Use of Biomarkers in Everglades Restoration

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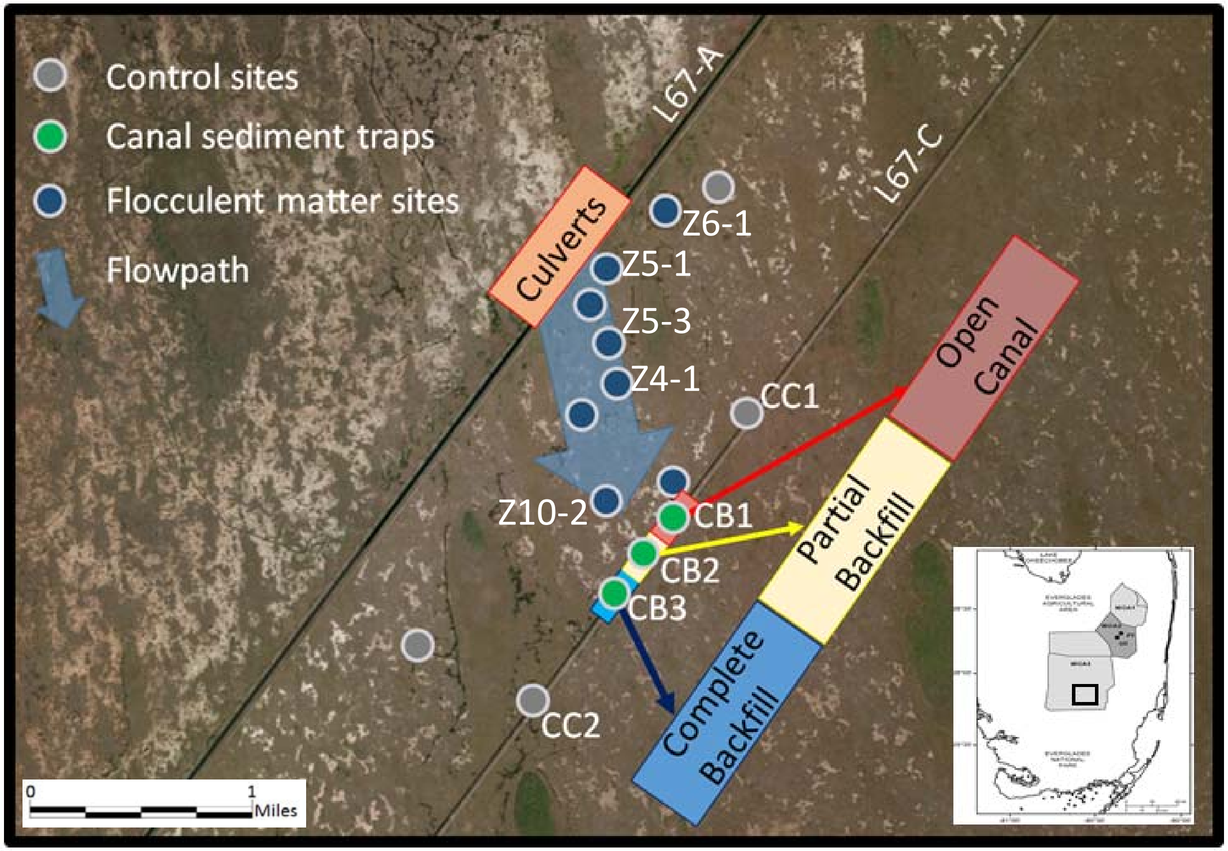
Decompartmentalization Physical Model (DPM)

- Landscape-scale test
- Construction finished in 2013
- Water Conservation Area 3
- "The Pocket": between L67-A and L67-C
- Degraded ridge and slough wetland
- Research questions:
  - Best way to re-establish sheetflow?
  - How to restore ridge/slough microtopography?
  - Re-engineer flow barriers (canals, levees)?

Canal photo: Jacob Bransky: https://ssl.panoramio.com/photo/109525318

Study site



- Flow-path through test-plot:
  - Inflow: 10 culverts along L67-A
  - Removed 3000m of L67-C levee
- Sheetflow through degraded ridge/slough wetland
- 3 backfill sections (1000m)
  - Open (control)
  - Partial backfill
  - Complete backfill
- Proof of concept: increased sheetflow rebuilds degraded ridge and slough topography

http://sofia.usgs.gov/projects/int_geochem_foodweb/isoevi_geer03abs.html

Questions

- **Project Objective:** determine if biomarkers can distinguish ridge and slough organic matter and trace source and transport

- **Organic Matter Transport**
  - **Question:** How will increased sheetflow re-arrange ridge and slough organic matter?
  - **Hypothesis:** Increased sheetflow will preferentially mobilize slough organic matter

- **Canal Backfilling**
  - **Question:** Will canal-backfilling affect organic matter transport?
  - **Hypothesis:** Sediment trapped in backfilled sites will differ from open-canal traps

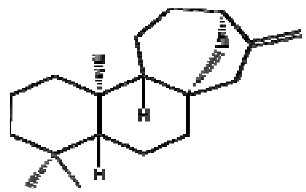
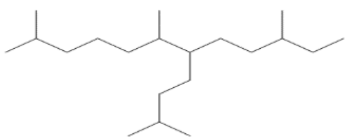
Need a way to distinguish between ridge and slough organic matter

Biomarkers

- Organic molecules
- "Chemical fossils" – used to trace organic matter
  - Source (ridge vs. slough)
  - Transport
- Good biomarkers
  - **Source-specific**
  - Enough present to quantify
  - Easy to identify – unique structure
  - Resistant to degradation
- Everglades applications
  - Indicators of environmental trends
  - Applied in fresh and marine waters
  - Applied in soils, flocculent organic matter (floc), sediments

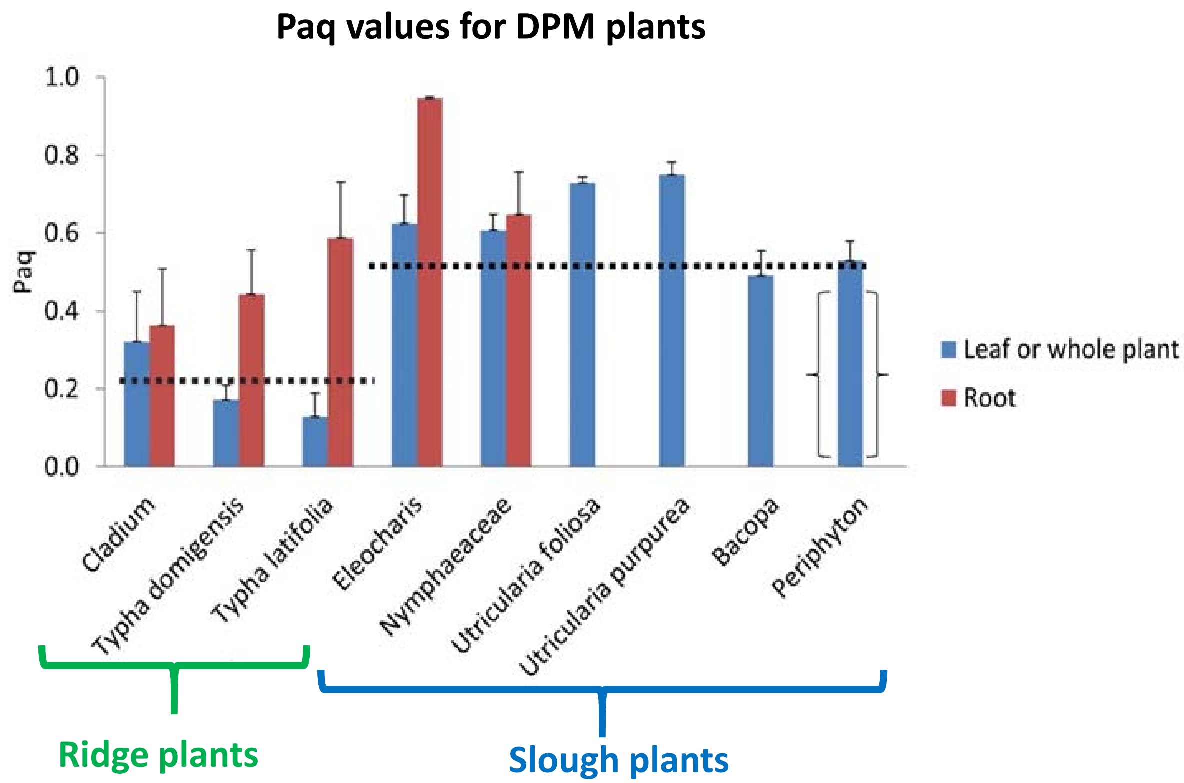
Jaffé et al., 2013, Jaffé et al., 2014, Saunders et al., 2006, Saunders et al., 2014

Biomarkers

	1	2	3	4
	Aquatic proxy (Paq)	**Kaurenes**	**C_{20} highly branched isoprenoids (C_{20} HBI)**	**Botryococcenes**
Structure	$\frac{(C_{23}+C_{25})}{(C_{23}+C_{25}+C_{29}+C_{31})}$ Ratio of n-alkanes			
Source	emergent and submerged plants	enriched in sawgrass	cyanobacteria	algae
Indicator	Ridge and Slough	Ridge	Slough	Slough

Ficken et al., 2000; Saunders et al., 2006; Gao et al., 2007

Aquatic Proxy (Paq)



Jaffé 2013

Sampling

- Flocculent organic matter (floc)
- Sediment (sediment traps)
- Sampling
  - Low flow
    - **Before** high flow
    - **After** high flow
  - High flow
- Ridge to slough transects
- Spatial sampling
- Canal traps

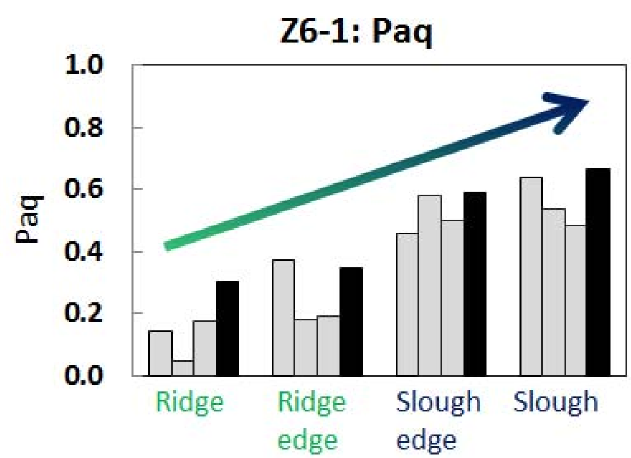
Floc

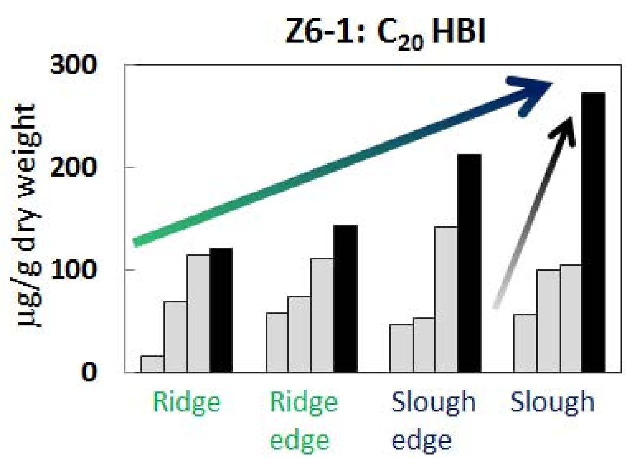
Sediment

Sample preparation

Freeze-dry floc and sediment → Solvent Extraction → Column Chromatography → GC/MS

Distinguishing ridge and slough





Dates:

10/2012 – low flow

01/2013 – low flow

10/2013 – low flow

01/2014 – high flow

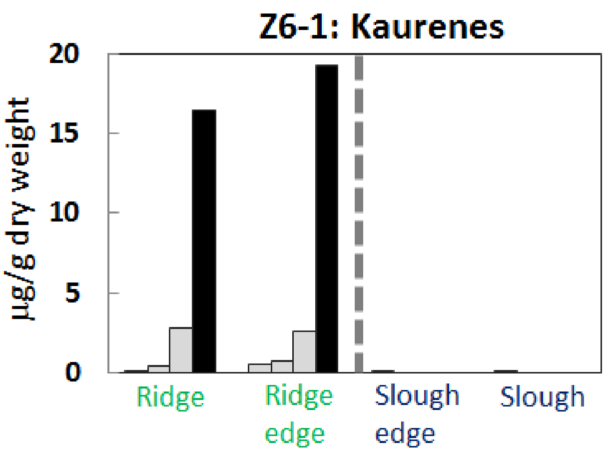
Paq

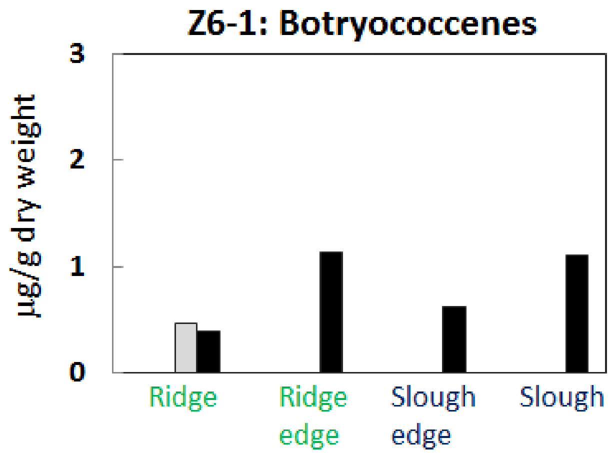
- Distinguishes ridge and slough
- Strongest indicator

C_{20} HBI

- Distinguishes ridge and slough
- Increase from low to high flow – seasonality or periphyton?

Distinguishing ridge and slough





low flow

high flow

Dates:

10/2012 – low flow

01/2013 – low flow

10/2013 – low flow

01/2014 – high flow

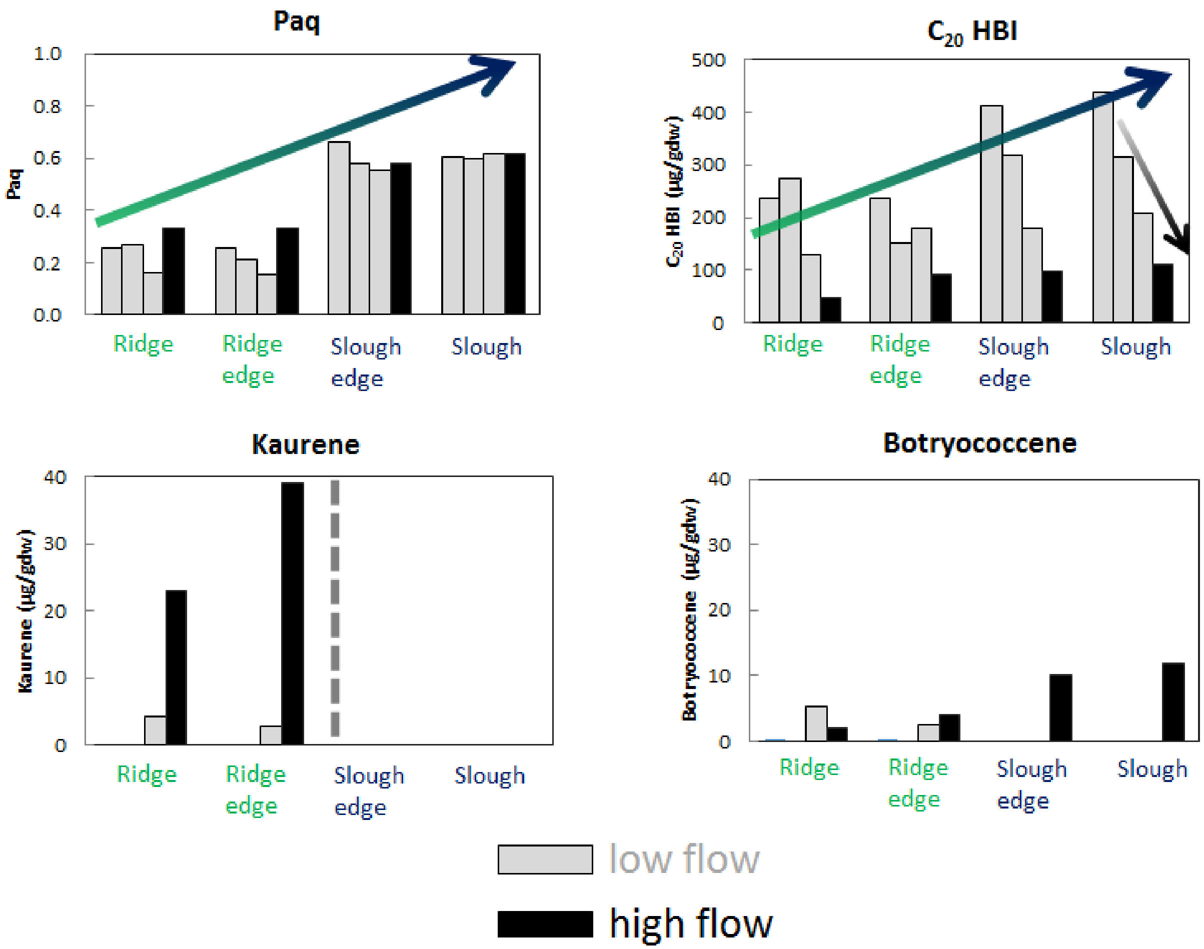
Kaurenes

- Ridge signal
- Virtually absent in sloughs

Botryococcenes

- No clear ridge-slough trends
- Increase with high flow – seasonality or periphyton?

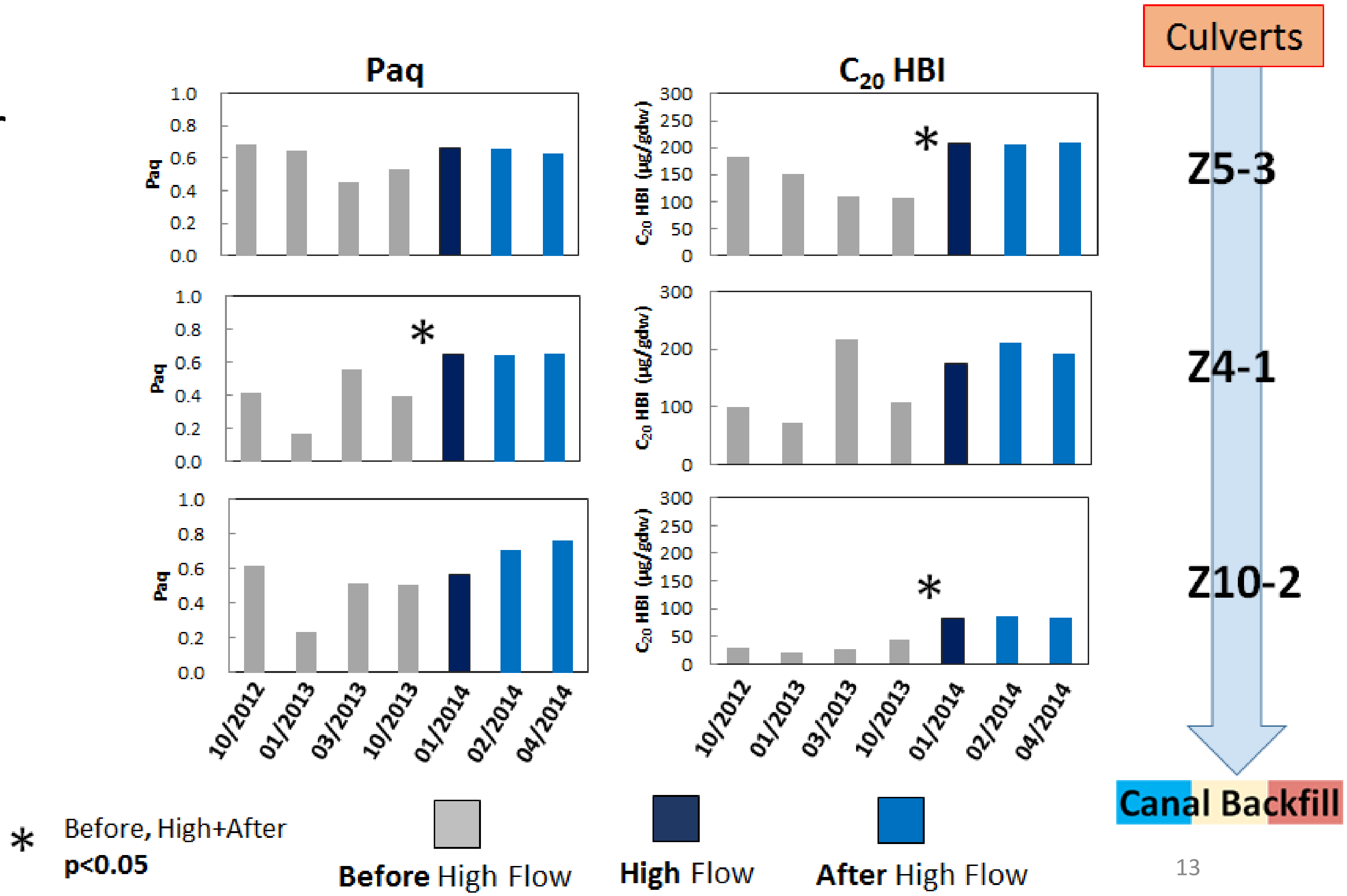
Distinguishing ridge and slough – Z5-1



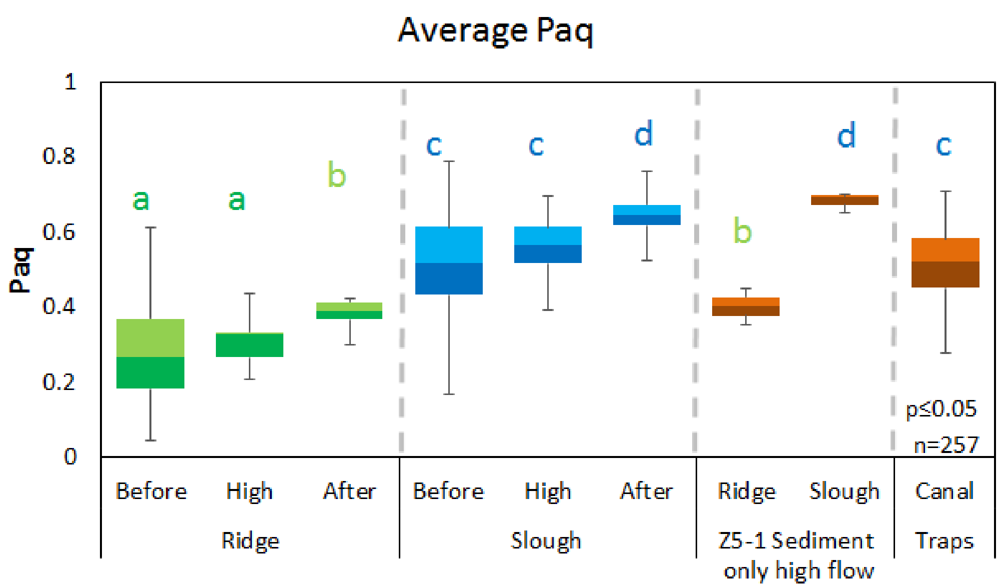
- Paq
  - Distinguishes ridge/slough
  - Most consistent biomarker
- C_{20} HBI
  - Ridge-slough increase
  - Opposite low/high pattern
  - Seasonality?

Spatial transect

- Low vs. High + After
  - Increased Paq
  - Increase HBI
- Temporal variability before high flow

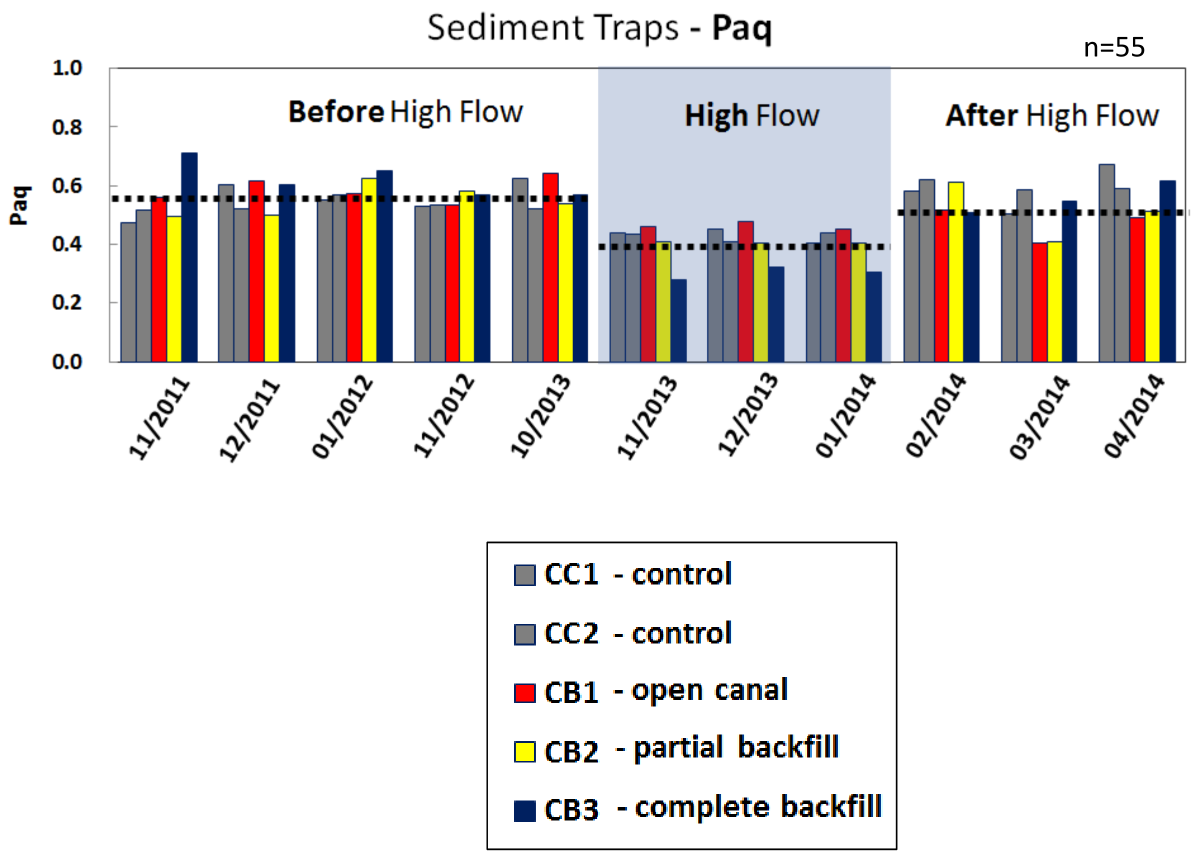


Mobilization of slough organic matter



- Ridge and Slough
  - Increase during and after high flow
  - Ridges separates from sloughs
- Z5-1 sediment traps
  - Z5-1: ridge/slough transect site
  - Only high flow data
  - Ridge associates with high flow ridge floc
  - Slough associates with high flow slough floc
- Canal Traps – average of flows
  - Appears most related to slough

Canal sediment traps



- Paq decreases at high flow – opposite of ridge and slough
  - Upstream canal inputs?
  - Entrainment of smaller ridge-like particles?
- High variability, limited samples
  - Careful interpretation
  - Currently gathering additional data
- Additional information: Colin Saunders – Session 18, 11:30am, Wednesday

Conclusions

- Biomarkers
  - Paq: distinguishes ridge and slough
  - C_{20} HBI: ridge/slough trends – weaker
  - Kaurenes: ridge-associated
  - Botryococcenes: variable

- **Hypothesis 1:** Slough OM is preferentially mobilized during high flow
- **Hypothesis 2:** Canal sediments show response to flow? Need more data.

- Flocculent matter is highly variable: need more data to better understand trends

- Ongoing work – 2015-2016
  - High flow – late 2014 to early 2015 (completed)
  - High flow – late 2015 to early 2016

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http://www.southdadeswcd.org/; http://presidentscouncil.fiu.edu/; http://serc.fiu.edu/

Questions?

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