



NEON Site-Level Plot Summary

Pu'u Maka'ala Natural Area Reserve (PUUM)

Document Information

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Site Background

The Pu'u Maka'ala Natural Area Reserve (PUUM) is on windward, northeast-facing lava flows from Mauna Loa shield volcano on the Island of Hawaii. The natural area reserve is managed by the State of Hawaii, Division of Forestry and Wildlife, Department of Land and Natural Resources. It was established in 1981 to protect unique native rainforest, geologic features, and cultural resources for current and future generations. The koa and ohia rainforest of this reserve are important habitat for some of Hawaii's rarest birds and several rare plants. The NEON site within PUUM consists of 11,665 acres (Table 1).

Site Information

The PUUM site occurs in Major Land Resource Area (MLRA) 159 – Humid and Very Humid Volcanic Ash Soils on Low and Intermediate Rolling Mountain Slopes, MLRA 161A– Lava Flows and Rock Outcrops, and and MLRA 162– Humid and Very Humid Organic Soils on Lava Flows. MLRA 162 makes up 70 percent (8,149 acres) of the area and represents the majority of soils, geology, climate, and vegetation of the PUUM site.

Land use at PUUM is dominated by forest with a few areas cleared for pasture and general use. Plant communities are dominantly evergreen forest consisting of native rainforest tree species ohia, koa, hapuu, and kanawao. There are some areas of scrub/shrub land consisting of the native species ohia, pukiawe, lycopodium, and uluhe; grassland consisting of kikuyugrass, California, pangola and Wainaku grasses; and bare land on lava flows.

Mean annual air temperature ranges from 13.6-17.4°C and the site does not experience frost. Precipitation ranges between 2,032 and 7,112 mm. Site elevation ranges from 1,052 to 1,874 m. Soils and geology range from 200-30,000 years. The soils at the PUUM site (Table 1) have parent materials that consist of organic matter, basic volcanic ash and cinders over `a`a or pahoe-hoe lava flows. Landforms consist of lava flows, ash fields, and cinder cones.

Map Unit Symbol	Soil Map Unit Name	NEON Plots in Map Unit	Acres in Area	% Total Area
10	Lava flows, `a`a, 2 to 20 percent slopes	NONE	3.0	0.0
519	Lalaa very cobbly highly decomposed plant material, 2 to 10 percent slopes	PUUM_031*; PUUM_032*; PUUM_034*; PUUM_036*	1,303.1	11.2
602	Keamoku stony medial loam, 3 to 10 percent slopes	NONE	517.8	4.4
608	Kau-Lalo complex, 3 to 10 percent slopes	NONE	10.9	0.1
609	Piihonua hydrous silty clay loam, 20 to 35 percent slopes	NONE	200.4	1.7
610	Piihonua hydrous silty clay loam, 0 to 3 percent slopes	NONE	244.2	2.1
611	Kulani hydrous highly organic loam, 10 to 20 percent slopes	NONE	142.1	1.2
612	Kulani hydrous highly organic loam, 3 to 10 percent slopes	NONE	516.8	4.4
613	Kiloa extremely cobbly highly decomposed plant material, 3 to 10 percent slopes	PUUM_015*; PUUM_019	770.0	6.6
615	Kau hydrous silt loam, 3 to 10 percent slopes	PUUM_005; PUUM_006*; PUUM_008; PUUM_018; PUUM_020	911.5	7.8
616	Kahaluu highly decomposed plant material, 3 to 10 percent slopes	PUUM_001; PUUM_009; PUUM_010*; PUUM_014*; PUUM_017	1,135.1	9.7
617	Kaholimo medial silt loam, 3 to 10 percent slopes	NONE	912.5	7.8
621	Eheuiki-Pekailio complex, 3 to 10 percent slopes	NONE	2,467.7	21.2
622	Kopua-Makaala complex, 3 to 10 percent slopes	NONE	339.8	2.9
625	Hao medial loam, 3 to 10 percent slopes	NONE	191.8	1.6
626	Lalaa-Lava flows complex, 2 to 20 percent slopes	PUUM_012	522.9	4.5

627	Kahaluu-lava flows-Ainahou complex, 2 to 10 percent slopes	PUUM_002; PUUM_003; PUUM_011; PUUM_013	708.5	6.1
651	Keel slightly decomposed plant material, 3 to 10 percent slopes	PUUM_004*; PUUM_007*; PUUM_016	757.1	6.5
Totals for Area		24 Plots total 10 sampled	11,655.2	100.0

Table 1. Soil map units and areal coverages at PUUM site. Asterisk (*) denotes plots that were sampled.

Analysis of Plots for Sampling

NEON provided locations for 24 pre-selected plots (20 distributed plots and 4 tower plots) that occur in seven different soil map units with a total area of 6,108 acres. The pre-selected plots occur in MLRA 161A (3 plots) and MLRA 162 (21 plots). Soil landscape relationships were not considered when NEON identified the 24 pre-selected plots. Therefore, some map units within the site did not contain any pre-selected plots.

NRCS prioritized sampling at the seven map units that contain NEON plots with the highest areal coverages within the PUUM site. Due to the sensitive ecosystems and shallow soils located at the site, the sampling effort was limited to ten total plots. The NRCS selected 10 plots (Table 1) for sampling, and three (3) backup plots were selected in the event that one or more of these plots could not be sampled. The selected plots are located in map units that represent 47.9% of the PUUM site area and 80 percent (4,877 acres) of the map unit area in which the NEON plots are located. Plots chosen for sampling ensure a relatively even plot distribution across the site and are representative of the map unit delineations that exist on the site. Eleven plots that were not chosen for sampling were either in MLRA 161A or were not located in the most extensive map units at the site.

Summary of Soils

PUUM_004, User Site ID S2018001004: This plot occurs in map unit 651 - Keel slightly decomposed plant material, 3 to 10 percent slopes. This plot occurs in the same map unit delineation as PUUM_007 (S2018HI001007). The sampled soil was classified and identified as Kopua – Hydrous, ferrihydritic, isothermic, Lithic Hydrudands. This soil, as described in the field, is deeper and is considered to have more volcanic ash and less organic carbon than Keel soils, which are very shallow and organic. Kopua soils can be a dissimilar minor component in the map unit. These soils can occur together in the map unit on different hillslope positions and geographically due to proximity to volcanic ash sources like Kilauea Crater and Pu’u Maka’ala. After lab analyses, data may show that the samples have more organic carbon (>25 percent in the control section) than expected from field observations. It then may classify as Euic, isothermic, Lithic Udifolists, which is similar to Keel soils.

PUUM_006, User Site ID S2018001006: This plot occurs in map unit 615 - Kau hydrous silt loam, 3 to 10 percent slopes. The sampled soil was classified and identified as Kau taxadjunct – fragmental, isotic, isomesic, Typic Udorthents. This soil, as described in the field, is similar but

has less volcanic ash and more cobble size `a`a lava fragments than the typical Kau soil. Kau taxadjunct soils can be a similar component in the map unit, especially on young `a`a lava flows. These soils can occur together in the map unit on different hillslope positions. After lab analyses, data may show that the samples have more organic carbon (>25 percent in the control section) than expected from field observations. It then may classify as Euic, isomesic, Typic Udifolists. It may also be identified as Lalaau soil, which is a dissimilar minor component.

PUUM_010, User Site ID S2018001010: This plot occurs in map unit 616 - Kahaluu highly decomposed plant material, 3 to 10 percent slopes. This plot occurs in the same map unit delineation as PUUM_014 (S2018HI001014). The sampled soil was classified and identified as Kulani – Hydrous, ferrihydritic, isomesic, Typic Placudands. This soil, as described in the field, is deeper, has `a`a lava coarse fragments, is considered to have more volcanic ash and less organic carbon than Kahaluu soils, which are shallow, organic, and over pahoehoe lava. Kulani soils can be a dissimilar minor component in the map unit. These soils can occur in the map unit together on different hillslope positions and geographically due to proximity to volcanic ash sources like Kilauea Crater and Pu`u Maka`ala. After lab analyses, data may show that the samples have more organic carbon (>25 percent in the control section) than expected from field observations. It then may classify as Euic, isomesic, Typic Udifolists and may be identified as Lalaau soil, which is also a dissimilar minor component.

PUUM_014, User Site ID S2018001014: This plot occurs in map unit 616. This plot occurs in the same map unit delineation as PUUM_010. The sampled soil was classified and identified as Lalaau - Euic, isomesic, Typic Udifolists. This soil, as described in the field, is deeper and has `a`a lava coarse fragments. Kahaluu soils are shallow, organic soils over pahoehoe lava. Lalaau can be a dissimilar minor component in the map unit. These soils can occur in the map unit together on different hillslope positions.

PUUM_015, User Site ID S2018001015: This plot occurs in map unit 613 – Kiloa extremely cobbly highly decomposed plant material, 3 to 10 percent slopes. The sampled soil was classified and identified as Kopua – Hydrous, ferrihydritic, isothermic, Lithic Hydrudands. This soil, as described in the field, is considered to have more volcanic ash and less organic carbon than Kiloa soils, which are organic, extremely cobbly on the surface, and over `a`a lava. Kopua soils can be a dissimilar minor component in the map unit. These soils can occur together in the map unit on different hillslope positions and geographically due to proximity to volcanic ash sources like Kilauea Crater and Puu Makaala. After lab analyses, data may show that the samples have more organic carbon (>25 percent in the control section) than expected from field observations. It then may classify as Euic, isothermic, Lithic Udifolists and identified as Keei soil, which is also a dissimilar minor component.

PUUM_031, User Site ID S2018001031: This plot occurs in map unit 519 – Lalaau very cobbly highly decomposed plant material, 2 to 10 percent slopes. This plot occurs in the same map unit delineation as PUUM_033, PUUM_034, and PUUM_036. The sampled soil was classified and identified as Kulani – Hydrous, ferrihydritic, isomesic, Typic Placudands. This soil, as described in the field, has less aa lava coarse fragments, is considered to have more cinders, volcanic ash and less organic carbon than Lalaau soils, which are organic and very cobbly on the surface. Kulani soils can be a dissimilar minor component in the map unit. These soils can occur in the

map unit together on different hillslope positions and geographically due to proximity to volcanic ash sources like Kilauea Crater and Puu Makaala. After lab analyses, data may show that the samples have more organic carbon (>25 percent in the control section) than expected from field observations. It then may classify as Euic, isomesic, Typic Udifolists and be identified as similar to Lalaau soil.

PUUM_032, User Site ID S2018001032: This plot occurs in map unit 519, and occurs in the same map unit delineation as PUUM_031, PUUM_034, and PUUM_036. The sampled soil was classified and identified as Kahaluu taxadjunct – Euic, isomesic, micro Lithic Udifolists. This soil, as described in the field, is very shallow compared to Lalaau soils, which are deep to `a`a lava bedrock. Kahaluu taxadjunct soils can be a dissimilar minor component in the map unit. These soils can occur in the map unit together on different hillslope positions. The plant community at this plot differs from all other sample plots as it is more of scrub/shrub land consisting predominantly of native species ohia, pukiawe, lycopodium, and uluhe. The different plant community may be due to the relatively cooler, drier climate and very young age of the pahoehoe lava flow at this plot.

PUUM_034, User Site ID S2018001034: This plot occurs in map unit 519, along with plots PUUM_031, PUUM_032, and PUUM_036. The sampled soil was classified and identified as Lalaau – Euic, isomesic, Typic Udifolists. This soil, as described in the field, is not very cobbly on the surface but is considered similar to the major component due to the organic matter parent material and presence of some `a`a lava coarse fragments on the surface. These similar soils can occur in the map unit together on different hillslope positions.

PUUM_036, User Site ID S2018001036: This plot occurs in map unit 519, along with plots PUUM_031, PUUM_032, and PUUM_034. The sampled soil was classified and identified as Lalaau – Euic, isomesic, Typic Udifolists. This soil, as described in the field, is moderately decomposed plant material and not very cobbly on the surface; but, it is considered similar to the major component due to the presence of organic matter parent material and cobbles of `a`a lava coarse fragments in the soil profile. These similar soils can occur in the map unit together on different hillslope positions.

It was discussed and noted by NRCS soil scientists that the PUUM site and some sample plots had more volcanic ash than expected based on map units in the area. Some plots that were expected to be organic soil had highly organic volcanic ash horizons when described and sampled. The difference is difficult to discern in the field but lab data may show that some plots have more organic carbon and actually classify as organic soil (>25 percent organic carbon in the control section). Soils from organic matter and volcanic ash parent materials can occur together in complexes or as minor components within a map unit, especially on young lava flows. Map unit compositions such as these are common in Hawaii and the different soils can be found on different hillslope positions with no repeatable or discernable pattern. It is suggested, after lab data becomes available, that all samples be reviewed for andic soil properties and organic carbon contents.