Sensing Climate Change: Using sensors to identify drivers of climate change in aquatic ecosystems

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Lakes Signal Climate Change

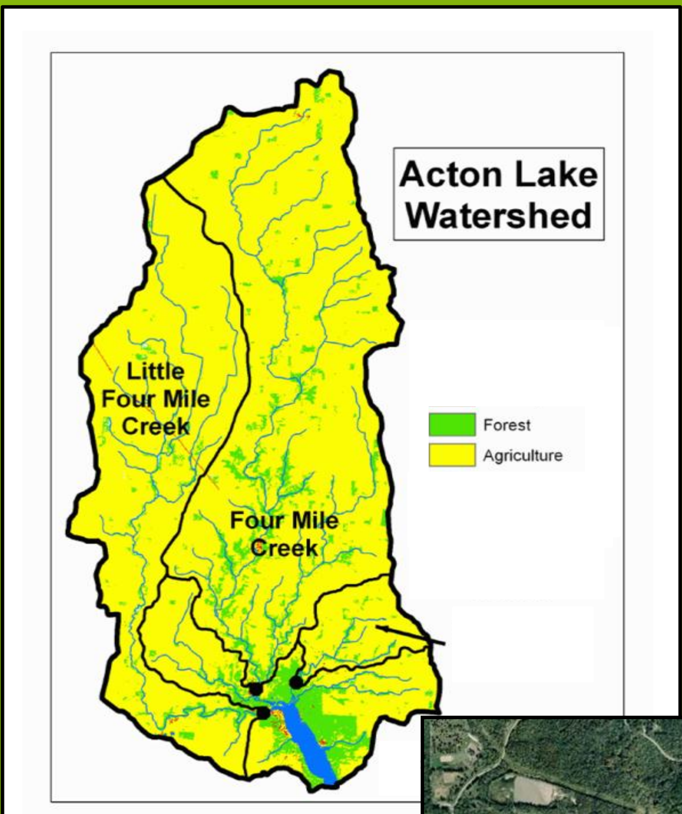


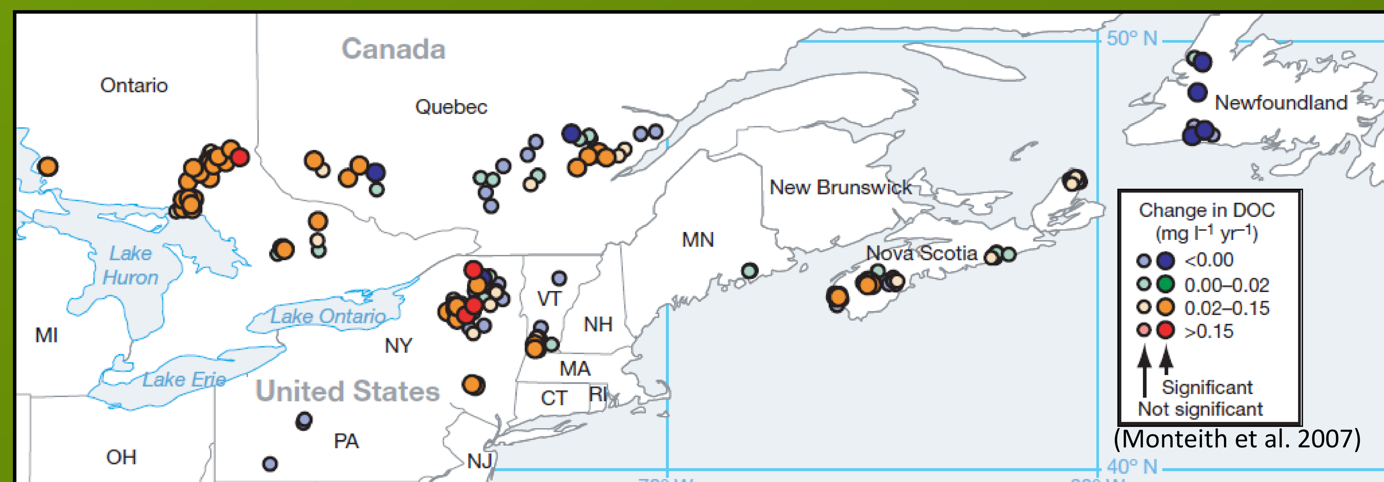
Figure 1. Lakes integrate changes across the entire watershed ie. increased agriculture results in increased sediment inputs into the lake

Lakes integrate environmental perturbations from the entire watershed into a single location (Figure 1)

- Perturbations occur over time and space
  - Time: land use change
  - Space: point source versus non-point source pollution
- Climate change happens over *time* and *space* AND affects every environmental factor differently

How do we decide *what* to measure in the lake to understand the effects of climate change?

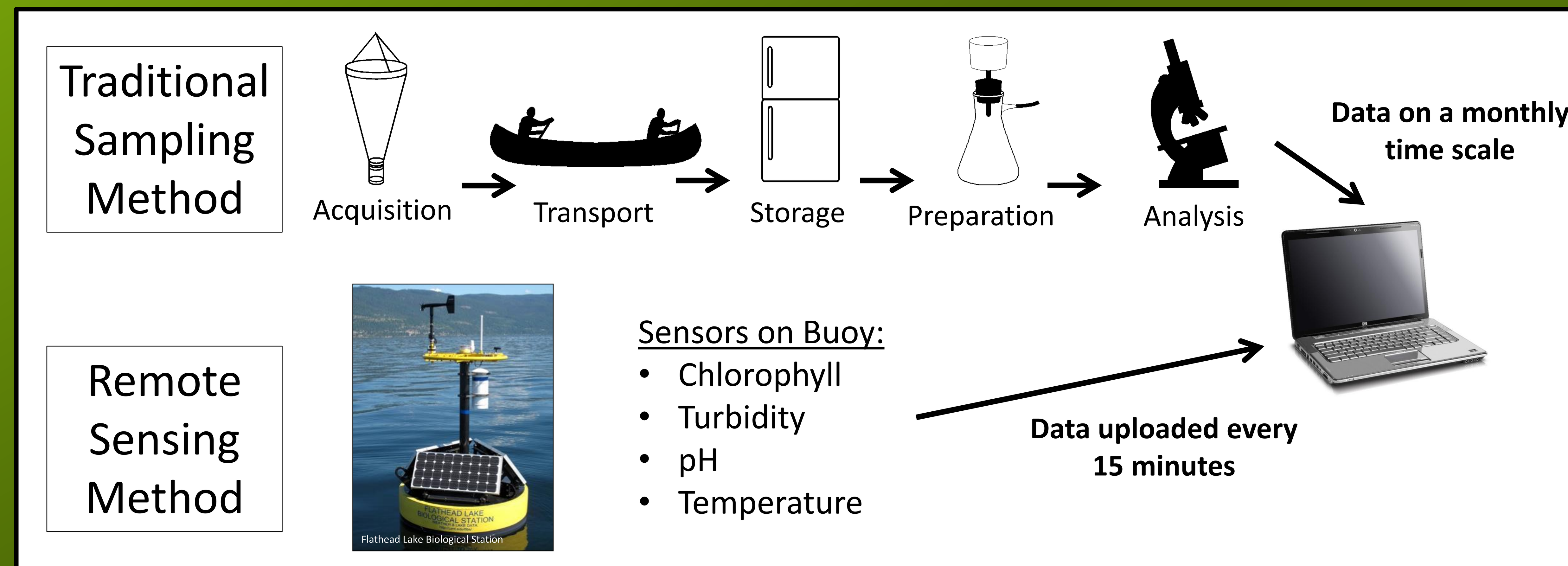
- Long-term increase in DOM concentrations in lakes in NE USA



What sensor-measured environmental factors drive changes in DOM quality?

Traditional sampling methods have identified a pattern (DOM increase) but have not suggested a mechanism

- Precipitation changes at a higher frequency then traditional weekly or monthly sampling
- Remote sensing platforms measure *many* variables on time scales not possible previously; data available instantly and at a high frequency.



Dissolved Organic Matter: Our Metric of Climate Change

DOM quality: complexity of carbon molecules (Figure 2)

Many factors contribute to the ***quality*** of DOM in lakes

- Source (terrestrial or aquatic, maple or hemlock) and UV-radiation (photobleaching; decreases quality) determine the ***quality*** of DOM present
- Precipitation brings in fresh terrestrial DOM while temperature positively correlates with UV-radiation

Our optical index of climate change: the relationship between photobleaching and color (Figure 3)

Goal: Use the optical index to study *short-term events* (seasonal precipitation or extreme storm events) that *mimic potential long-term* changes forecasted by climate change.

How can we isolate the mechanisms of changing DOM?

Figure 2. a) A common autumn site: dissolved organic matter leaching from a fallen oak leaf b) a household example of DOM quality-4 varieties of tea, c)natural example of DOM quality: DOM from 4 tree species

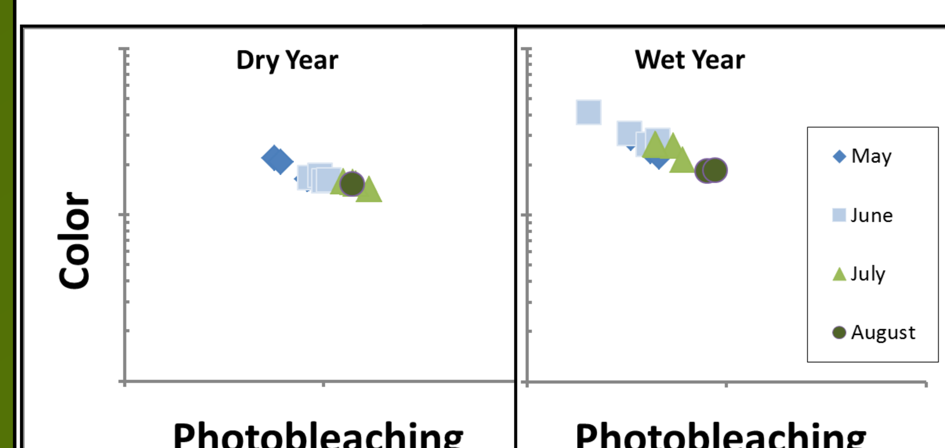


Figure 3. Spring has a higher optical index than summer a) dry year has lighter color and higher photobleaching and b)wet year has darker color and less photobleaching

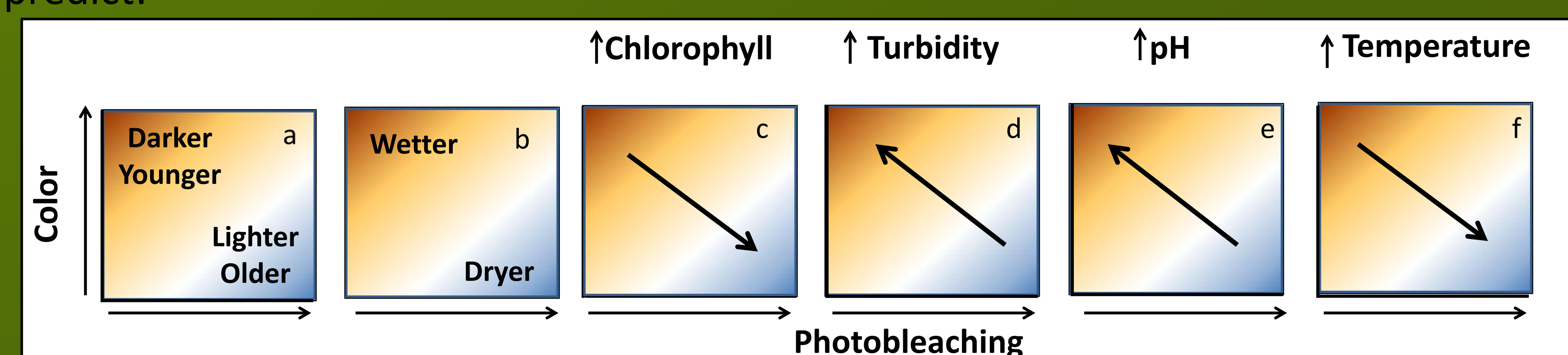
Linking Optical Properties to Sensor Data in Diverse Aquatic Ecosystems

This summer we are testing the universality of our index in *diverse aquatic ecosystems*

- Alpine lakes, human-made reservoirs, natural lakes, streams, and wetlands
- Across Ohio, Pennsylvania, and Canadian Rockies

We are comparing monthly optical index samples to high-frequency sensor data.

We predict:



Rationale:

c) Increased chlorophyll decreases color of the DOM

d) Turbidity is positively correlated with precipitation, sediment and other terrestrial (higher quality) inputs

e) Increasing pH is associated with increased litter decomposition rates, soil solubility and DOM mobilization

f) Lake temperature is positively correlated with sunlight and photobleaching

Monteith DT, Stoddard JL, Evans CD, et al. 2007. Dissolved organic carbon trends resulting from changes in atmospheric deposition chemistry. Nature 450:537-540