

Ecological site QX191X01X503

Very Shallow to Moderately Deep Soils on Limestone Plateaus

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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

Major Land Resource Area (MLRA): 191X–High Limestone Plateaus of the Mariana Islands

This MLRA consists of the northern half of Guam and the islands of Saipan), Tinian, Rota, and Aguijan. Topography consists mostly of limestone plateaus. The highest elevations are 1,700 feet (520 meters) on Rota, 1,485 feet (450 meters) on Saipan, 655 feet (200 meters) on Tinian, and 860 feet (260 meters) in the northern part of Guam. The limestone plateaus were uplifted by tectonic activity. Deeply weathered volcanic rock is exposed on some ridges and slopes. Average annual rainfall is 100 inches (2,540 millimeters) on northern Guam and 80 inches (2,030 millimeters) on Saipan, Tinian, Aguijan, and Rota. The rainy season occurs from July through November; the dry season occurs from December through June. Trade winds blow from the northeast. Average annual temperature is 79 degrees F (26 degrees C). Typhoons are frequent. Soils are Alfisols, Andisols, Entisols, Mollisols, or Oxisols. The dominant soil moisture regime is ustic. The soil temperature regime is isohyperthermic. Native vegetation consists of mixed tropical hardwoods; introduced white leadtree or tangantangan (*Leucaena leucocephala*) are abundant. Introduced deer, pigs, goats, and water buffalo are common (USDA-NRCS, 2006). The main human disturbance is clearing land for cultivation. Feral pigs, feral cattle, brown tree snakes, stray dogs (Boonie dogs), and introduced deer are destructive to the native forest (Amand, 2000; CNMI SWARS Council, 2010; Donnegan et al., 2011; Liske-Clark, 2015; Willsey et al., 2019).

Classification relationships

This ecological site occurs within Major Land Resource Area (MLRA) 191 – High

Limestone Plateaus of the Mariana Islands.

Ecological site concept

This ecological site occurs on the islands of Guam, Saipan, Tinian, Rota, and Aguijan in the Mariana Islands. It occurs on nearly level to steep (0 to 30 percent slopes) limestone plateaus at elevations ranging from 10 to 1,476 feet (3 to 450 meters) (USDA-SCS, 1988; USDA-SCS, 1989).

Soils range from very shallow to the shallower range of the moderately deep class. They are well drained Mollisols (Argiustolls and Haplustolls), Alfisols, and Entisols that formed in sediment or residuum over coralline limestone or argillaceous limestone. Some phases consist of fill deposited over the natural soil surface. Soil temperature regimes are isohyperthermic; soil moisture regimes are ustic. Average annual precipitation is 88 inches (2,240 millimeters) and ranges from 78 to 95 inches (1,980 to 2,410 millimeters) (Prism, 2006). Water runoff is predominately low; permeability is slow to moderately rapid. Effective rooting depth ranges from 2 to 20 inches (5 to 50 centimeters); some roots occur in cracks in the underlying limestone. Available water-holding capacity is 2 to 3 inches (3 to 10 centimeters) in the upper 40 inches (100 centimeters) of soil (USDA-SCS, 1988; USDA-SCS, 1989). Areas not farmed are vegetated by mostly introduced grass, forb, and tree species, with some areas of native forest. Tangantangan (*Leucaena leucocephala*) is abundant in places (Amidon et al., 2017; Falanruw et al., 1989; Fosberg, 1960; Liu and Fischer, 2008; Stone, 1970; Wagner and Grether, 1948; Willsey et al., 2019).

Associated sites

QX192X01X003	Shallow Soils on Volcanic Uplands Soils of QX192X01X003 (The Shallow and Shallow Soils on Volcanic Uplands Ecological Site) formed in volcanic materials, have effective rooting depths from 4 to 15 inches, and have very low available water holding capacity. Most of the area is vegetated by grasses, forbs, and forest. Soils of QX191X01X503 (The Very Shallow to Moderately Deep Soils on Limestone Plateaus Ecological Site) formed in fine materials over porous coralline or argillaceous limestone. Effective rooting depth is 2 to 20 inches and available water holding capacity is very low to low. Areas not farmed are vegetated by mostly introduced grass, forb, and tree species, with some areas of native upland forest. Tangantangan is abundant in places.
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QX191X01X505	<p>Very Low Available Water Capacity Soils on Limestone Plateaus and Escarpments</p> <p>Soils of QX191X01X505 (The Very Low Available Water Capacity Soils on Limestone Plateaus and Escarpments Ecological Site) occur on plateaus. They are well drained, shallow, very-cobbly clays and cobbly clay loams with very low (1 inch) available water holding capacity. Sub surface soils contain 13 to 40 percent rock fragments greater than 3 inches. Most of the area is vegetated by native forest. Soils of QX191X01X503 (The Very Shallow to Moderately Deep Soils on Limestone Plateaus Ecological Site) also occur on limestone plateaus. They are well drained, very shallow to moderately deep (8 to 26 inches) clays, clay loams, and very gravelly sandy loams. Available water-holding capacity is very low (2 to 3 inches). Sub surface soils contain 0 to 13 percent rock fragments greater than 3 inches. Much of the area is farmed. Areas not farmed are vegetated by mostly introduced grass, forb, and tree species, with some areas of native upland forest.</p>
QX191X01X506	<p>Somewhat Poorly and Poorly Drained Valley Bottoms and Coastal Plains</p> <p>Soils of QX191X01X506 (The Somewhat Poorly and Poorly Drained Valleys and Alluvial Coastal Plains Ecological Site) are in broad river valley bottoms and alluvial coastal plains. They are poorly to somewhat poorly drained. They formed in alluvium or beach deposits, have aquic moisture regimes, shallow water tables, areas of slightly brackish groundwater, and are occasionally flooded. They have moderately high (4 inches) or high (5 inches) water holding capacity. Most of the area is vegetated by grasses, forbs, and wetland forest. Soils of QX191X01X503 (The Very Shallow to Moderately Deep Soils on Limestone Plateaus Ecological Site) occur on limestone plateaus. They are well drained, very shallow to moderately deep (8 to 26 inches) clays, clay loams and very gravelly sandy loams. Available water-holding capacity is very low (2 to 3 inches). Sub surface soils contain 0 to 13 percent rock fragments greater than 3 inches. Much of the area is farmed. Areas not farmed are vegetated by mostly introduced grass, forb, and tree species, with some areas of native upland forest.</p>
QX191X01X004	<p>Somewhat Poorly and Poorly Drained Limestone Basins</p> <p>Soils of QX191X01X004 (The Somewhat Poorly and Poorly Drained Limestone Basins Ecological Site) occur on basin floors; they rarely flood or pond. They are moderately deep and deep, somewhat poorly and poorly drained, have low to moderate (5 inches) available water holding capacity, and somewhat neutral to slightly basic soils (pH ranges from 5.8 to 7.0). Most of the area is vegetated by water- tolerant grasses and forest. Soils of QX191X01X503 (The Very Shallow to Moderately Deep Soils on Limestone Plateaus Ecological Site) occur on plateaus. They are well drained, very shallow to moderately deep (8 to 26 inches) clays, clay loams and very gravelly sandy loams. Available water-holding capacity is very low (2 to 3 inches). Sub surface soils contain 0 to 13 percent rock fragments greater than 3 inches. Much of the area is farmed. Areas not farmed are vegetated by mostly introduced grass, forb, and tree species, with some areas of native upland forest.</p>

QX192X01X501	<p>Somewhat Poorly Drained Alluvium</p> <p>Soils of QX192X01X501 (The Somewhat Poorly Drained Alluvium Ecological Site) occur in stream channels, depressions, and seeps on volcanic uplands. The soils, which formed in alluvium from volcanic tuff and tuff breccia, are somewhat poorly drained, have effective rooting depths greater than 60 inches, high available water holding capacity, shallow water tables during the rainy season, and are occasionally flooded. Most of the area is vegetated by wetland forest, grasses, and sedges. Soils of Soils of QX191X01X503 (The Very Shallow to Moderately Deep Soils on Limestone Plateaus Ecological Site) formed in fine mineral materials over porous coralline or argillaceous limestone. Soils have ustic moisture regimes, deep water tables, only fresh groundwater, and no flooding or ponding. Areas not farmed are vegetated by mostly introduced grass, forb, and tree species, with some areas of native upland forest.</p>
QX191X01X005	<p>Very Poorly Drained Muck</p> <p>Soils of QX191X01X005 (The Very Poorly Drained Muck Ecological Site) occurs in depressions on nearly level (0 to 2 percent) slopes at elevations ranging from 0 to 20 feet. The surface soil is 8 inches of muck over mucky clay loam. The soil moisture regimes are aquic; the soils are wet at the surface (0 inches). Groundwater varies from fresh to saline (EC 8 to 16 dS/m) depending on location. Flooding is frequent. Most of the area is vegetated by marsh grasses and, in a few locations, small stands of hibiscus (<i>Hibiscus tiliaceus</i>) or mangrove forest. Soils of QX191X01X503 (The Very Shallow to Moderately Deep Soils on Limestone Plateaus Ecological Site) formed in fine mineral materials over porous coralline or argillaceous limestone. Soils have ustic moisture regimes, deep water tables, only fresh groundwater, and no flooding or ponding. Areas not farmed are vegetated by mostly introduced grass, forb, and tree species, with some areas of native upland forest.</p>
QX192X01X001	<p>Moderately Deep Oxic Soils on Volcanic Uplands</p> <p>Soils of QX192X01X001 (The Very Deep Oxic Soils on Volcanic Uplands Ecological Site) formed in volcanic materials and have effective rooting depths greater than 60 inches, moderately high available water holding capacity, low base saturation, low pH, and aluminum toxicity. Most of the area is vegetated by Pacific silver grass or swordgrass (<i>Miscanthus floridulus</i>). Soils of QX191X01X503 (The Very Shallow to Moderately Deep Soils on Limestone Plateaus Ecological Site) formed in fine materials over porous coralline or argillaceous limestone. Effective rooting depth is 2.5 to 26 inches, available water holding capacity is very low to low, base saturation is high, pH is high, and there is no aluminum toxicity. Areas not farmed are vegetated by mostly introduced grass, forb, and tree species, with some areas of native upland forest. Tangantangan is abundant in places.</p>

QX192X01X002	<p>Deep Alfic Soils on Volcanic Uplands</p> <p>Soils of QX192X01X002 (The Deep Alfic Soils on Volcanic Uplands Ecological Site) formed in volcanic materials and have effective rooting depths greater of 40 to 60 inches, low available water holding capacity, fairly high base saturation, pH above 5.0, and no aluminum toxicity. Most of the area is vegetated by forest, grasses, and forbs. Soils of QX191X01X503 (The Very Shallow to Moderately Deep Soils on Limestone Plateaus Ecological Site) formed in fine materials over porous coralline or argillaceous limestone. Effective rooting depth is 2 to 20 inches, available water holding capacity is very low to low, base saturation is high, pH is high, and there is no aluminum toxicity. Areas not farmed are vegetated by mostly introduced grass, forb, and tree species, with some areas of native upland forest. Tangantangan is abundant in places.</p>
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Similar sites

QX191X01X502	<p>Deep and Very Deep Soils on Limestone Plateaus</p> <p>QX191X01X502 (Deep and Very Deep Soils on Limestone Plateaus Ecological Site) formed in fine materials over porous coralline or argillaceous limestone. Effective rooting depth is 40 to 60 inches or deeper and available water holding capacity is moderate. Most of this ecological site is used for farmland; areas not farmed are vegetated by mostly introduced grass, forb, and tree species. Tangantangan (<i>Leucaena leucocephala</i>) is abundant in places. Soils of QX191X01X503 (Very Shallow to Moderately Deep Soils on Limestone Plateaus Ecological Site) formed in fine materials over porous coralline or argillaceous limestone. Effective rooting depth is 2 to 20 inches and available water holding capacity is very low to low. For both ecological sites, areas not farmed are vegetated by mostly introduced grass, forb, and tree species, with some areas of native upland forest. Tangantangan is abundant in places.</p>
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Table 1. Dominant plant species

Tree	(1) <i>Intsia bijuga</i> (2) <i>Guamia mariannae</i>
Shrub	(1) <i>Cycas circinalis</i>
Herbaceous	Not specified

Legacy ID

F191XY503MP

Physiographic features

This ecological site primarily occurs on limestone plateaus. A few soil map unit components occur on basin floor (USDA-SCS, 1988; USDA-SCS, 1989). The depth to water is greater than 72 inches.

Table 2. Representative physiographic features

Landforms	(1) Plateau
Runoff class	Low to medium
Flooding frequency	None
Ponding frequency	None
Elevation	3–451 m
Slope	0–30%
Water table depth	183 cm
Aspect	Aspect is not a significant factor

Table 3. Representative physiographic features (actual ranges)

Runoff class	Very low to very high
Flooding frequency	Not specified
Ponding frequency	Not specified
Elevation	Not specified
Slope	0–60%
Water table depth	Not specified

Climatic features

Summary for this Ecological Site

Rainfall statistics were determined from PRISM rainfall raster data (PRISM, 2006). Representative (20th and 80th percentiles) values for mean annual precipitation range from 78 to 95 inches (1,980 to 2,410 millimeters) while actual (10th and 90th percentiles) values for mean annual precipitation range from 75 to 96 inches (1,910 to 2,440 millimeters). Extreme values range from 69 to 104 inches (1,750 to 2,640 millimeters). The average annual precipitation is 88 inches (2,240 millimeters) and the median annual average precipitation is 93 inches (2,360 millimeters).

Temperature statistics were determined from PRISM temperature raster data (PRISM, 2006) Representative (20th and 80th percentiles) values for mean annual temperatures range from 80 to 81 degrees F (26 to 27 degrees C) while actual (10th and 90th percentiles) values for mean annual temperatures also range from 80 to 81 degrees F (26 to 27 degrees C). Extreme values range from 75 to 82 degrees F (24 to 28 degrees C). The average annual temperature is 81 degrees F (27 degrees C), and the median annual temperature is also 81 degrees F (27 degrees C).

The data presented in the climate normals tables below are from select climate stations in Guam and Saipan. I used the data from these stations because they are representative of the spatial distribution of this ecological site and because they provide a reasonable approximation of the PRISM data presented above, e.g. the average annual precipitation is 91 inches (2,310 millimeters), and the average annual temperature is 80 degrees F (26 degrees C).

General Principles

The climate is uniformly warm and humid throughout the year. Afternoon temperatures typically are about 86 degrees F (30 degrees C); nighttime temperatures are about 68 F (20 C). Relative humidity is 65 to 75 percent in the afternoon to 85 to 100 percent at night. Though temperature and humidity vary only slightly throughout the year, rainfall and wind conditions vary markedly. There are two main seasons, the dry season from December through June and the rainy season from mid-July to mid-November. Moisture deficit occurs between January and June. Mean annual rainfall ranges from about 98 inches (2,490 millimeters) on the windward (eastern) side of the higher mountains to about 79 inches (2,005 millimeters) along the coast of the western side of the islands. On average, about 15 percent of the annual rainfall occurs during the dry season and 55 percent during the rainy season (Fosberg, 1960; USDA-SCS, 1988; USDA-SCS, 1989).

Throughout the year, the dominant winds are the trade winds that blow from the east or northeast. The trade winds are strongest and most constant during the dry season, when windspeeds of 15 to 25 mph (25 to 40 kph) are common. Coastal areas that have east, and northeast exposures are subject to salt spray and buffeting winds (Fosberg, 1960; USDA-SCS, 1988; USDA-SCS, 1989).

During the rainy season the trade winds may break down and be replaced by a weak, westerly monsoon influence that brings heavy showers or steady and sometimes torrential rains. The islands lie in the path of typhoons from the southeast and east. They bring heavy rains and violent winds that may result in a surge of water onto low-lying coastal areas. They occur most frequently during the latter half of the year. The chance of having one or more typhoons pass close to the islands in any particular year is about once in three years. The chance of having a typhoon move directly across an island is about once in eight years (Fosberg, 1960; USDA-SCS, 1988; USDA-SCS, 1989).

Table 4. Representative climatic features

Frost-free period (characteristic range)	365 days
Freeze-free period (characteristic range)	365 days
Precipitation total (characteristic range)	1,981-2,413 mm
Frost-free period (actual range)	365 days
Freeze-free period (actual range)	365 days

Precipitation total (actual range)	1,905-2,438 mm
Frost-free period (average)	365 days
Freeze-free period (average)	365 days
Precipitation total (average)	2,235 mm

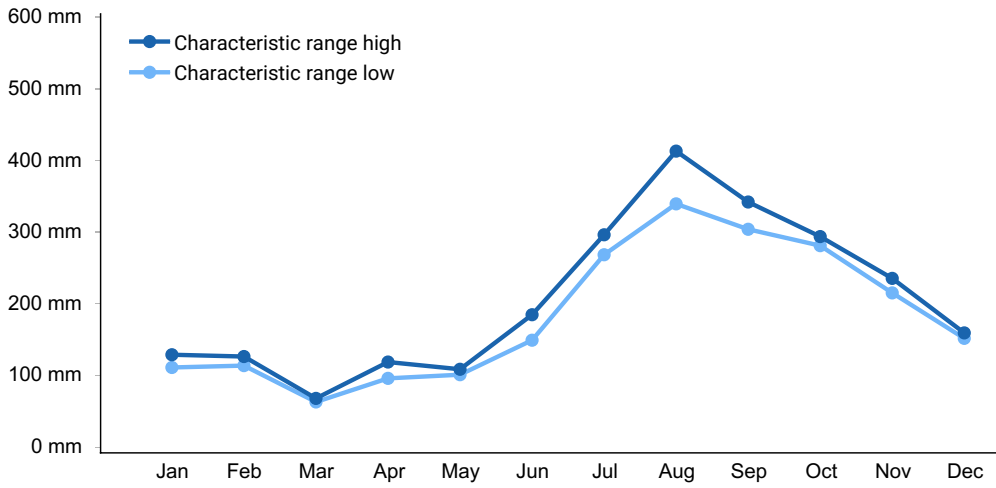


Figure 1. Monthly precipitation range

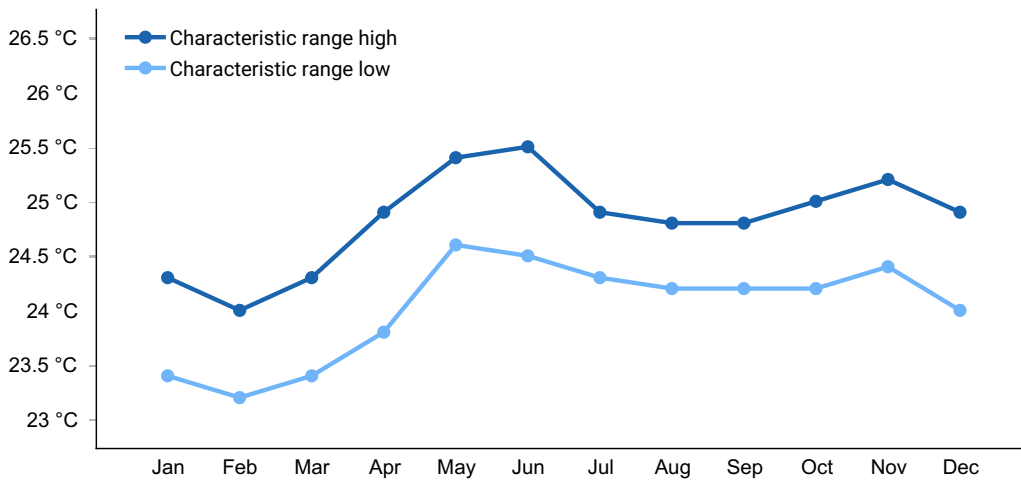


Figure 2. Monthly minimum temperature range

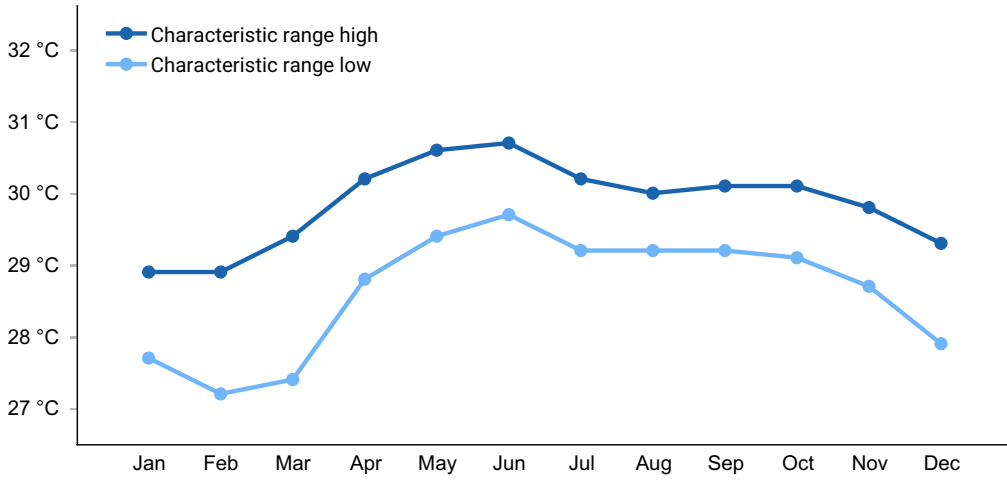


Figure 3. Monthly maximum temperature range

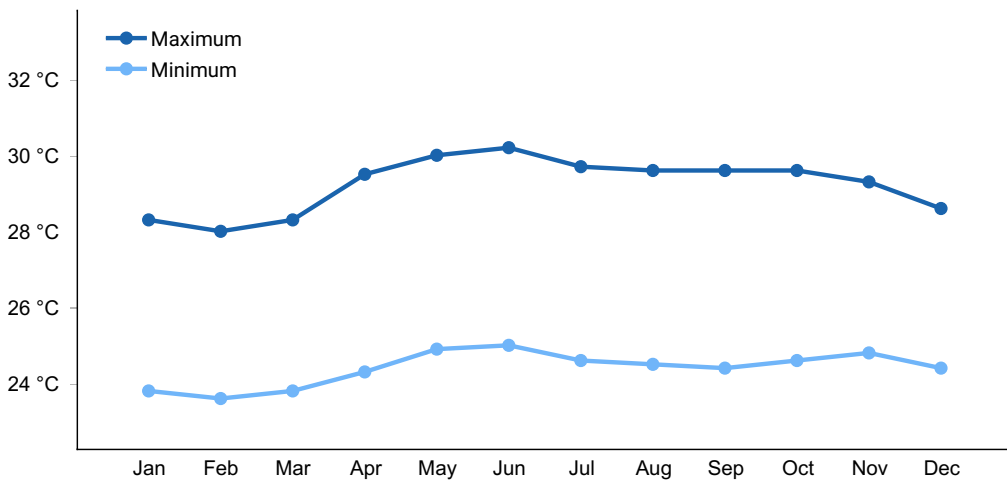


Figure 4. Monthly average minimum and maximum temperature

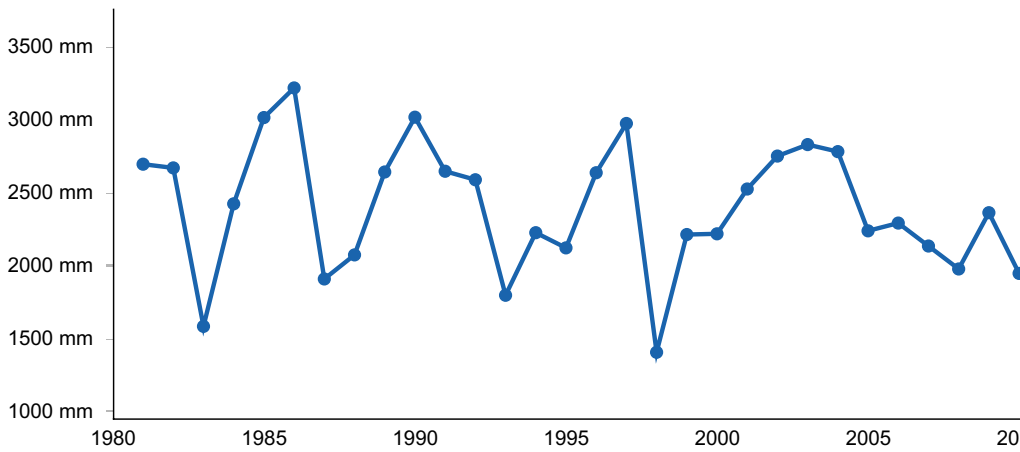


Figure 5. Annual precipitation pattern

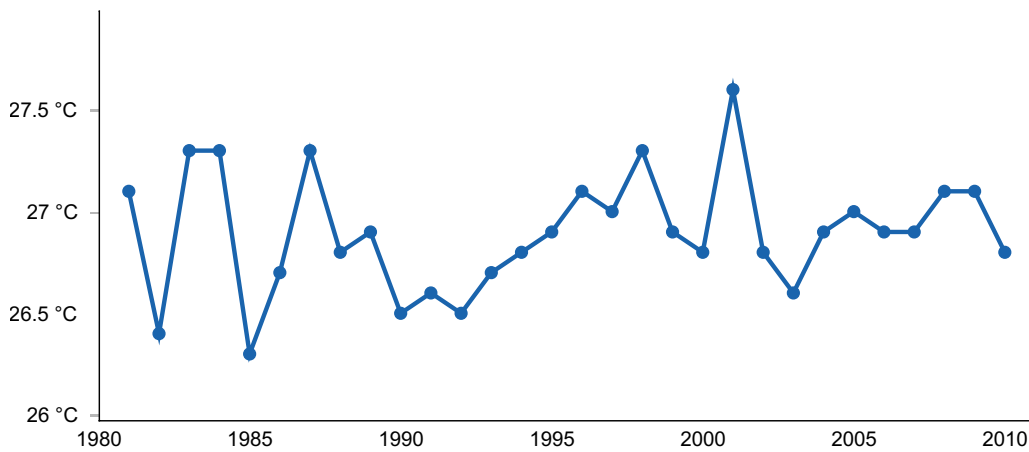


Figure 6. Annual average temperature pattern

Climate stations used

- (1) CAPITOL HILL 1 [CQC00914080], MP
- (2) ANDERSEN AFB GUAM [GQC00914025], GU
- (3) GUAM INTL AP [GQW00041415], GU

Influencing water features

Number of National Wetland Inventory (NWI) features overlapping ecological site: Riverine (156), freshwater emergent wetlands (123), freshwater forested/shrub wetlands (78), estuarine and marine wetland (48), freshwater pond (21), and estuarine and marine deepwater (20) (USFWS, 2023).

Soil features

The soil components associated with this ecological site are Banaderu (Mollisols), Chinen (Mollisols), Dandan (Inceptisols), Pulantat (Mollisols), Guam (Entisols), and Chacha (Alfisols) (USDA-SCS, 1988; USDA-SCS, 1989). Soil temperature regimes are isohyperthermic; soil moisture regimes are ustic. They are very shallow to the shallower end of moderately deep, and well drained. The underlying limestone is porous. Two phases of Chinen series consist of very gravelly sandy loam fill deposited over the natural soil surface.

Table 5. Representative soil features

Parent material	(1) Residuum–coral limestone (2) Residuum–argillaceous limestone
Surface texture	(1) Clay (2) Clay loam (3) Cobbly clay loam

Family particle size	(1) Fine (2) Clayey
Drainage class	Well drained
Permeability class	Slow to moderate
Depth to restrictive layer	5–51 cm
Soil depth	5–51 cm
Surface fragment cover ≤ 3 "	0–14%
Surface fragment cover > 3 "	0–9%
Available water capacity (0-101.6cm)	3.56–9.91 cm
Calcium carbonate equivalent (0-101.6cm)	0–99%
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–1
Soil reaction (1:1 water) (0-25.4cm)	6.5–7.9
Subsurface fragment volume ≤ 3 " (0-101.6cm)	0–20%
Subsurface fragment volume > 3 " (0-101.6cm)	0–9%

Ecological dynamics

The main human disturbance is clearing land for cultivation. Much of the area is currently used for farmland. Feral pigs, feral cattle, and introduced deer are destructive to the forest (CNMI SWARS Council, 2010; Donnegan et al., 2011; Liske-Clark, 2015; Willsey et al., 2019).

The main natural disturbance is strong storms that can damage or kill vegetation by high wind speeds. Natural fire is rare in forested areas due to the low amounts of fine fuels on the ground (CNMI SWARS Council, 2010; Donnegan et al., 2011; Liske-Clark, 2015; Willsey et al., 2019).

State and transition model

Very Shallow to Moderately Deep Soils on Limestone Plateaus F191XY503MP

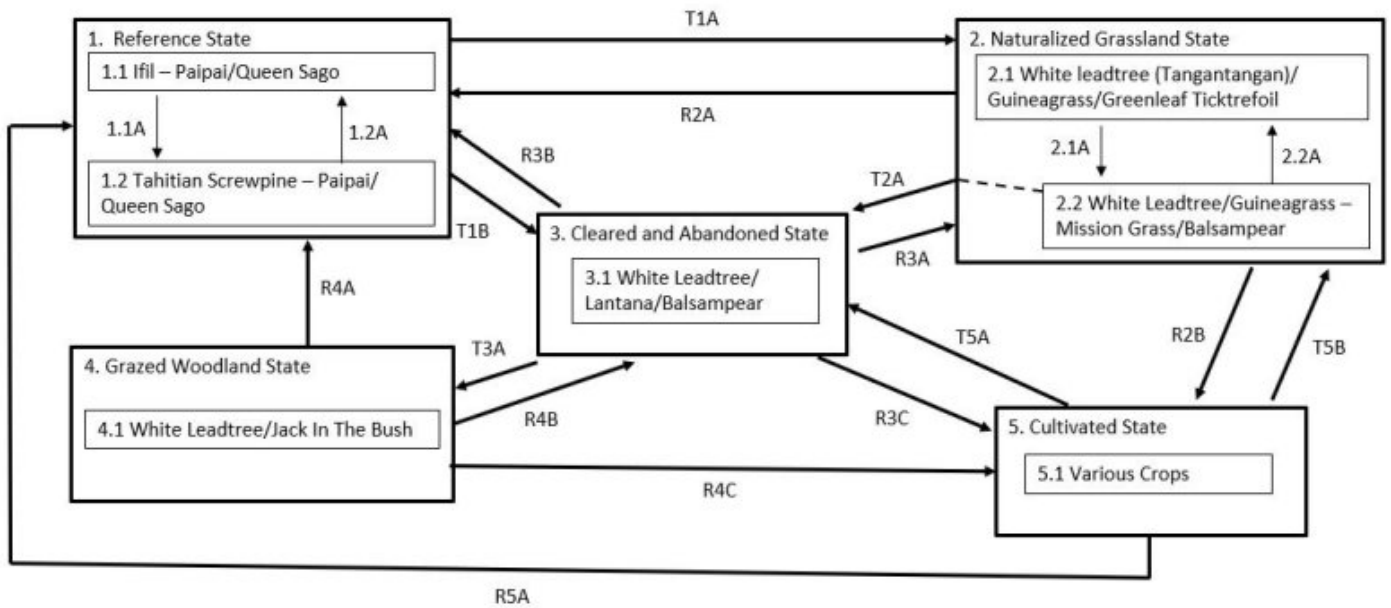


Figure 7. State-and-Transition Model for F191XY503MP (Very Shallow to Moderately Deep Soils on Limestone Plateaus)

State 1 Reference State

The Reference State (1) has two community phases consisting of diverse native forests. The overstory may grow to between 22 and 45 feet (7 and 14 meters) tall, although the original forest may have been taller than this (Amidon et al., 2017; Falanruw et al., 1989; Fosberg, 1960; Liu and Fischer, 2008; Stone, 1970; Wagner and Grether, 1948; Willsey et al., 2019). Dominant canopy species can vary by island and region of island, making this forest type hard to characterize by dominant or even characteristic species. The undergrowth in this forest is usually sparse and perhaps not very flammable (Amidon et al., 2017; Falanruw et al., 1989; Fosberg, 1960; Liu and Fischer, 2008; Stone, 1970; Wagner and Grether, 1948; Willsey et al., 2019).

Community 1.1 Ifil - Paipai/Queen Sago

Dominant trees include ifil (*Intsia bijuga*), artocarpus (*Artocarpus mariannensis*), grand devil's claws (*Pisonia grandis*), fig (*Ficus prolixa*), *Merrilliodendron megacarpum*, fern-leaved tamarind (*Tristiropsis acutangula*), *Mammea odorata*, and quandong (*Elaeocarpus sphaericus*). Subdominant trees include Tahitian screwpine (*Pandanus tectorius*), bakong (*P. dubius*), *Aglaiia mariannensis*, *Guamia mariannae*, queen sago (*Cycas circinalis*), neisosperma (*Neisosperma oppositifolia*), *Macaranga thompsonii*, cynometra (*Cynometra ramiflora*), and many others. Undergrowth is generally very sparse, the two most important components being monarch fern (*Phymatosorus scolopendria*) and Hawai'i birdnest fern (*Asplenium nidus*). Woody understory species may include *Discocalyx megacarpa*, yellow-

boxwood (*Planchonella obovata*), tiger's claw (*Erythrina variegata* var. *orientalis*), *Melanolepis multiglandulosa*, *Macaranga thompsonii*, and *Pipturus argenteus*. Epiphytes may include *Freycinetia reineckei*, Hawai'i birdnest fern (*Asplenium nidus*), and the fern *Davallia solida* (Amidon et al., 2017; Falanruw et al., 1989; Fosberg, 1960; Liu and Fischer, 2008; Stone, 1970; Wagner and Grether, 1948; Willsey et al., 2019).

Dominant plant species

- ifil (*Intsia bijuga*), tree
- (*Guamia mariannae*), tree
- queen sago (*Cycas circinalis*), shrub

Community 1.2

Tahitian Screwpine – Paipai/Queen Sago

Storm damage to dominant overstory trees allows fast-growing or abundant subdominant species to temporarily become more abundant. Some typical species include Tahitian screwpine (*Pandanus tectorius*), paipai (*Guamia mariannae*), queen sago (*Cycas circinalis*), sea hibiscus (*Hibiscus tiliaceus*), and beach sheoak (*Casuarina equisetifolia*) (CNMI SWARS Council, 2010; Donnegan et al., 2011; Liske-Clark, 2015; Willsey et al., 2019).

Dominant plant species

- Tahitian screwpine (*Pandanus tectorius*), tree
- (*Guamia mariannae*), tree
- queen sago (*Cycas circinalis*), shrub

Pathway 1.1A

Community 1.1 to 1.2

Community phase 1.1 may shift to phase 1.2 by damage from powerful storms.

Pathway 1.2A

Community 1.2 to 1.1

Community phase 1.2 reverts to phase 1.1 by regrowth of the original dominant species if given enough time between strong storm events.

State 2

Naturalized Grassland State

The Naturalized Grassland State (2) consists of two community phases consisting mostly of introduced grass species.

Community 2.1

White Leadtree (Tangantangan)/Guineagrass/Greenleaf Ticktrefoil

White leadtree or tangantangan (*Leucaena leucocephala*) is present with the grassland but not dominant. It provides valuable forage if twigs and leaves remain within reach of animals. Guineagrass (*Urochloa maxima*) is the main grass species. Greenleaf ticktrefoil (*Desmodium intortum*), a leguminous forb, also provides good forage. Other possible species are elephant grass (*Pennisetum purpureum*) and the legumes calopo (*Calopogonium mucunoides*), Flor de conchitas (*Centrosema pubescens*), Sarawakbean (*Vigna hosei*), hyacinthbean or lablab (*Lablab purpureus*), and Hawai'i ticktrefoil (*Desmodium sandwicense*) (CNMI SWARS Council, 2010; Donnegan et al., 2011; Liske-Clark, 2015; Willsey et al., 2019).

Dominant plant species

- white leadtree (*Leucaena leucocephala*), tree
- guineagrass (*Urochloa maxima*), grass
- greenleaf ticktrefoil (*Desmodium intortum*), other herbaceous

Community 2.2

White Leadtree/Guineagrass – Mission Grass/Balsampear

Guineagrass (*Urochloa maxima*) is still common but has been heavily grazed, leaving openings for other species such as mission grass to invade the site. White leadtree (*Leucaena leucocephala*) or tangantangan has been browsed either so the limbs and leaves are unreachable by animals, or it is in the form of stumps. Unpalatable forbs such as balsampear (*Momordica charantia*) are common. Other possible common, but not abundant, species are romerillo (*Bidens alba*), scaly swordfern (*Nephrolepis hirsutula*), Philippine ground orchid (*Spathoglottis plicata*), monarch fern (*Phymatosorus scolopendria*), climbing hempvine (*Mikania scandens*), Jack in the bush (*Chromolaena odorata*), Canadian horseweed (*Conyza canadensis*), and dryland sedges (*Carex* spp.) (CNMI SWARS Council, 2010; Donnegan et al., 2011; Liske-Clark, 2015; Willsey et al., 2019).

Dominant plant species

- white leadtree (*Leucaena leucocephala*), tree
- guineagrass (*Urochloa maxima*), grass
- mission grass (*Pennisetum polystachion*), grass
- balsampear (*Momordica charantia*), other herbaceous

Pathway 2.1A

Community 2.1 to 2.2

Community phase 2.1 will shift to phase 2.2 by overgrazing, which allows invasion by unpalatable grass and forb species.

Pathway 2.2A

Community 2.2 to 2.1

Community phase 2.2 will revert to phase 2.1 with properly managed grazing, which allows desirable species to gradually regain dominance, and possible spot weed control.

State 3

Cleared and Abandoned State

The Cleared and Abandoned State (3) consists of one community phase dominated by weedy, mostly introduced species.

Community 3.1

White Leadtree/Lantana/Balsampear

Common species in this community phase are white leadtree or tangantangan (*Leucaena leucocephala*), probably grown out of reach by animals, the spiny shrub lantana (*Lantana camara*), and the unpalatable forb balsampear (*Momordica charantia*). Guineagrass (*Urochloa maxima*) is still present in patches. Other abundant species may be mission grass (*Pennisetum polystachion*), giant false sensitive plant (*Mimosa diplotricha*), romerillo (*Bidens alba*), scaly swordfern (*Nephrolepis hirsutula*), Philippine ground orchid (*Spathoglottis plicata*), monarch fern (*Phymatosorus scolopendria*), climbing hempvine (*Mikania scandens*), Jack in the bush (*Chromolaena odorata*), Canadian horseweed (*Conyza canadensis*), and dryland sedges (*Carex* spp.) (CNMI SWARS Council, 2010; Donnegan et al., 2011; Liske-Clark, 2015; Willsey et al., 2019).

Dominant plant species

- white leadtree (*Leucaena leucocephala*), tree
- lantana (*Lantana camara*), shrub
- balsampear (*Momordica charantia*), grass

State 4

Grazed Woodland State

The Grazed Woodland State (4) consists of a variable mix of introduced tree species, sometimes with a few native species, that form a dense forest. White leadtree or tangantangan (*Leucaena leucocephala*) may dominate, or other tree species may gradually invade a site. Cattle often forage in these forests, but carrying capacity is generally low (CNMI SWARS Council, 2010; Donnegan et al., 2011; Liske-Clark, 2015; Willsey et al., 2019).

Community 4.1

White Leadtree/Jack In The Bush

White leadtree (*Leucaena leucocephala*) is typically dominant, forming a canopy up to 33 feet (10 meters) tall with an open understory. In some locations in Guam, the introduced tree smallflower chastetree (*Vitex parviflora*) is dominant. Other common introduced tree species are small Philippine acacia (*Acacia confusa*), royal poinciana (*Delonix regia*), woman's tongue (*Albizia lebbek*), African tuliptree (*Spathodea campanulata*), and monkeypod (*Pithecellobium dulce*). Possible native species are beach sheoak (*Casuarina equisetifolia*), coconut palm (*Cocos nucifera*), *Guamia mariannae*, *Melanolepis multiglandulosa*, and *Psychotria* spp. Invasive vines such as Jack in the bush (*Chromolaena odorata*) are likely to be present (CNMI SWARS Council, 2010; Donnegan et al., 2011; Liske-Clark, 2015; Willsey et al., 2019).

Dominant plant species

- white leadtree (*Leucaena leucocephala*), tree
- Jack in the bush (*Chromolaena odorata*), other herbaceous

State 5 Cultivated State

The Cultivated State (5) consists of one community phase that is used for intensive agriculture for a variety of crops.

Community 5.1 Various Crops

A variety of crops are supported by this community phase.

Transition T1A State 1 to 2

The Reference State (1) may transition to the Naturalized Grassland State (2) by mechanical clearing of the land followed by invasion by or planting of introduced forage species.

Transition T1B State 1 to 3

The Reference State (1) may transition to the Cleared and Abandoned State (3) by clearing the forest, temporary cultivation of crops, abandonment, and invasion by mostly introduced species.

Restoration pathway R2A State 2 to 1

The Naturalized Grassland State (2) can be restored to a facsimile of the Reference State

(1) by suppressing the forage species and replanting native trees.

Transition T2A

State 2 to 3

The Naturalized Grassland State (2) will transition to the Cleared and Abandoned State (3) from Community Phase 2.1 if the forage species are reduced in cover and vitality by heavy grazing before abandonment, allowing invasion of the site by weedy shrub, forb, and vine species.

Restoration pathway R2B

State 2 to 5

The Naturalized Grassland State (2) can be restored to the Cultivated State (5) by killing forage species and cultivating for crops.

Restoration pathway R3B

State 3 to 1

The Cleared and Abandoned State (3) can be restored to a facsimile of the Reference State (1) by brush and weed control followed by replanting of native trees.

Restoration pathway R3A

State 3 to 2

The Cleared and Abandoned State (3) may be restored to the Naturalized Grassland State (2) by brush control, weed control, reseeding of desired forage species, and cutting back white leadtree (*Leucaena leucocephala*) to a shorter stature.

Transition T3A

State 3 to 4

The Cleared and Abandoned State (3) will transition to the Grazed Woodland State (4) by continued growth and spread of white leadtree (*Leucaena leucocephala*), possible invasion by other tree species, and closure of the overstory to shade out most shrubs, forbs, and grasses.

Restoration pathway R3C

State 3 to 5

The Cleared and Abandoned State (3) can be restored to the Cultivated State (5) by clearing the land and cultivating crops.

Restoration pathway R4A

State 4 to 1

The Grazed Woodland State (4) may be restored to a facsimile of the Reference State (1) by brush and weed control followed by replanting of native trees.

Restoration pathway R4B

State 4 to 3

The Grazed Woodland State (4) may be restored to the Cleared and Abandoned State (3) by clearing and abandoning the site, allowing lower-growing species that require sunlight to invade.

Restoration pathway R4C

State 4 to 5

The Grazed Woodland State (4) may be restored to the Cultivated State (5) by clearing the site, instituting weed control, and cultivating crops.

Restoration pathway R5A

State 5 to 1

The Cultivated State (5) may be restored to a facsimile of the Reference State (1) by weed control followed by replanting of native trees.

Transition T5B

State 5 to 2

The Cultivated State (5) may transition to the Naturalized Grassland State (2) by planting desired forages and eventually bringing grazing animals back to the site.

Transition T5A

State 5 to 3

The Cultivated State (5) will transition to the Cleared and Abandoned State (3) by simple abandonment.

Additional community tables

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate.

Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	04/11/2026
Approved by	Kendra Moseley
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. Number and extent of rills:

2. Presence of water flow patterns:

3. Number and height of erosional pedestals or terracettes:

4. Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):

5. Number of gullies and erosion associated with gullies:

6. Extent of wind scoured, blowouts and/or depositional areas:

7. Amount of litter movement (describe size and distance expected to travel):

8. Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

Dominant:

Sub-dominant:

Other:

Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

14. **Average percent litter cover (%) and depth (in):**

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a**

dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:

17. Perennial plant reproductive capability:
