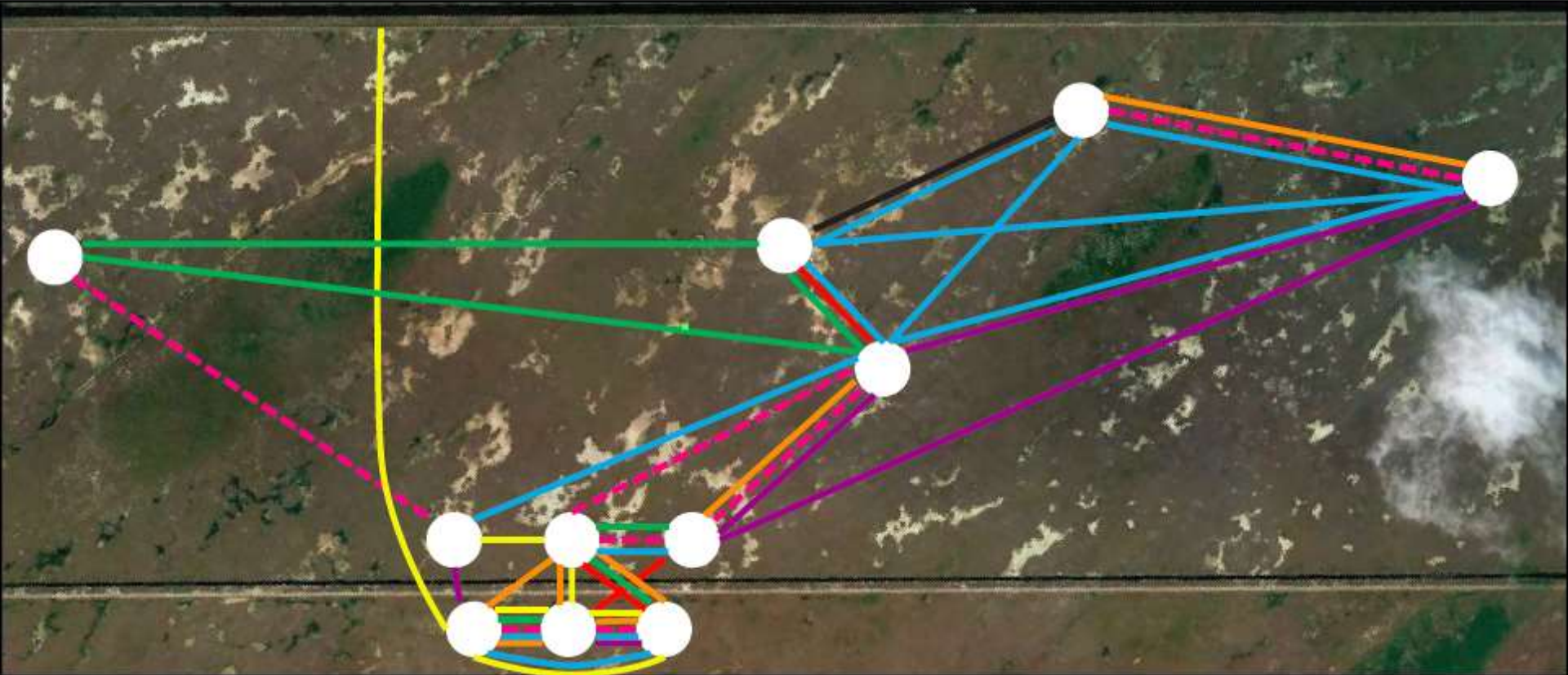


# Effects of Flow Reconnection on Connectivity of Biogeochemical Processes in the Central Everglades

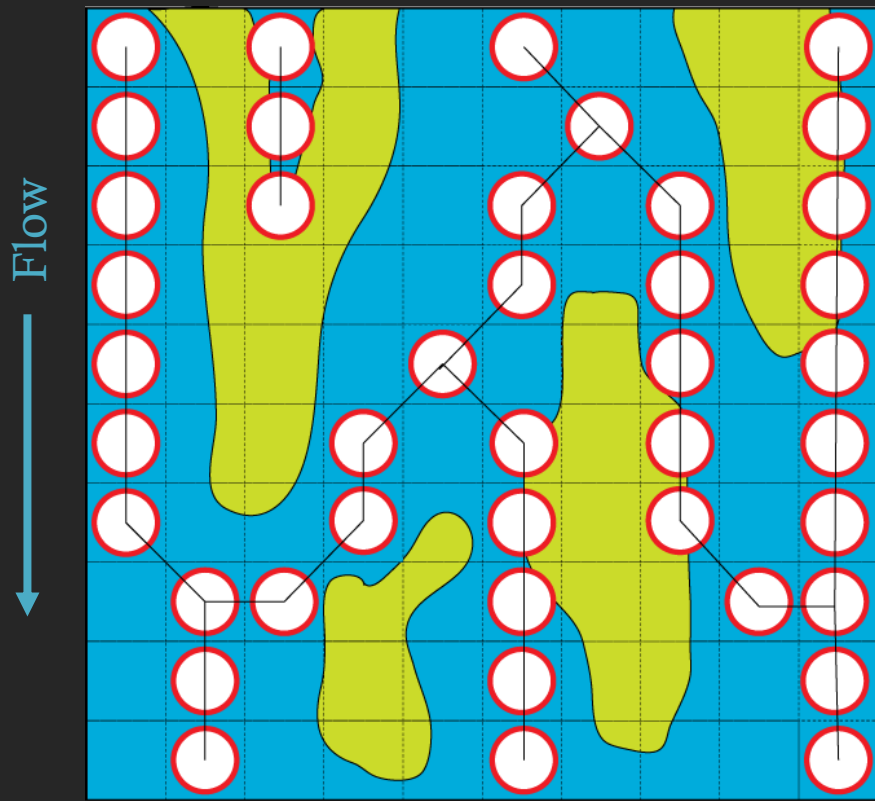
Laurel Larsen, Susan Newman, Colin Saunders, and Jud Harvey



# Acknowledgements

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- **Field and analysis assistance:** Aaron Hurst, Allison Swartz, Jenny Lewis

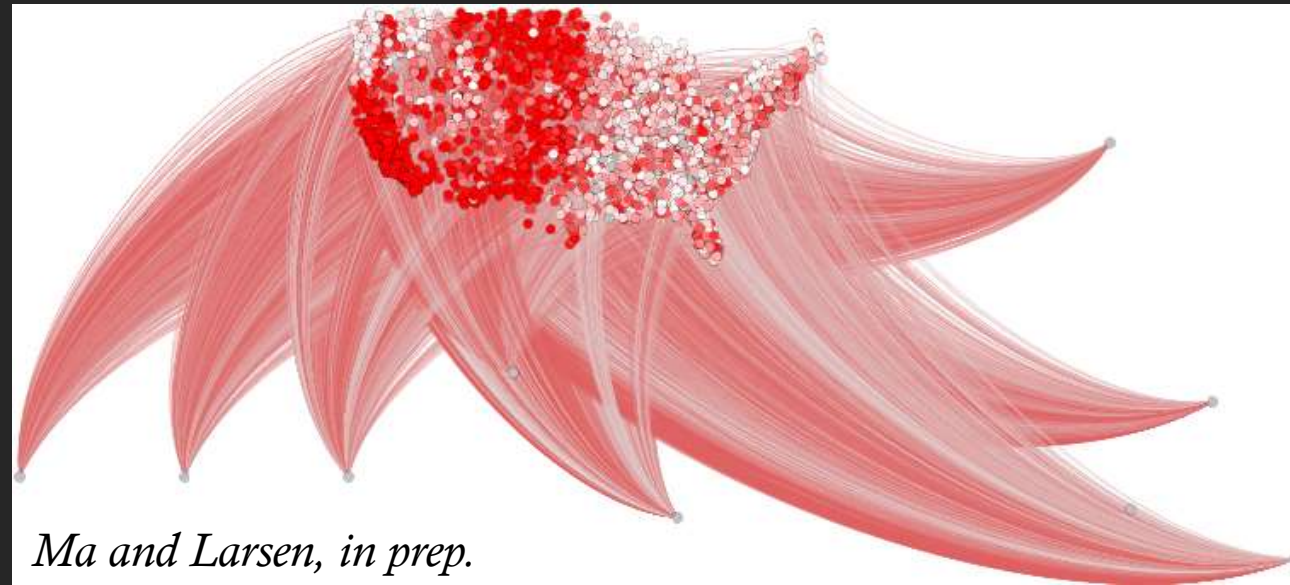




**Structural connectivity** describes the adjacency/contiguity of physical landscape features.

*Larsen et al., Ecological Appl., 2012*

**Functional connectivity** maps transfers of mass or information or processes in space.



*Information transfer from climate indices to U.S. precipitation gauge stations*

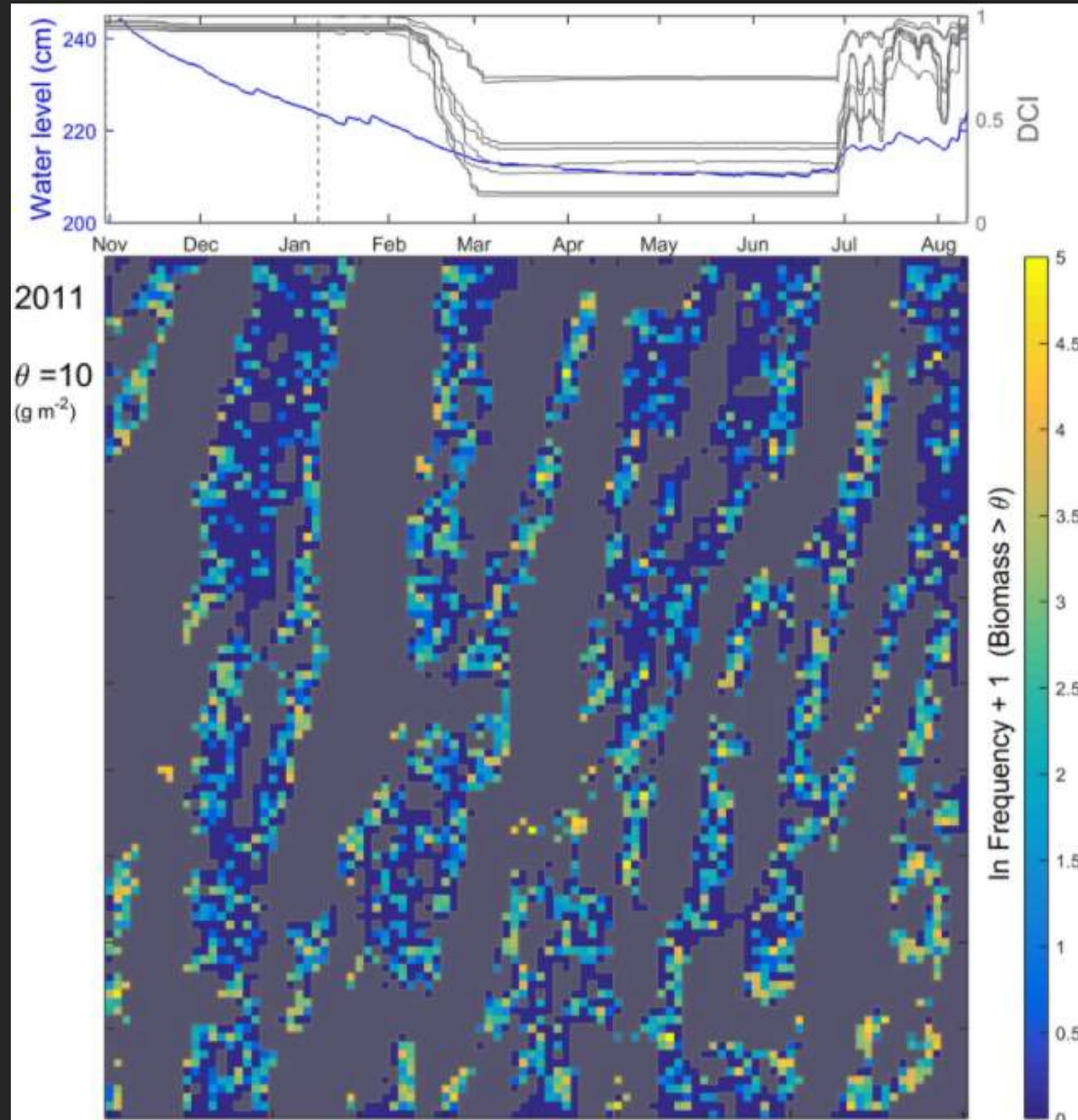
*Ma and Larsen, in prep.*

# Many ways to quantify connectivity

Structural connectivity over 8 cardinal directions

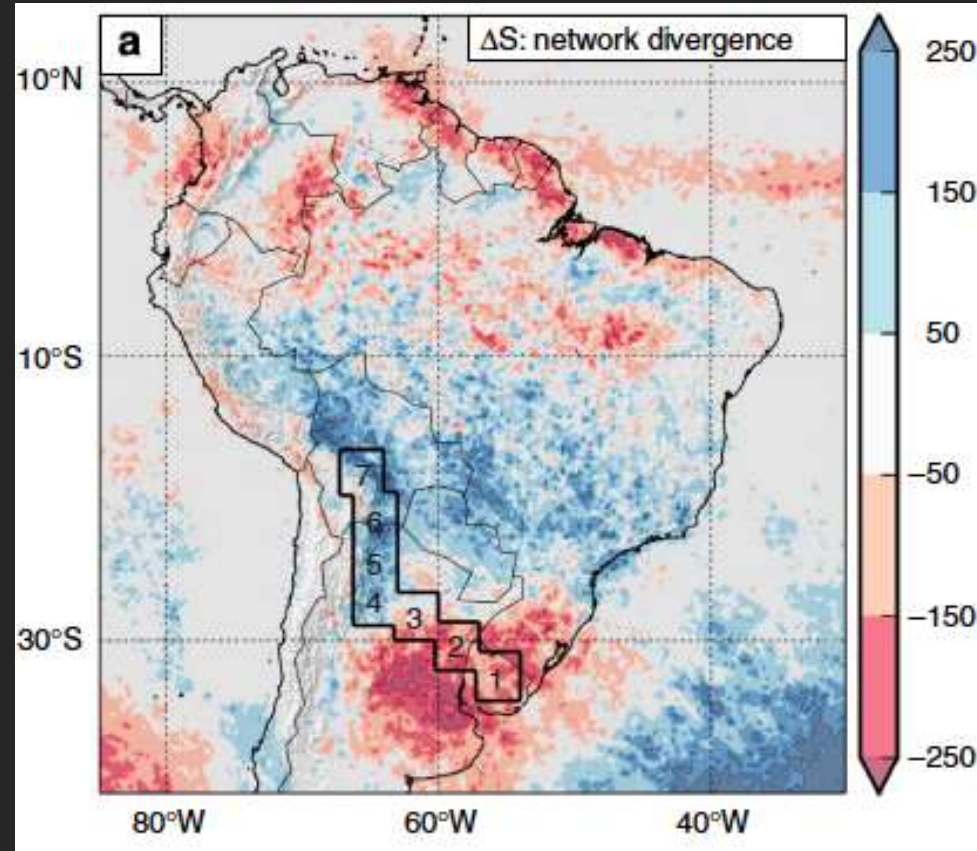
Functional connectivity as map of biomass persistence over time

Source:



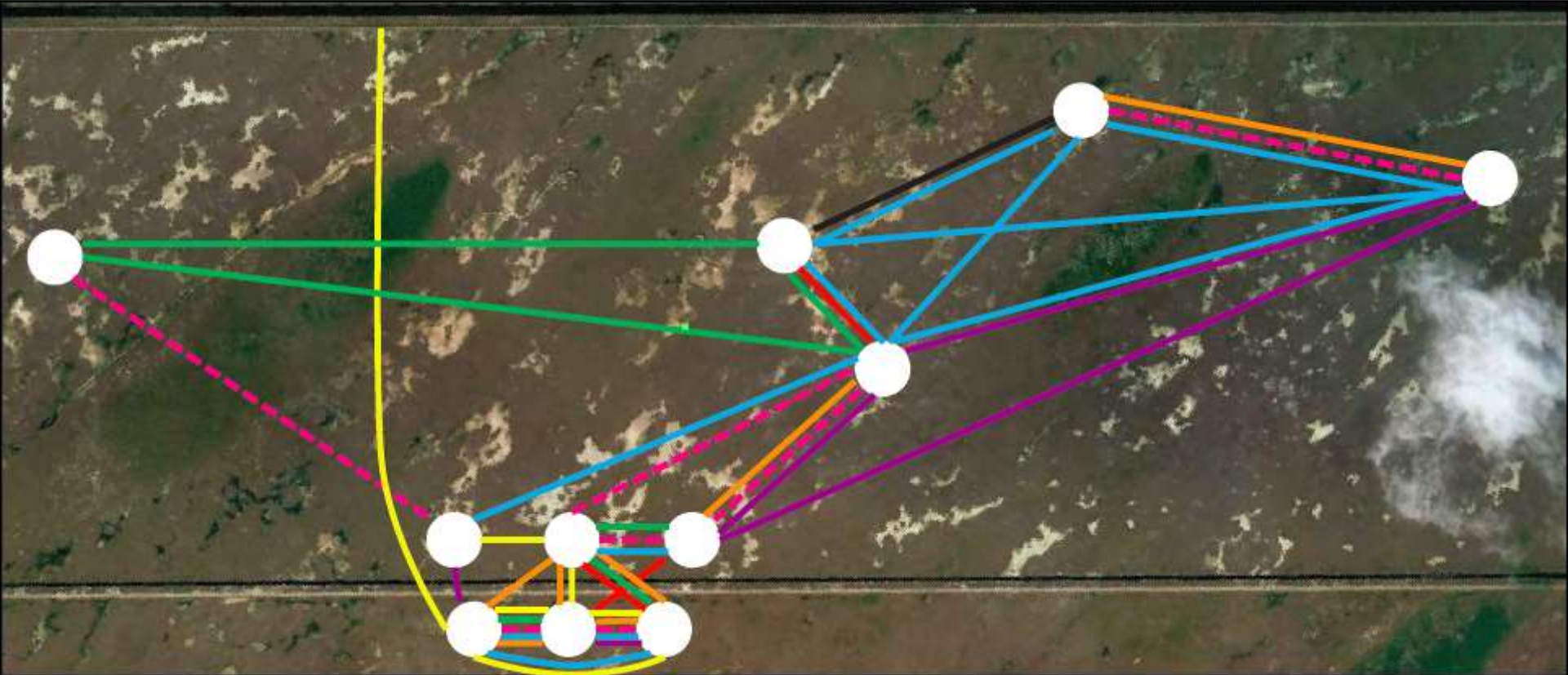
# Typical “functional connectivity” questions

- What are the spatial scales over which a disturbance or process propagates?
  - Contaminant transport
  - Nutrient uptake or transformation
- Where are the “hotspots” or critical locations for the propagation of solutes or processes?



Boers et al., *Nature Communications*, 2014

# Network approach ideal for identifying critical spatial scales and hotspots



# Decomartmentalization Physical Model (DPM): Restore flow connectivity

- Flow releases in Nov. of 2013, 2014, 2015, 2016
- Pre-release monitoring from 2010-2013
- How are ecologically relevant functional connectivity networks impacted?

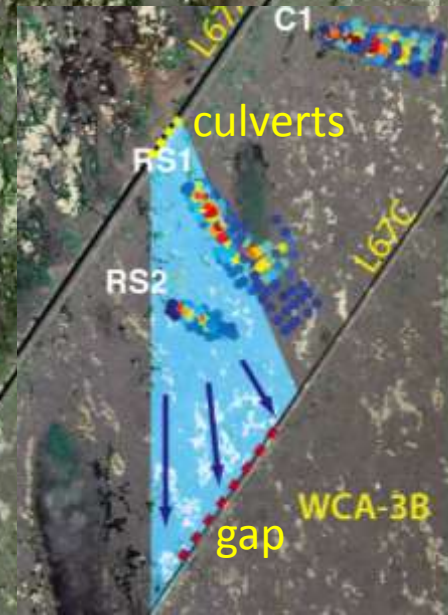


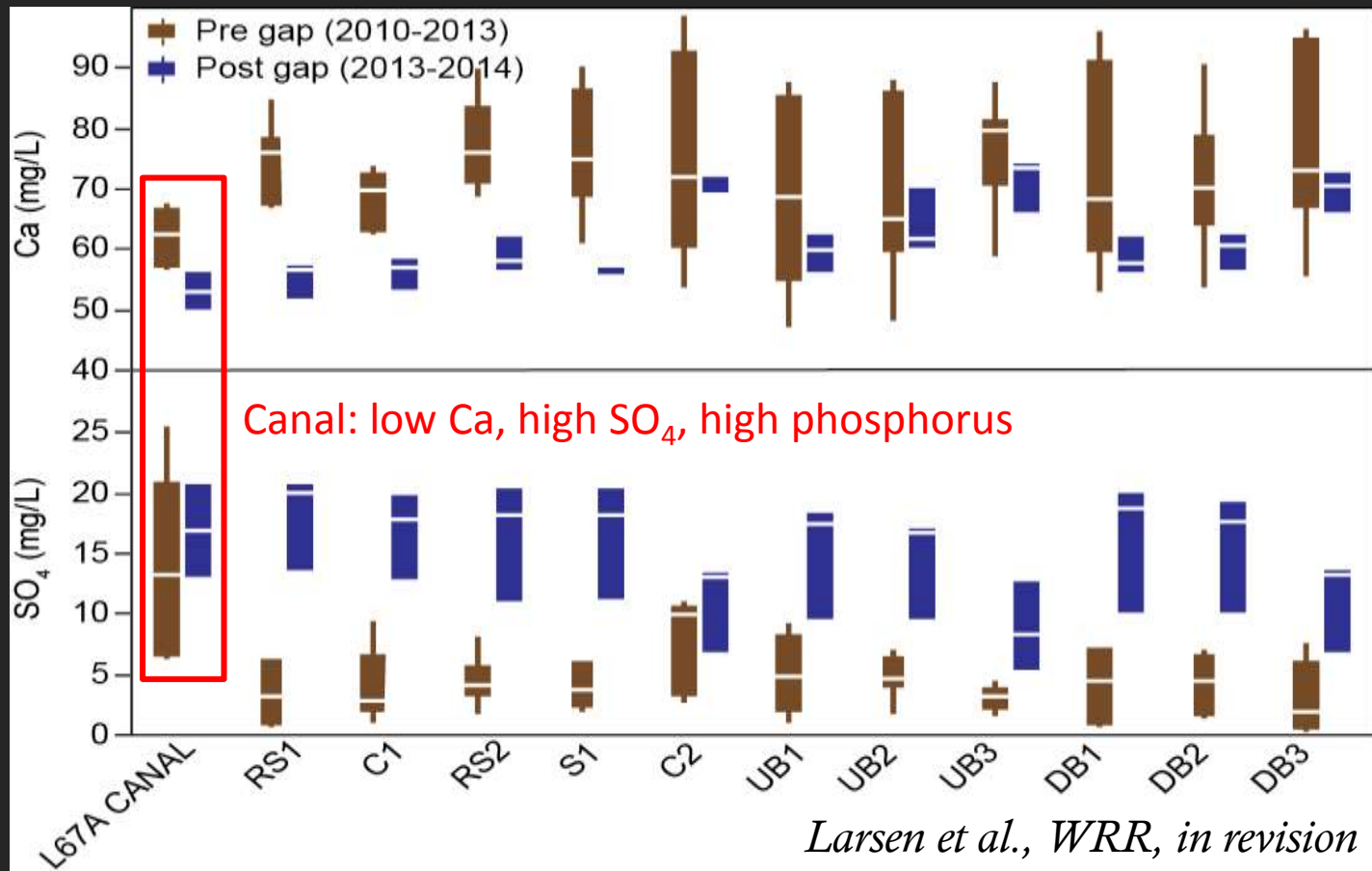
Image: D. Ho (U Hawaii)  
and L. Larsen

3.70 km

Image © 2013 The Florida Department of Environment

# Functional connectivity questions

1. Over what spatial scales do solutes representative of canals have an influence on ecological processes under pulsed flow releases?

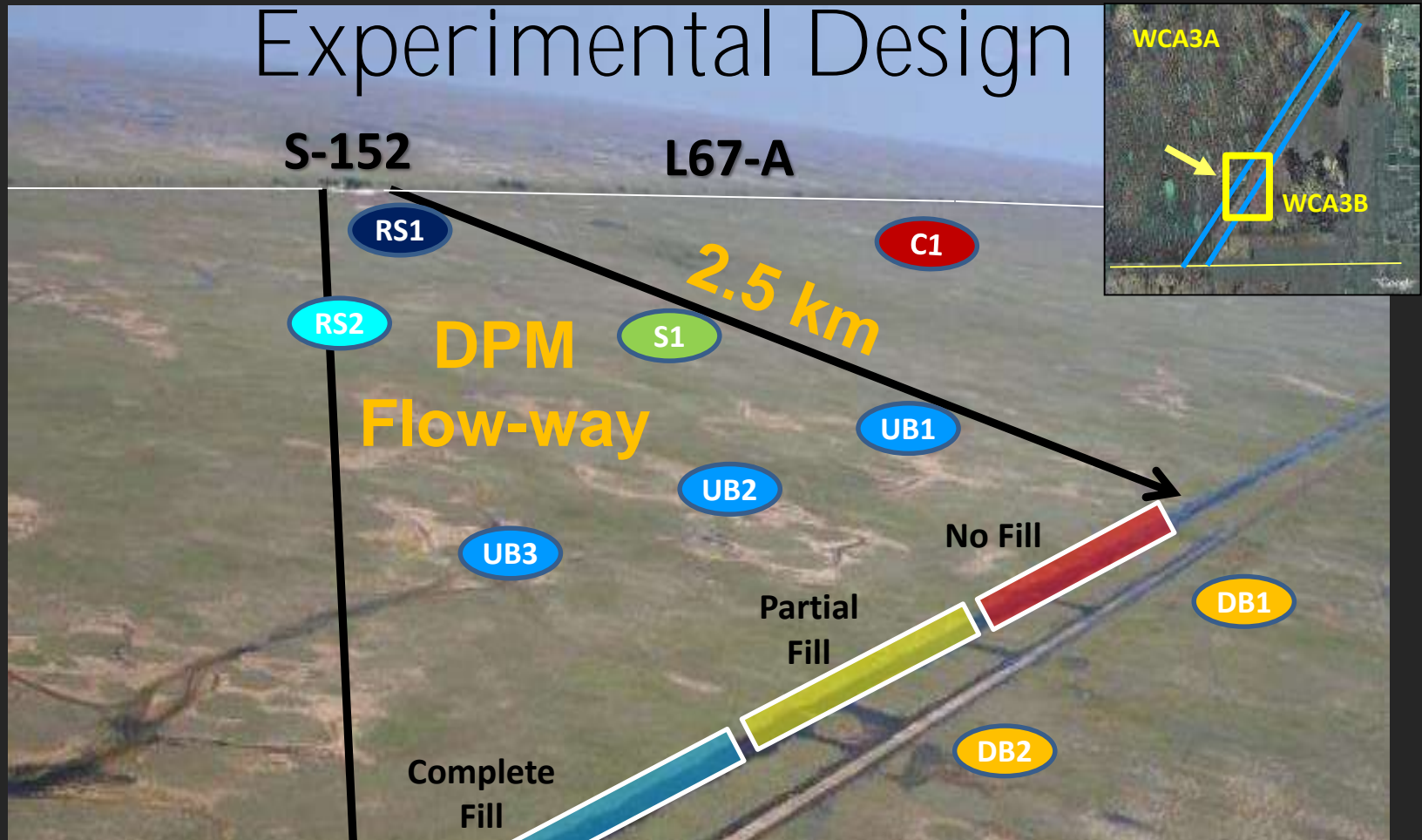




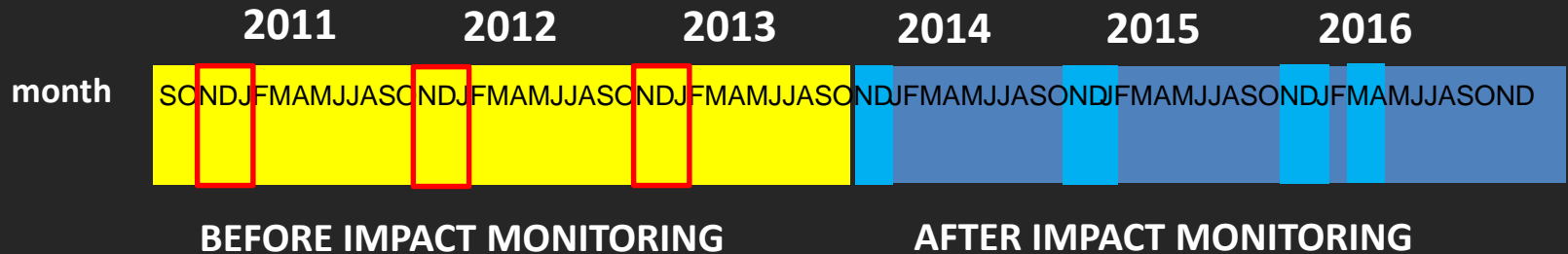
# Functional connectivity questions

2. How do gradients of velocity and vicinity to inflows structure markers of metabolism and other biogeochemical processes?
3. To what extent must canals be removed to restore contiguity of ecological processes to the Everglades landscape?

# Experimental Design

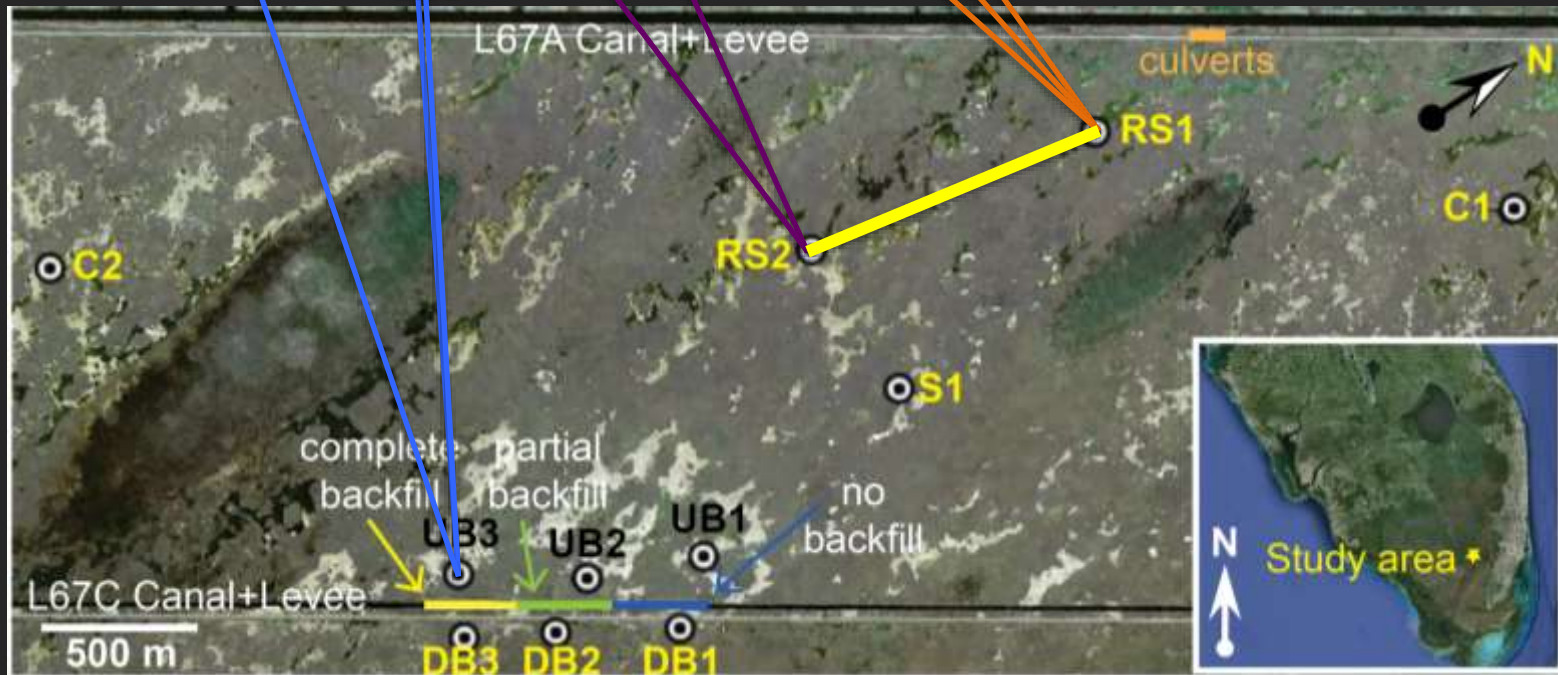
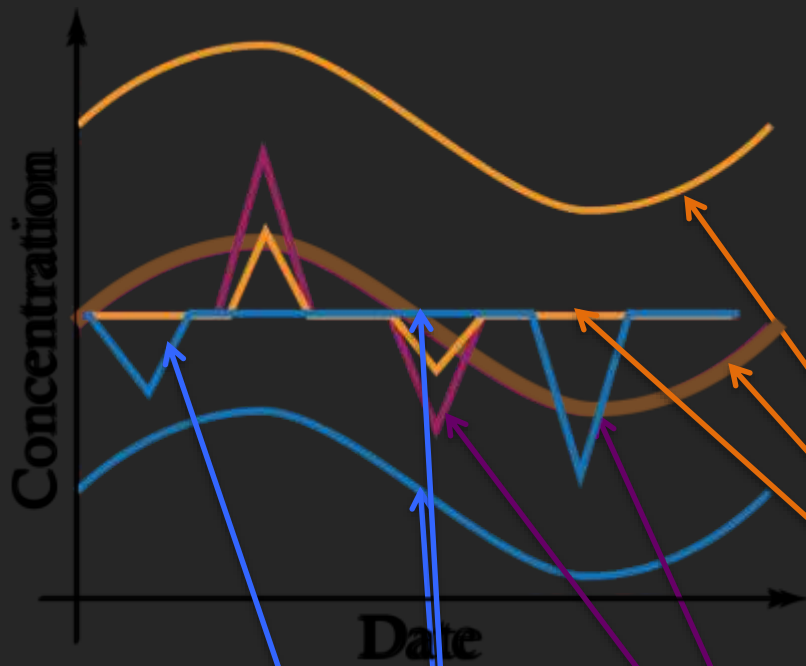


## BACI TIME LINE

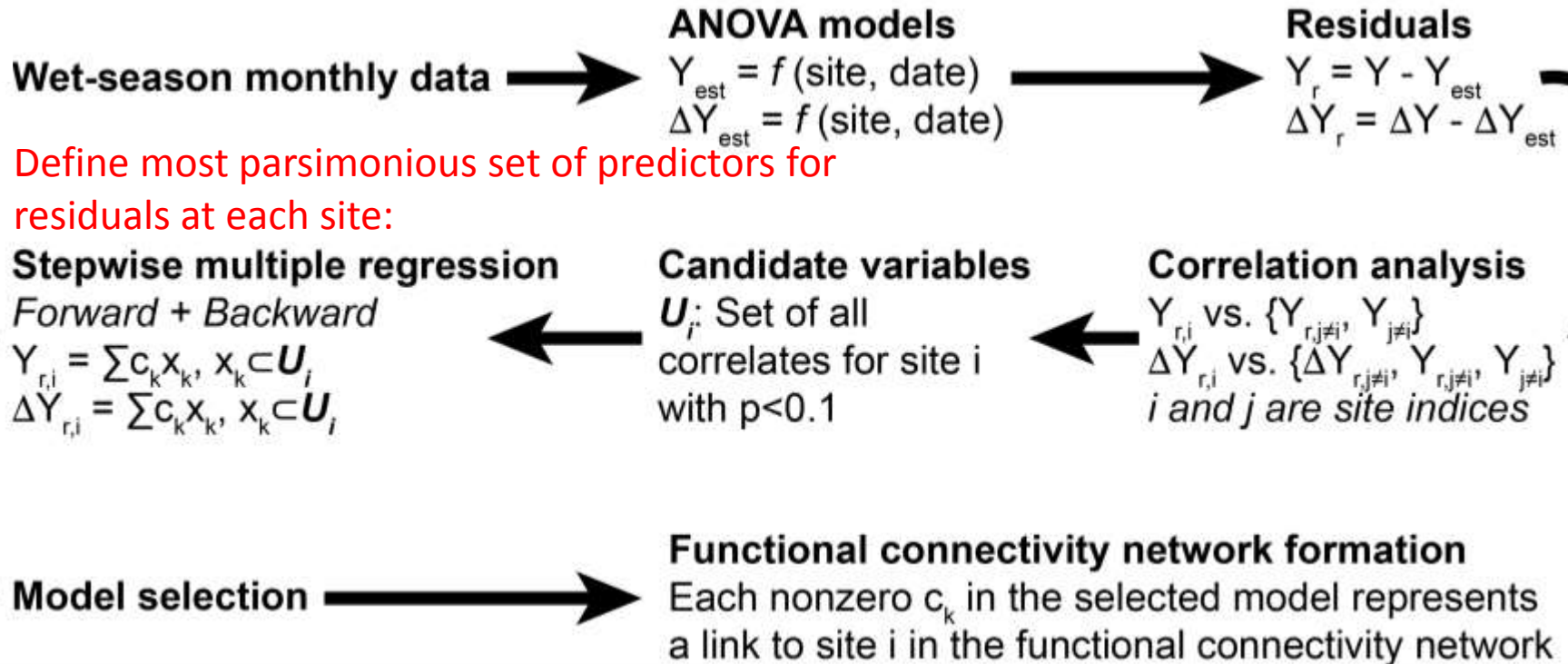


# Resolve functional connectivity by tracking perturbations in water quality signals

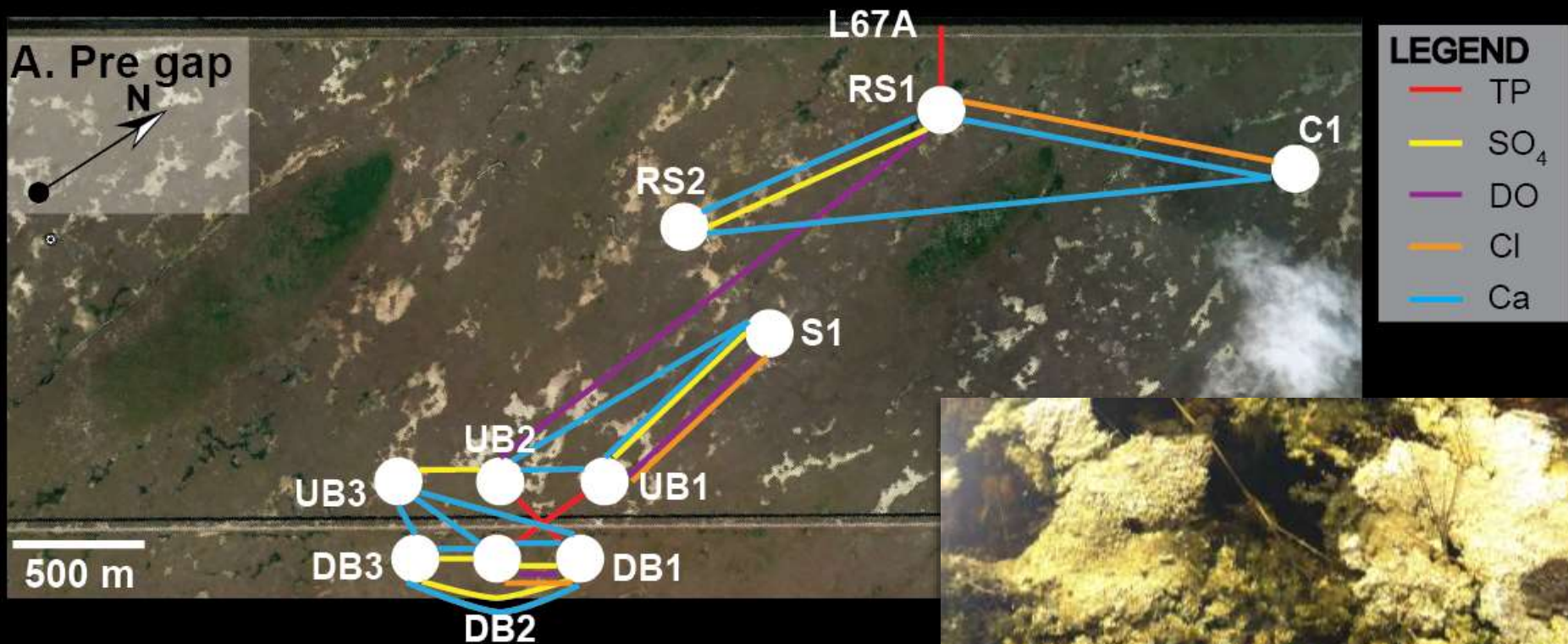
- Remove site effect
- Remove date effect



# Statistical approach

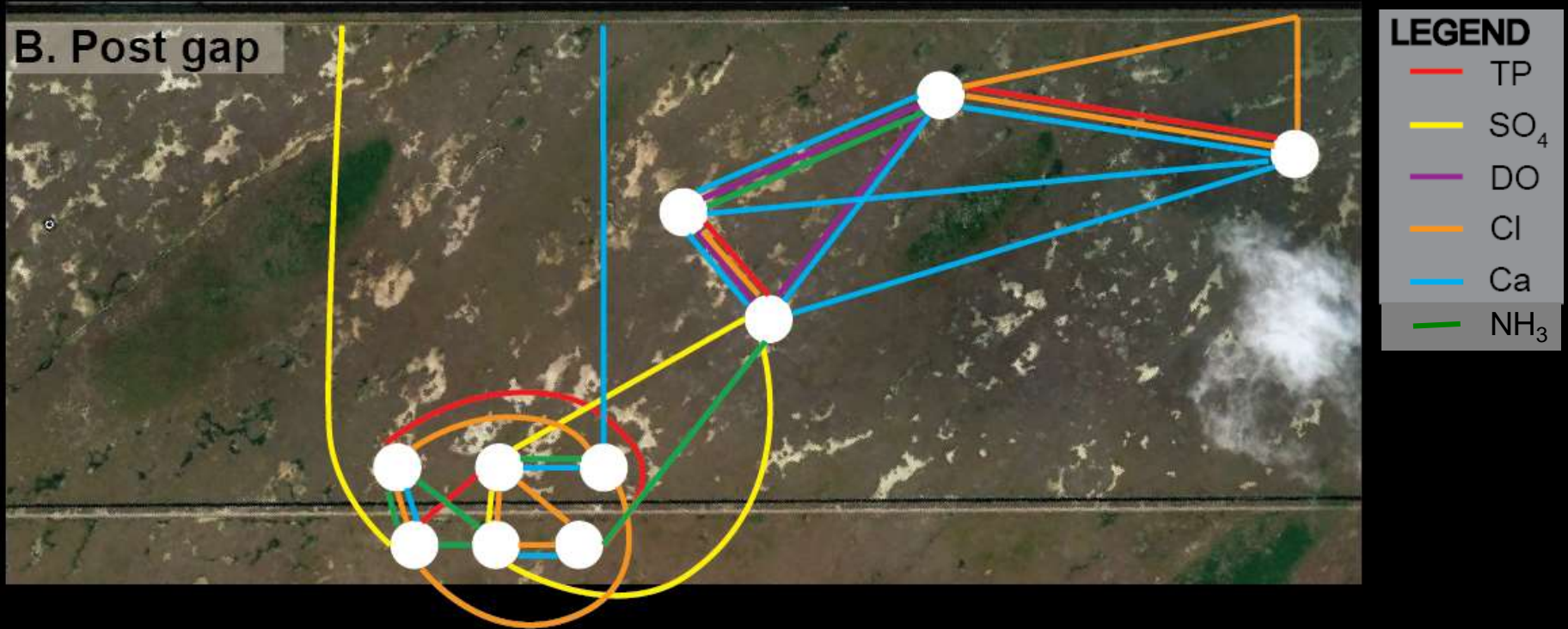


# Pre-gap functional connectivity networks structured by leaching of P from canal



*CaCO<sub>3</sub>-precipitating periphyton in sloughs*

# Post-gap connectivity networks reflect low-level P loading and decrease in calcitic periphyton



# Functional connectivity <sup>answers</sup> ~~questions~~

1. Over what spatial scales do solutes representative of canals have an influence on ecological processes under pulsed flow releases?

Expanded calcium networks likely reflect slow, low-level influence of P loading on biotic communities at a scale of  $\sim 1$  km from inflows, a “biotic filter” effect



*Photo: Michael Manna*

# Functional connectivity <sup>answers</sup> questions

2. How do gradients of velocity and vicinity to inflows structure markers of metabolism and other biogeochemical processes?

Sites with flow velocity  $> 0.8$  cm/s functionally cluster together and experience strong similarities in dissolved oxygen perturbation signals.

*Photo: Michael Manna*





# Functional connectivity <sup>answers</sup> ~~questions~~

3. To what extent must canals be removed to restore contiguity of ecological processes to the Everglades landscape?

Complete reconnection (i.e., complete backfill) across former canal-levee discontinuities needed to restore connectivity of conservative and nonconservative solutes



*Photo: Michael Manna*