SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Chapter 40E-63 Part III
Master Permit Renewal Application

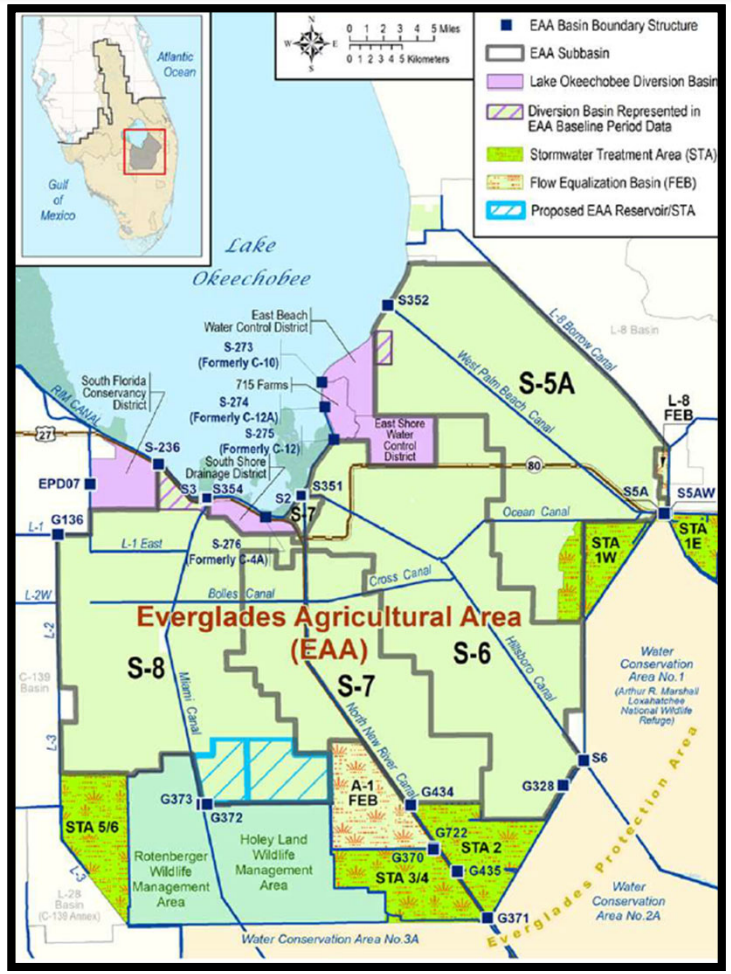
Best Management Practices (BMPs) Research, Testing, and Implementation to Address Water Quality Standards

Public Workshop
July 16, 2025
9:30 AM

sfwmd.gov

Agenda

- **SFWMD Introduction**
  - Gary Priest, Section Administrator
  - Thomas Davison, Regulatory Professional
- **EAA-EPD Research Permit 2025-2030 – Proposed Scope of Work**
  - Dr. Samira Daroub, University of Florida
- **Questions & Comments**
- **Next Steps**



WY2020 EAA Basin map of boundaries and structures.

Background

The Everglades Forever Act (EFA) mandated that rule 40E-63 be amended to implement a comprehensive program of research, testing, and implementation of BMPs to address water quality standards within the Everglades Agricultural Area (EAA) and Everglades Protection Area:

- ***"EAA landowners, through the EAA Environmental Protection District or otherwise, shall sponsor a program of BMP research with qualified experts to identify appropriate BMPs."***
- ***"Consistent with the water quality monitoring program, BMPs will be field-tested in a sufficient number of representative sites in the EAA to reflect soil and crop types and other factors that influence BMP design and effectiveness.***
- ***"The District shall conduct research in cooperation with EAA landowners to identify water quality parameters that are not being significantly improved either by the stormwater treatment areas (STAs) or the BMPs, and to identify further BMP strategies needed to address these parameters."***

Chapter 40E-63, FAC, Part III

- ...establish a schedule on BMP research, testing, and implementation to identify water quality parameters that are not being significantly improved by the STAs and the current level of BMPs being widely implemented throughout the EAA, and to identify strategies to address such parameters.
- The research program prescribed by this Chapter shall include field testing of BMPs in a sufficient number of representative sites in the EAA which reflect soil and crop types within EAA, as well as other factors that effect BMP effectiveness and design.
- …This rule shall be reviewed at a minimum of once every five years and amended, if necessary.

Conditions for Issuance

Current Chapter 40E-63 states that the scope of work shall provide reasonable assurance that these requirements are met:

1. **Provides verification of BMP effectiveness at ten farms or at other locations in sufficient number to reflect soil and crop types and other factors that influence BMP design and effectiveness.**
2. **Includes development, testing, and implementation of BMPs for reduction of particulate phosphorus.**
3. **Includes monitoring of specific conductance and development, testing and implementation of BMPs to address specific conductance.**
4. **Monitors for Atrazine and Ametryn in accordance with the FDEP Operating Permit.**
5. **Includes an education and prevention program for misapplication of pesticides.**
6. **Is initiated within 6 months of approval.**

Permit History

- Ongoing BMP training for phosphorus and pesticides
- 1997 - 2001: BMP Effectiveness Studies at ten representative farms
- 2001 - 2005: BMP Effectiveness studies with focus on conductance and particulate phosphorus (PP) BMPs at three farms
- 2005 - 2010: Statistical analyses of research permit data, and comprehensive PP BMP demonstration at UF-IFAS
- 2010 - 2015: Improved management of floating aquatic vegetation (FAV) at eight farms
- 2015 - 2020: Continued research of improved management of FAV
- 2020 - 2025: Implementation and Verification of BMPs to Reduce EAA Farm P Loads: Evaluation of performance differences of EAA Farm basins with similar BMPS
- 2025 - 2030: Proposed: Continued research on the evaluation of performance differences of EAA Farm basins with similar BMPs

Renewal Application – Chronology

- **April 10, 2025: Scope of Work submitted for 2025 – 2030;**
  - **Application 250410-1**
- **May 6, 2025: SFWMD Request for Additional Information Letter**
- **June 5, 2025: EAA-EPD Response and Revised Scope**
- **July 9, 2025: Annual Report 5 provided for the 2020-2025 permit duration**
- **Today's Public Workshop**

EAA-EPD Research Master Permit – Proposed Scope

- Determine differences in performance in select farms in the EAA basins by evaluating the impact of soil chemistry and historical land use on P concentration and loads on these farms.
- Integrate additional statistical tools to evaluate the influence of soil properties, historical and current land use, and environmental conditions on water quality in select farms in the EAA.
- BMP Education and extension activities: use the information from this research to determine what BMPs work most effectively on farms in the EAA with similar soil, crop, and management conditions.

The EAA Best Management practices Master Permit Renewal 2025-2030:

Evaluation of performance differences of EAA farm basins with similar BMPs

PUBLIC WORKSHOP *July 16, 2025*

Samira Daroub, Professor & Center Director

Everglades Research and Education Center

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Outline

1. Works of the District EAA Master Permit renewal.
2. Review and progress of current Master Scope of Work (2020-2025).
   - ❑Objective and methodology.
   - ❑Results.
   - ❑COVID-19 and variability in soil/ water quality.
3. Proposed SOW for next 5 years.
   - ❑Objective.
   - ❑Methodology.
   - ❑Timeline.

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Everglades Works of the District – Permit No. 50-00001-E

- Renewal of Master Permit for BMP Research, Testing, Implementation, Everglades Agricultural Area, Palm Beach and Hendry counties, Chapter 40E-63, Part III FL Administrative Code.
- BMP permit scope of work duration is 5 years. The current SOW will expire September 15, 2025.
- Paragraph 40E-63.310(a)1, F.A.C., requires that the Everglades Agricultural Area Environmental Protection District (EAAEPD) sponsored farm-scale research be conducted at locations throughout the Everglades Agricultural Area (EAA) representative in sufficient number to reflect soil and crop types and other factors that influence BMP design and effectiveness.

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Review and progress of current master scope of work (2020-2025)

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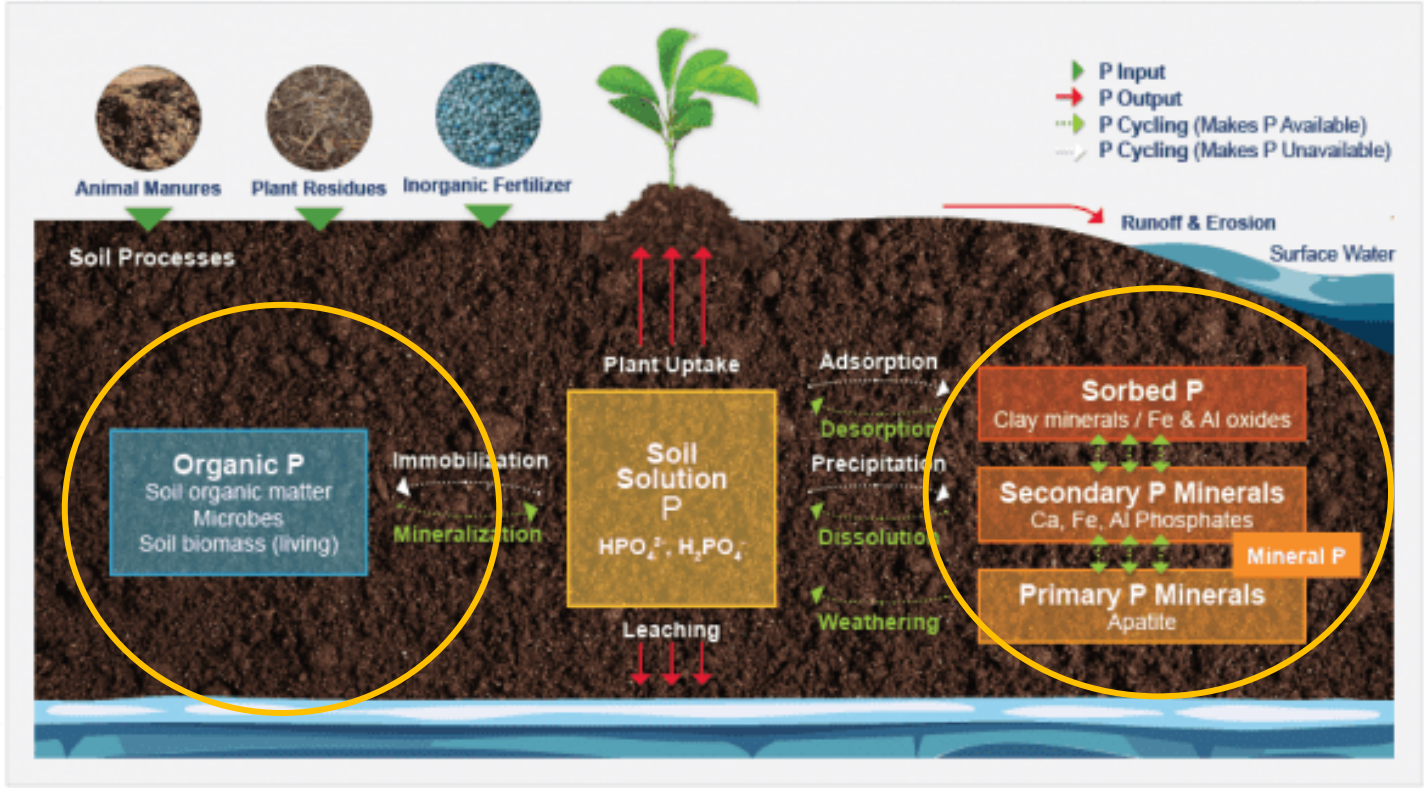
Phosphorus Chemistry in EAA Soils

- The P cycle is complex due to high soil organic matter content, organic forms of P, and Fe transformations.
- The Fe and Al oxide contents of Histosols tends to increase in shallow soils with less organic matter.



Source/ aces.edu

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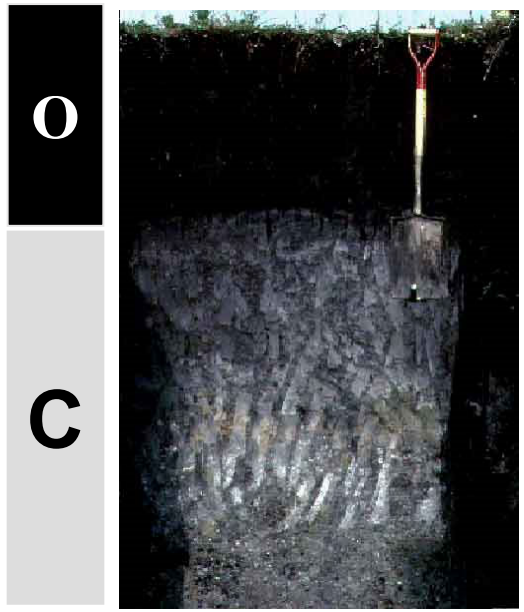
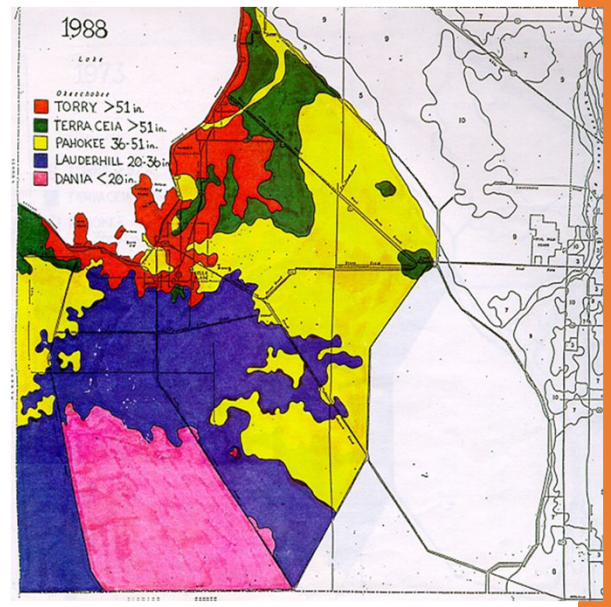
EAA Soil Properties

- EAA soil series: Organic layer (O) above a $CaCO_3$ bedrock.
- Deeper soils (East of the Lake): Torry, Terra Ceia and Pahokee series.
- Shallower soils (South of the Lake): Tend to have more inorganic components (Fe oxides, Al oxides and $CaCO_3$) that will increase P-sorption capacity.





TORRY > 35% mineral material

TERRA CEIA > 129 cm

PAHOKEE 91-129 cm

LAUDERHILL : 61- 91 cm

DANIA : 20-60 cm

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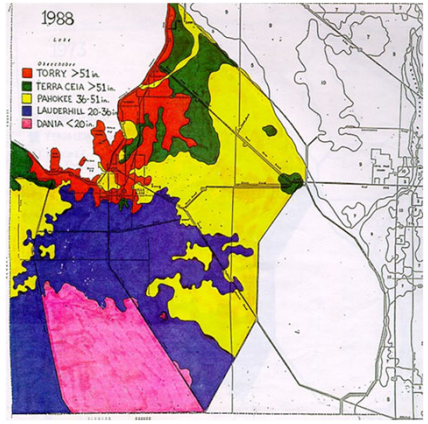
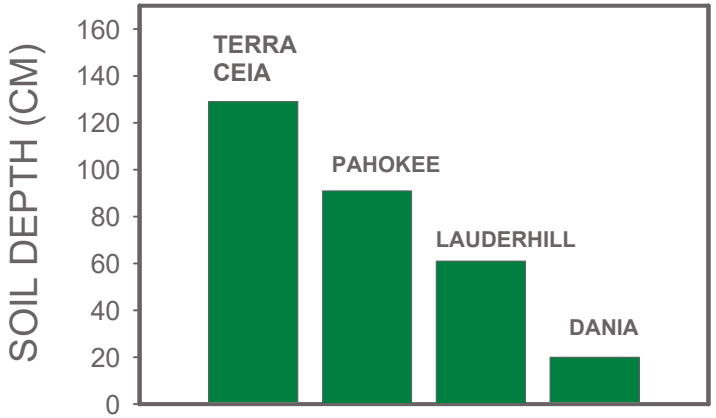
Justification



CLASSIFICATION OF MUCK SOILS RELATIVE TO THICKNESS OF ORGANIC LAYERS OVER BEDROCK



- EAA farms implement BMPs in a similar manner, but there are differences in farm discharge P concentrations or loads.
- Differences may be related to soil properties, historical land use and cropping patterns.
- Mineral content of soils, P saturation, and other properties may shed light on differences between BMP performance as related to soils differences.

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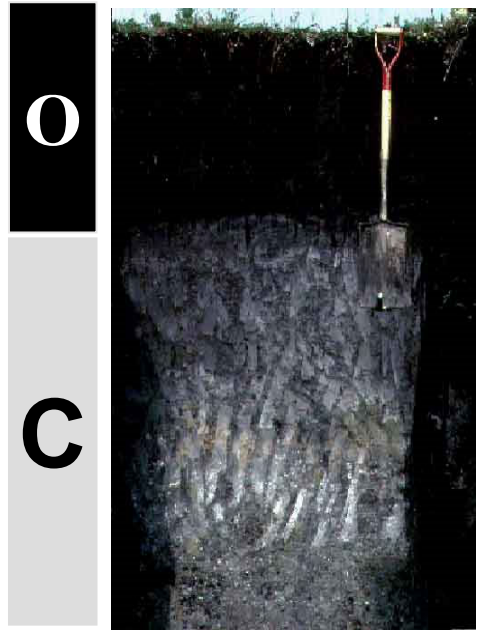
Hypothesis

Phosphorus in drainage water is impacted by:

- ❑Historical land use.
- ❑Deeper soils.
- ❑Soils with low P-sorption capacity (low content Fe, Al or Ca minerals).



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Objectives

1. Determine differences in performance in selected farms in the EAA basin by evaluating the **impact of soil chemistry** and **historical land use** on P concentration and loads on these farms.

2. BMP education and extension activities: Use the information from this research to educated farmers on the BMPs that work most effectively on farms in the EAA with similar soil, crop, and management conditions.

Image Source: https://www.nrcs.usda.gov/sites/default/files/styles/hero/public/2022-09/Soils.jpg?h=aa856ebb&itok=qMH6e4Bk

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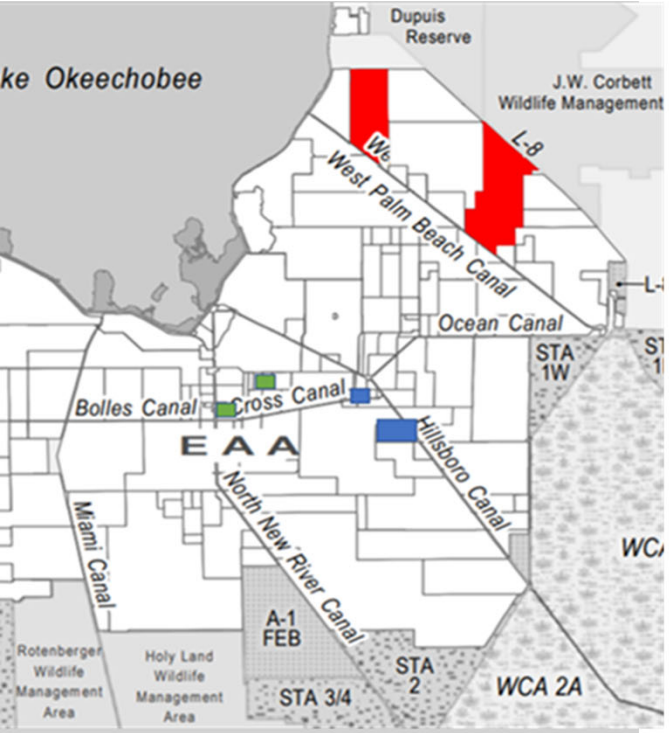

Basin ID	Pair	Soil series	Mineral Content (%)	O Horizon Thickness (cm)
50-018-01	1	Terra Ceia muck	<35	>130
		Pahokee muck	<35	91-130
		Other	<35	
50-018-03	1	Terra Ceia muck	<35	>130
		Okeelanta muck	<35	41-127
		Other	<35	
50-028-01	2	Pahokee muck	<35	91-130
50-048-01	2	Pahokee muck	<35	91-130
		Terra Ceia muck	<35	>130
50-061-07	3	Torry muck	>35	>130
		Pahokee muck	<35	91-130
50-061-12	3	Pahokee muck	<35	91-130

NUTRIENT CONTROL PRACTICES (Points)	1801	1803	2801	4801	6107	6112
Nutrient Application Control	2.5	2.5	2.5	2.5	2.5	2.5
Nutrient Spill Prevention	2.5	2.5	2.5	2.5	2.5	2.5
Soil Testing	5	5	5	5	5	5
PARTICULATE MATTER AND SEDIMENT CONTROLS (Points)						
Particulate Matter, Sediment Controls (4, 6)	5	5	5	5	10	10
WATER MANAGEMENT PRACTICES (Points)						
Water Management (0.5, 1.0-inch)	10	10	10	10	5	5
TOTALS (minimum 25 points)	25	25	25	25	25	25
Crops	Sugarcane, Vegetables, Corn		Vegetables, Sugarcane, Sod		Sugarcane, Vegetables, Corn, Rice	
Area (acres)	5857	9063	213	1186	319	731

Farm Selection Criteria

Similar:

- ❑ Farm operators and BMP plan.
- ❑ Soil types and cropping management practices.

Different:

- ❑ Historical P-loads.
- ❑ Geographical basins (S-5A, S6, and S-7).

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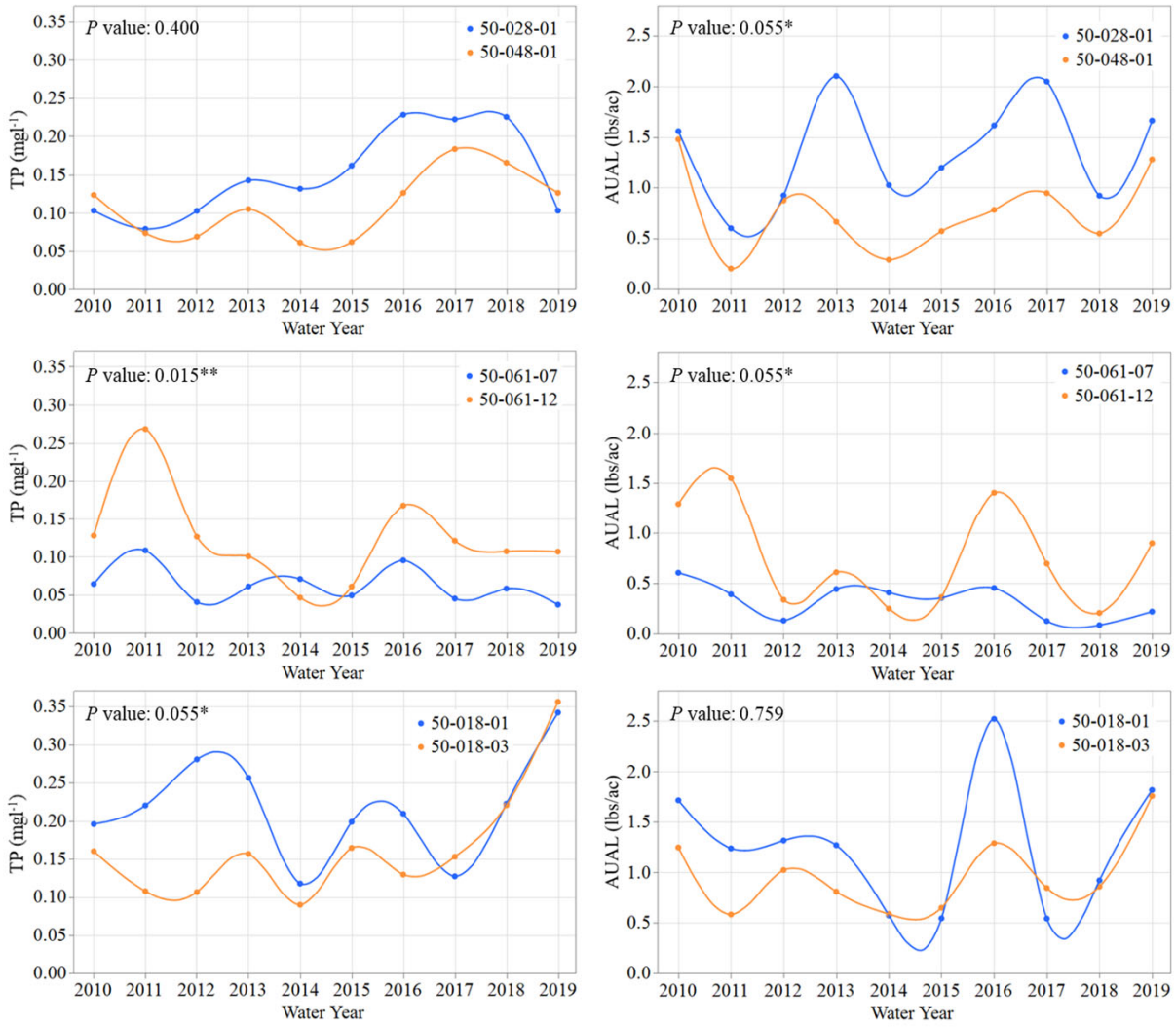
FARM SELECTION

- Historical Adjusted Unit Area P Load (AUAL) and/or P concentration determined that the selected farm pairs were statistically different when performing the Kolmogorov-Smirnov test (p-value ≤ 0.1).
- Kolmogorov-Smirnov Test: Evaluates the differences in mean/median and variance of the distribution as well as the general shape of the distribution.



Comparison of flow-weighted total phosphorus concentration (mg L^{-1}) and adjusted unit area load (lbs ac^{-1}) between farm pairs for WY 2010-2019.

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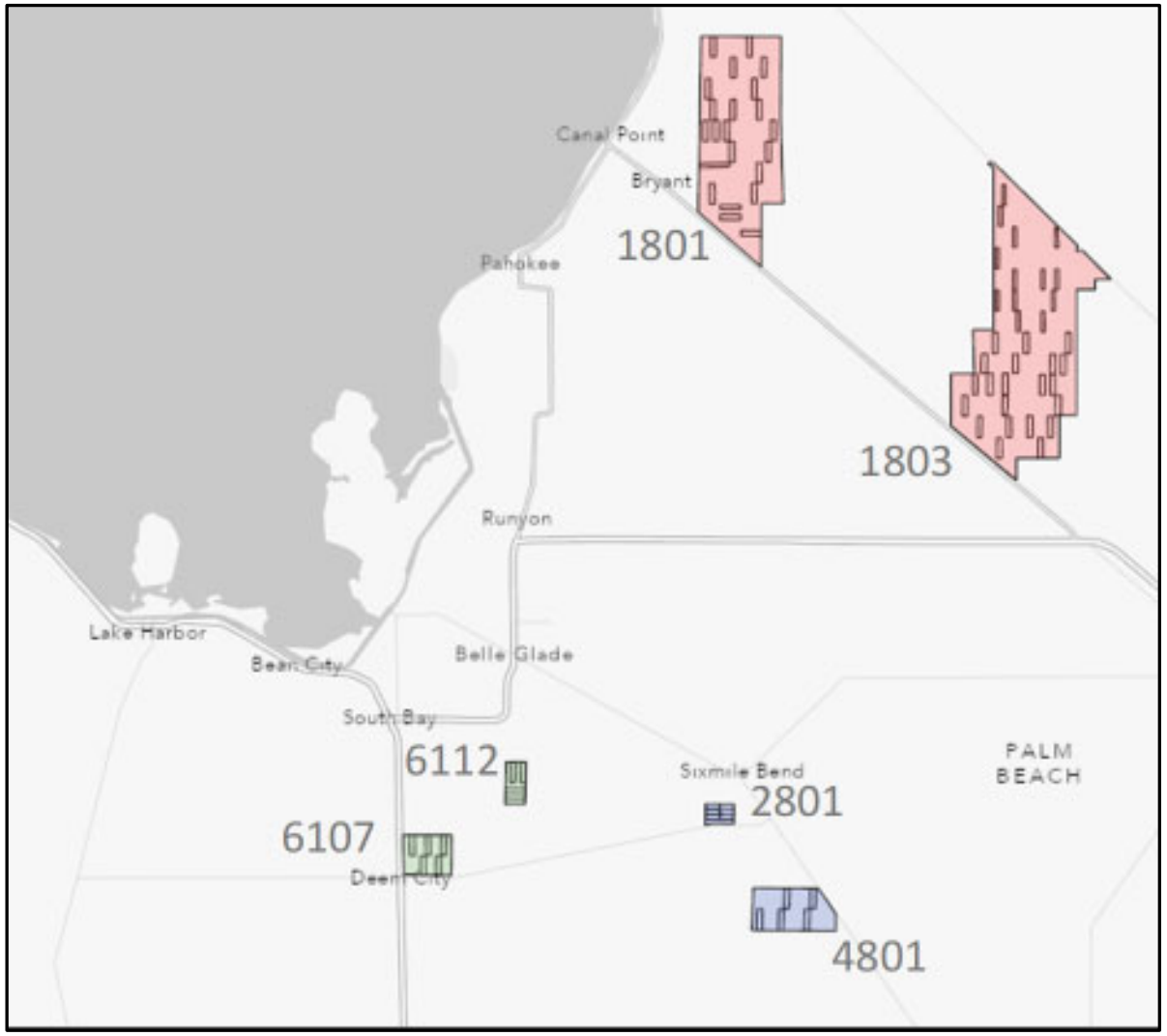
Soil Sampling

Farm	Acreage	Estimated # 40-ac plots	# of Sampled Plots
1801	5857	146	22
1803	9063	227	34
2801	213	5	5
4801	1186	30	5
6107	319	8	5
6112	731	18	5
Total			76



Minimum of 15% of plots were sampled (at least 5 plots)

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Methodology-Soil Analyses

Initial measurements (Composite soil sampling at 0-6 and 6-12 in depths):

- ❑pH, organic C and organic matter content.
- ❑Total P, total N, Fe, Al, Ca, $CaCo_3$.
- ❑Soil depth.

Annual measurements:

- ❑Water extractable (Pw).
- ❑Mehlich3 extractable P (PM3).

Statistical analysis

- ❑Non-parametric Wilcoxon Ranked Sum test ($p<0.05$).
- ❑Comparison of soils parameters.

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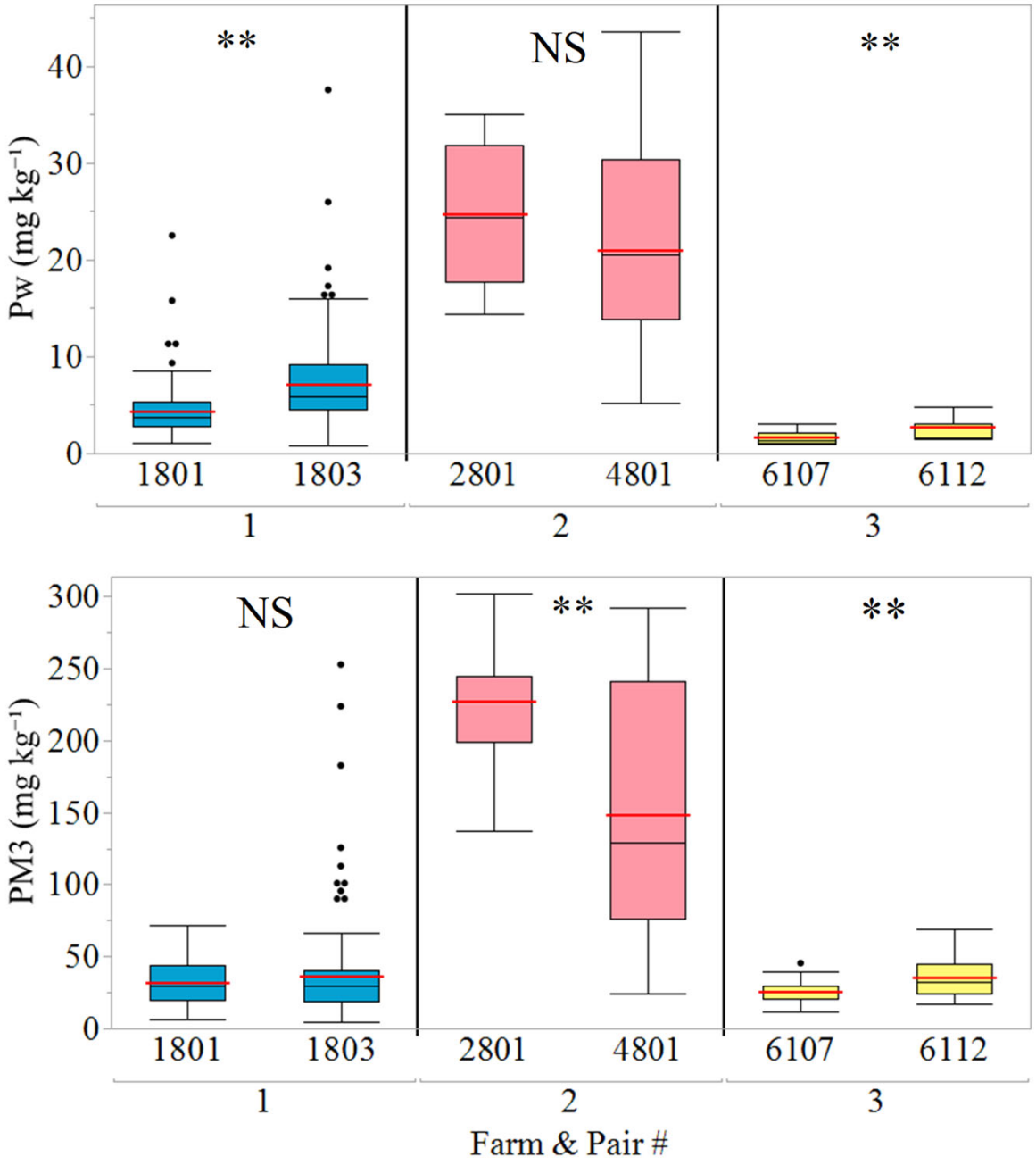
Soil Properties



- Differences in median values of water extractable phosphorus (Pw, mg kg^{-1}) and Mehlich-3 extractable phosphorus (PM3, mg kg^{-1}) between farm pairs at 0-15 cm depth were assessed using the Wilcoxon test on combined data from 2020 to 2025.

- Statistical significance is denoted as follows: $P < 0.05$ (*), $P < 0.01$ (**), NS = Not Significant.

- Sample sizes were $N_{1801} = 104$, $N_{1803} = 160$, $N_{2801} = 25$, $N_{4801} = 24$, $N_{6107} = 25$, and $N_{6112} = 25$.

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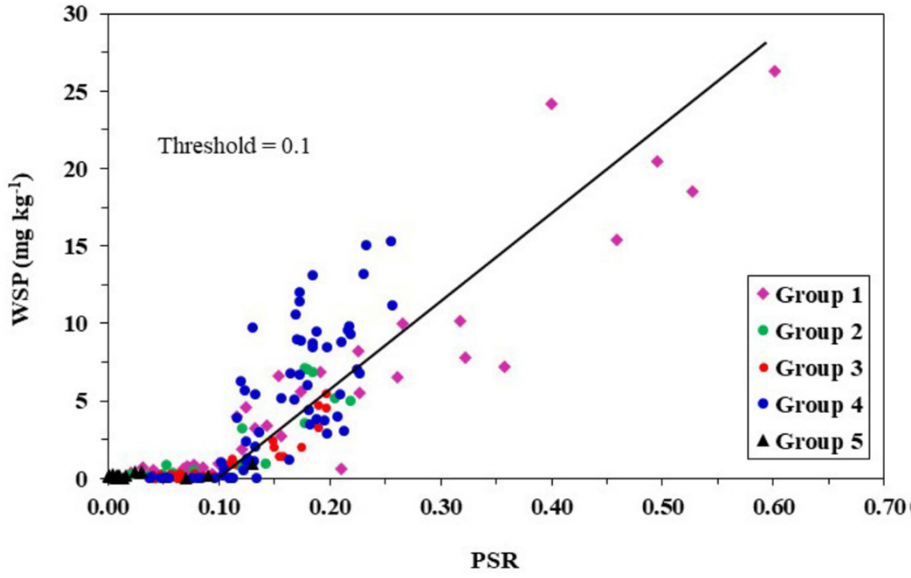
PHOSPHORUS SATURATION RATIO

- Mineral content: Mehlich3 extractable Fe (M3-Fe) and Mehlich3 extractable Al (M3-Al); and calcium content.

- P saturation ratio:
  - $PSR = \frac{PM3 \,/\, 31}{(M3{-}Fe \,/\, 56) + (M3{-}Al \,/\, 27)}$

- Soil P storage capacity (mg kg^{-1}):
  - *(Threshold PSR- Soil PSR) **
  - *[(M3 - Fe/56)+(M3 –Al /27)]/31*



Dari et al 2018
Agrosystems, Geosciences & Environment

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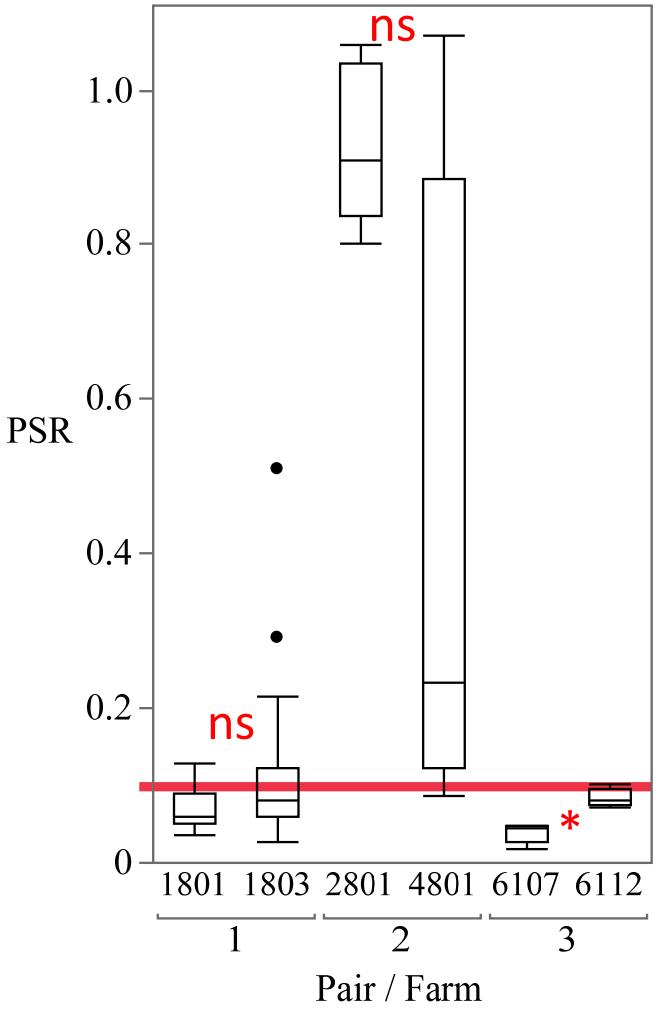
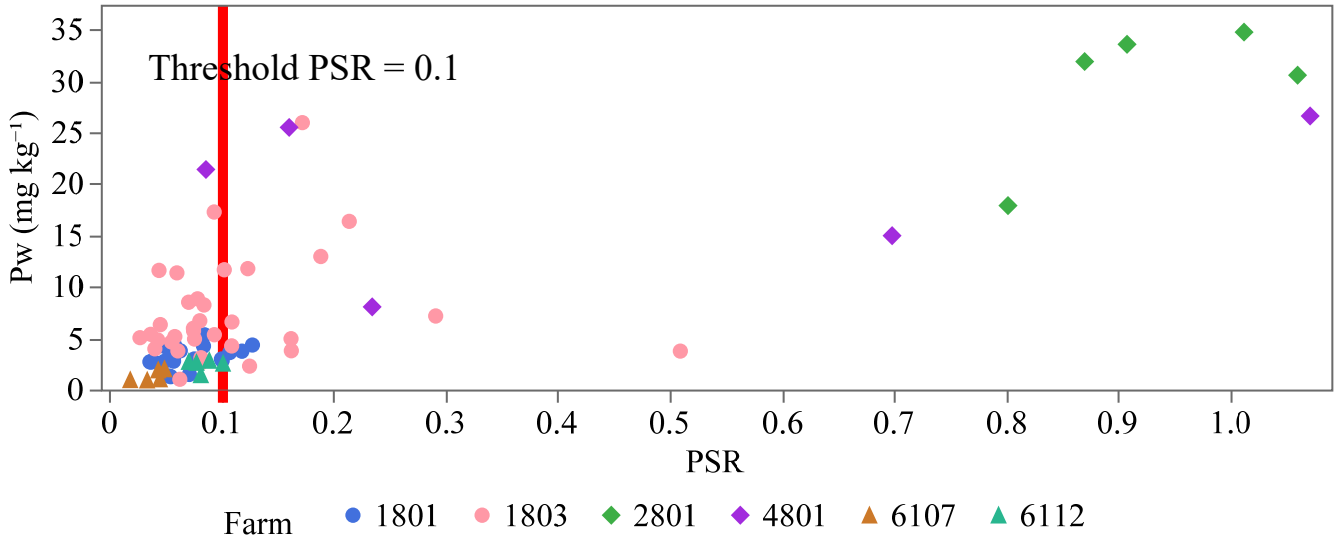
PHOSPHORUS SATURATION RATIO (PSR)





Wetland soils with PSR above 0.1 threshold have higher risk of P leaching (Nair and Reddy, 2013).

Box plots of the P saturation ratio between the farm pairs. Statistical significance is shown with ns=not significant, *=<0.05, **=<0.01, ***=<0.001.

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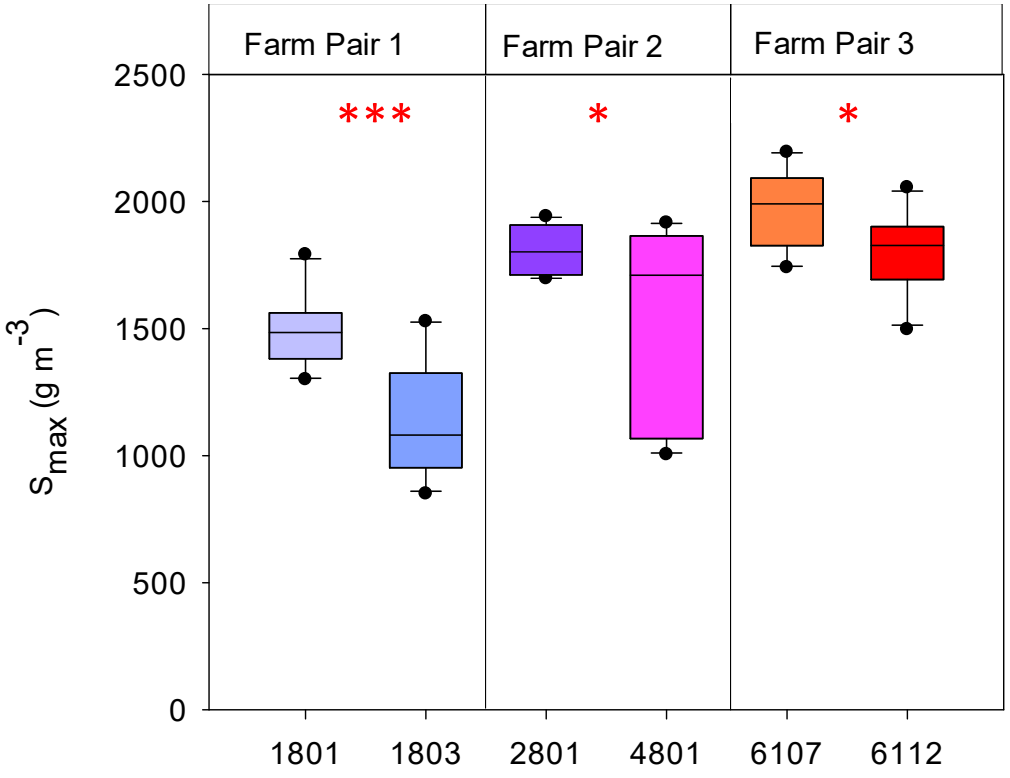
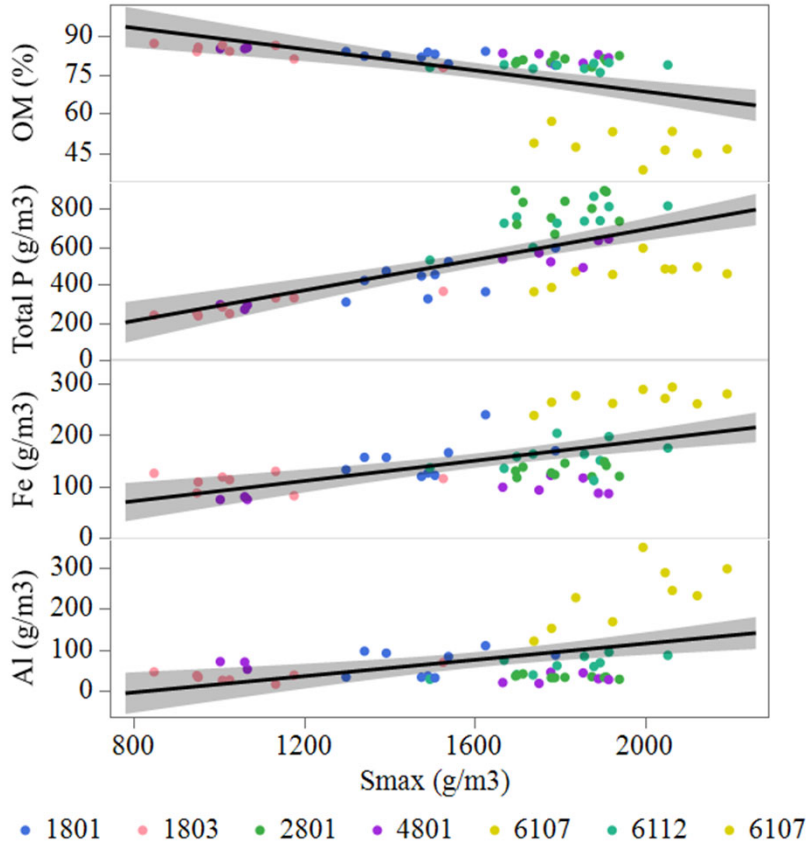
P SORPTION CAPACITY





Box plots of the Phosphorus maximum sorption capacity (Smax) between the farm pairs. Statistical significance is shown with ns=not significant, *=<0.05, **=<0.01, *=<0.001.**

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Instrumentation- Water Quality

- Data loggers, canal level sensors, pump RPM sensors, auto-samplers with solar panels, refrigerators with solar panels, and tipping bucket rain gauges

Water Analyses

- Started with rainy season May 2021
- Composite sample daily during drainage events

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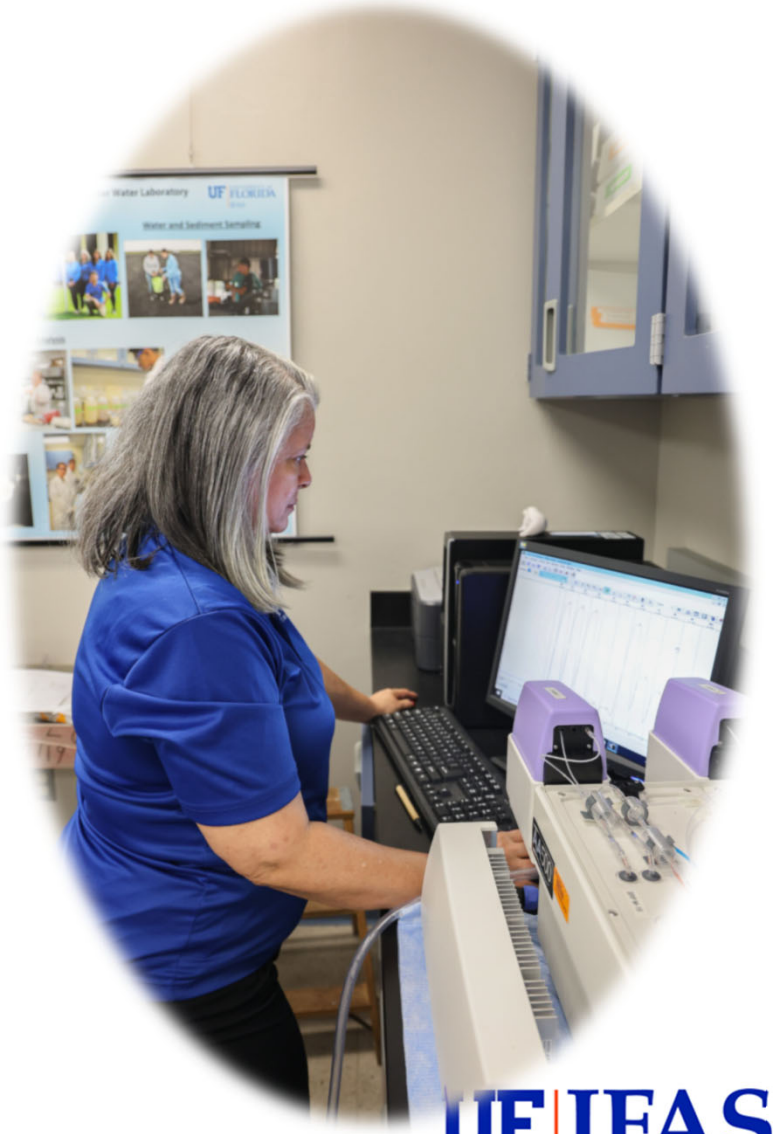
Methodology-Water Quality Analyses

Annual Measurements:

- ❑ pH
- ❑ Total P (TP)
- ❑ Total Dissolved P (TDP)
- ❑ Particulate P (PP) = TP – TDP
- ❑ Soluble Reactive P (SRP)
- ❑ Dissolved Organic P (DOP)= TDP – SRP
- ❑ Total Suspended Solids (TSS)

Statistical Analysis (p-value ≤ 0.1):

- ❑ Nonparametric Kolmogorov-Smirnov test
- ❑ Wilcoxon Rank Sum test



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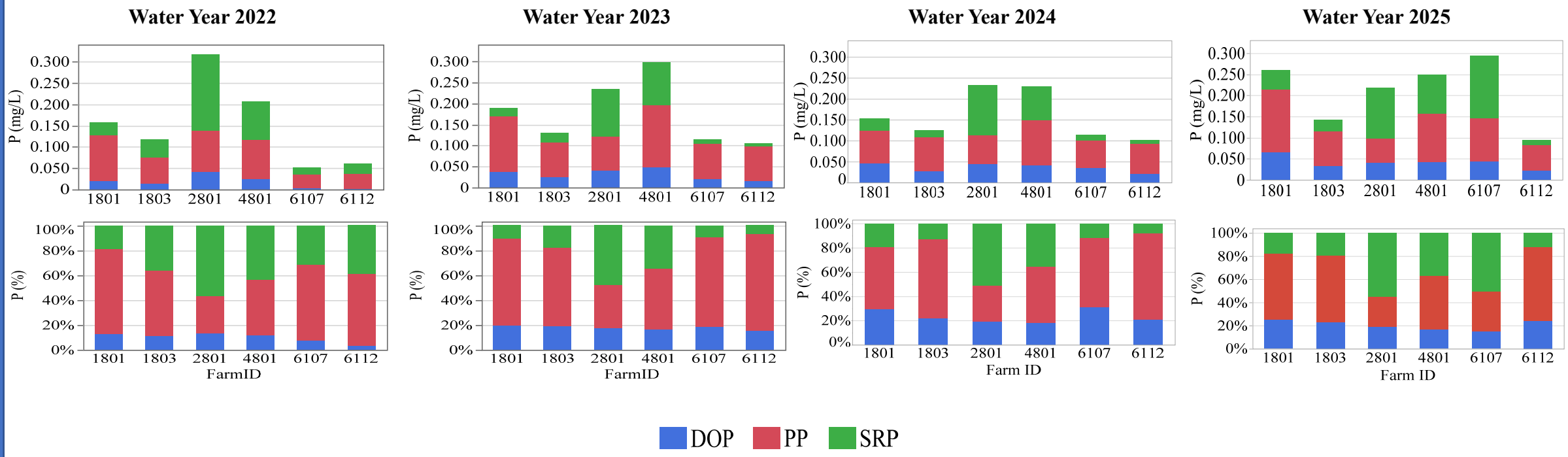
Water Quality Data



Drainage water phosphorus (P) speciation concentrations and percent of total P for water years (2022-2025) of studied farms. Each bar represents the average annual TP concentration at a given farm. Different colors represent the P species: DOP= Dissolved Organic P, PP= Particulate P, and SRP= Soluble Reactive P.

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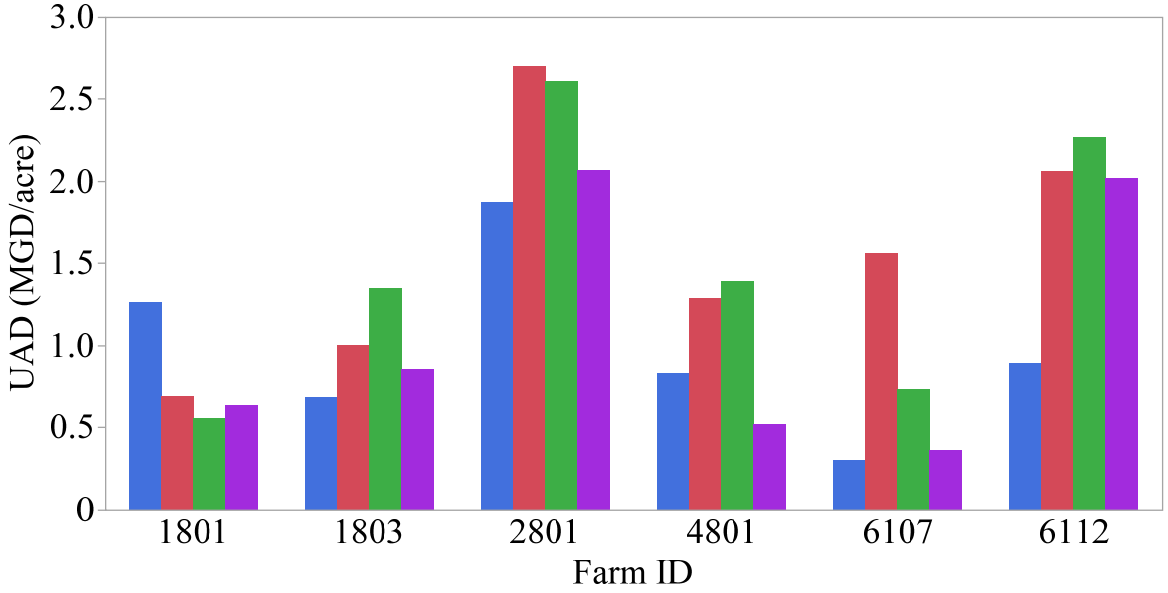
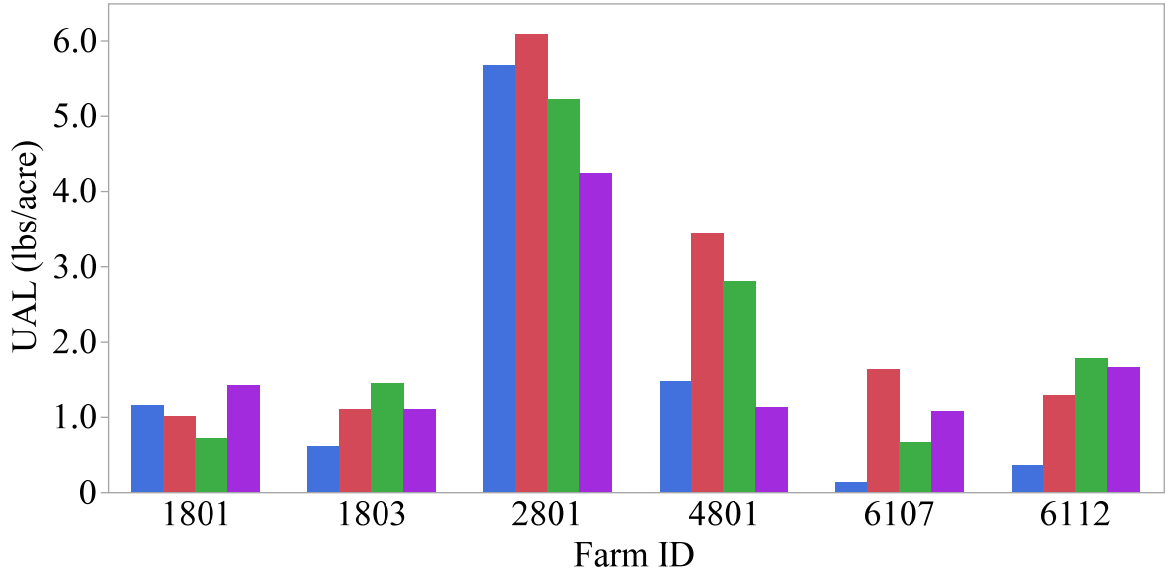


Unit Area Drainage (UAD)

Unit Area Load (UAL)



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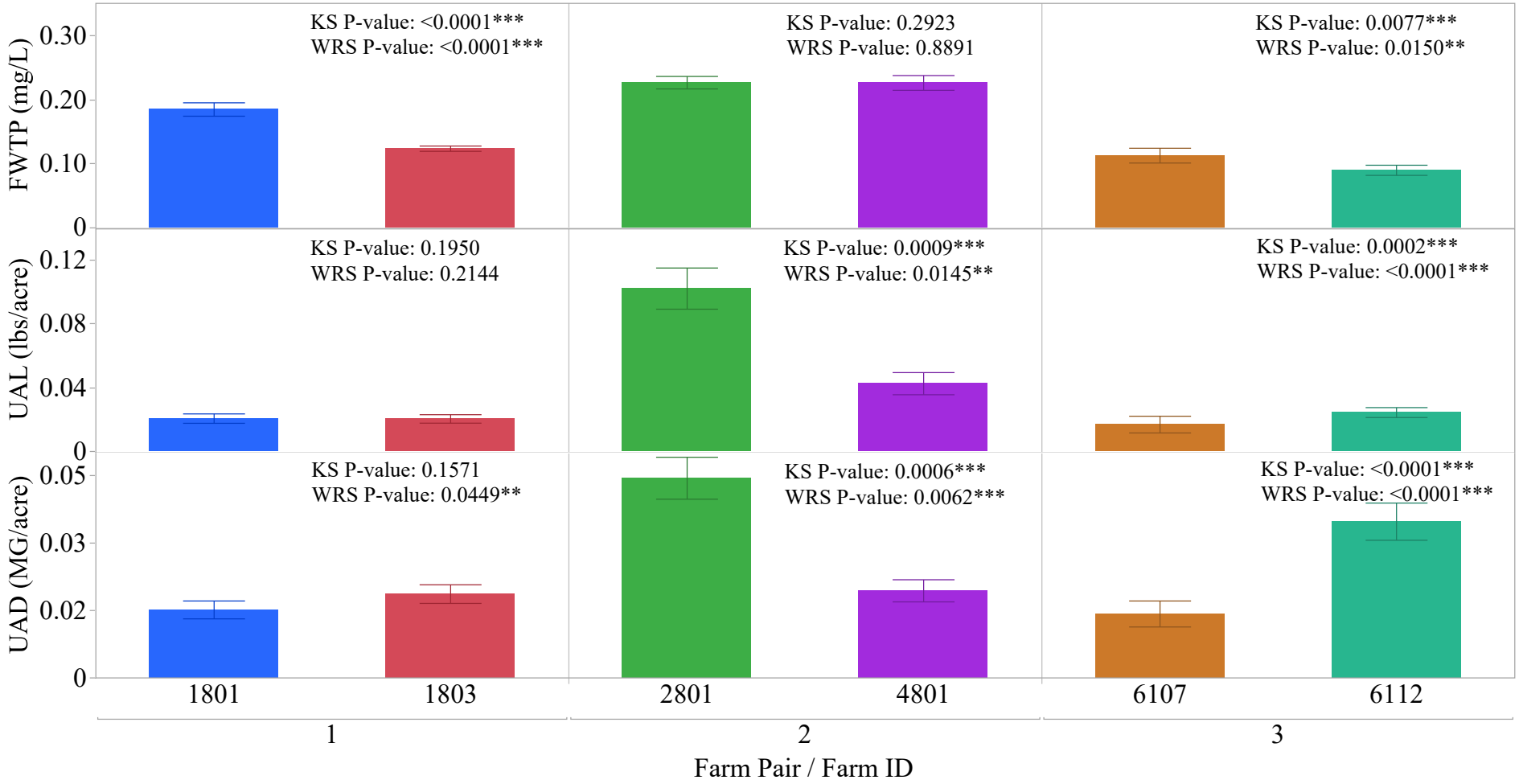
Statistical Analysis of Water Quality Data



Bar graph of the flow weighted total phosphorus (P) concentration (FWTP), unit area P load (UAL) and unit area drainage (UAD) between the farm pairs. Statistical significance is considered at with **≤ 0.05, *** ≤ 0.01.

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Proposed Master Permit Scope of Work 2025-2030

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Justification

- Delayed start due to COVID-19 restrictions.
- Preliminary analyses reveal significant variability in soil and water data collected so far, highlighting the necessity for extended data collection to ensure robust statistical evaluations.
- A more comprehensive long-term dataset is essential to refine statistical models assessing the relationships among geo-environmental factors, soil chemistry, and phosphorus loads.
- Time allocated for data evaluation, calibration, and validation of statistical models.

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Objectives

1) Determine differences in performance in select farms in the EAA basins by evaluating the impact of soil chemistry and historical land use on P concentration and loads on these farms.

2) *Integrate additional statistical tools to evaluate the influence of soil properties, historical and current land use, and environmental conditions on water quality in select farms in the EAA.*

3) BMP education and extension activities: Use the information from this research to educated farmers on the BMPs that work most effectively on farms in the EAA with similar soil, crop, and management conditions.

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Methodology: Statistical Analysis

Employing a whole system approach through advanced modeling statistical methods to evaluate drainage water phosphorus loads in the selected studied farms in the EAA:

1. Characterization of geo-environmental factors affecting P-loads.
2. Characterization of soil chemical and physical factors affecting P-loads.
3. Link geo-environmental, soil chemical, and physical factors into statistical models to evaluate P-loads.

Data analysis will focus mostly on machine learning & deep learning predictive and explainable AI (XAI) models (Angelov et al., 2021) (Dwivedi et al., 2023).

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Additional Data Needed

1. Annual characterization of soil parameters
2. Collect grab samples during non-pumping events:
   - Total P (TP), Soluble Reactive P (SRP) and Total Dissolved P (TDP). Particulate P will be calculated.
3. Data on historical cropping rotations.
4. Remote sensing spectral data for land cover and vegetation characterization.
5. Spectral scans for soils and vegetation (visible-near-infrared spectroscopy, Vis-NIR).
6. Newly published high resolution soil characterization data sets (100m) from SOLUS (Soil Landscapes of the United States - USDA).

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Methodology

1. Characterize the geo-environmental factors affecting P loads in the paired farms in the EAA: Data acquisition:

- Soil Landscapes of the U.S. 100-m (SOLUS100) soil data (NRCS-USDA)
- Crop management data on historical cropping rotations:
  - BMP permits and farmers' interview as available.
  - Remote sensing (RS) multi-temporal sequence: Sentinel-2 or Landsat (past 10 years) to characterize land cover and vegetation characteristics
  - 40-year space-time spectral hypercube (Landsat) [30 m spatial resolution]
- Derive various vegetation indices from RS images :
  - Normalized Difference Vegetation Index (NDVI)
  - Enhanced vegetation index (EVI)
  - Normalized Difference Tillage Index (NDTI)

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Methodology

1. Characterize the geo-environmental factors affecting P loads in the paired farms in the EAA: **Data acquisition (cont'd)**

- Land use supervised classification using RS images and ground truth data. Or: available land use geodata (source: Florida Geographic Data Library)
- Climate data (long-term 40-year normals of precipitation and temperature): PRISM Climate data. https://prism.oregonstate.edu/)

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Methodology

2) Characterize the soil chemical factors affecting P loads in the paired farms in the EAA:

Initial soil characterization has been completed. For renewal, we propose to have the detailed analyses every year.

a) pH

b) organic C and organic matter

c) Total P content

d) Available P content (P extracted with water and with Mehlich3-P)

e) Mineral content: Fe oxide content and Al oxide content, Ca and Mg content

- Build a spectral library for soil chemical properties in select EAA farms through *proximal soil sensing (visible-near-infrared spectroscopy, Vis-NIR)*

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Methodology

3. Link geo-environmental, soil chemical, and physical factors into advanced statistical models to evaluate P-loads in select farms in the EAA:

- ❑ Build a database to link geo-environmental data and point (site-specific) soil sampling locations.
- ❑ Develop (train) and validate predictive and explainable AI (XAI) models that predict P loads (outputs) from geo-environmental data (including remote sensing data) + soil chemical measurements (input data) + soil spectral data (input data). Various AI methods will be tested and the best performing AI model to predict P loads identified.
- ❑ Assess AI model performance (various error metrics) and uncertainty for training and validation of models.

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Co-PI: Data analysis expert

Sabine Grunwald, PhD

Professor, Pedometrics, Landscape Analysis and GIS

Soil, Water, and Ecosystem Sciences Department

College of Agricultural and Life Sciences

University of Florida, Gainesville, Florida, USA.

Research Expertise:

- Carbon modeling.
- Soil carbon sequestration.
- Conservation management in agriculture.
- Pedometrics.
- Digital soil mapping.
- Soil proximal sensing.
- Remote sensing.
- Geospatial technologies.
- Artificial intelligence (AI) - machine learning, and deep learning algorithms.
- Statistical and geostatistical modeling.
- Process-based mechanistic ecosystem.
- Water quality modeling.

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BMP Trainings: Twice Yearly

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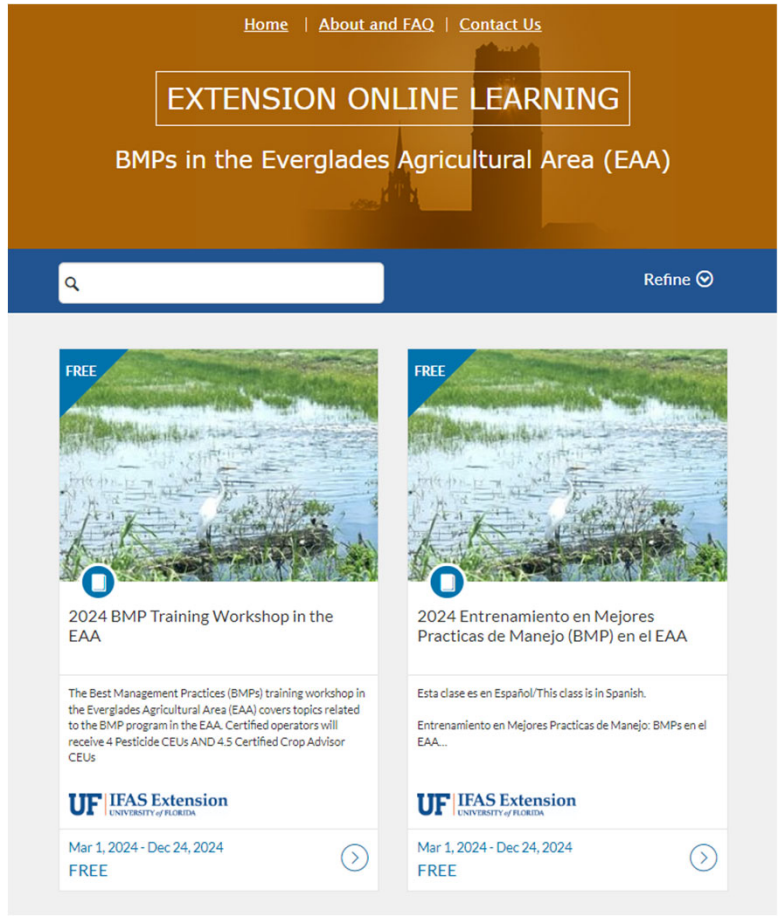
ONLINE BMP TRAINING

- ❑UF IFAS Extension Online Learning: https://ifas.catalog.instructure.com/
- ❑6 modules covering BMP program- Short quizzes
- ❑Certificate of completion issued as well as pesticide CEUs & Certified Crop Advisor (CCA)
- ❑Always available: finish at own pace
- ❑English & Spanish



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TIMELINE

Tasks and Activities	Tentative timeline
Approval of Scope of Work (SOW)	**Month 0**
Objective 1: On-farm BMP study: Determine factors leading to differences in performance of select farms in the S5 A, S6, and S7 basins Utilize additional tools to model the impact of soil properties, historical and current land use, and environmental conditions on water quality in select EAA farms.	
• Purchasing and instrumenting the plots (data loggers, canal level sensors, pump RPM sensors, auto-samplers, refrigerators, and tipping bucket rain gauges. • *Due to COVID-19 restrictions instrumentation was prolonged until April 2021.	**Months 1-3** *Tentative: Oct – Dec, 2020
• Interviewing the farm operators about past BMP practices. • Collecting historical land use data • Initial soil Sampling and characterization analyses	**Months 1-24** Oct 1, 2020 to Sept. 2022
• Drainage Water sampling and monitoring of farms • Soil sampling once annually for available P testing • Soil sampling for additional soil parameters • Collecting grab samples during non-pumping events • Compiling data on historical cropping rotations from BMP permits • **Drainage water sampling and monitoring of farms began in WY 2022 due to COVID-19 restrictions.	**Months 4 - 103** **(8.0 Water Years)** **~~WY2021 (partial): Jan 2021 – April 30, 2021~~ WY2022 = May 1, 2021 – April 30, 2022 WY2023 = May 1, 2022 – April 30, 2023 WY2024 = May 1, 2023 – April 30, 2024 WY2025 = May 1, 2024 – April 30, 2025 WY2026 = May 1, 2025 – April 30, 2026 WY2027 = May 1, 2026 – April 30, 2027 WY2028 = May 1, 2027 – April 30, 2028 WY2029 = May 1, 2028 – April 30, 2029
• Acquiring remote sensing spectral data for land cover and vegetation characterization • Utilizing spectral scans for soils and vegetation • Combining ground truth data with high resolution soil characterization data sets (100m) from SOLUS (Soil Landscapes of the United States – USDA-NRCS)	**Month 61 - 103** October 1, 2025, to April 30, 2029
• Utilize additional statistical modeling tools to analyze data and issue a Final report~~)~~	**Month 104 - 120** May 1, 2029, to September 30, 2030
Objective 2: BMP outreach and extension	**Two workshops per year**
DELIVERABLES	**DATE**
Annual Reports An annual report will be submitted to the EAA-EPD with a copy to the SFWMD according to the listed schedule. The report will also include a list of BMPs workshops conducted during the year. A list of attendees will be sent separately annually to the district.	July 2021 – July 2029
Final Report A final report will be submitted to the SFWMD and EAA-EPD.	September 30, 2030

Thank you!

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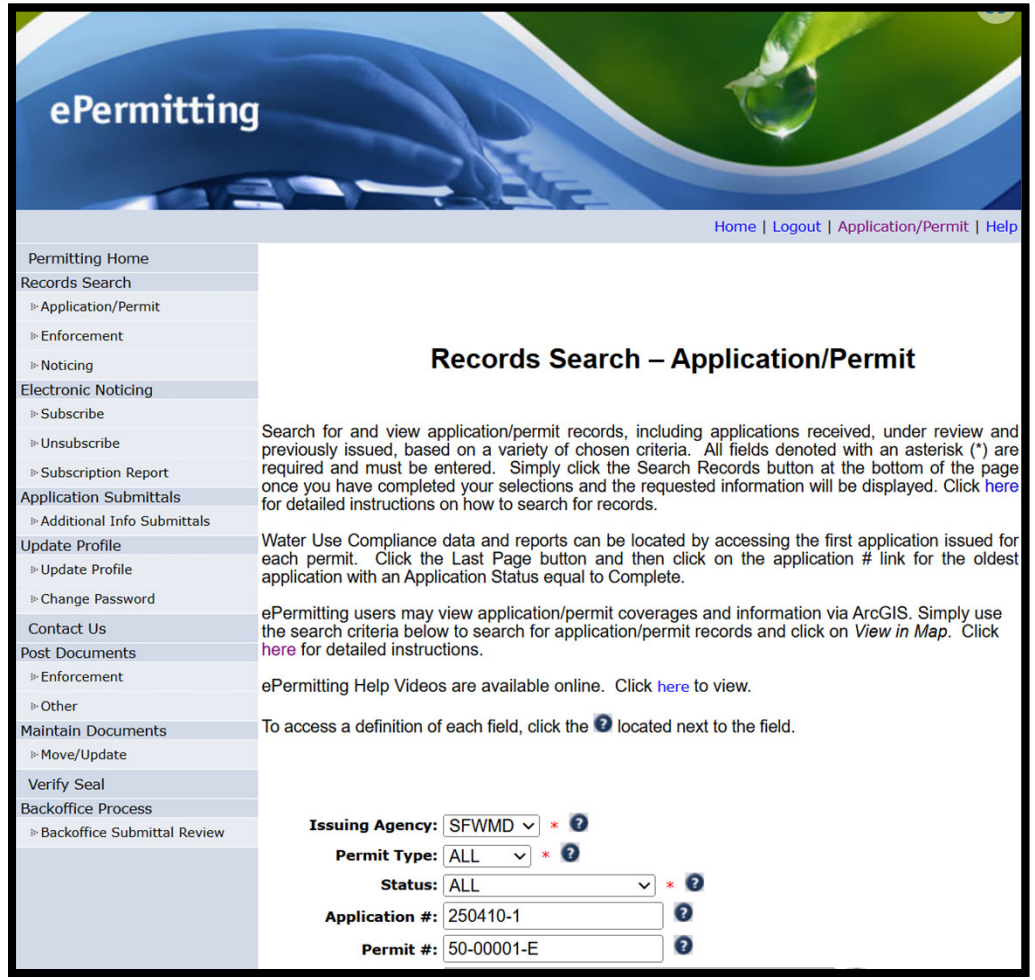
Permit Information

- ePermitting is still available for Works of the District permits.
  - Application #: 250410-1
  - Permit #: 50-00001-E
- After September 8, 2025, RegPermitting portal will be available for searching records.



EAA-EPD Research Master Permit Public Comments

- **If you're participating in person**
  - Approach the microphone or raise your hand
- **If you are participating via Zoom**
  - Use the "Raise Hand" feature
  - If you are participating via phone –

    -To Raise Hand: enter *9 on the keypad

    -To Mute/Unmute: Enter *6 on the keypad
  - We will call your name and invite you to speak

EAA-EPD Research Master Permit – Next Steps

- **July 16, 2025: Public Workshop - Public comment period begins**
  - **Public Workshop will be posted to YouTube channel SFWMDTV**
- **July 23, 2025: Draft permit posted to ePermitting**
- **August 15, 2025: Public comment period ends**
- **August 27, 2025: Proposed permit posted to ePermitting**
- **September 3, 2025: Last day for agency action**
- **All comments and questions can also be sent to:**

SFWMD
c/o Gary Priest
3301 Gun Club Road
West Palm Beach, FL 33406
gpriest@sfwmd.gov
(863) 462-5260 x3016

Meeting Adjourned