THRILLER

Tracing **H**ighly **R**elevant **I**sotope **L**evels for **L**oosely **E**valuated **R**easons:

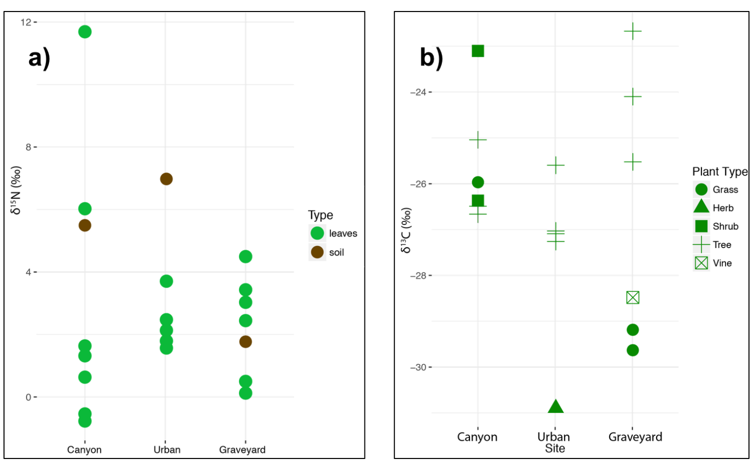
Carbon and Nitrogen Isotopes in Urban Environments

Background: Nitrogen is an essential nutrient that is often limiting in ecosystems, and thus its rapid addition is a large control on productivity. Urban ecosystems are heavily influenced by nitrogen inputs via synthetic fertilizers created with the Haber-Bosch reaction and pollution. To trace excess nitrogen inputs, we can examine the $\delta^{15}N$ isotopic compositions of communities across urban versus natural ecosystems. $\delta^{13}C$ values increase with increasing water stress; therefore, if plants are receiving water from urban irrigation they will have lower $\delta^{13}C$ values.

Research question: How does urban activity influence the $\delta^{15}N$ and $\delta^{13}C$ isotopic compositions of plant communities in urban to natural locations?

Hypothesis: We expect to find lower $\delta^{15}N$ values in more urban ecosystems because they will be more fertilized than natural ecosystems: fertilized areas within the inversion layer should show the lowest $\delta^{15}N$ values, but the urban inversion layer might also cause lower $\delta^{15}N$ values in urban unfertilized areas than in areas above the inversion layer in Big Cottonwood Canyon. We also expect that $\delta^{13}C$ isotopic composition will be lighter in more irrigated localities.

Methods: To investigate this question, we took plant, soil, and insect samples from three locations. The first location was the Salt Lake City Cemetery (Graveyard, highly fertilized, highly irrigated inside the urban inversion layer); the second location was the mouth of Red Butte Canyon (Urban, unfertilized, unirrigated, inside the urban inversion layer); and the third location was Big Cottonwood Canyon (Canyon, unfertilized, unirrigated, more outside the urban inversion layer). Samples were dried overnight and then finely ground and homogenized. All samples were analyzed on an EA continuous flow IRMS.



Results:

Fig. 1: $\delta^{15}N$ (a) and $\delta^{13}C$ (b) values for samples across all locations.

Our data supports our hypothesis that more urban areas have lower $\delta^{15}N$ values. This is demonstrated in Fig. 1a by the low $\delta^{15}N$ values of soils in the graveyard tracking closely with the plant communities. In contrast, in more natural systems the $\delta^{15}N$ values are higher and varied indicating alternate nitrogen sources, not fertilizers. Additionally, the carbon isotope data indicates that the urban and graveyard sites are receiving more water than the canyon, reflected in the lighter $\delta^{13}C$ values (Fig. 1b).

GHOSTBUSTERS

Gauging **H**ydrogen & **O**xygen i**S**o**T**ope abundances **B**etween
Urban **S**ystems **t**o **E**valuate water **R**esource**s** for plants

Background: Big Cottonwood Canyon's watershed supplies 25-30% of the water used by Salt Lake City. Big Cottonwood Creek runs the length of the canyon and is fed by snowmelt tributaries from the peaks of the surrounding mountains. The water is treated for human consumption at a treatment facility at the base of the canyon.

Research Question: Are there longitudinal differences in $\delta^{18}O$ of surface water and water extracted from plants that is attributable to water source?

Hypothesis: $\delta^{18}O$ values change with distance from the source and city irrigation water is expected to be similar to stream water. Deuterium and oxygen isotope values of stem water is expected to reflect the source water.

Methods: Water samples were collected from tributaries and the mainstem of the creek along the main road from Silver Lake to the water treatment facility at the bottom of the canyon. The sample collected at Silver Lake was a snow sample and regarded as the source sample. Stem samples from different plant species for water extraction were collected at the three sites described in the THRILLER project: Graveyard, Urban and Canyon. Stem water was extracted by cryogenic vacuum distillation. All samples were analysed using Picarro.

Results: The water from the river main stream and tributaries are nearly identical in the valley and also match the irrigation water at the graveyard. The source water (snow at high elevation) show higher δD and $\delta^{18}O$ values than the mainstem of the water and is likely the result of a combination of warm snowfall and recent evaporation. The lower river δD and $\delta^{18}O$ values were gathered from the outflow of the water treatment plant. These also showed higher values compared to the mainstem, which could result from evaporation as well as from processing and settling tanks in the plant. Because the irrigation water was so similar to the untreated river, we believe that the irrigation water was not treated, but rather was simply surface water routed to the graveyard.

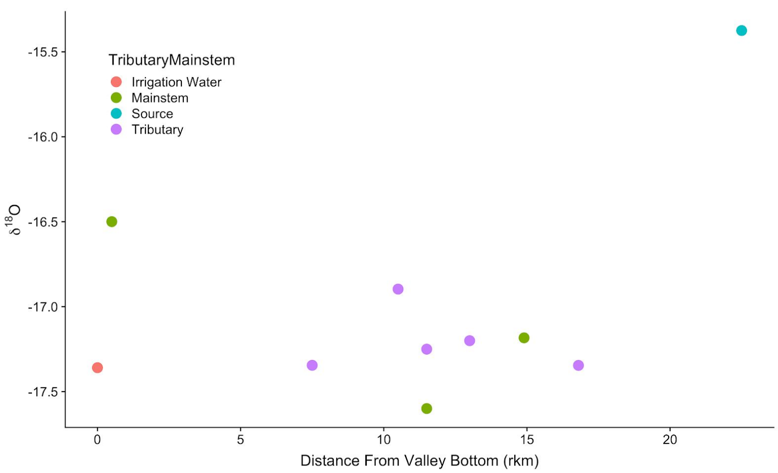


Figure 2: $\delta^{18}O$ values of water collected from the Big Cottonwood Canyon source snow (blue), along the main stem of the river (green), from tributaries feeding into the river (purple), and from the irrigation water system at the graveyard site (pink).

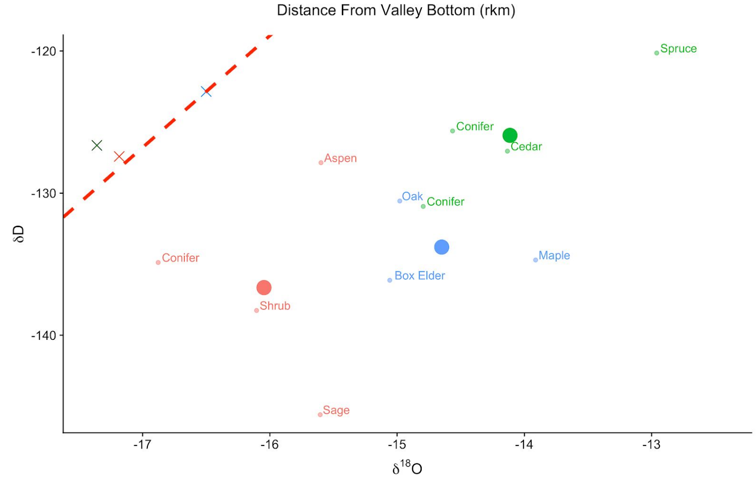


Figure 3: Stem water $\delta^{18}O$ and δD values from the water of plant xylem collected in the Canyon (pink), graveyard (green), and urban sites (blue). Each point is labeled with their functional group. Each site's mean $\delta^{18}O$ and δD value is shown in the large point. Potential source waters $\delta^{18}O$ and δD values collected from surface waters at each from site (X). δD are meaningless.