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Powerful Surveillance: Dual Deployment of Complementary Technologies Detects HABS and their Toxins

By McLane Research Laboratories



As global demand for healthy, sustainable food from the ocean continues to grow, the industry disproportionately faces the challenge of Harmful Algal Blooms (HABs). In the United States alone, HAB events have an annual negative economic impact of approximately \$82 million. Detecting these toxic blooms using innovative, real-time instrumentation shows great promise for understanding HABs and their impacts. In Maine, two complementary technologies have demonstrated the power of taking an integrative approach to real-time monitoring of HABs to protect fisheries.

In collaboration with McLane Research Laboratories, the harmful algal bloom research group at the Woods Hole Oceanographic Institution (WHOI) and the Roesler Lab in the Department of Earth and Oceanographic Science at Bowdoin College, deployed two McLane Research Laboratories instruments, an Environmental Sample Processor (ESP) and an Imaging FlowCytobot (IFCB), together in the flowing seawater laboratory at the Bowdoin College Schiller Coastal Studies Center on Orrs Island, Maine.

Co-deploying the two McLane instruments in the Casco Bay monitoring location was successful at providing cell abundance information in near real-time, rather than waiting days or weeks for results. In the past, HAB monitoring has relied on infrequent, labor-intensive water collection and shellfish flesh testing, often after a fish kill or algal bloom has occurred.

Dr. Michael Brosnahan of WHOI comments, "The combination of continuous plankton imaging from IFCB and molecule detection of HAB toxins and nucleic acids by ESP provide far more powerful HAB surveillance and insight into ongoing blooms than either sensor alone."

IFCB is an in-situ automated submersible microscope that generates images of individual cells or particles in-flow taken from the aquatic environment that can be used for taxonomic classification. The IFCB acts as a "continuous record-keeper" by collecting tens or hundreds of thousands of plankton images every hour in a single location. When the data are then coupled to the neural network-based post-processing classification system larger trends and high temporal resolution population dynamics may be discerned.

McLane Environmental Sample Processor (ESP) shown in a side by side Bowdoin College Schiller Coastal Studies Center seawater lab deployment with the Imaging FlowCytobot (not shown).

Real-time, computer-based classification results of IFCB image analysis can alert aquaculture and resource managers to the presence of harmful organisms, such as the dinoflagellate *Alexandrium catenella*. This species causes annual closures in New England and many other regions of the world due to risks of paralytic shellfish poisoning (PSP). The IFCB is an effective monitoring tool but may not distinguish between closely related toxic and non-toxic species. In such cases as these, the ESP's near real-time genetic analysis proves critical. The instrument collects discrete water samples, concentrates cells and other particles, and delivers chemical extracts from these samples to assays that identify microorganisms by their unique nucleic acid sequences and other molecular products.

Initiating collection of ESP samples based on streaming image data from the IFCB conserves reagents and assays, making much more efficient use of the impressive analytical capability than is possible when ESPs are deployed alone. Additionally, ESP observations strengthen the results obtained from IFCB by providing genetically specific results.

The dual-deployment in Casco Bay measured the concentration of *Alexandrium* cells throughout the algal bloom period (May-June). The Bowdoin marine wet lab was well-suited for the project as the lab continuously pumps water from Harpswell Sound, a water body extending from Casco Bay that is purported to be a natural incubator for this phytoplankton species.

Bowdoin College's Dr. Collin Roesler states that "*Alexandrium* is the putative organism responsible for paralytic shellfish poisoning in coastal Maine waters. Although found along the Gulf of Maine coast, Harpswell Sound presents a unique environment for the incubation of *Alexandrium* populations. The Sound is characterized by a reverse estuarine circulation driven by strong freshwater input at the mouth from the Upstream Kennebec River. This results in net transport into the sound and retention of surface waters at the head, providing perfect conditions for dinoflagellate bloom development. Periodic flushing releases the cells into Maine coastal current for transport down the coast."

The IFCB and ESP are part of a new generation of instrumen-



Imaging FlowCytobot (IFCB) is an in-situ automated submersible imaging flow cytometer.

tation that have been used for a number of successful HABs detection deployments including in the service of fishery and aquaculture protection. Dr. Daniel Ward of Ward Aquafarms used the IFCB in a 2017 pilot study as an early warning system to protect juvenile shellfish from *Cochlodinium polykrikoides* at his farm. In 2019, the National Oceanic and Atmospheric Administration (NOAA) funded Dr. Ward's project further, to expand the application and share monitoring information with users impacted by the oxygen-starving plankton. At Texas A&M, Dr. Lisa Campbell uses multiple IFCBs to serve data to resource managers in the Gulf of Mexico, protecting valuable oyster harvests. Catalina Sea Ranch, a 100-acre aquaculture farm located on the Los Angeles, CA coastline purchased an IFCB to evaluate the effects of offshore aquaculture impacts on phytoplankton communities and to help improve animal husbandry and protection efforts.

The ESP has been used extensively in the Gulf of Maine providing Red Tide monitoring in near real-time. During these deployments, near real-time data on cell abundance were made available to state and federal resource managers, researchers, other Gulf of Maine stake-

holders, and the public via a web server. In Lake Erie, an ESP deployed in the Western Lake basin provides rapid, advanced warnings to municipal drinking water managers in order to safeguard the drinking water supplies from toxic *microcystins*. NOAA's Northwest Fisheries Science Center has also deployed an ESP in Puget Sound to detect a variety of dangerous algal blooms or pathogens that threaten local fisheries.

See live and archived data from Bowdoin's Coastal Studies Center and the North Pacific Ocean (as part of the NASA EXPORTS experiment) on the IFCB dashboard <https://ifcb.bowdoin.edu/continuous>

See live and archived data as well as ten-year data series at Martha's Vineyard Coastal Observatory IFCB dashboard <http://ifcb-data.whoi.edu/mvco/>

Learn more about the ESP <https://mclanelabs.com/environmental-sample-processor/esp-video/>

Learn more about the IFCB at <http://mclanelabs.com/ifcb-videos/>