Cross-sectional Monitoring Phosphorus to Investigate Influence of Flow Dynamics and Gate Structure at S-333

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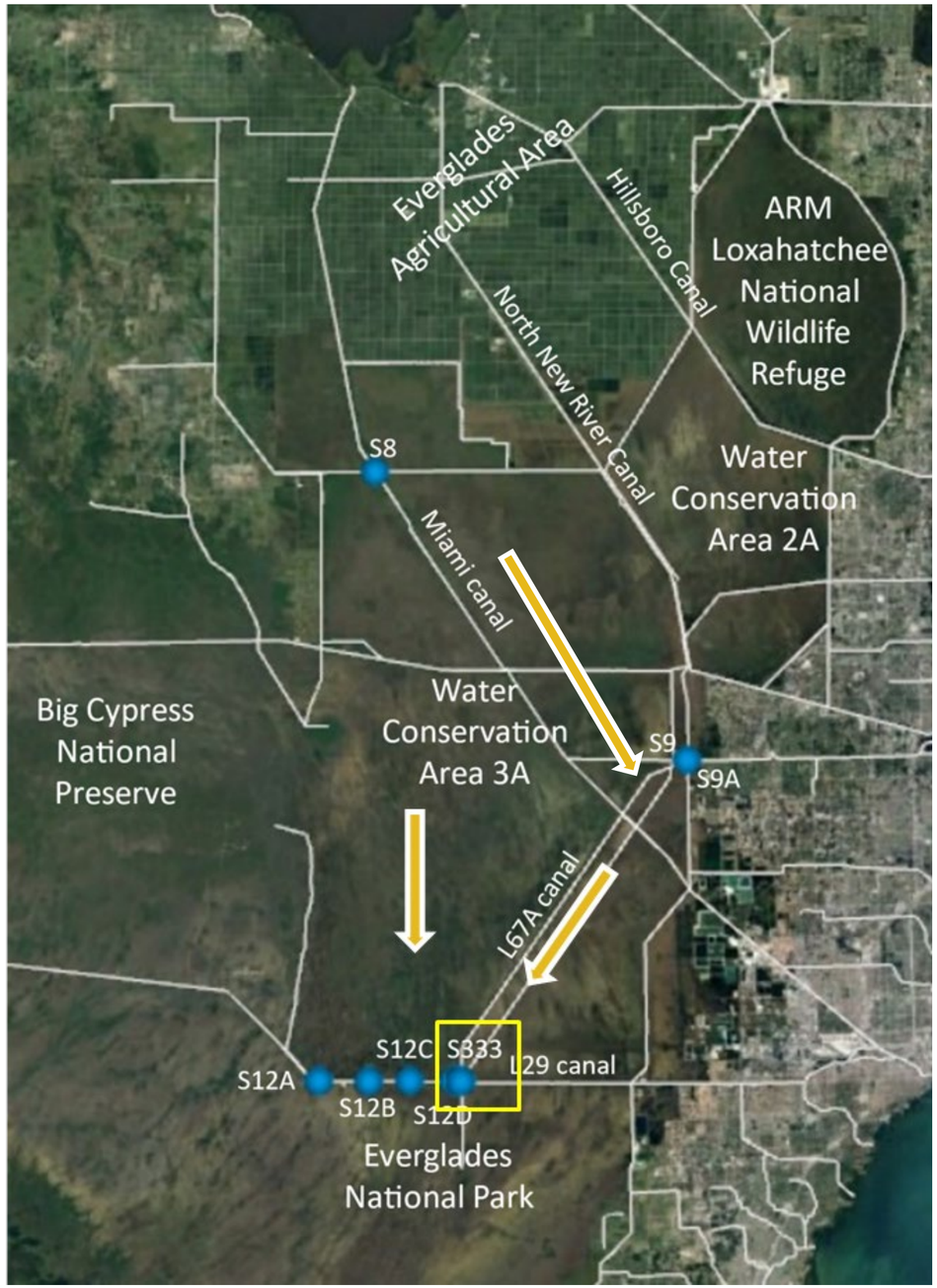
BACKGROUND

- Northern ENP receives water elevated in TP during low water stage conditions

- Water delivered to the Park originates from:
  - Water Conservation Area (WCA) 3A marsh
  - Treated water is delivered into and through WCA3A via Miami canal and a fraction is intercepted by L67A and delivered to S333
  - Urban area through structure S9

- Structure S333 receives a mix of water from the marsh and the L67A canal



OBJECTIVES

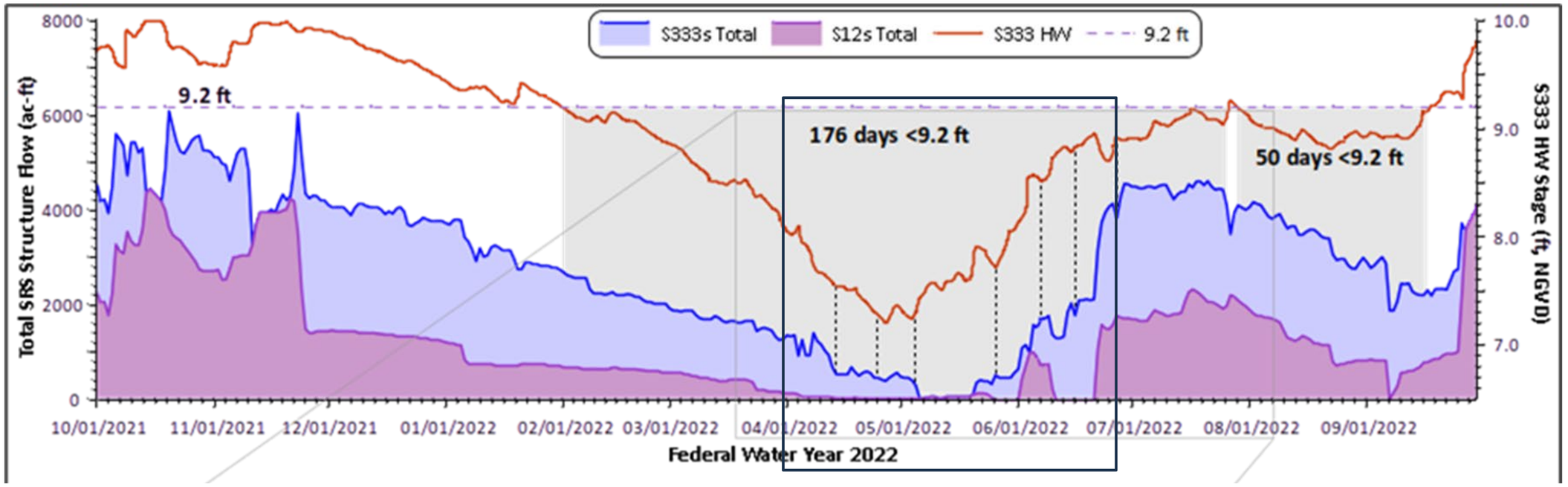
- Conduct a sediment characterization to understand the drivers of elevated TP delivered to Shark River Slough
- Focus on cross-sectional flow variations of TP upstream of the S333 gate to understand sediment entrainment
- Specifically:
  - Examine flow profiles and direction in L67A, L29, and at the S333 gate
  - Develop sediment physiochemical profiles for L67A, L29, and the bay in front of S333
  - Investigate sediment transport at the S333 gate and upstream in the L67A and L29
  - Quantify sediment volume using an acoustic sediment survey along the canal floor

METHODS

- Flow profile & direction
- Water sampling
- Sediment core sampling
- Spatial and statistical data analyses

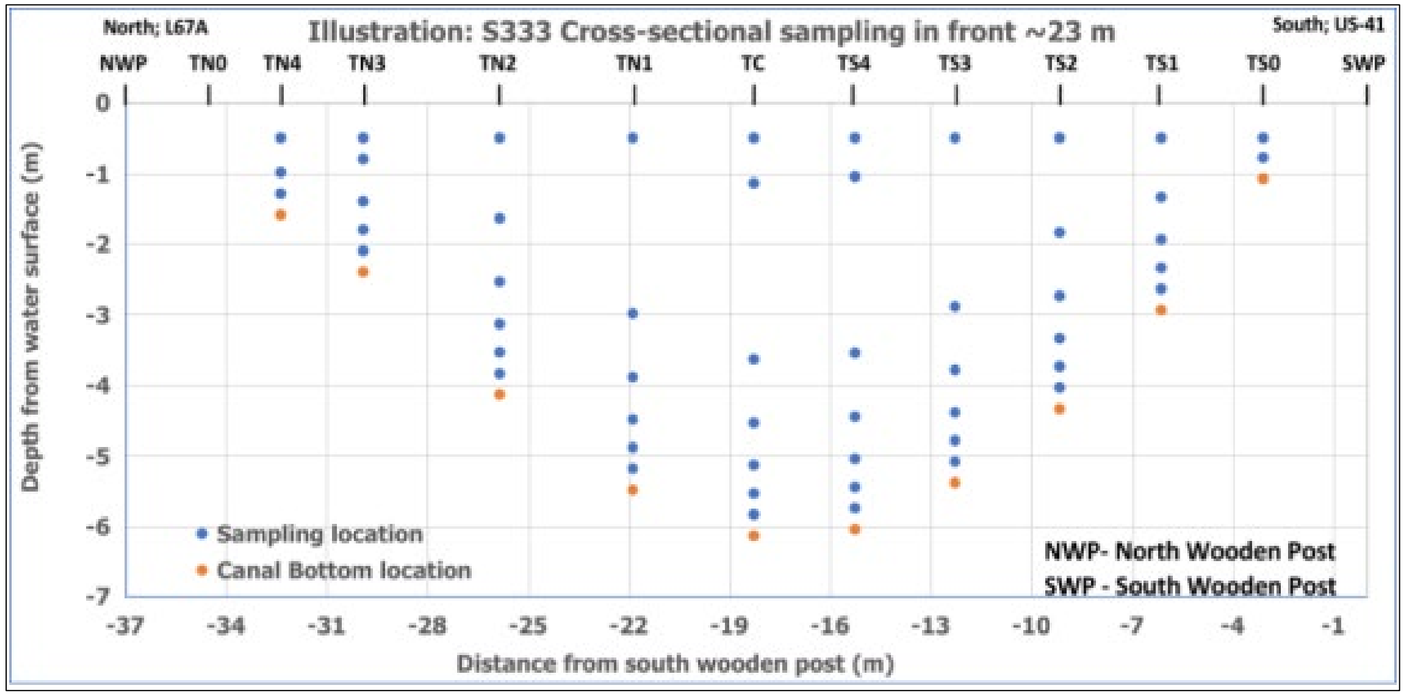
Flow Profile & Direction

- Acoustic Doppler Current Profiler (ADCP) measured current velocity
- Tilt current meters (TCM) continuously measured flow direction
- 7 events (headwater of S333 structure < 9.2 ft)



Cross-sectional Water sampling

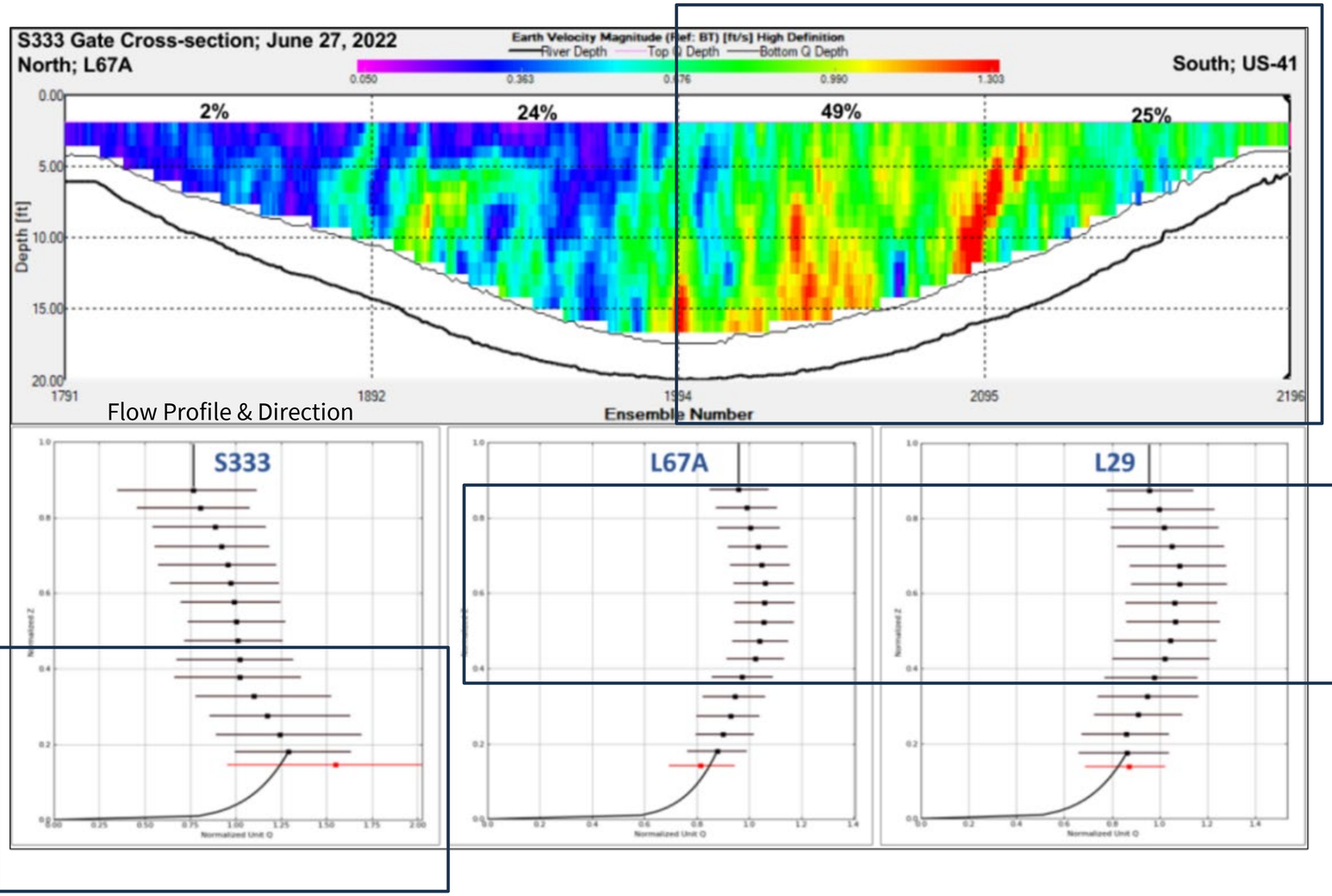
- In front (~23 m) of S333 on a horizontal transect across vertical transects
- 3 - 8 depths
  - 30, 60, 100, 160, 250, and 500 cm from the canal bed
  - 50 and 100 cm from the water surface
- Measured for:
  - Total phosphorus (TP)
  - Particle size distribution



Sediment Core Sampling

- A total of 79 sampling sites
  - L67A: 10 transects
  - L29: 12 transects
  - S333: 8 transects
- Measured for:
  - Total P
  - Bulk density
  - Particle size
  - Sediment depth
  - Total phosphorus mass
  - Aerial volume of sediment TP for removal

RESULTS - Flow Profile



Flow Profile & Direction

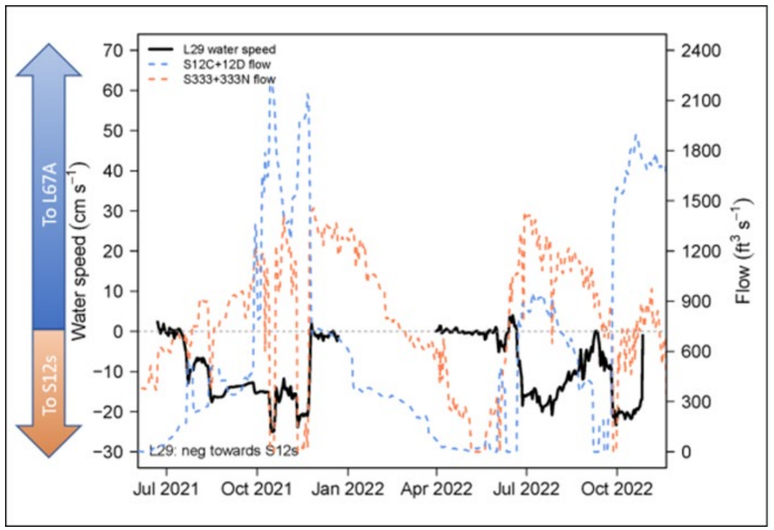
About ~75 % of flows at S333 occurred in the southern half of the canal on June 27

Higher flows occurred towards the bottom of the canal, coincident with the gate lifting at S333

Away from the structure, higher flows were observed in the upper middle half of the canals

RESULTS - Flow Direction

- L29 canal predominantly flows westwards towards S12C&D and draws water from L67A canal when S12C&D gates are discharging
- Most L67A flows goes to S333 remainder moves west when S12s open



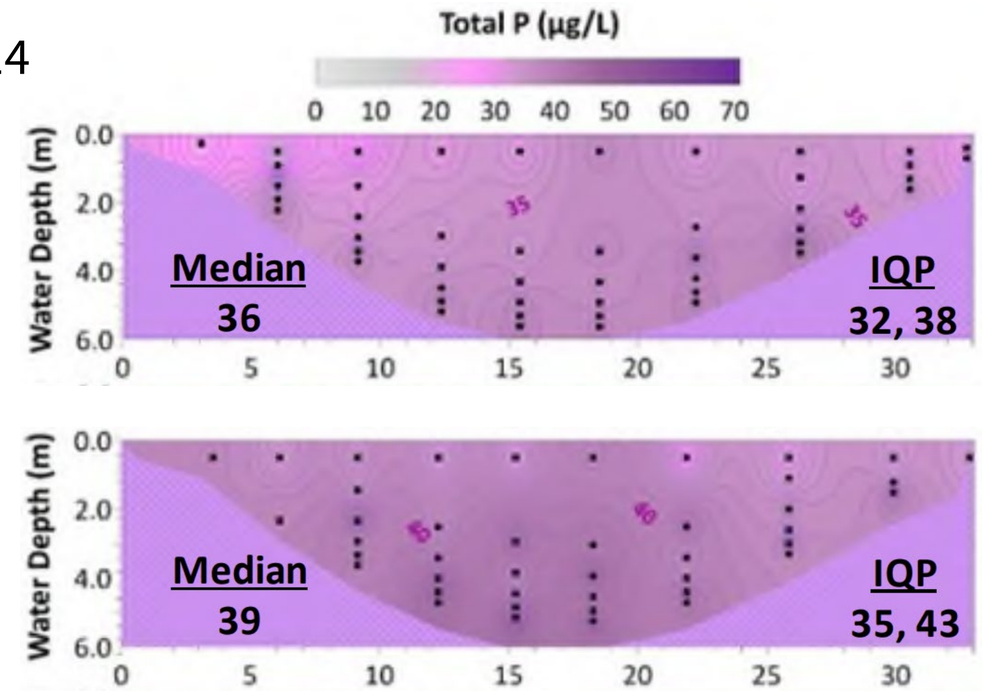
Date	S333 Gate data			Flow (cfs)	Flow (cfs) ADCP measurements (QRev)			Remarks for L29 Flow
	Gate opening (ft)	Head Stage (ft)	Tail Stage (ft)	S333 DBHYDRO	S333	L67A	L29	
Apr-14, 2022	8.20	7.55	7.52	283.1	366.7	389.1	-30.2	flowing east towards S333
Apr-25, 2022	8.20	7.28	7.26	194.6	209.9	259.6	-16.6	flowing east towards S333
May-05, 2022	8.18	7.27	7.25	233.6	228.1	229.8	-97.0	flowing east towards S333
May-26, 2022	2.40	7.63	7.02	327.7	307.1	410.3	-1.4	flowing east towards S333
Jun-07, 2022	3.21	8.53	7.77	488.4	454.3	577.8	**142.6**	**flowing west towards S12C&D**
Jun-16, 2022	3.80	8.86	8.01	614.9	562.1	830.5	**260.6**	**flowing west towards S12C&D**
Jun-27, 2022	5.00	8.95	8.27	719.6	670.9	1614.0	**823.9**	**flowing west towards S12C&D**

RESULTS - Cross-sectional Water Sampling

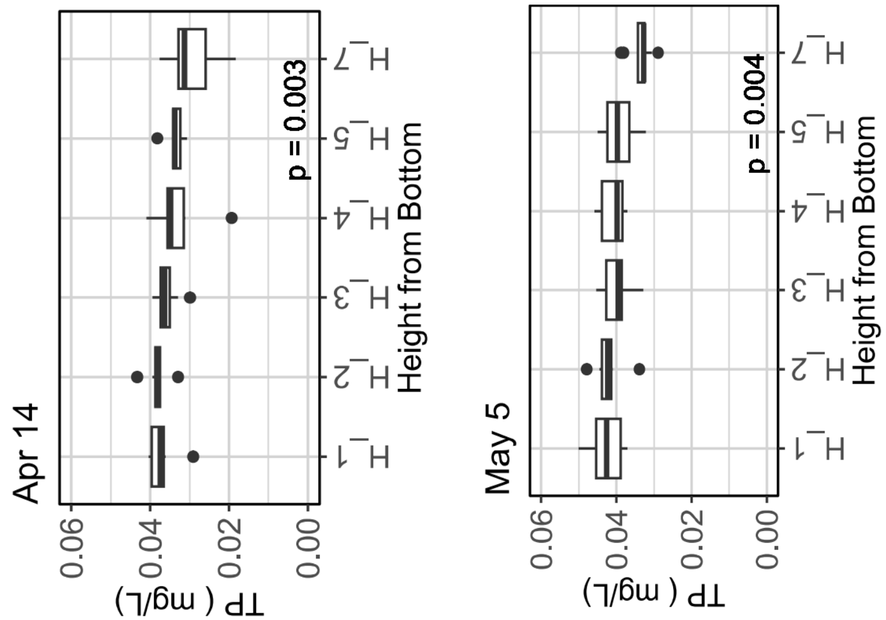
- There were significant relationships between distance from the canal bed and TP concentrations for 4 sample events (April 14, May 5, May 26, and June 16)
- For 7 sampling events, TP concentrations were much greater than 8 µg/L (protective inflow target)
- Higher TP concentrations near the canal bottom

April 14

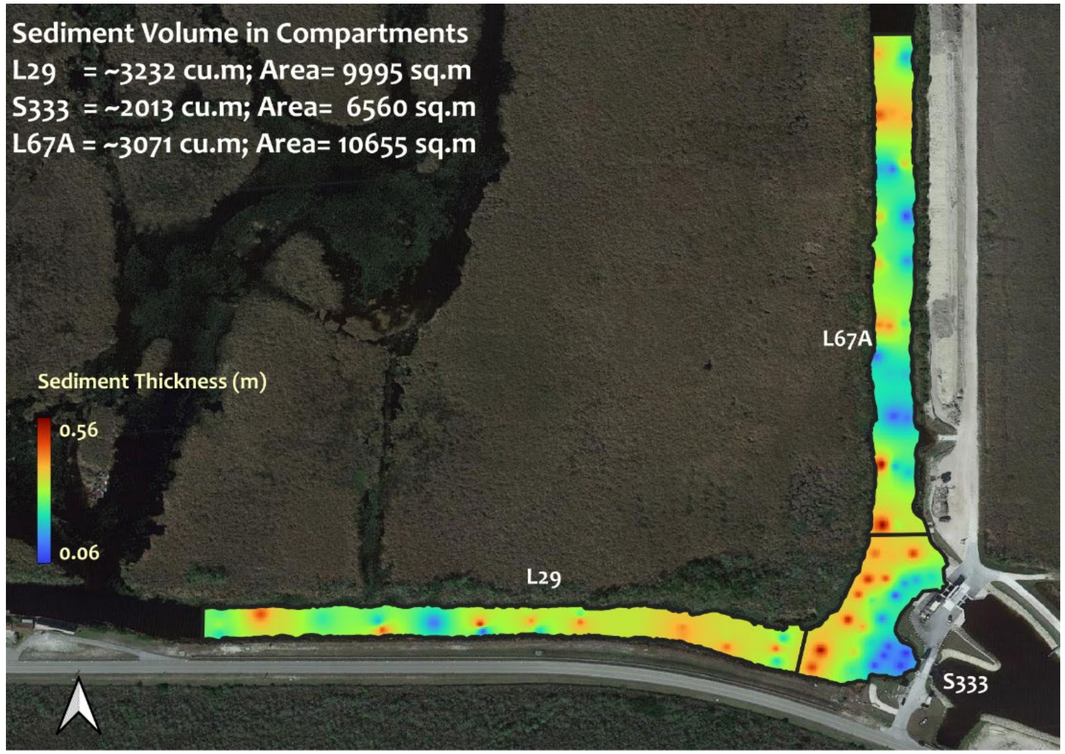
May 5

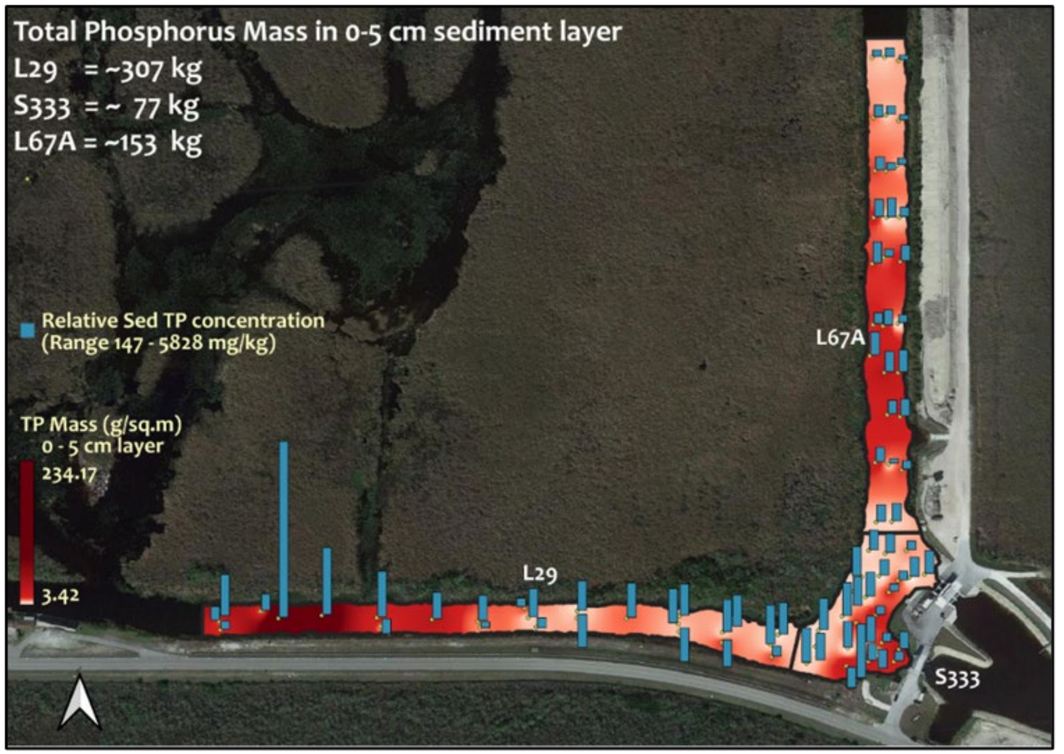


H1 represents 30 cm from the canal floor
H7 represents 50 cm from the canal surface



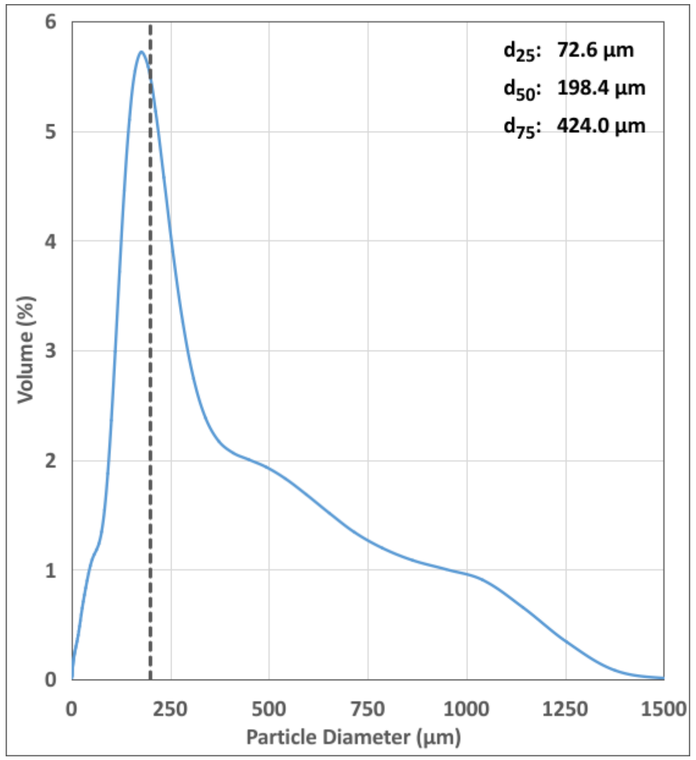
RESULTS - Sediment Volume and TP Mass



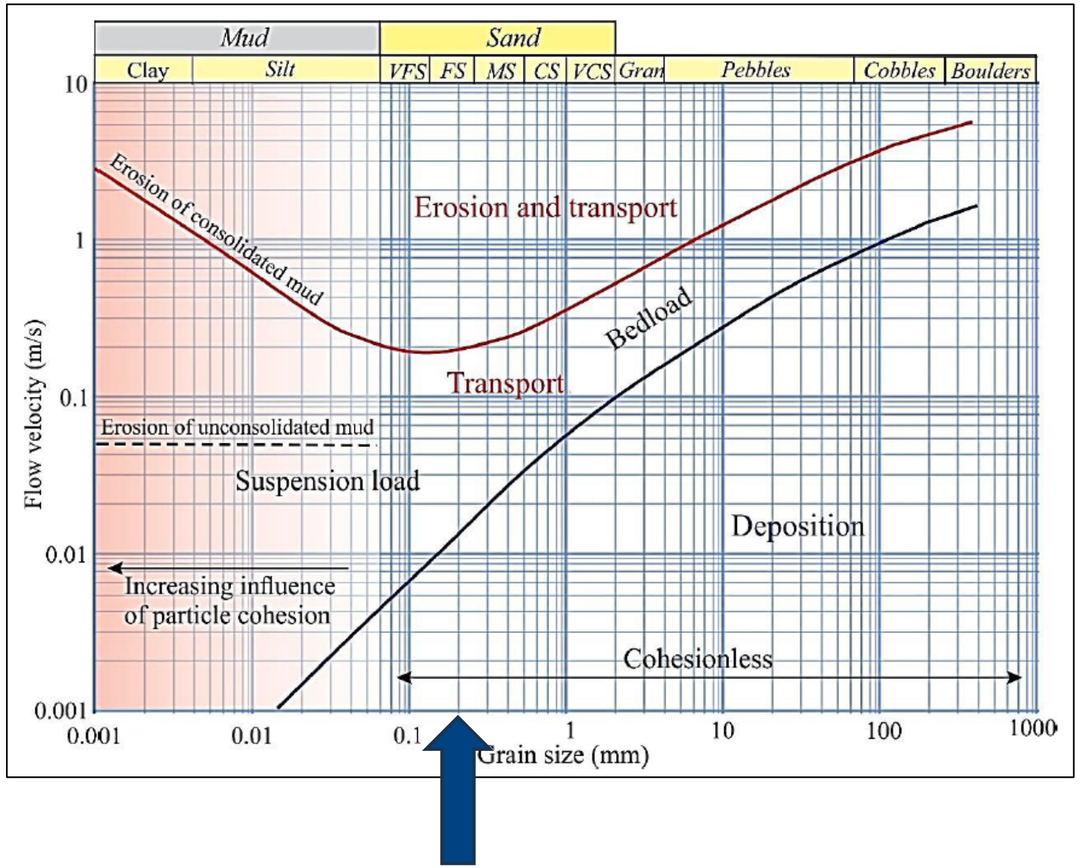


Compartment	Total Area (m^2)	Sediment Volume (m^3)	Total P Mass in 0-5 cm (kg)
L29 Canal	9,995	3,232	307
L67A Canal	**10,655**	**3,071**	**153**
S333	6,560	2,013	77

Particle Size Distribution (Laser Diffraction)

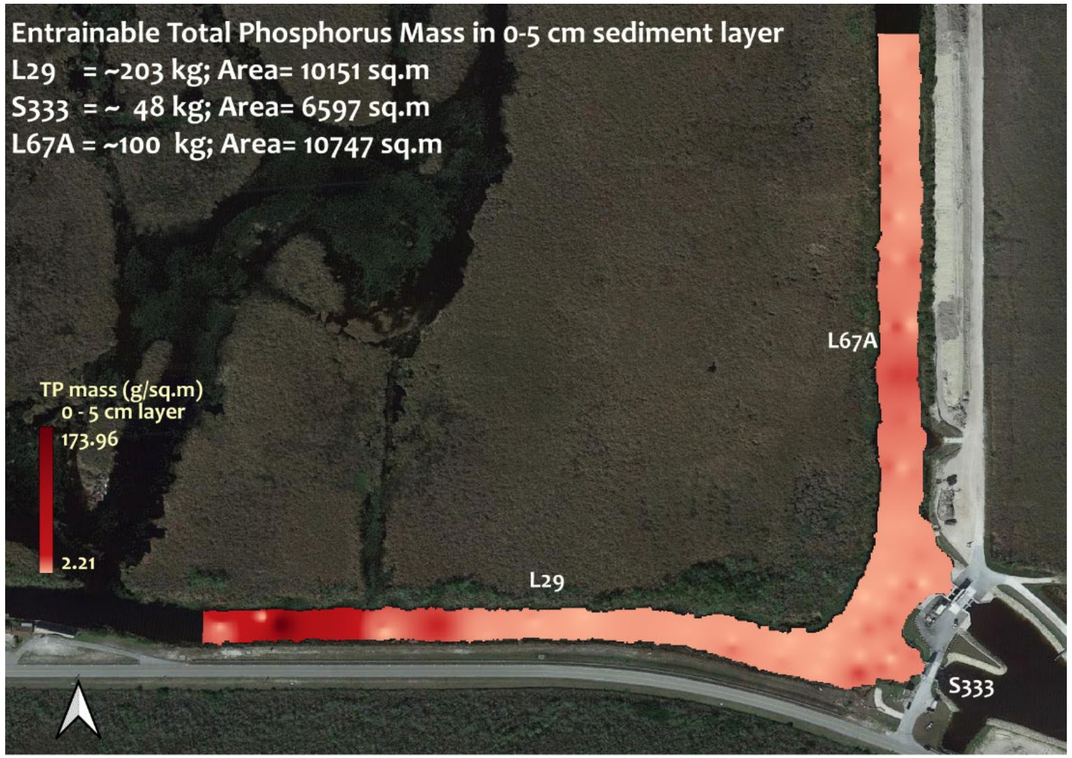


Compartment	Median particle size d_{50} (µm)	25%	75%
L29 Canal	188	169	206
L67A Canal	166	145	**224**
S333	**143**	130	188



Used 200 µm to delineate entrainable sediment grains

Entrainable Sediment Volume & TP Mass



Compartment	Total Area (m^2)	Sediment Volume (m^3)	TP Mass in 0-5 cm (kg)
L29 Canal	9,995	290	203
L67A Canal	**10,655**	**352**	**100**
S333	6,560	222	48

SUMMARY

Sediment Transport
&
Elevated TP
Concentration

Water

- L67A canal contributes to L29 canal
- Observed velocities high enough to entrain TP-rich sediments
- Higher velocities at the canal bed
- Highest water TP at the bottom when the gate was open

Sediment

- Volume ~ 8,000 m^3 in study area
- TP mass ~ 537 kg
- Entrainable particle size ≤ 200 μm
- Entrainable TP mass ~100 kg in L67A

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Greater Everglades Ecosystem Restoration

Thank You!

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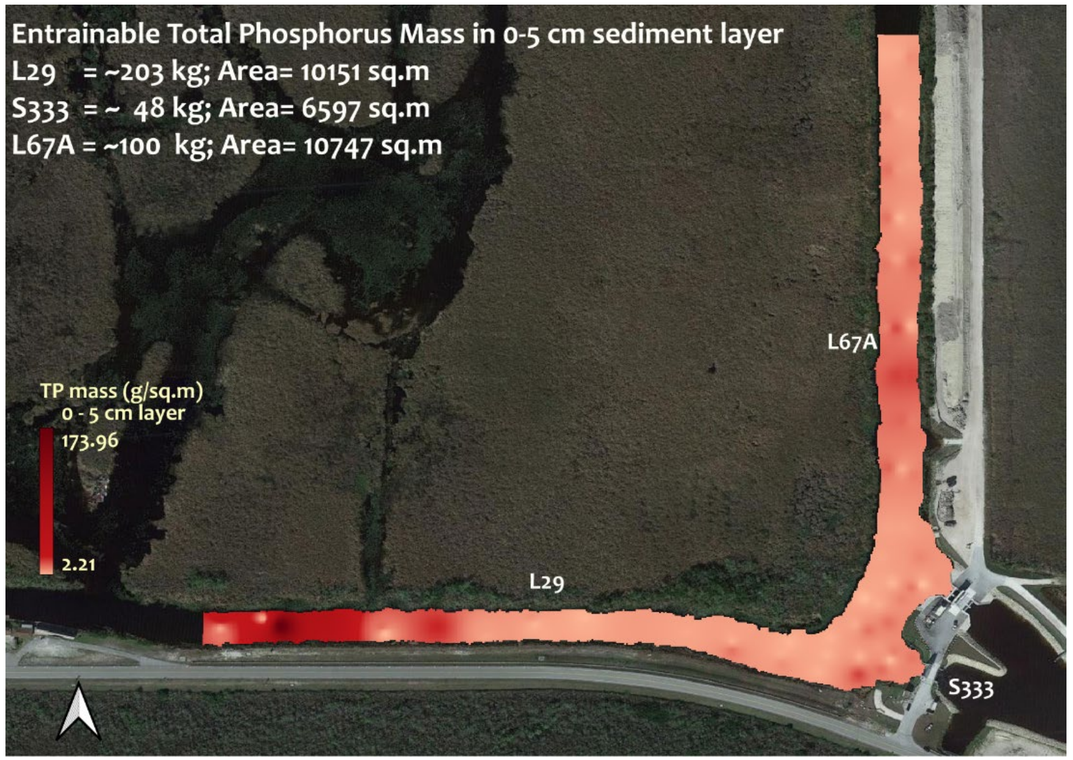
April 22, 2025
Coral Springs, FL

Entrainable Sediment Volume & TP Mass



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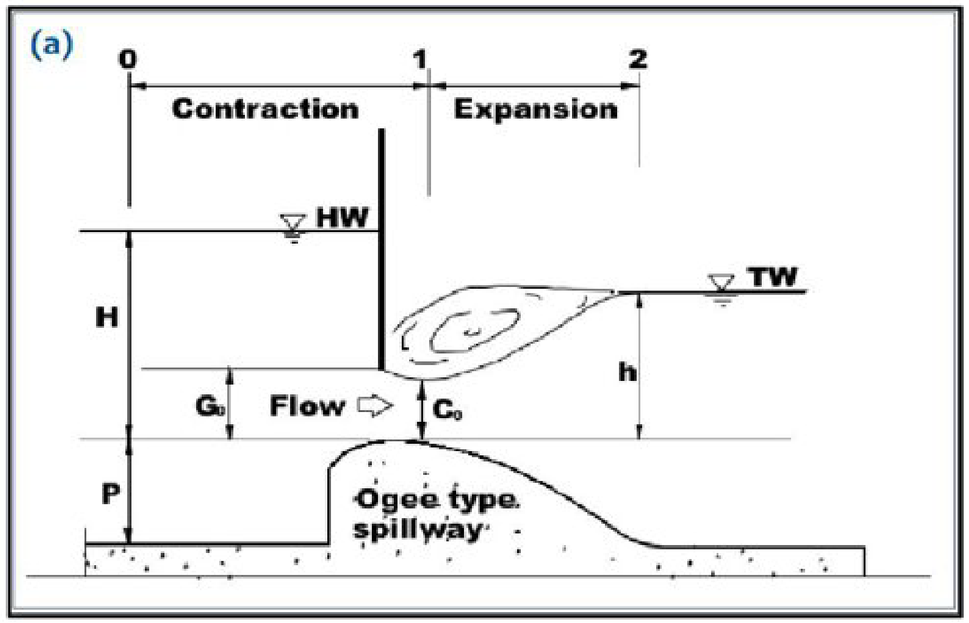
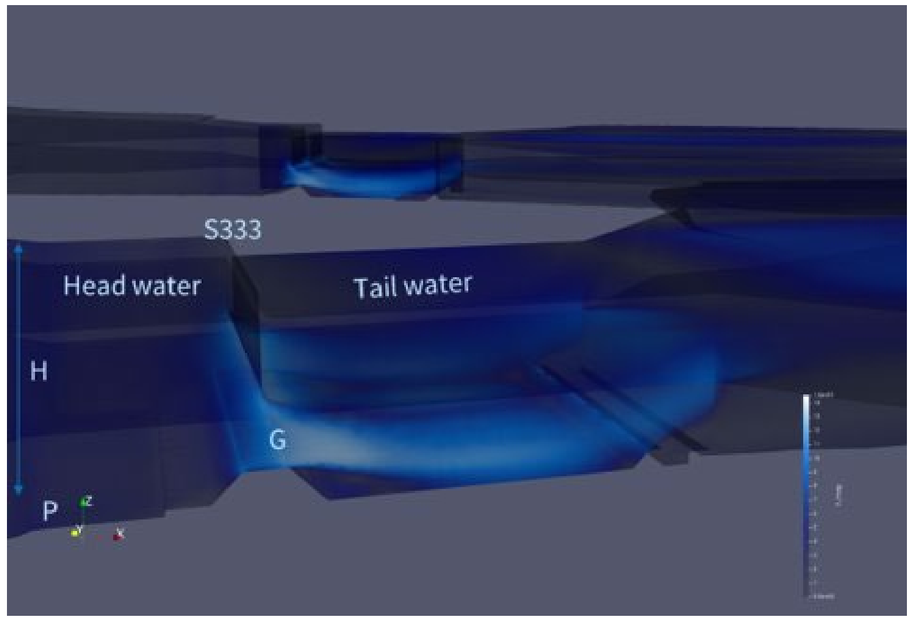
Extra - Canal Flow Velocity

- Lifting the gate open from the bottom (canal floor), promoting flow intake from canal bottom that can induce near canal bed scouring and entrain nutrient rich sediments
- Under low stage conditions, these entrained sediments increase water column TP concentration and thus TP loads delivered to the Park





S333 gated structure design. Spillway with a lift-gate resting on it 3 ft from canal floor

FURTHER CONSIDERATIONS

- This study resulted recommendations to dredge sediments at the front of S333 and upstream along the L67A and L29 canals
- Follow-up vibracoring studies by SFWMD identified a significantly larger volume of sediments than observed in our study (See S333 WORKING GROUP PHASE 1 SYNTHESIS REPORT)
- The engineering solution is currently being implemented by SFWMD, with completion anticipated by November 2026