FATE AND MANAGEMENT OF PHOSPHORUS IN AGRICULTURAL SYSTEMS

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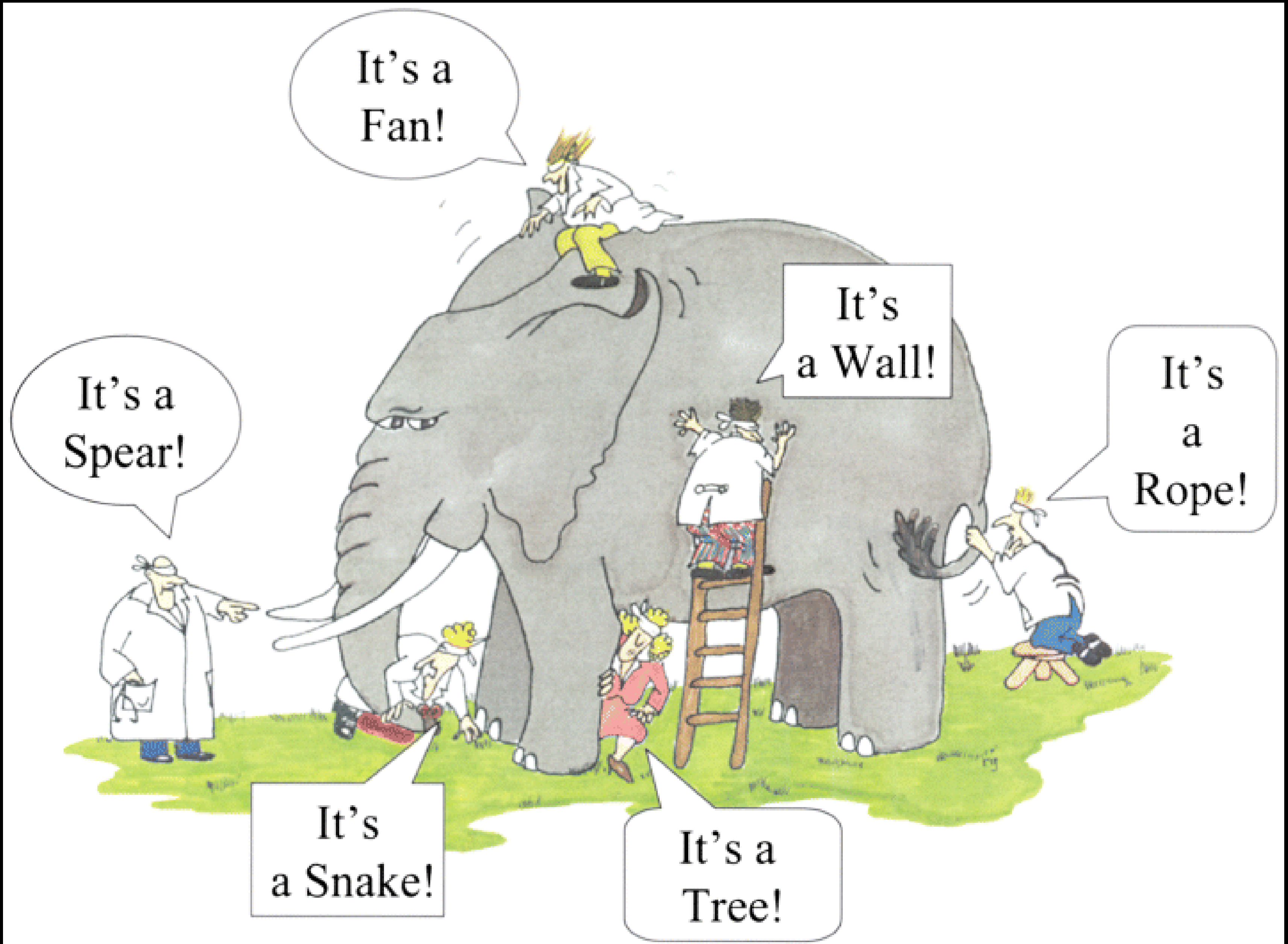
Sustainable Water Resources
Complex Challenges, Integrated Solutions
Nutrient Dynamics, Policy and Management in Watersheds

Blue Waters, Green Pastures, and the Elephant in the Room

Today's presentation

- ✓ Why are we here?
- ✓ Source & transport
- ✓ Risk management
- ✓ Fluvial interactions
- ✓ Legacy P – where the past confronts the future
- ✓ Where do we go from here?

Why are we here?

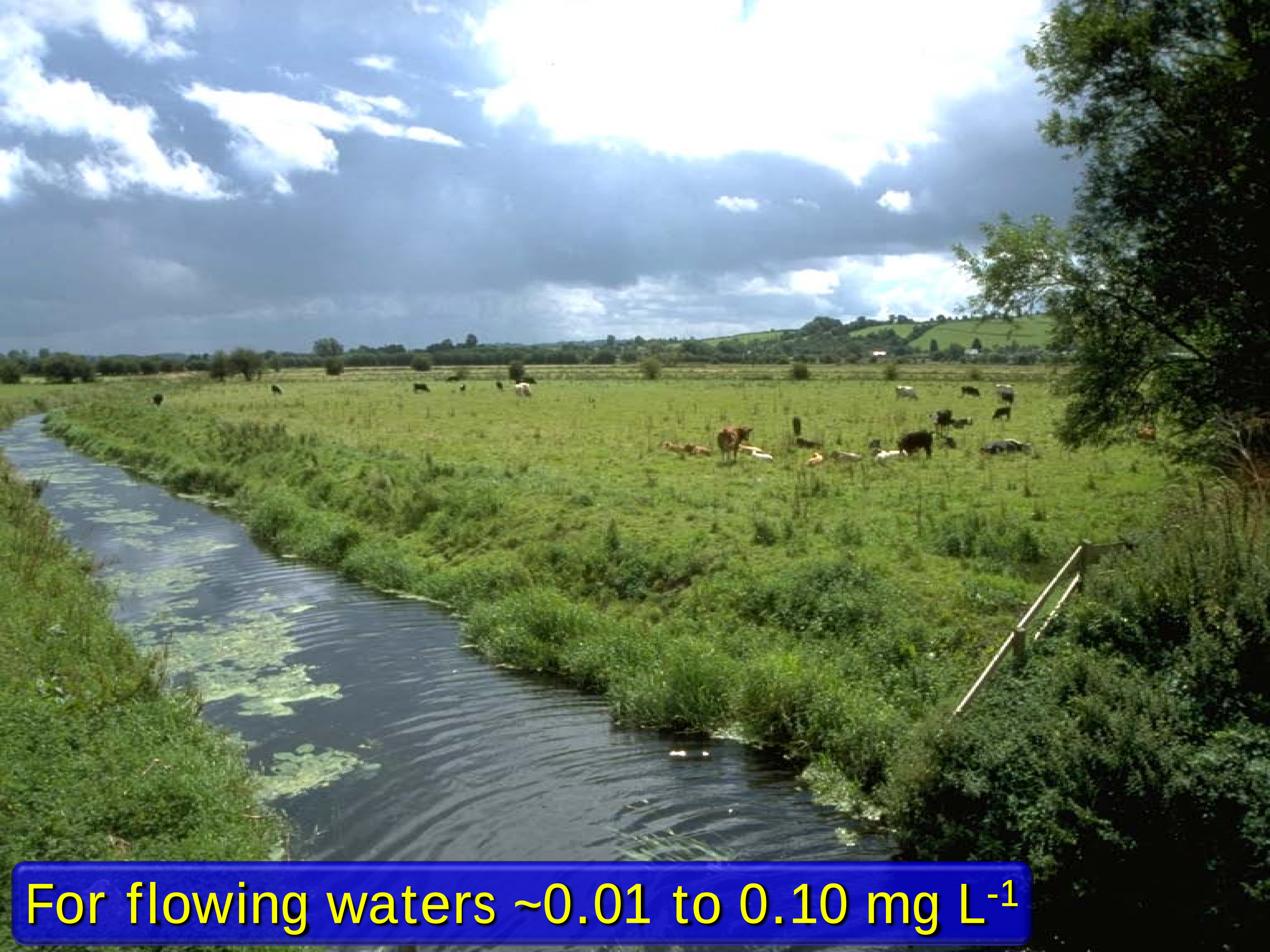


Source & transport

Red tide bloom *Karenia brevis* along FL SW coast

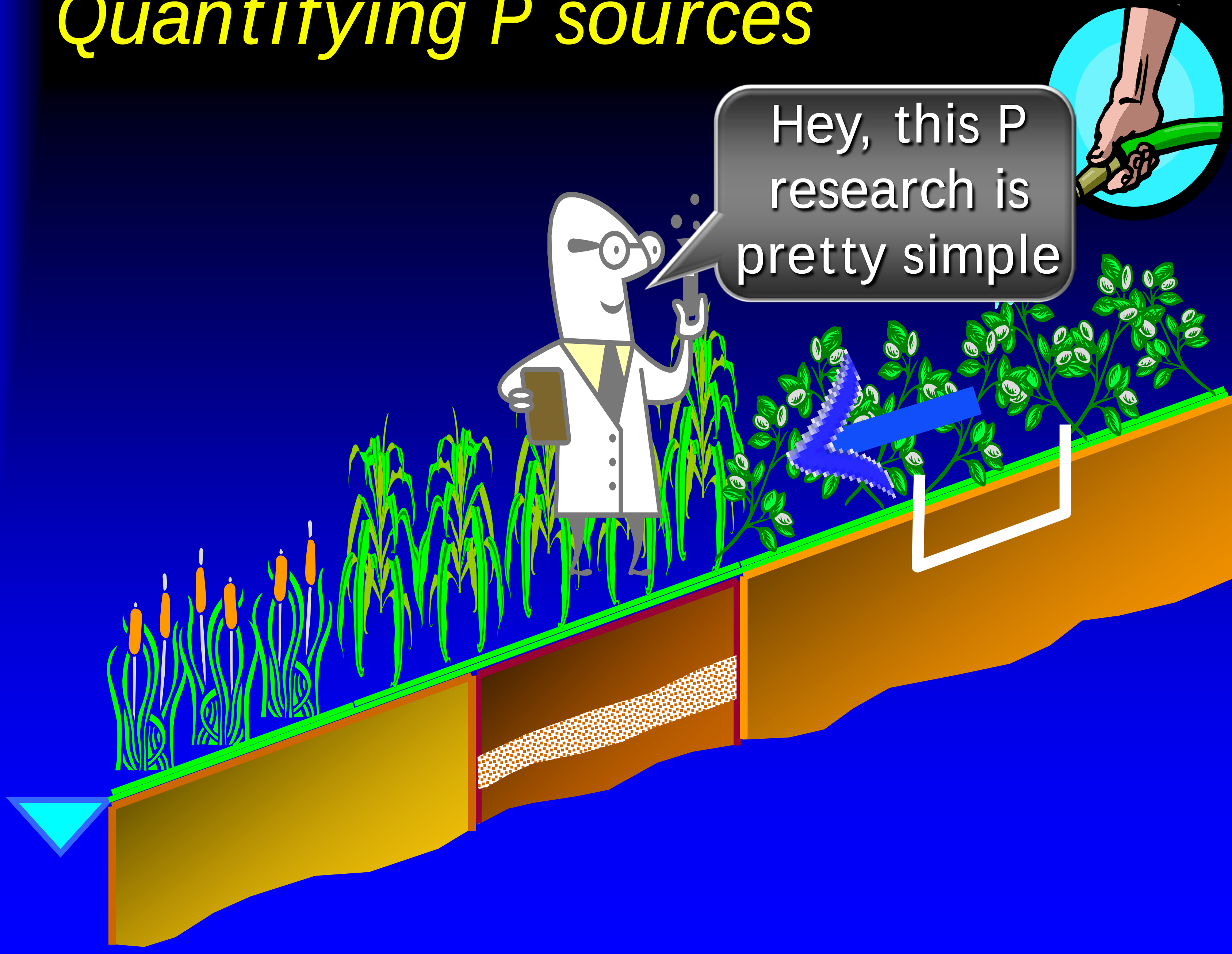
Cyanobacterial blooms in Baltic Sea


Optimal soil P concentrations for plant growth ~0.20 mg L^{-1}

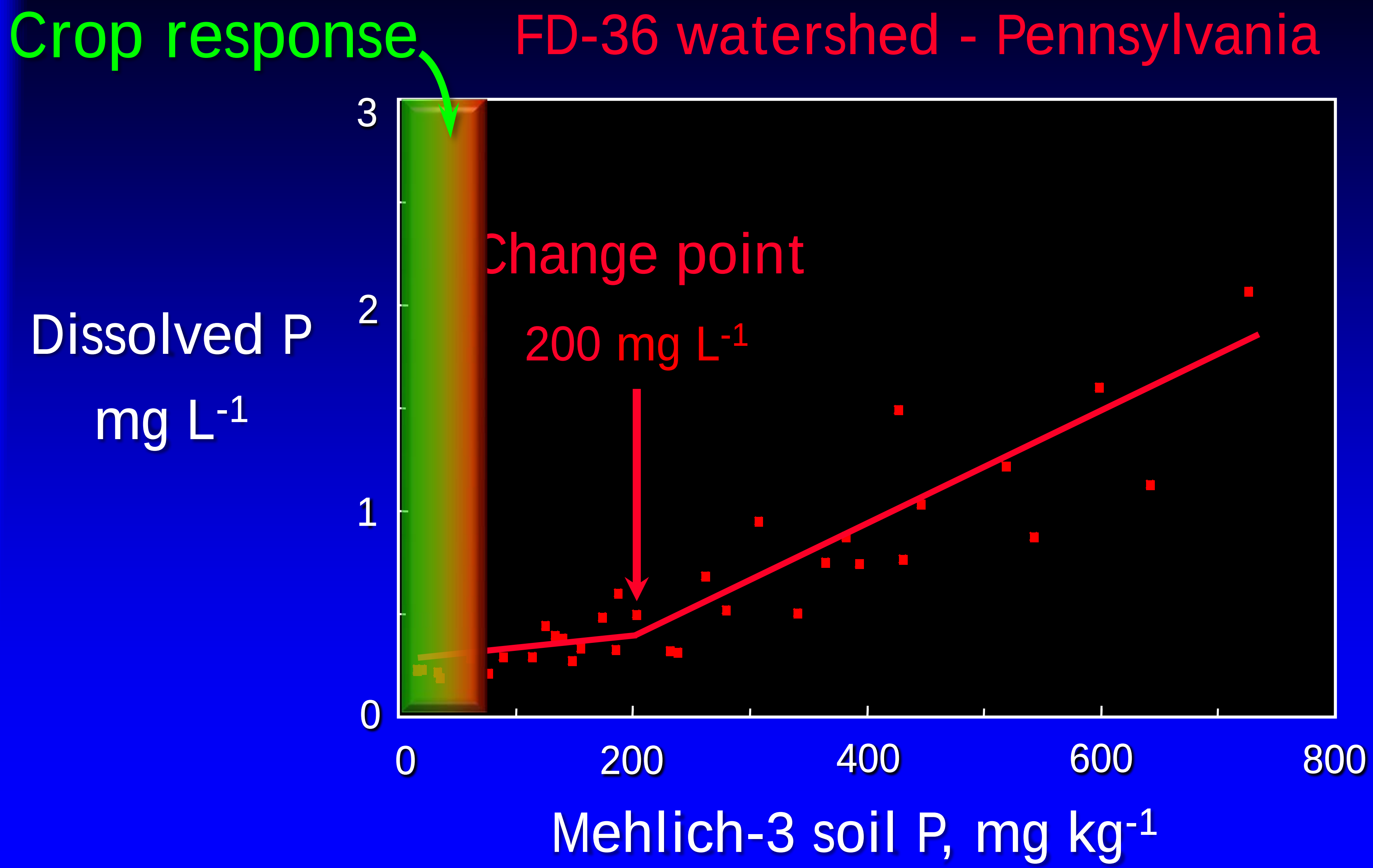

For flowing waters ~0.01 to 0.10 mg L^{-1}

For lakes ~0.01 to 0.04 mg L-1

Quantifying P sources

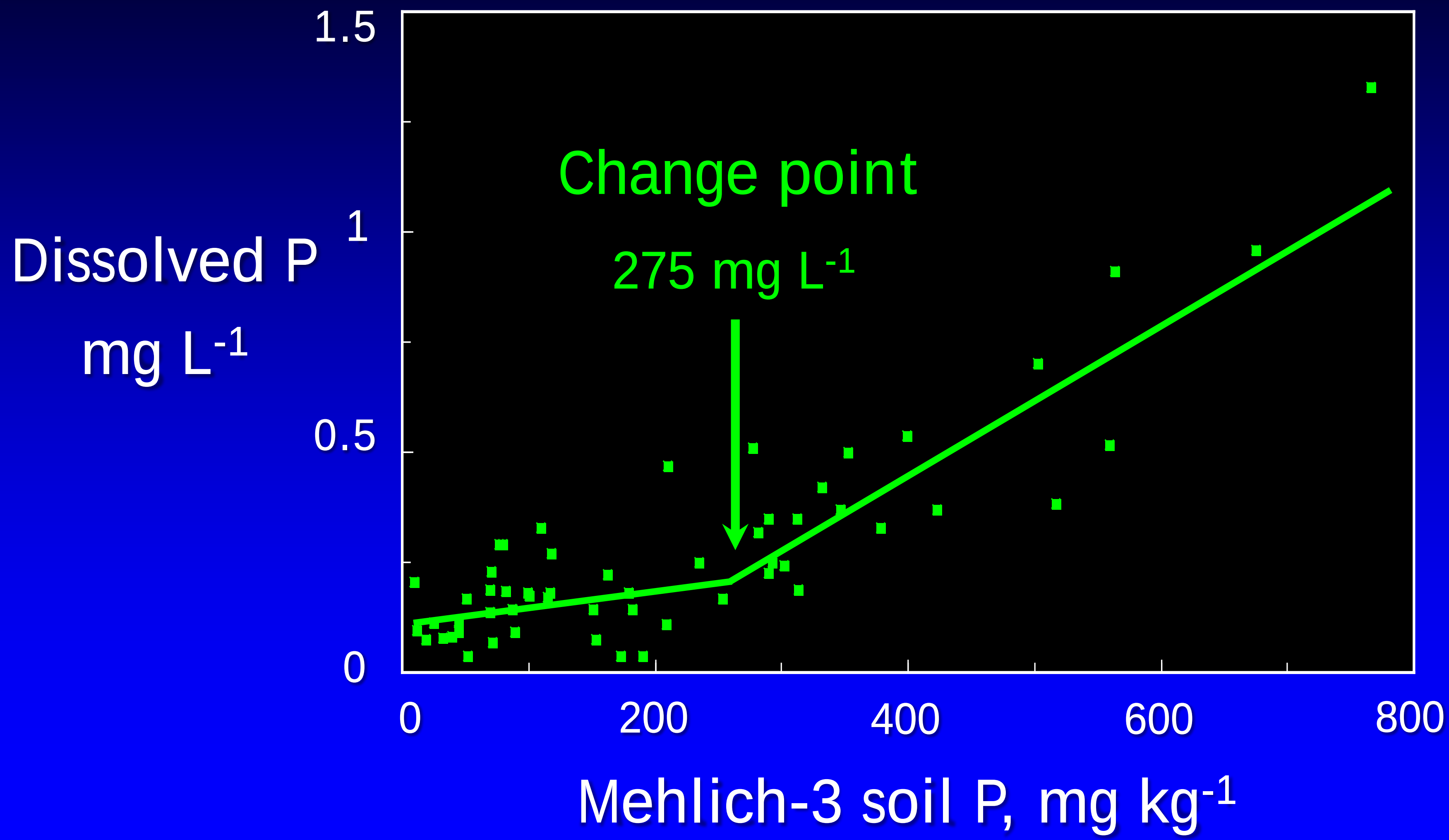


Relating STP to runoff P



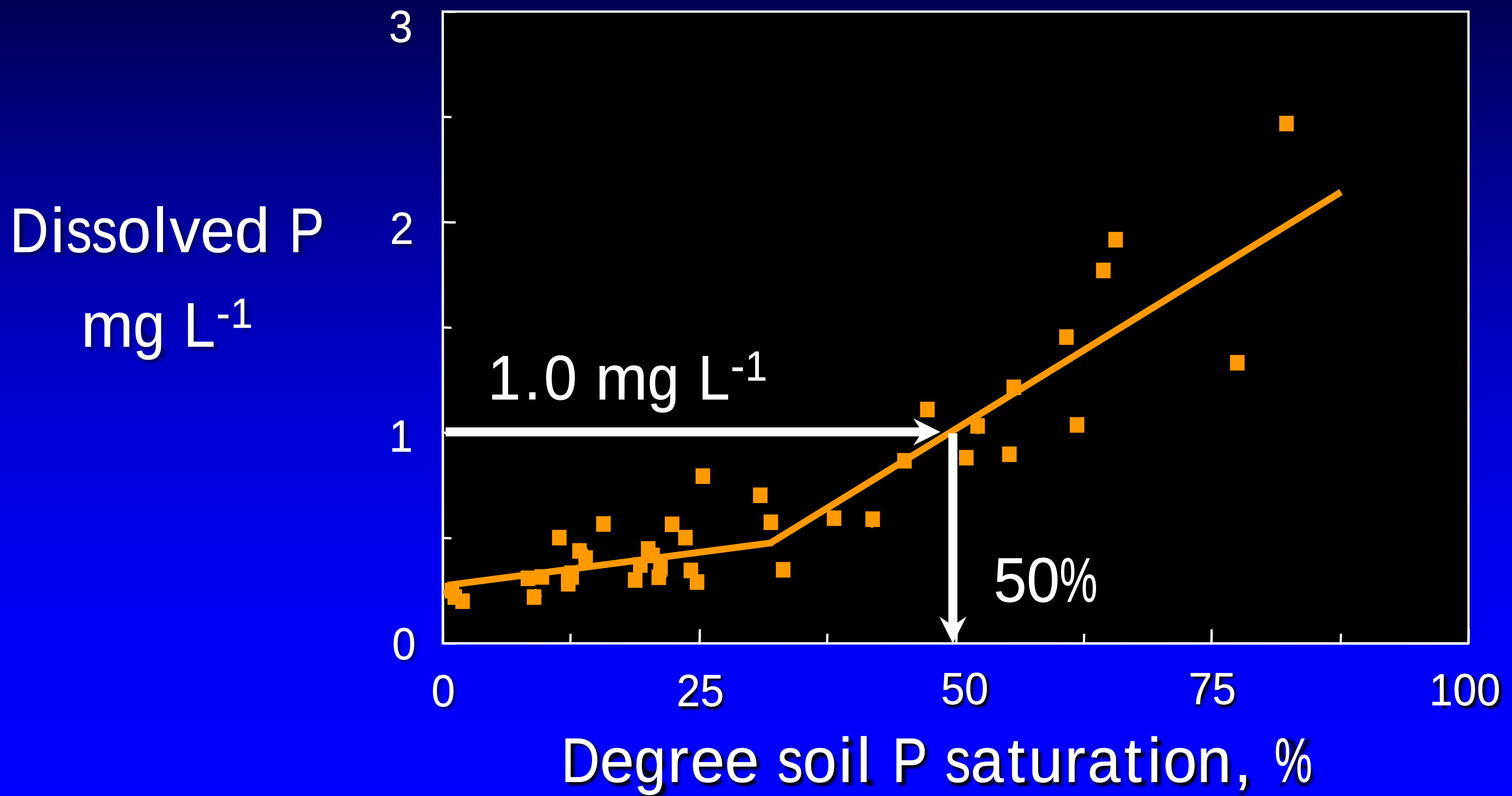
Soil P and subsurface drainage

Drainage from 50 cm undisturbed soil lysimeters

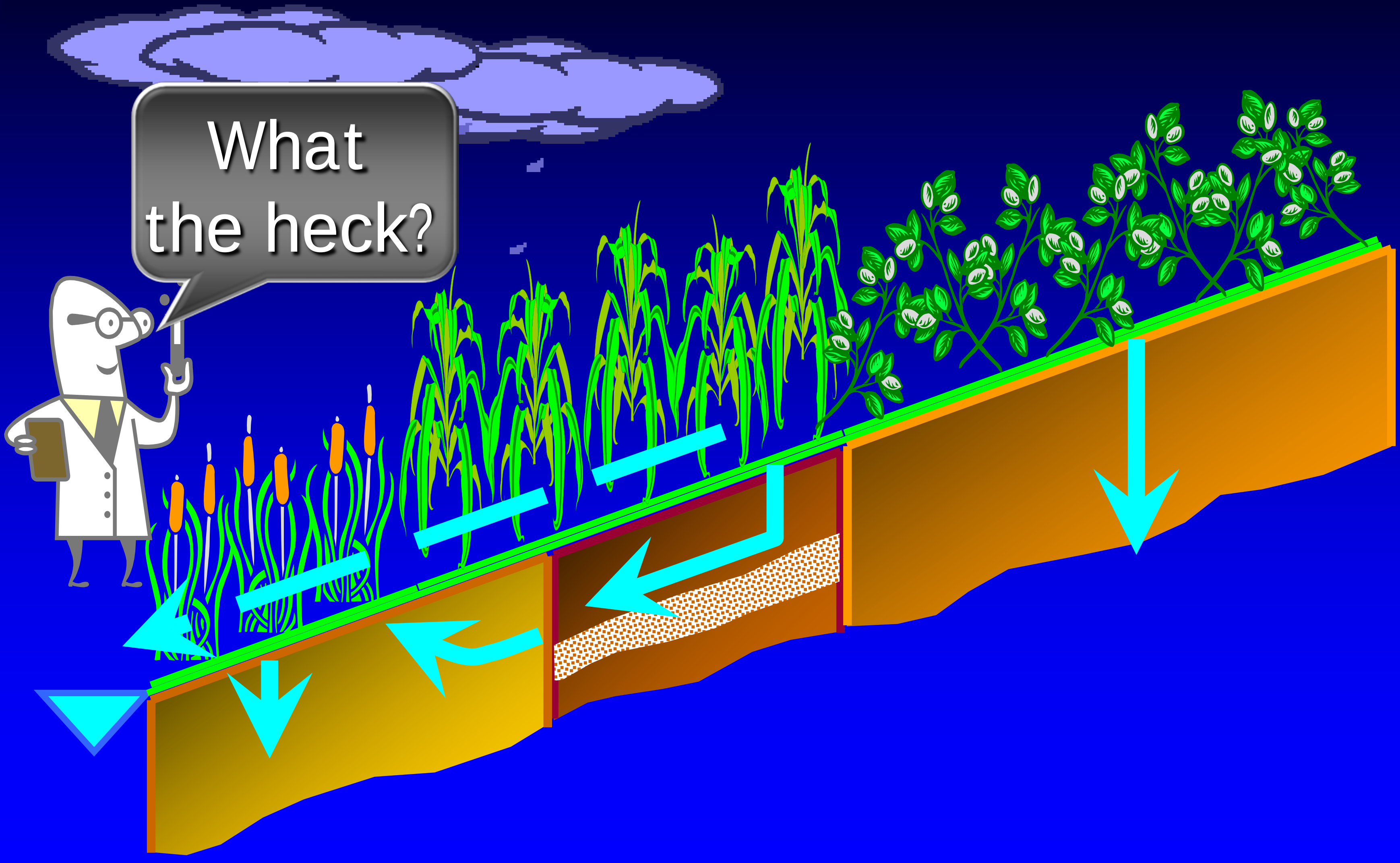



P sorption saturation & runoff P

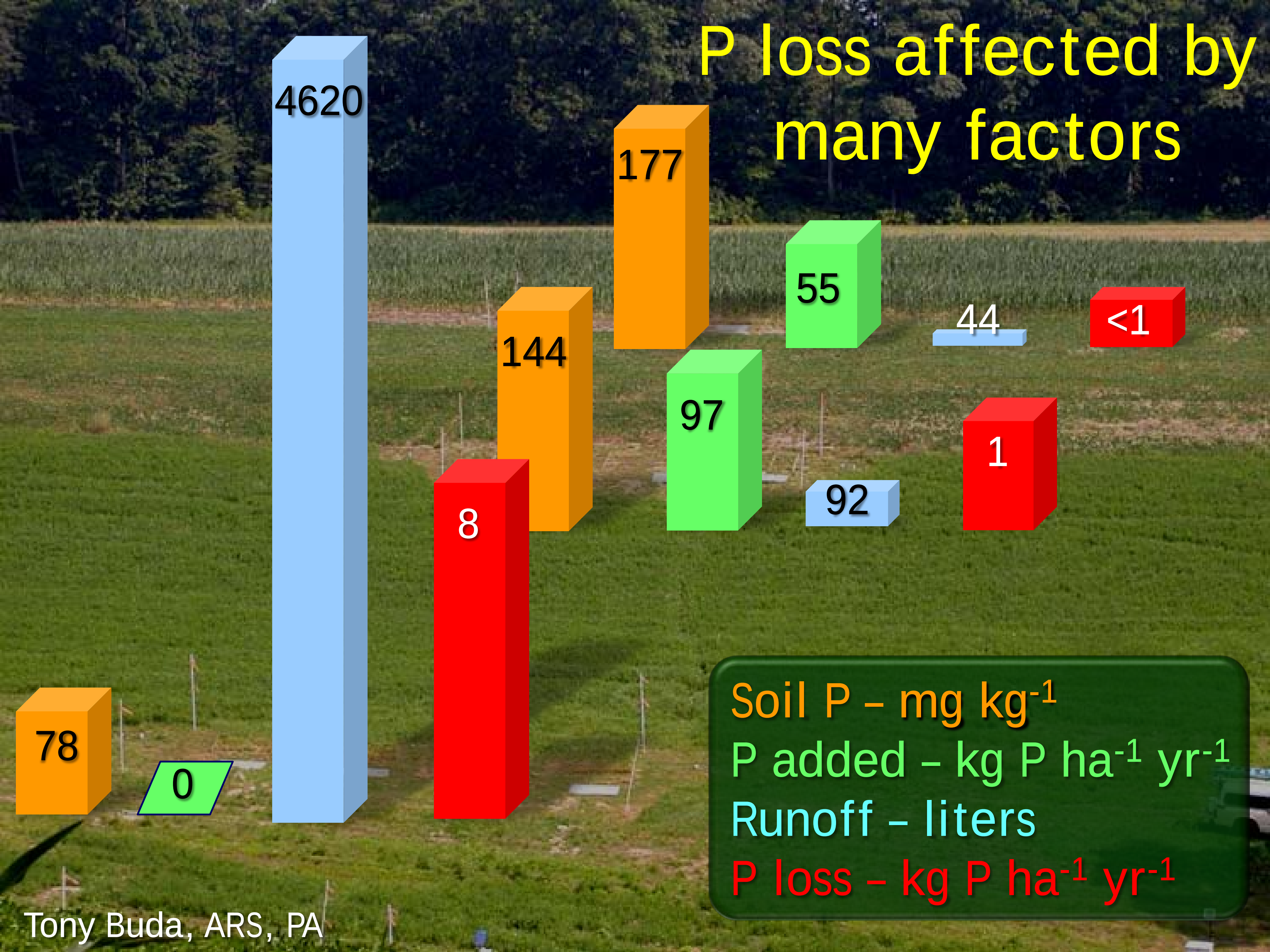
20% P saturation threshold proposed in Chesapeake Bay – Kovzelove et al



Scaling up - landscapes



Risk management


P loss affected by many factors
4620
177
144
55
44
<1
97
8
92
1
78
0
Soil P – mg kg-1
P added – kg P ha-1 yr-1
Runoff – liters
P loss – kg P ha-1 yr-1
Tony Buda, ARS, PA

Factors in P Index

Source

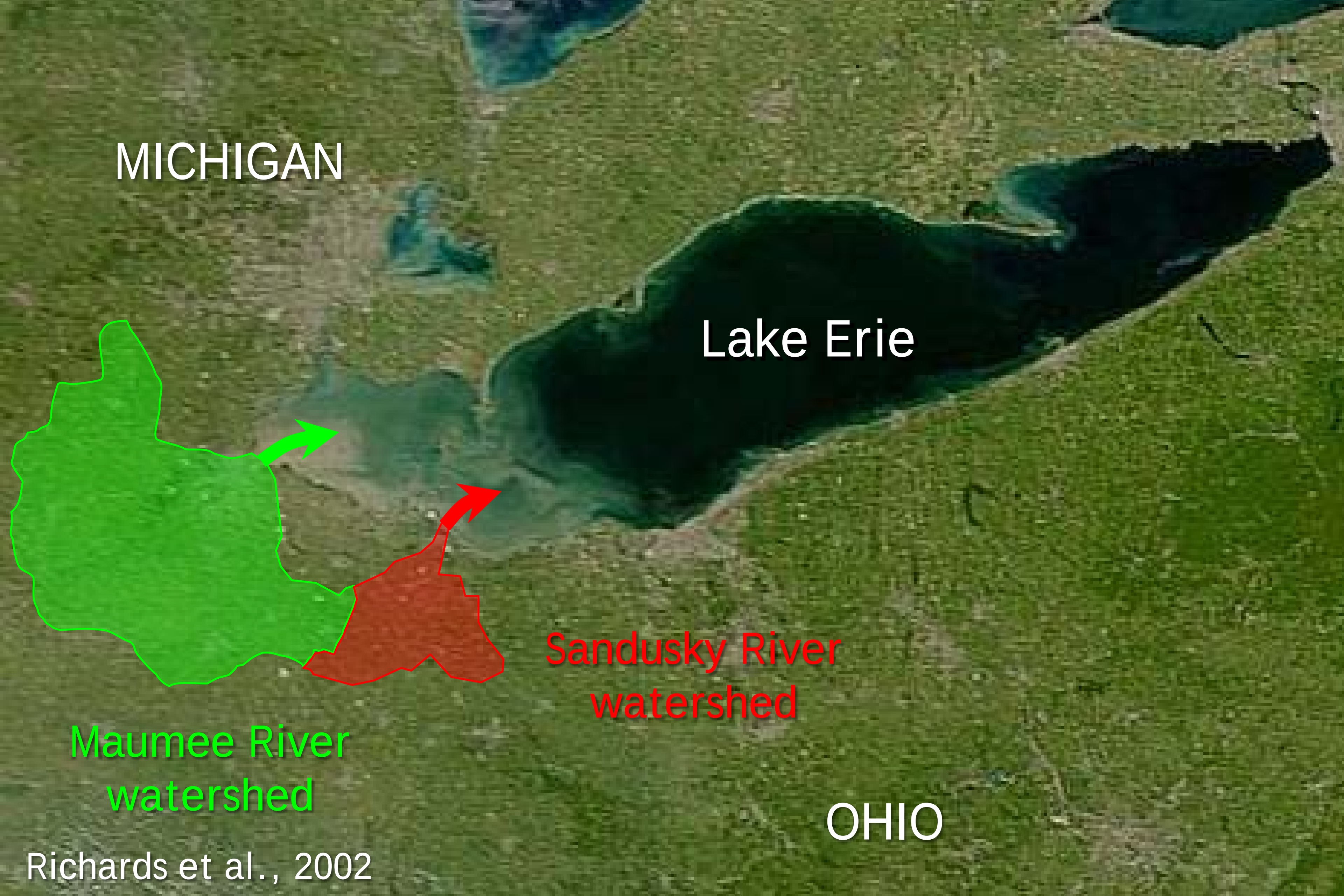
- ✓ Soil P content
- ✓ Added P
  - Rate, method, timing of fertilizer & manure
  - Manure P solubility

Transport

- ✓ Runoff potential
- ✓ Erosion potential
- ✓ Leaching potential
- ✓ Proximity to stream

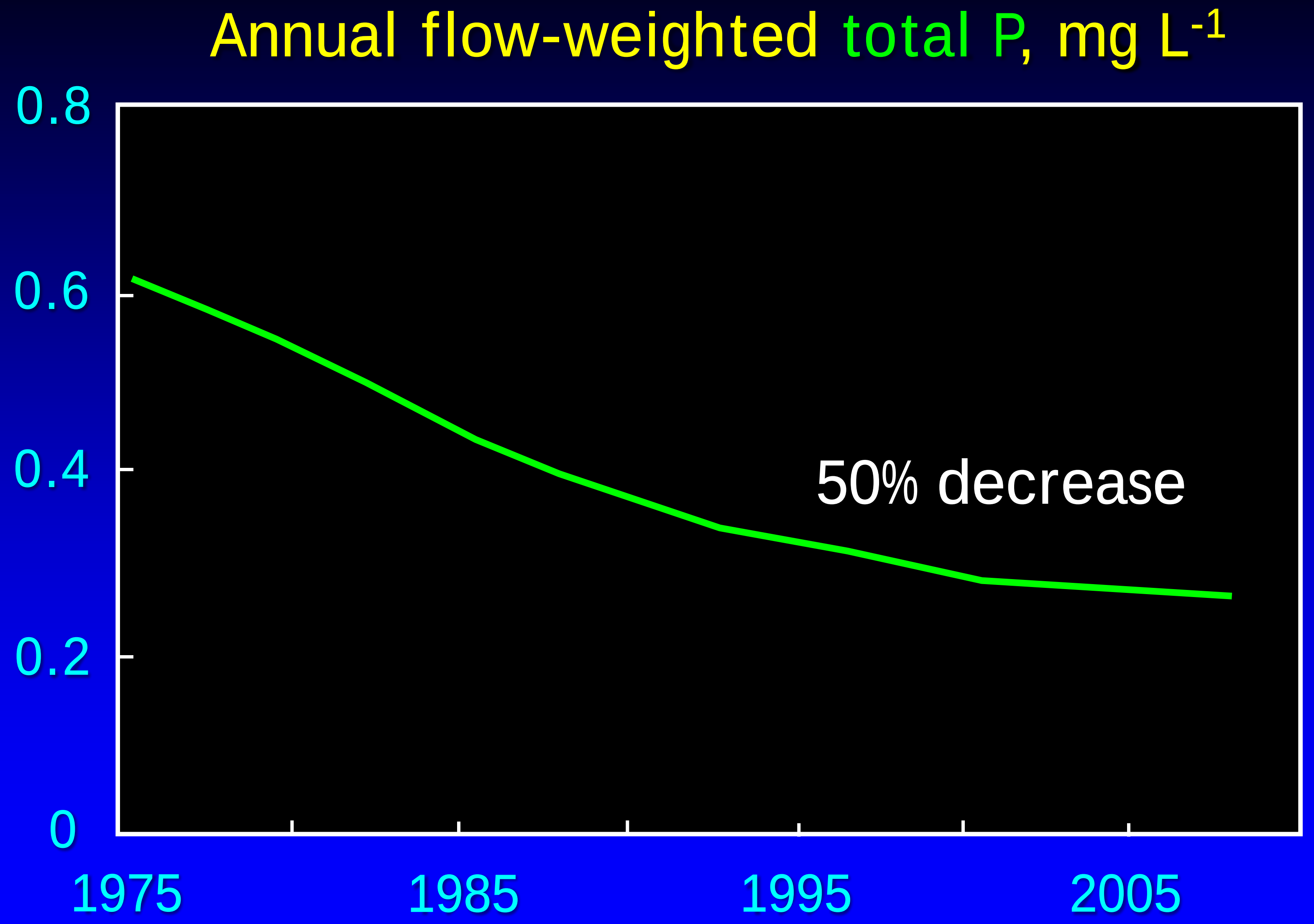

Land management


Lesson from Lake Erie Basin



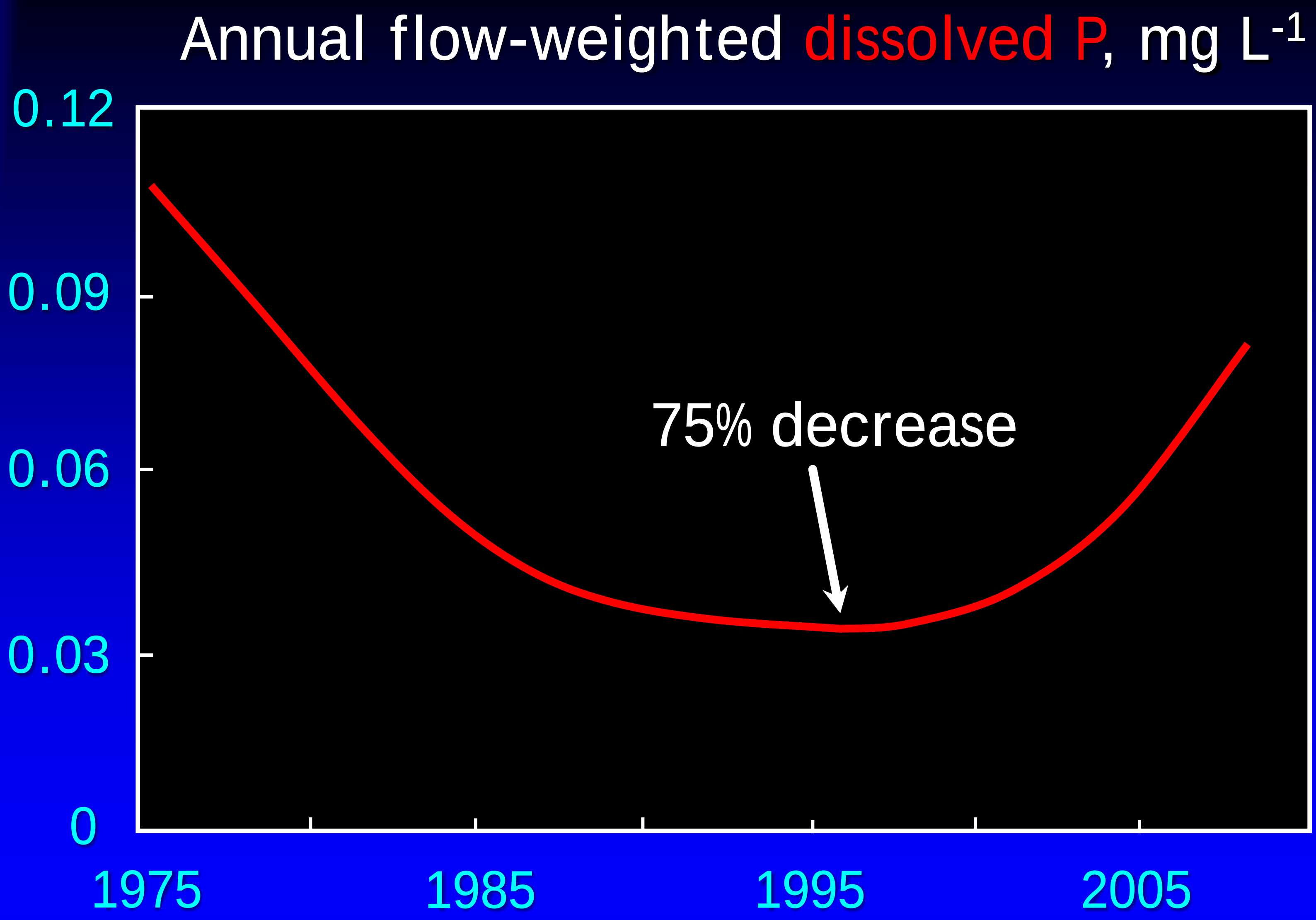
Richards et al., 2002

Trends in P – Maumee River

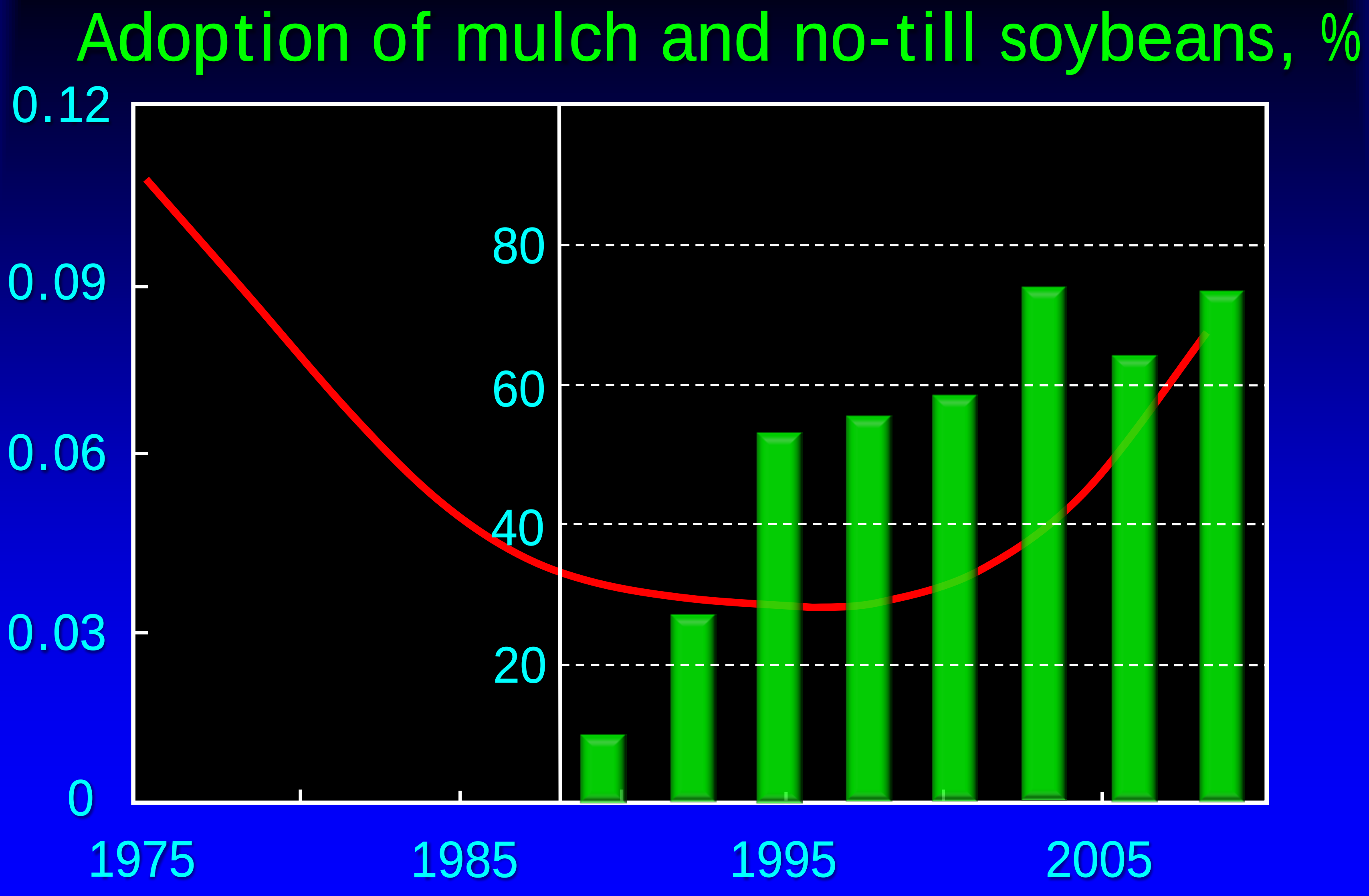


Dave Baker & Peter Richards, OH

Trends in P – Maumee River



Trends in P – Maumee River



Trends in P – Maumee River

0.12
0.09
0.06
0.03
0

Adaptive management may have reduced nutrient loss

- Incorporation of fertilizer and manure
- Winter cover crops
- Spring fertilization

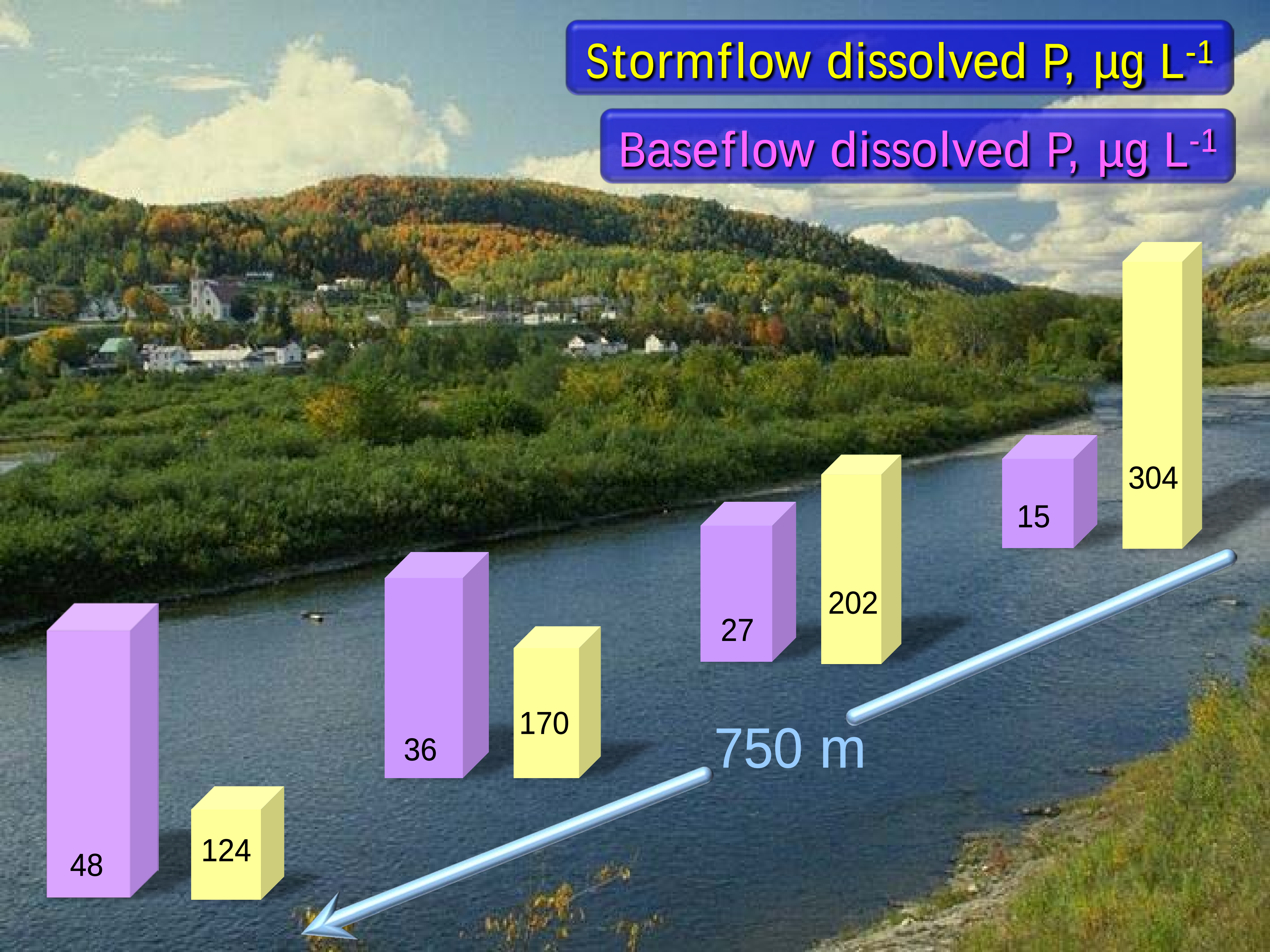
1975 1985 1995 2005

But the reality is …….

- For farmers
  - Spring workload is huge
  - Fertilizer usually costs more in spring
  - Less soil compaction on frozen ground

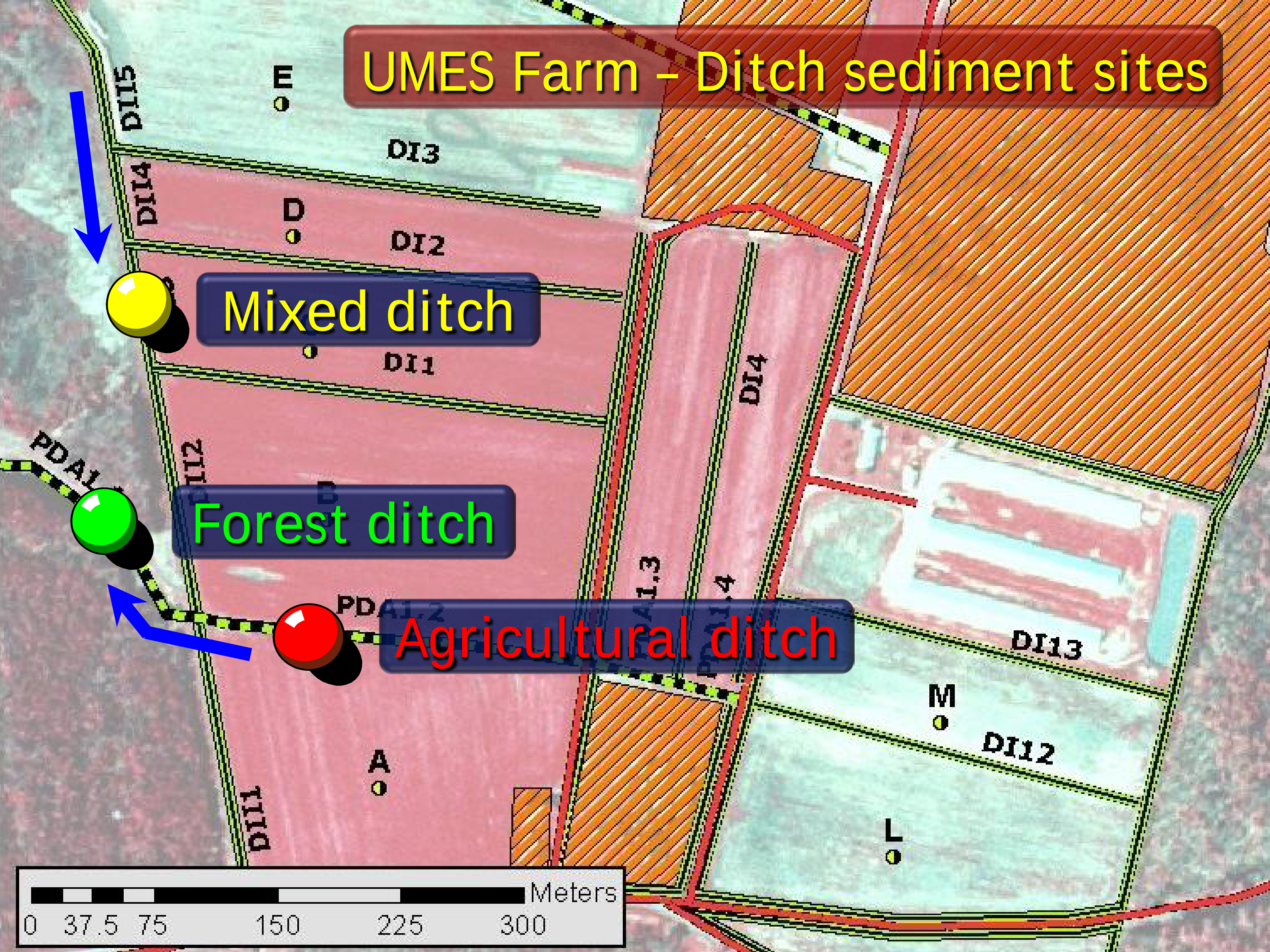


Fluvial interactions

Stormflow dissolved P, µg L-1
Baseflow dissolved P, µg L-1
48
124
36
170
27
202
15
304
750 m

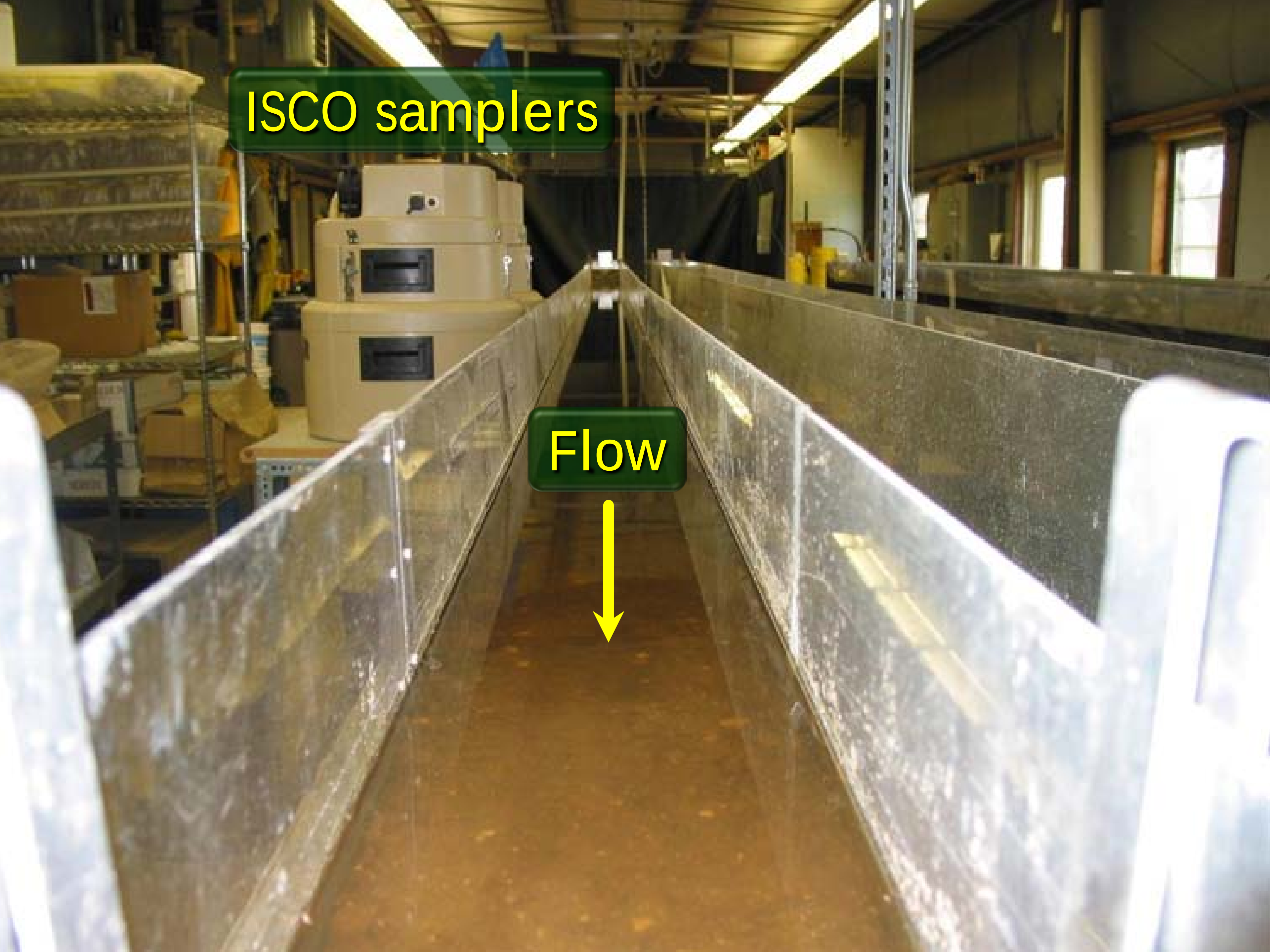
UMES Farm – Ditch sediment sites



Forest ditch

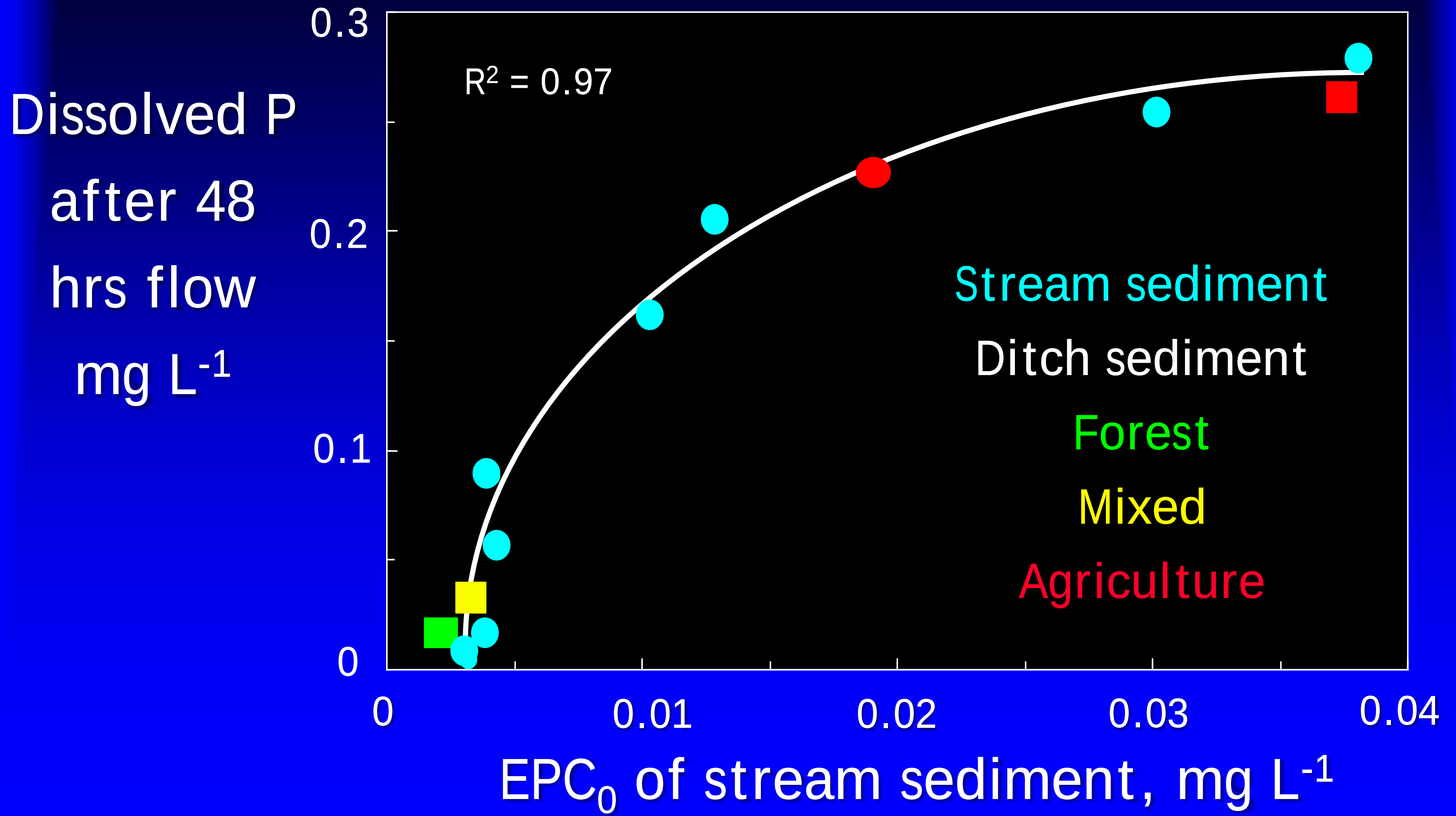
Mixed-use ditch

Agricultural ditch


ISCO samplers
Flow

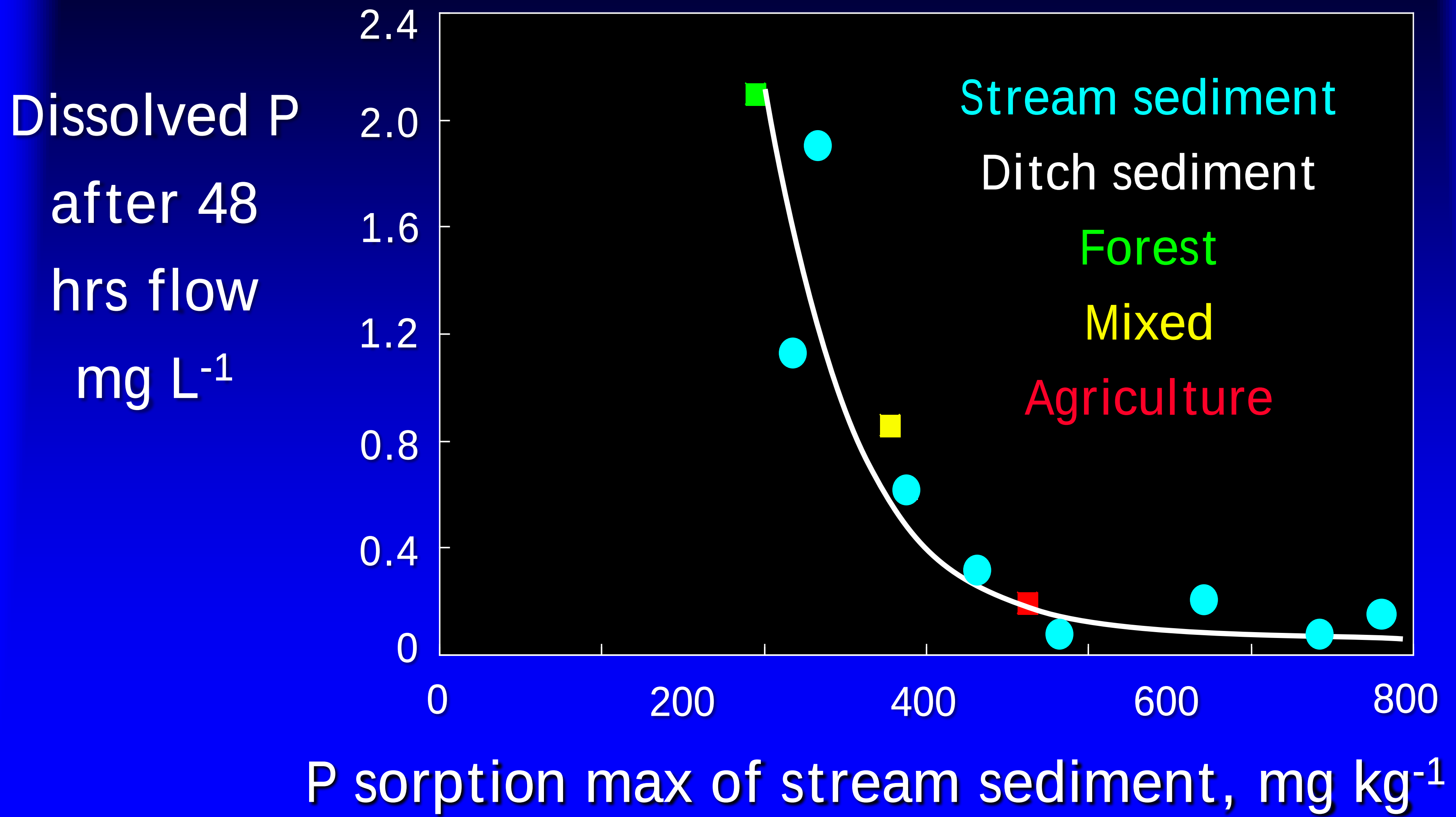
Sediment P release

Initial dissolved P was 0.005 mg L^{-1}



Sediment P uptake

Initial dissolved P was 2.60 mg L^{-1}

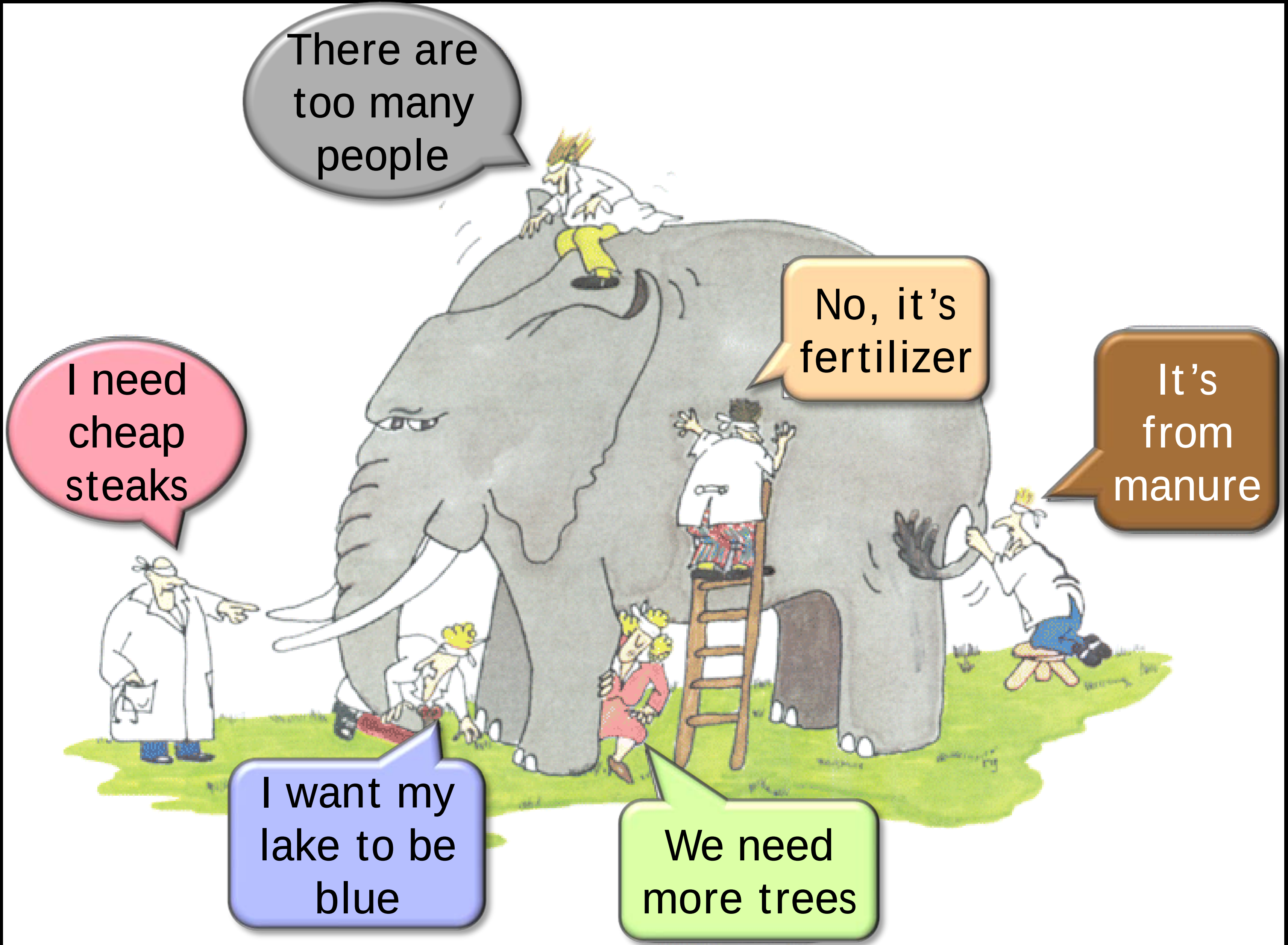


Legacy P in Greater Everglades Ecosystem

- ✓ 20 - 50 years @ 500 mt P yr^{-1} to Lake Okeechobee from the Basin
- ✓ 10 – 30 years @ 112 mt P yr^{-1} from Lake Okeechobee sediment
- ✓ 50 – 120 years @ 170 mt P yr^{-1} from Everglades Agric. Area surface soils to Stormwater Treat. Area

Reddy et al., 2011

Where do we go from here?



Herding elephants

- Public expect blue waters & green pastures
- With predicted population growth, 50 -100% increase in crops yields on same acreage
  - Create pressures to intensify
  - Pressures to maximize yields
  - Economics will remain a major driver

Herding elephants

- ✓ Complex site hydrology turns everything on it's head
- ✓ Explaining legacy effects to public
- ✓ Policy requires black & white guidelines
- ✓ Science tries to account for all variables and situations

In conclusion …

- ✓ Many sources of P in a watershed
- ✓ Hydrology can overwhelm P sources
- ✓ Drainage needed but increases source connectivity
- ✓ Fluvial processes can influence impacts of edge-of-field losses & time for receiving waters to respond
- ✓ Robust monitoring to document change

Thank you