A new method to use benthic chlorophyll *a* for water quality assessment

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Background

- Environmental monitoring
  - EMAP (environmental monitoring and assessment program)
    - EPA wanted more comprehensive monitoring
      - Statistical comparisons
      - Long term trends
      - Prediction
      - Data storage

- Nonpoint source management program (Sec 319)
  - Water quality
  - Stream habitat
  - Aquatic communities

Biologic Monitoring

- Assess ecologic conditions
  - Includes adjacent land use/land cover
  - In Stream Habitat
  - Aquatic communities
    - Fish
    - Macrophytes
    - Periphyton

Tar Creek (Miami OK)

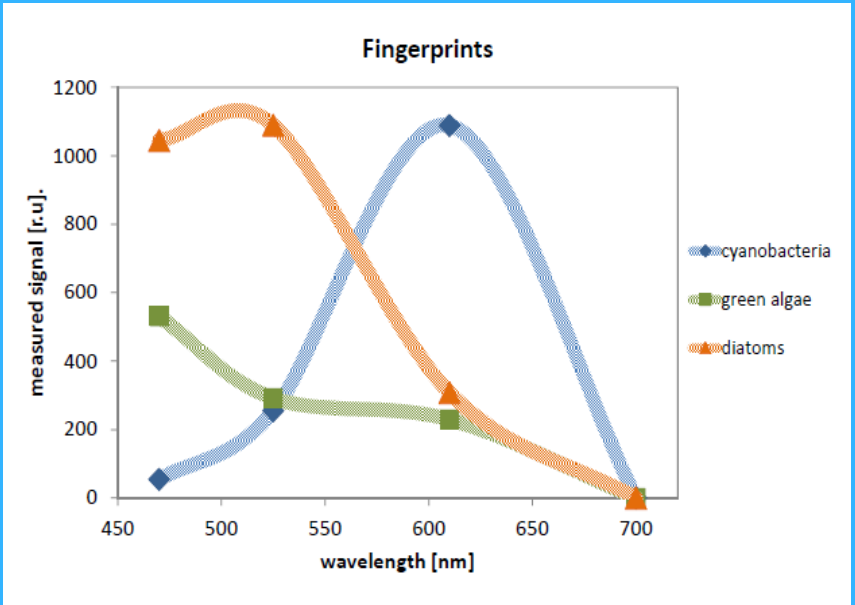
Periphyton Sampling
Traditional Method

Periphyton Sampling
BenthoTorch®

- Commercial Fluorometer
  - *In situ* and *in vivo*
  - Provides results in 20 seconds
    - Stores files for later upload
  - Measure total biomass (by chlorophyll fluorescence)
  - Internal proprietary algorithm for relative abundance for three periphyton divisions
  - Used in monitoring and research across the world
  - Two published comparison with traditional method

BenthoTorch®
Based on Principal of Fluorescence

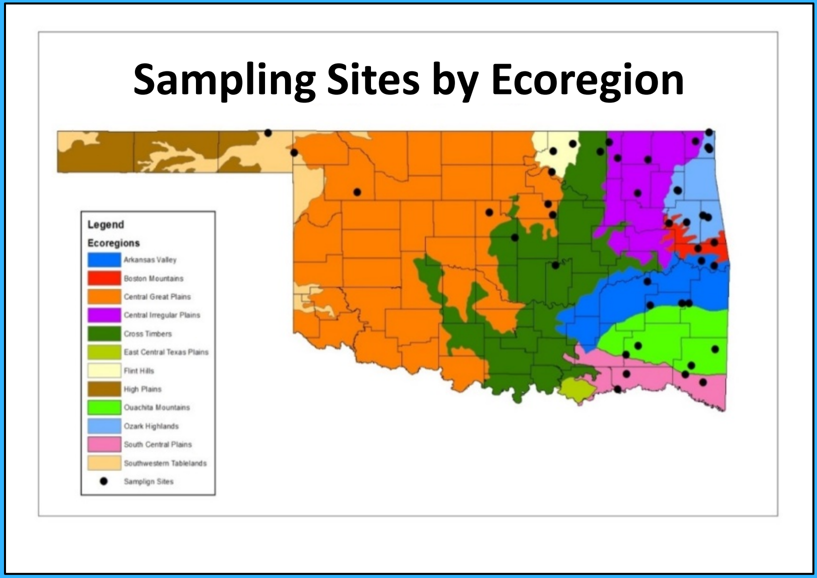
- LED wave lengths (nm): 470, 525, 610, 700
- Light directed at algae in pulses (PAM)
- Chlorophyll emits light at longer wavelength (Stokes Shift)
- 700 nm used to compensate for background reflection



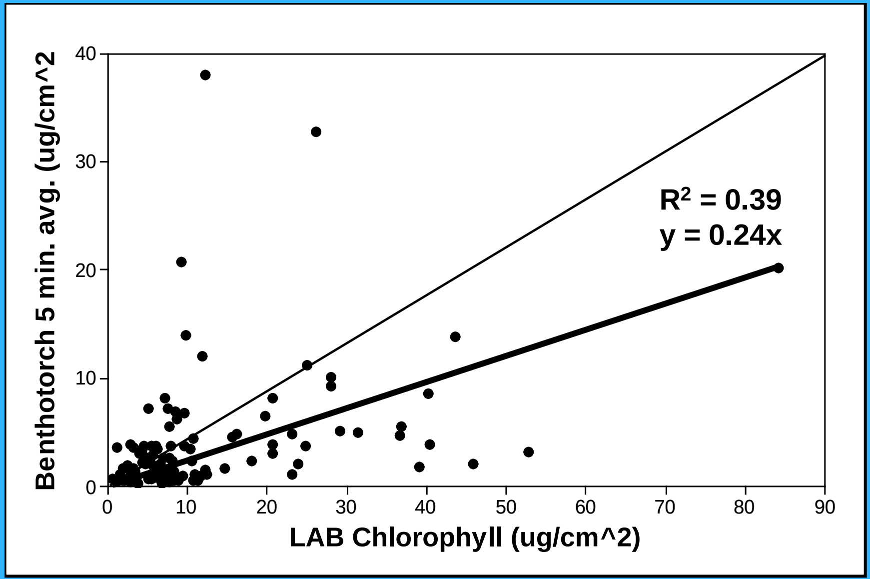
BenthoTorch®®
Algal Class Fingerprint

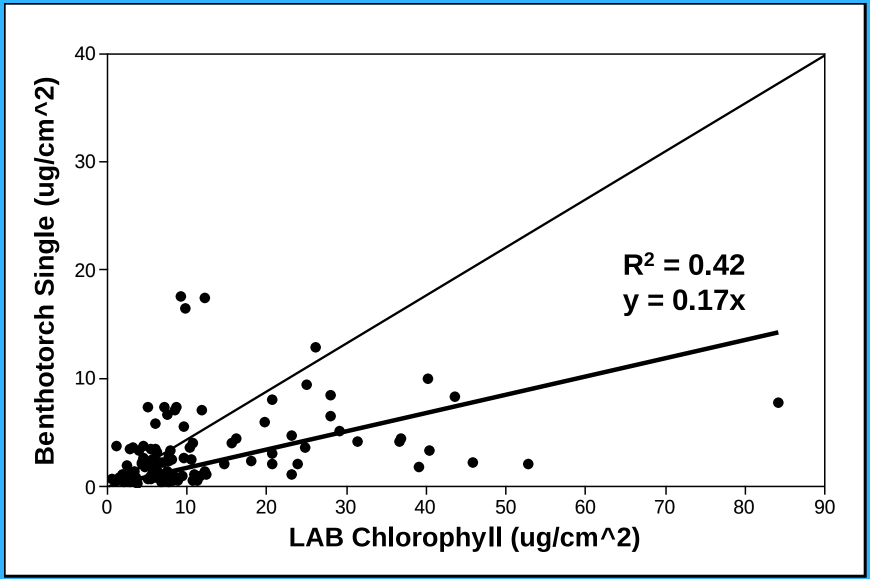
Objective

- **Assess the accuracy of the Benthotorch® compared to traditional methods in estimating total benthic algal biomass across major stream types and conditions throughout Oklahoma**



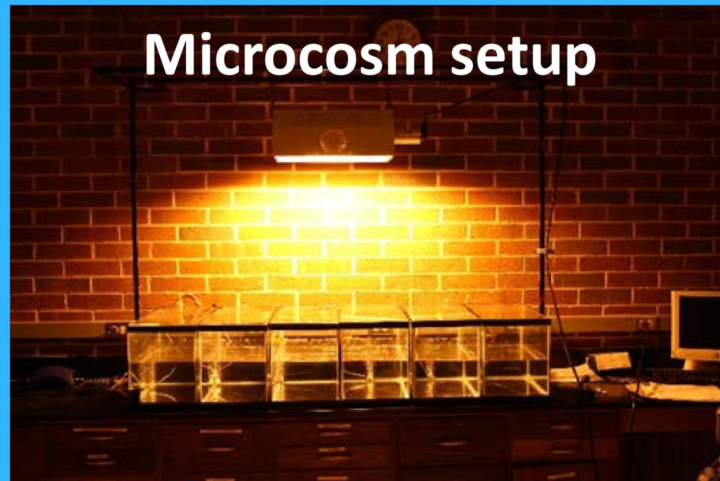
Results: Field 2014

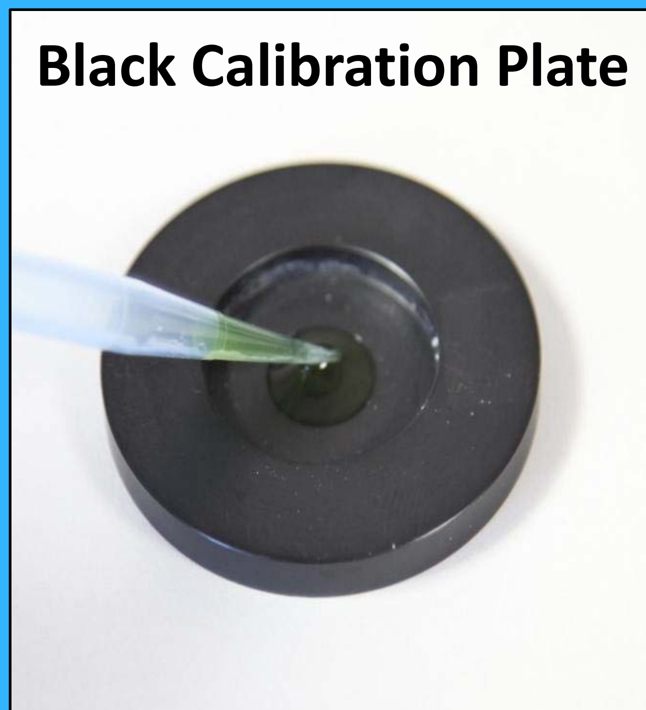


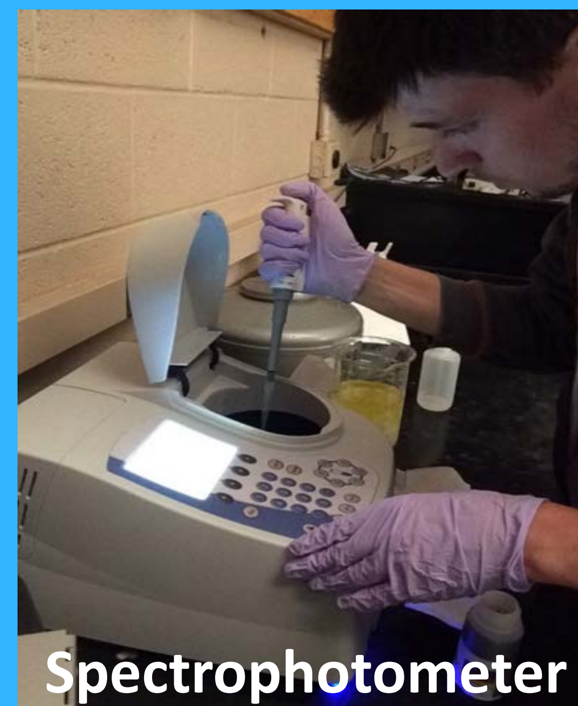


- BenthoTorch®: no significant relationship with Taxonomist
- Using light adjustment & continuous measurements correlated better with laboratory results
- Variance within BenthoTorch® readings increased with increasing chlorophyll a
- Improved accuracy with non-filamentous

Laboratory Methods



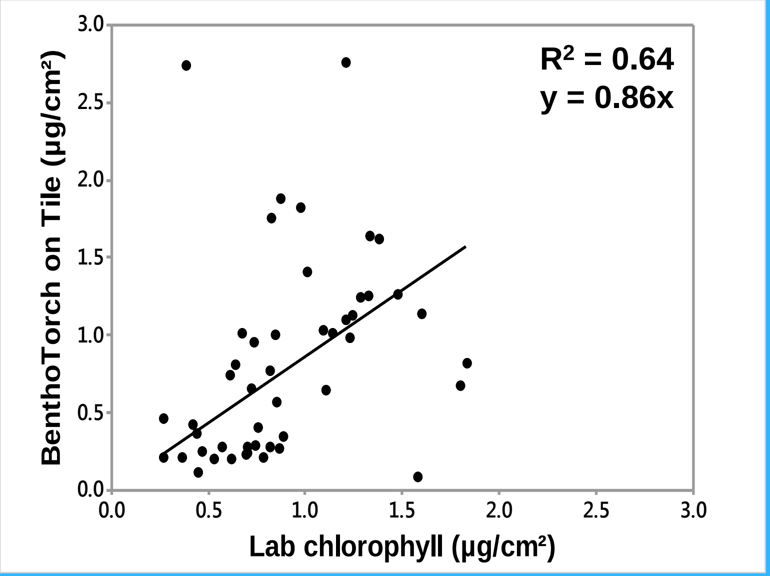




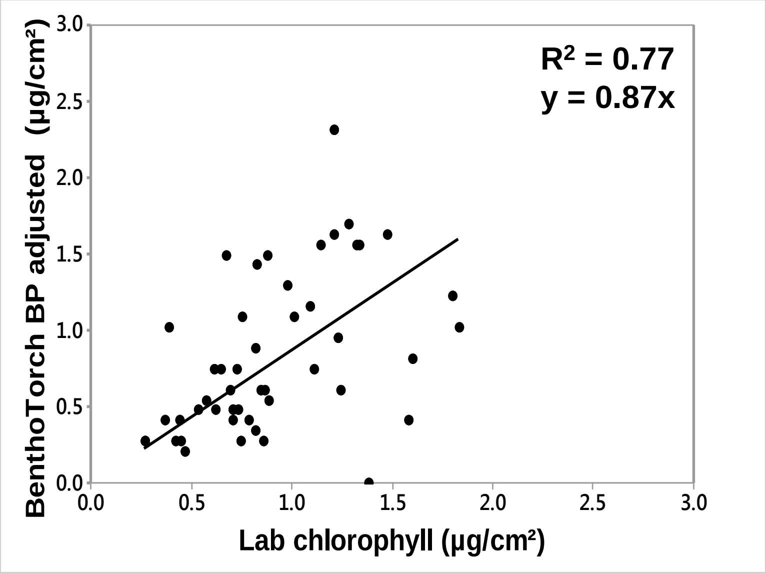
Results: Laboratory 2015-2016

BenthoTorch® Comparison with Lab Extracted Chlorophyll

In Situ Tile



Black Calibration Plate



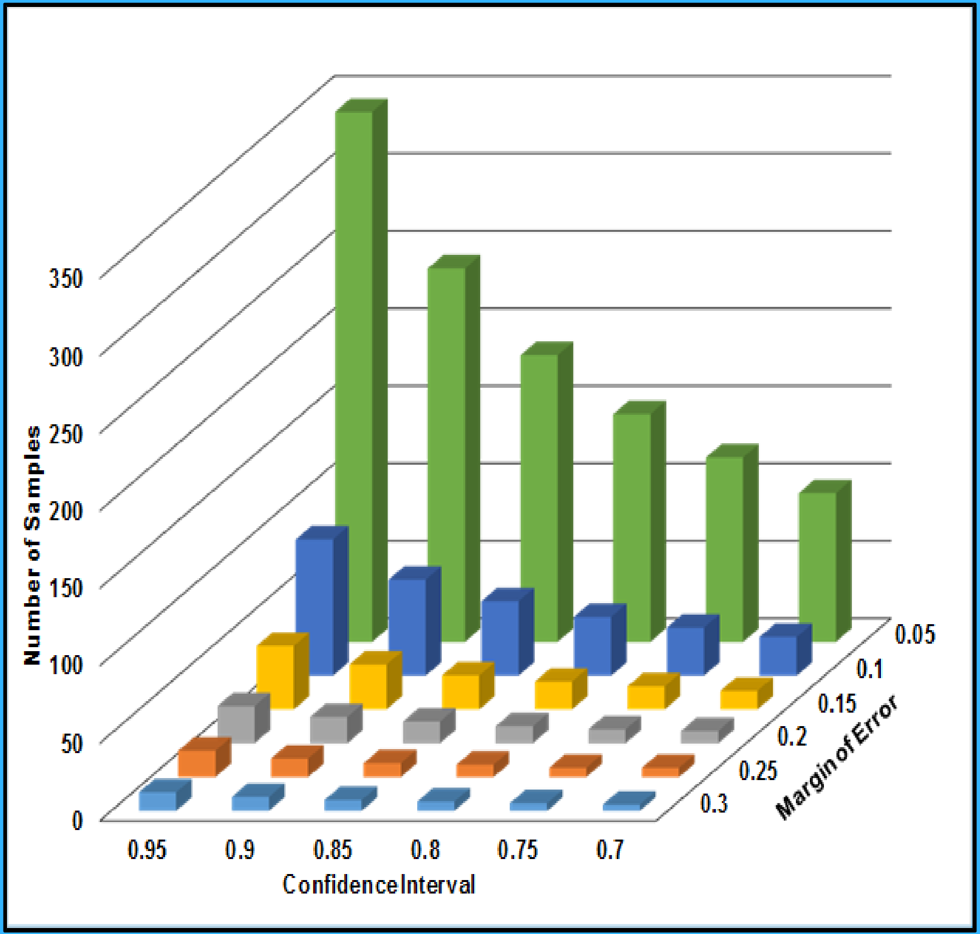
- Significant (α=0.05) and reasonable regression equations
- Mean BenthoTorch® vs lab chlorophyll *a* not significantly different (paired t-test, α=0.05)

Laboratory Study Conclusions

- BenthoTorch® *In Situ* Laboratory Tiles
  - Compares favorably in controlled environment with low chlorophyll *a* concentrations
- Modified Black Calibration Plate method looks promising for field conditions
  - Needs additional testing at sites with higher periphyton density
- BenthoTorch® likely a good tool to detect trends in periphyton density

Further Studies

- **Stream reach characterization methods must be developed**
  - **Number of BenthoTorch® samples to equal one traditional sample with specific confidence and margin of error.**
  - **RMSE from lab experiment used as a predicted standard deviation in the sample-size estimate equation used by Montana DEQ (2011)**
  - **Graph based on RMSE of 0.47 ug/cm^2 chlorophyll *a***
  - **Needs validation in field**



Questions?