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NEON Site-Level Plot Summary
Guanica Dry Forest (GUAN)

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Site Background

The Guánica State Forest (Spanish: Bosque Estatal de Guánica) is a subtropical dry forest located in southwest Puerto Rico. The temperatures in the forest are, on average, around 80 °F (27 °C) in shaded areas and 100 °F (38 °C) in exposed areas. The average annual rainfall is 791 millimeters (31.1 in). Approximately half of Puerto Rico's birds and nine of sixteen endemic bird species occur in the Guánica State Forest, including the Puerto Rican woodpecker, the Puerto Rican lizard cuckoo and the Puerto Rican emerald hummingbird, as well as the critically endangered Puerto Rican nightjar. The vegetation in the forest is divided into three main groups: upland deciduous forest (which occupies 23.5 square kilometers or 9.1 square miles), semi-evergreen forest (7.2 square kilometers or 2.8 square miles), and scrub forest (5.8 square kilometers or 2.2 square miles). Similar to other insular dry forests**,** species diversity is low; between 30 and 50 tree species are found per ha. There are more than 700 plant species, of which 48 are endangered and 16 are endemic to the forest. The reserve is home to numerous reptiles and amphibians, including the indigenous coquí – several species of tiny frogs endemic to Puerto Rico and the Virgin Islands. Named for the sound they make, the common coquí is widely accepted as the unofficial symbol of Puerto Rico. Due to its biodiversity and climatic conditions**,** this forest is considered the best preserved, subtropical forest and the best example of dry forest in the Caribbean. The site is in the South Coast Dry Forest of the Island of Puerto Rico. The forest covers part of three counties; Guánica, Yauco, and Guayanilla. The Guánica State Forest & Biosphere Reserve encompasses almost 8,629.54 acres and is maintained by the Department of Natural and Environmental resources. The area was designated as a forest reserve in 1919; In 1981 it was designated as a United Nations International Biosphere Reserve in recognition of the efforts to conserve natural processes and resources in the forest.

Latitude: 17° 58' 6.125" N (17.968368); Longitude: 66° 51' 47.200" W (-66.863111); Elevation ranges from sea level to 250 meters; Datum: WGS 1984.

Site Information

The Guánica NEON site (GUAN) has relatively high relief, distinct landforms, uniform geology, and relatively detailed soil mapping. GUAN is within MLRA 271 (Semiarid Mountains and Valleys) in the southern portion of Guánica and consists of 8,629.54 acres. For sampling purposes,

the west part of the reserve (Monte de la Brea) was not included. The area marked for sampling by NEON covered approximately 7,181 acres. Within the sampling area, the dominant bedrock is limestone from Juana Diaz and Ponce geologic formations. The process that generates the parent material for soil is basically controlled by the interaction of three factors: (1) the physical and chemical nature of the rock or substratum, (2) the geomorphic position in the landscape, and (3) the climatic conditions. Based on these attributes, the soil was mostly derived from residuum and colluvium from limestone bedrock. Areas underlain by limestone typically show surface features that indicate the more soluble rock type is underneath, such as caves or sinkholes. However, these features are lacking in this area and are usually due to the presence of tertiary limestones as well as the scarcity of precipitation in the southwest area of the island due to the rain shadow effect of the Cordillera Central.

The Juana Diaz and Ponce limestone in the semiarid area typically weathers to a shallow carbonic regolith. In many places, however, it is capped by a hard and impermeable layer of secondary carbonates at shallow depths. This cap hampers weathering and results in shallow and coarse fragmental matrix soils.

Landforms identified on the NEON Guánica site were residuum ridgetops, shoulder slopes, and back slopes as well as colluvium foot slopes, fans and low stream terraces. The difference between the mean summer soil temperature and mean winter soil temperature is 4.2 degrees F at a depth of 12 inches. These temperatures are representative of an isohyperthermic soil temperature regime. Land use is predominately forest land with inclusions of pastures.

In general, soils on the site were dominated by shallow to moderately deep soils. The shallow ones were clayey to clayey skeletal and the moderately deep were fine loamy to coarse loamy. Major soil series on the site are predominately Pitahaya, Seborruco, Tuque and La Covana. All are Aridisols. These soils are carbonatic and mixed and are typically considered well suited for forestland and wildlife habitat and are unsuited for agriculture use.

Analysis of Plots for Sampling

Existing data on the soils, geology and landforms were used to determine which NEON plots to sample. These three features were identified for each plot. Plots that represented a unique setting were identified and chosen for sampling. Where multiple plots occurred in the same setting, plot access was considered to choose the sample plot. Soil mapping consisted of 28 different map units (including water), but the NEON pre-determined plots available for sampling were located in only five map units. The analysis resulted in 18 plots being selected for sampling with five chosen for alternates. The alternate plots were selected as replacements for selected plots to insure the soil variability was captured for the site. Overall, the Guánica plots were well distributed. A summary of the plots and corresponding soil conditions is below:

- 8 plots in PsF – Pitahaya-Limestone outcrop-Seboruco complex, 40 to 60 percent slopes. Approximately 3,941 acres (28% of the plots).
- 5 plots in TuF – Tuque stony clay loam, 12 to 60 percent slopes, approximately 1,373 acres (17% of the plots). Based upon conversations with former soil survey staff (Carmen Santiago, Jorge Lugo and Greg Brannon) this map unit has a potential to be re-correlated

to Pitahaya-Limestone outcrop-Seboruco complex. Information and observation from the NEON sampling will be valuable for Soil Survey update in the region.

- 11 plots in LcE – La Covana-Limestone outcrop-Seboruco complex, 12 to 20 percent slopes. Approximately 2,018 acres (39% of the plots).
- 1 plot in MoC – Montalva clay, 5 to 12 percent slopes. Approximately 129 acres (4% of the plots).
- 3 plots SoC – Seboruco silty clay loam, 2 to 12 percent slope. Approximately 436 acres (12% of the plots).

Guánica Forest Soil Map Units

Approximately 11% of the GUAN site contains soil map units that were not sampled. These include:

Map unit symbol	Map Unit Name	% Total site area
AhF	Aguilita gravelly clay loam, 12 to 20 percent slopes	**1**
BhB	Bahia Salinas sand, 0 to 5 percent slopes, rarely flooded	**0**
BkB	Beaches, sand, 0 to 5 percent slopes	**0**
CkF	Cerro Mariquita gravelly clay loam, 20 to 60 percent slopes	**0**
CoF2	Callabo silty clay loam, 40 to 60 percent slopes eroded	**0**
CuD	Costa-Pitahaya complex, 5 to 20 percent slopes	**0**
CuF	Costa-Pitahaya complex, 20 to 60 percent slopes	**1**
EpC	El Papayo gravelly clay loam, 2 to 12 percent slopes	**0**
EpF	El Papayo gravelly clay loam, 20 to 60 percent slopes	**1**
GyC	Guayacan clay, 5 to 12 percent slopes	**0**
JaC	Jacana clay, 5 to 12 percent slopes	**0**
MDA	Manglillo, Boqueron and Serrano soils, very frequently flooded	**0**
Mr	Meros sand	**0**
PsG	Limestone outcrop-Seboruco complex, 60 to 90 percent slopes	**2**
Pt	Pits and Quarries	**0**
PzB	Pozo Blanco clay, 0 to 5 percent slopes	**0**
Sa	Salt flats, ponded	**0**
SoC	Seboruco silty clay loam, 2 to 12 percent slopes	**6**
Tf	Tidal flats	**0**
TuF	Tuque stony clay loam, 12 to 60 percent slopes	**0**
Ua	Urban land	**0**
W	Water >40 acres	**0**
YcB	Yauco silty clay loam, 2 to 5 percent slopes	**0**
	Total	**11**

Sampled units represent approximately 88% of the GUAN site area. These include:

Map unit symbol	Map Unit Name	% Total site area
LcE	La Covana-Limestone outcrop-Seboruco complex, 12 to 20 percent slopes	29
MoC	Montalva clay, 5 to 12 percent slopes	2
PsF	Pitahaya-Limestone outcrop-Seboruco complex, 40 to 60 percent slopes	36
TuF	Tuque stony clay loam, 12 to 60 percent slopes	20
	Total	**88**

Details of plot selection decisions

The following plots were sampled due to their locations within the existing map unit boundary and their potential to capture the variability of the soil conditions at the Guanica Dry Forest**:**

GUAN_014; GUAN_020; GUAN_022; GUAN_008; GUAN_009; GUAN_024; GUAN_023; GUAN_004; GUAN_001; GUAN_012; GUAN_006; GUAN_016; GUAN_003; GUAN_015; GUAN_017.

GUAN_002: Plot selected for sampling as an alternate to Plot 021. 021 was rejected due limestone outcropping covering 100% of the area. This simply would not allow the team to sample the plot. The NRCS staff discovered this during the site assessment phase of this project and recommended to the Domain Manager that an alternative plot be considered. The NEON Technician present during the initial investigation agreed with soil staff recommendations. The issue was discussed with the NEON domain manager (Mgr D04) and all agreed to this change.

GUAN_010: This plot was originally chosen as an alternate site for GUAN_016 or GUAN_015.

GUAN_013: This plot was chosen as an alternate to GUAN_048, which was rejected in the field. GUAN_048 was located in the NEON tower airshed and was required to be sampled using a soil auger method. According to our assessment, GUAN_048 had approximately 85 percent coarse fragments with sizes between 0.5 inches to 10 inches. Using a soil auger to do the sampling for This plot was therefore not possible. Also, the team would not have been able to obtain even an estimated fragment count using the auger method.

The following plots were selected as alternates and not sampled:

GUAN_005: This plot was selected as an alternate to GUAN_016, which was sampled.

GUAN_011: Plot was selected as an alternate site to GUAN_015, which was sampled.

GUAN_018: Plot was selected as an alternate site to GUAN_003, which was sampled.

GUAN_019: Plot was selected as an alternate to GUAN_006, which was sampled.

The following NEON plots were not selected for sampling:

GUAN_042: The plot was deemed redundant and therefore not necessary since numerous other plots in the same soil conditions had been selected.

GUAN_043: The plot was deemed redundant and therefore not necessary since numerous other plots in the same soil conditions had been selected.

GUAN_048: Plot was rejected in the field. The plot is located within the tower airshed and is therefore limited to sampling using a soil auger method. According to our assessment, this plot has approximately 85 percent coarse fragments with sizes between 0.5 inches to 10 inches. Using a soil auger for sampling was therefore not possible. Also, the team would not have been able to obtain even an estimated fragment count using the auger method. An alternate plot (GUAN_013) was selected.

GUAN_049: Plot was not selected for sampling due to it being located within the tower airshed and the restrictions of only using hand augers to sample with.

GUAN_021: This plot was rejected in the field due limestone outcropping covering 100% of the area; GUAN_002 was selected for sampling as an alternate.

GUAN_007: Plot was rejected during the evaluation process. The plot was deemed redundant and therefore not necessary since numerous other plots in the same soil conditions had been selected.

Plot Findings

The 18 pedons sampled represent four soil map units (Table 1). The area of the sampling is mostly complex and dominated by different soil components, depending of the landform position. The major components are Tuque, Pitahaya, Seboruco, La Covana, and Montalva and the minor components are Costa, Altamira, El Papayo and Melones. Results from the field sampling and observations sometimes showed soils that differed from those indicated on the soil survey. The parent material for the soils sampled consisted of 95% residuum and 5% colluvium.

All sampled sites were forested. Because these soils were under the forest canopy, they were generally covered by a very thin organic (or duff) layer that was too thin to describe or sample.

Table 1. NEON plot-level soil map unit and vegetation cover.

Plot ID	Cover Kind	Map Unit	Map Unit Name	Correlated name from sampling/field observations	Reasoning for not finding named major component
GUAN_001	Tree cover	LcE	La Covana-Limestone outcrop-Seboruco complex, 12 to 20 percent slopes	Tuque	Tuque was not recognized as a minor component and finding this soil is unexpected. But is very similar to La covana soil. Difference: Tuque is clayey, have less than 35% of coarse fragments in the control section.
GUAN_002	Tree cover	TuF	Tuque stony clay loam, 12 to 60 percent slopes	Pitahaya	Pitahaya was not recognized as a minor component and finding this soil is unexpected. Difference: Pitahaya is clayey-skeletal.
GUAN_003	Tree cover	PsE	Pitahaya-Limestone outcrop-Seboruco complex, 40 to 60 percent slopes	La Covana	La Covana is a minor component (5%) in the PsF map unit and finding this soil is expected. Difference: La Covana have a petrocalcic horizons between 15 to 50 centimeters.
GUAN_004	Tree cover	LcE	La Covana-Limestone outcrop-Seboruco complex, 12 to 20 percent slopes	Seboruco	N/A
GUAN_006	Tree cover	PsF	Pitahaya-Limestone outcrop-Seboruco complex, 40 to 60 percent slopes	La Covana	La Covana is a minor component (5%) in the PsF map unit and finding this soil is expected. Difference: La Covana have a petrocalcic horizons between 15 to 50 centimeters.
GUAN_008	Tree cover	TuF	Tuque stony clay loam, 12 to 60 percent slopes	Seboruco	This soil and plot was correlated to Seboruco-like and finding this soil is unexpected. Difference: Seboruco has an argillic horizon but is shallow to bedrock. Less soil development.

Plot ID	Cover Kind	Map Unit	Map Unit Name	Correlated name from sampling/field observations	Reasoning for not finding named major component
GUAN_009	Tree cover-Multi-story show evidence of grazing activity.	MoC	Montalva clay, 5 to 12 percent slopes	Montalva	N/A
GUAN_010	Tree cover	LcE	La Covana-Limestone outcrop-Seboruco complex, 12 to 20 percent slopes	La Covana	N/A
GUAN_012	Tree cover	PsF	Pitahaya-Limestone outcrop-Seboruco complex, 40 to 60 percent slopes	La Covana	La Covana is a minor component (5%) in the PsF map unit and finding this soil is expected. Difference: La Covana have a petrocalcic horizons between 15 to 50 centimeters.
GUAN_013	Tree cover	TuF	Tuque stony clay loam, 12 to 60 percent slopes	Pitahaya-like	Pitahaya was not recognized as a minor component and finding this soil is unexpected. Difference: Pitahaya is clayey-skeletal and have a have a lithic contact between 50 to 76 centimeters.
GUAN_014	Tree cover	PsF	Pitahaya-Limestone outcrop-Seboruco complex, 40 to 60 percent slopes	Pitahaya-like	Pitahaya was not recognized as a minor component and finding this soil is unexpected. Difference: Pitahaya is clayey-skeletal
GUAN_015	Tree cover	LcE	La Covana-Limestone outcrop-Seboruco complex, 12 to 20 percent slopes	Altamira	Altamira was not recognized as a minor component and finding this soil is expected due to the parent material source is present in the sampling area. Difference: Altamira is deep soil and is more weathered than the MU composition soils.

Plot ID	Cover Kind	Map Unit	Map Unit Name	Correlated name from sampling/field observations	Reasoning for not finding named major component
GUAN_016	Tree cover	LcE	La Covana-Limestone outcrop-Seboruco complex, 12 to 20 percent slopes	La Covana	N/A
GUAN_017	Tree cover	TuF	Tuque stony clay loam, 12 to 60 percent slopes	Pitahaya-like	Pitahaya was not recognized as a minor component and finding this soil is unexpected. Difference: Pitahaya is clayey-skeletal.
GUAN_020	Tree cover	PsF	Pitahaya-Limestone outcrop-Seboruco complex, 40 to 60 percent slopes	Seboruco	N/A
GUAN_022	Tree cover	TuF	Tuque stony clay loam, 12 to 60 percent slopes	La Covana	La Covana was not recognized as a minor component and finding this soil is unexpected. Difference: La Covana is clayey-skeletal.
GUAN_023	Tree cover	LcE	La Covana-Limestone outcrop-Seboruco complex, 12 to 20 percent slopes	Seboruco	N/A
GUAN_024	Tree cover	PsF	Pitahaya-Limestone outcrop-Seboruco complex, 40 to 60 percent slopes	Seboruco	N/A

Summary of Soils

Of the 18 plots sampled, 6 were La Covana (GUAN_003, 006, 010, 012, 016 and 022)(Table 1); 5 were Seboruco (GUAN_004, 008, 020, 023 and 024); 4 were Pitahaya (GUAN_002, 013, 014, 017); 1 was Tuque (GUAN_001); 1 Montalva (GUAN_009) and 1 was Altamira (GUAN_015).

La Covana, Altamira, Tuque, and Pitahaya are all very similar soils. All have clayey subsoils mixed with gravel and are weathered from limestone. All are found on ridgetops, summits, and upper side slopes. For explanation purposes, all soils will be compared to La Covana.

La Covana:

The La Covana series consists of shallow, well drained, very slowly permeable soils on ridge tops, summits and side slopes of the limestone hills of the Semiarid Mountains and Valleys MLRA. They formed in material that weathered from limestone bedrock. Slopes range from 12 to 40 percent.

La Covana taxonomic class: Clayey-skeletal, carbonatic, isohyperthermic Calcic Lithic Petrocalcids

Tuque is a La Covana with paralithic contact (Cr layer), meaning that the soil profile has layers of highly weathered limestone rock below the thin, clayey subsoil and petrocalcic layer where La Covana just has a petrocalcic layer. Altamira is like Tuque except it just has the Cr layer (paralithic) and no petrocalcic (Tuque without a petrocalcic layer).

Pitahaya is only dissimilar to La Covana in that it does not have a petrocalcic layer nor does it have paralithic contact (Cr layer). This changes the soil order of Pitahaya as well from being an Aridisol (like all other soils mentioned at this point) to an Entisol.

Seboruco is somewhat different from the previously mentioned soils. Seboruco is often found on side slopes and saddles adjacent to the above-mentioned soils. Seboruco is also weathered from shallow marine sediments that are over limestone bedrock. This gives the soil a more loamy texture where the other soils weathered from limestone have more clay. This makes Seboruco “fine-loamy”. Seboruco also lacks a petrocalcic layer.

Montalva is found down the hill or below the above-mentioned soils. Montalva is weathered from volcanic rocks that produce very heavy clays that are highly active (they shrink and swell as wetted and dried). This makes Montalva a Vertisol.

Montalva and Seboruco are deeper soils, meaning there’s more soil over the rock or petrocalcic layer. This often results in higher plant populations and higher suitability for plant growth. However, as noted above, the most prominent soils at Guanica are shallow. This factor, along with the obvious climatic factors, explains the “stunted” appearance of much of the vegetation seen at the site.