USDA Natural Resources Conservation Service

# Ecological site VX162X01X504
# Pahoehoe Organic Fern Savanna

Accessed: 05/03/2024

## 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.

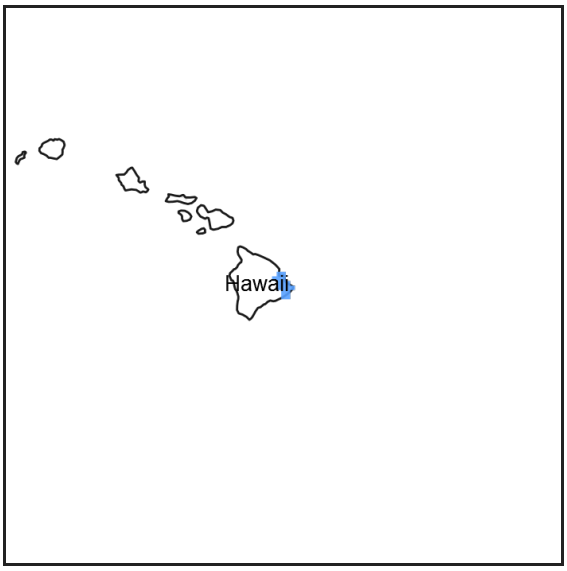


**Figure 1. Mapped extent**

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

## MLRA notes

Major Land Resource Area (MLRA): 162X–Humid and Very Humid Organic Soils on Lava Flows

This MLRA occurs in the State of Hawaii on the Big Island of Hawaii on the southeastern slopes of Mauna Loa and Mauna Kea volcanoes. Elevation ranges from sea level to 4000 feet (0 to 1200 meters). Slopes follow the undulating to very steep topography of the lava flows. The flows are basaltic aa or pahoehoe lava, which are covered by a very shallow layer of organic material or in limited areas by recent volcanic ash. Climate is mostly wet tropical. Average annual precipitation typically ranges from 60 to 235 inches (1500 to 5875 millimeters), increasing with elevation and to the north. Rainfall occurs mostly from November through April in udic areas and is evenly distributed throughout the year in perudic areas. Average annual temperatures range from 54 to 73 degrees F (12 to 23 degrees C), with little seasonal variation. Soils are mostly Udifolists with isothermic or isohyperthermic soil temperature regimes. Very young lava flows may have no soil covering. Native vegetation consists of moderate to tall stature rain forests, low stature dry forests, and “savannas” dominated by dense thickets of uluhe ferns.

## Classification relationships

This ecological site occurs within Major Land Resource Area (MLRA) 162 - Humid and Very Humid Organic Soils on Lava Flows.

## Ecological site concept

This ecological site is the uluhe-covered area that exists makai of Hilo and Route 11 south to Keaa and then south along both sides of Route 130 to Pahoa. Much of the area is private land or owned by the State of Hawaii and is easily viewed and accessed from public roads.

The central concept of the Pahoehoe Organic Fern Savanna is of well drained, very shallow soils formed in deposits of highly decomposed plant material over pahoehoe (flat lava flows). Lava flows are young, ranging from 200 to 2,000 years old. Annual air temperatures and rainfall create hot (isohyperthermic), moist (udic) soil conditions. These soils support what might be termed a savanna but is actually more like a thicket of dense, deep (to 13 feet or 4 meters), uluhe fern (*Dicranopteris linearis*) with a very open, emergent canopy of ohia lehua (Metrosideros polymorpha) that is 30 to 50 feet (9 to 15 meters) tall.

## Associated sites

| | |
|---|---|
| VX162X01X500 | **Isohyperthermic Forest**<br>F162XY500 Isohyperthermic Forest is a forest ecological site that borders on F162XY504. F162XY500 also occurs in kipukas that were not covered by the pahoehoe flows on which F162XY504 occurs. |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | (1) *Metrosideros polymorpha* |
| Shrub | Not specified |
| Herbaceous | (1) *Dicranopteris linearis* |

## Legacy ID

F162XY504HI

## Physiographic features

This ecological site occurs on a broad area of young lava flows on the slope of Kilauea volcano. Lava flows are pahoehoe (smooth, relatively unbroken).

**Table 2. Representative physiographic features**

| | |
|---|---|
| Landforms | (1) Shield volcano<br>(2) Lava flow |
| Flooding duration | Extremely brief (0.1 to 4 hours) |
| Flooding frequency | Very rare to occasional |
| Ponding duration | Long (7 to 30 days) |
| Ponding frequency | None to frequent |
| Elevation | 15–366 m |
| Slope | 2–10% |
| Ponding depth | 0–10 cm |
| Water table depth | 152 cm |
| Aspect | NE, E |

## Climatic features

Average annual precipitation ranges from 120 to 150 inches (3000 to 3750 millimeters). Most of the precipitation falls from October through March. Average annual temperature is about 63 to 72 degrees F (17 to 22 degrees C).

Air temperature in Hawaii is buffered by the surrounding ocean so that the range in temperature through the year is narrow. This creates “iso-“ soil temperature regimes in which mean summer and winter temperatures differ by less than 6 degrees C (11 degrees F).

Hawaii lies within the trade wind zone. Significant amounts of moisture are picked up from the ocean by trade winds up to an altitude of more than 6000 feet (very roughly 2000 meters). As the trade winds from the northeast are forced up the mountains of the island their moisture condenses, creating rain on the windward slopes; the leeward side of the island receives little of this moisture.

On the windward side of the island, cool, moist air at higher elevations descends toward the ocean where it meets the trade winds; this process brings night-time rainfall to lower elevation areas.

In winter, low pressure systems often approach the island from the west, producing extensive rainstorms that primarily affect the leeward sides of the island.

Reference: Giambelluca and Schroeder 1998.

**Table 3. Representative climatic features**

| | |
|---|---|
| Frost-free period (average) | 365 days |
| Freeze-free period (average) | 365 days |
| Precipitation total (average) | 3,226 mm |

## Climate stations used

- (1) HILO INTL AP [USW00021504], Hilo, HI

## Influencing water features

Small, very shallow sedge bogs can be found in disturbed areas of this ecological site. It is not known if they are natural features or caused by human disturbance.

## Soil features

The soils of this ecological site formed in highly decomposed organic matter and small amounts of volcanic ash deposited over pahoehoe lava.

Typical depth of these soils is only three or four inches (75 to 100 millimeters).

The soil temperature regime is isohyperthermic. Soil moisture regimes are udic (the soil is typically moist throughout the profile but may experience periodic drying of the control section less than 90 cumulative days, usually during the months of April to October) to perudic (The soil is typically moist throughout the profile. Precipitation exceeds evapotranspiration in all months of normal years).

The organic soils of the Island of Hawaii are classified as Histosols. They were formed mainly in organic material consisting of highly decomposed leaves, twigs, and wood with small amounts of basic volcanic ash, cinders, and weathered lava; this is called highly decomposed parent material. Some of these soils contain slightly or moderately decomposed parent material, especially at or near the soil surface.

Unlike many organic soils such as peat or muck that form in long-term water-saturated conditions, these organic soils form by accumulation and transformation of litter on dry surfaces of lava rock or in gaps between lava rocks. These organic soils are referred to as litter or an O horizon.

All of the Histosols on the Big Island are classified as “euic,” which means they have relatively high base saturation as indicated by a pH of 4.5 or higher; most Big Island Histosols have pH well above this minimum.

Histosols on pahoehoe lava tend to be shallow (less than 20 inches or 50 centimeters) or very shallow (less than 10 inches or 25 centimeters). Pahoehoe is referred to as a “lithic contact,” which is a boundary between soil and underlying material that is coherent, continuous, difficult to dig with a spade, and contains few cracks that can be

penetrated by roots (Soil Survey Staff 1999). Pahoehoe is typically very limiting to root penetration due to the spacing and size of cracks. However, this characteristic of pahoehoe is variable, and there are many instances of large trees growing on very shallow and shallow soils over pahoehoe. When depth of soil to pahoehoe is less than 18 cm (7.2 inches), the soil is referred to as “micro.”

Ripping and crushing lava by heavy machinery transforms these organic soils into Arents, which basically means sandy (the “Ar” or arenic; think of a sandy arena) soils with little or no natural horizon development (the “ents” or Entisols). Ripping pahoehoe lava eliminates the root-limiting layer of the lava. Crushing of ripped pahoehoe fragments reduces the size of the fragments and the gaps between them and creates some finer, sand-sized particles. As much as 50% of the original organic matter can be lost in this process due to oxidation, but the resulting Arents are more suitable for agricultural operations. Arents are very susceptible to weed invasion, but there have been apparently successful attempts at restoration of native plant species.

**Figure 6. Keaukaha soil**

**Table 4. Representative soil features**

| | |
|---|---|
| Parent material | (1) Organic material–basalt |
| Surface texture | (1) Highly decomposed plant material |
| Drainage class | Well drained |
| Permeability class | Very slow to rapid |
| Soil depth | 5–18 cm |
| Surface fragment cover <=3" | 0% |
| Surface fragment cover >3" | 0% |
| Available water capacity (0-101.6cm) | 2.54–5.08 cm |
| Calcium carbonate equivalent (0-101.6cm) | 0% |
| Electrical conductivity (0-101.6cm) | 0–2 mmhos/cm |
| Sodium adsorption ratio (0-101.6cm) | 0 |
| Soil reaction (1:1 water) (0-101.6cm) | 4.5–5.5 |
| Subsurface fragment volume <=3" (Depth not specified) | 0–25% |
| Subsurface fragment volume >3" (Depth not specified) | 0% |

## Ecological dynamics

The information in this ecological site description (ESD), including the state-and-transition model (STM), was developed using archaeological and historical data, professional experience, and scientific studies. The information is representative of a complex set of plant communities. Not all scenarios or plants are included. Key indicator plants, animals, and ecological processes are described to inform land management decisions.

Human-related disturbances have been much more important than natural disturbances in this ecological site since the arrival of Polynesians and, later, Europeans. This is reflected in the State and Transition Model Diagram.

Lava flows in this ecological site are all recent, having occurred within the past few hundred to few thousand years. These very young surfaces have not received many inputs of volcanic ash, so soils are very shallow and consist of highly decomposed organic matter. These very young soils support natural stands of largely pioneer plant species that arrive from surrounding areas and small kipukas.

Humans arrived in the Hawaiian Islands 1200 to 1500 years ago. Their population gradually increased so that by 1600 AD at least 80% of all the lands in Hawaii below about 1500 feet (roughly 500 meters) in elevation had been extensively altered by humans (Kirch 1982)). This ecological site occurs within that elevation range, but human habitation has been inhibited by two factors. First, the deep, dense thickets of uluhe fern are nearly impenetrable in many areas. Second, the soils on this ecological site are not suitable for agriculture. Soils over large areas are only 2 to 4 inches (5 to 10 centimeters) deep, underlain by solid pahoehoe lava with low water holding capacity, and consisting of highly decomposed organic matter. Kipukas with slightly deeper soils that were used for agriculture exist within the boundaries this ecological site; these kipukas are part of Ecological Site F162XY500 Isohyperthermic Forest. It is likely that human activities in the kipukas and along the coast may have affected surrounding areas.

The Polynesians introduced dogs, Pacific rats, and small pigs to the islands. Cattle, sheep, horses, goats, and larger European pigs were introduced in the final decades of the 18th century. These animals ranged free on the islands, becoming very numerous and destructive by the early decades of the 19th century (Henke 1929). Through the 20th and into the 21st centuries, increases in human populations with attendant land development, as well as accelerated introduction of non-native mammals, birds, reptiles, amphibians, invertebrates, plants, and microorganisms, have brought about dramatic changes to wild ecosystems in Hawaii.

Much of the original vegetation of this ecological site appears to be intact. However, the native plant community has been highly disturbed and in some places destroyed due to wildfires, clearing followed by abandonment, crushing and ripping of surface lava flows by heavy equipment, domestic and feral ungulate foraging, and invasion by introduced species. Introduced weeds are abundant in disturbed areas. Introduced weed invasion is inhibited, but not entirely prevented, by the typically dense stands of native uluhe or Old World forkedfern (*Dicranopteris linearis*) in this ecological site.

## State and transition model

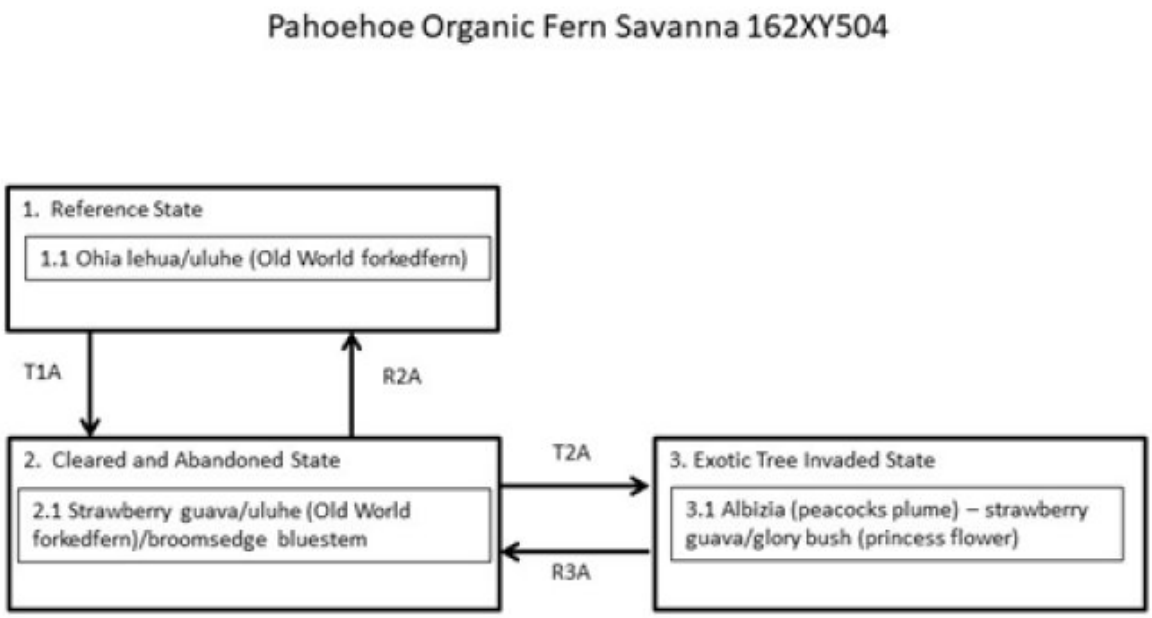


**Figure 7. STM for F162XY504**

## State 1
## Reference State

The Reference State consists of one community phase. State 1 can transition into State 2 Cleared and Abandoned by clearing and abandonment or by wildfire. Ripping and crushing of the underlying pahoehoe by heavy equipment creates soils called Arents, in which rock fragments are comminuted into smaller pieces down to sand size. This action causes loss of organic matter by oxidation, but creates fine, sand-filled interstices between rocks that provide a rooting medium in which to establish plants. Abandoned Arents are very susceptible to weed invasion.

## Community 1.1
## `Ohi`a lehua/Old World forkedfern (uluhe)

**Figure 8. Reference community phase. 12/15/05 D Clausnitzer MU653**

**Figure 9. Opihikao soil under uluhe. Amy Koch, NRCS**

This plant community is a deep (to 12 feet or 3.5 meters), nearly impenetrable thicket of uluhe fern with a very open canopy of ohia lehua trees that are 30 to 50 feet (9 to 15 meters) tall. These savannas have standing live timber of 0 to 700 cubic feet per acre, with a representative value of about 150 cubic feet per acre.

**Forest overstory.** The uppermost forest canopy consists of ohia lehua (Metrosideros polymorpha). While most ohia lehua in this ecological site are up to about 50 feet (15 meters) tall, taller specimens, up to about 80 feet (25 meters) occasionally occur. These specimens may be older because they are near kipukas containing ohia lehua or because their roots are able to access pits and cracks in the pahoehoe. A scattering of shorter stature tree kopiko or wild coffee (Psychotria sp.) emerges through the uluhe. Pandanus or Tahitian screwpine (Pandanus tectorius) is an occasional emergent nearer the coast, while hapuu (Cibotium glaucum) occur at the wetter, inland extremes of the ecological site.

**Forest understory.** The understory is dense uluhe or Old World forkedfern (Dicranopteris linearis). Akia (Wikstroemia sp.) shrubs occur sparsely, along with ekaha (Elaphoglossum crassifolium) ferns, the native grass ohe (Isachne distichophylla), and the native sedges uki (Machaerina sp.) and nutgrass (Scleria testacea).

**Table 5. Soil surface cover**

| | |
|---|---|
| Tree basal cover | 0-1% |
| Shrub/vine/liana basal cover | 0% |
| Grass/grasslike basal cover | 0% |
| Forb basal cover | 0.5-1.0% |
| Non-vascular plants | 0% |
| Biological crusts | 0% |
| Litter | 80-90% |

| | |
|---|---|
| Surface fragments >0.25" and <=3" | 0% |
| Surface fragments >3" | 0% |
| Bedrock | 0-1% |
| Water | 0% |
| Bare ground | 0% |

**Table 6. Woody ground cover**

| | |
|---|---|
| Downed wood, fine-small (<0.40" diameter; 1-hour fuels) | – |
| Downed wood, fine-medium (0.40-0.99" diameter; 10-hour fuels) | – |
| Downed wood, fine-large (1.00-2.99" diameter; 100-hour fuels) | – |
| Downed wood, coarse-small (3.00-8.99" diameter; 1,000-hour fuels) | 0% |
| Downed wood, coarse-large (>9.00" diameter; 10,000-hour fuels) | – |
| Tree snags** (hard***) | – |
| Tree snags** (soft***) | – |
| Tree snag count** (hard***) | 0-5 per hectare |
| Tree snag count** (hard***) | 0-5 per hectare |

*** Decomposition Classes: N - no or little integration with the soil surface; I - partial to nearly full integration with the soil surface.**

**** >10.16cm diameter at 1.3716m above ground and >1.8288m height--if less diameter OR height use applicable down wood type; for pinyon and juniper, use 0.3048m above ground.**

***** Hard - tree is dead with most or all of bark intact; Soft - most of bark has sloughed off.**

**Table 7. Canopy structure (% cover)**

| Height Above Ground (M) | Tree | Shrub/Vine | Grass/ Grasslike | Forb |
|---|---|---|---|---|
| <0.15 | 0% | 0% | 0% | 1-2% |
| >0.15 <= 0.3 | 0% | 0% | 0-1% | 1-2% |
| >0.3 <= 0.6 | 0% | 0% | 0-1% | 1-2% |
| >0.6 <= 1.4 | 0% | 0% | 0-1% | 10-20% |
| >1.4 <= 4 | 1-2% | 0% | – | 80-90% |
| >4 <= 12 | 10-25% | – | – | – |
| >12 <= 24 | 0-10% | – | – | – |
| >24 <= 37 | – | – | – | – |
| >37 | – | – | – | – |

## State 2
## Cleared and Abandoned State

This state is comprised of one community phase. It occurs in abandoned fields and in areas that have burned. Widespread, human-caused fires historically have been common in this community. Restoration to State 1 Reference may be possible by excluding ungulates, creating a firebreak, controlling invasive plants, and reintroducing uluhe ferns. Propagation of uluhe is very difficult. However, it might be accomplished by placing rotting logs under uluhe thickets to collect spores, allowing the spores to develop, and then placing the logs in the restoration area. This state transitions to State 3 Exotic Tree Invaded when fire is absent long enough (maybe 10 to 20 years) to allow introduced tree species to grow.

### Community 2.1
### Strawberry guava//Old World forkedfern (uluhe)broomsedge bluestem

**Figure 10. Sparse ohia lehua with weedy understory. 12/15/05 D Clausnitzer MU653**

The general aspect is an open field with weedy, fire-prone grasses, clumps of weedy shrubs, vines, and small trees, and scattered trees of medium height. Small, isolated wet areas dominated by a native sedge (*Scleria testacea*) occur. These wet areas are not apparent in the native plant community and may be created by human disturbances. If they exist beneath uluhe thickets, they are either not visible or are filled by organic matter that accumulates beneath the ferns.

**Forest overstory.** The overstory consists of tall, scattered ohia lehua (Metrosideros polymorpha) and possibly a few pandanus (Pandanus tectorius) and/or kopiko (Psychotria sp.). Tall introduced trees are usually present, most commonly albizia or peacocksplume (Falcataria moluccana), trumpet tree (Cecropia obtusifolia), octopus tree (Schefflera actinophylla), and gunpowder tree or oriental Trema (Trema orientale).

**Forest understory.** Seedlings and saplings of native ohia lehua, kopiko, or pandanus may be absent, but they occur on some sites. Seedlings and saplings of potentially tall introduced trees are common. Shoebutton ardisia (Ardisia elliptica) are common. Strawberry guava (Psidium cattleianum) are abundant up to about 13 feet (4 meters) tall. Koster's curse (Clidemia hirta), Asian melastome (Melastoma candidum), and glorybush (Tibouchina urvilleana) are very common.

**Table 8. Soil surface cover**

| | |
|---|---|
| Tree basal cover | 0.5-1.0% |
| Shrub/vine/liana basal cover | 0.5-1.0% |
| Grass/grasslike basal cover | 3-5% |
| Forb basal cover | 0.5-1.0% |
| Non-vascular plants | 3-5% |
| Biological crusts | 0% |
| Litter | 55-65% |
| Surface fragments >0.25" and <=3" | 0-1% |
| Surface fragments >3" | 0-5% |
| Bedrock | 1-3% |
| Water | 0% |
| Bare ground | 1-2% |

**Table 9. Canopy structure (% cover)**

| Height Above Ground (M) | Tree | Shrub/Vine | Grass/ Grasslike | Forb |
|---|---|---|---|---|
| <0.15 | 0% | 0% | 0% | 0% |
| >0.15 <= 0.3 | 0% | 0-1% | 1-2% | 0% |
| >0.3 <= 0.6 | 0-1% | 1-1% | 3-5% | 5-10% |
| >0.6 <= 1.4 | 0-1% | 25-35% | 25-35% | 15-25% |
| >1.4 <= 4 | 0-5% | 0-5% | – | – |
| >4 <= 12 | 0-5% | – | – | – |
| >12 <= 24 | – | – | – | – |
| >24 <= 37 | – | – | – | – |
| >37 | – | – | – | – |

## State 3
## Exotic Tree Invaded State

This state consists of one community phase. It transitions from State 2 Cleared and Abandoned when fire is absent long enough for a dense tree canopy to develop, possibly within about 20 years. Despite the shallowness of the soils, many introduced tree species are able to establish. Their potential densities and sizes are not yet known, but dense stands with very tall trees currently exist. It is conceivable that tree roots may extend through cracks in the pahoehoe to reach buried volcanic ash soils beneath. This state might restore itself to State 2 Cleared and Abandoned by occurrence of an intense wildfire during a dry period.

### Community 3.1
### Peacocks plume (albizia) - strawberry guava//princess flower (glory bush)

**Figure 11. Forest of exotic species dominated by large albizia. D Clausnitzer generic photo**

This community phase is a dense, low to medium height (30 to 60 feet or 9 to 18 meters) forest with patches of weedy shrubs, grasses, and ferns in openings. Tall (to 100+ feet or 31 meters) trees are common.

**Forest overstory.** The tree overstory often contains tall, remnant ohia lehua (Metrosideros polymorpha). Albizia (Falcataria moluccana) commonly grows to well over 100 feet. A suite of other introduced tree species is typically present.

**Forest understory.** Some remnant native pandanus and kopiko are often present. Many seedlings and saplings of introduced species are present. Strawberry guava (Psidium cattleianum) forms dense stands, as does glorybush or princess-flower (Tibouchina urvilleana). Remnant thickets of uluhe (Dicranopteris linearis) are often present.

**Table 10. Soil surface cover**

| | |
|---|---|
| Tree basal cover | 2-4% |

| | |
|---|---|
| Shrub/vine/liana basal cover | 0.5-1.0% |
| Grass/grasslike basal cover | 0% |
| Forb basal cover | 0.5-1.0% |
| Non-vascular plants | 5-10% |
| Biological crusts | 0% |
| Litter | 70-80% |
| Surface fragments >0.25" and <=3" | 0% |
| Surface fragments >3" | 0-1% |
| Bedrock | 0% |
| Water | 0% |
| Bare ground | 0-1% |

**Table 11. Woody ground cover**

| | |
|---|---|
| Downed wood, fine-small (<0.40" diameter; 1-hour fuels) | – |
| Downed wood, fine-medium (0.40-0.99" diameter; 10-hour fuels) | – |
| Downed wood, fine-large (1.00-2.99" diameter; 100-hour fuels) | – |
| Downed wood, coarse-small (3.00-8.99" diameter; 1,000-hour fuels) | 0-1% |
| Downed wood, coarse-large (>9.00" diameter; 10,000-hour fuels) | 0-1% |
| Tree snags** (hard***) | – |
| Tree snags** (soft***) | – |
| Tree snag count** (hard***) | 0-2 per hectare |
| Tree snag count** (hard***) | 0-5 per hectare |

*** Decomposition Classes: N - no or little integration with the soil surface; I - partial to nearly full integration with the soil surface.**

**** >10.16cm diameter at 1.3716m above ground and >1.8288m height--if less diameter OR height use applicable down wood type; for pinyon and juniper, use 0.3048m above ground.**

***** Hard - tree is dead with most or all of bark intact; Soft - most of bark has sloughed off.**

**Table 12. Canopy structure (% cover)**

| Height Above Ground (M) | Tree | Shrub/Vine | Grass/ Grasslike | Forb |
|---|---|---|---|---|
| <0.15 | 0% | 0% | 0% | 0% |
| >0.15 <= 0.3 | 0-1% | 0-1% | 0-1% | 0-1% |
| >0.3 <= 0.6 | 1-1% | 1-2% | 1-2% | 10-20% |
| >0.6 <= 1.4 | 5-10% | 5-10% | – | 5-10% |
| >1.4 <= 4 | 25-35% | 15-25% | – | – |
| >4 <= 12 | 35-45% | – | – | – |
| >12 <= 24 | 5-25% | – | – | – |
| >24 <= 37 | 0-25% | – | – | – |
| >37 | – | – | – | – |

## Transition T1A
## State 1 to 2

The Reference State can transition to State 2 Cleared and Abandoned by wildfire or by clearing with heavy

machinery, followed by abandonment and invasion by introduced plant species. If the cleared site is not near a weed seed source, native uluhe and native trees can reclaim the site without human intervention.

### Restoration pathway R2A
### State 2 to 1

It may be possible to restore State 2 to State 1 Reference by excluding ungulates, practicing weed control, and reestablishing dense stands of uluhe. Any remnant uluhe must be preserved the site. Uluhe fern is difficult to propagate and relocate to sites from which it is absent. It is possible to naturally propagate uluhe by placing mossed-covered pieces of tree wood beneath uluhe thickets to collect spores, allowing the spores to develop into ferns, and then moving them to the restoration site. Uluhe is a very competitive, fast-growing plant that can reclaim cleared or burned sites. If the local weed seed bank is not abundant, uluhe will naturally recover a site, eventually allowing native trees to emerge through it. Where some weeds are present, it has been demonstrated that moderate weed control efforts can allow uluhe to regain dominance of a site (personal communication, Fred Stone, UH-Hilo, retired).

### Transition T2A
### State 2 to 3

State 2 may transition State 3 Exotic Tree Invaded when lack of wildfire allows introduced trees to survive and grow to large size and/or dense populations.

### Restoration pathway R3A
### State 3 to 2

State 3 might possibly be restored to State 2 Cleared and Abandoned by wildfire that is sufficiently intense to destroy stands of introduced trees during dry weather.

## Additional community tables

**Table 13. Community 1.1 forest overstory composition**

| Common Name | Symbol | Scientific Name | Nativity | Height (M) | Canopy Cover (%) | Diameter (Cm) | Basal Area (Square M/Hectare) |
|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | |
| Porter's melicgrass | MEPO | *Melica porteri* | Native | 4–12.2 | 5–20 | 5.1–15.2 | – |
| Porter's melicgrass | MEPO | *Melica porteri* | Native | 12.2–15.2 | 0–10 | 15.2–22.9 | – |
| Tahitian screwpine | PATE2 | *Pandanus tectorius* | Native | 4–6.1 | 0–1 | – | – |
| wild coffee | PSYCH | *Psychotria* | Native | 4–7.6 | 0–1 | – | – |

**Table 14. Community 1.1 forest understory composition**

| Common Name | Symbol | Scientific Name | Nativity | Height (M) | Canopy Cover (%) |
|---|---|---|---|---|---|
| **Grass/grass-like (Graminoids)** | | | | | |
| ridgetop bloodgrass | ISDI | *Isachne distichophylla* | Native | 0.3–0.6 | 0–1 |
| twigrush | MACHA2 | *Machaerina* | Native | 0.3–0.6 | 0–1 |
| Hawai'i nutrush | SCTE6 | *Scleria testacea* | Native | 0.1–0.2 | – |
| **Fern/fern ally** | | | | | |
| Old World forkedfern | DILI | *Dicranopteris linearis* | Native | 0.6–4 | 95–100 |
| royal tonguefern | ELCR2 | *Elaphoglossum crassifolium* | Native | 0.2–0.3 | – |
| **Shrub/Subshrub** | | | | | |
| false ohelo | WIKST | *Wikstroemia* | Native | 0.6–2.4 | – |
| **Tree** | | | | | |
| 'ohi'a lehua | MEPO5 | *Metrosideros polymorpha* | Native | 0.6–4 | 0–1 |
| Tahitian screwpine | PATE2 | *Pandanus tectorius* | Native | 0.6–4 | 0–1 |
| wild coffee | PSYCH | *Psychotria* | Native | 0.6–4 | 0–1 |
| **Tree Fern** | | | | | |
| hapu'u | CIGL | *Cibotium glaucum* | Native | 0.6–3 | – |

**Table 15. Community 2.1 forest overstory composition**

| Common Name | Symbol | Scientific Name | Nativity | Height (M) | Canopy Cover (%) | Diameter (Cm) | Basal Area (Square M/Hectare) |
|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | |
| 'ohi'a lehua | MEPO5 | *Metrosideros polymorpha* | Native | 4–12.2 | 0–2 | – | – |
| trumpet tree | CEOB | *Cecropia obtusifolia* | Introduced | 4–7.6 | 0–1 | – | – |
| 'ohi'a lehua | MEPO5 | *Metrosideros polymorpha* | Native | 12.2–15.2 | 0–1 | – | – |
| octopus tree | SCAC2 | *Schefflera actinophylla* | Introduced | 4–7.6 | 0–1 | – | – |
| Oriental trema | TROR | *Trema orientalis* | Introduced | 4–9.1 | 0–1 | – | – |
| fig | FITH2 | *Ficus thonningii* | Introduced | 12.2–15.2 | – | – | – |
| peacocksplume | FAMO | *Falcataria moluccana* | Introduced | 12.2–18.3 | – | – | – |
| peacocksplume | FAMO | *Falcataria moluccana* | Introduced | 4–12.2 | – | – | – |
| Tahitian screwpine | PATE2 | *Pandanus tectorius* | Native | 4–6.1 | – | – | – |
| wild coffee | PSYCH | *Psychotria* | Native | 4–6.1 | – | – | – |

**Table 16. Community 2.1 forest understory composition**

| Common Name | Symbol | Scientific Name | Nativity | Height (M) | Canopy Cover (%) |
|---|---|---|---|---|---|
| **Grass/grass-like (Graminoids)** | | | | | |
| Colombian bluestem | SCCO10 | *Schizachyrium condensatum* | Introduced | 0.6–0.9 | 10–20 |
| broomsedge bluestem | ANVI2 | *Andropogon virginicus* | Native | 0.6–0.9 | 5–15 |
| molassesgrass | MEMI2 | *Melinis minutiflora* | Introduced | 0.3–0.6 | 1–5 |
| Hawai'i nutrush | SCTE6 | *Scleria testacea* | Introduced | 0.1–0.2 | 0–3 |
| twigrush | MACHA2 | *Machaerina* | Native | 0.6–0.9 | 0–1 |
| **Forb/Herb** | | | | | |
| bamboo orchid | ARGR6 | *Arundina graminifolia* | Introduced | 0.6–0.9 | 1–2 |
| Philippine ground orchid | SPPL | *Spathoglottis plicata* | Introduced | 0.6–0.9 | 1–2 |
| porterweed | STACH2 | *Stachytarpheta* | Introduced | 0.6–0.9 | 0–1 |
| **Fern/fern ally** | | | | | |
| scaly swordfern | NEHI | *Nephrolepis hirsutula* | Introduced | 0.3–0.6 | 5–10 |
| Old World forkedfern | DILI | *Dicranopteris linearis* | Native | 7.6–10.7 | 1–3 |
| **Shrub/Subshrub** | | | | | |
| soapbush | CLHI3 | *Clidemia hirta* | Introduced | 0.6–1.2 | 5–20 |
| Asian melastome | MECA9 | *Melastoma candidum* | Introduced | 0.6–4 | 1–10 |
| princess-flower | TIUR | *Tibouchina urvilleana* | Introduced | 0.6–4 | 2–10 |
| cure for all | PLCA10 | *Pluchea carolinensis* | Introduced | 0.6–1.5 | 1–2 |
| lantana | LACA2 | *Lantana camara* | Introduced | 0.6–1.2 | 0–1 |
| false ohelo | WIKST | *Wikstroemia* | Native | 0.9–1.8 | – |
| **Tree** | | | | | |
| strawberry guava | PSCA | *Psidium cattleianum* | Introduced | 0.6–4 | 1–10 |
| shoebutton | AREL4 | *Ardisia elliptica* | Introduced | 0.6–3 | 0–2 |
| octopus tree | SCAC2 | *Schefflera actinophylla* | Introduced | 0.6–4 | 0–2 |
| Oriental trema | TROR | *Trema orientalis* | Introduced | 0.6–4 | 0–1 |
| trumpet tree | CEOB | *Cecropia obtusifolia* | Introduced | 0.6–4 | 0–1 |
| guava | PSGU | *Psidium guajava* | Introduced | 0.6–2.4 | 0–1 |
| peacocksplume | FAMO | *Falcataria moluccana* | Introduced | 0.6–4 | – |
| Tahitian screwpine | PATE2 | *Pandanus tectorius* | Native | 0.6–4 | – |
| **Vine/Liana** | | | | | |
| yellow Himalayan raspberry | RUEL3 | *Rubus ellipticus* | Introduced | 0.3–0.9 | 1–2 |
| stinkvine | PAFO3 | *Paederia foetida* | Introduced | 0.3–3 | 0–1 |

**Table 17. Community 3.1 forest overstory composition**

| Common Name | Symbol | Scientific Name | Nativity | Height (M) | Canopy Cover (%) | Diameter (Cm) | Basal Area (Square M/Hectare) |
|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | |
| strawberry guava | PSCA | *Psidium cattleianum* | Introduced | 4–6.1 | 15–30 | – | – |
| peacocksplume | FAMO | *Falcataria moluccana* | Introduced | 12.2–24.4 | 1–20 | – | – |
| trumpet tree | CEOB | *Cecropia obtusifolia* | Introduced | 4–12.2 | 5–10 | – | – |
| peacocksplume | FAMO | *Falcataria moluccana* | Introduced | 24.4–30.5 | 0–5 | – | – |
| octopus tree | SCAC2 | *Schefflera actinophylla* | Introduced | 4–15.2 | 1–5 | – | – |
| 'ohi'a lehua | MEPO5 | *Metrosideros polymorpha* | Native | 12.2–15.2 | 0–5 | – | – |
| peacocksplume | FAMO | *Falcataria moluccana* | Introduced | 4–15.2 | 0–5 | – | – |
| pengua | MAMA28 | *Macaranga mappa* | Introduced | 4–7.6 | 3–5 | – | – |
| Oriental trema | TROR | *Trema orientalis* | Introduced | 4–18.3 | 0–2 | – | – |
| 'ohi'a lehua | MEPO5 | *Metrosideros polymorpha* | Native | 4–12.2 | 0–1 | – | – |
| wild coffee | PSYCH | *Psychotria* | Native | 4–7.6 | 0–1 | – | – |
| trumpet tree | CEOB | *Cecropia obtusifolia* | Introduced | 12.2–18.3 | 0–1 | – | – |
| hierba del soldado | MEUM3 | *Melochia umbellata* | Introduced | 4–6.1 | 0–1 | – | – |
| fig | FITH2 | *Ficus thonningii* | Introduced | 6.1–18.3 | – | – | – |
| Tahitian screwpine | PATE2 | *Pandanus tectorius* | Native | 4–6.1 | – | – | – |

**Table 18. Community 3.1 forest understory composition**

| Common Name | Symbol | Scientific Name | Nativity | Height (M) | Canopy Cover (%) |
|---|---|---|---|---|---|
| **Grass/grass-like (Graminoids)** | | | | | |
| basketgrass | OPHI | *Oplismenus hirtellus* | Introduced | 0.2–0.3 | 0–1 |
| broomsedge bluestem | ANVI2 | *Andropogon virginicus* | Introduced | 0.3–0.6 | 0–1 |
| Colombian bluestem | SCCO10 | *Schizachyrium condensatum* | Introduced | 0.3–0.6 | 0–1 |
| **Forb/Herb** | | | | | |
| bamboo orchid | ARGR6 | *Arundina graminifolia* | Introduced | 0.6–0.9 | 0–1 |
| Philippine ground orchid | SPPL | *Spathoglottis plicata* | Introduced | 0.3–0.6 | 0–1 |
| **Fern/fern ally** | | | | | |
| scaly swordfern | NEHI | *Nephrolepis hirsutula* | Introduced | 0.3–0.6 | 10–20 |
| Old World forkedfern | DILI | *Dicranopteris linearis* | Native | 0.6–4 | 5–15 |
| **Shrub/Subshrub** | | | | | |
| princess-flower | TIUR | *Tibouchina urvilleana* | Introduced | 0.6–4 | 5–30 |
| soapbush | CLHI3 | *Clidemia hirta* | Introduced | 0.6–1.5 | 5–10 |
| **Tree** | | | | | |
| strawberry guava | PSCA | *Psidium cattleianum* | Introduced | 0.6–4 | 25–35 |
| Oriental trema | TROR | *Trema orientalis* | Introduced | 0.6–4 | 1–5 |
| shoebutton | AREL4 | *Ardisia elliptica* | Introduced | 0.6–3 | 1–5 |
| trumpet tree | CEOB | *Cecropia obtusifolia* | Introduced | 0.6–4 | 0–1 |
| wild coffee | PSYCH | *Psychotria* | Native | 0.6–4 | 0–1 |
| hierba del soldado | MEUM3 | *Melochia umbellata* | Introduced | 0.6–4 | 0–1 |
| pengua | MAMA28 | *Macaranga mappa* | Introduced | 0.6–4 | 0–1 |
| guava | PSGU | *Psidium guajava* | Introduced | 1.8–3 | 0–1 |
| octopus tree | SCAC2 | *Schefflera actinophylla* | Introduced | 0.6–4 | 0–1 |
| Tahitian screwpine | PATE2 | *Pandanus tectorius* | Native | 0.6–4 | – |
| peacocksplume | FAMO | *Falcataria moluccana* | Introduced | 0.6–4 | – |
| **Vine/Liana** | | | | | |
| stinkvine | PAFO3 | *Paederia foetida* | Introduced | 0.6–9.1 | 0–1 |
| yellow Himalayan raspberry | RUEL3 | *Rubus ellipticus* | Introduced | 0.6–1.2 | 0–1 |

## Animal community

The Io or Hawaiian hawk (Buteo solitarius) has been observed in this ecological site.

Feral pigs are abundant.

## Hydrological functions

Runoff occurs frequently on this very shallow soils over pahoehoe lava. This runoff can cause localized flooding in low-lying kipukas and ponding in low spots on the pahoehoe.

The water permeability of pahoehoe is highly variable due to variable cracking and uplift of the lava. However, most areas of pahoehoe in this ecological site have relatively little cracking.

## Recreational uses

Hunting for feral pigs is possible. The dense stands of uluhe fern make access difficult in many areas.

## Wood products

None.

## Other products

None.

## Other information

Definitions
These definitions have been greatly simplified for brevity and do not cover every aspect of each topic.

Aa lava: A type of basaltic lava having a rough, jagged, clinkery surface and a vesicular interior.

Alluvial: Materials or processes associated with transportation and/or deposition by running water.

Aquic soil moisture regime: A regime in which the soil is free of dissolved oxygen because it is saturated by water. This regime typically exists in bogs or swamps.

Aridic soil moisture regime: A regime in which defined parts of the soil are, in normal years, dry for more than half of the growing season and moist for less than 90 consecutive days during the growing season. In Hawaii it is associated with hot, dry areas with plants such as kiawe, wiliwili, and buffelgrass. The terms aridic and torric are basically the same.

Ash field: a land area covered by a thick or distinctive deposit of volcanic ash that can be traced to a specific source and has well defined boundaries. The term “ash flow” is erroneously used in the Physiographic section of this ESD due to a flaw in the national database.

Ashy: A “soil texture modifier” for volcanic ash soils having a water content at the crop wilting point of less than 30 percent; a soil that holds relatively less water than “medial” and “hydrous” soils.

Available water capacity: The amount of soil water available to plants to the depth of the first root-restricting layer.

Basal area or basal cover: The cross sectional area of the stem or stems of a plant or of all plants in a stand.

Blue rock: The dense, hard, massive lava that forms the inner core of an aa lava flow.

Bulk density: the weight of dry soil per unit of volume. Lower bulk density indicates a greater amount of pore space that can hold water and air in a soil.

CaCO3 equivalent: The amount of free lime in a soil. Free lime exists as solid material and typically occurs in regions with a dry climate.

Canopy cover: The percentage of ground covered by the vertical projection downward of the outermost perimeter of the spread of plant foliage. Small openings within the canopy are included.

Community pathway: A description of the causes of shifts between community phases. A community pathway is reversible and is attributable to succession, natural disturbances, short-term climatic variation, and facilitating practices, such as grazing management.

Community phase: A unique assemblage of plants and associated dynamic soil properties within a state.

Dominant species: Plant species or species groups that exert considerable influence upon a community due to size, abundance, or cover.

Drainage class: The frequency and duration of a water table in a soil. There are seven drainage classes, ranging from “excessively drained” (soils with very rare or very deep water tables) to “well drained” (soils that provide ample

water for plant growth but are not so wet as to inhibit root growth) to “very poorly drained” (soils with a water table at or near the surface during much of the growing season that inhibits growth of most plants).

Electrical conductivity (EC): A measure of the salinity of a soil. The standard unit is deciSiemens per meter (dS/m), which is numerically equivalent to millimhos per centimeter (mmhos/cm). An EC greater than about 4 dS/m indicates a salinity level that is unfavorable to growth of most plants.

Friability: A soil consistency term pertaining to the ease of crumbling of soils.

Hydrous: A “soil texture modifier” for volcanic ash soils having a water content at the crop wilting point of 100 percent or more; a soil that holds more water than “medial” or “ashy” soils.

Ion exchange capacity: The ability of soil materials such as clay or organic matter to retain ions (which may be plant nutrients) and to release those ions for uptake by roots.

Isohyperthermic soil temperature regime: A regime in which mean annual soil temperature is 72 degrees F (22 degrees C) or higher and mean summer and mean winter soil temperatures differ by less than 11 degrees F (6 degrees C) at a specified depth.

Isomesic soil temperature regime: A regime in which mean annual soil temperature is 47 degrees F (8 degrees C) or higher but lower than 59 degrees F (15 degrees C) and mean summer and mean winter soil temperatures differ by less than 11 degrees F (6 degrees C) at a specified depth.

Isothermic soil temperature regime: A regime in which mean annual soil temperature is 59 degrees F (15 degrees C) or higher but lower than 72 degrees F (22 degrees C) and mean summer and mean winter soil temperatures differ by less than 11 degrees F (6 degrees C) at a specified depth.

Kipuka: An area of land surrounded by younger (more recent) lava. Soils and plant communities within a kipuka are older than, and often quite different from, those on the surrounding surfaces.

Major Land Resource Area (MLRA): A geographic area defined by NRCS that is characterized by a particular pattern of soils, climate, water resources, and land uses. The island of Hawaii contains nine MLRAs, some of which also occur on other islands in the state.

Makai: a Hawaiian word meaning “toward the sea.”

Mauka: a Hawaiian word meaning “toward the mountain” or “inland.”

Medial: A “soil texture modifier” for volcanic ash soils having a water content at the crop wilting point of 30 to 100 percent; a soil that holds an amount of water intermediate to “hydrous” or “ashy” soils.

Naturalized plant community: A community dominated by adapted, introduced species. It is a relatively stable community resulting from secondary succession after disturbance. Most grasslands in Hawaii are in this category.

Pahoehoe lava: A type of basaltic lava with a smooth, billowy, or rope-like surface and vesicular interior.

Parent material: Unconsolidated and chemically weathered material from which a soil is developed.

Perudic soil moisture regime: A very wet regime found where precipitation exceeds evapotranspiration in all months of normal years. On the island of Hawaii, this regime is found on top of Kohala and on parts of the windward side of Mauna Kea.

pH: The numerical expression of the relative acidity or alkalinity of a soil sample. A pH of 7 is neutral; a pH below 7 is acidic and a pH above 7 is basic.

Phosphorus adsorption: The ability of soil materials to tightly retain phosphorous ions, which are a plant nutrient. Some volcanic ash soils retain phosphorus so strongly that it is partly unavailable to plants.

Reference community phase: The phase exhibiting the characteristics of the reference state and containing the full complement of plant species that historically occupied the site. It is the community phase used to classify an ecological site.

Reference state: A state that describes the ecological potential and natural or historical range of variability of an ecological site.

Restoration pathway: A term describing the environmental conditions and practices that are required to recover a state that has undergone a transition.

Sodium adsorption ratio (SAR): A measure of the amount of dissolved sodium relative to calcium and magnesium in the soil water. SAR values higher than 13 create soil conditions unfavorable to most plants.

Soil moisture regime: A term referring to the presence or absence either of ground water or of water held at a tension of less than 1500 kPa (the crop wilting point) in the soil or in specific horizons during periods of the year.

Soil temperature regime: A defined class based on mean annual soil temperature and on differences between summer and winter temperatures at a specified depth.

Soil reaction: Numerical expression in pH units of the relative acidity or alkalinity or a soil.

State: One or more community phases and their soil properties that interact with the abiotic and biotic environment to produce persistent functional and structural attributes associated with a characteristic range of variability.

State-and-transition model: A method used to display information about relationships between vegetation, soil, animals, hydrology, disturbances, and management actions on an ecological site.

Torric soil moisture regime: See Aridic soil moisture regime.

Transition: A term describing the biotic or abiotic variables or events that contribute to loss of state resilience and result in shifts between states.

Udic soil moisture regime: A regime in which the soil is not dry in any part for as long as 90 cumulative days in normal years, and so provides ample moisture for plants. In Hawaii it is associated with forests in which hapuu (tree ferns) are usually moderately to highly abundant.

Ustic soil moisture regime: A regime in which moisture is limited but present at a time when conditions are suitable for plant growth. In Hawaii it usually is associated with dry forests and subalpine shrublands.

## Type locality

| Location 1: Hawaii County, HI | |
|---|---|
| Latitude | 19° 31′ 32″ |
| Longitude | 154° 57′ 45″ |
| General legal description | Hawaii County, USGS Quad: Pahoa South. From intersection of Hwy 130 and Kahakai Blvd just NW of Pahoa, go NW on Hwy 130 for 2.0 mi, turn right onto subdivision road, turn right at first intesection, and drive to end of dead end. Site is to N of road. |

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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 | |
| Approved by | |
| 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:**