Gypsum Soils Analysis Technical Conditions:  
Do soil factors control distributions of the Las Vegas Buckwheat?

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Clark County DCP Project 2005-UNLV-609F
Las Vegas buckwheat (Niles’s Wild Buckwheat)


- One of several presumed gypsophiles (*almost* exclusively) found in Clark County

- Isolated populations – not all gypsum soils are suitable habitat?

- Need to better understand ecology of this selective habitat species in light of:
  1. Continued urban development
  2. Projected climate changes
Project Objectives: Soil Properties & Processes

(1) From *patterns* of soils and land-surface properties underlying buckwheat distributions,

(2) Interpret which *characteristics* most directly influence distributions of the Las Vegas Buckwheat
Study Areas
Study Sites (Soil Profiles) within the CS Study Area
Study Sites (Soil Profiles) within the GB Study Area
Study Sites (Soil Profiles) within the BS Study Area
Scope of Work

1. **Mapping**
   - Surficial Geologic maps → soil-geomorphology, habitat implications, surface parameters

2. **Soil Characterization & Sampling**
   - 97 profiles dug, described (genetic horizons) & sampled
     - 319 horizon samples (101 from CS; 126 GB; 92 BS)
   - Surfaces characterized & sampled
     - 223 surface samples (74 from CS; 82 GB; 67 BS)

3. **Laboratory Analysis**
   - Chemical, mineralogical, & physical analyses:
     - pH, EC, plant available elements, texture, etc. *(33 variables)*
Data Classes Based on Mapping

Bitter Spring (White Basin) Study Area

NAIP (2007)
Existing maps were too coarse in resolution for our purposes...

Here, NRCS 1:24,000 soil survey data

177 = St. Thomas-Upperline-Whitebasin complex
232 = Wechech-Upperline association
310 = Weiser-Arizo association
821 = Helkitchen-St.Thomas complex, 15-20 percent slopes
Habitat Classification:

(1) Habitat
(2) Potential Habitat
(3) Non-Habitat
Laboratory Analyses included:

- pH (3 methods) & EC
- CaCO$_3$ & Total C $\rightarrow$ calculate Inorganic C, Organic C
- Plant available ions (Mehlich method):
  - Na, K, Mg, Ca (AAS)
  - P, Mn, Fe, Ni, Cu, Zn, Co, B, Mo, As (ICP-MS)
  - anions: NO$_3$, SO$_4$, Cl (ICS)
- Particle Size Determination (LASR)
- Moisture content

Also: Bulk & Phyllosilicate Mineralogy (XRD)
Sampling: by Horizon & by Canopy Type

- **Canopy** (non-buckwheat sp.) = UC
- **Interspace** (between plants) = IN
- **Buckwheat Canopy** (*E. corymbosum*) = BW

### Samples & Data by Cover Class
- GB07-S-UC
- GB07-S-IN
- GB07-S-BW

### Site #
- IN 8.25
- UC 8.34
- BW 8.27

### Data by Horizon
- GB07-Av
  - Av 8.25
- GB07-By
  - By1 8.75
  - By2 8.16
- GB07-By2

### Site #
- Av 8.38
- Avg 8.38

Data by Profile
Surface Characterization: Point Counts

- ~125 counts (5 locations x 25 points) per canopy class
- Normalized to percentage when BW < 5, or UC < 5
Surface Characterization Included:

- Bare soil
- Lichen
- Mosses
- Cyanobacteria
- Rock fragments (& lithology)
- leaf/shrub litter
- grasses/grass litter
Statistical Analysis

How to group horizon & profile data?

= 192 data tables

PHAB vs. NHAB comparisons were run using mean values only.
Surface groups:

(1) by presence or absence

(2) by habitat class

Statistical Analysis

Surface Data: Unpaired comparison of interspaces

- BW vs. NBW
- HAB vs. PHAB
- PHAB vs. NHAB

Coyote Springs
Gold Butte
Bitter Spring
All Study Areas

x
63 variables

Surface Data: Paired comparison of canopy classes within buckwheat sites

- BW vs. IN
- IN vs. UC
- BW vs. UC

Coyote Springs
Gold Butte
Bitter Spring
All Study Areas

x
63 variables

(1) by presence or absence (objective)

(2) by habitat class (part objective, part interpretive)
Non-parametric t-tests
  – Mann Whitney U-test (unpaired)
  – Wilcoxon (paired)

Spearman’s Rho (correlation tests for select variables)

(Sample groups \( n \) too few for multivariate statistics; nonparametric t-tests O.K.)
**Example Tables:** Summary of independent, non-parametric t-tests of soil profile means (all horizons averaged) between "Buckwheat" sites & "Non-Buckwheat" Sites.

### Table 3-1a: Summary for Coyote Springs sites only.

<table>
<thead>
<tr>
<th>Significant Variable</th>
<th>p-value (2-tailed)</th>
<th>Non-BW Median</th>
<th>BW Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH Sat Paste</td>
<td>0.048</td>
<td>7.579</td>
<td>7.713</td>
</tr>
<tr>
<td>Total N</td>
<td>0.039</td>
<td>0.011</td>
<td>0.007</td>
</tr>
<tr>
<td>Total C</td>
<td>0.002</td>
<td>6.248</td>
<td>7.694</td>
</tr>
<tr>
<td>Inorganic C</td>
<td>0.002</td>
<td>6.049</td>
<td>7.553</td>
</tr>
<tr>
<td>CaCO₃</td>
<td>0.002</td>
<td>50.404</td>
<td>62.940</td>
</tr>
<tr>
<td>P</td>
<td>0.002</td>
<td>1.191</td>
<td>0.136</td>
</tr>
<tr>
<td>Fe</td>
<td>0.000</td>
<td>10.146</td>
<td>13.497</td>
</tr>
<tr>
<td>Ni</td>
<td>0.000</td>
<td>0.084</td>
<td>0.114</td>
</tr>
<tr>
<td>Ca</td>
<td>0.000</td>
<td>597.744</td>
<td>977.149</td>
</tr>
<tr>
<td>Mg</td>
<td>0.020</td>
<td>146.040</td>
<td>199.908</td>
</tr>
</tbody>
</table>

*Coyote Springs n (number of sites) 20 10*

### Table 3-6b: Summary for Gold Butte sites only.

<table>
<thead>
<tr>
<th>Significant Variable</th>
<th>p-value (2-tailed)</th>
<th>Non-BW Median</th>
<th>BW Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total C</td>
<td>0.000</td>
<td>1.922</td>
<td>4.895</td>
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<tr>
<td>Inorganic C</td>
<td>0.000</td>
<td>1.674</td>
<td>4.453</td>
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<tr>
<td>CaCO₃</td>
<td>0.000</td>
<td>13.946</td>
<td>37.112</td>
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<tr>
<td>P</td>
<td>0.031</td>
<td>1.373</td>
<td>0.708</td>
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<tr>
<td>Fe</td>
<td>0.011</td>
<td>6.899</td>
<td>10.440</td>
</tr>
<tr>
<td>Ni</td>
<td>0.015</td>
<td>0.068</td>
<td>0.096</td>
</tr>
<tr>
<td>Mg</td>
<td>0.040</td>
<td>48.673</td>
<td>66.574</td>
</tr>
<tr>
<td>CEC</td>
<td>0.001</td>
<td>6.087</td>
<td>4.392</td>
</tr>
</tbody>
</table>

*Gold Butte n (number of sites) 28 9*
Summary of Results: Horizons & Profiles

• Significant only rarely: $\text{SO}_4^{2-}$

• Higher in BW soils:
  
  Fe, Ni, Ca, Mg, CaCO$_3$ (& Inorg. C, Total C), and sometimes As

• Lower in BW soils:
  
  P, Co, Cu, Mn, Zn, Total N or NO$_3^-$

• Buckwheat Soils: significantly higher CaCO$_3$....

• Many nutrients $\Rightarrow$ unavailable when pH > 7.0 (calcareous soils ~ 8.3)
Essential nutrients we found to be statistically significant and that become more unavailable as pH increases are:

Zn, Cu, Fe, Mn, Co, K, P, Ni and B.

Of these, Zn, Cu, Mn, Co, & P (sometimes B) follow predicted behavior, are less available in BW habitats, but:

Fe & Ni are MORE available in Buckwheat Habitats.
Problem: High CaCO$_3$ AND high avail. Fe

Ca-Mg-Fe(CO$_3$)$_2$
Ankerite/Dolomite
parent material
**NOT soluble**

CaCO$_3$-saturated soil

↓

CO$_3$ minerals not soluble

Fe should not be available
How to explain higher Fe, Ni availability?

Soluble salts $\rightarrow$ concentrations of many crystals

Soluble salts attract water (hygroscopic)

Creates microsites w/unique chemistry: micropores high in Na, Cl, SO$_4$

(Correlated in BW HAB)

increased Fe solubility
Las Vegas Buckwheat:

(1) Prefers soils w/ more CaCO$_3$ & available Fe, Ni, Ca, & Mg

(2) May have lower requirements for P, N, Co, Mn, Zn, & Cu, OR mechanism to obtain these in deficient soils.
Buckwheat surfaces have:

**1.** More *Cyanobacteria* (and/or bare surfaces)

2. Lower: P, Mn, Co

3. Higher Calcite, Fe, Ni, Ca

4. More Arsenic in interspaces; BW may be able to tolerate higher As surfaces
(1) BW prefers geologic units that are highly calcareous and have some soluble salts (e.g., Las Vegas Fm).

(2) BW habitat does NOT include desert pavement surfaces or coarse alluvium.

(3) habitat *can* include young geomorphic surfaces - *i.e.*, shallow alluvium over gypsum sediments - *if* they are not very rocky.

GIS models and remote sensing can be trained for these attributes (if surficial geologic data available).
• Gypsophily? Gypsum may only set habitat boundary conditions; but it is not the full story.

• **Carbonate** is a (previously unknown!) factor: *Eriogonum corymbosum var. nilesii* favors higher CaCO$_3$

• **Nutrient deficiencies** (P, N, Co, Cu, Zn, Mn) likely critical.

• Arid soils = controlled by geology (geochemistry); example: Arsenic may be an important player; further study needed

• Had only one study area been selected, → different results? Habitat requirements may vary site by site....
Wrapping up: For Future Study

• Little is known about buckwheat nutrient uptake capabilities, requirements, tolerances, and/or toxicities, → speculation based on our results.

• Many other avenues of research:
  - germination
  - water
  - allelopathy
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