# Comparison of Total Phosphorus in Lakes in Kalkaska County, Michigan and Relation to Trophic State

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# Overview

* Background – What?
* Questions – Why?
* Methods – How?
* Results & Conclusions – So what?

# Lakes

* 75% of the earth covered by water
  * 3% is fresh water
  * 1% available in surface waters
* Lakes are lentic systems
  * Equilibrium affected by surrounding land
* Increase in nutrients leads to eutrophication

# Eutrophication

* The natural aging of lakes
  * Increased biological productivity
  * Two types:
    * Natural eutrophication
      * ground water, organic matter, rainfall
    * Cultural eutrophication
      * fertilizers, sewage, runoff

# Nutrients

* Phosphorus and nitrogen can lead to eutrophication of lakes
  * Increased productivity
* Phosphorus is the limiting nutrient in most lakes
  * Lake 226
  * Lake morphometry

http://www.cbc.ca/news/canada/story/2010/10/15/f-david-schindler.html

# Background

* Forms of phosphorus in lakes
  * Orthophosphate
    * Soluble Reactive Phosphorus (SRP)
    * - aquatic plants, algae and animals
  * Hydrolyzable
    * $P_2O_7$, $P_3O_{10}$, organic phosphorus
    * Free
* Total phosphorus
  * Acid digestion
  * Hydrolyzable Phosphorus -> SRP

# Trophic State Index

* Carlson's Index is widely used
  * Classification based on algal productivity
  * Uses secchi depth, total P or chlorophyll a

# Classification

* Oligotrophic
  * Deep, low in nutrients, low biological activity
* Mesotrophic
  * Moderate amount of nutrients and biological activity
* Eutrophic
  * High in nutrients and biological activity
* Dystrophic
  * Shallow lakes, fairly high nutrients, lots of plant life.

# Overview

* Background
  * Phosphorus is the limiting nutrient in most lakes
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# Hypothesis

Questions

Does the total phosphorus concentration of lakes in the same area vary with lake depth?

Does human activity affect this concentration?

Hypotheses

Deeper lakes should have less total phosphorus concentrations than shallow lakes.

Lakes with more houses around them may have more total phosphorus concentration.

# Overview

* Background
  * Phosphorus is the limiting nutrient in most lakes
* Questions
  * Does the total phosphorus concentration for lakes in the same area vary with lake depth? Does human activity affect this concentration?
* Methods- How?
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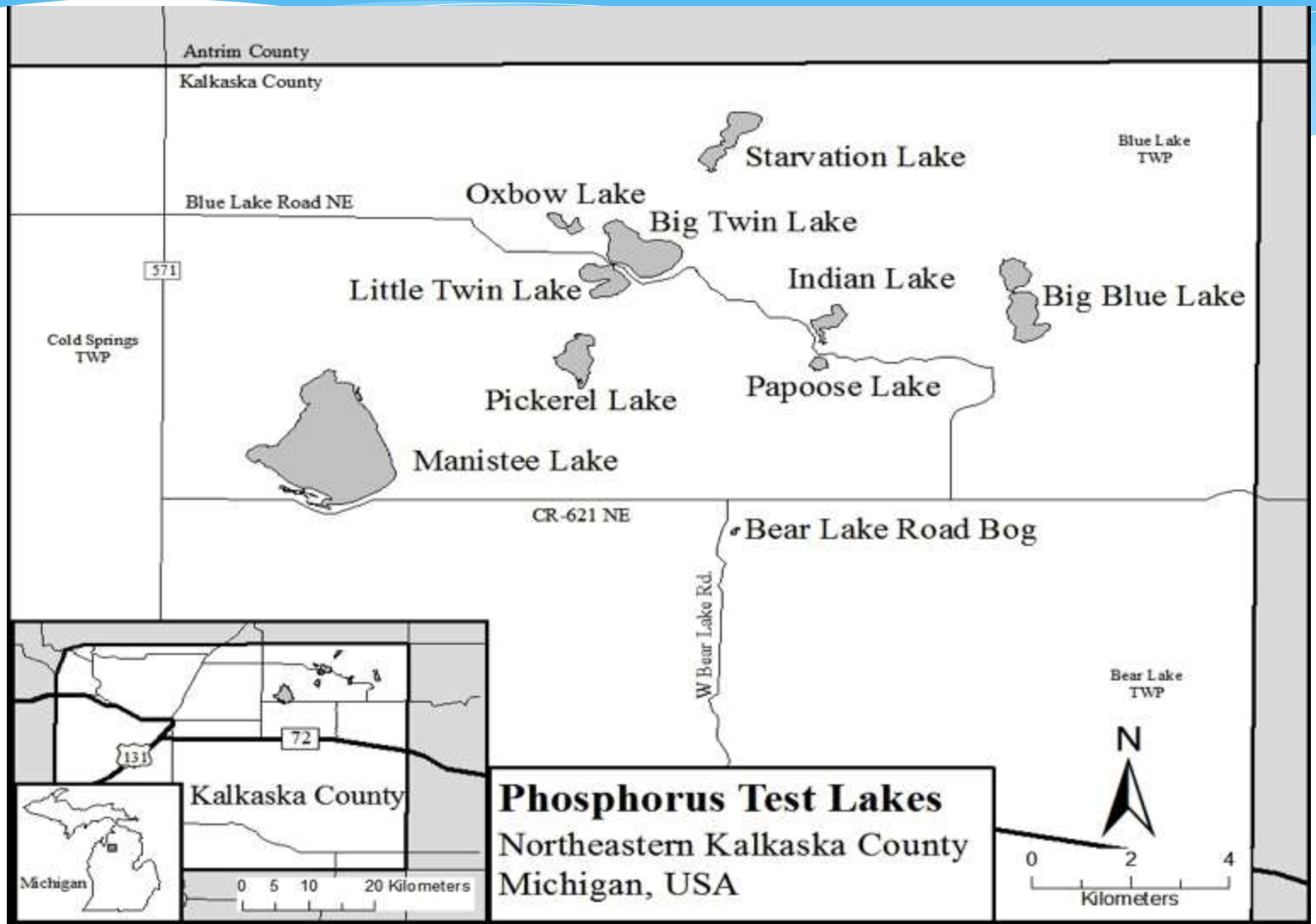
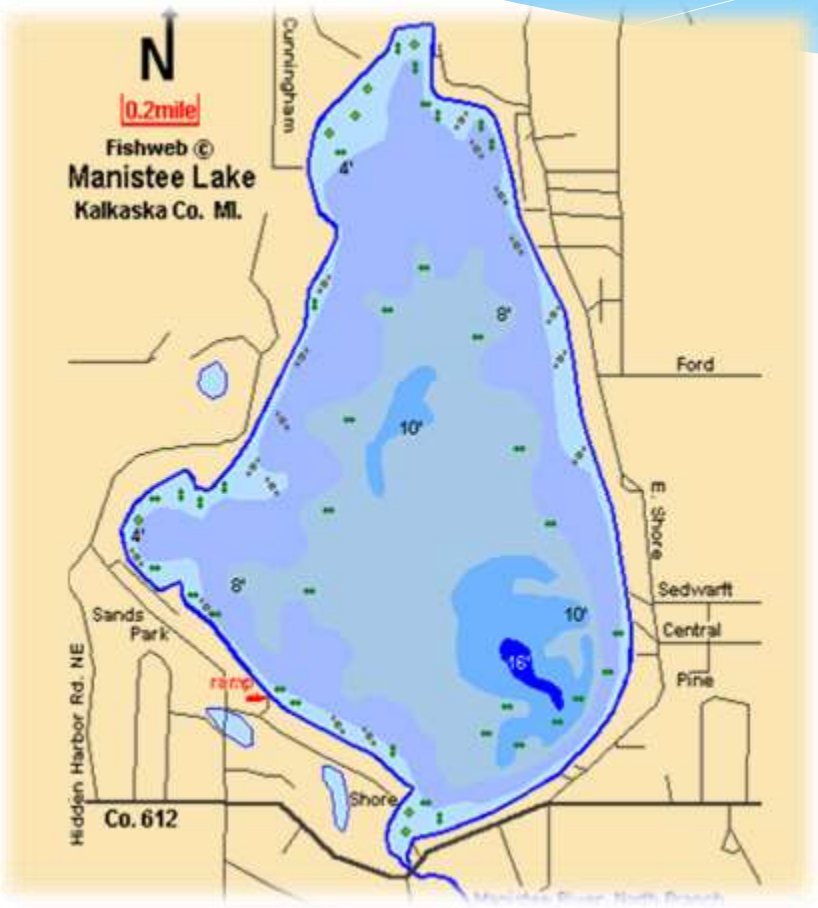
# Methods

## Location: Kalkaska County, Northern Michigan



# Methods- Lake Manistee



# Methods

* Sampled surface and bottom
  - Triplicates from each depth
* Samples frozen

http://www.ag.auburn.edu/fish/image_gallery/details.php?image_id=1713&sessionid=eb4e832e58fada

# Methods

* Persulfate digestion
  * Colorimetric method
  * Sulfuric acid digestion
  * NaOH neutralization
  * Color change
* Spectrophotometer measured absorption
  * 10 cm cuvette used
  * Spec-21 used

# Methods

* Other data
  * Secchi depth
  * Number of houses

http://www.tnfish.org/WaterQualitySampling_TWRA/TWRAtennesseeervoirWaterQualitySamples.htm

# Methods

* Carlson's Trophic State Index calculated for:
  * Total Phosphorus
  * Secchi depth

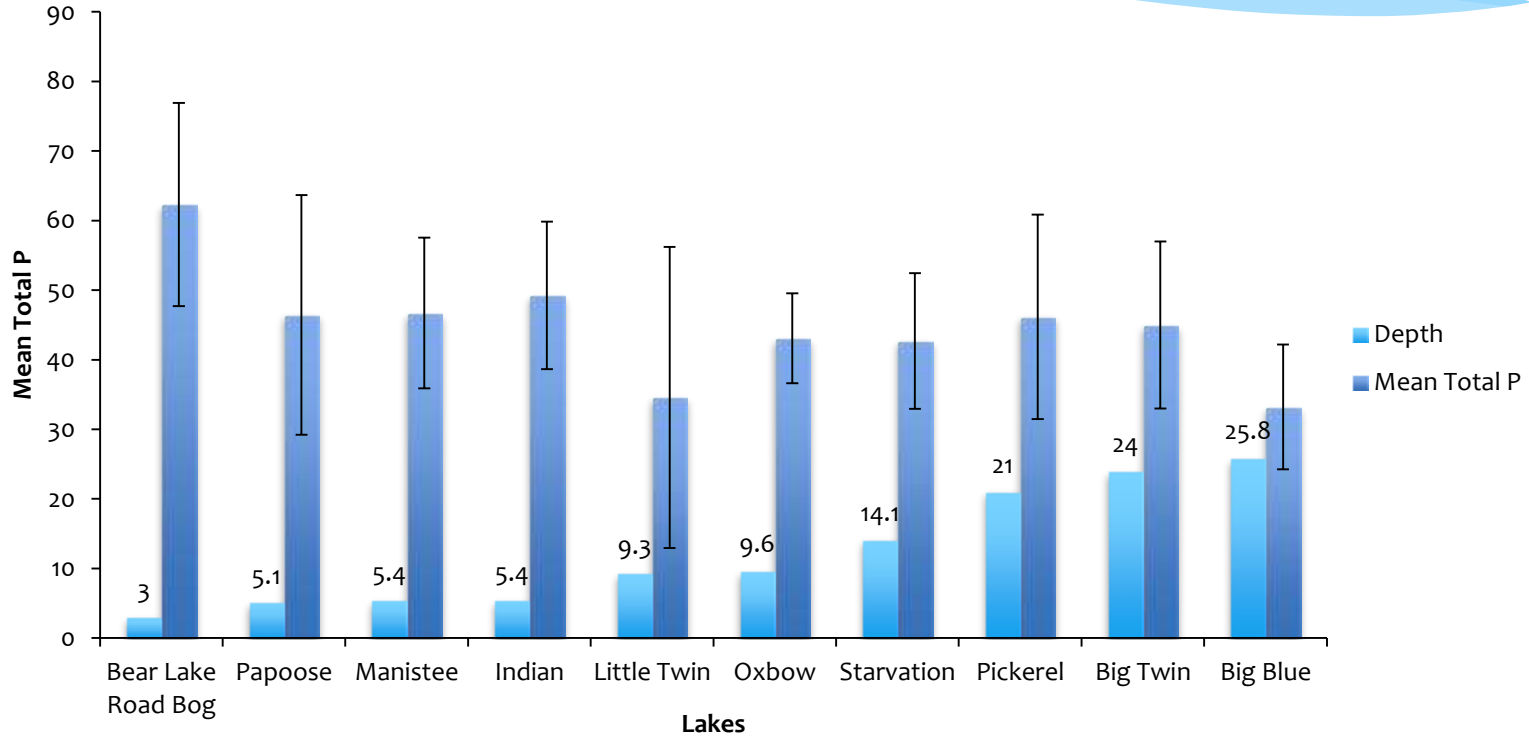
# Overview

* Background
  * Phosphorus is the limiting nutrient in most lakes
* Questions
  * Does the total phosphorus concentration for lakes in the same area vary with lake depth? Does human activity affect this concentration?
* Methods
  * Measure the total phosphorus concentration in 10 lakes in Kalkaska County, Michigan
* Results & Conclusions- So what?

# Results

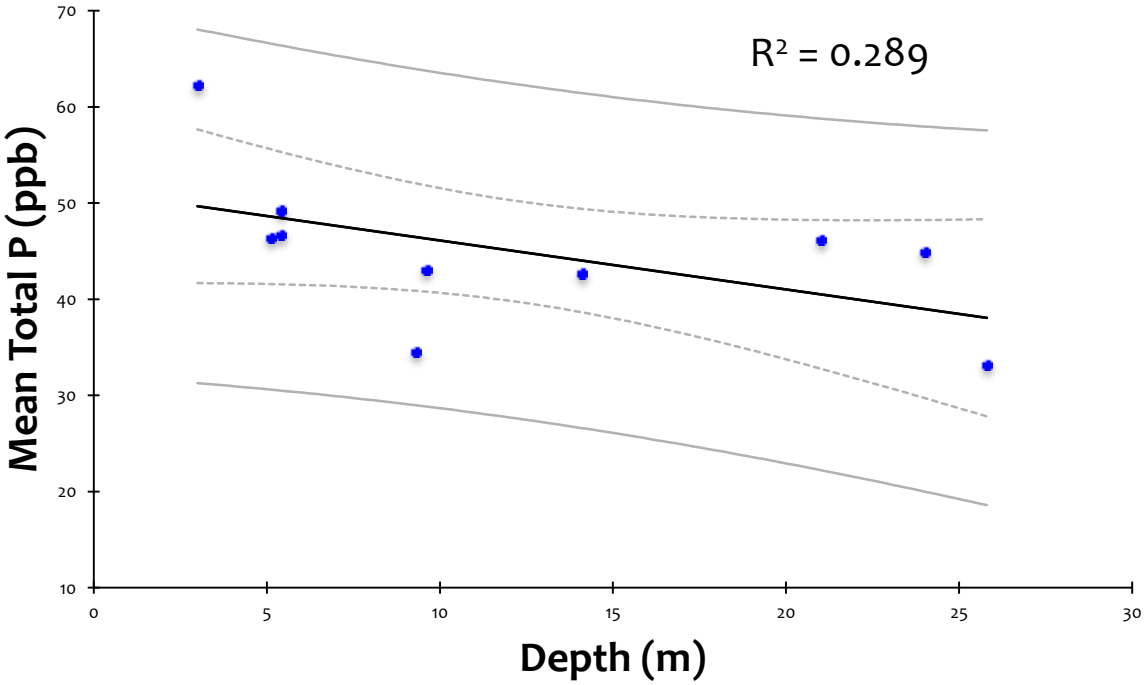
* Phosphorus values in the lakes ranged from ~33 – 49 ppb
* All lakes had similar concentrations
* Bog had highest concentration ~ 62 ppb
* Results reported as Total P ($PO_4$-P)
* CLMP Report- Total phosphorus values < 5 - 74 ppb

# Results


90
80
70
60
50
40
30
20
10
0
Mean Total P
3
5.1
5.4
5.4
9.3
9.6
14.1
21
24
25.8
Bear Lake Road Bog
Papoose
Manistee
Indian
Little Twin
Oxbow
Starvation
Pickerel
Big Twin
Big Blue
Lakes
Depth
Mean Total P

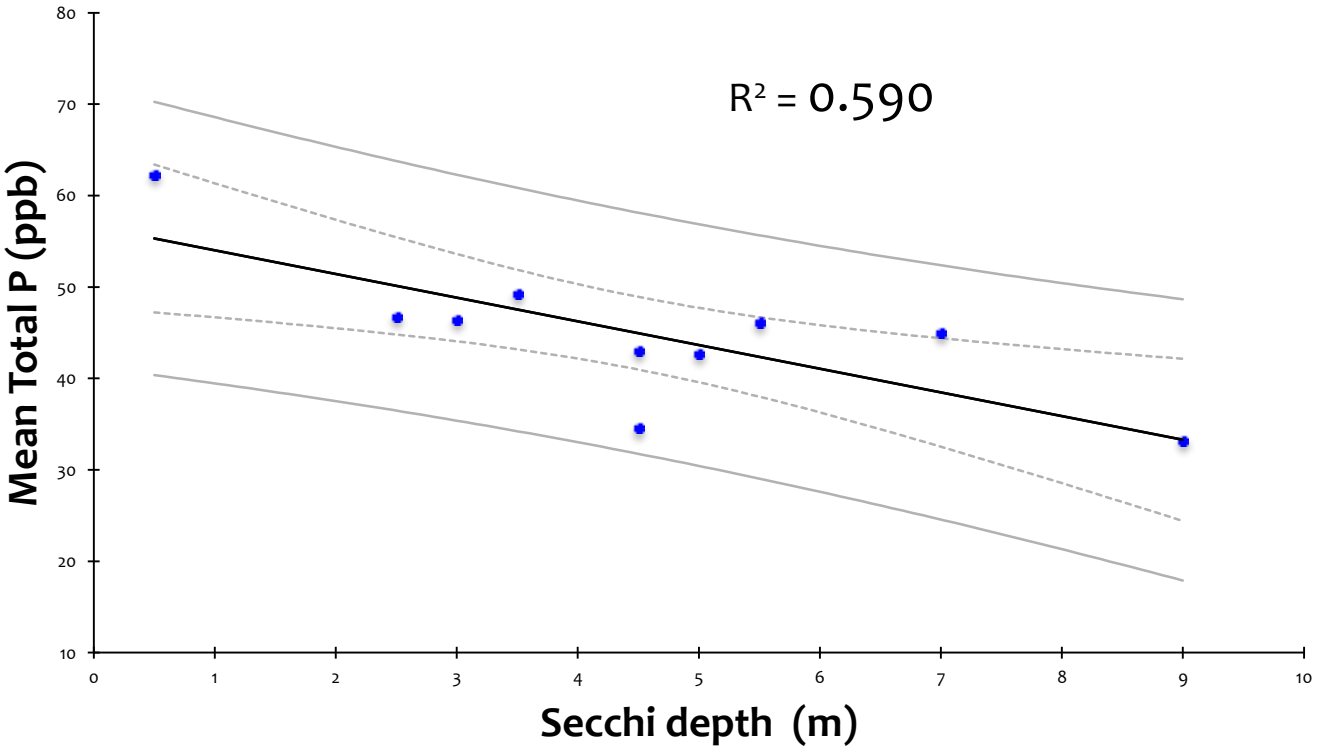
# Results

* Linear regression analyses performed using data from all sources
* Mean total phosphorus vs. maximum depth



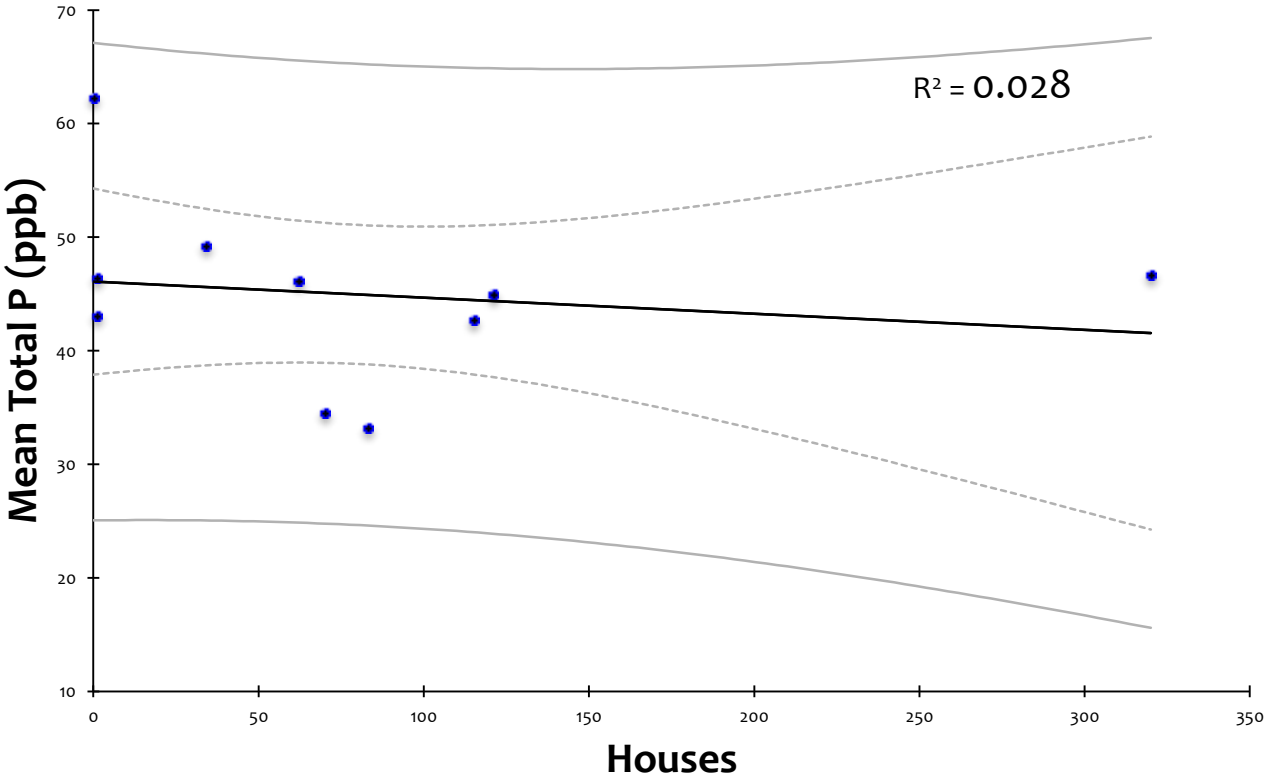
# Results

* Mean total phosphorus vs. Secchi depth



# Results

* Mean total phosphorus vs. number of houses



# Conclusion

* Depth and total phosphorus had no significant correlation
  * Lake volume
* Number of houses also had no correlation with mean total phosphorus
  * Land use, septic systems
* Carlson's Trophic State Index
  * Lakes mostly mesotrophic
* Other factors could also be considered

# Acknowledgments


* God
* Au Sable Institute
* Dave Mahan & Scott Carr
* John Korstad, Hal Reed, Kenneth Weed
* Members of the various lake associations
* Family & Friends

# Questions?

# Additional Information

| Lake | Carlson TSI |
|---|---|
| Starvation | Mesotrophic |
| Indian | Mesotrophic |
| Oxbow | Mesotrophic |
| Papoose | Mesotrophic |
| Little Twin | Oligotrophic |
| Big Blue | Oligotrophic |
| Big Twin | Mesotrophic |
| Pickerel | Mesotrophic |
| Manistee | Mesotrophic |
| Bear Lake Road Bog | Eutrophic (Dystrophic) |

# Additional Data

| Lake | Mean Total P | TSI (TP) | TSI (SD) | Carlson TI |
|---|---|---|---|---|
| Starvation | 42.71 | 58.31 | 36.78 | Mesotrophic |
| Indian | 49.26 | 60.37 | 41.93 | Mesotrophic |
| Oxbow | 43.08 | 58.44 | 38.30 | Mesotrophic |
| Papoose | 46.43 | 59.52 | 44.15 | Mesotrophic |
| Little Twin | 34.57 | 55.27 | 38.30 | Oligotrophic |
| Big Blue | 33.20 | 54.68 | 28.30 | Oligotrophic |
| Big Twin | 44.98 | 59.06 | 31.93 | Mesotrophic |
| Pickerel | 46.17 | 59.44 | 35.41 | Mesotrophic |
| Manistee | 46.73 | 59.61 | 46.78 | Mesotrophic |
| Bear Lake Road Bog | 62.30 | 63.76 | 70.00 | Eutrophic |