18080

Hawai'i Lowland Rainforest

BpS Model/Description Version: Aug. 2020

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Vegetation Type

Forest and Woodland

Map Zones

79

Geographic Range

This system occurs from sea level to 1,000m (0-3,280ft) elevation on Kaua'i, O'ahu, Moloka'i, Lana'i, Maui, and Hawai'i. Hawai'i Lowland Rainforest occurs on all the main islands except Ni'ihau and Kaho'olawe.

Biophysical Site Description

Lowland wet forests are thought to have been the predominant original vegetation of the windward lowlands on the larger main islands (Zimmerman, 1948). The system occurs on windward slopes high enough to intercept orographic rainfall resulting from rising moist tradewind air. Soils vary throughout the island chain, from gray acid clays on older islands to thin organic mucks over lava flows and ash beds on Hawai'i.

Vegetation Description

The canopy is dominated by *Metrosideros polymorpha* or, in some forests, by *Acacia koa* where it attains heights of up to 40m. On some islands, this system forms a distinct belt above Acacia-dominated mesic forest. Diversity in the lowland rainforest is high, and *Metrosideros* and *Acacia* at times form an emergent layer over a diverse layer of native trees beneath the *Metrosideros* canopy, and an understory of native ferns, herbs, shrubs and vines, including *Alyxia oliviformis*, *Antidesma platyphyllum*, *Broussaisia arguta*, *Cheirodendron* spp., *Cibotium* spp., *Coprosma* spp., *Cyrtandra* spp., *Dicranopteris linearis*, *Diospyros sandwicensis*, *Freycinetia arborea*, *Hedyotis* spp., *Ilex anomala*, *Korthalsella* spp., *Machaerina* spp., *Melicope* spp., *Myrsine* spp., *Peperomia* spp., *Pittosporum* spp., *Perrottetia sandwicensis*, *Psychotria* spp., *Sadleria* spp., *Smilax melastomifolia*, and in some areas *Pritchardia* spp. Native trees that occur in the understory include kopiko (*Psychotria hawaiiensis*) and hame (*Antidesma platyphyllum*). The endemic liama (*Freycinetia arborea*) is often abundent in these forests. Species that act as epiphytes include *Astelia menziesiana*, *Peperomia* spp., *Adenophorus*, *Huperzia*, and *Elaphoglossum* spp. In the upper reaches of the lowland ohi'a forest on the island of Hawai'i the understory is dominated by tree ferns or hapu'u (*Cibotium* spp.) which form a distinct closed layer beneath the trees. A more open *Metrosideros* forest with other scattered native trees and a dense ground cover of the indigenous mat-forming uluhe (*Dicranopteris linearis*) and other related ferns (*Diplopterigium pinnatum*, *Sticherus owhyensis*) is seen on steep ridges and valley walls of Kaua'i, O'ahu, Moloka'i, Maui, and the Kohola Mountains of Hawai'i Island (Cuddihy et al. 1990). *Freycinetia*, *Antidesma platyphyllum*, *Perrottetia*, and *Bobea* are constituents restricted largely to the lowland zone.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| MEPO5 | *Metrosideros polymorpha* | 'ohi'a lehua |
| CHTR2 | *Cheirodendron trigynum* | Olapalapa |
| BOEL3 | *Bobea elatior* | 'ahakea lau nui |
| ANPL2 | *Antidesma platyphyllum* | Ha'a |
| BRAR6 | *Broussaisia arguta* | Kanawao |
| DILI | *Dicranopteris linearis* | Old world forkedfern |
| PESA3 | *Perrottetia sandwicensis* | Olomea |
| CIGL | *Cibotium glaucum* | Hapu'u |

Species names are from the NRCS PLANTS database. Check species codes at http://plants.usda.gov.

Disturbance Description

The lowland wet forest was historically (pre-Polynesian times) more widespread below 1,000m (3,280ft) elevation on the larger islands in windward areas with deep soils before being subjected to cultivation by Hawaiians. Where lands cultivated by Hawaiians were not subsequently used for agriculture, grazing, or urban development, they were invaded by species of Polynesian introduction, particularly kukui (*Aleurites moluccana*) and by later post-European introductions such as strawberry guava (*Psidium cattleianum*). Disturbances in this system include landslides in wet valleys, flood, lava flows, storms, rat predation, and fire. Landslides occur in all seral states except the early development. Landslides are considered to be infrequent events but they have large impacts and will cause later development (seral) stages to transition back to A. Landslides are not currently incorporated into the model.

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement |  |  |  |  |
| Moderate (Mixed) | 1090 | 100 |  |  |
| Low (Surface) |  |  |  |  |
| All Fires | 1090 | 100 |  |  |

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

Adjacency or Identification Concerns

This system closely resembles and is often found adjacent to Hawai'I Montane Rainforest (CES412.215) and Hawai'i Uluhe Fern Shrubland (CES412.219).

Issues or Problems

The boundary between the lowland and montane wet forests in Hawai'i is not generally agreed upon by all botanists and ecologists, and it may be variable on different islands. A clear picture of pre-human vegetation is complicated by the extreme disturbance the lowlands have suffered. Nonetheless, roughly 1,000m elevation marks the transition between the warmer lowlands and the cooler montane zone.

Native Uncharacteristic Conditions

Comments

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Succession Classes

**Mapping Rules**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Upper Layer Lifeform** | **Height (m)** | **Canopy Cover (%)** | | | | | | | | | |
| **0-10** | **11-20** | **21-30** | **31-40** | **41 - 50** | **51-60** | **61-70** | **71-80** | **81-90** | **91-100** |
| Herb | 0-0.5 | A | A | A | A | A | A | A | A | A | A |
| Herb | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Herb | >1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0-0.5 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 1.0-3.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | >3.0 | A | A | A | A | A | A | A | A | A | A |
| Tree | 0-5 | B | B | B | B | B | B | C | C | C | C |
| Tree | 5-10 | B | B | B | B | B | B | C | C | C | C |
| Tree | 10-25 | E | E | E | E | E | E | D | D | D | D |
| Tree | 25-50 | E | E | E | E | E | E | D | D | D | D |
| Tree | >50 | E | E | E | E | E | E | D | D | D | D |

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

**Description**

Class A 5 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| MEPO5 | Metrosideros polymorpha | 'ohi'a lehua | Upper |
| DILI | Dicranopteris linearis | Old world forkedfern | Upper |
| VARE | Vaccinium reticulatum | Ohelo 'ai | Upper |
| POPE5 | Polypodium pellucidum | Dotted polypody | Upper |

Description

Recent lava flow landscape with 0-10% pioneer vegetation that can include sapling M*etrosideros* and various ferns, forbs, and shrub species. Variants may include *Dicranopteris*-dominated pioneer vegetation. Of the two major lava flow types, seral development occurs more rapidly on 'a'a (rough, clinkery) than on pahoehoe (smooth). Current restricted to the island of Hawai‘i, largely on the eastern flank, associated with lava flows from Mauna Loa and Kilauea, running through lowland wet regions.

*Maximum Tree Size Class*  
None

Class B 10 Mid Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| MEPO5 | Metrosideros polymorpha | 'ohi'a lehua | Upper |
| DILI | Dicranopteris linearis | Old world forkedfern | Lower |
| SAPA11 | Sadleria pallida | Ama'u | Lower |
| BRAR6 | Broussaisia arguta | Kanawao | Low-Mid |

Description

Open woodland of *Metrosideros* over a mixed groundcover of *Dicranopteris*, other ferns, and shrubs. Dominant cover is understory ferns and shrubs.

*Maximum Tree Size Class*  
Medium 9-21"DBH

Class C 16 Mid Development 2 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| MEPO5 | Metrosideros polymorpha | 'ohi'a lehua | Upper |
| PSHA3 | Psychotria hawaiiensis | Kopiko 'ula | Middle |
| DILI | Dicranopteris linearis | Old world forkedfern | Lower |
| CIGL | Cibotium glaucum | Hapu'u | Middle |

Description

Closed *Metrosideros* forest with simple understory of trees, treeferns, shrubs, and ferns. Other native trees may include *Pandanus*, *Cheirodendron*, *Ilex*, and *Myrsine*. Tree ferns include *Cibotium* and *Sadleria* spp. Shrubs include *Cyrtandra*, *Broussaisia*, and *Coprosma*. Lianas and vines include *Freycinetia* and *Alyxia*. Ferns include *Diplazium*, *Athyrium*, *Pteris*, *Elaphoglossum*, and *Asplenium* spp. Herbs and forbs include *Astelia*, and *Peperomia*.

*Maximum Tree Size Class*  
Large 21-33" DBH

Class D 60 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| MEPO5 | Metrosideros polymorpha | 'ohi'a lehua | Upper |
| CHTR2 | Cheirodendron trigynum | Olapalapa | Upper |
| PSHA3 | Psychotria hawaiiensis | Kopiko 'ula | Lower |
| ANPL2 | Antidesma platyphyllum | Ha'a | Lower |

Description

*Metrosideros* is the tallest forest canopy former among many other native Hawaiian tree species found in this mature forest type. Other common trees in this rich climax stage include *Ilex*, *Bobea*, *Melicope*, *Diospyros*, *Pritchardia*, *Myrsine*, *Tetraplasandra*, *Pandanus*, *Perrottetia*, *Syzygium*, *Acacia*, and *Claoxylon*. Shrubs include *Toucharida*, *Hedyotis*, *Broussaisia*, *Cyrtandra*, *Clermontia*, *Cyanea*, *Coprosma*, and *Vaccinium*. Lianas and vines include *Freycinetia*, *Alyxia*, and *Smilax*. Many ferns and herbs in groundcover.

*Maximum Tree Size Class*  
Very Large >33" DBH

Class E 9 Late Development 1 - Open

Upper Layer Lifeform: Tree

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| MEPO5 | Metrosideros polymorpha | 'ohi'a lehua | Upper |
| CHTR2 | Cheirodendron trigynum | Olapalapa | Upper |
| PSHA3 | Psychotria hawaiiensis | Kopiko 'ula | Lower |
| ANPL2 | Antidesma platyphyllum | Ha'a | Lower |

Description

This is a storm-disturbance and/or canopy dieback variant in which canopy has been opened, but constituent species remain largely the same (rich in several layers).

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Mid1:OPN | 50 |
| Mid1:OPN | 51 | Mid2:CLS | 90 |
| Mid2:CLS | 91 | Late1:CLS | 180 |
| Late1:CLS | 181 | Late1:CLS | 999 |
| Late1:OPN | 181 | Late1:CLS | 205 |

Probabilistic Transitions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Disturbance Type** | **Disturbance occurs In** | **Moves vegetation to** | **Disturbance Probability** | **Return Interval (yrs)** | **Reset Age to New Class Start Age After Disturbance?** | **Years Since Last Disturbance** |
| Optional 2 | Early1:ALL | Early1:ALL | 0.0025 | 400 | Yes | 0 |
| Mixed Fire | Mid1:OPN | Mid1:OPN | 0.001 | 1000 | No | 0 |
| Optional 1 | Mid1:OPN | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Mid1:OPN | Mid1:OPN | 0.005 | 200 | No | 0 |
| Mixed Fire | Mid2:CLS | Mid1:OPN | 0.001 | 1000 | Yes | 0 |
| Optional 1 | Mid2:CLS | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Mid2:CLS | Mid1:OPN | 0.005 | 200 | Yes | 0 |
| Mixed Fire | Late1:OPN | Late1:OPN | 0.0005 | 2000 | No | 0 |
| Optional 1 | Late1:OPN | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Late1:OPN | Late1:OPN | 0.005 | 200 | No | 0 |
| Mixed Fire | Late1:CLS | Mid1:OPN | 0.001 | 1000 | Yes | 0 |
| Optional 1 | Late1:CLS | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Late1:OPN | 0.0066 | 152 | Yes | 0 |

Optional Disturbances

Optional 1: lava flow

Optional 2: Hawaiian agriculture

References

Cuddihy, L. W. and C. P. Stone. 1990. Alteration of native Hawaiian vegetation-Effects of humans, their activities and introductions

Gagne, W.C., and L.W. Cuddihy. 1990. Vegetation. Pages 45-114 in: W.L. Wagner, D.R. Herbst, and S.H. Sohmer, editors. Manual of the Flowering Plants of Hawaii. 2 Volumes. University of Hawaii Press, Honolulu.

Mueller-Dombois, D., K.W. Bridges, and H.L. Carson. 1981. Island Ecosystems: Biological Organization in Selected Hawaiian Communities. Volume 15 US/IBP Synthesis Series. Hutchinson Ross Publishing Company, Pennsylvania. 583 pp.

Mueller-Dombois, D., and F. R. Fosberg. 1998. Vegetation of the tropical Pacific islands. Springer-Verlag, New York. 733 pp.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: September 3, 2008 ).

Price, J.P., S.M. Gon III, J.D. Jacobi, and D. Matsuwaki. 2007. Mapping plant species ranges in the Hawaiian Islands: Developing a methodology and associated GIS layers. Hawai'i Cooperative Studies Unit. Technical Report HCSU-008. Pacific Aquaculture and Coastal Resources Center (PACRC), University of Hawai'i, Hilo. 58 pp., includes 16 figures and 6 tables.

Wagner, W. L., D. R. Herbst, and S. H. Sohmer. 1999. Manual of the flowering plants of Hawaii. Revised edition. Volumes 1 and 2. University of Hawaii Press and Bishop Museum Press, Honolulu. 1919 pp.

Western Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Boulder, CO.

Zimmerman, E.C. 1948. Insects of Hawaii. Vol. 1. Introduction. Univ. Hawaii Press, Honolulu. 206pp.