

APPENDIX A
SOIL SERIES DESCRIPTIONS

Sites 1 and 2 Soil Series Description



Natural Resources Conservation Service
MLRA Soil Survey Office
1615 S Plaza Way
Flagstaff, AZ 86001
(928) 214-0450

United States Department of Agriculture

Date: 6/25/2015

Subject: TSS – Technical Soil Service, Flagstaff MLRA SSO

To: NAU School of Earth Sciences and Environmental Sustainability

Purpose: Soil investigation for grazed and ungrazed plots on private land, Flying M Ranch.

Participants: James Harrigan, Jennifer Puttere, Aradhana Roberts

Location: Flying M Ranch near Mile Marker 324 on Lake Mary Rd, Flagstaff, AZ; Z12 0460148E 3871915N. Elevation is 2125m (6971 ft). Major vegetation is representative of proposed LRU 35.9. Ponderosa pine, Utah juniper, Alligator juniper, oneseed juniper, blue grama, western wheatgrass and squirreltail. There is no ESD written for this site. This site occurs on a private allotment within National Forest land.

Background and Status: The location of the site has only been mapped by US Forest Service in the Terrestrial Ecosystems Survey of the Coconino National Forest where it is described as Vertic Argiborolls.

Activities: Hand-dug soil pits were observed and described. Vegetation lines were used to characterize plant species composition.

Observations and Decisions: Three auger holes were observed within the site. At each site soils were fine and very deep at all locations. The soil and the landform across the field where the research area is located appears to be uniform.

Recommendations: The soil description is provided as a reference for NAU staff.

Author: Jennifer Puttere

Attachments: Soil Description and two maps

Summary:

Three key species are being observed for this project:

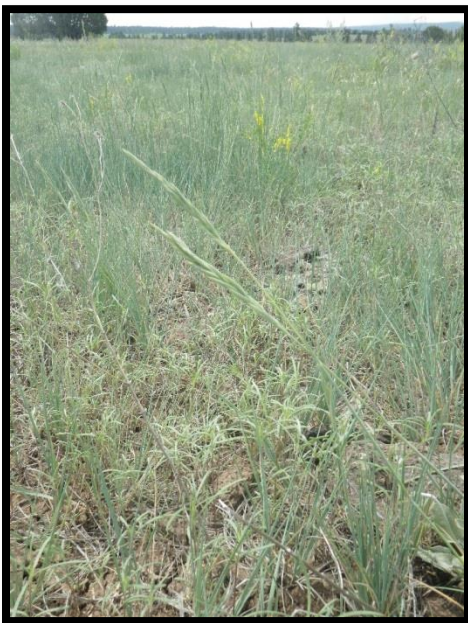
Artemisia spp. (Mugwort)

Pascopyrum smithii (Western wheatgrass)

Bouteloua gracilis (Blue grama)



Artemisia spp.



Pascopyron spp.

Table 1. Species observed on this site

Common Name	Scientific Name	Percent Occurrence
Squirreltail	<i>Elymus elymoides</i> subsp. <i>Elymoides</i>	15
Western wheatgrass	<i>Pascopyrum smithii</i>	25
Cheatgrass	<i>Bromus tectorum</i>	5
Musk thistle	<i>Carduus</i> spp.	2
Sweetclover	<i>Melilotus</i> spp.	10
Western salsify	<i>Tragopogon dubius</i>	2
Annual forbs	Annual forbs	15
Doubting mariposa lily	<i>Calochortus ambiguus</i>	TR
Fleabane daisy	<i>Erigeron</i> spp.	TR
Buckwheat	<i>Eriogonum</i> spp.	5
Geranium	<i>Geranium</i> spp.	TR
Locoweed	<i>Oxytropis</i> spp.	2
Utah juniper	<i>Juniperus osteosperma</i>	2
Artemisia	<i>Artemisia</i> spp.	15
Skunkbush sumac	<i>Rhus trilobata</i>	2

The second observed site had blue grama, and has been ungrazed for 18 years.

Table 2. Observed Soil Pit Description

Depth cm	Horizon	Color moist	Texture	Structure	pH	Effervescence	Clay %
0-5	A	7.5YR 2.5/3	L	2MGR	7.2	VS	26
5-15	ABt	7.5 YR 2.5/3	C	3MABK	7.2	VS	45
15-37	Bt	7.5YR 3/3	C	2FSBK	8.0	VS	42
37-70	Btk1	7.5YR 3/3	C	N/A	8.0	ST	40
70-107	Btk2	7.5YR 4/3	C	N/A	8.0	ST	40
107-125	Btk3	7.5YR 3/3	C	N/A	8.0	VE	40

Production: 249 lb/acre

Bare ground: 76%

Canopy cover: 72%

Basal Cover: 24%

Other ground cover: None

Other observations:



This site, when viewed as a landscape, appears to have good vegetative cover (Top photo). However, when viewed closely, there are large patches of bare ground along with hoof damage from grazing (Lower photo).

Soil Description; June 23, 2015

Taxonomic Classification: Fine, mixed, superactive, mesic Pachic Argiustolls

Location

Geographic Coordinate System (Latitude-Longitude):

34° 59' 20.8" north, 111° 26' 12.0" west

A—0 to 2 inches (0 to 5 cm); loam, very dark brown (7.5YR 2.5/3), moist; 26 percent clay; moderate medium granular structure; moderately sticky and moderately plastic; common fine and very fine roots throughout; 5 percent gravel; very slightly effervescent; neutral, pH 7.2; clear smooth boundary.

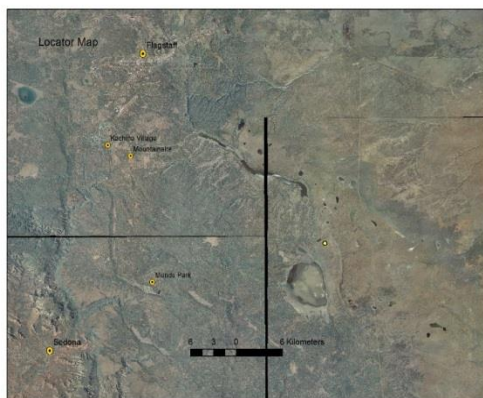
ABt—2 to 6 inches (5 to 15 cm); clay, very dark brown (7.5YR 2.5/3), moist; 45 percent clay; strong medium angular blocky structure; very sticky and very plastic; common medium, fine, and very fine roots throughout; prominent clay films, 0 percent gravel; very slightly effervescent; neutral, pH 7.2; clear smooth boundary.

Bt—6 to 15 inches (15 to 37 cm); clay, dark brown (7.5YR 3/3), moist; 42 percent clay; moderate medium subangular blocky structure; very sticky and very plastic; few very fine roots throughout; prominent clay films and pressure faces, 1 percent gravel; very slightly effervescent; moderately alkaline, pH 8.0; gradual smooth boundary.

Btk1—15 to 28 inches (37 to 70 cm); clay, dark brown (7.5YR 3/3), moist; 40 percent clay; moderate fine subangular blocky structure; very sticky and very plastic; few very fine roots throughout; medium spherical carbonate masses in matrix, prominent pressure faces, 0 percent gravel; strongly effervescent; moderately alkaline, pH 8.0; gradual smooth boundary.

Btk2—28 to 42 inches (70 to 107 cm); clay, brown (7.5YR 4/3), moist; 40 percent clay; moderate fine subangular blocky structure; very sticky and very plastic; coarse spherical carbonate masses in matrix, 0 percent gravel; strongly effervescent; moderately alkaline, pH 8.0; gradual smooth boundary.

Btk3—42 to 49 inches (107 to 125 cm); clay, dark brown (7.5YR 3/3), moist; 40 percent clay; moderate fine subangular blocky structure; very sticky and very plastic; coarse spherical carbonate masses in matrix, prominent pressure faces, 0 percent gravel; violently effervescent; moderately alkaline, pH 8.0.



Site 3 Soil Series Description

LOCATION DEAMA

NM+AZ

Established Series
Rev. REN-DGS-RLB
11/2014

DEAMA SERIES

The Deama series consists of shallow and very shallow, well drained soils with moderately slow permeability above very slowly permeable limestone bedrock. They formed in colluvium mainly from limestone. Deama soils are on hills, ridges, plateaus, or mesas. Slope ranges from 0 to 90 percent. Mean annual precipitation is about 15 inches and mean annual air temperature is about 52 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic, mesic Lithic Calciustolls

TYPICAL PEDON: Deama very stony loam, rangeland. (Colors are for dry soil unless otherwise noted.)

A--0 to 4 inches; dark grayish brown (10YR 4/2) very stony loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; 15 percent angular limestone pebbles, 15 percent cobbles, 15 percent stones; slightly effervescent; moderately alkaline; gradual wavy boundary. (1 to 7 inches thick)

Bk1--4 to 8 inches; dark grayish brown (10YR 4/2) very stony loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; 20 percent angular limestone and hard caliche pebbles; 10 percent cobbles, 10 percent stones; discontinuous hard calcium carbonate coatings on rock fragments; violently effervescent; moderately alkaline; clear wavy boundary.

Bk2--8 to 13 inches; brown (10YR 4/3) very stony loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; 25 percent angular limestone and caliche pebbles, 15 percent cobbles, 20 percent stones; many moderately thick hard calcium carbonate coatings on rock fragments, most numerous on the bottom side; violently effervescent; moderately alkaline; clear abrupt boundary. (Combined thickness of the Bk horizon is 6 to 13 inches)

R--13 to 18 inches; limestone bedrock; upper surface coated with hard calcium carbonate about 1/8 inch thick.

TYPE LOCATION: Otero County, New Mexico; approximately 1.1 mile northwest of Red Lake-Augustine Tank road; near the center of the northwest quarter, sec. 4, T. 13S., R. 16E. Latitude 33 degrees 13 minutes 3.89 seconds north and longitude 105 degrees 22 minutes 48.07 seconds west. UTM 464587E and 3675300N.

RANGE IN CHARACTERISTICS:

Soil Moisture: An ustic moisture regime bordering on aridic. Intermittently moist in some part of the soil moisture control section November through March and July through September. The soil is driest during May and June.

Mean Annual Soil Temperature: 47 to 59 degrees F.

Depth to bedrock: 7 to 20 inches

Reaction: Slightly to strongly alkaline

Rock fragments: 35 to 85 percent in the particle-size control section

Clay content: 18 to 35 percent in the particle-size control section

Calcium carbonate equivalent: 40 to 60 percent in the particle-size control section

A horizon

Hue: 5YR, 7.5YR, 10YR

Value: 2 to 6 dry, 1 to 4 moist

Chroma: 2 or 3, dry or moist

Texture: fine sandy loam, sandy loam, loam, silt loam, clay loam

Rock fragments: 15 to 85 percent

Bk horizon

Hue: 5YR, 7.5YR, 10YR

Value: 4 to 8 dry, 2 to 7 moist

Chroma: 2 to 4, dry or moist

Texture: sandy loam, loam, sandy clay, clay loam

COMPETING SERIES: This is the [Legate](#)(NM) series. Similar soils are the [Ector](#), [Lozier](#),[Oro Grande](#), [Rudd](#), and [Tortugas](#) series. Legate soils average less than 18 percent clay in the particle size control section. Ector soils have a thermic temperature regime. Lozier soils do not have a mollic epipedon. Oro Grande and Rudd soils have less than 40 percent carbonates in the control section.

[Tortugas](#) soils do not have a calcic horizon.

GEOGRAPHIC SETTING: The Deama soils are on hills, ridges, mesas, or plateaus. Slopes range from 0 to 90 percent. The soils formed in colluvium derived mainly from limestone. Mean annual precipitation ranges from 12 to 18 inches and mean annual temperature ranges from 45 to 58 degrees F. Frost-free season ranges from 110 to 180 days and elevation ranges from 4,500 to

8,660 feet

GEOGRAPHICALLY ASSOCIATED SOILS: These are the [Asparas](#), [Cale](#), [Darvey](#), [Harvey](#), [Jarita](#), [Kerrick](#), [Pena](#), and [Shanta](#) soils and the competing [Lozier](#) soils.

[Asparas](#), [Darvey](#), and [Harvey](#) soils: more than 40 inches deep.

[Jarita](#) soils: deeper than 20 inches to bedrock and have an argillic horizon.

[Kerrick](#) soils: have a petrocalcic horizon.

[Pena](#) soils: do not have a lithic contact within 20 inches of the surface.

[Shanta](#) and [Cale](#) soils: have less than 35 percent rock fragments.

DRAINAGE AND PERMEABILITY: Well drained. Permeability of the soil material is moderately slow above a very slowly permeable bedrock. Runoff is high on slopes less than 1 percent and very high on slopes greater than 1 percent.

USE AND VEGETATION: These soils are used primarily for livestock grazing. Principal vegetation is blue grama, black grama, hairy grama, sideoats grama, bluestem spp, oak bush, pinyon, alligator juniper, and oneseed juniper.

DISTRIBUTION AND EXTENT: Foothills adjoining mountainous areas of south-central New Mexico and northern Arizona. The series is moderately extensive. MLRA 42.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: Valencia County (East Valencia Area), New Mexico, 1970.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon - 0 to 8 inches. (A and Bk1 horizon).

Calcic horizon - 4 to 13 inches. (Bk horizons).

Lithic contact - The R contact at 13 inches.

Classified according to Soil Taxonomy Second Edition, 1999; Keys to Soil Taxonomy, Twelfth Edition, 2014.

Revised for the correlation of White Sands Missile Range, New Mexico; October, 2014, NMS

National Cooperative Soil Survey
U.S.A.

Sites 4 and 5 Soil Series Description

LOCATION WINONA

AZ+NM UT

Established Series

Rev. DRT/RLB

10/2011

WINONA SERIES

The Winona series consists of very shallow and shallow, well drained soils that formed in eolian deposits over alluvium from limestone and calcareous sandstone. Winona soils are on plateaus and hills and have slopes of 0 to 70 percent. The mean annual precipitation is about 11 inches and the mean annual air temperature is about 52 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic, mesic Lithic Ustic Haplocalcids

TYPICAL PEDON: Winona extremely gravelly loam - rangeland. (Colors are for dry soil unless otherwise noted.)

A--0 to 2 inches; brown (7.5YR 5/3) extremely gravelly loam, brown (7.5YR 4/3) moist; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many very fine roots; common very fine irregular pores; 60 percent gravel, 20 percent cobble and 5 percent stones; violently effervescent, 32 percent calcium carbonate equivalent; moderately alkaline (pH 7.9); clear wavy boundary. (1 to 4 inches thick)

Bw--2 to 10 inches; brown (7.5YR 5/3) extremely gravelly loam, brown (7.5YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; 55 percent gravel and 10 percent cobble; violently effervescent, 37 percent calcium carbonate equivalent; moderately alkaline (pH 7.9); abrupt wavy boundary. (6 to 10 inches thick)

Bk--10 to 17 inches; very pale brown (10YR 7/3) extremely gravelly loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; 50 percent gravel and 10 percent cobble; many coarse soft calcium carbonate masses and thin coatings on rock fragments; violently effervescent, 54 percent calcium carbonate equivalent; moderately alkaline (pH 8.0); abrupt wavy boundary. (1 to 8 inches thick)

2R--17 inches; fractured limestone; discontinuous calcium carbonate coatings.

TYPE LOCATION: Coconino County, Arizona; 1900 feet north and 2200 feet east of the

southwest corner of section 15. T. 32 N., R. 4 W.

RANGE IN CHARACTERISTICS:

Soil moisture - Intermittently moist in some part of the soil moisture control section during July-September and December-February. Driest during May and June. Ustic aridic soil moisture regime.

Soil Temperature - 48 to 56 degrees F.

Rock fragments - 35 to 70 percent limestone and chert gravel, channers, cobble and flagstones

Depth to bedrock - 6 to 20 inches

Calcium carbonate - 40 to 60 percent calcium carbonate equivalent

A horizon

Hue: 5YR, 7.5YR, 10YR

Value: 4 to 6 dry, 3 or 4 moist

Chroma: 2 to 4 dry

Reaction: slightly or moderately alkaline

Bk horizon

Hue: 5YR, 7.5YR, 10YR

Value: 5 to 7 dry, 3 to 6 moist

Chroma: 2 to 4, dry or moist

Texture: loam, sandy loam, very fine sandy loam, fine sandy loam, silt loam, clay loam (15 to 30 percent clay)

Calcium carbonate: segregated and as coatings on rock fragments

Bw horizon is not present in all pedons.

COMPETING SERIES: Competing series are the [Scrapy](#) (NV), [Splimo](#) (UT) and [Yaki](#) (UT) series.

[Scrapy](#) soils have a calcic horizon at 1 to 3 inches below the surface.

[Splimo](#) soils have mean annual soil temperature of 47 to 51 degrees and a calcic horizon at 5 to 10 inches deep.

[Yaki](#) soils do not have Bw horizon and the profile is dominated by cobbles.

GEOGRAPHIC SETTING: Winona soils are on plateaus and hills. Slopes are dominantly 2 to 15 percent, but range from 0 to 70 percent. These soils formed in eolian deposits over alluvium from limestone and calcareous sandstone. Elevations range from 4700 to 7100 feet. The climate is semiarid with a mean annual precipitation of 8 to 14 inches occurring as summer thunderstorms and gentle winter rain and snow. The mean annual air temperature ranges from 46

to 54 degrees F. The mean temperature for July is 71 degrees F. and for December is 31 degrees F. The frost-free period ranges from 120 to 180 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are [Boysag](#), [Tovar](#), and [Tusayan](#) soils. Boysag and Tovar soils have argillic horizons. Tusayan soils are 20 to 40 inches deep over bedrock.

DRAINAGE AND PERMEABILITY: Well drained; slow to rapid runoff; moderate permeability.

USE AND VEGETATION: These soils are used for livestock grazing and wildlife habitat. Vegetation is blue grama, black grama, needleandthread, galleta, sand and spike dropseed, hairy grama, muttongrass, bottlebrush, squirreltail, alkali sacaton, winterfat, bigelow sage, fourwing saltbush, cliffrose, juniper and pinyon pine.

DISTRIBUTION AND EXTENT: Northern Arizona and west central New Mexico. MLRAs 35, 36, 38

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Phoenix, Arizona.

SERIES ESTABLISHED: Coconino County, (Long Valley Area), Arizona; 1971.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - The zone from 0 to 2 inches (A horizon)

Calcic horizon - The zone from 10 to 17 inches (Bk horizon)

Lithic contact - The boundary at 17 inches (2R horizon)

Classified according to Soil Taxonomy Second Edition, 1999; Keys to Soil Taxonomy Eleventh Edition, 2010

The type location is moved to a site with carbonatic mineralogy. The original site averaged 29 percent calcium carbonate equivalent. New Mexico has correlated and published Winona as carbonatic or the mineralogy would be reclassified as mixed.

Update and revisions for the correlation of Little Colorado River Area (AZ707), Sept. 2011, CEM

Site 6 Soil Series Description

LOCATION EPIKOM AZ

Established Series
Rev. DRT/RLB
10/2011

EPIKOM SERIES

The Epikom series consists of shallow, well drained soils that formed in alluvium from sandstone, mudstone and shale. Epikom soils are on plateaus and mesas and have slopes of 0 to 25 percent. The mean annual precipitation is about 8 inches and the mean annual air temperature is about 51 degrees F.

TAXONOMIC CLASS: Loamy, mixed, superactive, mesic Lithic Haplocambids

TYPICAL PEDON: Epikom fine sandy loam - rangeland. (Colors are for dry soil unless otherwise noted.)

A--0 to 3 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; common fine vesicular and many irregular pores; violently effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary. (3 to 5 inches thick)

Bw--3 to 15 inches; reddish yellow (5YR 6/6) gravelly loam, yellowish red (5YR 5/6) moist; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine and medium roots; few irregular and tubular pores; 20 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary. (7 to 15 inches thick)

2R--15 inches; interbedded sandstone and shale; common calcium carbonate coatings in joints.

TYPE LOCATION: Coconino County, Arizona; about 48 miles east and 18 miles south of Flagstaff; 600 feet west of the center of section 32, T. 18 N., R. 14 E.

RANGE IN CHARACTERISTICS:

Soil Moisture: Intermittently moist in some part of the soil moisture control section during July-September and December-February. Driest during May and June. Typic aridic soil moisture regime.

Soil Temperature: 51 to 59 degrees F.

Depth to bedrock: 10 to 20 inches

Clay content: Averages less than 18 percent in the control section

Rock Fragments: Averages less than 35 percent in the control section; can range to 60 percent in any one horizon.

A horizon

Hue: 2.5YR, 5YR, 7.5YR

Value: 4 to 7 dry, 3 to 5 moist

Chroma: 2 to 6, dry or moist

Reaction: Slightly to strongly alkaline

B horizon

Hue: 2.5YR, 5YR, 7.5YR

Value: 4 to 7 dry, 3 to 6 moist

Chroma: 2 to 6, dry or moist

Texture: Sandy loam, loam, fine sandy loam

Reaction: Slightly to strongly alkaline

Calcium carbonate: Less than 15 percent calcium carbonate equivalent as disseminated or coatings on rock fragments.

COMPETING SERIES: These are the [Leanto](#)(UT) and [Lyeflat](#) (OR) series. Leanto soils have hue yellower than 5YR and are moist in the moisture control section for longer periods due to a higher rainfall component. Lyeflat soils have 10YR or 2.5Y hues and SAR that range from 13 to 30 percent.

GEOGRAPHIC SETTING: Epikom soils are on plateaus and mesas and have slopes of 0 to 25 percent. These soils formed in alluvium from sandstone, mudstone and shale. Elevations range from 4,220 to 7,000 feet. The mean annual precipitation ranges from 6 to 10 inches. The mean annual air temperature is 49 to 57 degrees F. The frost-free period is 130 to 180 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the [Boysag](#), [Navajo](#),[Purgatory](#), and [Tours](#) soils. Boysag soils have argillic horizons. Navajo and Tours soils are very deep. Tours soils are also fine-silty. Purgatory soils have bedrock at depths of 20 to 40 inches.

DRAINAGE AND PERMEABILITY: Well drained; slow to moderate runoff; moderate or moderately rapid permeability.

USE AND VEGETATION: Epikom soils are used for livestock grazing and wildlife habitat.

The present vegetation is black grama, blue grama, galleta, alkali sacaton and fourwing saltbush.

DISTRIBUTION AND EXTENT: Northern Arizona. This series is extensive. MLRA 35.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: Coconino County Area, Arizona, Central Part; 1980.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - The zone from 0 to 3 inches (A horizon)

Cambic horizon - The zone from 3 to 15 inches (Bw horizon)

Lithic contact - The boundary at 15 inches (2R horizon)

Classified according to Soil Taxonomy Second Edition, 1999; Keys to Soil Taxonomy, Eleventh Edition, 2010

Update and revisions for the correlation of Little Colorado River Area (AZ707), Sept. 2011,
CEM

National Cooperative Soil Survey
U.S.A.

APPENDIX B: SUPPLEMENTARY GRAPHS

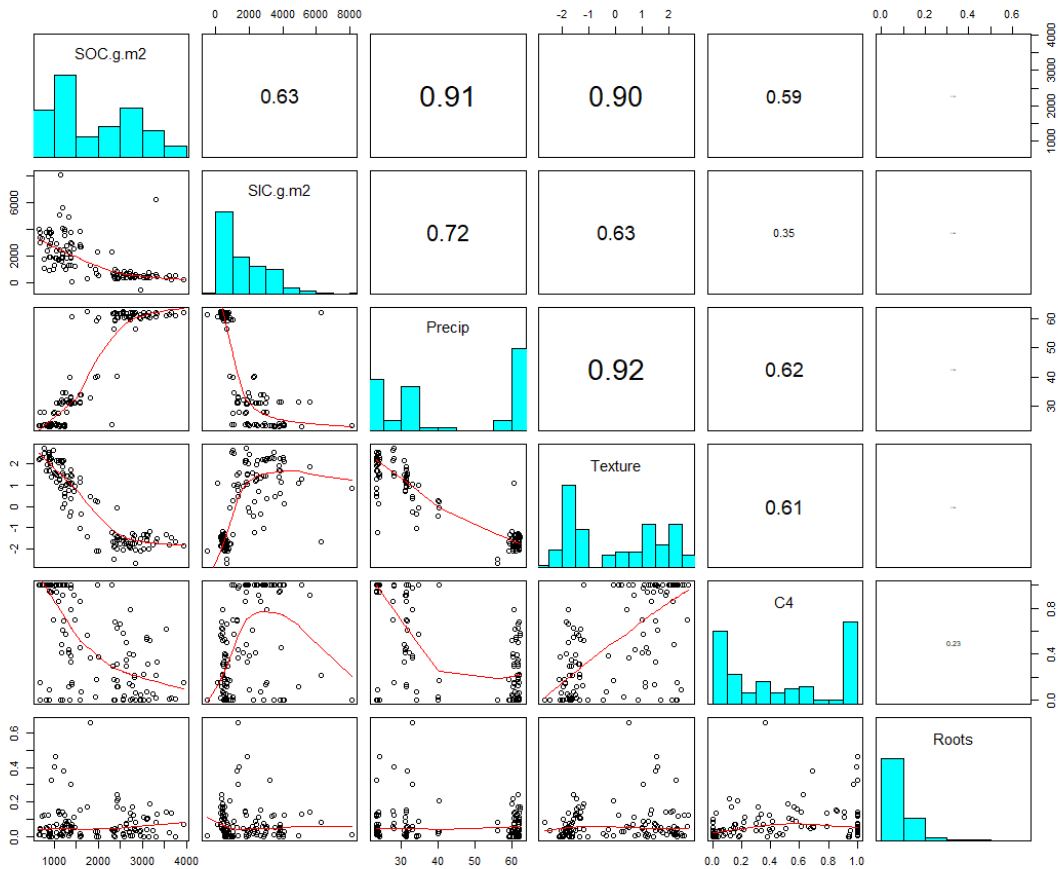


Figure S1. A pairs plots examining the Pearson correlation coefficients for all variables on the surface. Significance is displayed by the proportional size of the path values written in the upper right half of the figure. The only coefficients that weren't significant were the relationships involving the roots.

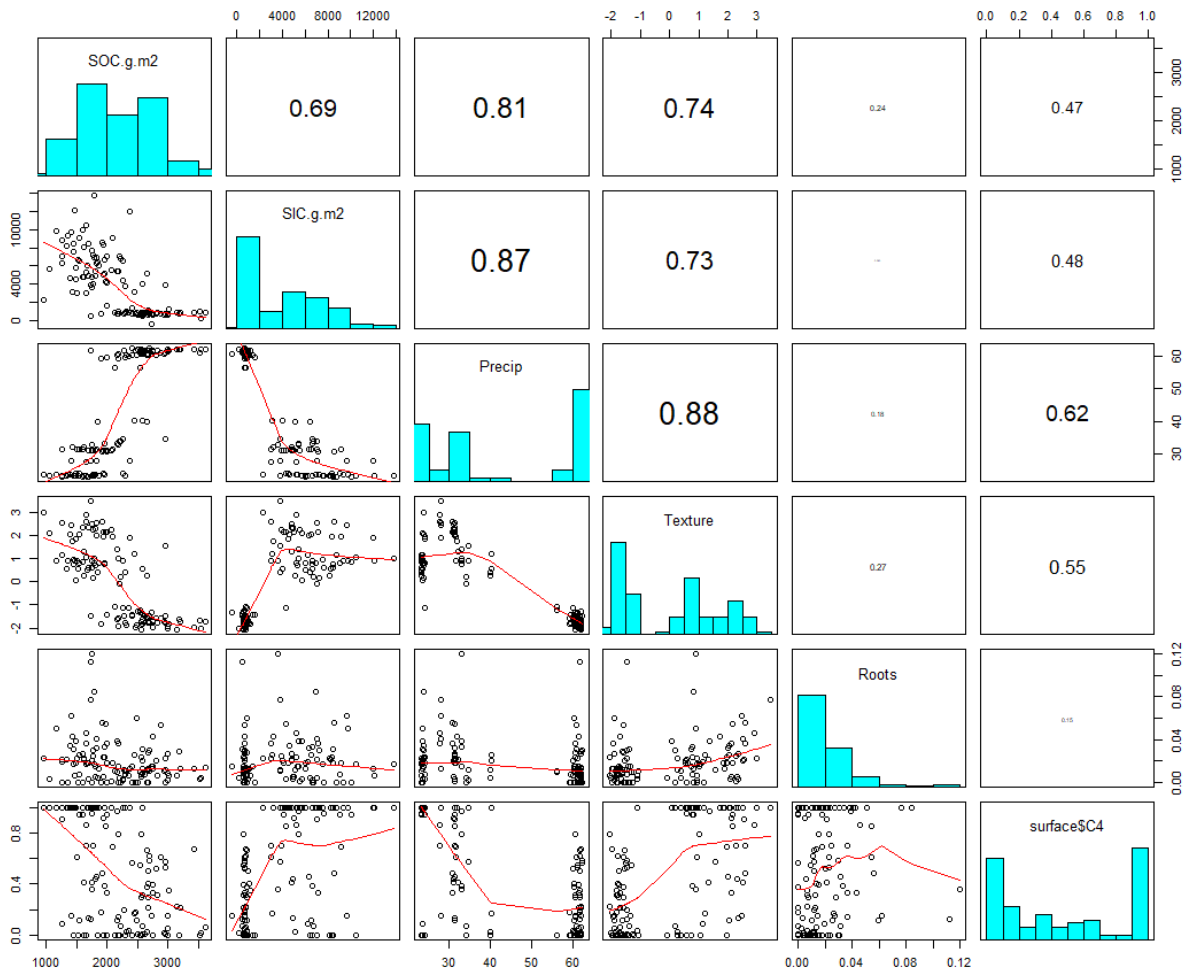


Figure S2. A pairs plots examining the Pearson correlation coefficients for all variables on the subsurface. Significance is displayed by the proportional size of the path values written in the upper right half of the figure. The only coefficients that weren't significant were the relationships involving the roots.

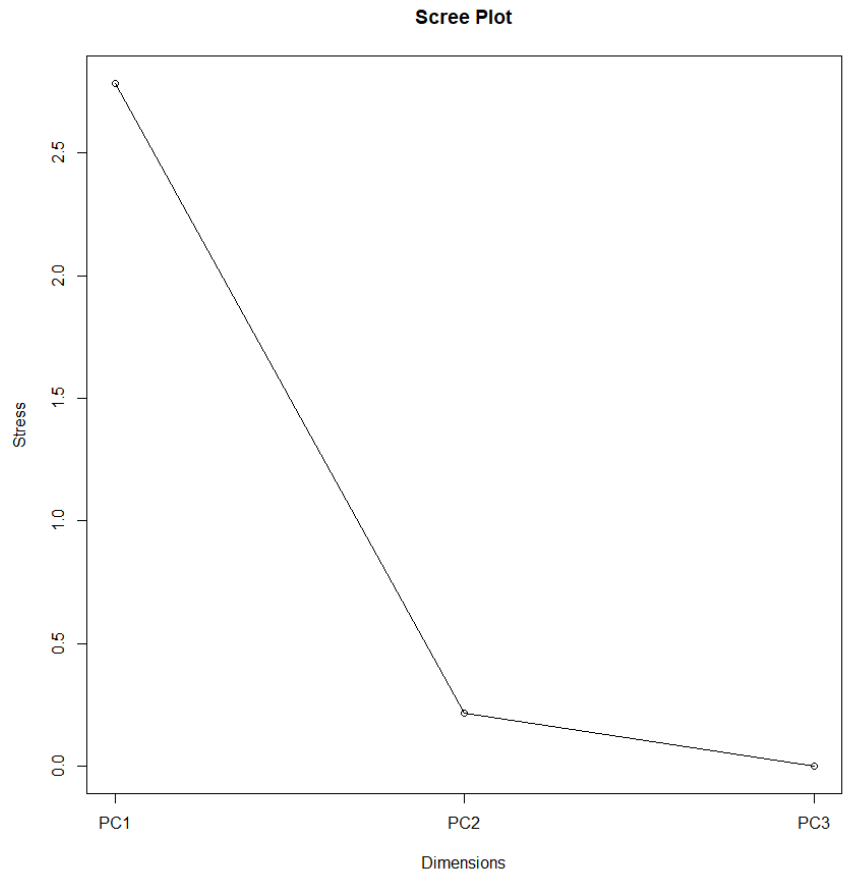


Figure S3. A scree plot from the texture PCA displaying stress as a function of the number of principal components. “Stress” is inversely related to how well the data fit.

	PC1	PC2	PC3
Standard Deviation	1.673	0.44844	0.001996
Proportion of Variance	0.933	0.06703	0

Table S1. Proportion of the variance captured from each axis within the texture PCA

Scree Plot for Vegetation nMDS Ordination

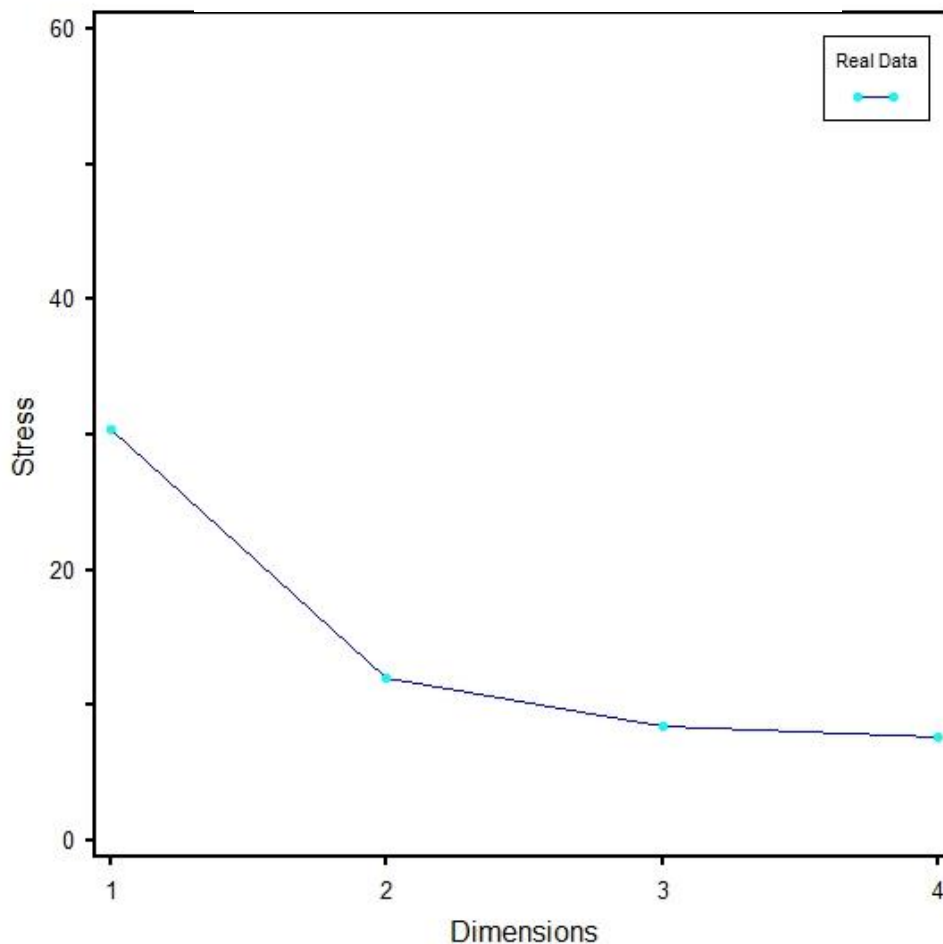


Figure S4. A scree plot from the vegetation nMDS displaying stress as a function of the number of axes. “Stress” is inversely related to how well the data fit.

Axis	Increment	Cumulative
1	0.379	0.379
2	0.540	0.920

Table S2. Proportion of variance captured by axes 1 and 2 from the nMDS>

	C4 Grasses	C3 Grasses	Shrubs	Forbs
MDS1	0.294	-0.385	0.337	-0.453
MDS2	0.533	-0.266	-0.477	0.018

Table S3. Proportion of the variance captured by each variable for axes 1 and 2 from the nMDS.

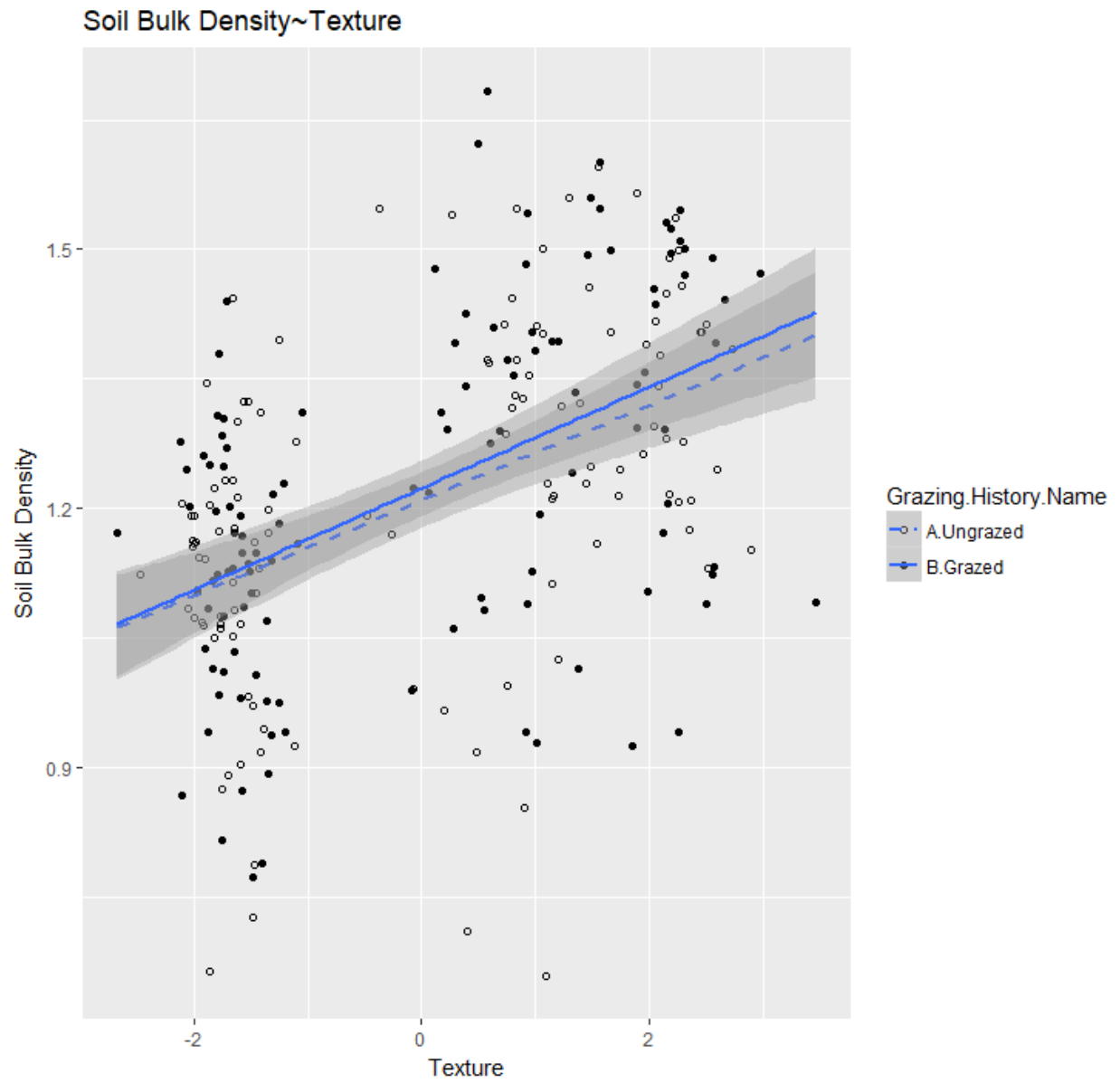


Figure S5. A linear regression of soil bulk density across a span of textures. Bulk density increased in the more sandy, dry soils

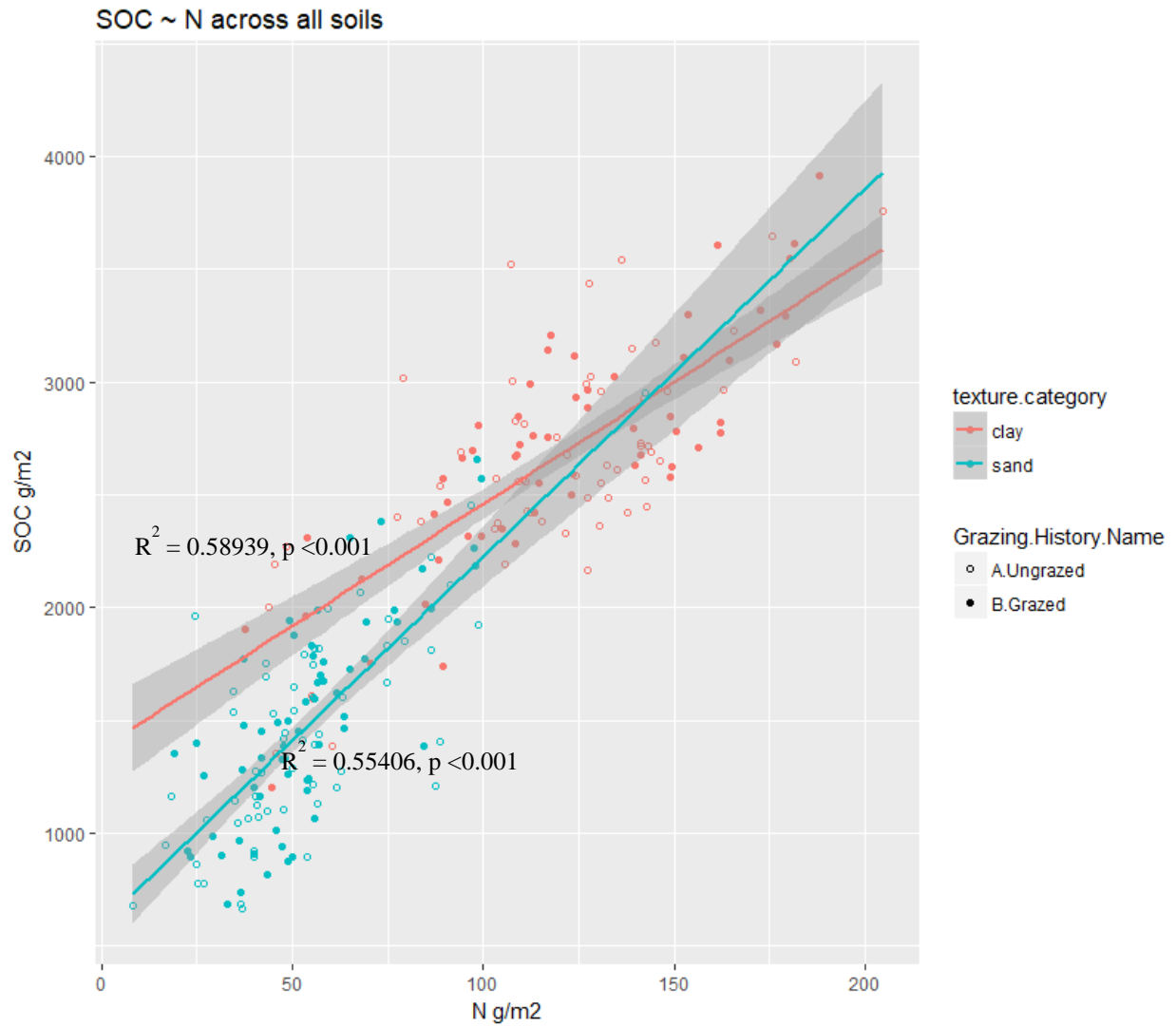


Figure S6. A linear regression evaluating the relationship between nitrogen and soil organic carbon. The slopes were significantly different from each other. The clay-rich, wetter sites had a higher R² value compared to the sandy, dry sites.

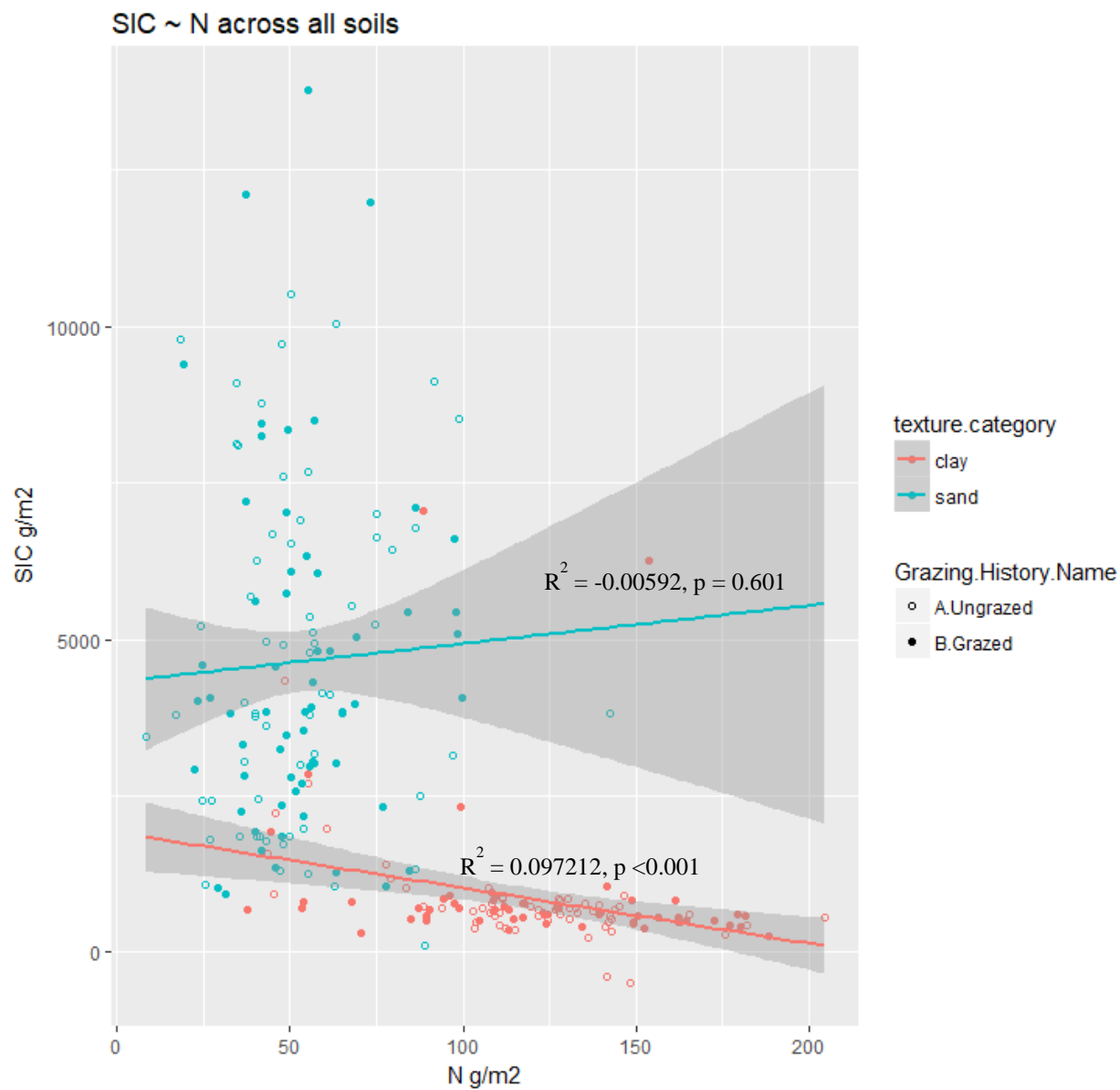


Figure S7. A linear regression evaluating the relationship between nitrogen and soil organic carbon. The slopes were significantly different from each other. The clay-rich, wetter sites had a higher R^2 value compared to the sandy, dry sites.

APPENDIX C:
SUPPLEMENTARY TABLES

SOC GLM	SOC ~ Texture + C4 Grasses + Roots + Grazing History + Depth + Grazing History*Depth + Depth*Texture + Grazing History * Texture
SIC GLM	SIC ~ Texture + C4 Grasses + Roots + Grazing History + Depth + Grazing History*Depth + Depth*Texture + Grazing History * Texture

Table S4. Table of the general linear models run for SOC and SIC. Depth, texture, and the interaction between depth and texture were all significant.

Source	N	F Ratio	Prob > F
Grazing.History	120	0.8551	0.3565
Depth	120	8.5985	0.0038*
Bufflo.Site	120	0.0058	0.9395
Texture	120	188.6915	<.0001*
Cleaned Root Weight (g)	120	1.0513	0.3065
%C4 Grass	120	3.8623	0.0508
Bufflo.Site*Grazing.History.Name	120	0.0022	0.9631
Grazing.History*Depth	120	1.3783	0.2421
Texture*Depth	120	34.0782	<.0001*
Grazing.History*Texture	120	0.0000	0.9953

Table S5. F-ratios from general linear model of soil organic carbon. Significant effects and interactions are indicated

Source	Nparm	DF	DFDen	F Ratio	Prob > F
Grazing.History	1	1	143.9	0.0005	0.9818
Depth	1	1	161.7	50.2967	<.0001*
Bufflo.Site	1	1	39.8	0.1524	0.6983
Texture	1	1	130.3	34.7129	<.0001*
Cleaned Root Weight (g)	1	1	167.6	1.5389	0.2165
%C4 Grass	1	1	170.7	0.0051	0.9433
Grazing.History*Depth	1	1	143.8	0.8242	0.3655
Texture*Depth	1	1	154.4	63.9769	<.0001*
Grazing.History*Texture	1	1	145.9	0.9216	0.3386
Bufflo.Site*Grazing.History	1	1	143.9	0.0356	0.8506

Table S6. F-ratios from general linear model of soil inorganic carbon. Significant effects and interactions are indicated..

Source	Nparm	DF	DFDen	F Ratio	Prob > F
C4Grass	1	1	95.7	6.4289	0.0128*
Grazing.History	1	1	57.31	1.6509	0.2040
Buffalo.Sites*Grazing.History	1	1	56.06	0.0949	0.7592
Buffalo.Sites	1	1	59.6	3.6071	0.0624
Surface.Texture	1	1	104	195.7720	<.0001*
Surface.Roots	1	1	84.5	4.9044	0.0295*

Table S7. F-ratios from general linear model of surface soil organic carbon. Significant effects and interactions are indicated

Source	Nparm	DF	DFDen	F Ratio	Prob > F
C4Grass	1	1	107.4	0.0412	0.8395
Grazing.History	1	1	54.24	0.4189	0.5202
Buffalo.Sites*Grazing.History	1	1	52.78	0.0421	0.8383
Buffalo.Sites	1	1	56	1.7168	0.1955
Surface.Texture	1	1	96.95	42.3726	<.0001*
Surface.Roots	1	1	96.21	3.8499	0.0526

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Grazing.History	1	1	1048365	0.7637	0.3840
C4.Grass	1	1	96514	0.0703	0.7914
Surface.Roots	1	1	5669400	4.1301	0.0444*
Surface.Texture	1	1	72454952	52.7829	<.0001*

Table S8. F-ratios from general linear model of surface soil inorganic carbon. Significant effects and interactions are indicated. The first model is the first run. Buffalo sites were removed from the second model because the effects were not significant.

Source	Nparm	DF	DFDen	F Ratio	Prob > F
Subsurface.Texture	1	1	98.94	88.8755	<.0001*
Grazing.History	1	1	57.99	0.0122	0.9124
Subsurface.Roots	1	1	91.41	4.1587	0.0443*
C4.Grass	1	1	94.38	0.0034	0.9536
Buffalo.Sites	1	1	63.06	9.8915	0.0025*
Buffalo.Sites*Grazing.History	1	1	58.08	0.0005	0.9819

Table S9. F-ratios from general linear model of subsurface soil organic carbon. Significant effects and interactions are indicated

Source	Nparm	DF	DFDen	F Ratio	Prob > F
Subsurface.Texture	1	1	99.22	44.5744	<.0001*
Grazing.History	1	1	55.58	1.2160	0.2749
Subsurface.Roots	1	1	86.49	2.9370	0.0902
C4.Grass	1	1	89.78	2.7872	0.0985
Buffalo.Sites	1	1	60.94	0.1934	0.6617
Buffalo.Sites*Grazing.History	1	1	55.72	0.2457	0.6221

Table S10. F-ratios from general linear model of subsurface soil inorganic carbon. Significant effects and interactions are indicated.

Source	Nparm	DF	DFDen	F Ratio	Prob > F
Grazing.History	1	1	57.73	6.5103	0.0134*
Surface.Texture	1	1	66.68	65.9242	<.0001*
Surface.Texture*Grazing.History	1	1	64.29	0.0123	0.9120

Table S11. F-ratios from general linear model for C₄ grasses. Significant effects and interactions are indicated