



# OpenCTD as a Low-Cost Tool for Small-Scale Wave Energy Characterization

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North Carolina  
Renewable Ocean  
Energy Program

# The CTD Instrument

- “Conductivity” (Salinity)
- “Temperature”
- “Depth”

A tool to study the physical, chemical, and biological properties of a marine environment.



**EXPENSIVE**

## The OpenCTD



**Low-Cost**



**Open-Source**

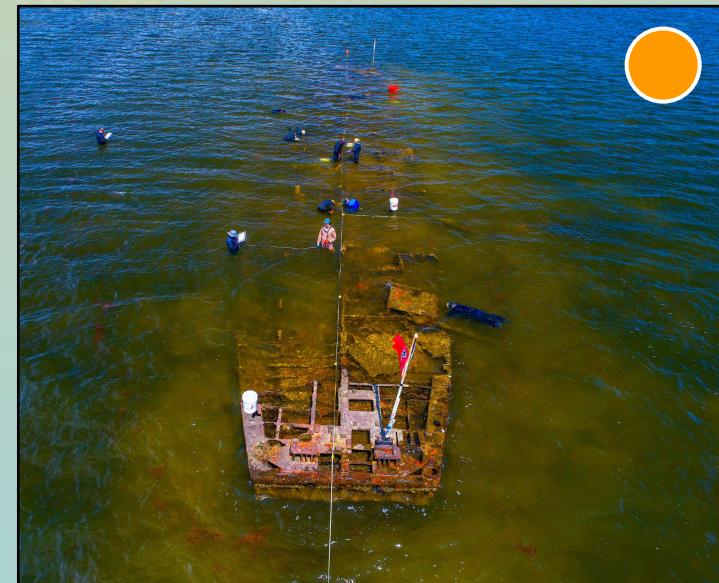


**DIY**

# NCROEP 2024-2025 Project

## Objectives

1. Develop a local curriculum and workshop
2. Demonstrate a long term OpenCTD deployment
3. **Resource characterization of site-specific wave energy**

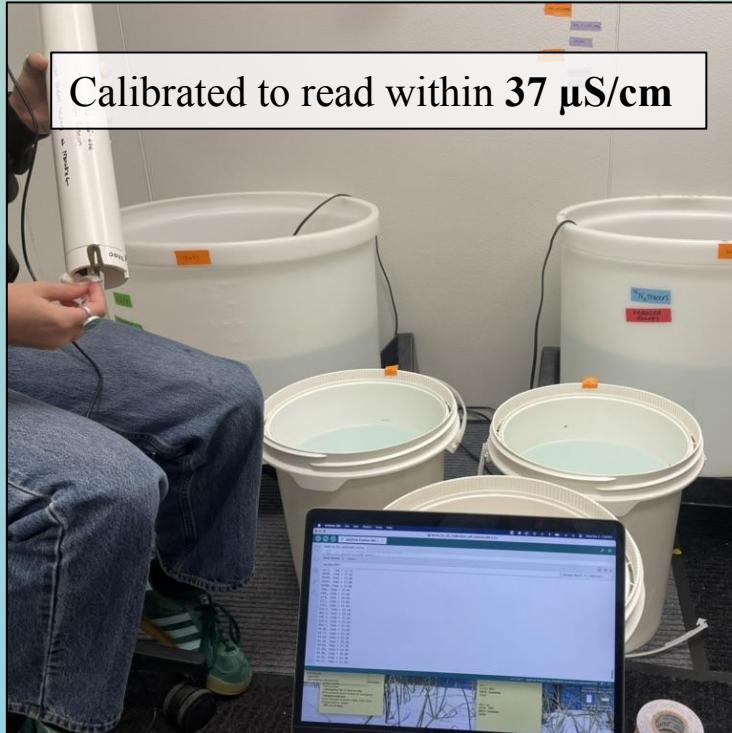


# Pre-Deployment Preparations

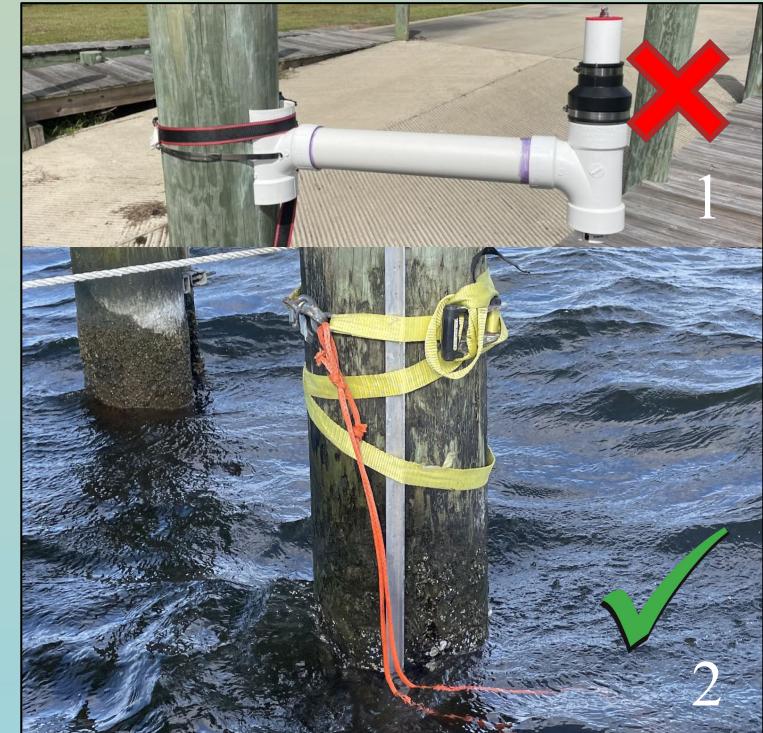
## Construction



## Calibration



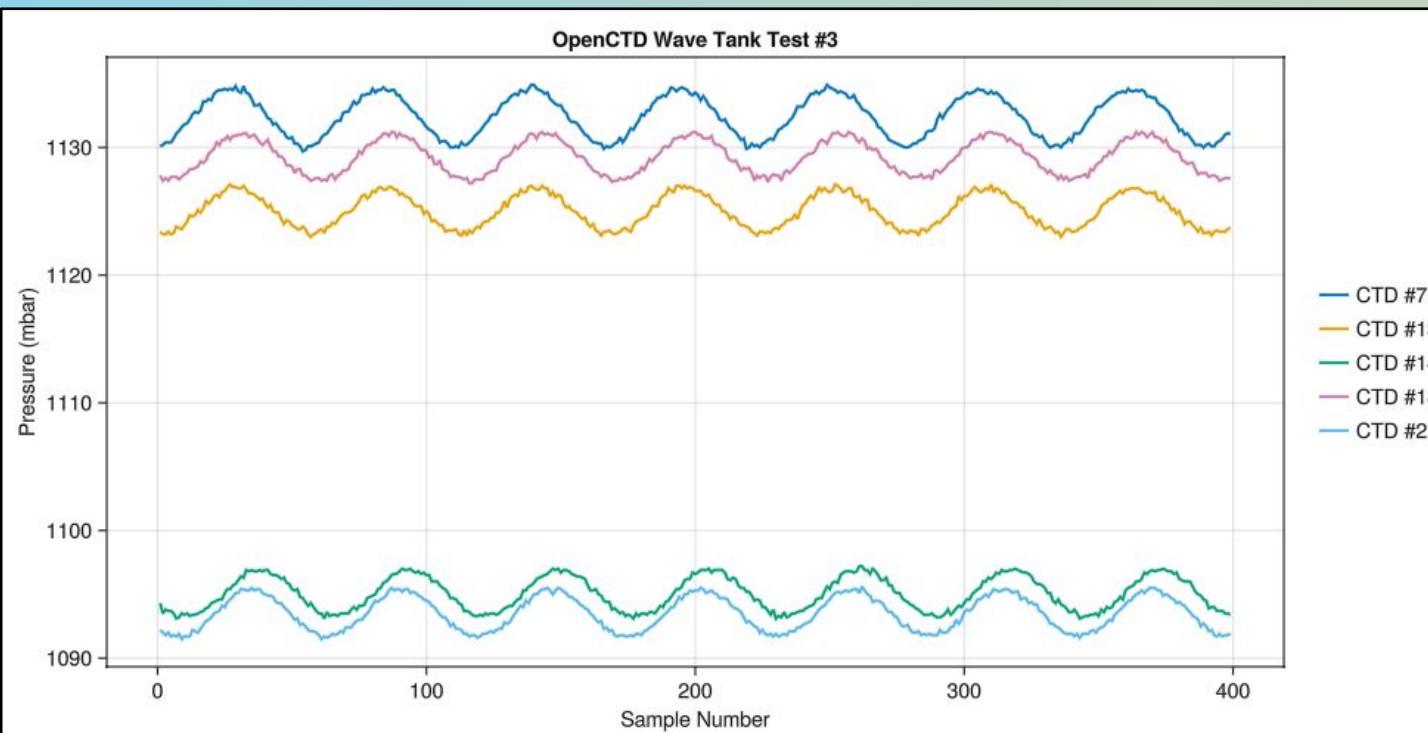
## Field Testing



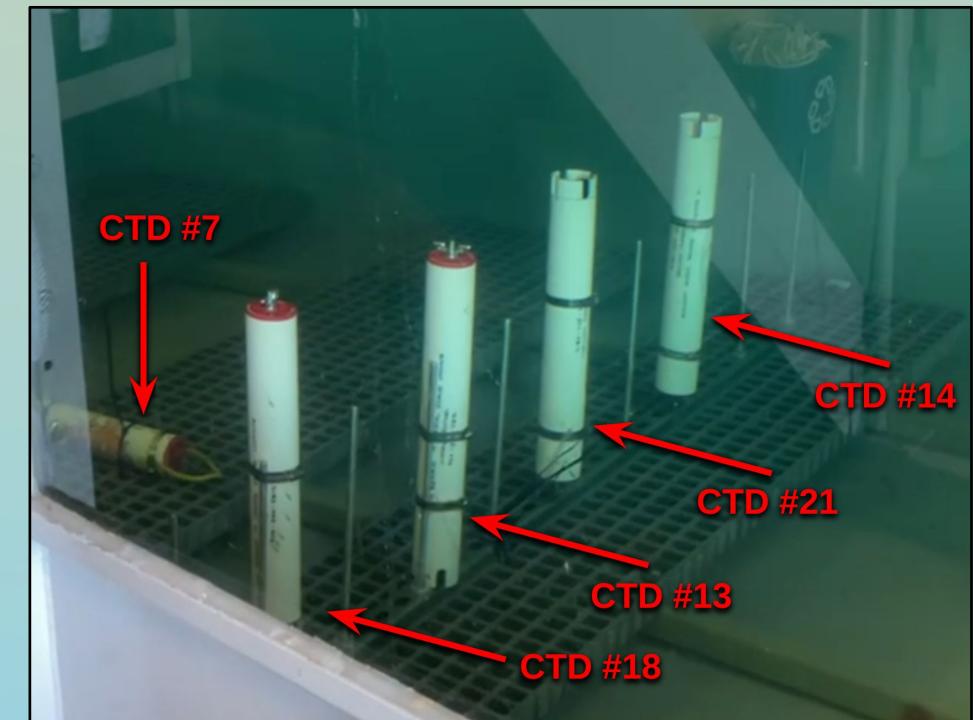
## Modifications

- ✓ Larger capacity battery
- ✓ Low power mode
- ✓ Limited power draw: 86+ days
- ✓ 20 Hz water level sampling
- ✓ Code for moored sampling: once every 5 minutes

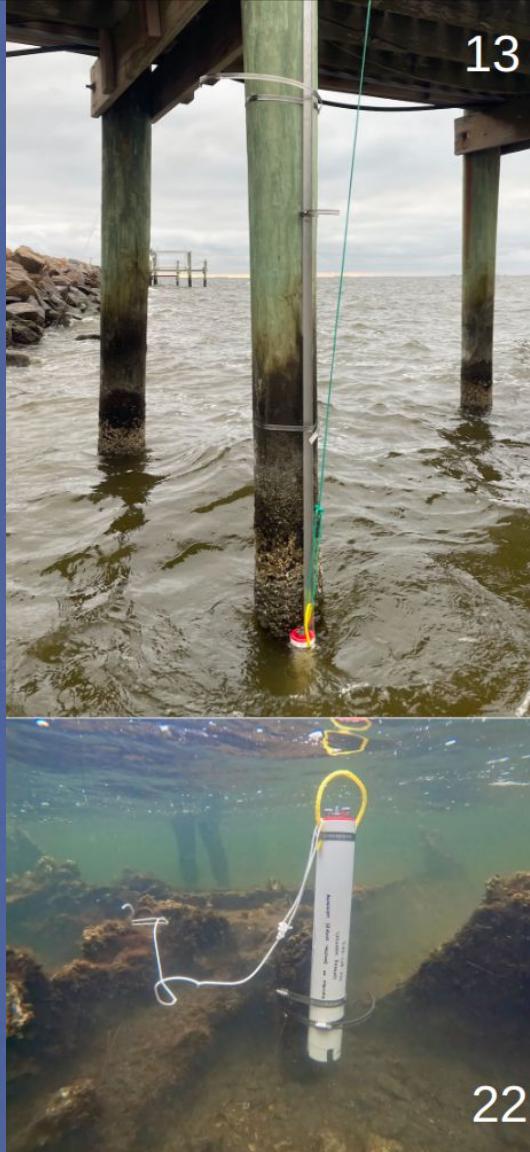
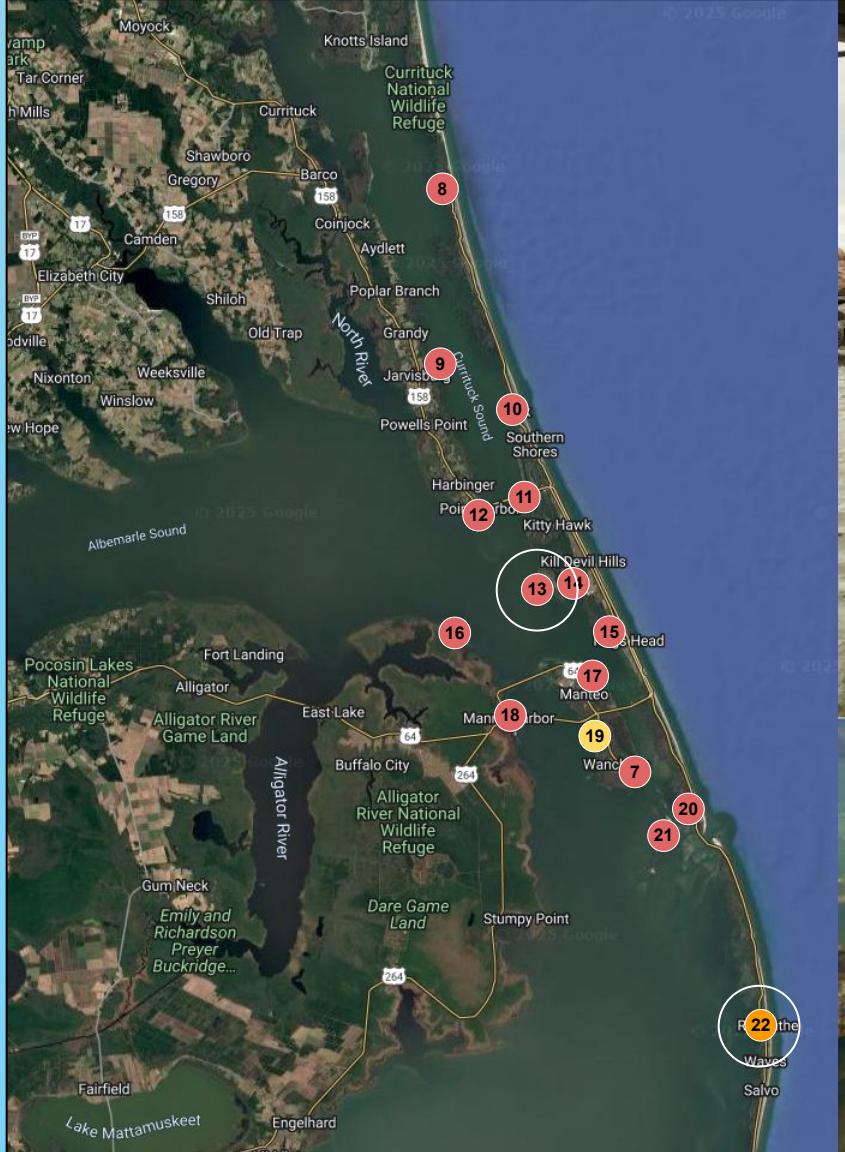
# Wave Tank Testing



- Wave generator produced 5cm wave height with 1s period.
- CTDs recorded different pressures due to varying sensor depths.
- Pressure signals misaligned from real-time clock offsets.



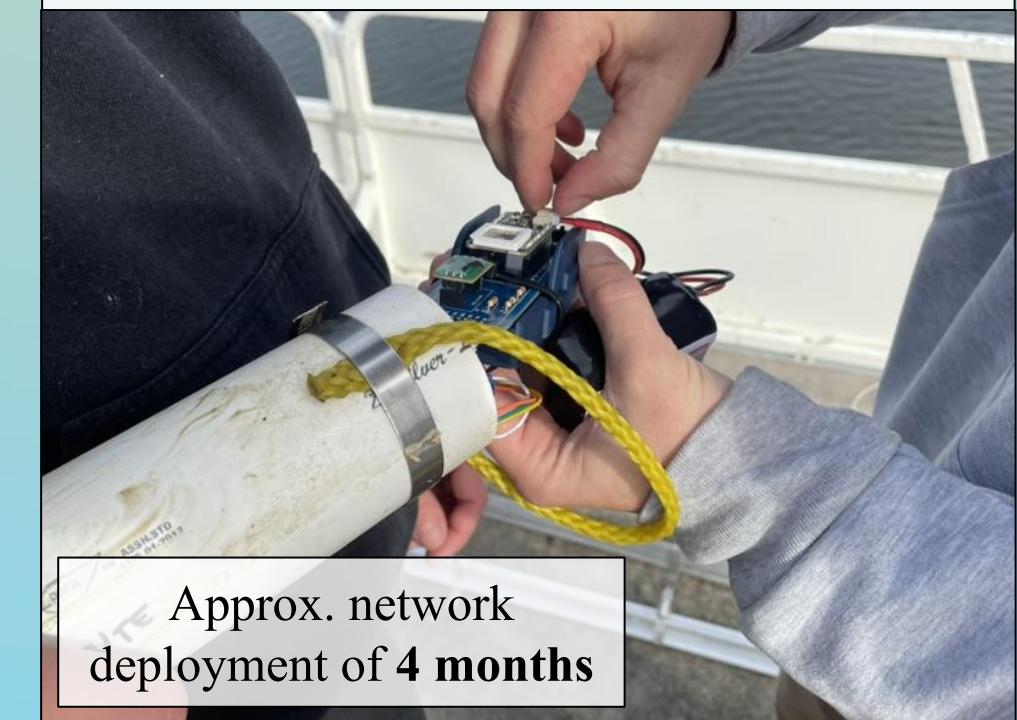
# Deployment (Nov. 2024 - Mar. 2025)



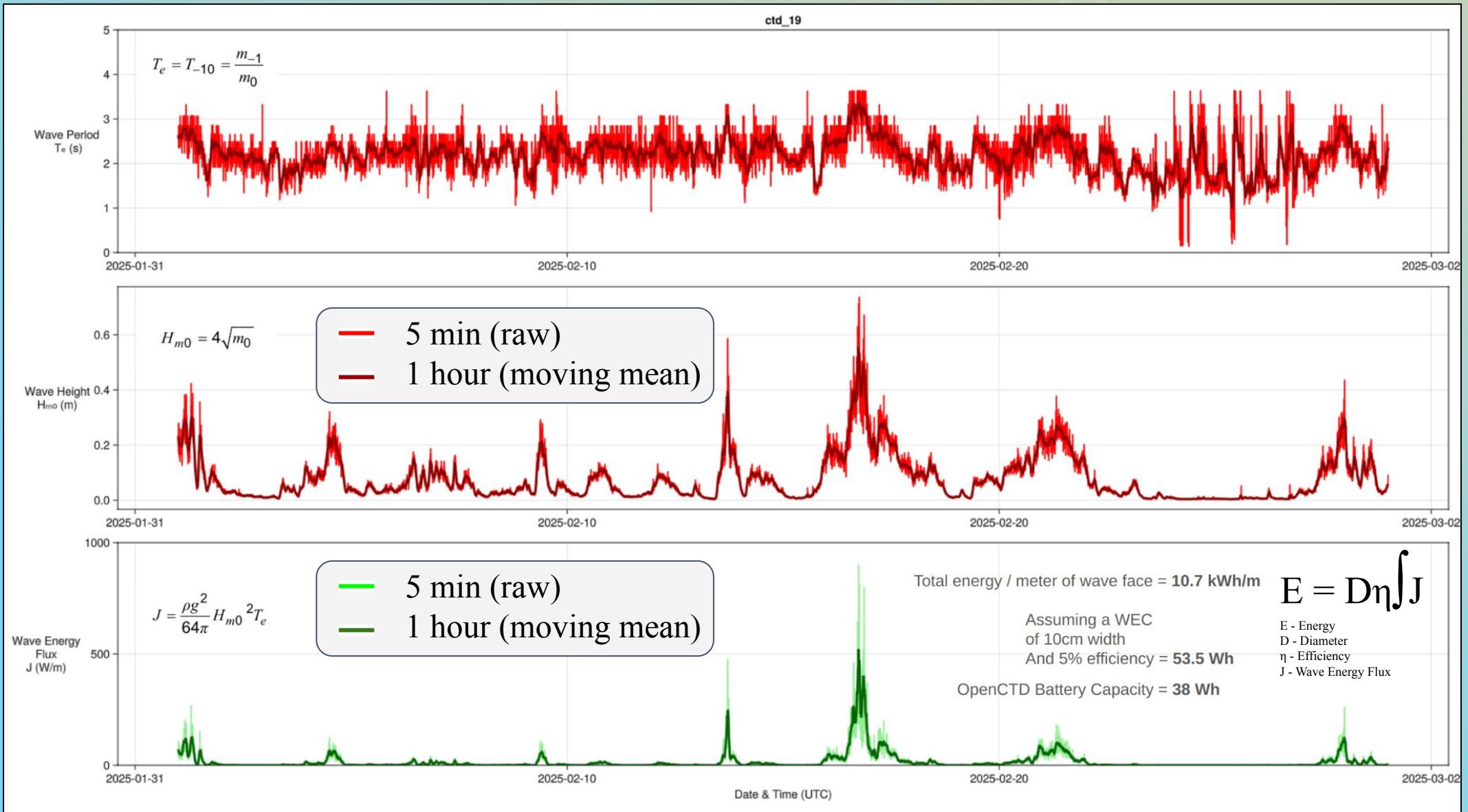
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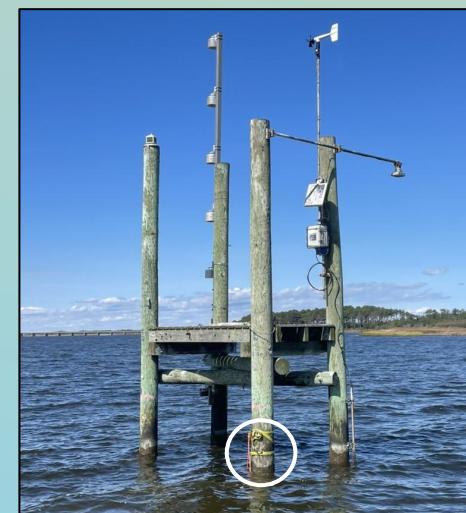
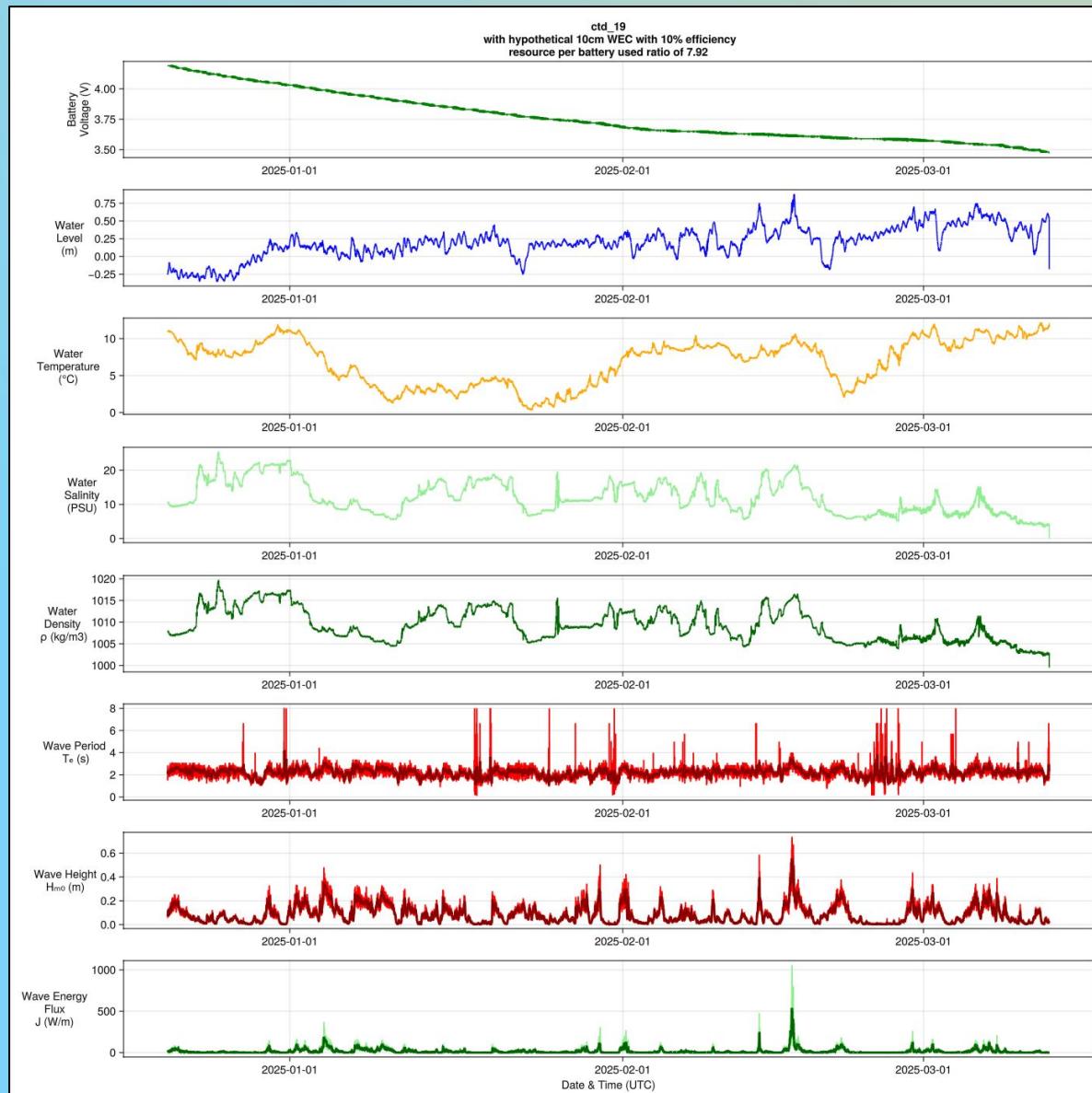
- Mid-November: 16 CTDs deployed
- Early-December: 6 recovered
- Late-December: All sites re-installed/serviced
- Mid-March: All sites recovered



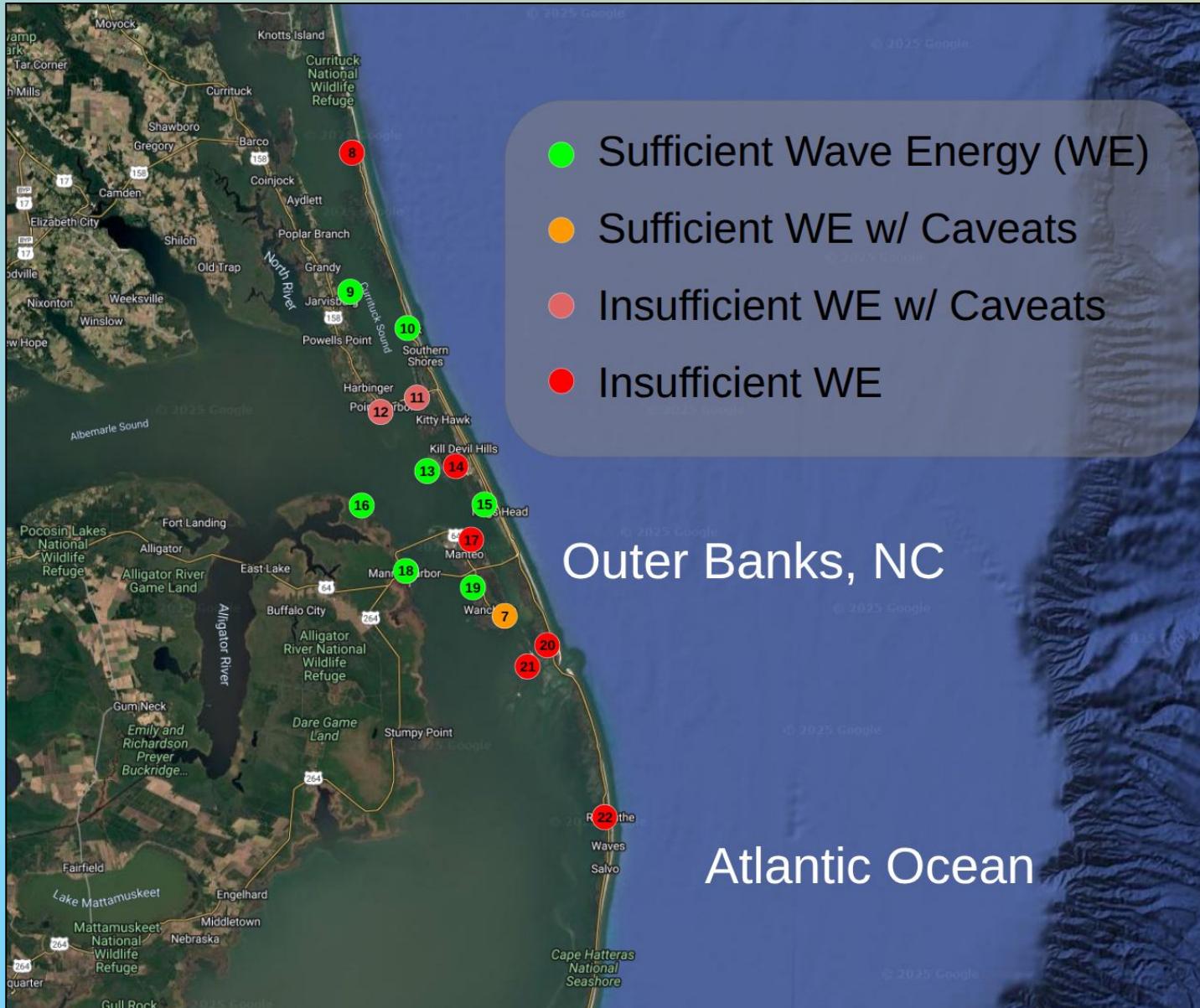
# Results: Wave Characterization



# Results: Site Viability Analysis



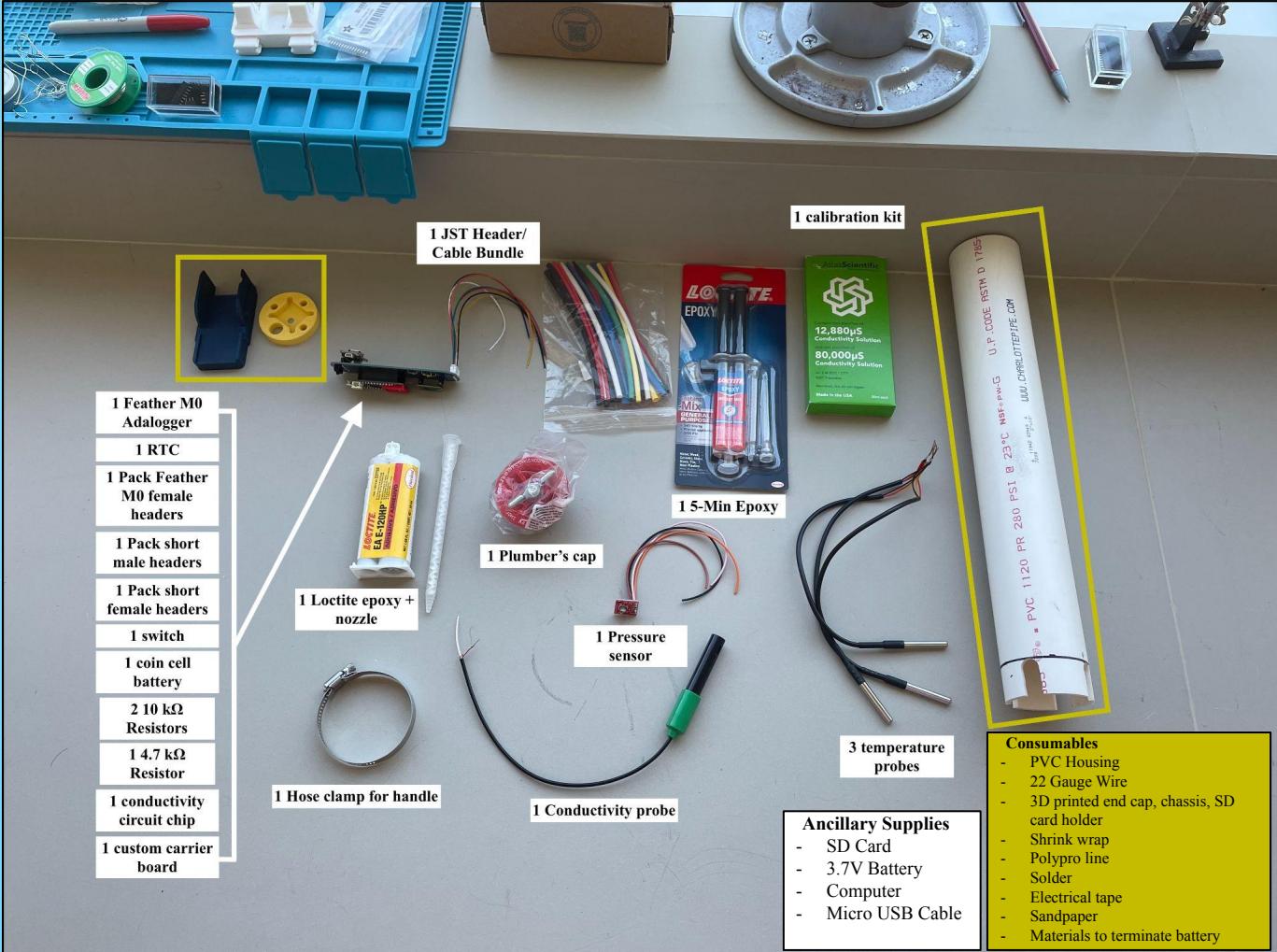
Site #	Location	WE/BE conservative (10cm + 10% $\eta$ )	WE/BE reasonable (20cm + 20% $\eta$ )
7	Wanchese	0.10	0.40
8	Corolla Light	0.22	0.87
9	Jarvisburg	4.62	18.49
10	Duck	2.04	8.15
11	Kitty Hawk	0.52	2.06
12	Powells Point	0.01	0.03
13	Colington	2.17	8.70
14	Colington	0.04	0.18
15	Nags Head	1.75	6.99
16	Mashoers	9.79	39.14
17	Manteo	0.48	1.91
18	Manns Harbor	7.39	29.55
19	Wanchese	7.92	31.68
20	Herring Shoal Island	0.06	0.22
21	Oregon Inlet	0.68	2.73
22	Rodanthe	0.92	3.69



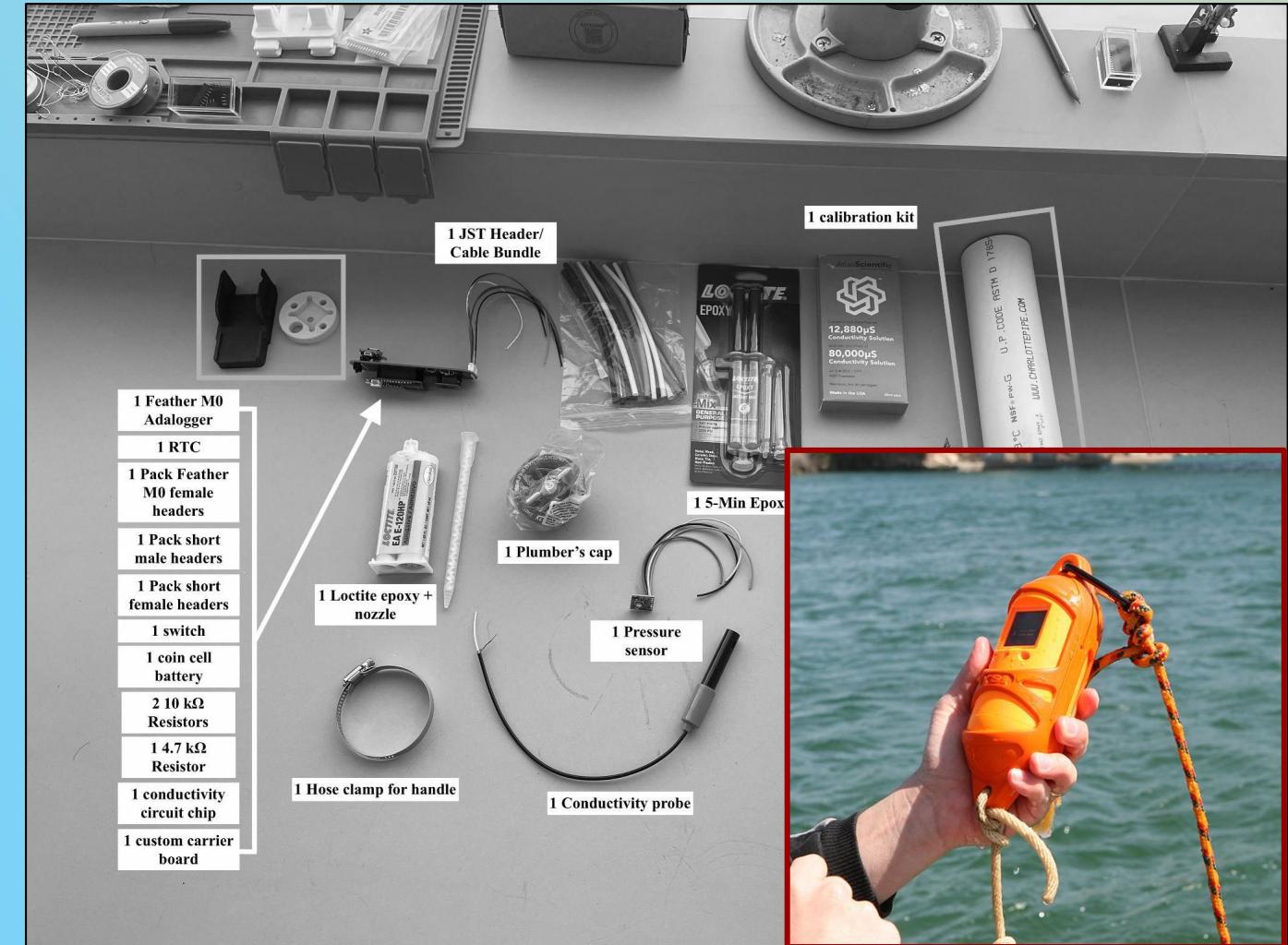
# 20 cm WEC / 20% Efficiency



# Impact: Accessible, Open, and Low-Cost



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OpenCTD Materials & Supplies



	Per Unit	Per 16 Units
OpenCTD Materials	\$381.15	\$6,098.40
Mount	\$47.42	\$758.72
<b>Total</b>	<b>\$428.57</b>	<b>\$6,857.12</b>
YSI SonTek CastAway-CTD	<b>\$7,100</b>	<b>\$156,200</b>

# Next Steps

## Landowner Engagement

- Citizen scientists and property impacts
- Interest in continuing and expanding study sites

## Submerged Historic Properties

- Salinity/Temp → corrosion studies
- Waves → sedimentation studies
- Interest from NC UAB in expanding to state-wide monitoring

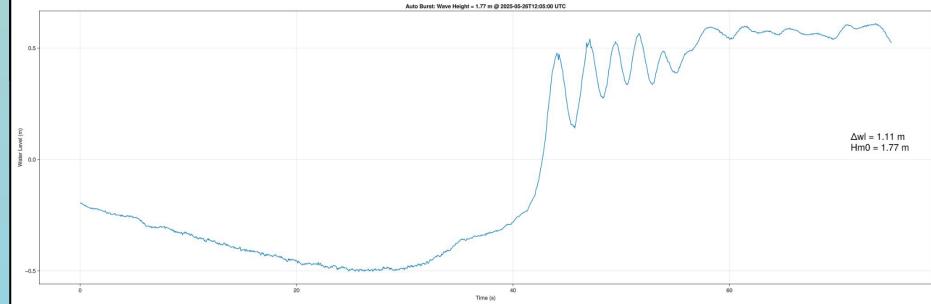
## NC Aquaculture

- Optimizing oyster harvest at peak salinity
- Interest in real-time salinity monitoring by local oyster farms

## Integrating Marine Energy

- Future design and integration
- Some sites have demonstrated adequate wave power
- Limited battery draw

Herring Shoal Shellfish Co.  
Blossie Creek Lease



# Thank you!

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Energy Program



*\*Images courtesy of presenting authors, John McCord, Parker Murphy, Lauren Kerlin, and Jeremy Borrelli.*

