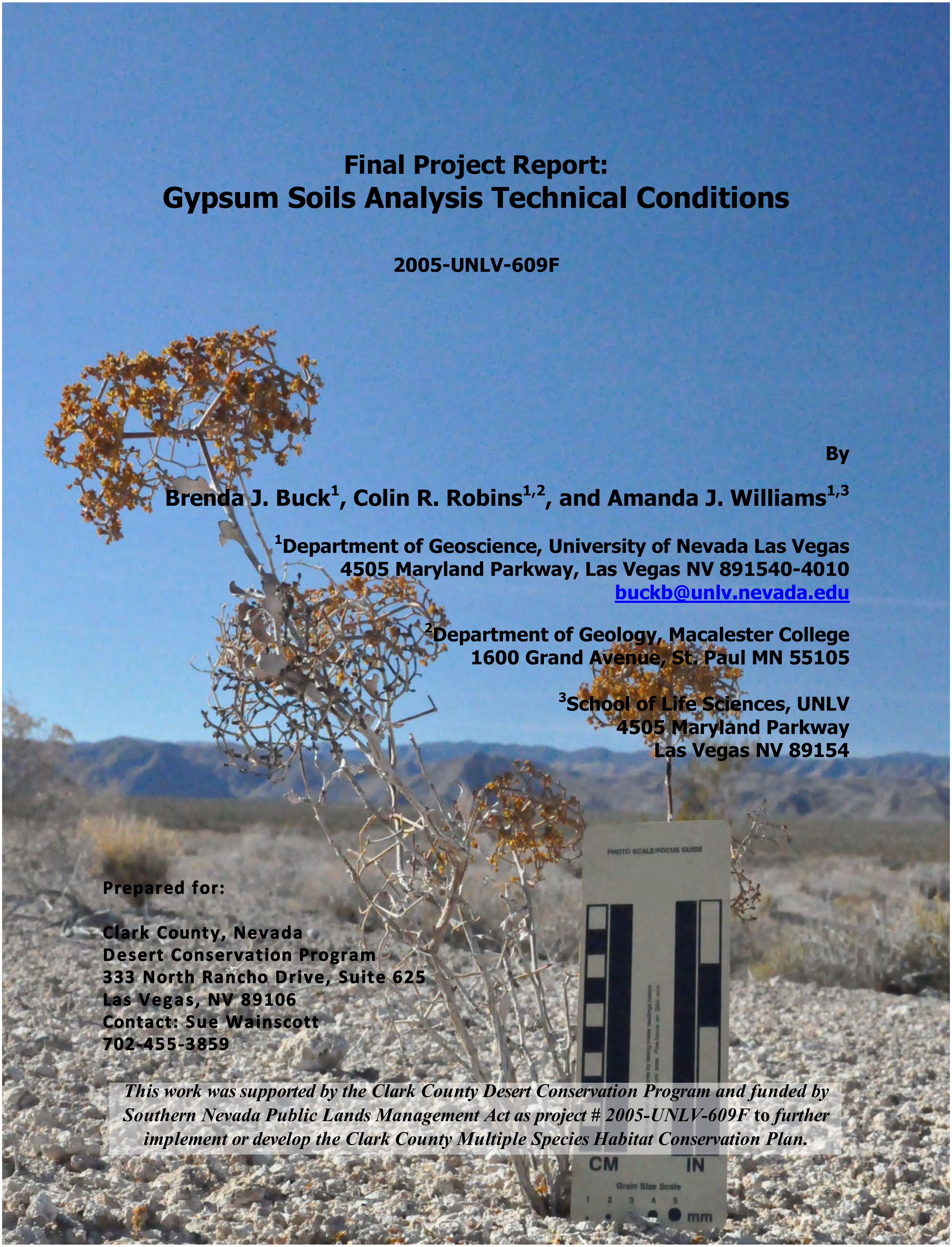

Final Project Report:
Gypsum Soils Analysis Technical Conditions

2005-UNLV-609F

By

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Executive Summary

Purpose

The purpose of this two-year field and laboratory project was to determine whether soil-geomorphic variables influence the distribution of the Las Vegas buckwheat, *Eriogonum corymbosum* Bentham *var. nilesii* (Reveal, 2004), in Clark County, NV. This study was designed to address critical gaps in the current scientific understanding of buckwheat habitats, especially regarding the soil chemical properties and surface characteristics of these spatially restricted areas.

This study was composed of the following components: (1) high-resolution mapping of surficial geology, (2) comprehensive field description of soil profile and soil surface characteristics, (3) laboratory assessment of soil chemical and physical properties, and interpretation of these combined data sets. Data were examined for statistical patterns or correlations among all variables, and interpreted for differences in soil geomorphologic, chemical, or biological processes between habitat classes.

Three study areas, at Coyote Springs, Gold Butte, and Bitter Spring (the White Basin), were selected based on their known buckwheat populations, and for their distinct but partially overlapping types of soil landforms. Approximately 30 sites at each study area were selected to compare habitat conditions to adjacent, similar landforms not currently supporting the species.

Surficial Geology

The surficial geology of each study area was mapped at the 1:3,000 scale, in ESRI ArcGIS 9.3, using field observations, airborne LiDAR data, NAIP imagery, and Quickbird imagery. The detailed maps produced as part this project have furthered understanding of buckwheat habitat characteristics.

In Coyote Springs, buckwheat was almost always found growing in flat-lying deposits of the late Pleistocene Las Vegas Formation, which was most likely exposed during middle Holocene erosion. In contrast, buckwheat at Gold Butte was found primarily along very young, thin, eolian and alluvial sediments deposited in swales between resistant outcrops of dipping gypsiferous strata. At Bitter Spring, buckwheat was associated with poorly-lithified siltstone, claystone and gypsum marl of the upper Horse Springs Formation (Thumb member) and relatively inactive geomorphic surfaces composed of very young alluvium adjacent to active arroyos. Surficial geologic mapping also permitted grouping of soil chemical and surficial data for statistical analysis and interpretation of trends. Sites were grouped (1) by buckwheat presence/absence as well as (2) by interpreted habitat class: Habitat, Potential habitat and Non-habitat (see Chapter 2).

Combining data from all three sites suggest that Las Vegas buckwheat is most likely to be found: (1) on surfaces with few rock clasts – buckwheat is extremely unlikely to be found in areas of thick gravelly alluvium, (2) on exposures of the Las Vegas Formation (not covered by thick gravels), (3) on calcareous and/or gypsiferous outcrops of the Horse springs Formation (not covered by thick gravels) and (4) in shallow sandy alluvium overlying gypsum bedrock.

Soil Chemistry

Chemical and physical analyses of 97 soil profiles at Coyote Springs, Bitter Spring and Gold Butte indicate that soils in which Las Vegas buckwheat currently grow are enriched in $CaCO_3$, and have higher available Fe, Ni, Ca, and Mg and have lower available P, Co, Mn, Zn, Cu, K, and N than non-habitat soils. The dataset suggests that: (1) Las Vegas buckwheat may be more tolerant of high concentrations of plant-available arsenic; (2) Las Vegas buckwheat may have either lower requirements for P, Co, Mn, Zn, Cu and N, or some enhanced physiological or symbiotic means of obtaining these elements from soils in which they are poorly available; (3) The buckwheat may have increased requirements for Fe, Ni, Ca, and Mg, although Ca:Mg ratios suggest Mg may not be an important indicator; and (4) Although we found few significant correlations between buckwheat sites and SO_4, we believe that localized occurrences of gypsum, halite and/or other soluble salts in buckwheat subsurface horizons may provide important soil microsites that promote higher Fe availability (Chapter 3). Thus, while the data in this study do not support obligate gypsophily of the Las Vegas buckwheat, we note that gypsum and other soluble salts in these highly calcareous substrates may still indirectly, through soil processes, prove critical for its habitat.

Surface Soil Chemistry and Characteristics

Surface data corroborate the soil profile and horizon data interpretations, and provide additional insights. First, this study identified a significant positive relationship between buckwheat habitat and percent cyanobacterial crust cover. Compared to non-buckwheat areas, buckwheat soil surfaces also tended to be low in available P, Mn, Co and have low percent of grass litter cover, while having increased $CaCO_3$, available Fe, Ni, Ca, As, and sometimes Mg and/or SO_4. Lastly, plant-available arsenic at the surface was greatest in buckwheat habitats, and because these amounts are high enough to impact agricultural crops, we speculate that they may play some role in the germination or establishment of buckwheat, or of other plants within buckwheat habitat. The effects of arsenic on buckwheat and other native plants are unknown. Our results confirm that buckwheat canopies do significantly differ from habitat interspaces. Buckwheat canopies were found to contain more organic C, total C, available B, Co, Cu, Mn, Zn, Cl and to exhibit higher EC values. Thus, many nutrients in the subsoil that could be potentially growth-limiting (e.g. Co, Mn, Zn, Cu – see chapter 3) were increased under buckwheat canopies.

Overall Conclusions

Combining the results from all components of this project, surficial geologic and soil profile and surface chemistry data indicate that Las Vegas Buckwheat is most likely to be found in environments with the following characteristics:

(1) surfaces with few rock clasts – buckwheat is extremely unlikely to be found in areas of thick gravelly alluvium
(2) exposures of the Las Vegas Formation (not covered by thick gravels),
(3) calcareous and/or gypsiferous outcrops of the Horse springs Formation (not covered by thick gravels)
(4) shallow sandy alluvium overlying gypsum bedrock
(5) in soils that are enriched in $CaCO_3$, available Fe, Ni, Ca, (maybe Mg) relative to non-habitat soils
(6) in soils that are depleted in available P, Co, Zn, Cu, Mn and N relative to non-habitat soils
(7) in surface soils enriched in arsenic relative to non-habitat soils
(8) in surface soils enriched in $CaCO_3$ available Fe, Ni, Ca relative to non-habitat soils
(9) in surface soils depleted in P, Co, and Mn relative to non-habitat soils
(10) on surfaces with greater percent cyanobacterial crust cover as compared to non-habitat soils

This study demonstrates that 1:3,000 scale surficial geologic mapping, and 1.5 to 2.0 m resolution topographic raster data and landscape imagery are adequate to resolve changes between areas of buckwheat habitat, and other adjacent substrates which do not currently support the species.

The results of this study provide important, previously lacking, surficial geologic, soil chemical, and surface characterization data that help better constrain or define habitat criteria for *Eriogonum corymbosum* var. *nilesii*. Although additional data are needed, especially regarding the tissue chemistry and physiology of the Las Vegas buckwheat, the data described in this report should provide a sound basis for future habitat modeling, and/or germination study of this rare and potentially threatened or endangered species in Clark County.

Recommendations

- Results from this study found that the three sites studied had specific differences in many of the factors measured. Had this study been designed without including such spatially distinct study areas, very different, and potentially misleading results would have produced. We strongly recommend that future studies for the Las Vegas buckwheat or other restricted habitat species include, as much as possible, the full array of landscapes, soil types, and plant communities known or available for study.

- An analysis of buckwheat tissue chemistry is strongly recommended for the same sites as this study. This would help confirm whether variables found to be significant in this study reflect general soil environmental requirements, or instead whether they reflect specific plant nutrient requirements. Data that would enable comparison of buckwheat physiology and chemistry to that of spatially associated species might also improve our understanding of edaphic controls on habitat viability.

- This study measured plant-available nutrients. We strongly recommend that an analysis of total soil chemistry be performed on the same (currently archived) samples as used in this study. Total chemical analysis would shed light on the geologic variables between study areas and between buckwheat and non-buckwheat sites. In addition, more detailed mineralogical analyses would greatly assist in determining the sources of plant nutrients, and therefore help to interpret processes controlling nutrient availability and constraining and modeling parameters for probable buckwheat habitats elsewhere.

- We recommend future research on soil conditions required for germination or establishment.

- We recommend future research on possible roles and/or competition among species within the buckwheat habitat communities.

- We recommend future research into how buckwheat plants might alter the chemistry of their substrates once they have been established (bioaccumulation), and what timescales (years, decades) might be involved.

- We strongly recommend future research into the relationships between biological soil crusts and buckwheat (and/or other important vascular plants).

- We strongly recommend future research into the controls that soil water may have on buckwheat habitat. Future insolation modeling at finer scales than this study may shed light on buckwheat habitats. Information is needed on soil infiltration, permeability and water status in buckwheat soils.

Chapter 1: Project Introduction

Brenda J. Buck and Colin R. Robins

I. Description of the Project

The purpose of this project was to determine what, if any, soil-geomorphic variables might influence the distribution of *Eriogonum corymbosum* Bentham var. *nilesii* (Reveal, 2004), in Clark County, NV. This species is one of several sensitive or selective habitat species thought to be restricted to gypsum-rich substrates. However, its fragmented distribution suggests that some gypsiferous soils are unsuitable for its habitation while other low-gypsum soils may support thriving populations. At present there exists no explanation as to why individuals may grow in one location, but not in a similar location a short distance away, a lack of understanding which has also been noted for other rare plants in Clark County (Etyemezian et al., 2010). This study was designed to address these uncertainties and to provide more precise soil and surficial geologic criteria for the definition of *E. corymbosum* var. *nilesii* habitat in Clark County.

II. Background & Need for the Project

Eriogonum corymbosum var. *nilesii* (Reveal, 2004), is commonly called either "Niles' wild buckwheat," "Las Vegas buckwheat", or "golden buckwheat." In this report, this species is generally referred to as either "Las Vegas buckwheat" or more simply "buckwheat." Accordingly, we also use "non-buckwheat" to describe sites or areas in which *E. corymbosum* var. *nilesii* is absent for at least 50-100 m in all directions.

The Las Vegas buckwheat is considered a sensitive or special status species by the BLM and a candidate species for federal protection (Morefield, 2004; USFWS, 2007). The species is at risk due to its restricted habitat distributions and the vulnerability of habitat areas to urban development, off-road vehicle use, mining operations, illegal dumping, and wildfire (Morefield, 2001; USFWS, 2007). Clark County, NV, encompasses most known populations of this plant, but the species has also been documented in Washington and Kane Counties in Utah, and Mohave and Coconino Counties, Arizona (Morefield, 2001; USFWS, 2007; Mrowka, 2008; Ellis, 2009; Ellis et al., 2009; Utah Board of Water Resources, 2010). Some uncertainty exists regarding the true taxonomy of the *E. corymbosum* var. *nilesii* occurrences outside Nevada due to complicating factors that include: an extensive history of taxonomic revision, multiple defined varieties of *E. corymbosum* that require expertise to correctly distinguish, and the possibility of genetic hybridization (Reveal, 1967; Morefield, 2001; Ellis, 2009; Ellis et al., 2009; Utah Board of Water Resources, 2010). Should the presently defined *E. corymbosum* varieties become further revised or divided in the future, then the distributions of the *nilesii* variety could prove to be even more restricted and more threatened than previously thought. Projections for continued urban development and population growth in Nevada and the southwestern U.S.A., as well as uncertain future climate trends, underscore the strong need for greatly improved knowledge of Las Vegas buckwheat habitat characteristics, especially soil properties.

The relationship between Las Vegas buckwheat and gypsum substrates is not yet fully understood. *Eriogonum corymbosum* var. *nilesii* is one of several selective habitat species long considered to be restricted to gypsum soils, either as a gypsophile (whether facultative or obligate) or a gypsocline (Meyer, 1986; Mrowka, 2008; Drohan & Merkler, 2009). Its habitat is specifically defined as occurring on and/or near gypsum substrates on badlands surfaces or sideslopes, or within thin, sandy alluvium over gypsum bedrock in washes (Morefield, 2001; Drohan & Merkler, 2009). However, its fragmented distribution suggests that, for reasons not previously determined, not all gypsum-rich soils are suitable for its habitation. Furthermore, Drohan and Merkler (2009) have used buckwheat tissue and soil analyses to suggest that the species is not a true gypsophile. Apart from the paper by Drohan & Merkler (2009), a preceding report by Drohan & Buck (2006), and a study by Boettinger et al. (2010), we are aware of no other detailed soil chemical data from buckwheat habitat, especially for habitat sites outside the Las Vegas Valley. Without chemical data from individual genetic soil horizons, it is not possible to elucidate relationships between buckwheat and gypsum soils, nor to more precisely define the physical and chemical requirements of viable buckwheat habitat. Data regarding the Las Vegas buckwheat's tolerated range of soil chemical and physical properties are also requisite in order to design effective germination studies.

Soil profile, soil chemical, and soil-geomorphic spatial data are often inadequate in published studies of desert plants. Though very little research has been done specifically on buckwheat, a handful of other studies in southern Nevada and neighboring regions have attempted to identify the factors most critical to the establishment, distribution, and survival of other selective habitat or proposed "gypsophile" plant species, for example *Arctomecon californica* and *Arctomecon merriami* (Nelson & Harper, 1991; Sheldon, 1994; Sheldon Thompson & Smith, 1997; Hickerson & Wolf, 1998; Boettinger et al., 2010). However, most of these and other published studies on purported gypsophiles either exclude soil characterization entirely, or limit their study to soil surface crusts or generalized mineralogical trends (i.e., for gypsiferous, calcareous, or quartz-dominated substrates). Some studies (Meyer, 1986; Meyer & García-Moya 1989; Nelson & Harper 1991; Sheldon Thompson & Smith, 1997) do analyze soils under target species but sample by depth rather than by genetic horizon and do not provide the soil profile morphology data needed to rule out potential mixing of two or more distinct soil horizons, each of which can have a different effect on plant dynamics. Even studies that do specifically address genetic horizon characteristics (e.g., Drohan & Merkler, 2009) may lack detailed soil or surficial geologic maps, do not define inhabited or non-inhabited sites in terms of spatial extent or geomorphic landform, or perform full plant-essential element analyses.

Predictive habitat modeling requires both soil chemical data and also, due to the expense of soil sample analysis, the ability to locate candidate habitat areas via remote sensing or mapping of soils, rock types, and/or landforms. (e.g., Boettinger et al, 2010). Despite the lack of soils data and the ambiguity of buckwheat's possible gypsophily, classification of gypsum substrates using ASTER satellite data has facilitated identification of previously unrecognized buckwheat habitat in Clark County (Clark County DCP, unpublished data, 2009). Nevertheless, soil and geologic data sets are still needed to refine these efforts. Publicly available NRCS soil surveys and geologic maps for most areas in the western United States are commonly too coarse for the purposes of defining soil habitat characteristics, and most plant studies provide insufficient data for soil taxonomic classification. Well-intended attempts to correlate plant distributions based on substrate characteristics sometimes employ outdated map units which confuse bedrock lithology with soil type, geologic unit names, and landform type (e.g., The Nature Conservancy, 2007, Appendix 4, Table A) – these groups are not comparable because each indicates different concepts and spatial scales of landscape classification. These shortcomings and the need for better soils-based research were acknowledged in the report by the Nature Conservancy on rare plants in Clark County (The Nature Conservancy, 2007), and by Hamerlynck et al. (2002), who note that soil geomorphologic context is a vital part of interpreting vegetation structure and dynamics in arid landscapes.

Several general soil geomorphic and biological factors are already known to influence plant dynamics (e.g., growth, nutrient uptake, ecological relationships, etc.) on gypsum soils, including physical surface crusts, biological surface crusts, soil chemistry, and ecological dynamics (competition, refugia). The role of each these factors must be considered when evaluating mechanisms that control plant distributions.

Physical surface crusts may directly influence seed germination and plant establishment either by resisting rooting, or by providing a smooth surface that causes seeds to blow off exposed and weathered gypsum substrates (Meyer & García-Moya, 1989; Meyer et al., 1992; Escudero et al, 1997; Rubio & Escudero, 2000). In this way, restrictive physical gypsum crusts can be a more important factor than subsoil nutrient content (Meyer et al., 1992), and in some cases a veneer of alluvium or other sediment over gypsum subsoils may be required to permit germination and growth (Meyer & García-Moya, 1989). The presence of non-indurated surface horizons, as well as established biological cover, also influences infiltration rates and soil water dynamics. Physical crusts, desert pavements, soil textural contrasts, the degree of soil profile development, and the configuration of indurated or salt-plugged subsurface horizons greatly influence soil hydrology and the availability of seasonal moisture (Meyer & García-Moya, 1989; Hamerlynck et al., 2000; Hamerlynck et al., 2002). Soil moisture is further determined by topographic parameters such as slope angle and slope aspect. These factors, combined with surface erosion, can enhance or diminish the role of physical soil crusts on plant establishment in gypsum soils especially (Meyer et al., 1992; Guerrero-Campo et al., 1999; Pueyo & Alados, 2007).

Biological soil crusts (BSCs) can have equally crucial but even more complex effects on vascular plants, by directly or indirectly influencing seed establishment, surface erosion dynamics, soil moisture content, soil temperature, and soil nutrient availability (West, 1990; Prasse & Bornkamm, 2000; Belnap et al., 2001; Belnap, 2006; Briggs & Morgan, 2008; Caldwell et al., 2009). BSCs are soil surface complexes comprised of microorganisms and sediments, and include distinct assemblages of mosses, lichens, bacteria, fungi, liverworts, or algae (West, 1990; Belnap et al., 2001). Gypsum soils in the western U.S. commonly support high BSC and cover and diversity of cyanobacteria, lichens and mosses (Belnap et al., 2001). The composition, properties, and density of BSCs may influence microclimate at the soil surface, and therefore seed germination and nutrient cycling (Harper & Pendleton, 1993; Caldwell et al., 2009), however, the nature and magnitude of the effect can be highly species specific, depending on both crust and plant species (Escudero et al., 2007). Harper and Belnap (2001) note that cyanobacteria and *Collema* sp. may fix N, and that certain types of crusts, especially those comprised of cyanobacteria and/or *Collema* sp. may greatly increase the uptake by short-lived and shallow-rooted plants of several other essential elements, including Cu, K, Mg, and Zn. However, the same study also notes that this effect is greatly diminished for deeply rooted shrubs (Harper & Belnap, 2001). Under the right conditions, cyanobacteria may also suppress seed establishment by forming a smooth crust that prevent seeds from coming to rest in some sandy substrates (Prasse & Bornkamm, 2000). BSCs therefore represent a complex set of factors and processes that must be considered as possible influences on desert shrub habitats, especially on gypsum soils.

Physical and biological crusts vary spatially with vegetation in arid environments. Over time (10^0 to 10^2 y), the type of soil cover both reflects and influences surface stability, which is controlled by complex feedback loops among geomorphic processes, biota, and climate. The generally sparse plant canopy cover of arid environments is a well-known result of low moisture availability. As plants compete for limited water and available nutrients, zones of enhanced soil water availability form as a consequence of differential runoff and infiltration rates in soils under plants versus soils in interspaces between plants (Schlesinger et al., 1996; Caldwell et al., 2008; Brady & Weil, 2011). Over time, continued growth, water uptake, and nutrient cycling by the vegetation amplifies differences between canopy and interspace soils, producing "fertile islands" of generally higher nutrient and organic matter content under canopies (Schlesinger et al., 1996; Caldwell et al., 2008; Brady & Weil, 2011). Physical differences affecting infiltration and runoff also develop, and feedbacks may arise between soil cover type, soil hydrology, and soil nutrient content. Complicating matters, biological soil crusts may be as significant as shrubs in driving or arresting this divergence of canopy and interspace soil properties. For example, moss-lichen crusts can enhance the availability of many cations in the soil solution, potentially subduing chemical disparities between canopy and interspace soils (Williams, 2011). Thus, comparison of canopy and interspace soil characteristics can provide insights into important, scale-dependent chemical and hydrological processes that are vital to vegetation dynamics in arid systems (Schlesinger et al., 1996; Caldwell et al., 2008; Williams, 2011). These considerations are especially vital for any study of plants on gypsum soils within arid environments.

Given the complex linkages and lack of detailed studies on soil surface characteristics, parent material characteristics, soil profile development, and surface (geomorphic) processes, much more research is required to adequately describe the habitat requirements of the Las Vegas buckwheat. Accordingly, this study sought to identify edaphic controls on the buckwheat distributions in Clark County by analyzing data from three important habitat components briefly mentioned in the discussion above, namely: surficial geology, soil profile characteristics, and soil surface characteristics including physical features and biological crusts. This work is an initial step towards a better understanding of abiotic controls on the Las Vegas buckwheat distribution.

III. Management Actions Addressed

This was an information gathering project, intended to improve understanding of a special status, potentially threatened or endangered, species in Clark County, and to provide data to facilitate better predictive habitat modeling. Better habitat modeling is warranted given the difficulty of locating isolated populations of the Las Vegas buckwheat during field surveys (e.g., ICF Jones & Stokes, 2010), and also due to the restriction of most, if not all, existing soil chemical data to the Las Vegas Valley.

IV. Study Area Locations

Three study areas were selected from among the known population clusters of Las Vegas buckwheat in Clark County, NV (FWS, 2007; Mrowka, 2008). Selection of these areas was intended to enable comparison between spatially discontiguous areas with potentially distinct surficial geology. The three study areas were: (1) Coyote Springs, located ~2 km southeast of the intersection of U.S. Highway 93 and State Route 168 near the northern border of Clark County; (2) Gold Butte, located immediately east of New Gold Butte Road, approximately ~10 km south of Whitney Pocket; and (3) Bitter Spring, located north of Lake Mead National Recreation Area, in the White Basin between the Muddy Mountains, Bitter Ridge, and the Longwell Ridges (**Figure 1**). Approximately 30 sites within each study area were selected for targeted study in order to compare buckwheat habitat conditions to adjacent, similar landforms not currently supporting the species.

V. Goals and Objectives of the Project

Our objectives were (1) to identify *patterns* of soil and land-surface properties that might control or influence distributions of the Las Vegas buckwheat, and from those correlations (2) to interpret which soil geomorphologic *processes* or *characteristics* most directly influence Las Vegas buckwheat. A secondary goal was to determine what spatial scale is needed to adequately resolve soil geomorphic variability within the study areas and habitat classes. Project components designed to satisfy these objectives included: (1) high-resolution mapping of surficial geology, (2) comprehensive field description of soil profile and soil surface characteristics, (3) laboratory assessment of soil chemical and physical properties, and interpretation of these combined data sets.

VI. Methods

Methods for each of the project components are detailed separately in the chapters of this report. Within each profile, genetic soil horizons were described based on attributes including: thickness, structure, color, boundary character, ped and/or void surface features, secondary mineral concentrations, porosity, roots, effervescence, and percent gravel content. Soil samples were collected and analyzed in the UNLV Environmental Soil Analytical Laboratory for pH, EC, total C, N, and S, percent $CaCO_3$, Cl^-, SO_4^{2-}, NO_3^-, plant available cations, cation exchange capacity, and soil texture. Additional soil profile and site data collected included geomorphic information, , parent material (lithology), biological soil crust coverage, and surface clast coverage.

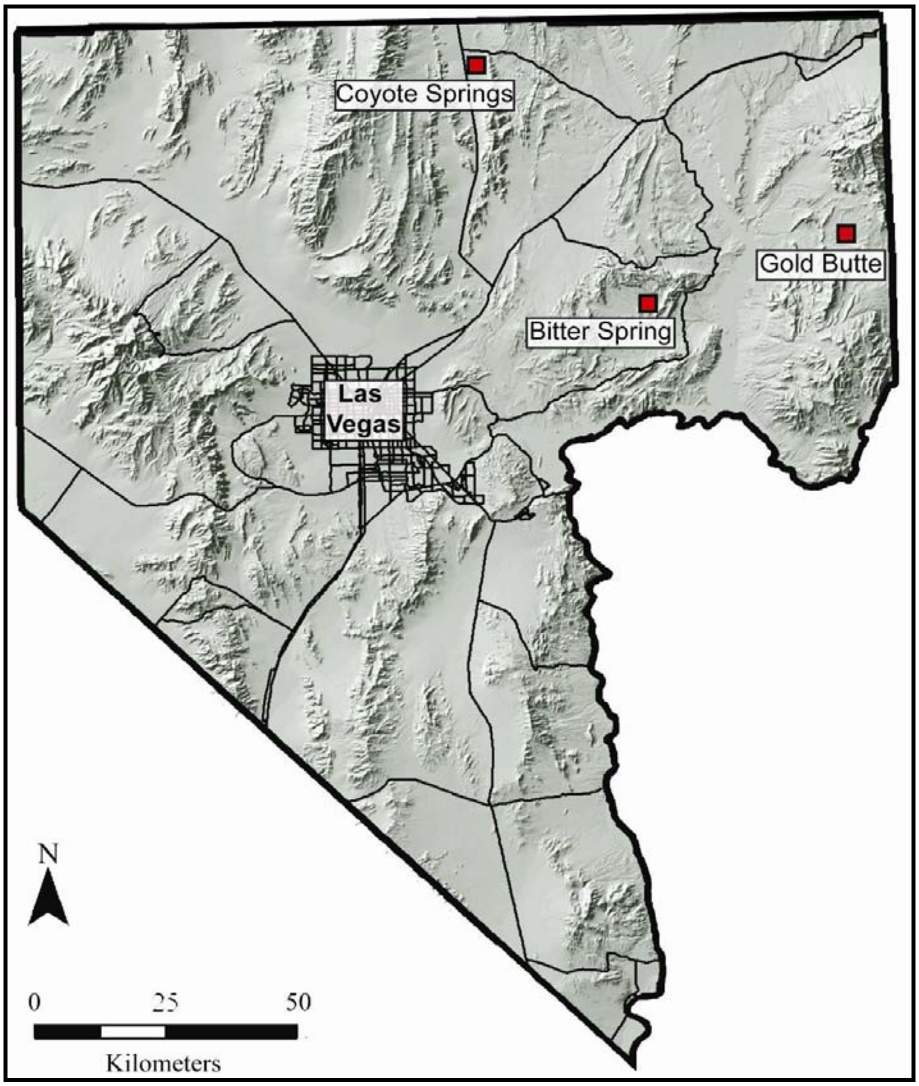

Figure 1: General locations of the three study areas of Gypsum Soils Analysis Technical Conditions (UNLV-2005-609F). *Base data from Clark County GISMO and the USGS*.

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Chapter 2: Mapping: Surficial Geology, Insolation, and Habitat Classes

Colin R. Robins and Brenda J. Buck

I. Purpose

The development of detailed (1:3,000 scale) surficial geologic maps was an important project directive intended to improve both understanding and definition of existing Las Vegas buckwheat habitat. These maps were also produced with the objective of facilitating identification of previously unknown buckwheat populations or potential buckwheat habitats in future remote sensing and/or field projects.

Surficial geologic maps commonly delineate unconsolidated sedimentary materials that occur as a veneer over bedrock. These maps illustrate the distribution of geomorphic surfaces and their associated sedimentary deposits. Geomorphic surfaces are mappable features defined as "portions of the landscape specifically defined in space and time" (Ruhe, 1969), and may form via deposition, erosion, or some combination of both. Surficial geologic maps are interpretations of the genesis, history, and characteristics of soils, surfaces, and landforms. Their study can effectively identify the surface processes most influential in shaping the landscape, and can yield insight into the timing of key changes in climate and landscape stability. Each map unit is an interpretation of a particular suite of variables including stratigraphic relationships among and between different deposits, topographic characteristics of individual landforms (e.g. inset or nested relationships), surface morphology (e.g. bars& swales on alluvial landforms), drainage patterns, degree of soil development (especially carbonate morphology), sediment size and sorting (soil texture), substrate lithology (soil mineralogy), slope angle (soil stability), the presence of desert pavement or biological surface crusts (soil stability and hydrology), and the relative importance of wind, water, or gravity in locally eroding or depositing material. Because landform morphology, hydrology, sedimentation rates, rock weathering and soil formation rates all influence and create feedbacks with vegetation dynamics, this type of map can prove very useful for predicting vegetation types and densities in arid environments.

II. Methodology

General study locations were selected based on their known populations of *E. corymbosum* var. *nilesii* and also based on their overlapping ranges of landform and soil types (Chapter 1). We situated study area borders in order to best encompass the full range of geomorphic surfaces and landforms expressed at each site. We also attempted to ensure similar study area sizes and comparable degrees of landscape complexity between the three locations.

The 1:3,000 map scale best suited the needs and resources of this project. With this scale, we sought to maximize the ability of our data to explain differences between existing habitats and adjacent, similar soil landforms that do not currently support *E. corymbosum* var. *nilesii* but which could theoretically become habitat in the future. We also hoped the scale of study and data collected would help explain why these "potential habitat" areas are not populated. Existing NRCS soil surveys (1:24,000 or coarser) and geologic maps (1:100,000 or coarser) of the study areas are currently insufficient for these purposes because their map units, by definition, incorporate a high degree soil and surficial geologic variability. Most relevant to the study of desert shrubs, the 1:3,000 scale permits delineation of landforms as small as ~5 m^2, and linear features, like rills or gullies, that are as narrow as 1.5 m. Such landforms may provide critical niche space for individual shrubs, but cannot be resolved at a smaller (i.e., broader or coarser) spatial scale.

Using field and remote sensing data, we differentiated geomorphic surfaces and landforms based on morphostratigraphic relationships, surface characteristics (including physical and biological crusts), sediment texture and lithology, soil profile characteristics, and vegetation. Planar geomorphic surfaces and their side slopes were sometimes distinguished from one another as separate map units because of the need to capture factors that could potentially influence habitat suitability, such as changes in hydrology and surface clast cover. By convention, authors of most other surficial geologic maps tend to combine a landform and its side slopes into one unit. For additional detail on the field methodology for mapping of soils, surficial geology, and landforms, see Peterson (1981) and Compton (1985). Mapping was done between September 2009 and March 2011, in the field and also remotely using ESRI ArcGIS 9.3 software. Several types of digital base-map data were used to support field-based landform interpretations.

Light detection and ranging (LiDAR) topographic data collected by Airborne1 in November, 2009, for this project, were used to generate a 1.5-meter resolution digital elevation model (DEM), hillshade, slope map (slopeshade), aspect map, and 1-meter resolution topographic contour map for each study area. These LiDAR-based datasets helped constrain contacts between map units. For instance, slope maps and contour lines helped delineate the transition between planar alluvial fan surfaces and steep colluvial side slopes, or narrow outcrops of well-lithified bedrock. ESRI ArcGIS 9.3 was used to convert LAS-format LiDAR data into ESRI grid-format DEMs, and the Surface Analysis tool was used to develop all derivative data sets from the DEM.

Quickbird imagery for Clark County, made available through the Southern Nevada Public Lands Management Act Round 5 Conservation Initiative Program, was also used. Additional base data used for mapping included color aerial photomosaics from the National Agricultural Imagery Program (NAIP), and 10-meter USGS DEMs. Final surficial geologic maps include many of these data sets superimposed on top of one another as semi-transparent, brightness-and-contrast-adjusted rasters. The shaded relief map for each study area was made by superimposing the hillshade raster on a slopeshade. Slopeshade maps are an alternative take on shaded relief maps, in which steeper slope angles are displayed as darker areas, and flatter surfaces as lighter (method from P.K. House, personal communication, 2009), without obscuring landforms in shadow. Our combination of raster base data was tailored to each study area in order to best illustrate local landform morphology and relief.

Solar insolation

Solar insolation is a measure of the total amount of energy imparted upon the earth's surface from sunlight. Insolation affects soil moisture content, soil temperature, freeze-thaw, photosynthesis, and many other edaphic, ecological, and geomorphic processes. To estimate solar insolation for any given point or target area, a three-dimensional model, or DEM, of that target's viewshed is needed. The viewshed consists of all land surface area visible from the target of interest. Any landform protruding above the target's elevation between the target and the horizon may shade the target and reduce the amount of solar radiation received, even if only during sunrise or sunset. Failure to incorporate the entire viewshed will lead to overestimation of total yearly insolation. Similarly, high resolution DEMs are best for insolation modeling because minor topographic features obscured by coarse pixel sizes also affect local insolation over the course of a year.

LiDAR data were acquired for the viewshed of each study area, however, available computing power for this study was insufficient to use the very large LiDAR data sets for insolation calculations. Instead, we combined high resolution LiDAR data within each study area with lower resolution, less memory-intensive 10 m USGS DEMs covering the viewshed. Pixel resolution of the LiDAR DSM was reduced from 1.5 m to 5 m, and resolution of the USGS DEM was artificially increased from 10 m to 5 m. Cells overlapping the study area were clipped out of the USGS DEM, and the LiDAR DSM was patched in, creating one 5 m DEM for each study area and viewshed. This DEM could be analyzed on a standard computer, yet permitted more accurate insolation modelling of fine-scale topography within the study area, while also incorporating the shading effects of adjacent mountains.

Insolation values for soil profile sites were calculated using the Points Solar Radiation tool in ArcGIS 9.3. For illustrative purposes, rasters showing insolation variability across the whole viewshed were also produced using the Area Solar Radiation tool. Clearly discernable artifacts (walls or cliffs) appear at the edge of each study area, however, these artifacts are not large enough to influence insolation calculations at the soil profile sites. All calculations were run for the whole year using a monthly interval, a sky size of 200 cells, and assuming uniform sky.

Map Unit Nomenclature

Surficial geologic map units follow conventional alpha-numeric nomenclature. The first character of the unit name indicates the age of the geomorphic surface or deposit: **Q**, Quaternary; **T**, Tertiary. The second character describes the type of deposit: **a**, alluvium; **c**, colluvium; **ea**, mixed eolian & alluvial sediments; **p**, playa; **lv**, eroded Las Vegas Formation; **x**, anthropogenically disturbed; **rock**, well-lithified sedimentary bedrock; **ss**, poorly lithified sedimentary rock; **gyp**, gypsum bedrock; **tuff**, tuffaceous (volcaniclastic) bedrock. Additional descriptor suffixes were used to indicate stratigraphic relationships (i.e., 1 is oldest, 2 younger, etc.) or landscape position (e.g., summit; or erode = sideslope).

Habitat Classification Systems

The relationship between buckwheat distributions, map units, and soils was considered in two ways. Because of the timing and scope of this project, and the need to complete preliminary mapping before choosing sample sites, it proved necessary to define buckwheat habitat classes prior to soil profile sampling and chemical analysis. Thus, habitat classifications are based on surficial geologic characteristics and observed distributions of *E. corymbosum* var. *nilesii*.

First, soil profile sites and map units were classified on an objective presence or absence basis. Using this system, sites and map units are either “Buckwheat,” known to contain one or more individuals of *E. corymbosum* var *nilesii*, or they are “Non-buckwheat,” and the species is known to be absent. This system is based on field observations, and works especially well at Gold Butte and Bitter Spring, where map unit polygons are small (see Results), and distribution of buckwheat within map polygons is fairly uniform. All sites within these two study areas can be quickly classified using the same presence/absence definition as the polygon in which they are located. The only spatial constraint is the map unit polygon boundary.

Conversely, the presence/absence definition at Coyote Springs is site specific, rather than map unit polygon specific. This minor distinction of “non-buckwheat” site definition at Coyote Springs is caused primarily by the greater spatial extent of its landforms, surficial geologic units, and, consequently, map polygons (see Results). Moreover, some, but not all, of the large map unit polygons at Coyote Springs, each of which represents a single, continuous, and apparently homogenous soil geomorphic surface, were observed to contain both large areas in which buckwheat was present, and large areas in which it was absent. These polygons could not be subdivided based on any soil or surficial geologic criteria. Thus, a Coyote Springs map unit polygon classified as “Buckwheat” may contain areas or sites of “Non-buckwheat”, and it was necessary to develop a secondary, distance-based definition to the habitat classification of Coyote Springs study sites. Thus, designation of a site as “Non-buckwheat” at Coyote Springs means that either: the species is absent for the full spatial extent of the particular surficial geologic map unit polygon in which the site occurs (i.e., the same definition as in the other study areas) or it is absent for a distance of at least 50 m in all directions from the soil sampling location. At Gold Butte and Bitter Spring, “non-buckwheat” sites indicate that there are no Las Vegas buckwheat plants within the entire map unit polygon in which the site is located. Many of the polygons at Gold Butte and Bitter Spring were significantly smaller than 50 m, and no single, objective definition for presence/absence could be found that worked for all three field areas in this study.

The second, more subjective habitat classification system is site specific. Buckwheat sites are simply re-named “Habitat”, however, non-buckwheat sites are further subdivided into either “Non-habitat” or “Potential Habitat” based on field interpretations of soil and surficial geologic attributes. “Non-habitat” sites in this system are those in which buckwheat are absent, and in which soil-geomorphic conditions are inconsistent with habitat characteristics as generally observed in the given study area. “Potential Habitat” sites are those in which buckwheat are absent, but which bear close soil surface and/or geomorphic similarity to habitat characteristics and are thus considered likely to be able to support buckwheat.

The first classification system, Buckwheat/Non-buckwheat, is objective and statistically significant differences between the two would support the hypothesis that soil conditions are fundamentally distinct between each class. The second system, Habitat/Non-habitat/Potential habitat, is partly objective and partly subjective. In this comparison we test our data against a hypothesis of soil habitat suitability. We hypothesize that buckwheat could grow in the "Potential Habitat" sites, but have not yet become established for unknown reasons. Thus, our hypothesis in this case requires (1) that there should be no statistically significant differences between "Habitat" and "Potential Habitat" sites, and also (2) that significant differences should exist between each of those two classes and "Non-habitat".

Statistical Analysis of Map Units

A series of chi-square tests quantified the presence/absence of buckwheat as a function of aspect classes and surficial geologic map units. Pearson Chi-Square tests for independence were completed at the 0.05 level of significance in IBM SPSS Statistics 19. Yates Continuity Corrections were used for 2x2 categorical comparisons. Aspect classes (N, E, S, W) were compared against the presence/absence of buckwheat, both for all aspect classes combined and then for each aspect class against the others. Similarly, surficial geologic map units were compared against the presence/absence of buckwheat. The dominant habitat unit was also compared to the other map units at each site.

III. Results

Results from surficial geologic mapping are presented below for each study area in succession: first Coyote Springs, then Gold Butte, followed by Bitter Spring. For each area, we display NAIP imagery, followed by NRCS web soil survey data, solar insolation data, a reduced version of this study's surficial geologic map, an explanation of map unit descriptions, photographs of representative map units, and a figure depicting map units re-interpreted into buckwheat habitat suitability classes.

Additional habitat class summary data, and statistical results from the chi-square tests are also presented.

A. Surficial Geology of the Coyote Springs Study Area

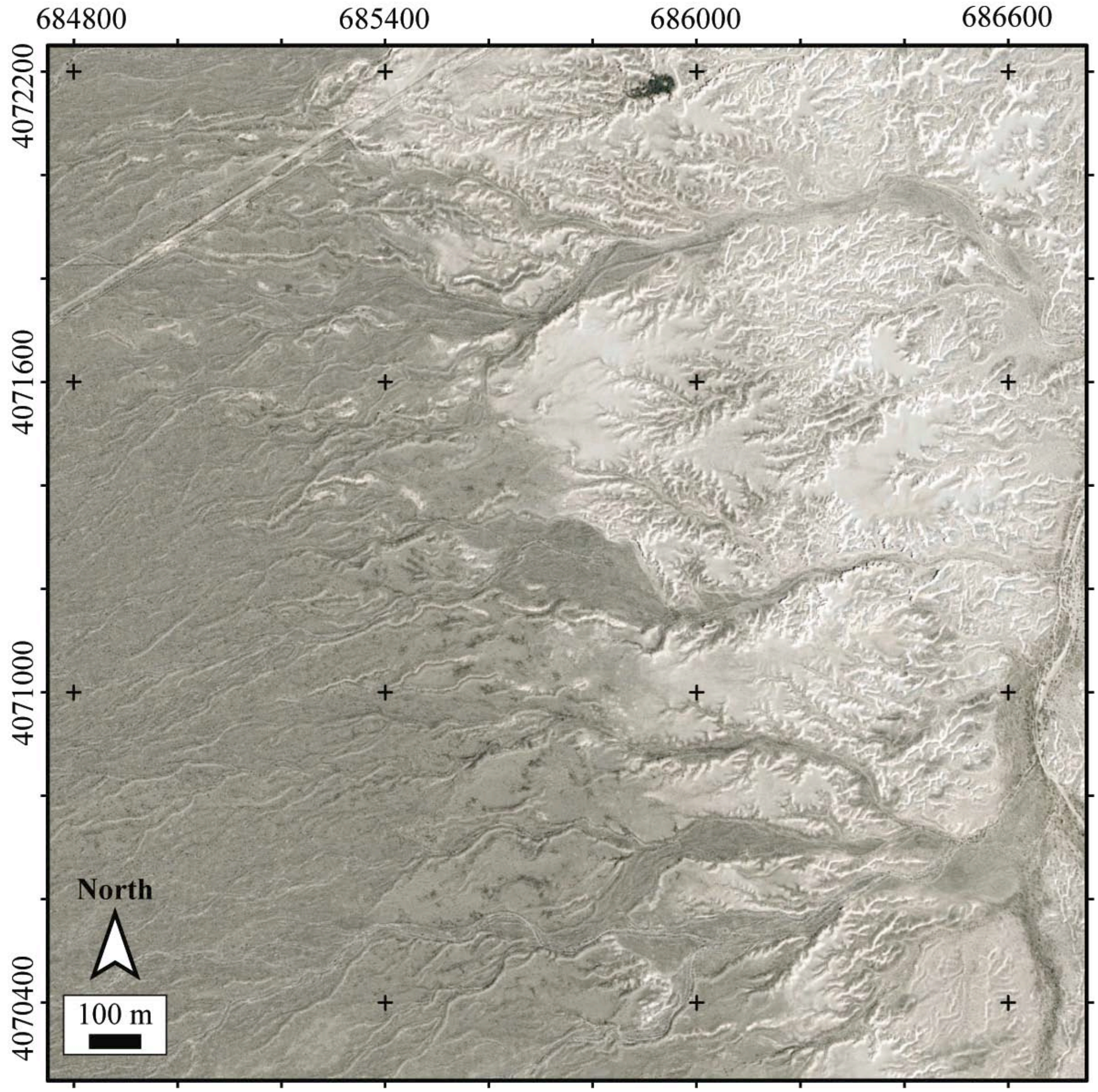

Figure 2-1: Contrast-enhanced NAIP imagery (USDA-FSA, 2006) of the Coyote Springs study area, superimposed over a LiDAR-derived slopeshade.

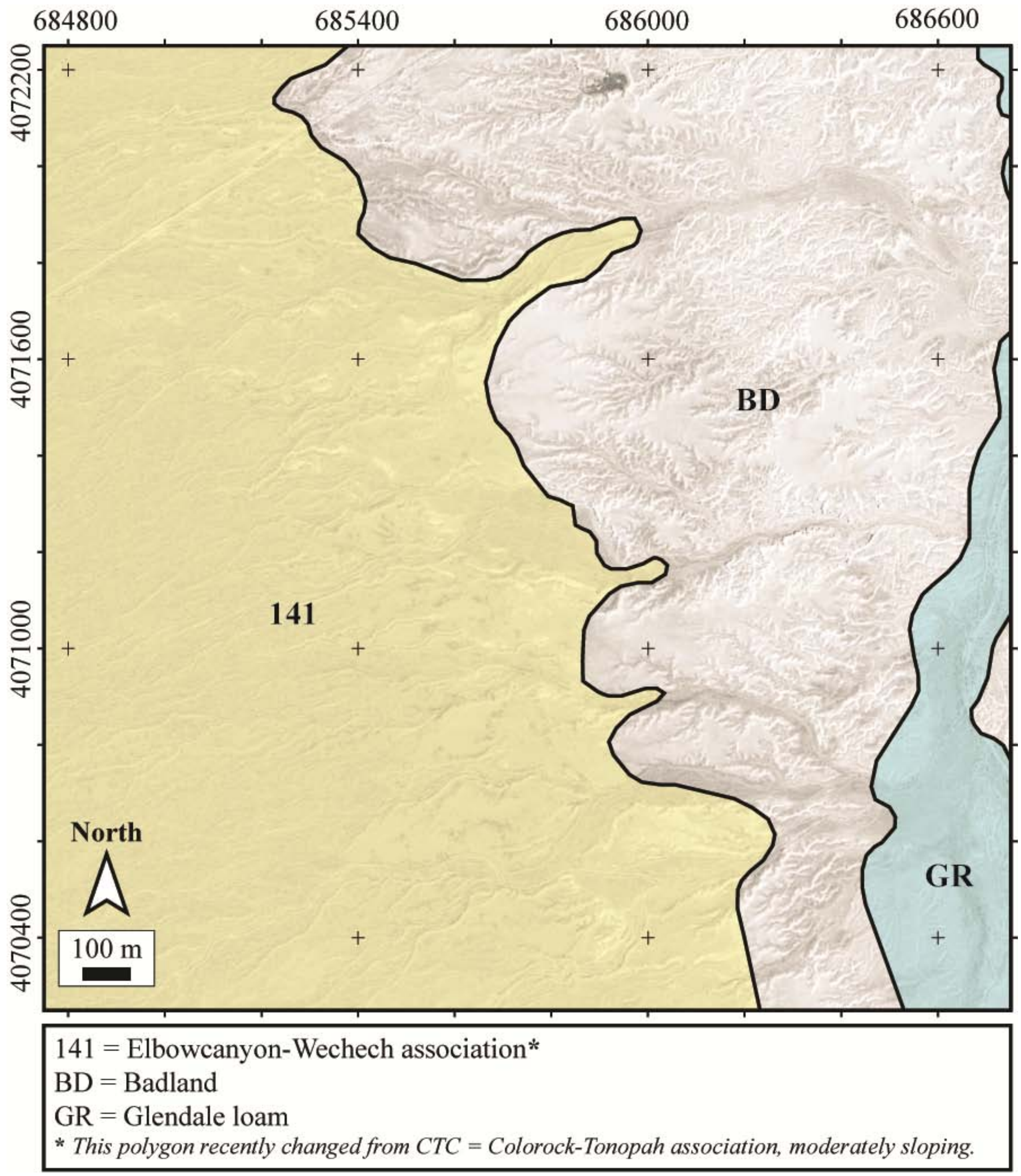

Figure 2-2: NRCS Soil Survey data for the Coyote Springs study area, mapped at 1:24,000 (Soil Survey Staff, 2006; Soil Survey Staff, 2011). Three distinct survey units are identified. Data in this figure have been modified for display purposes and are shown beyond their intended scale – these soil associations cannot reveal small areas of distinct soil types occurring within the area.

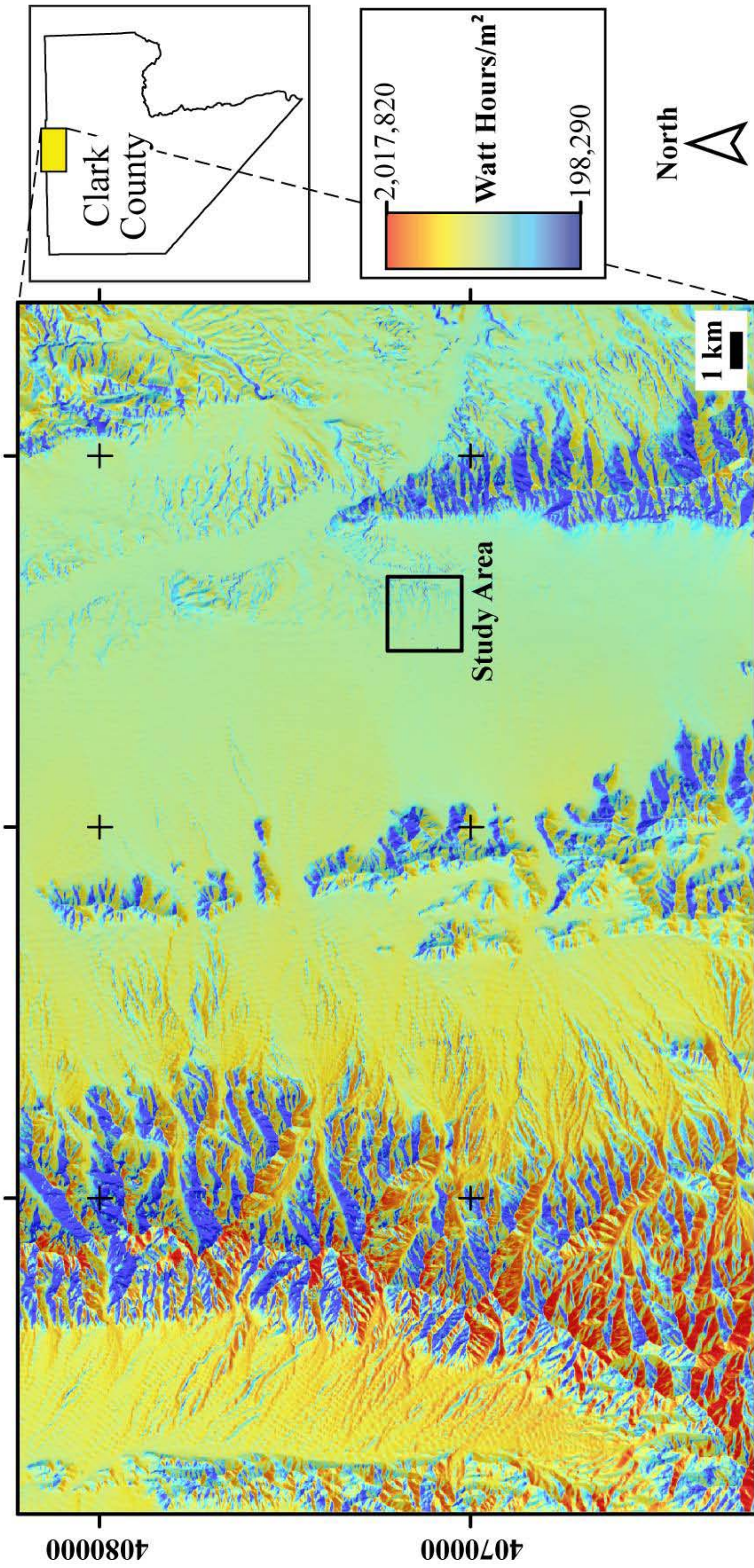

Figure 2-3: Solar insolation map of the greater Coyote Springs study area. Coordinates are in meters (NAD 83 UTM 11N).

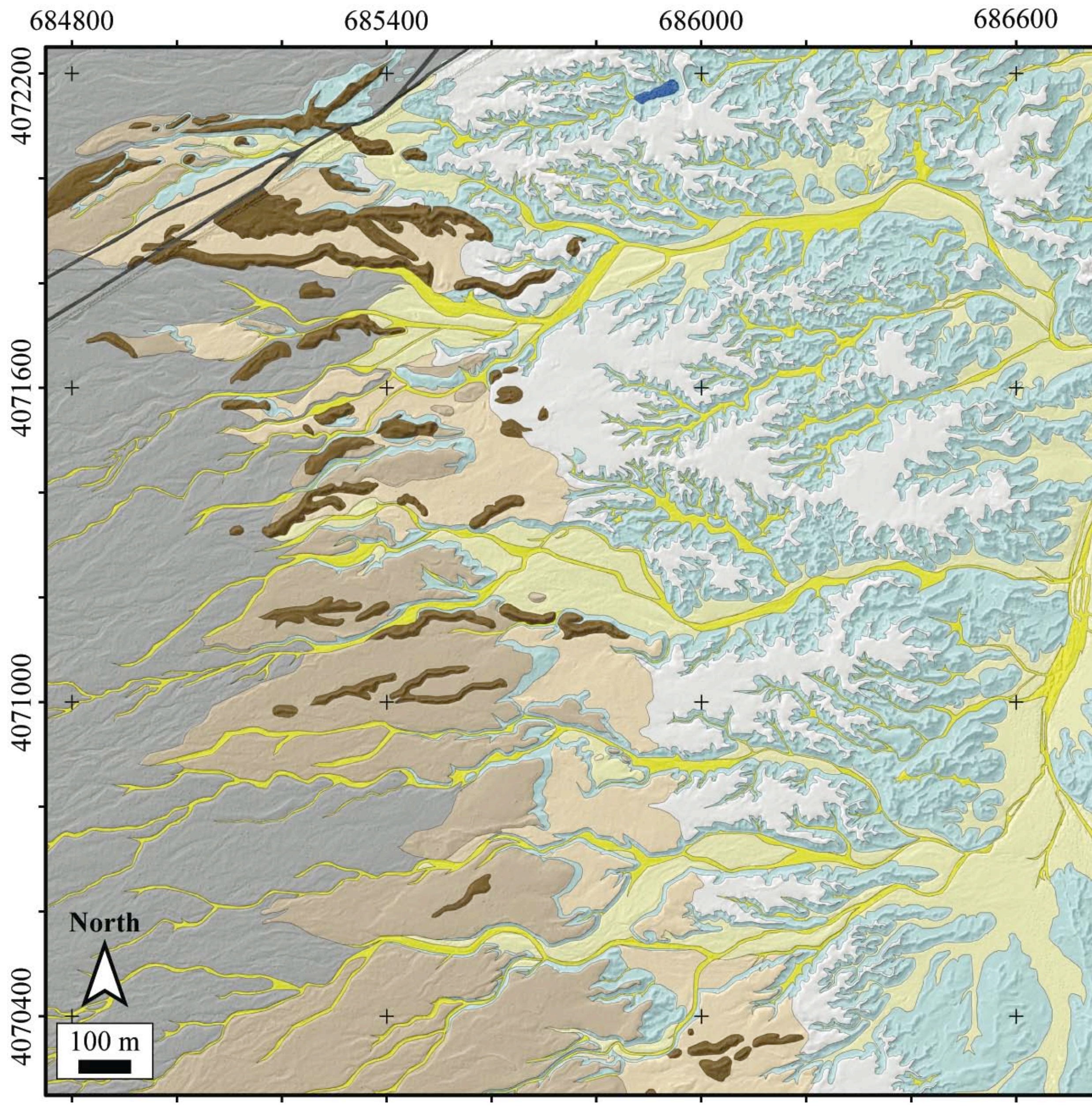

Figure 2-4: Surficial Geologic map of the Coyote Springs study area (reduced from original 1:3,000 scale). The map unit key is shown on the next page (Figure 2-5).

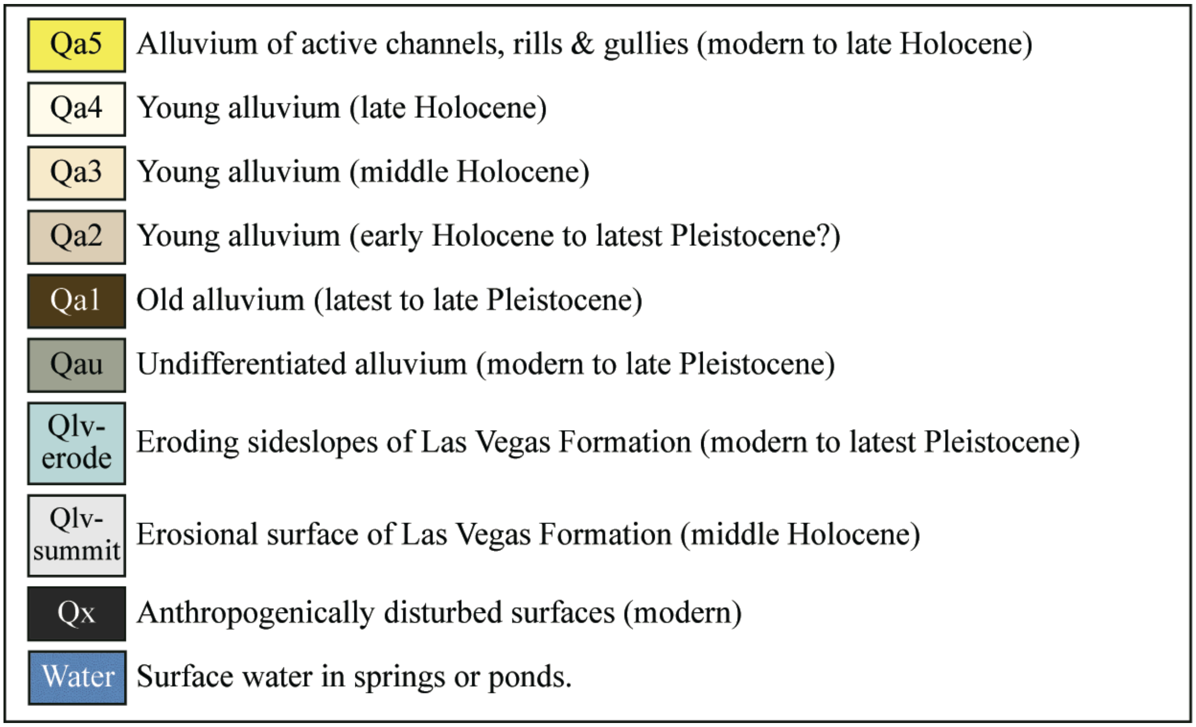

Figure 2-5: Key to the Coyote Springs surficial geologic map (Figure 2-4).

Explanation of Coyote Springs Surficial Geologic Map Units

***Qa5*: Alluvium of active channels, rills and gullies (modern to late Holocene)**. Active wash and fan deposits composed of poorly to moderately sorted gravel, sand, and silt forming fresh bar and channel morphology and exhibiting relatively low vegetation density. Commonly found as rills and gullies cut into residuum of the Las Vegas Formation (Qlv-summit and Qlv-erode).

***Qa4*: Young alluvium (late Holocene)**. Mostly inactive surfaces (affected by only the very largest precipitation or channel avulsion events) that occur up to 1 m above active washes. Composed of poorly to moderately sorted gravel, sand and minor silt that may grade into thin colluvium or alluvium washed from small rills upslope. Surface morphology consists of bars and swales often incised by active washes. Vegetation is dominated by creosote, blackbrush, and Mojave yucca. Typically, this unit varies from 0.5 to 1.5 m thick. Soil development is weak, characterized by Av-Bw or Bk-C horizons with either no soil carbonates, or very faint stage I carbonate morphology (Gile et al., 1966).

***Qa3*: Young alluvium (middle Holocene)**. Inactive surfaces that occur ~2 m above Qa4 with well developed planar surface morphology, and strong to moderately-developed desert pavement. Sediments contain poorly to moderately sorted gravel, sand and silt. Surface clasts are mostly Paleozoic limestone. Qa3 deposits grade downslope into Qlv-summit, both as a product of initial deposition as thin sheets onto the fringes of Qlv-summit, and also as a result of surface erosion. Qa3 is typically separated from Qa2 by a broad, 1 to 2 m scarp exposing sediments of the Las Vegas Formation (Qlv-erode). Isolated, discontinuous, and/or degraded surfaces intermediate to Qa3 and Qa2 do occur within the study area but were incorporated into this map unit due to their small spatial extent, their degraded character, and their overall similarity to Qa3. Soil development in Qa3 is characterized by Av-Bk-C horizons with stage I carbonate morphology (Gile et al., 1966).

***Qa2*: Young alluvium (early Holocene to latest Pleistocene?)**. Inactive surfaces that occur 1-2 m above Qa3 and are composed of poorly to moderately sorted gravels, sand and silt. Planar to faint bar and swale undulating surface morphology with 1 to 3 m^2 patches of well-developed desert pavement with sparse creosote, blackbrush, yucca, and other vegetation. This map unit grades upslope into Qau, and reflects deposits intermediate in age to Qa3 and Qa1. This unit also includes incised active channels too small or too discontinuous to map at this scale. Soil development is characterized by Av-Bk horizons with stage I to incipient stage II carbonate morphology (Gile et al., 1966).

***Qa1*: Old alluvium (latest to late Pleistocene)**. Relict, inactive alluvial silts, sands, and isolated gravels in actively eroding, narrow (2-5 m wide) ballena landforms that lie ~2 to 3+ m above Qa2/Qau surfaces. Alluvial deposits up to 0.5m thick overlie Las Vegas Formation strata, but often as only a thin (10-20 cm thick) gravel lag. Qa1 is the oldest geomorphic surface in the study area. Soil development is negligible due to extensive erosion, however paleosol horizons from the Las Vegas Formation may be exposed. Vegetation on this unit consists chiefly of blackbrush and less commonly creosote.

***Qau*: Undifferentiated alluvium (modern to late Pleistocene).** Undifferentiated alluvium in the western portion of the field area. Primarily composed of inactive surfaces 1 to 2 m or more above Qa3, and grading downslope to Qa2. This unit is composed of poorly to moderately sorted gravels, sand and silt with variable bar and swale morphology. Younger, inset surfaces and active washes are also included within this undivided unit.

***Qlv-erode*: Sideslopes of exposed Las Vegas Formation (modern to latest Pleistocene)**.Well-stratified, partly indurated calcareous silts, mudstones and calcic paleosols of the earliest Holocene to latest Pleistocene Las Vegas Formation exposed in actively eroding sideslopes and channel cut banks. Locally derived colluvium is lumped within this map unit. Qlv-erode contains abundant calcified root traces and stage I to weak stage III calcic horizons, and amorphous silica cements. These deposits are extensively rilled and gullied, forming badlands topography. Qlv-erode grades downslope into Qa4 or the active washes of Qa5. Vegetation is extremely sparse to absent.

***Qlv-summit*: Planar erosional surface of Las Vegas Formation (middle Holocene)**.Planar (< 3˚) erosional surface roughly equivalent to Qa3. Composed of exposed Las Vegas Formation (earliest Holocene to late Pleistocene) (Longwell et al., 1965; Haynes 1967; Quade & Pratt, 1989) silts, mudstones, and calcic paleosols covered by a moderate to well-developed desert pavement. Pavement clasts are composed of calcareous siltstone and rhizolith fragments derived from erosion of underlying Las Vegas Formation. Unit is bare to sparsely vegetated. In satellite and air-photo imagery, this unit is distinguished from others by its very pale to white color. Soil development can be highly variable because modern soil profiles overprint paleosols in the Las Vegas Formation. Soils are characterized by A, Av, or Avk horizons overlying Bk or Bky horizons grading into Bt, Btk, Bkq, Bkm, or Bkqm horizons.

***Qx*: Anthropogenically disturbed surfaces (modern)**. Well-established dirt roads and bulldozed vehicle pullouts along major power-lines. Individual 4x4 and/or utility vehicle tracks occur throughout the study area, especially in the Qlv-summit unit, but because of scale, these were not included in this mapping unit.

***Water*: Surface water in springs or ponds.**

Table 2-1: Coyote Springs Map Units and Soil Profile Sites

Map Unit	Soil profile sites within each unit
Qa5	none
Qa4	19, 20 & 28
Qa3	6, 16, 22, 26 & 30
Qa2	8 & 29
Qa1	none
Qau	none
Qlv-erode	14 & 15
Qlv-summit	0-5, 7, 9-13, 21, 23-25 & 27
Qx	none
Water	none

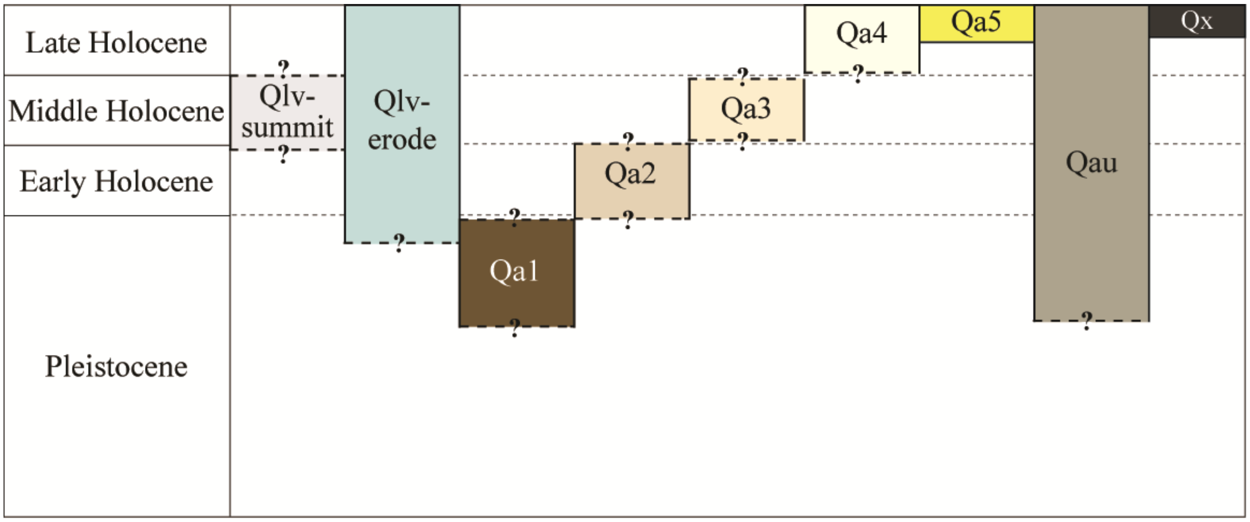

Figure 2-6: Approximate age relationships among Coyote Springs surficial geologic map units.

Photographs of the Coyote Springs Surficial Geologic Map Units

Figure 2-7: An eroding ballena of Qa1 sediments. This narrow ridge is only a few meters wide, but is 100s of meters long and sits 3-5 meters above surrounding map units. Gravels from an old alluvial surface have been let down during erosion and now drape over residual, planar-bedded silts and sands.

Figure 2-8: The Qa2 surface showing desert pavement (with the edge of a soil profile excavation in the foreground).

Figure 2-9: A view of theQa2 surface in the southern half of the study area, looking West. Most of the area vegetated in the background was mapped as unit Qau.

Figure 2-10: Characteristic desert pavement on the Qa3 surface. Clasts are relatively fine, and are chiefly composed of limestone.

Figure 2-11: The Contact between units Qa3 and Qlv-summit. The geologist is walking on Qa3 sediments (redder) and pointing towards the paler Qlv-summit surface. This contact is gradual over 3 to 5 meters and Qlv-summit is commonly 10 to 20 cm lower in elevation than Qa3.

Figure 2-12: A small, ~40cm gully cut bank in Qlv-summit, showing highly-indurated polygenetic soils and a pavement composed of calcium-carbonate rhizolith fragments. This is buckwheat habitat.

Figure 2-13: The Qlv-summit surface (foreground) and its morphostratigraphic position below Qa1 (ballena in background).

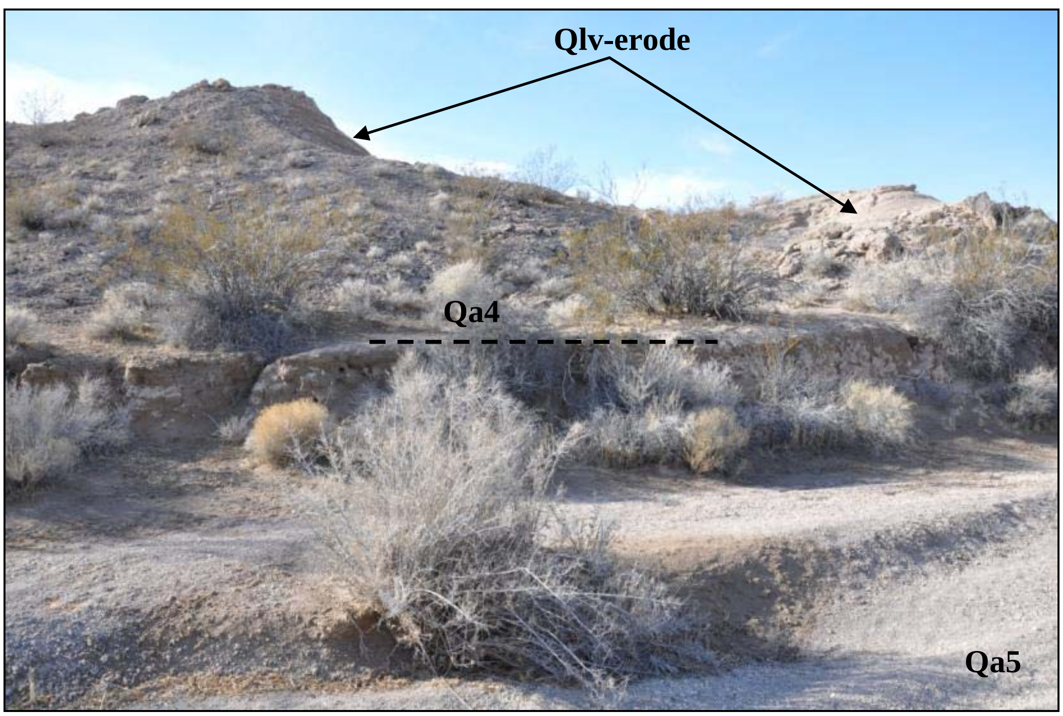

Figure 2-14: Relative elevation of Qa4 above Qa5 (A small, 20cm intermediate terrace in the foreground between them is lumped within Qa5). In the background, Qlv-erode is graded to Qa4.

Figure 2-15: Badlands comprised of the planar Qlv-summit surface, and steep, unstable side slopes of Qlv-erode.

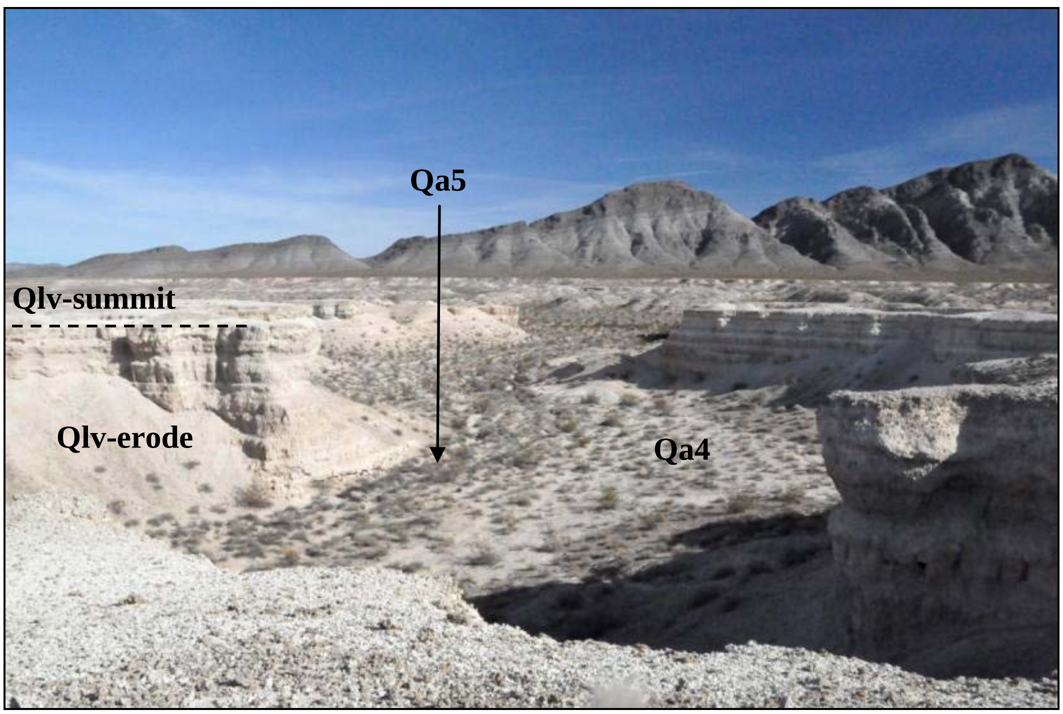

Figure 2-16: Relationships between Qlv-summit, Qlv-erode, Qa4 (pale, sparsely vegetated alluvium in right-side of valley), & Qa5 (narrow, more vegetated wash in left center of image).

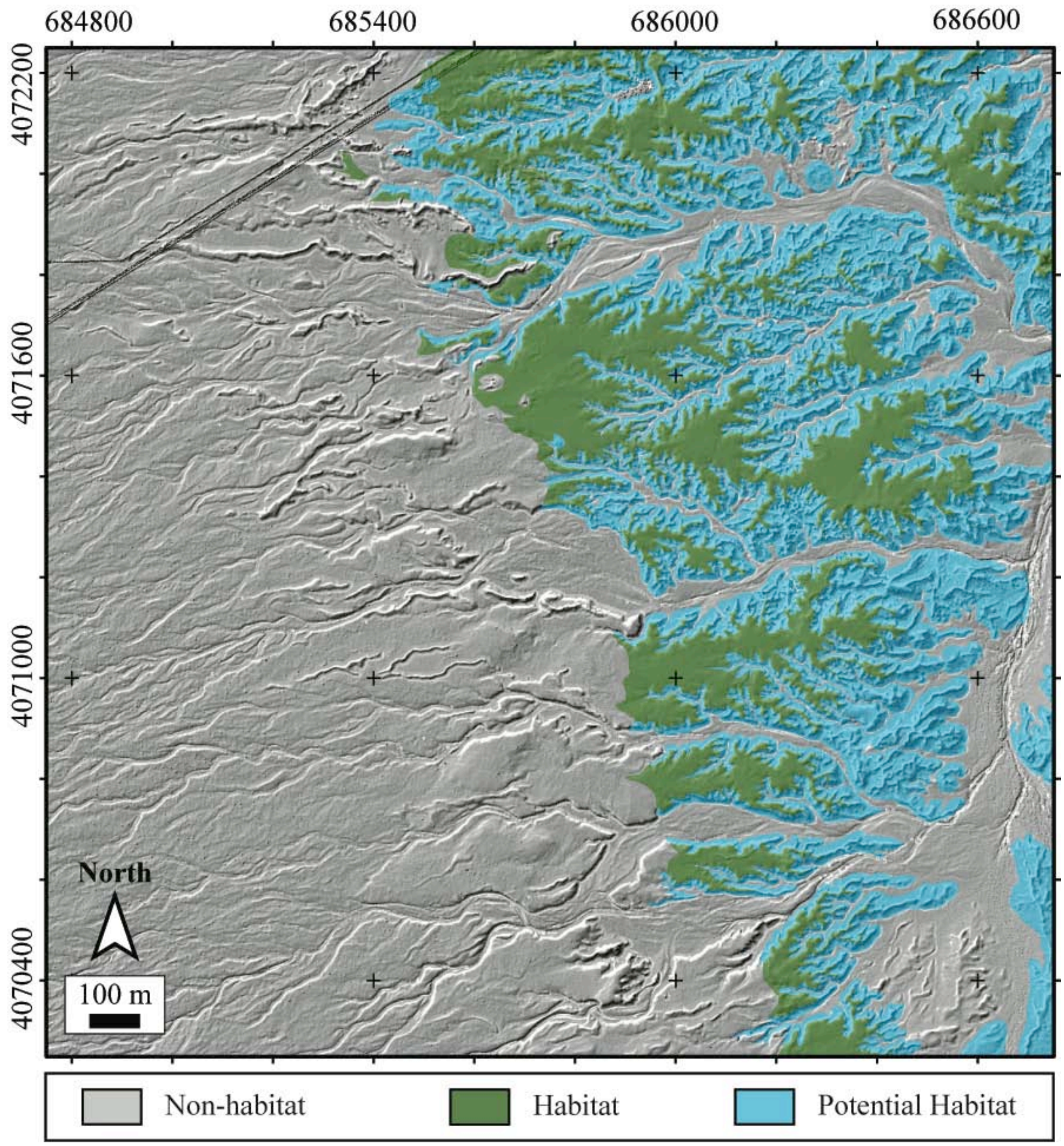

Figure 2-17: Distribution of buckwheat habitat classes within the Coyote Springs study area. Buckwheat may be locally absent or unevenly distributed across habitat areas in this particular study area.

B. Surficial Geology of the Gold Butte Study Area

Figure 2-18: Contrast-enhanced NAIP imagery (USDA-FSA, 2006) of the Gold Butte study area, superimposed over a LiDAR-derived slopeshade.

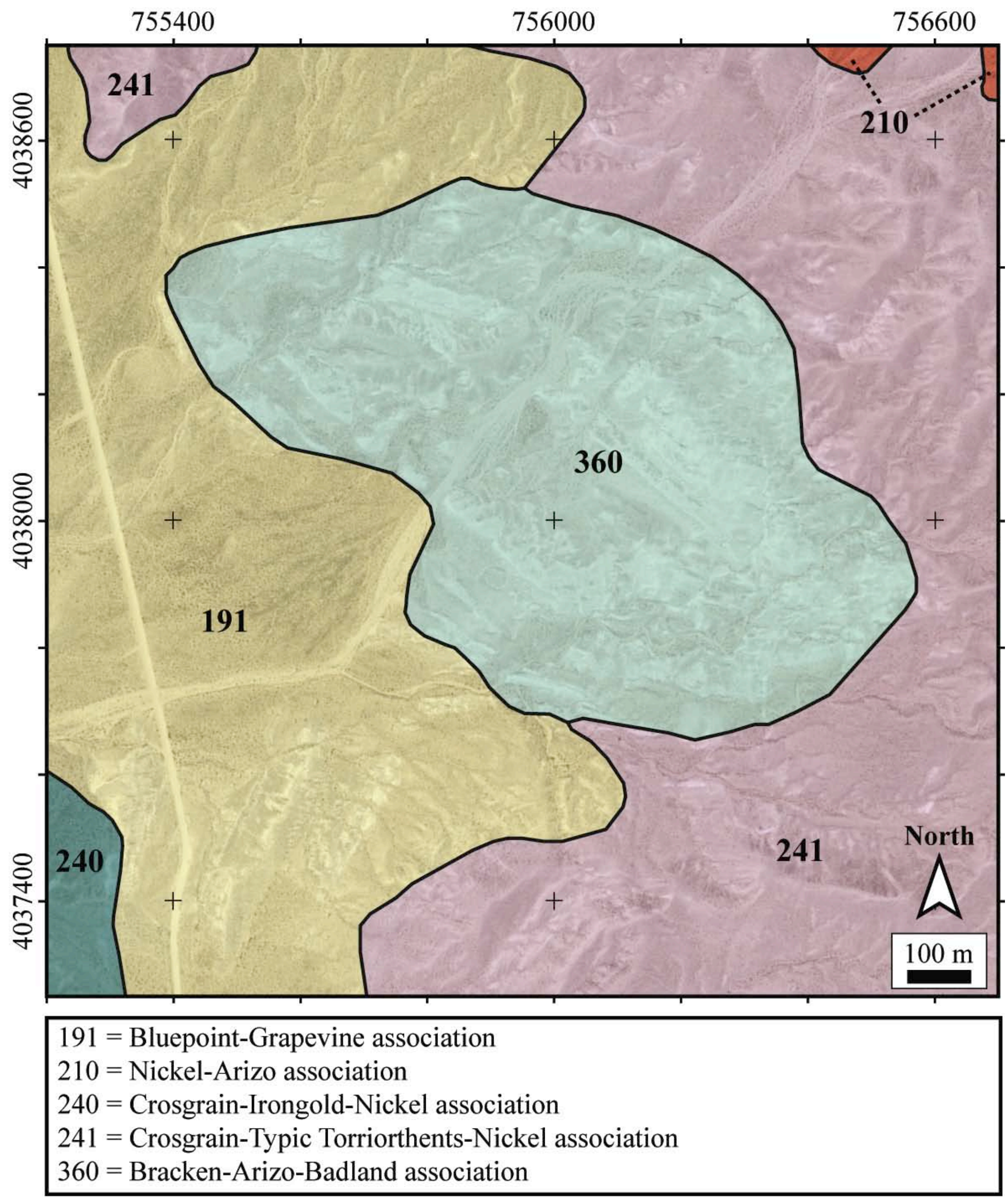

Figure 2-19: NRCS Soil Survey data for the Gold Butte study area, mapped at 1:24,000 (Soil Survey Staff, 2006; Soil Survey Staff, 2011). Five distinct soil associations are identified at Gold Butte. Data in this figure have been modified for display purposes and are shown beyond their intended scale – soil associations and complexes cannot reveal small areas of distinct soil types occurring within the area.

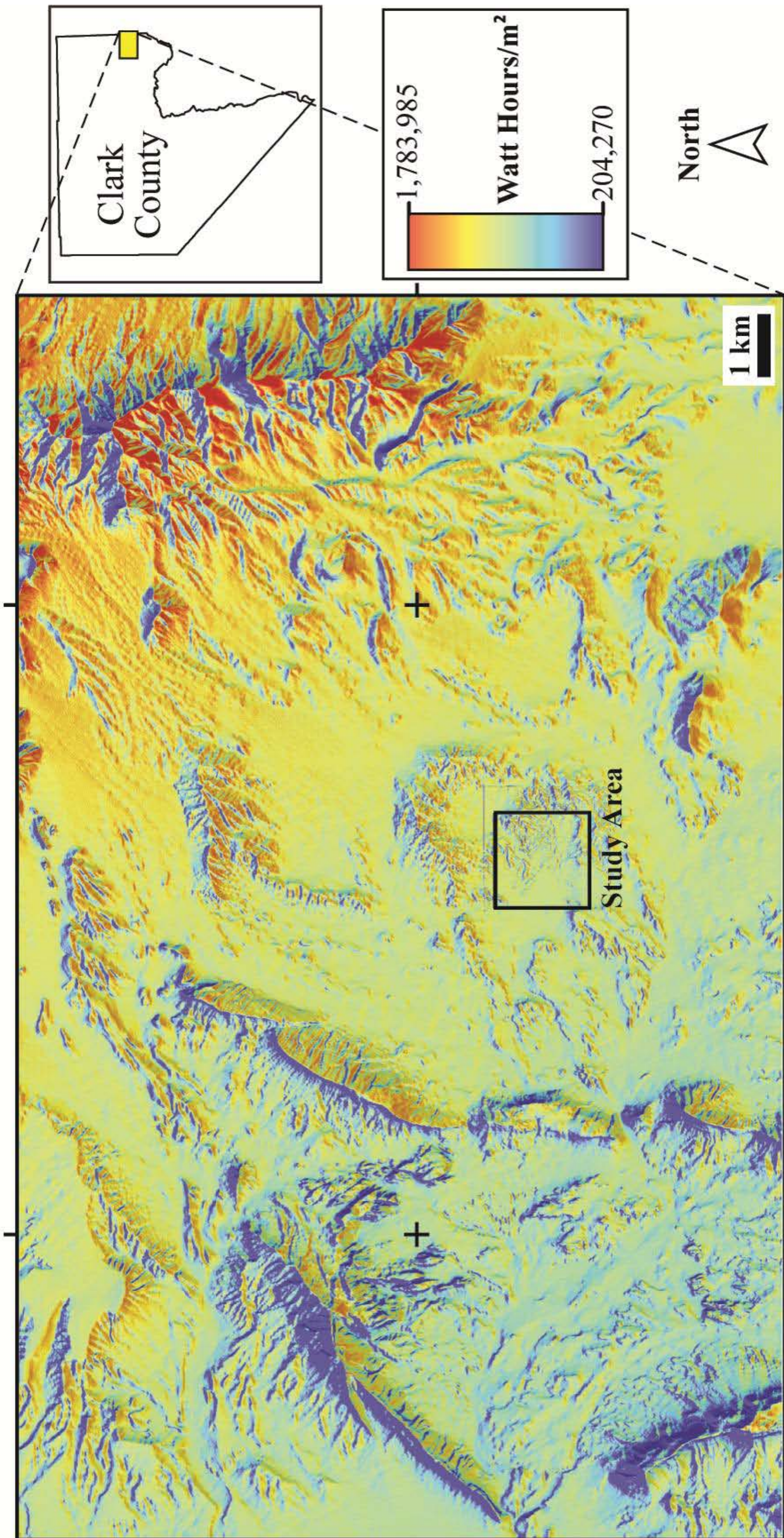

Figure 2-20: Solar insolation map of the greater Gold Butte study area. Coordinates are in meters (NAD 83 UTM 11N).

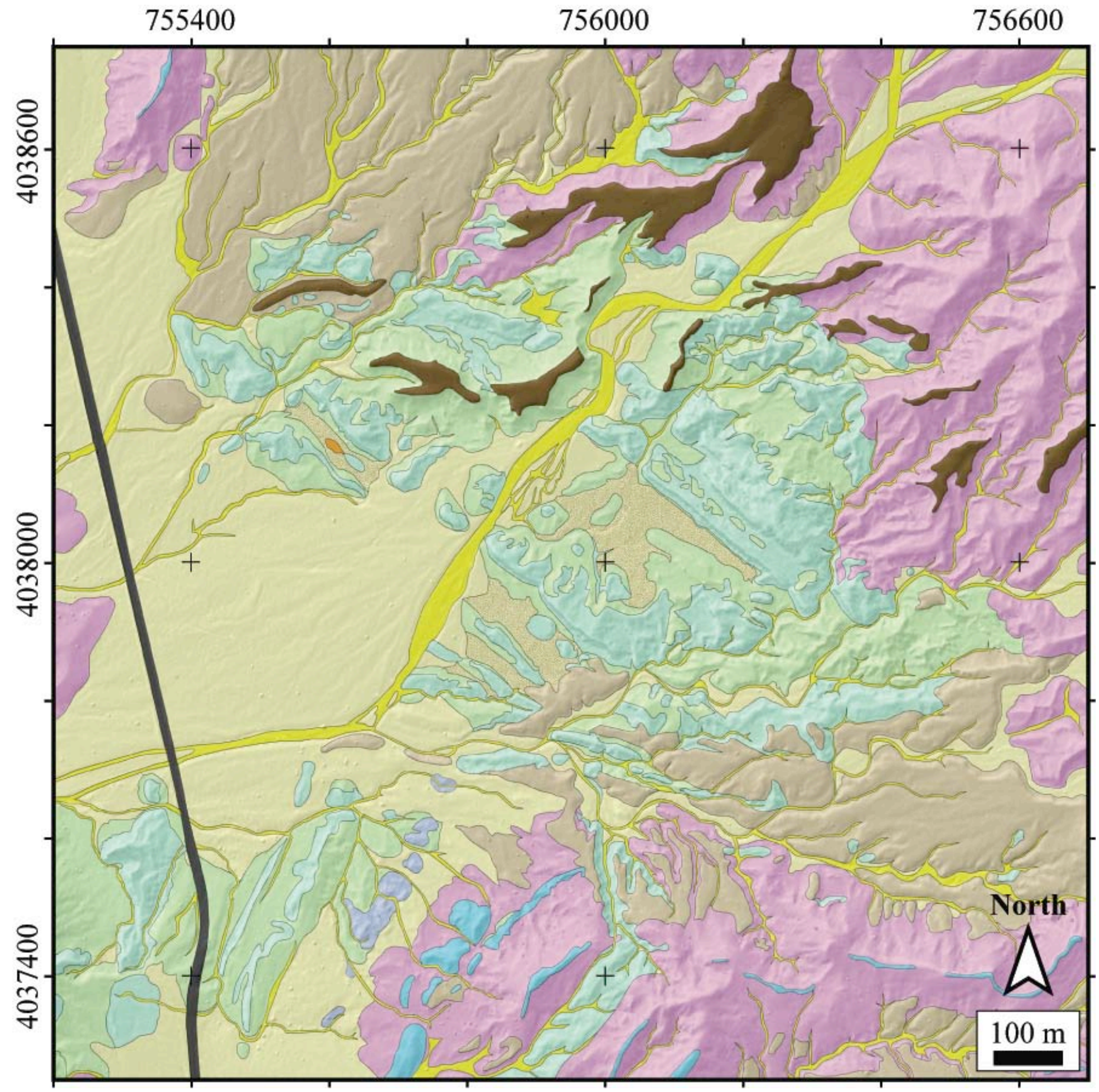

Figure 2-21: Surficial Geologic map of the Gold Butte study area (reduced from original 1:3,000 scale). The map unit key is shown on the next page.

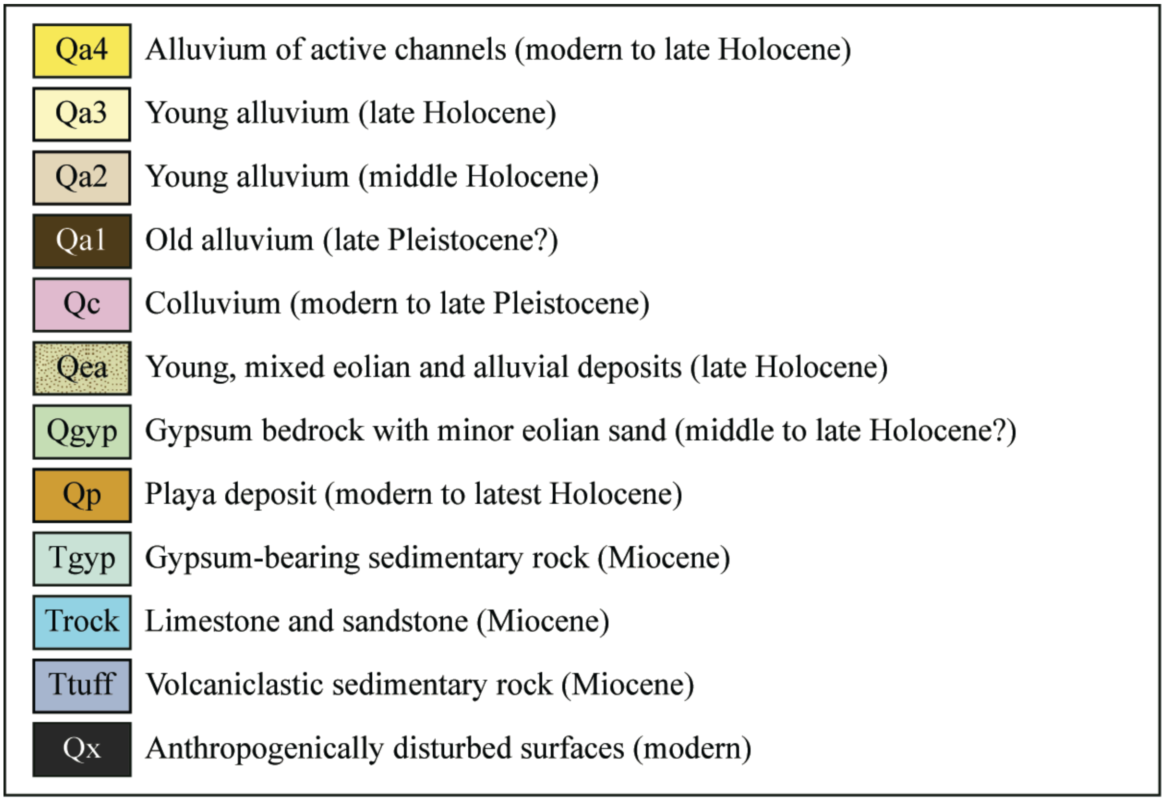

Figure 2-22: Key to the Gold Butte surficial geologic map (Figure 2-21).

Explanation of Gold Butte Surficial Geologic Map Units

***Qa4*: Alluvium of active channels (modern to late Holocene).** Active wash deposits composed of poorly to moderately sorted gravel and sand forming fresh bar and channel morphology and exhibiting little to no vegetation. Commonly found as rills and gullies cut into residuum with or without thin (< 10 cm) accumulations of bed sediment.

***Qa3*: Young alluvium (late Holocene).** Mostly inactive surfaces that occur up to 1 m above active washes. Commonly found as localized deposits within narrow inset valleys. Vegetation dominated by creosote and blackbrush. Surface is composed of poorly to moderately sorted gravel and sand that commonly grades into finer-grained thin colluvium upslope. Surface morphology composed of strong bar and swale topography often incised by active washes too small or discontinuous to map separately. Qa3 in the eastern portion of the map area contains well-developed patches of biological crusts. Soil development is weak, characterized by A or Av horizons overlying Bw, Bk or Bky horizons grading into C horizons. When present, carbonate morphology is very faint stage I (Gile et al., 1966). Stage I gypsum snowballs (e.g. Buck and Van Hosen, 2002) are present.

***Qa2*: Young alluvium (middle Holocene).** Inactive surfaces that occur 2 to 3 m above active washes. Composed of moderately sorted gravel, sand, and silt. Surface morphology composed of muted bar and swale topography. Thickness of this unit is variable with the Horse Springs Formation occurring at shallow depths (< 25 cm) near eroded slopes of this unit. Weakly to moderately developed desert pavement occurs especially where this unit grades into Trock. Soil development is characterized by A or Av horizons overlying Bk or By horizons grading into BC or C horizons with very faint stage I carbonate morphology (Gile et al., 1966) and stage I gypsum snowballs (e.g. Buck and Van Hoesen, 2002).

***Qa1*: Old alluvium (late Pleistocene?).** High-standing, inactive, fan remnant composed of poorly sorted gravel and sand deposited on steeply dipping gypsum-bearing sedimentary rocks of the upper Horse Springs Fm. This unit is approximately 10 meters above active washes, and exhibits well-developed desert pavement and planar surface morphology.

***Qc:* Colluvium (modern to late Pleistocene).** Undivided unit comprised of sand and gravel of variable thickness, with localized eroded clasts from Trock, Tgyp, Ttuff or Qa1 on moderately steep to very steep slopes (>10-30°). Qc deposits mantle residual bedrock hills, channel cut banks, and steep sideslopes to Qa1.

***Qea*: Young, mixed eolian and alluvial deposits (late Holocene).** Inactive surfaces primarily occurring in swales between resistant outcrops of gypsiferous bedrock. Composed of alluvial and eolian sand, silt, and gypsum residuum. Surface clasts are sparse to absent. Biological crusts containing pinnacles of Collema, Psora, and other cryptogams are abundant and give this surface a darker color where sand dominates; a lighter color where gypsum dominates. Biologic crusts are absent in minor active channels (10-30 cm wide, < 5 cm deep) that transport alluvium across this surface from Tgyp and Qgyp upslope. Qea grades gradually into Qgyp upslope, and is topographically similar in elevation and is considered age-equivalent to Qa3. Soil profiles are variable: surface horizons vary between Av and A; subsurface horizons may be Bw, By or rarely Bky overlying C or Cr. When present, pedogenic gypsum occurs as stage I snowballs (e.g. Buck and Van Hoesen, 2002).

***Qgyp*: Gypsum bedrock with minor eolian sand (middle to late Holocene?)** Inactive summit and sideslope surfaces of Tgyp covered by thin (< 20 cm) deposits of fine eolian sand. Dark, pinnacled biological soil crusts dominate this surface and contrast greatly with white gypsum exposed as Tgyp. Soils commonly have Av-By-C/Cr horizons.

***Qp*: Playa deposit (modern to latest Holocene).** Flat-lying deposit of even proportions of silt and fine sand with soluble minerals. When dry, the surface is characterized by polygonal desiccation cracks and surface efflorescence. Vegetation is sparse. Soils are characterized by A-By-Cr horizons.

***Tgyp*: Gypsum-bearing sedimentary rock (Miocene).** Includes resistant, bedded gypsum or gypsum marl of the upper Horse Springs Formation (Thumb member) (Beard et al., 2007).

***Trock*: Limestone and sandstone (Miocene).** Well-lithified, thinly bedded limestone and calcareous sandstone of the Horse Springs Fm (Thumb member) (Beard et al., 2007).

***Ttuff*: Volcaniclastic sedimentary rock (Miocene).** Tuffaceous siltstone within the Thumb member of the Horse Springs Fm.

***Qx*: Anthropogenically disturbed surfaces (modern).** Anthropogenically disturbed sediment and rock surfaces in established and maintained dirt roads. Individual 4x4 and utility vehicle tracks found within the study area are not mapped within this unit due to scale constraints.

Table 2-2: Gold Butte Map Units and Soil Profile Sites

Map Unit	Soil profile sites within each unit
Qa4	N/A
Qa3	9, 10, 24, 31, 32, & 33
Qa2	16 & 25
Qa1	N/A
Qc	N/A
Qea	1, 2, 4, 6, 7, 8, 12, 14, 15, 29, & 30
Qgyp	0, 3, 11 18, 19, 22, 26, & 37
Qp	23
Tgyp	5, 13, 17, 21, 34, & 36
Trock	N/A
Ttuff	N/A
Qx	N/A

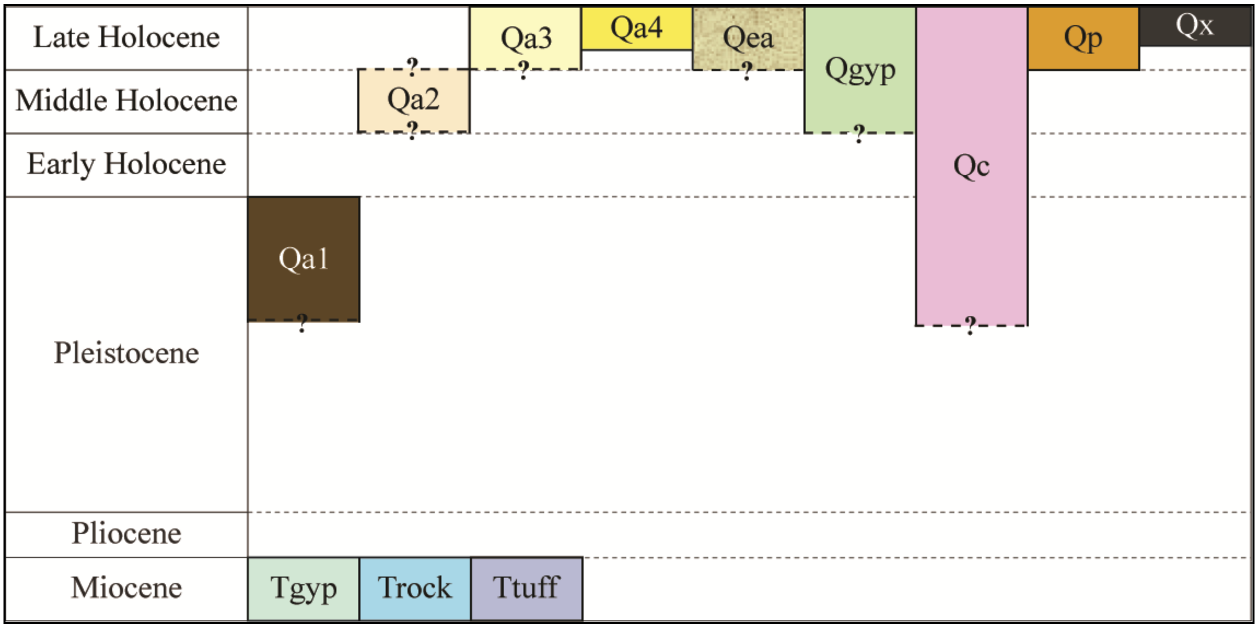

Figure 2-23: Approximate age relationships among the Gold Butte surficial geologic map units.

Photographs of the Gold Butte Surficial Geologic Map Units

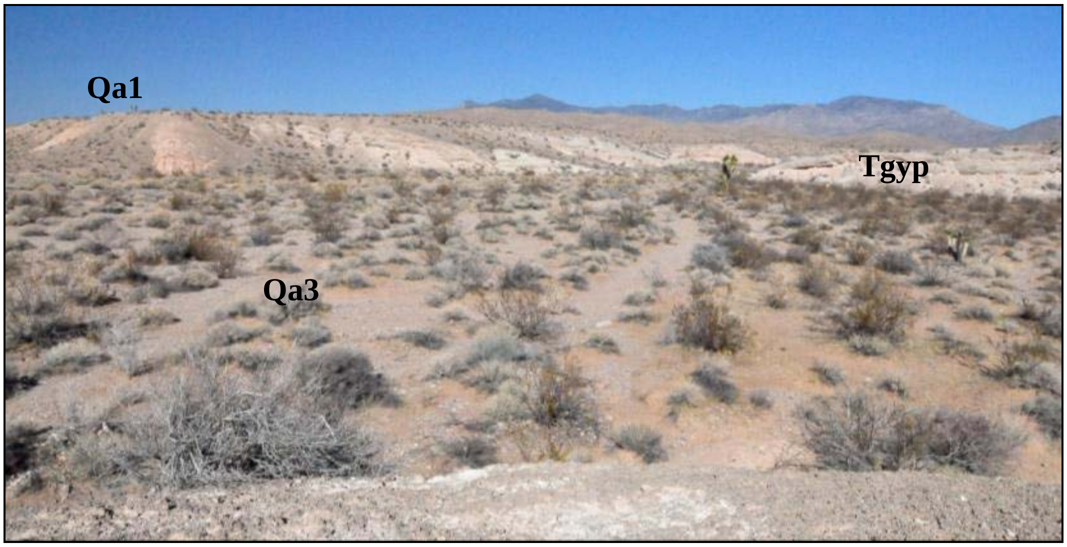

Figure 2-24: Relationship between Qa1, Qa3, and Tgyp. Elevation of the erosional surface of Tgyp in most of the field area is roughly correlative with the elevation of the Qa2 surface. Qa1 is typically 2 to 3 meters higher. The Qa1 surface is graded at a slightly shallower angle than Qa2, and originates from a higher elevation.

Figure 2-25: Cobbly desert pavement on the surface of Qa2.

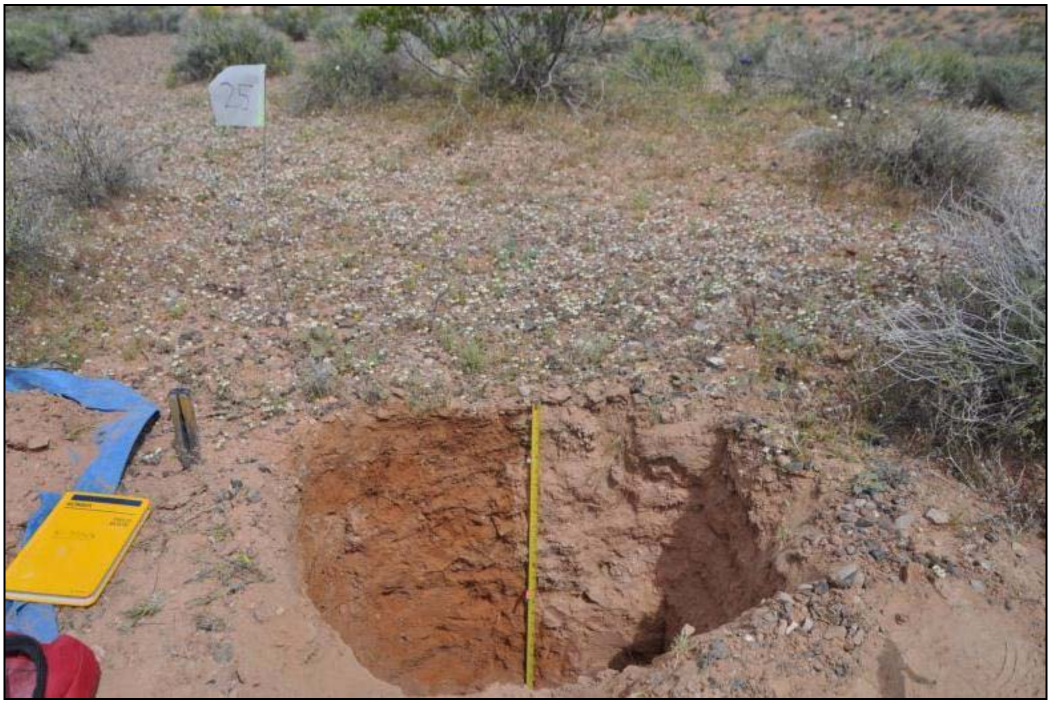

Figure 2-26: Qa2 surface and fine, sandy sediments shown in a soil profile excavation.

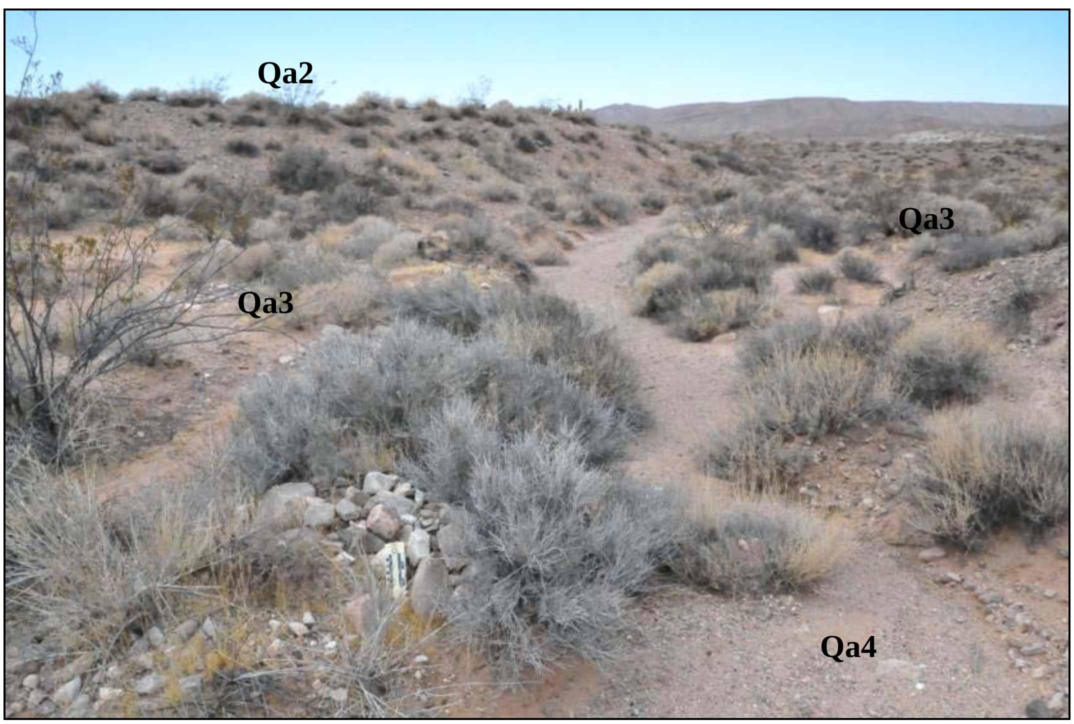

Figure 2-27: Morphostratigraphic relationships between units Qa4, Qa3, and Qa2.

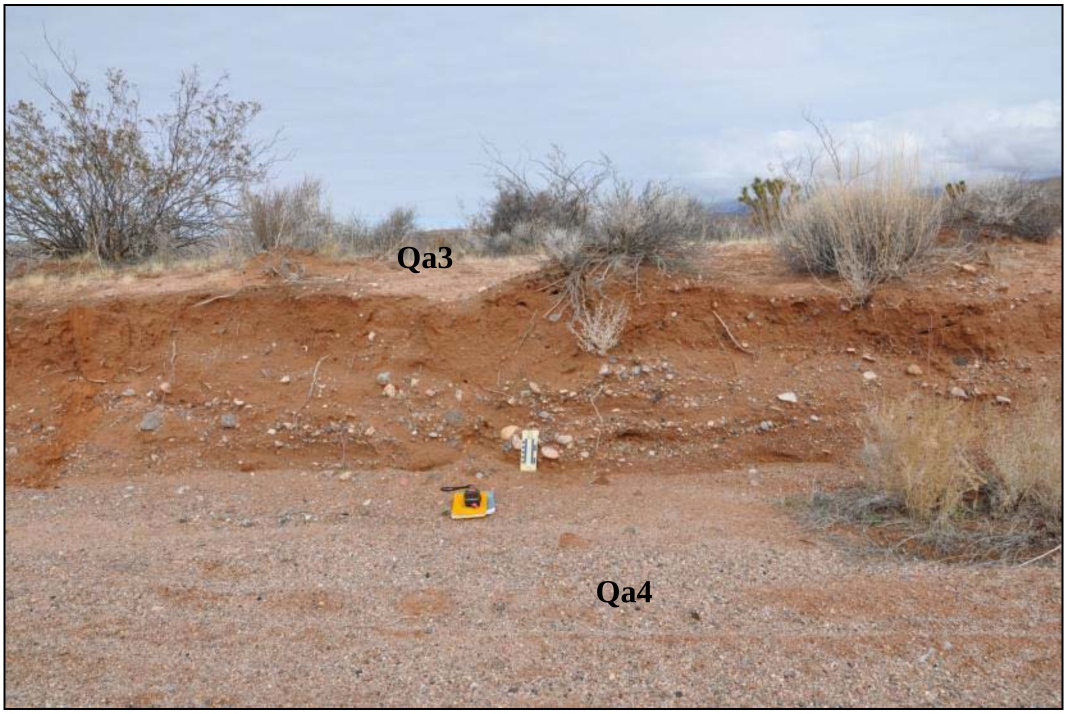

Figure 2-28: Qa3 alluvium and geomorphic surface above Qa4.

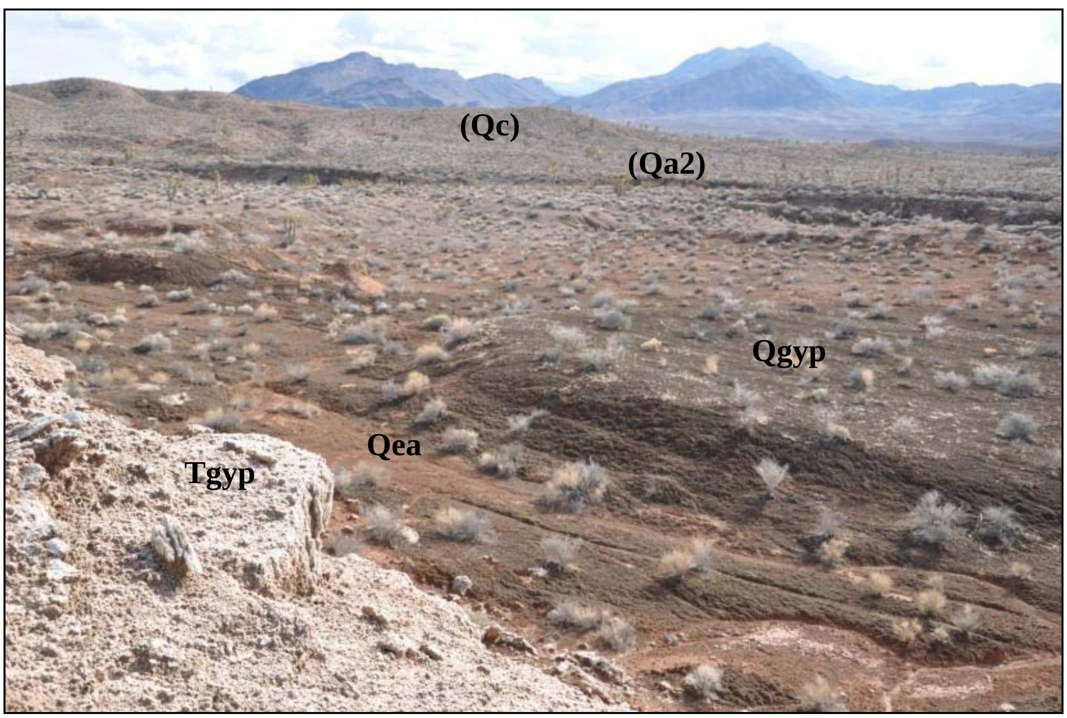

Figure 2-29: Tgyp, Qgyp, and Qea (from ~N to S). Qc hill slopes and the Qa2 surface are visible in the background.

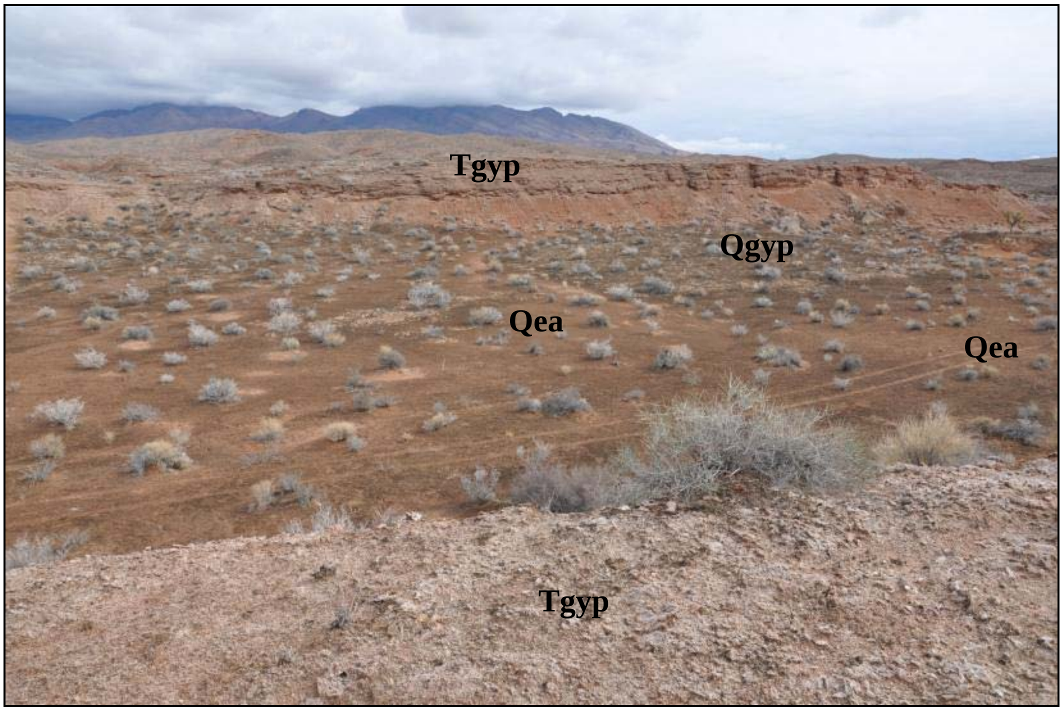

Figure 2-30: View from opposite the ridge used as the vantage point in Figure 2-29. Photograph taken from SSW to NNE.

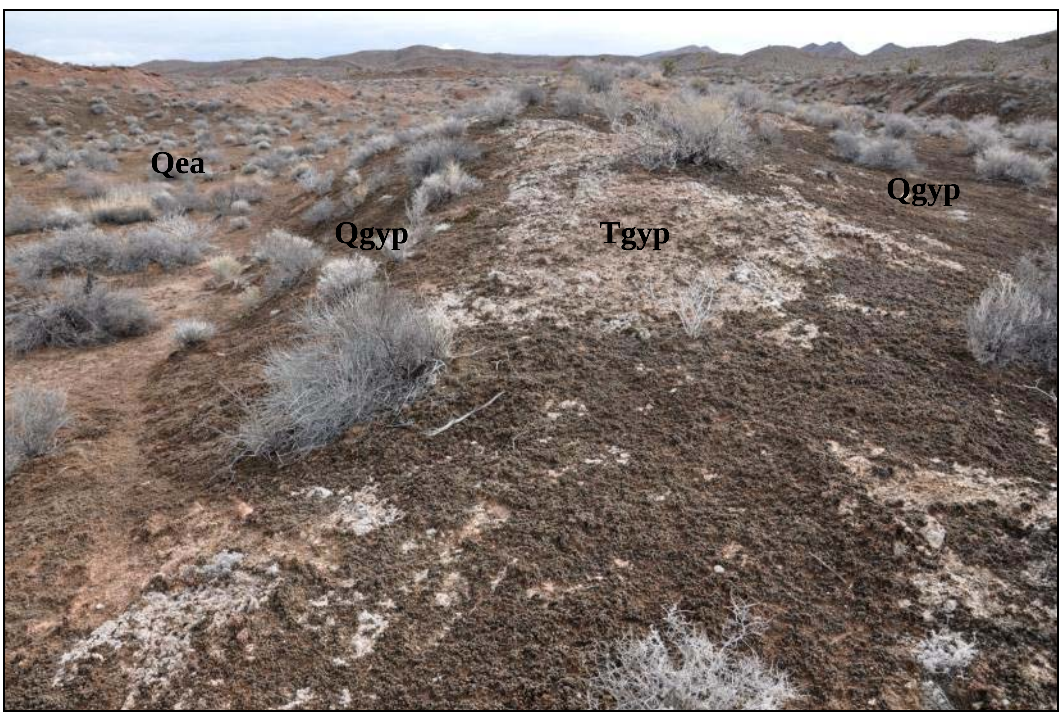

Figure 2-31: Relationships between units Tgyp, Qgyp, and Qea.

Figure 2-32: Soil profile excavation in unit Qea below a buckwheat plant.

Figure 2-33: Soil profile excavation in unit Qp. Desiccation polygons are faintly visible behind and to the right of the pit.

Figure 2-34: Outcrop of unit Ttuff.

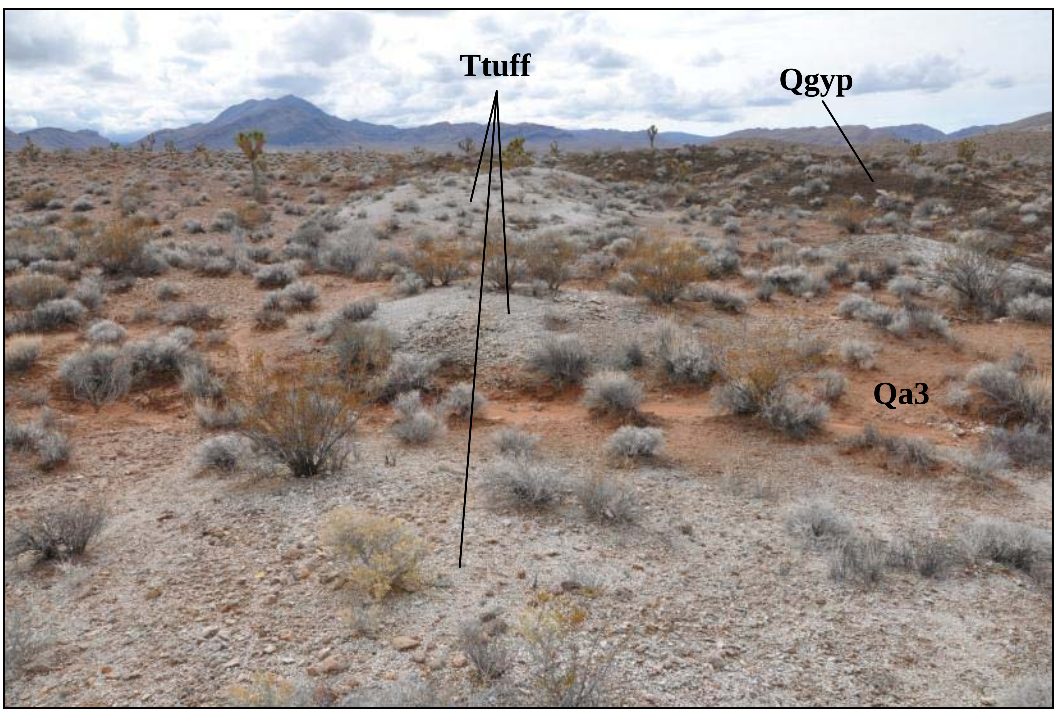

Figure 2-35: Outcrops of pale Ttuff outcrops amid deposits of unit Qa3 (redder). Unit Qgyp, mantled with biological soil crusts, is visible as the darker material in the background.

Figure 2-36: An example of Trock. In this photo it occurs as thinly-bedded calcareous siltstone.

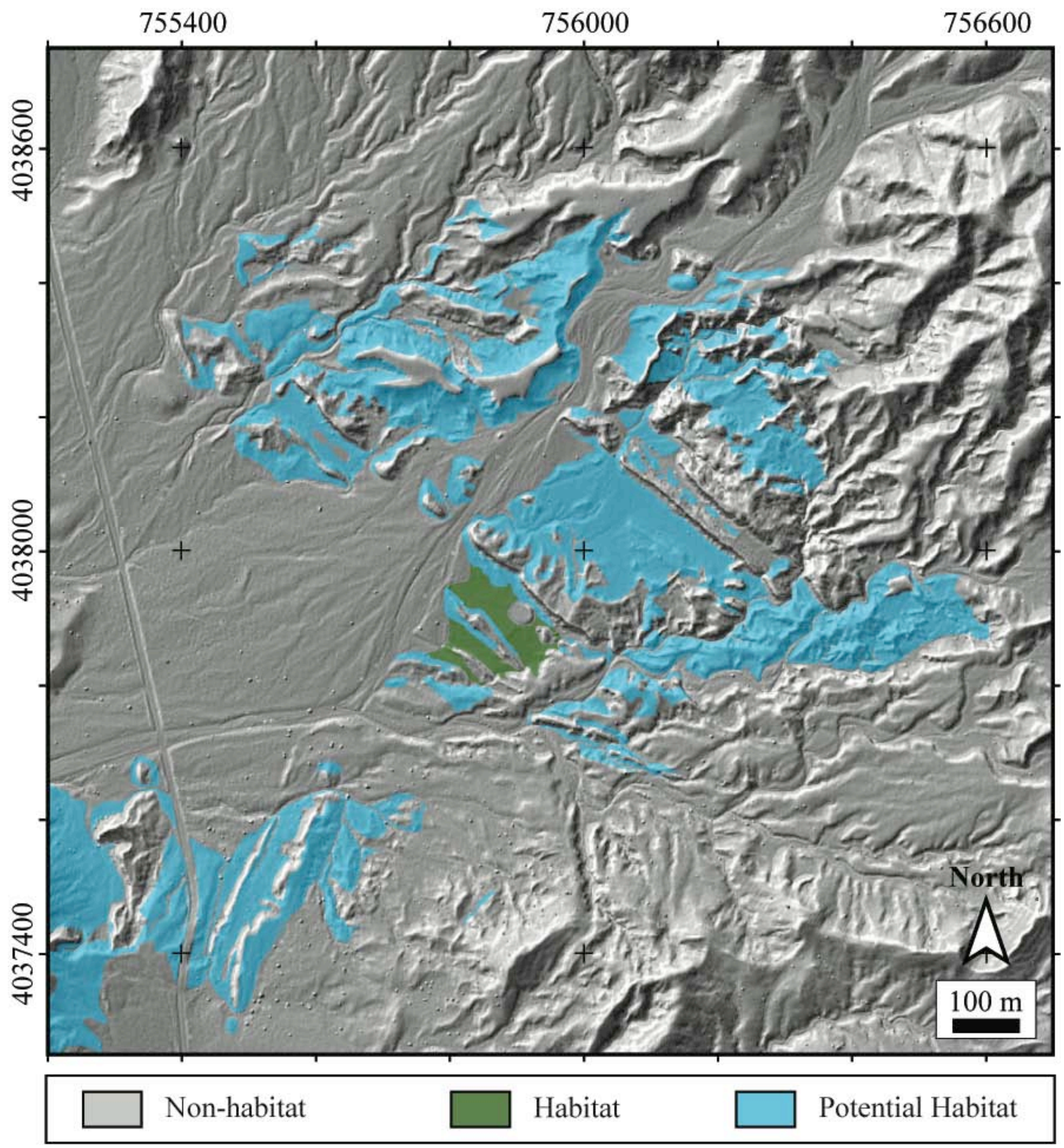

Figure 2-37: Distribution of buckwheat habitat classes within the Gold Butte study area.

C. Surficial Geology of the Bitter Spring Study Area

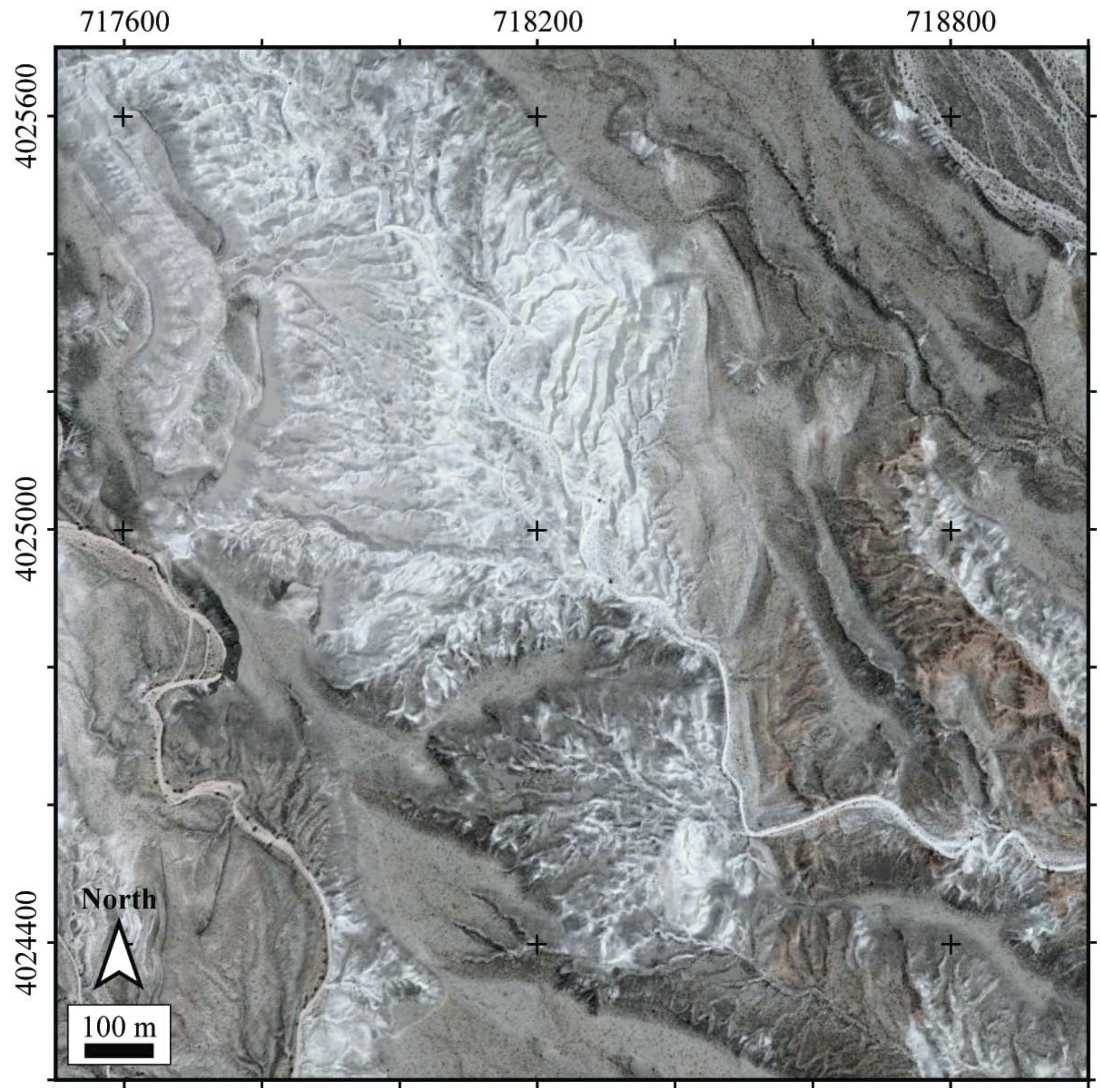

Figure 2-38: Contrast-enhanced NAIP imagery (USDA-FSA, 2006) of the Bitter Spring study area, superimposed over a LiDAR-derived slopeshade.

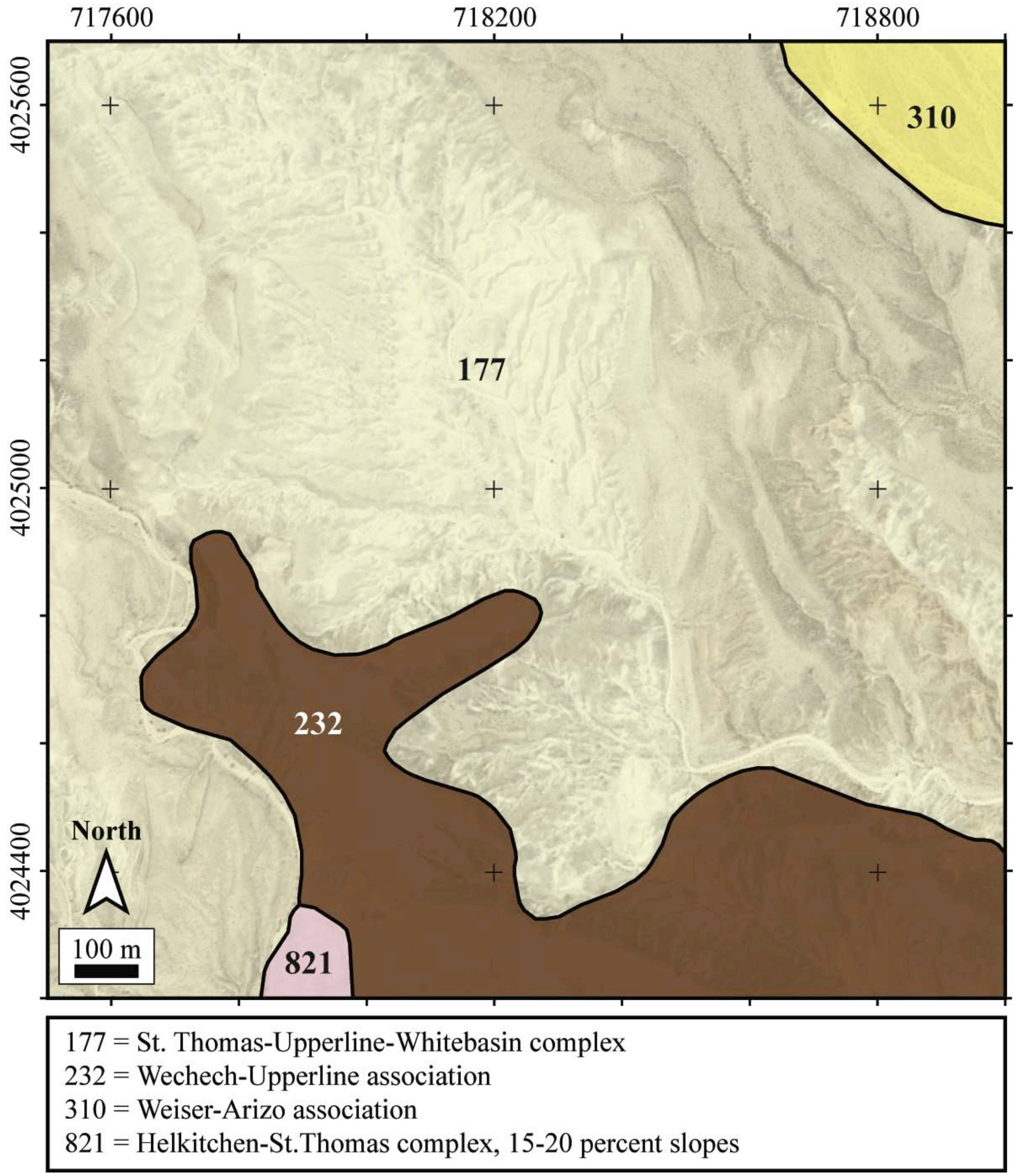

Figure 2-39: NRCS Soil Survey data for the Bitter Spring study area, mapped at 1:24,000 (Soil Survey Staff, 2006; Soil Survey Staff, 2011). Two soil associations and two complexes are identified. Data in this figure have been modified for display purposes and are shown beyond their intended scale – soil associations and complexes cannot reveal small areas of distinct soil types occurring within the area.

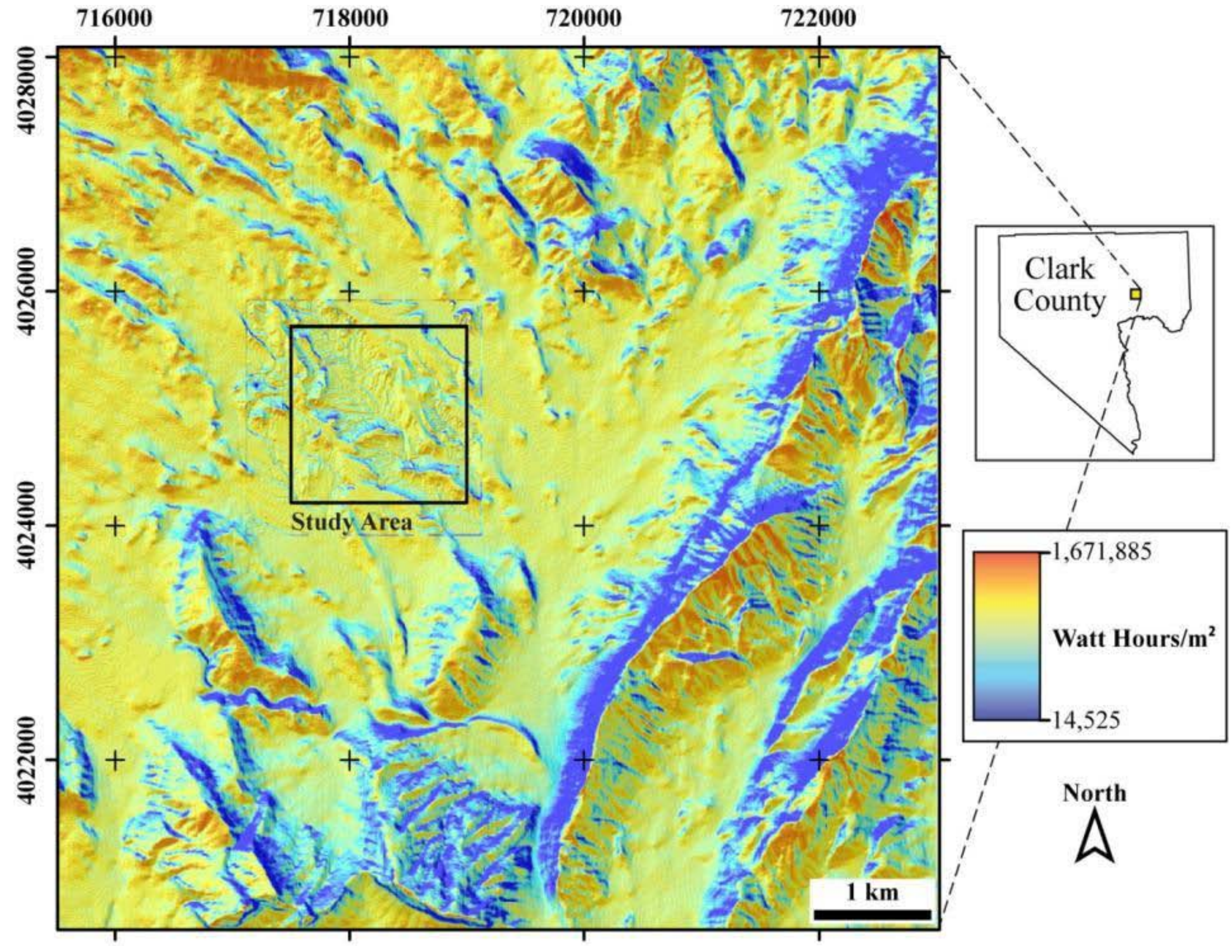

Figure 2-40: Solar insolation map of the greater Bitter Spring study area. Coordinates are in meters (NAD 83 UTM 11N).

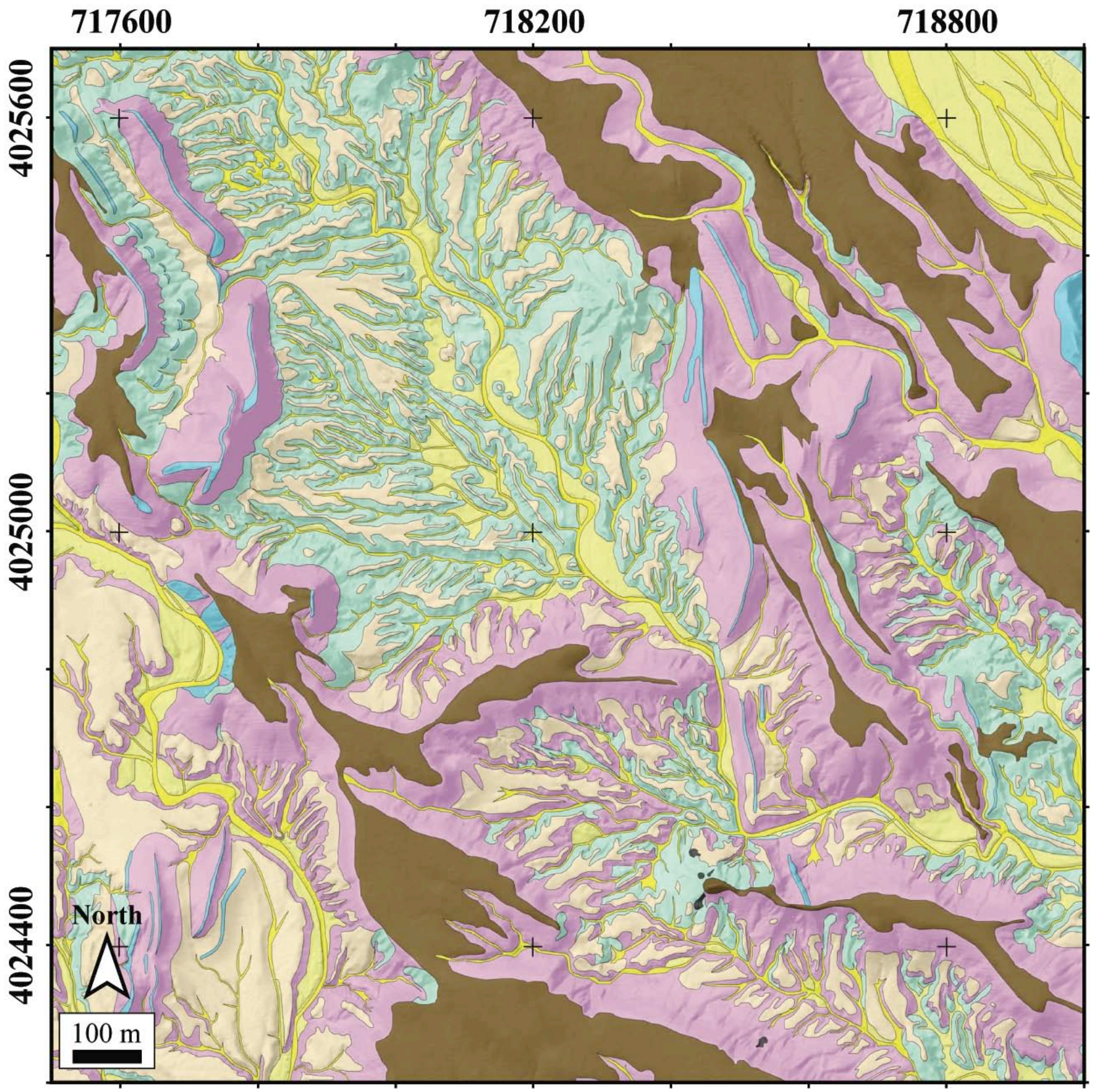

Figure 2-41: Surficial geologic map of the Bitter Spring study area (reduced from original 1:3,000 scale). The map unit key is shown on the next page (Figure 2-42).

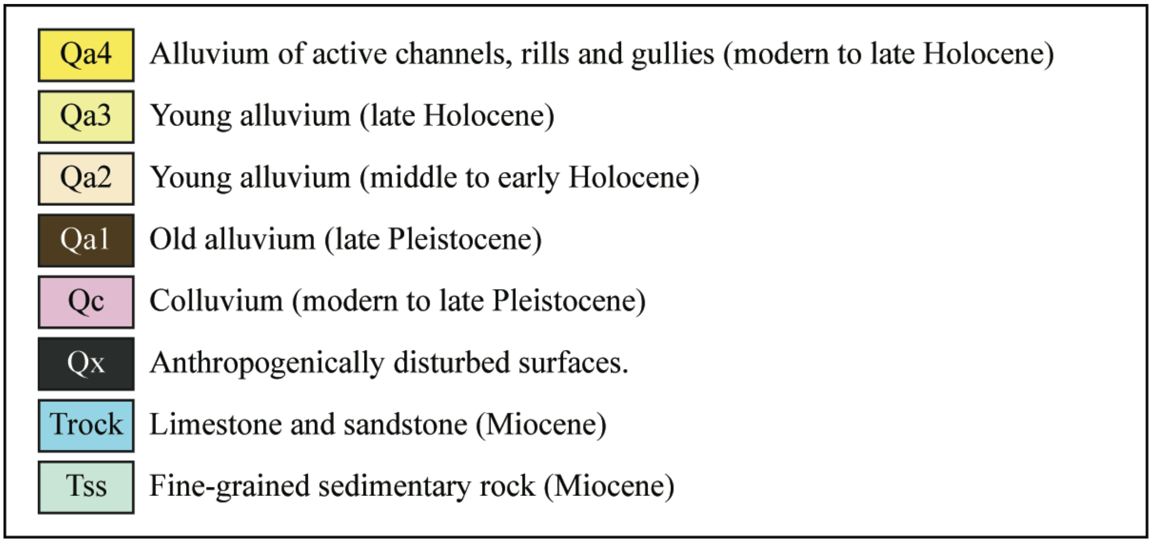

Figure 2-42: Key to the Bitter Spring surficial geologic map (Figure 2-41)

Explanation of the Bitter Spring Surficial Geologic Map Units

***Qa4*: Alluvium of active channels, rills and gullies (modern to late Holocene).** Active wash deposits composed of poorly to moderately sorted sand with some gravel, forming fresh bar and channel morphology and exhibiting little to no vegetation. Commonly found as rills and gullies cut into residuum with or without thin (< 10 cm) accumulations of bed sediment.

***Qa3*: Young alluvium (late Holocene).** Mostly inactive surfaces that occur up to 1 m above active washes. Composed of poorly to moderately sorted sand, silt and gravel that may grade into thin colluvium or alluvium washed from small rills upslope. Surface morphology composed of bars and swales. Vegetation dominated by creosote and blackbrush; occasionally vegetated by the Las Vegas buckwheat. Soil development is weak, characterized by A-By-C/Cr or A-C/Cr horizons, with the sum of A and B horizons commonly totaling < 50 cm in thickness.

***Qa2*: Young alluvium (middle to early Holocene).** Inactive surfaces composed of gravelly or cobbly sand that occur approximately 2 m above Qa3. Characterized by well-developed planar surface morphology, and strongly to moderately developed desert pavement. Surface clasts are composed primarily of Paleozoic sedimentary rocks, chiefly limestone. Depth to weathered Tss or Trock is on the order of 50 cm, but may be locally shallow (< 25 cm). Soil development is characterized by an A or Av horizon overlying By or Bk horizons (depending on local parent material mineralogy) containing stage I gypsum snowballs (e.g. Buck and Van Hoesen, 2002) and/or stage I carbonate filaments (e.g. Gile et al., 1966; Bachman & Machette, 1977).

***Qa1*: Old alluvium (late Pleistocene).** Inactive fan remnants composed of alluvial gravel and sand. Planar surface with moderate to well-developed desert pavement in large (up to ~ 9 m^2) interspaces between creosote, blackbrush, and other vegetation. Qa1 surfaces are 15 to 20 m above active washes. Alluvium is several meters thick and overlies Tss and Trock. Soil development is characterized by Av horizons overlying Bk-Bkm horizons exhibiting strong stage III carbonate morphology (Gile et al., 1966; Bachman & Machette, 1977). Petrocalcic fragments are common where surface soil is eroded.

***Qc*: Colluvium (modern to late Pleistocene).** Undivided unit comprised of coarse, cobbly to gravelly colluvium and sandy alluvium on steep sideslopes (>10-15˚). Thickness can vary from a layer one cobble thick, up to several decimeters at the base of slopes. This unit is most commonly found on sideslopes of Qa1, Qa2, or Trock.

***Qx*: Anthropogenically disturbed surfaces**. Mine spoil, slag (1920's) and bulldozed tranches (1920's to 1980's?). Individual 4x4 and/or utility vehicle tracks occur throughout the study area, but are not included in this mapping unit.

***Trock*: Limestone and sandstone (Miocene).** Well-lithified, thinly bedded limestone and calcareous sandstone of the Horse Springs Fm (Thumb member) (Beard et al., 2007). Strata in map area generally dip to the west at ~ 45˚. Discontinuous or thin (< 1m thick) exposures commonly occur within Tss and Qa4 units and are not mapped within this unit.

***Tss*:** **Fine-grained sedimentary rock (Miocene).** Poorly-lithified siltstone, claystone, and gypsum marl of the Red Sandstone Unit and/or upper Horse Springs Fm. (Thumb member) (Beard et al., 2007). Primarily occurs as badlands, with exposures in steep, unstable sideslopes. May be thinly mantled with gravel derived from Qa2, Qa1, or Qc.

Table 2-3: Bitter Spring Map Units and Soil Profile Sites

Map Unit	Soil profile sites within each unit
Qa4	N/A
Qa3	6, 11
Qa2	5, 7, 10, 15, 17, 18, 22, 24, & 25
Qa1	4 & 21
Qc	2
Qx	N/A
Trock	N/A
Tss	0, 1, 3, 8, 9, 12, 14, 16, 19, 23, 26, 27, 28, & 29

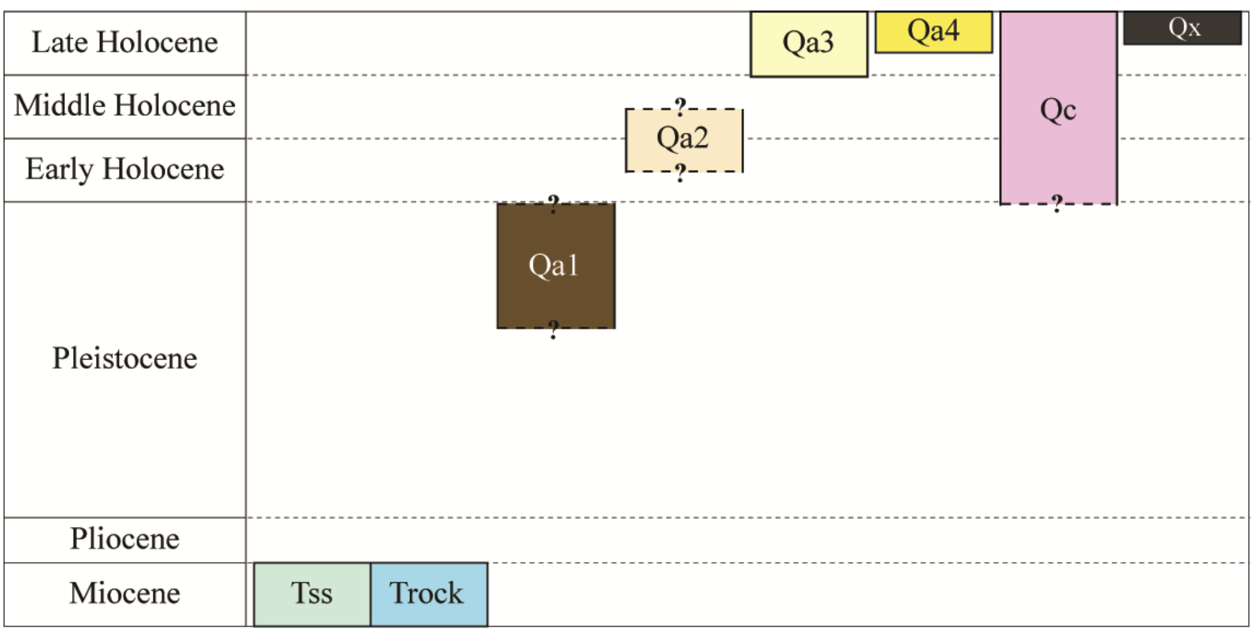

Figure 2-43: Approximate age relationships among the Bitter Spring surficial geologic map units.

Photographs of the Bitter Spring Surficial Geologic Map Units

Figure 2-44: Qa1 surface with cobble-sized fragments of pale, reddish, degraded, stage III calcic soil visible in lower left.

Figure 2-45: Gully cut bank revealing a characteristic soil profile (w/ some case hardening) in Qa1 sediments.

Figure 2-46: Gully cut bank revealing the gravelly calcic soil profile of unit Qa1.

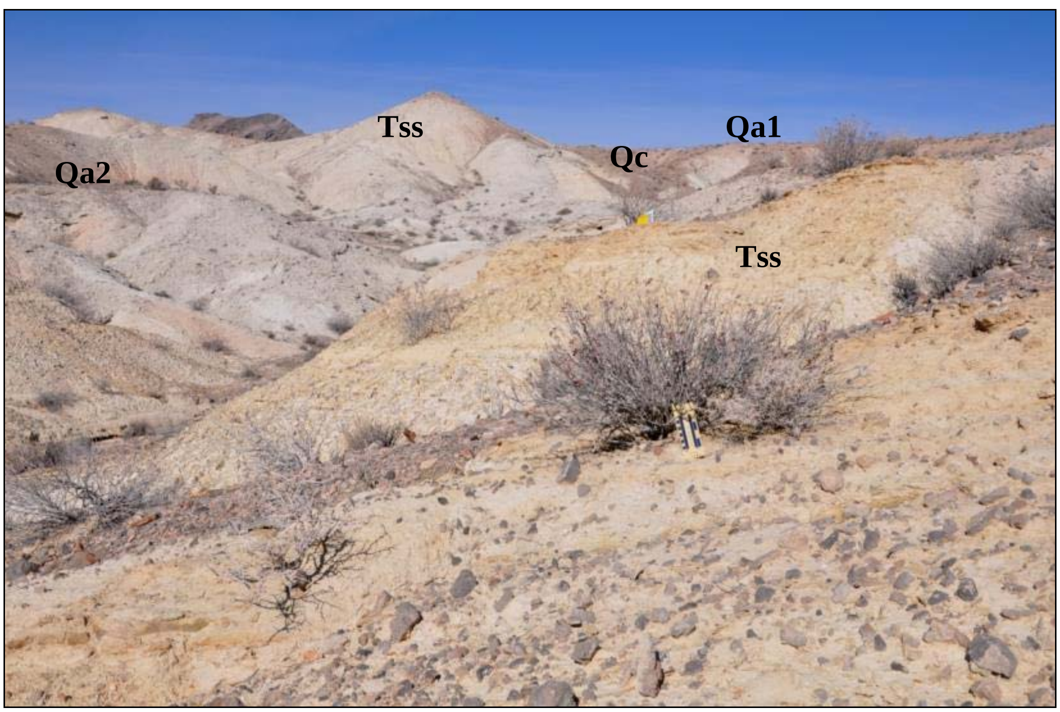

Figure 2-47: Examples of units Tss, Qa1, Qa2, and Qc. Sparse mantles of colluvium or residual pebbles from Qa2 are almost ubiquitous on Tss.

Figure 2-48: Sedimentary strata of Tss exposed beneath a thin colluvial mantle from eroding Qa2 sediments.

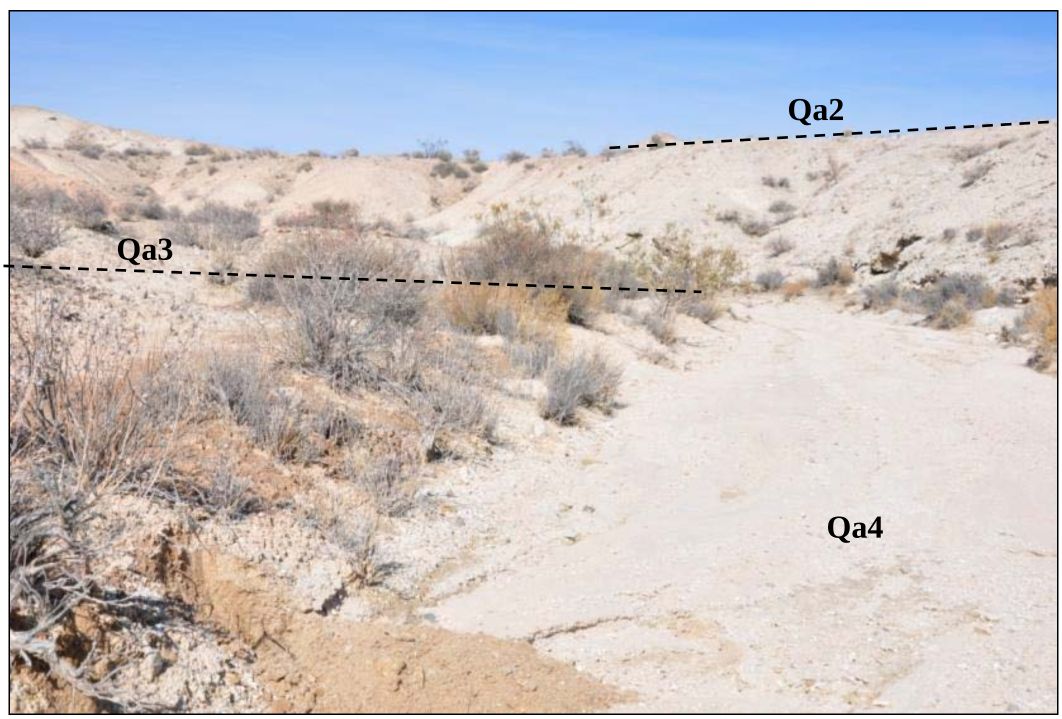

Figure 2-49: Relative surface elevations of alluvial units Qa4, Qa3, and Qa2.

Figure 2-50: Overview of the Bitter Spring study area. Outcrop of Trock in left foreground; relative surface elevations of Qa1 and Qa2 visible in right background. Tss is also visible as paler, sparsely vegetated to bare patches on side slopes.

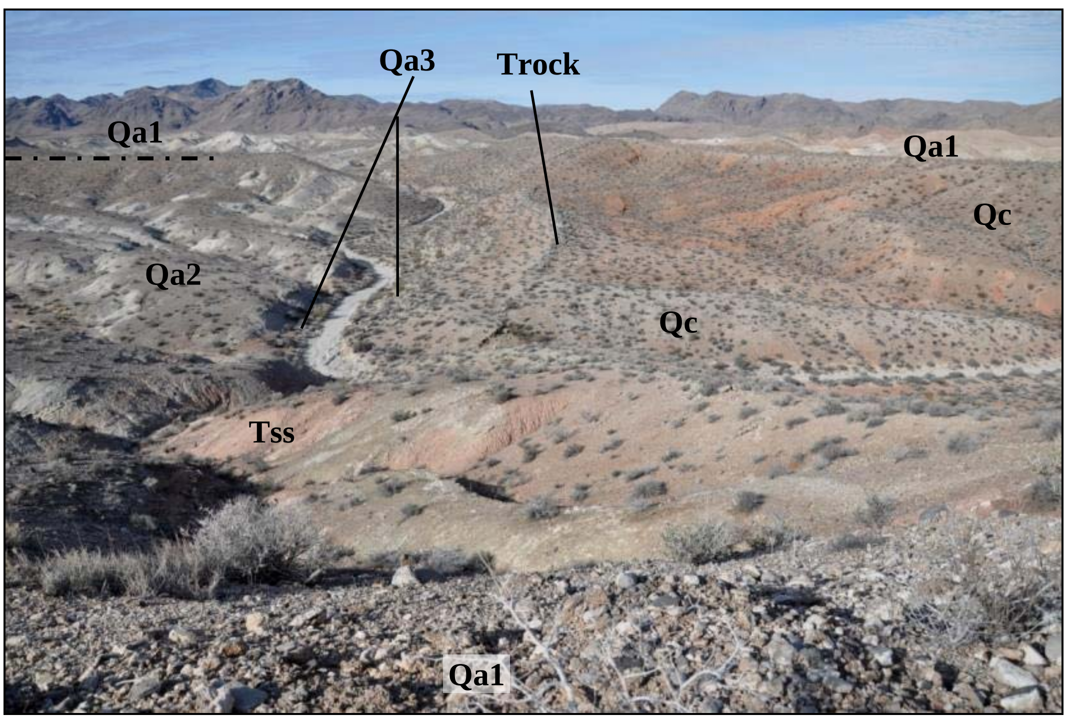

Figure 2-51: View to the north from atop a narrow ridge of Qa1 in the south central part of the Bitter Spring study area.

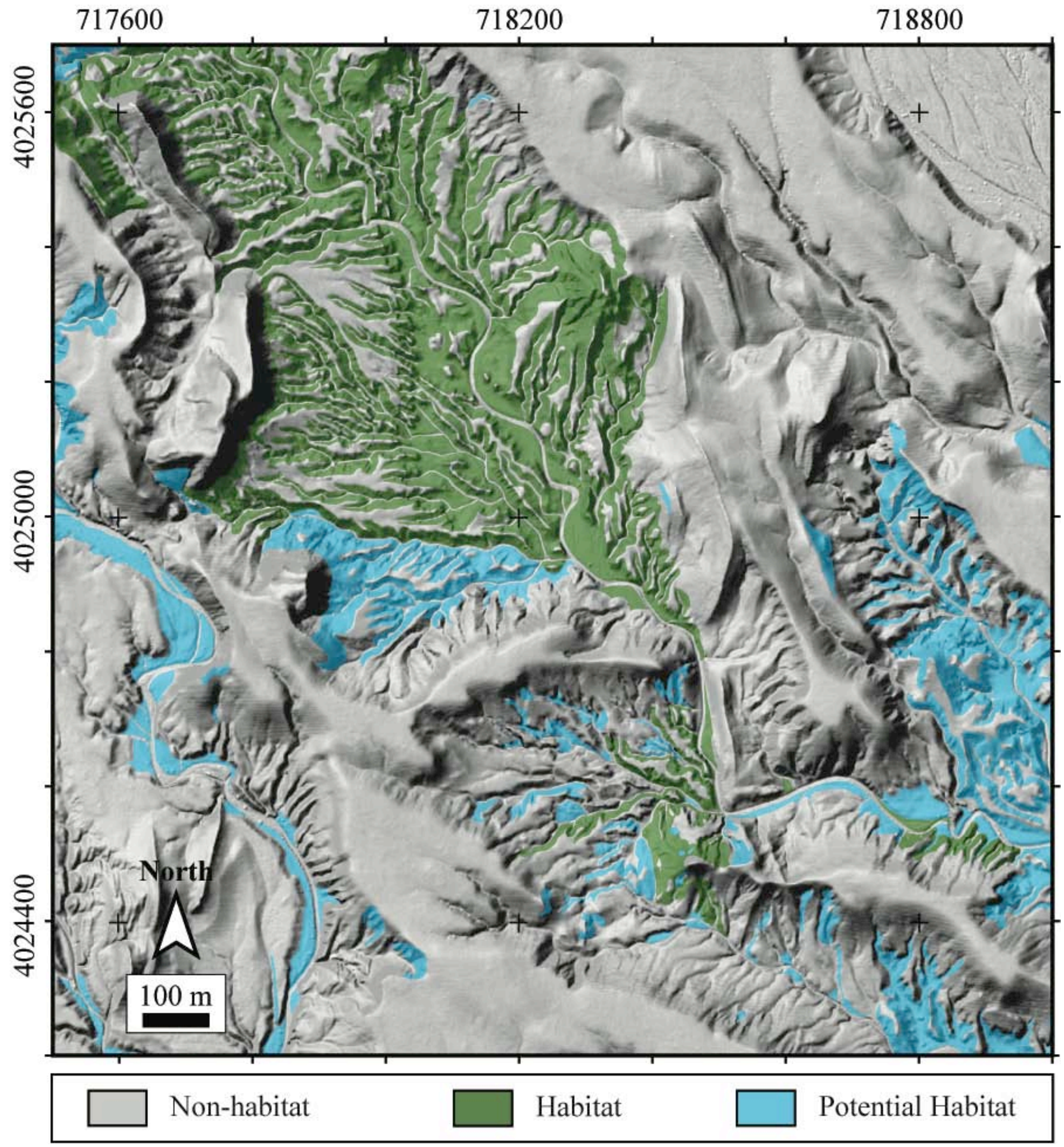

Figure 2-52: Distribution of buckwheat habitat classes within the Bitter Spring study area.

D. Additional Data and Statistical Results for All Study Areas

The total area of each habitat class was calculated in ArcGIS, and is summarized by study area in Table 2-4a (hectares) and 2-4b (percent of study area) for all sites.

Table 2-4a: Habitat Class Areas (hectares)			
Habitat Class	**Gold Butte**	**Coyote Springs**	**Bitter Spring**
Habitat	1.21	49.10	32.21
Potential Habitat	32.27	90.59	18.81
Non-Habitat	191.78	260.63	174.15
Total area (hectares)	225	400	225
Table 2-4b: Habitat Class Areas (% of total area)			
Habitat	0.5	12.3	14.3
Potential Habitat	14.3	22.6	8.4
Non-Habitat	85.1	65.1	77.3

Chi square tests of aspect classes and surficial geologic map units did not return significant results, except when comparing Coyote Springs map unit Qlv-summit against the presence/absence of buckwheat (Table 2-5).

Table 2-5: Summary of Chi-Square Test for Coyote Springs Unit Qlv-summit				
		No BW	**BW**	**Total**
Other Map Units (not Qlv Summit)	Count	14	1	15
	% within Qlv-summit	93.3%	6.7%	100.0%
	% within all	66.7%	9.1%	46.9%
	% of Total	43.8%	3.1%	46.9%
Qlv Summit	Count	7	10	17
	% within Qlv-summit	41.2%	58.8%	100.0%
	% within all	33.3%	90.9%	53.1%
	% of Total	21.9%	31.3%	53.1%
Total	Count	21	11	32
	% within Qlv-summit	65.6%	34.4%	100.0%
	% within all	100.0%	100.0%	100.0%
	% of Total	65.6%	34.4%	100.0%

Chi-square with Yates Continuity Correction
Asymp. Signif. = 0.006

IV. Discussion & Interpretation

All three study areas are similarly comprised of a range of geomorphic surfaces spanning the late Pleistocene through the Holocene as well as outcrops of late Pleistocene and Miocene bedrock. Ages of the surficial map units were estimated by comparing their soil development and surficial characteristics to similar surfaces in the region. This includes alluvial fans north and west of Las Vegas (Sowers et al., 1988; Bell et al., 1998, 1999; Page et al., 2005), south of Las Vegas in the Ivanpah Valley (House et al. 2006; 2010), near the Nevada Test Site between Beatty and north Las Vegas (Taylor, 1986; Harden et al., 1991; Peterson et al., 1995), and in the central Mojave Desert near Silver Lake and the Providence Mountains (Wells et al, 1987; McFadden, 1988; Reheis et al., 1989; Harden et al., 1991; McDonald et al., 2003). Additionally, in the Coyote Springs study area, ages of surficial units were estimated by extrapolating the ages of the Las Vegas Formation in the northern Las Vegas Valley to the same unit in the study area (Longwell et al., 1965; Haynes, 1967; Quade et al., 1986; Quade and Pratt, 1989; Springer et al., 2008). In the Gold Butte and Bitter Spring study areas, formation names and ages of bedrock units were based off of map unit descriptions by Beard et al. (2007).

Alluvial deposits

Modern washes in the three study areas are still experiencing active stream deposition and erosion. These surfaces are labeled Qa5 in Coyote Springs, and Qa4 in Bitter Springs and Gold Butte. All three study areas also contain young geomorphic surfaces that are ~ 1 m or less above these modern, active channels. These higher surfaces are labeled Qa4 for Coyote Springs, and Qa3 for Bitter Springs and Gold Butte. These surfaces exhibit bar and swale surface morphology and very little soil development. Therefore Qa4 (Coyote Springs) and Qa3 (Bitter Springs and Gold Butte) are likely younger than the Qay2 surface of House et al. (2006, 2010). These surfaces also correspond well with other late Holocene surfaces in the region (see House et al., 2010; Fig. 40 for regional comparisons).

The next older surfaces are Qa3 in Coyote Springs and Qa2 in Bitter Springs and Gold Butte. Qa3 at Coyote Springs and Qa2 in Gold Butte have weak to moderate desert pavement and weak soil development. These surfaces are comparable to Qay2 in the Ivanpah Valley, south of Las Vegas (House et al., 2006; House et al., 2010) and are probably middle Holocene in age. The Qa2 surface at Bitter Springs may be slightly older and may extend into the latest part of the early Holocene based on its increased soil and desert pavement development. However, it is important to note that many factors affect the rate at which carbonate accumulates in arid soils including: (1) the amount of effective precipitation, (2) the amount of Ca^{2+}ion input through rain and dust, (3) the length of time the surface is stable so that soil formation can take place (little/no erosion/sedimentation), (4) presence of carbonate minerals in the parent material, (5) soil texture, (6) presence and density of vegetation (Rech et al., 2003; Amit et al., 2006; Breecker et al., 2010), and (7) potential for microbial precipitation of carbonate (e.g. Monger et al., 1991; Lian et al., 2006). This shows that care must be taken when deciding how much weight to give the use of soil carbonate morphology in estimating the age of a geomorphic surface. Therefore, increased soil development at Gold Butte for the Qa2 surface may not be a reflection of increased age and our extension of the age of this unit into the early Holocene should be considered tentative.

Unit Qa2 at Coyote Springs is interpreted to be early Holocene in age because of its well-developed desert pavement and soil development that is similar to Qay1 in the Ivanpah Valley, NV (House et al., 2006; 2010). Portions of this unit may extend into the latest Pleistocene, as interpreted for Qay1 in the Ivanpah Valley. In contrast to Ivanpah Valley, alluvial deposits of the Qa2 surface in the Coyote Springs study area lie on top of undated deposits of the Las Vegas Formation. The Las Vegas Formation is thought to have been deposited in a wetland environment during the latest Pleistocene (Longwell et al., 1965; Haynes, 1967;Quade et al., 1986; Quade and Pratt, 1989, Springer et al., 2007). Deposition slowed and then ceased as the climate became increasingly more arid at the end of the Pleistocene/beginning of the Holocene. In the northern Las Vegas Valley, the Las Vegas Formation has been dated to the latest Pleistocene and in some areas as young as early Holocene (Haynes, 1967; Springer et al., 2007). In the Coyote Springs study area, it is conceivable that during this climatic transition, spring activity and deposition of the Las Vegas Formation likely transitioned towards lower elevations in the Coyote Springs area before ceasing entirely. Because incision and alluvial deposition could have been occurring upslope simultaneously as deposition of the Las Vegas Formation occurred downslope, the age of the Qa2 surface may extend into the latest Pleistocene.

The Qa1 surface at Coyote Springs is topographically higher (2-3 m) and older than the surface of Qa2. Erosion of the underlying fine-grained Las Vegas Formation has resulted in the formation of small ballenas in which much of the overlying Qa1 alluvium has been removed, leaving only a thin gravel lag. Because of this, it is difficult to determine an age for this surface. However, we interpret it as most likely latest, and possibly late Pleistocene in age. This is based on the high topographic position of Qa1 and the fact that it overlies Las Vegas Formation deposits occurring along the uppermost portion of the distal fan. These deposits are mostly likely correlative to the last pluvial maximum in which the wetland environment should have been at its most extensive. Radiometric dating and further study of these sediments in this basin could provide more precise age estimates.

Unit Qa1 at Bitter Springs contains a well-developed soil with stage III carbonate morphology and lies 15-20 m above the modern washes. This great degree of incision at this site is likely attributable to the easily erodible, poorly lithified marls and siltstones of the underlying Horse Springs Formation (Beard et al., 2007). This unit corresponds to the youngest subunit of the Qai map unit in the Ivanpah Valley (House et al., 2006, 2010) and is interpreted to be late Pleistocene in age. Similarly, the Qa1 surface at Gold Butte is also considered to be late Pleistocene in age, although data on its soil development is not available.

Colluvial deposits

Colluvial map units (Qc) are present in all three study areas. These deposits most commonly occur along steep sideslopes or cutbanks, and/or mantle bedrock hills. Because these surfaces remain active today, their ages extend from the time of the initial incision forming the cutbanks and sideslopes until today.

Eolian deposits

Minor eolian (< 14 cm) deposits occur on nearly all alluvial surfaces and form Av horizons underneath desert pavements. However, unit Qea at Gold Butte is composed of a mix of eolian and alluvial sediment accumulating in swales between more resistant gypsiferous bedrock. This unit is dominated by biological soil crusts which actively trap eolian dust (Williams et al., 2010) and because of its special surficial characteristics it was mapped as a separate unit. Because it is topographically similar in elevation to Qa3, it is considered late Holocene in age.

Playa deposits

One, very small (~300 m^2) playa deposit (Qp) was recognized at Gold Butte and mapped separately because of its unique surface characteristics that indicate intermittent surface water ponding. This unit represents very recent to modern periods in which surface water may be present for very short intervals. This unit also occupies an area thought during initial mapping to be potential habitat for *E. corymbosum*.

Bedrock units

Many bedrock units are exposed at the surface in the three mapping areas. At Gold Butte, these include gypsum-rich sedimentary rock (Tgyp), well-lithified thinly bedded limestone and calcareous sandstone (Trock) and tuffaceous siltstone (Ttuff) of the Miocene Horse Springs Formation (Beard et al., 2007). Similar Trock deposits also occur at Bitter Springs, as do poorly-lithified exposures of gypsum marl, siltstone and claystone (Tss) of the Red Sandstone and/or upper Horse Springs Formation (Thumb member) (Beard et al., 2007).

Erosional units

In the Coyote Springs study area, the Las Vegas Formation is exposed as either actively eroding sideslopes (Qlv-erode) or as spatially extensive (1.5 to 17.5 hectare) planar erosional surfaces (Qlv-summit) bearing an erosional lag of calcareous siltstone or rhizolith fragments. Both of these map units are erosional geomorphic surfaces and therefore the age of the geomorphic surfaces are younger than the bedrock being eroded (Figure 2-5). As described previously, the Las Vegas Formation is composed of interbedded siltstone, mudstone, and calcareous paleosols that were deposited in wetland environments during the latest Pleistocene (Longwell et al., 1965; Haynes, 1967; Quade et al., 1986; Quade & Pratt, 1989; Springer et al., 2007). Deposition of the Las Vegas Formation is predicted to be tightly connected to water-table levels such that increased aridity at the end of the last glacial period would shift deposition eastward as the wetland shrunk in size. Therefore, the western-most, and topographically highest, Qlv-erode geomorphic surfaces in the study area are thought to have been first exposed in the latest Pleistocene when downcutting caused deposition on the Qa1 surfaces to cease and exposed

Las Vegas Formation deposits along channel cut banks. Continued incision during the Holocene further eroded and exposed Las Vegas Formation deposits along younger cut banks adjacent to Qa2 and Qa3 geomorphic surfaces. These exposed cut banks evolved into the sideslopes seen today. The Qlv-summit surface is a planar, erosional surface exposing Las Vegas Formation deposits. This erosional surface is believed to be age-equivalent to Qa3 (middle Holocene) because of their similar topographic position.

Comparison of Map Units to NRCS Soil Survey

Allowing for the large discrepancy in map scale, there is relatively good agreement between placement of the NRCS soil associations and the new surficial geologic map units from this study (Figure pairs 2-2 & 2-4, 2-19 & 2-21, and 2-39 & 2-41). However, because the existing NRCS soil survey data is mapped at an order 3 level, individual map units contain several different types of soils grouped together as an 'association' (see Robins et al., 2009 for additional discussion on this topic). This also coarsens the differences in conceptual precision beyond difference in mapping scale between the 1:24,000 NRCS data and the 1:3,000 surficial geologic data. Use of associations also results in greater error when using the NRCS maps to estimate buckwheat habitats. In some cases, these inaccuracies can be quite large, in others, they are less so. Specific details for each study are discussed below.

At Coyote Springs, units Qlv-summit and Qlv-erode are understandably incorporated into one Soil Survey unit, Badlands (Figures 2-2 & 2-4), which consists of incised fan remnants (Soil Survey Staff, 2011). This unit unavoidably contains inclusions of Qa4 due to the 1:24,000 mapping scale. Alluvial units Qa1 through Qa 5 and Qau are encompassed by the Elbowcanyon-Wechech association, which also overlaps areas of Qlv-summit and Qlv-erode. As described by the NRCS, these soils chiefly occur on shallow sloping (1° to 5°) fan aprons composed of alluvium derived from limestone and/or dolomite (Soil Survey Staff, 2011), which is consistent with map unit interpretations in this study. The final NRCS map unit in the Coyote Springs study area is the Glendale Loam, and was the least well-matched in terms of placement. The Glendale Loam encompasses units Qa4 and Qa5, along with areas of Qlv-erode. Use of 1:24,000 soil survey data in lieu of the 1:3,000 surficial geologic map would have led to inaccurate estimates of buckwheat habitat classes at the Coyote Springs study area, overestimating "Non-habitat" in the Elbowcanyon-Wechech association polygons, and overestimating "Habitat" in the Badlands polygon. It would not have been possible to define "Potential Habitat" areas using the soil survey.

Qualitatively, Gold Butte exhibited the best overall agreement between NRCS polygons and surficial geologic map units (Figures 2-19 & 2-21). Contacts between NRCS units reflect the transitions between landforms dominated by colluvial backslopes, outcrops of gypsum-rich bedrock, and the various assemblages of alluvial sediments. The Crosgrain-Irongold-Nickel association consists largely of alluvium derived from mixed or metamorphic parent materials, preserved as fan remnants or on backslopes (Soil Survey Staff, 2011). This association chiefly encompasses map units Qc, Trock, Qa1, and Qa2, with minor inclusions of Tgyp and Qgyp. The

Bracken-Arizo-Badland association consists of soils formed in colluvium and/or gypsum bedrock residuum (Soil Survey Staff, 2011). This association is roughly equivalent to units Tgyp and Qgyp, with inclusions of other units (most noteably Qea) not identified due to scale. The Bluepoint-Grapevine association of sandy fan deposits influenced by gypsiferous but mixed alluvium was found to broadly correlate with map units Qa3 and Qa4, with significant inclusions of Qa2. In the Gold Butte study area, the Bracken-Arizo-Badland association might be used to generally predict candidate areas for buckwheat habitat or “Potential Habitat”. However, the 1:24,000 scale means that small areas of Tgyp, Qgyp, and Qea are unavoidably missed, which is especially problematic given the relatively small size (mean = 693 m^2) of Qea “Habitat” landforms in particular.

Soil Survey associations and surficial geologic map units were least similar at Bitter Spring (Figures 2-39 & 2-41). The Weiser-Arizo association of alluvial soils correlate well with map units Qa4 and Qa3, but only overlap in the northeastern corner of the study area. Similarly, The Helkitchen-St.Thomas complex on steep side slopes correlates with unit Qc, but only occurs in a small portion of the field area. The Wechech-Upperline association consists of soils developed in fan remnant summits and commonly having a petrocalcic horizon (Soil Survey Staff, 2011). At Bitter Spring, this polygon incorporates two ridges of Qa1, but excludes other instances of Qa1 elsewhere in the field area. More importantly for this study, the association obscures critical areas of buckwheat habitat in valley-bottom and badland sideslope exposures of Tss in the southern edge of the study area. Last, the St. Thomas-Upperline-Whitebasin complex covers the greatest proportion of the study area, but encompasses every surficial geologic map unit, and every single habitat class. Consequently, ecological studies attempting to employ Soil Survey data for prediction of buckwheat habitat areas should independently assess or map areas described as belonging to either the St. Thomas-Upperline-Whitebasin complex or the Wechech-Upperline association.

Map Units as Habitat

At Coyote Springs, Las Vegas buckwheat was found almost exclusively within Qlv-summit (Figure 2-17), and therefore this map unit is designated as “Habitat.” However, within the Qlv-summit unit, many areas 100 m or greater in diameter were found to be completely barren of vegetation, including buckwheat. These areas are especially common along the eastern edge of the study area. In addition to Qlv-summit, two small buckwheat individuals were also found within areas mapped as Qlv-erode. We therefore consider Qlv-erode to be “Potential Habitat” when adjacent to Qlv-summit, but recognize that portions of this map unit are likely too steep and too unstable to support any vegetation at all. Except for the margin of Qa3 immediately adjacent to Qlv-summit, none of the alluvial units (Qa1, Qa2, Qa3, Qa4, Qa5, and Qau) at Coyote Springs were found to support the plant. These units are therefore considered “Non-Habitat”.

At Gold Butte (Figure 2-37), buckwheat were found most commonly within unit Qea, however, the fringes of unit Qgyp within ~ 1 m elevation of Qea were found to support several of the plants. Additionally, one large individual was found growing on an eroding sideslope of Qa2 immediately adjacent to Qea, and, again, within approximately 1 vertical meter of the Qea surface. Both Qea and Qgyp, are considered potential buckwheat habitat.

At Bitter Spring, map units Tss and Qa3 were found to support thriving Las Vegas buckwheat populations, and are mapped as "Habitat" wherever field observations confirmed the presence of the species (Figure 2-52). Although Qa3 is an alluvial unit, its thickness is highly variable, and it is possible that the depth to buried Tss strata is shallow where buckwheat are growing in Qa3. Thus, instances of both Tss and Qa3 in which buckwheat do not occur are classified as "Potential Habitat". Map units Qa1, Qa2, Qa4, Trock, and Qc were not found to support any buckwheat and are considered "Non-habitat".

Of the three sites, Gold Butte contained the lowest total area of "Habitat", at ~1.1 ha, or just under 0.5% of the total study area. This restricted distribution reflects the occurrence of Qea only within swales between outcrops of Tgyp. Habitat at Coyote Springs and Bitter Spring was more widely distributed, with ~50 ha at Coyote Springs (~12% of the study area) and ~32 ha at Bitter Spring (~14% of the study area).

Statistics and Other Data

Apart from Qlv-summit at Coyote Springs, no other map units and no studied aspect classes, at any study area, returned significant associations using the Chi-square test for independence (with Yates Continuity Correction). A significant relationship between Qlv summit and buckwheat habitat (p=.006) was indicated at Coyote Springs. Within this study area, 90.9% of all "Habitat" sites sit within unit Qlv-summit. This result confirms the significance of the distribution as noted above. Results at the other study areas may reflect small sample sizes, as well as the occurrence of buckwheat in two map units at Bitter Spring, and three at Gold Butte (Qea, Qgyp, and one Qa2).

Lack of significant results among the aspect classes may indicate that some edaphic factor (e.g., surface characteristics, soil texture, etc.) outweighs the importance of slope aspect in determining habitat suitability.

V. Conclusions

Fine-scale (1:3,000) surficial geologic maps were created for areas containing Las Vegas Buckwheat in Coyote Springs, Gold Butte, and Bitter Spring, in southern Nevada, USA. Using field and remote sensing data, geomorphic surfaces and landforms were differentiated based on morphostratigraphic relationships, surface characteristics (including physical and biological crusts), sediment texture and lithology, soil profile characteristics, and vegetation. All three study areas are composed of complex assemblages of Holocene to late Pleistocene geomorphic surfaces and outcrops of late Pleistocene and Miocene bedrock. Of these, buckwheat was predominantly found along different types of map units in each of the three study areas.

In Coyote Springs, buckwheat is almost always found growing in the flat-lying deposits of the late Pleistocene Las Vegas Formation that were mostly likely exposed due to erosion during the middle Holocene (Qlv-summit). In contrast, in Gold Butte, buckwheat is found primarily along very young, thin, eolian and alluvial sediments deposited in swales between resistant outcrops of gypsiferous bedrock (Qea). Minor occurrences however were found in adjacent map units Qgyp and Qa2. At Bitter Spring, buckwheat is associated with poorly-lithified siltstone, claystone and gypsum marl of the upper Horse Springs Formation (Thumb member) (Tss) and mostly inactive geomorphic surfaces composed of very young alluvium near active arroyos (Qa3). Chi-square tests for independence (with Yates Continuity Correction) found a significant association for buckwheat on only the planar, late Pleistocene Las Vegas Formation map unit (Qlv-summit) at Coyote Springs. The lack of significant results at the other study sites may be a result of the small sample sizes or the occurrence of buckwheat in more than one map unit in each area. Additionally, the lack of significant results among the aspect classes may indicate that an edaphic factor such as soil texture, surface characteristics, etc. outweigh the importance of slope in determining habitat suitability for Las Vegas Buckwheat.

VI. Recommendations

Models developed to predict Las Vegas buckwheat habitats should address the increased likelihood of Las Vegas buckwheat occurrences in the following types of environments:

(1) Surfaces with few rock clasts – buckwheat is extremely unlikely to be found in areas of thick gravelly alluvium and/or strongly developed desert pavement.

(2) Exposures of the Las Vegas Formation (not covered by thick gravels)

(3) Calcareous and/or gypsiferous outcrops of the Horse Springs Formation (not covered by thick gravels)

(4) Shallow sandy alluvium overlying gypsum bedrock in either very young, inactive geomorphic surfaces adjacent to modern sandy arroyos, or within rills or small gullies.

Individual deposits, soils, and landforms which the Las Vegas buckwheat may be quite small, thus, use of large-scale or high-resolution map or satellite data are recommended for any attempt at habitat modelling. This study, demonstrates that a scale of 1:3,000 is sufficient to model habitat distributions, and, while there is no direct translation between map scale and raster resolution, we note that 1.5 to 2 meter resolution topographic or satellite data are also ideal. This scale of mapping or resolution of landscape imagery will permit identification of habitat substrates only moderately larger than many of the individual buckwheat plants themselves.

Additional analysis of microclimate and/or very-high resolution (~0.1 to 0.5 m) solar insolation studies are also recommended, because of their potential to identify important soil-water relationships that were not resolved at the 1:3,000 surficial geologic map scale and 5 m resolution solar insolation analysis used in this study.

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Chapter 3: Soil Profiles and Statistics

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I. Purpose

An important project directive was to measure soil physical and chemical characteristics in order to try and better understand the parameters that might be controlling the presence and habitat potential of Las Vegas buckwheat. In this portion of the study, we excavated and described 97 soil profiles in buckwheat habitat, potential habitat, and non-habitat in the three study sites: Coyote Springs, Bitter Spring, and Gold Butte. Additionally, we collected and analyzed soil samples to determine the chemical and physical parameters that are known to affect vegetation, including the essential macro- and micronutrients.

Soil profiles are composed of one or more distinct genetic horizons that reflect physical, chemical, and/or biological processes at the Earth's surface. Profiles also influence these processes through complex feedback dynamics. By definition, each genetic horizon has distinct physical and chemical characteristics that result from numerous geological, chemical, biological and climatic processes through time. Soil properties such as texture, pH, salinity, and cation exchange capacity can vary widely among horizons and influence vegetation dynamics in many different ways (Chapter 1). Although soil horizons generally parallel the Earth's surface, the many soil-forming factors occurring through time can create abrupt and highly variable changes in the depths of soil horizons across a landscape. Consequently, studies that sample by depth and ignore genetic horizons run a very high risk of compounding error by ignoring the very soil processes that control the characteristics being measured. Studies that compare soil characteristics by depth will partially or wholly mask edaphic controls by averaging distinct chemical and physical characteristics together. On the other hand, sampling by genetic horizon may entail greatly increased sample numbers and necessarily more complex statistical interpretations.

Objective

The soil profile descriptions, sampling, laboratory analyses, and statistics described in this chapter comprise an attempt to test more comprehensively and rigorously for relationships between soil characteristics and the spatial distribution of *Eriogonum corymbosum* var *nilesii*. These relationships are used to determine soil characteristics specific to three sites of Las Vegas buckwheat habitat in Clark County, Nevada.

Background

As explained in Chapter 2, "buckwheat" sites in this study are those which contain *Eriogonum corymbosum* var *nilesii*, whereas "non-buckwheat" sites are those in which the species is absent for a distance of at least 50 to 100 m, or for the full spatial extent of the surficial geologic map unit polygon in which the site occurs. Buckwheat "habitat" and "non-habitat" are defined in a similar fashion, such that the "buckwheat present" and "buckwheat habitat"classes are synonymous, while all non-habitat sites are encompassed by the non-buckwheat class. "Potential" habitat sites represent areas that do not currently contain buckwheat, but based upon field observations, appear to have similar geomorphic and soil characteristics to known buckwheat habitats. Therefore, we hypothesize that these areas could potentially support buckwheat, but the plants have not yet become established for reasons unknown.

II. Methodology

Soil Profile Descriptions

Using surficial geologic maps and other data described in Chapter 2, approximately thirty sites at each study area were chosen for detailed soil and surface analysis (Figures 3-1, 3-2, & 3-3). Each site was contained within one surficial geologic unit (Chapter 2), contained one described and sampled soil profile (this chapter), and contained one or more canopy classes whose surface characteristics were also extensively analyzed (Chapter 4). A total of 97 sites were established: 30 at the Coyote Springs study area, 37 at Gold Butte, and 30 at Bitter Spring. Sites were distributed in an attempt to obtain data from all key surficial geologic map units identified within each study area, and from each of the three habitat classes (Habitat, Non-habitat, and Potential habitat). Site distributions were also designed to yield replication adequate for statistical analysis.

Soil profile description and sampling was conducted between April 13th and May 24th, 2010. Horizon descriptions and nomenclature followed standard procedures and terminology prescribed by Schoenenberger (2002) and Soil Survey Staff (2010). Rectangular, 0.5 to 1.0 m^2 pits for soil profile description were excavated with shovels and picks to a depth of approximately one meter, or to unaltered parent material (C horizon), or to an impenetrably indurated soil horizon, whichever was reached first. Data recorded at each pit were: horizon type, depth (thickness), boundary type, color, structure, coarse fragment content, soil consistence, mottles, redoximorphic features, concentrations, ped void or surface features, roots, pores, and effervescence in dilute (10%) hydrochloric acid. Coarse fragments (> 2 mm) were estimated volumetrically after sieving in the field. Soil surface characterization data, collected synchronously alongside the soil profile descriptions, are presented separately (Chapter 4).

Soil Sampling

Soil samples (2 to 5 kg each) were collected from all horizons immediately following soil profile description and surface characterization. Coarse fragments were excluded from soil samples by sieving whenever the total volume of rock fragments in a given horizon exceeded 5 to10%. A total of 319 samples were collected from the described soil horizons: 101 from Coyote Springs, 126 from Gold Butte, and 92 from Bitter Spring. All samples were collected in sealable bags of clean, unused industrial plastic and stored at University of Nevada Las Vegas Environmental Soil Analysis Laboratory (ESAL) until analysis initiated in June, 2010.

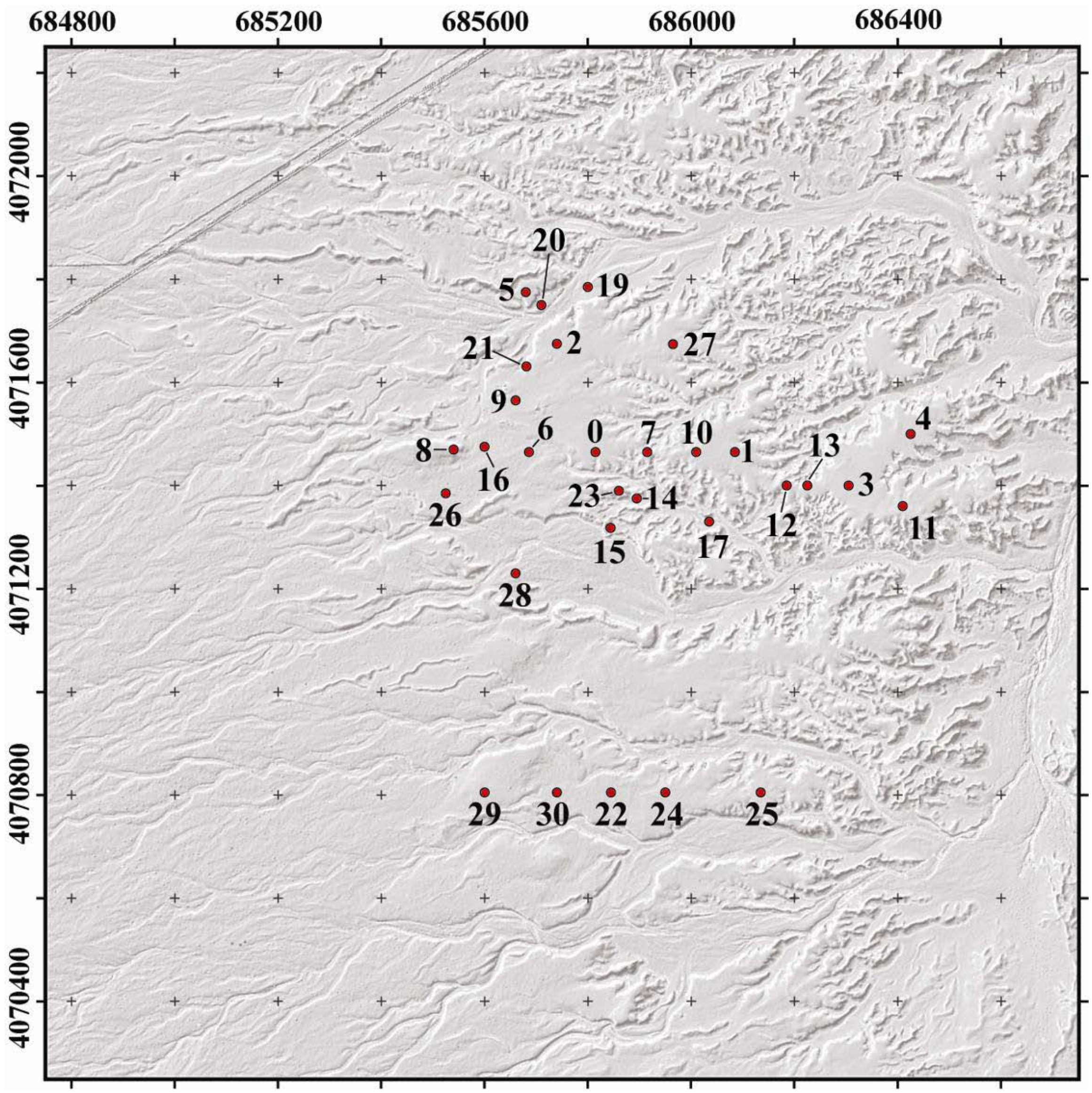

Figure 3-1: Distribution of sites within the Coyote Springs study area, superimposed on a shaded relief map.

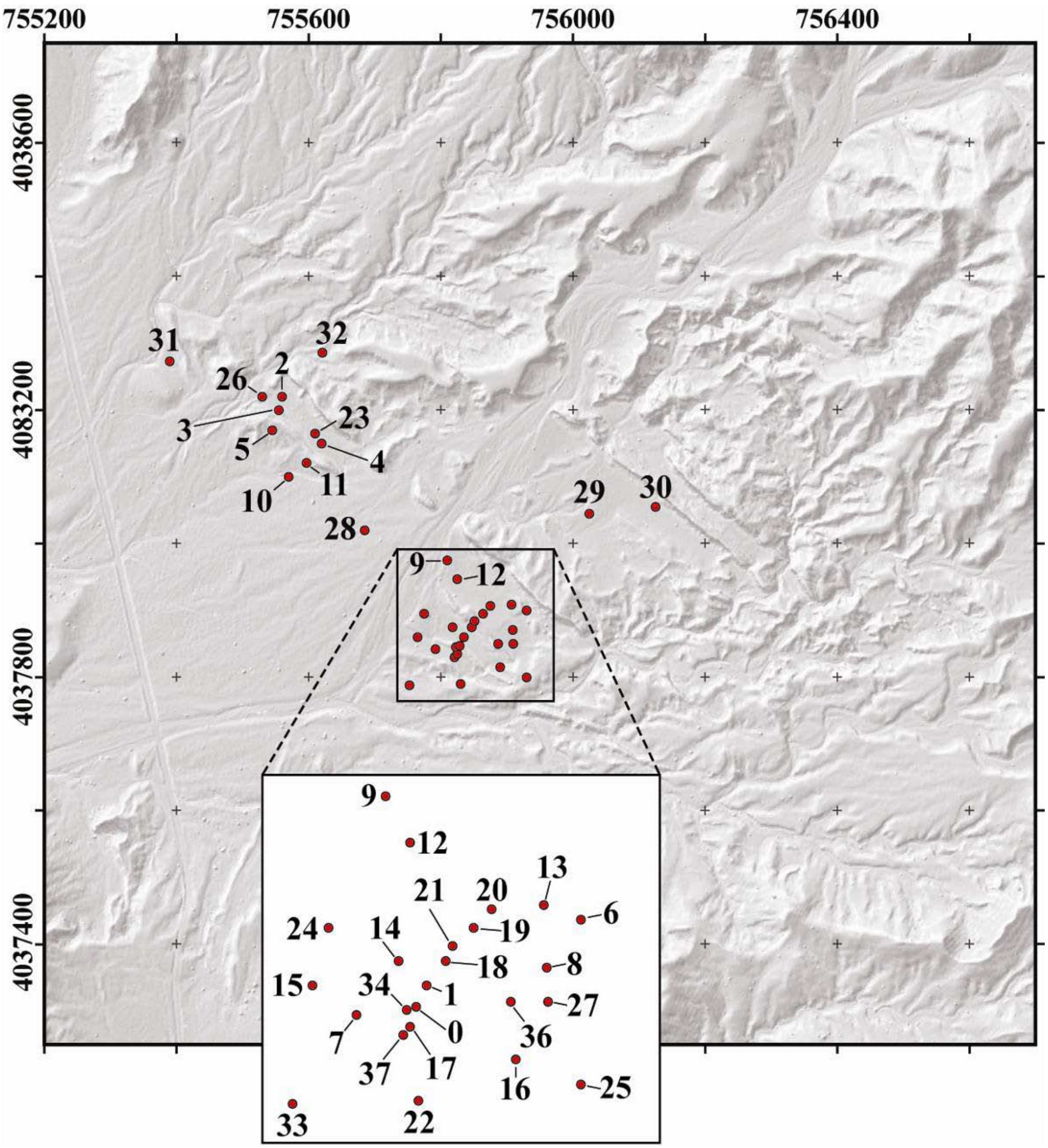

Figure 3-2: Distribution of sites within the Gold Butte study area, superimposed on a shaded relief map. Sites are generally closer together at Gold Butte than in the other study areas (see inset).

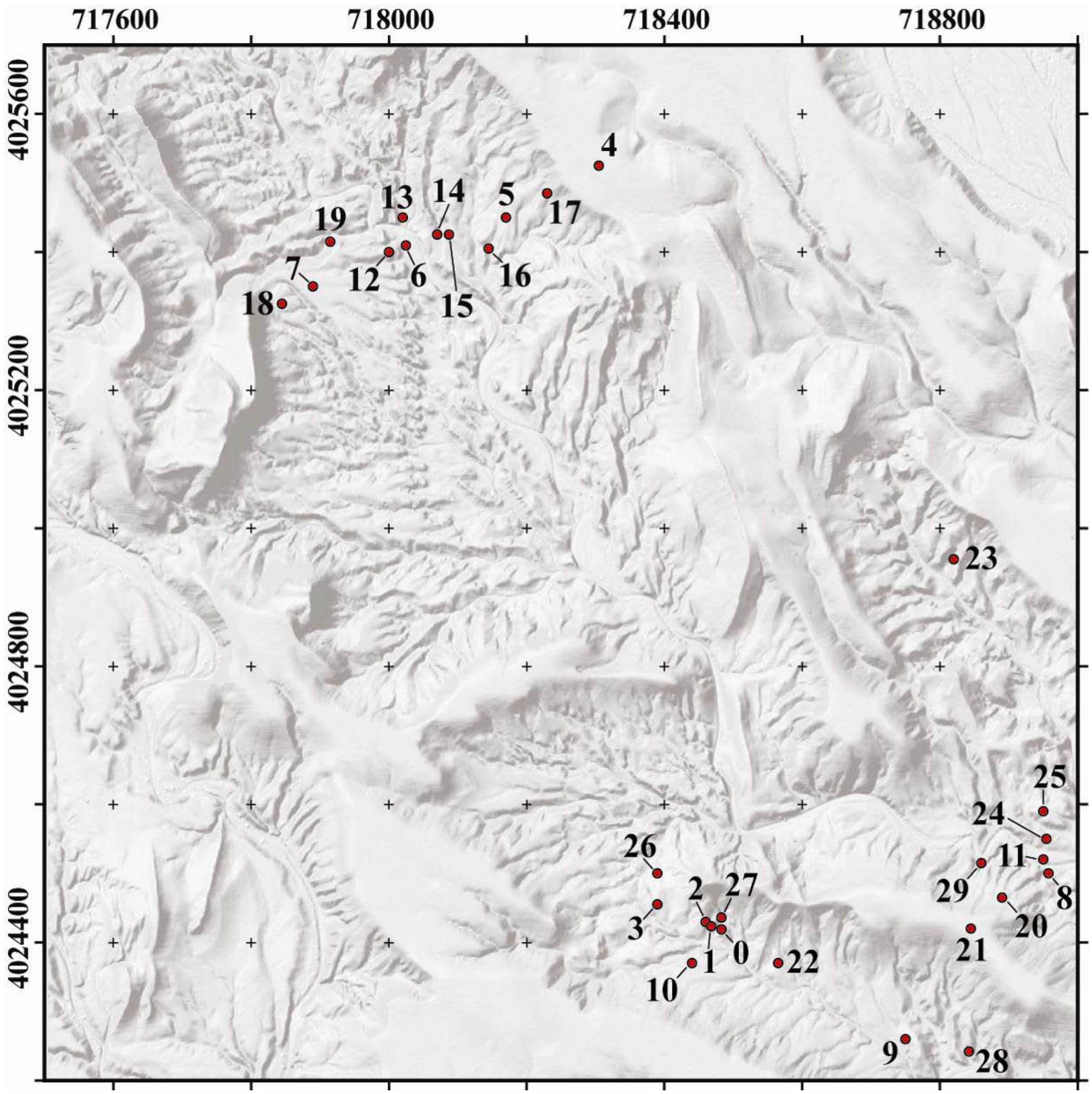

Figure 3-3: Distribution of sites within the Bitter Spring (White Basin) study area, superimposed on a shaded relief map.

Soil Laboratory Analysis

Approximately 1,000 g of soil from each of the original samples was spread to air-dry, sieved to exclude all coarse fragments (i.e., < 2 mm), and then re-bagged for analysis at ESAL. Concretions or soil aggregates indurated by gypsum or carbonate were gently crushed by hand when possible, but excluded during sieving when they were too rigid to disaggregate manually. Laboratory analyses produced a total of 33 data values for each sample. Measurements included: soil moisture content, pH, electrical conductivity, total nitrogen, total carbon, organic carbon, inorganic carbon, percent carbonate equivalence, plant available cations, soluble anions, cation exchange capacity, and soil texture. Ca/Mg and K/(Ca+Mg) ratios were also calculated from these raw data. Whenever possible, analyses followed standard procedures of the Soil Survey Laboratory (Burt, 2004). However, alternative methodologies were used when traditional methods were known to cause significant errors as a result of the presence of soluble salts and cements (common in arid soils).

The pH of arid soils is best evaluated using a combination of methods that partly distinguish between active and salt-replaceable/exchangeable acidity (McBride, 1994; Burt, 2004; Essington, 2004; Brady & Weil, 2008). We used three methods to measure pH with a VWR SB70P pH/ISE/temperature meter. First, we measured a one-to-one soil-to-water ratio (Burt, 2004; method 4C1a2a1), and a 1:2 ratio of soil to 0.01 M $CaCl_2$ solution (Burt, 2004; method 4C1a2a2). We also measured the pH of saturated paste extracts (Burt, 2004; method 4C1a1a2). This latter method is often assumed to be the most representative of natural field conditions and is especially used for arid region soils with soluble salts (Burt, 2004). Typically, 1:1 H_2O pH > 1:2 $CaCl_2$ pH > saturated paste pH, however, these trends depend on salinity and sodicity values and require careful interpretation (Burt, 2004). Saturated paste extracts were also used to measure electrical conductivity (Burt, 2004; method 4F2b1) with a Fisher Scientific Accumet BASIC AB30 conductivity meter.

Gravimetric moisture content was determined using the methods of Burt (2004), however this measure is also greatly influenced by the presence of hydrous minerals (i.e. gypsum and other salts). When hydrous minerals are present, gravimetric water content is overestimated. Anion concentrations used in soluble salt content analyses and calculations included chloride, sulfate, nitrate, and nitrite (Burt 2004; method 4F2c1b1a1-8). These were measured on saturated paste extracts using a Dionex ICS-3000 DC RFIC ion chromatographer. Plant available phosphorous was measured using a Perkin Elmer Lambda-25 UV/via spectrometer (Burt, 2004; method 4D5a1). Total carbon and total nitrogen were determined using a Vario Max CNS elemental analyzer (Burt, 2004; method 1B1b2d1) and the percent equivalence of soil carbonate was determined via digital monometer (Burt, 2004; method 4E1a1). Total inorganic carbon was calculated as 0.12*$CaCO_3$ equivalence, and organic carbon content was calculated as the difference between total C and inorganic C.

Plant available ions were extracted following the Mehlich No. 3 method (Burt, 2004, method 4D6) and analyzed using two distinct instruments. The four major elements (Na, K, Mg, and Ca) were measured on a Perkin-Elmer atomic adsorption flame spectrometer (AAS) (Burt, 2004; method 4B1b1b; Tan, 1996) in ESAL, while P, Mn, Fe, Ni, Cu, Zn, Co, B and As (Burt, 2004; method 4D6b) and Mo (Fontes & Coelho, 2005) were measured on an inductively coupled plasma spectrometer (ICP-MS) at California State University, Bakersfield.

Sodium adsorption ratio (SAR) and cation exchange capacity (CEC) were calculated after using the NH_4OAC method to measure Ca, Mg, Na, and K (Burt, 2004; method 4B1a1a1a1). Soils containing gypsum and other soluble salts pose significant difficulties in obtaining accurate CEC measurements. No method has been developed to accurately measure cation concentrations in soils containing salt minerals.

Soil particle size distributions (soil texture) were measured using a Malvern Mastersizer 2000 laser diffraction particle size analyzer and a modified procedure that employed isopropyl alcohol in place of deionized water during analysis. This modified procedure (Buck et al., 2011, unpublished data) is designed to prevent dissolution of gypsum and other soluble salt particulates. All traditional soil texture methods require the removal of soluble salts and $CaCO_3$ prior to analyses. As such, these older methods only measure particle sizes of insoluble minerals, and do not accurately represent natural field conditions in arid soils.

XRD Analysis

X-ray diffraction (XRD) analysis of (1) whole-sample (bulk) mineralogy, and (2) phyllosilicate mineralogy was conducted on selected samples to provide greater context for interpretation of soil chemical data.

Bulk XRD analyses were conducted on crushed, powdered samples using a PANalytical X'pert Pro X-ray diffraction spectrometer at the UNLV XRF/XRD Laboratory. Analyses were run using spinner-stage scans from 4 to 80° 2θ, at 45 kV and 40 mA, and using 1/2° antiscatter and 1/4° divergence slits.

Phyllosilicate mineralogy was conducted following treatment of bulk samples in pH 5 sodium acetate buffer solution (NaOAc) to digest carbonates (Jackson, 1965; Kunze & Dixon, 1986), sodium hypochlorite to remove organic matter (Soukup et al., 2008), and citrate-dithionite buffer (CDB) solution (Soukup et al., 2008) to remove amorphous iron and aluminum oxides that would obscure important clay-mineral peaks. The clay-sized particle fraction of the treated samples was fractionated by centrifugation and pipetting (Soukup et al., 2008) between hypochlorite and CDB treatments. Each sample was divided into separate aliquots for $MgCl_2$ and KCl saturation (Soukup et al., 2008), and the Mg- and K-saturated samples were then smeared onto frosted, glass slides for analysis.

Following base-line XRD analysis of the samples at room-temperature, Mg-treated sample slides were saturated with ethylene glycol under vacuum at 50°C overnight and re-scanned. K-treated slides were heated to 400°C for two hours and then analyzed. After analysis, the K-treated slides were heated again for two hours at 550°C and re-scanned. All slides were analyzed within 2 hours of heating and/or ethylene glycol saturation. The clay mineralogical analyses were also conducted on a PANalytical X'pert Pro X-ray diffraction spectrometer. XRD analyses used Cu Kα radiation for continuous, 10 minute flat-stage scans from 3 to 40° 2θ, at 45 kV and 40 mA, and using 1/4° antiscatter and 1/8° divergence slits.

XRD data were interpreted using XPert High Score Plus software. Detailed interpretations were also made by comparing data to published clay mineralogy and x-ray diffraction references (Dixon & Weed, 1989; Moore & Reynolds, 1997; Poppe et al., 2001).

Grouping Data for Statistical Analysis

There are many viable means of statistically analyzing pairs or groups of multivariate data sets. The non-parametric univariate and bivariate statistical methods chosen in this study suited the desired comparisons and the distributions and complexities of these unique data. Multivariate analyses were not performed because most require high numbers of samples (n>100), which would have necessitated grouping all data together. Combining all samples would have masked many statistically significant relationships observed when data were analyzed by site, habitat class, soil profile, and specific soil horizons.

Hierarchical distinctions were used to parse or to combine data into discrete conceptual groups for comparison. As we have already described in Chapter 2, the primary interest of this project was to detect and to explain differences between areas populated by buckwheat and areas in which it was absent. Thus, the most fundamental conceptual groups relate to the distribution of buckwheat within the study areas. Each individual data record (i.e., a horizon sample or averaged profile value) was classified as: (1) Buckwheat or Non-buckwheat, and as (2) Habitat, Non-habitat, or Potential Habitat. Identical statistical analyses were run for each of these systems (Figures 3-4 & 3-5). Following this fundamental division, data could be further grouped across all study areas, or divided into data sets for each individual study area (Figures 4 & 5). This constitutes the second conceptual data grouping used in this study, and it includes four classes: (1) Coyote Springs, (2) Gold Butte, (3) Bitter Spring, or (4) all areas combined.

Third, our data could be grouped to illustrate significant trends or differences based on genetic soil horizons, or, for greater simplicity and/or for comparison with other studies, based on whole-profile averages. Thus, this division contains four classes: (1) whole profile data, (2) A horizon data, (3) B horizon data, and (4) C horizon data.

Finally, there are several ways to consider data within profile or horizon classes. Non-parametric t-tests compare the median values of raw data groups, however, complex natural relationships among multiple variables may not be detectable using medians only. Therefore, chemistry and texture data from the soil profiles were processed prior to statistical analysis to simplify profile and horizon classes into minimum, maximum, mean, and thickness-weighted mean values for each site (Table 3-1). For example, the whole profile mean for a profile containing Av, Bw1 and Bw2, and Cr horizons was calculated by averaging those four distinct values together, while the thickness-weighted mean was calculated by first weighting each value based on the thickness of each horizon as a percentage of the whole profile (Table 3-1). We sought statistical trends among calculated values for each horizon and profile class for each of the 33 laboratory variables (Figure 3-4).

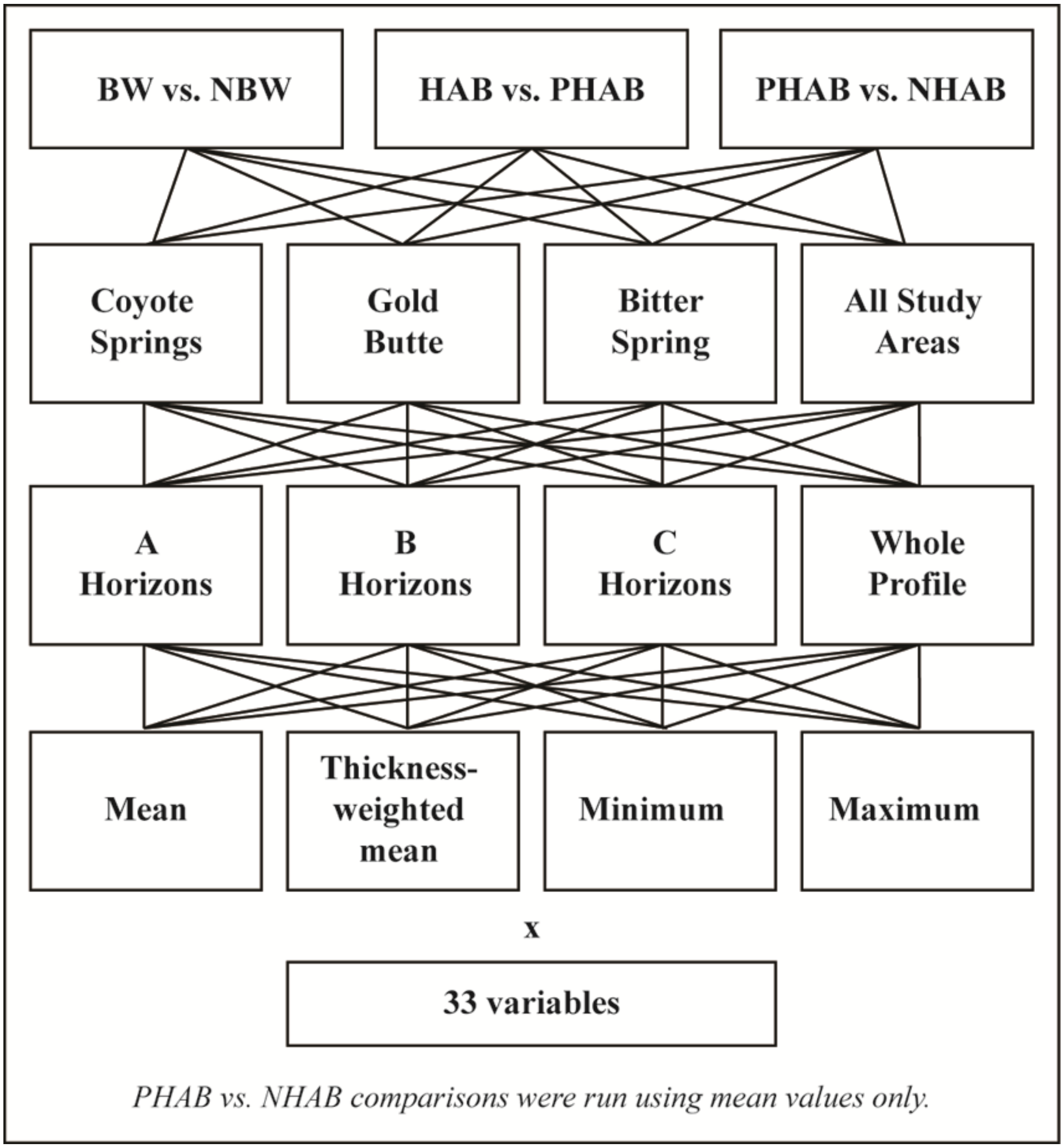

Figure 3-4: Schematic illustration of data groups for unpaired non-parametric t-tests, showing division by buckwheat presence/absence or habitat class (top row), study area (second row), horizon or profile (third row), and data group (fourth row). All comparisons tested for differences between buckwheat groups among 33 variables. BW = Buckwheat present, NBW = buckwheat absent, HAB = Habitat, PHAB = Potential Habitat, and NHAB = Non-Habitat.

Table 3-1: Horizon and profile data processing	
Data Type	**Description & Processing**
Profile Minimum	Within each profile, the minimum analyte value reported among the A, B, and C horizons
Profile Maximum	Within each profile, the maximum analyte value reported among the A, B, and C horizons
Profile Mean	Within each profile, the mean analyte value from the A, B, and C horizons *Profile mean = (A value + B value + C value) / 3*
Profile Thickness-weighted Mean	Within each profile, the weighted mean analyte value from the A, B, and C horizons, where values are weighted by horizon thickness (as a % of whole-profile thickness).
Horizon Minimum	Within each master horizon from each profile, the minimum analyte value reported among the component horizons *(i.e., for a B horizon: the single lowest value among Bk1, Bk2, By, etc. at each site)*
Horizon Maximum	Within each master horizon from each profile, the maximum analyte value reported among the component horizons.
Horizon Mean	Within each master horizon from each profile, the mean analyte value reported its component horizons Ex: *B horizon Mean = (Bk1 value + Bk2 value) / 2*
Horizon Thickness-weighted Mean	Within each master horizon from each profile, the weighted mean analyte value of the componenent horizons, where values are weighted by horizon thickness.

Statistical Methods

Sets of non-parametric independent sample t-tests (Mann-Whitney U Tests) were used to quantify differences among whole-profile and horizon characteristics associated with the presence/absence and habitat potential of buckwheat (Figure 3-1). T-tests were completed at the 0.05 significance level and were conducted in IBM SPSS Statistics 19. Descriptive statistics of variables from individual t-test groups were calculated and produced the following data: number of samples, minimum, maximum, range, mean, standard deviation of mean, variance, mean standard error and median. It is important to remember that these analyses were run on pre-grouped (rather than unsorted raw) data values, thus, the "median" stated in our results and used to assess statistical significance is the median among mean, minimum, maximum, or weighted-mean values. This held true for all Mann-Whitney U tests except for those comparing Ca:Mg and K/(Ca + Mg) ratios. Here, we calculated these values on a sample by sample basis using the raw chemical data, not the median values.

To gain further insights into the possible causes of significant trends detected the by non-parametric t-tests, we also employed Spearman rank correlation tests in IBM SPSS Statistics 19. These tests illustrated co-variance between specific variables including, but not limited to percent $CaCO_3$ equivalence and plant-available Fe.

III. Results

Maps of study area and site locations (see Chapter 1), and the distribution of habitat classes within each study area were previously presented in this report (see Chapter 2).

Written soil profile descriptions, which explain the changes among soil characteristics between genetic horizons within each profile and, thus, also implicitly explain the reasoning behind horizon divisions, are presented in the Appendix. These data are a written summary of Deliverable 14, Soil Profile Descriptions, which was submitted in November, 2010 using NRCS National Soil Information System abbreviations.

Laboratory analysis of 319 samples, and statistical analysis of the 33 distinct variables for each one of those samples, predictably produced a data set too large to present concisely outside of a digital spreadsheet. Instead, a summary of the laboratory data is presented in Tables 3-2 through 3-5, which indicates the minimum, maximum, and mean of each analyte for Coyote Springs (Table 3-2), Gold Butte (Table 3-3), Bitter Spring (Table 3-4), and all areas combined(Table 3-5).

Results of the XRD analyses are summarized in Tables 3-6 for bulk mineralogy, and 3-7, for phyllosilicate mineralogy.

Results of Mann-Whitney Tests

These results have been greatly simplified in this chapter for ease of display and discussion. Results of Mann-Whitney tests are presented in Tables 3-8 to 3-43, each of which presents the p-value and the median values for each of the two compared classes (i.e., buckwheat/non-buckwheat, habitat/potential habitat, potential habitat/non-habitat), for each variable found to have significant differences between classes. Furthermore, each numbered table consists of four sub-tables that describe the results for (a) Coyote Springs, (b) Gold Butte, (c) Bitter Spring, and (d) all study areas combined. At Coyote Springs, no C horizons were present in buckwheat/habitat soil profiles, so C-horizon statistics could not be performed for that study area. Results are presented first for comparisons between Buckwheat and Non-buckwheat sites, second for Habitat versus Potential Habitat sites, and third for Potential Habitat versus Non-habitat sites. Statistical analyses of calculated Ca/Mg and K/(Ca + Mg) ratios by profile and by horizon are presented separately (Tables 3-44 to 3-47). For assistance in navigating these tables, we outline the order of these tables here:

(i) Buckwheat vs. Non-buckwheat

- Soil Whole Profile mean (Table 3-8)
- Soil Whole Profile minimum (Table 3-9)

- Soil Whole Profile maximum (Table 3-10)
- Soil Whole Profile weighted mean (Table 3-11)
- A Horizon mean (Table 3-12)
- B Horizon mean (Table 3-13)
- C Horizon mean (insufficient data at CS) (Table 3-14)
- A Horizon minimum (Table 3-15)
- A Horizon maximum (Table 3-16)
- B Horizon minimum (Table 3-17)
- B Horizon maximum (Table 3-18)
- C Horizon minimum (insufficient data at CS) (Table 3-19)
- C Horizon maximum (insufficient data at CS) (Table 3-20)
- A Horizon thickness-weighted mean (Table 3-21)
- B Horizon thickness-weighted mean (Table 3-22)
- C Horizon thickness-weighted mean (Table 3-23)

(ii) Habitat vs. Potential Habitat

- Soil Whole Profile mean (Table 3-24)
- Soil Whole Profile minimum (Table 3-25)
- Soil Whole Profile maximum (Table 3-26)
- Soil Whole Profile weighted mean (Table 3-27)
- A Horizon mean (Table 3-28)
- B Horizon mean (Table 3-29)
- C Horizon mean (Table 3-30)
- A Horizon minimum (Table 3-31)
- A Horizon maximum (Table 3-32)
- B Horizon minimum (Table 3-33)
- B Horizon maximum (Table 3-34)
- C Horizon minimum (Table 3-35)
- C Horizon maximum (Table 3-36)
- A Horizon thickness-weighted mean (Table 3-37)
- B Horizon thickness-weighted mean (Table 3-38)
- C Horizon thickness-weighted mean (Table 3-39)

(iii) Potential Habitat vs. Non Habitat

- Soil Whole Profile mean (Table 3-40)
- A Horizon mean (Table 3-41)
- B Horizon mean (Table 3-42)
- C Horizon mean (Table 3-43)

(iv) Summary of relative trends

- Buckwheat vs. Non-buckwheat Sites (Table 3-44)
- Habitat vs. Potential Habitat (Table 3-45)
- Potential Habitat vs. Non-habitat (Table 3-46)

(v) Buckwheat versus Non-buckwheat – Ca/Mg and K/(Ca+Mg) ratios

- Profile medians (Table 3-44)
- A horizon medians (Table 3-45)
- B horizon medians (Table 3-46)
- C horizon medians (Table 3-47)

We also provide relative trend summary tables for all t-tests, grouped by habitat comparison (Tables 3-48 through 3-50).

Results of the Spearman rank coefficient tests

Significant correlations identified by the Spearman tests are summarized in Tables 3-51 through 3-110. These tables are organized first by study area in the order: Coyote Springs, Gold Butte, Bitter Spring, and All Areas combined, for correlations using (1) Profile means (Tables 3-51 to 3-66), (2) A horizon raw data (Tables 3-67 to 3-82), (3) B horizon raw data (Tables 3-83 to 3-98), and (4) C horizon raw data (Tables 3-99 to 3-110). Because few C horizons were sampled at Coyote Springs, this study area is not present in the Spearman's rho correlation tests of C horizon data.

Table 3-2: Minimum, Maximum, and Mean values of laboratory sample data between site classes at **Coyote Springs**.

	Non-Buckwheat			Buckwheat / Habitat			Potential Habitat			Non-Habitat		
Variable	**MIN**	**MAX**	**MEAN**	**MIN**	**MAX**	**MEAN**	**MIN**	**MAX**	**MEAN**	**MIN**	**MAX**	**MEAN**
Horizon Thickness (cm)	1	35	13	2	43	12	1	35	12	5	33	15
Moisture Content (%)	0.394	6.221	2.051	0.814	12.252	3.066	0.641	6.221	2.319	0.394	3.930	1.766
pH 1:1 H_2O	8.05	9.25	8.62	8.02	9.01	8.60	8.10	9.13	8.60	8.05	9.25	8.64
pH $CaCl_2$	7.82	8.27	8.01	7.73	8.32	8.03	7.82	8.25	8.01	7.83	8.27	8.02
pH Sat'd paste	6.90	8.04	7.59	6.98	8.34	7.70	6.90	7.99	7.59	6.97	8.04	7.58
ECe Sat'd. Paste	0.170	10.100	0.692	0.179	4.010	0.579	0.197	10.100	0.935	0.170	5.029	0.435
Total N %	0.001	0.037	0.011	0.000	0.022	0.008	0.001	0.037	0.010	0.004	0.033	0.012
Total C %	3.741	8.469	6.336	5.144	8.977	7.346	5.045	8.469	6.797	3.741	8.378	5.846
Organic C %	0.011	1.191	0.144	0.008	1.426	0.177	0.014	0.602	0.123	0.011	1.191	0.165
Inorganic C %	3.626	8.302	6.192	5.092	8.579	7.169	5.025	8.175	6.673	3.626	8.302	5.680
$CaCO_3$ %	30.218	69.179	51.599	42.433	71.496	59.740	41.871	68.126	55.612	30.218	69.179	47.336
Cl^- (ppm)	1.000	1732.680	56.205	1.000	77.720	7.255	1.000	1732.680	89.335	1.480	482.160	21.003
SO_4^{2-} (ppm)	7.280	14526.880	391.735	11.520	5096.480	343.904	8.940	14526.880	510.282	7.280	7261.300	265.778
$NO3^-$ (ppm)	0.040	1371.900	25.585	0.400	27.320	3.020	0.600	1371.900	46.348	0.040	45.900	3.524
B (µg/g)	0.003	1.302	0.095	0.017	1.529	0.157	0.003	1.302	0.102	0.012	0.728	0.088
P (µg/g)	0.032	5.195	1.139	0.040	3.007	0.294	0.032	4.692	0.787	0.040	5.195	1.514
Mo (ppb) µg/kg	0.100	4.900	1.842	0.200	29.920	2.981	0.220	4.900	2.414	0.100	3.880	1.234
Mn (µg/g)	0.268	5.271	1.271	0.454	1.652	0.968	0.268	4.161	1.155	0.317	5.271	1.395
Fe (µg/g)	4.679	15.346	10.244	7.095	17.407	13.496	6.642	15.346	11.334	4.679	15.285	9.086
Co (µg/g)	0.002	0.051	0.008	0.003	0.011	0.006	0.002	0.051	0.007	0.002	0.025	0.009
Ni (µg/g)	0.030	0.141	0.085	0.045	0.155	0.117	0.030	0.141	0.094	0.030	0.140	0.075
Cu (µg/g)	0.036	0.184	0.077	0.052	0.154	0.073	0.046	0.184	0.080	0.036	0.121	0.074
Zn (µg/g)	0.005	0.266	0.045	0.015	0.097	0.037	0.014	0.266	0.048	0.005	0.169	0.042
As (µg/g)	0.004	0.086	0.025	0.009	0.445	0.044	0.004	0.086	0.025	0.009	0.076	0.026
Na (µg/g)	19.180	233.830	42.501	32.071	68.420	39.194	19.180	233.830	45.581	28.177	71.287	39.228
K (µg/g)	7.079	50.899	21.143	12.287	61.131	25.920	7.079	50.899	21.618	8.589	48.609	20.638
Ca (µg/g)	125.928	1277.346	663.994	344.606	1379.092	991.296	125.928	1277.346	760.739	143.815	1201.541	561.204
Mg (µg/g)	60.972	471.022	172.597	108.978	551.538	252.146	80.826	471.022	212.176	60.972	271.125	130.546
CEC ($cmol_c$/kg)	2.915	31.643	10.531	*	*	*	3.005	31.643	11.490	2.915	29.764	9.512
Clay %	0.36	21.90	8.98	5.67	19.04	10.96	0.78	21.90	7.80	0.36	20.54	10.24
Silt %	2.36	41.39	22.13	15.53	32.62	23.88	4.36	41.39	22.82	2.36	38.44	21.40
Sand %	42.96	97.28	68.89	52.30	74.45	65.17	42.96	94.86	69.38	49.86	97.28	68.36

**Data for CEC ($cmol_c$/kg) are not available for all samples.*

Data for all horizons (all A, B, C samples, but no surface/canopy samples)

Table 3-3: Minimum, Maximum, and Mean values of laboratory sample data between site classes at **Gold Butte**.

	Non-Buckwheat			Buckwheat / Habitat			Potential Habitat			Non-Habitat		
Variable	**MIN**	**MAX**	**MEAN**	**MIN**	**MAX**	**MEAN**	**MIN**	**MAX**	**MEAN**	**MIN**	**MAX**	**MEAN**
Horizon Thickness (cm)	2	50	16	2	33	14	2	50	16	3	41	16
Moisture Content (%)	0.14	20.14	6.31	0.57	16.98	6.40	0.30	20.14	8.31	0.14	17.26	2.42
pH 1:1 H_2O	7.74	9.18	8.31	7.83	8.62	8.19	7.74	8.90	8.15	7.81	9.18	8.62
pH $CaCl_2$	7.61	9.05	8.23	7.66	8.60	8.12	7.61	8.86	8.08	7.69	9.05	8.54
pH Sat'd paste	6.71	8.32	7.62	7.12	8.11	7.69	6.71	8.32	7.58	7.28	8.29	7.69
ECe Sat'd. Paste	0.194	17.240	2.235	1.538	10.340	2.791	0.208	17.240	2.684	0.194	11.000	1.366
Total N %	0.003	0.117	0.022	0.005	0.086	0.020	0.003	0.117	0.025	0.003	0.065	0.015
Total C %	0.467	6.427	2.375	1.366	7.993	4.836	0.467	6.427	2.791	0.644	4.892	1.570
Organic C %	0.012	2.596	0.273	0.020	0.878	0.284	0.012	1.023	0.295	0.018	2.596	0.229
Inorganic C %	0.071	6.330	2.103	0.981	7.771	4.552	0.071	6.330	2.495	0.551	4.620	1.342
$CaCO_3$ %	0.594	52.752	17.521	8.175	64.757	37.929	0.594	52.752	20.793	4.595	38.502	11.181
Cl^- (ppm)	0.100	2433.920	92.097	0.200	835.280	77.846	0.200	2433.920	118.831	0.100	899.880	40.301
SO_4^{2-} (ppm)	24.260	18735.980	2875.004	520.160	13276.200	3669.406	132.960	18735.980	3550.549	24.260	10057.300	1566.135
$NO3^-$ (ppm)	0.020	785.880	24.559	0.020	199.260	17.239	0.020	785.880	35.748	0.060	13.480	2.879
B (µg/g)	0.015	0.592	0.126	0.026	5.365	0.338	0.015	0.592	0.144	0.021	0.298	0.092
P (µg/g)	0.000	5.549	1.508	-0.049	4.278	0.984	0.103	5.318	1.333	0.000	5.549	1.846
Mo (ppb) µg/kg	0.160	16.300	1.803	0.160	8.180	1.573	0.240	16.300	2.105	0.160	6.200	1.219
Mn (µg/g)	0.437	7.074	1.940	0.340	4.897	1.584	0.437	5.790	1.893	0.507	7.074	2.031
Fe (µg/g)	2.639	21.760	7.816	5.476	21.627	10.156	3.792	21.760	8.652	2.639	17.434	6.197
Co (µg/g)	0.004	0.042	0.014	0.004	0.040	0.012	0.004	0.031	0.013	0.005	0.042	0.015
Ni (µg/g)	0.020	0.188	0.076	0.042	0.157	0.095	0.037	0.188	0.084	0.020	0.171	0.060
Cu (µg/g)	0.046	0.208	0.100	0.044	0.189	0.101	0.051	0.208	0.105	0.046	0.144	0.089
Zn (µg/g)	0.011	0.650	0.070	0.018	0.153	0.059	0.016	0.650	0.073	0.011	0.247	0.063
As (µg/g)	0.003	0.247	0.061	0.005	6.234	0.321	0.003	0.247	0.072	0.009	0.161	0.040
Na (µg/g)	23.259	154.132	40.725	26.118	65.160	38.903	23.259	154.132	41.257	24.098	96.195	39.693
K (µg/g)	2.362	29.297	9.823	1.759	74.359	11.457	2.805	29.297	9.474	2.362	21.623	10.500
Ca (µg/g)	118.491	2670.155	1006.286	290.310	1507.460	1042.493	288.664	2670.155	1167.989	118.491	1844.621	692.988
Mg (µg/g)	9.089	590.215	65.107	15.386	681.419	132.306	9.089	590.215	72.014	9.626	345.754	51.725
CEC ($cmol_c$/kg)	2.102	13.839	5.919	*	*	*	2.102	13.839	5.782	3.000	11.590	6.190
Clay %	2.09	20.11	8.79	4.21	17.76	8.56	2.71	14.75	8.60	2.09	20.11	9.17
Silt %	5.09	54.65	28.13	15.26	51.20	26.16	14.08	48.26	27.79	5.09	54.65	28.78
Sand %	34.40	92.82	63.08	39.85	78.44	65.28	42.41	77.63	63.61	34.40	92.82	62.05

**Data for CEC ($cmol_c$/kg) are not available for all samples.*

Data for all horizons (all A, B, C samples, but no surface/canopy samples)

Table 3-4: Minimum, Maximum, and Mean values of laboratory sample data between site classes at **Bitter Spring**.

	Non-Buckwheat			Buckwheat / Habitat			Potential Habitat			Non-Habitat		
Variable	**MIN**	**MAX**	**MEAN**	**MIN**	**MAX**	**MEAN**	**MIN**	**MAX**	**MEAN**	**MIN**	**MAX**	**MEAN**
Horizon Thickness (cm)	2	42	16	2	43	16	3	34	15	2	42	16
Moisture Content (%)	0.60	17.17	5.81	1.84	14.55	6.68	3.01	17.17	8.67	0.60	11.93	3.77
pH 1:1 H_2O	7.56	9.46	8.40	7.78	8.76	8.12	7.85	8.95	8.35	7.56	9.46	8.44
pH $CaCl_2$	7.50	8.96	8.33	7.65	8.71	8.06	7.85	8.93	8.31	7.50	8.96	8.35
pH Sat'd paste	6.60	8.70	7.44	6.67	7.93	7.29	6.60	8.70	7.51	6.74	8.15	7.39
ECe Sat'd. Paste	0.188	25.630	3.458	0.261	5.132	2.526	0.291	25.630	5.890	0.188	10.470	1.721
Total N %	0.001	0.035	0.013	0.001	0.035	0.010	0.001	0.035	0.014	0.002	0.032	0.013
Total C %	0.300	6.968	3.242	1.715	7.256	3.947	0.300	6.968	2.625	0.842	6.272	3.682
Organic C %	0.003	0.736	0.135	0.016	1.072	0.158	0.003	0.417	0.130	0.014	0.736	0.138
Inorganic C %	0.181	6.827	3.107	1.562	7.240	3.789	0.181	6.827	2.495	0.796	6.145	3.545
$CaCO_3$ %	1.506	56.894	25.893	13.019	60.334	31.578	1.506	56.894	20.789	6.631	51.208	29.538
Cl^- (ppm)	0.400	1512.040	111.804	0.200	443.420	21.118	0.400	1512.040	157.289	0.400	1235.520	79.314
SO_4^{2-} (ppm)	30.380	31500.340	4165.124	56.180	9163.540	3647.338	61.220	31500.340	7169.923	30.380	9304.320	2018.839
$NO3^-$ (ppm)	0.600	208.660	14.080	0.600	13.080	2.106	0.600	208.660	26.939	0.600	36.360	4.895
B (µg/g)	0.055	44.451	3.620	0.004	2.153	0.263	0.089	44.451	7.790	0.055	8.230	0.641
P (µg/g)	0.066	3.025	0.735	0.015	1.767	0.511	0.105	2.600	0.815	0.066	3.025	0.677
Mo (ppb) µg/kg	0.280	716.060	38.954	0.300	5.460	1.793	0.280	716.060	86.385	0.400	105.600	5.074
Mn (µg/g)	0.221	8.376	1.819	0.011	4.286	1.704	0.229	8.376	2.710	0.221	4.606	1.183
Fe (µg/g)	4.698	17.762	10.323	0.222	17.224	11.821	4.889	17.649	9.427	4.698	17.762	10.963
Co (µg/g)	0.005	0.038	0.011	0.000	0.015	0.008	0.005	0.032	0.012	0.005	0.038	0.011
Ni (µg/g)	0.029	0.194	0.088	0.000	0.155	0.107	0.029	0.161	0.067	0.035	0.194	0.104
Cu (µg/g)	0.045	0.497	0.109	0.002	0.160	0.088	0.050	0.305	0.107	0.045	0.497	0.110
Zn (µg/g)	0.012	0.324	0.053	0.001	0.126	0.057	0.017	0.154	0.055	0.012	0.324	0.050
As (µg/g)	0.022	13.538	1.796	0.004	5.874	1.193	0.038	13.538	3.013	0.022	6.061	0.927
Na (µg/g)	27.632	1755.284	189.437	0.225	77.200	39.998	35.013	1755.284	389.654	27.632	189.175	46.424
K (µg/g)	7.253	475.768	72.463	0.300	992.649	126.218	7.253	475.768	123.340	8.191	88.177	36.122
Ca (µg/g)	140.368	1689.803	789.050	8.353	1352.746	966.302	140.368	1634.000	572.230	170.050	1689.803	943.922
Mg (µg/g)	38.156	413.550	94.407	0.340	155.494	79.950	43.371	413.550	117.705	38.156	218.911	77.766
CEC ($cmol_c$/kg)	4.358	34.247	14.895	*	*	*	4.358	34.247	15.065	6.440	32.026	14.770
Clay %	0.717	12.529	5.332	2.092	12.322	6.185	0.869	11.061	5.774	0.717	12.529	5.017
Silt %	3.577	44.028	24.043	13.622	48.665	28.039	4.610	44.028	27.580	3.577	40.865	21.517
Sand %	44.912	95.702	70.625	45.319	84.286	65.776	44.912	94.313	66.646	47.418	95.702	73.466

**Data for CEC ($cmol_c$/kg) are not available for all samples.*

Data for all horizons (all A, B, C samples, but no surface/canopy samples)

Table 3-5: Minimum, Maximum, and Mean values of laboratory sample data between site classes and across **all study areas**.

	Non-Buckwheat			Buckwheat / Habitat			Potential Habitat			Non-Habitat		
Variable	**MIN**	**MAX**	**MEAN**	**MIN**	**MAX**	**MEAN**	**MIN**	**MAX**	**MEAN**	**MIN**	**MAX**	**MEAN**
Horizon Thickness (cm)	1	50	15	2	43	14	1	50	15	2	42	16
Moisture Content (%)	0.14	20.14	4.89	0.57	16.98	5.31	0.298	20.143	6.629	0.14	17.26	2.69
pH 1:1 H_2O	7.56	9.46	8.43	7.78	9.01	8.31	7.74	9.13	8.32	7.56	9.46	8.56
pH $CaCl_2$	7.50	9.05	8.20	7.65	8.71	8.07	7.61	8.93	8.11	7.50	9.05	8.30
pH Sat'd paste	6.60	8.70	7.56	6.67	8.34	7.56	6.60	8.70	7.57	6.74	8.29	7.55
ECe Sat'd. Paste	0.170	25.630	2.106	0.179	10.340	1.923	0.197	25.630	2.859	0.170	11.000	1.191
Total N %	0.001	0.117	0.016	0.000	0.086	0.013	0.001	0.117	0.019	0.002	0.065	0.013
Total C %	0.300	8.469	3.800	1.366	8.977	5.436	0.300	8.469	3.899	0.644	8.378	3.699
Organic C %	0.003	2.596	0.196	0.008	1.426	0.206	0.003	1.023	0.213	0.011	2.596	0.176
Inorganic C %	0.071	8.302	3.603	0.981	8.579	5.230	0.071	8.175	3.686	0.551	8.302	3.523
$CaCO_3$ %	0.594	69.179	30.028	8.175	71.496	43.587	0.594	68.126	30.720	4.595	69.179	29.357
Cl^- (ppm)	0.100	2433.920	86.704	0.200	835.280	34.553	0.200	2433.920	119.275	0.100	1235.520	47.856
SO_4^{2-} (ppm)	7.280	31500.340	2481.874	11.520	13276.200	2486.590	8.940	31500.340	3451.453	7.280	10057.300	1305.865
$NO3^-$ (ppm)	0.020	1371.900	22.009	0.020	199.260	7.321	0.020	1371.900	37.190	0.040	45.900	3.800
B (µg/g)	0.003	44.451	1.070	0.004	5.365	0.250	0.003	44.451	1.543	0.012	8.230	0.285
P (µg/g)	0.000	5.549	1.186	-0.049	4.278	0.587	0.032	5.318	1.072	0.000	5.549	1.325
Mo (ppb) µg/kg	0.100	716.060	11.947	0.160	29.920	2.142	0.220	716.060	18.399	0.100	105.600	2.587
Mn (µg/g)	0.221	8.376	1.706	0.011	4.897	1.405	0.229	8.314	1.800	0.221	7.074	1.526
Fe (µg/g)	2.639	21.760	9.228	0.222	21.627	11.875	3.792	21.760	9.588	2.639	17.762	8.816
Co (µg/g)	0.002	0.051	0.011	0.000	0.040	0.008	0.002	0.051	0.011	0.002	0.042	0.012
Ni (µg/g)	0.020	0.194	0.082	0.000	0.157	0.107	0.029	0.188	0.084	0.020	0.194	0.080
Cu (µg/g)	0.036	0.497	0.095	0.002	0.189	0.087	0.046	0.305	0.098	0.036	0.497	0.092
Zn (µg/g)	0.005	0.650	0.058	0.001	0.153	0.050	0.014	0.650	0.062	0.005	0.324	0.052
As (µg/g)	0.003	13.538	0.523	0.004	6.234	0.505	0.003	13.538	0.633	0.009	6.061	0.349
Na (µg/g)	19.180	1755.284	81.815	0.225	77.200	39.360	19.180	1755.284	107.682	24.098	189.175	41.923
K (µg/g)	2.362	475.768	30.303	0.300	992.649	53.664	2.805	475.768	34.680	2.362	88.177	22.835
Ca (µg/g)	118.491	2670.155	844.352	8.353	1507.460	999.766	125.928	2670.155	936.624	118.491	1844.621	739.105
Mg (µg/g)	9.089	590.215	105.345	0.340	681.419	157.751	9.089	590.215	120.789	9.626	345.754	86.409
CEC ($cmol_c$/kg)	2.102	34.247	9.762	*	*	*	2.102	34.247	9.369	2.915	32.026	10.293
Clay %	0.4	21.9	7.9	2.1	19.0	8.6	0.8	21.9	7.8	0.4	20.5	8.0
Silt %	2.4	54.7	25.2	13.6	51.2	26.0	4.4	48.3	26.3	2.4	54.7	23.8
Sand %	34.4	97.3	66.9	39.9	84.3	65.4	42.4	94.9	65.9	34.4	97.3	68.1

**Data for CEC ($cmol_c$/kg) are not available for all samples.*

Data for all horizons (all A, B, C samples, but no surface/canopy samples)

Table 3-6: General mineral compositions of select samples, from XRD analysis of bulk powder samples.

Bitter Spring	Quartz	Calcite[1]	Dolomite/Ankerite[2]	Gypsum	Feldspar[3]	Phyllosilicates[4]	Hab.Class
BS-06-A	XX	XX	X	X	X	x	*HAB*
BS-06-ByC	X	XX	---	XXX	x	x	*HAB*
BS-06-Cr	XX	XX	---	XX	x	X	*HAB*
BS-07-A	XX	XX	x	x	XX	X	*PHAB*
BS-07-Bk1	XX	XX	x	x	XX	X	*PHAB*
BS-19-A	XX	XX	x	XX	X	X	*HAB*
BS-19-By	X	XX	---	XXX	x	x	*HAB*
BS-26-AC	X	XX	x	XXX	X	X	*PHAB*
BS-26-C1	XX	XX	x	XX	x	x	*PHAB*
Coyote Springs	**Quartz**	**Calcite[1]**	**Dolomite/Ankerite[2]**	**Gypsum**	**Feldspar[3]**	**Phyllosilicates[4]**	**Hab.Class**
CS-10-Av	XX	XX	XX	x	X	x	*PHAB*
CS-10-Bk1	XX	XX	XX	x	X	x	*PHAB*
CS-10-Bk2	XX	XX	XX	x	X	x	*PHAB*
CS-15-A	X	XX	XXx	x	XX	x	*HAB*
CS-15-2Btkb	XX	XX	Xx	x	Xx	x	*HAB*
CS-23-Avk	XX	XX	XX	---	XX	X	*PHAB*
CS-23-Bkq	X	XX	XX	---	X	x	*PHAB*
CS-23-Bkqm	XX	XX	XX	---	X	x	*PHAB*
CS-26-Av	X	XX	XX	---	X	X	*NHAB*
CS-26-Bk	X	XXX	x	---	X	x	*NHAB*
Gold Butte	**Quartz**	**Calcite[1]**	**Dolomite/Ankerite[2]**	**Gypsum**	**Feldspar[3]**	**Phyllosilicates[4]**	**Hab.Class**
GB-01-A	X	XX	XX	XX	X	X	*HAB*
GB-01-Bw1	x	X	XX	XX	X	x	*HAB*
GB-01-Bw2	X	X	XX	XXX	X	x	*HAB*
GB-01-Cr	X	XX	XX	XX	X	x	*HAB*
GB-04-Av	XX	XX	XX	x	X	x	*PHAB*
GB-04-B1	XX	X	XX	x	X	x	*PHAB*
GB-04-By	X	XX	XX	XXX	X	x	*PHAB*
GB-16-Av	XX	XX	XX	x	x	x	*HAB*
GB-16-By	X	XX	XX	XX	x	x	*HAB*
GB-16-CB	XX	XX	XX	X	x	x	*HAB*
GB-23-A	XX	X	XX	X	X	X	*PHAB*
GB-23-By2	X	X	XX	XXX	x	x	*PHAB*
GB-28-B	XX	XX	X	---	X	X	*NHAB*

[1] *Calcite and low-Mg calcite*

[2] *Dolomite and ankerite are grouped together in this analysis*

[3] *Feldspars, undifferentiated*

[4] *Phyllosilicate minerals, undifferentiated (see Table 3-7)*

x = present in trace or very minor amounts (< 5% crude semi-quantitative estimate)

X = present in some abundance (~5 - 15%)

XX = abundant (~20-40% crude semi-quantitative estimate)

XXX = Present as the dominant mineral consituent; intense diffraction peaks (> 50%semi-quantitative)

--- = Absent

Table 3-7: Results of Phyllosilicate Mineralogical analysis on select samples

Bitter Spring	***Kaolinite***	***Illite/Mica***	***Expandable Clays (Smectite group)***	***Chlorite***	***Quartz***	***Hab. Class***
BS-06-A	*X*	*XX*	*XX*	*x*	*XX*	*HAB*
BS-06-ByC	*X*	*XX*	*XX*	*x*	*XXX*	*HAB*
BS-06-Cr	*x*	*XX*	*XX*	*XX*	*XX*	*HAB*
BS-26-AC	*x*	*X*	*XX*	*X*	*X*	*PHAB*
BS-26-C1	*x*	*x*	*XXX*	-	*XX*	*PHAB*
Coyote Springs	***Kaolinite***	***Illite/Mica***	***Expandable Clays (Smectite group)***	***Chlorite***	***Quartz***	***Hab. Class***
CS-10-Av	*X*	*X*	*XX*	*x*	*XX*	*PHAB*
CS-10-Bk1	*X*	*x*	*XX*	*x*	*XXX*	*PHAB*
CS-10-Bk2	*x*	*x*	*X*	*?*	*X*	*PHAB*
CS-15-A	*X*	*X*	*x*	*x*	*XX*	*HAB*
CS-15-2Btkb	*X*	*X*	*X*	*x*	*XX*	*HAB*
Gold Butte	***Kaolinite***	***Illite/Mica***	***Expandable Clays (Vermiculite group)***	***Chlorite***	***Quartz***	***Hab. Class***
GB-04-Av	*X*	*X*	*X*	*X*	*XX*	*PHAB*
GB-04-B1	*X*	*X*	*X*	*X*	*XX*	*PHAB*
GB-04-By	*X*	*x*	*XX*	-	*XX*	*PHAB*
GB-16-Av	*X*	*X*	-	*X*	*XX*	*HAB*
GB-16-By	*x*	*X*	-	*x*	*X*	*HAB*
GB-16-CB	*x*	*X*	-	*X* *	*XX*	*HAB*

** possibly interstratified Illite-Chlorite*

x = present, but in minor or trace amounts

X = present

XX = present, peaks are prominent within the diffraction patterns

XXX = Present as the dominant mineral consituent; accounts for the maximum diffraction pattern intensity

Table 3-8: Summary of independent non-parametric t-tests for differences among soil profile means (all horizons averaged) between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-8a: 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 3-8b: 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*

Table 3-8c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
pH 1:1	0.015	**8.429**	8.065
pHCaCl2	0.012	**8.384**	8.021
NO_3^-	0.027	**3.513**	1.980
B	0.021	**0.548**	0.161
Co	0.024	**0.009**	0.008
Bitter Spring **n** (number of sites)		*19*	*11*

Table 3-8d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total N	0.018	**0.014**	0.010
Total C	0.001	3.494	**5.690**
Inorganic C	0.001	3.319	**5.559**
$CaCO_3$	0.001	27.656	**46.329**
P	0.000	**1.073**	0.467
Fe	0.000	8.889	**11.951**
Co	0.000	**0.010**	0.008
Ni	0.000	0.077	**0.110**
Ca	0.000	774.019	**961.053**
Mg	0.047	89.906	**116.111**
All Areas ***n*** *(number of sites)*		*67*	*30*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

- ***Bold*** *median values indicate the larger value between BW and Non-BW.*

Table 3-9: Summary of non-parametric t-tests among soil **profile Minimum** values between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-9a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	Non- BW Median	BW Median
Total N	0.002	**0.006**	0.002
Total C	0.001	5.736	**6.856**
Inorganic C	0.000	5.505	**6.625**
$CaCO_3$	0.000	45.873	**55.209**
Fe	0.001	7.053	**12.245**
Ni	0.000	0.042	**0.105**
K	0.043	12.448	**17.235**
Ca	0.000	226.869	**887.754**
Mg	0.001	98.547	**168.101**
*Coyote Springs **n** (number of sites)*		*20*	*10*

Table 3-9b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	Non- BW Median	BW Median
Total C	0.001	1.245	**3.584**
Inorganic C	0.001	1.116	**2.978**
$CaCO_3$	0.001	9.299	**24.813**
B	0.047	0.038	**0.108**
P	0.003	**0.463**	0.042
Fe	0.005	5.602	**8.299**
Ni	0.009	0.045	**0.082**
Mg	0.019	18.698	**39.106**
CEC	0.008	**4.193**	2.789
Clay	0.037	3.952	**6.163**
*Gold Butte **n** (number of sites)*		*28*	*9*

Table 3-9c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	Non- BW Median	BW Median
Ni	0.043	0.049	**0.083**
Zn	0.045	0.027	**0.044**
Bitter Spring **n** (number of sites)		*19*	*11*

Table 3-9d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non- BW Median	BW Median
Moisture	0.039	1.495	**2.689**
Total N	0.018	**0.007**	0.005
Total C	0.000	2.664	**4.815**
Inorganic C	0.001	2.371	**4.629**
$CaCO_3$	0.001	19.758	**38.572**
P	0.000	**0.308**	0.094
Fe	0.000	6.535	**9.662**
Ni	0.000	0.043	**0.087**
Zn	0.048	0.024	**0.029**
Ca	0.000	375.205	**841.512**
*All Areas **n** (number of sites)*		*67*	*30*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-10: Summary of non-parametric t-tests among soil **profile Maximum** values between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-10a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
Ni	0.006	0.110	**0.128**
Zn	0.039	**0.070**	0.053
As	0.025	0.029	**0.051**
Ca	0.005	857.171	**1168.760**
Mg	0.048	190.357	**230.641**
*Coyote Springs **n** (number of sites)*		*20*	*10*

Table 3-10b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
Total C	0.001	2.606	**6.659**
Inorganic C	0.000	2.320	**6.347**
$CaCO_3$	0.000	19.337	**52.893**
Fe	0.015	8.259	**10.975**
Co	0.040	**0.018**	0.014
Ni	0.026	0.083	**0.111**
CEC	0.004	**8.729**	6.665
*Gold Butte **n** (number of sites)*		*28*	*9*

Table 3-10c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
pH 1:1	0.006	**8.682**	8.156
pH $CaCl_2$	0.006	**8.671**	8.126
NO_3^-	0.017	**6.920**	3.100
B	0.019	**0.733**	0.208
Mo (ppb)	0.041	**5.280**	2.000
Co	0.031	**0.014**	0.010
Na	0.027	**62.841**	45.603
Bitter Spring **n** (number of sites)		*19*	*11*

Table 3-10d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
Total C	0.001	4.390	**6.578**
Inorganic C	0.001	4.275	**6.301**
$CaCO_3$	0.001	35.624	**52.507**
P	0.000	**2.323**	0.833
Mn	0.021	**2.177**	1.560
Fe	0.000	11.301	**13.443**
Co	0.000	**0.015**	0.009
Ni	0.000	0.104	**0.125**
Zn	0.007	**0.076**	0.059
As	0.038	0.053	**0.103**
K	0.047	21.623	**33.768**
Ca	0.044	1004.494	**1192.150**
Mg	0.042	127.811	**150.669**
*All Areas **n** (number of sites)*		*67*	*30*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-11: Summary of non-parametric t-tests among soil **profile** weighted **means** (all horizons averaged and weighted based on thickness) between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-11a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total N	0.025	**0.010**	0.007
Total C	0.011	6.363	**7.396**
Inorganic C	0.012	6.233	**7.304**
$CaCO_3$	0.012	51.938	**60.865**
P	0.008	**0.625**	0.080
Fe	0.000	10.666	**13.487**
Ni	0.002	0.093	**0.119**
K	0.031	17.318	**26.123**
Ca	0.001	675.493	**1006.592**
Coyote Springs ***n*** *(number of sites)*		*20*	*10*

Table 3-11b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.000	1.924	**5.736**
Inorganic C	0.000	1.676	**5.451**
$CaCO_3$	0.000	13.968	**45.427**
P	0.026	**0.950**	0.455
Fe	0.016	7.013	**9.935**
Mg	0.037	56.310	**83.909**
CEC	0.003	**5.277**	3.724
Gold Butte ***n*** *(number of sites)*		*28*	*9*

Table 3-11c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
pH 1:1	0.010	**8.486**	8.096
pH $CaCl_2$	0.013	**8.434**	8.057
B	0.019	**0.677**	0.165
Co	0.019	**0.009**	0.007
Bitter Spring **n** (number of sites)		*19*	*11*

Table 3-11d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total N	0.013	**0.012**	0.009
Total C	0.001	3.505	**5.747**
Inorganic C	0.002	3.310	**5.544**
$CaCO_3$	0.002	27.585	**46.202**
P	0.000	**0.798**	0.292
Fe	0.000	9.334	**11.730**
Co	0.002	**0.009**	0.007
Ni	0.000	0.078	**0.108**
K	0.025	16.363	**26.123**
Ca	0.013	824.776	**980.019**
Mg	0.042	101.485	**129.393**
All Areas ***n*** *(number of sites)*		*67*	*30*

- *Only variables flagged as statistically signficant ($p < 0.05$) are shown.*
- ***Bold*** *median values indicate the larger value between BW and Non-BW.*

Table 3-12: Summary of non-parametric t-tests among **mean A horizon** values between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-12a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.001	5.754	**7.459**
Inorganic C	0.001	5.690	**7.093**
$CaCO_3$	0.001	47.417	**59.106**
P	0.002	**2.988**	0.251
Fe	0.005	7.477	**13.369**
Co	0.035	**0.011**	0.006
Ni	0.001	0.042	**0.118**
Cu	0.005	**0.090**	0.073
Ca	0.001	228.569	**927.972**
Mg	0.005	109.284	**168.101**
Coyote Springs ***n*** *(number of sites)*		*19*	*10*

Table 3-12b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.000	1.759	**4.444**
Inorganic C	0.001	1.444	**4.043**
$CaCO_3$	0.001	12.036	**33.693**
Mn	0.010	**2.766**	1.033
Fe	0.006	6.646	**9.183**
Co	0.005	**0.016**	0.008
Ni	0.002	0.050	**0.096**
As	0.015	0.027	**0.076**
Ca	0.005	546.157	**1203.729**
CEC	0.018	**7.930**	5.243
Clay	0.015	5.828	**7.775**
Silt	0.012	32.210	**39.432**
Sand	0.008	**62.921**	53.383
Gold Butte ***n*** *(number of sites)*		*28*	*8*

Table 3-12c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Inorganic C	0.050	2.961	**4.233**
$CaCO_3$	0.050	24.672	**35.273**
NO_3^-	0.019	**2.180**	0.600
Bitter Spring **n** (number of sites)		*19*	*11*

*(**Table 3-12d** is located on the next page)*

Table 3-12d: Summary of **All Study Areas** combined.			
Significant Variable	**p-value (2-tailed)**	**Non-BW Median**	**BW Median**
Total C	0.000	3.222	**5.595**
Inorganic C	0.000	2.969	**5.505**
$CaCO_3$	0.000	24.743	**45.873**
P	0.000	**2.084**	0.622
Mn	0.003	**2.007**	1.210
Fe	0.000	7.262	**12.333**
Co	0.000	**0.014**	0.008
Ni	0.000	0.049	**0.109**
Cu	0.021	**0.096**	0.082
Zn	0.024	**0.069**	0.051
Ca	0.000	425.375	**1014.972**
Mg	0.024	56.515	**74.547**
All Areas ***n*** *(number of sites)*		*66*	*29*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-13: Summary of non-parametric t-tests among **mean B horizon** values between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-13a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
pH Sat Paste	0.026	7.576	**7.785**
Total N	0.008	**0.011**	0.006
Total C	0.006	6.448	**7.763**
Inorganic C	0.004	6.370	**7.699**
$CaCO_3$	0.004	53.080	**64.160**
P	0.022	**0.403**	0.067
Fe	0.001	10.915	**13.337**
Ni	0.002	0.100	**0.119**
Ca	0.003	772.164	**986.685**
Mg	0.035	160.575	**211.099**
Coyote Springs ***n*** *(number of sites)*		*20*	*10*

Table 3-13b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.008	2.327	**4.849**
Inorganic C	0.009	1.936	**4.553**
$CaCO_3$	0.009	16.131	**37.940**
CEC	0.009	**5.042**	3.442
Silt	0.044	28.871	**32.443**
Gold Butte ***n*** *(number of sites)*		*22*	*8*

Table 3-13c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Moisture	0.045	5.497	**7.562**
pH 1:1	0.007	**8.376**	8.003
pH $CaCl_2$	0.010	**8.293**	7.990
SO_4^{2-}	0.045	1751.430	**4029.210**
B	0.003	**0.271**	0.110
Co	0.038	**0.008**	0.007
Na	0.032	**45.172**	36.337
Bitter Spring **n** (number of sites)		*15*	*7*

Table 3-13d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Moisture	0.032	3.108	**6.130**
pH1:1	0.041	**8.489**	8.258
Total N	0.008	**0.012**	0.009
Total C	0.017	4.285	**5.782**
Inorganic C	0.016	4.170	**5.484**
$CaCO_3$	0.016	34.746	**45.697**
Cl-	0.006	**8.047**	3.320
P	0.003	**0.620**	0.145
Fe	0.002	10.183	**12.589**
Ni	0.002	0.092	**0.114**
All Areas ***n*** *(number of sites)*		*57*	*25*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-14: Summary of non-parametric t-tests among **mean C horizon** values between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-14a: Summary for **Coyote Springs** sites only.		
Too few C horizons at Coyote Springs; statistical analysis not possible.		
*Coyote Springs **n** (number of sites)*	*Non-BW: 2*	*BW: 0*

Table 3-14b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.001	1.151	**6.341**
Inorganic C	0.002	1.040	**6.191**
$CaCO_3$	0.002	8.667	**51.594**
SO_4^{2-}	0.039	2893.720	**4915.030**
P	0.008	**0.851**	0.070
Fe	0.010	6.364	**10.597**
K	0.045	6.439	**14.169**
Mg	0.039	39.503	**117.888**
Clay	0.045	3.686	**6.518**
*Gold Butte **n** (number of sites)*		*15*	*8*

Table 3-14c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.016	2.038	**3.620**
Inorganic C	0.022	1.908	**3.062**
$CaCO_3$	0.022	15.897	**25.515**
B	0.005	**2.215**	0.178
Mo	0.022	**5.660**	1.610
Ni	0.047	0.067	**0.104**
Ca	0.041	549.122	**1038.613**
Bitter Spring **n** (number of sites)		*13*	*10*

Table 3-14d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.000	1.415	**4.161**
Inorganic C	0.000	1.364	**3.854**
$CaCO_3$	0.000	11.370	**32.114**
P	0.001	**0.715**	0.225
Fe	0.005	7.978	**11.114**
Ni	0.004	0.069	**0.105**
Ca	0.027	712.418	**989.053**
*All Areas **n** (number of sites)*		*30*	*18*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-15: Summary of non-parametric t-tests among **minimum A horizon** values between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-15a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.001	5.754	**7.459**
Inorganic C	0.001	5.690	**7.093**
$CaCO_3$	0.001	47.417	**59.106**
P	0.002	**2.988**	0.251
Fe	0.005	7.477	**13.369**
Co	0.035	**0.011**	0.006
Ni	0.001	0.042	**0.118**
Cu	0.005	**0.090**	0.073
Ca	0.001	228.569	**927.972**
Mg	0.005	109.284	**168.101**
*Coyote Springs **n** (number of sites)*		*19*	*10*

Table 3-15b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.000	1.759	**4.444**
Inorganic C	0.001	1.444	**4.043**
$CaCO_3$	0.001	12.036	**33.693**
Mn	0.013	**2.510**	1.033
Fe	0.005	6.382	**9.183**
Co	0.006	**0.016**	0.008
Ni	0.002	0.050	**0.096**
As	0.015	0.027	**0.076**
Ca	0.005	546.157	**1203.729**
CEC	0.025	**7.930**	5.243
Clay	0.015	5.828	**7.775**
Silt	0.012	32.210	**39.432**
Sand	0.009	**61.522**	53.383
*Gold Butte **n** (number of sites)*		*28*	*8*

Table 3-15c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Inorganic C	0.050	2.961	**4.233**
$CaCO_3$	0.050	24.672	**35.273**
NO_2^-	0.019	**2.180**	0.600
Bitter Spring **n** (number of sites)		*19*	*11*

*(**Table 3-15d** is located on the next page.)*

Table 3-15d: Summary of **All Study Areas** combined.			
Significant Variable	**p-value (2-tailed)**	**Non-BW Median**	**BW Median**
Total C	0.000	3.222	**5.595**
Inorganic C	0.000	2.969	**5.505**
$CaCO_3$	0.000	24.743	**45.873**
P	0.000	**1.968**	0.622
Mn	0.004	**1.919**	1.210
Fe	0.000	7.262	**12.333**
Co	0.000	**0.014**	0.008
Ni	0.000	0.049	**0.109**
Cu	0.025	**0.093**	0.082
Zn	0.024	**0.069**	0.051
Ca	0.000	425.375	**1014.972**
Mg	0.024	56.515	**74.547**
*All Areas **n** (number of sites)*		*66*	*29*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-16: Summary of non-parametric t-tests among **maximum A horizon** values between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-16a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.001	5.754	**7.459**
Inorganic C	0.001	5.690	**7.093**
$CaCO_3$	0.001	47.417	**59.106**
P	0.002	**2.988**	0.251
Fe	0.005	7.477	**13.369**
Co	0.035	**0.011**	0.006
Ni	0.001	0.042	**0.118**
Cu	0.005	**0.090**	0.073
Ca	0.001	228.569	**927.972**
Mg	0.005	109.284	**168.101**
Coyote Springs ***n*** *(number of sites)*		*19*	*10*

Table 3-16b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.000	1.910	**4.444**
Inorganic C	0.001	1.444	**4.043**
$CaCO_3$	0.001	12.036	**33.693**
Mn	0.010	**2.766**	1.033
Fe	0.007	6.646	**9.183**
Co	0.004	**0.017**	0.008
Ni	0.002	0.050	**0.096**
As	0.017	0.027	**0.076**
Ca	0.005	547.008	**1203.729**
CEC	0.013	**8.060**	5.243
Clay	0.015	5.828	**7.775**
Silt	0.015	32.459	**39.432**
Sand	0.008	**62.921**	53.383
Gold Butte ***n*** *(number of sites)*		*28*	*8*

Table 3-16c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Inorganic C	0.050	2.961	**4.233**
$CaCO_3$	0.050	24.672	**35.273**
NO_3^-	0.019	**2.180**	0.600
Bitter Spring **n** (number of sites)		*19*	*11*

(***Table 3-16d*** *is located on the next page.)*

Table 3-16d: Summary of **All Study Areas** combined.			
Significant Variable	**p-value (2-tailed)**	**Non-BW Median**	**BW Median**
pH $CaCl_2$	0.046	**7.923**	7.870
Total C	0.000	3.222	**5.595**
Inorganic C	0.000	2.969	**5.505**
$CaCO_3$	0.000	24.743	**45.873**
P	0.000	**2.084**	0.622
Mn	0.003	**2.007**	1.210
Fe	0.000	7.339	**12.333**
Co	0.000	**0.014**	0.008
Ni	0.000	0.049	**0.109**
Cu	0.020	**0.096**	0.082
Zn	0.024	**0.069**	0.051
Ca	0.000	425.375	**1014.972**
Mg	0.025	56.515	**74.547**
All Areas ***n*** *(number of sites)*		*66*	*29*

- *Only variables flagged as statistically signficant ($p < 0.05$) are shown.*
- ***Bold*** *median values indicate the larger value between BW and Non-BW.*

Table 3-17: Summary of non-parametric t-tests among **minimum B horizon** values between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-17a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total N	0.003	**0.007**	0.002
Total C	0.009	6.212	**6.956**
Inorganic C	0.005	6.078	**6.861**
$CaCO_3$	0.005	50.646	**57.175**
Fe	0.001	9.732	**12.245**
Ni	0.008	0.085	**0.107**
K	0.031	13.740	**20.652**
Ca	0.003	660.497	**887.754**
Mg	0.016	139.996	**180.488**
*Coyote Springs **n** (number of sites)*		*20*	*10*

Table 3-17b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Moisture	0.017	2.451	**5.255**
Total N	0.039	**0.008**	0.005
Total C	0.010	3.485	**5.584**
Inorganic C	0.009	3.466	**5.176**
$CaCO_3$	0.009	28.884	**43.135**
P	0.029	**0.228**	0.101
Fe	0.000	8.325	**11.732**
Ni	0.001	0.079	**0.106**
Ca	0.028	788.796	**954.806**
*Gold Butte **n** (number of sites)*		*22*	*8*

Table 3-17c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Moisture	0.026	3.582	**7.562**
Inorganic C	0.805	3.230	**3.281**
$CaCO_3$	0.805	26.919	**27.340**
SO4	0.026	625.740	**3233.800**
Bitter Spring **n** (number of sites)		*15*	*7*

Table 3-17d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Moisture	0.026	3.582	**7.562**
Inorganic C	0.805	3.230	**3.281**
$CaCO_3$	0.805	26.919	**27.340**
SO_4	0.026	625.740	**3233.800**
*All Areas **n** (number of sites)*		*57*	*25*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-18: Summary of non-parametric t-tests among **maximum B horizon** values between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-18a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Moisture	0.043	2.563	**3.771**
pH $CaCl_2$	0.045	8.077	**8.183**
pH Sat Paste	0.019	7.743	**7.890**
Total C	0.028	6.806	**8.142**
Inorganic C	0.020	6.714	**8.007**
$CaCO_3$	0.020	55.947	**66.722**
B	0.035	0.061	**0.139**
Fe	0.002	12.049	**14.168**
Ni	0.005	0.108	**0.125**
As	0.022	0.029	**0.051**
K	0.048	21.302	**28.944**
Ca	0.008	842.476	**1110.482**
Mg	0.039	176.497	**230.641**
*Coyote Springs **n** (number of sites)*		*20*	*10*

Table 3-18b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.019	2.522	**5.278**
Inorganic C	0.018	2.278	**5.130**
$CaCO_3$	0.018	18.986	**42.749**
CEC	0.010	**5.042**	4.156
Sand	0.017	**68.261**	61.993
*Gold Butte **n** (number of sites)*		*22*	*8*

Table 3-18c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
pH1:1	0.005	**8.568**	8.012
pH $CaCl_2$	0.008	**8.506**	7.991
Cl-	0.044	**6.580**	3.200
B	0.002	**0.335**	0.110
Co	0.034	**0.009**	0.007
Na	0.015	**47.758**	36.337
Bitter Spring **n** (number of sites)		*15*	*7*

Table 3-18d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
pH1:1	0.027	**8.682**	8.266
Total N	0.021	**0.014**	0.011
Total C	0.046	4.301	**5.850**
Inorganic C	0.033	4.258	**5.749**
$CaCO_3$	0.033	35.483	**47.909**
Cl-	0.006	**10.300**	4.580
P	0.002	**0.704**	0.210
Fe	0.008	11.664	**13.130**
Ni	0.012	0.105	**0.124**
*All Areas **n** (number of sites)*		*57*	*25*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-19: Summary of non-parametric t-tests among **minimum C horizon** values between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-19a: Summary for **Coyote Springs** sites only.

Too few C horizons at Coyote Springs; statistical analysis not possible.		
*Coyote Springs **n** (number of sites)*	*Non-BW: 2*	*BW: 0*

Table 3-19b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.001	1.151	**6.256**
Inorganic C	0.002	1.040	**6.027**
$CaCO_3$	0.002	8.667	**50.225**
Cl^-	0.039	18.100	**80.940**
SO_4	0.028	2893.720	**4915.030**
P	0.003	**0.796**	0.067
Fe	0.024	6.364	**10.248**
CEC	0.020	**4.507**	3.207
*Gold Butte **n** (number of sites)*		*15*	*8*

Table 3-19c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
pH 1:1	0.012	**8.505**	8.136
pH $CaCl_2$	0.012	**8.480**	8.083
ECeSP	0.041	**4.838**	2.954
Total C	0.006	1.255	**3.620**
Inorganic C	0.008	1.192	**3.062**
$CaCO_3$	0.008	9.930	**25.515**
B	0.007	**2.504**	0.178
P	0.025	**0.495**	0.285
Mo	0.021	**6.900**	1.190
Ni	0.048	0.057	**0.097**
Ca	0.035	451.488	**1003.410**
Bitter Spring **n** (number of sites)		*12*	*10*

Table 3-19d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non-BW Median	BW Median
Total C	0.000	1.223	**4.161**
Inorganic C	0.000	1.099	**3.854**
$CaCO_3$	0.000	9.158	**32.114**
P	0.000	**0.697**	0.210
Fe	0.004	6.695	**10.716**
Co	0.050	**0.008**	0.007
Ni	0.005	0.069	**0.099**
Ca	0.030	702.849	**989.053**
*All Areas **n** (number of sites)*		*29*	*18*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-20: Summary of non-parametric t-tests among **maximum C horizon** values between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-20a: Summary for **Coyote Springs** sites only.		
Too few C horizons at Coyote Springs; statistical analysis not possible.		
Coyote Springs ***n*** *(number of sites)*	*Non-BW: 2*	*BW: 0*

Table 3-20b: Summary for **Gold Butte** sites only.			
Significant Variable	**p-value (2-tailed)**	**Non-BW Median**	**BW Median**
Total C	0.001	1.151	**6.341**
Inorganic C	0.002	1.040	**6.208**
$CaCO_3$	0.002	8.667	**51.735**
P	0.008	**0.851**	0.074
Fe	0.010	6.364	**10.745**
K	0.039	6.719	**15.595**
Mg	0.033	48.336	**117.888**
CEC	0.028	**4.507**	3.219
Gold Butte ***n*** *(number of sites)*		*15*	*8*

Table 3-20c: Summary for **Bitter Spring** sites only.			
Significant Variable	**p-value (2-tailed)**	**Non-BW Median**	**BW Median**
Total C	0.030	2.411	**3.620**
Inorganic C	0.047	2.329	**3.062**
$CaCO_3$	0.047	19.407	**25.515**
B	0.005	**2.215**	0.202
Mo	0.026	**6.900**	1.800
Ni	0.035	0.073	**0.115**
Bitter Spring **n** (number of sites)		*13*	*10*

Table 3-20d: Summary of **All Study Areas** combined.			
Significant Variable	**p-value (2-tailed)**	**Non-BW Median**	**BW Median**
Total C	0.000	1.415	**4.161**
Inorganic C	0.000	1.364	**3.959**
$CaCO_3$	0.000	11.370	**32.991**
P	0.002	**0.784**	0.240
Fe	0.002	7.978	**11.144**
Ni	0.001	0.070	**0.108**
Ca	0.012	768.815	**1038.613**
All Areas ***n*** *(number of sites)*		*30*	*18*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-21: Summary of non-parametric t-tests among **A horizon weighted-mean** values (all horizons averaged and wieghted by horizon thickness), between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-21a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
Total C	0.001	5.754	**7.459**
Inorganic C	0.001	5.690	**7.093**
$CaCO_3$	0.001	47.417	**59.106**
P	0.002	**2.988**	0.251
Fe	0.005	7.477	**13.369**
Co	0.035	**0.011**	0.006
Ni	0.001	0.042	**0.118**
Cu	0.005	**0.090**	0.073
Ca	0.001	228.569	**927.972**
Mg	0.005	109.284	**168.101**
*Coyote Springs **n** (number of sites)*		*19*	*10*

Table 3-21b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
Total C	0.000	1.759	**4.444**
Inorganic C	0.001	1.444	**4.043**
$CaCO_3$	0.001	12.036	**33.693**
Mn	0.010	**2.664**	1.033
Fe	0.006	6.533	**9.183**
Co	0.006	**0.016**	0.008
Ni	0.002	0.050	**0.096**
As	0.015	0.027	**0.076**
Ca	0.005	546.157	**1203.729**
CEC	0.015	**7.930**	5.243
Clay	0.015	5.828	**7.775**
Silt	0.012	32.210	**39.432**
Sand	0.008	**62.921**	53.383
*Gold Butte **n** (number of sites)*		*28*	*8*

Table 3-21c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
Inorganic C	0.050	2.961	**4.233**
$CaCO_3$	0.050	24.672	**35.273**
NO_3^-	0.019	**2.180**	0.600
Bitter Spring **n** (number of sites)		*19*	*11*

*(**Table 3-21d** is located on the next page.)*

Table 3-21d: Summary of **All Study Areas** combined.			
Significant Variable	**p-value (2-tailed)**	**No BW Median**	**BW Median**
Total C	0.000	3.222	**5.595**
Inorganic C	0.000	2.969	**5.505**
$CaCO_3$	0.000	24.743	**45.873**
P	0.000	**2.084**	0.622
Mn	0.003	**2.007**	1.210
Fe	0.000	7.262	**12.333**
Co	0.000	**0.014**	0.008
Ni	0.000	0.049	**0.109**
Cu	0.023	**0.096**	0.082
Zn	0.024	**0.069**	0.051
Ca	0.000	425.375	**1014.972**
Mg	0.024	56.515	**74.547**
*All Areas **n** (number of sites)*		*66*	*29*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-22: Summary of non-parametric t-tests among **B horizon weighted-mean** values (all horizons averaged and wieghted by horizon thickness), between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-22a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
pH Sat Paste	0.033	7.579	**7.764**
Total N	0.018	**0.010**	0.006
Total C	0.020	6.466	**7.394**
Inorganic C	0.016	6.390	**7.305**
$CaCO_3$	0.016	53.248	**60.875**
B	0.031	0.053	**0.116**
P	0.039	**0.333**	0.063
Ni	0.002	0.101	**0.118**
As	0.035	0.026	**0.036**
K	0.039	17.538	**26.877**
Ca	0.002	768.478	**994.664**
Mg	0.043	164.617	**205.236**
*Coyote Springs **n** (number of sites)*		*20*	*10*

Table 3-22b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
Total C	0.007	2.316	**5.185**
Inorganic C	0.008	1.904	**4.911**
$CaCO_3$	0.008	15.870	**40.928**
CEC	0.013	**4.942**	3.171
Silt	0.031	27.972	**32.519**
*Gold Butte **n** (number of sites)*		*22*	*8*

Table 3-22c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
pH1:1	0.007	**8.340**	8.005
pH $CaCl_2$	0.010	**8.288**	7.990
B	0.003	**0.259**	0.110
Co	0.032	**0.009**	0.007
Na	0.032	**45.218**	36.337
Bitter Spring **n** (number of sites)		*15*	*7*

Table 3-22d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
Total N	0.026	**0.011**	0.009
Total C	0.023	4.262	**5.782**
Inorganic C	0.018	4.140	**5.557**
$CaCO_3$	0.018	34.504	**46.309**
Cl-	0.006	**7.907**	3.858
P	0.003	**0.564**	0.146
Fe	0.003	9.879	**12.670**
Ni	0.005	0.097	**0.112**
*All Areas **n** (number of sites)*		*57*	*25*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-23: Summary of non-parametric t-tests among **C horizon weighted-mean** values (all horizons averaged and wieghted by horizon thickness), between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-23a: Summary for **Coyote Springs** sites only.

Too few C horizons at Coyote Springs; statistical analysis not possible.		
*Coyote Springs **n** (number of sites)*	*Non-BW: 2*	*BW: 0*

Table 3-23b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
Total C	0.001	1.151	**6.341**
Inorganic C	0.002	1.040	**6.208**
$CaCO_3$	0.002	8.667	**51.735**
SO_4^{2-}	0.039	2893.720	**4915.030**
P	0.006	**0.851**	0.069
Fe	0.010	6.364	**10.649**
K	0.039	6.393	**14.169**
Mg	0.039	38.415	**117.888**
CEC	0.024	**4.507**	3.215
Clay	0.045	3.686	**6.574**
*Gold Butte **n** (number of sites)*		*15*	*8*

Table 3-23c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
Total C	0.013	1.943	**3.620**
Inorganic C	0.018	1.833	**3.062**
$CaCO_3$	0.018	15.276	**25.515**
B	0.006	**2.215**	0.178
Mo	0.022	**5.660**	1.250
Bitter Spring **n** (number of sites)		*13*	*10*

Table 3-23d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	No BW Median	BW Median
Total C	0.000	1.415	**4.161**
Inorganic C	0.000	1.364	**3.854**
$CaCO_3$	0.000	11.370	**32.114**
P	0.001	**0.711**	0.221
Fe	0.004	7.978	**11.114**
Ni	0.005	0.069	**0.104**
Ca	0.030	712.418	**989.867**
*All Areas **n** (number of sites)*		*30*	*18*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-24: Summary of non-parametric t-tests among soil **profile means** (all horizons averaged) between "Habitat" sites and "Potential Habitat" Sites.

Table 3-24a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
pH Sat Paste	0.041	7.547	**7.713**
Total C	0.034	6.857	**7.694**
Inorganic C	0.027	6.703	**7.553**
$CaCO_3$	0.027	55.859	**62.940**
Fe	0.006	10.866	**13.497**
Ni	0.009	0.100	**0.114**
Ca	0.014	758.288	**977.149**
*Coyote Springs **n** (number of sites)*		*9*	*10*

Table 3-24b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Total C	0.003	2.457	**4.895**
Inorganic C	0.004	2.129	**4.453**
$CaCO_3$	0.004	17.740	**37.112**
CEC	0.001	**6.598**	4.392
*Gold Butte **n** (number of sites)*		*18*	*9*

Table 3-24c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
B	0.021	**1.213**	0.161
Co	0.016	**0.010**	0.008
Ni	0.026	0.057	**0.099**
Na	0.021	**63.524**	41.627
Ca	0.026	499.683	**914.814**
Mg	0.033	**89.906**	72.777
Bitter Spring **n** (number of sites)		*7*	*11*

Table 3-24d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Total N	0.010	**0.017**	0.010
Total C	0.003	3.235	**5.690**
Inorganic C	0.003	2.971	**5.559**
$CaCO_3$	0.003	24.757	**46.329**
NO_3^-	0.017	**7.913**	2.531
P	0.001	**0.984**	0.467
Fe	0.001	9.415	**11.951**
Co	0.006	**0.010**	0.008
Ni	0.000	0.079	**0.110**
Cu	0.042	**0.097**	0.084
K	0.040	14.419	**22.028**
Ca	0.045	840.919	**961.053**
*All Areas **n** (number of sites)*		*34*	*30*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-25: Summary of non-parametric t-tests among soil **profile minimum** values between "Habitat" sites and "Potential Habitat" Sites.

Table 3-25a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Total C	0.027	5.957	**6.856**
Inorganic C	0.009	5.757	**6.625**
$CaCO_3$	0.009	47.979	**55.209**
Fe	0.027	7.823	**12.245**
Ni	0.027	0.061	**0.105**
Ca	0.022	417.600	**887.754**
Coyote Springs ***n*** *(number of sites)*		*9*	*10*

Table 3-25b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Total C	0.005	1.894	**3.584**
Inorganic C	0.005	1.537	**2.978**
$CaCO_3$	0.005	12.809	**24.813**
P	0.003	**0.449**	0.042
Fe	0.045	5.860	**8.299**
CEC	0.018	**4.193**	2.789
Gold Butte ***n*** *(number of sites)*		*18*	*9*

Table 3-25c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Total C	0.004	1.287	**3.131**
Inorganic C	0.006	1.200	**2.986**
$CaCO_3$	0.006	10.001	**24.883**
B	0.033	**0.158**	0.081
Ni	0.008	0.033	**0.083**
Ca	0.008	216.516	**724.933**
Bitter Spring **n** (number of sites)		*7*	*11*

Table 3-25d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Total C	0.001	2.371	**4.815**
Inorganic C	0.001	1.979	**4.629**
$CaCO_3$	0.001	16.494	**38.572**
P	0.000	**0.337**	0.094
Fe	0.001	6.647	**9.662**
Ni	0.000	0.051	**0.087**
Ca	0.003	482.971	**841.512**
All Areas ***n*** *(number of sites)*		*34*	*30*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-26: Summary of non-parametric t-tests among soil **profile maximum** values between "Habitat" sites and "Potential Habitat" Sites.

Table 3-26a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Fe	0.014	12.876	**15.146**
Coyote Springs **n** *(number of sites)*		*9*	*10*

Table 3-26b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Total C	0.003	3.434	**6.659**
Inorganic C	0.001	2.851	**6.347**
$CaCO_3$	0.001	23.760	**52.893**
CEC	0.001	**9.443**	6.665
Gold Butte **n** *(number of sites)*		*18*	*9*

Table 3-26c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
pH 1:1	0.026	**8.719**	8.156
pH $CaCl_2$	0.026	**8.712**	8.126
B	0.016	**2.793**	0.208
Co	0.006	**0.015**	0.010
Na	0.021	**115.935**	45.603
Clay	0.021	2.723	**5.754**
Bitter Spring **n** (number of sites)		*7*	*11*

Table 3-26d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Total N	0.050	**0.029**	0.018
Total C	0.005	4.030	**6.578**
Inorganic C	0.004	3.694	**6.301**
$CaCO_3$	0.004	30.780	**52.507**
NO_3^-	0.013	**20.200**	4.440
P	0.007	**1.647**	0.833
Mn	0.027	**2.166**	1.560
Fe	0.005	11.829	**13.443**
Co	0.001	**0.015**	0.009
Ni	0.002	0.105	**0.125**
Cu	0.019	**0.129**	0.105
Zn	0.004	**0.078**	0.059
K	0.027	21.063	**33.768**
All Areas **n** *(number of sites)*		*34*	*30*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-27: Summary of non-parametric t-tests among soil **profile means** (all horizons averaged and weighted based on thickness) between "Habitat" sites and "Potential Habitat" Sites.

Table 3-27a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Fe	0.006	11.377	**13.487**
Ni	0.014	0.101	**0.119**
Ca	0.022	786.061	**1006.592**
*Coyote Springs **n** (number of sites)*		*9*	*10*

Table 3-27b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Total C	0.003	2.602	**5.736**
Inorganic C	0.002	2.300	**5.451**
$CaCO_3$	0.002	19.163	**45.427**
CEC	0.004	**5.679**	3.724
*Gold Butte **n** (number of sites)*		*18*	*9*

Table 3-27c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
B	0.026	**1.712**	0.165
Co	0.033	**0.009**	0.007
Ni	0.042	0.060	**0.099**
Na	0.021	**62.938**	40.184
Ca	0.042	574.140	**981.284**
Bitter Spring **n** (number of sites)		*7*	*11*

Table 3-27d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Total N	0.013	**0.014**	0.009
Total C	0.006	3.426	**5.747**
Inorganic C	0.006	3.095	**5.544**
$CaCO_3$	0.006	25.788	**46.202**
NO_3^-	0.036	**10.607**	2.546
P	0.002	**0.820**	0.292
Fe	0.002	9.759	**11.730**
Co	0.020	**0.009**	0.007
Ni	0.001	0.081	**0.108**
K	0.022	15.963	**26.123**
*All Areas **n** (number of sites)*		*34*	*30*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-28: Summary of non-parametric t-tests among **mean A** horizon values between "Habitat" sites and "Potential Habitat" Sites.

Table 3-28a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Cu	0.016	**0.091**	0.073
*Coyote Springs **n** (number of sites)*		*8*	*10*

Table 3-28b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Total C	0.004	2.419	**4.444**
Inorganic C	0.009	2.236	**4.043**
$CaCO_3$	0.009	18.635	**33.693**
Mn	0.030	**2.510**	1.033
Co	0.026	**0.015**	0.008
Ni	0.023	0.068	**0.096**
Ca	0.040	595.565	**1203.729**
CEC	0.011	**8.729**	5.243
*Gold Butte **n** (number of sites)*		*18*	*8*

Table 3-28c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Co	0.033	**0.013**	0.008
Ni	0.033	0.049	**0.104**
Ca	0.033	344.108	**1014.972**
Clay	0.010	2.654	**5.754**
Bitter Spring **n** (number of sites)		*7*	*11*

Table 3-28d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Total C	0.001	2.703	**5.595**
Inorganic C	0.002	2.506	**5.505**
$CaCO_3$	0.002	20.882	**45.873**
P	0.003	**1.691**	0.622
Mn	0.017	**1.872**	1.210
Fe	0.006	8.059	**12.333**
Co	0.001	**0.013**	0.008
Ni	0.001	0.059	**0.109**
Cu	0.007	**0.108**	0.082
Zn	0.018	**0.071**	0.051
Ca	0.005	553.458	**1014.972**
Clay	0.047	6.608	**8.587**
*All Areas **n** (number of sites)*		*33*	*29*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-29: Summary of non-parametric t-tests among **mean B** horizon values between "Habitat" sites and "Potential Habitat" Sites.

Table 3-29a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Fe	0.003	11.344	**13.337**
Ni	0.007	0.101	**0.119**
Ca	0.027	772.727	**986.685**
*Coyote Springs **n** (number of sites)*		*9*	*10*

Table 3-29b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Total C	0.034	2.914	**4.849**
Inorganic C	0.048	2.534	**4.553**
$CaCO_3$	0.048	21.116	**37.940**
Cl-	0.048	**17.930**	4.430
CEC	0.017	**5.630**	3.442
*Gold Butte **n** (number of sites)*		*14*	*8*

Table 3-29c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
B	0.008	**0.440**	0.110
Na	0.023	**47.978**	36.337
Mg	0.023	**96.238**	53.850
Bitter Spring **n** (number of sites)		*4*	*7*

Table 3-29d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Total N	0.041	**0.011**	0.009
Total C	0.049	4.389	**5.782**
Cl^-	0.002	**13.125**	3.320
P	0.011	**0.679**	0.145
Fe	0.012	10.513	**12.589**
Ni	0.004	0.096	**0.114**
*All Areas **n** (number of sites)*		*27*	*25*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-30: Summary of non-parametric t-tests among **mean C** horizon values between "Habitat" sites and "Potential Habitat" Sites.

Table 3-30a: Summary for **Coyote Springs** sites only.

Too few C horizons at Coyote Springs; statistical analysis not possible.		
*Coyote Springs **n** (number of sites)*	*P.Hab.: 0*	*BW Hab.: 0*

Table 3-30b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Moisture	0.006	**14.955**	6.709
pH 1:1	0.021	8.108	**8.378**
pH $CaCl_2$	0.010	8.060	**8.331**
Total C	0.006	1.173	**6.341**
Inorganic C	0.006	0.770	**6.191**
$CaCO_3$	0.006	6.420	**51.594**
P	0.036	**0.716**	0.070
Fe	0.036	6.137	**10.597**
Clay	0.021	3.504	**6.518**
*Gold Butte **n** (number of sites)*		*8*	*8*

Table 3-30c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
pH 1:1	0.040	**8.719**	8.151
pH $CaCl_2$	0.040	**8.712**	8.110
Total C	0.032	2.038	**3.620**
B	0.019	**2.793**	0.178
Ni	0.008	0.057	**0.104**
Ca	0.006	522.838	**1038.613**
Bitter Spring **n** (number of sites)		*7*	*10*

Table 3-30d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	BW Hab Median
Moisture	0.010	**11.766**	7.955
Total C	0.000	1.287	**4.161**
Inorganic C	0.001	1.284	**3.854**
$CaCO_3$	0.001	10.703	**32.114**
P	0.013	**0.522**	0.225
Fe	0.019	6.649	**11.114**
Ni	0.003	0.067	**0.105**
Ca	0.021	683.216	**989.053**
*All Areas **n** (number of sites)*		*15*	*18*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-31: Summary of non-parametric t-tests among **minimum A** horizon values between "Habitat" sites and "Potential Habitat" Sites.

Table 3-31a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Cu	0.016	**0.091**	0.073
Coyote Springs ***n*** *(number of sites)*		*8*	*10*

Table 3-31b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Total C	0.004	2.419	**4.444**
Inorganic C	0.009	2.236	**4.043**
$CaCO_3$	0.009	18.635	**33.693**
Mn	0.046	**2.250**	1.033
Fe	0.046	7.339	**9.183**
Co	0.035	**0.015**	0.008
Ni	0.020	0.068	**0.096**
Ca	0.040	595.565	**1203.729**
CEC	0.017	**8.729**	5.243
Gold Butte ***n*** *(number of sites)*		*18*	*8*

Table 3-31c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Co	0.033	**0.013**	0.008
Ni	0.033	0.049	**0.104**
Ca	0.033	344.108	**1014.972**
Clay	0.010	2.654	**5.754**
Bitter Spring **n** (number of sites)		*7*	*11*

Table 3-31d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Total C	0.001	2.703	**5.595**
Inorganic C	0.002	2.506	**5.505**
$CaCO_3$	0.002	20.882	**45.873**
P	0.004	**1.638**	0.622
Mn	0.023	**1.826**	1.210
Fe	0.006	8.059	**12.333**
Co	0.001	**0.013**	0.008
Ni	0.001	0.057	**0.109**
Cu	0.009	**0.099**	0.082
Zn	0.018	**0.071**	0.051
Ca	0.005	553.458	**1014.972**
Clay	0.043	6.608	**8.587**
All Areas ***n*** *(number of sites)*		*33*	*29*

- *Only variables flagged as statistically signficant ($p < 0.05$) are shown.*
- ***Bold*** *median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-32: Summary of non-parametric t-tests among **maximum A** horizon values between "Habitat" sites and "Potential Habitat" Sites.

Table 3-32a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Cu	0.016	**0.091**	0.073
*Coyote Springs **n** (number of sites)*		*8*	*10*

Table 3-32b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Total C	0.004	2.503	**4.444**
Inorganic C	0.009	2.236	**4.043**
$CaCO_3$	0.009	18.635	**33.693**
Mn	0.030	**2.510**	1.033
Co	0.023	**0.016**	0.008
Ni	0.023	0.070	**0.096**
Ca	0.040	595.565	**1203.729**
CEC	0.006	**9.091**	5.243
*Gold Butte **n** (number of sites)*		*18*	*8*

Table 3-32c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Co	0.033	**0.013**	0.008
Ni	0.033	0.049	**0.104**
Ca	0.033	344.108	**1014.972**
Clay	0.010	2.654	**5.754**
Bitter Spring **n** (number of sites)		*7*	*11*

Table 3-32d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Total C	0.001	2.703	**5.595**
Inorganic C	0.002	2.506	**5.505**
$CaCO_3$	0.002	20.882	**45.873**
P	0.003	**1.691**	0.622
Mn	0.017	**1.872**	1.210
Fe	0.008	8.059	**12.333**
Co	0.001	**0.013**	0.008
Ni	0.001	0.059	**0.109**
Cu	0.006	**0.108**	0.082
Zn	0.018	**0.071**	0.051
Ca	0.005	553.458	**1014.972**
Clay	0.049	6.608	**8.587**
*All Areas **n** (number of sites)*		*33*	*29*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-33: Summary of non-parametric t-tests among **minimum B** horizon values between "Habitat" sites and "Potential Habitat" Sites.

Table 3-33a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Total C	0.041	6.220	**6.956**
Inorganic C	0.041	6.137	**6.861**
$CaCO_3$	0.041	51.138	**57.175**
Fe	0.004	10.065	**12.245**
Ni	0.014	0.090	**0.107**
K	0.018	14.704	**20.652**
Ca	0.009	691.550	**887.754**
*Coyote Springs **n** (number of sites)*		*9*	*10*

Table 3-33b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
pH 1:1	0.044	8.088	**8.201**
pH Sat Paste	0.024	7.394	**7.768**
Total C	0.034	2.371	**4.127**
Inorganic C	0.032	2.038	**3.723**
$CaCO_3$	0.032	16.986	**31.026**
Silt	0.034	27.321	**32.260**
*Gold Butte **n** (number of sites)*		*14*	*8*

Table 3-33c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Na	0.038	**41.345**	36.337
Mg	0.023	**93.220**	52.784
Bitter Spring **n** (number of sites)		*4*	*7*

Table 3-33d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
pH Sat Paste	0.036	7.389	**7.556**
Total C	0.018	3.368	**5.584**
Inorganic C	0.016	2.851	**5.176**
$CaCO_3$	0.016	23.760	**43.135**
Fe	0.001	8.186	**11.732**
Ni	0.001	0.079	**0.106**
*All Areas **n** (number of sites)*		*27*	*25*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-34: Summary of non-parametric t-tests among **maximum B** horizon values between "Habitat" sites and "Potential Habitat" Sites.

Table 3-34a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Fe	0.022	12.631	**14.168**
Ni	0.027	0.110	**0.125**
As	0.050	0.030	**0.051**
*Coyote Springs **n** (number of sites)*		*9*	*10*

Table 3-34b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Cl^-	0.034	**20.670**	4.430
CEC	0.009	**6.296**	4.156
Sand	0.048	**67.218**	61.993
*Gold Butte **n** (number of sites)*		*18*	*8*

Table 3-34c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
B	0.008	**0.585**	0.110
Na	0.023	**54.612**	36.337
Mg	0.038	**99.256**	53.850
Bitter Spring **n** (number of sites)		*4*	*7*

Table 3-34d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Total N	0.039	**0.014**	0.011
Cl^-	0.001	**15.420**	4.580
NO_3^-	0.030	**7.960**	2.000
P	0.007	**0.704**	0.210
*All Areas **n** (number of sites)*		*27*	*25*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-35: Summary of non-parametric t-tests among **minimum C** horizon values between "Habitat" sites and "Potential Habitat" Sites.

Table 3-35a: Summary for **Coyote Springs** sites only.

Too few C horizons at Coyote Springs; statistical analysis not possible.		
Coyote Springs ***n*** *(number of sites)*	*P.Hab.: 0*	*BW Hab.: 0*

Table 3-35b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Moisture	0.006	**14.955**	6.360
pH 1:1	0.036	8.096	**8.369**
pH $CaCl_2$	0.018	8.044	**8.309**
Total C	0.006	1.173	**6.256**
Inorganic C	0.006	0.770	**6.027**
$CaCO_3$	0.006	6.420	**50.225**
Cl^-	0.036	17.990	**80.940**
SO_4^{2-}	0.036	2932.060	**4915.030**
P	0.016	**0.648**	0.067
CEC	0.036	**4.998**	3.207
Clay	0.021	3.504	**6.361**
Gold Butte ***n*** *(number of sites)*		*8*	*8*

Table 3-35c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
pH 1:1	0.015	**8.719**	8.136
pH $CaCl_2$	0.019	**8.712**	8.083
Total C	0.015	1.287	**3.620**
Inorganic C	0.025	1.284	**3.062**
$CaCO_3$	0.025	10.703	**25.515**
B	0.011	**2.793**	0.178
Ni	0.025	0.043	**0.097**
Na	0.040	**115.935**	40.413
Ca	0.019	372.996	**1003.410**
Bitter Spring **n** (number of sites)		*7*	*10*

Table 3-35d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Moisture	0.007	**11.766**	7.955
Total C	0.000	1.223	**4.161**
Inorganic C	0.001	1.091	**3.854**
$CaCO_3$	0.001	9.088	**32.114**
P	0.003	**0.500**	0.210
Fe	0.013	6.364	**10.716**
Ni	0.008	0.065	**0.099**
Ca	0.036	556.736	**989.053**
All Areas ***n*** *(number of sites)*		*15*	*18*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-36: Summary of non-parametric t-tests among **maximum C** horizon values between "Habitat" sites and "Potential Habitat" Sites.

Table 3-36a: Summary for **Coyote Springs** sites only.

Too few C horizons at Coyote Springs; statistical analysis not possible.		
Coyote Springs ***n*** *(number of sites)*	*P.Hab.: 0*	*BW Hab.: 0*

Table 3-36b: Summary forGold Butte sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Moisture	0.009	**14.955**	6.709
pH 1:1	0.036	8.120	**8.384**
pH $CaCl_2$	0.024	8.077	**8.338**
Total C	0.009	1.173	**6.341**
Inorganic C	0.009	0.770	**6.208**
$CaCO_3$	0.009	6.420	**51.735**
P	0.027	**0.716**	0.074
Fe	0.036	6.137	**10.745**
CEC	0.046	**4.998**	3.219
Clay	0.036	3.504	**6.702**
Gold Butte ***n*** *(number of sites)*		*8*	*8*

Table 3-36c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
B	0.019	**2.793**	0.202
Ni	0.008	0.057	**0.115**
Ca	0.019	522.838	**1038.613**
Bitter Spring **n** (number of sites)		*7*	*10*

Table 3-36d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Habitat Median
Moisture	0.013	**11.766**	7.955
Total C	0.001	1.287	**4.161**
Inorganic C	0.001	1.284	**3.959**
$CaCO_3$	0.001	10.703	**32.991**
P	0.015	**0.733**	0.240
Fe	0.010	6.707	**11.144**
Ni	0.002	0.068	**0.108**
Ca	0.019	697.680	**1038.613**
All Areas ***n*** *(number of sites)*		*15*	*8*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-37: Summary of non-parametric t-tests among **A horizon weighted-mean** values (all horizons averaged and wieghted by horizon thickness), between "Habitat" sites and "Potential Habitat" Sites.

Table 3-37a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Cu	0.016	**0.091**	0.073
Coyote Springs ***n*** *(number of sites)*		*8*	*10*

Table 3-37b: Summary forGold Butte sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Total C	0.004	2.419	**4.444**
Inorganic C	0.009	2.236	**4.043**
$CaCO_3$	0.009	18.635	**33.693**
Mn	0.030	**2.510**	1.033
Co	0.035	**0.015**	0.008
Ni	0.020	0.068	**0.096**
Ca	0.040	595.565	**1203.729**
CEC	0.008	**8.729**	5.243
Gold Butte ***n*** *(number of sites)*		*18*	*8*

Table 3-37c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Co	0.033	**0.013**	0.008
Ni	0.033	0.049	**0.104**
Ca	0.033	344.108	**1014.972**
Clay	0.010	2.654	**5.754**
Bitter Spring **n** (number of sites)		*7*	*11*

Table 3-37d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Total C	0.001	2.703	**5.595**
Inorganic C	0.002	2.506	**5.505**
$CaCO_3$	0.002	20.882	**45.873**
P	0.004	**1.691**	0.622
Mn	0.017	**1.872**	1.210
Fe	0.006	8.059	**12.333**
Co	0.001	**0.013**	0.008
Ni	0.001	0.059	**0.109**
Cu	0.008	**0.108**	0.082
Zn	0.018	**0.071**	0.051
Ca	0.005	553.458	**1014.972**
Clay	0.044	6.608	**8.587**
All Areas ***n*** *(number of sites)*		*33*	*29*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-38: Summary of non-parametric t-tests among **B horizon weighted-mean** values (all horizons averaged and wieghted by horizon thickness), between "Habitat" sites and "Potential Habitat" Sites.

Table 3-38a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Fe	0.003	11.488	**13.295**
Ni	0.006	0.102	**0.118**
As	0.050	0.026	**0.036**
Ca	0.022	793.147	**994.664**
*Coyote Springs **n** (number of sites)*		*9*	*10*

Table 3-38b: Summary forGold Butte sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Total C	0.029	3.019	**5.185**
Inorganic C	0.034	2.740	**4.911**
$CaCO_3$	0.034	22.837	**40.928**
CEC	0.029	**5.338**	3.171
*Gold Butte **n** (number of sites)*		*14*	*8*

Table 3-38c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
B	0.008	**0.407**	0.110
Na	0.023	**47.031**	36.337
Mg	0.038	**96.841**	53.850
Bitter Spring **n** (number of sites)		*4*	*7*

Table 3-38d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Cl^-	0.002	**11.793**	3.858
P	0.012	**0.568**	0.146
Fe	0.013	10.416	**12.670**
Ni	0.007	0.097	**0.112**
*All Areas **n** (number of sites)*		*27*	*25*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-39: Summary of non-parametric t-tests among **C horizon weighted-mean** values (all horizons averaged and wieghted by horizon thickness), between "Habitat" sites and "Potential Habitat" Sites.

Table 3-39a: Summary for **Coyote Springs** sites only.

Too few C horizons at Coyote Springs; statistical analysis not possible.		
Coyote Springs ***n*** *(number of sites)*	*P.Hab.: 0*	*BW Hab.: 0*

Table 3-39b: Summary forGold Butte sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Moisture	0.009	**14.955**	6.709
pH 1:1	0.016	8.106	**8.382**
pH $CaCl_2$	0.010	8.058	**8.338**
Total C	0.006	1.173	**6.341**
Inorganic C	0.006	0.770	**6.208**
$CaCO_3$	0.006	6.420	**51.735**
P	0.021	**0.711**	0.069
Fe	0.036	6.137	**10.649**
CEC	0.046	**4.998**	3.215
Clay	0.021	3.504	**6.574**
Gold Butte ***n*** *(number of sites)*		*8*	*8*

Table 3-39c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
pH 1:1	0.040	**8.719**	8.151
pH $CaCl_2$	0.032	**8.712**	8.110
Total C	0.025	1.943	**3.620**
Inorganic C	0.040	1.833	**3.062**
$CaCO_3$	0.040	15.276	**25.515**
B	0.019	**2.793**	0.178
Ni	0.019	0.057	**0.103**
Ca	0.008	522.838	**1033.443**
CEC	0.040	**21.487**	17.449
Bitter Spring **n** (number of sites)		*7*	*10*

Table 3-39d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	P.Hab. Median	Hab Median
Moisture	0.011	**11.766**	7.955
Total C	0.000	1.287	**4.161**
Inorganic C	0.001	1.284	**3.854**
$CaCO_3$	0.001	10.703	**32.114**
P	0.009	**0.567**	0.221
Fe	0.015	6.649	**11.114**
Ni	0.005	0.065	**0.104**
Ca	0.023	616.544	**989.867**
All Areas ***n*** *(number of sites)*		*15*	*18*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Potential Habitat and Habitat.*

Table 3-40: Summary of non-parametric t-test for differences among soil **profile mean** values (averages of all horizons combined) between "Non-habitat" and "Potential Habitat" sites.

Table 3-40a: Data for Coyote Springs only.

Significant Variable	p-value (two-tailed)	Non-Hab. Median	Pot. Hab. Median
Total C	0.011	5.865	**6.857**
Inorganic C	0.011	5.715	**6.703**
$CaCO_3$	0.011	47.628	**55.859**
P	0.017	**1.584**	0.620
Mo (ppb)	0.030	0.540	**2.935**
Fe	0.006	8.861	**10.866**
Co	0.037	**0.009**	0.006
Ni	0.017	0.071	**0.100**
Ca	0.020	532.257	**758.288**
Mg	0.009	118.937	**190.203**
Silt	0.030	**28.069**	23.559
*Coyote Springs **n** (number of sites)*		*11*	*9*

Table 3-40b: Data for Gold Butte only.

Significant Variable	p-value (two-tailed)	Non-Hab. Median	Pot. Hab. Median
Moisture	0.002	1.889	**7.754**
pH 1:1	0.014	**8.640**	8.102
pH $CaCl_2$	0.013	**8.563**	8.038
ECe Sat Paste	0.002	1.203	**2.261**
Total N	0.019	0.014	**0.022**
Total C	0.035	1.300	**2.457**
NO_3^-	0.011	1.591	**10.425**
B	0.027	0.069	**0.134**
Fe	0.006	5.693	**7.741**
Ni	0.006	0.058	**0.078**
As	0.013	0.033	**0.060**
Ca	0.017	728.677	**1089.333**
Silt	0.002	23.364	**32.990**
Sand	0.003	**71.127**	61.503
*Gold Butte **n** (number of sites)*		*10*	*18*

Table 3-40c: Data for Bitter Spring only.

Significant Variable	p-value (two-tailed)	Non-Hab. Median	Pot. Hab. Median
Moisture	0.022	3.224	**7.528**
CEC	0.004	10.142	**18.953**
Clay	0.002	**6.540**	1.971
Silt	0.014	**28.241**	14.437
Sand	0.007	66.473	**83.887**
*Bitter Spring **n** (number of sites)*		*12*	*7*

*(**Table 3-40d** is located on the next page)*

Table 3-40d: Data for all study areas combined.

Significant Variable	p-value (two-tailed)	Non-Hab. Median	Pot. Hab. Median
Moisture	0.000	2.649	**5.960**
pH 1:1	0.002	**8.617**	8.216
pH $CaCl_2$	0.039	**8.166**	8.046
ECe Sat Paste	0.002	0.670	**2.202**
Cl^-	0.046	8.430	**15.634**
SO_4^{2-}	0.022	558.200	**2813.509**
NO_3^-	0.004	2.505	**7.913**
*All Areas **n** (number of sites)*		*33*	*34*

- *Only variables flagged as statistically signficant ($p < 0.05$) are shown.*
- ***Bold** median values indicate the larger value between Non-habitat and Potential Habitat*

Table 3-41: Summary of non-parametric t-test for differences among **mean A** horizon values, between "Non-habitat" and "Potential Habitat" sites.

Table 3-41a: Data for **Coyote Springs** sites only.

Significant Variable	p-value (two-tailed)	Non-Hab. Median	Pot. Hab. Median
Total C	0.003	5.124	**6.147**
Inorganic C	0.003	5.109	**6.019**
$CaCO_3$	0.003	42.573	**50.155**
Fe	0.000	6.914	**11.563**
Co	0.039	**0.013**	0.007
Ni	0.005	0.038	**0.072**
K	0.032	**21.946**	14.246
Ca	0.006	202.726	**558.046**
Mg	0.004	92.257	**128.179**
*Coyote Springs **n** (number of sites)*		*11*	*8*

Table 3-41b: Data for **Gold Butte** sites only.

Significant Variable	p-value (two-tailed)	Non-Hab. Median	Pot. Hab. Median
Moisture	0.002	0.518	**2.265**
pH 1:1	0.003	**8.657**	7.895
pH $CaCl_2$	0.005	**8.632**	7.789
ECe Sat Paste	0.001	1.160	**2.098**
Total N	0.027	0.018	**0.038**
Total C	0.000	1.346	**2.419**
Inorganic C	0.002	1.053	**2.236**
$CaCO_3$	0.002	8.772	**18.635**
SO_4^{2-}	0.021	842.790	**2602.300**
B	0.014	0.045	**0.118**
Fe	0.001	4.295	**7.339**
Ni	0.000	0.035	**0.068**
Cu	0.019	0.102	**0.126**
As	0.000	0.016	**0.040**
Ca	0.003	201.298	**595.565**
Clay	0.044	4.825	**6.789**
Silt	0.001	24.654	**35.670**
Sand	0.001	**70.215**	56.737
*Gold Butte **n** (number of sites)*		*10*	*18*

Table 3-41c: Data for **Bitter Spring** sites only.

Significant Variable	p-value (two-tailed)	Non-Hab. Median	Pot. Hab. Median
Moisture	0.011	1.902	**5.181**
ECe Sat Paste	0.043	1.125	**2.230**
Clay	0.003	**7.777**	2.654
Silt	0.035	**31.899**	17.458
Sand	0.014	62.014	**79.888**
*Bitter Spring **n** (number of sites)*		*12*	*7*

*(**Table 3-41d** is located on the next page.)*

Table 3-41d: Data for **all study areas** combined.			
Significant Variable	**p-value (two-tailed)**	**Non-Hab. Median**	**Pot. Hab. Median**
Moisture	0.005	1.230	**2.599**
pH1:1	0.000	**8.584**	7.996
pHCaCl2	0.000	**8.047**	7.863
ECeSP	0.003	0.359	**1.952**
Fe	0.003	6.646	**8.059**
Ni	0.003	0.040	**0.059**
K	0.014	**20.295**	12.462
Ca	0.001	225.169	**553.458**
*All Areas **n** (number of sites)*		*33*	*33*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.

*- **Bold** median values indicate the larger value between Non-habitat and Potential Habitat*

Table 3-42: Summary of non-parametric t-test for differences among **mean B** horizon values, between "Non-habitat" and "Potential Habitat" sites.

Table 3-43a: Data for **Coyote Springs** sites only.

Significant Variable	p-value (two-tailed)	Non-Hab. Median	Pot. Hab. Median
Total N	0.044	**0.013**	0.007
Total C	0.044	6.179	**6.859**
Inorganic C	0.030	6.010	**6.806**
$CaCO_3$	0.030	50.085	**56.719**
Mo	0.028	0.420	**2.727**
Mg	0.025	128.276	**210.034**
CEC	0.017	4.952	**7.527**
Clay	0.011	7.075	**10.834**
Silt	0.030	**26.180**	23.429
*Coyote Springs **n** (number of sites)*		*11*	*9*

Table 3-42a: Data for **Gold Butte** sites only.

Significant Variable	p-value (two-tailed)	Non-Hab. Median	Pot. Hab. Median
Moisture	0.000	.718151	**9.211391**
pH 1:1	0.009	**8.740333**	8.169500
pH $CaCl_2$	0.008	**8.664167**	8.110833
ECeSP	0.001	.650000	**2.181000**
Inorganic C	0.029	1.143912	**2.533872**
$CaCO_3$	0.029	9.532600	**21.115600**
Cl-	0.041	5.983333	**17.930000**
SO_4^{2-}	0.000	273.410000	**2969.703333**
NO_3^-	0.046	1.165000	**8.636667**
Fe	0.014	6.281270	**8.385520**
Ni	0.020	.065360	**.087930**
As	0.024	.033180	**.073460**
Ca	0.017	864.846200	**1332.364233**
Mg	0.048	33.416483	**81.363363**
*Gold Butte **n** (number of sites)*		*8*	*14*

Table 3-42c: Data for **Bitter Spring** sites only.

Significant Variable	p-value (two-tailed)	Non-Hab. Median	Pot. Hab. Median
pH Sat Paste	0.050	**7.466**	7.098
CEC	0.013	9.950	**18.780**
Clay	0.050	**6.628**	1.757
*Bitter Spring **n** (number of sites)*		*11*	*4*

Table 3-42d: Data for **all study areas** combined.

Significant Variable	p-value (two-tailed)	Non-Hab. Median	Pot. Hab. Median
Moisture	0.000	2.042	**6.376**
pH1:1	0.003	**8.670**	8.275
ECeSP	0.001	0.381	**2.137**
Cl-	0.042	5.300	**13.125**
SO_4^{2-}	0.003	164.045	**2714.000**
NO_3^-	0.023	1.200	**4.533**
*All Areas **n** (number of sites)*		*30*	*27*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
*- **Bold** median values indicate the larger value between Non-habitat and Potential Habitat*

Table 3-43: Summary of non-parametric t-test for differences among **mean C** horizon values, between "Non-habitat" and "Potential Habitat" sites.

Table 3-43a: Summary for **Coyote Springs** sites only.		
Too few C horizons at Coyote Springs; statistical analysis not possible.		
*Coyote Springs **n** (number of sites)*	*Non-BW: 2*	*BW: 0*

Table 3-43b: Summary for **Gold Butte** sites only.			
Moisture	0.037242545	6.516	**14.955**
Total N	0.037242545	0.010	**0.019**
*Gold Butte **n** (number of sites)*		7	8

Table 3-43c: Data for **Bitter Spring** sites only.			
Significant Variable	**p-value (two-tailed)**	**Non-Hab. Median**	**Pot. Hab. Median**
CEC	0.004274734	7.766	**21.671**
*Bitter Spring **n** (number of sites)*		6	7

Table 3-43d: Data for **all study areas** combined.			
Significant Variable	**p-value (two-tailed)**	**Non-Hab. Median**	**Pot. Hab. Median**
Moisture	0.036202791	6.979	**11.766**
CEC	0.032669594	4.423	**9.237**
*All Areas **n** (number of sites)*		15	15

- *Only variables flagged as statistically signficant ($p < 0.05$) are shown.*
- ***Bold** median values indicate the larger value between Non-habitat and Potential Habitat*

Table 3-44: Summary of independent non-parametric t-tests for differences among soil profile median values between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-44a: Summary of **Coyote Springs** data only.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		1.35	9.83	1.64	9.90
K/(Ca+Mg) ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		0.007	0.180	0.008	0.067
*Coyote Springs **n** (number of values)*		*66*		*35*	

Table 3-44b: Summary of **Gold Butte** data only.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	.025	**22.191**		14.338	
		Minimum	Maximum	Minimum	Maximum
		1.49	118.96	.67	57.77
K/(Ca+Mg) ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		0.002	0.133	0.002	0.192
*Gold Butte **n** (number of values)*		*94*		*32*	

Table 3-44c: Summary of **Bitter Spring** data only.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	.029	9.443		**12.007**	
		Minimum	Maximum	Minimum	Maximum
		.51	30.11	2.52	29.81
K/(Ca+Mg) ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		0.005	1.235	0.006	1.276
*Bitter Spring **n** (number of values)*		*60*		*32*	

Table 3-44d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		.51	118.96	.67	57.77
K/(Ca+Mg) ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		0.002	1.235	0.002	1.276
*All Areas **n** (number of values)*		*99*		*220*	

- ***Bold** median values indicate the larger value between BW and Non-BW.*

Table 3-45: Summary of non-parametric independent samples t-tests for differences in A horizon median values, between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-45a: Summary of **Coyote Springs** data only.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	0.002	2.406		**5.3083**	
		Minimum	Maximum	Minimum	Maximum
		1.35	9.25	2.87	9.90
K/(Ca+Mg) ratio	0.006	**0.062**		0.0146	
		Minimum	Maximum	Minimum	Maximum
		0.007	0.144	0.008	0.067
*Coyote Springs **n** (number of values)*		*19*		*10*	

Table 3-45b: Summary of **Gold Butte** data only.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		3.31	67.64	13.021	57.770
K/(Ca+Mg) ratio	0.003	**0.014**		0.007	
		Minimum	Maximum	Minimum	Maximum
		0.002	0.133	0.002	0.016
*Gold Butte **n** (number of values)*		*29*		*8*	

Table 3-45c: Summary of **Bitter Spring** data only.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		1.51	30.11	2.52	28.40
K/(Ca+Mg) ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		0.005	0.768	0.010	0.424
*Bitter Spring **n** (number of values)*		*19*		*11*	

Table 3-45d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		1.35	67.64	2.52	57.77
K/(Ca+Mg) ratio	.013	**0.041**		0.015	
		Minimum	Maximum	Minimum	Maximum
		0.002	0.768	0.002	0.424
*All Areas **n** (number of values)*		*67*		*29*	

- Bold median values indicate the larger value between BW and Non-BW.

Table 3-46: Summary of non-parametric independent samples t-tests for differences in B horizon median values, between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-46a: Summary of **Coyote Springs** data only.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		1.56	9.83	1.64	7.98
K/(Ca+Mg) ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		0.008	0.180	0.010	0.050
*Coyote Springs **n** (number of values)*		*45*		*25*	

Table 3-46b: Summary of **Gold Butte** data only.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		3.02	118.96	1.74	36.78
K/(Ca+Mg) ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		0.002	0.045	0.002	0.069
*Gold Butte **n** (number of values)*		*48*		*13*	

Table 3-46c: Summary of **Bitter Spring** data only.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	0.032	13.652		**19.339**	
		Minimum	Maximum	Minimum	Maximum
		.81	27.39	13.73	29.81
K/(Ca+Mg) ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		0.007	1.235	0.006	1.276
*Bitter Spring **n** (number of values)*		*25*		*8*	

Table 3-46d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		.81	118.96	1.64	36.78
K/(Ca+Mg) ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		0.002	1.235	0.002	1.276
*All Areas **n** (number of values)*		*118*		*46*	

- Bold median values indicate the larger value between BW and Non-BW.

Table 3-47: Summary of non-parametric independent samples t-tests for differences in C horizon median values, between "Buckwheat" sites and "Non-Buckwheat" Sites.

Table 3-47a: Summary of **Coyote Springs** data only.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	**----**	----		----	
		Minimum	Maximum	Minimum	Maximum
		----	----	----	----
K/(Ca+Mg) ratio	**----**	----		----	
		Minimum	Maximum	Minimum	Maximum
		----	----	----	----
Coyote Springs ***n*** *(number of values)*		*0 (no data)*		*0 (no data)*	

Table 3-47b: Summary of **Gold Butte** data only.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	**0.036**	**19.887**		6.407	
		Minimum	Maximum	Minimum	Maximum
		1.49	101.95	.67	22.16
K/(Ca+Mg) ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		0.003	0.020	0.004	0.192
Gold Butte ***n*** *(number of values)*		*17*		*11*	

Table 3-47c Summary of **Bitter Spring** data only.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	0.044	4.513		**9.483**	
		Minimum	Maximum	Minimum	Maximum
		.51	24.51	5.62	28.69
K/(Ca+Mg) ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		0.009	0.775	0.028	0.505
Bitter Spring ***n*** *(number of values)*		*16*		*13*	

Table 3-47d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non-BW Median		BW Median	
Ca/Mg ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		.51	101.95	.67	28.69
K/(Ca+Mg) ratio	No significance	NA		NA	
		Minimum	Maximum	Minimum	Maximum
		0.003	0.775	0.004	0.505
All Areas ***n*** *(number of values)*		*35*		*24*	

- Bold median values indicate the larger value between BW and Non-BW.

Table 3-48: Summary of trends in statistically significant results on soil analyses between Buckwheat sites (BW) and Non-Buckwheat sites.

Table 3-48a: Summary for **Coyote Springs** sites only.

Significant Variable	Whole Profile Means	Whole Profile Weighted means	A Horizon Means	A Horizon Weighted Means	B Horizon Means	B Horizon Weighted Means	C Horizon Means	C Horizon Weighted Means
pH Sat Paste	Greater in BW	NA	NA	NA	Greater in BW	Greater in BW	---	---
Total C	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	---	---
Inorganic C	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	---	---
$CaCO_3$	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	---	---
Ca	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	---	---
Mg	Greater in BW	NA	Greater in BW	Greater in BW	Greater in BW	Greater in BW	---	---
Fe	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	NA	---	---
Ni	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	---	---
K	NA	Greater in BW	NA	NA	NA	Greater in BW	---	---
B	NA	NA	NA	NA	NA	Greater in BW	---	---
As	NA	NA	NA	NA	NA	Greater in BW	---	---
P	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW	---	---
Co	NA	NA	Lower in BW	Lower in BW	NA	NA	---	---
Cu	NA	NA	Lower in BW	Lower in BW	NA	NA	---	---
Total N	Lower in BW	Lower in BW	NA	NA	Lower in BW	Lower in BW	---	---
Ca/Mg ratio	NA	-	Greater in BW	-	NA	-	-	-
K/Ca+Mg	NA	-	Lower in BW	-	NA	-	-	-

NA = no significant differences detected ($p > 0.05$)

*--- = insufficient **n** for statistical analysis; and/or no data available*

Statistics on calculated Ca/Mg and K (Ca+Mg) ratios were analyzed separately as raw data values (see text)

Table 3-48b: Summary for **Gold Butte** sites only.

Significant Variable	Whole Profile Means	Whole Profile Weighted means	A Horizon Means	A Horizon Weighted Means	B Horizon Means	B Horizon Weighted Means	C Horizon Means	C Horizon Weighted Means
Total C	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
Inorganic C	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
$CaCO_3$	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
Ca	NA	NA	Greater in BW	Greater in BW	NA	NA	NA	NA
Mg	Greater in BW	Greater in BW	NA	NA	NA	NA	Greater in BW	Greater in BW
Fe	Greater in BW	Greater in BW	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW
Ni	Greater in BW	NA	Greater in BW	Greater in BW	NA	NA	NA	NA
K	NA	NA	NA	NA	NA	NA	Greater in BW	Greater in BW
As	NA	NA	Greater in BW	Greater in BW	NA	NA	NA	NA
SO_4	NA	NA	NA	NA	NA	NA	Greater in BW	Greater in BW
P	Lower in BW	Lower in BW	NA	NA	NA	NA	Lower in BW	Lower in BW
Co	NA	NA	Lower in BW	Lower in BW	NA	NA	NA	NA
Mn	NA	NA	Lower in BW	Lower in BW	NA	NA	NA	NA
CEC	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW	NA	Lower in BW
Clay	NA	NA	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW
Silt	NA	NA	Greater in BW	Greater in BW	Greater in BW	Greater in BW	NA	NA
Sand	NA	NA	Lower in BW	Lower in BW	NA	NA	NA	NA
Ca/Mg ratio	Lower in BW	-	NA	-	NA	-	Lower in BW	-
K/Ca+Mg	NA	-	Lower in BW	-	NA	-	NA	-

NA = no significant differences detected ($p > 0.05$)

*--- = insufficient **n** for statistical analysis; and/or no data available*

Statistics on calculated Ca/Mg and K (Ca+Mg) ratios were analyzed separately as raw data values (see text)

Table 3-48c: Summary for **Bitter Spring** sites only.

Significant Variable	Whole Profile Means	Whole Profile Weighted means	A Horizon Means	A Horizon Weighted Means	B Horizon Means	B Horizon Weighted Means	C Horizon Means	C Horizon Weighted Means
pH (1:1)	Lower in BW	Lower in BW	NA	NA	Lower in BW	Lower in BW	NA	NA
pH ($CaCl_2$)	Lower in BW	Lower in BW	NA	Na	Lower in BW	Lower in BW	NA	NA
Total C	NA	NA	NA	NA	NA	NA	Greater in BW	Greater in BW
Inorganic C	NA	NA	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW
$CaCO_3$	NA	NA	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW
Ca	NA	NA	NA	NA	NA	NA	Greater in BW	NA
Ni	NA	NA	NA	NA	NA	NA	Greater in BW	NA
B	Lower in BW	Lower in BW	NA	NA	Lower in BW	Lower in BW	Lower in BW	Lower in BW
Mo	NA	NA	NA	NA	NA	NA	Lower in BW	Lower in BW
Co	Lower in BW	Lower in BW	NA	NA	Lower in BW	Lower in BW	NA	NA
Na	NA	NA	NA	NA	Lower in BW	Lower in BW	NA	NA
SO_4	NA	NA	NA	NA	Greater in BW	NA	NA	NA
Moisture	NA	NA	NA	NA	Greater in BW	NA	NA	NA
NO_3	Lower in BW	NA	Lower in BW	Lower in BW	NA	NA	NA	NA
Ca/Mg ratio	Greater in BW	-	NA	-	Greater in BW	-	Greater in BW	-
K/Ca+Mg	NA	-	NA	-	NA	-	NA	-

NA = no significant differences detected ($p > 0.05$)
*--- = insufficient **n** for statistical analysis; and/or no data available*

Statistics on calculated Ca/Mg and K (Ca+Mg) ratios were analyzed separately as raw data values (see text)

Table 3-48d: Summary for **All Study Areas Combined**.

Significant Variable	Whole Profile Means	Whole Profile Weighted means	A Horizon Means	A Horizon Weighted Means	B Horizon Means	B Horizon Weighted Means	C Horizon Means	C Horizon Weighted Means
pH (1:1)	NA	NA	NA	NA	Lower in BW	NA	NA	NA
Total C	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
Inorganic C	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
$CaCO_3$	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
Ca	Greater in BW	Greater in BW	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW
Mg	Greater in BW	Greater in BW	Greater in BW	Greater in BW	NA	NA	NA	NA
Fe	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
Ni	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
K	NA	Greater in BW	NA	NA	NA	NA	NA	NA
P	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW
Co	Lower in BW	Lower in BW	Lower in BW	Lower in BW	NA	NA	NA	NA
Mn	NA	NA	Lower in BW	Lower in BW	NA	NA	NA	NA
Cu	NA	NA	Lower in BW	Lower in BW	NA	NA	NA	NA
Zn	NA	NA	Lower in BW	Lower in BW	NA	NA	NA	NA
Moisture	NA	NA	NA	NA	Greater in BW	NA	NA	NA
Cl	NA	NA	NA	NA	Lower in BW	Lower in BW	NA	NA
Total N	Lower in BW	Lower in BW	NA	NA	Lower in BW	Lower in BW	NA	NA
Ca/Mg ratio	NA	-	NA	-	NA	-	NA	-
K/Ca+Mg	NA	-	Lower in BW	-	NA	-	NA	-

NA = no significant differences detected ($p > 0.05$)

*--- = insufficient **n** for statistical analysis; and/or no data available*

Statistics on calculated Ca/Mg and K (Ca+Mg) ratios were analyzed separately as raw data values (see text)

Table 3-49: Summary of trends in statistically significant results on soil analyses between Buckwheat Habitat (BW) versus Potential Habitat.

Table 3-49a: Summary for **Coyote Springs** sites only.

Significant Variable	Whole Profile Means	Whole Profile Weighted means	A Horizon Means	A Horizon Weighted Means	B Horizon Means	B Horizon Weighted Means	C Horizon Means	C Horizon Weighted Means
pH Sat Paste	Greater in BW	NA	NA	NA	Na	NA	---	---
Total C	Greater in BW	NA	NA	NA	NA	NA	---	---
Inorganic C	Greater in BW	NA	NA	NA	NA	NA	---	---
$CaCO_3$	Greater in BW	NA	NA	NA	NA	NA	---	---
Ca	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW	---	---
Fe	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW	---	---
Ni	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW	---	---
As	NA	NA	NA	NA	NA	Greater in BW	---	---
Cu	NA	NA	Lower in BW	Lower in BW	NA	NA	---	---
Ca/Mg ratio	*NA*	-	*NA*	-	*NA*	-	-	-
K/Ca+Mg	*NA*	-	*NA*	-	*NA*	-	-	-

NA = no significant differences detected ($p > 0.05$)
*--- = insufficient **n** for statistical analysis; and/or no data available*
Statistics on calculated Ca/Mg and K (Ca+Mg) ratios were analyzed separately as raw data values (see text)

Table 3-49b: Summary for **Gold Butte** sites only.

Significant Variable	Whole Profile Means	Whole Profile Weighted means	A Horizon Means	A Horizon Weighted Means	B Horizon Means	B Horizon Weighted Means	C Horizon Means	C Horizon Weighted Means
pH (1:1)	NA	NA	NA	NA	NA	NA	Greater in BW	Greater in BW
pH ($CaCl_2$)	NA	NA	NA	NA	NA	NA	Greater in BW	Greater in BW
Total C	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
Inorganic C	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
$CaCO_3$	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
Ca	NA	NA	Greater in BW	Greater in BW	NA	NA	NA	NA
Fe	NA	NA	NA	NA	NA	NA	Greater in BW	Greater in BW
Ni	NA	NA	Greater in BW	Greater in BW	NA	NA	NA	NA
P	NA	NA	NA	NA	NA	NA	Lower in BW	Lower in BW
Co	NA	NA	Lower in BW	Lower in BW	NA	NA	NA	NA
Mn	NA	NA	Lower in BW	Lower in BW	NA	NA	NA	NA
CEC	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW	NA	Lower in BW
Moisture	NA	NA	NA	NA	NA	NA	Lower in BW	Lower in BW
Cl	NA	NA	NA	NA	Lower in BW	NA	NA	NA
Clay	NA	NA	NA	NA	NA	NA	Greater in BW	Greater in BW
Ca/Mg ratio	*Lower in BW*	-	*NA*	-	*NA*	-	*NA*	-
K/Ca+Mg	*NA*	-	*Lower in BW*	-	*NA*		*NA*	-

NA = no significant differences detected ($p > 0.05$)
*--- = insufficient **n** for statistical analysis; and/or no data available*
Statistics on calculated Ca/Mg and K (Ca+Mg) ratios were analyzed separately as raw data values (see text)

Table 3-49c: Summary for **Bitter Spring** sites only.

Significant Variable	Whole Profile Means	Whole Profile Weighted means	A Horizon Means	A Horizon Weighted Means	B Horizon Means	B Horizon Weighted Means	C Horizon Means	C Horizon Weighted Means
pH (1:1)	NA	NA	NA	NA	NA	NA	Lower in BW	Lower in BW
pH ($CaCl_2$)	NA	NA	NA	Na	NA	NA	Lower in BW	Lower in BW
Total C	NA	NA	NA	NA	NA	NA	Greater in BW	Greater in BW
Inorganic C	NA	NA	NA	NA	NA	NA	NA	Greater in BW
$CaCO_3$	NA	NA	NA	NA	NA	NA	NA	Greater in BW
Ca	Greater in BW	Greater in BW	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW
Mg	Lower in BW	NA	NA	NA	Lower in BW	Lower in BW	NA	NA
Ni	Greater in BW	Greater in BW	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW
B	Lower in BW	Lower in BW	NA	NA	Lower in BW	Lower in BW	Lower in BW	Lower in BW
Co	Lower in BW	Lower in BW	Lower in BW	Lower in BW	NA	NA	NA	NA
Na	Lower in BW	Lower in BW	NA	NA	Lower in BW	Lower in BW	NA	NA
CEC	NA	NA	NA	NA	NA	NA	NA	Lower in BW
Clay	NA	NA	Greater in BW	Greater in BW	NA	NA	NA	NA
Ca/Mg ratio	*Greater in BW*	-	*Greater in BW*	-	*Greater in BW*	-	*Greater in BW*	-
K/Ca+Mg	*Lower in BW*	-	*NA*	-	*NA*	-	*Lower in BW*	-

NA = no significant differences detected (p > 0.05)

*--- = insufficient **n** for statistical analysis; and/or no data available*

Statistics on calculated Ca/Mg and K (Ca+Mg) ratios were analyzed separately as raw data values (see text)

Table 3-49d: Summary for **All Study Areas Combined.**

Significant Variable	Whole Profile Means	Whole Profile Weighted means	A Horizon Means	A Horizon Weighted Means	B Horizon Means	B Horizon Weighted Means	C Horizon Means	C Horizon Weighted Means
pH (1:1)	NA	NA	NA	NA	NA	NA	NA	NA
Total C	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	NA	Greater in BW	Greater in BW
Inorganic C	Greater in BW	Greater in BW	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW
$CaCO_3$	Greater in BW	Greater in BW	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW
Ca	Greater in BW	NA	Greater in BW	Greater in BW	NA	NA	Greater in BW	Greater in BW
Fe	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
Ni	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW	Greater in BW
K	Greater in BW	Greater in BW	NA	NA	NA	NA	NA	NA
P	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW	Lower in BW
Co	Lower in BW	Lower in BW	Lower in BW	Lower in BW	NA	NA	NA	NA
Mn	NA	NA	Lower in BW	Lower in BW	NA	NA	NA	NA
Cu	Lower in BW	NA	Lower in BW	Lower in BW	NA	NA	NA	NA
Zn	NA	NA	Lower in BW	Lower in BW	NA	NA	NA	NA
Moisture	NA	NA	NA	NA	NA	NA	Lower in BW	Lower in BW
Cl	NA	NA	NA	NA	Lower in BW	Lower in BW	NA	NA
NO_3	Lower in BW	Lower in BW	NA	NA	NA	NA	NA	NA
Total N	Lower in BW	Lower in BW	NA	NA	Lower in BW	NA	NA	NA
Clay	NA	NA	Greater in BW	Greater in BW	NA	NA	NA	NA
Ca/Mg ratio	*NA*	-	*NA*	-	*NA*	-	*NA*	-
K/Ca+Mg	*NA*	-	*NA*	-	*NA*	-	*NA*	-

NA = no significant differences detected ($p > 0.05$)

*--- = insufficient **n** for statistical analysis; and/or no data available*

Statistics on calculated Ca/Mg and K (Ca+Mg) ratios were analyzed separately as raw data values (see text)

Table 3-50: Summary of trends in statistically significant results on soil analyses between Potential Habitat (PHAB) versus Non-Habitat sites.

Table 3-50a: Summary for **Coyote Springs** sites only.

Significant Variable	Whole Profile Means	A Horizon Means	B Horizon Means	C Horizon Means
Total C	Greater in PHAB	Greater in PHAB	Greater in PHAB	---
Inorganic C	Greater in PHAB	Greater in PHAB	Greater in PHAB	---
$CaCO_3$	Greater in PHAB	Greater in PHAB	Greater in PHAB	---
Ca	Greater in PHAB	Greater in PHAB	NA	---
Mg	Greater in PHAB	Greater in PHAB	Greater in PHAB	---
Fe	Greater in PHAB	Greater in PHAB	NA	---
Ni	Greater in PHAB	Greater in PHAB	NA	---
K	NA	Lower in PHAB	NA	---
Mo	Greater in PHAB	NA	Greater in PHAB	---
P	Lower in PHAB	NA	NA	---
Co	Lower in PHAB	Lower in PHAB	NA	---
Total N	NA	NA	Lower in PHAB	---
CEC	NA	NA	Greater in PHAB	---
Clay	NA	NA	Greater in PHAB	---
Silt	Lower in PHAB	NA	Lower in PHAB	---
Ca/Mg ratio	NA	NA	Lower in PHAB	---
K/Ca+Mg	NA	Lower in PHAB	NA	---

NA = no significant differences detected ($p > 0.05$)

*--- = insufficient **n** for statistical analysis; and/or no data available*

Statistics on calculated Ca/Mg and K (Ca+Mg) ratios were analyzed separately as raw data values (see text)

Table 3-50b: Summary for **Gold Butte** sites only.

Significant Variable	Whole Profile Means	A Horizon Means	B Horizon Means	C Horizon Means
pH (1:1)	Lower in PHAB	Lower in PHAB	Lower in PHAB	NA
pH ($CaCl_2$)	Lower in PHAB	Lower in PHAB	Lower in PHAB	NA
Total C	Greater in PHAB	Greater in PHAB	NA	NA
Inorganic C	NA	Greater in PHAB	Greater in PHAB	NA
$CaCO_3$	NA	Greater in PHAB	Greater in PHAB	NA
Ca	Greater in PHAB	Greater in PHAB	Greater in PHAB	NA
Mg	NA	NA	Greater in PHAB	NA
Fe	Greater in PHAB	Greater in PHAB	Greater in PHAB	NA
Ni	Greater in PHAB	Greater in PHAB	Greater in PHAB	NA
B	Greater in PHAB	Greater in PHAB	NA	NA
As	Greater in PHAB	Greater in PHAB	Greater in PHAB	NA
Cu	NA	Greater in PHAB	NA	NA
SO4	NA	Greater in PHAB	Greater in PHAB	NA
Moisture	Greater in PHAB	Greater in PHAB	Greater in PHAB	Greater in PHAB
EC	Greater in PHAB	Greater in PHAB	Greater in PHAB	NA
Cl	NA	NA	Greater in PHAB	NA
NO3	Greater in PHAB	NA	Greater in PHAB	NA
Total N	Greater in PHAB	Greater in PHAB	NA	Greater in PHAB
Clay	NA	Greater in PHAB	NA	NA
Silt	Greater in PHAB	Greater in PHAB	NA	NA
Sand	Lower in PHAB	Lower in PHAB	NA	NA
Ca/Mg ratio	NA	Greater in PHAB	NA	NA
K/Ca+Mg	Lower in PHAB	Lower in PHAB	Lower in PHAB	NA

NA = no significant differences detected ($p > 0.05$)
*--- = insufficient **n** for statistical analysis; and/or no data available*

Statistics on calculated Ca/Mg and K (Ca+Mg) ratios were analyzed separately as raw data values (see text)

Table 3-50c: Summary for **Bitter Spring** sites only.

Significant Variable	Whole Profile Means	A Horizon Means	B Horizon Means	C Horizon Means
pH (sat. paste)	NA	NA	Lower in PHAB	NA
CEC	Greater in PHAB	NA	Greater in PHAB	Greater in PHAB
Moisture	Greater in PHAB	Greater in PHAB	NA	NA
EC	NA	Greater in PHAB	NA	NA
Clay	Lower in PHAB	Lower in PHAB	Lower in PHAB	NA
Silt	Lower in PHAB	Lower in PHAB	NA	NA
Sand	Greater in PHAB	Greater in PHAB	NA	NA
Ca/Mg ratio	Lower in PHAB	Lower in PHAB	Lower in PHAB	NA
K/Ca+Mg	Greater in PHAB	NA	NA	Greater in PHAB

Table 3-50d: Summary for **All Study Areas Combined.**

Significant Variable	Whole Profile Means	A Horizon Means	B Horizon Means	C Horizon Means
pH (1:1)	Lower in PHAB	Lower in PHAB	Lower in PHAB	NA
pH ($CaCl_2$)	Lower in PHAB	Lower in PHAB	NA	NA
Ca	NA	Greater in PHAB	NA	NA
Fe	NA	Greater in PHAB	NA	NA
Ni	NA	Greater in PHAB	NA	NA
K	NA	Lower in PHAB	NA	NA
CEC	NA	NA	NA	Greater in PHAB
SO_4	Greater in PHAB	NA	Greater in PHAB	NA
Moisture	Greater in PHAB	Greater in PHAB	Greater in PHAB	Greater in PHAB
Cl	Greater in PHAB	NA	Greater in PHAB	NA
NO_3	Greater in PHAB	NA	Greater in PHAB	NA
EC	Greater in PHAB	Greater in PHAB	Greater in PHAB	NA
Ca/Mg ratio	NA	NA	NA	NA
K/Ca+Mg	Lower in PHAB	Lower in PHAB	Lower in PHAB	NA

NA = no significant differences detected ($p > 0.05$)
*--- = insufficient **n** for statistical analysis; and/or no data available*
Statistics on calculated Ca/Mg and K (Ca+Mg) ratios were analyzed separately as raw data values (see text)

Table 3-51: Spearman's Rho All Habitats, Coyote Springs, Whole Soil Profile Mean

Table 3-51a: Summary for All Habitats, Coyote Springs, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.996	.000
P	Strong Negative	-.717	.000
Ca	Strong Positive	.661	.000
Fe	Strong Positive	.640	.000
Mg	Strong Positive	.638	.000
Ni	Strong Positive	.619	.000
Co	Strong Negative	-.559	.001
pH (sat. paste)	Strong Positive	.545	.002
Silt	Strong Negative	-.518	.003
Clay	Strong Positive	.453	.012
Total N	Moderate Negative	-.376	.041
Organic C	Moderate Positive	.361	.050

Table 3-52b: Summary for All Habitats, Coyote Springs, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ca	Very Strong Positive	.972	.000
Ni	Very Strong Positive	.970	.000
P	Strong Negative	-.861	.000
Total C	Strong Positive	.652	.000
Inorganic C	Strong Positive	.640	.000
$CaCO_3$	Strong Positive	.640	.000
Co	Strong Negative	-.522	.003
Silt	Strong Negative	-.480	.007
Mo	Strong Positive	.471	.009
Moisture	Strong Positive	.464	.010
Total N	Moderate Negative	-.448	.013
Mg	Moderate Positive	.446	.013
SO_4	Moderate Positive	.417	.022
K	Moderate Positive	.415	.022
EC	Moderate Positive	.412	.024
Mn	Moderate Negative	-.364	.048

Table 3-52: Spearman's Rho Buckwheat Habitat, Coyote Springs, Whole Soil Profile Mean

Table 3-52a: Summary for Buckwheat Habitat, Coyote Springs, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.952	.000
P	Strong Negative	-.891	.001

Table 3-52b: Summary for Buckwheat Habitat, Coyote Springs, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Strong Positive	.842	.002
Ca	Strong Positive	.842	.002
Cl	Strong Positive	.782	.008
SO_4	Strong Positive	.770	.009
Mg	Strong Negative	-.697	.025
Mn	Strong Positive	.648	.043
pH ($CaCl_2$)	Strong Negative	-.636	.048

Table 3-53: Spearman's Rho Non-Habitat, Coyote Springs, Whole Soil Profile Mean

Table 3-53: Summary for Non-Habitat, Coyote Springs, Whole Soil Profile Mean: Correlation to $CaCO_3$			
Significant Variable	**Correlation to $CaCO_3$**	**Correlation coefficient**	**P-value**
Total C	Very Strong Positive	.991	.000
SO_4	Strong Negative	-.682	.021
Sand	Strong Positive	.682	.021

Table 3-53b: Summary for Non-Habitat, Coyote Springs, Whole Soil Profile Mean: Correlation to Fe			
Significant Variable	**Correlation to $CaCO_3$**	**Correlation coefficient**	**P-value**
Ca	Very Strong Positive	.964	.000
Ni	Very Strong Positive	.955	.000
As	Strong Positive	.773	.005
NO_3	Strong Positive	.764	.006
Co	Strong Negative	-.743	.009
P	Strong Negative	-.718	.013
Mg	Strong Positive	.682	.021
Mn	Strong Negative	-.664	.026
CEC	Strong Positive	.664	.026

Table 3-54: Spearman's Rho Potential Habitat, Coyote Springs, Whole Soil Profile Mean

Table 3-54a: Summary for Potential Habitat, Coyote Springs, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	1.000	
Organic C	Very Strong Positive	.933	.000
pH (1:1)	Very Strong Negative	-.917	.001
Ca	Strong Positive	.733	.025

Table 3-54b: Summary for Potential Habitat, Coyote Springs, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.962	.000
Ca	Very Strong Positive	.917	.001
P	Strong Negative	-.850	.004
Co	Strong Negative	-.733	.025

Table 3-55: Spearman's Rho All Habitats, Gold Butte, Whole Soil Profile Mean

Table 3-55a: Summary for All Habitats, Gold Butte, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.984	.000
Clay	Strong Positive	.794	.000
Ni	Strong Positive	.714	.000
Mg	Strong Positive	.703	.000
Ca	Strong Positive	.676	.000
Fe	Strong Positive	.674	.000
Cl	Strong Positive	.564	.000
Sand	Strong Negative	-.562	.000
EC	Strong Positive	.544	.000
SO_4	Strong Positive	.540	.001
Co	Strong Negative	-.530	.001
P	Strong Negative	-.472	.003
Zn	Moderate Negative	-.448	.005
Mn	Moderate Negative	-.447	.005
Mo	Moderate Positive	.418	.010
Silt	Moderate Positive	.414	.011
NO_3	Moderate Positive	.391	.017
As	Moderate Positive	.366	.026
CEC	Moderate Negative	-.363	.027

Table 3-55b: Summary for All Habitats Gold Butte, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.931	.000
Ca	Strong Positive	.684	.000
Total C	Strong Positive	.683	.000
Inorganic C	Strong Positive	.674	.000
$CaCO_3$	Strong Positive	.674	.000
As	Strong Positive	.552	.000
Mg	Strong Positive	.523	.001
P	Strong Negative	-.508	.001
B	Strong Positive	.501	.002
Na	Moderate Positive	.441	.006
Mo	Moderate Positive	.422	.009
Clay	Moderate Positive	.398	.015
EC	Moderate Positive	.384	.019
Cu	Moderate Positive	.348	.035

Table 3-56: Spearman's Rho Habitat, Gold Butte, Profile Mean

Table 3-56a: Summary for Buckwheat Habitat, Gold Butte, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.983	.000
Moisture	Very Strong Negative	-.933	.000
pH ($CaCl_2$)	Strong Positive	.850	.004
Ca	Strong Positive	.767	.016
CEC	Strong Negative	-.750	.020

Table 3-56b: Summary for Buckwheat Habitat, Gold Butte, Whole Soil Profile Mean: Correlation to Fe

NO CORRELATIONS

Table 3-57: Spearman's Rho Non-Habitat, Gold Butte, Whole Soil Profile Mean

Table 3-57a: Summary for Non-Habitat, Gold Butte, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
P	Very Strong Negative	-.952	.000
Total C	Strong Positive	.879	.001
Clay	Strong Positive	.830	.003
Mg	Strong Positive	.770	.009
Sand	Strong Negative	-.770	.009
Co	Strong Negative	-.681	.030
Mn	Strong Negative	-.648	.043

Table 3-57b: Summary for Non-Habitat, Gold Butte, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.952	.000
Cu	Strong Positive	.818	.004
B	Strong Positive	.758	.011
Zn	Strong Positive	.661	.038

Table 3-58: Spearman's Rho Potential Habitat, Gold Butte, Whole Soil Profile Mean

Table 3-58a: Summary for Potential Habitat, Gold Butte, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.981	.000
Clay	Very Strong Positive	.911	.000
pH ($CaCl_2$)	Strong Positive	.897	.000
Mg	Strong Positive	.781	.000
pH (1:1)	Strong Positive	.749	.000
Organic C	Strong Negative	-.734	.001
Moisture	Strong Negative	-.713	.001
Fe	Strong Positive	.701	.001
Ni	Strong Positive	.697	.001
Ca	Strong Positive	.643	.004
Na	Strong Positive	.637	.004
Cl	Strong Positive	.606	.008
K	Strong Positive	.560	.016
Sand	Strong Negative	-.513	.030
Mo	Strong Positive	.494	.037
Zn	Strong Negative	-.484	.042

Table 3-58b: Summary for Potential Habitat, Gold Butte, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.920	.000
Ca	Strong Positive	.761	.000
Total N	Strong Negative	-.754	.000
pH ($CaCl_2$)	Strong Positive	.723	.001
Inorganic C	Strong Positive	.701	.001
$CaCO_3$	Strong Positive	.701	.001
Na	Strong Positive	.668	.002
Clay	Strong Positive	.649	.004
Total C	Strong Positive	.643	.004
pH (1:1)	Strong Positive	.641	.004
Organic C	Strong Negative	-.641	.004
Mg	Strong Positive	.624	.006
EC	Strong Positive	.548	.019
Moisture	Strong Negative	-.519	.027
K	Strong Positive	.476	.046

Table 3-59: Spearman's Rho All Habitats, Bitter Spring, Whole Soil Profile Mean

Table 3-59a: Summary for All Habitats, Bitter Spring, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.994	.000
EC	Strong Negative	-.575	.001
Mn	Strong Negative	-.570	.001
B	Strong Negative	-.555	.001
Co	Strong Negative	-.461	.010
P	Moderate Negative	-.448	.013
SO_4	Moderate Negative	-.412	.024
Moisture	Moderate Negative	-.362	.049

Table 3-59b: Summary for All Habitats, Bitter Spring, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.901	.000
Ca	Strong Positive	.885	.000
P	Strong Negative	-.695	.000
pH (1:1)	Moderate Negative	-.404	.027
SO_4	Moderate Positive	.393	.032
pH ($CaCl_2$)	Moderate Negative	-.389	.034

Table 3-60: Spearman's Rho Buckwheat Habitat, Bitter Spring, Whole Soil Profile Mean

Table 3-60a: Summary for Buckwheat Habitat, Bitter Spring, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.973	.000
EC	Strong Negative	-.655	.029
Mg	Strong Positive	.618	.043
Silt	Strong Negative	-.618	.043

Table 3-60b: Summary for Buckwheat Habitat, Bitter Spring, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.955	.000
Clay	Strong Positive	.891	.000
Zn	Strong Positive	.836	.001
Ca	Strong Positive	.827	.002
Sand	Strong Negative	-.791	.004
SO_4	Strong Positive	.709	.015
Mn	Strong Positive	.673	.023

Table 3-61: Spearman's Rho Non-Habitat, Bitter Spring, Whole Soil Profile Mean

Table 3-61a: Summary for Non-Habitat, Bitter Spring, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	1.000	
B	Strong Negative	-.804	.002
EC	Strong Negative	-.727	.007
Cu	Strong Negative	-.727	.007
Zn	Strong Negative	-.664	.018
SO_4	Strong Negative	-.615	.033
Mo	Strong Negative	-.608	.036
Mn	Strong Negative	-.608	.036
As	Strong Negative	-.601	.039

Table 3-61b: Summary for Non-Habitat, Bitter Spring, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ca	Very Strong Positive	.923	.000
Ni	Strong Positive	.895	.000
P	Strong Negative	-.776	.003
Mn	Strong Negative	-.622	.031
pH (sat. paste)	Strong Negative	-.580	.048

Table 3-62: Spearman's Rho Potential Habitat, Bitter Spring, Whole Soil Profile Mean

Table 3-62a: Summary for Potential Habitat, Bitter Spring, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	1.000	
P	Strong Negative	-.893	.007
Co	Strong Negative	-.786	.036

Table 3-62b: Summary for Potential Habitat, Bitter Spring, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Strong Positive	.857	.014
Ca	Strong Positive	.857	.014

Table 3-63: Spearman's Rho All Sites, All Habitats, Whole Soil Profile Mean

Table 3-63a: Summary for All Sites, All Habitats, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.997	.000
Mg	Strong Positive	.684	.000
Clay	Strong Positive	.661	.000
Co	Strong Negative	-.618	.000
Fe	Strong Positive	.557	.000
Moisture	Strong Negative	-.514	.000
Mn	Strong Negative	-.497	.000
SO_4	Strong Negative	-.493	.000
Ni	Strong Positive	.488	.000
P	Strong Negative	-.466	.000
pH (1:1)	Strong Positive	.458	.000
EC	Moderate Negative	-.442	.000
Zn	Moderate Negative	-.439	.000
Total N	Moderate Negative	-.428	.000
Cu	Moderate Negative	-.420	.000
As	Moderate Negative	-.390	.000
B	Weak Negative	-.293	.004
Organic C	Weak Negative	-.223	.028
K	Weak Positive	.218	.032
Ca	Weak Positive	.209	.040
Cl	Weak Negative	-.205	.044

Table 3-63a: Summary for All Sites, All Habitats, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.906	.000
P	Strong Negative	-.718	.000
Ca	Strong Positive	.637	.000
Inorganic C	Strong Positive	.557	.000
$CaCO_3$	Strong Positive	.557	.000
Total C	Strong Positive	.553	.000
Total N	Strong Negative	-.498	.000
Mg	Strong Positive	.491	.000
Co	Strong Negative	-.450	.000
K	Moderate Positive	.423	.000
Clay	Moderate Positive	.356	.000
Mo	Moderate Positive	.350	.000
Na	Moderate Positive	.310	.002
Mn	Weak Negative	-.251	.013
Silt	Weak Negative	-.226	.026
Organic C	Weak Negative	-.220	.031

Table 3-64: Spearman's Rho All Sites, Buckwheat Habitat, Whole Soil Profile Mean

Table 3-64a: Summary for All Sites, Buckwheat Habitat, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.995	.000
Moisture	Strong Negative	-.814	.000
pH (1:1)	Strong Positive	.785	.000
EC	Strong Negative	-.680	.000
As	Strong Negative	-.657	.000
SO_4	Strong Negative	-.637	.000
Clay	Strong Positive	.616	.000
P	Strong Negative	-.604	.000
pH (sat. paste)	Strong Positive	.591	.001
Mg	Strong Positive	.551	.002
Total N	Strong Negative	-.487	.006
Ni	Strong Positive	.472	.008
Mn	Moderate Negative	-.416	.022
B	Moderate Negative	-.403	.027
CEC	Moderate Negative	-.394	.031
Co	Moderate Negative	-.390	.033
Fe	Moderate Positive	.383	.037
Ca	Moderate Positive	.372	.043
Zn	Moderate Negative	-.361	.050

Table 3-64b: Summary for All Sites, Buckwheat Habitat, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Strong Positive	.817	.000
Total N	Strong Negative	-.491	.006
Ca	Strong Positive	.487	.006
P	Strong Negative	-.484	.007
Mg	Moderate Positive	.420	.021
Clay	Moderate Positive	.418	.022
Mn	Moderate Positive	.406	.026
Total C	Moderate Positive	.383	.037
Inorganic C	Moderate Positive	.383	.037
$CaCO_3$	Moderate Positive	.383	.037

Table 3-65: Spearman's Rho All Sites, Non-Habitat, Whole Soil Profile Mean

Table 3-65a: Summary for All Sites, Non-Habitat, Whole Soil Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.991	.000
Clay	Strong Positive	.619	.000
Mg	Strong Positive	.600	.000
SO4	Strong Negative	-.577	.000
EC	Strong Negative	-.545	.001
Zn	Strong Negative	-.490	.004
Cu	Strong Negative	-.452	.008
Co	Moderate Negative	-.443	.010
pH ($CaCl_2$)	Moderate Negative	-.392	.024
Sand	Moderate Negative	-.387	.026
Mn	Moderate Negative	-.369	.034
Fe	Moderate Positive	.364	.037

Table3-65b: Summary for All Sites, Non-Habitat, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.943	.000
Ca	Strong Positive	.729	.000
P	Strong Negative	-.637	.000
K	Strong Positive	.570	.001
Mn	Strong Negative	-.568	.001
Na	Strong Positive	.544	.001
Co	Strong Negative	-.510	.002
B	Strong Positive	.504	.003
As	Strong Positive	.473	.005
pH (sat. paste)	Moderate Negative	-.431	.012
CEC	Moderate Positive	.394	.023
pH (1:1)	Moderate Negative	-.372	.033
Total C	Moderate Positive	.367	.036
Inorganic C	Moderate Positive	.364	.037
$CaCO_3$	Moderate Positive	.364	.037
Mg	Moderate Positive	.351	.045

Table 3-66: Spearman's Rho All Sites, Potential Habitat, Whole Soil Profile Mean

Table 3-66a: Summary for All Sites, Potential Habitat, Whole Soil Profile Profile Mean: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.994	.000
Moisture	Strong Negative	-.827	.000
Mg	Strong Positive	.810	.000
pH (1:1)	Strong Positive	.733	.000
Fe	Strong Positive	.733	.000
Clay	Strong Positive	.724	.000
Co	Strong Negative	-.674	.000
Ni	Strong Positive	.633	.000
Total N	Strong Negative	-.592	.000
Mn	Strong Negative	-.560	.001
Organic C	Strong Negative	-.511	.002
K	Strong Positive	.466	.005
Cu	Strong Negative	-.465	.006
SO_4	Moderate Negative	-.447	.008
Zn	Moderate Negative	-.447	.008
P	Moderate Negative	-.444	.009
As	Moderate Negative	-.440	.009
B	Moderate Negative	-.365	.034
EC	Moderate Negative	-.339	.050

Table 3-66b: Summary for All Sites, Potential Habitat, Whole Soil Profile Mean: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Strong Positive	.812	.000
Inorganic C	Strong Positive	.733	.000
$CaCO_3$	Strong Positive	.733	.000
Total C	Strong Positive	.714	.000
Total N	Strong Negative	-.701	.000
Moisture	Strong Negative	-.593	.000
P	Strong Negative	-.583	.000
Mg	Strong Positive	.582	.000
pH (1:1)	Strong Positive	.533	.001
Organic C	Strong Negative	-.468	.005
K	Strong Positive	.467	.005
Clay	Moderate Positive	.440	.009
Co	Moderate Negative	-.421	.013
Ca	Moderate Positive	.410	.016
Mo	Moderate Positive	.406	.017
pH ($CaCl_2$)	Moderate Positive	.381	.026
Na	Moderate Positive	.381	.026
Silt	Moderate Negative	-.370	.031

Table 3-67: Spearman's Rho All Habitats, Coyote Springs, A horizon

Table 3-67a: Summary for All Habitats, Coyote Springs, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.975	.000
Ni	Strong Positive	.850	.000
Ca	Strong Positive	.803	.000
Fe	Strong Positive	.779	.000
P	Strong Negative	-.748	.000
Mg	Strong Positive	.724	.000
Silt	Strong Negative	-.591	.001
Sand	Strong Positive	.521	.004
Thickness	Strong Negative	-.519	.004
Mn	Strong Negative	-.518	.004
K	Strong Negative	-.482	.008
Co	Strong Negative	-.452	.014
pH ($CaCl_2$)	Moderate Negative	-.444	.016
Cu	Moderate Negative	-.441	.017
Organic C	Moderate Positive	.403	.030

Table 3-67b: Summary for All Habitats, Coyote Springs, A Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Strong Positive	.841	.000
Ca	Strong Positive	.841	.000
Mg	Strong Positive	.802	.000
Total C	Strong Positive	.796	.000
Inorganic C	Strong Positive	.779	.000
$CaCO_3$	Strong Positive	.779	.000
Thickness	Strong Negative	-.758	.000
P	Strong Negative	-.702	.000
Silt	Strong Negative	-.638	.000
Co	Strong Negative	-.511	.005
Mn	Strong Negative	-.489	.007
Cl	Strong Positive	.471	.010
pH ($CaCl_2$)	Moderate Negative	-.426	.021
Sand	Moderate Positive	.391	.036
Organic C	Moderate Positive	.389	.037

Table 3-68: Spearman's Rho Habitat, Coyote Springs, A horizon

Table 3-68a: Summary for Habitat, Coyote Springs, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
As	Strong Negative	-.770	.009
Total C	Strong Positive	.745	.013
Silt	Strong Negative	-.721	.019
Ni	Strong Positive	.709	.022
Thickness	Strong Negative	-.661	.037
Sand	Strong Positive	.661	.038
Cl	Strong Positive	.648	.043

Table 3-68b: Summary for Habitat, Coyote Springs, A Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ca	Very Strong Positive	.939	.000
Ni	Very Strong Positive	.915	.000
Na	Strong Positive	.855	.002
Zn	Strong Positive	.794	.006
Cl	Strong Positive	.709	.022
Total C	Strong Positive	.661	.038

Table 3-69: Spearman's Rho Non-Habitat, Coyote Springs, A horizon

Table 3-69a: Summary for Non-Habitat, Coyote Springs, A horizon: Correlation to CaCO3

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.991	.000
Clay	Strong Negative	-.791	.004
SO_4	Strong Negative	-.773	.005
pH (sat. paste)	Strong Positive	.700	.016
Total N	Strong Positive	.664	.026
Sand	Strong Positive	.636	.035

Table 3-69b: Summary for Non-Habitat, Coyote Springs, A Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Na	Strong Positive	.682	.021
Cl	Strong Positive	.655	.029
Silt	Strong Negative	-.636	.035

Table 3-70: Spearman's Rho Potential Habitat, Coyote Springs, A horizon

Table 3-70a: Summary for Potential Habitat, Coyote Springs, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.976	.000
Ca	Strong Positive	.857	.007
Ni	Strong Positive	.833	.010
Organic C	Strong Positive	.762	.028

Table 3-70b: Summary for Potential Habitat, Coyote Springs, A Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Silt	Strong Negative	-.786	.021
P	Strong Negative	-.762	.028
Ca	Strong Positive	.738	.037
Organic C	Strong Positive	.714	.047

Table 3-71: Spearman's Rho All Chemistry, Gold Butte, A horizon

Table 3-71a: Summary for All Chemistry, Gold Butte, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.978	.000
Clay	Strong Positive	.838	.000
Sand	Strong Negative	-.829	.000
Ni	Strong Positive	.755	.000
Silt	Strong Positive	.754	.000
Ca	Strong Positive	.746	.000
As	Strong Positive	.731	.000
Fe	Strong Positive	.712	.000
Zn	Strong Negative	-.592	.000
Mg	Strong Positive	.583	.000
Co	Strong Negative	-.560	.000
Mn	Strong Negative	-.554	.000
SO_4	Moderate Positive	.417	.010

Table 3-71b: Summary for All Chemistry, Gold Butte, A Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.927	.000
Ca	Strong Positive	.772	.000
As	Strong Positive	.752	.000
Total C	Strong Positive	.720	.000
Inorganic C	Strong Positive	.712	.000
$CaCO_3$	Strong Positive	.712	.000
Mg	Strong Positive	.522	.001
Co	Strong Negative	-.518	.001
Sand	Strong Negative	-.498	.002
Clay	Strong Positive	.471	.003
EC	Strong Positive	.462	.004
Silt	Strong Positive	.450	.005
Mn	Moderate Negative	-.413	.011
SO_4	Moderate Positive	.407	.012
Moisture	Moderate Positive	.382	.020
P	Moderate Negative	-.380	.020

Table 3-72: Spearman's Rho Habitat, Gold Butte, A horizon

Table 3-72a: Summary for Habitat, Gold Butte, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.976	.000
CEC	Strong Negative	-.833	.010
pH ($CaCl_2$)	Strong Positive	.810	.015
Moisture	Strong Negative	-.762	.028
pH (sat. paste)	Strong Positive	.762	.028

Table 3-72a: Summary for Habitat, Gold Butte, A Horizon: Correlation to Fe

Ni	Very Strong Positive	.952	.000
Mg	Very Strong Positive	.905	.002
As	Strong Positive	.881	.004
Mo	Strong Positive	.786	.021

Table 3-73: Spearman's Rho Non-Habitat, Gold Butte, A horizon

Table 3-73a: Summary for Non-Habitat, Gold Butte, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.964	.000
Mn	Strong Negative	-.818	.004
Co	Strong Negative	-.745	.013
NO_3	Strong Positive	.738	.015
Clay	Strong Positive	.733	.016
Moisture	Strong Positive	.685	.029
Mo	Strong Negative	-.673	.033

Table 3-73b: Summary for Non-Habitat, Gold Butte, A Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Na	Strong Positive	.794	.006
B	Strong Positive	.782	.008
Ni	Strong Positive	.770	.009
Cu	Strong Positive	.733	.016

Table 3-74: Spearman's Rho Potential Habitat, Gold Butte, A horizon

Table 3-74a: Summary for Potential Habitat, Gold Butte, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.963	.000
Clay	Strong Positive	.857	.000
Zn	Strong Negative	-.849	.000
Organic C	Strong Negative	-.768	.000
Sand	Strong Negative	-.760	.000
Mg	Strong Positive	.683	.001
pH ($CaCl_2$)	Strong Positive	.642	.003
Moisture	Strong Negative	-.620	.005
B	Strong Negative	-.613	.005
Silt	Strong Positive	.610	.006
Ca	Strong Positive	.575	.010
Mn	Strong Negative	-.573	.010
pH (1:1)	Strong Positive	.565	.012
Ni	Strong Positive	.550	.015
As	Strong Positive	.527	.020
Fe	Strong Positive	.518	.023
pH (sat. paste)	Strong Positive	.488	.034

Table 3-74b: Summary for Potential Habitat, Gold Butte, A Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.902	.000
Co	Strong Negative	-.586	.008
P	Strong Negative	-.584	.009
Ca	Strong Positive	.584	.009
Mg	Strong Positive	.523	.022
Inorganic C	Strong Positive	.518	.023
$CaCO_3$	Strong Positive	.518	.023
Zn	Strong Negative	-.516	.024
Total C	Strong Positive	.482	.036
As	Strong Positive	.472	.041

Table 3-75: Spearman's Rho All Habitats, Bitter Spring, A horizon

Table 3-75a: Summary for All Habitats, Bitter Spring, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.994	.000
Mn	Strong Negative	-.579	.001
K	Strong Negative	-.550	.002
Na	Strong Negative	-.514	.004
Co	Strong Negative	-.502	.005
B	Strong Negative	-.466	.009
EC	Moderate Negative	-.415	.023
Cl	Moderate Negative	-.379	.039

Table 3-75b: Summary for All Habitats, Bitter Spring, A Horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ca	Strong Positive	.893	.000
Ni	Strong Positive	.859	.000
P	Strong Negative	-.645	.000
pH (1:1)	Strong Negative	-.599	.000
As	Strong Positive	.586	.001
pH ($CaCl_2$)	Strong Negative	-.538	.002
Co	Strong Negative	-.513	.004
SO_4	Moderate Positive	.415	.023
K	Moderate Negative	-.381	.038

Table 3-76: Spearman's Rho Buckwheat Habitat, Bitter Spring, A horizon

Table 3-76a: Summary for Buckwheat Habitat, Bitter Spring, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	1	.000
EC	Strong Negative	-.691	.019
K	Strong Negative	-.618	.043

Table 3-76b: Summary for Buckwheat Habitat, Bitter Spring, A Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ca	Very Strong Positive	.964	.000
Ni	Very Strong Positive	.927	.000
As	Strong Positive	.800	.003
pH (1:1)	Strong Negative	-.700	.016
Mg	Strong Negative	-.664	.026

Table 3-77: Spearman's Rho Non-Habitat, Bitter Spring, A horizon

Table 3-77a: Summary for Non-Habitat, Bitter Spring, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.982	.000

Table 3-77b: Summary for Non-Habitat, Bitter Spring, A Horizon: Correlation to Fe

Ni	Very Strong Positive	.991	.000
Ca	Very Strong Positive	.991	.000
As	Strong Positive	.745	.008
P	Strong Negative	-.736	.010
pH (sat. paste)	Strong Negative	-.736	.010
pH ($CaCl_2$)	Strong Negative	-.718	.013
pH (1:1)	Strong Negative	-.645	.032
EC	Strong Positive	.645	.032
Mn	Strong Negative	-.609	.047

Table 3-78: Spearman's Rho Potential Habitat, Bitter Spring, A horizon

Table 3-78a: Summary for Potential Habitat, Bitter Spring, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	1.000	.000
Mn	Strong Negative	-.738	.037

Table 3-78b: Summary for Potential Habitat, Bitter Spring, A Horizon: Correlation to Fe

Total N	Very Strong Negative	-.905	.002
Silt	Strong Negative	-.833	.010
Sand	Strong Positive	.833	.010
pH (1:1)	Strong Negative	-.810	.015
SO_4	Strong Positive	.714	.047

Table 3-79: Spearman's Rho All Sites, All Habitats, A horizon

Table 3-79a: Summary for All Sites, All Habs, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.995	.000
Mg	Strong Positive	.734	.000
Co	Strong Negative	-.614	.000
Clay	Strong Positive	.605	.000
Mn	Strong Negative	-.547	.000
Fe	Strong Positive	.536	.000
EC	Strong Negative	-.504	.000
SO_4	Strong Negative	-.503	.000
B	Moderate Negative	-.441	.000
Zn	Moderate Negative	-.414	.000
Ni	Moderate Positive	.401	.000
Cu	Moderate Negative	-.360	.000
Total N	Moderate Negative	-.343	.001
P	Moderate Negative	-.326	.001
NO3	Weak Positive	.295	.004
pH (1:1)	Weak Positive	.290	.004
Ca	Weak Positive	.279	.006
Cl	Weak Negative	-.277	.006
pH (sat. paste)	Weak Positive	.270	.008
CEC	Weak Negative	-.251	.014
Silt	Weak Negative	-.225	.028
Organic C	Weak Negative	-.205	.045

Table 3-79b: Summary for All Sites, All Habs, A horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Strong Positive	.842	.000
Ca	Strong Positive	.725	.000
P	Strong Negative	-.639	.000
Co	Strong Negative	-.610	.000
Inorganic C	Strong Positive	.536	.000
$CaCO_3$	Strong Positive	.536	.000
Total C	Strong Positive	.531	.000
Mn	Strong Negative	-.503	.000
Mg	Strong Positive	.466	.000
Zn	Moderate Negative	-.331	.001
Thickness	Weak Negative	-.283	.005
Clay	Weak Positive	.278	.006
As	Weak Positive	.269	.008
Cu	Weak Negative	-.257	.012
pH ($CaCl_2$)	Weak Negative	-.255	.012
Mo	Weak Positive	.251	.014
Total N	Weak Negative	-.250	.014
Na	Weak Positive	.241	.018
pH (1:1)	Weak Negative	-.208	.042

Table 3-80: Spearman's Rho All Sites, Habitat, A horizon

Table 3-80a: Summary for All Sites, Habitat, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.982	.000
B	Strong Negative	-.662	.000
EC	Strong Negative	-.661	.000
NO_3	Strong Positive	.656	.000
pH (1:1)	Strong Positive	.641	.000
Moisture	Strong Negative	-.626	.000
Mg	Strong Positive	.617	.000
SO_4	Strong Negative	-.590	.001
P	Strong Negative	-.577	.001
As	Strong Negative	-.518	.004
Clay	Strong Positive	.513	.004
CEC	Strong Negative	-.473	.009
Silt	Moderate Negative	-.449	.014
Fe	Moderate Positive	.441	.017
pH (sat. paste)	Moderate Positive	.429	.020
Thickness	Moderate Negative	-.406	-.440
Mn	Moderate Negative	-.385	.039
Total N	Moderate Negative	-.380	.042

Table 3-80b: Summary for All Sites, Habitat, A horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.944	.000
Ca	Strong Positive	.684	.000
P	Strong Negative	-.584	.001
Na	Strong Positive	.501	.006
Clay	Strong Positive	.454	.013
Inorganic C	Moderate Positive	.441	.017
$CaCO_3$	Moderate Positive	.441	.017
Thickness	Moderate Negative	-.440	.017
Total C	Moderate Positive	.425	.022
Mg	Moderate Positive	.411	.027

Table 3-81: Spearman's Rho All Sites, Non-Habitat, A horizon

Table 3-81a: Summary for All Sites, Non-Habitat, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.996	.000
Mg	Strong Positive	.820	.000
Clay	Strong Positive	.662	.000
Thickness	Strong Positive	.611	.000
SO_4	Strong Negative	-.588	.000
EC	Strong Negative	-.574	.001
NO_3	Strong Positive	.478	.006
pH ($CaCl_2$)	Strong Negative	-.460	.008
Sand	Moderate Negative	-.417	.018
Moisture	Moderate Positive	.400	.023
K	Moderate Positive	.372	.036
Fe	Moderate Positive	.368	.038
Co	Moderate Negative	-.368	.038

Table 3-81b: Summary for All Sites, Non-Habitat, A horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Strong Positive	.709	.000
B	Strong Positive	.540	.001
As	Strong Positive	.523	.002
Ca	Strong Positive	.504	.003
Co	Strong Negative	-.491	.004
Mn	Strong Negative	-.475	.006
K	Strong Positive	.473	.006
Na	Moderate Positive	.436	.013
pH (sat. paste)	Moderate Negative	-.435	.013
pH (1:1)	Moderate Negative	-.433	.013
Mg	Moderate Positive	.406	.021
Total C	Moderate Positive	.380	.032
Inorganic C	Moderate Positive	.368	.038
$CaCO_3$	Moderate Positive	.368	.038

Table 3-82: Spearman's Rho All Sites, Potential Habitat, A horizon

Table 3-82a: Summary for All Sites, Potential Habitat, A horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.987	.000
B	Strong Negative	-.710	.000
EC	Strong Negative	-.682	.000
Mn	Strong Negative	-.663	.000
Co	Strong Negative	-.656	.000
Mg	Strong Positive	.645	.000
Clay	Strong Positive	.638	.000
pH (1:1)	Strong Positive	.636	.000
Fe	Strong Positive	.629	.000
Moisture	Strong Negative	-.578	.000
SO_4	Strong Negative	-.556	.001
Zn	Strong Negative	-.511	.002
CEC	Strong Negative	-.453	.006
Total N	Moderate Negative	-.447	.007
Cl	Moderate Negative	-.447	.007
Organic C	Moderate Negative	-.412	.014
Ni	Moderate Positive	.411	.014
pH (sat. paste)	Moderate Positive	.375	.027

Table 3-82b: Summary for All Sites, Potential Habitat, A horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Inorganic C	Strong Positive	.629	.000
$CaCO_3$	Strong Positive	.629	.000
Co	Strong Negative	-.627	.000
Ni	Strong Positive	.610	.000
Total C	Strong Positive	.604	.000
Mg	Strong Positive	.599	.000
Total N	Strong Negative	-.572	.000
Mn	Strong Negative	-.525	.001
Zn	Strong Negative	-.522	.001
P	Strong Negative	-.506	.002
B	Strong Negative	-.471	.004
Silt	Strong Negative	-.464	.005
Cu	Strong Negative	-.452	.006
Mo	Moderate Positive	.403	.016
Ca	Moderate Positive	.387	.022
CEC	Moderate Negative	-.376	.026
Organic C	Moderate Negative	-.351	.039
Clay	Moderate Positive	.351	.039

Table 3-83: Spearman's Rho All Chemistry, Coyote Springs, B Horizon

Table 3-83a: Summary for All Habitats at Coyote Springs, B Horizon: Correlation to CaCO3

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.992	.000
Mg	Strong Positive	.563	.000
pH (sat. paste)	Strong Positive	.501	.000
P	Strong Negative	-.484	.000
Silt	Moderate Negative	-.415	.000
Total N	Moderate Negative	-.398	.001
Clay	Moderate Positive	.391	.001
Co	Weak Negative	-.274	.022
Zn	Weak Positive	.262	.028
Ca	Weak Positive	.245	.041

Table 3-83b: Summary for All Habitats at Coyote Springs, B Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.968	.000
Ca	Very Strong Positive	.934	.000
P	Strong Negative	-.599	.000
K	Moderate Positive	.424	.000
Moisture	Moderate Positive	.359	.002
SO_4	Moderate Positive	.341	.004
B	Moderate Positive	.337	.004
Total N	Moderate Negative	-.322	.007
Mo	Moderate Positive	.313	.008
Na	Moderate Positive	.300	.012
EC	Weak Positive	.266	.026
pH (1:1)	Weak Negative	-.252	.035

Table 3-84: Spearman's Rho Habitat, Coyote Springs, B Horizon

Table 3-84a: Summary for Habitat, Coyote Springs, B Horizon: Correlation to $CaCO_3$			
Significant Variable	**Correlation to $CaCO_3$**	**Correlation coefficient**	**P-value**
Total C	Very Strong Positive	.989	.000
K	Strong Negative	-.535	.006
Mn	Strong Negative	-.469	.018
EC	Moderate Negative	-.435	.030
P	Moderate Negative	-.433	.031
B	Moderate Negative	-.425	.034
Silt	Moderate Negative	-.421	.036
Cu	Moderate Positive	.409	.043
Moisture	Moderate Negative	-.407	.043

Table 3-84b: Summary for Habitat, Coyote Springs, B Horizon: Correlation to Fe			
Significant Variable	**Correlation to $CaCO_3$**	**Correlation coefficient**	**P-value**
Ni	Very Strong Positive	.939	.000
Ca	Strong Positive	.846	.000
Co	Strong Positive	.671	.000
Mg	Strong Negative	-.563	.003
Mo	Strong Positive	.467	.019
EC	Strong Positive	.463	.020
Total N	Moderate Negative	-.438	.029
SO_4	Moderate Positive	.438	.029
Mn	Moderate Positive	.412	.041
P	Moderate Negative	-.402	.046

Table 3-85: Spearman's Rho Non-Habitat, Coyote Springs, B Horizon

Table 3-85a: Summary for Non-Habitat, Coyote Springs, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.975	.000
Silt	Strong Negative	-.641	.003
Total N	Strong Negative	-.630	.004
Sand	Strong Positive	.577	.010
Mo	Strong Positive	.567	.011
Zn	Strong Positive	.563	.012
pH ($CaCl_2$)	Strong Positive	.505	.028

Table 3-85b: Summary for Non-Habitat, Coyote Springs, B Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.995	.000
Ca	Very Strong Positive	.979	.000
P	Strong Negative	-.704	.001
Mn	Strong Negative	-.565	.012
Mg	Strong Positive	.461	.047

Table 3-86: Spearman's Rho Potential Habitat, Coyote Springs, B Horizon

Table 3-86a: Summary for Potential Habitat, Coyote Springs, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.992	.000
P	Strong Negative	-.580	.002
pH (sat. paste)	Strong Positive	.573	.002
Mg	Strong Positive	.525	.006
Ca	Strong Positive	.458	.019

Table 3-86b: Summary for Potential Habitat, Coyote Springs, B Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.965	.000
Ca	Very Strong Positive	.936	.000
P	Strong Negative	-.582	.002
K	Strong Positive	.470	.015
Moisture	Moderate Positive	.419	.033

Table 3-87: Spearman's Rho All Habitats at Gold Butte, B Horizon

Table 3-87a: Summary for All Habitats at Gold Butte, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.962	.000
Mg	Strong Positive	.674	.000
Clay	Strong Positive	.561	.000
Sand	Strong Negative	-.552	.000
Silt	Strong Positive	.477	.000
Fe	Strong Positive	.462	.000
SO_4	Strong Positive	.454	.000
Ni	Moderate Positive	.428	.001
EC	Moderate Positive	.373	.003
Ca	Moderate Positive	.351	.006
Mo	Moderate Positive	.349	.006
B	Moderate Positive	.304	.017

Table 3-87b: Summary for All Habitats at Gold Butte, B Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.936	.000
Ca	Strong Positive	.767	.000
As	Strong Positive	.566	.000
Inorganic C	Strong Positive	.462	.000
$CaCO_3$	Strong Positive	.462	.000
Total C	Strong Positive	.454	.000
pH (1:1)	Strong Negative	-.450	.000
Mg	Moderate Positive	.392	.002
EC	Moderate Positive	.380	.003
P	Moderate Negative	-.378	.003
Cu	Moderate Positive	.373	.003
pH ($CaCl_2$)	Moderate Negative	-.372	.003
Na	Moderate Positive	.330	.009
Mo	Weak Positive	.261	.042

Table 3-88: Spearman's Rho Habitat, Gold Butte, B Horizon

Table 3-88a: Summary for Habitat, Gold Butte, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	1.000	.000
pH (1:1)	Strong Positive	.819	.001
pH (CaCl2)	Strong Positive	.808	.001
Moisture	Strong Negative	-.731	.005

Table 3-88b: Summary for Habitat, Gold Butte, B Horizon: Correlation to Fe

Ni	Strong Positive	.764	.002
As	Strong Positive	.698	.008
Total N	Strong Negative	-.681	.010
Organic C	Strong Negative	-.665	.013
Ca	Strong Positive	.610	.027

Table3-89: Spearman's Rho Non-Habitat, Gold Butte, B Horizon

Table 3-89a: Summary for Non-Habitat, Gold Butte, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
As	Strong Positive	.808	.000
Moisture	Strong Positive	.794	.000
Ca	Strong Positive	.761	.001
pH ($CaCl_2$)	Strong Negative	-.738	.002
pH (1:1)	Strong Negative	-.727	.002
Fe	Strong Positive	.660	.007
Total C	Strong Positive	.645	.009
Sand	Strong Negative	-.633	.011
Mg	Strong Positive	.631	.012
Ni	Strong Positive	.624	.013
Silt	Strong Positive	.624	.013
Co	Strong Negative	-.567	.028
SO_4	Strong Positive	.545	.036
Mn	Strong Negative	-.545	.036
P	Strong Negative	-.524	.045

Table 3-89b: Summary for Non-Habitat, Gold Butte, B Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.986	.000
Total C	Strong Positive	.818	.000
Ca	Strong Positive	.814	.000
Mg	Strong Positive	.800	.000
As	Strong Positive	.768	.001
pH (1:1)	Strong Negative	-.725	.002
pH ($CaCl_2$)	Strong Negative	-.671	.006
Inorganic C	Strong Positive	.660	.007
$CaCO_3$	Strong Positive	.660	.007
pH (sat. paste)	Strong Negative	-.604	.017
Moisture	Strong Positive	.593	.020

Table 3-90: Spearman's Rho Potential Habitat, Gold Butte, B Horizon

Table 3-90a: Summary for Potential Habitat, Gold Butte, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.982	.000
Clay	Strong Positive	.700	.000
Mg	Strong Positive	.692	.000
pH ($CaCl_2$)	Strong Positive	.614	.000
Sand	Strong Negative	-.544	.001
Moisture	Strong Negative	-.543	.001
K	Strong Positive	.466	.006
Mo	Moderate Positive	.420	.015
Silt	Moderate Positive	.357	.041
NO_3	Moderate Positive	.354	.043

Table 3-90b: Summary for Potential Habitat, Gold Butte, B Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.924	.000
Ca	Strong Positive	.750	.000
Cu	Moderate Positive	.448	.009
Thickness	Moderate Negative	-.427	.013
Na	Moderate Positive	.403	.020
Moisture	Moderate Negative	-.347	.048
As	Moderate Positive	.346	.048

Table 3-91: Spearman's Rho All Habitats, Bitter Spring, B Horizon

Table 3-91a: Summary for All Habitats at Bitter Spring, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.992	.000
P	Strong Negative	-.579	.000
Mn	Strong Negative	-.576	.000
Cu	Strong Negative	-.545	.001
Zn	Strong Negative	-.518	.002
SO_4	Strong Negative	-.473	.005
B	Strong Negative	-.467	.006
EC	Moderate Negative	-.443	.010
Organic C	Moderate Positive	.420	.015
Co	Moderate Negative	-.373	.032
Ca	Moderate Positive	.356	.042
As	Moderate Negative	-.354	.043
Moisture	Moderate Negative	-.348	.047

Table 3-91b: Summary for All Habitats at Bitter Spring, B Horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ca	Very Strong Positive	.945	.000
Ni	Very Strong Positive	.942	.000
Cl	Strong Negative	-.586	.000
P	Moderate Negative	-.437	.011
B	Moderate Negative	-.410	.018
Total C	Moderate Positive	.366	.036

Table 3-92: Spearman's Rho Habitat, Bitter Spring, B Horizon

Table 3-92a: Summary for Habitat, Bitter Spring, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	1.000	.000
Thickness	Strong Negative	-0.881	.004
Fe	Strong Positive	.857	.007
Organic C	Strong Positive	.833	.010
Ni	Strong Positive	.738	.037
Clay	Strong Positive	.738	.037

Table 3-92b: Summary for Habitat, Bitter Spring, B Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Very Strong Positive	.905	.002
Total C	Strong Positive	.857	.007
Inorganic C	Strong Positive	.857	.007
$CaCO_3$	Strong Positive	.857	.007
Moisture	Strong Negative	-.833	.010
Mg	Strong Positive	.738	.037
Clay	Strong Positive	.738	.037
B	Strong Negative	-.714	.047

Table 3-93: Spearman's Rho Non-Habitat, Bitter Spring, B

Table 3-93a: Summary for Non-Habitat, Bitter Spring, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.993	.000
Cu	Strong Negative	-.874	.000
Zn	Strong Negative	-.798	.000
Mn	Strong Negative	-.745	.000
Co	Strong Negative	-.600	.008
Organic C	Strong Positive	.580	.012
Mg	Strong Positive	.577	.012
pH (sat. paste)	Strong Positive	.569	.014
SO_4	Strong Negative	-.522	.026
P	Strong Negative	-.520	.027
B	Strong Negative	-.469	.050

Table 3-93b: Summary for Non-Habitat, Bitter Spring, B Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ca	Very Strong Positive	.950	.000
Ni	Very Strong Positive	.948	.000
Zn	Strong Positive	.486	.041

Table 3-94: Spearman's Rho Potential Habitat, Bitter Spring, B Horizon

Table 3-94a: Summary for Potential Habitat, Bitter Spring, B Horizon: Correlation to CaCO3

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	1.000	.000
Fe	Strong Positive	.893	.007
P	Strong Negative	-.857	.014
Ni	Strong Positive	.857	.014
Ca	Strong Positive	.857	.014

Table 3-94b: Summary for Potential Habitat, Bitter Spring, B Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
P	Very Strong Negative	-.964	.000
Ni	Very Strong Positive	.964	.000
Ca	Very Strong Positive	.964	.000
Total C	Strong Positive	.893	.007
Inorganic C	Strong Positive	.893	.007
$CaCO_3$	Strong Positive	.893	.007
Moisture	Strong Negative	-.857	.014
B	Strong Negative	-.857	.014

Table 3-95: Spearman's Rho All Sites, All Habitats, B Horizon

Table 3-95a: Summary for All Sites, All Habitats, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.994	.000
Mg	Strong Positive	.779	.000
Clay	Strong Positive	.607	.000
SO_4	Strong Negative	-.566	.000
Co	Strong Negative	-.566	.000
P	Strong Negative	-.565	.000
EC	Strong Negative	-.473	.000
Fe	Strong Positive	.463	.000
As	Strong Negative	-.450	.000
pH (1:1)	Moderate Positive	.384	.000
K	Moderate Positive	.377	.000
Ni	Moderate Positive	.335	.000
Moisture	Moderate Negative	-.305	.000
Cu	Moderate Negative	-.302	.000
Total N	Weak Negative	-.293	.000
Silt	Weak Negative	-.276	.000
Organic C	Weak Negative	-.265	.001
Mn	Weak Negative	-.254	.001
pH ($CaCl_2$)	Weak Negative	-.212	.007
Mo	Weak Positive	.198	.011
B	Weak Negative	-.163	.037

Table 3-95b: Summary for All Sites, All Habs, B Horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.952	.000
P	Strong Negative	-.618	.000
Ca	Strong Positive	.564	.000
Inorganic C	Strong Positive	.463	.000
$CaCO_3$	Strong Positive	.463	.000
Total C	Strong Positive	.451	.000
K	Moderate Positive	.420	.000
Mg	Moderate Positive	.373	.000
Na	Moderate Positive	.348	.000
pH ($CaCl_2$)	Weak Negative	-.298	.000
Clay	Weak Positive	.290	.000
Mo	Weak Positive	.283	.000
CEC	Weak Positive	.262	.001
Organic C	Weak Negative	-.244	.002
Cl	Weak Negative	-.236	.002
pH (sat. paste)	Weak Negative	-.219	.005
Total N	Weak Negative	-.217	.005
B	Weak Positive	.187	.017
Co	Weak Negative	-.181	.021
pH (1:1)	Weak Negative	-.156	.046

Table 3-96: Spearman's Rho All Sites, Habitat, B Horizon

Table 3-96a: Summary for All Sites, Habitat, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.996	.000
Moisture	Strong Negative	-.822	.000
pH (1:1)	Strong Positive	.767	.000
Mg	Strong Positive	.729	.000
EC	Strong Negative	-.699	.000
SO_4	Strong Negative	-.681	.000
Clay	Strong Positive	.625	.000
As	Strong Negative	-.557	.000
P	Strong Negative	-.492	.001
Co	Strong Negative	-.465	.001
Total N	Moderate Negative	-.437	.002
Silt	Moderate Negative	-.420	.004
Fe	Moderate Positive	.312	.035
B	Moderate Negative	-.302	.042
pH (sat. paste)	Moderate Positive	.301	.042
Organic C	Weak Negative	-.291	.050

Table 3-96b: Summary for All Sites, Habitat, B Horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.919	.000
Ca	Strong Positive	.542	.000
CEC	Strong Positive	.514	.000
Mo	Strong Positive	.491	.001
K	Strong Positive	.488	.001
Organic C	Strong Negative	-.460	.001
P	Moderate Negative	-.444	.002
Silt	Moderate Negative	-.444	.002
Mn	Moderate Positive	.436	.002
Total N	Moderate Negative	-.435	.003
pH (sat. paste)	Moderate Negative	-.431	.003
Na	Moderate Positive	.385	.008
Sand	Moderate Positive	.316	.032
Inorganic C	Moderate Positive	.312	.035
$CaCO_3$	Moderate Positive	.312	.035
pH ($CaCl_2$)	Weak Negative	-.298	.044

Table 3-97: Spearman's Rho All Sites, Non-Habitat, B Horizon

Table 3-97a: Summary for All Sites, Non-Habitat, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.976	.000
Mg	Strong Positive	.795	.000
Co	Strong Negative	-.564	.000
SO_4	Strong Negative	-.521	.000
Mn	Strong Negative	-.497	.000
P	Moderate Negative	-.427	.002
pH ($CaCl_2$)	Moderate Negative	-.424	.002
Moisture	Moderate Positive	.410	.003
Cu	Moderate Negative	-.400	.003
EC	Moderate Negative	-.388	.004
Clay	Moderate Positive	.374	.006
Fe	Moderate Positive	.347	.012
Zn	Moderate Negative	-.342	.013

Table 3-97b: Summary for All Sites, Non-Habitat, B Horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.982	.000
Ca	Strong Positive	.830	.000
P	Strong Negative	-.648	.000
Mg	Strong Positive	.538	.000
pH (1:1)	Strong Negative	-.499	.000
Na	Strong Positive	.483	.000
B	Strong Positive	.482	.000
As	Strong Positive	.459	.001
Moisture	Strong Positive	.457	.001
Mn	Moderate Negative	-.430	.001
pH ($CaCl_2$)	Moderate Negative	-.407	.003
Mo	Moderate Positive	.395	.004
K	Moderate Positive	.392	.004
Inorganic C	Moderate Positive	.347	.012
$CaCO_3$	Moderate Positive	.347	.012
pH (sat. paste)	Moderate Negative	-.340	.014
Total C	Moderate Positive	.333	.016
Co	Moderate Negative	-.310	.025

Table 3-98: Spearman's Rho All Sites, Potential Habitat, B Horizon

Table 3-98a: Summary for All Sites, Potential Habitat, B Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.996	.000
Mg	Strong Positive	.771	.000
Moisture	Strong Negative	-.747	.000
Clay	Strong Positive	.672	.000
P	Strong Negative	-.666	.000
As	Strong Negative	-.641	.000
SO_4	Strong Negative	-.613	.000
Co	Strong Negative	-.572	.000
EC	Strong Negative	-.540	.000
pH (1:1)	Strong Positive	.528	.000
Fe	Strong Positive	.520	.000
K	Strong Positive	.516	.000
Organic C	Moderate Negative	-.422	.000
Ni	Moderate Positive	.365	.003
Cu	Moderate Negative	-.342	.005
Silt	Weak Negative	-.296	.016
Total N	Weak Negative	-.269	.029
B	Weak Negative	-.244	.049

Table 3-98b: Summary for All Sites, Potential Habitat, B Horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.930	.000
P	Strong Negative	-.573	.000
Inorganic C	Strong Positive	.520	.000
$CaCO_3$	Strong Positive	.520	.000
Total C	Strong Positive	.518	.000
Ca	Strong Positive	.451	.000
Moisture	Moderate Negative	-.354	.004
K	Moderate Positive	.316	.010
Clay	Moderate Positive	.304	.013
Mg	Moderate Positive	.300	.014
Na	Weak Positive	.294	.017
CEC	Weak Positive	.264	.032
Co	Weak Negative	-.253	.041

Table 3-99: Spearman's Rho All Habitats, Gold Butte, C Horizon

Table 3-99a: Summary for All Habitats, Gold Butte, C Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.988	.000
Clay	Strong Positive	.725	.000
Fe	Strong Positive	.721	.000
P	Strong Negative	-.710	.000
Mg	Strong Positive	.695	.000
Moisture	Strong Negative	-.663	.000
Cl	Strong Positive	.623	.000
Mo	Strong Positive	.609	.001
EC	Strong Positive	.608	.001
Ni	Strong Positive	.603	.001
Na	Strong Positive	.593	.001
SO_4	Strong Positive	.588	.001
pH ($CaCl_2$)	Strong Positive	.545	.003
pH (1:1)	Strong Positive	.530	.004
B	Strong Positive	.489	.008
K	Strong Positive	.489	.008
Ca	Strong Positive	.480	.010
Zn	Moderate Positive	.426	.024
CEC	Moderate Negative	-.416	.031
Cu	Moderate Positive	.387	.042

Table 3-99a: Summary for All Habitats, Gold Butte, C Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Ni	Strong Positive	.836	.000
Inorganic C	Strong Positive	.721	.000
$CaCO_3$	Strong Positive	.721	.000
Total C	Strong Positive	.703	.000
Cu	Strong Positive	.681	.000
Ca	Strong Positive	.667	.000
Zn	Strong Positive	.574	.001
Mg	Strong Positive	.571	.001
B	Strong Positive	.531	.004
Moisture	Strong Negative	-.520	.005
Clay	Strong Positive	.482	.009
Mn	Strong Positive	.461	.013
Mo	Strong Positive	.451	.016
K	Moderate Positive	.439	.019
P	Moderate Negative	-.434	.021
Na	Moderate Positive	.377	.048

Table 3-100: Spearman's Rho Habitat, Gold Butte, C Horizon

Table 3-100a: Summary for Habitat, Gold Butte, C Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	1.000	.000
P	Strong Negative	-.773	.005
pH ($CaCl_2$)	Strong Positive	.755	.007
Sand	Strong Negative	-.755	.007
CEC	Strong Negative	-.733	.016
Moisture	Strong Negative	-.718	.013
pH (1:1)	Strong Positive	.682	.021
Ni	Strong Positive	.682	.021
Ca	Strong Positive	.682	.021

Table 3-100b: Summary for Habitat, Gold Butte, C Horizon: Correlation to Fe

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Cu	Strong Positive	.764	.006
Ni	Strong Positive	.664	.026

Table 3-101: Spearman's Rho Non-Habitat, Gold Butte, C Horizon

Table 3-101a: Summary for Non-Habitat, Gold Butte, C Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.964	.000
Mo	Very Strong Positive	.964	.000
Mg	Very Strong Positive	.929	.003
Na	Strong Positive	.893	.007
Clay	Strong Positive	.893	.007
B	Strong Positive	.857	.014
Sand	Strong Negative	-.857	.014
Silt	Strong Positive	.786	.036

Table 3-101b: Summary for Non-Habitat, Gold Butte, C Horizon: Correlation to Fe

Ni	Very Strong Positive	.964	.000
Mn	Strong Positive	.821	.023
Cu	Strong Positive	.821	.023
K	Strong Positive	.821	.023

Table 3-102: Spearman's Rho Potential Habitat, Gold Butte, C Horizon

Table 3-102a: Summary for Potential Habitat, Gold Butte, C Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Moisture	Very Strong Negative	-.985	.000
Total C	Very Strong Positive	.979	.000
Fe	Very Strong Positive	.924	.000
pH ($CaCl_2$)	Strong Positive	.872	.001
pH (1:1)	Strong Positive	.802	.005
Ni	Strong Positive	.766	.010
Mg	Strong Positive	.748	.013
Organic C	Strong Negative	-.681	.030
Na	Strong Positive	.681	.030
Ca	Strong Positive	.638	.047
B	Strong Positive	.632	.050

Table 3-102b: Summary for Potential Habitat, Gold Butte, C Horizon: Correlation to Fe

Moisture	Very Strong Negative	-.927	.000
Inorganic C	Very Strong Positive	.924	.000
$CaCO_3$	Very Strong Positive	.924	.000
Total C	Strong Positive	.879	.001
Ni	Strong Positive	.855	.002
Organic C	Strong Negative	-.818	.004
pH ($CaCl_2$)	Strong Positive	.717	.020
Na	Strong Positive	.709	.022
Ca	Strong Positive	.661	.038

Table 3-103: Spearman's Rho All Habitats, Bitter Spring, C Horizon

Table 3-103a: Summary for All Habitats, Bitter Spring, C Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.991	.000
P	Strong Negative	-.594	.001
Ca	Strong Positive	.557	.002
Ni	Strong Positive	.528	.003
Moisture	Strong Negative	-.510	.005
Fe	Strong Positive	.488	.007
B	Strong Negative	-.484	.008
Co	Strong Negative	-.469	.010
Zn	Moderate Negative	-.396	.033
EC	Moderate Negative	-.381	.042

Table 3-103b: Summary for All Habitats Bitter Spring, C Horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ca	Very Strong Positive	.902	.000
Ni	Strong Positive	.857	.000
P	Strong Negative	-.706	.000
Total C	Strong Positive	.494	.007
Inorganic C	Strong Positive	.488	.007
$CaCO_3$	Strong Positive	.488	.007

Table 3-104: Spearman's Rho Habitat, Bitter Spring, C Horizon

Table 3-104a: Summary for Habitat, Bitter Spring, C Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.978	.000
pH (sat. paste)	Strong Positive	.663	.014
NO_3	Strong Positive	.630	.021
Ca	Strong Positive	.604	.029
P	Strong Negative	-.555	.049

Table 3-104b: Summary for Habitat, Bitter Spring, C Horizon: Correlation to Fe

Ca	Very Strong Positive	.973	.000
Ni	Very Strong Positive	.918	.000
Mo	Strong Positive	.698	.008
Co	Strong Positive	.591	.033
Thickness	Strong Positive	.586	.035
K	Strong Positive	.571	.041
NO_3	Strong Positive	.569	.042

Table 3-105: Spearman's Rho Non-Habitat, Bitter Spring, C Horizon

Table 3-105a: Summary for Non-Habitat, Bitter Spring, C Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	1.000	.000
EC	Very Strong Negative	-.943	.005
Total N	Very Strong Negative	-.943	.005
Organic C	Very Strong Positive	.943	.005
B	Very Strong Negative	-.943	.005
Zn	Very Strong Negative	-.943	.005
NO_3	Strong Negative	-.829	.042
Co	Strong Negative	-.829	.042
Cu	Strong Negative	-.829	.042
Na	Strong Negative	-.829	.042

Table 3-105b: Summary for Non-Habitat, Bitter Spring, C Horizon: Correlation to Fe

SO_4	Very Strong Negative	-.943	.005
Ca	Very Strong Positive	.943	.005
Ni	Strong Positive	.886	.019
pH ($CaCl_2$)	Strong Negative	-.829	.042

Table 3-106: Spearman's Rho Potential Habitat, Bitter Spring, C Horizon

Table 3-106a: Summary for Potential Habitat, Bitter Spring, C Horizon: Correlation to $CaCO_3$			
Significant Variable	**Correlation to $CaCO_3$**	**Correlation coefficient**	**P-value**
Total C	Very Strong Positive	.976	.000
Ni	Strong Positive	.661	.038
P	Strong Negative	-.636	.048

Table 3-106b: Summary for Potential Habitat, Bitter Spring, C Horizon: Correlation to Fe			
Significant Variable	**Correlation to $CaCO_3$**	**Correlation coefficient**	**P-value**
P	Strong Negative	-.758	.011
Ca	Strong Positive	.685	.029

Table 3-107: Spearman's Rho All Sites, All Habitats, C Horizon

Table 3-107a: Summary for All Sites, All Habitats, C Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.992	.000
Moisture	Strong Negative	-.595	.000
P	Strong Negative	-.590	.000
Fe	Strong Positive	.557	.000
Ni	Strong Positive	.540	.000
Ca	Strong Positive	.457	.000
Mg	Moderate Positive	.429	.001
Clay	Moderate Positive	.371	.004
pH (1:1)	Weak Positive	.282	.031
Co	Weak Negative	-.260	.047

Table 3-107b: Summary for All Sites, All Habitats, C Horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Strong Positive	.834	.000
Ca	Strong Positive	.720	.000
Inorganic C	Strong Positive	.557	.000
$CaCO_3$	Strong Positive	.557	.000
P	Strong Negative	-.548	.000
Total C	Strong Positive	.543	.000
Moisture	Moderate Negative	-.413	.001
Cu	Moderate Positive	.413	.001
Zn	Moderate Positive	.391	.002
K	Moderate Positive	.389	.002
Mg	Moderate Positive	.372	.004
Total N	Moderate Negative	-.328	.011
As	Moderate Positive	.307	.018
B	Moderate Positive	.306	.018
Mo	Moderate Positive	.304	.019
Na	Weak Positive	.275	.035

Table 3-108: Spearman's Rho All Sites, Habitat, C Horizon

Table 3-108a: Summary for All Sites, Habitat, C Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.976	.000
P	Strong Negative	-.670	.000
NO_3	Strong Positive	.616	.001
pH (1:1)	Strong Positive	.611	.002
pH ($CaCl_2$)	Strong Positive	.601	.002
Ca	Strong Positive	.579	.003
pH (sat. paste)	Strong Positive	.573	.003
Moisture	Strong Negative	-.551	.005

Table 3-108b: Summary for All Sites, Habitat, C Horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Strong Positive	.730	.000
Ca	Strong Positive	.609	.002
Mg	Strong Positive	.489	.015
Cu	Strong Positive	.450	.028
Zn	Moderate Positive	.404	.050

Table 3-109: Spearman's Rho All Sites, Non-Habitat, C Horizon

Table 3-109a: Summary for All Sites, Non-Habitat, C Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.989	.000
Mg	Strong Positive	.525	.044

Table 3-109b: Summary for All Sites, Non-Habitat, C Horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Strong Positive	.886	.000
K	Strong Positive	.800	.000
pH (sat. paste)	Strong Negative	-.618	.014
As	Strong Positive	.614	.015
CEC	Strong Positive	.564	.028
B	Strong Positive	.514	.050

Table 3-110: Spearman's Rho All Sites, Potential Habitat, C Horizon

Table 3-110a: Summary for All Sites, Potential Habitat, C Horizon: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.982	.000
Moisture	Strong Negative	-.797	.000
Fe	Strong Positive	.720	.000
pH ($CaCl_2$)	Strong Positive	.636	.003
pH (1:1)	Strong Positive	.619	.004
Na	Strong Positive	.569	.009
Mg	Strong Positive	.555	.011
Organic C	Strong Negative	-.545	.013
Ni	Strong Positive	.481	.032
Mo	Strong Positive	.455	.044

Table 3-110b: Summary for All Sites, Potential Habitat, C Horizon: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Moisture	Strong Negative	-.734	.000
Inorganic C	Strong Positive	.720	.000
$CaCO_3$	Strong Positive	.720	.000
Total C	Strong Positive	.708	.000
Ni	Strong Positive	.592	.006
Organic C	Strong Negative	-.564	.010
Ca	Strong Positive	.513	.021
P	Strong Negative	-.502	.024
Na	Strong Positive	.501	.025
Mg	Strong Positive	.492	.028

IV. Discussion and Interpretation

General Overview

At the most general level, we note that total carbon, inorganic carbon, percent calcium carbonate equivalence, available calcium, iron, and nickel were consistently found to be significantly ($p < 0.05$) higher in buckwheat/habitat sites compared to soils in non-buckwheat or non-habitat sites (see Table 3-48). Deviations from this trend were not found even for comparisons in which these variables did not prove statistically significant. Phosphorus, cobalt, and total nitrogen were generally found to be significantly lower in buckwheat habitat than in non-habitat or potential habitat (also non-buckwheat which includes non-habitat and potential habitat combined) (Tables 3-48 to 3-50). Again, these trends generally held true even when the differences were statistically inconclusive. We also note that sulfate was only infrequently indicated as a significant variable in our analysis, thus underscoring the point that the content of soil gypsum or other sulfate salt minerals does not by itself seem to account for the distributions of the Las Vegas buckwheat in Clark County. It may be that either the species is not a true gypsophile (e.g., Drohan & Merkler, 2009), or that other factors common to gypsum soils are more important.

Other variables besides those already mentioned were found to be significant between sample groupings, however, they were either found infrequently, occurred less consistently between different comparisons, or occurred in only one study area. For instance, the CEC of buckwheat habitat soils at Gold Butte was significantly lower than non-buckwheat sites, however, this trend did not hold true at the other areas (Table 3-8). Similarly, available boron was lower in buckwheat sites in almost all comparisons at Bitter Spring (Tables 3-48c & 3-49c), but was greater only in the B horizons at Coyote Springs (Table 3-48a), and was not at all significant with regard to buckwheat sites at Gold Butte (Tables 3-48b & 3-49b). Comparison of boron values both between classes and between study areas reveals overlapping ranges and/or similar means (e.g.,Tables 3-2 to 3-5). This point underscores the need to interpret any variable identified as significant within the context of other soil factors (including geologic parent materials), and as part of the natural scenarios under which micronutrient deficiency or toxicity may respond to soil pH, texture, mineralogy, or other site-specific properties. Trends specific to each individual study area, and determined for the entire data set are discussed in detail below.

Coyote Springs Trends

Variables most commonly found to be significant between buckwheat and non-buckwheat sites at Coyote Springs included total C, inorganic C, $CaCO_3$, available Ca, Mg, Fe, Ni, P, and total N (Tables 3-48a, 3-49a, & 3-50a). Of these variables, only available P and total N were lower in buckwheat habitat; the others were all higher. Additional variables including available K, As, B, Co, and Cu were significant only in some comparisons. Of these, available K, As, and B were greater in buckwheat sites, and available Co and Cu were lower (Tables 3-48a, 3-49a, & 3-50a).

Comparisons of minimum and maximum values within the Coyote Springs data (e.g., Tables 3-9a, 3-10a, and 3-15a to 3-20a) reveal that, except for total N, available Co, P, and Cu, the higher median consistently fell into the buckwheat habitat class, suggesting that those variables *could* indicate the lower thresholds (especially in the case of the minimum values) of habitat-limiting soil factors. It seems unlikely that the reverse is true - high total N may drive competition with other plants, but it is not likely to limit growth of the buckwheat. However, it is possible that the lower available Cu values do reflect either a lower nutrient requirement for or higher sensitivity to Cu than other species in the study area. This point will be revisited below.

Variables that were most commonly found to be significant between buckwheat habitat and potential habitat include available Ca, Fe, and Ni. All of these variables are greater in buckwheat habitats (Table 3-49a). Additionally, pH, total C, inorganic C, $CaCO_3$ were greater in the whole profile means, and available Cu was lower in the A horizon comparisons (Table 3-49a). Available arsenic was found to be higher in the B horizon weighted means only.

Comparisons between potential habitat and non-habitat returned a suite of significant variables similar to those of the buckwheat vs. non-buckwheat sites. This indicates that the visual observations used to define potential habitats at Coyote Springs were accurate and may prove useful in other similar settings. Potential habitat soils contained greater amounts of total C, inorganic C, $CaCO_3$, available Ca, Mg, Fe, and Ni; and lower amounts of available P, Co, and total N compared to non-habitats (Tables 3-50a). Differences in these trends included greater Mo, CEC, and clay; and less silt in the potential habitats. The latter may be due to the prevalence of desert pavements in non-habitat map units at Coyote Springs. The increase in CEC in the B horizons of potential habitats is likely caused by the corresponding increase in clay. Higher clay content likely reflects increased pedogenesis in these sites and the presence of numerous paleosols within the Las Vegas Formation (see Chapter 2). One of the most interesting observations to make from the Coyote Springs results is that of trends between habitat classes. For some variables, potential habitat medians fell perfectly between habitat and non-habitat values. Using Fe medians in the soil profile comparisons (i.e., the *median* profile mean) as an example: Non-habitat Fe = 8.861 < Potential Habitat Fe = 10.866 < Habitat Fe = 13.497.

Gold Butte Trends

Similar to Coyote Springs, the variables most commonly found to be significant between buckwheat sites and non-buckwheat sites at Gold Butte were total C, inorganic C, $CaCO_3$, and available Fe, which were all higher in buckwheat sites, and available P and CEC which were lower (Table 3-48b). Other variables significant in some comparisons included available Ca (greater in A horizons), available Mg (greater in whole profile and C horizons), available Ni (greater in while profile and A horizons), available K (greater in C horizons), available As (greater in A horizons), SO_4 (greater in C horizons), available Co & Mn (lower in A horizons), clay (greater in A and C horizons), silt (greater in A and B horizons) and sand (lower in A horizons) (Table 3-48b). Interestingly, the Gold Butte data are distinct from Coyote Springs because they exhibit consistent differences in (1) CEC, which are lower in buckwheat sites, and (2) soil textural parameters, which overall indicate less sand in the buckwheat-populated soils.

Comparisons of minimum and maximum values within the Gold Butte data also seem to parallel the consistently higher buckwheat habitat medians for variables such as total C, inorganic C, available Fe, Ni, Ca, and lower medians for available P and CEC (e.g., Tables 3-9b, 3-10b, and 3-15b to 3-20b).

Comparisons among buckwheat habitat, potential habitat, and non-habitat indicate that visual observations were less effective at predicting changes in soil chemical and physical characteristics that might control buckwheat distribution. There were many significant differences between buckwheat habitat and potential habitat, and there were also many differences between potential habitat and non-habitat. Some of these characteristics mirror trends between buckwheat sites and non-buckwheat sites whereas others do not. When comparing buckwheat habitat to potential habitat, we found that habitat consistently contained more total C, inorganic C, $CaCO_3$, and had a lower CEC (Table 3-49b). Other significant results were found less often: habitat had higher pH values, available Fe, and clay (in C horizons), higher available Ca & Ni (in A horizons), lower available P (in C horizons), lower available Co & Mn (in A horizons), lower moisture (in C horizons), and lower Cl (in B horizons) (Table 3-49b).

Differences between potential habitat and non-habitat were many: potential habitat had lower pH values and sand, and had greater total C, inorganic C, $CaCO_3$, available Ca, Mg (B horizons only), Fe, Ni, B, As, Cu (A horizons only), SO_4, moisture, EC, Cl (B horizons only), NO_3, total N, clay (A horizons only), and silt (Tables 3-50b). Currently, there are no accurate methods to measure moisture in soils containing gypsum and other soluble salts. In soils such as these, moisture estimates are generally greater whenever hydrous minerals (i.e. gypsum) are present. Thus, increased moisture values in this study most likely indicate that hydrous salts are present and do not accurately reflect air-dry soil water contents. Further support for this interpretation lies in the common association of higher moisture with increased SO_4, Cl, and/or EC.

While differences between buckwheat and non-buckwheat sites are similar at both Coyote Springs and at Gold Butte, the other habitat groupings reveal greater complexity at Gold Butte. This complexity likely reflects the proportionately greater soil and surficial geologic differences between habitat classes at Gold Butte versus Coyote Springs.

This point is supported by the fact that sulfate was found to be a significant variable in C-horizons of buckwheat sites versus non-buckwheat sites at Gold Butte (e.g., Tables 3-14b and 3-23b). We interpret this as a logical result given the narrow distribution of buckwheat within Qea swales between outcrops of gypsum bedrock (Chapter 2). Depth to bedrock is shallow in buckwheat sites; in comparison, non-buckwheat sites are dominated by sandier, thicker Qa alluvium that extends to depth (1-2 meters or more). Therefore an important controlling factor for buckwheat distribution here may not be SO_4 at all, but depth to a restricting layer where water may be more available to shallow roots.

Bitter Spring Trends

Bitter Spring was the most unique of the three study areas. Statistical analysis of data from Bitter Spring sites reveals few significant variables consistently shared with either Coyote Springs or Gold Butte. Moreover, the variables that are indicated as statistically different are less pervasive between different groupings or comparisons of the Bitter Spring data. Whereas $CaCO_3$, total carbon, inorganic C, available Ca, and Mg typically might *all* be significant at the same time in any one Coyote Springs or Gold Butte comparison, only *one* of those variables might prove significantly different in a Bitter Spring test. The most frequently significant variable at Bitter Spring was available boron, which was lower in buckwheat sites versus other classes. While the trends for the other significant variables found at the other two sites still hold true at Bitter Spring, what differs is that the buckwheat and non-buckwheat sites at Bitter Spring are more similar to each other than they are in Coyote Springs or Gold Butte, and therefore they do not show up as being statistically significant. Results do broadly agree with the other sites in that greater inorganic C, $CaCO_3$, available Ca, Ni and lower available Co were also found in Bitter Spring habitat sites.

Buckwheat sites were significantly different from non-buckwheat sites at Bitter Spring in the following characteristics: lower pH values, available Co (whole profile and B horizons), lower available B (in all comparisons except A horizons), lower NO_3 (whole profile and A horizons), lower Na (in B horizons), lower available Mo (in C horizons), higher available Ni, Ca, and total C (in C horizons), higher inorganic C and $CaCO_3$ (in A and C horizons), and higher SO_4 and moisture (in B horizons) (see Table 3-48c).

Comparisons of profile and horizon minima and maxima at Bitter Spring revealed, overall, significantly higher $CaCO_3$, inorganic C, available Ni, and Zn in buckwheat sites versus non-buckwheat, and significantly lower pH, available Cl, B, Co, Na, and NO_3 (e.g., Tables 3-9c, 3-10c, and 3-15c to 3-20c). A horizons generally exhibited the fewest numbers of significant variables, while C horizons exhibited the most. These results were similar for comparisons of minimum and maximum values between habitat and potential habitat (Tables 3-25c, 3-26c, and 3-31c to 3-36c).

Significant variables between buckwheat habitat and "potential" habitat included: greater available Ca and Ni (in all comparisons except B horizons), lower B (in all comparisons except A horizons), lower available Co (in whole profile and A horizons), lower available Mg & Na (whole profile and B horizons), lower pH & CEC values (in C horizons), greater C, inorganic C, $CaCO_3$ (in C horizons) and greater clay (in A horizons) in buckwheat habitats (Table 3-49c).

There was almost no overlap between the Bitter Spring data and the other sites when it came to comparisons between potential habitat and non-habitat. Potential habitat contained greater sand and moisture (in whole soil and A horizons), greater EC values (A horizons), greater CEC values (in all comparisons except A horizons), lower clay (in all but C horizons) and lower silt (in whole soil and A horizons) (Table 3-50c). In some cases the trends at Bitter Spring were reversed relative to the other study areas. As an example, mean profile sand percentages were higher in potential habitat than non-habitat sites at Bitter Spring, but lower in Gold Butte potential habitat sites. Out of the three study areas, visual observations to predict buckwheat habitat were least useful in Bitter Spring.

Trends across all study areas (all sites combined)

Results from comparisons of all of the data across all of the study areas combined indicate that, compared to non-buckwheat sites, buckwheat/habitat sites contained: greater total C, inorganic C, and $CaCO_3$, more available Fe & Ni, lower available P (in all correlations), greater Ca (in all correlations except B horizons), lower N (in whole profiles and B horizons), greater Mg (in whole profiles and A horizons), greater K (in whole profiles), greater moisture (in B horizons), lower available Co (in whole profiles and A horizons), lower available Mn, Cu, Zn (in A horizons), lower Cl (in B horizons), and lower pH values (in B horizons) (Table 3-48d). Comparisons of profile and horizon minimum and maximum values corroborate these trends.

Compared to potential habitat, buckwheat/habitat sites contained greater total C, available Fe & Ni, and lower available P (in all correlations), greater inorganic C, $CaCO_3$, Ca (in all correlations except B horizons), lower available Co & Cu (in whole profiles and A horizons), lower available Mn & Zn (in A horizons), lower total N (in whole profiles and B horizons), lower NO_3 (in whole profiles), greater available K (in whole profiles), lower Cl (in B horizons), lower moisture (in C horizons), and higher clay (in A horizons) (Table 3-49d).

Mann-Whitney results from potential habitat to non-habitat comparisons across all study areas (Table 3-50d) were distinct from the other group comparisons, demonstrating that potential habitat contained greater moisture in all comparisons, greater SO_4, Cl, and NO_3 (in whole profile and B horizons), greater EC and lower pH values (in all comparisons except C horizons), lower K (in A horizons), greater CEC (in C horizons), and greater available Ca, Fe, and Ni (in A horizons). The lower pH, and higher SO_4, Cl, NO_3, EC and moisture values suggests higher salinity in potential habitat sites due to the greater dominance of evaporites and related sedimentary rock strata (map units Tss and Tgyp). In comparison, non-habitat sites were dominated by alluvium or colluvium (Qa4 or Qa5 through Qa1).

Interpretations

The worldwide paucity of published research into non-agricultural arid soil properties and native plant requirements poses a major obstacle to interpreting our results. Despite this limitation, we note that commonly recurring significant results in this study do allow several major inferences. Our results suggest that buckwheat favors soils both rich in $CaCO_3$ and that contain more available Fe, Ni, Ca, and/or Mg. The significantly lower amounts of available P, Co, Mn, Cu, and Zn in buckwheat habitats are likely also very important, particularly in relation to competition with other plants.

Soils that contain $CaCO_3$ *and* have highly available Fe are extremely rare and only occur where specific combinations of parent materials and pedogenic processes operate in tandem. This rarity may, in part, explain the localized and infrequent occurrences of buckwheat. However, if Fe availability were the only determining factor, other plants should also be thriving on, or restricted to, these soils. At present, we have no data to conclusively suggest that this is the case, however, we do note that the restricted habitat conditions of *Arctomecon californica* do sometimes overlap *E. corymbosum* var. *nilesii* (Drohan & Merkler 2009; field observations from this study). We also note that buckwheat was often the dominant species, and more rarely the sole species, within habitat sites at Coyote Springs. Thus, some additional factor, or set of factors likely affects vegetation dynamics in buckwheat habitats. Buckwheat is also apparently able to tolerate low available P, Co, Mn, Cu, and Zn, which may also either limit competition from other plants, or drive some other critical ecological process. Lastly, some buckwheat sites had significantly more As. Although As was not significant at all study areas, it may be an additional complicating edaphic or ecological factor. These parameters describe at least partly, the abiotic factors involved in controlling the rarity of suitable environments for buckwheat. Although much further research is needed, interpretations are presented below regarding the geologic factors and soil processes most likely to be creating the correlations found in this study.

Because greater $CaCO_3$, inorganic C, and total C, and available Ca & Mg, all result directly from increased soil $CaCO_3$, the strong correlations between these variables and buckwheat distributions suggest that *E. corymbosum* var. *nilesi* favors soil habitats high in $CaCO_3$. In fact, some buckwheat sites were very strongly restricted to highly calcareous geologic deposits (e.g. Las Vegas Formation in Coyote Springs – see Chapter 2). In such arid, calcareous, sparsely-vegetated soils, percent $CaCO_3$ often determines total C because inorganic C is the largest source of soil C (e.g., Tables 3-51a to 3-66a). This holds true except for rare desert wetland or spring environments, or under plant canopies, where organic C can become an important component of the soil's total C (see Chapter 4). Similarly, available Ca and Mg are strongly controlled by soil and lithological carbonate. In Mojave soils, available Ca is primarily a function of $CaCO_3$ and gypsum, whereas Mg is commonly derived from dolomite, high Mg-calcite or Mg-rich limestone. XRD results suggest that Mg in our study areas is primarily derived from carbonate minerals enriched in Mg (Table 3-6). Mg was statistically significant slightly less often than Ca, but this is expected because dolomite not only contains both Ca and Mg, but also is typically less abundant than calcite in parent materials and more variable in composition. Moreover, pedogenic $CaCO_3$ generally is composed of low-Mg calcite (~3-4% Mg).

The ratio of Ca to Mg is sometimes considered more important to plant availability than total Mg because Mg is less tightly held in the soil than Ca (Brady & Weil, 2008). This relationship is not well-studied for non-agricultural, calcareous soils, but in general it is thought that plants can meet their Mg requirements with Ca:Mg ratios less than 15:1 (Brady & Weil, 2008). Although, Lafuente et al., (2001) suggest that grasses and shrubs in northern Spain may be Mg-deficient at Ca:Mg ratios greater than 10:1. Therefore, we compared the Ca:Mg ratios of soil horizons and whole profiles in buckwheat sites versus non-buckwheat sites (Tables 3-44 to 3-47). Coyote Springs produced no significant relationships between Ca:Mg ratios in buckwheat sites versus non-buckwheat sites and the ratios varied between approximately 1:1 and 9:1 (Table 3-44a to 3-46a). In contrast, at Bitter Spring, buckwheat site Ca:Mg ratios were significantly higher (nearly 30:1) in whole soil profiles, B horizons, and C horizons (Tables 3-44c to 3-47c).

This indicates that buckwheat sites are more deficient in Mg as compared to non-buckwheat sites. At Gold Butte, we found significantly different Ca:Mg ratios in the whole profile and in C horizons. In both cases, the lower buckwheat Ca:Mg ratio indicates that there is more available Mg as compared to non-buckwheat sites. Some non-buckwheat sites have ratios as high as 118:1 (Tables 3-44d & 3-46d), suggesting that some of these soils are likely very Mg deficient. Ca:Mg ratios were not statistically significant when data from all sites were combined (Tables 3-44d to 3-47d), however, absolute values ranged from very low to extremely high. This indicates enormous variability in plant-available Mg across all study areas.

Worldwide, arid soils ubiquitously contain $CaCO_3$, either as a component of the parent material, whether primary or blown in as eolian dust, and/or as a result of pedogenic accumulations in arid to semi-arid climates. Accumulation of $CaCO_3$ over time is one of the most important pedogenic processes occurring in arid soils is (Gile et al., 1981). Dust and rain add copious amounts of Ca^{+2} ions to arid soils (Gile et al., 1966, 1981), while plant root respiration pumps CO_2 into the soil. Ca^{+2}, H_2O, and CO_2 combine to form $CaCO_3$, which accumulates in the subsurface because arid climates lack the water necessary to leach it from the soil. This lack of leaching in arid soils also prevents losses of $CaCO_3$-containing parent materials. The net result is that nearly all soils in arid and semi-arid climates contain some amount of $CaCO_3$. Soils on older landforms and those that form in $CaCO_3$-rich parent materials, may contain so much $CaCO_3$ that it controls nearly all of their physical and chemical properties (e.g. Brock and Buck, 2009). Consequently, high $CaCO_3$ content alone must not determine habitat viability for buckwheat, otherwise, buckwheat would be far more prevalent in Clark County, and far more widely distributed within the study areas. Many of the "non-habitat" soils contain large amounts of $CaCO_3$, and a few buckwheat sites contain relatively low amounts of $CaCO_3$ (< 10%). Therefore, the results of this study suggest that several processes working in tandem provide suitable habitat for buckwheat, but that it is likely that $CaCO_3$ is one of the most important factors for defining buckwheat habitat.

Calcite and/or other carbonate minerals exert a strong control on soil characteristics including but not limited to pH and micronutrient availability. The normal pH of calcic soils at equilibrium with atmospheric CO_2 is ~8.3 (Brady & Weil, 2008). Increased root respiration (soil P_{CO2}) (Marion et al., 2007) and/or the presence of organic matter can lower pH values (~ 7.0 to 8.0), whereas the presence of Na_2CO_3 can significantly raise pH values (~ 8.5 to 10.5) (Brady & Weil, 2008). In this study, pH values averaged for all horizons and across all sites ranged from approximately 6.6 to 8.3 using saturated paste, and 7.7 to 9.0 using 1:1 H_2O (typically, 1:1 H_2O > 1:2 $CaCl_2$ > saturated paste) (Tables 3-2 to 3-5). This range differs relatively little from the pH range found in non-habitat and "potential" habitat, (i.e. non-buckwheat sites). When considering only the horizon-specific data, buckwheat median pH values typically fall within 7.7 to 8.3. Non-buckwheat or non-habitat sites varied more widely in pH, with some medians lower, and others higher than the buckwheat soils. This, too, is consistent with the surficial geology of the study areas. Soils formed on evaporitic deposits containing Na will exhibit higher pH, whereas soils developed in sandy, well-drained alluvial terraces or washes should accumulate fewer salts, may have higher organic matter contents due to the moisture regime, and thus can have lower pH values. Surfaces in which gypsum or other neutral salt minerals dominate may also have a lower pH (generally < 8.0). In summary, while buckwheat habitats fall within a set range of pH values consistent with calcic soils, non-buckwheat sites display a broader and more variable range of pH conditions indicative of many different soil properties.

Many nutrients become insoluble and unavailable to plants at pH values above 7.0, therefore plants growing in arid soils often experience deficiencies and/or use adaptive mechanisms to survive in these environments. The essential nutrients that were found to be statistically significant in this study and that become increasingly unavailable with increased pH values and $CaCO_3$ are: Zn, Cu, Fe, Mn, Co, K, P, Ni and B. Of these, Zn, Cu, Mn, Co, P and sometimes B follow the predicted behavior of being less available in the buckwheat habitats where $CaCO_3$ is increased (Tables 3-8 to 3-43 & summary Tables 3-48 to 3-50). However, the results for available Fe and Ni do not follow the expected trends and were found to be more available in the buckwheat soils (Tables 3-8 to 3-43). This result is completely unexpected and is discussed in detail later.

The availability of Zn, Cu, Fe, and Mn is so reduced in soils with pH values above 7.0, that these nutrients commonly cause deficiencies in plants not adapted to alkaline soils (Brady and Weil, 2008). In addition, calcareous soils have another mechanism that also decreases the availability of Cu, Zn, and Mo. These nutrients are also readily adsorbed by carbonate minerals (Mg-carbonates especially absorb Zn) and Fe or Mn oxides, which are also very common in alkaline, calcareous soils (Brady & Weil, 2008; Kabata-Pendias, 2011). Mn is highly insoluble at alkaline pH and under well-aerated, oxidizing conditions; and the lack of complexing organic compounds can also reduce Mn availability (Kabata-Pendias, 2011). Additionally, Fe and Mn are antagonistic and the increased available Fe at buckwheat sites can inhibit the uptake of Mn. Therefore, the lower available Mn at buckwheat habitats may inhibit other types of vegetation in these areas – and buckwheat may either have lower Mn requirements or may have adaptive mechanisms to grow well in soils high in Fe and low in Zn, Cu, and Mn.

Worldwide, K is one of the most limiting elements for plant growth – usually after N and P (Brady & Weil, 2008). Potassium plays an important role in helping plants adapt to environmental stresses, including drought, insects, fungal diseases and extreme temperatures (Brady & Weil, 2008). Potassium is derived from weathering of K-bearing minerals, particularly micas and feldspars. Once in solution, if not leached or taken up by plants, it commonly is held on the exchange sites of soil colloids, or is fixed in silicate clay minerals (Brady & Weil, 2008). Higher soil pH values tend to cause lower K availability due to increased fixation in colloids. Moreover, high levels of Ca^{+2} and Mg^{+2} in soils interfere with plant uptake of K^{+}. In this study, available K is significantly greater for buckwheat sites for C horizons at Gold Butte, for the weighted B horizons at Coyote Springs, and in the weighted whole soil profiles for all sites combined and Coyote Springs (Table 3-48). The ratio K/(Ca+Mg) is considered a more accurate indication of available K than elemental measures alone (Brady & Weil, 2008). Using this ratio, we found that available K was significantly *lower* for buckwheat sites in A horizons at Coyote

Springs, Gold Butte, and in all sites combined (Table 3-45). Therefore, the higher availability of Ca and Mg at buckwheat sites causes greatly reduced K availability and may be a critical limitation for non-buckwheat plant species.

Phosphorus is also increasingly unavailable with increased pH because it precipitates as Ca & Mg phosphate minerals that are not available to plants (Shariatmadari et al., 2006). Therefore, not surprisingly, P was less available in the buckwheat sites (see Tables 3-48d & 3-49d), which also contain increased $CaCO_3$, and available Ca, and Mg. Although it has been demonstrated that $CaCO_3$ can directly prevent the uptake of phosphorus by plants (Lajtha & Schlesinger, 1998), many plants, bacteria, and fungi have adapted mechanisms to make P more available in these soils by excreting organic acids that dissolve these phosphate minerals and allow uptake (Brady & Weil, 2008). It may be that in these low available P soils, Las Vegas buckwheat has an adaptive strategy that allows it to extract P where other plants cannot, or that it has lower P requirements. To make the issue even more complex, increased arsenic uptake is one side effect for plants growing in P-deficient soils (Baxter et al., 2008).

Arsenic is phytotoxic (Sheppard, 1992) and its chemical behavior is largely similar to that of P in soils (e.g. Fitz & Wenzel, 2002; Sturchio et al., 2011). Drohan & Merkler (2009) found mean arsenic concentrations of 412 mg kg^{-1} in *E. corymbosum* tissues from North Las Vegas, Nevada, potentially corroborating the significantly greater buckwheat habitat arsenic values in B horizons at Coyote Springs and A horizons at Gold Butte (Tables 3-48b 3-48a). Although arsenic did not differ significantly between buckwheat and non-buckwheat sites at Bitter Spring, the mean available arsenic was higher in habitat compared to non-habitat, but lower than potential habitats (Table 3-4). Correspondingly, mean P was also lower at buckwheat sites (Table 3-4). Therefore buckwheat habitats at Bitter Spring have higher arsenic and lower P compared to non-habitats. Because this situation occurs at all three study sites, it is possible that buckwheat has either a greater tolerance to arsenic uptake or decreased P requirements relative to other native plants in the region, and therefore is able to thrive in the habitats studied.

Boron is also commonly unavailable in arid soils, because it is increasingly adsorbed on Fe-oxides and silicate clays with increasing soil pH. In addition, plants that grow in soils with high Ca^{+2}, tend to need increased amounts of boron which further increases the potential for deficiencies (Brady & Weil, 2008). Although the levels between B deficiency and B toxicity are fairly narrow, B deficiency usually dominates in alkaline and calcareous soils. Soils developed on clay-rich marine or evaporite deposits are likely to contain high B contents (Shani et al., 2002; Kabata-Pendias, 2011), and the borate-rich mineralogy of the Thumb Member of the Horse Springs Formation is a perfect example of such substrates (Castor, 1993; Beard et al., 2007). As previously stated, the lack of research on nutrient dynamics in arid, non-agricultural soils makes interpretation of elemental data difficult, and boron is no exception. Agriculturally viable soils generally have total B values between 2 – 100 mg/kg (Atullah et al., 1999). As expected for non-agricultural soils, mean boron levels in this study were much lower. Boron was significantly lower in buckwheat sites at Bitter Spring and thus potentially important (Tables 3-48c & 3-49c). In contrast, available boron was significantly greater in weighted comparisons of B horizons at

Coyote Springs (Table 3-48a), and not significant at Gold Butte or in all sites combined (B is absent in Table 3-48b&d). These mixed results suggests that available boron may not be a direct factor in buckwheat distribution, at least pertaining to subsurface processes.

Cobalt in soils is typically sourced directly from weathered parent material, especially mafic or ultramafic igneous or metamorphic rocks, and is essential for fixing N in microorganisms (Kabata-Pendias, 2011). Cobalt is strongly absorbed to Fe & Mn oxides and this behavior is increased at higher pH (Han et al., 2002; Kabata-Pendias, 2011). Cobalt is also commonly bound or fixed to phyllosilicate clays (Brady and Weil, 2008). Cobalt deficiencies commonly occur in soils where the original geologic materials are low in Co, and in which Fe or Mn oxides and silicate clays are abundant. It is likely that geologic factors (geochemistry of parent materials, abundance of Fe & Mn oxides, and silicate clays) are primary controls behind lower available Co in buckwheat sites. While Co is known to be essential for N fixation by microorganisms, its role in higher plants is not yet certain (Pilon-Smits et al., 2009; Collins & Kinsel, 2011; Kabata-Pendias, 2011). Cobalt may help higher plants better resist drought and pathogens (Pilon-Smits et al., 2009). Other plants may have greater Co requirements than buckwheat and therefore do not grow in buckwheat habitat, or buckwheat may have mechanisms to increase Co uptake in these soils that other plants do not have or cannot utilize as successfully. Cobalt is thought to be absorbed into plant roots through passive transport, and that the same membrane carriers are used for Ni and possibly Fe (Pilon-Smits et al., 2009). Plants grown under reduced Fe availability were found to increase Co in their tissues because enhanced acidification of the rhizosphere increased uptake of Fe, as well as Co, Mn, and Zn (Baxter et al., 2008). Because so little is known about buckwheat nutrient uptake capabilities, requirements, tolerances, and/or toxicities, we can only speculate on possible parameters for buckwheat habitat based on our results.

Nickel is an essential element for plants, but most published research focuses on Ni toxicity in contaminated sites (Brady & Weil, 2008). Less is known about Ni deficiencies or specific plant requirements (Phipps et al., 2002). Except in anthropogenically polluted soils, Ni is derived from the parent material weathering, with greater abundances in basic igneous rocks and lesser amounts in sedimentary rocks (Kabata-Pendias, 2011). Nickel is strongly controlled by soil pH, and becomes unavailable with increasing pH (Tye et al., 2004). Nickel can also be absorbed to clays, and Fe or Mn minerals. Few data have been reported for available Ni concentrations in alkaline, calcareous soils. However, available Ni values in this study are an order of magnitude lower (Tables 3-2 to 3-5) compared to soils on non-ultramafic parent materials in Morocco that have reported values of 1 to 1.8 mg kg-1 (Ater et al., 2000). Because sedimentary parent materials, like those in our study, do contain lower amounts of Ni, it is difficult to know whether the available Ni in this study can be considered normal. Our results did show significantly greater amounts of available Ni in buckwheat habitats as compared to non-buckwheat sites in all areas (see Table 3-48d). Nickel was significant less often in soils at Bitter Spring (Tables 3-48c and 3-49c), but absolute amounts of available Ni at Bitter Spring are very similar to soils in the other study areas. This suggests that there is similar overall Ni availability at Bitter Spring, but that there are no significant differences between buckwheat and non-buckwheat sites there. Overall, the repeated significance of Ni in buckwheat sites versus non-buckwheat sites suggests that it may be an important variable in defining buckwheat habitat. Evidence for decreased Ni uptake by plants in the presence of available arsenic (Norton et al., 2010) makes understanding how Ni might influence buckwheat habitat even more complicated.

There was consistently more available Fe in buckwheat sites versus non-buckwheat sites in nearly all comparisons (Tables 3-48 and 3-49). This was unexpected because Fe deficiency is normally limiting in arid, calcareous soils. Iron can be a major component of the soil, but it is tied up in minerals that are insoluble in these environments. The higher available Fe was even more unexpected because buckwheat sites contained significantly more $CaCO_3$. Increased available Fe can inhibit the uptake by plants of Mn and other micronutrients. Normally, plants faced with low available Fe respond by increasing acidification of the rhizosphere (Marschner & Romheld, 1994; Kim & Guerinot, 2007), which not only increases the uptake and accumulation of Fe, but also Mn, Co, Zn, and Cd (Baxter et al., 2008). If the reverse holds true, and plants are growing in soils where Fe is relatively high (such as in our study), then it might be plausible that Mn, Co, and Zn may be even more difficult to obtain without also accumulating problematic quantities of Fe. Drohan and Merkler (2009) found high levels of Fe in buckwheat tissues in North Las Vegas, suggesting that buckwheat may either require increased Fe, or may tolerate increased Fe uptake in order to obtain vital Mn, Co, and Zn. In another study, Oyonarte et al. (2002) found consistently higher concentrations of Fe and lower concentrations of Mn in the rhizospheres of gysophile plants compared to nongypsophile plants. These complex relationships indicate the need to perform buckwheat tissue analyses in order to better interpret the chemical data of this study.

The lack of research on soil chemistry of highly calcareous soils hinders our ability to interpret the magnitude and ranges of available Fe in our study. Oyonarte and Sanchez (2002) summarize some available Fe contents for gypsiferous soils, and report values between 2.5 and 4.5 ug g^{-1} and mean values of 3.1 ug g^{-1} (gypsiferous soils) and 2.5 ug g^{-1} (non-gypsiferous soils). Soils in this study have mean values that are an order of magnitude greater (Tables 3-2 to 3-5). These very high Fe concentrations indicate the need for us to consider additional factors that could be affecting our results.

All methods to measure plant available nutrients are designed to mimic the various biochemical processes that plants use to gain necessary nutrients from the soil, however, no standard method currently exists to measure plant available ions specifically for arid soils. In general, there is a problematic lack of accurate laboratory procedures to measure arid soil chemical and physical characteristics because arid environments were, until recently, seen as unimportant and/or have received little scientific study (compared to more humid agricultural or forest lands). Arid soils are difficult to analyze properly because they commonly contain or are entirely comprised of soluble mineral phases ($CaCO_3$, gypsum, and other soluble salts) that can readily dissolve during chemical or physical analysis. Consequently, the resulting data may or may not accurately reflect “real” soil characteristics. Moreover, nearly all traditional soil laboratory methods purposely remove $CaCO_3$ and soluble salts so that they do not interfere with results (Soukup et al., 2008). Clearly, removing the very materials that make up an arid soil and define its physical and chemical properties will not yield accurate or meaningful data, and will complicate interpretation of key soil processes. Most traditional soil laboratory procedures cannot be applied to arid soils without fundamental problems, especially if applied without due consideration of how the target variable is influenced by arid soil genesis.

Given these challenges, the Mehlich No. 3 method (Burt, 2004, method 4D6) was chosen to measure available nutrients in this study because it was deemed most likely to accurately represent nutrient dynamics in the study areas, and because it provides a basis for comparison between this study and other published soil data. The Mehlich No. 3 method uses solutions of acetic acid, ammonium nitrate, nitric acid, ammonium fluoride and EDTA (see: http://www.ncagr.gov/agronomi/meh3.htm) to assess nutrient pools including the soil solution, exchangeable ions, and portions of the adsorbed or complexed ion pool (Cancela et al., 2002). Research regarding the Mehlich No. 3 method has primarily been done on neutral and acidic soils used in agriculture. However, some studies have tested the use of the Mehlich no. 3 method for soils that have alkaline pH values and carbonate (e.g. Schmisek et al., 1997; Zbiral, 2000; Cancela et al., 2002). Overall the Mehlich no. 3 method has been reported to be very effective in measuring plant-available nutrients in alkaline, neutral and acidic soils but the vast majority of examples of alkaline soils are those with significantly less calcium carbonate than in our study (e.g. Mallarino, 1997; Schmisek et al., 1997; Cancela et al. 2002; Vidal-Vazquez et al., 2005; Kabata-Pendias, 2011). Most studies using the Mehlich No. 3 method have been performed specifically to measure available P for soil management purposes on agricultural soils. These studies compare the results of older methods to the Mehlich No.3 method to determine which methods give the most consistent and comparable data. Schmisek et al. (1997) reported that the Mehlich No. 3 method correlated well with other soil methods for P, K and Zn values in North Dakota soils with pH values 7.0 to 8.3, but did not correlate well for Fe and Mn. Novillo et al. (2002) reported that the method may overestimate Zn availability in calcic soils. Most researchers do not attempt to explain why different methods yield different results, but alkaline pH values nearly always produce poor correlations among different methods (Mallarino, 1997; Zbiral, 2000; Cancela et al., 2002).

Based on this information, we hypothesized that the unexpected correlation of increased Fe with high-$CaCO_3$ buckwheat soils could best be explained by acid dissolution during the Mehlich No. 3 procedure. We believe these acids preferentially dissolved Fe, either from within the crystalline structure of Fe-bearing carbonate (e.g. Ankerite – see XRD Tables) from within the lattices of more soluble minerals, or off of adsorption sites on mineral surfaces. As intended by the method, this artifact of the laboratory process may actually mimic processes acting in nature. It is widely known that plants have several mechanisms to increase mineral dissolution and thereby gain essential nutrients (Marschner, 1995). Dissolution of $CaCO_3$ by plants in soils is well known and actually utilized as a mechanism to remediate saline-sodic and sodic soils by replacing Na^+ on the exchange sites with Ca^{+2} (Qadir et al., 2007). Because this method was used consistently on all soil samples, and because it likely mimics acidifying processes in the rhizosphere, we feel that the statistical relationships presented in this study are accurate. The absolute values (magnitude) of available nutrients, however, may or may not reflect values in the rhizosphere, which are both site and species dependent.

Spearman’s rho correlation tests were intended to help elucidate what processes might cause the significant geochemical relationships identified in this study. Specifically, because of the consistent, significantly higher $CaCO_3$ and available Fe in buckwheat sites, we performed correlation tests for these two variables against all measured chemical values, and considered data grouped by study area, profile, and genetic horizon (Tables 3-51 to 3-110).

When comparing data for all study areas combined, buckwheat habitats, non-habitats, and potential habitats all exhibited moderate to strong positive correlations between available Fe and $CaCO_3$ (see Tables 3-63 to 3-66). In fact, the strongest correlations were found in the potential habitat sites (Table 3-66). When comparing specific sites, the correlations between available Fe and $CaCO_3$ varied, but were all moderate to strongly positive. Additionally, Ni was always strongly correlated to Fe, suggesting that these elements may share a common or similar mineral source(s). XRD data reveal dolomite and/or ankerite as common soil components (Table 3-6). These minerals reflect a variable range of substitution for Ca within the carbonate crystal lattice – in dolomite, ($CaMg(CO_3)_2$) Mg substitution dominates, while in Ankerite ($Ca(Fe,Mn,Mg)(CO_3)_2$), Fe^{+2}, Mn^{+2}, and Mg^{+2} all substitute variably for Ca^{+2}. These data suggest that carbonate minerals, likely derived from Paleozoic bedrock in the upper watersheds surrounding each study area (Beard et al., 2007; Chapter 2) constitute the most likely source of Mg, and sometimes, Fe in our study areas.

Variability in the data between different sites and soil horizons suggests that there may be different mineral phases and/or soil processes supplying Fe (and Ni) to variable degrees (Table 3-6). Relationships between available Fe & Mg, and Fe & Ca were investigated as a way to estimate potential mineral sources of available Fe. Based on XRD data, we assume that the major sources of Mg in all soils in this study are carbonate minerals (e.g. dolomite, ankerite, high Mg-calcite). In contrast, available Ca may come from many sources including carbonate minerals, gypsum and other sulfate minerals, and possibly other soluble salts. Therefore strong correlations between Mg and Fe could suggest that the primary mechanism supplying available Fe is the carbonate mineral (e.g. ankerite) dissolution, whereas a low or negative correlation of Mg & Fe could suggest Fe (or Mg) is being sourced from other minerals. Geochemical data on the Fe-and Mg-containing minerals is needed to support this assumption, but given the current dataset, this is a reasonable interpretation. Additionally, we tested for correlation between available Fe and variables associated with gypsum or other soluble salts (SO_4, electrical conductivity, Na, Cl, NO_3) to elucidate other possible mineral controls on Fe availability.

At Coyote Springs, available Fe strongly correlated to SO_4 and EC in B horizons and exhibited a strong negative correlation to Mg. These correlations are not present in non-habitat or potential habitat sites and suggest that the greater available Fe in habitat may be due to direct or indirect processes related to the presence of soluble salts. Negative correlation to Mg also suggests that available Fe is not being derived from Mg-carbonate minerals (e.g. ankerite), and/or that it is being derived from other (as yet unidentified) Fe-bearing minerals. The strong negative correlation between Fe and Mg suggests that one or more processes are occurring in which Fe is preferentially going into solution, whereas Mg is not. This would explain the increased available Fe in these horizons at this site. Similarly, available Fe strongly correlated to soluble salts in all habitat classes in the Bitter Spring area, again suggesting that Fe availability is tied to the presence and amount of soluble salts at this study area as well. In fact, it may be the wide distribution of soluble salts at Bitter Spring, both in buckwheat and non-buckwheat habitats, that renders Fe so available at all sites here such that there were no significant differences in available Fe between habitat classes (Fe is absent in Tables 3-48c to 3-50c). Additionally, Fe displayed a strong negative correlation to Mg in the A horizons of buckwheat habitats at Bitter Spring, which suggests that Mg-carbonate minerals are not a likely source for soluble Fe in this horizon and/or one or more processes are operating which increase Fe solubility and decrease Mg. This changes abruptly in the B horizon, where available Fe is strongly correlated to Mg (Table 3-92b). However, this B horizon is one of the rare instances where buckwheat/habitat sites exhibited significantly increased SO_4 as compared to non-habitat (Table 3-48c). Combining these results suggests that soluble salts play an important role – either directly or indirectly – in providing increased available Fe at Coyote Springs and Bitter Spring buckwheat habitats.

Buckwheat habitats at Gold Butte have both more $CaCO_3$ and available Fe in A and C horizons and more $CaCO_3$ in B horizons (Table 3-48b). Although not significant in B horizons, the absolute values of available Fe are still very high. Available Fe did not correlate with soluble salts in the soil data (e.g., Table 3-56b), but there was a strong negative correlation to EC in the surface data (see Chapter 4). Despite the lack of correlations between Fe and soluble salts, soils at Gold Butte exhibited similar ranges of available Na, Cl, SO_4, Fe, Mg, and Ni, although slightly lower minimum values overall (Tables 3-2 to 3-5). All habitat classes at Gold Butte have strong positive correlations between Fe and $CaCO_3$, suggesting that Fe-carbonate minerals probably are the most likely source for available Fe.

Overall, strong positive correlations exist between Fe-Ni, Fe-Mg, Fe-As, Fe-$CaCO_3$, and Fe-K. These associations as well as the mining and mineral exploration in this region indicate that parent materials in these soils have likely undergone some amount of hydrothermal alteration and/or diagenesis. More research is needed to determine the mineral sources(s) of the available nutrients at these sites, but diagenic and hydrothermal alteration commonly increase Fe, Ni, Mg, As, other heavy metals, and K in carbonate phases (e.g. Boyle & Jonasson, 1973; Beratan, 1999). Less clear are the soil-processes that might be providing a mechanism for dissolution of Fe-Mg-carbonate minerals.

Carbonates in arid environments are highly insoluble because soil solutions are saturated or supersaturated in $CaCO_3$ (e.g. Marion et al., 2007). Due to the common ion effect, Ca-phosphate minerals are also highly insoluble, which helps explain why P has such low availability in calcareous soils. Dissolution of carbonate minerals in these soils is limited to only the very uppermost few centimeters where rainwater has not yet become saturated in $CaCO_3$ (McFadden et al., 1998). At greater depths, other mechanisms must operate in order to dissolve these minerals. The strong correlation of available Fe to soluble salt minerals (EC, Cl, Na, SO_4, NO_3) may indicate a mechanism in which these Fe-Mg-carbonate minerals can more easily dissolve in these highly calcareous soils.

The presence of gypsum and/or other soluble salt minerals, which are more soluble than $CaCO_3$ – especially in $CaCO_3$-saturated environments – may provide Fe through the following processes:

(1) Directly via salt mineral dissolution if Fe is absorbed on the mineral or present in the mineral structure.

(2) By providing microsites with lower pH in areas where soluble salts have concentrated. Such concentrations of soluble salts are a common phenomenon caused by pedogenic processes (e.g. Buck & Van Hoesen, 2002; Buck et al., 2006). Pore spaces in these areas are less likely to be in equilibrium with $CaCO_3$, therefore essentially diluting the effects of $CaCO_3$, and lowering pH.

(3) By concentrating water in these microsites. Salt minerals are hygroscopic and attract and hold water more tightly than surrounding silicate minerals (e.g. Buck and Van Hoesen, 2002, Dong et al., 2007). As such, areas of concentrated gypsum or other soluble salt minerals will have a greater ability to attract and hold pore waters as compared to other areas in the soil. Increased water will increase the potential for dissolution of soluble minerals. It will likely also attract roots and other organisms to these areas (e.g. Buck and Van Hoesen, 2002; Dong et al., 2007).

(4) By changing pore water chemistry to increase solubility of Mg-Fe-Ni-carbonate or other minerals. Concentrations of pedogenic salts will have pore waters saturated with ions from the surrounding salt minerals (ex; Na, Cl, Ca, SO_4, etc.). These pore waters are very likely to be significantly lower in bicarbonate, and therefore the common ion effect is less likely to be present such that Mg-Fe-Ni-carbonates will become more soluble. The common ion effect decreases the solubility of substances that have a common ion between them. So, for example, calcite ($CaCO_3$) will become less soluble in the presence of gypsum ($CaSO_4 \cdot H_2O$), because both minerals share the common ion: Ca.

Of these, the latter two mechanisms are probably the most likely to increase carbonate mineral dissolution and increase Fe (and Ni) availability in buckwheat habitats. The second mechanism (lowering pH) may also be important, especially if plants are able to utilize these microsites to decrease the energy required in obtaining necessary micronutrients through acid excretion or other mechanisms.

Halite (NaCl) is present in this study, and some soils have significantly high concentrations. Na commonly correlated to available Fe throughout all sites, and in some cases Na & Cl were strongly correlated. This is a strong argument for NaCl concentrations greatly enhancing the latter two mechanisms for Fe-Mg-carbonate mineral dissolution. It is much less likely that the first mechanism (salt mineral dissolution) plays a large role in this study area at least for Fe and Ni because Fe-Ni-sulfate minerals could only form in these soils if pyrite was present (e.g. Mrozek et al., 2006). Currently there is no data to suggest the presence of pyrite in the shallow surface soils studied herein.

Overall, without additional mineralogical data, the results suggest that at Bitter Spring and Coyote Springs, available Fe (and Ni) may be sourced either directly from, or as a result of soil environmental changes caused by, gypsum, halite, and/or other soluble salt mineral phases that enhance the dissolution of ankerite or other Fe-containing minerals. Results are less clear at Gold Butte for the subsurface horizons, but indicate that at the surface A horizon, available Fe (and Ni) are likely sourced from carbonate minerals. Interestingly, Gold Butte soils also exhibit a strong positive correlation between $CaCO_3$ and arsenic. If buckwheat plants are actively dissolving carbonate minerals to obtain their required Fe and Ni, they would also be exposing themselves to significantly increased available arsenic.

Interestingly, total N and/or NO_3 were found to be lower in buckwheat sites than in non-buckwheat sites for all areas except Gold Butte (Table 3-48). Nitrogen is a vital nutrient for plants and an essential component of protein (Brady & Weil, 2008). As such it can be a major limiting nutrient. We note that although total N was measured, our sampling procedures did not allow the cold storage and prompt analyses necessary for accurate measurement of NH_4. Thus, total N values in this study are probably lower than actual values because NH_4 could have volatilized prior to N analysis. Organic N is likely to be minimal except possibly for some A horizons with increased organic matter (especially under canopies - see Chapter 4). Nitrate is highly soluble and is usually quickly leached within the soil depending upon the amount of effective precipitation and soil infiltration/permeability (e.g. Graham et al., 2008). The lower values of total N and NO_3 in buckwheat sites may partially reflect the lack of well-developed vesicular horizons and desert pavement at buckwheat sites (see Chapters 2 & 4). Vesicular horizons restrict water infiltration and therefore significantly decrease leaching such that even highly soluble NO_3 salts can accumulate (Graham et al., 2008). Smaller plant canopy size, foliar density, or vegetation density within buckwheat sites may also reduce the recycling and availability of nitrogen in organic matter. These topics are addressed in greater detail in our analysis of soil surface characteristics (Chapter 4).

Lastly, water is considered to be the most limiting factor for vegetation in the Mojave Desert (Turner & Randall, 1989; Smith et al., 1997). As such, there is a high probability that soil moisture plays an important role in determining buckwheat habitat. As mentioned previously, gravimetric water content is overestimated when hydrous minerals (e.g. gypsum) are present. Moisture values in this study may also reflect bias due to the timing of sample collection, and the unusually high precipitation levels received in early 2010. Therefore, soil moisture trends in this dataset are not especially useful and cannot be used to interpret differences regarding buckwheat habitat. Observations of topography and surface crusts during geomorphic mapping (Chapter 2) suggest that in general, many buckwheat sites are likely to receive less effective precipitation versus non-buckwheat sites because of increased runoff and decreased infiltration. Additional research is needed to better quantify the changes in surface and subsurface hydrologic processes (e.g., infiltration rates, average water holding capacity, etc.) within buckwheat and non-buckwheat sites at each of the three study areas.

V. Conclusions

Chemical and physical analyses of 97 soil profiles at Coyote Springs, Bitter Spring and Gold Butte revealed that buckwheat habitats have significantly increased available Fe, Ni, Ca, Mg, and $CaCO_3$. Buckwheat sites also have significantly decreased available P, Co, Mn, Zn, Cu and N (or NO_3). Although Las Vegas buckwheat has been suggested as a gypsophile, we only found SO_4 to be significantly greater in two general cases: C horizons at Gold Butte and B horizons at Bitter Spring. Arsenic was found to be significantly higher in A horizons at Gold Butte and B horizons at Coyote Springs. Boron was found to be significantly greater in B horizons of Coyote Springs, and lower in all comparisons except A horizons at Bitter Spring. Ratios of K:(Ca + Mg), which are considered a better indication of available K, were found to be significantly lower in A horizons at Coyote Springs, Gold Butte, and for all study areas combined. Ratios of Ca:Mg are highly variable and suggest that Mg may not be an important indicator of buckwheat habitat.

Alkaline pH values and significant $CaCO_3$ in buckwheat habitat can explain the decreased P, Co, Mn, Zn, and Cu also found in these soils. These nutrients are strongly controlled by pH and/or absorption by $CaCO_3$. However, Fe (and Ni) in buckwheat habitats should also be less available. This increased availability is believed to be due to increased dissolution of Fe-carbonate minerals or minerals in which these elements are absorbed. Dolomite and ankerite are likely sources for the increased available Fe (and Ni). However, these minerals are not normally very soluble in these $CaCO_3$-saturated environments. Without additional mineralogical or plant tissue data, our results suggest that the high Fe (and Ni) may come either directly from, or as a result of soil environmental changes caused by gypsum and/or other soluble salt mineral phases that enhance carbonate mineral dissolution. Interestingly, Gold Butte soils also have a strong positive correlation between $CaCO_3$ and arsenic. Dissolution of carbonate minerals here may expose buckwheat plants to increased available arsenic.

In summary, because so little is known about buckwheat nutrient uptake capabilities, requirements, tolerances, and/or toxicities, we can only speculate on possible abiotic parameters for buckwheat habitat based on our results. The results of this study suggest that buckwheat: (1) prefers calcareous soils with higher available Fe, Ni, Ca, and Mg (although Ca:Mg ratios suggest Mg may not be an important indicator); (2) may be more tolerant of high arsenic; (3) may have lower requirements for P, Co, Mn, Zn, Cu, K, and N; or may have mechanisms, including symbiotic relationships with mycorrhizae or other organisms, to obtain these elements from soils in which they are poorly available. Although we found few significant correlations between buckwheat sites and SO_4, we believe that the higher availability of Fe in buckwheat soils is very likely due to localized occurrences of gypsum, halite and/or other soluble salts in the subsurface.

Therefore, although the data in this study do not support the interpretation of the Las Vegas Buckwheat as a gypsophile, gypsum, halite and other soluble salts in these highly calcareous soils may, through indirect processes, be critical for buckwheat survival.

VI. Recommendations

- We note that this study greatly benefitted from the inclusion of three spatially distinct study areas, and that our results would have been incomplete or potentially misleading had only one study area been selected. We encourage a similar approach for future research on the Las Vegas Buckwheat or other restricted habitat species.

- We strongly recommend analysis of buckwheat tissue chemistry at the same sites as this study. This would help confirm whether variables found to be significant in this study reflect general soil environmental requirements, or instead whether they reflect specific plant nutrient requirements. Data that would enable comparison of buckwheat physiology and chemistry to that of spatially associated species might also improve our understanding of edaphic controls on habitat viability.

- We also recommend laboratory analysis of total soil chemistry – (only plant available chemistry was measured in this study). Total chemical analysis would shed light on the geologic variables between study areas and between buckwheat and non-buckwheat sites. These analyses should be performed on archived samples from this study so that accurate comparisons of results can be made. In addition, more detailed mineralogical analyses would greatly assist in determining the sources of plant nutrients, and therefore help to interpret processes controlling nutrient availability and constraining parameters for probable buckwheat habitats elsewhere.

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Chapter 4: Surface Characterization & Statistics

Brenda J. Buck, Colin R. Robins, and Amanda J. Williams

I. Purpose

Soil surface characteristics can impose important controls upon the germination, establishment, growth dynamics, and survival of plant species, especially in gypsum soils of the Mojave Desert (see Chapter 1). In particular, characteristics such as biological soil crust cover, physical soil crust cover, rock fragment cover, surface soil chemistry, canopy type, and other factors all bear consideration when attempting to define species-specific habitats. It would be impossible to elucidate relationships between buckwheat and gypsum soils, let alone to more precisely define viable buckwheat habitat, with the current, near-total lack of data on soil chemistry and surface characteristics in buckwheat habitat. Many of these important factors were beyond the scope of this study, but should be an important focus for future research projects. In this study, we focused solely on the soil surface chemistry and a set of other surface components such as rock clasts, biological soil crusts (limited types), and plant litter. The objective of the characterization study described here was to determine whether surface soil chemistry or other surface components influence population distributions of *E. corymbosum* var. *nilesii* in Clark County soils. Significant trends found in these data should (1) further our understanding of soil chemical differences between buckwheat canopy dynamics and other vegetation, (2) potentially shed light on germination processes, (3) contribute to interpretation and/or understanding of subsurface soil chemistry and processes (see Chapter 3); and (4) assist in defining surface characteristics that could potentially be used to model or predict buckwheat habitat (e.g. Chapter 2).

II. Methodology

Surface Categorization & Characterization

Soil surfaces were classified into one of three categories according to vegetative cover or lack thereof: (1) under canopy, (2) buckwheat canopy, and (3) interspaces (Figure 4-1). Areas classified as “under canopy” (UC) consist of all ground surfaces directly underlying the branches and leaves of any plant besides *E. corymbosum* var. *nilesii*. These areas extend from the most distal branch or leaf tips to the principle trunk stem(s) of the plant, and can consist of multiple plant species inter-grown within one shrub “island”. Dead but standing shrubs were also categorized as “canopy”. The “buckwheat canopies” category (BW) is similar to “under canopy” but occurs only underneath *E. corymbosum* var. *nilesii*. Buckwheat canopies only infrequently included other species in addition to the buckwheat, such as grasses, growing underneath buckwheat branches or, far more rarely, other shrubs growing intertwined with the buckwheat. The interspaces (IN) category is defined as any unvegetated soil surface between plant canopies, and can be comprised of bare soil or sand, well-developed desert pavement, and/or thin silty physical or biological surface crusts.

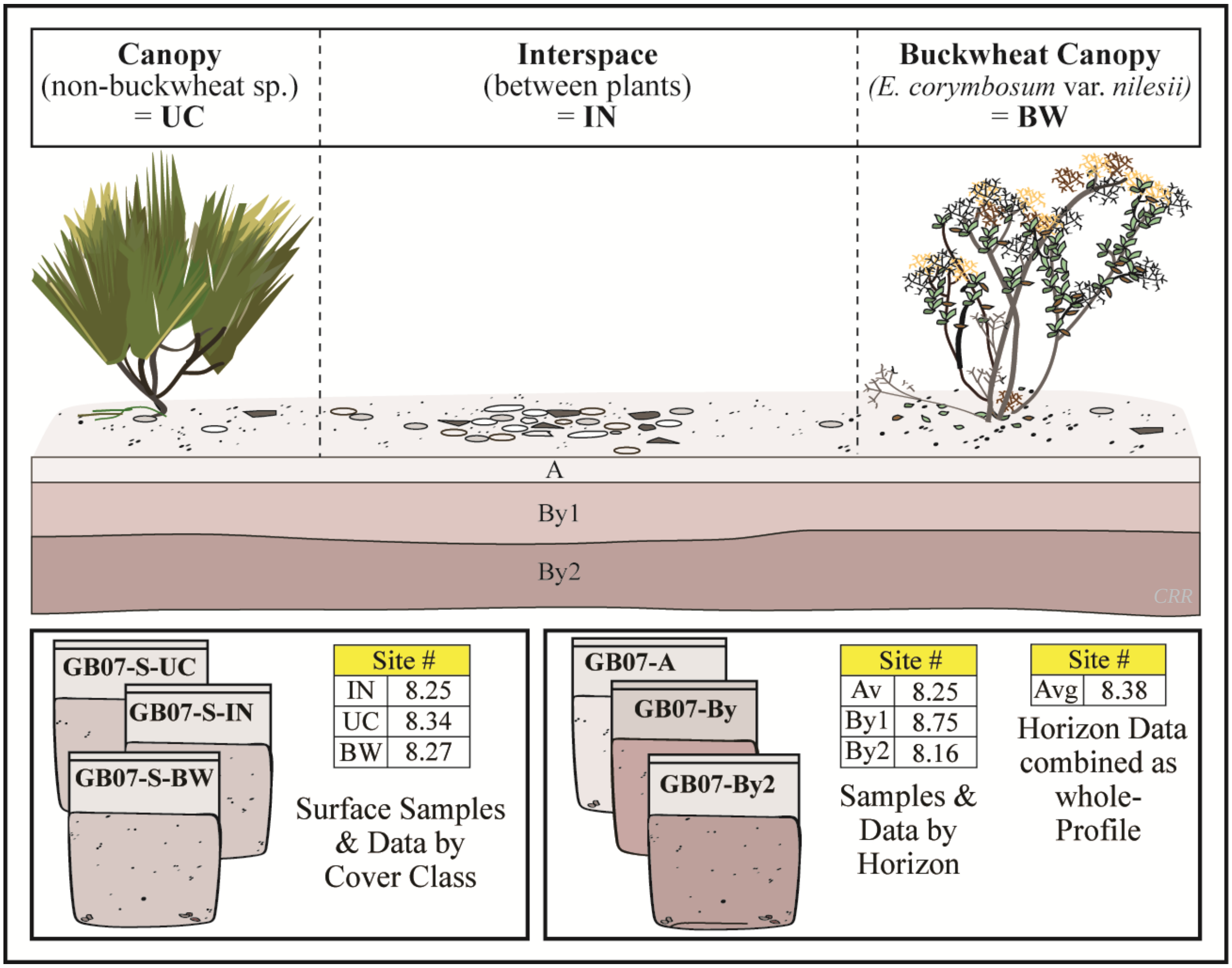

Figure 4-1: Illustration of surface cover classes, and distinct sampling/data analysis strategies for surface and horizon samples.

We used a plastic grid to collect 125 point counts of surface characteristics under each canopy type present at each site. Twenty-five 1 cm^2 observation holes, laid out in a numbered 5 x 5 grid, were cut from a plastic mesh square 25 cm on each side (Figure 4-2). The numbered observation holes were ~ 2.5 cm apart. For each canopy class, five distinct observation locations were randomly selected by the survey team. In some cases, there were fewer than five distinct buckwheat individuals or five distinct non-buckwheat plants in a site, and in those instances data were collected from all available canopy locations for a smaller point count total. To normalize comparisons between all sites and all canopy types, all raw point count tallies were converted to percentages. Because soil surface characteristics can include several distinct components even within the space of 1 cm^2, the precise spot for each observation was determined using a 2 mm diameter pointer. Prior to conducting the point counts, survey team members were trained to recognize all locally represented rock types, most biological soil crust types (for lichens, to the genus level), vegetation types, and surficial geologic map units. Table 4-1 lists the soil surface components sought in this study.

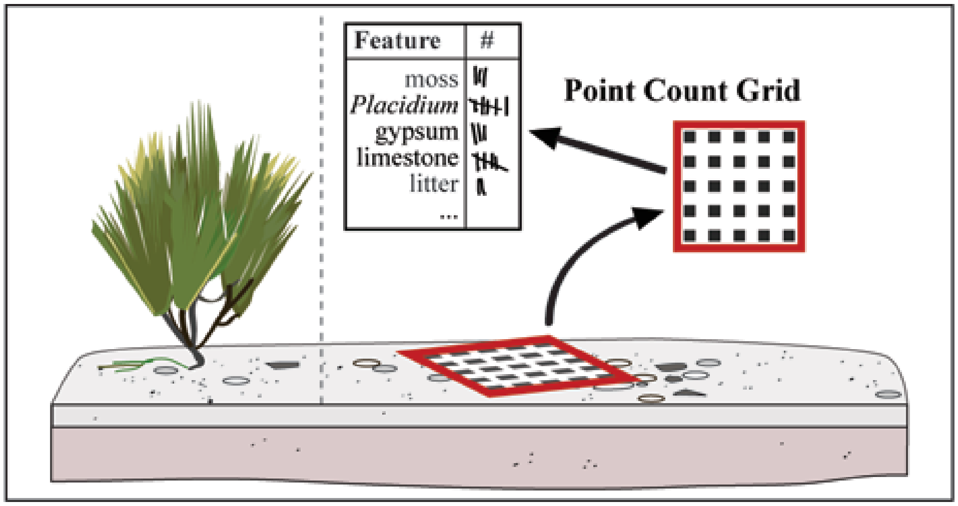

Figure 4-2: Illustration of the surface point count method and observation/sampling grid.

Soil Sampling & Analysis

Soil samples were collected from each of the three canopy cover classes, when present. One soil sample was collected from the uppermost 3-4 cm of soil at three randomly chosen locations within each class; these three aliquots were combined into one sample bag and homogenized for laboratory analysis. We collected a total of 223 surface samples: 74 from Coyote Springs, 82 from Gold Butte, and 67 from Bitter Spring. Laboratory analyses performed on surface samples followed the same procedures as the soil profile/horizon analyses described in Chapter 3.

Statistical Analysis

Statistical analysis of surface characteristics incorporated transect and point count data, the results from laboratory chemical analysis of soil samples, and attributes from GIS data sets. A complete list of the variables considered are displayed in Table 4-1. In addition, several composite classes were created for linked or similar variables, especially those pertaining to surface clasts and biological soil crusts (Table 4-2). These composite classes were intended to emphasize potential relationships that might not otherwise have been detected by statistical analysis when spread out among separate variables. For example, the composite class “AllRock” includes all observed clast lithologies, including chert, quartzite, limestone, and rock gypsum. Although these distinct rock types behave differently in terms of their chemical influences, rock fragments, regardless of composition, may collectively exert an identical physical influence on plant-soil dynamics.

T-tests, including both non-parametric paired t-tests and also independent sample t-tests, were used to quantify differences in soil surface characteristics between buckwheat presence/absence and habitat classes (defined in Chapter 2). All t-tests were conducted at the 0.05 significance level in IBM SPSS Statistics 19. Mann-Whitney U Tests were used as a non-parametric alternative to the independent samples t-tests to quantify differences in interspace surface characteristics between sites with and without buckwheat, between sites from the three distinct habitat classes (habitat, potential habitat, and non-habitat) (Figure 4-3a). Similarly, Wilcoxon signed rank tests were used as a non-parametric alternative to paired sample t-tests within buckwheat sites only (Figure 4-3b). The Wilcoxon tests compared characteristics between:

- Buckwheat canopies (BW) and non-buckwheat canopies (UC),
- Interspace characteristics (IN) versus buckwheat canopy (BW) characteristics,
- Interspace (IN) characteristics to those of non-buckwheat canopies (UC).

In contrast to the subsurface horizon statistical analyses, grouping of surface sample laboratory data was unnecessary. Thus, surface statistics sought trends among raw data values, and did not use pre-grouped site means, minima, or maxima.

Table 4-1: Statistical analysis of surface data sought trends among these 63 variables from three categories.

Point Count Variables	***Laboratory analysis variables***	***Morphometric and GIS-derived variables***
Cyanobacteria	Moisture (%)	Elevation (m)
Moss	pH-1:1 Soil:H_2O	Slope angle (deg)
Collema sp.	pH-$CaCl_2$	Aspect (deg)
Placidium sp.	pH -Saturated Paste	Surface Horizon Thickness (cm)
Psora sp.	Saturated Paste ECe	Whole-Year Insolation
Blue Lichen *(unknown taxon)*	Total N	
White Lichen *(dead or unknown taxon)*	Total C	
Yellow Lichen (*unknown taxon)*	Organic C	
Chert	Inorganic C	
Limestone Clast	$CaCO_3$	
Sandstone Clast	Cl^-	
Petrocalcic Clast	SO_4^{2-}	
Other Igneous Clast	NO_3^-	
Other Rock	B	
Gypsum/Rock gypsum	P	
Quartzite	Mo	
Siltstone	Mn	
Bare	Fe	
Litter	Co	
Grass Litter	Ni	
Total Lichen*****	Cu	
Moss-Lichen*****	Zn	
Total BSC*****	As	
Cyanobacteria-Bare*****	Na	
Total Rock*****	K	
AllRock*****	Ca	
Carbonate Rock*****	Mg	
Chert-Quartzite*****	Percent Clay	
***** *Composite variable (see Table 4-2)*	Percent Silt	
	Percent Sand	

Table 4-2: Summary of composite variable classes used in statistical analysis of surface data.

Composite Class	***Component Categories***
Total Lichen	Sum of all lichen cover from point count data.
Moss-lichen	Sum of all moss and lichen cover from point count data.
Total BSCs	Sum of cyanobacteria, moss, and all lichen from point count data
Cyanobacteria-Bare	Sum of cyanobacteria and bare soil cover from point count data.
All Rock (including gypsum)	Sum of surface rock cover from point count data; clasts include gypsum, limestone, sandstone, petrocalcic, igneous, quartzite, siltstone, and “other” rock fragments
Total Rock (Non-Gypsum Rock)	Sum of **non-gypsum** surface rock cover from point count data; clasts include limestone, sandstone, petrocalcic, igneous, quartzite, siltstone, and “other” rock fragments.
Carbonate Rock	Sum of limestone and petrocalcic surface rock cover from point count data.
Chert-Quartzite	Sum of all chert and quartzite rock cover from point count data.
Surface Horizon Thickness	Thickness of A or Av horizon in cm. AC horizons are not included - listed as 0 cm thickness.

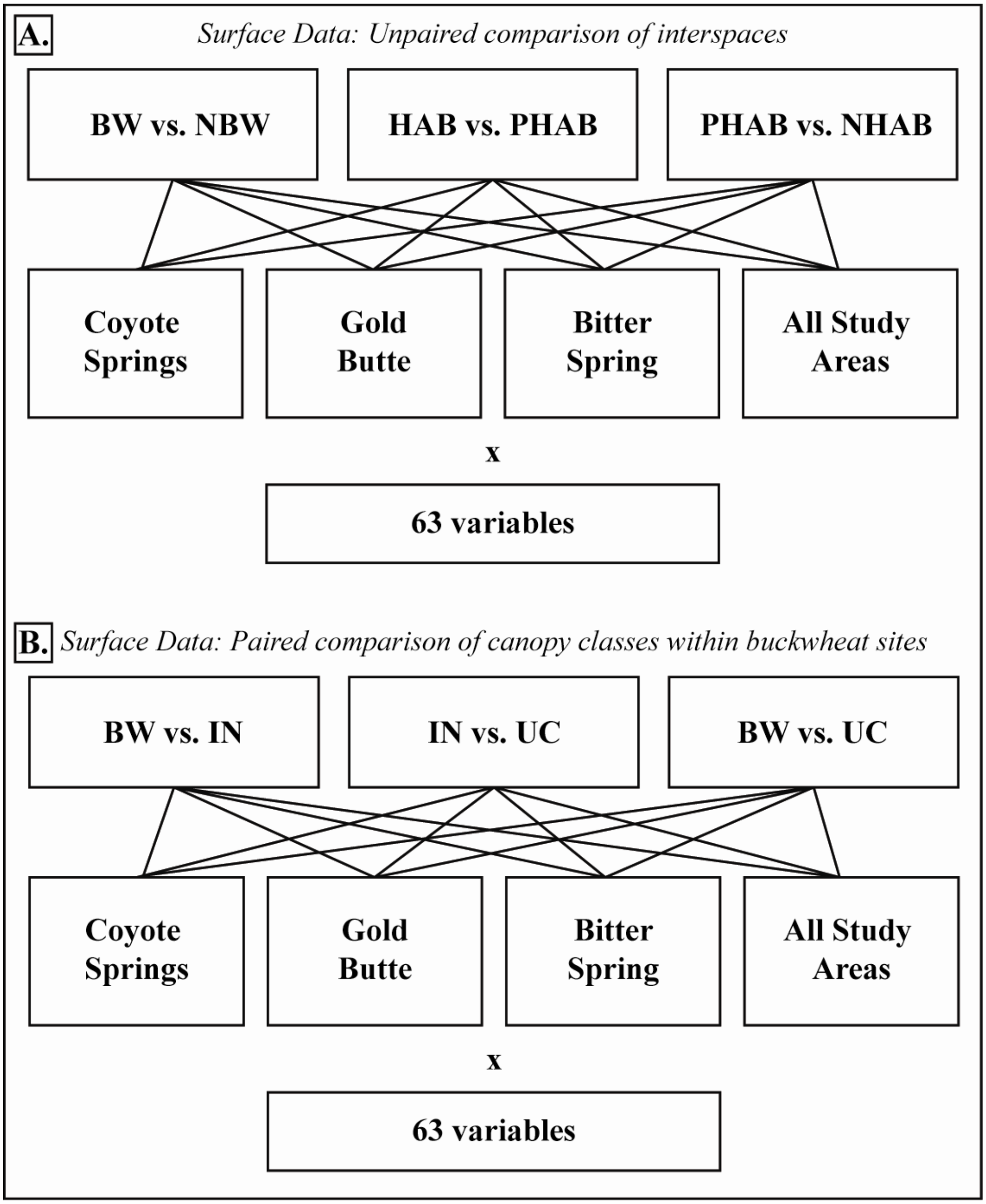

Figure 4-3: Schematic illustration of (**A**) unpaired and (**B**) paired surface sample data analyses. Abbreviations for buckwheat presence/absence or habitat classes are BW = buckwheat, NBW = non-buckwheat, HAB = habitat, PHAB = potential habitat, NHAB = non-habitat. Canopy type abbreviations are BW = buckwheat canopy, IN = interspace, UC = other plant canopy.

III. Results

Laboratory analysis of 223 samples produced a data set too large to present concisely outside of a digital spreadsheet. Similarly, statistical comparisons of the 63 variables incorporated from laboratory, point count, and GIS data generated 24 distinct spreadsheets with detailed descriptive statistics.

Consequently, results have been greatly simplified for ease of display and discussion. Results from the Mann-Whitney and the Wilcoxon tests are presented in Tables 4-3 to 4-8, each of which presents the p-value, and the median values for each of the two compared classes (i.e., buckwheat/non-buckwheat, habitat/potential habitat, potential habitat/non-habitat), for each variable found to vary significantly between classes. Furthermore, each principle table consists of four sub-tables that describe the results for (a) Coyote Springs, (b) Gold Butte, (c) Bitter Spring, and (d) all study areas combined. For assistance in navigating these tables, we outline their order here:

- Unpaired comparison of buckwheat interspaces and non-buckwheat interspaces (Table 4-3)
- Paired comparison of soils under buckwheat canopies to soils under other plant canopies within buckwheat habitat (Table 4-4).
- Paired comparison of soils under buckwheat canopies versus interspace soils within buckwheat habitat (Table 4-5).
- Paired comparison of soils under other plant canopies versus soils in interspaces within buckwheat habitat (Table 4-6).
- Unpaired comparison of habitat interspaces versus potential habitat interspaces (Table 4-7).
- Unpaired comparison of potential habitat interspaces versus non-habitat interspaces (Table 4-8).

We also provide a summary of relative trends in these results to assist with the navigation and understanding of the statistical data (Tables 4-9 through 4-14).

To gain further insights into the possible causes of significant trends detected the by non-parametric t-tests, we also employed Spearman rank correlation tests in IBM SPSS Statistics 19, in a fashion nearly identical to that described for soil profile data (Chapter 3). These tests illustrated co-variance between specific variables including percent $CaCO_3$, plant-available Fe, organic C, litter, and grass litter (Tables 4-15 through 4-38).

Table 4-3: Summary of unpaired non-parametric t-tests between **interspaces** in **"Buckwheat"** sites vs. interspaces in "**Non-Buckwheat**" Sites.

Table 4-3a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	BW Median	Non-BW Median
Limestone Clast	0.003	4.000	**52.318**
Bare	0.010	**26.174**	10.667
Cyanobacteria-Bare	0.010	**26.174**	10.667
Total Rock	0.013	66.000	**75.333**
Carbonate Rock	0.006	59.459	**75.333**
Chert-Quartzite	0.008	0.000	**0.000***
Total C	0.002	**6.759**	5.980
Inorganic C	0.001	**6.625**	5.513
$CaCO_3$	0.001	**55.209**	45.943
P	0.045	0.048	**2.176**
Fe	0.045	**10.310**	8.466
Co	0.039	0.007	**0.016**
Ca	0.034	**864.676**	558.585
Mg	0.031	**185.940**	123.684
Surface Horizon (cm)	0.005	3.000	**7.000**
AllRock	0.013	66.000	**75.333**
*Coyote Springs **n** (number of sites)*		*11*	*21*

Table 4-3b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	BW Median	Non-BW Median
Cyanobacteria	0.001	**70.199**	3.333
Placidium	0.029	3.974	**11.667**
Bare	0.020	2.000	**7.667**
Grass Litter	0.022	0.000	**0.000***
Total BSC	0.008	**88.667**	29.333
Cyanobacteria-Bare	0.027	**71.333**	30.898
Total C	0.000	**4.338**	1.680
Inorganic C	0.000	**4.157**	1.419
$CaCO_3$	0.000	**34.641**	11.826
SO_4^{2-}	0.005	**2600.060**	2057.660
Mn	0.009	1.416	**2.326**
Fe	0.002	**7.990**	5.818
Co	0.019	0.008	**0.015**
Ni	0.001	**0.072**	0.038
As	0.001	**0.048**	0.022
K	0.023	7.263	**10.078**
Ca	0.001	**566.470**	263.860
Clay	0.013	**7.556**	5.783
Sand	0.040	54.809	**62.324**
*Gold Butte **n** (number of sites)*		*9*	*28*

Table 4-3c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	BW Median	Non-BW Median
Cyanobacteria	0.007	**3.947**	0.000
Moisture (%)	0.008	**4.993**	2.015
pH 1:1	0.005	7.820	**8.252**
P	0.017	0.487	**1.137**
Bitter Spring **n** (number of sites)		*11*	*18*

*(**Table 4-3d** is on the next page)*

Table 4-3d: Summary of **All Study Areas** combined.			
Significant Variable	**p-value (2-tailed)**	**BW Median**	**Non-BW Median**
Cyanobacteria	0.015	**2.667**	0.000
Grass Litter	0.040	0.000	**0.000***
Cyanobacteria-Bare	0.002	**39.073**	18.667
Moisture (%)	0.004	**3.301**	1.854
pH 1:1	0.028	7.937	**8.385**
Total C	0.003	**4.756**	3.755
Inorganic C	0.002	**4.587**	3.534
$CaCO_3$	0.002	**38.221**	29.446
P	0.000	0.742	**1.997**
Mn	0.007	1.053	**1.959**
Fe	0.000	**9.923**	7.121
Co	0.000	0.007	**0.013**
Ni	0.000	**0.089**	0.048
As	0.022	**0.049**	0.027
Ca	0.000	**768.452**	327.418
Surface Horizon (cm)	0.015	4.000	**5.000**
*All Areas **n** (number of sites)*		*31*	*67*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
*- Medians in **bold** are the larger value.*
*- ***** Medians are equal, however, the class in bold has a larger mean.*

Table 4-4: Summary of paired non-parametric t-tests for difference between soils under **buckwheat canopies** vs. soils under **other plant canopies** (paired within "Buckwheat" sites)

Table 4-4a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	BW Median	UC Median
Litter	0.028	2.673	**4.923**
Total Rock	0.047	**66.000**	57.667
Fe	0.009	**11.208**	9.153
Ni	0.037	**0.105**	0.084
AllRockBW	0.047	**66.000**	57.667
Coyote Springs ***n*** *(number of sites)*		*10*	*10*

Table 4-4b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	BW Median	UC Median
Moss	0.036	1.587	**3.448**
Psora	0.017	2.649	**9.655**
Grass Litter	0.043	0.000	**0.667**
Sat Paste pH	0.015	**7.095**	6.819
Total N	0.021	0.039	**0.059**
Mo	0.007	0.380	**0.520**
Co	0.015	**0.011**	0.007
AllRockBW	0.050	**3.974**	1.333
Gold Butte ***n*** *(number of sites)*		*9*	*9*

Table 4-4c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	BW Median	UC Median
Litter	0.006	14.400	**27.152**
Total Rock	0.037	**43.791**	27.632
Total N	0.026	0.024	**0.038**
AllRock	0.033	**54.000**	34.211
Bitter Spring **n** (number of sites)		*11*	*11*

Table 4-4d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	BW Median	UC Median
Psora	0.017	**0.000***	0.000
Limestone Clast	0.026	5.982	**6.042**
Litter	0.001	11.582	**21.594**
Grass Litter	0.016	0.000	**0.333**
Total Rock	0.002	**47.895**	31.200
Carbonate Rock	0.005	**39.000**	24.333
pH Sat Paste	0.001	**7.273**	7.140
Total N	0.001	0.024	**0.037**
P	0.003	0.780	**1.419**
AllRockBW	0.001	**55.000**	33.105
All Areas ***n*** *(number of sites)*		*30*	*30*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
- Medians in ***bold*** *are the larger value.*
- ***** *Medians are equal, however, the class in bold has a larger mean.*

Table 4-5: Summary of paired non-parametric t-tests for difference between soils under **buckwheat canopies** vs. soils in **interspaces** at buckwheat sites (paired within "Buckwheat" sites).

Table 4-5a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	IN Median	BW Median
Limestone Clast	0.033	4.000	**5.298**
Litter	0.007	0.000	**2.667**
ECe Sat Paste	0.013	0.298	**0.395**
Total N	0.010	0.012	**0.021**
Fe	0.021	10.310	**11.476**
Ni	0.008	0.093	**0.106**
K	0.016	10.887	**16.929**
Coyote Springs ***n*** *(number of sites)*		*11*	*11*

Table 4-5b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	IN Median	BW Median
Cyanobacteria	0.011	**70.199**	20.667
Psora	0.028	0.000	**2.649**
Bare	0.028	2.000	**11.000**
Litter	0.008	0.667	**24.000**
Total BSC	0.011	**88.667**	53.642
Cyanobacteria-Bare	0.011	**71.333**	33.333
Moisture (%)	0.015	3.209	**5.745**
pH $CaCl_2$	0.011	7.740	**7.916**
ECe Sat Paste	0.008	2.169	**2.640**
Cl^-	0.008	2.400	**5.880**
SO_4^{2-}	0.038	2600.060	**2978.920**
NO_3^-	0.018	1.200	**3.440**
B	0.015	0.116	**0.346**
Zn	0.044	0.066	**0.111**
K	0.011	7.263	**18.801**
Gold Butte ***n*** *(number of sites)*		*9*	*9*

Table 4-5c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	IN Median	BW Median
Litter	0.003	3.333	**14.400**
Moisture (%)	0.016	**4.993**	3.238
ECe Sat Paste	0.003	2.171	**2.385**
Total C	0.050	3.782	**4.475**
Organic C	0.006	0.063	**0.276**
Cl^-	0.050	2.700	**4.240**
B	0.013	0.073	**0.479**
Mn	0.006	1.053	**1.792**
Co	0.008	0.007	**0.010**
Cu	0.010	0.052	**0.058**
Zn	0.026	0.040	**0.063**
Bitter Spring **n** (number of sites)		*11*	*11*

(Table 4-5d** is on the next page**)

Table 4-5d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	IN Median	BW Median
Cyanobacteria	0.006	2.667	**4.000**
Psora	0.028	0.000	**0.000***
Litter	0.000	1.333	**11.258**
Total BSC	0.005	**16.000**	13.072
Cyanobacteria-Bare	0.002	**39.073**	26.174
ECe Sat Paste	0.000	2.088	**2.285**
Total N	0.001	0.013	**0.024**
Organic C	0.001	0.103	**0.220**
Cl^-	0.002	2.700	**4.360**
SO_4^{2-}	0.022	2280.440	**2474.700**
B	0.000	0.071	**0.114**
Mn	0.001	1.053	**1.494**
Co	0.011	0.007	**0.009**
Zn	0.010	0.048	**0.083**
K	0.001	10.451	**18.801**
Clay	0.044	**7.933**	7.608
*All Areas **n** (number of sites)*		*31*	*31*

- *Only variables flagged as statistically signficant (p < 0.05) are shown.*
- *Medians in **bold** are the larger value.*
- ****** Medians are equal, however, the class in bold has a larger mean.*

Table 4-6: Summary of paired non-parametric t-tests for differences between soils under **other plant canopies** vs. soils in **interspaces** (paired within "Buckwheat" sites).

Table 4-6a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	IN Median	UC Median
Litter	0.005	0.333	**4.923**
Moisture (%)	0.037	**1.876**	1.823
pH 1:1	0.025	**8.399**	8.367
ECe Sat Paste	0.005	0.302	**0.417**
Total N	0.013	0.012	**0.022**
Organic C	0.028	0.085	**0.188**
P	0.028	0.102	**0.352**
Mn	0.022	0.948	**1.374**
Fe	0.037	**10.178**	9.153
Co	0.009	0.007	**0.009**
K	0.013	11.296	**15.555**
Clay	0.022	**13.024**	10.229
*Coyote Springs **n** (number of sites)*		*10*	*10*

Table 4-6b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	IN Median	UC Median
Cyanobacteria	0.008	**70.199**	19.333
Moss	0.018	0.000	**3.448**
Psora	0.017	0.000	**9.655**
Yellow Lichen	0.043	0.000	**0.671**
Bare	0.015	2.000	**9.655**
Litter	0.008	0.667	**27.333**
Grass Litter	0.042	0.000	**0.667**
Total BSC	0.021	**88.667**	48.000
Cyanobacteria-Bare	0.017	**71.333**	27.333
Total Rock	0.043	**0.662**	0.000
pH 1:1	0.028	7.866	**7.963**
pH $CaCl_2$	0.038	7.740	**7.853**
pH Sat Paste	0.015	**7.113**	6.819
ECe Sat Paste	0.008	2.169	**2.718**
Total N	0.015	0.028	**0.059**
Inorganic C	0.015	**4.157**	3.651
$CaCO_3$	0.015	**34.641**	30.429
Cl^-	0.021	2.400	**11.860**
NO_3^-	0.018	1.200	**2.600**
B	0.008	0.116	**0.341**
P	0.038	1.777	**2.646**
K	0.008	7.263	**20.186**
Mg	0.011	29.276	**43.216**
Clay	0.008	**7.556**	6.026
AllRockIN	0.036	**5.333**	1.333
*Gold Butte **n** (number of sites)*		*9*	*9*

Table 4-6c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	IN Median	UC Median
Limestone Clast	0.037	**36.301**	24.667
Gypsum	0.024	**0.667***	0.667
Litter	0.003	3.333	**27.152**
Total Rock	0.028	**42.000**	27.632
Carbonate Rock	0.037	**36.301**	24.667
Moisture (%)	0.008	**4.993**	3.491
pH Sat Paste	0.033	**7.463**	7.285
ECe Sat Paste	0.026	2.171	**2.399**
Organic C	0.033	0.063	**0.239**
Cl^-	0.016	2.700	**6.420**
B	0.004	0.073	**0.252**
P	0.004	0.487	**1.277**
Mn	0.033	1.053	**1.521**
Fe	0.033	**11.361**	9.337
Cu	0.003	0.052	**0.064**
Ca	0.016	**887.253**	665.381
AllRockIN	0.003	**61.333**	34.211
Bitter Spring **n** (number of sites)		*11*	*11*

Table 4-6d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	IN Median	UC Median
Cyano	0.003	**3.307**	2.667
Moss	0.018	**0.000***	0.000
Psora	0.017	**0.000***	0.000
Yellow Lichen	0.043	**0.000***	0.000
Limestone Clast	0.003	**10.333**	6.042
Gypsum	0.028	0.000	**0.000***
Litter	0.000	1.342	**21.594**
TotBSC	0.040	16.088	**17.088**
CyanoBare	0.006	**39.203**	29.438
AllRock	0.000	**53.306**	33.105
Total Rock	0.007	**43.000**	31.200
Carbonate Rock	0.010	**35.114**	24.333
pH $CaCl_2$	0.048	7.811	**7.856**
pH Sat Paste	0.001	**7.377**	7.140
ECe Sat Paste	0.000	2.093	**2.321**
Total N	0.000	0.014	**0.037**
Organic C	0.000	0.099	**0.297**
Cl^-	0.001	2.680	**4.960**
SO_4^{2-}	0.028	2284.780	**2612.390**
B	0.000	0.072	**0.208**
P	0.000	0.790	**1.419**
Mn	0.002	1.115	**1.586**
Cu	0.047	0.070	**0.074**
Zn	0.035	0.047	**0.071**
K	0.000	10.457	**20.232**
Clay	0.000	**7.866**	6.776
All Areas ***n*** *(number of sites)*		*30*	*30*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
*- Medians in **bold** are the larger value.*
*- ***** Medians are equal, however, the class in bold has a larger mean.*

Table 4-7: Summary of unpaired non-parametric t-tests between interspaces in "**Habitat**" sites vs. interspaces in "**Potential Habitat**" Sites.

Table 4-7a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	PH Median	Habitat Median
Total C	0.019	6.173	**6.803**
Inorganic C	0.016	6.082	**6.693**
$CaCO_3$	0.016	50.682	**55.771**
Clay	0.049	10.265	**13.252**
Coyote Springs ***n*** *(number of sites)*		*10*	*10*

Table 4-7b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	PH Median	Habitat Median
Cyanobacteria	0.008	20.921	**70.199**
Total BSC	0.035	69.667	**88.667**
CyanoBare	0.045	30.898	**71.333**
Total C	0.003	2.647	**4.338**
Inorganic C	0.005	2.379	**4.157**
$CaCO_3$	0.005	19.829	**34.641**
SO_4^{2-}	0.031	2184.900	**2600.060**
Mn	0.040	**2.234**	1.416
Fe	0.027	6.882	**7.990**
Ni	0.010	0.048	**0.072**
As	0.016	0.028	**0.048**
Ca	0.012	366.605	**566.470**
Gold Butte ***n*** *(number of sites)*		*9*	*18*

Table 4-7c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	PH Median	Habitat Median
Cyanobacteria-Bare	0.041	9.396	**25.333**
P	0.033	**1.395**	0.487
Bitter Spring **n** (number of sites)		*11*	*7*

Table 4-7d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	PH Median	Habitat Median
TotLichen	0.036	**16.000**	5.687
Moss-Lichen	0.036	**16.000**	5.687
Total N	0.047	**0.021**	0.013
Total C	0.010	3.755	**4.726**
Organic C	0.030	**0.156**	0.107
Inorganic C	0.010	3.534	**4.587**
$CaCO_3$	0.010	29.446	**38.221**
P	0.016	**1.827**	0.790
Mn	0.029	**1.928**	1.115
Fe	0.006	7.551	**9.768**
Co	0.003	**0.013**	0.007
Ni	0.002	0.054	**0.087**
Ca	0.004	402.877	**729.216**
All Areas ***n*** *(number of sites)*		*30*	*35*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
- Medians in ***bold*** *are the larger value.*

Table 4-8: Summary of unpaired non-parametric t-tests between interspaces in "**Potential Habitat**" sites vs. interspaces in "**Non-Habitat**" Sites.

Table 4-8a: Summary for **Coyote Springs** sites only.

Significant Variable	p-value (2-tailed)	Non-Habitat Median	Potential Hab. Median
Blue Lichen	0.002	0.000	**0.669**
LS clast	0.005	**75.082**	14.667
Bkm Clast	0.014	5.953	**51.333**
Quartzite	0.012	**0.333**	0.000
Bare	0.004	5.647	**16.667**
CyanoBare	0.004	5.647	**16.667**
AllRock	0.006	**90.118**	70.140
TotRock	0.006	**90.118**	70.140
CarbRock	0.018	**89.118**	70.000
ChertQrzt	0.012	**2.000**	0.000
Inorganic C	0.021	5.374	**6.082**
$CaCO_3$	0.021	44.785	**50.682**
P	0.018	**2.614**	0.927
Mg	0.041	108.237	**185.769**
Surface Horizon (cm)	0.047	**7.500**	4.000
*Coyote Springs **n** (number of sites)*		*12*	*10*

Table 4-8b: Summary for **Gold Butte** sites only.

Significant Variable	p-value (2-tailed)	Non-Habitat Median	Potential Hab. Median
Cyanobacteria	0.004	0.000	**20.921**
LS clast	0.026	**9.674**	0.333
Gypsum	0.036	0.000	**0.662**
Bare	0.008	**23.179**	4.352
Litter	0.030	**2.676**	1.329
Grass Litter	0.002	**4.662**	0.000
TotRock	0.027	**33.000**	0.667
CarbRock	0.026	**9.674**	0.333
Moisture	0.014	0.795	**2.642**
pH 1:1	0.003	**8.558**	7.831
pH $CaCl_2$	0.020	**7.941**	7.718
ECe Sat Paste	0.005	0.360	**2.151**
Total N	0.017	0.018	**0.034**
Total C	0.005	1.175	**2.647**
Organic C	0.031	0.142	**0.251**
Inorganic C	0.014	1.061	**2.379**
$CaCO_3$	0.014	8.842	**19.829**
SO_4^{2-}	0.004	58.100	**2184.900**
B	0.003	0.050	**0.158**
Fe	0.000	3.685	**6.882**
Ni	0.000	0.023	**0.048**
Cu	0.006	0.058	**0.098**
As	0.000	0.012	**0.028**
Ca	0.001	106.219	**366.605**
Clay	0.044	5.189	**6.584**
Silt	0.011	23.571	**36.614**
Sand	0.014	**71.118**	57.175
Elevation	0.049	702.857	**704.639**
*Gold Butte **n** (number of sites)*		*10*	*18*

Table 4-8c: Summary for **Bitter Spring** sites only.

Significant Variable	p-value (2-tailed)	Non-Habitat Median	Potential Hab. Median
Moisture	0.016394307	1.425935	**3.630315**
Clay	0.026494636	**8.396638**	4.373816
Bitter Spring **n** (number of sites)		*11*	*7*

Table 4-8d: Summary of **All Study Areas** combined.

Significant Variable	p-value (2-tailed)	Non-Habitat Median	Potential Hab. Median
Cyanobacteria	0.000	0.000	**0.000**
Collema	0.008	1.961	**10.667**
Psora	0.016	0.000	**0.000***
LS clast	0.000	**46.667**	3.333
Quartzite	0.009	**0.000***	0.000
Grass Litter	0.049	**1.987**	0.000
Total Lichen	0.037	8.609	**16.000**
Moss-Lichen	0.043	8.609	**16.000**
Total BSC	0.014	8.609	**16.000**
Total Rock	0.002	**61.589**	10.000
Carbonate Rock	0.002	**52.318**	3.333
Chert & Quarttzite	0.036	**0.000***	0.000
Moisture	0.003	1.426	**2.614**
pH 1:1	0.002	**8.484**	7.973
pH $CaCl_2$	0.004	**7.915**	7.811
Ece Sat Paste	0.042	0.354	**2.122**
Organic C	0.011	0.088	**0.156**
Fe	0.035	6.724	**7.551**
All Areas ***n*** *(number of sites)*		*33*	*35*

- Only variables flagged as statistically signficant ($p < 0.05$) are shown.
- Medians in ***bold*** *are the larger value.*
- ***** *These medians are equal, however, the class in bold has a larger mean.*

Table 4-9: Summary of trends in statistically significant results on surface characteristics between "**Buckwheat" site Interspaces** and **"Non-Buckwheat" site Interspaces.**

Table 4-9a: Summary for Coyote Springs sites only.

Significant Variable	Buckwheat Median
Limestone clast	Less/Fewer in BW interspaces
Carbonate rock	Less/Fewer in BW interspaces
Chert-Quartzite	Less/Fewer in BW interspaces
Total Rock	Less/Fewer in BW interspaces
All Rock	Less/Fewer in BW interspaces
Total C	More/Greater in BW interspaces
Inorganic C	More/Greater in BW interspaces
$CaCO_3$	More/Greater in BW interspaces
Ca	More/Greater in BW interspaces
Mg	More/Greater in BW interspaces
Fe	More/Greater in BW interspaces
P	Less/Fewer in BW interspaces
Co	Less/Fewer in BW interspaces
Surface horizon (cm)	Less/Fewer in BW interspaces
Bare	More/Greater in BW interspaces
Cyanobacteria - Bare	More/Greater in BW interspaces

Table 4-9b: Summary for Gold Butte sites only.

Significant Variable	Buckwheat Median
Sand	Less/Lower in BW interspaces
Clay	More/Greater in BW interspaces
Total C	More/Greater in BW interspaces
Inorganic C	More/Greater in BW interspaces
$CaCO_3$	More/Greater in BW interspaces
Ca	More/Greater in BW interspaces
Fe	More/Greater in BW interspaces
Ni	More/Greater in BW interspaces
K	Less/Fewer in BW interspaces
As	More/Greater in BW interspaces
Co	Less/Fewer in BW interspaces
Mn	Less/Fewer in BW interspaces
SO_4	More/Greater in BW interspaces
Grass Litter	Less/Fewer in BW interspaces
Bare	Less/Fewer in BW interspaces
Cyanobacteria - Bare	More/Greater in BW interspaces
Cyanobacteria	More/Greater in BW interspaces
Placidium	Less/Fewer in BW interspaces
Total BSC	More/Greater in BW interspaces

(Table 4-9 continues on the next page)

Table 4-9c: Summary for Bitter Spring sites only.	
Significant Variable	**Buckwheat Median**
pH (1:1)	Less/Lower in BW interspaces
P	Less/Fewer in BW interspaces
Moisture	More/Greater in BW interspaces
Cyanobacteria	More/Greater in BW interspaces

Table 4-9d: Summary for All Sites Combined.	
Significant Variable	**Buckwheat Median**
pH (1:1)	Less/Lower in BW interspaces
Total C	More/Greater in BW interspaces
Inorganic C	More/Greater in BW interspaces
$CaCO_3$	More/Greater in BW interspaces
Ca	More/Greater in BW interspaces
Fe	More/Greater in BW interspaces
Ni	More/Greater in BW interspaces
As	More/Greater in BW interspaces
P	Less/Fewer in BW interspaces
Co	Less/Fewer in BW interspaces
Mn	Less/Fewer in BW interspaces
Surface Horizon	Less/Fewer in BW interspaces
Moisture	More/Greater in BW interspaces
Grass Litter	Less/Fewer in BW interspaces
Cyanobacteria - Bare	More/Greater in BW interspaces
Cyanobacteria	More/Greater in BW interspaces

Table 4-10: Summary of trends in statistically significant results on surface characteristics under **Buckwheat canopies vs. under other plant canopies** (paired within "Buckwheat" sites)

Table 4-10a: Summary for **Coyote Springs** sites only.

Significant Variable	Buckwheat Median
Total Rock	More/Greater in BW canopies
All Rock BW (?)	More/Greater in BW canopies
Fe	More/Greater in BW canopies
Ni	More/Greater in BW canopies
Litter	Less/Fewer in BW canopies

Table 4-10b: Summary for **Gold Butte** sites only.

Significant Variable	Buckwheat Median
pH (sat. paste)	Higher/Greater in BW canopies
All rock BW (?)	More/Greater in BW canopies
Co	More/Greater in BW canopies
Mo	Less/Fewer in BW canopies
Total N	Less/Fewer in BW canopies
Grass Litter	Less/Fewer in BW canopies
Moss	Less/Fewer in BW canopies
Psora	Less/Fewer in BW canopies

Table 4-10c: Summary for **Bitter Spring** sites only.

Significant Variable	Buckwheat Median
Total rock	More/Greater in BW canopies
All rock	More/Greater in BW canopies
Total N	Less/Fewer in BW canopies
Litter	Less/Fewer in BW canopies

Table 4-10d: Summary for **All Sites Combined**.

Significant Variable	Buckwheat Median
pH (sat. paste)	Higher/Greater in BW canopies
Limestone Clast	Less/Fewer in BW canopies
Carbonate Rock	More/Greater in BW canopies
Total Rock	More/Greater in BW canopies
All Rock BW (?)	More/Greater in BW canopies
P	Less/Fewer in BW canopies
Total N	Less/Fewer in BW canopies
Grass Litter	Less/Fewer in BW canopies
Litter	Less/Fewer in BW canopies
Psora	More/Greater in BW canopies

Table 4-11: Summary of trends in statistically significant results on surface characteristics under **Buckwheat canopies vs. interspaces** at Buckwheat sites (paired within Buckwheat sites).

Table 4-11a: Summary for **Coyote Springs** sites only.

Significant Variable	Buckwheat Median
Limestone Clast	More/Greater in BW canopies
Fe	More/Greater in BW canopies
Ni	More/Greater in BW canopies
K	More/Greater in BW canopies
Total N	More/Greater in BW canopies
EC	More/Greater in BW canopies
Litter	More/Greater in BW canopies

Table 4-11b: Summary for **Gold Butte** sites only.

Significant Variable	Buckwheat Median
pH ($CaCl_2$)	Higher/Greater in BW canopies
K	More/Greater in BW canopies
B	More/Greater in BW canopies
Zn	More/Greater in BW canopies
SO4	More/Greater in BW canopies
Cl	More/Greater in BW canopies
NO_3	More/Greater in BW canopies
EC	More/Greater in BW canopies
Moisture	More/Greater in BW canopies
Litter	More/Greater in BW canopies
Bare	More/Greater in BW canopies
Cyanobacteria - Bare	Less/Fewer in BW canopies
Cyanobacteria	Less/Fewer in BW canopies
Psora	More/Greater in BW canopies
Total BSC	Less/Fewer in BW canopies

Table 4-11c: Summary for **Bitter Spring** sites only.

Significant Variable	Buckwheat Median
Total C	More/Greater in BW canopies
Organic C	More/Greater in BW canopies
B	More/Greater in BW canopies
Co	More/Greater in BW canopies
Cu	More/Greater in BW canopies
Mn	More/Greater in BW canopies
Zn	More/Greater in BW canopies
Cl	More/Greater in BW canopies
EC	More/Greater in BW canopies
Moisture	Less/Fewer in BW canopies
Litter	More/Greater in BW canopies

(Table 4-11 continues on the next page)

Table 4-11d: Summary for **All Sites Combined**.

Significant Variable	Buckwheat Median
Clay	Less/Fewer in BW canopies
Organic C	More/Greater in BW canopies
K	More/Greater in BW canopies
B	More/Greater in BW canopies
Co	More/Greater in BW canopies
Mn	More/Greater in BW canopies
Zn	More/Greater in BW canopies
SO_4^{2-}	More/Greater in BW canopies
Cl	More/Greater in BW canopies
EC	More/Greater in BW canopies
Total N	More/Greater in BW canopies
Litter	More/Greater in BW canopies
Cyanobacteria - Bare	Less/Fewer in BW canopies
Cyanobacteria	More/Greater in BW canopies
Psora	More/Greater in BW canopies
Total BSC	Less/Fewer in BW canopies

Table 4-12: Summary of trends in statistically significant results on surface characteristics under **other plant canopies vs. interspaces** at Buckwheat sites (paired within Buckwheat sites).

Table 4-12a: Summary for **Coyote Springs** sites only.

Significant Variable	Other Canopy Median
pH (1:1)	Less/Fewer in Other canopies
Clay	Less/Fewer in Other canopies
Organic C	More/Greater in Other canopies
Fe	Less/Fewer in Other canopies
K	More/Greater in Other canopies
P	More/Greater in Other canopies
Co	More/Greater in Other canopies
Mn	More/Greater in Other canopies
EC	More/Greater in Other canopies
Moisture	Less/Fewer in Other canopies
Total N	More/Greater in Other canopies
Litter	More/Greater in Other canopies

Table 4-12b: Summary for **Gold Butte** sites only.

Significant Variable	Other Canopy Median
pH (1:1)	Higher/Greater in Other canopies
pH ($CaCl_2$)	Higher/Greater in Other canopies
pH (sat. paste)	Less/Lower in Other canopies
Clay	Less/Fewer in Other canopies
Total Rock	Less/Fewer in Other canopies
All RockIN	Less/Fewer in Other canopies
Inorganic C	Less/Fewer in Other canopies
$CaCO_3$	Less/Fewer in Other canopies
Mg	More/Greater in Other canopies
B	More/Greater in Other canopies
K	More/Greater in Other canopies
P	More/Greater in Other canopies
Cl	More/Greater in Other canopies
NO3	More/Greater in Other canopies
Total N	More/Greater in Other canopies
EC	More/Greater in Other canopies
Grass Litter	More/Greater in Other canopies
Litter	More/Greater in Other canopies
Bare	More/Greater in Other canopies
Cyanobacteria - Bare	Less/Fewer in Other canopies
Cyanobacteria	Less/Fewer in Other canopies
Moss	More/Greater in Other canopies
Psora	More/Greater in Other canopies
Yellow Lichen	More/Greater in Other canopies
Total BSC	Less/Fewer in Other canopies

(Table 4-12 continues on the next page)

Table 4-12c: Summary for **Bitter Spring** sites only.	
Significant Variable	**Other Canopy Median**
pH (sat. paste)	Less/Lower in Other canopies
Limestone Clast	Less/Fewer in Other canopies
Carbonate Rock	Less/Fewer in Other canopies
Gypsum	Less/Fewer in Other canopies
Total Rock	Less/Fewer in Other canopies
All Rock IN	Less/Fewer in Other canopies
Organic C	More/Greater in Other canopies
Ca	Less/Fewer in Other canopies
Fe	Less/Fewer in Other canopies
B	More/Greater in Other canopies
P	More/Greater in Other canopies
Mn	More/Greater in Other canopies
Cu	More/Greater in Other canopies
Cl	More/Greater in Other canopies
EC	More/Greater in Other canopies
Moisture	Less/Fewer in Other canopies
Litter	More/Greater in Other canopies

Table 4-12d: Summary for **All Sites Combined**.	
Significant Variable	**Other Canopy Median**
pH ($CaCl_2$)	Higher/Greater in Other canopies
pH (sat. paste)	Less/Fewer in Other canopies
Clay	Less/Fewer in Other canopies
Limestone Clast	Less/Fewer in Other canopies
Carbonate Rock	Less/Fewer in Other canopies
Gypsum	More/Greater in Other canopies
Total Rock	Less/Fewer in Other canopies
All Rock	Less/Fewer in Other canopies
Organic C	More/Greater in Other canopies
K	More/Greater in Other canopies
B	More/Greater in Other canopies
P	More/Greater in Other canopies
Mn	More/Greater in Other canopies
Cu	More/Greater in Other canopies
Zn	More/Greater in Other canopies
SO_4^{2-}	More/Greater in Other canopies
Cl	More/Greater in Other canopies
EC	More/Greater in Other canopies
Total N	More/Greater in Other canopies
Litter	More/Greater in Other canopies
Cyanobacteria - Bare	Less/Fewer in Other canopies
Cyanobacteria	Less/Fewer in Other canopies
Moss	Less/Fewer in Other canopies
Psora	Less/Fewer in Other canopies
Yellow Lichen	Less/Fewer in Other canopies
Total BSC	More/Greater in Other canopies

Table 4-13: Summary of trends in statistically significant results on surface characteristics in *interspaces* in Buckwheat habitat vs. *interspaces* in "Potential" habitat sites.

Table 4-13a: Summary for **Coyote Springs** sites only.

Significant Variable	Buckwheat Habitat Interspaces Median
Clay	More/Greater in BW interspaces
Total C	More/Greater in BW interspaces
Inorganic C	More/Greater in BW interspaces
$CaCO_3$	More/Greater in BW interspaces

Table 4-13b: Summary for **Gold Butte** sites only.

Significant Variable	Buckwheat Habitat Interspaces Median
Total C	More/Greater in BW interspaces
Inorganic C	More/Greater in BW interspaces
$CaCO_3$	More/Greater in BW interspaces
Ca	More/Greater in BW interspaces
Fe	More/Greater in BW interspaces
Ni	More/Greater in BW interspaces
As	More/Greater in BW interspaces
Mn	Less/Fewer in BW interspaces
SO_4	More/Greater in BW interspaces
Cyanobacteria - Bare	More/Greater in BW interspaces
Cyanobacteria	More/Greater in BW interspaces
Total BSC	More/Greater in BW interspaces

Table 4-13c: Summary for **Bitter Spring** sites only.

Significant Variable	Buckwheat Habitat Interspaces Median
P	Less/Fewer in BW interspaces
Cyanobacteria - Bare	More/Greater in BW interspaces

Table 4-13d: Summary for **All Sites Combined**.

Significant Variable	Buckwheat Habitat Interspaces Median
Organic C	Less/Fewer in BW interspaces
Total C	More/Greater in BW interspaces
Inorganic C	More/Greater in BW interspaces
$CaCO_3$	More/Greater in BW interspaces
Ca	More/Greater in BW interspaces
Fe	More/Greater in BW interspaces
Ni	More/Greater in BW interspaces
P	Less/Fewer in BW interspaces
Co	Less/Fewer in BW interspaces
Mn	Less/Fewer in BW interspaces
Total N	Less/Fewer in BW interspaces
Moss-Lichen	Less/Fewer in BW interspaces
Total Lichen	Less/Fewer in BW interspaces

Table 4-14: Summary of trends in statistically significant results on surface characteristics in interspaces in "Potential" habitat sites vs interpaces in Non-Habitat sites.

Table 4-14a: Summary for Coyote Springs sites only.

Significant Variable	"Potential" Habitat Interspaces Median
Limestone Clast	Less/Fewer in "Potential" interspaces
Carbonate Rock	Less/Fewer in "Potential" interspaces
Bkm clast	More/Greater in "Potential" interspaces
Quartzite	Less/Fewer in "Potential" interspaces
Chert-Quartzite	Less/Fewer in "Potential" interspaces
Total Rock	Less/Fewer in "Potential" interspaces
All Rock	Less/Fewer in "Potential" interspaces
Inorganic C	More/Greater in "Potential" interspaces
$CaCO_3$	More/Greater in "Potential" interspaces
Mg	More/Greater in "Potential" interspaces
P	Less/Fewer in "Potential" interspaces
Surface horizon (cm)	Less/Fewer in "Potential" interspaces
Bare	More/Greater in "Potential" interspaces
Cyanobacteria-Bare	More/Greater in "Potential" interspaces
Blue Lichen	More/Greater in "Potential" interspaces

Table 4-14b: Summary for Gold Butte sites only.

Significant Variable	"Potential" Habitat Interspaces Median
pH (1:1)	Less/Lower in "Potential" interspaces
pH ($CaCl_2$)	Less/Lower in "Potential" interspaces
Clay	More/Greater in "Potential" interspaces
Silt	More/Greater in "Potential" interspaces
Sand	Less/Fewer in "Potential" interspaces
Elevation	More/Greater in "Potential" interspaces
Limestone Clast	Less/Fewer in "Potential" interspaces
Carbonate Rock	Less/Fewer in "Potential" interspaces
Gypsum	More/Greater in "Potential" interspaces
Total Rock	Less/Fewer in "Potential" interspaces
Organic C	More/Greater in "Potential" interspaces
Total C	More/Greater in "Potential" interspaces
Inorganic C	More/Greater in "Potential" interspaces
$CaCO_3$	More/Greater in "Potential" interspaces
Ca	More/Greater in "Potential" interspaces
Fe	More/Greater in "Potential" interspaces
Ni	More/Greater in "Potential" interspaces
B	More/Greater in "Potential" interspaces
As	More/Greater in "Potential" interspaces
Cu	More/Greater in "Potential" interspaces
SO_4	More/Greater in "Potential" interspaces
EC	More/Greater in "Potential" interspaces
Total N	More/Greater in "Potential" interspaces

Table 4-14b (continued)	
Significant Variable	**"Potential" Habitat Interspaces Median**
Moisture	More/Greater in "Potential" interspaces
Grass Litter	Less/Fewer in "Potential" interspaces
Litter	Less/Fewer in "Potential" interspaces
Bare	Less/Fewer in "Potential" interspaces
Cyanobacteria	More/Greater in "Potential" interspaces

Table 4-14c: Summary for Bitter Spring sites only.

Significant Variable	"Potential" Habitat Interspaces Median
Moisture	More/Greater in "Potential" interspaces
Clay	Less/Fewer in "Potential" interspaces

Table 4-14d: Summary for All Sites Combined.

Significant Variable	"Potential" Habitat Interspaces Median
pH (1:1)	Less/Lower in "Potential" interspaces
pH ($CaCl_2$)	Less/Fewer in "Potential" interspaces
Limestone Clast	Less/Fewer in "Potential" interspaces
Carbonate Rock	Less/Fewer in "Potential" interspaces
Quartzite	Less/Fewer in "Potential" interspaces
Chert & Quartzite	Less/Fewer in "Potential" interspaces
Total Rock	Less/Fewer in "Potential" interspaces
Organic C	More/Greater in "Potential" interspaces
Fe	More/Greater in "Potential" interspaces
EC	More/Greater in "Potential" interspaces
Moisture	More/Greater in "Potential" interspaces
Grass Litter	Less/Fewer in "Potential" interspaces
Cyanobacteria	More/Greater in "Potential" interspaces
Psora	More/Greater in "Potential" interspaces
Collema	More/Greater in "Potential" interspaces
Moss-Lichen	More/Greater in "Potential" interspaces
Total Lichen	More/Greater in "Potential" interspaces
Total BSC	More/Greater in "Potential" interspaces

Table 4-15: Spearman's Rho Buckwheat Interspace, Surface Data, All Sites

Table 4-15a: Summary for Buckwheat Interspace, Surface Data, All Sites: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.994	.000
Mg	Strong Positive	.762	.000
Northing	Strong Positive	.717	.000
pH (1:1)	Strong Positive	.690	.000
As	Strong Negative	-.685	.000
EC	Strong Negative	-.677	.000
Bkm Clast	Strong Positive	.671	.000
SO_4	Strong Negative	-.645	.000
Slope	Strong Negative	-.636	.000
Clay	Strong Positive	.629	.000
Gypsum	Strong Negative	-.627	.000
Easting	Strong Negative	-.572	.001
Moisture	Strong Negative	-.552	.001
B	Strong Negative	-.540	.002
Elevation	Strong Negative	-.522	.003
pH ($CaCl_2$)	Strong Positive	.513	.003
NO_3	Strong Positive	.463	.009
Cyanobacteria	Strong Negative	-.462	.009
CarbRock	Strong Positive	.460	.009
TotRock	Strong Positive	.456	.010
Silt	Strong Negative	-.451	.011
Litter	Moderate Negative	-.449	.011
Blue Lichen	Moderate Positive	.437	.014
Grass Litter	Moderate Negative	-.407	.023
P	Moderate Negative	-.355	.050

Table 4-15b: Summary for Buckwheat Interspace, Surface Data, All Sites: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.929	.000
Ca	Strong Positive	.804	.000
P	Strong Negative	-.652	.000
Total N	Strong Negative	-.544	.002
Mn	Strong Negative	-.492	.005
Co	Moderate Negative	-.386	.032
Easting	Moderate Negative	-.371	.040
Placidium	Moderate Negative	-.358	.048

(continued on next page)

Table 4-15c: Summary for Buckwheat Interspace, Surface Data, All Sites: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Na	Strong Positive	.608	.000
TotRock	Moderate Negative	-.424	.017
Collema	Moderate Positive	.419	.019
CarbRock	Moderate Negative	-.415	.020
Total N	Moderate Positive	.367	.042
LS clast	Moderate Negative	-.359	.047

Table 4-15d: Summary for Buckwheat Interspace, Surface Data, All Sites: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
As	Strong Positive	.635	.000
Grass Litter	Strong Positive	.577	.001
Northing	Strong Negative	-.573	.001
Clay	Strong Negative	-.506	.004
Total C	Strong Negative	-.465	.008
Inorganic C	Moderate Negative	-.449	.011
$CaCO_3$	Moderate Negative	-.449	.011
Bkm Clast	Moderate Negative	-.441	.013
Chert	Moderate Positive	.408	.023
pH (1:1)	Moderate Negative	-.378	.036
LS clast	Moderate Positive	.375	.037

(continued on next page)

Table 4-15e: Summary for Buckwheat Interspace, Surface Data, All Sites: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
Clay	Strong Negative	-.706	.000
LS clast	Strong Positive	.637	.000
As	Strong Positive	.629	.000
Cu	Strong Negative	-.621	.000
Sand	Strong Positive	.619	.000
Litter	Strong Positive	.577	.001
Northing	Strong Negative	-.570	.001
Collema	Strong Negative	-.552	.001
K	Strong Positive	.540	.002
Moisture	Strong Positive	.490	.005
Na	Strong Negative	-.480	.006
Zn	Moderate Negative	-.445	.012
Total C	Moderate Negative	-.434	.015
pH (sat. paste)	Moderate Positive	.412	.021
Inorganic C	Moderate Negative	-.407	.023
$CaCO_3$	Moderate Negative	-.407	.023
Bkm Clast	Moderate Negative	-.391	.029
Co	Moderate Negative	-.386	.032
Silt	Moderate Negative	-.386	.032
TotLichen	Moderate Negative	-.385	.033
MossLichen	Moderate Negative	-.385	.033
EC	Moderate Positive	.357	.048
SO_4	Moderate Positive	.356	.049

Table 4-16: Spearman's Rho Buckwheat Interspace, Surface Data, Bitter Springs

Table 4-16a: Summary for Buckwheat Interspace, Surface Data, Bitter Springs: Correlation to $CaCO_3$			
Significant Variable	**Correlation to $CaCO_3$**	**Correlation coefficient**	**P-value**
Total C	Very Strong Positive	.998	.000

Table 4-16b: Summary for Buckwheat Interspace, Surface Data, Bitter Springs: Correlation to Fe			
Significant Variable	**Correlation to Fe**	**Correlation coefficient**	**p-value**
Ni	Strong Positive	.855	.001
Clay	Strong Positive	.764	.006
SO_4	Strong Positive	.727	.011
Grass Litter	Strong Negative	-.694	.018
Gypsum	Strong Positive	.653	.029

Table 4-16c: Summary for Buckwheat Interspace, Surface Data, Bitter Springs: Correlation to Organic C			
Significant Variable	**Correlation to Organic C**	**Correlation coefficient**	**p-value**
P	Strong Positive	.782	.004

Table 4-16d: Summary for Buckwheat Interspace, Surface Data, Bitter Springs: Correlation to Litter			
Significant Variable	**Correlation to Litter**	**Correlation coefficient**	**p-value**
NONE			

Table 4-16e: Summary for Buckwheat Interspace, Surface Data, Bitter Springs: Correlation to Grass Litter			
Significant Variable	**Correlation to Grass Litter**	**Correlation coefficient**	**p-value**
Clay	Strong Negative	-.851	.001
NO_3	Strong Positive	.791	.004
K	Strong Positive	.777	.005
Gypsum	Strong Negative	-.767	.006
pH (sat. paste)	Strong Positive	.699	.017
Sand	Strong Positive	.699	.017
Fe	Strong Negative	-.694	.018
Placidium	Strong Positive	.692	.018
pH ($CaCl_2$)	Strong Positive	.685	.020
TotRock	Strong Positive	.630	.038

Table 4-17: Spearman's Rho Buckwheat Interspace, Surface Data, Coyote Springs

Table 4-17a: Summary for Buckwheat Interspace, Surface Data, Coyote Springs: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.982	.000
Silt	Strong Negative	-.845	.001
As	Strong Negative	-.836	.001
P	Strong Negative	-.655	.029
Sand	Strong Positive	.609	.047

Table 4-17b: Summary for Buckwheat Interspace, Surface Data, Coyote Springs: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.973	.000
Ca	Strong Positive	.873	.000
P	Strong Negative	-.782	.004
Co	Strong Negative	-.773	.005

Table 4-17c: Summary for Buckwheat Interspace, Surface Data, Coyote Springs: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Na	Very Strong Positive	.909	.000
Ca	Strong Positive	.709	.015
pH ($CaCl_2$)	Strong Positive	.700	.016
B	Strong Negative	-.691	.019
Mg	Strong Positive	.609	.047

Table 4-17d: Summary for Buckwheat Interspace, Surface Data, Coyote Springs: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
SO_4	Strong Negative	-.676	.022
Total N	Strong Positive	.666	.025

Table 4-17e: Summary for Buckwheat Interspace, Surface Data, Coyote Springs: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
NONE			

Table 4-18: Spearman's Rho Buckwheat Interspace, Surface Data, Gold Butte

Table 4-18a: Summary for Buckwheat Interspace, Surface Data, Gold Butte: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.983	.000
Mg	Very Strong Positive	.983	.000
Gypsum	Very Strong Negative	-.966	.000
Ni	Strong Positive	.800	.010
Zn	Strong Negative	-.783	.013
Total N	Strong Negative	-.750	.020
Ca	Strong Positive	.717	.030
P	Strong Negative	-.700	.036
Clay	Strong Positive	.700	.036
Slope	Strong Negative	-.700	.036
Organic C	Strong Negative	-.683	.042

Table 4-18b: Summary for Buckwheat Interspace, Surface Data, Gold Butte: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ca	Strong Positive	.800	.010
Total N	Strong Negative	-.783	.013
Ni	Strong Positive	.783	.013
EC	Strong Negative	-.753	.019
Zn	Strong Negative	-.733	.025
Other Rock	Strong Positive	.707	.033
K	Strong Negative	-.700	.036

Table 4-18c: Summary for Buckwheat Interspace, Surface Data, Gold Butte: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Ca	Strong Negative	-.783	.013
Ni	Strong Negative	-.767	.016
Zn	Strong Positive	.767	.016
Total N	Strong Positive	.750	.020
Mg	Strong Negative	-.733	.025
Cl	Strong Positive	.700	.036
Inorganic C	Strong Negative	-.683	.042
$CaCO_3$	Strong Negative	-.683	.042
P	Strong Positive	.683	.042

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Table 4-18d: Summary for Buckwheat Interspace, Surface Data, Gold Butte: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
Ni	Strong Positive	.787	.012
Ca	Strong Positive	.787	.012
As	Strong Positive	.743	.022
Aspect	Strong Positive	.743	.022
Surf horz thk cm	Strong Negative	-.722	.028
P	Strong Negative	-.717	.030
Mn	Strong Negative	-.699	.036
pH (sat. paste)	Strong Positive	.682	.043

Table 4-18e: Summary for Buckwheat Interspace, Surface Data, Gold Butte: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
NONE			

Table 4-19: Spearman's Rho Non-BW Interspace, Surface Data, All Sites

Table 4-19a: Summary for Non-BW Interspace, Surface Data, All Sites: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.995	.000
Mg	Strong Positive	.762	.000
Elevation	Strong Negative	-.696	.000
Easting	Strong Negative	-.679	.000
Bkm clast	Strong Positive	.676	.000
Carb Rock	Strong Positive	.650	.000
Tot Rock	Strong Positive	.611	.000
Clay	Strong Positive	.595	.000
Northing	Strong Positive	.510	.000
SO_4	Strong Negative	-.500	.000
Fe	Strong Positive	.500	.000
B	Strong Negative	-.489	.000
Placidium	Strong Negative	-.487	.000
NO_3	Strong Positive	.478	.000
EC	Strong Negative	-.466	.000
Ni	Moderate Positive	.435	.000
LS clast	Moderate Positive	.423	.000
All Rock	Moderate Positive	.405	.001
Chert Qzt	Moderate Positive	.401	.001
Ca	Moderate Positive	.398	.001
Grass Litter	Moderate Negative	-.389	.001
pH ($CaCl_2$)	Moderate Positive	.386	.001
Moss-Lichen	Moderate Negative	-.369	.002
Tot Lichen	Moderate Negative	-.362	.003
Tot BSC	Moderate Negative	-.358	.003
Moss	Moderate Negative	-.338	.005
pH (sat. paste)	Moderate Positive	.333	.006
pH (1:1)	Moderate Positive	.327	.007
Aspect	Moderate Negative	-.326	.007
Qtzite	Moderate Positive	.323	.008
Cyanobacteria	Moderate Negative	-.321	.008
Blue Lichen	Moderate Positive	.318	.009
Gypsum	Moderate Negative	-.313	.010
Other Rock	Moderate Negative	-.309	.011
Surf horz thk cm	Weak Positive	.277	.026
Slope	Weak Negative	-.276	.024
Mn	Weak Negative	-.252	.040
Zn	Weak Negative	-.245	.046
Chert	Weak Positive	.244	.047

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Table 4-19b: Summary for Non-BW Interspace, Surface Data, All Sites: Correlation to Fe			
Significant Variable	**Correlation to Fe**	**Correlation coefficient**	**p-value**
Ni	Strong Positive	.861	.000
Ca	Strong Positive	.852	.000
Mg	Strong Positive	.586	.000
Total C	Strong Positive	.518	.000
Grass Litter	Strong Negative	-.505	.000
Inorganic C	Strong Positive	.500	.000
$CaCO_3$	Strong Positive	.500	.000
Placidium	Strong Negative	-.484	.000
NO_3	Strong Positive	.472	.000
Moisture	Moderate Positive	.444	.000
As	Moderate Positive	.435	.000
Elevation	Moderate Negative	-.432	.000
Clay	Moderate Positive	.401	.001
Mn	Moderate Negative	-.394	.001
yrInsolation	Moderate Negative	-.394	.001
Easting	Moderate Negative	-.390	.001
Bkm clast	Moderate Positive	.366	.002
P	Moderate Negative	-.357	.003
Other Rock	Moderate Negative	-.350	.004
Co	Moderate Negative	-.327	.007
Na	Moderate Positive	.310	.011
Cl	Moderate Positive	.305	.012
Moss	Moderate Negative	-.301	.013
Other Ign	Weak Negative	-.292	.016
Gypsum	Weak Positive	.281	.021
All Rock	Weak Positive	.276	.024
Aspect	Weak Negative	-.269	.028
Carb Rock	Weak Positive	.255	.037
Moss-Lichen	Weak Negative	-.248	.043
Tot Lichen	Weak Negative	-.241	.050

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Table 4-19c: Summary for Non-BW Interspace, Surface Data, All Sites: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Total N	Strong Positive	.547	.000
Psora	Strong Positive	.518	.000
Carb Rock	Moderate Negative	-.429	.000
pH (1:1)	Moderate Negative	-.427	.000
All Rock	Moderate Negative	-.404	.001
Tot Rock	Moderate Negative	-.404	.001
Cyanobacteria	Moderate Positive	.400	.001
LS clast	Moderate Negative	-.393	.001
Collema	Moderate Positive	.390	.001
pH ($CaCl_2$)	Moderate Negative	-.390	.001
EC	Moderate Positive	.386	.001
B	Moderate Positive	.384	.001
Silt	Moderate Positive	.357	.003
Tot Lichen	Moderate Positive	.343	.005
Moss-Lichen	Moderate Positive	.342	.005
SO_4	Moderate Positive	.332	.006
Tot BSC	Moderate Positive	.319	.008
Easting	Moderate Positive	.304	.012
CyanoBare	Moderate Positive	.301	.013
Elevation	Weak Positive	.289	.018
Mg	Weak Negative	-.274	.025
pH (sat. paste)	Weak Negative	-.266	.029
Zn	Weak Positive	.262	.032
Clay	Weak Negative	-.259	.034
Cu	Weak Positive	.258	.035
SS clast	Weak Negative	-.257	.036
Moisture	Weak Positive	.257	.036
P	Weak Positive	.251	.040
Na	Weak Positive	.248	.043
Moss	Weak Positive	.242	.480

Table 4-19d: Summary for Non-BW Interspace, Surface Data, All Sites: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
Northing	Moderate Negative	-.338	.005
Bkm clast	Weak Negative	-.269	.028
Chert	Weak Negative	-.262	.032

(continued on next page)

Table 4-19e: Summary for Non-BW Interspace, Surface Data, All Sites: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
Ca	Strong Negative	-.524	.000
Fe	Strong Negative	-.505	.000
Ni	Moderate Negative	-.433	.000
Total C	Moderate Negative	-.407	.001
Psora	Moderate Negative	-.395	.001
Cu	Moderate Negative	-.390	.001
Bkm clast	Moderate Negative	-.389	.001
Inorganic C	Moderate Negative	-.389	.001
$CaCO_3$	Moderate Negative	-.389	.001
Northing	Moderate Negative	-.371	.002
Clay	Moderate Negative	-.333	.006
Other Rock	Moderate Positive	.302	.013
Moisture	Moderate Negative	-.301	.013
Blue Lichen	Weak Negative	-.272	.026
Ls clast	Weak Positive	.265	.030
Collema	Weak Negative	-.262	.032
K	Weak Positive	.259	.034
pH (1:1)	Weak Positive	.244	.046
Other Ign	Weak Positive	.240	.500

Table 4-20: Spearman's Rho Non-BW Interspace, Surface Data, Bitter Spring

Table 4-20a: Summary for Non-BW Interspace, Surface Data, Bitter Spring: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.994	.000
Mn	Strong Negative	-.664	.003
Collema	Strong Negative	-.615	.007
Co	Strong Negative	-.593	.009
Na	Strong Negative	-.548	.019
Tot Lichen	Strong Negative	-.528	.024
Moss-Lichen	Strong Negative	-.528	.024
K	Strong Negative	-.503	.034
Cl	Strong Negative	-.494	.037

Table 4-20b: Summary for Non-BW Interspace, Surface Data, Bitter Spring: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ca	Very Strong Positive	.965	.000
Ni	Strong Positive	.748	.000
Gypsum	Strong Positive	.681	.002
As	Strong Positive	.633	.005
Total N	Strong Negative	-.624	.006
YrInsolation	Strong Negative	-.622	.006
EC	Strong Positive	.581	.011
SO_4	Strong Positive	.560	.016
Slope	Strong Positive	.482	.043
pH (1:1)	Strong Negative	-.474	.047

Table 4-20c: Summary for Non-BW Interspace, Surface Data, Bitter Spring: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Placidium	Strong Negative	-.526	.025
LS clast	Strong Negative	-.512	.030
CarbRock	Strong Negative	-.512	.030
AllRock	Strong Negative	-.494	.037

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Table 4-20d: Summary for Non-BW Interspace, Surface Data, Bitter Spring: Correlation to Litter			
Significant Variable	**Correlation to Litter**	**Correlation coefficient**	**p-value**
Aspect	Strong Negative	-.580	.012
As	Strong Negative	-.508	.031
Moisture	Strong Negative	-.506	.032
Slope	Strong Negative	-.501	.034

Table 4-20e: Summary for Non-BW Interspace, Surface Data, Bitter Spring: Correlation to Grass Litter			
Significant Variable	**Correlation to Grass Litter**	**Correlation coefficient**	**p-value**
Total N	Strong Positive	.614	.007
Ca	Strong Negative	-.514	.029

Table 4-21: Spearman's Rho Non-BW Interspace, Surface Data, Coyote Springs

Table 4-21a: Summary for Non-BW Interspace, Surface Data, Coyote Springs: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.961	.000
LS clast	Strong Negative	-.772	.000
Easting	Strong Positive	.750	.000
P	Strong Negative	-.656	.001
Bkm clast	Strong Positive	.649	.001
AllRock	Strong Negative	-.640	.002
TotRock	Strong Negative	-.640	.002
Blue Lichecn	Strong Positive	.597	.004
Tot Lichen	Strong Positive	.588	.005
Moss-Lichen	Strong Positive	.588	.005
TotBSC	Strong Positive	.588	.005
CarbRock	Strong Negative	-.588	.005
Grass Litter	Strong Negative	-.581	.006
Collema	Strong Positive	.530	.013
Bare	Strong Positive	.528	.014
CyanoBare	Strong Positive	.528	.014
Litter	Strong Positive	.471	.031
Sand	Strong Positive	.471	.031
Aspect	Moderate Positive	.442	.045

Table 4-21b: Summary for Non-BW Interspace, Surface Data, Coyote Springs: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Mg	Strong Positive	.818	.000
Ni	Strong Positive	.769	.000
Ca	Strong Positive	.743	.000
Na	Strong Positive	.645	.002
Moisture	Strong Positive	.630	.002
Surf Hrz thk cm	Strong Negative	-.575	.010
pH ($CaCl_2$)	Strong Positive	.565	.008
SS clast	Strong Negative	-.464	.034
Northing	Moderate Positive	.434	.049

Table 4-21c: Summary for Non-BW Interspace, Surface Data, Coyote Springs: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
pH (sat. paste)	Moderate Positive	.447	.042

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Table 4-21d: Summary for Non-BW Interspace, Surface Data, Coyote Springs: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
Northing	Strong Positive	.571	.007
Qtzite	Strong Positive	.566	.008
Total C	Strong Positive	.562	.008
Chert	Strong Negative	-.493	.023
Inorganic C	Strong Positive	.471	.031
$CaCO_3$	Strong Positive	.471	.031

Table 4-21e: Summary for Non-BW Interspace, Surface Data, Coyote Springs: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
Bkm clast	Strong Negative	-.701	.000
Ls clast	Strong Positive	.632	.002
Total C	Strong Negative	-.584	.005
Inorganic C	Strong Negative	-.581	.006
$CaCO_3$	Strong Negative	-.581	.006
Zn	Strong Positive	.558	.009
Easting	Strong Negative	-.533	.013
Ca	Strong Negative	-.511	.018
P	Strong Positive	.501	.021
Northing	Strong Negative	-.483	.026
Silt	Strong Positive	.454	.039
Sand	Strong Negative	-.451	.040
Mo	Moderate Positive	.442	.045

Table 4-22: Spearman's Rho Non-BW Interspace, Surface Data, Gold Butte

Table 4-22a: Summary for Non-BW Interspace, Surface Data, Gold Butte: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.984	.000
Clay	Strong Positive	.818	.000
Sand	Strong Negative	-.773	.000
As	Strong Positive	.738	.000
Silt	Strong Positive	.711	.000
Mg	Strong Positive	.585	.001
Zn	Strong Negative	-.500	.007
AllRock	Strong Negative	-.489	.008
CyanoBare	Strong Positive	.486	.009
Grass Litter	Strong Negative	-.472	.011
TotBSC	Strong Positive	.461	.013
Ca	Moderate Positive	.413	.029
Cyanobacteria	Moderate Positive	.412	.029
Fe	Moderate Positive	.399	.036
Slope	Moderate Negative	-.398	.036
Mn	Moderate Negative	-.396	.037
Surf horz thk cm	Moderate Positive	.396	.037
Ni	Moderate Positive	.395	.037
TotLichen	Moderate Positive	.388	.042

Table 4-22b: Summary for Non-BW Interspace, Surface Data, Gold Butte: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.917	.000
Ca	Strong Positive	.878	.000
Grass Litter	Strong Negative	-.792	.000
As	Strong Positive	.673	.000
SO_4	Strong Positive	.672	.000
Bare	Strong Negative	-.632	.000
B	Strong Positive	.622	.000
EC	Strong Positive	.610	.001
Moisture	Strong Positive	.600	.001
pH (1:1)	Strong Negative	-.596	.001
pH ($CaCl_2$)	Strong Negative	-.574	.001
Cu	Strong Positive	.558	.002
Psora	Strong Positive	.553	.002
Cyanobacteria	Strong Positive	.524	.004
Total N	Strong Positive	.519	.005
Organic C	Strong Positive	.507	.006
Gypsum	Strong Positive	.503	.006
Total C	Strong Positive	.496	.007

Table 4-22b (continued)			
Significant Variable	**Correlation to Fe**	**Correlation coefficient**	**p-value**
TotRock	Strong Negative	-.488	.008
CarbRock	Strong Negative	-.488	.008
LS clast	Strong Negative	-.488	.008
Silt	Strong Positive	.456	.015
Sand	Moderate Negative	-.421	.026
TotBSC	Moderate Positive	.413	.029
Cl	Moderate Positive	.401	.035
Inorganic C	Moderate Positive	.399	.036
$CaCO_3$	Moderate Positive	.399	.036
K	Moderate Negative	-.394	.038
Slope	Moderate Positive	.375	.049

Table 4-22c: Summary for Non-BW Interspace, Surface Data, Gold Butte: Correlation to Organic C			
Significant Variable	**Correlation to Organic C**	**Correlation coefficient**	**p-value**
B	Strong Positive	.842	.000
Total N	Strong Positive	.829	.000
Cu	Strong Positive	.749	.000
pH (1:1)	Strong Negative	-.733	.000
EC	Strong Positive	.626	.000
Psora	Strong Positive	.594	.001
SO_4	Strong Positive	.587	.001
Collema	Strong Positive	.572	.001
TotLichen	Strong Positive	.572	.001
pH ($CaCl_2$)	Strong Negative	-.564	.002
Moss-Lichen	Strong Positive	.557	.002
Fe	Strong Positive	.507	.006
Silt	Strong Positive	.492	.008
Grass Litter	Strong Negative	-.476	.010
TotBSC	Strong Positive	.453	.015
pH (sat. paste)	Strong Negative	-.453	.015
Na	Moderate Positive	.448	.017
Zn	Moderate Positive	.447	.017
TotRock	Moderate Negative	-.437	.020
Other Ign	Moderate Negative	-.435	.021
Sand	Moderate Negative	-.435	.021
Cl	Moderate Positive	.426	.024
LS clast	Moderate Negative	-.425	.024
CarbRock	Moderate Negative	-.425	.024
Moisture	Moderate Positive	.419	.026
Ni	Moderate Positive	.381	.045

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Table 4-22d: Summary for Non-BW Interspace, Surface, Gold Butte: Correlation to Litter			
Significant Variable	**Correlation to Litter**	**Correlation coefficient**	**p-value**
Elevation	Moderate Negative	-.432	.022
Other rock	Moderate Positive	.416	.028
LS clast	Moderate Positive	.408	.031
CarbRock	Moderate Positive	.408	.031
TotRock	Moderate Positive	.389	.041

Table 4-22e: Summary for Non-BW Interspace, Surface Data, Gold Butte: Correlation to Grass Litter			
Significant Variable	**Correlation to Grass Litter**	**Correlation coefficient**	**p-value**
Ca	Strong Negative	-.802	.000
Fe	Strong Negative	-.792	.000
Ni	Strong Negative	-.789	.000
SO_4	Strong Negative	-.718	.000
Psora	Strong Negative	-.678	.000
TotRock	Strong Positive	.674	.000
LS clast	Strong Positive	.664	.000
CarbRock	Strong Positive	.664	.000
Moisture	Strong Negative	-.655	.000
As	Strong Negative	-.655	.000
Cyanobacteria	Strong Negative	-.633	.000
EC	Strong Negative	-.617	.000
pH ($CaCl_2$)	Strong Positive	.575	.001
B	Strong Negative	-.572	.001
Bare	Strong Positive	.565	.002
pH (1:1)	Strong Positive	.549	.002
Cu	Strong Negative	-.545	.003
Collema	Strong Negative	-.543	.003
Total C	Strong Negative	-.543	.003
Silt	Strong Negative	-.513	.005
Sand	Strong Positive	.502	.007
Gypsum	Strong Negative	-.495	.007
TotBSC	Strong Negative	-.490	.008
Other rock	Strong Positive	.477	.010
Organic C	Strong Negative	-.476	.010
Inorganic C	Strong Negative	-.472	.011
$CaCO_3$	Strong Negative	-.472	.011
Total N	Strong Negative	-.460	.014
TotLichen	Moderate Negative	-.445	.018
Clay	Moderate Negative	-.436	.021
Moss-Lichen	Moderate Negative	-.407	.031
K	Moderate Positive	.406	.032
Cl	Moderate Negative	-.399	.036
Slope	Moderate Negative	-.396	.037
Other Ign	Moderate Positive	.390	.040
P	Moderate Positive	.385	.043

Table 4-23: Spearman's Rho Potential Habitat Interspace, Surface Data, All Sites

Table 4-23a: Summary for Potential Habitat Interspace, Surface Data, All Sites: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.997	.000
Bkm clast	Strong Positive	.755	.000
Clay	Strong Positive	.752	.000
CarbRock	Strong Positive	.709	.000
Mg	Strong Positive	.703	.000
pH ($CaCl_2$)	Strong Positive	.690	.000
SO_4	Strong Negative	-.687	.000
pH (1:1)	Strong Positive	.669	.000
B	Strong Negative	-.640	.000
EC	Strong Negative	-.625	.000
BlueLichen	Strong Positive	.612	.000
TotRock	Strong Positive	.612	.000
Northing	Strong Positive	.612	.000
Elevation	Strong Negative	-.586	.000
Gypsum	Strong Negative	-.581	.000
LS clast	Strong Positive	.549	.001
NO_3	Strong Positive	.549	.001
Organic C	Strong Negative	-.539	.001
Easting	Strong Negative	-.532	.001
Slope	Strong Negative	-.491	.003
pH (sat. paste)	Strong Positive	.480	.004
Moisture	Strong Negative	-.461	.005
Mn	Moderate Negative	-.447	.007
Fe	Moderate Positive	.433	.009
Ni	Moderate Positive	.425	.011
Co	Moderate Negative	-.422	.012
Zn	Moderate Negative	-.408	.015
SS clast	Moderate Positive	.368	.030
Ca	Moderate Positive	.366	.030
Grass Litter	Moderate Negative	-.363	.032
Bare	Moderate Positive	.361	.033
P	Moderate Negative	-.358	.035
Collema	Moderate Negative	-.347	.041
Cyanobacteria	Moderate Negative	-.337	.048

Table 4-23b: Summary for Potential Habitat Interspace, Surface Data, All Sites: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Strong Positive	.841	.000
Ca	Strong Positive	.777	.000
Mg	Strong Positive	.554	.001
Clay	Strong Positive	.459	.006

Table 4-23b (continued)			
Mn	Strong Negative	-.452	.006
Elevation	Strong Negative	-.450	.007
Easting	Moderate Negative	-.441	.008
Total C	Moderate Positive	.438	.008
Inorganic C	Moderate Positive	.433	.009
$CaCO_3$	Moderate Positive	.433	.009
NO_3	Moderate Positive	.431	.010
CarbRock	Moderate Positive	.416	.013
Bkm clast	Moderate Positive	.396	.018
LS clast	Moderate Positive	.390	.020
P	Moderate Negative	-.365	.031
Co	Moderate Negative	-.348	.041
Placidium	Moderate Negative	-.335	.049
Total N	Moderate Negative	-.334	.050

Table 4-23c: Summary for Potential Habitat Interspace, Surface Data, All Sites: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Total N	Strong Positive	.652	.000
B	Strong Positive	.650	.000
Moss-Lichen	Strong Positive	.615	.000
TotLichen	Strong Positive	.614	.000
Psora	Strong Positive	.568	.000
pH (1:1)	Strong Negative	-.567	.000
Silt	Strong Positive	.558	.000
Placidium	Strong Positive	.557	.001
Inorganic C	Strong Negative	-.539	.001
$CaCO_3$	Strong Negative	-.539	.001
TotBSC	Strong Positive	.529	.001
pH ($CaCl_2$)	Strong Negative	-.515	.002
Total C	Strong Negative	-.503	.002
Collema	Strong Positive	.501	.002
SO_4	Strong Positive	.500	.002
AllRock	Strong Negative	-.495	.003
EC	Strong Positive	.495	.003
P	Strong Positive	.476	.004
Bkm Clast	Strong Negative	-.464	.005
Mg	Moderate Negative	-.438	.008
CarbRock	Moderate Negative	-.423	.011
Cyanobacteria	Moderate Positive	.418	.013
Sand	Moderate Negative	-.405	.016
TotRock	Moderate Negative	-.402	.017
Easting	Moderate Positive	.402	.017
Zn	Moderate Positive	.384	.023
Elevation	Moderate Positive	.361	.033
Cu	Moderate Positive	.360	.034
LS clast	Moderate Negative	-.337	.047

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Table 4-23d: Summary for Potential Habitat Interspace, Surface Data, All Sites: Correlation to Litter			
Significant Variable	**Correlation to Litter**	**Correlation coefficient**	**p-value**
As	Moderate Positive	.400	.017

Table 4-23e: Summary for Potential Habitat Interspace, Surface Data All Sites: Correlation to Grass Litter			
Significant Variable	**Correlation to Grass Litter**	**Correlation coefficient**	**p-value**
Northing	Strong Negative	-.485	.003
Clay	Strong Negative	-.483	.003
K	Strong Positive	.470	.004
Psora	Moderate Negative	-.411	.014
Ca	Moderate Negative	-.405	.016
Total C	Moderate Negative	-.375	.027
Inorganic C	Moderate Negative	-.363	.032
$CaCO_3$	Moderate Negative	-.363	.032
Siltstone	Moderate Positive	.351	.039
Ni	Moderate Negative	-.336	.049

Table 4-24: Spearman's Rho Potential Habitat Interspace, Surface Data, Bitter Spring

Table 4-24a: Summary for Potential Habitat Interspace, Surface Data, Bitter Spring: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.964	.000
Organic C	Strong Negative	-.786	.036
Collema	Strong Negative	-.768	.044
TotLichen	Strong Negative	-.768	.044
Moss-Lichen	Strong Negative	-.768	.044

Table 4-24b: Summary for Potential Habitat Interspace, Surface Data, Bitter Spring: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ca	Very Strong Positive	.964	.000
Clay	Strong Positive	.893	.007
YrInsolation	Strong Negative	-.821	.023

Table 4-24c: Summary for Potential Habitat Interspace, Surface Data, Bitter Spring: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
AllRock	Strong Negative	-.857	.014
Collema	Strong Positive	.808	.028
TotLichen	Strong Positive	.808	.028
Moss-Lichen	Strong Positive	.808	.028
Inorganic C	Strong Negative	-.786	.036
$CaCO_3$	Strong Negative	-.786	.036

Table 4-24d: Summary for Potential Habitat Interspace, Surface Data, Bitter Spring: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
Easting	Strong Positive	.845	.017
Clay	Strong Positive	.811	.027
Ni	Strong Positive	.775	.041

Table 4-24e: Summary for Potential Habitat Interspace, Surface Data, Bitter Spring: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
NONE			

Table 4-25: Spearman's Rho Potential Habitat Interspace, Surface Data, Coyote Springs

Table 4-25a: Summary for Potential Habitat Interspace, Surface Data, Coyote Springs: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.988	.000
Bkm clast	Strong Positive	.821	.004
LS clast	Strong Negative	-.778	.008
NO_3	Strong Positive	.729	.017
Cl	Strong Positive	.697	.025

Table 4-25b: Summary for Potential Habitat Interspace, Surface Data, Coyote Springs: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
AllRock	Strong Negative	-.794	.006
TotRock	Strong Negative	-.794	.006
Northing	Strong Positive	.788	.007
CarbRock	Strong Negative	-.758	.011
SurfHorzThk cm	Strong Negative	-.753	.012
Collema	Strong Positive	.729	.017
TotLichen	Strong Positive	.709	.022
Moss-Lichen	Strong Positive	.709	.022
TotBSC	Strong Positive	.709	.022
Na	Strong Positive	.697	.025
Bare	Strong Positive	.687	.028
CyanoBare	Strong Positive	.687	.028
Moisture	Strong Positive	.648	.043

Table 4-25c: Summary for Potential Habitat Interspace, Surface Data, Coyote Springs: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
pH (sat. paste)	Strong Positive	.721	.019
Slope	Strong Positive	.721	.019
EC	Strong Negative	-.675	.032

Table 4-25d: Summary for Potential Habitat Interspace, Surface Data, Coyote Springs: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
NONE			

Table 4-25e: Summary for Potential Habitat Interspace, Surface Data, Coyote Springs: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
NONE			

Table 4-26: Spearman's Rho Potential Habitat Interspace, Surface Data, Gold Butte

Table 4-26a: Summary for Potential Habitat Interspace, Surface Data, Gold Butte: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.986	.000
Clay	Strong Positive	.881	.000
pH ($CaCl_2$)	Strong Positive	.750	.000
Mg	Strong Positive	.737	.000
Sand	Strong Negative	-.727	.001
Moisture	Strong Negative	-.719	.001
pH (1:1)	Strong Positive	.697	.001
Zn	Strong Negative	-.679	.002
Silt	Strong Positive	.671	.002
As	Strong Positive	.647	.004
Slope	Strong Negative	-.631	.005
CyanoBare	Strong Positive	.570	.013
Gypsum	Strong Negative	-.558	.016
AllRock	Strong Negative	-.533	.023
pH (sat. paste)	Strong Positive	.530	.024
Cyanobacteria	Strong Positive	.490	.039

Table 4-26b: Summary for Potential Habitat Interspace, Surface Data, Gold Butte: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.915	.000
Ca	Strong Positive	.841	.000
Grass Litter	Strong Negative	-.581	.011
Bare	Strong Negative	-.562	.015

Table 4-26c: Summary for Potential Habitat Interspace, Surface Data, Gold Butte: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
B	Strong Positive	.814	.000
Total N	Strong Positive	.736	.001
Cu	Strong Positive	.688	.002
Zn	Strong Positive	.562	.015
pH (1:1)	Strong Negative	-.556	.017
Na	Strong Positive	.556	.017

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Table 4-26d: Summary for Potential Habitat Interspace, Surface Data, Gold Butte: Correlation to Litter			
Significant Variable	**Correlation to Litter**	**Correlation coefficient**	**p-value**
LS clast	Strong Positive	.546	.019
CarbRock	Strong Positive	.546	.019
TotRock	Strong Positive	.518	.028
SO_4	Strong Positive	.493	.038
NO_3	Strong Positive	.478	.045
Ni	Strong Positive	.471	.048

Table 4-26e: Summary for Potential Habitat Interspace, Surface Data, Gold Butte: Correlation to Grass Litter			
Significant Variable	**Correlation to Grass Litter**	**Correlation coefficient**	**p-value**
Fe	Strong Negative	-.581	.011
Ca	Strong Negative	-.550	.018
Psora	Strong Negative	-.534	.022
Cyanobacteria	Strong Negative	-.504	.033
Bare	Strong Positive	.485	.041

Table 4-27: Spearman's Rho Non-Habitat Interspace, Surface Data, All Sites

Table 4-27a: Summary for Non-Habitat Interspace, Surface Data, All Sites: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.994	.000
Mg	Strong Positive	.815	.000
Easting	Strong Negative	-.803	.000
Elevation	Strong Negative	-.795	.000
Placidium	Strong Negative	-.687	.000
AllRock	Strong Positive	.677	.000
Fe	Strong Positive	.650	.000
CarbRock	Strong Positive	.645	.000
SurfHorzThk cm	Strong Positive	.640	.000
TotRock	Strong Positive	.627	.000
Bkm clast	Strong Positive	.572	.001
Moss-Lichen	Strong Negative	-.545	.001
TotBSC	Strong Negative	-.545	.001
TotLichen	Strong Negative	-.536	.001
Qtzite	Strong Positive	.533	.001
Ni	Strong Positive	.531	.001
Grass Litter	Strong Negative	-.527	.002
ChertQrzt	Strong Positive	.523	.002
LS clast	Strong Positive	.508	.003
Moss	Strong Negative	-.474	.005
Ca	Strong Positive	.471	.006
Other rock	Strong Negative	-.468	.006
Other Ign	Strong Negative	-.452	.008
Northing	Moderate Positive	.449	.009
Aspect	Moderate Negative	-.430	.012
Moisture	Moderate Positive	.402	.020
NO_3	Moderate Positive	.395	.023
Clay	Moderate Positive	.380	.029
B	Moderate Negative	-.369	.035
Cu	Moderate Positive	.359	.040
As	Moderate Positive	.350	.046

Table 4-27b: Summary for Non-Habitat Interspace, Surface Data, All Sites: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ca	Strong Positive	.879	.000
Ni	Strong Positive	.878	.000
Mg	Strong Positive	.752	.000
Placidium	Strong Negative	-.692	.000
As	Strong Positive	.690	.000

Table 4-27b (continued)			
Total C	Strong Positive	.664	.000
Grass Litter	Strong Negative	-.658	.000
Inorganic C	Strong Positive	.650	.000
$CaCO_3$	Strong Positive	.650	.000
Elevation	Strong Negative	-.648	.000
NO_3	Strong Positive	.638	.000
Easting	Strong Negative	-.575	.000
AllRock	Strong Positive	.559	.001
Moisture	Strong Positive	.556	.001
TotBSC	Strong Negative	-.519	.002
CarbRock	Strong Positive	.518	.002
Moss-Lichen	Strong Negative	-.512	.002
YrInsolation	Strong Negative	-.510	.002
TotLichen	Strong Negative	-.508	.003
Other rock	Strong Negative	-.506	.003
Aspect	Strong Negative	-.473	.005
Clay	Strong Positive	.457	.008
Other Ign	Moderate Negative	-.444	.010
LS clast	Moderate Positive	.440	.010
TotRock	Moderate Positive	.436	.011
Qtzite	Moderate Positive	.422	.014
Gypsum	Moderate Positive	.409	.018
Cl	Moderate Positive	.389	.025
Bkm clast	Moderate Positive	.379	.030
Moss	Moderate Negative	-.377	.030
P	Moderate Negative	-.364	.037
SurfHorzThk cm	Moderate Positive	.363	.045

Table 4-27c: Summary for Non-Habitat Interspace, Surface Data, All Sites: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Total N	Moderate Positive	.396	.023
Psora	Moderate Positive	.373	.032

Table 4-27d: Summary for Non-Habitat Interspace, Surface Data, All Sites: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
Moss	Moderate Positive	.380	.029
Other rock	Moderate Positive	.379	.030
pH (1:1)	Moderate Negative	-.358	.041
Chert	Moderate Negative	-.356	.042
Clay	Moderate Negative	-.346	.049

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Table 4-27e: Summary for Non-Habitat Interspace, Surface Data, All Sites: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
Fe	Strong Negative	-.658	.000
Ca	Strong Negative	-.634	.000
Ni	Strong Negative	-.562	.001
YrInsolation	Strong Positive	.538	.001
Total C	Strong Negative	-.535	.001
Inorganic C	Strong Negative	-.527	.002
CaCO3	Strong Negative	-.527	.002
Elevation	Strong Positive	.499	.003
Other rock	Strong Positive	.490	.004
Mg	Strong Negative	-.489	.004
Placidium	Strong Positive	.479	.005
Bkm clast	Strong Negative	-.476	.005
Moisture	Strong Negative	-.451	.009
Cu	Moderate Negative	-.448	.009
As	Moderate Negative	-.447	.009
Aspect	Moderate Positive	.405	.019
NO_3	Moderate Negative	-.399	.021
Moss	Moderate Positive	.363	.038

Table 4-28: Spearman's Rho Non-Habitat Interspace, Surface Data, Bitter Spring

Table 4-28a: Summary for Non-Habitat Interspace, Surface Data, Bitter Spring: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.982	.000
Moisture	Strong Positive	.645	.032
pH ($CaCl_2$)	Strong Negative	-.645	.032

Table 4-28b: Summary for Non-Habitat Interspace, Surface, Bitter Spring: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ca	Very Strong Positive	.991	.000
Ni	Strong Positive	.800	.004
Gypsum	Strong Positive	.797	.003
As	Strong Positive	.791	.004
Total N	Strong Negative	-.773	.005
Slope	Strong Positive	.755	.007
P	Strong Negative	-.682	.021
EC	Strong Positive	.665	.026
SO_4	Strong Positive	.645	.032
Mg	Strong Positive	.618	.043

Table 4-28c: Summary for Non-Habitat Interspace, Surface Data, Bitter Spring: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Bare	Strong Positive	.664	.026
CyanoBare	Strong Positive	.664	.026
TotBSC	Strong Negative	-.661	.027
Siltstone	Strong Positive	.607	.048

Table 4-28d: Summary for Non-Habitat Interspace, Surface Data, Bitter Spring: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
Slope	Strong Negative	-.612	.045

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Table 4-28e: Summary for Non-Habitat Interspace, Surface Data, Bitter Spring: Correlation to Grass Litter			
Significant Variable	**Correlation to Grass Litter**	**Correlation coefficient**	**p-value**
Easting	Strong Negative	-.752	.008
Elevation	Strong Positive	.750	.008
Total N	Strong Positive	.726	.011
YrInsolation	Strong Positive	.698	.017
Mo	Strong Negative	-.675	.023
Na	Strong Negative	-.631	.037

Table 4-29: Spearman's Rho Non-Habitat Interspace, Surface Data, Coyote Springs

Table 4-29a: Summary for Non-Habitat Interspace, Surface Data, Coyote Springs: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.951	.000
Clay	Strong Negative	-.804	.002
Collema	Strong Positive	.725	.008
Litter	Strong Positive	.699	.011
TotLichen	Strong Positive	.696	.012
Moss-Lichen	Strong Positive	.696	.012
TotBSC	Strong Positive	.696	.012
SurfHorzThk cm	Strong Positive	.673	.033
AllRock	Strong Negative	-.664	.018
TotRock	Strong Negative	-.664	.018
Easting	Strong Positive	.655	.021
LS clast	Strong Negative	-.623	.030
CarbRock	Strong Negative	-.618	.032
Total N	Strong Positive	.615	.033
Bare	Strong Positive	.606	.037
CyanoBare	Strong Positive	.606	.037
pH (1:1)	Strong Negative	-.594	.042

Table 4-29b: Summary for Non-Habitat Interspace, Surface Data, Coyote Springs: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ca	Strong Positive	.895	.000
Ni	Strong Positive	.860	.000
As	Strong Positive	.846	.001
Mg	Strong Positive	.818	.001
SO_4	Strong Positive	.725	.008
pH ($CaCl_2$)	Strong Positive	.713	.009
K	Strong Positive	.699	.011
Bare	Strong Negative	-.658	.020
CyanoBare	Strong Negative	-.658	.020
B	Strong Positive	.643	.024
Moisture	Strong Positive	.615	.033
Cl	Strong Positive	.580	.048

Table 4-29c: Summary for Non-Habitat Interspace, Surface Data, Coyote Springs: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
YrInsolation	Strong Negative	-.615	.033
Total N	Strong Positive	.608	.036
Na	Strong Positive	.601	.039

Table 4-29d: Summary for Non-Habitat Interspace, Surface Data, Coyote Springs: Correlation to Litter			
Significant Variable	**Correlation to Litter**	**Correlation coefficient**	**p-value**
Qtzite	Strong Positive	.882	.000
Northing	Strong Positive	.738	.006
Total C	Strong Positive	.714	.009
Inorganic C	Strong Positive	.699	.011
$CaCO_3$	Strong Positive	.699	.011
ChertQrzt	Strong Positive	.682	.015

Table 4-29e: Summary for Non-Habitat Interspace, Surface Data, Coyote Springs: Correlation to Grass Litter			
Significant Variable	**Correlation to Grass Litter**	**Correlation coefficient**	**p-value**
Bkm clast	Strong Negative	-.695	.012

Table 4-30: Spearman's Rho Non-Habitat Interspace, Surface Data, Gold Butte

Table 4-30a: Summary for Non-Habitat Interspace, Surface Data, Gold Butte: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.939	.000
As	Strong Positive	.891	.001
Ca	Strong Positive	.855	.002
Ni	Strong Positive	.770	.009
CyanoBare	Strong Positive	.733	.016
Mo	Strong Negative	-.671	.034
Grass Litter	Strong Negative	-.663	.037
Aspect	Strong Negative	-.648	.043

Table 4-30b: Summary for Non-Habitat Interspace, Surface, Gold Butte: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
B	Very Strong Positive	.939	.000
AllRock	Strong Negative	-.794	.006
TotRock	Strong Negative	-.790	.007
LS clast	Strong Negative	-.729	.017
CarbRock	Strong Negative	-.729	.017
Psora	Strong Positive	.696	.025

Table 4-30c: Summary for Non-Habitat Interspace, Surface Data, Gold Butte: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Other Ign	Strong Negative	-.799	.006
Slope	Strong Positive	.758	.011
Collema	Strong Positive	.718	.019
pH (1:1)	Strong Negative	-.709	.022
pH (sat. paste)	Strong Negative	-.697	.025
Psora	Strong Positive	.696	.025
EC	Strong Positive	.669	.035
Total N	Strong Positive	.648	.043

Table 4-30d: Summary for Non-Habitat Interspace, Surface Data, Gold Butte: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
Moss	Strong Positive	.778	.008
SurfHorzThk cm	Strong Positive	.754	.012
Co	Strong Negative	-.745	.013
Other rock	Strong Positive	.690	.027

Table 4-30e: Summary for Non-Habitat Interspace, Surface Data, Gold Butte: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
Moisture	Very Strong Negative	-.973	.000
Ni	Very Strong Negative	-.906	.000
As	Very Strong Negative	-.900	.000
SO_4	Strong Negative	-.888	.001
Ca	Strong Negative	-.827	.003
Total C	Strong Negative	-.802	.005
P	Strong Positive	.748	.013
Psora	Strong Negative	-.698	.025
Inorganic C	Strong Negative	-.663	.037
$CaCO_3$	Strong Negative	-.663	.037
Sand	Strong Positive	.632	.050

Table 4-31: Spearman's Rho BW canopy BW plots, Surface Data, All Sites

Table 4-31a: Summary for BW canopy BW plots, Surface Data, All Sites: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.924	.000
B	Strong Negative	-.754	.000
Mg	Strong Positive	.710	.000
EC	Strong Negative	-.696	.000
TotRock	Strong Positive	.666	.000
Northing	Strong Positive	.659	.000
Easting	Strong Negative	-.655	.000
Bkm clast	Strong Positive	.636	.000
pH (1:1)	Strong Positive	.624	.000
Clay	Strong Positive	.622	.000
P	Strong Negative	-.616	.000
SO_4	Strong Negative	-.609	.000
Moisture	Strong Negative	-.590	.000
Litter	Strong Negative	-.587	.001
Cyanobacteria	Strong Negative	-.578	.001
As	Strong Negative	-.573	.001
CarbRock	Strong Positive	.571	.001
Slope	Strong Negative	-.531	.002
Total N	Strong Negative	-.521	.003
K	Strong Negative	-.521	.003
Ca	Strong Positive	.519	.003
Elevation	Strong Negative	-.519	.003
AllRock	Strong Positive	.517	.003
Gypsum	Strong Negative	-.497	.004
Fe	Strong Positive	.457	.010
TotBSC	Moderate Negative	-.443	.013
SS clast	Moderate Positive	.412	.021
BlueLichen	Moderate Positive	.408	.023
Mn	Moderate Negative	-.396	.028
Moss	Moderate Negative	-.395	.028
Yellow Lichen	Moderate Negative	-.378	.036
SurfHorzThk cm	Moderate Negative	-.372	.039

Table 4-31b: Summary for BWcanopy BW plots, Surface Data, All Sites: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Strong Positive	.885	.000
Ca	Strong Positive	.766	.000
Total N	Strong Negative	-.591	.000
Clay	Strong Positive	.484	.006
Total C	Strong Positive	.465	.008
Inorganic C	Strong Positive	.457	.010

Table 4-31b (continued)			
$CaCO_3$	Strong Positive	.457	.010
EC	Moderate Negative	-.380	.035
Easting	Moderate Negative	-.370	.041
P	Moderate Negative	-.363	.045
Mg	Moderate Positive	.355	.050

Table 4-31c: Summary for BWcanopy BW plots, Surface Data, All Sites: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Bare	Strong Negative	-.463	.009
B	Moderate Positive	.417	.020

Table 4-31d: Summary for BWcanopy BW plots, Surface Data, All Sites: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
EC	Strong Positive	.801	.000
Cyanobacteria	Strong Positive	.785	.000
TotRock	Strong Negative	-.732	.000
Easting	Strong Positive	.730	.000
Mg	Strong Negative	-.718	.000
Bkm clast	Strong Negative	-.702	.000
CarbRock	Strong Negative	-.697	.000
Elevation	Strong Positive	.685	.000
AllRock	Strong Negative	-.633	.000
SO_4	Strong Positive	.624	.000
Total C	Strong Negative	-.616	.000
Moss	Strong Positive	.603	.000
Inorganic C	Strong Negative	-.587	.001
$CaCO_3$	Strong Negative	-.587	.001
B	Strong Positive	.586	.001
pH (sat. paste)	Strong Negative	-.576	.001
pH (1:1)	Strong Negative	-.565	.001
Gypsum	Strong Positive	.551	.001
BlueLichen	Strong Negative	-.536	.002
TotBSC	Strong Positive	.530	.002
Northing	Strong Negative	-.514	.003
P	Strong Positive	.505	.004
Cl	Strong Positive	.494	.005
Total N	Strong Positive	.491	.005
Psora	Strong Positive	.457	.010
Placidium	Moderate Positive	.446	.012
Slope	Moderate Positive	.442	.013
Mn	Moderate Positive	.423	.018
Silt	Moderate Positive	.422	.018
As	Moderate Positive	.413	.021
Co	Moderate Positive	.410	.022
Moisture	Moderate Positive	.397	.027
YrInsolation	Moderate Positive	.378	.036

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Table 4-31e: Summary for BWcanopy BW plots, Surface Data, All Sites: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
As	Strong Positive	.577	.001
Northing	Strong Negative	-.561	.001
LS clast	Strong Positive	.457	.010
Collema	Strong Negative	-.452	.011
TotLichen	Moderate Negative	-.449	.011
Moss-Lichen	Moderate Negative	-.449	.011
Clay	Moderate Negative	-.396	.027
B	Moderate Positive	.380	.035
Bkm clast	Moderate Negative	-.365	.043
Siltstone	Moderate Positive	.359	.048

Table 4-32: Spearman's Rho BWcanopy BW plots, Surface Data, Bitter Spring

Table 4-32a: Summary for BWcanopy BW plots, Surface Data, Bitter Spring: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
EC	Strong Negative	-.718	.013
Total C	Strong Positive	.618	.043
P	Strong Negative	-.618	.043

Table 4-32b: Summary for BWcanopy BW plots, Surface Data, Bitter Spring: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Strong Positive	.855	.001
As	Strong Positive	.745	.008
Cyano	Strong Positive	.716	.013
Ca	Strong Positive	.682	.021

Table 4-32c: Summary for BWcanopy BW plots, Surface Data, Bitter Spring: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Easting	Strong Positive	.764	.006
Total N	Strong Positive	.736	.010
Cu	Strong Positive	.718	.013
Elevation	Strong Negative	-.636	.035

Table 4-32d: Summary for BWcanopy BW plots, Surface Data, Bitter Spring: Correlation to Litter

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
EC	Strong Positive	.618	.043

Table 4-32e: Summary for BWcanopy BW plots, Surface Data, Bitter Spring: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
TotLichen	Strong Negative	-.886	.000
Moss-Lichen	Strong Negative	-.886	.000
TotBSC	Strong Negative	-.856	.001
AllRock	Strong Positive	.840	.001
TotRock	Strong Positive	.775	.005
Silt	Strong Negative	-.692	.018
pH (1:1)	Strong Positive	.664	.026
pH (sat. paste)	Strong Positive	.608	.047

Table 4-33: Spearman's Rho BWcanopy BW plots, Surface Data, Coyote Springs

Table 4-33a: Summary for BWcanopy BW plots, Surface Data, Coyote Springs: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Strong Positive	.664	.026

Table 4-33b: Summary for BWcanopy BW plots, Surface Data, Coyote Springs: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.991	.000
Ca	Strong Positive	.727	.011
Silt	Strong Positive	.718	.013
Sand	Strong Negative	-.718	.013

Table 4-33c: Summary for BWcanopy BW plots, Surface Data, Coyote Springs: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
NONE			

Table 4-33d: Summary for BWcanopy BW plots, Surface Data, Coyote Springs: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
NONE			

Table 4-33e: Summary for BWcanopy BW plots, Surface Data, Coyote Springs: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
Placidium	Very Strong Positive	1.000	

Table 4-34: Spearman's Rho BWcanopy BW plots, Surface Data, Gold Butte

Table 4-34a: Summary for BWcanopy BW plots, Surface Data, Gold Butte: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.983	.000
Zn	Strong Negative	-.867	.002
Ca	Strong Positive	.833	.005
Silt	Strong Positive	.800	.010
Sand	Strong Negative	-.800	.010
LS clast	Strong Positive	.798	.010
TotRock	Strong Positive	.798	.010
CarbRock	Strong Positive	.798	.010
Mn	Strong Negative	-.733	.025
Mg	Strong Positive	.733	.025
Clay	Strong Positive	.733	.025
Easting	Strong Positive	.683	.042

Table 4-34b: Summary for BWcanopy BW plots, Surface Data, Gold Butte: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.967	.000
Ca	Strong Positive	.833	.005
LS clast	Strong Positive	.771	.015
TotRock	Strong Positive	.771	.015
CarbRock	Strong Positive	.771	.015
Mg	Strong Positive	.683	.042

Table 4-34c: Summary for BWcanopy BW plots, Surface Data, Gold Butte: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Bare	Strong Negative	-.767	.016
Moisture	Strong Negative	-.767	.016
TotLichen	Strong Positive	.750	.020

Table 4-34d: Summary for BWcanopy BW plots, Surface Data, Gold Butte: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
SO_4	Strong Negative	-.767	.016
YrInsolation	Strong Positive	.767	.016
Bare	Strong Positive	.750	.020
Placidium	Strong Negative	-.728	.026

(continued on next page)

Table 4-34e: Summary for BWcanopy BW plots, Surface Data, Gold Butte: Correlation to Grass Litter			
Significant Variable	**Correlation to Grass Litter**	**Correlation coefficient**	**p-value**
SO_4	Strong Positive	.707	.033

Table 4-35: Spearman's Rho Other Plants-Under Canopy in BW plots, Surface Data, All Sites

Table 4-35a: Summary for Other Plants-Under Canopy in BW plots, Surface Data, All Sites: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.960	.000
Mg	Strong Positive	.872	.000
TotRock	Strong Positive	.756	.000
SO_4	Strong Negative	-.749	.000
EC	Strong Negative	-.734	.000
AllRock	Strong Positive	.724	.000
Bkm clast	Strong Positive	.718	.000
B	Strong Negative	-.656	.000
Easting	Strong Negative	-.650	.000
Northing	Strong Positive	.646	.000
Slope	Strong Negative	-.644	.000
Cyanobacteria	Strong Negative	-.642	.000
CarbRock	Strong Positive	.632	.000
Elevation	Strong Negative	-.624	.000
Placidium	Strong Negative	-.607	.000
Clay	Strong Positive	.598	.000
Moisture	Strong Negative	-.587	.001
As	Strong Negative	-.586	.001
pH (1:1)	Strong Positive	.581	.001
Litter	Strong Negative	-.563	.001
Total N	Strong Negative	-.557	.001
Silt	Strong Negative	-.548	.002
BlueLichen	Strong Positive	.547	.002
Gypsum	Strong Negative	-.495	.005
TotBSC	Strong Negative	-.485	.007
K	Strong Negative	-.483	.007
Psora	Moderate Negative	-.440	.015
Organic C	Moderate Negative	-.434	.016
Grass Litter	Moderate Negative	-.429	.018
P	Moderate Negative	-.417	.022
NO_3	Moderate Negative	-.410	.024
pH (sat. paste)	Moderate Positive	.401	.028
Moss	Moderate Negative	-.382	.037
Yellow Lichen	Moderate Negative	-.377	.040
Cl	Moderate Negative	-.372	.043

(Table 4-35 continues on the next page)

Table 4-35b: Summary for Other Plants-Under Canopy in BW plots, Surface Data, All Sites: Correlation to Fe			
Significant Variable	**Correlation to Fe**	**Correlation coefficient**	**p-value**
Ni	Very Strong Positive	.931	.000
Ca	Strong Positive	.889	.000
P	Strong Negative	-.568	.001
Total N	Strong Negative	-.493	.006
Organic C	Moderate Negative	-.438	.015
Clay	Moderate Positive	.437	.016

Table 4-35c: Summary for Other Plants-Under Canopy in BW plots, Surface Data, All Sites: Correlation to Organic C			
Significant Variable	**Correlation to Organic C**	**Correlation coefficient**	**p-value**
Total N	Strong Positive	.743	.000
EC	Strong Positive	.602	.000
pH (sat. paste)	Strong Negative	-.574	.001
Silt	Strong Positive	.542	.002
P	Strong Positive	.531	.003
Cl	Strong Positive	.507	.004
Cyanobacteria	Strong Positive	.486	.006
Moss	Strong Positive	.456	.011
Mn	Strong Positive	.456	.011
Fe	Moderate Negative	-.438	.015
Inorganic C	Moderate Negative	-.434	.016
$CaCO_3$	Moderate Negative	-.434	.016
AllRock	Moderate Negative	-.427	.019
Sand	Moderate Negative	-.426	.019
Elevation	Moderate Positive	.404	.027
Zn	Moderate Positive	.388	.034
Ca	Moderate Negative	-.386	.035
Cu	Moderate Positive	.381	.038
Psora	Moderate Positive	.380	.038
TotRock	Moderate Negative	-.379	.039

Table 4-35d: Summary for Other Plants-Under Canopy in BW plots, Surface Data, All Sites: Correlation to Litter			
Significant Variable	**Correlation to Litter**	**Correlation coefficient**	**p-value**
AllRock	Strong Negative	-.704	.000
Easting	Strong Positive	.694	.000
TotRock	Strong Negative	-.682	.000
Bkm clast	Strong Negative	-.675	.000
CarbRock	Strong Negative	-.632	.000
B	Strong Positive	.629	.000
Northing	Strong Negative	-.619	.000
Mg	Strong Negative	-.606	.000
Grass Litter	Strong Positive	.605	.000

Table 4-35d (continued)			
Clay	Strong Negative	-.595	.001
BlueLichen	Strong Negative	-.593	.001
Elevation	Strong Positive	.589	.001
EC	Strong Positive	.567	.001
Inorganic C	Strong Negative	-.563	.001
$CaCO_3$	Strong Negative	-.563	.001
As	Strong Positive	.536	.002
Total C	Strong Negative	-.534	.002
SO_4	Strong Positive	.532	.003
Cyanobacteria	Strong Positive	.463	.010
Co	Moderate Negative	-.442	.014
pH (1:1)	Moderate Negative	-.439	.015
Total N	Moderate Positive	.410	.024
Silt	Moderate Positive	.406	.026
Placidium	Moderate Positive	.403	.027
Aspect	Moderate Positive	.393	.032
Moss	Moderate Positive	.391	.033
Slope	Moderate Positive	.391	.033
pH (sat. paste)	Moderate Negative	-.390	.033

Table 4-35e: Summary for Other Plants-Under Canopy in BW plots, Surface Data, All Sites: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
Northing	Strong Negative	-.691	.000
As	Strong Positive	.658	.000
Litter	Strong Positive	.605	.000
Bkm clast	Strong Negative	-.595	.001
Na	Strong Negative	-.557	.001
Clay	Strong Negative	-.542	.002
B	Strong Positive	.504	.004
Mg	Strong Negative	-.496	.005
K	Strong Positive	.481	.007
Aspect	Moderate Positive	.438	.016
InorganicC	Moderate Negative	-.429	.018
$CaCO_3$	Moderate Negative	-.429	.018
BlueLichen	Moderate Negative	-.413	.023
Easting	Moderate Positive	.399	.029
Co	Moderate Negative	-.396	.030
Slope	Moderate Positive	.385	.035
Elevation	Moderate Positive	.379	.039
Total C	Moderate Negative	-.374	.042
Ca	Moderate Negative	-.368	.046
EC	Moderate Positive	.363	.049

Table 4-36: Spearman's Rho Other Plants-Under Canopy in BW plots, Surface Data, Bitter Spring

Table 4-36a: Summary for Other Plants-Under Canopy in BW plots, Surface Data,, Bitter Spring: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Strong Positive	.784	.004
Mg	Strong Positive	.647	.031
Mn	Strong Negative	-.642	.033
TotRock	Strong Positive	.621	.041
Silt	Strong Negative	-.615	.044

Table 4-36b: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Bitter Spring: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.918	.000
Ca	Strong Positive	.855	.001
Total N	Strong Negative	-.791	.004
As	Strong Positive	.718	.013
pH (1:1)	Strong Negative	-.709	.015
Total C	Strong Negative	-.709	.015
P	Strong Negative	-.691	.019

Table 4-36c: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Bitter Spring: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Cl	Strong Positive	.645	.032

Table 4-36d: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Bitter Spring: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
Easting	Strong Positive	.790	.015
Mo	Strong Negative	-.609	.047

Table 4-36e: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Bitter Spring: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
SO_4	Very Strong Negative	-.961	.000
Moisture	Strong Negative	-.746	.008
Gypsum	Strong Negative	-.711	.014
As	Strong Negative	-.695	.018
TotBSC	Strong Negative	-.682	.021

Table 4-37: Spearman's Rho Other Plants-Under Canopy in BW plots, Surface Data, Coyote Springs

Table 4-37a: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Coyote Springs: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Total C	Very Strong Positive	.939	.000
As	Strong Negative	-.830	.003
Clay	Strong Positive	.661	.038
Silt	Strong Negative	-.661	.038
Organic C	Strong Negative	-.648	.043

Table 4-37b: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Coyote Springs: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.976	.000
Ca	Very Strong Positive	.939	.000
P	Very Strong Negative	-.903	.000
Mn	Very Strong Negative	-.903	.000
pH (sat. paste)	Strong Positive	.891	.001
Co	Strong Negative	-.830	.003
Clay	Strong Positive	.770	.009
NO_3	Strong Positive	.657	.039
Mg	Strong Positive	.636	.048

Table 4-37c: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Coyote Springs: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
Total N	Strong Positive	.794	.006
Silt	Strong Positive	.745	.013
Inorganic C	Strong Negative	-.648	.043
$CaCO_3$	Strong Negative	-.648	.043
Clay	Strong Negative	-.648	.043

Table 4-37d: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Coyote Springs: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
NONE			

Table 4-37e: Summary for Other Plants-Under Canopy in BW plots, Surface Data,Coyote Springs: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
NONE			

Table 4-38: Spearman's Rho Other Plants-Under Canopy in BW plots, Surface Data, Gold Butte

Table 4-38a: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Gold Butte: Correlation to $CaCO_3$

Significant Variable	Correlation to $CaCO_3$	Correlation coefficient	P-value
Clay	Strong Positive	.800	.010
Easting	Strong Positive	.733	.025
TotLichen	Strong Negative	-.700	.036
Slope	Strong Negative	-.683	.042

Table 4-38b: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Gold Butte: Correlation to Fe

Significant Variable	Correlation to Fe	Correlation coefficient	p-value
Ni	Very Strong Positive	.983	.000
Ca	Very Strong Positive	.950	.000
Silt	Strong Positive	.883	.002
Sand	Strong Negative	-.883	.002
Mg	Strong Positive	.850	.004
Na	Strong Positive	.717	.030
Organic C	Strong Negative	-.700	.360

Table 4-38c: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Gold Butte: Correlation to Organic C

Significant Variable	Correlation to Organic C	Correlation coefficient	p-value
EC	Strong Positive	.700	.036
Fe	Strong Negative	-.700	.036

Table 4-38d: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Gold Butte: Correlation to Litter

Significant Variable	Correlation to Litter	Correlation coefficient	p-value
Slope	Strong Negative	-.783	.013
Placidium	Strong Negative	-.762	.017
AllRock	Strong Negative	-.745	.021
Psora	Strong Negative	-.733	.025

(continued on next page)

Table 4-38e: Summary for Other Plants-Under Canopy in BW plots, Surface Data, Gold Butte: Correlation to Grass Litter

Significant Variable	Correlation to Grass Litter	Correlation coefficient	p-value
TotBSC	Strong Negative	-.883	.002
Yellow Lichen	Strong Negative	-.822	.007
TotLichen	Strong Negative	-.813	.008
Psora	Strong Negative	-.804	.009
Moss-Lichen	Strong Negative	-.769	.015
Cu	Strong Negative	-.769	.015
Co	Strong Negative	-.720	.029

IV. Discussion

General Overview

Results of surface chemistry characteristics (interspaces) between buckwheat sites and non-buckwheat sites (potential and non-habitat) are very similar to those found for soils (see Chapter 3). Overall, buckwheat surfaces contained more $CaCO_3$, available Fe, Ni, and Ca, and less P, Co, Mn, and total N. Exceptions to these trends occurred under plant canopies due to the effects of greater organic C and plant bioaccumulation. Buckwheat areas also exhibited significantly more cyanobacterial crusts, bare surfaces, less grass litter, and lower percent rock cover (when rocks were present) as compared to non-buckwheat sites. Differences between buckwheat canopies and other plant canopies generally were a function of the smaller size and lower amount of input of organics and litter from buckwheat plants.

Coyote Springs Trends

At Coyote Springs, buckwheat site interspaces contained statistically lower percent rock cover, a thinner surface horizon, and less available P & Co than non-buckwheat site interspaces (Tables 4-3a & 4-9a). Buckwheat site interspaces also contained more total C, inorganic C, $CaCO_3$, available Ca, Mg, Fe, and more bare spaces (Table 4-9a). Buckwheat habitat interspaces were also compared to interspaces on potential habitat (Tables 4-7a & 4-13a). Buckwheat habitat contained significantly greater amounts of clay, total C, inorganic C, and $CaCO_3$. When comparing potential habitat interspaces to interspaces in non-habitat sites, potential habitat contained lower percent rock cover including limestone, carbonate, quartzite, chert-quartzite, total rock and all rock – but contained a greater percent of petrocalcic rock cover (Tables 4-8a & 4-14a). Potential habitat interspaces also contained less available P, a thinner surface horizon, and more inorganic C, $CaCO_3$, Mg, blue lichen, and bare spaces with and without cyanobacterial crusts compared to non-habitat.

When comparing buckwheat canopies to other plant canopies within buckwheat sites, the buckwheat canopies contained significantly greater percent total rock cover, more available Fe and Ni, and less plant litter (Tables 4-4a & 4-10a). Compared to interspaces (Tables 4-5a & 4-11a), buckwheat canopies contained statistically greater percent limestone rock cover, more available Fe, Ni, K, and total N, higher EC values, and greater percent plant litter cover. In contrast, other plant canopies at buckwheat sites contained more organic C, available K, P, Co, Mn, and total N than interspaces (Tables 4-6a & 4-12a). Other plant canopies also contained a greater percent plant litter cover, less moisture, less available Fe, less clay and a statistically significant lower pH (1:1) than buckwheat interspaces.

Gold Butte Trends

In the Gold Butte study area, comparisons of buckwheat site interspaces to non-buckwheat site interspaces identified numerous statistically significant trends. Buckwheat site interspaces contained more clay, total C, inorganic C, $CaCO_3$, available Ca, Fe, Ni, As, SO_4, greater percent total biological soil crust, and cyanobacterial surface crust cover (Table 4-3b and

4-9b). Buckwheat site interspaces also exhibited statistically lower available K, Co, and Mn, and contained less sand, lower percent of grass litter, *Placidium*, and bare soil cover. Compared to potential habitat interspaces, buckwheat interspaces contained more total C, inorganic C, $CaCO_3$, Ca, Fe, Ni, As, SO_4, greater percent cyanobacterial crust and total biological soil crust cover (Tables 4-7b & 4-13b). Buckwheat interspaces also contained less available Mn than potential habitat. Interspaces in potential habitats had many variables that differed significantly from non-habitat interspaces. Potential habitat interspaces contained more clay, silt, gypsum clasts, organic C, total C, inorganic C, $CaCO_3$, available Ca, Fe, Ni, B, As, Cu, SO_4, total N, moisture, higher EC values, were found at higher elevations, and greater percent cyanobacterial crust cover (Tables 4-8b & 4-14b). Potential habitat interspaces also contained less sand, lower percent limestone, carbonate, and total rock cover, lower percent grass litter and other litter cover, had lower pH values, and lower percent bare surface cover than non-habitat.

Buckwheat canopies compared to other plant canopies within buckwheat sites contained greater percent rock cover (all lithologies), more available Co, and had higher pH values (Tables 4-4b & 4-10b). Buckwheat canopies also had lower available Mo, total N, lower percent grass litter, moss and *Psora* cover. In paired comparisons of buckwheat canopies to interspaces within buckwheat sites, the canopies contained more available K, B, Zn, SO_4, Cl, NO_3, moisture, greater percent litter, *Psora*, and bare soil cover, and had higher pH values (Tables 4-5b & 4-11b). Buckwheat canopies also contained lower percent of total biological soil crust, and cyanobacterial crust cover. Compared to interspaces, other plant canopies in buckwheat sites had significantly more available Mg, B, K, P, Cl, NO_3, total N, greater percent grass and other litter, moss, *Psora*, yellow lichen, and bare space cover, and higher EC and pH values (Tables 4-6b and 4-12b). Other plant canopies also had lower percent of total rock, total biological soil crust, and cyanobacterial crust cover, clay, inorganic C, $CaCO_3$ and the saturated paste pH values were lower.

Bitter Spring Trends

Interspaces in buckwheat sites at Bitter Spring contained greater percent cyanobacterial surface crust cover, more moisture, lower pH values, and less available P compared to interspaces in non-buckwheat sites (Tables 4-3c & 4-9c). Similarly, buckwheat habitat interspaces contained less available P and greater percent bare surface cover with or without cyanobacterial crusts than interspaces in potential habitat (Tables 4-7c & 4-13c). Potential habitat interspaces had higher moisture values and less clay than non-habitat interspaces (Tables 4-8c & 4-14c).

Buckwheat canopies differed from other plant canopies in having greater percent total rock clast cover and less total N and lower percent litter cover (Tables 4-4c & 4-10c). Buckwheat canopies differed from adjacent interspaces in having more total C, organic C, available B, Co, Cu, Mn, Zn, Cl, greater percent litter cover, higher EC values and less moisture (Tables 4-5c & 4-11c). Other plant canopies differed from adjacent interspaces in buckwheat sites in their greater amounts of organic C, available B, P, Mn, Cu, Cl, and percent litter cover, and higher EC values. Plant canopies also had lower pH values, lower percent rock cover including gypsum, less available Ca, Fe and lower moisture values than interspaces (Tables 4-6c & 4-12c).

Trends among all study areas combined

When all surface data were combined and buckwheat interspaces were compared to interspaces in non-buckwheat sites, the buckwheat interspaces had significantly more total C, inorganic C, $CaCO_3$, available Ca, Fe, Ni, and As, higher moisture values, and a greater percent cynaobacteria crust +/- bare surface cover (Tables 4-3d & 4-9d). These buckwheat interspaces also contained less available P, Co, Mn, and lower percent grass litter cover, had thinner surface horizons, and had a lower 1:1 pH. Similarly, interspaces in habitats, versus potential habitats, contained significantly more total C, inorganic C, $CaCO_3$, available Ca, Fe, and Ni, and less organic C, available P, Co, Mn, total N, lower percent moss-lichen and total lichen crust cover (Tables 4-7d & 4-13d). In contrast, potential habitat interspaces differed from non-habitat interspaces by having significantly more organic C, available Fe, moisture, higher EC values, greater percent cyanobacteria, *Psora*, Collema, Moss-lichen, total lichen and total biological soil crust cover, but lower percent rock and grass litter cover and lower pH values (Tables 4-8d and 4-14d).

Buckwheat canopies had a greater percent carbonate, total rock, and *Psora* cover than other plant canopies, but a lower percent limestone cover (Tables 4-4d & 4-10d). Buckwheat canopies also had less available P, total N, lower percent grass and other litter cover compared to other plant canopies in buckwheat sites. Buckwheat canopies had higher EC values, more organic C, available K, B, Co, Mn, Zn, SO_4, Cl, total N, greater percent litter, cyanobacterial crust, and *Psora* cover compared to interspaces (Tables 4-5d & 4-11d). Buckwheat canopies also had less clay, lower percent total biological crust, and bare space with and without cyanobacterial crust cover as compared to interspaces. Other plant canopies in buckwheat sites had many more significant differences when compared to interspaces: greater percent gypsum clast, litter, and total biological soil crust cover, increased organic C, available K, B, P, Mn, Cu, Zn, SO_4, Cl, total N, higher EC and pH (using the $CaCl_2$ method) (Tables 4-6d & 4-12d). Other plant canopies also had less clay, lower percent rock cover (except gypsum), lower percent bare space with cyanobacterial crust cover, and lower percent cyanobacterial crust, yellow lichen, moss, and *Psora* cover, and lower pH values (when using the saturated paste method).

Interpretations

Surface characteristics can affect the distribution of the Las Vegas buckwheat through many mechanisms (e.g. water distribution, germination, insolation, soil chemistry, seed distribution, etc.). In this study, we collected baseline data on differences in surficial characteristics (e.g. soil chemistry, biological soil crusts, rock cover) among buckwheat habitat, potential habitat, and non-habitat. Our study was designed to help direct future studies towards a better understanding of the mechanisms controlling the distribution of the Las Vegas buckwheat.

A wide range of geomorphic processes act upon Mojave Desert surfaces, and with varying magnitude. Some very old, stable landscapes may experience little to no active alluvial deposition (e.g. Brock & Buck, 2009). In contrast, young surfaces in active arroyos may experience seasonal deposition and/or erosion. The relative age of a surface and the degree of geomorphic activity occurring upon it can greatly impact plant community composition and structure (e.g. Smith et al., 1995; Hamerlynck et al., 2002). The effect of wind on geomorphic surfaces is especially important in these environments. Eolian erosion potential is much higher on bare surfaces than on surfaces mantled by rocks, biological soil crusts or vascular plants. Similarly, these features also affect eolian deposition. Surfaces on which eolian sand has been or currently is being deposited will exhibit drastically different soil texture, chemistry, water holding capacity, and infiltration. For example, increased deposition of fine-grained sand constitutes a very important component for the development of biological soil crusts (Williams, 2011). Deposition of fine dust provides an important source of nutrients, and drives the formation of desert pavements and associated Av horizons (McFadden et al., 1998; Anderson et al., 2002). In turn, progressive development of vesicular horizons (Av) causes significantly reduced infiltration/increased runoff and consequently produces an enormous impact on vascular plant distribution (Turk & Graham, 2011). Therefore, eolian and other geomorphic processes significantly influence the distribution and type of vascular plants on desert substrates. More research is needed, but in this study, we found that in field areas where rock clasts were generally common (Coyote Springs), Las Vegas buckwheat favored the few available sites with lower percentage of clast cover. In our other study areas, surfaces composed of fine-grained sediment were more common in the general area such that both buckwheat sites and non-sites had fewer rock clasts and no statistically significant relationship was found. Therefore, as a general rule, our observations suggest that buckwheat habitats are far more likely to occur on surfaces with few to no rock clasts.

The strong control by geomorphic processes of surface characteristics is especially important in interspaces. Distinctions between buckwheat site interspace properties and non-buckwheat site interspaces largely paralleled the differences found in soil profile characteristics (see Chapter 3). Buckwheat interspaces contain more CaCO3, available Ca, Fe, Ni, and As, and less available P, Co and Mn (Table 4-9d). Individual sites varied somewhat from these overall trends. In addition to the trends already mentioned, buckwheat interspaces at Gold Butte also had less available K and more SO_4 (Table 4-9b). These results indicate that soil chemistry, which in these areas is largely controlled by geologic processes, is the most important determinant of nutrient availability in interspaces.

A second very important characteristic found in arid regions, including the Mojave Desert, is the establishment of fertile islands (Charley & West, 1977; Schlesinger et al., 1990; Schlesinger et al., 1996; Kieft et al., 1998; Schlesinger & Pilmanis, 1998; Aguiar & Sala, 1999; Bolling & Walker 2002; Titus et al., 2002; Ewing et al., 2007; Li, 2007). The fertile island effect describes the uneven distribution of biological resources across desert landscapes, particularly the concentration of resources beneath plant canopies over time. In this study, when all data are combined, buckwheat canopies exhibit less P, total N, and lower percent litter (grass and other) cover compared to other plant species growing in buckwheat sites (Table 4-10d). These general soil chemistry trends, and the increase in Fe and Ni in buckwheat canopies in Coyote Springs (Table 4-10a) mirror subsurface results (see Chapter 3). Surprisingly, buckwheat canopies did have a greater percent rock cover (except limestone) and *Psora* cover than other plant canopies in buckwheat habitats.

Specific variations in soil nutrient contents beneath shrubs most often result from two major processes: (1) the effects of bioaccumulation, and (2) the increased cation exchange capacity provided by increased amounts of organic C (i.e. humus). In the first process, plant uptake of nutrients and the accumulation and decomposition of plant tissues under the canopy can increase nutrient contents according to the chemical signature of the plant tissues (e.g. Jobbagy & Jackson, 2001, 2004). In the second process, plant nutrients are more strongly retained at the surface because they are held tightly to exchange sites on organic matter, which increases in content under canopies (Brady & Weil, 2008). We have no data with which to test the first process (bioaccumulation), and this represents a subject in major need of future research. However, the second process was evaluated using Spearman correlation tests (Tables 4-15 to 4-38). Buckwheat canopies at Gold Butte exhibited more available Co and less Mo than other plant canopies (Table 4-10b). However, we found no significant correlations between organic carbon and Co or Mo in Gold Butte buckwheat canopies (Table 4-34c). There was a strong positive correlation between organic C and available Cu in buckwheat canopies at Bitter Spring (Table 4-32c), and there was a moderate positive correlation between organic C and available boron when all the sites were combined (Table 4-31c).

Correlations between organic C and other soil nutrients for plant canopies of species other than buckwheat are markedly distinct. For these other canopies, we found strong positive correlations between organic C and total N, available P, Cl, and Mn, and moderate positive correlations with Zn, and Cu (Table 4-35c). Such relationships suggest that organic C may play a more important role in nutrient cycling and availability for other plants in buckwheat habitats than for buckwheat. Organic C may be a more important component for non-buckwheat canopies in part because of their generally larger observed canopy diameters, and therefore greater organic matter inputs to the soil. Although organic carbon did not differ significantly between other plant canopies and buckwheat canopies, percent litter and grass litter cover were significantly more abundant in other canopies than under buckwheat. Again, this trend may reflect the generally smaller and less-densely vegetated canopy, and reduced shade provision, of *E. corymbosum* var. *nilesii* at our study sites. More data is needed to adequately interpret these results. In particular, analysis of plant tissue chemistry, and additional field data regarding canopy size, plant species, shrub ages, and the effects of biological soil crusts (among other parameters) could all greatly further our understanding of nutrient cycling within buckwheat habitat.

Buckwheat canopies did differ significantly from interspaces in buckwheat sites. Buckwheat canopies exhibited increased organic C, total C, available B, Co, Cu, Mn, Zn, Cl, and EC values (Table 4-11c). These results indicate that many of the potentially limiting nutrients in the subsoil (e.g. Co, Mn, Zn, Cu – see chapter 3) are more available under buckwheat canopies. Although the Spearman's correlation tests did not indicate any significant co-variance between these nutrients and organic C, we maintain that these increases reflect both bioaccumulation as well as retention on soil humus exchange sites. Other processes that likely have contributed to these results include increased dust capture under canopies. If dust is enriched in any of the above elements, this process could explain these increases. In addition, interception of rainwater by plant canopies often decreases leaching of the soil directly underneath the canopy. This process, perhaps combined with greater evapotranspiration, likely plays an important role in the increased soluble salts found underneath all plant canopies (as measured by Cl, SO_4, EC) (Tables 4-11d and 4-12d).

The results of this study touched upon an additional interaction that may have important controls on buckwheat distribution – namely, relationships between biological soil crusts and vascular plants. We identified a significant positive relationship between buckwheat habitat and cyanobacteria. This relationship may be the result of both cyanobacteria and buckwheat favoring surfaces with low percent rock cover (Williams, 2011). However, cyanobacteria fix N (Harper & Belnap, 2001), and they stabilize geomorphically active surfaces (Belnap, 2001; Williams, 2011). These, and possibly other cyanobacteria-driven mechanisms, may also impact buckwheat germination and establishment. Explaining the potential effects of cyanobacteria (or other BSCs) on buckwheat (or vice versa) is beyond the capabilities of this dataset. However, previous studies on BSC influences on vascular plants have produced contradictory results. These studies include many different biological soil crusts and are not centered around cyanobacteria crusts alone. Some studies suggest that BSCs benefit vascular plants through effects that include: reduced soil erosion (Belnap and Gillette, 1997), N fixation (Harper & Belnap, 2001), increased site fertility (DeFalco et al., 2001), seed catching and provision of prime germination and establishment microhabitats (West, 1990; Eckert et al., 1986), and increased infiltration and water retention (Maestre et al., 2002). Other studies suggest that BSCs may inhibit establishment of vascular plants by creating physical barriers (Romao & Escudero, 2005), producing exudates (West, 1990), or competing for resources (Belnap et al., 2001). More recent research suggests that BSC effects on vascular plants are strongly species specific (both crust and plant species) (Maestre, 2003; Escudero et al., 2007) but that the effects are especially strong on emergence and early growth of seedlings, and that variations in seed size, among other traits, are important (Escudero et al., 2007).

This study could not directly assess germination, however, we can make some assumptions regarding soil conditions at the time of germination. If we assume that surface characteristics at buckwheat sites today have changed little since the current buckwheat plants first germinated, then our surface chemistry data can be used to infer possible controls on buckwheat (or other plant) distributions. This assumption is probably valid, because the vast majority of buckwheat surfaces are not geomorphically active, and it is unlikely that significant changes to surface slope, topography, rock clast type and size have occurred within the likely timeframe of the buckwheat currently present (see Chapter 2). Thus, based on this assumption, buckwheat seeds reaching interspaces would have encountered a soil environment with more $CaCO_3$, available Ca, Fe, Ni, As, greater percent cyanobacteria cover, and less available P, Co, Mn, and lower percent grass litter cover. Of these characteristics, the increased arsenic stands out as a possible factor limiting germination and/or initial establishment.

Arsenic is a known phytotoxin (e.g. Sheppard, 1992; Patra et al., 2004). Research (primarily performed on agricultural crops in various climates) has shown reduced seed germination, decreased plant height, reduced root growth, reduced leaf area and an associated reduction in photosynthesis (e.g., see list of references in Nagy et al., 2005). Arsenic is a known toxin for seed germination. A study on 23 cultivars of flax (*Linum usitatissiumum L.)* found arsenic to have the greatest toxicity on seed germination compared to other toxic metals including Cu, Cd, Co, Cr, Ni, Pb, Cr, and Zn (Soudek et al., 2010). Similarly, arsenic was found to be the most toxic element for mustard seed germination compared to Pb, Cr, Hg and Cd (Fargasova, 1994). Many researchers have noted that arsenic damages root growth, accounting for the inability of plants intolerant of arsenic to become established (e.g. Fargasova, 1994; Elahi et al., 2010; Soudek et al., 2010; Bagur-Gonzalez et al., 2011). In our study, the maximum plant-available arsenic concentrations in surface samples were found in buckwheat habitat (up to 2.953 ppm). Bagur-Gonzalez et al. (2011) found, based on root length effects, that soluble arsenic was moderately to highly toxic at levels between 0.1 and 1.1 ppm. Although the Bagur-Gonzalez et al. (2011) study was for lettuce (*Lactuca sativa*), we are aware of no data describing what amounts or forms of arsenic might impact plants native to the Mojave Desert or adjacent areas. Additionally, cyanobacteria are known to accumulate and/or exhibit resistance to arsenic (see Banerjee, 2008; Bhattacharya and Pal, 2011; Yin et al., 2011 and references within). Cyanobacteria can also convert inorganic As into volatile compounds for detoxification (Yin et al. 2011). Although Nagy et al., (2005) found that cyanobacteria in biological soil crusts in Utah could easily tolerate the concentrations of arsenic found in this study, it is important to note that research thus far has focused on cyanobacteria in environments other than the Mojave Desert. Therefore, it is not yet known if the species endemic to our study areas have similar responses. It is a hypothesis worth testing. But, the association of cyanobacteria and buckwheat to surfaces soils containing greater arsenic concentrations may reflect the ability of each to tolerate increased arsenic.

V. Conclusions

Surface data indicate that buckwheat in this study occurs in soils that are low in P, Mn, Co, have lower percentage of grass litter cover, and higher $CaCO_3$, available Fe, Ni, Ca, As, and sometimes Mg and/or SO_4. Although the percentage of rock cover was not significant in all study areas, buckwheat was not found in desert pavements or surfaces with extensive or thick clast cover (see Chapter 2). It is likely that the lack of statistical significance in some sites has more to do with the availability of coarse clasts (surficial geology) in the selected study areas.

Differences between buckwheat site interspaces and non-buckwheat interspaces largely paralleled differences found in soil profile and horizon characteristics between classes (see

Chapter 3). These results indicate that soil chemistry, which in these areas is largely controlled by geologic processes, is the most important control on nutrient availability in interspaces.

Except for Cu, we found no significant correlations between organic C and plant nutrients in soils under buckwheat canopy. In contrast, other plant canopies in buckwheat habitat exhibited strong positive correlations between organic C and total N, available P, Cl, and Mn, and moderate positive correlations with Zn, and Cu. These relationships suggest that organic C may play a more important role in nutrient cycling and nutrient availability for other plants in buckwheat habitats as compared to buckwheat.

Buckwheat canopies do significantly differ from habitat interspaces. Buckwheat canopies contain more organic C, total C, available B, Co, Cu, Mn, Zn, Cl and exhibit higher EC values. This indicates that many of the potentially limiting nutrients in the subsoil (e.g. Co, Mn, Zn, Cu – see chapter 3) are increased under buckwheat canopies.

There is a significant positive relationship between buckwheat habitat and percent cyanobacterial crust cover. Understanding what effect cyanobacteria might have on buckwheat (or vice versa) is beyond the capabilities of this dataset. However, previous studies on the effects that biological soil crusts have on vascular plants have provided contradictory results, and indicate an important direction for future research. Lastly, germination and/or establishment of plants on buckwheat surfaces may require some level of tolerance to arsenic. Plant-available arsenic at the surface was greatest in buckwheat habitats, and the amounts are great enough to impact agricultural crops. What, if any, effect they could have on native plants is unknown.

VI. Recommendations

- Results of soil surface characterization largely corroborate results described for subsoil samples, and suggest that this study has provided useful soil chemical data of potential benefit to future germination studies on the Las Vegas buckwheat because more is now known regarding the range of soil conditions in which buckwheat occurs. To fully understand buckwheat habitat, research on germination is needed.

- We note that the present data cannot answer key questions relevant to habitat definitions for *E. corymbosum* var. *nilesii*. In particular: Do differences between buckwheat and other plant canopies reflect "time zero" substrate differences (i.e., characteristics at the time of plant germination), or do the present differences instead reflect plant-soil nutrient dynamics between time zero and the present day? We suggest that plant tissue chemistry and litter analysis might help answer this question and recommend such analyses for future research efforts.

- Furthermore, we recognize that, lacking age control on existing buckwheat individuals, our data cannot help determine what timescales (years, decades) might be involved if buckwheat plants do indeed alter the chemistry of their substrates following establishment. However, we also suggest that this issue of potential soil change in response to plant growth and nutrient cycling may be discounted due to the erosional nature of many of the study sites (Chapter 2). Given the role of badlands erosion, slow rates of pedogenesis, and low total organic matter content, it is likely that bioaccumulation overprints background (interspace) soil conditions only weakly (if at all).

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APPENDIX: Soil Profile Descriptions

Soil profiles were described between April 13th and May 24th, 2010. Horizon descriptions and nomenclature followed standard procedures and terminology prescribed by Schoenenberger (2002) and Soil Survey Staff (2010). Locations indicated are UTM coordinates (NAD 83, zone 11N), and should be considered accurate to ± 3m. Buckwheat status indicates the presence or absence of *Eriogonum corymbosum* var. *nilesii* for the given site. Soil profile descriptions are presented first for the Coyote Springs study area, then Gold Butte, and then Bitter Spring.

I. Coyote Springs Soil Profile Descriptions

Site CS 00
Location: 685815E, 4071465N
Buckwheat: Present

A--0 to 3 centimeters; 7.5YR 7/2, 7.5YR 5/2 moist; 30 percent fine subangular gravel (5 percent limestone, 20 percent eroded petrocalcic, and 5 percent chert); strong very thick platy structure; soft, very sticky, slightly plastic; no roots; many (10+) very fine, many (5) medium and fine vesicular pores throughout; strongly effervescent; abrupt wavy boundary. (0 to 4 centimeters thick).

Bk--3 to 9 centimeters; 7.5YR 8/2, 7.5YR 7/3 moist; medium fine angular blocky structure; loose to slightly hard, slightly sticky; common (1) fine roots between peds; many (5+) very fine irregular pores throughout; 85 percent fine to medium, hard, irregular plates and blocks of calcium carbonate throughout separated by soil peds; stage III brecciated; strongly effervescent; abrupt wavy boundary.

Bkm1t--9 to 17 centimeters; 7.5YR 8/2 silty clay, 7.5YR 7/3 moist; strong fine angular blocky structure; slightly hard to extremely hard, slightly sticky; no roots; many (5) very fine to medium dendritic tubular pores; 95 percent medium, extremely hard, irregular calcium carbonate plates and blocks throughout; 5 percent silt and clay, clay skins coating dendritic tubular pores; stage III; strongly effervescent; abrupt wavy boundary.

Btkm2 (or Btkmb)--17 to 39+ centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; strong medium angular blocky structure; extremely hard, slightly sticky; common (2) very fine roots between calcium carbonate peds; common (3) very fine and fine dendritic tubular pores; 25 percent coarse, extremely hard, calcium carbonate dendritic tubular and irregular root casts containing secondary dendritic tubular pores on cast surfaces; stage II to III; violently effervescent.

Site CS 01
Location: 685085E, 4071465N
Buckwheat: Absent

Av--0 to 4 centimeters;7.5YR 8/2, 7.5YR 8/3 moist; 5 to 35 percent fine limestone and eroded pedogenic carbonate gravel as desert pavement; strong thick to very thick platy structure; soft to slightly hard, very sticky, very plastic; no roots; many (10+) very fine vesicular and irregular pores; up to15 percent finely disseminated carbonate throughout, 5YR 8/2; common faint silt coats on ped faces and in pores; violently effervescent; very abrupt wavy boundary.

Bky--4 to 13 centimeters; 7.5YR 7/3, 7.5YR 7/4 moist; moderate medium to coarse subangular blocky structure; soft, very sticky, very plastic; common (4) very fine to fine roots throughout; common (4) very fine dendritic tubular pores throughout; 2 to 20 percent prominent, soft, 7.5YR 7/3 gypsum crystals throughout around faces of peds; common red-stained sand grains throughout; violently effervescent; abrupt wavy boundary.

Bkq--13 to 34 centimeters; 7.5YR 8/2, 7.5YR 8/3 moist; moderate medium to coarse subangular blocky structure; soft, very sticky, very plastic; common (4) fine, common (2) medium, common (1) coarse roots throughout; common (1) medium dendritic tubular pores throughout; up to20 percent finely disseminated carbonate throughout, 7.5YR 8/2; hard, clear 7.5YR 8/2 silica coats on ped faces; violently effervescent; clear wavy boundary.

Bkqm--34 to 52+ centimeters; 7.5YR 8/2, 7.5YR 8/3 moist; strong medium to coarse subangular blocky structure; common (2) fine to medium roots throughout; common (1) very fine, common (2) fine and medium dendritic tubular pores throughout; 2 millimeter white, botryoidal silica masses under ped surfaces; red (7.5YR8/4) sand filling root casts; clay coats in pores; violently effervescent.

Site CS 02
Location: 685740E, 4071675N
Buckwheat: Present

Av--0 to 3 centimeters; 7.5YR 7/2, 7.5YR 6/3 moist; 10 percent subrounded limestone and soil carbonate gravel to cobble as pavement; strong medium to thick platy structure; soft, very sticky, very plastic; no roots; many (10+) very fine to fine vesicular and irregular pores; strongly effervescent; very abrupt wavy boundary.

Bk--3 to 10 centimeters; 7.5YR 8/2, 7.5YR 7/3 moist; moderate medium platy parting to weak fine subangular blocky structure; soft, moderately sticky, very plastic; common (1) fine and medium roots throughout; many (5) very fine to fine dendritic tubular pores throughout; 50 percent hard, white, 1 centimeter angular, soil carbonate fragments brecciated in situ; strongly effervescent; abrupt wavy boundary.

Btk1--10 to 26 centimeters; 7.5YR 8/2, 7.5YR 7/2 moist; moderate medium to coarse subangular blocky structure; moderately hard, moderately sticky, very plastic; common (3) very fine roots throughout; many (5) very fine to medium dendritic tubular pores throughout; faint, diffuse, 7.5YR 6/4 silt coats in pores; 1 percent fine calcium carbonate nodules throughout, distinct, abrupt; strongly effervescent; clear wavy boundary.

Btk2--26 to 50+ centimeters; 7.5YR 7/3, 7.5YR 7/3 moist; strong medium subangular blocky structure; very hard, slightly sticky; common (1) fine roots throughout; clear silt or clay coats on ped faces; 0.9 percent faint, white, soft masses throughout; calcified root traces, rounded, eroded; strongly effervescent.

Site CS 03
Location: 686305E, 4071400N
Buckwheat: Present

Avk--0 to 5 centimeters; 10YR 8/2, 10YR 6/3 moist; 15 percent fine subangular limestone and carbonate gravel as pavement; strong very thick platy structure; slightly hard, moderately sticky, moderately plastic; no roots; many (10+) very fine to medium vesicular pores throughout; 50 percent finely disseminated carbonate coating pores and throughout, faint; 30 to 50 percent very fine white, prominent calcium carbonate masses filling vesicular pores, especially at depth; 15 percent discontinuous 1 to 2 millimeter calcium carbonate pendants under plates; violently effervescent; abrupt smooth boundary.

Bk1--5 to 17 centimeters; 10YR 8/2, 10YR 7/3 moist; weak thin platy structure parting to strong fine subangular blocky structure; slightly to moderately hard, slightly sticky; common (1) very fine roots throughout; common (1) very fine dendritic tubular, common (4) very fine irregular pores throughout; 30 percent finely disseminated carbonate 10YR 7/2 on ped faces, cracks, and lining pores; grey to red very fine sand in dendritic tubular pores; strongly effervescent; clear wavy boundary

Bk2--17 to 35+ centimeters; 10YR 8/2, 10YR 7/2 moist; moderate medium subangular blocky structure; soft to extremely hard, very sticky, moderately plastic; no roots; many (10) very fine vesicular, many (5) very fine to fine dendritic tubular pores throughout; 50 percent finely disseminated carbonate throughout especially coating pores, 10YR 8/2; 0.9 percent very fine gypsum crystals; prominent, fine, brown (10YR5/4) sand coating dendritic tubular pores; violently effervescent.

Site CS 04
Location: 686425E, 4071500N
Buckwheat: Absent

Avk--0 to 4 centimeters; 7.5YR 8/2, 7.5YR 6/3 moist; 25 percent fine subrounded petrocalcic gravel; strong very thick platy structure; slightly hard, moderately sticky, slightly plastic; no roots; many (10) very fine to fine, many (5) medium vesicular pores; 2 to 5 percent 1 to 3 millimeter calcium carbonate masses in pores; few, faint finely disseminated carbonate throughout; distinct cemented calcium carbonate silans coating all pores, 7.5YR 8/2; violently effervescent; abrupt wavy boundary.

Bk1--4 to 9 centimeters; 7.5YR 8/2, 7.5YR 7/3 moist; no rock fragments; strong fine subangular blocky structure; soft to hard, slightly sticky; no roots; many (8) very fine dendritic tubular pores throughout; 5 percent finely disseminated carbonate on faces of peds, distinct; 5 percent soft calcium carbonate masses in pores, prominent; calcium carbonate silans throughout, distinct, 7.5YR 8/2; thickness varies between 5 to 8 centimeters; strongly effervescent; clear wavy boundary.

Bk2--9 to 19 centimeters; 7.5YR 8/2, 7.5YR 7/2 moist; no rock fragments; strong medium subangular blocky structure; slightly hard, moderately sticky; common (4) very fine roots throughout; 20 percent finely disseminated carbonate and calcium carbonate masses throughout, distinct, white; red stained silt in pores; calcium carbonate silans throughout, 7.5YR 8/2 to 7.5YR 8/3; violently effervescent; clear wavy boundary.

Bkq--19 to 31+ centimeters; 7.5YR 8/2, 7.5YR 7/2 moist; 20 percent reworked root cast fragments; moderate medium subangular blocky structure; slightly hard to extremely hard, moderately sticky; no roots; 30 percent finely disseminated carbonate and calcium carbonate masses throughout, distinct, white; red stained silt in pores; calcium carbonate silans throughout, prominent, possible silica, 7.5YR 8/2 to 7.5YR 8/3; violently effervescent.

Site CS 05
Location: 685680E, 4071775N
Buckwheat: Present

Av--0 to 5 centimeters; 7.5YR 7/2, 7.5YR 5/3 moist; 70 percent petrocalcic fragments from 0 to 2 centimeters; strong very thick platy structure; soft to slightly hard, slightly sticky, slightly plastic; common (1) very fine roots throughout; many (10) very fine, many (5) fine, common (1) medium vesicular pores throughout; 35 percent finely disseminated carbonate and silt coats throughout, faint, diffuse, 7.5YR 7/2; 35 percent very fine calcium carbonate masses on the bottoms of ped faces, white, distinct; violently effervescent; very abrupt wavy boundary.

Bk--5 to 20 centimeters; 7.5YR 8/2, 7.5YR 7/3 moist; no rock fragments; moderate fine subangular blocky structure; soft, slightly sticky; common (3) very fine, common (1) medium roots throughout; common (1) fine dendritic tubular pores throughout; 5 percent fine calcium carbonate masses throughout, white, soft; 10 percent finely disseminated carbonate throughout; violently effervescent; clear wavy boundary.

Bkqm1--20 to 37 centimeters; 7.5YR 8/2, 7.5YR 6/4 moist; no rock fragments; strong medium to coarse subangular blocky structure; extremely hard, slightly sticky; common (2) fine and medium roots throughout; common (4) fine dendritic tubular pores throughout; 25 percent finely disseminated carbonate; botryoidal red sand filling dendritic pores; silica and calcium carbonate cement throghout; violently effervescent; clear wavy boundary.

Bkqm2--37+ centimeters. Not described.

Site CS 06
Location: 685686E, 4071465N
Buckwheat: Absent

Av--0 to 7 centimeters; 7.5YR 7/3, 7.5YR 6/4 moist; 75 percent gravel as desert pavement; strong very thick platy structure; soft, moderately sticky, moderately plastic; common (2) very fine roots throughout; many (10+) very fine to fine vesicular and irregular pores throughout; 0.9 percent very fine silt coats lining pores, very faint; strongly effervescent; abrupt wavy boundary.

Bk--3 to 9 centimeters; 7.5YR 6/4, 7.5YR 5/4 moist; no rock fragments; moderate fine subangular blocky structure; soft, slightly sticky, moderately plastic; many (5) very fine to fine roots throughout; many (5) very fine to fine dendritic tubular pores throughout; 5 to 10 percent white masses throughout, irregular, soft, distinct, clear; thin clay skins on faces of peds, faint; strongly effervescent; abrupt wavy boundary.

2Bt1--9 to 17 centimeters; 7.5YR 6/4, 7.5YR 4/4 moist; 4.9 percent fine to medium limestone gravel; strong angular blocky structure; slightly hard, moderately sticky, very plastic; common (2) fine roots throughout; common (1) fine dendritic tubular pores throughout; faint to prominent white masses on faces of peds throughout, irregular, gradual to distinct; clay skins throughout, blocky clay structure; strongly effervescent; abrupt wavy boundary.

2Bt2--17 to 39+ centimeters; 7.5YR 7/2, 7.5YR 6/3 moist; no rock fragments; strong fine to coarse angular blocky structure; slightly hard, moderately sticky, very plastic; common (2) fine roots throughout; many (5) very fine, common (2) fine to medium dendritic tubular pores throughout; clay skins lining pores and on faces of peds, 7.5YR 6/3, 7.5YR 6/4; strongly effervescent.

Site CS 07
Location: 685915E, 4071465N
Buckwheat: Absent

Avk--0 to 2 centimeters;7.5YR 8/2, 7.5YR 8/2 moist; 35 percent gravel and cobble; strong thick to very thick platy structure; soft, very sticky, moderately plastic; no roots; many (10+) very fine to medium vesicular; 20 percent finely disseminated carbonate; 50 percent calcium carbonate films on faces of peds, distinct, clear, 7.5 YR 8/2; accumulated calcium carbonate silt or mud; violently effervescent.

Bk1--2 to 11 centimeters; 10YR 8/2, 10YR 7/3 moist; no rock fragments; moderate thin platy parting to subangular blocky structure; soft to hard, moderately sticky, moderately plastic; common (3) very fine roots throughout; many (5) very fine to fine dendritic tubular, common (3) very fine irregular pores throughout; 10 to 15 percent finely disseminated carbonate; 25 percent fine calcium carbonate films, clear, 10YR 8/2; violently effervescent.

Bk2--11 to 35 centimeters; 7.5YR 7/2, 7.5YR 6/3 moist; 5 percent fine to medium gravel; strong medium to coarse angular blocky structure; soft, moderately sticky, moderately plastic; common

(1) fine roots throughout; common (3) very fine to fine dendritic tubular pores throughout; 50 to 80 percent finely disseminated carbonate; 50 to 80 percent medium calcium carbonate films, faint, 7.5YR 7/2; red iron stained sand filling pores; coarse calcium carbonate root casts reworked, indurated; violently effervescent.

Bk3--35 to 43+ centimeters; 7.5YR 7/2, 7.5YR 6/3 moist; 5 percent fine to medium gravel; strong medium subangular blocky parting to angular blocky structure; soft, moderately sticky, very plastic; common (1) fine roots throughout; many (5) fine dendritic tubular pores; 60 to 90 percent finely disseminated carbonate; 80 to 90 percent medium calcium carbonate films, faint, 7.5YR 6/4; stage I to II filaments; coarse calcium carbonate root casts reworked, indurated; violently effervescent.

Site CS 08
Location: 685540E, 4071470N
Buckwheat: Absent

Av--0 to 5 centimeters; 7.5YR 7/3, 7.5YR 5/4 moist; 3 percent coarse limestone gravel; strong very thick platy structure; slightly hard, moderately sticky, moderately plastic; no roots; many (10+) very fine, common (3) fine vesicular pores; 15 percent finely disseminated carbonate and silt coats throughout, distinct, diffuse, 7.5YR 7/3; 0.9 percent fine calcium carbonate masses throughout, white, round, spherical, clear; violently effervescent; abrupt smooth boundary.

Bk1--5 to 12 centimeters; 10YR 7/3 loam, 10YR 5/4 moist; 20 percent limestone gravel to cobble; moderate thin platy parting to medium subangular blocky structure; soft, slightly sticky, nonplastic; common (2) very fine roots throughout; common (2) very fine dendritic tubular pores throughout; 10 percent finely disseminated carbonate throughout, white, distinct, diffuse; 2 millimeter calcium carbonate pendants on the bottoms of limestone clasts; violently effervescent; clear smooth boundary.

Bk2--12 to 32 centimeters; 10YR 7/3 loam, 10YR 5/4 moist; 30 percent limestone gravel to cobble; moderate medium to coarse subangular blocky structure; soft, nonsticky, nonplastic; common (4) very fine roots throughout; 2 percent calcium carbonate filaments throughout; 10 percent finely disseminated carbonate throughout; violently effervescent; abrupt smooth boundary.

Bk3--32 to 50 centimeters; 10YR 6/3 silt loam, 10YR 5/4 moist; 25 percent limestone gravel; strong coarse subangular blocky structure; moderately hard, slightly sticky, slightly plastic; many (5 to 10) very fine roots throughout; 5 percent finely disseminated carbonate and filaments throughout; 0.9 percent very fine calcium carbonate masses, white, sharp, distinct; violently effervescent; abrupt wavy boundary.

BC--50 to 68+ centimeters; 7.5YR 6/4 silt loam, 7.5YR 4/4 moist; 30 percent limestone gravel; weak fine subangular blocky structure; loose, nonsticky, nonplastic; many (5) very fine roots throughout; no pores; 5 to 10 percent finely disseminated carbonate throughout, white, distinct, diffuse; thinly white calcium carbonate coats on all surfaces of rock fragments; violently effervescent.

Site CS 09
Location: 685660E, 4071565N
Buckwheat: Absent

Av--0 to 1 centimeters; 10YR 7/3, 10YR 5/3 moist; 5 to 20 percent fine limestone gravel; moderate thin platy structure; soft, moderately sticky, moderately plastic; no roots; many (5 to 10) very fine to fine vesicular pores; physical surface crust only; strongly effervescent; very abrupt smooth boundary.

Bk1--1 to 6 centimeters; 10YR 7/3, 10YR 5/3 moist; 2 to 5 percent fine subrounded limestone gravel; weak thin platy parting to moderate fine subangular blocky structure; soft to hard, moderately sticky; common (3) very fine roots throughout; common (1) very fine, common (2) medium dendritic tubular pores throughout; 30 to 50 percent calcium carbonate nodules, hard, irregular; 30 to 50 percent soft calcium carbonate masses dusting faces of peds, faint; stage II calcium carbonate (hard nodules); strongly effervescent; abrupt wavy boundary

Bk2--6 to 15 centimeters; 10YR 7/3, 10YR 5/4 moist; 0.9 percent subrounded limestone gravel; moderate medium subangular blocky structure; soft, slightly sticky, slightly plastic; many (5) very fine roots throughout; common (3) very fine dendritic tubular pores throughout; 10 percent soft calcium carbonate masses, irregular, clear, abrupt; stage II throughout; strongly effervescent; clear irregular boundary.

Bt1--15 to 34 centimeters; 10YR 7/3, 10YR 6/3 moist; no rock fragments; strong fine to medium angular blocky structure; slightly hard, slightly sticky, moderately plastic; common (1) fine and medium roots throughout; common (4) fine dendritic tubular pores throughout; calcium carbonate masses, few, faint, irregular, soft, gradual; clay skins on faces of peds and coating pores, distinct, brown, prominent, clear; stage II calcium carbonate; strongly effervescent; clear wavy boundary.

Bt2--34 to 48 centimeters; 10YR 7/3, 10YR 6/4 moist; no rock fragments; strong coarse angular blocky structure; slightly hard, slightly sticky, moderately plastic; common (1) fine and medium roots throughout; many (10) fine, common (3) medium dendritic tubular pores throughout; clay skins on faces of peds and coating pores, distinct, brown, prominent, clear; strongly effervescent; clear wavy boundary

Bt3--48 to 52+ centimeters; very dense, very hard, very similar to Bt2; strongly effervescent.

Site CS 10
Location: 686010E, 4071465N
Buckwheat: Absent

Av--0 to 4 centimeters; 7.5YR 8/2, 7.5YR 8/3 moist; 5 percent fine limestone gravel, 20 percent fine petrocalcic gravel; strong thick platy structure; slightly hard, very sticky, very plastic; no roots; many (10+) very fine to medium vesicular pores throughout; 20 percent finely disseminated carbonate; 20 percent calcium carbonate films throughout matrix and coating pores, distinct, clear; strongly effervescent; abrupt wavy boundary.

Bk1--4 to 9 centimeters; 7.5YR 8/2, 7.5YR 8/3 moist; no rock fragments; moderate thin platy parting to moderate medium subangular blocky structure; slightly hard, moderately sticky, very plastic; common (3) very fine, common (1) fine roots throughout; common (4) fine dendritic tubular pores throughout; 25 to 30 percent finely disseminated carbonate; 25 to 30 percent calcium carbonate films throughout, faint, clear, 7.5YR 8/2; 5 percent eroded petrocalcic nodule fragments; 5 to 10 percent medium to coarse eroded petrocalcic nodules and root cast fragments; violently effervescent; clear wavy boundary.

Bk2--9 to 44+ centimeters; 7.5YR 8/2, 7.5YR 8/3 moist; no rock fragments; strong medium subangular blocky structure; moderately hard, moderately sticky, very plastic; common (1) fine roots throughout; many (5) very fine, common (2) fine dendritic tubular pores throughout; finely disseminated carbonate; very fine iron stained sand lining pores; 20 to 30 percent calcium carbonate films throughout matrix and lining pores, white, distinct, clear; violently effervescent.

Site CS 11
Location: 686410E, 4071360N
Buckwheat: Present

Av--0 to 4 centimeters; 7.5YR 8/2, 7.5YR 6/4 moist; 30 to 50 percent very fine and fine petrocalcic gravel; strong thick to very thick platy structure; soft, very sticky, moderately plastic; no roots; many (10+) very fine to fine vesicular, common (1) medium irregular pores throughout; 30 percent finely disseminated carbonate throughout matrix and lining pores, very fine, faint, soft, irregular, 7.5YR 8/2; 0.9 percent fine crystals throughout; violently effervescent; abrupt wavy boundary.

Bk1--4 to 12 centimeters; 7.5YR 7/3, 7.5YR 6/4 moist; no rock fragments; moderate thin to thick platy parting to fine subangular blocky structure; soft, moderately sticky, moderately plastic; many (5) very fine to fine roots throughout; many (10) very fine, common (2) fine dendritic tubular, common (1) fine irregular pores throughout; 10 percent masses throughout, soft, white, irregular, prominent; 30 percent finely disseminated carbonate throughout, white, 7.5YR 8/2; 50 percent red silt and very fine sand filling pores, distinct; violently effervescent; clear wavy boundary.

Bk2--12 to 29 centimeters; 10YR 8/2, 10YR 7/3 moist; no rock fragments; strong fine subangular blocky structure; soft to hard, very sticky, very plastic; many (5) very fine, common (1) medium roots throughout; many (5) very fine and fine dendritic tubular pores throughout; 20 percent finely disseminated carbonate throughout, white; common to many cement/silan on faces of peds; prominent red stained silt and cement, some clay, filling pores; violently effervescent; clear wavy boundary.

Bk3--29 to 49 centimeters; 10YR 8/2, 10YR 6/3 moist; no rock fragments; strong fine to medium subangular blocky structure; soft; common (2) fine, common (1) medium roots throughout; 0.9 percent finely disseminated carbonate, white; calcium carbonate masses and filaments, soft, white, prominent; calcium carbonate coats lining all pores, cracks and faces of peds, distinct; violently effervescent; gradual wavy boundary.

Bkq--49 to 56+ centimeters; 10YR 8/2, 10YR 7/2 moist; 10 percent root casts or calcium carbonate/silica nodules; moderate medium subangular blocky structure; slightly hard to extremely hard; common (1) coarse roots throughout; 50 percent finely disseminated carbonate throughout, white; calcium carbonate coats lining all pores, cracks, nodules/cemented root casts and faces of peds, distinct; strongly effervescent.

Site CS 12
Location: 686185E, 4071400N
Buckwheat: Present

Av--0 to 3 centimeters; 10YR 8/2, 10YR 6/2 moist; 50 percent fine petrocalcic gravel; strong thick platy structure; soft, moderately sticky, moderately plastic; no roots; many (10+) very fine to medium vesicular pores throughout; 20 percent finely disseminated carbonate throughout, soft, white, distinct, 10YR 8/2; many silt coats on faces of peds and lining pores, faint, 10YR 8/2; violently effervescent; abrupt wavy boundary.

Bk--3 to 11 centimeters; 10YR 8/2, 10YR 7/2 moist; no rock fragments; strong fine to medium subangular blocky structure; soft to very hard; many (5) very fine, common (1) fine to medium roots throughout; many very fine dendritic tubular pores throughout; finely disseminated carbonate, calcium carbonate and silica throughout; red stained silt and fine sand lining fine pores; reworked calcium carbonate nodules, plates and blocks; strongly effervescent; abrupt wavy boundary.

Bkq--11 to 44+ centimeters; 10YR 8/2, 10YR 7/2 moist; no rock fragments; soft to extremely hard, moderately sticky, very plastic; common (2) very fine, common (1) medium and coarse roots throughout; common (4) fine dendritic tubular pores throughout; 20 percent finely disseminated carbonate throughout; red stained sand filling pores; silica coats on faces of peds and throughout matrix, thin, faint, common, grey 10YR 8/1, 10YR 7/1; 4.9 percent reworked calcium carbonate root casts; strongly effervescent.

Site CS 13
Location: 686225E, 4071400N
Buckwheat: Present

Av--0 to 3 centimeters; 7.5YR 8/2, 7.5YR 7/3 moist; 70 percent fine subangular petrocalcic gravel; strong thick platy structure; soft to slightly hard, very sticky, very plastic; no roots; many (10+) very fine to medium vesicular and irregular pores throughout; 15 to 25 percent finely disseminated carbonate, white, diffuse, faint, soft; many silt and calcium carbonate coats lining pores and faces of peds, white, 7.5YR 8/2; violently effervescent; abrupt wavy boundary.

Bk--3 to 9 centimeters; 7.5YR 8/2, 7.5YR 8/2 moist; no rock fragments; moderate medium subangular blocky structure; soft to extremely hard, slightly sticky; common (1) very fine roots throughout; skeletal very fine irregular, common (3) very fine dendritic tubular pores throughout; finely disseminated carbonate on faces of peds and lining pores; red silt lining pores; violently effervescent; abrupt wavy boundary.

Bkq--9 to 44+ centimeters; 7.5YR 8/2, 7.5YR 7/3 moist; 10 percent reworked calcium carbonate root casts; strong medium subangular blocky structure; slightly hard, moderately sticky, very plastic; no roots; common (3) fine, common (2) medium dendritic tubular pores throughout; finely disseminated carbonate and silica on faces of peds and lining pores, faint, hard, 7.5YR 8/2; many cemented silans lining pores and faces of peds, faint, 7.5YR 8/2; common red stained very fine sand lining pores; 10 percent reworked coarse (2 to 5 centimeters) calcium carbonate root casts; violently effervescent.

Site CS 14
Location: 685895E, 4071375N
Buckwheat: Absent

Bk--0 to 23 centimeters; 10YR 6/3, 10YR 4/3 moist; 0.9 percent gravel; moderate coarse angular blocky structure; slightly hard, nonsticky, slightly plastic; common (1) very fine roots throughout; many (5) very fine dendritic tubular pores throughout; 15 percent finely disseminated carbonate throughout, white, irregular, soft, faint; very fine; 1 percent fine calcium carbonate masses throughout, white, soft, prominent, distinct; upper 1 to 4 centimeters is lightly weathered B horizon, in process of eroding; violently effervescent; abrupt wavy boundary.

Btky--23 to 47+ centimeters; 7.5YR 6/4, 7.5YR 5/4 moist; 4.9 percent limestone gravel; strong fine to coarse angular blocky structure; hard, moderately sticky, very plastic; common (2) very fine and fine roots throughout; many (5 to 10) very fine dendritic tubular pores throughout; 5 percent 1 to 3 millimeter gypsum or calcium carbonate nests throughout cracks and on faces of peds, white, needle-like, diffuse; 50 percent very fine to medium clay coats throughout, brown, distinct; violently effervescent.

Site CS 15
Location: 685844E, 4071318N
Buckwheat: Present

A--0 to 2 centimeters; 7.5YR 8/2, 7.5YR 7/3 moist; 50 percent petrocalcic gravel; strong thick platy structure; soft, slightly sticky, very plastic; no roots; many (7) very fine, common (3) fine, and medium vesicular pores throughout; 25 percent finely disseminated carbonate and silt coats throughout, soft, faint, 7.5YR 8/2; strongly effervescent; abrupt wavy boundary.

2Btkb--2 to 45+ centimeters; 7.5YR 7/2, 7.5YR 6/3 moist; no rock fragments; strong fine to coarse subangular blocky structure; slightly hard, very sticky, very plastic; common (3) very fine roots throughout; many (5+) fine to coarse dendritic tubular pores throughout; 30 percent calcium carbonate root casts, hard, white, prominent, 0.5 centimeters wide by 3 centimeters long; 5 to 10 percent finely disseminated carbonate throughout, faint, diffuse, white; 25 percent clay skins lining pores and faces of peds, brown; violently effervescent.

Site CS 16
Location: 685600E, 4071475N
Buckwheat: Absent

Av--0 to 5 centimeters; 10YR 6/3, 10YR 5/4 moist; 40 percent gravel as pavement; strong very thick platy structure; slightly hard, slightly sticky, moderately plastic; common (1) very fine roots throughout; many (5) very fine, many (7) fine to medium vesicular pores; 35 to 50 percent finely disseminated carbonate and/or silt coats throughout matrix and lining pores, faint, diffuse, 10YR 6/3; violently effervescent; abrupt smooth boundary.

Bk1--5 to 18 centimeters; 7.5YR 7/3, 7.5YR 5/4 moist; 15 percent fine and medium petrocalcic and limestone gravel; strong medium subangular blocky structure; slightly hard, nonsticky, nonplastic; common (1) very fine and fine roots throughout; common (1) fine and medium dendritic tubular pores throughout; 15 to 20 percent finely disseminated carbonate on faces of peds, white, distinct, diffuse; 2 to 5 percent medium calcium carbonate masses throughout, soft, white, sharp; thin (0.9 millimeter) calcium carbonate coating rock fragments; violently effervescent; clear smooth boundary.

Bk2--18 to 47+ centimeters; 7.5YR 6/4, 7.5YR 5/4 moist; 20 percent fine to medium limestone gravel; strong fine to medium subangular blocky structure; slightly to moderately hard, nonsticky, slightly plastic; common (2) very fine roots throughout; common (3) fine to medium dendritic tubular pores throughout; 20 percent finely disseminated carbonate lining pores, in cracks and on faces of peds, white, prominent, diffuse; 0.5 to 2 millimeter calcium carbonate pendants on bottoms of rock fragments; violently effervescent.

Site CS 17
Location: 686035E, 4071330N
Buckwheat: Absent

Av--0 to 8 centimeters; 7.5YR 6/2 sandy clay loam, 7.5YR 5/3 moist; moderate thick platy structure; soft, moderately sticky, slightly plastic; common (3) fine and medium roots throughout; many (10+) very fine vesicular and irregular pores throughout; 10 to 20 percent finely disseminated carbonate throughout, soft, faint; 2 percent calcium carbonate masses lining pores, white, distinct, clear; strongly effervescent; abrupt wavy boundary.

Bk1--8 to 18 centimeters; 7.5YR 6/3 sandy loam, 7.5YR 5/3 moist; limestone and petrocalcic fragments; moderate fine to medium subangular blocky structure; soft, slightly sticky, nonplastic; many (5) very fine and fine roots throughout; many (5) very fine dendritic tubular pores throughout; 20 percent finely disseminated carbonate throughout, soft, faint; strongly effervescent; stage I; clear wavy boundary.

Bk2--18 to 51 centimeters; 7.5YR 7/2 sandy loam, 7.5YR 5/3 moist; 5 percent fine (2 to 4 millimeters) gravel; 20 percent petrocalcic fragments; moderate fine to medium subangular blocky structure; soft, slightly sticky, nonplastic; many (10) very fine, common (3) medium roots throughout; common (3) very fine dendritic tubular pores; 20 percent finely disseminated carbonate and filaments throughout, white, distinct, soft; stage I; strongly effervescent.

C--51+ centimeters; 30 percent loose sand and gravel; massive; strongly effervescent.

Note: There is no Coyote Springs Site #18. This site was originally planned using GIS and remote sensing data, but was cancelled because its soil geomorphic setting would not have contributed useful information to this project and/or presented logistical challenges. Site approval (archaeological survey) and field data collection had already begun in the study area when this site was cancelled, thus it remains as an apparent but artificial gap in our list of study sites.

Site CS 19
Location: 685800E, 4071785
Buckwheat: Absent

Av--0 to 9 centimeters; 10YR 6/3 sandy loam, 10YR 4/4 moist; 20 percent coarse gravel to fine cobble limestone; moderate thick platy structure; soft, nonsticky, nonplastic; many (5) very fine, common (2) fine roots throughout; many (10+) very fine vesicular pores throughout; 20 percent finely disseminated carbonate throughout, distinct, white, diffuse; strongly effervescent; abrupt smooth boundary.

Bk--9 to 27 centimeters; 10YR 6/3, 10YR 4/4 moist; 60 percent limestone gravel and cobble; moderate fine subangular blocky structure; soft, nonsticky, slightly plastic; common (4) very fine, common (1) fine and coarse roots throughout; no pores; 15 percent finely disseminated carbonate throughout, faint, diffuse, 10YR 6/3; all clast have old, reworked calcium carbonate casts; reworked calcium carbonate nodules and fragments from rhizoliths in Las Vegas formation; strongly effervescent; abrupt smooth boundary.

C--27 to 43+ centimeters; 10YR 6/3, 10YR 5/4 moist; 50 percent fine limestone gravel to cobble; single grained; loose, nonsticky, nonplastic; many (5) very fine roots throughout; no pores; 10 percent finely disseminated carbonate; 2 to 5 percent sand-sized calcium carbonate fragments, prominent, reworked; strongly effervescent.

Site CS 20
Location: 685710E, 4071750N
Buckwheat: Absent

Av--0 to 10 centimeters; 7.5YR 8/2, 7.5YR 5/4 moist; strong thick platy structure; slightly hard, very sticky, very plastic; common (2) very fine roots throughout; many (10+) fine to medium vesicular pores throughout; 50 percent finely disseminated carbonate and silt coats throughout, faint, diffuse, 7.5YR 8/2; violently effervescent; abrupt wavy boundary.

Bk--10 to 36+ centimeters; 10YR 7/3, 10YR 5/4 moist; 35 percent gravel, stones; massive; loose, nonsticky, nonplastic; common (2) very fine, common (1) fine roots throughout; no pores; 10 to 20 percent finely disseminated carbonate throughout, faint, white; 1.9 percent very fine (less than 2 millimeters) calcium carbonate masses, white, discontinuous; violently effervescent.

Site CS 21
Location: 685681E, 4071631N
Buckwheat: Absent

A--0 to 1 centimeters; 10YR 6/3, 10YR 5/3 moist; 15 percent subrounded limestone gravel to stone; moderate thin platy structure; soft, slightly sticky, moderately plastic; no roots; many (5) very fine vesicular and irregular pores throughout; strongly effervescent; very abrupt wavy boundary.

Bk--1 to 8 centimeters; 10YR 6/3, 10YR 5/3 moist; no rock fragments; strong fine to medium angular blocky structure; loose to soft, slightly sticky, moderately plastic; common (1) fine and medium roots throughout; common (3) very fine dendritic tubular and vesicular pores throughout; 5 percent fine to medium (<5 millimeters) calcium carbonate masses throughout, irregular, white, soft; oxidized organic matter lining pores; possible very thin clay coats on faces of peds; stage II; strongly effervescent; abrupt smooth boundary

Btk1--8 to 36 centimeters; 10YR 6/4, 10YR 5/4 moist; no rock fragments; moderate fine subangular blocky structure; soft, slightly sticky, very plastic; common (2) fine, common (1) medium roots throughout; many (8) fine dendritic tubular pores throughout; 20 percent calcium carbonate masses throughout, irregular, faint, white, diffuse; clay coats on faces of peds, in cracks and lining pores; strongly effervescent; clear wavy boundary.

Btk2--36 to 48 centimeters; 10YR 7/3, 10YR 6/3 moist; no rock fragments; strong fine to medium angular blocky structure; slightly hard, slightly sticky, moderately plastic; common (1) fine roots throughout; many (10) very fine and fine dendritic tubular pores throughout; 30 percent calcium carbonate masses throughout, irregular, faint, white, diffuse; thin clay coats lining pores; strongly effervescent; clear wavy boundary

Bkm--48 to 53+ centimeters; 10YR 8/2, 10YR 7/3 moist; no rock fragments; strong medium angular blocky structure; rigid; common (1) fine to coarse roots throughout; common (3) very fine and fine dendritic tubular pores throughout; very thin clay coats on faces of peds and lining pores; violently effervescent.

Site CS 22
Location: 685845E, 4070805N
Buckwheat: Absent

Av--0 to 8 centimeters; 7.5YR 7/3, 7.5YR 5/4 moist; 35 percent limestone gravel; strong very thick platy structure; slightly hard, very sticky, moderately plastic; many (5) very fine roots throughout; many (10) very fine, many (5) fine, common (2) medium vesicular and irregular pores throughout; 20 percent finely disseminated carbonate and/or silt throughout matrix and lining pores, distinct; violently effervescent; abrupt wavy boundary.

Bk1--8 to 34 centimeters; 7.5YR 7/4, 7.5YR 6/4 moist; 25 percent limestone gravel to cobble; soft, moderately sticky, moderately plastic; many (5) very fine and fine, common (2) medium roots throughout; common (3) very fine to fine dendritic tubular pores throughout; 25 percent many very fine to coarse calcium carbonate masses coating rock fragments, soft, white, prominent; 10 to 20 percent finely disseminated carbonate throughout; violently effervescent; abrupt smooth boundary.

Bk2--34 to 45+ centimeters; 7.5YR 7/4, 7.5YR 6/4 moist; 9 percent limestone gravel to cobble; strong medium subangular blocky structure; soft, nonsticky, slightly plastic; common (3) very fine roots throughout; common (4) fine dendritic tubular pores throughout; finely disseminated carbonate lining pores and throughout matrix; violently effervescent.

Site CS 23
Location: 685860E, 4071390N
Buckwheat: Absent

Avk--0 to 5 centimeters; 7.5YR 8/2, 7.5YR 7/3 moist; 40 percent very fine and fine gravel, petrocalcic fragments throughout; strong thick and very thick platy structure; slightly hard, moderately sticky, moderately plastic; no roots; many (10+) very fine and fine vesicular and irregular pores throughout; 20 percent finely disseminated carbonate and/or silt coats throughout and lining pores, soft, faint, irregular; possible (inherited) fine (<2 millimeters) calcium carbonate nodules throughout, white, hard; violently effervescent; abrupt wavy boundary.

Bkq--5 to 17 centimeters; 10YR 8/2, 10YR 8/3 moist; no rock fragments; medium thin platy parting to medium fine and medium angular blocky structure; moderately hard, slightly sticky; common (2) very fine roots throughout; many (5) very fine, common (3) fine and common (2) medium dendritic tubular pores throughout; 50 percent finely disseminated carbonate throughout, distinct, diffuse, white; 10 percent silica and/or calcium carbonate microcrystals as hard cement on faces of peds and lining pores, Grey 6/3; 5 percent red sand lining pores; reworked/welded paleosol horizon; violently effervescent; clear wavy boundary.

Bkqm--17 to 48+ centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; no rock fragments; strong fine and medium angular blocky structure; slightly to extremely hard, moderately sticky; no roots; common (2) very fine and medium, common (3) fine dendritic tubular pores throughout; 35

percent finely disseminated carbonate throughout, distinct, diffuse, white; 25 percent silica and calcium carbonate as hard cement on faces of peds and lining pores; 8 percent red sand filling pores and coating ped faces, prominent; reworked/welded paleosol horizon; violently effervescent.

Site CS 24
Location: 685950E, 4070805N
Buckwheat: Absent

Av--0 to 8 centimeters; 10YR 7/3, 10YR 5/4 moist; 30 percent very fine through coarse limestone gravel; strong thick platy structure; slightly hard, moderately sticky, moderately plastic; no roots; many (10+) very fine irregular and vesicular and fine vesicular pores throughout; 50 percent finely disseminated carbonate and silt coats throughout, faint, 10YR 7/3; violently effervescent; abrupt wavy boundary.

Bk--8 to 18 centimeters; 10YR 6/4, 10YR 4/4 moist; fine and medium subangular blocky structure; soft, slightly sticky, moderately plastic; many (5) very fine, common (3) fine, common (1) coarse roots throughout; common (2) fine dendritic tubular pores throughout; 20 percent finely disseminate carbonate throughout, faint, 10YR 6/4; 2 to 5 percent very fine soft white masses throughout, prominent; violently effervescent; clear wavy boundary.

Bkq1--18 to 35 centimeters; 10YR 7/3, 10YR 4/4 moist; no rock fragments; strong medium angular blocky structure; soft to moderately hard, slightly sticky, moderately plastic; many (5) very fine, common (2) medium roots throughout; common (3) fine dendritic tubular pores throughout; 20 percent finely disseminate carbonate lining pores, white, distinct; very fine white nested crystals lining pores; possible silica as cement and durinodes, 1 to 2 centimeters; indurated root casts, reworked; strongly effervescent; clear wavy boundary.

Bkq2--35 to 51+ centimeters; 10YR 7/3, 10YR 4/4 moist; no rock fragments; strong coarse angular blocky structure; very hard; common (3) very fine, common (1) fine and medium roots throughout; many (5+) fine dendritic tubular pores throughout; strongly effervescent.

Site CS 25
Location: 686135E, 4070805N
Buckwheat: Present

Av--0 to 7 centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; strong very thick platy structure; slightly hard, moderately sticky, slightly plastic; no roots; many (10+) very fine and fine vesicular, many (5) very fine irregular pores throughout; 5 percent finely disseminated carbonate on faces of peds and throughout matrix, faint, diffuse, white, 7.5YR 7/3; thin silans lining vesicular pores, 7.5YR 7/3; strongly effervescent; abrupt wavy boundary.

Bk--7 to 14 centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; 5 percent petrocalcic gravel; medium thin platy parting to medium fine and medium subangular blocky structure; soft, slightly sticky, slightly plastic; many (7) very fine roots throughout; many (5) very fine and fine dendritic tubular pores throughout; 10 percent finely disseminated carbonate; rare to few silt coats lining pores, faint; strongly effervescent; abrupt wavy boundary.

Bqk--14 to 23 centimeters; 7.5YR 8/2, 7.5YR 7/2 moist; strong fine and medium subangular blocky structure; very hard; common (1) medium roots throughout; many (7) very fine and fine dendritic tubular pores throughout; 25 percent finely disseminated carbonate throughout, white, distinct; unknown cement coating ped faces and throughout matrix, 7.5YR 7/3, microcrystalline; red sand filling pores; violently effervescent; abrupt wavy boundary.

Bqkm--23 to 32+ centimeters; 7.5YR 8/2, 7.5YR 7/2 moist; strong medium subangular blocky structure; indurated pan; very hard; no roots; many (7) very fine and fine dendritic tubular pores throughout; 50 percent finely disseminated carbonate throughout, white, distinct; 20 percent unknown cement coating ped faces and throughout matrix, 7.5YR 7/3, microcrystalline; red sand coating and filling pores; violently effervescent.

Site CS 26
Location: 685525E, 4071385N
Buckwheat: Absent

Av--0 to 6 centimeters; 10YR 7/4, 10YR 4/6 moist; 10 percent fine limestone gravel as pavement; strong very thick platy structure; slightly hard, very sticky, moderately plastic; common (1) very fine roots throughout; many (10) very fine and fine, many (5) medium vesicular pores throughout; 25 percent calcium carbonate coats on the bottom of ped faces, prominent, diffuse, soft, pink, 5YR 2/3; 50 percent finely disseminated carbonate and silt coats throughout, distinct, diffuse, 10YR 7/4; violently effervescent; abrupt smooth boundary.

Bk--6 to 30 centimeters; 7.5YR 7/4, 7.5YR 5/4 moist; 50 percent medium limestone gravel to cobble; moderate medium subangular blocky structure; soft, slightly sticky, slightly plastic; common (4) very fine and common (1) fine roots throughout; common (1) fine dendritic tubular pores throughout; 30 percent calcium carbonate coats on faces of peds and in cracks, white; calcium carbonate filaments throughout, prominent, diffuse, white; all clast faces thinly coated with calcium carbonate; violently effervescent; abrupt wavy boundary.

C--30 to 50+ centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; 70 percent limestone coarse gravel through medium cobble; weak fine and medium subangular blocky structure; loose and soft, nonsticky, nonplastic; common (2) very fine roots throughout; no pores; 5 percent finely disseminated carbonate throughout, white, faint, diffuse; violently effervescent.

Site CS 27
Location: 685965E, 4071675N
Buckwheat: Present

Av--0 to 5 centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; 15 to 20 percent limestone gravel; strong very thick platy structure; slightly hard, nonsticky, slightly plastic; no roots; many (5+) very fine and fine vesicular, very fine irregular pores throughout; 30 percent very fine and fine white masses and nodules throughout; skeletal; 80 percent surface covered by pavement, 20 percent surface covered by limestone and petrocalcic gravel; slightly to strongly effervescent; very abrupt wavy boundary.

Bk--5 to 17 centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; no rock fragments; moderate fine and medium subangular blocky parting to weak thin platy structure; moderately hard, slightly sticky, nonplastic; common (3+) very fine roots throughout; common (3+) very fine and fine vesicular and dendritic tubular pores throughout; 0.9 percent iron stains and silt filling pores throughout, diffuse; fine through coarse calcium carbonate nodules and masses throughout, irregular and platy; thin silt or clay coats on faces of peds and lining pores; entire profile is reworked; slightly to strongly effervescent; clear wavy boundary.

Bkm--17 to35+ centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; no rock fragments; moderately medium subangular blocky structure; very hard, nonsticky, nonplastic; many (5+) very fine, common (1) coarse roots throughout; many (10+) very fine vesicular, common (1) medium dendritic tubular pores throughout; 0.9 percent iron stains; fine through coarse calcium carbonate nodules and masses; silt and clay coats lining pores; slightly to strongly effervescent; gradual wavy boundary.

2Btkb--17 to35+ centimeters; 7.5YR 6/3, 7.5YR 5/3 moist; no rock fragments; moderately coarse subangular blocky structure; soft, slightly sticky, moderately plastic; common (1) fine and medium roots throughout; common (3+) very fine and fine dendritic tubular pores throughout; 5 to 20 percent iron masses and stains lining root pores and throughout matrix, diffuse, 7.5YR 5/6; 10 percent calcified root traces, 4 centimeter diameter, 4 to 6 centimeter length, 7.5YR 6/3; 2 percent calcium carbonate nodules, 5 millimeters, 7.5YR 8/2; slightly to strongly effervescent; lower boundary not observed.

Site CS 28
Location: 685660E, 4071230N
Buckwheat: Absent

Av--0 to 8 centimeters; 10YR 6/3, 10YR 4/4 moist; 60 percent gravel; moderate thick platy structure; soft, nonsticky, slightly plastic; common (3) very fine and fine roots throughout; many (10+) fine vesicular, common (10) medium dendritic tubular pores throughout; 50 percent finely disseminated carbonate and silt coats throughout, distinct, 10YR 6/3; violently effervescent; abrupt wavy boundary.

Bw--8 to 20 centimeters; 10YR 6/4, 10YR 5/4 moist; 75 percent gravel; moderate fine subangular blocky structure; soft, nonsticky, slightly plastic; many (5) very fine, common (2) fine and medium roots throughout; common (4) very fine dendritic tubular pores throughout; 10 percent finely disseminated carbonate throughout, faint, 10YR 6/4; calcium carbonate coats on coarse rock fragments, no orientation; violently effervescent; abrupt wavy boundary.

C--20 to 38+ centimeters; 10YR 6/3, 10YR 4/4 moist; 85 percent gravel; massive; loose, nonsticky, nonplastic; many (5) very fine, common (2) medium roots throughout; no pores; 9 percent finely disseminated carbonate throughout, faint, 10YR 6/3; violently effervescent.

Site CS 29
Location: 685600E, 4070805N
Buckwheat: Absent

Av--0 to 8 centimeters; 7.5YR 7/3, 7.5YR 5/4 moist; 75 percent gravel through stones; strong very thick platy structure; slightly hard, very sticky, moderately plastic; common (1) fine roots throughout; many (10+) very fine through medium vesicular, many (5+) very fine and fine irregular pores throughout; finely disseminated carbonate and silt coats throughout, faint, 7.5YR 7/3; violently effervescent; very abrupt wavy boundary.

Bk1--8 to 18 centimeters; 7.5YR 7/4, 7.5YR 5/4 moist; 60 percent gravel; moderate medium subangular blocky structure; slightly hard, nonsticky, nonplastic; common (4) very fine, common (1) fine roots throughout; common (3) very fine dendritic tubular pores throughout; thin (0.9 millimeter) calcium carbonate masses as pendants on the bottom of rock fragments; finely disseminated carbonate and filaments throughout, white, prominent; marked increase of finely disseminated carbonate, especially within top 1 centimeter; stage I to II; violently effervescent; clear wavy boundary.

Bk2--18 to 32+ centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; moderate medium subangular blocky structure; common (3) very fine, common (1) fine, common (2) medium roots throughout; common (4) very fine and fine dendritic tubular pores throughout; violently effervescent.

Site CS 30
Location: 685740E, 4070805N
Buckwheat: Absent

Av--0 to 7 centimeters; 10YR 7/3, 10YR 5/4 moist; 25 percent limestone gravel; strong very thick platy structure; slightly hard, moderately sticky, moderately plastic; common (1) very fine roots throughout; many (10+) very fine through medium vesicular, many (5) very fine irregular pores throughout; finely disseminated carbonate and silt throughout, distinct; silt coats lining vesicular pores; violently effervescent; abrupt wavy boundary.

Bk1--7 to 18 centimeters; 7.5YR 6/4, 7.5YR 5/4 moist; 35 percent limestone gravel; strong medium subangular blocky structure; soft, moderately sticky, slightly plastic; common (4) very fine and fine, common (1) coarse roots throughout; common (2) very fine and fine dendritic tubular pores throughout; 10 percent finely disseminated carbonate throughout, white; discontinuous soft white coats on faces of peds and on the bottom of ped surfaces; 20 percent silt coats throughout, faint; red sand filling pores; strongly effervescent; clear wavy boundary.

Bk2--18 to 43+ centimeters; 7.5YR 7/4, 7.5YR 5/4 moist; 50 percent gravel and cobble; strong medium subangular blocky structure; soft, nonsticky, slightly plastic; common (3) very fine and fine, common (1) medium and coarse roots throughout; common (3) very fine dendritic tubular pores throughout; 10 percent finely disseminated carbonate; strongly effervescent.

(end of Coyote Springs profiles)

II. Gold Butte Soil Profile Descriptions

Site GB 00
Location: 755829E, 4037047N
Buckwheat: Present

A--0 to 7 centimeters; 7.5YR 7/3, 7.5YR 5/4 moist; no rock fragments; strong medium platy structure; soft, nonsticky, slightly plastic; no roots; many (10) fine tubular pores throughout; 0.5 centimeter calcium carbonate masses as pendants and gypsum on the bottom of plates, 7.5YR 8/3; slightly effervescent; very abrupt wavy boundary.

By1/Bw1--7 to 10 centimeters; 7.5YR 7/4, 7.5YR 6/4 moist; no rock fragments; weak fine subangular blocky structure; soft, nonsticky, nonplastic; common (1) fine and medium roots throughout; many (10) fine tubular pores throughout; 2 to 5 percent fine gypsum masses throughout, distinct, white, hard; slightly effervescent; clear smooth boundary.

By2/Bw2--10 to 42 centimeters; 7.5YR 7/4, 7.5YR 6/4 moist; no rock fragments; weak to medium coarse subangular blocky structure; soft, nonsticky, nonplastic; many (10) fine, common (2) medium, common (3) coarse roots throughout; many (10) fine tubular, common (3) medium dendritic tubular pores throughout; 10 percent fine to medium gypsum masses, white, distinct, hard; slightly effervescent; clear smooth boundary.

Cr--42 to 75+ centimeters; 7.5YR 6/4, 7.5YR 6/4 moist; massive parting to moderate medium angular blocky structure; soft, nonsticky, nonplastic; common (3) fine and medium roots throughout; many (5) medium irregular and dendritic tubular pores throughout; 10 percent fine to medium gypsum masses, white, distinct, hard; slightly effervescent.

Site GB 01
Location: 755835E, 4037860N
Buckwheat: Present

A--0 to 5 centimeters; 7.5YR 7/4, 7.5YR 6/4 moist; 2 to 5 percent gravel; moderate medium platy structure; soft, nonsticky, slightly plastic; no roots many (10+) very fine vesicular and irregular pores throughout; gypsum and calcium carbonate masses as pendants, white, very distinct; slightly effervescent; very abrupt wavy boundary.

Bw1--5 to 16 centimeters; 7.5YR 8/3, 7.5YR 6/4 moist; no rock fragments; weak fine and medium platy parting to subangular blocky structure; soft, nonsticky, nonplastic; common (1) fine roots throughout; many (10+) very fine vesicular and irregular pores throughout; 10 to 15 percent fine gypsum masses throughout, distinct; red iron stained silt, irregular, interspersed with gypsum crystals; very fine gypsum srystals throughout, sand sized and smaller; irregular reprecipitated gypsum; slightly effervescent; clear smooth boundary.

Bw2--16 to 43 centimeters; 7.5YR 7/3, 7.5YR 6/4 moist; no rock fragments; massive parting to moderate medium subangular blocky structure; soft, nonsticky, nonplastic; common (2) medium, common (3) very fine and fine roots throughout; common (2) fine irregular pores throughout; oxidized root traces; blocky, clayey silt lenses; 10 to 15 percent fine gypsum masses throughout, distinct; slightly effervescent; gradual smooth boundary.

Cr-- 43 to 53 centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; structureless parting to weak fine subangular blocky structure; soft, nonsticky, nonplastic; common (1) very fine and fine roots throughout; common (2) fine irregular pores throughout; 10 to 15 percent fine gypsum masses throughout, distinct; slightly effervescent; abrupt irregular boundary.

R--53+ centimeters; 10YR 7/3, clayey siltstone.

Site GB 02
Location: 755560E, 4038220N
Buckwheat: Absent

Av--0 to 8 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; no rock fragments; moderate thick platy structure; soft, slightly sticky, slightly plastic; no roots; many (10+) very fine to medium vesicular and irregular pores throughout; 10 to 20 percent fine through coarse gypsum masses on the bottom of plates, platy to spherical, white, soft, distinct; 1 millimeter to 1 centimeter agglomerate; strongly effervescent; abrupt smooth boundary.

By1--8 to 19 centimeters; 7.5YR 7/4, 7.5YR 5/6 moist; no rock fragments; moderate medium angular blocky structure; soft, nonsticky, nonplastic; common (3) fine, common (1) medium roots throughout; many (10+) very fine and fine irregular pores throughout; 5 to 15 percent fine gypsum masses and filaments, white; round gypsum spar lining pores and on the faces of peds; 10 percent skeletal gypsum spar; 5 to 10 percent pedogenic gypsum; strongly effervescent; clear smooth boundary.

By2--19 to 35 centimeters; 5YR 6/4, 5YR 5/6 moist; no rock fragments; moderate medium subangular blocky structure; soft, nonsticky, nonplastic; many (5) fine, common (1) medium roots throughout; many (6) very fine and fine dendritic tubular and irregular pores throughout; 10 percent 1 to 2 millimeter gypsum masses and filaments lining pores and on the faces of peds, prominent, white; strongly effervescent; abrupt smooth boundary.

By3--35 to 75 centimeters; 5YR 6/4, 5YR 5/4 moist; no rock fragments; weak to moderate medium subangular blocky structure; soft, slightly sticky, nonplastic; no roots; many (10+) very fine to fine irregular pores throughout; 15 percent very fine gypsum masses; 15 percent fine gypsum spar, grey, recrystallized; very fine blocks of red clay throughout; strongly effervescent; gradual smooth boundary.

By4/Cr--75+ centimeters; 7.5YR 6/4; no rock fragments; weak medium subangular blocky structure; slightly hard to hard, moderately sticky, slightly plastic; no roots; many (5) very fine irregular pores throughout; 4.9 percent gypsum masses; diffuse red stains (2.5YR 4/8) lining dendritic tubular pores; slightly effervescent.

Site GB 03
Location: 755555E 4038200N
Buckwheat: Absent

A--0 to 5 centimeters; 7.5YR 6/4, 7.5YR 5/4 moist; no rock fragments; moderate medium platy parting to subangular blocky structure; soft, slightly sticky, moderately plastic; no roots; many (10+) very fine irregular pores throughout; 1 centimeter gypsum masses as pendants on the bottom of plates, white, prominent; very fine gypsum snowballs lining vesicular pores, sharp, distinct; slightly effervescent; very abrupt wavy boundary.

By1--5 to 13 centimeters; 5YR 8/3, 5YR 6/3 moist; no rock fragments; moderate coarse subangular blocky structure; soft, nonsticky, nonplastic; common (1) very fine roots throughout; many (10+) very fine irregular pores throughout; 10 percent gypsum masses throughout, soft, white, prominent, 1 to 3 millimeter, spherical to irregular, distinct; slightly effervescent; abrupt smooth boundary

By2--13 to 39 centimeters; 5YR 7/4, 5YR 5/4 moist; no rock fragments; moderate medium to coarse subangular blocky structure; soft, nonsticky, nonplastic; common (3) very fine,.many (5) fine to medium roots throughout; many (5) very fine irregular, common (1) medium dendritic tubular pores throughout; 2 percent gypsum masses throughout, soft, white, irregular, prominent, sharp, abrupt; slightly effervescent; clear smooth boundary

By3--39 to 57 centimeters; 7.5YR 7/4, 7.5YR 5/4 moist; no rock fragments; moderate medium subangular blocky structure; soft, slightly sticky, nonplastic; common (2) fine, common (1) medium roots throughout; many (10+) very fine and fine irregular and skeletal pores; 1 to 2 percent fine gypsum masses, white; strongly effervescent; clear smooth boundary

Cr--57 to 75+ centimeters; 5YR 6/4, 5YR 4/4 moist; blocky, fissile claystone; 5 percent very fine and fine soft gypsum masses; sparry gypsum crystals between clay blocks; strongly effervescent.

Site GB 04
Location: 755620E, 4038150N
Buckwheat: Absent

Av--0 to 6 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; no rock fragments; strong medium to thick platy structure; soft, slightly sticky, slightly plastic; common (1) very fine and fine roots throughout; many (10+) very fine and fine vesicular, common (3) to many (5) fine and medium irregular and dendritic tubular pores throughout; few very fine silans on the surfaces of peds; strongly effervescent; abrupt smooth boundary.

B1--6 to 27 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; no rock fragments; moderate medium subangular blocky structure; soft, moderately sticky, moderately plastic; many (5) very fine, common (2) fine, common (1) coarse roots throughout; many (5) very fine, common (1) medium irregular and dendritic tubular pores throughout; common very fine and fine diffuse, distinct white masses on the surfaces of peds and in between cracks, 0.5 millimeters; very fine white microrhizae throughout, diffuse; strongly effervescent; gradual smooth boundary

B2--27 to 44 centimeters; 7.5YR 6/6, 7.5YR 4/6 moist; no rock fragments; moderate medium to coarse subangular blocky structure; soft, moderately sticky, moderately plastic; many (10+) very fine and fine roots throughout; many (10) very fine and fine tubular pores throughout; common very fine and fine diffuse, distinct white masses and filaments on the surfaces of peds and in between cracks, 0.5 millimeters; thin clay coats lining pores; strongly effervescent; abrupt smooth boundary

By--44 to 64 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; no rock fragments; moderate medium angular blocky structure; soft, slightly sticky, slightly plastic; common (1) very fine and fine roots throughout; many (10) very fine, common (3) fine and medium dendritic tubular pores throughout; 5 percent fine gypsum masses as snowball morphology, abrupt, distinct, white; 0.5 millimeter cuteans in between cracks and lining pores; strongly effervescent; very abrupt wavy boundary

Cr--64+ centimeters; indurated gypsipherous siltstone; very hard; strongly effervescent.

Site GB 05
Location: 755545E, 4038170N
Buckwheat: Absent

Av--0 to 3 centimeters; 7.5YR 7/3, 7.5YR 6/4 moist; no rock fragments; moderate very thick platy structure; slightly hard, nonsticky, nonplastic; no roots; common (2) very fine vesicular, many (10+) very fine irregular pores throughout; 50 percent fine and medium gypsum spar, lithogenic, skeletal; 2 percent fine gypsum masses lining pores; discontinuous; red clay and grey gypsum, prominent; slightly effervescent; clear smooth boundary.

C--3 to 10 centimeters; 7.5YR 8/3, 7.5YR 7/3 moist; no rock fragments; moderate fine angular blocky structure; slightly hard, nonsticky, nonplastic; common (1) very fine and fine roots throughout; skeletal pores; spary gypsum and some pedogenic gypsum lining pores; slightly effervescent; gradual wavy boundary.

Cr--10 to 41+ centimeters; 7.5YR 7/4, 7.5YR 6/4 moist; no rock fragments; soft to very hard, nonsticky, nonplastic; common (1) fine and medium roots throughout; skeletal pores; mostly lithogenic gypsum; 10 to 15 percent red clay; slightly effervescent.

Site GB 06
Location: 755930E, 4037900N
Buckwheat: Present

A--0 to 3 centimeters; 7.5YR 6/4, 7.5YR 5/6 moist; no rock fragments; strong medium platy structure; soft, slightly sticky, moderately plastic; no roots; common (3) very fine vesicular, common (2) very fine irregular pores throughout; discontinuous gypsum masses on the bottom of plates, less than 2 millimeters thick; strongly effervescent; very abrupt smooth boundary.

By1--3 to 7 centimeters; 7.5YR 6/4, 7.5YR 4/4 moist; no rock fragments; strong fine and medium platy structure; soft, slightly sticky, slightly plastic; common (2) very fine and fine roots throughout; many (5) very fine irregular pores throughout; 20 percent gypsum masses and nodules, white, distinct, spherical to platy; strongly effervescent; very abrupt smooth boundary

By2--7 to 12 centimeters; 7.5YR 7/3, 7.5YR 5/4 moist; no rock fragments; moderate medium subangular blocky structure; soft, nonsticky, slightly plastic; common (3) fine and medium roots throughout; many (5) very fine and fine dendritic tubular pores throughout; 5 percent gypsum masses, irregular; slightly effervescent; clear wavy boundary

BC--12 to 31 centimeters; 7.5YR 6/4, 7.5YR 5/4 moist; no rock fragments; moderate medium subangular blocky structure; soft, nonsticky, nonplastic; many (5+) very fine and fine roots throughout; many (10+) very fine to medium irregular and skeletal pores throughout; 20 to 30 percent fine gypsum spar throughout; gypsum lining pores; 70 to 80 percent clay lining pores; slightly effervescent; clear wavy boundary

Cr--31 to 60+ centimeters; moderate fine to coarse angular blocky structure, lithogenic; common (3) very fine roots throughout; sedimentary blocks, mixed characteristics, predominant massive indurated gray siltstone with gypsum in between fractures; red fissile to blocky siltstone or clayey siltstone; zone weathered, same as other sites; slightly effervescent.

Site GB 07
Location: 755792E, 4037842N
Buckwheat: Absent

Av--0 to 5 centimeters; 7.5YR 6/4, 7.5YR 4/4 moist; 2 to 5 percent fine through coarse round gravel; strong very thick platy structure; soft, slightly sticky, moderately plastic; common (1) very fine roots throughout; many (10+) very fine and fine vesicular and irregular pores throughout; strongly effervescent; very abrupt smooth boundary.

By--5 to 12 centimeters; 7.5YR 7/4, 7.5YR 4/6 moist; moderate medium subangular blocky structure; soft, slightly sticky, slightly plastic; common (1) medium and coarse roots throughout; many (10+) very fine irregular, common (2) fine dendritic tubular pores throughout; 10 percent very fine and fine gypsum masses and lenses primarily concentrated at the base of the horizon; strongly effervescent; abrupt wavy boundary.

Cr--12 to 62+ centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; moderate coarse angular blocky structure; moderately hard, nonsticky, nonplastic; common (2) fine, common (1) coarse roots throughout; skeletal pores; 50 percent gypsum; 50 percent clay; some secondary realteration of gypsum; slightly effervescent.

Site GB 08
Location: 755909E, 4037871N
Buckwheat: Present

Av--0 to 4 centimeters; 7.5YR 6/4, 7.5YR 4/4 moist; 1.9 percent limestone gravel; moderate medium through very thick platy structure; soft, slightly sticky, moderately plastic; no roots; many (10+) very fine and fine vesicular pores throughout; few fine (less than 2 millimeters) gypsum masses on the bottom of plates and filling vesicular pores, discontinuous; slightly effervescent; abrupt wavy boundary.

By--4 to 10 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; 1 percent coarse angular siltstone cobble at top of horizon; moderate thin to medium platy structure; soft, slightly sticky, moderately plastic; common (1) fine and medium roots throughout; many (10+) very fine vesicular, many (5+) very fine dendritic tubular pores throughout; many (10+) very fine and fine gypsum masses and nodules lining pores; strongly effervescent; abrupt wavy boundary

CB/C--10 to 36 centimeters; 5YR 7/3, 5YR 4/4 moist; 1 percent coarse angular siltstone cobble at top of horizon; weak medium subangular blocky structure; hard, moderately sticky, moderately plastic; many (5 to 10) very fine, common (1) medium and coarse roots throughout; skeletal pores; common (4) very fine gypsum masses and lenses throughout matrix and in between plates and blocks; locally cemented by gypsum; lithochromatic mottles, 5YR 4/4, 5YR 7/2; strongly effervescent; clear wavy boundary

Cr--36+ centimeters; platy to blocky structure; hard, very rigid; siltstone/claystone; very thin lenses of gypsum spar in claystone plates; common (1) fine roots in between cracks; skeletal pores; strongly effervescent.

Site GB 09
Location: 755810E, 4037975N
Buckwheat: Absent

Av--0 to 3 centimeters; 7.5YR 6/4, 7.5YR 5/4 moist; 10 percent very fine to medium rounded limestone gravel; moderate thick and very thick platy structure; soft, slightly sticky, nonplastic; common (2) very fine roots throughout; many (5) very fine vesicular and irregular pores throughout; 5 percent finely disseminated carbonate throughout, faint, white; violently effervescent; very abrupt wavy boundary.

Bk--3 to 10 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; 4.9 percent gravel; common (1) thin platy parting to moderate coarse subangular blocky structure; soft, nonsticky, nonplastic; common (2) fine roots throughout; common (4) very fine dendritic tubular pores throughout; 5 percent finely disseminated carbonate throughout and lining very fine roots and pores, faint, white; 20 percent silt coats throughout, faint, 7.5YR 6/4; violently effervescent; abrupt wavy boundary

Bky1--10 to 31 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; 4.9 percent gravel; moderate medium and coarse subangular blocky structure; soft, nonsticky, nonplastic; common (3) very fine, common (2) fine, common (1) medium roots throughout; common (1) very fine dendritic tubular pores throughout; 15 to 20 percent finely disseminated carbonate; few (0.9) gypsum masses throughout, white, distinct, less than 1 millimeter; violently effervescent; abrupt wavy boundary

Bky2—31 to 62+ centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; 10 percent very fine to medium gravel; moderate fine and medium subangular blocky structure; soft, nonsticky, nonplastic; common (2) fine roots throughout; common (1) very fine dendritic tubular pores throughout; 15 percent finely disseminated carbonate; few (0.9) gypsum masses, white, distinct, less than 1 millimeter; softer, weaker structure, almost loose; violently effervescent.

Site GB 10
Location: 755570E, 4038100N
Buckwheat: Absent

A--0 to 4 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; 20 percent gravel; moderate thick platy parting to fine to medium subangular blocky structure; soft, nonsticky, slightly plastic; common (2) very fine roots throughout; many (10+) very fine irregular pores throughout; strongly effervescent; abrupt wavy boundary.

Bw--4 to 16 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; 20 percent gravel; weak medium and moderate coarse subangular blocky structure; soft, nonsticky, slightly plastic; common (3) very fine, common (1) fine and medium roots throughout; many (5) very fine dendritic tubular pores throughout; extremely faint, diffuse, white coats on the faces of peds; strongly effervescent; abrupt wavy boundary

C--16 to 54+ centimeters; 5YR 6/6, 5YR 5/6 moist; 65 percent gravel; structureless; nonsticky, nonplastic; many (10+) very fine roots throughout; no pores; very few, faint, diffuse, discontinuous white coats on coarse fragments; strongly effervescent.

Site GB 11
Location: 755597E, 4038121N
Buckwheat: Absent

A--0 to 3 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; no rock fragments; strong very thick platy structure; soft, slightly sticky, slightly plastic; common (3) fine vesicular, many (5) very fine vesicular and irregular pores throughout; 0.5 to 1 centimeter thick continuous white gypsum pendants on the bottom of plates; strongly effervescent; abrupt wavy boundary.

Cr--3 to 13+ centimeters; sparry gypsum, white; skeletal pores; strongly effervescent.

Site GB 12
Location: 755825E, 4037947N
Buckwheat: Absent

Av--0 to 7 centimeters; no rock fragments; strong very thick platy structure; soft, very sticky, slightly plastic; common (2) very fine roots throughout; many (10+) very fine to medium vesicular, common (3) very fine irregular pores throughout; 5 percent gypsum masses within pores and on the bottom of plates, white, round to irregular, some discontinuous pendants; 15 percent finely disseminated carbonate throughout, faint; violently effervescent; abrupt wavy boundary.

By1--7 to 20 centimeters; 5YR 7/4, 5YR 4/4 moist; no rock fragments; moderate medium subangular blocky structure; slightly hard, very sticky, moderately plastic; common (3) fine roots throughout; common (4) fine dendritic tubular, common (2) fine irregular pores throughout; 2 percent fine gypsum masses, white, prominent, soft, irregular; 5 to 10 percent finely disseminated carbonate and filaments throughout, discontinuous, white, soft; violently effervescent; abrupt wavy boundary

By2--20 to 44 centimeters; 5YR 7/4, 5YR 5/6 moist; no rock fragments; moderate medium and coarse angular blocky structure; slightly hard, moderately sticky, slightly plastic; common (3) very fine, common (1) medium roots throughout; 5 percent fine gypsum masses, white, prominent, soft, irregular; 5 percent fine, grey pedogenic gypsum lining pores; 20 percent finely disseminated carbonate throughout; violently effervescent; clear smooth boundary

BCy--44 to 67+ centimeters; 5YR 7/4, 5YR 4/6 moist; no rock fragments; moderate medium and coarse subangular blocky structure; slightly hard, slightly sticky, slightly plastic; no roots; 40 percent grey gypsum crystals; 40 percent red clay blocks, less than 2 millimeters, very fine; 10 percent fine gypsum masses, white, prominent, soft, irregular; gypsum coating pores; strongly effervescent.

Site GB 13
Location: 755907E, 4037909N
Buckwheat: Absent

A--0 to 3 centimeters; 7.5YR 6/4, 7.5YR 5/4 moist; no rock fragments; moderate thick platy structure; soft, slightly sticky, moderately plastic; no roots; many (5+) very fine and fine vesicular pores throughout; slightly effervescent; very abrupt wavy boundary.

Cr--3 to 27+ centimeters; 10YR 8/3, 10YR 8/3 moist; no rock fragments; massive; very rigid; common (2) very fine roots in between cracks; very fine (micro) sparry crystalline gypsum, distinct; skeletal, irregular very fine and fine pores; slightly effervescent.

Site GB 14
Location: 755818E, 4037875N
Buckwheat: Present

Av--0 to 4 centimeters; 5YR 7/4, 5YR 5/4 moist; no rock fragments; strong very thick platy structure; soft, slightly sticky, moderately plastic; no roots; many (10) very fine vesicular, common (2) fine irregular pores throughout; 0.1 to 1+ centimeter white, discontinuous gypsum pendants on the bottom of plates; strongly effervescent; abrupt wavy boundary.

By--4 to 14 centimeters; 5YR 7/4, 5YR 6/4 moist; no rock fragments; strong fine and medium subangular blocky structure; soft, nonsticky, nonplastic; common (2) very fine roots throughout; many (10+) very fine and fine irregular, common (2) fine dendritic tubular pores throughout; gypsum spar and lithogenic clay; 5 percent gypsum masses lining pores, white, distinct, sharp; possible silt coats lining pores; strongly effervescent; gradual smooth boundary.

BC--14 to 34 centimeters; 5YR 6/4, 5YR 5/4 moist; no rock fragments; moderate medium subangular blocky structure; soft, nonsticky, nonplastic; common (2) fine, common (1) medium roots throughout; common (3) fine dendritic tubular and irregular, skeletal pores throughout; gypsum spar and lithogenic clay; 4.9 percent pedogenic gypsum masses; 5 percent fine gypsum masses, white; strongly effervescent; clear irregular boundary.

Cr--34 to 68+ centimeters; varied lithogenic composition; blocky, gypsum, siltstone and claystone; fissile; many (5+) fine roots throughout; structural pores throughout; strongly effervescent.

Site GB 15
Location: 755765E, 4037860N
Buckwheat: Absent

Av--0 to 6 centimeters; 7.5YR 6/4, 7.5YR 4/4 moist; 15 percent gravel; moderate thick platy structure; soft, slightly sticky, slightly plastic; common (2) very fine, common (1) fine roots throughout; many (5) very fine, common (2) medium vesicular, common (3) very fine irregular pores throughout; 20 percent finely disseminated carbonate and/or silans coating pores and sand grains and throughout, distinct; strongly effervescent; abrupt wavy boundary.

Bky--6 to 28 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; 4.9 percent gravel; moderate medium and coarse angular blocky structure; soft, nonsticky, nonplastic; many (5) fine, common (2) medium roots throughout; common (1) very fine, common (3) fine dendritic tubular pores throughout; 0.9 percent 1 millimeter gypsum or calcium carbonate masses throughout, white, prominent, spherical; 20 percent finely disseminated carbonate throughout, abrupt; slightly effervescent; gradual smooth boundary.

C--28 to 69+ centimeters; 7.5YR 6/4, 7.5YR 4/4 moist; no rock fragments; moderate coarse angular blocky structure; soft, slightly sticky, slightly plastic; common (3) very fine roots on the top of the horizon; skeletal pores throughout; weathered; gypsiferrous silt and clay, not blocky, not firm; 50 percent gypsum crystals and clay blocks throughout; 5 percent very fine gypsum masses within pores, white; reprecipitated pedogenic gypsum snowballs and irregular masses concentrated at the upper 1 to 3 centimeters of horizon and filling all pores, white, prominent, spherical to irregular, soft; very slightly effervescent.

Site GB 16
Location: 755890E, 4037815N
Buckwheat: Present

Av--0 to 2 centimeters; 7.5YR 7/4, 7.5YR 4/6 moist; 60 percent very fine to coarse mixed limestone gravel; strong thin to very thick platy structure; slightly hard, very sticky, moderately plastic; no roots; many (10) very fine vesicular, common (1) very fine dendritic tubular, common (2) fine irregular pores throughout; 15 percent finely disseminated carbonate, white, 7.5YR 7/4, faint; 5 to 10 percent gypsum masses throughout and especially lining pores, distinct, reprecipitated; violently effervescent; very abrupt wavy boundary.

By--2 to 23 centimeters; 5YR 7/4, 5YR 5/6 moist; no rock fragments; moderate medium angular blocky structure; slightly hard to hard; common (2) fine roots throughout; many (10) very fine irregular, many (5) fine dendritic tubular pores, skeletal pores throughout; 30 percent very fine to fine gypsum crystals throughout, distinct, clear; 5 percent gypsum masses lining pores; finely disseminated carbonate; 1 centimeter blocks of weathered clayey bedrock throughout; strongly effervescent; clear irregular boundary.

CB--23 to 33 centimeters; 5YR 7/3 to 5YR 4/4, 5YR 4/4 to 5YR 4/6 moist; no rock fragments; weak fine angular blocky structure; slightly hard to extremely hard; common (1) very fine and medium, common (2) fine roots throughout; common (3) very fine dendritic tubular and skeletal pores throughout; 30 percent very fine to fine gypsum crystals throughout, distinct, clear; 5 percent gypsum masses lining pores; finely disseminated carbonate; strongly effervescent; clear irregular boundary.

Cr--33 to 54+ centimeters; blocky gypsiferrous siltstone and claystone; lithogenic medium and coarse angular blocky structure; extremely hard; common (3) very fine roots throughout; skeletal pores throughout; strongly effervescent.

Site GB 17
Location: 755825E, 4037835N
Buckwheat: Present

C1--0 to 14 centimeters; 5YR 8/2, 5YR 7/3 moist; no rock fragments; moderate coarse subangular blocky structure; hard, nonsticky, nonplatic; common (3+) very fine, common (1) medium roots throughout; fine and medium skeletal pores throughout; 20 to 80 percent gypsum, 5YR8/1; 20 to 80 percent clay, 5YR 4/4; surface crust is platy; slightly effervescent; clear wavy boundary.

C2--14 to 26 centimeters; 5YR 5/3, 5YR 4/3 moist; no rock fragments; weak medium subangular blocky structure; moderately hard, very sticky, very plastic; many (5+) very fine, common (1) medium roots throughout; skeletal pores throughout; 15 percent very fine gypsum masses on the faces of peds and in between cracks; mostly slightly altered claystone; strongly effervescent; abrupt wavy boundary.

C3--26 to 56 centimeters; 5YR 7/3, 5YR 6/3 moist; no rock fragments; moderate fine and medium subangular blocky structure; slightly hard, nonsticky, moderately plastic; common (3) very fine, common (1) coarse roots throughout; fine and medium skeletal pores throughout; 30 to 50 percent fine and medium gypsum spar, 5YR 8/1, remainder is clay; strongly effervescent; clear wavy boundary.

Cr--56 to 76+ centimeters; fissile claystone with 15 percent gypsum spar; slightly effervescent.

Site GB 18
Location: 755847E, 4037875N
Buckwheat: Absent

A--0 to 4 centimeters; 7.5YR 7/4, 7.5YR 5/4 moist; no rock fragments; strong medium platy structure; soft, nonsticky, slightly plastic; no roots; many (10+) very fine vesicular and irregular pores throughout; 1 centimeter white pendants on the bottom of plates; very slightly effervescent; very abrupt wavy boundary.

By1--4 to 11 centimeters; 5YR 7/4, 5YR 6/4 moist; no rock fragments; weak medium subangular blocky structure; soft, nonsticky, nonplastic; common (1) very fine roots throughout; many (10+) very fine irregular and skeletal pores throughout; reprecipitated, fine gypsum throughout; slightly effervescent; abrupt smooth boundary.

By2--11 to 36 centimeters; 5YR 7/4, 5YR 5/4 moist; no rock fragments; weak medium subangular blocky structure; soft, nonsticky, slightly plastic; common (1) very fine and medium roots throughout; many (10+) very fine irregular and skeletal pores throughout; few distinct gypsum masses/fragments; reprecipitated gypsum; common (1) medium and coarse clay content (probably from bedrock) coating roots and base; slightly effervescent; clear smooth boundary.

BC--36 to 48 centimeters; 5YR 6/4, 5YR 4/4 moist; no rock fragments; moderate medium subangular blocky structure; soft, slightly sticky, slightly plastic; no roots; many (10+) fine irregular pores throughout; 75 percent red fissile clay; 25 percent gypsum masses; clay content probably from bedrock; slightly effervescent; clear irregular boundary.

Cr/R--48+ centimeters; 7.5YR 7/4; gypsiferrous claystone/siltstone; medium to coarse angular blocky lithogenic structure; slightly effervescent.

Site GB 19
Location: 755864E, 4037895N
Buckwheat: Absent

A--0 to 6 centimeters; 5YR 6/4, 5YR 4/4 moist; no rock fragments; strong medium platy structure; soft, slightly sticky, moderately plastic; common (2) very fine roots throughout; many (10) very fine vesicular, common (3) fine irregular pores throughout; 1 centimeter thick white gypsum pendants on the bottom of plates; slightly effervescent; very abrupt wavy boundary.

Bw--6 to 26 centimeters; 5YR 7/4, 5YR 6/4 moist; no rock fragments; weak fine and medium subangular blocky structure; soft, nonsticky, nonplastic; common (2) fine and medium roots throughout; many (5+) very fine irregular pores throughout; very fine mottles of white gypsum masses, lithogenic; gypsum spar and fine clay, red aggregates, 2 to 4 centimeters; medium roots only growing at border to C horizon; slightly effervescent; clear smooth boundary.

Cr—26 to 46+ centimeters; 5YR 7/4, 5YR 5/4 moist; massive; moderate fine and medium subangular blocky structure; soft, nonsticky, nonplastic; common (1) very fine roots throughout; no pores; clay filling irregular pores and lining plates; red clay dominates gypsum, can be greater than 5 millimeters; very dense high clay content (lithogenic clay) primary claystone with 10 percent gypsum; slightly effervescent.

Site GB 20
Location: 755864E, 4037895N
Buckwheat: Absent

Av--0 to 4 centimeters; 7.5YR 6/4, 7.5YR 4/4 moist; 2 percent surface limestone gravel; strong thick platy structure; soft, slightly sticky, moderately plastic; no roots; many (10+) very fine to medium vesicular pores throughout; 1 centimeter thick white gypsum pendants between plates; strongly effervescent; very abrupt wavy boundary.

By1--4 to 10 centimeters; 5YR 5/4, 5YR 4/4 moist; no rock fragments; moderate medium platy parting to weak fine subangular blocky structure; soft, nonsticky, nonplastic; common (1) very fine roots throughout; many (10+) very fine and fine vesicular and irregular pores throughout; 2 to 5 percent very fine gypsum spar; slightly effervescent; abrupt smooth boundary.

By2--10 to 38 centimeters; 7.5YR 6/4, 7.5YR 4/4 moist; no rock fragments; weak fine and medium subangular blocky structure; soft, nonsticky, nonplastic; common (1) fine roots throughout; many (10+) fine and medium irregular and skeletal pores throughout; 30 percent fine gypsum spar lining pores; white gypsum spar and red claystone, sand to silt sized fragments; very slightly effervescent; gradual smooth boundary.

BC--38 to 73 centimeters; 7.5YR 5/4, 7.5YR 5/4 moist; no rock fragments; massive; moderate medium subangular blocky structure; soft, nonsticky, nonplastic; common (3) fine, common (1) medium roots at the bottom of horizon; many (10+) fine and medium irregular and skeletal pores throughout; white gypsum spar and red claystone, sand to silt sized fragments; pore and crystal sizes increase; very slightly effervescent; abrupt wavy boundary.

Cr--73 to 81+ centimeters; 7.5YR 6/4; platy to blocky; gypsiferrous siltstone with lense of gypsum spar and plates of fine microcrystalline gypsum; very slightly effervescent.

Site GB 21
Location: 755851E, 4037884N
Buckwheat: Absent

A--0 to 2 centimeters; 7.5YR 7/2, 7.5YR 5/4 moist; no rock fragments; moderate fine and medium platy structure; soft, nonsticky, moderately plastic; no roots; many (5+) very fine irregular pores throughout; 50 percent weathered gypsum spar; slightly effervescent; very abrupt wavy boundary.

C--2 to 28 centimeters; 7.5YR 7/4, 5YR 6/4 moist; no rock fragments; moderate fine and medium subangular blocky structure; soft, nonsticky, nonplastic; many (5+) very fine, common (3) medium, common (1) coarse roots throughout; many (5) fine and medium dendritic tubular pores throughout; 5 to 10 percent gypsum spar, discrete areas of 7.5YR 7/4 silty clay; 7.5YR 7/6 gypsum masses; slightly effervescent; gradual irregular boundary.

Cr--28 to 49+ centimeters; weak medium subangular blocky structure; extremely hard, nonsticky, nonplastic; many (5+) very fine, common (1) medium roots throughout, in cracks and between blocks of peds; common (3) very fine irregular pores throughout; 90 percent fractured blocks of gypsum spar, spar is 10 to 15 percent red clay skeletal; noneffervescent.

Site GB 22
Location: 755830E, 4037790N
Buckwheat: Absent

Av--0 to 5 centimeters; 7.5YR 7/3, 7.5YR 4/4 moist; no rock fragments; strong very thick platy structure; soft, slightly sticky, slightly plastic; no roots; many (10+) very fine and fine vesicular pores throughout; 50 percent finely disseminated carbonate throughout, faint, 7.5YR 7/3; strongly effervescent; clear wavy boundary.

Cr--5 to 36+ centimeters; massive; moderate coarse angular blocky structure; slightly to extremely hard, nonsticky, nonplastic; no roots; skeletal pores coated by reprecipitated gypsum; 50 percent very fine and fine gypsum crystals; 50 percent very fine and fine red clay blocks, 5YR 4/6; slightly weathered gypsum and claystone bedrock interspersed; slightly effervescent.

Site GB 23
Location: 755610E, 4038165N
Buckwheat: Absent

A--0 to 6 centimeters; 5YR 6/4, 5YR 5/4 moist; no rock fragments; strong very thick platy structure; moderately hard, moderately sticky, very plastic; no roots; many (10+) very fine to coarse vesicular pores; 0.9 percent very fine silans coating pores; strongly effervescent; abrupt smooth boundary.

By1--6 to 16 centimeters; 5YR 6/4, 5YR 4/6 moist; no rock fragments; strong medium subangular blocky structure; slightly hard, moderately sticky, very plastic; common (3) very fine, common (1) fine and medium roots throughout; many (10+) very fine vesicular, common (3) very fine dendritic tubular pores throughout; 1 to 5 percent very fine gypsum masses throughout, diffuse, white, prominent, clear, platy; strongly effervescent; abrupt smooth boundary.

By2--16 to 43 centimeters; 5YR 6/4, 5YR 4/6 moist; no rock fragments; strong thin platy parting to moderate medium subangular blocky structure; slightly hard, nonsticky, nonplastic; common (3) very fine, common (1) coarse roots throughout; many (10) very fine and fine vesicular and skeletal pores throughout; fine recrystallized gypsum coating pores; skeletal gypsum spar; silt and gypsum spar, mixed lithogenic and pedogenic gypsum; strongly effervescent; clear smooth boundary.

By3--43 to 70 centimeters; 5YR 6/4, 5YR 4/6 moist; no rock fragments; moderate thin platy parting to strong coarse angular blocky structure; slightly hard, nonsticky, nonplastic; no roots; common (7) medium and coarse vesicular and skeletal pores throughout; fine recrystallized gypsum coating pores; skeletal gypsum spar; silt and gypsum spar; strongly effervescent; gradual smooth boundary.

By4/Cr--70 to 79+ centimeters; 2.5YR 5/6, 2.5YR 4/6 moist; no rock fragments; strong thick platy structure; soft, nonsticky, nonplastic; no roots; many (10+) very fine and fine dendritic tubular, irregular and vesicular pores throughout; fine gypsum spar lenses in pores and cracks, white diffuse masses; thin cutans in between cracks, platy; 5 percent mottled white gypsum; red (2.5YR 5/6) sand; slightly effervescent.

Site GB 24
Location: 755775E, 4037895N
Buckwheat: Absent

Av--0 to 4 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; no rock fragments; moderate thick platy structure; soft, slightly sticky, slightly plastic; common (3) very fine roots throughout; many (5) very fine vesicular, common (1) fine dendritic tubular pores throughout; 20 percent finely disseminated carbonate throughout, 7.5 YR 6/4; 20 percent silt coats throughout; strongly effervescent; abrupt wavy boundary.

Bky--4 to 34 centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; no rock fragments; moderate medium subangular blocky structure; soft, slightly sticky, slightly plastic; many (5) very fine, common (2) fine and medium roots throughout; common (3) very fine dendritic tubular pores throughout; 0.9 percent very fine white gypsum masses, less than 1 millimeter; strongly effervescent; abrupt wavy boundary.

C--34 to 51+ centimeters; 5YR 6/4, 5YR 4/6 moist; no rock fragments; moderate medium and coarse angular blocky structure; soft, moderately sticky, very plastic; common (1) fine roots throughout; skeletal pores; 50 percent gypsum coats on pores, common to many; 50 percent gypsum spar; 50 percent clay; strongly effervescent.

Site GB 25
Location: 755930E, 4037800N
Buckwheat: Absent

Av--0 to 3 centimeters; 5YR 7/4, 5YR 4/4 moist; 30 percent gravel; moderate thin to thick platy structure; soft, moderately sticky, moderately plastic; common (3) very fine roots throughout; common (3) very fine irregular, many (5) very fine vesicular pores throughout; 20 percent finely disseminated carbonate infused with silt, 5YR 7/4; 20 percent silt coats throughout and coating pores, 5YR 7/4; violently effervescent; abrupt wavy boundary.

Bk1--3 to 10 centimeters; 5YR 6/4, 5YR 5/4 moist; 5 percent gravel; weak thin platy parting to moderate fine subangular blocky structure; loose to soft, slightly sticky, slightly plastic; many (5) very fine roots throughout; common (3) very fine dendritic tubular, common (2) very fine irregular pores throughout; 20 percent finely disseminated carbonate; 1 percent very fine soft, white calcium carbonate masses and filaments throughout; violently effervescent; clear smooth boundary.

Bk2--10 to 36 centimeters; 5YR 6/4, 5YR 4/6 moist; 4.9 percent gravel; moderate medium and coarse subangular blocky structure; soft, nonsticky, nonplastic; common (3) fine roots throughout; common (4) fine dendritic tubular pores throughout; 10 percent finely disseminated carbonate around rock fragments and throughout matrix; violently effervescent; gradual wavy boundary.

Bk3--36 to 63+ centimeters; 5YR 6/4, 5YR 5/6 moist; 4.9 percent gravel; strong medium subangular blocky structure; soft, nonsticky, nonplastic; common (2) fine roots throughout; common (2) very fine dendritic tubular pores throughout; 10 percent finely disseminated carbonate throughout, white; 0.9 percent very fine calcium carbonate filaments and masses, white, distinct; strongly effervescent.

Site GB 26
Location: 755530E, 4038220N
Buckwheat: Absent

A--0 to 7 centimeters; 5YR 6/4, 5YR 5/4 moist; 40 percent round gravel; moderate thick platy parting to fine subangular blocky structure; soft, slightly sticky, slightly plastic; loose surface pavement, discontinuous; biological soil crust; strongly effervescent; abrupt wavy boundary.

C--7 to 41 centimeters; 5YR 6/4, 5YR 4/4 moist; 5 percent cobbles and stones, 15 to 20 percent fine to coarse gravel; weak fine and medium subangular blocky structure; loose, slightly sticky, nonplastic; many (10+) very fine, common (2) fine, common (1) medium roots throughout; no pores; possible extra fine, very faint, white, diffuse masses in matrix; strongly effervescent; abrupt smooth boundary.

Bwb--41 to 56 centimeters; 5YR 6/4, 5YR 5/4 moist; 2 to 5 percent very fine to medium gravel; moderate fine subangular blocky structure; soft, nonsticky, slightly plastic; many (5+) very fine roots throughout and in cracks; common (3) very fine irregular pores throughout; strongly effervescent; abrupt wavy boundary.

Byb--56 to 61+ centimeters; 5YR 7/3, 5YR 6/4 moist; no rock fragments; moderate medium subangular blocky structure; soft, nonsticky, nonplastic; common (1) fine and medium roots throughout and on top of horizon; many (5+) very fine irregular pores throughout; 30 percent very fine and fine gypsum masses filling pores and throughout matrix, less than 2 millimeters, soft, white, prominent; pink-red clay, silt and sand; strongly effervescent.

Site GB 27
Location: 755910E, 4037750N
Buckwheat: Present

A--0 to 5 centimeters; 7.5YR 7/3, 7.5YR 6/4 moist; 1 percent limestone gravel; strong thick platy structure; soft, slightly sticky, moderately plastic; no roots; many (10+) very fine and fine vesicular, many (5+) very fine irregular pores throughout; common, discontinuous, 2 millimeter, white gypsum nodules on the bottom of plates and filling pores; strongly effervescent; very abrupt wavy boundary.

By--5 to 20 centimeters; 7.5YR 5/4, 7.5YR 4/4 moist; no rock fragments; moderate medium and coarse subangular blocky structure; soft, slightly sticky, moderately plastic; common (2) fine and medium roots throughout; many (10+) very fine irregular pores throughout; 15 to 25 percent very fine and fine gypsum masses and nodules filling pores, white, distinct; slightly effervescent; clear wavy boundary.

C--20 to 42 centimeters; 7.5YR 5/4, 7.5YR 4/4 moist; no rock fragments; weak medium subangular blocky structure; soft to extremely hard, moderately sticky, very plastic; common (1) fine and medium roots throughout; common (1) very fine dendritic tubular and skeletal pores between plates and throughout; 1.9 percent gypsum masses; 50 percent diffuse stratified siltstone, 5YR 5/4, 7.5YR 7/3; very slightly effervescent; gradual smooth boundary.

Cr--42 to 54+ centimeters; mostly blocky, fissile; very rigid, extremely hard; siltstone and mudstone; lithogenic structure and bedding; indurated bedrock; common (2) very fine roots in between cracks, common (1) medium roots throughout; strongly effervescent.

Site GB 28
Location: 755685E, 4038020N
Buckwheat: Absent

A--0 to 7 centimeters; 7.5YR 5/4, 7.5YR 4/4 moist; 20 percent fine and medium gravel; moderate very thick platy parting to weak fine subangular blocky structure; soft, nonsticky, slightly plastic; many (6) very fine roots throughout; many (10+) very fine irregular, common (3) fine dendritic tubular pores throughout; strongly effervescent; abrupt smooth boundary.

B--7 to 24 centimeters; 5YR 6/4, 5YR 4/4 moist; 5 percent fine and medium gravel; moderate medium and coarse subangular blocky structure; soft, nonsticky, nonplastic; common (4) very fine, common (1) fine roots throughout; common (3) very fine, common (1) fine dendritic tubular pores throughout; 0.9 percent very fine round masses and filaments, white, distinct, clear; strongly effervescent; abrupt smooth boundary.

C1--24 to 50 centimeters; 5YR 6/4, 5YR 5/4 moist; 20 percent fine to coarse gravel; weak fine subangular blocky structure; soft, nonsticky, nonplastic; many (5+) very fine, common (2) fine, common (1) medium roots throughout; common (3) very fine dendritic tubular pores throughout; possible very fine white masses; strongly effervescent; gradual smooth boundary.

C2--50+ centimeters; 5YR 6/4, 5YR 4/4 moist; 20 percent fine to coarse gravel; single grained; loose, nonsticky, nonplastic; common (3) fine, common (1) medium roots throughout; no pores; strongly effervescent.

Site GB 29
Location: 756025E, 4038045N
Buckwheat: Absent

Av--0 to 5 centimeters; 5YR 6/4, 5YR 4/6 moist; 40 percent angular gravel; strong thin to thick platy structure; soft, slightly sticky, moderately plastic; no roots; many (10+) very fine to coarse vesicular pores throughout; 20 to 35 percent finely disseminated carbonate and silans throughout, faint, white, 5YR 6/4; strongly effervescent; abrupt wavy boundary.

Byk1--5 to 26 centimeters; 5YR 6/4, 5YR 4/6 moist; 10 percent very fine to medium gravel and gypsum fragments; strong medium subangular blocky structure; soft, nonsticky, nonplastic; common (3) very fine, common (2) fine roots throughout; many (10+) very fine irregular and skeletal pores throughout; 15 percent very fine to medium gypsum masses throughout matrix and gypsum coating pores, prominent, white to grey, soft; 5 percent gypsum within gravel; 5 to 10 percent 1 centimeter gypsum crystal nests, prominent, white, sparry, porous; 20 percent finely disseminated carbonate and silans; strongly effervescent; abrupt wavy boundary.

Byk2--26 to 58 centimeters; 5YR 6/4, 5YR 5/4 moist; 25 percent gravel; strong medium subangular blocky structure; soft to slightly hard, nonsticky, nonplastic; many (5) very fine roots throughout; many (10+) fine and medium irregular pores throughout; 2 percent fine and medium gypsum masses, prominent, white, soft; 10 percent gypsum spar with skeletal irregular pores; 5 to 10 percent 1 centimeter gypsum crystal nests, prominent, white, sparry, porous; strongly effervescent; abrupt wavy boundary.

Byk3--39 to 58+ centimeters; 5YR 6/4, 5YR 5/4 moist; 4.9 percent very fine limestone gravel; moderate medium to coarse subangular blocky structure; soft, slightly sticky, nonplastic; many (5) very fine roots throughout; many (5+) very fine irregular, common (4) fine dendritic tubular pores throughout; 10 percent finely disseminated carbonate/gypsum, diffuse, distinct, grey; 1 to 2 percent very fine to medium gypsum masses, white, prominent, soft; strongly effervescent.

Site GB 30
Location: 756125E, 4038055N
Buckwheat: Absent

Av--0 to 4 centimeters; 7.5YR 6/4, 7.5YR 5/4 moist; 0.9 percent gravel; strong very thick platy structure; soft to slightly hard, moderately sticky, moderately plastic; no roots; many (10+) very fine and fine, common (2) medium vesicular, common (3) very fine irregular pores throughout; 50 percent finely disseminated carbonate/silans; discontinuous white masses as pendants on the bottom of plates, soft, less than 0.5 centimeters thick; violently effervescent; abrupt wavy boundary.

By--4 to 20 centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; no rock fragments; moderate coarse subangular blocky structure; slightly hard, slightly sticky, nonplastic; common (3) very fine and fine roots throughout; common (1) medium dendritic tubular, many (10+) very fine skeletal pores throughout; 35 to 50 percent very fine and fine gypsum spar and crystals, grey, slightly hard, distinct; gypsum coats; 10 to 15 percent silans or finely disseminated carbonate throughout, 7.5YR 7/3; violently effervescent; clear wavy boundary.

CB--20 to 36 centimeters; 5YR 6/3, 5YR 5/4 moist; no rock fragments; strong fine to medium subangular blocky structure; soft, moderately sticky, slightly plastic; many (5 to 10) very fine, common (1) medium roots throughout; 5 to 10 percent finely disseminated carbonate; gypsum coats, masses and irregular filaments throughout; variegated red, green and grey lithogenic 20 percent blocks of weathered clay, 0.1 to 0.5 centimeters thick; violently effervescent; clear irregular boundary.

Cr--36 to 58+ centimeters; 5YR 6/4, 5YR 5/4 moist; blocky, slightly weathered claystone and siltstone; lithogenic structure; soft to extremely hard; common (1) very fine roots throughout; similar to BC horizon, but only 10 percent soil and 90 percent rock; violently effervescent.

Site GB 31
Location: 755390E, 4038273N
Buckwheat: Absent

A--0 to 9 centimeters; 7.5YR 6/4, 7.5YR 4/4 moist; no rock fragments; moderate thick platy parting to fine subangular blocky structure; soft, slightly sticky, moderately plastic; common (3) very fine roots throughout; many (10+) very fine and fine vesicular and irregular pores throughout; 5 percent fine (less than 3 millimeters) gypsum masses lining pores and on the bottom of plates and biological soil crust, white, prominent; 0.9 percent coarse gypsum fragments, irregular, soft, diffuse, gradual; strongly effervescent; very abrupt wavy boundary.

By1--9 to 28 centimeters; 5YR 5/4, 5YR 4/4 moist; no rock fragments; moderate medium subangular blocky structure; soft, nonsticky, nonplastic; common (3) fine, common (2) coarse roots throughout; common (4) fine and medium dendritic tubular pores throughout; 20 to 35 percent fine to coarse gypsum masses and filaments, soft, white, prominent, sharp, up to 0.5 centimeters, irregular; slightly effervescent; abrupt wavy boundary.

By2--28 to 64 centimeters; 5YR 7/4, 5YR 5/6 moist; no rock fragments; moderate coarse subangular to angular blocky structure; soft, nonsticky, nonplastic; many (5) very fine, common (2) fine roots throughout; common (4) fine dendritic tubular pores throughout; 25 percent very fine gypsum masses and filaments; slightly effervescent; abrupt wavy boundary.

Cr--64+ centimeters; lithogentic, fissile/blocky; moderately hard, no roots.

Site GB 32
Location: 755621E, 4038286N
Buckwheat: Absent

Av--0 to 6 centimeters; 5YR 7/4, 5YR 5/4 moist; 65 percent fine to coarse angular gravel; moderate medium platy structure; slightly hard, very sticky, very plastic; common (2) very fine roots throughout; many (10+) fine vesicular and irregular pores throughout; few thin silt coats lining vesicular pores, faint, 5YR 7/4; strongly effervescent; abrupt smooth boundary.

Bw1--6 to 14 centimeters; 5YR 6/4, 5YR 5/4 moist; 25 percent fine and medium angular and subangular gravel; moderate very thin platy parting to moderate fine and medium subangular blocky structure; soft, moderately sticky, very plastic; common (1) fine and medium roots throughout; common (3) fine, common (1) medium dendritic tubular pores throughout; 1.9 percent fine, soft, diffuse, iron stains within peds, 5YR 5/5; strongly effervescent; abrupt wavy boundary.

Bw2--14 to 38 centimeters; 7.5YR 7/4, 7.5YR 4/6 moist; no rock fragments; moderate medium to coarse subangular blocky structure; soft, very sticky, very plastic; many (5) very fine roots throughout, common (2) medium roots in between plates; many (7+) very fine to medium dendritic tubular pores throughout; few very fine, faint, diffuse, white coats and masses on the faces of peds; thin clay coats lining pores; strongly effervescent; clear wavy boundary.

By--38 to 61 centimeters; 7.5YR 5/4, 7.5YR 4/4 moist; no rock fragments; moderate medium to coarse subangular blocky structure; soft, nonsticky, nonplastic; common (3) very fine roots throughout; many (5+) very fine dendritic tubular pores throughout; 5 percent very fine gypsum masses, soft, white, distinct; 10 to 15 percent fine gypsum spar, distinct; 10 percent clay very fine blocks; slightly effervescent.

Cr--61 to 72+ centimeters; gypsiferrous claystone; fissile/platy; lithogenic structures; some gypsum recrystallization; slightly effervescent.

Site GB 33
Location: 755753E, 4037788N
Buckwheat: Absent

Av--0 to 4 centimeters; 7.5YR 5/4, 7.5YR 4/4 moist; 20 percent fine gravel; moderate thick platy structure; soft, nonsticky, nonplastic; common (1) very fine roots throughout; many (10) very fine vesicular, very fine and fine irregular pores throughout; 15 percent finely disseminated carbonate or silt throughout matrix, faint, diffuse, 7.5YR 5/4; very fine silt coats throughout, faint; strongly effervescent; abrupt wavy boundary.

Bk--4 to 11 centimeters; 7.5YR 4/6, 7.5YR 4/6 moist; 25 percent fine gravel; moderate medium to coarse subangular blocky structure; soft, nonsticky, nonplastic; common (3) very fine, common (1) fine and medium roots throughout; common (3) very fine, common (1) fine dendritic tubular pores throughout; 10 percent finely disseminated carbonate and very fine filaments throughout matrix and on roots; silt coats lining pores and on faces of peds, faint, discontinuous; strongly effervescent; clear wavy boundary.

Bky1--11 to 40 centimeters; 7.5YR 4/6, 7.5YR 4/6 moist; 5 percent very fine to medium gravel; strong medium subangular blocky structure; soft, nonsticky, nonplastic; common (3) very fine, common (2) fine, common (1) roots throughout; common (1) very fine, common (2) medium dendritic tubular pores throughout; 5 percent finely disseminated carbonate; 0.9 percent very fine gypsum throughout matrix, white, soft; strongly effervescent; clear wavy boundary.

Bky2--40 to 60+ centimeters; 5YR 5/6, 5YR 4/6 moist; 20 percent fine gravel; moderate fine to medium angular blocky structure; soft, nonsticky, nonplastic; common (1) fine roots throughout; common (1) fine dendritic tubular pores throughout; 5 percent finely disseminated carbonate throughout; 2 percent very fine gypsum snowballs, white, irregular, soft; strongly effervescent.

Site GB 34
Location: 755823E, 4037845N
Buckwheat: Absent

A--0 to 3 centimeters; 7.5YR 7/3, 7.5YR 5/4 moist; 15 percent angular paragravel; strong medium platy structure; soft, nonsticky, nonplastic; no roots; many (10) very fine vesicular and irregular pores throughout; biological soil crust; slightly effervescent; very abrupt smooth boundary.

AC--3 to 10 centimeters; 5YR 7/4, 5YR 6/4 moist; 50 percent angular paragravel; moderate thick platy structure; soft, nonsticky, nonplastic; common (1) fine roots throughout; many (10) very fine vesicular and irregular pores throughout; 50 percent fine mottles, 5YR 7/6, 5YR 8/2; slightly effervescent; clear smooth boundary.

Cr--10 to 56+ centimeters; 5YR 7/4, 5YR 6/4 moist; no rock fragments; massive; weak medium subangular blocky structure; soft, nonsticky, nonplastic; common (5) very fine, common (1) medium roots throughout; common (1) very fine irregular and dendritic tubular pores throughout; 50 percent medium mottles, 5YR 7/6, 5YR 8/2; weathered gypsiferrous sediments; slightly effervescent.

Note: There is no Gold Butte Site #35. This site was originally planned using GIS and remote sensing data, but was cancelled because its soil geomorphic setting would not have contributed useful information to this project and/or presented logistical challenges. Site approval (archaeological survey) and field data collection had already begun in the study area when this site was cancelled, thus it remains as an apparent but artificial gap in our list of study sites.

Site GB 36
Location: 755887E, 4037850N
Buckwheat: Absent

A--0 to 2 centimeters; 5YR 7/4, 5YR 5/4 moist; no rock fragments, 20 percent biological soil crust; strong thin platy structure; soft, nonsticky, slightly plastic; no roots; common (3 to 5) very fine vesicular, many (10+) very fine to fine irregular pores throughout; 20 to 25 percent fine and medium gypsum masses and nodules filling pores and on the bottom of plates; gypsum spar filling pores; 3 to 10 centimeter gypsum blocks and thin white gypsum crust with/without silty vesicles; slightly effervescent; very abrupt wavy boundary.

By--2 to 8 centimeters; 5YR 6/3, 5YR 5/4 moist; no rock fragments; moderate medium subangular blocky structure; soft, slightly sticky, very plastic; no roots; skeletal pores throughout; very fine gypsum spar throughout, gypsum coating pores; very fine (less than 1 millimeter) gypsum spar; very fine (less than 1 millimeter) red clay fragments; slightly effervescent; abrupt wavy boundary.

C/Cr--8 to 40+ centimeters; 5YR 6/4, 5YR 4/4 moist; zones of silty rocks; massive and coarse subangular blocky structure; soft to extremely hard, nonsticky, nonplastic; common (1) very fine and medium roots throughout; skeletal pores throughout; gypsum spar and clay throughout; relict oxidized root zones (iron stains) along root traces, 10 centimeter; silty clay lining many very fine roots, 10YR 8/6; 10 to 20 centimeter gypsum blocks; less than 2 centimeter gypsum spar; slightly effervescent.

Site GB 37
Location: 755821E, 4037830N
Buckwheat: Present

Av--0 to 3 centimeters; 7.5YR 6/4, 7.5YR 5/4 moist; 1.9 percent mixed gravel; soft, slightly sticky, moderately plastic; no roots; many (5+) very fine vesicular and irregular pores throughout; 1 centimeter thick coalesced gypsum masses and pendants on the bottom of plates, continuous; strongly effervescent; very abrupt smooth boundary.

By--3 to 14 centimeters; 7.5YR 7/4, 7.5YR 5/4 moist; no rock fragments; moderate thin platy parting to weak fine subangular blocky structure; soft, nonsticky, nonplastic; common (3) fine, common (2) medium roots throughout; many (5+) very fine dendritic tubular, many (10+) very fine skeletal pores throughout; few faint, diffuse, yellow, red and brown ferrous iron stains along root traces; very fine and fine gypsum spar throughout; rare very thin (0.5 millimeter) silt coats on some ped surfaces; slightly effervescent; clear wavy boundary.

C--14 to 29 centimeters; 5YR 5/3, 5YR 4/4 moist; no rock fragments; weak fine subangular blocky structure; soft, slightly sticky, very plastic; many (5+) very fine, common (2) medium roots throughout; skeletal pores throughout; 10 to 25 percent white to grey gypsum spar; predominant brown to red clay; common, faint, diffuse yellow, red and brown ferrous iron stains; fine and medium gypsum spar throughout; fine gypsum coating pores; slightly effervescent; gradual smooth boundary.

Cr--29 to 50+ centimeters; 5YR 6/4, 5YR 4/4 moist; dense clay-rich mixed sediment; predominantly fissile and platy; some gypsum veins and sparry gypsum crystals throughout; common (2) very fine and fine roots throughout; slightly effervescent.

(end of Gold Butte profiles)

III. Bitter Spring Soil Profile Descriptions

Site BS 00
Location: N/A
Buckwheat: Absent

A--0 to 3 centimeters; 10YR 8/2, 10YR 7/2 moist; strong thick platy structure; slightly hard, nonsticky, slightly plastic; no roots; common (1) medium dendritic tubular pores, common (3) fine irregular pores, many (5) very fine vesicular pores throughout; 20 percent sugary gypsum coats throughout, distinct, 10YR 8/2; low bulk density, very white; strongly effervescent; abrupt smooth boundary.

Byk--3 to 16 centimeters; 2.5YR 8/2, 2.5YR 7/3 moist; moderate medium and moderate coarse subangular blocky structure; soft, slightly sticky, slightly plastic; common (3) very fine and common (1) coarse roots throughout; common (3) very fine dendritic tubular pores throughout; 30 percent finely disseminated carbonate throughout, faint, diffuse, 2.5YR 8/2; 30 percent finely disseminated gypsum throughout, faint, diffuse, 2.5YR 8/2; 10 percent fine gypsum crystals throughout, faint, sharp, colorless to 2.5YR 8/2; 1 percent fine, white, round gypsum masses throughout, distinct, sharp; 1 to 2 percent yellow (2.5Y 8/4) masses, faint, diffuse mottles throughout; violently effervescent; clear smooth boundary.

C--16 to 50+ centimeters; 2.5YR 8/2, 2.5YR 8/3 moist; strong coarse angular blocky structure; soft, moderately sticky, moderately plastic; 10 percent, 5Y 7/4 mottles; 1 percent, 2/5Y 7/6 mottles; 30 percent coarse gypsum crystals throughout, prominent, sharp, colorless; violently effervescent.

Site BS 01
Location: 718468E, 4024423N
Buckwheat: Present

A--0 to 4 centimeters; 10YR 8/1, 10YR 7/3 moist; moderate thin to thick platy structure; soft, slightly sticky, slightly plastic; no roots; many (5+) very fine irregular and common (3) very fine vesicular pores; 2 to 5 percent very fine and fine white masses throughout, distinct, sharp, hard gypsum or calcium carbonate; 25 percent finely disseminated carbonate throughout, distinct, 10YR 8/1; violently effervescent; abrupt wavy boundary.

By--4 to 18 centimeters; 10YR 8/1, 10YR 7/3 moist; strong medium and coarse subangular blocky structure; moderately hard, slightly sticky, very plastic; common (1) fine roots throughout; many (5) very fine irregular pores throughout; 35 percent gypsum crystals throughout, sharp; finely disseminated carbonate throughout, distinct, 10YR 8/1; violently effervescent; abrupt smooth boundary.

C--18 to 48+ centimeters; 10YR 7/3, 10YR 7/3 moist; strong coarse subangular blocky structure; slightly hard, moderately sticky, very plastic; common (3) very fine, and common (1) coarse roots throughout; common (3) fine and coarse dendritic tubular pores throughout; 5 percent coarse, irregular, prominent, yellow (10YR 7/6) mottles throughout; 5 to 10 percent fine through coarse gypsum crystals throughout, prominent, sharp, clear to white; variegated gypsiferous silt and clay, not indurated, but very denser, almost massive; violently effervescent.

Site BS 02
Location: 718460E, 4024430N
Buckwheat: Absent

Av--0 to 10 centimeters; 7.5YR 7/3, 7.5YR 5/4 moist; 60 percent limestone gravel through cobble as pavement; moderate medium and coarse subangular blocky parting to moderate thick platy structure; soft, slightly sticky, slightly plastic; common (3) very fine roots throughout; common (3) very fine vesicular, and many (5) very fine irregular pores throughout; 10 percent finely disseminated carbonate throughout, faint, diffuse, 7.5YR 7/3; 10 percent silt coats throughout, faint, diffuse, 7.5YR 7/3; violently effervescent; abrupt wavy boundary.

By-- 10 to 26 centimeters; 7.5YR 7/3, 10YR 6/4 moist; 5 percent fine limestone gravel; moderate coarse subangular blocky structure; slightly hard, slightly sticky, slightly plastic; common (1) very fine and fine roots throughout; common (3) very fine dendritic tubular; 2 percent very fine gypsum masses, white, distinct, sharp; 30 percent gypsum crystals, possibly recrystallized from rock, white, prominent, clear; violently effervescent; clear wavy boundary.

C-- 26 to 63+ centimeters; 2.5YR 7/3, 2.5YR 6/4 moist; massive parting to moderate fine through coarse angular blocky structure; slightly hard, moderately sticky, moderately plastic; common (1) fine and common (2) medium roots throughout; common (3) and many (5) medium irregular pores throughout; 10 percent 10YR 7/6, clear, irregular mottles throughout; 30 percent gypsum crystals throughout, clear to grey, prominent, sharp; mottled, bedded gypsum clay and silt; skeletal between crystals; violently effervescent.

Site BS 03
Location: 718340E, 4024455N
Buckwheat: Absent

AC--0 to 10 centimeters; 7.5YR 6/3, 7.5YR 5/4 moist; strong coarse subangular blocky structure; loose to moderately hard, slightly sticky, very plastic; no roots; common (1) very fine dendritic tubular, and many (10) very fine irregular pores throughout; 5 percent fine gypsum throughout, prominent, white, sharp; 10 percent finely disseminated carbonate throughout, faint, diffuse; top 0.5 centimeters of surface crust is soft; strongly effervescent; clear wavy boundary.

C1--10 to 33 centimeters; 7.5YR 6/3, 7.5YR 5/4 moist; strong coarse angular blocky structure; hard, slightly sticky, very plastic; common (1) very fine roots throughout; common (3) fine and medium dendritic tubular pores throughout; grey 5 to 10Y 5/6 mottles; 5 to 10 percent gypsum crystals throughout, sharp, prominent; 2 to 5 percent fine gypsum masses throughout, white, round, prominent, clear; 5 percent carbonate and/or gypsum coats on faces of peds, distinct, diffuse, irregular; strongly effervescent; clear smooth boundary.

C2--33 to 50+ centimeters; 7.5YR 6/3, 7.5YR 5/4 moist; moderate fine and medium subangular blocky structure; soft, moderately sticky, moderately plastic; no roots; common (3) very fine dendritic tubular pores; 15 percent 7.5YR 8/1 gypsum, and 2 percent 7.5YR 5/2 mottles throughout; 2 to 5 percent fine and medium gypsum crystals throughout, distinct, sharp; noneffervescent.

Site BS 04
Location: 718305E, 4025525N
Buckwheat: Absent

Av--0 to 6 centimeters; 7.5YR 7/4, 7.5YR 5/4 moist; 15 percent limestone gravel; strong very thick platy structure; slightly hard, nonsticky, slightly plastic; common (2) very fine roots throughout; many (10) very fine and many (5) fine to medium vesicular pores; 20 percent finely disseminated carbonates and silt throughout, distinct, diffuse, 7.5YR 7/3; well developed pavement; violently effervescent; abrupt wavy boundary.

Bk1--6 to 21 centimeters; 7.5YR 6/4, 7.5YR 5/6 moist; 35 percent gravel; moderate medium subangular blocky structure; loose to soft, nonsticky, slightly plastic; common (3) very fine, common (2) fine, common (1) medium roots throughout; common (2) fine dendritic tubular pores throughout; 30 percent finely disseminated carbonate throughout, distinct, diffuse, 7.5 YR 7/3, on rock fragments; 0.9 percent very fine carbonate masses throughout, prominent, white, round; thick 0.5 centimeter pendants on rock fragments; rock fragments and pendants may be reworked; violently effervescent; abrupt wavy boundary.

Bk2--21 to 42+ centimeters; 7.5YR 6/6, 7.5YR 5/6 moist; 75 percent gravel; massive parting to moderate fine subangular blocky structure; loose to soft, moderately sticky, moderately plastic; common (1) very fine and coarse roots throughout; 2 percent fine carbonate masses throughout, white, round, sharp; 0.1 to 0.5 centimeter pendants on all rocks; finely disseminated carbonate on faces of peds, thin, discontinuous; hard color match, extremely gravelly horizon; violently effervescent.

Site BS 05
Location: 718170E, 4025450N
Buckwheat: Present

A--0 to 4 centimeters; 7.5YR 7/2, 7.5YR 7/2 moist; 25 percent rock fragments; moderate fine platy structure; loose to soft, moderately sticky, very plastic; common (1) very fine and fine roots throughout; common (4) fine vesicular, and common (1) fine dendritic tubular pores; 15 percent finely disseminated carbonate and silt throughout, faint, diffuse, 7.5YR7/2, concentrated in upper

0.5 centimeters; sediment composed largely of round gypsum crystals; eroded, reworked; violently effervescent; abrupt wavy boundary.

C--4 to 35+ centimeters; 10YR 7/3, 10YR 6/3 moist; moderate fine through coarse subangular blocky; soft to slightly hard, moderately sticky, very plastic; common (2) fine and common (1) medium roots throughout; many (5) very fine and fine dendritic tubular pores throughout; 10 percent clay and gypsum mottles, 10YR 6/8; 10 percent clay and gypsum mottles, 10YR 8/2; 30 percent clay and gypsum mottles, 10YR 7/2; 5 percent oxidized (ferric) iron masses, 10YR 6/8, in fine root pores in some parts of the horizon; 50 percent gypsum masses and crystals, white, throughout matrix and filling cracks; very gypsiferous claystone, possibly a past paleosol; violently effervescent.

Site BS 06
Location: 718025E, 4025410N
Buckwheat: Present

A--0 to 8 centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; 15 percent claystone gravel; weak medium subangular blocky structure; soft, slightly sticky, moderately plastic, common (1) fine and medium roots throughout; common (3) very fine dendritic tubular, and many (5) very fine irregular pores throughout; 10 to 20 percent finely disseminated carbonate throughout, white, distinct, diffuse; 2 percent gypsum masses throughout, white, fine, distinct, sharp; top 0.5 centimeters is physical crust and platy; violently effervescent; abrupt smooth boundary.

ByC--8 to 27 centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; 50 percent fine to medium claystone paragravel; strong medium to coarse subangular blocky structure; slightly hard, slightly sticky, moderately plastic; many (5) very fine, and common (3) fine roots throughout; common (1) very fine, and common (3) fine dendritic tubular pores throughout; 20 percent very fine and fine gypsum crystals throughout, distinct, sharp; violently effervescent; gradual smooth boundary.

Cr--27 to 52+ centimeters; 2.5YR 7/2, 2.5YR 6/3 moist; no rock fragments; strong coarse angular blocky structure; hard; common (3) fine, and common (1) medium roots throughout; scarcely, unaltered claystone; lithogenic; 0 to 50 percent fine gypsum crystals throughout; distinct, sharp, prominent; fissile blocky; violently effervescent.

Site BS 07
Location: 717890E, 4025350N
Buckwheat: Absent

Av--0 to 4 centimeters; 10YR 7/3, 10YR 6/4 moist; 65 percent gravel and cobble; strong very thick platy structure; slightly hard, slightly sticky, moderately plastic; many (5) very fine roots throughout; many (10+) fine and medium vesicular pores throughout; 50 percent silt coats throughout, distinct, lining pores, 10YR 7/3; very fine gypsum fragments throughout; violently effervescent; abrupt wavy boundary.

Bk1--4 to 13 centimeters; 7.5YR 7/3, 7.5YR 5/4 moist; 40 percent gravel; weak fine platy parting to moderate fine subangular blocky structure; loose to soft, nonsticky, slightly plastic; many (5) very fine roots throughout; 20 percent finely disseminated carbonate throughout, faint, diffuse, 10YR 7/3; fine to medium reworked calcium carbonate nodules or fragments; violently effervescent; clear smooth boundary.

Bk2--13 to 34 centimeters; 7.5YR 7/3, 7.5YR 6/4 moist; 35 percent gravel; strong fine and medium subangular blocky structure; soft, slightly sticky, slightly plastic; many (5) very fine, and common (1) fine roots throughout; common (4) very fine, common (1) fine and medium dendritic tubular pores throughout; 2 percent very fine and fine gypsum masses throughout, prominent, soft, round, white; 5 to 10 percent finely disseminated carbonate filaments throughout, diffuse, distinct, white; violently effervescent; clear smooth boundary.

Bk3-- 34 to 52+ centimeters; 7.5YR 7/3, 7.5YR 5/4 moist; 35 percent gravel; moderate fine subangular blocky structure; loose, slightly sticky; common (1) fine roots throughout; skeletal; 2 percent very fine and fine gypsum masses throughout, prominent, soft, round, white; 5 to 10 percent finely disseminated carbonate filaments throughout, diffuse, distinct, white; coarsely gravelly; violently effervescent.

Site BS 08
Location: 718957E, 4024500N
Buckwheat: Present

Avk--0 to 5 centimeters; 5YR 7/4, 5YR 5/6 moist; 4 percent fine limestone gravel; strong thick platy structure; slightly hard, slightly sticky, moderately plastic; common (1) very fine roots throughout; many (10+) very fine vesicular and irregular pores throughout; 15 percent finely disseminated carbonate on faces of peds, white, prominent, diffuse, irregular; 0.5 centimeter calcium carbonate pendants under plates and at horizon boundary, white, continuous, prominent, diffuse; violently effervescent; abrupt wavy boundary.

C-- 3 to 30 centimeters; 2.5YR 4/4, 2.5YR 4/6 moist; no rock fragments; moderate medium angular blocky structure; hard, moderately sticky, very plastic; common (3) very fine and fine, common (2) medium, common (1) coarse roots throughout; common (4) very fine dendritic tubular pores throughout; 5 percent fine calcium carbonate or gypsum masses on faces of peds and on the bottoms of lithogenic claystone fragments, irregular; 5 percent fine calcium carbonate or gypsum coats on faces of peds and on the bottoms of lithogenic claystone fragments, irregular; blocks are less angular and have more calcium carbonate and/or gypsum coats than Cr; violently effervescent; clear wavy boundary.

Cr-- 30 to 40+ centimeters; 2.5YR 4/4, 2.5YR 4/6 moist; no rock fragments, strong medium angular blocky structure; extremely hard, moderately sticky, very plastic; no roots; structural pores; 1 to 5 percent gypsum spar or veins throughout, lithogenic blocks, not pendants; thinly bedded red claystone or siltstone, blocky to fissile, no soil structure; violently effervescent.

Site BS 09
Location: 718750E, 4024260N
Buckwheat: Absent

A--0 to 4 centimeters; 10YR 7/3, 10YR 6/3 moist; 35 percent limestone gravel; moderate thick platy structure; loose to soft, moderately sticky, very plastic; common (2) very fine roots throughout; common (3) fine vesicular, common (1) fine dendritic tubular, many (5) fine irregular pores throughout; 20 percent finely disseminated carbonate or silt coats throughout, brown 10 YR 7/3, distinct, clear; 2 percent very fine and fine calcium carbonate or gypsum masses throughout, prominent, soft, white, round; violently effervescent; abrupt wavy boundary.

C--4 to 14 centimeters; 10YR 7/3, 10YR 7/3 moist; no rock fragments; moderately fine subangular blocky structure; soft, moderately sticky, very plastic; common (3) very fine and fine roots throughout; common (3) very fine dendritic tubular pores throughout; 5 percent very fine and fine finely disseminated carbonate and/or silt throughout, soft, white, prominent, mostly lithogenic concretions; strongly effervescent; abrupt irregular boundary

Cr--14 to 29+ centimeters; 7.5YR 8/2, 7.5YR 7/3 moist, and GLEY1 7/10, GLEY1 7/10 moist; no fragments; massive; soft to extremely hard, moderately sticky, very plastic; common (3) fine, common (1) medium roots throughout; structural pores throughout; jumbled siltstone and claystone, variable depth, irregular contacts, green bed is 3 centimeters thick; strongly effervescent.

Site BS 10
Location: 718440E, 4024370N
Buckwheat: Absent

Av--0 to 3 centimeters; 7.5YR 4/4, 7.5YR 5/4 moist; 50 percent very fine to coarse limestone gravel; moderate coarse subangular blocky parting to moderate very thick platy structure; slightly hard, moderately sticky, moderately plastic; common (1) very fine roots throughout; many (10) very fine and fine, many (5) medium vesicular pores throughout; 25 percent finely disseminated carbonate and/or silt throughout, diffuse, faint, irregular, 7.5YR 4/4; gravelly on surface; violently effervescent; abrupt smooth boundary.

Bk1--3 to 9 centimeters; 5YR 6/4, 5YR 4/4 moist; 25 percent fine limestone gravel to cobble; strong coarse subangular blocky structure; slightly hard, moderately sticky, very plastic; common (3) very fine, common (1) coarse roots throughout; common (3) very fine irregular, common (1) medium dendritic tubular pores throughout; 2 percent fine to coarse masses throughout, soft, white, prominent, sharp, <0.2 to 0.5 centimeters; 10 percent finely disseminated carbonate throughout, faint, diffuse; gravelly to cobbly; violently effervescent; clear smooth boundary.

Bk2--9 to 17+ centimeters; 7.5YR 6/4, 7.5YR 4/6 moist; 50 percent fine to coarse gravel, fine cobbles; weak fine subangular blocky structure; soft, nonsticky, slightly plastic; common (3) fine roots throughout; too loose to determine pores; 2 percent very fine to fine calcium carbonate masses throughout, white, prominent, sharp; 15 percent finely disseminated carbonate throughout, white, faint, diffuse; gravelly; violently effervescent.

Site BS 11
Location: 718950E, 4024520N
Buckwheat: Absent

Av--0 to 4 centimeters; 7.5YR 7/3, 7.5YR 5/4 moist; 25 percent gravel; moderate very thick platy structure; soft, nonsticky, nonplastic; common (4) very fine roots throughout; many (10+) fine vesicular pores; 20 percent finely disseminated carbonate, 7.5YR 7/3; 5 percent eroded calcite, sand-sized nodules/gravels; top 0.5 centimeters is physical crust and differentiated; violently effervescent; abrupt wavy boundary.

C1--4 to 46 centimeters; 7.5YR 7/4, 7.5YR 5/4 moist; 30 percent gravel; single grained parting to weak coarse subangular blocky structure; soft to loose, nonsticky, nonplastic; many (5) very fine, common (3) fine, common (2) medium, common (1) coarse roots throughout; common (1) fine dendritic tubular pores throughout; 10 percent finely disseminated carbonate; fine to medium gypsum crystal nests, prominent, abrupt; still stratified; strongly effervescent; clear wavy boundary.

C2--46 to 64+ centimeters; 7.5YR 7/3, 7.5YR 5/4 moist; 15 percent gravel; strong medium subangular blocky structure; soft, nonsticky, nonplastic; common (1) very fine and fine roots throughout; common (1) fine dendritic tubular pores throughout; 10 percent finely disseminated carbonate; 5 percent fine gypsum masses, white; strongly effervescent.

Site BS 12
Location: 718000E, 4025400N
Buckwheat: Present

A--0 to 2 centimeters; 10YR 8/1, 10YR 7/2 moist; 30 percent rock fragments; strong thick platy structure; slightly hard, very sticky, very plastic; no roots; many (5) very fine, common (2) fine, common (1) medium dendritic tubular, many (5) very fine to fine vesicular, common (3) fine irregular pores throughout; 10 percent very fine gypsum crystals throughout, white, distinct, sharp; 20 percent finely disseminated carbonate throughout, faint, diffuse; thickness varies from 0.2 to 2.5 centimeters; violently effervescent; very wavy boundary.

BC--2 to 12 centimeters; 10YR 8/1, 10YR 6/2 moist; no rock fragments; strong thin platy structure; hard, moderately sticky, very plastic; common (1) very fine and fine roots throughout; structural pores throughout; 5 percent isolated mottles throughout, 10YR 8/4, 10YR 6/6 moist; 2 percent fine to medium oxidized (ferric) iron masses throughout, clear, prominent, 7.5YR 5/6, 7.5YR 4/6 moist; 2 to 5 percent fine to medium gypsum crystals in nests throughout, irregular, diffuse, sharp; looks like structure is lithogenic; 5 to 10 percent calcium carbonate coats and finely disseminated carbonate on faces of peds, white, discontinuous, distinct, diffuse; violently effervescent; clear wavy boundary.

Cr--12 to 50+ centimeters; 10YR 8/1, 10YR 5/2 moist; no rock fragments; massive; rigid; many (5) very fine, common (3) fine, common (1) coarse roots throughout; structural pores between rocks; 50 percent mottles, 2.5YR 8/1, 2.5YR 6/2 moist; 2 percent fine to medium oxidized (ferric) iron masses throughout, clear, prominent, 7.5YR 5/6, 7.5YR 4/6 moist; 2 to 5 percent gypsum crystals on faces of peds and in between cracks, prominent, sharp; mix of fissile/blocky siltstone or claystone in massive cobbly limestone, both of which have lamina of discontinuous gypsum (gypsum is 1 to 3 centimeters thick); violently effervescent.

Site BS 13
Location: 718020E, 4025450N
Buckwheat: Present

Av--0 to 4 centimeters; 10YR 7/2, 10YR 6/3 moist; 25 percent gravel; strong thick to very thick platy structure; soft, slightly sticky, slightly plastic; no roots; many (5) very fine to fine irregular, and fine vesicular pores throughout; 20 percent finely disseminated carbonate and or silt throughout, faint, diffuse, 10YR 7/2; 0.5 centimeter cyano pinnacles with wormy structure; violently effervescent; abrupt wavy boundary.

By1--4 to 11 centimeters; 10YR 7/2, 10YR 6/3 moist; 20 percent gypsum and shale gravel; moderate thin platy parting to moderate coarse subangular blocky structure; soft, moderately sticky, moderately plastic; common (3) very fine roots throughout; many (5) very fine to fine dendritic tubular pores throughout; 5 to 10 percent very fine gypsum crystals throughout, distinct, sharp; 10 percent finely disseminated carbonate and silt throughout, faint, diffuse, 10YR 7/2; violently effervescent; abrupt smooth boundary.

By2--11 to 21 centimeters; 10YR 7/2, 10YR 6/3 moist; 5 percent gravel; strong fine to coarse angular blocky structure; soft to slightly hard, slightly sticky, very plastic; common (3) very fine and fine roots throughout; many (10) very fine irregular, common (1) fine dendritic tubular pores throughout; 1 to 2 percent very fine oxidized (ferric) iron masses in lithogenic plates, prominent, 5YR 4/6; 20 percent very fine gypsum crystals throughout, distinct, sharp; 2 to 5 percent finely disseminated carbonate as discontinuous coats on plates, white, distinct, diffuse; difficult color match; violently effervescent; abrupt smooth boundary.

Cr-- 21 to 48+ centimeters; 10YR 6/3, 10YR 6/3 moist; strong thin platy structure (lithogenic); extremely hard, very sticky, very plastic; many (5) very fine to fine, common (1) coarse roots throughout; structural pores between plates; 1 to 2 percent very fine oxidized (ferric) iron masses in lithogenic plates and lining root traces, prominent, 5YR 4/6; 2 to 5 very fine gypsum crystals on faces of lithogenic plates and in cracks, distinct, sharp; violently effervescent.

Site BS 14
Location: 718070E, 4025425N
Buckwheat: Present

A--0 to 10 centimeters; 10YR 7/2, 10YR 5/4 moist; 50 percent gravel; strong thin to very thick platy structure; soft, nonsticky, nonplastic; no roots; many (10+) very fine irregular, and common (1) fine vesicular pores throughout; 50 to 75 percent very fine gypsum crystals throughout; 10 percent finely disseminated carbonate throughout, white, faint, diffuse; thickness varies from 3 to 10 centimeters; violently effervescent; very irregular boundary.

Cr-- 10 to 43+ centimeters; 10YR 8/1, 10YR 5/2 moist; 95 percent gravel; massive; loose, rigid for rock fragments, nonsticky, nonplastic; many (5+) very fine, common (1) fine and medium roots in cracks and along faces of peds; 15 percent very fine gypsum crystals on rock faces, distinct, sharp; possible finely disseminated carbonate on rock faces, white, diffuse, discontinuous, very very thin; violently effervescent.

Site BS 15
Location: 7180879E, 4025425N
Buckwheat: Present

A--0 to 9 centimeters; 10YR 7/2, 10YR 6/3 moist; 30 percent gravel; strong thick platy structure; soft, nonsticky, slightly plastic; common (3) very fine roots throughout; common (2) fine dendritic tubular pores throughout; 20 percent finely disseminated carbonate and silt throughout, distinct, clear, 10YR 7/2; violently effervescent; abrupt wavy boundary.

ByC--9 to 44 centimeters; 10YR 7/3, 10YR 6/3 moist; 5 percent gravel; moderate medium subangular blocky structure; soft to slightly hard, nonsticky, nonplastic; many (5) very fine, common (1) fine, common (2) medium roots throughout; many (5 to 10) fine and medium irregular pores throughout; 5 to 20 percent fine to medium gypsum crystals on surfaces of rock fragments, distinct, sharp; 5 to 20 percent very fine gypsum masses on surfaces of rock fragments throughout, white, distinct, sharp; tough match for color; violently effervescent; abrupt irregular boundary

Cr--44+ centimeters; 2.5Y 6/3, 2.5Y 5/3 moist; massive; calcareous claystone; violently effervescent.

Site BS 16
Location: 718145E, 4025405N
Buckwheat: Present

AC--0 to 6 centimeters; 10YR 8/3, 10YR 7/3 moist; no rock fragments; strong medium subangular blocky structure; hard, very sticky, very plastic; common (2) very fine roots throughout; many (5+) very fine dendritic tubular pores throughout; 2 to 5 percent fine to medium gypsum masses throughout, white, prominent, sharp; 50 percent clay coating sand grains, lining pores, and on faces of peds throughout; strongly effervescent; clear smooth boundary.

C1--6 to 36 centimeters; 10YR 8/3, 10YR 7/3 moist; no rock fragments; strong coarse angular blocky structure; fissile, very sticky, very plastic; common (4) very fine roots throughout; common (3) fine dendritic tubular pores throughout; 2 to 5 percent fine to medium gypsum masses throughout, white, prominent, sharp; 20 to 30 percent fine gypsum crystals, faint, 10YR 8/3; 50 percent clay coating sand grains, lining pores, and on faces of peds throughout; common coarse root traces with decaying organic matter throughout the horizon; strongly effervescent; clear wavy boundary.

2C2--36 to 53+ centimeters; 2.5Y 7/3, 2.5Y 8/1 moist; no rock fragments; strong fine to medium angular blocky structure (lithogenic); fissile, very sticky, very plastic; common (1) medium roots throughout; many (5) very fine dendritic tubular and irregular pores throughout; 15 percent mottles, 2.5Y 7/8; 15 percent mottles 5YR 7/4; 70 percent mottles 5Y 8/2; 15 percent finely disseminated carbonate on faces of peds; 20 percent very fine gypsum crystals in cracks and on faces of peds; significant original lithogenic with approximately 30 percent gypsum crystals; strongly effervescent.

Site BS 17
Location: 718230E, 4025485N
Buckwheat: Absent

A--0 to 3 centimeters; 5YR 6/3, 5YR 5/4 moist; 50 percent gravel; strong thick platy structure; loose to soft, slightly sticky, very plastic; no roots; many (5) very fine to fine dendritic tubular and irregular pores; finely disseminated carbonate or gypsum throughout, faint, distinct, diffuse; violently effervescent; abrupt wavy boundary.

ByC--3 to 26 centimeters; 7.5YR 6/3, 7.5YR 5/3 moist; no rock fragments; strong coarse subangular blocky structure; moderately hard, slightly sticky, moderately plastic; common (3) very fine roots throughout; many (5) very fine to fine dendritic tubular pores throughout; 15 percent gypsum crystals, masses and filaments throughout, white, prominent; violently effervescent; abrupt wavy boundary.

2Cr--26 to 45+ centimeters; 7.5YR 6/4, 7.5YR 5/4 moist; no rock fragments; strong fine to medium angular blocky structure (lithogenic); rigid, very sticky, very plastic; no roots, structural pores throughout; 5 percent mottles as isolated masses, 5Y 8/4; 10 percent mottles as thin beds within matrix, 10YR 8/2; manganese oxide coats on faces of rock fragments, 7.5YR 3/1, black, shiny metallic; 2.5 percent very fine gypsum crystals and masses on faces of peds, white, prominent; violently effervescent.

Site BS 18
Location: 717845E, 4025325N
Buckwheat: Absent

A--0 to 7 centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; 25 percent gravel to cobble; moderate thin platy parting to moderate fine to medium subangular blocky structure; soft, nonsticky, moderately plastic; common (3) fine roots throughout; common (2) fine dendritic tubular pores throughout; 15 percent finely disseminated carbonate throughout, distinct, diffuse, 7.5YR 7/3; 2 to 5 percent very fine white masses throughout, prominent, sharp; violently effervescent; abrupt smooth boundary.

By--7 to 48+ centimeters; 7.5YR 7/3, 7.5YR 6/3 moist; 1.9 percent limestone gravel; strong medium to coarse angular blocky structure; soft, moderately sticky, very plastic; many (8) very fine, common (2) fine roots throughout; many (5) very fine, common (2) fine and medium dendritic tubular pores throughout; 15 percent calcium carbonate or gypsum masses and coats, irregular; finely disseminated carbonate as masses and lining pores throughout, white, diffuse, prominent, sharp; dry color very hard to match; violently effervescent.

Site BS 19
Location: 717915E, 4025415N
Buckwheat: Present

A--0 to 2 centimeters; 7.5YR 7/2, 7.5YR 6/3 moist; 20 percent gravel; strong very thick platy structure; slightly hard, moderately sticky, very plastic; no roots; many (10) very fine dendritic tubular and irregular, common (2) very fine, common (1) medium dendritic tubular pores throughout; 2 to 5 percent fine gypsum crystals throughout, distinct, very abrupt; 50 percent finely disseminated carbonate and silt throughout, 7.5YR 7/2, faint, clear; violently effervescent; very wavy boundary.

By--2 to 14 centimeters; 10YR 7/3, 10YR 7/3 moist; no rock fragments; moderate coarse subangular blocky structure; loose to soft, moderately sticky, very plastic; common (2) very fine roots throughout; common (1) medium dendritic tubular pores throughout; 15 percent gypsum spar and/or fragments; very difficult color match; 50 percent fine (2 to 5 millimeter) clay blocks; violently effervescent; abrupt wavy boundary.

Cr--14 to 57+ centimeters; 2.5Y 7/2, 2.5Y 6/2 moist; no rock fragments; strong coarse angular blocky structure; friable, very sticky, very plastic; common (1) fine, medium, coarse roots throughout; common (1) medium dendritic tubular pores throughout; 10 percent clay laminae, irregular, iatrogenic, 7.5YR 4/4; 0.5 to 1 centimeter gypsum spar in veins and cavities, lithogenic; violently effervescent.

Site BS 20
Location: 718890E, 4024465N
Buckwheat: Absent

A--0 to 10 centimeters; 10YR 7/3, 10YR 4/4 moist; 50 percent limestone gravel; moderate thin parting to very thick platy structure; soft, slightly sticky, slightly plastic; many (10+) very fine roots throughout; common (4) very fine dendritic tubular, many (5) very fine vesicular pores throughout; 20 percent very fine finely disseminated carbonate on bottoms of peds and rock fragments throughout, white, soft, irregular, distinct; violently effervescent; abrupt wavy boundary.

Byk1-- 0 to 34 centimeters; 10YR 7/4, 10YR 5/4 moist; no rock fragments; moderate fine to medium subangular blocky structure; soft, slightly sticky, slightly plastic; common (4) very fine, common (2) fine, common (1) medium roots throughout; many (5) very fine, common (2) fine, common (1) medium dendritic tubular pores throughout; 20 percent very fine finely disseminated carbonate on bottoms of peds and rock fragments throughout, white, soft, irregular, distinct; 0.9 percent very fine gypsum masses throughout, white, distinct; violently effervescent; abrupt wavy boundary.

Byk2--34 to 50 centimeters; 10YR 8/3, 10YR 6/3 moist; 1.9 percent gravel; moderate medium to coarse subangular blocky structure; soft, slightly sticky, moderately plastic; many (5) very fine to fine roots throughout; many (5) very fine, common (4) fine and medium dendritic tubular pores throughout; 10 percent fine to medium gypsum masses or gypsum sediment rock fragments, white, prominent, hard to tell if these are mottles (litho chromatic) or truly pedogenic; violently effervescent; clear wavy boundary.

C -- 50 to 69+ centimeters; 2.5YR 8/3, 2.5YR 7/3 moist; no rock fragments; massive; soft, slightly sticky, slightly plastic; common (1) fine roots throughout; skeletal pores; 50 percent gypsum spar; slightly effervescent.

Site BS 21
Location: 718845E, 4024420N
Buckwheat: Absent

Av--0 to 5 centimeters; 7.5YR 7/4, 7.5YR 4/6 moist; 50 percent gravel; moderate very thick platy structure; slightly hard, very sticky, very plastic; common (3) very fine roots throughout; many (5) very fine vesicular, common (1) fine and medium dendritic tubular pores throughout; 10 percent finely disseminated carbonate throughout, distinct, diffuse, 7.5YR 7/4; extremely gravelly discontinuous Av with gravel; abrupt wavy boundary.

Bk--5 to 23 centimeters; 7.5YR 6/4, 7.5YR 5/4 moist; 75 percent gravel; weak fine subangular blocky structure; loose, nonsticky, nonplastic; common (2) very fine, common (1) fine roots throughout; no pores; 10 percent finely disseminated carbonate; 5 percent very fine, soft to hard, round masses, hard to tell because of rock fragments; extremely gravelly, loose and soft; not sieved, most rock fragments are petrocalcic fragments; brecciated stage III; cannot remove calcium carbonate chunks without changing the soil; very wavy boundary

Bkm--23+ centimeters; 5YR 8/3, 5YR 7/4 moist; no rock fragments; massive; very rigid; no roots; no pores; 90 percent indurated calcium carbonate throughout, white, prominent; clasts with indurated pendants, mini pisoliths.

Site BS 22
Location: 718565E, 4024370N
Buckwheat: Absent

Av--0 to 6 centimeters; 5YR 6/6, 2.5YR 4/6 moist; 10 to 50 percent limestone fine gravel to stones; strong thick to very thick platy structure; slightly hard, slightly sticky, slightly plastic; no roots; many (10+) very fine and fine vesicular pores throughout; 20 percent finely disseminated carbonate and/or silt coats throughout, distinct, diffuse, irregular, 5YR 6/6; violently effervescent; abrupt wavy boundary.

Bk1--6 to 20 centimeters; 5YR 5/6, 5YR 4/6 moist; 0 to 5 percent fine to medium limestone gravel; strong medium to coarse angular blocky structure; slightly hard, nonsticky, slightly plastic; common (3) very fine, common (2) fine to medium roots throughout; common (3) fine, common (2) medium dendritic tubular pores throughout; 35 percent finely disseminated carbonate on faces of peds throughout, distinct, clear, white; less than 5 percent filaments; 0.9 percent very fine gypsum masses throughout, white; violently effervescent; gradual smooth boundary.

Bk2--20 to 37 centimeters; 2.5YR 6/4, 5YR 4/4 moist; no rock fragments; moderate fine to medium angular blocky structure; soft, slightly sticky, slightly plastic; many (5) very fine to fine roots throughout; many (5) very fine to fine dendritic tubular pores throughout; 20 to 25 percent finely disseminated carbonate throughout, distinct, white, clear; 1.9 percent filaments; 0.9 percent very fine gypsum masses throughout, white; violently effervescent; abrupt smooth boundary.

Cr --37 to 66+ centimeters; 5YR 5/4, 5YR 4/6 moist; no rock fragments; strong medium to coarse angular blocky structure (iatrogenic); hard to rigid; common (1) very fine roots throughout; structural pores throughout; 5 to 20 percent medium (0.5 centimeter) gypsum crystals throughout, spar, prominent, sharp, clear, 5YR 5/4; fissile to blocky, gypsiferous siltstone, thinly bedded (approximately 1 centimeter), relatively unaltered; strongly effervescent.

Site BS 23
Location: 718820E, 4024955N
Buckwheat: Absent

A--0 to 7 centimeters; 10YR 8/2, 10YR 8/2 moist; 10 percent gypsum gravel; moderate fine subangular blocky structure; soft, very friable, moderately sticky, very plastic; no roots; many (10+) very fine irregular pores throughout; 10 percent very fine gypsum spar and/or masses, white, faint; thin physical gypsum crust 0 to 1 centimeters thick; violently effervescent; abrupt wavy boundary.

By--7 to 26 centimeters; 10YR 8/2, 10YR 8/2 moist; no rock fragments; strong fine to coarse subangular blocky structure; soft, very friable, very sticky, very plastic; common (2) very fine, common (1) medium roots throughout; many (5) very fine irregular, common (1) fine dendritic tubular pores throughout; 10 percent fine to coarse laminae, prominent, platy, 10YR 7/8, iatrogenic; 20 percent medium to coarse gypsum nests throughout, prominent, white to grey; strongly effervescent; clear wavy boundary.

2ByC--26 to 38 centimeters; 10YR 7/3, 10YR 6/3 moist; no rock fragments; strong fine to coarse subangular blocky structure; very friable, very sticky, very plastic; no roots; common (1) fine dendritic tubular pores throughout; 30 percent blocky clay with 10YR 7/8 iron laminae throughout; 20 percent oxidized (ferric) iron laminae throughout (iatrogenic), continuous, prominent; 35 percent gypsum spar throughout, white, irregular, prominent; strongly effervescent; abrupt smooth boundary.

2C--38 to 50+ centimeters; 2.5YR 6/6, 2.5YR 6/6 moist; no rock fragments; lithogenic; blocky claystone with iron laminae, all iatrogenic structure; very friable, very sticky, very plastic; no roots; no pores; 20 percent oxidized (ferric) iron laminae throughout (iatrogenic), continuous, prominent; all clay and iron laminae; strongly effervescent.

Site BS 24
Location: 718955E, 4024550N
Buckwheat: Absent

Av--0 to 2 centimeters; 5YR 5/6, 2.5YR 4/6 moist; 30 percent limestone gravel; moderate thick platy structure; soft, moderately sticky, moderately plastic; no roots; common (4) very fine vesicular, many (5) very fine irregular pores throughout; 15 percent fine finely disseminated carbonate and silt throughout, faint, soft, irregular, diffuse, 5YR 5/6; violently effervescent; abrupt smooth boundary.

By1--2 to 9 centimeters; 5YR 5/6, 2.5YR 4/6 moist; 45 percent limestone gravel; soft, moderately sticky, moderately plastic; common (4) very fine roots throughout; many (5+) fine irregular pores throughout; 10 percent very fine gypsum crystals throughout, prominent, 5YR 8/2; 25 percent coarse gypsum rock fragments with clay, hard crystals; violently effervescent; abrupt smooth boundary.

By2--9 to 35 centimeters; 2.5YR 5/4, 2.5YR 4/6 moist; no rock fragments; moderate fine subangular blocky structure parting to lithic plates; soft, slightly sticky, slightly plastic; common (3) very fine roots throughout; many (5+) very fine to fine irregular pores throughout; 50 percent red gypsum spar and roses throughout, prominent, hard; 4.9 percent fine gypsum snowballs throughout; little altered siltstone and claystone; violently effervescent; abrupt smooth boundary.

C--35 to 57+ centimeters; 2.5YR 5/4, 2.5YR 4/6 moist; no rock fragments; lithogenic angular blocky structure; hard, very sticky, very plastic; no roots; many (5+) fine irregular pores throughout; 50 percent gypsum; 50 percent blocky red claystone; violently effervescent.

Site BS 25
Location: 718950E, 4024590N
Buckwheat: Absent

Av--0 to 5 centimeters; 5YR 6/4, 5YR 5/6 moist; 35 percent limestone fine gravel to coarse cobble; strong very thick platy structure; slightly hard, slightly sticky, moderately plastic; common (3) very fine roots throughout; many (5) very fine vesicular, common (2) fine dendritic tubular pores throughout; 15 percent finely disseminated carbonate and silt throughout, 5YR 6/4; 0.9 percent gypsum nests and masses throughout, faint, soft, irregular, white, diffuse; violently effervescent; abrupt wavy boundary.

Bk1--5 to 13 centimeters; 5YR 6/4, 5YR 4/6 moist; 9 percent gravel; moderate medium subangular blocky structure; soft, nonsticky, nonplastic; common (3) very fine, common (1) fine roots throughout; many (5) very fine dendritic tubular pores throughout; 10 percent medium (5 millimeter) calcium carbonate masses throughout, soft, white; 10 percent finely disseminated carbonate throughout, faint, diffuse, 5YR 6/4; violently effervescent; abrupt wavy boundary.

Bk2--13 to 33 centimeters; 5YR 7/4, 5YR 6/4 moist; 4.9 percent gravel; strong medium subangular blocky structure; soft, nonsticky, slightly plastic; common (3) very fine, common (1) fine roots throughout; common (2) very fine, common (1) fine dendritic tubular pores throughout; 30 percent finely disseminated carbonate; 10 percent calcium carbonate masses, soft; 0.9 percent very fine gypsum snowballs, soft, white, faint, diffuse; violently effervescent; abrupt smooth boundary.

Bk3-- 33 to 55+ centimeters; 5YR 5/6, 5YR 4/6 moist; no rock fragments; strong medium to coarse subangular blocky structure; soft, slightly sticky, moderately plastic; common (3) fine roots throughout; common (2) medium dendritic tubular pores throughout; 20 percent white masses in root fillings and veins throughout, 5YR 8/2, prominent, irregular; finely disseminated carbonate; 20 percent coarse calcium carbonate masses, irregular; violently effervescent.

Site BS 26
Location: 718390E, 4024500N
Buckwheat: Absent

AC--0 to 10 centimeters; 7.5YR 6/3, 7.5YR 5/3 moist; no rock fragments; strong coarse subangular blocky structure; hard, moderately sticky, very plastic; no roots; common (3) fine dendritic tubular; 2 percent fine to medium gypsum masses, prominent, white, sharp, round; 10 percent finely disseminated carbonate throughout, faint, diffuse; top 0.25 to 0.5 centimeters is crust; violently effervescent; clear smooth boundary.

C1-- 10 to 28 centimeters; 7.5YR 6/3, 7.5YR 5/4 moist; no rock fragments; strong coarse angular blocky structure; friable, slightly sticky, very plastic; common (1) fine roots throughout; many (5) fine irregular, common (1) medium dendritic tubular pores throughout; 5 percent mottles, gley 1 5/10Y; 5 percent medium gypsum crystals throughout, prominent, sharp; 5 to 10 percent very fine to fine gypsum masses and filaments throughout, white, prominent, sharp; 10 percent finely disseminated carbonate on faces of peds, distinct, diffuse, white; violently effervescent; abrupt smooth boundary.

C2-- 28 to 52+ centimeters; 7.5YR 6/3, 7.5YR 5/4 moist; no rock fragments; moderate fine to coarse subangular blocky structure; slightly hard, friable, slightly sticky, very plastic; no roots; common (4) very fine irregular pores throughout; 2 percent mottles, gley 1 8/10Y; 10 percent very fine gypsum coats and crystals throughout, distinct, clear, irregular; 10 percent medium to coarse gypsum crystals throughout, prominent, sharp; violently effervescent.

Site BS 27
Location: 718483E, 4024436N
Buckwheat: Absent

A--0 to 3 centimeters; 2.5Y 8/2, 2.5Y 7/3 moist; no rock fragments; strong thick to very thick platy structure; slightly hard, very sticky, very plastic; no roots; many (5) fine vesicular, common (3) medium irregular pores throughout; 20 percent fine to medium gypsum crystals under plates, white, prominent; 10 percent finely disseminated carbonate throughout, faint, diffuse, white; violently effervescent; very wavy boundary.

Byk--3 to 10 centimeters; 2.5Y 8/3, 2.5Y 7/3 moist; no rock fragments; moderate fine to medium subangular blocky parting to weak thick platy structure; soft to hard, moderately sticky, moderately plastic; common (2) very fine roots throughout; common (4) very fine dendritic tubular and irregular pores throughout; 30 percent fine to medium gypsum crystals throughout, white, prominent; violently effervescent; abrupt smooth boundary

C--10 to 35+ centimeters; 2.5Y 7/3, 2.5Y 6/3 moist; no rock fragments; strong coarse angular blocky structure; friable, very sticky, very plastic; no roots; many (5+) fine to medium irregular pores, skeletal between gypsum crystals; 2 percent fissile, blocky, claystone with gypsum lenses, greenish, 10YR 5/6; 20 percent medium to coarse gypsum crystals throughout, clear to white, prominent; bright pink in cracks throughout; violently effervescent.

Site BS 28
Location: 718842E, 4024242N
Buckwheat: Absent

A--0 to 9 centimeters; 7.5YR 8/3, 7.5YR 7/3 moist; 5 percent rock fragments, 0.9 percent limestone and fine gypsum; moderate thick to very thick platy structure; soft, nonsticky, slightly plastic; many (5) very fine roots throughout; many (10) very fine irregular, many (5) very fine vesicular pores throughout; 20 percent finely disseminated carbonate, silt coats and carbonate filaments throughout, faint, 7.5YR 8/3 to white; 20 percent gypsum crystals and very fine coats around ped faces throughout, distinct, hard, 7.5YR 8/3 to grey; 2 percent very fine gypsum masses throughout, white, prominent, abrupt; gypsum and cyanobacteria crust, part biological soil crust mostly physical; strongly effervescent; abrupt wavy boundary.

By--9 to 21 centimeters; 7.5YR 8/3, 7.5YR 5/3 moist; no rock fragments; moderate fine subangular blocky structure; slightly hard to hard, nonsticky, slightly plastic; many (10) very fine, common (2) fine, common (1) medium roots throughout; common (1) fine dendritic tubular, common (3) fine to medium irregular pores throughout; 5 percent very fine para-rock fragments of claystones or siltstone with weathered gypsum; 20 percent very fine to fine gypsum crystals throughout, distinct; 5 percent finely disseminated carbonate and silt coats on surface of peds and rock and siltstone fragments; slightly effervescent; clear wavy boundary.

2C--21 to 46 centimeters; 7.5YR 7/3, 7.5YR 4/4 moist; no rock fragments; moderate fine subangular blocky structure; soft, slightly sticky, very plastic; many (5) very fine, common (3) fine, common (1) medium roots throughout; many (5) very fine irregular, common (1) fine dendritic tubular pores throughout; 20 percent hard fragments of clayey, silty gypsum; 40 percent gypsum crystals, recrystallized as coats and spar filling pores and veins, prominent, grey to white; 40 percent clay and silt fragments; very strongly effervescent; gradual smooth boundary.

2Cr--46 to 58+ centimeters; 7.5YR 7/3, 7.5YR 4/4 moist; no rock fragments; strong medium subangular blocky structure; soft, moderately sticky, very plastic; common (2) fine and medium, common (1) coarse roots throughout; many (5) very fine irregular pores throughout, skeletal; 10 to 50 percent large fragments of claystone with gypsum throughout; 30 percent gypsum crystals, recrystallized as coats and spar filling pores and veins, prominent, grey to white; 50 percent fissile claystone; very strongly effervescent.

Site BS 29
Location: 718860E, 4024515N
Buckwheat: Present

Av--0 to 3 centimeters; 7.5YR 8/2, 7.5YR 7/2 moist; 35 percent limestone gravel; strong thick platy structure; soft, moderately sticky, slightly plastic; no roots; many (10) very fine vesicular, many (5) very fine irregular pores throughout; 10 percent very fine finely disseminated carbonate and silt throughout, soft, faint, irregular, 7.5YR 8/2; violently effervescent; very wavy boundary.

By--3 to 10 centimeters; 7.5YR 8/2, 7.5YR 7/2 moist; 35 percent very fine, rounded gypsum gravel; weak thin platy structure; loose, slightly sticky, very plastic; many (6) very fine roots throughout; no pores described; too loose to determine concentrations, mostly subrounded weathered gypsum; strongly effervescent; abrupt wavy boundary.

C1--10 to 35 centimeters; 7.5YR 8/2, 7.5YR 8/2 moist; no rock fragments; moderate medium subangular blocky structure; soft, moderately sticky, very plastic; many (5) very fine roots throughout; common (2) fine, common (1) coarse dendritic tubular pores throughout, skeletal; laminae across horizon, 10YR 6/4 to 10YR 6/6, lithogenic, prominent, distinct; few clear sedimentary structures, but no clear pedogenic features either; strongly effervescent; clear wavy boundary.

2Cr--35 to 49+ centimeters; gley 1 5/10Y; no rock fragments; no structure; common (1) very fine roots throughout; many (5+) medium irregular pores throughout, skeletal; 35 percent coarse lithogenic gypsum spar nests and crystals throughout, clear, prominent; claystone with 35 percent coarse (0.5 to 2 centimeters) gypsum spar; strongly effervescent.

(end of Bitter Spring profiles)