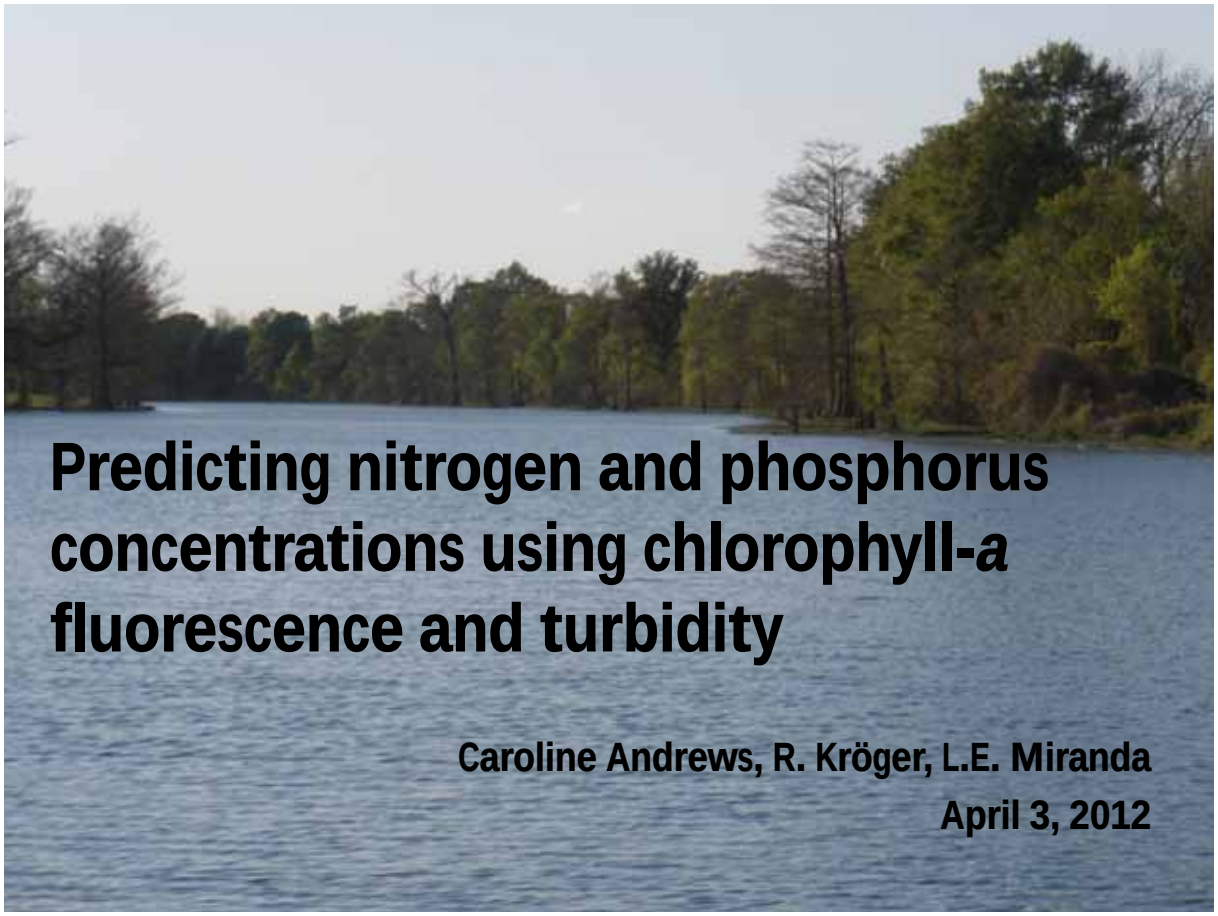
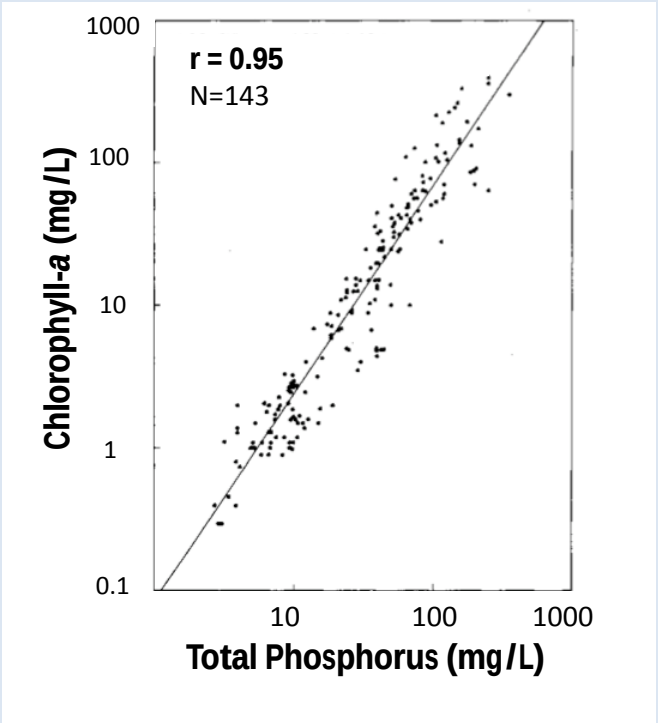


Predicting nitrogen and phosphorus concentrations using chlorophyll-*a* fluorescence and turbidity

Caroline Andrews, R. Kröger, L.E. Miranda

April 3, 2012

Nutrient – Chlorophyll Relationship



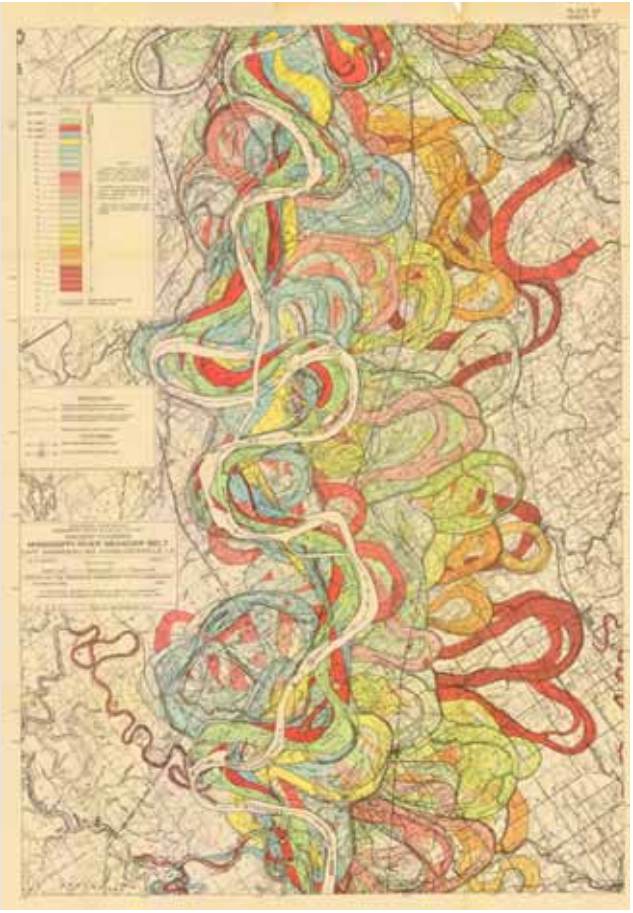
Jones and Bachmann 1976

Objectives

1. Assess the relationship between field and lab measurements of primary productivity (via chlorophyll-*a*) and suspended solids.
2. Assess the relationship between nutrients and easily obtained field measurements.
3. Determine if surrogate measures of chlorophyll-*a* and suspended solids are appropriate for predicting phosphorus and nitrogen concentrations in oxbow lakes.

Floodplain Lakes

- River meanders
- Range of connectivity
- Rich alluvial soil
  - Mississippi Alluvial Valley (MAV)



Mississippi Alluvial Valley

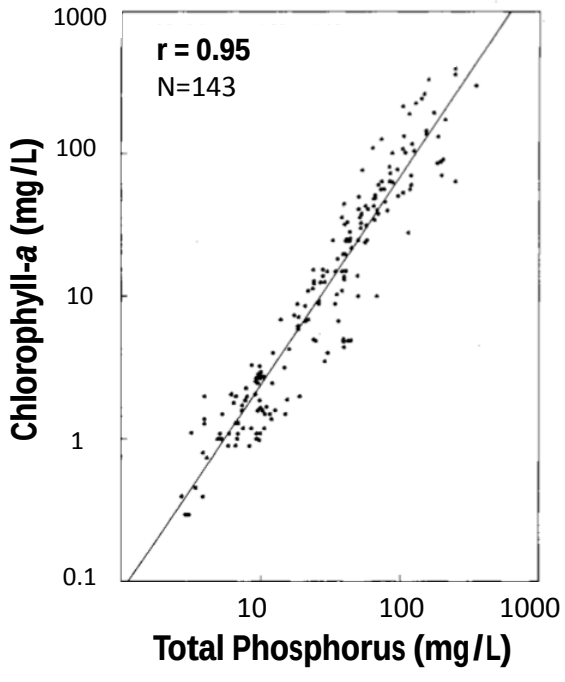
MAV Floodplain Lakes

- Recreational areas
- Major water quality issues
  - Sedimentation
  - Turbidity
  - Agricultural runoff
  - Highly productive

Water Quality Issues

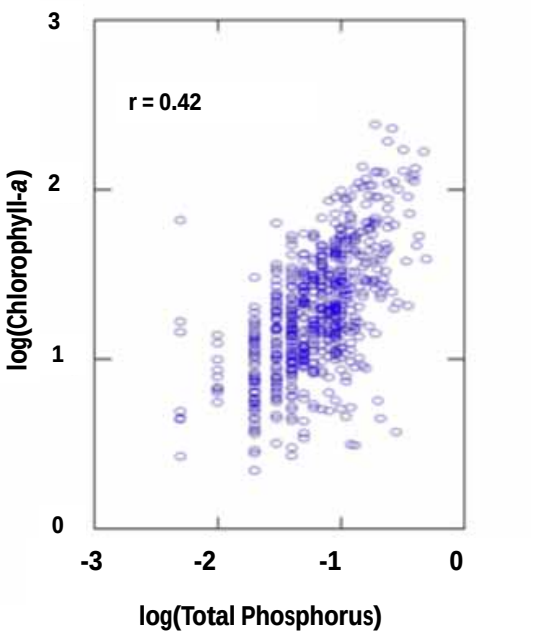
- Response variables
- Nutrient criteria
- Clean Water Act
- Designated uses
  - Warm water fisheries

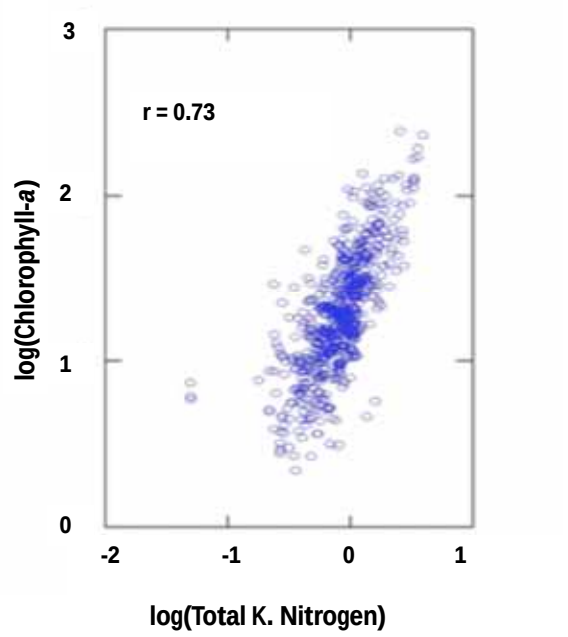
Nutrient – Chlorophyll Relationship



Jones and Bachmann 1976

MS Nutrient Criteria



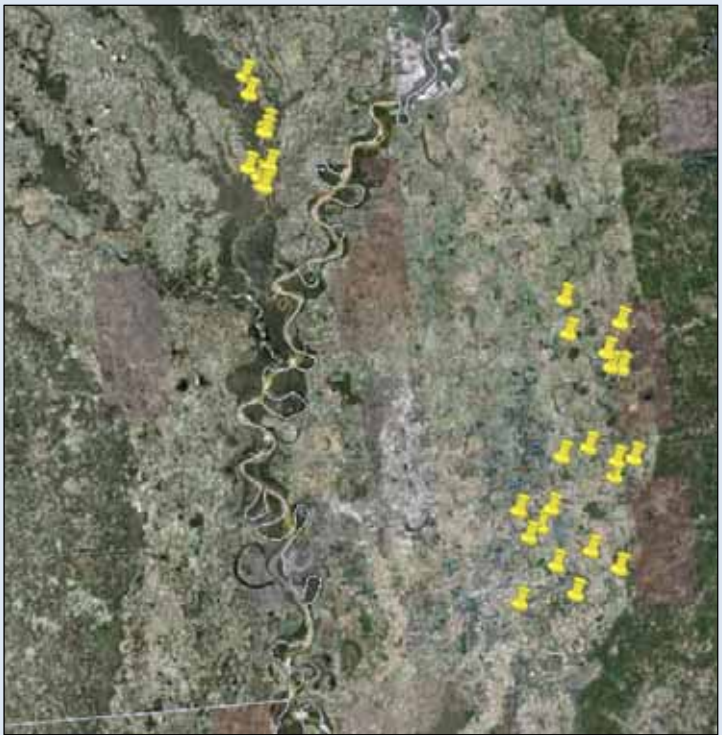


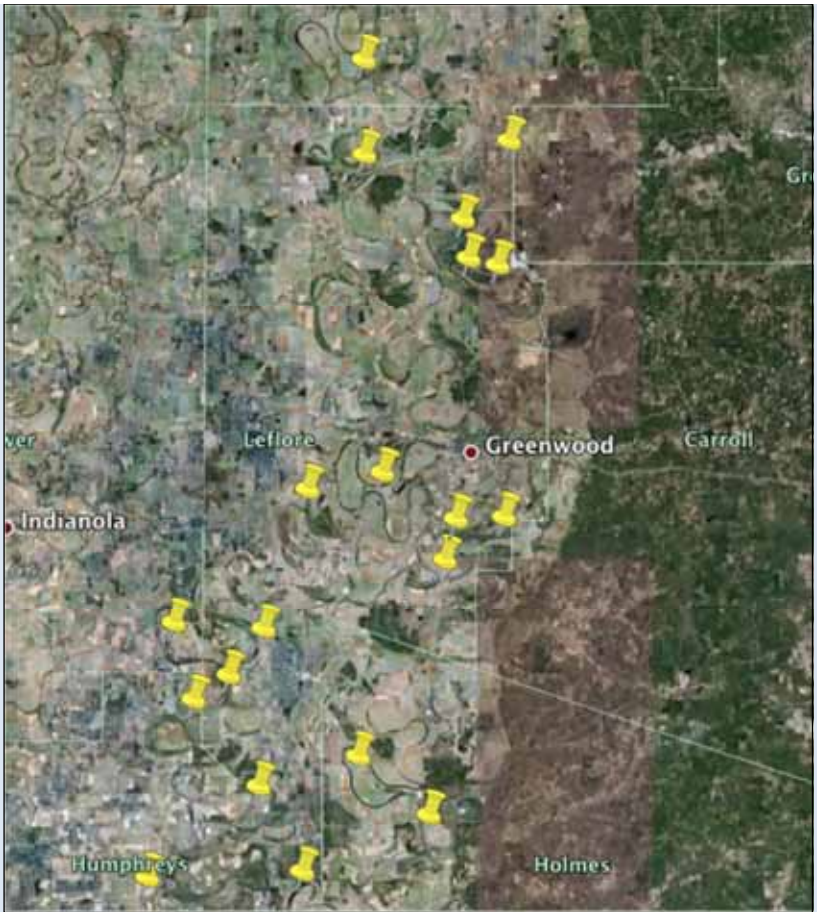
FTN 2007

Efficient monitoring

- Nutrients estimated by surrogates
- Field measurements allow faster processing and reduced costs
- Chlorophyll-*a* fluorescence
  - Response variable
  - Affected by many factors
- Turbidity
  - Light limitation
  - Phosphorus adsorption

Study Sites





Field measurements

- Water Column
  - Temp
  - pH
  - DO
  - Secchi depth
  - Max depth
- Composite sample
  - Turbidity (NTU)
  - Chlorophyll-a (RFU)
  - Alkalinity

Meters

- Fluorometer
  - Turner *Aqua*Fluor™
- Turbidimeter
  - HACH 2100p

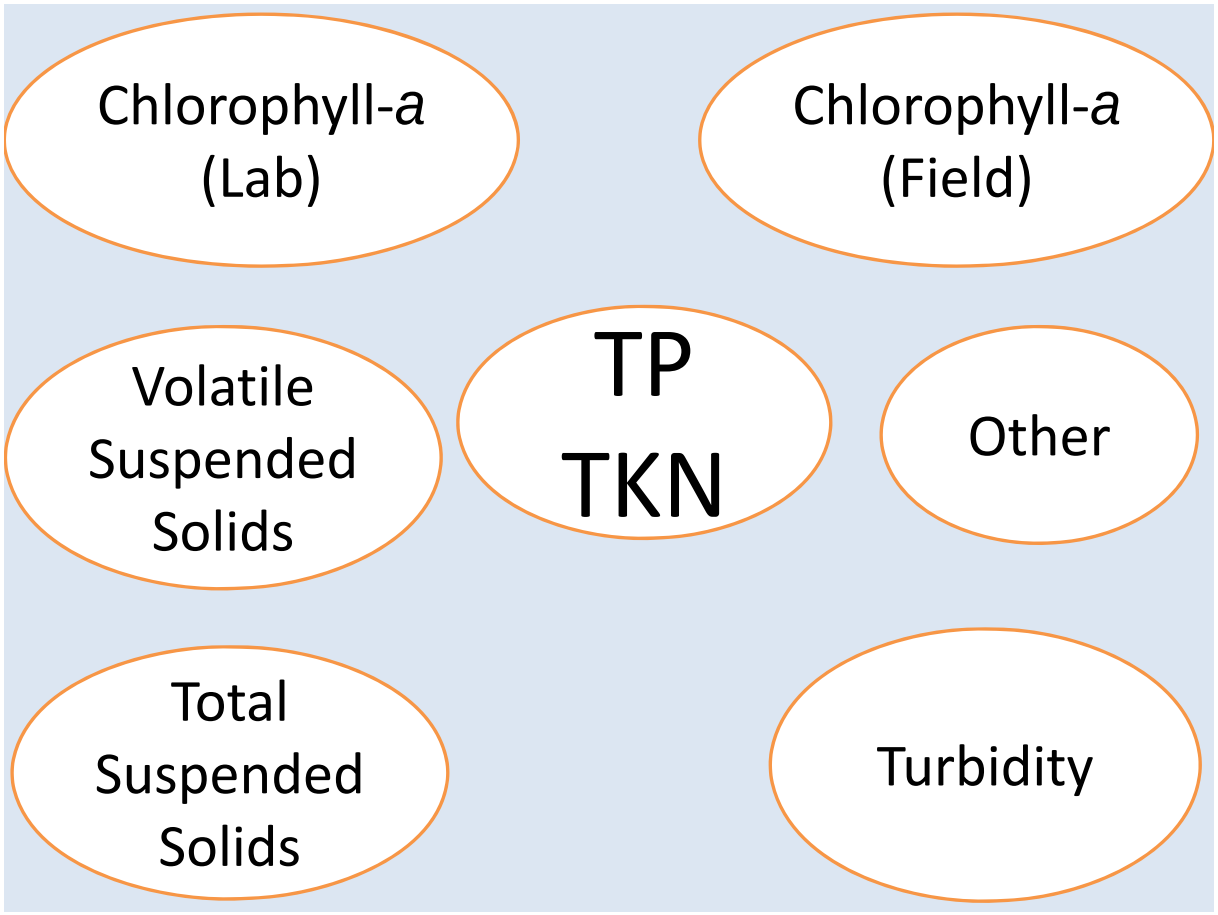
Chlorophyll-*a* (Field)

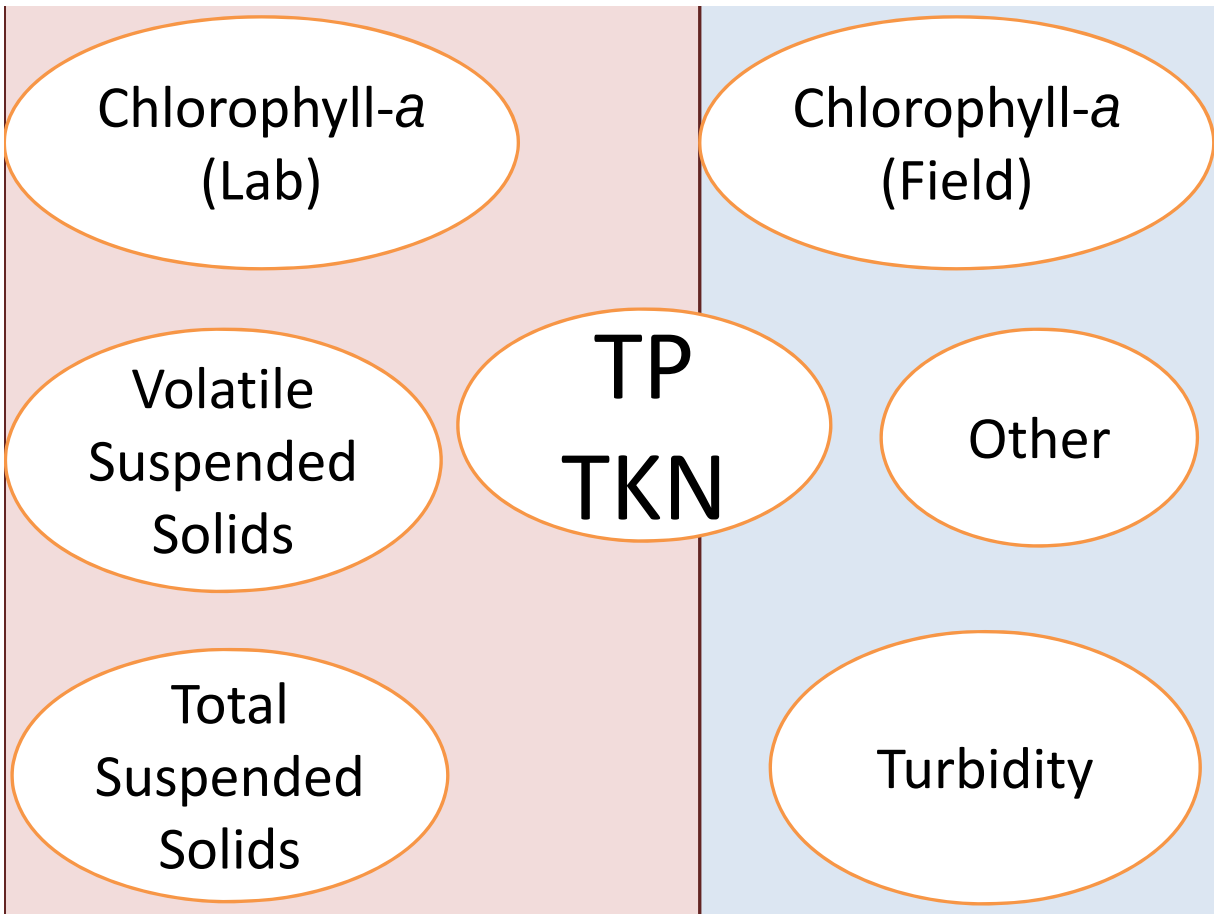
Other

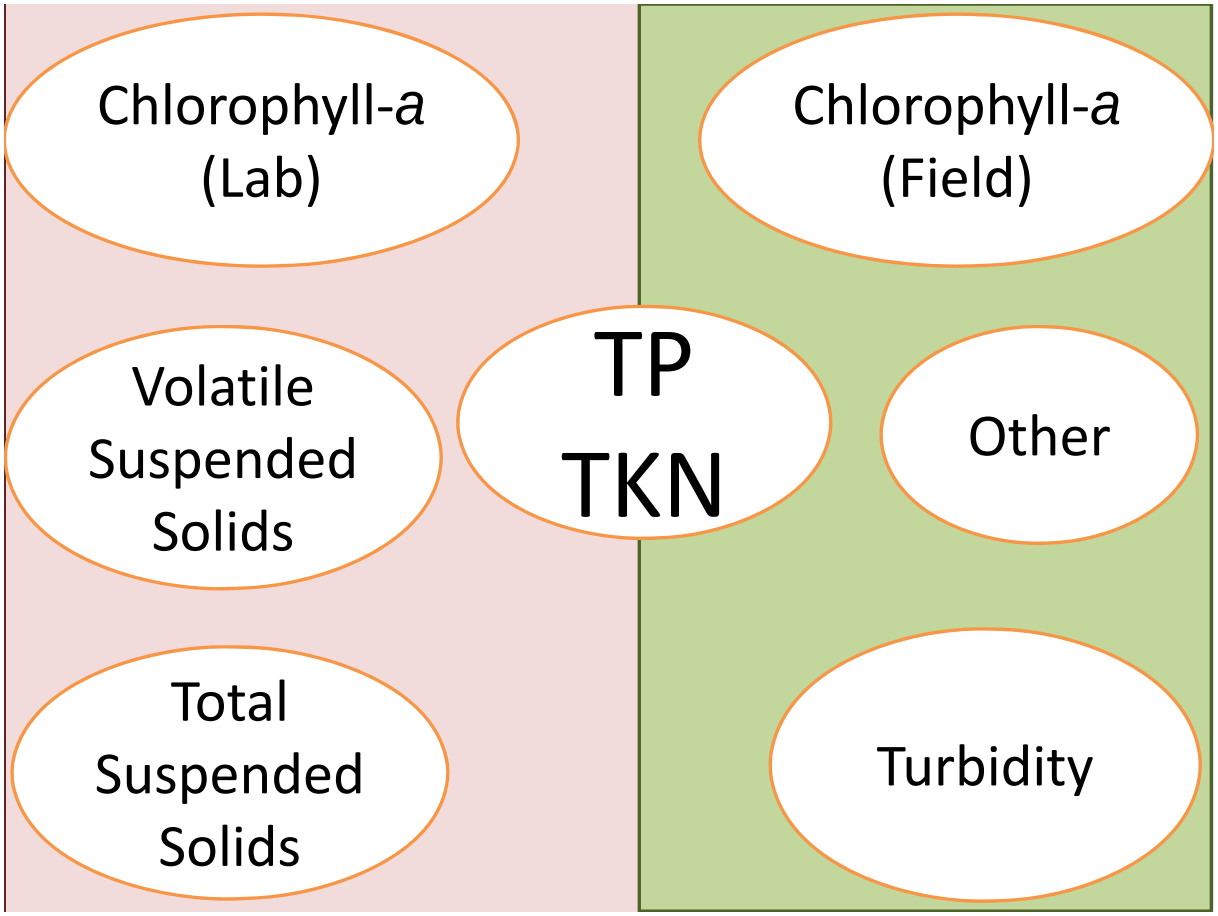
Turbidity

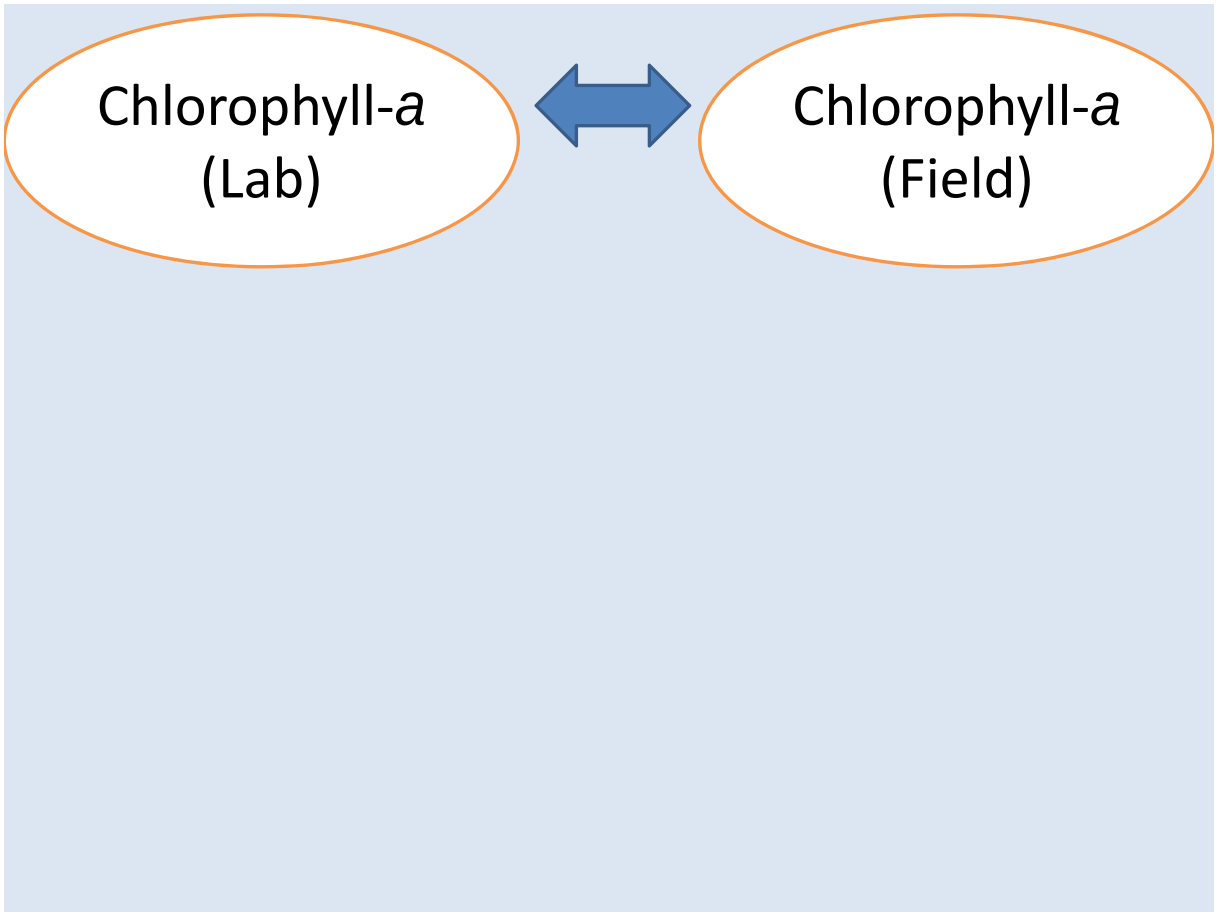
Lab measurements

- Composite sample
  - Chlorophyll-*a*
  - TSS, VSS
  - TKN, TP

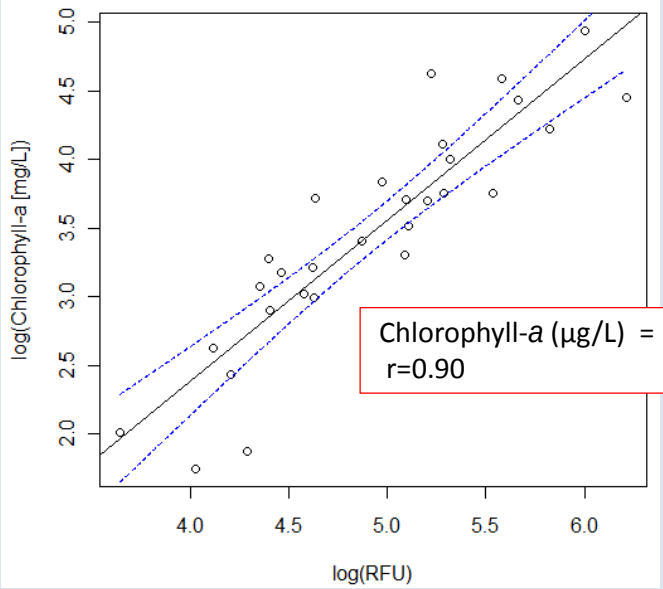

Chlorophyll-*a* (Lab)
Chlorophyll-*a* (Field)
Volatile Suspended Solids
TP
TKN
Other
Total Suspended Solids
Turbidity


Chlorophyll-*a* (Lab)
Chlorophyll-*a* (Field)
Volatile Suspended Solids
TP
TKN
Other
Total Suspended Solids
Turbidity


Chlorophyll-*a* (Lab)
Chlorophyll-*a* (Field)
Volatile Suspended Solids
TP
TKN
Other
Total Suspended Solids
Turbidity

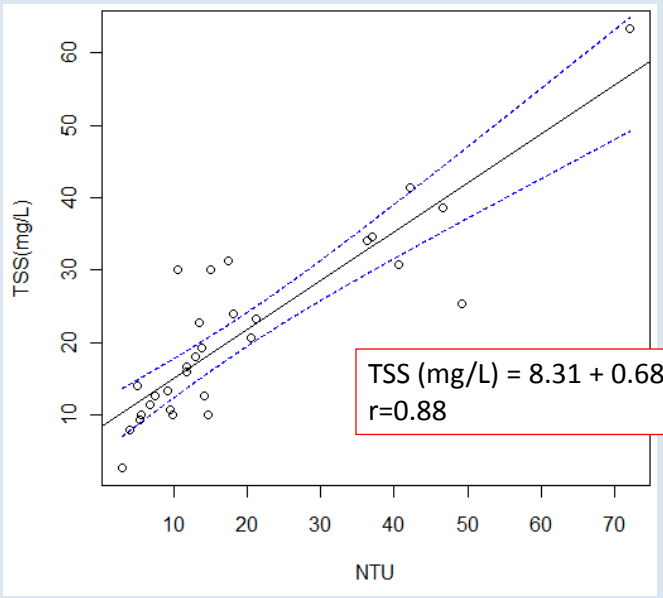

Chlorophyll-*a* (Lab)
Chlorophyll-*a* (Field)

Chlorophyll-*a* (Lab) ⟺ Chlorophyll-*a* (Field)



Chlorophyll-*a* (µg/L) = $e^{-2.31} \times RFU^{1.17}$
r=0.90

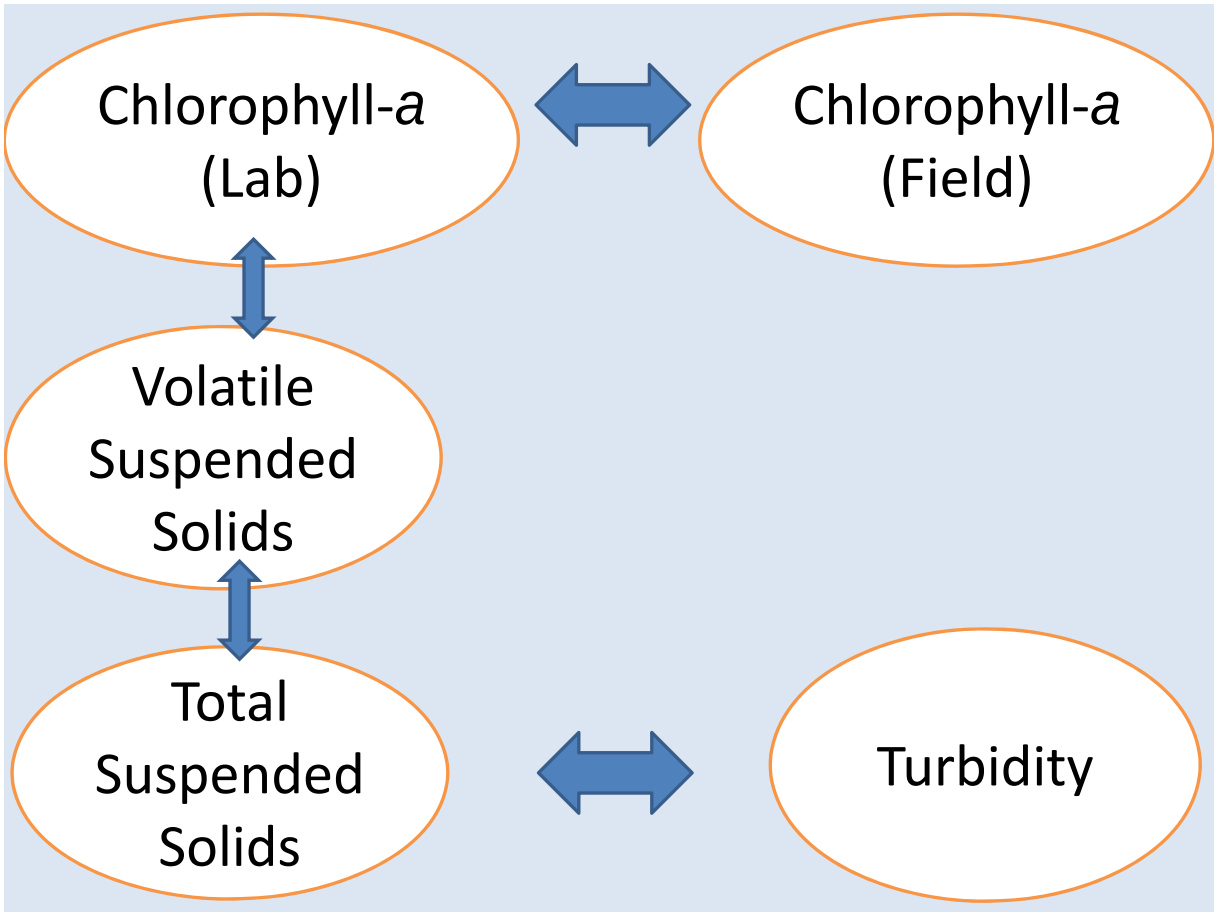
Total Suspended Solids ⟺ Turbidity

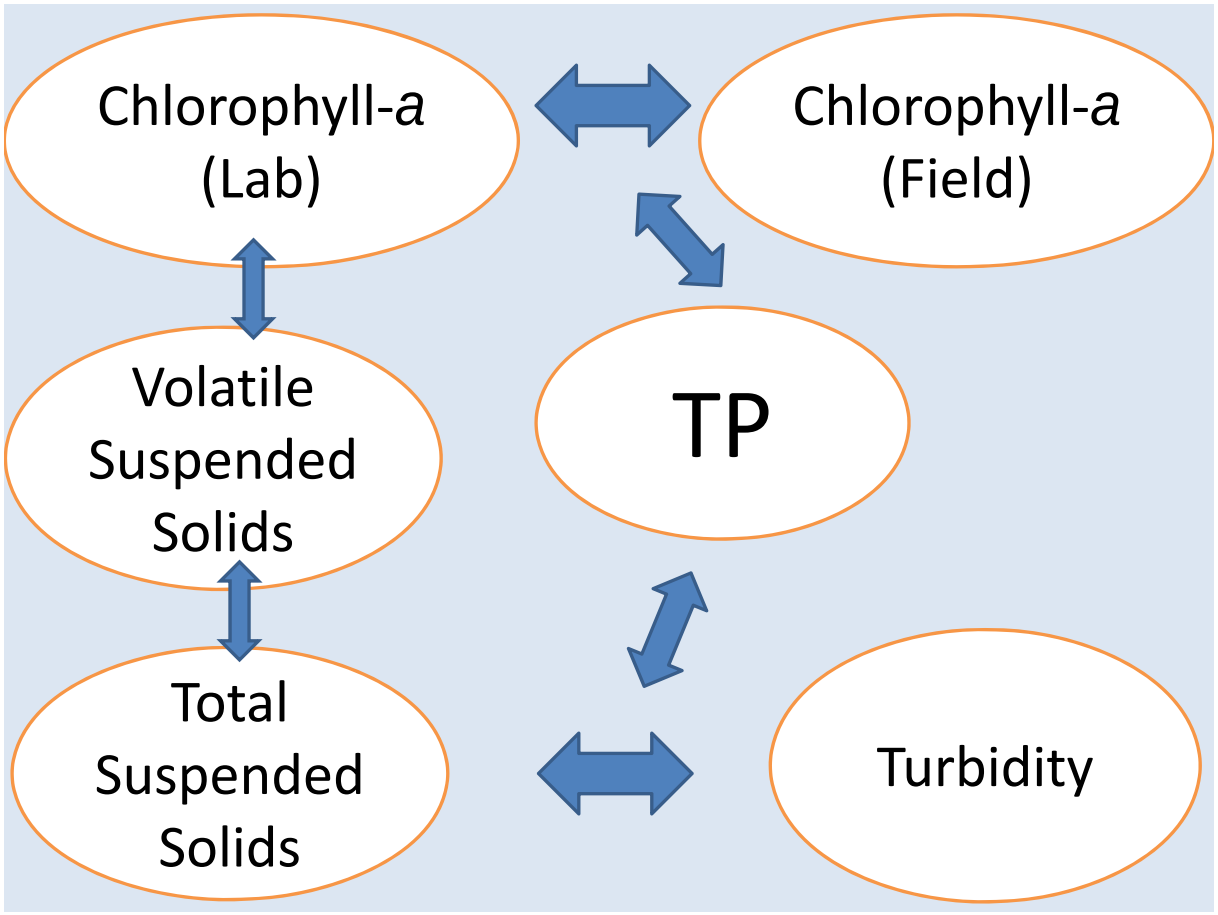


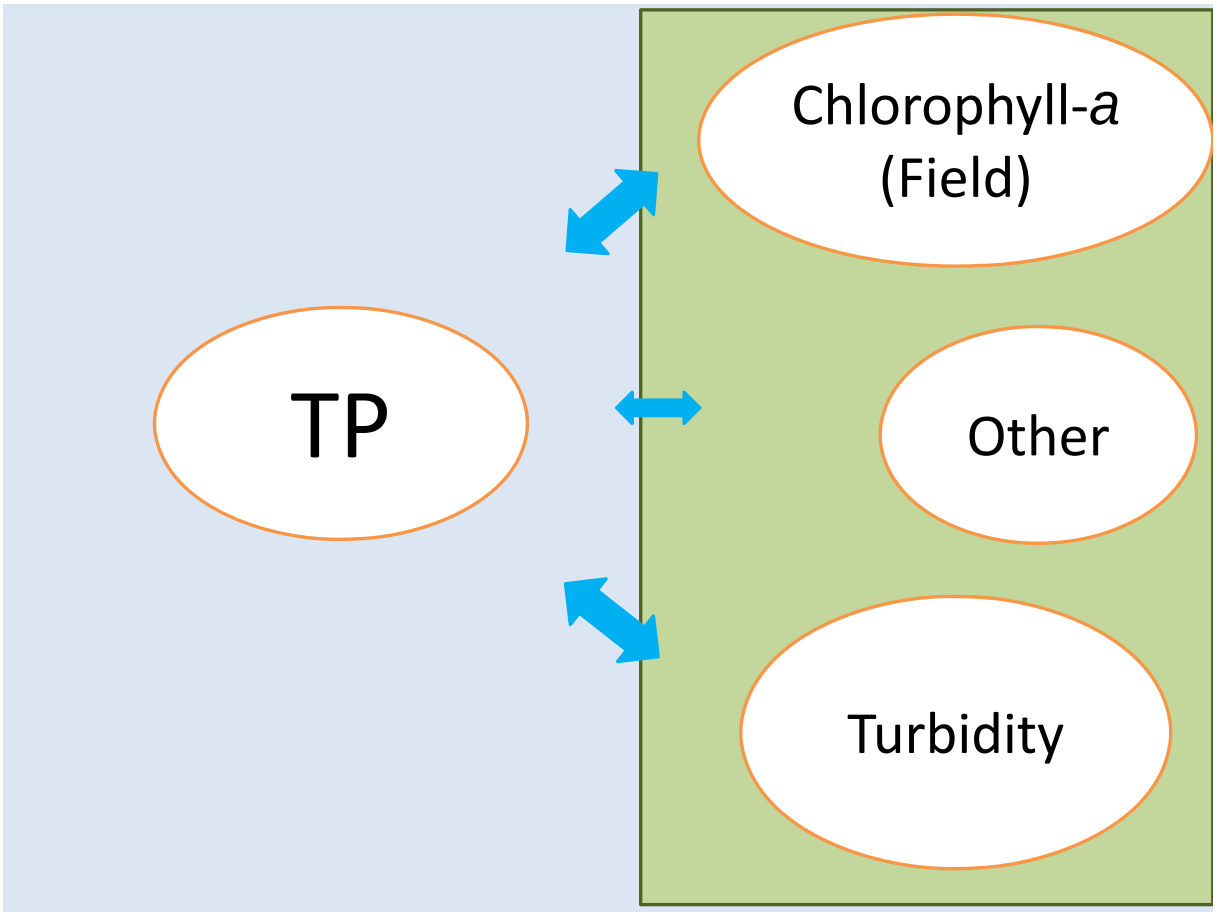
Total Suspended Solids ⟷ Turbidity

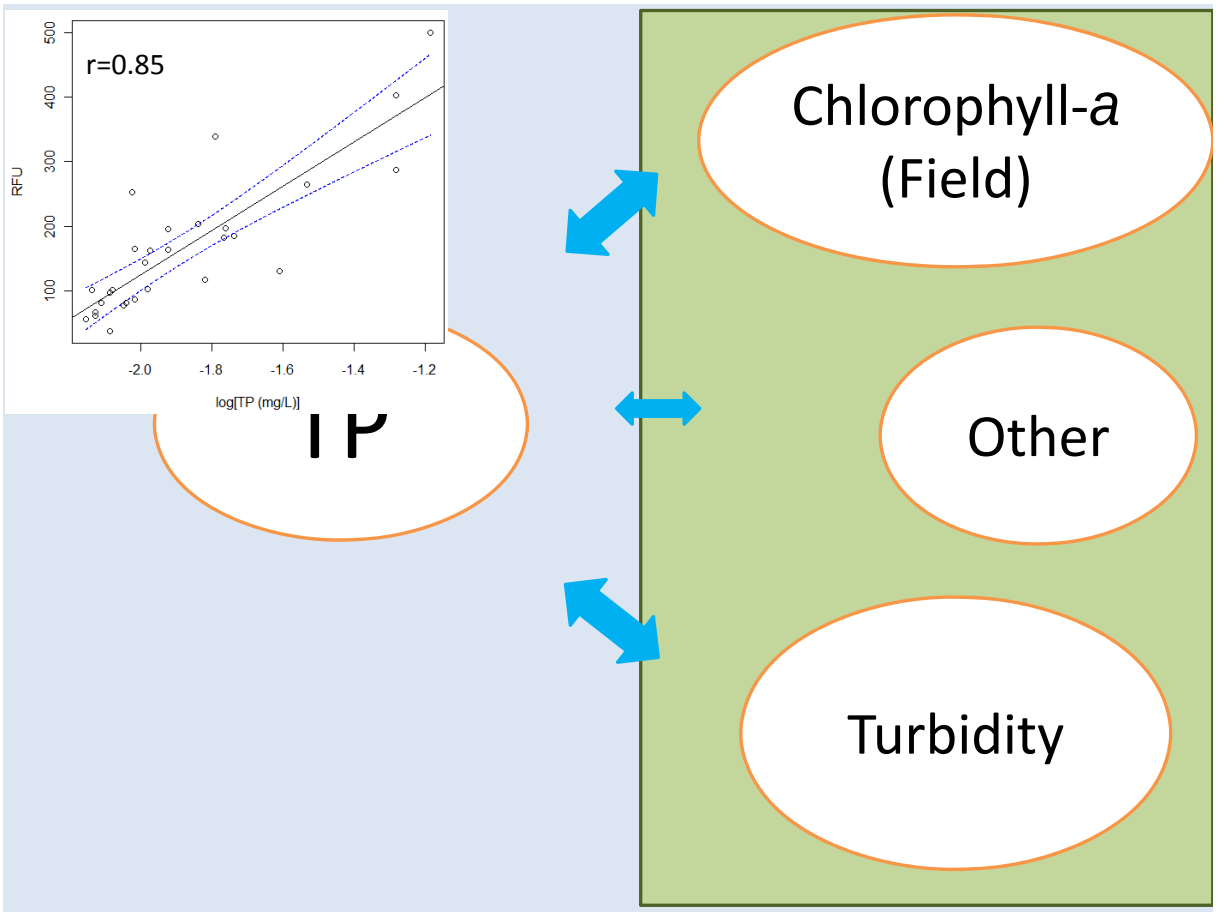
Chlorophyll-*a* (Lab) ⟷ Chlorophyll-*a* (Field)

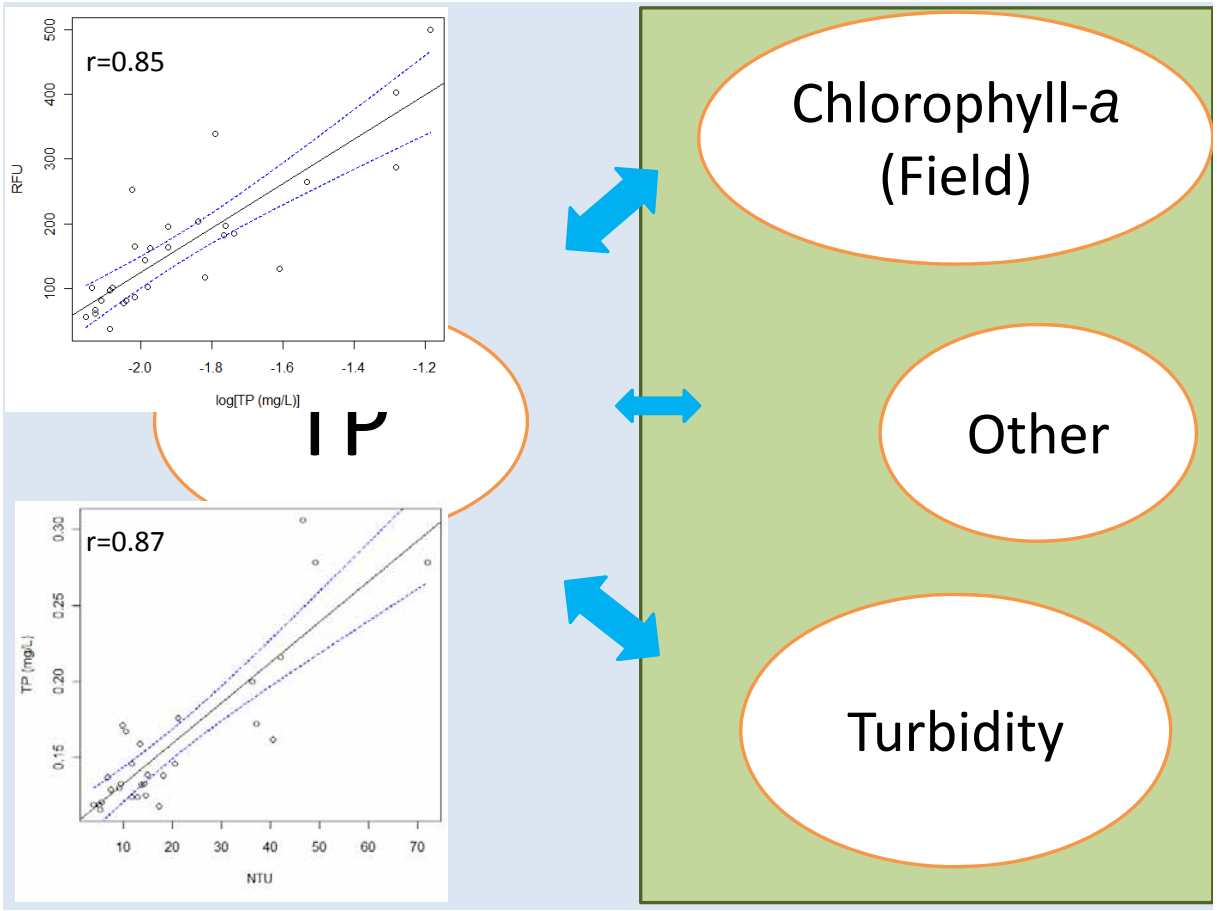
Total Suspended Solids ⟷ Turbidity

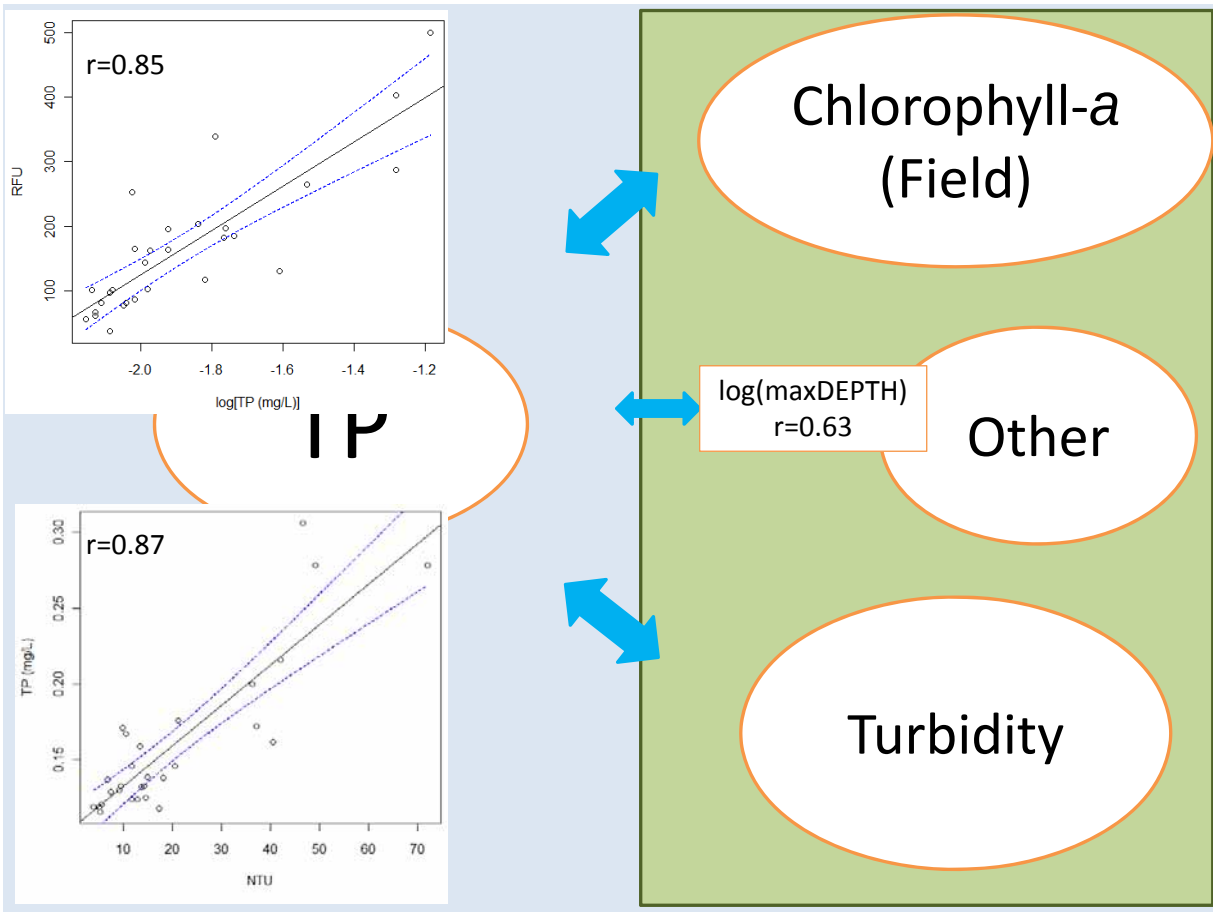

Chlorophyll-*a* (Lab)
Chlorophyll-*a* (Field)
Volatile Suspended Solids
Total Suspended Solids
Turbidity

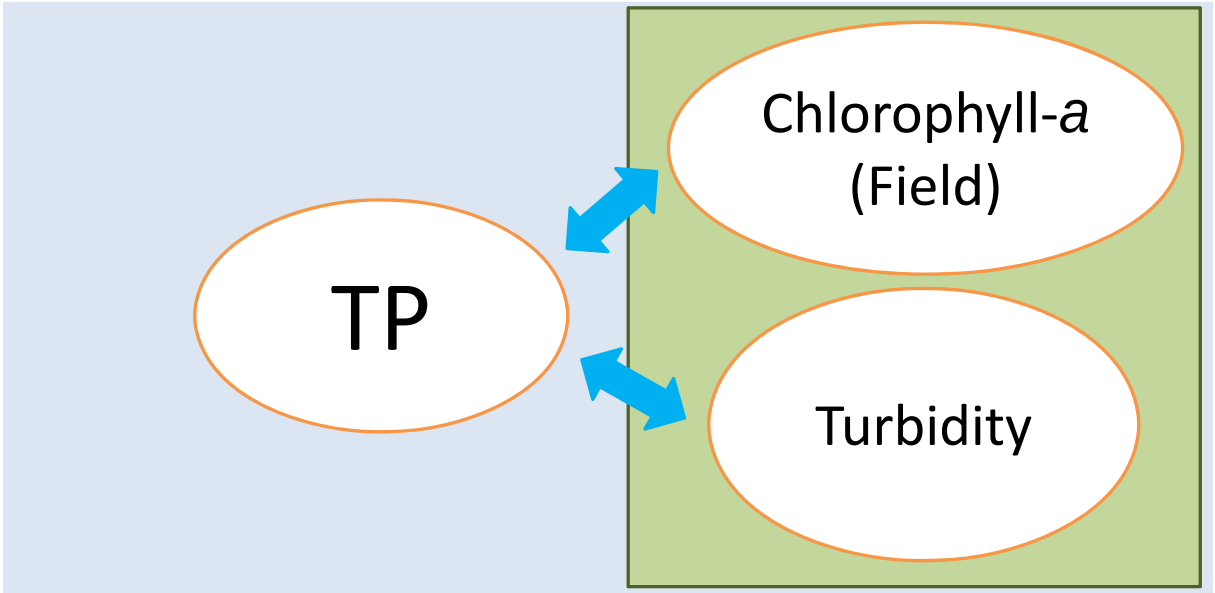

Chlorophyll-*a* (Lab)
Chlorophyll-*a* (Field)
TP
Volatile Suspended Solids
Total Suspended Solids
Turbidity


Chlorophyll-*a*
(Field)
TP
Other
Turbidity


r=0.85
RFU
100
200
300
400
500
-2.0
-1.8
-1.6
-1.4
-1.2
log[TP (mg/L)]
TP
Chlorophyll-*a*
(Field)
Other
Turbidity


r=0.85
RFU
log[TP (mg/L)]
TP
r=0.87
TP (mg/L)
NTU
Chlorophyll-a
(Field)
Other
Turbidity

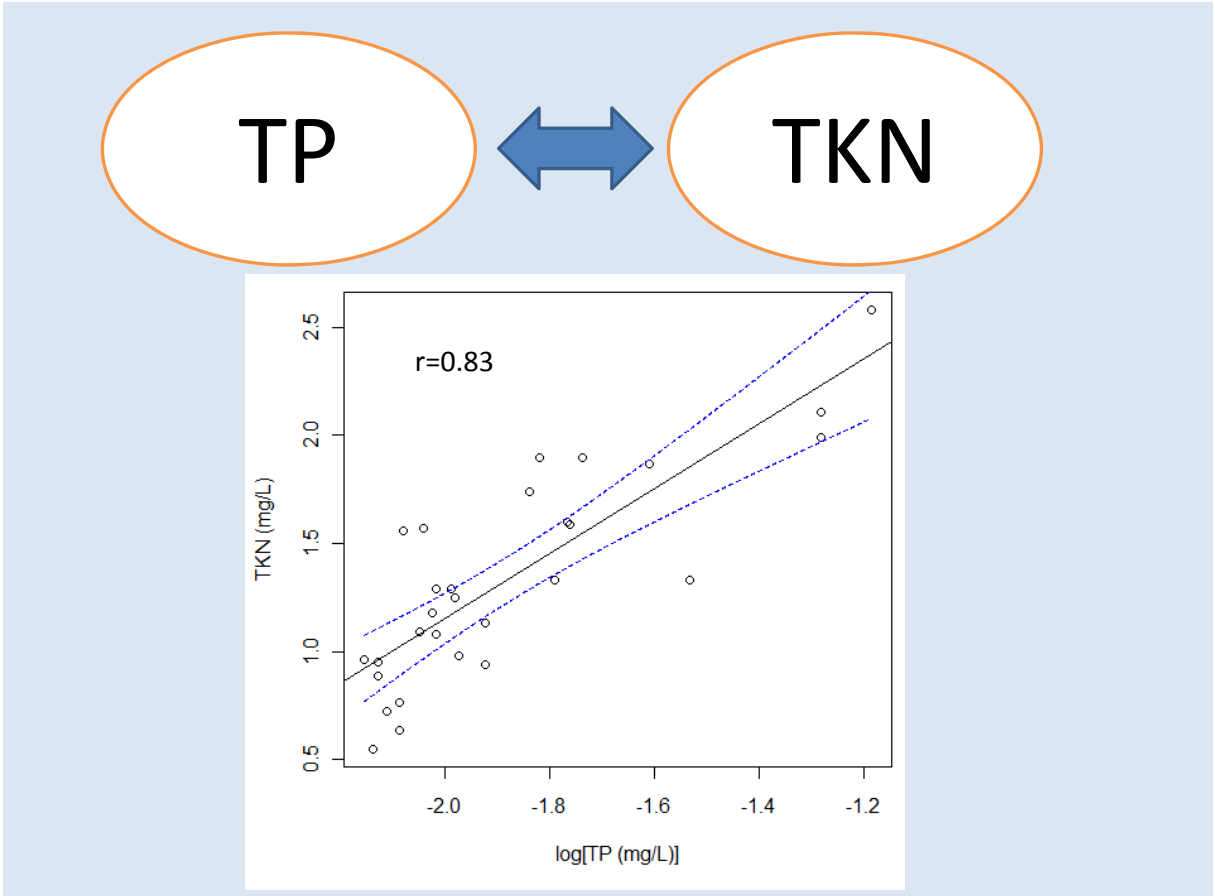

r=0.85
RFU
log[TP (mg/L)]
TP
r=0.87
TP (mg/L)
NTU
Chlorophyll-a
(Field)
log(maxDEPTH)
r=0.63
Other
Turbidity

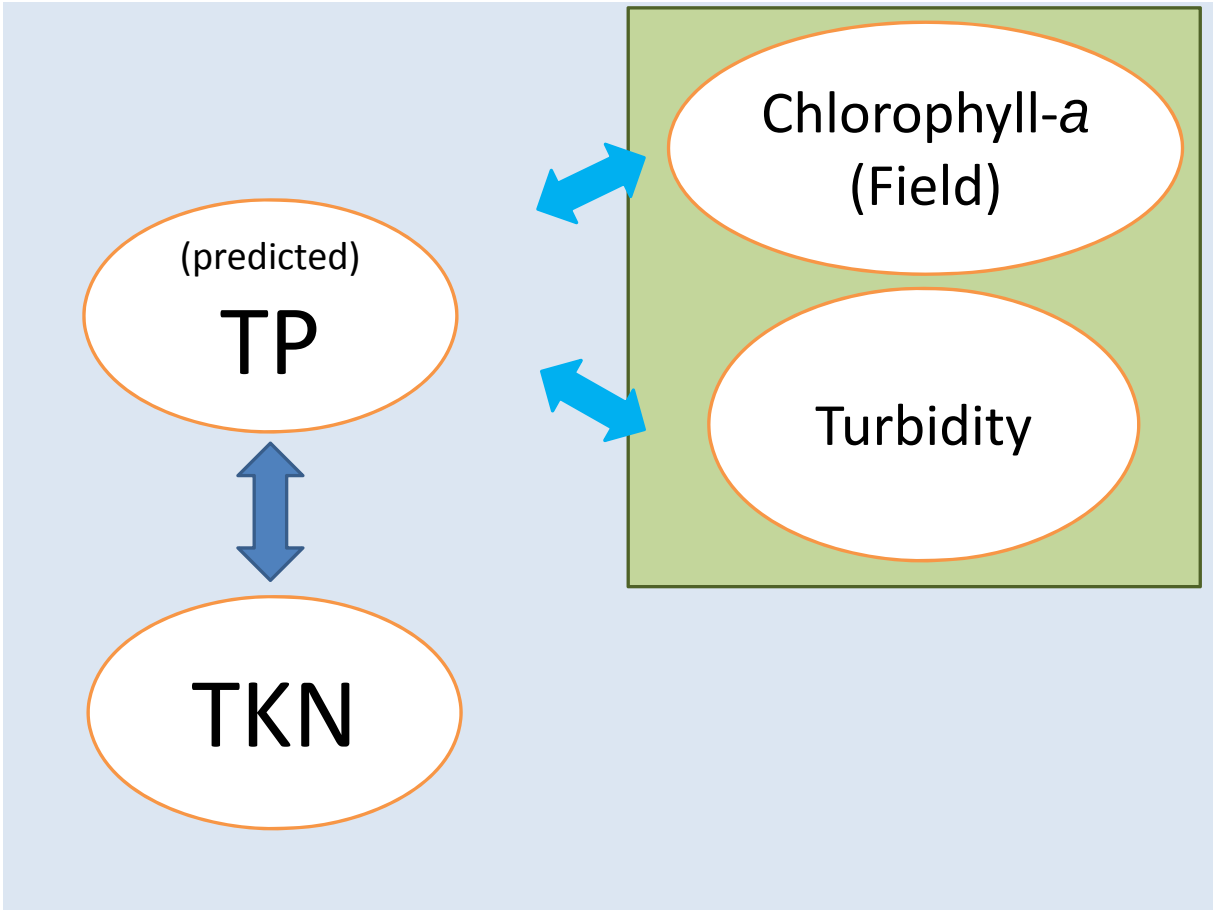


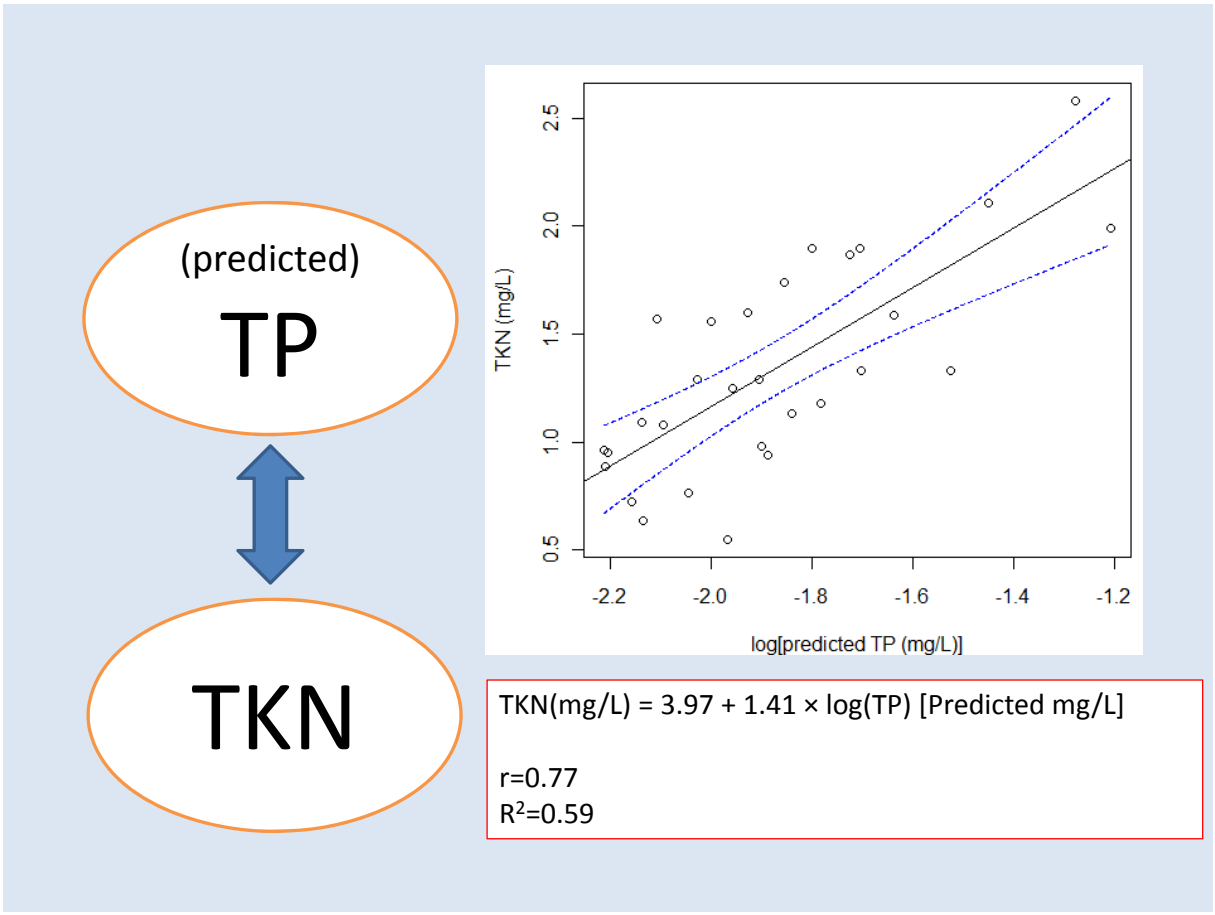
TP (µg/L) = 87.7 + 1.69NTU + 0.22RFU

r=0.94

R^2=0.89







TKN(mg/L) = 3.97 + 1.41 × log(TP) [Predicted mg/L]

r=0.77
R^2=0.59

Conclusions

- Relationships in MS lakes can be variable
  - Work on smaller scales
- Two measures (RFU, NTU) are needed to estimate TP in oxbow lakes
- Nitrogen may benefit from additional landscape parameters

Implications

- Delta oxbow lakes are potentially impaired
  - Need for more frequent monitoring
- More effort into response variables
  - Designated use
- More effort into sub-basin differences

Acknowledgements

- Dan Goetz
- Ted Alfermann
- Sky Wigen
- Landowners