Nitrogen Removal in Agricultural Headwater Streams

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Assumptions

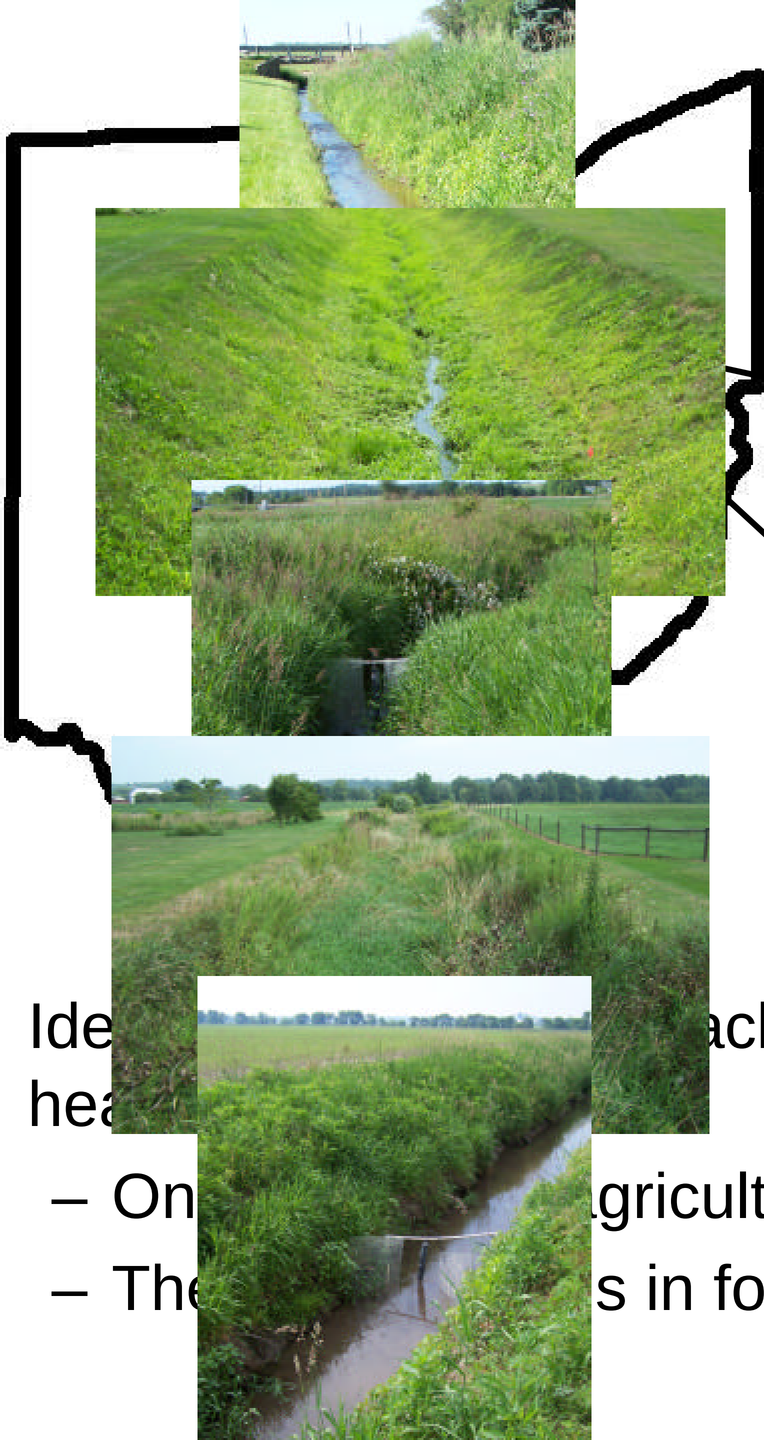
- NO_3^- is dominant form of N
- N removal is due to denitrification

- Human Health Concerns (direct and indirect)
- Ecological Impacts (hypoxia)
- Disparity in the literature…how well do these systems remove N?

Objective

- Determine what controls N removal in agricultural headwater streams

- Riparian land use
- Enzymatic effects (temp, NO_3^-, org C)
- Hydrology (Q, depth, residence time, transient storage)



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  - On gricultural/urban la
  - The s in forested land

Reach Comparison

Reach	Agricultural/Urban	Forested
Q (L^3 sec^{-1})	18.2 ± 27.3	13.8 ± 20.9
Width (m)	0.92 ± 0.30	1.85 ± 0.83
Depth (m)	0.16 ± 0.06	0.10 ± 0.04
NO_3^- (mg N L^{-1})	9.7 ± 6.5	10.7 ± 6.9
TN (mg N L^{-1})	10.7 ± 6.2	11.7 ± 6.9

All values are mean ± 1 standard deviation

Methods

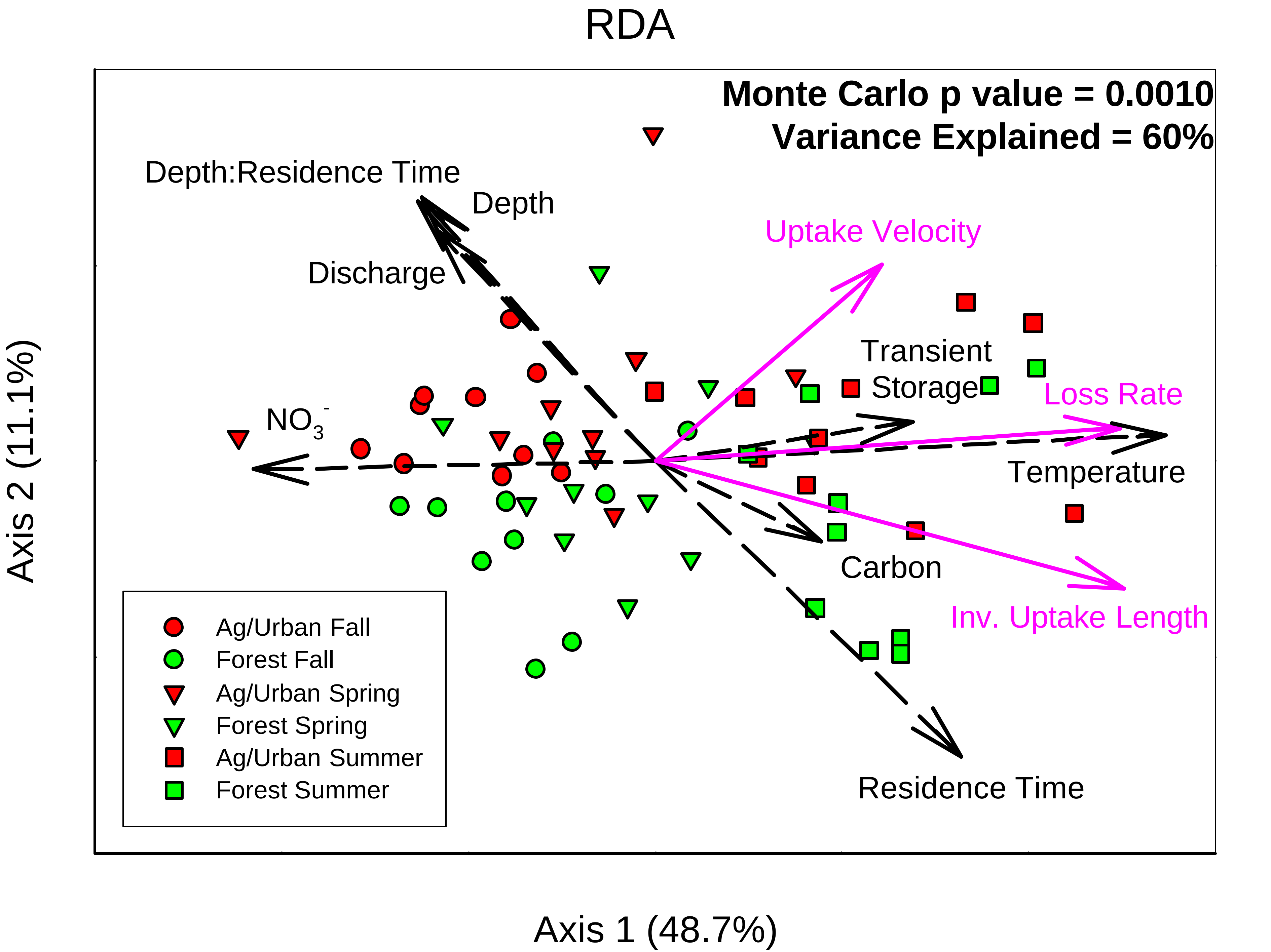
- Sediments collected randomly and homogenized for each reach
- Denitrification measured with C_2H_2 inhibition on slurries
- N and P measured with Lachat Quikchem 8500
- Sedimentary C measured on a CE Instruments CHN Analyzer
- Rhodamine WT slug injections were run for each reach to measure residence time and yield breakthrough curves
- OTIS-P was used to calculate dispersion and storage area on breakthrough curves

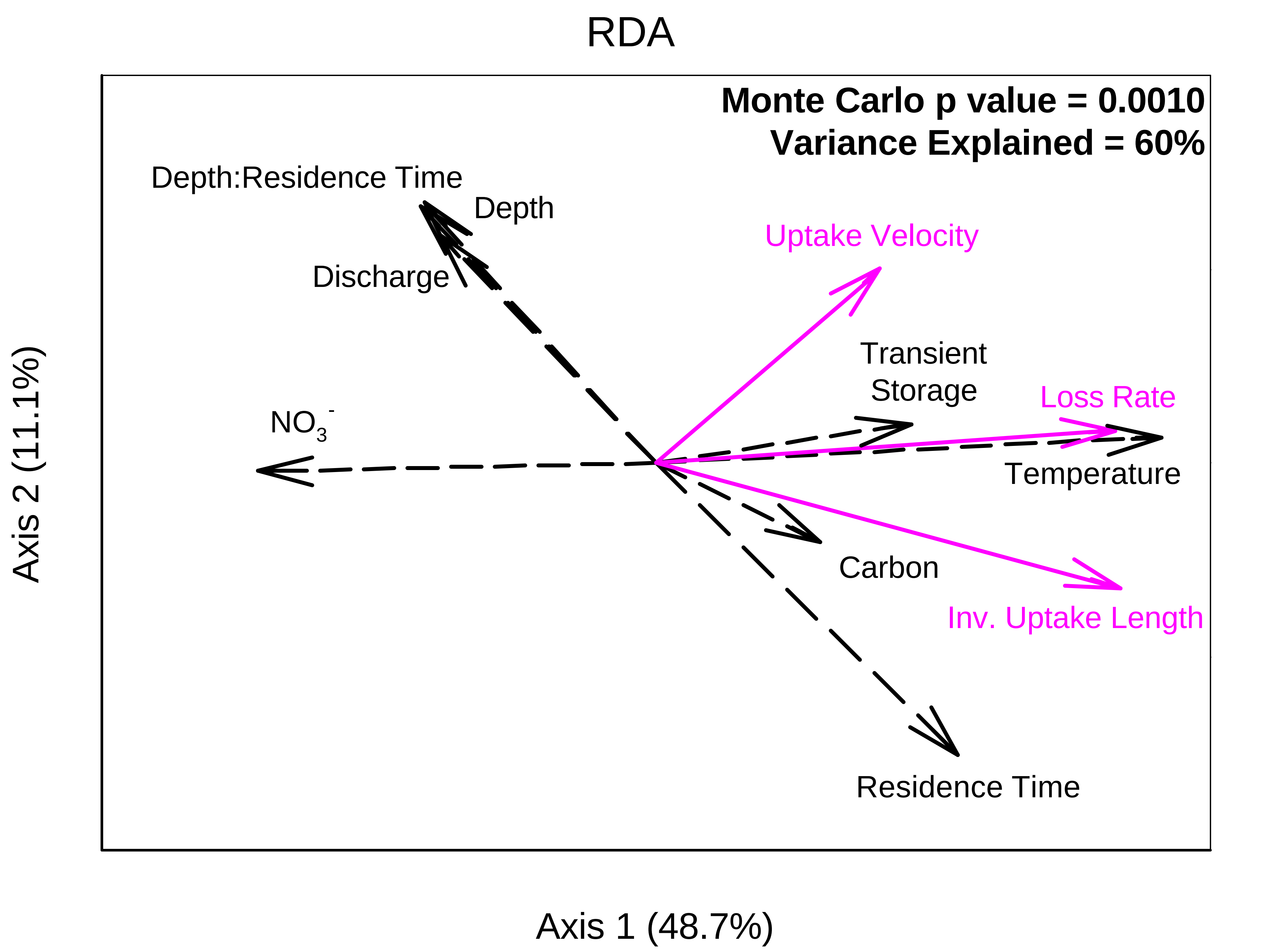
How do we analyze our results?

- Our objective is to determine if land use, Q, transient storage, depth, residence time, temperature, org C, or NO_3^- can explain N removal in headwater streams

1. More than one way to measure nitrogen removal (loss rate, uptake velocity, and uptake length)
2. Independent variables are highly correlated

Multivariate statistics ? Redundancy Analysis


RDA
Monte Carlo p value = 0.0010
Variance Explained = 60%
Depth:Residence Time
Depth
Uptake Velocity
Discharge
Transient
Storage
Loss Rate
NO3-
Temperature
Carbon
Inv. Uptake Length
Residence Time
Ag/Urban Fall
Forest Fall
Ag/Urban Spring
Forest Spring
Ag/Urban Summer
Forest Summer
Axis 2 (11.1%)
Axis 1 (48.7%)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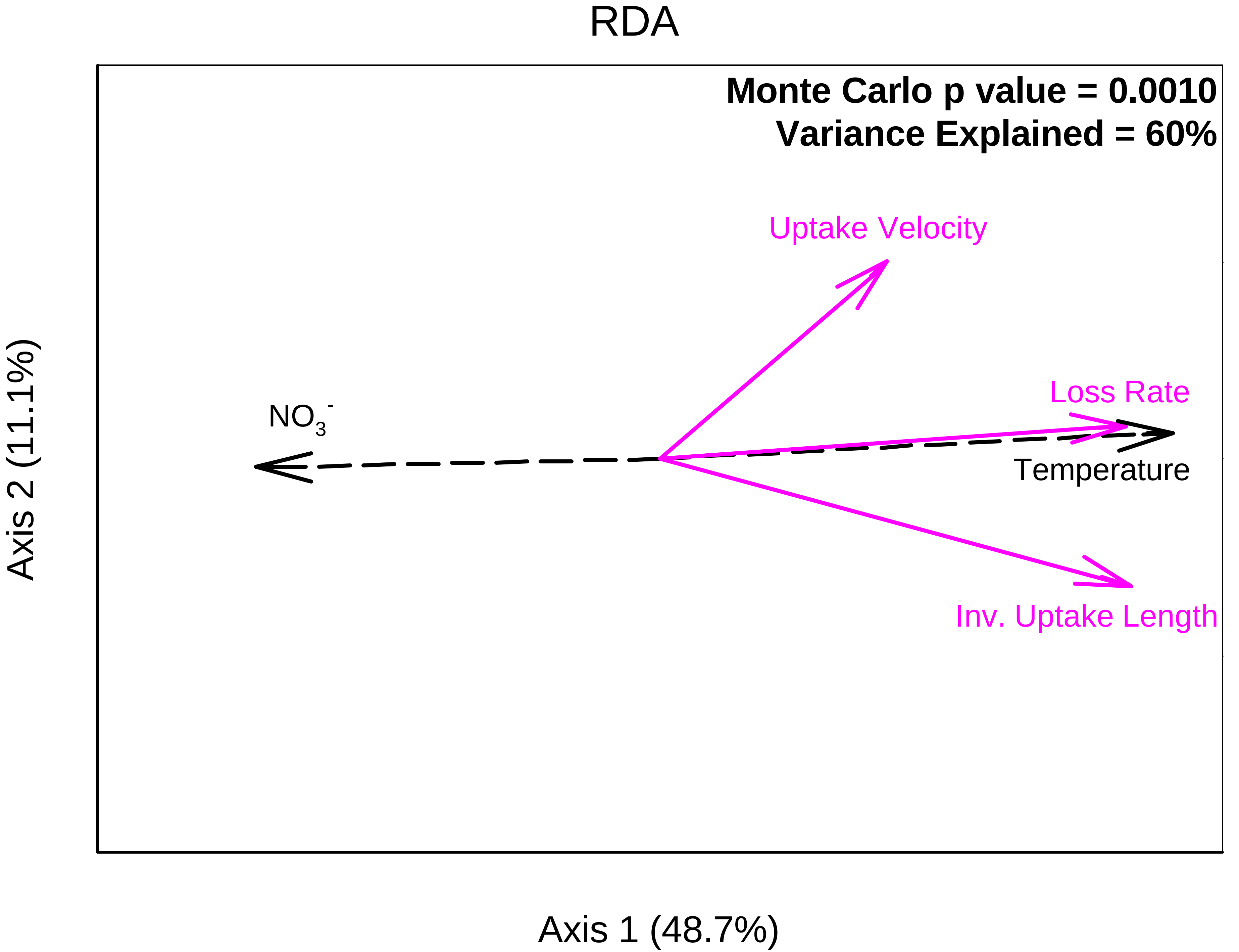
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Uptake Velocity
Loss Rate
NO_3^-
Temperature
Inv. Uptake Length
Axis 2 (11.1%)
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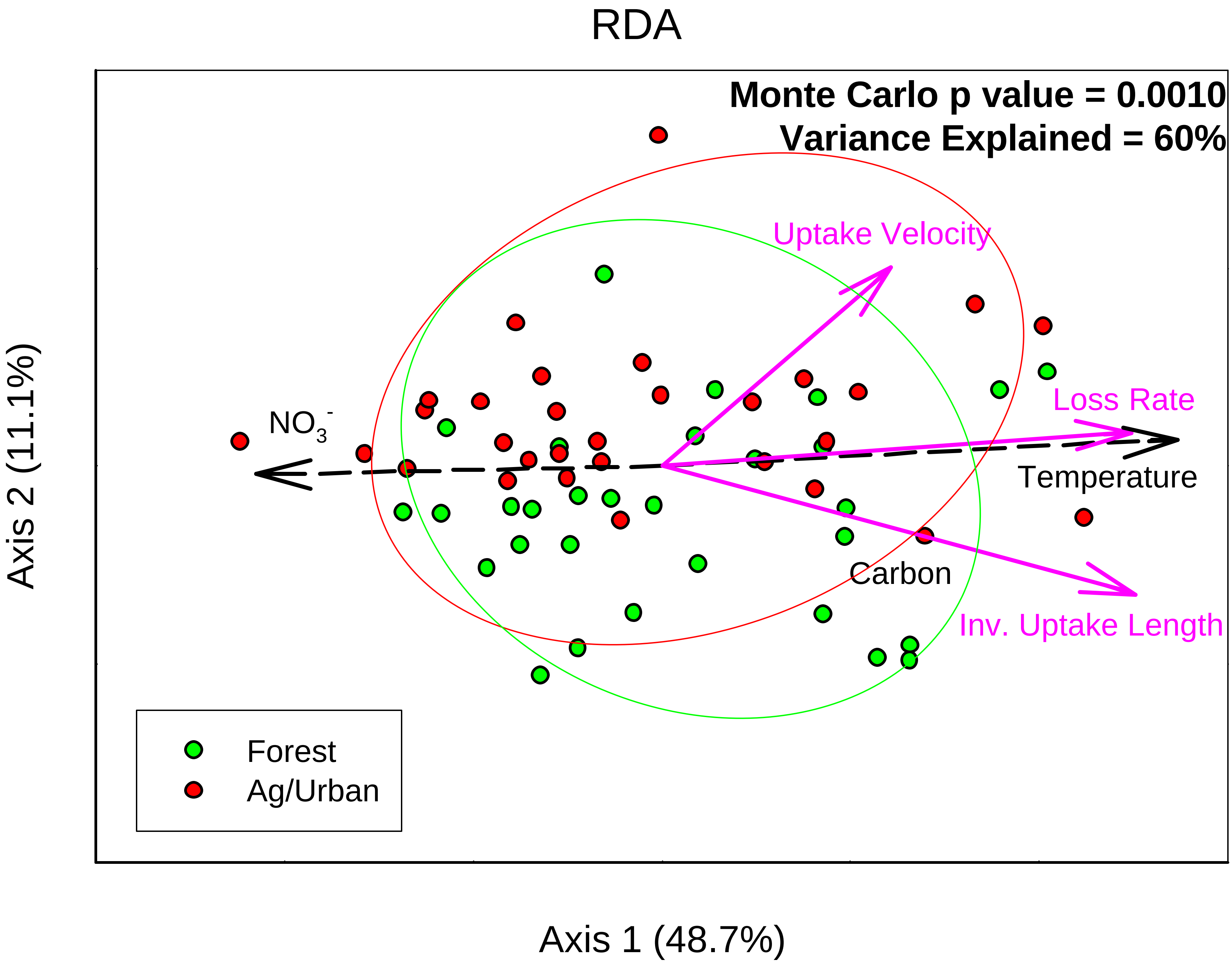
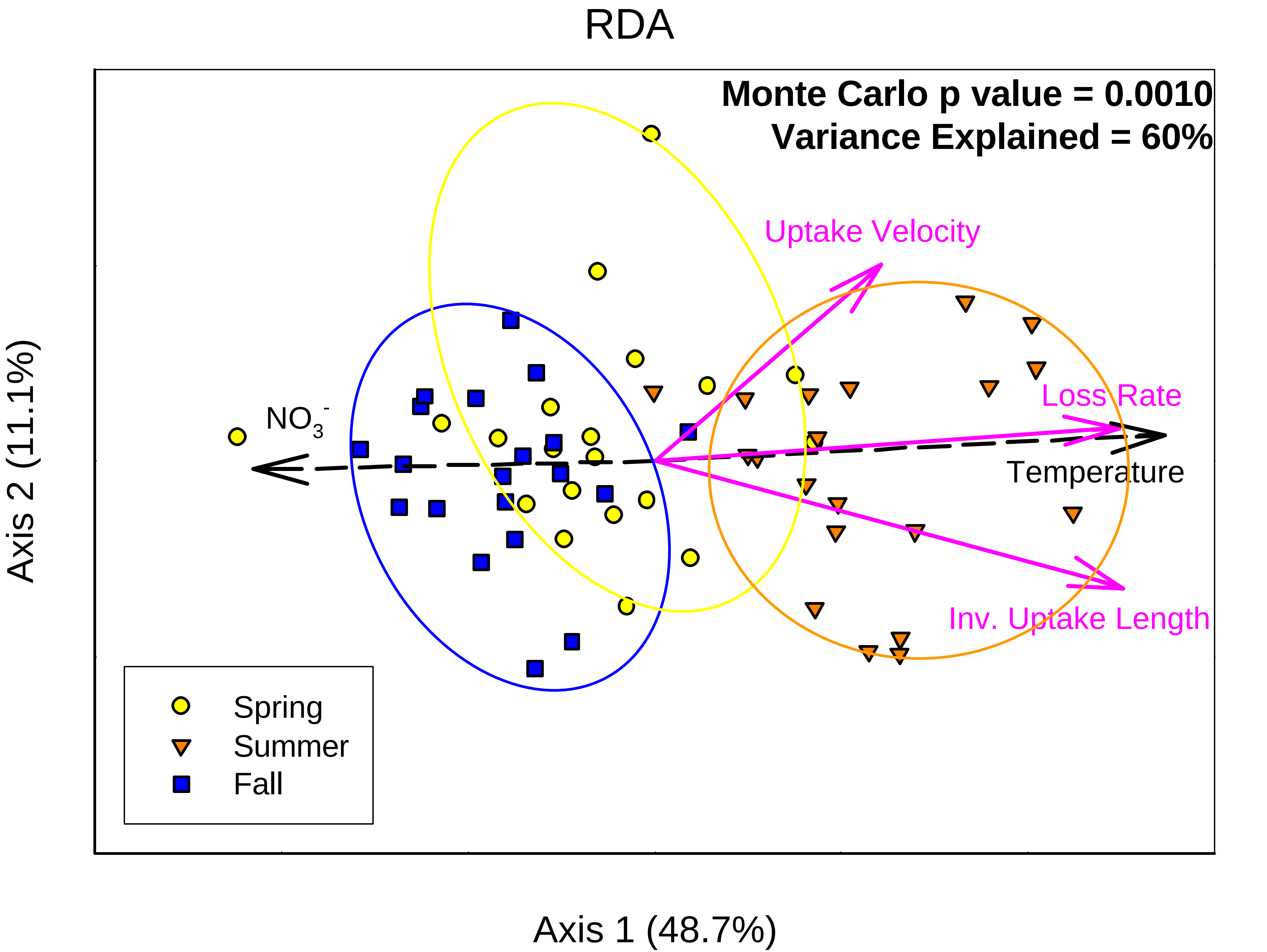
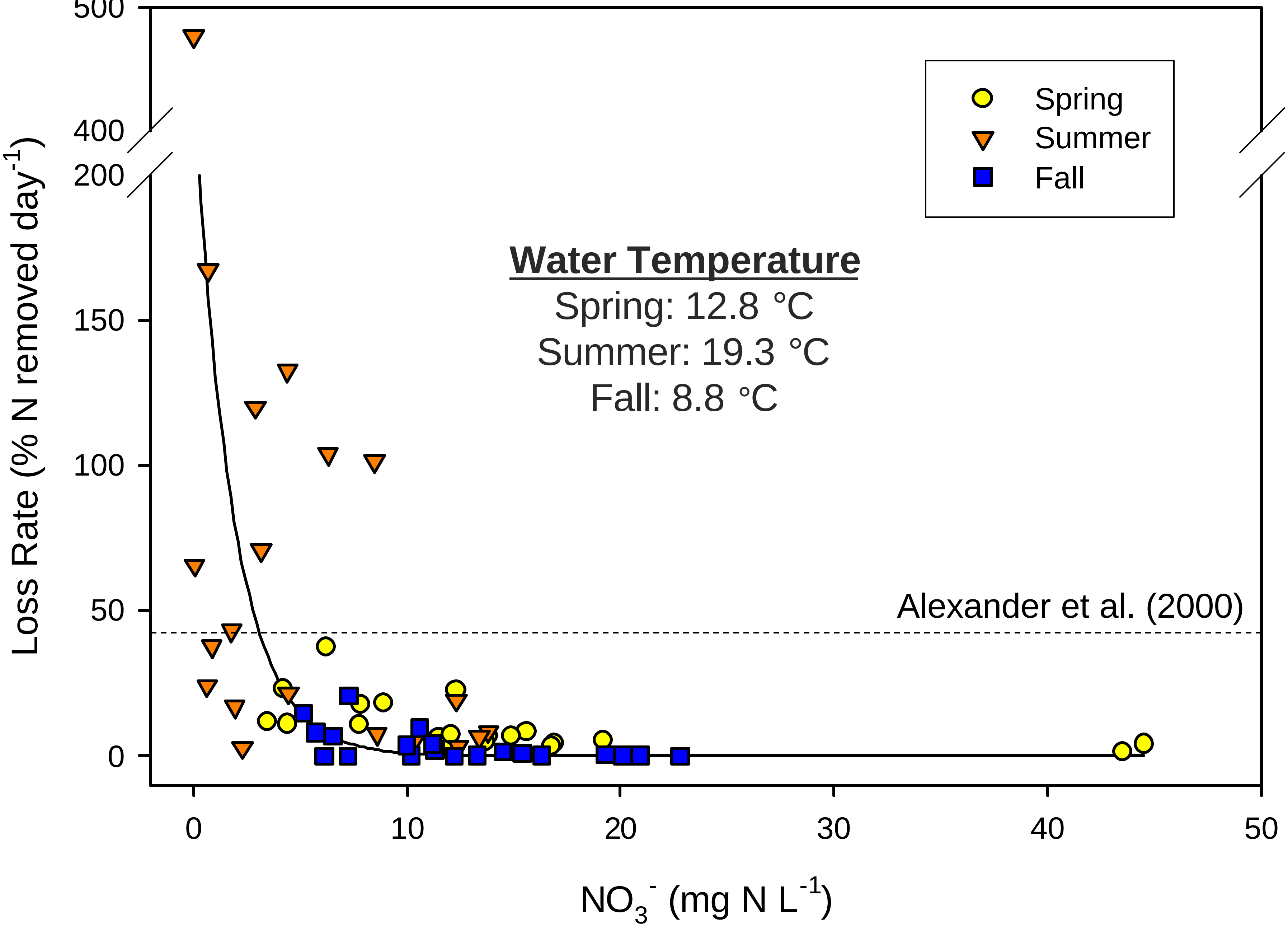


RDA
Monte Carlo p value = 0.0010
Variance Explained = 60%
Uptake Velocity
Loss Rate
Temperature
Carbon
Inv. Uptake Length
NO_3^-
Axis 2 (11.1%)
Axis 1 (48.7%)
Forest
Ag/Urban



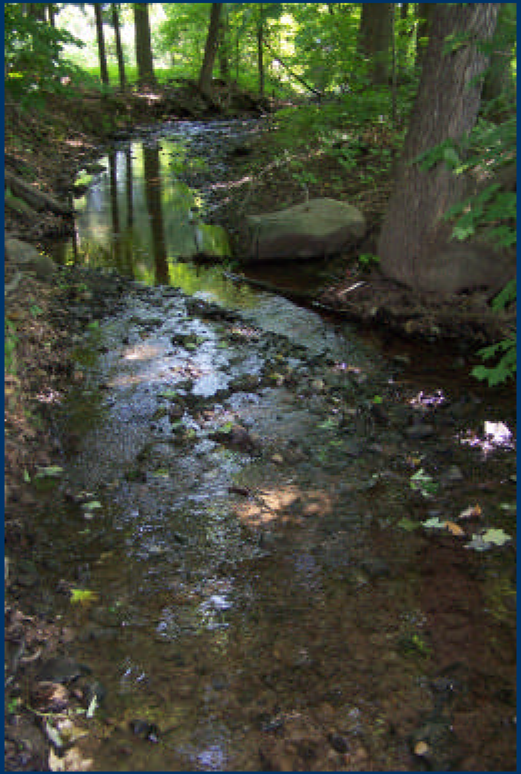
RDA
Monte Carlo p value = 0.0010
Variance Explained = 60%
Uptake Velocity
Loss Rate
Temperature
Inv. Uptake Length
NO3-
Spring
Summer
Fall
Axis 2 (11.1%)
Axis 1 (48.7%)

Seasonal and NO_3^- Effect



Conclusion

- Nitrogen removal in agricultural headwater streams is low and is significant only during brief periods in summer



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GO BEARS!