Key Factors Controlling Wetland Aquatic Productivity in the Everglades Stormwater Treatment Areas

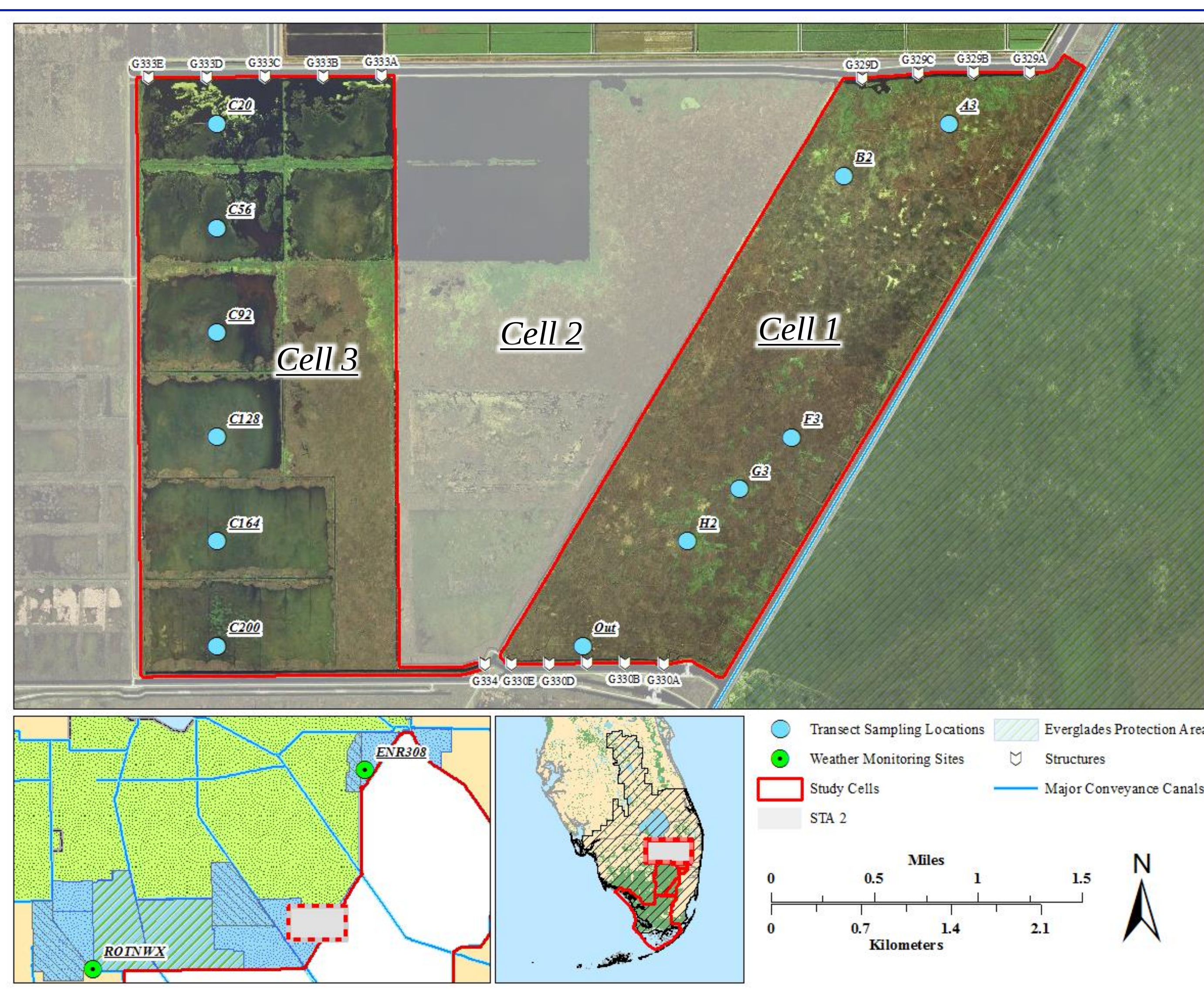
Paul Julian II[1,2], Matthew Powers[3], Rupesh Bhomia[4], Alan Wright[1] and Jacob Dombrowski[3]
[1]University of Florida, Soil and Water Sciences, Ft. Pierce, FL, USA
[2]Florida Department of Environmental Protection, Office of Ecosystem Projects, Ft. Myers, FL, USA.
[3]South Florida Water Management District, Water Quality Treatment, West Palm Beach FL, USA
[4]University of Florida, Soil and Water Sciences, Gainesville, FL, USA

1 Introduction

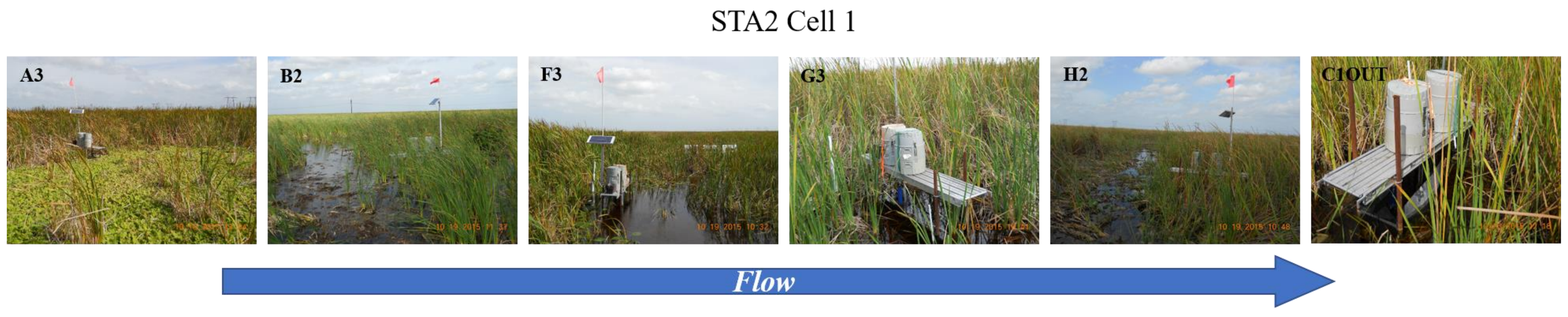
Net aquatic productivity (NAP) is the net effect of gross primary productivity (GPP) and ecosystem respiration (ER) and is a fundamental metric of an ecosystem related to organic matter, C sources and sinks. Gross primary productivity is the rate of organic matter production within an ecosystem by photosynthesis, ER is the total consumption of organic matter in an ecosystem via aerobic respiration, and NAP is the balance between GPP and ER. Aquatic metabolism can be driven by several key environmental drivers including water quality (i.e. nutrient concentration) and the quantity, timing and distribution in aquatic ecosystems.

The objective of this study was to evaluate changes in aquatic productivity relative to changes in flow regime, nutrient concentrations and dominant vegetative community. High frequency dissolved oxygen (DO), temperature and other water quality parameters were measure during prescribed flow regimes in two treatment cells within the Everglades Stormwater Treatment Areas (STAs) to assess the changes in nutrient concentrations along the treatment cell.

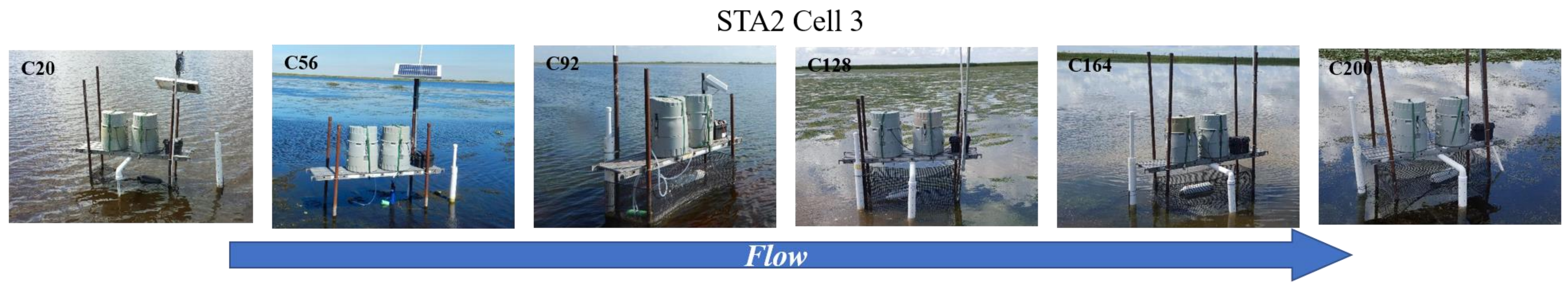
2 Material and Methods



STA2 Cell 1



STA2 Cell 3



Water Quality

- Autosamplers were deployed during flow events to collect surface water samples every 4 hours. Total phosphorus was measured on these samples.
- Specific conductance, total chlorophyll, pH, DO and temperature data were measured at 15-30 minute intervals along the flow transect using in-situ sondes.

Aquatic Productivity

- GPP, ER and NAP were estimated using the rate of DO change from hourly mean DO concentrations along flow transects (Odum 1956; Thébault and Loreau 2003).
- Hourly mean wind speed, air temperature and barometric pressure were used to estimate DO exchange rate between the atmosphere and water column via the volumetric re-aeration coefficient (Thébault and Loreau 2003).
- For sites with dense vegetation (i.e. Cell 1), it was assumed that vegetation would reduce wind speed at the air-water interface to effectively zero (Hagerthey et al. 2010).

Hagerthey SE , Cole JJ, Kilbane D (2010) Aquatic metabolism in the Everglades: Dominance of water column heterotrophy. Limn & Ocean 55:653–666.
Odum HT (1956) Primary production in flowing waters. Limn & Ocean. 1:102–117.
Thébault E, Loreau M (2003) Food-web constraints on biodiversity–ecosystem functioning relationships. PNAS 100:14949–14954.

3 Results

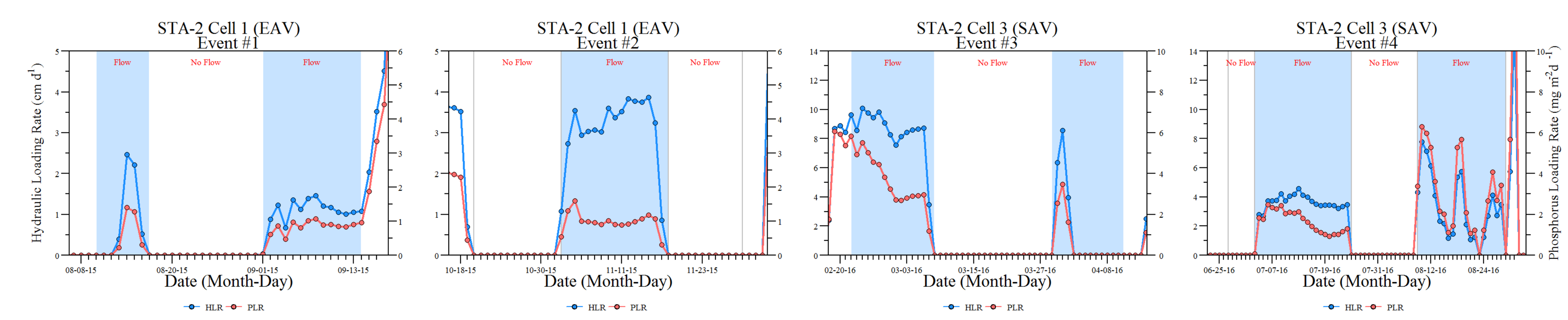


Fig 2. Hydraulic (cm d^{-1}) and P loading rates (mg m^{2} d^{-1}) for each flow event and STA cell.

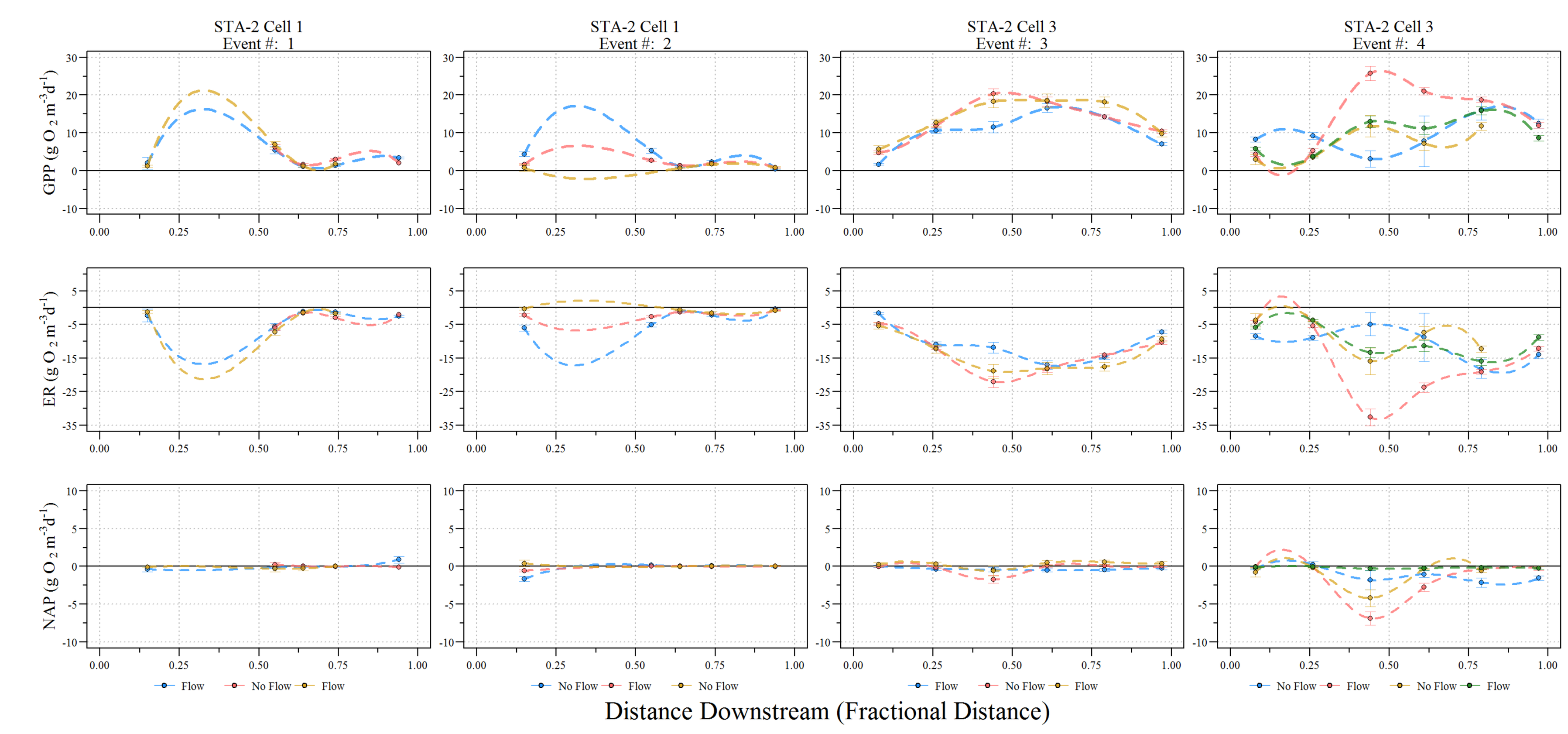


Fig 3. Flow period gross primary productivity (GPP), ecosystem respiration (ER) and net aquatic productivity (NAP) estimates along the treatment cell for each flow event and STA cell (mean ± SE).

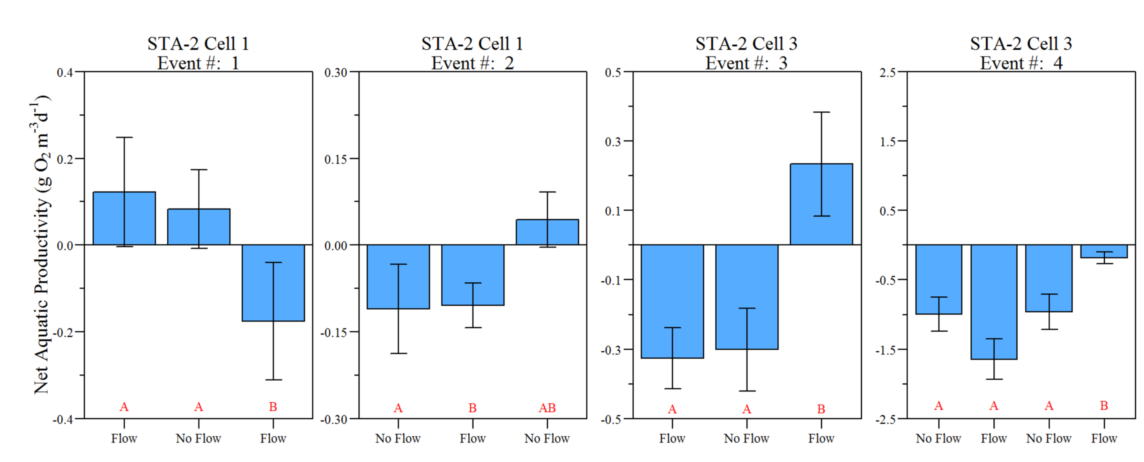


Fig 4. Net aquatic productivity for each flow period within each flow event and STA cell (Mean ± SE). Letters at the bottom of bars indicate differences between flow events within each flow event according to Dunn's multiple comparison test.

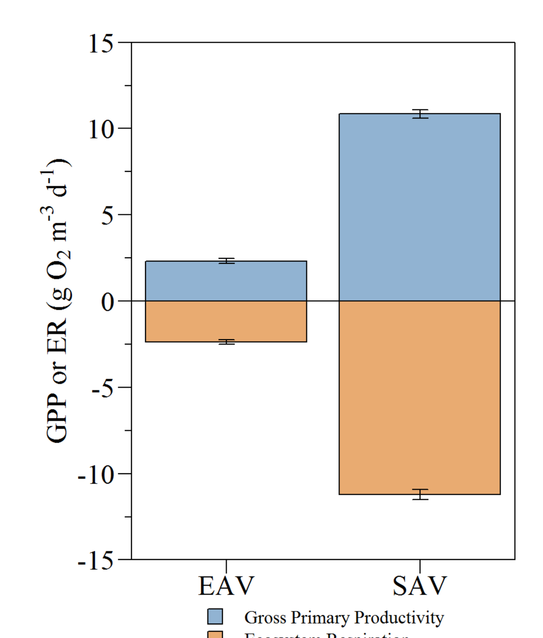


Fig 5. Gross primary productivity and respiration estimates aggregated by dominant vegetative community. (Mean ± SE)

Table 1. Spearman's rank correlation results for the comparison between net aquatic productivity and daily mean total phosphorus (estimated from 4-hour interval autosampler TP data), daily mean specific conductivity, pH and turbidity (estimated from high frequency sonde data) for data collected in STA-2 Cell 1 and STA2 Cell 3 during the four planned flow events.

		Total Phosphorus		Specific Conductivity		pH		Turbidity	
STA	**Comparison**	**ρ-value**	**Spearman's τ**	**ρ-value**	**Spearman's τ**	**ρ-value**	**Spearman's τ**	**ρ-value**	**Spearman's τ**
STA 2 Cell 1	All data (irrespective of flow)	*<0.05*	-0.24	0.16	0.08	0.08	0.11	<0.001	-0.20
	Flowing Conditions	*<0.01*	-0.34	0.93	0.007	0.18	0.11	0.08	-0.14
	No Flow Conditions	0.21	0.27	<0.01	0.23	0.49	0.06	<0.05	-0.22
STA 2 Cell 3	All data (irrespective of flow)	0.06	-0.08	0.17	0.06	0.57	-0.03	0.45	-0.03
	Flowing Conditions	0.34	-0.05	0.97	0.002	0.97	-0.002	0.90	0.006
	No Flow Conditions	0.25	-0.08	<0.01	0.18	0.38	-0.07	0.10	-0.12

4 Conclusions

- GPP, R and NAP differed between cells with STA2 Cell3 (i.e. SAV dominant) having an order of magnitude difference in productivity estimates (Fig. 3).
- NAP and daily mean TP (from 4-hour autosampler) was correlated for STA2 Cell1 under flowing conditions. NAP and daily mean TP was not significantly correlated for no-Flow conditions in STA2 Cell 1 or all conditions within STA2 Cell3 (Table 1).
- NAP was positively correlated with specific conductance during no flow conditions for both cells.
- Turbidity significantly negatively influenced aquatic productivity in STA2 Cell1 (EAV cells).
- Overall, flow conditions didn't significantly influence NAP in STA2 Cell 1 (χ^2=1.02, df=1, ρ=0.31). However, NAP was influenced by flow conditions for STA2 Cell 3 (χ^2=14.15, df=1, ρ<0.01).
- Additionally, flow timing qualitatively influenced aquatic productivity (Fig. 4).

5 Acknowledgements

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*Contact: pjulian@ufl.edu