Assessing the effects of tidal stage & rainfall on nutrient pollution: a case for continuous monitoring in Casco Bay

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Background

- Nutrient pollution in Casco Bay has been formally recognized by the Maine legislature as a state-wide priority
- Nutrient pollution is an excessive abundance of nutrients - such as nitrate, nitrite, ammonium and phosphorus
- Estuarine nutrient pollution can lead to rapid growth of harmful algal blooms, along with the creation of hypoxic regions (known as “dead zones”)
- Until recently, the current standard for monitoring nitrogen concentration in Casco Bay was through the collection of grab samples, however these tell little about temporal variations in concentration levels and their sources

Questions

1. **Can high frequency nitrogen data collected by the NuLAB provide insight into nutrient processes in Casco Bay?**
2. **Can we detect patterns between tidal stage, rainfall and nitrogen concentration?**

Methods

- Set the NuLAB to automatically collect nitrate + nitrite and ammonium samples every two hours
- Collected two quality assurance/quality control (QA/QC) grab samples as close to a NuLAB sampling time as possible, every two weeks
- Compare ancillary data (e.g. tidal stage, rainfall events, etc.) to nitrogen concentration

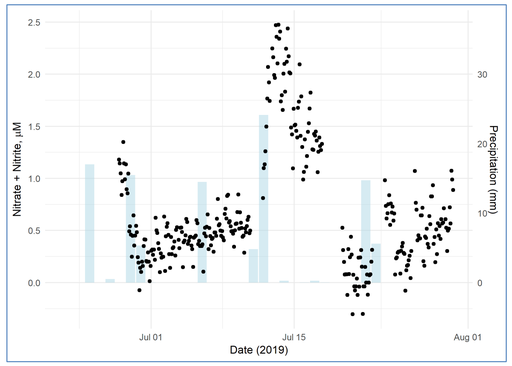

Figure 1. Nitrate + nitrite concentration (µM; black dots) and precipitation (mm; blue bars) over time in Casco Bay.

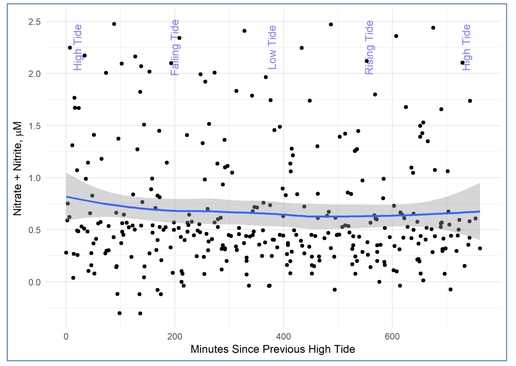

Figure 2. Nitrate + nitrite concentration (µM) vs. minutes since previous high tide. The blue line represents average nitrate + nitrite concentration. The shaded line represents a 95% confidence interval.

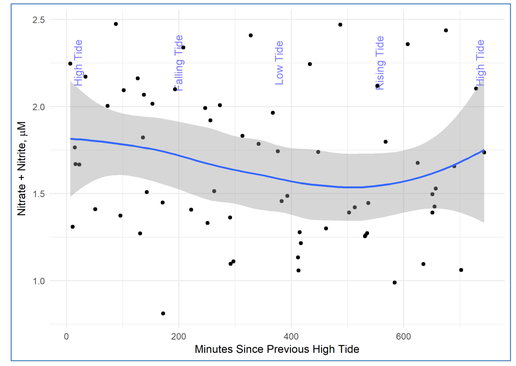

Figure 3. Nitrate + nitrite concentration (µM) vs. minutes since previous high tide, after a significant rainfall event (represented on July 15th, in Figure 1). The blue line represents average nitrate + nitrite concentration. The shaded line represents a 95% confidence interval.

NuLAB

Green Eyes’ NuLAB is a multichannel, autonomous, nutrient analyzer. In other words, the NuLAB can be equipped with up to three channels, each set to analyze distinct nutrient concentrations (nitrate + nitrite, ammonium, nitrite, phosphorous or silicate) in parallel. Coupled with a Raspberry Pi computer and a Wi-Fi hotspot, the NuLAB is capable of remote access and control. Additionally, the NuLAB can be programmed to collect and process water samples over specific time intervals (samples can be taken manually at any time as well).

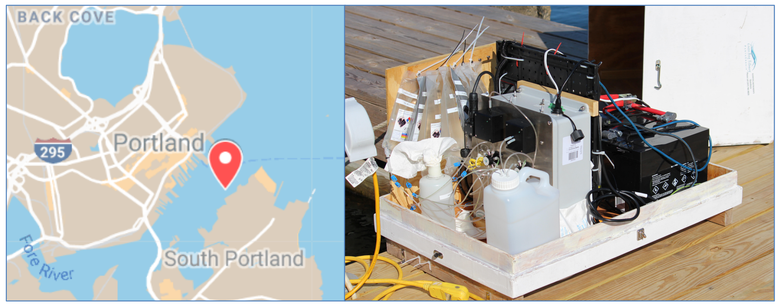

Figure 4. On the left, the red marker indicates the approximate position of deployment for the NuLAB (Portland Street Pier, South Portland, Maine). On the right, the NuLAB, peripherals and enclosure.

Acknowledgements

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Results

1. All data collected at this time is preliminary. Data collected on the nitrate channel (Fig. 1) appears to be returning realistic values, however this can not be confirmed until QA/QC grab sample results are returned. Data collected on the ammonium channel appears significantly noisy, therefore we consider this channel unreliable in its current state (i.e. additional troubleshooting is required).

2. The overall tidal stage and nitrogen concentration data (Fig. 2) suggests that a relationship between tidal stage and nitrogen concentration is unlikely. Interestingly, following a significant rainfall event (Fig. 3), we observe a possible, albeit small, relationship between tidal stage and nitrogen concentration.

Challenges & Future Directions

Deploying wet chemistry automation in the field has posed many practical challenges, such as managing power, reagents, communications and calibration. Additionally, this NuLAB device is subject to significant wave action as it is deployed on a floating dock. Data quality and continuity has improved over the course of deployment, as we gain a better understanding of the requirements for sound operation in the field.