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NEON Site Level Plot Summary
Northern Great Plains (NOGP)

Document Information

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Site Background

The Northern Great Plains (NOGP) site is on the USDA-ARS Northern Great Plains Research Laboratory facility near Mandan, North Dakota. The site is located on the eastern edge of Major Land Resource Area (MLRA) 54 – Rolling Soft Shale Plain. The site consists of 1,463 acres of rangeland located about two miles west of the Missouri River. This site is situated on an old high terrace above the Missouri River and encompasses the steep upland residual hills and ridges adjoining the old river terrace.

Site Information

The parent materials at the NOGP site are primarily residuum from marine sandstone and shale and local alluvium derived from the Cannonball Formation, one of the lower formations of the Paleocene age Fort Union Group. Higher areas near the Missouri River are still capped with silty loess deposited by wind after the last retreat of the glaciers before vegetation established and stabilized the surface. Elevation ranges from approximately 1650 feet to 1950 feet above sea level.

Land use is dominated by rangeland for grazing livestock. Steep wooded draws and coulees also provide wildlife habitat and cover. Plant communities are dominated by perennial grasses and forbs. The site has a long history of agricultural use, so most of the grasses are introduced species. Native forbs and some native grass species are common throughout the site. Soils on the site represent soil series developed in residuum (Cabba, Chama, Amor, Morton, Sen, and Janesburg), and alluvium (Savage, Grail, Parshall, Golva, and Farnuf), along with series formed in loess over glacial till (Temvik and Wilton). The residual and loess soils occur on ridge tops, shoulders, backslopes, and toeslopes. The alluvial soils are in shallow drainageways and lower toeslopes.

Analysis of Plots for Sampling

Soil map unit, landform, landform position, and lack of existing data on particular soil series were considered for selecting sampling plots. The landforms identified on the NOGP site were hills, ridgetops, shoulders, backslopes, and alluvial foot slopes and toe slopes, shallow drainageways, and stream (gravel) terraces. The soil survey of the site contained 41 map units. The sampling plots occurred in only 12 of the map units. The initial analysis resulted in 18 plots being selected for field description, sampling, and lab characterization. The 16 plots not sampled

were either duplicates of the selected plots or had named components that were similar to the plots selected. Roughly 36 percent of the NOGP site (70% of the site's total map units) consisted of map units that were not sampled (Table 1). The sampled map units represent approximately 64 percent of the NOGP site area (30% of the site's total map units, Table 2).

Map Unit Symbol	Map Unit Name	% Total Site
E0605A	Belfield-Grail clay loams, 0 to 2 percent slopes	0.07
E0617B	Belfield-Savage-Daglum complex, 2 to 6 percent slopes	0.89
E0623B	Grail-Belfield clay loams, 2 to 6 percent slopes	0.68
E0651C	Regent-Janesburg complex, 6 to 9 percent slopes	4.17
E0701F	Dogtooth-Janesburg-Cabba complex, 6 to 35 percent slopes	0.96
E0837B	Savage silty clay loam, 2 to 6 percent slopes	1.23
E0913D	Moreau-Wayden silty clays, 9 to 15 percent slopes	1.16
E1805B	Lihen-Parshall complex, 0 to 6 percent slopes	0.27
E1865B	Tally-Parshall fine sandy loams, 2 to 6 percent slopes	0.89
E1865C	Tally-Parshall fine sandy loams, 6 to 9 percent slopes	0.48
E1875E	Telfer loamy fine sand, 15 to 25 percent slopes	3.83
E2107A	Arnegard loam, 0 to 2 percent slopes	0.34
E2203B	Farland silt loam, 2 to 6 percent slopes	0.21
E2203C	Farland silt loam, 6 to 9 percent slopes	1.50
E2737C	Chama-Cabba-Sen silt loams, 6 to 9 percent slopes	0.75
E2801A	Amor-Arnegard loams, 0 to 3 percent slopes	0.55
E2927B	Morton-Farland silt loams, 3 to 6 percent slopes	0.68
E2931C	Morton-Cabba silt loams, 6 to 9 percent slopes	2.46
E2987B	Sen-Chama silt loams, 3 to 6 percent slopes	0.82
E3541C	Williams-Zahl loams, 6 to 9 percent slopes	0.27
E3555D	Zahl-Williams loams, 9 to 15 percent slopes	1.37
E3567F	Zahl-Max loams, dissected, 15 to 45 percent slopes	1.98
E3625B	Williams-Reeder loams, 3 to 6 percent slopes	0.62
E3763B	Temvik-Wilton-Williams silt loams, 3 to 6 percent slopes	3.69

E4139A	Korchea-Fluvaquents complex, channeled, 0 to 2 percent slopes, frequently flooded	1.03
E4553B	Tally fine sandy loam, gravelly substratum, 2 to 6 percent slopes	1.16
E4569F	Wabek-Cabba-Shambo complex, 6 to 35 percent slopes	3.21
E4581A	Parshall, gravelly substratum-Manning fine sandy loams, 0 to 2 percent slopes	0.07
E4585B	Manning fine sandy loam, 2 to 6 percent slopes	0.48
	% Total Area	**35.82**

Table 1. Identities and areal coverage of soil map units that were present at the NOGP site and were not sampled. Percent total site calculated based on the TOS sampling boundary, which may be less than the total site boundary area.

Map Unit	Map Unit Name	% Total Site
E0651B	Regent-Janesburg complex, 3 to 6 percent slopes	2.05
E0811A	Grail silty clay loam, 0 to 2 percent slopes	1.57
E0837C	Savage silty clay loam, 6 to 9 percent slopes	1.57
E1025C	Regent-Savage silty clay loams, 6 to 9 percent slopes	1.98
E1823A	Parshall fine sandy loam, 0 to 2 percent slopes	0.34
E1875D	Telfer loamy fine sand, 6 to 15 percent slopes	3.01
E2601C	Amor-Cabba loams, 6 to 9 percent slopes	0.96
E2601D	Amor-Cabba loams, 9 to 15 percent slopes	6.97
E2617F	Cabba-Chama-Shambo loams, 9 to 50 percent slopes	30.14
E2741D	Cabba-Chama-Sen silt loams, 9 to 15 percent slopes	2.94
E3755A	Temvik-Wilton silt loams, 0 to 3 percent slopes	12.24
E4555D	Wabek-Manning complex, 6 to 15 percent slopes	0.41
	% Total Area	**64.18**

Table 2. Identities and areal coverage of soil map units that were present at the NOGP site and were sampled.

Most of the selected plots are representative of one of the major or minor components or are a similar soil to one of the components in the map units in which they occur. They fall within the Range in Characteristics (RIC) of the individual component and typically occur on the landform position associated with that component in the map unit. One of the selected sample plots (NOGP_024) was a residual soil capped with loess, and was not representative of the Janesburg soil series in MLRA 54.

Variability in the soils and parent materials is a primary characteristic of the development of residual soils in MLRA 54, as such the NEON spatial design did not consistently allocate plots in the soil series that typically correspond to the variety of landform positions within the residual map units on the NOGP site. The site is on the far eastern edge of the MLRA 54, which is dominated by residual soils and is transitioning into MLRA 55B that is dominated by glacial till parent materials. The selected soils do accurately establish and represent the overall variability of the soils at the NOGP location.

Plot Findings

The 18 pedons sampled represent 12 soil map units and a variety of shallow and moderately deep residual soils and deep and very deep alluvial soils derived from residual parent materials. All plots sampled were in rangeland for grazing and dominated by plant communities of grasses and forbs.

Landforms and Parent Materials - Plots NOGP_012, NOGP_017, NOGP_021, NOGP_023, NOGP_024, and NOGP_030 are soils formed in residuum. Plot NOGP_024 was capped with 50 cm of loess, so was not typical of the named soil. Plots NOGP_001, NOGP_003, NOGP_008, NOGP_009, NOGP_015, NOGP_022, and NOGP_028 formed in alluvium derived from residuum. Plots NOGP_006, NOGP_018, NOGP_025, and NOGP_041 formed in loess over glacial till. Plot NOGP_014 developed on a river terrace from relatively recently deposited sandy and gravelly alluvium. Sampled plots were 44% alluvium, 34% residuum, and 22% loess over till.

Summary of Soils

Except for one shallow Entisol (Cabba), all the soils sampled at the NOGP site were prairie grassland Mollisols with dark mollic surface horizons ranging from 18 to 89 cm thick. The sampled soils generally follow the soil-landscape relationships based on the soil forming factors, and are typical of residual soils and their corresponding landform positions in MLRA 54. Paralithic sedimentary sandstone, siltstone, mudstone, and shale beds are the parent materials from which residual soils in MLRA 54 have developed. Shallow soils typically occur on convex shoulder slopes and have paralithic sedimentary beds between 25 and 50 cm from the soil surface. Moderately deep soils on back slopes and side slopes have the paralithic sedimentary beds between 50 and 100 cm. Deep soils on the foot slopes of these erosional landforms have paralithic sedimentary beds between 100 and 150 cm, and very deep soils on toeslopes and in drainageways have beds below 150 cm.

A moderately deep, fine-silty calcareous Chama (NOGP_021) was described and sampled in a delineation of Wabek-Manning complex, 6 to 15 percent slopes on the narrow top of a steep ridge that is the drainage divide between two small watersheds. Chama is a minor component in this map unit that is typically mapped on gravelly stream terraces.

Shallow soil components like the loamy Cabba (NOGP_023) series develop on steep, convex shoulder slopes of upland ridges and hills. This plot was near the edge of a Grail silty clay loam, 0 to 2 percent slopes delineation. This delineation had inclusions of steeper slopes and included the side slopes of the ridge. The soil identified within the targeted area was a shallow Cabba.

Moderately deep soil series develop on the side slopes and back slopes of residual landforms in MLRA 54. Soil textures range from fine-silty and fine-loamy to fine-textured. On gentler, more stable slopes less than 9%, many of these moderately deep soils have an increase in clay content in the subsoil and have developed an argillic horizon like the fine-silty Morton silt loam inclusion (NOGP_012) sampled in a delineation of fine-textured Regent-Savage silty clay loams, 6 to 9 percent slopes.

A natric horizon developed in the Janesburg pedon (NOGP_024) sampled in the Regent-Janesburg complex, 3 to 6 percent slopes map unit. The sedimentary parent materials in MLRA 54 are dominantly Tertiary coastal plain sediments and contain significant amounts of sodium and sulfate salts. Natric soils are extensive throughout the MLRA, and the Janesburg series (NOGP_024) that was sampled in a delineation of Regent-Janesburg complex, 3 to 6 percent slopes is severely sodium-affected. In MLRA 54, natric soils develop from soft, sodium-affected, residual sedimentary beds or alluvium derived from those soft, sodium-affected, residual sedimentary beds. This plot is not typical of sodium-affected soils in MLRA 54, since it is capped with 50 cm of loess over the natric horizon.

On steeper, more unstable slopes greater than 9%, clay has not translocated in moderately deep soils and they typically have not formed argillic horizons. The moderately deep, fine-silty Sen series (NOGP_017) and the moderately deep, fine-loamy Amor series (NOGP_030) develop on side slopes of upland ridges and hills in MLRA 54 and are components in the catena of soils described by the Cabba-Chama-Shambo loams, 9 to 50 percent slopes map unit. Both Sen and Amor have similar soil properties as the named components in that map unit.

Deep and very deep alluvial soils developed on the lower backslopes and erosional footslopes and toe slopes at the base of these upland residual landforms. The most common soil series sampled (3 samples) was the fine-textured Savage series on lower back slopes and foot slopes. Savage was the targeted soil series on NOGP_003 in a delineation of Savage silty clay loam, 6 to 9 percent slopes. The Savage components sampled on NOGP_009 and on NOGP_015 are minor components on foot slopes of steeper, upland hills and ridges that were mapped Amor-Cabba loams, 9 to 15 percent slopes and Cabba-Chama-Shambo loams, 9 to 50 percent slopes, respectively.

The fine-silty Golva series (NOGP_008) and the fine-loamy Farnuf series (NOGP_022) also developed on the same landform positions as Savage, but are derived from parent materials with less shale and more siltstone and sandstone, respectively. Golva is a component in the catena of soils described by the Cabba-Chama-Shambo loams, 9 to 50 percent slopes map unit and has similar soil properties as the named components in that map unit. Farnuf is considered a similar soil to Savage and is a lighter-textured minor component on the foot slopes in the fine-textured Regent-Savage silty clay loams, 6 to 9 percent slopes map unit.

Very deep soils were described and sampled in the shallow drainageways that cross the upland plains landscape that is characteristic of MLRA 54. Both the coarse-loamy Parshall series (NOGP_001) and the fine-textured Grail series (NOGP_028) are pachic soils that develop in overflow positions on the landscape. Parshall was described and sampled in a shallow drainageway in a delineation of Parshall fine sandy loam, 0 to 2 percent slopes and was the targeted soil for that plot. The fine-textured Grail is an inclusion in the Amor- Cabba loams, 6 to 9 percent slopes map unit, and typically develops in shallow drainageways and run-on positions in that map unit.

The Temvik, Wilton, and Bryant series are all very deep, fine-silty loess over till soils that developed on the bluffs high above the Missouri River after it makes the turn in central North Dakota and begins flowing southward. This silty loess is assumed to have been blown in at the end of the last Ice Age after the glacier re-routed the Missouri River to flow south along the glacier's edge. The prevailing northwest winds deposited the loess on top of the till after the glacier retreated and before vegetation had a chance to establish and stabilize the surface.

Redoximorphic features are common in the glacial till horizons in these soils and in the horizon directly above the discontinuity, and form when subsurface water flows laterally on top of the dense glacial till parent material. These loess capped areas are of small extent in MLRA 54 and unique to the high bluffs along the Missouri River on the eastern side of the MLRA. The Temvik (NOGP_006) and Wilton (NOGP_018 and NOGP_025) soils were all described and sampled in delineations of Temvik-Wilton silt loams, 0 to 3 percent slopes, and were the targeted soils on those plots. In the silty loess over till catena of soils in MLRA 54, Temvik is the typic component on the slight rises and Wilton is the pachic component that developed in the low areas of the landscape.

Bryant (NOGP_041) was described and sampled in a delineation of the residual Amor-Cabba loams, 9 to 15 percent slopes map unit, but this area was underlain by glacial till, so the soil was described as Bryant. Bryant typically has more sand in the surface and upper horizons than Temvik and Wilton, and is an inclusion in the Temvik-Wilton silt loams, 0 to 3 percent slopes map unit.

The sandy Schaller series (NOGP_014) was described and sampled in a delineation of the residual Telfer loamy fine sands, 6 to 15 percent slopes map unit, but the landform was a gravelly river terrace above the Heart River near its confluence with the Missouri River. Schaller is very deep and develops on relatively recently deposited sandy or gravelly alluvium on river terraces, so is a more suitable soil series for use on this gravelly river terrace landform. Field estimated clay content ranges from 2 to 8 percent throughout the profile and drainage is excessively well drained. All the other soils that were described and sampled at the NOGP site were well drained.