

Ecological site VX159A01X403

Isohyperthermic Udic Naturalized Grassland (Guineagrass / Desmodium)

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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): 159A–Humid and Very Humid Volcanic Ash Soils on Low and Intermediate Rolling Mountain Slopes

This MLRA occurs in the State of Hawaii on the windward, wetter sides of the islands of Hawaii and Maui. Elevation ranges from near sea level to 6000 feet (0 to 1830 meters). Topography is rolling mountain slopes that have been eroded by steep-sided gulches. In most of the area, volcanic ash is underlain by basic igneous rocks, although in some areas volcanic ash was deposited over cinders. Average annual precipitation in most of the area ranges from 120 to 200 inches (3050 to 5080 millimeters); extremes range from 70 inches to 300 inches (1780 to 7500 millimeters). Rainfall is well-distributed throughout the year with an enhanced rainy season from November through April. Average annual air temperatures range from 54 to 73 degrees F (12 to 23 degrees C) with little seasonal variation. The dominant soil order is Andisols with an isothermic or isohyperthermic soil temperature regime and udic or perudic soil moisture regime. Native vegetation consists of medium to tall statured rain forest and open bogs.

Classification relationships

This ecological site occurs within Major Land Resource Area (MLRA) 159A - Humid and Very Humid Volcanic Ash Soils on Low and Intermediate Rolling Mountain Slopes.

Ecological site concept

This ecological is situated on the southeastern extreme of the island of Maui and northern extreme of the island of Hawaii between elevations of 0 to 1800 feet (0 to 549 meters). Much of the land is in private ownership; some of the area is within Haleakala National Park. Parts of it are visible or accessible along Piilani Highway between Hana and Kaupo on Maui and at the end of Route 270 near Pololu Valley, along the northern part of Route 250, and along Route 240 between Honokaa and Waipio Valley on Hawaii. The central concept of the Isohyperthermic Udic Naturalized Grassland is of well drained, moderately deep and deep soils formed in volcanic ash. Annual air temperatures and rainfall are associated with very warm (isohyperthermic) soils that are moist for most of the year (udic to ustic soil moisture regimes). Because very little of the original native vegetation remains, the reference state of this ecological site consists of the dominant naturalized vegetation which includes guineagrass (*Megathyrsus maximus* syn. *Urochloa maximus*), haole koa (*Leucaena leucocephala*) and desmodium (*Desmodium* spp). Kikuyugrass (*Cenchrus clandestinus*) and white clover (*Trifolium repens*) are prevalent at higher elevations where this ecological site grades into the adjoining, wetter ecological sites. In the absence of disturbance (grazing is most typical), these naturalized grasslands convert to invasive forest. Forested areas contain many introduced species, with strawberry guava (*Psidium cattleianum*), Java plum (*Syzygium javanicum*), christmasberry (*Schinus terebinthifolius*), ironwood (*Casuarina* spp.), silver oak (*Grevillea robusta*), and, on Hawaii, poison devil's pepper (*Rauvolfia vomitoria*) among the more common species. These non-native trees and shrubs often become monotypic stands with low diversity and allelopathic properties. Historically, this site would have been native tropical forest, however the composition and production are unknown due to significant alterations by humans over the past 150+ years including land clearing, intensive agricultural practices, and urbanization. Native plant species still present in this site are those transitional between dry leeward and moist windward environments. These areas are often referred to as "Mesic Forests" in botanical sources. These native forests can no longer re-establish naturally due to the significant site alterations and lack of seed source and native pollinators.

Associated sites

VX159A01X002	Rocky Alluvium Naturalized Grassland (Koa haole/guineagrass/glycine) The Rocky Alluvial Naturalized Grassland borders on this ecological site at its relatively dry southwestern boundary on the island of Maui. It receives less annual rainfall and supports more typical dry forest tree species and the same dominant introduced grass species.
VX159A01X003	Isohyperthermic Perudic Naturalized Grassland (Guineagrass - Californiagrass) The Isohyperthermic Perudic Naturalized Grassland borders the wettest part of this ecological site on the islands of Maui and Hawaii. It receives more annual rainfall and has the same temperature regime, resulting in introduced grass species that overlap near the boundary but are different at the extremes and a forest with typical moist habitat species rather than the mix of dry and moist habitat species found in this ecological site.
VX158X01X401	Isohyperthermic Ustic Naturalized Grassland Koa haole/guineagrass/glycine (Leucaena leucocephala/Urochloa maxima/Neonotonia wightii) The Isohyperthermic Ustic Naturalized Grassland borders the lowest, driest parts of this ecological site on the island of Hawaii. It has a warmer, drier climate, resulting in different introduced grass species and a native forest of typical dry habitat species rather than the mix of dry and moist habitat species found in this ecological site.
VX164X01X500	Volcanic Ash Forest The Volcanic Ash Forest borders the highest elevations of this ecological site on the island of Hawaii. It has cooler temperatures and equal or greater rainfall, resulting in a forest of similar medium stature but having a mix of dry and moist habitat native species rather than just moist habitat species, and different introduced grass species.
VX164X01X002	Organic Surface Forest The Acidic Volcanic Ash Forest borders the highest elevations of this ecological site on the island of Maui. It has cooler temperatures and equal or greater rainfall, resulting in a forest of similar medium stature but having more koa trees, tree ferns, and typical moist forest species and lacking pandanus and lama trees.

Similar sites

VX158X01X005	Naturalized Grassland 50 to 90 inch PZ Ohia lehua/kikuyugrass (Metrosideros polymorpha/Pennisetum clandestinum) The Naturalized Grassland, 50 to 90 Inch Precipitation Zone borders the higher, moister parts of this ecological site on the islands of Maui, Molokai, Oahu, and Kauai. It has very similar climate and soils but is in a different MLRA. Vegetation and annual production are very similar in both ecological sites.
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Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) <i>Urochloa maxima</i> (2) <i>Desmodium</i>

Legacy ID

Physiographic features

This ecological site primarily occurs on volcanic ash fields on sloping mountainsides of shield volcanoes. Ash fields range from deep to very deep on the underlying lava. Lava flows are aa (loose, cobbly) or pahoehoe (smooth, relatively unbroken). This area is dissected by steep-walled gulches.

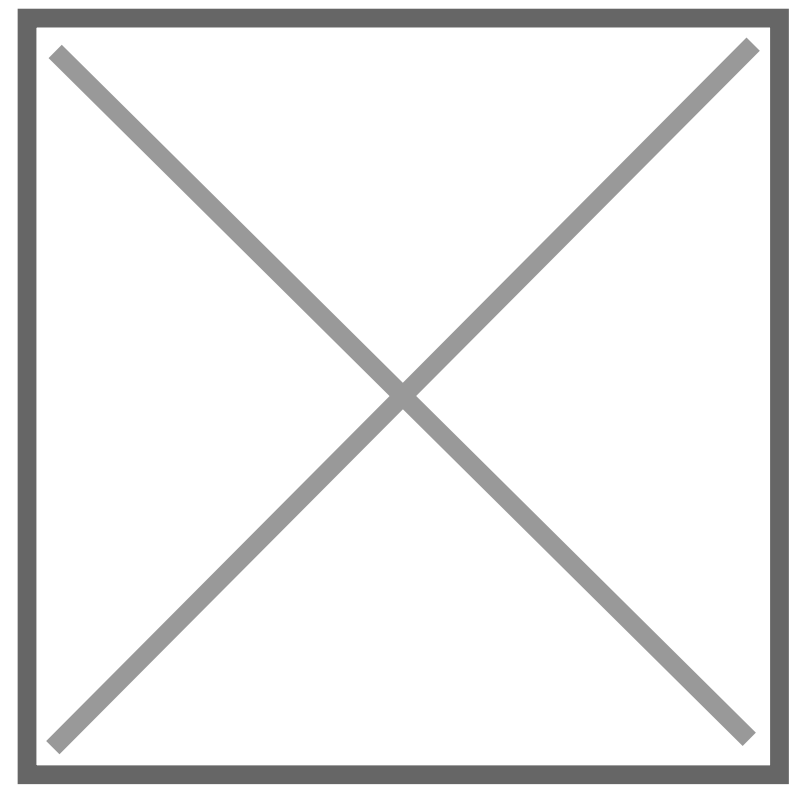


Figure 1.

Table 2. Representative physiographic features

Landforms	(1) Shield volcano > Ash field (2) Lava flow
Runoff class	Low to high
Flooding frequency	None
Ponding frequency	None
Elevation	0 – 550 m
Slope	0 – 40 %
Water table depth	150 cm

Aspect	NW, N, SE
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Table 3. Representative physiographic features (actual ranges)

Runoff class	Low to very high
Flooding frequency	None
Ponding frequency	None
Elevation	0 – 550 m
Slope	0 – 70 %
Water table depth	150 cm

Climatic features

Average annual precipitation ranges from 81 to 92 inches (2057 to 2336 millimeters). Extremes of average annual precipitation range from 60 inches to over 150 inches (1524 to 3810 millimeters) where this ecological site grades into the adjoining, wetter ecological sites. Most of the precipitation falls from October through April. Average annual temperature is 74 degrees F (23 degrees C).

Table 4 Representative climatic features

Frost-free period (characteristic range)	370 days
Freeze-free period (characteristic range)	370 days
Precipitation total (characteristic range)	2,060-2,340 mm
Frost-free period (actual range)	370 days
Freeze-free period (actual range)	370 days
Precipitation total (actual range)	1,520-3,810 mm
Frost-free period (average)	370 days
Freeze-free period (average)	370 days
Precipitation total (average)	2,210 mm

- (1) OHE'O 258.6 [USC00517000], Hana, HI
- (2) PAAUILO 221 [USC00517312], Paauilo, HI
- (3) HANA AP 355 [USC00511125], Hana, HI

Influencing water features

This ecological site is intersected by many small to medium size streams that have cut gulches into the landscape. The gulches contain plant species found in the rest of the ecological site.

Soil features

The soils in this ecological site all formed in volcanic ash deposited over aa or pahoehoe lava. On Hawaii, the soils are classified as Dystric Haplustands, which are Andisols with relatively low base saturation. On Maui, the soils are Andic Dystrudepts, which are Inceptisols (soils with moderate weathering of parent materials) with relatively low base saturation. Essentially, all the soils are taxonomically similar, having andic properties.

The volcanic ash soils of the Hawaiian Islands are derived mostly from basaltic ash that varies relatively little in chemical composition (Hazlett and Hyndman 1996; Vitousek 2004)). Most of these volcanic ash soils are classified today as Andisols. Andisols and other soils with andic properties have these general management characteristics: ion exchange capacity that varies with pH, but mostly retaining anions such as nitrate; high phosphorus adsorption, which restricts phosphorus availability to plants; excellent physical properties (low bulk density, good friability, weak stickiness, stable soil aggregates) for cultivation, seedling emergence, and plant root growth; resistance to compaction and an ability to recover from compaction following repeated cycles of wetting and drying; and high capacity to hold water that is available to plants relative to their apparent texture. These characteristics are due to the properties of the parent material, the clay-size noncrystalline materials formed by weathering, and the soil organic matter accumulated during soil formation (Shoji et al. 1993).

Soil depths are moderately deep to deep, with typical depths ranging from 30 to 46 inches (762 to 1168 millimeters). Soil temperature regimes are isohypothermic (very warm). Soil moisture regimes are udic (in which the soil is not dry in any part for as long as 90 cumulative days in normal years) or ustic (in which moisture is limited but present at a time when conditions are suitable for plant growth) but at the wetter extreme of ustic and nearly udic.

Surface horizons have pH ranging from 5.5 to 5.7. The exception is soils in the Ainakea series, which have pH of 4.4 in the 10 inch (25 centimeter) deep A horizon. However, the A horizon is umbric, meaning it contains a relatively high amount of organic matter, which probably binds up much of the toxic solubilized aluminum expected to occur at this low pH. In all the soils, extreme pH in subsurface horizons within 30 inches (75 centimeters) of the surface ranges from 5.6 to 6.6. Surface textures range from silty clay or clay. All the soils are well drained.

Table 5. Representative soil features

Parent material	(1) Basic volcanic ash – aa lava (2) Basaltic volcanic ash – pahoehoe lava
Surface texture	(1) Medial silty clay loam (2) Clay (3) Extremely stony silty clay (4) Silty clay
Drainage class	Well drained
Permeability class	Very slow to slow
Depth to restrictive layer	80 – 120 cm

Soil depth	80 – 120 cm
Surface fragment cover ≤3"	10 %
Surface fragment cover >3"	0 – 10 %
Available water capacity (0-101.6cm)	10.16 – 25.4 cm
Soil reaction (1:1 water) (0-25.4cm)	5.5 – 5.7
Subsurface fragment volume ≤3" (0-116.8cm)	10 – 40 %
Subsurface fragment volume >3" (0-116.8cm)	10 – 40 %

Table 6. Representative soil features (actual values)

Drainage class	Well drained
Permeability class	Very slow to moderately slow
Depth to restrictive layer	80 – 120 cm
Soil depth	80 – 180 cm
Surface fragment cover ≤3"	10 %
Surface fragment cover >3"	0 – 10 %
Available water capacity (0-101.6cm)	10.16 – 25.4 cm
Soil reaction (1:1 water) (0-25.4cm)	4.4 – 5.7

Subsurface fragment volume <=3" (0-116.8cm)	10 – 40 %
Subsurface fragment volume >3" (0-116.8cm)	0 – 40 %

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.

States and community phases within this ecological site were differentiated by inspection of data; ordination programs were not available. They were verified by professional consensus and observation of examples in the field.

Humans have altered this site considerably, starting with the native Hawaiian settlers as they brought plants with them and opened lands up for agriculture. More recently, starting in the mid-1800s, lands began being used for sugar cultivation. With the removal of the forest, introduction of non-native species, and then the later practices of industrial sugar production, the site has undergone many changes over the last 150 years. These alterations changed the site with fertilizer inputs, herbicides, and by removing the fertile topsoil and native plants resulting in lasting negative impacts to the soil-plant-water cycle.

This ecological site is currently a patchwork of naturalized species that reflect either grassland or forest depending on the pattern of disturbance and/or management. Today this site supports diversified agriculture including grazing lands, various orchards, annually tilled crops and some Eucalyptus plantations. The primary land use at this time is grazing land and these grasslands consist of tall warm-season species that are primarily naturalized to the site.

Historically, this ecological site would have been some form of lowland native tropical forest, however the composition and production are unknown due to significant alterations by humans including land clearing, intensive agricultural practices, and urbanization. Native plant species still present in this site are those transitional between dry leeward and moist windward environments. These areas are often referred to as "Mesic Forests" in botanical sources. These native forests can no longer re-establish naturally due to the significant site alterations and lack of seed source and native pollinators.

Because very little of the original native vegetation remains, the reference state of this ecological site consists of the dominant naturalized vegetation which includes guineagrass (*Megathyrsus maximus* syn. *Urochloa maximus*), haole koa (*Leucaena leucocephala*) and desmodium (*Desmodium* spp). Kikuyugrass (*Cenchrus clandestinus*) and white clover (*Trifolium repens*) are prevalent at higher elevations where this ecological site grades into the adjoining, wetter ecological sites. In the absence of disturbance (grazing is most typical), these naturalized grasslands convert to invasive forest.

Forested areas contain many introduced species, with strawberry guava (*Psidium cattleianum*), Java plum (*Syzygium javanicum*), christmasberry (*Schinus terebinthifolius*), ironwood (*Casuarina* spp.), silver oak (*Grevillea robusta*), and, on Hawaii, poison devil's pepper (*Rauvolfia vomitoria*) among the more common species. These non-native trees and shrubs often become monotypic stands with low diversity and allelopathic properties.

Natural Disturbances

The natural (not human-caused) disturbances most important for discussion in this ecological site are extended periods of drought (10-15 year cycle), periods of excessive rain, windthrow, and natural fire. Wind throw of vegetation can occur during hurricanes or other high wind events. Natural fires caused by lightning are very rare.

The naturalized grasses are very vulnerable to drought. These grasses rely on yearly moisture to meet their production and reproductive energy requirements, which results in root dieback within the soil profile and potentially some plant mortality, especially if they are also under grazing pressures which contribute to the stresses of a drought. This may result in the site becoming open to opportunistic herbs, brush and other woody species from the surrounding landscape to gain a foothold and begin to compete with the grasses. If not managed, these species can easily take over the site, as they are competitive and fast-growing.

Human Disturbances

Human-related disturbances have been much more important than natural disturbances in this ecological site since the arrival of

Polynesians and, later, Europeans. These are reflected in the State and Transition Model Diagram.

Humans arrived in the Hawaiian Islands 1200 to 1500 years ago. Their population gradually increased so that by 1600 AD at least 80 percent of all the lands in Hawaii below about 1500 feet (roughly 500 meters) in elevation had been extensively altered by humans (Kirch 1982); some pollen core data suggest that up to 100 percent of lowlands may have been altered (Athens 1997). By the time of European contact late in the 18th century, the Polynesians had developed high population densities and placed extensive areas under intensive agriculture (Cuddihy and Stone 1990, Lincoln 2020).

Prehistoric native lowland forest disturbance can be attributed to clearing for agriculture by hand or by fire, introduction of new plants and animals, and wood harvesting. Less accessible areas may have been affected by factors such as inadvertently introduced plant diseases and seed predation by the introduced Pacific rat (Athens 1997).

Native Hawaiians intensified virtually every arable habitat, made extremely marginal environments productive, developed innovative farming methods, and sustained production for hundreds of years without the use of external inputs, metals, draft animals, legumes or cover crops (Lincoln 2020, Handy et al., 1972; Lincoln and Vitousek, 2017). Two distinct Hawaiian agroforestry systems were utilized in this ecological site along the Hamakua coast on the island of Hawaii: A permanent arboricultural system with substantial breadfruit (*Artocarpus altilis* (Parkinson) Fosberg) and a shifting cultivation system based on candlenut (*Aleurites moluccanus* (L.) Willd). The distributions of these systems on the landscape appear to be constrained by soil fertility and temperature, with the swidden agricultural system occurring on the more fertile portion of the landscape and the permanent arboricultural system occupying the less fertile lands. These achievements, yet to be widely recognized, should inform the intelligent design of future alternative agricultural within this and similar ecological sites in Hawaii.

After the arrival of Europeans, documentary evidence attests to accelerated and extensive deforestation, erosion, siltation, and changes in local weather patterns (Kirch 1983) due to more intensive land use, modern tools, and introduction of more plant, animal, and microbe species.

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 decade the 18th century. These animals ranged free on the islands, becoming very numerous and destructive by the early decades of the 19th century.

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. This ecological site evolved without the presence of large mammals or human-caused fires.

The most important human disturbances in the ecological site are clearing for agriculture, domestic and feral ungulate foraging, and invasion by introduced plant and animal species. Much of the area is currently used for agriculture and pasture. Some areas had been cleared in the past and then abandoned; these areas are now dominated by forests of introduced species.

State and transition model

Figure 8. State and Transition Model.

Figure 9. Transitions and Pathways.

Figure 10. Community Pathways (State 1 Reference).

Additional community tables

Table 7. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 8. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 9. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 10. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 11. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 12. Community 5.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Other references

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.

Andic Dystrudepts: Inceptisol soils (soils with moderate weathering of parent materials) with relatively low base saturation.

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.

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, duration, and depth 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).

Dystric Haplustands: Andisol soils with relatively low base saturation.

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.

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.

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.

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.

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.

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 of 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.

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 the Hawaiian Islands, 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.

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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	09/26/2026
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:
