SCC-IRG: Connecting Coastal Communities with Continuous, Sensor-based Monitoring of Water Quality

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Project Challenges

Degraded water quality from nutrient pollution is the number one water quality problem in the US. Nutrient runoff leads to low oxygen and problems like fish kills in coastal waters. The US Environmental Protection Agency and state regulations specify oxygen thresholds.

Much of the water quality monitoring in the US is conducted by local or regional nonprofit community organizations, and many of these groups deploy dedicated and committed volunteers to collect physical water samples that are then sent to professional laboratories.

We know from deployment of a small number of continuous oxygen sensors that this traditional water monitoring by grab sampling fails to detect many periods of low oxygen (Fig. 1). Because warmer water holds less dissolved oxygen, climate change will make the problem worse.

This project is a collaboration among a community group that conducts environmental monitoring, natural scientists, and social scientists. It will examine the technical and social dimensions of the transition of water monitoring from traditional grab sampling to continuous sensors.

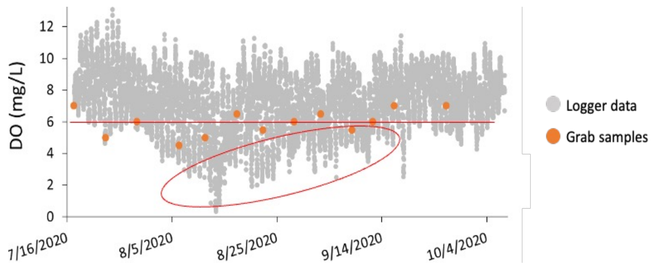

Figure 1. Plot of dissolved oxygen concentrations in a Buzzards Bay estuary measured by grab samples and by continuous logging with Onset® oxygen dataloggers. Grab samples periods of low dissolved oxygen concentrations that are below the State of Massachusetts water quality standard of 6 mg/L.

Many sensors that record continuous water quality are now inexpensive enough to allow widespread and dispersed deployment. They can capture dynamic patterns and exceedance of thresholds. They are accurate enough to be used for regulatory compliance when properly calibrated and maintained. Use of continuous water quality sensors could greatly enhance the understanding of water quality and the influence of community organizations that aim to improve water quality.

But organizations face major challenges in attempting to transition water quality monitoring from traditional grab sampling to continuous water quality sensors:

- How to maintain volunteers if volunteers' roles change from collecting samples to managing complex sensors?
- How and where to deploy sensors to collect information to characterize larger waterbodies and to provide relevant information to multiple users of water quality information?
- How to manage and present a deluge of data derived from continuous sensors?

Figure 2. New accurate and low-cost environmental sensors like these dissolved oxygen and salinity loggers made by our project partner Onset Computer create new opportunities for continuous water quality data collection. They also create new challenges for organizations to maintain sensors and manage much larger amounts of data.

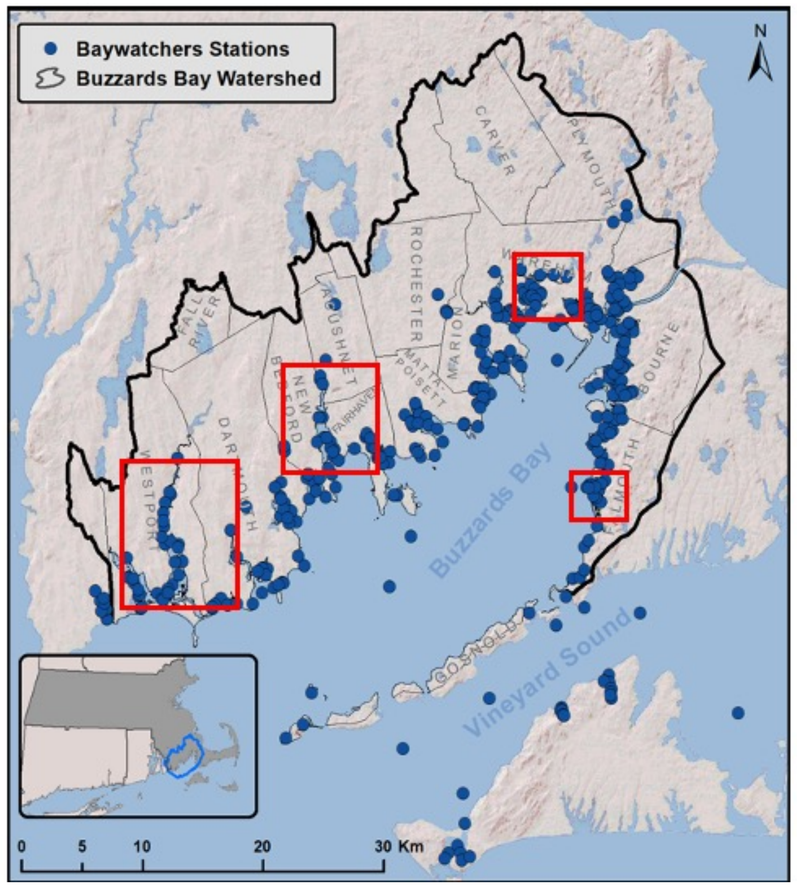

Figure 3. Location of Buzzards Bay and water quality stations monitored by the Buzzards Bay Coalition. In summer, volunteers measure dissolved oxygen, salinity, and water clarity every five days and collect water samples for nitrogen concentrations four times during July-August. Rectangles show the four estuaries in which we will pilot sensor deployments.

Intellectual Merit

This project will contribute integrated social and technical understandings of the transition to new technologies for water quality monitoring. It will pilot deployment of continuous Onset® dissolved oxygen sensors in four embayments around Buzzards Bay. These will be paired with existing long-term traditional water quality monitoring stations to compare the two monitoring methods.

We will test two different oxygen sensor deployment "platforms." One will be affixing sensors to traditional monitoring sites such as piers or docks. The other will be mounting sensors on low-cost and low-power TideRider robotic gliders that move around within embayments.

We will conduct interviews and focus groups with different coastal communities of people concerned with water quality to examine how they engage with new continuous data compared with traditional grab sampling data.

These communities include: (1) the Buzzards Bay Coalition's existing water quality volunteers; (2) local citizens and members of neighborhood groups and municipal committees; and (3) state water quality regulators.

We will use data from the deployments and focus groups to test how "local" water quality data need to best engage these communities of water quality data users.

Major Outcomes

This project started in October 2023. We have developed standardized data pipelines for continuous oxygen sensor data. We have worked with the Massachusetts Department of Environmental Protection to develop quality assurance protocols to ensure data generated will meet standards for regulatory use. We selected sites for May 2024 new fixed and mobile sensor deployments, and we recruited a cross-cutting natural science and social science research team that will manage sensor deployments and conduct interviews and focus groups.

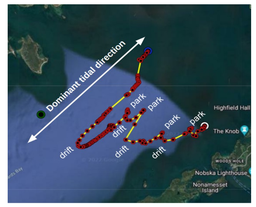

Figure. 4. Trace of a 2022 TideRider deployment showing how the device can navigate within an estuary using the dominant tidal currents.

Broader Impacts

The research will provide technical and social information to guide implementation and scaling of the use of continuous water quality sensors in Buzzards Bay. Findings will help community organizations, municipal and state agencies, and universities deploy automated water quality sensors, manage, and communicate the data they generate, while engendering and sustaining engagement by both monitoring program volunteers and concerned residents/organizations.

The project will help regulators adapt water quality standards to sensor data. It will also help sensor makers improve interfaces used by volunteers and persons conducting monitoring. It will train students in interdisciplinary projects that combine social science, data science, and coastal ecosystem science. Students will also receive training in data management and visualization designed to solve applied problems posed by a non-profit watershed organization.

This project will produce a "best practices" guide for nonprofit organizations contemplating transition from traditional collections of environmental samples to collections using automated sensors. It will convene a national workshop aimed at sharing. Information with other nonprofit community organizations that monitor different aspects of environmental quality.

Future Goals

In 2024 we will start deployments of fixed and glider-mounted sensors. We will test data collection pipelines and develop data displays based on traditional grab data and continuous sensor data that we will present in surveys and focus groups that we will begin later in the year.