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2015 Update Mtg: Processes of P loss in Cranberry Floods

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Phosphorus Loss in Cranberry
Floodwaters
State of The Science

Casey D. Kennedy
USDA-ARS



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BREAKING NEWS

\$10 million prize offered for reducing phosphorous in Kissimmee River

SEPTEMBER 23, 2014

By GEORGE BENNETT / Palm Beach Post

An anonymous donor is offering a \$10 million prize through the Everglades Foundation for a person or team who can develop a way to remove excess phosphorus from water supplies and recycle it to boost worldwide food production.

The nonprofit Everglades Foundation announced the prize on Monday, calling it the most ambitious effort in its 20-year history.

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Behind Toledo's Water Crisis, a Long-Troubled Lake Erie

By MICHAEL WINES AUG. 4, 2014

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TOLEDO, Ohio — It took a serendipitous slug of toxins and the loss of drinking water for a half-million residents to bring home what scientists and government officials in this part of the country have been saying for years: Lake Erie is in trouble, and getting worse by the year.

Flooded by tides of phosphorus washed from fertilized farms, cattle feedlots and leaky septic systems, the most intensely developed of the Great Lakes is [increasingly being choked each summer by thick mats of algae](#), much of it poisonous. What plagues Toledo and, experts say, potentially all 11 million lakeside residents, is increasingly a serious problem across the United States.

But while there is talk of action — and particularly in Ohio, real action — there also is



Algae-infested water from Lake Erie on Monday washed up onshore at Maumee Bay State Park in Oregon, Ohio, near Toledo. Joshua Lott for The New York Times

Behind Toledo's Water Crisis, a Long-Troubled Lake Erie

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Poisonous algae are found in polluted inland lakes from Minnesota to Nebraska to California, and even in the glacial-era kettle ponds of Cape Cod in Massachusetts.

Great Lakes is [increasingly being choked each summer by thick mats of algae](#), much of it poisonous. What plagues Toledo and, experts say, potentially all 11 million lakeside residents, is increasingly a serious problem across the United States.

But while there is talk of action — and particularly in Ohio, real action — there also is

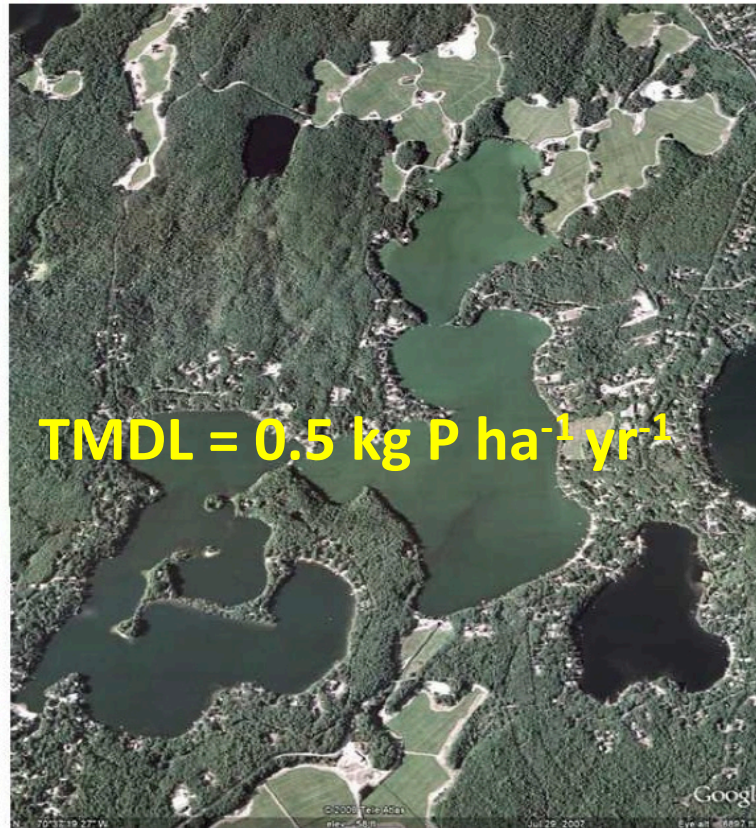


Algae-infested water from Lake Erie on Monday washed up onshore at Maumee Bay State Park in Oregon, Ohio, near Toledo. Joshua Lott for The New York Times

Monponsett Pond



**Final Total Maximum Daily Load of Total Phosphorus for
White Island Pond, Plymouth/Wareham, MA**



**COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
IAN A BOWLES, SECRETARY
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
LAURIE BURT, COMMISSIONER
BUREAU OF RESOURCE PROTECTION
GLENN HAAS, ACTING ASSISTANT COMMISSIONER**



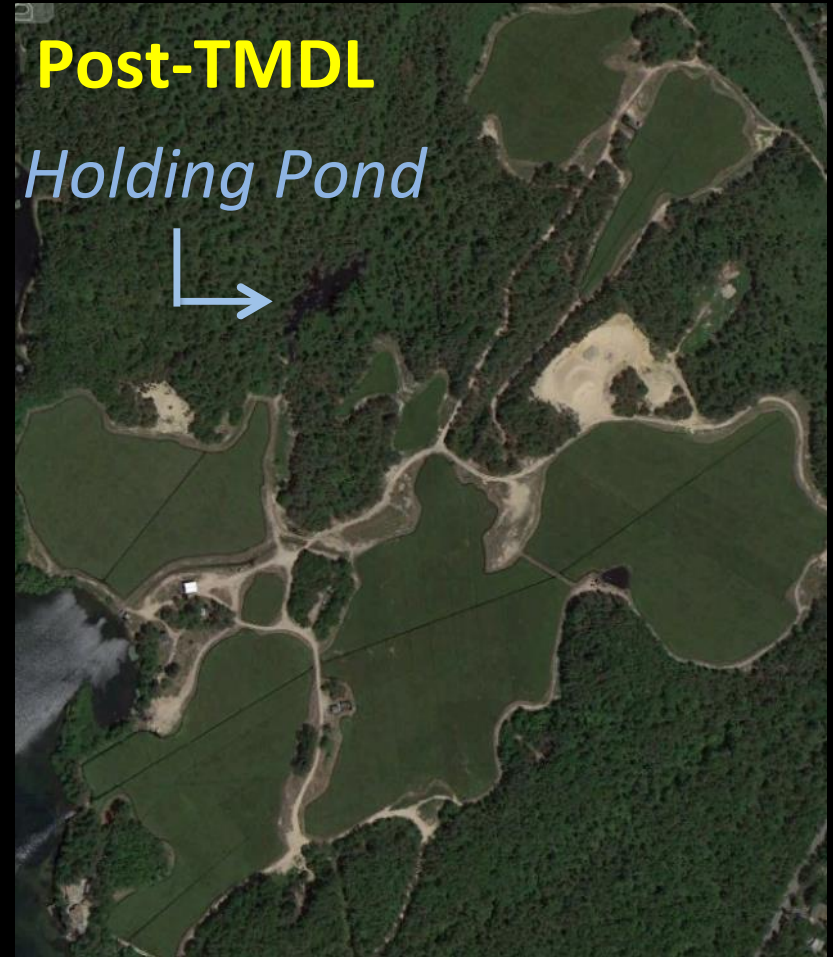
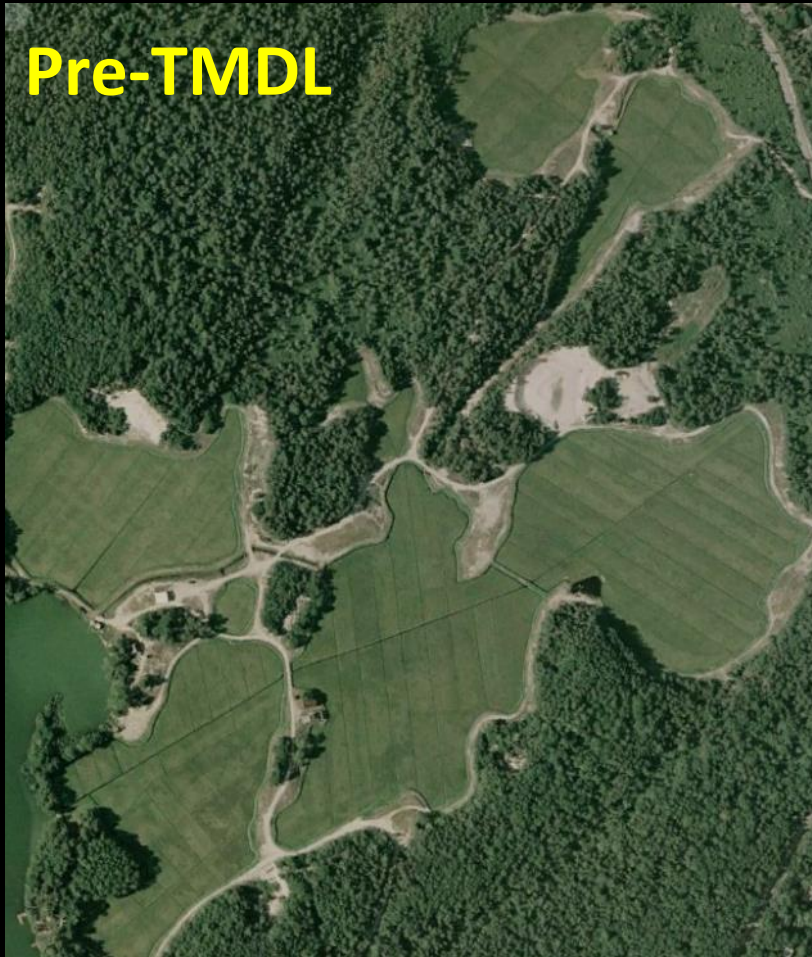
How Much Is 0.5 kg P ha^{-1} ?

- Phosphate in precipitation is $\sim 0.09 \text{ mg/L}$
(Valiela and Costa 1998, Valiela et al. 1978)
- Mean annual precipitation is 128 cm
- So... Precipitation equals $1.1 \text{ kg P ha}^{-1} \text{ yr}^{-1}$
(twice the White Island TMDL!)
- And... Precipitation only accounts for 50%
(max) of total water inputs
- And...TMDL's are NOT net losses, export only

Option 1: Bog -> Holding Pond



Option 2: Build Holding Pond



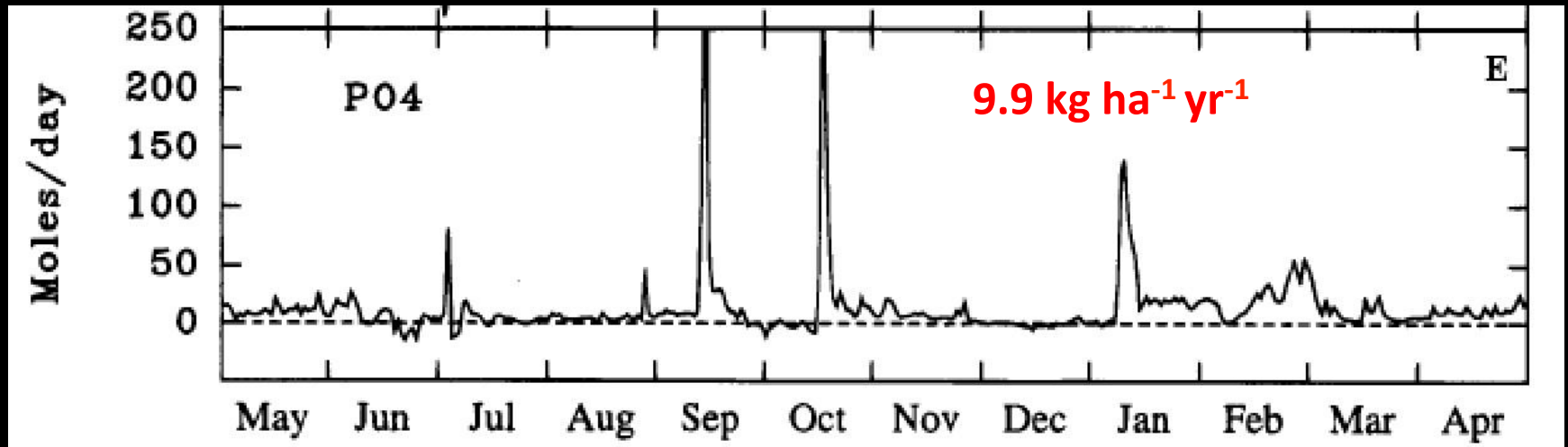
Option 3: Hope It Doesn't Rain ☺

- Preventative Practices
 - Low P fertilizer (<20 lb/A), doesn't control "legacy" P
 - Flood management, but is it *really* the floods?
 - Filter bed (in progress), presents many logistical challenges
 - Not much else...
- What's holding us back?
 - A fundamental understanding of P sources and transport pathways
 - Water are the sources? Derived from recent or past management? Variability in space and time?
 - What activities exacerbate P transport? What environmental/management conditions reduce/enhance P mobility?

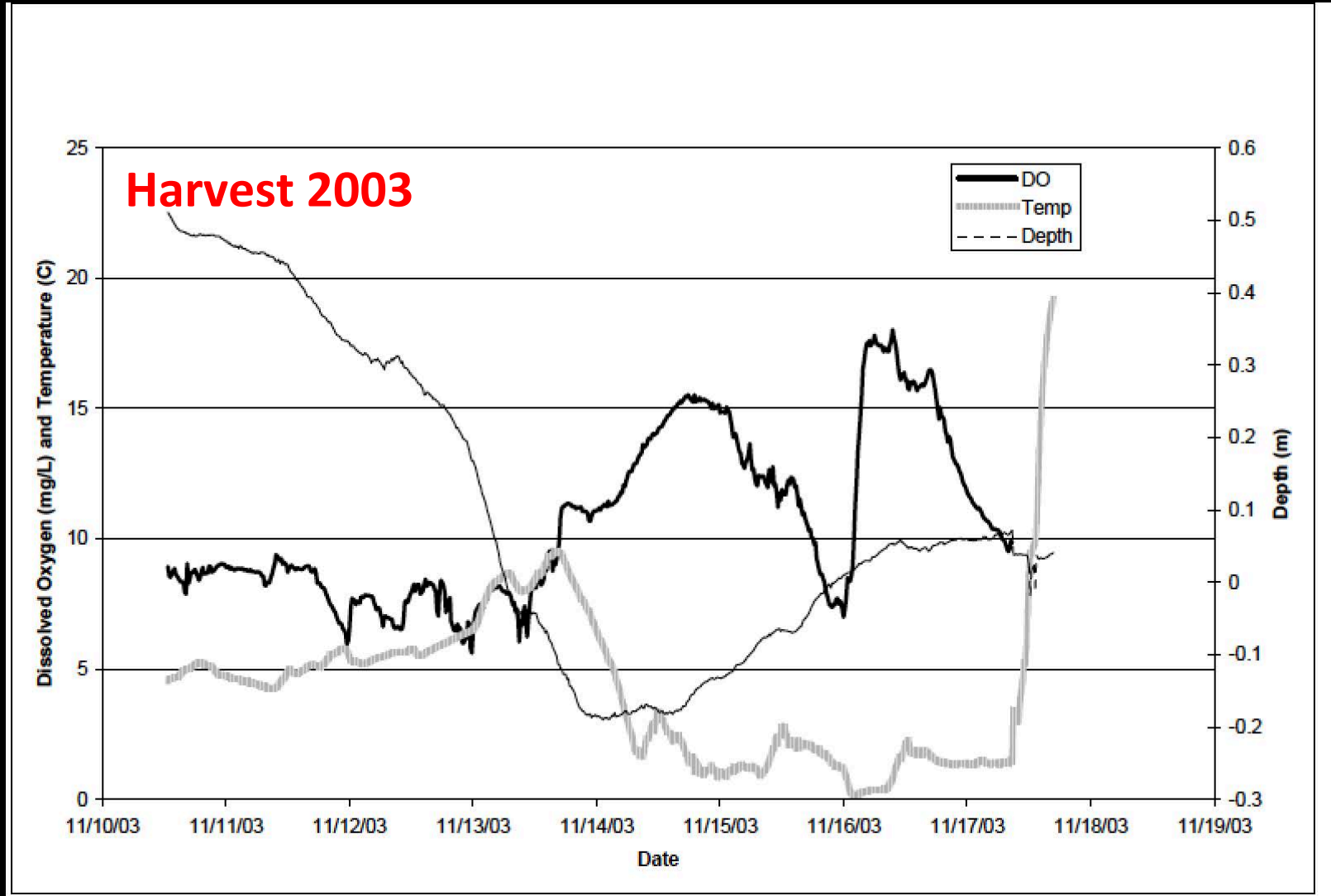
State of the Science

- Seminal/important/only papers on P Loss in cranberry
 - Howes and Teal (1995)
 - DeMoranville and Howes (2005)
 - DeMoranville (2006)
 - DeMoranville et al. (2009)
 - Kennedy et al., JEQ, under review

Howes and Teal (1995)



DeMoranville and Howes (2005)

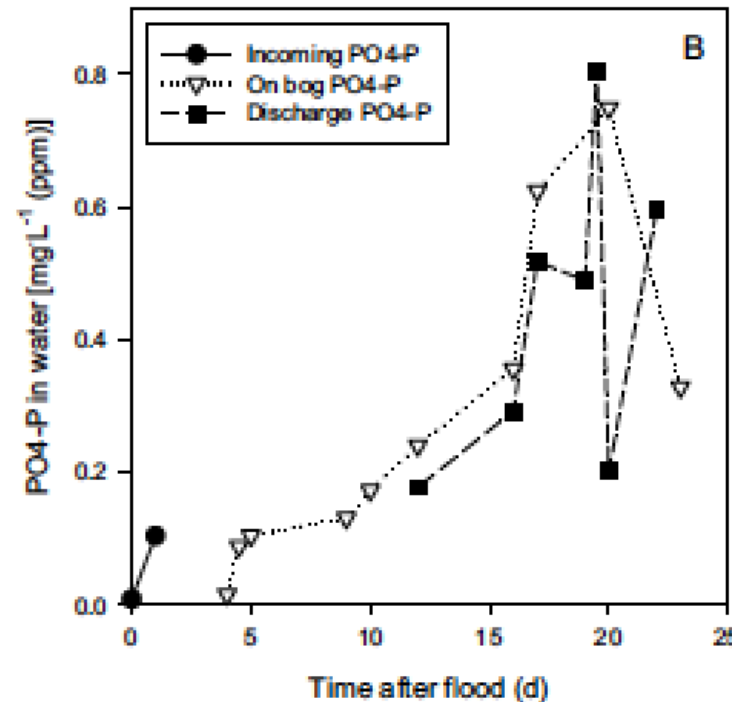
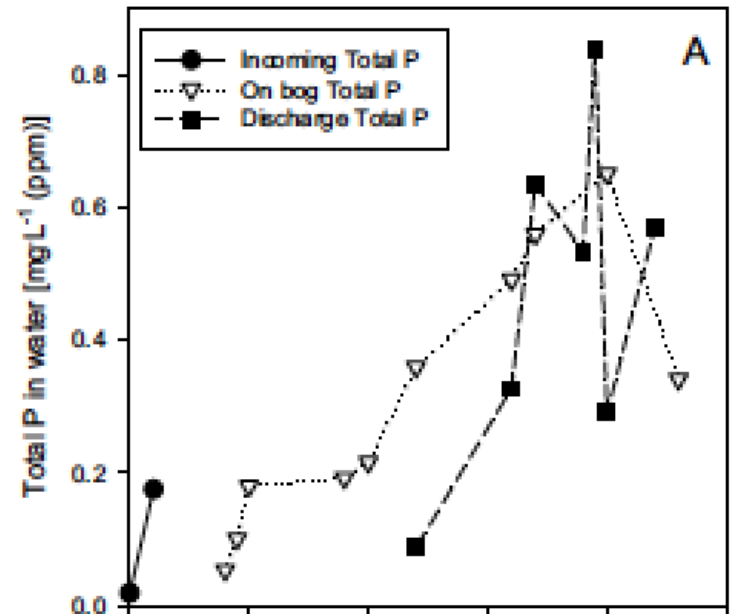


DeMoranville, C.J. and B.P. Howes. 2005. Phosphorus dynamics in cranberry production systems: developing the information required for the TMDL process for 303D water bodies receiving cranberry bog discharge. Available on Scholarworks (accessed October 2014):

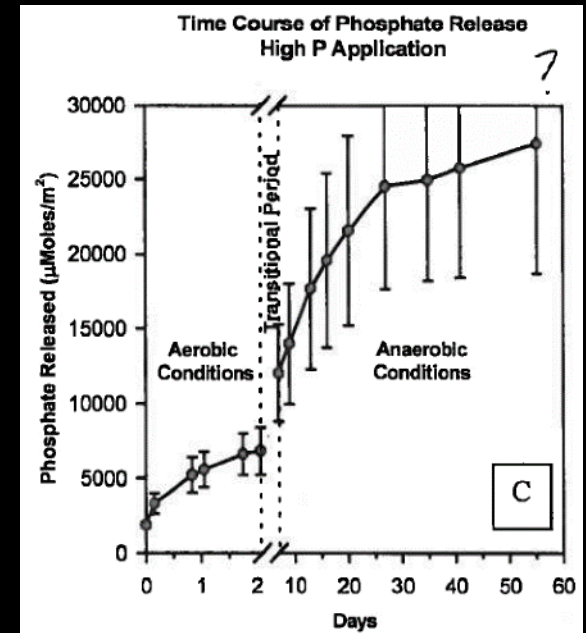
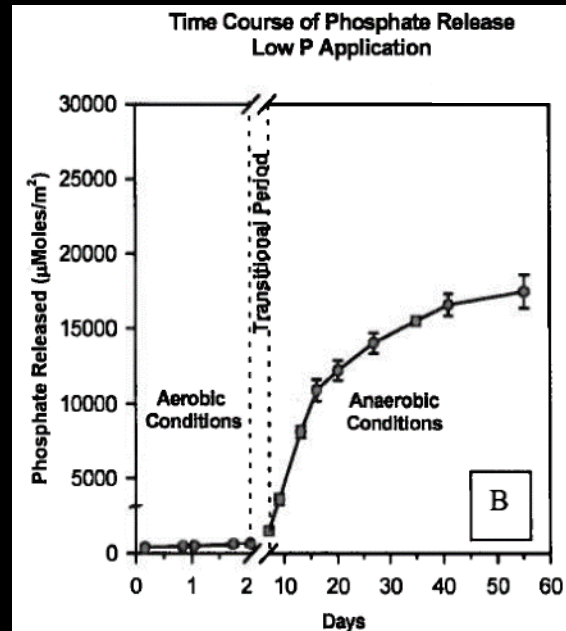
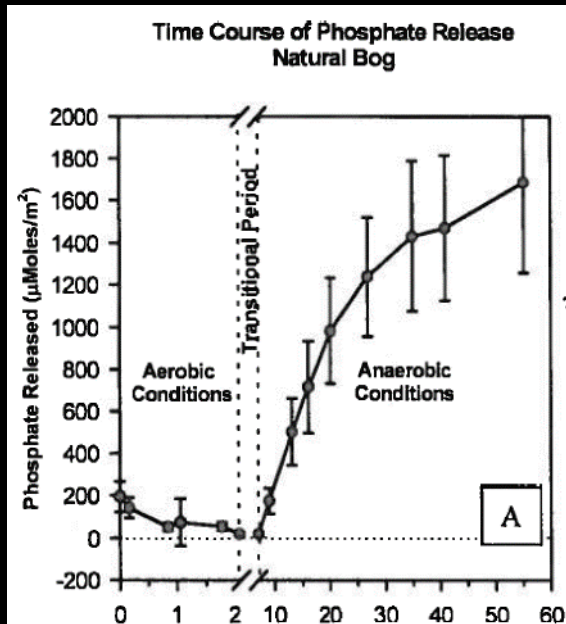
DeMoranville and Howes (2005)

	TP (kg ha ⁻¹ yr ⁻¹)	TN (kg ha ⁻¹ yr ⁻¹)	
Cranberry bogs - flow through	9.9	23	Howes and Teal, 1995
Cranberry bog - organic soil, contained	1.23 to 5.57	9.36 to 15.29	this study
Cranberry bog - organic soil, partial flow through	2.43 to 5.16	9.27 to 31.83	this study
Cranberry bog - mineral soil, contained	1.15 to 2.21	10.06 to 11.52	this study

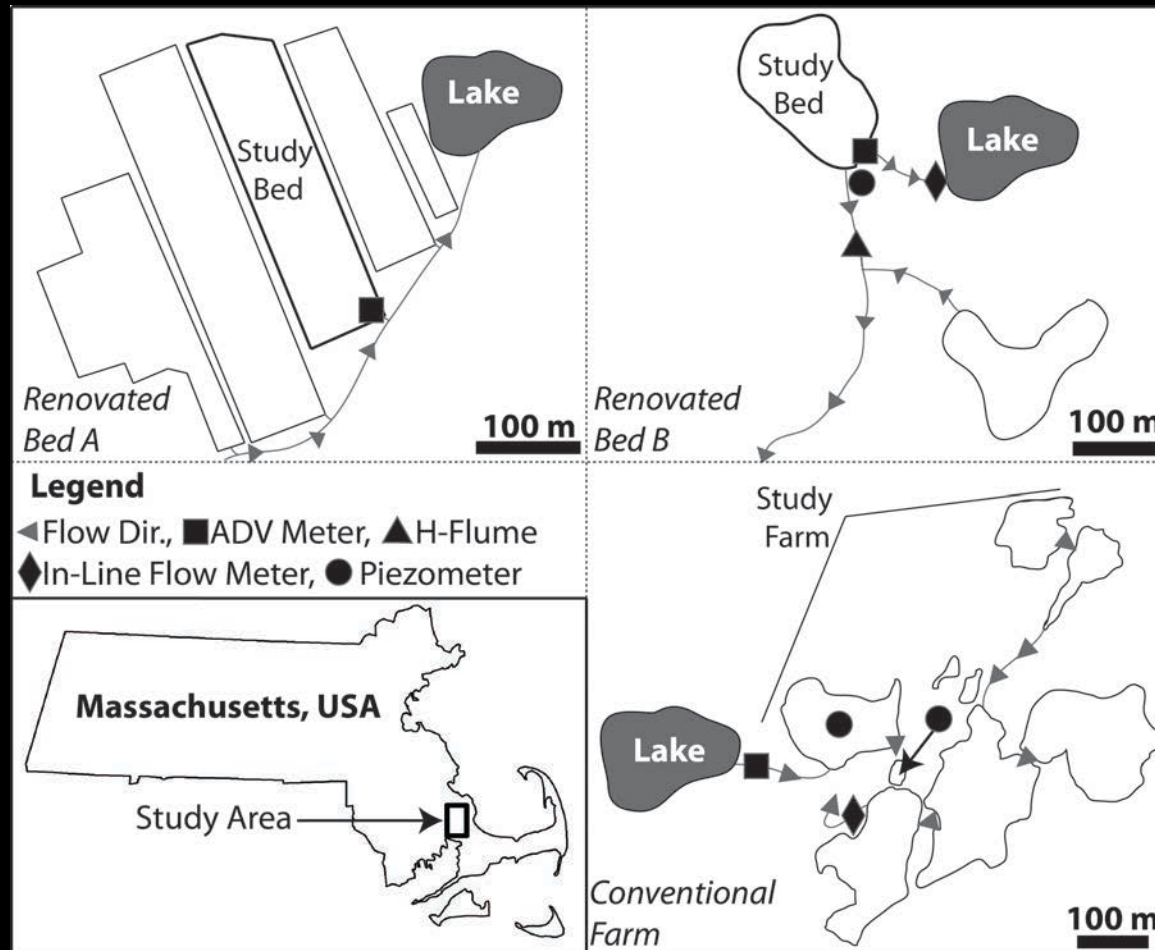
DeMoranville (2006)

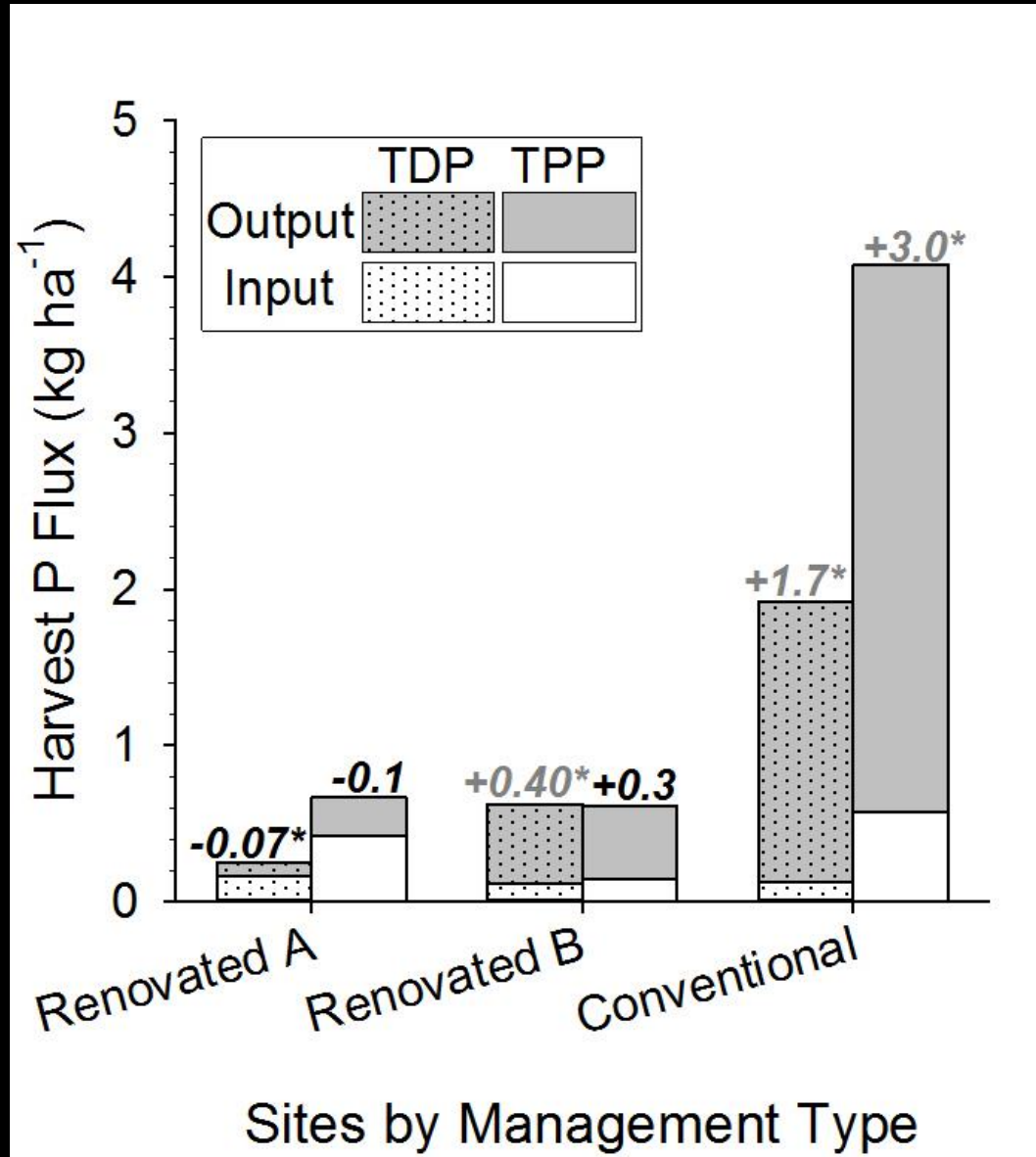


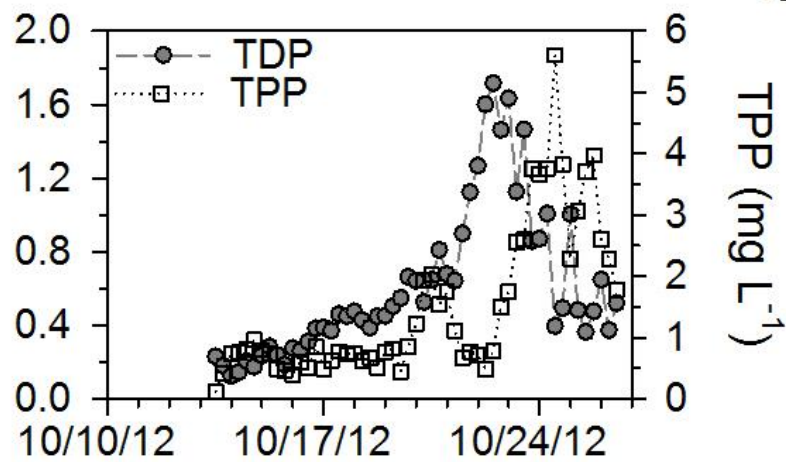
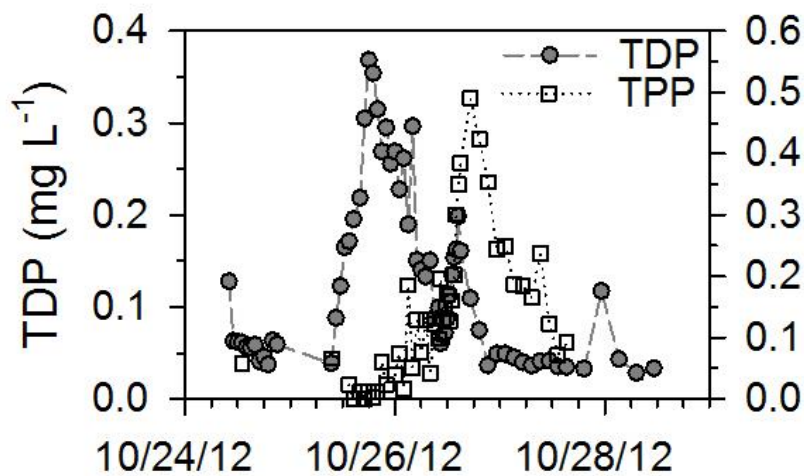
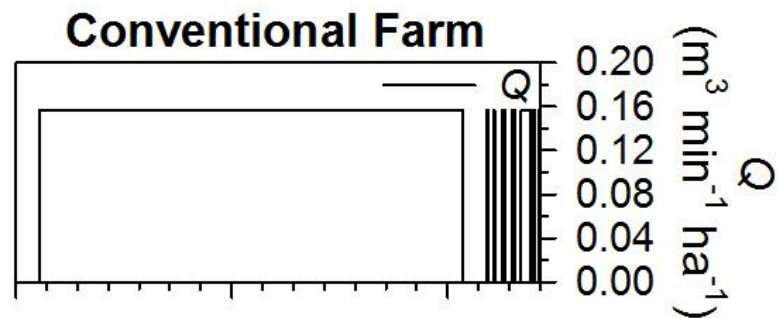
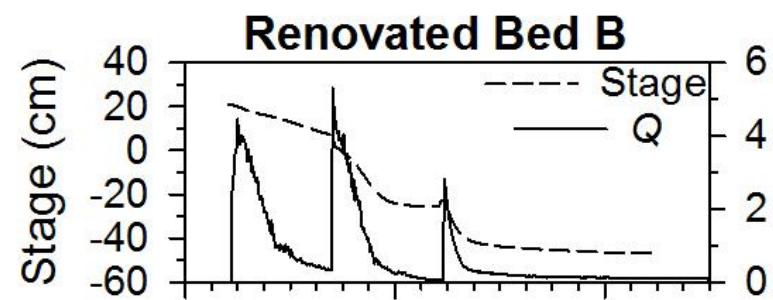
DeMoranville et al. (2009)

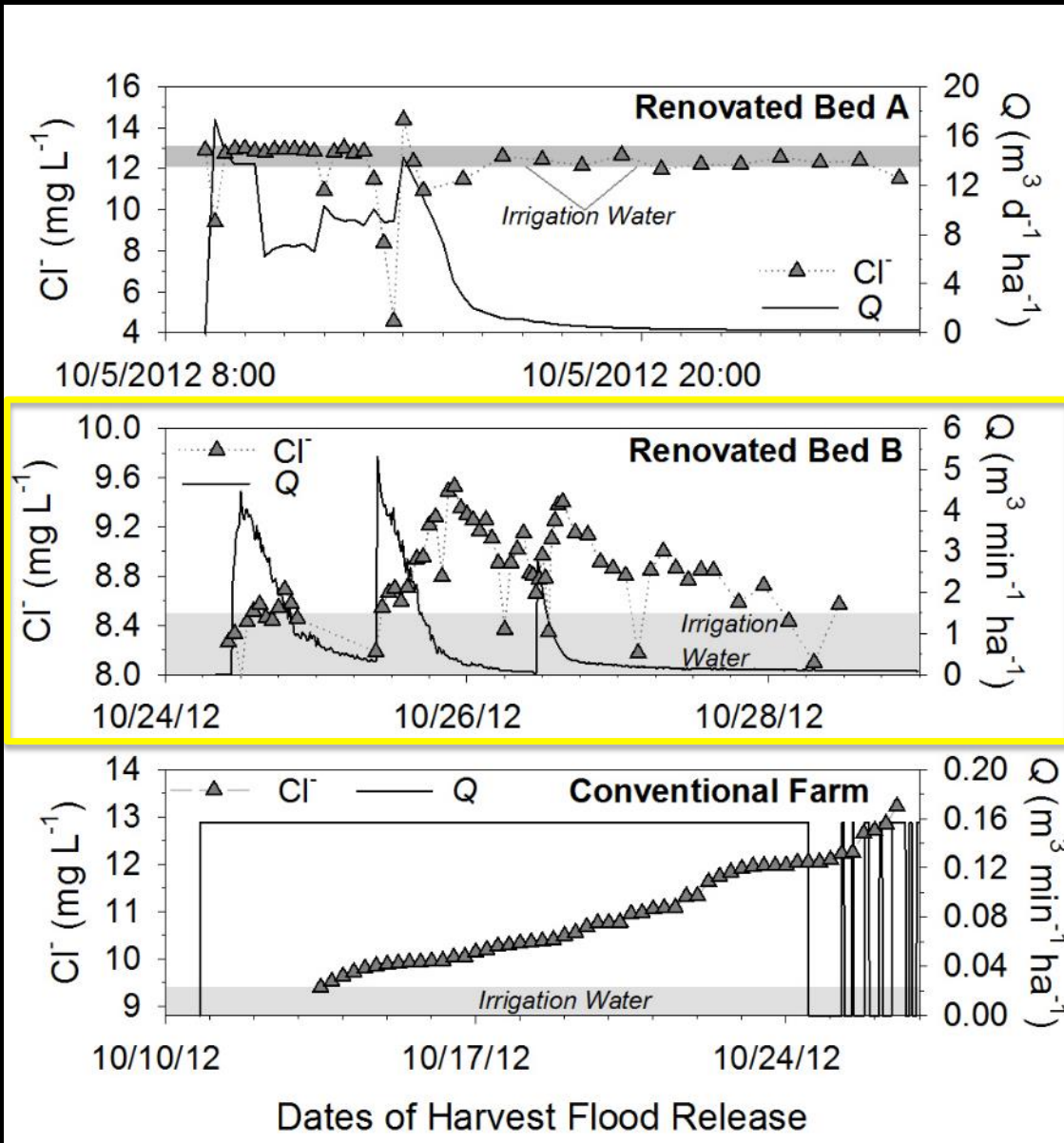


Kennedy et al.

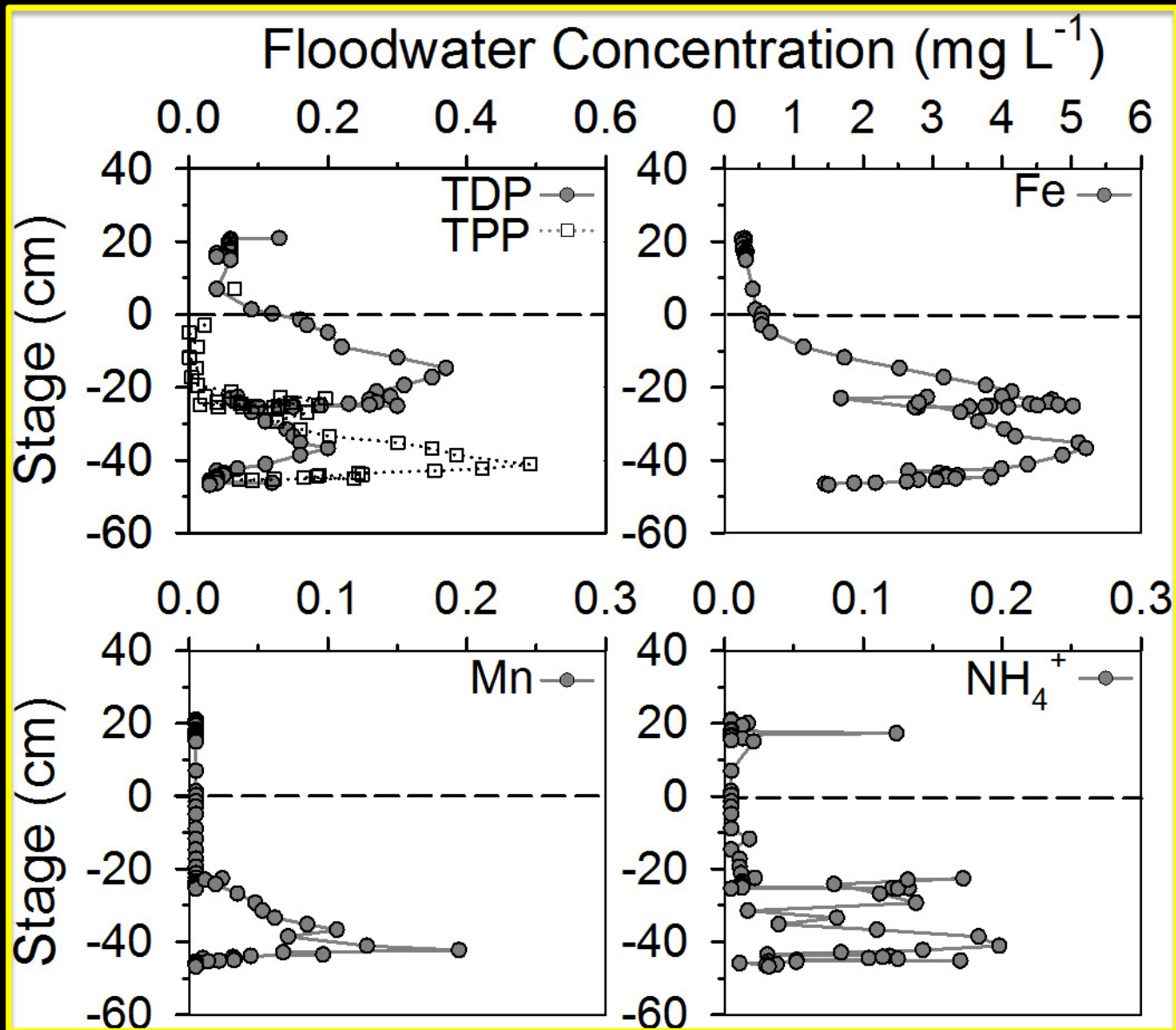






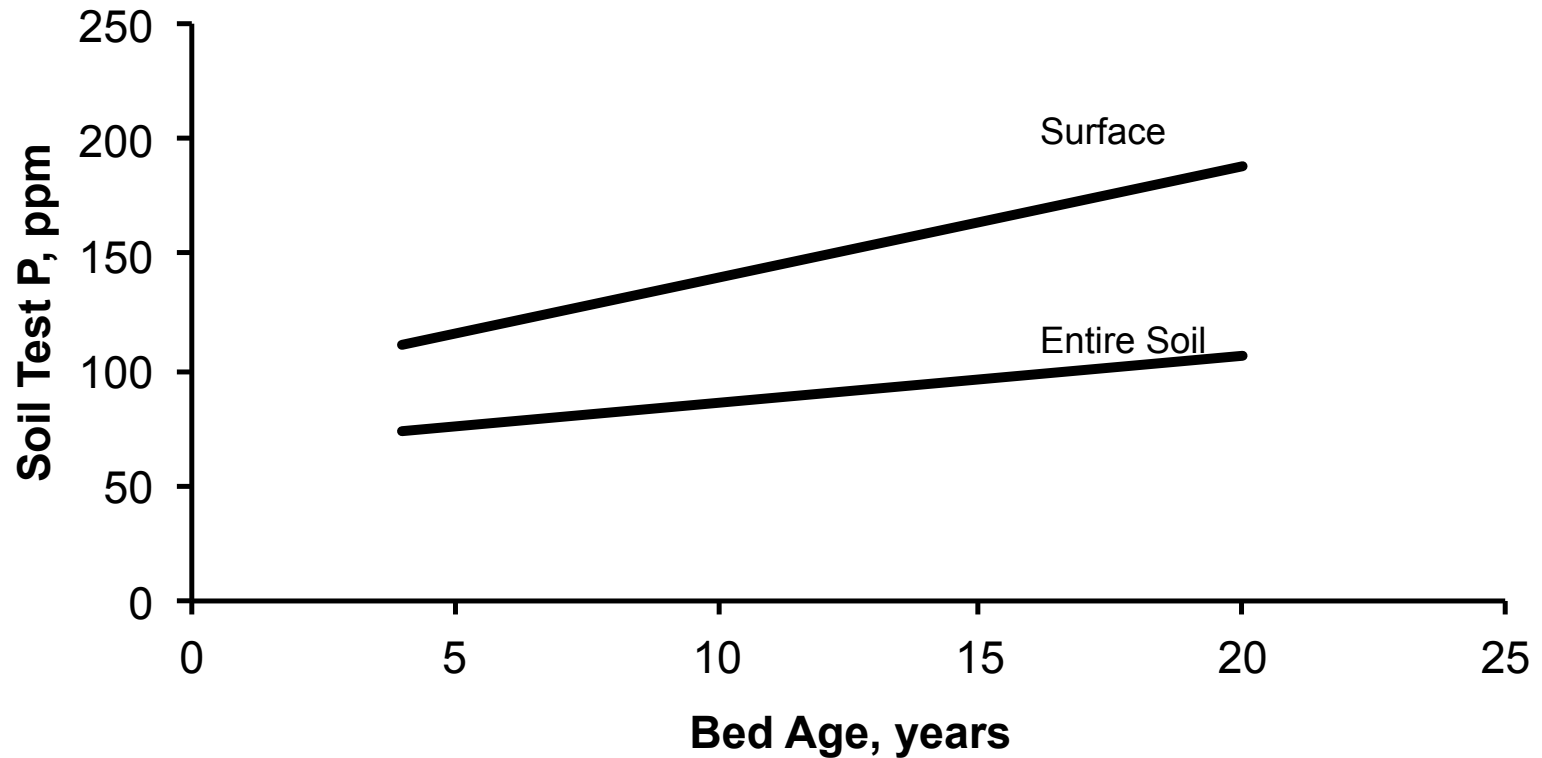


Kennedy, C.D., Kleinman, P.A.J., DeMoranville C., Scale effects on the hydrological and edaphic processes underlying phosphorus loss in cranberry floodwaters, *Journal of Environmental Quality*, under review.



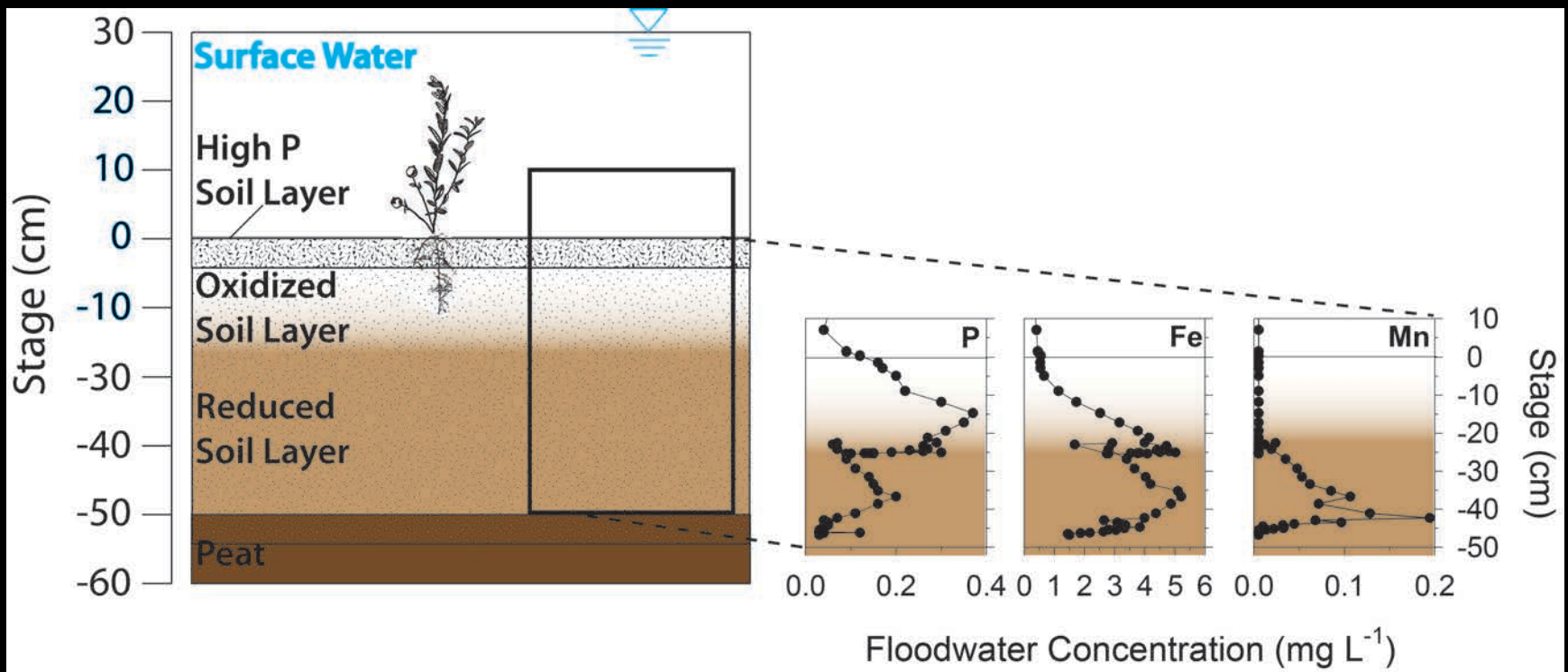
Evidence for Legacy P in Cranberry

Data from John Hart, Oregon, 2014





Conceptual Model of P



So... Knowns and Unknowns

- Known: Floods typically export P, generally higher for harvest
- Unknown: Role of storms, baseflow, other drainage events
- Known: P concentrations increase later in the flood release
- Unknown: Relative roles of chemical diffusion vs. physical leaching – both probably at play
- Known: Organic bogs generally export higher P
- Unknown: Role of legacy P in long-term management strategies (i.e., fertilizer reductions may not offer short-term solutions)
- Known: Reducing P loss is non-trivial – Buzzards Bay, Chesapeake Bay, Baltic Sea, everywhere on the planet...
- Unknown: Time required to develop comprehensive management plans for reducing P loss in cranberry bogs

Pontification

- Legacy P is a big deal, may confound response to fertilizer P reductions
- Floods are still a major flux of P, summer storms are probably not trivial
- Revisit 10-day flood holding time limit → longer holding times result in great groundwater recharge (i.e., use the cranberry bed as your filter)
- In-situ amendments need to be explored

Questions?