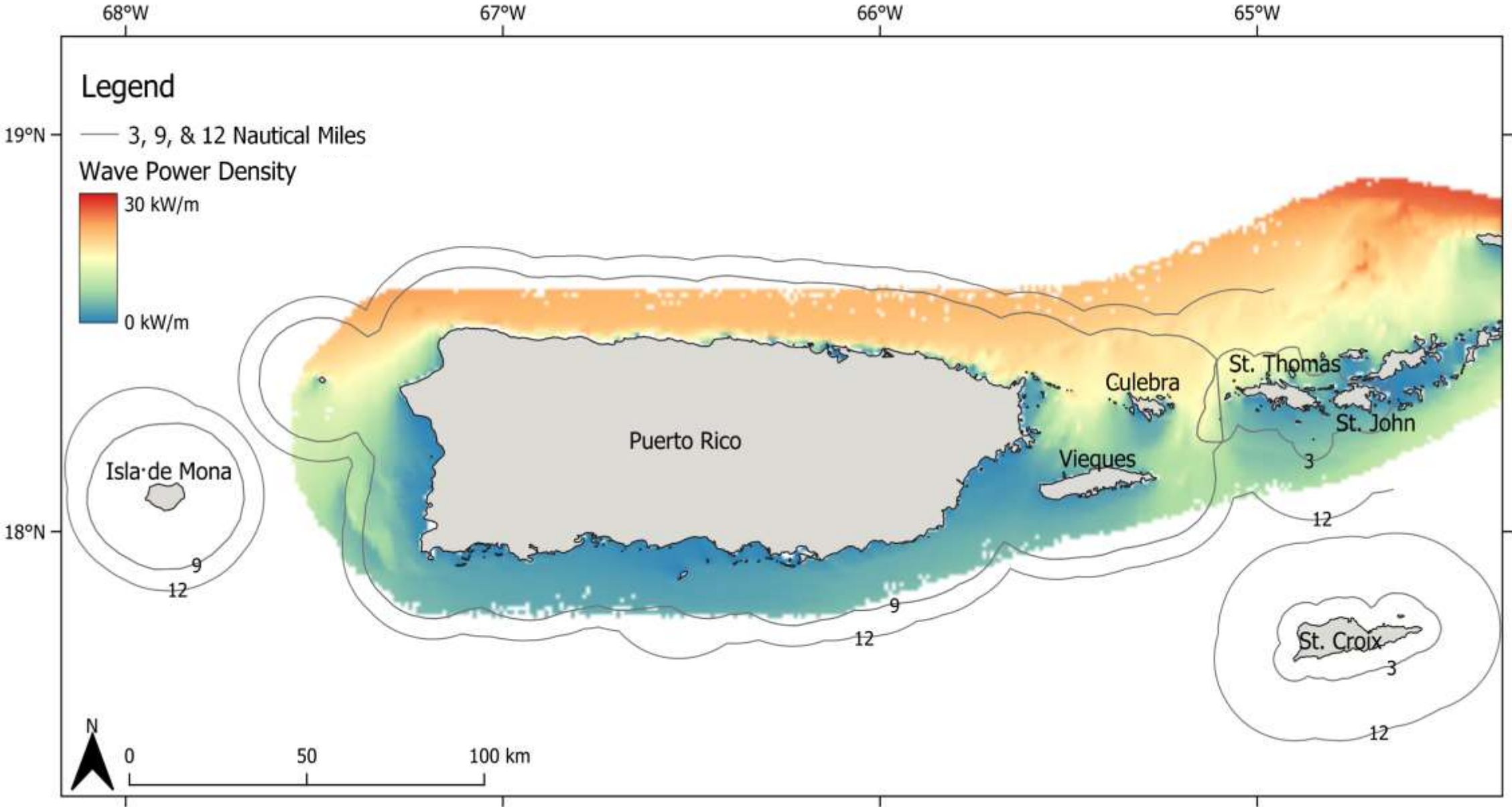
- Unexploded ordnance area
- Formerly used defense site
- Danger & restricted zones

- **Other ocean activities/considerations**

- Ocean disposal sites
- Wrecks and obstructions
- Fish aggregating devices
- Artificial reefs
- Pilot boarding areas

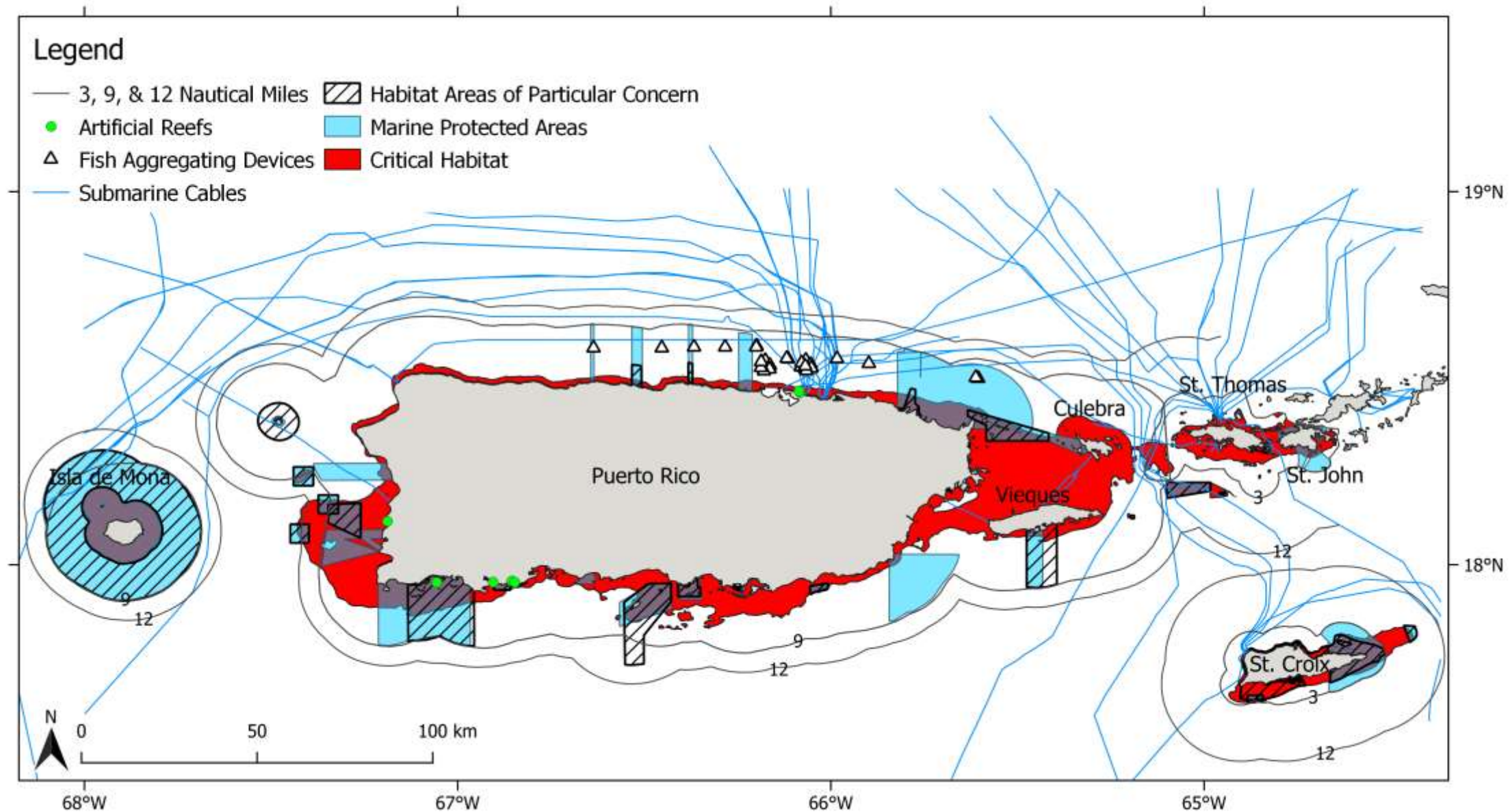
Spatial Analysis

Wave Energy Resource



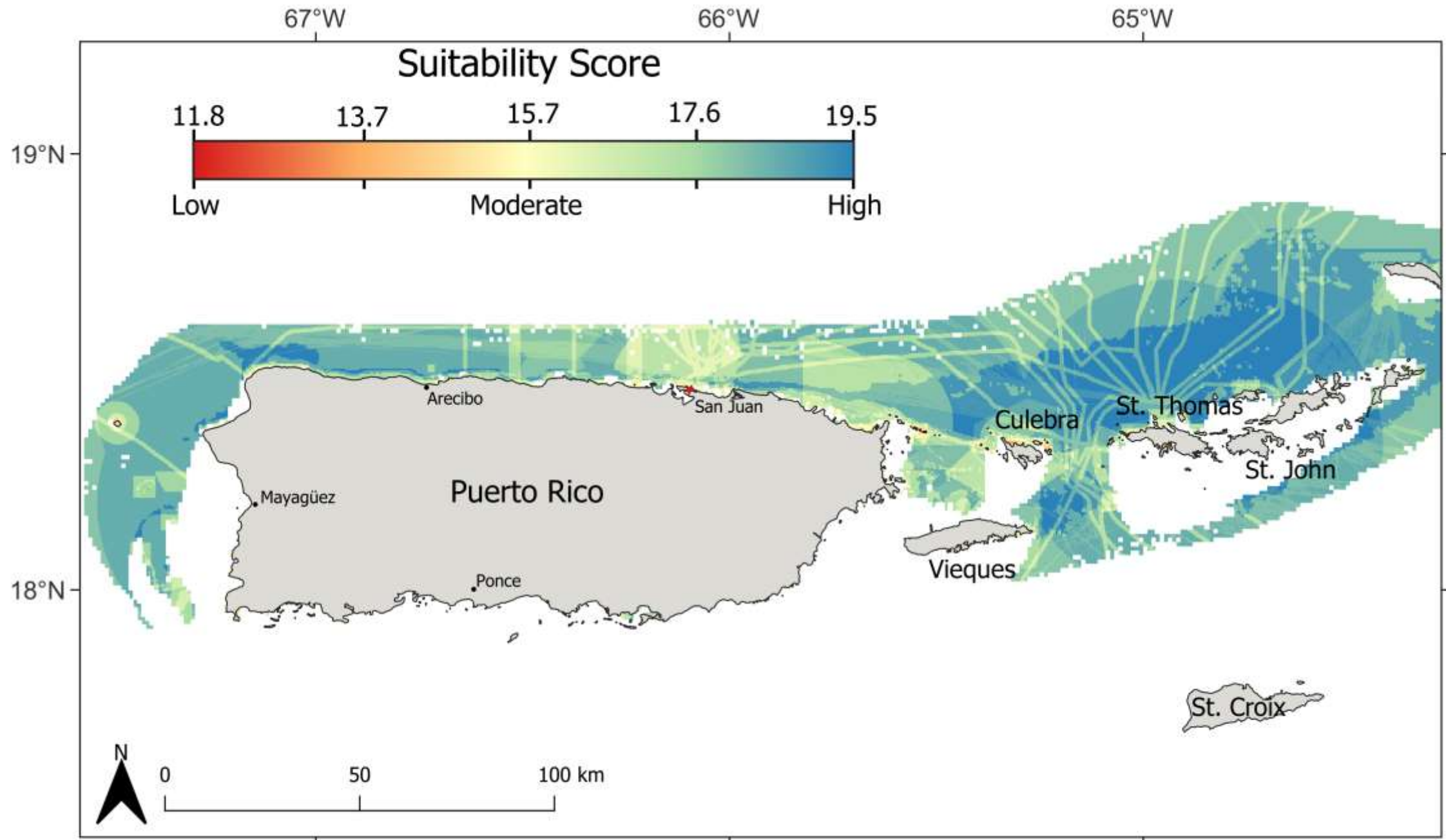
Spatial Analysis

Subset of Regulatory and Logistical Parameters



Spatial Analysis – Suitability

Higher suitability score = greater convergence of relevant parameters



Environmental Monitoring

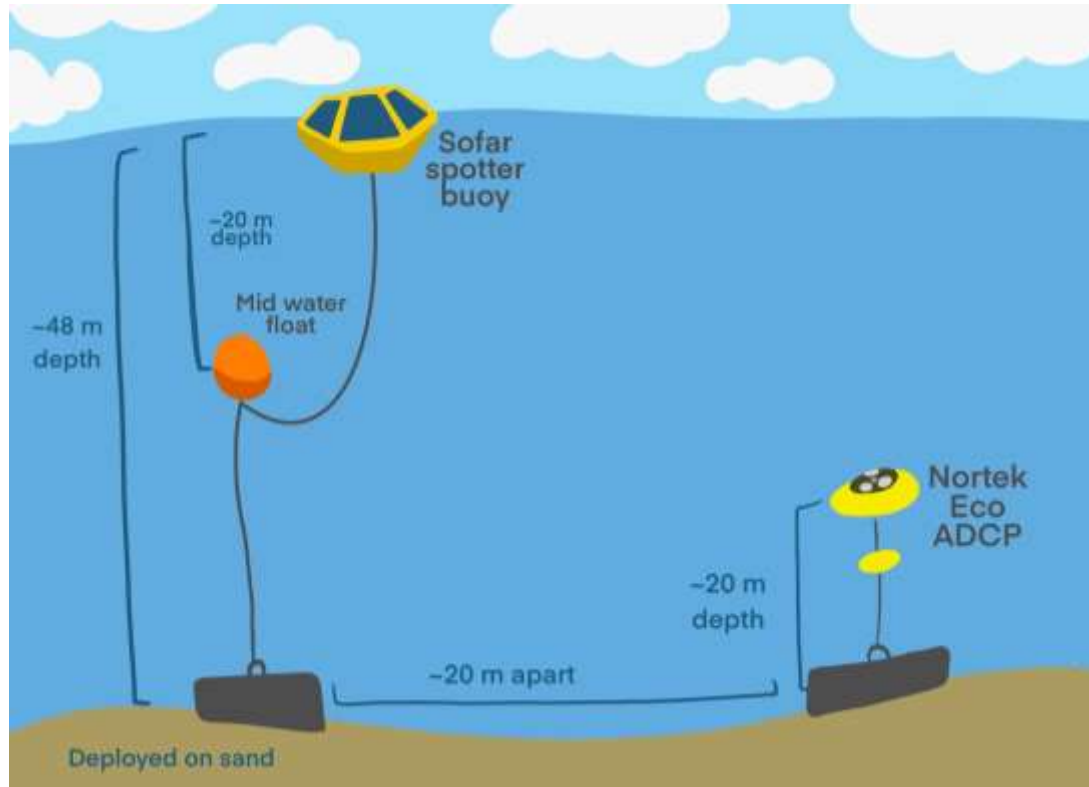
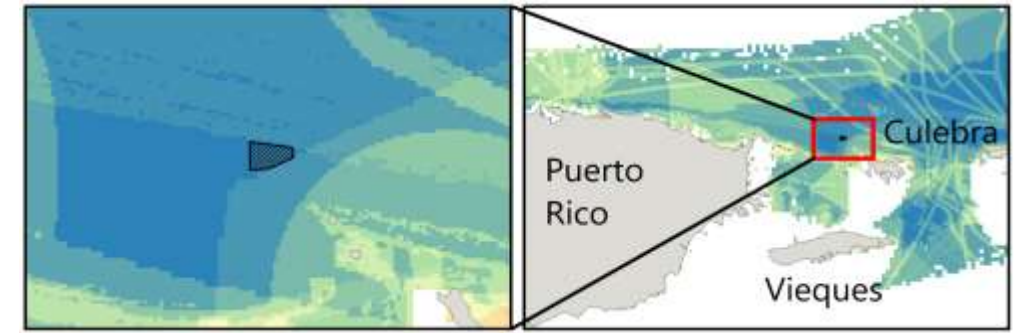


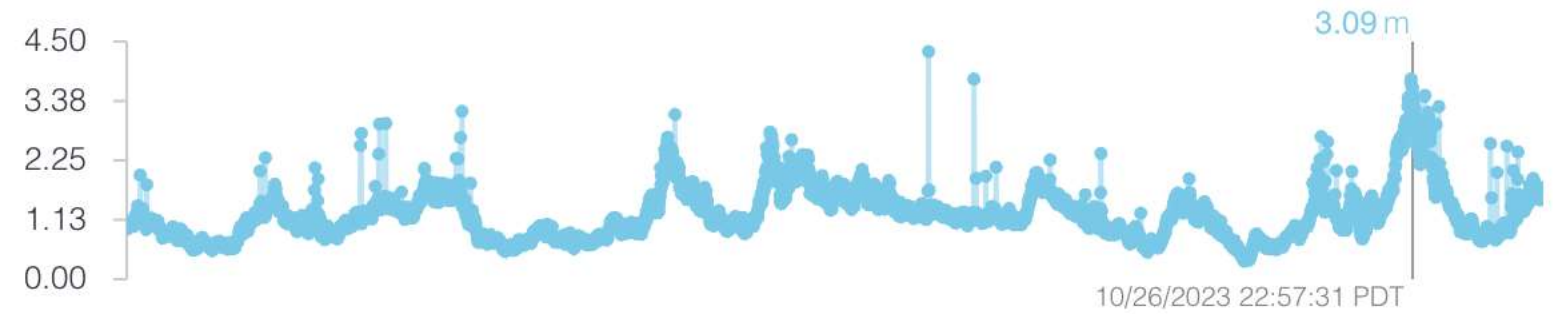
Illustration by Molly Grear



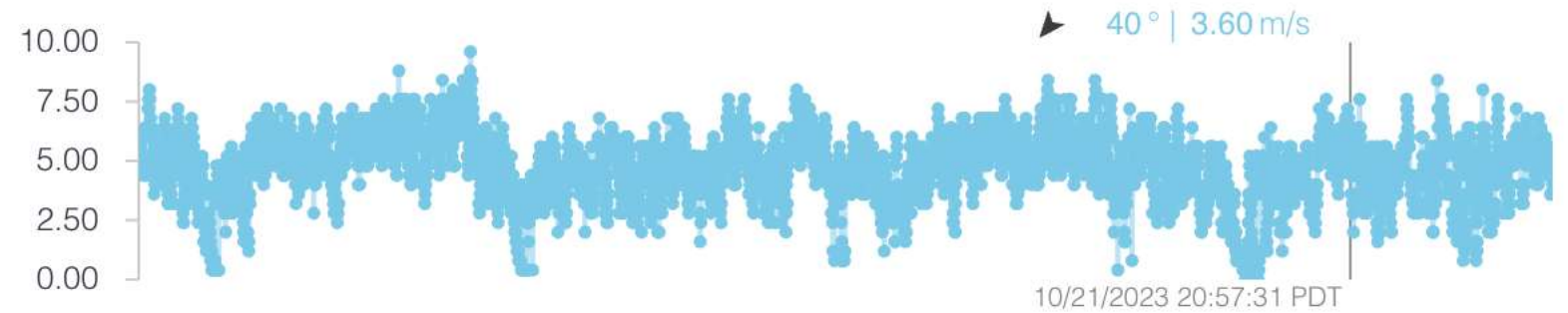
6 months of monitoring (July 2023 – January 2024)



Significant Wave Height



Wind Direction | Speed



Next Steps

- Continue to conduct outreach and engagement with Puerto Rico community
 - Discussions with communities in 2024
- Complete spatial analysis
 - Discuss suitable areas with communities during workshop
 - Finalize spatial analysis
- Analyze data collected from fieldwork – compare with nearby buoys and model outputs

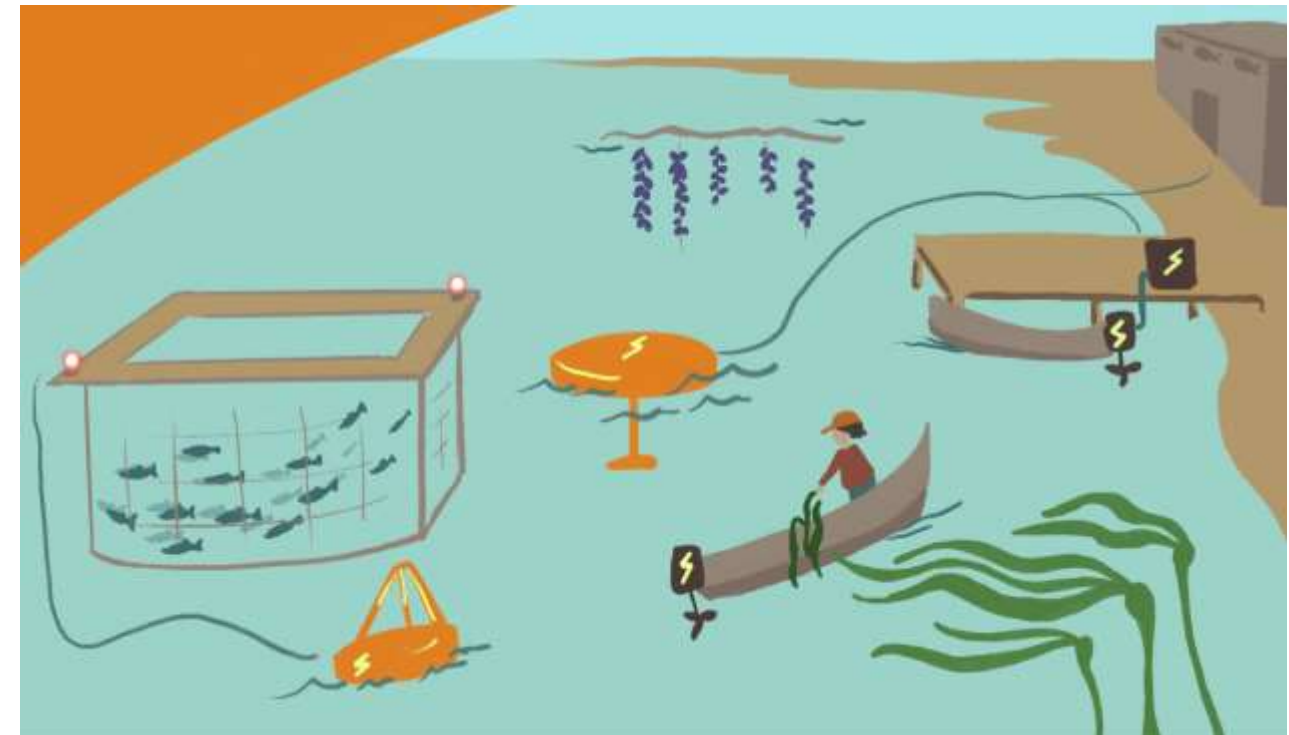


Illustration by Molly Gear



Thank you!

Lysel Garavelli, PhD
lysel.garavelli@pnnl.gov

