Urban Development and Land Management Impacts on Water Quality

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Learning Objectives

By the end of this presentations you will:

1. Know the state of water quality in FL
2. Understand how water quality is impacted by:
   - Land use & impervious cover
   - Soil management practices
   - Landscape design & management
   - Turfgrass management practices

Quality of FL Surface Water

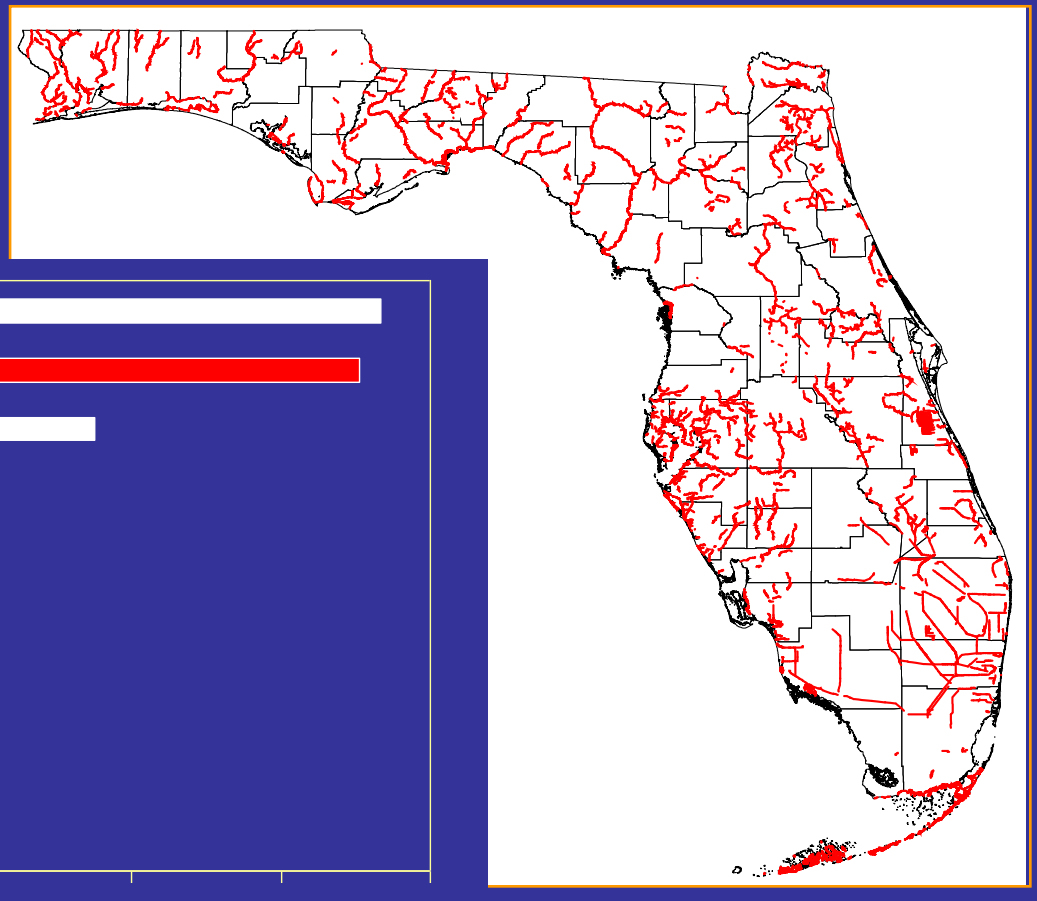
- Water quality problems are associated with:
  - Highly urbanized central and south Florida
  - Intense agricultural and industrial land use

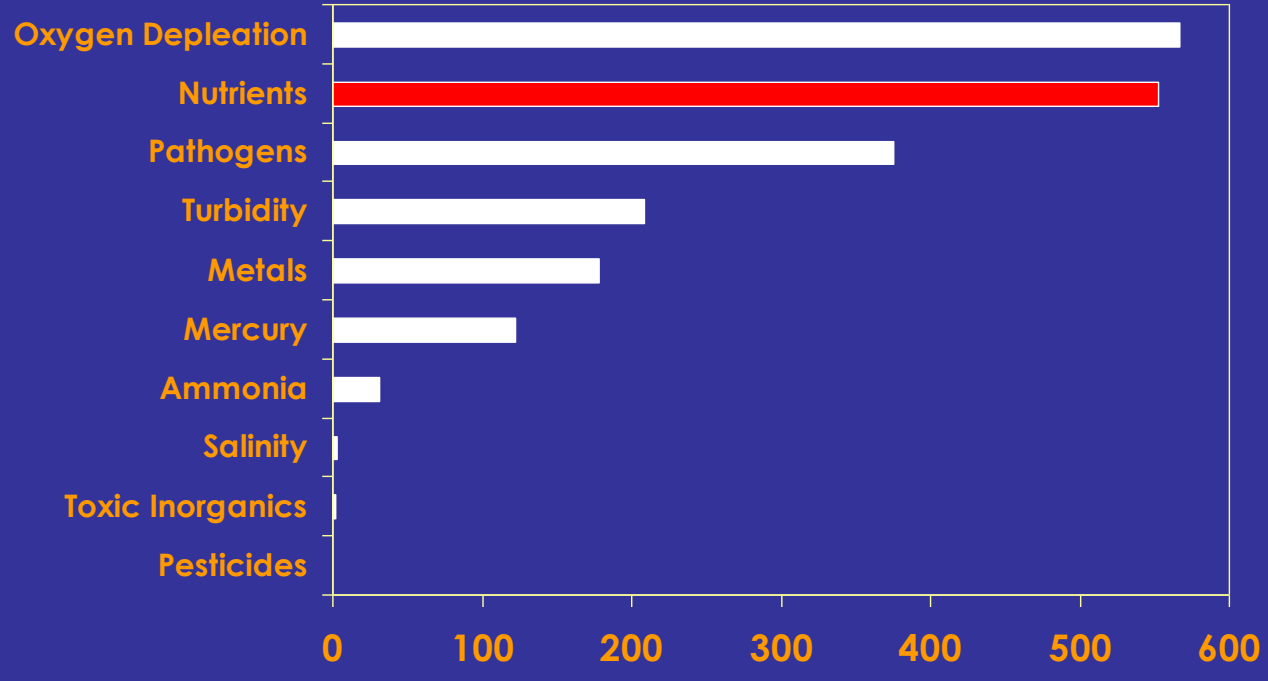
Quality of FL Surface Water

- 100% of the state evaluated
- "Poor" water quality
  - 28% of river and stream miles
  - 25% of lake acres (excluding Lake O)
  - 59% of estuary square miles
- 2,565 TMDLs needed for 1,688 waters
  - 322 TMDLs adopted for 166 water bodies
  - 3 BMAPs completed

Source: 2008 Florida 305(d) Report

Causes of Impairment





Number of Impairments

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Surface Water Quality Trends

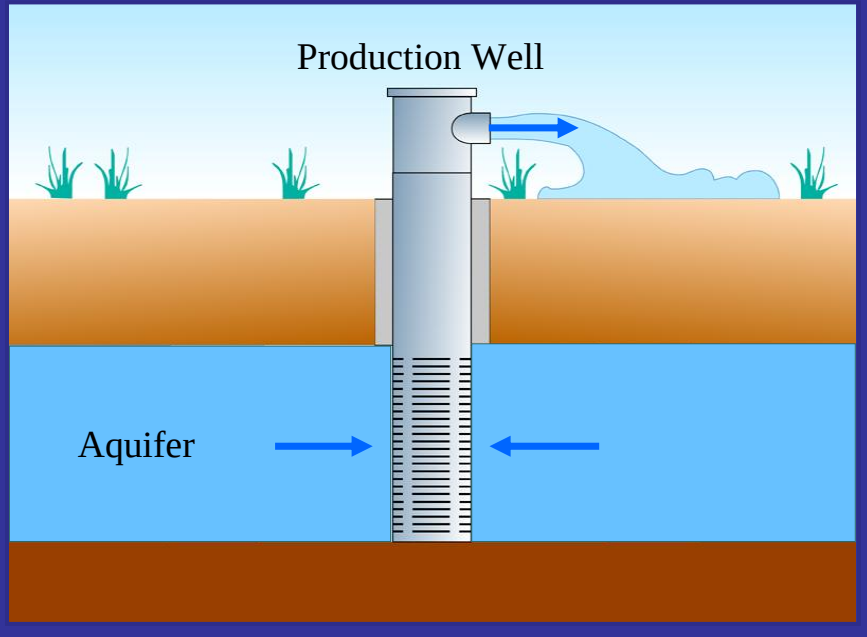
From 1997 to 2007 (823 waterbodies):

- 54% stable
- 22% improving (urban areas due to improved wastewater and stormwater treatment)
- 24% degrading
  - Ag areas like Suwannee River basin
  - Areas of urban growth

Source: 2008 Florida 305(d) Report

Groundwater Quality

- "Good" Overall quality of potable groundwater.
- Pollution issues included:
  - Volatile organics
  - Pesticides
  - Metals
  - Nutrients



Challenges to Maintain or Improve Water Quality

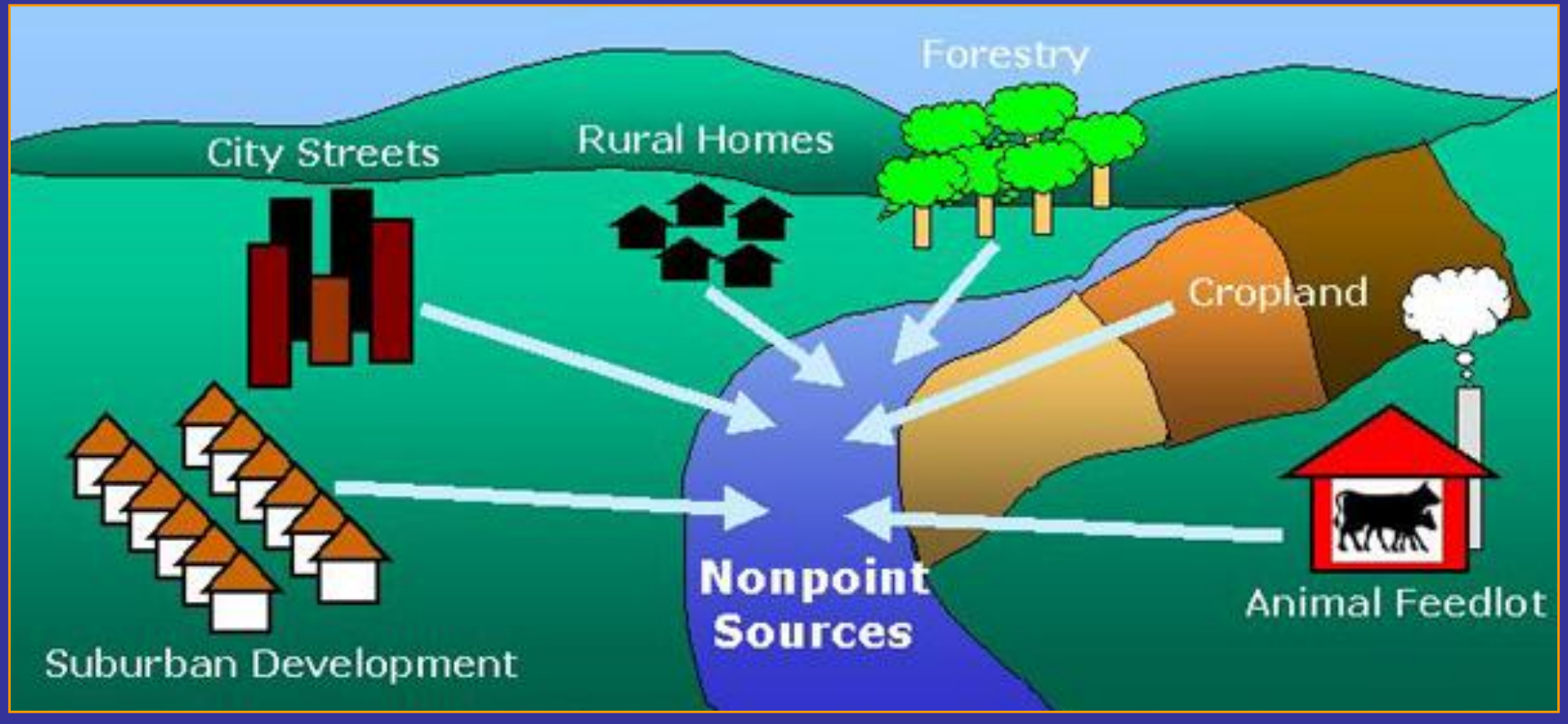
- Population projected to exceed 36 million by 2060
- Extensive agricultural operations
- Connectivity of surface and ground water

NUTRIENT SOURCES AND LOSS PATHWAYS

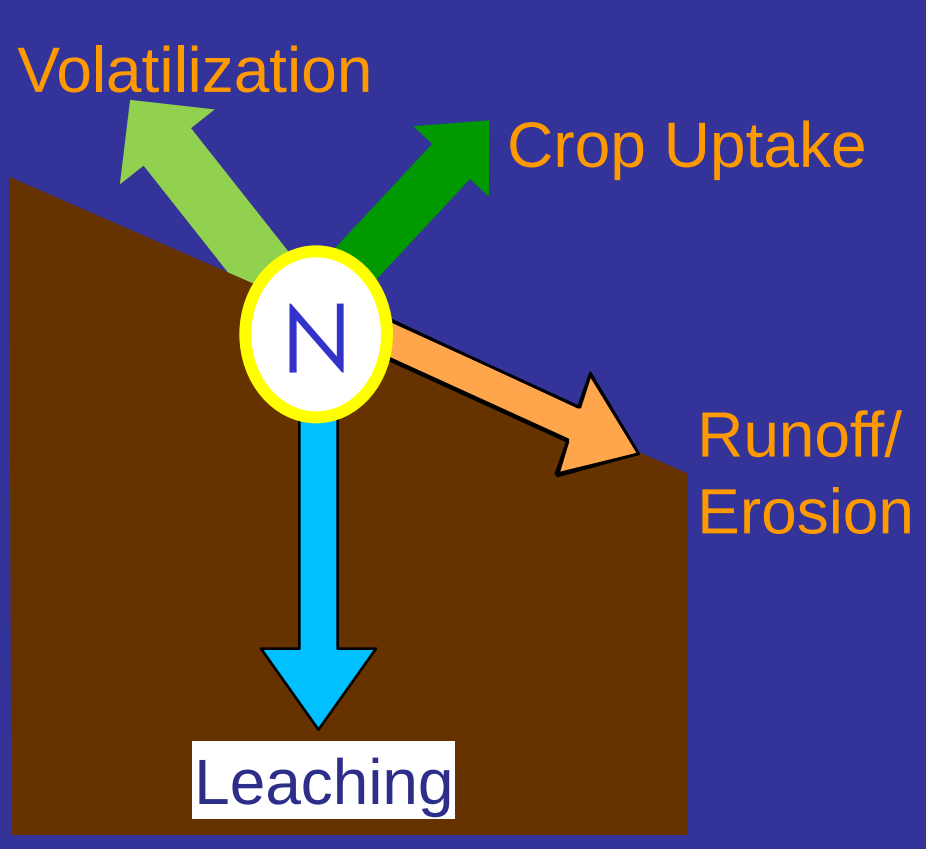
Point Source Pollution

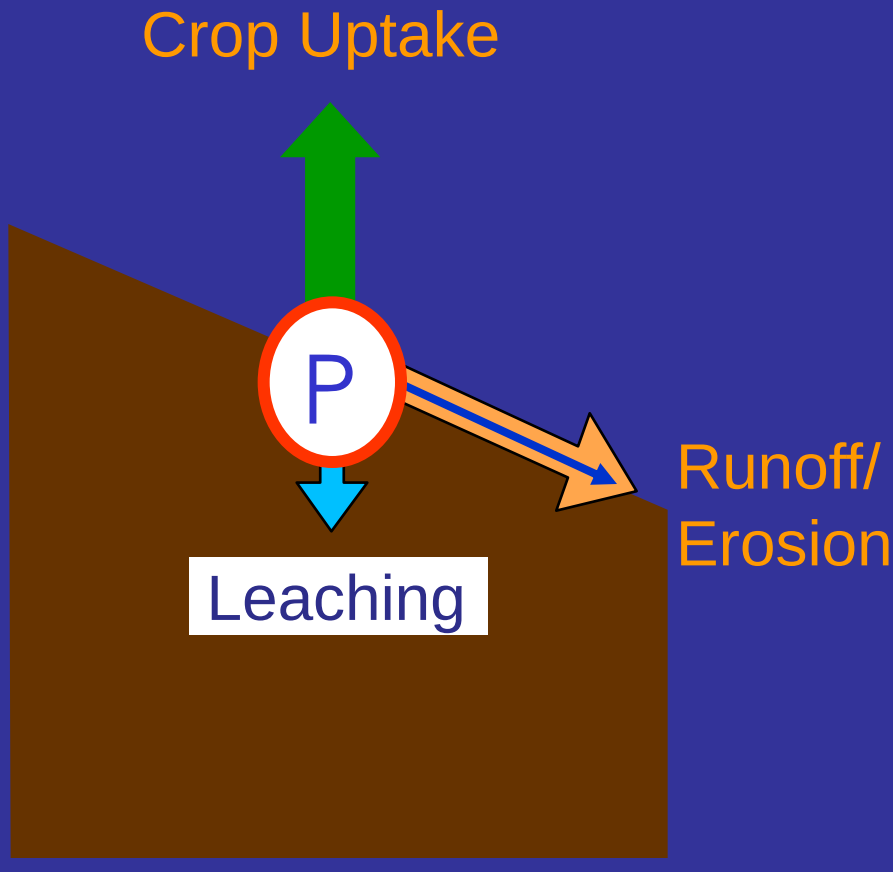
Permitted Urban Surface Water Discharge (NPDES)

Non-Point Source Pollution



Nutrient Loss Pathways





Factors Affecting Urban Nutrient Pollution

1. Land use & impervious cover
2. Soil management practices
3. Landscape design & management
4. Turfgrass management practices

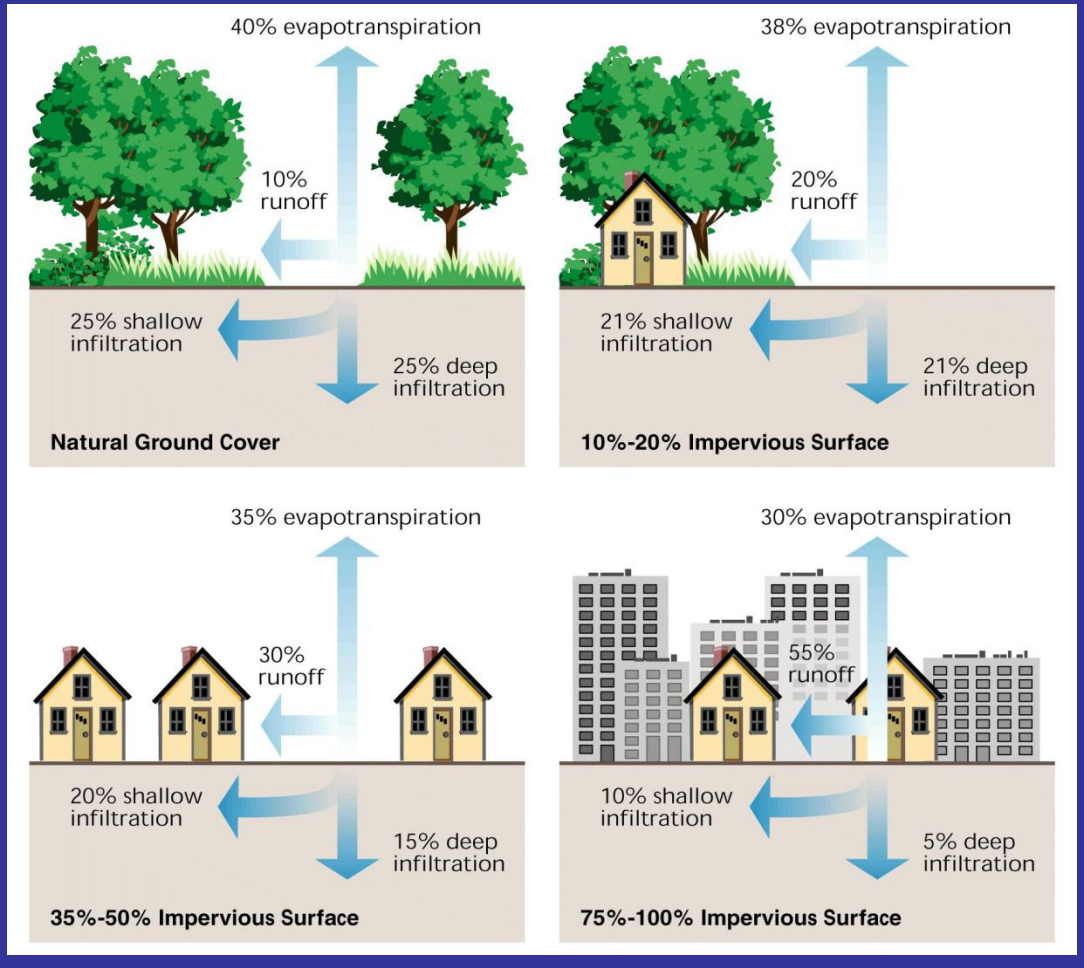
LAND USE & IMPERVIOUS COVER

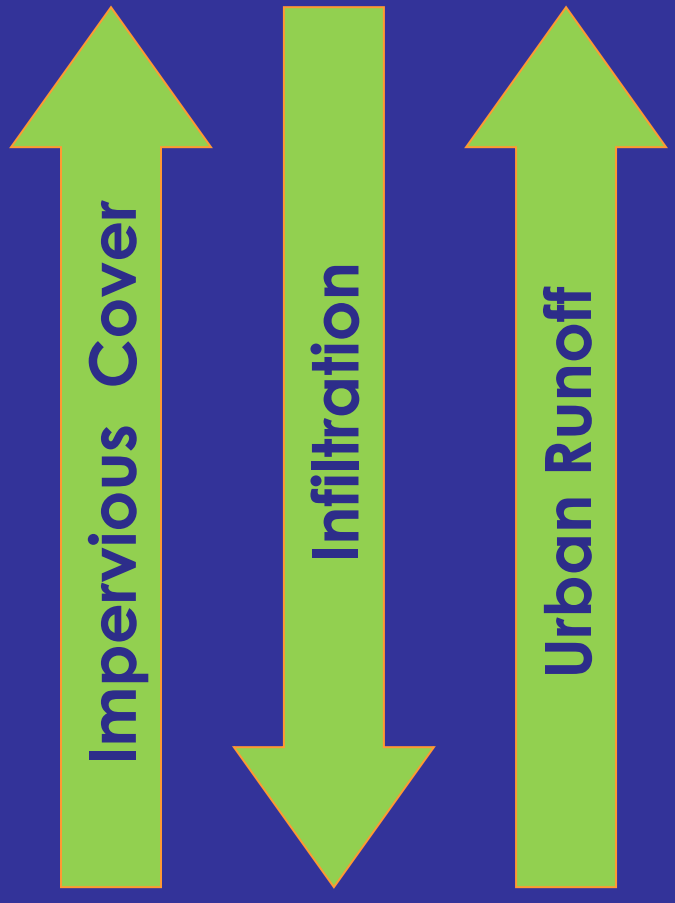
FL Major Land Use Statistics

Land Use	1982		2002	
	1000 Acres	%	1000 Acres	%
Cropland	4174	12	3716	11
Pasture	6229	18	4701	14
Forest	21179	61	14636	42
Urban	2867	8	3960	11
Total	34658		34513	

Source: USDA-ERS, 2006

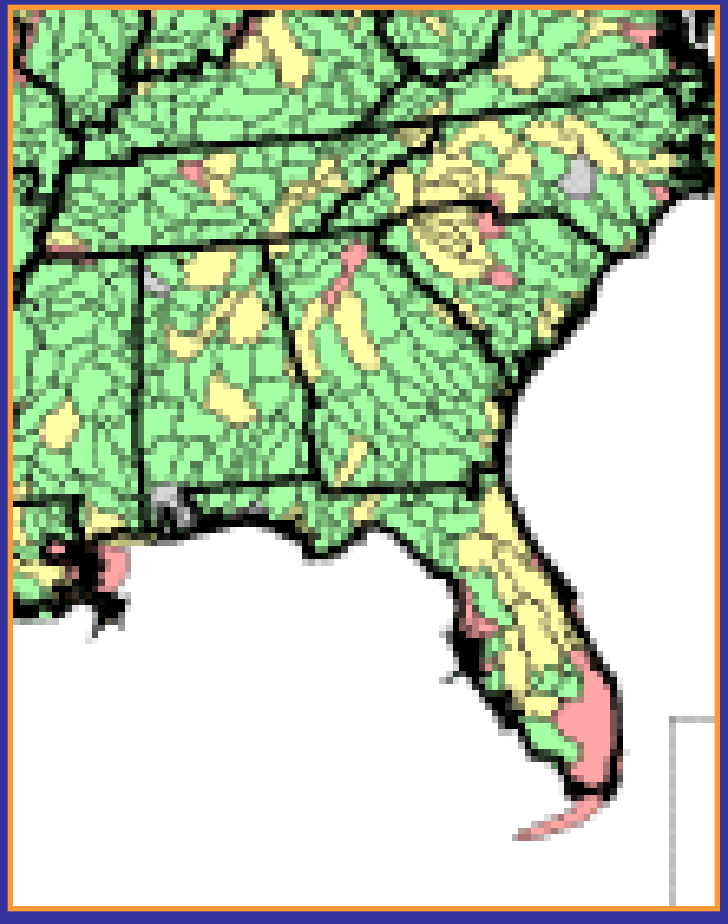
Land Use and Impervious Cover





Land Use and Impervious Cover

- Urban areas of FL have high runoff potential (e.g., JAX, ORL, MIA, TPA)



Land Use and Nutrient Runoff

Neuse River Basin, NC

Land Use	Rain (mm)	Runoff: Rainfall Ratio	Annual Pollutant Export Rate (kg ha^{-1})		
			NO_3-N	TKN	Total P
Construction-1[z]	1251	0.52	1.4	6.9	3.0
Construction-2[y]	1031	0.70	7.3	29.0	1.3
Residential	2204	0.57	3.2	20.7	2.3
Golf Course	1845	0.47	4.8	26.4	5.3
Dairy Pasture	2385	0.26	1.2	5.5	4.3
Wooded	1517	0.32	3.6	7.8	1.0

[z]Construction-1 = Clearing & grading
[y]Construction-2 = Road & home installation

Line et al. (2002)

Land Use and Water Quality

- Florida's population growth will lead to more urbanization
- More development = more impervious cover = more runoff = less infiltration
- Urban areas will continue to impact water quality and quantity

SOIL MANAGEMENT PRACTICES

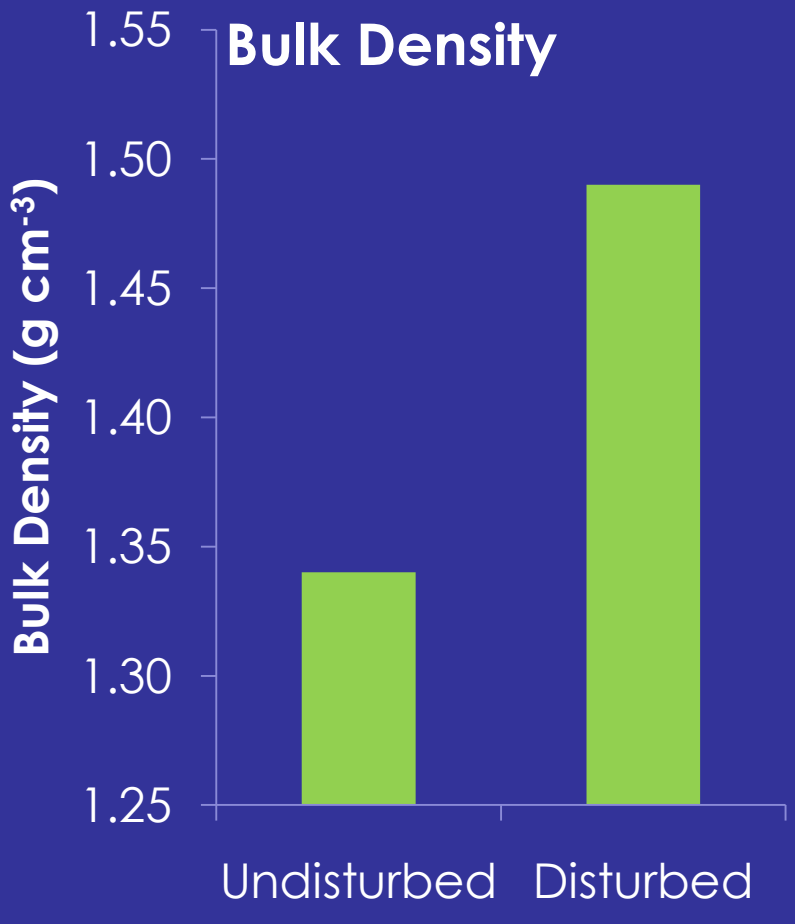
Florida Development Model

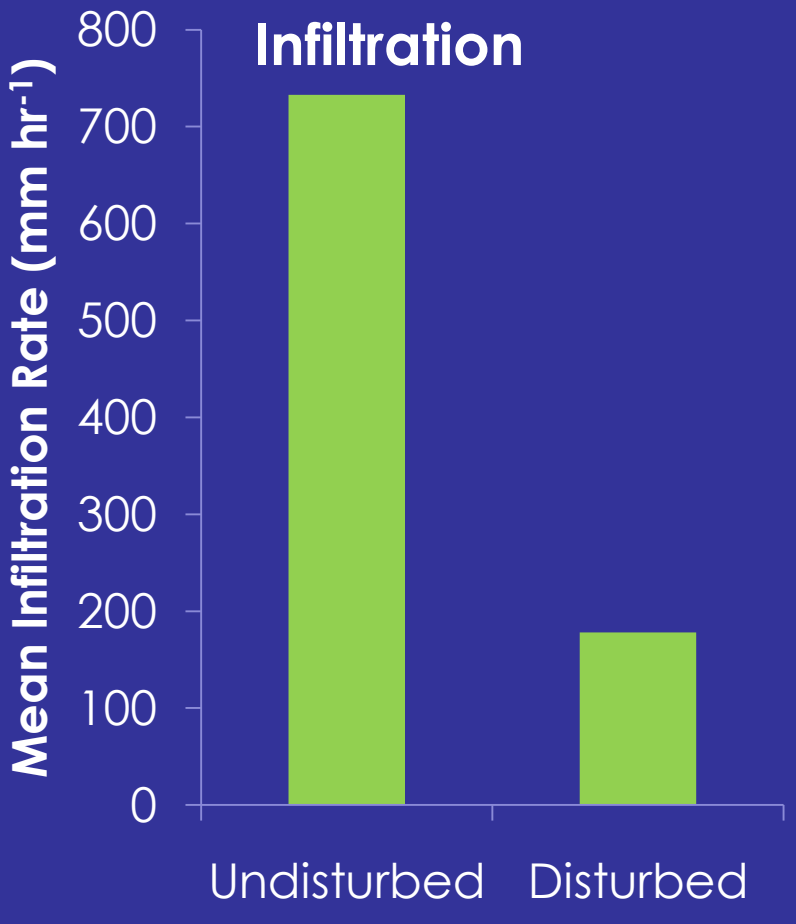
Soil Compaction

Landscape Installation

Photo Credit: Amy Shober, UF-IFAS

Soil Compaction & Infiltration





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Gregory et al. (2006)
J. Soil Water Conserv.

Comparison of Soil Properties

Parameter	Oscar Scherer State Park (n = 4)	Pre-Construction (n = 43)	Established Development (n = 96)
Bulk density, g cm^{-3}	ND	1.71	1.48
Soil pH	4.22	6.27	7.60
Organic matter, g kg^{-1}	27.5	72.0	30.2
Mehlich 3 P, mg kg^{-1}	5.02	35.1	79.0
DPS_{M3}, %	6.7	10	39
Total Kjeldahl N, mg kg^{-1}	616	ND	988

Median values reported
ND = Not determined

Urban Soil Profile Variability

Park Samples

Residential Samples

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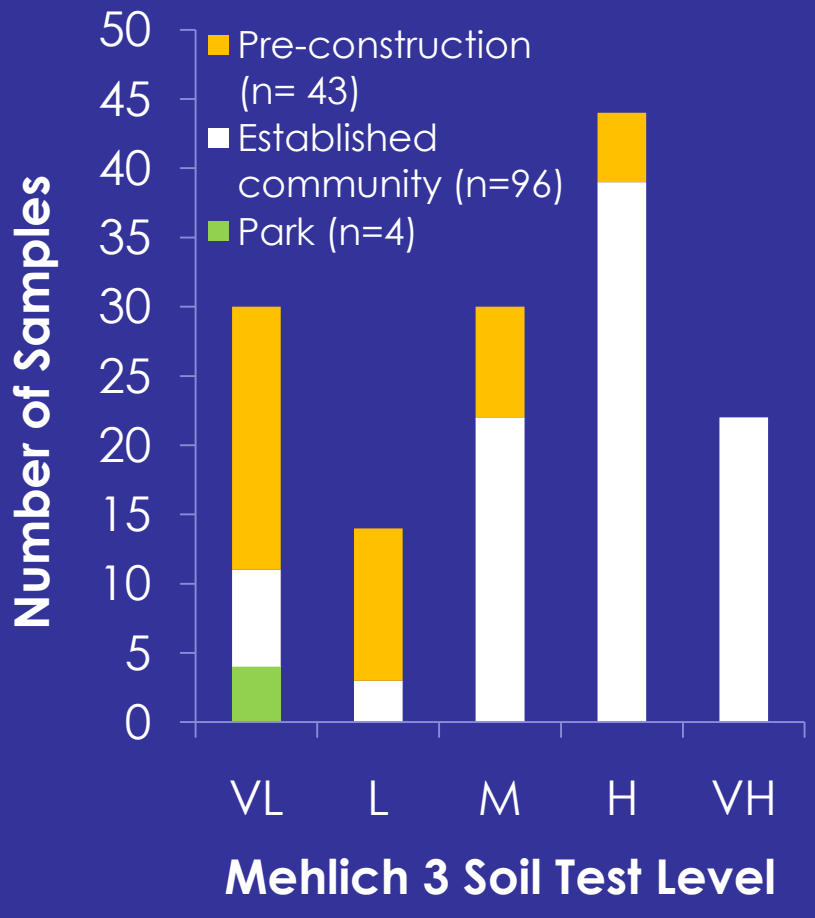
Urban Soil Test P

Soil Test P Level	Mehlich-1	Mehlich-3
	—mg/kg or ppm—	
Very Low (VL)	<10	<33
Low (L)	10-15	33-40
Medium (M)	16-30	41-62
High (H)	31-60	63-105
Very High (VH)	>60	>105



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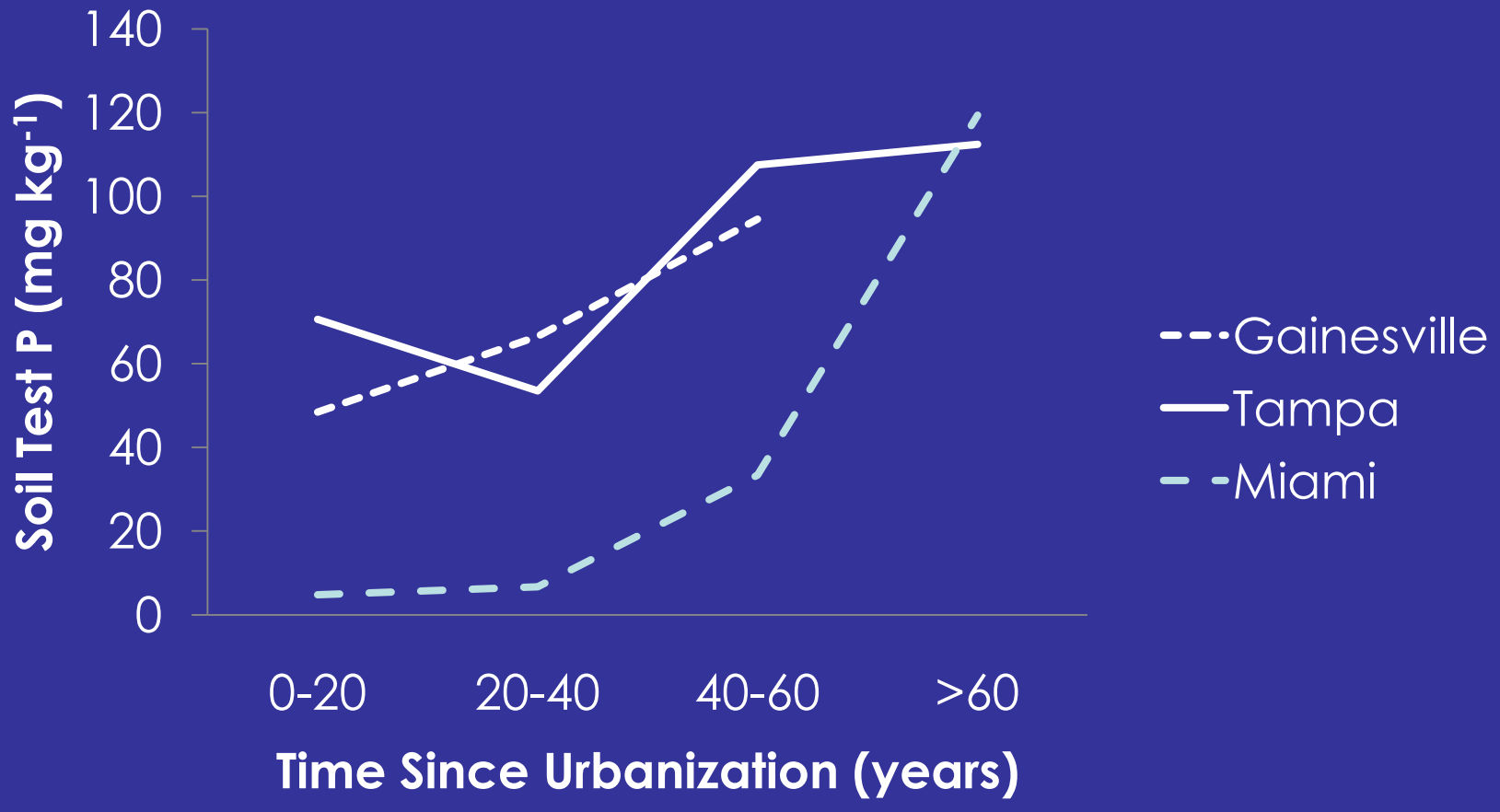
[z]Mehlich-3 values based on relationship of Mehlich-1 P and Mehlich-3 P reported by Mylavarapu et al. (2002).

Temporal Effects on Soil Nutrients



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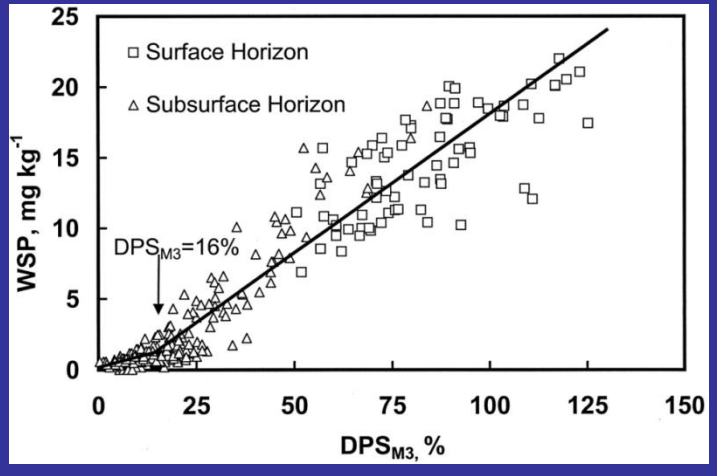
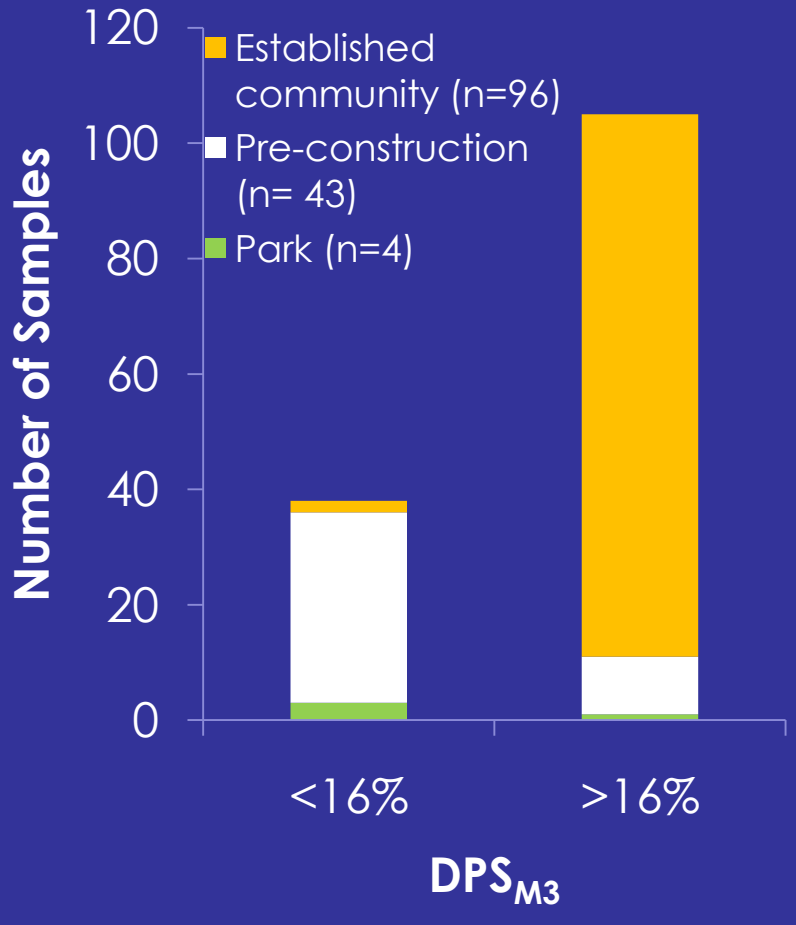
Hagen et al. (2010)

Soil P Saturation



Degree of P Saturation (DPS_{M3}) Threshold = 16%



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Nair et al. (2004); JEQ 33(1) 107-113

Soil Management

- Urbanization results in significant soil disturbance.
- Compaction reduces infiltration and increases runoff potential.
- Soil properties are highly variable.
- Some soils can become a source of P to surface water.

LANDSCAPE DESIGN AND MANAGEMENT

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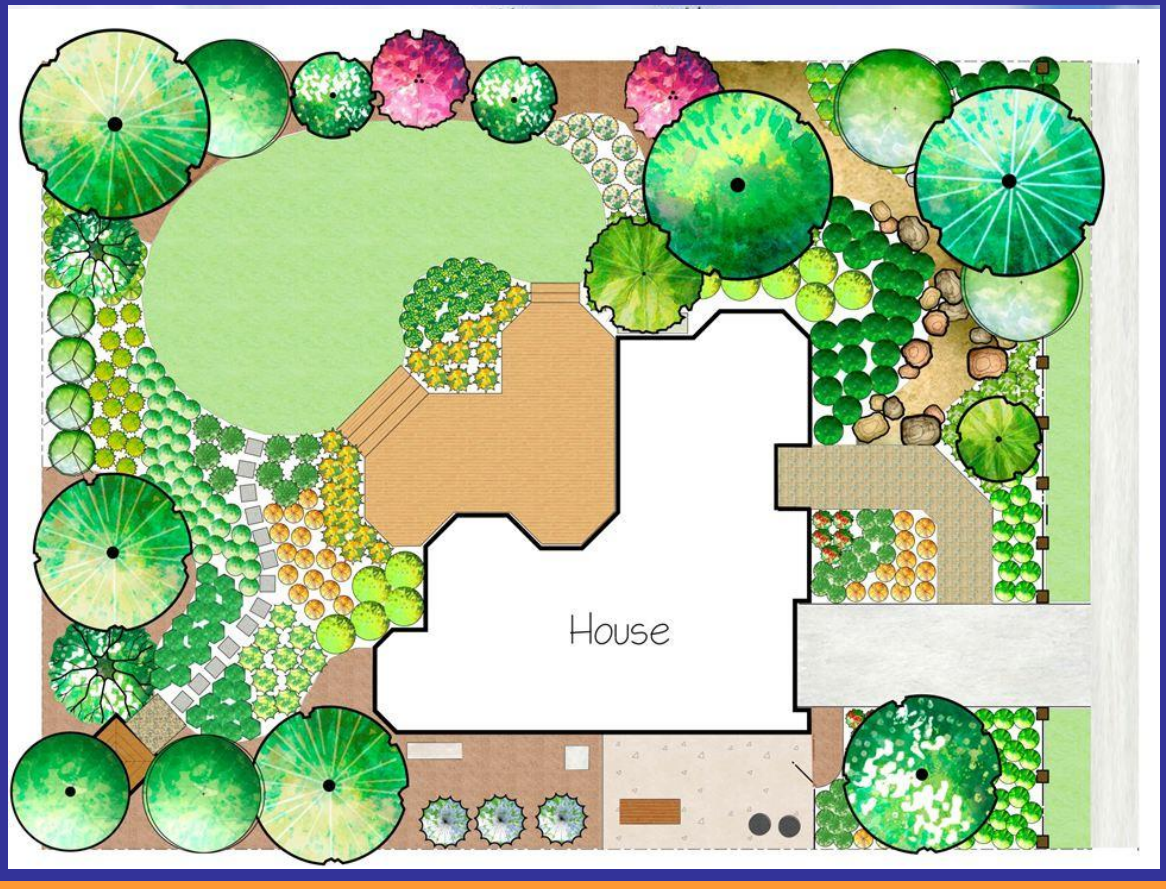
Florida-Friendly Landscaping™

"Right Plant, Right Place"



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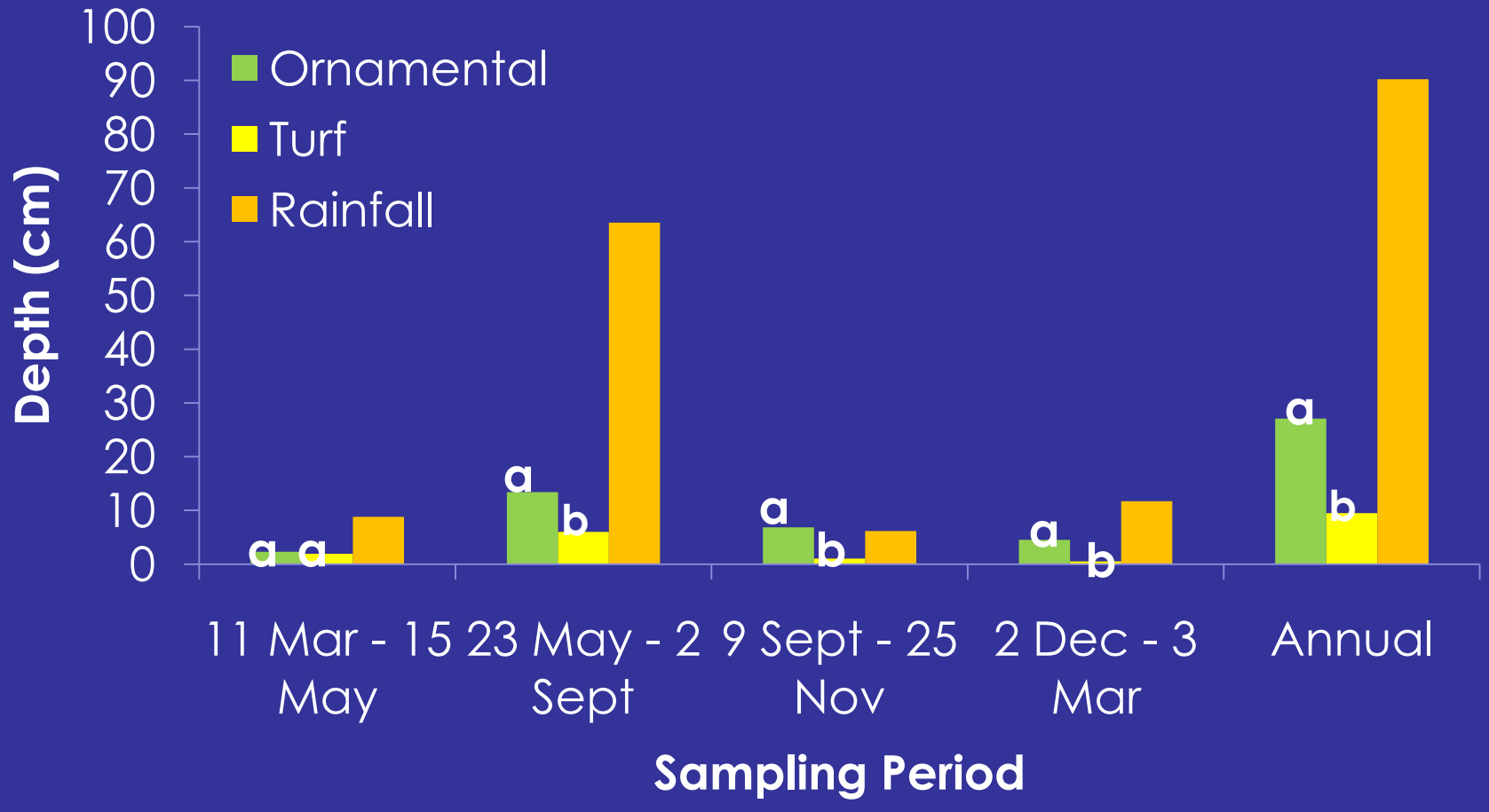
Florida Friendly design courtesy of Dr. Gail Hansen

Does Plant Type Effect Nutrient Leaching?

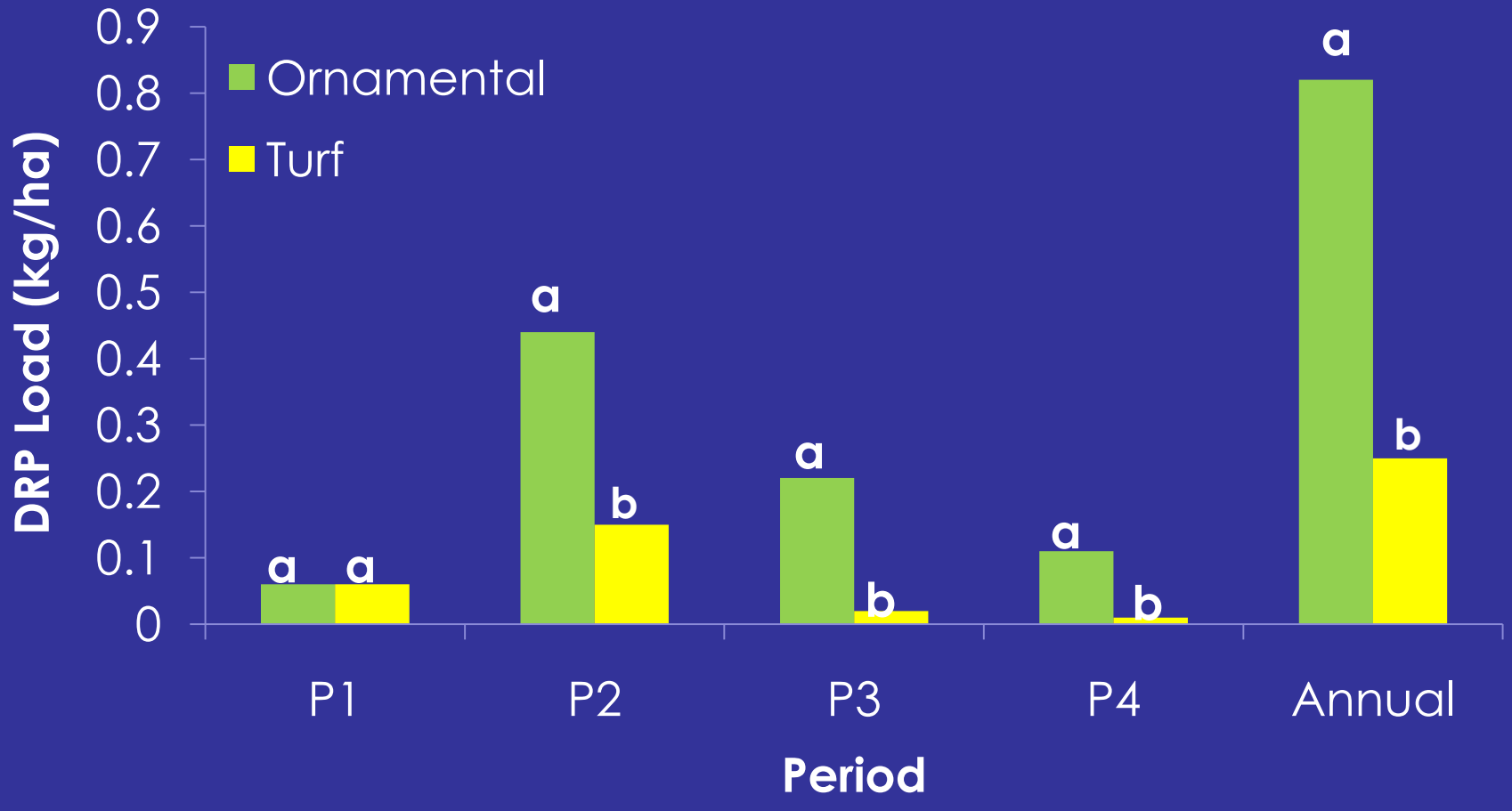
- More N, P, and K leached from ornamental beds than turf (Erickson et al., 2001; Erickson et al., 2005).

Nutrient Leaching From Mixed Landscapes

Drainage & Rainfall Depth

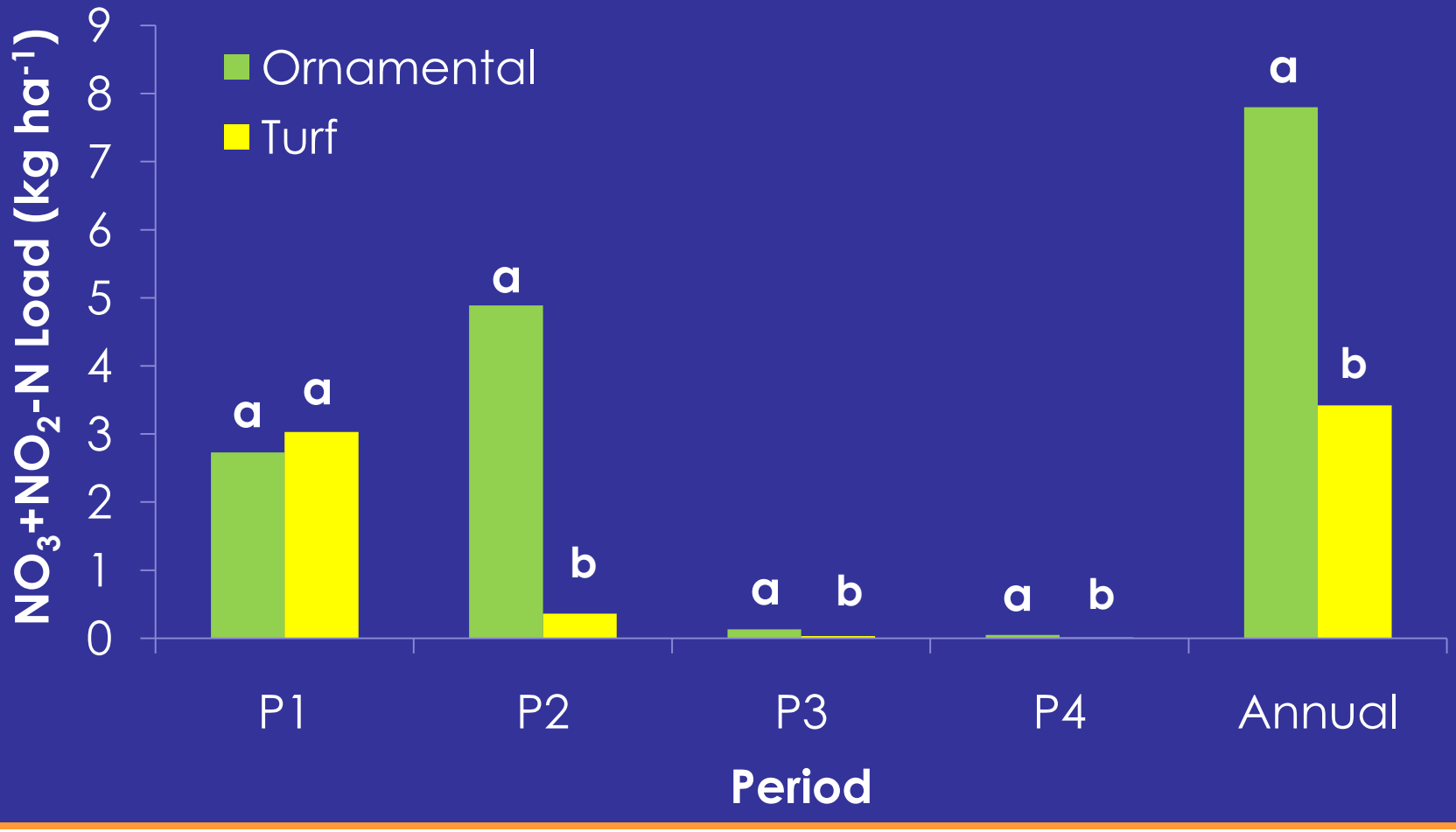


Phosphorus Load



Bars with different letters indicate a significant difference at a=0.05 using Tukey's HSD Test.

Nitrate Loads



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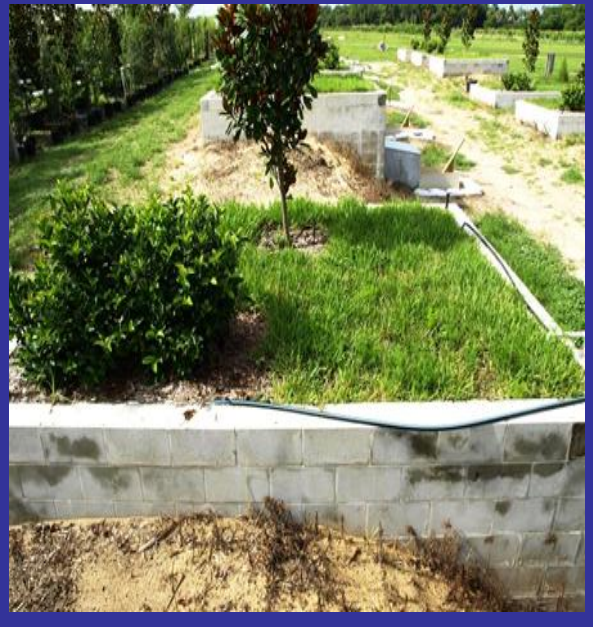
Bars with different letters indicate a significant difference at a=0.05 using Tukey's HSD Test.

Establishment Nutrient Losses

- Risk of nutrient leaching is higher for ornamental beds than for turf during plant establishment.
- Landowners should prevent applications of nutrients and water to areas of the soil that do not contain plant roots during plant establishment.

Nutrient Losses from Established Landscapes

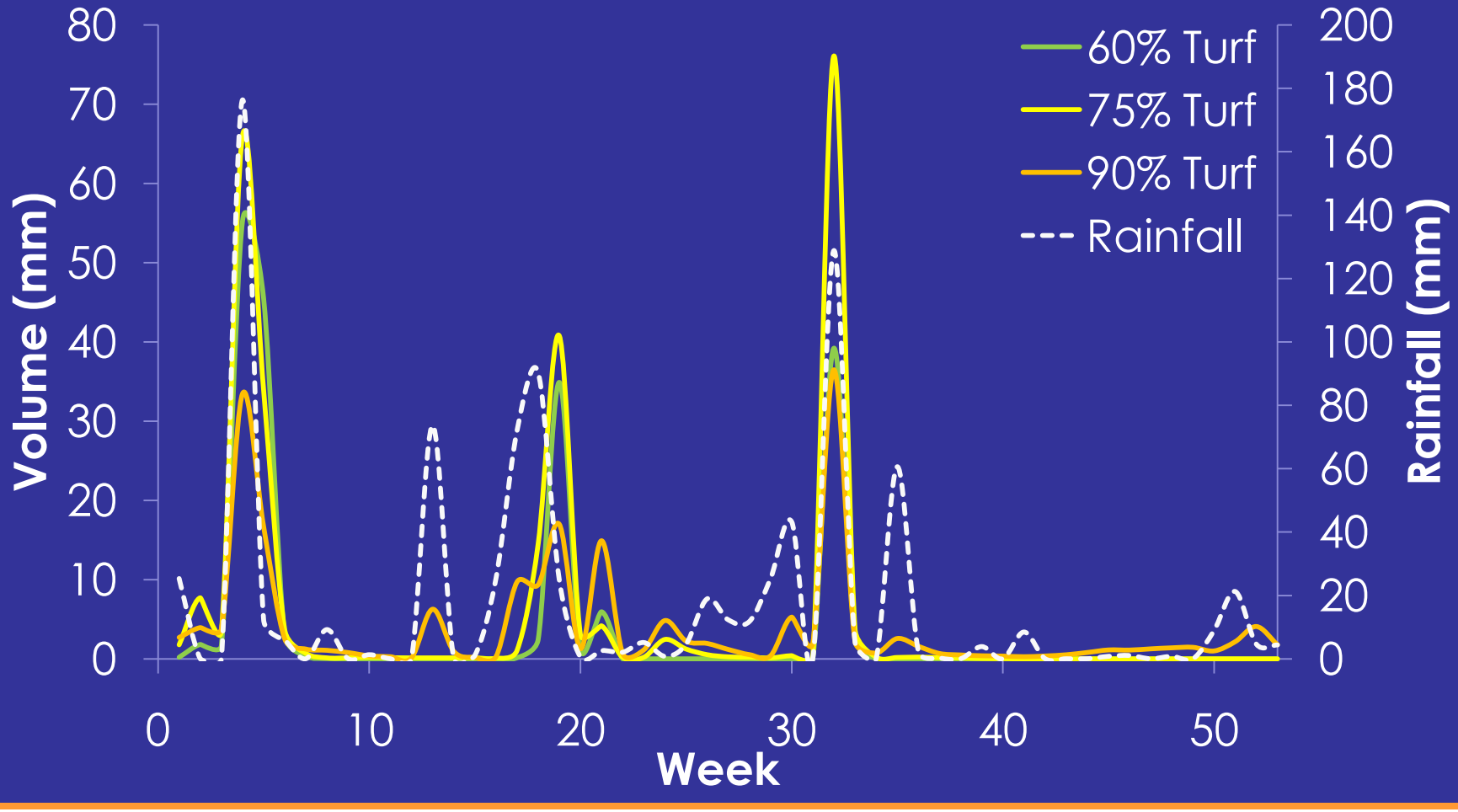
Treatment 1
90% Turf
10% Ornamental



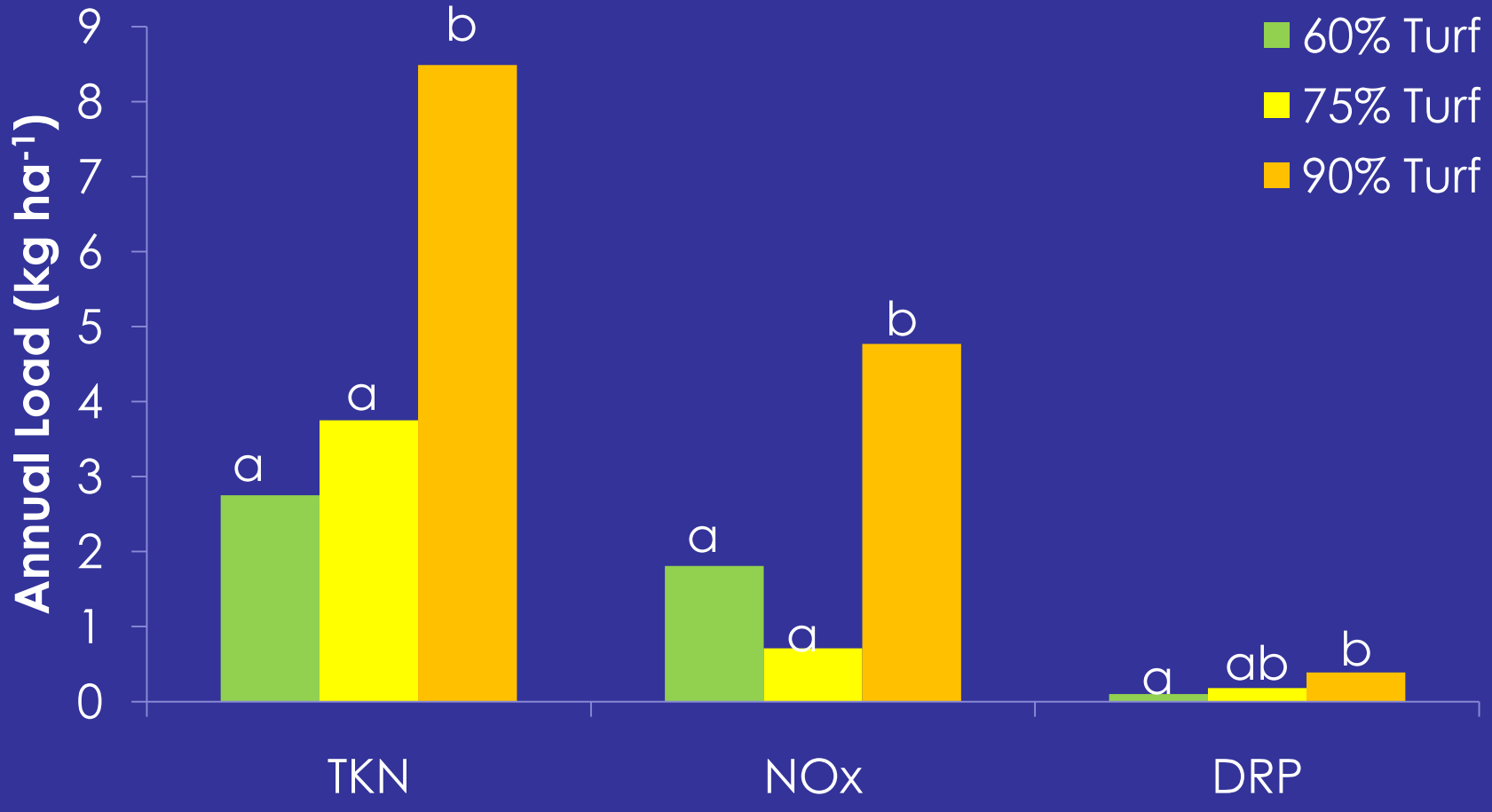
Treatment 2
75% Turf
25% Ornamental

Treatment 3
60% Turf
40% Ornamental

Lysimeter Drainage



Cumulative Nutrient Loads



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Bars with different letters indicate a significant difference at a=0.05 using Tukey's HSD Test.

Quarterly Mass Balance

Treatment	Input	Output	% Leached
	—— kg ha^{-1} ——		
		Nitrogen	
90% Turf	89.0	14.0	15.4
75% Turf	142	6.3	4.5
60% Turf	195	6.6	3.4
		Phosphorus	
90% Turf	9.92	2.3	23.6
75% Turf	18.0	1.5	8.4
60% Turf	26.0	1.1	4.1

Nutrient Losses from Mature Landscapes

- Landscapes containing higher proportions of established woody ornamentals may use nutrients and water better than turf dominated landscapes.

TURFGRASS MANAGEMENT

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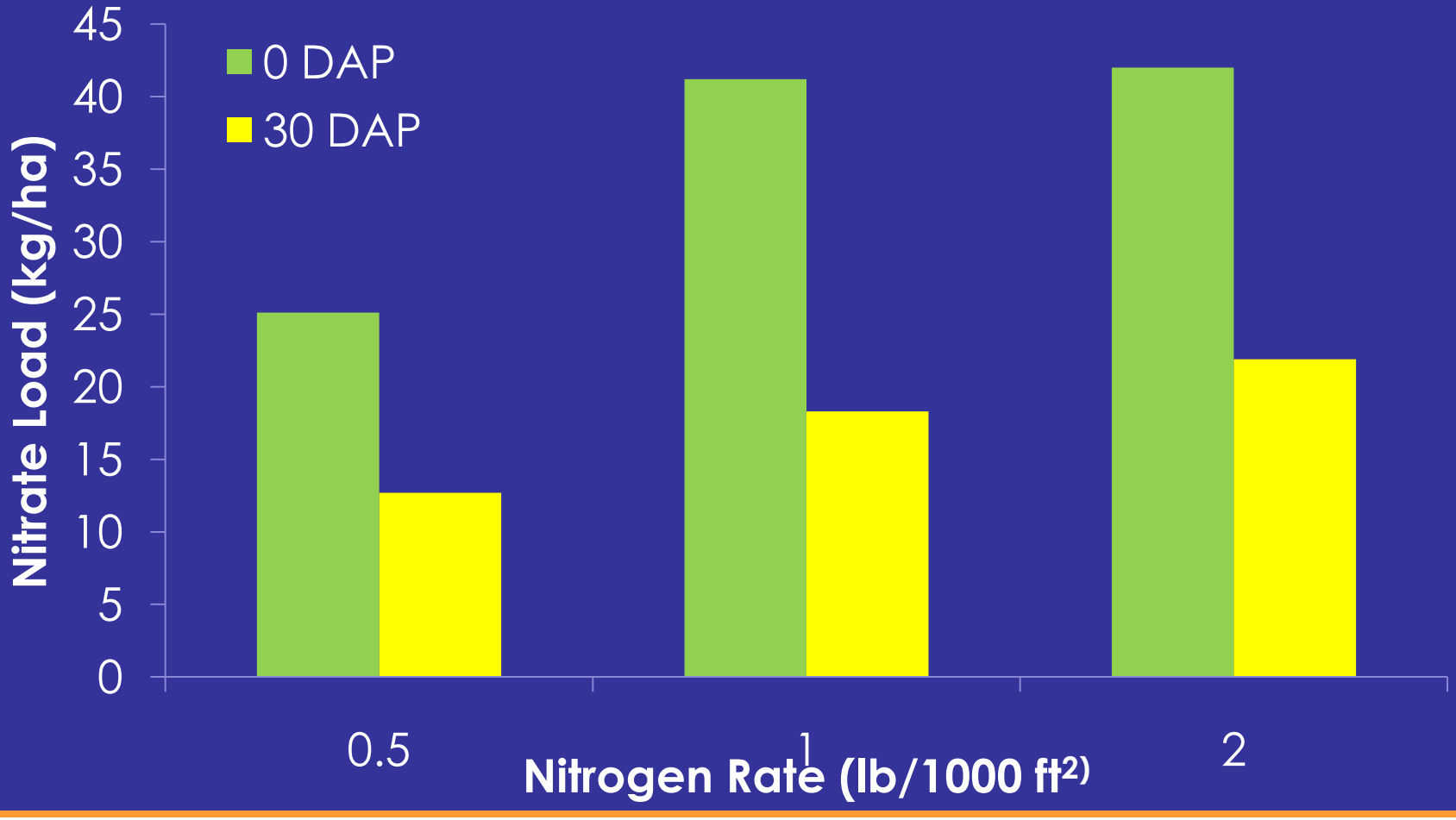
Data supplied by Dr. Laurie Trenholm (UF-IFAS)

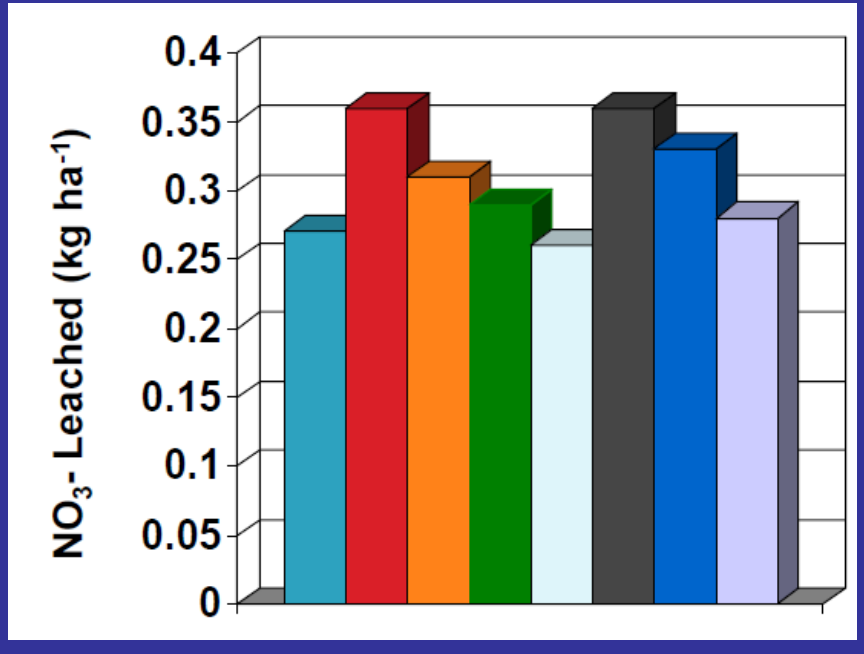
Nitrate Leaching - New Sod



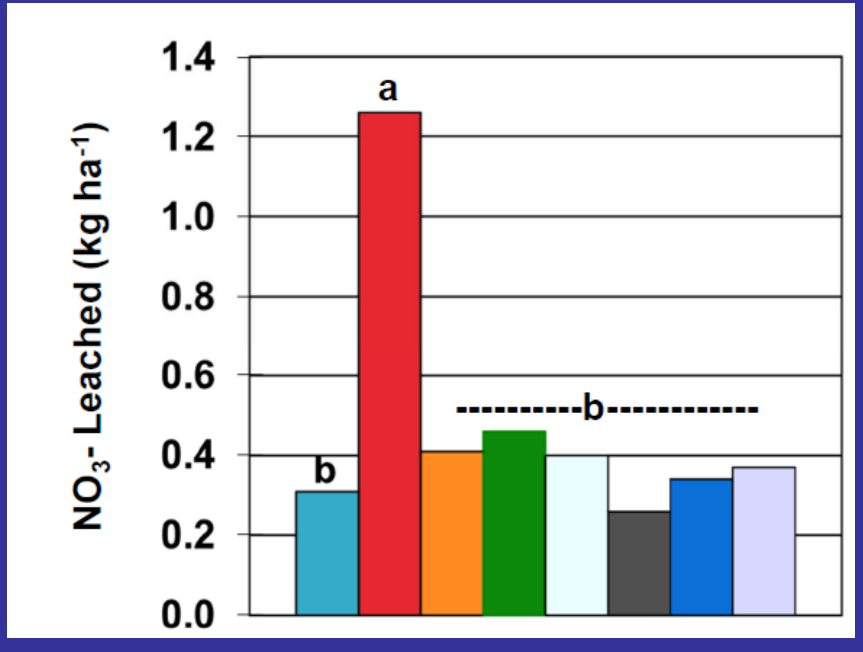
Trenholm et al. (2012)

Fertilizer Source

‘Floratam’ St. Augustine



‘Empire’ Zoysia



- Control
- Ammonium Nitrate
- Urea
- 30% Slow Release N
- 50% Slow Release N
- 30% Polymer Coated Urea
- 30% Polymer Coated Urea 2lbs/120
- Milorganite

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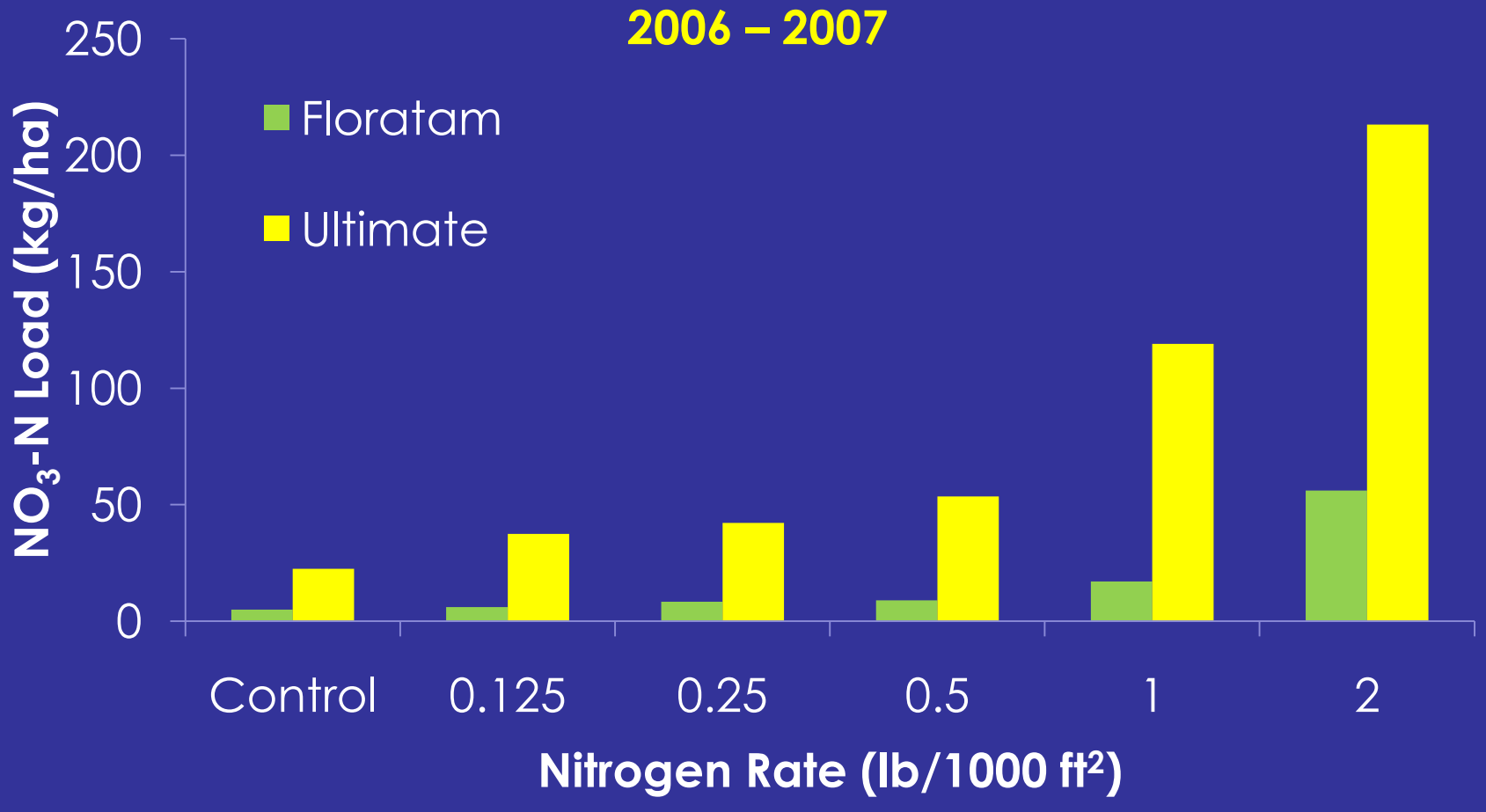
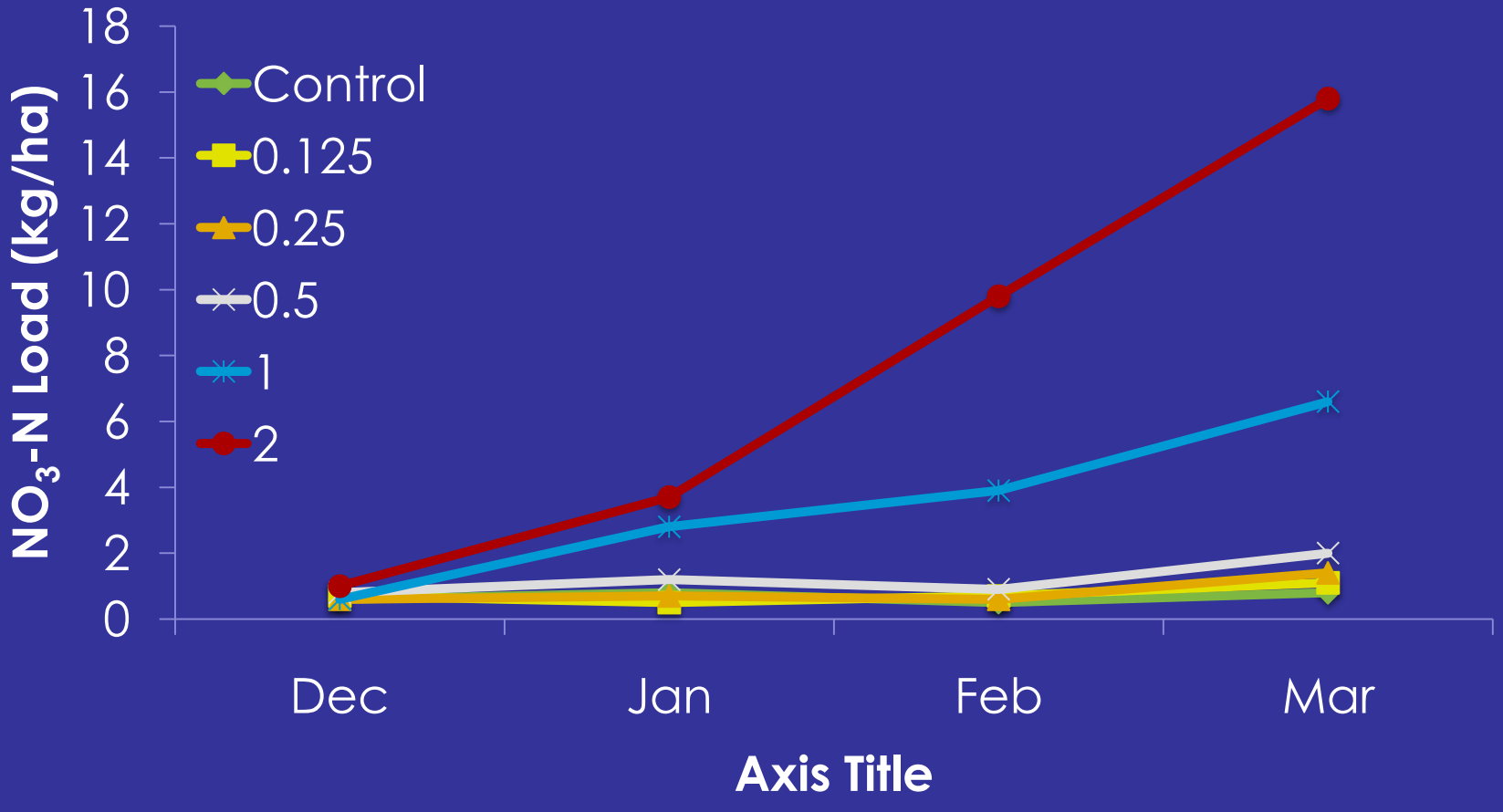
Trenholm et al. (2012)

Cumulative Nitrate Leaching in Winter Months



Trenholm et al. (2012)

Nitrate Leaching in Winter Months



Turfgrass Management Recommendations

- No fertilization of new sod for 30-60 days after installation.
- N source doesn't really influence NO_3-N leaching when applied according to recommendations.
- Skip turf fertilization during winter dormancy periods.

Summary

- Urban landscapes can be a significant source of nutrients.
- Management of land, soil, vegetation, and fertilizer affect nutrient loss potential.
- Following BMPs will help reduce the risk for nutrient loss from landscapes.

Review of Objectives

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Questions?