Lake Okeechobee: Long-Term Water Quality Trends

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Objectives

- Conducting water and nutrient budgets for the lake from water years (WYs) 1973-2018 (WY=May 1st through April 30th).
- Assessment of the long term regional nutrient contribution to Lake Okeechobee.
- Tracking water quality trends for water quality flowing into or out of the lake.
- In-Lake water quality assessment and trophic state classification.

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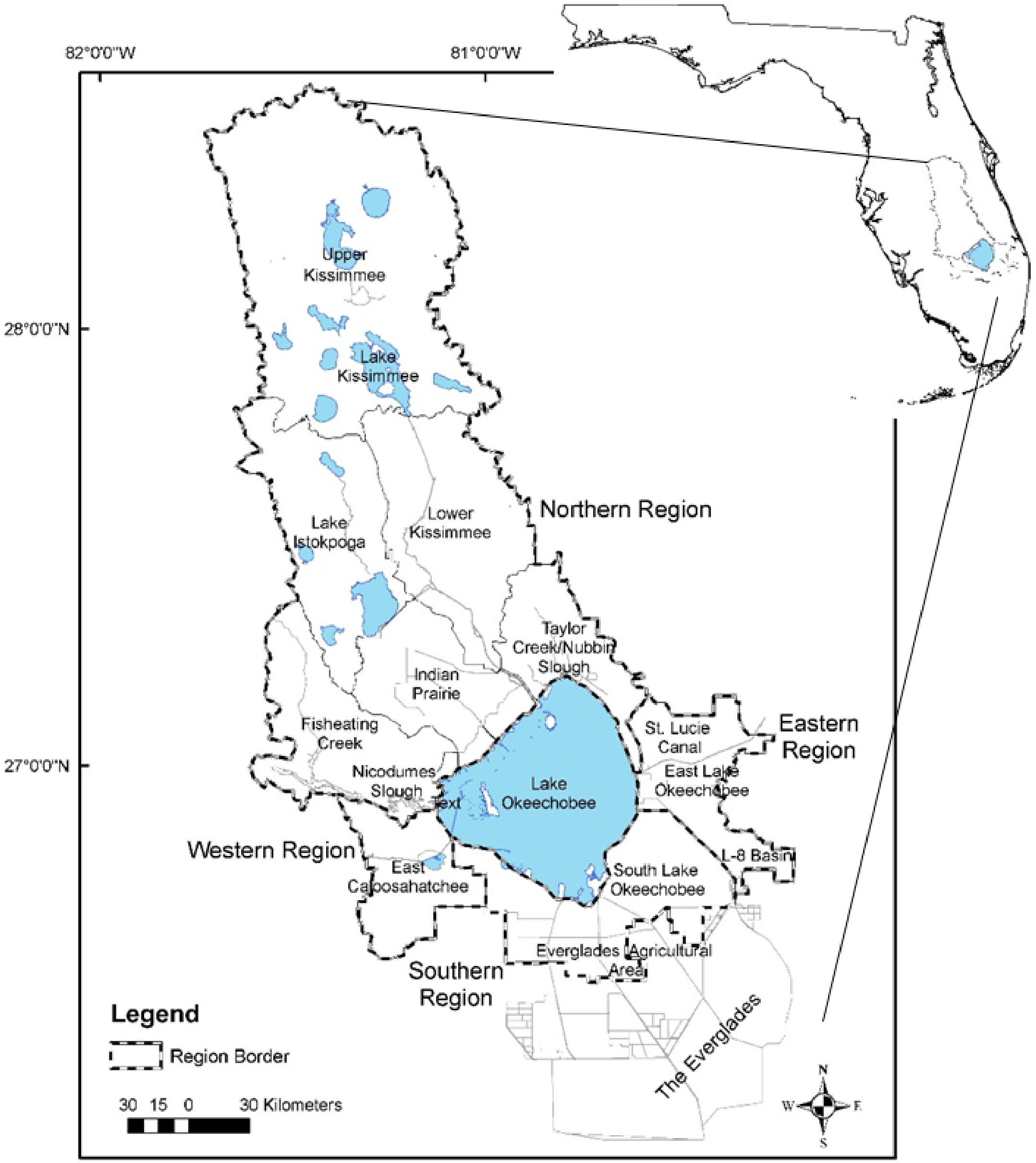
Lake Okeechobee

- Largest freshwater lake in Florida and described as the heart of the south Florida ecosystem.

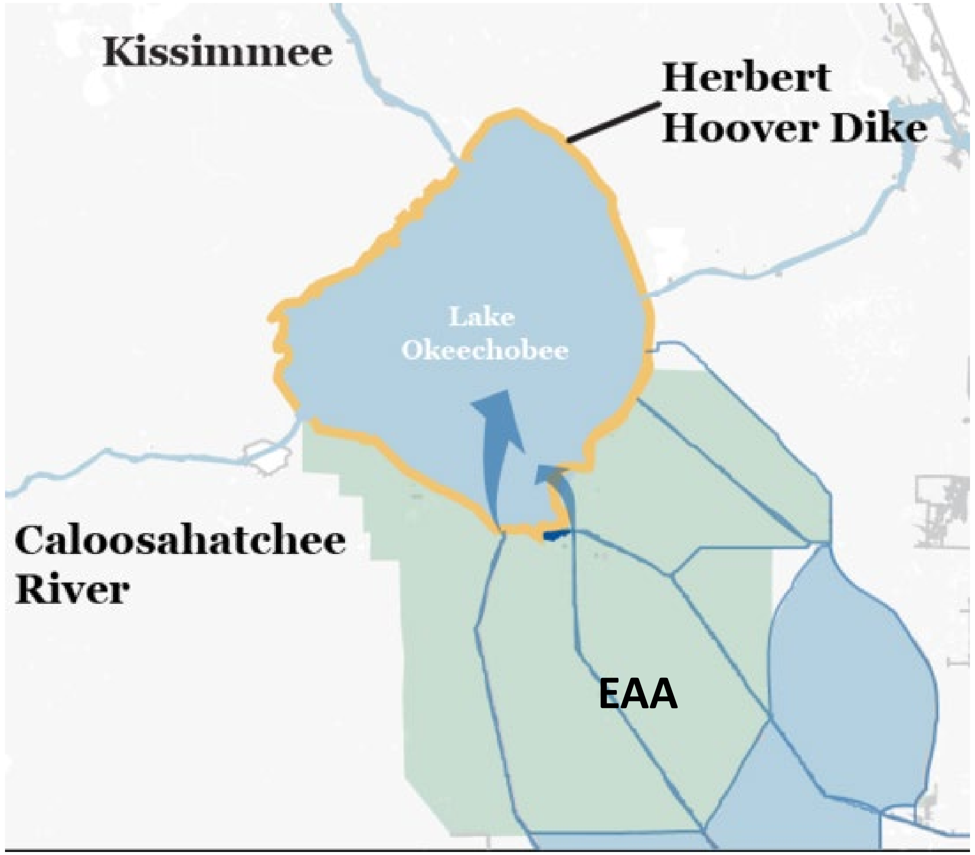
- Provides flood control and water supply as well as many ecosystem services (habitat to migratory species, etc.).

- The subtropical climate has two distinct wet and dry seasons.



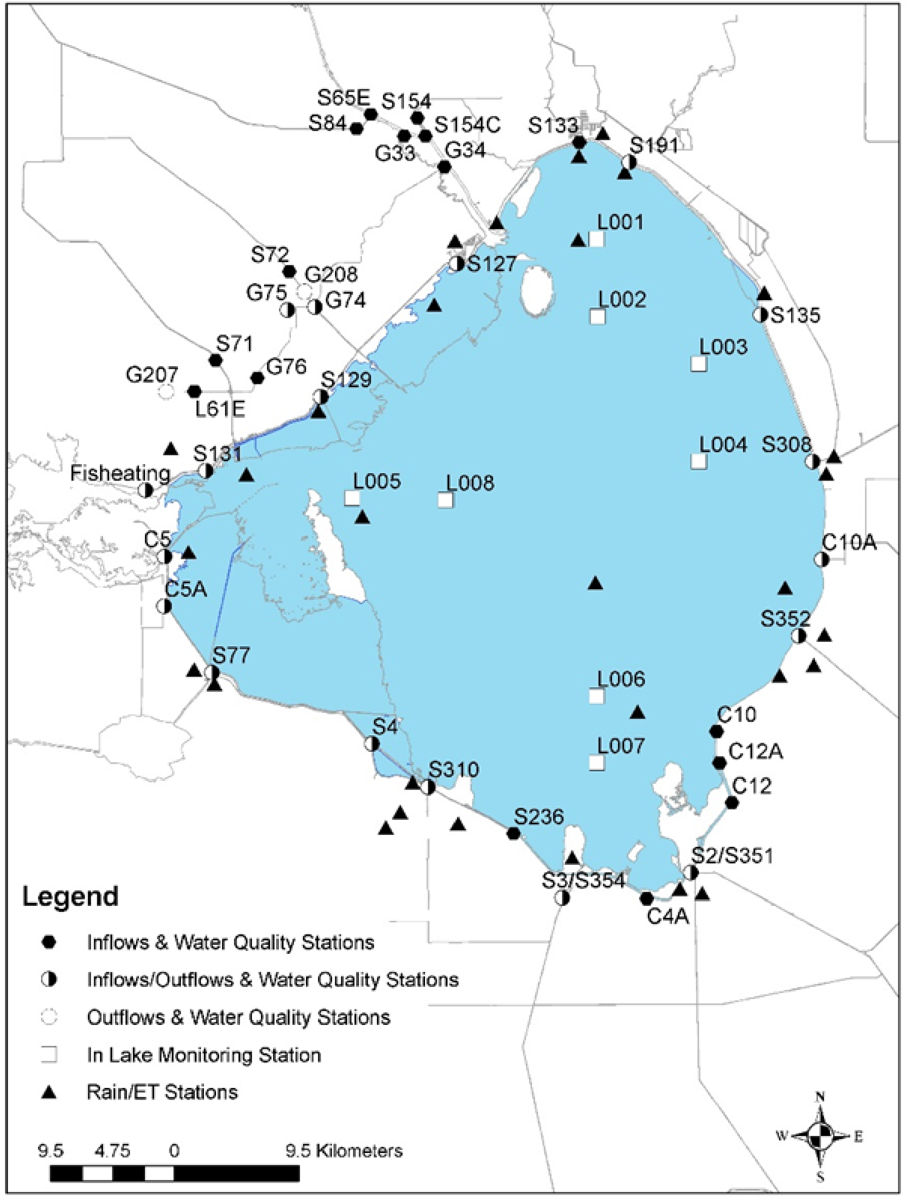
Inflows to Lake Okeechobee

- The hydrology of the lake is human-regulated and it receives inflows from the Northern, Eastern, Western and Southern regions.
- Usually lake water is drawn south by canals to irrigate sugarcane and other crops in the Everglades Agricultural Area (EAA).
- Reverse flow from the Southern region to the lake called back-pumping.



Data from WYs 1974-2018

- Nutrient loadings entering the lake from surface runoff, atmospheric deposition and internal nutrient releases were calculated.
- A database was created with water quality data, surface inflows and outflows, hydro-meteorological data and lake stages for the last 45 water years (WY1974-2018).
- 38 monitoring stations around the lake and 8 in-lake monitoring stations were used.



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Budget Models

- Budgets were stated as a series of mass balance equations for four regions

$$\Delta Storage = \sum Inputs - \sum Outputs$$

- Net Sedimentation rate equation used was:

$$\sigma = [(M_{in} - M_{out}) - (\Delta M_{lake})]/M_{lake}$$ *(James et al. 1995& Havens et al.2005)*

Where:

M_{in} *is the* yearly mass of nutrient entering the lake at the inflow structures and from atmospheric deposition.

M_{out} is the yearly mass leaving the lake at the outflow structures.

ΔM_{lake} is the year-to-year changes in lake mass based on the first and last day of WY values.

M_{lake} is the average annual lake mass.

Temporal Trend Analysis

- Non-parametric Mann-Kendall trend test on an annual time scale as well as seasonal cycles.
- The change point detection algorithm was used to determine changes in flows, nutrient concentrations, and loads to the lake:
  - Lake Okeechobee nutrient inflow and outflow loadings
  - Nutrient concentrations as well as the in-lake nutrient concentrations
  - Net P sedimentation rate

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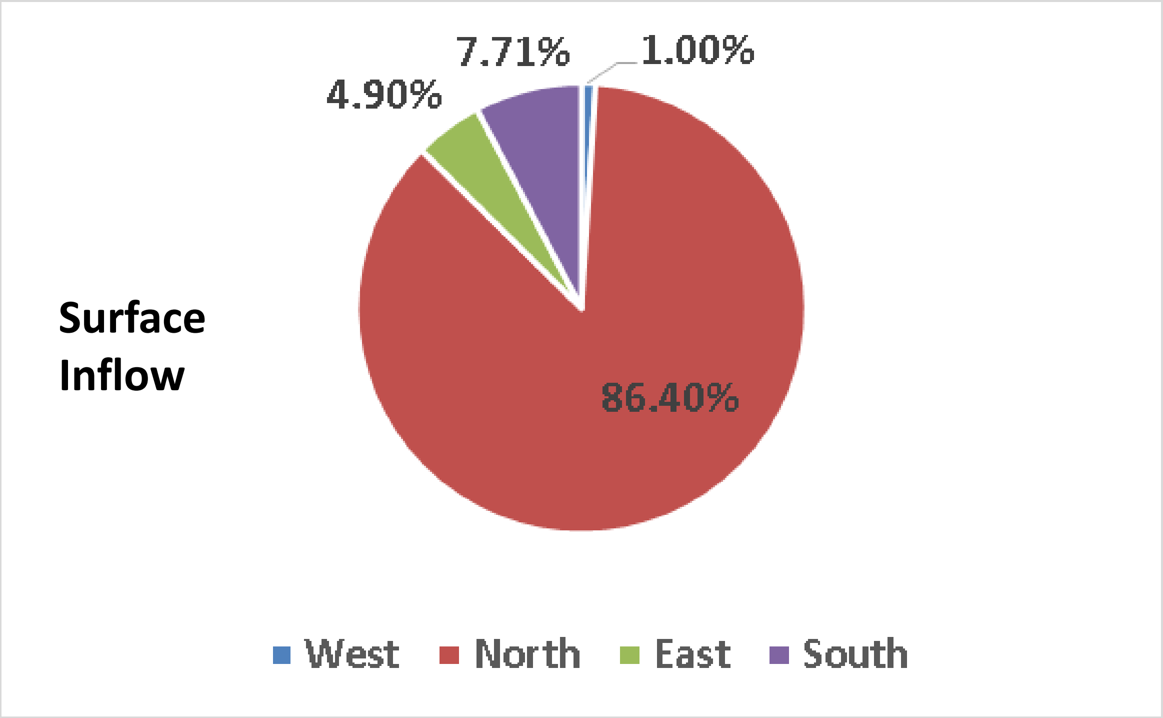
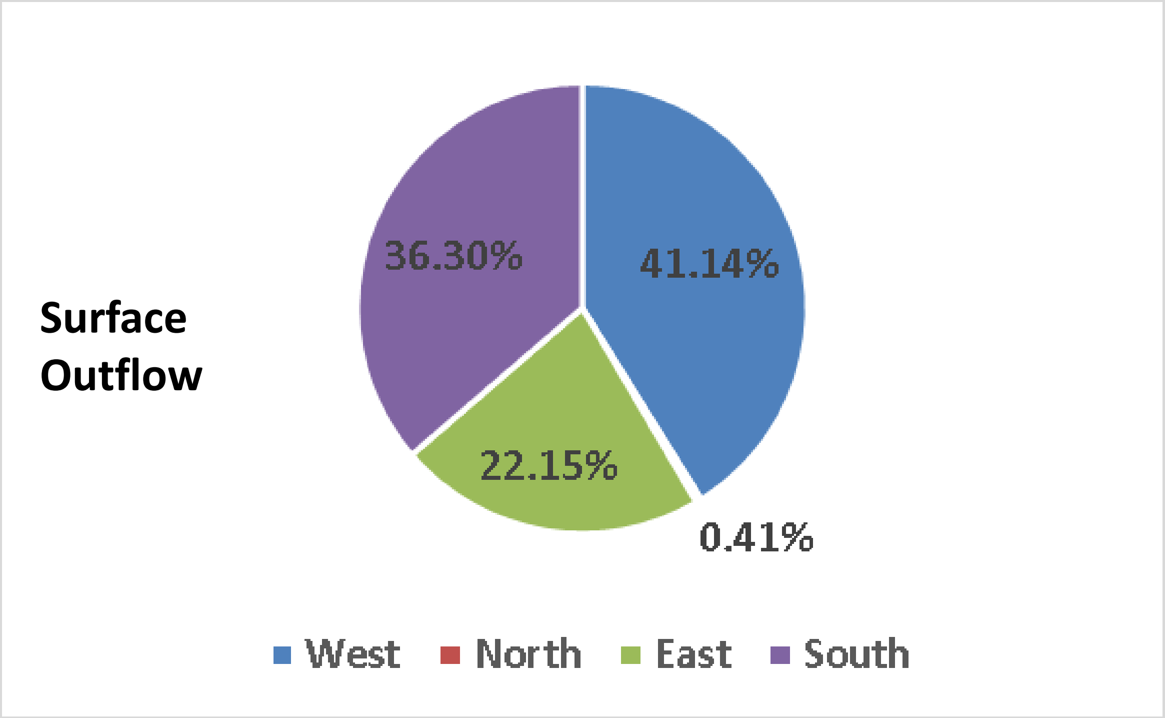
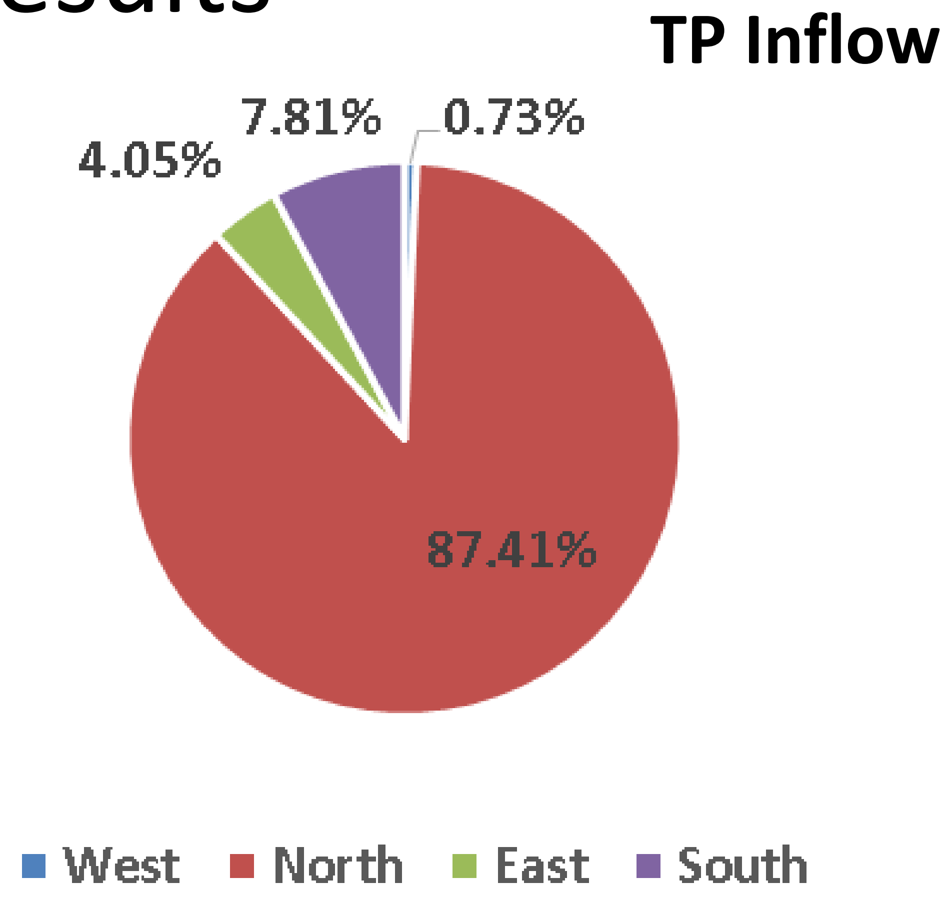
Results



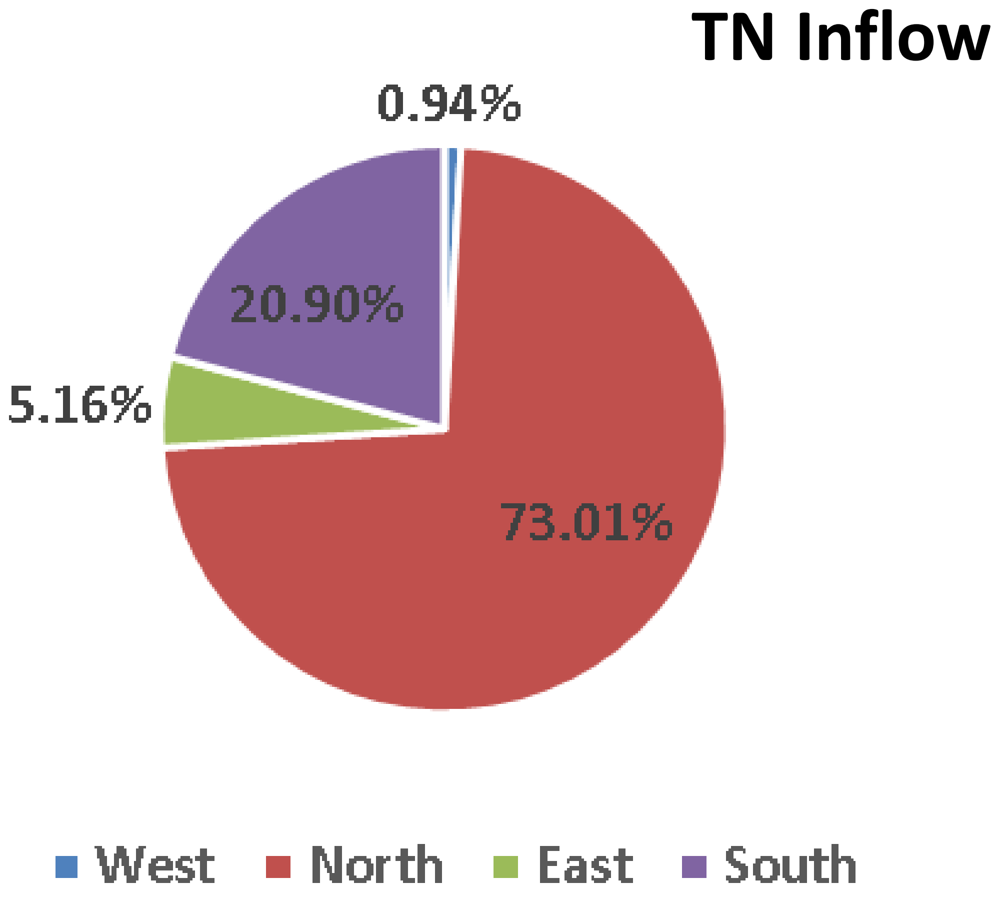


- The average inflow and outflow were 4,607 million and 4,202 million m^3 /yr, respectively.
- The surface inflow (2,671 million m^3 /yr) was substantially higher than the surface outflow (1,846 million m^3 /yr)
- About half of the water flowing into the lake was lost to *ET*.

Results



South 12% Pre 1986



South 37% Pre 1986

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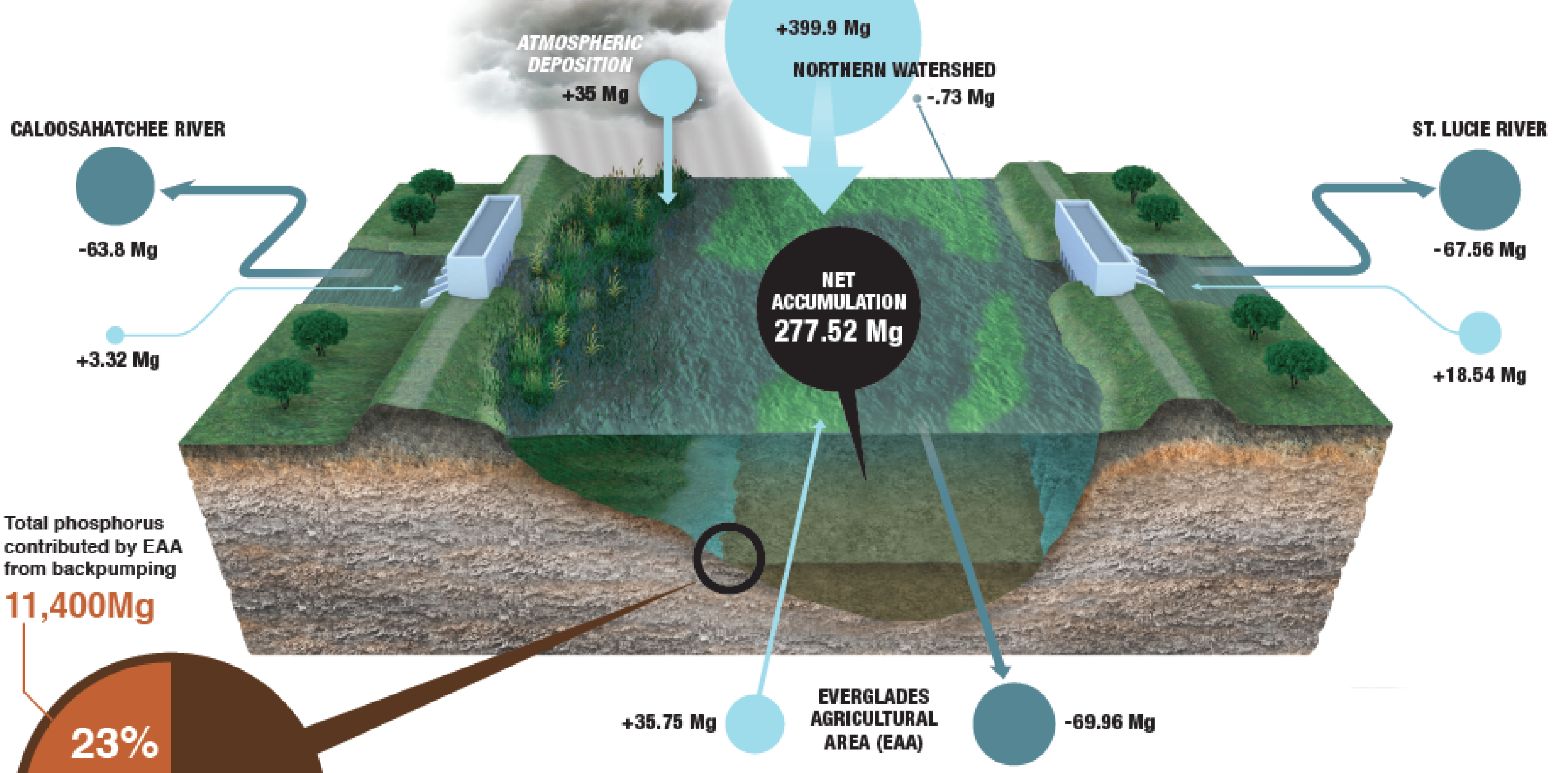
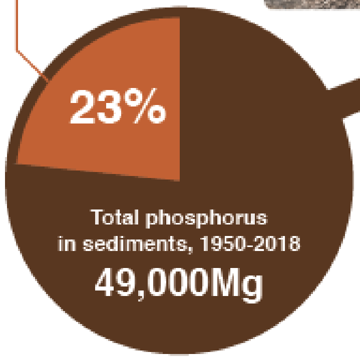
Phosphorus Budget

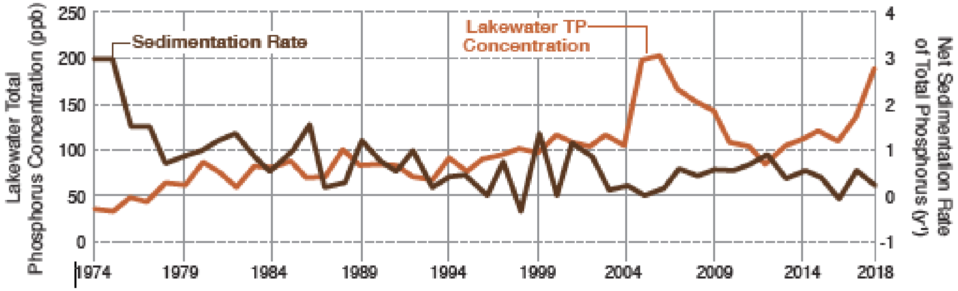
Mg = Megagram | 1 Megagram = 1 metric ton





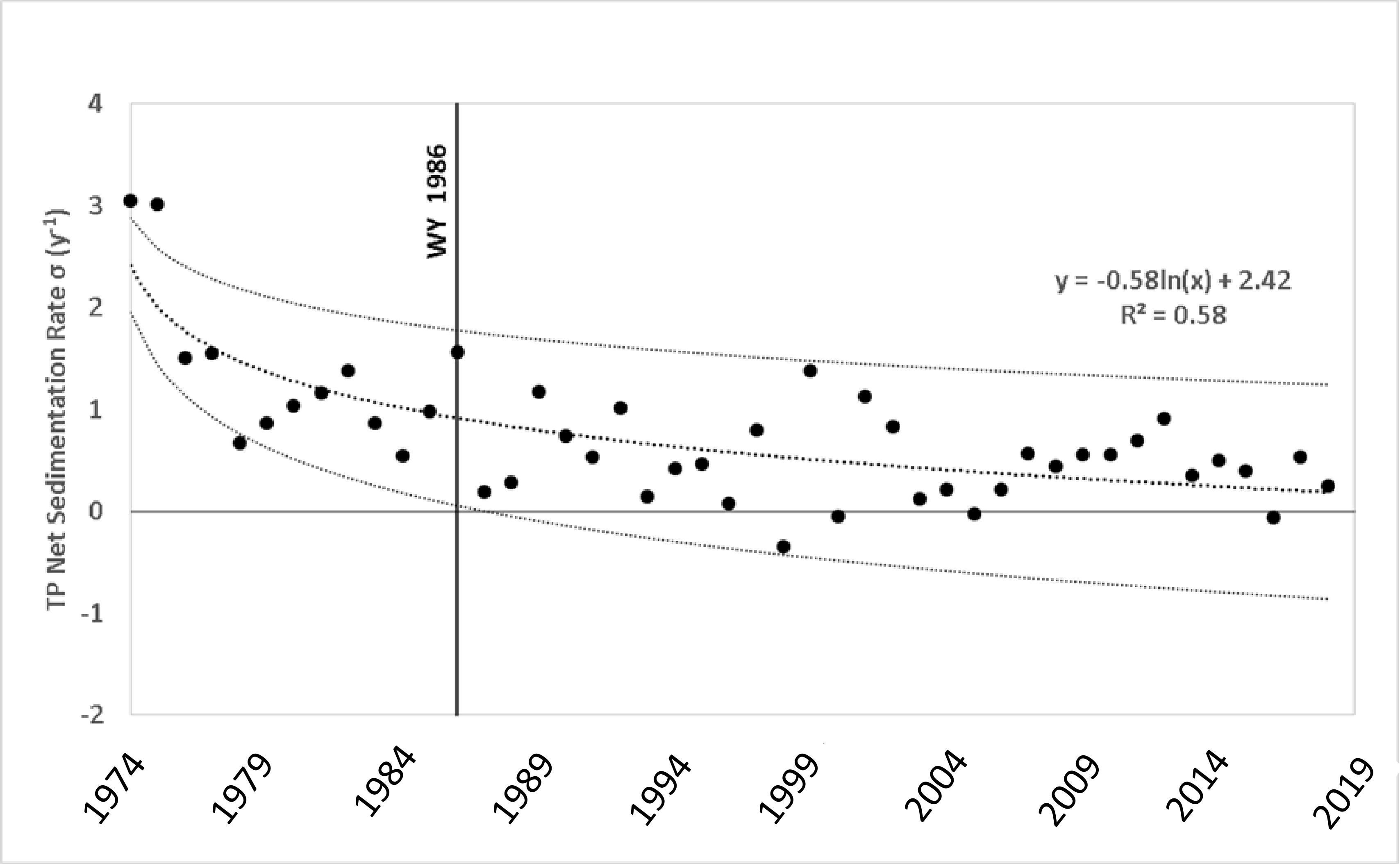
A DANGEROUS TREND

The net sedimentation rate has been significantly decreasing since 1970. When the curve reaches the zero x axis, then the sediments will start releasing phosphorus. This can happen as early as 2035.

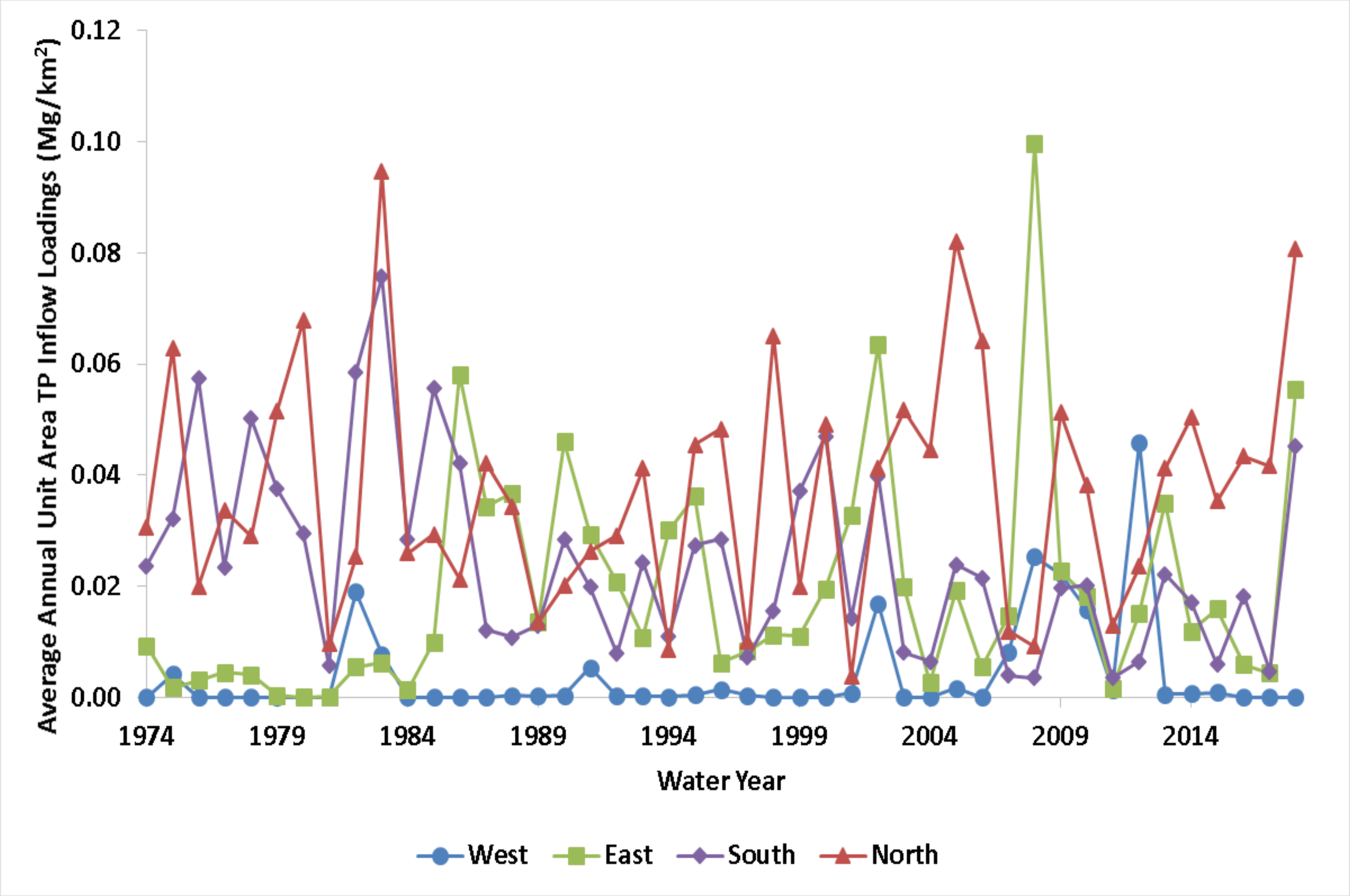


NOTE: Phosphorus numbers are based on a Lake Okeechobee mass balance conducted for 45 years from May 1, 1973 to April 30, 2018. Data were downloaded from DBHYDRO, South Florida Water Management District database.

Net Sedimentation Rate

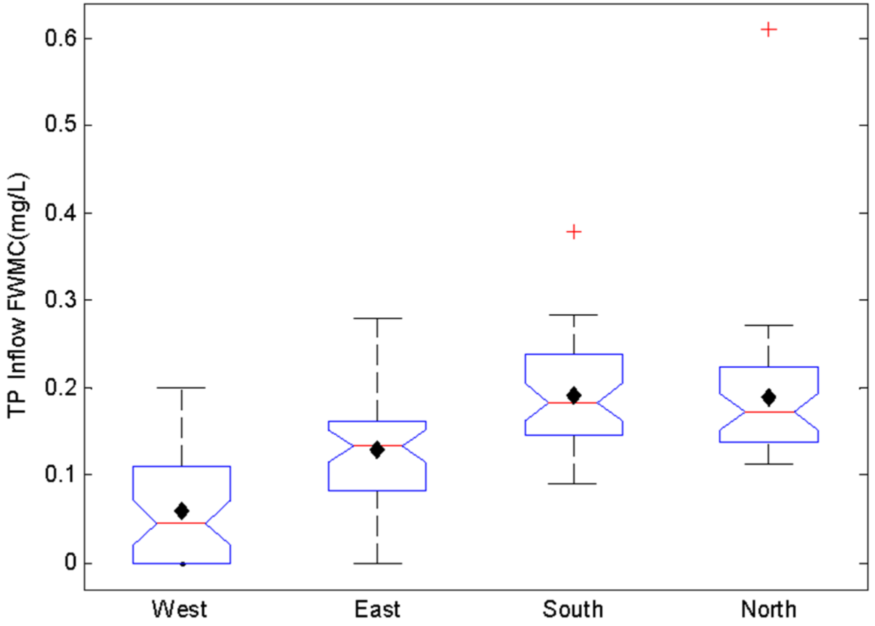


TP Trend Analysis

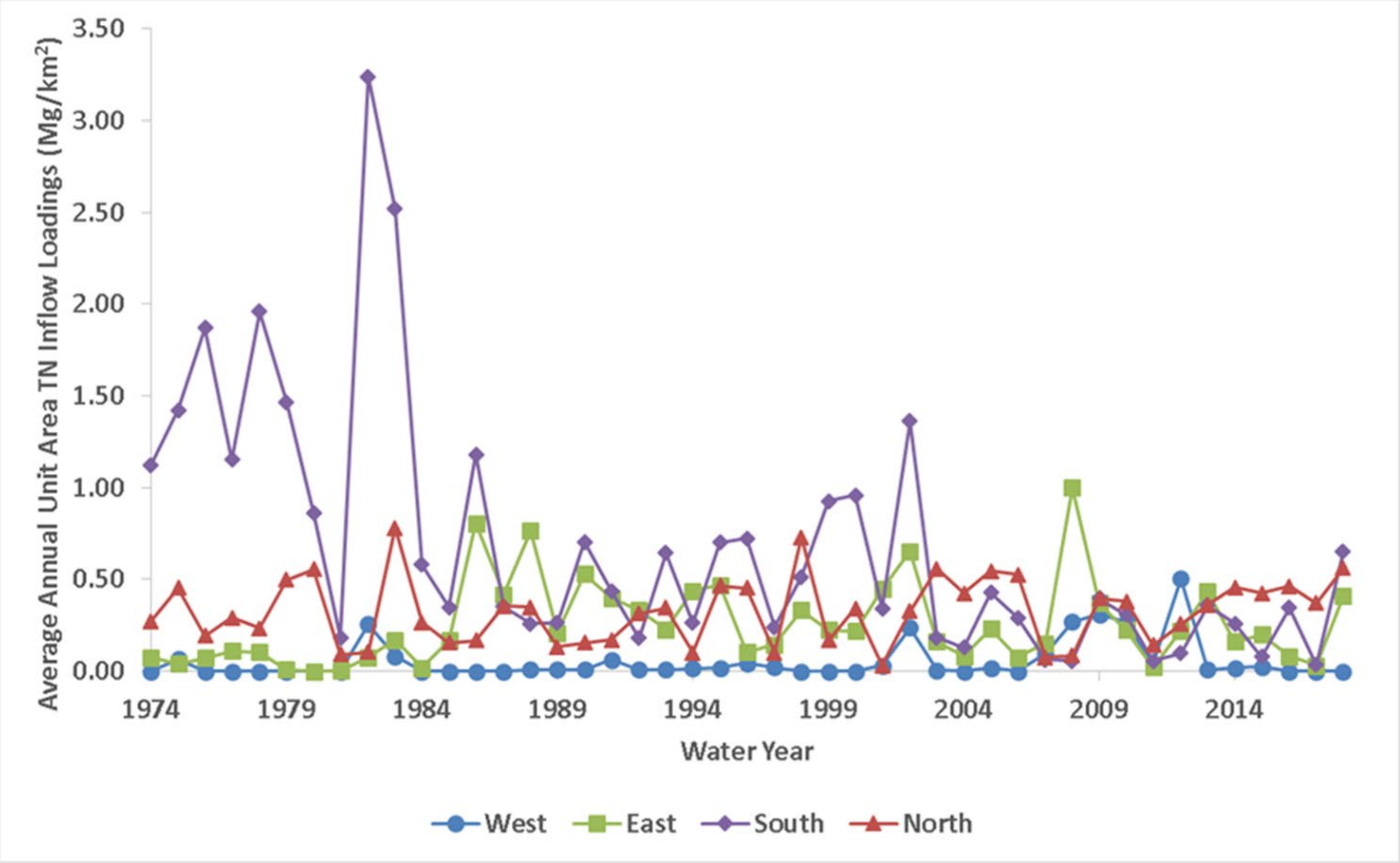


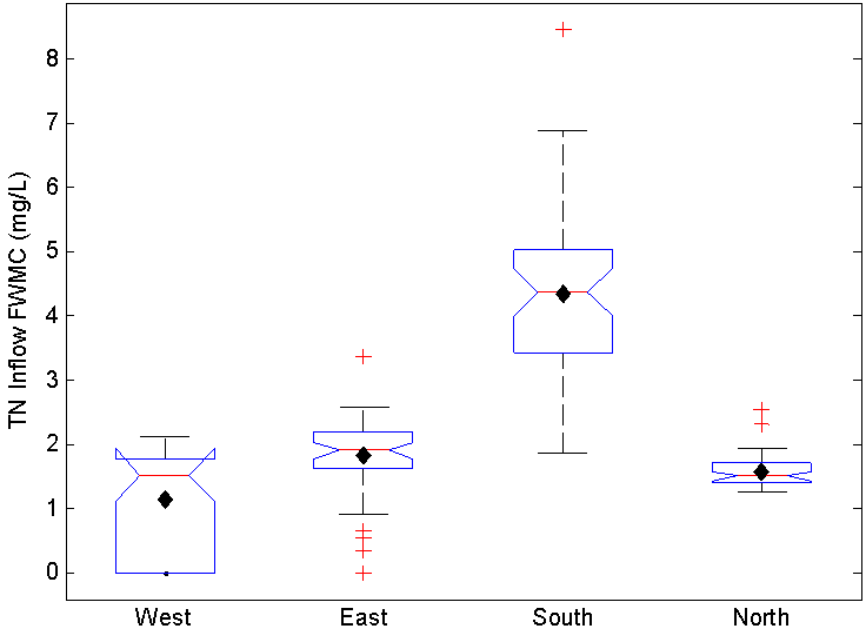
<u>Statistically Significant Increasing Trend :</u>

- TP Outflow Loadings (Dry >Wet Season)
- TP Outflow FWMC
- TP Inflow FWMC (South)



TN Trend Analysis





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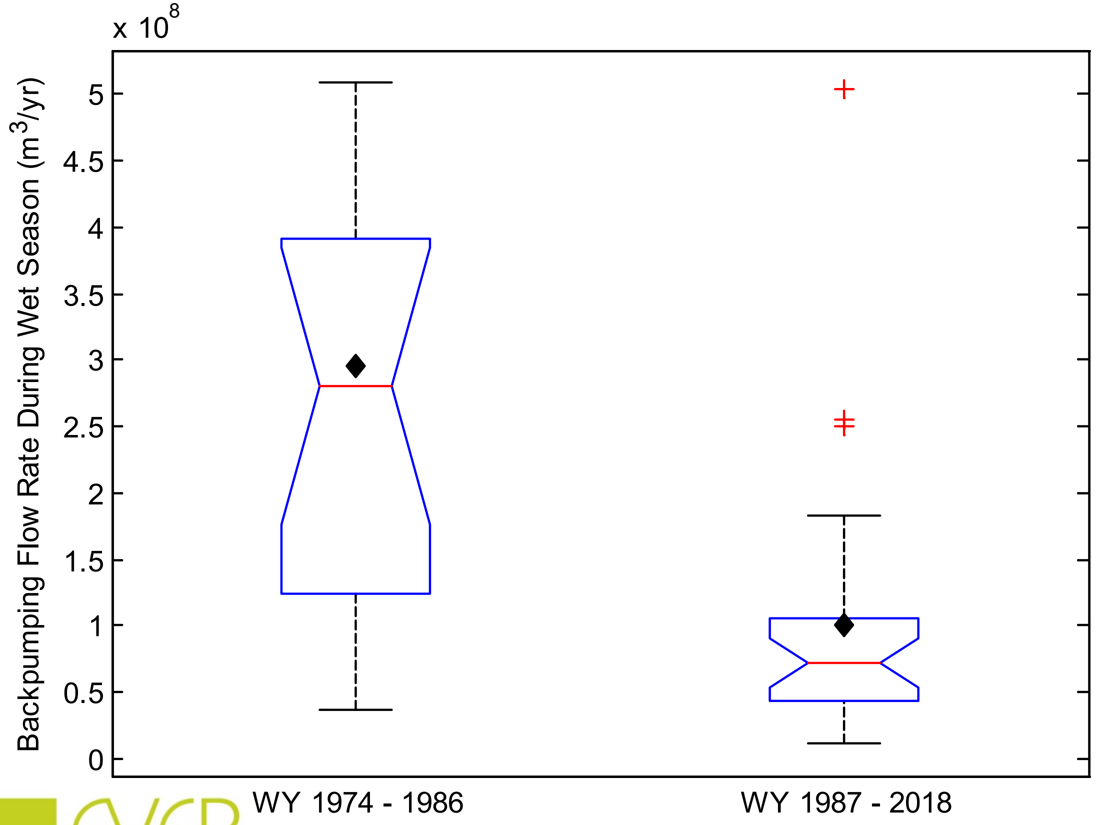
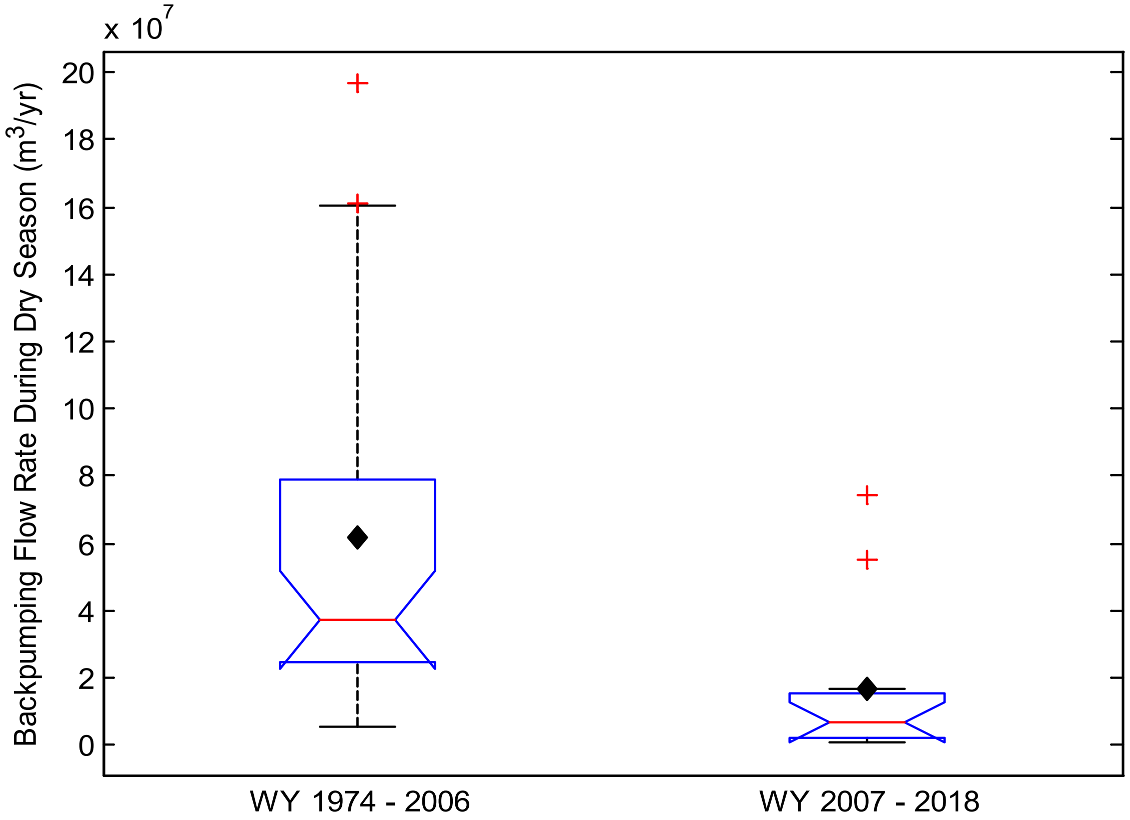
Back-pumping

- Average TP Conc. in back-pumping 0.19 mg/L
- Average In-Lake TP Conc. 0.10 mg/L
- Average TP Conc. of surface outflow southward 0.11 mg/L

- Average TN Conc. in back-pumping 4.35 mg/L
- Average In-Lake TN Conc. 1.54mg/L
- Average TN Conc. of surface outflow southward 1.76 mg/L





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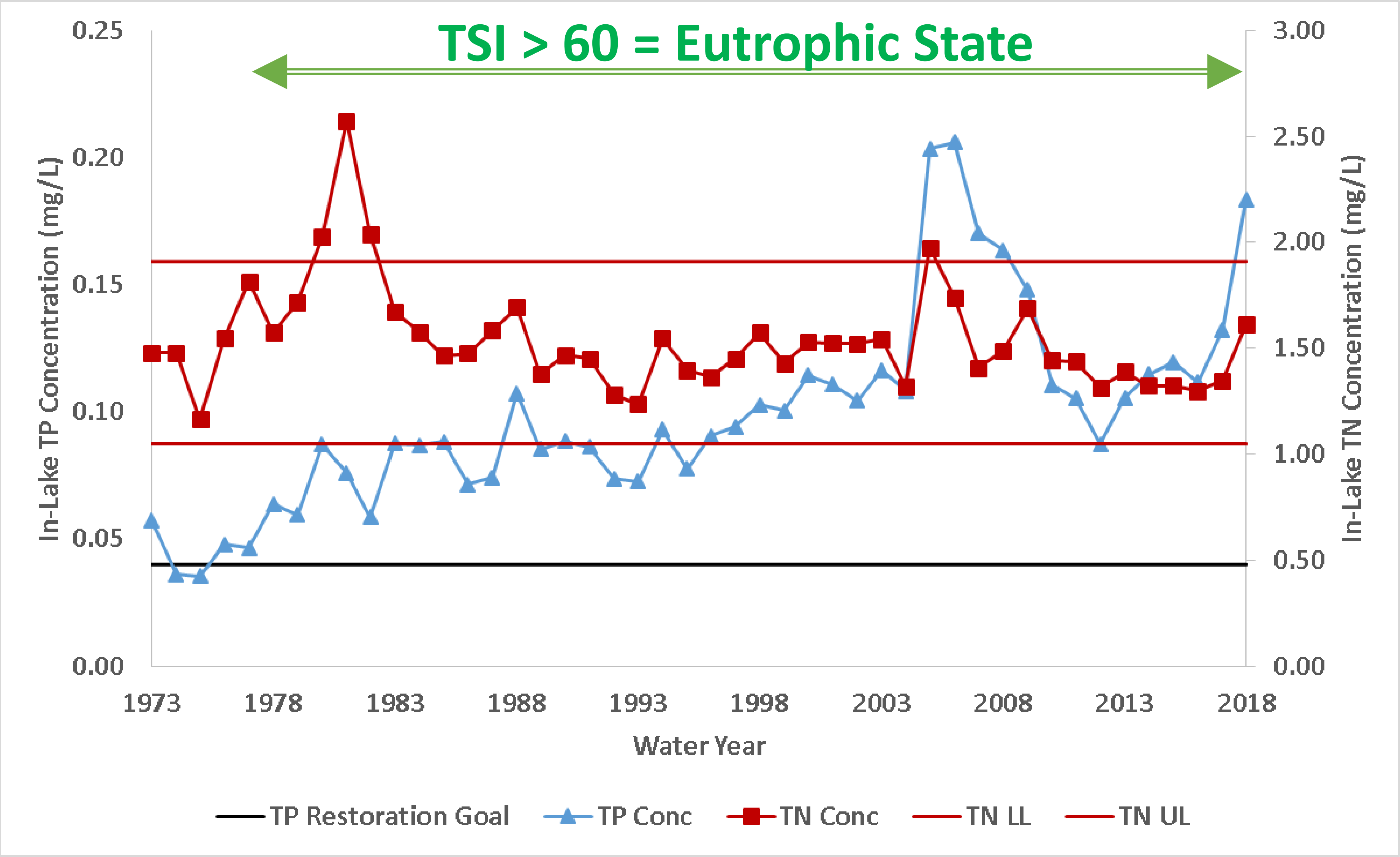
Lake Impairment & Classification



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