

The Common Range and Forage Types of the Islands of Hawaii

By Joseph A. May

On the Ground

- The major range and forage types on the islands of Hawaii are principally naturalized plant communities with a steady-state disclimax, though there are more seldom-occurring naturalized and even less-often-occurring native historic types present.
- In this article, I describe the characteristics of the six major range types using traditional Clements–Dyksterhuis range models for simplicity. My goal is to assist conservationists or professional agriculturalists in making decisions on ranches and public lands of Hawaii.

Keywords: Hawaii; range types; Clements–Dyksterhuis range model.

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Generally, the major range and forage types of Hawaii, which are principally naturalized plant communities, with a steady-state disclimax, can be categorized into about six groups. However, there are other, more seldom-occurring naturalized groups, and even less-often-occurring native, historic climax range-land plant communities still present. The principal six naturalized range and forage types that typically compose a good majority of the grazing land acres are 1) Leeward Coastal Desert range type, 2) Leeward Semiarid Midgrass Steppe range type, 3) Subhumid and Humid Tallgrass range types, 4) Temperate Subhumid range type, 5) Humid Lowland/Humid range type, and 6) Humid Very Tall Grass range type. In this article, I focus on these six naturalized range and forage types that occur on six of the eight major Hawaiian islands (Kauai, Oahu, Lanai, Molokai, Maui, and Hawaii). The islands of Niihau and Kahoolawe are not included as I have no field experiences on these two other major islands.

I have elected to present the ecological dynamics of each range type in a traditional Clements–Dyksterhuis range condition model for simplicity of reading and understanding. I hope to assist conservationists or professional agriculturalists in understanding the average annual forage production and ecological dynamics to better inform them for decision-making on ranches and public rangelands in the state of Hawaii.

Leeward Coastal Desert Range Type

The Leeward Coastal Desert range type occurs on the leeward sides of all the islands in the arid zones. The Leeward Coastal Desert range type was referred to as “Pasture Group 1” and “Pasture Group 2” in the soil survey of the island of Hawaii¹ and the soil survey of the islands of Kauai, Oahu, Molokai, and Lanai.² This range type occurs in the present Major Land Resource Areas (MLRAs)³ 157 and 166 and to a lesser extent in MLRA 163. This particular range type occurs in an annual rainfall zone of about 127 mm to 254 mm (5 to 10 inches), though it can occur into an annual rainfall area of about 381 mm (15 inches). The local climate of this range type is xeric–aridic in nature, with xeric meaning the principal rainfall is in the winter months, with hot summers with scant rainfall or none at all.

This range type should be considered a naturalized range-land. Thorn savannah (Fig. 1a) or open grassland (Fig. 1b) characterize this naturalized range type. The thorn savannah generally occurs immediately along leeward desert coastal areas, with the open grassland many times occurring just above the thorn savannah, at a slightly higher elevation, as a transition to the Subhumid Tallgrass range type. Some conservationists in Hawaii may refer to this range plant community in general terms as the “kiawe–buffelgrass” (*Prosopis pallida*–*Pennisetum ciliare*) or “buffelgrass” range type.

When this range type is heavily grazed by livestock, the buffelgrass, green panicgrass (*Panicum maximum* var. *trichoglume*), pilgrass (*Heteropogon contortus*), Australian bluegrass (*Dicantheum sericeum*), koa-haole (*Leucaena leucocephala*, also known as white leadtree on the US mainland), and desmanthus (*Desmanthus virgatus*, also known as wild tanton on the US mainland) decrease in volume. Pitted beardgrass (*Bothrio-*

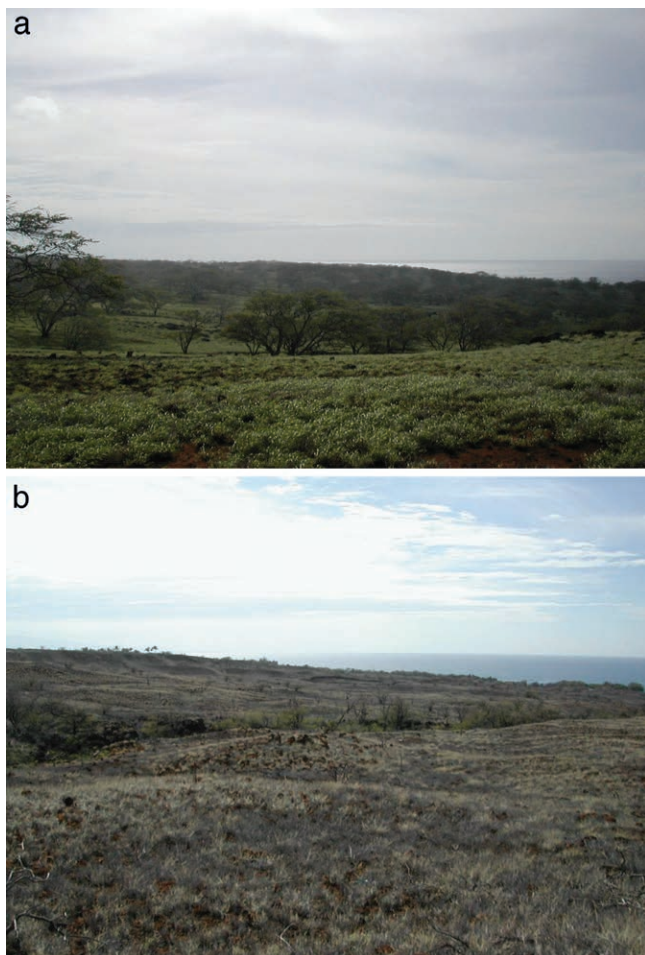


Figure 1. a, A landscape view of the Leeward Coastal Desert range type in rainy December. Note the luxuriant growth of buffelgrass, and the Pacific Ocean in the right background. This is a desert thorn savannah in MLRA 157, on the Kohala Coast of the island of Hawaii. **b,** The open grassland aspect of the Leeward Coastal Desert range type, in the dormant growth stage, in the dry summer months. Note the Pacific Ocean in the right background.

chloa pertusa, referred to as white pilgrass in the soil survey reports^{1,2}) can be the principal increasing grass under these circumstances, but also with smaller amounts of Rhodesgrass (*Chloris gayana*), Natal redtop (*Melinis repens*, rose Natal grass on the US mainland), feather fingergrass (*Chloris virgata*), swollen fingergrass (*Chloris barbata*) can increase. With continuous heavy livestock grazing, Bermudagrass (*Cynodon dactylon*) can begin to increase, as well as noticeable amounts of other undesirable and unpalatable forbs. Klu bush (*Acacia*

farnesiana, also known as sweet acacia in the US Southwest) and lantana (*Lantana camara*) may also be increasing at this deteriorated ecological state. At higher elevations, Carolina lovegrass (*Eragrostis pectinacea*) may also increase with continued deterioration, as may the three native annual arid panicgrasses: torrid panicgrass (*Panicum torridum*), Maui panicgrass (*Panicum pellitum*), and kakonakona (*Panicum xerophilum*).

A possible general Clements–Dyksterhuis pathway for the ecological dynamics of the naturalized MLRA157 and 166 Leeward Coastal Desert range type due to the influence of heavy, continuous livestock grazing is presented in Figure 2.

Leeward Semiarid Midgrass Steppe Range Type

The Leeward Semiarid Midgrass Steppe range type occurs principally on the leeward side of the island of Hawaii, and at elevations just above the Leeward Coastal Desert range type. Though this particular range type principally occurs on the island of Hawaii, it is of significant acreage, and thus is included in this paper. This particular range type occurs in MLRA 161B. It occurs in an annual rainfall zone of about 254 mm to 508 mm (10–20 inches) and has a xeric and semiarid climate in nature, with most of the rainfall and plant growth occurring in the winter and spring months, and a hot, dormant growing season in the summer months with little to no rainfall. This range type should be considered naturalized rangeland. The aspect should be characterized as either a shrub–midgrass steppe (Fig. 3a) or more of an open grassland (Fig. 3b). Some conservationists refer to this range plant community in general terms as the “fountaingrass” (*Pennisetum setaceum*) range type. When this particular range type occurs as a shrub–midgrass steppe it includes the native shrub, aalii (*Dodonaea viscosa*, also known as Florida hopbush, in Florida), and fountaingrass.

In an undisturbed disclimax or high range ecological condition, a scattered low overstory canopy of the native shrub, aalii, characterizes the shrub–midgrass steppe aspect with an understory principally dominated by fountaingrass. There can also be the presence of the introduced shrubs koa-haole and bush indigo (*Indigofera suffruticosa*). The open grassland steppe aspect has the same or very similar plant species composition, with the noticeable exception of aalii, in a near-disclimax state.

As this range type is subject to heavy livestock grazing, fountaingrass, koa-haole, and bush indigo decrease in volume. Increasing grasses, under these circumstances, can include thatchinggrass (*Hyparrhenia hirta*), barbwiregrass (*Cymbopogon refractus*), and Natal redtop, and smaller amounts of



Figure 2. Leeward Coastal Desert range type Clements–Dyksterhuis pathway.

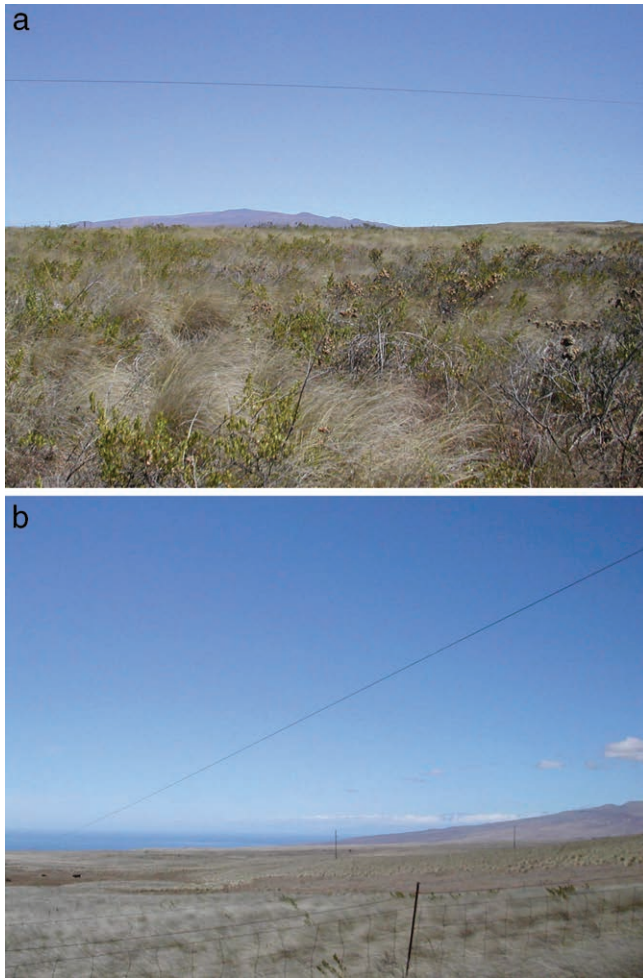


Figure 3. a, A close landscape view of the aalii-fountaingrass (shrub-midgrass) aspect in West Hawaii in the dry summer months. Note the extinct volcanic mountain of Mauna Kea in the far background. **b,** A landscape view of the Leeward Semiarid Midgrass Steppe range type in West Hawaii in the dry summer months. Note the Pacific Ocean in the far distant background.

buffelgrass, narrowleaf plaitain (*Plantago lanceolata*), lowhop clover (*Trifolium campestre*), and red pualele (*Emilia sonchifolia*, also known as lilac tasselflower on the US mainland). With severe deterioration, a shortgrass sod of Bermudagrass can now begin to increase at lower elevations, and low-vigor kikuyugrass (*Pennisetum clandestinum*) sod at higher elevations, as well as noticeable amounts of weedy annual forbs. Noxious shrubs may also begin to invade this range type under these circumstances.

A possible general Clements–Dyksterhuis pathway for the ecological dynamics of the naturalized Leeward Semiarid

Midgrass Steppe range type due to the influence of heavy, continuous livestock grazing is presented in Figure 4.

Subhumid and Humid Tallgrass Range Types

The Subhumid and Humid Tallgrass range types occur on both leeward and windward sides of most of the major islands, at sea level to middle elevations. These particular range types occur principally in MLRAs 158, 159A, and 159B, and to a lesser extent in MLRA 163. The Subhumid Tallgrass range type occurs in an annual rainfall zone of 508 mm to 1,651 mm (20 inches to about 65 inches). The Humid Tallgrass range type, likewise, can occur from sea level (particularly along the Hamakua Coast of eastern Hawaii) to middle elevations. However, the annual rainfall zone ranges from about 1,905 mm to 3,810 mm (75–150 inches). The aspect of both range types should be considered naturalized open, tall grassland (Fig. 5a), as a disclimax originating mostly on former commercial sugarcane and pineapple plantation farm-lands. In the case of the Subhumid Tallgrass range type, the aspect can include a thorn savannah (Fig. 5b) with a kiawe tree overstory. Conservationists refer to these range plant communities in general terms as the “guineagrass” range type. This range type is most similar to “Pasture Group 3” or “Pasture Group 5” in the soil survey reports.^{1,2}

In the present, naturalized disclimax steady state, the open grassland aspect is characterized by a tallgrass community dominated principally by guineagrass (*Panicum maximum*) and the twining, herbaceous legume, glycine (*Neonotonia wightii*). In the case of the Humid Tallgrass range type, the small herbaceous legume, hetero (*Desmodium heterophyllum*), is a conspicuous disclimax component. In the case of the Subhumid Grassland, the introduced shrubs koa-haole, desmanthus, and bush indigo can also occur in the present disclimax steady state. Desmanthus primarily occurs on this range type in the delineations of MLRA 158 and 159 on the islands of Oahu and Kauai.

As the Subhumid Tallgrass and Humid Tallgrass range types are subject to heavy livestock grazing, guineagrass, glycine, koa-haole, desmanthus, and bush indigo decrease in volume. Where the Subhumid Tallgrass range type occurs in an annual rainfall zone of about 508 mm to 889 mm (20–35 inches), pitted beardgrass is usually the increasing grass in these circumstances, but smaller amounts of Rhodesgrass, Natal redtop, feather fingergrass, and swollen fingergrass can also increase. Where the Subhumid Tallgrass occurs in an annual rainfall zone of about 889 mm to 1,651 mm (35–65 inches), Rhodesgrass, Natal redtop, sourgrass (*Digitaria insularis*), and buffelgrass (particularly in delineations of MLRA 163) can be the increasing grasses. In

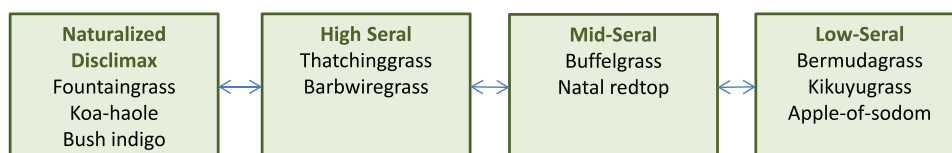


Figure 4. Leeward Semiarid Midgrass Steppe range type Clements–Dyksterhuis pathway.



Figure 5. a, A subhumid tallgrass land dominated by guineagrass in MLRA 158, in the northwest of the island of Hawaii. Note the luxuriant, verdure of this 1.5-m to 1.8-m-plus (5–6-foot-plus)-high stand of guineagrass. **b,** An ecologically deteriorated MLRA 158 subhumid thorn savannah on the island of Hawaii. The tall trees in the background are the thorny, leguminous kiawe. The dried bunchgrasses are dormant guineagrass in a matrix of midseral pitted beardgrass. The shrub in the right middle ground is the noxious apple-of-Sodom, also evidence of past heavy, continuous livestock grazing.

the Humid Tallgrass, Hilograss (*Paspalum conjugatum*) is the principal increasing grass but Rhodesgrass and green kyllinga (*Kyllinga brevifolia*), a sedge, also increase. With continuous heavy livestock grazing, wiregrass (*Eleusine indica*) (known as goosegrass on the US mainland), and Puerto Rican stargrass (*Cynodon plectostachyus*) now begin to increase, particularly in the 889-mm to 1,651-mm (35–65-inch) rainfall zone, as do Bermudagrass, in the 508-mm to 889-mm (20–35-inch) rainfall zone and Vaseygrass (*Paspalum urvillei*), in the Humid Tallgrass range type. Under severe deterioration, klu bush, lantana, and apple-of-Sodom (*Solanum sodomium*, in the Subhumid Tallgrass range type) may begin to invade, and guava (*Psidium guajava*) and sourbush (*Pluchea odorata*) will also readily invade the Humid Tallgrass range type. In both the Subhumid Tallgrass and Humid Tallgrass range types, Carolina lovegrass, rat-tail (*Sporobolus indicus* var. *capensis*), and smutgrass (*Sporobolus indicus* var. *indicus*) will invade under severe deterioration, as well as broomsedge (*Andropogon virginicus*) and bushy bluestem (*Andropogon glomeratus*) in the Humid Tallgrass.

Possible, general Clements–Dyksterhuis pathways for the ecological dynamics of the naturalized MLRA158 and 159A and 159B Subhumid Tallgrass range type and Humid Tallgrass range type due to the influence of heavy, continuous livestock grazing are presented in Figures 6a and 6b, respectively.

Temperate Subhumid Range Type

The Temperate Subhumid range type occurs on the leeward and windward sides of Hawaii, Maui, and Molokai, in particular, at middle to high elevations. The ranches and range-lands that occur at these higher elevations are described as “up country” by local residents in Hawaii. This particular range type occurs principally in MLRAs 158, 159A and 159B, 160, 161B, and 165. This range type occurs in an annual rainfall zone extending from about 508 mm (20 inches) to as high about as 2,540 mm (100 inches). This range type should be

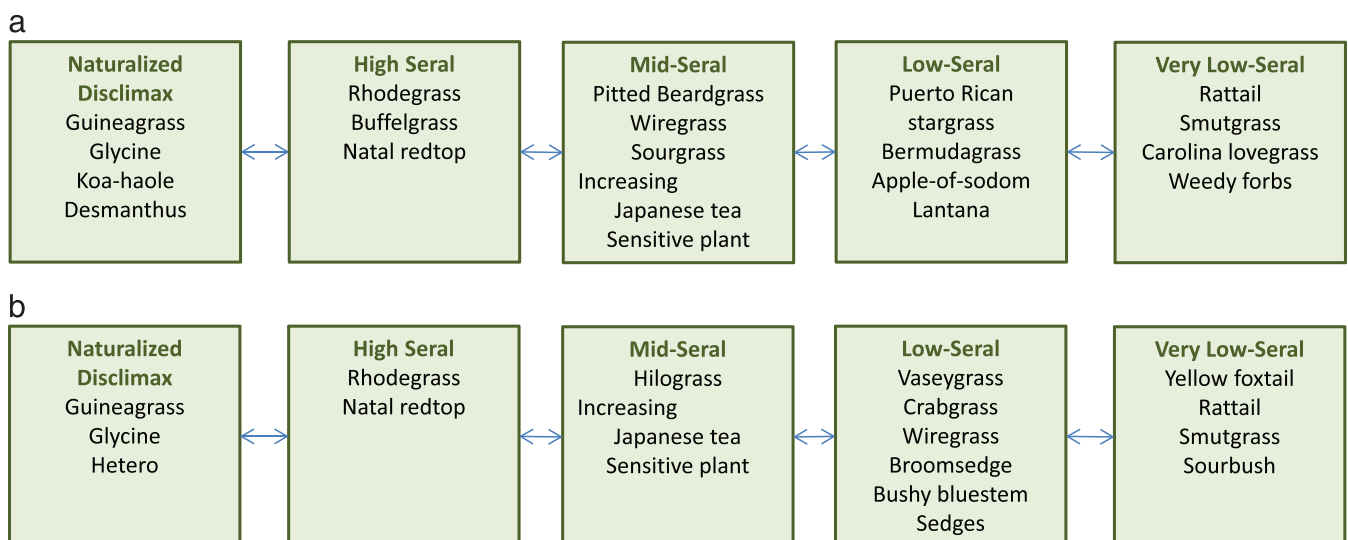


Figure 6. a, Subhumid Tallgrass range type Clements–Dyksterhuis pathway. **b,** Humid Tallgrass range type Clements–Dyksterhuis pathway.

considered naturalized rangeland and more specifically a naturalized pasture type as most of this range type occupies former native forestland, specifically in most cases the native ohia lehua (*Metrosideros polymorpha*) associations (Fig. 7a). The aspect of this range type is either a savannah type (Fig. 7b) or open grassland (Fig. 7c); depending on the amount of native trees left standing after forest-opening operations. Conservationists refer to this as the “kikuyugrass” range type or the “kikuyu–pangola” (*Digitaria eriantha*) range type. This range type can be separated into about three subtypes based on annual rainfall zones. Those annual rainfall zones would be 1) 508 mm to 762 mm (20–30 inches), 2) 762 mm to 1,905 mm (30–75 inches), and 3) 1,905 mm to 2,540 mm (75–100 inches). The principal defining difference between the three range subtypes is the amount of annual forage production.

In disclimax or a high range ecological condition state, the previously mentioned savannah aspect is characterized by a scattered overstory canopy of principally native ohia lehua trees and/or native koa trees (*Acacia koa*), and an understory principally dominated by kikuyugrass, pangola, kaimi clover (*Desmodium incanum*) or white clover (*Trifolium repens*), and in some instances greenleaf ticktrefoil (*Desmodium intortum*). At the higher elevations, particularly in the 1,905-mm to 2,540-mm (75–100-inch) annual rainfall range subtype, which has cooler ambient and soil temperatures, there can also occur smaller amounts of cool-season grasses such as orchardgrass (*Dactylis glomerata*), Kentucky bluegrass (*Poa pratensis*), Yorkshire fog or velvetgrass (*Holcus lanatus*), and perennial ryegrass (*Lolium perenne*).

As this range type is subject to heavy livestock grazing, kikuyugrass, pangola, cool-season grasses, and desirable forage legumes decrease in volume. The exception is kaimi clover, which, though it is relatively high in crude protein, is also relatively high in the secondary metabolites of tannins, and as a result is not always highly utilized by cattle, in particular. Under heavy livestock grazing, narrowleaf carpetgrass (*Axonopus fissifolius*) is the principal increasing grass, along with smaller amounts of rattail, smutgrass, and sedges (*Carex* spp.). With severe deterioration, noxious shrubs such as guava, strawberry guava (*Psidium cattleianum*), Christmasberry (*Schinus terebinthifolius* var. *raddianus*, also known as Brazilian peppertree on the US mainland), and thimbleberry (*Rubus rosifolius*) can invade at higher elevations, and Jerusalem cherry (*Solanum pseudocapsicum*) and apple-of-Sodom at lower elevations. Undesirable grasses and grasslike vegetation and weedy forbs such as yellow foxtail (*Setaria pumila*), sweet vernalgrass (*Anthoxanthum odoratum*), broomsedge, bushy bluestem, weedy annual forbs, and more recently the introduced noxious weed, fireweed (or Madagascar ragwort, *Senecio madagascariensis*) will also invade.

A possible general Clements–Dyksterhuis pathway for the ecological dynamics of the naturalized Temperate Sub-humid range type due to the influence of heavy, continuous livestock grazing is presented in Figure 8. This range type is most similar to “Pasture Group 7” (Improved) in the soil survey reports.^{1,2}



Figure 7. **a**, This is native, undisturbed, pristine climax ohia lehua–tree fern (“hapuu,” *Cibotium* sp.) cloud forest on the island of Hawaii. Most the kikuyugrass range type occupies what is now cleared native cloud forest. **b**, A kikuyugrass pasture in the upper elevations of MLRA 159, on the island of Hawaii. The scattered tree overstory is composed of native ohia lehua trees. This grazing land was formerly native cloud forest up until about the end of World War II. **c**, Typical of the kikuyugrass range type in MLRAs 159, 160, and 165 (particularly on the island of Maui). Note that there is essentially 100% ground cover.

Humid Lowland/Humid Range Types

The Humid Lowland/Humid range types occurs principally on the windward sides of most of the islands, in particular Hawaii, Maui, Oahu, and Kauai. This particular range type occurs principally in MLRAs 158, 158, 159A and B, 165, and 167. This Humid Lowland range type occurs principally

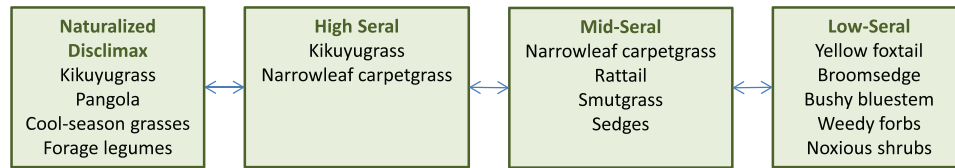


Figure 8. Temperate Subhumid range type Clements–Dyksterhuis pathway.

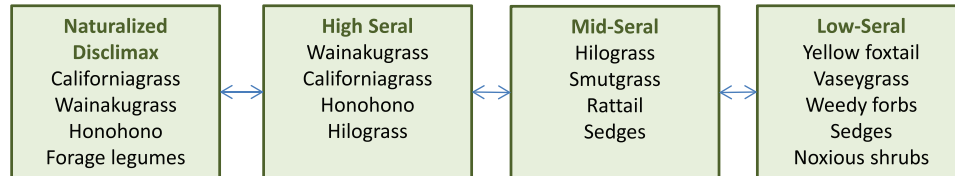


Figure 9. Humid Lowland/Humid range type Clements–Dyksterhuis pathway.

on lowland areas, at relatively low elevations. The Humid Lowland range type in most cases can be considered natural wetlands with hydric soils and a wetland hydrology. The Humid Lowland range type generally occurs in a 1,270-mm to 2,540-mm (50–100-inch) annual rainfall zone. When this naturalized plant community is found at higher elevations, the conservationist may wish to refer to this as the Humid range type, and it can occur where there are localized water tables on upland positions of the landscape. The Humid range does occur in a 2,540-mm to 5,080-mm (100–200-inch) rainfall zone in areas of MLRA 159A in East Hawaii.

The Humid Lowland/Humid range types should be considered naturalized rangeland. The aspect of the range type is an open grassland and, on former commercial sugarcane plantations, farmland, when it is considered the Humid range type. Conservationists refer to this plant community in general terms as the “Californiagrass” (*Brachiaria mutica*) range type. Californiagrass is also known by its South American common name, para. This range type is most similar to “Pasture Group 9 (unimproved)” in the soil survey reports.^{1,2}

In the present disclimax or a high range ecological condition state, the open grassland is characterized by almost a monoculture of Californiagrass, and in some instances, and a trailing naturalized forb, honohono (*Haplostachys haplostachya*) (climbing dayflower in other parts of the United States).

As this range type is subjected to heavy livestock grazing, Californiagrass and any forage legumes that may be present decrease in volume. Hilograss and sedges are generally the increasing plant species. For a time, honohono will increase as the disclimax monoculture is affected, but it too will disappear rapidly, as this forb is relished by cattle. Under severe deterioration on the upland Humid range type, yellow foxtail, rattail, smutgrass, weedy forbs, and noxious shrubs such as soursbush, guava, and strawberry guava will invade. In the Humid range type, Vaseygrass can invade also.

A possible general Clements–Dyksterhuis pathway for the ecological dynamics of the naturalized Humid Lowland/Humid range type due to the influence of heavy, continuous livestock grazing is presented in Figure 9.

Humid Very Tall Grass Range Type

The Humid Very Tall Grass range type occurs on both leeward and windward sides of most the islands at middle elevations. This particular range type occurs in MLRAs 158, 159A and B, and 165. This range type occurs in an annual rainfall zone of about 1,778 mm to 3,810 mm (70–150 inches). This range type should be considered a naturalized rangeland. The aspect can be generally characterized as tall-statured open grassland on former commercial sugarcane plantation farmlands. Some conservationists in Hawaii refer to this range plant community in general terms as the “Napier elephantgrass” (*Pennisetum purpureum*) range type. This range type is of relatively minor acreage in comparison to the other previously described range types.

In the present disclimax state, this tall-statured, open grassland is characterized by a monoculture of Napier elephantgrass, but with some smaller amounts of guineagrass in some instances.

As this range type is subject to heavy livestock grazing, the Napier elephantgrass and any guineagrass present, as well as any desirable forage legumes present, decrease in volume. Hilograss, rattail, smutgrass, Vaseygrass, and sedges can be the increasing grasses and grasslikes under these circumstances. With severe deterioration, noxious shrubs such as guava, strawberry guava, clidemia (*Clidemia hirta*), and soursbush can invade. Undesirable grasses and weedy forbs can also invade.

A possible general Clements–Dyksterhuis pathway for the ecological dynamics of the naturalized Humid Very Tall Grass range type due to the influence of heavy, continuous livestock grazing is presented in Figure 10.

Approximate Annual Forage Production and Annual Growth Curves

In Tables 1 and 2, I present average annual forage expectations and approximate growth curves for each of the six range types. I would like to clearly emphasize that all annual production figures (Table 1), as well as annual growth curve figures (Table 2), are not to be considered absolutes, but are average figures that can be used as a starting point in ranch management. On-

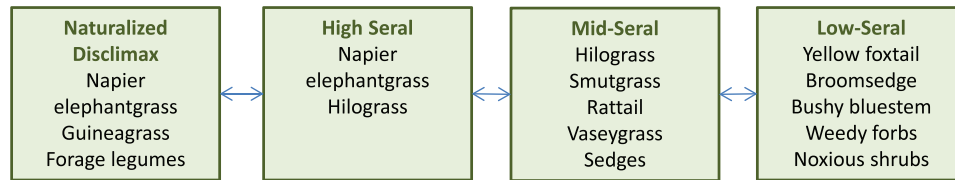


Figure 10. Humid Very Tall Grass range type Clements–Dyksterhuis pathway.

site forage and range inventories are preferred for determining on-ranch forage conditions and current annual production. All the annual production figures, whether stated in this report or determined by actual on-site inventories, can and will vary during periods of recognized drought.

Summary

I prepared this article to give an overview of the major naturalized range types of the state of Hawaii. Through there are

still some native historic climax rangeland ecological sites, the vast majority of Hawaii’s rangeland and livestock forage base does in fact consist of naturalized plant communities composed of principally introduced vegetation. My primary purpose is to provide the rangeland management specialist, professional agriculturalist, soil conservationist, extension agent, as well as other specialists the basis for making sound and informed, ecologically based conservation planning decisions on ranches and public lands in the state of Hawaii.

Table 1. Average annual forage production expectation (air-dried weights) in naturalized disclimax steady states only

Range types and precipitation zones	Above-average rainfall years		Average rainfall years		Below-average rainfall years	
	kg/ha	Pounds per acre	kg/ha	Pounds per acre	kg/ha	Pounds per acre
Leeward Coastal Desert	2,800	2,500	1,680	1,500	448–784	400–700
Leeward Semiarid Midgrass Steppe	3,360	3,000	2,240	2,000	448–784	400–700
Subhumid Tallgrass (508–889 mm PZ))	7,840	7,000	4,480	4,000	2,240	2,000
Subhumid Tallgrass (889–1,651 mm PZ) and Humid Tallgrass (1,905–3,810 mm PZ)	17,920	16,000	13,440	12,000	8,960	8,000
Temperate Subhumid (508–762 mm PZ)	5,600	5,000	2,240	2,000	560	500
762–1,905 mm PZ	8,960	8,000	4,480	4,000	2,240	2,000
1,905–2,540 mm PZ	5,600–8,960	5,000–8,000	4,480–6,720	4,000–6,000	1,120–2,240	1,000–2,000
Humid	6,720	6,000	3,360	3,000	1,120	1,000
Humid Lowland	8,960	8,000	6,720	6,000	4,480	4,000
Humid Very Tall Grass	17,920	16,000	15,680	14,000	11,200	10,000

PZ indicates precipitation zone.

Table 2. Approximate vegetative growth curves on percentage basis

An approximate annual growth curve for the Leeward Coastal Desert range type											
January	February	March	April	May	June	July	August	September	October	November	December
30	30	13	1	1	1	1	1	1	1	8	20
An approximate annual growth curve for the Leeward Semiarid Midgrass Steppe range type											
January	February	March	April	May	June	July	August	September	October	November	December
16	18	18	12	11	5	3	2	2	3	4	6
An approximate annual growth curve for the Temperate Subhumid range type											
January	February	March	April	May	June	July	August	September	October	November	December
2	2	3	4	6	16	18	18	12	11	5	3
An approximate annual growth curve for the Subhumid and Humid Tallgrass range types											
January	February	March	April	May	June	July	August	September	October	November	December
1	3	11	22	21	20	17	1	1	1	1	1
An approximate annual growth curve for the Humid Lowland and Humid range subtypes											
January	February	March	April	May	June	July	August	September	October	November	December
2	2	3	4	6	16	18	18	12	11	5	5
An approximate annual growth curve for the Humid Very Tall Grass range type											
January	February	March	April	May	June	July	August	September	October	November	December
1	3	11	22	21	20	17	1	1	1	1	1

Acknowledgments

The author would like to dedicate this article, in the spirit of aloha, to all past and present US Department of Agriculture, Natural Resources Conservation Service (NRCS)–Pacific Islands Area conservationists, as well as to all past and present personnel of the University of Hawaii at Manoa Cooperative Extension Service, and to all that “malama o ka aina” (love and respect the land) of Hawaii. This author would also like to dedicate this article to the memory of our good friend and colleague, the late Larry Shinshiro, former state conservation agronomist for NRCS–Hawaii, whom we all miss so much, and held in such high regard.

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