How Clean is Clean Enough?
Assessing Edge-of-Field Nutrient Runoff

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USDA
United States Department of Agriculture
Agricultural Research Service

Agricultural Research in the US

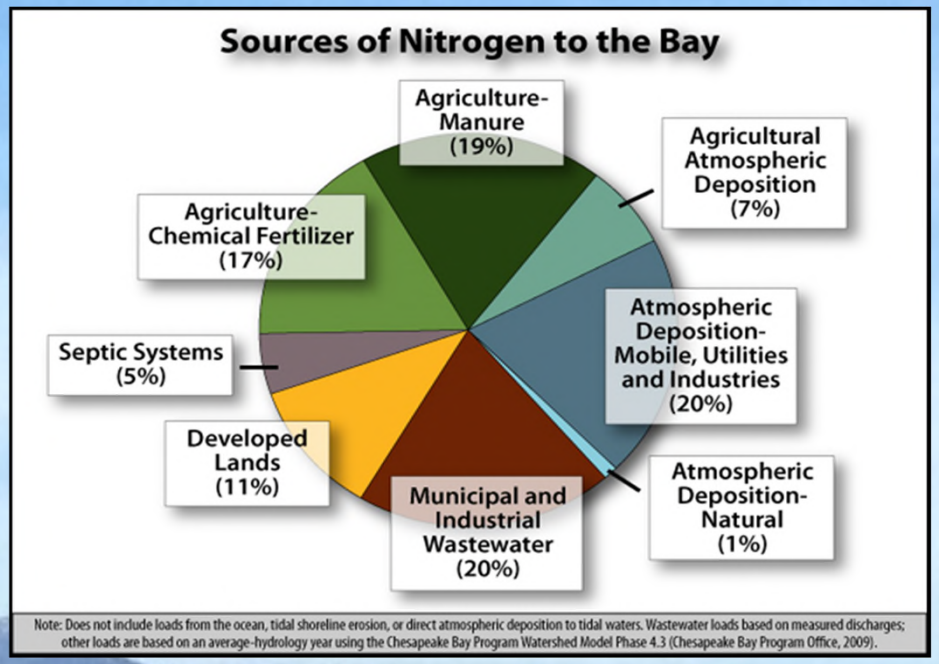
- Great investment (every $1 returns > $10)
- Broad definition of “Agricultural Research”
  - crop and animal production, food safety, human nutrition, water quality, ecology, plant and animal health, climate change, bioenergy, genetic resources, etc.
- ARS effectively complements University research
  - address short- and long-term needs
  - diverse funding mechanisms (competitive, dedicated)
  - basic and applied science

USDA United States Department of Agriculture
Agricultural Research Service

Colorado State University

Agricultural NPS Regulation

- **Agricultural nonpoint source (NPS) pollution and its contribution to nutrient enrichment of water bodies is a contentious issue.**



Agricultural NPS Regulation

- The fact that we cannot tell producers, policy makers, or management agencies "how clean is clean enough?" in terms of acceptable levels of nutrients in agricultural runoff hinders development of management strategies and resource policies that support economic and water resource sustainability.

- Not advocating for/against regulation; however, the topic is far too important not to discuss and evaluate!

Agricultural NPS Regulation

- 19 states have some type of NPS pollution regulation (Craig and Roberts, 2015), e.g.:
  - Florida – for impaired water bodies, the state requires BMPs, verifies implementation, and provides cost share.
  - Wisconsin - nutrient management plans must meet technical requirements including soil testing.
  - Colorado – may consider "adoption of prohibitions or precautionary measures… if the Commission determines that sufficient progress has not been demonstrated in agricultural nonpoint source nutrient management."

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

WATER QUALITY CONTROL COMMISSION

REGULATION #85

NUTRIENTS MANAGEMENT CONTROL REGULATION

5 CCR 1002-85

Agricultural NPS Regulation

- **No state NPS program mentions how to determine whether edge-of-field nutrient runoff is excessive (based on review of Environmental Law Institute, 1998).**
  - **In fact, *not a single mention* is made of determination or assessment of acceptable nutrient loss from farm or ranch fields.**
- **Is that surprising??**

How Clean is Clean Enough??

- Nutrients limits/standards in drinking water…
  - 10 mg/L for NO_3-N
  - 1 mg/L for NO_2-N

How Clean is Clean Enough??

- **What are acceptable levels of nutrients in runoff from agricultural fields?**

If you had to decide if runoff from the field above this flume was “acceptable”, how would you make that determination??

How Clean is Clean Enough??

- **Comparison with Reference Site**

Table 1
Summary of pros and cons for direct comparison alternatives for assessing nutrient runoff.

Direct comparison alternatives	Pros	Cons
Reference site	Water quality data collected from field(s) in question; reasonable to establish targets relative to reference conditions in same ecoregion.	Require measurement of water quality, which is difficult and expensive; numerous complicating factors (e.g., sample type, data compilation, concentrations vs. loads, allowable exceedances); unrealistic for agricultural fields to have same or lower nutrient levels as reference site, so some relative comparison would be necessary; limited data from reference sites; substantial variability in nutrient runoff even from reference sites.

Avg. annual load from native grassland = 2 kg/ha/yr total N, 0.5 kg/ha/yr total P (MANAGE, Harmel et al. 2006, 2008).

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- **Comparison with Existing Criteria or Standards**

Table 1
Summary of pros and cons for direct comparison alternatives for assessing nutrient runoff.

Direct comparison alternatives	Pros	Cons
Existing criteria or standards	Water quality data collected from field(s) in question; reasonable to establish targets relative to existing standards or criteria; stream nutrient criteria or screening levels exist for many states; drinking water standards exist for nitrate-nitrogen and nitrite-nitrogen.	Require measurement of water quality, which is difficult and expensive; numerous complicating factors (e.g., sample type, data compilation, concentrations vs. loads, allowable exceedances); scale difference difficult to address (e.g., stream with multiple sources and in-stream fate and transport mechanisms including dilution vs. edge-of-field); unrealistic for agricultural fields to have same or lower nutrient levels as drinking water, so some relative comparison would be necessary; episodic nature of runoff versus static target.

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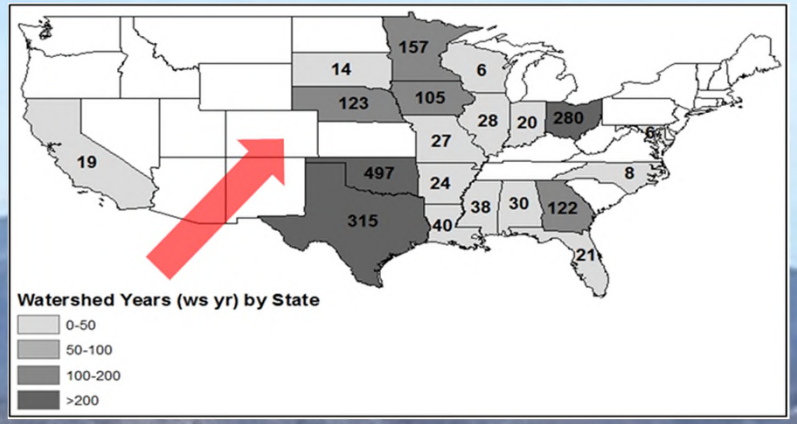
- **Comparison with Measured Data Compilation**

Table 1

Summary of pros and cons for direct comparison alternatives for assessing nutrient runoff.

Direct comparison alternatives	Pros	Cons
Measured data compilation	Water quality data collected from field(s) in question; based on measured data from "similar" field; readily defensible (strengthened if exhaustive data search and quality assurance effort undertaken).	Require measurement of water quality, which is difficult and expensive; surprisingly limited amount of published, land use specific data; data unequally distributed between land uses, regions, etc.



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- **Indirect assessment using Soil Test P**

Table 2
Summary of pros and cons for indirect assessment alternatives for assessing nutrient runoff.

Indirect assessment alternatives	Pros	Cons
Soil Test P	Simple, existing alternative; effective tool for ranking relative risks; relatively easy to assess.	Water quality protection is presumed not definitively confirmed; numerous factors affect P runoff (e.g., fertilizer rate, application timing, erosion, etc.)— therefore, may not be good indicator of nutrient loss; various extractants and soil conditions produce different soil test P values; soil test P levels can be "manipulated" (e.g., sampling location, additional irrigation); does not address N runoff.

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- **Indirect assessment using P Index or similar index**

Table 2
Summary of pros and cons for indirect assessment alternatives for assessing nutrient runoff.

Indirect assessment alternatives	Pros	Cons
P Index or similar "environmental index"	Existing, widely accepted alternative; effective tool for ranking relative risks; can be tailored to account for local/regional differences; relatively easy to assess loss relative to P loss rating or estimate of concentrations or loads; significant freedom to design methods (BMPs and/or management strategies) to achieve target; can help target effort and resources on fields with the greatest likelihood of contributing excess nutrient runoff.	Water quality protection is presumed not definitively confirmed; directly conflicts with P Index purpose if used to evaluate compliance or as a regulatory tool; does not address N runoff.

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- **Indirect assessment using Field-Scale Model**

Table 2
Summary of pros and cons for indirect assessment alternatives for assessing nutrient runoff.

Indirect assessment alternatives	Pros	Cons
Field-scale model	Existing technology; capable of estimating actual losses and impacts of management; can account for local/regional differences; easy to assess loss relative to predicted loss from model; significant freedom to design methods (BMPs and/or management strategies) to achieve target; utilizes best available science (nutrient cycling routines); can help target effort and resources on fields with the greatest likelihood of contributing excess nutrient runoff; can be used in conjunction with larger scale models to assess impacts on downstream water quality.	Water quality protection is presumed not definitively confirmed; not vigorously validated in all regions.

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- **Indirect assessment using Certainty Program**

Table 2
Summary of pros and cons for indirect assessment alternatives for assessing nutrient runoff.

Indirect assessment alternatives	Pros	Cons
Certainty programs	Proactive; can be tailored to account for local/regional differences; relatively easy to assess; significant freedom to design methods (BMPs and/or management strategies) to achieve target; provides legal protection to producer; utilizes best available science (science-based practice selection and placement); includes renewal provision so that advances in knowledge and improved practices can be incorporated; supported by US Environmental Protection Agency and Natural Resources Conservation Service.	Water quality protection is presumed not definitively confirmed; program monitoring required to assure practice installation and maintenance.

United State Environmental Protection Agency | Office of Water (4203) | EPA 833-F-00-008 January 2000 (revised December 2005) Fact Sheet 2.6

Stormwater Phase II Final Rule

Construction Site Runoff Control Minimum Control Measure

important to keep in mind that the small MS4 operator has a great deal of flexibility in choosing exactly how to satisfy the minimum control measure requirements.

Concluding Thoughts

- Most if not all would agree that:
  - agriculture should minimize its contribution to water quality degradation.
  - expecting producers to use cost-prohibitive practices to protect water quality is unrealistic.
  - unsubstantiated claims that nutrient BMPs are cost prohibitive are also unrealistic.
  - downstream interests and water users should rightly expect “clean” water from upstream.
  - Nutrients runoff from native prairies and virgin forests.

Any Questions??

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Assessing edge-of-field nutrient runoff from agricultural lands in the United States: How clean is clean enough?

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