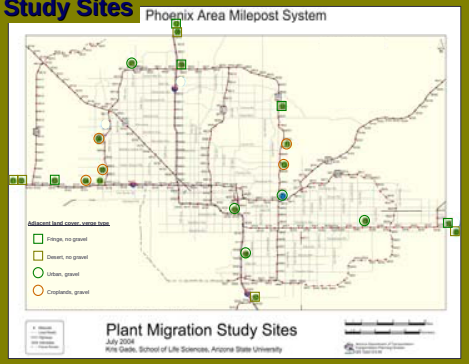
# The Role of Nitrogen in Plant Migration Along Freeway Corridors in Phoenix, Arizona

Kristin J. Gade and Ann P. Kinzig, School of Life Sciences, Arizona State University

## Study Sites




## Question

**How does nitrogen deposition affect roadside plant community composition?**

1. **Is there a gradient of nitrogen deposition to freeway verges from traffic exhaust?**
2. **Are there other sources of N to freeway verges?**
3. **Does adjacent land cover affect plant-available nitrate on freeway verges?**

**"Desert" sites: No gravel on verges, adjacent to desert**

**"Fringe" sites: No gravel on verges, adjacent to landscaped land**

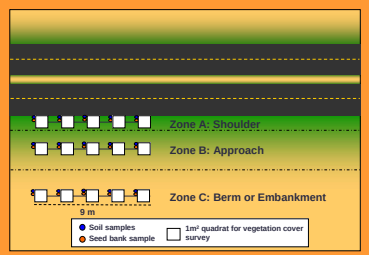
**"Cropland" sites: Gravel verges adjacent to croplands**

**"Urban" sites: Gravel verges adjacent to landscaped land**

Land adjacent to "urban" sites generally has higher density development than land adjacent to "fringe" sites.

## Sampling and Analytical Methods

- 0-2 cm and 2-12 cm samples
- 5 samples in each zone composited
- Available $NO_3$ extracted using 2M KCl; shaken for 1 hour
- Analyzed colorimetrically using TrAAcs autoanalyzer
- Subtracted average of sample blanks
- Log transformed data to achieve normality




## Results

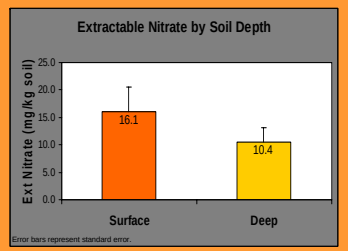
1. Across all sites, Zone A had significantly higher nitrate in surface samples than Zones B and C.

| | A | B | C |
|---|---|---|---|
| A | 1.000 | | |
| B | **0.003** | 1.000 | |
| C | **0.003** | 0.995 | 1.000 |

(ANOVA using log surface soil; n=30, F=5.556, P=0.005; Fisher's multiple comparison)

2. There were significant differences in extractable nitrate between surface (0-2 cm) and deep (2-12 cm) samples.

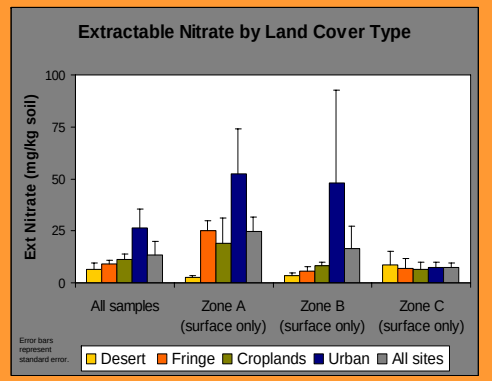
(2 sample t-test using log-transformed data; n=60, P<0.001).




3. There were significant differences in extractable nitrate between landcover types.

Urban > Crop > Fringe > Desert

(ANOVA using log surface soil; n=15, F=123.67, P<0.001; Fisher's multiple comparison all combos P<0.001)




## Discussion

### 1. Nitrogen Deposition from Traffic Exhaust

- Extractable nitrate concentrations were generally highest in surface soils and closest to the road (Zone A)
- These results support the idea that $NO_x$, $NH_3$, and N-containing particulates from exhaust are adsorbing/depositing to roadside soil (Padgett and Bytnerowicz 2001; Cape et al. 2004)
- Results also support the finding by Cape et al. (2004) that $NO_x$ and $NH_3$ gas concentrations decreased by 90% in the first 10-15m from edge of asphalt

### 2. Other Sources of Roadside N

- Exhaust from traffic on frontage roads
- Ammonia from fertilizers used in both current and abandoned agriculture
- Grey water use in landscape drippers

### 3. Role of Land Cover/Land Use

- Higher available $NO_3$ in landscaped verges adjacent to developed areas and agriculture; may be correlation between landscaped areas, higher traffic loads, and grey water use

### 4. Potential Effects on Plant Communities

- Reduced spatial variation in [soil N]
- Increased minimum values of [soil N]
- Competitive interactions in nutrient limited ecosystems (Grime 1974, 2001)
  - Low nutrient-adapted natives
  - High nutrient-adapted ruderals
- Implications for conservation value and verge management

### 5. Continuing/Future Work

- Analysis of plant survey data (percent cover, functional groups)
- Complete analysis of total C, N, and P in samples
- Seed bank and seed trapping results

**Acknowledgements**

- ASU's IGERT in Urban Ecology and CAP LTER
- Arizona Department of Transportation
- Monica Brennan, Kevin Johnson, Randy Matas, Sandy Van Horne, and Joshua Watts
- Grimm and Stromberg labs

**References**

Cape, J.N. et al. 2004. Concentrations of ammonia and nitrogen dioxide at roadside verges, and their contribution to nitrogen deposition. *Environmental Pollution* 132:469–478.

Grime, J.P. 1974. Vegetation classification by reference to strategies. *Nature* 250(26):231.

Grime, J.P. 2001. *Plant Strategies, Vegetation Processes, and Ecosystem Properties*, 2nd Ed. John Wiley & Sons.

Padgett, P.E. and A. Bytnerowicz. 2001. Deposition and adsorption of the air pollutant HNO vapor to soil surface. *Atmospheric Environment* 35:2405-2415.