

Lawn Care Best Management Practices for Protecting Water Quality

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Landscaping for Water Quality in the Lakes Region

New Hampshire Extension

Moultonborough, NH

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Reinforce Concept of Lawn BMP's and Water Quality



Common Sense Lawn Practices and Water Quality

<https://whereyoureplanted.com/fertilizer-on-your-sidewalk-helps-pollution-grow/>



<https://www.themasterslawncare.com/blog/do-i-really-need-sprinkler-rainfreeze-sensor>



http://www.lakesuperiorstreams.org/understanding/impact_fertilizer.html



<http://ecologywa.blogspot.com/2012/08/good-yard-care-practices-help-protect.html>



<http://lusciouslandscapes.blogspot.com/2015/03/revivin>



<https://www.yelp.com/biz/chesterfield-lawns-and-landscapes-chesterfield>

Water Quality Perspective

- **Nutrients**
 - **Phosphorus**
 - **Nitrogen**
- **Sediment**
- **Pesticides (not so much, although they should not be ignored!)**

Current New Hampshire Regulations State Statute (RSA: 431) as modified in 2013

- **Lawn fertilizers sold retail shall not exceed 0.9 lbs. total N per 1,000ft² per application.**
- **At least 20% N must be slow release form.**
- **Lawn fertilizers sold retail shall not exceed 0.7 lbs. per 1,000ft² of soluble N per application.**
- **Shall not exceed annual application rate of 3.25 lbs. per 1,000ft² total N.**
- **Illegal to apply any fertilizer within 25 feet of reference or high water line. Only lime can be applied within 25 feet of reference line. Beyond 25 feet but within 50 feet, only low P and slow release N (SRN) fertilizers may be used.**

- **P sold retail should be used only on newly established or repaired lawns, or on lawns testing deficient in P.**
- **Annual applications may not exceed a rate of 1 pound per 1,000ft² of available P (P₂O₅).**
- **No fertilizer sold retail intended for use on newly established or repaired lawns, or for lawns testing deficient in P shall exceed an application rate of 1 pound per 1,000ft² annually of available P (P₂O₅).**
- **Illegal to apply any fertilizer within 25 feet of reference or high water line. Only lime can be applied within 25 feet of reference line. Beyond 25 feet but within 50 feet, only low P and slow release N (SRN) fertilizers may be used.**

<https://extension.unh.edu/Sustainable-Landscapes-and-Turf/Environmental-Turf-Management>



University of New Hampshire
Cooperative Extension

Food & Agriculture

AGRICULTURE FACT SHEET
Spring 2014

New Hampshire's Turf Fertilizer Law What You Should Know

MARGARET HAGEN, Extension Field Specialist

Introduction

Nitrogen and phosphorus are nutrients essential for the growth of plants. However, an overabundance of these nutrients causes pollution in waterways.

In New Hampshire, more than half of the nitrogen pollution to Great Bay can be traced back to urban and suburban nonpoint source pollution, including fertilizer runoff.* Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many different sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and transports natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and ground waters.**

Once in our waterways, fertilizers designed to make our lawns lush and green may cause harmful algae blooms. As algae grow and then decompose, they block sunlight from reaching aquatic plants, rob the water of oxygen, and threaten underwater life. Algae blooms also reduce water clarity which can lead to fewer opportunities for fishing and swimming.

When fertilizers, either synthetic or organic, are applied in the proper amounts at appropriate times during the growing season, lawns will thrive and the risk of fertilizer nutrients entering our waterways will be reduced. Because of concerns over lawn fertilizer runoff, the New Hampshire legislature passed a bill in 2013 regulating the use of nitrogen and phosphorus in turf fertilizers that are sold at retail. The goal is to help homeowners maintain healthy lawns without applying unnecessary fertilizer.

FERTILIZE RESPONSIBLY

- **Nitrogen Content Reduced**
Lawn fertilizers sold at retail shall not exceed 0.9 pound of total nitrogen applied per 1,000 square feet per application when applied according to the label. At least 20% of the nitrogen must be in slow release form.
- **Phosphorus-Free**
Most NH soils provide all the phosphorus that a home lawn needs. Phosphorus sold at retail should be used only on newly established or repaired lawns, or on lawns testing deficient in phosphorus. Annual applications may not exceed a rate of 1 pound per 1,000 square feet of available phosphate.

When purchasing lawn fertilizers, the bag is labelled with a guaranteed analysis consisting of three numbers such as 22-0-3. These numbers stand for the percent, on a dry weight basis, of nitrogen, phosphorus (as phosphate), and potassium (as potash) contained in that fertilizer. These three nutrients are not available in sufficient quantities in many existing soils so we add them to the soil in

Turfgrass Nutrient Management Bulletin B-0100

New England Regional Nitrogen and Phosphorus Fertilizer and Associated Management Practice Recommendations For Lawns Based on Water Quality Considerations



University of
Connecticut
College of Agriculture
and Natural Resources
Departments of Plant Science
and Landscape Architecture

Addressing Water Quality for Turfgrass in the Landscape

- **Selection of Species – Higher vs. Lower Maintenance Requirements**
- **Mowing Heights and Clippings Management**
- **Water Management – Follow the Water**
- **Nutrients**
- **Pesticides**
- **Sediment**

Selection of Species – Higher vs. Lower Maintenance Requirements

- Kentucky bluegrass and Perennial ryegrass vs. Fescues



**Kentucky
bluegrass**



Perennial ryegrass

Photo credit: Bob Mugaas, U of MN



Turf-type tall fescue

Fine fescue

Photo credit: Bob Mugaas, U of MN

**Creeping red,
Chewings, and
Sheep**

Alternative Low-Input Species

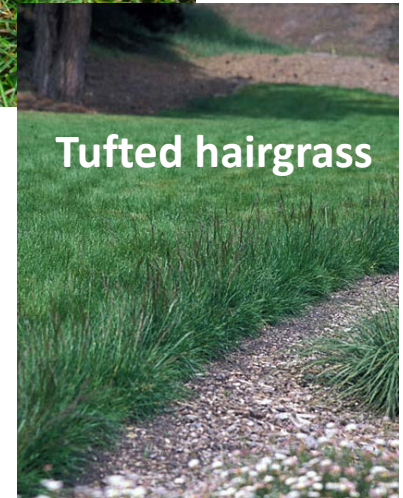
- Bentgrasses (*Agrostis* spp.)
 - Colonial bent (*A. tenuis* or *capillaris*)
 - Highland bent (*A. castellana*)
 - Redtop (*A. gigantea*)
- Junegrass (*Koeleria* spp.)
- Hairgrass (*Deschampsia* spp.)
- Poverty oatgrass (*Danthonia* spp.)
- Zoysiagrass (*Zoysia japonica*)?



Highland bentgrass



Colonial bentgrass



Tufted hairgrass



Prairie junegrass



Poverty oatgrass



Zoyisagrass

<http://www.finegolf.co.uk/what-is-fine-golf/green-keeping/fine-turf/>

<http://www.turfgrassproducts.com/seed.html>

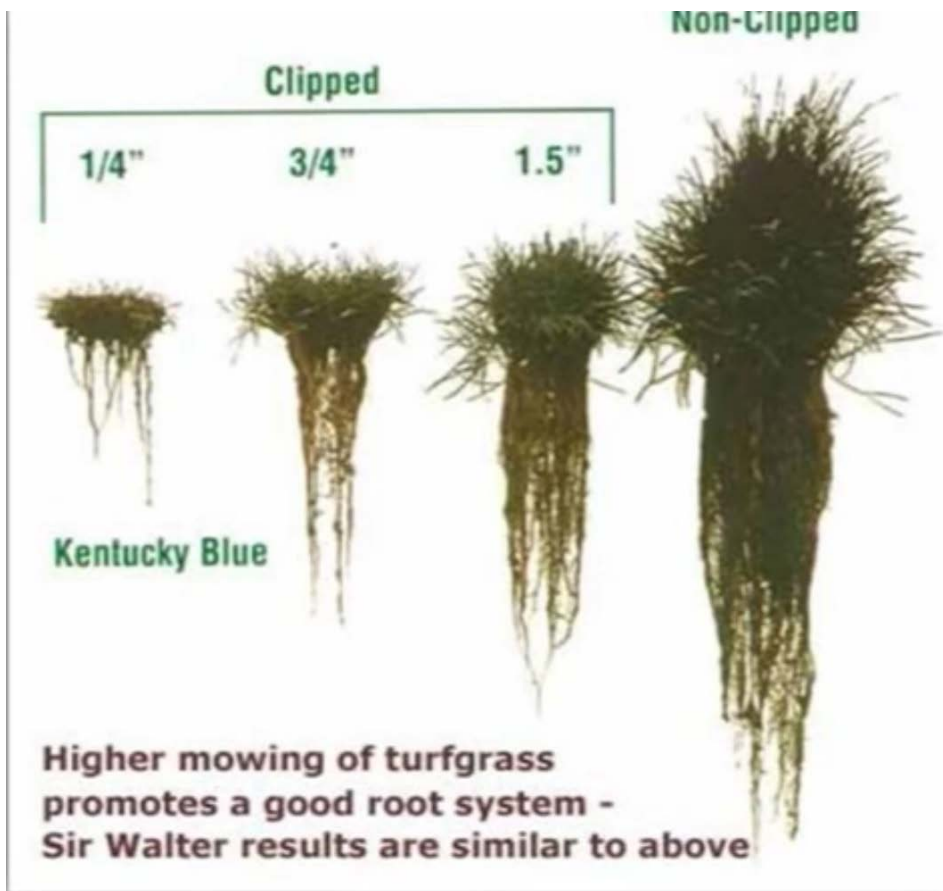
<https://www.pinterest.com/pin/362891682452749587/>

<http://zoysias.com/>

http://nativeson.com/annotated_catalog/grasscatalog.htm

Mowing Heights and Clippings Management

- **Cut it High – Let it Lie**



- **Clippings back on Turf**



Do not dump clippings near water





Grass Clippings In Woods Supports Spread of Earthworms into Forests

Growing Concern With Invasive Earthworm Species in Northern Forests

Without Earthworms

With Earthworms

Forest



Understory



Soil Horizon

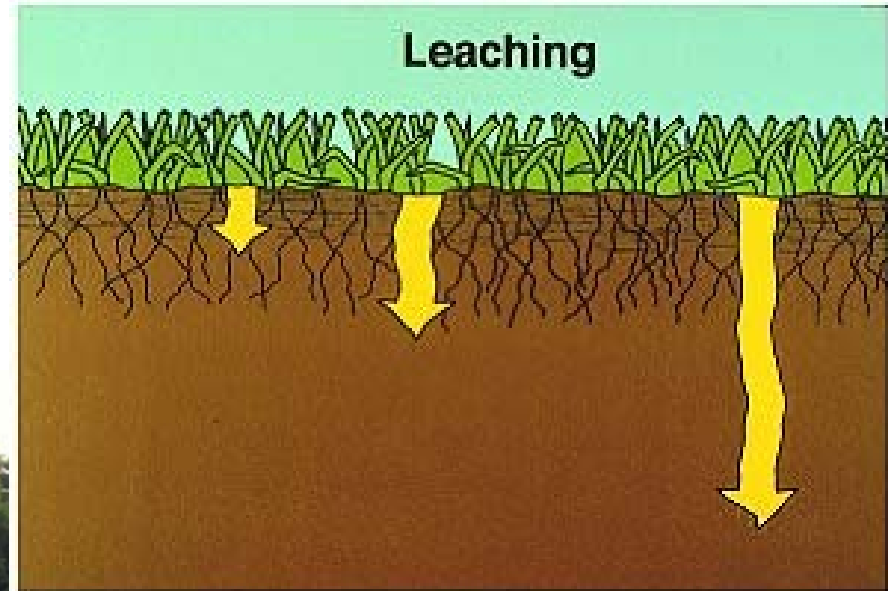


Water Management – Follow the Water

- Water transport of Nutrients, Sediment, Pesticides

- Leaching

- Runoff



Reported range of turfgrass ET by species

Common Name	Scientific Name	ET [†] (mm day ⁻¹)	Inch/wk
Tall Fescue	<i>Festuca arundinacea</i>	7-13	2.0-3.8
Perennial Ryegrass	<i>Lolium perenne</i>	7-11	1.8-3.1
St. Augustinegrass	<i>Stenotaphrum secundatum</i>	6-11	
Seashore Paspalum	<i>Paspalum vaginatum</i>	6-8	
Bahiagrass	<i>Paspalum notatum</i>	6-8	
Kikuyugrass	<i>Pennisetum clandestinum</i>	6-9	
Creeping Bentgrass	<i>Agrostis Palustris</i>	6-10	
Centipedegrass	<i>Eremochloa ophiuroides</i>	5-9	
Bermudagrass	<i>Cynodon spp.</i>	4-9	
Zoysiagrass	<i>Zoysia spp.</i>	5-8	
Kentucky Bluegrass	<i>Poa pratensis</i>	4-7	1.1-1.8
Buffalograss	<i>Buchloe dactyloides</i>	3-6	1.5-2.0

[†]Field grown under high evaporative demand conditions

Results Of Daily & Weekly Watering

This image is the property of SprinklerWarehouse



Watering 1/10 inch a day supplies about 1 inch of water per week. However, applying the water in a single 1-inch or two 1/2-inch increments will actually make your lawn healthier. The root system will be healthier and deeper when more water is applied at once.

- **Less Frequent and Deeper Watering**
- **Concept of Deficit Irrigation**

Measuring Soil Moisture

- Moisture meters and sensors



How Acclima's SCX Works

The SCX installs next to a conventional controller and connects to moisture sensors. When the scheduled time arrives the system is to be activated, the SCX first reads the soil moisture level. Warning will be allowed if it is dry (below the threshold), or saturated if it is too (above the threshold).

You set the moisture threshold level once and a unique field capacity. The SCX provides user controls to instantly alter settings.

SCX
Soil Control
Xpress

As reported and weather conditions change, the Acclima sensor and controller will adjust the frequency of irrigation cycles to meet the leaf-atmosphere health.

The sensor is used to install soil connects to your system through a wire line. It has a water head to run water all the way to the controller.

The sensor takes soil moisture and temperature data over the existing water wiring to the SCX controller.

The Acclima Sensor is placed under a representative section of turf and surrounded in a nearby valve.

Measuring Soil Moisture

- Footprinting
- Wilt



http://iaturf.blogspot.com/2012_09_01_archive.html



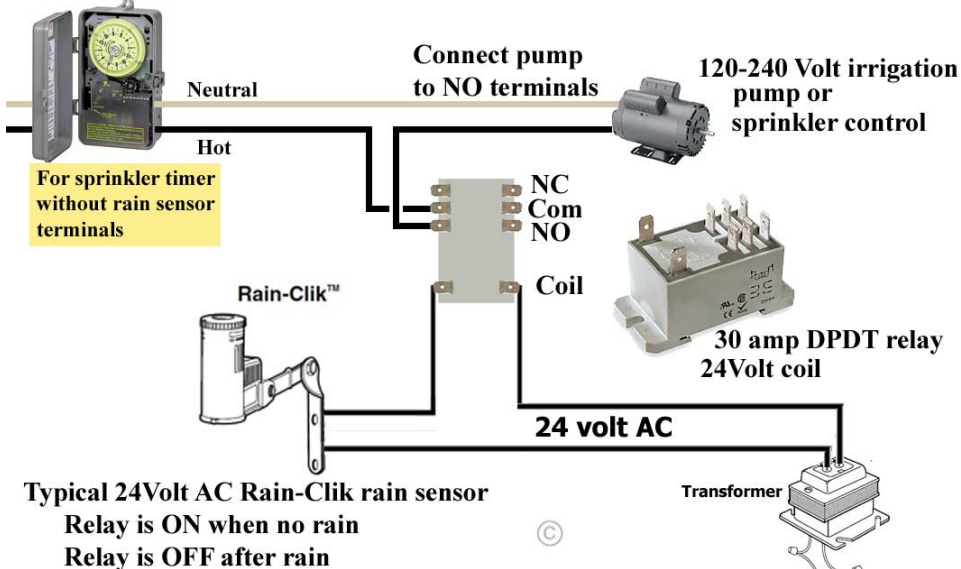
<http://purdueturf tips.blogspot.com/2012/05/time-to-water.html>

Rain Sensor Cut Offs



Intermatic sprinkler-irrigation timer 120-240Volts wired in typical way

Connect rain sensor to timer (when timer does not have rain sensor terminals)

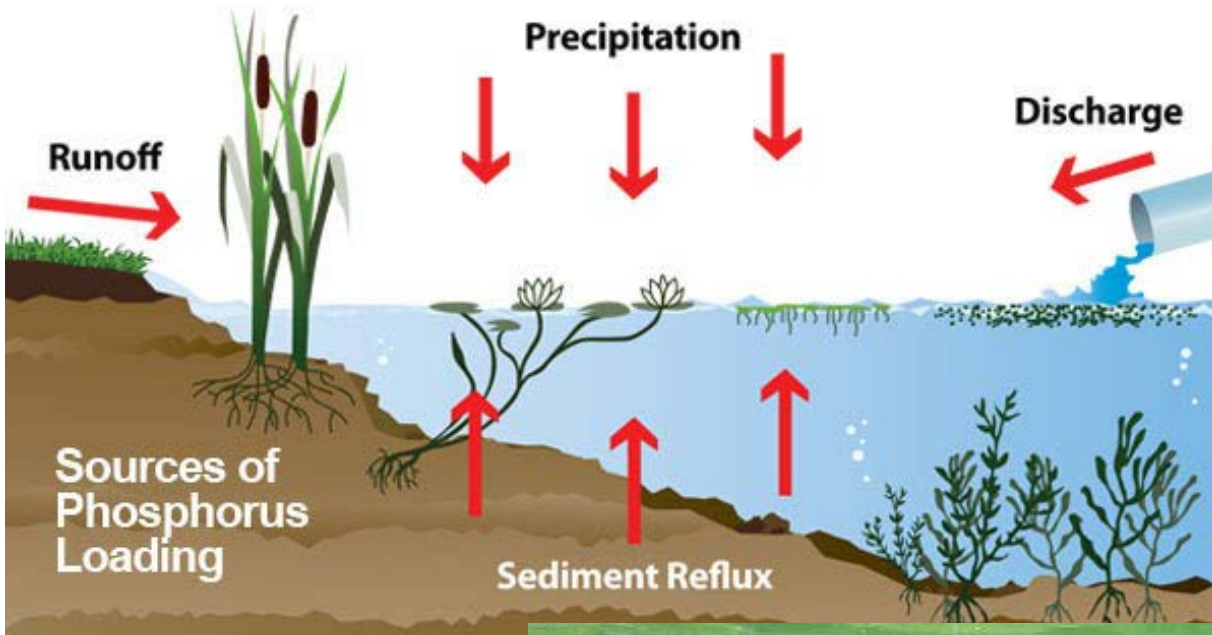


Nutrients

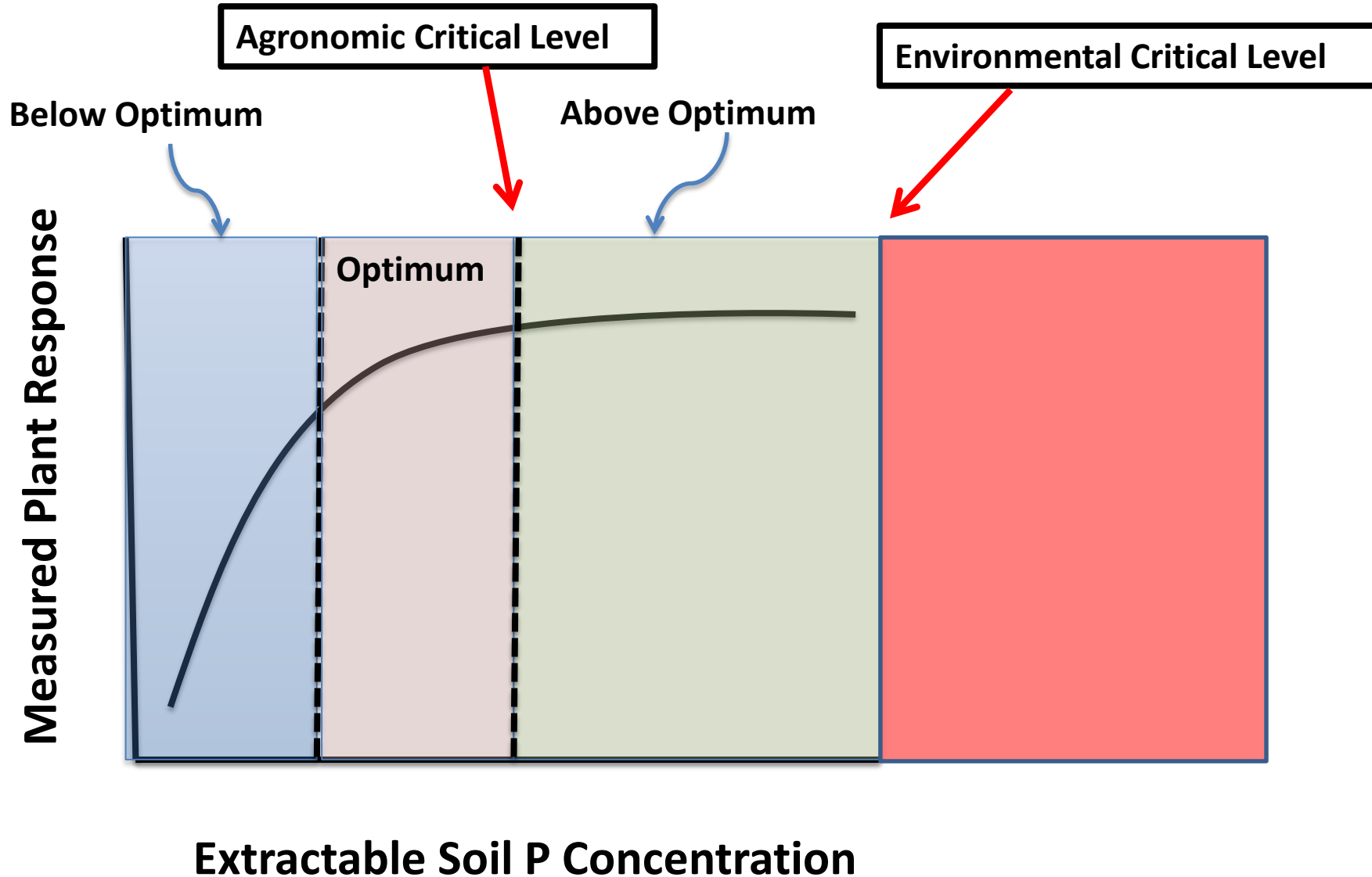
- Both Phosphorus (P) and Nitrogen (N) need to be managed carefully!
 - **Nitrogen** enhances eutrophication caused by excess **Phosphorus** in fresh water lakes and ponds
 - **Phosphorus** enhances eutrophication caused by excess **Nitrogen** in estuaries and coastal salt-waters

Nutrients

- Phosphorus



Plant Response to Soil Test Phosphorus



Soil Test – Don't Guess!

Test Data

			Optimum Range
pH - Soil (pH)	6.5		
Mehlich - Lime Test (Buffer pH)	6.25		
Calcium, Mehlich 3	1366.8 (ppm)	H	800 - 1200
Magnesium, Mehlich 3 (Mg)	362.0 (ppm)	VH	60 - 120
Potassium, Mehlich 3 (K)	146.0 (ppm)	L	170 - 280
Phosphorus, Mehlich 3 (P)	129.0 (ppm)	VH	30 - 50
Est. CEC	10.2		
Est. Base Sat.	100.0 %		
Est. Ca Sat.	66.8 %		
Est. Mg Sat.	29.5 %		
Est. K Sat.	3.7 %		

Optimum Range Key

VL - Very Low

L - Low

M - Medium

H - High

VH - Very High



<http://www.bbmainnanceservices.com/soiltesting.htm>

Turf and Dissolved P in Runoff

- Increasing Soil Test P does correspond to greater amounts of Dissolved P in runoff



<http://www.fairfaxcounty.gov/nvswcd/drainageproblem/control-runoff.htm>



<http://turfblog.rutgers.edu/?p=856>

- High-intensity rainfall
- Over/misadjusted irrigation
- Frozen ground/snow melt
- Compacted soil



<http://ocean.njaes.rutgers.edu/UnderstandingSoilCompaction.html>



<http://www.diychatroom.com/f16/standing-water-after-snow-melt-heavy-rain-457777/>

Nutrients

- Nitrogen



Nitrogen

- **Application rates, timing, and formulations**
- **Slow vs. Fast Release forms**
- **Timing – Fall Fertilization**
- **Fertilizer Substitution – Clovers and other legumes**
- **Maintain soil pH near neutral**
- **No- or Low-Fertilizer Buffer Strip Adjacent to Water Sources**

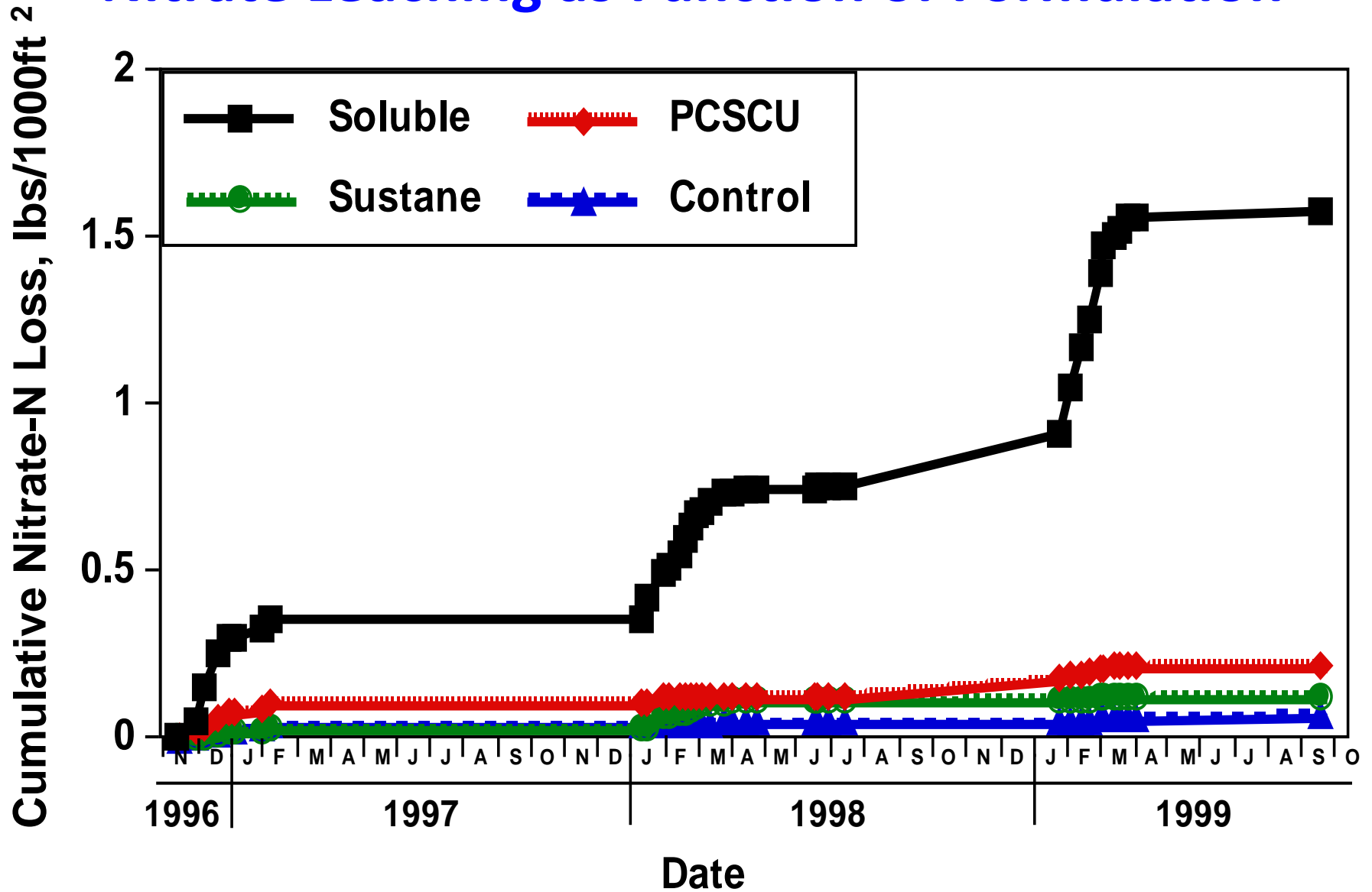
What Guides N Fertilization for Turfgrass?

- **Historical; Routine**
 - ❑ Usually 0.5-1.0 lb per 1000ft², 2-4 or more times a year for high-cut turf
 - ❑ much lower rates and more frequently for low-cut turf; every 10-14 days)
- **Subjective Assessment (usually based on color and density; or sports surface performance)**
- **Expected needs of specific grass species**
- **Objective Tests are not routinely used**

Without Objective Guide for Nitrogen

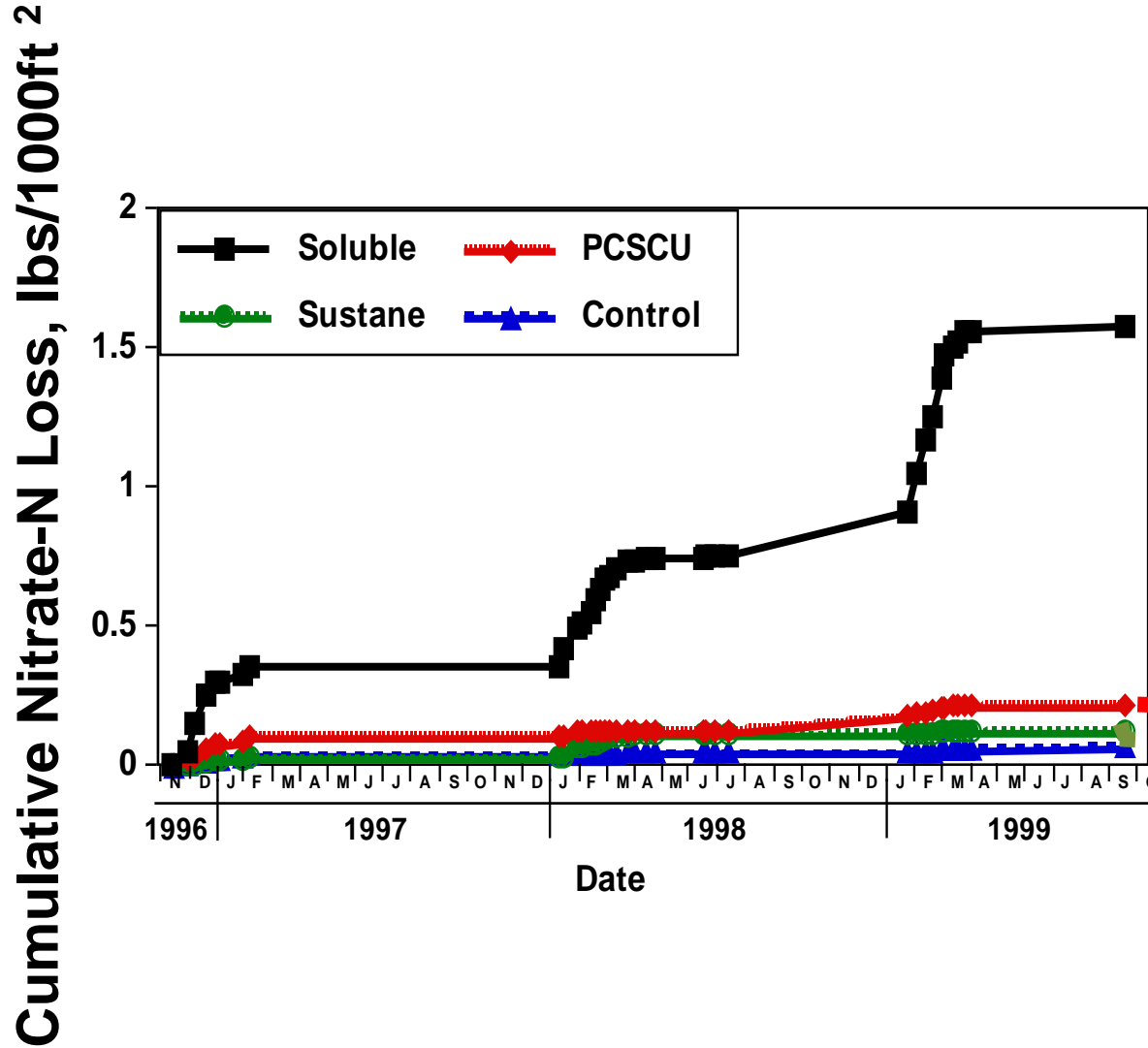
- For older established lawns, apply $\frac{1}{2}$ to $\frac{1}{3}$ (or less) of that recommended on fertilizer bag label.
- Reapply only when lawn response starts to fall below acceptability.
- Slow-release formulations are more preferable than soluble, fast-release formulations.

Nitrate Leaching as Function of Formulation



Guillard and Kopp (*J. Environ. Qual.* 33:1822-1827, 2004)

But, What are Long-Term Effects Of Slow-Release N?



10-20+ years in the future

Guillard and Kopp (*J. Environ. Qual.* 33:1822-1827, 2004)

Fall Fertilization Agronomic Benefits

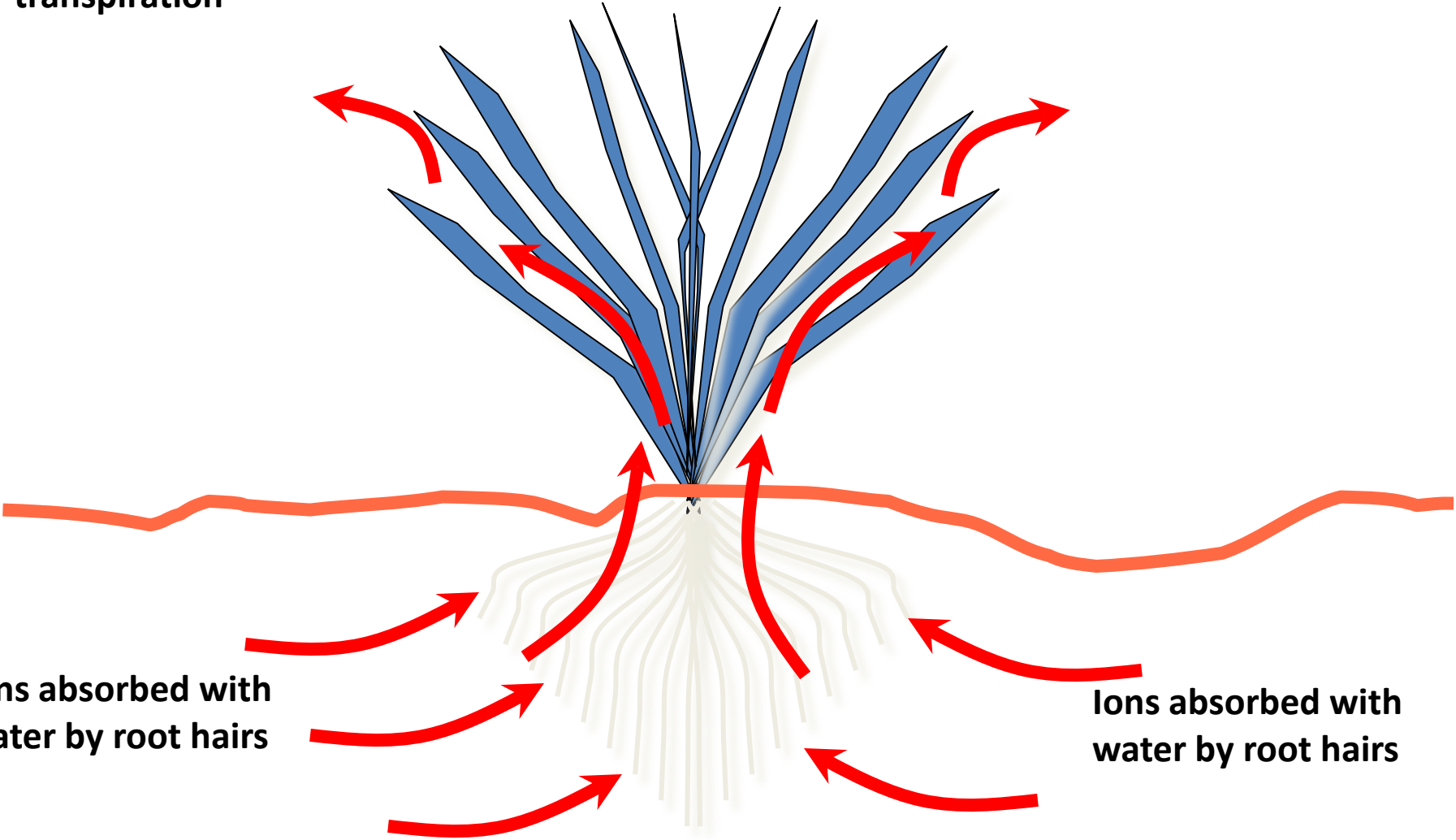


What Risk to Water Quality?

- **Agronomic benefits limited with later fall application dates.**
- **Higher probability of N loss with later fall application dates.**
- **In my opinion fall fertilization represents greatest risk to water quality other than establishment and gross over-application.**
- **Earlier cutoff date, lower rates, or rethinking of practice must be considered.**

Mechanism of Nitrogen Uptake Related to Transpiration and Mass Flow

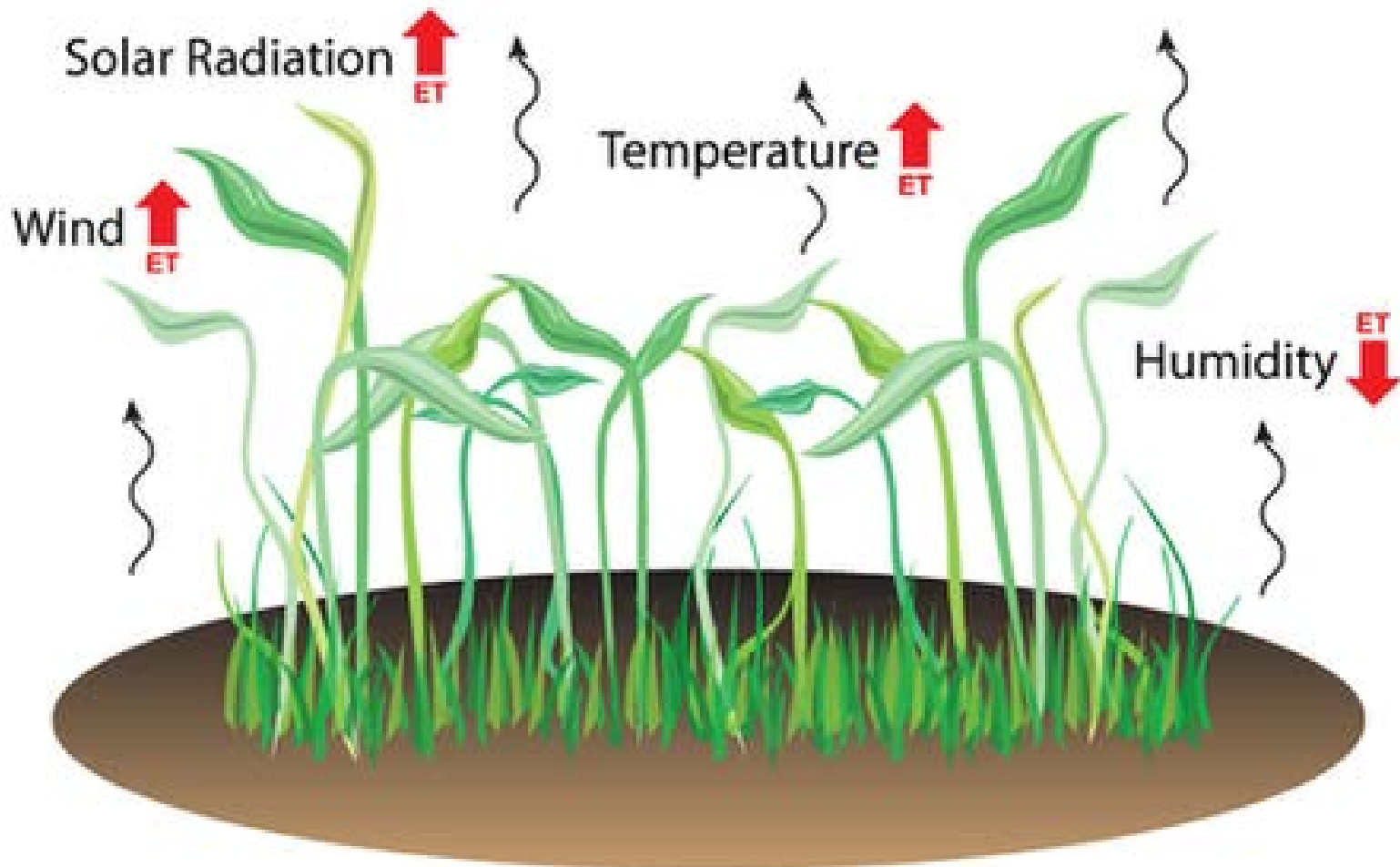
Water lost by transpiration



Ions absorbed with water by root hairs

Ions absorbed with water by root hairs

What is Likelihood of Sufficiently High Transpiration Rates in Late Fall to Drive Uptake of Large Volume of Soil Water?

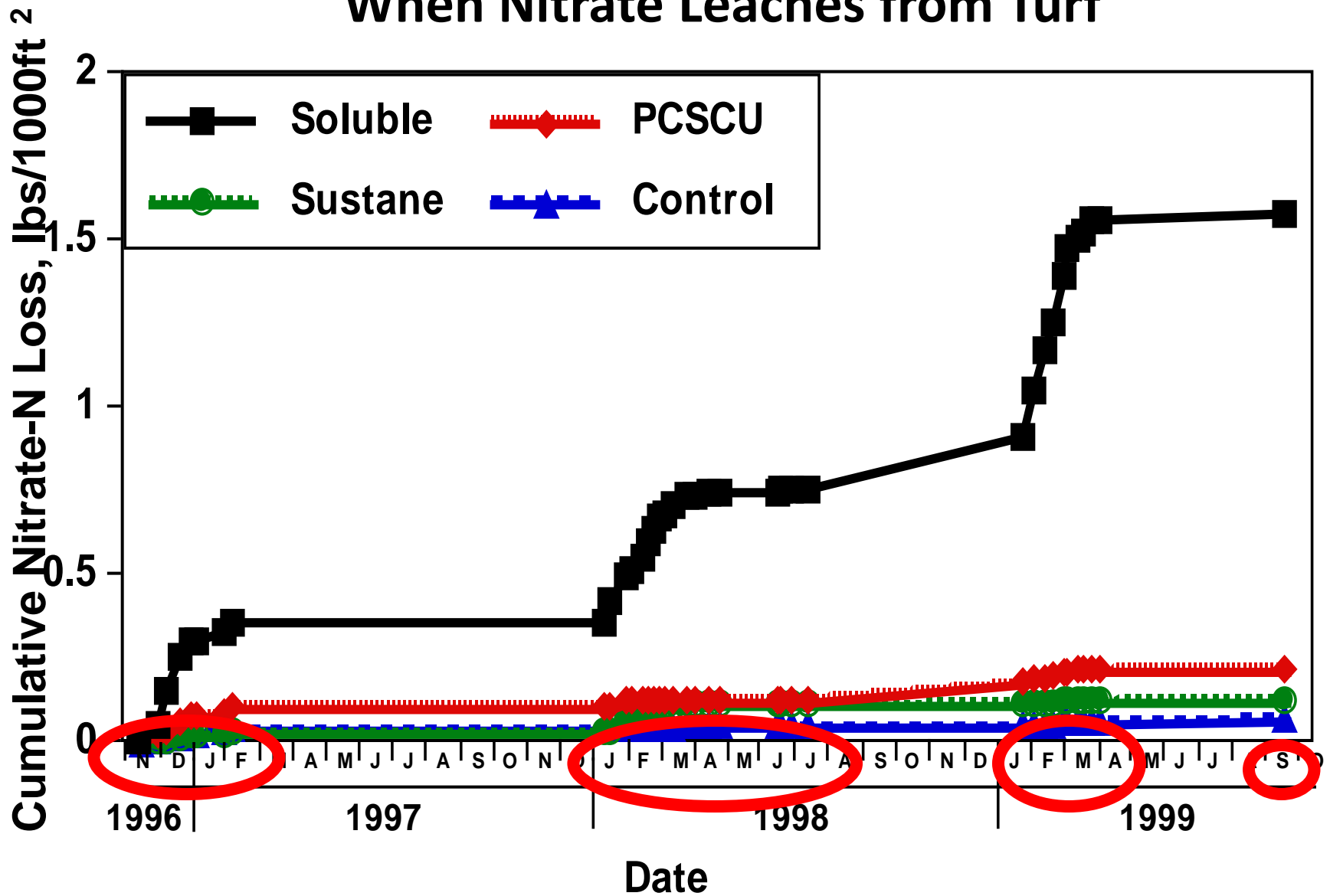


Potential Evapotranspiration (average monthly; inches) 1981-2010

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Concord, NH	0.33	0.53	1.17	2.2	3.46	3.97	4.42	3.84	2.48	1.42	0.63	0.35
Caribou, ME	0.17	0.3	0.73	1.51	2.88	3.39	3.64	3.07	1.84	0.89	0.31	0.16
Bangor, ME	0.27	0.45	0.98	1.86	3.11	3.56	3.91	3.42	2.20	1.20	0.49	0.27
Burlington, VT	0.24	0.42	0.97	1.96	3.26	3.74	4.13	3.47	2.18	1.13	0.45	0.23
Portland, ME	0.33	0.52	1.08	1.91	3.09	3.61	4.08	3.54	2.30	1.29	0.58	0.34
Worcester, MA	0.33	0.51	1.12	2.03	3.2	3.59	4.03	3.49	2.27	1.31	0.59	0.33
Boston, MA	0.37	0.57	1.15	1.95	3.09	3.58	4.02	3.49	2.29	1.36	0.63	0.37
Hartford, CT	0.39	0.61	1.31	2.28	3.56	4.02	4.45	3.74	2.52	1.54	0.72	0.41

<http://www.nrcc.cornell.edu/wxstation/pet/pet.html>

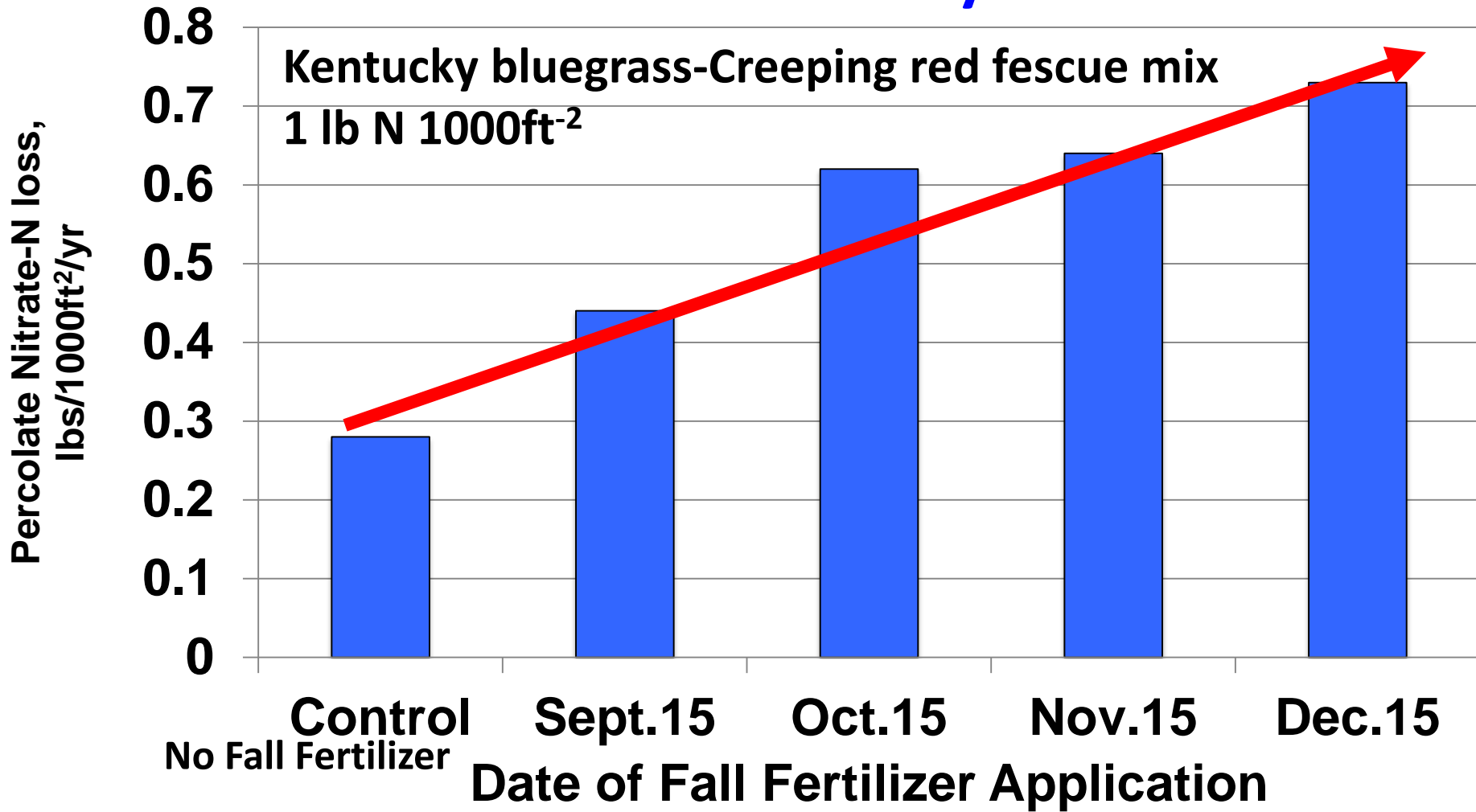
When Nitrate Leaches from Turf



Guillard and Kopp (*J. Environ. Qual.* 33:1822-1827, 2004)

University of Connecticut

Kentucky bluegrass-Creeping red fescue mix
1 lb N 1000ft⁻²



Mangiafico and Guillard

(*J. Environ. Qual.* 35:163-171, 2006)

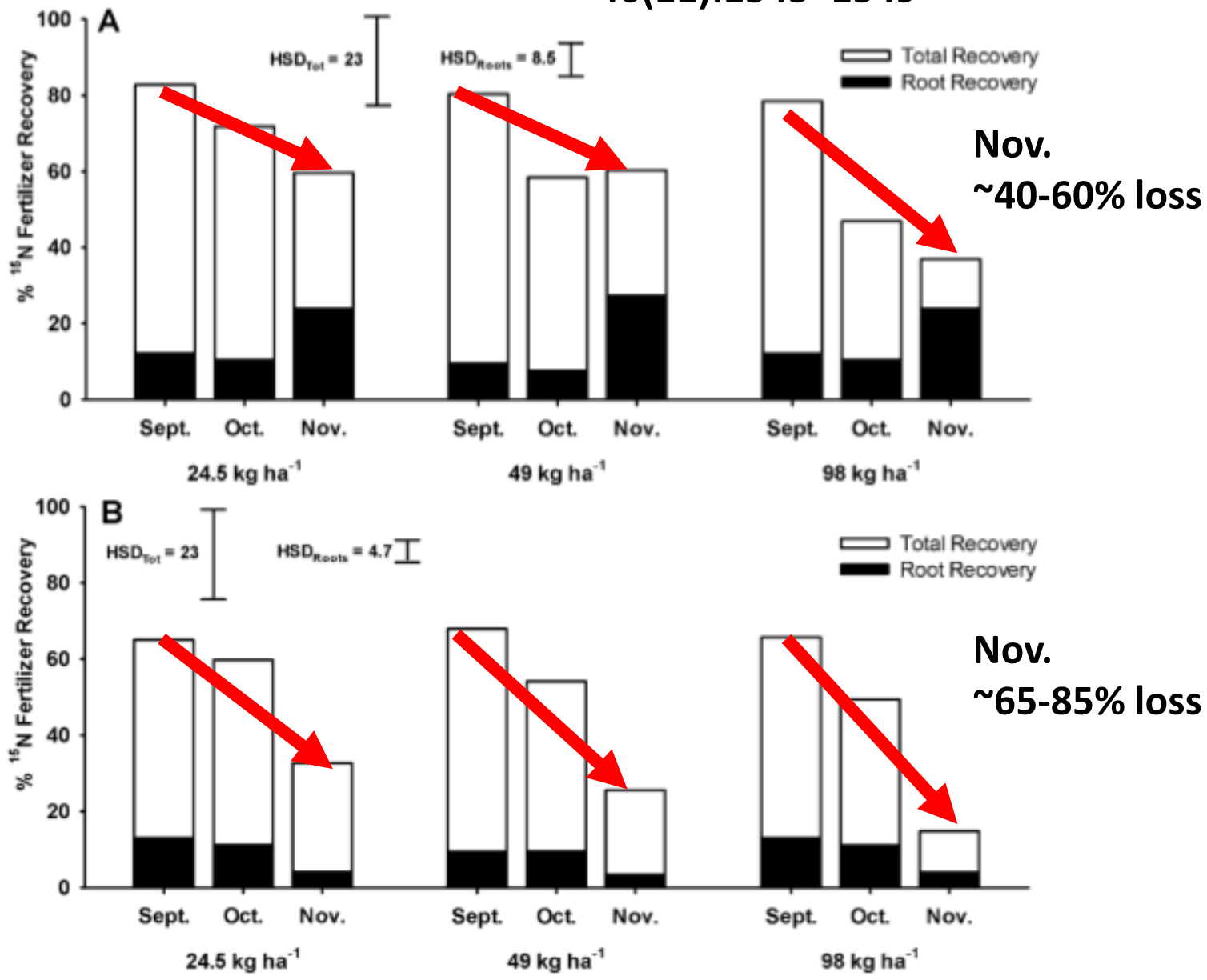


Fig. 1. Effect of temperature regimen and nitrogen application rate on ¹⁵N fertilizer recovery in roots and roots + verdure (total) for (A) Run 1 and (B) Run 2. Roots and verdure were harvested 10 d after nitrogen application. Temperature regimens correspond to 15 Sept., 15 Oct., and 15 Nov. in Madison, WI.

Sodat et al. 2017, Int. Turfgrass Soc. Res. J. *in press*

Controlled Environment

**Kentucky bluegrass
Tall fescue-fine fescue mix
1 lb N 1000ft⁻²**

**Fall lawn fertilizer applications should
be complete before September 15 in
northern New Hampshire and by
October 1 in southern New Hampshire**

Nitrate-N Leached, lbs/1000sqft

0.7
0.6
0.5
0.4
0.3

30

35

40

45

50

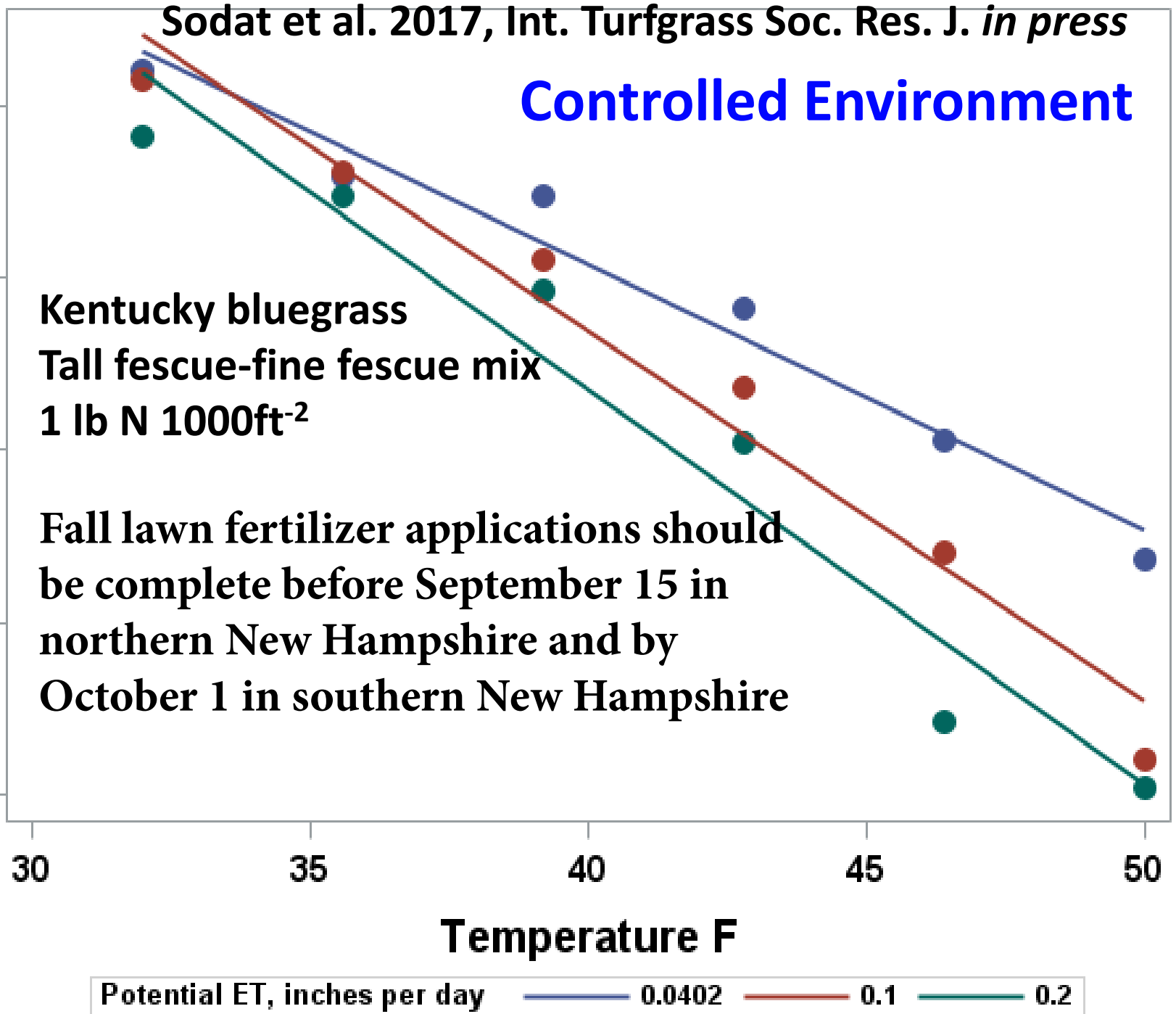
Temperature F

Potential ET, inches per day

0.0402

0.1

0.2



Fertilizer Substitution

- Dutch/Micro White Clover (*Trifolium repens*)



Estimated to provide 2.6 to 4.4 lbs N/1000ft²/yr
Joost, 1996, Missouri Grazing Manual

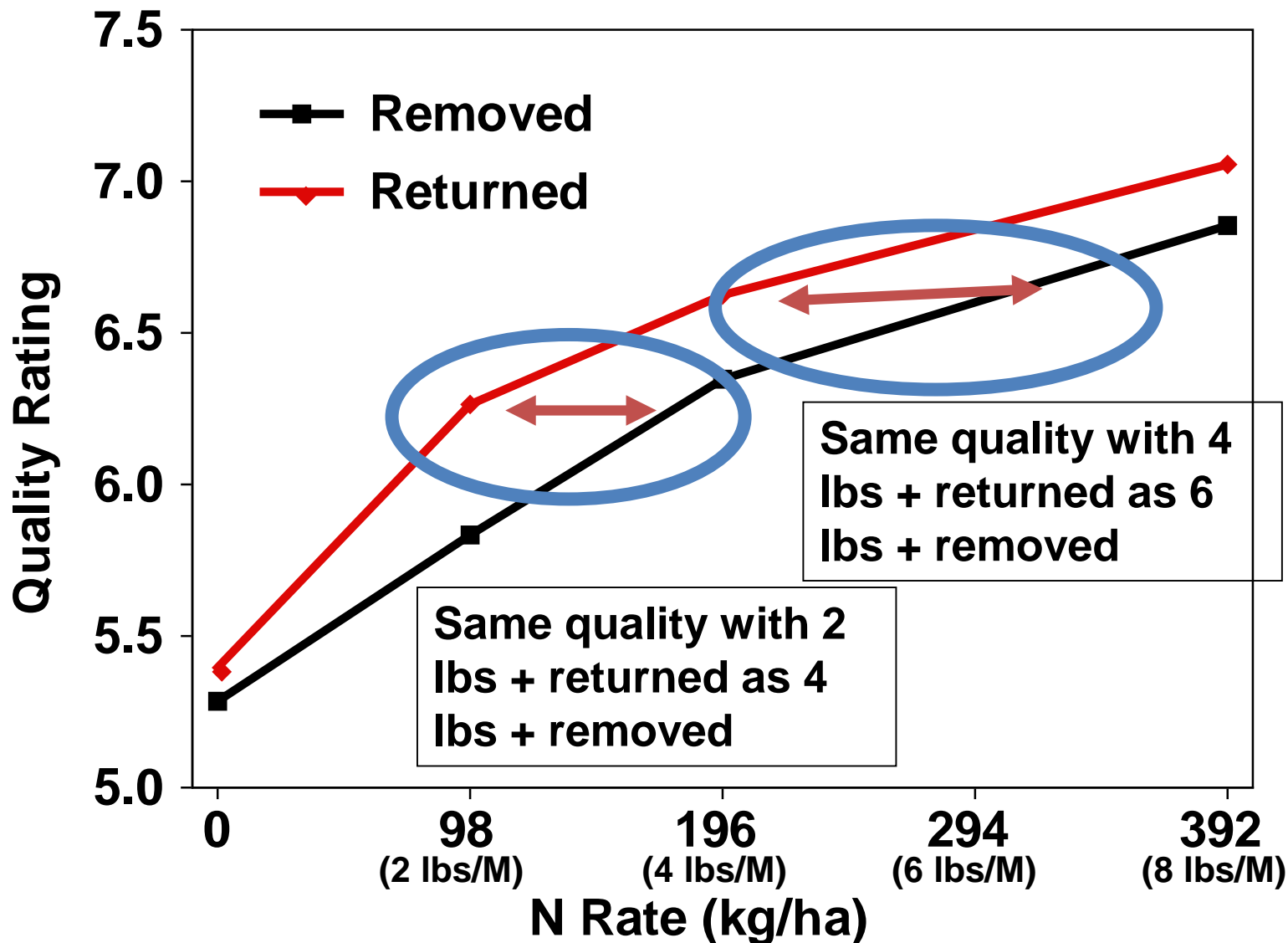
- **Grazing Birdsfoot trefoil (*Lotus corniculatus* var. *arvensis* 'Kalo')**



Estimated to provide 0.7 to 3.0 lbs N/1000ft²/yr
Joost, 1996, Missouri Grazing Manual

Return the Clippings to the Turf

Turfgrass Quality and Clipping Management

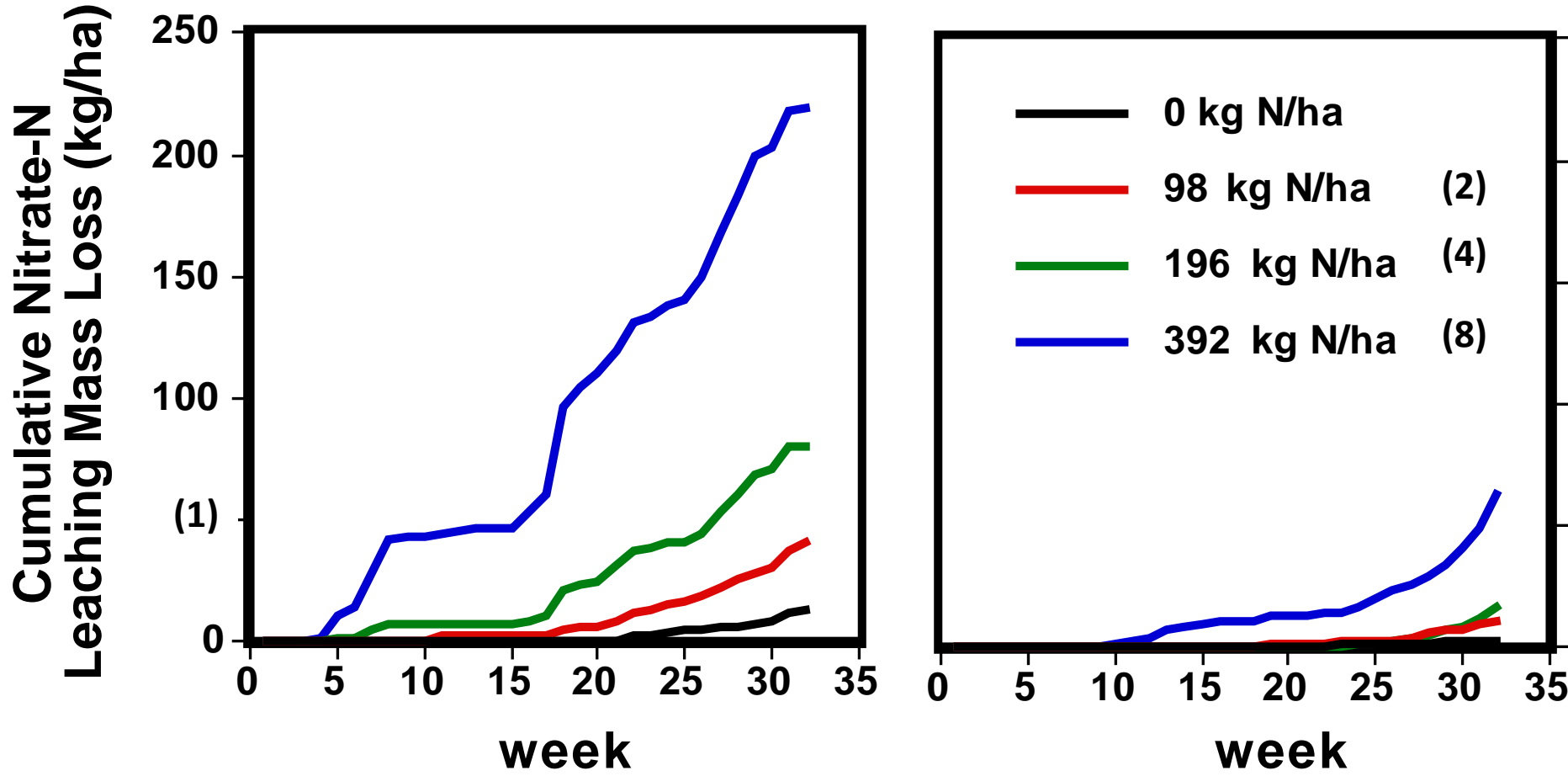


- When Clippings Returned, Reduce N Rates or total N Loading

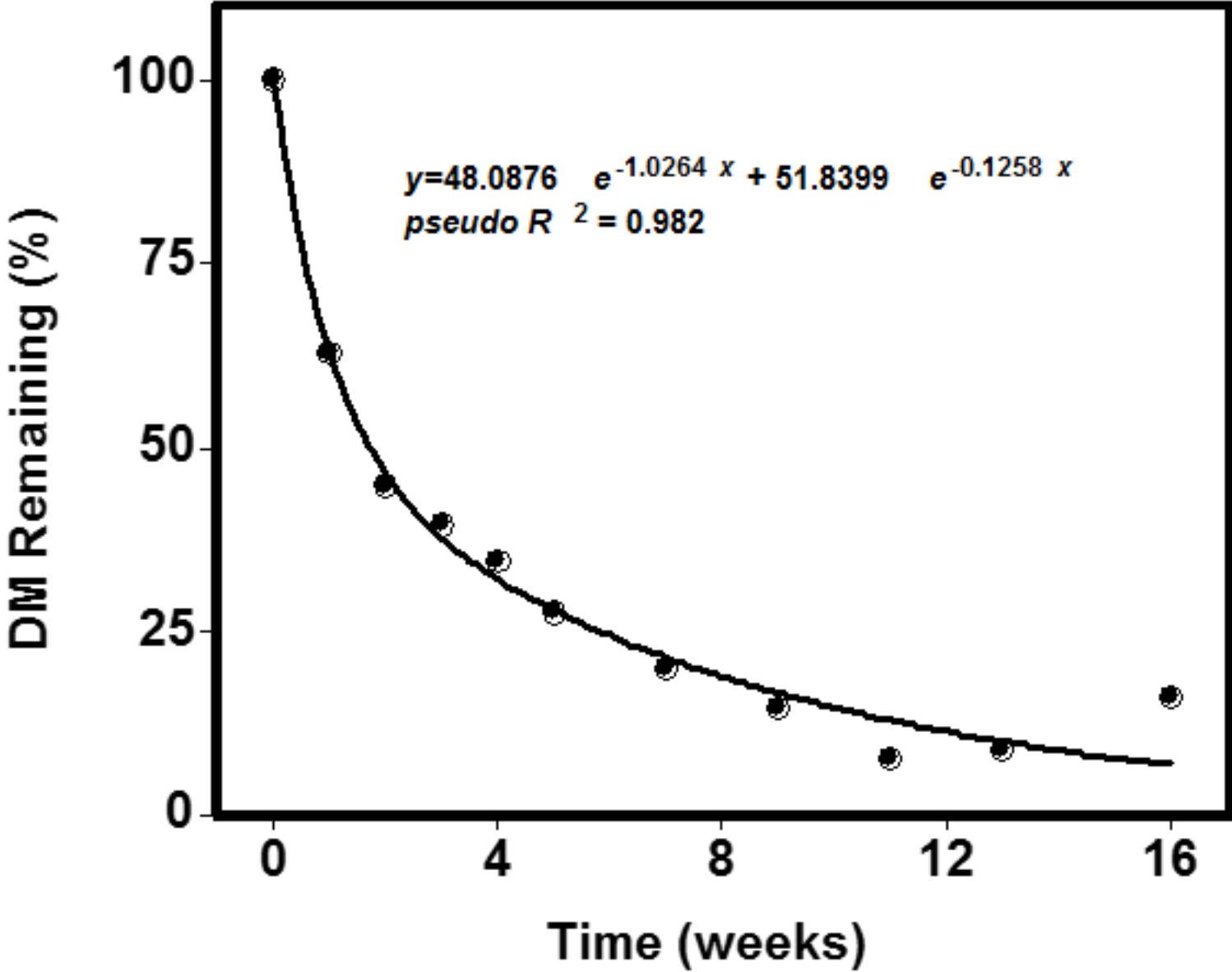
Bentgrass managed as fairway

Returned

Removed



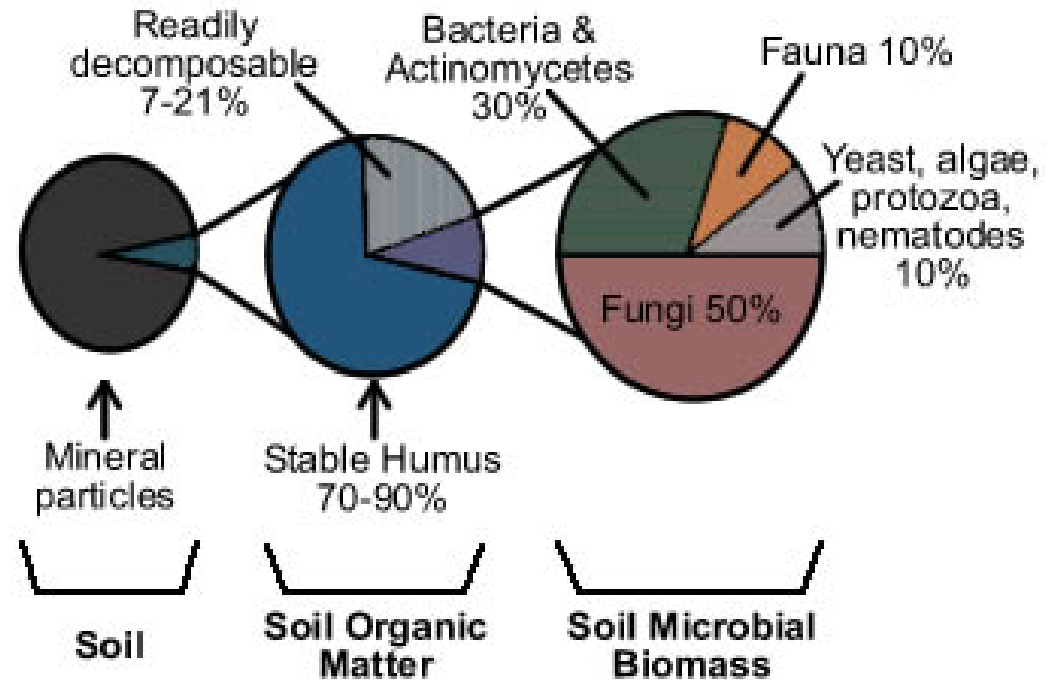
- Returning Clippings Does Not Increase Thatch



Maintain Soil pH Near Neutral

- 6.0 to 6.8 Ideal range
- Promotes soil organic matter mineralization

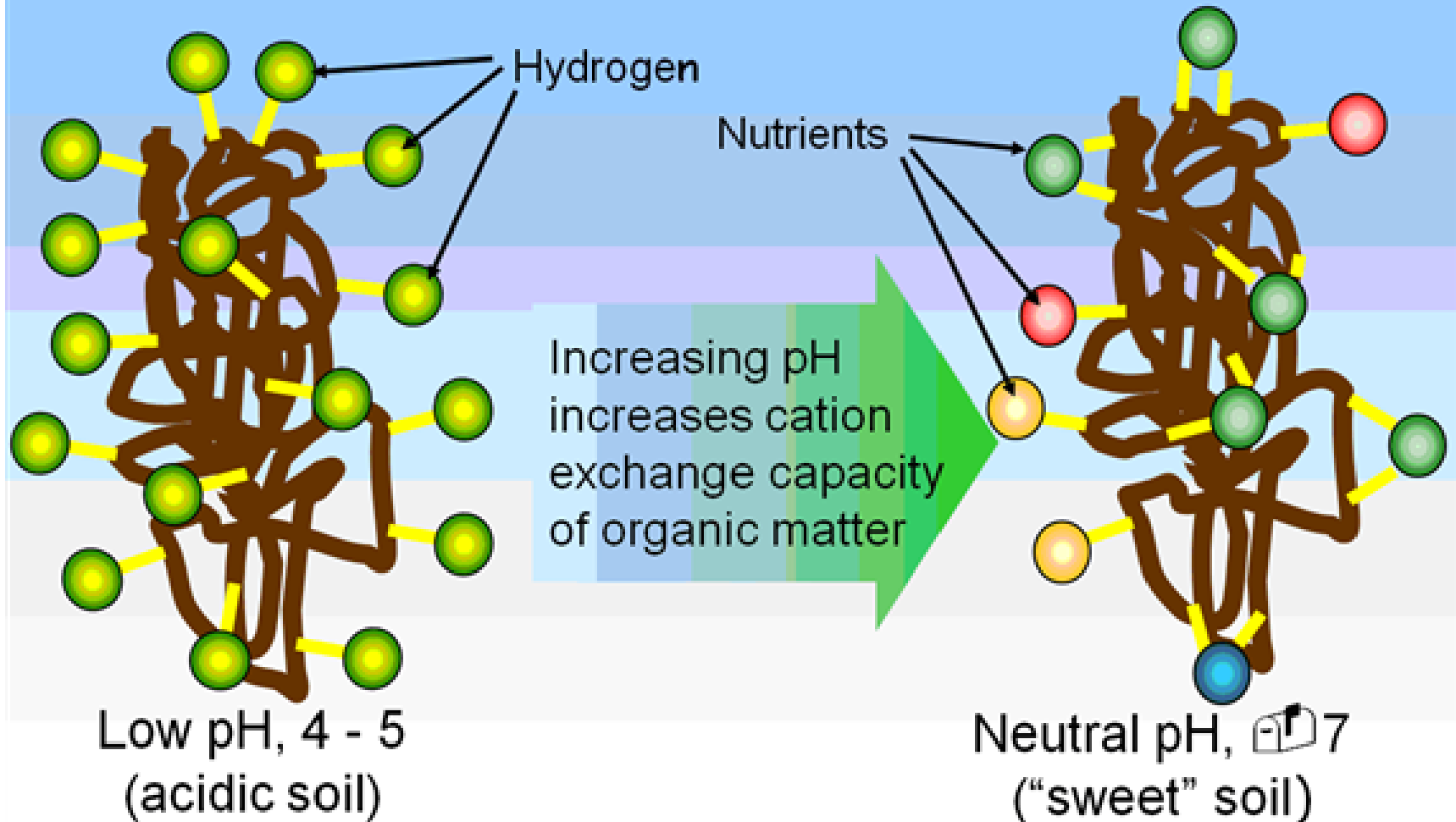
Figure 2. Components of Soil Organic Matter



Soil contains 1-6% organic matter. Organic matter contains 3-9% active microorganisms. These organisms include plant life, bacteria and actinomycetes, fungi, yeasts, algae, protozoa, and nematodes.

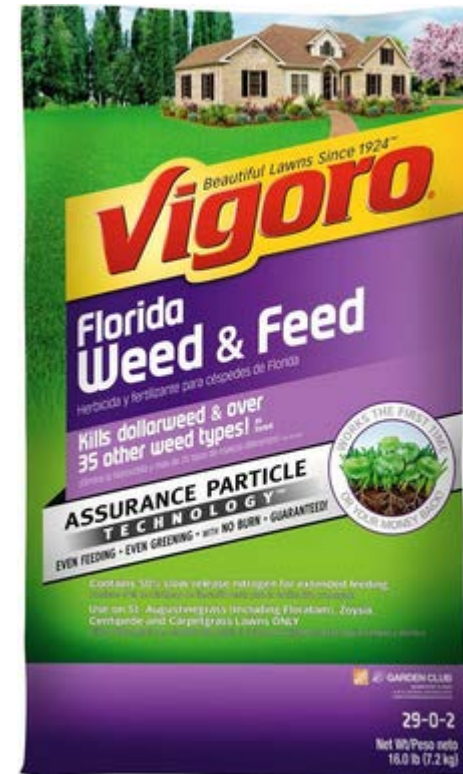
- Increase CEC – NH_4^+ retention

Cation Retention on Organic Matter



Pesticides and Water Quality

- Combination Fertilizer & Pesticide Products
- IPM



- **Pesticide Runoff 29 Chemicals (Haith and Duffany, 2007)**
 - ❑ **Turf pesticides runoff losses varying from 0 to 2% of applied chemicals.**
 - ❑ **Pesticide runoff depends on the nature of the grass surfaces; greater vegetation mass produce less water runoff and also more strongly adsorb chemicals.**
 - ❑ **Pesticide runoff not uniformly distributed throughout year; most occurs in brief, infrequent events.**
- **Maintaining dense vegetation decreases runoff**
- **Buffer Zones**
- **Most of turf pesticide leaching – sand putting greens**

Sediments

- **Runoff Related to Vegetative Cover and Infiltration**



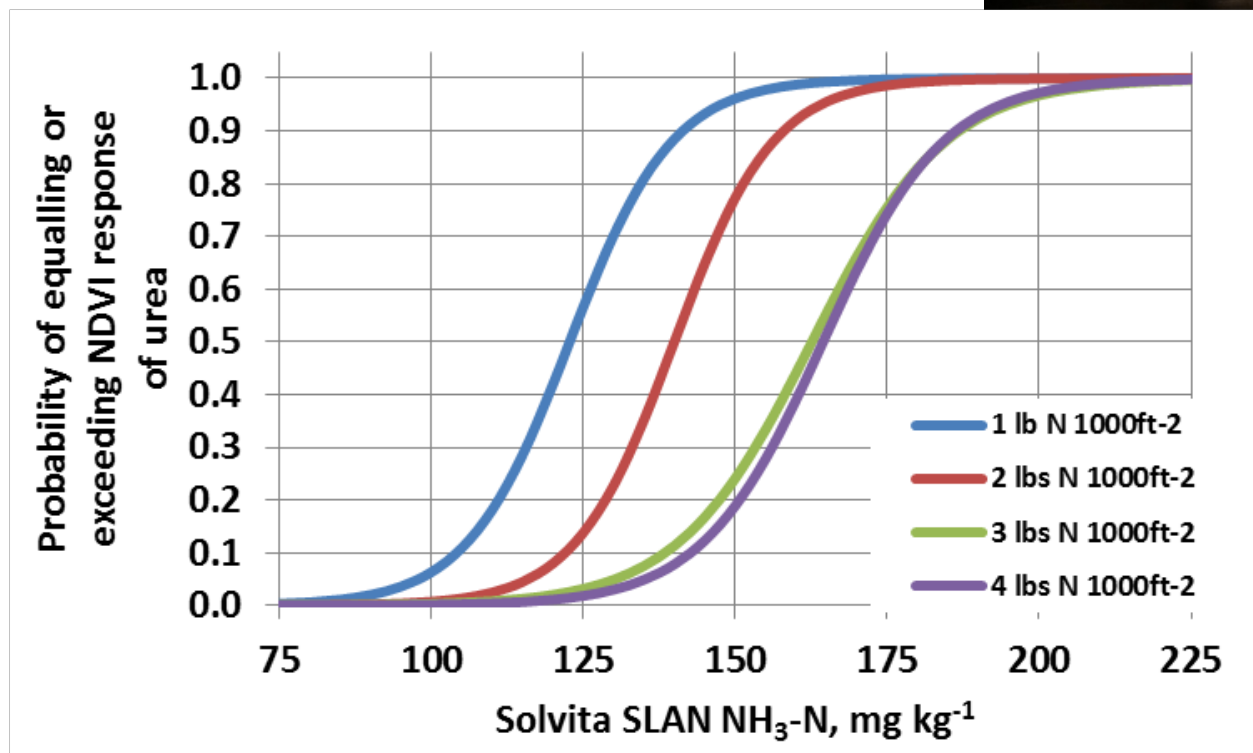
<http://ocean.njaes.rutgers.edu/UnderstandingSoilCompaction.html>



<http://turblog.rutgers.edu/?p=856>

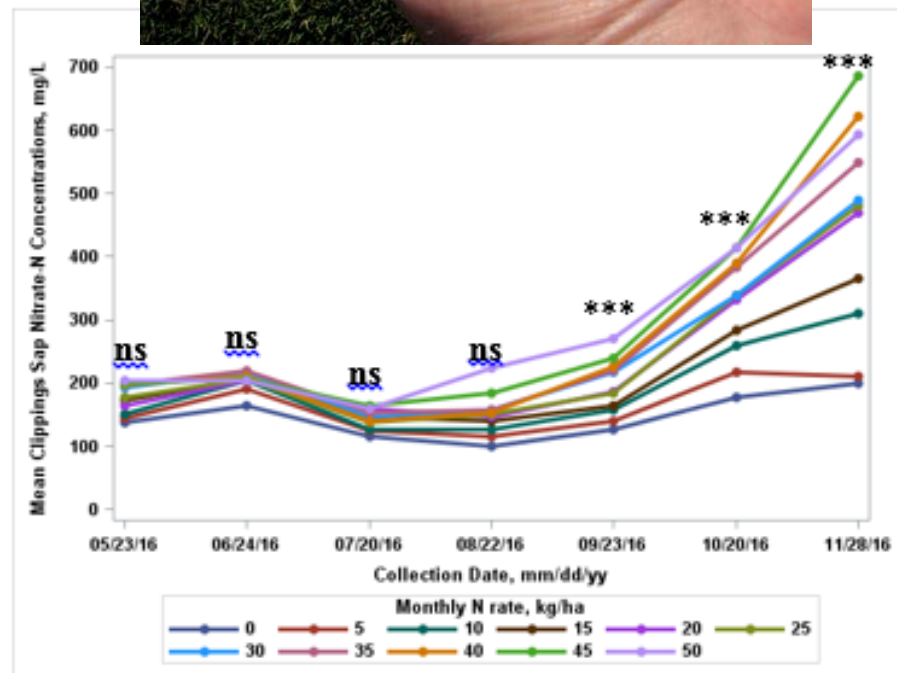
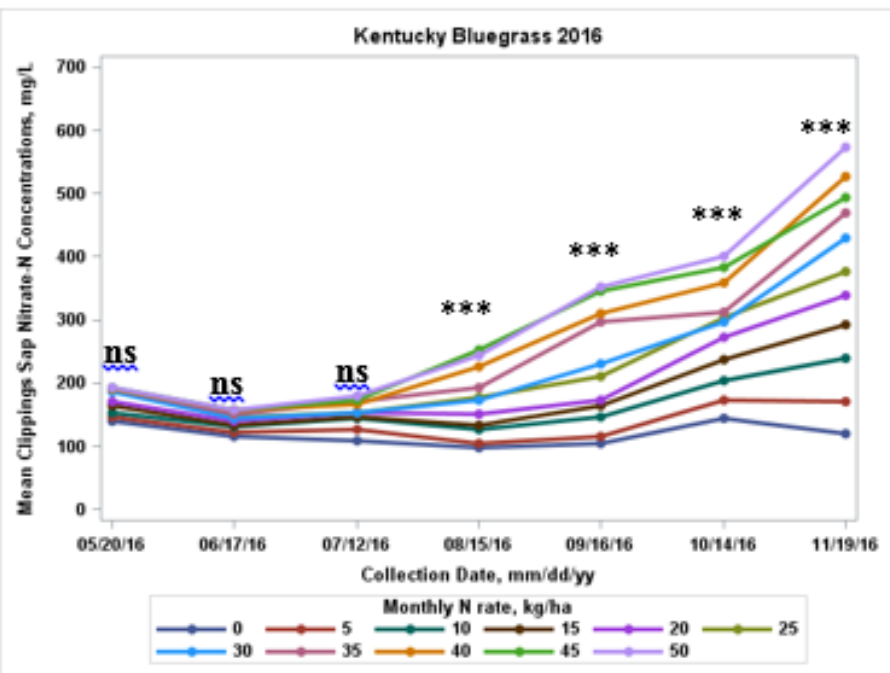
Current Research to Guide N Fertilization

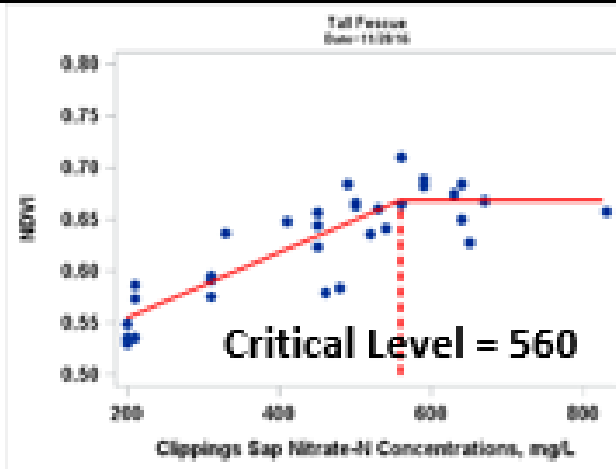
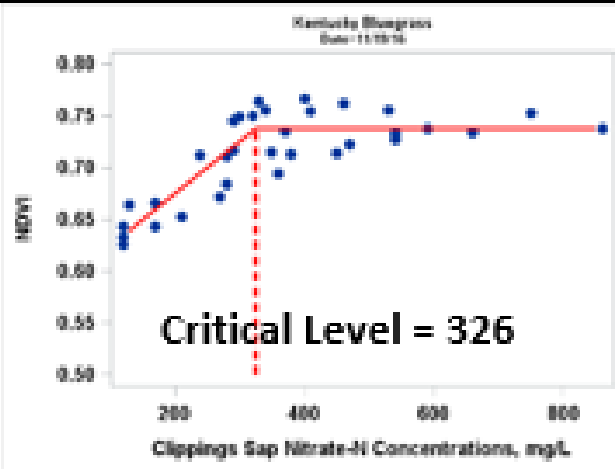
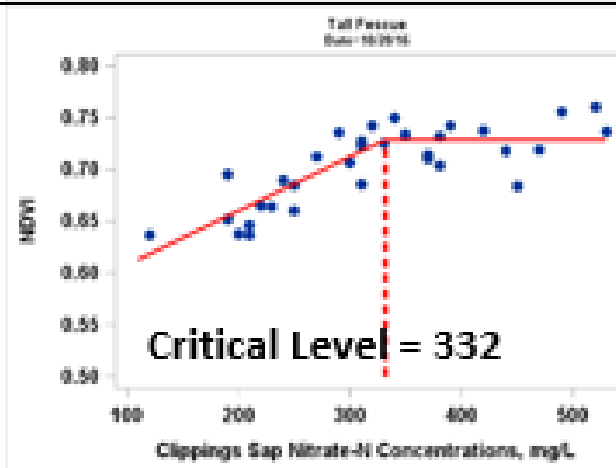
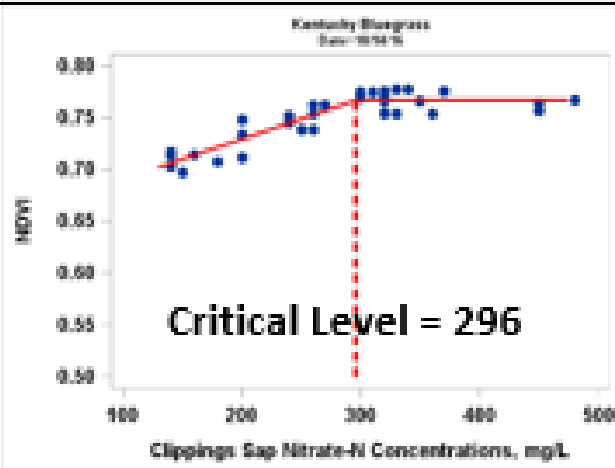
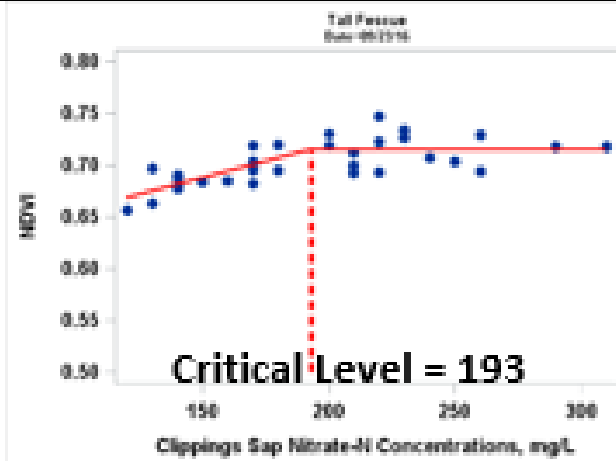
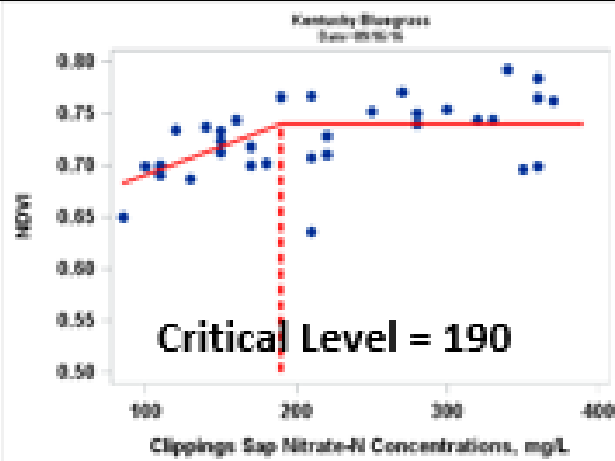
- Slovita Labile Amino N Test
- Sovita CO₂-Burst Test



Current Research to Guide N Fertilization

- Clippings Sap Nitrate in the Fall





Current Research to Guide N Fertilization

- Relectance Meters



Spectrum CM1000
Chlorophyll Meter

CM1000 NDVI
≈ \$2,500



Spectrum
TCM500 NDVI
Meter

≈ \$700



Trimble Greenseeker
RT100 NDVI Meter

≈ \$3,000 to \$5,500



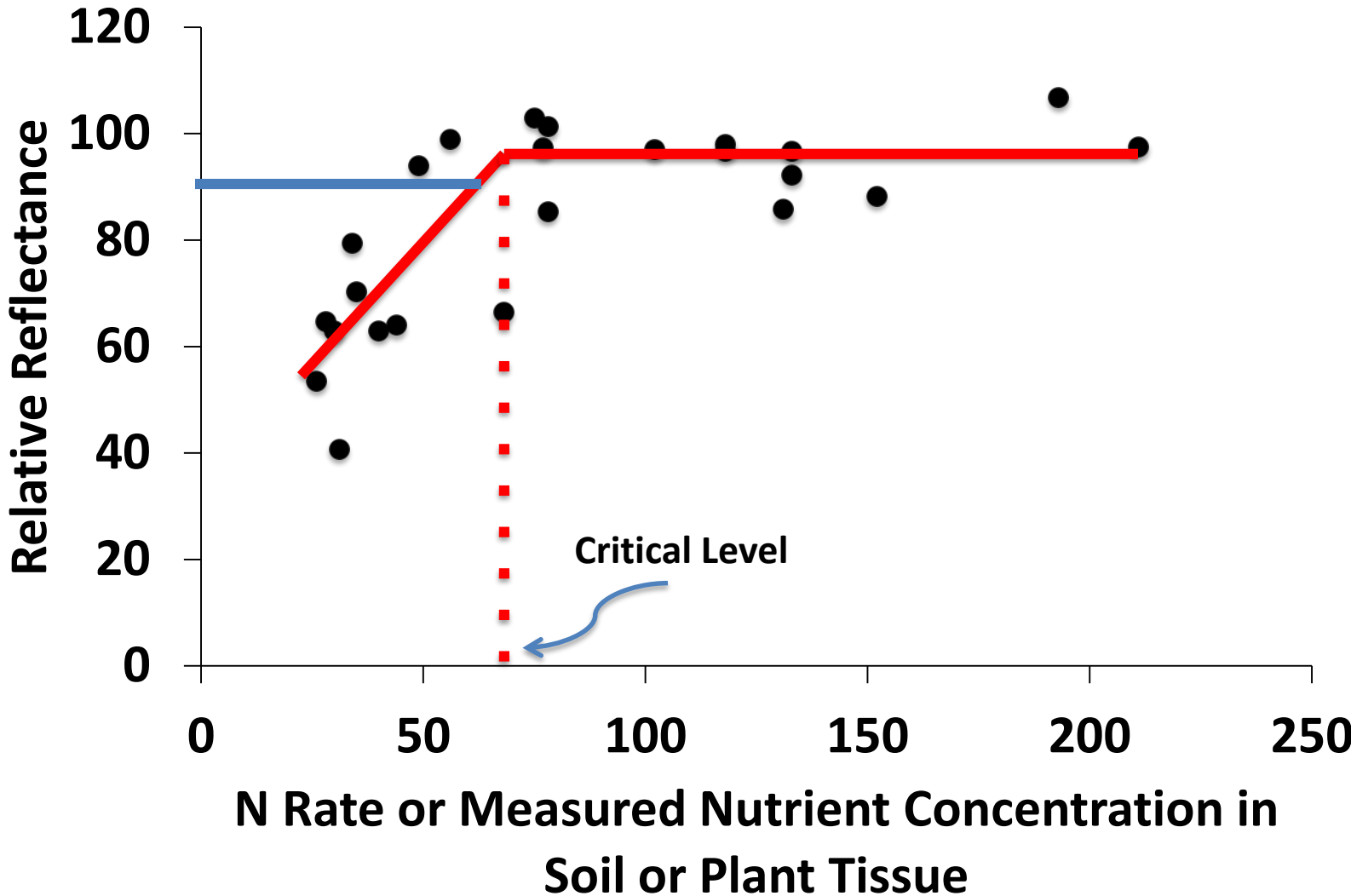
Trimble GreenSeeker
Handheld Crop Sensor
≈ \$495



Spectrum FieldScout
GreenIndex+ Turf App
and Board

\$100

- **90 to 95% of the Reading from a Well-Fertilized Reference Strip**



Concluding Thoughts

- **Lawn BMP's for water quality do not have to be in conflict with profitable business model.**
- **Common sense should guide most of your lawn-care management decisions with respect to water quality.**
- **Your feedback and input critical for future research.**

Questions?

karl.guillard@uconn.edu

<http://www.turf.uconn.edu/guillard.shtml>

