CHARACTERIZING LONG-TERM ECOLOGICAL RESPONSES TO HYDROLOGICAL CHANGE IN IMPAIRED DEPRESSIONAL WETLANDS (TAMPA BAY, FL)

Jessica Balerna, David B. Lewis, PhD and Carley DeFillips

USF Department of Integrative Biology

Motivations

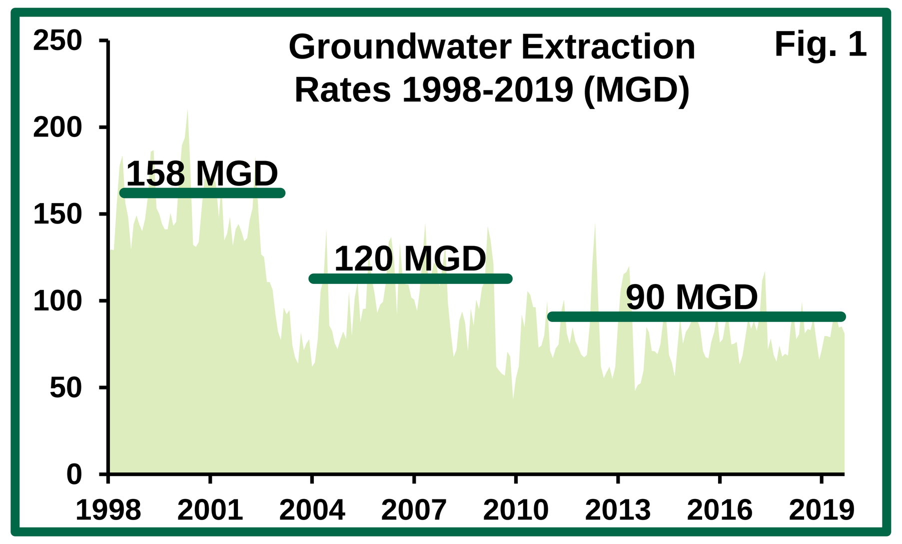
- Depressional wetlands provide numerous ecological services such as carbon sequestration, nutrient filtration, habitat provision, and flood mitigation.[1]
- They additionally increase water security in regions reliant on groundwater, including Tampa Bay, by buffering water table changes through interactions with the underlying aquifer.[2]
- Groundwater extraction is one of the key threats to these wetlands as it alters their hydrological regimes and subsequently their ecological structure and function.[3,4,5]
- Limited long-term and robust datasets are available to assess how wetlands respond to, and recover from, groundwater extraction; however, analyzing these trends can improve wetland conservation and protection, especially in areas where data collection is limited due to financial or labor resources.

Questions & Predictions

1) What are the predominant drivers of ecological change, including species richness and plant community structure—using wetland assessment procedure (WAP) scores as a proxy—in these wetlands? **I predict that while hydroperiod and net pool offset (NPO) will explain most of the variability in WAP scores and species richness, tree fall and soil subsidence are likely to be important co-factors that help explain why reductions in groundwater extraction have not resulted in recovery for all monitored wetlands.**
2) Have wetlands hydrologically and ecologically recovered from peak groundwater extraction rates and, if so, do these wetlands appear to achieve conditions similar to reference wetlands? **I predict that many wetlands will not achieve conditions similar to reference wetlands but instead reach an alternative state characterized by slightly reduced WAP scores and hydroperiods, but increased species richness due to lower, but continued, hydrological disturbances.**

Methods

- 157 wetlands were selected based on availability of water elevation, WAP score, and species richness data from 2005-2018.
- Several composite variables were calculated including **hydroperiod** (% time when water level elevation > wetland bottom elevation) and **net pool offset** (historic normal pool elevation minus water level elevation).
- Multiple linear regression (MLR) was used to assess significant predictors of ecological variables while ANOVA was used to assess differences in recovery trajectories by wellfield.



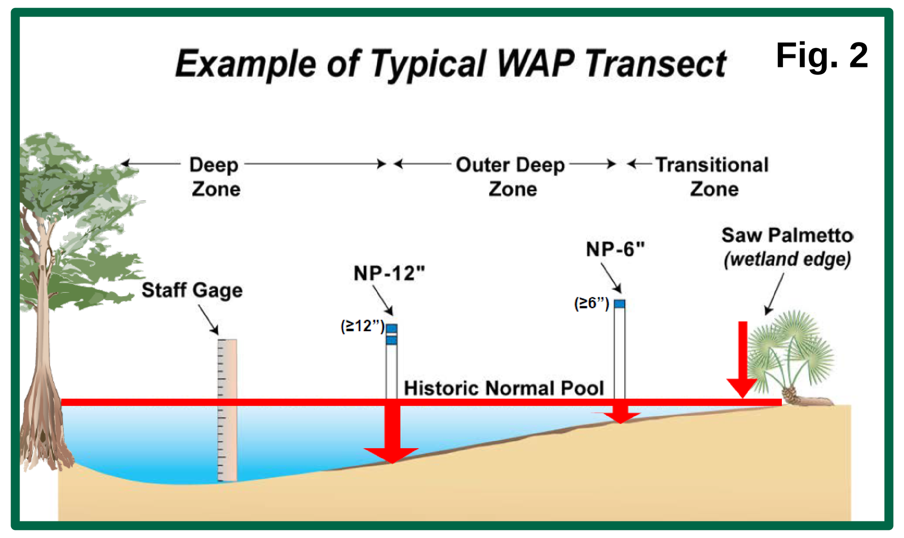


Figure 1 (top): Monthly groundwater extraction from 1998-2019 where values were reduced to counteract adverse effects to wetlands documented prior to 1998. Data provided by TBW. **Figure 2 (bottom):** Illustration of a monitored wetland transect provided by the SWFWMD.

Results

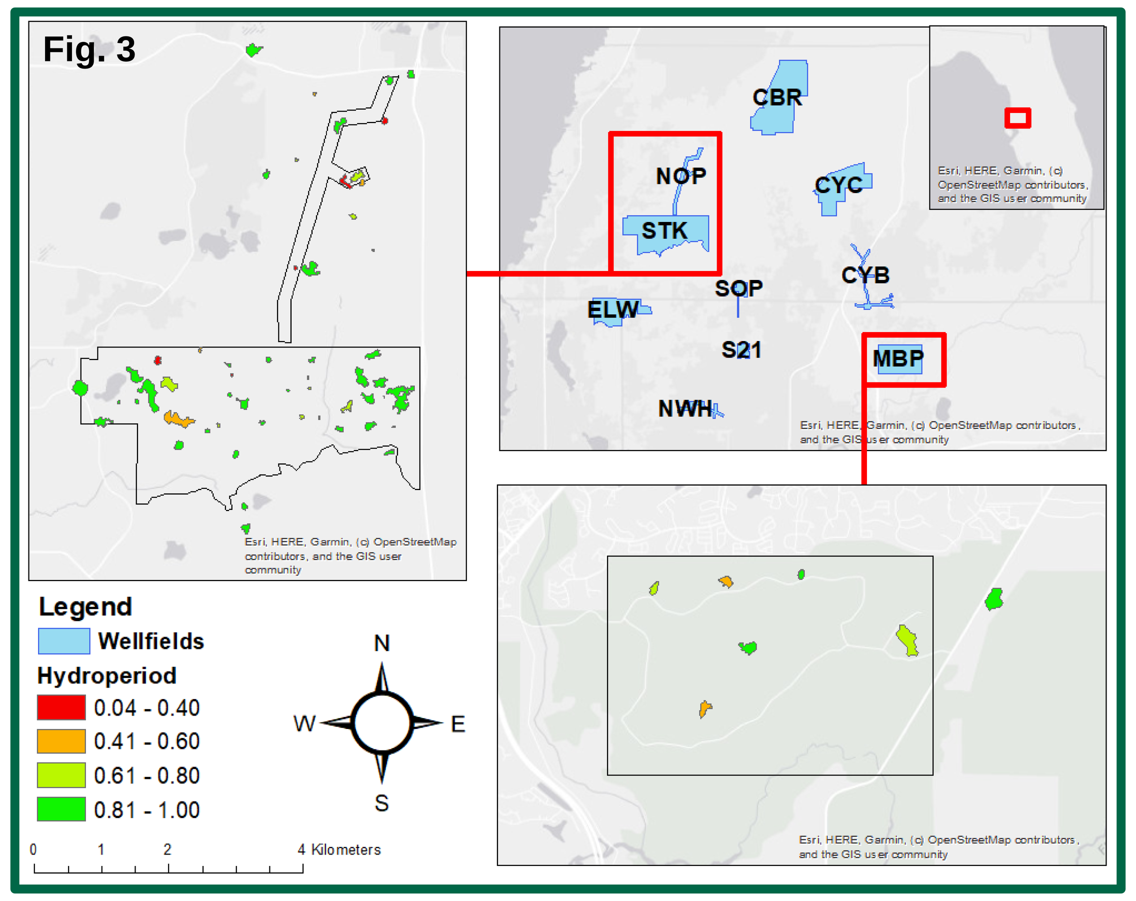
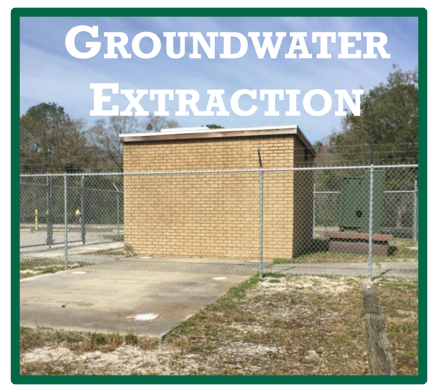


Figure 3: Site map of the Tampa Bay wellfields in 2005 with MBP and STK highlighted to demonstrate wetlands' stages of recovery.



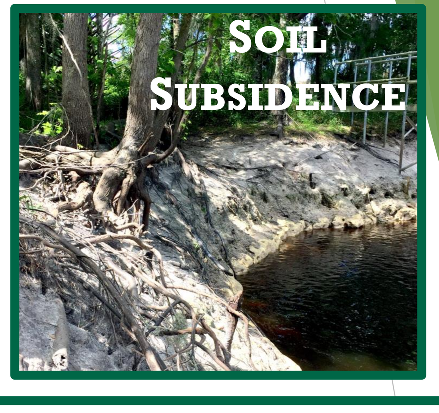


Table 1: Summary results from multiple linear regressions for groundcover WAP scores and species richness with both models significant at p<0.05.

Coefficient	T-statistic	P-value
Groundwater Extraction	-5.78, 6.39	<0.01, <0.01
Net Pool Offset	11.28, 0.50	<0.01, 0.61
Hydroperiod	-1.03, -0.48	0.30, 0.63
Soil Subsidence	3.36, 5.51	<0.01, <0.01
Hog Disturbance	-0.90, 4.89	0.37, <0.01
Tree Fall	4.38, -2.54	<0.01, 0.01

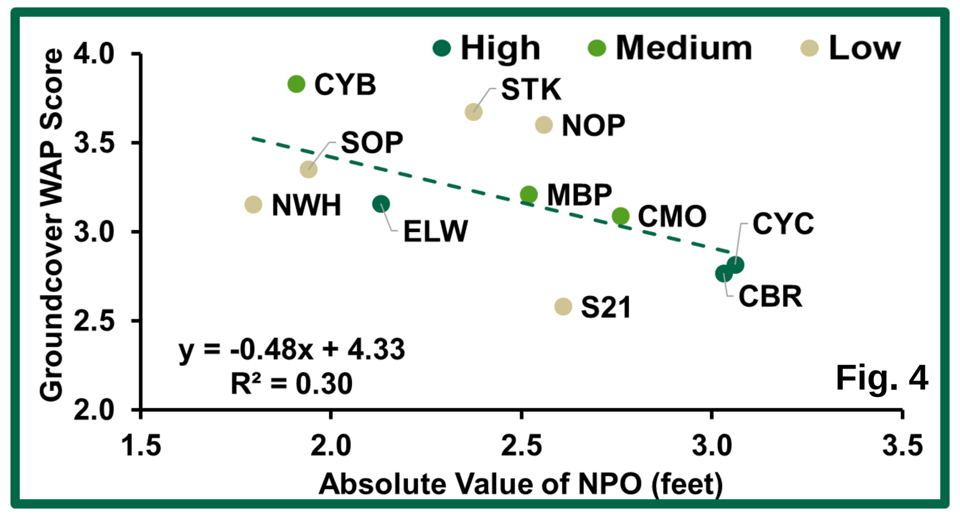


Figure 4: Scatterplot demonstrating the significant relationship (p<0.05) between groundcover WAP score and NPO grouped by historical extraction rates.

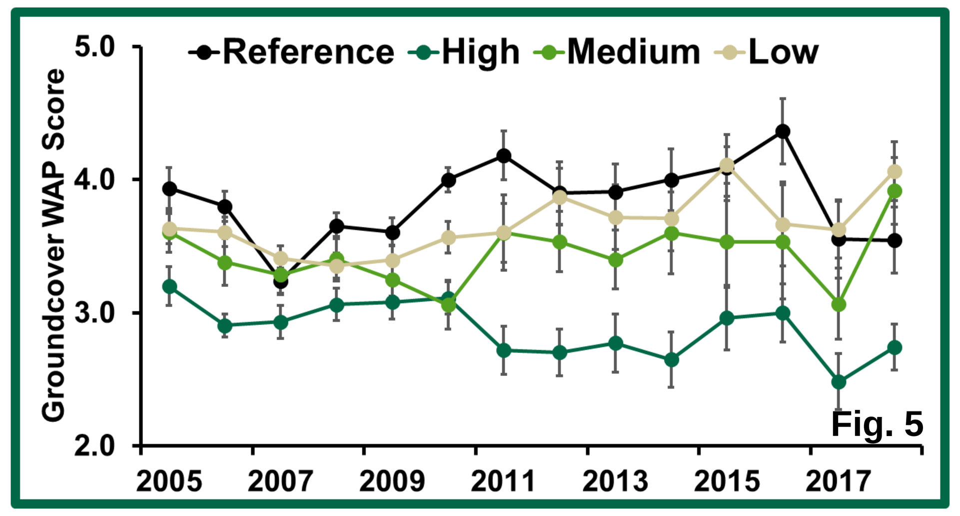


Figure 5: Changes in WAP scores for wetlands with historically high, medium, and low rates of groundwater extraction compared to reference sites.

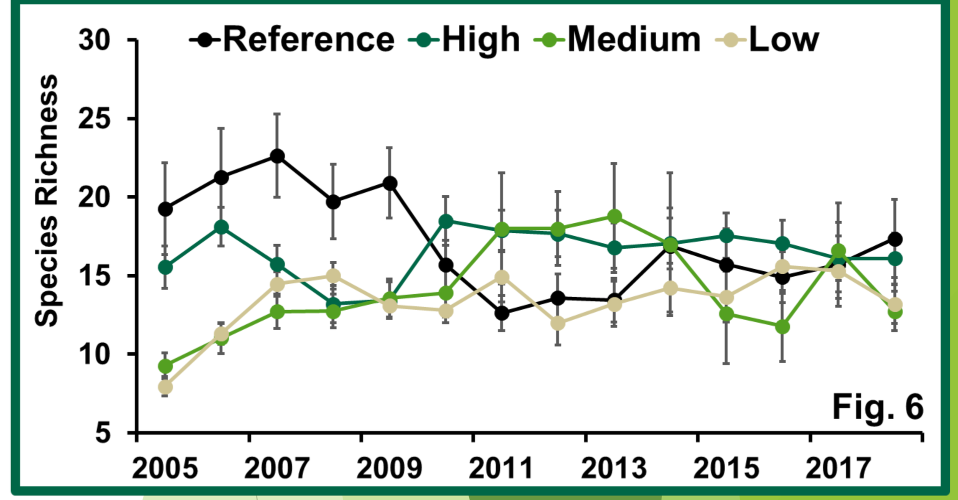


Figure 6: Changes in species richness for wetlands with historically high, medium, and low rates of groundwater extraction compared to reference sites.

Conclusions & Future Work

- **Question 1:** My first prediction was partially supported as the MLRs demonstrate different results for groundcover WAP scores and species richness, though in both cases there were significant predictors beyond hydrological variables (Table 1; Figure 4).
- **Question 2:** My second prediction was also partially supported as there were significant differences between reference and wellfield sites in groundcover WAP scores but not species richness (Figures 5-6).
- These results indicate the importance of measuring more than just hydrological variables when assessing wetland health, and the potential need for active restoration approaches for wetlands affected by groundwater extraction as passive approaches are not restoring all ecosystem services.
- **Future Work:** Calculating additional ecological variables such as percent native species and diversity indices could further delineate the recovery trajectories of these wetlands and better indicate whether they are approaching reference conditions.

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References: (1) Creed et al. 2017. *Nat Geosci.* 10(11):809-815; (2) McLaughlin et al. 2014. *Water Resour Res.* 50:7153-7166; (3) Yepson et al. 2014. *Agr Ecosyst Environ.* 197:11-20; (4) Lewis & Feit 2015. *Glob Change Biol.* 21:1704-1714; (5) Erban et al. 2014. *Environ. Res Lett.* 9:1-7

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