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14. ABSTRACT
Expeditionary deployments of autonomous ocean systems are often power limited by the capacity of their onboard batteries. Marine and hydrokinetic (MHK) resources have the potential to extend these missions, creating a strategic advantage to the US Navy. However, for current energy converters (CECs) or wave energy converters (WECs) to be effective, in situ resource characterization is required. The microFloat (μFloat) platform offers a revolutionary approach to rapidly explore dynamic marine environments and collect valuable site data at a fraction the cost of traditional methods. With the swarm of drifters deployed in these environments, the tracks may be used to resolve large scale turbulent currents.

15. SUBJECT TERMS
Autonomous Ocean Systems, Marine and Hydrokinetic (MHK) Resources, Wave Energy Converters, MicroFloats

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Buoyancy Controlled Micro Floats for Spatially Resolved Current Measurements (μFloats)
A DURIP Final Report

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The **Micro Float swarm sensing platform (μFloats) and Drifting Acoustic Instrumentation System (DAISy) localization array,** have been fully constructed and field tested. Three stages of testing were performed, including in the university test tank, on Lake Washington, and in Sequim Bay, WA. These tests were to verify the system capabilities for depth control and float localization and tracking.

The uFloat swarm sensing platform was funded by the Office of Naval Research to measure spatially resolved currents in tidal inlets. Figure 1 shows the platform operational concept using the uFloats and surface drifters to perform localization and tracking through environments with turbulent currents. With the swarm of drifters deployed in these environments, the tracks may be used to resolve large scale turbulent currents. This information is valuable to the development of marine energy systems to determine operational loads from these currents. Similarly, through the addition of auxiliary sensors such as hydrophones, the swarm may be used to map other variables of interest like large scale acoustic propagation.

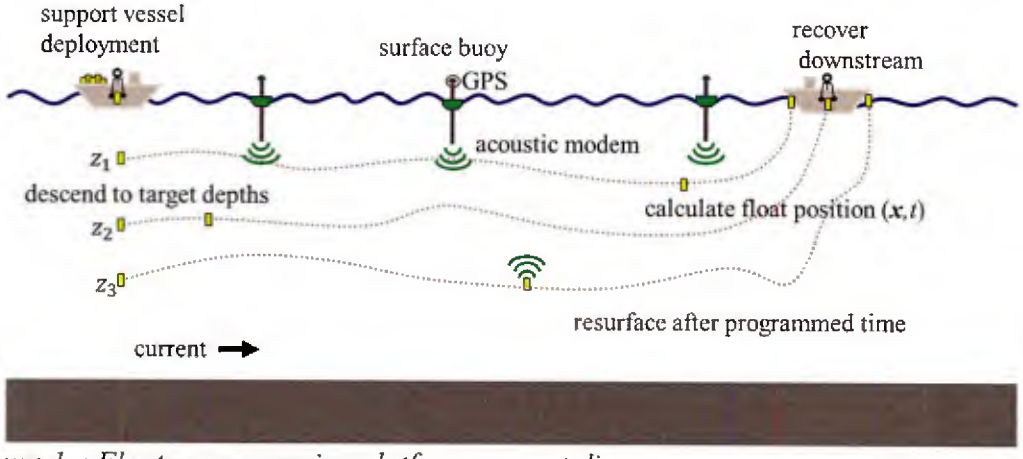

Figure 1. uFloat swarm sensing platform concept diagram.

Work competed:

November 2018:
Complete system redesign to enable swarm manufacturing at a cost of <$2,000 per float while maintaining float capabilities. This included a hardware redesign of the buoyancy engine to increase volume change up to 8%, allowing the system to be deployed in either fresh or salt water without re-ballasting or the addition of external auxiliary sensors.

February, 2019:
Complete swarm assembly of 30 uFloats and 5 DAISys. Perform initial system testing to verify operations in the university salt water test tank and pressure vessel. Follow on testing in Lake Washington to demonstrate individual float depth control.

23 May, 2019:
Field testing of the platform in the inlet channel to Sequim Bay, WA adjacent to the Pacific Northwest National Laboratory's Marine Science Lab. Figure 2 shows the uFloats and DAISys on the deck of the PNNL vessel used for the deployment.

Figure 2. Left: uFloats and DAISys on deck for deployment. Right: uFloat during deployment in Sequim Bay, WA.

Sample results:
Figure 3 shows example results from the Sequim Bay field testing including uFloat localization and depth control. Through this testing, along with the testing in Lake Washington, the underwater localization was demonstrated within ± 2 m at a range up to 500 m. Similarly, the depth control was demonstrated to ± 0.2 m from 0 to 100 m.

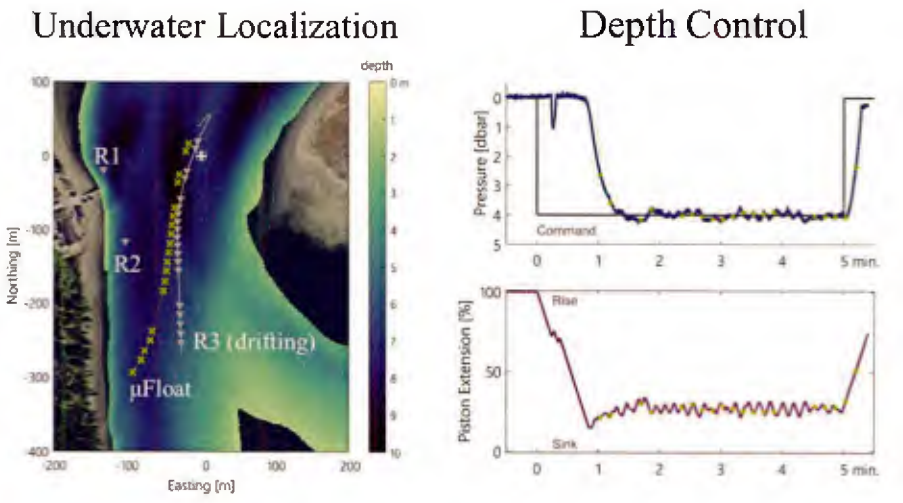

Figure 3. uFloat deployment results from testing in Sequim Bay, WA on May 23, 2019. Left: example uFloat drift track with localization points with two anchored DAISys (R1 and R2) and 1 drifting DAISy (R3). Right: example uFloat depth control for a 5 minute deployment at 4 m.

Continued uFloat platform testing and development has included testing in the university salt water test tank and Lake Washington to demonstrate improved depth control and localization in September and November, 2019. In Spring 2020, field deployments are planned for Agate Pass, WA to map turbulent currents prior to field testing of a tidal current turbine. This testing is funded by the Naval Facilities Engineering Command (NAVFAC) as part of the tidal turbine demonstration project.

Type of equipment: uFloat Swarm Platform with Drifting Acoustic Instrumentation System (DAISy) Localization Array
Manufacturer of equipment: APL/UW
Model numbers: 1 to 30 uFloats
Cost of equipment: $250,000
Quantity: 30 uFloats and 5 DAISys