Evaluation of Inundation Depth and Duration Threshold for Cattail Sustainability

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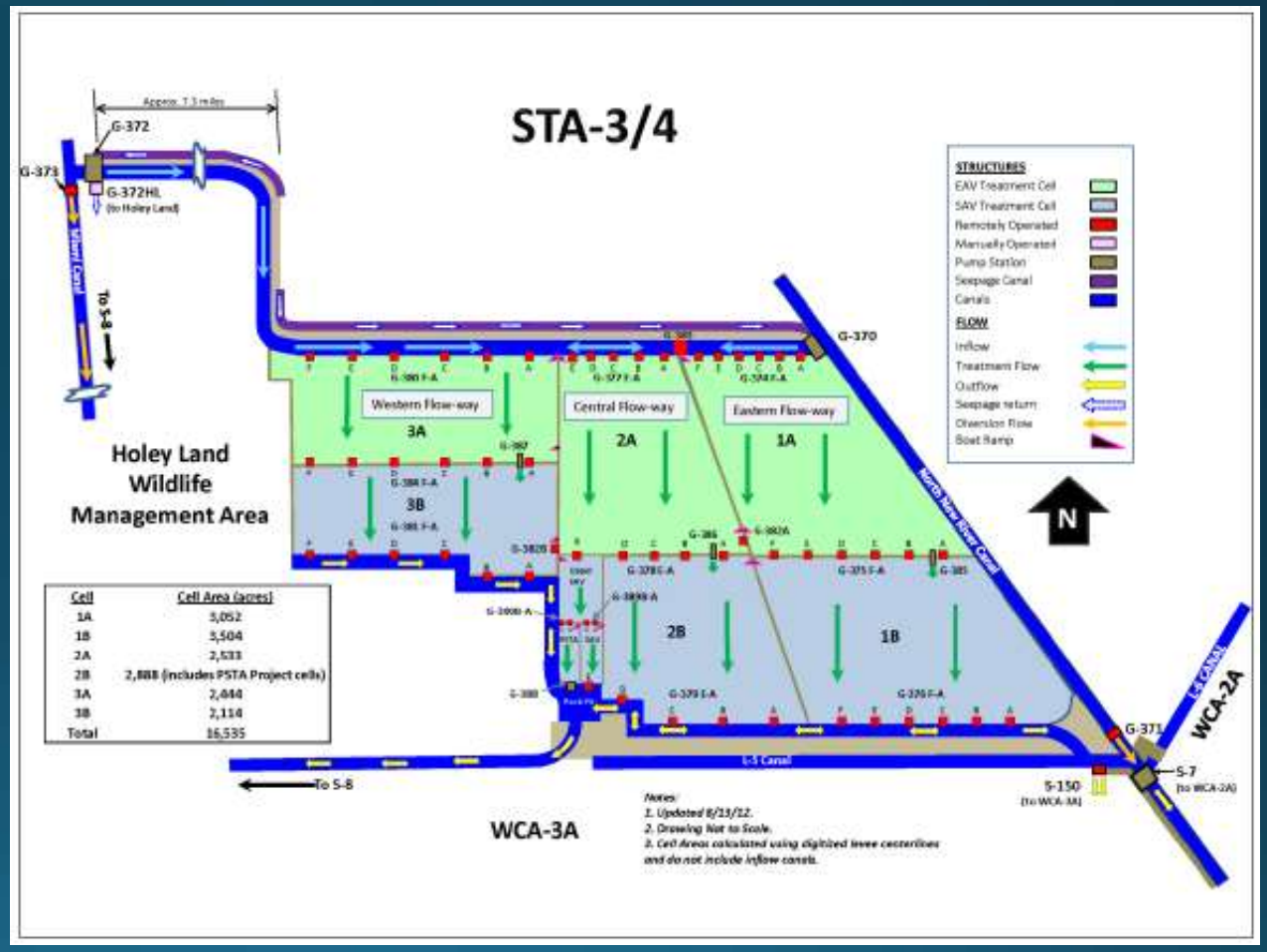
Background

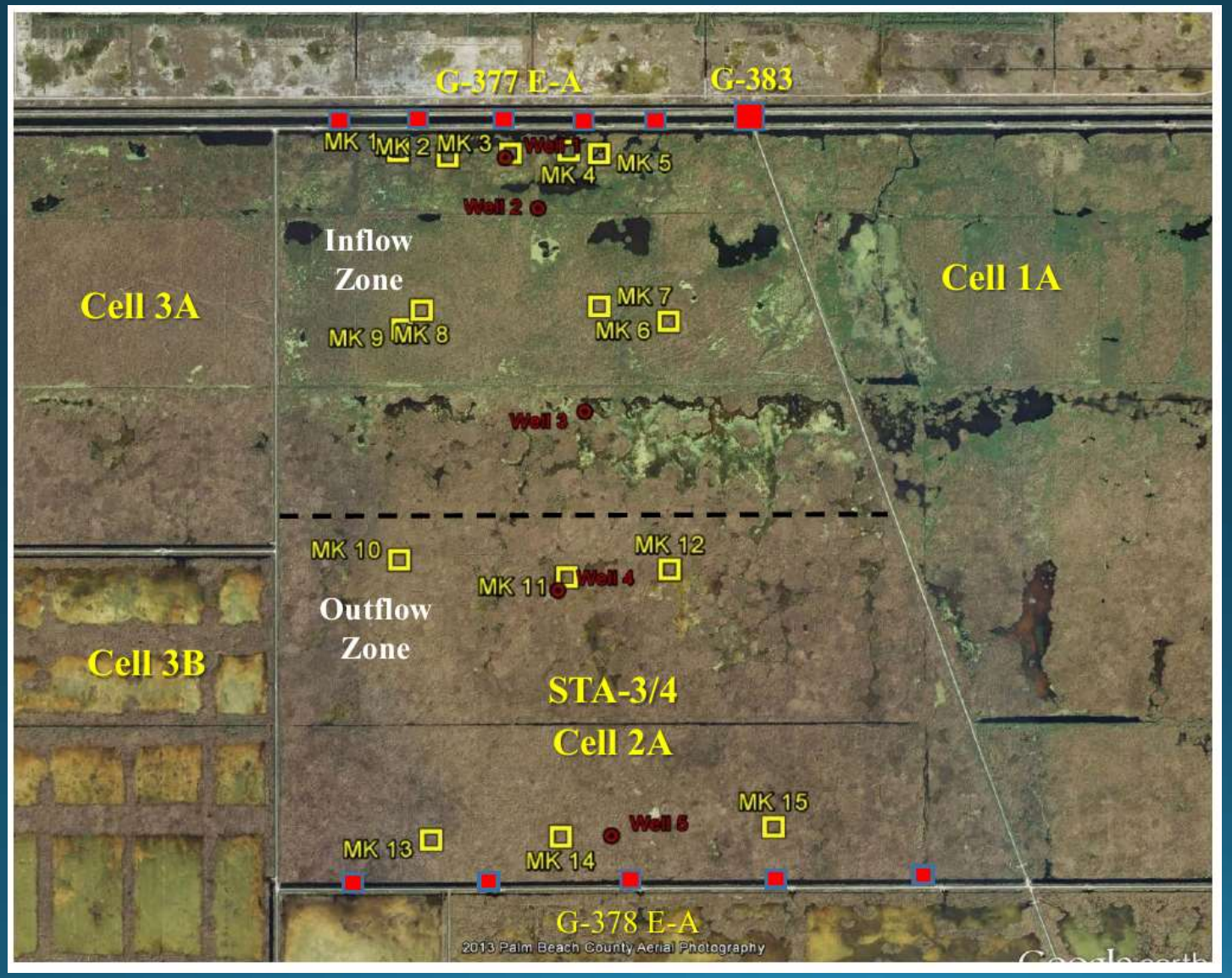
- Stormwater Treatment Area 3/4 (STA 3/4) is one of the best performing STAs .
- Emergent Aquatic Vegetation (EAV) cells exposed to high water depth for extended periods during heavy rain events.
- Previous reports show northern (inflow) regions experience the deepest water conditions, potentially stressing the cattail populations.



In-situ Study Objectives

- To identify how inundation depth and duration influence cattail sustainability in STA 3/4 Cell 2A.
- The variables to be discussed are: water depth, cattail density, photosynthetic rate, and leaf elongation.
  - Plant level : Photosynthesis and leaf elongation
  - Community level: Plant density
- Qualitative field observations include: presence of floating cattail, presence of emergent or floating aquatic plants within the plot, and photo-documentation of each plot.

Monitoring Locations



Water Depths in STA-3/4, Cell 2A

Methods:

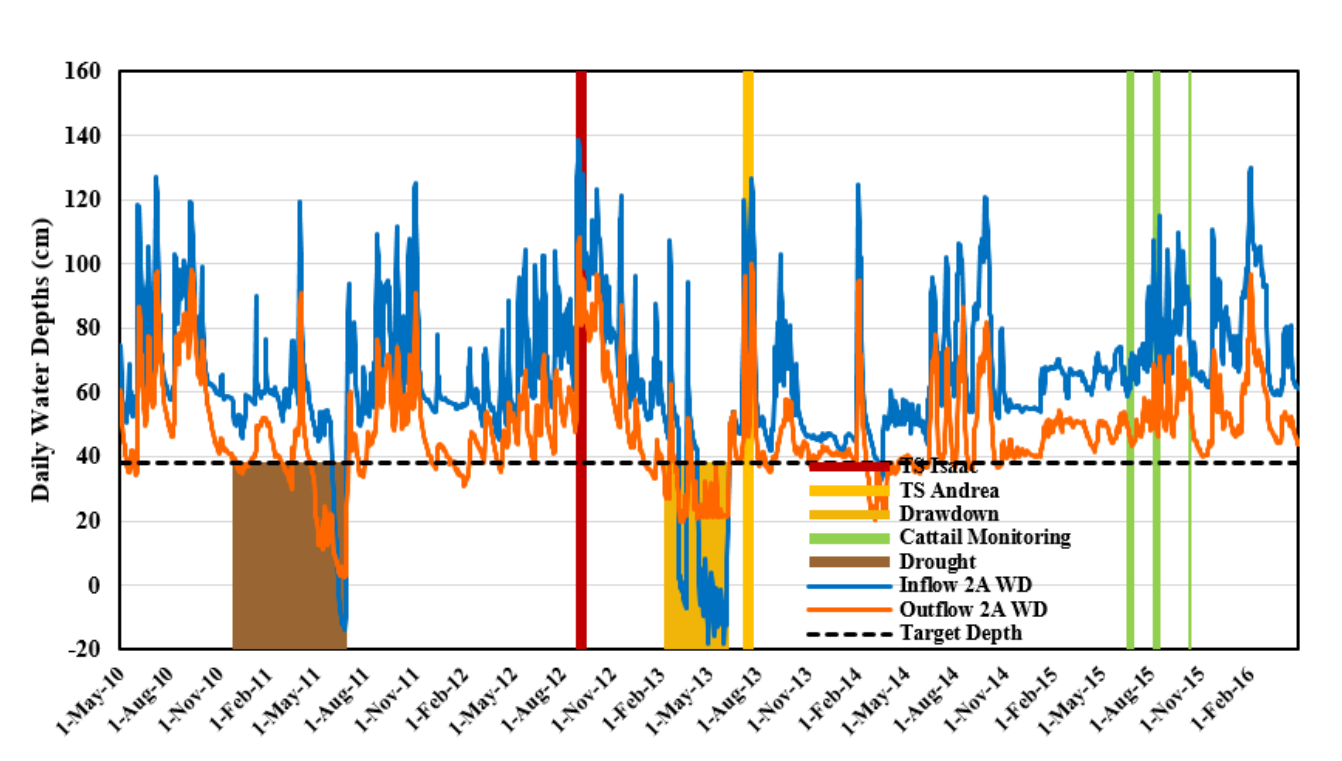
- Water Depths from DBHYDRO, WY2011 – WY2016

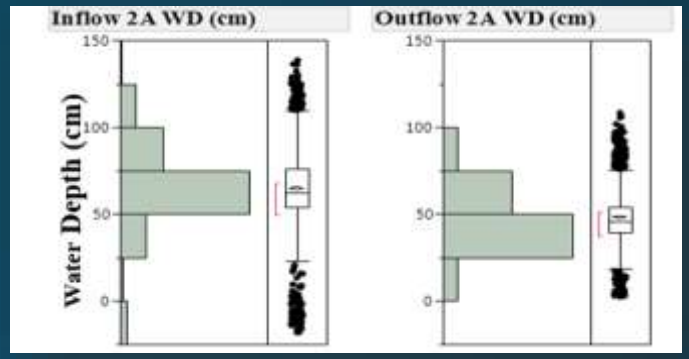
  STA-3/4, Cell 2A: Stations G377-T and G378-H

- *Solinst*® Pressure Transducers, July 2015 – Feb 2016

  Five *Solinst*® Pressure Transducers were installed across STA-3/4, Cell 2A.

Water Depths – DBHYDRO Data

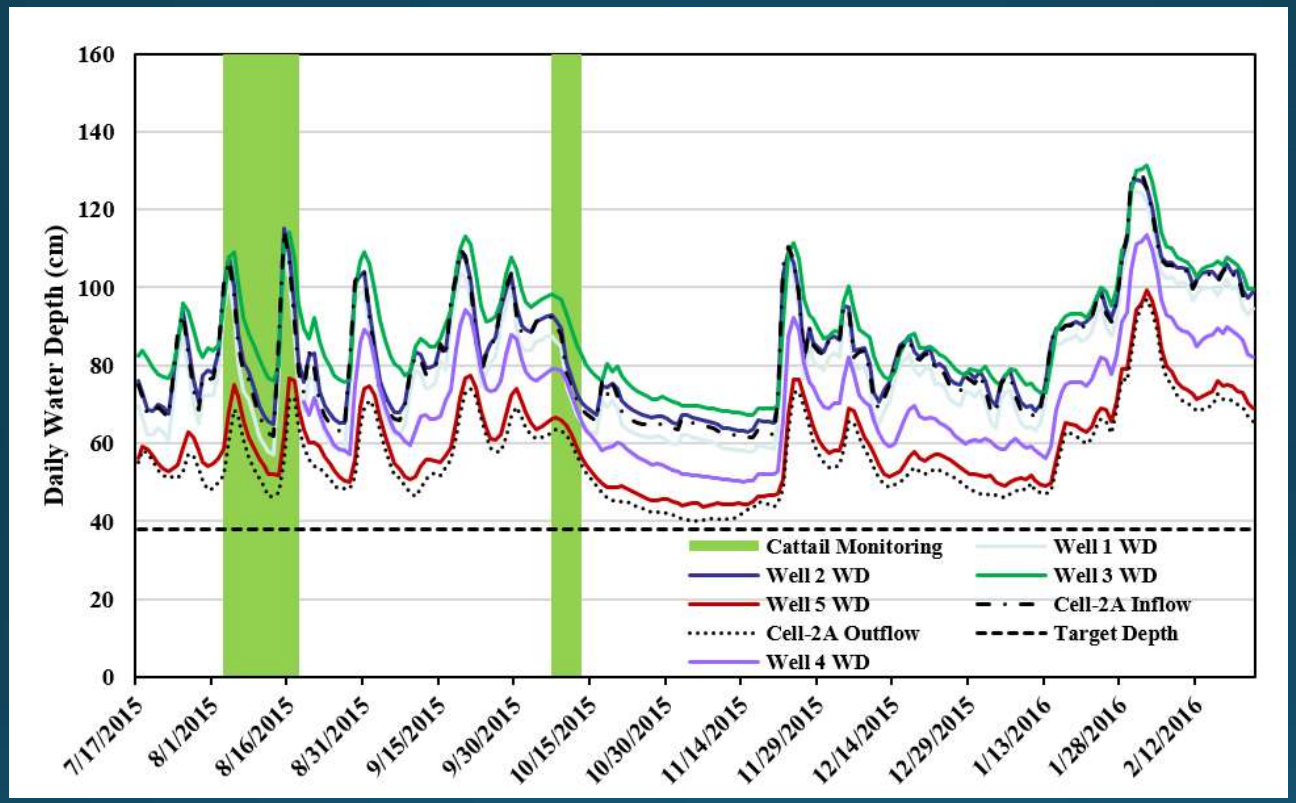




WY2011 - WY2016 -Inflow	
< 38 cm	5.0%
38 - 61 cm	**42.0%**
61 -76 cm	27.3%
76 -91 cm	12.4%
> 91 cm	13.4%
WY2016	
< 38 cm	0.0%
38 - 61 cm	6.0%
61 -76 cm	**51.6%**
76 -91 cm	23.2%
> 91 cm	19.1%

WY2011 - WY2016 - Outflow	
< 38 cm	20.3%
38 - 61 cm	**61.0%**
61 -76 cm	11.5%
76 -91 cm	4.3%
> 91 cm	3.2%
WY2016	
< 38 cm	0.0%
38 - 61 cm	**78.1%**
61 -76 cm	18.9%
76 -91 cm	1.4%
> 91 cm	1.6%

Water Depths – *Solinst*® Data



STA-3/4 Cell 2A Water Depths Ranges	Number of Days per Depth Range Category	% of Days per Depth Range Category	Number of Days per Depth Range Category	% of Days per Depth Range Category
cm	Inflow Wells Average		Outflow Wells Average	
< 38.10	0	0.0	0	0.0
38.10 - 60.96	0	0.0	105	47.3
60.96 - 76.20	85	38.3	75	33.8
76.20 - 91.44	73	32.9	36	16.2
> 91.44	64	28.8	6	2.7

†Data Range: July 7, 2015 to February 23, 2016.

Summary - Water Depths

- Water depths in STA-3/4 Cell 2A during WY2016 were generally deeper in the inflow area of the cell. About 52% of water depth was in the range of 61 to 76 cm, with water depths >76 cm accounting for 42% of the data.

- In contrast, about 78% of the water depths from the outflow area of the cell were in the range of 38 to 61 cm, with water depths >76 cm accounting for only 3% of the data.

- Deeper inundation depths and longer periods of deep water conditions present in the inflow region compared to the outflow region.

Plant Density – Materials and Methods

- Cattail plants categorized into 4 groups:
  - Live adults (>1.5 m in height)
  - Live juveniles (<1.5 m in height)
  - Live reproductive adults (with flower or seed stalk)
  - Dead cattail
- To improve count accuracy, each plot was further divided into subplots using PVC poles.
- For analysis, the number of live juveniles and live adult individuals for each 2 m x 3 m plot were aggregated and converted to number of individuals/m^2.

Photosynthetic Rate – Materials Methods

Photo from: https://www.licor.com/env/products/photosynthesis/LI-6400XT/

- Measured using a LI-6400XT Portable Photosynthesis System (Li-COR, Lincoln, Nebraska, USA).
- Five representative adult plants were selected for measurement in each plot.
- One mature, healthy leaf was selected from each plant for photosynthesis measurement.
- Li-Cor chamber was clamped 6-18 inches from the tip of the leaf and held in place to allow for stabilization before collecting a reading.

Leaf Elongation – Materials and Methods

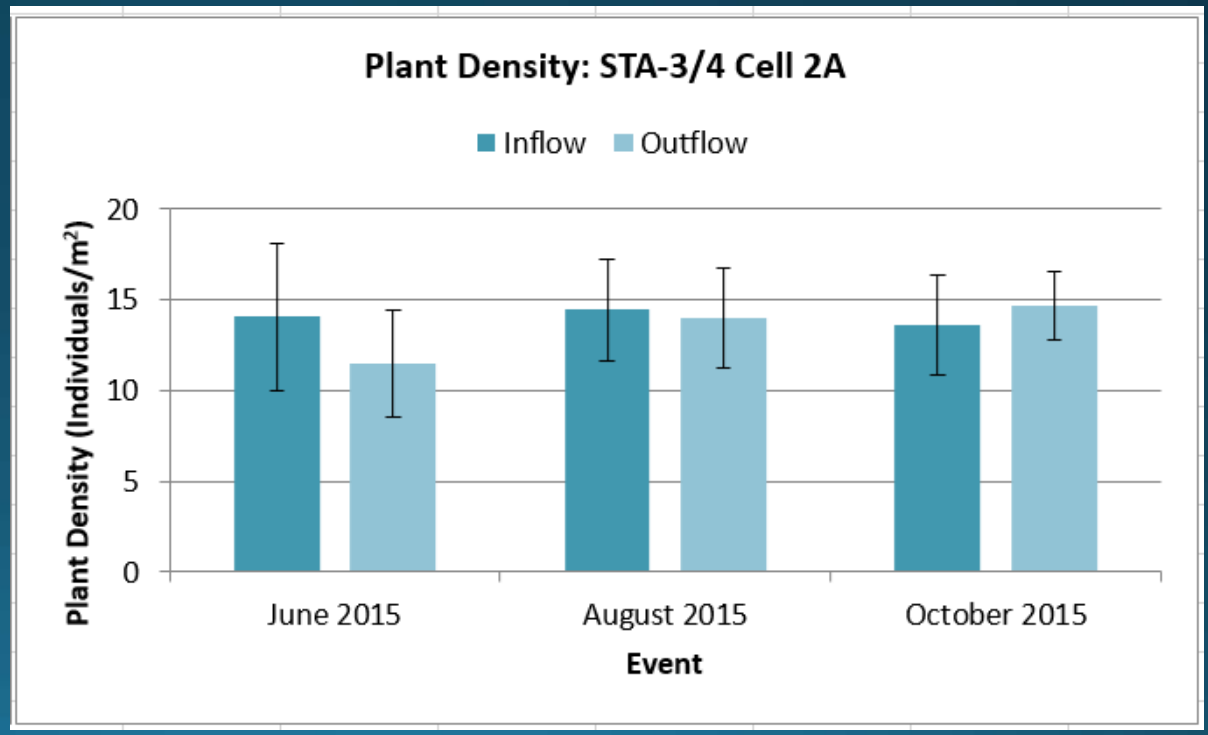
- The same five plants selected for photosynthesis readings were also used for leaf elongation measurements.
- Shortest and youngest leaf from the inner culm on each plant was identified and flagged (labeled 1-5).
- A measuring pole was used to measure leaf height, from the base of the plant to the tip of the leaf.
- Re-measurement occurred between 7-10 days after the initial measurement.

$$Leaf\ elongation\ rate = \frac{Height_2 - Height_1}{\#\ of\ days\ between\ measurements}$$

Results – Plant Density

- Plant density was not significantly different between the inflow (14.04 plants/m²) and outflow (13.39 plants/m²) regions of Cell 2A.

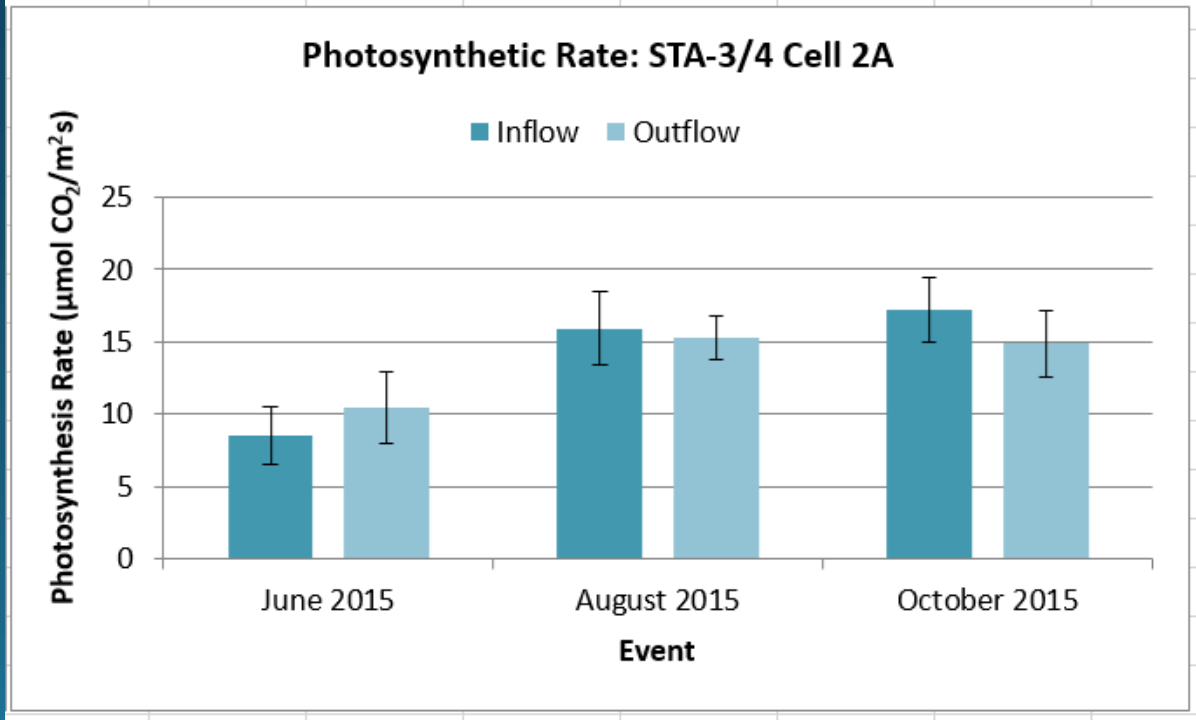
Monitoring Zone	Plant Density (plants/m²)
Inflow	14.04 ± 3.16
Outflow	13.39 ± 2.80
P = 0.492	



Results – Photosynthetic Rate

- Photosynthetic rate was consistent across the cell, with no significant difference between the inflow (13.90 µmol CO_2 $m^{-2}s^{-1}$) and outflow (13.53 µmol CO_2 $m^{-2}s^{-1}$) regions of the cell.

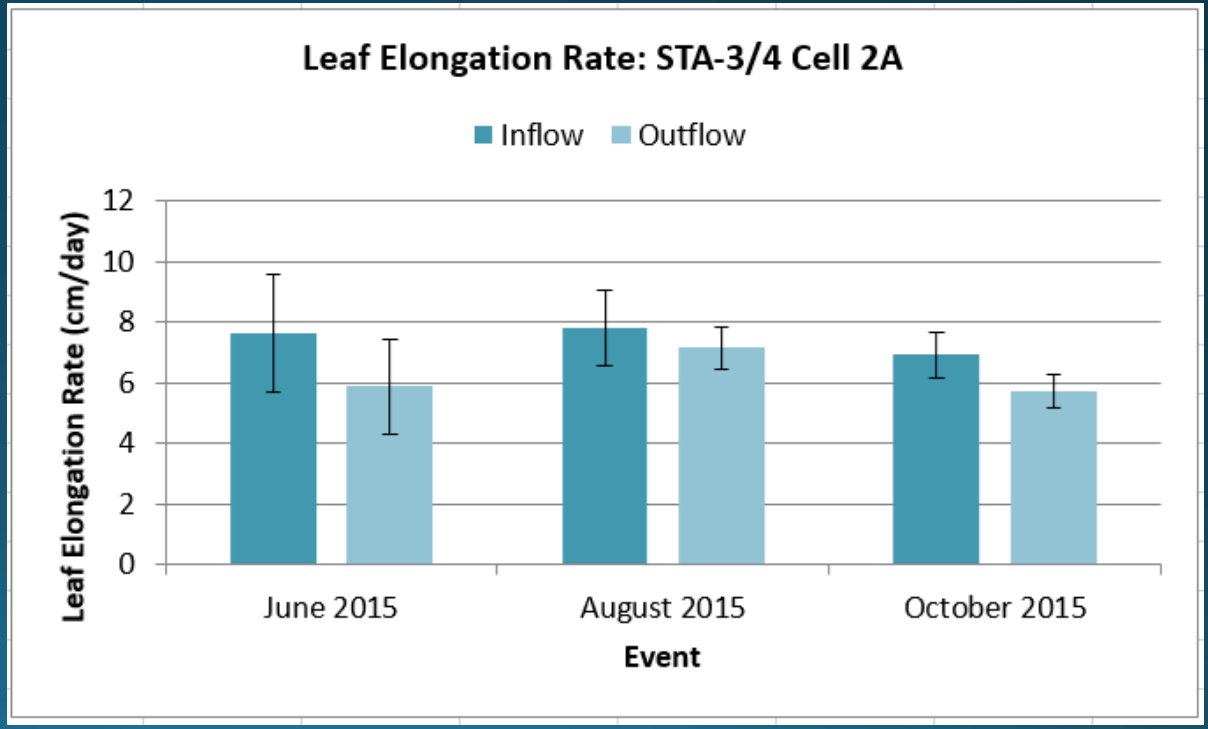
Monitoring Zone	Photosynthetic Rate (µmol CO_2 $m^{-2}s^{-1}$)
Inflow	13.90 ± 4.46
Outflow	13.53 ± 3.04
P = 0.755	



Results – Leaf Elongation

- Leaf elongation rate in the inflow region (7.46 cm/day) is significantly higher than the outflow region (6.25 cm/day; p=0.004).

Monitoring Zone	Leaf Elongation Rate (cm/day)
Inflow	7.46 ± 1.40
Outflow	6.25 ± 1.18
P = 0.004	



Summary – Plant Measurements

- No significant difference in photosynthetic rate or plant density between the inflow and outflow regions.

- Leaf elongation rate was significantly higher in the inflow than the outflow region.
  - Previous data have shown the opposite trend: Greater stress from deep water conditions = lower leaf elongation rate (Chen and Vaughan, 2014).
  - Data suggest deep water conditions may actually stimulate leaf growth rates of juvenile leaves, possibly to restore gas exchange between roots and the atmosphere (Bailey-Serres and Voesenek, 2008).
  - Further investigation warranted.

What's Next?

- 2016 wet season sampling events are complete.
- Continued monitoring through the 2017 wet season.
- A final report of the 2015, 2016, and 2017 sampling results to be completed in late 2017/early 2018.
- A separate component involving test cells will be added later.

Questions?