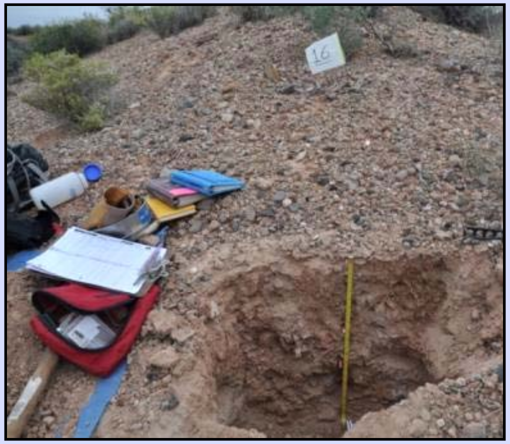
Gypsum Soils Analysis Technical Conditions:
Do soil factors control distributions of the Las Vegas Buckwheat?



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Clark County DCP Project 2005-UNLV-609F

Macalester College

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

Las Vegas buckwheat (Niles's Wild Buckwheat)

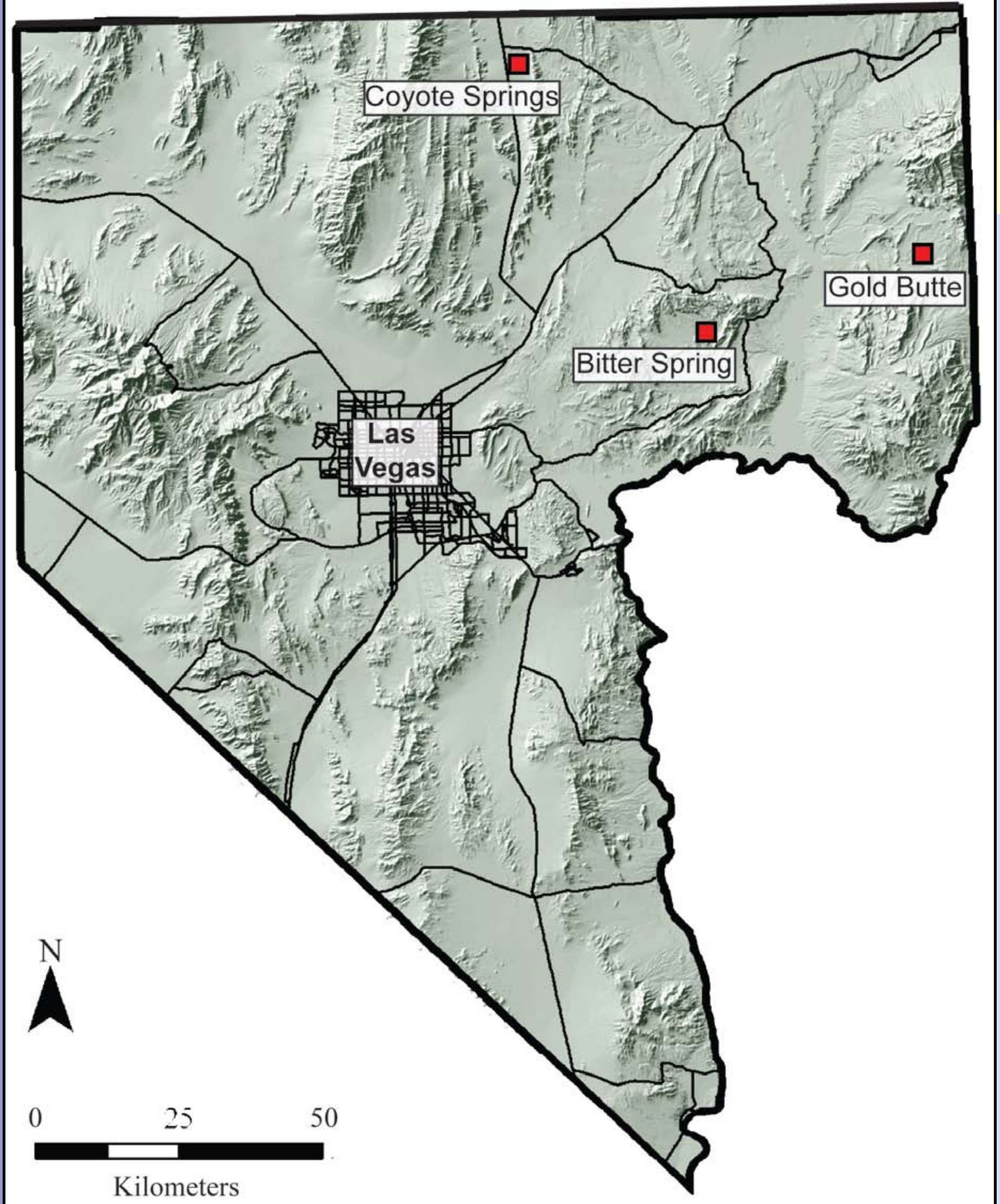
- *Eriogonum corymbosum* Bentham *var. nilesii* (Reveal, 2004)
- One of several presumed gypsophiles (*almost* exclusively) found in Clark County
- Isolated populations – not all gypsum soils are suitable habitat?
- Need to better understand ecology of this selective habitat species in light of:
  - (1) Continued urban development
  - (2) Projected climate changes

Project Objectives: Soil Properties & Processes

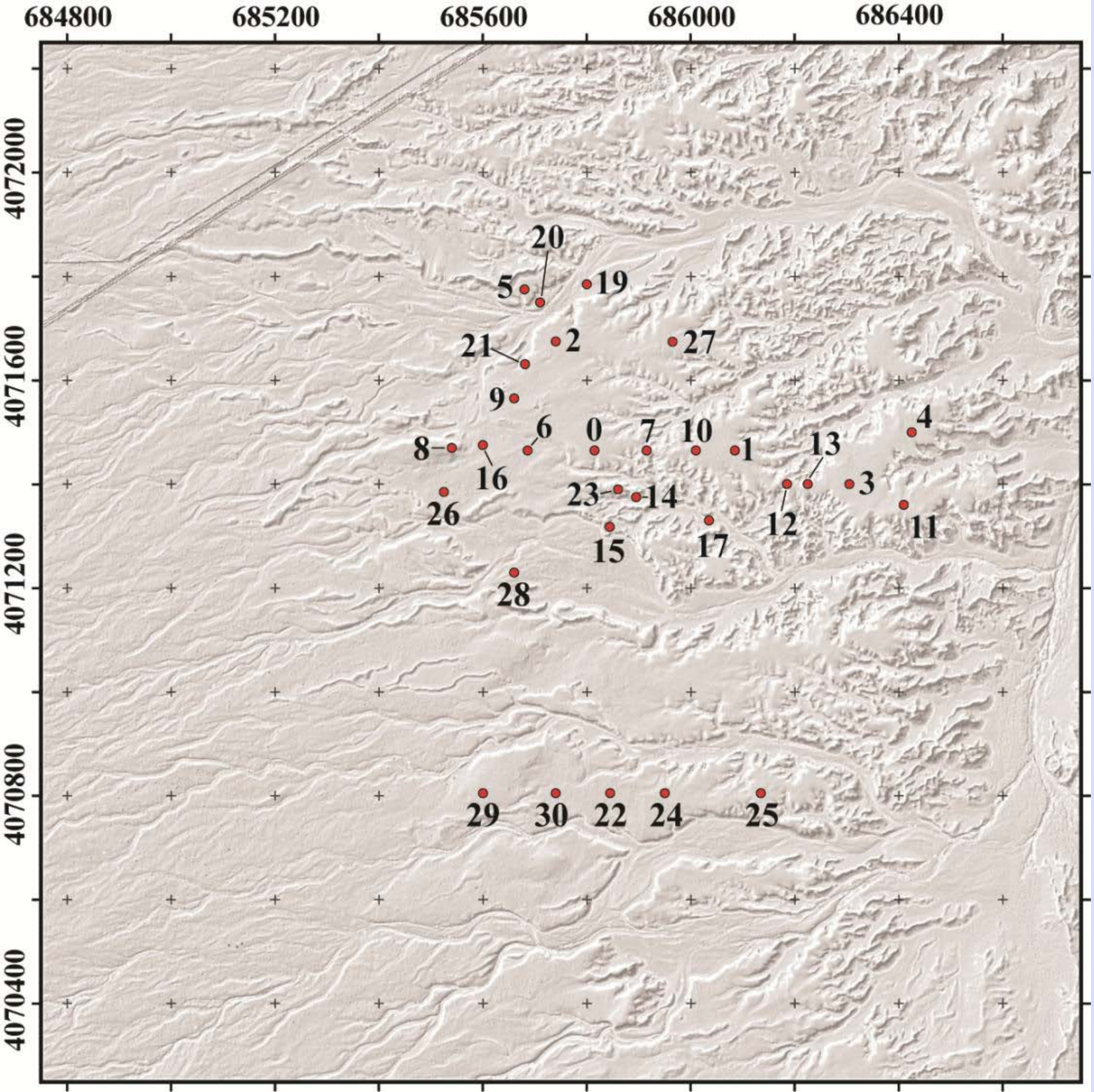
(1) From ***patterns*** of soils and land-surface properties underlying buckwheat distributions,

(2) Interpret which ***characteristics*** most directly influence distributions of the Las Vegas Buckwheat

Study Areas

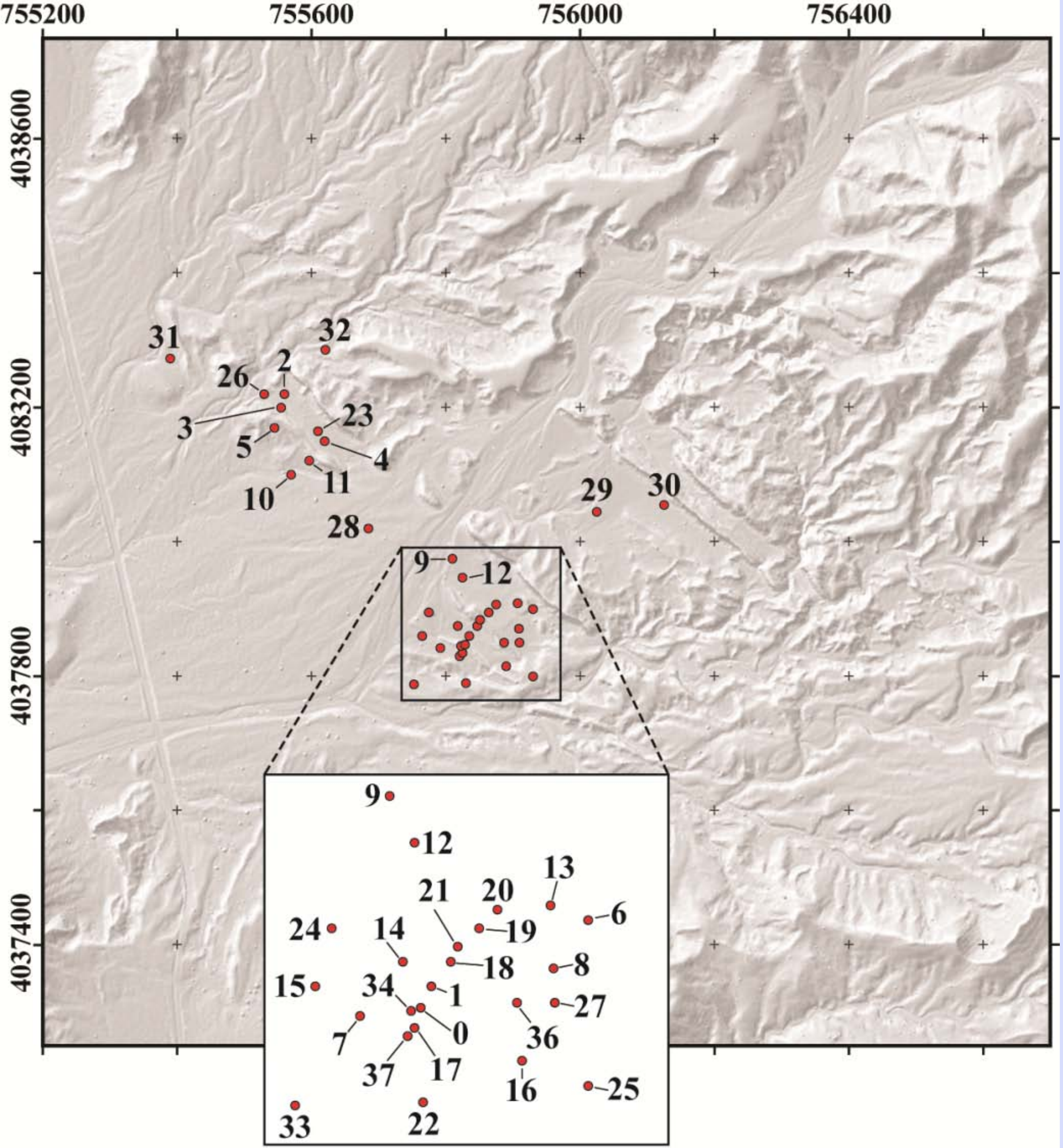

Coyote Springs
Gold Butte
Bitter Spring
Las Vegas
N
0
25
50
Kilometers

Coyote Springs Landscape



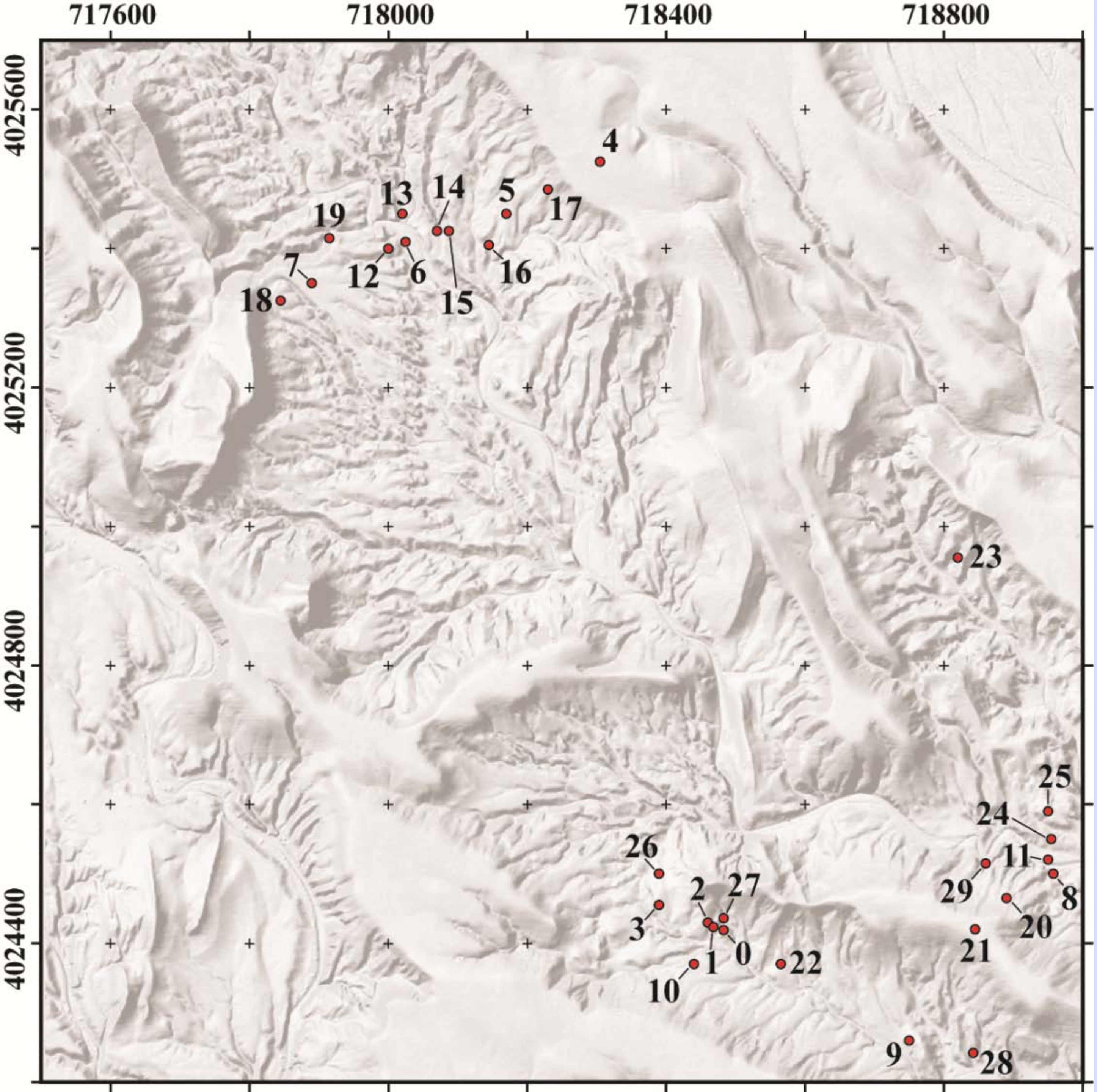
Study Sites (Soil Profiles) within the CS Study Area

Gold Butte Landscape



Study Sites (Soil Profiles) within the GB Study Area

Bitter Spring Landscape



Study Sites (Soil Profiles) within the BS Study Area

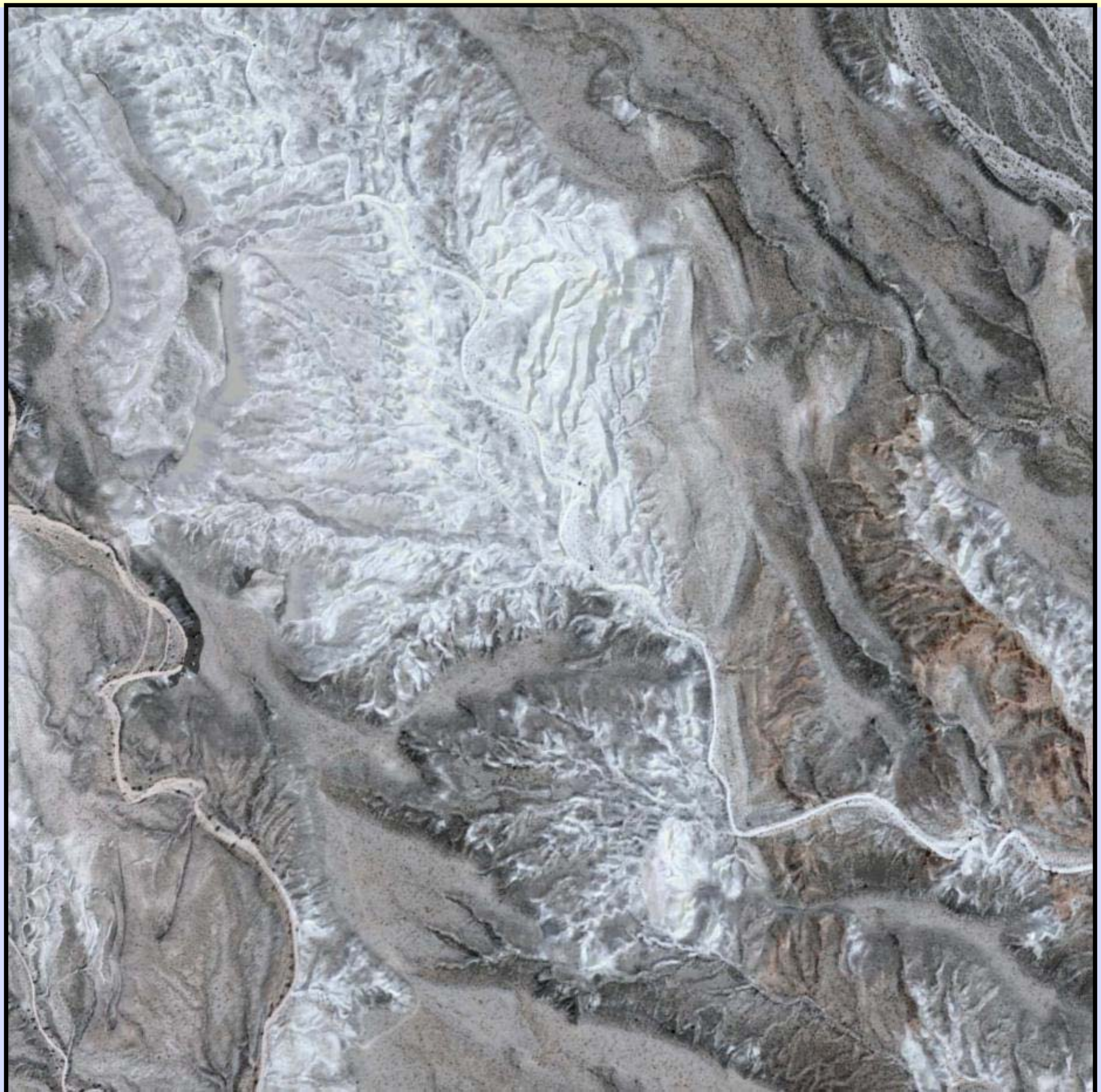
Scope of Work

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

2. **Soil Characterization** & **Sampling**
   - 97profiles 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)*

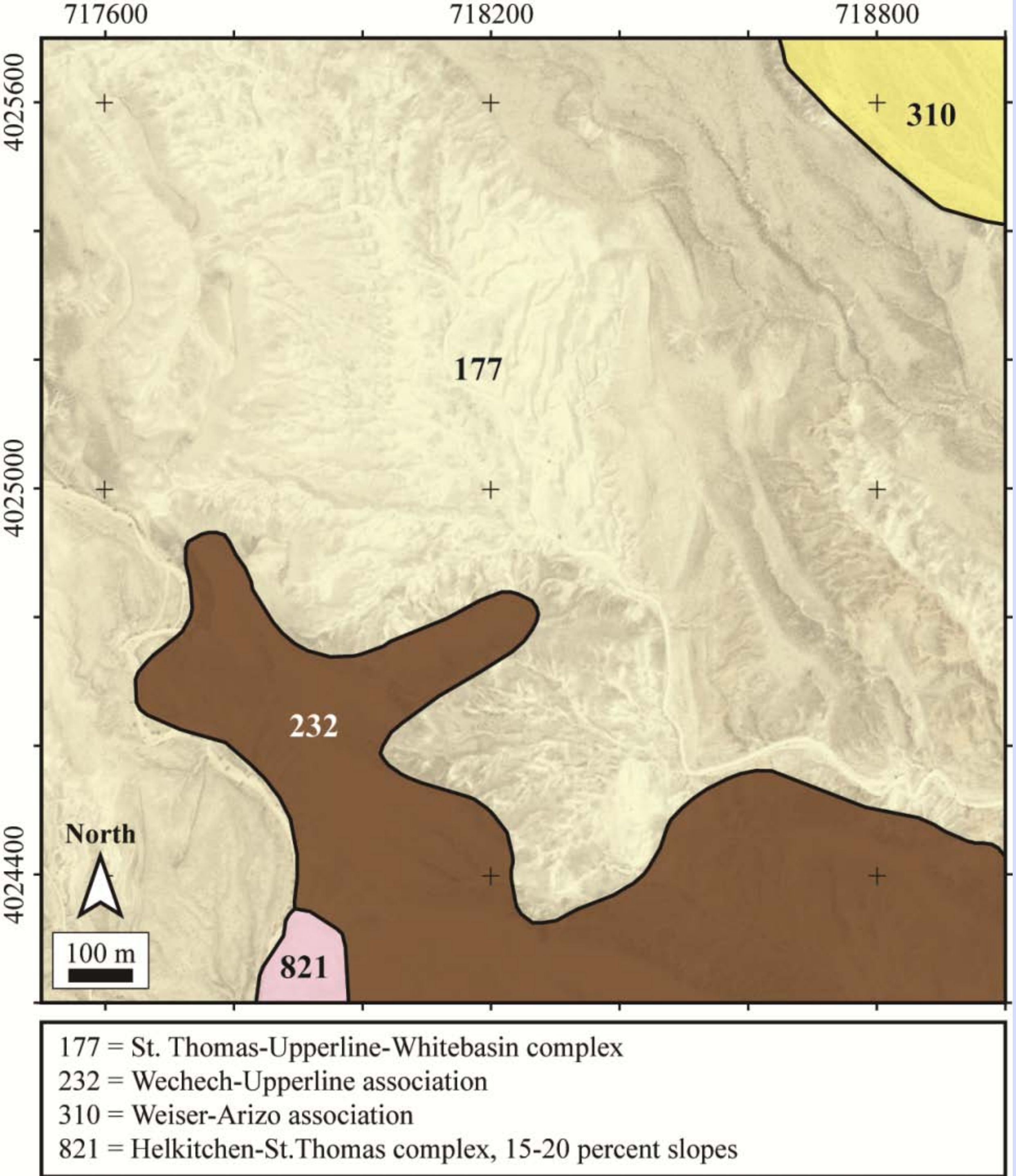
3. **Laboratory Analysis**
   - Chemical, mineralogical, & physical analyses:
     - pH, EC, plant available elements, texture, etc. ***(33 variables)***

Data Classes Based on Mapping



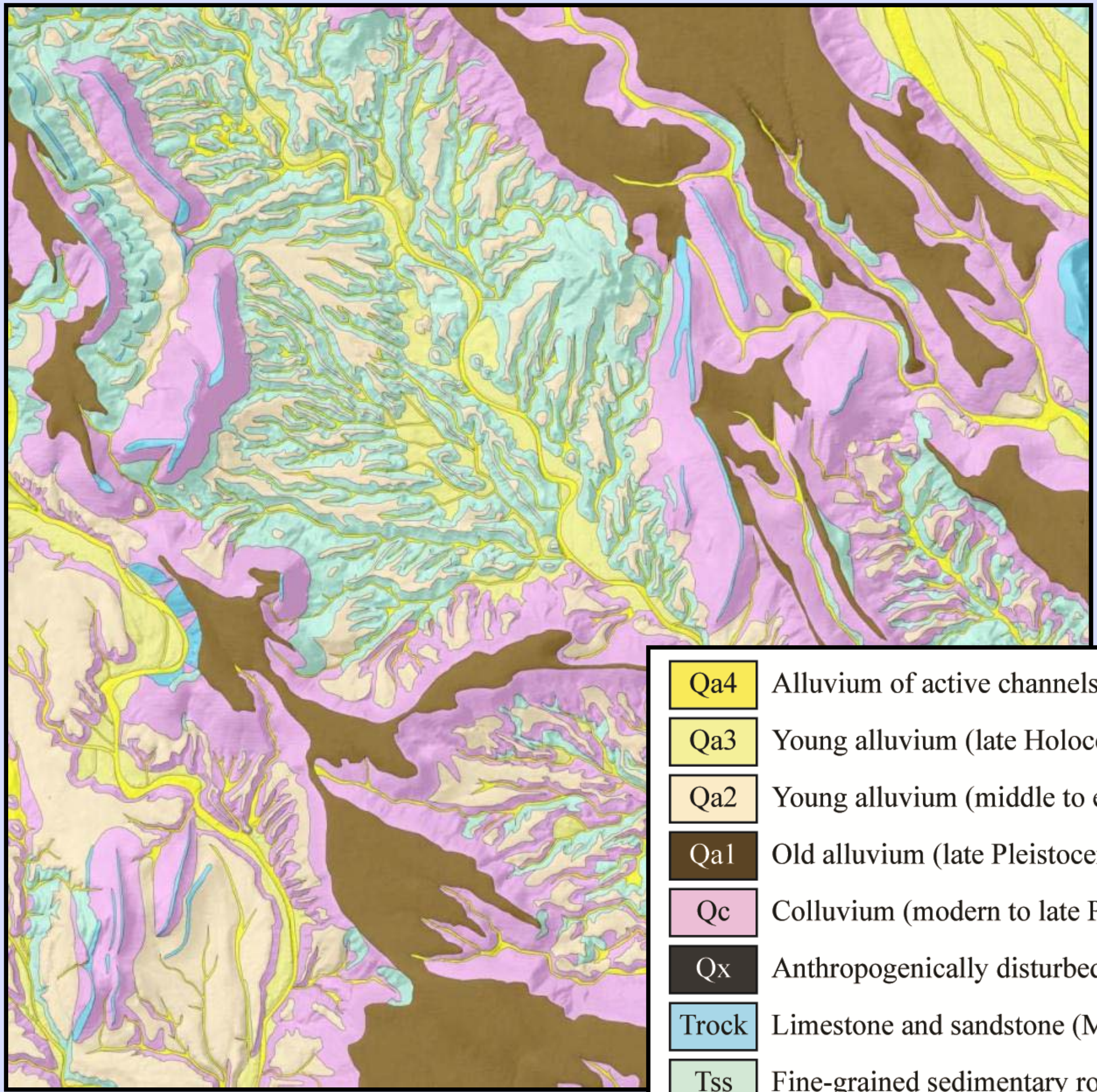
Bitter Spring
(White Basin)
Study Area

NAIP (2007)

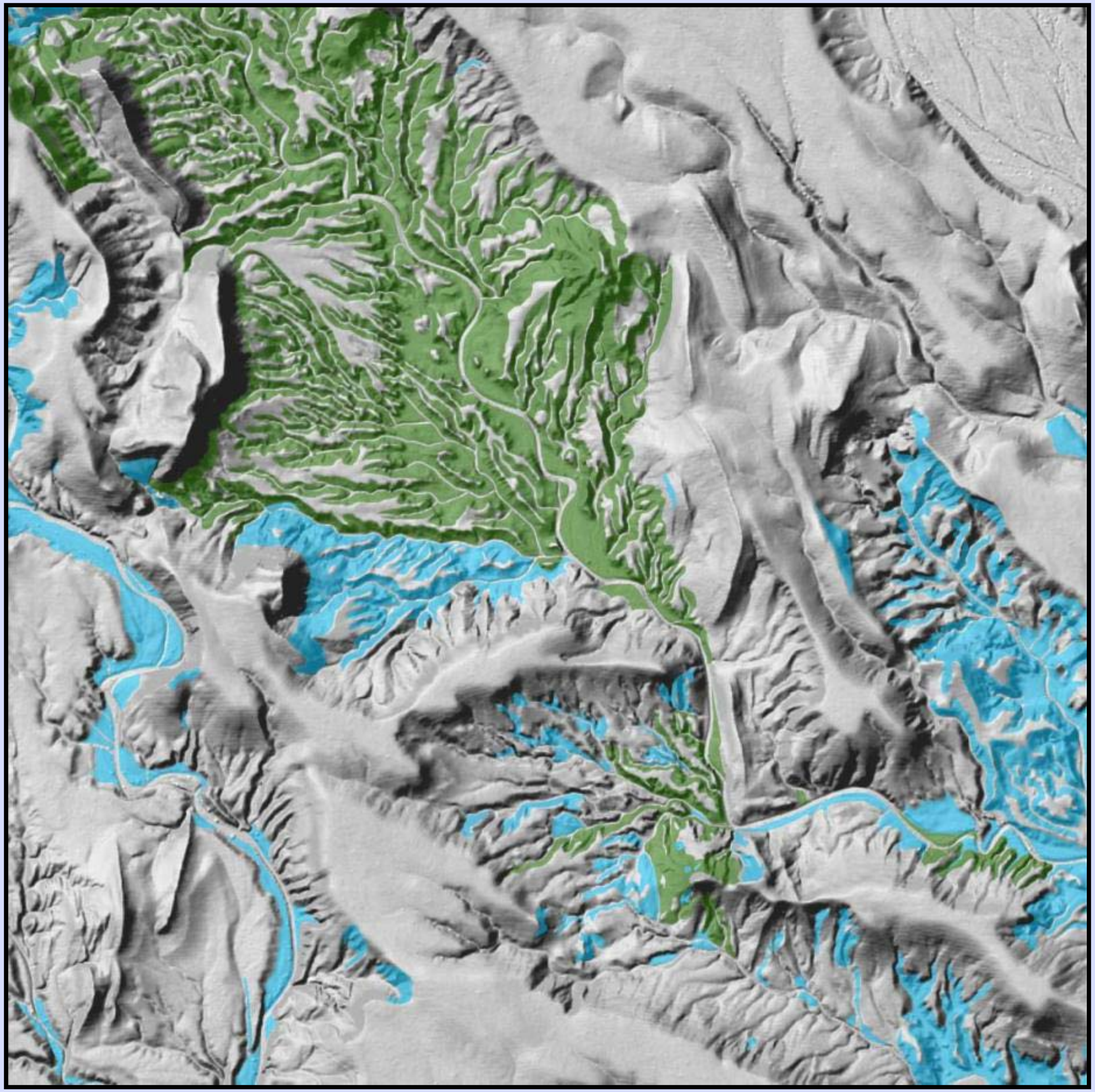


Existing maps were too coarse in resolution for our purposes…

← Here, NRCS 1:24,000 soil survey data



Qa4	Alluvium of active channels, rills and gullies (modern to late Holocene)
Qa3	Young alluvium (late Holocene)
Qa2	Young alluvium (middle to early Holocene)
Qa1	Old alluvium (late Pleistocene)
Qc	Colluvium (modern to late Pleistocene)
Qx	Anthropogenically disturbed surfaces.
Trock	Limestone and sandstone (Miocene)
Tss	Fine-grained sedimentary rock (Miocene)



Habitat Classification:

(1) Habitat
(2) Potential Habitat
(3) Non-Habitat

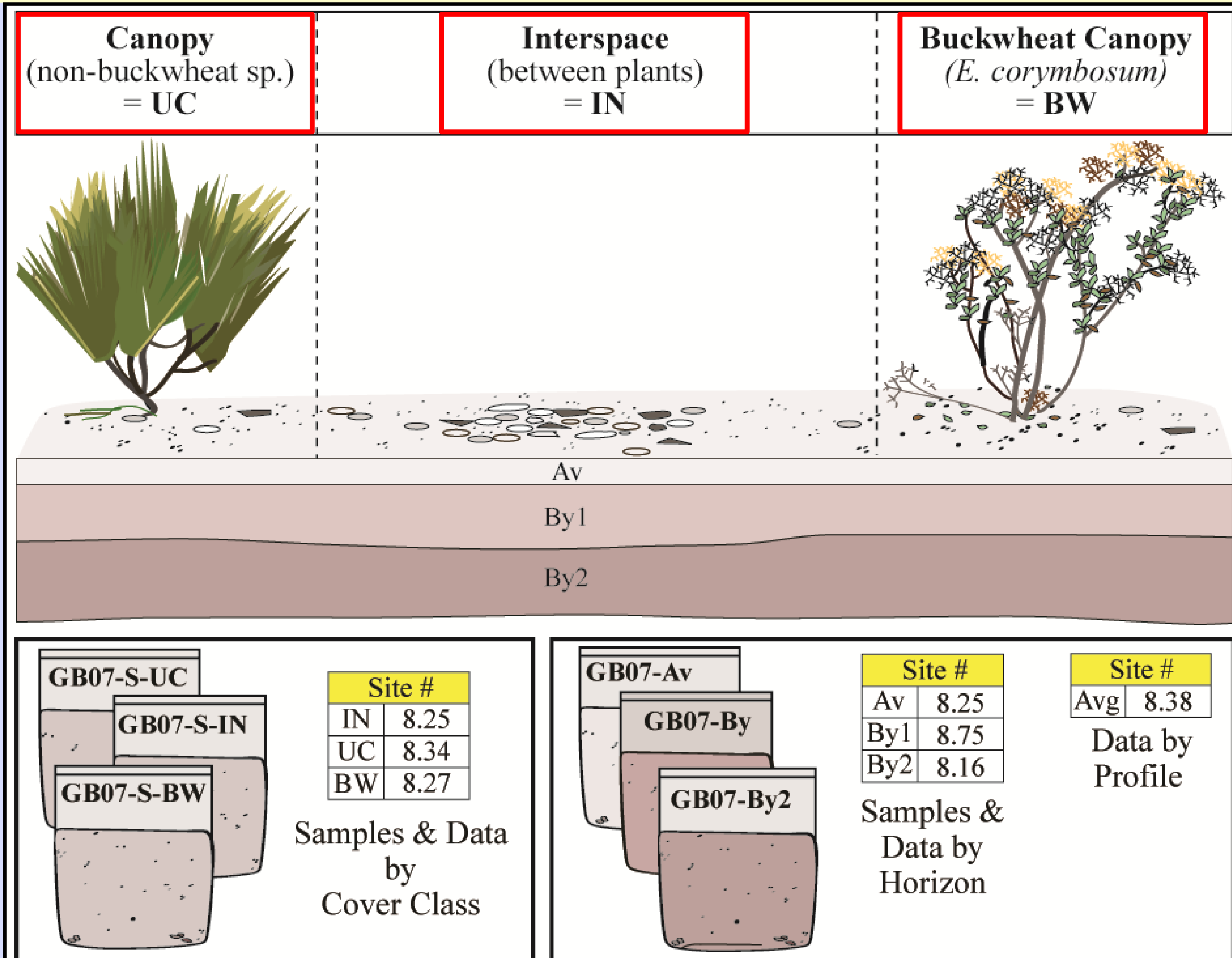
What properties were compared?

Laboratory Analyses included:

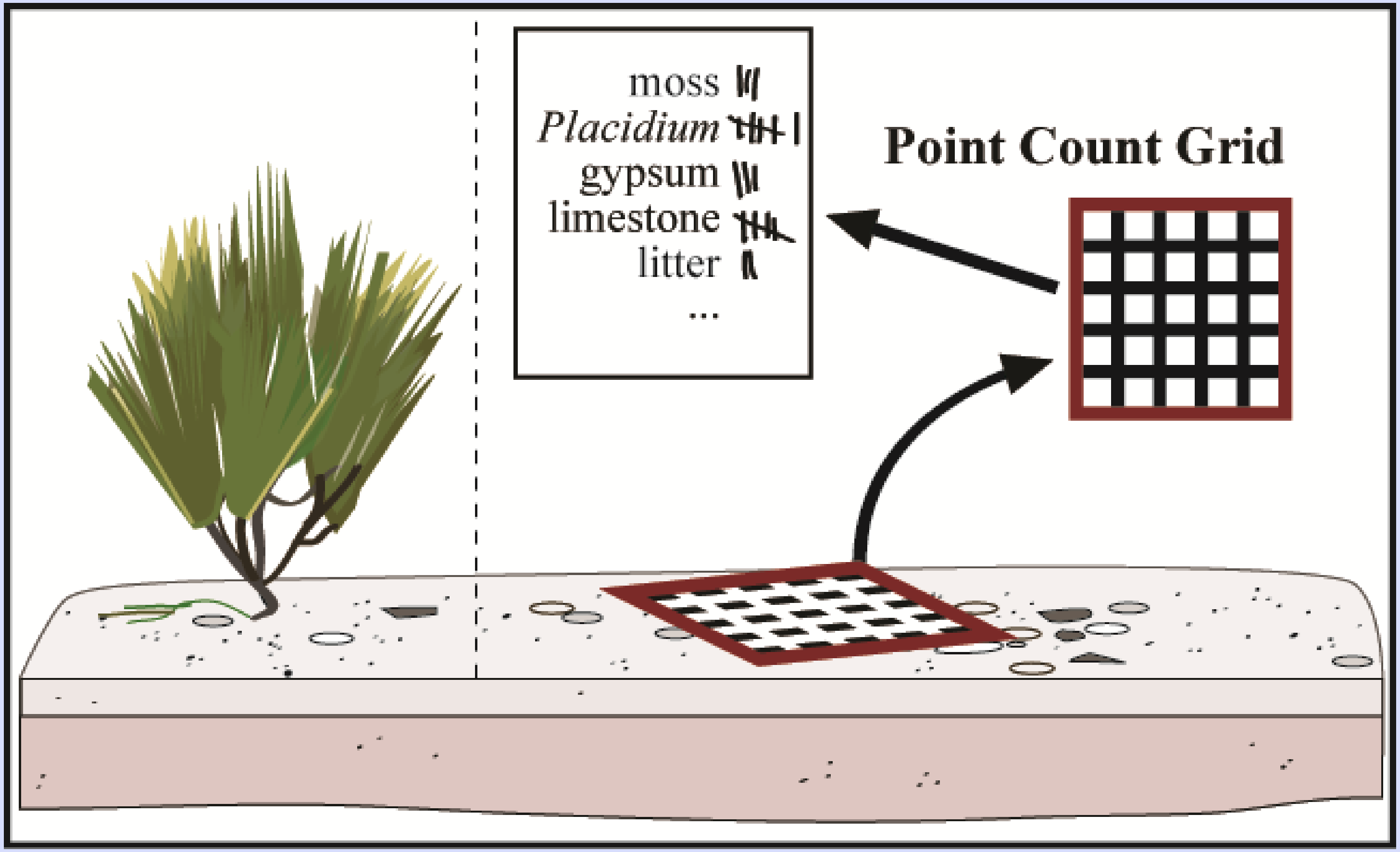
- pH (3 methods) & EC
- $CaCO_3$ & Total C → calculate Inorganic C, Organic C
- Plant available ions (Mehlich method):
  - Na, K, Mg, Ca (AAS)
  - P, Mn, Fe, Ni, Cu, Zn, Co, B, Mo, As (ICP-MS)
  - anions: NO_3, SO_4, Cl (ICS)
- Particle Size Determination (LASR)
- Moisture content

- *Also:* Bulk & Phyllosilicate Mineralogy (XRD)

Sampling: by Horizon & by Canopy Type



Surface Characterization: Point Counts

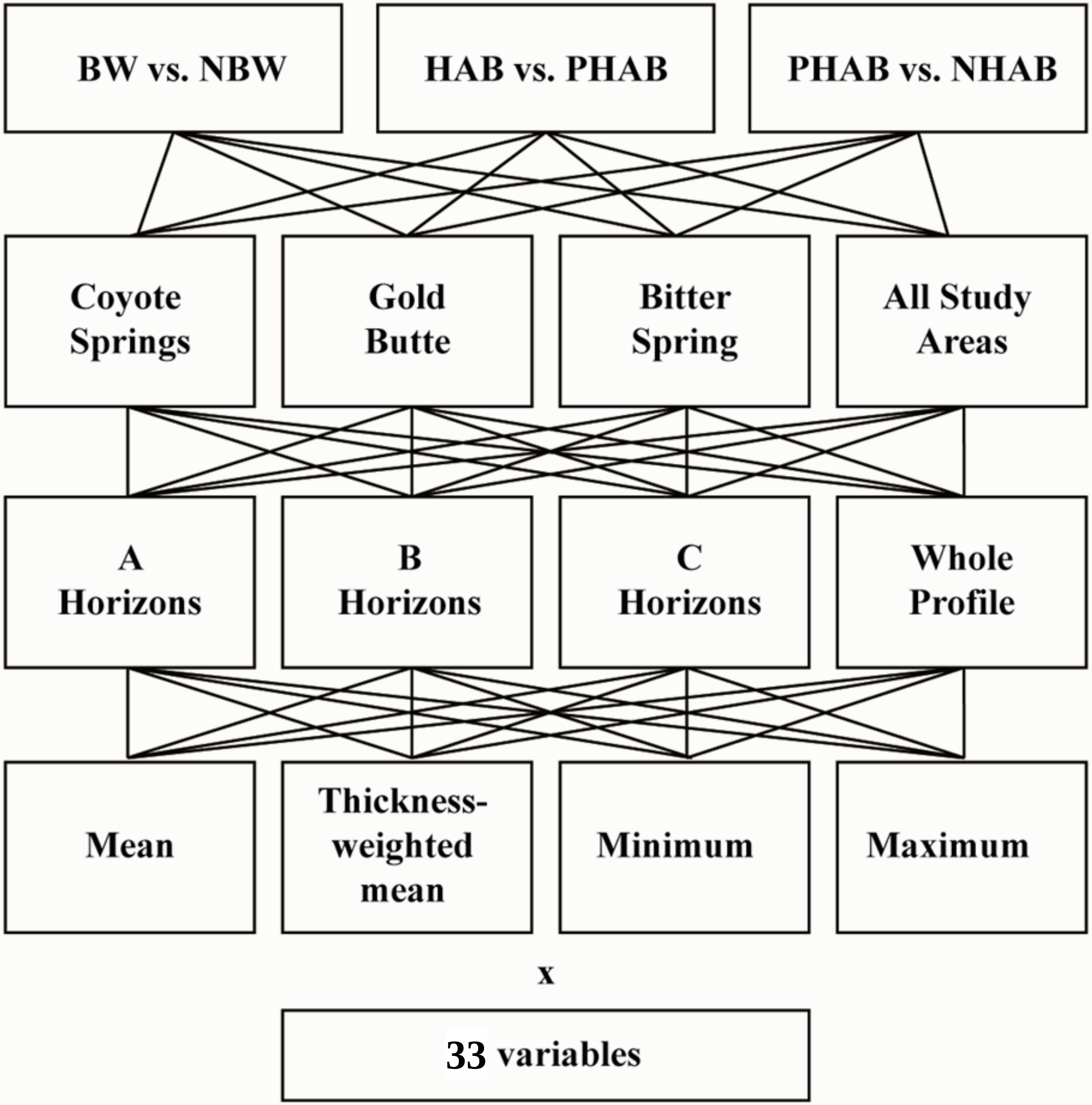


- ~ 125 counts (5 locations x 25 points) per canopy class
- Normalized to percentage when BW < 5, or UC < 5

Surface Characterization Included:

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

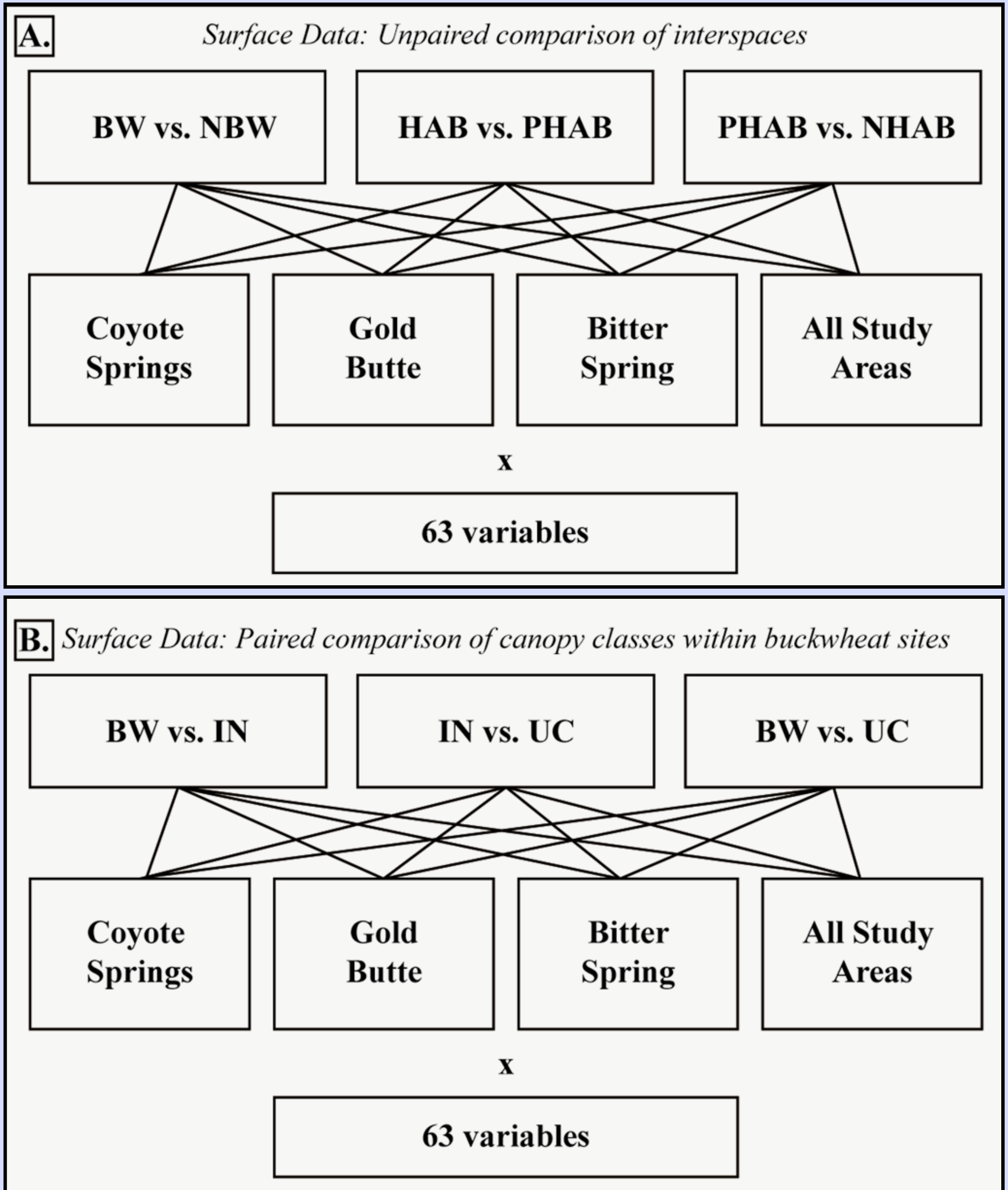
Statistical Analysis



PHAB vs. NHAB comparisons were run using mean values only.

How to group horizon & profile data?

= **192** data tables



Statistical Analysis

Surface groups:

(1) by presence or absence *(objective)*

(2) by habitat class *(part objective, part interpretive*)

Statistical Comparisons

- 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.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
pH Sat Paste	0.048	7.579	**7.713**
Total N	0.039	**0.011**	0.007
Total C	0.002	6.248	**7.694**
Inorganic C	0.002	6.049	**7.553**
$CaCO_3$	0.002	50.404	**62.940**
P	0.002	**1.191**	0.136
Fe	0.000	10.146	**13.497**
Ni	0.000	0.084	**0.114**
Ca	0.000	597.744	**977.149**
Mg	0.020	146.040	**199.908**
*Coyote Springs **n** (number of sites)*		*20*	*10*

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

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.000	1.922	**4.895**
Inorganic C	0.000	1.674	**4.453**
$CaCO_3$	0.000	13.946	**37.112**
P	0.031	**1.373**	0.708
Fe	0.011	6.899	**10.440**
Ni	0.015	0.068	**0.096**
Mg	0.040	48.673	**66.574**
CEC	0.001	**6.087**	4.392
*Gold Butte **n** (number of sites)*		*28*	*9*

Summary of Results: Horizons & Profiles

- **Significant only rarely**: 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 → unavailable when pH > 7.0 (calcareous soils ~ 8.3)

Alkaline Soil Nutrient Deficiencies

- 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

$Ca\text{-}Mg\text{-}Fe(CO_3)_2$
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?

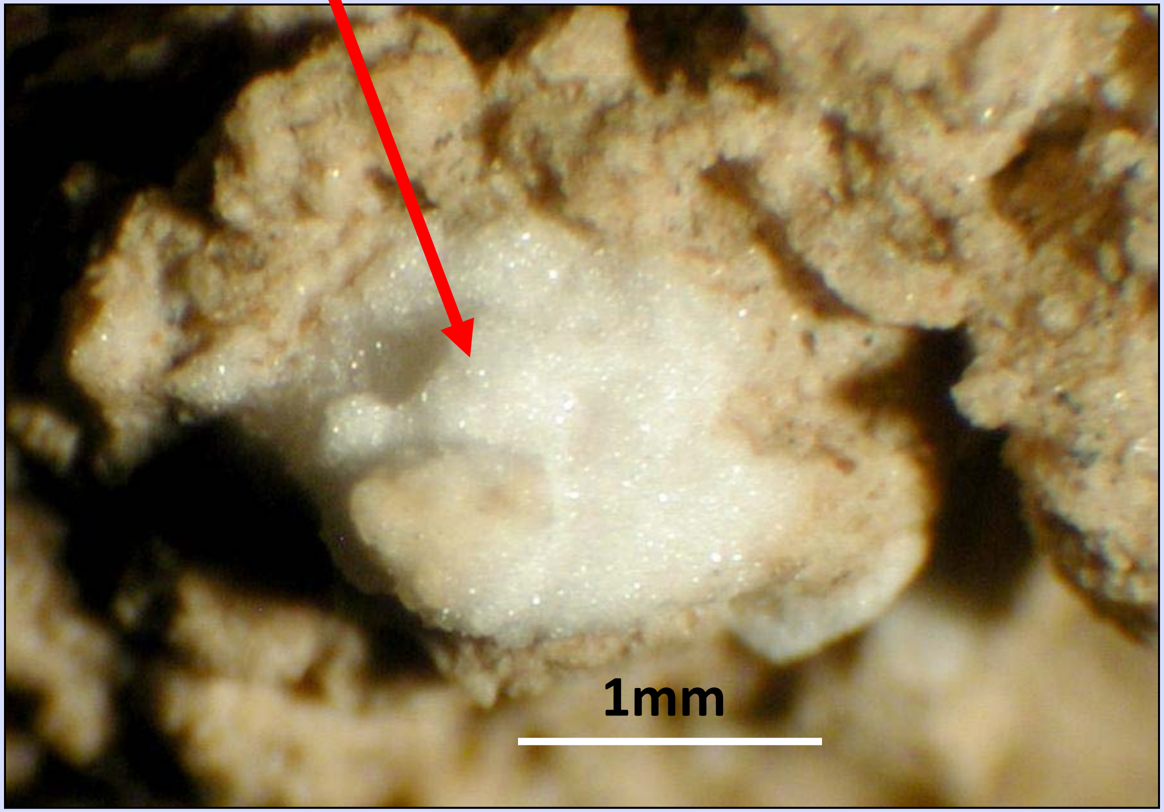
Soluble salts → concentrations of many crystals

Soluble salts attract water (hygroscopic)

Creates microsites w/unique chemistry: micropores high in Na, Cl, SO_4

(Correlated in BW HAB)

increased Fe solubility



Interpretations I: Horizon/Profile data:

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.

Interpretations II: Surface data

Photos by A.J. Williams

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

Interpretations III: Map Data

(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).

Summary: Take-home points...

•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


Buckwheat following fissures

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desert conservation PROGRAM

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