Pacific Northwest
NATIONAL LABORATORY

Offshore Aquaculture and Wave Energy in Puerto Rico

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U.S. DEPARTMENT OF ENERGY BATTELLE

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Why wave energy for offshore aquaculture?

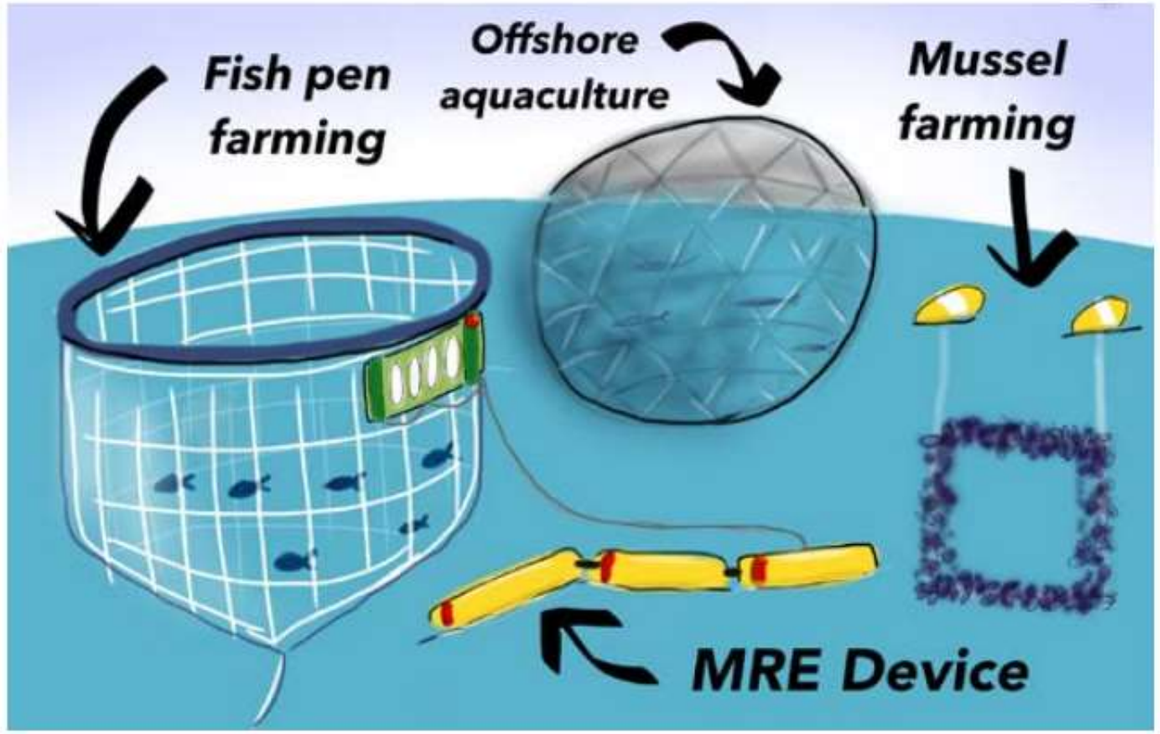


Illustration by Molly Grear (LiVecchi et al. 2019)

- 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

Offshore aquaculture: no agreed upon definition - 25 m depth or more

Co-location of offshore aquaculture and wave energy

<u>Co-location</u>: 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

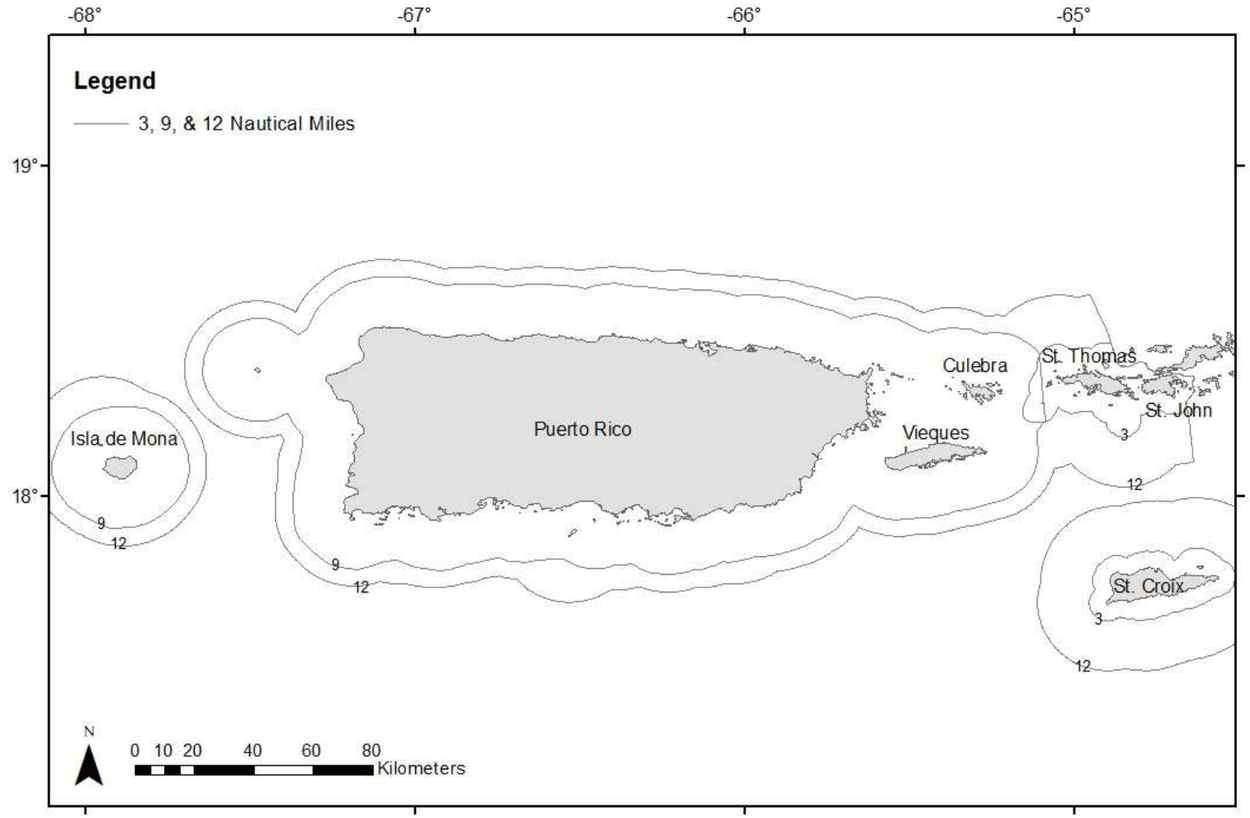

ERSEO project


Albatern – WaveNET array

Freeman et al. (2022)

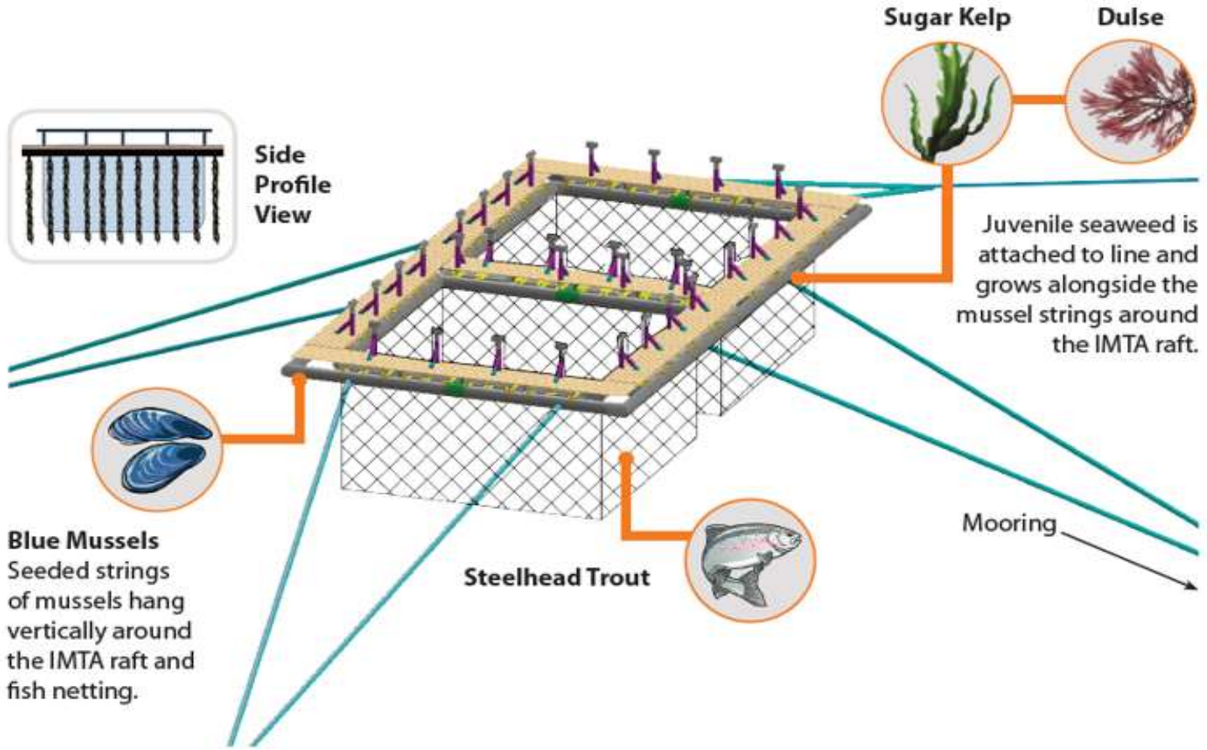
Co-location of offshore aquaculture and wave energy
Puerto Rico

- 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



Source: New Hampshire Sea Grant

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

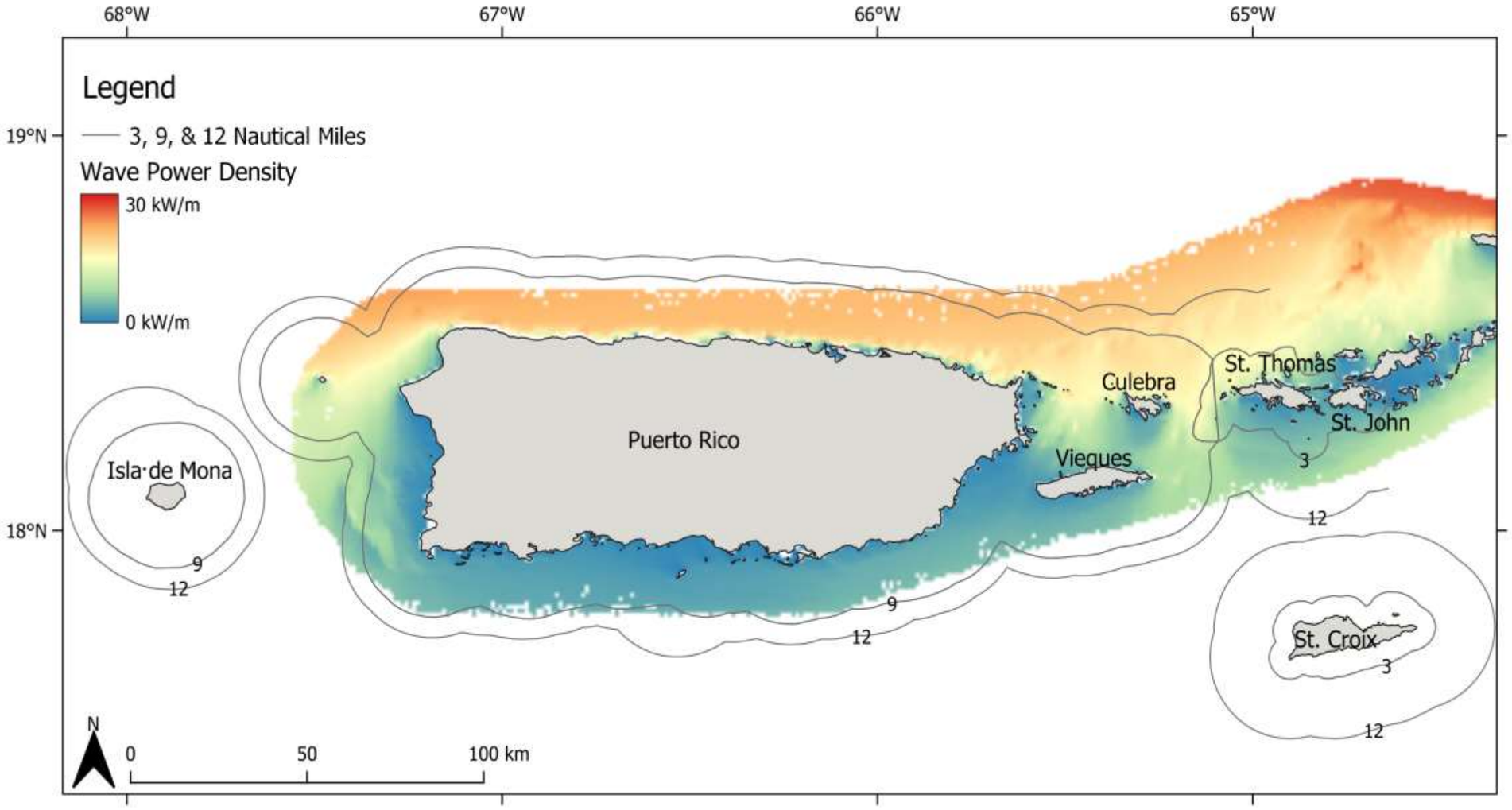
Spatial Analysis

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

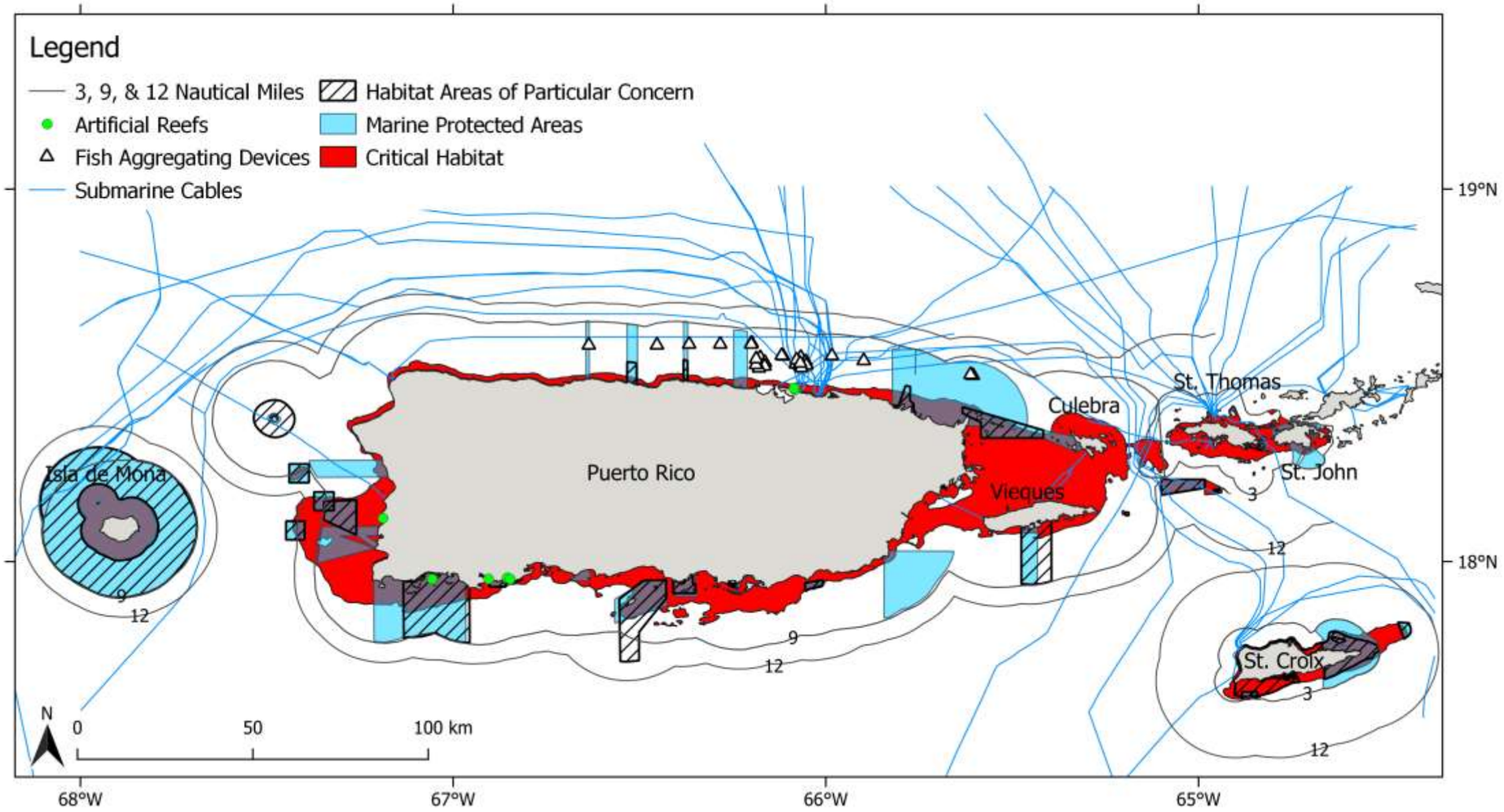
Spatial Analysis

Wave Energy Resource



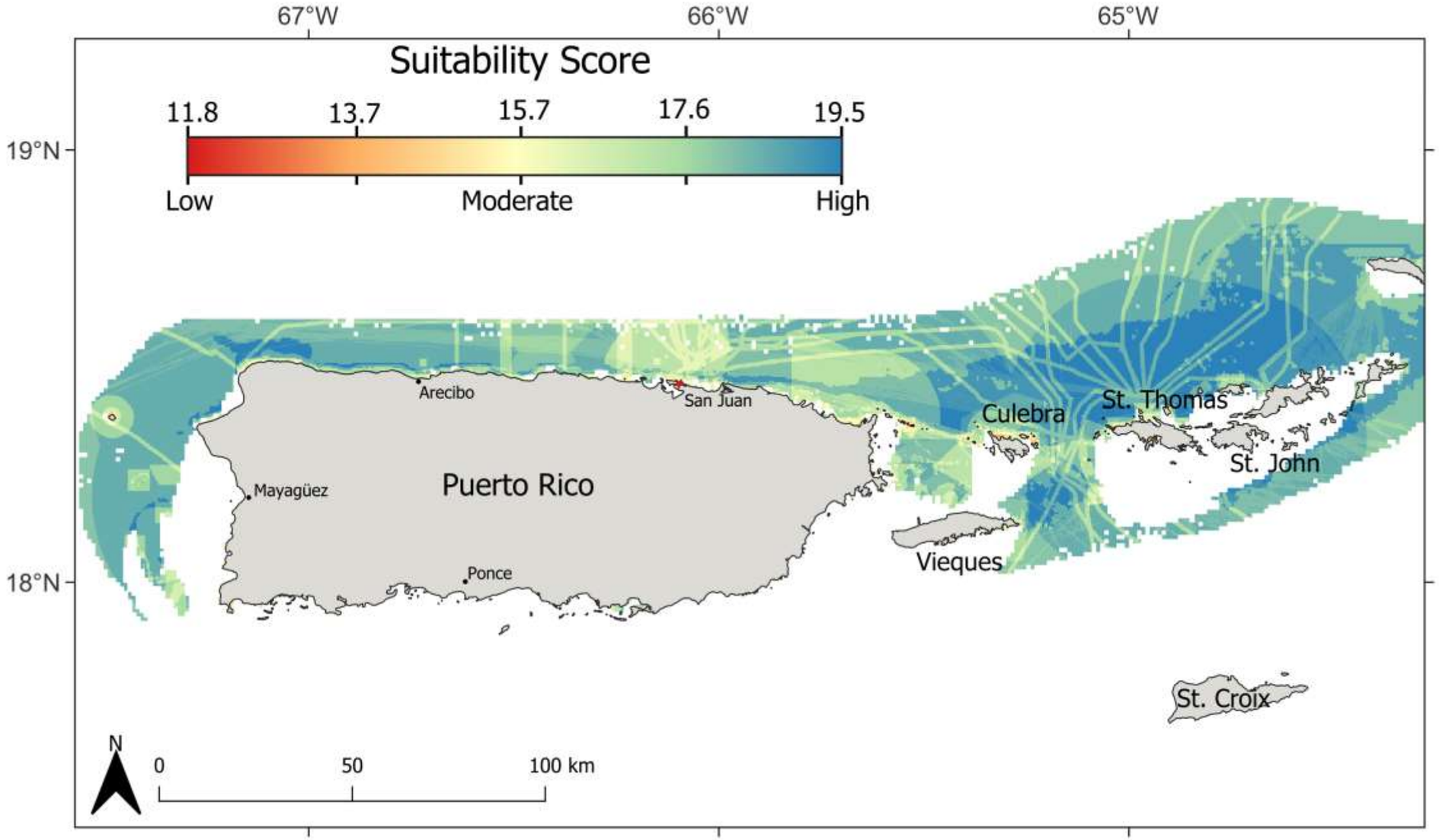
Spatial Analysis

Subset of Regulatory and Logistical Parameters



Spatial Analysis – Suitability

Higher suitability score = greater convergence of relevant parameters



Environmental Monitoring

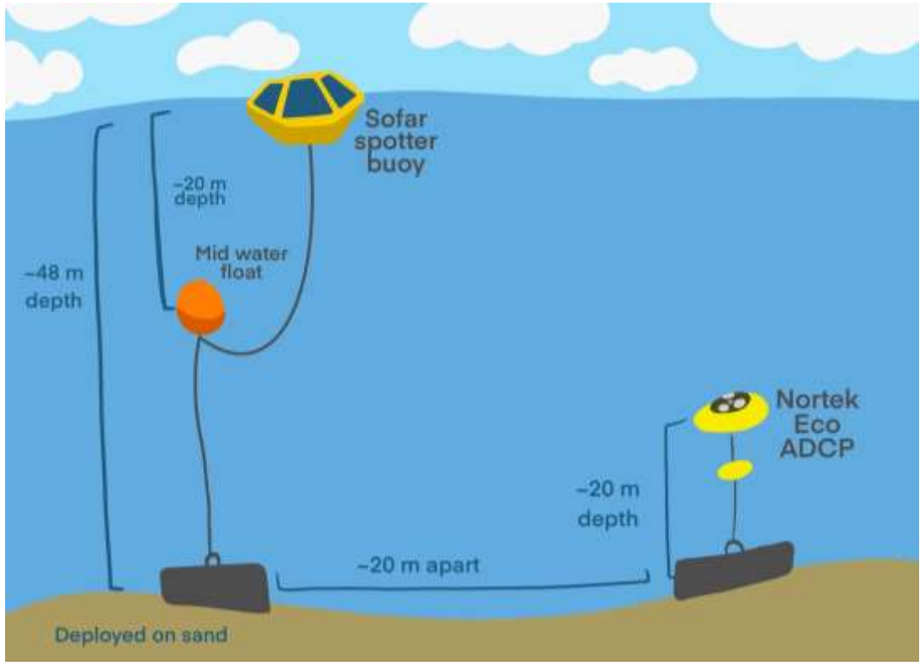
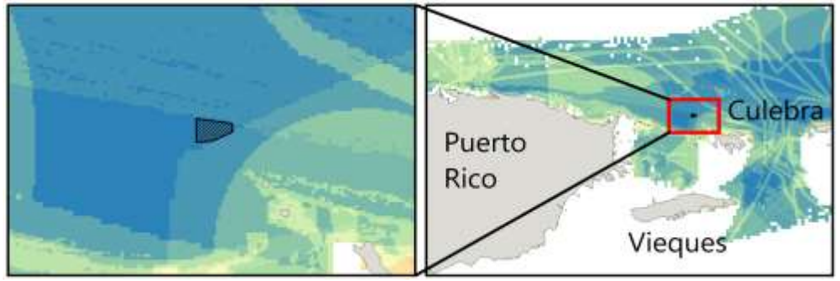
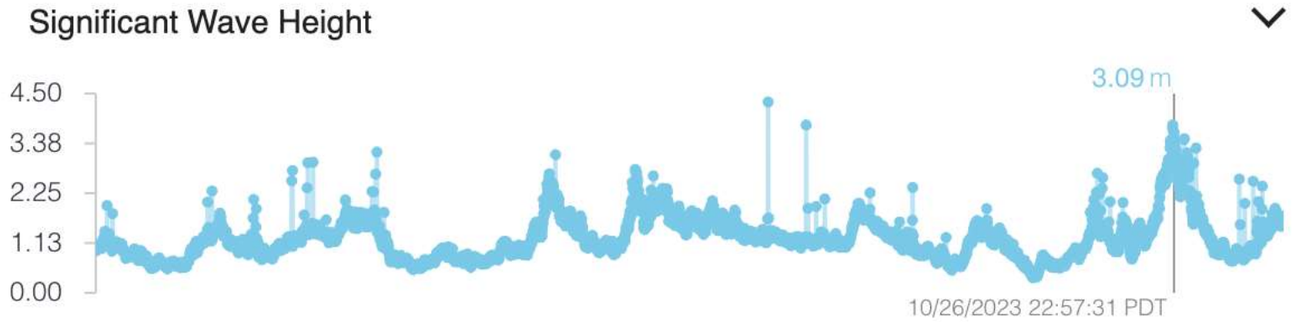


Illustration by Molly Grear

6 months of monitoring (July 2023 – January 2024)





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

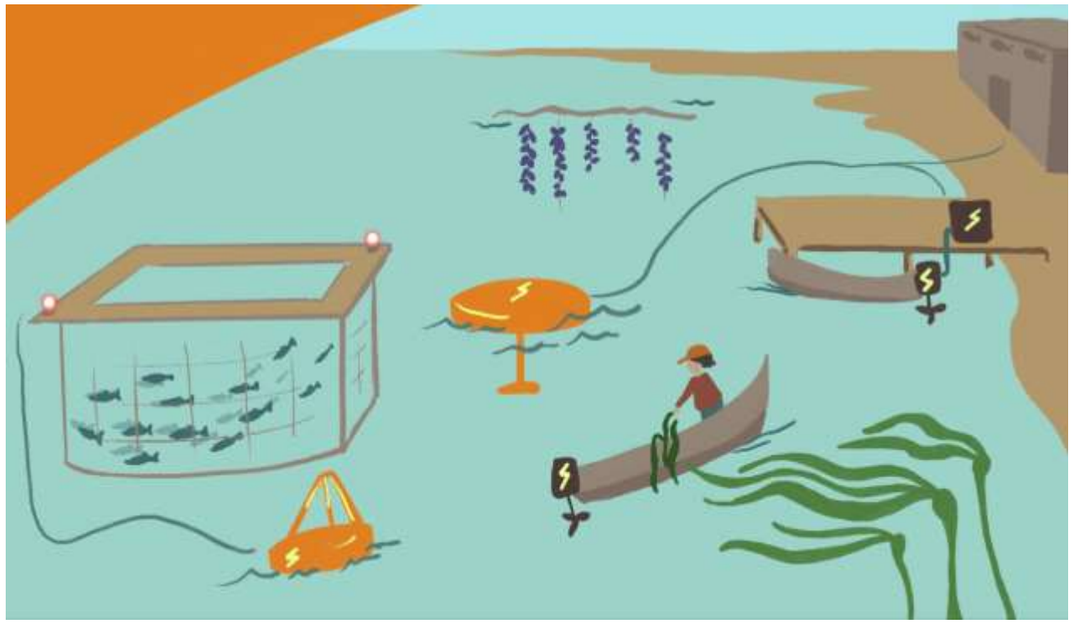


Illustration by Molly Grear

Thank you!

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