# Relating Hydrology to Wetland Plant Community Distribution


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# Rationale

- Wetland vegetation composition depends upon the restored hydroperiod

  (De Steven and Lowrance, 2011)
- Matching vegetation to restored hydrology remains a challenge

  (Zedler, 2000)

“I have a restoration site with an expected hydroperiod of X…what should I plant there”?

Or

“I want a community of Y at a restoration site…what hydroperiod do I need to design into the restoration?”

# Selected wetland communities

| | Pond Pine Woodland | Nonriverine Swamp Forest | High Pocosin | Bay Forest |
|---|---|---|---|---|
| Dominant Species | Pond Pine | Cypress, Swamp Tupelo | Pond Pine, Bays | Bays |
| Height (m) | 18 | 30 | 7.6 | 10 |
| Basal Area ($m^2$ $ha^{-1}$) | 12.6 | 22.3 | 1.9 | 7.9 |
| Available P (mg $dm^{-3}$) | 11.9 | 17.8 | 9.2 | 12.1 |
| Organic Layer (cm) | <40 | 20 - 80 | >80 | >80 |

Dimick et al., Castanaea, 2010

# Hydrology?

| Pond Pine Woodland | Nonriverine Swamp Forest | High Pocosin | Bay Forest |
|---|---|---|---|
| Temporarily flooded or saturated | Seasonally or frequently saturated or shallowly flooded | Seasonally flooded or saturated | |

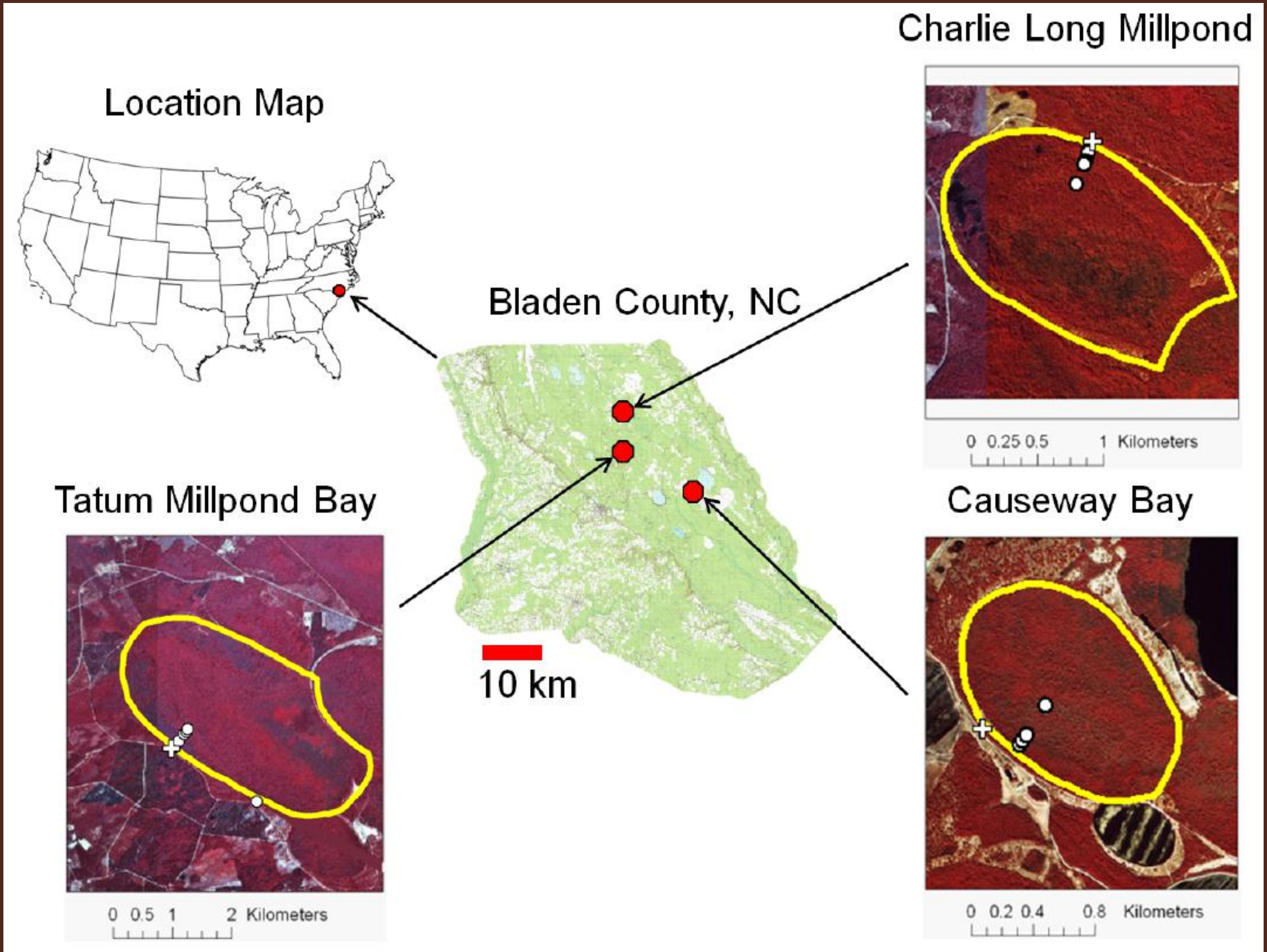
Schafale and Weakley, 1990

# Objective

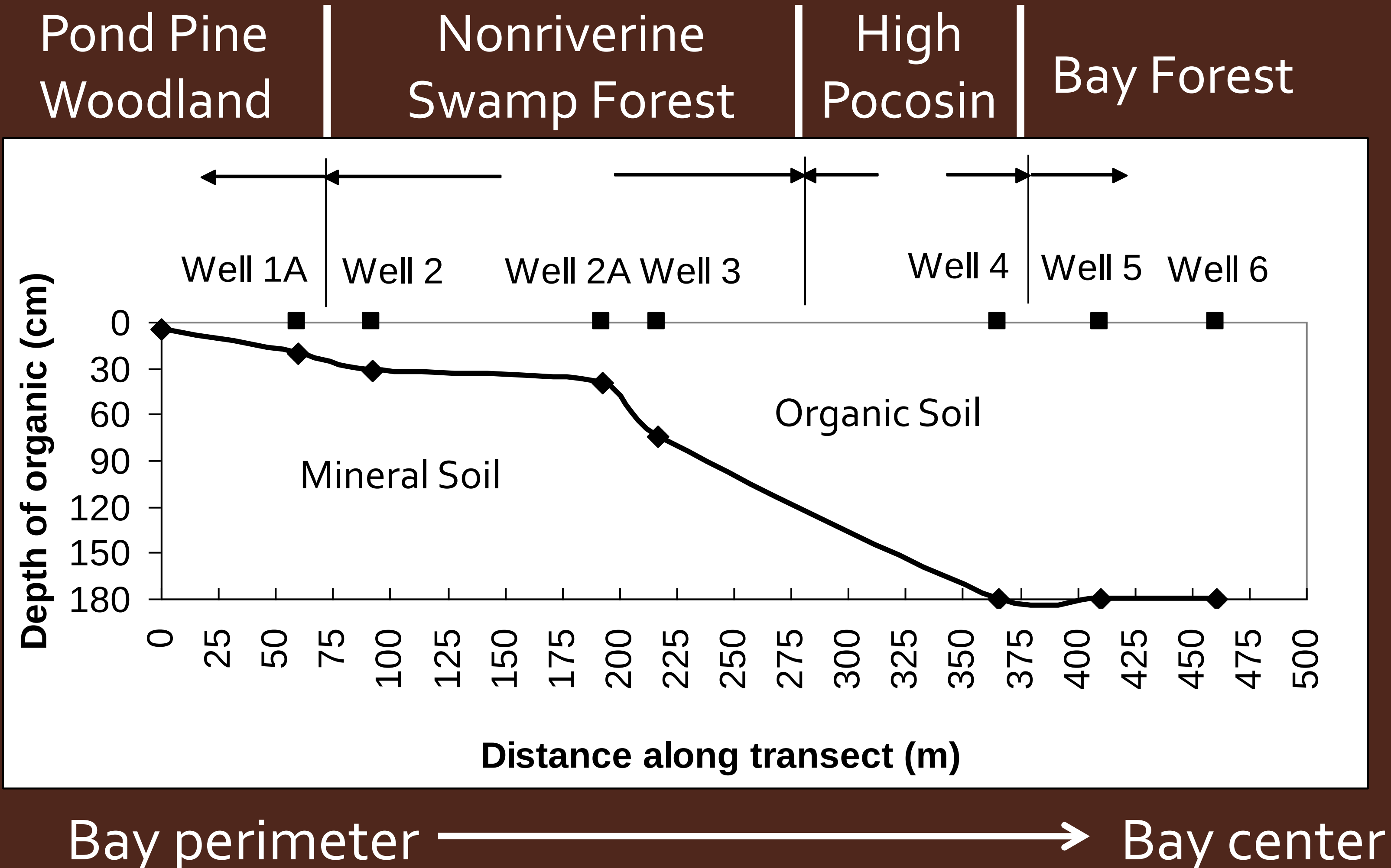
Compare and quantify the long-term hydrology associated with four plant communities found in Carolina Bays.

- Can hydrology explain where communities are established within the bays?
- Provide quantitative data describing the hydrology of the plant communities

# Site Locations



# Gradient of soil and vegetation



# Plant community plots

| Bay | Pond Pine Woodland | Nonriverine Swamp Forest | High Pocosin | Bay Forest |
|---|---|---|---|---|
| Charlie Long | 3 | | 1 | |
| Causeway | 2 | | 2 | |
| Tatum Millpond | 1 | 3 | 1 | 2 |
| Total | 6 | 3 | 4 | 2 |

# Methods

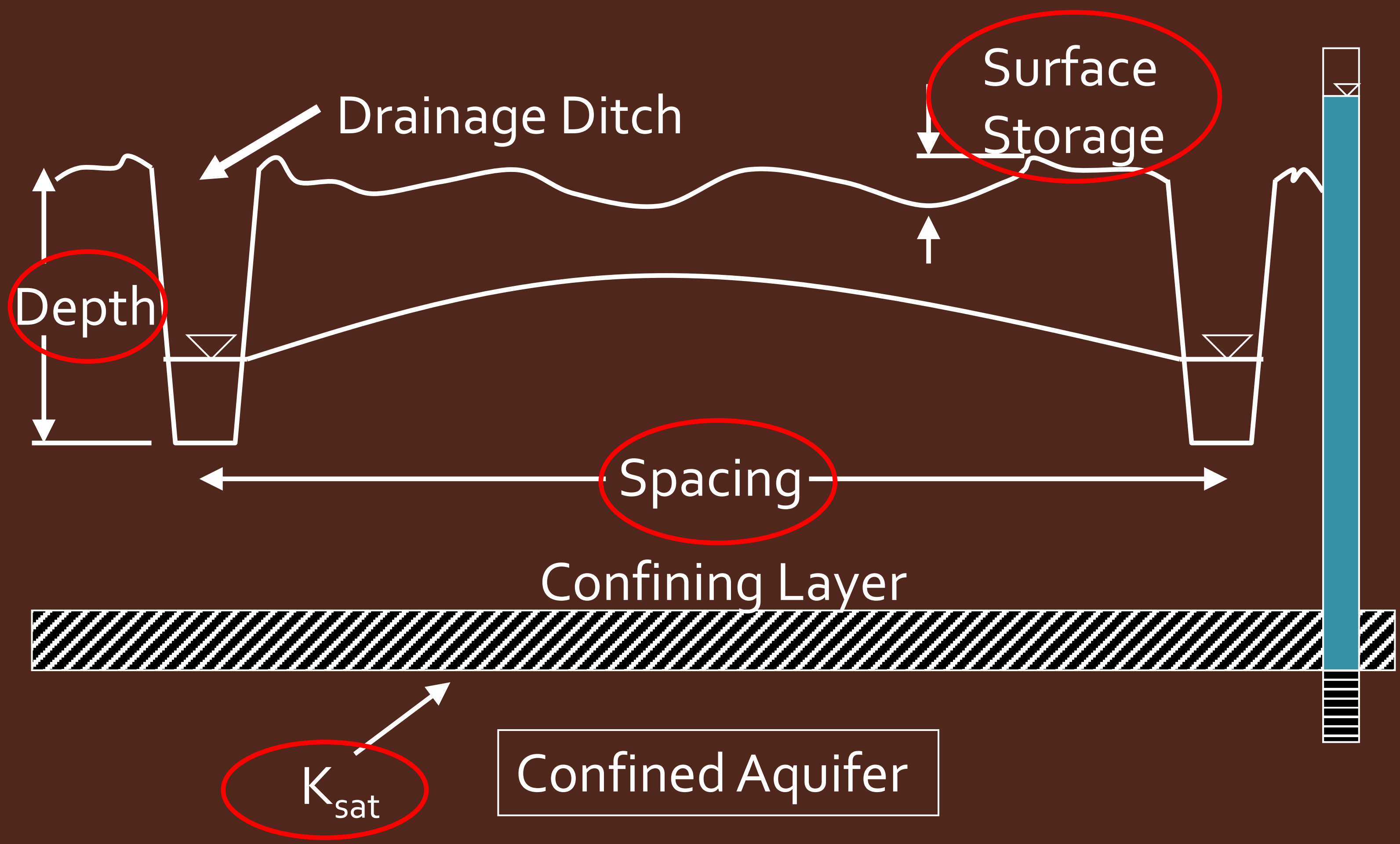
Collect site observations

Develop and calibrate DRAINMOD models

Input 40 year historical climate data

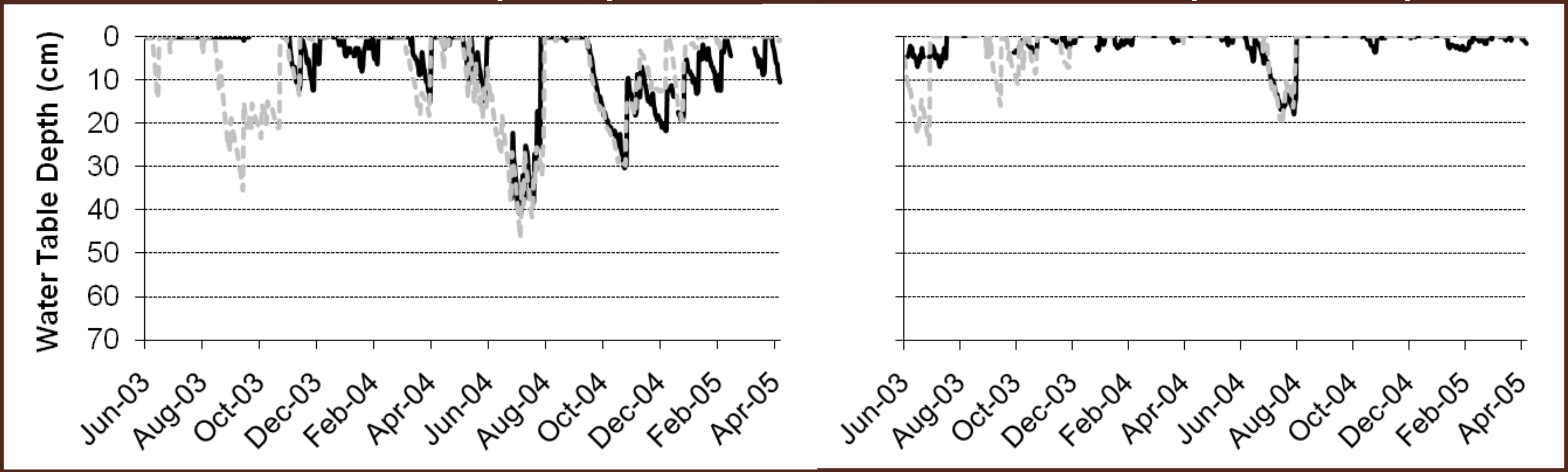
Compare hydrology in each plant community

# DRAINMOD


Drainage Ditch
Surface Storage
Depth
Spacing
Confining Layer
$K_{sat}$
Confined Aquifer

# Model Calibration

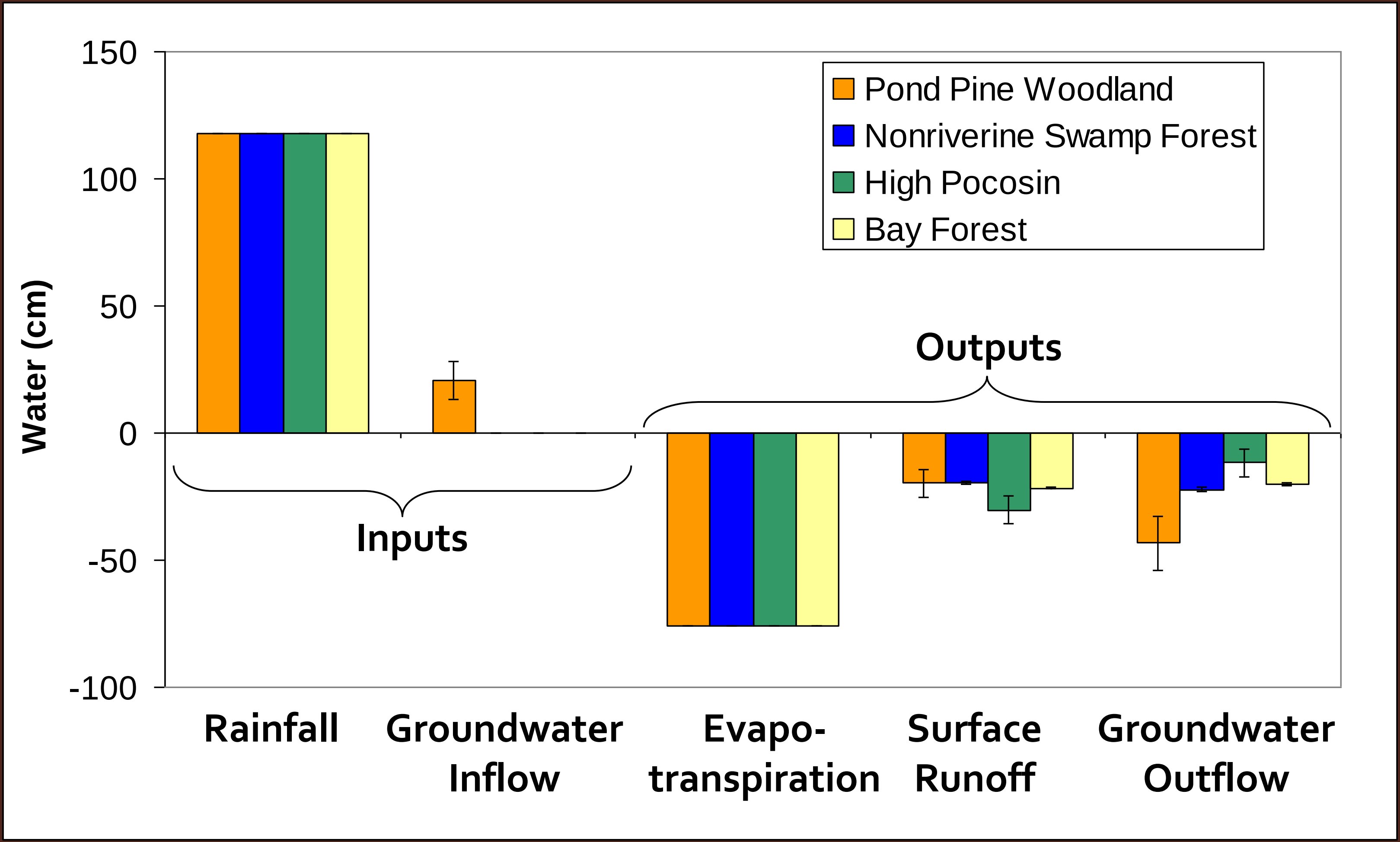
Pond Pine Woodland (Causeway Bay #1) | Bay Forest (Tatum Millpond Bay #5)




| Sites | Mean absolute error, daily WTD (cm) | $R^2$ pred vs. obs daily WTD |
|---|---|---|
| 15 | 0.2 – 6.1 (median 1.4) | -0.02 – 0.86 (median 0.53) |

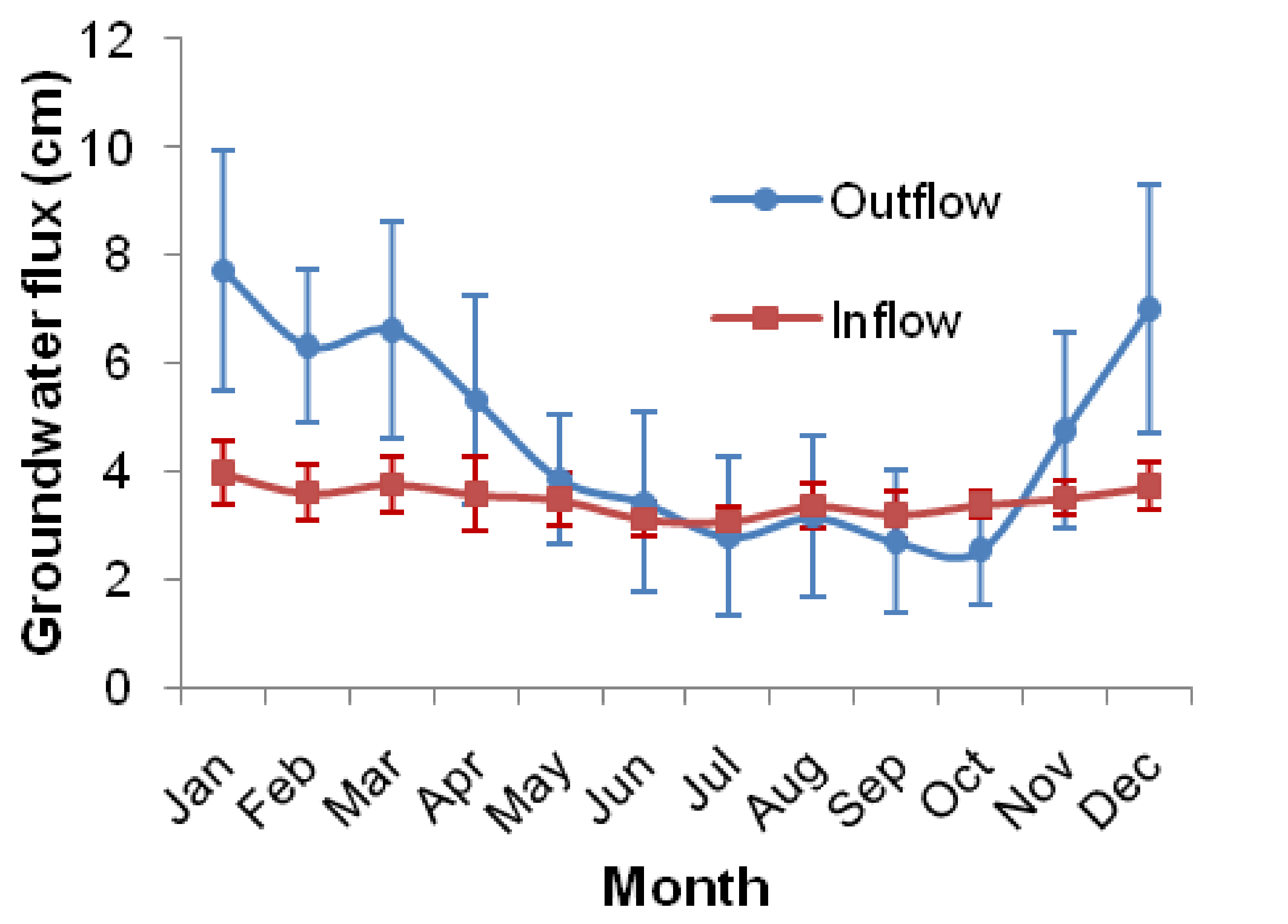
Caldwell et al., Wetlands 2007

# 40 year water balances



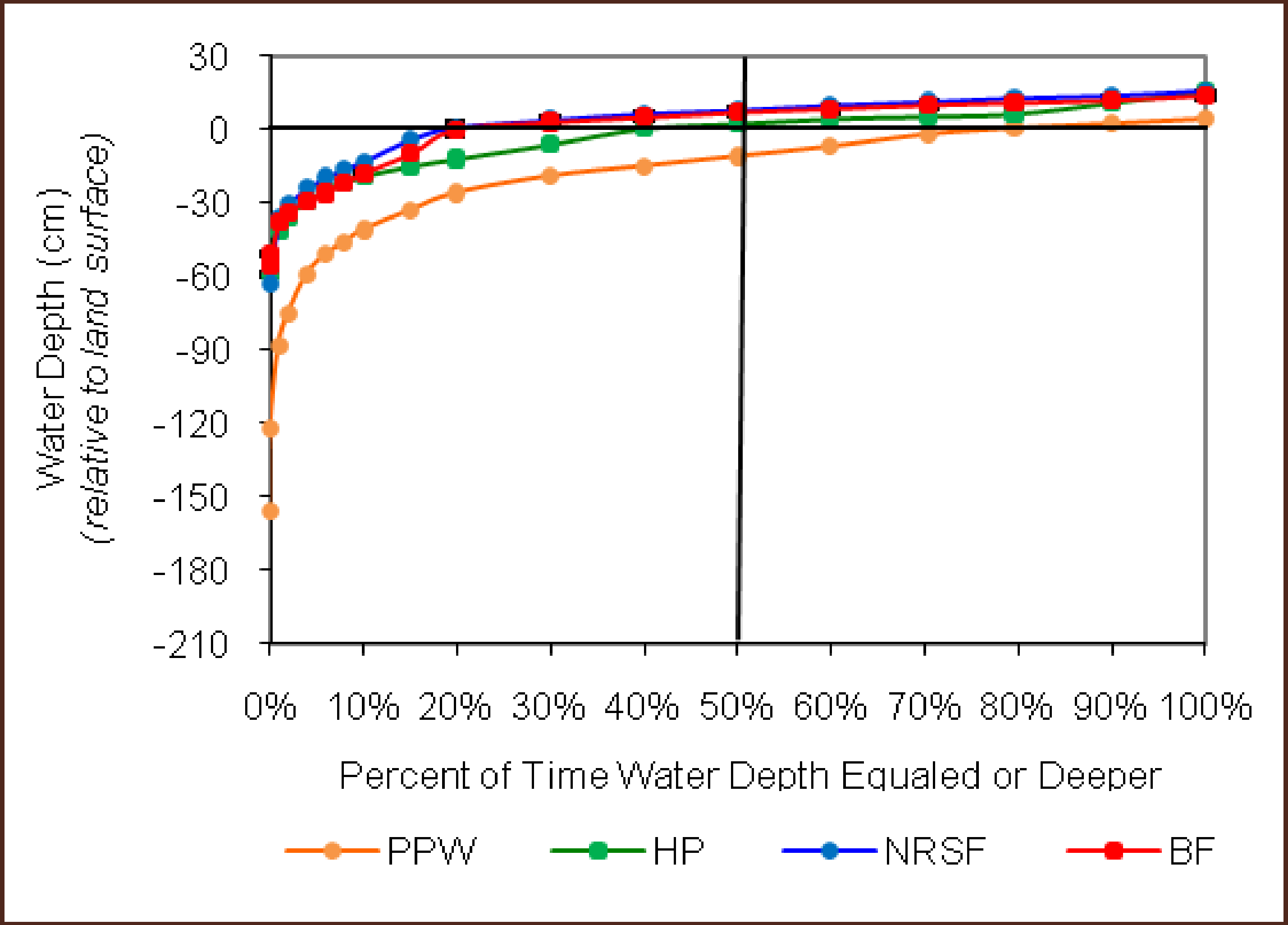

Caldwell et al., Trans ASABE 2011

# Groundwater Inflow




Caldwell et al., Trans ASABE 2011

# Daily water table depth distributions




Caldwell et al., Trans ASABE 2011

# Hydroperiods

| Community | Plots | Median water table depth (cm) | Median hydroperiod (d $yr^{-1}$) | Group ($\alpha$=0.05) | |
|---|---|---|---|---|---|
| Pond Pine Woodland | 6 | -8.0 | 91 | a | |
| Nonriverine Swamp Forest | 3 | 8.7 | 317 | | b |
| High Pocosin | 4 | 2.2 | 243 | a | b |
| Bay Forest | 2 | 7.5 | 307 | a | b |

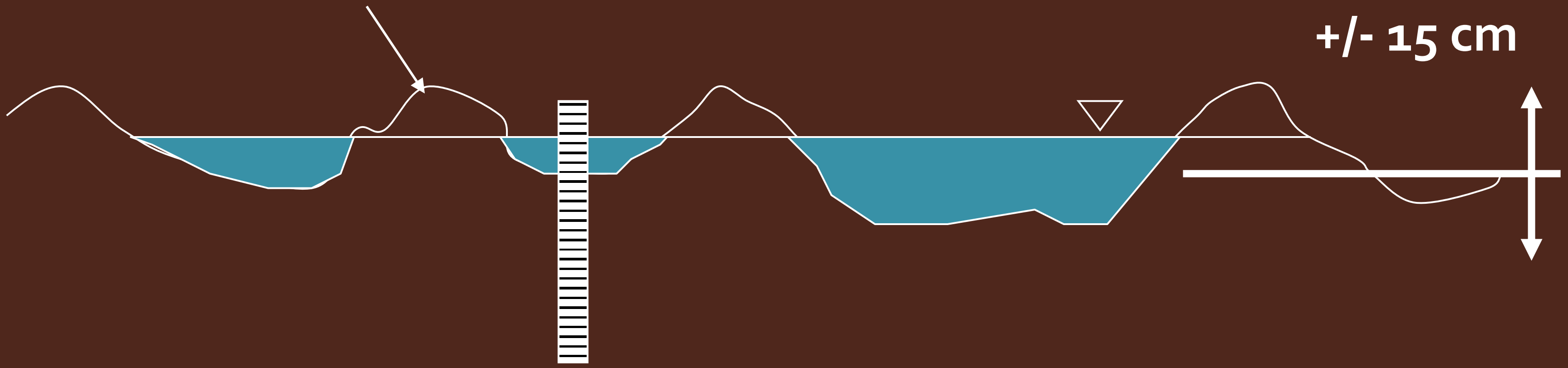
Caldwell et al., Trans ASABE 2011

# Duration of Continuous Saturation

| Community | Sites | Duration Minimum | Duration 50% of years |
|---|---|---|---|
| | n | days | days |
| Pond Pine Woodland | 6 | 28 – 91 (66) | 86 – 242 (162) |
| Nonriverine Swamp Forest | 3 | 93 – 112 (104) | 242 – 242 (242) |
| High Pocosin | 4 | 54 – 166 (113) | 122 – 242 (212) |
| Bay Forest | 2 | 91-106 (98) | 242-242 (242) |

Growing Season: 242 days, 5% = 12 days

# Microtopography




- Similar microtopography across all plant communities
- Local high elevations occupied by trees → wells placed in local low elevations
- Ponding does not indicate entire area  is flooded

# Other environmental factors

| | Nonriverine Swamp Forest | High Pocosin | Bay Forest |
|---|---|---|---|
| Available soil phosphorus | high | low | low |
| Disturbance (fire, logging, etc) | no | yes | no |

# Design Criteria for Restoration of Selected Plant Communities

| Organic layer thickness (cm) | Hydroperiod (d $yr^{-1}$) | Recommended community |
|---|---|---|
| <40 | 90 | Pond Pine Woodland |
| 40 to 80 | 310 | Nonriverine Swamp Forest |
| >80 | 310 | Bay Forest |

# Take away points

- Results support the notion that hydrology is a key driver in wetland vegetative community distribution
- Hydrologic models cost effectively estimate long term plant-hydrology relationships
- Methodology can be further refined and used to quantify the hydrology of other wetland communities.

# Thank you!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