Utilizing Mine Drainage Residuals to Control Phosphorus from Land-Applied Animal Manure

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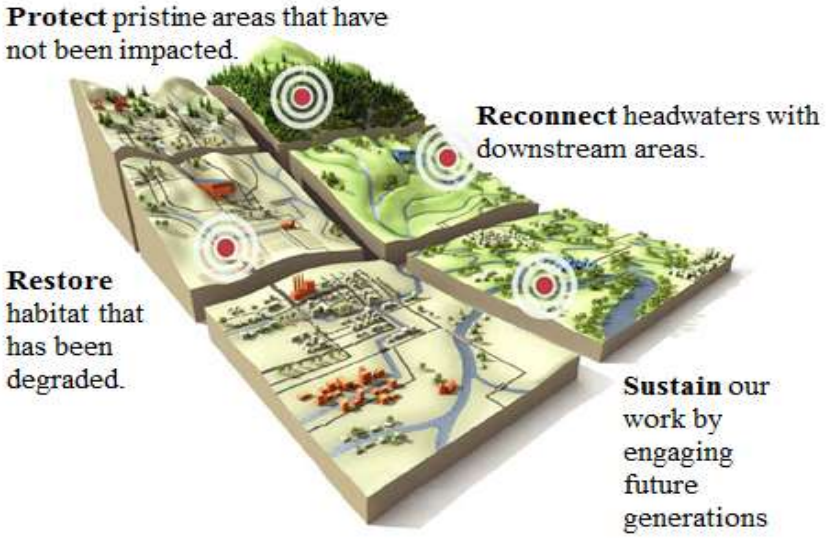
Trout Unlimited overview in Pennsylvania



Mission – To conserve, protect, and restore North America's coldwater fisheries and their watersheds

Abandoned Mine Drainage

- AMD Technical Assistance Program
- On-the-ground AMD remediation
- AMD youth education, outreach, and policy work
- Recovery research and monitoring

Coldwater Habitat

- Design and permitting assistance
- Instream habitat improvement
- Dirt and gravel road improvement
- Riparian reforestation
- Aquatic organism passage inventory and training
- Culvert replacement
- Coldwater habitat youth education, outreach, and policy work

Top two pollution sources to PA's waterways

Phosphorus pollution

- Dairy and swine manure contains high content of phosphorous (P)
- Animal manure is often applied at a rate greater than plant uptake
- Portion of P is water extractable (soluble) and can be environmentally mobile
- Agricultural-based P is a significant contributor to degradation of water quality in the Chesapeake Bay

Mine drainage residuals (MDR)

- Solids produced through the treatment of mine drainage
- Fe, Al, and Ca oxides, hydroxides, carbonates
- Considered nonhazardous by PA DEP
- Thousands of tons produced annually at systems operated by private companies, PA DEP, and non-profits
- Routinely disposed of through burial or landfilling
- MDR management can be substantial cost of operations of mine drainage treatment systems

MDR and P management?

- MDR consists of Fe, Al, and Ca solids that have capacity for adsorbing or reacting with phosphate
- Reactions shift P to a solid form that is not water extractable
- Adding MDR with P-sorption capacity to manure should decrease water extractable P and decrease environmental mobility of P
- Novel means to lower the P Source Coefficient
- Potential new BMP for producers with P concerns
- Win-win for dealing with both AMD and Ag pollution

Focus on Research and Applicability

- Do MDRs have chemical components of concern for use in agriculture?
- How effective are MDRs for decreasing water extractable P in manures?
- Do MDR additions affect crop yields?
- How would MDR be incorporated into manure management practices?

Project Partners and Funding 2008-present

Project Manager: Trout Unlimited

Principal Investigator: Iron Oxide Recovery/Hedin Environmental

Funding

Phase I - NRCS Conservation Innovation Grant (NFWF administered)

Phase II & III, - PA Growing Greener Program

Technical Steering Committee

- PA DEP, Office of Water Resources Planning
- USDA Agricultural Research Service, University Park, PA
- Penn State University Department of Ecosystem Science and Management
- USGS Leetown Science Center, Kearneysville, WV

MDR testing

- Chemical Analysis
  - pH
  - Elemental composition
  - Neutralization potential
- MDR dosing effect on water extractable P
- Greenhouse crop yield evaluation
- MDR used in field trials

Chemical composition of MDRs

- Collected 21 MDR samples from coal mine drainage treatment systems that varied in water chemistry and treatment technology
- Chemical variation:
  - Low pH acidic with Fe, Al, Mn
  - Neutral pH alkaline with Fe
- Treatment Technologies
  - Hydrated lime
  - Pebble lime
  - Hydrogen peroxide
  - Limestone (passive)
  - Aerobic ponds/wetlands (passive)

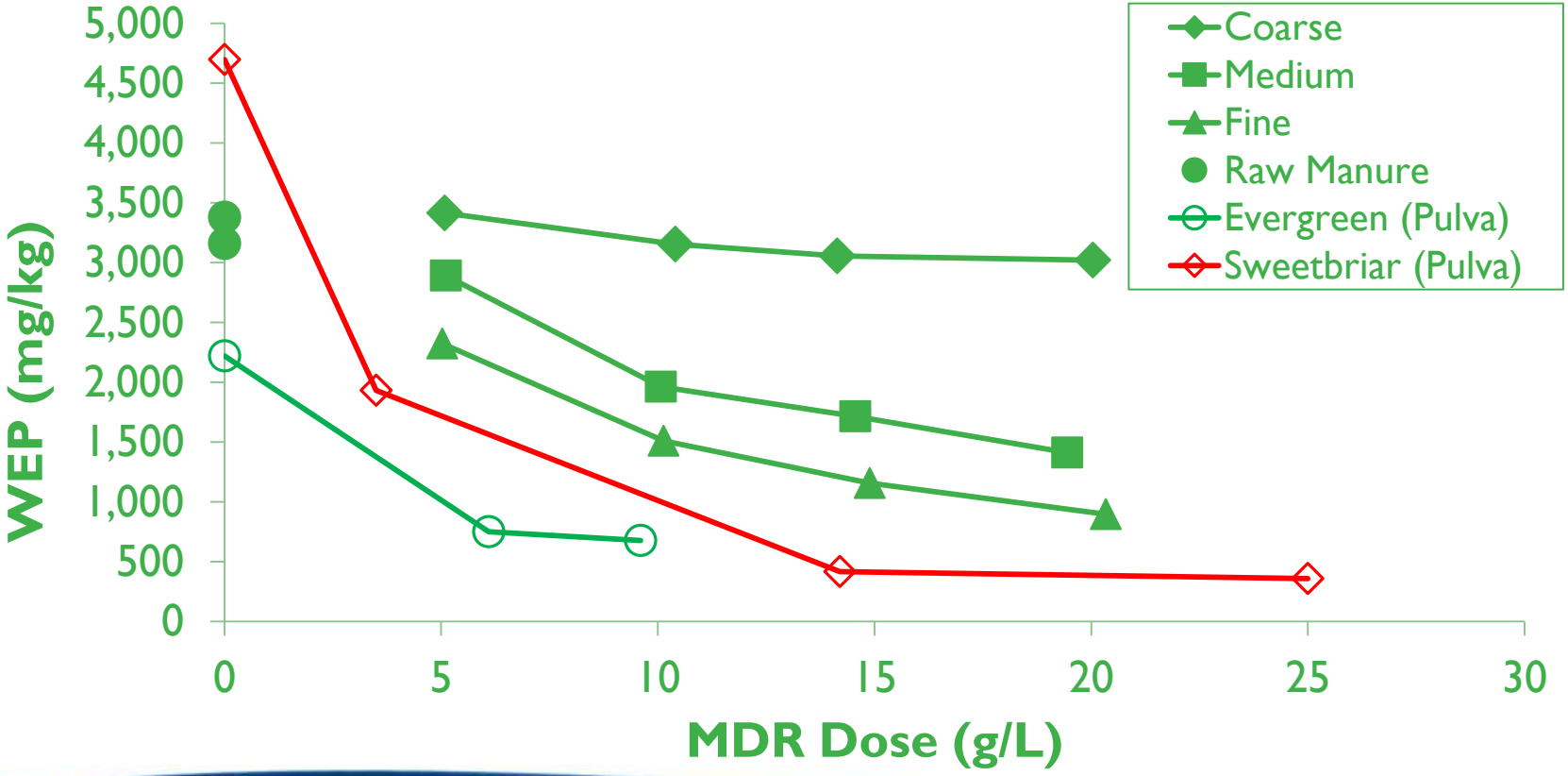
EPA Part 503 Biosolids Rule Screening

- Used as guideline; rule is not applicable to manure management practices
- Rule contains metal limits for land-applied biosolids
- If used for MDR-amended manure, the evaluations would be done for mixtures which are 99:1 dilutions
- For this project, screening of MDRs was done without manure dilution assumptions
- Arsenic and nickel were only metals that exceeded limits

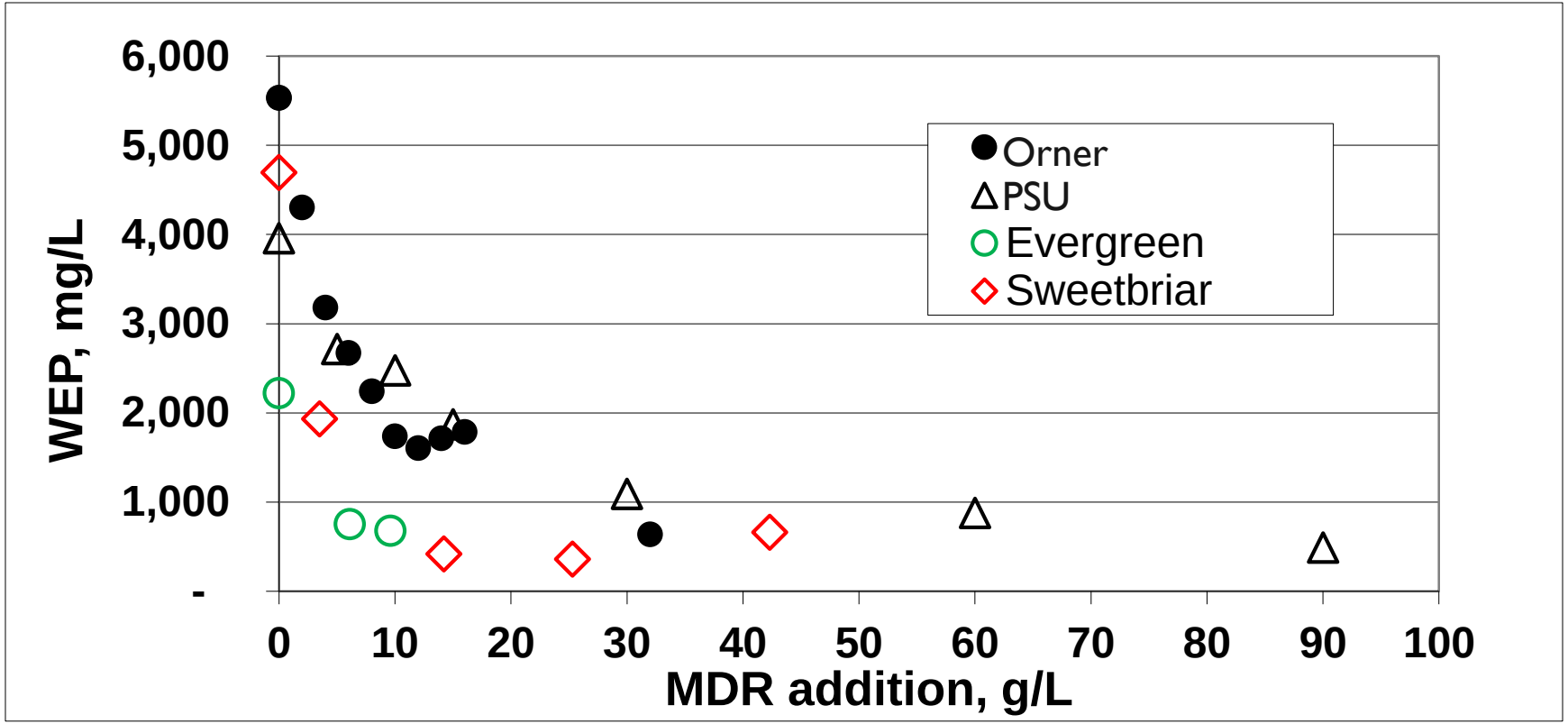
Dose-effect lab/field testing results

- MDR can significantly decrease WEP of manure
- Factors that influence the efficacy of the treatment
  - MDR chemistry
  - MDR particle size
  - Water extractable P content of manure

Effect of four particle size preparations of MDR on WEP



Effect of MDR additions on WEP



Greenhouse crop yield evaluation results

- Manure additions increased ryegrass growth
- No decrease in ryegrass growth at either MDR rate
- Leachates collected from pots of MDR-treatments contained less P than leachates from control pots

Field trial scenarios

- Operations ranged from 80 - 3,000 cows
- Manure storage tanks ranged from 100,000 - 400,000 gallons (some w/mechanical solids separator); added MDR into sump or tank
- Sawdust bedding in freestall where manure washed/pumped to earthen lagoon; bedding amended with MDR

Field trial results

- All scenarios resulted in decreasing water extractable P from 22% to 66%
- MDR addition decreased WEP similar to bench testing
- Dusty injection method; solved by modifying position of supersack in the tank

Summary to date

- Before working with MDR (or any solid material) should screen for high hazardous metal contents
- MDR's ability to decrease manure WEP is directly related to Fe and Al content and indirectly related to particle size
- Most common problem in field applications is dust
- No evidence that MDR interferes with crop growth
- Not all manures require management of WEP

Next steps

- PSU AASL will standardize MDR testing
- USDA ARS will conduct simulated precipitation experiments with MDR-amended manure
- Dose effect test and field trial(s) with swine manure
- Additional field trials (economics, cost-effective methods)
- Crop yield measurements associated with field trials
- Develop into BMP (PA Technical Guide practices list/NRCS)

THANK YOU!

TROUT UNLIMITED

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