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INTERNATIONAL
PLANT NUTRITION
INSTITUTE

Our Industry's Future with Increased Regulatory Involvement

C.S. Snyder

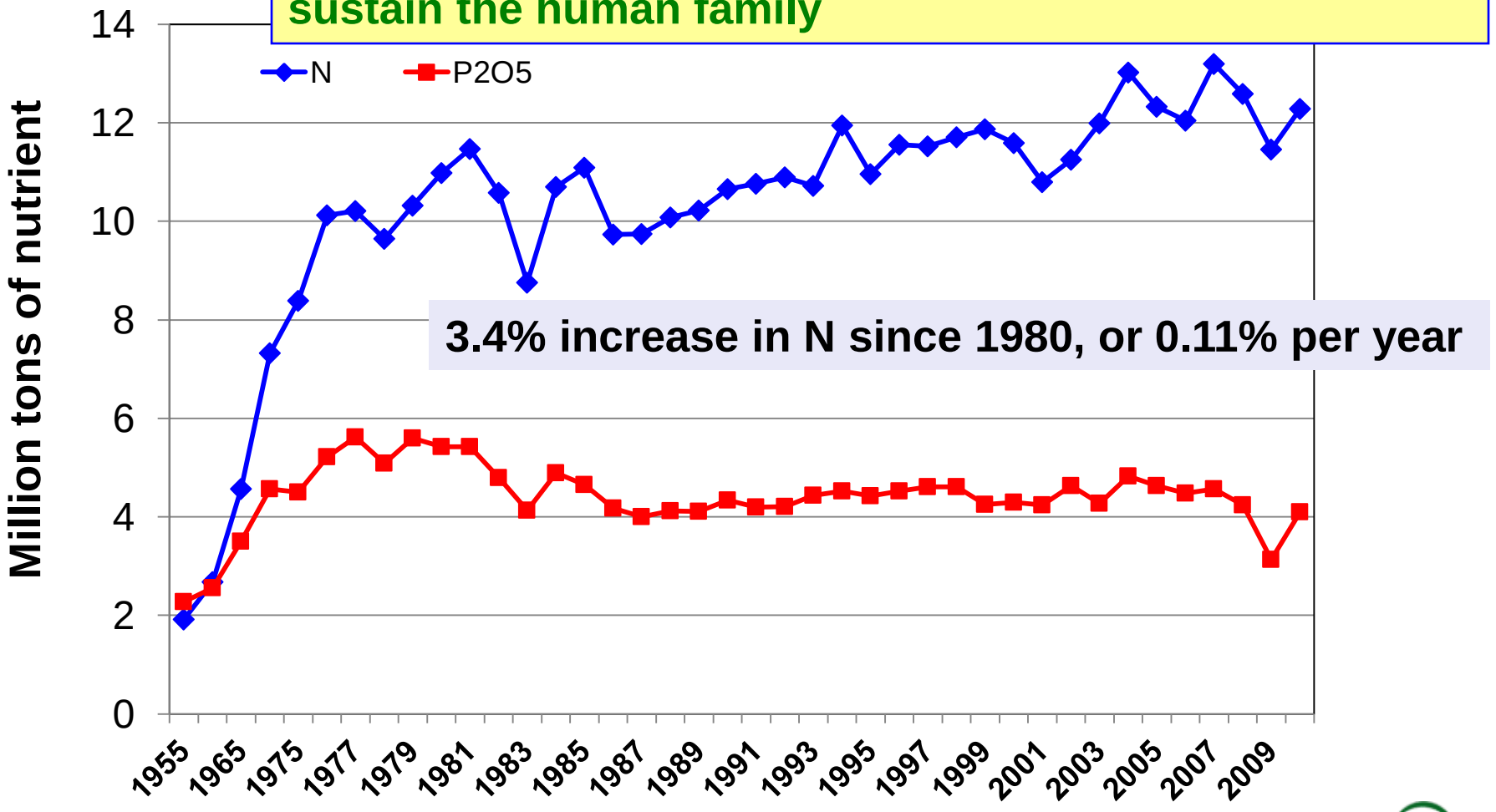
Nitrogen Program Director, Conway, AR

Fluid Fertilizer Forum

Scottsdale, AZ *February 20-21, 2012*

U.S. Fertilizer N and P_2O_5 Consumption

Fertilizer production and farmer use provide 40 to 60% of the global crop and food production necessary to sustain the human family



3.4% increase in N since 1980, or 0.11% per year

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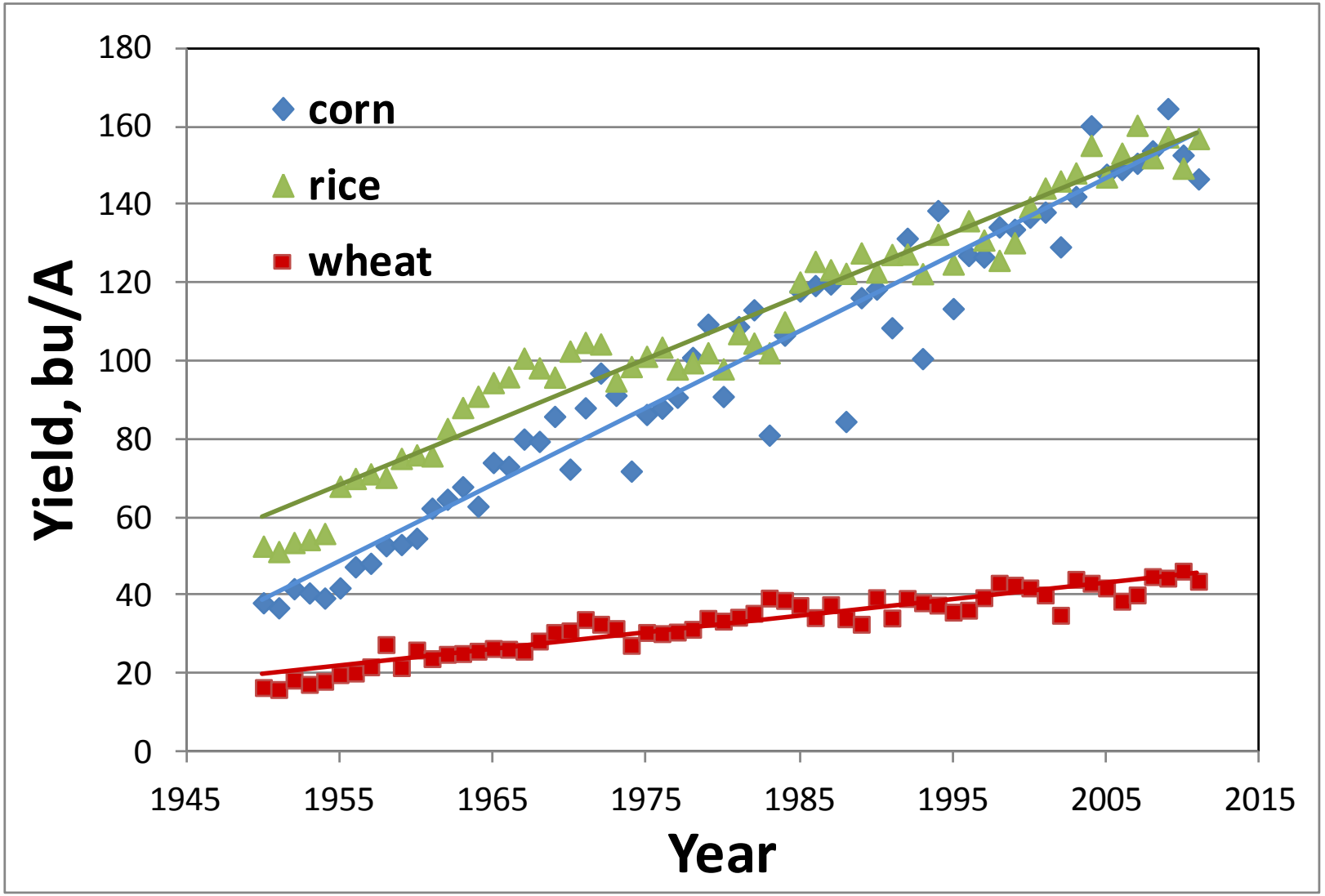
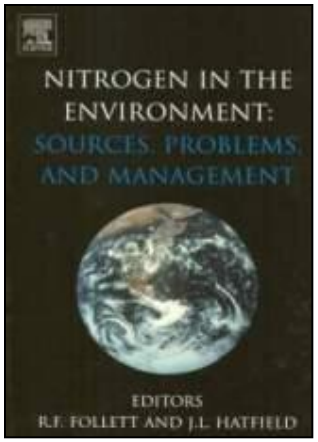
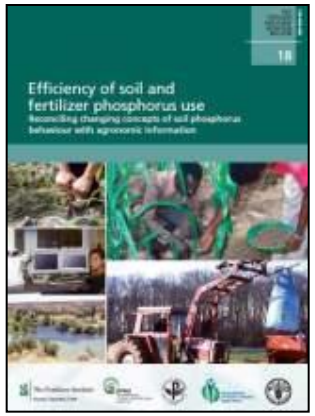
Yield Trends of Major U.S. Cereal Grains



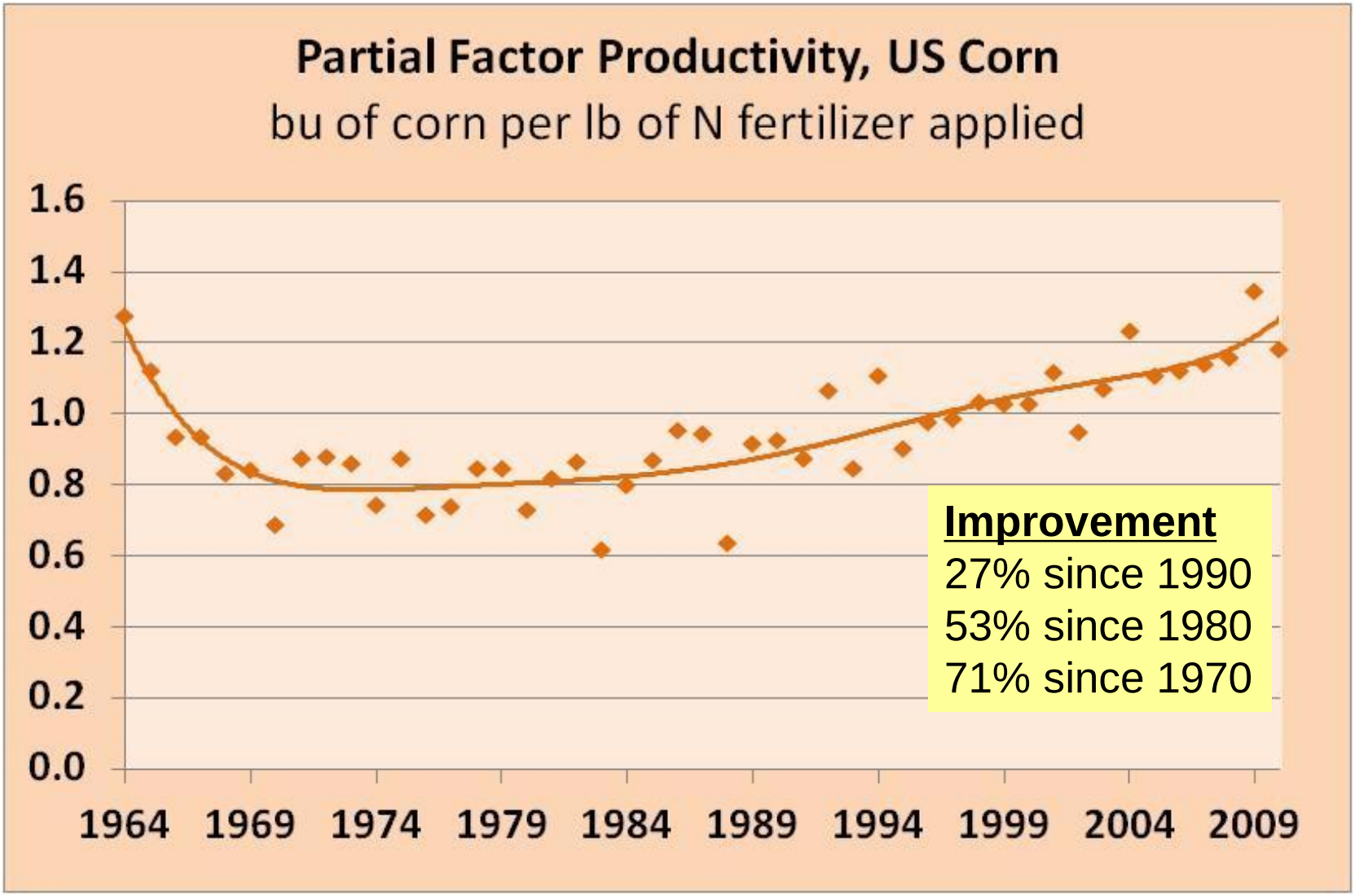
Nitrogen and Phosphorus Plant Recovery Efficiency

- **Nitrogen use efficiency … "rarely exceeds 70% ……. often ranges from 30-60%"**
- **"conversion of N inputs to products for arable crops can be 60-70% or even more" (Kitchen and Goulding, 2001)**
- **Phosphorus use efficiency …… often below 20-25% in year of fertilizer application**
- **But "efficiency of fertilizer P use is often high (up to 90 percent) when evaluated over an adequate time scale using the balance method." (Syers, Johnston, and Curtin, 2008)**





U.S. Corn - Estimated PFP_N



Courtesy, T. Bruulsema, IPNI 2011. *Based on USDA NASS and ERS data*

Fertilizer N & P Use Efficiency - Affected by:

- **N & P supply from:**
  - **Soil**
  - **Fertilizer**
  - **Other inputs**
- **Balanced supply of other essential nutrients**
- **Plant uptake**
- **N losses**
  - **volatilization, leaching, runoff, denitrification (**and nitrification**)**
- **P losses**
  - **runoff and some leaching**
- **All are affected by cropping system management and environmental conditions**

Agricultural Nutrient Loss Concerns

- **Air quality (N)**
  - **Ammonia emissions** (and NOx)
    - $PM_{2.5}$
      - smog, human health impacts
    - atmospheric deposition & acid rain
      - biodiversity loss of natural systems
      - eutrophication in sensitive aquatic systems
  - **Nitrous oxide** (*increased from 270 to 319 ppb*)
    - climate change/global warming
    - stratospheric ozone depletion (UV risks)
- **Water quality (N and P)**
  - groundwater **nitrate-N** contamination
  - surface water **N and P** contamination
    - eutrophication: lakes, streams/rivers, estuaries, and coastal waters





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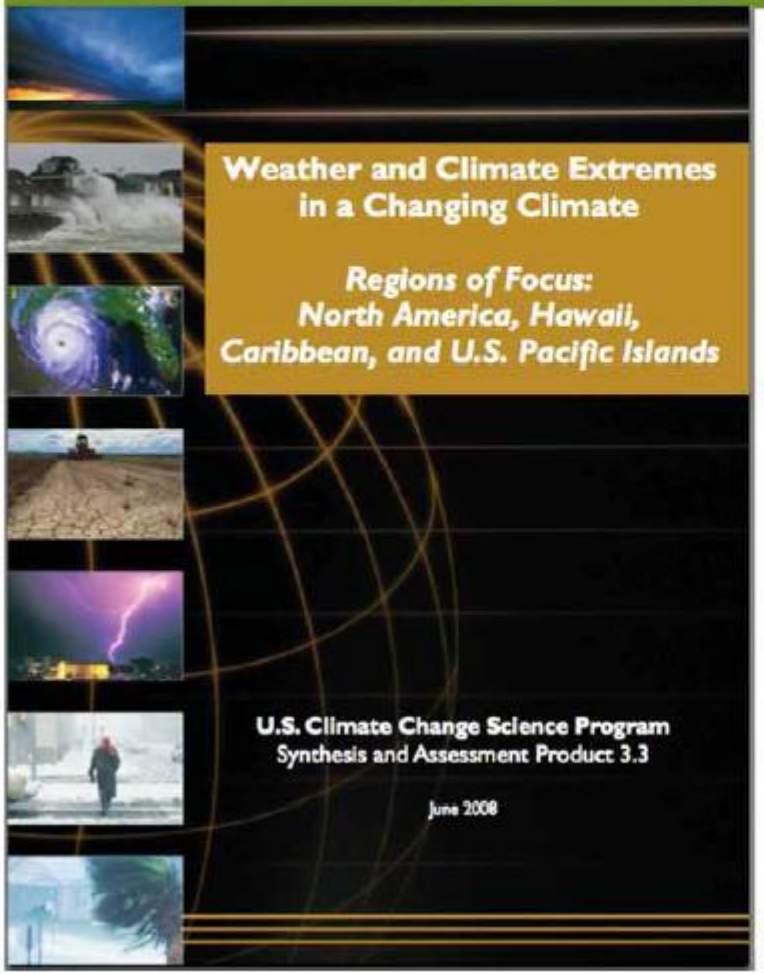

"One of the clearest trends in the United States observational record is an increasing frequency and intensity of heavy precipitation events… Over the last century there was a 50% increase in the frequency of days with precipitation over 101.6 mm (four inches) in the upper midwestern U.S.; this trend is statistically significant "

Karl, T. R., J. M. Melillo, and T. C. Peterson, (eds.), 2009: Global Climate Change Impacts in the United States. Cambridge University Press, 2009, 196pp.

http://www.leopold.iastate.edu/sites/default/files/pubs-and-papers/2011-02-will-climate-change-impact-sustainability-iowa-farms.pdf

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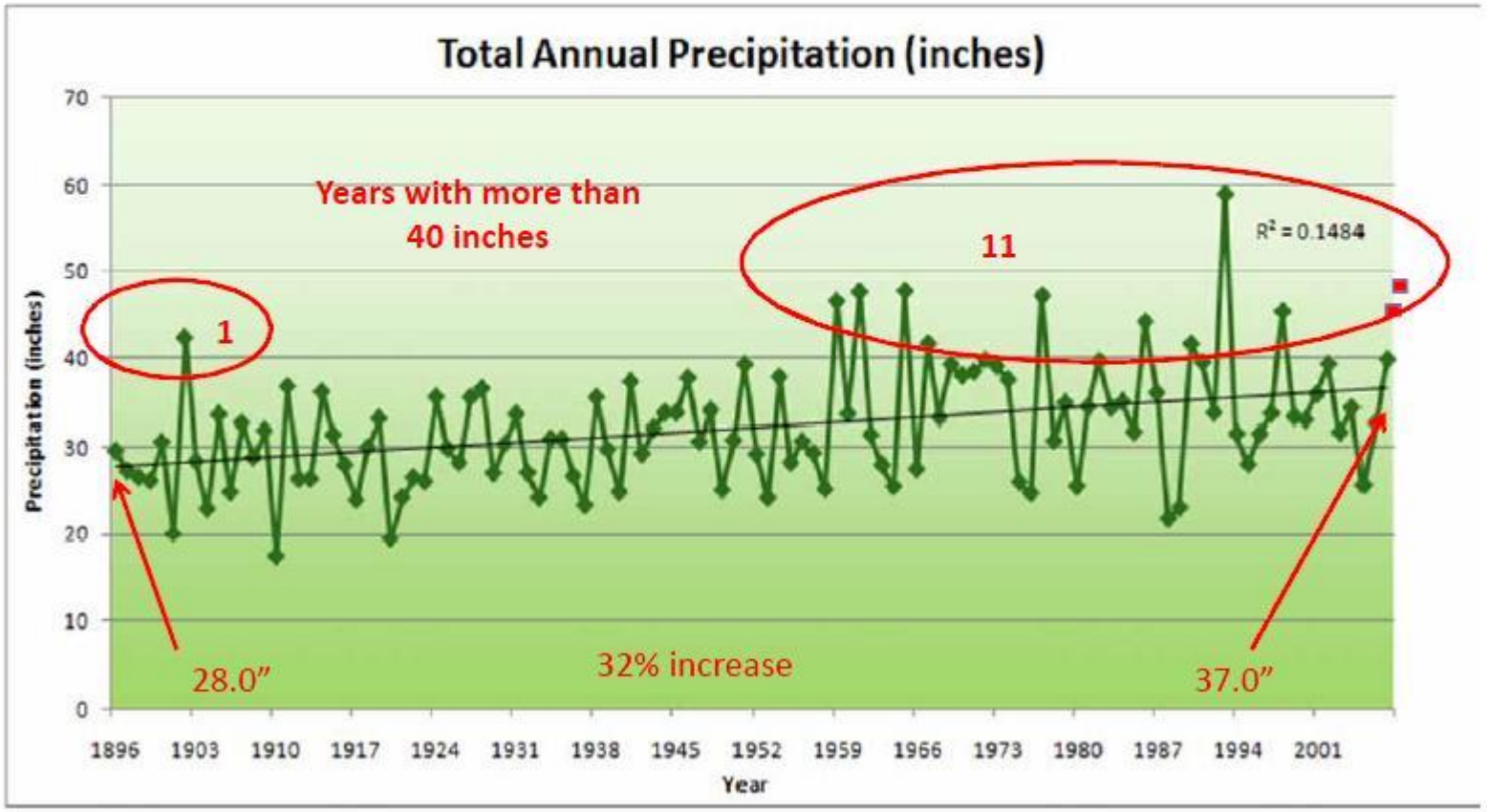
Cedar Rapids Data



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Eugene Takle

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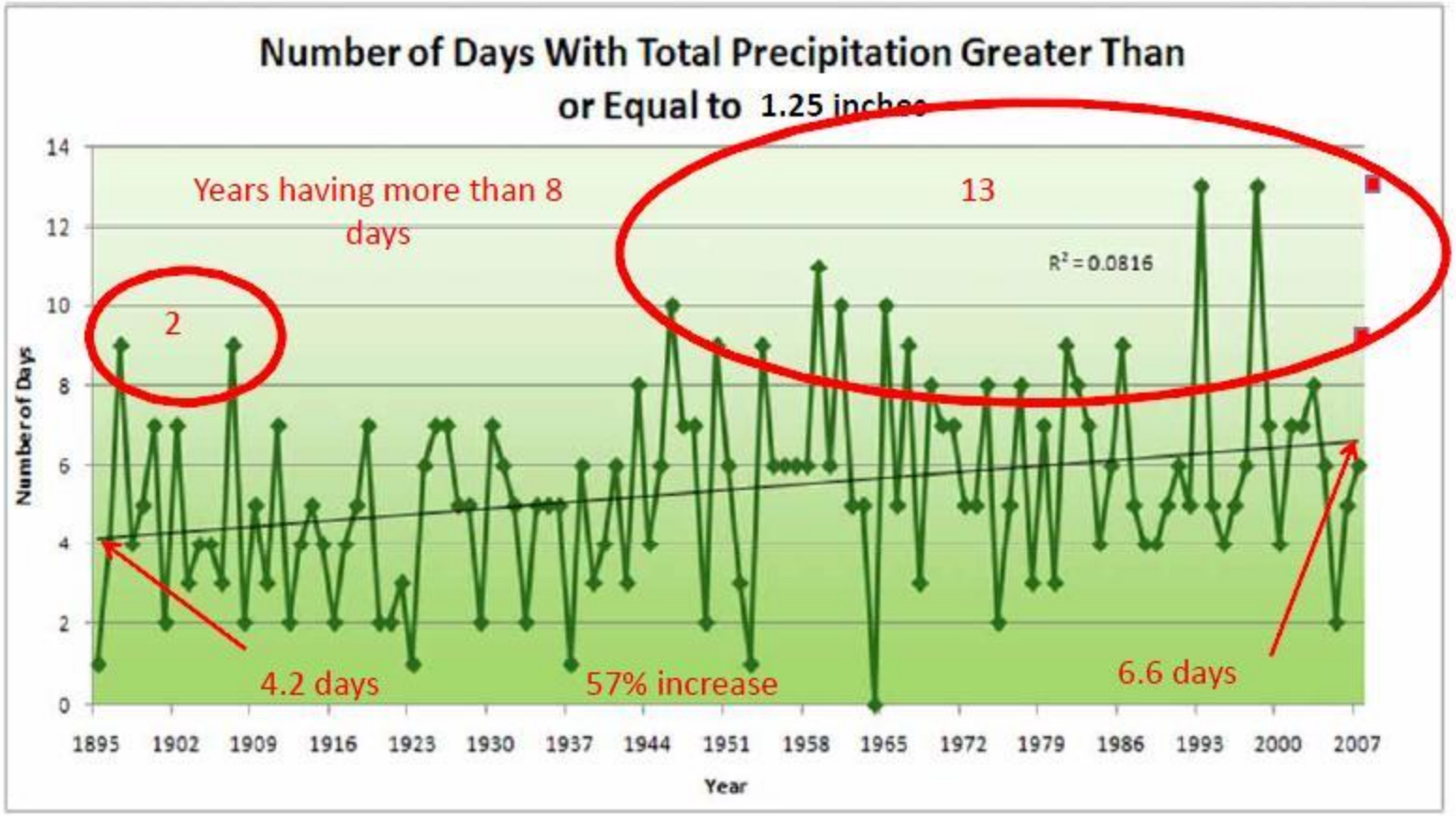

http://www.leopold.iastate.edu/sites/default/files/pubs-and-papers/2011-02-will-climate-change-impact-sustainability-iowa-farms.pdf
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http://images.google.com/images?client=safari&ris=en-us&q=cedar+rapids+flood+photos&oe=UTF-8&um=1&ie=UTF-8&ei=oYQaS7SwEcG0tge6ml3XAw&sa=X&oi=image_result_group&ct=title&resnum=1&ved=0CBMQsAQwAA

http://www.leopold.iastate.edu/sites/default/files/pubs-and-papers/2011-02-will-climate-change-impact-sustainability-iowa-farms.pdf

Eugene Takle

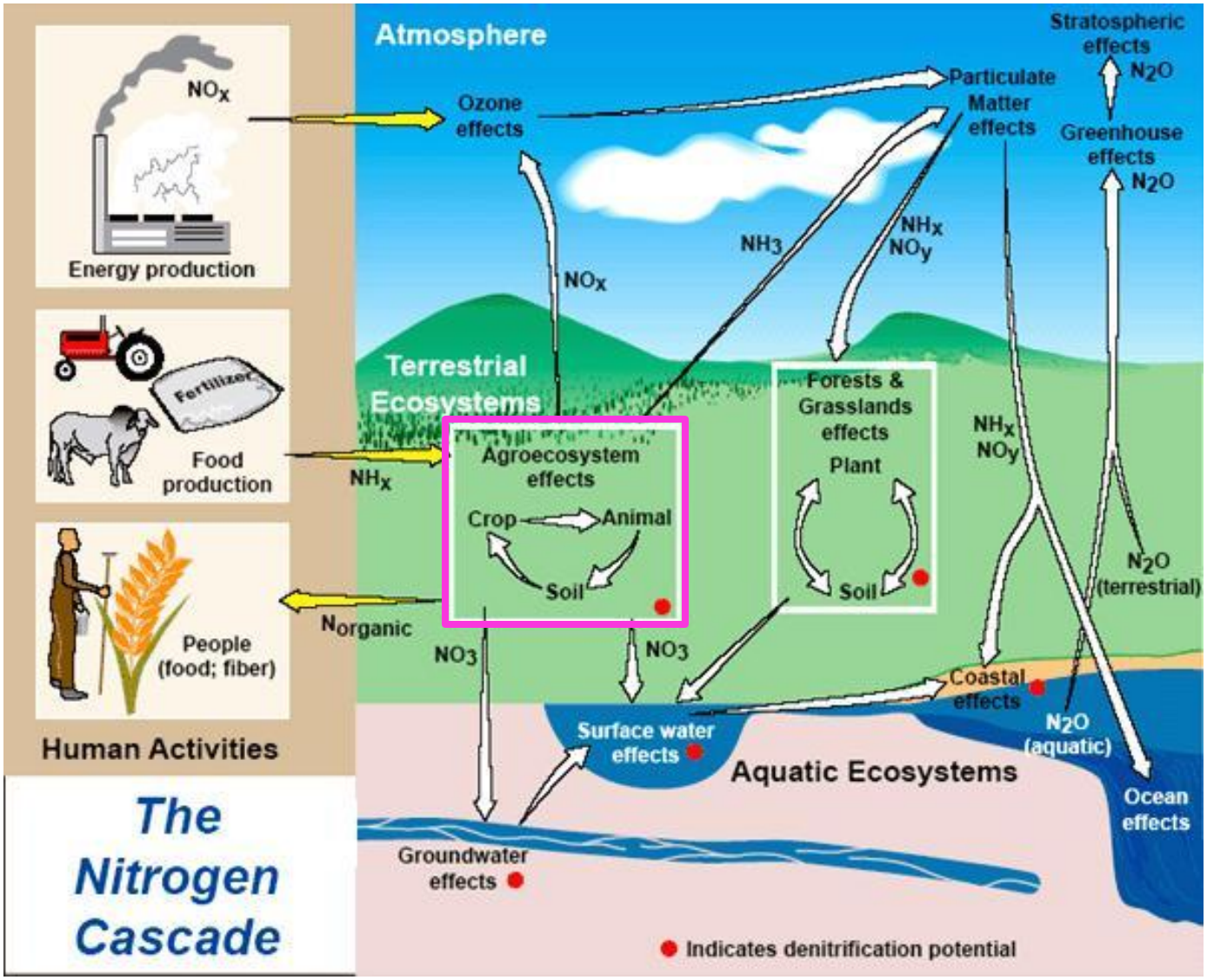
Is severe the new normal ?

Arkansas Times, July 20, 2011

Adapted from: USGS, Dr. John Czarnecki

The N Cascade

Galloway et al., 2007 Human Alteration of the Nitrogen Cycle: Threats, Benefits and Opportunities. April 2007 – No. 4. UNESCO-SCOPE



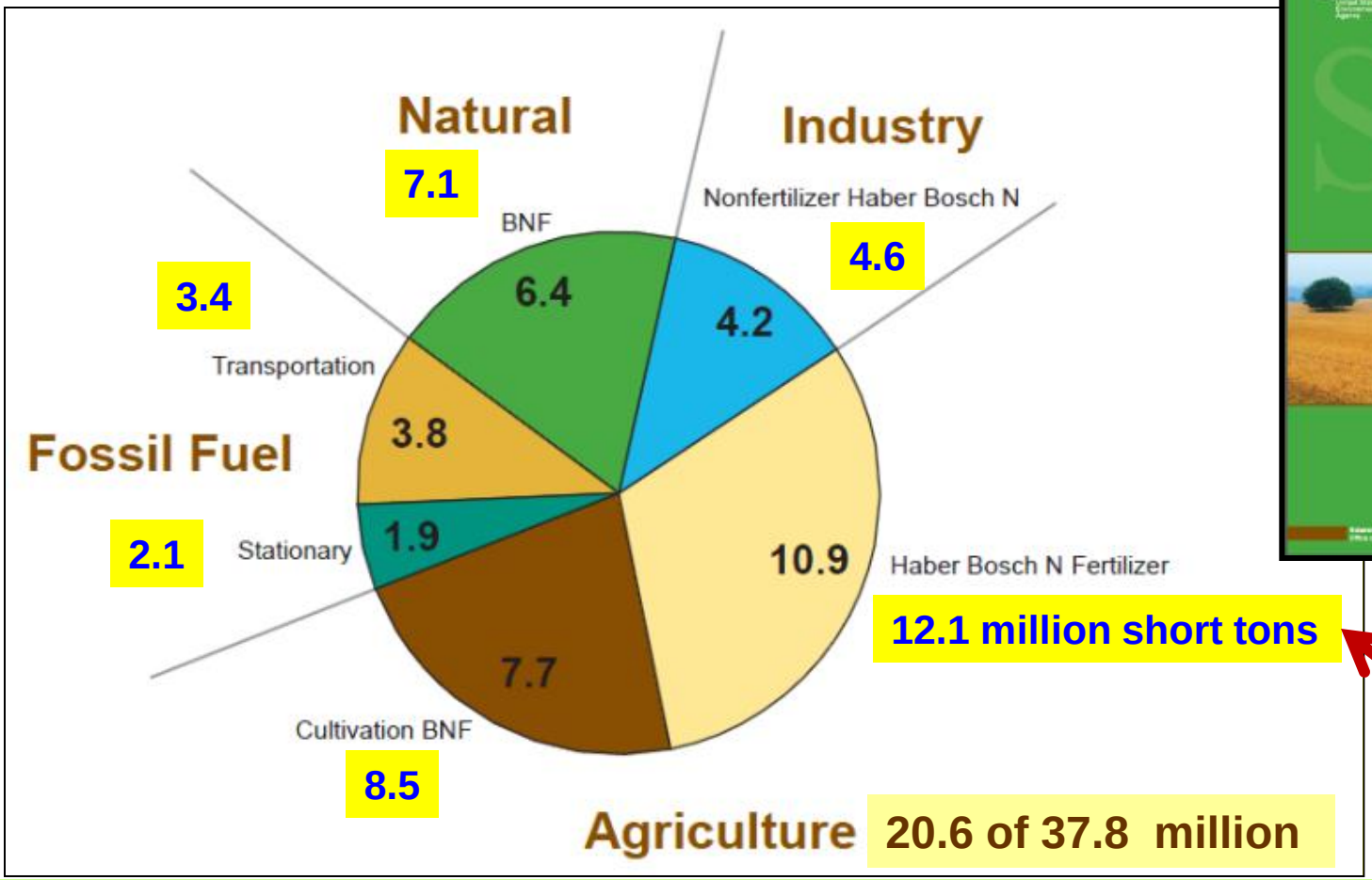
"The central challenge is how to optimize the use of nitrogen to sustain human life while minimizing the negative impacts on the environment and human health."

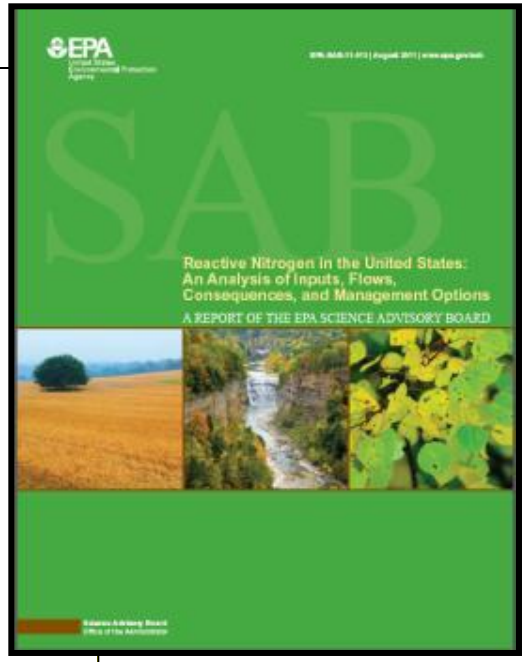
Alteration of Natural Systems

Source: Russ Gibson, NPS Program Manager, Ohio EPA

Source: U.S. Forest Service

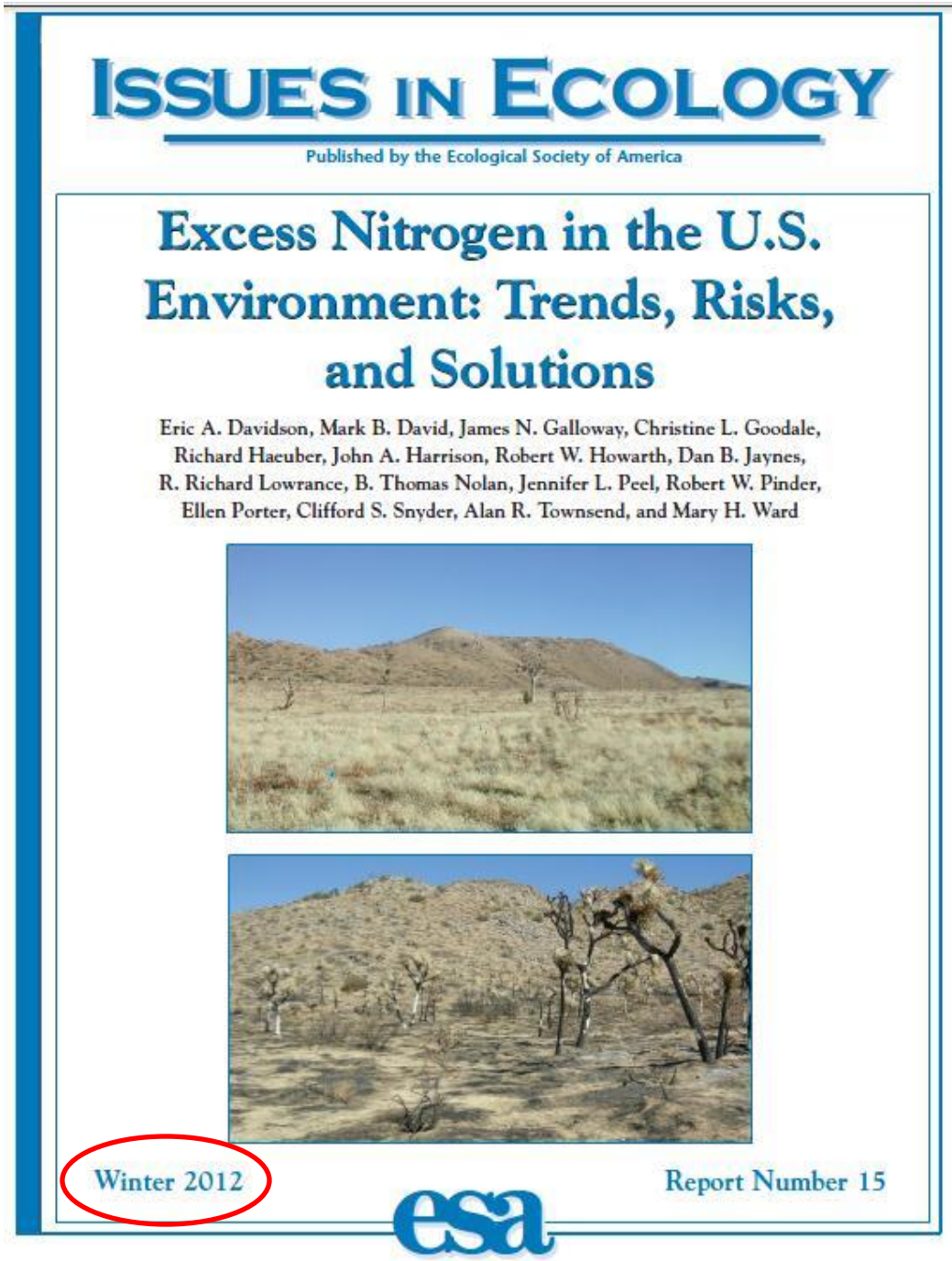
Sources of Reactive N (Nr) Introduced into U.S. in 2002 (Tg N/yr)





32% of N inputs

EPA SAB report: suggests crop N-uptake efficiencies be **increased by up to 25%** over current practices through a combination of knowledge-based practices and advances in fertilizer technology (such as controlled release and inhibition of nitrification).



- **N loss from farm and livestock operations can be reduced 30-50% using current practices and technologies**, and up to 70-90% with innovative applications of existing methods.
- Current U.S. agricultural policies and support systems, as well as declining investments in agricultural extension, impede the adoption of these practices.

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February 2012

"This isn't academic, folks," says Reed Rubinstein, senior counsel for the Chamber of Commerce. "When the federal government exercises its authority, it can send you to jail. We are all one regulation away from being out of business."

$PM_{2.5}$ and Ammonia Emission Implications?

- PM is the term for a mixture of solid particles and liquid droplets found in the air.
- Includes "inhalable *coarse particles",“ & "fine particles" (< 2.5* micrometers)
- Precursors: NOx, SOx, VOC, or ammonia

http://www.airnow.gov/ , and *www.epa.gov/.../policies_for_**pm25**_precursors-rich_damberg.ppt*

Role of Ammonia in Formation of $PM_{2.5}$

- **Europe, 2008 NATO paper*:**
  - EUROS model: ammonia can be provider of condensation nuclei to form ammonium nitrate and ammonium sulfate meteorological conditions, leading to rapid increase in $PM_{2.5}$
- **Mikkelson, Better Crops 2009, reported:**
  - "While livestock operations are the largest contributor to NH_3 emissions in North America, losses from N fertilizer also contribute significantly to total emissions."
- **NRCS, 2007 White Paper:**
  - "Though **ammonia is not designated as a pre-cursor pollutant under the CAA**, several air districts in California have chosen to include ammonia controls as part of their State Implementation Plans (SIPs) in PM non-*attainment zones."*

* Mensink and Deutsch. 2008. Air Pollution Modeling and Its Application XIX . NATO Science for Peace and Security Series C: Environmental Security. 5:548-556, DOI: 10.1007/978-1-4020-8453-9_60.

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EPA Requires Greater Accounting of Fertilizer N Related GHG Emissions

- **Beginning in 2010,**
  - **all U.S. ammonia production facilities are required to monitor, calculate and report their GHG emissions to EPA through its Greenhouse Gas Reporting Program.**
- **EPA will obtain data in late 2011 for 2010 emissions**
  - **from facilities based on use of higher tier methods and in particular assess how this data could be used to improve the overall method for calculating emissions from U.S. ammonia production.**

Draft EPA 2011 Inventory of U.S. GHG Emissions, 1990-2010

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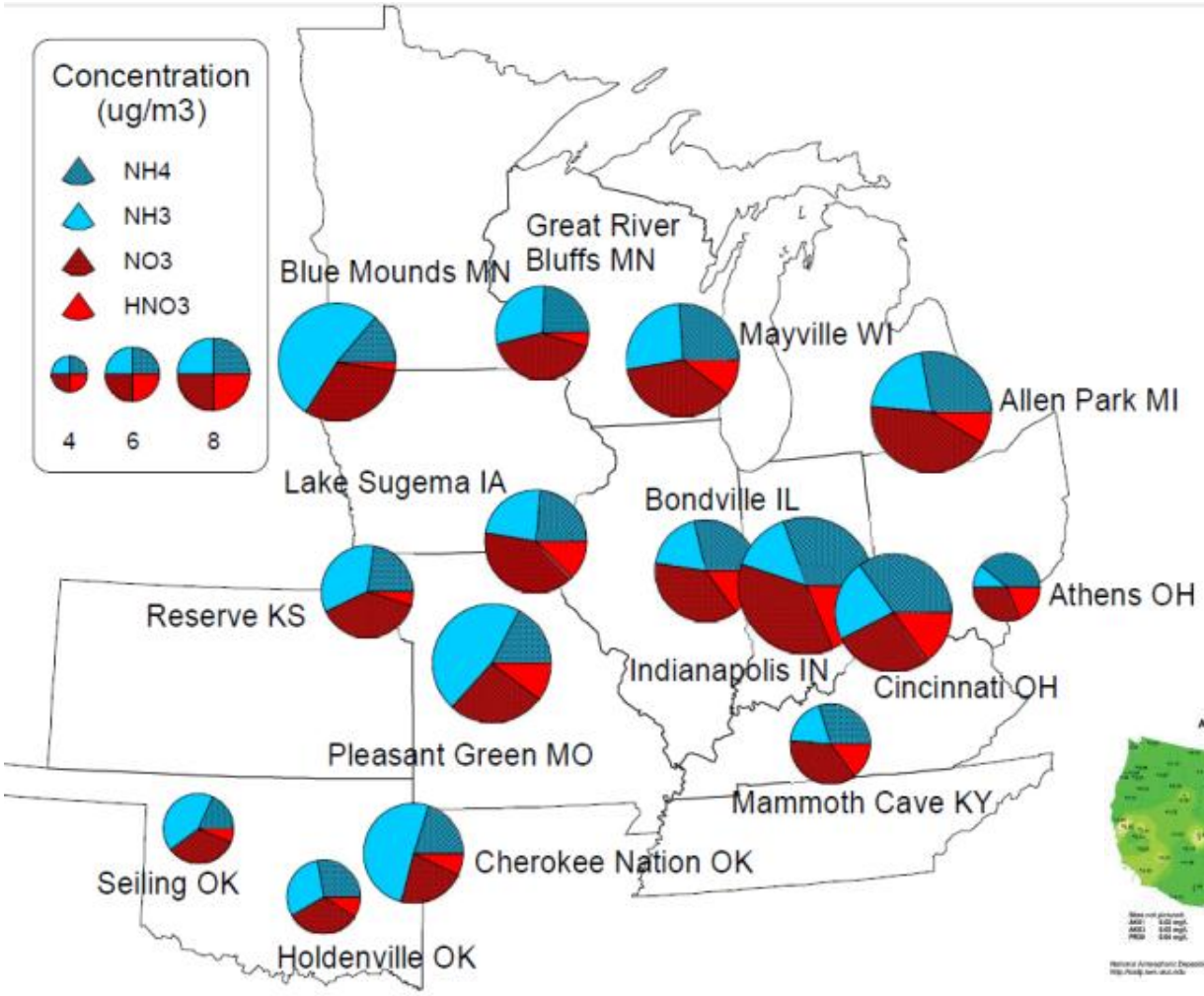
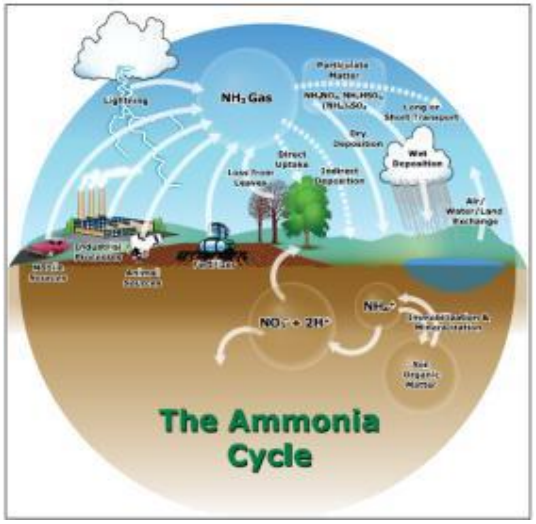
Midwest Ammonia Monitoring Network





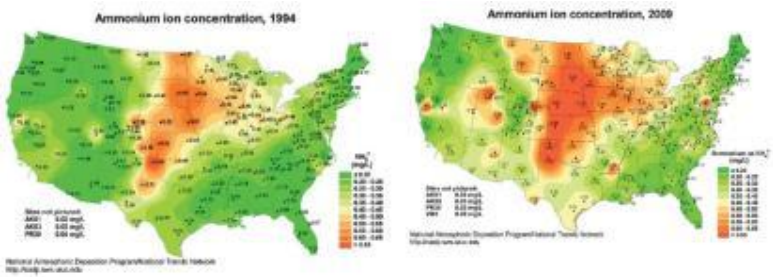
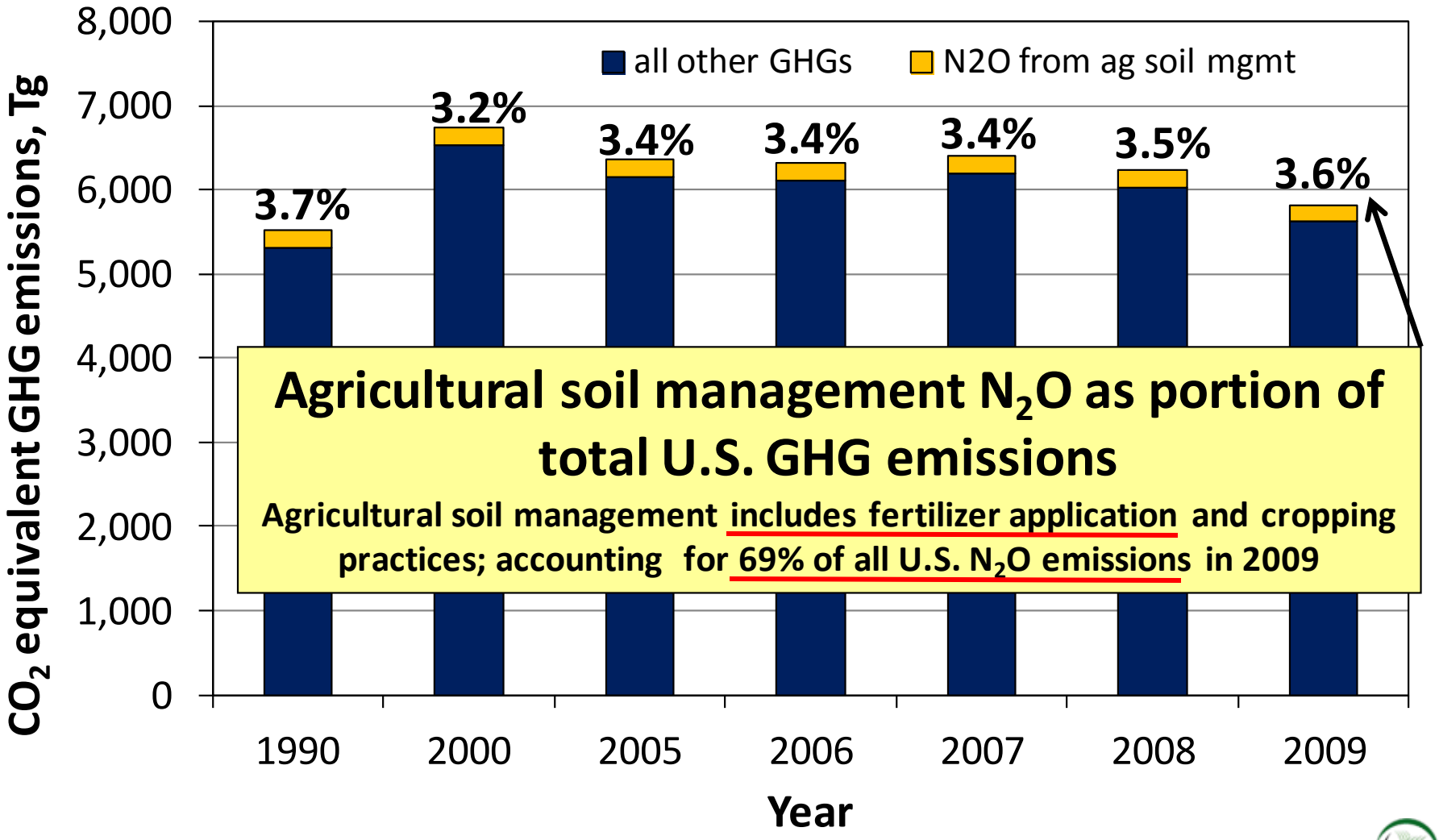


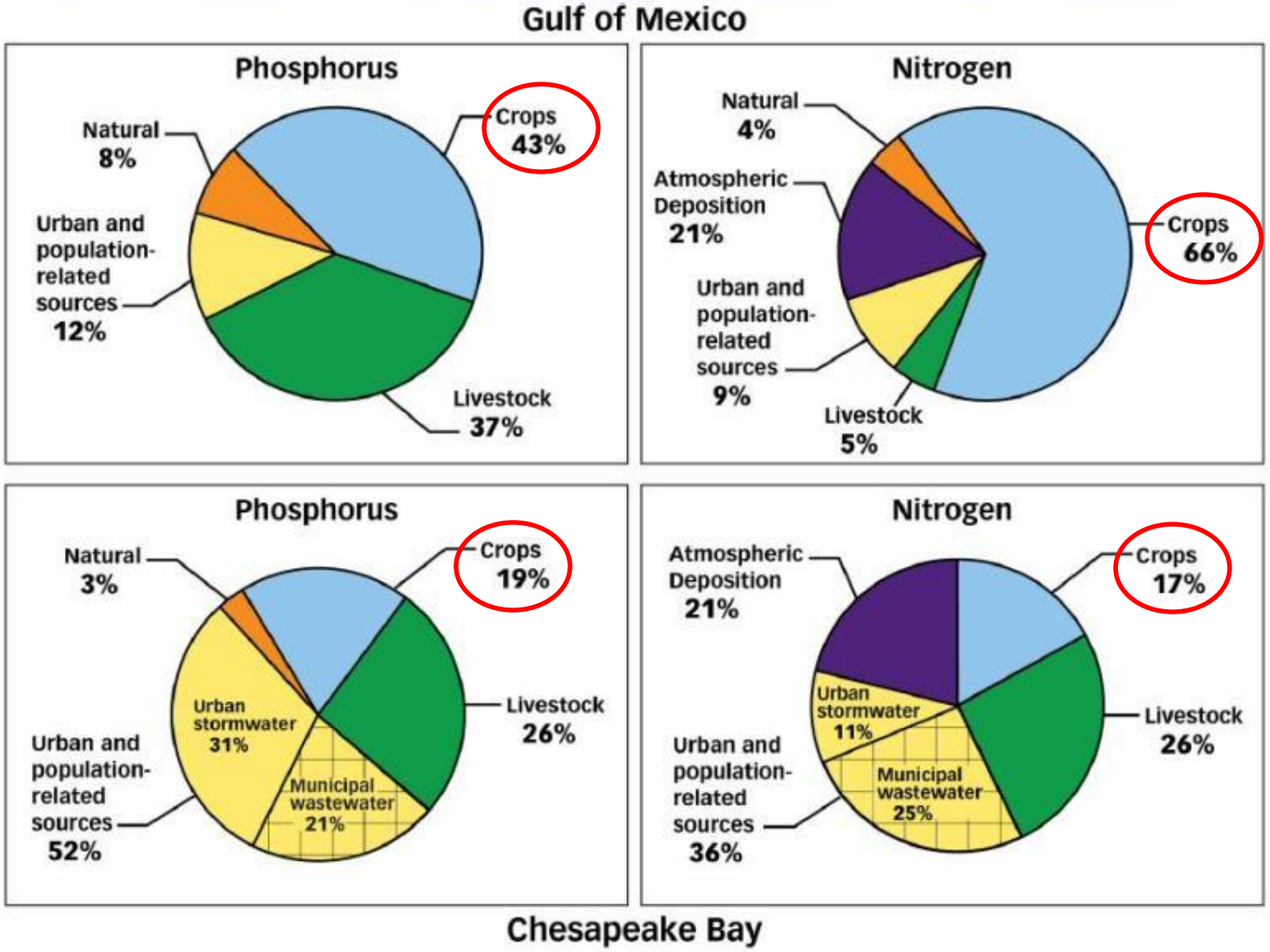
Figure 15. Mean concentrations of ammonia, ammonium, nitrate, and nitric acid at sites in the Midwest Ammonia Monitoring Project Network, Nov. 2003-June 2006.

Source: 2008 report prepared for Lake Michigan Air Directors Consortium
http://www.ladco.org/reports/rpo/data_analysis/analysis_of_midwest_ammonia_data.pdf

Net GHG Emissions and N_2O Associated with Agricultural Soil Management (EPA, 2011)



Relative Nutrient Source Contributions

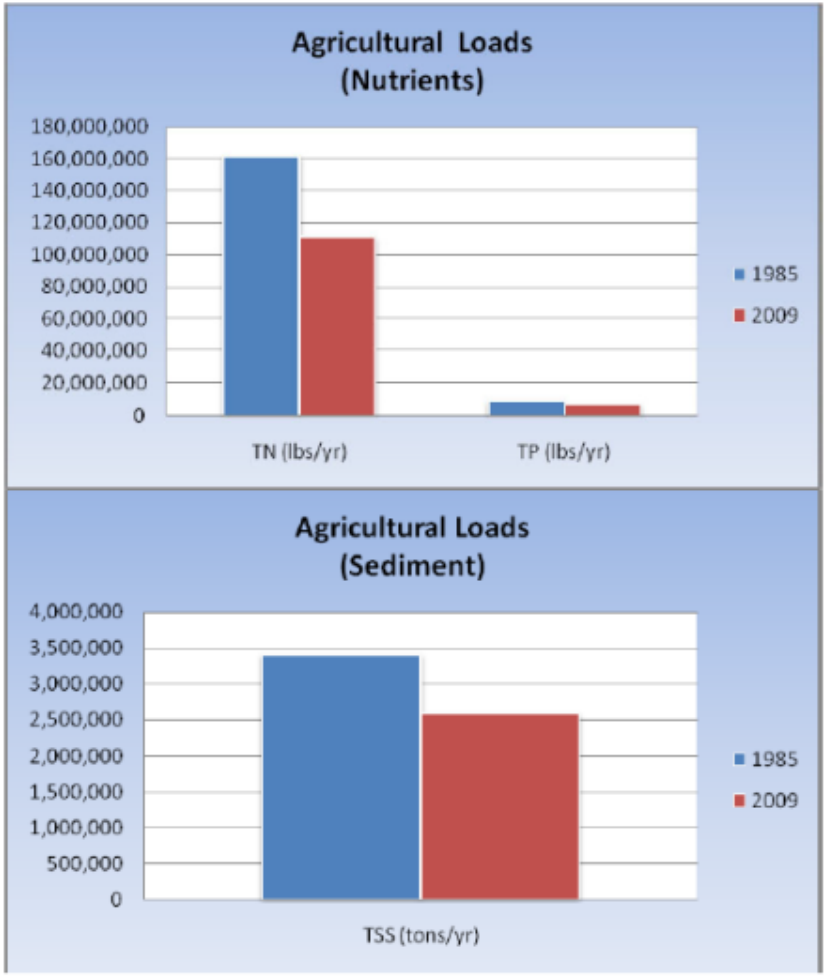


"The Chesapeake Bay pollution diet calls for a 25% reduction in N, 24% reduction in P and 20% reduction in sediment by 2025 "(EPA, 2010)

Graph Source: Ephraim King, EPA OST, 2010

Chesapeake Bay Final TMDL- Section 4 Info, Dec. 2010

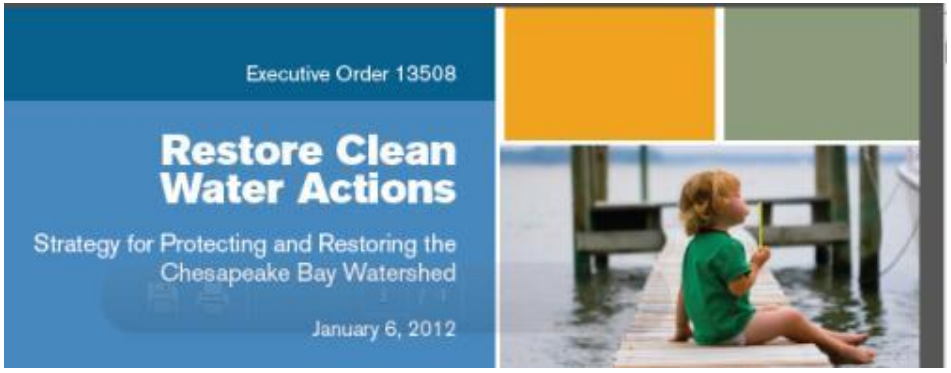
Chesapeake Bay TMDL



Source: Phase 5.3 Chesapeake Bay Watershed Model 1985 and 2009 Scenarios

1985 and 2009 modeled total N, P, and sediment loads from agricultural lands across the Chesapeake Bay watershed

- Model estimates of commercial fertilizer loads have been derived by back-calculation .
- *"As P*-based nutrient management plans increase, reliance on N fertilizer is expected to increase because less manure will be legally permitted to be applied to agricultural lands. **"Therefore chemical fertilizers are and will remain a significant potential source of N and P to the Bay***. "*



EPA & Expectations for Nutrient Load Reductions in Chesapeake Bay Watershed

- EPA expects *states to have "enforceable and accountable" measures for all agriculture,* including row crop farmers, implemented by 2025
- Chesapeake Bay Program model used to derive TMDLs
  - TFI challenged CBP model, and worked with LimnoTech to evaluate discrepancies between CBP model & USDA CEAP results
    - Differences: in land use and total acreage in the Bay watershed, and conservation practices.
    - CBP model: may overestimate nutrients and sediments from farmland reaching the Bay.

http://www.tfi.org/voice/limnotech-report-revisions-continue-highlight-importance-model-accuracy
http://www.nutrientpolicy.org/press_release_-_LTI_report_update_-_nov_8_2011_-_mk.pdf

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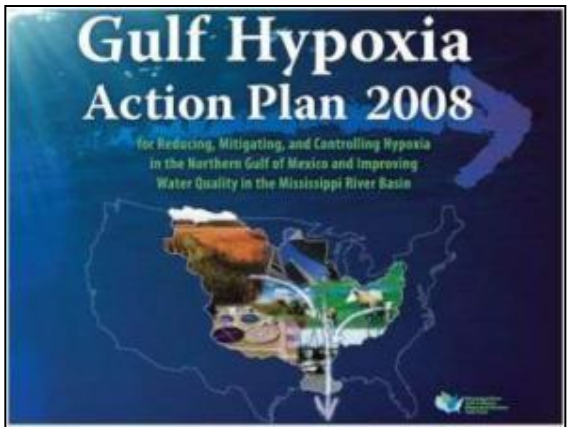
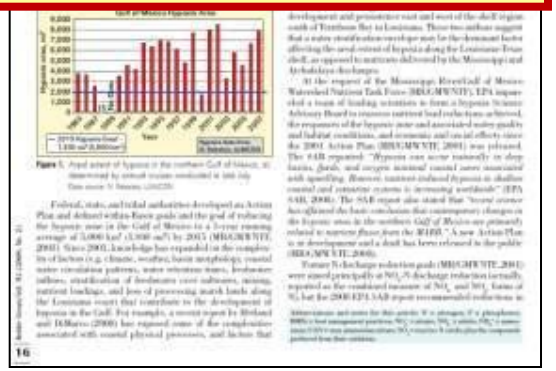
Virginia Law – Signed by the Governor Aug. 11, 2011

- *HB1830 (E. Scott) – Resource management plans; effect of implementation, exclusions*
- **"Allows farmers who develop and maintain agriculture resource management plans to be deemed as being in full compliance with any load allocation contained in a TMDL and any state water quality requirements for nutrient and sediment."**

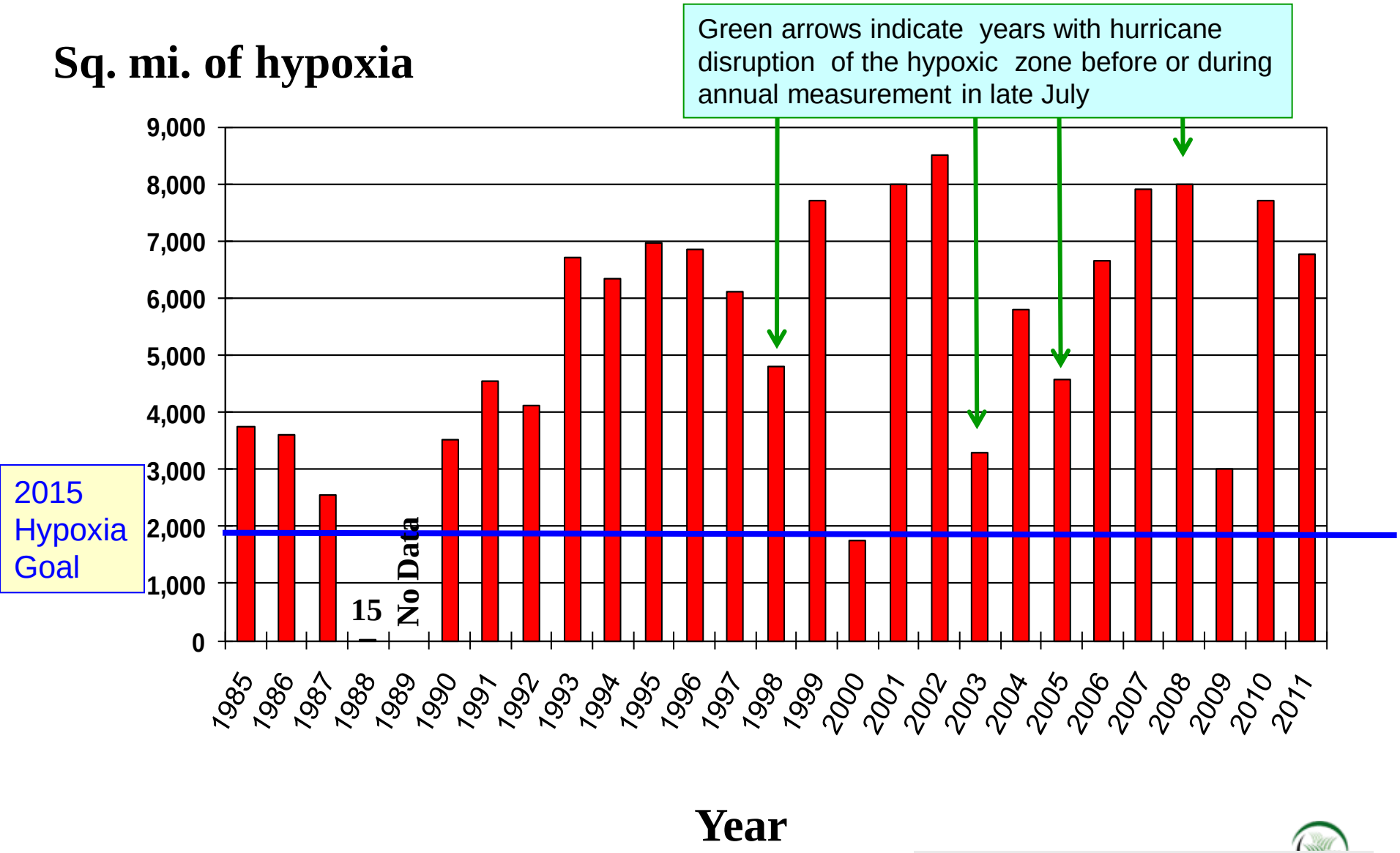
www.virginia.gov/news

EPA Hypoxia SAB report suggested
45% less total N
AND
45% less total P
discharge to the Gulf ….compared to average of 1980-1996, to reduce hypoxia





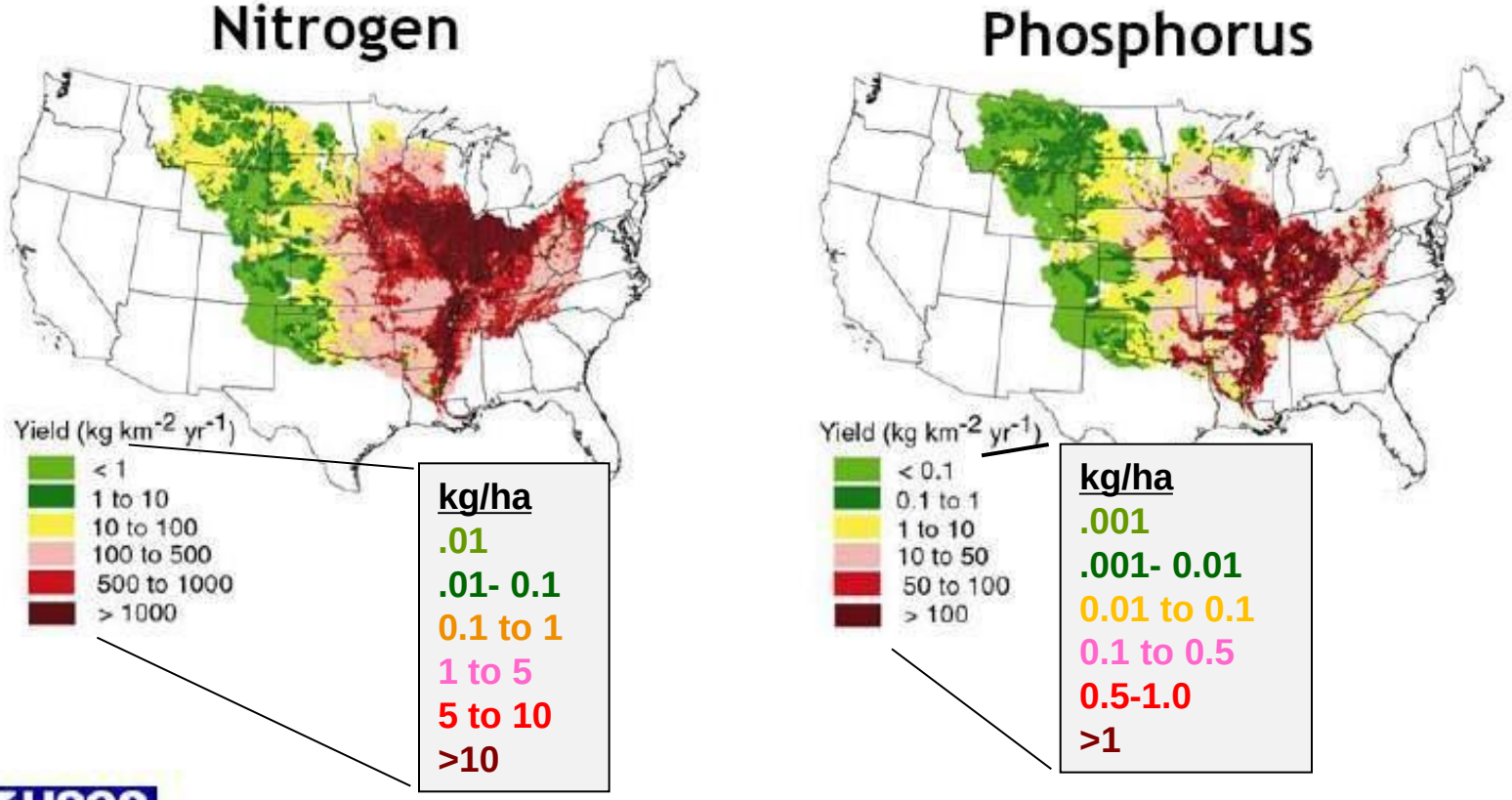
Gulf of Mexico Hypoxia Area



Hypoxia data from N. Rabalais, LUMCON

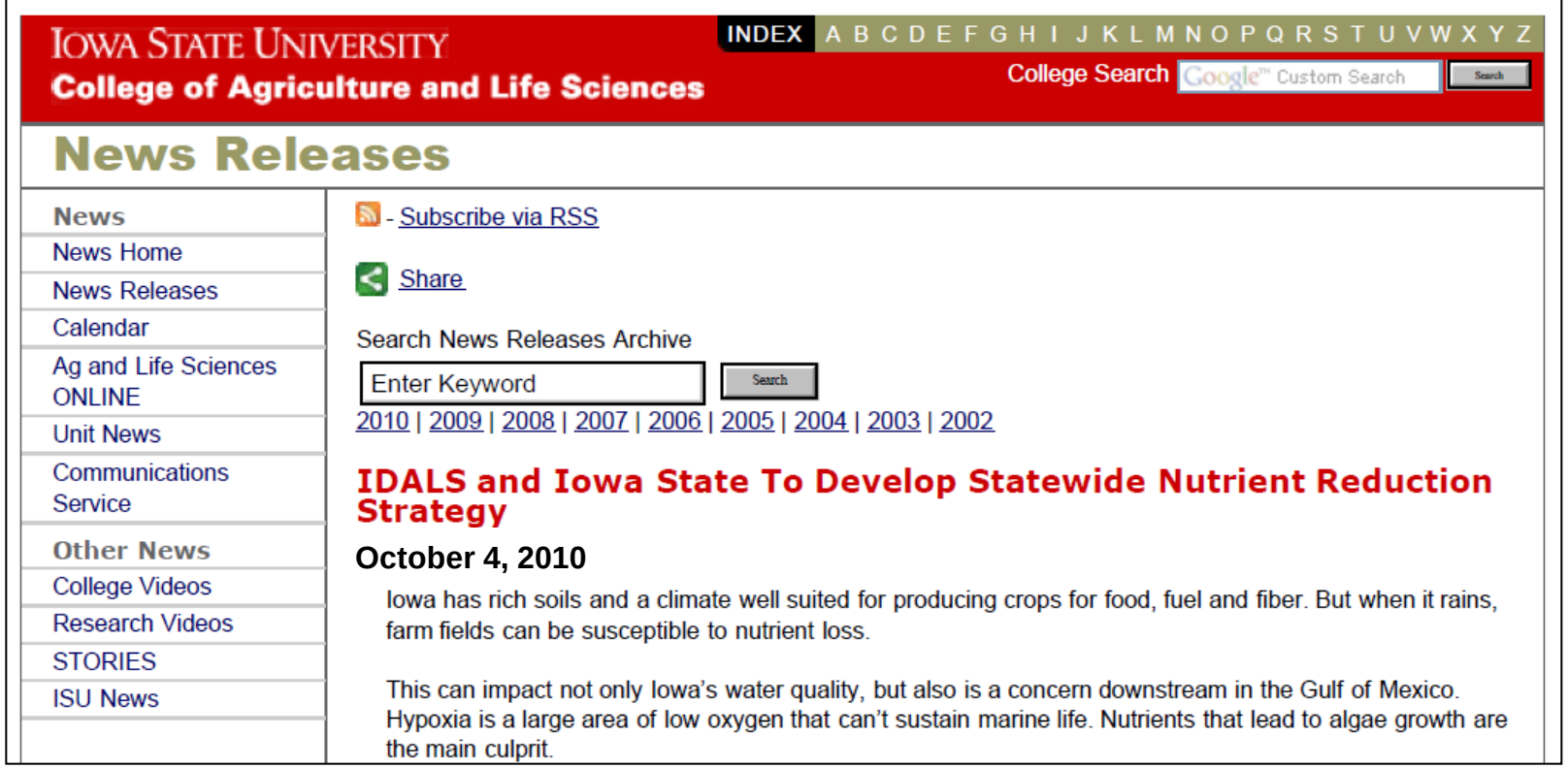
USGS Estimates of N and P Loss and Delivery to the Gulf of Mexico

SPARROW - Modeled Estimate of N and P Discharge in Watersheds of the Mississippi R. Basin



Alexander et al. *Environ. Sci. Technol. 2008, 42, 822–830*

- **"voluntary compliance, if you will, is not working. The self-regulated approach isn't working;"**
- **"one option is to look at applications and how much we allow people to apply and when we allow them to apply it."**
- **"I am in agreement with this newspaper in terms of what we've done in the past isn't working;"**
- **"We all have to acknowledge the fact that the problem is getting worse not better."**



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IDALS and Iowa State To Develop Statewide Nutrient Reduction Strategy

October 4, 2010

Iowa has rich soils and a climate well suited for producing crops for food, fuel and fiber. But when it rains, farm fields can be susceptible to nutrient loss.

This can impact not only Iowa's water quality, but also is a concern downstream in the Gulf of Mexico. Hypoxia is a large area of low oxygen that can't sustain marine life. Nutrients that lead to algae growth are the main culprit.

DesMoinesRegister.com

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Chet Culver: Limit use of fertilizer by farmers

By PERRY BEEMAN • pbeeman@dmreg.com • October 12, 2010

Iowa should consider limiting how much commercial fertilizer farmers apply to crop fields, Gov. Chet Culver said Monday.

The DNR has been ordered by the U.S. EPA to come up with standards for nitrogen and phosphorus in waterways. (*Wayne Gieselman, Environmental Services Division Chief, Iowa DNR*). "…. *commercial*-fertilizer management plans would be a good *idea.*"

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OH State Ag Agencies Recommend P Regulations – Oct. 17, 2011

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State Agencies Recommended Phosphorus Regulations

STATE DIRECTORS OF AGRICULTURE, NATURAL RESOURCES, AND OEPA ISSUE CALL FOR FARMERS TO ADOPT NEW AGRICULTURAL TECHNIQUES

Praise farmers for successfully reducing total phosphorus and sedimentation rates

Maumee Bay State Park — (Oct. 17, 2011) Meeting today along the shore of Lake Erie officials from the Ohio departments of Agriculture, Natural Resources, and the Environmental Protection Agency announced ongoing efforts towards reducing agriculture-related phosphorus from loading into the western basin, and encouraged farmers to immediately adopt updated best management practices for fertilizer application.

The three agencies also agreed, based on recommendations from a diverse working group that includes research scientists, agribusiness leaders, and environmentalists; to encourage farmers to adopt production guidelines known as 4R Nutrient Stewardship that is effective in reducing soluble forms of phosphorus from impacting waterways across the state.

The 4R concept promotes using the right fertilizer source, at the right rate, at the right time, with the right placement.

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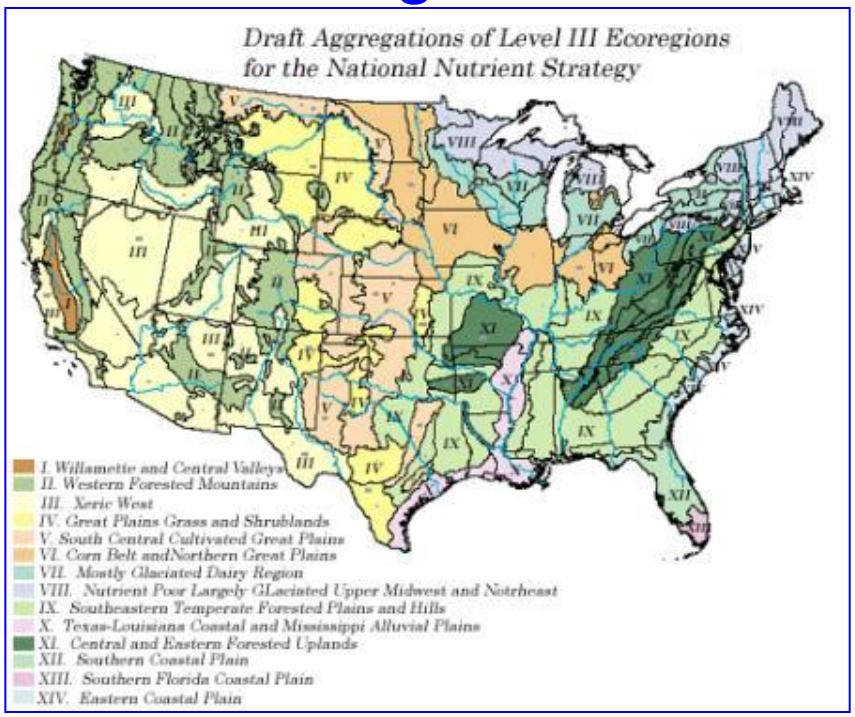
EPA National Nutrient Strategy

- Nutrient pollution is occurring at a national scale and has not been completely addressed.
- Forty-nine states and four territories have 303(d) listings due to nutrients,
  - about 50% of the states have >100 water quality impairments due to nutrients.
- Over 10,000 impairments are a result of nutrient pollution.

1998 - Ecoregional criteria



http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/strategy/index.cfm

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Florida Numeric Nutrient Criteria

- **FL submitted 1st draft NNC to EPA 2002**
  - 2002-2009: FDEP used Nutrient TAC and allocated ~$20 million in research and monitoring to develop criteria
  - 2010 (Jan): EPA proposes a NNC rule
- *2011 (Jun): EPA's initial response:*
  - If FDEP establishes protective nutrient criteria, then EPA will retract their rule: EPA not made up mind yet
- 2012 (Mar 6) EPA criteria take effect ??

Costs ??? – TBD by National Academy of Sciences

Adapted from T. Obreza

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What action can an ag producer take?

- The 1999 Florida Watershed Restoration Act provides a course of action: The FDACS BMP program.
- Producers who file a notice of intent and then implement appropriate BMPs are presumed to comply with water quality standards.
- In areas with Basin Management Action Plans (BMAPs), the BMP program is pseudo-regulatory. FL has bevy of BMP manuals

Adapted from: T. Obreza

Florida Watershed Restoration Act

- *"Implementation, in accordance with applicable rules, of* practices that have been verified by the department to be effective at representative sites shall provide a **presumption of compliance** with state water quality standards and release from the provisions of s. 376.307(5) for those pollutants addressed by the practices, and the department (i.e. ***Florida Department of Agriculture and Consumer Services***) is not authorized to institute proceedings against the owner of the source of pollution to recover costs or damages associated with the contamination of surface or ground *water caused by those pollutants."*

http://www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=Ch0403/SEC067.HTM&Title=-%3E2006-%3ECh0403-%3ESection%20067#0403.067

Water Legislation in Florida - FFAA 2/13/2012

- **FERTILIZER BILL DIES IN SENATE ENVIRONMENTAL PROTECTION**
  - a bill to recognize certified lawn care professionals with an exemption from any black out period for application that is in any local government ordinance
  - Committee voted down a compromise solution (4-3 vote), effectively killing the bill for this year.
- **NUMERIC NUTRIENT CRITERIA LEGISLATION PASSES**
  - FL adopted its own numeric nutrient criteria in opposition to that mandated by the EPA (H of R, 118-0 vote). The House companion substituted for Senate bill and passed by a 38-0 vote. **Governor signed Feb. 16, EPA delaying federal standard implementation**

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Environmental Groups Actively Pushing Stronger Regulations

Feb. 14, 2012

Dear Friend,

We've been slimed.

Every day, our streams, rivers, canals, and bays are under attack from fertilizer, sewage, and animal manure. **Maybe you've seen it yourself -- that telltale ugly green slime.** This pollution threatens our health, our way of life, and Florida's unique wildlife that depend on clean water.

The EPA developed pollution limits that could help clean up this slimy mess. **But, we need your help to get them implemented.** The Florida Department of Environmental Protection is moving to dumb down these new pollution limits. The EPA is signaling that they may approve these new "faux" limits. We can't let that happen.

Tell President Obama and the EPA to enforce strong, quantitative limits for pollution in Florida.

Together we can flood President Obama with letters demanding action to clean up this slimy mess. We must ensure that the EPA does its job and protects our water. A strong pollution limit is good news for anyone who swims, boats, fishes, or drinks water. It's time for the EPA to step up and act.

Call on President Obama today to take action and clean up Florida's toxic slime.

Thanks for all you do,

Cris Costello
Sierra Club

P.S. Activists from all over the state have been tracking and photographing Florida's toxic slime. Take a look, it isn't pretty.

Tell President Obama: Clean Up This Slime!

Take Action Today!

MN Turf and Lawn P Law – Since 1999

- **Use of P Fertilizer on Lawns and Turf is Restricted** (Minnesota Statutes 18C.60)
- Fertilizers containing P cannot be used on lawns and turf in Minnesota unless one of the following situations exists:
  - A soil test or plant tissue test shows a need for phosphorus.
  - A new lawn is being established by seeding or laying sod.
  - P fertilizer is being applied on a golf course by trained staff.
  - P fertilizer is being applied on farms growing sod for sale.
- When these situations do not exist, state law requires P-free lawn fertilizer is to be used.

http://www.mda.state.mn.us/phoslaw

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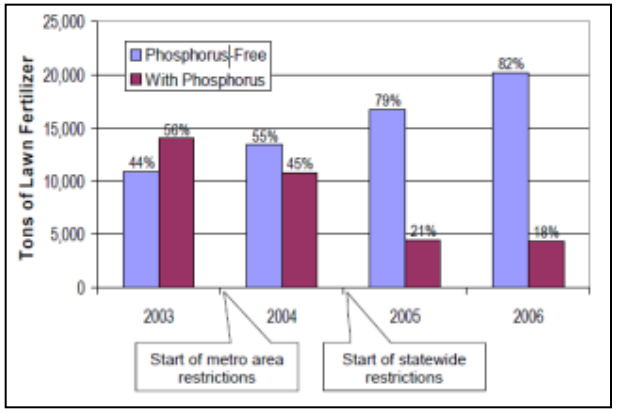
MN Turf and Lawn P Law – 2007 Results

- **P-free lawn fertilizer is readily available**
- **Law has reduced P lawn fertilizer use**
  - Use of lawn fertilizers containing P decrease 38% between 2003 and 2006.
  - In 2006, 82% of lawn fertilizer used was P-free
  - The amount of P in lawn fertilizer used decreased from 292 tons in 2003 to 151 tons in 2006
- **Law has not increased consumer cost**
- **No enforcement of the law has been reported**
- **Consumers supportive of the law**



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A novel strategy to reduce farm runoff will be tested starting in Minnesota

BY JOSEPHINE MARCOTTY
LAST UPDATED: JANUARY 16TH, 2012 05:33 PM (PST)

Minnesota will be the nation's first test site for a novel federal
cultural pollution that is strangling some of the country's great
the Gulf of Mexico and the Mississippi River.

Gov. Mark Dayton is expected to announce Minnesota's leadir
day morning, with Tom Vilsack, the U.S. secretary of agricultur
Environmental Protection Agency, at his side.

They are promoting the pilot project as a the start of an ambiti
give farmers a green seal of approval if they voluntarily choos
ahead of crop yields.

Behind the new strategy is a combination of political and fiscal
ingly concerned about clean water for drinking, swimming and
farmers - the primary source of unregulated water pollution in
hurdles. At the same time, funding for long-standing farm cons

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Secretary Vilsack Signs Historic Agreement with EPA and State of Minnesota Encouraging Farmers to Protect Rivers, Streams and Lakes

ST. PAUL, Minn., Jan, 17, 2012 – Agriculture Secretary Tom Vilsack today announced that the U.S. Department of Agriculture has signed a Memorandum of Understanding (MOU) with the U.S. Environmental Protection Agency and the state of Minnesota to develop a new state program for farmers designed to increase the voluntary adoption of conservation practices that protect local rivers, streams and other waters by reducing fertilizer run-off and soil erosion. Through this partnership producers, who undertake a substantial level of conservation activities to reduce nutrient run-off and erosion, will receive assurance from the state that their farms will meet Minnesota's water quality standards and goals during the life of the agreement. Vilsack, Minnesota Governor Mark Dayton and Environmental Protection Agency Administrator Lisa Jackson signed the MOU during a ceremony in the Minnesota Capitol.

http://www.thenewstribune.com/2012/01/16/v-printerfriendly/1985709/a-novel-strategy-to-reduce-farm.html

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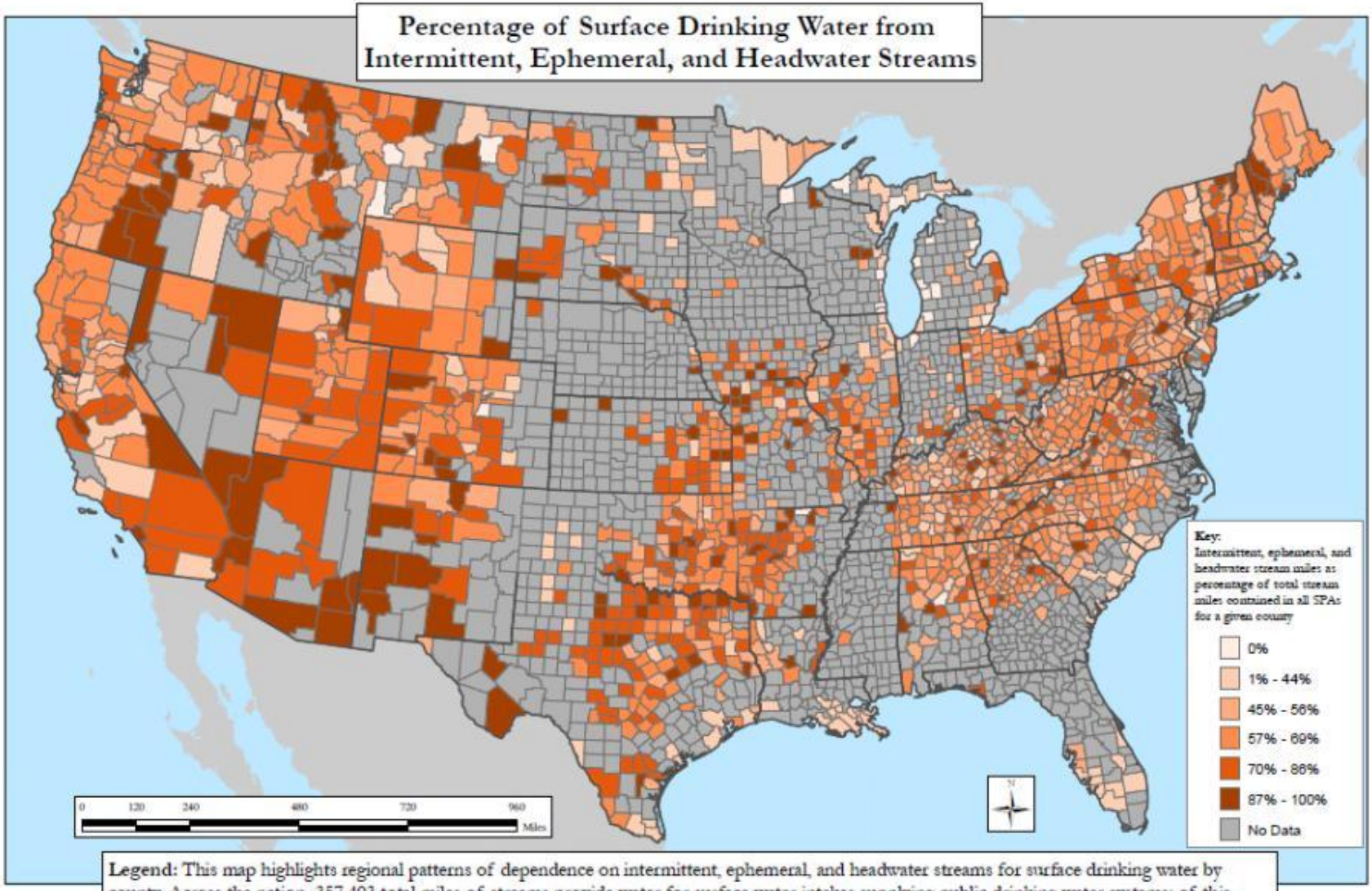
Minnesota, EPA, USDA Agreement Encouraging Farmers to Protect Rivers, Streams and Lakes (MOU signed Jan. 17, 2012)

- **assurances and incentives to participating farmers that their good deeds** – their strong commitment to conservation – **will be recognized**,
- " Vilsack said. "Farmers will know the rules of the game while the state, EPA and the public will know that this program will lead to *cleaner water."*
- USDA and EPA will offer support to Minnesota in developing its **certainty process for water quality improvements on private agricultural lands and eligible tribal lands in high priority watersheds.**
- *"..***producers who undertake a substantial level of conservation activities to reduce nutrient run-off and erosion will receive assurance from the state that their farms will meet Minnesota's water quality standards and goals during the life of the agreement** *(USDA NRCS)."*

Percentage of Surface Drinking Water from Intermittent, Ephemeral, and Headwater Streams



Legend: This map highlights regional patterns of dependence on intermittent, ephemeral, and headwater streams for surface drinking water by county. Across the nation, 357,403 total miles of streams provide water for surface water intakes supplying public drinking water systems; of this, 207,476 miles, or 58%, are intermittent, ephemeral, or headwater streams. Nationwide, over 117 million people receive drinking water from public drinking water systems that rely at least in part on intermittent, ephemeral, or headwater streams. This analysis compared the stream length of intermittent, ephemeral, and headwater streams to total stream length within all mapped Source Protection Areas (SPAs) for each county. A SPA is an area upstream from a drinking water source or intake that contributes surface water flow to the drinking water intake during a 24-hour period. This is based on data that generally do not include streams less than one mile in length. Intermittent streams are streams containing water for only part of the year. Ephemeral streams flow only in response to precipitation events. First-order streams have been used to represent headwater streams.
Data Sources: National Hydrography Dataset Plus at medium resolution; Federal Safe Drinking Water Information System 4th Quarter 2006 Data.

National Groundwater Nitrate

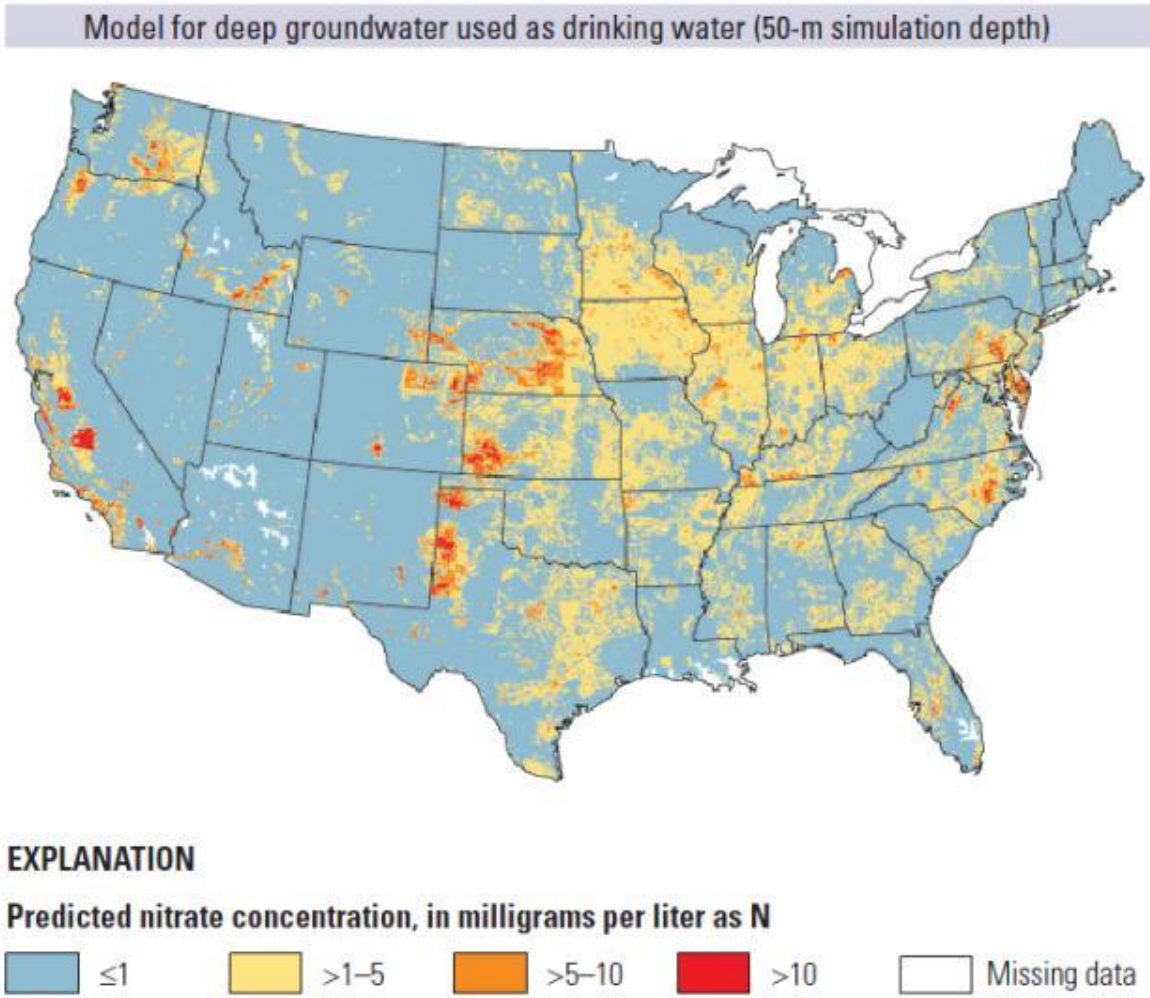


Figure 1-7. Results of model simulations suggest moderate (shown in yellow and orange) to severe (shown in red) nitrate contamination in relatively deep groundwater (greater than 164 feet or 50 meters below land surface) underlying parts of California, the Northwest, the High Plains, and the East. These areas typically are associated with large nitrogen input;

USGS Circ. 1350. 2010

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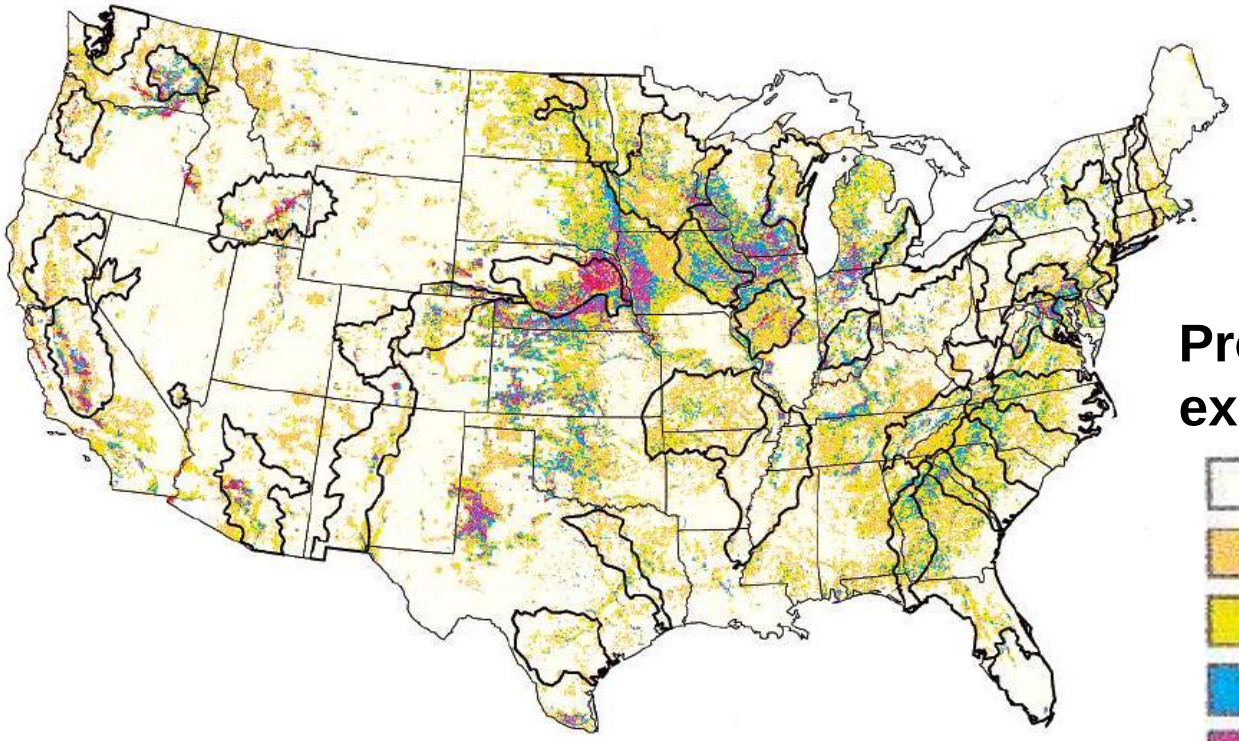
Probability of Nitrate Contamination of Recently Recharged Shallow Ground Waters in the Conterminous U.S.



Probability that nitrate-N exceeds 4 mg/L

- 0 – .17
- >.17 – .33
- >.33 – .50
- >.50 – .67
- >.67 – .83
- >.83 – 1

Nolan et al. Environ. Sci. & Technol. 2002. 36(10):2138-2145 (USGS)

Friday, March 9

7:30 am **Annual POWER Breakfast**
Topic: TBA

9:00 am **Breakout Sessions:**

The Klamath Dam Deal: A Model to Follow?
Greg Addington, *Executive Director, Klamath Water Users Association*

Nitrates in Groundwater: Is Regulating Agriculture the Answer?

Pamela Creedon, *Executive Officer, Central Valley Regional Water Quality Control Board*
Professor Thomas Harter, *Subsurface Hydrologist, UC Davis Cooperative Extension*
Maria Herrera, *Community Outreach Coordinator, Community Water Center*

Science, Money and Politics: Can They Coexist?
Byron Buck, *Executive Director, State and Federal Contractors Water Agency*
Tam Dudoc, *Board Member, State Water Resources Control Board*
Maureen McCarthy, *Executive Director, Tahoe Science Consortium*

Water Rights in a Climate Changed California: Adaptable or Abomination?
Tony Rossmann, *Partner, Rossmann and Moore*
Thomas Berliner, *Partner, Duane Morris LLP*

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State Commissioned - Preliminary Report on Nitrate Issues in California by UC-Davis

- **Charge:** help improve understanding of the causes of groundwater contamination due to nitrate, identify potential source reduction measures, remediation and treatment solutions, and funding sources to recover costs expended by the state to clean up or treat groundwater, and ensure the provision of safe drinking water to all communities.
- **Recommended practices can increase crop N recovery to ~60-80% of N inputs.**
- **Most promising revenue source: fee on nitrogen fertilizer use**
- **Significantly raise the cost of commercial fertilizer and for organic fertilizer sources (manure, green waste, wastewater effluent, biosolids, etc.).**
- **In areas declared at risk for nitrate contamination:**
  - **cap and trade system for nitrogen management**
  - **farm-level nutrient management plans, standards, and penalties**
  - **nitrogen fertilizer fees**

Source: R. Mikkelsen

http://www.waterboards.ca.gov/water_issues/programs/nitrate_project/index.shtml

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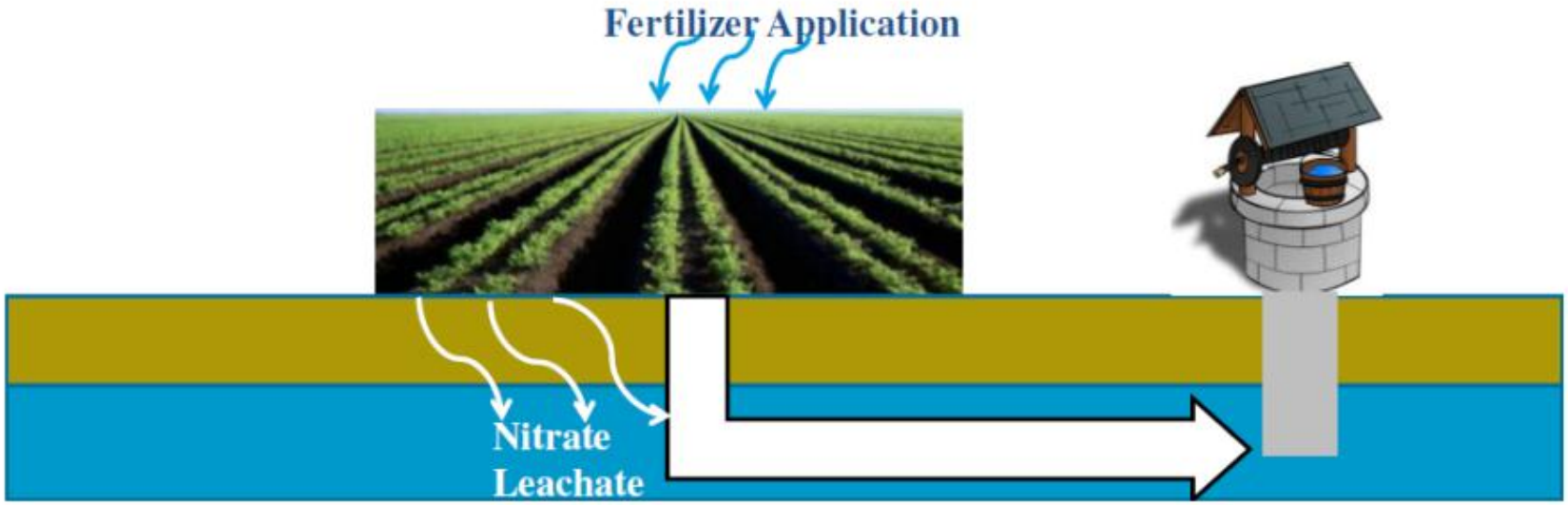
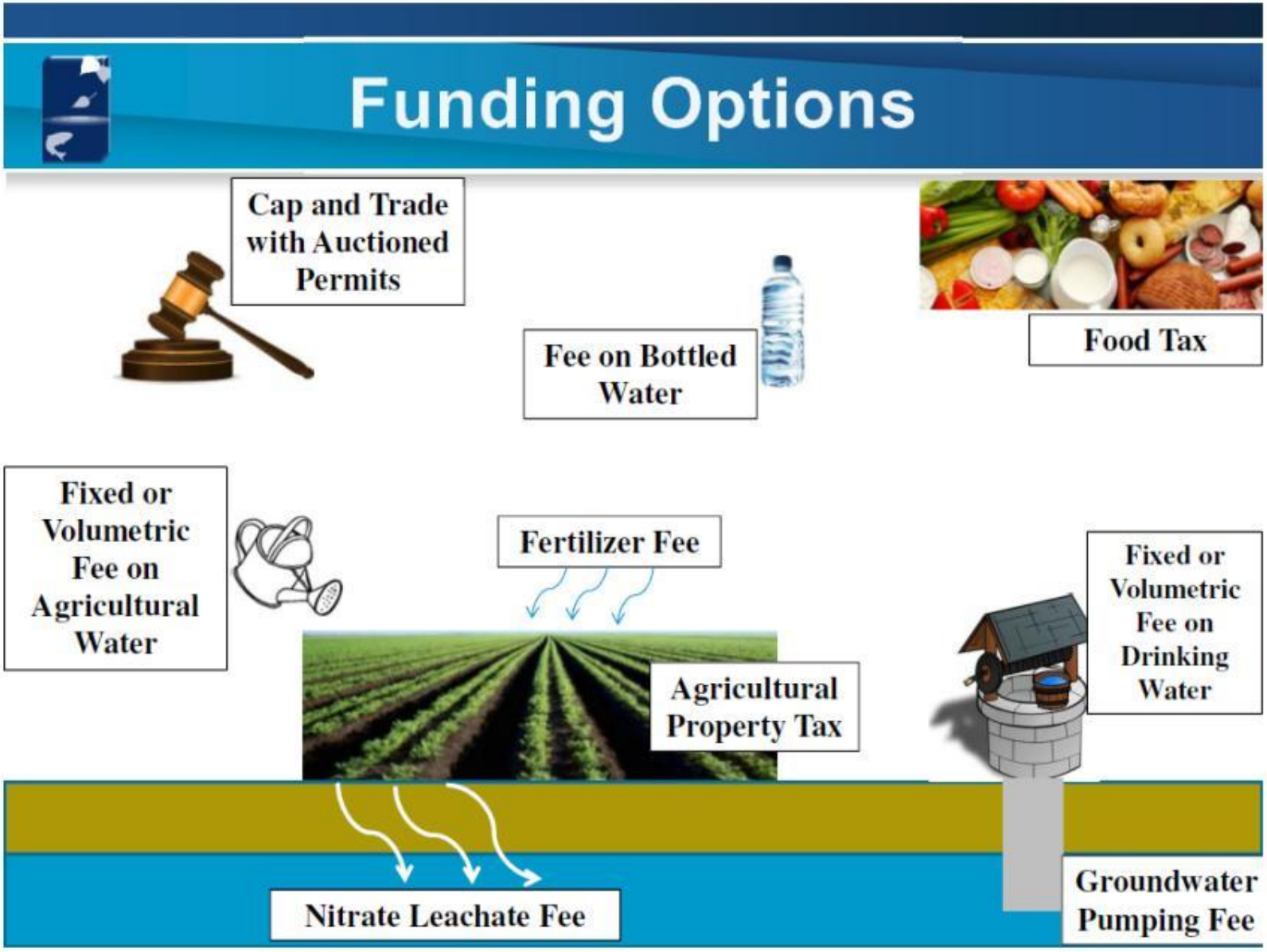
UC-Davis Report on Regulatory Options

What can be regulated?

Regulated Entity	Abatement Costs (costs incurred to reduce NO3 loading to achieve a standard)	Monitoring / Enforcement Costs	Information Requirements	Revenue Raising
Fertilizer Application	Higher – regulate input	Low	Low	Maybe
Nitrate Leachate	Lower – regulate pollutant	High	High	Maybe



UC-Davis Report – Funding Options



UC-Davis Report

Funding Options: Major Findings

- **Many options exist to fund clean drinking water, but all require someone to bear the cost.**
- **Some funding sources give polluters a price signal.**
  - Fees and auctioned permits induce emitters to reduce use of fertilizer or nitrate.
- **Farmers do not pay a sales tax on fertilizer in California.**
  - Expanding sales tax to fertilizer could generate $29 million per year in the study area and might reduce applied nitrogen by 5-10%.

UC-Davis Report

Regulatory Options: Major Findings

1. Many options exist to regulate nitrate in groundwater, but there is no ideal solution.

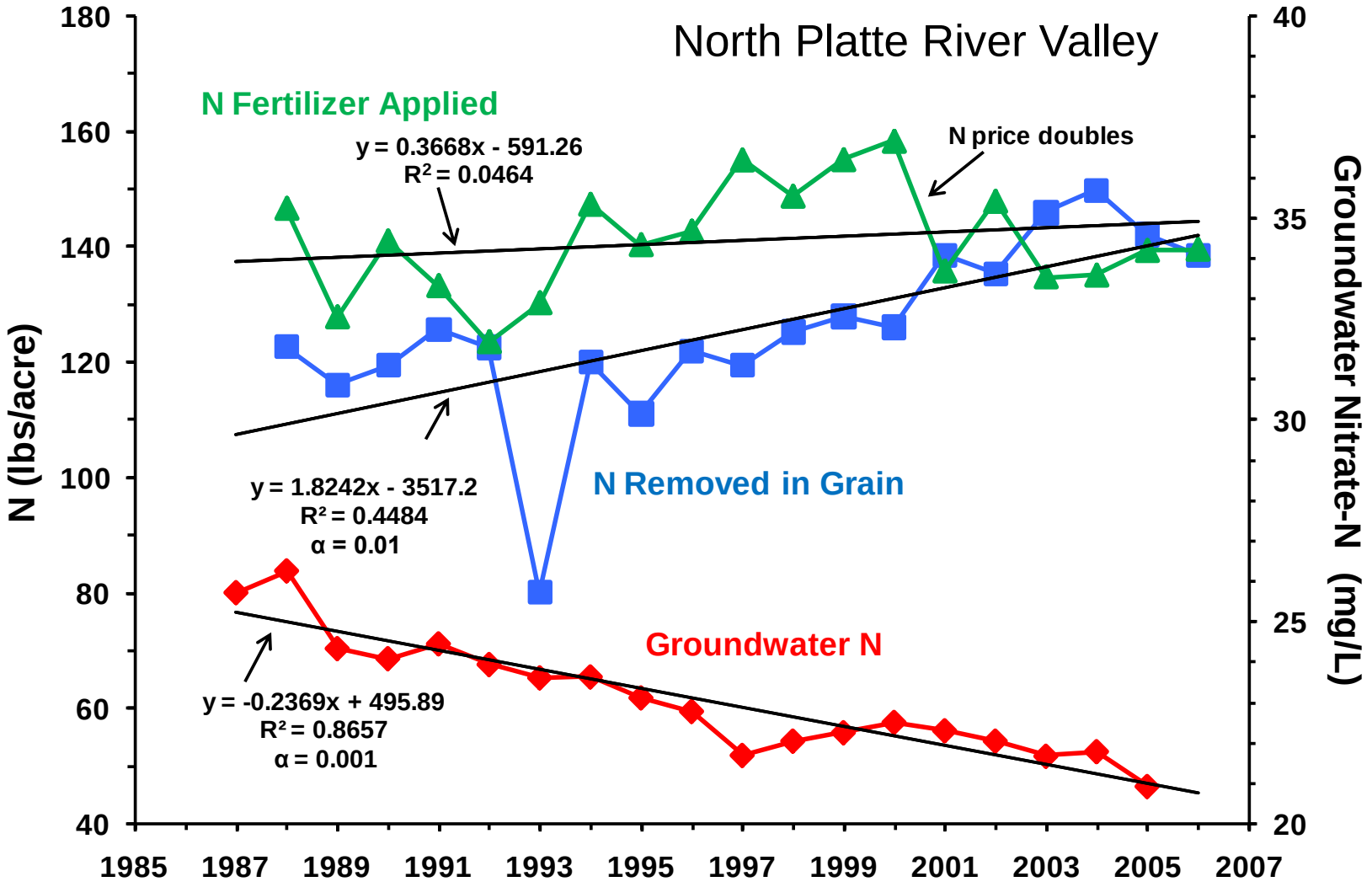
2. Fertilizer regulations have lower administrative costs and information requirements, but may be less direct in achieving nitrate abatement targets.

3. Market-based regulations reduce overall abatement costs, but require cap and trade institutions.

4. Well-defined and enforceable regulations are needed for liability rules to work.

5. Regulations cannot solve the drinking water quality problem in the short run.

Nitrogen Fertilizer Input vs. N Removal



Source: R. Ferguson, U. of Nebraska

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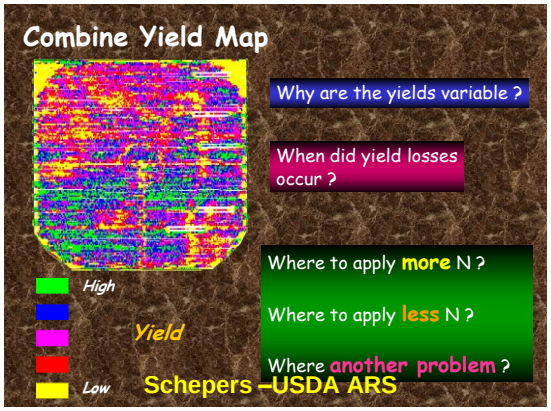
Many Factors Are Contributing to Changes in Nutrient Management and Educational Needs



Major changes in fertilizer costs or crop prices

Climate change induced shifts in cropping patterns, yields, soil processes

Genetic changes that alter crop yields and NUE

Changes in crop species due to bioenergy

Changes in plant parts harvested due to bioenergy

Manure composition changes due to distillers grains

Application of bioash

Government policy

Fertilizer and equipment technology & tools

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Crops & Soils

agronomy for practicing professionals

Reprint from
Crops & Soils magazine
Volume 42 • Issues 2–5

2009

Know your fertilizer rights

A five-part series created by the International Plant Nutrition Institute

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INTERNATIONAL PLANT NUTRITION INSTITUTE

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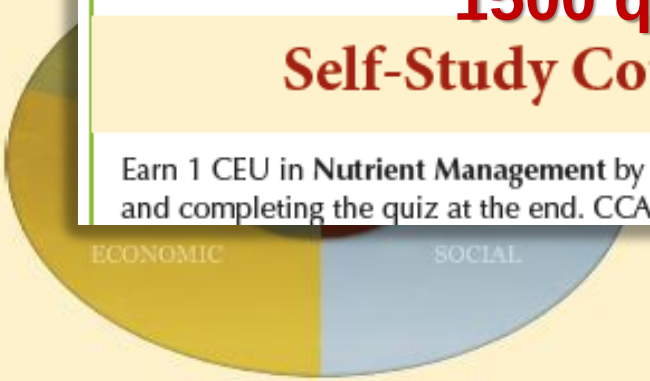
1500 quizzes

Self-Study Course

Earn 1 CEU in **Nutrient Management** by reading this article and completing the quiz at the end. CCAs may earn 20 CEUs



An American Society of Agronomy Publication

Know your fertilizer rights

By Tom Bruulsema, International Plant Nutrition Institute, Guelph, ON, Canada; ***Jerry Lemunyon***, USDA-NRCS, Fort Worth, TX; and ***Bill Herz***, The Fertilizer Institute, Washington, DC

The four fertilizer rights: Selecting the right source

By Robert Mikkelsen, International Plant Nutrition Institute, Merced, CA; ***Greg Schwab***, University of Kentucky, Lexington; and ***Gyles Randall***, University of Minnesota, Waseca

Selecting the right fertilizer rate: A component of 4R nutrient stewardship

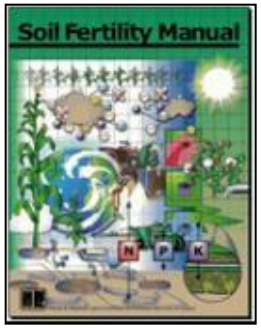
By S.B. Phillips, International Plant Nutrition Institute, Owens Cross Roads, AL; ***J.J. Camberato***, Purdue University, West Lafayette, IN; and ***D. Leikam***, Fluid Fertilizer Foundation, Manhattan, KS

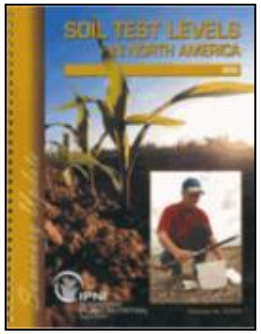
The four fertilizer rights: timing

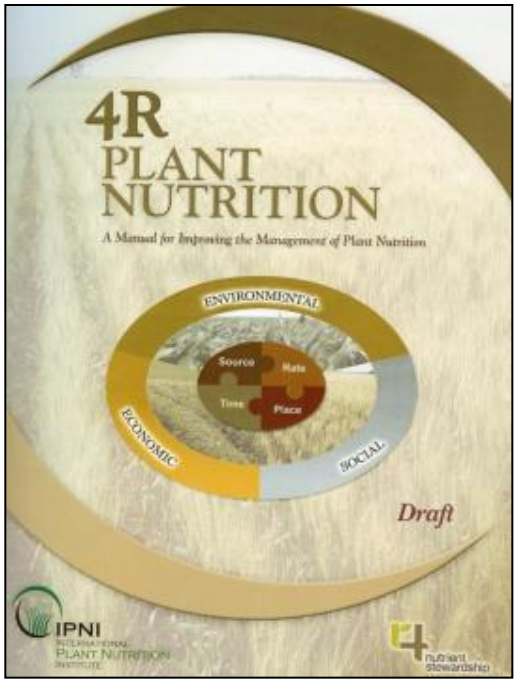
By W.M. Stewart, International Plant Nutrition Institute, Norcross, GA; ***J.E. Sawyer***, Iowa State University, Ames, IA; and ***M.M. Alley***, Virginia Tech, Blacksburg, VA

The four fertilizer rights: placement

Scott Murrell (IPNI),Tony Vyn (Purdue), Guy Lafond (AAFC), Dave Finlayson (CFI),







New 4R Nutrient Stewardship Education

- Intensified education: 6 IPNI regional directors in N. America, and other directors globally
- CCA and ag professional training
- Working with state fertilizer associations in key watersheds
- Scientific participants in USDA GHG CIG N_2O mitigation efforts in IA & IL
- Involved in U.S. Research Coord. Network for Reactive N in Environ., mitigation science advisory and protocol committees

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Illinois Enhanced Nutrient Stewardship Strategy

KIC 2025
Keep It for the Crop by 2025

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nutrient stewardship

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ILLINOIS COUNCIL ON BEST MANAGEMENT PRACTICES

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Illinois Corn Growers Association, the Illinois Soybean Association, the Illinois Farm Bureau, the Illinois Fertilizer & Chemical Association, the Illinois Pork Producers and Syngenta Crop Protection.

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http://www.kic2025.org/media/KIC%202025%20Program.pdf

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- **Fertilizer N BMPs can help minimize the potential for residual NO_3-N accumulation & losses**

- **N source, rate, timing, and place of application …. which may include**
  - **Urease inhibitors**
  - **Nitrification inhibitors**
  - **Slow-release materials**
  - **Controlled-release materials**
- **In combination with appropriate, site-specific cropping system and conservation practices**
  - **(e.g. conservation tillage, cover crops, vegetative buffers, managed drainage, wetlands, bioreactors, etc.)**
- ***What could we accomplish if in-field, edge of field, and above stream BMPs are coupled?***

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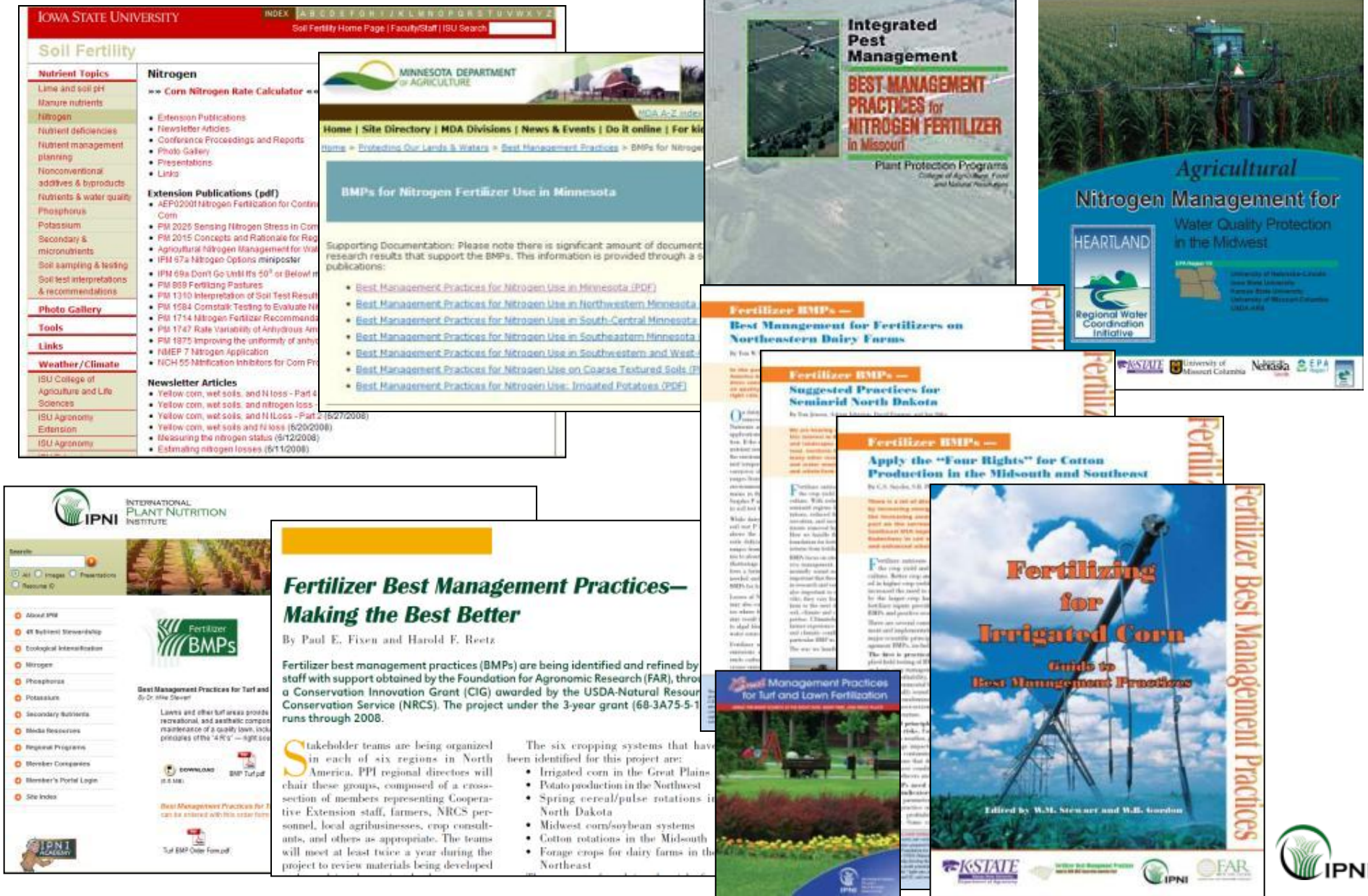
Example Fertilizer N BMP Guides



Fertilizer Nitrogen BMPs to Limit Losses that Contribute to Global Warming

By C.S. Snyder

THE CONCEPT of fertilizer best management practices (BMPs) is not new...it was first introduced almost 20 years ago (Roberts, 2007). Fertilizer BMPs are more important today than ever before and need to be based on a simple concept of matching the nutrient supply with crop requirements, while minimizing nutrient losses from fields. All fertilizer consumers should apply the correct nutrient in the amount needed, formed and placed to meet crop demand – "right product, right rate, right time, and right place." Fertilizer BMPs must be adaptable to all farming systems, since one size does not fit all (Roberts, 2007).

Properly balanced plant nutrition with fertilizer BMPs will maximize capture of carbon dioxide (CO_2) through crop photosynthesis and carbon (C) sequestration; crop productivity per unit of land area will be optimized, while also achieving farmer profitability and sustainability goals. Any fertilizer BMP that increases crop yields, nutrient uptake, and recovery of applied nutrients is likely to minimize or limit the potential for undesirable nutrient losses to water and air resources.

Science and experience show that the impact of a fertilizer BMP on crop yield, crop quality, profitability, and nutrient loss to water or air is greatly influenced by other agronomic practices such as plant population, cultivar, tillage, and pest management, as well as conservation practices such as terracing, strip cropping, residue management, riparian buffers, shelter belts, and others (Horn, 2007). Practices that are defined enough to be useful in making on-farm fertilizer use decisions often are "local" practices only when used in conjunction with other appropriate agronomic and conservation BMPs. A best fertilizer practice can be totally ineffective if the cropping system in which it is used has other serious inadequacies (Horn, 2007).

The discussion and guides that follow are oriented toward the central U.S. Corn Belt, but are relevant to other cropping systems with similar crop geographies. They are provided to assist in fertilizer nitrogen (N) management decisions that will help lessen the impact of fertilizer N use on greenhouse gas (GHG) emissions and help mitigate the global warming potential (GWP) – expressed as CO_2 equivalent. The three GHGs of interest to agriculture are nitrous oxide (N_2O), methane (CH_4), and CO_2. The GWP of CH_4 is 23 times greater and the GWP of N_2O is 296 times greater than that of CO_2. Because fertilizer N use can be associated with N_2O emissions, and because the GWP of N_2O is so much greater than CO_2, fertilizer N BMPs to reduce N_2O emissions are emphasized in this practical guide. For example, fertilizer N BMPs which help maintain nitrate versus nitrate (NO_3^-) in the soil during moist, wet, or waterlogged conditions can result in lowered rates for N_2O emissions. (Snyder et al., 2007).

Table 1. Relative effectiveness of management scenarios, shown as advantage of "Scenario 1" over "Scenario 2", in reducing N losses and greenhouse gas emissions. Effectiveness rating represents estimate of the relative potential N loss reduction, on-farm and within-watershed.[1]

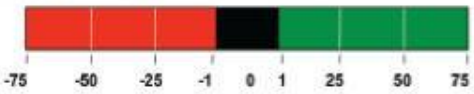
			Indirect effects on N_2O emissions			Direct greenhouse gas emission[3]
			Water discharges as NO_3^-		NH_3 volatilization	
N Source[2]	Fertilizer N Management Practice		Leaching	Runoff		N_2O
	Right agronomic N rate					
	Scenario 1	Scenario 2				
All Sources	Accounting for soil N supply and other input sources (e.g. manure, irrigation water, etc.)	No such N accounting (assumes over-application)				
All Sources	Site-specific N management (variable rate and/or source)	No site-specific management				
	Right N timing					
	Scenario 1	Scenario 2				
AA	Applied in the fall after soil temp below 50 °F (10 °C) for spring-planted crops	No waiting				
AA, AS, PA, U, UAN	Spring application, for spring planted crops (e.g. corn)	Fall application				
AA, AS, PA, U, UAN, AN, PN	Spring split or sidedress applied, for spring planted crops	All preplant applied				
AA, AS, PA, U, UAN, AN, PN	Spring or split fall-spring application, for fall planted crops (e.g. wheat, canola)	All fall applied				
AA, AS, PA, U, UAN, AN, PN	Nitrification inhibitor used	None used				
U	Controlled release technology used	None used				
	Right N placement					
	Scenario 1	Scenario 2				
AS, PA,U, UAN, AN	Subsurface incorporation	Surface broadcast				
U, UAN	Surface banded	Surface broadcast				
AS, PA, U, UAN, AN, PN	Shallow sidedress band – 1 in. (2 cm)	Sidedress band deeper than necessary – ≥ 4 in. (10 cm)				
U, UAN	Surface applied with urease inhibitor; abundant crop residues	No inhibitor				
U, UAN	Surface applied with urease inhibitor; minimal crop residues	No inhibitor				

[1] Relative percentage (%) advantage of "Scenario 1" over "Scenario 2," estimated from available literature and experienced observation. This rating scheme does not identify the quantity of N loss, which can be relatively small <1 to 2 lb/A (<1 to 2 kg/ha) in some conditions. Relative effects do not include emissions associated with manufacture or transport of inputs. Ratings are subject to change with research progress.

[2] N sources: AA=anhydrous ammonia, AS=ammonium sulfate, PA=predominantly ammonium containing, U=urea, UAN=urea ammonium nitrate solutions, AN=ammonium nitrate, PN=predominantly nitrate-containing.

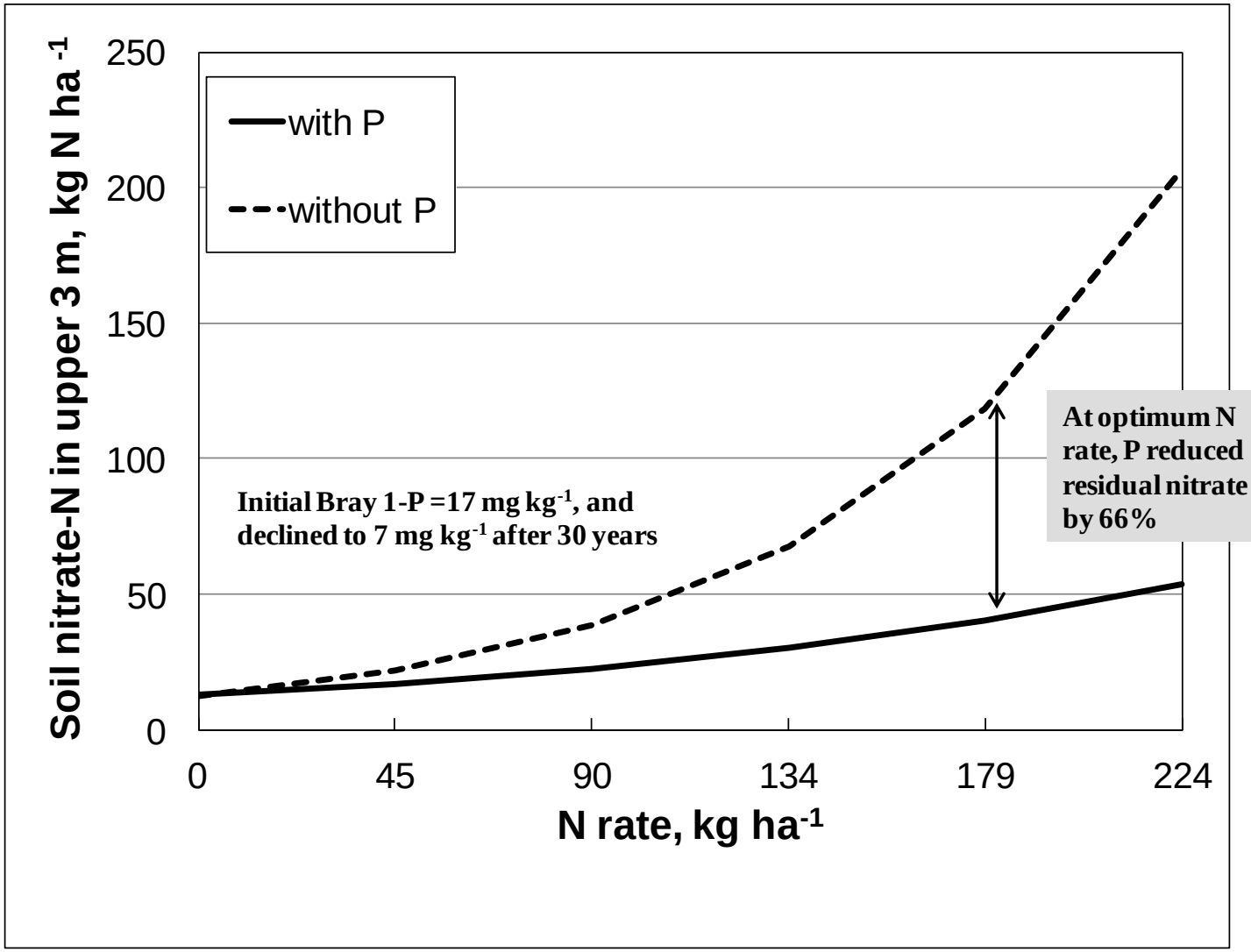
[3] Data insufficient to allow ratings for emissions of the other two principal greenhouse gases, CH_4 and CO_2.

Legend for ratings in table:

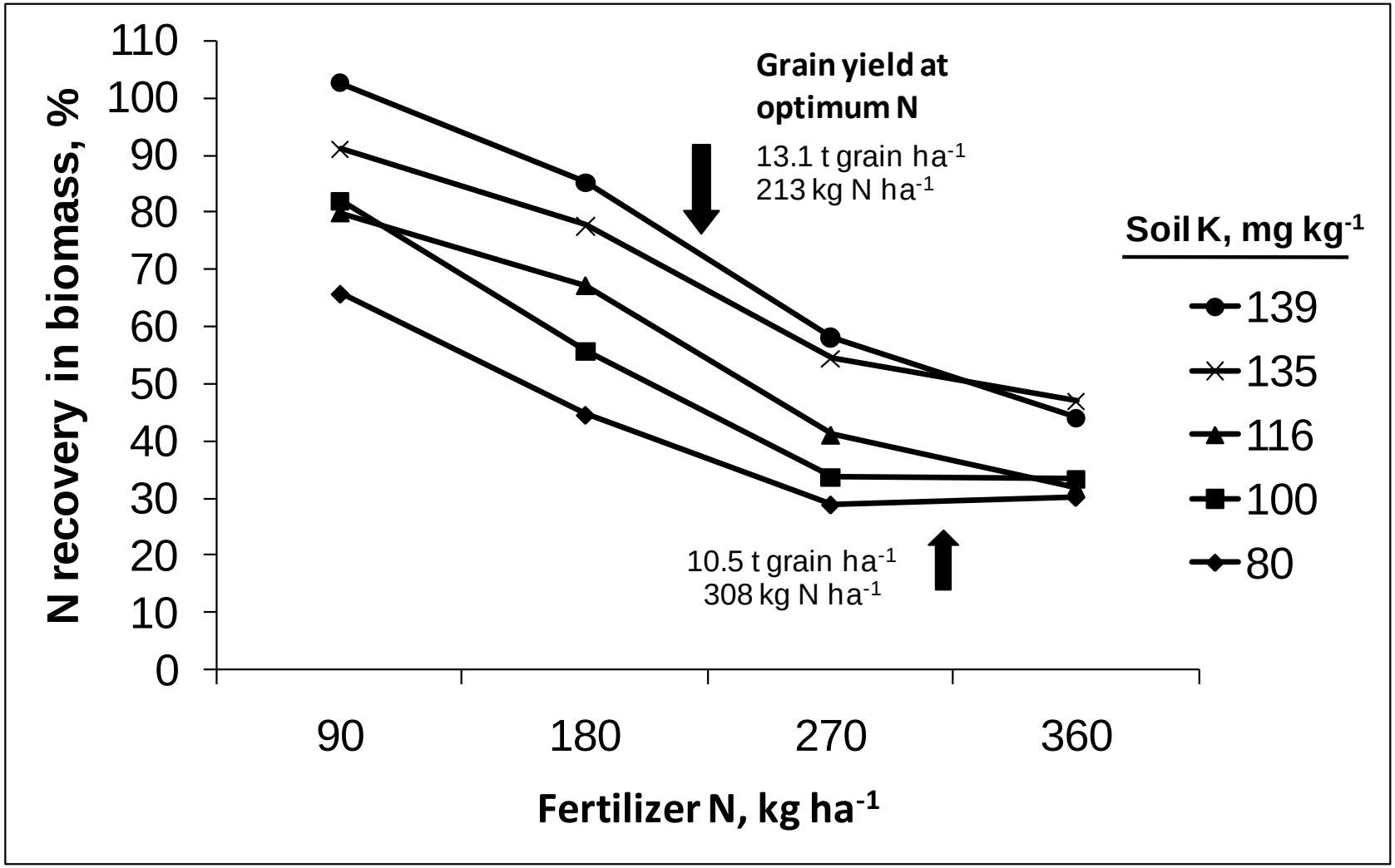


Ratings can represent broad, multiple ranges (e.g. negative to positive), or a single quartile. The rating scheme is based to some extent on a conservation practice rating scheme in Table 17 in EPA SAB (2008).

Adequate P fertilization of corn reduces soil profile nitrate and the potential for nitrate leaching (Schlegel et al. 1996)



Adequate K fertilization increases apparent nitrogen recovery by corn (Johnson et al. 1997)



Summary and Conclusions

- Appropriate fertilizer N and P use and balanced fertilization
  - enhance N and P use efficiency and effectiveness
  - increases crop biomass, helps restore/maintain/increase soil carbon

- Environmental N and P losses can vary among 4R factors ..depending on site-specific conditions, weather, cropping and tillage systems
- Industry is working more pro-actively with state and local partners to advance **4R Nutrient Stewardship** and site-specific BMP training and implementation, which should help improve crop N and P recovery

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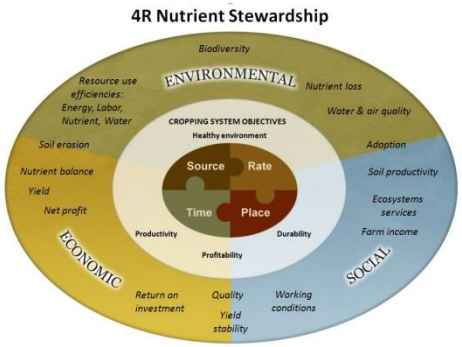
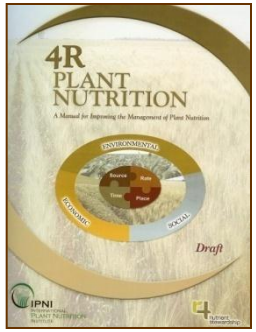
We Can Improve N & P Use Efficiency & Effectiveness

by implementing nutrient BMPs …..



Right source @ Right rate, Right time & Right place

4R Nutrient Stewardship



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Thank You

Better Crops, Better Environment … through Science

www.ipni.net

Clean Water Act,1972 – Recent Confusion

- Provides for protection of our health and environment by reducing the pollution in waterways.
- April 2011, EPA and USACOE released draft guidance to clarify protection and guidelines
- ~ 230,000 public comments were received, many recommended an EPA rule to clarify CWA
- **The agencies anticipate proposing a rule for public comment in 2012, with focus:**
  - protection of smaller waters that feed larger ones, to keep downstream water safe from upstream pollutants
  - reaffirming protection for wetlands

http://water.epa.gov/lawsregs/guidance/wetlands/CWAwaters.cfm

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Clean Water Act and EPA Authority?

- Environmentalists and EPA have reached an agreement in principle on two key Clean Water Act lawsuits, and are calling for **a stay of further proceedings until May 21, 2012:**
- Amid GOP Concern, EPA Seeks More Time For Controversial Water Pact
  - EPA and the Conservation Law Foundation (CLF) agree to settle a controversial set of lawsuits -- **a settlement that critics fear could set a precedent expanding the Clean Water Act's (CWA) jurisdiction over groundwater and nonpoint sources of pollution** -- though the litigants are asking a federal court to give *them more time to complete the deal."*

http://environmentalnewsstand.com/

National Scope of Nitrogen and Phosphorus Pollution: EPA database information

- 14,000 Nutrient-related impairment listings in 49 states
  - 2.5 million acres of lakes and reservoirs
  - 80,000 miles of rivers and streams
  - And this is an underestimate . . .
- Over 47% of streams have medium-to-high levels of P and over 53% have medium-to-high levels of N
- 78% of assessed continental U.S. coastal waters exhibit eutrophication, many with harmful algal blooms
- Nutrient impacts reflect doubling of U.S. population over past 50 years
  - Increased construction, wastewater, and food production

Joe Piotrowski, Senior Advisor, US EPA, Office of Wetlands, Oceans and Watersheds – Watershed Academy Webcast Jan. 26, 2011

Greater Monitoring and Public Reporting of State Water Quality Across U.S.

U.S. ENVIRONMENTAL PROTECTION AGENCY

Watershed Assessment, Tracking & Environmental ResultS

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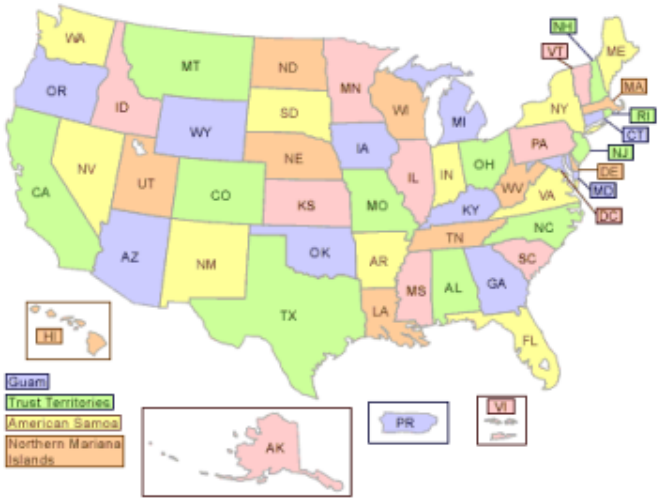
- Previously Impaired Waters Now Attaining All Uses
- Impaired Waters Listed by State
- Cumulative TMDLs by Pollutant
- Approved TMDLs by State
- Cumulative Number of TMDLs
- Status of Available Data Used in This Report

For More Information:

Download Excel compatible information

Download GIS Information (Internet Explorer only)

National Summary of State Information



Depicted below are national summary tables and charts for available water quality data reported by the States to EPA under Section 305(b) and 303(d) of the Clean Water Act.

This report displays the most current available reporting year data.
Check the Status of Available Data for more information.

Frequent Questions

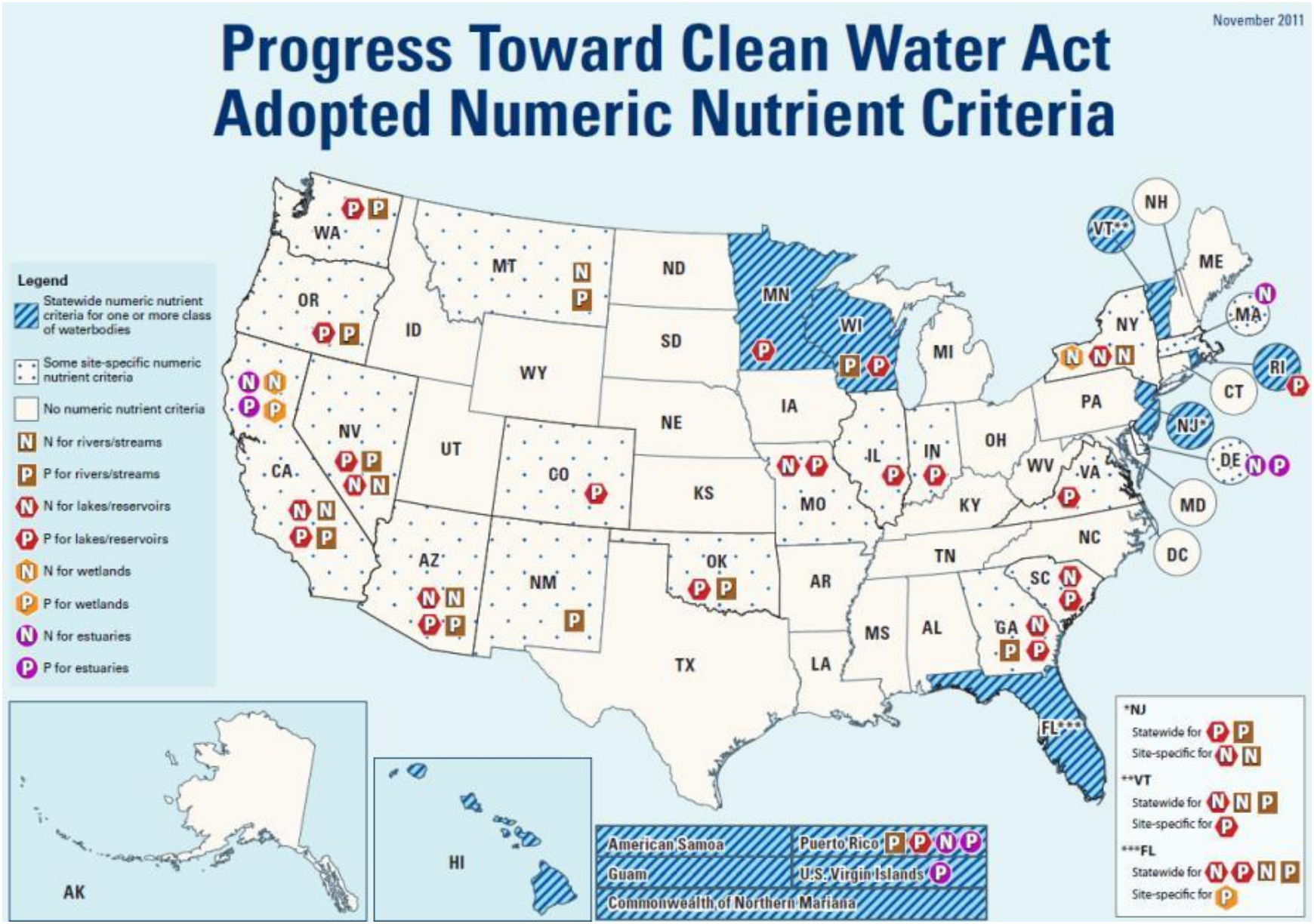
- About This Database (Integrated Report)
- About This Database (Separate Impaired and Assessed Waters Reports)
- Assessing Water Quality (Questions and Answers)
- Integrated Reporting Guidance
- Previous National Water Quality Reports
- EnviroMapper for Water
- AskWATERS
- EPA WATERS Homepage
- Exchange Network
- Assessment Database
- Statewide Statistical Surveys
  - Draft statistical survey web report
  - Demo of statistical survey template (mpeg4, 101MB zipped)

Assessed Waters of United States

Incomplete state reported information may lead to discrepancies and/or missing information in these reports.

http://iaspub.epa.gov/waters10/attains_nation_cy.control

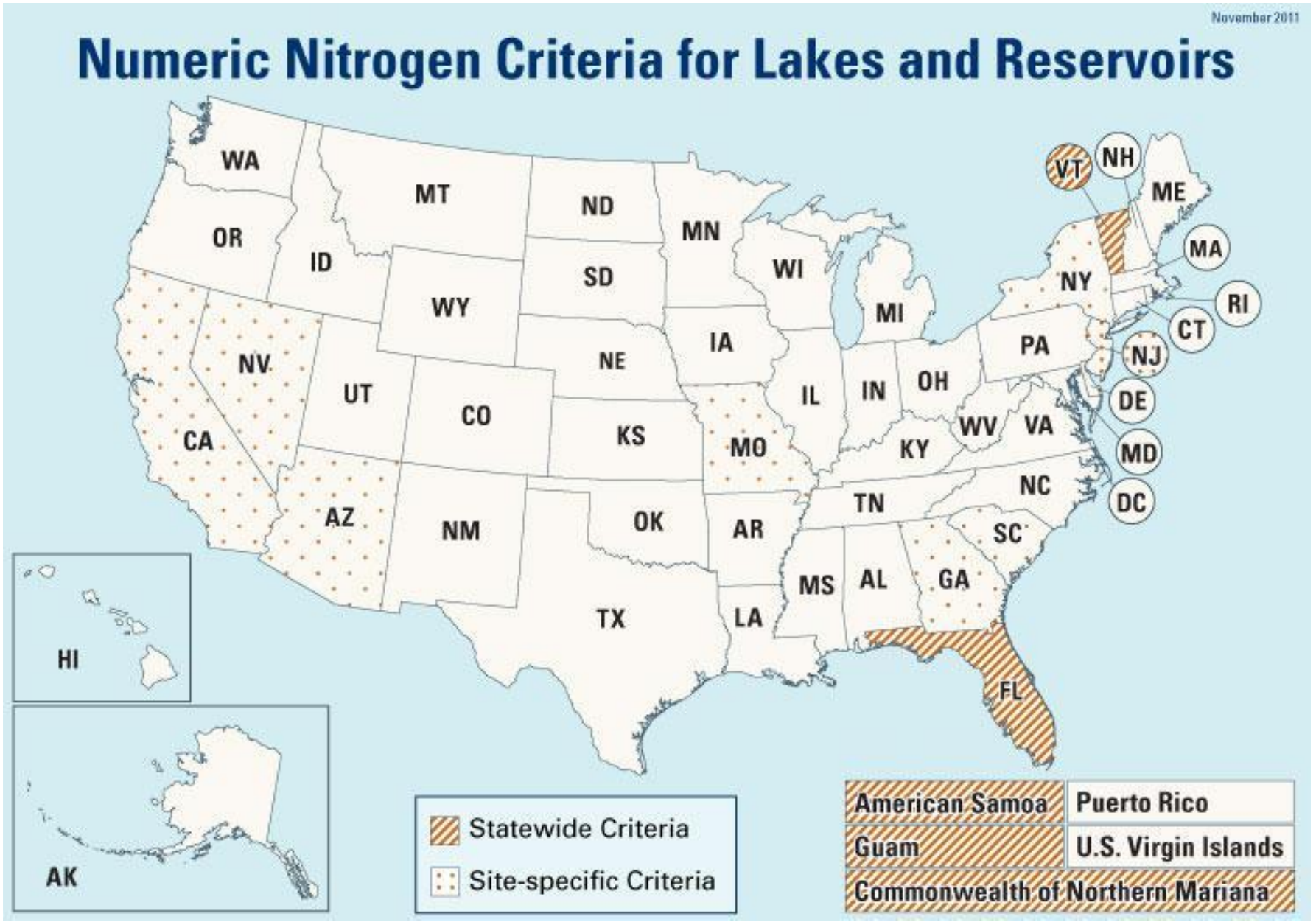
IPNI



http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/progress.cfm

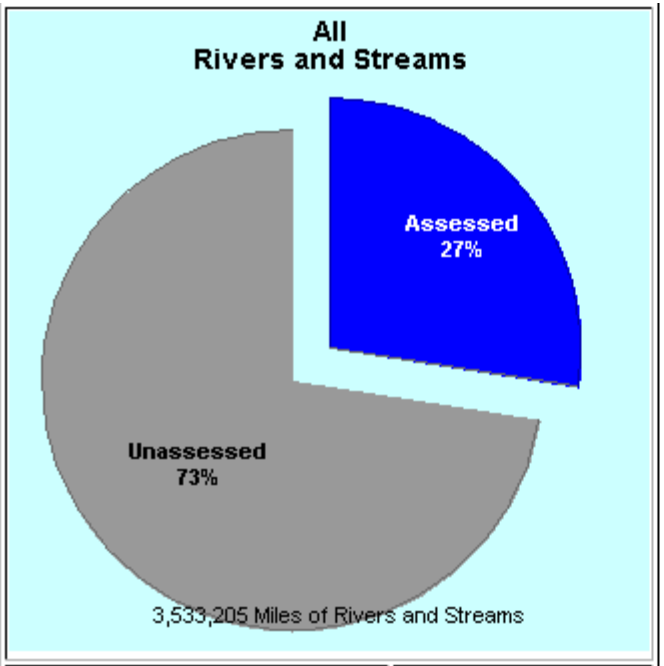
IPNI

http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/progress.cfm

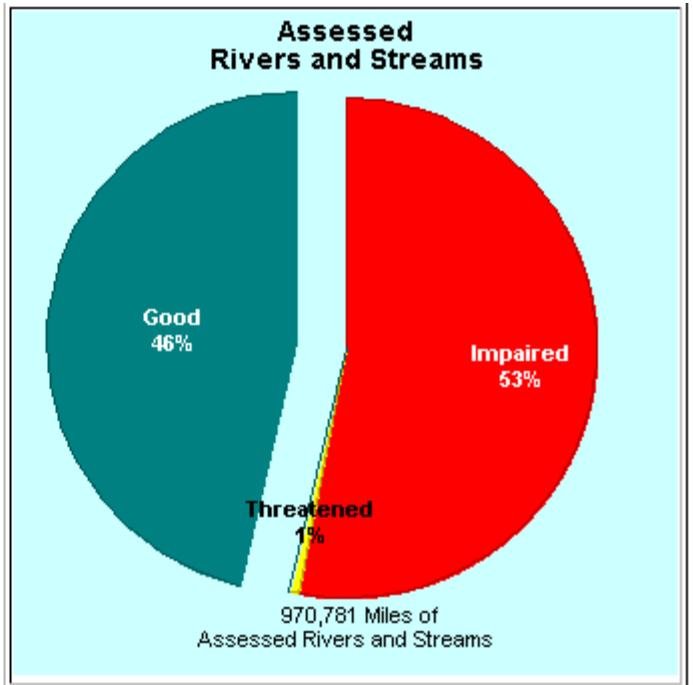


http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/progress.cfm

Water Quality Attainment in Assessed U.S. Rivers and Streams



Assessed Status	Miles
Assessed	970,781
Unassessed	2,562,424
Total Miles	**3,533,205**



Attainment Status	Miles
Good	449,617
Threatened	6,369
Impaired	514,795
Total Miles Assessed	**970,781**

http://iaspub.epa.gov/waters10/attains_nation_cy.control#STREAM/CREEK/RIVER

River & Stream Probable Impairment Source

Probable Source Group	Miles Threatened or Impaired
Agriculture	123,620
Atmospheric Deposition	101,015
Unknown	87,574
Hydromodification	58,915
Urban-Related Runoff/Stormwater	51,517
Natural/Wildlife	51,375
Municipal Discharges/Sewage	50,762
Unspecified Nonpoint Source	46,985
Habitat Alterations (Not Directly Related To Hydromodification)	32,415
Resource Extraction	26,264
Silviculture (Forestry)	19,444
Industrial	14,179
Construction	13,522
Other	10,170
Land Application/Waste Sites/Tanks	8,228
Legacy/Historical Pollutants	4,888
Spills/Dumping	2,420
Recreation And Tourism (Non-Boating)	1,741
Aquaculture	318
Groundwater Loadings/Withdrawals	178
Recreational Boating And Marinas	132
Military Bases	42

River & Stream Cause of Impairment

Cause of Impairment Group	Miles Threatened or Impaired
Pathogens	157,823
Sediment	106,057
Nutrients	101,228
Organic Enrichment/Oxygen Depletion	87,675
Polychlorinated Biphenyls (PCBs)	76,405
Habitat Alterations	75,578
Metals (other than Mercury)	72,335
Mercury	61,989
Flow Alteration(s)	50,479
Temperature	50,159
Cause Unknown	39,546
Cause Unknown - Impaired Biota	37,783
Salinity/Total Dissolved Solids/Chlorides/Sulfates	32,493
pH/Acidity/Caustic Conditions	29,330
Turbidity	28,124
Pesticides	17,097
Other Cause	17,082
Ammonia	12,701
Fish Consumption Advisory	10,029
Algal Growth	7,492
Total Toxics	7,226
Toxic Inorganics	6,834
Toxic Organics	4,886
Dioxins	4,318
Oil and Grease	2,740
Cause Unknown - Fish Kills	1,371
Nuisance Exotic Species	1,236
Taste, Color and Odor	925
Radiation	652
Chlorine	629