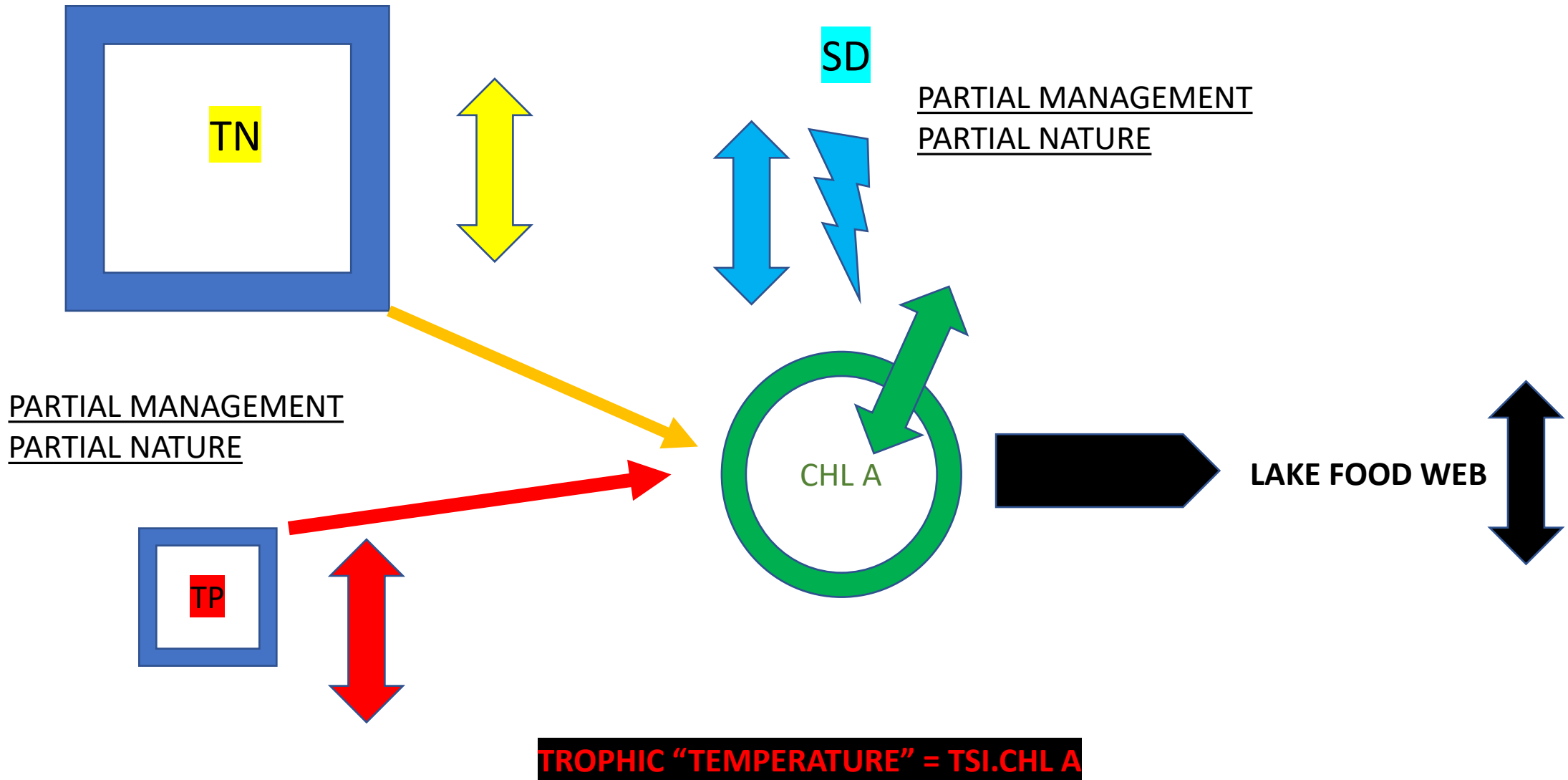


LAKE OKEECHOBEE: WHAT'S ITS TROPHIC "TEMPERATURE"
OR
IS THIS A RECIPE FOR BLUE-GREEN ALGAE SOUP?

Joseph L. Gilio, MS. PWS Emeritus,
President, Lake Okeechobee Restoration Initiative, Inc. [LORI]

LAKE OKEECHOBEE TROPHIC "TEMPERATURE" CONCEPT



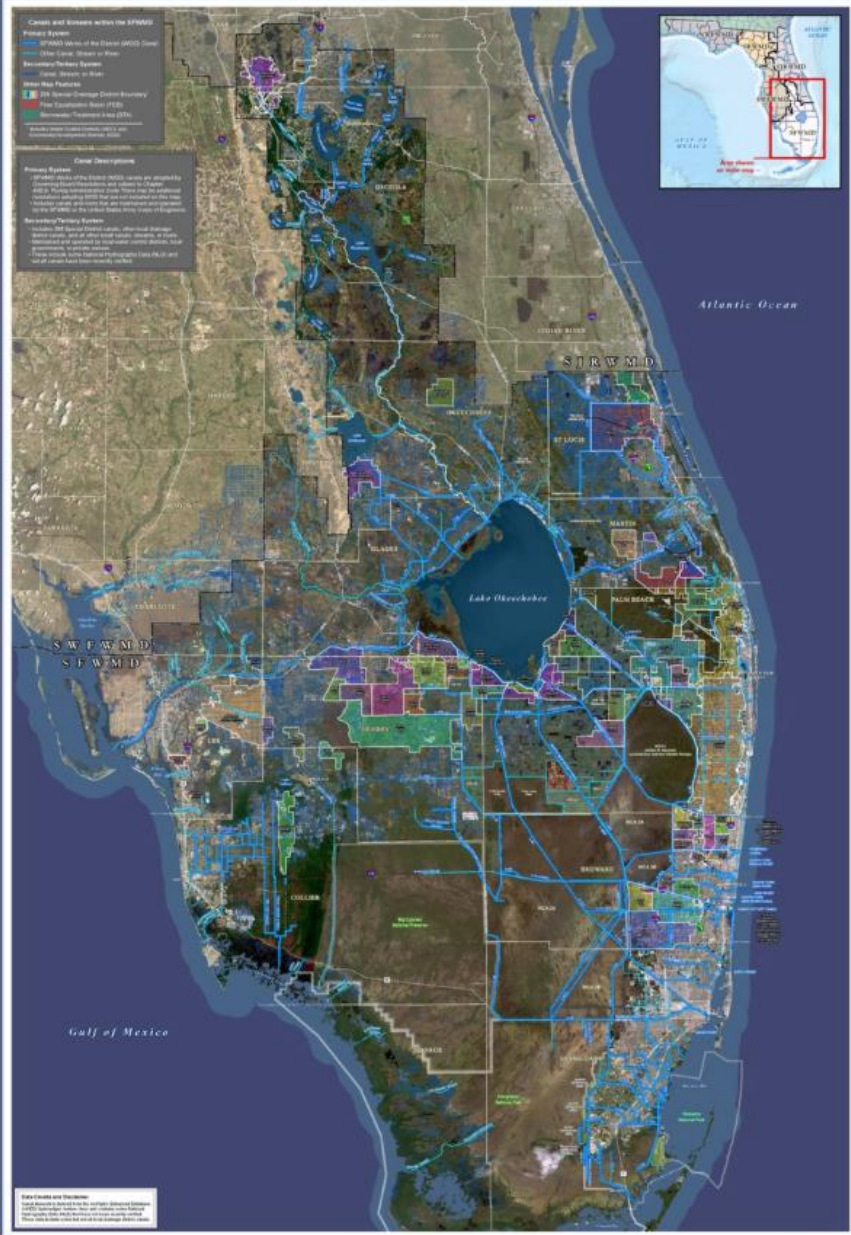
TSI scale of trophic metrics compared to classical chemical results

| Trophic | Carlson | Secchi disk | TP | Chla |
|-------------------------|---------|--------------|----------------------|----------------------|
| Descriptive | TSI | (m) | (mg/m ³) | (mg/m ³) |
| Ultra-hypo-oligotrophic | 0 - 9 | 64 - 32 | 0.75 - 1.5 | 0.04 - 0.12 |
| Hypo-oligotrophic | 10-19 | 32 - 16 | 1.5 - 3 | 0.12 - 0.34 |
| Oligotrophic | 20-29 | 16 - 8 | 3 - 6 | 0.34 - 0.94 |
| Oligo-mesotrophic | 30-39 | 8 - 4 | 6 - 12 | 0.94 - 2.6 |
| Mesotrophic | 40- 49 | 4 - 2 | 12 - 24 | 2.6 - 6.4 |
| Meso-eutrophic | 50 - 59 | 2 - 1 | 24 - 48 | 6.4 - 20 |
| Eutrophic | 60 - 69 | 1 - 0.5 | 48 - 96 | 20 - 56 |
| Eu-hypereutrophic | 70 - 79 | 0.5 - 0.25 | 96 - 192 | 56 - 154 |
| Hypereutrophic | 80 - 89 | 0.25- 0.12 | 192 - 384 | 154 - 427 |
| Ultra-hypereutrohic | 90 - 99 | 0.12 - 0.062 | 384 - 768 | 427 - 1183 |

DATA: PRECISION
AND
ACCURACY

- Table 2. DBHYDRO's manual [2020]. MDL is method detection limit at 99% confidence level. PQL is lowest analyte concentration determined within a given water sample matrix or if no matrix sample, then 4XMDL. Reportable Detection Limit is the lowest analyte value lab has confidence reporting.

| Chemical Species | MDL | PQL | RDL | |
|-------------------------|---------------------|---------------------|---------------------|--|
| Total phosphorus | 0.002 mg/l | 0.008 mg/l | 0.002 mg/l | |
| Total Kjeldhal Nitrogen | 0.05 mg/l | 0.2 mg/l | 0.05 mg/l | |
| Nitrate + Nitrite | 0.005 mg/l | 0.002 mg/l | 0.005 mg/l | |
| Chlorophyll a corrected | 1 mg/m ³ | 4 mg/m ³ | 1 mg/m ³ | |
| | | | | |



Monthly Water Quality Stations

- Legend**
- Chlorophyll *a*
 - Chl *a* and Microcystin
 - Pelagic Sites

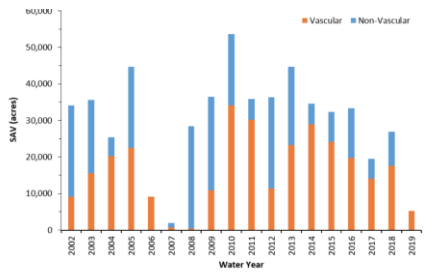
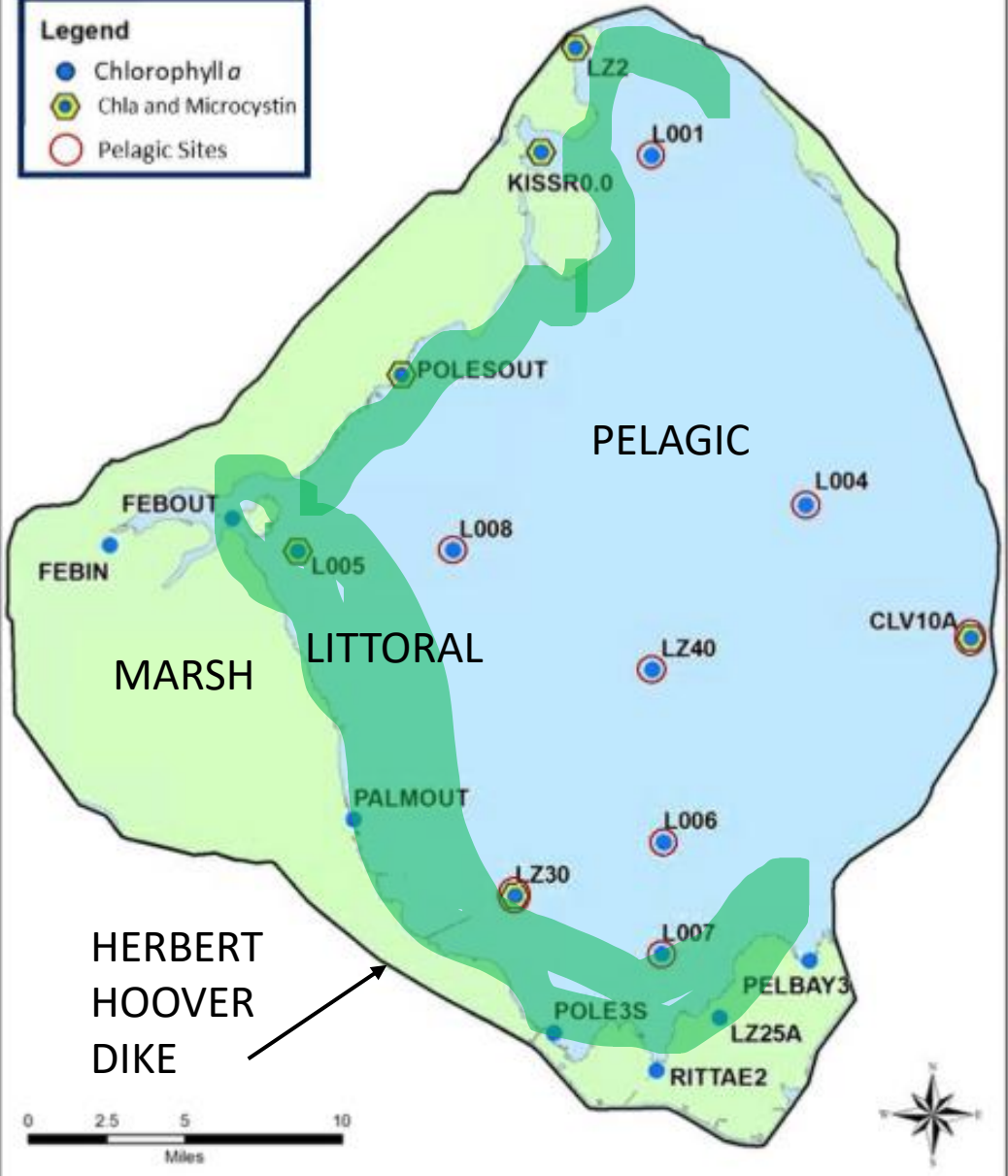
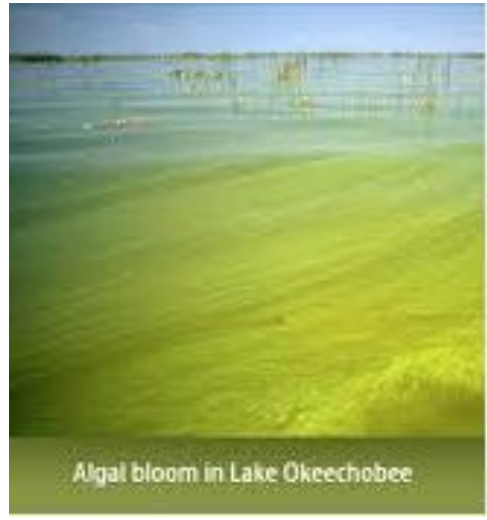


Figure 8B-26. Estimated coverage of vascular and non-vascular (macroalgae) SAV on Lake Okeechobee for WY2002-WY2019.



Carlson's 1977 LN transformative equations of Classical Independent [TP, TN, SD] and dependent variables to Trophic State Indexes are:

1. EQUATIONS

$$\text{TSI.SD} = 60 - 14.4 \cdot \text{LN}(\text{SD}). \text{ Range [0 -100]}$$

$$\text{TSI.TP} = 14.42 \cdot \text{LN}(\text{TP}) + 4.15. \text{ Range [0 -100]}$$

$$\text{TSI.TN} = 54.45 + 14.45 \cdot \text{LN}(\text{TN}) \text{ Range [0 -100]}$$

$$\text{TSI.CHLa} = 9.81 \cdot \text{LN}(\text{Chl}) + 30.6. \text{ Range [0 -100]}$$

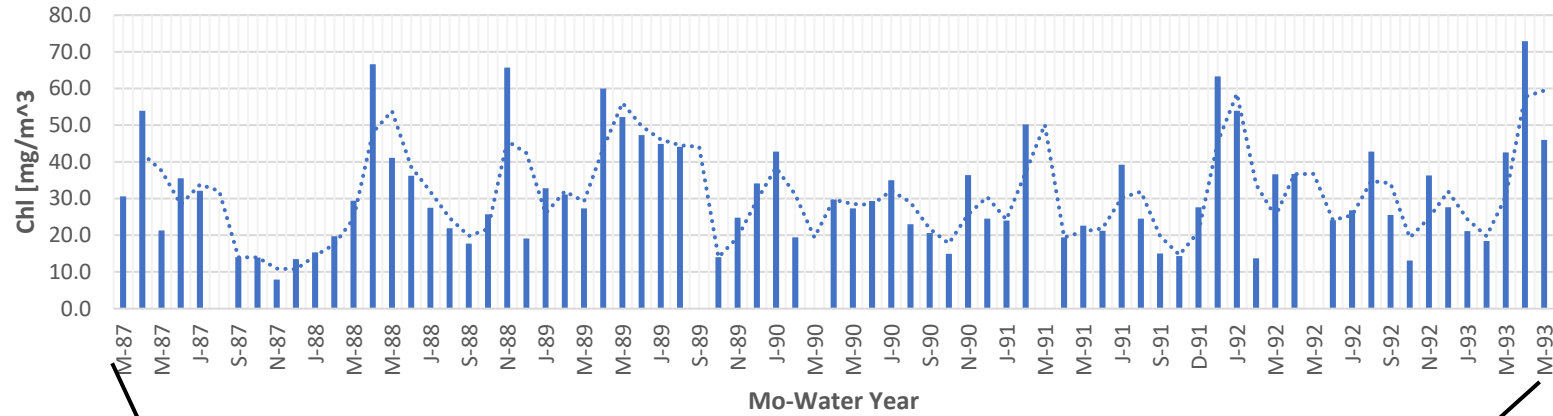
TSI's are equally comparable to the same scale.

2 A LAKE'S TROPHIC "TEMPERATURE":

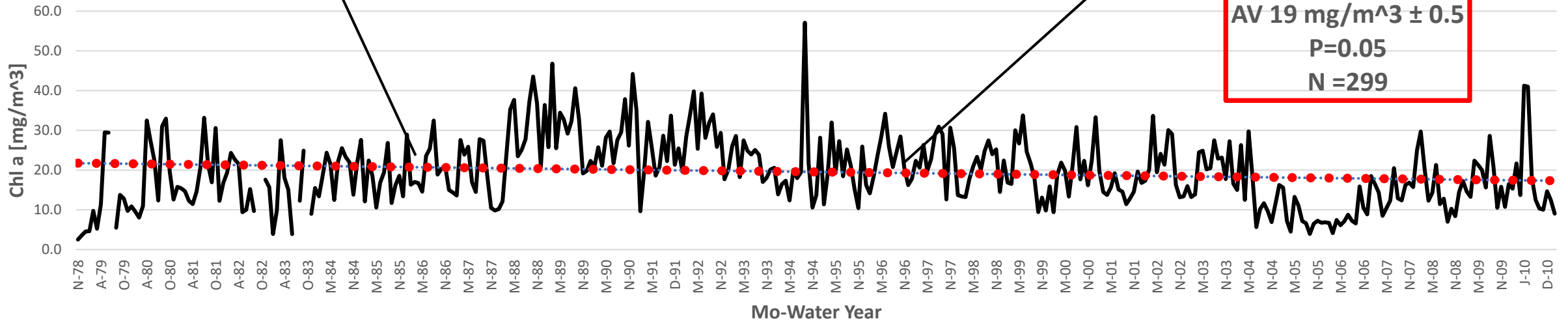
$$\text{"TEMPERATURE"} = \text{TSI.CHL}$$

3. $\text{TSI}_i / \sum \text{TSI}_j = \% \text{ contribution of each } \text{TSI}_i \text{ to contributing factors.}$

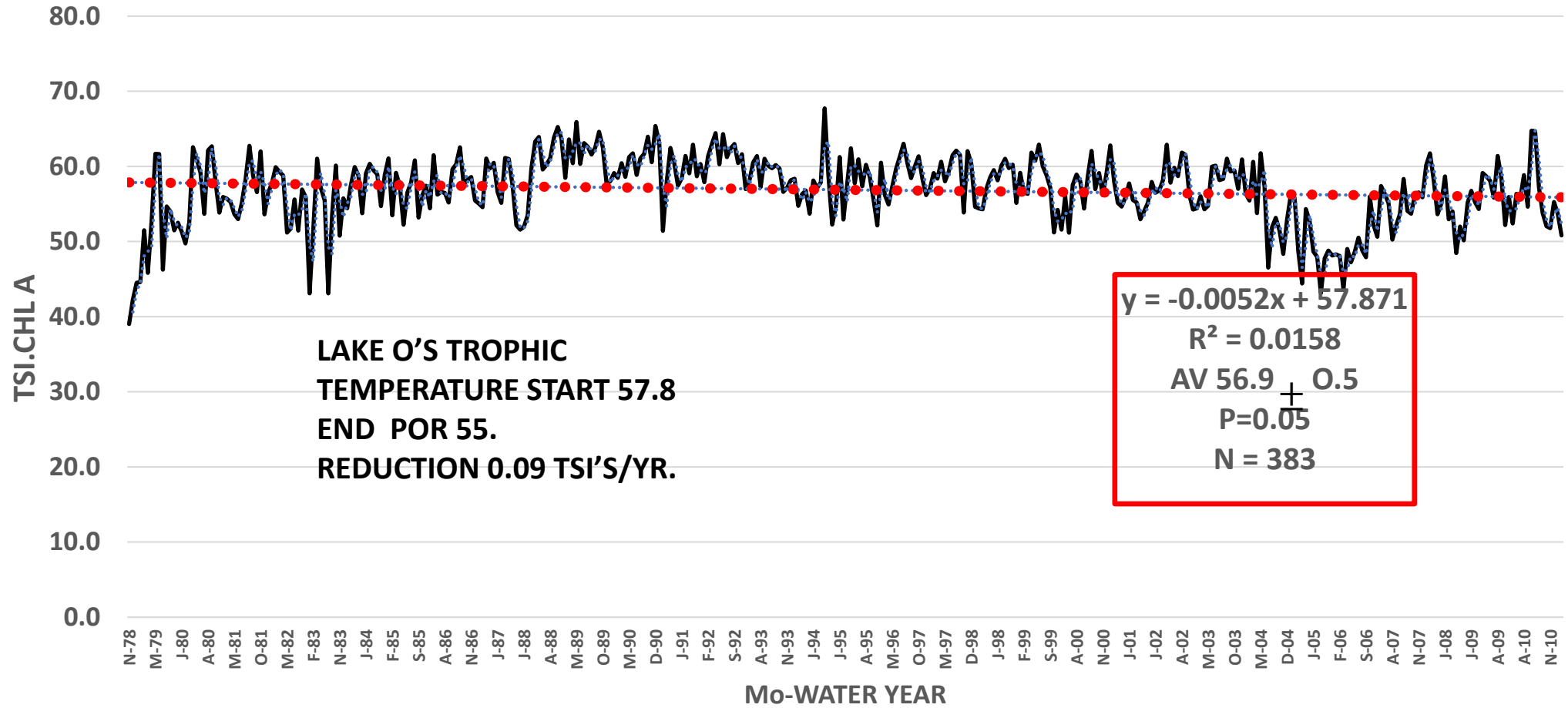
Lake Okeechobee Chlorophyll a L001
Seasonality [1987-1993]



Lake Okeechobee Pelagic Zone
Chlorophyll a mg/m³ [1978-2013]



LAKE OKEECHOBEE'S TROPHIC "TEMPERATURE"
TSI. CHLOROPHYLL A [1978-2010]



LAKE OKEECHOBEE'S TROPHIC "TEMPERATURE" HAS REDUCED OVER RECENT 32 YRS.

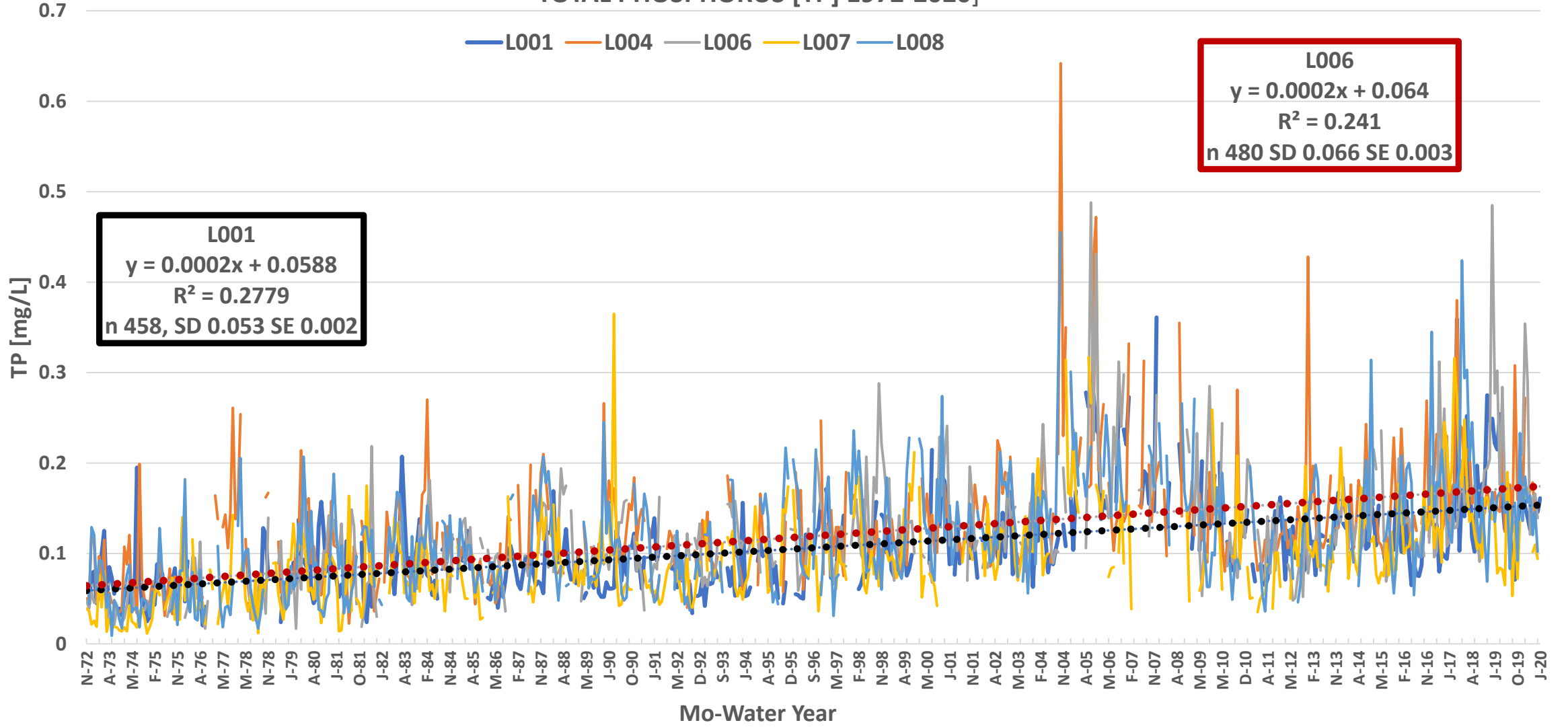
HUTCHINSON: MOST LAKES ARE BORNE TO DIE BY FILL-IN.

BUT DO MOST LAKES INCREASE OR DECREASE TN AND TP IN SENESENCE?

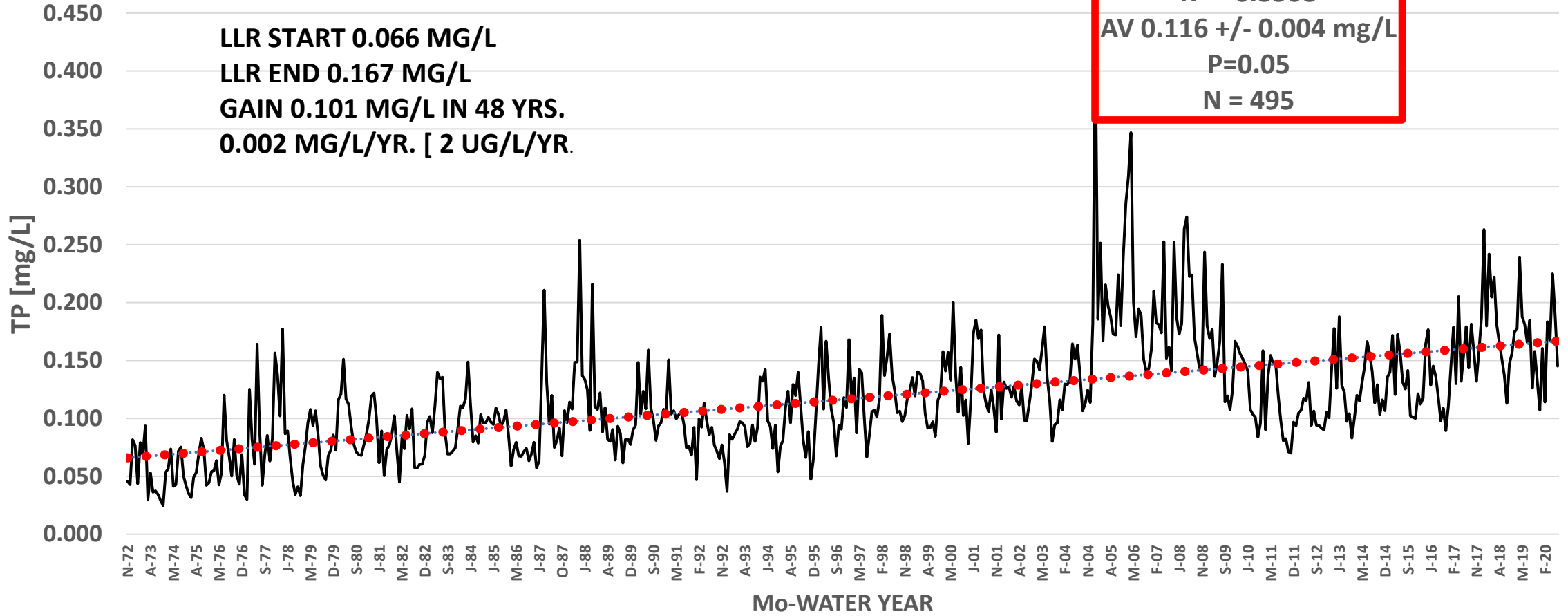
LAKE OKEECHOBEE'S LAST HALF CENTURY OF TN, TP & SD RECORD

FOLLOWS:

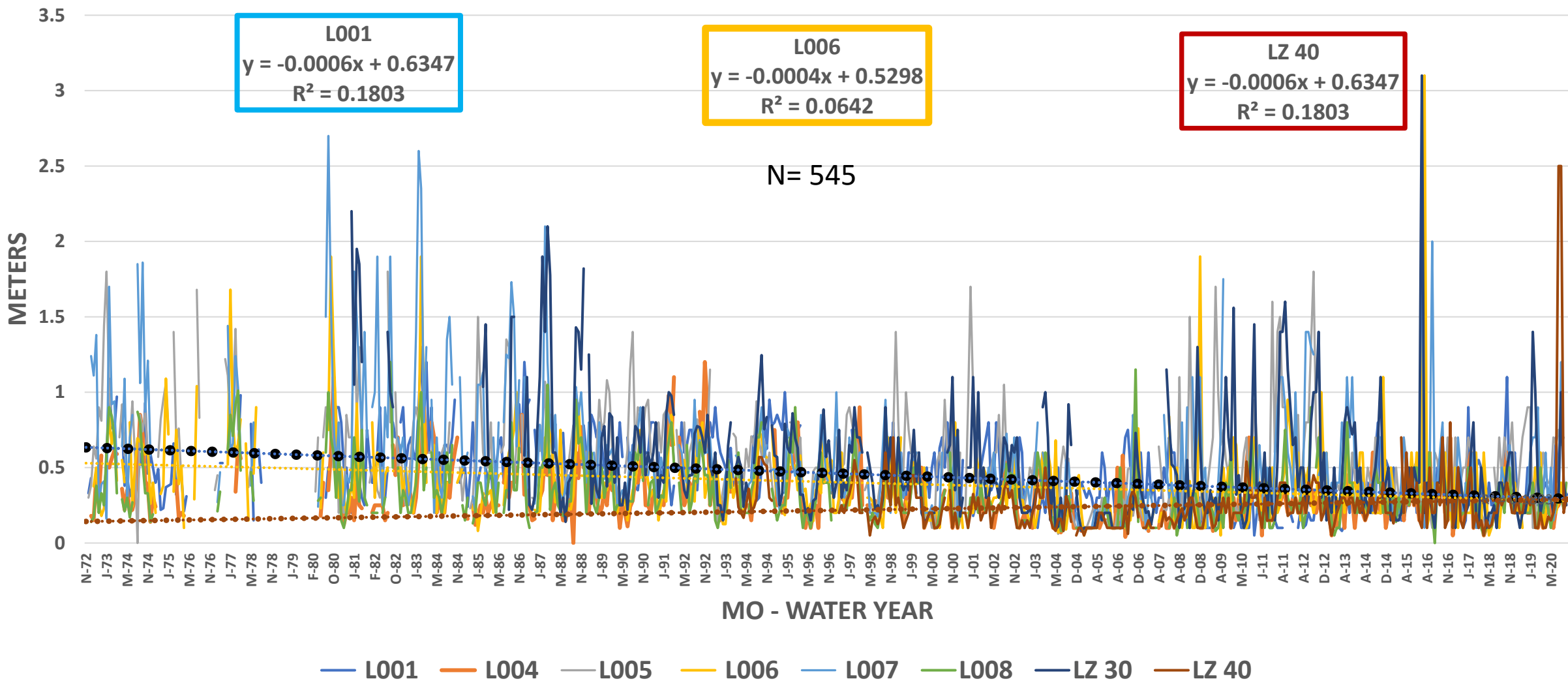
LAKE OKEECHOBEE PELAGIC ZONE STATIONS TOTAL PHOSPHORUS [TP] 1972-2020



LAKE OKEECHOBEE LONG-TERM PELAGIC AVERAGE
TOTAL PHOSPHATE 1972-2020
STA. L001, L004, L006, L007, L008



LAKE OKEECHOBEE SECCHI DISK DEPTHS [M] PELAGIC STATIONS [1972-2020]



**LAKE OKEECHOBEE MO. AVERAGE SECCHI DEPTHS
PELAGIC STATIONS [1972-2020]**

AV 0.44 ± 0.02 m

P= 0.05

N 554

St. Dev. 0.2 m

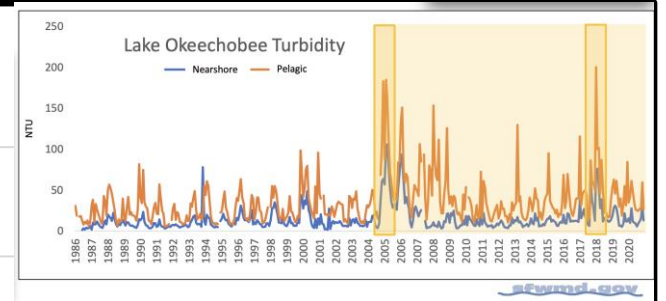
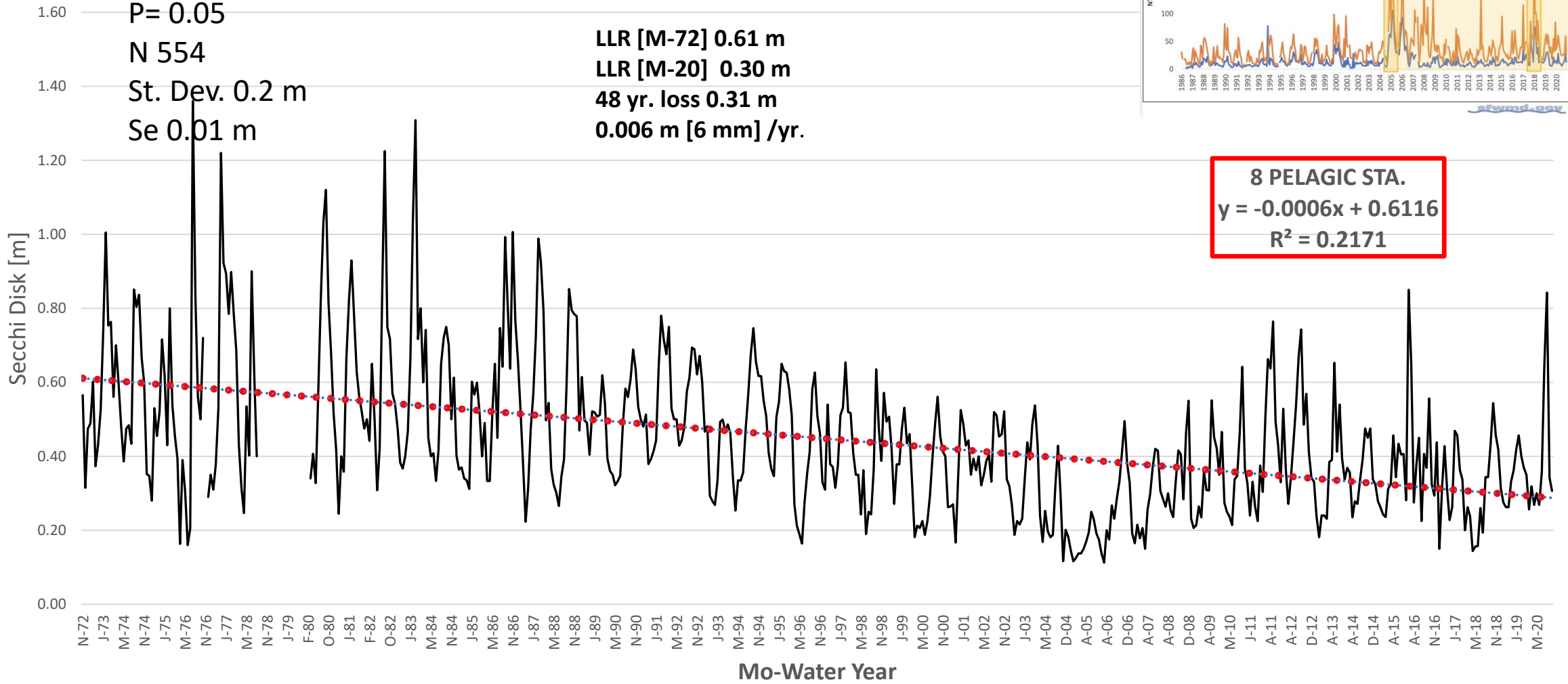
Se 0.01 m

LLR [M-72] 0.61 m

LLR [M-20] 0.30 m

48 yr. loss 0.31 m

0.006 m [6 mm] /yr.



LAKE OKEECHOBEE PELAGIC TOTAL NITROGEN [MG/L]

AVERAGE 8 LONG TERM STATIONS [1972-2020]

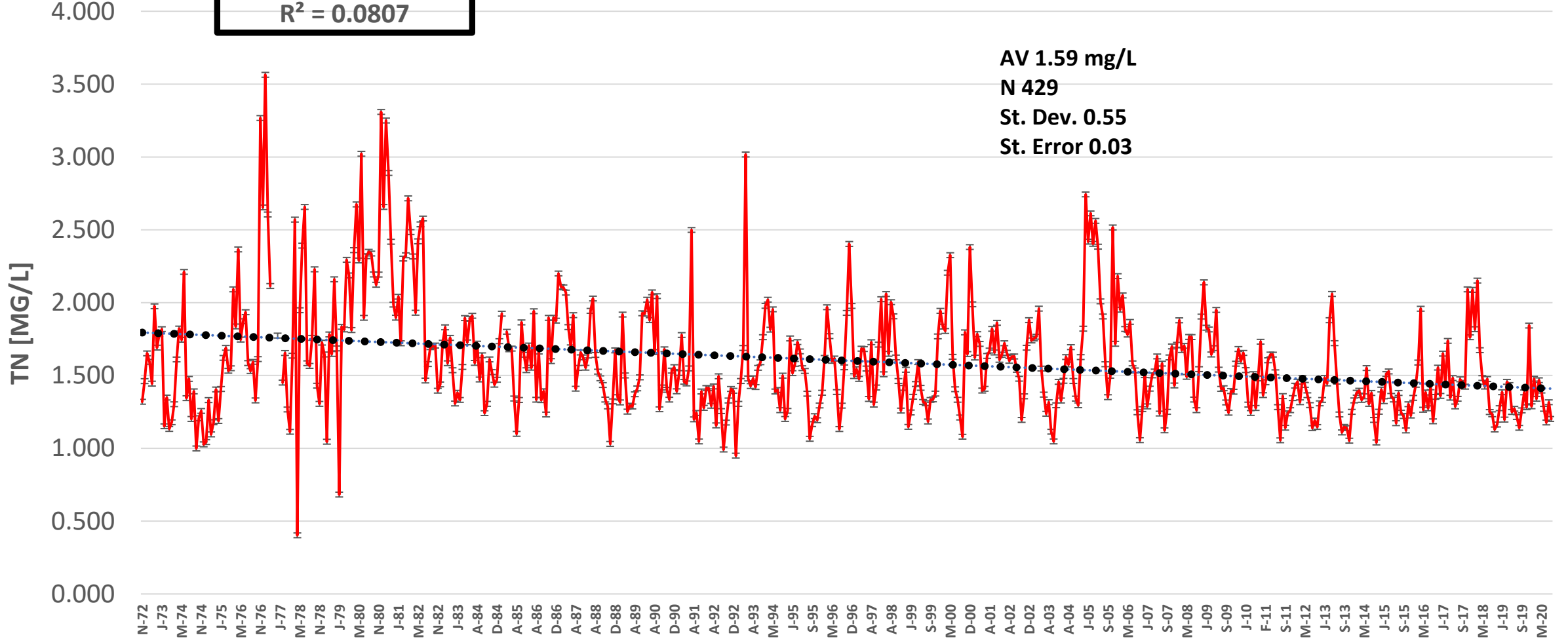
$y = -0.0007x + 1.7954$
 $R^2 = 0.0807$

AV 1.59 mg/L

N 429

St. Dev. 0.55

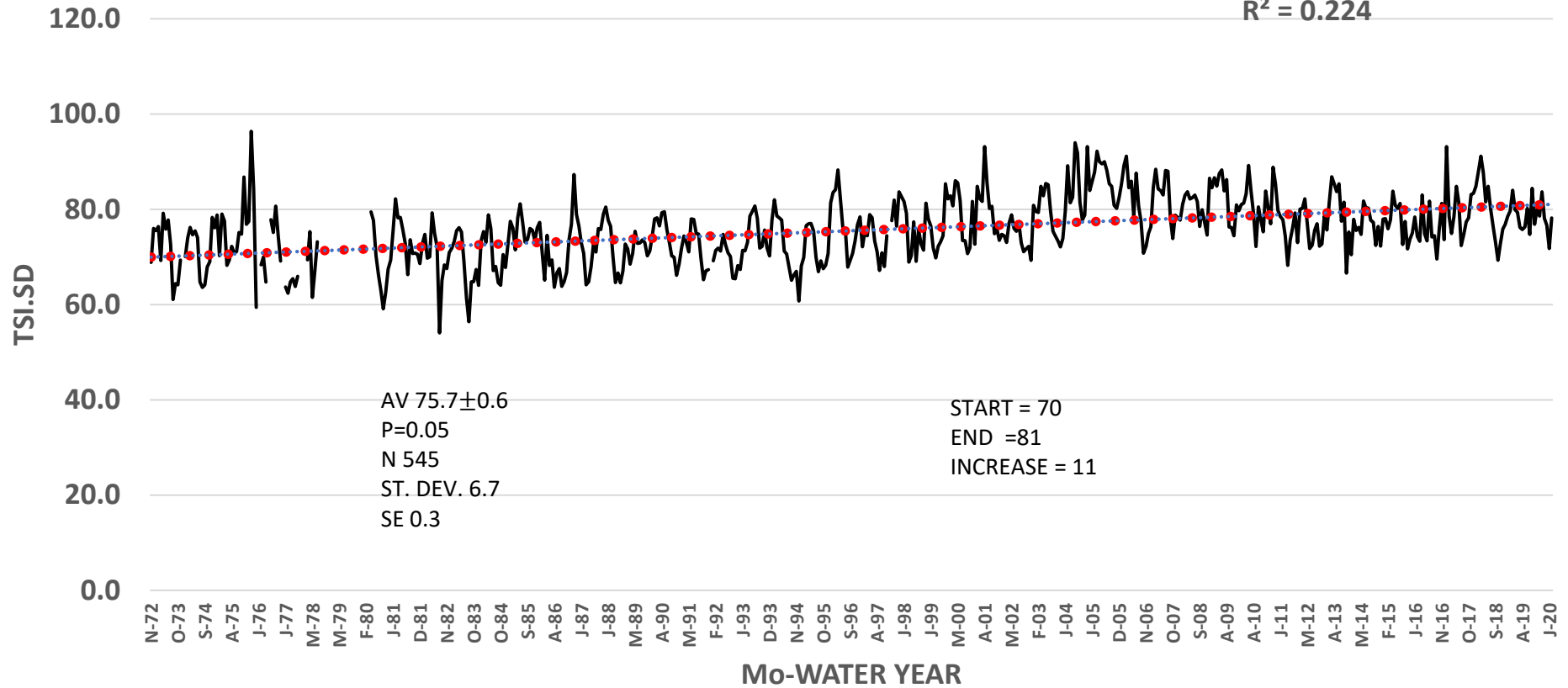
St. Error 0.03



Mo-WATER YEAR

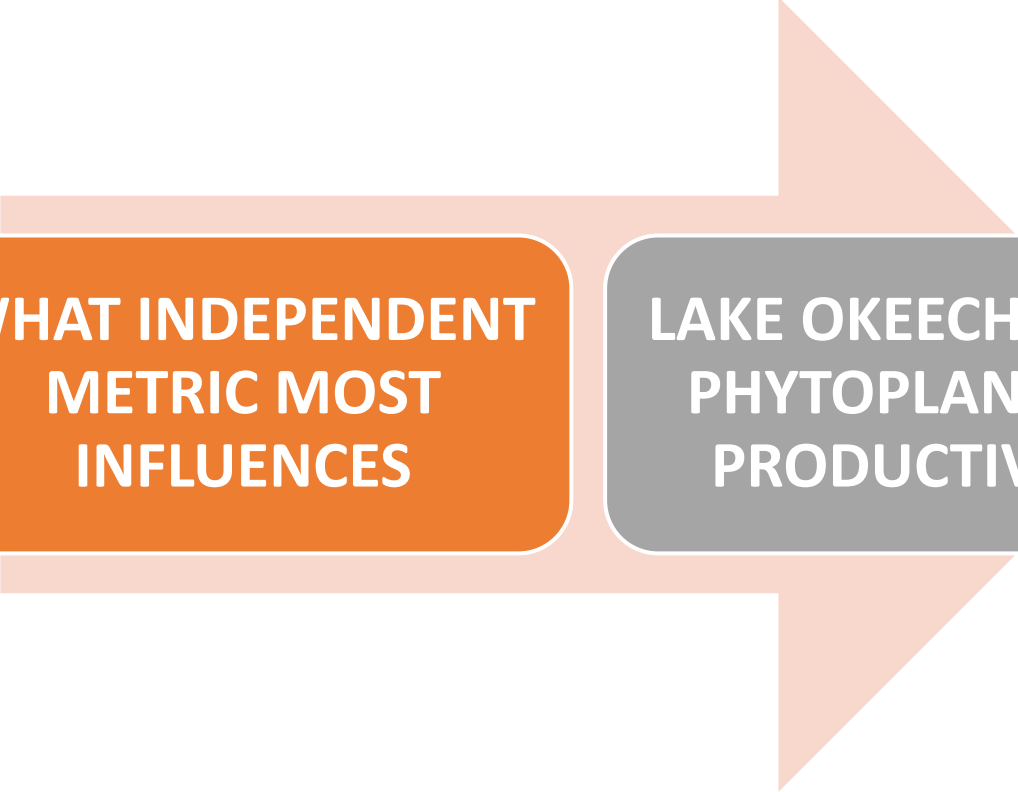
LAKE OKEECHOBEE PELAGIC TSI.SD
LONG-TERM AVERAGE 1972-2020

$y = 0.0194x + 69.929$
 $R^2 = 0.224$



LAKE OKEECHOBEE'S WATER QUALITY HISTORY 1972-2020

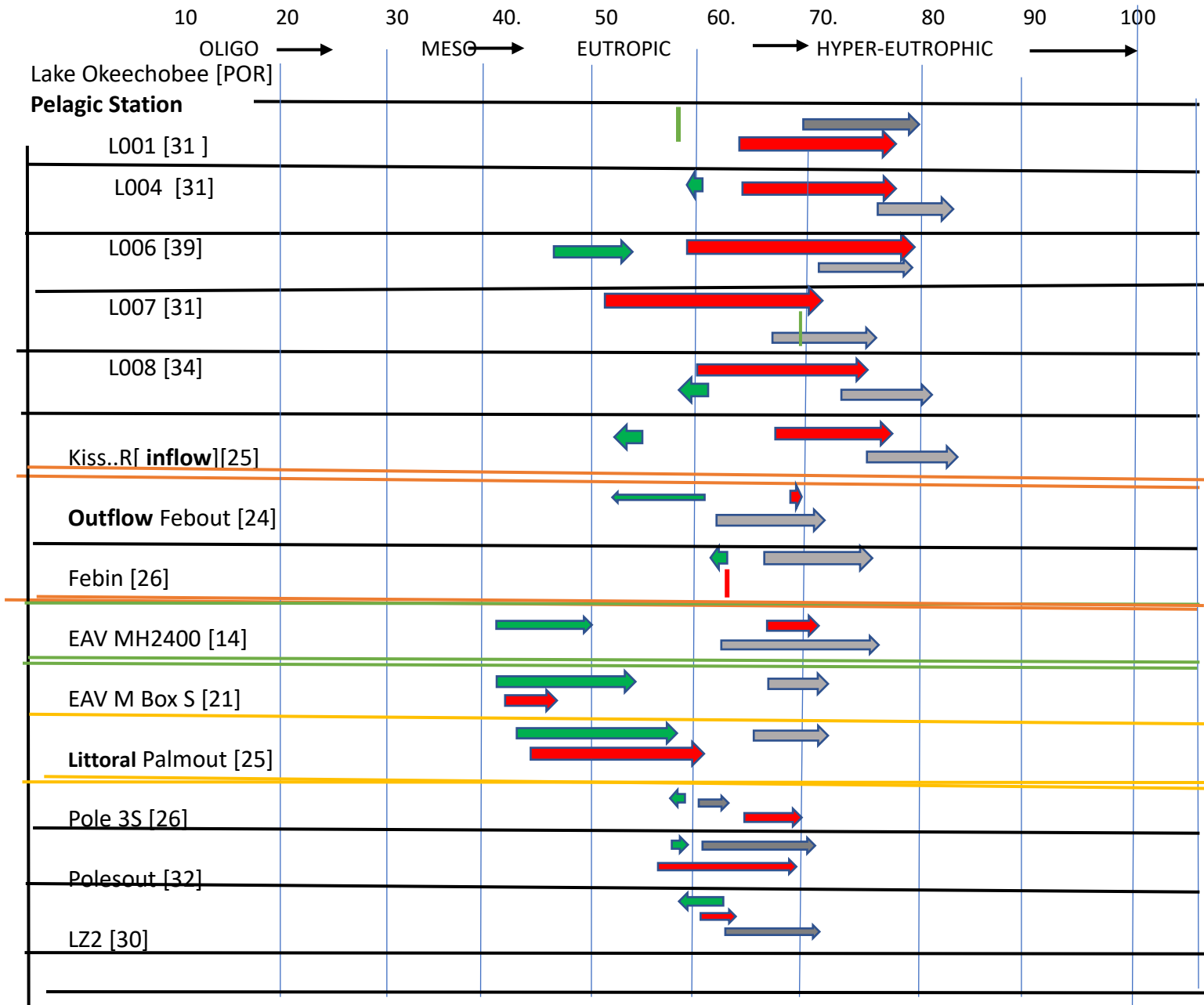
| METRIC | DESCRIPTION | START | END | TSI DIRECTION | % change |
|---------|-----------------------|-------|-----|---------------|----------|
| TSI.CHL | TROPHIC "TEMPERATURE" | 58 | 55 | DECREASE | 5 |
| TSI. TP | TOTAL PHOSPHORUS | 53 | 80 | INCREASE | 50 |
| TSI. TN | TOTAL NITROGEN | 62 | 59 | DECREASE | 5 |
| TSI.SD | SECCHI DISK DEPTH | 70 | 80 | INCREASE | 14 |



**WHAT INDEPENDENT
METRIC MOST
INFLUENCES**

**LAKE OKEECHOBEE'S
PHYTOPLANKTON
PRODUCTIVITY?**

START/ END/ TSI VECTORS of Trophic State Index for Lake Okeechobee 1972-2020



TSI.TP increased all lake zones
Pelagic CHL decrease 4 of 5

TSI.SD Increased in all zones, all stations.

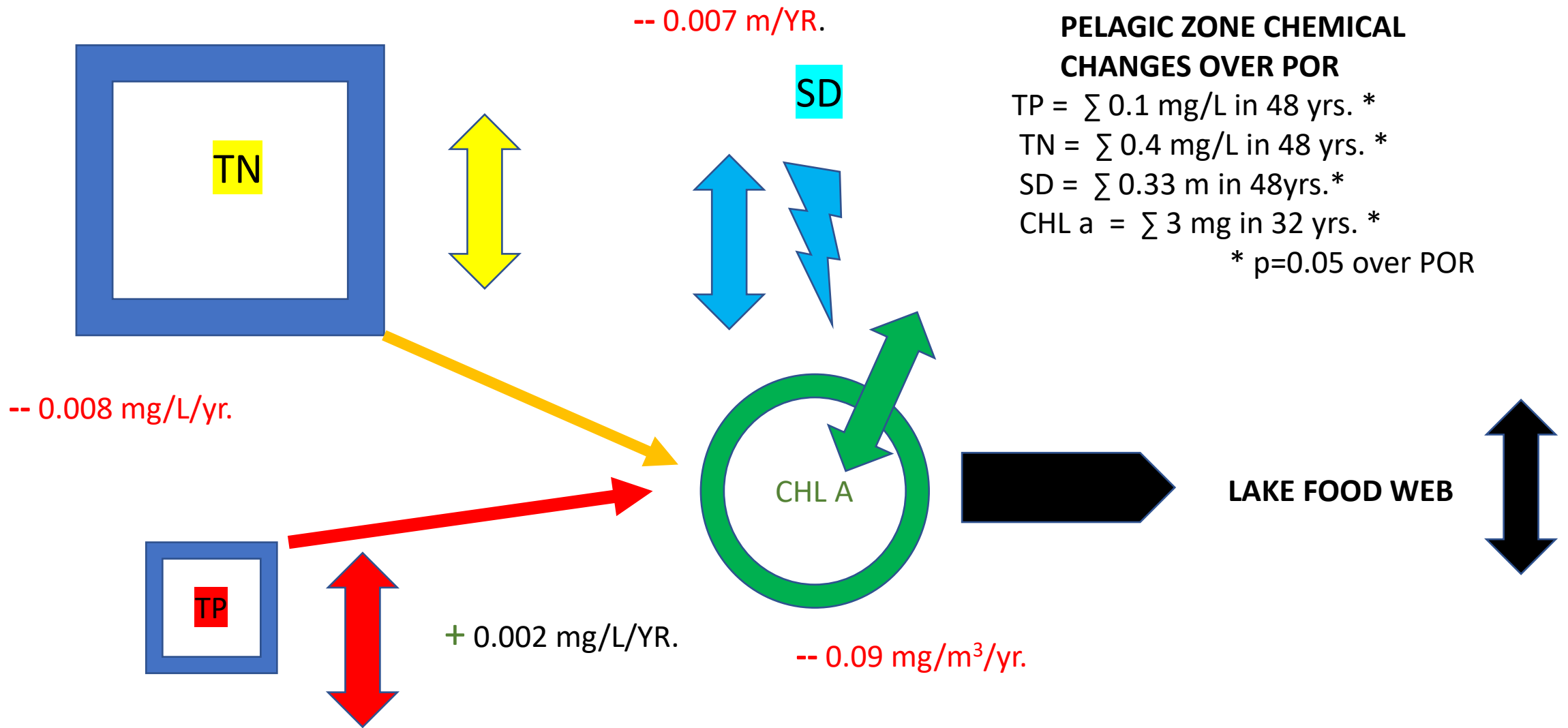
TSI.Kissimmee R. inflow decreased
TSI.Chl but increased in **TSI.TP** & **TSI.SD**

Outflow decreased in CHL , zero CHL increase but large SD [turbidity] outflows.

Marsh [EAV] increases in CHL , NUTIENTS & SD.

Littoral small CHL increase 2 of 3, increase of TP & SD.

OVERALL by aerial % CHL decrease, TP & SD increase.



LAKE OKEECHOBEE TROPHIC "TEMPERATURE" CONCEPT

CLASSICAL CHEMICAL PROXY EXTENTIONS FOR LAKE OKEECHOBEE

INCREASE

TP @ 2.1 ug/L/yr. X 277X 10⁺⁹ L → + ≅ 12 mt TP/yr. → + ≅ 570 mtTP/48 yr. POR. ≈ Annual river + aerial deposition of ≅ 500 mt./YR.TP in-lake inflow. Water column TP increase is 2% of Annual TP inload.

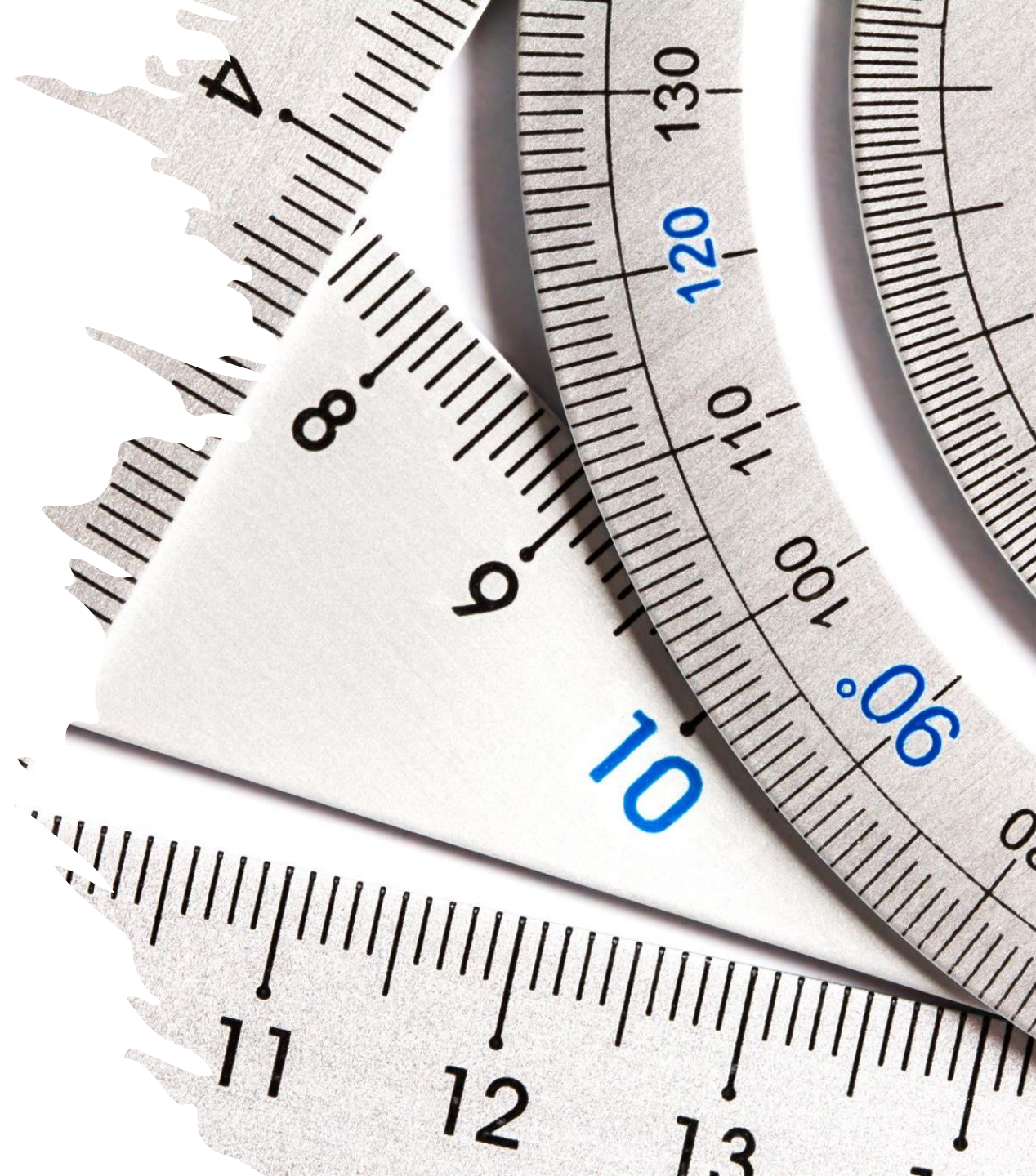
DECREASE

TN @ - 8 ug/L/yr. X 277*E+9 L → -- ≅ 45 mt TN /yr. → - ≅ 220 mt TN/48 yr. POR
[DENITRIFICATION?]

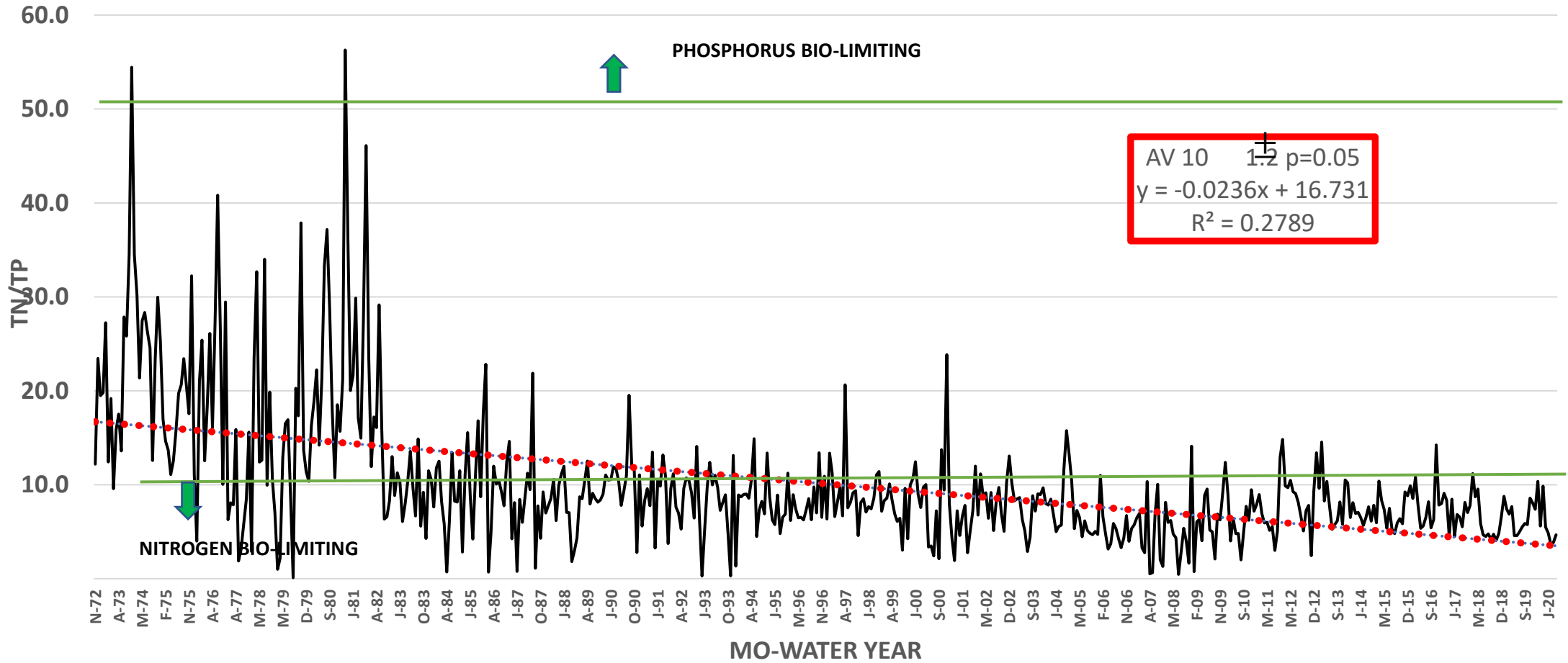
INADEQUATE VALUES FOR CHLA @ - 0.1 MG/³ /yr. To PHYTOPLANKTON BIOMASS reduction
&
Secchi disk depth decrease @ 7 mm/ yr. over 48 yrs.

Lake Okeechobee vol @ 15 ft. NGVD= 277X 10⁺⁹ L

Interrelationship
between
independent
metrics that have
known effects on
primary production



LAKE OKEECHOBEE 8 PELAGIC STA.
TN/TP [1972-2020]

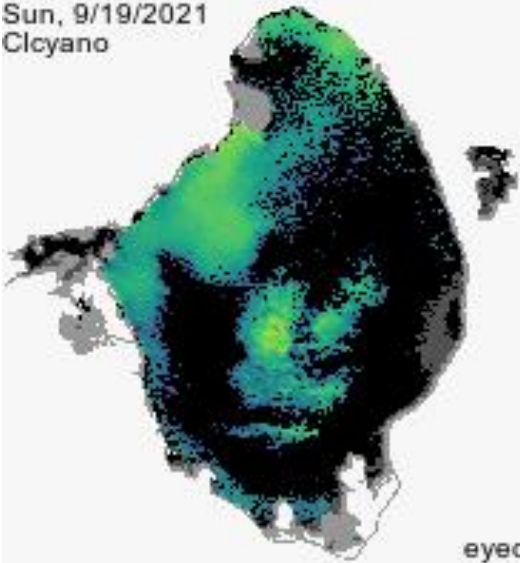


Mon, 11/2/2020
truecolor



keo.com

Sun, 9/19/2021
Clcyano



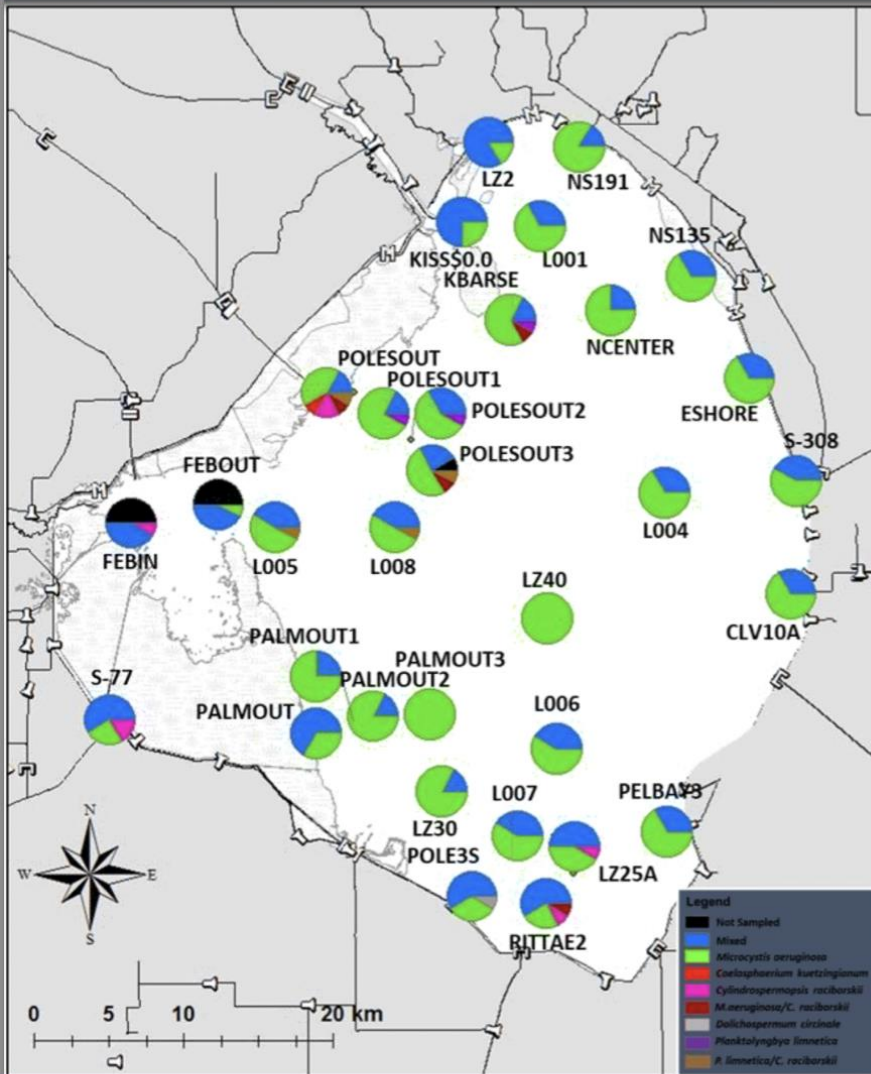
eyeonlakeo.com

Sun, 9/19/2021
truecolor

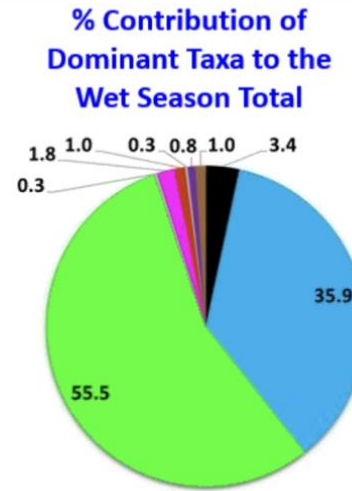
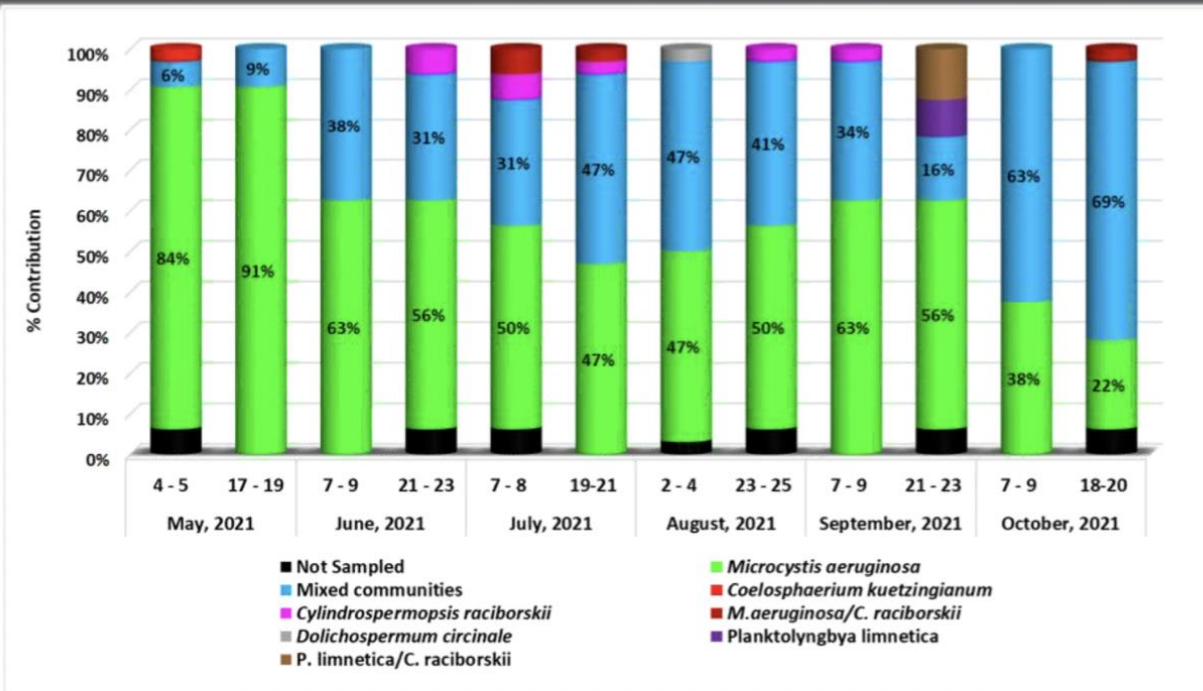


Dominant Taxa

Percent of Dominant Taxa Per Site



Changes in the Percentage of Dominant Taxa Over Time



- ❑ *Microcystis aeruginosa* was a dominant taxa in 55.5% of the samples collected
- ❑ The highest abundance of *M. aeruginosa* was recorded in May (84 - 91%), and then decreased over time. The lowest abundance was recorded in late July and early August
- ❑ Mixed communities and communities dominated by diazotrophic species were most abundant in nearshore areas, while communities dominated by *M. aeruginosa* were most commonly recorded in central and eastern parts of the Lake

ANALYTICAL RESULTS OF PRESENT WORK

| AVERAGE LAKE OKEECHOBEE'S PRIMARY PRODUCTION METRICS [P=0.05] | | | | |
|--|---------------|------------------------------------|----------------------|------------------------|
| | METRIC | CHEM VALUE | TSI VALUE | Long-term trend |
| DEPENDENT | CHL A | 19 +/- 0.5 mg/m³ | 57 +/- 0.5 | down / down |
| INDEPENDENT | TP | 0.116 +/- 0.004 mg/L | 57.9 +/- 0.5 | up / up |
| INDEPENDENT | TN | 1.59 +/- mg/L | 60.5 +/- 0.31 | down / down |
| INDEPENDENT | SD | 0.44 +/-0.02 m | 75.7 +/-0.6 | down/ up |

THE END

OR IS IT THE BEGINNING ?

QUESTIONS, COMMENTS