Conservation trade-offs and legacy P

USDA's Legacy Phosphorus Assessment

Pete Kleinman, Lisa Duriancik, Mike White and Zach Simpson

USDA UNITED STATES DEPARTMENT OF AGRICULTURE

Agricultural Research Service and Natural Resources Conservation Service

Conservation trade offs

Well documented, not new, but always relevant


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The science and art of natural resource management for sustainability

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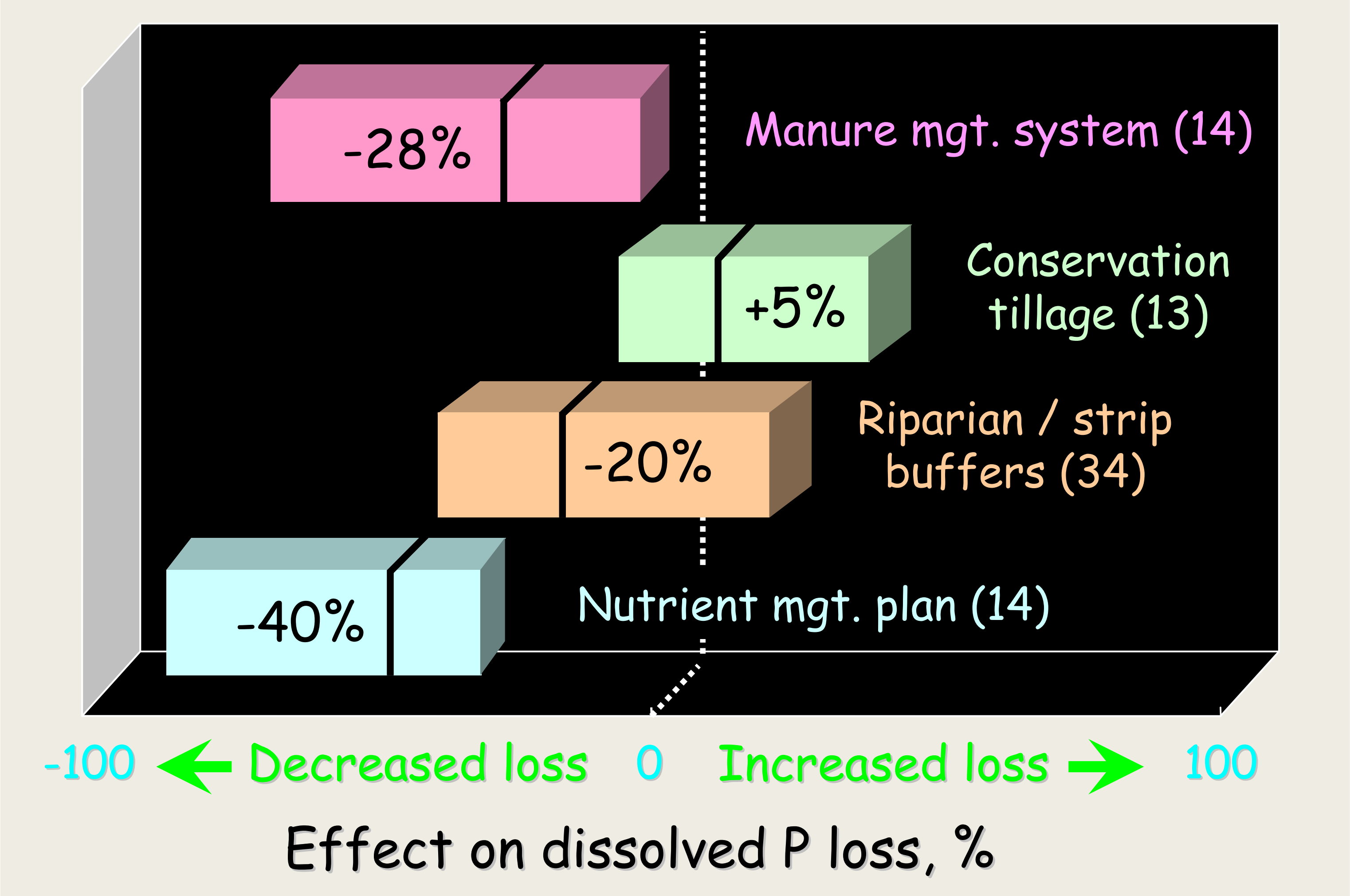
A tool for estimating best management practice effectiveness for phosphorus pollution control

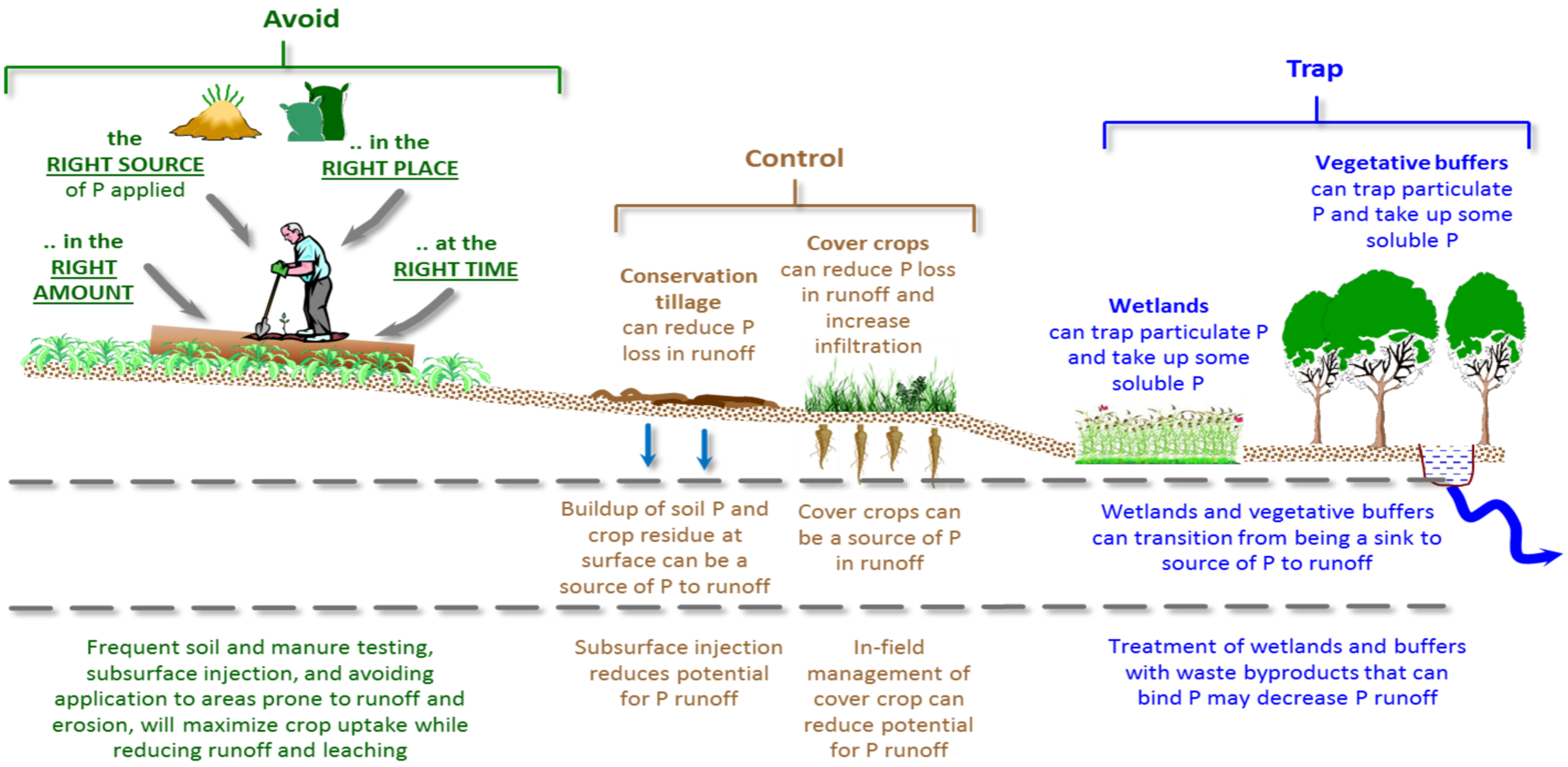
M.W. Gitau, W.J. Gburek and A.R. Jarrett

Journal of Soil and Water Conservation January 2005, 60 (1) 1-10;



Conservation 101

Conservation practices are managed as part of a system

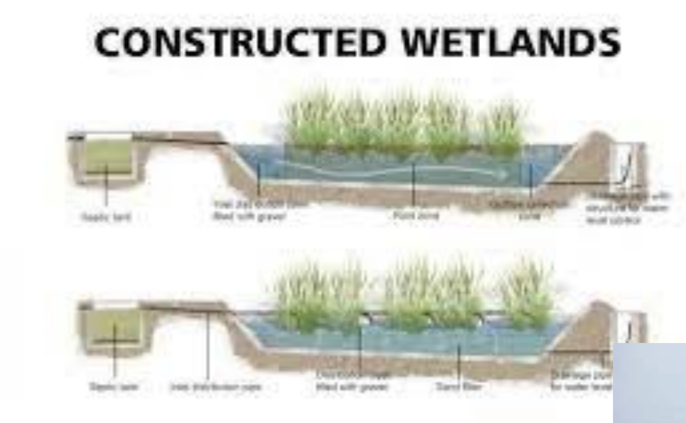


Conservation practices

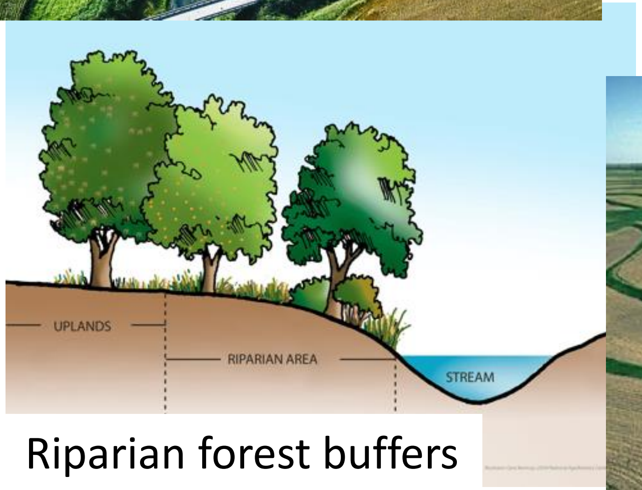
Traps

Vegetated filter strips

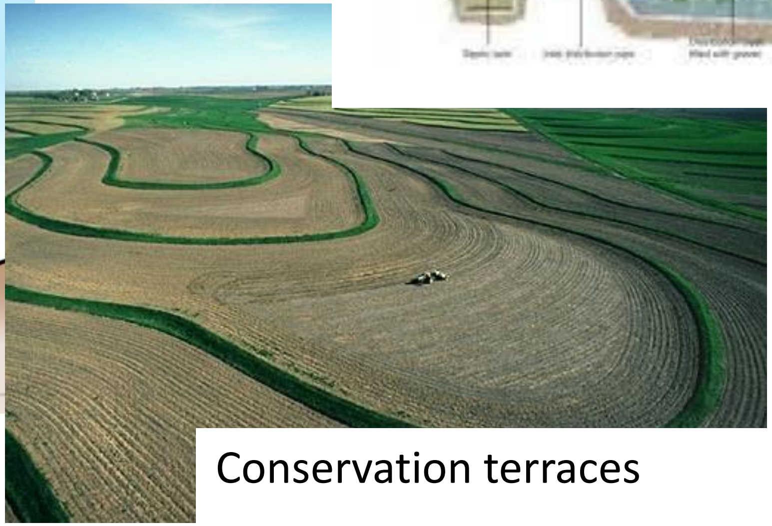
Grassed waterways



Restored wetlands



Riparian forest buffers



Conservation terraces

Water and sediment control basins

Conservation practices
Trapping processes

Impound runoff

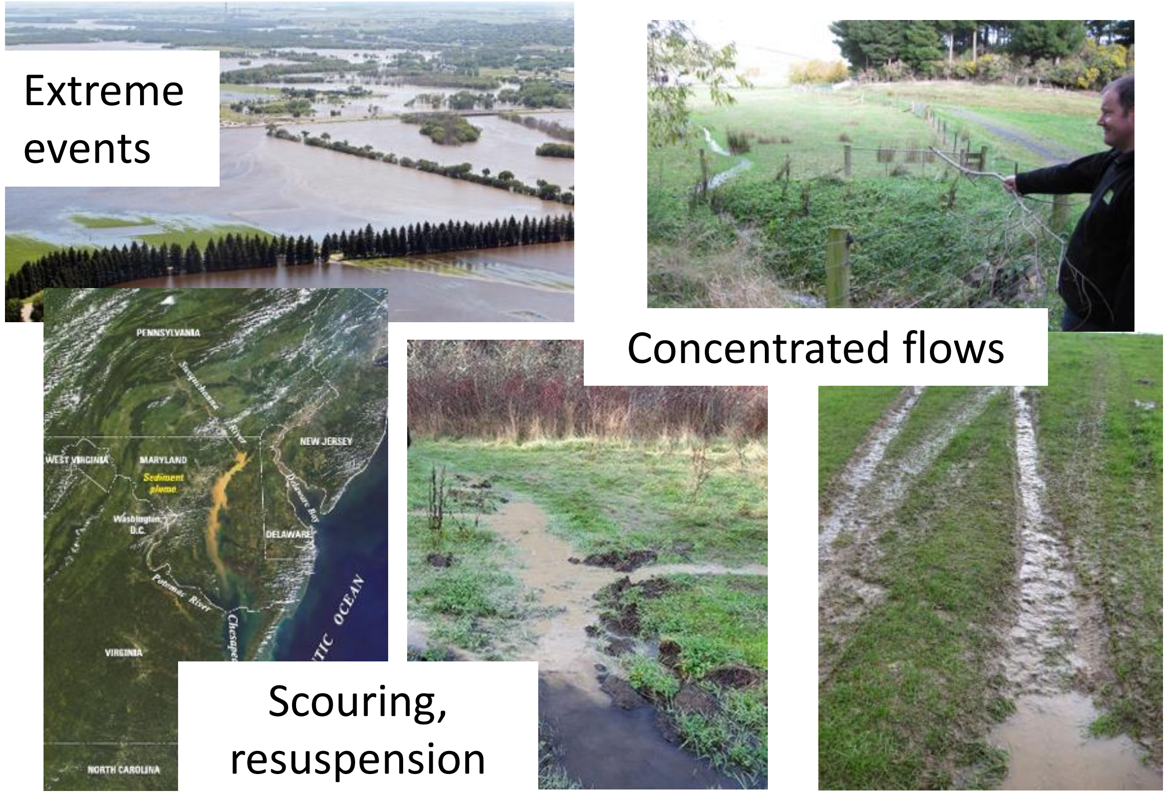
Diffuse flow
Promote infiltration

Sedimentation

Biological uptake,
soil processes

Trapping practices

Performance modifying processes



Dissolved P, dissolved P, dissolved P, dissolved P, dissolved P

Restored wetlands
P saturation, reductive dissolution, biological cycling

WETLANDS, Vol. 27, No. 4, December 2007, pp. 1025–1035

SOIL PHOSPHORUS RELEASE FROM A RESTORATION WETLAND, UPPER KLAMATH LAKE, OREGON

Allison R. Aldous[1], Christopher B. Craft[2], Carla J. Stevens[3], Matthew J. Barry[3], and Leslie B. Bach[1]
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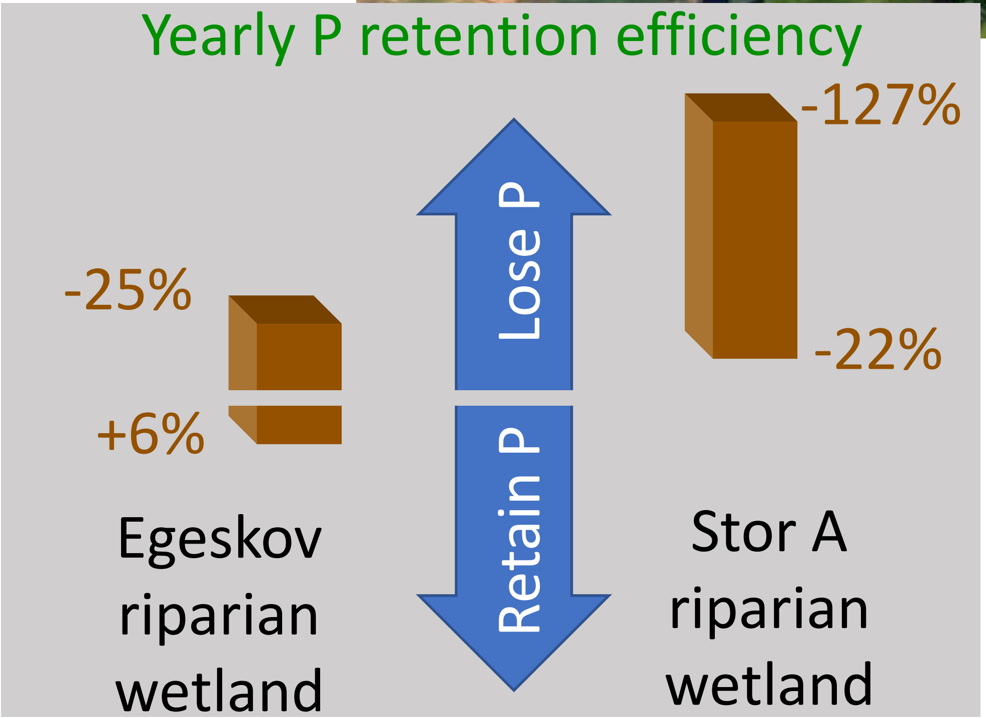
Contents lists available at SciVerse ScienceDirect
Ecological Engineering
journal homepage: www.elsevier.com/locate/ecoleng

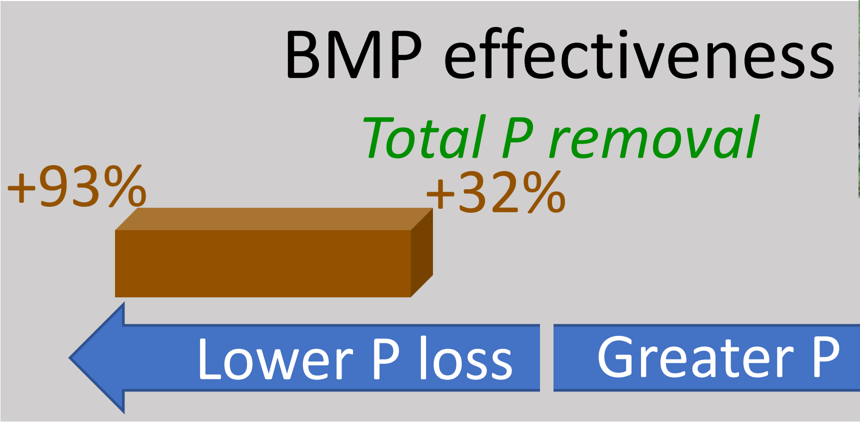
Low phosphorus release but high nitrogen removal in two restored riparian wetlands inundated with agricultural drainage water

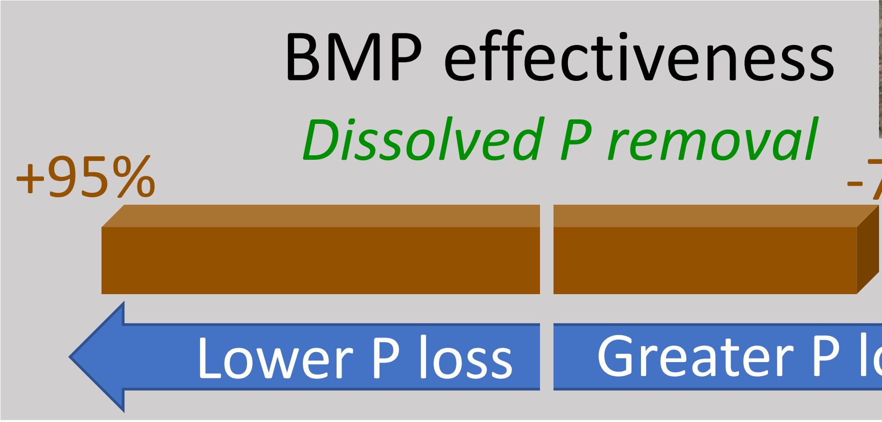
Carl Christian Hoffmann[a], Lisa Heiberg[b], Joachim Audet[a], Boris Schønfeldt[b,1], Ann Fuglsang[c,2], Brian Kronvang[a], Niels Bering Ovesen[a], Charlotte Kjaergaard[d], Hans Christian Bruun Hansen[e], Henning S. Jensen[b,*]

- Dissolved P release during wetland restoration



Vegetative buffers as a BMP for P
Global review





Journal of Environmental Quality

2009

Volume 38, Issue 5
September 2009
Pages 1942-1955

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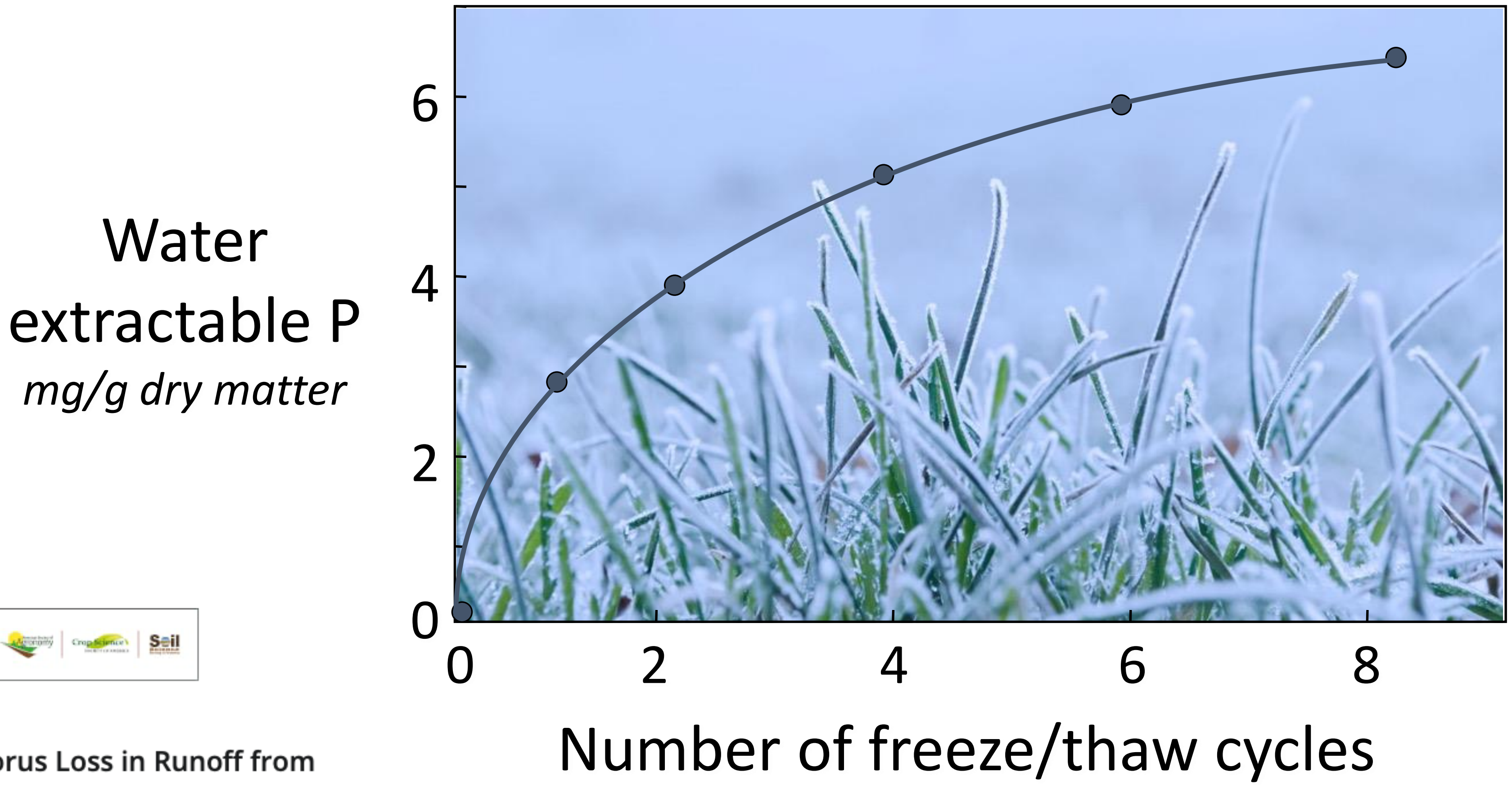
Phosphorus Retention in Riparian Buffers: Review of Their Efficiency

Carl Christian Hoffmann, Charlotte Kjaergaard, Jaana Uusi-Kämppä, Hans Christian Bruun Hansen, Brian Kronvang

First published: 01 September 2009 | https://doi.org/10.2134/jeq2008.0087 | Citations: 202

Vegetative buffers as a dissolved P source
Cold climates



Journal of Environmental Quality

Surface Water Quality | Full Access

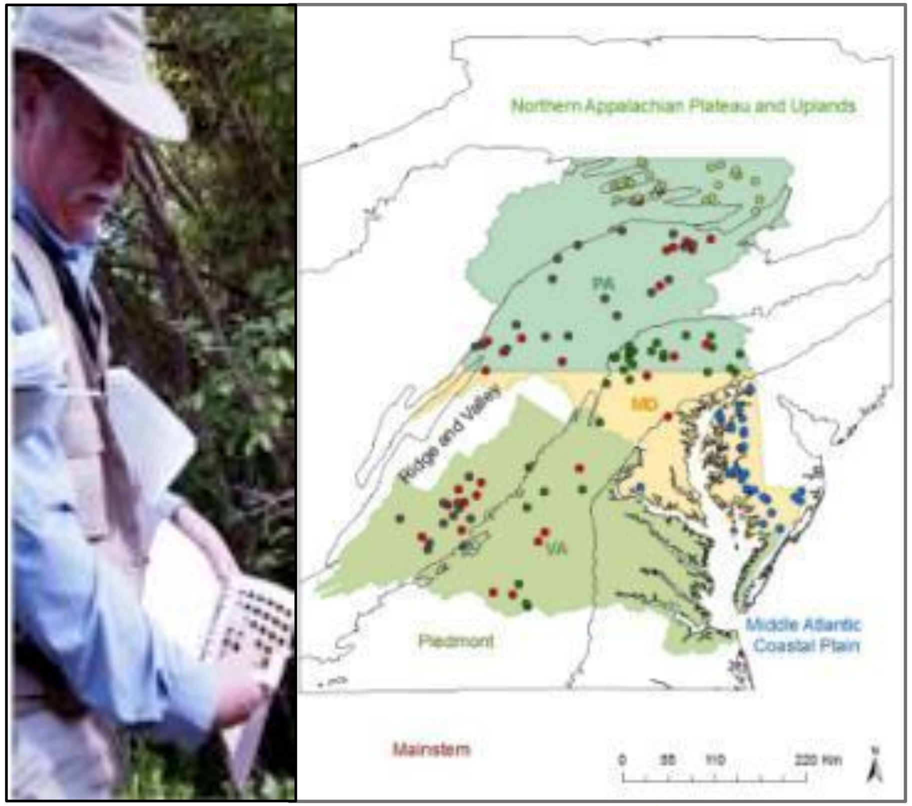
Freeze–Thaw Effects on Phosphorus Loss in Runoff from Manured and Catch-Cropped Soils

Marianne E. Bechmann, Peter J. A. Kleinman, Andrew N. Sharpley, Lou S. Saporito

First published: 01 November 2005 | https://doi.org/10.2134/jeq2004.0415 | Citations: 116

Vegetative buffers as a dissolved P source
A legacy of historical management

Chesapeake Survey



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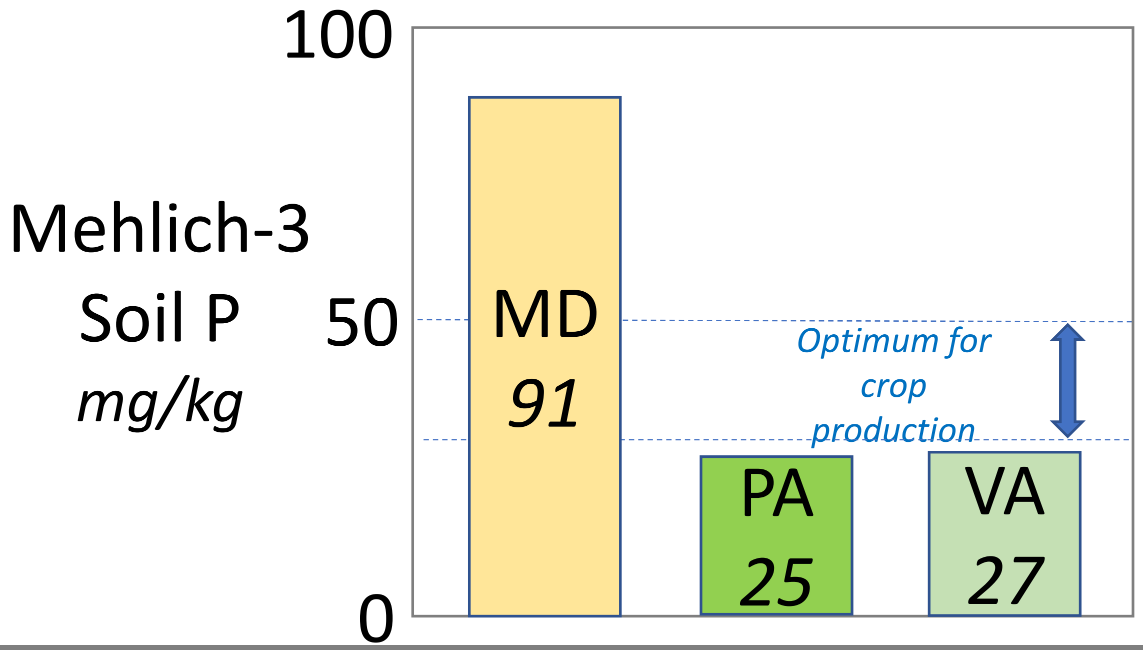
PennState



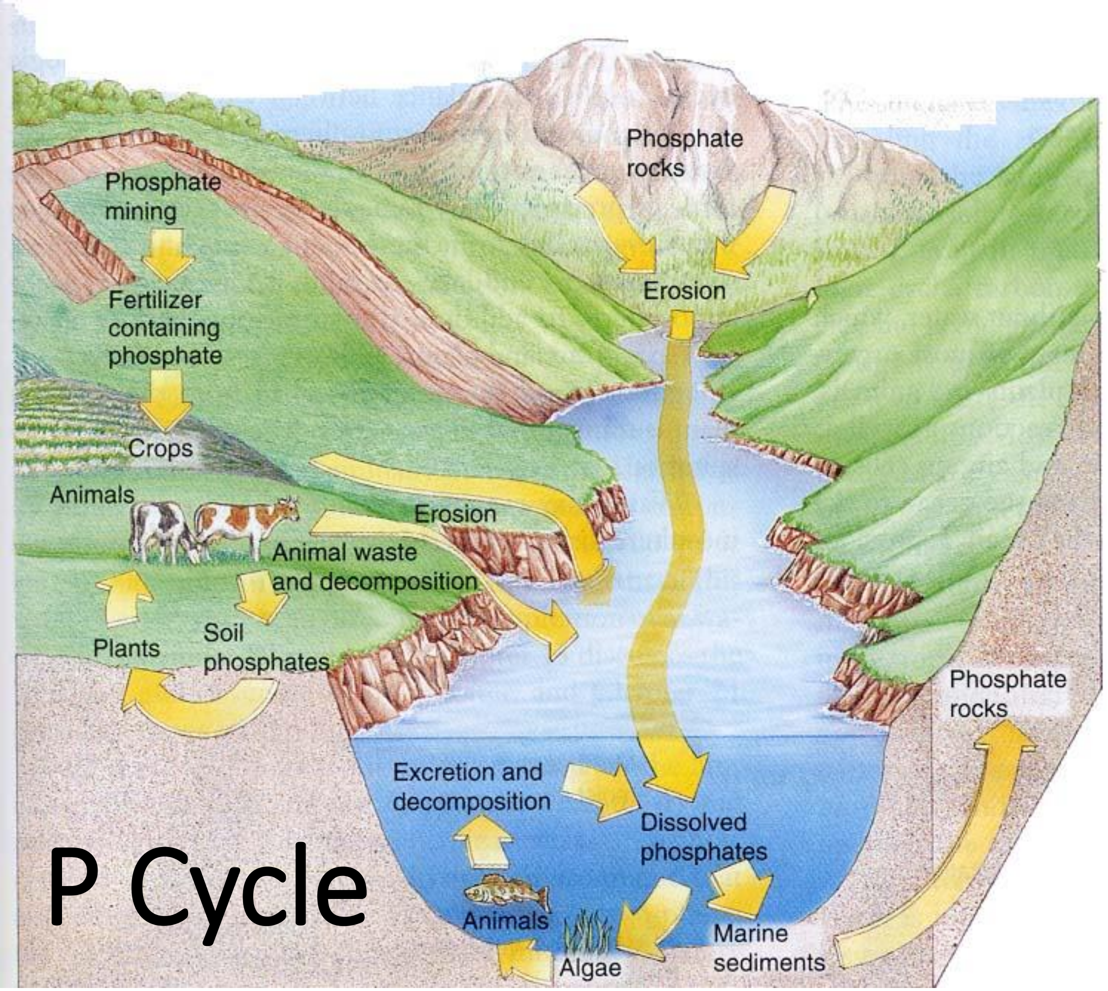
Soil P status of CP-22 buffers looks just like it did when the site was converted from production

Legacy P
What is it?

Residual P in the environment accumulated over decades/centuries of human activity

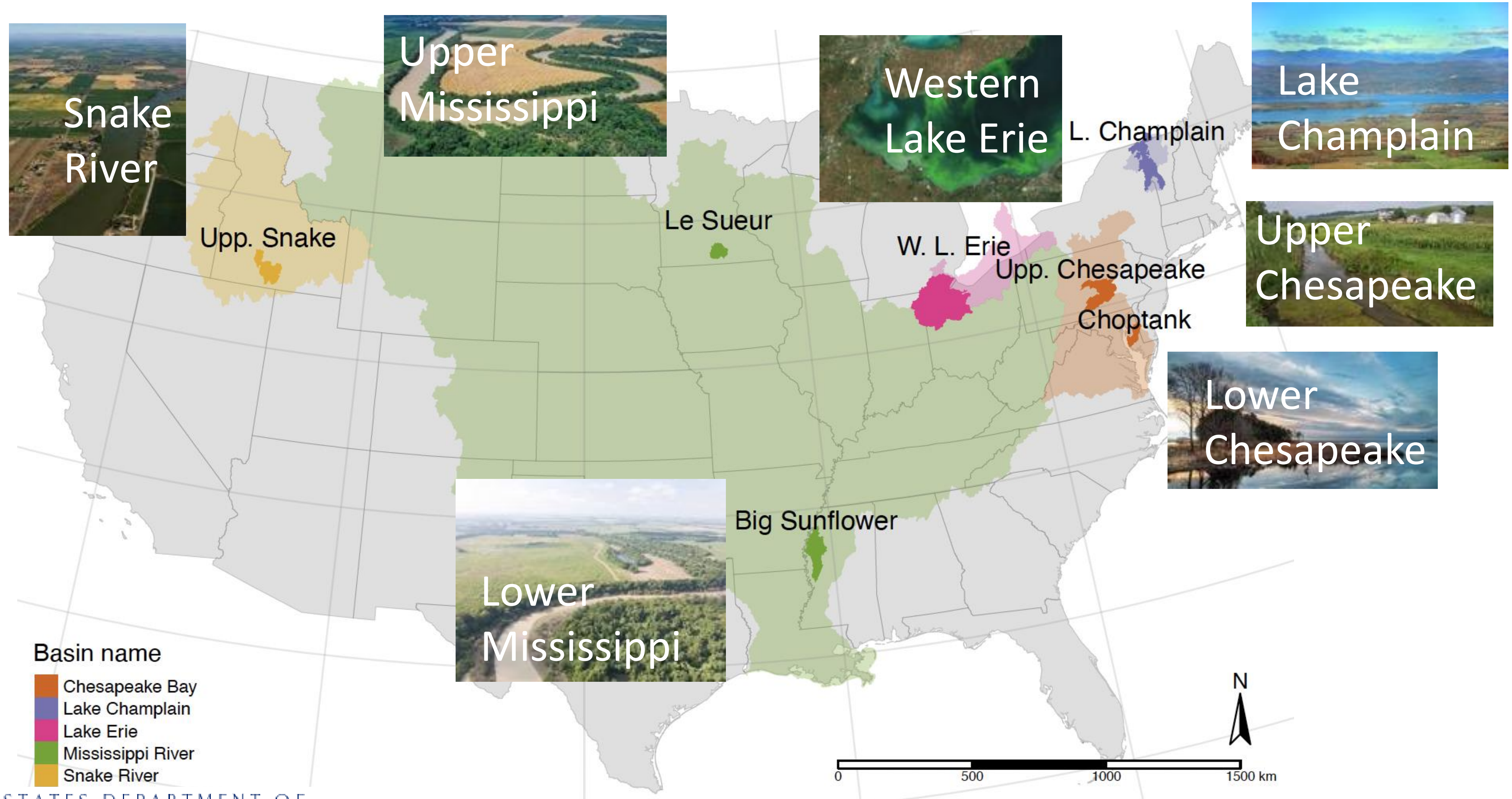
Where is it found?

- Soils
- Streams & Floodplains
- Small Impoundments
- Reservoirs
- Groundwater



USDA Legacy P Project:

Role of legacy P in watershed outcomes
Strategies to address legacy P



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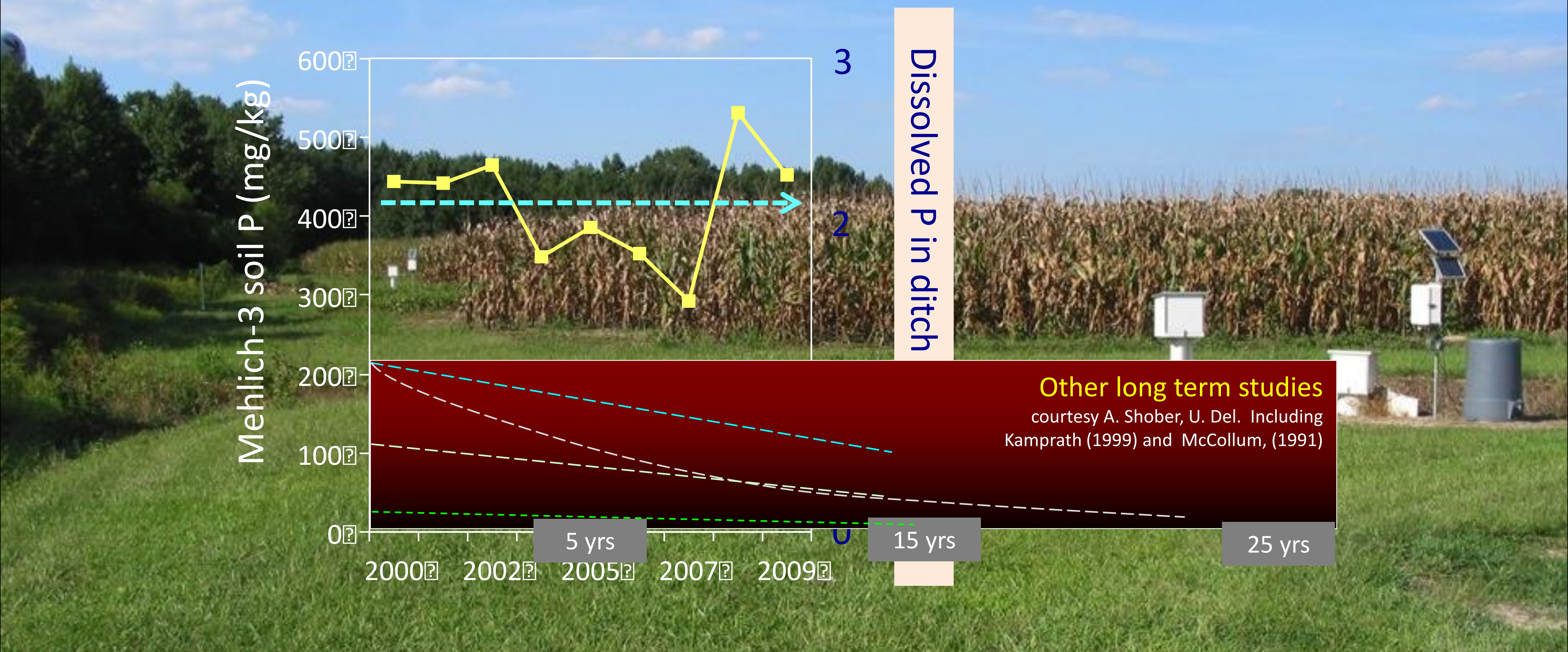
Conservation Effects Assessment Project

Legacy P – long term build up, long term decline

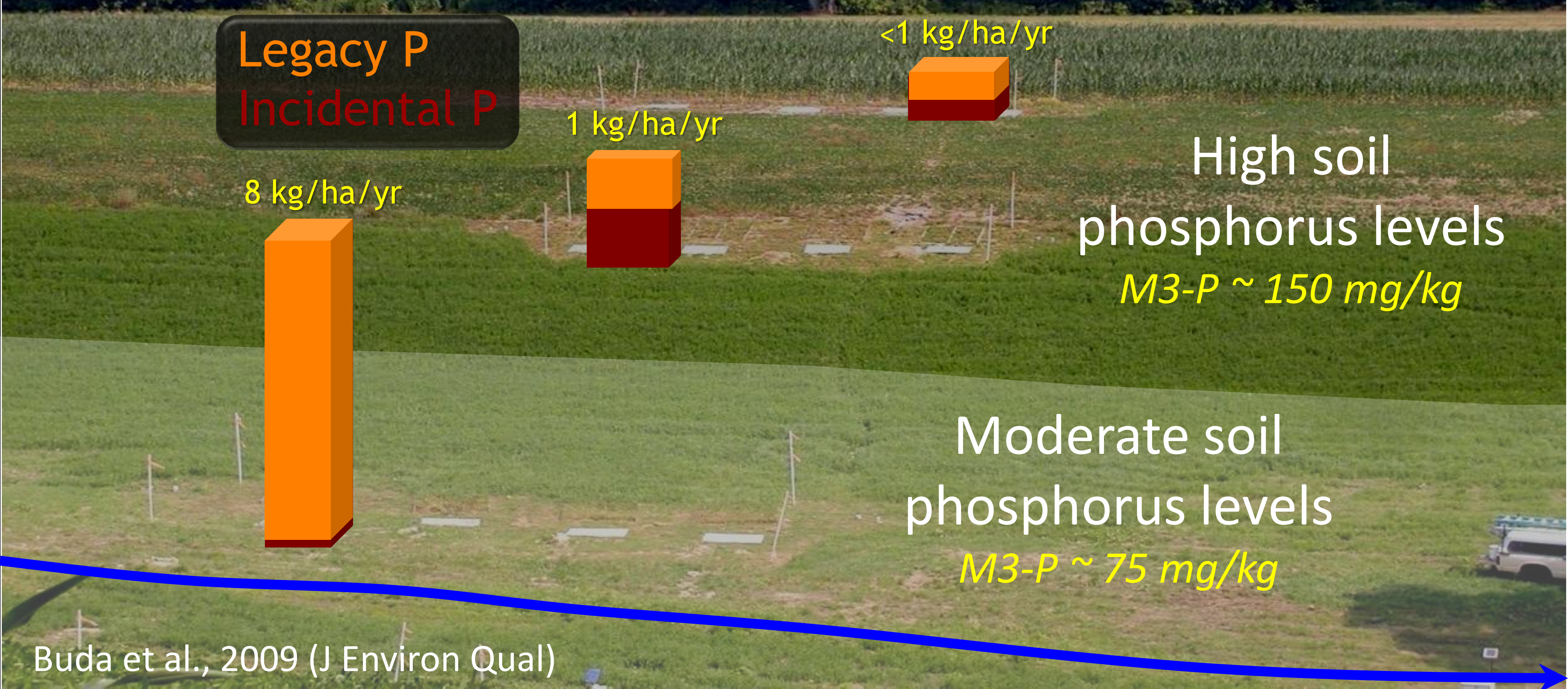
Manifest in soils, sediments and, ultimately, water



Kleinman et al., 2010 (Canadian J. Soil Science)

Legacy P

Can derive from unremarkable sources



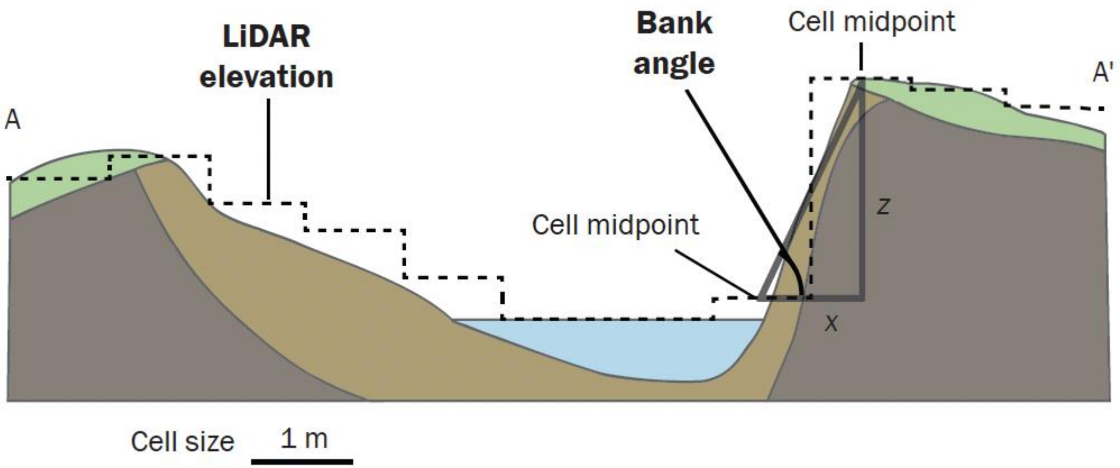
Buda et al., 2009 (J Environ Qual)

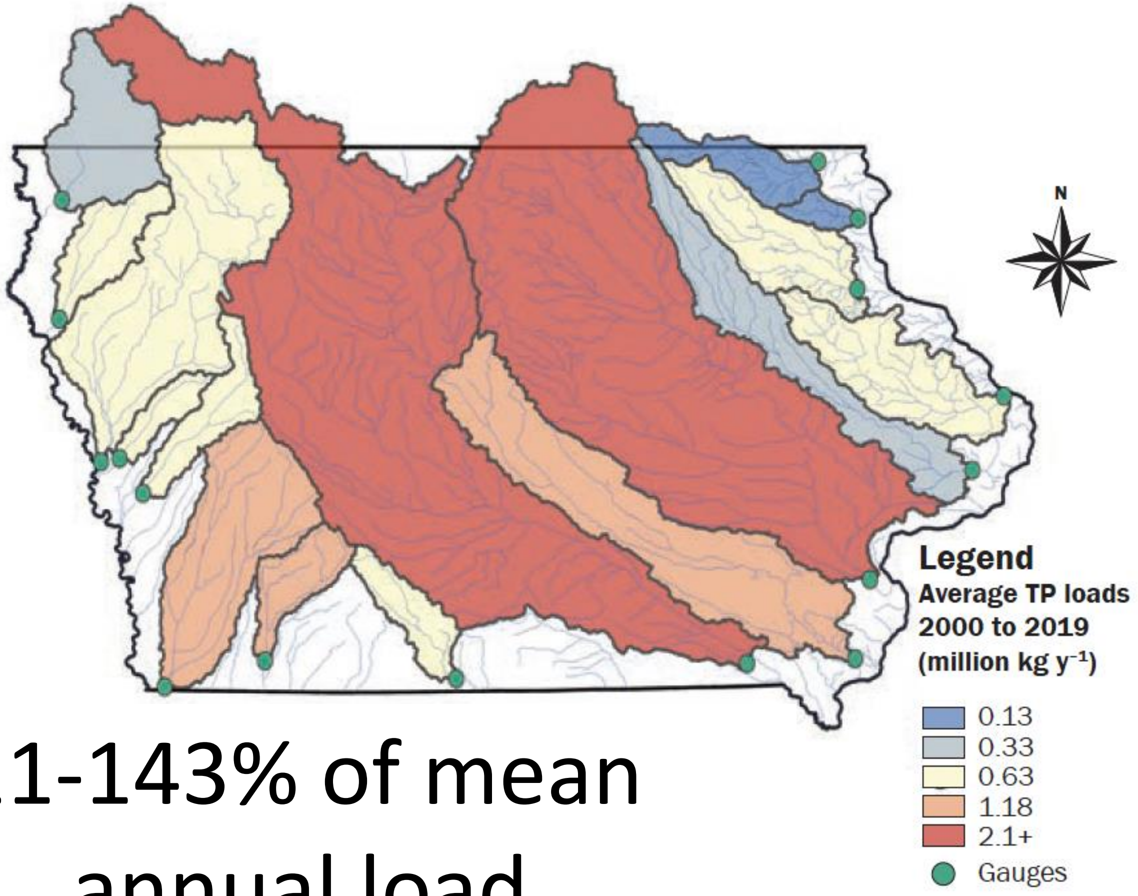
Legacy P in Streambanks

Iowa - nearly one third of total P loads

Contribution of streambanks to phosphorus export from Iowa

K.E. Schilling, T.M. Isenhart, C.F. Wolter, M.T. Streeter, and J.L. Kovar





11-143% of mean annual load

J. Soil and Water Conservation, 2022

USDA Legacy P Project

CEAP Watersheds

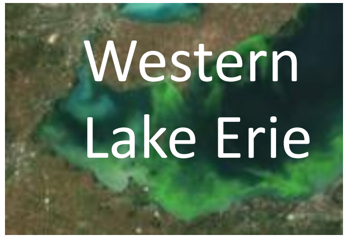
USDA Legacy P Project

Watershed highlights

Dairy farms, irrigation return flows

Streambank erosion, in-stream processes

Drainage management, sediment transport



Tile drains, 4R fertilizer management

Dairy farms, VSA hydrology, tile drains

Mixed livestock, in-stream process, VSA hydrology

Drainage ditches, riparian management, poultry farms

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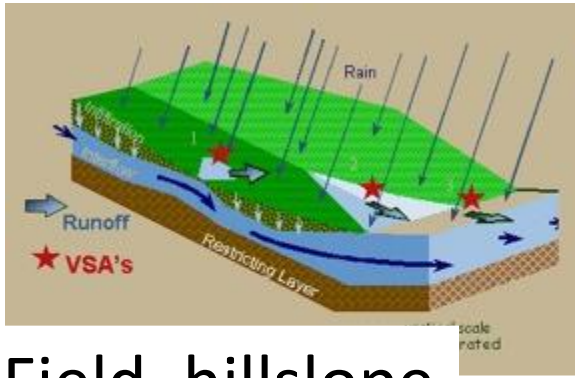
Scales of interpretation

Field characterization and data analysis

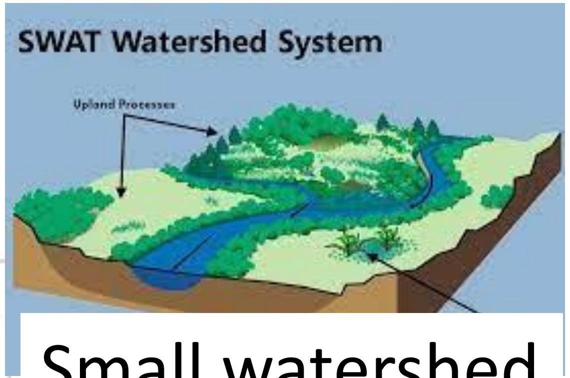
Edge of field

Small watershed

Simulation modeling



Field, hillslope



Small watershed

Large watershed

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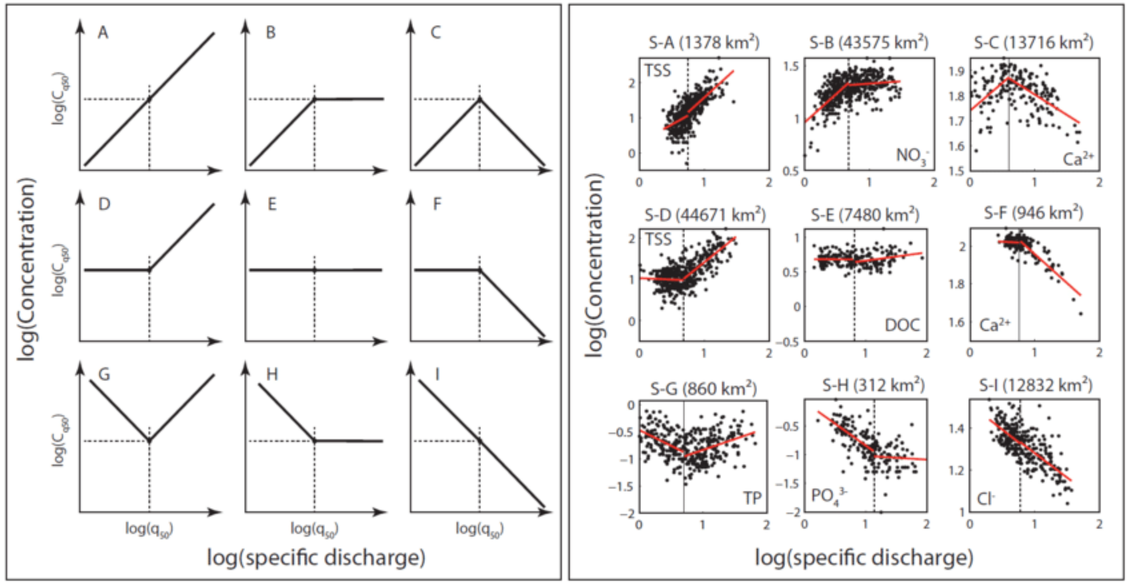
Legacy P assessment from long-term data

Long-term database

Edge of field

Small watershed

WRTDS and GAM analysis



CONCENTRATION/DISCHARGE AND MANAGEMENT RELATIONSHIPS

WRTDS (Weighted Regression on Time, Discharge and Season)
GAM (Generalized Additive Model)

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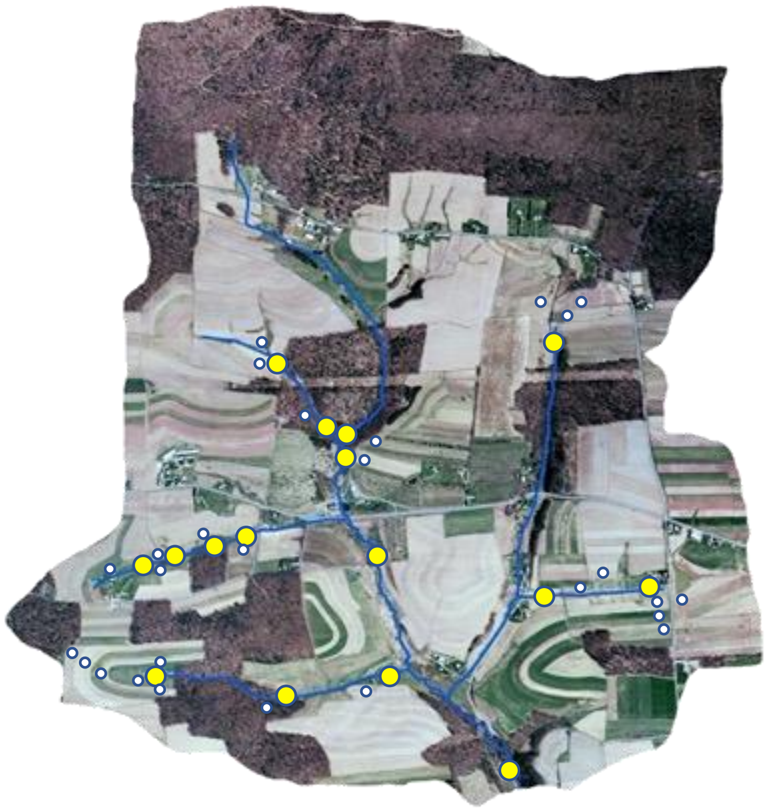
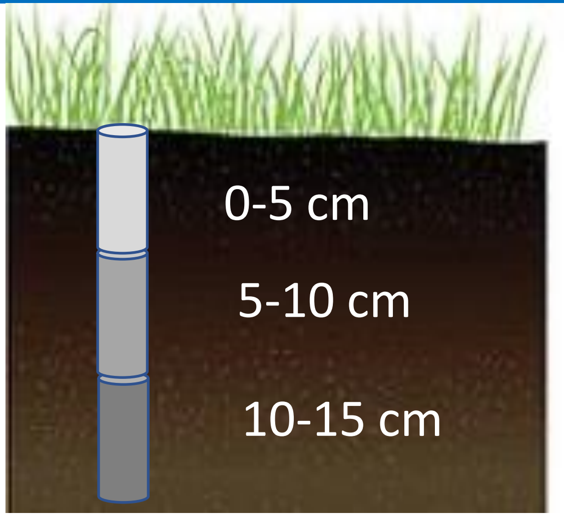
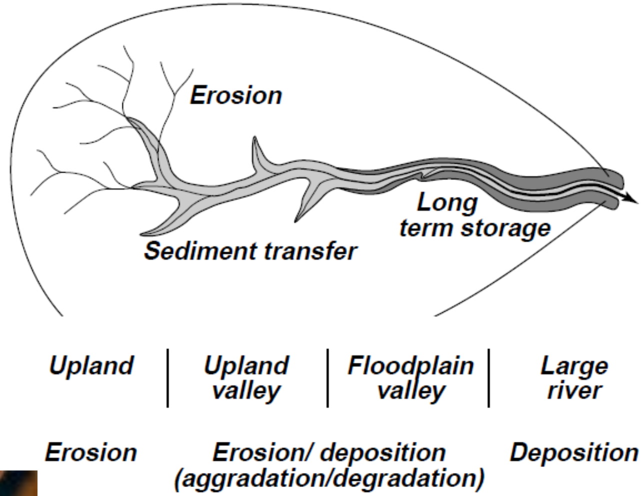
Coordinated site characterization

Locally-determined characterization strategies





Standard depths



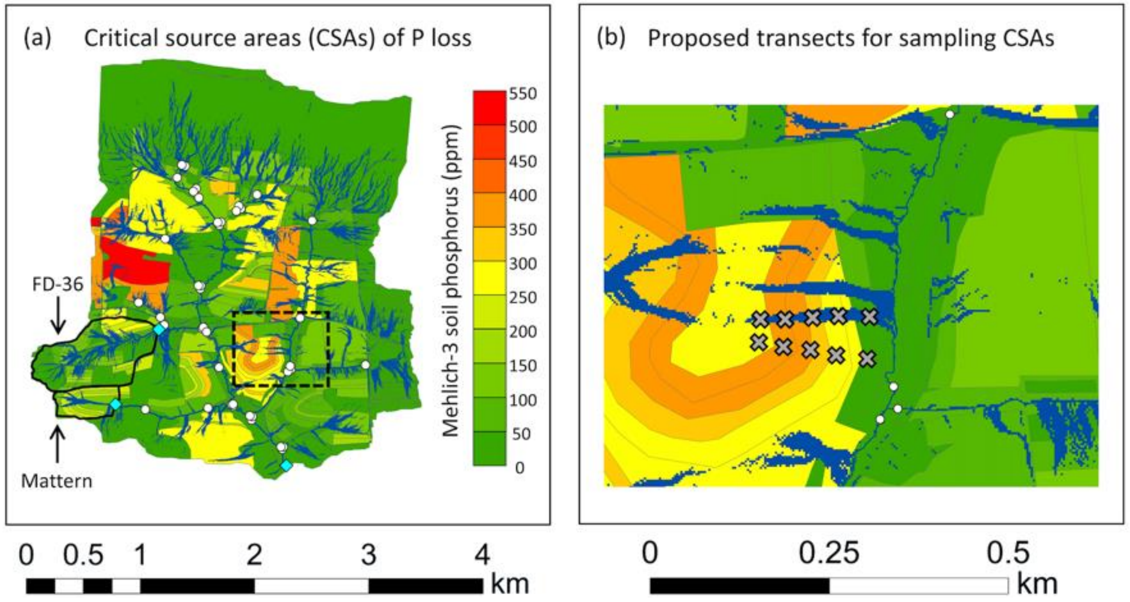
Common hypothesis testing

Standard sample handling protocols for soils and sediments

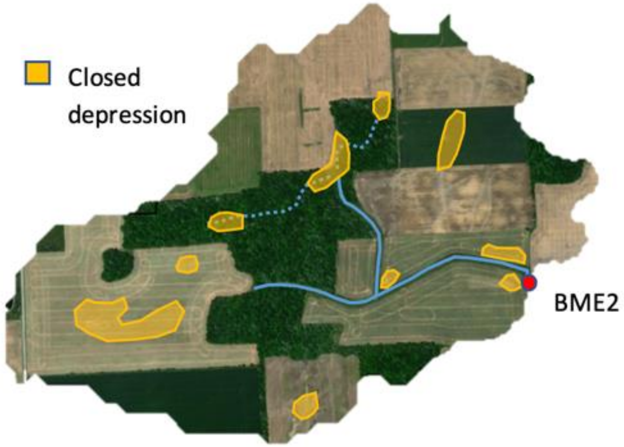
USDA Legacy P Project

Examples of hypothesis-driven sampling

Sloping landscapes - hydrologically active areas

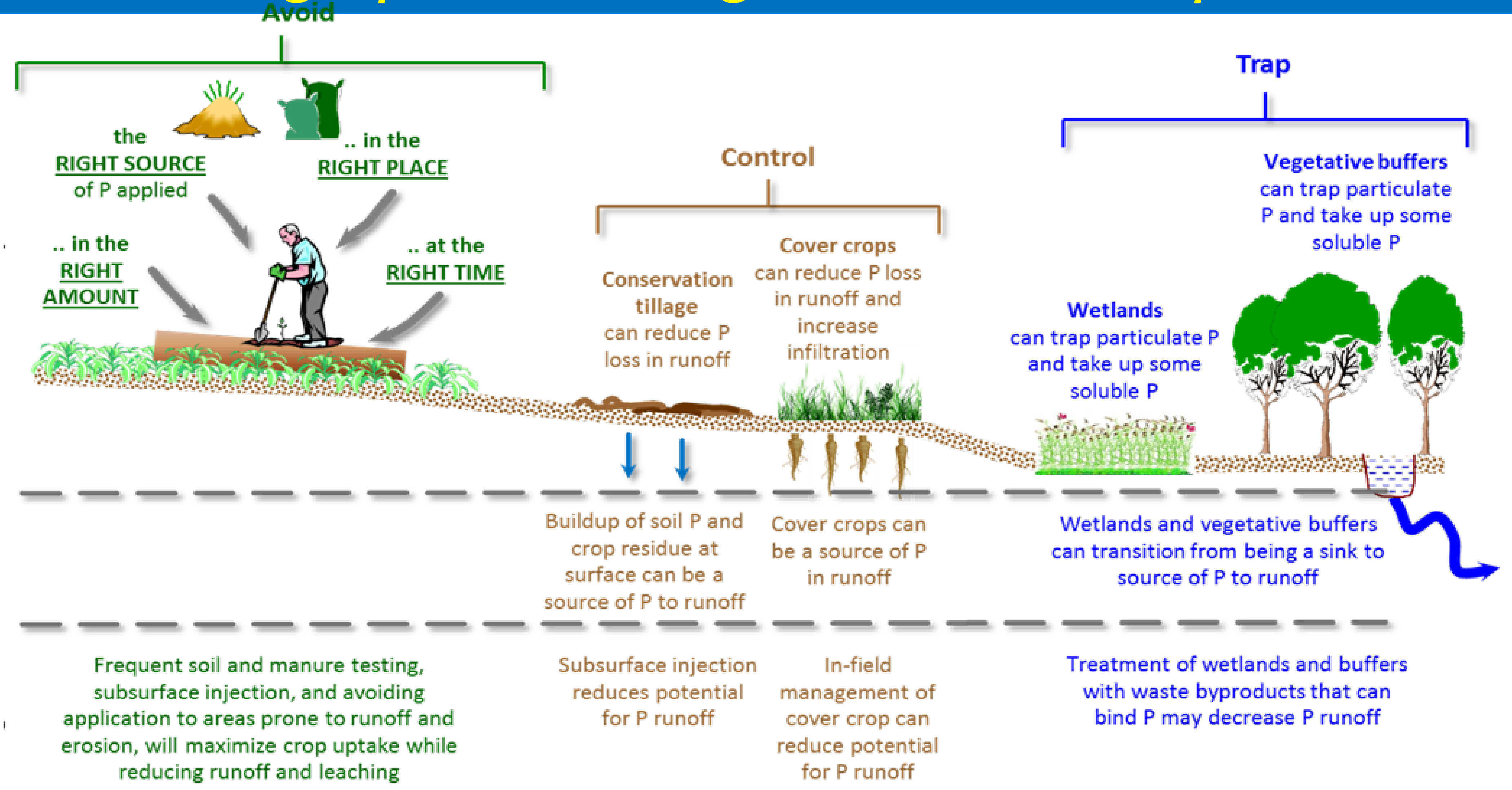


Flat landscapes – activation of legacy P with drainage



Legacy P Management Recommendations

Building upon existing conservation practices



Legacy P Mitigation Recommendations

Additional strategies

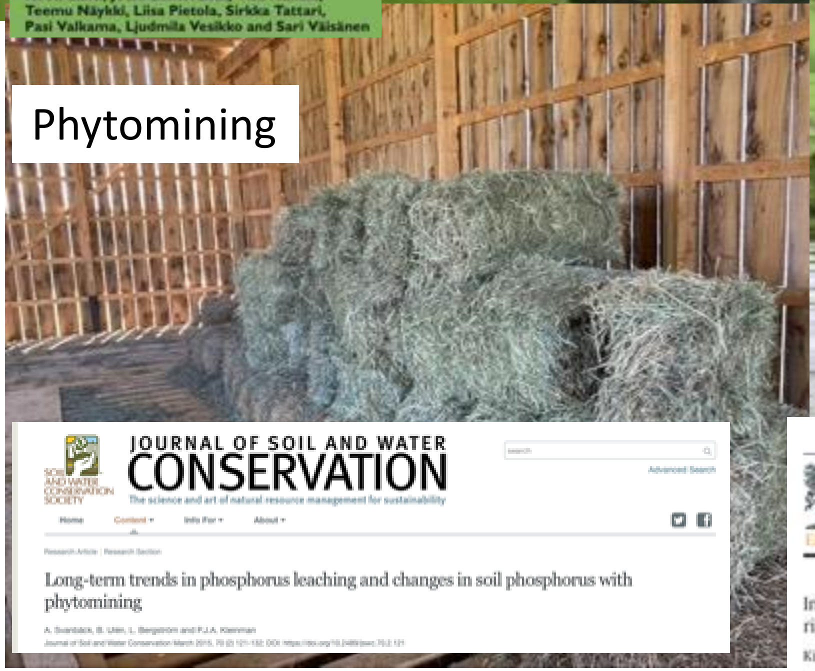
Soil amendments – build soil P ”sorption” capacity

THE FINNISH ENVIRONMENT 33 | 2011

The effect of gypsum on phosphorus losses at the catchment scale

Petri Ekholm, Elina Jaakkola, Mikko Kiirikki, Kirsti Lahti, Jouni Lehtoranta, Visa Mäkelä, Teemu Näykki, Liisa Pietola, Sirkka Tattari, Pasi Valkama, Ljudmila Vesikko and Sari Väisänen

Phytomining



JOURNAL OF SOIL AND WATER CONSERVATION

The science and art of natural resource management for sustainability

Long-term trends in phosphorus leaching and changes in soil phosphorus with phytomining

Clean outs

Science of the Total Environment

Impact of sediment dredging on sediment phosphorus flux in a restored riparian wetland

Kimberly A. Oldenborg, Alan D. Steinman

United States Department of Agriculture Natural Resources Conservation Service

Systems Approach to Nutrients: Avoiding, Controlling, Trapping (ACT)

Avoiding
- Nutrient management
  - Rate, Timing, Form, Method

Controlling
- Residue and tillage management

Trapping
- Buffers
- Wetlands designed for nutrient removal

Stacked practices

Chad J. Penn
James M. Bowen

Design and Construction of Phosphorus Removal Structures for Improving Water Quality

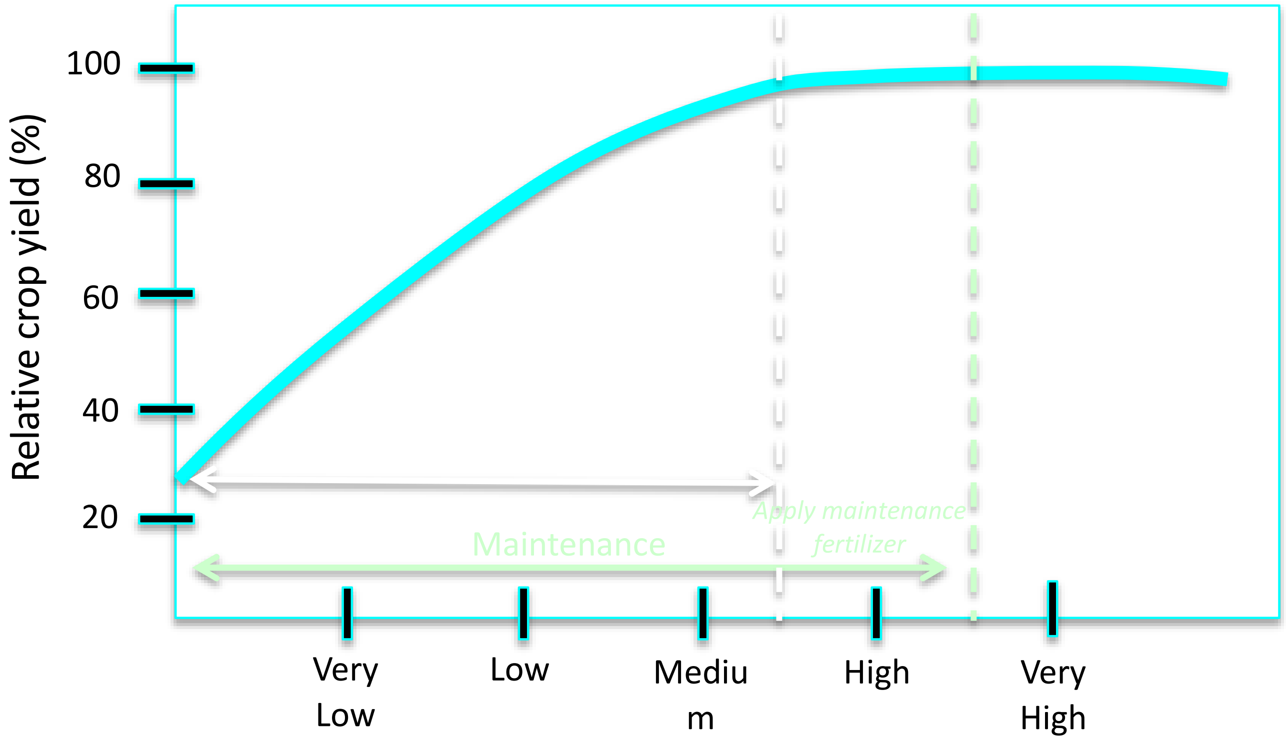
Springer

Engineered filters

Legacy P Avoidance Recommendations

Tackling the foundation of fertilizer management

"Build up and maintain" vs "Sufficiency"



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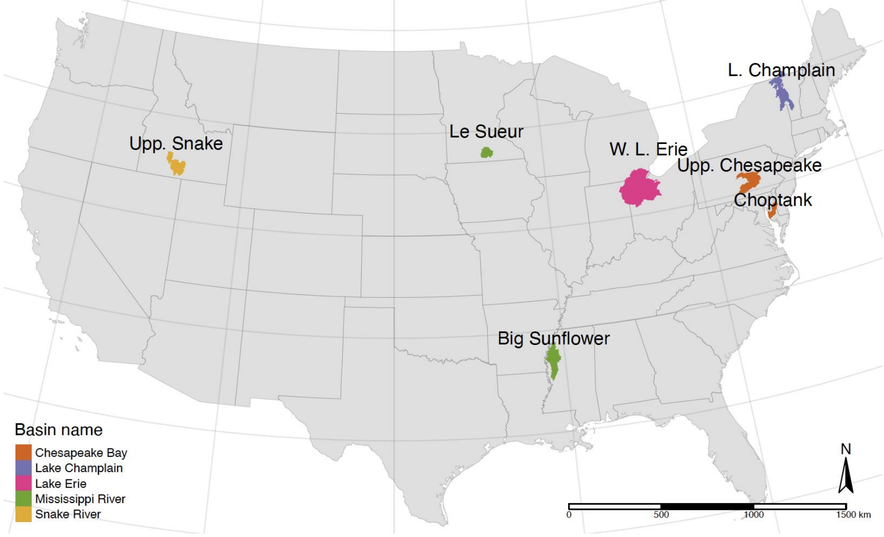
http://www.soiltestfrst.org

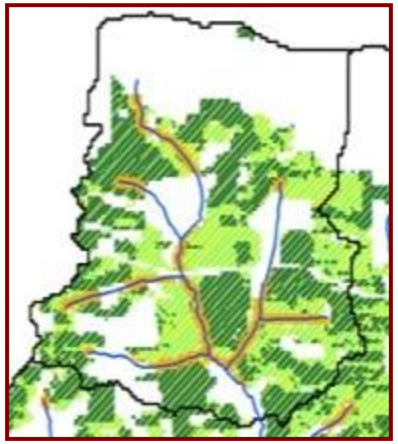
Legacy P watershed modeling

Extrapolate management recommendations



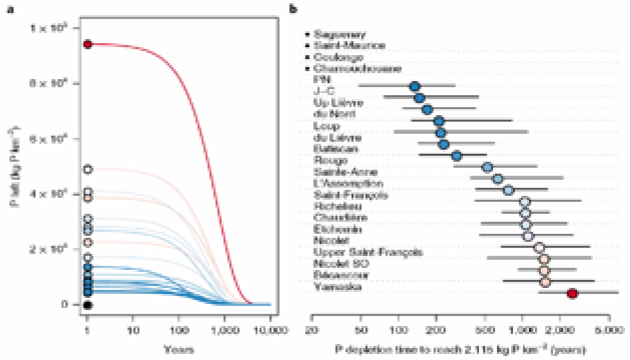
Soil & Water Assessment Tool SWAT

Can local strategies impact regional outcomes?



P legacies - Time lags in recovery

✓ Return to baseline conditions widely variable - decades to millennia



(Goyette et al 2018. Nature Geo.)

Sharpley etal 2013. J.Env. Qual. (review) **(~50 yrs)**

McDowell et al 2020. front. In Env. Sc. **(~50 yrs)**

Chen et al 2019. Biogeoch. **(~500 yrs)**

Carpenter 2005. PNAS. **(~1000 yrs)**

How long to recovery?

USDA Legacy P Project

USDA-ARS

- ✓ peter.kleinman@usda.gov

USDA-NRCS

- ✓ lisa.duriancik@usda.gov

- ✓ https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/ws/?cid=nrcseprd1890821