Moss nutrient plasticity over variations in soil resource availability in desert soils

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Introduction:

- In the Sonoran Desert in Arizona, moss are a ubiquitous riparian vegetation, and therefore represent a potentially significant terrestrial-aquatic linkage.
- Moss may play an important role connecting soil and stream nutrient cycling, if soil nutrients are taken up from the wash by streamside moss, which becomes an organic-matter source for the soil.
- In the urban Sonoran Desert in Phoenix, AZ, nitrogen (N) deposition increases soil N in comparison to the surrounding rural areas.
- Despite its importance, very little is known about moss's role in biogeochemical cycles, such the plasticity of their nutrient uptake and stoichiometry, and therefore it is unclear how urban pollution will affect their functional significance as an integrator of nutrient cycling in deserts.

Research Questions:

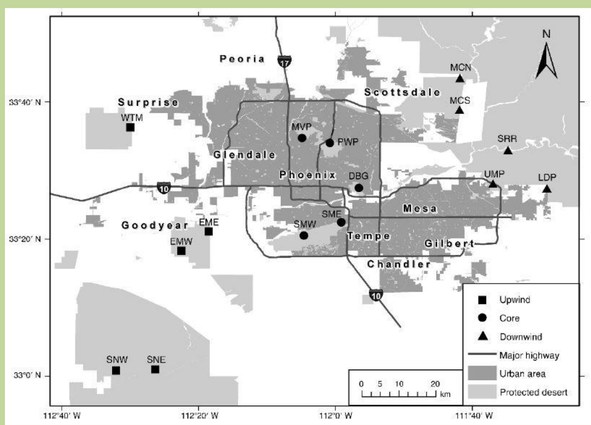
We sampled moss from the Sonoran Desert within urban Phoenix, subject to N deposition pollution, and outside the city core. We asked:

1.How much does moss stoichiometry vary across differences in soil resource availability?

2. Is moss a sink for excess N from air pollution?

Methods:

Sites: Moss and soil were sampled from 15 sites in the Sonoran Desert in and around Phoenix, covering the city core and both upwind and downwind of the city.



Hall et al. 2011. *Ecological Applications*. **21**:640-660.

Sample Collection:
- Moss sample (clean spoon)
- Soil sample beneath the moss (clean scoop)

Sample Analyses:
- Moss C:N:P and cations (elemental analyzer and ICP-OES)
- Soil C:N, mineral N and P (elemental analyzer, Lachat)
- Soil water content (oven drying)

Percent Cover:
- Ten 10-m transects in riparian areas along washes
- 25x25 cm quadrat every 1 m along transect

Results & Discussion:

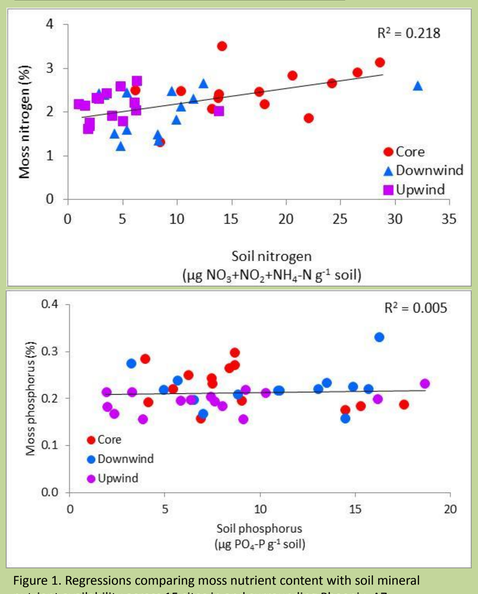


Figure 1. Regressions comparing moss nutrient content with soil mineral nutrient availability across 15 sites in and surrounding Phoenix, AZ.

- Moss N content increases with increasing soil N ($P = 0.002$).
- The core sites have higher concentrations in both soil ($P < 0.001$) and moss ($P = 0.038$) N content than the other two sites.
- The soil vs moss mineral P does not seem to have a strong relationship ($P = 0.669$).

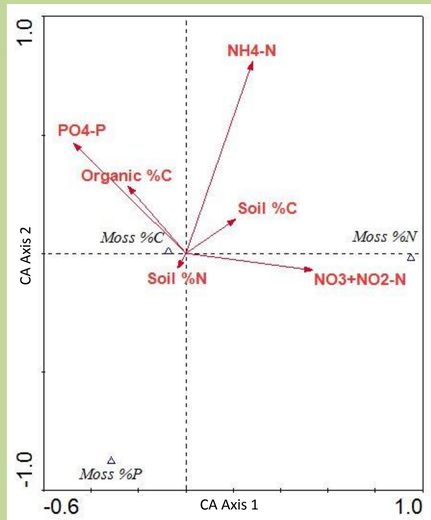


Figure 2. Canonical Analysis (CA) describing the relationship between nutrient content in moss and potential soil nutrient sources.

- Canonical Analysis demonstrates the relationship between moss nutrient content and the potential soil resources.
- There is a strong relationship between moss and soil N (indicated by their close proximity), and little or no relationship between other moss and soil nutrients.

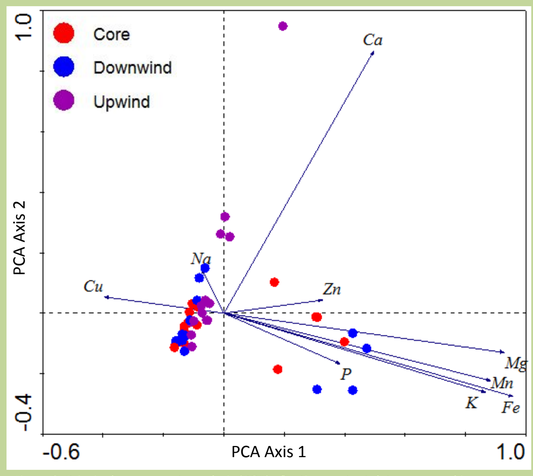


Figure 3. Principal components analysis (PCA) of cation content data measured in moss samples collected from the urban core of Phoenix and the surrounding area.

- Although some of the Downwind and Core sites have high content in cations like P and potassium, there is no correlation between cation content and site location.

- Core sites contain less moss cover than up- and downwind, though it is not statistically significant ($P = 0.262$).

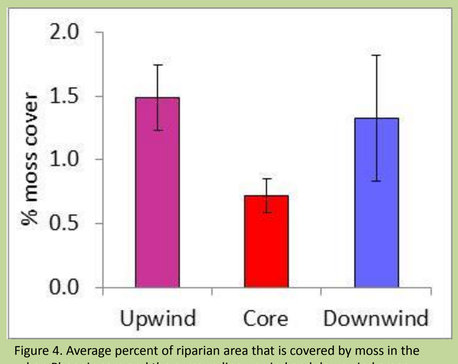


Figure 4. Average percent of riparian area that is covered by moss in the urban Phoenix core and the surrounding upwind and downwind areas.

Conclusions:

- Moss uptake of N appears plastic, in that it takes up more N when soil resources are available. However, this is not the case for P.
- The city core tended to have higher soil N, associated with higher levels of N deposition from air pollution. Moss may play a role in sequestering the excess N from air pollution.
- Moss cover along the edges of washes is relatively low, particularly in the city core, limiting its ability to act as a sink for that excess N. However, these washes drain the much larger area, potentially concentrating soil N transported during rainfall events in the riparian areas for moss uptake.

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