The Contrasting Mineral Chemistry of the Predrainage and Managed Everglades:

Hydrologic Basis and Biogeochemical Significance

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"The predrainage Everglades was a rainfall-driven ecosystem"

- Rainfall-driven peatlands are characterized by:
  - low inputs of limiting nutrients such as phosphorus (P)
  - mineral depleted (soft-water) conditions
  - Acidic-neutral pH
- The P-limited condition of the predrainage Everglades is widely accepted
- The widely held belief that the Everglades was always a hard-water, high pH ecosystem is not supported by available data
  - Historic water sources
  - Peat profiles
  - Paleoecological studies

What do we mean by mineral chemistry?

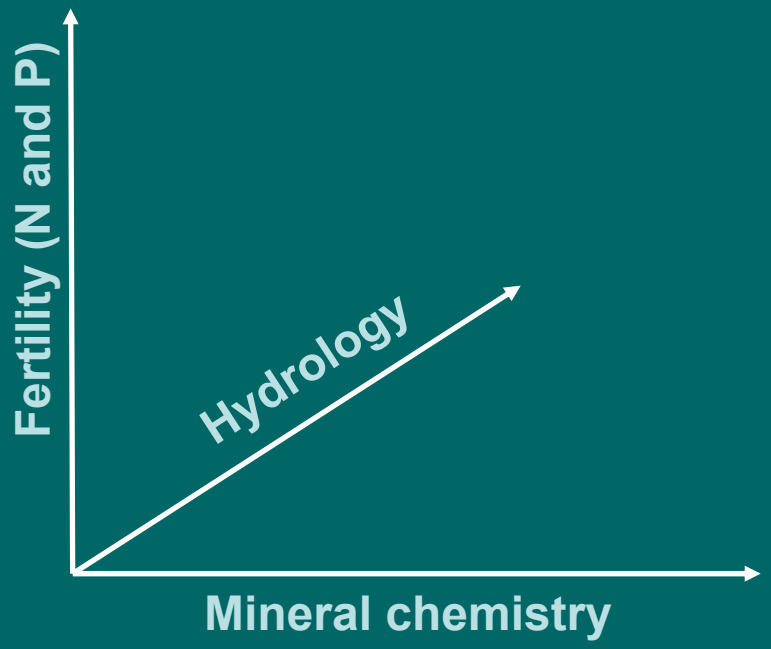
- 7 major ions:
  - Cations: Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}
  - Anions: Cl^{-}, HCO_3^{-}/CO_3^{2-}, SO_4^{2-}
- Bedrock and upland sources
- Differing chemical properties
- Specific conductance (µS/cm) as a proxy

Correlations between specific conductance and major ions across the Everglades (17 long-term monitoring stations):

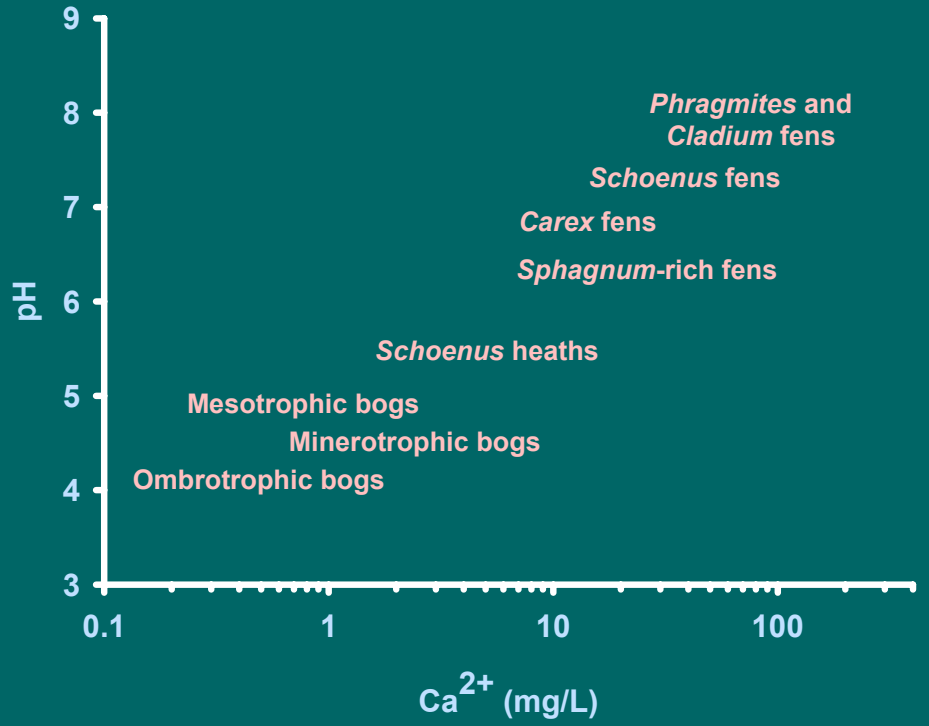
Ion	r
Alkalinity	0.940
Chloride	0.964
Calcium	0.867
Magnesium	0.967
Potassium	0.979
Sodium	0.938
Sulfate	0.932

Mineral chemistry has a major influence on peatland ecology

Major environmental gradients in peatlands:



Peatlands are classified across mineral gradients*:



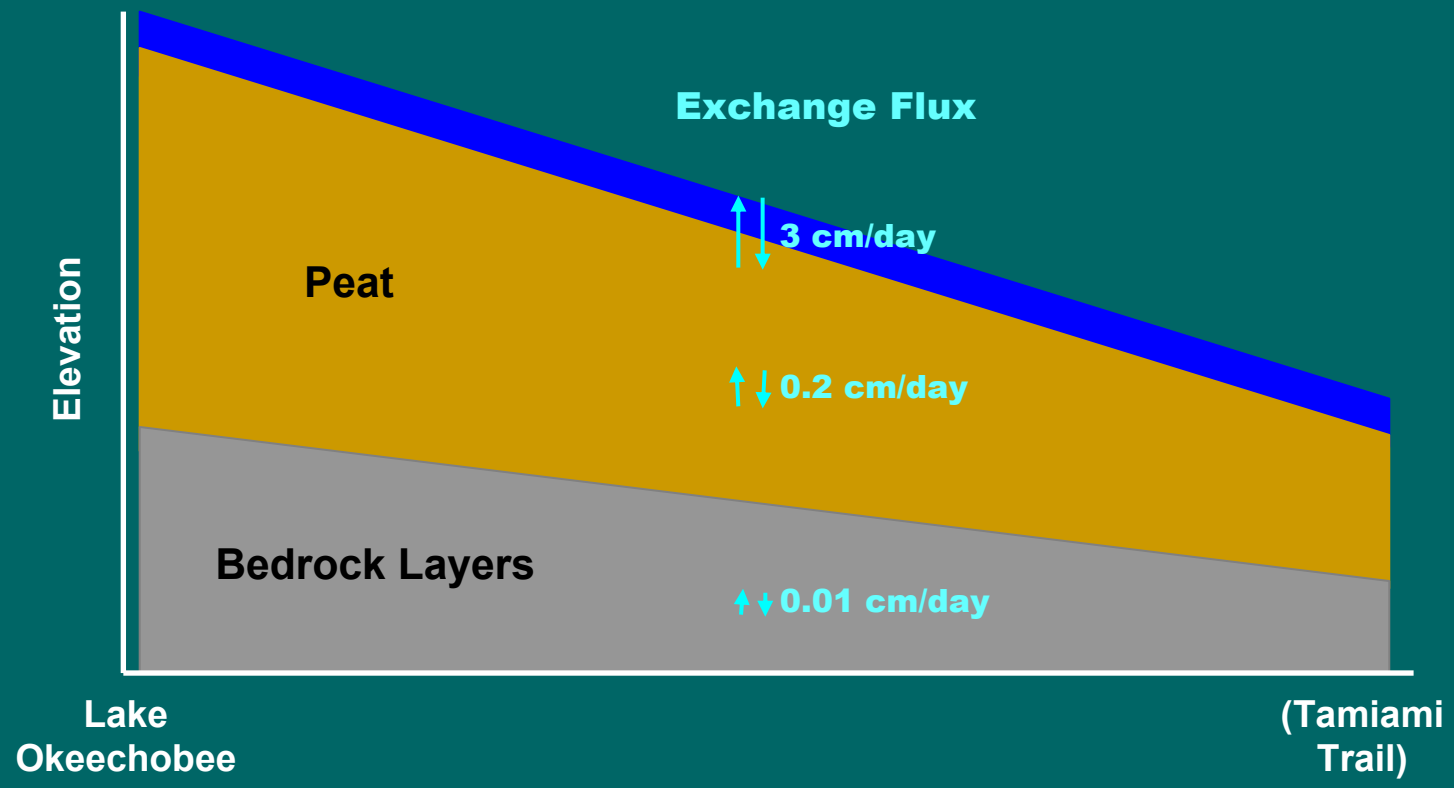
**Adapted from: Wheeler, B.D., & M.C.F. Proctor, 2000. Ecological gradients, subdivisions, and terminology of north-west European mires. Journal of Ecology 88:187-203.*

Were the northern and central Everglades always minerotrophic peatlands?

Reasoning to support this view:

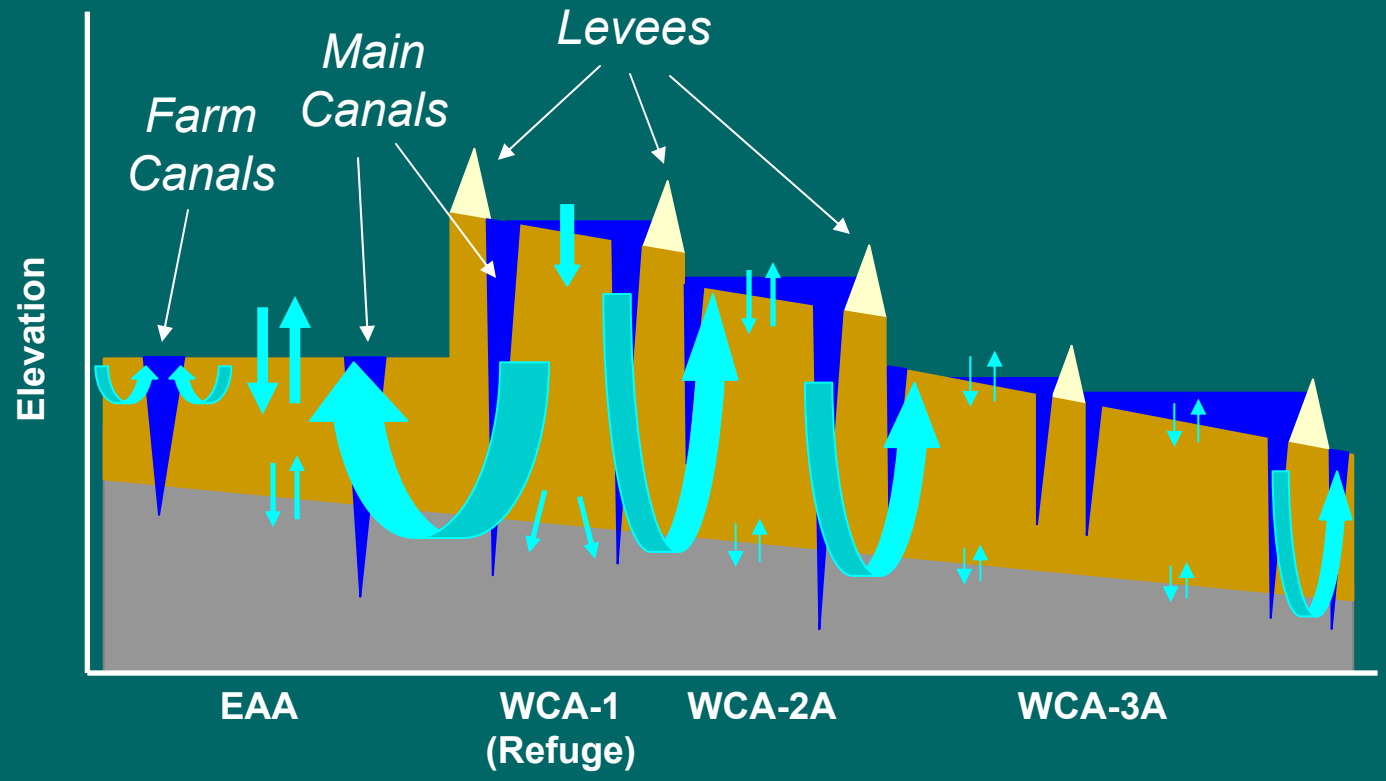
- The Everglades is underlain by limestone bedrock
- Many parts of the Everglades are mineral-rich today
- Spatial differences in surface-water chemistry correspond to differences in underlying bedrock

Ground water-surface water interactions were limited in the predrainage system



**Based on: Harvey and McCormick. In press. Hydrogeology Journal.*

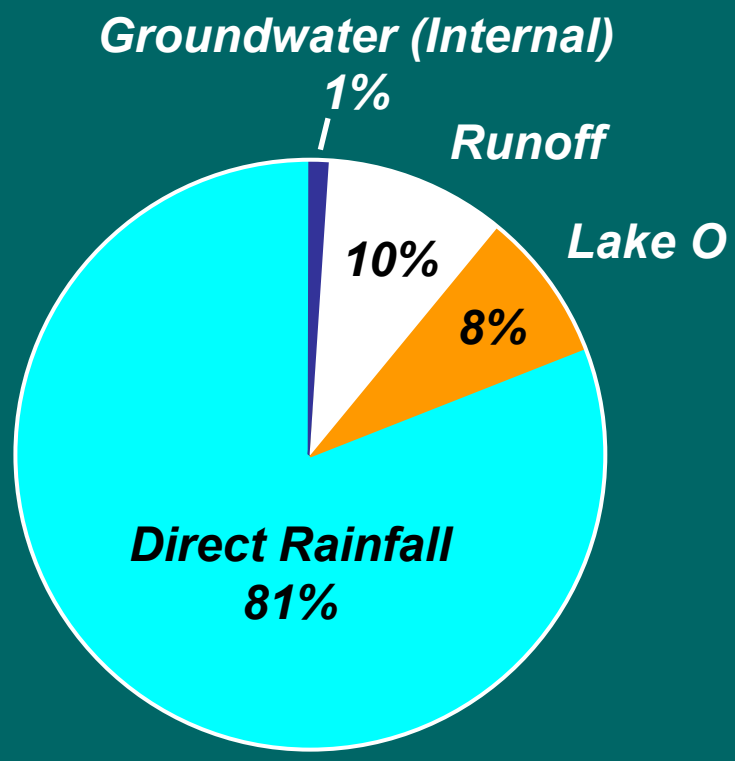
Canal construction, drainage, and subsidence have increased vertical water fluxes in the managed system



*Based on: Harvey, Krupa, and Krest. 2004. Groundwater.
Harvey and McCormick. In press. Hydrogeology Journal.

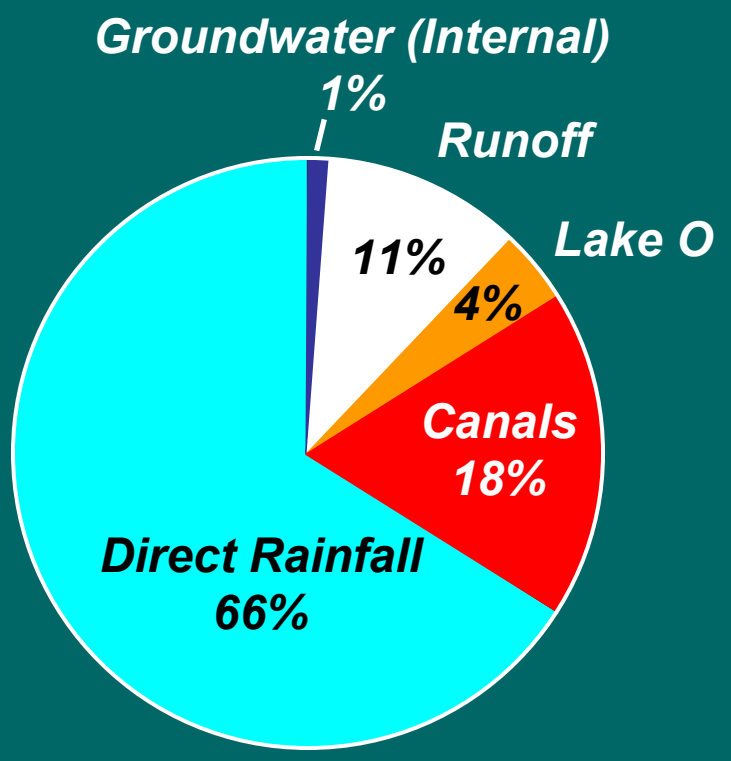
Water Sources to the Predrainage and Managed Everglades

Predrainage



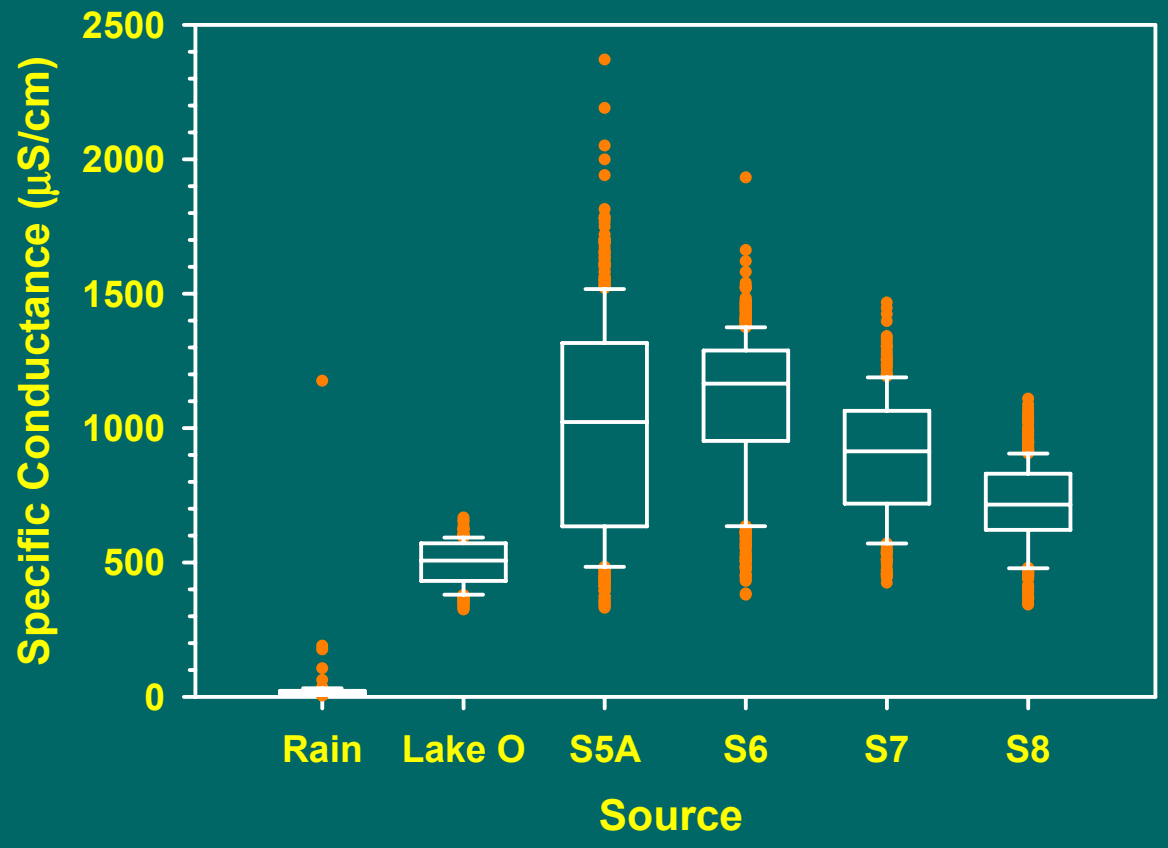
Based on the Natural Systems Model (SFWMD 2006)

Managed



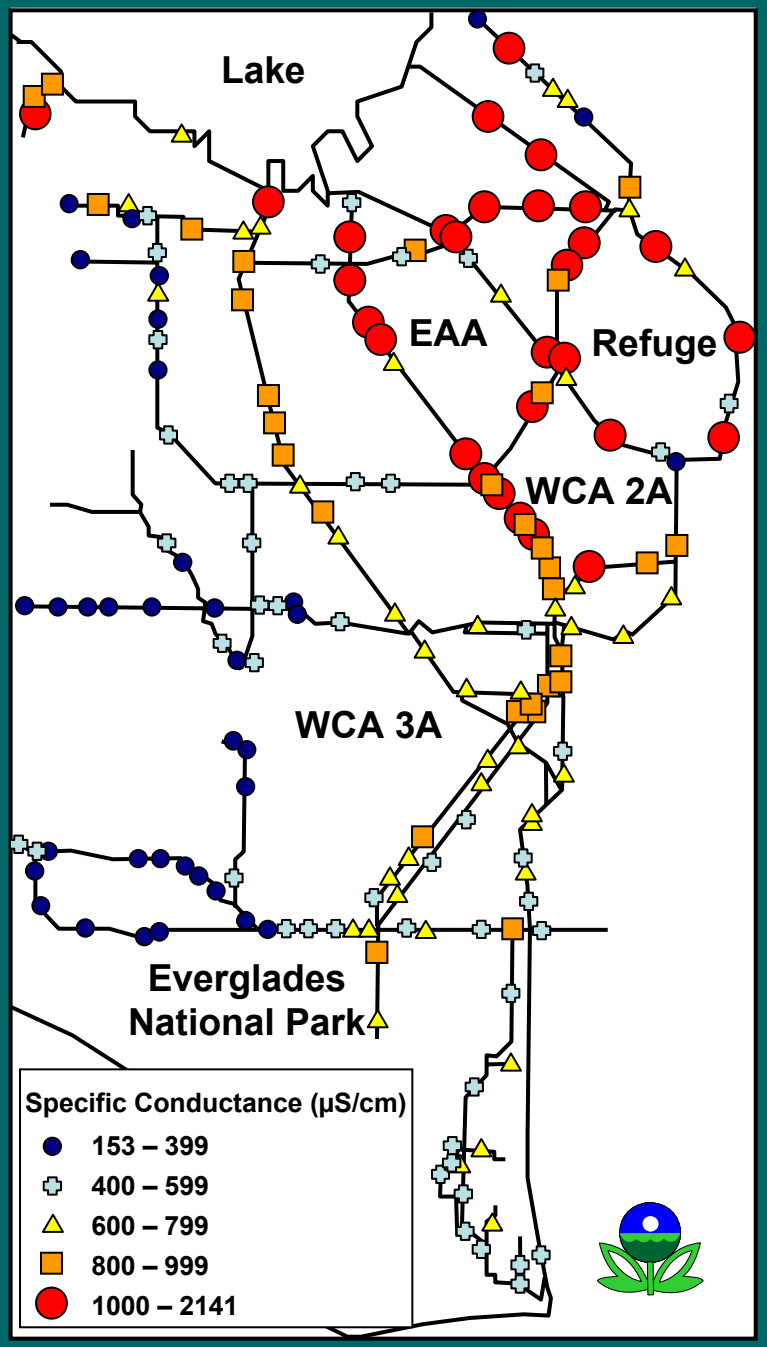
Based on the South Florida Water Management Model (SFWMD 2006)

Canal waters are highly mineralized compared to historical water sources



Source: SFWMD

Patterns of canal conductivity identify the EAA as a major mineral source

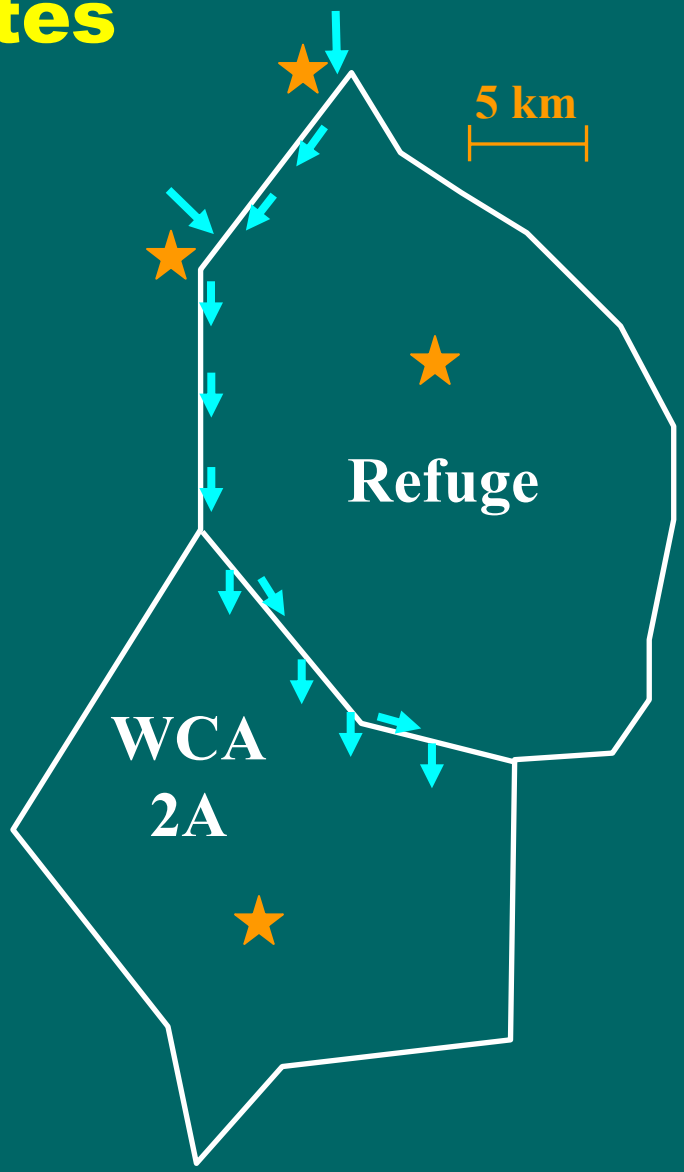


Redrawn with permission from:

Stober, J., D. Scheidt, R. Jones, K. Thornton, R. Ambrose & D. France, 1998. South Florida Ecosystem Assessment: Monitoring for Adaptive Management: Implications for Ecosystem Restoration: Final Technical Report - Phase I, United States Environmental Protection Agency EPA-904-R-98-002.

Canal-water intrusion creates differences in mineral chemistry across the Everglades interior

Parameter	Canal Discharges	WCA 2A Interior	Refuge Interior
TP (µg/L)	106 (S5A) 30 (STA1W)	8	6
Spec. Cond. (µS/cm)	1096	1163	105
pH units	7.5	7.5	6.2



Source: SFWMD

Several factors have contributed to changes in Everglades mineral chemistry

Predrainage

- Little groundwater influence
- Peat accretion (storage)
- No anthropogenic additions
- Lower atmospheric inputs?

Managed

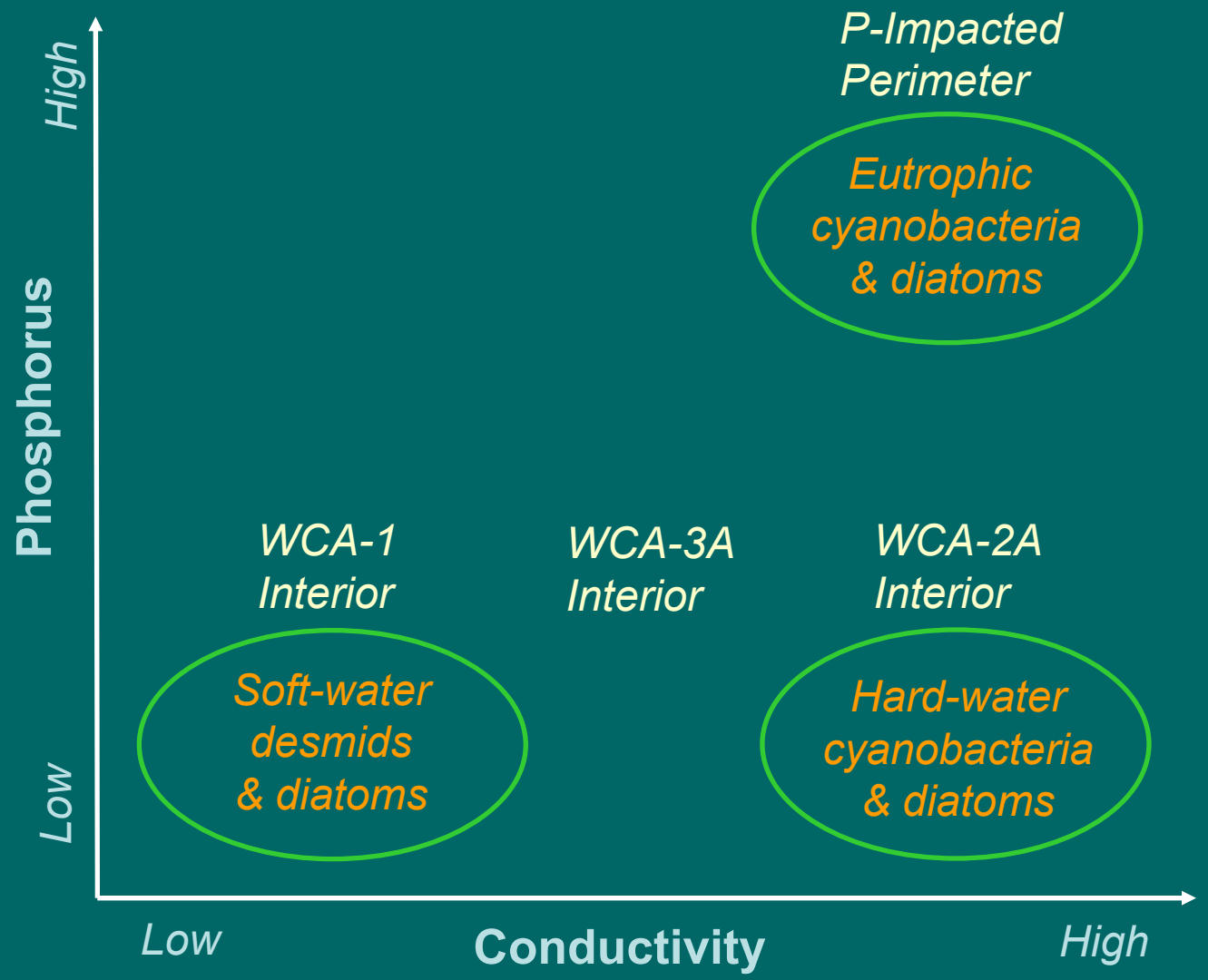
- Considerable groundwater influence
- Peat oxidation (release)
- Import to the watershed (fertilizers, etc.)
- Higher atmospheric inputs?

Biogeochemical Responses to Changing Mineral Chemistry

The international literature reports a broad range of responses:

- **Nutrient cycles** *(Newman Tue 4:40 p.m.)*
- **Contaminant cycles (***Orem Mon 2:20 p.m.***)**
- **Periphyton communities** *(Gaiser Mon 11:50 a.m.)*
- **Plant communities** *(McCormick Poster Session 2)*
- **Landscape patterns** *(McCormick Poster Session 2)*
- **Faunal communities** *(Trexler @ meeting)*

Periphyton Communities



Plant Communities

- Loss of sensitive soft-water taxa:

Xyris

Nymphoides

Eriocaulon

Landscape Patterns

- **Coexistence of sawgrass and slough habitats:**

Growth of sawgrass seedlings in slough soils that are (right to left):

1) ***Unenriched (Control);***
2) ***Enriched with P;***
3) ***Enriched with P and minerals.***

Conclusions

- Mineral concentrations have increased across large areas of the Everglades
- These increases are a result of regional changes in hydrology and land use
- These increases have biogeochemical consequences
- Additional research and modeling needed to determine relevance to ecosystem restoration

Acknowledgments

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