Applications of High Resolution Biological Sensing in Aquatic Systems

Graduate Students:
Robert Gilbert & Christine Lee

Faculty:
Richard Ambrose, Jenny Jay, & William Kaiser
Motivation

• Public Health and Recreation
  – Does a 24-hr delay in results/postings protect swimmers from being exposed to poor water quality?
  – What standards should be set to prevent algal impairment in streams

• Research and environmental monitoring
  – How can these data be combined with physiochemical measurements to understand the spatial and temporal changes occurring in aquatic environments?
• Many physicochemical conditions vary on small spatial and temporal scales

• Microorganisms spatiotemporal distributions result from an integration of physicochemical conditions

• High resolution biological sensing may be better than physicochemical sampling alone
How do we currently measure water quality?

- Culture (~ 24 hrs incubation)
- Special media for selective indicator growth (like *E.coli*)
- IDEXX
- Membrane Filtration
Proposed Method: Immunomagnetic Separation/ATP quantification

1. Extract target ATP and add enzymes.
2. Isolate target using antibody-magnetic bead complex.
3. Measure light emission, sends data to computer.

Enzymes degrade ATP, light is a byproduct.
Calibrating photomultiplier tube

**ATP Standard Calibration Curve**

\[ y = 0.738x + 14.38 \]
\[ R^2 = 0.967 \]

**log(mols ATP)**

**log(counts/second)**

**lab culture E.coli calibration**

\[ y = 0.575x + 1.803 \]
\[ R^2 = 0.871 \]

**log(E.coli/100mL)**

---

**SCCWRP eval & Prev Data**

\[ y = 1.171x + 1.852 \]
\[ R^2 = 0.694 \]

**Luminometer - log(rlu/100mL)**

**IDEXX - log(mpn/100mL)**

**Correlating 2 methods of measuring E.coli: ATP (RLU) with**

\[ RLU = 684.47(MPN) - 1629.9 \]
Stream Characterization

- 20m of stream
- 15 locations selected
- Water samples
- Manual sensing
  - PAR, Velocity, algal cover, pH
- Sediment cores
Biosensors and Pendent Loggers

- Place algal biosensors and pendent loggers
- Begin logging for 72 hours
Determining Autosampling Locations

- 8 locations selected for water sampling every 2-3 hours
- Selection based on pendent logger data
- Temperature vs. light is proxy for water residence time
24 Hour Autosampling

- 2 ISCO samplers used to sample 8 locations
24 Hour Autosampling

- 2 ISCO samplers used to sample 8 locations
- Sampler tube is split using manifold and solenoids
24 Hour Autosampling

- 2 ISCO samplers used to sample 8 locations
- Sampler tube is split using manifold and solenoids
- Water samples used to determine *diurnal and spatial* variation of NO3 and PO4
Conclusions

• New biological sensing methods can enable integrative and high resolution ways to study small scale biological variations.

• Physical or chemical proxies are often very useful, but don’t always provide enough information

• Biological sensing methods that can measure on the same scales as physical and chemical sensors are important for future high-resolution studies