Decadal Changes In Nitrogen And Phosphorus Species Along The Lake Worth Lagoon In South Florida

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Water Institute 2022,
Complex Challenges, Integrated Solutions

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The Lake Worth Lagoon Estuary (LWL)

- Originally a freshwater lake that received waters from the Everglades.
- Two inlets were constructed in the early 20th Century giving the lagoon brackish conditions.
- The LWL provides habitat, protects shorelines, and supports residential and touristic activities in South Florida.
- The West Palm Beach-C51 (C51) canal accounts for 50% of freshwater discharges into LWL.

Photo credits: Historical Society of Palm Beach County

Image from https://discover.pbcgov.org/

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The West Palm Beach – C51 canal

- The WPB and C51 canals connect Lake Okeechobee with LWL.
- The WPB and C51 canals go through the Everglades Agricultural Area (EAA) and urbanized areas before it reaches LWL.
- Changes in sediment and nutrient influx from freshwater discharges impact LWL.

- Changes in N, P, and N:P ratios can affect limiting nutrients, trigger algal blooms, and impact LWL biodiversity.

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Objectives

1) To determine decadal trends of N and P species along the WPB and C51 canals to LWL system (2009 to 2019).

2) To determine differences in N and P species between sections along the WPB and C51 canals.

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Methods

Four water quality stations selected; 2009 to 2019 period of study.

Photo credit: South Florida Water Management District

S352

Image from https://palmbeach.floridaweekly.com

S5A

Image from https://discover.pbcgov.org/

LWL

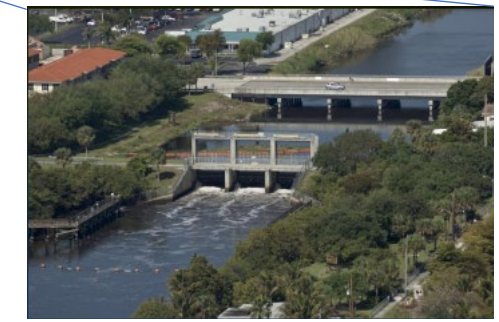

Photo credit: South Florida Water Management District

C51S155

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Data

- Data on water quality parameters (WQ) and flow obtained from DBHYDRO database of the South Florida Water Management District.
- Rainfall data obtained from stations in the vicinity of selected stations.

water quality parameters	
Parameter	Abbreviation
Total phosphorus	TP
Orthophosphate	OP
Particulate + dissolved organic phosphorus	PP+DOP
Total nitrogen	TN
Nitrate-N + Nitrite-N	NO_3+NO_2
Ammonia-N	NH_3
Organic nitrogen	ON
Total suspended solids	TSS

Statistics

- Seasonal Mann Kendall and Sen slope used to determine trends on WQ parameters.
- Spearman correlations used to establish correlations between rainfall, flow and WQ parameters.
- Nonparametric pairwise comparisons used to compare WQ parameters between selected stations.

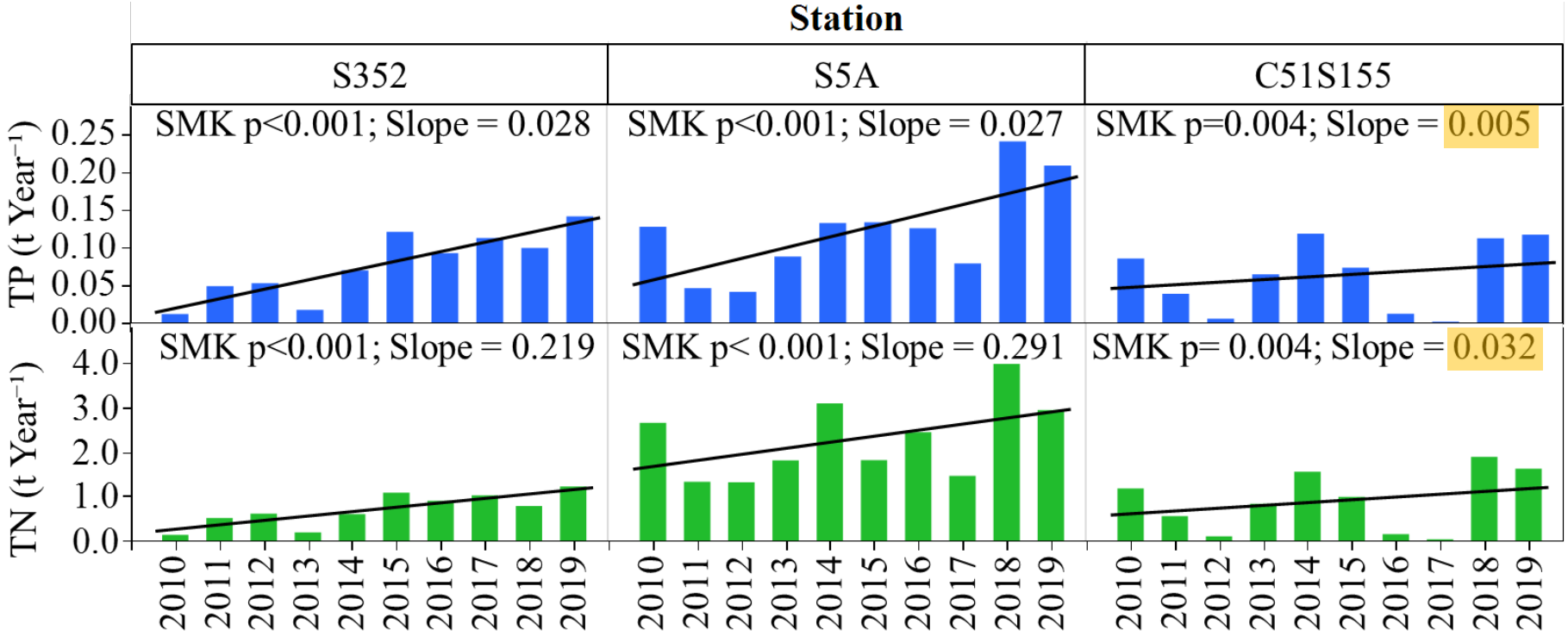
Results and discussion

Trend analysis

Station	TP	PP+DOP	OP	TN	NO_3+NO_2	NH_3	ON	TN:TP	TSS	Flow
S352	+	+	NS	NS	+	-	NS	-	+	+
S5A	+	+	NS	-	-	-	-	-	NS	+
C51S155	+	NS	+	NS	+	+	NS	-	NS	+
LWL	+	+	NS	+	+	+	+	+	+	NA

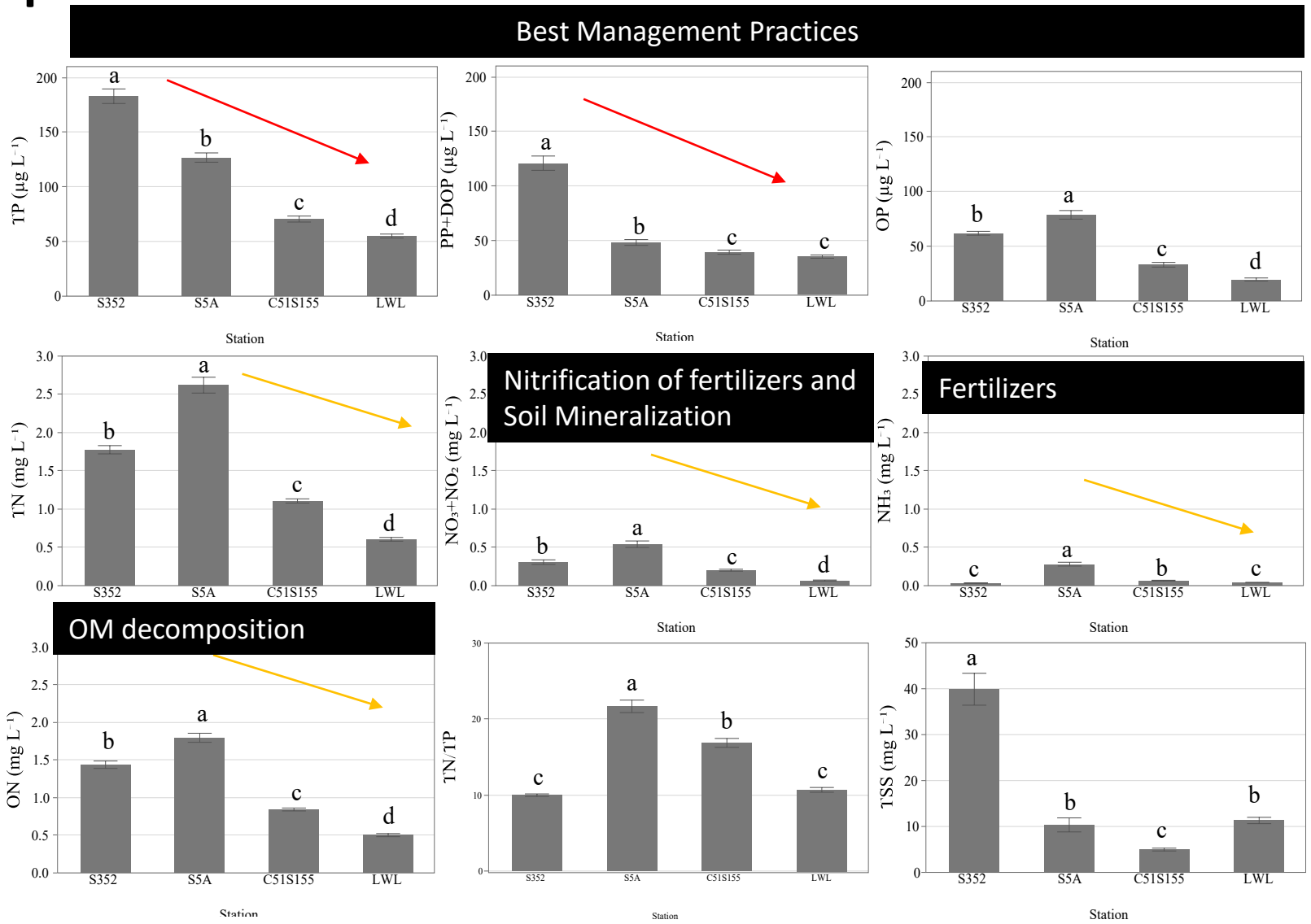
(+) increasing trend; (-) decreasing trend; NS not significant trend; NA no trend analysis done

- Predominantly increasing trends of P forms' concentrations partially due to legacy P released from Lake Okeechobee's sediments into the water column (Reddy et al., 2011).
- Urbanization along areas of the C51 canal can partly explain increasing trends.



- Increasing concentrations correspond to increasing loads.
- Increasing loads can be explained by larger discharges from Lake Okeechobee into the WPB and C51 canals in recent years (increasing flow).
- Increasing trends at station C51S155 into LWL are between 5 and 9 times lower than increases at other stations, possibly due to assimilation, precipitation and denitrification reactions.

Spatial differences



- Reduction in TP and PP+DOP concentrations from Lake Okeechobee to LWL due to assimilation and precipitation reactions. Sediment and carbonate layers previously shown to act as a sink for P at the WPB-C51 canal (Das et al., 2012).
- Reduction of N forms from station S5A to LWL possibly due to plants and microbes' assimilation and denitrification.

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Correlations

Flow										
Station	TP	PP+DOP	OP	TN	NO_3+NO_2	NH_3	ON	TN:TP	TSS	Rainfall
S352	0.23 *	0.27 **	-0.04	0.04	0.03	-0.28 **	0.09	-0.32 ***	0.19 *	-0.32 ***
S5A	0.73 ***	0.37 ***	0.52 ***	0.33 ***	0.16	0.29 **	0.31 ***	-0.24 **	0.17	0.62 ***
C51S155	0.53 ***	0.34 ***	0.41 ***	0.57 ***	0.21 *	0.53 ***	0.58 ***	-0.24 *	0.37 **	0.53 ***
Rainfall										
Station	TP	PP+DOP	OP	TN	NO_3+NO_2	NH_3	ON	TN:TP	TSS	Flow
S352	-0.03	-0.18	0.20 *	-0.15	-0.22 *	0.41 ***	-0.18	-0.13	-0.17	-0.32 ***
S5A	0.46 ***	0.11	0.37 ***	0.47 ***	0.23 *	0.45 ***	0.47 ***	0.13	0.01	0.62 ***
C51S155	0.21 *	0.35 ***	0.01	0	-0.34 **	0.06	0.30 **	-0.27 **	0.24	0.53 ***
LWL	0.36 ***	0.18	0.27 **	0.46 ***	0.20	0.30 **	0.47 ***	0.21	-0.16	N/A

- Strong positive correlations with flow at stations S5A and C51S155 (characteristic of diffuse, non-point sources).
- Negative flow correlations and weak correlations with rainfall show water management decisions along the WPB-C51 canal.
- Negative correlations between TN:TP and flow show higher P than N mobility under strong flow events.

Conclusions

- **Increasing trends in TP and TN loads** found at the WPB-C51 canal are possibly due to **higher nutrient concentrations, urbanization,** and **larger discharges from Lake Okeechobee** in recent years**.**
- **TP and TN** concentrations **progressively declined** along the path from Lake Okeechobee **(WPB-C51 canals)** to **LWL**.
- **Average TP concentration** in water reaching the LWL was **higher than** the **numeric criteria** (49 µg L^{-1}) established by the state of Florida.
- Overall, **increasing trends in TP and TN loads** along the WPB-C51 canal, **emphasize the need** to implement strategies in order to **minimize nutrient inputs** into LWL.

References

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Thank you.

Questions?

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