18090

Hawai'i Montane Cloud Forest

BpS Model/Description Version: Aug. 2020

Update: 6/6/2018

|  |  |  |  |
| --- | --- | --- | --- |
| **Modelers** |  | **Reviewers** |  |
| Darren Johnson | darren\_johnson@tnc.org |  |  |
| Jim Jacobi | jim\_jacobi@usgs.gov |  |  |
| Sam Gon III | sgon@tnc.org |  |  |

Vegetation Type

Forest and Woodland

Map Zones

79

Geographic Range

This system is found from 1,065-1,830m (3,500-6,000ft) elevation on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i.

Biophysical Site Description

Hawai'i Montane Cloud Forest occurs between 1,065-1,830m (3,500-6,000ft) elevation as a large-patch mosaic on windward aspects of all high islands that receive evenly distributed orographically derived rainfall exceeding 2,500mm (99in) annually. Montane cloud forests are defined by the regular presence of clouds, low stature of the tree canopy, the abundance of epiphytes, and the significant proportion by which those passing clouds contribute fog water (fog drip) to total annual precipitation (up to 1,073mm [42in]). Regular fog drip sustains relatively constant streamflow and shallow groundwater hydrology in montane forests, particularly during dry seasons. Hawai'i cloud forests occur on older volcanic substrates that are nutrient-poor and lateritic due to leaching. They generally have a gley layer 10-70cm (4-28in) thick with an organic overlay that vary from 10-30cm (4-12in) deep.

Vegetation Description

This ecological system is rich in species, with multiple species represented in each of several genera of shrubs and ferns. Vegetation is dominated by low stature *Metrosideros polymorpha* and *Cheirodendron* spp. (specifically *C. platyphylla* on O'ahu and *C. dominii* on Kaua'i), which form a low to medium-height canopy from 3-40m high. Subdominant tree species include *Ilex anomala*, *Alyxia oliviformis*, and shrubs: *Clermontia* spp., *Cyanea* spp., *Dubautia platyphylla*, *Korthalsella* spp., *Myrsine* spp., *Trematolobelia* spp., *Smilax melastomifolia*, *Stenogyne* spp., *Phyllostegia* spp., and *Vaccinium* spp. This system supports an abundance of epiphytic shrubs, ferns, mosses and bryophytes. Species that act as epiphytes include *Astelia menziesiana*, *Peperomia* spp., and thick mats of bryophytes. Ferns include *Dicranopteris linearis*, *Cibotium* spp., *Astelia*, *Adenophorum*, and *Elaphoglossum* spp. Cloud forests are distinguished from montane rainforests by the low stature of the tree canopy and the presence of ground-level clouds for a portion of nearly every day. Cloud forests generally support more epiphytes than montane rainforests.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| MEPO5 | *Metrosideros polymorpha* | 'ohi'a lehua |
| CHEIR | *Cheirodendron* | Cheirodendron |
| ILAN | *Ilex anomala* | Hawai'i holly |
| ALOL2 | *Alyxia oliviformis* | Maile |
| NEGR2 | *Nertera granadensis* | Makole |
| ASME4 | *Astelia menziesiana* | Pua'akuhinia |
| DILI | *Dicranopteris linearis* | Old world forkedfern |
| TREMA2 | *Trematolobelia* | False lobelia |

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

Disturbance Description

The major disturbance factors in this system are from climatic factors, particularly hurricanes and drought.

Fire Frequency

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

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

Hawai'i Montane Cloud Forest is similar to Hawaiian Montane Wet Forest, but this community is generally found only on wet wind-exposed upper slopes of the major Hawaiian Islands, and is characterized by a low-stature tree canopy and thick mats of bryophytes and epiphytes.

Issues or Problems

Native Uncharacteristic Conditions

Comments

Additional modelers include: Wayne Ching (wayne.f.ching@hawaii.gov); Andrew Beavers (Andrew.Beavers@ColoState.EDU); Richard Nezelek (rnezelek@pdc.org); Glenn Shishido (Glenn.N.Shishido@hawaii.gov); Ron Cannarella (Ronald.J.Cannarella@hawaii.gov); Dawn Greenlee (Dawn\_Greenlee@fws.gov); and Keith Schulz (keith\_schulz@natureserve.org)

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 | A | A | A | A | A | A | A | A | A | A |
| Tree | 5-10 | B | B | B | B | B | B | C | C | C | C |
| Tree | 10-25 | D | D | D | D | D | D | E | E | E | E |
| Tree | 25-50 | D | D | D | D | D | D | E | E | E | E |
| Tree | >50 | D | D | D | D | D | D | E | E | E | E |

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 |
| CHEIR | Cheirodendron | Cheirodendron | Upper |
| DILI | Dicranopteris linearis | Old world forkedfern | Mid-Upper |
| TREMA2 | Trematolobelia | False lobelia | Low-Mid |

Description

This system is found from 1,065-1,830m (3,500-6,000ft) elevation on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i. This ecological system is rich in species, with multiple species represented in each of several genera of shrubs and ferns. Vegetation is dominated by low stature *Metrosideros polymorpha* and *Cheirodendron* spp. (specifically *C. platyphylla* on O'ahu and *C. dominii* on Kaua'i), which form a low to medium-height canopy from 3-40m high. Subdominant tree species include *Ilex anomala*, *Alyxia oliviformis*, and shrubs: *Clermontia* spp., *Cyanea* spp., *Dubautia platyphylla*, *Korthalsella* spp., *Myrsine* spp., *Trematolobelia* spp., *Smilax melastomifolia*, *Stenogyne* spp., *Phyllostegia* spp., and *Vaccinium* spp. This system supports an abundance of epiphytic shrubs, ferns, mosses and bryophytes. Species that act as epiphytes include *Astelia menziesiana*, *Peperomia* spp., and thick mats of bryophytes. Ferns include *Dicranopteris linearis*, *Cibotium* spp., *Astelia*, *Adenophorum*, and *Elaphoglossum* spp. Cloud forests are distinguished from montane rainforests by the low stature of the tree canopy and the presence of ground-level clouds for a portion of nearly every day. Cloud forests generally support more epiphytes than montane rainforests. Cloud forests in the Kohala section of the island of Hawai'i include dense mats of *Shagnum palustre*. This moss species was introduced to Mt. Kaala on the island of Oahu in the 1960s and is now considered to be an invasive species in this site.

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

Class B 5 Mid Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| MEPO5 | Metrosideros polymorpha | 'ohi'a lehua | Upper |
| CHEIR | Cheirodendron | Cheirodendron | Upper |
| DUPL | Dubautia plantaginea | Plantainleaf dubautia | Middle |
| TREMA2 | Trematolobelia | False lobelia | Low-Mid |

Description

This unit represents the Hawai'i Montane Cloud Forest after major disturbance by a hurricane. Although the tree canopy will be opened up this the wind force, most of the species found in the tree canopy, subcanopy, and understory will still be found. Due to the increased light levels with the open canopy, species like *Dicranopteris linerais* may temporally increase in cover.

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

Class C 9 Mid Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| MEPO5 | Metrosideros polymorpha | 'ohi'a lehua | Upper |
| CHEIR | Cheirodendron | Cheirodendron | Upper |
| DUPL | Dubautia plantaginea | Plantainleaf dubautia | Middle |
| TREMA2 | Trematolobelia | False lobelia | Low-Mid |

Description

Disturbances in this seral stage include storms and landslides.

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

Class D 74 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| MEPO5 | Metrosideros polymorpha | 'ohi'a lehua | Upper |
| VIMA6 | Viola maviensis | Hawai'i bog violet | Lower |
| TREMA2 | Trematolobelia | False lobelia | Low-Mid |
| DUPL | Dubautia plantaginea | Plantainleaf dubautia | Middle |

Description

The endemic tree ohi'a (*Metrosideros collina* subsp. *Polymorpha*) is one of the most abundant native tree species which occurs on all of the high Hawaiian Islands. It is also one of the taller growing forest canopy formers among the many other native Hawaiian tree species. These ohi'a forests serve the important function of watershed cover on the windward slopes and on certain parts of the leeward slopes (Mueller-Dombois et al. 1998). Spaghnum moss is a major component of the understory in the Kohala mountains.

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

Class E 7 Late Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| MEPO5 | Metrosideros polymorpha | 'ohi'a lehua | Upper |
| LOHY | Lobelia hypoleuca | Kuhi'aikamo'owahie | Low-Mid |
| TREMA2 | Trematolobelia | False lobelia | Low-Mid |
| DUPL | Dubautia plantaginea | Plantainleaf dubautia | Middle |

Description

The endemic tree ohi'a (*Metrosideros collina* subsp. *Polymorpha*) is one of the most abundant native tree species which occurs on all of the high Hawaiian Islands. It is also one of the taller growing forest canopy formers among the many other native Hawaiian tree species. These ohi'a forests serve the important function of watershed cover on the windward slopes and on certain parts of the leeward slopes (Mueller-Dombois et al. 1998).

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

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Mid1:OPN | 50 |
| Mid1:OPN | 51 | Mid1:CLS | 90 |
| Mid1: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 | 0.001 | 1000 | No | 0 |
| Wind or Weather or Stress | Early1:ALL | Early1:ALL | 0.004 | 250 | No | 0 |
| Optional 2 | Mid1:OPN | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Mid1:OPN | Mid1:OPN | 0.004 | 250 | No | 0 |
| Optional 2 | Mid1:CLS | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Mid1:CLS | Mid1:OPN | 0.004 | 250 | Yes | 0 |
| Optional 2 | Late1:OPN | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Late1:OPN | Late1:OPN | 0.004 | 250 | No | 0 |
| Optional 2 | Late1:CLS | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Late1:OPN | 0.004 | 250 | Yes | 0 |

Optional Disturbances

Optional 1: Landslides

References

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., 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.

Scholl, M. A., S. B. Gingerich, and G. W. Tribble. 2002. The influence of microclimates and fog on stable isotope signatures used in interpretation of regional hydrology: East Maui, Hawai'i. Journal of Hydrology 264(1-4):170-184.

Scholl, M. A., S. Gingerich, L. Loope, T. Giambelluca, and M. Nullet. 2004. Quantifying the importance of fog drip to ecosystem hydrology and water resources in windward and leeward tropical montane cloud forests on East Maui, Hawai'i. Venture Capital Project Final Report, July 2004.

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.