The Linkage of Water Level Dynamics and TP Concentration in the WCA-3A Marsh-Canal System

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Water level has a strong influence

Past attention to stage is encouraging-

1. In 2010, a multi-agency Everglades Restoration Transition Plan (ERTP) team developed a regression model to predict TP concentrations based upon the daily WCA-3A stage.

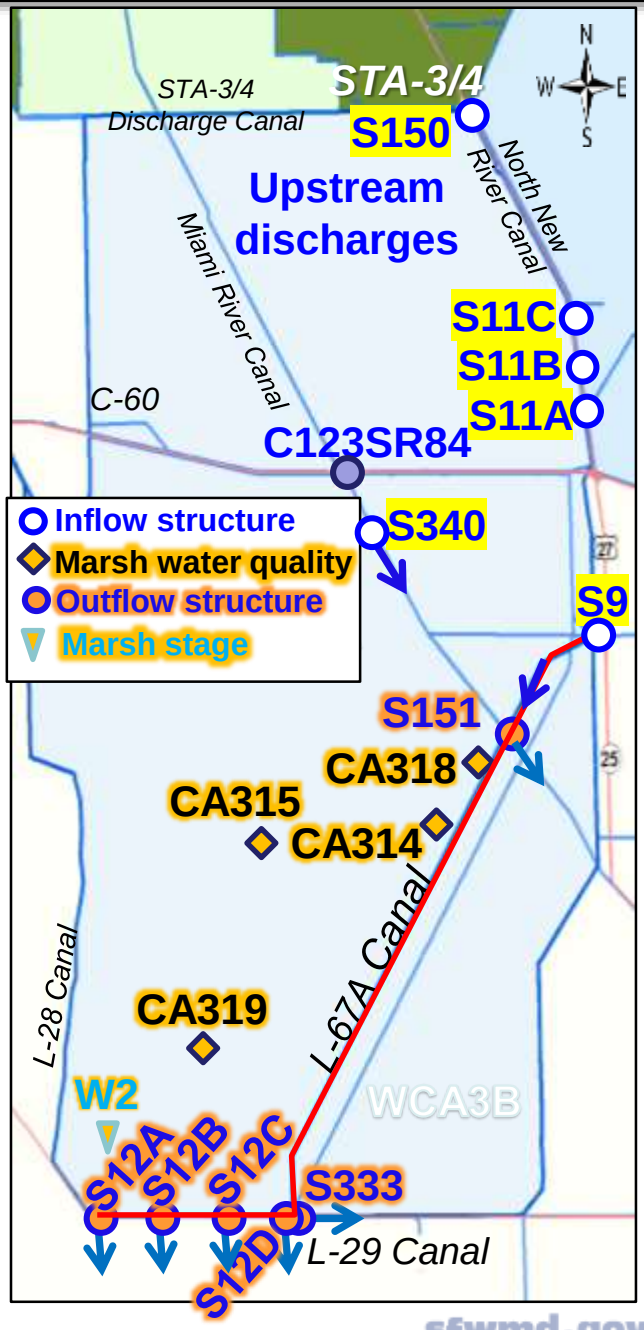
2. In 2013, an updated regression model was used in the Central Everglades Planning Project (CEPP).

3. Starting with ERTP and CEPP, Army Corps of Engineers put less emphasis on upstream TP and water level gained traction as a factor.

4. This study, building on the previous work, continues to explore stage influence on TP variations using long-term data.

Data sources

- Rainfall, stage, inflow, and outflow in WCA-3A were retrieved from USGS EDEN and SFWMD DBHYDRO databases.
- TP data were retrieved from DBHYDRO:
  a. **Inflow structure TP**: Flow-weighted-mean (FWM) TP calculated from data when water was flowing.



* Marsh samples were collected ≥ 10 cm depth per FDEP Protocol

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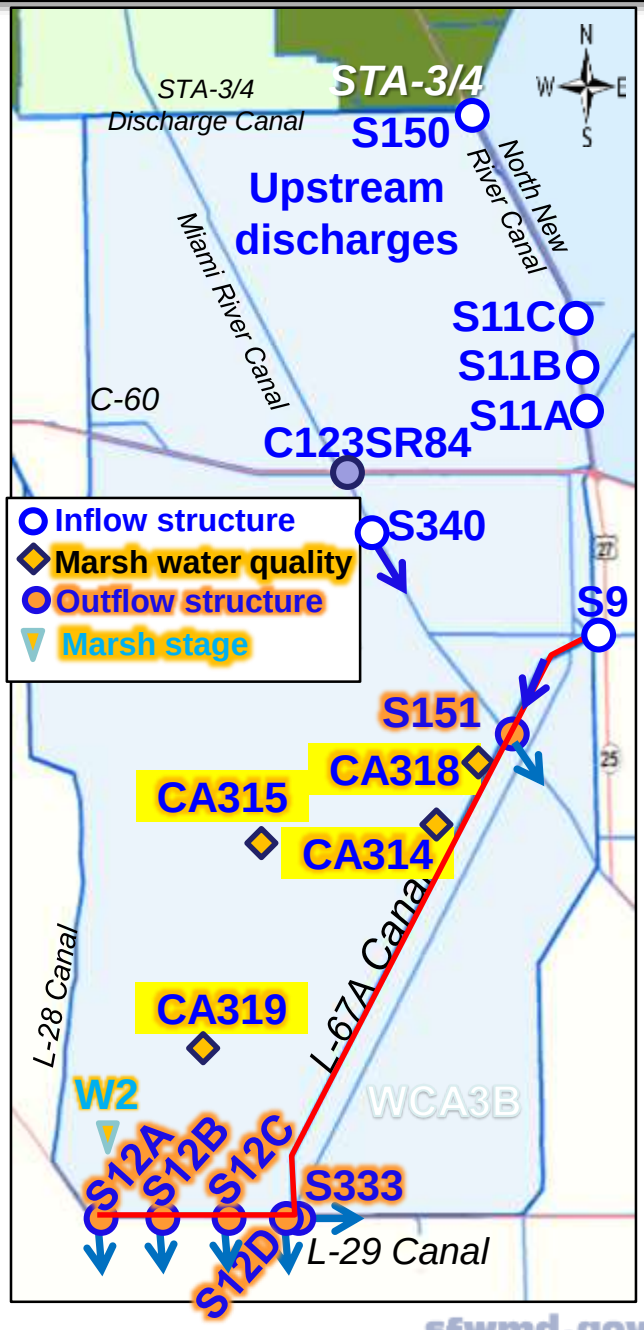

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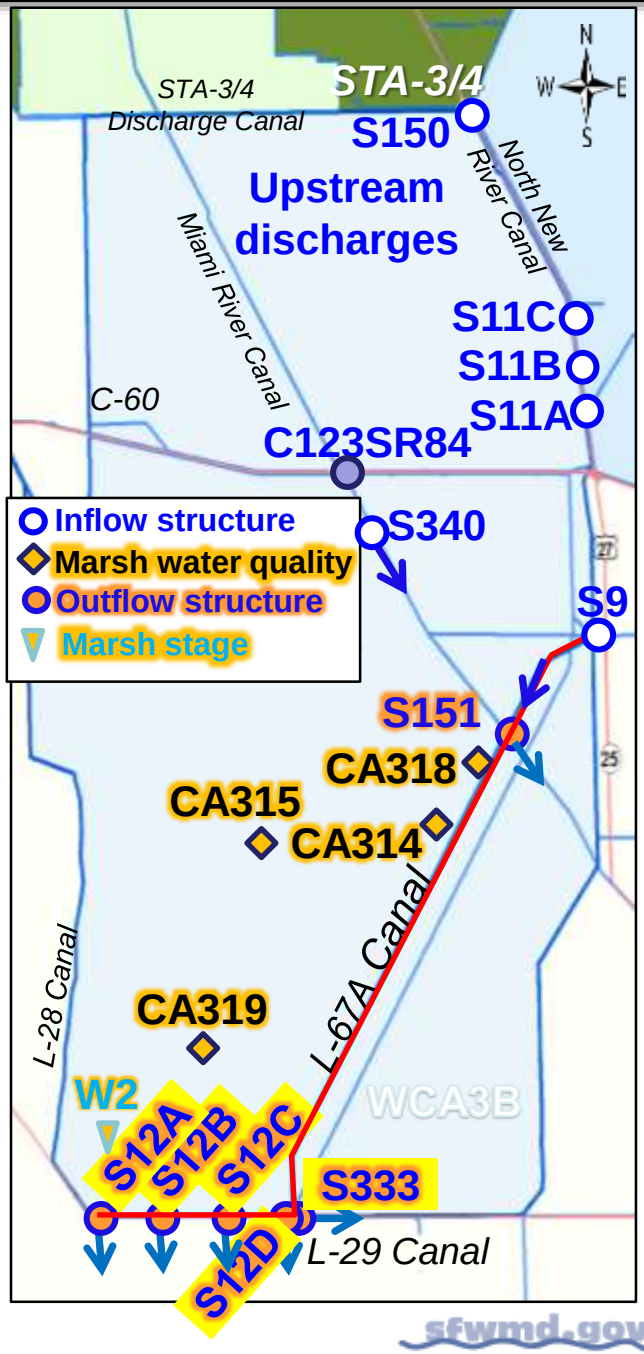

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- Daily **marsh** and **canal** stages were retrieved.

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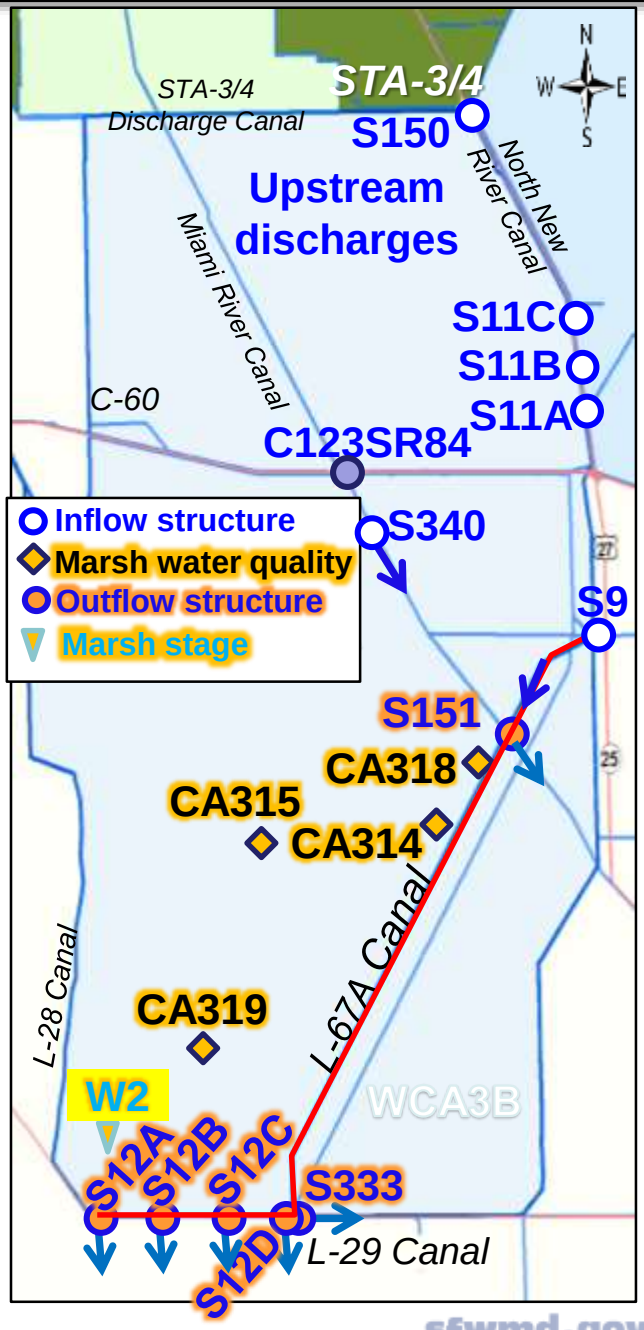
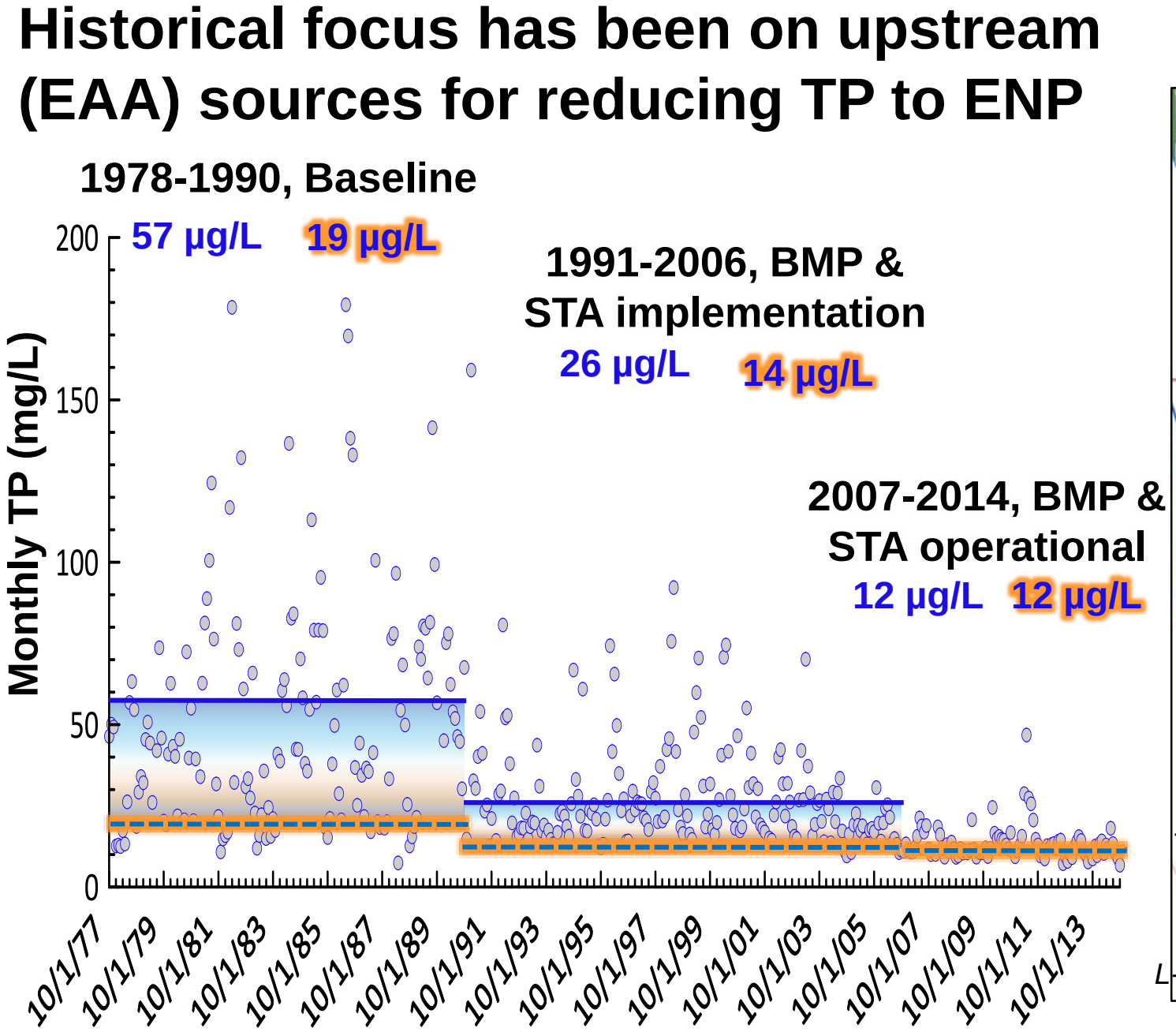
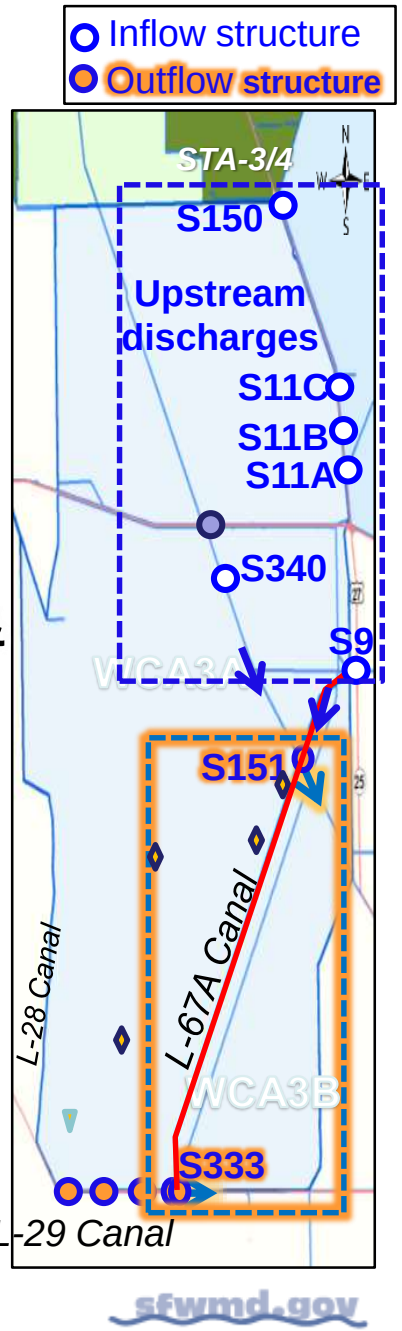
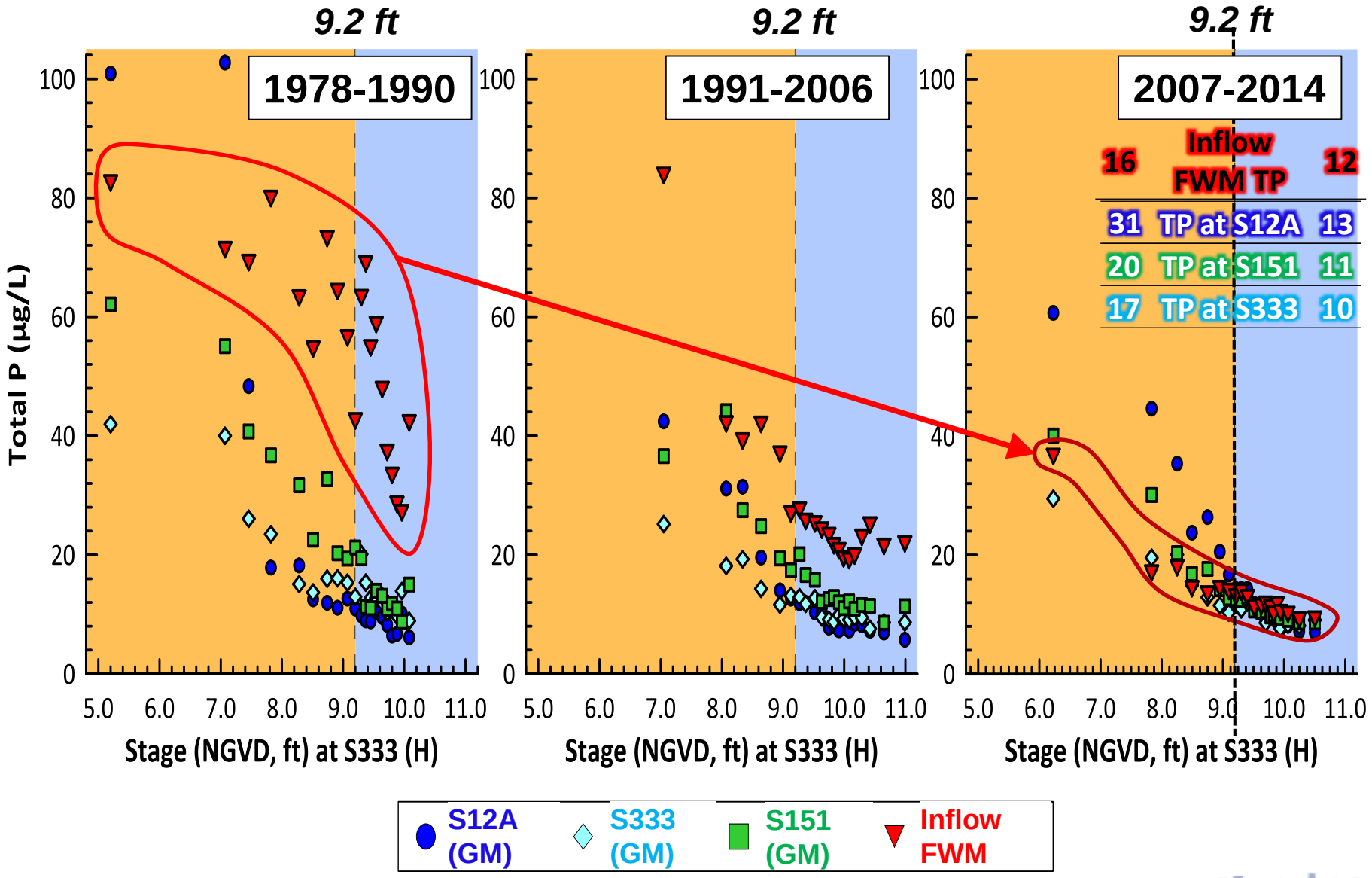


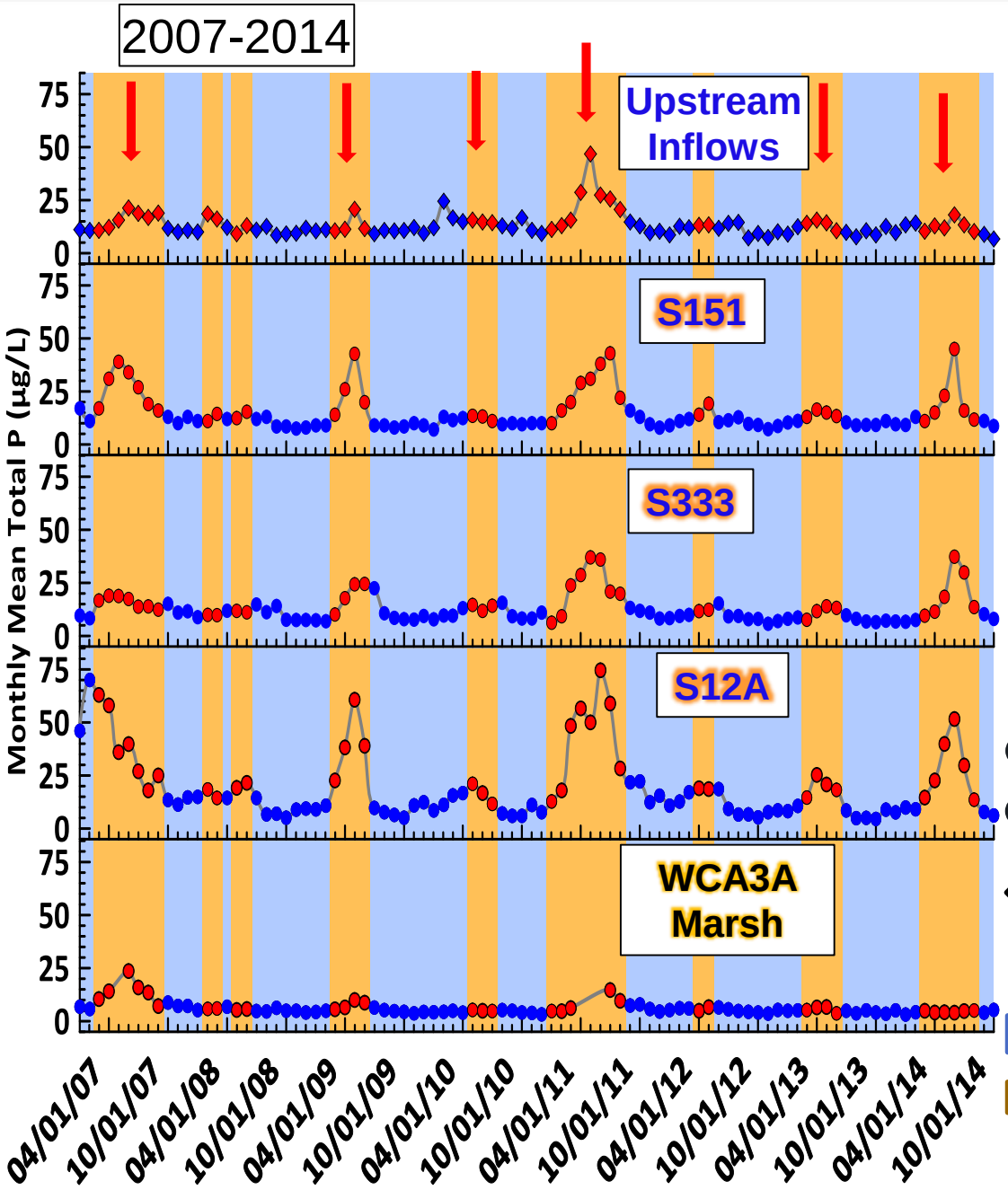
Historical focus has been on upstream (EAA) sources for reducing TP to ENP





Upstream sources went down





GM TP S333HW ≥9.2 ft

GM TP S333HW <9.2 ft

FWM TP S333HW ≥9.2 ft

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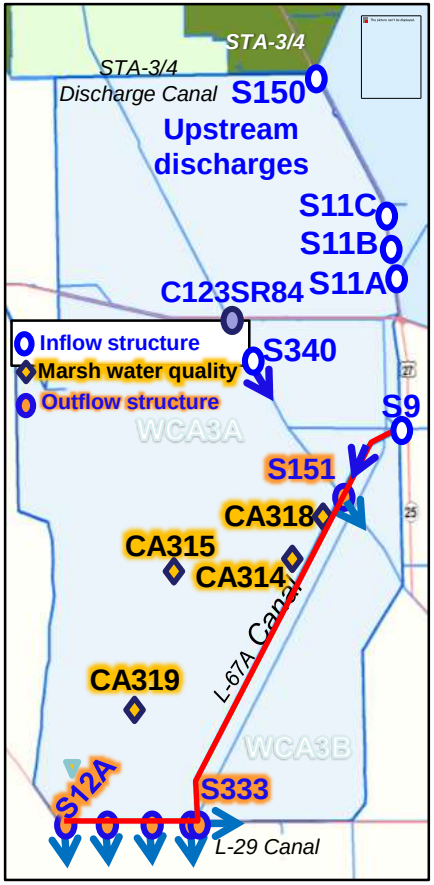
Why do we still see TP spikes at WCA-3A outflow structures not explained by the upstream sources?



Multi-variable correlation analysis

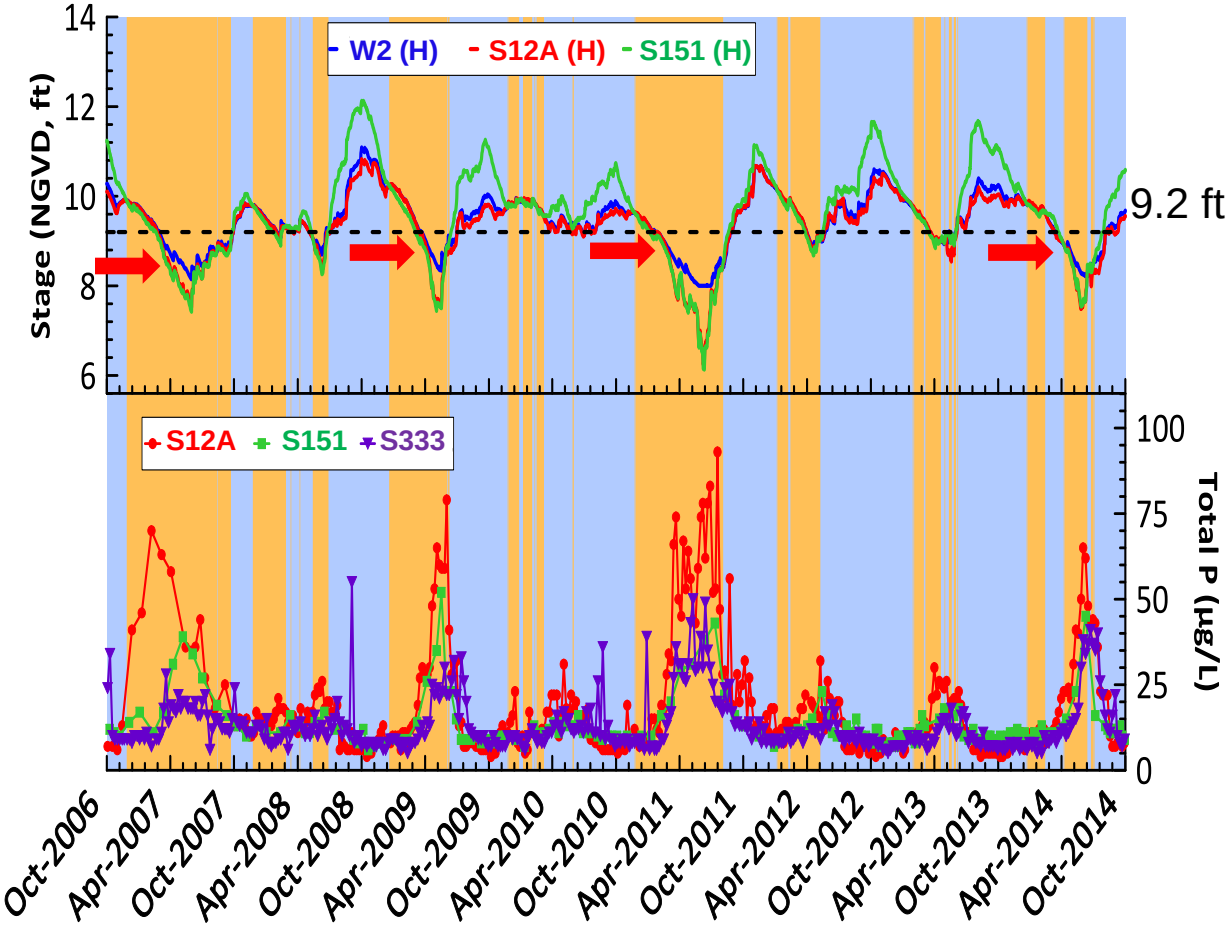
Factor loading	1	2	3	4	5
Stage at S333	**0.94**	0.16	0.07	0.16	-0.15
Stage at W2 in marsh	**0.93**	0.10	0.11	0.16	-0.14
TP at S333	**-0.88**	0.19	0.13	-0.03	0.15
TP at S151	**-0.91**	0.01	-0.20	-0.01	0.18
TP at S12A	**-0.84**	-0.11	-0.12	-0.35	0.03
30-d stage rise at S333	0.15	**0.91**	0.02	-0.03	0.05
Rainfall	-0.31	**0.79**	0.07	0.21	0.08
Inflow	0.19	**0.83**	0.23	0.24	-0.19
Flow at S333	0.05	0.04	**0.93**	-0.11	0.07
Flow at S151	0.14	0.22	**0.78**	0.24	-0.24
Flow at S12A	0.35	0.28	0.04	**0.86**	-0.03
Inflow FWM TP	-0.57	0.00	-0.13	-0.04	**0.78**

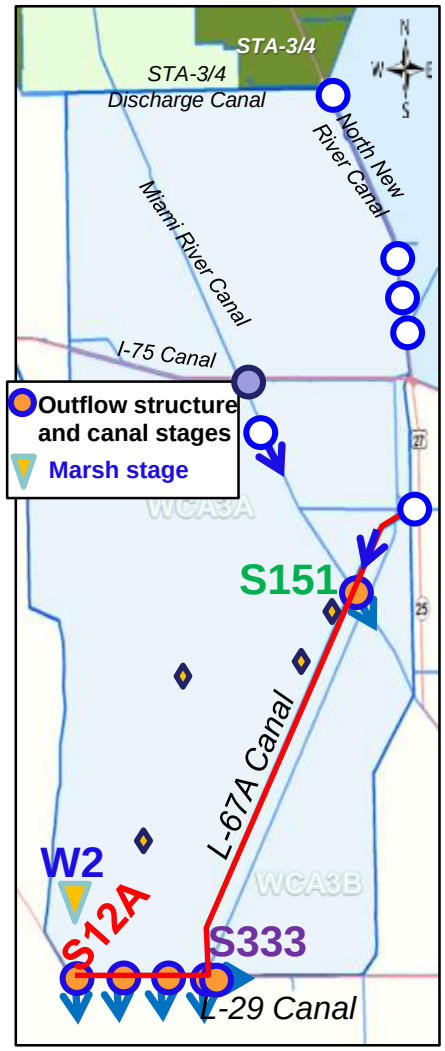
- Method: Factor Analysis (FA) with rotated loading matrix.
- |factor loading|>0.75, highlighted in bold, indicates strong correlation.
- Stage is the key driver to TP variations at outflow structures.

Stage dynamics and canal-marsh interaction changes with flow regime

Canal Stage (S151) > Marsh Stage (W-2)

Canal Stage (S151) ≤ Marsh Stage (W-2)





- A closer look with daily data
- The timing of high TP events was synchronized with stage difference (marsh-canal).

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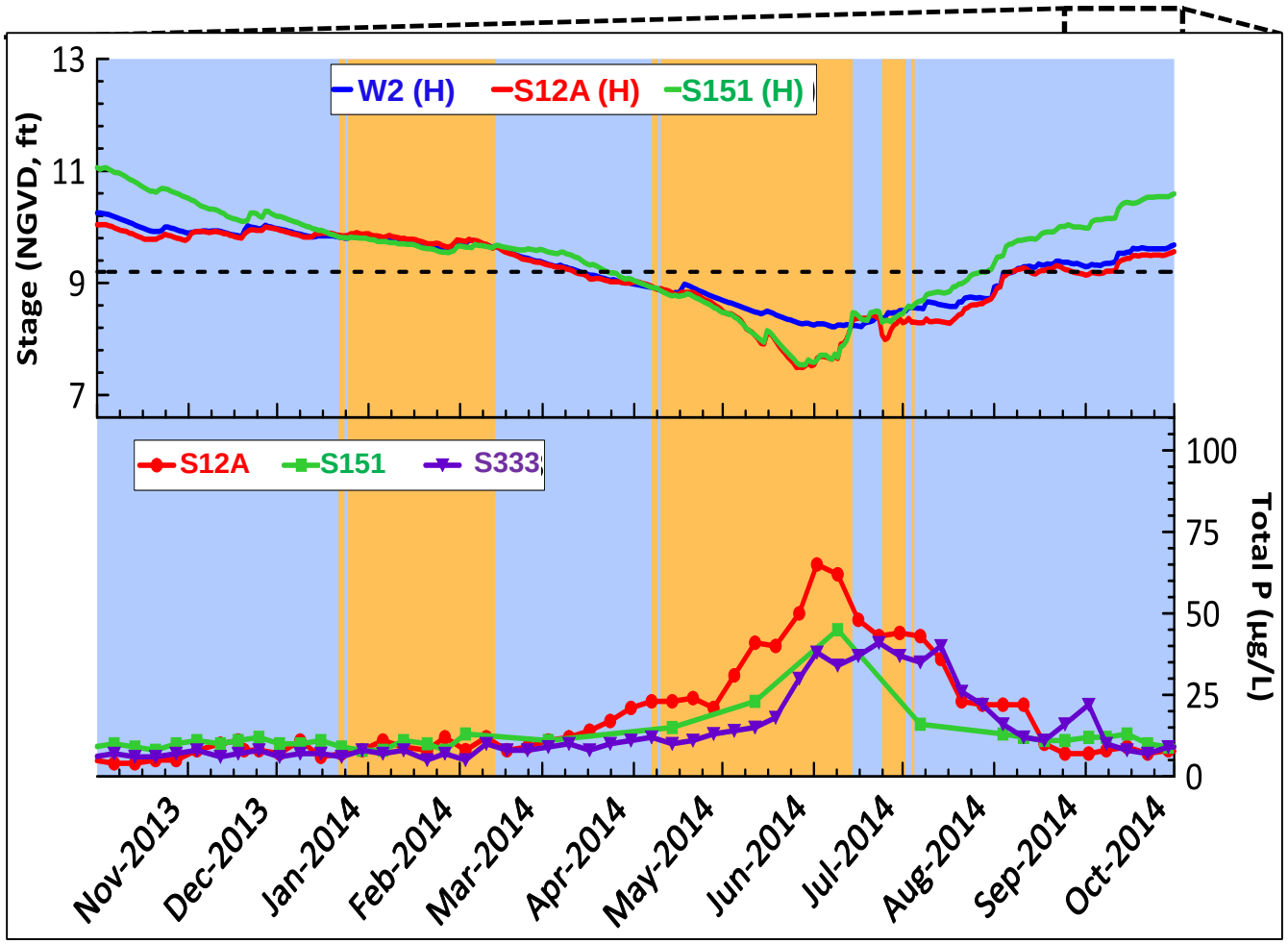

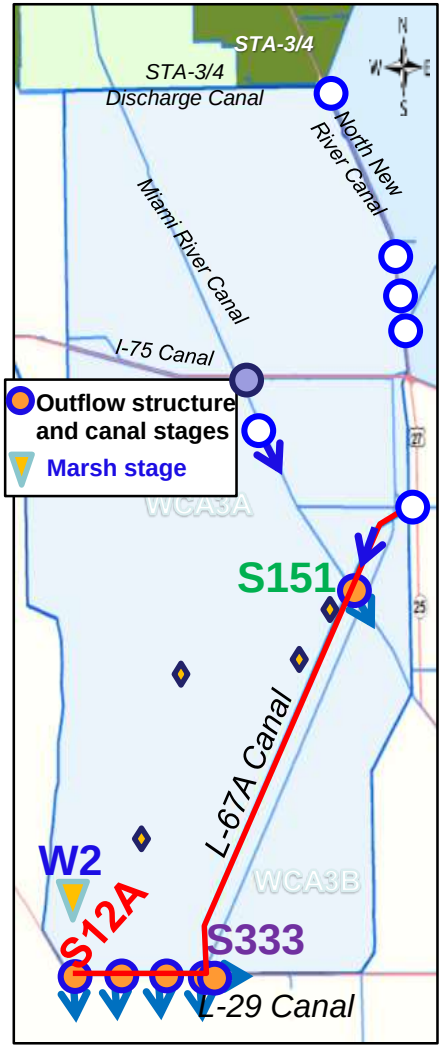

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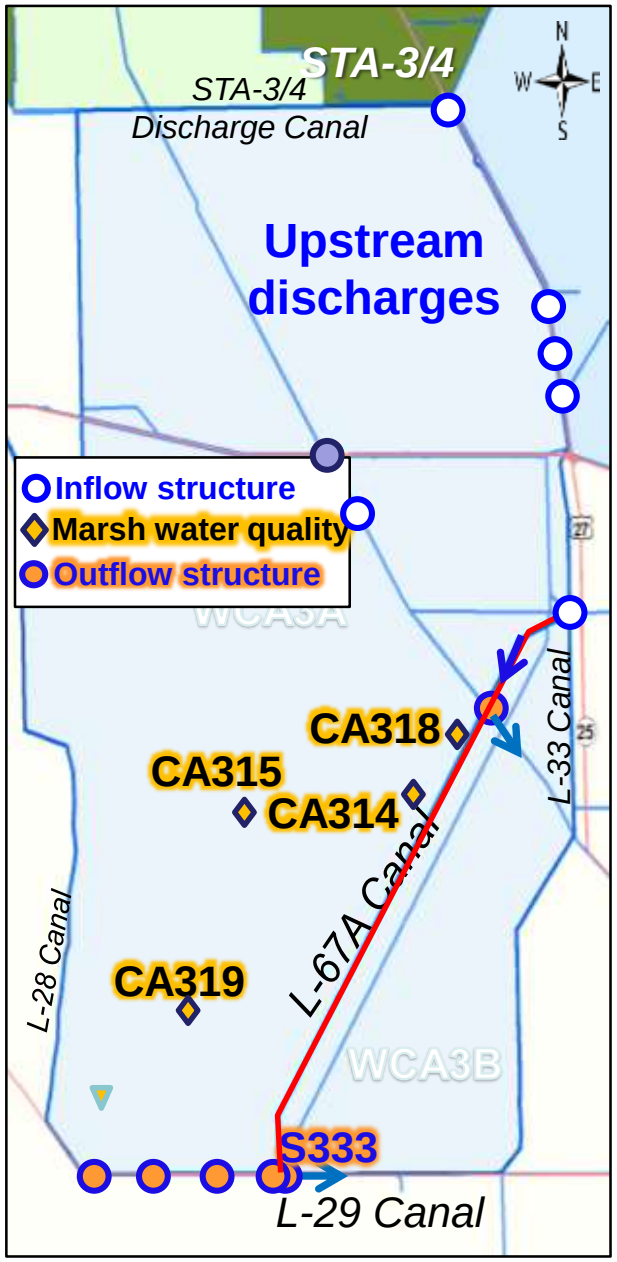
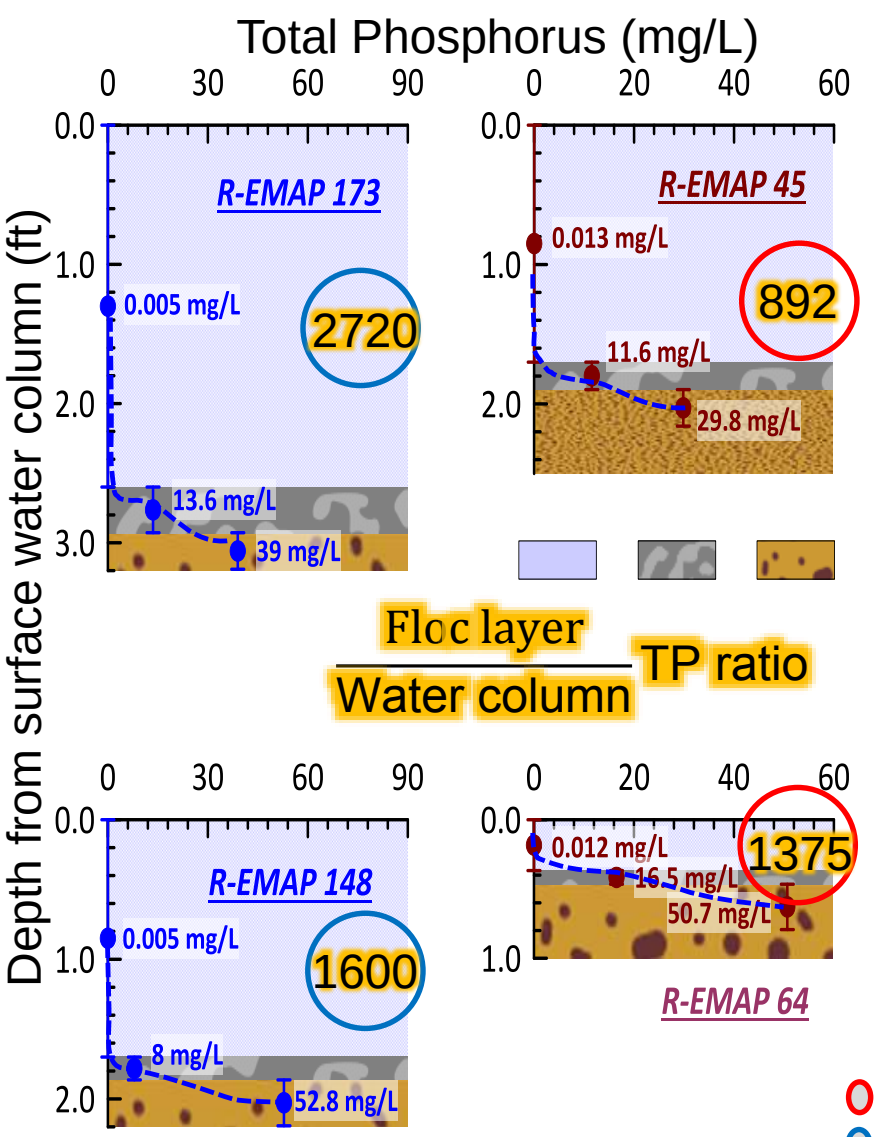


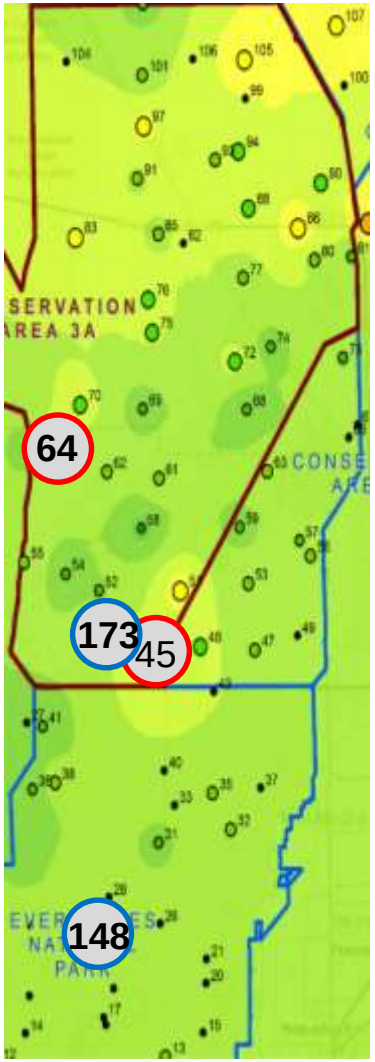
Identify potential TP sources using a mass balance approach

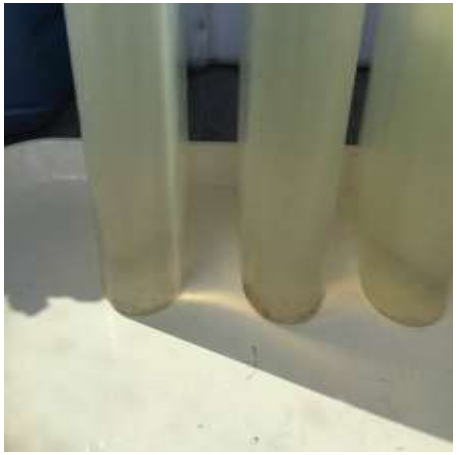
Sources	Flow (ac-ft)	TP concentration (µg/L)	TP load (kg)
Outflow	**17,000**	**20**	**430**
Inflow	2,800	12	40
Marsh	14,000	6	80
Deficit (unexplained TP load)			**310**

- A dry period was selected (May 2014).
- The flow deficit of 14,000 ac-ft was used to account for contribution from marsh.
- Using marsh TP of 6 µg/L resulted in marsh TP loading of 80 kg.
- 310 kg of extra load is the deficit of TP load discharged through outflow structures.
- This extra load cannot be explained by the upstream load; rather it implies an internal WCA-3A loading source.

Hypothesis: marsh flocculent layer could be the possible source of TP





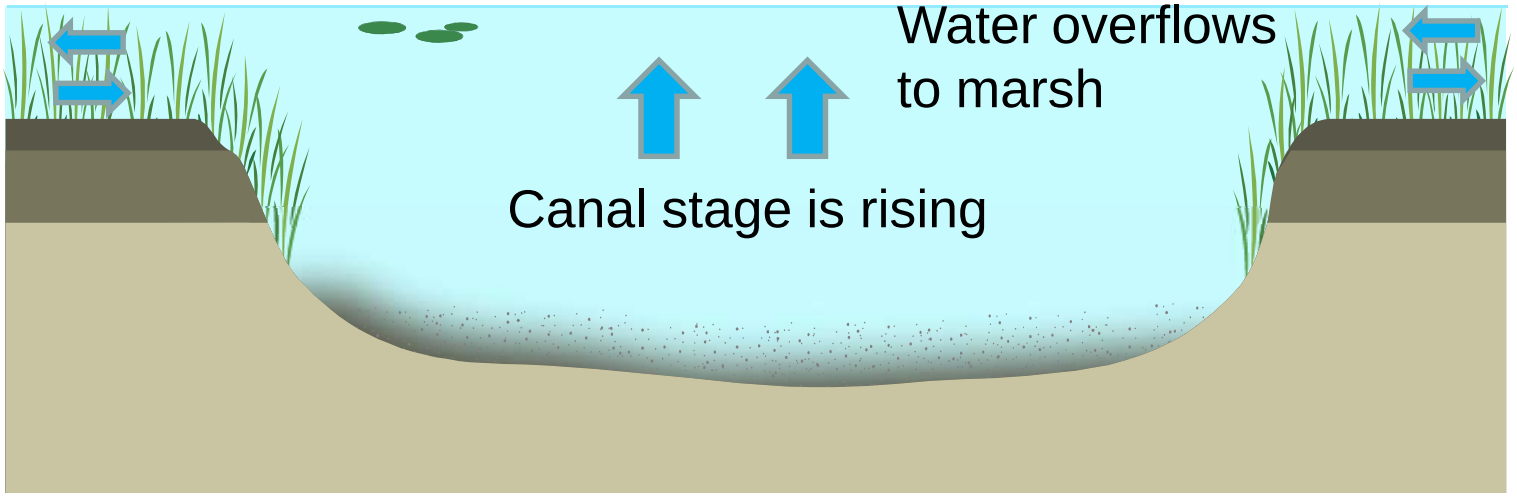


Dry season R-EMAP sites
Wet season R-EMAP sites

Two TP transport regimes are proposed

An upstream discharge dominated regime at high stage:

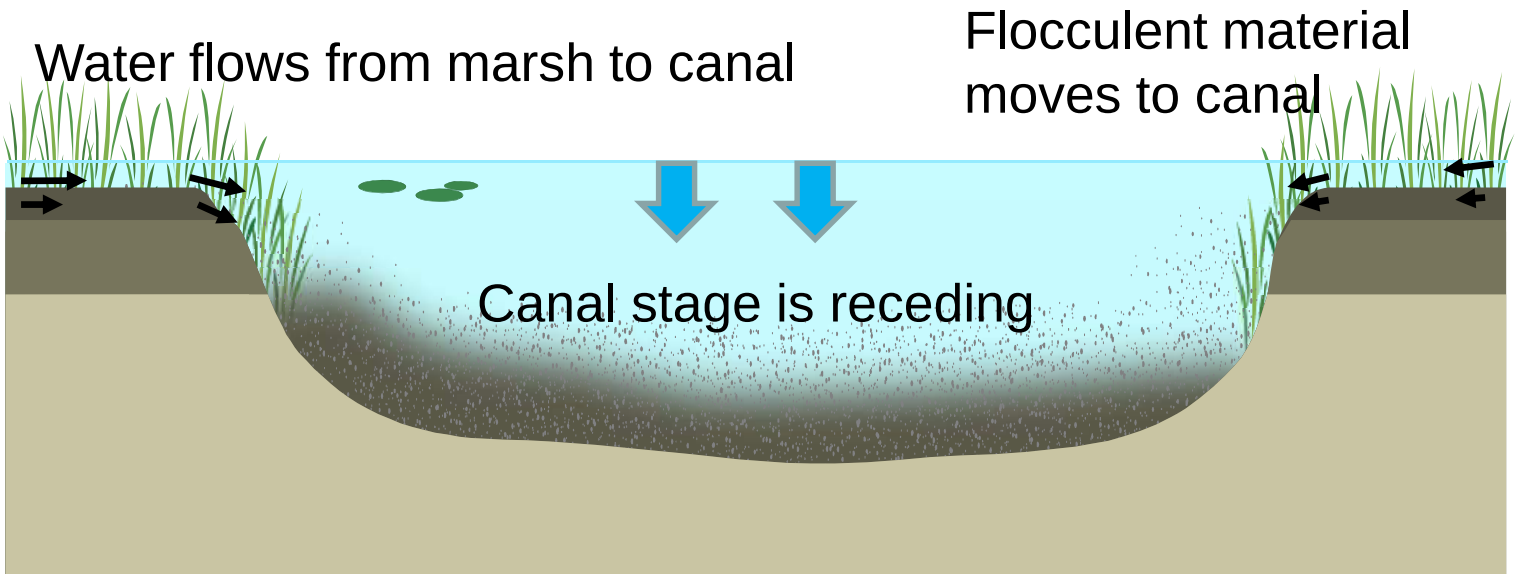
- Canal stage > marsh stage (S333 headwater > 9.2 ft) with high upstream discharges.
- Floc layer is intact.
- Upstream inflow FWM TP > S151 TP.



Two TP transport regimes are proposed

An marsh loading dominated regime at low stage:

- Canal stage < marsh stage (S333 headwater <9.2 ft), driving water from marsh to canal.
- The floc layer is mobilized, moving with surface flow and subsurface seepage.
- Upstream inflow FWM TP < S151 TP; high TP in low-lying areas and in canals.

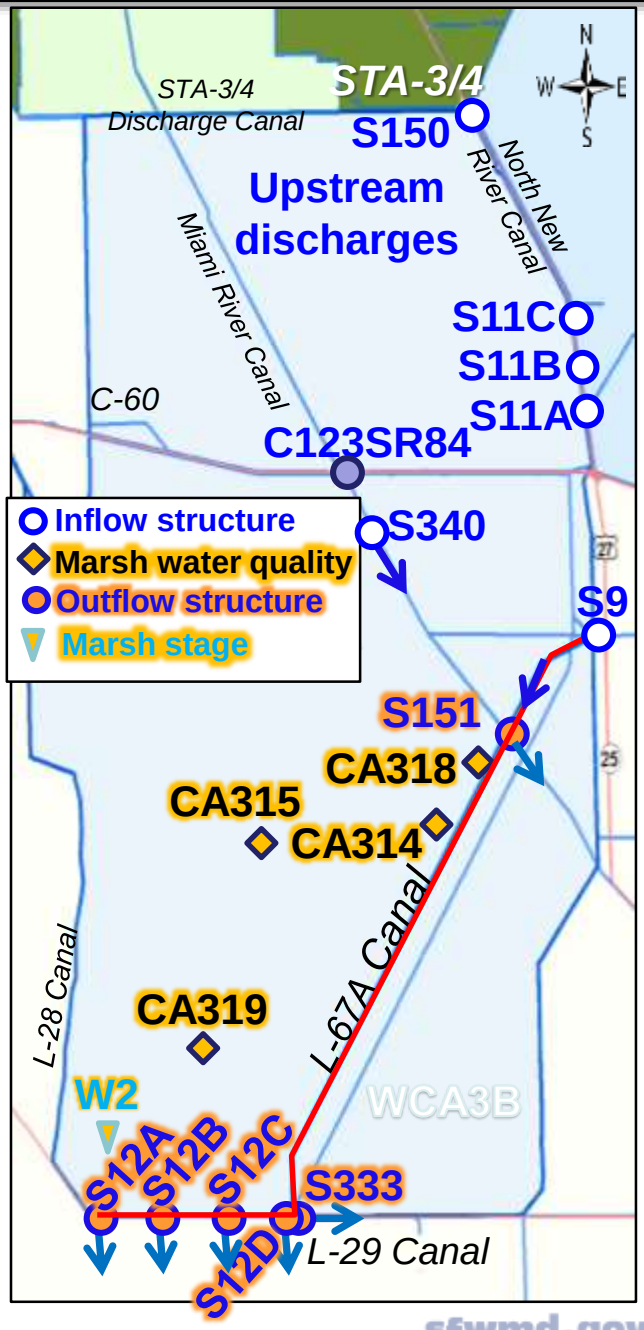


Key findings

- TP concentrations from upstream sources has been reduced greatly with full operation of BMPs and STAs.
- The system transitioned from the upstream inflow to stage as the main driver to TP variations at WCA-3A outflow structures.
- S12A had the highest TP concentrations among the outflow structures.
- Two TP transport regimes are proposed.
    - Under high stage, TP concentrations across the system are low.
    - Under low stage, higher TP concentrations observed at outflow structures are caused by downstream TP loading, likely associated with mobilization of the floc layer.
- Further study of marsh-canal interaction is needed.

Implication – Get the water level right

Moving towards future, improving water level management with Everglades restoration is an important mechanism to achieve low TP at outflow structures.



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