Applications and Modifications of the Riparian Ecosystem Management Model

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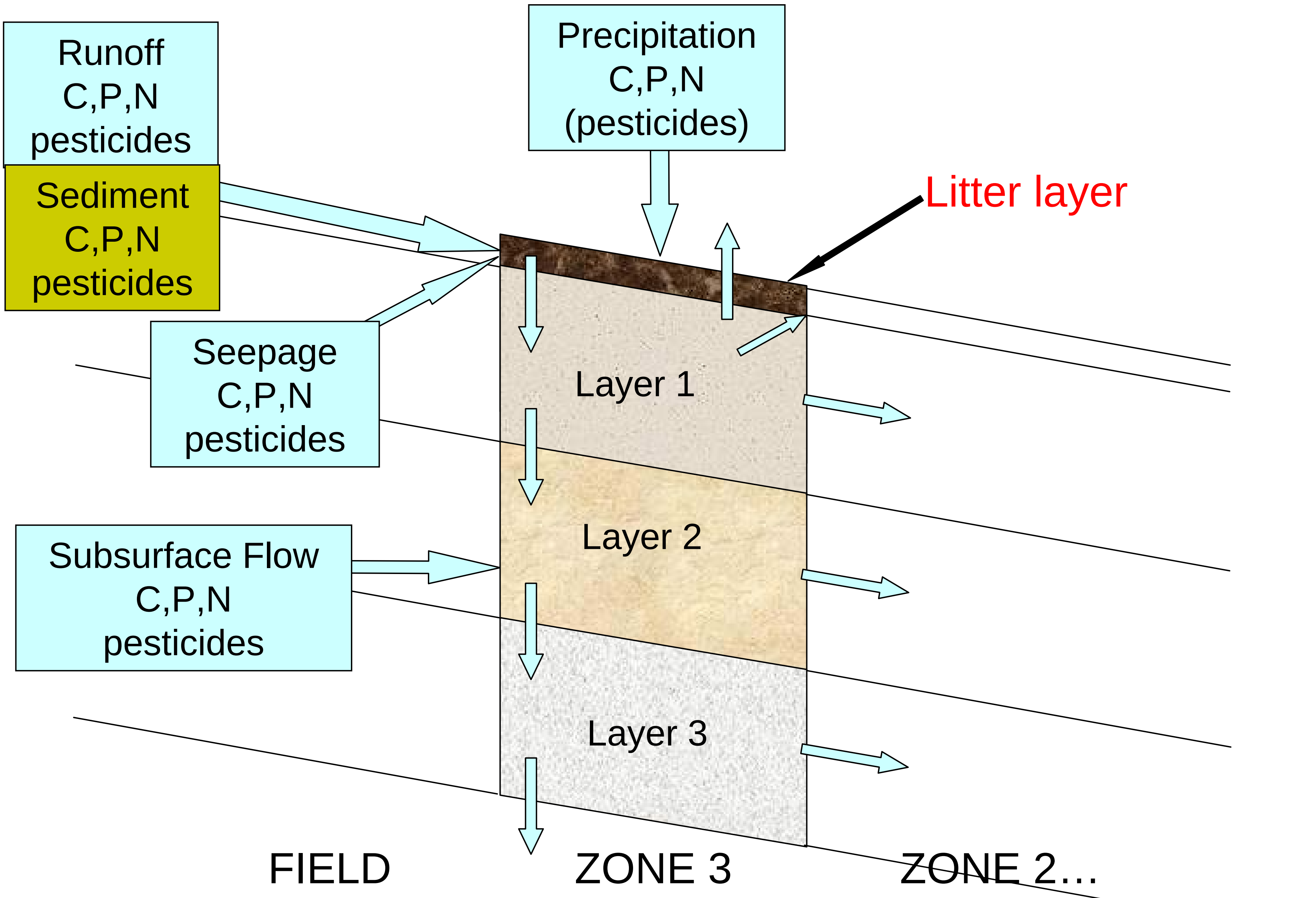
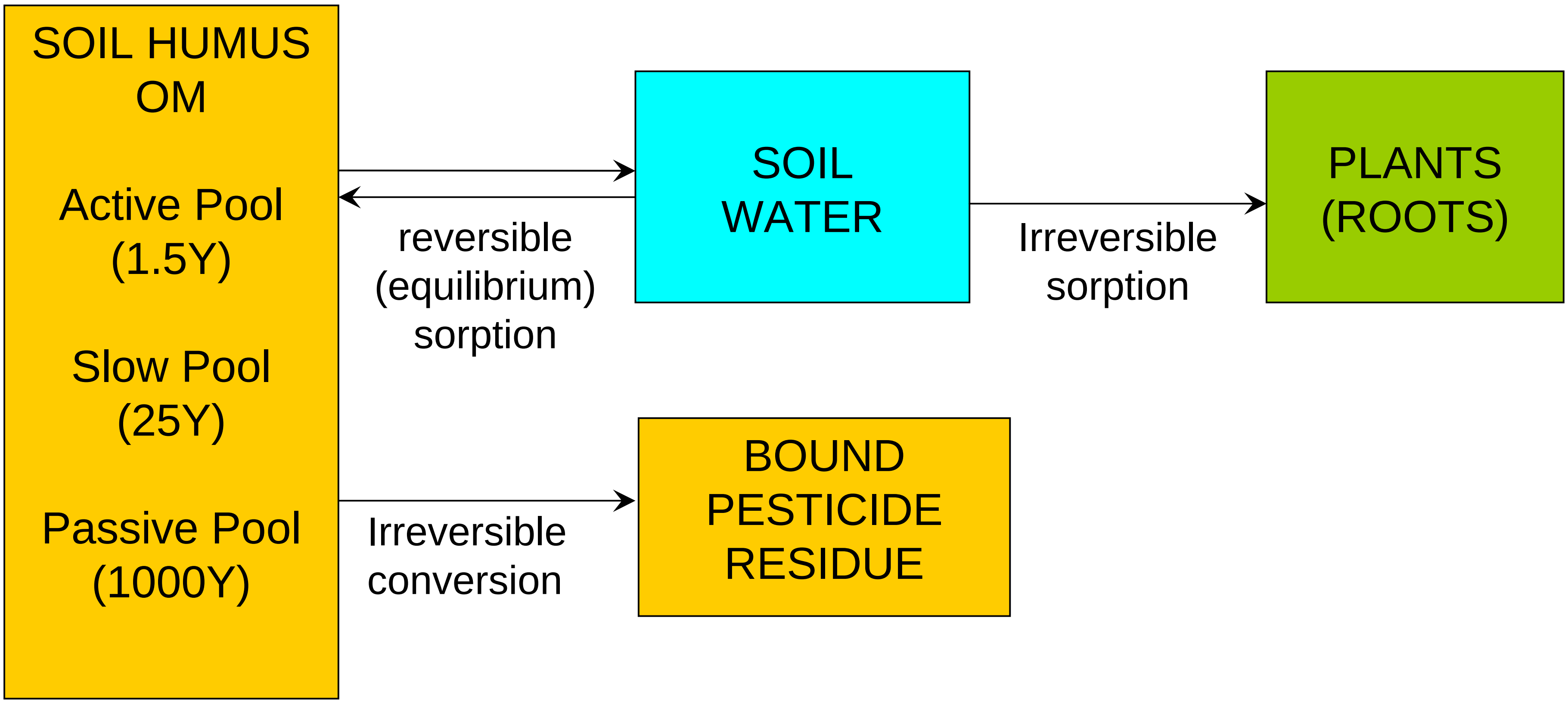
Outline

- Addition of pesticide components
- Simulation of pesticide transport
- Parameterization of two soils with different denitrification potentials & soil carbon
- Comparison to measured denitrification values
- Denitrification and N transport

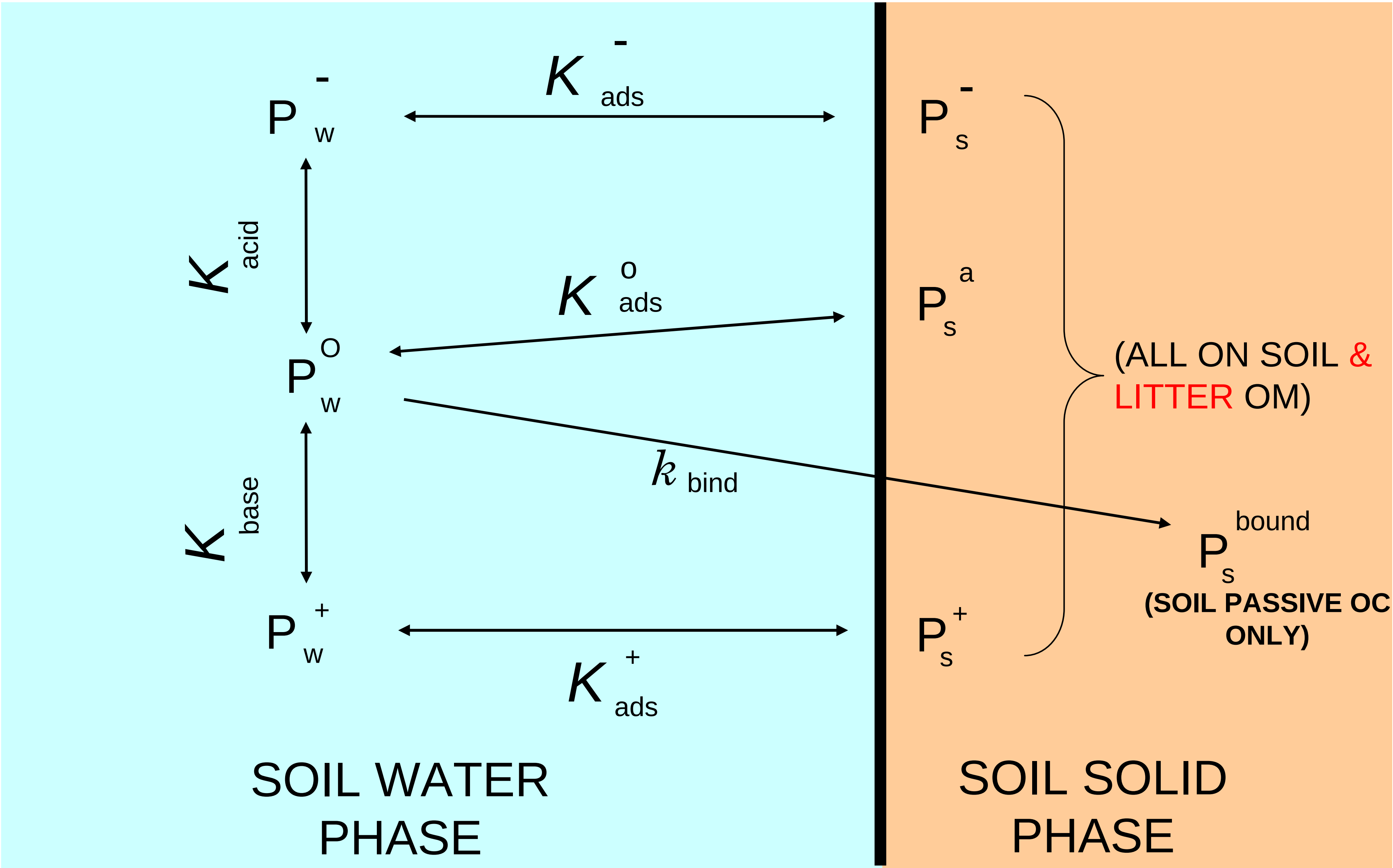
PESTICIDE INPUTS INTO BUFFER



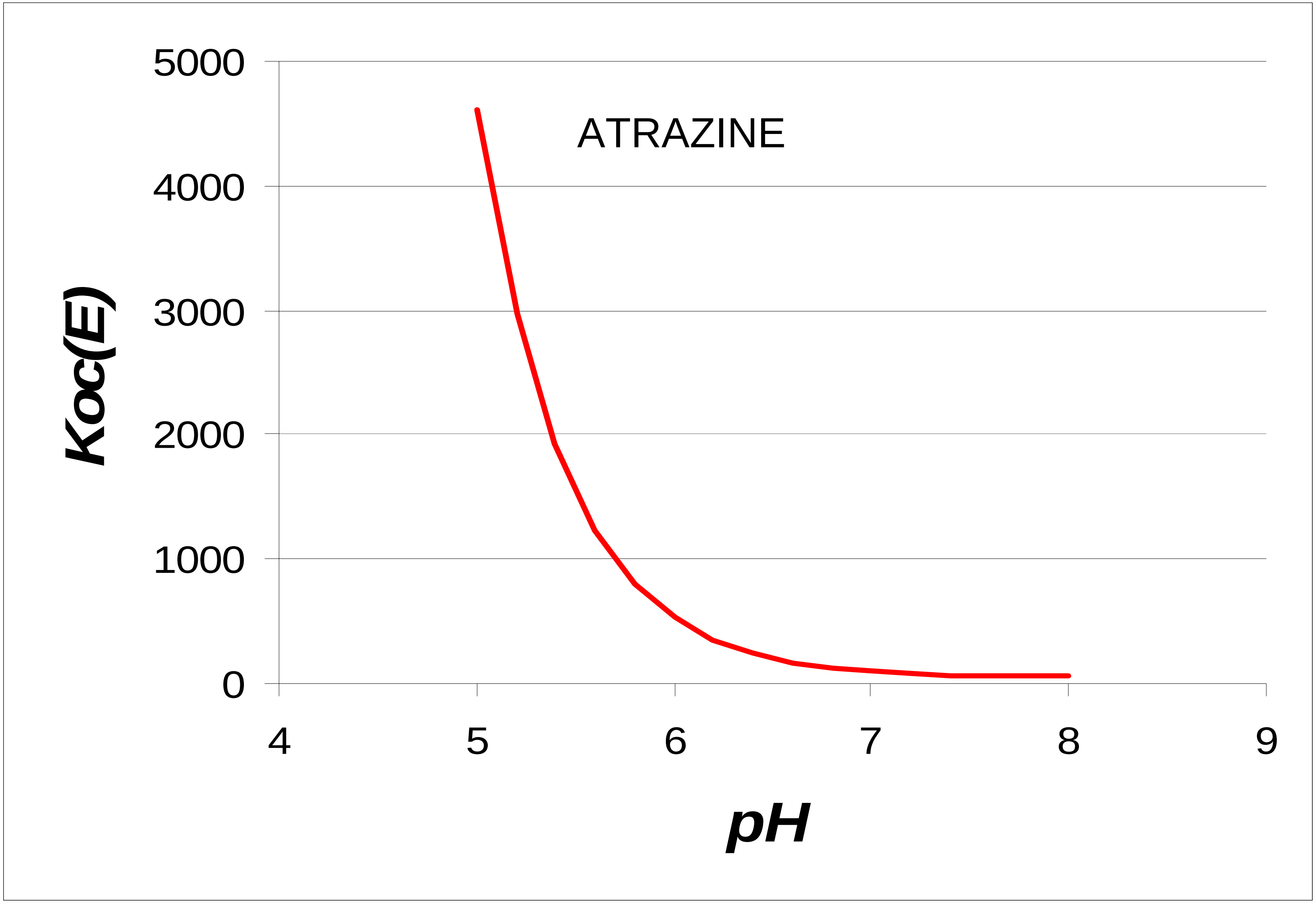
PESTICIDE POOLS IN SOIL AND LITTER LAYERS



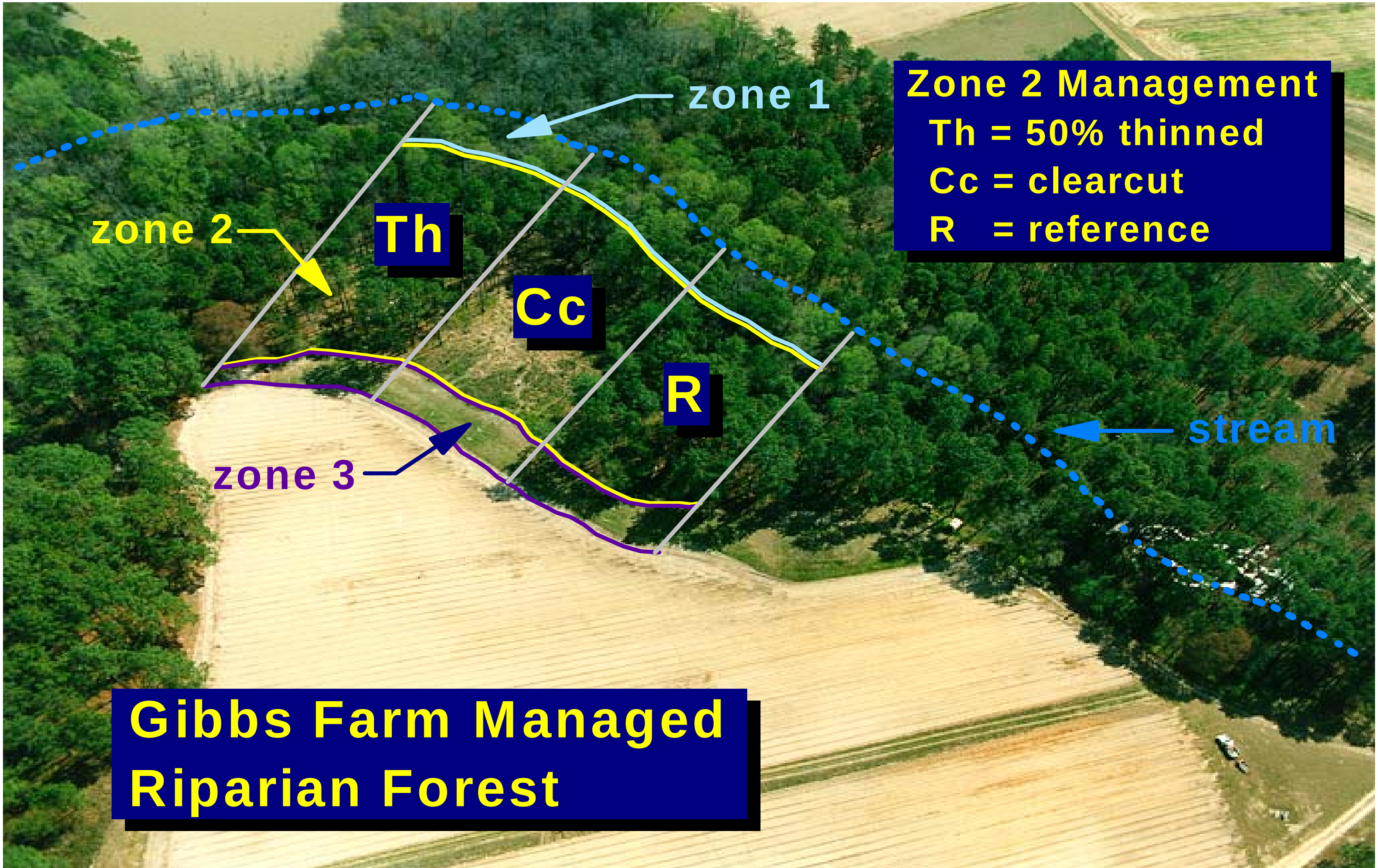
SOIL SOLUTION & SORPTION EQUILIBRIA & BINDING - RZWQM



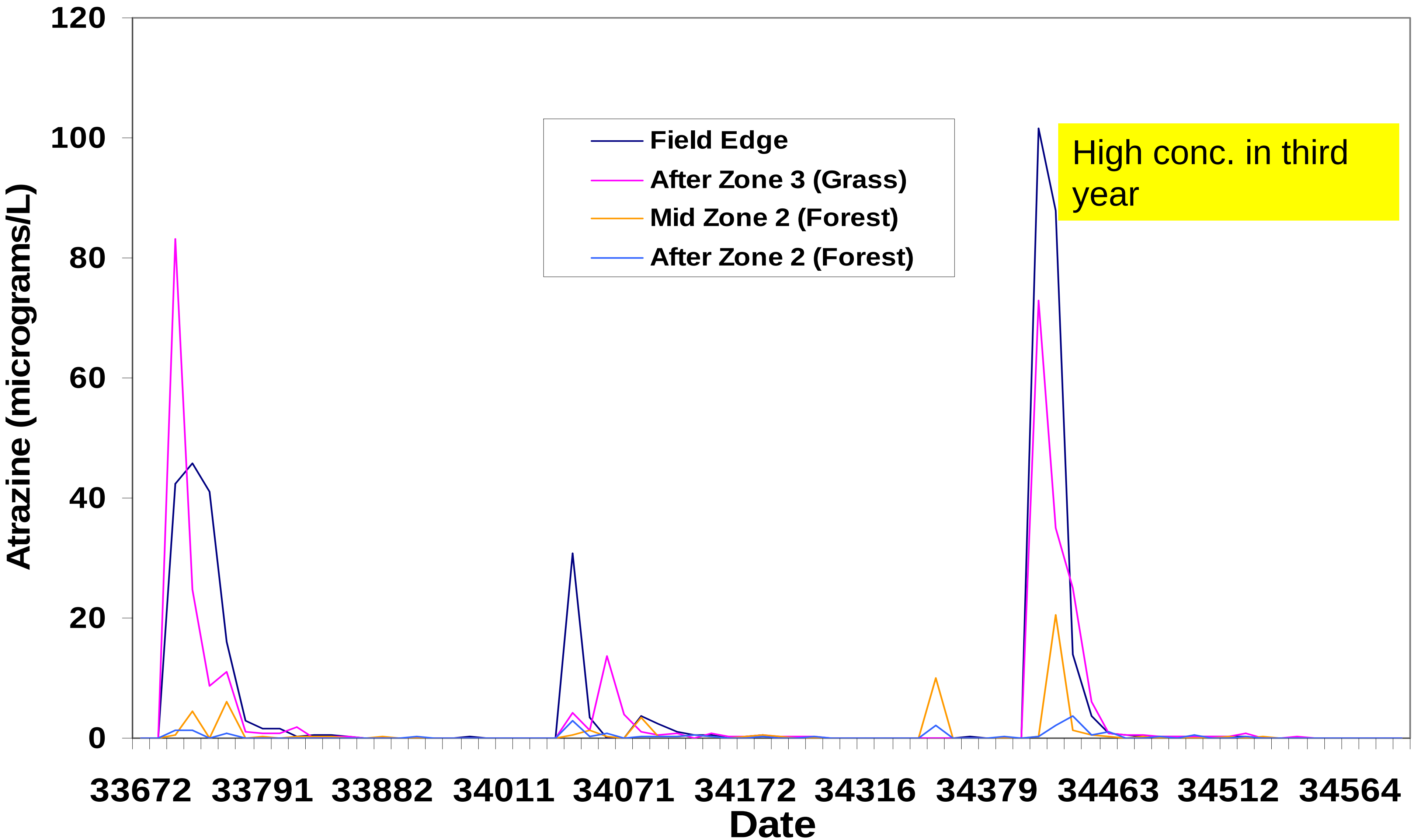
SOIL OC SORPTION pH DEPENDENCE



Managed Three Zone Buffer: Gibbs Farm Site



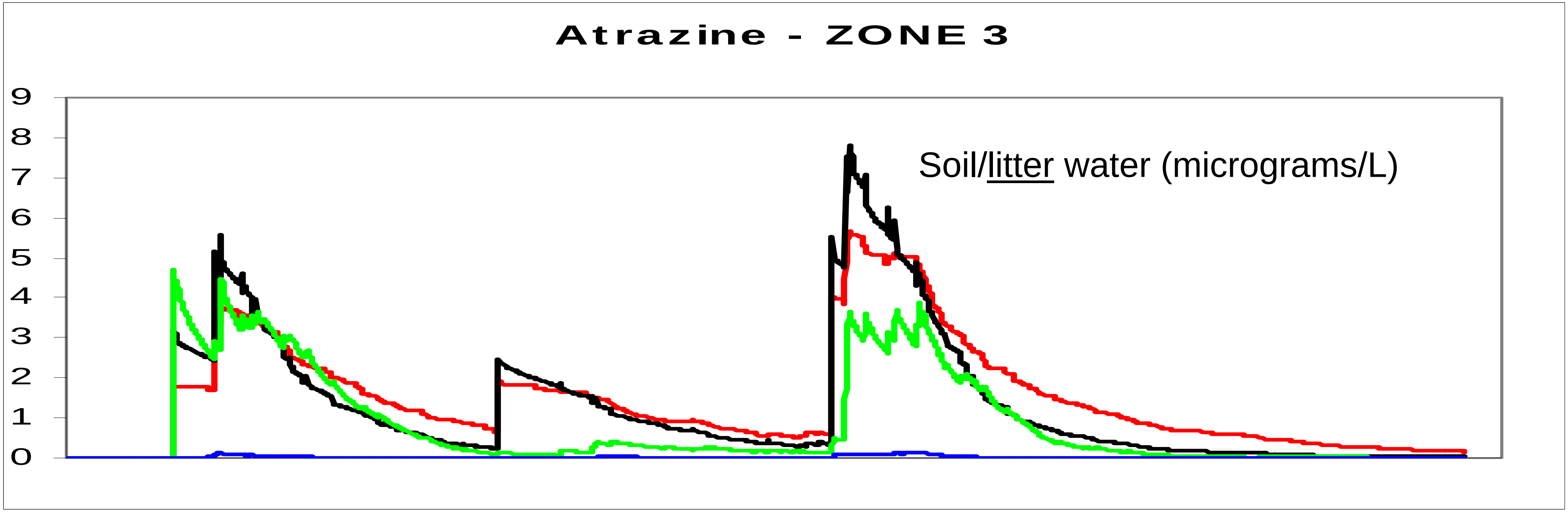
Atrazine in Surface Runoff



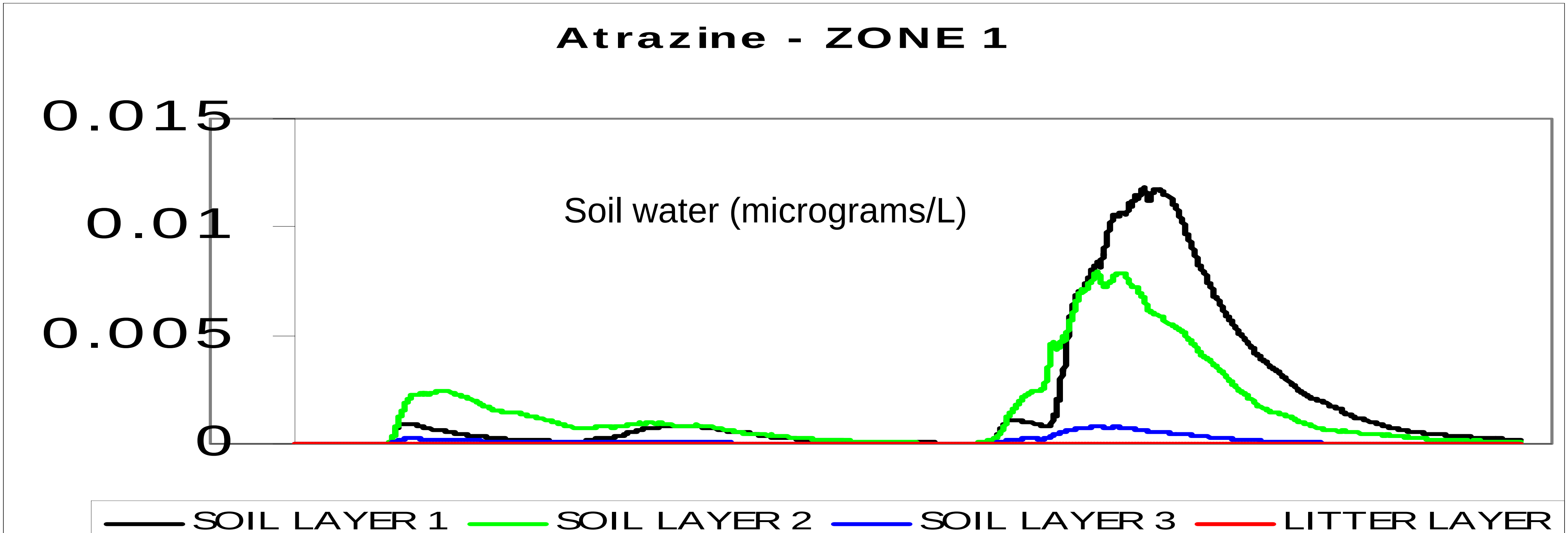
REMM Input Pesticide Properties

from Pesticide Properties Database

Property	Units	Atrazine	Cypermethrin
Aqueous solubility	mg/L	33	0.004
Soil OM binding half-life	d	365	365
Soil aerobic degr. half-life	d	60	30 E
Reference soil moisture content	%	FC	FC
Walker exponent	--	0.8	0.8
Reference soil temperature	^{0}C	20	20
Aerobic energy of activation	kJ/mol	54	54
Soil anaerobic deg. half-life	d	60	30
Ionization constant	--	1.68	-99
High-*pH* soil OM sorpt. coeff.	L/Kg	50	-99
Octanol-water partition coeff.	--	437	400000

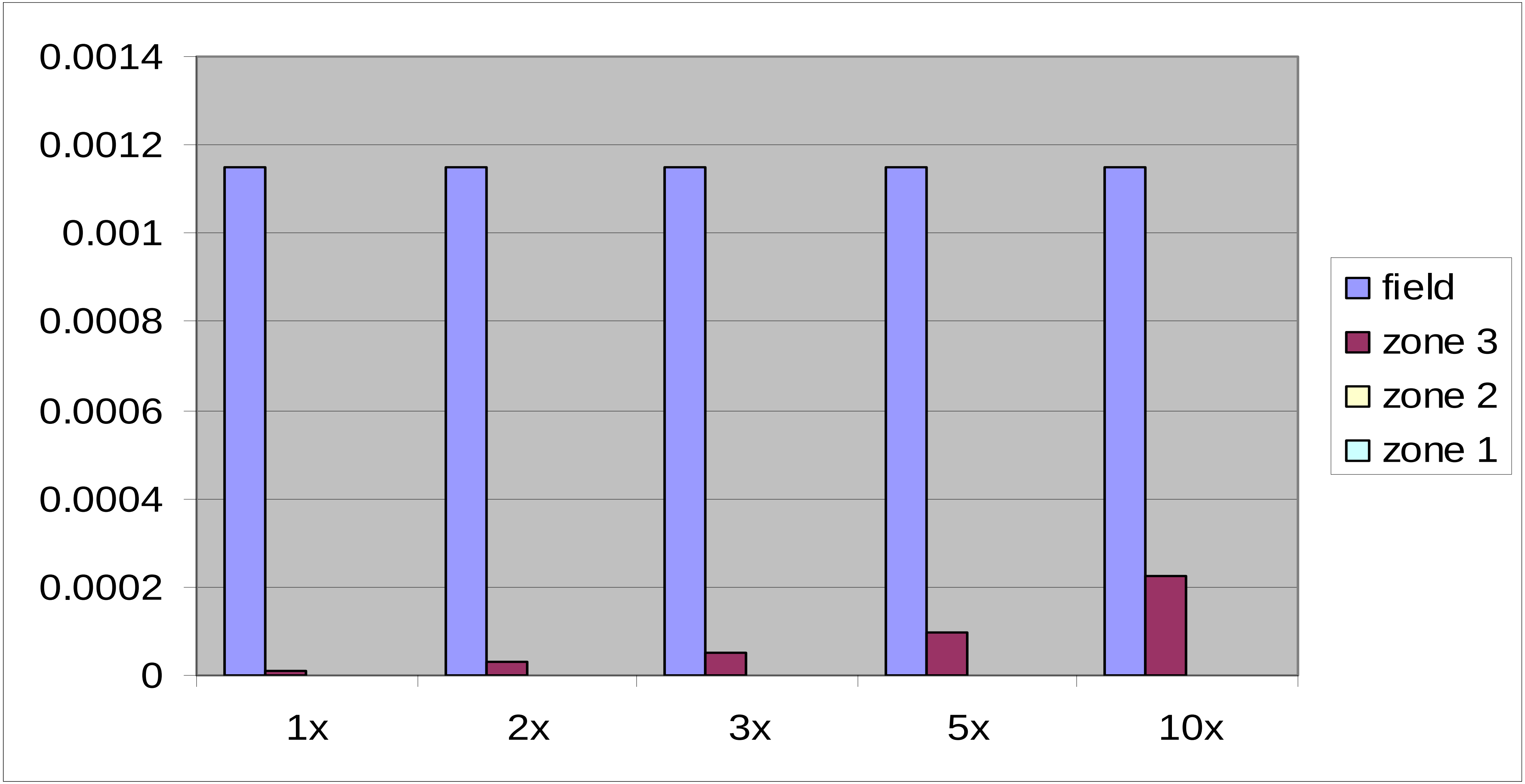


Atrazine - ZONE 3
Soil/litter water (micrograms/L)
9
8
7
6
5
4
3
2
1
0



Atrazine - ZONE 1
Soil water (micrograms/L)
0.015
0.01
0.005
0
SOIL LAYER 1
SOIL LAYER 2
SOIL LAYER 3
LITTER LAYER

CYPERMETHRIN: TOTAL LOADS 1x to 10x Field:Buffer Area (Surface and Subsurface)



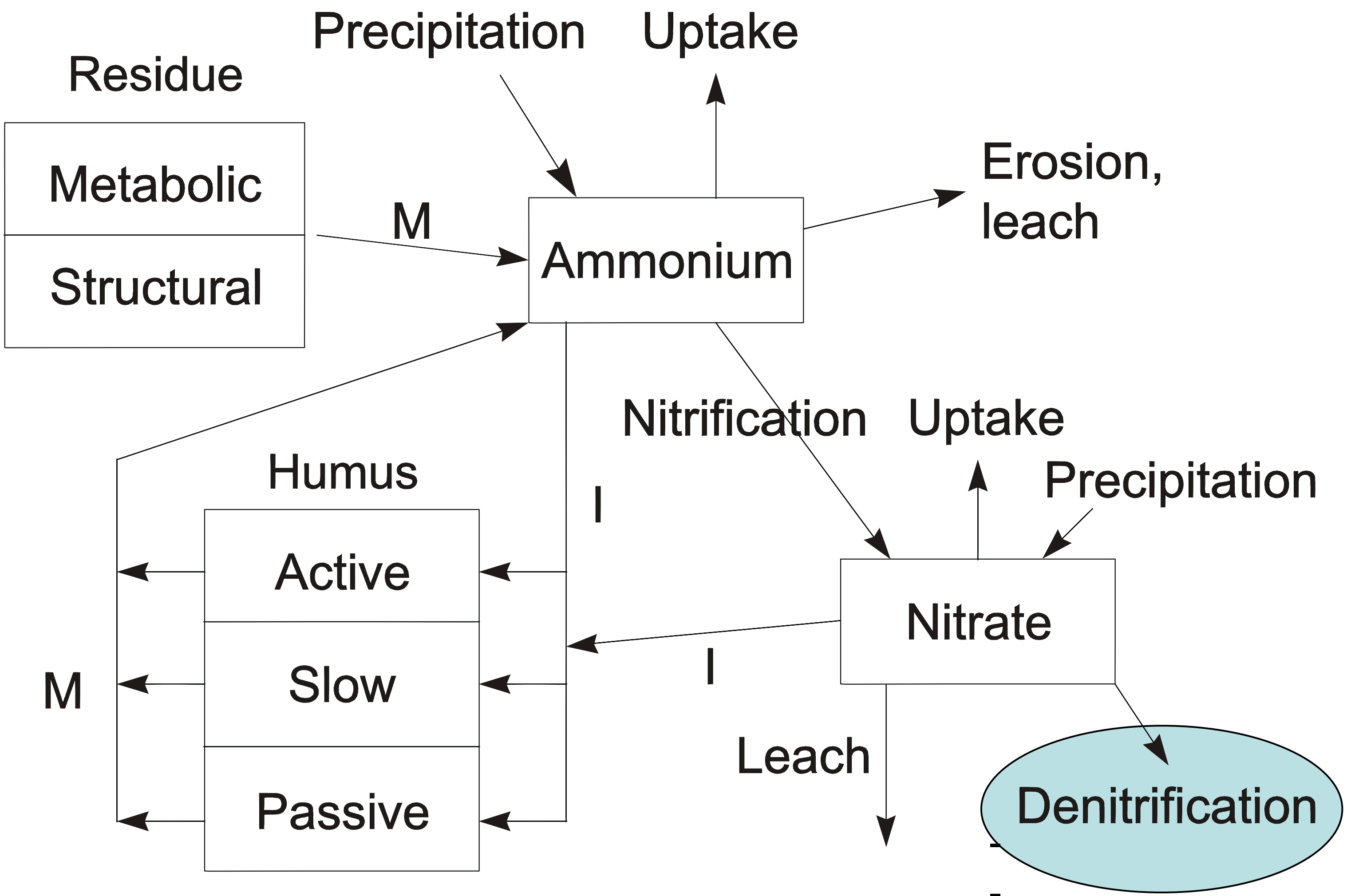
Conclusions

- Represents pesticides with different properties realistically
- Responds to increased loadings based on changing field/buffer area ratios
- Represents changes in pesticide soil and water concentrations moving away from source area (field)

Denitrification Studies

Use of REMM to Compare Denitrification N Removal

N Cycling Processes for a Zone, Layer



M = Mineralization

I = Immobilization

REMM Calculates Daily Denitrification by Zone, Layer

Denitrification (kg NO_3-N/ha/day)=

Denitrification Potential (g N/ha-cm)

x soil layer depth (cm) x Anaerobic Factor x Temperature Factor x (N factor+C factor)/1000

All Factors are 0-1 scalars (except N factor)

Constrained by nitrate in a layer on that day

Denitrification potential measured on soil slurries (Tiedje, 1982)

Two Wetland Soils

- For purposes of these simulations, the two soils differ ONLY in humus pools (and associated N and P pools) and denitrification potentials

- **Alapaha** series – loamy siliceous subactive thermic Arenic Plinthic Paleaquult
- Total C = 79 Mg C/ha Along smaller streams (order 1-3) (typically 10-15% of watershed)

- **Kinston** series – fine-loamy siliceous, semiactive, acid, thermic Fluvaquentic Endoaquept
- Total C = 109 Mg C/ha. Along larger streams (order 3-5) (typically 6-8% of watershed)

Humus pools and denitrification rate constants for three depths of the two soils. Potential denitrification from Ambus and Lowrance, 1991. *not measured, estimated same as Alapaha soil.

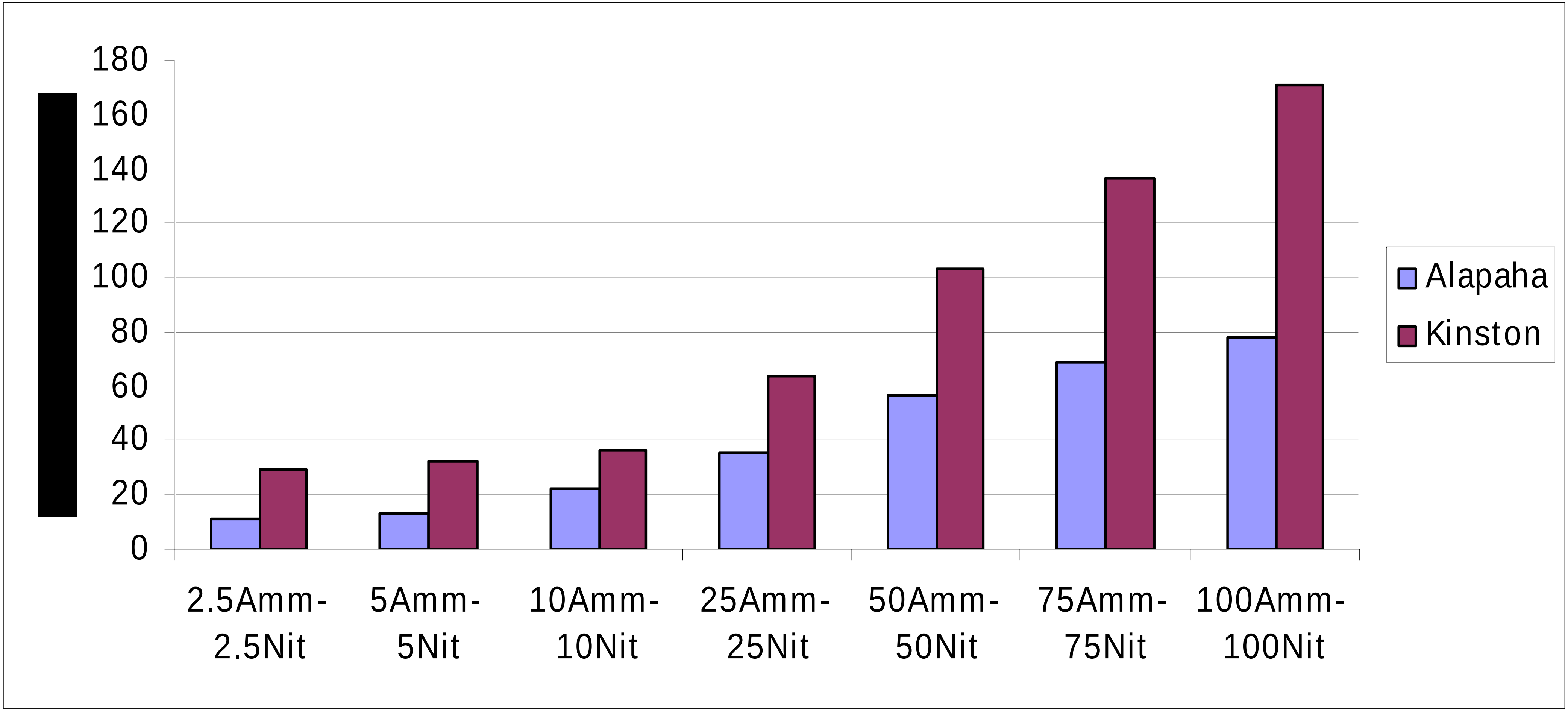
Soil Series	Layer (cm)	Active Humus (kg C/ha)	Slow Humus (kg C/ha)	Passive Humus (kg C/ha)	Potential Denitrification (g N/ha/cm/day)
Alapaha	0-30	680	35009	23740	23
	30-120	300	4636	3079	12
	120-270	196	6928	4625	0.6
	Total	1176	46573	31444	
Kinston	0-30	817	38244	26023	4110
	30-120	657	14730	9852	59
	120-270	293	11215	7495	0.6*
	Total	1767	64189	43370	

Loading scenarios simulated for the two soils

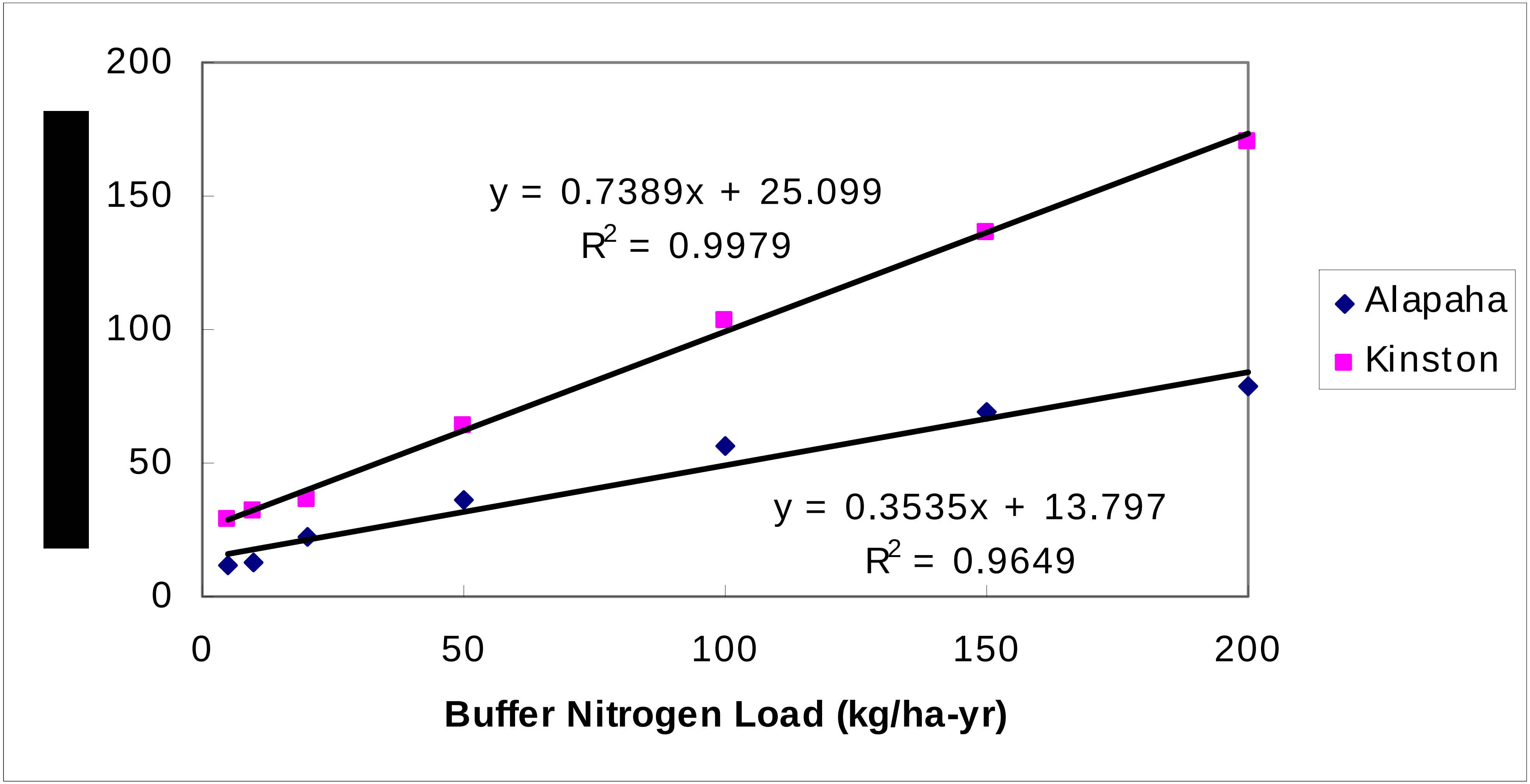
Kg N $ha^{-1}yr^{-1}$

Total Inorganic Load	**Equal** (NO_3:NH_4)	**High Nitrate** (NO_3:NH_4)	**High Ammonium** (NO_3:NH_4)
5	2.5:2.5	NA	NA
10	5:5	NA	NA
20	10:10	10:10	10:10
50	25:25	40:10	10:40
100	50:50	90:10	10:90
150	75:75	140:10	10:140
200	100:100	190:10	10:190

Denitrification for equal (NH4:NO3) loading scenarios



Denitrification for equal load (NH4:NO3) scenarios



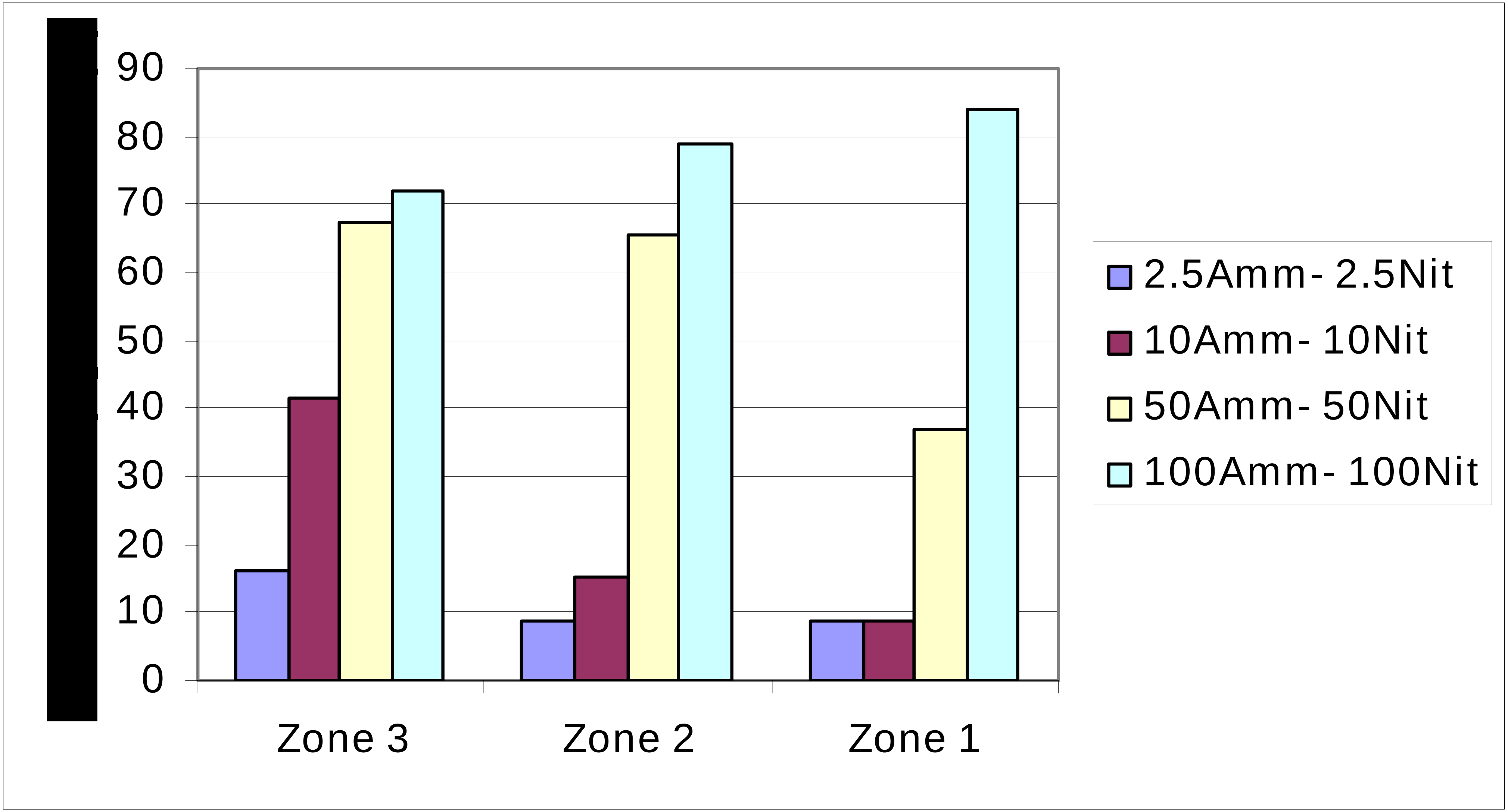
Comparison to Measured Rates

(Kg N $ha^{-1}yr^{-1}$)

Soil	Loading	Field Estimate	Model Estimate
Alapaha	139	68*	63
Kinston	139	NA	128
Alapaha	30	39**	24
Kinston	30	NA	46

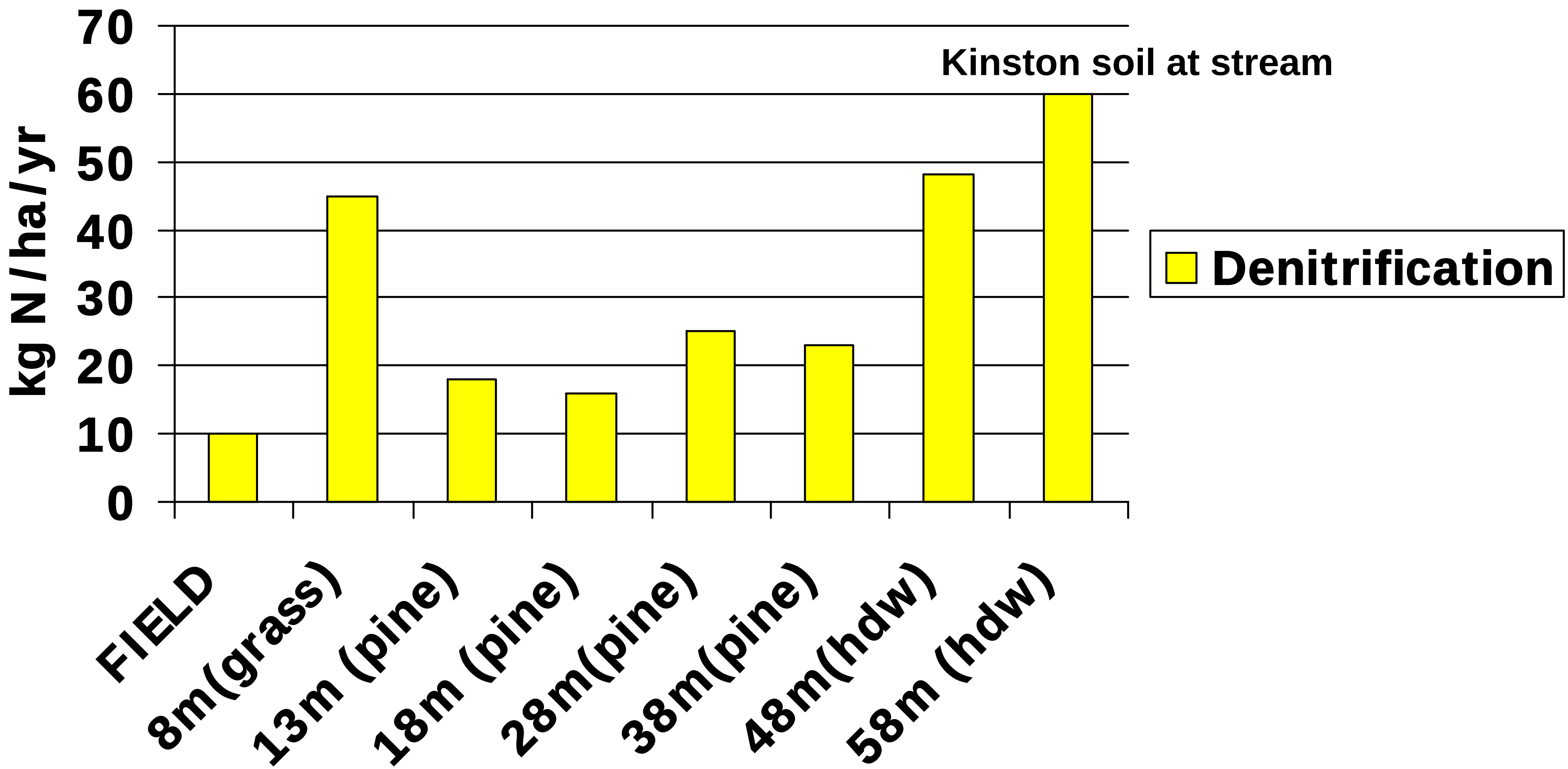
*Acetylene inhibition, intact cores – Vellidis et al., 2003
** Acetylene inhibition, intact cores – Inamdar et al, 1999a

Alapaha – Denitrification by Zone

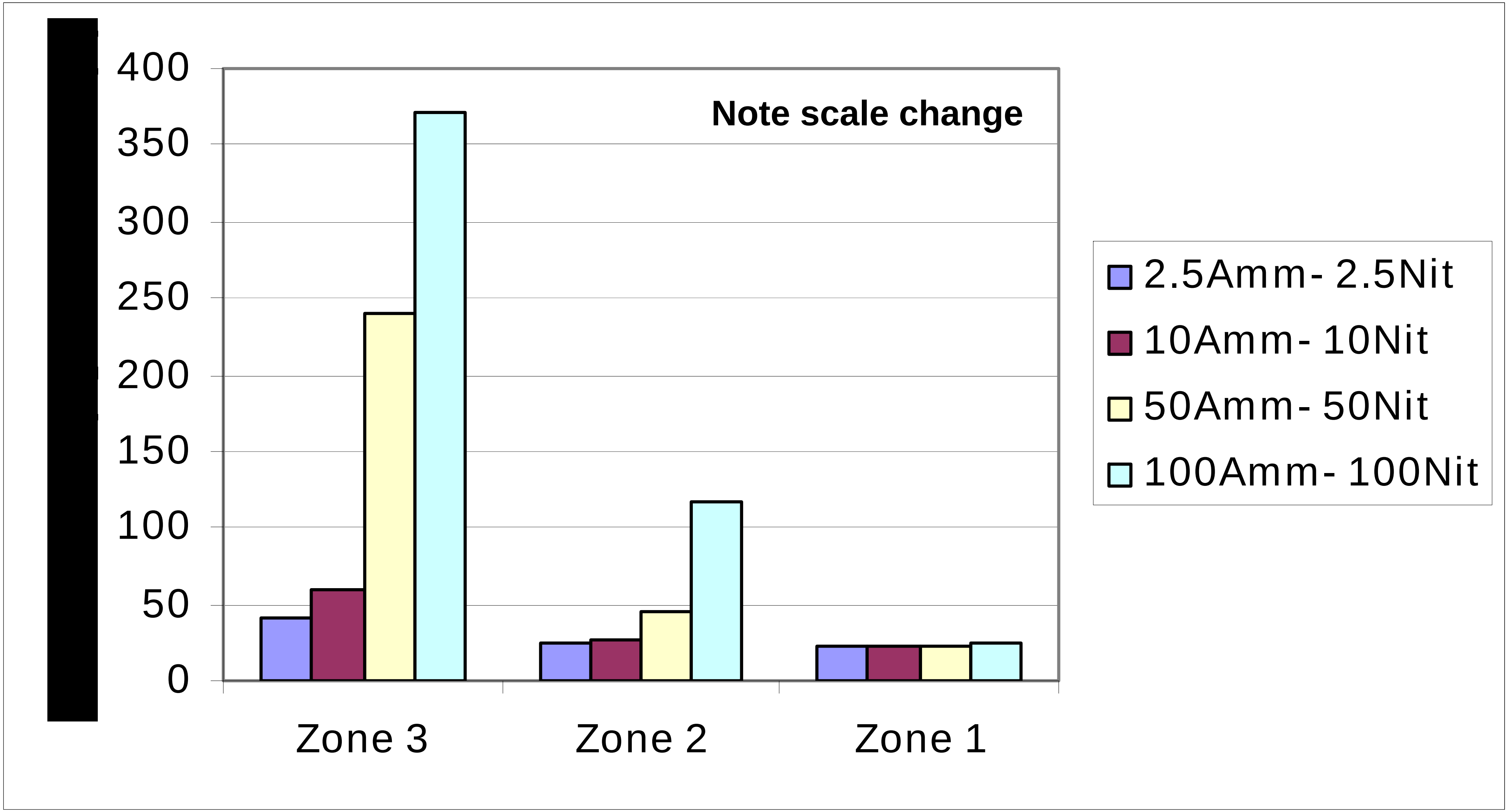


Denitrification in a grass/forest riparian buffer

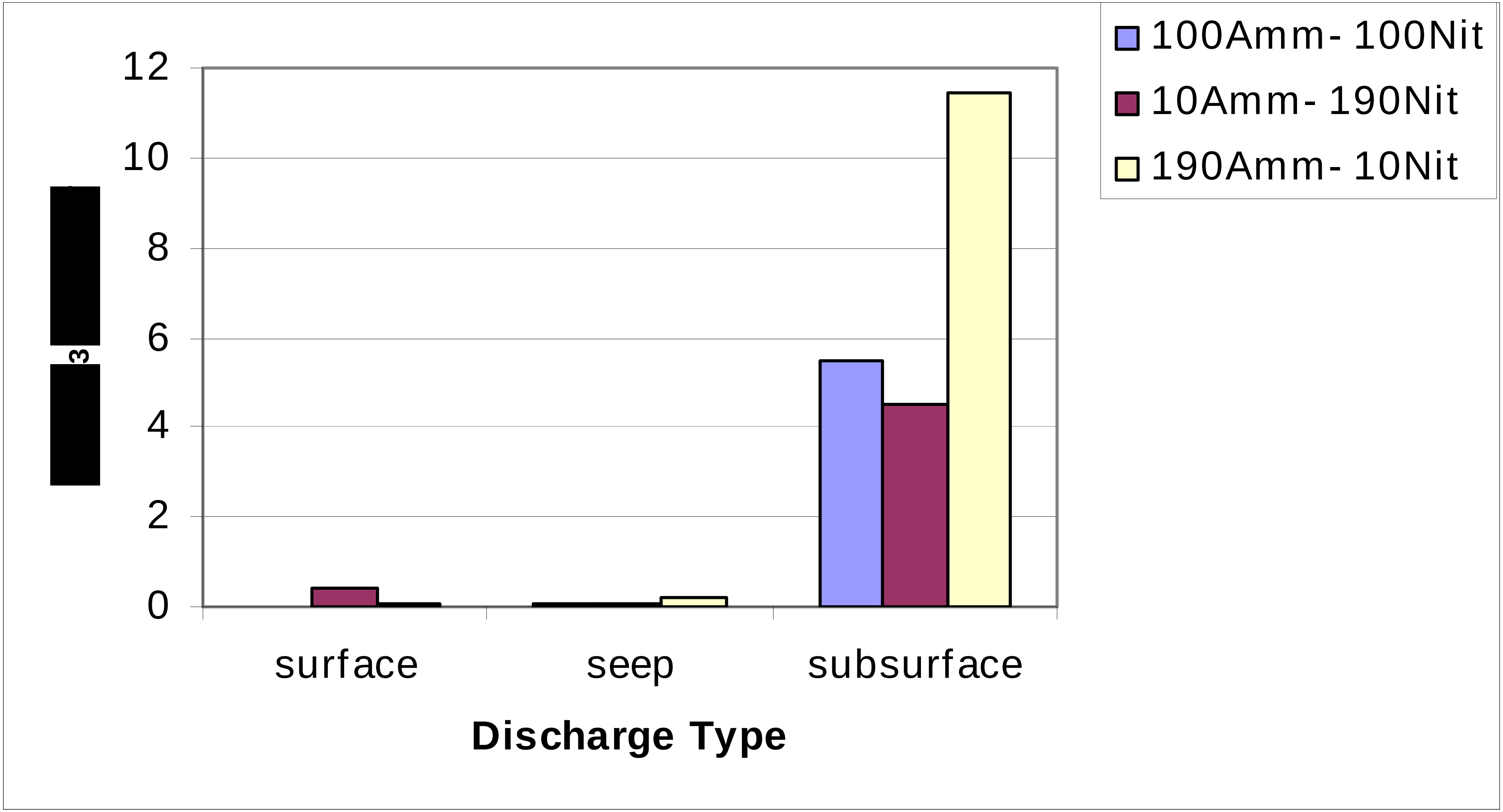
(Lowrance, 1992)



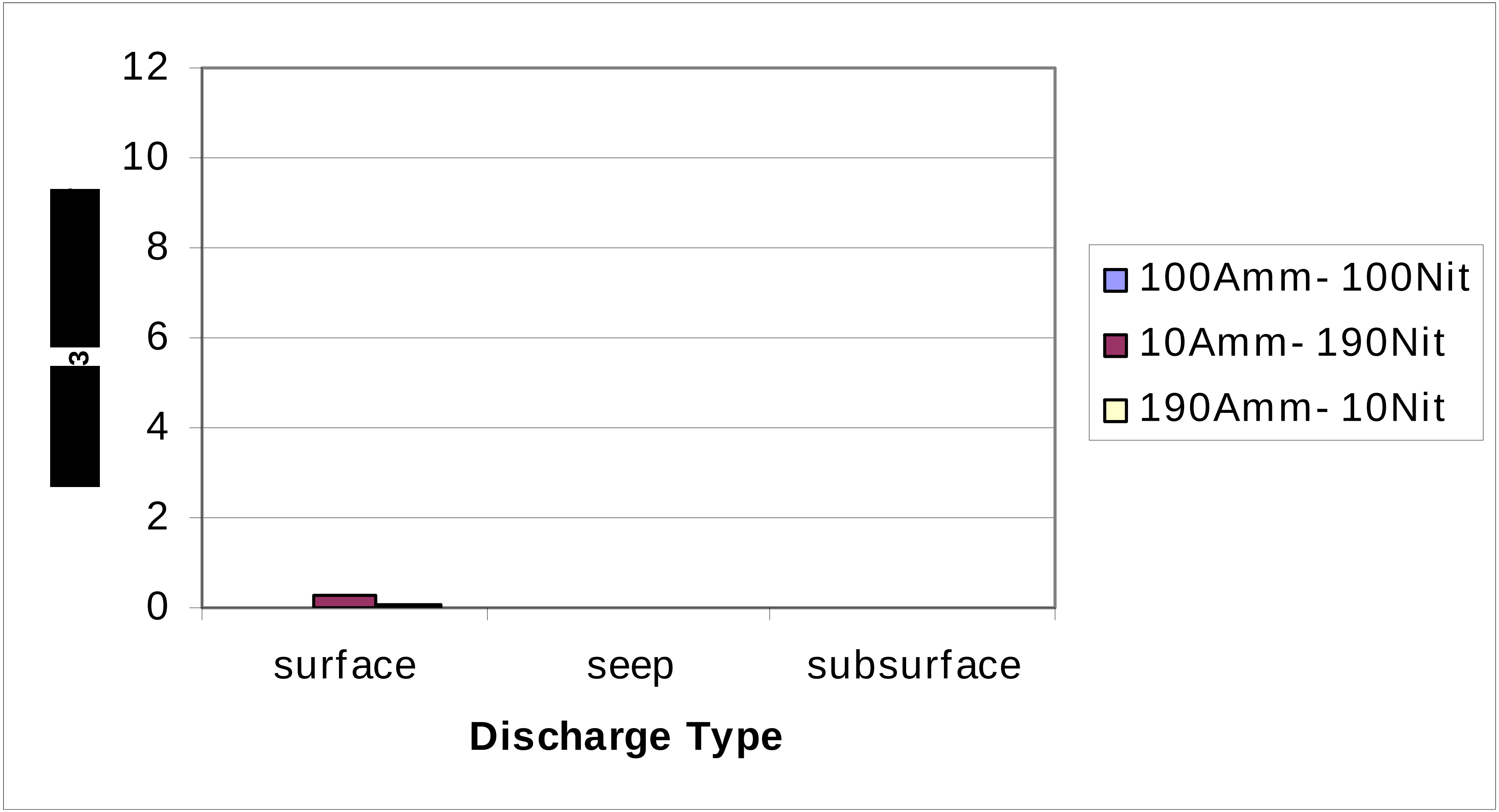
Kinston – Denitrification by Zone



Alapaha – Nitrate output to stream for three high loading scenarios.



Kinston – Nitrate output to stream for three high loading scenarios.



Conclusions

- Modeled annual rates are similar to measured rates
- Kinston soil with higher OM and much higher potential had higher denitrification
- REMM demonstrates zonation but not clear if it reflects real-world
- Denitrification rates estimated with REMM reflect stratification of denitrification -RNS

Conclusions

- Denitrification rates are influenced by loading and type of loading
- Denitrification in lower zones was limited by nitrate transport on the Kinston soil even at highest loading. Not on Alapaha soil
- Modeled rates at highest loadings were similar to rates anticipated for riparian zones and wetlands in watershed restoration