Tributary Nutrient Loading Trends in the Lake Okeechobee Watershed

Joyce Zhang, Patricia Burke, Lucia Baldwin, Cheol Mo, Steven Hill, Water Resources Division

INTRODUCTION

As required by the Northern Everglades and Estuaries Protection Program, the SFWMD monitors the water quality of inflows to and outflows from Lake Okeechobee control structures and maintains a long-term water quality monitoring network within the Lake Okeechobee Watershed (Figure 1). This network is continuously reviewed for efficiency and to ensure all data objectives associated with legislatively mandated and permit-required monitoring are being met. A request was received to evaluate the tributary load stations being monitored by the District and U.S. Geological Survey (USGS). This long-term tributary monitoring program was established to monitor changes resulting from restoration activities implemented throughout this area (Figure 2). Both flow and water quality data were collected. To assess the success or deficiencies of restoration efforts, many years of continued evaluation of these tributary loading stations for statistically significant trends were performed.

OBJECTIVES

The overall objective of this study was to conduct statistical and trend analysis for the 14 OKUSGS project tributary loading stations through water year (WY) 2015, Specific objectives were:

1. Obtain monthly data - flow, TP load, flow-weighted mean TP concentration, TN load and flow-weighted mean TN concentration for WY2006 through WY2015,
2. Conduct statistical and trend analyses, and
3. Summarize results and make recommendations for continuation of this monitoring network.

METHODS

- Summary statistics: mean, median, minimum, maximum, and standard deviation
- Seasonal Kendall's Tau test
  - Monthly values from WY2006 to WY2015
  - p-value < 0.05
- Trends of five parameters: flow, TP load, TP flow weighted mean concentration, TN load, and TN flow weighted mean concentration

NUTRIENT LOADING TREND

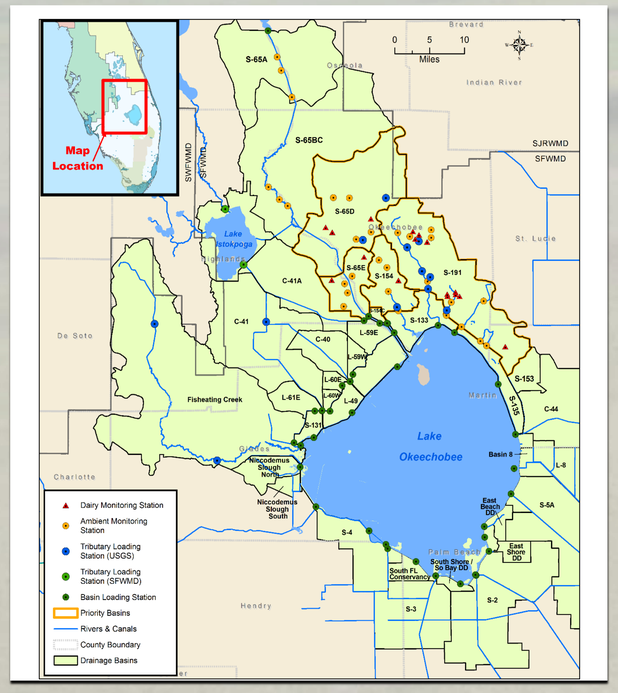

Figure 1. Location of Water Year 2015 (May 1, 2014 – April 30, 2015) water quality sampling stations under ambient, tributary and basin loading projects in the Lake Okeechobee Watershed.

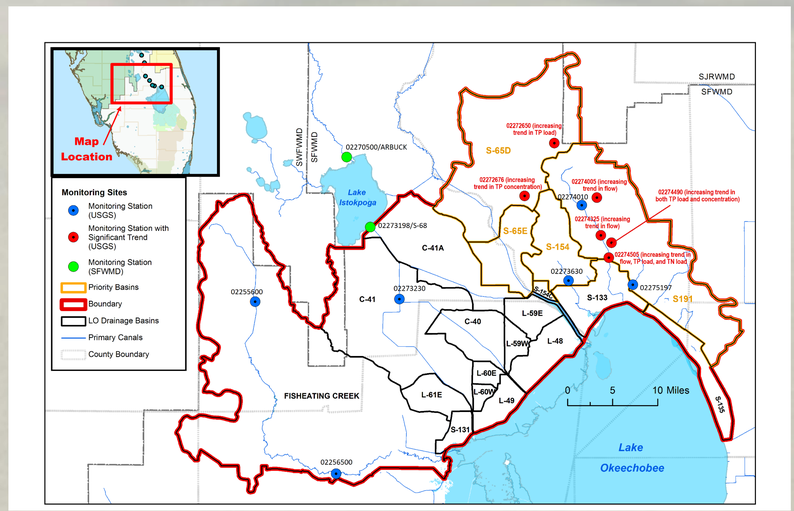

Figure 2. Current OKUSGS project tributary loading stations highlighting stations with significant trend in one or more parameters using Seasonal Kendall Tau trend analyses for water year 2006–2015..

SUMMARY AND CONCLUSIONS

- Flow - Increase (3 stations)
- TP load - Increase (3 stations)
- TP concentration - Increase (2 stations)
- TN Load - Increase (1 station)
- TN concentration - No trend

- no sites with decreasing trends for any parameters
- continuation of monitoring is recommended.
- Further analysis of upstream land use or hydrological changes that may have affected nutrient loadings is recommended.
- Additional analysis of basin level trends should be compared with the upstream tributary loading analysis.

Table 1. Seasonal Kendall Tau trend analyses of flow, TP load, TP conc., TN load, and TN conc. (WY2006–2015) for stations with increasing trends in one or more parameters. **Bolded** parameters indicate significant changes. (Note: NA – not available)

Station	Parameter (unit)	Number of Month	Number of Month with NA	Kendall's Tau	Seasonal Sen Slope	Intercept	P Value
02272650	Flow (ac-ft x 10^3)	120	0	0.244	0.028	0.216	0.111
	TP Load (mt)	**120**	**0**	**0.259**	**0.011**	**0.072**	**0.000**
	TP FWMC (µg/L)	120	0	0.189	15.3	180.7	0.176
	TN Load (mt)	120	0	0.233	0.051	0.557	0.111
	TN FWMC (mg/L)	120	0	0.013	0.004	1.717	0.926
02272676	Flow (ac-ft x 10^3)	120	0	0.287	0.048	0.165	0.078
	TP Load (mt)	120	0	0.324	0.019	0.076	0.053
	TP FWMC (µg/L)	**120**	**19**	**0.292**	**20.2**	**256.7**	**0.039**
	TN Load (mt)	120	0	0.302	0.080	0.423	0.056
	TN FWMC (mg/L)	120	19	-0.079	-0.006	1.454	0.644
02274005	**Flow (ac-ft x 10^3)**	**120**	**0**	**0.146**	**0.004**	**0.075**	**0.044**
	TP Load (mt)	120	0	0.274	0.003	0.020	0.056
	TP FWMC (µg/L)	120	0	0.256	18.2	226.6	0.053
	TN Load (mt)	120	0	0.200	0.021	0.135	0.209
	TN FWMC (mg/L)	120	0	0.337	0.098	1.441	0.061
02274325	**Flow (ac-ft x 10^3)**	**120**	**0**	**0.144**	**0.047**	**0.604**	**0.047**
	TP Load (mt)	120	0	0.089	0.013	0.253	0.225
	TP FWMC (µg/L)	120	0	-0.041	-2.0	326.5	0.760
	TN Load (mt)	120	0	0.122	0.079	1.534	0.093
	TN FWMC (mg/L)	120	0	-0.026	-0.004	1.713	0.832
02274490	Flow (ac-ft x 10^3)	120	0	-0.063	-0.008	0.375	0.394
	TP Load (mt)	**120**	**0**	**0.144**	**0.006**	**0.135**	**0.047**
	TP FWMC (µg/L)	**120**	**0**	**0.389**	**31.2**	**212.6**	**0.031**
	TN Load (mt)	120	0	0.070	0.009	0.563	0.339
	TN FWMC (mg/L)	120	0	0.300	0.054	1.240	0.069
02274505	**Flow (ac-ft x 10^3)**	**120**	**0**	**0.235**	**0.004**	**0.021**	**0.001**
	TP Load (mt)	**120**	**0**	**0.276**	**0.001**	**0.006**	**0.000**
	TP FWMC (µg/L)	120	0	0.156	7.6	181.5	0.160
	TN Load (mt)	**120**	**0**	**0.207**	**0.004**	**0.036**	**0.004**
	TN FWMC (mg/L)	120	0	0.159	0.018	1.136	0.151

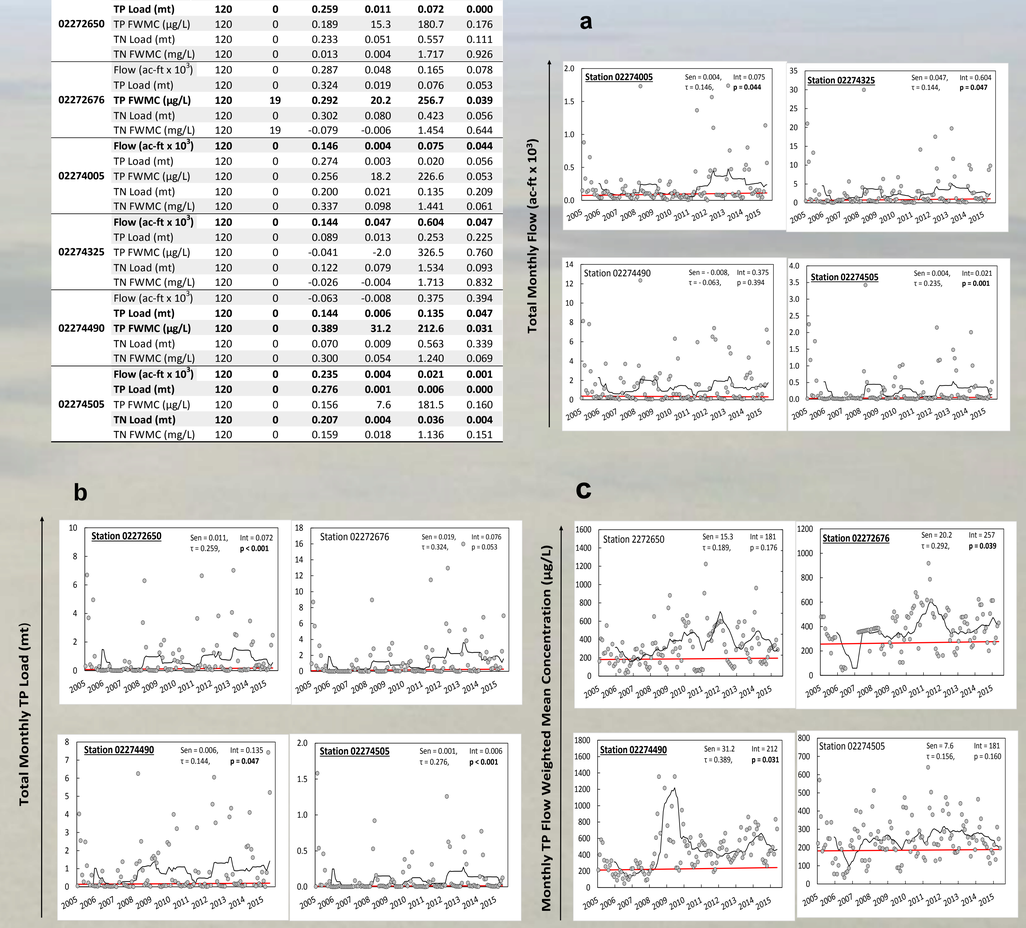

Figure 3. Monthly a) flows b) TP loads c) TP concentrations for sample tributary loading sites with significant trend for one or more parameters. Gray dots represent monthly values, black lines represent 12-month moving averages, and red lines represent Seasonal Kendall trend lines. Bold and underline station labels signify a significant relationship.