



Phosphorus Biogeochemistry of the Everglades: Implications to Restoration

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Phosphorus Cycling Processes

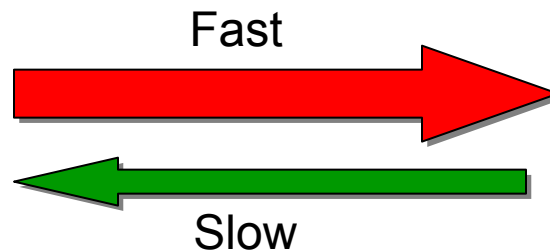
Topic Outline

- Introduction
- Forms of phosphorus
- Abiotic processes
- Biotic processes
- Ecosystem phosphorus memory
- Implications to restoration



Phosphorus Gradients

Phosphorus
Limited
Wetlands



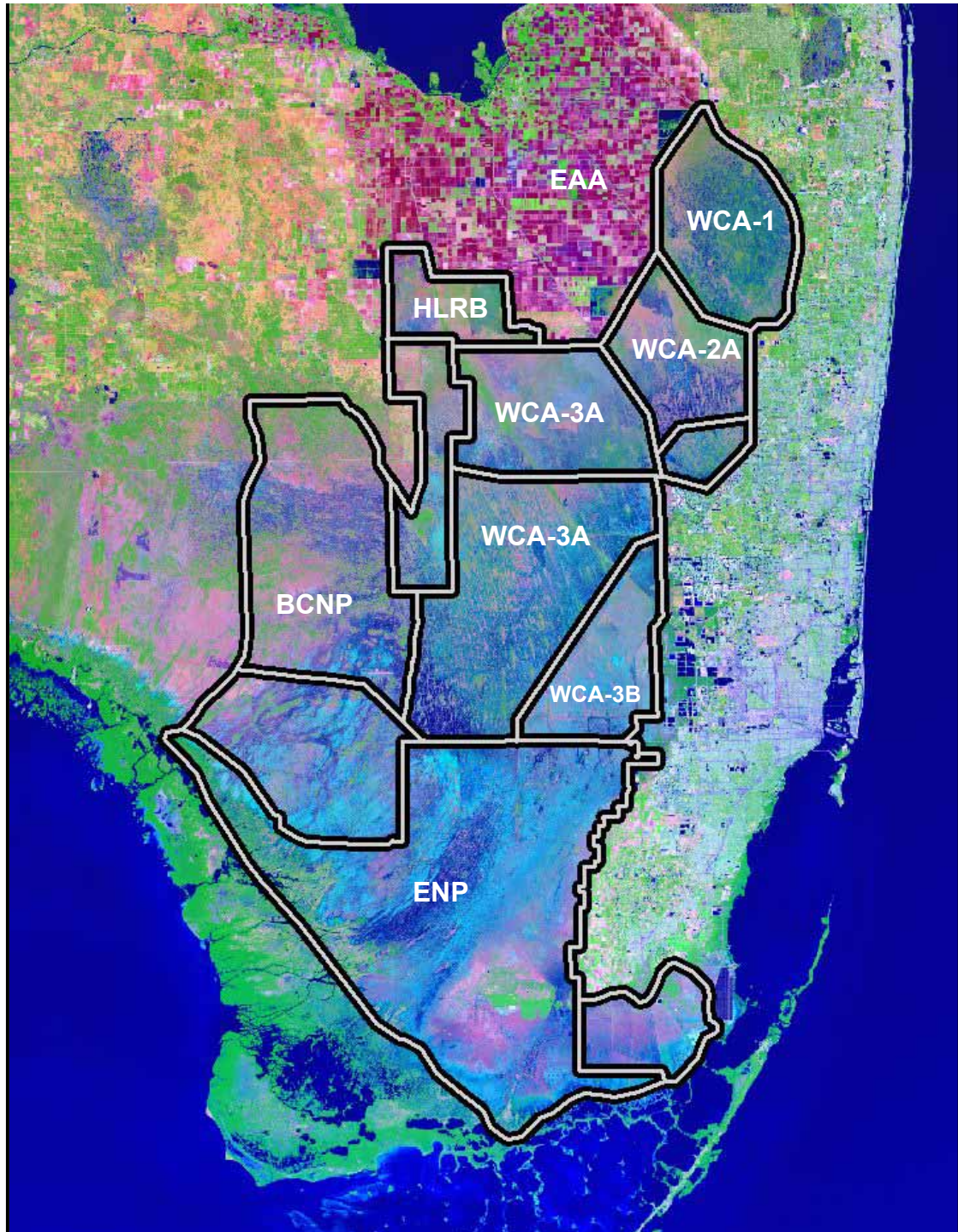
Phosphorus
Enriched
Wetlands

C:N:P Ratios
[High]

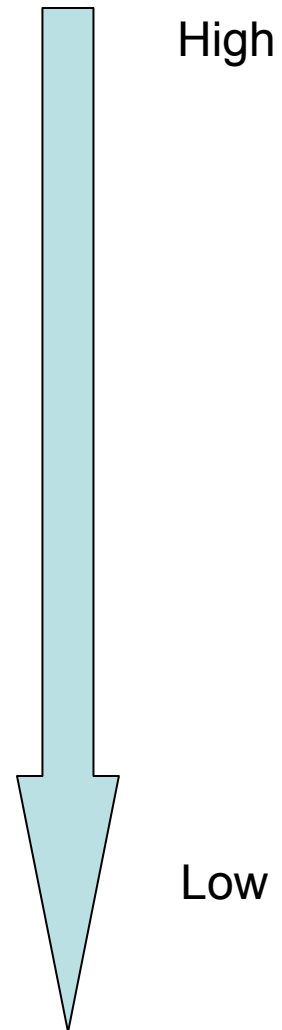
Low Organic Matter
Accumulation
Slow turnover rates
Longer residence time
High nutrient use efficiency

C:N:P Ratios
[Low]

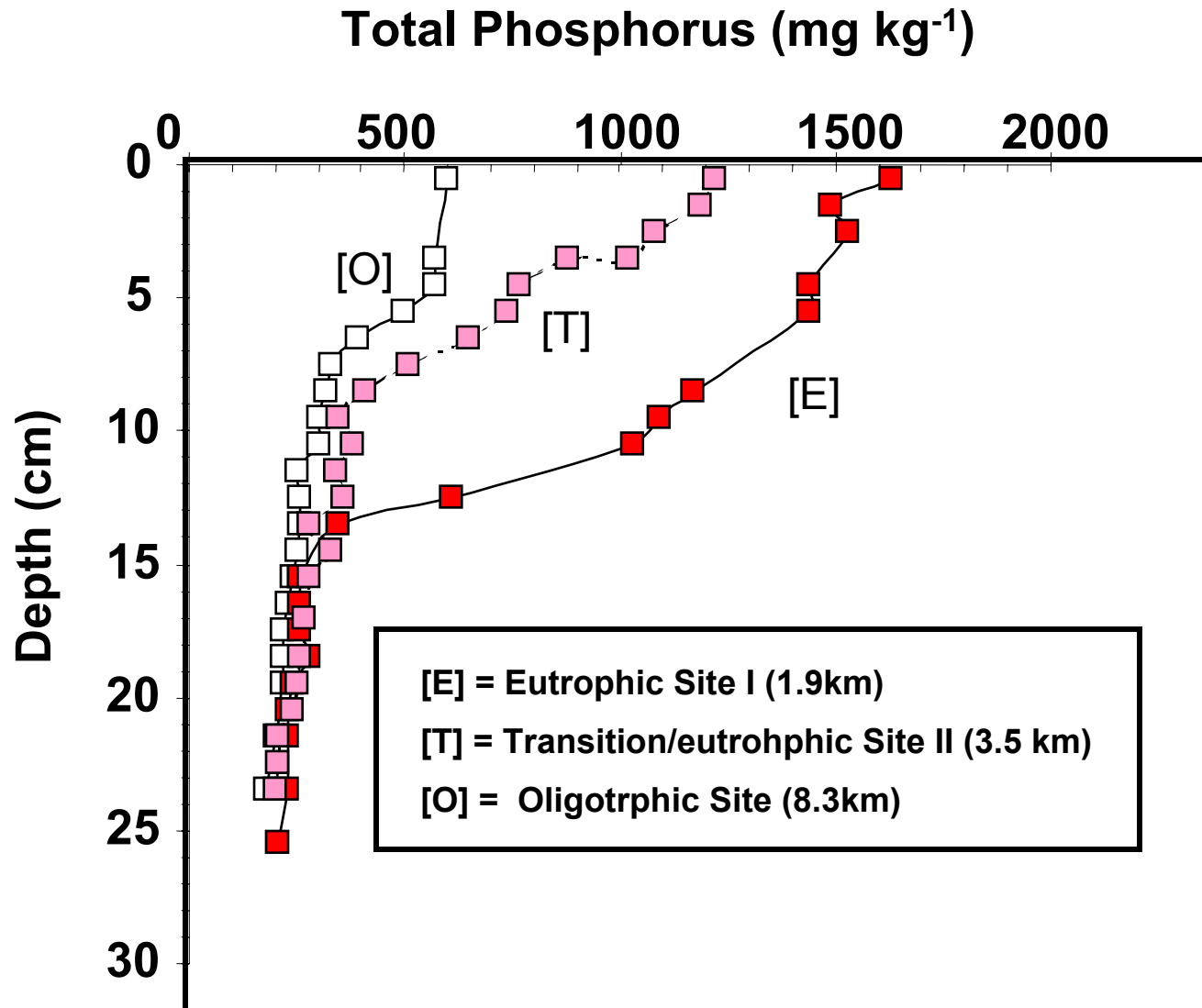
High Organic Matter
Accumulation
High turnover rates
Shorter residence time
Low nutrient efficiency



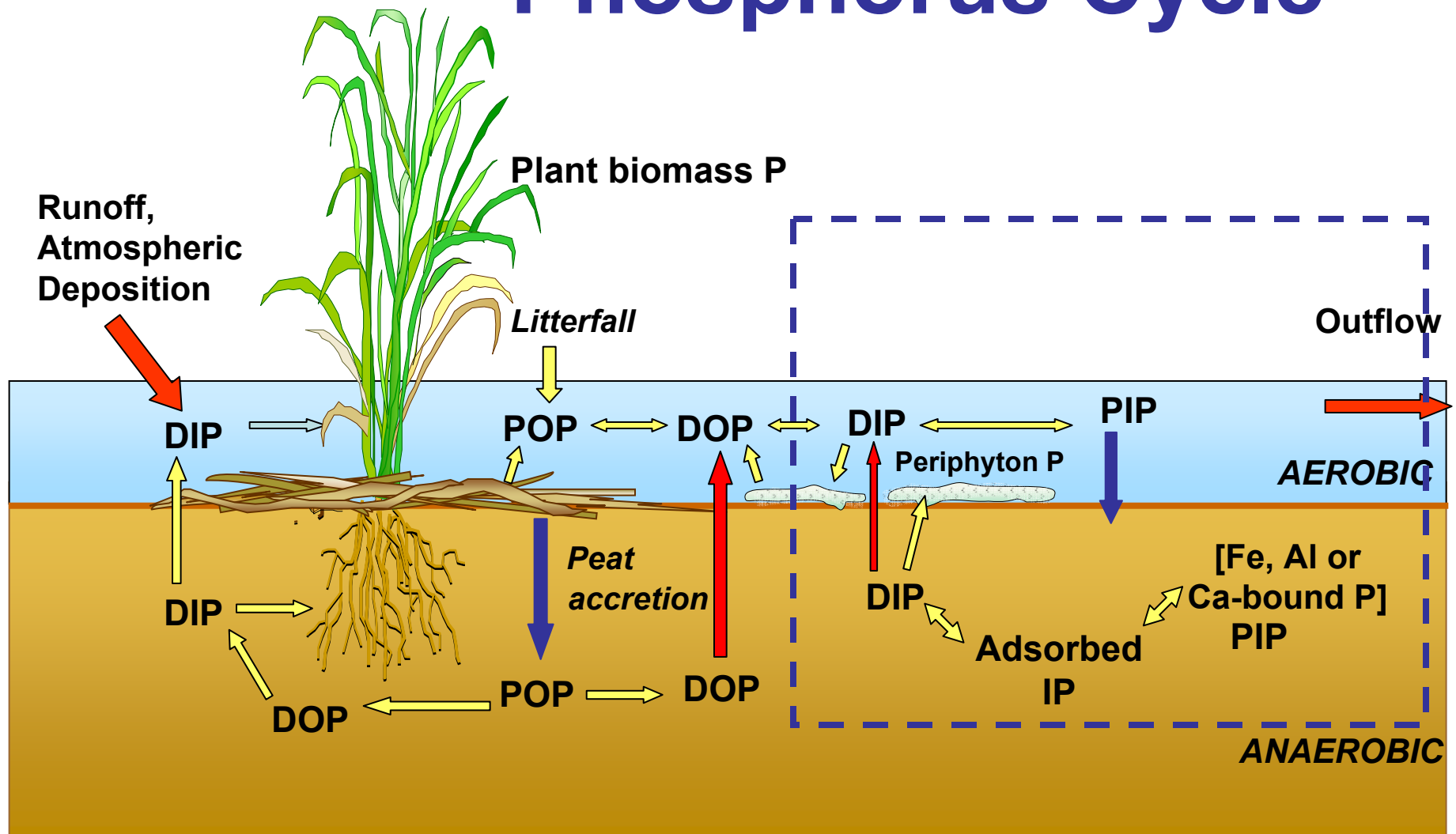
Phosphorus Gradients



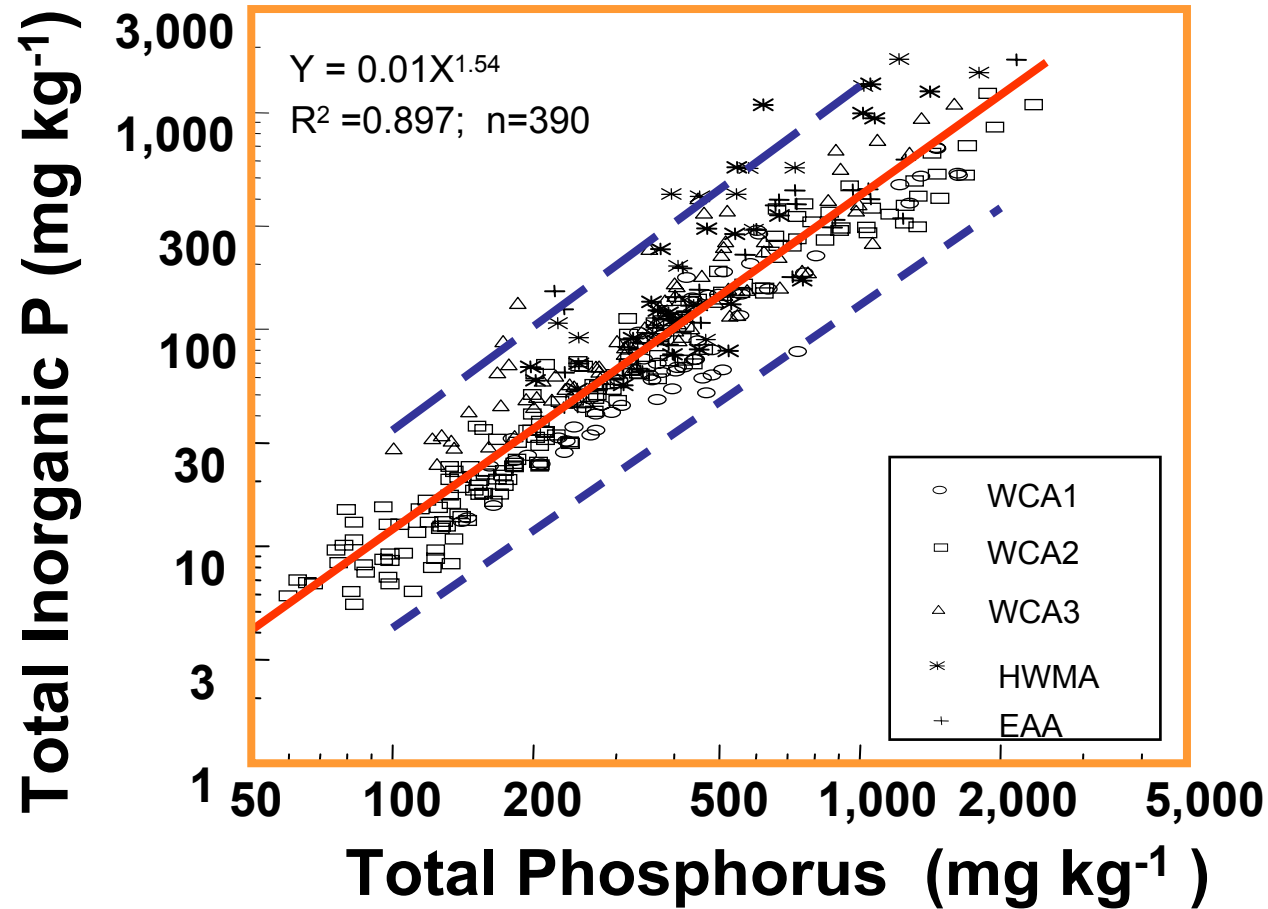
Phosphorus Gradients – WCA-2a



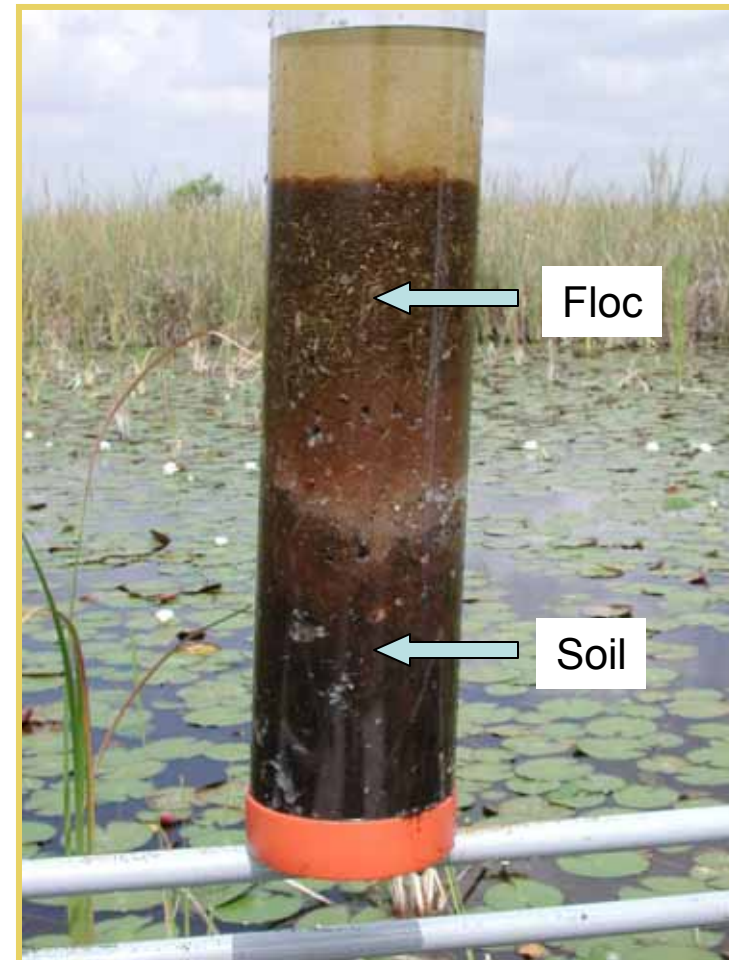
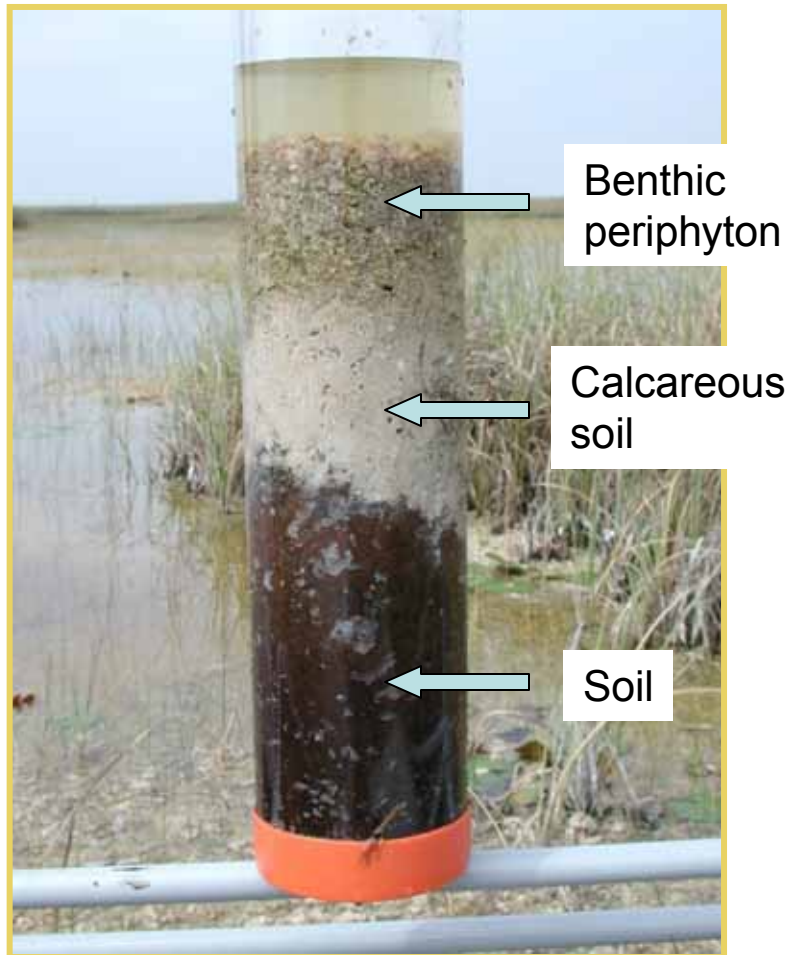
Phosphorus Cycle



Inorganic Phosphorus- Organic Soils

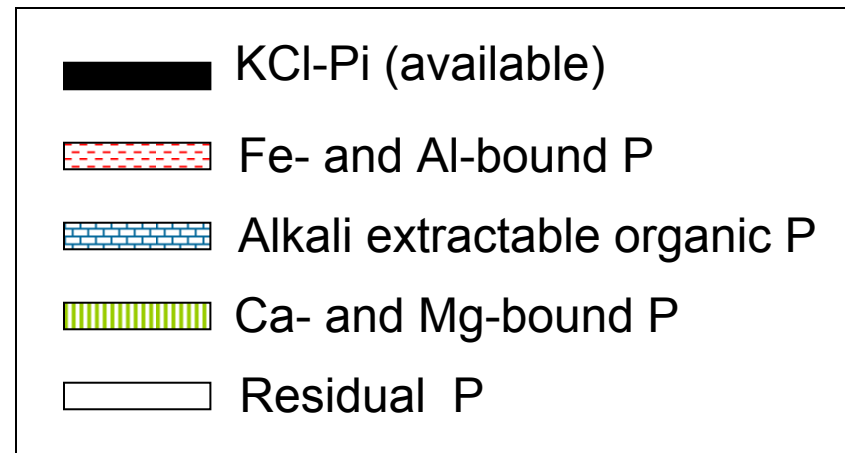
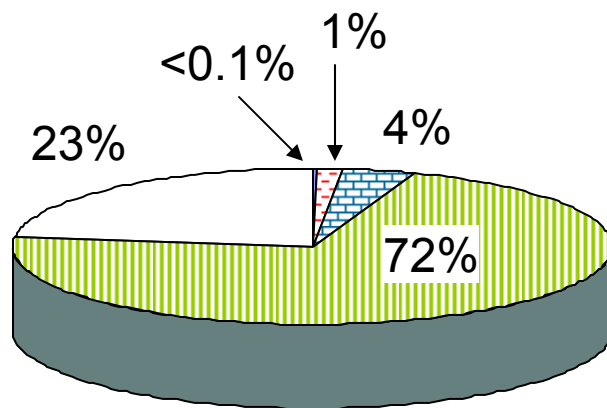


Soil Cores - WCAs

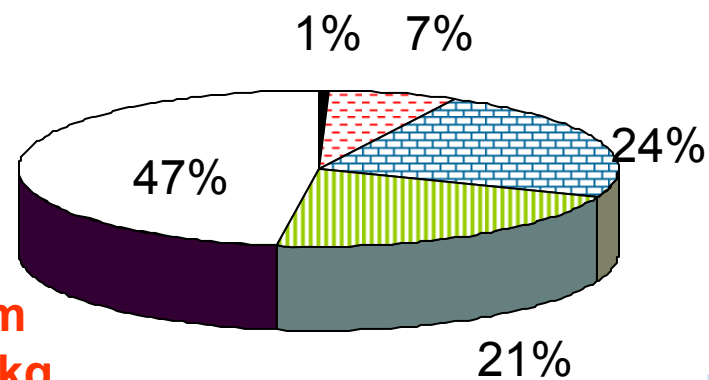


S. Newman, SFWMD)

Organic Wetland Soils – Drainage Effects

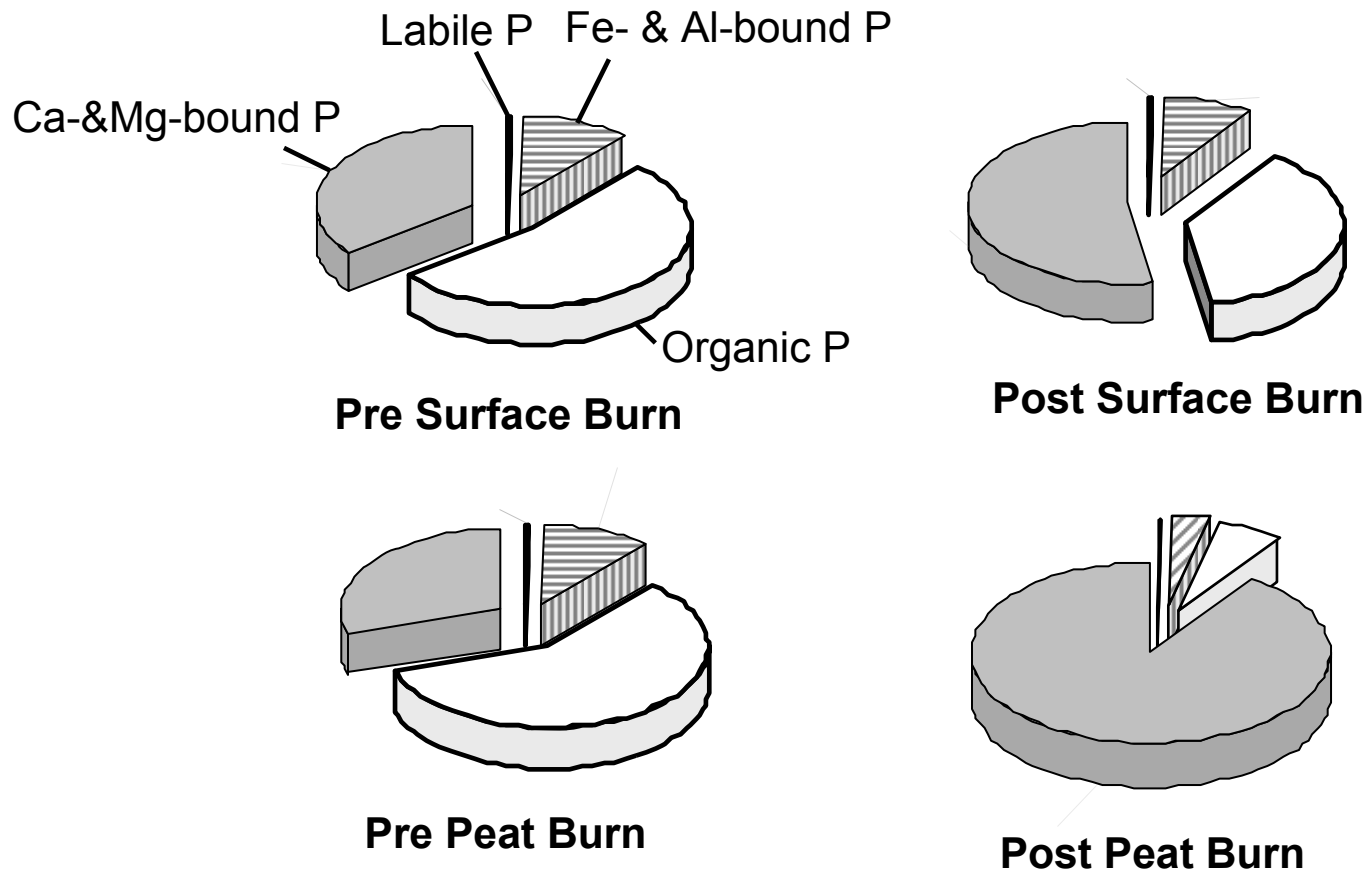


Peat Depth < 10 cm
Total P = 836 mg P/kg

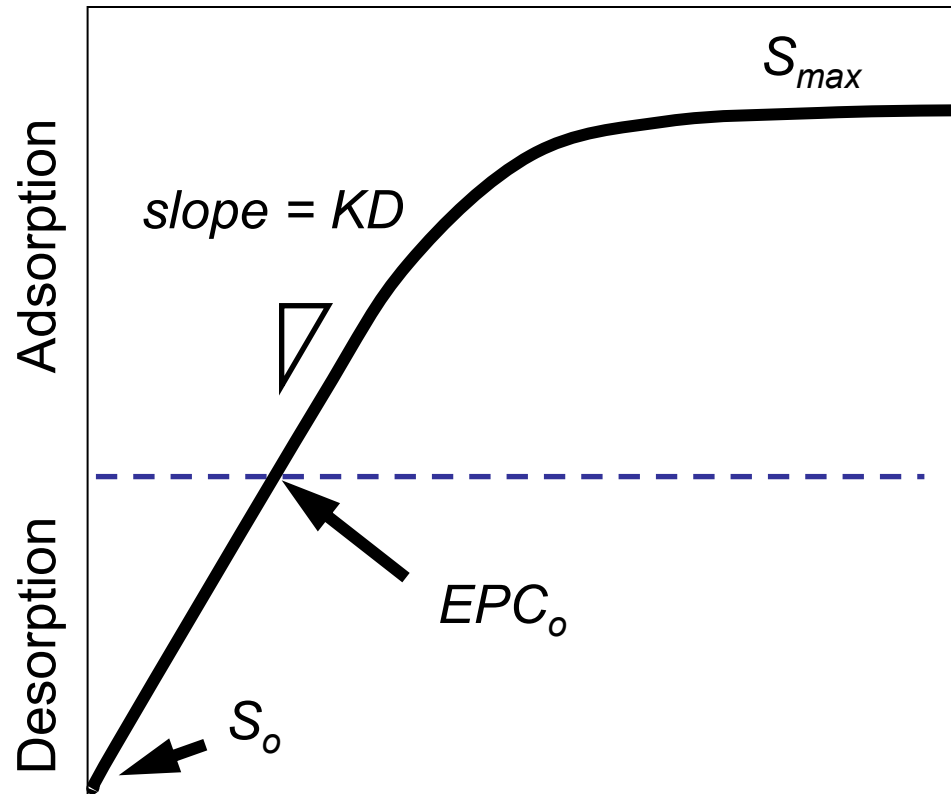
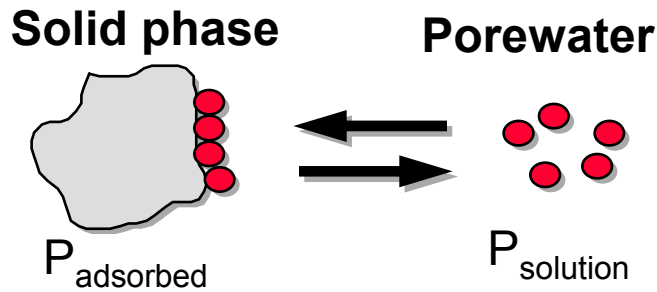
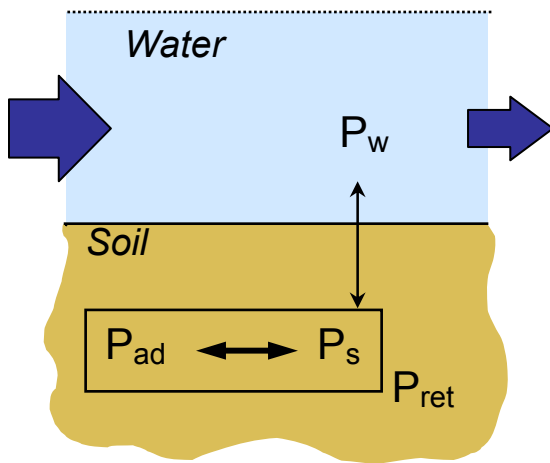


Peat Depth > 30 cm
Total P = 411 mg P/kg

Organic Wetland Soils – Fire Effects



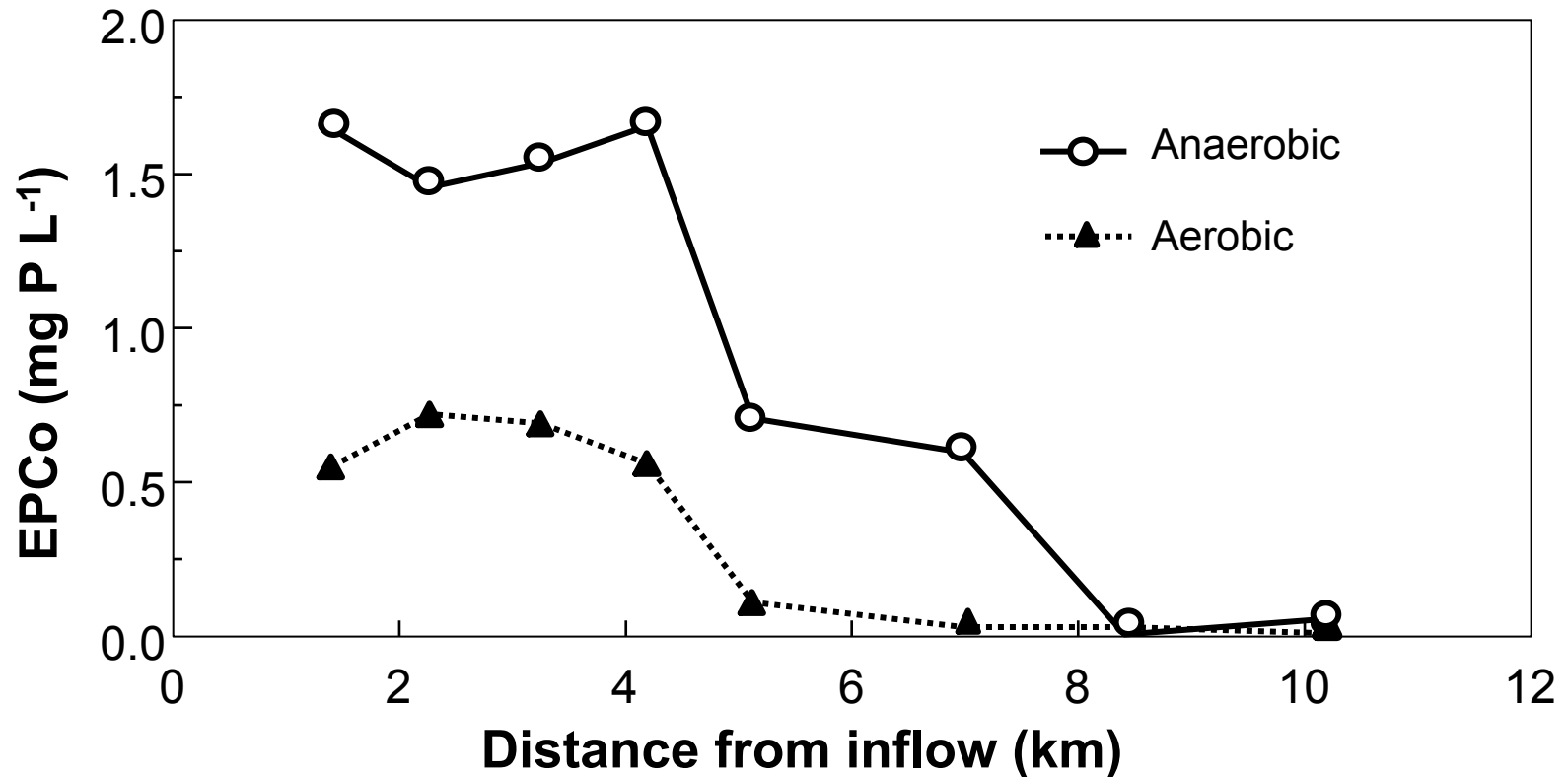
Inorganic Phosphorus Retention



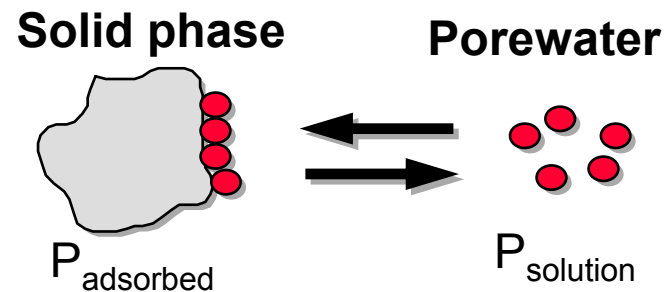
Phosphorus in Soil Porewater

EPC_0 = Equilibrium P concentration at which point adsorption equals desorption

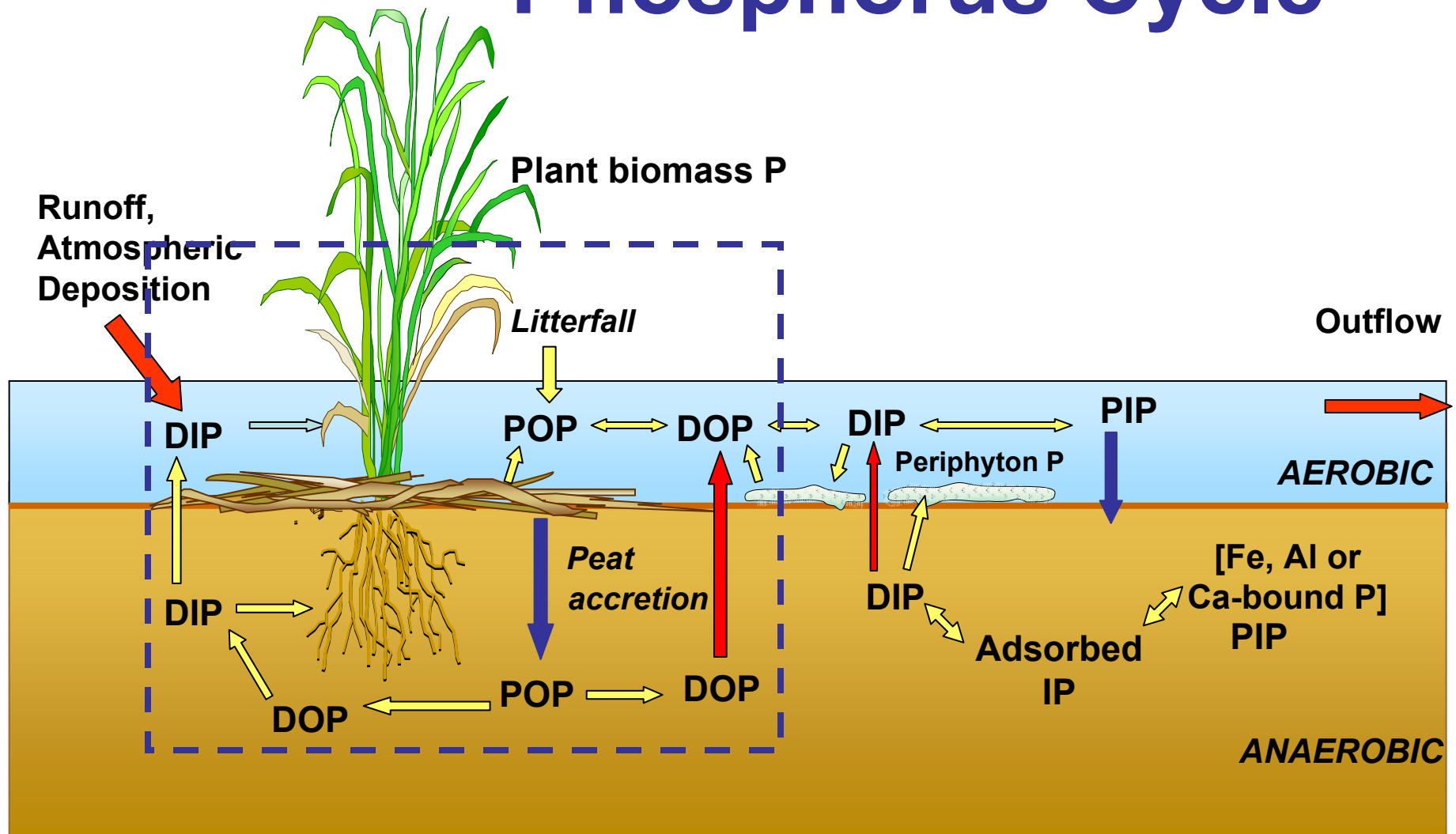
Inorganic Phosphorus Retention-WCA-2A



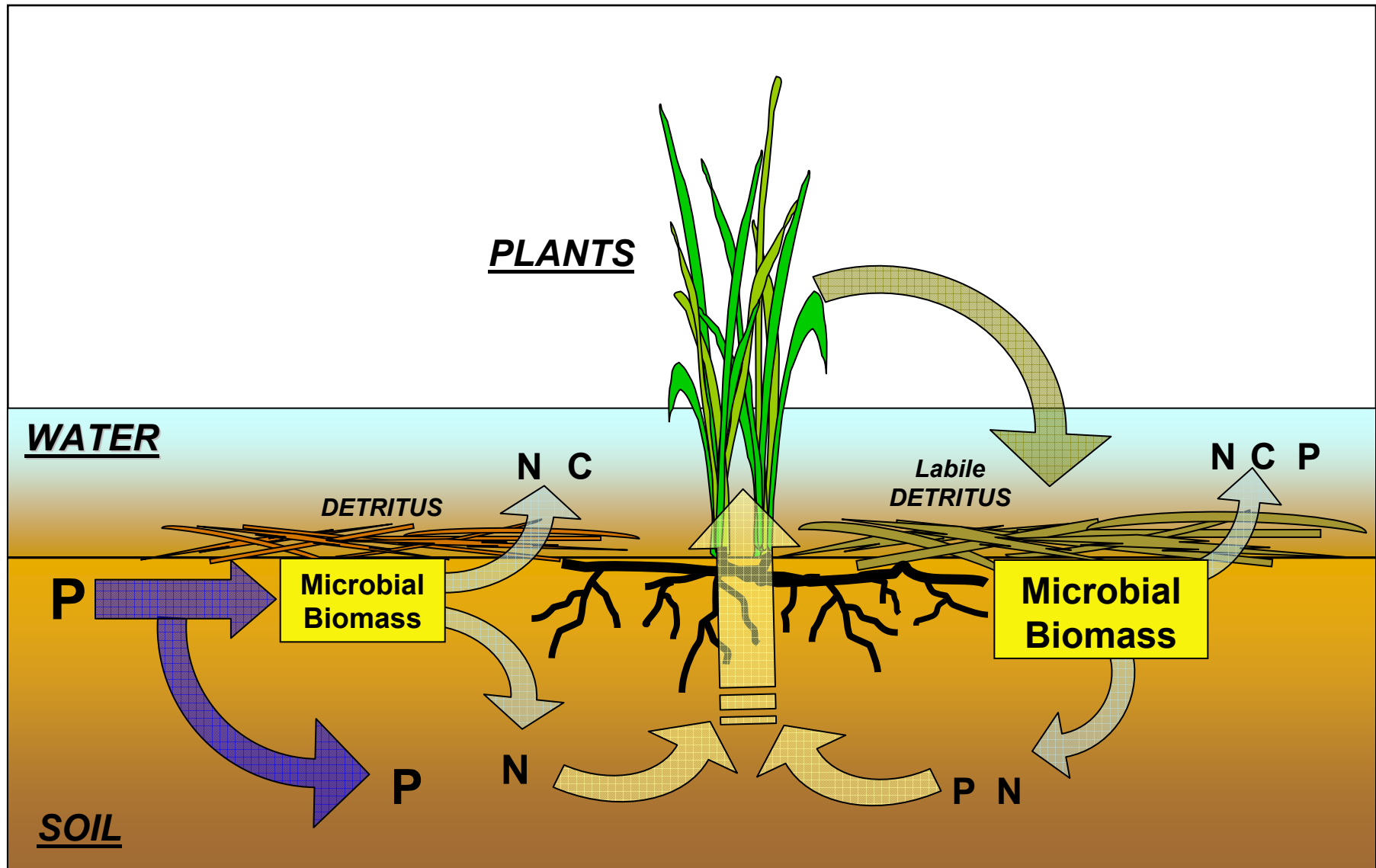
EPC₀ = Equilibrium P concentration at which point adsorption equals desorption



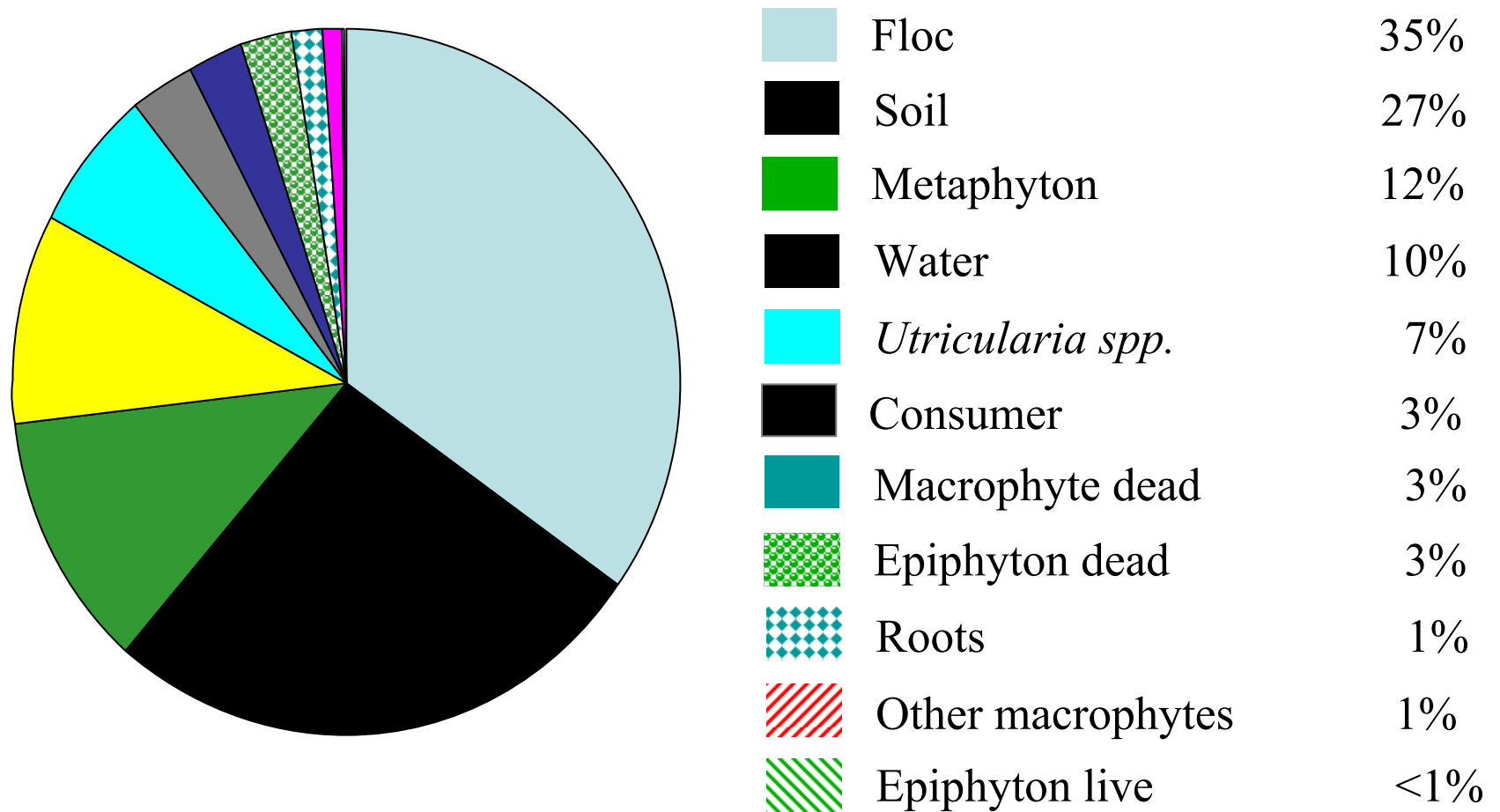
Phosphorus Cycle



Phosphorus Loading – Biotic Processes

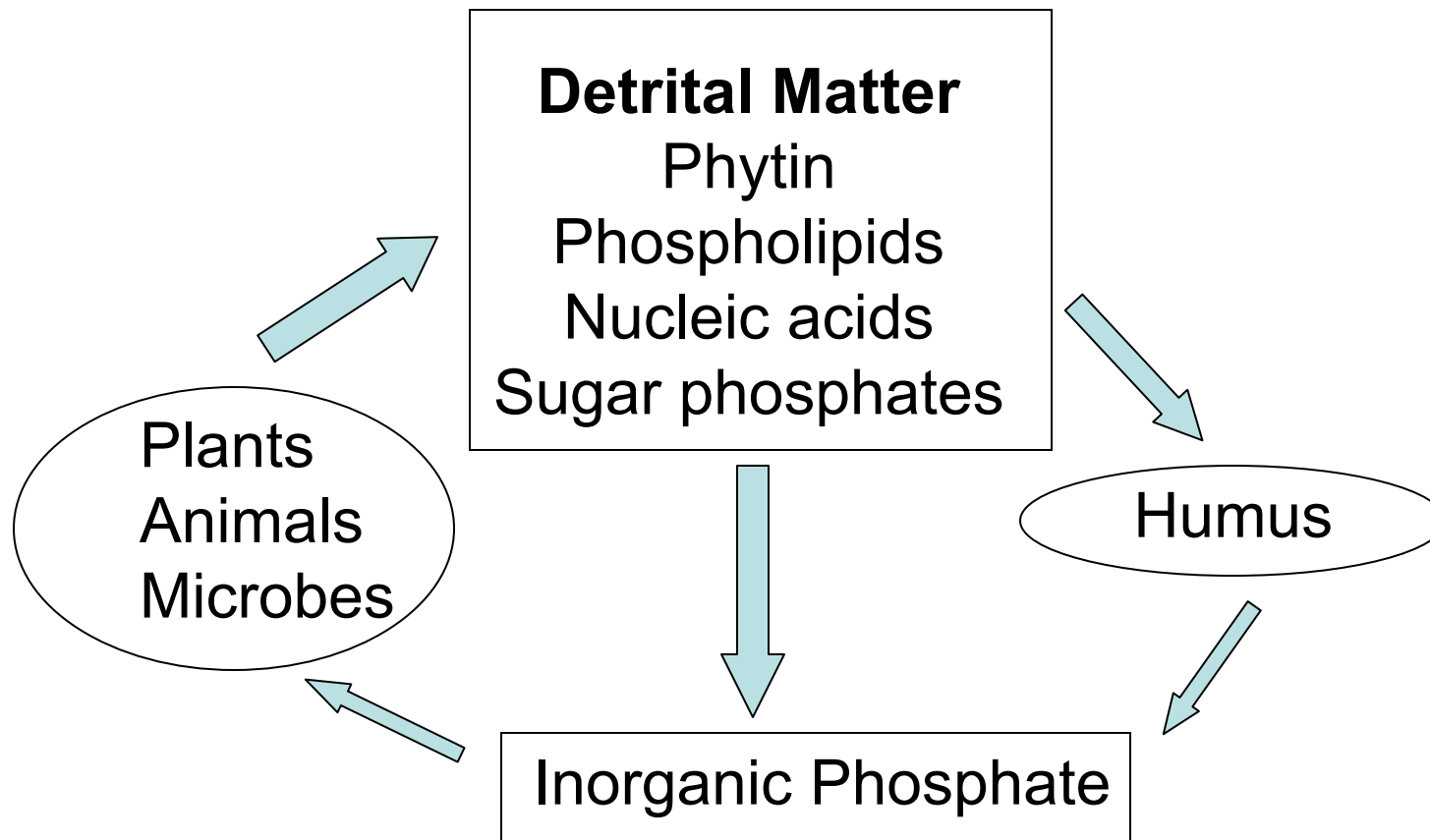


Short-term P partitioning: ^{32}P 18 days



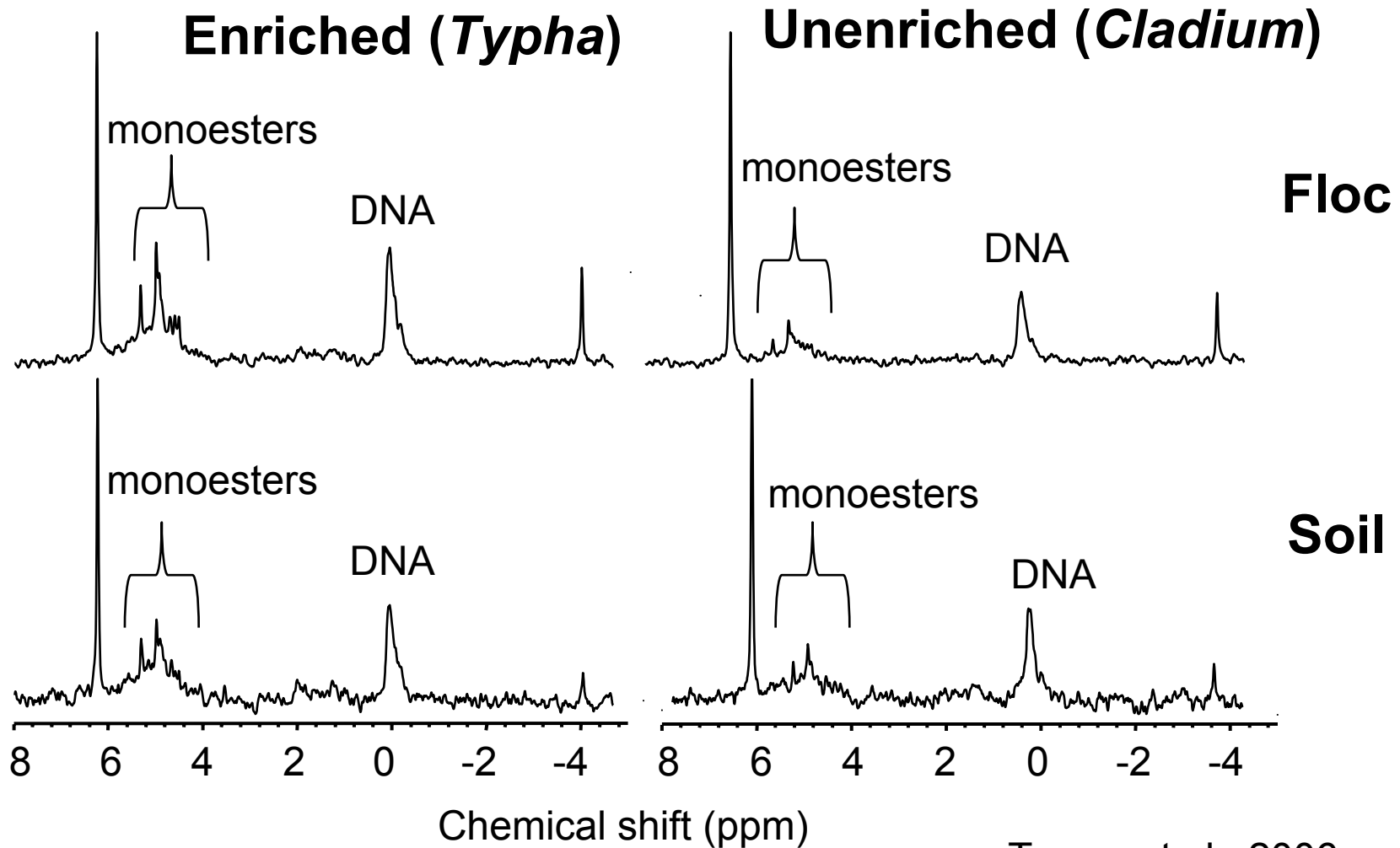
(Noe et al. Freshwater Biology 2003)

Organic Phosphorus



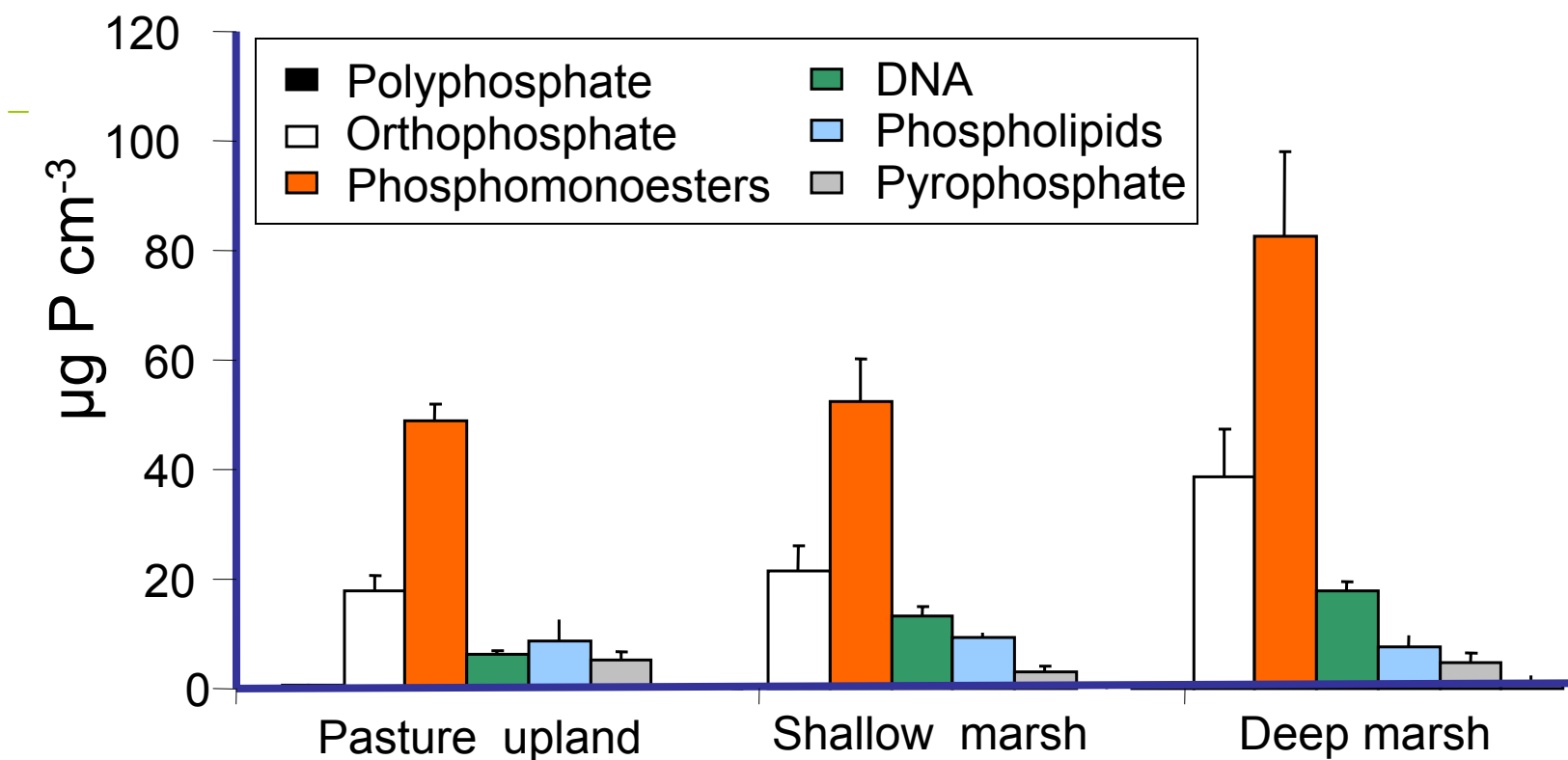
Organic Phosphorus – WCA-2A

[³¹P NMR spectroscopy]



Turner et al., 2006

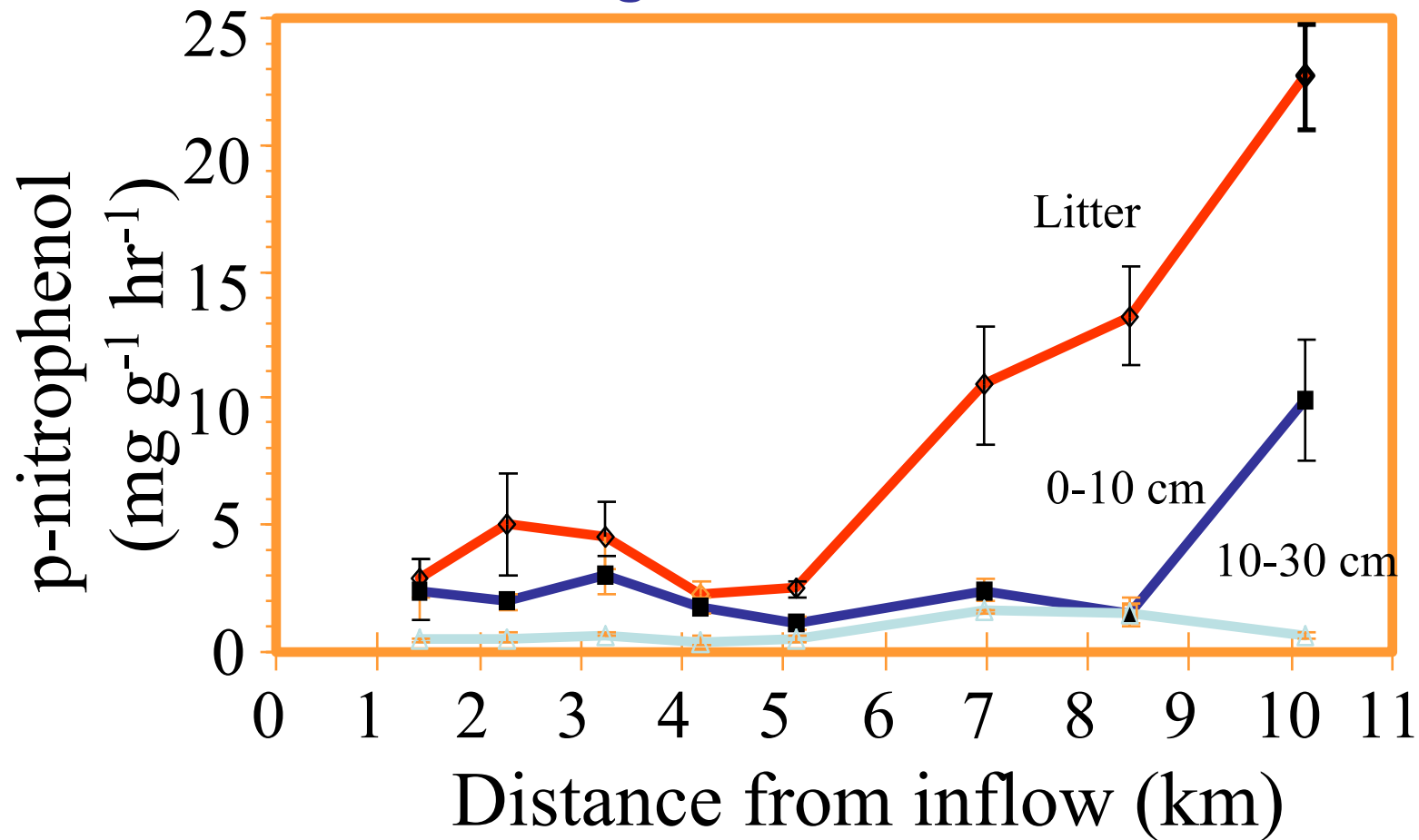
Organic Phosphorus – Isolated Wetlands- Okeechobee Basin



Cheesman et al., 2008

Alkaline Phosphatase Activity

Everglades- WCA-2A

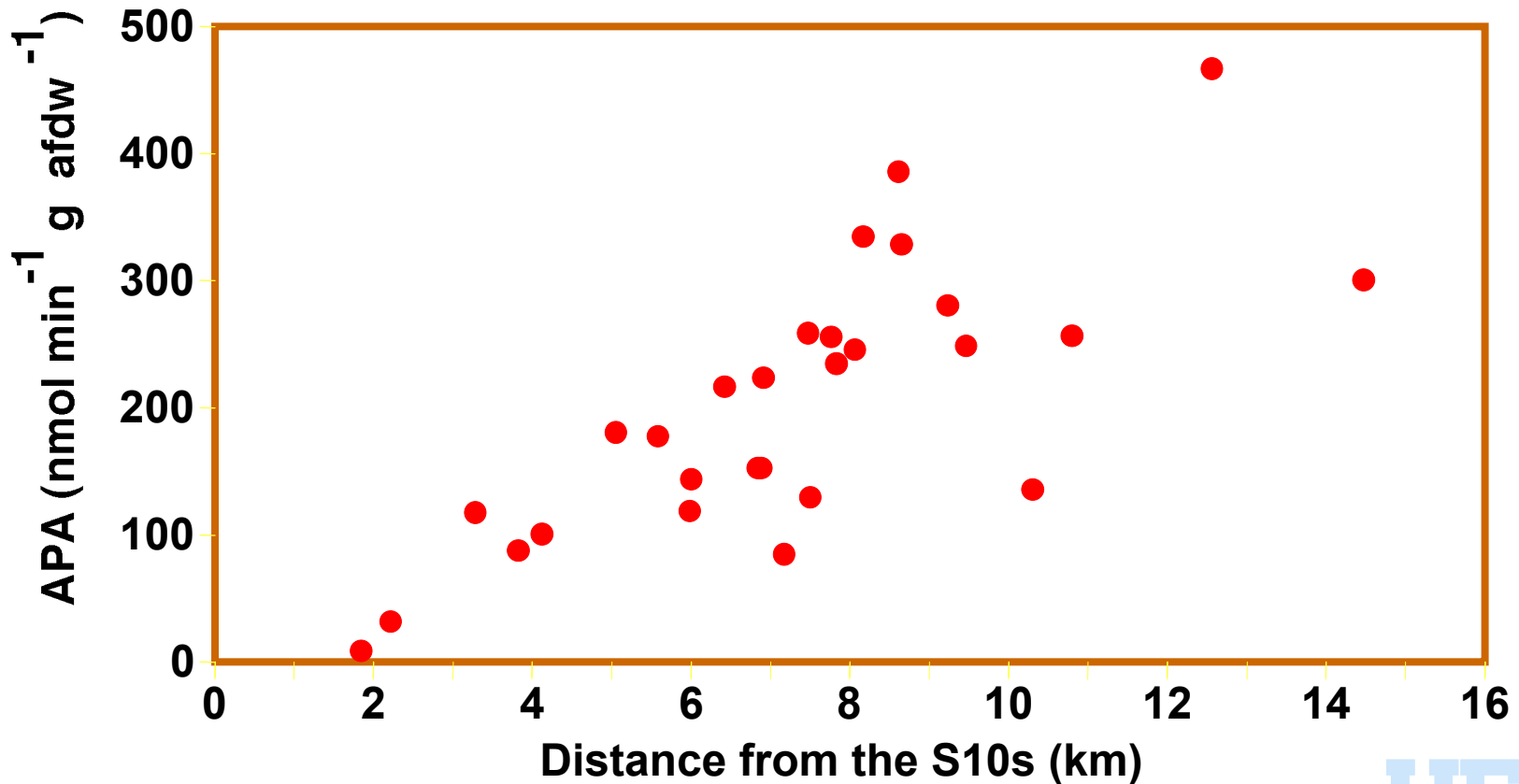


Wright and Reddy, 2001

Phosphatase Activity

Periphyton APA along the WCA 2a Nutrient Gradient

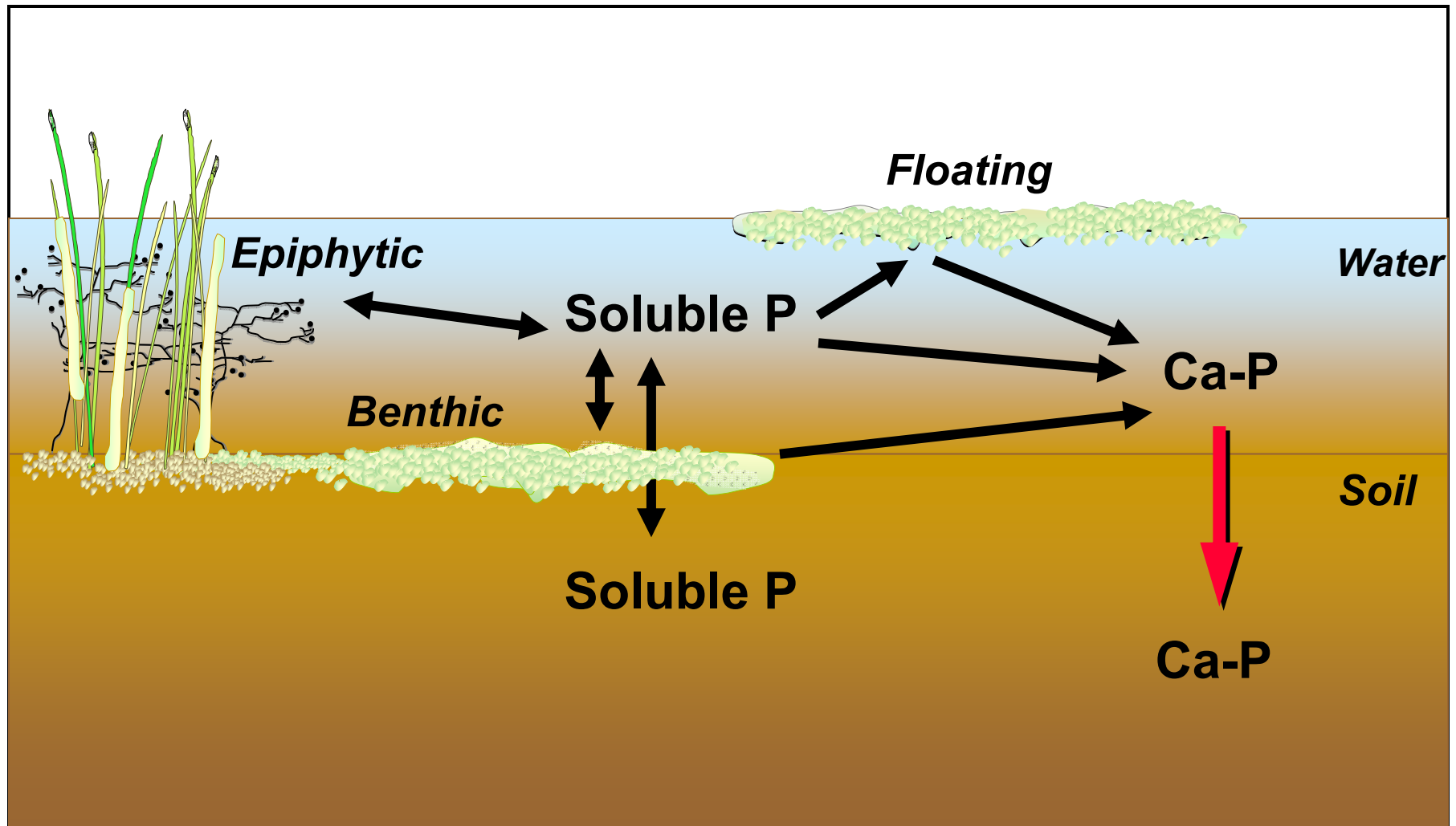
July 1996 [Newman, S]



8/19/2008

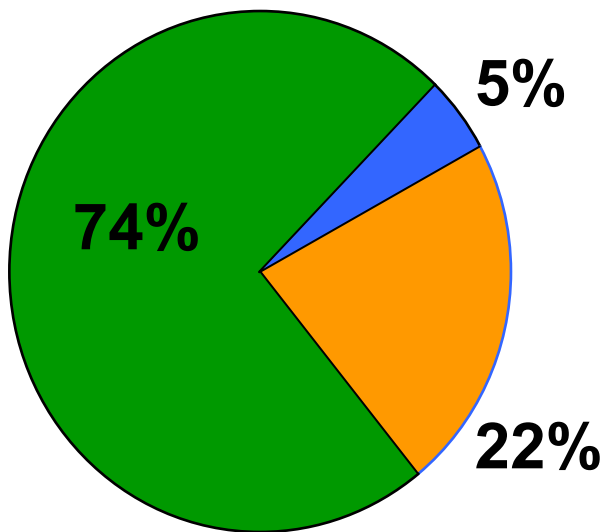
WBL

Biotic and Abiotic Interactions

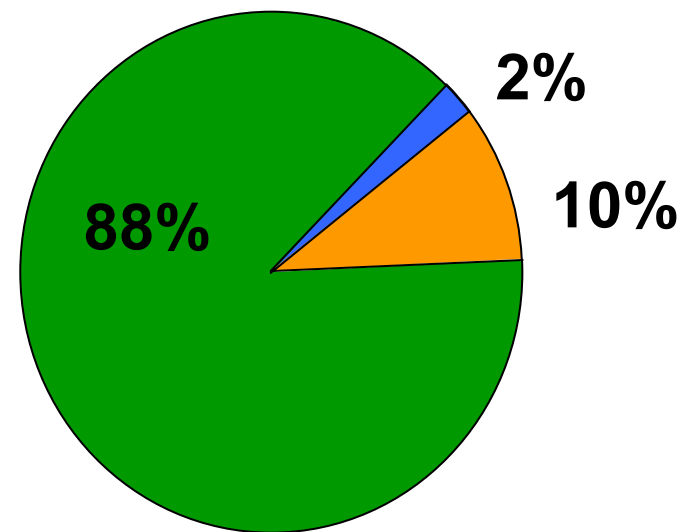


^{32}P Partitioning- Periphyton

Abiotic Biotic Water



1 hr



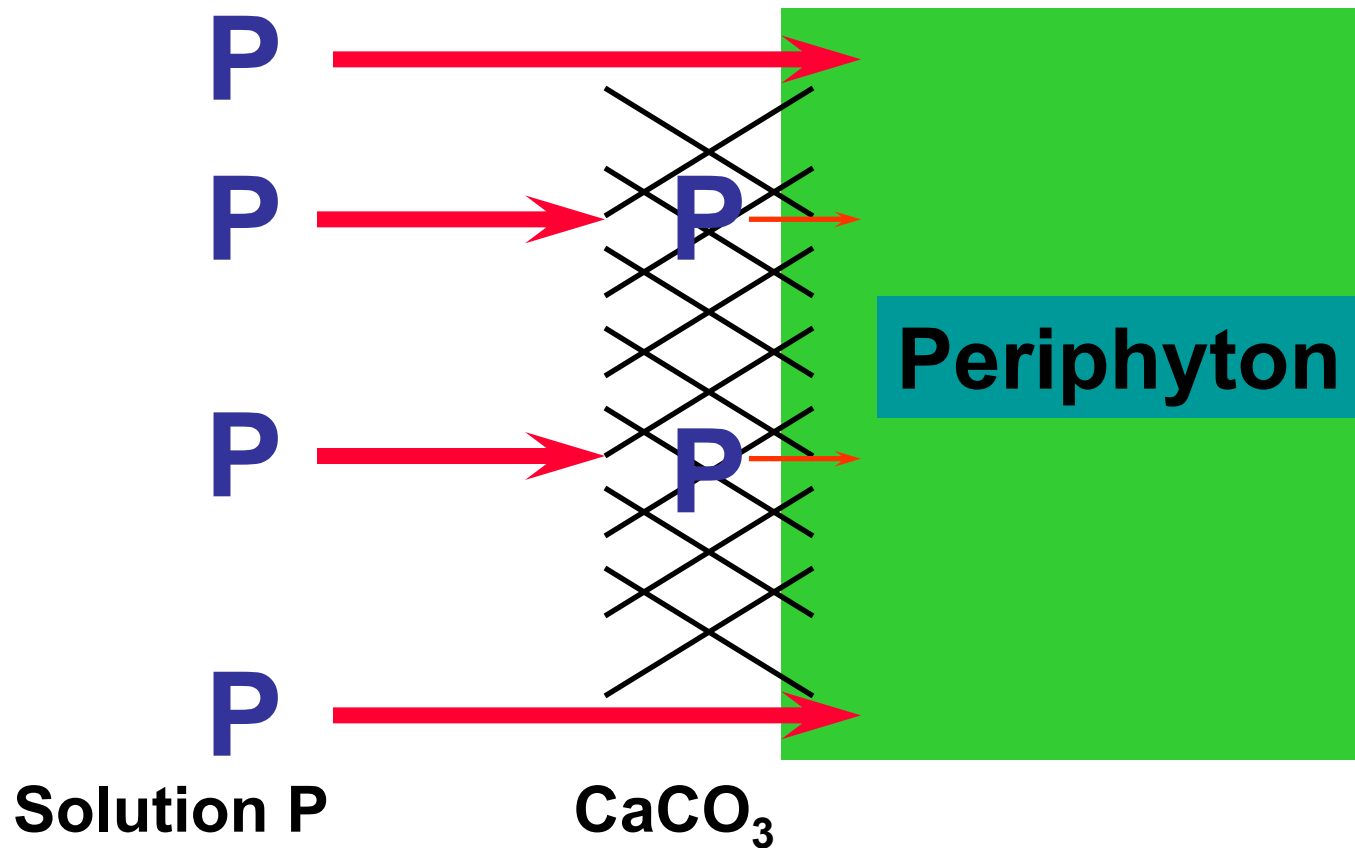
12 hr

Water DRP: $5 \mu\text{g l}^{-1}$

Light : 10 W m^{-2}

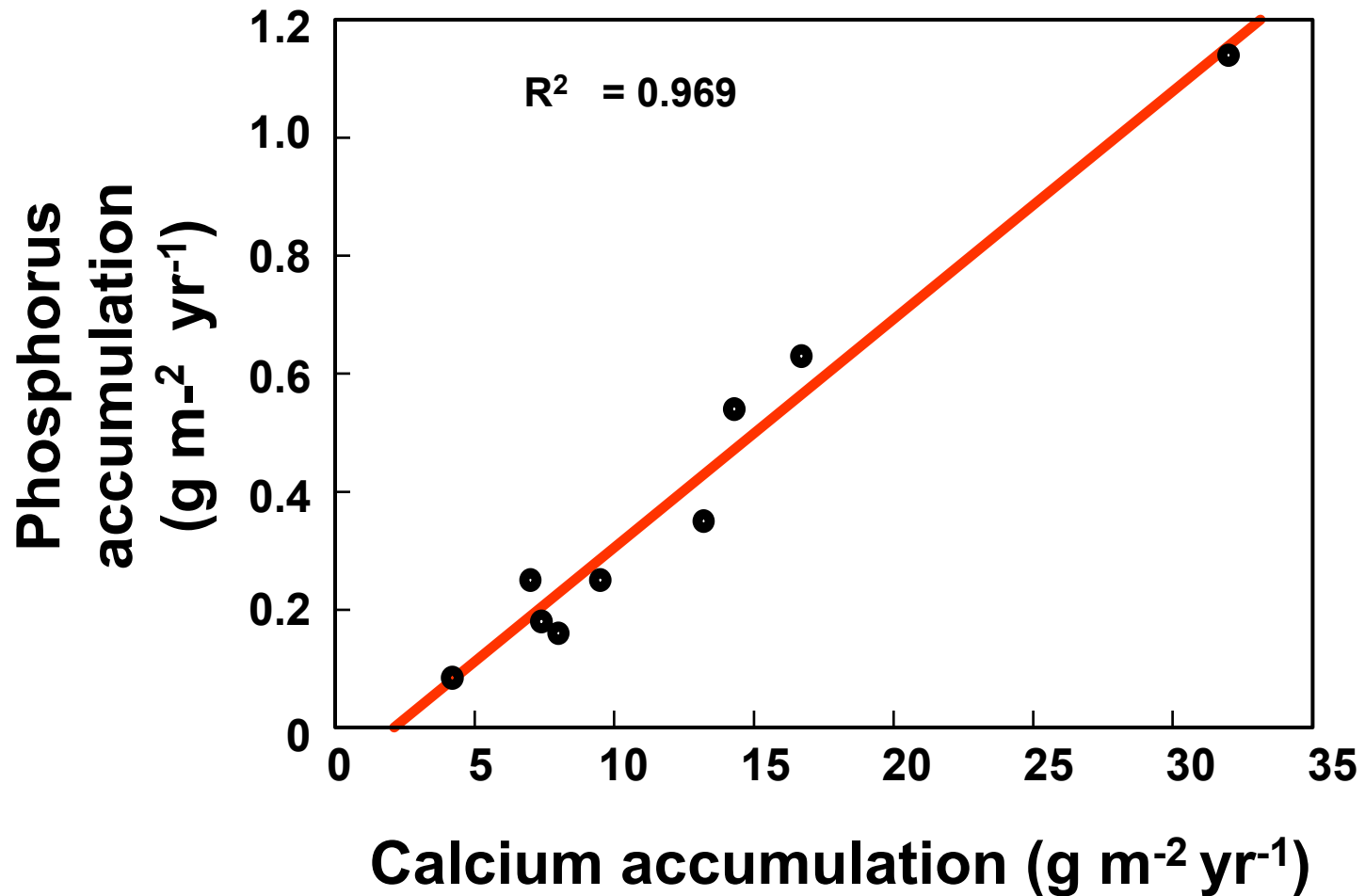
(Scinto and Reddy, Aquatic Botany, 2003)

Periphyton-Phosphorus- CaCO_3 Interactions

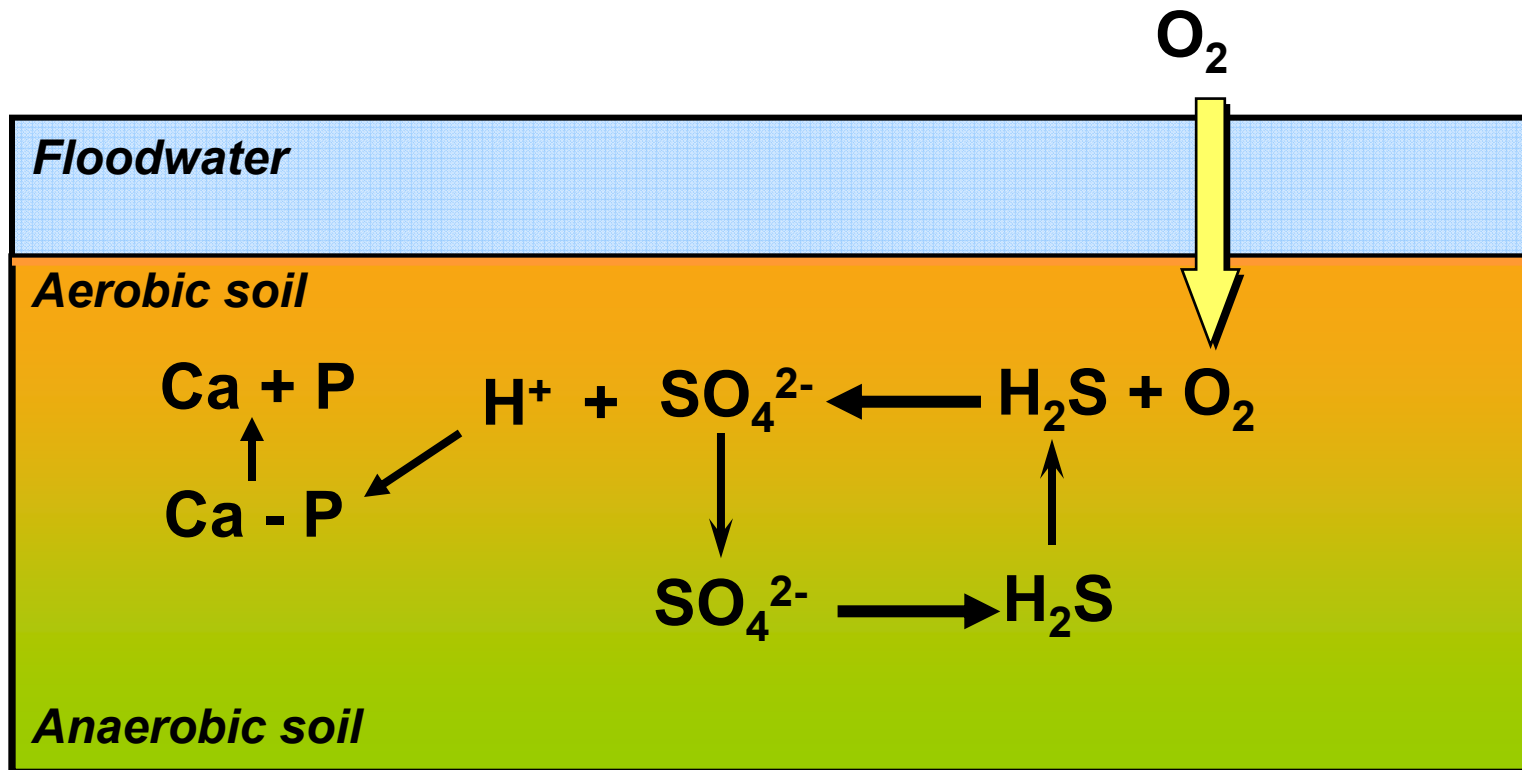


(Scinto and Reddy, Aquatic Botany, 2003)

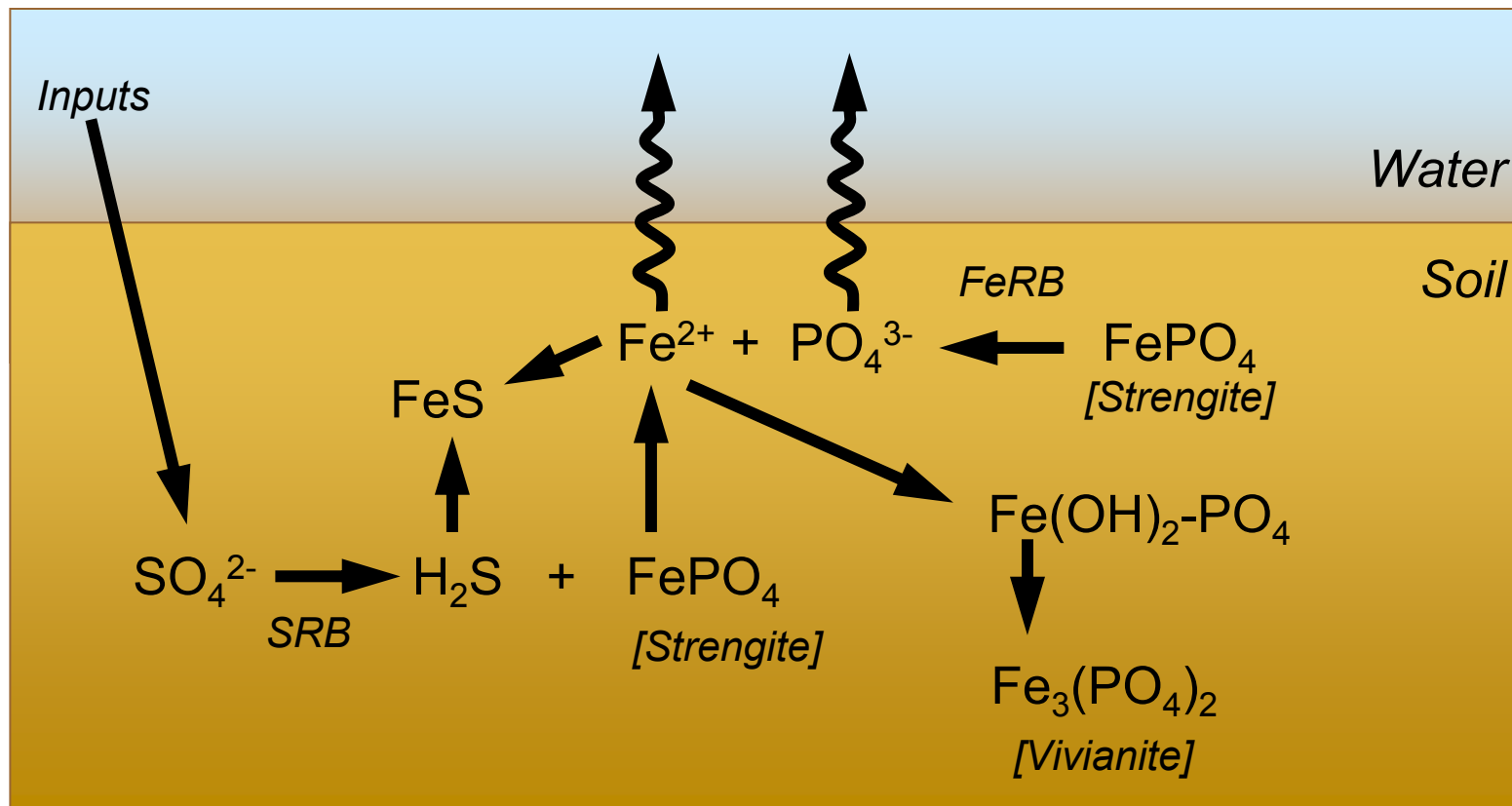
Phosphorus and Calcium Accumulation-WCA-2a



Sulfur-Calcium -Phosphorus Interactions under Aerobic Soil Conditions

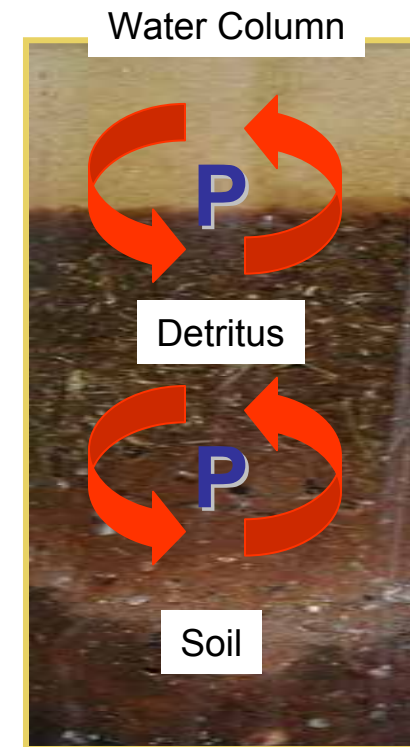


Sulfur-Iron -Phosphorus Interactions under Anaerobic Soil Conditions

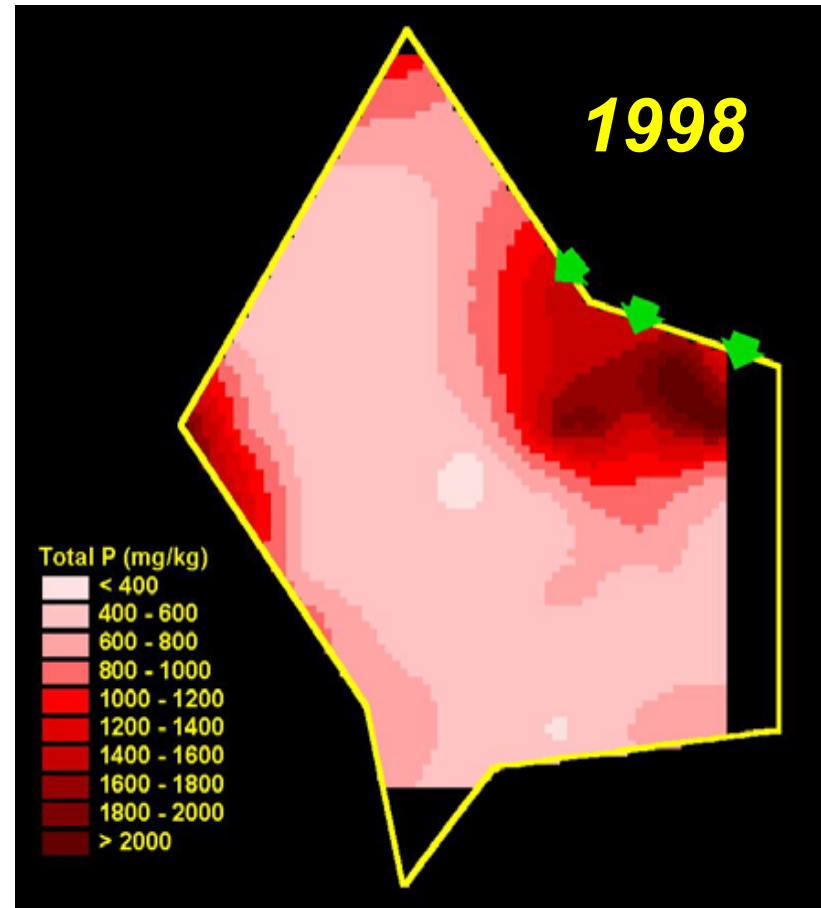
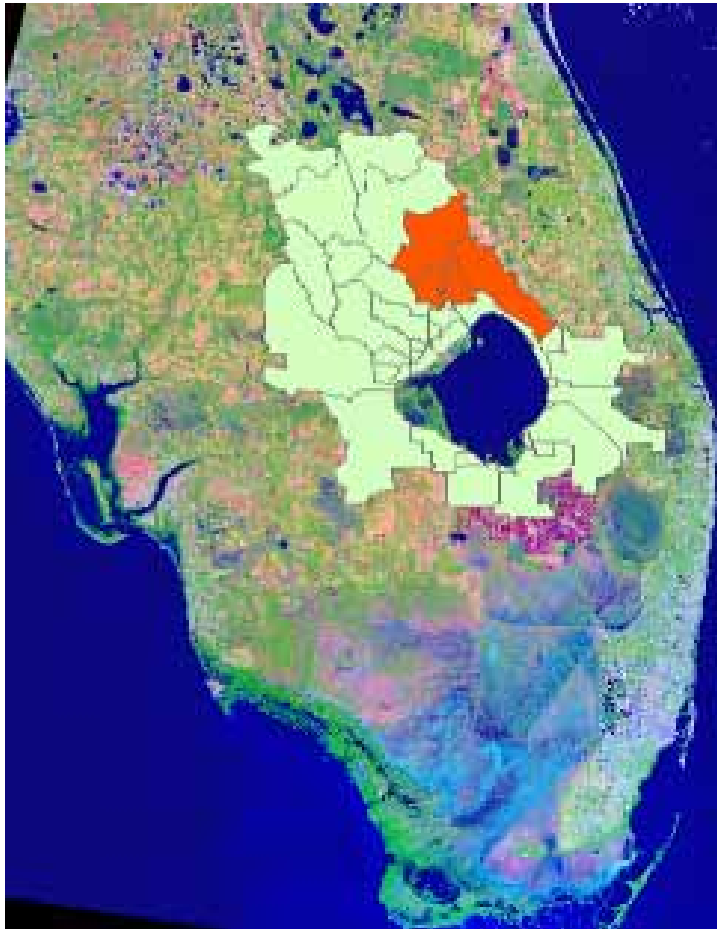


Phosphorus Memory in the Everglades

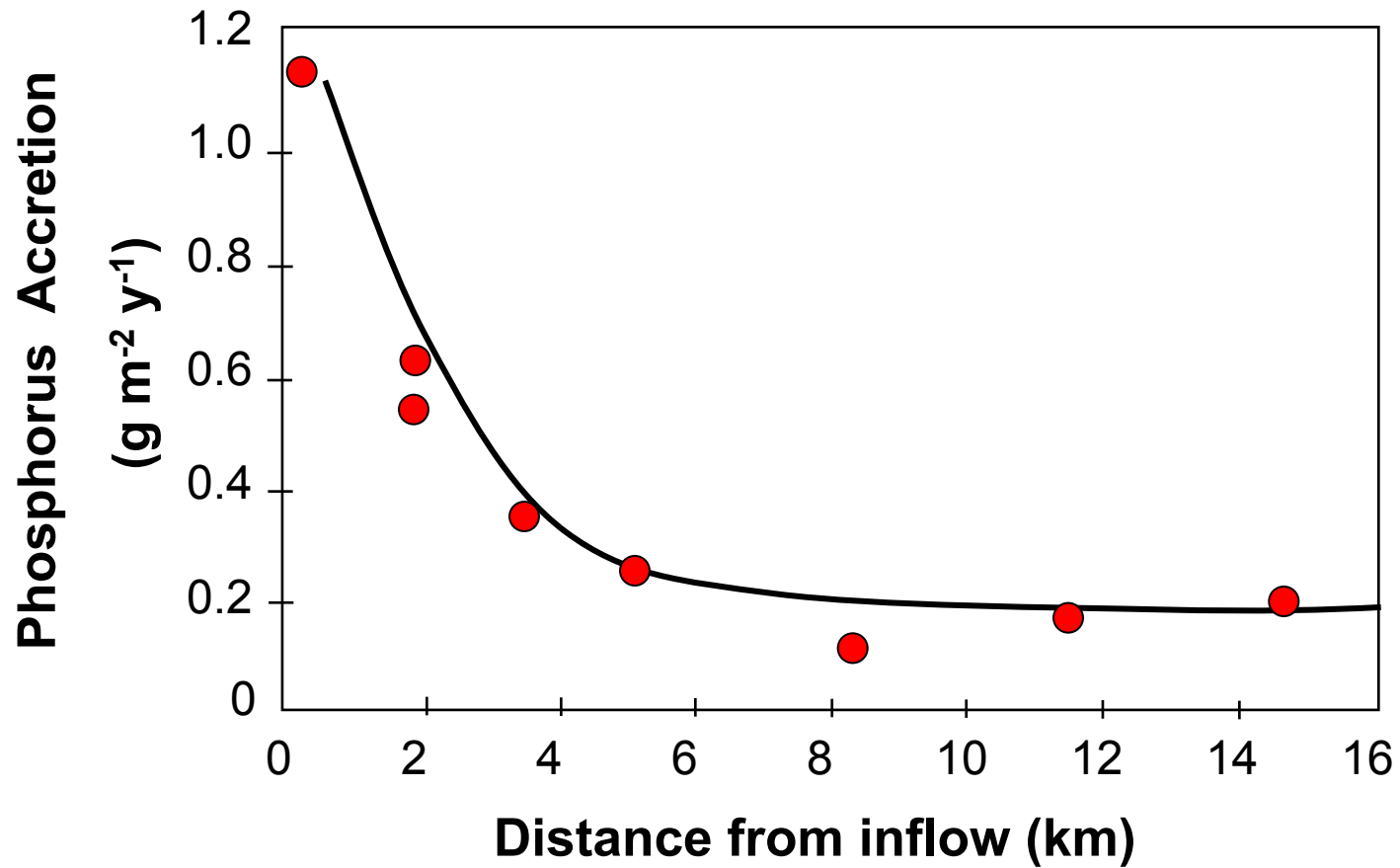
- ❑ Legacy phosphorus in various ecosystem components (uplands, wetlands, and aquatic systems)
 - ❑ Transient pools
 - ❑ Stable pools
- ❑ Capacity for showing effects as a result of past practices
- ❑ Length of time over which phosphorus release extends before returning to a stable condition



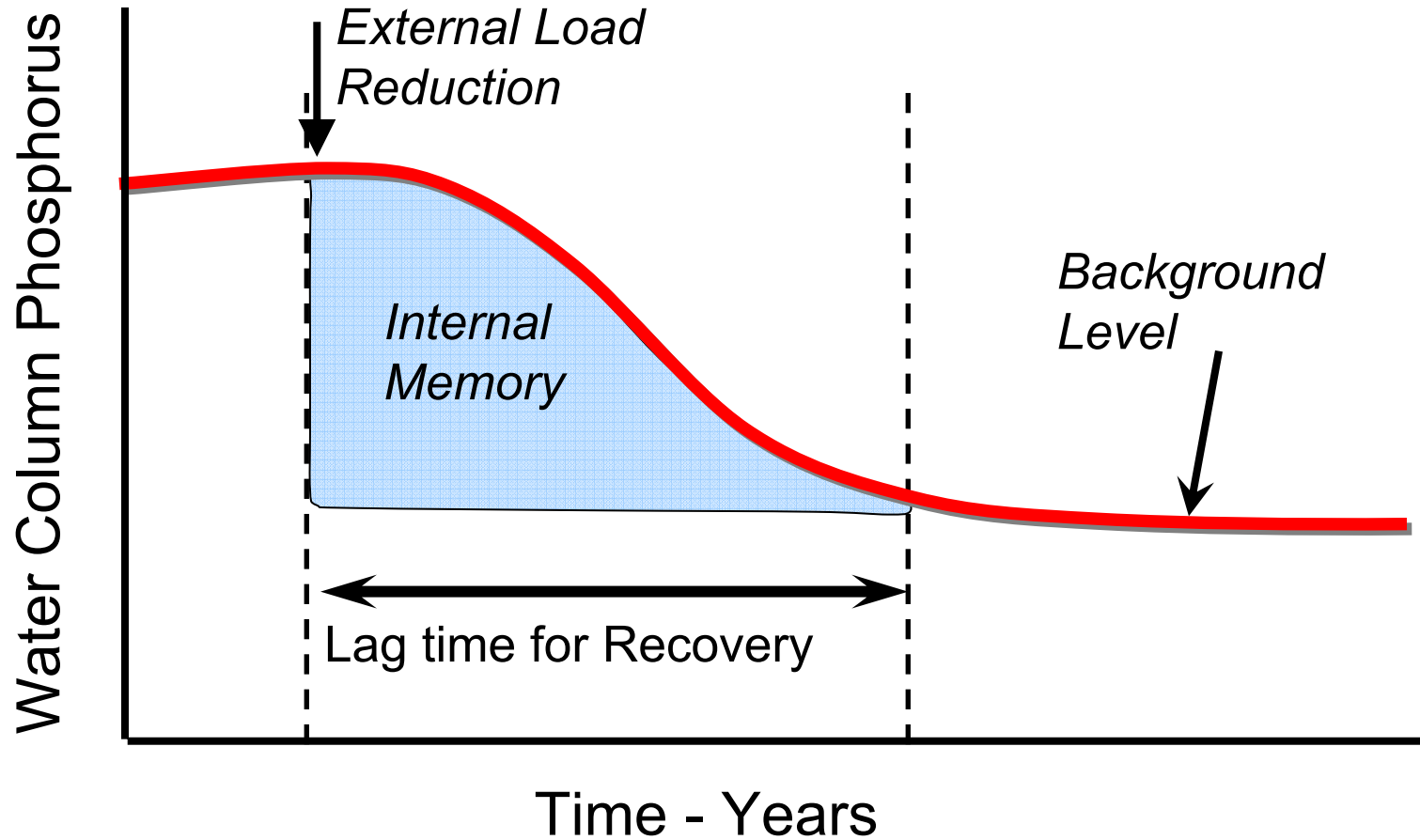
Legacy Phosphorus



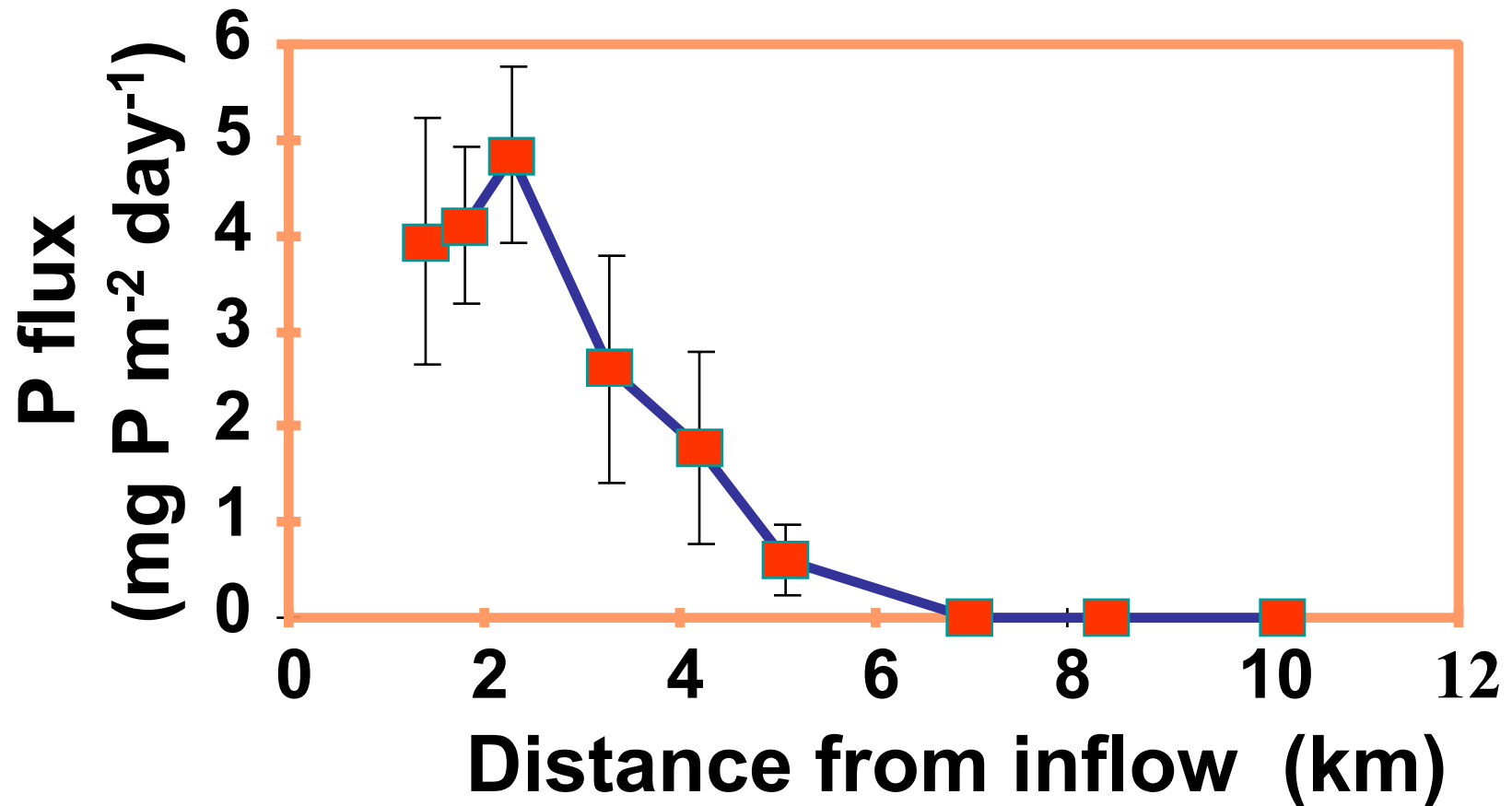
Phosphorus Accretion-WCA-2A



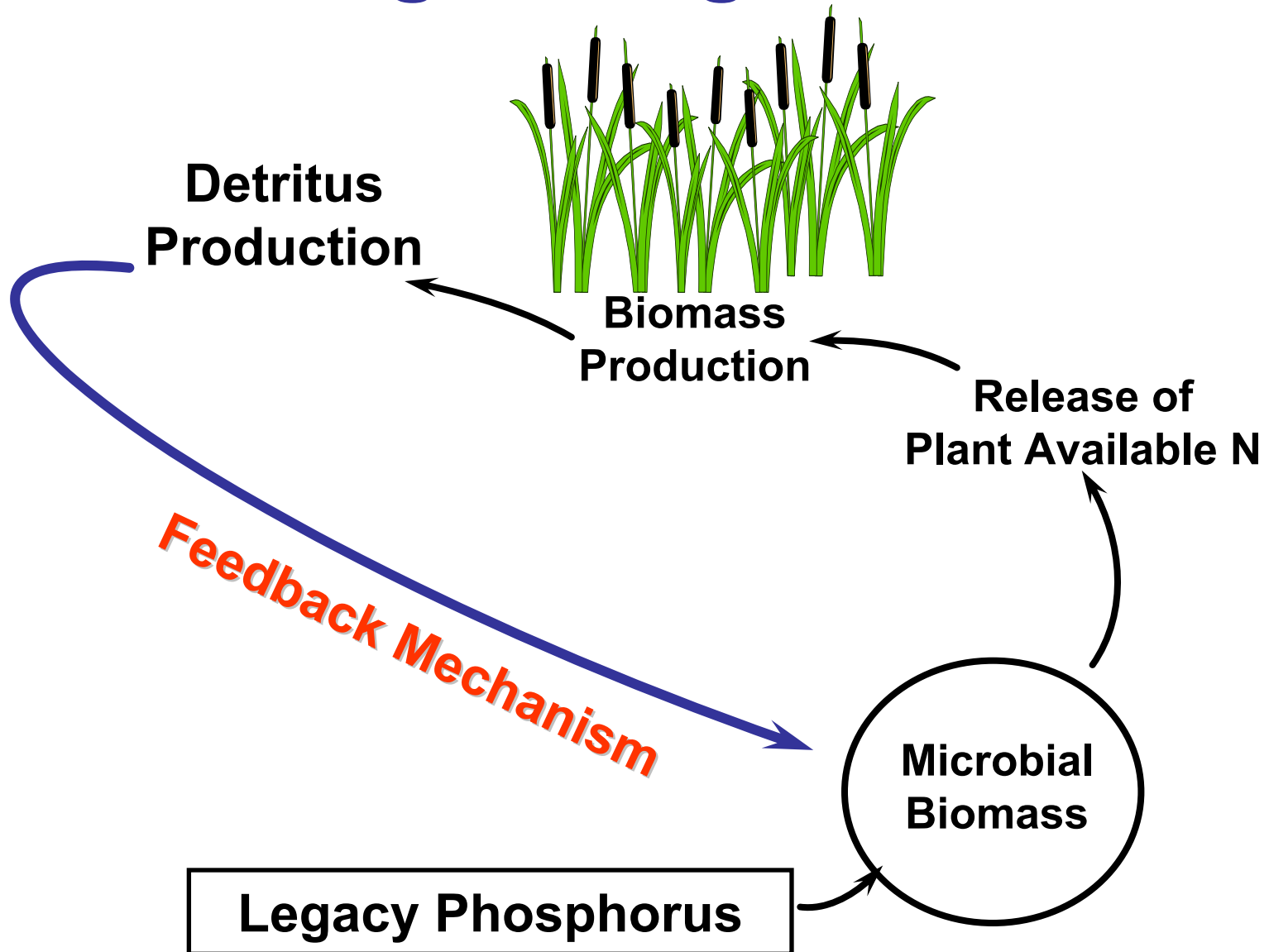
Phosphorus Memory



Phosphorus Memory - Everglades -WCA-2A



Ecological Significance



White, 1999

Research Needs

- ❖ Identification of inorganic and organic P compounds
- ❖ Stability of legacy P under range of hydrologic/redox conditions
- ❖ Multiple roles of microbial and plant mediated processes on P retention and release
- ❖ Develop methods to reduce P memory effects to enhance the recovery
- ❖ Linkage between P biogeochemistry and other elemental cycles
- ❖ Forecast models based on mechanistic understanding of biogeochemical processes



<http://wetlands.ifas.ufl.edu>
<http://soils.ifas.ufl.edu>