Application of Wisconsin Lake Modeling Suite (WiLMS) for the Upper Fox-Wolf Basins TMDL

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UFWB TMDL Stakeholder Meeting

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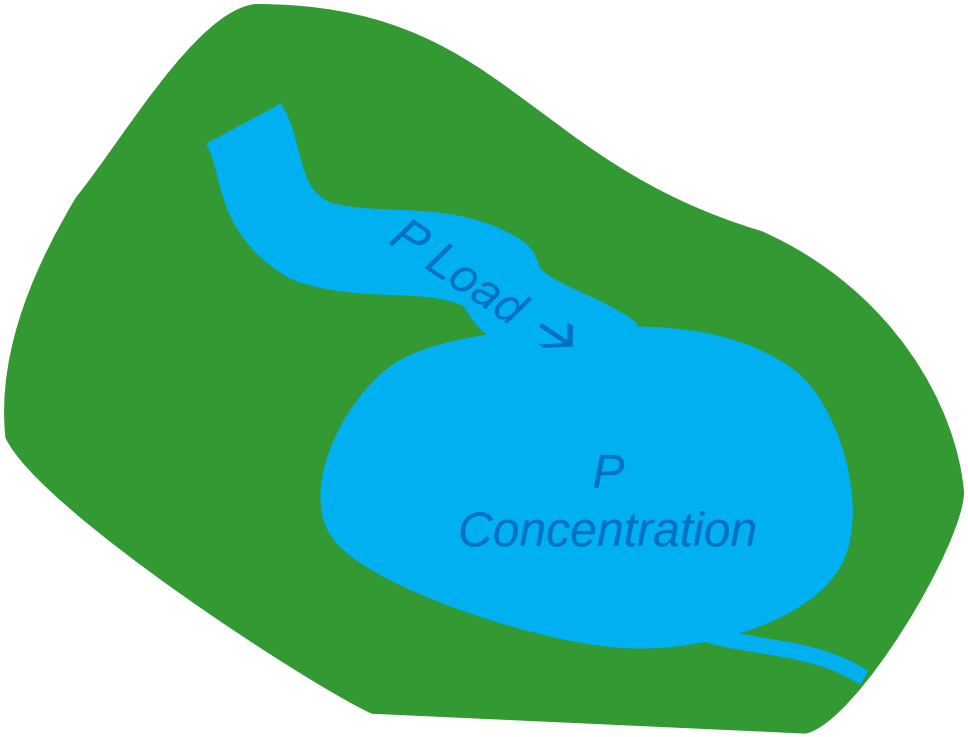
WiLMS Lake Modeling Purpose & Objectives

- Evaluate phosphorus loading capacity for impaired UFWB lakes (other than Winnebago pool lakes).
- Results used to determine phosphorus allocations for sources to each lake.

Wisconsin Lake Modeling Suite (WiLMS)

- Empirically-Based
  - Regression models relating phosphorus loading to in-lake phosphorus concentration.
    - Derived from phosphorus measurements in lakes across the US
  - 13 built-in regressions



Wisconsin Lake Modeling Suite (WiLMS)

- Completely Mixed (Zero-Dimensional)
  - Lake modeled as single basin.
  - No horizontal or vertical variability.
- Steady-State
  - Annual phosphorus loads and inflow volumes used to predict growing season mean phosphorus concentration.

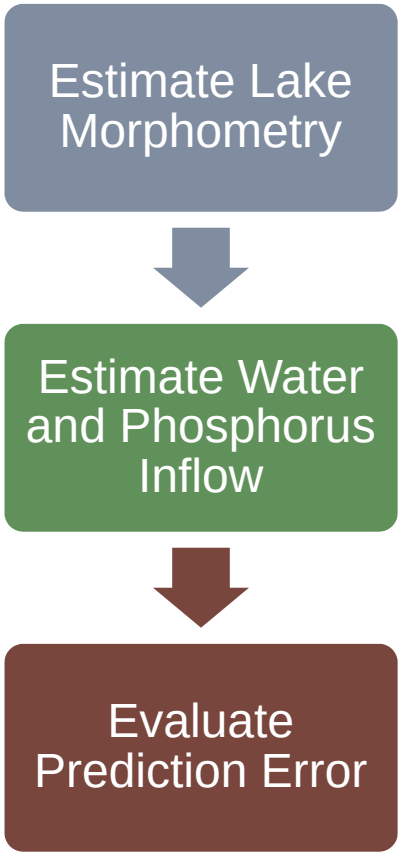
$$P = \frac{L}{z(0.162(L/z)^{0.458} + p)}$$ *Canfield-Bachmann (1981)*

P = Growing Season Mean Total Phosphorus Concentration
L = Annual Total Phosphorus Load
p = Lake Flushing Rate
z = Average Lake Depth

Why WiLMS?

- Accessibility
  - Public domain code and software: http://dnr.wi.gov/lakes/model/
- Suitability
  - Able to simulate parameter of interest (growing season mean P).
  - Previous applications to Wisconsin lakes.

WiLMS Modeling Process



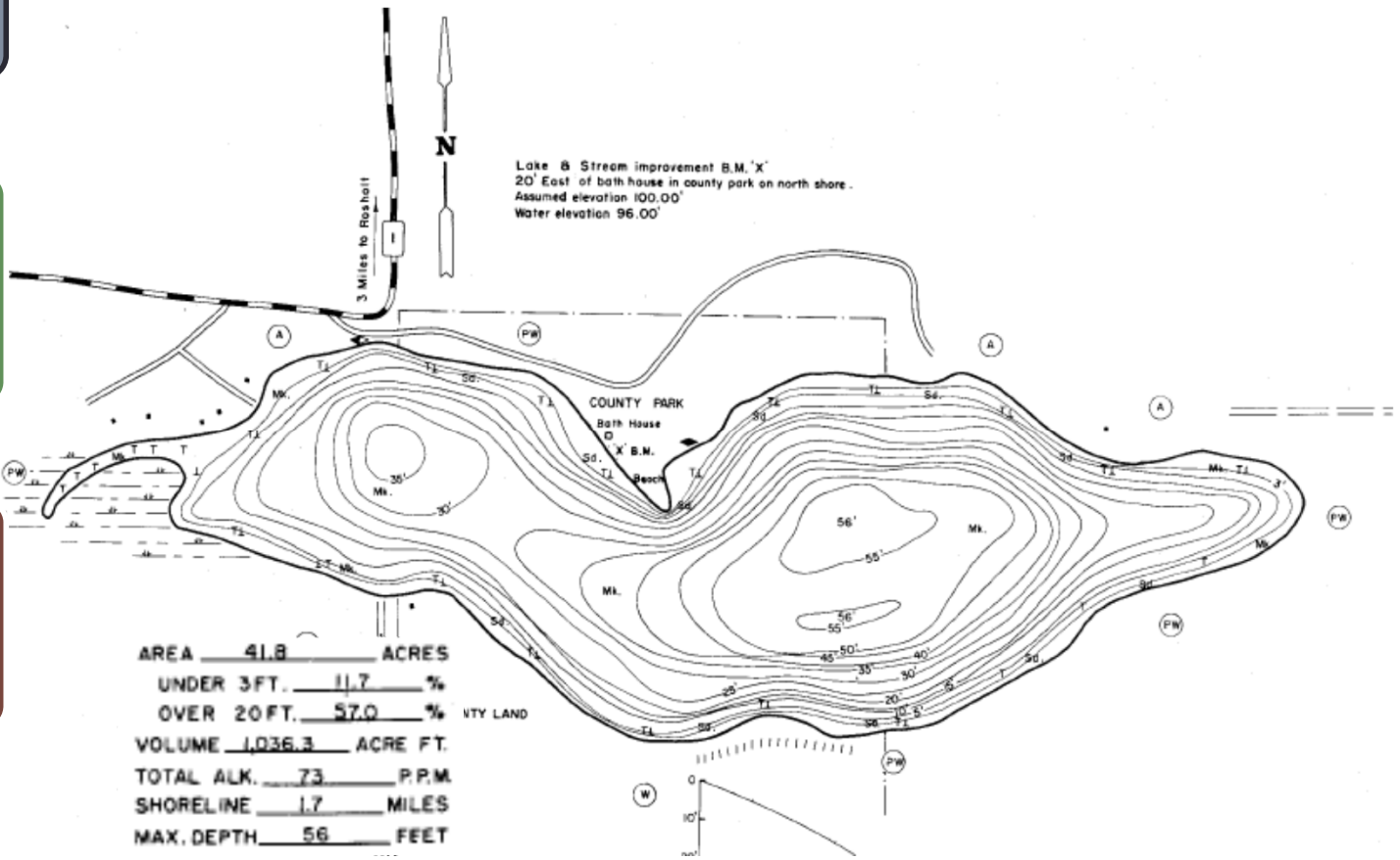
Lake Morphometry

Estimate Lake Morphometry

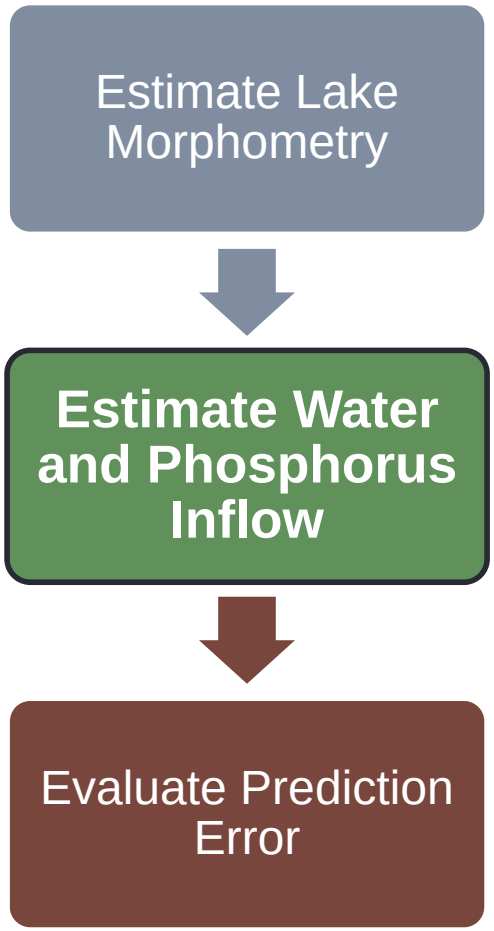
Estimate Water and Phosphorus Inflow

Evaluate Prediction Error

- Use DNR contour maps for lake surface area, volume, and average lake depth.

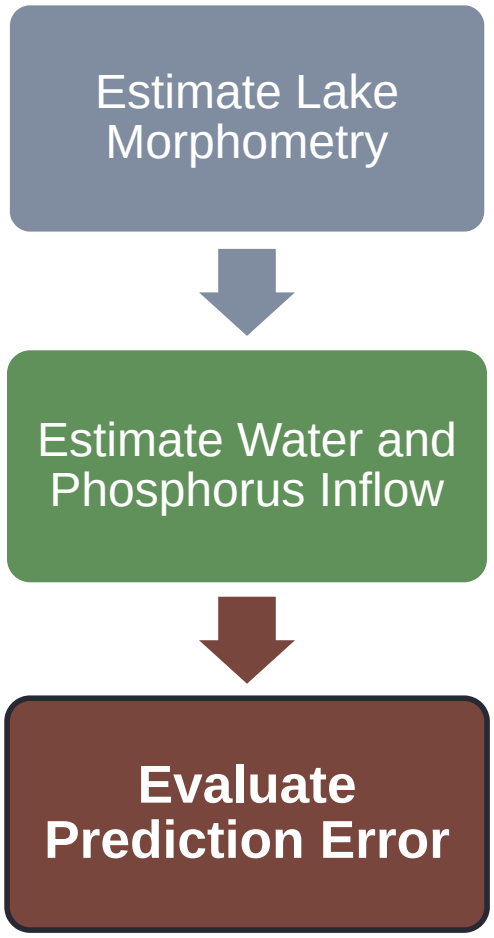


Water and Phosphorus Inflow



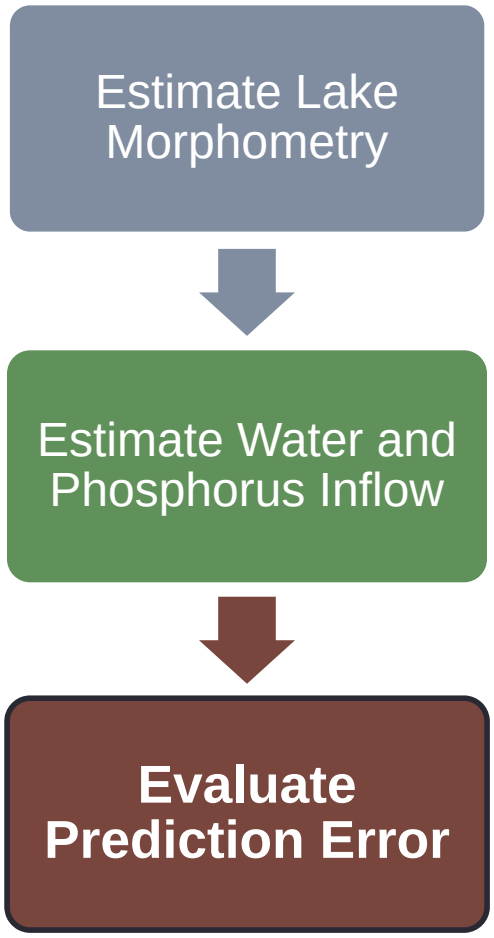
- Annual tributary loads
  - Phosphorus loads and runoff volumes from validated SWAT model
- Nearshore septic systems
  - Number of nearshore septics
    - Land parcels
    - Sewer system coverage
  - Phosphorus production rate (lbs/household/year)
  - Phosphorus export coefficient
    - Soil characteristics

Evaluate Prediction Error



- Morphometry inputs = only parameters for calibration, assumed to be accurate
- Focus is therefore on evaluating prediction error not calibration
- For each lake, compare predicted growing season mean concentration to observed concentration
  - Is difference within acceptable range of error?
- Initially evaluate predictions from Canfield-Bachmann regression

Evaluate Prediction Error



- If error is large, evaluate other regressions
- If error is within reasonable range, use regression to calculate loading capacity of lake

$$P = \frac{L}{z(0.162(L/z)^{0.458} + p)}$$ *Canfield-Bachmann (1981)*

P = Total Phosphorus Criteria (Growing Season Mean Concentration)
L = Annual Total Phosphorus Loading Capacity
p = Lake Flushing Rate
z = Average Lake Depth

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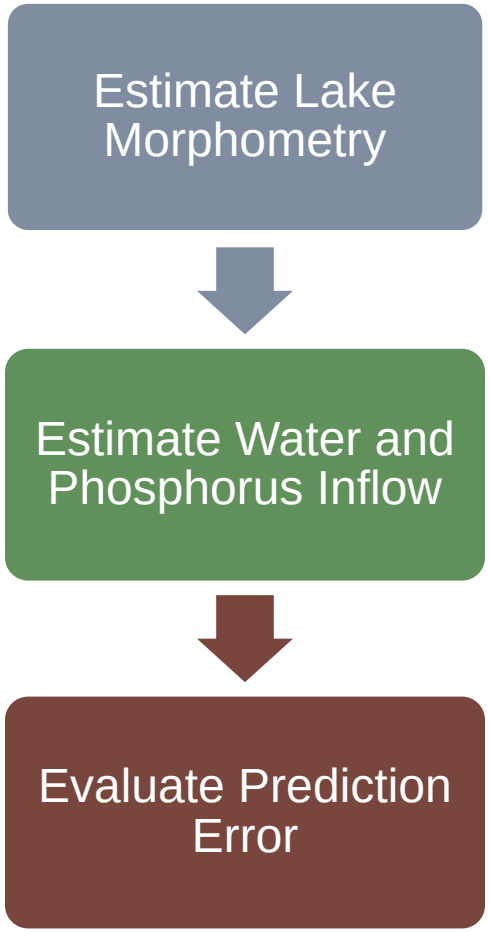

- Questions?