Islands of “fertility” in the Mojave Desert ??

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Introduction

- Sloped Mojave Desert soils are a mix of fine sands and $CaCO_3$ sediments
- Soil nitrogen (N) contents are typically low, except under shrubs
- Literature refers to shrubs with high soil N values as “islands of fertility”
- Free living bacteria with N_2-fixing capacities also occur in these soils

Brittlebush *(Encelia farinosa)* (see photo)

- roots do not form N_2-fixing nodules
- do not have mycorrhizae
- shrubs have higher soil N contents, creating an “island of soil fertility”
- leaf allelopathic compounds prevent seed germination under adult plants

Factors influencing soil N

Soil $\delta^{15}N$ and N are influenced by

- biological N_2 fixation which increases soil N pools and reduces pool $\delta^{15}N$
- denitrification and mineralization increase with precipitation and also elevate $\delta^{15}N$ of active soil N pool

Soil NO_3^- is

- the primary N form available to plants
- not isotopically discriminated against during root NO_3^- uptake

Methods

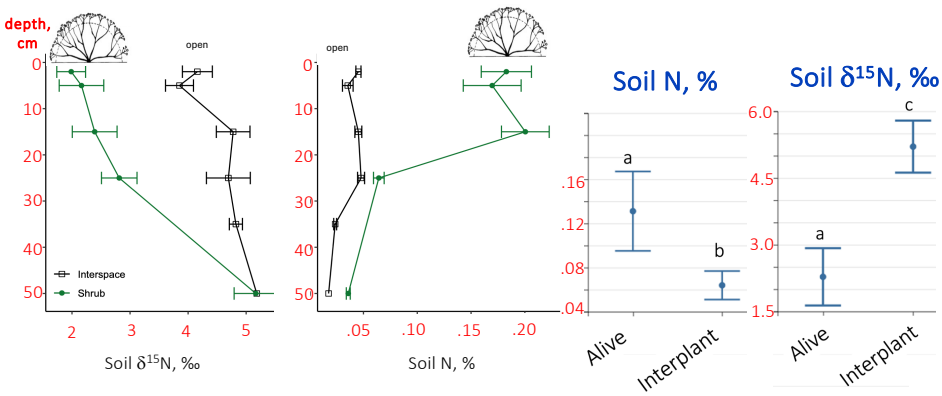
- Leaves and soils were dried and stored until analyzed
- Soils were sieved to remove gravel
- Leaves and soils were combusted on a CN analyzer coupled to a Delta V IRMS to determine $\delta^{15}N$ and %N values

Modeling

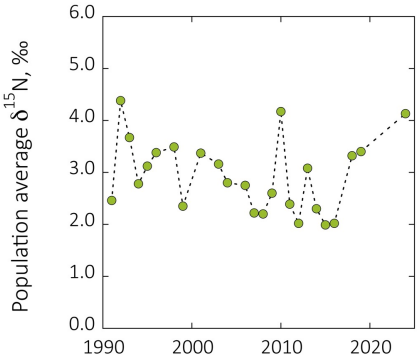
- We assume that leaf $\delta^{15}N$ reflects the $\delta^{15}N$ of the available soil N pool
- We assume that free living N_2-fixing bacteria activities and mineralization rates are both positively related to annual precipitation
- We assume that any exudates provide an additional carbon source available to free living N_2-fixing bacteria

Do high-N islands provide additional N for growth?

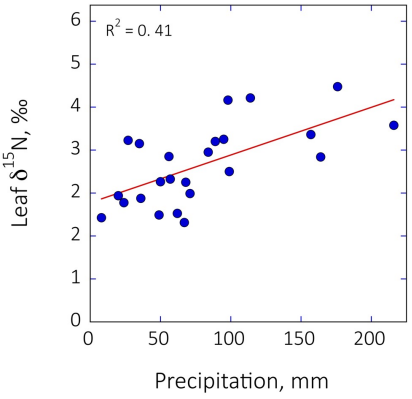
Soil %N and $\delta^{15}N$ values differ under shrubs versus in open spaces



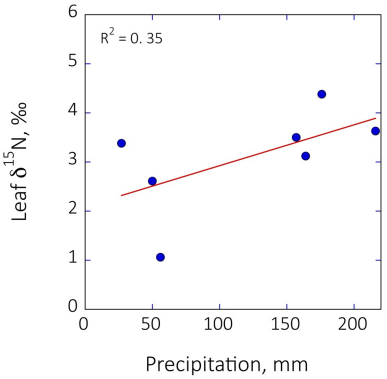
Adult leaf $\delta^{15}N$ values exhibit small interannual variations



Leaf $\delta^{15}N$ values are proportional to annual precipitation



Although seedlings develop only in open sites, leaf $\delta^{15}N$ values also vary with precipitation



Current interpretation

- Open sites have low soil N
- Seedlings germinate in open sites and likely supply carbon to free living N_2-fixing bacteria (exudates?)
- $\delta^{15}N$ of both juvenile and adult plants co-vary with precipitation, suggesting limited soil N pools that are subject to denitrification
- Much of the accumulated soil N under shrubs is likely recalcitrant
- “Islands of fertility” is a misnomer

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