

# Lessons from Manure-applied Legacy P Drawdown in the Mid-Atlantic USA



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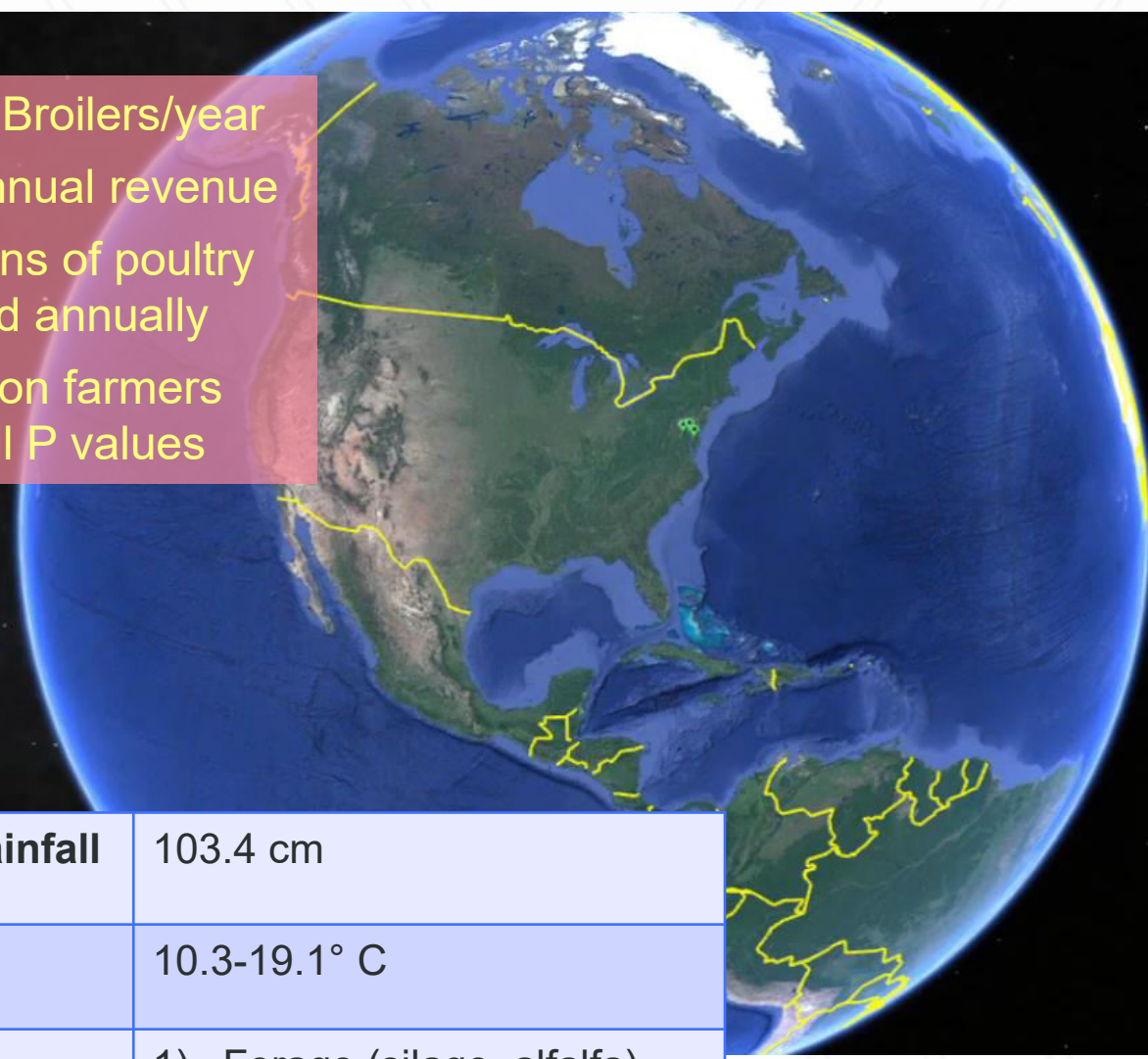
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# Mid-Atlantic US Region: *State of Maryland*

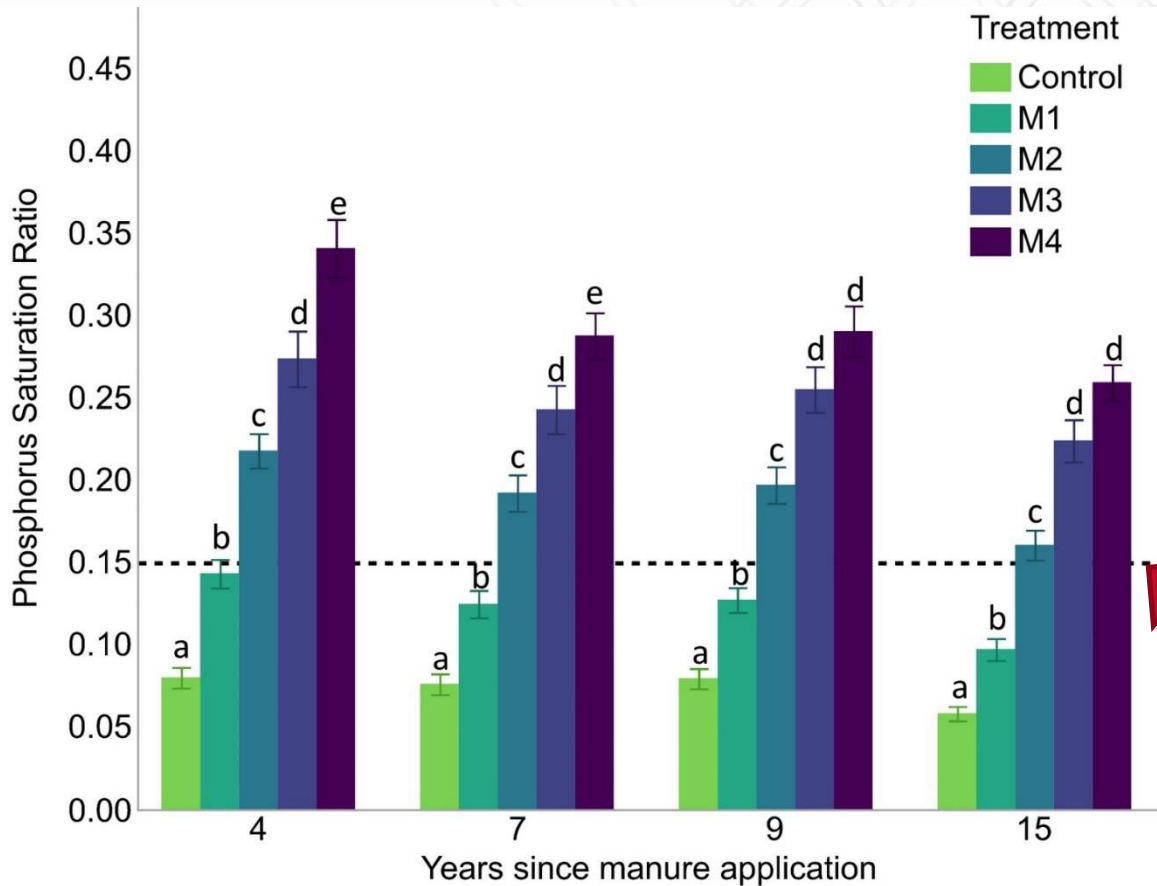
- >287 Million Broilers/year
- ~ 1 Billion annual revenue
- ~ 345,000 tons of poultry litter removed annually
- Regulations on farmers based on soil P values



<b>Mean Annual Rainfall</b>	103.4 cm
<b>Mean Temp.</b>	10.3-19.1° C
<b>Crop systems</b>	1) Forage (silage, alfalfa) 2) Grain (corn, soybeans)
<b>Manure Treatments</b>	0, 100, 200, 300, 400 kg total P ha <sup>-1</sup> annually for 4 years

# Mehlich-3 P Saturation Ratio Over 15 Years

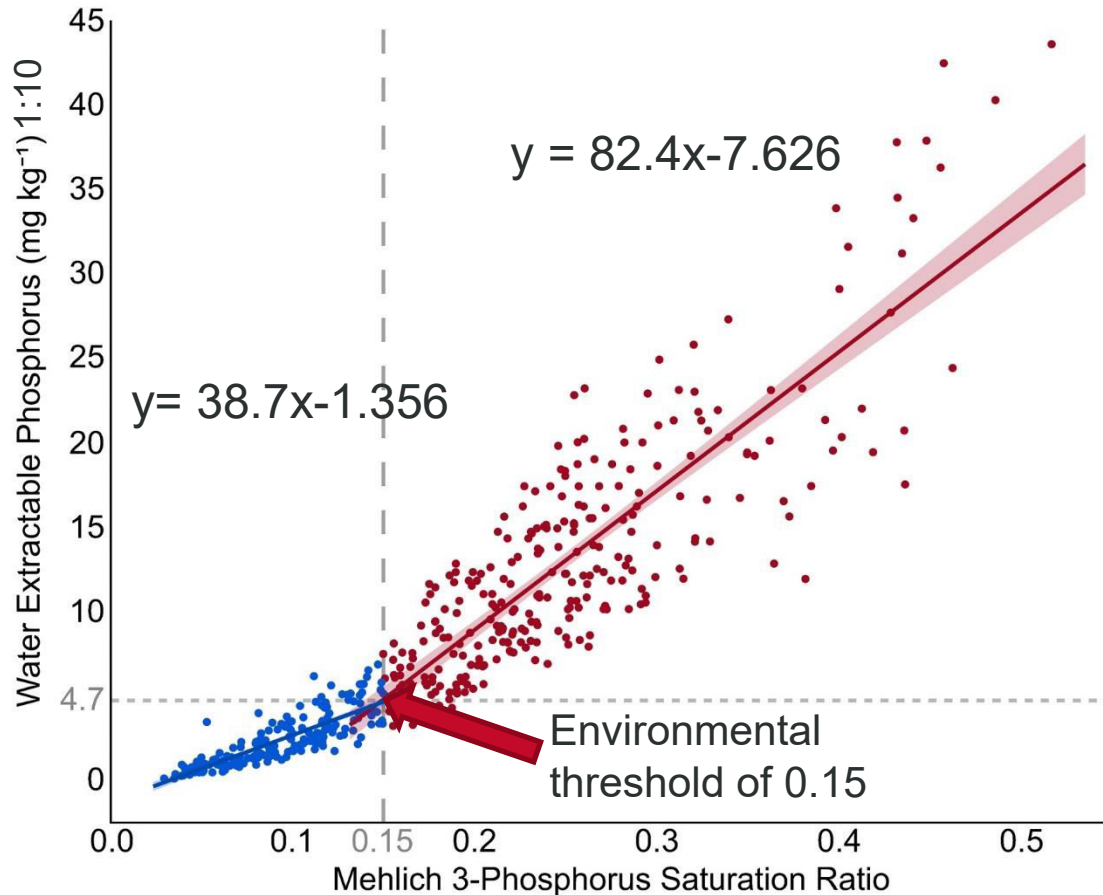
$$M3-PSR = \frac{M3-P}{(M3-Fe) + (M3-Al)}$$



- ❖ P saturation exceeds environmental threshold at 15 years of no P application
- ❖ Minimal decline in PSR
- ❖ ***Lesson: M3-PSR will remain above environmental risk for decades***

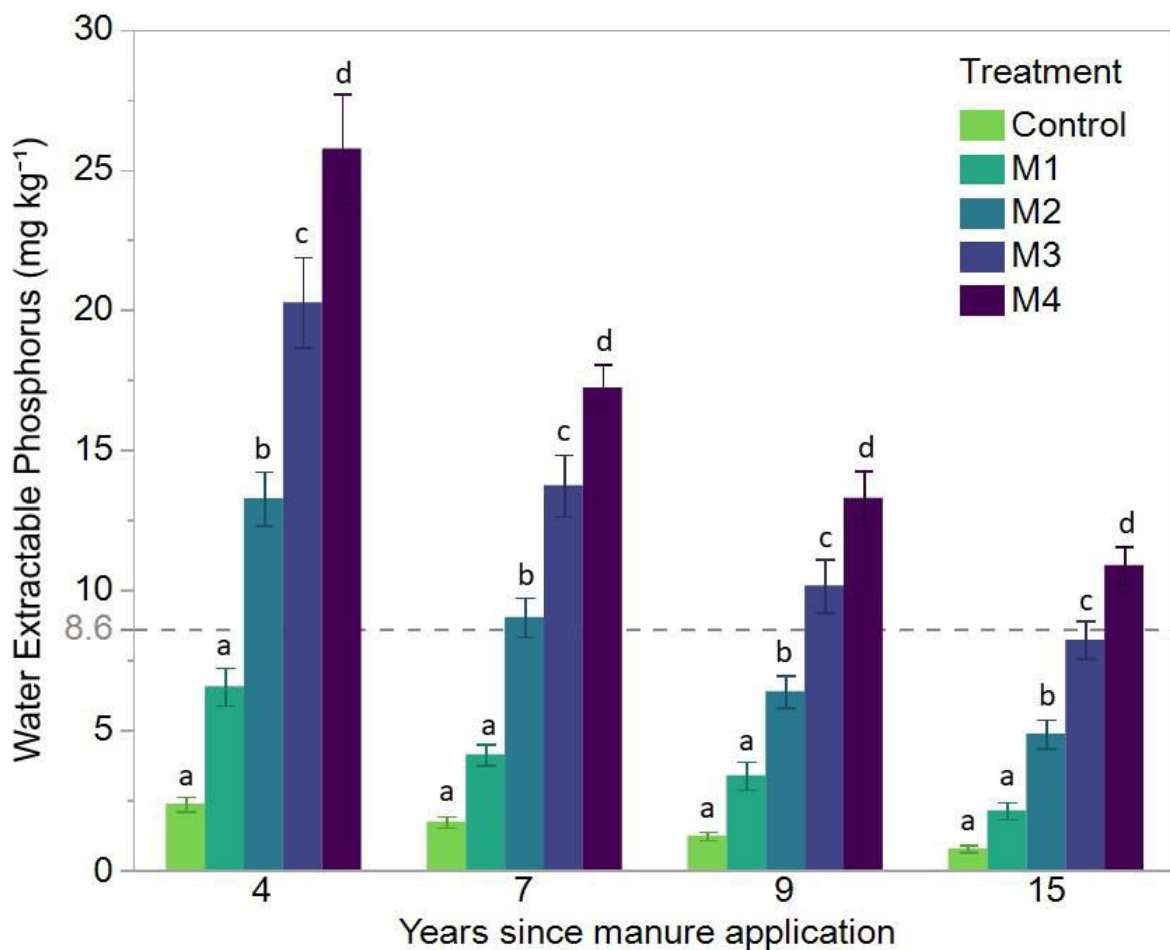
Environmental threshold of 0.15 or 15%

# Relationship between P Saturation and WEP



- ❖ WEP indicates high potential for soluble P loss
- ❖ *Change point:* Increased and more variable P loss above 0.15 P saturation

# Decline in Water Extractable P Over 15 years

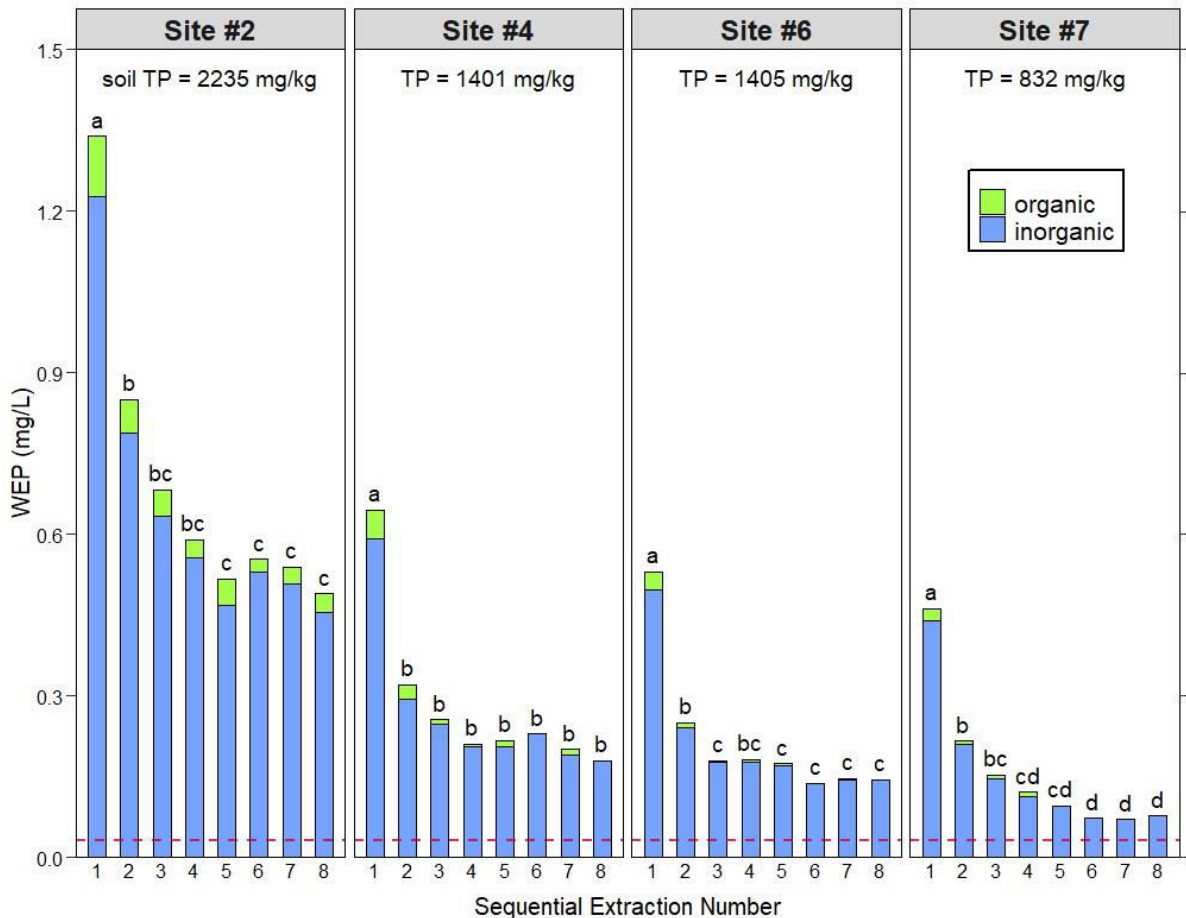


- ❖ No significant decline between 9 and 15 years
- ❖ Highest 2 manure treatments remained above environmental threshold

Environmental threshold of 8.6 mg/kg

*Lucas et al. 2021*  
*AEE*

# Water Extractable P in Legacy P Soils *Not Exhausted*

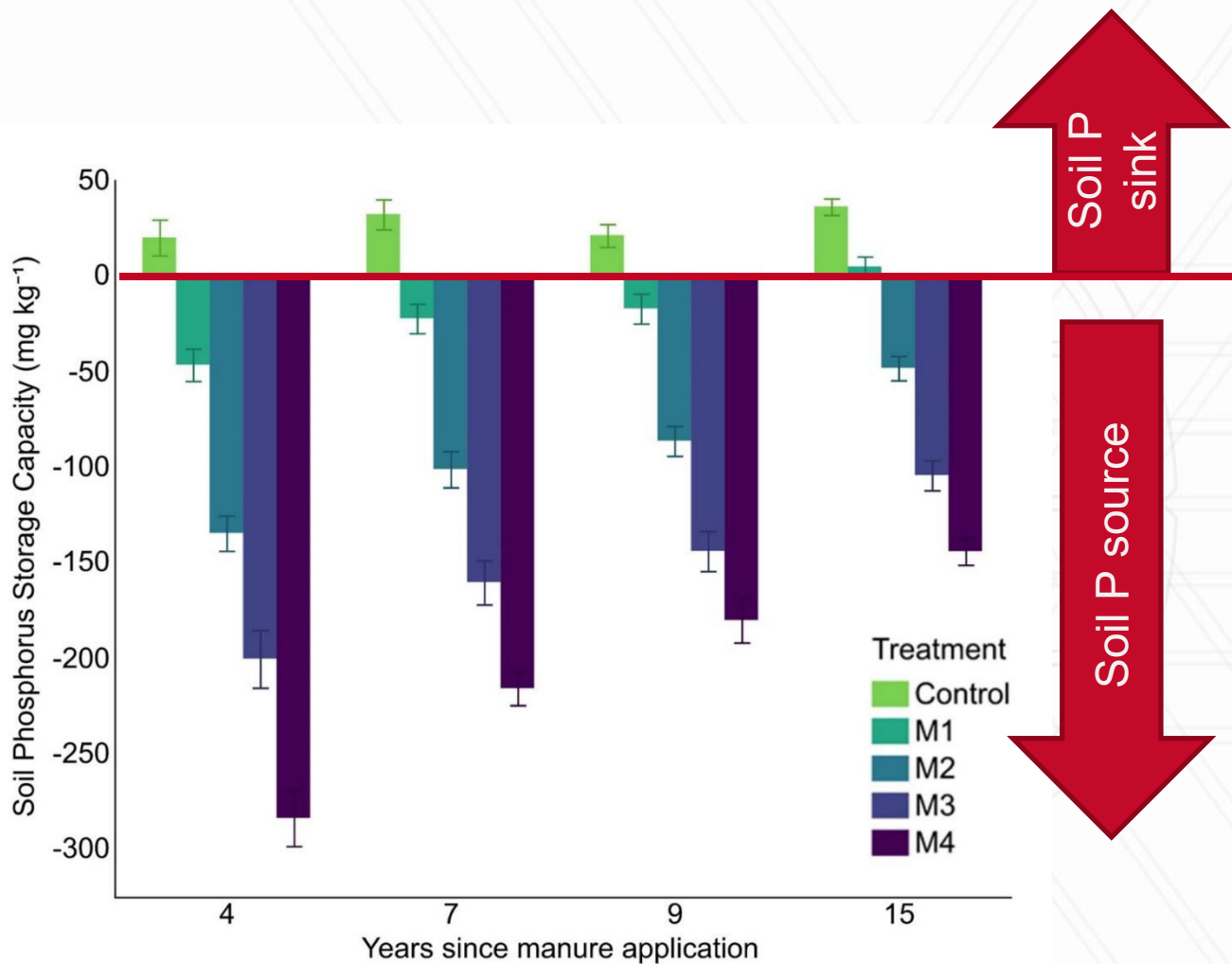


- ❖ After 8 sequential extractions of 1:100, P was not exhausted below the US EPA P threshold
- ❖ ***Lesson: WEP pool will continue to be fed by legacy P stored in soils for decades***

← US EPA threshold  
0.03 mg/L



# Soil P Storage Capacity Over 15 Years



❖ Soils with manure treatments had P source (enough available P). P sink in control.

❖ ***Lesson: P is available to crops during the drawdown period***

Lucas et al. 2021  
AEE

# Consult these papers for more info:

- Lucas, E., G.S. Toor, & J. McGrath. 2021. [Agronomic and environmental phosphorus decline in coastal plain soils after cessation of manure application](https://doi.org/10.1016/j.agee.2021.107337). *Agriculture, Ecosystems & Environment*, 311, 107337. <https://doi.org/10.1016/j.agee.2021.107337>
- Roswall, T., E. Lucas, Y. Yang, C. Burgis, Isis SPC Scott, & G.S. Toor. 2021. [Hotspots of legacy phosphorus in agricultural landscapes: Revisiting water-extractable phosphorus pools in soils](https://doi.org/10.3390/w13081006). *Water*, 13, 1006. <https://doi.org/10.3390/w13081006>

- Toor, G.S., & J.T. Sims. 2015. [Managing phosphorus leaching in mid-Atlantic soils: importance of legacy sources](https://doi.org/10.2136/vzj2015.08.0108). *Vadose Zone Journal*. 14: DOI:10.2136/vzj2015.08.0108.
- Toor, G.S. & J.T. Sims. 2016. [Phosphorus leaching in soils amended with animal manures generated with modified diets](https://doi.org/10.2134/jeq2015.10.0542). *Journal of Environmental Quality*, 45:1–7. DOI: 10.2134/jeq2015.10.0542.

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