



Vegetation Mapping Inventory Project

Haleakalā National Park

Natural Resource Report NPS/PACN/NRR—2015/986



ON THE COVER

Haleakalā Crater at Haleakalā National Park.

Photograph by: Kass Green

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July 2015

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Please cite this publication as:

Green, K., K. Schulz, C. Lopez, A. Ainsworth, M. Selvig, K. Akamine, C. Meston, J. Mallinson, E. Urbanski, S. Fugate, M. Hall, and G. Kudray. 2015. Vegetation mapping inventory project: Haleakalā National Park. Natural Resource Report NPS/PACN/NRR—2015/986. National Park Service, Fort Collins, Colorado.

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Executive Summary

This report details the methods used and results of the vegetation inventory for Haleakalā National Park (HALE). HALE's unique vegetation spans 13,462 ha (33,265 ac) on the Hawaiian Island of Maui and includes an active volcano. The park's dynamic landscape, huge expanse, and extreme range of elevation and climate combine to create a distinctive and exciting national park. The vegetation inventory was a team effort managed by the National Park Service (NPS), Pacific Island Network (PACN), and staffed by personnel from the NPS, University of Hawaii (UH), Cogan Technology, Inc. (CTI), NatureServe, and Kass Green & Associates (KGA).

The objective of a vegetation inventory is to “produce high-quality, standardized maps and associated data sets of vegetation and other land-cover occurring within parks” in support of resource assessment, park management and conservation needs (NPS 2013c). NPS vegetation inventories rely on a 12 Step Guidance Document which outlines the tasks to be completed in a NPS vegetation inventory:

1. Review Existing Data and "Best Practices" to Develop a Brief Proposal (1-5 pages) to Develop a Park or Network Vegetation Inventory Study Plan
2. Planning and Scoping to Gather the Detailed Information Needed to Develop the Study Plan
3. Develop and Submit a Detailed Study Plan for Approval of Funding
4. Field Plot Data Collection (for the Ecological Classification)
5. Develop Vegetation Classification, Vegetation Type Descriptions, and Field Key
6. Develop Mapping Model (Calibration)
7. Acquire and Prepare Imagery
8. Imagery Analysis / Imagery Classification
9. Geographic Information System (GIS) Project Preparation
10. Validation of Thematic Accuracy of Map Products
11. Formal Accuracy Assessment (AA)
12. Deliver Final Reports, GIS Database and Required Products (NPS 2013c).

Following completion of the first three steps, the NPS collected 220 vegetation classification plots and observation sites at HALE which were analyzed by NatureServe to create a key for 73 and descriptions for 52 of the 76 vegetation associations at HALE. To ensure data compatibility throughout the NPS and other agencies, the National Vegetation Classification Standard, Version 2 was used to characterize HALE's vegetation.

Digital Globe Quickbird and Worldview2 imagery of HALE were obtained from the US Department of Agriculture – National Resource Conservation Service (USDA - NRCS). The imagery was segmented in eCognition software and both the imagery and the segments were taken to the field to

support the calibration trip. Following the calibration trip, KGA labeled the segments using the imagery, ancillary data sets, and classification and regression tree analysis to create a preliminary map. The preliminary map was reviewed by PACN staff and assessed in the field by KGA and HALE staff during the validation trip. Manual edits based on the comments and results from the validation trip were made to the preliminary map to create HALE's draft vegetation map.

PACN personnel collected 601 accuracy assessment (AA) samples of HALE's vegetation. The sample reference labels (i.e. AA samples) were compared to the draft map labels at each sample location to create an error matrix. Overall draft map accuracy of HALE is 76% using the primary reference label, and 80% when the secondary label is accepted. Using the AA results, PACN and KGA personnel reviewed the AA data and decided which associations would be collapsed into map classes for creation of HALE's final vegetation map, resulting in 71 vegetated and four unvegetated map classes. The draft map was manually edited for errors discovered during AA, and the final map was delivered.

Acknowledgments

The production of this vegetation inventory for this important ecological site required the enthusiasm and energy of many people over several years. The authors gratefully acknowledge the dedication of all involved in the production of this report.

We are grateful to the staff at Haleakalā National Park (HALE) and the Pacific Island Network (PACN), who went out of their way to support field checking, assisting the field crews, and providing expert advice. Their support and hospitality were critical to the success of the project from arranging logistics, to trekking across distant reaches of HALE, to reviewing the results and suggesting valuable changes. Specifically, we would like to recognize Matt Brown and Steve Anderson at HALE for their continued support during this project.

We would like to specifically thank National Park Service Volunteers-in-Park (Monica Lomahuklah and Joey Latsha), Pacific Island Inventory and Monitoring (PACN) staff (Michelle Osgood and Mara MacKinnon), HALE staff (Lindsay Moore, Patti Welton, and Bill Haus) and Hawai‘i Volcanoes National Park staff (David Benitez and Mark Wasser) for their assistance during field work.

Penny Latham with the Pacific West Region Inventory and Monitoring Program provided important program oversight. Kelly Kozar and Scott Kichman also with PACN provided critical data support and assistance through all aspects of this project.

We would also like to thank Marion Reid, the NatureServe project manager.

Dr. Patrick Hart, the principal investigator for the University of Hawai‘i-NPS cooperative agreement, provided important oversight, support for accuracy assessment field work, and report writing.

Tony Kimmit of the US Department of Agriculture was always generous with his time and was essential to the NPS gaining access to the USDA purchased Digital Globe high resolution satellite imagery used in the project.

We are appreciative to all who provided mapping support which was integral to the production of the HALE vegetation map. Gene Forsburg of Kass Green & Associates provided support during calibration field data collection as well as access to numerous publications on the vegetation of Hawaii from his personal library. Thai Truong, Chin Chan, and Emily Foster with Quantum Spatial provided additional contributions to the project.

Special recognition goes to Dr. Karl Brown and Tammy Cook with NPS for prioritizing the need for this project and providing funding. Without the financial support from the NPS Vegetation Inventory Program the project would not have been possible.

Introduction

Vegetation Classification and Mapping, Haleakalā National Park

Vegetation classification and mapping of National Park Service (NPS) units is one of the twelve resource inventories tasked to NPS's Inventory and Monitoring Program (I&M). In 2006, the NPS I&M began planning for vegetation inventories of the NPS units in the Pacific Island Network (PACN). Over the next several years, NPS personnel collected classification plot data for the PACN units, and NatureServe was retained to analyze the field data for developing the vegetation association keys and descriptions for each. In 2009, PACN contracted with Kass Green & Associates (KGA) (DBA The Alta Vista Company) to design the sampling plan for Kalaupapa National Historical Park (KALA), Haleakalā National Park (HALE), and the National Park of American Samoa (NPSA) and to create the vegetation maps and analyze the accuracy of Hawai'i Volcanoes National Park (HAVO), KALA, HALE, and NPSA. In 2011, PACN contracted University of Hawaii (UH) staff to lead the accuracy assessment (AA) work with NPS staff at NPSA, KALA, HAVO, and HALE.

This report details the methods used and results of the vegetation inventory for HALE. The park's dynamic landscape, huge expanse, and extreme range of elevation and climate combine to create a distinctive and exciting national park. HALE also supports a wide range of ecological conditions. Spanning 13,462 ha (33,265 ac) on Haleakalā Volcano, HALE's unique vegetation ranges the shrublands of native *Leptecophylla tameiameia*, *Vaccinium reticulatum*, and *Sophora chrysophylla* in the crater and western slope, to native *Acacia koa* and *Metrosideros polymorpha* forests in Kīpahulu, to forests dominated by non-native species such as *Schinus terebinthifolius*, *Phyllostachys nigra*, and *Mangifera indica* on the eastern coast.

This report on the vegetation of HALE is organized as follows:

- The remainder of this introduction presents an overview of the NPS I&M Program, I&M's PACN, the NPS Guidance for vegetation inventories, and the National Vegetation Classification Standard (NVCS). This section concludes with an overview of the roles and responsibilities of the team members who contributed to the HALE vegetation inventory.
- The second section provides a brief summary of the setting and history of HALE and reviews prior vegetation maps completed for the park.
- The third section details the vegetation classification and mapping methods used to inventory the park's vegetation and to assess the accuracy of the resulting maps. This section's organization parallels that of the NPS Twelve Step Guidance Document (NPS 2013b).
- The fourth section presents the results of the classification, mapping, and AA efforts.
- The final section discusses the results and reviews lessons learned.
- The appendices provide several documents critical for the effective use of the vegetation maps, including the association and map keys and descriptions.

National Park Service Inventory and Monitoring Program

Overview

In 1998, Congress mandated the creation of the NPS Natural Resource I&M Program to:

- Inventory NPS natural resources to determine their nature and status.
- Monitor park ecosystems to better understand their dynamic nature and condition and provide reference points for comparison with other environments.
- Establish natural resource inventory and monitoring as a standard practice throughout the National Park System that transcends traditional program, activity, and funding boundaries.
- Integrate natural resource inventory and monitoring information into NPS planning, management, and decision making.
- Share NPS accomplishments and information with other natural resource organizations and form partnerships for attaining common goals and objectives (NPS 2013a).

The I&M Program is charged with establishing 12 basic resource inventories of species occurrence and distribution on 270 NPS units which have been organized into 32 ecoregional networks as illustrated in Figure 1. Specific inventories include:

- Natural Resource Bibliography
- Base Cartography Data
- Air Quality Data
- Air Quality Related Values
- Climate
- Geologic Resources
- Soil Resources
- Water Body Location and Classification
- Baseline Water Quality Data
- Vegetation
- Species Lists
- Species Occurrence and Distribution

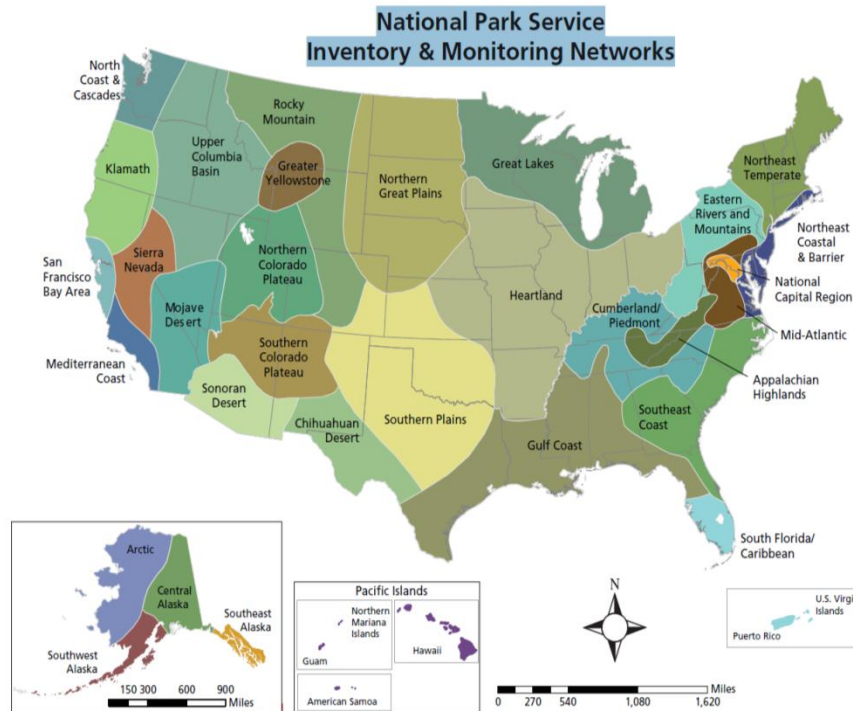


Figure 1. National Park Service Networks. Source http://science.nature.nps.gov/im/assets/docs/IM_Program_Brief.pdf

NPS Guidance for Vegetation Inventories

The objective of a vegetation inventory is to; “produce high-quality, standardized maps and associated data sets of vegetation and other land-cover occurring within parks” in support of resource assessment, park management and conservation needs (NPS 2013c). By the end of 2013, the NPS has classified and mapped the vegetation of 173 national park units. Vegetation inventory on 94 additional units is in process.

NPS Vegetation Inventories rely on a 12 Step Guidance Document which outlines each step to be taken in the process of implementing a vegetation inventory. The Guidance captures the “best management practices” and provides examples and standards for developing vegetation maps and associated databases (NPS 2013b). The 12 steps of a NPS vegetation inventory are:

1. Review Existing Data and "Best Practices" to Develop a Brief Proposal (1-5 pages) to Develop a Park or Network Vegetation Inventory Study Plan
2. Planning and Scoping to Gather the Detailed Information Needed to Develop the Study Plan
3. Develop and Submit a Detailed Study Plan for Approval of Funding
4. Field Plot Data Collection (for the Ecological Classification)
5. Develop Vegetation Classification, Vegetation Type Descriptions, and Field Key

6. Develop Mapping Model (Calibration)
7. Acquire and Prepare Imagery
8. Imagery Analysis / Imagery Classification
9. Geographic Information System (GIS) Project Preparation
10. Validation of Thematic Accuracy of Map Products
11. Formal Accuracy Assessment (AA)
12. Deliver Final Reports, GIS Database and Required Products (NPS 2013c)

National Vegetation Classification Standard

In 1994, the NPS GIS Division began five prototype park mapping efforts, and funded the first development of uniform vegetation classification concepts with the Nature Conservancy. By 1997, the US Geological Survey (USGS) Center for Biological Informatics and the NPS shared the development and project support that later became the NPS Vegetation Inventory Program (VIP) under the NPS Natural Resource I&M. The objective of this program was to create a Service-wide process for mapping that uses the best available technologies, uses the developing taxonomic concepts that form a hierarchical classification standard and methodology, and meets the management needs of the Parks.

The VIP adopted the U.S. National Vegetation Classification (USNVC) (Grossman et al. 1998) as a basis for the *a priori* definition of vegetation units to be inventoried. The USNVC has since been revised by NatureServe and in 2008 the Federal Geographic Data Committee (FGDC) formally adopted the rules and structure of the National Vegetation Classification Standard (NVCS; FGDC 2008).

Use of a standardized vegetation classification system, such as the NVCS helps to ensure data compatibility throughout the NPS and other agencies. This is critical for a systematic inventory and classification of the nation's biological resources to foster efficient stewardship and prioritize conservation efforts. The NVCS is being used for vegetation classification and mapping projects at PACN parks. It evolved from the original USNVC, which was developed jointly by The Nature Conservancy (TNC) with NPS support, NatureServe, and the Natural Heritage Program network over more than two decades (TNC and ESRI 1994a; Grossman et al. 1998).

The NVCS is a hierarchical system that allows for vegetation classification at multiple scales. There are eight levels with specific criteria set for each level as summarized in Table 1. The upper three levels are based on climate and physiognomic characteristics that reflect geographically widespread (global) topographic and edaphic factors. The middle three levels focus largely on broad sets of diagnostic plant species and habitat factors along regional-to-continental topographic, edaphic, and disturbance gradients. These middle levels have been drafted and are undergoing peer review. The lower two levels, as in the original USNVC, are the alliance and association and are distinguished by differences in local floristic composition. The broader alliances are physiognomically distinct groups of plant associations sharing one or more differential or diagnostic species (Mueller-Dombois and Ellenberg 1974). These are commonly the dominant(s) found in the uppermost strata of vegetation.

The plant association is the fundamental base unit of the classification, and following the International Botanical Congress of 1910, is defined as a community of definite floristic composition (i.e., a repeating assemblage of species), uniform physiognomy, and habitat conditions (Mueller-Dombois and Ellenberg 1974).

Table 1a. Summary of USNVC upper hierarchy levels and criteria for natural vegetation. Physiognomy plays a predominant role in these levels.

Hierarchy Level	Criteria
L1 – Formation Class	Broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and substrate/aquatic conditions.
L2 - Formation Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate/aquatic conditions.
L3 – Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.

Table 2b. Summary of USNVC mid hierarchy levels and criteria for natural vegetation. Floristics and physiognomy play predominant roles in these levels.

Hierarchy Level	Criteria
L4 – Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
L5 – Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms, that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
L6 – Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology and disturbance regimes.

Table 3c. Summary of USNVC lower hierarchy levels and criteria for natural vegetation. Floristics plays a predominant role in these levels.

Hierarchy Level	Criteria
L7 – Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes.
L8 – Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

In addition, there is a category of classification confidence used in the classification of vegetation types for park units in PACN: Provisional (FGDC 2008). Provisional types are types where a clear

effort has been made to apply the USNVC to vegetation units that do not appear to be covered by the concepts of known units for the area being classified (FGDC 2008). These types have not yet been formally accepted into the USNVC through the peer review process and are designated as “Provisional” in the name (FGDC 2008).

The USNVC is maintained by NatureServe and the network of affiliated Natural Heritage Programs and Conservation Data Centers for use by government agencies and the public. The USNVC database allows for tracking of vegetation at all scales and provides narrative descriptions of many alliances and associations. Descriptions of Macrogroups and Groups are being written in three phases. Phase 1 descriptions are currently undergoing peer review. The content of this database is available to the public and is regularly updated through NatureServe Explorer (<http://www.natureserve.org/explorer>).

Associations are generally the same as the original USNVC, although revisions have begun in certain areas such as PACN projects. Substantial revisions of the alliances have begun and will continue in the future. For HAVO, Macrogroups, Groups, and plant associations have been developed for this project and NatureServe will continue vegetation hierarchical unit review and revision as other PACN vegetation inventory projects are completed. Although NatureServe’s documentation of vegetation alliances and associations is the most accessible national listing (www.natureserve.org/explorer/), the data within the USNVC are not complete, and projects such as this one constantly add to the documentation and listing of USNVC types.

NVC associations and alliances are commonly used for vegetation inventory projects. Their use within the VIP facilitates effective resource stewardship by ensuring compatibility and widespread use of the information throughout the NPS as well as by other federal and state agencies. These vegetation maps and associated information support a wide variety of resource assessment, park management, and planning needs. In addition they can be used to provide a structure for framing and answering critical scientific questions about vegetation communities and their relationship to environmental conditions and ecological processes across the landscape.

Project Partners’ Roles and Responsibilities

The vegetation classification and mapping of HALE was managed by the NPS’s PACN and carried out by a mixture of NPS employees, UH cooperators, NatureServe, and contractors KGA and CTI. The roles of each organization in the implementation of the 12 vegetation inventory steps are summarized in Table 2. The following paragraphs provide a brief introduction to the organizations and a summary of their responsibilities in the HALE vegetation inventory.

Pacific Island Network, Inventory and Monitoring Program

PACN (<http://science.nps.gov/im/units/pacn/>) was established to provide an efficient means of carrying out expanded natural resource I&M activities for all 11 national park units scattered across the Pacific Ocean (Figure 2). PACN personnel include scientists, data management staff, biological technicians, volunteers, and administrative staff supplying reliable, organized and retrievable information about the Pacific Island parks.

Currently PACN contains a mixture of both small and large parks including Ala Kahakai National Historic Trail (ALKA), American Memorial Park (AMME), KALA, HALE, Kaloko-Honokōhau National Historical Park (KAHO), NPSA, Pu‘ukoholā Heiau National Historic Site (PUHE), Pu‘uhonua o Hōnaunau National Historical Park (PUHO), HAVO, World War II Valor in the Pacific National Monument (VALR), and War in the Pacific National Historical Park (WAPA). VALR does not contain significant natural resources and does not host PACN activities. The larger parks, HAVO, HALE, and KALA are located on the islands of Hawai‘i, Maui, and Moloka‘i, respectively and VALR (formally the USS Arizona Memorial) is located on the island of O‘ahu. NPSA spans three American Samoa islands and the smaller parks, PUHE, PUHO, KAHO, and ALKA are located on Hawai‘i Island. AMME is located on the island of Saipan, and WAPA is located on Guam. All of the parks in the PACN occur on remote islands ranging from approximately 4,000 to 10,000 km (2,500 to 6,200 mi) west and southwest of the United States mainland.

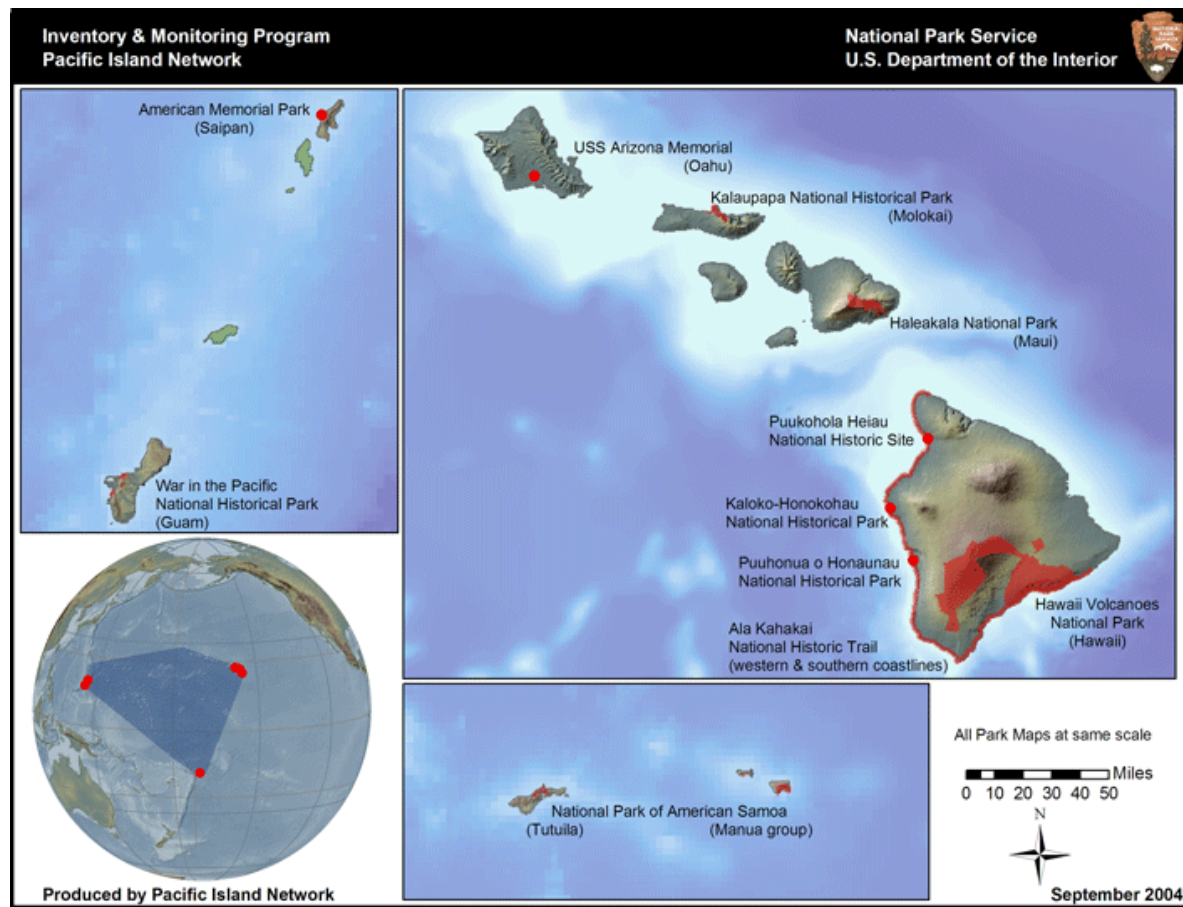


Figure 2. Map of PACN National Parks within the Pacific Island Network. Source: <http://science.nature.nps.gov/im/units/pacn/parks/index.cfm#map>.

PACN is involved in numerous activities such as organizing and cataloging data, data analysis and synthesis, modeling, providing data and expertise to park planners, providing data and expertise for resource assessments and resource stewardship strategies, and contributing to performance reporting. PACN is a key source and supplier of reliable, organized, and retrievable information about the

Pacific Island park units. Their primary responsibilities include facilitating baseline inventories, collecting, managing, analyzing and reporting long-term data on vital signs (measurements of resource condition), and effectively delivering data and information on resource condition to park managers, planners, interpreters, and other key audiences (NPS 2013d). Besides managing the HALE project, PACN personnel and volunteers were integrally involved in every step of the vegetation inventory process. Data and reports for PACN projects can be accessed online at: <http://science.nature.nps.gov/im/units/pacn/index.cfm>.

Table 2. Roles and responsibilities for the HALE vegetation inventory project.

Roles	NPS PACN	NatureServe	Kass Green & Associates	Cogan Technologies
1. & 2. Planning and Scoping	✓			✓
3. Study Plan	✓			✓
4. Classification Field Plot Data Collection	✓		✓	
5. Vegetation Classification, Descriptions & Field Key	✓	✓		
6. Develop Mapping Model	✓		✓	
7. Acquire and Prepare Imagery	✓		✓	
8. Imagery Analysis / Classification			✓	
9. GIS Project Preparation			✓	
10. Validation	✓		✓	
11. Formal Accuracy Assessment	✓		✓	
12. Final Reports, GIS Database & Required Products	✓	✓	✓	

NatureServe

NatureServe is a non-profit conservation organization whose mission is to provide the scientific basis for effective conservation action. NatureServe collects and manages detailed local information on plants, animals, and ecosystems, and also develops information products, data management tools, and conservation services to help meet local, national, and global conservation needs. NatureServe ecology staff in the western U.S. has been engaged in various roles in some three dozen NPS vegetation mapping efforts over the past 15 years. For the HALE project, NatureServe analyzed the classification field plot data to create the vegetation field key (Appendix C), and wrote the vegetation association descriptions (Appendix D) which are the products of Step 5, and wrote portions of this final report (part of Step 12). NatureServe staff also assisted in map calibration field work and provided mapping support during conference calls throughout much of the project. The NatureServe ecologist's time in field with the mapping team provided valuable insights in how to improve the vegetation association key and clarify classification issues with the mapping team.

Kass Green & Associates

In 2009, KGA was chosen by the NPS to design the classification sampling design and to map the vegetation of HALE using a NVCS compliant classification. KGA is a woman-owned small firm that consults on remote sensing and GIS technology and policy issues to private, educational, and public organizations. KGA revolutionized vegetation association mapping from high resolution imagery through the introduction of object oriented image classification using image segmentation and classification and regression tree analysis. For the HALE mapping project, KGA designed the

classification sampling (part of Step 4), collaborated with PACN to develop the mapping model (Step 6), worked with PACN and US Department of Agriculture Natural Resource Conservation Service (USDA NRCS) to acquire and prepare the satellite imagery used in the project (Step 7), classified the imagery (Step 8), prepared the GIS project (Step 9), validated the vegetation map (Step 10), analyzed the AA data collected by NPS personnel (part of Step 11), and led the preparation of this final report and development of the GIS database and required products (Step 12).

Haleakalā National Park

Location and Setting

HALE occupies the southern portion of the Island of Maui's east volcano, from the upper slopes and summit of Haleakalā, east and south down three gulches to the sea (Figures 3 and 4). While much of the visitor activity is focused on the summit and the pools of 'Ohe'o Gulch, HALE's ecological variation is dramatic, ranging from the alpine and subalpine shrublands of the volcano's western slope to the massive, sparsely vegetated Haleakalā Crater, to the native rain forests of Kīpahulu Valley, to the heavily non-native invaded coastal forests and grasslands. HALE's weather is marine influenced and especially affected by the park's extreme topographical variation. Much of the park is dominated by vegetation native to the Hawaiian Islands with *Metrosideros polymorpha*, *Acacia koa*, *Sophora chrysophylla*, *Leptecophylla tameiameia*, and *Dodonaea viscosa* being the most abundant. However, several areas have been aggressively invaded by non-native species such as *Phyllostachys nigra*, *Psidium cattleianum*, *Schinus terebinthifolius*, *Prosopis pallida*, and *Paspalum conjugatum*. The park's vegetation has also been affected by the foraging and grazing of feral ungulates. Figures 5 through 10 provide examples of the ecological diversity of HALE.

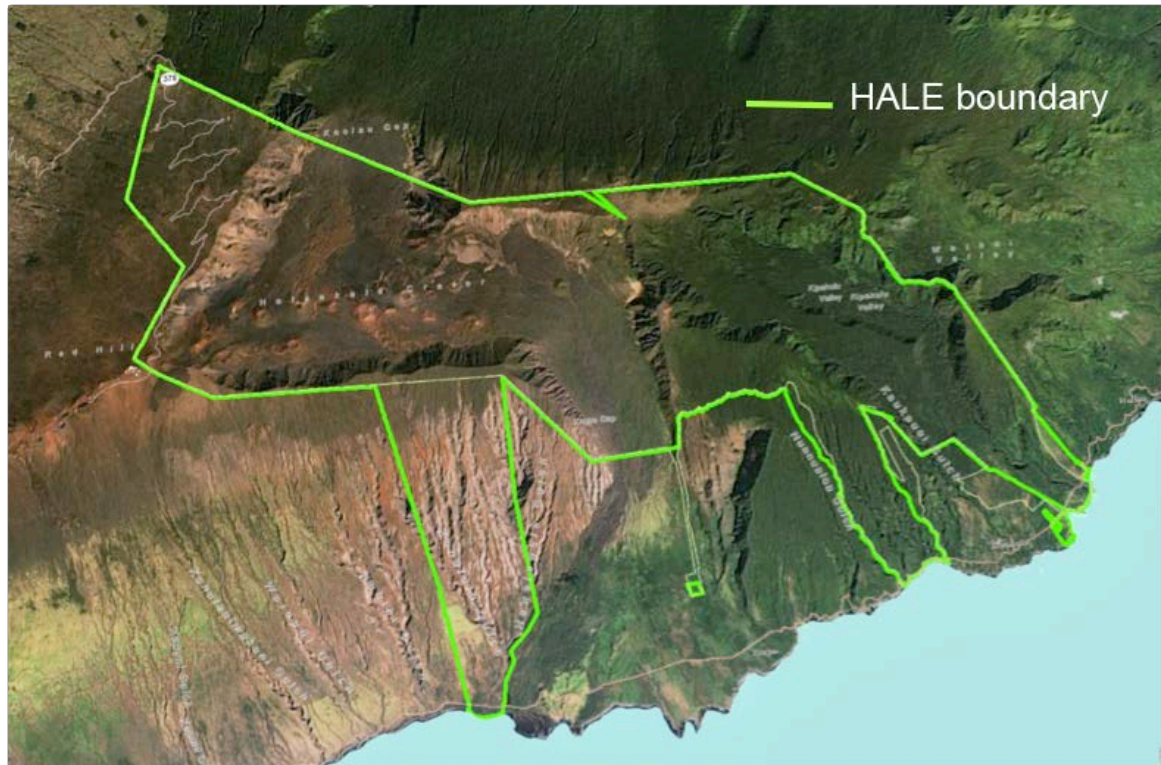


Figure 3. Landsat TM true color satellite imagery of the island of Maui showing the HALE boundary.

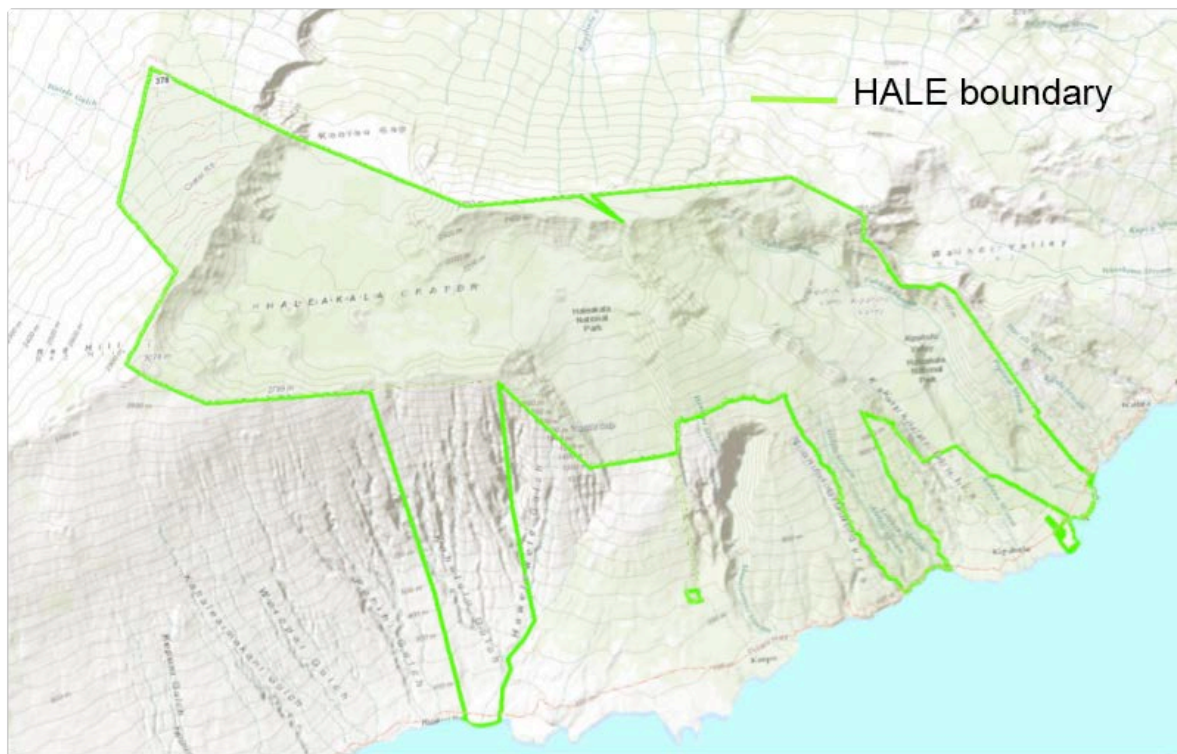


Figure 4. Shaded relief map of HALE and surroundings showing the elevation and topographic variability of the park.



Figure 5. *Argroxiphium sandwicense* ssp. *macrocephalum* in Haleakalā crater.



Figure 6. *Metrosideros polymorpha* draped cliffs above Palikū cabin. The bottom of the cliffs is ringed with native *Rubus hawaiensis* which transition into non-native *Holcus lanatus* grassland.



Figure 7. Haleakalā Crater floor and side slopes covered with *Leptecophylla tameiameiae* and *Dodonaea viscosa* shrublands.



Figure 8. Dense thicket of non-native *Phyllostachys nigra* above 'Ohe'o Gulch.



Figure 9. *Pandanus tectorius* and *Scaevola taccada* at the mouth of Palikea Stream.



Figure 10. Non-native *Ficus microcarpa* in 'Ohe'o Gulch.

History

Haleakalā rose above the sea level of the Pacific Ocean approximately one million years ago as the result of over two million years of volcanic activity (USGS 2014). Prior to the arrival of the Polynesians, the archipelago's isolation from the rest of the world's landmasses produced a unique flora and fauna which had been transported over vast distances to the islands either by the wind or the sea.

The first Polynesians are believed to have arrived in the Hawaiian Islands between the 5th and 7th centuries with another group arriving in the 13th century (Tuggle and Tomonari-Tuggle 2008). They brought with them domestic animals, agricultural crops, and tree seeds resulting in the “greatest force leading to environmental change in pre-contact times” (Kirch 1985). While the summit of Haleakalā had limited agricultural use by the Polynesians because of the poor soils and high elevation, it was of great spiritual importance as the home of the demigod Maui who slowed down the passage of the sun so that his mother's kapa could dry. Contrastingly, archeological evidence indicates that the fertile Kīpahulu coastal area of HALE supported a large population of Hawaiians who fished, terraced its rich farmlands (Smith et al 1985), and raised domestic animals (NPS 2014a).

The first Europeans arrived on Maui in 1779 with Captain Cook's expedition. Soon after, missionaries arrived and trade with the islands became robust spurred by China's insatiable demand for sandalwood, whaling, and the California Gold rush. European contact greatly altered the vegetation of Maui not only through agriculture (primarily sugar, coffee, pineapple) and logging, but also through the decimation of the native Hawaiian population resulting from the introduction of contagious diseases (Cuddihy and Stone 1990).

Established as a national park in 1916, the summit of HALE was included in Hawai'i National Park, as the nation's 15th national park (National Park Service 2013e). Its early inclusion in the National Park System (before the NPS was created) is a testament to HALE's unique geography and environment. In 1951, Congress authorized the inclusion of the Kīpahulu Valley but portions were not added until 1969 (NPS 1999). In 1961 Hawai'i National Park was divided into HALE and HAVO (NPS 2014b). In 1974 HALE was expanded to include the remainder of Kīpahulu Valley, the upper Hāna rain forest, Kuiki/Manawainui and Kaumakani Planezes. In the 1990s acreage was added in Puhilele, and Manawainui Planeze (NPS 1999). Nu'u unit 1738 ha (4295 ac) was added in 2008. In 1976, Congress set aside 7,798ha (19,270 ac) of HALE as wilderness which was enlarged to 10,003 ha (24,719 ac) in 2005 (NPS 2014b).

HALE's landscape has been greatly impacted by human activity, especially the damage done by feral pigs and goats (Whiteaker 1980) which has been mitigated over the last three decades with hunting and fencing. In the early part of the 20th century non-native forests were planted on the western slopes of Haleakalā and persist in the northwest corner of the park. During the Great Depression, HALE hosted a Civilian Conservation Corps camp who built trails and structures and removed invasive plants and animals (NPS 2014a).

Vegetation Studies at Haleakalā National Park

The first vegetation map of HALE was part of a larger effort to map the vegetation of the Hawaiian Islands (Ripperton and Hosaka 1942). The map was small scale (1:500,000 for the island of Maui) and presents a generalized view of the potential vegetation of the islands. In the late 1960's the Haleakalā resource plan included a four class, 1:62,000 scale vegetation map of the crater area (Larson 1969).

The first large scale (1:24,000) map of HALE was completed of the crater area (7,545 ha; 18,643 ac) by Whiteaker (1980) from field reconnaissance, black and white 1:12,000 aerial photographs collected in 1954, and high altitude infrared color photographs flown by NASA. Vegetation was classified into 53 structural-floristic communities. Soon after, in 1985, Smith et al (1985) produced a 1:6000 scale map of Kīpahulu Valley below 700 meters from high altitude NASA 1978 infrared photography. The vegetation of the valley below 700 meters was mapped into 92 structural-floristic communities.

In 1989, Jacobi produced vegetation maps of the upland plant communities of Hawai'i, Maui, Moloka'i and Lana'i based on 1:40,000 black and white aerial photographs captured in 1976-77 (Jacobi 1989) to support the US Fish and Wildlife Service's Hawaii Forest Bird Survey. Information from the aerial photographs was transferred to 1:24,000 USGS quadrangles to produce maps of tree canopy cover, tree canopy height, tree species composition, species association type, understory species composition, and other information. A composite of the Jacobi, Whiteaker, and Smith maps was created, but "normalizing the disparate classification schemes allowed for only a very broad classification" (Pratt 2006).

Two maps of Haleakalā vegetation have been produced from satellite imagery as part of a larger effort to map all of the Hawaiian Islands. The first was completed by USGS from 1999-2001 Landsat imagery using Classification and Regression Tree (CART) modeling as part of the GAP program (USGS 2014b). In 2005, the National Oceanic and Atmospheric Administration (NOAA 2005) used high resolution satellite imagery, field reconnaissance and CART modeling to create a life form map of all of the Hawaiian Islands, including HALE.

Vegetation Classification and Mapping Methods

This section of the report reviews the methods used to implement the 12 steps of the NPS vegetation inventory at HALE. The methods are presented step by step; however, Step 6 (Development of the Mapping Model) was moved to follow AA since we mapped to association for the draft map.

Development of the Proposal and Study Plan (Steps 1-3)

In 2006, the PACN contracted with CTI to create the draft report, *Vegetation Classification and Mapping Recommendations, Pacific Island Network* (Cogan 2007). CTI met with PACN personnel to document park needs, existing data, and current efforts. The report summarized their findings and was the basis for a 2007 proposal from PACN to the NPS Vegetation and Inventory program for the initiation of vegetation mapping of PACN parks.

In 2009, CTI and NPS personnel cooperated to develop the *Vegetation Classification and Inventory Work Plan* which identifies the tasks required, provides a timeline, and details cost estimates for vegetation mapping of each PACN national park (Cogan and Kudray 2009).

Classification Sampling Design and Data Collection (Step 4)

Introduction

The fourth step in a vegetation inventory is the collection of field plot data to (1) “serve as the raw data from which to build the park ecological classification, and thus, the map classification”, and (2) “as a permanent record of the floristic characteristics of each vegetation type” (NPS 2013c). Two tasks are required to collect field data: creation of a sampling design which guides field personnel in the placement of field plot locations, and actual collection of the field data.

Sampling Design

The vegetation classification plot sampling design for HALE was developed by KGA in 2010. It relies on the Department of Interior’s (DOI) 1994 Field Methods for Vegetation Mapping which directs that “representative polygons for each vegetation type will be selected for sampling across the park based on the stratification of each type across the different biophysical environments” (TNC and ESRI 1994a). “Representative polygons” were developed using image segmentation (see the section on Image Segmentation, below) and GIS modeling. The resulting sampling design coverage is a GIS geodatabase which relies on a combination of spectral variation and access to guide field crews. The underlying assumptions behind the sampling coverage are:

- Variation in vegetation of interest to the NPS is highly correlated with variation in aspect, elevation, slope, and imagery spectral response.
- Access cost is an important variable for determining the location of field samples.

First, a coarse image segmentation was run on Quickbird high resolution imagery in eCognition software, and non-vegetated segments identified from the NOAA 2005 High Resolution Land Cover geodatabases (NOAA 2005) were eliminated from the coverage. Next, the aspect, slope, elevation, and spectral mean and standard deviation of each segment were input into the ordination software package, PC-Ord. Then, a Ward’s complete linkage Euclidian clustering algorithm was run on the

segment data to cluster the segments into groups that are similar in slope, aspect, elevation, and spectral response. The result was coverage with the segments labeled according to their similarity in aspect, slope, elevation, and spectral response group. The group coverage was then combined with an access coverage which ranked the relative difficulty of accessing a given polygon given its steepness and distance from roads or trails. The combined coverage was used by local PACN personnel to identify locations for field sampling.

Field Data Collection

The field methods used for developing the classification and conducting the AA at HALE followed the methodology outlined by the VIP (TNC and ESRI 1994b) for large sized park units. Field crews were composed of PACN ecologists with plant community sampling experience in the Pacific Islands and other landscapes. The sampling goal was to collect between three and five classification plots in every vegetation type within the HALE project area. However, some common associations were sampled more often and some rare types were sampled less often. An effort was made to achieve a good spatial distribution of plots across the landscape and to capture the full range of vegetation variation within the park. When a representative stand of vegetation was located, a relevé macroplot was established to record stand characteristics; transitional areas such as ecotones were usually avoided unless they exceeded the project minimum mapping unit (MMU) of 0.5 ha (1.2 ac). Highly disturbed areas were also avoided unless they supported a distinct plant community. Classification plots were generally located in stands exceeding the MMU; however a few plots were sampled in smaller patches if the vegetation was rare and distinctive (such as coastal strand sites). Plots were 400 m² and circular in shape.

Environmental data were recorded on the plot field forms (Appendix A) including elevation, slope, aspect, landform, topographic position, soil texture and drainage, hydrologic (flooding) regime, and evidence of disturbance or wildlife use. The unvegetated surface was estimated and recorded as percent cover of: bedrock, litter and duff, wood, bare soil, large rocks (>10 cm), small rocks (0.2-10 cm), sand (0.1-2 mm), lichens, and mosses. Next the vegetation was visually divided into strata, with the height and canopy cover of the dominant vegetation estimated for each stratum. For each stratum, all taxa within the plot area were identified and foliar cover per taxon was estimated (Table 3).

In addition to the vegetation classification plots, PACN field crews collected vegetation and environmental data at several observation points. Data recorded at observation points reflected the vegetation of an area of variable spatial extent around the point rather than a measured plot, and were less detailed. Overall conditions at each observation point were documented by one or more digital photographs. These data were intended primarily to support modeling and interpretation of the base imagery, but were also used to help describe plant associations when local descriptions were prepared. Specifically, observation point data were collected when:

- The vegetation was homogenous, representative, and several classification plots had been sampled;
- Sampling the environs outside the HALE boundary;
- The vegetation was highly disturbed, ecotonal, or otherwise anomalous and therefore unlikely to be classified under the USNVC;

- To document special features as requested by HALE staff including invasive plant stands;
- To document a vegetation type that consistently occurred in stands smaller than the 0.5 ha (1.2 ac) MMU;
- The sample point could not be safely accessed to complete the full plot.

Table 3a. Vegetation strata.

Strata	Description
T1	Emergent Canopy
T2	Main Canopy
T3	Subcanopy
S1	Tall Shrubs
S2	Short Shrubs
S3	Dwarf-shrubs
H1	Herbaceous (Graminoids)
H2	Herbaceous (Forbs)
H3	Herbaceous (Ferns)
H4	Herbaceous (Tree seedlings)
A1	Floating-leaved aquatics
A2	Submerged-leaved aquatics

Table 3b. Cover classes.

Cover Class	Percent Cover
T	0–1%
P	>1–5%
1	>5–15%
2	>15–25%
3	>25–35%
4	>35–45%
5	>45–55%
6	>55–65%
7	>65–75%
8	>75–85%
9	>85–95%
10	>95%

Quality Control

Upon completion of the plot data collection, plot data were entered into the PLOTS 2.0 database by PACN staff. The PLOTS database is the standard NPS VIP database which uses Microsoft Access. The database mirrors the standard field form with fields and tables that match all of the data recorded on the field forms. Following data entry, error checking was performed to minimize errors associated with duplicate entries or erroneously selected plant or association names or types. Next, the database was converted to meet NatureServe standards and all of the plant taxonomy was standardized to the USDA. Unknown species, especially those with high cover were identified and mostly resolved as were other taxonomic issues including grouping subspecies and varieties judged to be ecologically similar. All digital data were subjected to a second quality check (QC) to eliminate data entry errors. The final classification to HALE's USNVC association, along with the association-specific code (i.e. Elcode), was added as an attribute for each plot, and these were incorporated into the master database maintained by PACN data management. Figure 11 shows the distribution of classification plots and observation points at HALE.

Development of Vegetation Classification, Vegetation Type Descriptions and Field Key (Step 5)

Introduction

The primary dataset used for the vegetation classification of HALE included 220 classification plots and observation points collected during 2011 by HALE and PACN staff (Figure 11). The raw data consisted of 340 taxa and 11 strata for a total of 408 unique species-strata records (pseudo species). The number of pseudo species was reduced to 362 by combining some of the strata, taxa subspecies or varieties and deleting unknown species. These plots were classified using standard quantitative techniques including cluster analysis, ordination, and summary statistics. Each sample from the HALE dataset was reviewed and assigned to an existing USNVC association when possible, and when not, a new USNVC association or local community type was developed. Several additional vegetation types from map calibration and validation field work were identified. These were included in the final classification.

Data Preparation and Screening

All 220 classification plots and observation points were used in the data analysis. Prior to data analysis, standard screening and preparations were performed to facilitate the interpretation of results such as looking for data transcription errors and data entry errors like duplicate species records, synonymy of scientific names, species records without plant symbols, or missing cover data. Using field data records, standard taxonomic information and database queries, species records were updated wherever possible. Species strata data were also reviewed to ensure species were consistently given the same strata or life-form code: Grasses and grass-like herbaceous plants- H1, Forbs- H2, most Ferns- H3. Woody species form distinct strata. Tree species were recorded as Emergent (T1), Main canopy (T2), Sub canopy (T3), and Seedling (H4). Tree ferns were treated as trees, usually as T3. Shrub strata included Tall shrub (S1), Short shrub (S2), Dwarf-shrub (S3). Mosses and lichens formed the non-vascular stratum (N). These strata are briefly defined in NVCS (FGDC 2008). For more discussion on strata see Jennings et al. (2009) and Tart et al (2005).

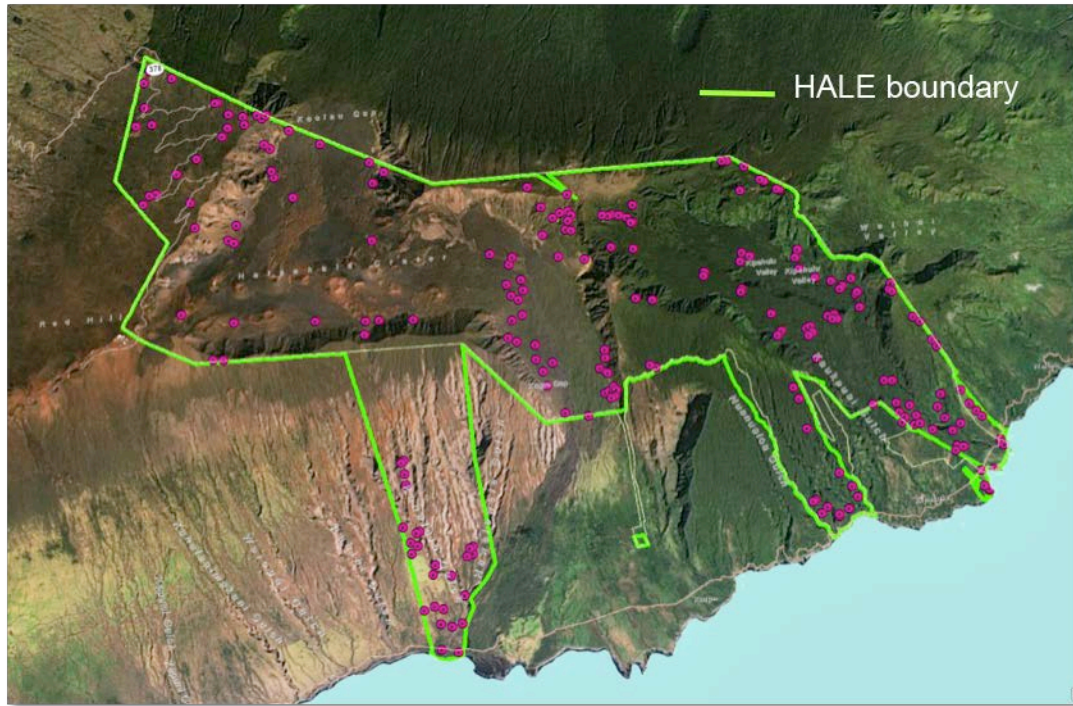


Figure 11. Distribution of classification plots and observation points at HALE.

After species data review was complete a dataset was created for multivariate analysis. This dataset was reviewed further to identify and delete records determined to be not informative in the analysis such as species identified only to genus or family, or some taxa if recorded only once with low cover value. Because field crews only assigned woody species to a single strata code per plot, no additional analyses were necessary to account for overlapping canopies. Finally, the dataset was exported in list format from the database, and then imported into a matrix for analysis using PC-Ord (McCune and Mefford 1999) after species names and cover classes were formatted to meet PC-Ord requirements.

Multivariate Analysis

Vegetation classification was accomplished through a multivariate analysis of the plot data using techniques including cluster analysis and ordination. Cluster analysis was performed using Lance-Williams Flexible-Beta linkage method (beta value = -0.25) and the Bray-Curtis dissimilarity measure. Ordination was performed using nonmetric multi-dimensional scaling (NMS) using the Sorenson (Bray-Curtis) distance measure. A secondary grouping matrix was created to graph the distribution of groups in clusters.

Cluster analysis and ordinations were performed using raw species cover values on all plots and observation points. The ordinations identified several outlier plots, mostly single plot types that are strongly dominated by a single species that is not well represented in other plant communities. Outlier community types included *Eucalyptus* spp. - Mixed Alien Semi-natural Forest/Plantation, *Cenchrus clandestinus* Semi-natural Herbaceous Vegetation, *Vaccinium calycinum* Subalpine Mesic Shrubland, and *Phyllostachys nigra* Semi-natural Thicket (Figure 12). Additionally, types based on observations points with only a few dominant species recorded were also often outliers. Ordinations

were not very useful in the analysis of this dataset because of the high number of observation points (~20%) lacking full species inventories. Observations points are often outliers as they frequently only have few dominant species recorded and so do not ordinate well with plots with full species composition.

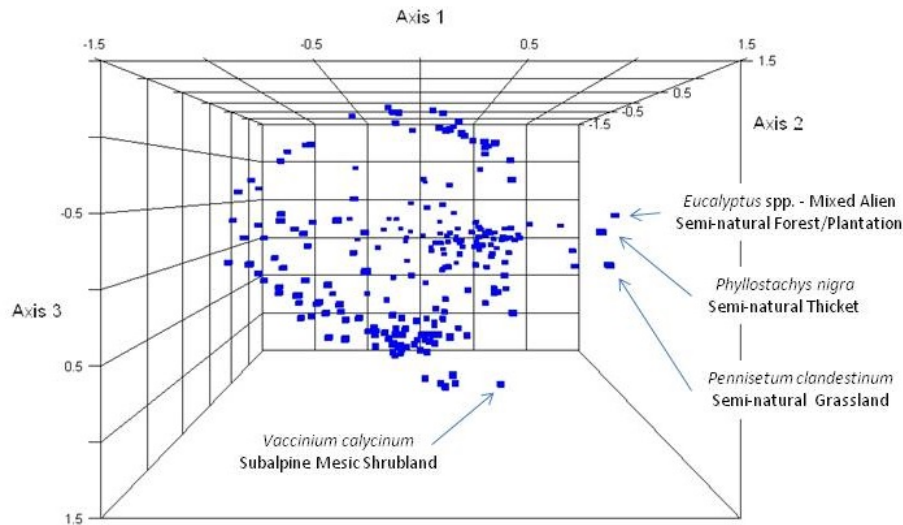


Figure 12. NMS Ordination of full HALE dataset (220 plots and observation points, 362 species). Note that outliers are mostly single plot plant communities that are strongly dominated by a single species.

Multiple cluster analyses were performed on the full dataset using group membership levels of 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, and 140. Cluster analysis results were entered by membership levels into a database with the plot data. This was a very useful technique to organize plots for ecological review, allowing the analyst to easily sort plots and compare cluster analysis results of different group membership levels. Some classification plots form ecologically distinct clusters at low membership levels such as *Psidium cattleianum* Lowland Wet Semi-natural Forest or *Mangifera indica* Semi-natural Forest, while other groups are not evident until a higher membership level is used, such as the many different associations of *Metrosideros polymorpha* dominated and co-dominated forests.

With small datasets such as at HALE it was possible to evaluate each plot individually during the classification process that combined both quantitative analyses and qualitative analyses using floristic and ancillary data such as elevation, moisture zone, topographic position, substrate or field crew comments. Each sample was assigned to an existing USNVC association, or a new USNVC association or local community type [Park Special] depending on the number of plots and the ecologist's confidence. After plots were initially classified, additional cluster analyses were conducted on subsets of the dataset to validate results such as the montane and subalpine forest plots below (Table 4 and Figure 13).

Table 4. HALE montane and subalpine forest USNVC associations in cluster dendrogram (Figure 13).

ELCODE	USNVC Association	Number of Samples
CEGL008008	<i>Metrosideros polymorpha</i> - <i>Cheirodendron trigynum</i> / (<i>Cibotium</i> spp.) Montane Wet Forest	7
CEGL008041	<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Montane Wet Woodland	2
CEGL008135	<i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Woodland	2
CEGL008144	<i>Eucalyptus</i> spp. - Mixed Alien Semi-natural Forest/Plantation [Provisional]	1
CEGL008155	<i>Acacia koa</i> / <i>Leptecophylla tameiameiae</i> - (<i>Dodonaea viscosa</i>) Montane Woodland	2
CEGL008187	<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Wet Montane Woodland	11
CEGL008188	<i>Acacia koa</i> / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Woodland	2
CEGL008200	<i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - (<i>Broussaisia arguta</i> , <i>Coprosma foliosa</i>) / <i>Athyrium microphyllum</i> Montane Wet Forest	6
CEGL008201	<i>Metrosideros polymorpha</i> / <i>Carex alligata</i> - (<i>Machaerina angustifolia</i>) Wet Woodland	3
CEGL008202	<i>Metrosideros polymorpha</i> / <i>Dryopteris wallichiana</i> Subalpine Mesic Forest	4
CEGL008203	<i>Metrosideros polymorpha</i> / <i>Rubus hawaiiensis</i> Montane Wet Forest	3
CEGL008204	<i>Myrsine lessertiana</i> - (<i>Metrosideros polymorpha</i>) / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Forest	2
CEPS009672	Mixed Forest Plantation [Park Special]	1
CEPS009704	<i>Metrosideros polymorpha</i> - <i>Melicope clusiifolia</i> Montane Wet Forest [Park Special]	1

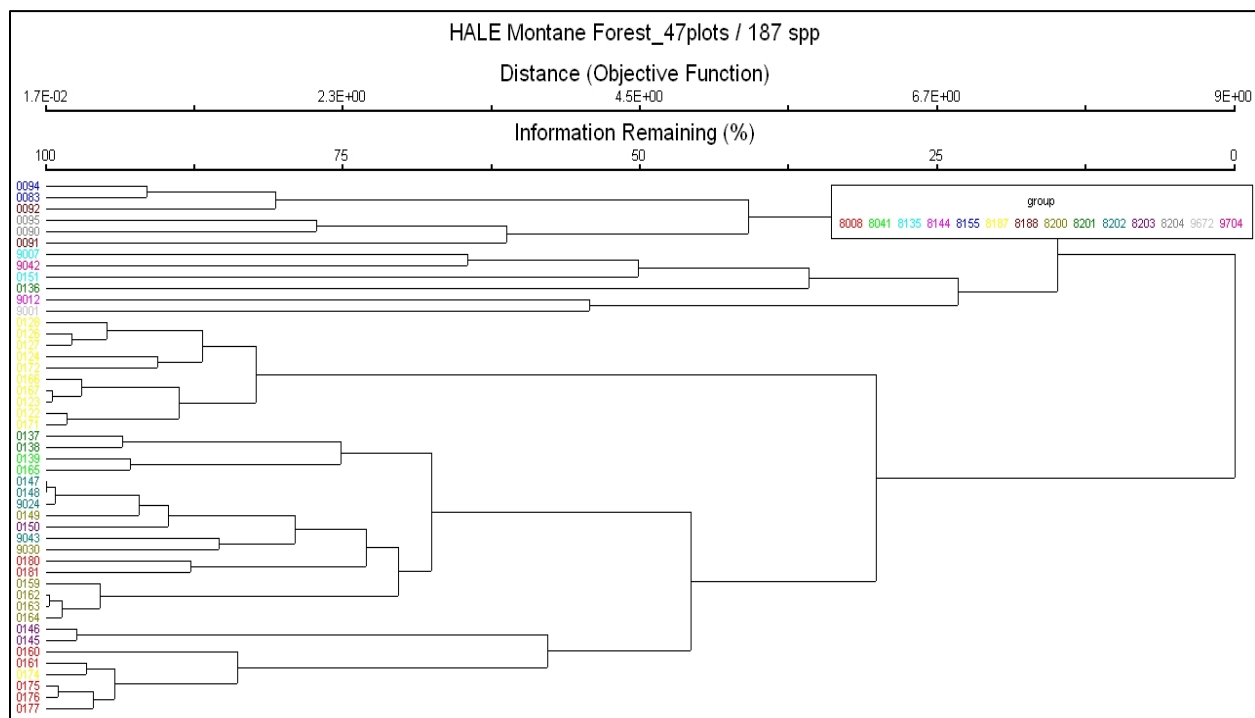


Figure 13. Cluster dendrogram of classification plot data from montane and subalpine forest USNVC associations at HALE. Each color represents a set of classification plots that parsed out into the same USNVC association.

The individual plot review was especially important because the dataset had relatively few plots across a highly diverse landscape ranging from coastal strand and lowland grasslands and forests to montane and subalpine rain forests and alpine vegetation. Additional issues included: a significant number of plant communities were represented by only one or two plots and many low elevation plots had significant cover of non-native species which required close evaluation to determine if plot was a poor condition native community or represents a complete conversion to a non-native dominated (semi-natural) community.

The draft classification was reviewed by PACN and local ecologists and was tested along with the field key to associations and local descriptions during map segmentation and validation field work. Refinements to the classification, including several additional vegetation types were identified from information collected during the map calibration and validation field work, creating an iterative process to finalizing the vegetation classification.

Development of Vegetation Association Key and Descriptions

NatureServe used the classification to draft a dichotomous field key to plant associations of HALE (Appendix C) which is designed to assist users in identifying vegetation associations in the field. The key has two levels; the first level is defined by the physiognomy of the vegetation, (i.e. sparse vegetation, forest and woodlands, shrublands and herbaceous). The second level focuses on the dominant species' canopy cover. Within the second level, strata tiers are indicated by a “/”, co-dominance is indicated by a “-” and parenthesis () indicate that a species may or may not be present at the site.

Because the key is based on a sample of the vegetation, it probably does not account for all associations occurring within the park, nor does it explain the full range of variation of all associations as they appear in the park.

Field keys need to be more inclusive than the descriptions, as the plot data collected is only a small selection of the total range of variation one may see in the field. Therefore the key is based on the classified information, but is not restricted to maximal or minimal percent covers, and has couplets that allow for new associations not previously described. Draft field keys were reviewed by PACN staff and the mapping team and then updated and finalized by NatureServe ecologists. This field key was then used during the map segmentation and validation field work by the mapping team. Comments and suggestions from the mapping team were used by NatureServe ecologists to improve the field key which evolved over the course of the project as new types were added to the classification and variation within each vegetation type was better understood. The field key in Appendix C is the final version of the association key containing revisions based on these suggestions. It also contains the new associations discovered during the calibration, validation and AA phases of the project as well as the map class codes in which the associations can be found on the map.

Park specific (called “local”) plant association descriptions were written for selected communities by NatureServe ecologists and were based on plot information collected for each type. Descriptive information included the range of cover of consistently present species along with a list of commonly

recorded species. Environmental data were used to describe the typical setting including the range in elevation, slope, aspect and soil characteristics for each association. Draft local descriptions were reviewed by PACN staff and edits incorporated by NatureServe ecologists into final local descriptions as part of the NVC. These local descriptions were then updated and finalized by NatureServe and delivered to PACN.

PACN staff then modified some of the local descriptions to match their plant taxonomic standard for this report because the NatureServe plant taxonomic standard is different than the standard used by PACN. NatureServe uses Kartesz (1999), which is very similar to USDA PLANTS. PACN uses the Manual of the Flowering Plants of Hawaii (Wagner et al. 1999), Hawaii's Fern and Fern Allies (Palmer 2003), and Hawaiian Vascular Plant Updates: A Supplement to the Manual of the Flowering Plants of Hawai'i and Hawai'i's Fern and Fern Allies (Wagner et al. 2012). Plant common names (non-scientific names) were standardized by PACN staff and inserted into the HAVO vegetation classification, the associations field key (Appendix C) and the local descriptions (Appendix D). Species names in the USNVC associations that have been modified from those posted on the NatureServe website (www.natureserve.org/explorer) are identified with a footnote.

Acquire and Prepare Imagery (Step 7)

Multiple imagery datasets were used in the HALE vegetation mapping project, including Quickbird 4 band optical imagery collected between 2004 and 2005 (Table 5), Worldview2 8 band optical imagery captured between 2010 and 2012 (Table 6), Landsat 7 band imagery from 2003 and, interferometric synthetic aperture radar imagery flown by Intermap.

All high resolution imagery was obtained either from the NPS or from the USDA NRCS National Geospatial Center of Excellence in Fort Worth, Texas. NRCS ordered 1:12,000 terrain corrected and georeferenced imagery from Digital Globe for all of the Hawaiian Islands and represent the best available products that were acquired and licensed by the US government. NRCS mosaicked and color balanced the imagery to provide continuous imagery and to remove clouds and shadows where possible. Digital Globe 1:12,000 product standards maintain no more than 10-12 m (33-40 ft) positional error for Quickbird data, and 3-6 m (10-20 ft) positional error for Worldview2 data. These high resolution data were delivered to KGA over the course of the project with the Quickbird imagery for the entire park in 2010 and the Worldview2 imagery arriving in early 2012. Upon receipt of imagery, KGA reviewed the datasets for quality and registration. All high resolution datasets were determined to be within NPS standards for positional accuracy for use in the vegetation mapping project except the interferometric synthetic aperture radar imagery which was too noisy. The high resolution Worldview2 imagery and its NRCS metadata were delivered to PACN at the end of the project where they are archived and available by contacting PACN.

Table 5. Digital Globe Quickbird imagery used in vegetation classification at HALE.

DOQQ_NAME	USDA_Names	Image Date
Hana SW	m2015517_sw	11/22/2004 - 08/22/2005
Kaupō NE	m2015632_ne	08/22/2005
Kaupō NW	m2015632_nw	08/22/2005
Kaupō SW	m2015632_sw	08/22/2005
Kilohana SE	m2015623_se	04/10/2005 - 05/16/2005
Kīpahula NW	m2015525_nw	11/22/2004 - 08/22/2005
Lualailua Hills NE	m2015631_ne	04/10/2005 - 05/16/2005
Nahiku SE	m2015624_se	08/22/2005
Nahiku SW	m2015624_sw	08/22/2005

Table 6. Digital Globe Worldview2 imagery used in the vegetation classification of HALE.

Image Name	Image Date
Tile 1	1/3/2010
Tile 2	2/16/2010
Tile 3	2/27/2010
Tile 4	4/1/2010

Imagery Analysis / Classification (Step 8) / GIS Project Preparation (Step 9)

Introduction

Using remotely sensed data and ancillary information to map vegetation type is effective only because a high correlation exists between variation in the imagery and ancillary data, and variation in vegetation as specified by the classification scheme. In other words, when the vegetation on the ground changes, the spectral response of the imagery and/or the classes of ancillary data also change. Using remotely sensed data and ancillary information to map land cover and land use requires understanding what factors cause variation on the ground and how the imagery and ancillary information represent those variations. Therefore, vegetation mapping requires completion of three basic steps:

- Develop a classification scheme to specify the type of land cover and land use characteristics to be detected and mapped,
- control variation in the imagery and ancillary information that is not related to variation in the classification scheme, and
- classify variation that is related to the variation in the classification scheme.

Since early last century, these steps have been completed through the manual photo interpretation of remotely sensed data to delineate and identify vegetation by relying on seven indicators of vegetation type; color, tone, texture, location, context, height, and shape of the feature of interest (Spurr 1948). While a mainstay for decades, manual interpretation can be extremely time consuming, costly, and inconsistent. Semi-automated classification involves data exploration to establish relationships between the imagery, ancillary information, and features on the ground. Semi-automated methods

can be more cost effective and consistent than manual interpretation by allowing computer data analysis to label the easily identified features, thereby focusing the skilled remote sensing analysts' efforts on difficult and complex features. This project employed semi-automated techniques.

Innovations over the last decade have resulted in the development of the semi-automated classification method of object oriented classification. Object oriented image classification classifies image objects (polygons) instead of single pixels, allowing for the incorporation of not only texture, tone, and color, but also shape and context into the creation of vegetation data. Object oriented classification closely mimics manual interpretation by creating vegetation polygons, yet brings substantial increase to the speed of map production, consistency, accuracy, and detail. While powerful in the classification of medium resolution data (e.g. Landsat), object oriented classification is pivotal for semi-automated classification of high resolution airborne imagery, (such as Quickbird and Worldview imagery) because of the mixture of shadow and illuminated features in the imagery and the need to group pixels together to map vegetation classes instead of individual vegetation features such as individual trees.

This project's semi-automated techniques included object oriented image segmentation, classification and regression tree (CART) analysis, local expertise, field data collection, manual image interpretation and editing, and GIS modeling to create a vegetation map for HALE.

Image Segmentation

KGA employed Trimble's (formally Definens) eCognition software (<http://www.ecognition.com/>) to segment the high resolution imagery into spectrally unique objects. Similar to the manual delineation of polygons in photo interpretation, segmentation algorithms delineate digital imagery into groups of pixels, called objects or segments, which have more spectral variation *between* than *within* segments, based on a user defined set of inputs. Automated segmentation improves on manual delineation by forcing consistency and increasing detail in the delineation process.

Table 7 presents the input bands and eCognition parameters used to create the HALE segments from the Worldview2 imagery. It is desirable to have eCognition create more segments than will be needed because it is easier to dissolve between adjacent segments with the same map label than it is to edit in new segment lines. At the end of the mapping process, delineations between adjacent segments with the same map and modifier classes were dissolved to create map vegetation polygons. Segmentation was done across the entire park at once.

Table 7. eCognition parameters used to segment the Worldview2 imagery.

Input Image Bands	Band Weight	Shape	Compactness	Scale	Segmentation Cycles
WV2 Red band	2	0.3	0.7	60	10
WV2 Green band	2				
WV2 Blue band	2				
WV2 NIR1	2				
WV2 NIR2	2				
WV2 NIR1 texture 20x20	1				

Collect and Process Ancillary Data

While many of the indicators of vegetation type can be derived from remotely sensed data (i.e. color, tone, texture, shape, and height), others such as location and context must be derived from ancillary data. Data ancillary to the imagery are critical to vegetation map creation because they can capture causes of variation in vegetation type that are not captured by the imagery.

The NPS supplied KGA with numerous geodatabases of ancillary data. KGA also acquired multiple datasets and created several ancillary data layers. Measures of each segment's mean color and tone, and texture (color and tone variance across the segment) were separately derived from the QuickBird, Worldview2, and Landsat TM imagery. Measures of shape were obtained from the eCognition segment shape outputs. Location information was acquired from ancillary data layers such as digital elevation models (DEM), stream and shoreline coverages, climate zones, and soil. Table 8 summarizes ancillary data used in the HALE vegetation mapping project.

Once the independent variable layers were created or acquired, they were reviewed for quality and registration. Verification and co-registration of ancillary data and imagery is an important task which ensures that the independent variables being sampled are associated with the vegetation class of interest. Following review, several ancillary data sets were rejected for use in CART and were used as reference data only.

Each independent variable layer was intersected with the segment layer in ArcGIS and segment zonal statistics for each layer (usually the mean and the standard deviation) were created for each variable for each segment. A relational database of each sample segment's dependent variable (i.e. vegetation association or map class) and independent variables (from either eCognition or ArcGIS) was created in Microsoft Access.

Other ancillary data depicting the vegetation of the project area from earlier or smaller scale projects were also acquired but used only as reference data in map review, and not in CART analysis. Legacy vegetation data included the NPS observation and classification field plots, monitoring plots, the combined vegetation map created from the maps by Whiteaker (1980), Smith et al (1985) and Jacobi (1989), and NOAA's 2005 life form map.

Table 8. Ancillary data sources used to map the vegetation of HALE.

Dataset	Description	File Type	Used
WorldView2 8 bands	8 bit and 16 bit, 50cm resolution	raster	CART
QuickBird 4 bands	8 bit, 50 cm resolution	raster	CART
Image texture	texture bands from satellite imagery NIR bands	raster	CART
Landsat imagery	2003 Landsat	raster	CART
Digital Terrain Model (DTM)	from IfSAR, 5m resolution	raster	reference
Digital Surface Model	from IfSAR, 5m resolution	raster	reference
Contours	derived from IfSAR	vector	reference
Hillshade, two versions	derived from IfSAR DTM	raster	reference
Slope degree	derived from IfSAR DTM	raster	reference
Slope percent	derived from IfSAR DTM	raster	reference

Table 8 (continued). Ancillary data sources used to map the vegetation of HALE.

Dataset	Description	File Type	Used
Aspect	derived from IfSAR DTM	raster	reference
Vegetation/feature height	IfSAR DSM - NED DTM	raster	CART
NED Digital Elevation Model (DEM)	10m DEM	raster	CART
NED aspect	Aspect created from NED DEM	raster	CART
NED slope degree	Slope created from NED DEM in degrees	raster	CART
NED slope percent	Slope created from NED DEM in percent	raster	CART
NPS field plots	NPS vegetation plot points	vector	reference
2006 high resolution C-CAP	NOAA CCAP high resolution land cover	raster	reference
Roads and trails	NPS roads and trails	vector	reference
Digital Raster Graphs	topography	raster	reference
NPS PACN classification field plots	NPS vegetation plot points	vector	reference
NPS PACN monitoring data	species data from monitoring plots and transects	vector	reference
Flora and Fauna inventories	flora and fauna present in park	vector	reference
Geology	soil/rock type and age	vector	CART

Calibration Trip

Field sampling is the most effective way to understand how remotely sensed and ancillary data may be used to map vegetation because it provides an understanding of:

- causes of vegetation variability, and
- the relationship between vegetation variability and that of the imagery and ancillary data layers.

Collection of field data used to create the HALE vegetation map started with NPS classification field sample collection, continued with KGA calibration and validation sample collection, and ended with NPS formal AA site collection. This section of the report summarizes the calibration trip procedures.

In November of 2012, a six day calibration trip was made to HALE. Three 2-3 person crews (composed of HALE, PACN, and KGA personnel) collected sample segments throughout accessible portions of the park. Helicopter access by KGA to sections of the park was not possible. As a result, these portions of the park were not visited in the field by KGA calibration or validation field crews. However, most areas of the park were visited by NPS classification and/or AA personnel. These NPS data were instrumental in creation of the HALE vegetation map.

The focus of the calibration trip was to capture as much field verified information as possible and to collect samples in vegetation classes that were under represented in the NPS plots and/or were spectrally interesting. Field sample data were collected on Trimble Yumas (Figure 14) and segments were labeled at every opportunity. Segment labeling was implemented by selecting segments from the processing region segment coverage and choosing the vegetation association from a pull down menu in the attribute table. Detailed field sample data were collected for unique vegetation types using the field forms created for the HALE vegetation mapping project. The form automatically

provides quality control and calculates the vegetation association of the sample segment using the KGA created Autolabeler program. The form also provides the option of selecting one or two alternative acceptable vegetation class label(s) for the site for later analysis.



Figure 14. Calibration field data entry at HALE on a Trimble Yuma.

Guidelines for the selection of calibration field sample segments were:

- *Informational homogeneity* – The sample must represent one and only one vegetation class. Segments including more than one vegetation class were edited to represent only one class.
- *Spectral homogeneity* – The sample should have more between than within segment spectral response.
- *Minimum size* – Samples should be larger than the MMU of 0.5 hectares.
- *Project-wide distribution* – For each class, field personnel attempted to distribute the sites evenly across that class's distribution in the project area.
- *Spectral uniqueness* – Samples were collected of vegetation with spectrally unique characteristics.

Creation of the Classification and Regression Tree (CART) Sample Database

Upon return from the field, all calibration data underwent quality control. Each sample was reviewed for data entry or logic errors and segments were edited where needed so that each sample segment represented only one vegetation association. Additionally, NPS classification plots were transformed into sample segments where possible by comparing the segment imagery to the USNVC plot label. If

the USNVC plot label was an acceptable label for the segment, the segment was given the plot label and it was included as a sample for CART modeling. The USNVC label was rejected if it appeared to not be representative of the segment (i.e. if the plot label was for a vegetation association below the MMU of 0.5 ha; 1.2 ac). The result was a combined set of KGA and NPS sample segments. Finally, all NPS classification data were run through the autolabeler to check for consistency and errors.

CART Modeling

The HALE vegetation map was created using a combination of CART modeling and manual editing. CART analysis builds “tree” diagrams for predicting variables from categorical and continuous data (Breiman et al. 1984). It “mines” the sample data and builds rules which are if-then statements in hierarchical “trees” that predict vegetation classes. CART is powerful because:

- it can accept both continuous and categorical data inputs,
- the results are easy to interpret,
- unlike a maximum likelihood classifier, no assumptions are required concerning the distributions of the independent variables,
- it identifies simple and complex relationships between variables that other techniques might not uncover, and
- it forces consistency and analytical rigor into the segment labeling process.

CART analysis was performed on the combined NPS and KGA samples using See5 (<http://www.rulequest.com/see5-info.html>) software. HALE was divided into seven processing regions. With a park as diverse as HALE, processing regions allow constraining the occurrence of map classes to only the regions where they are known to exist (Figure 15). Input variables to CART were the sample segment vegetation associations (the dependent variables), and segment independent variables, such as the various measures from the high resolution imagery (e.g., tone, color, segment shape, texture) and ancillary data sets (e.g., Landsat imagery, slope, aspect, elevation, climate, rainfall). The CART model was built from the sample segments and then the model was applied to the remaining segments. The resultant CART labels were then imported into ArcGIS. Figure 16 provides a conceptual illustration of how CART analysis works.

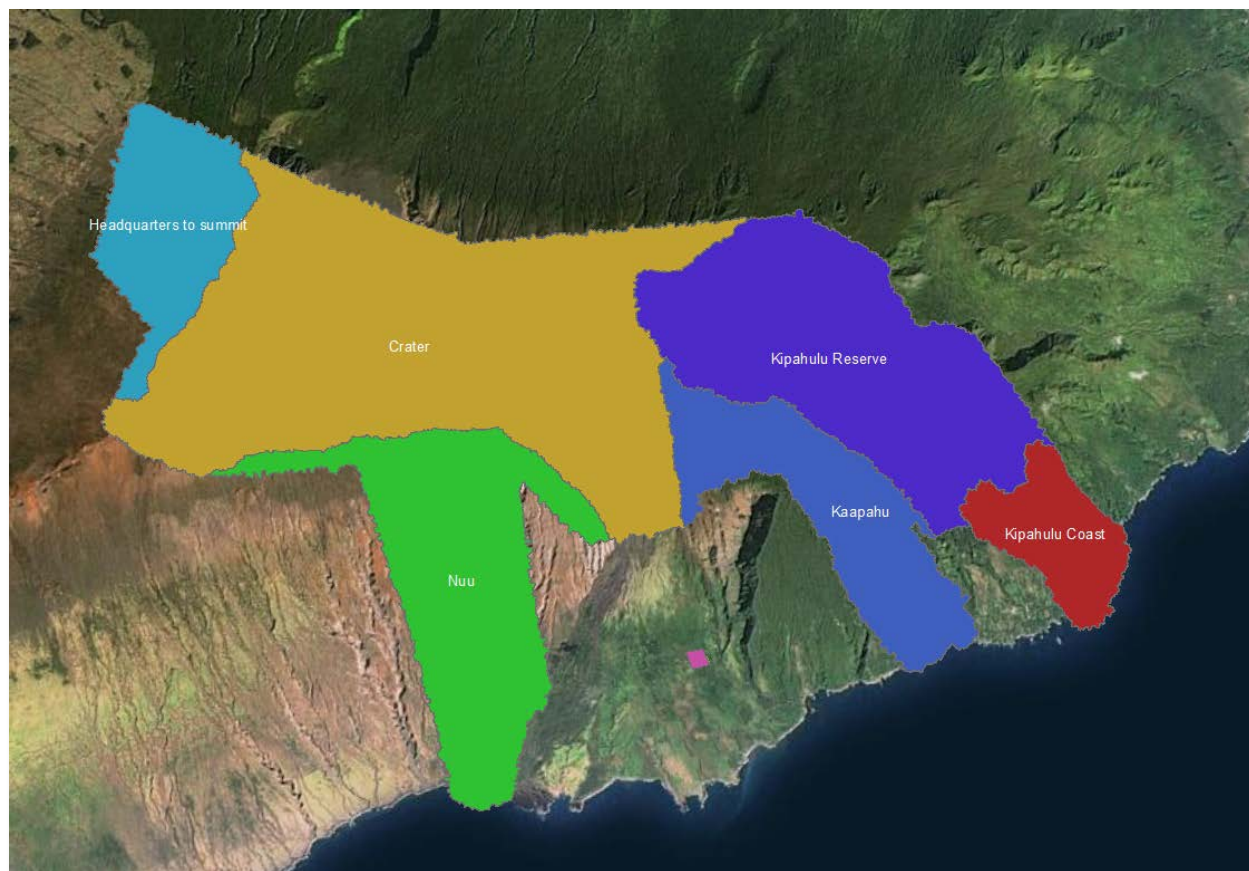


Figure 15. HALE CART processing regions. The regions are slightly buffered beyond HALE boundary to ensure that imagery of all of the park is captured.

Editing

Manual edits were conducted to improve the accuracy of the map resulting from CART modeling. Manual editing was done in ArcMap and involved changing a segment's boundaries and/or changing a segment's map label to a more accurate map class. Edits were based on manual interpretation of all image sets, field notes, ancillary data, and legacy vegetation maps and data. For quality control, pull down lists of allowable attribute domains were created for map class editing. Typically, manual editing took place at scales between 1:5,000 and 1:10,000. At times, however, analysts would work at larger scales, especially in coastal areas. The result of the CART modeling and editing was the HALE preliminary vegetation map which was field checked during the validation trip.

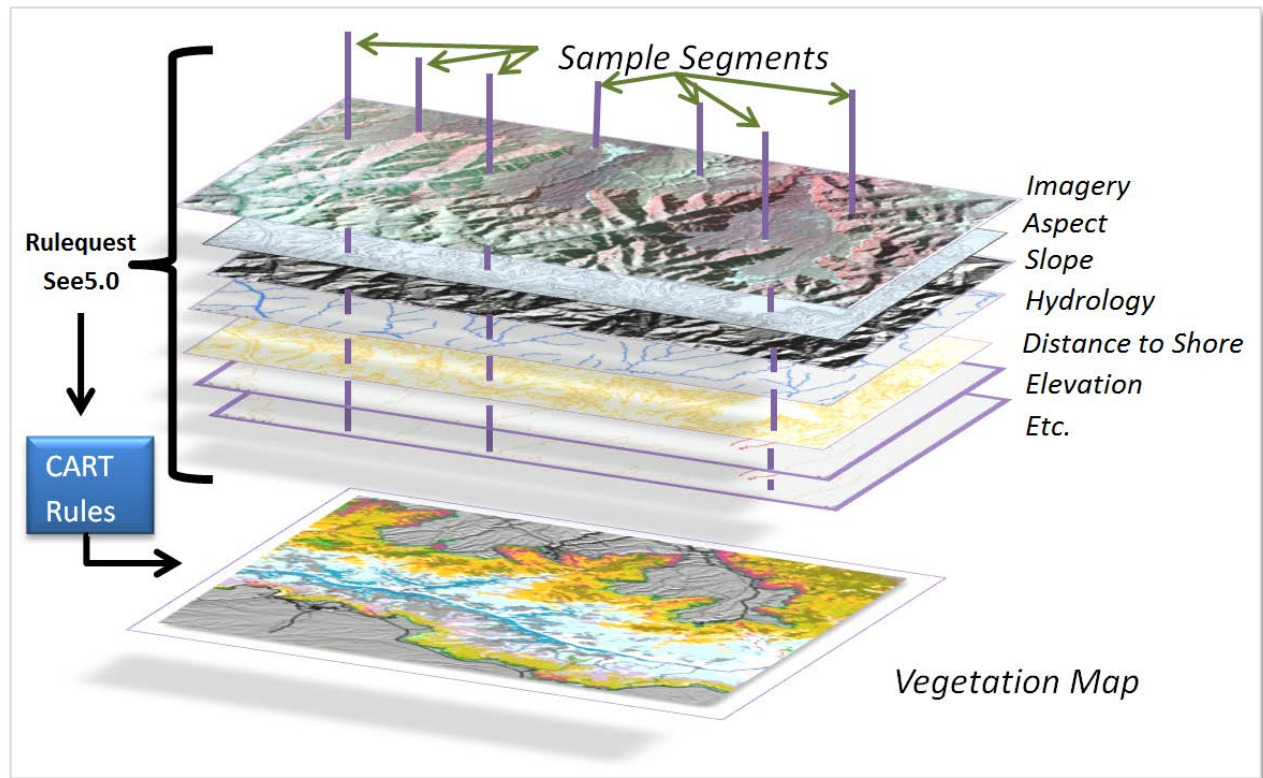


Figure 16. Conceptual illustration of the CART data mining and rule creation process.

Validation (Step 10)

In late August of 2013, KGA personnel returned to HALE to check the preliminary map. One 3-person crew (KGA and HALE personnel) spent six days evaluating the preliminary map. Corrections to the map were made in the field on a Trimble Yuma. Upon return from the field, the preliminary map was further edited in the office and sent to the NPS for review. Comments on the preliminary map were then incorporated into the map, additional edits were made, and the draft map was created.

Draft Map and Digital Database Production

In December of 2013, KGA delivered the HALE draft vegetation map (Figure 17) and digital database to the NPS. The vegetation map feature class attribute tables were formatted according to NPS standards. The following standard fields were included in the attribute tables based on an example table sent to KGA by the NPS and approved by the NPS after delivery of the data.

1. NVC_Elcode – String field, populated with the vegetation association code.
2. Association – String field, populated with the vegetation association name or N/A if no association exists.
3. MapClass_CD – String field, to be populated by the NPS.
4. Map_Class – String field, populated with the vegetation map class name.
5. X_Centroid – Double numeric field, populated with the X centroid coordinate for the polygon in meters.

6. Y_Centroid – Double numeric field, populated with the Y centroid coordinate for the polygon in meters.

Some additional fields were included in the attribute tables that were not specifically requested by the NPS.

1. Poly_ID – Long numeric field, populated with a unique identifier number for the polygon.
2. Hectares – Double numeric field, populated with the polygon area in hectares.
3. Sparse/Dense “modifiers” were used for the map classes “*Leptecophylla tameiameiae* - *Vaccinium reticulatum* Subalpine Mesic Shrubland” and “*Pityrogramma austroamericana* - *Heterotheca grandiflora* Semi-natural Herbaceous Vegetation” as follows:
 - Dense – if total shrub/herbaceous cover is $\geq 20\%$
 - Sparse – if total shrub/herbaceous cover is $< 20\%$

Figure 17. Draft HALE vegetation map. High quality pdf available <http://science.nature.nps.gov/im/inventory/veg/products.cfm>.

Formal Accuracy Assessment (Step 11)

Introduction

An important and necessary aspect of this project is the AA which entails collecting independent ground data to determine the accuracy of the map. As such, users of this product should remember that the GIS mapping and the classification portions of this project were conducted separately from both the classification plot and AA field data collection.

AA is of two types: positional and thematic. Positional accuracy quantifies errors in the locations of geographic position. In the case of the VIP however, the spatial/positional accuracy is relative to the accuracy of Quickbird and Worldview2 imagery and allows for the assumption that all products derived from them are well within the NPS national map accuracy standards for 1:12,000-scale maps (± 9 m; 30 ft).

Thematic maps capture the spatial variation of one or a small number of themes such as climate, soil type, population density, or vegetation. The HALE vegetation map is a thematic map of vegetation and land use as defined by the HALE map class key and map class descriptions.

Sampling Design

The thematic accuracy of the vegetation map was assessed using the methodology standards provided by the VIP (Nature Conservancy and ESRI 1994). The protocols include a four step AA process consisting of a sample design, sample site selection, data collection, and data analysis. The design of the HALE AA sample followed the five scenarios provided in the 1994 field manual with stratified accessible random targets placed in each map class based on their respective frequency and abundance (Table 9).

AA sample points were generated for each map class using ArcGIS. Polygons less than the MMU (0.5 ha) were eliminated from the assessment using a definition query. Polygons classified as water or human made features were also removed. Steep areas ($\geq 70\%$ slope) were identified (intersected with 5 m DEM) and eliminated from the analysis for crew safety. Inaccessible areas, based on road/trail GIS layers and park-specific knowledge, were also eliminated. In order to generate random points across each map class, all single part polygons per map class were dissolved into one multipart polygon feature. Multipart polygons allow selection of individual map classes to generate the required amount of sampling points across the map class spatial extent. AA sample points were generated for each map class using the random point generator within the dissolved feature class. Three times the required number of sample points were generated per map class to ensure the creation of enough accessible samples. A 45 m (148 ft) buffer was created around each point using the proximity tool to represent a 0.5 ha (1.2 ac) circle with a 5 m (16 ft) buffer accounting for the horizontal error typically encountered in GPS receivers. A random feature ID was assigned and each buffer was unioned with the previously processed map data. Samples were selected (853) only if points and buffers were 100% within map polygons. If necessary, buffers were shifted up to 40 m to fit within polygons (68 samples). Some had odd shaped (i.e. linear) polygons in which 0.5 ha circles did not fit (103 samples) and requiring polygon based sampling. Sample points were rejected when buffers intersected other point's buffers to ensure no overlapping samples. AA sample points were randomly selected from the list of acceptable points per map class. Point data were exported from

GIS into GPS field devices. For map classes that required polygon based sampling, polygon boundaries excluding map class labels were uploaded to GPS units.

Table 9. VIP Sampling protocol for AA points. Source: Final Draft AA Procedures, National Park Service 1994.

Scenario	Description	# Polygons	Area (ac)	Recommended # of Samples
A	The class is abundant. It covers more than 50 hectares of the total area and consists of at least 30 polygons. In this case, the recommended sample size is 30.	> 30	> 125	20*
B	The class is relatively abundant. It covers more than 50 hectares of the total area but consists of fewer than 30 polygons. In this case, the recommended sample size is 20. The rationale for reducing the sample size for this type of class is that sample sites are more difficult to find because of the lower frequency of the class.	< 30	> 125	20
C	The class is relatively rare. It covers less than 50 hectares of the total area but consists of more than 30 polygons. In this case, the recommended sample size is 20. The rationale for reducing the sample size is that the class occupies a small area. At the same time, however, the class consists of a considerable number of distinct polygons that are possibly widely distributed. The number of samples therefore remains relatively high because of the high frequency of the class.	> 30	< 125	20
D	The class is rare. It has more than 5 but fewer than 30 polygons and covers less than 50 hectares of the area. In this case, the recommended number of samples is 5. The rationale for reducing the sample size is that the class consists of small polygons and the frequency of the polygons is low. Specifying more than 5 sample sites will therefore probably result in multiple sample sites within the same (small) polygon. Collecting 5 sample sites will allow an accuracy estimate to be computed, although it will not be very precise.	5-30	< 125	5
E	The class is very rare. It has fewer than 5 polygons and occupies less than 50 hectares of the total area. In this case, it is recommended that the existence of the class be confirmed by a visit to each sample site. The rationale for the recommendation is that with fewer than 5 sample sites (assuming 1 site per polygon) no estimate of level of confidence can be established for the sample (the existence of the class can only be confirmed through field checking).	< 5	< 125	Visit all and confirm

*Recommended sample size reduced to meet time and cost restraints.

Field Data Collection

From December 2013 to July 2014, PACN, HALE, and HAVO staff and volunteers collected 601AA samples at HALE (Figure 18). Using GPS units, field maps, and compasses, field crews navigated to the target location and assessed the vegetation of the sample (0.5 ha), typically as a circular plot (40 m radius). In areas where boundaries of vegetation follow long, sinewy formations (e.g. along ridge tops) where circular plots did not fit, vegetation was assessed within the polygon boundaries. At each site, field crews recorded the percent cover of dominant plant species by stratum on AA forms

(Appendix F). Based on these estimates, crews used the classification key (Appendix C) to identify the vegetation association. The association description (Appendix D) was reviewed and comments were included where necessary (e.g. main descriptive species missing). In sites where the vegetation matched more than one association (e.g. percent covers were near the cut-off between physiognomic groups), crews assigned a secondary and in some cases a tertiary field call. Photos were taken in each plot in all cardinal directions (N-E-S-W), and of the canopy, ground, and completed data forms. Nearby vegetation, topographic features, or recent disturbance were also recorded. If the crew encountered a vegetation type that was new to the HALE vegetation classification, they also completed an environmental field form (Appendix F) and developed a species list for the site.

If the crew could not access the sample (> 12 m from target location) due to steep terrain or dense vegetation, they noted this limitation and assessed the vegetation at the closest proximity.

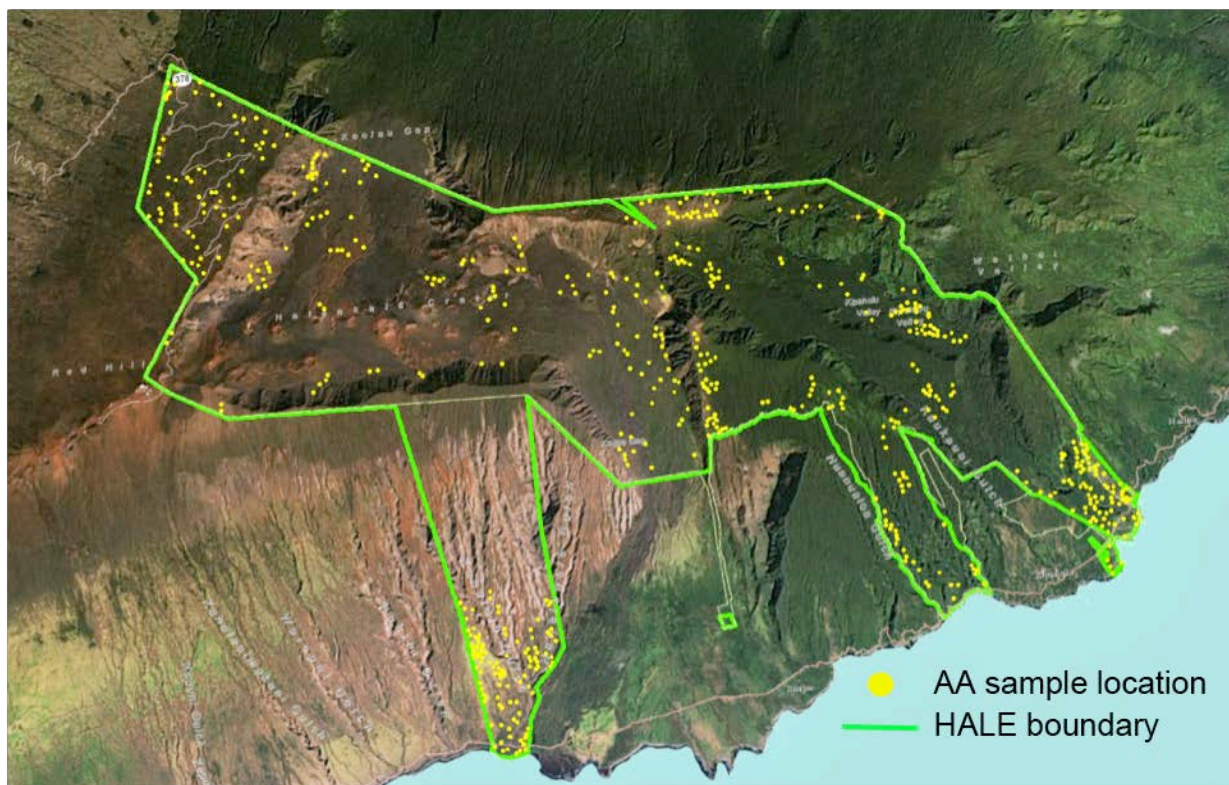


Figure 18. Distribution of AA sites at HALE.

Quality Control

AA data forms were reviewed for errors, entered into the NPS Microsoft Access database (PLOTS), and proofed for data entry errors by PACN staff. KGA also reviewed the AA data for errors and ran data for each sample through the autolabeler to check for any inconsistencies in sample labeling. An interim analysis and description of possible errors were transmitted to the PACN staff and most discrepancies in sites were resolved.

Analysis

The AA analyses was completed by:

- reviewing each site's database, scanned field form, and field photos,
- running the reference site data through the autolabeler, and
- comparing the site's reference AA label to its draft map label, its autolabeler label, the high resolution imagery, and validation and calibration field samples and photos.

KGA and PACN then reviewed the AA data and decided if errors had been made in data entry or labeling and changes were made to the data where warranted. Any post-hoc changes to AA field calls are identified in Appendix G. Next, error matrices were developed as detailed in the NPS National Vegetation Mapping Program's 1994 (NPS 1994) standards.

Develop the Mapping Model (Step 6)

Ideally, when the vegetation associations change on the ground, the response of the remotely sensed data and the classes of the ancillary data also change, resulting in a one to one relationship between the associations and map classes. However, because vegetation associations are often distinguished from one another by sub canopy and/or scarce indicator species, it is often impossible to map to the association level, resulting in the need to collapse associations into less detailed map model classes. Therefore, a critical step in the HALE project was the translation of the HALE ecological association descriptions and key into a map key and map class descriptions composed of classes which could be mapped from remotely sensed data and ancillary information.

In some NPS vegetation mapping projects which rely on manual photo interpretation, the development of the mapping model occurs following the collection of the imagery and completion of the calibration trip, when the photo interpreters have developed an understanding of what vegetation associations are distinguishable from the imagery and what need to be collapsed upward into more general map classes. In this project, development of the mapping model (Step 6) spanned across Steps 5 through 11. Development of the model started with the associations developed in Step 5. Following the calibration trip (Step 7) and validation trip (Step 9), several associations were added which were not sampled as part of the classification work (e.g. *Cocos nucifera* Strand Woodland) and some were removed because they were not encountered again in the field (e.g. *Vaccinium calycinum* Subalpine Mesic Shrubland [Park Special]). Most of the development of the mapping model was performed following AA of the draft map (Step 11). As a result, only associations shown to be confused from the AA were combined.

Following AA, KGA, and PACN staff worked together to finalize the map model classes. For each USNVC association a determination was made regarding if the association was:

- abundant and distinguishable using the imagery and/or ancillary data so as to be mapable using CART modeling coupled with manual editing,
- indistinguishable from the imagery and ancillary data and, therefore, needing to be collapsed upward into a map class or modeled using local knowledge of HALE staff, or
- too rare to be mapped using CART modeling coupled with manual editing, in which case it would appear on the final map only in places where it was field verified during the PACN and KGA field data collection efforts.

Final Map, Reports, and GIS Database (Step 12)

Following AA the draft map was edited based on AA results. Details of edits per map class can be found in Appendix H. Figure 19 illustrates the impact of the final editing on a portion of HALE.

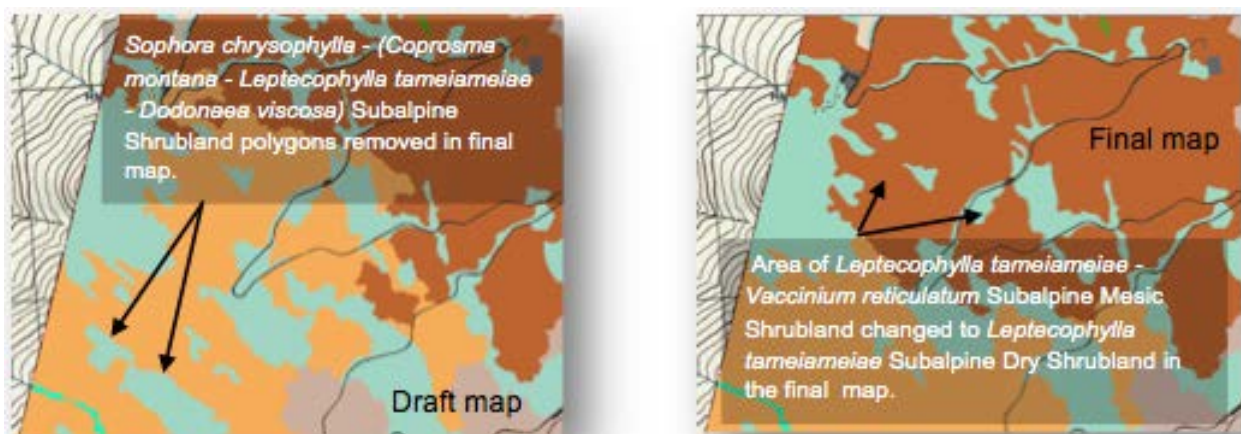


Figure 19. Area near park headquarters in the front county showing an example of the impact of editing between the draft map and the final map as a result of information gained from AA samples.

The most significant edits of the draft map focused on editing errors discovered during AA or changing labels to new map classes. They included:

- Correcting errors of commission of *Leptecophylla tameiameiaae* - *Vaccinium reticulatum* Subalpine Mesic Shrubland near the switch backs in the front country to the AA field verified label of *Leptecophylla tameiameiaae* Subalpine Dry Shrubland.
- Correcting errors of commission of *Holcus lanatus* Semi-natural Grassland to the AA field verified label of *Pteridium aquilinum* ssp. *decompositum* Herbaceous Vegetation in the crater near Maunahina.
- Correcting errors of commission of *Leptecophylla tameiameiaae* Montane Mesic Shrubland to the AA field verified label of *Leptecophylla tameiameiaae* - *Dodonaea viscosa* Montane Shrubland in Kaupō Gap.
- Adding a new map class of *Metrosideros polymorpha* / *Vaccinium calycinum* - *Rubus hawaiensis* / (*Coprosma foliosa* - *Leptecophylla tameiameiaae*) Montane Wet Forest at the top of the Kīpahulu Valley.
- Changing areas of *Metrosideros polymorpha* / *Rubus hawaiensis* Montane Wet Forest to the new map class of *Metrosideros polymorpha* / *Vaccinium calycinum* - *Rubus hawaiensis* / (*Coprosma foliosa* - *Leptecophylla tameiameiaae*) Montane Wet Forest.
- Correcting errors of commission of *Myrsine lessertiana* - (*Metrosideros polymorpha*) / *Coprosma foliosa* - *Dodonaea viscosa* Montane Mesic Forest to the AA field verified label of *Acacia koa* / *Coprosma foliosa* - *Dodonaea viscosa* Montane Mesic Woodland along the Kaupō Trail.

- Correcting errors of commission of *Metrosideros polymorpha* / *Sadleria cyatheoides* Forest to the AA field verified label of *Acacia koa* / *Leptecophylla tameiameia* - (*Dodonaea viscosa*) Montane Woodland east of the Kaupō Trail.
- Correcting errors of commission of *Schinus terebinthifolius* Semi-natural Scrub Woodland to the AA field verified label of *Syzygium cumini* Lowland Mesic Semi-natural Forest near the coast in 'Ohe'o.
- Correcting errors of commission of *Cenchrus ciliaris* - *Bothriochloa pertusa* Semi-natural Herbaceous Vegetation to *Lantana camara* Semi-natural Shrubland in Nu'u.
- Changing the *Melinis repens* - Mixed Semi-natural Sparse Vegetation polygon on the western cliffs of the Kaupō Gap to *Melinis minutiflora* - (*Schizachyrium condensatum*) Semi-natural Herbaceous Vegetation.

Final delivery included electronic and digital high resolution PDF maps. Additionally, a geodatabase of the final maps was delivered in Universal Transverse Mercator (UTM) North American Datum of 1983 (NAD83) High Accuracy Reference Network (HARN) datum. All electronic data, including GIS Data, are metadata compliant with Federal Geographic Data Committee Metadata Standards. The following fields were included in the final vegetation map attribute table.

- NVC_ELCODE – String field, populated with the vegetation association code or NA if no code exists.
- Association – String field, populated with the vegetation association name or NA if no association exists.
- MapClass_CD – String field, to be populated by the NPS.
- MapClass – String field, populated with the vegetation map class name.
- MapClass_Common_Name - String field, populated with the vegetation map class common name.
- HECTARES – Double numeric field, populated with the polygon area in hectares.
- MMU – Double numeric field, populated with the minimum mapping unit for the class.
- MMU_COMMENT – String field, populated with comments regarding the MMU for the class.
- X_Centroid – Double numeric field, populated with the X centroid coordinate for the polygon in meters.
- Y_Centroid – Double numeric field, populated with the Y centroid coordinate for the polygon in meters

Results

Vegetation Sampling

Vegetation sampling at HALE was completed by PACN and NPS staff. Given the high diversity of habitats and plant communities and the extreme ruggedness of the terrain, it was a challenging landscape to sample. Over sixty percent of the 76 association level communities are based on two or less plots (7 types with no plots, 23 single plot types, and 17 two plots types). Other factors contributing to the low sampling per association include the rare nature of many of the native communities and varying degrees of degradation by invasive non-native species. When possible, NatureServe recommends 3-5 plots of each type to capture some of the range of variability within each type.

Vegetation Classification

The vegetation data collected from HALE were classified into 13 USNVC macrogroups, 17 USNVC groups, and 76 association level community types (Table 10). Of these community types, 32 were attributed to existing USNVC associations and 27 were considered new USNVC associations from HALE. Seventeen types were considered park specials due to lack of sufficient information to justify creating new USNVC associations. Associations are termed “park specials” when they occur only in small stands, are tentatively considered unique to the park and lack sufficient documentation in the literature. Park specials are identified in the classification by an Elcode prefix of “CEPS” (Table 10). When HALE plant communities are summarized by physiognomic class, there are a total of 38 tree dominated communities (scrub forests/woodlands/ rain forests, coastal strand woodland), 17 shrublands, 18 herbaceous vegetation and three sparse vegetation types. A key (Appendix C) was created for the associations and most were described. Descriptions were developed for all associations with two or more classification plots, and a few associations of special interest to HALE were described based on one classification plot, which resulted in descriptions for 52 of the 76 associations (Appendix D).

Each association or park special is represented by zero to 22 full plot samples. Appendix E has the HALE vegetation classification arranged alphabetically with supporting plots and observation points. The six association level community types that lack classification plots or observation points were based on opportunistic data collected (dominant species and location) during the map calibration/validation process field work. Some of these types were widespread USNVC types such as *Cenchrus purpureus* Semi-natural Herbaceous Vegetation (CEGL008210). Other additional types observed by map calibration field crews were less common but thought to be important such as *Cocos nucifera* Strand Woodland (CEGL005402) and *Metrosideros polymorpha* / *Sadleria cyatheoides* Forest [Park Special] (CEPS009712). These six additional types, (four existing USNVC association and two park specials) were added to the draft HALE vegetation classification after quantitative analysis was complete. These additional types are noted with an “*” next to their name in Table 10 and are noted in Appendix E. These types may be rare in the park, or were simply not sampled as a result of difficult access or limitations of the original sampling design. Although more field data is needed to support these types, they were added because it is important that the vegetation classification be as comprehensive as possible to maximize vegetation mapping accuracy.

Table 10. USNVC hierarchical classification of vegetation at HALE organized by macrogroup, group, and association.

USNVC Association	Common Name	ELCODE	USNVC Group	USNVC Macrogroup
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Lowland Mesic Forest	Koa - 'Ōhi'a Lowland Mesic Forest	CEGL008023	Hawaiian Lowland - Coastal Seasonal Rainforest	Hawaiian Lowland Rainforest
<i>Pandanus tectorius</i> Coastal Mesic Forest	Hala Coastal Mesic Forest	CEGL008032		
<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Mesic Woodland	'Ōhi'a / Uluhe Lowland Mesic Woodland	CEGL008039		
<i>Acacia koa</i> - <i>Cheirodendron trigynum</i> - (<i>Antidesma platyphyllum</i> , <i>Syzygium sandwicense</i>) / (<i>Clidemia hirta</i>) Lowland Wet Forest	Koa - 'Ōlapa - (Hame, 'Ōhi'a Ha) / (Koster's curse) Lowland Wet Forest	CEGL008185		
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Wet Forest	Koa - 'Ōhi'a / Uluhe Lowland Wet Forest	CEGL008186		
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> / <i>Hedygium gardnerianum</i> Semi-natural Woodland [Park Special]	Koa - 'Ōhi'a / Kahili Ginger Semi-natural Woodland [Park Special]	CEPS009700		
<i>Syzygium cumini</i> Lowland Mesic Semi-natural Forest	Java Plum Lowland Mesic Semi-natural Forest	CEGL008111	Polynesian Semi-natural Lowland Rainforest	Polynesian Semi-natural Lowland Rainforest
<i>Grevillea robusta</i> Lowland Mesic Semi-natural Forest	Silk Oak Lowland Mesic Semi-natural Forest	CEGL008113		
<i>Psidium cattleianum</i> Lowland Wet Semi-natural Forest	Strawberry Guava Lowland Wet Semi-natural Forest	CEGL008116		
<i>Eucalyptus</i> spp. - Mixed Alien Semi-natural Forest/Plantation [Provisional]	Eucalyptus spp.- Mixed Alien Semi-natural Forest/Plantation [Provisional]	CEGL008144		
<i>Psidium guajava</i> / Disturbed Understory Semi-natural Forest	Common Guava / Disturbed Understory Semi-natural Forest	CEGL008147		
<i>Schinus terebinthifolius</i> Semi-natural Scrub Woodland	Christmas Berry Semi-natural Scrub Woodland	CEGL008148		
<i>Acacia koa</i> - <i>Psidium cattleianum</i> Semi-natural Forest	Koa – Strawberry Guava Semi-natural Forest	CEGL008184		
<i>Mangifera indica</i> Semi-natural Forest	Mango Semi-natural Forest	CEGL008199		
<i>Phyllostachys nigra</i> Semi-natural Thicket	Black bamboo Semi-natural Thicket	CEGL008205		
<i>Syzygium jambos</i> Lowland Mesic Semi-natural Woodland	Rose Apple Lowland Mesic Semi-natural Woodland	CEGL008208		
<i>Terminalia catappa</i> Semi-natural Woodland [Park Special]	Pacific Almond Semi-natural Woodland [Park Special]	CEPS009651		

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al (2012).

* Association at HALE added following the calibration trip.

Table 10 (continued). USNVC hierarchical classification of vegetation at HALE organized by macrogroup, group, and association.

USNVC Association	Common Name	ELCODE	USNVC Group	USNVC Macrogroup
<i>Thevetia peruviana</i> Semi-natural Woodland [Park Special]	Lucky-nut Semi-natural Woodland [Park Special]	CEPS009652	Polynesian Semi-natural Lowland Rainforest	Polynesian Semi-natural Lowland Rainforest
<i>Spathodea campanulata</i> - <i>Psidium</i> spp. Semi-natural Forest [Park Special]	African Tuliptree - Guava species Semi-natural Forest [Park Special]	CEPS009708		
<i>Metrosideros polymorpha</i> - <i>Cheirodendron trigynum</i> / (<i>Cibotium</i> spp.) Montane Wet Forest	‘Ōhi‘a - ‘Ōlapa / (Hapu‘u species) Montane Wet Forest	CEGL008008	Hawaiian Montane Rainforest & Cloud Forest	Hawaiian Montane & Cloud Forest
<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Montane Wet Woodland	‘Ōhi‘a / Uluhe Montane Wet Woodland	CEGL008041		
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Wet Montane Woodland	Koa - ‘Ōhi‘a Wet Montane Woodland	CEGL008187		
<i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - (<i>Broussaia arguta</i> , <i>Coprosma foliosa</i>) / <i>Athyrium microphyllum</i> Montane Wet Forest	‘Ōhi‘a / ‘Ōhelo - (Kanawao, Pilo) / ‘Ākōlea Montane Wet Forest	CEGL008200		
<i>Metrosideros polymorpha</i> / <i>Carex alligata</i> - (<i>Machaerina angustifolia</i>) Wet Woodland	‘Ōhi‘a / <i>Carex alligata</i> - (‘Uki) Wet Woodland	CEGL008201		
<i>Metrosideros polymorpha</i> / <i>Rubus hawaiensis</i> Montane Wet Forest	‘Ōhi‘a / ‘Ākala Montane Wet Forest	CEGL008203		
<i>Metrosideros polymorpha</i> - <i>Melicope clusiifolia</i> Montane Wet Forest [Park Special]	‘Ōhi‘a - Kolokolo Mokihana Montane Wet Forest [Park Special]	CEPS009704		
<i>Metrosideros polymorpha</i> / <i>Sadleria cyatheoides</i> Forest [Park Special]*	‘Ōhi‘a / ‘Ama‘u Forest [Park Special]	CEPS009712		
<i>Acacia koa</i> / <i>Leptecophylla tameiameia</i> - (<i>Dodonaea viscosa</i>) Montane Woodland ¹	Koa / Pūkiawe - (A‘ali‘i) Montane Woodland	CEGL008155	Hawaiian Montane-Subalpine Mesic Forest	
<i>Acacia koa</i> / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Woodland	Koa / Pilo - A‘ali‘i Montane Mesic Woodland	CEGL008188		
<i>Metrosideros polymorpha</i> / <i>Dryopteris wallichiana</i> Subalpine Mesic Forest	‘Ōhi‘a / ‘I‘o nui Subalpine Mesic Forest	CEGL008202		
<i>Myrsine lessertiana</i> - (<i>Metrosideros polymorpha</i>) / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Forest	Kōlea Lau Nui - (‘Ōhi‘a) / Pilo - A‘ali‘i Montane Mesic Forest	CEGL008204		
<i>Aleurites moluccana</i> Lowland Wet Forest	Kukui Lowland Wet Forest	CEGL008115	Hawaiian Riparian & Floodplain Forest & Shrubland	Hawaiian Flooded & Swamp Forest
<i>Hibiscus tiliaceus</i> Lowland Wet Forest [Provisional]	Hau Lowland Wet Forest [Provisional]	CEGL008163		

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al (2012).

* Association at HALE added following the calibration trip.

Table 10 (continued). USNVC hierarchical classification of vegetation at HALE organized by macrogroup, group, and association.

USNVC Association	Common Name	ELCODE	USNVC Group	USNVC Macrogroup
<i>Erythrina sandwicensis</i> Lowland Dry Woodland	Wiliwili Lowland Dry Woodland	CEGL008036	Hawaiian Lowland Dry Forest & Woodland	Hawaiian Dry Forest
<i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameia</i> - <i>Dodonaea viscosa</i> Montane Woodland ¹	‘Ōhi’a / Pūkiawe - A‘ali‘i Montane Woodland	CEGL008135	Hawaiian Montane-Subalpine Dry Forest & Woodland	Hawaiian Dry Forest
<i>Prosopis pallida</i> Coastal Dry Semi-natural Woodland	Kiawe Coastal Dry Semi-natural Woodland	CEGL008118	Polynesian Semi-natural Dry Forest	Polynesian Semi-natural Dry Forest
<i>Portulaca lutea</i> Herbaceous Vegetation [Park Special]	‘Ihi Herbaceous Vegetation [Park Special]	CEPS009706	Hawaiian Lowland Mesic-Wet Shrubland & Grassland	Hawaiian Lowland Shrubland, Grassland & Savanna
<i>Leucaena leucocephala</i> / <i>Urochloa maxima</i> Semi-natural Shrubland	Koa Haole / Guinea Grass Semi-natural Shrubland	CEGL005404	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna
<i>Cenchrus ciliaris</i> Semi-natural Herbaceous Vegetation ^{1*}	Buffelgrass Semi-natural Herbaceous Vegetation	CEGL005407		
<i>Cenchrus clandestinus</i> Semi-natural Herbaceous Vegetation ¹	Kikuyu Grass Semi-natural Herbaceous Vegetation	CEGL005408		
<i>Leucaena leucocephala</i> Lowland Dry Semi-natural Shrubland	Koa Haole Lowland Dry Semi-natural Shrubland	CEGL008114		
<i>Lantana camara</i> Semi-natural Shrubland [Provisional]	Lantana Semi-natural Shrubland [Provisional]	CEGL008145		
<i>Andropogon virginicus</i> Semi-natural Lowland Herbaceous Vegetation*	Broomsedge Semi-natural Lowland Herbaceous Vegetation	CEGL008166		
<i>Melinis minutiflora</i> - (<i>Schizachyrium condensatum</i>) Semi-natural Herbaceous Vegetation	Molasses Grass - (Beardgrass) Semi-natural Herbaceous Vegetation	CEGL008169		
<i>Paspalum conjugatum</i> - <i>Sacciolepis indica</i> - <i>Axonopus fissifolius</i> Mixed Semi-natural Herbaceous Vegetation [Provisional]	Hilo Grass - Glenwood Grass - Carpetgrass Mixed Semi-natural Herbaceous Vegetation [Provisional]	CEGL008170		
<i>Bothriochloa pertusa</i> Semi-natural Grassland	Pitted Beardgrass Semi-natural Grassland	CEGL008189		
<i>Spermacoce assurgens</i> - <i>Zinnia peruviana</i> - <i>Digitaria insularis</i> Semi-natural Herbaceous Vegetation [Provisional]	Buttonweed - Peruvian Zinnia - Sourgrass Semi-natural Herbaceous Vegetation [Provisional]	CEGL008207		
<i>Cenchrus purpureus</i> Semi-natural Herbaceous Vegetation ¹	Napier Grass Semi-natural Herbaceous Vegetation	CEGL008210		

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al (2012).

* Association at HALE added following the calibration trip.

Table 10 (continued). USNVC hierarchical classification of vegetation at HALE organized by macrogroup, group, and association.

USNVC Association	Common Name	ELCODE	USNVC Group	USNVC Macrogroup
<i>Ageratina adenophora</i> - <i>Paspalum conjugatum</i> Semi-natural Herbaceous Bog [Park Special]	Maui Pamakani - Hilo Grass Semi-natural Herbaceous Bog [Park Special]	CEPS009702	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna
<i>Plantago lanceolata</i> - <i>Rumex acetosella</i> Semi-natural Herbaceous Vegetation [Park Special]*	English Plantain - Sheep Sorrel Semi-natural Herbaceous Vegetation [Park Special]	CEPS009714		
<i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Shrubland ¹	Pūkiawe - A'ali'i Montane Shrubland	CEGL008172	Hawaiian Montane-Subalpine Dry Shrubland & Grassland	Hawaiian Montane Shrubland, Grassland & Savanna
<i>Leptecophylla tameiameiae</i> Subalpine Dry Shrubland ¹	Pūkiawe Subalpine Dry Shrubland	CEGL008063		
<i>Rubus hawaiiensis</i> Montane Wet Shrubland	ʻĀkala Montane Wet Shrubland	CEGL008052	Hawaiian Montane-Subalpine Mesic-Wet Shrubland & Grassland	
<i>Deschampsia nubigena</i> Montane and Subalpine Mesic Herbaceous Vegetation	Deschampsia nubigena Montane and Subalpine Mesic Herbaceous Vegetation	CEGL008085		
<i>Coprosma montana</i> / <i>Leptecophylla tameiameiae</i> Subalpine Shrubland [Provisional] ¹	Pilo / Pūkiawe Subalpine Shrubland [Provisional]	CEGL008191		
<i>Leptecophylla tameiameiae</i> - (<i>Dodonaea viscosa</i>) / <i>Cenchrus clandestinus</i> Montane - Subalpine Mesic Semi-natural Shrubland ¹	Pūkiawe - (A'ali'i) / Kikuyu Grass Montane - Subalpine Mesic Semi-natural Shrubland	CEGL008194		
<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Geranium cuneatum</i>) / <i>Deschampsia nubigena</i> Subalpine Mesic Shrubland ¹	Pūkiawe - ʻŌhelo - (Nohoanu) / Deschampsia nubigena Subalpine Mesic Shrubland	CEGL008195		
<i>Leptecophylla tameiameiae</i> - <i>Sadleria cyatheoides</i> Subalpine Mesic Shrubland ¹	Pūkiawe - ʻAma'u Subalpine Mesic Shrubland	CEGL008196		
<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> Subalpine Mesic Shrubland ¹	Pūkiawe - ʻŌhelo Subalpine Mesic Shrubland	CEGL008197		
<i>Leptecophylla tameiameiae</i> Montane Mesic Shrubland ¹	Pūkiawe Montane Mesic Shrubland	CEGL008198		
<i>Sophora chrysophylla</i> - (<i>Coprosma montana</i> , <i>Leptecophylla tameiameiae</i>) Subalpine Shrubland ¹	Māmane - (Pilo, Pūkiawe) Subalpine Shrubland	CEGL008209		
<i>Pteridium aquilinum</i> ssp. <i>decompositum</i> Herbaceous Vegetation [Park Special]	Kīlau Herbaceous Vegetation [Park Special]	CEPS009665		
<i>Dodonaea viscosa</i> Montane Mesic Shrubland [Park Special]	A'ali'i Montane Mesic Shrubland [Park Special]	CEPS009668		

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al (2012).

* Association at HALE added following the calibration trip.

Table 10 (continued). USNVC hierarchical classification of vegetation at HALE organized by macrogroup, group, and association.

USNVC Association	Common Name	ELCODE	USNVC Group	USNVC Macrogroup
<i>Vaccinium calycinum</i> Subalpine Mesic Shrubland [Park Special]	‘Ōhelo Subalpine Mesic Shrubland [Park Special]	CEPS009710	Hawaiian Montane-Subalpine Mesic-Wet Shrubland & Grassland	Hawaiian Montane Shrubland, Grassland & Savanna
<i>Sophora chrysophylla</i> - <i>Dodonaea viscosa</i> - (<i>Leptecophylla tameiameiae</i>) Montane Shrubland [Park Special] ^{1*}	Māmane - A‘ali‘i- (Pūkiawe) Montane Shrubland [Park Special]	CEPS009721		
<i>Holcus lanatus</i> Semi-natural Grassland [Provisional]	Common Velvet Grass Semi-natural Grassland [Provisional]	CEGL008193		
<i>Pityrogramma austroamericana</i> - <i>Heterotheca grandiflora</i> Semi-natural Herbaceous Vegetation	Gold Fern – Telegraph Weed Semi-natural Herbaceous Vegetation	CEGL008206	Polynesian Semi-natural Subalpine-Montane Shrubland & Grassland	Polynesian Semi-natural Montane Shrubland, Grassland & Savanna
<i>Ageratina adenophora</i> - (<i>Pellaea ternifolia</i> , <i>Oenothera stricta</i>) Semi-natural Subalpine Herbaceous Vegetation [Park Special]	Maui Pamakani - (Kalamoho Lau Lī‘i, Evening Primrose) Semi-natural Subalpine Herbaceous Vegetation [Park Special]	CEPS009701		
<i>Sporobolus africanus</i> - <i>Anthoxanthum odoratum</i> Rock Slide Semi-natural Herbaceous Vegetation [Park Special]	Rattail Grass - Sweet Vernalgrass Rock Slide Semi-natural Herbaceous Vegetation [Park Special]	CEPS009709		
<i>Cocos nucifera</i> Strand Woodland*	Coconut Palm Strand Woodland	CEGL005402		
<i>Scaevola taccada</i> Coastal Dry Shrubland ¹	Naupaka Kahakai Coastal Dry Shrubland	CEGL008054	Hawaiian Dry Scrub & Herb Coastal Strand	Hawaiian Scrub & Herb Coastal Vegetation
<i>Carex</i> (<i>alligata</i> , <i>echinata</i> , <i>montis-eeka</i> , <i>thunbergii</i>) - (<i>Deschampsia nubigena</i>) Mixed Herbaceous Montane Bog	<i>Carex</i> (<i>alligata</i> , <i>echinata</i> , <i>montis-eeka</i> , <i>thunbergii</i>) - (<i>Deschampsia nubigena</i>) Mixed Herbaceous Montane Bog	CEGL008190	Hawaiian Bog	Hawaiian Bog & Fen
<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> Montane and Subalpine Sparse Vegetation ¹	Pūkiawe - ‘Ōhelo Montane and Subalpine Sparse Vegetation	CEGL008178	Hawaiian Dry-Site Lava Flow	Hawaiian Cliff, Scree & Rock Vegetation
<i>Dubautia menziesii</i> - (<i>Argyroxiphium sandwicense</i>) Subalpine Sparse Vegetation	Na‘ena‘e - (‘Āhinahina) Subalpine Sparse Vegetation	CEGL008192		
<i>Melinis repens</i> - Mixed Semi-natural Sparse Vegetation [Park Special]	Natal Redtop - Mixed Semi-natural Sparse Vegetation [Park Special]	CEPS009703		
Mixed Forest Plantation [Park Special]	Mixed Forest Plantation [Park Special]	CEPS009672	Unclassified	

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al (2012).

* Association at HALE added following the calibration trip.

Vegetation Mapping

Following AA, KGA, and PACN personnel collapsed the 76 HALE associations into 71 vegetated and four unvegetated map classes. Table 11 compares HALE's USNVC associations to the final map classes. The final HALE map model is a result of the following actions or conditions:

- The Mixed Forest Plantation [Park Special] and *Eucalyptus* spp. - Mixed Alien Semi-natural Forest/Plantation [Provisional] were merged into *Eucalyptus* spp. - Mixed Semi-natural Forest because the AA showed that the mixed alien forests are often dominated by *Eucalyptus* spp.
- To capture diverse vegetation of the unique Kīpahulu area of HALE, the *Metrosideros polymorpha* - *Cheirodendron trigynum* / (*Cibotium* spp.) Montane Wet Forest, *Metrosideros polymorpha* / *Rubus hawaiiensis* Montane Wet Forest, and *Metrosideros polymorpha* / *Vaccinium calycinum* - (*Broussaisia arguta*, *Coprosma foliosa*) / *Athyrium microphyllum* Montane Wet Forest associations were combined into the *Metrosideros polymorpha* / *Vaccinium calycinum* – *Rubus hawaiiensis* / (*Coprosma foliosa* - *Leptecophylla tameiameiae*) Montane Wet Forest in some areas of Kīpahulu.
- In Kuiki, *Metrosideros polymorpha* / *Sadleria cyatheoides* Forest [Park Special] and *Metrosideros polymorpha* / *Dryopteris wallichiana* Subalpine Mesic Forest were combined to create the *Metrosideros polymorpha* / *Leptecophylla tameiameiae* - *Vaccinium reticulatum* - (*Dryopteris wallichiana* - *Sadleria cyatheoides*) Montane Mesic Forest map class.
- Because *Leucaena leucocephala* / *Urochloa maxima* Semi-natural Shrubland is a rare class (only one classification plot and no AA samples), it was merged with *Leucaena leucocephala* Lowland Dry Semi-natural Shrubland to create the *Leucaena leucocephala* Semi-natural Shrubland map class.
- As NatureServe originally concluded and AA confirmed, there is only one distinguishable *Sophora chrysophylla* type at HALE. Therefore, the *Sophora chrysophylla* - (*Coprosma montana*, *Leptecophylla tameiameiae*) Subalpine Shrubland, *Sophora chrysophylla* - *Dodonaea viscosa* - (*Leptecophylla tameiameiae*) Montane Shrubland [Park Special], and *Coprosma montana* / *Leptecophylla tameiameiae* Subalpine Shrubland [Provisional] associations were combined into the *Sophora chrysophylla* - (*Coprosma montana* - *Leptecophylla tameiameiae* - *Dodonaea viscosa*) Subalpine Shrubland map class.
- The *Bothriochloa pertusa* Semi-natural Grassland and *Cenchrus ciliaris* Semi-natural Herbaceous Vegetation associations were combined into the *Cenchrus ciliaris* - *Bothriochloa pertusa* Semi-natural Herbaceous Vegetation map class because the species occur intermixed with one another at HALE.
- The *Ageratina adenophora* - (*Pellaea ternifolia*, *Oenothera stricta*) Semi-natural Subalpine Herbaceous Vegetation [Park Special] and *Sporobolus africanus* - *Anthoxanthum odoratum* Rock Slide Semi-natural Herbaceous Vegetation [Park Special] associations were combined into the *Ageratina adenophora* - (*Sporobolus africanus* - *Anthoxanthum odoratum*) Semi-natural Herbaceous Vegetation map class because the two associations are indistinguishable on the imagery and cannot be modeled using GIS data.

- Two associations with only one classification plot each (*Metrosideros polymorpha* - *Melicope clusiifolia* Montane Wet Forest [Park Special] and *Vaccinium calycinum* Subalpine Mesic Shrubland [Park Special]) were not encountered during the calibration, validation, or AA field efforts and are considered too rare to appear on the HALE map.
- Three associations created following the calibration trip were not encountered during the validation trip or AA and were also considered too rare to occur on the HALE map. They are *Andropogon virginicus* Semi-natural Lowland Herbaceous Vegetation, *Plantago lanceolata* - *Rumex acetosella* Semi-natural Herbaceous Vegetation [Park Special], and *Melinis repens* - Mixed Semi-natural Sparse Vegetation [Park Special].

Table 11. USNVC associations and the map classes found at HALE. For each association, the table shows the resulting map classes, total map class size in hectares, percentage of vegetated land area of HALE, and the number of classification plots per association.

USNVC Association	ELCODE	Map Class	Map Code	Size (ha)	% of HALE	Plots
<i>Acacia koa</i> - <i>Cheirodendron trigynum</i> - (<i>Antidesma platyphyllum</i> , <i>Syzygium sandwicense</i>) / (<i>Clidemia hirta</i>) Lowland Wet Forest	CEGL008185	<i>Acacia koa</i> - <i>Cheirodendron trigynum</i> - (<i>Antidesma platyphyllum</i> , <i>Syzygium sandwicense</i>) / (<i>Clidemia hirta</i>) Lowland Wet Forest	F_ACCHANSYCL	156.1	1.15	8
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Wet Forest	CEGL008186	<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Wet Forest	F_ACMEI	273.7	2.01	2
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> / <i>Hedychium gardnerianum</i> Semi-natural Woodland [Park Special]	CEPS009700	<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> / <i>Hedychium gardnerianum</i> Semi-natural Woodland	W_ACMEHE	1.9	0.01	1
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Lowland Mesic Forest	CEGL008023	<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Lowland Mesic Forest	F_ACME_L	131.3	0.96	1
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Wet Montane Woodland	CEGL008187	<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Wet Montane Woodland	W_ACME_W	552.3	4.05	11
<i>Acacia koa</i> - <i>Psidium cattleianum</i> Semi-natural Forest	CEGL008184	<i>Acacia koa</i> - <i>Psidium cattleianum</i> Semi-natural Forest	F_ACPS_S	414.6	3.04	2
<i>Acacia koa</i> / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Woodland	CEGL008188	<i>Acacia koa</i> / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Woodland	W_ACCODO	64.2	0.47	2
<i>Acacia koa</i> / <i>Leptecophylla tameiameia</i> - (<i>Dodonaea viscosa</i>) Montane Woodland ¹	CEGL008155	<i>Acacia koa</i> / <i>Leptecophylla tameiameia</i> - (<i>Dodonaea viscosa</i>) Montane Woodland	W_ACLEDO	46.2	0.34	2
<i>Ageratina adenophora</i> - (<i>Pellaea ternifolia</i> , <i>Oenothera stricta</i>) Semi-natural Subalpine Herbaceous Vegetation [Park Special]	CEPS009701	<i>Ageratina adenophora</i> - (<i>Sporobolus africanus</i> - <i>Anthoxanthum odoratum</i>) Semi-natural Herbaceous Vegetation	H_AGSPAN	35.5	0.26	2
<i>Sporobolus africanus</i> - <i>Anthoxanthum odoratum</i> Rock Slide Semi-natural Herbaceous Vegetation [Park Special]	CEPS009709					1
<i>Ageratina adenophora</i> - <i>Paspalum conjugatum</i> Semi-natural Herbaceous Bog [Park Special]	CEPS009702	<i>Ageratina adenophora</i> - <i>Paspalum conjugatum</i> Semi-natural Herbaceous Bog	H_AGPA	1.4	0.01	1
<i>Aleurites moluccana</i> Lowland Wet Forest	CEGL008115	<i>Aleurites moluccana</i> Lowland Wet Forest	F_ALMO_L	19.1	0.14	1

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. (2012).

*Associations at HALE added following the calibration trip.

Table 11 (continued). USNVC associations and the map classes found at HALE. For each association, the table shows the resulting map classes, total map class size in hectares, percentage of vegetated land area of HALE, and the number of classification plots per association.

USNVC Association	ELCODE	Map Class	Map Code	Size (ha)	% of HALE	Plots
<i>Carex (alligata, echinata, montis-eeka, thunbergii)</i> - (<i>Deschampsia nubigena</i>) Mixed Herbaceous Montane Bog	CEGL008190	<i>Carex (alligata, echinata, montis-eeka, thunbergii)</i> - (<i>Deschampsia nubigena</i>) Mixed Herbaceous Montane Bog	H_CADE	10.9	0.08	4
<i>Cenchrus ciliaris</i> Semi-natural Herbaceous Vegetation	CEGL005407	<i>Cenchrus ciliaris</i> - <i>Bothriochloa pertusa</i> Semi-natural Herbaceous Vegetation	H_CEBO	177	1.30	2
<i>Bothriochloa pertusa</i> Semi-natural Grassland	CEGL008189					4
<i>Cenchrus clandestinus</i> Semi-natural Herbaceous Vegetation ¹	CEGL005408	<i>Cenchrus clandestinus</i> Semi-natural Herbaceous Vegetation	H_CECL	1.2	0.01	1
<i>Cenchrus purpureus</i> Semi-natural Herbaceous Vegetation ^{1*}	CEGL008210	<i>Cenchrus purpureus</i> Semi-natural Herbaceous Vegetation	H_CEPU	13.6	0.10	0
<i>Cocos nucifera</i> Strand Woodland*	CEGL005402	<i>Cocos nucifera</i> Strand Woodland	W_CONU	0.2	0.00	0
<i>Deschampsia nubigena</i> Montane and Subalpine Mesic Herbaceous Vegetation	CEGL008085	<i>Deschampsia nubigena</i> Montane and Subalpine Mesic Herbaceous Vegetation	H_DENU	134.5	0.99	8
<i>Dodonaea viscosa</i> Montane Mesic Shrubland [Park Special]	CEPS009668	<i>Dodonaea viscosa</i> Montane Mesic Shrubland	S_DOVI_M	9	0.07	1
<i>Dubautia menziesii</i> - (<i>Argyroxiphium sandwicense</i>) Subalpine Sparse Vegetation	CEGL008192	<i>Dubautia menziesii</i> - (<i>Argyroxiphium sandwicense</i>) Subalpine Sparse Vegetation	SP_DUAG	276.2	2.03	2
<i>Erythrina sandwicensis</i> Lowland Dry Woodland	CEGL008036	<i>Erythrina sandwicensis</i> Lowland Dry Woodland	W_ERSA	1.2	0.01	1
Eucalyptus spp. - Mixed Alien Semi-natural Forest/Plantation [Provisional]	CEGL008144	Eucalyptus spp. - Mixed Semi-natural Forest	F_EUMI	8.7	0.06	1
Mixed Forest Plantation [Park Special]	CEPS009672					1
<i>Grevillea robusta</i> Lowland Mesic Semi-natural Forest	CEGL008113	<i>Grevillea robusta</i> Lowland Mesic Semi-natural Forest	F_GRRO	1.2	0.01	1
<i>Hibiscus tiliaceus</i> Lowland Wet Forest [Provisional]	CEGL008163	<i>Hibiscus tiliaceus</i> Lowland Wet Forest	F_HITI_L	4.6	0.03	1

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. (2012).

*Associations at HALE added following the calibration trip.

Table 11 (continued). USNVC associations and the map classes found at HALE. For each association, the table shows the resulting map classes, total map class size in hectares, percentage of vegetated land area of HALE, and the number of classification plots per association.

USNVC Association	ELCODE	Map Class	Map Code	Size (ha)	% of HALE	Plots
<i>Holcus lanatus</i> Semi-natural Grassland [Provisional]	CEGL008193	<i>Holcus lanatus</i> Semi-natural Grassland	H_HOLA	177.2	1.30	3
<i>Lantana camara</i> Semi-natural Shrubland [Provisional]	CEGL008145	<i>Lantana camara</i> Semi-natural Shrubland	S_LACA	244	1.80	5
<i>Leptecophylla tameiameiae</i> - (<i>Dodonaea viscosa</i>) / <i>Cenchrus clandestinus</i> Montane - Subalpine Mesic Semi-natural Shrubland ¹	CEGL008194	<i>Leptecophylla tameiameiae</i> - (<i>Dodonaea viscosa</i>) / <i>Cenchrus clandestinus</i> Montane - Subalpine Mesic Semi-natural Shrubland	S_LEDOCE	10.1	0.07	3
<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> Montane and Subalpine Sparse Vegetation ¹	CEGL008178	<i>Leptecophylla tameiameiae</i> - (<i>Vaccinium reticulatum</i>) Montane and Subalpine Sparse Vegetation	SP_LEVA_M	298.6	2.19	1
<i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Shrubland ¹	CEGL008172	<i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Shrubland	S_LEDO_M	620.1	4.56	8
<i>Leptecophylla tameiameiae</i> - <i>Sadleria cyatheoides</i> Subalpine Mesic Shrubland ¹	CEGL008196	<i>Leptecophylla tameiameiae</i> - <i>Sadleria cyatheoides</i> Subalpine Mesic Shrubland	S_LESA	129.8	0.95	4
<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Geranium cuneatum</i>) / <i>Deschampsia nubigena</i> Subalpine Mesic Shrubland ¹	CEGL008195	<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Geranium cuneatum</i>) / <i>Deschampsia nubigena</i> Mesic Shrubland	S_LEVAGEDE	268.4	1.97	7
<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> Subalpine Mesic Shrubland ¹	CEGL008197	<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> Subalpine Mesic Shrubland	S_LEVA	1116.4	8.2	5
<i>Leptecophylla tameiameiae</i> Montane Mesic Shrubland ¹	CEGL008198	<i>Leptecophylla tameiameiae</i> Montane Mesic Shrubland	S_LETA_M	113.6	0.84	3
<i>Leptecophylla tameiameiae</i> Subalpine Dry Shrubland ¹	CEGL008063	<i>Leptecophylla tameiameiae</i> Subalpine Dry Shrubland	S_LETA_D	1194.3	8.78	22
<i>Leucaena leucocephala</i> / <i>Urochloa maxima</i> Semi-natural Shrubland	CEGL005404	<i>Leucaena leucocephala</i> Semi-natural Shrubland	S_LELE_S	111.3	0.87	1
<i>Leucaena leucocephala</i> Lowland Dry Semi-natural Shrubland	CEGL008114					2
<i>Mangifera indica</i> Semi-natural Forest	CEGL008199	<i>Mangifera indica</i> Semi-natural Forest	F_MAIN_S	93.3	0.70	4

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. (2012).

*Associations at HALE added following the calibration trip.

Table 11 (continued). USNVC associations and the map classes found at HALE. For each association, the table shows the resulting map classes, total map class size in hectares, percentage of vegetated land area of HALE, and the number of classification plots per association.

USNVC Association	ELCODE	Map Class	Map Code	Size (ha)	% of HALE	Plots
<i>Melinis minutiflora</i> - (<i>Schizachyrium condensatum</i>) Semi-natural Herbaceous Vegetation	CEGL008169	<i>Melinis minutiflora</i> - (<i>Schizachyrium condensatum</i>) Semi-natural Herbaceous Vegetation	H_MESC	143.3	1.05	1
<i>Metrosideros polymorpha</i> - <i>Cheirodendron trigynum</i> / (<i>Cibotium</i> spp.) Montane Wet Forest	CEGL008008	<i>Metrosideros polymorpha</i> - <i>Cheirodendron trigynum</i> / (<i>Cibotium</i> spp.) Montane Wet Forest	F_MECHCI	266.1	2.0	7
<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Montane Wet Woodland	CEGL008041	<i>Metrosideros polymorpha</i> / (<i>Dicranopteris linearis</i> - <i>Sticherus owhyhensis</i> - <i>Diplopterygium pinnatum</i>) Montane Wet Woodland	W_MEDISTDI	689.8	5.06	2
<i>Metrosideros polymorpha</i> / <i>Carex alligata</i> - (<i>Machaerina angustifolia</i>) Wet Woodland	CEGL008201	<i>Metrosideros polymorpha</i> / <i>Carex alligata</i> - (<i>Machaerina angustifolia</i>) Wet Woodland	W_MECAMA	7.4	0.05	3
<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Mesic Woodland	CEGL008039	<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Mesic Woodland	W_MEDI_L	95.9	0.70	3
<i>Metrosideros polymorpha</i> / <i>Dryopteris wallichiana</i> Subalpine Mesic Forest	CEGL008202	<i>Metrosideros polymorpha</i> / <i>Dryopteris wallichiana</i> Mesic Forest	F_MEDR	183	1.34	4
<i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Woodland ¹	CEGL008135	<i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Woodland	W_MELEDO_M	115	0.84	2
<i>Metrosideros polymorpha</i> / <i>Dryopteris wallichiana</i> Subalpine Mesic Forest	CEGL008202	<i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Dryopteris wallichiana</i> - <i>Sadleria cyatheoides</i>) Montane Mesic Forest	F_MELEVADRSA	20.5	0.15	4
<i>Metrosideros polymorpha</i> / <i>Sadleria cyatheoides</i> Forest [Park Special]*	CEPS009712					0
<i>Metrosideros polymorpha</i> / <i>Rubus hawaiensis</i> Montane Wet Forest	CEGL008203	<i>Metrosideros polymorpha</i> / <i>Rubus hawaiensis</i> Montane Wet Forest	F_MERU	86.5	0.63	3
<i>Metrosideros polymorpha</i> / <i>Sadleria cyatheoides</i> Forest [Park Special]*	CEPS009712	<i>Metrosideros polymorpha</i> / <i>Sadleria cyatheoides</i> Forest	F_MESA	94.1	0.70	0

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. (2012).

*Associations at HALE added following the calibration trip.

Table 11 (continued). USNVC associations and the map classes found at HALE. For each association, the table shows the resulting map classes, total map class size in hectares, percentage of vegetated land area of HALE, and the number of classification plots per association.

USNVC Association	ELCODE	Map Class	Map Code	Size (ha)	% of HALE	Plots
<i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - (<i>Broussaisia arguta</i> , <i>Coprosma foliosa</i>) / <i>Athyrium microphyllum</i> Montane Wet Forest	CEGL008200	<i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - (<i>Broussaisia arguta</i> , <i>Coprosma foliosa</i>) / <i>Athyrium microphyllum</i> Montane Wet Forest	F_MEVABRCOAT	751.2	5.51	6
<i>Metrosideros polymorpha</i> - <i>Cheirodendron trigynum</i> / (<i>Cibotium</i> spp.) Montane Wet Forest	CEGL008008	<i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - <i>Rubus hawaiiensis</i> / (<i>Coprosma foliosa</i> - <i>Leptecophylla tameiameiae</i>) Montane Wet Forest	F_MEVARUCOLE	248.2	1.82	7
<i>Metrosideros polymorpha</i> / <i>Rubus hawaiiensis</i> Montane Wet Forest	CEGL008203					3
<i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - (<i>Broussaisia arguta</i> , <i>Coprosma foliosa</i>) / <i>Athyrium microphyllum</i> Montane Wet Forest	CEGL008200					6
None	NA	<i>Metrosideros polymorpha</i> / <i>Vaccinium reticulatum</i> - <i>Leptecophylla tameiameiae</i> Montane Mesic Dwarf Woodland	W_MEVALE	1.6	0.01	1
None	NA	Mixed Non-native Disturbed Herbaceous Vegetation	H_MIDI	12.1	0.09	0
<i>Myrsine lessertiana</i> - (<i>Metrosideros polymorpha</i>) / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Forest	CEGL008204	<i>Myrsine lessertiana</i> - (<i>Metrosideros polymorpha</i>) / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Forest	F_MYMECODO	0.5	0.00	2
<i>Pandanus tectorius</i> Coastal Mesic Forest	CEGL008032	<i>Pandanus tectorius</i> Coastal Mesic Forest	F_PATE_C	1.5	0.01	3
<i>Paspalum conjugatum</i> - <i>Sacciolepis indica</i> - <i>Axonopus fissifolius</i> Mixed Semi-natural Herbaceous Vegetation [Provisional]	CEGL008170	<i>Paspalum conjugatum</i> - <i>Sacciolepis indica</i> - <i>Axonopus fissifolius</i> Mixed Semi-natural Herbaceous Vegetation	H_PASAAX	58.7	0.43	2
<i>Phyllostachys nigra</i> Semi-natural Thicket	CEGL008205	<i>Phyllostachys nigra</i> Semi-natural Thicket	T_PHNI	68.5	0.50	2
<i>Pityrogramma austroamericana</i> - <i>Heterotheca grandiflora</i> Semi-natural Herbaceous Vegetation	CEGL008206	<i>Pityrogramma austroamericana</i> - <i>Heterotheca grandiflora</i> Semi-natural Herbaceous Vegetation	H_PIHE	310.5	2.27	3

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. (2012).

*Associations at HALE added following the calibration trip.

Table 11 (continued). USNVC associations and the map classes found at HALE. For each association, the table shows the resulting map classes, total map class size in hectares, percentage of vegetated land area of HALE, and the number of classification plots per association.

USNVC Association	ELCODE	Map Class	Map Code	Size (ha)	% of HALE	Plots
<i>Portulaca lutea</i> Herbaceous Vegetation [Park Special]	CEPS009706	<i>Portulaca lutea</i> Herbaceous Vegetation	H_POLU	0	0	1
<i>Prosopis pallida</i> Coastal Dry Semi-natural Woodland	CEGL008118	<i>Prosopis pallida</i> Coastal Dry Semi-natural Woodland	W_PRPA	92.4	0.68	4
<i>Psidium cattleianum</i> Lowland Wet Semi-natural Forest	CEGL008116	<i>Psidium cattleianum</i> Lowland Wet Semi-natural Forest	F_PSCA	163.7	1.20	8
<i>Psidium guajava</i> / Disturbed Understory Semi-natural Forest	CEGL008147	<i>Psidium guajava</i> / Disturbed Understory Semi-natural Forest	F_PSGU	38.2	0.28	4
<i>Pteridium aquilinum</i> ssp. <i>decompositum</i> Herbaceous Vegetation [Park Special]	CEPS009665	<i>Pteridium aquilinum</i> ssp. <i>decompositum</i> Herbaceous Vegetation	H_PTAQ	313.2	2.30	2
<i>Rubus hawaiiensis</i> Montane Wet Shrubland	CEGL008052	<i>Rubus hawaiiensis</i> Montane Wet Shrubland	S_RUHA	9	0.07	2
<i>Scaevola taccada</i> Coastal Dry Shrubland ¹	CEGL008054	<i>Scaevola taccada</i> Coastal Dry Shrubland	S_SCTA	5.7	0.04	1
<i>Schinus terebinthifolius</i> Semi-natural Scrub Woodland	CEGL008148	<i>Schinus terebinthifolius</i> Semi-natural Scrub Woodland	W_SCTE_S	124.3	0.91	7
<i>Coprosma montana</i> / <i>Leptecophylla tameiameiae</i> Subalpine Shrubland [Provisional] ¹	CEGL008191	<i>Sophora chrysophylla</i> - (<i>Coprosma montana</i> - <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i>) Subalpine Shrubland	S_SOCLEDO	328.8	2.41	1
<i>Sophora chrysophylla</i> - (<i>Coprosma montana</i> , <i>Leptecophylla tameiameiae</i>) Subalpine Shrubland ¹	CEGL008209					4
<i>Sophora chrysophylla</i> - <i>Dodonaea viscosa</i> - (<i>Leptecophylla tameiameiae</i>) Montane Shrubland [Park Special] ^{1*}	CEPS009721					0
<i>Spathodea campanulata</i> - <i>Psidium</i> spp. Semi-natural Forest [Park Special]	CEPS009708	<i>Spathodea campanulata</i> - <i>Psidium</i> spp. Semi-natural Forest	F_SPPS	12	0.07	1
<i>Spermacoce assurgens</i> - <i>Zinnia peruviana</i> - <i>Digitaria insularis</i> Semi-natural Herbaceous Vegetation [Provisional]	CEGL008207	<i>Spermacoce assurgens</i> - <i>Zinnia peruviana</i> - <i>Digitaria insularis</i> Semi-natural Herbaceous Vegetation	H_SPZIDI	4.8	0.04	2

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. (2012).

*Associations at HALE added following the calibration trip.

Table 11 (continued). USNVC associations and the map classes found at HALE. For each association, the table shows the resulting map classes, total map class size in hectares, percentage of vegetated land area of HALE, and the number of classification plots per association.

USNVC Association	ELCODE	Map Class	Map Code	Size (ha)	% of HALE	Plots
<i>Syzygium cumini</i> Lowland Mesic Semi-natural Forest	CEGL008111	<i>Syzygium cumini</i> Lowland Mesic Semi-natural Forest	F_SYCU	59.3	0.44	1
<i>Syzygium jambos</i> Lowland Mesic Semi-natural Woodland	CEGL008208	<i>Syzygium jambos</i> Lowland Mesic Semi-natural Woodland	W_SYJA	38.6	0.28	3
<i>Terminalia catappa</i> Semi-natural Woodland [Park Special]	CEPS009651	<i>Terminalia catappa</i> Semi-natural Woodland	W_TECA	1.9	0.01	2
<i>Thevetia peruviana</i> Semi-natural Woodland [Park Special]	CEPS009652	<i>Thevetia peruviana</i> Semi-natural Woodland	W_THPE	1.3	0.01	1
None	NA	Unclassified Polynesian Semi-natural Lowland Shrubland, Grassland, and Savanna	S_POSN_L	204.6	1.50	0
None	NA	Unclassified Polynesian Semi-natural Montane and Subalpine Shrubland and Grassland	S_POSN_SA	313.2	2.30	0
<i>Metrosideros polymorpha</i> - <i>Melicope clusiifolia</i> Montane Wet Forest [Park Special]	CEPS009704	Unmapped - Rare association	NA	0	0	1
<i>Vaccinium calycinum</i> Subalpine Mesic Shrubland [Park Special]	CEPS009710	Unmapped - Rare association	NA	0	0	1
<i>Andropogon virginicus</i> Semi-natural Lowland Herbaceous Vegetation ^{1*}	CEGL008166	Unmapped - Rare association	NA	0	0	0
<i>Melinis repens</i> - Mixed Semi-natural Sparse Vegetation [Park Special]	CEPS009703	Unmapped - Rare association	NA	0	0	1
<i>Plantago lanceolata</i> - <i>Rumex acetosella</i> Semi-natural Herbaceous Vegetation [Park Special]*	CEPS009714	Unmapped - Rare association	NA	0	0	0

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. (2012).

*Associations at HALE added following the calibration trip.



Figure 20. Final HALE vegetation map. High quality pdf available <http://science.nature.nps.gov/im/inventory/veg/products.cfm>.

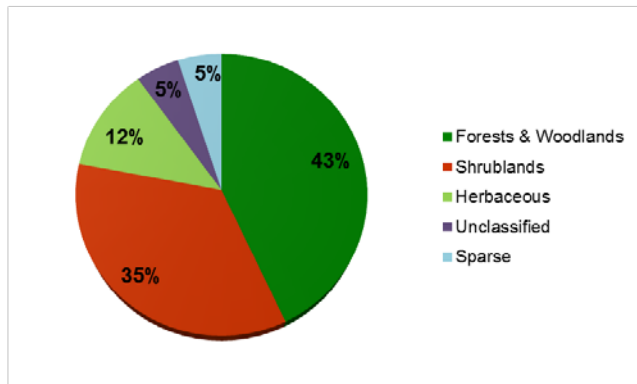


Figure 21. HALE vegetated areas by life form (85% of park lands vegetated).

Metrosideros polymorpha dominated or co-dominated, classes comprise the largest portion of HALE's forests and woodlands (72%) with *Acacia koa* dominated forests at 14% (Figure 22). Invasive, non-native species have greatly altered the vegetation at HALE, especially on the coast, with 14% of the park's forest and woodlands dominated by introduced tree species. Conversely, HALE's shrublands are for the most part dominated or co-dominated by native species, with native *Leptecophylla tameiameia* map classes inhabiting the vast majority (92%) of HALE's shrublands.

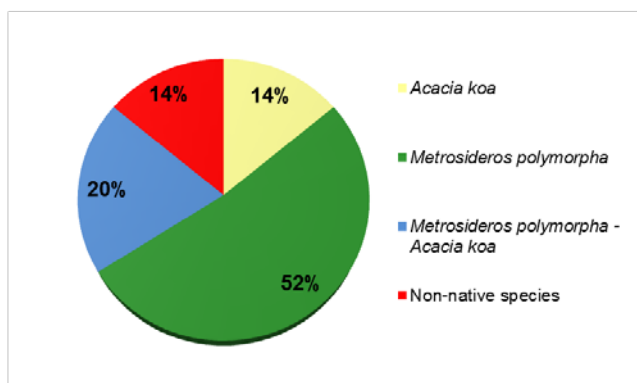


Figure 22. Forest and woodland types at HALE by dominant or co-dominant species.

Accuracy Assessment

A total of 60 of HALE's 71 vegetated map classes were assessed for accuracy. Classes not assessed include:

- *Acacia koa* - *Metrosideros polymorpha* / *Hedygium gardnerianum* Semi-natural Woodland which occurs in one polygon containing a classification plot.
- *Cocos nucifera* Strand Woodland which occurs in one small polygon which was field verified during the calibration trip.
- *Metrosideros polymorpha* / *Dicranopteris linearis* Lowland Mesic Woodland mostly occurs in the Kaumakani region which was not prioritized during AA due to time constraints.

- *Metrosideros polymorpha* / *Vaccinium reticulatum* - *Leptecophylla tameiameiae* Montane Mesic Dwarf Woodland which were created following AA.
- Mixed Non-native Disturbed Herbaceous Vegetation since AA sample data represented new map classes at HALE.
- *Portulaca lutea* Herbaceous Vegetation which occurs in one small coastal polygon containing a classification plot.
- *Syzygium jambos* Lowland Mesic Semi-natural Woodland which has undergone high mortality in the past decade.
- *Pityrogramma austroamericana* - *Heterotheca grandiflora* Semi-natural Herbaceous Vegetation which occurs in a difficult to access portion of Nu'u.
- *Spermacoce assurgens* - *Zinnia peruviana* - *Digitaria insularis* Semi-natural Herbaceous Vegetation had one AA site but this point was omitted from the analysis due to incorrect coordinates putting this site out of the park boundary.
- Unclassified Polynesian Semi-natural Lowland Shrubland, Grassland, and Savanna and Unclassified Polynesian Semi-natural Montane and Subalpine Shrubland and Grassland which both exist in inaccessible parts of Nu'u.

AA analysis requires examination of each AA sample's map label and reference label, and identifying which differences are actually map error and which are caused by some other phenomena such as reference label errors or change in the landscape (e.g., wildfires) (Congalton and Green 2009). Of the total 601 AA samples, none were problematic and only three were omitted from the analysis because the sample data represented new map classes at HALE - Mixed Non-native Disturbed Herbaceous Vegetation and *Metrosideros polymorpha* / *Vaccinium reticulatum* - *Leptecophylla tameiameiae* Montane Mesic Dwarf Woodland.

Overall draft map accuracy of HALE is 76% using the primary reference label, and 80% when the secondary labels are accepted. These are high accuracies for a map of HALE's complexity, detail, and size. Table 12 presents the error matrix for the HALE draft map. The yellow highlighted cells with astricks on the diagonal represent samples where the field reference primary labels (columns) and the draft map labels (rows) match. User accuracy for each map class is calculated by dividing the yellow highlighted cell (reference label matches draft map) by the total number of samples in that row (all field AA plots visited that are labeled as that map class on the draft map). Producer accuracy for each map class is calculated by dividing the yellow highlighted cell (reference label matches draft map) by the total number of samples in each column (all field AA plots assigned this map class regardless of what they are labeled on the map).

Table 12. Error matrix for the HALE draft map. The yellow highlighted cells, also marked with an asterisk, on the diagonal represent samples where the field reference (column) and the map (row) labels match.

MAP CODE	F_ACCHANSYCL	F_ACMEDI	F_ACME_L	W_ACME_W	F_ACPS_S	W_ACCODO	W_ACLEDO	H_AGSPAN	H_AGPA	F_ALMO_L	B_COSE	H_CADE
F_ACCHANSYCL	16*			2								
F_ACMEDI	2	4*		3								
F_ACME_L			15*	1	1							
W_ACME_W		1		10*								
F_ACPS_S			2		2*							
W_ACCODO						*						
W_ACLEDO							3*					
H_AGSPAN								3*				
H_AGPA									*			
F_ALMO_L										2*		
B_COSE											1*	
H_CADE												4*
H_CEBO												
H_CECL												
H_CEPU												
H_DENU												
S_DOVI_M												
SP_DUAG												
W_ERSA												
F_EUMI												
F_GRRO												
F_HITI_L												
H_HOLA												
S_LACA												
S_LEDOCE												
S_LEDO_M												
S_LESA												
S_LEVAGEDE												
SP_LEVA_M												
S_LEVA												
S_LETA_M												
S_LETA_D												
S_LELE_S												
F_MAIN_S												
H_MESC												
F_MECHCI				2								
W_MECAMA		2										
W_MEDISTDI												
F_MEDR												
W_MELEDO_M												
F_MELEVADRSA												
F_MERU												
F_MESA		2				1	6					
F_MEVABRCOAT												
F_MEVARUCOLE												
F_MYMECODO						2						
F_PATE_C												
H_PASAAX												
T_PHNI												
W_PRPA												
F_PSCA												
F_PSGU												
H_PTAQ												
S_RUHA												
S_SCTA												
W_SCTE_S												
S_SOCOLEDO												
F_SPPS												
F_SYCU												
W_TECA												
W_THPE												
Unvegetated												
Total	18	9	17	18	3	3	9	3	0	2	1	4
Producer's Accuracy	88.9%	44.4%	88.3%	55.6%	66.7%	0.0%	33.3%	100.0%	0.0%	100.0%	100.0%	100.0%

* Represent samples where the reference and the map labels match.

Table 12 (continued). Error matrix for the HALE draft map. The yellow highlighted cells, also marked with an asterisk, on the diagonal represent samples where the field reference (column) and the map (row) labels match.

MAP CODE	H_CEBO	H_CECL	H_CEPU	H_DENU	S_DOVI_M	SP_DUAG	W_ERSA	F_EUMI	F_GRRO	F_HITI_L	H_HOLA	S_LACA	S_LEDOCE	S_LEDO_M
F_ACCHANSYCL														
F_ACMEDI														
F_ACME_L														
W_ACME_W														
F_ACP_S														
W_ACCODO														
W_ACLEDO					1									
H_AGSPAN														
H_AGPA														
F_ALMO_L														
B_COSE														
H_CADE														
H_CEBO	29*											9		
H_CECL		*									1			
H_CEPU			4*											
H_DENU				20*										
S_DOVI_M					3*									1
SP_DUAG						14*								
W_ERSA							*							
F_EUMI								4*						
F_GRRO									1*					
F_HITI_L										1*				
H_HOLA											12*			
S_LACA												17*		
S_LEDOCE													3*	
S_LEDO_M					1								1	11*
S_LESA														
S_LEVAGEDE														
SP_LEVA_M						1								
S_LEVA														
S_LETA_M														4
S_LETA_D						1								1
S_LELE_S							1					3		
F_MAIN_S														
H_MESC														1
F_MECHCI														
W_MECAMA														
W_MEDISTDI														
F_MEDR														
W_MELEDO_M														
F_MELEVADRSA														
F_MERU														
F_MESA														
F_MEVABRCOAT														
F_MEVARUCOLE														
F_MYMECODO														
F_PATE_C														
H_PASAAX														
T_PHNI														
W_PRPA														
F_PSCA										1				
F_PSGU														
H_PTAQ														
S_RUHA														
S_SCTA														
W_SCTE_S														
S_SOCOLED														
F_SPPS														
F_SYCU														
W_TECA														
W_THPE														
Unvegetated														
Total	29	0	4	20	5	16	1	4	1	2	13	29	4	18
Producer's Accuracy	100.0%	0.0%	75.0%	100.0%	60.0%	87.5%	0.0%	100.0%	100.0%	50.0%	92.3%	58.6%	75.0%	61.1%

* Represent samples where the reference and the map labels match.

Table 12 (continued). Error matrix for the HALE draft map. The yellow highlighted cells, also marked with an asterisk, on the diagonal represent samples where the field reference (column) and the map (row) labels match.

MAP CODE	S_LESA	S_LEVAGEDE	SP_LEVA_M	S_LEVA	S_LETA_M	S_LETA_D	S_LELE_S	F_MAIN_S	H_MESC	F_MECHCI	W_MECAMA	W_MEDISTDI	F_MEDR
F_ACCHANSYCL													
F_ACMEDI													
F_ACME_L													
W_ACME_W													
F_ACP_S													
W_ACCODO													
W_ACLEDO													
H_AGSPAN													
H_AGPA											1		
F_ALMO_L													
B_COSE													
H_CADE													
H_CEBO													
H_CECL													
H_CEPU													
H_DENU													
S_DOVI_M													
SP_DUAG			1										
W_ERSA													
F_EUMI													
F_GRRO													
F_HITI_L													
H_HOLA													
S_LACA													
S_LEDOCE													
S_LEDO_M				1									
S_LESA	6*			1									
S_LEVAGEDE	3	11*		3		2							
SP_LEVA_M			13*	2									
S_LEVA		3		9*		2							
S_LETA_M				2	2*								
S_LETA_D				4		9*							
S_LELE_S							17*						
F_MAIN_S								16*					
H_MESC									2*				
F_MECHCI										1*		3	
W_MECAMA											*		
W_MEDISTDI												13*	
F_MEDR										1			7*
W_MELEDO_M													
F_MELEVADRSA													
F_MERU										1			
F_MESA	1												1
F_MEVABRCOAT										1			
F_MEVARUCOLE													
F_MYMECODO													
F_PATE_C													
H_PASAAX													
T_PHNI													
W_PRPA													
F_PSCA													
F_PSGU													
H_PTAQ													
S_RUHA													
S_SCTA													
W_SCTE_S													
S_SOCOLEDO				2		5							
F_SPPS													
F_SYCU													
W_TECA													
W_THPE													
Unvegetated													
Total	10	14	14	24	2	18	17	16	2	4	2	16	8
Producer's Accuracy	60.0%	78.6%	92.9%	37.5%	100.0%	50.0%	100.0%	100.0%	100.0%	25.0%	0.0%	81.3%	87.5%

* Represent samples where the reference and the map labels match.

Table 12 (continued). Error matrix for the HALE draft map. The yellow highlighted cells, also marked with an asterisk, on the diagonal represent samples where the field reference (column) and the map (row) labels match.

MAP CODE	W_MELEDO_M	F_MELEVADRSA	F_MERU	F_MESA	F_MEVABRCOAT	F_MEVARUCOLE	F_MYMECODO	F_PATE_C	H_PASAAX	T_PHNI	W_PRPA	F_PSCA
F_ACCHANSYCL												
F_ACMEDI												
F_ACME_L												
W_ACME_W												
F_ACP_S												
W_ACCODO												
W_ACLEDO												
H_AGSPAN												
H_AGPA												
F_ALMO_L												
B_COSE												
H_CADE												
H_CEBO											2	
H_CECL												
H_CEPU								1				
H_DENU												
S_DOVI_M												
SP_DUAG												
W_ERSA											1	
F_EUMI												
F_GRRO												
F_HITI_L												
H_HOLA												
S_LACA												
S_LEDOCE												
S_LEDO_M												
S_LESA				4	1							
S_LEVAGEDE												
SP_LEVA_M												
S_LEVA												
S_LETA_M	1											
S_LETA_D												
S_LELE_S												
F_MAIN_S												
H_MESC												
F_MECHCI					1							
W_MECAMA												
W_MEDISTDI												
F_MEDR			3		2							
W_MELEDO_M	4*											
F_MELEVADRSA		5*										
F_MERU			*		1							
F_MESA				4*								
F_MEVABRCOAT					8*							
F_MEVARUCOLE					1	11*						
F_MYMECODO							*					
F_PATE_C								2*				
H_PASAAX									13*			
T_PHNI										14*		
W_PRPA											20*	
F_PSCA												18*
F_PSGU												
H_PTAQ												
S_RUHA												
S_SCTA												
W_SCTE_S												
S_SOCOLED												
F_SPPS												
F_SYCU												1
W_TECA												
W_THPE												
Unvegetated												
Total	5	5	3	8	14	11	0	3	13	14	23	19
Producer's Accuracy	80.0%	100.0%	0.0%	50.0%	57.1%	90.9%	0.0%	66.7%	100.0%	100.0%	87.0%	94.7%

* Represent samples where the reference and the map labels match.

Table 12 (continued). Error matrix for the HALE draft map. The yellow highlighted cells, also marked with an asterisk, on the diagonal represent samples where the field reference (column) and the map (row) labels match.

MAP CODE	F_PSGU	H_PTAQ	S_RUHA	S_SCTA	W_SCTE_S	S_SOCOLED	F_SPPS	F_SYCU	W_TECA	W_THPE	Unvegetated	TOTAL	User's Accuracy
F_ACCHANSYCL												18	88.9%
F_ACMEDI							1					10	40.0%
F_ACME_L												17	88.3%
W_ACME_W												11	90.9%
F_ACPS_S												4	50.0%
W_ACCODO												0	0.0%
W_ACLEDO												4	75.0%
H_AGSPAN												3	100.0%
H_AGPA												1	0.0%
F_ALMO_L												2	100.0%
B_COSE												1	100.0%
H_CADE												4	100.0%
H_CEBO												40	72.5%
H_CECL												1	0.0%
H_CEPU												4	100.0%
H_DENU												20	100.0%
S_DOVI_M												4	75.0%
SP_DUAG											5	20	70.0%
W_ERSA												1	0.0%
F_EUMI												4	100.0%
F_GRRO												1	100.0%
F_HITI_L												1	100.0%
H_HOLA		3										15	80.0%
S_LACA												17	100.0%
S_LEDOCE						1						4	75.0%
S_LEDO_M												14	78.6%
S_LESA												12	50.0%
S_LEVAGEDE						1						20	55.0%
SP_LEVA_M												16	81.3%
S_LEVA						1						15	60.0%
S_LETA_M												9	22.2%
S_LETA_D						1						16	56.3%
S_LELE_S												21	81.0%
F_MAIN_S	1				1			2				19	84.2%
H_MESC												3	66.7%
F_MECHCI												7	14.3%
W_MECAMA												2	0.0%
W_MEDISTDI												14	92.9%
F_MEDR												13	53.9%
W_MELEDO_M												4	100.0%
F_MELEVADRSA												5	100.0%
F_MERU												3	0.0%
F_MESA												15	26.7%
F_MEVABRCOAT												9	88.9%
F_MEVARUCOLE												11	100.0%
F_MYMECODO												2	0.0%
F_PATE_C												2	100.0%
H_PASAAX	3				3							20	65.0%
T_PHNI												14	100.0%
W_PRPA												20	100.0%
F_PSCA												19	94.7%
F_PSGU	4*											4	100.0%
H_PTAQ		17*										17	100.0%
S_RUHA			3*									3	100.0%
S_SCTA				3*								3	100.0%
W_SCTE_S					10*			5	1			17	58.8%
S_SOCOLED						24*						31	77.4%
F_SPPS							3*					3	100.0%
F_SYCU								3*	1			5	60.0%
W_TECA									*			0	0.0%
W_THPE										1*		1	1.0%
Unvegetated											*	0	0.0%
Total	8	20	3	3	14	28	4	10	2	1	5	596	
Producer's Accuracy	50.0%	85.0%	100.0%	100.0%	71.4%	88.9%	75.0%	30.0%	0.0%	100.0%	0.0%		

* Represent samples where the reference and the map labels match.

Table 13 shows the draft map producer and user accuracies for the map classes. The following summarizes the major sources of confusion in the draft map:

- Nine samples were labeled *Cenchrus ciliaris* - *Bothriochloa pertusa* Semi-natural Herbaceous Vegetation in the draft map and *Lantana camara* Semi-natural Shrubland by the reference samples. All nine samples had significant cover of *Bothriochloa pertusa* (12-54%). However, because ungulates are being excluded from the park, it is likely that these areas are converting and will continue to convert to *Lantana camara* Semi-natural Shrubland.
- The draft map had several errors of omission of *Leptecophylla tameiameiae* - *Vaccinium reticulatum* Subalpine Mesic Shrubland which was usually confused only with other *Leptecophylla tameiameiae* map classes.
- On the slope from park headquarters to the summit, *Sophora chrysophylla* - (*Coprosma montana* - *Leptecophylla tameiameiae* - *Dodonaea viscosa*) Subalpine Shrubland was confused with the *Leptecophylla tameiameiae* shrubland classes. *Sophora chrysophylla* shrubs are scattered throughout the thinly vegetated slope and small changes in cover estimates of each species can easily change the vegetation label.
- Five samples mapped as *Dubautia menziesii* - (*Argyroxiphium sandwicense*) Subalpine Sparse Vegetation received unvegetated reference labels. However, several of the unvegetated labeled samples contained low percentage cover of *Dubautia menziesii*.
- Six spatially autocorrelated samples within one polygon were labeled *Metrosideros polymorpha* / *Sadleria cyatheoides* Forest in the draft map, but *Acacia koa* / *Leptecophylla tameiameiae* - (*Dodonaea viscosa*) Montane Woodland by the reference data.

Detail about which draft map classes were confused with one another and what edits were made to produce the final map based on the AA data can be found by map class in the map class descriptions in Appendix H.

Table 13. HALE draft map class user and producer accuracies listed by the average producer and user accuracies.

Map Class	User's Accuracy	Producer's Accuracy
<i>Ageratina adenophora</i> - (<i>Sporobolus africanus</i> - <i>Anthoxanthum odoratum</i>) Semi-natural Herbaceous Vegetation	100%	100%
<i>Aleurites moluccana</i> Lowland Wet Forest	100%	100%
Built-up Commercial and Services	100%	100%
<i>Carex</i> (<i>alligata</i> , <i>echinata</i> , <i>montis-eeka</i> , <i>thunbergii</i>) - (<i>Deschampsia nubigena</i>) Mixed Herbaceous Montane Bog	100%	100%
<i>Deschampsia nubigena</i> Montane and Subalpine Mesic Herbaceous Vegetation	100%	100%
<i>Eucalyptus</i> spp. - Mixed Semi-natural Forest	100%	100%
<i>Grevillea robusta</i> Lowland Mesic Semi-natural Forest	100%	100%
<i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Dryopteris wallichiana</i> - <i>Sadleria cyatheoides</i>) Montane Mesic Forest	100%	100%
<i>Phyllostachys nigra</i> Semi-natural Thicket	100%	100%
<i>Rubus hawaiiensis</i> Montane Wet Shrubland	100%	100%
<i>Scaevola taccada</i> Coastal Dry Shrubland	100%	100%
<i>Thevetia peruviana</i> Semi-natural Woodland	100%	100%
<i>Psidium cattleianum</i> Lowland Wet Semi-natural Forest	94.7%	94.7%
<i>Prosopis pallida</i> Coastal Dry Semi-natural Woodland	100%	87%
<i>Pteridium aquilinum</i> ssp. <i>decompositum</i> Herbaceous Vegetation	100%	85%
<i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - <i>Rubus hawaiiensis</i> / (<i>Coprosma foliosa</i> - <i>Leptecophylla tameiameiae</i>) Montane Wet Forest	100%	92%
<i>Leucaena leucocephala</i> Semi-natural Shrubland	80.9%	100%
<i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Woodland	100%	80%
<i>Acacia koa</i> - <i>Cheirodendron trigynum</i> - (<i>Antidesma platyphyllum</i> , <i>Syzygium sandwicense</i>) / (<i>Clidemia hirta</i>) Lowland Wet Forest	88.9%	88.9%
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Lowland Mesic Forest	88.2%	88.2%
<i>Spathodea campanulata</i> - <i>Psidium</i> spp. Semi-natural Forest	100%	75%
<i>Leptecophylla tameiameiae</i> - (<i>Vaccinium reticulatum</i>) Montane and Subalpine Sparse Vegetation	81.3%	92.9%
<i>Metrosideros polymorpha</i> / (<i>Dicranopteris linearis</i> - <i>Sticherus owhyhensis</i> - <i>Diplopterygium pinnatum</i>) Montane Wet Woodland	92.9%	81.3%
<i>Mangifera indica</i> Semi-natural Forest	79%	93.8%
<i>Cenchrus ciliaris</i> - <i>Bothriochloa pertusa</i> Semi-natural Herbaceous Vegetation	72.5%	100%
<i>Holcus lanatus</i> Semi-natural Grassland	80%	92.3%
<i>Melinis minutiflora</i> - (<i>Schizachyrium condensatum</i>) Semi-natural Herbaceous Vegetation	66.7%	100%
<i>Pandanus tectorius</i> Coastal Mesic Forest	100%	66.7%
<i>Paspalum conjugatum</i> - <i>Sacciolepis indica</i> - <i>Axonopus fissifolius</i> Mixed Semi-natural Herbaceous Vegetation	65%	100%
<i>Sophora chrysophylla</i> - (<i>Coprosma montana</i> - <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i>) Subalpine Shrubland	74.2%	85.2%
<i>Lantana camara</i> Semi-natural Shrubland	100%	58.6%

Table 13 (continued). HALE draft map class user and producer accuracies listed by the average producer and user accuracies.

Map Class	User's Accuracy	Producer's Accuracy
<i>Dubautia menziesii</i> - (<i>Argyroxiphium sandwicense</i>) Subalpine Sparse Vegetation	70%	87.5%
<i>Cenchrus purpureus</i> Semi-natural Herbaceous Vegetation	75%	75%
<i>Hibiscus tiliaceus</i> Lowland Wet Forest	100%	50%
<i>Leptecophylla tameiameiae</i> - (<i>Dodonaea viscosa</i>) / <i>Cenchrus clandestinus</i> Montane - Subalpine Mesic Semi-natural Shrubland	75%	75%
<i>Psidium guajava</i> / Disturbed Understory Semi-natural Forest	100%	50%
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Wet Montane Woodland	90.9%	55.6%
<i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - (<i>Broussaisia arguta</i> , <i>Coprosma foliosa</i>) / <i>Athyrium microphyllum</i> Montane Wet Forest	88.9%	57.1%
<i>Metrosideros polymorpha</i> / <i>Dryopteris wallichiana</i> Mesic Forest	53.9%	87.5%
<i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Shrubland	78.6%	61%
<i>Dodonaea viscosa</i> Montane Mesic Shrubland	75%	60%
<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Geranium cuneatum</i>) / <i>Deschampsia nubigena</i> Mesic Shrubland	55%	78.6%
<i>Schinus terebinthifolius</i> Semi-natural Scrub Woodland	58.8%	71.4%
<i>Leptecophylla tameiameiae</i> Montane Mesic Shrubland	22.2%	100%
<i>Acacia koa</i> - <i>Psidium cattleianum</i> Semi-natural Forest	50%	66.7%
<i>Leptecophylla tameiameiae</i> - <i>Sadleria cyatheoides</i> Subalpine Mesic Shrubland	50%	60%
<i>Acacia koa</i> / <i>Leptecophylla tameiameiae</i> - (<i>Dodonaea viscosa</i>) Montane Woodland	75%	33.3%
<i>Leptecophylla tameiameiae</i> Subalpine Dry Shrubland	56.3%	50%
<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> Subalpine Mesic Shrubland	60%	37.5%
<i>Syzygium cumini</i> Lowland Mesic Semi-natural Forest	60%	30%
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Wet Forest	40%	44.4%
<i>Metrosideros polymorpha</i> / <i>Sadleria cyatheoides</i> Forest	26.7%	50%
<i>Metrosideros polymorpha</i> - <i>Cheirodendron trigynum</i> / (<i>Cibotium</i> spp.) Montane Wet Forest	14.3%	25%
<i>Acacia koa</i> / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Woodland	0%	0%
<i>Ageratina adenophora</i> - <i>Paspalum conjugatum</i> Semi-natural Herbaceous Bog	0%	0%
<i>Cenchrus clandestinus</i> Semi-natural Herbaceous Vegetation	0%	0%
<i>Erythrina sandwicensis</i> Lowland Dry Woodland	0%	0%
<i>Metrosideros polymorpha</i> / <i>Carex alligata</i> - (<i>Machaerina angustifolia</i>) Wet Woodland	0%	0%
<i>Metrosideros polymorpha</i> / <i>Rubus hawaiensis</i> Montane Wet Forest	0%	0%
<i>Myrsine lessertiana</i> - (<i>Metrosideros polymorpha</i>) / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Forest	0%	0%
<i>Terminalia catappa</i> Semi-natural Woodland	0%	0%
Unvegetated	0%	0%

Vegetation Distribution

Plant communities at HALE can be described as belonging to five elevational zones: coastal, lowland, montane, subalpine, and alpine. NatureServe used 1000 m elevation as the boundary between lowland and montane although this boundary ranges on the landscape from 900-1200 m. The boundary between the montane and subalpine zones generally occurs from 1800-2000 m depending on aspect and is depicted on the map by the 2000 m contour line. The alpine zone is found above 3000 m as subalpine shrubs thin out, leaving only cold and drought tolerant lichens, mosses, and grasses. Within each of these zones there are three possible moisture regimes: dry, mesic, and wet with the exception of the lack of wet and mesic zones in the alpine. The dry zone is limited as much of this park occurs on the wet or mesic windward side of Haleakalā. The coastal lowland zone is a mixture of native and non-native plant dominated communities with the less disturbed montane and subalpine zones mostly composed of native species. The montane zone is also mostly vegetated with native species except for the forest plantations near park headquarters. This section of the report summarizes the distribution of map classes at HALE.

HALE reaches the coast at three places: between Nu‘u and Huakini Bays, at Ka‘āpahu Bay, and between Awapaewa‘a and Pepeiaolepo Bays. Agricultural use of these coastal areas by early Polynesians was high, and continued intensively after post European contact. As a result the landscape has been greatly impacted by human activity and non-native species dominate most locations, especially forests and herbaceous communities. Common lowland communities include non-native dominated woodlands such as *Psidium cattleianum* Lowland Wet Semi-natural Forest, *Psidium guajava* / Disturbed Understory Semi-natural Forest, *Schinus terebinthifolius* Semi-natural Scrub Woodland, *Mangifera indica* Semi-natural Forest, *Phyllostachys nigra* Semi-natural Thicket, and *Syzygium cumini* Lowland Mesic Semi-natural Forest (Figures 23-25). In the lowland, dry zone non-native *Prosopis pallida* Coastal Dry Semi-natural Woodlands dominate. Remnant native lowland dry woodlands such as *Erythrina sandwicensis* Dry Lowland Woodland also occur in HALE (Figure 26). Herbaceous areas tend to be dominated by non-natives including *Paspalum conjugatum* - *Sacciolepis indica* - *Axonopus fissifolius* Mixed Semi-natural Herbaceous Vegetation and *Cenchrus purpureus* Semi-natural Herbaceous Vegetation. Common coastal native shrub map classes include *Scaevola taccada* Coastal Dry Shrubland and *Pandanus tectorius* Coastal Mesic Forest (Figures 27 & 28).



Figure 23. Dense *Psidium cattleianum* Lowland Wet Semi-natural Forest stand sampled near Makahiku in 'Ohe'o.



Figure 24. *Schinus terebinthifolius* Semi-natural Scrub Woodland growing near Puhilele in 'Ohe'o.



Figure 25. *Phyllostachys nigra* Semi-natural Thicket.



Figure 26. *Erythrina sandwicensis* Dry Lowland Woodland with an *Urochloa maxima* dominated understory.



Figure 27. *Scaevola taccada* Coastal Dry Shrubland typically occurs as dense patches.



Figure 28. *Pandanus tectorius* Coastal Mesic Forest near the coast. Dense stands often lack herbaceous understory.

Rising in elevation from the coast, the native wet to mesic lowland forests of Kīpahulu and Ka‘apahu include *Acacia koa* - *Metrosideros polymorpha* / *Dicranopteris linearis* Lowland Wet Forest, *Acacia koa* - *Metrosideros polymorpha* Lowland Mesic Forest, and *Acacia koa* - *Cheirodendron trigynum* - (*Antidesma platyphyllum*, *Syzygium sandwicense*) / (*Clidemia hirta*) Lowland Wet Forest (Figure 29). Mixed native and non-native *Acacia koa* / *Psidium cattleianum* Semi-natural Forest (Figure 30) is a large map class which is expanding as the non-native *Psidium cattleianum* continues to invade *Acacia koa* stands. The mid slope areas of the drier Nu‘u area are dominated by alternating stringers (thin strips of distinct vegetation types) of *Leucaena leucocephala* Semi-natural Shrubland, *Cenchrus ciliaris* Semi-natural Herbaceous Vegetation, *Lantana camara* Semi-natural Shrubland, and Unclassified Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (Figure 31).



Figure 29. The native *Acacia koa* - *Cheirodendron trigynum* - (*Antidesma platyphyllum*, *Syzygium sandwicense*) / (*Clidemia hirta*) Lowland Wet Forest.



Figure 30. *Acacia koa* / *Psidium cattleianum* Semi-natural Forests have thick almost impenetrable understories of invasive *Psidium cattleianum*.



Figure 31. *Leucaena leucocephala* Lowland Dry Semi-natural Shrubland in Nu'u.

The upper reaches of Kīpahulu and Ka‘apahu are draped in native montane and subalpine map classes characterized by mesic and wet forests and shrublands. Forests change from *Acacia koa* and *Metrosideros polymorpha* co-dominated to *Metrosideros polymorpha* dominated as elevation increases. The forests include *Acacia koa* - *Metrosideros polymorpha* Wet Montane Woodland, *Metrosideros polymorpha* / *Dicranopteris linearis* Montane Wet Woodland, *Metrosideros polymorpha* / *Vaccinium calycinum* - *Rubus hawaiiensis* / *Coprosma foliosa* – *Leptecophylla tameiameiae*) Montane Wet Forest (Figure 32). Other native trees found in these forest classes include *Kadua axillaris*, *Ilex anomala*, *Melicope clusiifolia*, *Myrsine lessertiana*, *Psychotria hawaiiensis*, or *Psychotria mauiensis*. Wind exposed forests on ridges often have a dwarfed structure. Montane forested wetlands are important but uncommon communities at HALE and include *Metrosideros polymorpha* / *Carex alligata* - (*Machaerina angustifolia*) Wet Woodland (Figure 33). Shrublands are rare in this area only two medium sized *Leptecophylla tameiameiae* - *Vaccinium reticulatum* - (*Geranium cuneatum*) / *Deschampsia nubigena* Mesic Shrubland polygons occur near the summit. Small patches of *Carex* (*alligata*, *echinata*, *montis-eeka*, *thunbergii*) - (*Deschampsia nubigena*) Mixed Herbaceous Montane Bog occur in the highest elevations in the northeast corner of the park (Figure 34).



Figure 32. Diverse, native *Metrosideros polymorpha* / *Vaccinium calycinum* - (*Broussaisia arguta*, *Coprosma foliosa*) / *Athyrium microphyllum* Montane Wet Forest in the upper Kīpahulu Valley.



Figure 33. *Metrosideros polymorpha* / *Carex alligata* - (*Machaerina angustifolia*) Wet Woodland sampled in the Kīpahulu Valley. *Metrosideros polymorpha* is shrub-like in this stand.



Figure 34. *Carex* (*alligata*, *echinata*, *montis-eeka*, *thunbergii*) - (*Deschampsia nubigena*) Mixed Herbaceous Montane Bog sampled near Smith camp. This site is co-dominated by the invasive non-native grass *Holcus lanatus*.

The eastern portions of Haleakalā crater are vegetated with open to sparse *Leptecophylla tameiameiae* shrublands often with *Dodonaea viscosa* or *Vaccinium reticulatum* (e.g., *Leptecophylla tameiameiae* - *Vaccinium reticulatum* Subalpine Mesic Shrubland, *Leptecophylla tameiameiae* Montane Mesic Shrubland, *Leptecophylla tameiameiae* Subalpine Dry Shrubland) (Figures 35 & 36), alternating with *Sophora chrysophylla* - (*Coprosma montana* - *Leptecophylla tameiameiae* - *Dodonaea viscosa*) Subalpine Shrubland the south facing slopes. *Rubus hawaiiensis* Montane Wet Shrubland edges the bottoms of the eastern cliffs (Figure 37). The western portions of the crater thin to *Dubautia menziesii* - (*Argyroxiphium sandwicense*) Subalpine Sparse Vegetation with iconic Hawaiian alpine plant *Argyroxiphium sandwicense* ssp. *macrocephalum* (Figure 38), and are often unvegetated. Forests are absent. Herbaceous map classes include the non-native *Holcus lanatus* Semi-natural Grassland, *Pteridium aquilinum* ssp. *decompositum* Herbaceous Vegetation, and the native *Deschampsia nubigena* Montane and Subalpine Mesic Herbaceous Vegetation near Kapalaoa Cabin (Figure 39) and the north side of Kalapawili Ridge.



Figure 35. *Leptecophylla tameiameiae* Subalpine Dry Shrubland sampled 45 m upslope on ‘Ō‘ili Pu‘u from Halemau‘u trail in East Crater.



Figure 36. *Leptecophylla tameiameia* - *Vaccinium reticulatum* - (*Geranium cuneatum*) / *Deschampsia nubigena* Mesic Shrubland occurring on a south facing slope near Lau Ulu trail in East Crater. The presence of an herbaceous layer dominated by *Deschampsia nubigena* is characteristic of this plant community.



Figure 37. Native *Rubus hawaiensis* Montane Wet Shrubland occurring near Palikū Cabin in East Crater.



Figure 38. *Dubautia menziesii* - (*Argyroxiphium sandwicense*) Subalpine Sparse Vegetation with iconic Hawaiian alpine plant *Argyroxiphium sandwicense* ssp. *macrocephalum* sampled near Sliding Sands in the crater of Haleakalā.



Figure 39. *Deschampsia nubigena* Montane and Subalpine Mesic Herbaceous Vegetation occurring near Kaluanui in East Crater.

The floor of the Kaupō Gap from the crater down is covered with *Leptecophylla tameiameiae* Montane Mesic Shrubland (Figure 40) which transitions to *Leptecophylla tameiameiae* - *Dodonaea viscosa* Montane Shrubland with falling elevation. Isolated stringers of *Metrosideros polymorpha* / *Leptecophylla tameiameiae* - *Dodonaea viscosa* Montane Woodland occupy gullies within the gap. Along the sides of Kaupō stream are tree sized *Dodonaea viscosa* Montane Mesic Shrubland in the north, and *Acacia koa* / *Coprosma foliosa* - *Dodonaea viscosa* Montane Mesic Woodlands in the south.



Figure 40. *Leptecophylla tameiameiae* - *Dodonaea viscosa* Montane Shrubland at the top of Kaupō Gap.

The slopes of Haleakalā from park headquarters to the summit are primarily vegetated with open to sparse *Leptecophylla tameiameiae* shrublands often with *Vaccinium reticulatum* (e.g. *Leptecophylla tameiameiae* Subalpine Dry Shrubland, *Leptecophylla tameiameiae* - *Vaccinium reticulatum* Subalpine Mesic Shrubland) intermixed with *Sophora chrysophylla* - (*Coprosma montana* - *Leptecophylla tameiameiae* - *Dodonaea viscosa*) Subalpine Shrubland (Figure 41), *Deschampsia nubigena* Montane and Subalpine Mesic Herbaceous Vegetation covers the higher west facing reaches of the summit. Isolated non-native forests occur near park headquarters, in the Hosmer Grove (Figure 42) and along a gully which supports a stringer of *Eucalyptus* spp. - Mixed Semi-natural Forest near the southwest corner of the park. A stand of native *Metrosideros polymorpha* / *Leptecophylla tameiameiae* - *Dodonaea viscosa* Montane Woodland occupies a gulch east of Hosmer's Grove.



Figure 41. *Sophora chrysophylla* - (*Coprosma montana* - *Leptecophylla tameiameiae*) Subalpine Shrubland on the slope leading up to the Haleakalā overlook.



Figure 42. *Eucalyptus* spp. - Mixed Semi-natural Forest.

Discussion

This section of the report discusses the results and lessons learned from this project. It is organized along the significant post planning steps of the 12 Step Mapping Guidance Document (NPS 2013b).

Classification Sampling Design and Data Collection (Step 4)

Vegetation sampling at HALE was completed by PACN and HALE staff. Two hundred and twenty classification and observation samples were collected. Given the high diversity of habitats and plant communities, and the extreme ruggedness of the terrain, it was a challenging landscape to sample. This contributed to a relatively high number of association level communities with two or fewer samples (50) of the 76 association level communities in the final vegetation classification. When possible, NatureServe recommends three to five plots of each type to capture some of the range of variability within each type. Other factors contributing to the low number of samples per type might include the rare nature of many of the native communities, and varying degrees of degradation by invasive non-native species. However, many associations received more than five samples and two widespread native communities at HALE, *Acacia koa* - *Metrosideros polymorpha* Wet Montane Woodland (11 samples) and *Leptecophylla tameiameiae* Subalpine Dry Shrubland (22 samples) had abundant samples (Table 8).

The 220 samples were well distributed throughout HALE, capturing the vast majority of variation in HALE's vegetation which is a testament to the HALE vegetation classification sample design and implementation. Except for the *Acacia koa* - *Psidium cattleianum* Semi-natural Forest association, unsampled vegetated associations discovered after classification sampling were few at HALE and included mostly rare and/or small vegetation types. Future efforts should look to HALE as an example of thorough vegetation classification sampling within accessible terrain. The park does have abundant area located on steep inaccessible terrain that was left unsurveyed. These steep areas were not accurately measured and may contain new classifications. In the future, steps should be taken to have these communities measured and represented. NPS vegetation classification sampling procedures should include consideration of the plots relative to their surroundings and the NPS MMU of 0.5 ha so as to minimize the creation of vegetation associations which exist only below the MMU.

Develop Vegetation Classification, Type Descriptions, and Field Key (Step 5)

Seventy-six vegetation associations were created for HALE. Of these almost two-thirds (50) were represented by only one or two classification plots. However, of those 50 low sampled associations, most (42) were encountered multiple times during the calibration, validation, and AA field work, which showcases both the sample design and NatureServe's ability to use ordination analysis to tease significant vegetation distinctions out of small sample sets.

Invasive non-native species have greatly altered the vegetation at HALE. Almost half (35) of the plant associations identified are dominated or co-dominated by non-native plant species and are classified as semi-natural or plantations (type conversion). Some degraded plant communities have a native woody overstory with understories dominated by non-native species such as *Acacia koa* - *Metrosideros polymorpha* Wet Montane Woodland, *Acacia koa* - *Metrosideros polymorpha* /

Hedychium gardnerianum Semi-natural Woodland, and *Leptecophylla tameiameia* - (*Dodonaea viscosa*) / *Cenchrus clandestinus* Montane - Subalpine Mesic Semi-natural Shrubland. Although formerly native plant communities, these types have been so altered/degraded by non-native species that the former community cannot be determined and the current floristic composition represents a long-lived, widespread novel plant community.

Notably this project provided new significant information with over half the association level plant communities being either new USNVC associations (27) or local Park Specials (17). This significant addition to the knowledge of the area indicates how little association level vegetation sampling and classification has occurred in Hawaii. Projects like this are critical to creating baseline information on vegetation that can be used to improve the understanding and management of the extraordinary vegetation in Haleakalā National Park, Maui, and the Hawaiian Islands.

NatureServe and Natural Heritage Programs have a system of imperilment ranks for species and plant communities. Each of these elements of natural diversity is assigned a rank that indicates its relative degree of imperilment on a five-point scale (for example, 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of known distinct localities or populations. Also of importance are the size of the geographic range, the number of individuals, the trends in both population and distribution, identifiable threats, and the number of protected occurrences. Although most associations at HALE are not ranked, there are ten associations of concern listed in Table 14 (G1= 1, and G3 = 9). The global ranks for Hawaiian vegetation associations have not been updated based on new information from HALE or the other VIP projects, but these associations likely have not become more secure since they were ranked over ten years ago. A comprehensive global rank review of native Hawaiian associations is desirable.

Types such as native bog, *Carex (alligata, echinata, montis-eeka, thunbergii)* - (*Deschampsia nubigena*) Mixed Herbaceous Montane Bog (CEGL008190) and the alpine community, *Dubautia menziesii* - (*Argyroxiphium sandwicense*) Subalpine Sparse Vegetation (CEGL008192) with the G2 imperiled species *Argyroxiphium sandwicense* are known to be rare or threatened and may warrant globally imperiled status. These associations need to be further compared to imperiled or uncommon USNVC associations *Argyroxiphium sandwicense* - *Dubautia menziesii* Dry Dwarf-shrubland (CEGL008082) (G1), *Carex echinata* - *Deschampsia nubigena* Bog Herbaceous Vegetation (CEGL008092) (G2), and *Carex alligata* Montane Wet Herbaceous Vegetation (CEGL008091) (G3).

Table 14. List of G1-G3 global ranks for USNVC associations at HALE.

USNVC Association	ELCODE	Global Rank
<i>Acacia koa</i> / <i>Metrosideros polymorpha</i> - <i>Dicranopteris linearis</i> Lowland Wet Forest	CEGL008005	G3
<i>Acacia koa</i> / <i>Metrosideros polymorpha</i> Lowland Mesic Forest	CEGL008023	G3
<i>Deschampsia nubigena</i> Montane and Subalpine Mesic Herbaceous Vegetation	CEGL008085	G1
<i>Erythrina sandwicensis</i> Lowland Dry Woodland	CEGL008036	G3
<i>Leptecophylla tameiameia</i> Subalpine Dry Shrubland ¹	CEGL008063	G3
<i>Metrosideros polymorpha</i> - <i>Cheirodendron trigynum</i> / (<i>Cibotium</i> spp.) Montane Wet Forest	CEGL008008	G3
<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Wet Woodland	CEGL008039	G3
<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Montane Wet Woodland	CEGL008041	G3
<i>Pandanus tectorius</i> Coastal Mesic Forest	CEGL008032	G3
<i>Rubus hawaiiensis</i> Montane Wet Shrubland	CEGL008052	G3

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al (2012).

The Heritage Conservation Status Global Rank which best characterizes the relative rarity or endangerment of the Association worldwide. Values for Global Rank are:

G1 = Critically imperiled globally = Generally 5 or fewer occurrences and/or very few remaining acres or very vulnerable to elimination throughout its range due to other factor(s).

G2 = Imperiled globally = Generally 6-20 occurrences and/or few remaining acres or very vulnerable to elimination throughout its range due to other factor(s).

G3 = Rare or uncommon = Generally 21-100 occurrences; either very rare and local throughout its range or found locally, even abundantly, within a restricted range or vulnerable to elimination throughout its range due to specific factor(s).

G4 = Widespread, abundant, and apparently secure, but with cause for long-term concern = Uncommon but not rare (although it may be quite rare in parts of its range, especially at the periphery); apparently not vulnerable in most of its range.

G5 = Demonstrably widespread, abundant and secure = Common, widespread, and abundant (although it may be quite rare in parts of its range, especially at the periphery); not vulnerable in most of its range.

Acquire and Prepare Imagery (Step 7)

The Digital Globe satellite imagery used in this project was acquired by USDA's NRCS-National Geospatial Center of Excellence, who worked with Digital Globe to acquire cloud free ortho imagery over the Hawaiian Islands for use by multiple government agencies. The spectral quality and spatial accuracy of the imagery are exceptional. However, because of HALE's extreme terrain, and lack of ground control, parts of the imagery are smeared (Figure 43) which results from the stretching of pixels across large elevation changes during the georeferencing of the imagery. Smeared pixels are difficult to interpret and limit the usefulness of imagery in those areas.

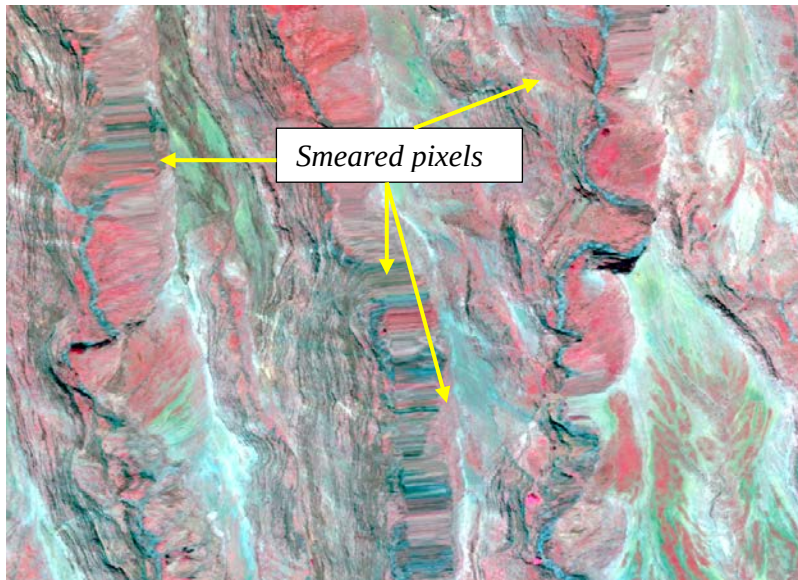


Figure 43. Example of smeared pixels on the Worldview2 imagery of HALE in the Kahikinui Forest Reserve of Nu'u.

Imagery Analysis and Classification (Step 8)

Field reconnaissance, image segmentation, CART analysis, and manual image interpretation were used to classify the imagery. This combination of methods was successful, especially for a park the size and diversity of HALE where the economies of scale of automated segmentation and CART modeling can be significant. Unlike other parks mapped by KGA for PACN, the HALE map required minimal manual editing which speaks to lessons learned on the other parks.

Accuracy Assessment (Step 11)

Despite the challenges encountered during the AA of numerous vegetation classes at HALE (71), there were no quality control problems with the AA data (601 plots).

Data collection

AA data collection was an immense effort spanning several months and hundreds of personnel hours. Accuracy reference estimates of vegetative cover were consistent with the draft map. This points to the excellent calibration between the mapping and AA personnel.

Analysis

Users need to move beyond the overall and class accuracy percentages and fully understand the error matrix to be aware of which classes are likely to be confused with one another and which are not. For example, from the error matrix the user can learn that there is confusion between the six *Leptecophylla tameiameiae* map classes, but that the classes are infrequently confused with non-*Leptecophylla tameiameiae* classes. The error matrix also shows the number of accuracy samples collected per map class. Producer and user accuracies of classes with low sample sizes have low statistical confidence and those with high sample sizes will have higher statistical confidence.

Some of the most significant changes between the draft and the final map were the result of collapsing some associations into map classes (see below Map Model section), and manual editing of

the map to incorporate learnings from the AA field work. While this final editing does not affect the accuracy analysis of the draft map, it does improve the map appreciably. The AA samples are an expensive and valuable source of field data which should be incorporated into the final map.

Some areas of HALE were inaccessible for all vegetation inventory field efforts (i.e. classification plots, calibration, validation and AA samples). The inaccessible areas include the mid-section of Kīpahulu Valley, the upper reaches of Nu‘u, and the cliffs above Palikea Stream. Some of these areas were viewed through binoculars from trails and overlooks during the calibration and validation trip to determine their vegetation associations. Other areas, were completely inaccessible and were mapped based solely on image interpretation, and HALE staff knowledge. If access is gained to these areas for other NPS projects in the future, information should be collected on the distribution of vegetation, and the map should be updated as appropriate.

Map Model (Step 6)

The map model (i.e. final map classes) was determined throughout Steps 5-11, rather than prior to image classification which had several advantages:

- Associations were collapsed into map classes only where AA showed the associations to be confused, removing guess work from the map model step.
- Determining the map classes following AA on the association level draft map also allowed for more associations to be retained in the final map.
- The map classes were informed by data collected on AA samples in areas such as the Kīpahulu Valley which was inaccessible to the mapping crews.

As a recommendation, the NPS could consider formally moving the map model step from step 6 to between steps 11 and 12 in the 12 Step Guidance. However, this approach requires that the USNVC associations adequately represent the vegetation present and it also probably requires a more expensive AA sampling effort, because the assessment is performed at the association rather than the map class level.

Research Opportunities

Having an accurate and current vegetation classification and map presents many new and exciting research opportunities. The locational information for specific species in the modifiers attribute field can be used to target particular management needs and also can be bolstered to include more species or increase the number of known individuals. Research could include expanding or linking the GIS layer to derive other information including fire models, habitat monitoring locations, guides for rare plant surveys, wildlife habitat structural analyses, and inventorying areas that are likely vectors for invasive species. The map could also be enhanced by overlaying other existing GIS layers including geology, hydrology, elevation, and soils. In this manner complex interactions between these layers could be examined and yield important information about growth rates, regeneration after disturbance, biomass distribution, and stream morphology. Finally, through innovative analyses the vegetation layer could possibly be used as a springboard for other ecological studies including examining how the vegetation interacts with soil chemistry, pollution, paleontological/archeological sites, weather patterns, etc.

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Appendix A: Classification Plot Form

PACN PLOT SURVEY FORM
2011 VEGETATION MAPPING PROGRAM

Entered by ____

Checked by ____

SURVEY AND SITE INFORMATION

Plot Code: _____	Descriptive Location _____	Survey Date: _____			
Park Site Name _____	Park Name _____				
Surveyors _____					
Datum: WGS 84 <i>NAD 83</i> Other _____ Field X/UTME _____ Field Y/UTM N _____ GPS UNIT: Garmin 76 Garmin 60CSx Other: _____ Error: +/- _____ m					
GPS Comments: _____					
Directions to Plot: _____					
Circ. Plot (100 m ² , 400 m ² , 1000m ²)	Sq. plot (20 x 20) (10m x 10m)	Rect Plot: len(m) _____ x wid(m) _____			
Camera ID _____ Camera Ht: _____ m Photopoint coords (if not plot center) Northing _____ (UTM) Easting _____ (UTM)		Azi _____ deg			
Description of Photopoint: _____					
View #	Photo #	V or H	Bearing	Photographer	View from Photopoint
1					
2					
3					
4					
a					
Views 1-4 - cardinal directions N,E,S,W; view a - person standing on the photopoint itself to help relocate it in future; additional representative views					
Plot representativeness (discuss plot placement and explain non-representativeness):					

ENVIRONMENTAL DESCRIPTION

Elevation _____ m From: GPS / Map (circle one)	Slope _____ (deg) Aspect _____
Topographic Position: High level High Slope Mid Slope Low Slope Backslope Step in Slope Toe Slope Low Level Interfluve	
Landform: Alluvial Fan, Colluvium, Rockpile, Drainage Channel, Valley Bottom Fill, Side Slope, Interfluve, Intermittent Stream, Ridge, Terrace, Butte, Cliff, Talus, Sand Dune, Plateau, Beach, Recent Lava Flow, Other: _____	Geology: A 'a lava, Pahoe-hoe Lava, Ash, Cinder, Coral, Limestone, Pumice, Obscured by soil, Other: _____
Environmental Comments (factors controlling community/plant distribution, seral stage, fire history etc):	

PACN PLOT SURVEY FORM
2008 VEGETATION MAPPING PROGRAM

PLOT CODE: _____

DATE: _____

ENVIRONMENTAL DESCRIPTION (Continued)

Ground Cover: (please estimate to the nearest percentage. Sum = 100%) ☐ Bare soil (<0.1 mm) ☐ Litter/Duff (dead plant material <3 cm diameter) ☐ Lichen (ground) ☐ Sand (0.1-2 mm) ☐ Coarse woody debris (dead wood 3-10 cm) ☐ Moss (ground) ☐ Gravel (2 mm - 6.4 cm) ☐ Woody debris structure (dead >10 cm deep & wide) ☐ Microbiotic soil crust ☐ Rock (> 6.4 cm) ☐ Live veg (litter / wood) ☐ Water ☐ Bedrock (solid surface) ☐ Other: _____		
Soil Texture (optional - see soil key): modify to fewer classes ☐ sand ☐ loam ☐ silt ☐ clay ☐ peat ☐ muck		
Surface Water w/in 25m? YES/NO Seep, Spring, Stream, Pothole, River, ~~Archaeologic~~ Pond, Ocean, Estuary		Soil Moisture: dry moist saturated standing water
Animal Use Evidence: ☐ Burrows ☐ Animal / Game Trails ☐ Animal Sighting ☐ Scat (Whose? _____) ☐ Vegetation Damage (animal) ☐ Other: _____ ☐ Browsing Evidence ☐ Bedding Sites ☐ Grazing Evidence ☐ Nests (Whose? _____)		
Anthropogenic Disturbances: ☐ Campsite Evidence ☐ Vegetation Damage (human) ☐ Trails ☐ ORV Evidence ☐ Rock Cairns ☐ Historic Feature ☐ Archaeological Feature ☐ Other: _____		Natural disturbances: ☐ Drought (tree & shrub die-back) ☐ Fire ☐ Flood ☐ Mass Wasting ☐ Water gullies ☐ Vegetation Damage (natural) ☐ Other: _____
Other Comments: Describe surrounding communities and how they relate to the plot.		

VEGETATION DESCRIPTION (Only check one within each box)

Phenological notes: For each strata, note phenological state of dominant species. (Especially note in herbaceous vegetation if annuals or perennials are dominant)	Leaf Type (of dominant stratum) ☐ Broad-leaved ☐ Needle-leaved ☐ Microphyllous ☐ Graminoid ☐ Forb ☐ Pteridophyte ☐ Non-vascular ☐ Mixed (describe)	Physiognomic Class (see cheat sheet) ☐ Forest ☐ Woodland ☐ Shrubland ☐ Wooded Shrubland ☐ Dwarf Shrubland ☐ Shrub Herbaceous ☐ Wooded Herbaceous ☐ Herbaceous ☐ Nonvascular ☐ Sparsely Vegetated
--	--	--

Plot Name: _____

Date: _____

Provisional Community Name:

Species/Notes: Starting with the uppermost stratum list all species with full scientific names, cover class and % cover for each species in the stratum. For each tree species estimate seedling sapling and total cover in appropriate stratum. Once species level information is completed, then complete height class and cover class for each tree (shaded blocks). Indicate with an asterisk (*) diagnostic species for each stratum and check where a specimen has been collected. Additional space is available on the back side of this form. List species outside the plot at the end of the table and designate with a 0 in Cover Class Column.

SPECIES STRATA TABLE / TREES & SHRUBS					SPECIES STRATA TABLE / HERBACEOUS				
State / Species Scientific Name	Cover	%	Spec		State / Species Scientific Name	Cover	%	Spec	
	Class	Cover	✓			Class	Cover	✓	
Whole Plot: Total Vegetation Cover ____ (%)					Maximum Vegetation Height ____ (m)				
T1 EMERGENT Strata Height ____ Strata Cover ____					H1 HERBACEOUS Sum of H1, H2, H3, H4 Strata Height ____ Strata Cover ____				
					H1 GRAMINOIDS Strata Height ____ Strata Cover ____				
T2 CANOPY Strata Height ____ Strata Cover ____									
T3 SUBCANOPY Strata Height ____ Strata Cover ____									
S1 TALL SHRUB (>2m) Strata Height ____ Strata Cover ____									
S2 SHORT SHRUB (<2m) Strata Height ____ Strata Cover ____									
S3 DWARF SHRUB (<0.5m) Strata Height ____ Strata Cover ____									
H3 FERNS & ALLIES Strata Height ____ Strata Cover ____									
H4 TREE SEEDLINGS Strata Height ____ Strata Cover ____									
N NON-VASCULAR Strata Height ____ Strata Cover ____									
Cover Scale for Species									
t = few	T = <1%	1a = 5.01 -> 10%	2 = 15.01 -> 25%	4 = 35.01 -> 45%	6 = 55.01 -> 65%	8 = 75.01 -> 85%	10 = >95%		
	P = 1-5%	1b = 10.01 -> 15%	3 = 25.01 -> 35%	5 = 45.01 -> 55%	7 = 65.01 -> 75%	9 = 85.01 -> 95%			
Height Scale for Strata									
01 = <0.5 m	03 = 1.01 -> 2 m	05 = 5.01 -> 10 m	07 = 15.01 -> 20 m	09 = 35.01 -> 50 m					
02 = 0.5-1 m	04 = 2.01 -> 5 m	06 = 10.01 -> 15 m	08 = 20.01 -> 35 m	10 = >50 m					

Appendix B: Plant Species Found within Sample Plots at Haleakalā National Park

At least three hundred and fifty-six plant species were encountered while sampling field plots, observation points, and accuracy assessment plots. An additional twenty-four plants were identified to the genera level only, which may or may not be duplicates. Family, genus, species, common names, and origin are reported. Nomenclature follows that of Wagner et al. (1999) for flowering plants and Palmer (2003) for ferns and Wagner et al. (2012) updates for all. Common names listed were selected primarily from Wagner et al. (1999) and Palmer (2003) by PACN and used throughout the document.

Appendix B: Plant Species Found within Sample Plots at Haleakalā National Park.

Family	Scientific Name	Common Name	Origin
Amaranthaceae	<i>Amaranthus spinosus</i> L.	spiny amaranth	Non-Native
Amaranthaceae	<i>Chenopodium carinatum</i> R. Br.	Chenopodium carinatum	Non-Native
Anacardiaceae	<i>Mangifera indica</i> L.	mango	Non-Native
Anacardiaceae	<i>Schinus terebinthifolius</i> Raddi	Christmas berry	Non-Native
Apiaceae	<i>Centella asiatica</i> (L.) Urb.	Asiatic pennywort	Non-Native
Apocynaceae	<i>Alyxia stellata</i> (J.R.Forst & G. Forst) Roem. & Schult.	maile	Native
Apocynaceae	<i>Asclepias curassavica</i> L.	butterfly weed	Non-Native
Apocynaceae	<i>Asclepias physocarpa</i> (E. Mey.) Schlechter	balloon plant	Non-Native
Apocynaceae	<i>Catharanthus roseus</i> (L.) G. Don	Madagascar periwinkle	Non-Native
Apocynaceae	<i>Thevetia peruviana</i> (Pers.) K. Schum.	lucky-nut	Non-Native
Aquifoliaceae	<i>Ilex anomala</i> Hook. & Arnott	kāwa'u	Native
Araliaceae	<i>Cheirodendron trigynum</i> ssp. <i>trigynum</i> (Gaudich) A. Heller	'ōlapa	Native
Araliaceae	<i>Polyscias hawaiiensis</i> (A. Gray) Lowry & G. M. Plunkett	'ohe	Native
Araliaceae	<i>Polyscias kawaiensis</i> (H. Mann) Lowry & G. M. Plunkett	'ohe'ohe	Native
Araliaceae	<i>Polyscias oahuensis</i> (A. Gray) Lowry & G. M. Plunkett	'ohe mauka	Native
Arecaceae	<i>Cocos nucifera</i> L.	coconut palm	Non-Native
Arecaceae	<i>Phoenix</i> spp.	date palm	Non-Native
Asparagaceae	<i>Cordyline fruticosa</i> (L.) A. Chev	ti	Non-Native
Asparagaceae	<i>Furcraea foetida</i> (L.) Haw.	Mauritius hemp	Non-Native
Aspleniaceae	<i>Asplenium adiantum-nigrum</i> L.	'iwa'iwa	Native
Aspleniaceae	<i>Asplenium contiguum</i> Kaulf.	forest spleenwort	Native
Aspleniaceae	<i>Asplenium haleakalense</i> W. H. Wagner	<i>Asplenium haleakalense</i>	Native
Aspleniaceae	<i>Asplenium insiticism</i> Brack.	pi'ipi'i lau manamana	Native
Aspleniaceae	<i>Asplenium nidus</i> L.	'ēkaha	Native
Aspleniaceae	<i>Asplenium normale</i> D. Don	<i>Asplenium normale</i>	Native
Aspleniaceae	<i>Asplenium</i> spp.	<i>Asplenium</i> spp.	Native
Aspleniaceae	<i>Asplenium trichomanes</i> ssp. <i>densum</i> L.; (Brack.) W. H. Wagner	'oāli'i	Native
Asteliaceae	<i>Astelia menziesiana</i> Sm.	pa'iniu	Native
Asteraceae	<i>Ageratina adenophora</i> (Spreng.) R. King & H. Robinson	Maui pamakani	Non-Native

Appendix B: Plant Species Found within Sample Plots at Haleakalā National Park.

Family	Scientific Name	Common Name	Origin
Asteraceae	<i>Ageratina riparia</i> (Regel) R. M. King & H. Rob.	hamakua pamakani	Non-Native
Asteraceae	<i>Ageratum conyzoides</i> L.	maile honohono	Non-Native
Asteraceae	<i>Argyroxiphium grayanum</i> (Hillebr.) Degener	greensword	Native
Asteraceae	<i>Argyroxiphium sandwicense</i> ssp. <i>macrocephalum</i> (A. Gray) Meyrat	'āhinahina	Native
Asteraceae	<i>Aster</i> spp.	<i>Aster</i> spp.	Non-Native
Asteraceae	<i>Bidens pilosa</i> L.	Spanish needle	Non-Native
Asteraceae	<i>Cirsium vulgare</i> (Savi) Ten.	bull thistle	Non-Native
Asteraceae	<i>Conyza bonariensis</i> (L.) Cronq.	hairy horseweed	Non-Native
Asteraceae	<i>Conyza canadensis</i> var. <i>pusilla</i> (L.) Cronquist; (Nutt.) Cronquist	horseweed	Non-Native
Asteraceae	<i>Dubautia menziesii</i> (A. Gray) D. D. Keck	na'ena'e	Native
Asteraceae	<i>Dubautia menziesii</i> X <i>reticulata</i>	na'ena'e	Native
Asteraceae	<i>Dubautia plantaginea</i> ssp. <i>plantaginea</i> Gaudich.	na'ena'e	Native
Asteraceae	<i>Dubautia platyphylla</i> (A.Gray) D.D.Keck	na'ena'e	Native
Asteraceae	<i>Dubautia scabra</i> ssp. <i>scabra</i> (DC) D. D. Keck	na'ena'e	Native
Asteraceae	<i>Elephantopus mollis</i> Kunth	elephant's foot	Non-Native
Asteraceae	<i>Emilia fosbergii</i> Nicolson	Emilia fosbergii	Non-Native
Asteraceae	<i>Erechtites valerianifolia</i> (Wolf) DC.	fireweed	Non-Native
Asteraceae	<i>Gamochaeta purpurea</i> (L.) Cabrera	purple cudweed	Non-Native
Asteraceae	<i>Heterotheca grandiflora</i> Nutt.	telegraph weed	Non-Native
Asteraceae	<i>Hypochoeris glabra</i> L.	smooth cat's ear	Non-Native
Asteraceae	<i>Hypochoeris radicata</i> L.	hairy cat's ear	Non-Native
Asteraceae	<i>Lapsana communis</i> L.	nipplewort	Non-Native
Asteraceae	<i>Pseudognaphalium sandwicense</i> (Gaudich.) A. Anderb.	'ena'ena	Native
Asteraceae	<i>Pseudognaphalium sandwicense</i> var. <i>sandwicense</i> (Gaudich.) A. Anderb.	'ena'ena	Native
Asteraceae	<i>Senecio vulgaris</i> L.	common groundsel	Non-Native
Asteraceae	<i>Sonchus asper</i> (L.) J. Hill	prickly sow thistle	Non-Native
Asteraceae	<i>Sonchus oleraceus</i> L.	pualele	Non-Native
Asteraceae	<i>Synedrella nodiflora</i> (L.) Gaertn.	nodeweed	Non-Native
Asteraceae	<i>Tetramolopium humile</i> ssp. <i>haleakalae</i> (A. Gray) Hillebr.; Lowrey	Tetramolopium humile ssp. <i>haleakalae</i>	Native
Asteraceae	<i>Tetramolopium humile</i> ssp. <i>humile</i> (A. Gray) Hillebr.	Tetramolopium humile ssp. <i>humile</i>	Native
Asteraceae	<i>Verbesina encelioides</i> (Cav.) Benth. & Hook.	golden crownbeard	Non-Native
Asteraceae	<i>Xanthium strumarium</i> var. <i>canadense</i> L.; (Mill.) Torr & A. Gray	cocklebur	Non-Native
Asteraceae	<i>Zinnia peruviana</i> (L.) L.	Peruvian zinnia	Non-Native
Bignoniaceae	<i>Spathodea campanulata</i> P. Beauv.	African tuliptree	Non-Native
Blechnaceae	<i>Blechnum appendiculatum</i> Willd.	<i>Blechnum appendiculatum</i>	Non-Native
Blechnaceae	<i>Sadleria cyatheoides</i> Kaulf.	'ama'u	Native
Blechnaceae	<i>Sadleria pallida</i> Hook. & Arn.	'ama'u	Native
Blechnaceae	<i>Sadleria souleyetiana</i> (Gaudich.) T. Moore	'ama'u	Native
Blechnaceae	<i>Sadleria</i> spp.	<i>Sadleria</i> spp.	Native
Brassicaceae	<i>Cardimine</i> spp.	bittercress	Non-native
Brassicaceae	<i>Sisymbrium officinale</i> var. <i>officinale</i> (L.) Scop.	Hedge mustard	Non-Native

Appendix B: Plant Species Found within Sample Plots at Haleakalā National Park.

Family	Scientific Name	Common Name	Origin
Campanulaceae	<i>Clermontia arborescens</i> ssp. <i>waihia</i> (H. Mann) Hillebr.; (Wawra) Lammers	‘ōhā wai nui	Native
Campanulaceae	<i>Clermontia</i> spp.	‘ōha wai	Native
Campanulaceae	<i>Cyanea macrostegia</i> ssp. <i>macrostegia</i> Hillebr.	hāhā	Native
Campanulaceae	<i>Lobelia gloria-montis</i> Rock	Lobelia gloria-montis	Native
Campanulaceae	<i>Lobelia hillebrandii</i> Rock	Lobelia hillebrandii	Native
Campanulaceae	<i>Trematolobelia macrostachys</i> (Hook. & Arn.) Zahlbr.	koli'i	Native
Caryophyllaceae	<i>Cerastium fontanum</i> ssp. <i>triviale</i> Baumg., (Link) J alas	common mouse-ear chickweed	Non-Native
Caryophyllaceae	<i>Drymaria cordata</i> var. <i>pacifica</i> (L.) Willd. ex Roem. & Schult.; M.Mizush.	pilipili	Non-Native
Caryophyllaceae	<i>Polycarpon tetraphyllum</i> (L.) L.	fourleaf manyseed	Non-Native
Cibotiaceae	<i>Cibotium glaucum</i> (Sm.) Hook. & Arn.	hāpu'u pulu	Native
Cibotiaceae	<i>Cibotium menziesii</i> Hook.	hāpu'u i'i	Native
Cibotiaceae	<i>Cibotium</i> spp.		Native
Combretaceae	<i>Terminalia catappa</i> L.	Pacific almond	Non-Native
Commelinaceae	<i>Commelina diffusa</i> Burm. f.	honohono	Non-Native
Convolvulaceae	<i>Ipomoea</i> spp.	morning glory	Non-Native
Convolvulaceae	<i>Ipomoea violacea</i> L.	heavenlyblue morning-glory	Non-Native
Cucurbitaceae	<i>Momordica charantia</i> L.	balsam pear	Non-Native
Cucurbitaceae	<i>Sicyos hispidus</i> Hillebr.	‘ānunu	Native
Cyatheaceae	<i>Sphaeropteris cooperi</i> (Hook. ex F. Muell.) R. M. Tryon	Australian tree fern	Non-Native
Cyperaceae	<i>Carex alligata</i> Boott	Carex alligata	Native
Cyperaceae	<i>Carex echinata</i> Murray	Carex echinata	Native
Cyperaceae	<i>Carex longii</i> Mack.	Carex longii	Non-Native
Cyperaceae	<i>Carex macloviana</i> ssp. <i>subfusca</i> D'Urv.; (W. Boott) T. Koyama	Carex macloviana ssp. subfusca	Native
Cyperaceae	<i>Carex montis-eeka</i> Hillebr.	Carex montis-eeka	Native
Cyperaceae	<i>Carex nealae</i> R. Krauss	Carex nealae	Native
Cyperaceae	<i>Carex</i> spp.	Carex spp.	Unknown
Cyperaceae	<i>Carex wahuensis</i> C. A. Mey.	Carex wahuensis	Native
Cyperaceae	<i>Cyperaceae</i> spp.	Cyperaceae spp.	Unknown
Cyperaceae	<i>Cyperus haspan</i> L.	Cyperus haspan	Non-Native
Cyperaceae	<i>Cyperus javanicus</i> Houtt.	‘ahu'awa	Native
Cyperaceae	<i>Cyperus polystachyos</i> Rottb.	Cyperus polystachyos	Native
Cyperaceae	<i>Eleocharis obtusa</i> (Willd.) Schult.	kohekohe	Native
Cyperaceae	<i>Fimbristylis cymosa</i> R. Br.	mau'u	Native
Cyperaceae	<i>Fimbristylis dichotoma</i> (L.) Vahl	Fimbristylis dichotoma	Native
Cyperaceae	<i>Kyllinga brevifolia</i> Rottb.	Kyllinga brevifolia	Non-Native
Cyperaceae	<i>Kyllinga nemoralis</i> (J. R. Forst. & G. Forst.) Dandy ex Hutch. & Dalziel	whitehead spikesedge	Non-Native
Cyperaceae	<i>Machaerina angustifolia</i> (Gaudich) T. Koyama	‘uki	Native
Cyperaceae	<i>Morelotia gahniiformis</i> Gaudich.	Morelotia gahniiformis	Native
Cyperaceae	<i>Oreobolus furcatus</i> H. Mann	Oreobolus furcatus	Native
Cyperaceae	<i>Rhynchospora caduca</i> Elliott	beak-rush	Non-Native
Cyperaceae	<i>Rhynchospora chinensis</i> ssp. <i>spiciformis</i> Nees	spiked beaksedge	Native

Appendix B: Plant Species Found within Sample Plots at Haleakalā National Park.

Family	Scientific Name	Common Name	Origin
	& Meyen; (Hillebr.) T. Koyama		
Cyperaceae	<i>Rhynchospora rugosa</i> ssp. <i>lavarum</i> (Vahl)	pu'uko'a	Native
	Gale; (Gaudich.) T. Koyama		
Cyperaceae	<i>Uncinia brevicaulis</i> Thouars	false watermeal	Native
Cyperaceae	<i>Uncinia uncinata</i> (L. f.) Kük.	Uncinia uncinata	Native
Dennstaedtiaceae	<i>Pteridium aquilinum</i> ssp. <i>decompositum</i> (L.) Kuhn; (Gaudich) Lamoureux ex J. A. Thomson	kīlau	Native
Dioscoreaceae	<i>Dioscorea bulbifera</i> L.	hoi	Non-Native
Dipentodontaceae	<i>Perrottetia sandwicensis</i> A. Gray	olomea	Native
Dryopteridaceae	<i>Ctenitis squamigera</i> (Hook. & Arn.) Copel	pauoa	Native
Dryopteridaceae	<i>Cyrtomium caryotideum</i> (Wall.) C. Presl	kā'ape'ape	Native
Dryopteridaceae	<i>Dryopteris fusco-atra</i> var. <i>fusco-atra</i> (Hillebr.) W. J. Rob.	'i'i	Native
Dryopteridaceae	<i>Dryopteris glabra</i> (Brack.) Kuntze	kīlau	Native
Dryopteridaceae	<i>Dryopteris glabra</i> var. <i>soripes</i> (Brack.) Kuntze; (Hillebr.) Herat ex Fraser-Jenk.	kīlau	Native
Dryopteridaceae	<i>Dryopteris hawaiiensis</i> (Hillebr.) W. J. Rob.	Dryopteris hawaiiensis	Native
Dryopteridaceae	<i>Dryopteris rubiginosa</i> (Brack.) Kuntze.		Unknown
Dryopteridaceae	<i>Dryopteris sandwicensis</i> (Hook. & Arn.) C. Chr.	Dryopteris sandwicensis	Native
Dryopteridaceae	<i>Dryopteris</i> spp.	Dryopteris spp.	Unknown
Dryopteridaceae	<i>Dryopteris tetrapinnata</i> W.H.Wagner & Hobdy		Native
Dryopteridaceae	<i>Dryopteris wallichiana</i> (Spreng.) Hyl.		Native
Dryopteridaceae	<i>Elaphoglossum aemulum</i> (Kaulf.) Brack.	'ēkaha	Native
Dryopteridaceae	<i>Elaphoglossum paleaceum</i> (Hook. & Grev.)	māku'e	Native
Dryopteridaceae	<i>Elaphoglossum</i> spp.	Māui's paddle	Native
Dryopteridaceae	<i>Elaphoglossum wawrae</i> (Luer) C. Chr.	laukahi	Native
Ebenaceae	<i>Diospyros sandwicensis</i> (A. DC.) Fosberg	lama	Native
Ericaceae	<i>Leptecophylla tameiameia</i> (Cham. & Schltdl.) C. M. Weiller	pūkiawe	Native
Ericaceae	<i>Vaccinium calycinum</i> Sm.	'ōhelo	Native
Ericaceae	<i>Vaccinium reticulatum</i> Sm.	'ōhelo	Native
Ericaceae	<i>Vaccinium</i> spp.	'ōhelo	Native
Euphorbiaceae	<i>Aleurites moluccana</i> (L.) Willd. Var. <i>katoi</i> O. Deg., I. Deeg. & B. C. Stone	kukui	Non-Native
Euphorbiaceae	<i>Euphorbia celastroides</i> var. <i>lorifolia</i> Boiss.; (A. Gray) Sherff	'akoko	Native
Euphorbiaceae	<i>Euphorbia heterophylla</i> L.	Euphorbia heterophylla	Non-Native
Euphorbiaceae	<i>Euphorbia hirta</i> L.	hairy spurge	Non-Native
Fabaceae	<i>Acacia koa</i> A. Gray	koa	Native
Fabaceae	<i>Chamaecrista nictitans</i> ssp. <i>patellaria</i> var. <i>glabrata</i> (L.) Moench; (DC. Ex Collad.) H. S. Irwin & Barneby; (Vogel) H. S. Irwin & Barneby	partridge pea	Non-Native
Fabaceae	<i>Crotalaria assamica</i> Benth.	rattlepod	Non-Native
Fabaceae	<i>Crotalaria pallida</i> Aiton	smooth rattlepod	Non-Native
Fabaceae	<i>Crotalaria</i> spp.	rattlepod	Non-Native
Fabaceae	<i>Desmodium incanum</i> DC.	Spanish clover	Non-Native

Appendix B: Plant Species Found within Sample Plots at Haleakalā National Park.

Family	Scientific Name	Common Name	Origin
Fabaceae	<i>Desmodium intortum</i> (Mill.) Urb.	Desmodium intortum	Non-Native
Fabaceae	<i>Desmodium triflorum</i> (L.) DC.	Desmodium triflorum	Non-Native
Fabaceae	<i>Erythrina sandwicensis</i> O. Deg.	wiliwili	Native
Fabaceae	<i>Indigofera suffruticosa</i> Mill.	indigo	Non-Native
Fabaceae	<i>Leucaena leucocephala</i> (Lam.) de Wit	koa haole	Non-Native
Fabaceae	<i>Macroptilium lathyroides</i> (L.) Urb.	wild bean	Non-Native
Fabaceae	<i>Mimosa pudica</i> L.; (Duchass. & Walp.) Griseb.	sleeping grass	Non-Native
Fabaceae	<i>Neonotonia wightii</i> (Wight & Arn.) Lackey	glycine	Non-Native
Fabaceae	<i>Prosopis pallida</i> (Humb. & Bonpl. ex Willd.) Kunth	kiawe	Non-Native
Fabaceae	<i>Senna occidentalis</i> (L.) Link	coffee senna	Non-Native
Fabaceae	<i>Senna pendula</i> var. <i>advena</i> (Humb. & Bonpl. Ex Willd.) Kunth; (Vogel) H. S. Irwin & Barneby	<i>Senna pendula</i> var. <i>advena</i>	Non-Native
Fabaceae	<i>Senna septemtrionalis</i> (Viv.) H. S. Irwin & Barneby	kolomona	Non-Native
Fabaceae	<i>Sophora chrysophylla</i> (Salisb.) Seem.	māmane	Native
Fabaceae	<i>Trifolium arvense</i> var. <i>arvense</i> L.	rabbit-foot clover	Non-Native
Fabaceae	<i>Trifolium campestre</i> Schreb.	big hop clover	Non-Native
Fabaceae	<i>Ulex europaeus</i> L.	gorse	Non-Native
Fabaceae	<i>Vicia sativa</i> ssp. <i>nigra</i> L.; (L.) Ehrh.	common vetch	Non-Native
Fabaceae	<i>Vigna marina</i> (Burm.) Merr.	fue sina	Native
Fabales	<i>Medicago</i> spp.		Unknown
Geraniaceae	<i>Erodium cicutarium</i> (L.) L'Her. Ex Aiton	alfilaria	Non-Native
Geraniaceae	<i>Geranium cuneatum</i> Hook.	nohoanu	Native
Geraniaceae	<i>Geranium cuneatum</i> ssp. <i>cuneatum</i> Hook.	Nohoanu	Unknown
Geraniaceae	<i>Geranium cuneatum</i> ssp. <i>tridens</i> Hook.; (Hillebr.) Carlquist & Bissing	nohoanu	Native
Geraniaceae	<i>Geranium hanaense</i> A. C. Medeiros & H. St. John	nohoanu	Native
Gesneriaceae	<i>Cyrtandra</i> spp.	ha'iwale	Native
Gleicheniaceae	<i>Dicranopteris linearis</i> (Burm. f.) Underw.	uluhe	Native
Gleicheniaceae	<i>Diplopterygium pinnatum</i> (Kunze) Nakai	uluhe lau nui	Native
Gleicheniaceae	<i>Sticherus owhyhensis</i> (Hook.) Ching	uluhe, unuhe	Native
Goodeniaceae	<i>Scaevola chamissoniana</i> Gaudich.	naupaka kuahiwi	Native
Goodeniaceae	<i>Scaevola taccada</i> (Gaertn.) Roxb.	naupaka kahakai	Native
Hydrangeaceae	<i>Broussaisia arguta</i> Gaudich.	kanawao	Native
Hymenophyllaceae	<i>Hymenophyllum recurvum</i> Gaudich.	‘ōhi’a kū	Native
Hymenophyllaceae	<i>Vandenboschia davallioides</i> (Gaudich.) Copel.	palai hihi	Native
Juncaceae	<i>Juncus bufonius</i> L.	common rush	Non-Native
Juncaceae	<i>Juncus planifolius</i> R. Br.	rush	Non-Native
Juncaceae	<i>Luzula hawaiiensis</i> var. <i>hawaiiensis</i> Buchenau; Buchenau	<i>Luzula hawaiiensis</i> var. <i>hawaiiensis</i>	Native
Lamiaceae	<i>Hyptis pectinata</i> (L.) Poit.	comb hyptis	Non-Native
Lamiaceae	<i>Ocimum gratissimum</i> L.	African basil	Non-Native

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Family	Scientific Name	Common Name	Origin
Lamiaceae	<i>Prunella vulgaris</i> L.	heal-all	Non-Native
Lamiaceae	<i>Stachys arvensis</i> L.	staggerweed	Non-Native
Lamiaceae	<i>Stenogyne kamehamehae</i> Wawra	Stenogyne kamehamehae	Native
Lauraceae	<i>Persea Americana</i> Mill.	avacado	Non-Native
Lindsaeaceae	<i>Sphenomeris chinensis</i> (L.) Maxon	pala'ā	Native
Loganiaceae	<i>Labordia hedyosmifolia</i> Baill.	kāmakahala	Native
Loganiaceae	<i>Labordia hirtella</i> H. Mann	kāmakahala	Native
Lomariopsidaceae	<i>Nephrolepis brownii</i> (Desv.) Hovenkamp & Miyam.	sword fern	Non-Native
Lomariopsidaceae	<i>Nephrolepis</i> spp.	swordfern	Unknown
Lycopodiaceae	<i>Huperzia filiformis</i> (Sw.) Holub	Huperzia filiformis	Native
Lycopodiaceae	<i>Huperzia phyllantha</i> (Hook. & Arn.) Holub	wāwae'iole	Native
Lycopodiaceae	<i>Lycopodiella cernua</i> (L.) Pic. Serm.	wāwae'iole	Native
Lycopodiaceae	<i>Lycopodium</i> spp.	Lycopodium spp.	Native
Lycopodiaceae	<i>Lycopodium venustulum</i> Gaudich.	Lycopodium venustulum	Native
Lycopodiaceae	<i>Lycopodium venustulum</i> var. <i>venustulum</i> Gaudich.;	Lycopodium venustulum var. <i>venustulum</i>	Native
Lythraceae	<i>Cuphea carthagenensis</i> (Jacq.) J. F. Macbr.	tarweed	Non-Native
Lythraceae	<i>Lythrum maritimum</i> Kunth	pūkāmole	Non-Native
Malvaceae	<i>Hibiscus tiliaceus</i> L.	hau	Native
Malvaceae	<i>Malva parviflora</i> L.	cheese weed	Non-Native
Malvaceae	<i>Malvastrum coromandelianum</i> ssp. <i>coromandelianum</i> (L.) Garcke	false mallow	Non-Native
Malvaceae	<i>Sida rhombifolia</i> L.	arrowleaf sida	Non-Native
Malvaceae	<i>Sida</i> spp.	Sida spp.	Non-Native
Malvaceae	<i>Thespesia populnea</i> (L.) Sol. ex Corrêa	milo	Native
Malvaceae	<i>Triumfetta semitriloba</i> Jacq.	Sacramento bur	Non-Native
Malvaceae	<i>Waltheria indica</i> L.	'uhaloa	Native
Marattiaceae	<i>Marattia douglasii</i> (C. presl) Baker	pala	Native
Melastomataceae	<i>Clidemia hirta</i> (L.) D. Don	Koster's curse	Non-Native
Melastomataceae	<i>Tibouchina herbacea</i> (DC.) Cogn.	cane tibouchina	Non-Native
Menispermaceae	<i>Cocculus orbiculatus</i> (L.) DC.	huehue	Native
Moraceae	<i>Artocarpus altilis</i> (Parkinson) Fosberg	'ulu	Non-Native
Moraceae	<i>Ficus microcarpa</i> L. f.	Chinese banyan	Non-Native
Myoporaceae	<i>Myoporum sandwicense</i> A. Gray	naio	Native
Myrsinaceae	<i>Ardisia elliptica</i> Thunb.	shoebutton ardisia	Non-Native
Myrsinaceae	<i>Embelia pacifica</i> Hillebr.	kilioe	Native
Myrtaceae	<i>Eucalyptus globulus</i> Labill.	blue gum	Non-Native
Myrtaceae	<i>Metrosideros polymorpha</i> Gaudich.	'ōhi'a	Native
Myrtaceae	<i>Psidium cattleianum</i> Sabine	strawberry guava	Non-Native
Myrtaceae	<i>Psidium guajava</i> L.	common guava	Non-Native
Myrtaceae	<i>Syzygium cumini</i> (L.) Skeels	java plum	Non-Native

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Family	Scientific Name	Common Name	Origin
Myrtaceae	<i>Syzygium jambos</i> (L.) Alston	rose apple	Non-Native
Myrtaceae	<i>Syzygium malaccense</i> (L.) Merr. & L. M. Perry	mountain apple	Non-Native
Myrtaceae	<i>Syzygium sandwicense</i> (A. Gray) Müll.Berol.	‘ōhi’a hā	Native
Nyctaginaceae	<i>Boerhavia</i> spp.	Boerhavia spp.	Unknown
Nyctaginaceae	<i>Pisonia umbellifera</i> (G. Forst.) Seem.	papala	Native
Onagraceae	<i>Oenothera stricta</i> ssp. <i>stricta</i> Ledeb. ex Link	evening primrose	Non-Native
Ophioglossaceae	<i>Ophioglossum pendulum</i>	puapua moa	Native
Orchidaceae	<i>Anoectochilus sandwicensis</i> Lindl.	Anoectochilus sandwicensis	Native
Oxalidaceae	<i>Oxalis corniculata</i> L.	yellow wood sorrel	Non-Native
Oxalidaceae	<i>Oxalis debilis</i> Kunth	pink wood sorrel	Non-Native
Oxalidaceae	<i>Oxalis</i> spp.	wood sorrel	Non-Native
Pandanaceae	<i>Freycinetia arborea</i> Gaudich.	‘ie‘ie	Native
Pandanaceae	<i>Pandanus tectorius</i> Parkinson ex Z	hala	Native
Papaveraceae	<i>Argemone glauca</i> var. <i>glauca</i> (Nutt. ex Prain) Pope	pua kala	Native
Passifloraceae	<i>Passiflora</i> spp.	passion flower	Non-Native
Passifloraceae	<i>Passiflora subpeltata</i> Ortega	white passionflower	Non-Native
Phyllanthaceae	<i>Antidesma platyphyllum</i> H. Mann	hame	Native
Phyllanthaceae	<i>Antidesma platyphyllum</i> var. <i>platyphyllum</i> H. Mann	hame	Native
Pinaceae	<i>Pinus coulteri</i> D. Don	coulter pine	Non-Native
Pinaceae	<i>Pinus patula</i> Schiede & ex Schltdl. & Cham.	mexican weeping pine	Non-Native
Pinaceae	<i>Pinus pinaster</i> Aiton	maritime pine	Non-Native
Pinaceae	<i>Pinus radiata</i> D. Don	Monterey pine	Non-Native
Piperaceae	<i>Peperomia blanda</i> var. <i>floribunda</i> (Jacq.) Kunth; (Miq.) H. Huber	‘ala‘ala wai nui	Native
Piperaceae	<i>Peperomia cookiana</i> C. DC.	‘ala‘ala wai nui	Native
Piperaceae	<i>Peperomia globulanthra</i> C. DC.	‘ala‘ala wai nui	Native
Piperaceae	<i>Peperomia hirtipetiolata</i> C. DC.	‘ala‘ala wai nui	Native
Piperaceae	<i>Peperomia kipahuluensis</i> H. St. John & Lamoureux	‘ala‘ala wai nui	Native
Piperaceae	<i>Peperomia mauiensis</i> Wawra	‘ala‘ala wai nui	Native
Piperaceae	<i>Peperomia obovatilimba</i> C. DC.	‘ala‘ala wai nui	Native
Piperaceae	<i>Peperomia</i> spp.	‘ala‘ala wai nui	Native
Plantaginaceae	<i>Plantago lanceolata</i> L.	English plantain	Non-Native
Plantaginaceae	<i>Plantago pachyphylla</i> A. Gray	manene	Native
Poaceae	<i>Agrostis sandwicensis</i> Hillebr.	Agrostis sandwicensis	Native
Poaceae	<i>Andropogon virginicus</i> L.	broomsedge	Non-Native
Poaceae	<i>Anthoxanthum odoratum</i> L.	sweet vernalgrass	Non-Native
Poaceae	<i>Axonopus compressus</i> (Sw.) P. Beauv.	broadleaf carpetgrass	Non-native
Poaceae	<i>Axonopus fissifolius</i> (Raddi) Kuhlms.	carpetgrass	Non-Native
Poaceae	<i>Bothriochloa pertusa</i> (L.) A. Camus	pitted beardgrass	Non-Native

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Family	Scientific Name	Common Name	Origin
Poaceae	<i>Bromus catharticus</i> Vahl	rescue grass, rescue brome, rescuegrass	Non-Native
Poaceae	<i>Bromus tectorum</i> L.	cheat grass	Non-Native
Poaceae	<i>Cenchrus ciliaris</i> L.	buffelgrass	Non-Native
Poaceae	<i>Cenchrus clandestinus</i> (Hochst. ex Chiov.)	kikuyu grass	Non-Native
Poaceae	<i>Cenchrus purpureus</i> (Schumach.) Morrone	napier grass	Non-Native
Poaceae	<i>Cymbopogon refractus</i> (R. Br.) A. Camus	barbwire grass	Non-Native
Poaceae	<i>Cynodon dactylon</i> (L.) Pers.	Bermuda grass	Non-Native
Poaceae	<i>Dactylis glomerata</i> L.	cocksfoot	Non-Native
Poaceae	<i>Deschampsia nubigena</i> Hillebr.	Deschampsia nubigena	Native
Poaceae	<i>Digitaria ciliaris</i> (Retz.) Koeler	Henry's crabgrass	Non-Native
Poaceae	<i>Digitaria eriantha</i> Steud.	pangolagrass	Non-Native
Poaceae	<i>Digitaria insularis</i> (L.) Mex ex Ekman	sourgrass	Non-Native
Poaceae	<i>Digitaria violascens</i> Link	smooth crabgrass	Non-Native
Poaceae	<i>Eleusine indica</i> (L.) Gaertn.	wiregrass	Non-Native
Poaceae	<i>Eragrostis brownie</i> (Kunth) Nees ex Steud.	sheepgrass	Non-Native
Poaceae	<i>Eragrostis grandis</i> Hillebr.	Eragrostis grandis	Native
Poaceae	<i>Eragrostis tenella</i> (L.) P. Beauv. Ex Roem. & Schult	lovegrass	Unknown
Poaceae	<i>Festuca myuros</i> L.	rat tail fescue	Non-Native
Poaceae	<i>Festuca rubra</i> L.	red fescue	Non-Native
Poaceae	<i>Holcus lanatus</i> L.	common velvet grass	Non-Native
Poaceae	<i>Isachne distichophylla</i> Munro ex Hillebr.	'ohe	Native
Poaceae	<i>Lachnagrostis filiformis</i> (G. Forst.) Trin.	he'upeuo	Native
Poaceae	<i>Melinis minutiflora</i> P. Beauv.	molasses grass	Non-Native
Poaceae	<i>Melinis repens</i> (Willd.) Zizka	natal redtop	Non-Native
Poaceae	<i>Oplismenus hirtellus</i> (L.) P. Beauv.	basketgrass	Non-Native
Poaceae	<i>Paspalum conjugatum</i> P. J. Bergius	Hilo grass	Non-Native
Poaceae	<i>Paspalum scrobiculatum</i> L.	mau'u laiki	Native
Poaceae	<i>Paspalum urvillei</i> Steud.	vasey grass	Non-Native
Poaceae	<i>Phyllostachys nigra</i> var. <i>henionis</i> (Lodd. ex Lindl.) Munro; (Mitford) Stapf ex Rendle	black bamboo	Non-Native
Poaceae	<i>Poa annua</i> L.	annual bluegrass	Non-Native
Poaceae	<i>Poa pratensis</i> L.	Kentucky bluegrass	Non-Native
Poaceae	<i>Poa</i> spp.	bluegrass	Non-Native
Poaceae	<i>Sacciolepis indica</i> (L.) Chase	glenwood grass	Non-Native
Poaceae	<i>Setaria verticillata</i> (L.) P. Beauv.	bristly foxtail	Non-Native
Poaceae	<i>Sporobolus africanus</i> (Poir.) Robyns & Tournay	rattail grass	Non-Native
Poaceae	<i>Sporobolus indicus</i> R. Br.	Indian dropseed	Unknown
Poaceae	<i>Sporobolus</i> spp.	dropseed	Non-Native
Poaceae	<i>Stenotaphrum secundatum</i> (Walter) Kuntze	St. Augustine grass	Non-Native
Poaceae	<i>Trisetum glomeratum</i> (Kunth) Trin.	pili uka	Native

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Family	Scientific Name	Common Name	Origin
Poaceae	<i>Urochloa maxima</i> (Jacq.) R. D. Webster	guinea grass	Non-Native
Poaceae	<i>Urochloa mutica</i> (Forssk.) T. Q. Nguyen	California grass	Non-Native
Polygonaceae	<i>Rumex acetosella</i> L.	sheep sorrel	Non-Native
Polypodiaceae	<i>Adenophorus pinnatifidus</i> var. <i>pinnatifidus</i> Gaudich.	Adenophorus pinnatifidus var. pinnatifidus	Native
Polypodiaceae	<i>Adenophorus tamariscinus</i> var. <i>tamariscinus</i> (Kaulf.) Hook. & Grev.	wahine noho mauna	Native
Polypodiaceae	<i>Lepisorus thunbergianus</i> (Kaulf.) Ching	pākahakaha	Native
Polypodiaceae	<i>Phymatosorus grossus</i> (Langsd. & Fisch.) Brownlie	naturalized laua'e	Non-Native
Polypodiaceae	<i>Polypodium pellucidum</i> Kaulf.	'ae	Native
Polypodiaceae	<i>Polypodium pellucidum</i> var. <i>pellucidum</i> Kaulf.	'ae	Native
Portulacaceae	<i>Portulaca lutea</i> Sol. ex G. Forster	'ihi	Native
Primulaceae	<i>Anagallis arvensis</i> L.	scarlet pimpernel	Non-Native
Primulaceae	<i>Lysimachia remyi</i> Hillebr.	Lysimachia remyi	Native
Primulaceae	<i>Myrsine lessertiana</i> A. DC.	kōlea lau nui	Native
Primulaceae	<i>Myrsine sandwicensis</i> A. DC.	kōlea lau li'i	Native
Proteaceae	<i>Grevillea robusta</i> A. Cunn. ex R. Br.	silk oak	Non-Native
Psilotaceae	<i>Psilotum complanatum</i> Sw.	moa	Native
Psilotaceae	<i>Psilotum nudum</i> (L.) P. Beauv.	moa	Native
Pteridaceae	<i>Adiantum raddianum</i> C. Presl	Adiantum raddianum	Non-Native
Pteridaceae	<i>Coniogramme pilosa</i> (Brack.) Hieron.	lo'ulu	Native
Pteridaceae	<i>Pellaea ternifolia</i> (Cav.) Link	kalamoho lau li'i	Native
Pteridaceae	<i>Pityrogramma austroamericana</i> Domin	gold fern	Non-Native
Pteridaceae	<i>Pteris cretica</i> L.	'ōali	Native
Pteridaceae	<i>Pteris excelsa</i> Gaudich.	waimakanui	Native
Rosaceae	<i>Fragaria chiloensis</i> ssp. <i>sandwicensis</i> (L.) Duchesne; (Decne.) Staudt	'ōhelo papa	Native
Rosaceae	<i>Osteomeles anthyllidifolia</i> (Sm.) Lindl.	'ūlei	Native
Rosaceae	<i>Rubus argutus</i> Link	prickly Florida blackberry	Non-Native
Rosaceae	<i>Rubus hawaiiensis</i> A. Gray	'ākala	Native
Rosaceae	<i>Rubus rosifolius</i> Sm.	thimbleberry	Non-Native
Rubiaceae	<i>Coffea arabica</i> L.	Arabian coffee	Non-Native
Rubiaceae	<i>Coprosma ernodeoides</i> A. Gray	kūkaenēnē	Native
Rubiaceae	<i>Coprosma foliosa</i> A. Gray	pilo	Native
Rubiaceae	<i>Coprosma menziesii</i> A. Gray	pilo	Native
Rubiaceae	<i>Coprosma montana</i> Hillebr.	pilo	Native
Rubiaceae	<i>Coprosma ochracea</i> W. R. B. Oliv.	pilo	Native
Rubiaceae	<i>Coprosma pubens</i> A. Gray	pilo	Native
Rubiaceae	<i>Coprosma</i> spp.	pilo	Native
Rubiaceae	<i>Kadua affinis</i> (DC)	manono	Native
Rubiaceae	<i>Kadua axillaris</i> (Wawra) W. L. Wagner & Lorence	manono	Native

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Family	Scientific Name	Common Name	Origin
Rubiaceae	<i>Kadua</i> spp.	Kadua spp.	Native
Rubiaceae	<i>Morinda citrifolia</i> L.	noni	Non-Native
Rubiaceae	<i>Nertera granadensis</i> (Mutis ex L. f.) Druce	mākole	Native
Rubiaceae	<i>Psychotria</i> spp.	kōpiko	Native
Rubiaceae	<i>Psydrax odorata</i> (G. Forst.) A. C. Sm. & S. P. Darwin	alahe'e	Native
Rubiaceae	<i>Richardia brasiliensis</i> Gomes	tropical Mexican clover	Non-Native
Rubiaceae	<i>Spermacoce assurgens</i> Ruiz & Pav.	buttonweed	Non-Native
Rutaceae	<i>Melicope clusiifolia</i> (A. Gray) T. G. Hartley & B. C. Stone	kolokolo mokihana	Native
Rutaceae	<i>Melicope peduncularis</i> (H.Lév.) T.G.Hartley & B.C.Stone	alani	Native
Rutaceae	<i>Melicope</i> spp.	alani	Native
Rutaceae	<i>Melicope volcanica</i> (A. Gray) T. G. Hartley & B. C. Stone	alani	Native
Rutaceae	<i>Platydesma spathulata</i> (A. Gray) B. Stone	pilo kea	Native
Santalaceae	<i>Korthalsella complanata</i> (Tiegh.) Engl.	hulumoa	Native
Santalaceae	<i>Korthalsella</i> spp.	hulumoa	Native
Santalaceae	<i>Santalum haleakalae</i> var. <i>haleakalae</i> Hillebr.	`iliahi	Native
Sapindaceae	<i>Dodonaea viscosa</i> Jacq.	a'ali'i	Native
Selaginellaceae	<i>Selaginella arbuscula</i> (Kaulf.) Spring	lepelepe a moa	Native
Smilacaceae	<i>Smilax melastomifolia</i> Sm.	hoi kuahiwi	Native
Solanaceae	<i>Nicotiana glauca</i> Graham	tree tobacco	Non-Native
Solanaceae	<i>Solanum americanum</i> Mill.	pōpolo	Native
Thelypteridaceae	<i>Cyclosorus dentatus</i> (Forssk.) Ching	Cyclosorus dentatus	Non-Native
Thelypteridaceae	<i>Cyclosorus sandwicensis</i> (Brack.) Copel.	hō'i'o kula	Native
Thelypteridaceae	<i>Thelypteris globulifera</i> (Brack.) C. F. Reed	palapalai a Kamapua'a	Native
Thymelaeaceae	<i>Wikstroemia monticola</i> Skottsb.	'ākia	Native
Thymelaeaceae	<i>Wikstroemia oahuensis</i> var. <i>oahuensis</i> (A. Gray) Rock	'ākia	Native
Urticaceae	<i>Pipturus albidus</i> (Hook. & Arnott) A. Gray	māmaki	Native
Urticaceae	<i>Pipturus forbesii</i> Krajina	mamaki	Native
Verbenaceae	<i>Lantana camara</i> L.	lantana	Non-Native
Verbenaceae	<i>Stachytarpheta australis</i> Moldenke	Stachytarpheta australis	Non-Native
Verbenaceae	<i>Stachytarpheta cayennensis</i> (Rich.) Vahl	Stachytarpheta cayennensis	Non-Native
Verbenaceae	<i>Stachytarpheta jamaicensis</i> (L.) Vahl	Jamaica vervain	Non-Native
Verbenaceae	<i>Stachytarpheta urticifolia</i> (Salisb.) Sims	nettleleaf velvetberry	Unknown
Verbenaceae	<i>Verbena litoralis</i> Kunth	ha'uowi	Non-Native
Violaceae	<i>Viola maviensis</i> H. Mann	Viola maviensis	Native
Woodsiaceae	<i>Athyrium microphyllum</i> (Sm.) Alston	'ākōlea	Native
Woodsiaceae	<i>Cystopteris douglasii</i> Hook.	Cystopteris douglasii	Native
Woodsiaceae	<i>Deparia petersenii</i> (Kunze) M. Kato	false spleenwort	Non-Native
Woodsiaceae	<i>Diplazium sandwichianum</i> (C. Presl) Diels	hō'i'o	Native

Appendix B: Plant Species Found within Sample Plots at Haleakalā National Park.

Family	Scientific Name	Common Name	Origin
Xanthorrhoeaceae	<i>Dianella sandwicensis</i> Hook. & Arn.	'uki'uki	Native
Zingiberaceae	<i>Hedychium coronarium</i> J. König	white ginger	Non-Native
Zingiberaceae	<i>Hedychium gardnerianum</i> Ker- Gawler	kahili ginger	Non-Native

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Appendix C: Vegetation Map Key

FIELD KEY TO THE MAP CLASSES OF Haleakalā National Park, Hawai‘i

The vegetation of Haleakalā National Park, Hawaii (HALE) was classified using field plot data collected in 2011 as part of the National Park Service Vegetation Mapping Program. To assist in the accurate field identification of the 75 map classes, this dichotomous key has been developed from the plot data, and has been further refined from field observations taken during the vegetation mapping calibration and validation field trips.

This key is structured to facilitate identification of vegetation types with one or a combination of “diagnostic species”- species or group of species whose relative constancy or abundance differentiates one vegetation type from another. Most of these diagnostic species are “dominant species” - species which occur constantly in the plots with high percent cover in a vegetation type or a canopy layer, usually in the tallest (upper most) layer. Several species may also co-dominate with the greatest absolute cover. Other diagnostic species include “differential species” – species with high constancy that because of its fidelity are clearly associated with a particular vegetation type and “indicator species”- species with known fidelity to certain habitat conditions such as soil moisture, soil nutrients, flooding regime, and disturbance history.

Special instructions for Field Crews

1. The key relies on the absolute percent cover of individual species by major lifeform layers (tree, shrub and herbaceous). Stands with an “overwhelming dominance” (highest absolute cover is more than double any other species in that layer) of a single species are usually keyed by that dominant species. Sometimes diagnostic species co-dominate a layer.
2. Dominance is defined as having >50% relative cover in a layer and refers to a species or group of species such as (natives). Co-dominance is generally defined as two (or more) of the most abundant species in a layer usually with nearly equal cover. Some couplets have specific criteria for co-dominance such as both species have at least 10% cover.
3. At HALE there are several widespread dominant species that define most associations and have broad ecological amplitudes such as *Metrosideros polymorpha*. These associations are distinguished by their life zones based on elevation and moisture availability, which influence species composition. We relied on species that occurred consistently in most or all stands classified as a single type (referred to as the “differential” or “indicator” species) to justify the classification. These diagnostic species often do not have the highest absolute cover in the stand but have relatively high constancy or fidelity.
4. Scrub forests and woodlands such as those dominated by *Schinus terebinthifolius* are included with taller forest and woodlands in the Forest and Woodland key. Scrub forests and woodlands typically occur because of harsh environmental conditions that limit tree growth such as high winds or saturated soils.
5. In this classification ~1000 m elevation threshold is used to separate “lowland” from “montane” and “subalpine” vegetation types although floristic composition and vegetation structure may modify this threshold +/- ~100 m.
6. If a vegetation type keys out to an unclassified vegetation type, collect as much data as possible. Fill out an environmental form and record all species which occur in the plot so that the data and field notes can be reviewed and the stand classified at a later date.
7. In Haleakalā National Park, *Sophora chrysophylla* and *Coprosma montana* are always considered to be shrubs, regardless of their height. Therefore, there are no *Sophora chrysophylla* or *Coprosma montana* forests or woodlands in Haleakalā National Park.
8. During AA, crews may go to randomly selected points which may fall within ecotones – a boundary or transition zone between vegetation types where diagnostic species intermix, and it may be difficult to determine a definitive type. In such cases, be sure to fill in a secondary label. Also, be aware that a map polygon may have inclusions of other vegetation types which are below the minimum mapping unit of 0.5 hectares. Ignore the small inclusions when determining the accuracy assessment label.

Physiognomic Group Key

- 1a. Water comprises greater than 80% of the site.....**Water**
- 1b. Water comprises less than 80% of the site.....**2**

- 2a. Cover of vascular plant species less than 5% and water comprises less than 80% of the site.....**Unvegetated**

- 2a. Cover of vascular plant species greater than 5%**3**

- 3a. Land cover comprised of areas of intensive human use with much of the land area taken up by structures or transportation infrastructure. (This class takes precedence over others when the criteria for more than one class are met. For example, areas dominated by intensive human land use, but also with vegetative cover greater than 5% will be labeled as built up and not as vegetated).....**Go To Built Up Key (pg 12)**
- 3b. Area not as above.....**4**

- 4a. Canopy of vascular plant species exceeds 15%..... **5**
- 4b. Cover of vascular plant species less than 15% **Go to Sparse Vegetation Key (pg 11)**

- 5a. Trees form a canopy layer with at least 10% cover forming an open to closed tree layer. Note that early successional forests and woodlands with short trees key here and not in the shrubland key.....**Go to Forest and Woodland Key (pg 3)**
- 5b. Tree cover, if present has less than 10% canopy cover. Stands may have inclusions of scattered trees or shrubs (individuals or clumps) that may slightly exceed 10% cover when totaled, but does not form a distinct layer as an open woodland. These sites are often disturbed or transitional. **6**

- 6a. Shrub species comprise at least 10% cover, individually or in the aggregate; if the stand has reduced total vegetation cover (< 20%), then the shrub component exceeds herbaceous cover. Many shrubland stands are heavily invaded by exotic grass species**Go to Shrubland Key (pg 7)**
- 6b. Shrub species comprise less than 10% canopy cover, and herbaceous species typically constitute more than 10% cover. If the stand has reduced total vegetation cover (< 20%); then the herbaceous component exceeds shrub cover. Occasionally clumps of mixed shrubs or mixed trees might slightly exceed 10% cover (but < 20% cover) when total vegetation has a dense herbaceous layer with > 75% cover. The scattered mixed shrub or mixed tree species do not form a distinct layer.....**Go to Herbaceous Key (pg 9)**

Forest and Woodland Key

- 1a. Forests, woodlands and scrub (dwarf woodland) dominated by native tree species or one of several tree species thought to be early Polynesian introductions (*Aleurites moluccana*, *Cocos nucifera*, *Hibiscus tiliaceus*, or *Pandanus tectorius*). Introduced non-native trees such as species *Psidium* or *Schinus* may be present but not dominant. 2
- 1b. Forests, woodlands and scrub (dwarf woodland) dominated by non-native species of *Eucalyptus*, *Grevillea*, *Mangifera*, *Phyllostachys*, *Prosopis*, *Psidium*, *Schinus*, *Spathordea*, *Syzygium*, *Terminalia*, *Thevetia* or other non-native species.....27
- 2a. Forests and woodlands with canopies dominated or co-dominated by *Aleurites moluccana*, *Erythrina sandwicensis*, *Hibiscus tiliaceus*, *Myrsine lessertiana*, or *Pandanus tectorius*.. 3
- 2b. Forests, woodlands and scrub (dwarf woodland) dominated or co-dominated by *Acacia koa*, *Metrosideros polymorpha* or other native tree species.....8
- 3a. Forests and woodlands with canopies dominated or co-dominated by *Aleurites moluccana* often with *Syzygium cumini* or species of *Psidium*. ***Aleurites moluccana* Lowland Wet Forest (F_ALMO_L)**
- 3b. Forests and woodlands with canopies dominated or co-dominated by *Erythrina sandwicensis*, *Hibiscus tiliaceus*, *Myrsine lessertiana*, *Pandanus tectorius*, or *Cocos nucifera*. 4
- 4a. Forests and woodlands with canopies dominated or co-dominated by *Pandanus tectorius* often with *Schinus terebinthifolius* or *Terminalia catappa* ***Pandanus tectorius* Coastal Mesic Forest (F_PATE_C)**
- 4b. Forests and woodlands with canopies dominated or co-dominated by *Erythrina sandwicensis*, *Hibiscus tiliaceus*, *Myrsine lessertiana*, or *Cocos nucifera* 5
- 5a. Forests and woodlands with canopies dominated by *Hibiscus tiliaceus*. *Aleurites moluccana* and other wet and riparian tree species may be present in canopy. ***Hibiscus tiliaceus* Lowland Wet Forest (F_HITI_L)**
- 5b. Forests and woodlands with canopies dominated or co-dominated by *Erythrina sandwicensis*, *Myrsine lessertiana*, or *Cocos nucifera* 6
- 6a. Forests and woodlands with tree canopy dominated by *Erythrina sandwicensis*. ***Erythrina sandwicensis* Lowland Dry Woodland (W_ERSA)**
- 6b. Forests and woodlands with canopies dominated by *Myrsine lessertiana* or *Cocos nucifera* -.....7
- 7a. Forests and woodlands with tree canopies dominated or co-dominated by *Myrsine lessertiana*. *Metrosideros polymorpha* may be present to co-dominant. Understory is typically dominated by *Coprosma foliosa* and *Dodonaea viscosa*..... ***Myrsine lessertiana* - (*Metrosideros polymorpha*) / *Coprosma foliosa* - *Dodonaea viscosa* Montane Mesic Forest (F_MYMECODO)**
- 7b. Forests and woodlands with tree canopies dominated by *Cocos nucifera*...***Cocos nucifera* Strand Woodland (W_CONU)**
- 8a. Forests and woodlands with canopies dominated or co-dominated by *Acacia koa*. If *Metrosideros polymorpha* is present then cover of *Acacia koa* is 1/3 or more cover of *Metrosideros polymorpha* in the tree canopy.....9
- 8b. Forests and woodlands with canopies dominated or co-dominated by *Metrosideros polymorpha*. If *Acacia koa* is present then cover is low (<1/3 cover) of *Metrosideros polymorpha* tree canopy 16
- 9a. Forest and woodlands with canopies dominated by *Acacia koa* and/or *Cheirodendron trigynum* If *Metrosideros polymorpha* is present then cover of *Metrosideros polymorpha* is < 1/3 the cover of *Acacia koa* in the tree canopy. Non-native trees such as *Psidium cattleianum* may be present to co-dominant 10
- 9b. Forests and woodlands with canopies co-dominated by *Acacia koa* and *Metrosideros polymorpha*. Each species has a least 1/3 cover of the other species 13
- 10a. Forests and woodlands with mixed tree canopy co-dominated by *Acacia koa* and *Cheirodendron trigynum* with *Antidesma platyphyllum* and/or *Syzygium sandwicense* trees often present to co-dominant. Non-native trees such as *Psidium cattleianum* may be present to co-dominant with native trees in disturbed stands of this diverse, wet lowland forest. Non-native shrubs *Clidemia hirta* or *Rubus rosifolius* may dominate the understory in disturbed stands..... ***Acacia koa* - *Cheirodendron trigynum* - (*Antidesma platyphyllum*, *Syzygium sandwicense*) / (*Clidemia hirta*) Lowland Wet Forest (F_ACCHANSYCL)**
- 10b. Forests not as above 11
- 11a. Forests and woodlands with upper canopies dominated by > 10% *Acacia koa* and with subcanopy strongly to exclusively dominated by *Psidium cattleianum* ***Acacia koa* - *Psidium cattleianum* Semi-natural Forest (F_ACPS_S)**
- 11b. Forests and woodlands with canopies strongly dominated by *Acacia koa* 12

- 12a. Montane mesic forests dominated by *Acacia koa* with *Coprosma foliosa* and *Dodonaea viscosa* present to co-dominant in the understory ***Acacia koa* / *Coprosma foliosa* - *Dodonaea viscosa* Montane Mesic Woodland (W_ACCODO)**
- 12b. Montane mesic forests dominated by *Acacia koa* with *Leptecophylla tameiameiae* dominant or co-dominant with *Dodonaea viscosa* in the understory. *Coprosma foliosa* is typically absent.....
..... ***Acacia koa* / *Leptecophylla tameiameiae* - (*Dodonaea viscosa*) Montane Woodland (W_ACLEDO)**
- 13a. Understory dominated by *Hedychium gardnerianum*. This is a disturbed wet forest type.....
..... ***Acacia koa* - *Metrosideros polymorpha* / *Hedychium gardnerianum* Semi-natural Woodland (W_ACMEHE)**
- 13b. Understory not dominated by *Hedychium gardnerianum* **14**
- 14a. Wet montane forests and woodlands with canopies co-dominated by *Metrosideros polymorpha* and *Acacia koa* with *Melicope clusiifolia* and *Cheirodendron trigynum* trees often present. Native trees dominate the stand, but non-native trees such as *Psidium cattleianum* may be present to co-dominant. The diverse understory is composed of an open to dense shrub layer with wet indicator species such as *Alyxia oliviformis*, *Astelia menziesiana*, *Broussaisia arguta*, *Clermontia arborescens* ssp. *waihae*, *Freycinetia arborea*, *Hedyotis terminalis*, or *Smilax melastomifolia*. The open to moderately dense, mixed herbaceous layer composed of diverse ferns and high cover of moss. *Dicranopteris linearis* may co-dominate the herbaceous layer with up to 30% cover, but does not strongly dominant the understory. *Diplazium sandwichianum* had high cover of at least one plot. Epiphytes are common. ***Acacia koa* - *Metrosideros polymorpha* Wet Montane Woodland (W_ACME_W)**
- 14b. Lowland forests and woodlands generally < 1000 m elevation **15**
- 15a. Lowland wet forests co-dominated by *Metrosideros polymorpha* and *Acacia koa*. *Dicranopteris linearis* strongly dominates the understory forming a dense mat. (generally >40% of *Dicranopteris linearis* with low diversity of other understory species). Shrubs are generally absent or have low cover.
..... ***Acacia koa* - *Metrosideros polymorpha* / *Dicranopteris linearis* Lowland Wet Forest (F_ACME DI)**
- 15b. Lowland diverse mesic forests co-dominated by *Metrosideros polymorpha* and *Acacia koa*. *Antidesma platyphyllum* and *Melicope clusiifolia* trees may be present to co-dominant. The sampled stand occurred at 780 m and was disturbed with moderate cover of the non-native tree *Psidium cattleianum* and understory strongly dominated by the non-native shrub *Clidemia hirta* ***Acacia koa* - *Metrosideros polymorpha* Lowland Mesic Forest (F_ACME_L)**
- 16a. Forests and woodlands with tree canopies co-dominated by *Myrsine lessertiana*. *Metrosideros polymorpha* may co-dominant.. The understory is typically dominated by *Coprosma foliosa* and *Dodonaea viscosa*.....
..... ***Myrsine lessertiana* - (*Metrosideros polymorpha*) / *Coprosma foliosa* - *Dodonaea viscosa* Montane Mesic Forest (F_MYMECODO)**
- 16b. Forests and woodlands with canopies dominated by *Metrosideros polymorpha* and/or *Melicope clusiifolia*..... **17**
- 17a. Wet montane forests with tree canopies co-dominated by *Metrosideros polymorpha* and *Melicope clusiifolia*. The understory often dominated by *Elaphoglossum wawrae*. Other ferns *Diplazium sandwichianum* and *Dryopteris wallichiana* are present, but not co-dominant..... ***Metrosideros polymorpha* - *Melicope clusiifolia* Montane Wet Forest (not mapped)**
- 17b. Forests and woodlands dominated or co-dominated by *Metrosideros polymorpha*. *Melicope clusiifolia* is absent or if present then <10% cover..... **18**
- 18a. Wet, upper montane forests and woodlands with tree canopies dominated by *Metrosideros polymorpha* and *Rubus hawaiiensis* dominating the shrub layer. *Vaccinium calycinum* may be present to co-dominant. Ferns such as *Dryopteris wallichiana*, *Diplazium sandwichianum* or *Sadleria cyatheoides*, and mosses are often abundant... ..
..... ***Metrosideros polymorpha* / *Rubus hawaiiensis* Montane Wet Forest (F_MERU)**
- 18b. Forests and woodlands dominated or co-dominated by *Metrosideros polymorpha*. *Rubus hawaiiensis* is absent or if present then with <10% cover..... **19**
- 19a. Wet, montane forests and woodlands with tree canopies dominated by *Metrosideros polymorpha* and diverse shrub layer dominated or co-dominated by *Vaccinium calycinum*, often with *Broussaisia arguta* and/or *Coprosma foliosa* present to co-dominant. *Athyrium microphyllum* is present in herbaceous layer. Other wet forest indicator species may include *Astelia menziesiana*, *Clermontia arborescens*, *Nertera granadensis*, *Melicope clusiifolia* and *Sadleria pallida*. *Dicranopteris linearis* or *Diplazium sandwichianum* are often present but do not strongly dominate. Other ferns and mosses are typically abundant. Epiphytes are usually abundant.... ..
..... ***Metrosideros polymorpha* / *Vaccinium calycinum* - (*Broussaisia arguta*, *Coprosma foliosa*) / *Athyrium microphyllum* Montane Wet Forest (F_MEVABRCOAT)**
- 19b. Forests and woodlands dominated or co-dominated by *Metrosideros polymorpha*. *Vaccinium calycinum* does not dominate or co-dominate the understory..... **20**

20a. Wet montane forests and woodlands with tree canopies co-dominated by <i>Metrosideros polymorpha</i> and <i>Cheirodendron trigynum</i> ssp. <i>trigynum</i> with both species generally having at least 10% cover although <i>Metrosideros polymorpha</i> often has higher cover. If <i>Ilex anomala</i> or <i>Myrsine lessertiana</i> is present, then cover of <i>Cheirodendron</i> spp. is greater in cover than either. <i>Cibotium</i> spp. may be present to dominant in tree subcanopy and understory. Understory is often strongly dominated by <i>Diplazium sandwichianum</i> (ferns) and moss. Epiphytes are abundant.....	
..... <i>Metrosideros polymorpha</i> - <i>Cheirodendron trigynum</i> / (<i>Cibotium</i> spp.) Montane Wet Forest (F_MECHCI)	
20b. Forests and woodlands dominated or co-dominated by <i>Metrosideros polymorpha</i> . <i>Cheirodendron</i> spp. is absent or if present then with low cover <5% cover	21
21a. Forests and woodlands with tree canopies dominated by <i>Metrosideros polymorpha</i> and <i>Sadleria cyatheoides</i> strongly dominating the understory	<i>Metrosideros polymorpha</i> / <i>Sadleria cyatheoides</i> Forest (F_MESA)
21b. Forests and woodlands dominated or co-dominated by <i>Metrosideros polymorpha</i> . <i>Sadleria cyatheoides</i> is absent or if present then with relatively low cover	22
22a. Forests and woodlands with open to moderately dense tree canopies dominated by <i>Metrosideros polymorpha</i> and a wet, boggy herbaceous understory dominated or co-dominated by <i>Carex alligata</i> and/or <i>Machaerina angustifolia</i> . Disturbed stands may be co-dominated by non-native species <i>Ageratina adenophora</i> , <i>Paspalum urvillei</i> or <i>Tibouchina herbacea</i>	
..... <i>Metrosideros polymorpha</i> / <i>Carex alligata</i> - (<i>Machaerina angustifolia</i>) Wet Woodland (W_MECAMA)	
22b. Forests and woodlands dominated or co-dominated by <i>Metrosideros polymorpha</i> . <i>Carex alligata</i> and <i>Machaerina angustifolia</i> absent or if present then with low cover	23
23a. Wet forests and woodlands dominated or co-dominated by <i>Metrosideros polymorpha</i> with the ferns <i>Dicranopteris linearis</i> or <i>Dryopteris wallichiana</i> dominating the understory	24
23b. Forests and woodlands not as above	Unclassified Native Forest or Woodland at HALE
24a. Wet forests and woodlands dominated or co-dominated by <i>Metrosideros polymorpha</i> with the fern, <i>Dicranopteris linearis</i> strongly dominating the understory with 25% or more cover.....	25
24b. Forests and woodlands dominated or co-dominated by <i>Metrosideros polymorpha</i> . The fern <i>Dicranopteris linearis</i> is absent or if present does not strongly dominate the understory	26
25a. Wet lowland forests and woodlands generally below 1000 m elevation. Non-native species such as <i>Psidium cattleianum</i> , <i>Clidemia hirta</i> , and <i>Tibouchina herbacea</i> are more common in lowland stands.	
..... <i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Mesic Woodland (W_MEDI_L)	
25b. Wet montane forests and woodlands generally above 1000 m elevation. Native wet species such as <i>Broussaisia arguta</i> , <i>Elaphoglossum paleaceum</i> , <i>Hedyotis terminalis</i> , and <i>Lycopodiella cernua</i> are common in these montane stands.....	
..... <i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Montane Wet Woodland (W_MEDISTDI)	
26a. Mesic subalpine forests and woodlands dominated by <i>Metrosideros polymorpha</i> with the fern, <i>Dryopteris wallichiana</i> dominating the understory. <i>Lycopodium venustulum</i> may be present to co-dominant	
..... <i>Metrosideros polymorpha</i> / <i>Dryopteris wallichiana</i> Subalpine Mesic Forest (F_MEDR)	
26b. Montane mesic forest with tree canopy dominated by <i>Metrosideros polymorpha</i> and open to dense shrub layer dominated or co-dominated by <i>Leptecophylla tameiameiae</i> and <i>Dodonaea viscosa</i>	
..... <i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Woodland (W_MELEDO_M)	
27a. Forests and woodlands with canopies dominated by <i>Prosopis pallida</i> often with a tall shrub layer dominated by <i>Leucaena leucocephala</i> . Understory is typically strongly dominated by introduced grasses.....	
..... <i>Prosopis pallida</i> Coastal Dry Semi-natural Woodland (W_PRPA)	
27b. Forests and woodlands not as above	28
28a. Forests and woodlands with canopies dominated by <i>Terminalia catappa</i> . <i>Syzygium cumini</i> may be present to co-dominant. Common along coast lines, where stands tend to be small.	<i>Terminalia catappa</i> Semi-natural Woodland (W_TECA)
28b. Forests and woodlands not as above	29
29a. Forests and woodlands with tree canopy strongly dominated by <i>Thevetia peruviana</i> . Native tree, <i>Erythrina sandwicensis</i> was subdominant (12% cover) in the single sampled stand.....	
..... <i>Thevetia peruviana</i> Semi-natural Woodland (W_THPE)	
29b. Forests and woodlands not as above	30
30a. Former plantation areas dominated or co-dominated by <i>Eucalyptus globulus</i> and/or <i>Eucalyptus saligna</i>	
..... <i>Eucalyptus</i> spp. - Mixed Alien Semi-natural/Plantation Forest (F_EUMI)	
30b. Forests and woodlands not as above	31

31a. Forests and woodlands with canopies dominated by <i>Grevillea robusta</i>	
..... <i>Grevillea robusta</i> Lowland Mesic Semi-natural Forest (F_GRRO)	
31b. Forests and woodlands not as above	32
32a. Forests and woodlands with canopies strongly dominated by <i>Phyllostachys nigra</i>	
..... <i>Phyllostachys nigra</i> Semi-natural Thicket (T_PHNI)	
32b. Forests and woodlands not as above	33
33a. Forests and woodlands with canopies dominated by often emergent <i>Mangifera indica</i> . Non-native <i>Ficus microcarpa</i> , <i>Psidium cattleianum</i> , <i>Schinus terebinthifolius</i> , and <i>Syzygium cumini</i> trees may be present to co-dominant.	
..... <i>Mangifera indica</i> Semi-natural Forest (F_MAIN_S)	
33b. Forests and woodlands not as above	34
34a. Forests and woodlands with canopies dominated by <i>Spathodea campanulata</i> . The single stand sampled had moderate cover of <i>Aleurites moluccana</i> and <i>Psidium guajava</i> and high cover of the non-native grass <i>Oplismenus hirtellus</i>	
..... <i>Spathodea campanulata</i> - <i>Psidium</i> spp. Semi-natural Forest (F_SPPS)	
34b. Forests and woodlands not as above	35
35a. Canopy ranges from moderately dense tall woodland to dense scrub woodland strongly dominated by <i>Schinus</i> <i>terebinthifolius</i> (usually 2x cover or more of other tree species). <i>Psidium guajava</i> trees are often present and may be co- dominant.....	
..... <i>Schinus terebinthifolius</i> Semi-natural Scrub Woodland (W_SCTE_S)	
35b. Forests and woodlands not as above	36
36a. Forests and woodlands with tree canopy dominated by <i>Syzygium cumini</i> . Single sampled stands had <i>Mangifera indica</i> sub- dominant.....	
..... <i>Syzygium cumini</i> Lowland Mesic Semi-natural Forest (F_SYCU)	
36b. Forests and woodlands not as above	37
37a. Forests and woodlands with tree canopy dominated or co-dominated by <i>Syzygium jambos</i> . <i>Psidium guajava</i> trees may be present to co-dominant	
..... <i>Syzygium jambos</i> Lowland Mesic Semi-natural Woodland (W_SYJA)	
37b. Forests and woodlands not as above	38
38a. Forests and woodlands with canopies strongly dominated by <i>Psidium cattleianum</i> . May have an emergent canopy of <i>Acacia</i> <i>koa</i>	
..... <i>Acacia koa</i> - <i>Psidium cattleianum</i> Semi-natural Forest (F_ACPS_S)	39
38b. Forests and woodlands not as above	40
39a. Forests and woodlands dominated by <i>Psidium cattleianum</i> with an emergent canopy dominated by > 10% <i>Acacia koa</i>	
..... <i>Acacia koa</i> - <i>Psidium cattleianum</i> Semi-natural Forest (F_ACPS_S)	
39b. Forests and woodlands with canopies strongly dominated by <i>Psidium cattleianum</i> . <i>Psidium guajava</i> , <i>Schinus</i> <i>terebinthifolius</i> , and <i>Syzygium cumini</i> are often present sometimes with remnant native tree species	
..... <i>Psidium cattleianum</i> Lowland Wet Semi-natural Forest (F_PSCA)	
40a. Forests and woodlands with canopies dominated by <i>Psidium guajava</i> . Other introduced trees are common. Understory is often disturbed and dominated by introduced species.	
..... <i>Psidium guajava</i> / Disturbed Understory Semi-natural Forest (F_PSGU)	
40b. Forests and woodlands not as above	41
41a. Plantation Forests and woodlands with canopies dominated by <i>Cryptomeria japonica</i> , <i>Melaleuca quinquenervia</i> , <i>Pinus</i> <i>radiata</i> or <i>Syncarpia glomulifera</i> . Other introduced trees are common.	
..... Mixed Forest Plantation (F_EUMI)	
41b. Forests and woodlands not as above	Unclassified Semi-natural Forest or Woodland at HALE

Shrubland Key

- 1a. Shrublands dominated by *Lantana camara*, *Leucaena leucocephala*, or other non-native shrubs.....2
- 1b. Shrublands dominated or co-dominated by native species of *Coprosma*, *Dodonaea*, *Geranium*, *Leptecophylla*, *Rubus*, *Perrottetia*, *Scaevola*, *Sophora*, or *Vaccinium* 5
- 2a. Shrublands dominated by *Lantana camara*. *Indigofera suffruticosa* is often present. Herbaceous layer of non-native species such as *Spermacoce assurgens* and *Bothriochloa pertusa* is common ***Lantana camara* Semi-natural Shrubland (S_LACA)**
- 2b. Shrublands dominated by *Leucaena leucocephala*, or other non-native shrubs.....3
- 3a. Shrublands dominated by a tall shrub layer dominated by *Leucaena leucocephala*.....4
- 3b. Shrublands dominated by other non-native shrubs **Unclassified Semi-natural Shrubland at HALE**
- 4a. Shrublands with tall shrub layer dominated by *Leucaena leucocephala* with understory dominated by *Urochloa maxima*. Other non-native shrubs may be present to co-dominant such as *Lantana camara* ***Leucaena leucocephala* / *Urochloa maxima* Semi-natural Shrubland (S_LELE_S)**
- 4b. Shrublands with tall shrub layer dominated by *Leucaena leucocephala*. Other non-native shrubs such as *Lantana camara* may be present and form a short shrub layer. Herbaceous layer is variable and may be dominated by *Digitaria insularis*, *Urochloa maxima* or other non-native species. ***Leucaena leucocephala* Lowland Dry Semi-natural Shrubland (S_LELE_S)**
- 5a. *Sophora chrysophylla* cover is at least 1/3 cover of all other shrub species combined or at least 10% absolute cover.....6
- 5b. Vegetation not as above.....7
- 6a. *Leptecophylla tameiameiae* is frequently present and often co-dominant. *Dodonaea viscosa* is present and may be codominant. *Coprosma montana* may also be present but in low cover and is less than *Dodonaea viscosa*..... ***Sophora chrysophylla* - *Dodonaea viscosa* - (*Leptecophylla tameiameiae*) Montane Shrubland (S_SOCOLEDO)**
- 6b. *Leptecophylla tameiameiae* is frequently present and often co-dominant, and *Coprosma montana* is often present and may be co-dominant. *Dodonaea viscosa* is absent ***Sophora chrysophylla* - (*Coprosma montana* - *Leptecophylla tameiameiae*) Subalpine Shrubland (S_SOCOLEDO)**
- 7a. Shrublands dominated or co-dominated by *Leptecophylla tameiameiae* 12
- 7b. Shrublands dominated or co-dominated by other species. If present, *Leptecophylla tameiameiae* has low cover.....8
- 8a. Shrublands dominated by *Scaevola taccada* ***Scaevola taccada* Coastal Dry Shrubland (S_SCTA)**
- 8b. Shrublands not as above.....9
- 9a Shrublands dominated by *Dodonaea viscosa*. If present, *Leptecophylla tameiameiae* has low cover (<1/3 cover of *Dodonaea viscosa*). ***Dodonaea viscosa* Montane Mesic Shrubland (S_DOVI_M)**
- 9b. Shrublands dominated or co-dominated by native species of *Rubus* or *Vaccinium* 10
- 10a. Shrublands dominated by *Rubus hawaiiensis*. *Leptecophylla tameiameiae*, *Coprosma ernodeoides*, or *Vaccinium reticulatum* may be present with low cover. *Ageratina adenophora* or other non-native species may be present to co-dominant in disturbed stands. Sites are wet..... ***Rubus hawaiiensis* Montane Wet Shrubland (S_RUHA)**
- 10b. Shrublands dominated by *Vaccinium calycinum*. *Rubus hawaiiensis* may be present with relatively low cover. Scattered *Metrosideros polymorpha* (5% cover) occurred on the single sampled plot..... ***Vaccinium calycinum* Subalpine Mesic Shrubland (not mapped)**
- 11a. Subalpine shrubland dominated by *Coprosma montana* in tall or short shrub layers with *Leptecophylla tameiameiae* dominant in short shrub layer. Other shrubs such as *Vaccinium reticulatum* may be present ***Coprosma montana* / *Leptecophylla tameiameiae* Subalpine Shrubland (S_SOCOLEDO)**
- 11b. Shrublands dominated or co-dominated by native species of *Geranium*, *Leptecophylla*, *Sadleria* or *Vaccinium*.....12
- 12a. Subalpine mesic shrubland co-dominated by *Leptecophylla tameiameiae* and *Sadleria cyatheoides*. *Pteridium aquilinum* ssp. *decompositum* is prominent in one plot ***Leptecophylla tameiameiae* - *Sadleria cyatheoides* Subalpine Mesic Shrubland (S_LESA)**
- 12b. Shrublands not co-dominated by *Sadleria cyatheoides*.....13
- 13a. Shrublands co-dominated by *Leptecophylla tameiameiae* and *Vaccinium reticulatum*.....14
- 13b. Shrublands not co-dominated by *Vaccinium reticulatum*.....15

- 14a. Mesic subalpine shrubland co-dominated by *Leptecophylla tameiameiae* and *Vaccinium reticulatum* with understory co-dominated or dominated by *Deschampsia nubigena*. Subalpine indicator species *Geranium cuneatum* is often present to co-dominant. ***Leptecophylla tameiameiae* - *Vaccinium reticulatum* - (*Geranium cuneatum*) / *Deschampsia nubigena* Mesic Shrubland (S_LEVAGEDE)**
- 14b. Montane and subalpine mesic shrublands co-dominated by *Leptecophylla tameiameiae* and *Vaccinium reticulatum* generally with both species having a 1/3 or more the cover of the other. Other shrubs may be present with low cover. *Pteridium aquilinum* ssp. *decompositum* is prominent in one stand. If present, the herbaceous layer is often dominated by non-native grasses such as *Holcus lanatus* and *Anthoxanthum odoratum*. *Deschampsia nubigena* is absent or at very low cover. *This association occurs as two phases at HALE: an open canopy phase with 10-20% total shrub cover and a moderate-dense canopy phase with 21-70% cover total shrub cover. Field crew needs to record percent total shrub cover and note the presence and cover of *Sophora chrysophylla* to further clarify the type ***Leptecophylla tameiameiae* - *Vaccinium reticulatum* Subalpine Mesic Shrubland (S_LEVA)**
- 15a. Subalpine shrubland dominated or co-dominated by *Leptecophylla tameiameiae* sometime with *Dodonaea viscosa* present to co-dominant. The understory is strongly dominated by *Cenchrus clandestinus*. ***Leptecophylla tameiameiae* - (*Dodonaea viscosa*) / *Cenchrus clandestinus* Montane - Subalpine Mesic Semi-natural Shrubland (S_LEDICE)**
- 15b. *Leptecophylla tameiameiae* dominated shrublands with understory not dominated by *Cenchrus clandestinus* **16**
- 16a. Montane shrubland co-dominated by *Leptecophylla tameiameiae* and *Dodonaea viscosa* co-dominant with both species having 1/3 or more the cover of the other. *Osteomeles anthyllidifolia* is typically present to co-dominant and is a good indicator of mesic montane shrublands. Non-native grasses *Festuca rubra*, *Melinis repens*, and *Sporobolus africanus* have invaded many stands. ***Leptecophylla tameiameiae* - *Dodonaea viscosa* Montane Shrubland (S_LEDOM)**
- 16b. Shrublands not as above. **17**
- 17a. Subalpine dry shrubland dominated by *Leptecophylla tameiameiae* with *Dodonaea viscosa* absent or low cover (less than 1/3 the cover of *Leptecophylla tameiameiae*). Low constancy/high fidelity indicators of this dry subalpine shrubland include *Agrostis sandwicensis*, *Dianella sandwicensis*, *Dubautia menziesii*, *Geranium cuneatum* ssp. *cuneatum*, *Hypochoeris glabra*, *Tetramolopium humile* ssp. *humile*. Herbaceous species are typically not dense enough to form a layer. ***Leptecophylla tameiameiae* Subalpine Dry Shrubland (S_LETA_D)**
- 17b. Shrublands not as above. **18**
- 18a. Montane mesic shrubland dominated by *Leptecophylla tameiameiae* with *Dodonaea viscosa* absent or low cover (less than 1/3 the cover of the *Leptecophylla tameiameiae*). *Osteomeles anthyllidifolia* is a high constancy indicator species. Other species present generally have lower cover although they may be diverse. Herbaceous species are typically not dense enough to form a layer ***Leptecophylla tameiameiae* Montane Mesic Shrubland (S_LETA_M)**
- 18b. Shrublands dominated by other native shrubs. **Unclassified Native Shrubland at HALE**

Herbaceous Key

- 1a. Herbaceous vegetation dominated or co-dominated by native species of *Carex*, *Deschampsia*, *Dicranopteris*, *Portulaca*, *Pteridium*, or *Trisetum*.....2
- 1b. Herbaceous vegetation dominated or co-dominated by non-native species of *Ageratina*, *Andropogon*, *Axonopus*, *Bothriochloa*, *Cenchrus*, *Digitaria*, *Heterotheca*, *Holcus*, *Melinis*, *Paspalum*, *Pityrogramma*, *Sacciolepis*, *Schizachyrium*, *Spermacoce*, *Sporobolus*, or *Zinnia*.....6
- 2a. Diverse montane herbaceous bog dominated or co-dominated by *Carex alligata*, *C. echinata*, *C. montis-eeka*, and/or *C. thunbergii*, which are indicator species of this type. *Athyrium microphyllum* and *Deschampsia nubigena* are prominent on some sites. Scattered trees or shrubs may be present but do not form distinct layers cover. Disturbed sites may be co-dominated by *Holcus lanatus* or other non-native species.....
.....***Carex (alligata, echinata, montis-eeka, thunbergii) - (Deschampsia nubigena) Mixed Herbaceous Montane Bog (H_CADE)***
- 2b. Herbaceous vegetation dominated or co-dominated by species of *Deschampsia*, *Portulaca*, *Pteridium*, or *Trisetum*.....3
- 3a. Subalpine mesic grassland dominated by *Deschampsia nubigena*. *Trisetum glomeratum* and/or *Pteridium aquilinum* ssp. *decompositum* may be present to co-dominant in some stands. Scattered shrubs may be present but do not form a layer. Non-native grass, *Holcus lanatus* is common in disturbed stands
.....***Deschampsia nubigena* Montane and Subalpine Mesic Herbaceous Vegetation (H_DENU)**
- 3b. Herbaceous vegetation dominated by other native species 4
- 4a. Lowland herbaceous vegetation dominated by *Portulaca lutea*.....***Portulaca lutea* Herbaceous Vegetation (H_POLU)**
- 4b. Herbaceous vegetation dominated by other native species 5
- 5a. Montane to subalpine vegetation dominated by *Pteridium aquilinum* ssp. *decompositum*.
.....***Pteridium aquilinum* ssp. *decompositum* Herbaceous Vegetation (H_PTAQ)**
- 5b. Herbaceous vegetation dominated by other native species**Unclassified Native Herbaceous Vegetation at HALE (H_UNNA)**
- 6a. Grasslands dominated or co-dominated by non-native *Bothriochloa pertusa*. Sampled stand had scattered shrubs especially *Lantana camara*, but not enough to form a layer. Other non-native herbaceous species such as *Spermacoce assurgens* or *Cenchrus ciliaris* may be present to co-dominant.***Bothriochloa pertusa* Semi-natural Grassland (H_CEB0)**
- 6b. Herbaceous vegetation not dominated by *Bothriochloa pertusa*.....7
- 7a. Herbaceous vegetation dominated or co-dominated by non-native *Pityrogramma austroamericana* and/or *Heterotheca grandiflora*. Scattered *Lantana camara* may be present but do not form a shrub layer (<10%cover).....
.....***Pityrogramma austroamericana - Heterotheca grandiflora* Semi-natural Herbaceous Vegetation (H_PIHE)**
- 7b. Herbaceous vegetation not as above 8
- 8a. Grasslands strongly dominated by non-native grass *Holcus lanatus*. Non-native grass *Poa pratensis* may be present to co-dominant in some stands. *Pteridium aquilinum* may be present. If native grasses are present such as *Deschampsia nubigena*, then *Holcus lanatus* has over twice as much cover.***Holcus lanatus* Semi-natural Grassland (H_HOLA)**
- 8b. Herbaceous vegetation not dominated by *Holcus lanatus*.....9
- 9a. Grasslands dominated by non-native grass *Cenchrus ciliaris* (*Pennisetum ciliaris*).....
.....***Cenchrus ciliaris* Semi-natural Herbaceous Vegetation (H_CEB0)**
- 9b. Herbaceous vegetation not dominated by *Cenchrus ciliaris*.....10
- 10a. Grasslands dominated by non-native grass *Cenchrus clandestinus* (*Pennisetum clandestinum*). Some transitional stands with scattered, mixed trees with up to 15% cover are included when stand is strongly dominated (>75% cover) by *Cenchrus clandestinus*.....***Cenchrus clandestinus* Semi-natural Herbaceous Vegetation (H_CECL)**
- 10b. Herbaceous vegetation not dominated by *Cenchrus clandestinus*.....11
- 11a. Grasslands strongly dominated by non-native grass *Cenchrus purpureus*
.....***Cenchrus purpureus* Semi-natural Herbaceous Vegetation (H_CEPU)**
- 11b. Herbaceous vegetation not dominated by *Cenchrus purpureus* 12

- 12a. Herbaceous vegetation dominated by *Andropogon virginicus*
..... ***Andropogon virginicus* Semi-natural Lowland Herbaceous Vegetation (not mapped)**
- 12b. Herbaceous vegetation dominated or co-dominated by other non-native species **13**
- 13a. Herbaceous vegetation dominated by *Melinis minutiflora* or co-dominated by *Schizachyrium condensatum*.
..... ***Melinis minutiflora* - (*Schizachyrium condensatum*) Semi-natural Herbaceous Vegetation (H_MESC)**
- 13b. Grasslands dominated or co-dominated by other non-native species **14**
- 14a. Lowland herbaceous vegetation dominated or co-dominated by non-native species *Spermacoce assurgens*, *Zinnia peruviana*, and *Digitaria insularis*. Scattered *Indigofera suffruticosa* or *Lantana camara* shrubs may be present, but not enough to form a layer.
..... ***Spermacoce assurgens* - *Zinnia peruviana* - *Digitaria insularis* Semi-natural Herbaceous Vegetation (H_SPZIDI)**
- 14b. Herbaceous vegetation not as above **15**
- 15a. Herbaceous vegetation dominated by the non-native grass *Sporobolus africanus* with lower cover of *Anthoxanthum odoratum*. The single plot had scattered *Leptecophylla tameiameia*, but not enough to form a layer.
..... ***Sporobolus africanus* - *Anthoxanthum odoratum* Rock Slide Semi-natural Herbaceous Vegetation (H_AGSPAN)**
- 15b. Herbaceous vegetation co-dominated by other non-native species such as *Ageratina adenophora* *Axonopus fissifolius*, *Paspalum conjugatum*, *Plantago lanceolata* or *Sacciolepis indica*, ... **16**
- 16a. Herbaceous vegetation dominated or co-dominated by *Ageratina adenophora*. *Rubus hawaiiensis* may be present with low cover (<10%). If cover of *Rubus hawaiiensis* < 10% then go to Shrubland Key. **17**
- 16b. Herbaceous vegetation dominated or co-dominated by other non-native species **18**
- 17a. Wet herbaceous vegetation co-dominated by *Paspalum conjugatum* and *Ageratina adenophora* occurring in disturbed bog sites ***Ageratina adenophora* - *Paspalum conjugatum* Semi-natural Herbaceous Bog (H_AGPA)**
- 17b. Subalpine herbaceous vegetation dominated by *Ageratina adenophora* and *Oenothera stricta* occurring on disturbed sites. There is moderate cover of lichens, moss and the fern *Pellaea ternifolia* on mesic plots
..... ***Ageratina adenophora* - (*Pellaea ternifolia*, *Oenothera stricta*) Semi-natural Subalpine Herbaceous Vegetation (H_AGSPAN)**
- 18a. Herbaceous vegetation co-dominated by *Plantago lanceolata* and *Rumex acetosella*.
..... ***Plantago lanceolata* - *Rumex acetosella* Semi-natural Herbaceous Vegetation (not mapped)**
- 18b. Grasslands dominated or co-dominated by other non-native species **19**
- 19a. Herbaceous vegetation dominated or co-dominated by *Paspalum conjugatum*, *Sacciolepis indica*, *Axonopus fissifolius* and/or *Andropogon virginicus*. Scattered trees (*Psidium* spp.) may be present, but not enough to form a layer.
..... ***Paspalum conjugatum* - *Sacciolepis indica* - *Axonopus fissifolius* Mixed Semi-natural Herbaceous Vegetation (H_PASAAX)**
- 19b. Grasslands dominated or co-dominated by other non-native species
..... **Unclassified Non-native Herbaceous Vegetation at HALE (not mapped)**

Sparse Vegetation Key

- 1b. Cover of vascular plant species ranges from 5-15% 2
- 1b. Cover of vascular plant species less than 5%..... **Unvegetated (UNVEG)**
- 2a. Sparse vegetation characterized by non-native species *Melinis repens*, *Oenothera stricta*, and *Sporobolus africanus*. The type is based on a single sample and represent large stream channel at montane elevations.
.....***Melinis repens* - mixed Semi-natural Sparse Vegetation (not mapped)**
- 2b. Sparse vegetation not as above 3
- 3a. Sparse subalpine vegetation characterized by *Dubautia menziesii* with other scattered short shrubs such as *Leptecophylla tameiameiae*, and *Tetramolopium humile* with *Argyroxiphium sandwicense* sometimes present to dominant.
.....***Dubautia menziesii* - (*Argyroxiphium sandwicense*) Subalpine Sparse Vegetation (SP_DUAG)**
- 3b. Sparse vegetation not as above 4
- 4a. Sparse subalpine vegetation with scattered short shrubs including *Leptecophylla tameiameiae*, *Vaccinium reticulatum*, *Coprosma ernodeoides*, or *Sophora chrysophylla* (<10% cover) and a few ferns,.....
.....***Leptecophylla tameiameiae* - (*Vaccinium reticulatum*) Montane and Subalpine Sparse Vegetation (SP_LEVA_M)**
- 4b. Sparse vegetation not as above **Unclassified Sparse Vegetation at HALE**

Built Up Key

- 1a. Built up structures, primarily buildings used for commercial and services...**Built up Commercial and Services (B_COSE)**
- 1b. Built up structures, primarily infrastructure for transportation, communications, and utilities.....
.....**Built up Transportation, Communications, and Utilities (B_TRCOUT)**

Appendix D: Vegetation Association Descriptions

NATIONAL VEGETATION CLASSIFICATION

Vegetation Communities of Haleakalā National Park

29 April 2013

by

NatureServe

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This subset of the International Ecological Classification Standard covers vegetation communities of Haleakalā National Park. This classification has been developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. Comments and suggestions regarding the contents of this subset should be directed to Mary J. Russo, Central Ecology Data Manager, Durham, NC mary_russo@natureserve.org, and/or Keith Schulz, Vegetation Ecologist, Boulder, CO [<keith_schulz@natureserve.org>](mailto:keith_schulz@natureserve.org).



Citations:

The following citation should be used in any published materials which reference ecological system and/or International Vegetation Classification (IVC hierarchy) and association data:

NatureServe. 2013. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of 29 April 2013.

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NatureServe. 2013. International Ecological Classification Standard: Terrestrial Ecological Classifications. Vegetation Communities of Haleakalā National Park. NatureServe Central Databases. Arlington, VA. Data current as of 29 April 2013.

¹ NatureServe is an international organization including NatureServe regional offices, a NatureServe central office, U.S. State Natural Heritage Programs, and Conservation Data Centres (CDC) in Canada and Latin America and the Caribbean. Ecologists from the following organizations have contributed the development of the ecological systems classification:

United States

Central NatureServe Office, Arlington, VA; Eastern Regional Office, Boston, MA; Midwestern Regional Office, Minneapolis, MN; Southeastern Regional Office, Durham, NC; Western Regional Office, Boulder, CO; Alabama Natural Heritage Program, Montgomery AL; Alaska Natural Heritage Program, Anchorage, AK; Arizona Heritage Data Management Center, Phoenix AZ; Arkansas Natural Heritage Commission Little Rock, AR; Blue Ridge Parkway, Asheville, NC; California Natural Heritage Program, Sacramento, CA; Colorado Natural Heritage Program, Fort Collins, CO; Connecticut Natural Diversity Database, Hartford, CT; Delaware Natural Heritage Program, Smyrna, DE; District of Columbia Natural Heritage Program/National Capital Region Conservation Data Center, Washington DC; Florida Natural Areas Inventory, Tallahassee, FL; Georgia Natural Heritage Program, Social Circle, GA; Great Smoky Mountains National Park, Gatlinburg, TN; Gulf Islands National Seashore, Gulf Breeze, FL; Hawaii Natural Heritage Program, Honolulu, Hawaii; Idaho Conservation Data Center, Boise, ID; Illinois Natural Heritage Division/Illinois Natural Heritage Database, Springfield, IL; Indiana Natural Heritage Data Center, Indianapolis, IN; Iowa Natural Areas Inventory, Des Moines, IA; Kansas Natural Heritage Inventory, Lawrence, KS; Kentucky Natural Heritage Program, Frankfort, KY; Louisiana Natural Heritage Program, Baton Rouge, LA; Maine Natural Areas Program, Augusta, ME; Mammoth Cave National Park, Mammoth Cave, KY; Maryland Wildlife & Heritage Division, Annapolis, MD; Massachusetts Natural Heritage & Endangered Species Program, Westborough, MA; Michigan Natural Features Inventory, Lansing, MI; Minnesota Natural Heritage & Nongame Research and Minnesota County Biological Survey, St. Paul, MN; Mississippi Natural Heritage Program, Jackson, MI; Missouri Natural Heritage Database, Jefferson City, MO; Montana Natural Heritage Program, Helena, MT; National Forest in North Carolina, Asheville, NC; National Forests in Florida, Tallahassee, FL; National Park Service, Southeastern Regional Office, Atlanta, GA; Navajo Natural Heritage Program, Window Rock, AZ; Nebraska Natural Heritage Program, Lincoln, NE; Nevada Natural Heritage Program, Carson City, NV; New Hampshire Natural Heritage Inventory, Concord, NH; New Jersey Natural Heritage Program, Trenton, NJ; New Mexico Natural Heritage Program, Albuquerque, NM; New York Natural Heritage Program, Latham, NY; North Carolina Natural Heritage Program, Raleigh, NC; North Dakota Natural Heritage Inventory, Bismarck, ND; Ohio Natural Heritage Database, Columbus, OH; Oklahoma Natural Heritage Inventory, Norman, OK; Oregon Natural Heritage Program, Portland, OR; Pennsylvania Natural Diversity Inventory, PA; Rhode Island Natural Heritage Program, Providence, RI; South Carolina Heritage Trust, Columbia, SC; South Dakota Natural Heritage Data Base, Pierre, SD; Tennessee Division of Natural Heritage, Nashville, TN; Tennessee Valley Authority Heritage Program, Norris, TN; Texas Conservation Data Center, San Antonio, TX; Utah Natural Heritage Program, Salt Lake City, UT; Vermont Nongame & Natural Heritage Program, Waterbury, VT; Virginia Division of Natural Heritage, Richmond, VA; Washington Natural Heritage Program, Olympia, WA; West Virginia Natural Heritage Program, Elkins, WV; Wisconsin Natural Heritage Program, Madison, WI; Wyoming Natural Diversity Database, Laramie, WY

Canada

Alberta Natural Heritage Information Centre, Edmonton, AB, Canada; Atlantic Canada Conservation Data Centre, Sackville, New Brunswick, Canada; British Columbia Conservation Data Centre, Victoria, BC, Canada; Manitoba Conservation Data Centre, Winnipeg, MB, Canada; Ontario Natural Heritage Information Centre, Peterborough, ON, Canada; Quebec Conservation Data Centre, Quebec, QC, Canada; Saskatchewan Conservation Data Centre, Regina, SK, Canada; Yukon Conservation Data Centre, Yukon, Canada

Latin American and Caribbean

Centro de Datos para la Conservacion de Bolivia, La Paz, Bolivia; Centro de Datos para la Conservacion de Colombia, Cali, Valle, Columbia; Centro de Datos para la Conservacion de Ecuador, Quito, Ecuador; Centro de Datos para la Conservacion de Guatemala, Ciudad de Guatemala, Guatemala; Centro de Datos para la Conservacion de Panama, Quarry Heights, Panama; Centro de Datos para la Conservacion de Paraguay, San Lorenzo, Paraguay; Centro de Datos para la Conservacion de Peru, Lima, Peru; Centro de Datos para la Conservacion de Sonora, Hermosillo, Sonora, Mexico; Netherlands Antilles Natural Heritage Program, Curacao, Netherlands Antilles; Puerto Rico-Departamento De Recursos Naturales Y Ambientales, Puerto Rico; Virgin Islands Conservation Data Center, St. Thomas, Virgin Islands.

NatureServe also has partnered with many International and United States Federal and State organizations, which have also contributed significantly to the development of the International Classification. Partners include the following The Nature Conservancy; Provincial Forest Ecosystem Classification Groups in Canada; Canadian Forest Service; Parks Canada; United States Forest Service; National GAP Analysis Program; United States National Park Service; United States Fish and Wildlife Service; United States Geological Survey; United States Department of Defense; Ecological Society of America; Environmental Protection Agency; Natural Resource Conservation Services; United States Department of Energy; and the Tennessee Valley Authority. Many individual state organizations and people from academic institutions have also contributed to the development of this classification.

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1. Forest to Open Woodland

1.A.1. Tropical Seasonally Dry Forest

1.A.1.Oc. Polynesian Dry Forest

M210. Hawaiian Dry Forest

G405. Hawaiian Lowland Dry Forest & Woodland

Erythrina sandwicensis Lowland Dry Woodland

Wiliwili Lowland Dry Woodland

Identifier: CEGLO08036

USNVC CLASSIFICATION

Division	Polynesian Dry Forest (1.A.1.Oc)
Macrogroup	Hawaiian Dry Forest (M210)
Group	Hawaiian Lowland Dry Forest & Woodland (G405)
Association	<i>Erythrina sandwicensis</i> Lowland Dry Woodland

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This lowland woodland association is known from a gentle slope at 126 m elevation on a lowslope topographic position. The site has a southerly aspect and was sampled along a drainage channel, but extends up and downslope with less cover of trees. Ground surface has high cover of litter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This coastal association is characterized by an open tree canopy dominated by *Erythrina sandwicensis*. Widespread, dry non-native tree *Prosopis pallida* is often present to codominant with a subcanopy or tall-shrub layer dominated by *Leucaena leucocephala*. The understory is characterized by a moderate to dense herbaceous layer dominated by non-native grasses *Urochloa maxima* and *Cenchrus ciliaris*. Average species richness per plot is 5.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Erythrina sandwicensis</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Erythrina sandwicensis*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Leucaena leucocephala* (invasive/exotic), *Cenchrus ciliaris* (invasive/exotic, High), *Prosopis pallida* (invasive/exotic), *Urochloa maxima* (invasive/exotic)

Global: Vulnerable: *Erythrina sandwicensis* (G2)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (1-Dec-1997).

CLASSIFICATION

Status: Standard

Classification Confidence: 2 - Moderate

Global Related Concepts:

Wiliwili (*Erythrina*) Forest (Gagne and Cuddihy 1990) =

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This dry lowland woodland association is known from Western Nu‘u Gulch.

Nations: US

States/Provinces: HI:S3

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 1 plot: HALE.9004.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Gagne and Cuddihy 1990, Gon 2008, Western Ecology Working Group n.d.

G406. Hawaiian Montane-Subalpine Dry Forest & Woodland

***Metrosideros polymorpha* / *Leptecophylla tameiameiae* - *Dodonaea viscosa* Montane Woodland¹**

‘Ōhi‘a / Pūkiawe - A‘ali‘i Montane Woodland

Identifier: CEG008135

USNVC CLASSIFICATION

Division	Polynesian Dry Forest (1.A.1.Oc)
Macrogroup	Hawaiian Dry Forest (M210)
Group	Hawaiian Montane-Subalpine Dry Forest & Woodland (G406)
Association	<i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i>
Montane Woodland ¹	

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This woodland association is known from mid to high slopes at approximately 1500-2000 m in elevation. Slopes are gentle and southeast-facing on a‘a lava.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by an open canopy of *Metrosideros polymorpha* ranging from 15-40% cover. Understories are shrub-dominated by *Leptecophylla tameiameiae* and *Dodonaea viscosa*, ranging from open to dense from <15 to 75% cover.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Metrosideros polymorpha</i>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Dodonaea viscosa</i> , <i>Leptecophylla tameiameiae</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Dodonaea viscosa*, *Metrosideros polymorpha*, *Leptecophylla tameiameiae*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (5-Dec-2011).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from Kaupō and the East Crater.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā, Hawai‘i Volcanoes)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0151, HALE.9007.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

M213. Polynesian Semi-natural Dry Forest

G407. Polynesian Semi-natural Dry Forest

Prosopis pallida Coastal Dry Semi-natural Woodland

Kiawe Coastal Dry Semi-natural Woodland

Identifier: CEGLO08118

USNVC CLASSIFICATION

Division	Polynesian Dry Forest (1.A.1.Oc)
Macrogroup	Polynesian Semi-natural Dry Forest (M213)
Group	Polynesian Semi-natural Dry Forest (G407)
Association	<i>Prosopis pallida</i> Coastal Dry Semi-natural Woodland

ELEMENT CONCEPT

Global Summary: This is a typically open woodland 2 to >10 m in height that is found in dry coastal to lowland settings, usually on leeward slopes of all main islands in the Hawaiian chain. This community is dry (typically less than 127 cm [50 inches] of precipitation per year), often tolerating sea spray and brackish water tables. The canopy is open, 2 to >10 m in height, and typically entirely dominated by *Prosopis pallida*. Subcanopy vegetation may be entirely lacking (bare lava substrates) or sparse to dense mixtures of alien and native grasses and shrubs such as *Leucaena leucocephala*, *Passiflora foetida*, *Waltheria indica*, *Cenchrus ciliaris*, *Cenchrus setaceus*, *Urochloa maxima* (in more mesic settings), *Sida fallax*, and *Acacia farnesiana*.

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This semi-natural woodland association is known from very dry coastal areas of the park on lowslopes, toeslopes and terraces at elevations ranging from approximately 30-150 m. Slopes are gentle and are south- and southwest-facing. All sampled areas were either recently or historically grazed.

Global Environment: This community is dry (typically less than 127 cm [50 in] of precipitation per year), often tolerating sea spray and brackish water tables.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is composed of an open canopy dominated by the non-native tree *Prosopis pallida* ranging from 15-45% cover. No other consistent canopy associates occur; however, some stands have a subcanopy/tall-shrub layer composed of *Leucaena leucocephala*. The understory is strongly dominated by dense layers of the non-native grasses *Cenchrus ciliaris* and *Urochloa maxima* ranging from 50-100% cover.

Global Vegetation: The canopy is open to moderately dense, 2 to >10 m in height, and typically entirely dominated by *Prosopis pallida*, although occasionally other trees species such as *Morinda citrifolia*, *Schinus terebinthifolius*, and *Thespesia populnea* may be present with low cover. Subcanopy vegetation may be entirely lacking (bare lava substrates) or sparse to dense mixtures of alien and native grasses and shrubs such as *Leucaena leucocephala*, *Passiflora foetida*, *Waltheria indica*, *Cenchrus ciliaris*, *Cenchrus setaceus*, *Urochloa maxima* in more mesic settings), *Sida fallax*, and *Acacia farnesiana*.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Prosopis pallida</i>

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Cenchrus ciliaris* (invasive/exotic, High), *Urochloa maxima* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (24-Jan-2003).

CLASSIFICATION

Status: Standard

Classification Confidence: 3 - Weak

Global Similar Associations:

Prosopis pallida / *Urochloa maxima* Woodland (CEGL007632) In Hawaii, subcanopy associations typically lack *Urochloa maxima*.

Global Related Concepts:

- 12. Kiawe forest on sandy back of strand (Canfield 1990) <
- 27. Kiawe inland forest on pāhoehoe (Canfield 1990) <
- Kiawe (*Prosopis*) Forest (Gagne and Cuddihy 1990) =

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is only known from a few locations at Nu‘u.

Global Range: Within the Hawaiian archipelago, *Prosopis pallida* woodland occupies leeward coastal and lowland settings subject to occasional fires. This includes the islands of Ni‘ihau, Kaua‘i, O‘ahu, Moloka‘i, Lana‘i, Kaho‘olawe, Maui, and Hawai‘i.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā, Kaloko-Honokōhau, Pu‘uhonua o Honaunau, Pu‘ukoholā Heiau)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 4 plots. HALE.0006, HALE.0008, HALE.0052, HALE.0053.

Local Description Authors: M.E. Hall

Global Description Authors: S. Gon and L. Durand, mod. M.J. Russo

References: Canfield 1990, Cogan et al. 2011a, Cogan et al. 2011b, Cogan et al. 2011c, Gagne and Cuddihy 1990, Wagner et al. 1999, Western Ecology Working Group n.d.

1.A.2. Tropical Lowland Humid Forest

1.A.2.Oa. Polynesian Lowland Rainforest

M187. Hawaiian Lowland Rainforest

G388. Hawaiian Lowland - Coastal Seasonal Rainforest

Acacia koa - *Metrosideros polymorpha* Lowland Mesic Forest

Koa / ‘Ōhi‘a Lowland Mesic Forest

Identifier: CEGL008023

USNVC CLASSIFICATION

Division	Polynesian Lowland Rainforest (1.A.2.Oa)
Macrogroup	Hawaiian Lowland Rainforest (M187)
Group	Hawaiian Lowland - Coastal Seasonal Rainforest (G388)
Association	<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Lowland Mesic Forest

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This mesic forest association occurs in Ka‘āpahu on Razorback Ridge at 780 m elevation. The single sampled stand occurs on moderately sloping (16 degrees) sideslope with southerly aspect on a lowslope topographic position. Substrates are moist with high cover of litter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by a tall (10-15 m), closed tree canopy codominated by *Metrosideros polymorpha* and *Acacia koa* with *Antidesma platyphyllum* and *Melicope clusiifolia* present to codominant in the subcanopy. Non-native trees such as *Psidium cattleianum* may be present to codominant with native trees in disturbed stands. The non-native shrub *Clidemia hirta* strongly dominates (70% cover) the single sample stand. The non-native fern *Sphaeropteris cooperi* is also present. It is not clear what the native understory would be in an undisturbed plot. Average species diversity is 25 species per plot.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (1-Dec-1997).

CLASSIFICATION

Status: Standard

Classification Confidence: 2 - Moderate

Global Related Concepts: 'Ōhi'a (*Metrosideros*) Lowland Mesic Forest (Gagne and Cuddihy 1990) =

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association occurs in Kīpahulu Valley along Razorback Ridge east of trail and 400 m from Ka'āpahu Camp.

Nations: US

States/Provinces: HI:S3

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 1 plot: HALE.9039.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Gagne and Cuddihy 1990, Gon 2008, Western Ecology Working Group n.d.

Pandanus tectorius Coastal Mesic Forest

Hala Coastal Mesic Forest

Identifier: CEGLO08032

USNVC CLASSIFICATION

Division	Polynesian Lowland Rainforest (1.A.2.Oa)
Macrogroup	Hawaiian Lowland Rainforest (M187)
Group	Hawaiian Lowland - Coastal Seasonal Rainforest (G388)
Association	<i>Pandanus tectorius</i> Coastal Mesic Forest

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This mesic coastal forest association is known from elevations below 70 m on flat to gentle slopes. Landforms include headlands, terraces and sideslopes. Sampled sites had east and southeast aspects. Ground cover has moderate to high cover of litter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This coastal association is characterized by an open to dense tree canopy dominated or codominated by *Pandanus tectorius* which ranges from 3-90% cover. Tree canopy is often mixed with *Cocos nucifera*, another early Polynesian introduction. More recently introduced non-native trees include *Terminalia catappa* or *Schinus terebinthifolius*. The moderately dense shrub layer may be dominated or codominated by *Scaevola taccada*. The non-native shrub *Lantana camara* codominates one stand. Tree seedlings and non-native graminoids *Urochloa mutica*, *Digitaria eriantha*, and *Oplismenus hirtellus* may form a sparse to moderately dense herbaceous layer. The most frequent species are *Pandanus tectorius*, *Terminalia catappa*, and *Schinus terebinthifolius*. Average species richness per plot is 5.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Acacia koa</i> , <i>Metrosideros polymorpha</i> , <i>Pandanus tectorius</i> , <i>Terminalia catappa</i>
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Clidemia hirta</i> , <i>Scaevola sericea</i> var. <i>taccada</i>
Herb (field)	Fern or fern ally	<i>Cyathea cooperi</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Acacia koa*, *Metrosideros polymorpha*, *Pandanus tectorius*, *Scaevola sericea* var. *taccada*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Clidemia hirta* (invasive/exotic), *Cyathea cooperi* (invasive/exotic), *Digitaria eriantha* (invasive/exotic), *Lantana camara* (invasive/exotic, Medium), *Oplismenus hirtellus* (invasive/exotic), *Oplismenus hirtellus* (invasive/exotic), *Psidium cattleianum* (invasive/exotic), *Schinus terebinthifolius* (invasive/exotic, High), *Terminalia catappa* (invasive/exotic), *Urochloa mutica* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (1-Dec-1997).

CLASSIFICATION

Status: Standard

Classification Confidence: 2 - Moderate

Global Related Concepts:

Hala (*Pandanus*) Forest (Gagne and Cuddihy 1990) =

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This coastal association is known from Pūhilele, Hana side of ‘O‘heo Gulch, and below ‘O‘heo Baseyard.

Nations: US

States/Provinces: HI:S3

Federal Lands: NPS (Haleakalā, Kalaupapa)

ELEMENT SOURCES

Haleakalā National Park Inventory Notes: One plot is a restoration site with *Pandanus tectorius* and *Scaevola taccada* out-plantings.

Haleakalā National Park Plots and Observation Points: 3 plots: HALE.9003, HALE.9014, HALE.9038.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Gagne and Cuddihy 1990, Gon 2008, Western Ecology Working Group n.d.

G389. Hawaiian Lowland Rainforest

***Acacia koa* - *Cheirodendron trigynum* - (*Antidesma platyphyllum*, *Syzygium sandwicense*) / (*Clidemia hirta*) Lowland Wet Forest**

Koa - ‘Ōlapa - (Hame, ‘Ōhi‘a Ha) / (Koster's curse) Lowland Wet Forest

Identifier: CEG008185

USNVC CLASSIFICATION

Division	Polynesian Lowland Rainforest (1.A.2.Oa)
Macrogroup	Hawaiian Lowland Rainforest (M187)
Group	Hawaiian Lowland Rainforest (G389)
Association	<i>Acacia koa</i> - <i>Cheirodendron trigynum</i> - (<i>Antidesma platyphyllum</i> , <i>Syzygium sandwicense</i>) / (<i>Clidemia hirta</i>) Lowland Wet Forest

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This wet forest association occurs in the lower Kīpahulu Valley from 721-971 m elevation. Positions are midslope with northeast to south-southwest aspects. Slopes are gentle to steep (2-46 degrees). Substrates are moist to wet with substantial litter and/or moss development. Some sites have a history of pig disturbance in the area, but no current evidence.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by an open to moderately closed mixed tree canopy codominated by *Acacia koa* and *Cheirodendron trigynum* ssp. *trigynum* with *Antidesma platyphyllum* and/or *Syzygium sandwicense* trees often present to codominant. *Metrosideros polymorpha* trees may be present with low cover (<1/3 cover of *Acacia koa*). Non-native trees such as *Psidium cattleianum* may be present to codominant with native trees in disturbed stands of this diverse, wet lowland forest. Native shrubs *Broussaisia arguta*, *Clermontia arborescens* ssp. *waihae*, *Hedyotis* spp., *Vaccinium calycinum*, and fern *Sadleria pallida* are frequently present in the understory, but non-native shrubs *Clidemia hirta* or *Rubus rosifolius* have heavily invaded

many stands along with non-native species *Hedychium gardnerianum* and tree fern *Sphaeropteris cooperi*. Average species diversity is 28 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Acacia koa</i> , <i>Antidesma platyphyllum</i> , <i>Cheirodendron trigynum</i> , <i>Syzygium sandwicense</i>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Broussaisia arguta</i> , <i>Clidemia hirta</i>
Herb (field)	Forb	<i>Hedychium gardnerianum</i>
Herb (field)	Fern or fern ally	<i>Cyathea cooperi</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Acacia koa*, *Antidesma platyphyllum*, *Cheirodendron trigynum*, *Syzygium sandwicense*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: **Invasive/Exotic:** *Clidemia hirta* (invasive/exotic), *Cyathea cooperi* (invasive/exotic), *Hedychium gardnerianum* (invasive/exotic, Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association occurs in lower Kīpahulu Valley near Fern, Dogleg and Ginger camps.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 8 plots: HALE.0115, HALE.0116, HALE.0117, HALE.0118, HALE.0119, HALE.0120, HALE.0121, HALE.0125

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

Acacia koa - *Metrosideros polymorpha* / *Dicranopteris linearis* Lowland Wet Forest

Koa - 'Ōhi'a / Uluhe Lowland Wet Forest

Identifier: CEG008186

USNVC CLASSIFICATION

Division	Polynesian Lowland Rainforest (1.A.2.Oa)
Macrogroup	Hawaiian Lowland Rainforest (M187)
Group	Hawaiian Lowland Rainforest (G389)
Association	<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Wet Forest

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This forest association occurs on often windy, mesic to very wet sites ranging from 810-940 m elevation on gentle to moderate (9-18 degrees) sideslopes or ridges on midslope topographic positions. Aspects are east and southeast. Substrates are moist to saturated with a ground cover composed mostly of bedrock or litter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by a moderate to dense tree canopy codominated by *Metrosideros polymorpha* and *Acacia koa* with each species having a least 1/3 cover of the other species. Scattered *Cheirodendron trigynum* ssp. *trigynum* or *Cibotium glaucum* may be present in the subcanopy

with low (<10%) cover. One stand has high tree diversity with significant cover (10%) of *Aleurites moluccana*, *Melicope clusiifolia*, and *Syzygium sandwicense*. Non-native trees such as *Psidium cattleianum* may be present to codominant with native trees in disturbed stands. Boggy areas often have shorter statured trees (2-5 m). The understory is represented by a dense herbaceous layer dominated usually (>40% cover) by *Dicranopteris linearis*. The mat-forming fern often strongly dominates the herbaceous layer with 50-80% cover in sampled plots. The native clubmoss *Lycopodiella cernua* may be present in wetter sites. Many disturbed stands have understories that are invaded by the non-native shrub *Clidemia hirta*, and herbaceous species *Ageratina adenophora*, *Hedychium gardnerianum*, and *Paspalum urvillei*. Few other herbaceous species occur with >5% cover. Average species richness is 24 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Acacia koa</i> , <i>Metrosideros polymorpha</i>
Herb (field)	Fern or fern ally	<i>Dicranopteris linearis</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Acacia koa*, *Dicranopteris linearis*, *Metrosideros polymorpha*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: **Invasive/Exotic:** *Ageratina adenophora* (invasive/exotic), *Clidemia hirta* (invasive/exotic), *Paspalum urvillei* (invasive/exotic), *Psidium cattleianum* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association was sampled near Delta in Kīpahulu Valley and the lower shelf of Kīpahulu above Fern Camp.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0114, HALE.0178.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

Metrosideros polymorpha / *Dicranopteris linearis* Lowland Mesic Woodland

‘Ōhi‘a / Uluhe Lowland Mesic Woodland

Identifier: CEGL008039

USNVC CLASSIFICATION

Division	Polynesian Lowland Rainforest (1.A.2.Oa)
Macrogroup	Hawaiian Lowland Rainforest (M187)
Group	Hawaiian Lowland Rainforest (G389)
Association	<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Mesic Woodland

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This woodland association occurs on often windy, mesic to very wet sites ranging from 785-975 m elevation on moderate to steep (15-30 degrees) midslopes with southerly aspects. Substrates are moist to saturated with an unvegetated surface composed mostly of litter and duff.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by a moderately dense canopy dominated by *Metrosideros polymorpha* ranging from 50-65% cover. If present, *Acacia koa* trees have low cover (<10%) and are not codominant. Scattered *Cheirodendron trigynum* ssp. *trigynum* or *Cibotium glaucum* may be present in the subcanopy with low (<10%) cover. The invasive non-native species *Psidium cattleianum* is frequently present. The understory is represented by a dense herbaceous layer strongly dominated by *Dicranopteris linearis* with over 80% cover in sampled plots. Native *Lycopodiella cernua* may be present in wetter sites. The moderately dense herbaceous layer has been invaded by non-native species *Clidemia hirta*, *Tibouchina herbacea*, and *Ageratina adenophora* with *Hedychium gardnerianum*, *Nephrolepis multiflora*, and *Paspalum urvillei* often present. Species richness is generally moderate and few other species occur with >5% cover. Average species richness is 18 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Metrosideros polymorpha</i>
Herb (field)	Fern or fern ally	<i>Dicranopteris linearis</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Dicranopteris linearis*, *Metrosideros polymorpha*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Ageratina adenophora* (invasive/exotic), *Clidemia hirta* (invasive/exotic), *Tibouchina herbacea* (invasive/exotic, Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (1-Dec-1997).

CLASSIFICATION

Status: Standard

Classification Confidence: 2 - Moderate

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association was sampled in Kīpahulu Valley west of the fence and 50 m west of Kaumakani Camp.

Nations: US

States/Provinces: HI:S3

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 3 plots: HALE.0140, HALE.0141, HALE.0142.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Gon 2008, Western Ecology Working Group n.d.

M190. Polynesian Semi-natural Lowland Rainforest

G390. Polynesian Semi-natural Lowland Rainforest

Mangifera indica Semi-natural Forest

Mango Semi-natural Forest

Identifier: CEGLO08199

USNVC CLASSIFICATION

Division	Polynesian Lowland Rainforest (1.A.2.Oa)
Macrogroup	Polynesian Semi-natural Lowland Rainforest (M190)
Group	Polynesian Semi-natural Lowland Rainforest (G390)
Association	<i>Mangifera indica</i> Semi-natural Forest

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This semi-natural forest and woodland association is found on mesic and seasonally mesic lowslopes and low level positions at elevations ranging from approximately 150-400 m. Slopes range from gentle to moderate on all aspects.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by open to dense canopies dominated by *Mangifera indica* with cover ranging from 20-80%. *Schinus terebinthifolius* and *Psidium cattleianum* may codominate some stands. The understory is composed of a variety of non-native shrubs and herbs, none of which is considered characteristic of the association.

MOST ABUNDANT SPECIES

Haleakalā National Park

Stratum

Tree canopy

Lifeform

Broad-leaved evergreen tree

Species

Mangifera indica

CHARACTERISTIC SPECIES

Haleakalā National Park: *Mangifera indica*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Psidium cattleianum* (invasive/exotic), *Schinus terebinthifolius* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from only a few locations in O'heo and Ka'āpahu .

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 4 plots: HALE.0033, HALE.0076, HALE.0078, HALE.0079.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

Phyllostachys nigra Semi-natural Thicket

Black Bamboo Semi-natural Thicket

Identifier: CEGL008205

USNVC CLASSIFICATION

Division

Polynesian Lowland Rainforest (1.A.2.Oa)

Macrogroup

Polynesian Semi-natural Lowland Rainforest (M190)

Group

Polynesian Semi-natural Lowland Rainforest (G390)

Association

Phyllostachys nigra Semi-natural Thicket

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This lowland thicket association is found on moist to very wet sites ranging from 100-210 m in elevation on gently sloping sideslopes with lowslope topographic positions. Aspects are variable, occurring on both northeast and southwest aspects. One stand occurs on a gentle slope 60 m away from a stream. Substrates are moist to wet with the ground cover composed of high cover of litter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by a 10- to 15-m tall, dense tree canopy dominated by non-native *Phyllostachys nigra*, often in monotypic stands. A few scattered older *Aleurites moluccana*

trees (<1% cover) are present in one stand. Shrub and herbaceous layers are absent as stands often form large, dense thickets with only a few scattered shrubs or herbs present. Other species information is not available.

MOST ABUNDANT SPECIES

Haleakalā National Park

Stratum

Tree canopy

Lifeform

Broad-leaved evergreen tree

Species

Phyllostachys nigra

CHARACTERISTIC SPECIES

Haleakalā National Park: *Pandanus tectorius*, *Scaevola sericea* var. *taccada*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Phyllostachys nigra* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from 'O'heo near Pīpīwai trail.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0035, HALE.0036.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

Psidium cattleianum Lowland Wet Semi-natural Forest

Strawberry Guava Lowland Wet Semi-natural Forest

Identifier: CEG008116

USNVC CLASSIFICATION

Division

Polynesian Lowland Rainforest (1.A.2.Oa)

Macrogroup

Polynesian Semi-natural Lowland Rainforest (M190)

Group

Polynesian Semi-natural Lowland Rainforest (G390)

Association

Psidium cattleianum Lowland Wet Semi-natural Forest

ELEMENT CONCEPT

Global Summary: Alien forest invading and displacing lowland wet settings in the Hawaiian Islands.

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This semi-natural forest association occurs on low and midslopes, valley bottoms and low ridges at elevations ranging from approximately 200-850 m. Slopes range from gentle to very steep on all aspects.

Global Environment: Wet to mesic settings, steep to flat slopes, all aspects, typically below 1200 m (4000 feet) elevation.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by dense canopies of the non-native tree *Psidium cattleianum* ranging from 60-90% cover and often in monotypic thickets. No other canopy associates are consistently present, although the native tree *Acacia koa* (<10% cover), as well as the non-native trees *Schinus terebinthifolius* and *Syzygium cumini*, may occur at lower coverage. Shrub layers are typically sparse and the understory is herbaceous species-dominated, although cover is low and no species have high consistency. Ferns are the most abundant species and include the non-native species *Cyclosorus dentatus*, *Nephrolepis multiflora*, and *Phymatosorus grossus*.

Global Vegetation: Very dense canopy, 2-5 m, occasionally 5-10 m tall. Forms dense thickets of slender-stemmed individuals. Often monotypic.

MOST ABUNDANT SPECIES

Haleakalā National Park

Stratum

Tree canopy

Lifeform

Broad-leaved evergreen tree

Species

Psidium cattleianum

CHARACTERISTIC SPECIES

Haleakalā National Park: *Psidium cattleianum*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Clidemia hirta* (invasive/exotic), *Nephrolepis multiflora* (invasive/exotic), *Phymatosorus grossus* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (24-Jan-2003).

CLASSIFICATION

Status: Standard

Global Related Concepts:

Guava (**Psidium*) Forest (Gagne and Cuddihy 1990) =

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from 'O'heo, Ka'āpahu, Palikea flats, Lower Kīpahulu, Valley, and Upper Shelf Kīpahulu.

Global Range: *Psidium cattleianum* is one of the worst invasive species in forests of Hawaii, Tahiti, La Réunion and Mauritius.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā, Kalaupapa)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 8 plots: HALE.0037, HALE.0072, HALE.0073, HALE.0074, HALE.0075, HALE.0077, HALE.0099, HALE.0108.

Local Description Authors: M.E. Hall

Global Description Authors: S. Gon and L. Durand

References: Gagne and Cuddihy 1990, Wagner et al. 1999, Western Ecology Working Group n.d.

Psidium guajava / Disturbed Understory Semi-natural Forest

Common Guava / Disturbed Understory Semi-natural Forest

Identifier: CEGLO08147

USNVC CLASSIFICATION

Division

Polynesian Lowland Rainforest (1.A.2.Oa)

Macrogroup

Polynesian Semi-natural Lowland Rainforest (M190)

Group

Polynesian Semi-natural Lowland Rainforest (G390)

Association

Psidium guajava / Disturbed Understory Semi-natural Forest

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This semi-natural woodland and forest association occurs on mesic to moderately wet lowslopes and valley bottoms at elevations ranging from approximately 400-550 m. Slopes are gentle to moderate and are southeast- and southwest-facing. All sampled areas were noted to have been heavily impacted by cows and pigs.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by an open to dense tree canopy dominated by *Psidium guajava* with cover ranging from 10-80%. Stands tend to be monotypic or nearly so in the canopy. The understory is composed of a variety of non-native shrubs and herbs, none of which appears to have an

affinity to this semi-natural community, although *Clidemia hirta* is found to be the overwhelming shrub dominant in two stands that were sampled.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Psidium guajava</i>

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Clidemia hirta* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (5-Dec-2011).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is found at Palikea Flats, 'O'heo, and the lower Kīpahulu Valley.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā, Kalaupapa)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 4 plots: HALE.0100, HALE.0102, HALE.0105, HALE.0106.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

Schinus terebinthifolius Semi-natural Scrub Woodland

Christmas Berry Semi-natural Scrub Woodland

Identifier: CEGL008148

USNVC CLASSIFICATION

Division	Polynesian Lowland Rainforest (1.A.2.Oa)
Macrogroup	Polynesian Semi-natural Lowland Rainforest (M190)
Group	Polynesian Semi-natural Lowland Rainforest (G390)
Association	<i>Schinus terebinthifolius</i> Semi-natural Scrub Woodland

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This semi-natural forest and woodland association is found on mesic lowslope, midslope and low level topographic positions at elevations ranging from approximately 50-350 m. Slopes range from gentle to moderate on all aspects. Most sampled areas were noted to have been heavily impacted by ungulates.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is strongly dominated by the non-native tree *Schinus terebinthifolius* with canopy cover ranging from 40-90%. *Psidium guajava* is often present to codominant. Although no understory species are consistent across stands, non-native grasses are the typical dominants and include *Axonopus fissifolius*, *Digitaria eriantha*, *Melinis minutiflora*, *Oplismenus hirtellus*, *Paspalum scrobiculatum*, *Sacciolepis indica*, *Stenotaphrum secundatum*, and *Sporobolus africanus*.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Schinus terebinthifolius</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Schinus terebinthifolius*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Axonopus fissifolius* (invasive/exotic), *Digitaria eriantha* (invasive/exotic), *Melinis minutiflora* (invasive/exotic), *Oplismenus hirtellus* (invasive/exotic), *Oplismenus hirtellus* (invasive/exotic), *Paspalum scrobiculatum* (invasive/exotic, Low/Insignificant), *Sacciolepis indica* (invasive/exotic), *Schinus terebinthifolius* (invasive/exotic, High), *Sporobolus indicus* var. *capensis* (invasive/exotic), *Stenotaphrum secundatum* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (5-Dec-2011).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from Kaumakani, Makahiku, Palikea Flats, Pūhilele in 'O'heo, and along donkey trail in on ridge east of Alelele in Ka'āpahu .

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā, Kalaupapa)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 7 plots: HALE.0030, HALE.0031, HALE.0032, HALE.0040, HALE.0041, HALE.0080, HALE.9037.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

Syzygium jambos Lowland Mesic Semi-natural Woodland

Rose Apple Lowland Mesic Semi-natural Woodland

Identifier: CEG008208

USNVC CLASSIFICATION

Division	Polynesian Lowland Rainforest (1.A.2.Oa)
Macrogroup	Polynesian Semi-natural Lowland Rainforest (M190)
Group	Polynesian Semi-natural Lowland Rainforest (G390)
Association	<i>Syzygium jambos</i> Lowland Mesic Semi-natural Woodland

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This semi-natural woodland association is known from mesic lowslopes and valley bottoms at elevations ranging from 400-700 m. Slopes are gentle to moderate on all aspects.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by open woodland canopies of *Syzygium jambos* with 10-30% cover. *Acacia koa* and *Psidium* spp. may be present to codominant. Understories are dense thickets of *Clidemia hirta* which has >70% cover. No herbaceous species are consistent across stands.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Syzygium jambos</i>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Clidemia hirta</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Clidemia hirta*, *Syzygium jambos*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from a few locations in the Lower Kīpahulu Valley and 'O'heo.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 3 plots: HALE.0104, HALE.0107, HALE.0170.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

Terminalia catappa Semi-natural Woodland [Park Special]

Pacific Almond Semi-natural Woodland

Identifier: CEPS009651

USNVC CLASSIFICATION

Division

Polynesian Lowland Rainforest (1.A.2.Oa)

Macrogroup

Polynesian Semi-natural Lowland Rainforest (M190)

Group

Polynesian Semi-natural Lowland Rainforest (G390)

Association

Terminalia catappa Semi-natural Woodland [Park Special]

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This semi-natural woodland occurs on lowslope positions at elevations of approximately 50 m. Slopes are gentle to moderate and are southwest- and east-facing on plateaus and recent lava flows. Indications of past grazing by cattle are present.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by open to dense canopies dominated by *Terminalia catappa* which ranges from approximately 40-80% cover. *Syzygium cumini* is present in both sampled stands and nearly codominant in one. Other non-native trees may be present, such as *Morinda citrifolia*, *Psidium guajava*, and *Cocos nucifera*. In one stand the understory is nearly barren, whereas the other is heavily invaded by the non-native grass *Oplismenus hirtellus* and the non-native fern *Phymatosorus grossus*.

MOST ABUNDANT SPECIES

Haleakalā National Park

Stratum

Tree canopy

Lifeform

Broad-leaved evergreen tree

Species

Syzygium cumini, *Terminalia catappa*

CHARACTERISTIC SPECIES

Haleakalā National Park: *Syzygium cumini*, *Terminalia catappa*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (2-Dec-2011).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from 'O'heo.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā, Kalaupapa)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0007, HALE.0038.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

***Thevetia peruviana* Semi-natural Woodland [Park Special]**

Lucky-nut Semi-natural Woodland

Identifier: CEPS009652

USNVC CLASSIFICATION

Division	Polynesian Lowland Rainforest (1.A.2.Oa)
Macrogroup	Polynesian Semi-natural Lowland Rainforest (M190)
Group	Polynesian Semi-natural Lowland Rainforest (G390)
Association	<i>Thevetia peruviana</i> Semi-natural Woodland [Park Special]

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: The only known occurrence of this vegetation is on a low colluvial slope at 428 m elevation. The slope is very steep and west-facing on a'a lava.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This plot has a canopy dominated by the non-native tree *Thevetia peruviana* (78% cover) with *Erythrina sandwicensis* present at much lower cover (12% cover). Total canopy cover is 90%. Scattered *Lantana camara* shrubs are present. The open herbaceous layer is composed of the non-native species *Ocimum gratissimum* and *Digitaria insularis*.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Thevetia peruviana</i>
Herb (field)	Forb	<i>Ocimum gratissimum</i>
Herb (field)	Graminoid	<i>Digitaria insularis</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Thevetia peruviana*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Digitaria insularis* (invasive/exotic), *Lantana camara* (invasive/exotic, Medium), *Ocimum gratissimum* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (2-Dec-2011).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from one location in Nu'u.

Nations: US

States/Provinces: HI **Federal Lands:** NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 1 plot: HALE.9022.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

1.A.3. Tropical Montane Humid Forest

1.A.3.Oa. Polynesian Montane & Cloud Forest

M194. Hawaiian Montane & Cloud Forest

G393. Hawaiian Montane Rainforest & Cloud Forest

Acacia koa - *Metrosideros polymorpha* Wet Montane Woodland

Koa - 'Ōhi'a Wet Montane Woodland

Identifier: CEG008187

USNVC CLASSIFICATION

Division	Polynesian Montane & Cloud Forest (1.A.3.Oa)
Macrogroup	Hawaiian Montane & Cloud Forest (M194)
Group	Hawaiian Montane Rainforest & Cloud Forest (G393)
Association	<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Wet Montane Woodland

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This wet woodland association occurs in the Kīpahulu Valley and on Razorback Ridge from 960-1250 m elevation. Positions are midslope with northeast to south to west aspects. Slopes are gentle to moderately steep (8-24 degrees). Substrates are moist to saturated with substantial litter and moss development. Some sites have evidence of pig disturbance.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by an open to moderately closed tree canopy codominated by *Metrosideros polymorpha* and *Acacia koa* with the understory composed of a wet shrub layer, a mixed herbaceous layer composed of diverse ferns and high cover of moss. In the tree canopy, *Melicope clusiifolia* and *Cheirodendron trigynum* trees are frequently present. Non-native trees such as *Psidium cattleianum* may be present to codominant in disturbed stands. The understory is characterized by a diverse mix of wet shrub and herbaceous species. Characteristic woody species include *Alyxia oliviformis*, *Astelia menziesiana*, *Broussaisia arguta*, *Clermontia arborescens ssp. waihae*, *Freycinetia arborea*, *Hedyotis terminalis*, and *Smilax melastomifolia*. The herbaceous layer is variable, but is typically diverse with low to moderate cover of ferns, forbs and grasses. Ferns such as *Cibotium glaucum*, *Cibotium menziesii*, *Dicranopteris linearis*, *Diplazium sandwichianum*, or *Sadleria pallida* frequently codominate or dominate, but many other ferns are present, including *Adenophorus pinnatifidus* var. *pinnatifidus*, *Adenophorus tamariscinus* var. *tamariscinus*, *Asplenium contiguum*, *Asplenium insiticium*, *Asplenium normale*, *Athyrium microphyllum*, *Dryopteris rubiginosa*, *Dryopteris wallichiana*, *Elaphoglossum paleaceum*, *Elaphoglossum wawrae*, *Lycopodium* spp., *Hymenophyllum recurvum*, *Polypodium pellucidum*, *Pteris excelsa*, and *Vandenboschia davallioides*. *Diplazium sandwichianum* has high cover in at least one plot. *Dicranopteris linearis* may codominate the herbaceous layer with up to 30% cover, but is not strongly dominant (40-90% cover), forming a dense mat without a shrub layer. Native forbs *Astelia menziesiana*, *Peperomia cookiana*, *Peperomia hirtipetiolata*, *Peperomia mauiensis*, or *Stenogyne kamehamehae* may be present with low cover. Non-native shrub *Clidemia hirta* has invaded some stands along with some non-native herbaceous species. Other common non-native herbs include *Hedychium gardnerianum* and *Paspalum conjugatum*. There is moderate to often high cover of moss and epiphytic plants. Average species diversity is 33 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Acacia koa</i> , <i>Cheirodendron trigynum</i> , <i>Metrosideros polymorpha</i>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Broussaisia arguta</i> , <i>Hedyotis terminalis</i>
Herb (field)	Fern or fern ally	<i>Cibotium glaucum</i> , <i>Cibotium menziesii</i> , <i>Dicranopteris linearis</i> , <i>Diplazium sandwichianum</i> , <i>Sadleria pallida</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Acacia koa*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Clidemia hirta* (invasive/exotic), *Cyathea cooperi* (invasive/exotic), *Hedychium gardnerianum* (invasive/exotic, Medium), *Psidium cattleianum* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association occurs in Kīpahulu Valley near Dogleg, Ginger, ‘Ohe, and Palikea camps. Also along Razorback Ridge east of trail and 400 m from Ka‘āpahu Camp.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 11 plots: HALE.0122, HALE.0123, HALE.0124, HALE.0126, HALE.0127, HALE.0128, HALE.0166, HALE.0167, HALE.0171, HALE.0172, HALE.0174.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

***Metrosideros polymorpha* - *Cheirodendron trigynum* / (*Cibotium* spp.) Montane Wet Forest**

‘Ōhi‘a - ‘Ōlapa / (Hapu‘u species) Montane Wet Forest

Identifier: CEGLO08008

USNVC CLASSIFICATION

Division	Polynesian Montane & Cloud Forest (1.A.3.Oa)
Macrogroup	Hawaiian Montane & Cloud Forest (M194)
Group	Hawaiian Montane Rainforest & Cloud Forest (G393)
Association	<i>Metrosideros polymorpha</i> - <i>Cheirodendron trigynum</i> / (<i>Cibotium</i> spp.) Montane
Wet	Forest

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This montane rainforest association was sampled at elevations ranging from 920-1800 m, mostly on southeastern aspects with north and south aspects less common. Sites are gentle to steep sideslopes with mid and high slope positions. Substrates are moist to saturated. Ground cover has moderate to high cover of litter and moss.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This montane wet forest association is characterized by moderate to dense tree cover codominated by *Metrosideros polymorpha* and *Cheirodendron trigynum* ssp. *trigynum* with 65-75% combined cover in tree canopy and subcanopy with both species having a least 10% cover. *Acacia koa* trees may be present with less cover than 1/3 cover of *Metrosideros polymorpha*. Tree canopy may be diverse with low cover of *Ilex anomala*, *Melicope clusiifolia*, *Myrsine lessertiana*, or *Perrottetia sandwicensis*. *Cibotium* spp. (tree fern) cover is typically low (<10%) or absent in sampled plots. An open to moderately dense shrub layer is typically present. Most frequent shrubs are *Broussaisia arguta*, *Vaccinium calycinum*, *Coprosma foliosa*, *Clermontia arborescens* ssp. *waihia*, *Kadua affinis*, *Rubus hawaiiensis*, *Leptecophylla tameiameia*, *Pipturus albidus*, and *Platydesma spathulata*. *Broussaisia arguta*, *Coprosma foliosa*, and *Leptecophylla tameiameia* are abundant (>10% cover) in at least one plot. The non-native shrub *Clidemia hirta* is abundant on one plot. Herbaceous layer is moderate to dense. Understory is often dominated by native ferns (*Diplazium sandwichianum*, *Dryopteris wallichiana*, *Sadleria cyatheoides*) and mosses. Epiphytes are abundant and diverse. Average species diversity is 30 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Metrosideros polymorpha</i>
Tree subcanopy	Broad-leaved evergreen tree	<i>Cheirodendron trigynum</i> ssp. <i>trigynum</i>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Broussaisia arguta</i> , <i>Coprosma foliosa</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Broussaisia arguta*, *Cheirodendron trigynum* ssp. *trigynum*, *Coprosma foliosa*, *Diplazium sandwichianum*, *Metrosideros polymorpha*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: **Invasive/Exotic:** *Clidemia hirta* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (1-Dec-1997).

CLASSIFICATION

Status: Standard

Classification Confidence: 2 - Moderate

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association was sampled in Kīpahulu Valley, Manawainui and near Smith Camp.

Nations: US

States/Provinces: HI:S3

Federal Lands: NPS (Haleakalā, Hawai‘i Volcanoes, Kalaupapa)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 7 plots: HALE.0160, HALE.0161, HALE.0175, HALE.0176, HALE.0177, HALE.0180, HALE.0181.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Gon 2008, Western Ecology Working Group n.d.

Metrosideros polymorpha / *Carex alligata* - (*Machaerina angustifolia*) Wet Woodland

‘Ōhi‘a / *Carex alligata* - (‘Uki) Wet Woodland

Identifier: CEG008201

USNVC CLASSIFICATION

Division	Polynesian Montane & Cloud Forest (1.A.3.Oa)
Macrogroup	Hawaiian Montane & Cloud Forest (M194)
Group	Hawaiian Montane Rainforest & Cloud Forest (G393)
Association	<i>Metrosideros polymorpha</i> / <i>Carex alligata</i> - (<i>Machaerina angustifolia</i>) Wet
Woodland	

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This montane forested wetland association was sampled at Kīpahulu Valley at elevations ranging from 1230-1270 m on southeastern and southern aspects. Sites are gentle (6-12 degrees) sideslopes and ridges on midslope topographic positions. Substrates are saturated with standing water on some sites. Ground cover has moderate to high cover of litter and moss.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This montane wet woodland association is characterized by an open to moderate tree canopy dominated by *Metrosideros polymorpha* with 10-60% cover. Tree canopy is typically 2-5 m tall, but may be shorter on poorly drained, boggy sites (<2 m tall). *Cheirodendron trigynum* ssp. *trigynum* is frequently present in the tree subcanopy with low cover. Other subcanopy trees may include presence of *Melicope clusiifolia*, *Syzygium sandwicense*, or *Polyscias oahuensis*. The understory is characterized by a diverse, moderately dense to dense herbaceous layer dominated or codominated by *Carex alligata* and/or *Machaerina angustifolia*. Disturbed stands may be codominated by non-native species *Paspalum urvillei*, *Tibouchina herbacea*, or *Ageratina*

adenophora. Frequent, high-fidelity native herbaceous species include *Isachne distichophylla*, *Korthalsella complanata*, *Lycopodiella cernua*, and *Peperomia* spp. There may be scattered shrubs present, such as *Broussaisia arguta*, *Dubautia plantaginea* ssp. *plantaginea*, *Hedyotis terminalis*, *Lobelia hillebrandii*, *Trematolobelia macrostachys*, or *Vaccinium calycinum*, but generally not enough to form a layer. Average species diversity is 32 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Metrosideros polymorpha</i>
Herb (field)	Forb	<i>Machaerina angustifolia</i> , <i>Tibouchina herbacea</i>
Herb (field)	Graminoid	<i>Carex alligata</i> , <i>Paspalum urvillei</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Carex alligata*, *Machaerina angustifolia*, *Metrosideros polymorpha*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Ageratina adenophora* (invasive/exotic), *Paspalum urvillei* (invasive/exotic), *Tibouchina herbacea* (invasive/exotic, Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This montane forested wetland association was sampled in Kīpahulu Valley near Kaumakani.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 3 plots: HALE.0136, HALE.0137, HALE.0138.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

Metrosideros polymorpha / *Dicranopteris linearis* Montane Wet Woodland

‘Ōhi‘a / Uluhe Montane Wet Woodland

Identifier: CEGLO08041

USNVC CLASSIFICATION

Division	Polynesian Montane & Cloud Forest (1.A.3.Oa)
Macrogroup	Hawaiian Montane & Cloud Forest (M194)
Group	Hawaiian Montane Rainforest & Cloud Forest (G393)
Association	<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Montane Wet Woodland

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This montane woodland association occurs on exposed, windy, very wet sites ranging from 1030-1370 m elevation on gently sloping sideslopes with midslope topographic positions. Substrates are wet to saturated with an unvegetated surface composed mostly of litter and duff.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by a relatively short (2-10 m tall), moderate to dense tree canopy ranging from 60-80% cover that is dominated by *Metrosideros polymorpha*. Scattered *Cheirodendron trigynum* ssp. *trigynum*, *Cibotium glaucum*, or *Cibotium menziesii* may be present in the subcanopy with low (<10%) cover. If present, *Acacia koa* trees have low cover and are not codominant. Shrubs may be present, but typically do not form a layer (<10% total cover). Shrub species may include *Astelia menziesiana*,

Broussaisia arguta, *Clermontia arborescens* ssp. *waihia*, *Hedyotis terminalis*, *Leptecophylla tameiameia*, or *Vaccinium calycinum*. The understory is characterized by a moderate to dense herbaceous layer (60-90% cover) dominated by the native mat-forming fern *Dicranopteris linearis*, often with very high cover. Native *Lycopodiella cernua* may be present on wetter sites. Other native ferns present with low cover include *Adenophorus tamariscinus* var. *tamariscinus*, *Asplenium normale*, *Elaphoglossum paleaceum*, *Hymenophyllum*, or *Sphenomeris chinensis*. Native forbs generally have low cover. *Carex alligata* may be present on wetter sites. The herbaceous layer in disturbed stands is often invaded by non-native species such as *Ageratina adenophora*, *Carex longii*, *Hedychium gardnerianum*, *Paspalum urvillei*, or *Tibouchina herbacea*. Average species richness is 25 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Metrosideros polymorpha</i>
Herb (field)	Fern or fern ally	<i>Dicranopteris linearis</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Dicranopteris linearis*, *Metrosideros polymorpha*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Ageratina adenophora* (invasive/exotic), *Carex longii* (invasive/exotic), *Tibouchina herbacea* (invasive/exotic, Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (1-Dec-1997).

CLASSIFICATION

Status: Standard

Classification Confidence: 1 - Strong

Global Related Concepts:

‘Ōhi‘a (*Metrosideros*) Montane Wet Forest (Gagne and Cuddihy 1990) =

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association was sampled in Kīpahulu Valley near Kaumakani and Upper Kīpahulu Valley near Rat 2 Station.

Nations: US

States/Provinces: HI:S3

Federal Lands: NPS (Haleakalā, Hawai‘i Volcanoes, Kalaupapa)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0139, HALE.0165.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Gagne and Cuddihy 1990, Gon 2008, Western Ecology Working Group n.d.

Metrosideros polymorpha / *Rubus hawaiiensis* Montane Wet Forest

‘Ōhi‘a / Akala Montane Wet Forest

Identifier: CEG008203

USNVC CLASSIFICATION

Division	Polynesian Montane & Cloud Forest (1.A.3.Oa)
Macrogroup	Hawaiian Montane & Cloud Forest (M194)
Group	Hawaiian Montane Rainforest & Cloud Forest (G393)
Association	<i>Metrosideros polymorpha</i> / <i>Rubus hawaiiensis</i> Montane Wet Forest

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This wet, upper montane forest association was sampled in Upper Kīpahulu Valley ranging from 1850-2080 m elevation on moderate to steep (11-22 degrees) sideslopes with southeast to southwest aspects. Substrates are moist to wet with high cover of leaf litter on the soil surface.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This forest association is characterized by a moderate to dense tree canopy dominated by *Metrosideros polymorpha* ranging from 40-90% cover. *Cheirodendron trigynum* ssp. *trigynum* is frequently present in the tree subcanopy with relatively low cover (not codominant). The understory is characterized by a moderately dense (30-50% cover) shrub layer typically dominated by *Rubus hawaiiensis* with *Vaccinium calycinum*, which may be present to codominant. Other common shrubs with low cover include *Coprosma foliosa* or *Leptecophylla tameiameia*. The herbaceous layer is moderate to dense (40-90% cover) with *Astelia menziesiana*, *Carex alligata*, and *Uncinia uncinata* with high constancy and *Peperomia globulanthera* with high cover in one plot. Much of the abundant herbaceous layer is composed of diverse ferns such as *Athyrium microphyllum*, *Dryopteris wallichiana*, *Diplazium sandwichianum*, or *Sadleria cyatheoides*. Mosses are also abundant. Average species richness is 20 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Metrosideros polymorpha</i>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Rubus hawaiiensis</i> , <i>Vaccinium calycinum</i>
Herb (field)	Forb	<i>Peperomia globulanthera</i>
Herb (field)	Fern or fern ally	<i>Diplazium sandwichianum</i> , <i>Dryopteris wallichiana</i> , <i>Sadleria cyatheoides</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Metrosideros polymorpha*, *Rubus hawaiiensis*, *Vaccinium calycinum*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This upper montane forest association was sampled in Upper Kīpahulu Valley, West side and Wainene.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 3 plots: HALE.0145, HALE.0146, HALE.0150.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

***Metrosideros polymorpha* / *Vaccinium calycinum* - (*Broussaisia arguta*, *Coprosma foliosa*) / *Athyrium microphyllum* Montane Wet Forest**

‘Ōhi‘a / ‘Ōhelo - (Kanawao, Pilo) / ‘Ākōlea Montane Wet Forest

Identifier: CEG008200

USNVC CLASSIFICATION

Division	Polynesian Montane & Cloud Forest (1.A.3.Oa)
Macrogroup	Hawaiian Montane & Cloud Forest (M194)
Group	Hawaiian Montane Rainforest & Cloud Forest (G393)
Association	<i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - (<i>Broussaisia arguta</i> , <i>Coprosma foliosa</i>) / <i>Athyrium microphyllum</i> Montane Wet Forest

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This montane rainforest association was sampled in Kīpahulu Valley at elevations ranging from 1370-1960 m, mostly on southeastern aspects with north and south aspects less common. Sites are gentle to steep (5-27 degrees) sideslopes with mid and high slope and plateau topographic positions.

Substrates are moist to saturated with standing water on some sites. Ground cover has moderate to high cover of litter and moss.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This montane wet forest association is characterized by a moderate to dense tree canopy dominated by *Metrosideros polymorpha* with 65-75% cover. Tree canopy is typically tall (5-20 m tall), but may be shorter on poorly drained, boggy sites (<5 m tall). *Cheirodendron trigynum ssp. trigynum* is frequently present in the tree subcanopy with relatively low cover (not codominant). Other subcanopy trees may include presence of *Ilex anomala*, *Melicope clusiifolia*, *Myrsine lessertiana*, *Syzygium sandwicense*, or *Polyscias oahuensis*. The understory is characterized by a diverse shrub layer codominated by *Vaccinium calycinum* often with *Broussaisia arguta* and/or *Coprosma foliosa* present to codominant. Other frequent shrubs include *Kadua affinis* and *Leptecophylla tameiameia* with other less frequent wet forest understory species such as *Astelia menziesiana*, *Clermontia arborescens*, and *Nertera granadensis*. *Sadleria pallida* cover is moderately high on several sites, and *Cibotium* spp. are occasionally present. The typically diverse herbaceous layer varies from open to dense with *Athyrium microphyllum*, *Carex alligata*, *Dryopteris wallichiana*, *Elaphoglossum wawrae*, and *Uncinia uncinata* frequently present with low cover. *Dicranopteris linearis* or *Diplazium sandwichianum* are also common but are not strongly dominant. Epiphytes are abundant and diverse and moss typically has high cover (60-80% cover). Average species diversity is 28 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Metrosideros polymorpha</i>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Broussaisia arguta</i> , <i>Coprosma foliosa</i> , <i>Vaccinium calycinum</i>
Herb (field)	Graminoid	<i>Uncinia uncinata</i>
Herb (field)	Fern or fern ally	<i>Athyrium microphyllum</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Athyrium microphyllum*, *Broussaisia arguta*, *Cheirodendron trigynum ssp. trigynum*, *Coprosma foliosa*, *Metrosideros polymorpha*, *Uncinia uncinata*, *Vaccinium calycinum*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

Haleakalā National Park Comments: Plot HALE.0159 is a dwarfed woodland that is a borderline wooded bog with wetland indicator species in the understory and 80% cover of moss, but best classified in this association.

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association was sampled in Kīpahulu Valley near Central Pali trail/Charlie, Smith Camp and Upper Kīpahulu Valley.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 6 plots: HALE.0149, HALE.0159, HALE.0162, HALE.0163, HALE.0164, HALE.9030.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

G625. Hawaiian Montane-Subalpine Mesic Forest

Acacia koa / *Coprosma foliosa* - *Dodonaea viscosa* Montane Mesic Woodland

Koa / Pilo - A'ali'i Montane Mesic Woodland

Identifier: CEGL008188

USNVC CLASSIFICATION

Division	Polynesian Montane & Cloud Forest (1.A.3.Oa)
Macrogroup	Hawaiian Montane & Cloud Forest (M194)
Group	Hawaiian Montane-Subalpine Mesic Forest (G625)
Association	<i>Acacia koa</i> / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Woodland

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This woodland association occurs on mesic montane sites in East Kaupō ranging from 1290-1310 m elevation. Sites are gentle to moderate (17-23 degrees) sideslopes with southwesterly aspects on midslope topographic positions. Substrates are moist with an unvegetated surface composed of moderate to high cover of litter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by a moderate tree canopy dominated by *Acacia koa* with a dense, tall-shrub canopy typically codominated by *Coprosma foliosa* and *Dodonaea viscosa*. *Coprosma foliosa* is always present although sometimes only with low cover. Additional trees present with low cover include *Myrsine lessertiana* and *Sophora chrysophylla*. Other native species may be present, such as *Pipturus albidus* and *Alyxia oliviformis*. *Leptecophylla tameiameia* is absent or has low cover. The herbaceous layer is generally sparse because of dense shading from shrub and tree layers. However, when there are gaps in the woody canopy, non-native grasses such as *Cenchrus clandestinus* or *Melinis minutiflora* may become abundant. Average species richness is 11 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Acacia koa</i>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Coprosma foliosa</i> , <i>Dodonaea viscosa</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Acacia koa*, *Coprosma foliosa*, *Dodonaea viscosa*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Melinis minutiflora* (invasive/exotic), *Cenchrus clandestinus* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association was sampled in East Kaupō near Kaupō trail and north-northeast of Cat trail.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0091, HALE.0092.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

***Acacia koa* / *Leptecophylla tameiameiae* - (*Dodonaea viscosa*) Montane Woodland¹**

Koa / Pūkiawe - (A‘ali‘i) Montane Woodland

Identifier: CEG008155

USNVC CLASSIFICATION

Division	Polynesian Montane & Cloud Forest (1.A.3.Oa)
Macrogroup	Hawaiian Montane & Cloud Forest (M194)
Group	Hawaiian Montane-Subalpine Mesic Forest (G625)
Association	<i>Acacia koa</i> / <i>Leptecophylla tameiameiae</i> - (<i>Dodonaea viscosa</i>) Montane
Woodland ¹	

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This woodland association occurs on mesic, montane sites ranging from 1230-1260 m elevation on gentle sideslopes with east and southeast aspects on midslope topographic positions. Substrates are moist with ground cover composed mostly a`a lava or litter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by an open tree canopy dominated by *Acacia koa* with an open to moderately dense tall-shrub canopy codominated by *Leptecophylla tameiameiae* and *Dodonaea viscosa*. If present, *Metrosideros polymorpha* trees have low cover (<1/3 cover of *Acacia koa*). The short shrubs *Osteomeles anthyllidifolia* and *Vaccinium reticulatum* are frequently present with relatively low cover. *Coprosma foliosa* is typically absent. The herbaceous layer has moderate to dense cover and is dominated by non-native grasses *Cenchrus clandestinus* and *Melinis minutiflora*. Other than the ferns *Pteridium aquilinum* ssp. *decompositum* and *Sadleria cyatheoides*, native herbaceous species are uncommon. Other non-native herbaceous species with low cover include *Ageratina adenophora*, *Ageratina riparia*, *Holcus lanatus*, *Hypochaeris radicata*, *Lythrum maritimum*, *Melinis repens*, and *Oenothera stricta*. Average species richness is 15 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Acacia koa</i>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Dodonaea viscosa</i> , <i>Leptecophylla tameiameiae</i>
Herb (field)	Graminoid	<i>Melinis minutiflora</i> , <i>Cenchrus clandestinus</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Acacia koa*, *Coprosma foliosa*, *Dodonaea viscosa*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: **Invasive/Exotic:** *Ageratina adenophora* (invasive/exotic), *Melinis minutiflora* (invasive/exotic), *Cenchrus clandestinus* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (5-Dec-2011).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association was sampled in East Kaupō near Kaupō trail and Kaupō northeast of Cat trail.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā, Hawai‘i Volcanoes)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0083, HALE.0094.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

***Metrosideros polymorpha* / *Dryopteris wallichiana* Subalpine Mesic Forest**

‘Ōhi‘a / ‘I‘o nui Subalpine Mesic Forest

Identifier: CEG008202

USNVC CLASSIFICATION

Division	Polynesian Montane & Cloud Forest (1.A.3.Oa)
Macrogroup	Hawaiian Montane & Cloud Forest (M194)
Group	Hawaiian Montane-Subalpine Mesic Forest (G625)
Association	<i>Metrosideros polymorpha</i> / <i>Dryopteris wallichiana</i> Subalpine Mesic Forest

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This mesic subalpine forest association occurs in Upper Kīpahulu Valley and Manawainui ranging from 2000-2110 m elevation on moderate to steep (15-30 degrees) sideslopes with east to south aspects. Substrates are moist with high cover of leaf litter on the soil surface.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This mesic forest association is characterized by a moderate to dense tree canopy dominated by *Metrosideros polymorpha* ranging from 40-90% cover. *Cheirodendron trigynum* ssp. *trigynum* is frequently present in the tree subcanopy with relatively low cover (not codominant). The understory is characterized by a moderately dense (30-50% cover) herbaceous layer typically strongly dominated by the fern *Dryopteris wallichiana*, but including stands with an understory dominated or codominated by *Lycopodium venustulum* with *Dryopteris wallichiana* codominating. Shrubs are generally sparse, but range from absent to 10% cover, forming an open, mixed layer. Common species include *Astelia menziesiana*, *Coprosma foliosa*, *Ilex anomala*, *Leptecophylla tameiameia*, *Rubus hawaiiensis*, or *Vaccinium calycinum*. Average species richness is 13 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Metrosideros polymorpha</i>
Herb (field)	Fern or fern ally	<i>Dryopteris wallichiana</i> , <i>Lycopodium venustulum</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Dryopteris wallichiana*, *Lycopodium venustulum*, *Metrosideros polymorpha*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This subalpine forest association was sampled in Upper Kīpahulu Valley, West side and Manawainui.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 4 plots: HALE.0147, HALE.0148, HALE.9024, HALE.9043.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

Myrsine lessertiana* - (*Metrosideros polymorpha*) / *Coprosma foliosa* - *Dodonaea viscosa

Montane Mesic Forest

Kōlea Lau Nui - (‘Ōhi‘a) / Pilo - A‘ali‘i Montane Mesic Forest

Identifier: CEGLO08204

USNVC CLASSIFICATION

Division	Polynesian Montane & Cloud Forest (1.A.3.Oa)
Macrogroup	Hawaiian Montane & Cloud Forest (M194)
Group	Hawaiian Montane-Subalpine Mesic Forest (G625)
Association	<i>Myrsine lessertiana</i> - (<i>Metrosideros polymorpha</i>) / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i>
	Montane Mesic Forest

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This forest association occurs on mesic montane sites in East Kaupō ranging from 1290-1310 m elevation. Sites are gentle to moderate (15-26 degrees) sideslopes with south to southwest aspects on midslope topographic positions. Substrates are moist with the ground surface composed of high to moderate cover of litter and low to moderate cover of a`a lava colluvium.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by a moderately dense tree canopy dominated by *Myrsine lessertiana* with a moderately dense tall-shrub canopy codominated by *Coprosma foliosa* and *Dodonaea viscosa*. *Metrosideros polymorpha* may be present to codominant. Occasional *Acacia koa* trees may also be present. Other native species may be present, such as shrub *Lysimachia remyi* and vine *Alyxia oliviformis*. *Leptecophylla tameiameia* is absent or has low cover (<5%). The herbaceous layer is generally sparse because of dense shading from shrub and tree layers, although it may be diverse. Common native herbaceous species include ferns *Dryopteris sandwicensis*, *Dryopteris wallichiana*, *Lepisorus thunbergianus*, and *Pteris cretica*; graminoids *Carex alligata* or *Deschampsia nubigena*; and tree seedlings. Non-native forb *Lapsana communis* is frequently present and non-native grass *Cenchrus clandestinus* has significant cover (5%) on one plot. Average species richness is 18 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Metrosideros polymorpha</i> , <i>Myrsine lessertiana</i>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Coprosma foliosa</i> , <i>Dodonaea viscosa</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Coprosma foliosa*, *Dodonaea viscosa*, *Metrosideros polymorpha*, *Myrsine lessertiana*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: **Invasive/Exotic:** *Lapsana communis* (invasive/exotic), *Cenchrus clandestinus* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association was sampled in East Kaupō near Kaupō trail.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0090, HALE.0095.

Local Description Authors: K.A. Schulz

Global Description Authors: **References:** Western Ecology Working Group n.d.

1.A.4. Tropical Flooded & Swamp Forest

1.A.4.Ob. Polynesian Flooded & Swamp Forest

M201. Hawaiian Flooded & Swamp Forest

G398. Hawaiian Riparian & Floodplain Forest & Shrubland

Hibiscus tiliaceus Lowland Wet Forest [Provisional]

Hau Lowland Wet Forest

Identifier: CEG008163

USNVC CLASSIFICATION

Division	Polynesian Flooded & Swamp Forest (1.A.4.Ob)
Macrogroup	Hawaiian Flooded & Swamp Forest (M201)
Group	Hawaiian Riparian & Floodplain Forest & Shrubland (G398)
Association	<i>Hibiscus tiliaceus</i> Lowland Wet Forest [Provisional]

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This wet lowland forest association is known from a single site on a moderately steep sideslope with a midslope topographic position. Elevation of the stand is approximately 315 m. Ground cover has moderate to high cover of litter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This lowland association is characterized by a dense tree canopy dominated by *Hibiscus tiliaceus*, possibly an early Polynesian introduction. Typically there is no or minimal understory layers because the high cover of *Hibiscus tiliaceus* shades out other species. Scattered non-native shrubs *Clidemia hirta* and *Rubus rosifolius* and the fern *Cyclosorus dentatus* may be present. Average species richness per plot is 4.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved evergreen tree	<i>Hibiscus tiliaceus</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Hibiscus tiliaceus*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Clidemia hirta* (invasive/exotic), *Rubus rosifolius* (invasive/exotic), *Thelypteris dentata* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (5-Dec-2011).

CLASSIFICATION

Status: Provisional

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from Kaumakani in 'O'heo.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā, Kalaupapa)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 1 plot: HALE.9011.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Stone and Pratt 2002, Western Ecology Working Group n.d.

2. Shrubland & Grassland

2.A.1. Tropical Lowland Grassland, Savanna & Shrubland

2.A.1.OI. Polynesian Lowland Shrubland, Grassland & Savanna

M220. Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna

G413. Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna

Ageratina adenophora - *Paspalum conjugatum* Semi-natural Herbaceous Bog [Park Special]

Maui Pamakani – Hilo Grass Semi-natural Herbaceous Bog

Identifier: CEPS009702

USNVC CLASSIFICATION

Division	Polynesian Lowland Shrubland, Grassland & Savanna (2.A.1.OI)
Macrogroup	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (M220)
Group	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (G413)
Association	<i>Ageratina adenophora</i> - <i>Paspalum conjugatum</i> Semi-natural Herbaceous Bog
[Park Special]	

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This semi-natural herbaceous association is known from one location in a bog at 860 m in elevation with an area approximately 150 m in diameter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This plot sample contains 50% cover by *Paspalum conjugatum* and 20% cover of *Ageratina adenophora*. A few scattered individuals of *Metrosideros polymorpha* and *Acacia koa* are present. Other graminoids present include *Sacciolepis indica*, *Cyperus haspan*, *Carex alligata*, and *Carex longii*.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Forb	<i>Ageratina adenophora</i>
Herb (field)	Graminoid	<i>Paspalum conjugatum</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Ageratina adenophora*, *Paspalum conjugatum*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Carex longii* (invasive/exotic), *Cyperus haspan* (invasive/exotic), *Sacciolepis indica* (invasive/exotic), *Tibouchina herbacea* (invasive/exotic, Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (4-Apr-2013).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from Patti's Bog.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 1 plot: HALE.9040.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

***Bothriochloa pertusa* Semi-natural Grassland**

Pitted Beardgrass Semi-natural Grassland

Identifier: CEGLO08189

USNVC CLASSIFICATION

Division	Polynesian Lowland Shrubland, Grassland & Savanna (2.A.1.O1)
Macrogroup	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (M220)
Group	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (G413)
Association	<i>Bothriochloa pertusa</i> Semi-natural Grassland

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This semi-natural grassland occurs on moderately dry low and midslopes at elevations ranging from approximately 250-800 m. Slopes are gentle to very steep and on southeast and southwest aspects. All sampled stands were noted to occur in heavily disturbed areas grazed by goats.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This non-native grassland is dominated by *Bothriochloa pertusa* with cover ranging from open to very dense. The non-native forb *Spermacoce assurgens* is present in all sampled stands with up to 20% cover. *Cenchrus ciliaris* may also be codominant at lower elevations. The shrub *Lantana camara* is typically present, but does not exceed 5% cover.

MOST ABUNDANT SPECIES

Haleakalā National Park

Stratum

Herb (field)

Lifeform

Graminoid

Species

Bothriochloa pertusa

CHARACTERISTIC SPECIES

Haleakalā National Park: *Bothriochloa pertusa*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Lantana camara* (invasive/exotic, Medium), *Cenchrus ciliaris* (invasive/exotic, High), *Spermacoce assurgens* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is only known from Nu'u.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 4 plots: HALE.0109, HALE.0113, HALE.0135, HALE.0169.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

***Lantana camara* Semi-natural Shrubland [Provisional]**

Lantana camara Semi-natural Shrubland

Identifier: CEGLO08145

USNVC CLASSIFICATION

Division	Polynesian Lowland Shrubland, Grassland & Savanna (2.A.1.OI)
Macrogroup	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (M220)
Group	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (G413)
Association	<i>Lantana camara</i> Semi-natural Shrubland [Provisional]

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This semi-natural shrubland is known from low, gentle slopes on northeastern aspects at elevations ranging from approximately 250-550 m. All sampled areas are noted to have been heavily grazed by goats.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by an open short-shrub layer dominated by *Lantana camara*. *Leucaena leucocephala* is typically absent or has low cover (<10 % cover). A variety of other shrubs may occur, such as *Indigofera suffruticosa*, but none codominate. The herbaceous layer is strongly dominated by non-native species, including *Ageratum conyzoides*, *Bothriochloa pertusa*, and *Spermacoce assurgens*.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Lantana camara</i>
Herb (field)	Forb	<i>Ageratum conyzoides</i> , <i>Spermacoce assurgens</i>
Herb (field)	Graminoid	<i>Bothriochloa pertusa</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Lantana camara*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Ageratum conyzoides* (invasive/exotic), *Bothriochloa pertusa* (invasive/exotic), *Indigofera suffruticosa* (invasive/exotic), *Spermacoce assurgens* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (14-Dec-2011).

CLASSIFICATION

Status: Provisional

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is only known from a few locations at Nu'u.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā, Kalaupapa)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 5 plots: HALE.0110, HALE.0111, HALE.0112, HALE.0143, HALE.0168.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

***Leucaena leucocephala* Lowland Dry Semi-natural Shrubland**

Koa Haole Lowland Dry Semi-natural Shrubland

Identifier: CEG008114

USNVC CLASSIFICATION

Division	Polynesian Lowland Shrubland, Grassland & Savanna (2.A.1.OI)
Macrogroup	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (M220)
Group	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (G413)
Association	<i>Leucaena leucocephala</i> Lowland Dry Semi-natural Shrubland

ELEMENT CONCEPT

Global Summary: This shrubland community is found in dry to mesic settings, typically below 457 m (1500 feet) elevation and on leeward settings. It is a disclimax shrubland maintained by fire, but strongly dominant due to allelopathic litter. The vegetation is characterized by a moderately dense, closed-canopy tall-shrub layer (2-5 m tall) that is dominated by nearly monotypic *Leucaena leucocephala*. There is often a sparse low-shrub stratum, though no single taxon is dominant; shrubs include *Sida cordifolia*, *Sida fallax*, *Waltheria indica*, and *Indigofera suffruticosa*. The sparse herbaceous stratum is dominated by *Talinum triangulare* with some *Urochloa maxima* and scattered seedlings of canopy trees, *Kalanchoe pinnata*, *Passiflora foetida*, *Catharanthus roseus*, and *Commelina benghalensis*.

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This association is known from lowslope positions at elevations ranging from approximately 170-300 m. Slopes are gentle and southeast-facing. Stands in lower Nu‘u show evidence of disturbance. Nu‘u is a recently acquired area that is unfenced, heavily impacted by its ranching history, and currently browsed by feral goats, deer, and pigs.

Global Environment: This shrubland is found in dry to mesic settings, typically below 457 m elevation and on leeward settings.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by the non-native, small tree/tall shrub *Leucaena leucocephala* that forms an open tall-shrub layer typically with 10% or more cover. The understory is variable and may be herb- or shrub-dominated. In one sample, *Lantana camara* forms a moderately dense short-shrub layer (40% cover) with a dense herbaceous layer of non-native grass *Digitaria insularis* and non-native forb *Spermacoce assurgens*. The other sample is herb-dominated by *Spermacoce assurgens* and *Momordica charantia*.

Global Vegetation: The vegetation is characterized by a moderately dense, closed-canopy tall-shrub layer (2-5 m tall) that is dominated by nearly monotypic *Leucaena leucocephala*. There is often a sparse low-shrub stratum, though no single taxon is dominant; shrubs may include *Sida cordifolia*, *Sida fallax*, *Waltheria indica*, and *Indigofera suffruticosa*. The sparse herbaceous stratum is dominated by *Talinum triangulare* with some *Urochloa maxima* and scattered seedlings of canopy trees, *Kalanchoe pinnata*, *Passiflora foetida*, *Catharanthus roseus*, and *Commelina benghalensis*.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Leucaena leucocephala</i>
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Lantana camara</i>
Herb (field)	Forb	<i>Spermacoce assurgens</i>
Herb (field)	Graminoid	<i>Digitaria insularis</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Leucaena leucocephala*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Ageratum conyzoides* (invasive/exotic), *Bothriochloa pertusa* (invasive/exotic), *Eragrostis cumingii* (invasive/exotic), *Momordica charantia* (invasive/exotic), *Sisymbrium officinale* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (26-May-2006).

CLASSIFICATION

Status: Standard

Global Comments: In Hawaii, *Leucaena leucocephala* shrublands are marked by distinct understory grasses and herbs.

This community is found in several Pacific parks. Many of the lower strata species, while typical at some parks, is infrequent at Hawai'i Volcanoes National Park.

Global Similar Associations:

Leucaena leucocephala Shrubland [Provisional] (CEGL004872)

Global Related Concepts:

Koa Haole (*Leucaena*) Shrubland (Gagne and Cuddihy 1990) >

Koa Haole (*Leucaena*) Shrubland (Wagner et al. 1999) >

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from only from Nu'u.

Global Range: This type is dominated by a new-world tropical species that is invasive throughout Polynesia, and has been documented to occur in Hawaii and Guam. In Hawaii, this association covers large portions of leeward dry to mesic regions. Through introductions, it is now virtually pantropical.

Nations: GU, MP, US

States/Provinces: HI

Federal Lands: NPS (American Memorial, Haleakalā, Hawai'i Volcanoes, Kalaupapa, Pu'uuhonua o Honaunau, War in the Pacific)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0098, HALE.0144.

Local Description Authors: K.A. Schulz

Global Description Authors: S. Gon and L. Durand, mod. M.J. Russo

References: Cogan et al. 2011c, Gagne and Cuddihy 1990, Wagner et al. 1999, Western Ecology Working Group n.d.

Paspalum conjugatum - *Sacciolepis indica* - *Axonopus fissifolius* Mixed Semi-natural Herbaceous Vegetation [Provisional]

Hilograss - Glenwood Grass - Carpetgrass Mixed Semi-natural Herbaceous Vegetation

Identifier: CEGL008170

USNVC CLASSIFICATION

Division	Polynesian Lowland Shrubland, Grassland & Savanna (2.A.1.OI)
Macrogroup	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (M220)
Group	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (G413)
Association	<i>Paspalum conjugatum</i> - <i>Sacciolepis indica</i> - <i>Axonopus fissifolius</i> Mixed
Semi-natural Herbaceous	Vegetation [Provisional]

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This association is known from lowslope topographic positions at approximately 350-450 m in elevation. Slopes are gentle and southeast-facing. Sites were actively grazed by cows during time of sampling.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is only known from two locations. Both sites have a dense herbaceous layer dominated by non-native grasses *Paspalum conjugatum* on one site and *Axonopus fissifolius* at another with total herbaceous cover >90%. Many other non-native herbaceous species are also present. Scattered shrubs and small trees may be present, including *Psidium cattleianum*, *Psidium guajava*, and *Rubus rosifolius*.

MOST ABUNDANT SPECIES

Haleakalā National Park

Stratum

Herb (field)

Lifeform

Graminoid

Species*Axonopus fissifolius*, *Paspalum conjugatum***CHARACTERISTIC SPECIES****Haleakalā National Park:** *Axonopus fissifolius*, *Paspalum conjugatum***CONSERVATION STATUS RANK****Global Rank & Reasons:** GNA (ruderal) (5-Dec-2011).**CLASSIFICATION****Status:** Provisional**ELEMENT DISTRIBUTION****Haleakalā National Park Range:** This association is known only from 'O'heo.**Nations:** US**States/Provinces:** HI**Federal Lands:** NPS (Haleakalā, Kalaupapa)**ELEMENT SOURCES****Haleakalā National Park Plots and Observation Points:** 2 plots: HALE.0039, HALE.0101.**Local Description Authors:** M.E. Hall**Global Description Authors:****References:** Western Ecology Working Group n.d.***Cenchrus ciliaris* Semi-natural Herbaceous Vegetation¹****Buffelgrass Semi-natural Herbaceous Vegetation****Identifier:** CEGL005407**USNVC CLASSIFICATION**

Division

Polynesian Lowland Shrubland, Grassland & Savanna (2.A.1.OI)

Macrogroup

Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (M220)

Group

Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (G413)

Association

Cenchrus ciliaris Semi-natural Herbaceous Vegetation¹**ELEMENT CONCEPT**

Global Summary: This semi-natural herbaceous association is currently sampled from a single national historical park in Hawaii, and this description is based on occurrences there. Additional global information will be added as it becomes available. It is found from sea level to 46 m in elevation and on gentle slopes of any aspect. Sites are dry low slopes or low level areas and nearly all are over recent a'a or pāhoehoe lava. This community has sparse or absent woody strata composed of *Prosopis pallida*. The herbaceous stratum is variable; *Cenchrus ciliaris* is the most abundant herbaceous species. Other common taxa are *Eragrostis tenella* and Asteraceae spp.

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This association is known from lowslope topographic positions at approximately 20-150 m elevation. Slopes are gentle and southeast- and southwest-facing. Both sites were historically grazed.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This semi-natural association is overwhelmingly dominated by the non-native grass *Cenchrus ciliaris*. Other non-native grass associates present may include *Bothriochloa pertusa* and *Urochloa maxima*. The non-native forb *Spermacoce assurgens* is present in both stands as well.

MOST ABUNDANT SPECIES**Haleakalā National Park****Stratum**

Herb (field)

Lifeform

Graminoid

Species*Cenchrus ciliaris***CHARACTERISTIC SPECIES****Haleakalā National Park:** *Cenchrus ciliaris*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Bothriochloa pertusa* (invasive/exotic), *Spermacoce assurgens* (invasive/exotic), *Urochloa maxima* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (2-Apr-2010).

CLASSIFICATION

Status: Standard

Classification Confidence: 3 - Weak

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known only from Nu‘u.

Global Range: This community is currently sampled from one national historical park in Hawaii; additional global distribution will be added as it becomes available.

Nations: US

States/Provinces: HI **Federal Lands:** NPS (Haleakalā, Pu‘ukoholā Heiau)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0054, HALE.0055.

Local Description Authors: M.E. Hall

Global Description Authors: M.J. Russo

References: Cogan et al. 2011b, Western Ecology Working Group n.d.

Cenchrus clandestinus Semi-natural Herbaceous Vegetation¹

Kikuyu Grass Semi-natural Herbaceous Vegetation

Identifier: CEGLO05408

USNVC CLASSIFICATION

Division	Polynesian Lowland Shrubland, Grassland & Savanna (2.A.1.OI)
Macrogroup	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (M220)
Group	Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (G413)
Association	<i>Cenchrus clandestinus</i> Semi-natural Herbaceous Vegetation ¹

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This semi-natural herbaceous association is known from midslope positions at elevations of approximately 1500 m elevation. Slope is gentle and south-facing.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This herbaceous association is characterized by a dense herbaceous layer that is strongly dominated by the non-native grass *Cenchrus clandestinus*, with 80% cover in the single sampled stand. Some stands in this association are transitioning to open woodland and typically have low cover of mixed trees or shrubs that sometimes exceeds 10% total cover, but do not form distinct tree or shrub canopies. The single sampled stand has significant cover (15%) from native trees *Myrsine lessertiana* and *Myoporum sandwicense*, but this tree stand is strongly dominated by grasses. Many of these stands are likely transitioning from grassland to open woodlands; however, the dense herbaceous layer (80% cover) overwhelmingly characterizes the vegetation, so they are classified as grasslands.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Graminoid	<i>Cenchrus clandestinus</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Cenchrus clandestinus*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Cenchrus clandestinus* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (2-Apr-2010).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from East Kaupō .

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā, Hawai'i Volcanoes)

ELEMENT SOURCES

Haleakalā National Park Inventory Notes: Observation point HALE.9016 is a *Cenchrus clandestinus* grassland. Site has been treated with glyphosate and has numerous out-planted *Acacia koa* and *Dodonaea viscosa*, remnant *Myoporum sandwicense* and scattered *Myrsine lessertiana*.

Haleakalā National Park Plots and Observation Points: 1 plot: HALE.9016.

Local Description Authors: K.A. Schulz

Global Description Authors: **References:** Gagne and Cuddihy 1990, Western Ecology Working Group n.d.

Spermacoce assurgens - *Zinnia peruviana* - *Digitaria insularis* Semi-natural Herbaceous Vegetation [Provisional]

Buttonweed - Peruvian Zinnia - Sourgrass Semi-natural Herbaceous Vegetation

Identifier: CEGLO08207

USNVC CLASSIFICATION

Division

Polynesian Lowland Shrubland, Grassland & Savanna (2.A.1.OI)

Macrogroup

Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (M220)

Group

Polynesian Semi-natural Lowland Shrubland, Grassland & Savanna (G413)

Association

Spermacoce assurgens - *Zinnia peruviana* - *Digitaria insularis* Semi-natural

Herbaceous

Vegetation [Provisional]

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This dry-site herbaceous association is known from lowslopes at approximately 60-120 m elevation. Slopes are nearly flat on southeast and northeast aspects derived of pāhoehoe lava. Both sites were noted as being heavily impacted by ungulates.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is dominated by *Spermacoce assurgens* which has 10-15% cover. Other herbaceous associates include *Crotalaria pallida*, *Zinnia peruviana*, and *Digitaria insularis*, which have about half the cover of *Spermacoce assurgens* individually. Scattered shrubs occur at low cover and include *Indigofera suffruticosa* and *Lantana camara*.

MOST ABUNDANT SPECIES

Haleakalā National Park

Stratum

Herb (field)

Herb (field)

Lifeform

Forb

Graminoid

Species

Spermacoce assurgens, *Zinnia peruviana*

Digitaria insularis

CHARACTERISTIC SPECIES

Haleakalā National Park: *Digitaria insularis*, *Spermacoce assurgens*, *Zinnia peruviana*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (4-Apr-2013).

CLASSIFICATION

Status: Provisional

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from Nu'u.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0096, HALE.0097.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

2.A.2. Tropical Montane Grassland & Shrubland

2.A.2.Oh. Polynesian Montane Shrubland, Grassland & Savanna

M224. Hawaiian Montane Shrubland, Grassland & Savanna

G416. Hawaiian Montane-Subalpine Dry Shrubland & Grassland

Leptecophylla tameiameia - *Dodonaea viscosa* Montane Shrubland¹

Pūkiawe - A‘ali‘i Montane Shrubland

Identifier: CEG008172

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Hawaiian Montane Shrubland, Grassland & Savanna (M224)
Group	Hawaiian Montane-Subalpine Dry Shrubland & Grassland (G416)
Association	<i>Leptecophylla tameiameia</i> - <i>Dodonaea viscosa</i> Montane Shrubland ¹

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This association is known from dry to mesic montane and subalpine zones in East, Central and West Kaupō at elevations ranging from 1170-1960 m. Sites are on midslopes with southeast to south aspects and gentle to moderate slopes (6-17 degrees). Substrates are typically recent a‘a lava flows and vary from having abundant exposed bedrock and gravel to being largely covered by litter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by open to moderately dense shrublands codominated by *Leptecophylla tameiameia* and *Dodonaea viscosa*. Total shrub cover ranges from 10-80% cover, and either of the two nominal species may dominate or codominate with each species having 1/3 or more the cover of the other. *Osteomeles anthyllidifolia* is typically present to codominant and is a good indicator of montane shrublands. *Vaccinium reticulatum* is absent or has low cover. Herbaceous cover may be sparse or range up to 40% cover. Few herbaceous species attain high cover; the most frequent include *Deschampsia nubigena* and *Pteridium aquilinum* ssp. *decompositum* with *Carex wahuensis*, *Luzula hawaiiensis* var. *hawaiiensis*, *Morelotia gahniiformis*, and *Pellaea ternifolia* less common. Non-native grasses *Festuca rubra*, *Melinis minutiflora*, *Melinis repens*, and *Sporobolus africanus* have invaded many stands. Average species richness is 17 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Dodonaea viscosa</i> , <i>Leptecophylla tameiameia</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Deschampsia nubigena*, *Dodonaea viscosa*, *Osteomeles anthyllidifolia*, *Leptecophylla tameiameia*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Festuca rubra* (invasive/exotic, Unknown), *Melinis minutiflora* (invasive/exotic), *Melinis repens* (invasive/exotic), *Sporobolus indicus* var. *capensis* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (5-Dec-2011).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from dry montane and subalpine zones in East, Central and West Kaupō including Upper Kaupō Gap below Palikū trail, Kaupō trail, and Waikane near Zankou trail.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā, Hawai‘i Volcanoes)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 8 plots: HALE.0025, HALE.0082, HALE.0085, HALE.0087, HALE.0088, HALE.0153, HALE.0154, HALE.0156.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

Leptecophylla tameiameiae Subalpine Dry Shrubland¹

Pūkiawe Subalpine Dry Shrubland

Identifier: CEG008063

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Hawaiian Montane Shrubland, Grassland & Savanna (M224)
Group	Hawaiian Montane-Subalpine Dry Shrubland & Grassland (G416)
Association	<i>Leptecophylla tameiameiae</i> Subalpine Dry Shrubland ¹

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This widespread shrubland association is found in the dry upper montane and subalpine zones. This association is found in the Front Country and around the Haleakalā Crater at 1915-2850 m in elevation. Slopes are flat to gentle on mid and upper slopes. Substrates are often composed of a'a lava.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This subalpine association is generally characterized by a moderately open *Leptecophylla tameiameiae*-dominated shrub layer (20-30% cover) with a depauperate understory. Shrub cover ranges from 10-70%. Scattered *Sophora chrysophylla* or *Coprosma montana* small trees/tall shrubs may be present, but rarely exceed 5% cover. *Dodonaea viscosa* may be present but not codominant (less than 1/3 the cover of *Leptecophylla tameiameiae*). *Vaccinium reticulatum* has high constancy, but relatively low cover (<10% cover) and does not codominate. Native species *Deschampsia nubigena* has fairly high constancy and ranges from 0-14% cover. Other native herbaceous species include *Carex wahuensis*, *Morelotia gahniiformis*, *Pellaea ternifolia*, and *Pteridium aquilinum* ssp. *decompositum*. When the herbaceous layer exceeds 20% cover, then it is usually invaded by various non-native species, including *Anthoxanthum odoratum*, *Eragrostis brownei*, *Festuca rubra*, *Holcus lanatus*, *Hypochaeris radicata*, or *Sporobolus africanus*. Various subalpine indicator species such as *Agrostis sandwicensis*, *Dianella sandwicensis*, *Dubautia menziesii*, *Geranium cuneatum* var. *cuneatum*, *Hypochaeris glabra*, and *Tetramolopium humile* ssp. *humile* are usually present with low cover. Average species richness is 17 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Leptecophylla tameiameiae</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Agrostis sandwicensis*, *Deschampsia nubigena*, *Dianella sandwicensis*, *Geranium cuneatum* var. *cuneatum*, *Hypochaeris glabra*, *Leptecophylla tameiameiae*, *Tetramolopium humile* ssp. *humile*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Anthoxanthum odoratum* (invasive/exotic), *Clidemia hirta* (invasive/exotic), *Hypochaeris radicata* (invasive/exotic, High/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (1-Dec-1997).

CLASSIFICATION

Status: Standard

Classification Confidence: 2 - Moderate

Global Related Concepts:

Styphelia Mixed Shrubland (Shaw and Castillo 1997)

Pūkiawe/"Ōhelo (*Styphelia/Vaccinium*) Shrubland (Gagne and Cuddihy 1990) =

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This widespread subalpine association is found in the Front Country and around the Haleakalā Crater including the Visitor Center, Halemauū trail, Kalahaku, Kapalaoa, Upper Kaupō Gap and Ō‘ili Pu‘u, as well as Haupa‘akea Ridge, East Kaupō, Ko‘olau Gap, and Hōlua.

Nations: US

States/Provinces: HI:S3

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 22 plots: HALE.0018, HALE.0021, HALE.0022, HALE.0023, HALE.0024, HALE.0027, HALE.0028, HALE.0029, HALE.0043, HALE.0044, HALE.0045, HALE.0047, HALE.0051, HALE.0057, HALE.0061, HALE.0064, HALE.0065, HALE.0068, HALE.0129, HALE.0130, HALE.0131, HALE.9002.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Gagne and Cuddihy 1990, Gon 2008, Shaw and Castillo 1997, Western Ecology Working Group n.d.

G417. Hawaiian Montane-Subalpine Mesic-Wet Shrubland & Grassland

Deschampsia nubigena Montane and Subalpine Mesic Herbaceous Vegetation

Deschampsia nubigena Montane and Subalpine Mesic Herbaceous Vegetation

Identifier: CEGLO08085

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Hawaiian Montane Shrubland, Grassland & Savanna (M224)
Group	Hawaiian Montane-Subalpine Mesic-Wet Shrubland & Grassland (G417)
Association	<i>Deschampsia nubigena</i> Montane and Subalpine Mesic Herbaceous Vegetation

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This association is known from locations in the South, East and West Crater areas and upper Kīpahulu Valley and Pōhaku Palaha at elevations ranging from 2125-2800 m. Positions are high slopes with flat to moderate slopes (0-18 degrees) with northwest, north, east and southeast aspects. Sites range from dry to mesic. Substrates are recent lava flows and cinder to soil.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by open to dense herbaceous vegetation dominated by *Deschampsia nubigena*. *Trisetum glomeratum* and/or *Pteridium aquilinum* ssp. *decompositum* may be present to codominant in some stands. Scattered shrubs, particularly *Leptecophylla tameiameiae* and *Vaccinium reticulatum*, may be present but do not form a layer. Non-native grasses are common associates and may include *Anthoxanthum odoratum*, *Holcus lanatus*, and *Poa pratensis*. *Holcus lanatus* is a codominant in some disturbed stands. Average species richness is 8 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Graminoid	<i>Deschampsia nubigena</i> , <i>Holcus lanatus</i> , <i>Trisetum glomeratum</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Deschampsia nubigena*, *Holcus lanatus*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Holcus lanatus* (invasive/exotic, High/Medium)

Global: Vulnerable: *Deschampsia nubigena* (G3)

CONSERVATION STATUS RANK

Global Rank & Reasons: G1 (1-Dec-1997).

CLASSIFICATION

Status: Standard

Classification Confidence: 2 - Moderate

Global Related Concepts:

Deschampsia Grassland (Gagne and Cuddihy 1990) =

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from the East Crater at Kaluanui, West Crater at base of Kalahaku Pali and Waikau, South Crater at Kapalaoa, Pu'u Kimo in Upper Kīpahulu Valley and Pōhaku Palaha.

Nations: US

States/Provinces: HI:S1.2

Federal Lands: NPS (Haleakalā, Hawai'i Volcanoes)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 8 plots: HALE.0009, HALE.0017, HALE.0042, HALE.0059, HALE.9005, HALE.9013, HALE.9021, HALE.9027.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Gagne and Cuddihy 1990, Gon 2008, Western Ecology Working Group n.d.

Pteridium aquilinum ssp. *decompositum* Herbaceous Vegetation [Park Special]

Kīlau Herbaceous Vegetation

Identifier: CEPS009665

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Hawaiian Montane Shrubland, Grassland & Savanna (M224)
Group	Hawaiian Montane-Subalpine Mesic-Wet Shrubland & Grassland (G417)
Association	<i>Pteridium aquilinum</i> ssp. <i>decompositum</i> Herbaceous Vegetation [Park Special]

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This herbaceous association is known from high level and high slope topographic positions at elevations ranging from approximately 2250-2350 m. Slopes are gentle to moderate on northeast and southeast aspects. Substrates include a'a and cinder.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by herbaceous vegetation dominated by the fern *Pteridium aquilinum* ssp. *decompositum*. The remainder of the herbaceous composition is variable and may include *Deschampsia nubigena*, *Hypochaeris radicata*, *Oenothera stricta*, and *Festuca rubra*. Scattered shrubs include *Leptecophylla tameiameia* and *Coprosma montana*.

MOST ABUNDANT SPECIES

Haleakalā National Park

Stratum

Herb (field)

Lifeform

Fern or fern ally

Species

Pteridium aquilinum ssp. *decompositum*

CHARACTERISTIC SPECIES

Haleakalā National Park: *Pteridium aquilinum* ssp. *decompositum*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (5-Dec-2011).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from the West Crater.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0058, HALE.9020.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

Rubus hawaiensis Montane Wet Shrubland

‘Ākala Montane Wet Shrubland

Identifier: CEG008052

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Hawaiian Montane Shrubland, Grassland & Savanna (M224)
Group	Hawaiian Montane-Subalpine Mesic-Wet Shrubland & Grassland (G417)
Association	<i>Rubus hawaiensis</i> Montane Wet Shrubland

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This wet, upper montane shrubland association was sampled in a bog in Smith Camp and in a depression along a drainage channel in East Crater. The nearly flat to gently sloping sites occur on high level and high slope topographic positions ranging from 1760-2110 m in elevation. Aspects are variable. Substrates are wet with high cover of leaf litter on the soil surface. In East Crater, surrounding areas have less cover of *Rubus hawaiensis*; however, similar dense pockets do occur in depressions throughout this region.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This shrubland association is characterized by a moderate to dense, tall-shrub canopy dominated by *Rubus hawaiensis*. Scattered *Sophora chrysophylla* trees/tall shrubs and low cover of other shrubs such as *Coprosma ernodeoides*, *Leptecophylla tameiameia*, and *Vaccinium reticulatum* may be present. The herbaceous layer is sparse to moderately dense with low cover of the native ferns *Athyrium microphyllum*, *Dryopteris wallichiana*, and *Pteridium aquilinum* ssp. *decompositum*, and low cover of native graminoids *Carex macloviana* and *Luzula hawaiiensis* var. *hawaiiensis*. Non-native species *Holcus lanatus* and *Rumex acetosella* frequently dominate the herbaceous layer. Average species richness is 10 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Rubus hawaiensis</i>
Herb (field)	Forb	<i>Holcus lanatus</i>
Herb (field)	Fern or fern ally	<i>Dryopteris wallichiana</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Rubus hawaiensis*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Holcus lanatus* (invasive/exotic, High/Medium), *Rumex acetosella* (invasive/exotic, Medium/Low)

Global: Vulnerable: *Rubus hawaiensis* (G2G3)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (1-Dec-1997).

CLASSIFICATION

Status: Standard

Classification Confidence: 2 - Moderate

Global Related Concepts:

‘Ākala (*Rubus*) Shrubland (Gagne and Cuddihy 1990) =

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This upper montane forest association was sampled in East Crater near Lau‘ulu and Smith Camp near the new greensword area.

Nations: US

States/Provinces: HI:S3
Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.0020, HALE.9031.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Gagne and Cuddihy 1990, Gon 2008, Western Ecology Working Group n.d.

***Sophora chrysophylla* - (*Coprosma montana*, *Leptecophylla tameiameiae*) Subalpine Shrubland¹**

Māmane - (Pilo, Pūkiawe) Subalpine Shrubland

Identifier: CEG008209

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Hawaiian Montane Shrubland, Grassland & Savanna (M224)
Group	Hawaiian Montane-Subalpine Mesic-Wet Shrubland & Grassland (G417)
Association	<i>Sophora chrysophylla</i> - (<i>Coprosma montana</i> , <i>Leptecophylla tameiameiae</i>)
Subalpine Shrubland ¹	

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This subalpine shrubland association occurs in seasonally mesic zones at elevations from 2100-2200 m. Positions are mid to high slopes with gentle to moderately steep slopes on all aspects. Substrates are moist and may be composed of soil or cinder with moderate to abundant litter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by an open to moderately dense tall-shrub (2-4 m) canopy with 10-50% cover of *Sophora chrysophylla*. *Coprosma montana* is often present and may be codominant. An open to moderately dense short-shrub layer is frequently present that is composed of *Leptecophylla tameiameiae* ranging from 5-50% cover. *Vaccinium reticulatum* is often present at covers less than 5%. Other shrubs may include *Coprosma ernodeoides*, *Dubautia menziesii*, or *Rubus hawaiensis*. The herbaceous layer is variable and typically dominated by non-native grasses such as *Anthoxanthum odoratum* and *Holcus lanatus*, although the native grass *Deschampsia nubigena* is often present. The native fern *Pteridium aquilinum* ssp. *decompositum* may dominate some sites.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Sophora chrysophylla</i>
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Leptecophylla tameiameiae</i> , <i>Vaccinium reticulatum</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Coprosma montana*, *Sophora chrysophylla*, *Leptecophylla tameiameiae*, *Vaccinium reticulatum*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Anthoxanthum odoratum* (invasive/exotic), *Holcus lanatus* (invasive/exotic, High/Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from the Front Country, East and West craters.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Inventory Notes: This *Sophora chrysophylla* vegetation is a shrubland in the park.

Haleakalā National Park Plots and Observation Points: 4 plots: HALE.0003, HALE.0019, HALE.0056, HALE.0063.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

Leptecophylla tameiameiae* - (*Dodonaea viscosa*) / *Cenchrus clandestinus

Montane - Subalpine Mesic Semi-natural Shrubland¹

Pūkiawe - (A‘ali‘i) / Kikuyu Grass Montane - Subalpine Mesic Semi-natural Shrubland

Identifier: CEG008194

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Hawaiian Montane Shrubland, Grassland & Savanna (M224)
Group	Hawaiian Montane-Subalpine Mesic-Wet Shrubland & Grassland (G417)
Association	<i>Leptecophylla tameiameiae</i> - (<i>Dodonaea viscosa</i>) / <i>Cenchrus clandestinus</i>
Montane - Subalpine	Mesic Semi-natural Shrubland ¹

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This association is known from mesic montane and subalpine zones in pastures in the Front Country and East Kaupō at elevations ranging from 1250-2100 m. Sites are on midslopes with southeast to south aspects and gentle to moderate slopes (6-17 degrees). Substrates are typically recent a‘a lava flows and vary from having abundant exposed bedrock and gravel to being largely covered by litter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by open to moderately dense shrublands (10-30% cover) dominated by *Leptecophylla tameiameiae* and sometimes with *Dodonaea viscosa* present to codominant. *Vaccinium reticulatum* is absent or has low cover. Herbaceous cover is moderately dense to dense (60-90% cover) and is strongly dominated by *Cenchrus clandestinus*. Few herbaceous species attain high cover. The most frequent include *Pteridium aquilinum* ssp. *decompositum* and non-natives *Anagallis arvensis*, *Eragrostis brownei*, *Juncus bufonius*, *Oenothera stricta*, *Plantago lanceolata*, and *Rumex acetosella*. Average species richness is 13 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Dodonaea viscosa</i> , <i>Leptecophylla tameiameiae</i>
Herb (field)	Graminoid	<i>Cenchrus clandestinus</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Dodonaea viscosa*, *Cenchrus clandestinus*, *Leptecophylla tameiameiae*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: **Invasive/Exotic:** *Cenchrus clandestinus* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from mesic montane and subalpine zones in pastures in the Front Country and near Kaupō trail in East Kaupō.

Nations: US
States/Provinces: HI
Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 3 plots: HALE.0001, HALE.0002, HALE.0093.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

***Leptecophylla tameiameiae* - *Sadleria cyatheoides* Subalpine Mesic Shrubland¹**

Pūkiawe - 'Ama'u Fern Subalpine Mesic Shrubland

Identifier: CEG008196

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Hawaiian Montane Shrubland, Grassland & Savanna (M224)
Group	Hawaiian Montane-Subalpine Mesic-Wet Shrubland & Grassland (G417)
Association	<i>Leptecophylla tameiameiae</i> - <i>Sadleria cyatheoides</i> Subalpine Mesic Shrubland ¹

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This association is found in mesic subalpine sites in the Front Country and far Upper Kīpahulu Valley at elevations ranging from 2125-2225 m. Sites are on steep (30-43 degrees) high slopes with north to southeast aspects. There is significant soil development on most plots although one occurs on a'a. Litter cover is moderate to high and rock cover is low. There are small pockets of erosional/slide areas on steep slopes.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by shrublands dominated by *Leptecophylla tameiameiae* with the fern *Sadleria cyatheoides* dominating or sometimes codominating the understory with non-native grass *Anthoxanthum odoratum*. Scattered *Metrosideros polymorpha* may be present, but rarely exceed 5% cover. Total shrub cover ranges from 10-30%. The moderate to dense herbaceous layer (50-80% cover) is dominated by a mix of ferns and grasses. Species with moderately high constancy with low cover (<10%) include *Vaccinium reticulatum*, *Pteridium aquilinum* ssp. *decompositum*, and *Coprosma ernodeoides*. Other native herbaceous species include *Deschampsia nubigena*, *Dryopteris wallichiana*, *Dubautia menziesii*, *Luzula hawaiiensis* var. *hawaiiensis*, and *Morelotia gahniiiformis*. Average species richness is 14 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Leptecophylla tameiameiae</i>
Herb (field)	Graminoid	<i>Anthoxanthum odoratum</i>
Herb (field)	Fern or fern ally	<i>Sadleria cyatheoides</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Sadleria cyatheoides*, *Leptecophylla tameiameiae*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Anthoxanthum odoratum* (invasive/exotic), *Holcus lanatus* (invasive/exotic, High/Medium), *Hypochaeris radicata* (invasive/exotic, High/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is found in mesic subalpine sites in the Front Country near Halemau'u (Rainbow Bridge) and far Upper Kīpahulu Valley in Wainēnē.

Nations: US
States/Provinces: HI
Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 4 plots: HALE.0048, HALE.0049, HALE.0050, HALE.9026.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

***Leptecophylla tameiameiae* - *Vaccinium reticulatum* - (*Geranium cuneatum*) / *Deschampsia nubigena* Subalpine Mesic Shrubland¹**

Pūkiawe - 'Ōhelo - (Nohoanu) / *Deschampsia nubigena* Subalpine Mesic Shrubland

Identifier: CEG008195

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Hawaiian Montane Shrubland, Grassland & Savanna (M224)
Group	Hawaiian Montane-Subalpine Mesic-Wet Shrubland & Grassland (G417)
Association	<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Geranium cuneatum</i>) / <i>Deschampsia nubigena</i> Subalpine Mesic Shrubland ¹

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This association is found in mesic subalpine sites in Front Country and East Crater at elevations ranging from 2230-2580 m. Sites have gentle to moderate slopes on mid and high slope topography. Aspects are mostly northerly, ranging from northwest to northeast, with one site on a bench on a south-facing slope of Kaluanui. There is significant soil development, although some sites are cindery/rocky. Litter cover is moderate to high and rock cover is low.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by shrublands codominated by *Leptecophylla tameiameiae* and *Vaccinium reticulatum* with understory dominated or codominated by *Deschampsia nubigena*. Subalpine indicator species *Geranium cuneatum* is often present to codominant. Scattered *Sophora chrysophylla* small trees/tall shrubs may be present, but rarely exceed 5% cover. Total shrub cover ranges from 20-50%. The moderately dense herbaceous layer (50% cover) is dominated by grasses. Although dominated or codominated by *Deschampsia nubigena*, other grasses, especially non-native species, may be present to codominant, such as *Anthoxanthum odoratum* or *Holcus lanatus*. Native fern *Pteridium aquilinum* ssp. *decompositum* has high constancy with low cover (<10%). Other native herbaceous species include *Luzula hawaiiensis* var. *hawaiiensis* and *Morelotia gahniiformis*. Average species richness is 13 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Leptecophylla tameiameiae</i>
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Geranium cuneatum</i> var. <i>cuneatum</i> , <i>Vaccinium reticulatum</i>
Herb (field)	Graminoid	<i>Anthoxanthum odoratum</i> , <i>Deschampsia nubigena</i> , <i>Holcus lanatus</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Deschampsia nubigena*, *Geranium cuneatum* var. *cuneatum*, *Leptecophylla tameiameiae*, *Vaccinium reticulatum*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Anthoxanthum odoratum* (invasive/exotic), *Holcus lanatus* (invasive/exotic, High/Medium), *Hypochaeris radicata* (invasive/exotic, High/Low), *Lythrum maritimum* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is found in mesic subalpine sites in Front Country and East Crater near the Supply and Lau'ulu trails, park catchment, Upper Hanamanu Gulch and north slope of Kalapawili Ridge.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 7 plots: HALE.0010, HALE.0011, HALE.0012, HALE.0013, HALE.0016, HALE.0046, HALE.9008.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

Leptecophylla tameiameiae - *Vaccinium reticulatum* Subalpine Mesic Shrubland¹

Pūkiawe - 'Ōhelo Subalpine Mesic Shrubland

Identifier: CEG008197

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Hawaiian Montane Shrubland, Grassland & Savanna (M224)
Group	Hawaiian Montane-Subalpine Mesic-Wet Shrubland & Grassland (G417)
Association	<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> Subalpine Mesic Shrubland ¹

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This association is found in mesic subalpine sites in the East Crater and West Crater at elevations ranging from 1970-2370 m. Sites occur on benches, mid and high slope topographic positions with gentle to steep slopes. Aspects are southeast, southwest and north. There is significant soil development although some sites are cindery/rocky. Litter cover is moderate and rock cover is low.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by an open to moderately dense shrubland codominated by *Leptecophylla tameiameiae* and *Vaccinium reticulatum* with each species having 1/3 or more the cover of the other. *Dodonaea viscosa* is usually absent, but if present, then it has low cover (<1/3 cover of *Leptecophylla tameiameiae*). Scattered *Sophora chrysophylla* small trees/tall shrubs may be present, but rarely exceed 5% cover. Total shrub cover ranges from 20-60%. The herbaceous layer is variable, either sparse with several native species or moderate to dense (20-70% cover) and dominated by non-native grasses *Anthoxanthum odoratum* and *Holcus lanatus*. Frequent native herbaceous species present include *Deschampsia nubigena*, *Luzula hawaiiensis* var. *hawaiiensis*, *Morelotia gahniiformis* and the fern *Pteridium aquilinum* ssp. *decompositum*. Average species richness is 14 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Leptecophylla tameiameiae</i>
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Vaccinium reticulatum</i>
Herb (field)	Graminoid	<i>Anthoxanthum odoratum</i> , <i>Holcus lanatus</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Leptecophylla tameiameiae*, *Vaccinium reticulatum*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Anthoxanthum odoratum* (invasive/exotic), *Holcus lanatus* (invasive/exotic, High/Medium), *Hypochaeris radicata* (invasive/exotic, High/Low), *Lythrum maritimum* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is found in mesic subalpine sites in the East Crater near Halemau'u trail – Palikū and Lau'ulu trail, and in West Crater at base of Switchbacks.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 5 plots: HALE.0005, HALE.0014, HALE.0015, HALE.0026, HALE.0067.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

Leptecophylla tameiameiae Montane Mesic Shrubland¹

Pūkiawe Montane Mesic Shrubland

Identifier: CEG008198

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Hawaiian Montane Shrubland, Grassland & Savanna (M224)
Group	Hawaiian Montane-Subalpine Mesic-Wet Shrubland & Grassland (G417)
Association	<i>Leptecophylla tameiameiae</i> Montane Mesic Shrubland ¹

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This association is known from mesic and dry montane zones in West Kaupō at elevations ranging from 1540-1800 m. Sites are on midslopes with southeast to south aspects and gentle to moderate slopes (10-20 degrees). Substrates are typically recent a'a lava flows and vary from having abundant exposed bedrock and gravel to being largely covered by litter.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by moderately dense shrublands dominated by *Leptecophylla tameiameiae* with *Dodonaea viscosa* absent or at low cover (less than 1/3 the cover of *Leptecophylla tameiameiae*). Total shrub cover ranges from 40-60% cover. *Osteomeles anthyllidifolia* is frequently present to codominant and is a good indicator of montane shrublands. *Vaccinium reticulatum* is absent or has low cover. Herbaceous cover is usually sparse and does not form a layer although it may be diverse. Few native herbaceous species attain more than trace cover; the most frequent include *Deschampsia nubigena* and *Pteridium aquilinum* ssp. *decompositum* with *Carex wahuensis*, *Cyperus javanicus*, *Eragrostis grandis*, *Morelotia gahniiformis*, and *Pellaea ternifolia* less common. Non-native grasses *Eragrostis brownei*, *Festuca rubra*, and *Melinis repens* have invaded many stands. Other non-native forb species include *Ageratina adenophora*, *Anagallis arvensis*, and *Hypochaeris radicata*. Average species richness is 16 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Leptecophylla tameiameiae</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Deschampsia nubigena*, *Osteomeles anthyllidifolia*, *Pteridium aquilinum* spp. *decompositum*, *Leptecophylla tameiameiae*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Ageratina adenophora* (invasive/exotic), *Anagallis arvensis* (invasive/exotic, Medium/Insignificant), *Eragrostis cumingii* (invasive/exotic), *Festuca rubra* (invasive/exotic, Unknown), *Hypochaeris radicata* (invasive/exotic, High/Low), *Melinis repens* (invasive/exotic), *Sporobolus indicus* var. *capensis* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from mesic to dry montane zones near Waikane in West Kaupō .

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 3 plots: HALE.0084, HALE.0086, HALE.0152.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

M227. Polynesian Semi-natural Montane Shrubland, Grassland & Savanna

G418. Polynesian Semi-natural Subalpine-Montane Shrubland & Grassland

Ageratina adenophora - (*Pellaea ternifolia*, *Oenothera stricta*) Semi-natural Subalpine Herbaceous Vegetation [Park Special]

Maui Pamakani - (Kalamoho Lau Li'i, Evening Primrose) Semi-natural Subalpine Herbaceous Vegetation

Identifier: CEPS009701

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Polynesian Semi-natural Montane Shrubland, Grassland & Savanna (M227)
Group	Polynesian Semi-natural Subalpine-Montane Shrubland & Grassland (G418)
Association	<i>Ageratina adenophora</i> - (<i>Pellaea ternifolia</i> , <i>Oenothera stricta</i>) Semi-natural Subalpine Herbaceous Vegetation [Park Special]

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This uncommon herbaceous association is known from high slope positions at elevations ranging from approximately 2100-2250 m. Slopes are gentle and northeast- to northwest-facing. Occurrences are known from a recent a`a lava flow and an alluvial fan.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by herbaceous vegetation dominated by the non-native forb *Ageratina adenophora* with *Oenothera stricta* and/or *Pellaea ternifolia* codominant. Total herbaceous cover is approximately 10-15%. Scattered short shrubs such as *Dodonaea viscosa* and *Leptecophylla tameiameiae* are common, but at low covers.

MOST ABUNDANT SPECIES

Haleakalā National Park

Stratum

Herb (field)

Lifeform

Forb

Species

Ageratina adenophora, *Oenothera stricta*

Herb (field)

Fern or fern ally

Pellaea ternifolia

CHARACTERISTIC SPECIES

Haleakalā National Park: *Ageratina adenophora*, *Oenothera stricta*, *Pellaea ternifolia*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (4-Apr-2013).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from two locations on the West Crater.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots. HALE.0060, HALE.0069.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

Holcus lanatus Semi-natural Grassland [Provisional]

Common Velvet Grass Semi-natural Grassland

Identifier: CEG008193

USNVC CLASSIFICATION

Division

Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)

Macrogroup

Polynesian Semi-natural Montane Shrubland, Grassland & Savanna (M227)

Group

Polynesian Semi-natural Subalpine-Montane Shrubland & Grassland (G418)

Association

Holcus lanatus Semi-natural Grassland [Provisional]

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This semi-natural grassland association is known from the subalpine zone on high slope and high level positions at elevations ranging from approximately 1950-2400 m. Substrates are rocky and gravelly.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is strongly dominated by non-native grass *Holcus lanatus*. Non-native grass *Poa pratensis* may be present to codominant in some stands. If native grasses are present, such as *Deschampsia nubigena*, then *Holcus lanatus* has over twice as much cover. *Rumex acetosella* is a common associate, but at low cover.

MOST ABUNDANT SPECIES

Haleakalā National Park

Stratum

Herb (field)

Lifeform

Graminoid

Species

Holcus lanatus, *Poa pratensis*

CHARACTERISTIC SPECIES

Haleakalā National Park: *Holcus lanatus*, *Poa pratensis*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: **Invasive/Exotic:** *Holcus lanatus* (invasive/exotic, High/Medium), *Poa pratensis* (invasive/exotic, Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (4-Apr-2013).

CLASSIFICATION

Status: Provisional

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is known from Waikau, Holua and the East Crater.

Nations: US

States/Provinces: HI **Federal Lands:** NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 3 plots: HALE.0062, HALE.0070, HALE.9006.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

Pityrogramma austroamericana - *Heterotheca grandiflora* Semi-natural Herbaceous Vegetation

Gold Fern – Telegraph Weed Semi-natural Herbaceous Vegetation

Identifier: CEG008206

USNVC CLASSIFICATION

Division	Polynesian Montane Shrubland, Grassland & Savanna (2.A.2.Oh)
Macrogroup	Polynesian Semi-natural Montane Shrubland, Grassland & Savanna (M227)
Group	Polynesian Semi-natural Subalpine-Montane Shrubland & Grassland (G418)
Association	<i>Pityrogramma austroamericana</i> - <i>Heterotheca grandiflora</i> Semi-natural
Herbaceous Vegetation	

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This montane herbaceous association is known from mesic slopes and ridge positions at elevations ranging from 900-1100 m. Slopes are steep with southern aspects and substrates are very rocky.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is characterized by herbaceous vegetation dominated by the non-native fern *Pityrogramma austroamericana* and forb *Heterotheca grandiflora* at low cover, ranging from approximately 10-40% combined. Although herbaceous-dominated, *Lantana camara* is common at low cover. Other herbaceous associates include *Ageratina riparia*, *Ageratum conyzoides*, *Bothriochloa pertusa*, *Festuca rubra*, *Hypochaeris radicata*, *Oxalis corniculata*, and *Spermacoce assurgens*.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Forb	<i>Heterotheca grandiflora</i>
Herb (field)	Fern or fern ally	<i>Pityrogramma austroamericana</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Heterotheca grandiflora*, *Pityrogramma austroamericana*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Ageratina riparia* (invasive/exotic), *Ageratum conyzoides* (invasive/exotic), *Bothriochloa pertusa* (invasive/exotic), *Festuca rubra* (invasive/exotic, Unknown), *Hypochaeris radicata* (invasive/exotic, High/Low), *Oxalis corniculata* (invasive/exotic), *Spermacoce assurgens* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is only known from a few locations in Nu‘u.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 3 plots: HALE.0132, HALE.0133, HALE.0134.

Local Description Authors: M.E. Hall

Global Description Authors:

References: Western Ecology Working Group n.d.

2.A.4. Tropical Bog & Fen

2.A.4.Oa. Polynesian Bog & Fen

M238. Hawaiian Bog & Fen

G426. Hawaiian Bog

Carex (alligata, echinata, montis-eeka, thunbergii) - (Deschampsia nubigena) Mixed Herbaceous Montane Bog

Carex (alligata, echinata, montis-eeka, thunbergii) - (Deschampsia nubigena) Mixed Herbaceous Montane Bog

Identifier: CEGL008190

USNVC CLASSIFICATION

Division	Polynesian Bog & Fen (2.A.4.Oa)
Macrogroup	Hawaiian Bog & Fen (M238)
Group	Hawaiian Bog (G426)
Association	<i>Carex (alligata, echinata, montis-eeka, thunbergii) - (Deschampsia nubigena)</i>
Mixed Herbaceous	Montane Bog

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This native herbaceous wetland association is known from Smith Camp and Kīpahulu Valley from 1670-2060 m in elevation, on flat, often exposed windy sites. Sites are nearly level, sometimes with slight northern aspects. Positions are typically high level sites such as depressions on plateaus. Water table is very high with open water at the surface of some plots.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This association is a diverse montane herbaceous bog characterized by a lush herbaceous layer with 65-90% cover that is dominated or codominated by *Carex alligata*, *Carex echinata*, *Carex montis-eeka*, and/or *Carex thunbergii*, which are indicator species of this type. *Argyroxiphium grayanum* and *Geranium hanaense* also have high diagnostic value, but with lower cover. *Athyrium microphyllum* and *Deschampsia nubigena* are prominent on some sites. Scattered trees or shrubs, especially *Metrosideros polymorpha*, *Cheirodendron trigynum* ssp. *trigynum*, *Rubus hawaiiensis* or *Vaccinium calycinum*, may be present but do not form distinct layers. Disturbed sites may be codominated by *Holcus lanatus*. Average species richness is 12 species per plot.

MOST ABUNDANT SPECIES - Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Graminoid	<i>Carex alligata</i> , <i>Carex echinata</i> , <i>Carex montis-eeka</i> , <i>Carex thunbergii</i> , <i>Deschampsia nubigena</i>
Herb (field)	Fern or fern ally	<i>Athyrium microphyllum</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Carex alligata*, *Carex echinata*, *Carex montis-eeka*, *Carex thunbergii*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Holcus lanatus* (invasive/exotic, High/Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This bog association was sampled near Smith Camp and far upper Kīpahulu Valley.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 4 plots: HALE.0157, HALE.0158, HALE.9028, HALE.9029.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

6. Rock Vegetation

6.A.1. Tropical Cliff, Scree & Other Rock Vegetation

6.A.1.Oa. Polynesian Cliff, Scree & Rock Vegetation

M265. Hawaiian Cliff, Scree & Rock Vegetation

G440. Hawaiian Dry-Site Lava Flow

Dubautia menziesii - (*Argyroxiphium sandwicense*) Subalpine Sparse Vegetation

Na‘ena‘e - (‘Āhinahina) Subalpine Sparse Vegetation

Identifier: CEGLO08192

USNVC CLASSIFICATION

Division	Polynesian Cliff, Scree & Rock Vegetation (6.A.1.Oa)
Macrogroup	Hawaiian Cliff, Scree & Rock Vegetation (M265)
Group	Hawaiian Dry-Site Lava Flow (G440)
Association	<i>Dubautia menziesii</i> - (<i>Argyroxiphium sandwicense</i>) Subalpine Sparse Vegetation

ENVIRONMENTAL DESCRIPTION

Haleakalā National Park Environment: This sparse vegetation association is found in the very dry high subalpine zone on West Crater. Elevation ranges from 2495-2825 m. Slopes are gentle to moderate on high level topographic positions. Substrates are composed of recent a‘a lava. Ground cover is mostly gravel and rock.

VEGETATION DESCRIPTION

Haleakalā National Park Vegetation: This subalpine association is generally characterized by a sparse cover of shrub *Dubautia menziesii*, sometimes with scattered *Leptecophylla tameiameia*. *Argyroxiphium sandwicense* ssp. *macrocephalum* is a diagnostic forb species that ranges from present to 8% cover. Other characteristic dry subalpine taxa include *Tetramolopium humile* ssp. *Haleakalāe* and *Trisetum glomeratum*. *Rumex acetosella*, a non-native forb, is present on one plot. Average species richness is 5 species per plot.

MOST ABUNDANT SPECIES

Haleakalā National Park

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Dubautia menziesii</i>
Herb (field)	Forb	<i>Argyroxiphium sandwicense</i> ssp. <i>macrocephalum</i>
Herb (field)	Graminoid	<i>Trisetum glomeratum</i>

CHARACTERISTIC SPECIES

Haleakalā National Park: *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Dubautia menziesii*, *Tetramolopium humile* ssp. *Haleakalāe*, *Trisetum glomeratum*

OTHER NOTEWORTHY SPECIES

Haleakalā National Park: Invasive/Exotic: *Rumex acetosella* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (4-Apr-2013).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Haleakalā National Park Range: This association is found in the West Crater area along Sliding Sands trail.

Nations: US

States/Provinces: HI

Federal Lands: NPS (Haleakalā)

ELEMENT SOURCES

Haleakalā National Park Plots and Observation Points: 2 plots: HALE.9009, HALE. 9019.

Local Description Authors: K.A. Schulz

Global Description Authors:

References: Western Ecology Working Group n.d.

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Appendix E: Field Plot Crosswalk to National Vegetation Classification Associations

At Haleakalā National Park, plots were assigned to USNVC associations and park specials. Element codes are used by NatureServe and state Natural Heritage Programs to track nomenclature and status of rare plants, rare animals, and communities (“elements”). Nomenclature used by USNVC follows Kartesz (1999), while nomenclature preferred by PACN follows Wagner et al. (1999) and Palmer (2003) with updates from Wagner et al. (2012) and is referenced below. Any differences in the nomenclature between USNVC and PACN are indicated by footnotes.

USNVC Association	ELCODE	Supporting Plots	Number of Samples
<i>Acacia koa</i> - <i>Cheirodendron trigynum</i> - (<i>Antidesma platyphyllum</i> , <i>Syzygium sandwicense</i>) / (<i>Clidemia hirta</i>) Lowland Wet Forest	CEGL008185	HALE.0115, HALE.0116, HALE.0117, HALE.0118, HALE.0119, HALE.0120, HALE.0121, HALE.0125	8
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Wet Forest	CEGL008186	HALE.0114, HALE.0178	2
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> / <i>Hedychium gardnerianum</i> Semi-natural Woodland [Park Special]	CEPS009700	HALE.9032	1
<i>Acacia koa</i> - <i>Metrosideros</i> Lowland Mesic Forest	CEGL008023	HALE.9039	1
<i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Wet Montane Woodland	CEGL008187	HALE.0122, HALE.0123, HALE.0124, HALE.0126, HALE.0127, HALE.0128, HALE.0166, HALE.0167, HALE.0171, HALE.0172, HALE.0174,	11
<i>Acacia koa</i> - <i>Psidium cattleianum</i> Semi-natural Forest	CEGL008184	HALE.0103, HALE.9018.	2
<i>Acacia koa</i> / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Woodland	CEGL008188	HALE.0091, HALE.0092	2
<i>Acacia koa</i> / <i>Leptecophylla tameiameia</i> - (<i>Dodonaea viscosa</i>) Montane Woodland ¹	CEGL008155	HALE.0083, HALE.0094	2
<i>Ageratina adenophora</i> - (<i>Pellaea ternifolia</i> , <i>Oenothera stricta</i>) Semi-natural Subalpine Herbaceous Vegetation [Park Special]	CEPS009701	HALE.0060, HALE.0069	2
<i>Ageratina adenophora</i> - <i>Paspalum conjugatum</i> Semi-natural Herbaceous Bog [Park Special]	CEPS009702	HALE.9040	1
<i>Aleurites moluccana</i> Lowland Wet Forest	CEGL008115	HALE.9010	1
<i>Andropogon virginicus</i> Semi-natural Lowland Herbaceous Vegetation	CEGL008166	Based on map calibration/validation observations	
<i>Bothriochloa pertusa</i> Semi-natural Grassland	CEGL008189	HALE.0109, HALE.0113, HALE.0135, HALE.0169	4
<i>Carex (alligata, echinata, montis-eeka, thunbergii)</i> - (<i>Deschampsia nubigena</i>) Mixed Herbaceous Montane Bog	CEGL008190	HALE.0157, HALE.0158, HALE.9028, HALE.9029	4
<i>Cenchrus ciliaris</i> Semi-natural Herbaceous Vegetation ¹	CEGL005407	HALE.0054, HALE.0055	2

USNVC Association	ELCODE	Supporting Plots	Number of Samples
<i>Cenchrus clandestinus</i> Semi-natural Herbaceous Vegetation ¹	CEGL005408	HALE.9016	1
<i>Cenchrus purpureus</i> Semi-natural Herbaceous Vegetation ¹	CEGL008210	Based on map calibration/validation observations	
<i>Cocos nucifera</i> Strand Woodland	CEGL005402	Based on map calibration/validation observations	
<i>Coprosma montana</i> / <i>Leptecophylla tameiameiae</i> Subalpine Shrubland [Provisional] ¹	CEGL008191	HALE.0004	1
<i>Deschampsia nubigena</i> Montane and Subalpine Mesic Herbaceous Vegetation	CEGL008085	HALE.0009, HALE.0017, HALE.0042, HALE.0059, HALE.9005, HALE.9013, HALE.9021, HALE.9027	8
<i>Dodonaea viscosa</i> Mesic Montane Shrubland [Park Special]	CEPS009668	HALE.0155	1
<i>Dubautia menziesii</i> - (<i>Argyroxiphium sandwicense</i>) Subalpine Sparse Vegetation	CEGL008192	HALE.9009, HALE.9019	2
<i>Erythrina sandwicensis</i> Lowland Dry Woodland	CEGL008036	HALE.9004	1
<i>Eucalyptus</i> spp. - Mixed Alien Semi-natural Forest/Plantation [Provisional]	CEGL008144	HALE.9012	1
<i>Grevillea robusta</i> Lowland Mesic Semi-natural Forest	CEGL008113	HALE.9034	1
<i>Hibiscus tiliaceus</i> Lowland Wet Forest [Provisional]	CEGL008163	HALE.9011	1
<i>Holcus lanatus</i> Semi-natural Grassland [Provisional]	CEGL008193	HALE.0062, HALE.0070, HALE.9006	3
<i>Lantana camara</i> Semi-natural Shrubland [Provisional]	CEGL008145	HALE.0110, HALE.0111, HALE.0112, HALE.0143, HALE.0168	5
<i>Leptecophylla tameiameiae</i> - (<i>Dodonaea viscosa</i>) / <i>Cenchrus clandestinus</i> Montane - Subalpine Mesic Semi-natural Shrubland ¹	CEGL008194	HALE.0001, HALE.0002, HALE.0093	3
<i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Shrubland ¹	CEGL008172	HALE.0025, HALE.0082, HALE.0085, HALE.0087, HALE.0088, HALE.0153, HALE.0154, HALE.0156	8
<i>Leptecophylla tameiameiae</i> - <i>Sadleria cyatheoides</i> Subalpine Mesic Shrubland ¹	CEGL008196	HALE.0048, HALE.0049, HALE.0050, HALE.9026	4
<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Geranium cuneatum</i>) / <i>Deschampsia nubigena</i> Subalpine Mesic Shrubland ¹	CEGL008195	HALE.0010, HALE.0011, HALE.0012, HALE.0013, HALE.0016, HALE.0046, HALE.9008	7
<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> Montane and Subalpine Sparse Vegetation ¹	CEGL008178	HALE.0066	1
<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> Subalpine Mesic Shrubland ¹	CEGL008197	HALE.0005, HALE.0014, HALE.0015, HALE.0026, HALE.0067	5
<i>Leptecophylla tameiameiae</i> Montane Mesic Shrubland ¹	CEGL008198	HALE.0084, HALE.0086, HALE.0152	3

USNVC Association	ELCODE	Supporting Plots	Number of Samples
<i>Leptecophylla tameiameiae</i> Subalpine Dry Shrubland ¹	CEGL008063	HALE.0018, HALE.0021, HALE.0022, HALE.0023, HALE.0024, HALE.0027, HALE.0028, HALE.0029, HALE.0043, HALE.0044, HALE.0045, HALE.0047, HALE.0051, HALE.0057, HALE.0061, HALE.0064, HALE.0065, HALE.0068, HALE.0129, HALE.0130, HALE.0131, HALE.9002,	22
<i>Leucaena leucocephala</i> / <i>Urochloa maxima</i> Semi-natural Shrubland	CEGL005404	HALE.9033	1
<i>Leucaena leucocephala</i> Lowland Dry Semi-natural Shrubland	CEGL008114	HALE.0098, HALE.0144	2
<i>Mangifera indica</i> Semi-natural Forest	CEGL008199	HALE.0033, HALE.0076, HALE.0078, HALE.0079	4
<i>Melinis repens</i> - Mixed Semi-natural Sparse Vegetation [Park Special]	CEPS009703	HALE.9015	1
<i>Melinis minutiflora</i> - (<i>Schizachyrium condensatum</i>) Semi-natural Herbaceous Vegetation	CEGL008169	Based on map calibration/validation observations	1
<i>Metrosideros polymorpha</i> - <i>Cheirodendron trigynum</i> / (<i>Cibotium</i> spp.) Montane Wet Forest	CEGL008008	HALE.0160, HALE.0161, HALE.0175, HALE.0176, HALE.0177, HALE.0180, HALE.0181	7
<i>Metrosideros polymorpha</i> - <i>Melicope clusiifolia</i> Montane Wet Forest [Park Special]	CEPS009704	HALE.9042	1
<i>Metrosideros polymorpha</i> / <i>Carex alligata</i> - (<i>Machaerina angustifolia</i>) Wet Woodland	CEGL008201	HALE.0136, HALE.0137, HALE.0138	3
<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Wet Woodland	CEGL008039	HALE.0140, HALE.0141, HALE.0142	3
<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Montane Wet Woodland	CEGL008041	HALE.0139, HALE.0165	2
<i>Metrosideros polymorpha</i> / <i>Dryopteris wallichiana</i> Subalpine Mesic Forest	CEGL008202	HALE.0147, HALE.0148, HALE.9024, HALE.9043	4
<i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Woodland ¹	CEGL008135	HALE.0151, HALE.9007	2
<i>Metrosideros polymorpha</i> / <i>Rubus hawaiiensis</i> Montane Wet Forest	CEGL008203	HALE.0145, HALE.0146, HALE.0150	3
<i>Metrosideros polymorpha</i> / <i>Sadleria cyatheoides</i> Forest [Park Special]	CEPS009712	Based on map calibration/validation observations	
<i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - (<i>Broussaisia arguta</i> , <i>Coprosma foliosa</i>) / <i>Athyrium microphyllum</i> Montane Wet Forest	CEGL008200	HALE.0149, HALE.0159, HALE.0162, HALE.0163, HALE.0164, HALE.9030	6
Mixed Forest Plantation [Park Special]	CEPS009672	HALE.9001	1
<i>Myrsine lessertiana</i> - (<i>Metrosideros polymorpha</i>) / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Forest	CEGL008204	HALE.0090, HALE.0095	2
<i>Pandanus tectorius</i> Coastal Mesic Forest	CEGL008032	HALE.9003, HALE.9014, HALE.9038	3

USNVC Association	ELCODE	Supporting Plots	Number of Samples
<i>Paspalum conjugatum</i> - <i>Sacciolepis indica</i> - <i>Axonopus fissifolius</i> Mixed Semi-natural Herbaceous Vegetation [Provisional]	CEGL008170	HALE.0039, HALE.0101	2
<i>Phyllostachys nigra</i> Semi-natural Thicket	CEGL008205	HALE.0035, HALE.0036	2
<i>Pityrogramma austroamericana</i> - <i>Heterotheca grandiflora</i> Semi-natural Herbaceous Vegetation	CEGL008206	HALE.0132, HALE.0133, HALE.0134	3
<i>Plantago lanceolata</i> - <i>Rumex acetosella</i> Semi-natural Herbaceous Vegetation [Park Special]	CEPS009714	Based on map calibration/validation observations	
<i>Portulaca lutea</i> Herbaceous Vegetation [Park Special]	CEPS009706	HALE.9036	1
<i>Prosopis pallida</i> Coastal Dry Semi-natural Woodland	CEGL008118	HALE.0006, HALE.0008, HALE.0052, HALE.0053	4
<i>Psidium cattleianum</i> Lowland Wet Semi-natural Forest	CEGL008116	HALE.0037, HALE.0072, HALE.0073, HALE.0074, HALE.0075, HALE.0077, HALE.0099, HALE.0108	8
<i>Psidium guajava</i> / Disturbed Understory Semi-natural Forest	CEGL008147	HALE.0100, HALE.0102, HALE.0105, HALE.0106	4
<i>Pteridium aquilinum</i> ssp. <i>decompositum</i> Herbaceous Vegetation [Park Special]	CEPS009665	HALE.0058, HALE.9020	2
<i>Rubus hawaiensis</i> Montane Wet Shrubland	CEGL008052	HALE.0020, HALE.9031	2
<i>Scaevola taccada</i> Coastal Dry Shrubland ¹	CEGL008054	HALE.9035	1
<i>Schinus terebinthifolius</i> Semi-natural Scrub Woodland	CEGL008148	HALE.0030, HALE.0031, HALE.0032, HALE.0040, HALE.0041, HALE.0080, HALE.9037	7
<i>Sophora chrysophylla</i> - (<i>Coprosma montana</i> - <i>Leptecophylla tameiameia</i>) Subalpine Shrubland ¹	CEGL008209	HALE.0003, HALE.0019, HALE.0056, HALE.0063	4
<i>Sophora chrysophylla</i> - <i>Dodonaea viscosa</i> - (<i>Leptecophylla tameiameia</i>) Montane Shrubland [Park Special] ¹	CEPS009721	Based on map calibration/validation observations	
<i>Spathodea campanulata</i> - <i>Psidium</i> spp. Semi-natural Forest [Park Special]	CEPS009708	HALE.0034	1
<i>Spermacoce assurgens</i> - <i>Zinnia peruviana</i> - <i>Digitaria insularis</i> Semi-natural Herbaceous Vegetation [Provisional]	CEGL008207	HALE.0096, HALE.0097	2
<i>Sporobolus africanus</i> - <i>Anthoxanthum odoratum</i> Rock Slide Semi-natural Herbaceous Vegetation [Park Special]	CEPS009709	HALE.0071	1
<i>Syzygium cumini</i> Lowland Mesic Semi-natural Forest	CEGL008111	HALE.0081	1
<i>Syzygium jambos</i> Lowland Mesic Semi-natural Woodland	CEGL008208	HALE.0104, HALE.0107, HALE.0170	3
<i>Terminalia catappa</i> Semi-natural Woodland [Park Special]	CEPS009651	HALE.0007, HALE.0038	2

USNVC Association	ELCODE	Supporting Plots	Number of Samples
<i>Thevetia peruviana</i> Semi-natural Woodland [Park Special]	CEPS009652	HALE.9022	1
<i>Vaccinium calycinum</i> Subalpine Mesic Shrubland [Park Special]	CEPS009710	HALE.9025	1

¹USNVC name modified based on Wagner and Herbst (1999) and Wagner et al (2012).

Appendix F: Accuracy Assessment Form

Entered by ____

Checked by ____

PACN VEGETATION MAPPING ACCURACY ASSESSMENT FORM

**IDENTIFIERS/LOCATORS

AA Target No. _____ Park Site Name: _____			
Survey Date _____ Surveyors _____			
Datum: WGS 84 NAD 83 Field UTM X _____ m (E) Field UTM Y _____ m (N)			
GPS Unit: Garmin 76 / 5 / 60CSX Trimble Other _____ Error +/- _____ m			
GPS Notes: _____			
Relocated/Reshaped Plot? No Yes Notes: _____			
Radio Reception? No Yes Notes: _____			
Cell phone reception (Verizon)? No Yes Notes: _____			
Camera: Ricoh-GPS Other: _____			
View#	Bearing	Photographer	Comments
1			
2			
3			
4			
Canopy			
Ground			
Data			

**ASSOCIATION INFORMATION

Primary Name Veg Association: _____	Corresponding Assc. Code: _____
Secondary Name Veg Association: _____	Corresponding Assc. Code: _____
Tertiary Name Veg Association: _____	Corresponding Assc. Code: _____
Representativeness of point within polygon/surrounding area (within 1 ha) <u>Good</u> <u>Fair</u> <u>Poor</u> ...of association to description: <u>Good</u> <u>Fair</u> <u>Poor</u> <u>N/A</u>	
Classification Comments: (complications, uncertainties, explanation of poor representativeness)	
Does the key work? Yes ____ No ____ N/A ____ Comments:	
Is the corresponding description accurate? Yes ____ No ____ N/A ____ Comments:	

Target Number _____

Date: _____

***VEGETATION DESCRIPTION (Only complete all stratum layers if association is difficult to key, or is a new type)**

Height Class Scale	Cover Class Scale			MMU=0.5 ha
01 < 0.5 m	T < 1%			Circle: r=40m
02 0.5-1 m	P 1-5%			*Rectangle: 50m x 100m
03 1-2 m	1a 5.01-10%			*Square: 71m x 71m
04 2-5 m	1b 10.01-15%			
05 5-10 m	02 15.01-25%			
06 10-15 m	03 25.01-35%			
07 15-20 m	04 35.01-45%			
08 20-35 m	05 45.01-55%			
09 35-50 m	06 55.01-65%			
10 > 50 m	07 65.01-75%			
	08 75.01-85%			
	09 85.01-95%			*Only sample if cannot sample a circular plot
	10 > 95%			

Total Vegetation Cover: _____ Cover estimates based on: **MMU 0.5ha circle/ other**

If other: **Size:** _____ **Shape:** _____

Stratum Code	Height Class	Cover Class	Dominant species in stratum (mark diagnostic species with a *)	%Cover
_____	_____	_____	_____	_____

_____	_____	_____	_____	_____

_____	_____	_____	_____	_____

Strata:

T1 Emergent (above canopy)	S1 Tall shrub (> 2 m)	H1 Graminoids	H4 Tree Seedlings
T2 Canopy	S2 Short Shrub (> 0.5 m- 2 m)	H2 Forbs	N Nonvascular
T3 Sub-canopy	S3 Dwarf-shrub (< 0.5 m)	H3 Ferns & Allies	V Vine/Liana

Target Number _____

Date: _____

ENVIRONMENTAL DESCRIPTION (Only complete if association is difficult to key or if it is a new type)

Elevation _____ From: <u>GPS / Map</u> (circle one) Slope _____ Aspect _____		
Topographic Position: High level High Slope Mid Slope Low Slope Backslope Step in Slope Toe Slope Low Level Interfluv		
Landform: Alluvial Fan, Colluvium, Rockpile, Drainage Channel, Valley Bottom Fill, Side Slope, Interfluv, Intermittent Stream, Ridge, Terrace, Butte, Cliff, Talus, Sand Dune, Plateau, Beach, Recent Lava Flow, Other: _____		Geology: A 'a lava, Pahoehoe Lava, Ash, Cinder, Coral, Limestone, Pumice, Obscured by soil, Other: _____
Ground Cover: (please estimate to the nearest percentage. Sum = 100%)		
___ Bare soil (<0.1 mm) ___ Sand (0.1-2 mm) ___ Small Rock (2mm-6.4cm) ___ Rock (> 6.4 cm) ___ Bedrock (solid surface)	___ Litter/Duff (dead plant material <3 cm diameter) ___ Coarse woody debris (dead wood 3-10 cm) ___ Woody debris structure (dead >10 cm deep & wide) ___ Live veg (litter / wood)	___ Lichen (ground) ___ Moss (ground) ___ Microbiotic soil crust ___ Water ___ Other: _____
Surface Water w/in 25m? YES/NO Seep, Spring, Stream, Pothole, River, Anchialine Pond, Ocean, Estuary		
Environmental Comments:		

Appendix G: Map Classes with *Post-Hoc* Changes

The following map classes received *post-hoc* changes following accuracy assessment (AA) to improve the final map. These changes were proposed and agreed upon by KGA and the PACN. The tables include map classes composed of multiple USNVC associations (Table G1), modified names based on AA data (Table G2), new classes with no comparable USNVC associations (Table G3), and classes of special park interest that include smaller than 0.5 ha polygons (Table G4).

Table G1. Composite map classes containing multiple USNVC associations.

Map Class	USNVC Association	Description
<i>Ageratina adenophora</i> – (<i>Sporobolus africanus</i> - <i>Anthoxanthum odoratum</i>) Semi-natural Herbaceous Vegetation	<i>Ageratina adenophora</i> - (<i>Pellaea ternifolia</i> , <i>Oenothera stricta</i>) Semi-natural Subalpine Herbaceous Vegetation [Park Special]	These associations were merged into one map class because they are indistinguishable on the imagery and cannot be modeled using GIS data.
	<i>Sporobolus africanus</i> - <i>Anthoxanthum odoratum</i> Rock Slide Semi-natural Herbaceous Vegetation [Park Special]	
<i>Cenchrus ciliaris</i> - <i>Bothriochloa pertusa</i> Semi-natural Herbaceous Vegetation	<i>Bothriochloa pertusa</i> Semi-natural Grassland	Intermixed grass species indistinguishable in the imagery.
	<i>Cenchrus ciliaris</i> Semi-natural Herbaceous Vegetation ¹	
<i>Eucalyptus</i> spp. - Mixed Semi-natural Forest	<i>Eucalyptus</i> spp. - Mixed Alien Semi-natural Forest/Plantation [Provisional]	Mixed alien forests typically dominated by <i>Eucalyptus</i> spp.
	Mixed Forest Plantation [Park Special]	
<i>Leucaena leucocephala</i> Semi-natural Shrubland	<i>Leucaena leucocephala</i> / <i>Urochloa maxima</i> Semi-natural Shrubland	<i>Leucaena leucocephala</i> / <i>Urochloa maxima</i> is a rare class with only one classification plot and no AA plots. It was merged into the larger Semi-natural Shrubland class.
	<i>Leucaena leucocephala</i> Lowland Dry Semi-natural Shrubland	
<i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Dryopteris wallichiana</i> - <i>Sadleria cyatheoides</i>) Montane Mesic Forest	<i>Metrosideros polymorpha</i> / <i>Sadleria cyatheoides</i> Forest [Park Special]	This diverse mosaic forested area of Kuiki had high shrub cover and represents a combination of these two USNVC associations.
	<i>Metrosideros polymorpha</i> / <i>Dryopteris wallichiana</i> Subalpine Mesic Forest	
<i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> – <i>Rubus hawaiensis</i> / (<i>Coprosma foliosa</i> – <i>Leptecophylla tameiameiae</i>) Montane Mesic Forest	<i>Metrosideros polymorpha</i> - <i>Cheirodendron trigynum</i> / (<i>Cibotium</i> spp.) Montane Wet Forest	<i>Rubus hawaiensis</i> is not the distinguishing feature in this area but, rather this forest has a diverse composition of native tree and shrub species. This area of upper Kīpahulu Valley is a transition zone from higher mesic to lower wet forest..
	<i>Metrosideros polymorpha</i> / <i>Rubus hawaiensis</i> Montane Wet Forest	
	<i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - (<i>Broussaisia arguta</i> , <i>Coprosma foliosa</i>) / <i>Athyrium microphyllum</i> Montane Wet Forest	
<i>Sophora chrysophylla</i> - (<i>Coprosma montana</i> - <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i>) Subalpine Shrubland	<i>Sophora chrysophylla</i> - (<i>Coprosma montana</i> , <i>Leptecophylla tameiameiae</i>) Subalpine Shrubland ¹	AA confirmed that there is only one distinguishable <i>Sophora chrysophylla</i> type at HALE and the Montane and Subalpine types were merged into one map class. <i>Coprosma montana</i> / <i>Leptecophylla tameiameiae</i> Subalpine Shrubland was determined to be a rare class at HALE and was also merged into this shrubland map class.
	<i>Sophora chrysophylla</i> - <i>Dodonaea viscosa</i> - (<i>Leptecophylla tameiameiae</i>) Montane Shrubland [Park Special] ¹	
	<i>Coprosma montana</i> / <i>Leptecophylla tameiameiae</i> Subalpine Shrubland [Provisional] ¹	

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al (2012).

Table G2. Map classes modified from USNVC associations based on accuracy assessment data.

Map Class	USNVC Association	Description
<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Geranium cuneatum</i>) / <i>Deschampsia nubigena</i> Mesic Shrubland	<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Geranium cuneatum</i>) / <i>Deschampsia nubigena</i> Subalpine Mesic Shrubland ¹	This vegetation type is not restricted to the subalpine environment. Removed the elevation designation in the final map class.
<i>Leptecophylla tameiameiae</i> - (<i>Vaccinium reticulatum</i>) Montane and Subalpine Sparse Vegetation	<i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> Montane and Subalpine Sparse Vegetation ¹	This vegetation type may or may not be co-dominated by the shrub <i>Vaccinium reticulatum</i> .
<i>Metrosideros polymorpha</i> / (<i>Dicranopteris linearis</i> - <i>Sticherus owhyhensis</i> - <i>Diplopterygium pinnatum</i>) Montane Wet Woodland	<i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Montane Wet Woodland	All of these plots had substantial cover of <i>Sticherus owhyhensis</i> <i>Dicranopteris linearis</i> , and/or <i>Diplopterygium pinnatum</i> requiring recognition of these species in the map class name.

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al (2012).

Table G3. Map classes with no comparable USNVC association. These vegetation types were missed during classification and are of interest to park management.

Map Class	Description
<i>Metrosideros ploymorpha</i> / <i>Vaccinium reticulatum</i> - <i>Leptecophylla tameiameiae</i> Montane Mesic Dwarf Woodland	Dwarf <i>Metrosideros polymorpha</i> has significant cover in sections of Kuiki. This type was detected in multiple locations based on AA data and in the imagery and the map was updated to reflect this information.
Mixed Non-native Disturbed Herbaceous Vegetation	Highly disturbed non-native ephemeral environments which appear unvegetated at times (Nu'u) or dominated by non-native grasses not found in the USNVC (i.e. <i>Urochloa mutica</i> near 'Ohe'o).
Unclassified Polynesian Semi-natural Lowland Shrubland, Grassland, and Savanna	Inaccessible region of Nu'u. Due to remote location, the actual vegetation composition is unknown, and is mapped based on elevation.
Unclassified Polynesian Semi-natural Montane and Subalpine Shrubland and Grassland	Inaccessible region of upper Nu'u. Due to remote locations, the actual vegetation composition is unknown, and is mapped based on elevation.

Table G4. Map classes where polygons below the MMU were retained because they were of special interest to park management and were either evident on the imagery or field verified. Importantly, mapped ranges may not adequately represent the full distribution of small (<MMU) populations for these classes.

Map Class	Description
<i>Ageratina adenophora</i> - <i>Paspalum conjugatum</i> Semi-natural Herbaceous Bog	Bogs are ecologically important regardless of size. Additionally, they are easily identifiable in the imagery.
Built-up Commercial and Services	Easily identifiable in the imagery.
Built-up Transportation, Communications, and Utilities	Easily identifiable in the imagery.
<i>Carex (alligata, echinata, montis-eeka, thunbergii)</i> - (<i>Deschampsia nubigena</i>) Mixed Herbaceous Montane Bog	These high elevation bogs are critical habitat for rare plants at HALE.
<i>Cocos nucifera</i> Strand Woodland	<i>Cocos nucifera</i> is cultural significant to HALE and map class is easily identifiable in the imagery.
<i>Deschampsia nubigena</i> Montane and Subalpine Mesic Herbaceous Vegetation	Native grassland is of ecological importance to HALE.

Table G4 (continued). Map classes where polygons below the MMU were retained because they were of special interest to park management and were either evident on the imagery or field verified. Importantly, mapped ranges may not adequately represent the full distribution of small (<MMU) populations for these classes.

Map Class	Description
<i>Dubautia menziesii</i> - (<i>Argyroxiphium sandwicense</i>) Subalpine Sparse Vegetation	Ecologically important native subalpine shrubland.
<i>Leptecophylla tameiameia</i> - (<i>Vaccinium reticulatum</i>) Montane and Subalpine Sparse Vegetation	Kīpukas have ecological importance and are easily identifiable in the imagery.
<i>Leptecophylla tameiameia</i> - <i>Dodonaea viscosa</i> Montane Shrubland	Kīpukas have ecological importance and are easily identifiable in the imagery.
<i>Metrosideros polymorpha</i> / <i>Carex alligata</i> - (<i>Machaerina angustifolia</i>) Wet Woodland	Invasive species of concern with identifiable invasion.
<i>Myrsine lessertiana</i> - (<i>Metrosideros polymorpha</i>) / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Forest	Small polygon field verified near Paliku cabin.
<i>Phyllostachys nigra</i> Semi-natural Thicket	Important to map range of invasion, in even small areas. Additionally, this type is easily identifiable in the imagery.
<i>Portulaca lutea</i> Herbaceous Vegetation	This native coastal strand maps class only occurs in small areas of 'Ohe'o, a highly disturbed area of HALE. The range of this native community is ecologically significant.
<i>Pteridium aquilinum</i> ssp. <i>decompositum</i> Herbaceous Vegetation [Park Special]	Kīpukas have ecological importance and are easily identifiable in the imagery.
<i>Scaevola taccada</i> Coastal Dry Shrubland	Ecologically important native coastal shrub.
<i>Sophora chrysophylla</i> - (<i>Coprosma montana</i> - <i>Leptecophylla tameiameia</i> - <i>Dodonaea viscosa</i>) Subalpine Shrubland	Kīpukas have ecological importance and are easily identifiable in the imagery.
<i>Syzygium cumini</i> Lowland Mesic Semi-natural Forest	Invasive species of concern with identifiable invasion.
<i>Terminalia catappa</i> Semi-natural Woodland	Culturally important species.
Water	Easily identifiable in the imagery.
<i>Leptecophylla tameiameia</i> - <i>Dodonaea viscosa</i> Montane Shrubland	Kīpukas have ecological importance and are easily identifiable in the imagery.

Appendix H: Map Class Descriptions

This appendix describes the vegetated map classes for Haleakalā National Park. The purpose of these descriptions is to provide the map user with a comprehensive portrayal of each map class. For each vegetated map class the following is provided:

- Latin name
- Common name
- Map code
- USNVC_ELCODE
- A representative ground photograph of the map class. Photographs were selected from the classification, accuracy assessment (AA), calibration, and validation photos captured over the life of the vegetation inventory project.
- A representative portion of the Worldview2 infrared imagery of the map class. The polygons of the map class are delineated in yellow and the map code label of the map class (in yellow or black) has been inserted into or points to a representative number of the map class polygons.
- The USNVC Association(s) that comprise the map class.
- A description of the map class and how it was mapped. Where available and appropriate, USNVC local vegetation association descriptions were used as the map class description. When two associations comprise one map class, the USNVC association descriptions were combined. USNVC descriptions were sometimes edited for brevity to keep the map class descriptions to one page. If a USNVC description does not exist for the map class, the AA and/or classification data were used to create a simple map class description. The description also discusses the characteristics of the map class on infrared imagery and how AA sites were employed to correct draft map errors to produce the final map.
- The most abundant species found in the map class.
- The map class's distribution and location at HALE.
- For each map class, a table is also provided which presents the final map class's hectares, number of classification plots, draft map user accuracy, draft map producer accuracy, number of AA map samples, and number of AA reference samples. AA map samples are the total number of AA samples with the map label of the map class being described. AA reference samples are the total number of AA samples with the reference label of the map class. When the totals differ, it is because of either errors of omission (the map class was omitted from the map at the location of the sample) or commission (the map was erroneously labeled the map class at the location of the sample). Even when the sample numbers match, there can still be errors of commission or omission which offset each other. Most errors of commission or omission revealed during AA were corrected in the final map. Errors were not corrected if the secondary label of the AA site matched the map label, or if mapping personnel believed the AA sample label to be incorrect.

The map classes at HALE are based on the HALE USNVC plant associations and additional vegetation types discovered during the calibration, validation, and AA field work. Some of the USNVC associations exist only in rare, below minimum mapping unit (MMU) areas, and, therefore, do not occur on the map and do not have map class descriptions. Other USNVC associations were combined into one map class because they were impossible to distinguish from one another using remote sensing methods and prioritized field reconnaissance. Several map classes were not sampled during the classification effort and do not have USNVC associations or have associations developed for other PACN parks. Table 11 of the main body of the report, provides information about how map classes and USNVC associations relate to one another.

HALE Map Classes

MAP CODE: F_ACCHANSYCL

ELCODE: CEGL008185

Map Class Name: <i>Acacia koa</i> - <i>Cheirodendron trigynum</i> - (<i>Antidesma platyphyllum</i> , <i>Syzygium sandwicense</i>) / (<i>Clidemia hirta</i>) Lowland Wet Forest	Common Name: Koa - ‘Ōlapa - (Hame, ‘Ōhi‘a hā) / (Koster's curse) Lowland Wet Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Acacia koa* - *Cheirodendron trigynum* - (*Antidesma platyphyllum*, *Syzygium sandwicense*) / (*Clidemia hirta*) Lowland Wet Forest

Description: Characterized by an open to moderately closed mixed tree canopy codominated by *Acacia koa* and *Cheirodendron trigynum* ssp. *trigynum* with *Antidesma platyphyllum* and/or *Syzygium sandwicense* trees often present to codominant. *Metrosideros polymorpha* trees may be present with low cover. Trees such as *Psidium cattleianum* may be present to codominant with native trees. Native shrubs *Broussaia arguta*, *Clermontia arborescens* ssp. *waihae*, *Kadua* spp., *Vaccinium calycinum*, and fern *Sadleria pallida* and non-native *Clidemia hirta* are frequently present in the understory. This class was mapped using a combination of CART modeling and manual interpretation. It is distinguished by its location and its mixture of grey *Acacia koa* and smaller dark red *Metrosideros polymorpha* crowns mixed with deeper red *Cheirodendron trigynum* crowns. This highly accurate class was confused only with *Acacia koa* - *Metrosideros polymorpha* Wet Montane Woodland (two samples) and *Acacia koa* - *Metrosideros polymorpha* / *Dicranopteris linearis* Lowland Wet Forest (two samples) on the draft map.

Most Abundant Species: *Acacia koa*, *Antidesma platyphyllum*, *Cheirodendron trigynum*, *Syzygium sandwicensis*

Distribution/Location: This wet forest map class occurs entirely the in the lower Kīpahulu Valley near Fern, Dogleg and Ginger camps from 721-971m elevation. Stands are midslope on gentle to steep slopes.

Classification Samples: 8	Hectares: 156.10
User's Accuracy: 89%	Producer's Accuracy: 89%
Accuracy Assessment Map Samples: 18	Accuracy Assessment Reference Samples: 18

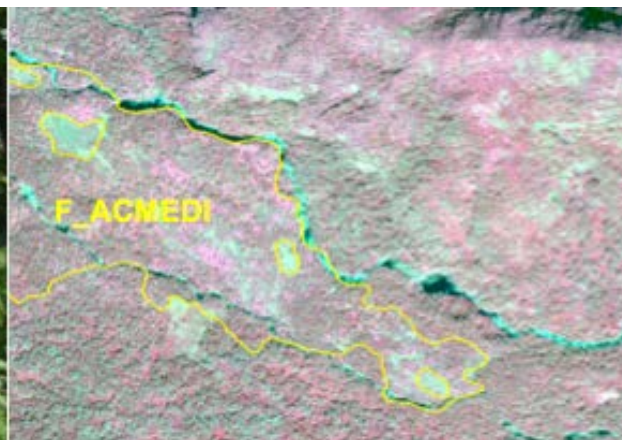
MAP CODE: F_ACMEDI

ELCODE: CEG008186

Map Class Name: <i>Acacia koa</i> - <i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Wet Forest	Common Name: Koa - 'Ōhi'a / Uluhe Lowland Wet Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Acacia koa* - *Metrosideros polymorpha* / *Dicranopteris linearis* Lowland Wet Forest

Description: Characterized by a moderate to dense tree canopy codominated by *Metrosideros polymorpha* and *Acacia koa* with each species having a least 1/3 cover of the other species. Scattered *Cheirodendron trigynum* ssp. *trigynum* or *Cibotium* spp. may be present in the subcanopy with low (<10%) cover. Non-native trees such as *Psidium cattleianum* may be present to codominant with native trees in disturbed stands. The understory is represented by a dense herbaceous layer dominated (>40% cover) of *Dicranopteris linearis*. This class was mapped using a combination of CART modeling and manual interpretation. It is distinguished by its location and the strong light pink of the *D. linearis* mats between the dark red *M. polymorpha* and grey *A. koa* crowns. Its draft map accuracies were low, with the class most commonly confused with *Acacia koa* - *Metrosideros polymorpha* Wet Montane Woodland (three samples), *Metrosideros polymorpha* / *Carex alligata* - (*Machaerina angustifolia*) Wet Woodland (two samples), and *Acacia koa* - *Cheirodendron trigynum* - (*Antidesma platyphyllum*, *Syzygium sandwicense*) / (*Clidemia hirta*) Lowland Wet Forest (two samples). The confusion with *Metrosideros polymorpha* / *Carex alligata* - (*Machaerina angustifolia*) Wet Woodland was corrected for the final map. The other types of confusion were not edited because samples occur in ecotones between classes.

Most Abundant Species: *Acacia koa*, *Dicranopteris linearis*, *Metrosideros polymorpha*

Distribution/Location: This forest map class occurs in the Kīpahulu Valley near Delta Camp and the lower shelf of Kīpahulu above Fern Camp. It is seen on mesic to very wet sideslopes or ridges from 810-940m elevation on gentle east and southeast aspects and steep west aspects.

Classification Samples: 2	Hectares: 273.72
User's Accuracy: 40%	Producer's Accuracy: 44%
Accuracy Assessment Map Samples: 10	Accuracy Assessment Reference Samples: 9

MAP CODE: W_ACMEHE

ELCODE: CEPS009700

Map Class Name: *Acacia koa* - *Metrosideros polymorpha* / *Hedychium gardnerianum* Semi-natural Woodland

Common Name: Koa - 'Ōhi'a / Kahili Ginger
Semi-natural Woodland



Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Acacia koa* - *Metrosideros polymorpha* / *Hedychium gardnerianum* Semi-natural Woodland [Park Special]

Description: This class is represented by one classification plot and one map polygon. It is characterized by a sparse canopy of *Metrosideros polymorpha* (18%) mixed with *Cheirodendron trigynum* ssp. *trigynum* (8%) and *Clermontia arborescens* ssp. *waihia* (6%). The understory is totally dominated by *Hedychium gardnerianum* (90%). This class was mapped using manual interpretation based on the one classification sample and occurs on the map only in this one field verified location. It is distinguished on the imagery by the bright pink mats of *Hedychium gardnerianum* with scattered crowns of *Metrosideros polymorpha* above. This class was not assessed for accuracy.

Most Abundant Species: *Acacia koa*, *Metrosideros polymorpha*, *Hedychium gardnerianum*

Distribution/Location: This map class occupies one polygon in Kīpahulu Valley facing on the southwest side of Kaukaui Gulch between 975 and 1035 m in elevation. HALE staff believes this type may occur up to 1250 m along the steep southwestern wall of Kīpahulu, but this area was not sampled.

Classification Samples: 1	Hectares: 1.85
User's Accuracy: Not Assessed	Producer's Accuracy: Not Assessed
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 0

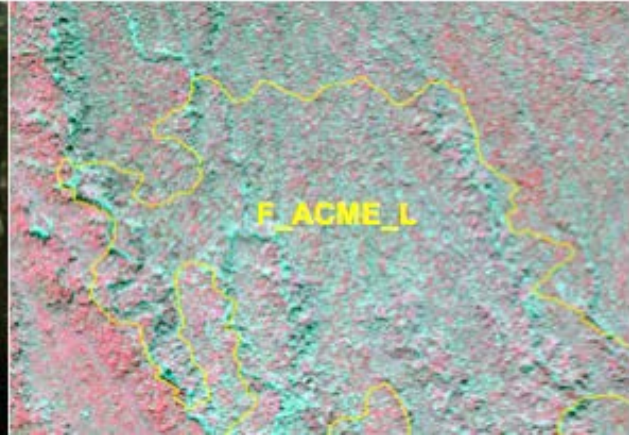
MAP CODE: F_ACME_L

ELCODE: CEG008023

Map Class Name: <i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Lowland Mesic Forest	Common Name: Koa - 'Ōhi'a Lowland Mesic Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Acacia koa* - *Metrosideros polymorpha* Lowland Mesic Forest

Description: This map class is characterized by a tall (10-15 m), closed tree canopy codominated by *Metrosideros polymorpha* and *Acacia koa* with *Antidesma platyphyllum* and *Melicope clusiifolia* codominant in the subcanopy. Non-native trees such as *Psidium cattleianum* may be present to codominant with native trees in disturbed stands. The non-native shrub *Clidemia hirta* and non-native fern *Cyathea cooperi* may also be present. This class was mapped using a combination of field reconnaissance, CART modeling and manual interpretation. It is distinguished by its location, its mixed grey *Acacia koa* and dark red *Metrosideros polymorpha* crowns and its lower amount of bright red *Psidium cattleianum* which occurs in the *Acacia koa* - *Psidium cattleianum* Semi-natural Forest map class. On the draft map this highly accurate map class was confused only with *Acacia koa* - *Psidium cattleianum* Semi-natural Forest (three samples) and *Acacia koa* - *Metrosideros polymorpha* Wet Montane Woodland (one sample). None of these areas were edited for the final map because they all had secondary reference labels of *Acacia koa* - *Metrosideros polymorpha* Lowland Mesic Forest.

Most Abundant Species: *Metrosideros polymorpha*, *Acacia koa*, *Psidium cattleianum*

Distribution/Location: This mesic forest map class occurs in two distinct areas. It exists in Ka'apahu on Razorback Ridge from 300-900m elevation and in the Kīpahulu Valley from 750-900m. These stands occur on moderately sloping (16 degrees) sideslopes with southerly aspects. HALE staff believe that this map class occurs in a wet (not mesic) environment in Kīpahulu and likely needs further refinement and description in the future.

Classification Samples: 1	Hectares: 131.26
User's Accuracy: 88%	Producer's Accuracy: 88%
Accuracy Assessment Map Samples: 17	Accuracy Assessment Reference Samples: 17

MAP CODE: W_ACME_W

ELCODE: CEG008187

Map Class Name: <i>Acacia koa</i> - <i>Metrosideros polymorpha</i> Wet Montane Woodland	Common Name: Koa - 'Ōhi'a Wet Montane Woodland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Acacia koa* - *Metrosideros polymorpha* Wet Montane Woodland

Description: This map class is characterized by an open to moderately closed tree canopy codominated by *Metrosideros polymorpha* and *Acacia koa* with a diverse understory. In the tree canopy, *Melicope clusiifolia* and *Cheirodendron trigynum* trees are frequently present and *Psidium cattleianum* may be present to codominant in disturbed stands. The understory is characterized by a diverse mix of wet shrub, fern and herbaceous species. This class was mapped using a combination of CART modeling and manual interpretation. It is distinguished on the imagery by its location, the dominance of grey *Acacia koa* crowns and its lower cover of deep red *Cheirodendron trigynum* crowns than found in the *Acacia koa* - *Cheirodendron trigynum* - (*Antidesma platyphyllum*, *Syzygium sandwicense*) / (*Clidemia hirta*) Lowland Wet Forest map class. The class has a high user accuracy, but low producer accuracy primarily because of errors of omission of *Acacia koa* - *Cheirodendron trigynum* - (*Antidesma platyphyllum*, *Syzygium sandwicense*) / (*Clidemia hirta*) Lowland Wet Forest (two samples), *Acacia koa* - *Metrosideros polymorpha* / *Dicranopteris linearis* Lowland Wet Forest (three samples), and *Metrosideros polymorpha* - *Cheirodendron trigynum* / (*Cibotium* spp.) Montane Wet Forest (two samples). These errors were not edited for the final map because they occur on ecotones between this class and the confused classes.

Most Abundant Species: *Acacia koa*

Distribution/Location: This wet woodland map class occurs extensively in the Kīpahulu Valley from 960-1250m and in Ka‘āpahu on Razorback Ridge from 960-1450m elevation. Sites occur on gentle to moderately steep (8-24 degrees) midslopes with northeast, south, and west aspects.

Classification Samples: 11	Hectares: 552.28
User's Accuracy: 91%	Producer's Accuracy: 56%
Accuracy Assessment Map Samples: 14	Accuracy Assessment Reference Samples: 18

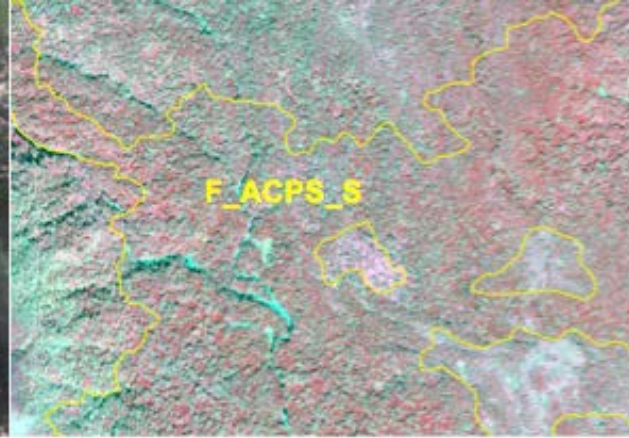
MAP CODE: F_ACPS_S

ELCODE: CEG008184

Map Class Name: <i>Acacia koa</i> - <i>Psidium cattleianum</i> Semi-natural Forest	Common Name: Koa - Strawberry Guava Semi-natural Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Acacia koa* - *Psidium cattleianum* Semi-natural Forest

Description: This map class is characterized by a moderately open (30%) emergent canopy of *Acacia koa* with a moderately closed understory tree canopy dominated by *Psidium cattleianum* (38-60%) to the near exclusion of other understory species. Tree associates in this understory canopy can include *Metrosideros polymorpha* (4-10%) and *Cheirodendron trigynum* (4-6%). The herbaceous layer is poorly developed with little or no cover (0-3%). This class was mapped using a combination of field reconnaissance, CART modeling and manual interpretation. It is distinguished on the imagery by the deep red understory of *Psidium cattleianum* with a scattered overstory of grey *Acacia koa* crowns. It is confused only with three samples of *Acacia koa* - *Metrosideros polymorpha* Lowland Mesic Forest which were not edited for the final map. During AA field crews had difficulty distinguishing between these two types and several field calls referenced both map classes. HALE staff believe that the distribution and exact boundaries of this map class may need to be refined.

Most Abundant Species: *Acacia koa*, *Psidium cattleianum*

Distribution/Location: This semi-natural, wet forest map class occurs extensively in the Kīpahulu Valley extending into Ka‘āpahu from 365-1160m. Sites occur on gentle to moderately steep (8-24 degrees) midslopes on all aspects.

Classification Samples: 2	Hectares: 414.64
User’s Accuracy: 50%	Producer’s Accuracy: 67%
Accuracy Assessment Map Samples: 4	Accuracy Assessment Reference Samples: 3

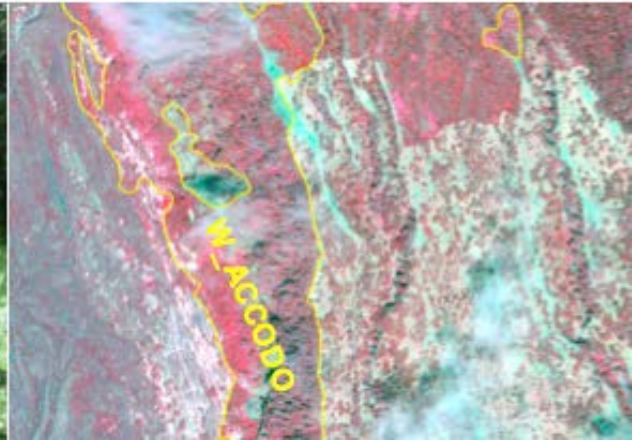
MAP CODE: W_ACCODO

ELCODE: CEG008188

Map Class Name: <i>Acacia koa</i> / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Woodland	Common Name: Koa / Pilo - 'A'ali'i Montane Mesic Woodland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Acacia koa* / *Coprosma foliosa* – *Dodonaea viscosa* Montane Mesic Woodland

Description: Class characterizes an area that was primarily *Cenchrus clandestinus* 20 years ago, but restoration in the mid 1990s resulted in a self-sustaining forest of moderately dense tree canopies dominated by *Acacia koa* with a dense, tall-shrub canopy codominated by *Coprosma foliosa* and *Dodonaea viscosa*. Additional trees present with low cover include *Myrsine lessertiana* and *Sophora chrysophylla*. Other native species may be present, such as *Pipturus albidus* and *Alyxia stellata*. *Leptecophylla tameiameia* is absent or has low cover. The herbaceous layer is generally sparse because of dense shading from shrub and tree layers. However, when there are gaps in the woody canopy, non-native grasses such as *Cenchrus clandestinus* or *Melinis minutiflora* may become abundant. This class was mapped using a combination of field reconnaissance, CART modelling, and manual interpretation. It is distinguished on the imagery by its location along the Kaupō trail and the mixture of grey *Acacia koa* crowns with bright red, tree-sized *Dodonaea viscosa*. It was confused on the draft map with *Myrsine lessertiana* – (*Metrosideros polymorpha*) / *Coprosma foliosa* – *Dodonaea viscosa* Montane Mesic Forest (two samples in one long thin polygon). The entire draft map polygon of *Myrsine lessertiana* – (*Metrosideros polymorpha*) / *Coprosma foliosa* – *Dodonaea viscosa* Montane Mesic Forest was relabelled *Acacia koa* / *Coprosma foliosa* – *Dodonaea viscosa* Montane Mesic Woodland.

Most Abundant Species: *Acacia koa*, *Coprosma foliosa*, *Dodonaea viscosa*

Distribution/Location: This woodland map class occurs on mesic montane sites in East Kaupō from 1290-1850m. Sites exist on the gentle to steep, west to southwest facing sideslopes east of the Kaupō trail.

Classification Samples: 2	Hectares: 64.19
User's Accuracy: 0%	Producer's Accuracy: 0%
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 3

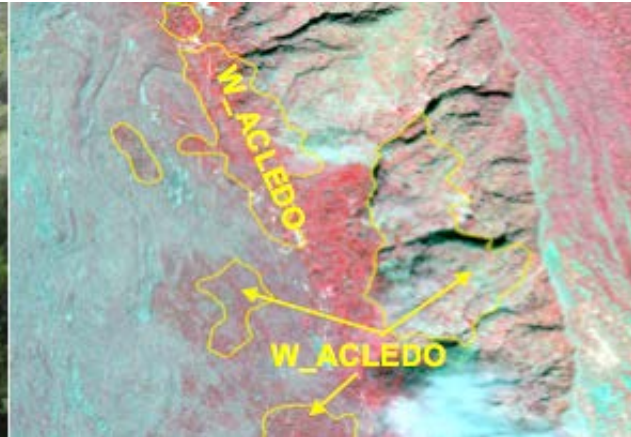
MAP CODE: W_ACLEDO

ELCODE: CEG008155

Map Class Name: <i>Acacia koa</i> / <i>Leptecophylla tameiameiae</i> - (<i>Dodonaea viscosa</i>) Montane Woodland	Common Name: Koa / Pūkiawe - ('A'ali'i) Montane Woodland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Acacia koa* / *Leptecophylla tameiameiae* - (*Dodonaea viscosa*) Montane Woodland¹

Description: This map class is characterized by an open tree canopy dominated by *Acacia koa* with an open to moderately dense tall-shrub canopy comprised primarily of *Leptecophylla tameiameiae* and *Dodonaea viscosa*. If present, *Metrosideros polymorpha* trees have low cover (<1/3 cover of *Acacia koa*). The short shrubs *Osteomeles anthyllidifolia*, *Sophora chrysophylla*, and *Vaccinium reticulatum* are frequently present with relatively low cover. *Coprosma foliosa* is typically absent. The herbaceous layer has moderate to dense cover and is dominated by non-native grasses *Cenchrus clandestinus* and *Melinis minutiflora*. Other than the ferns *Pteridium aquilinum* ssp. *decompositum* and *Sadleria cyatheoides*, native herbaceous species are uncommon. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is distinguished by its location and its grey *Acacia koa* crowns over dull red *Leptecophylla tameiameiae* and blue grey herbaceous species. The major draft map source of confusion was errors of commission of *Acacia koa* / *Leptecophylla tameiameiae* - (*Dodonaea viscosa*) Montane Woodland to *Metrosideros polymorpha* / *Sadleria cyatheoides* Forest (six samples in one polygon). These errors were corrected in the final map.

Most Abundant Species: *Acacia koa*, *Coprosma foliosa*, *Dodonaea viscosa*, *Leptecophylla tameiameiae*

Distribution/Location: This woodland map class occurs on mesic, montane sites ranging from 1100-2000m. It is seen in East Kaupō on gentle sideslopes along Kaupō Trail and on the steep, southwest facing sideslopes to the east of the trail.

Classification Samples: 2	Hectares: 46.1982
User's Accuracy: 75%	Producer's Accuracy: 33%
Accuracy Assessment Map Samples: 4	Accuracy Assessment Reference Samples: 9

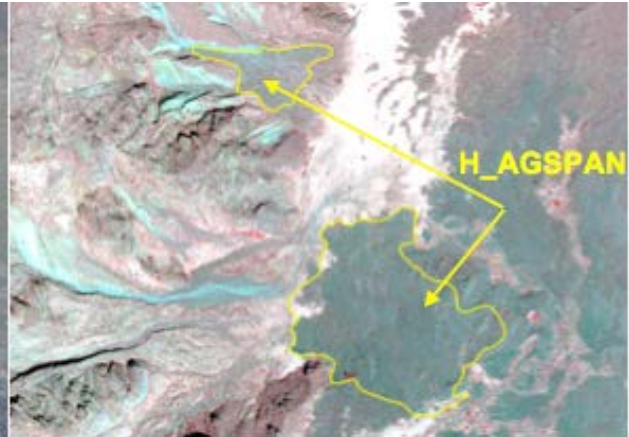
MAP CODE: H_AGSPAN

ELCODE: CEPS009701, CEPS009709

Map Class Name: <i>Ageratina adenophora</i> - (<i>Sporobolus africanus</i> - <i>Anthoxanthum odoratum</i>) Semi-natural Herbaceous Vegetation	Common Name: Maui Pamakani - (Rattail Grass - Sweet Vernalgrass) Semi-natural Herbaceous Vegetation
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Ageratina adenophora* - (*Pellaea ternifolia*, *Oenothera stricta*) Semi-natural Subalpine Herbaceous Vegetation [Park Special], *Sporobolus africanus* - *Anthoxanthum odoratum* Rock Slide Semi-natural Herbaceous Vegetation [Park Special]

Description: This map class is a combination of the *Ageratina adenophora* - (*Pellaea ternifolia*, *Oenothera stricta*) Semi-natural Subalpine Herbaceous Vegetation [Park Special] and *Sporobolus africanus* - *Anthoxanthum odoratum* Rock Slide Semi-natural Herbaceous Vegetation [Park Special] associations. It is characterized by herbaceous vegetation dominated by the non-native forb *Ageratina adenophora* and/or *Sporobolus africanus* mixed other herbaceous species such as *Oenothera* or *Pellaea ternifolia*. Total herbaceous cover is approximately 10-25%. Scattered short shrubs such as *Dodonaea viscosa* and *Leptecophylla tameiameia* are common, but at low covers. This highly accurate class was mapped using manual interpretation guided by the classification samples.

Most Abundant Species: *Ageratina adenophora*, *Oenothera stricta*, *Sporobolus africanus*

Distribution/Location: This uncommon herbaceous map class occurs in four polygons on east facing gentle slopes both north and south of Holua Cabin in West Crater from 2000-2300m.

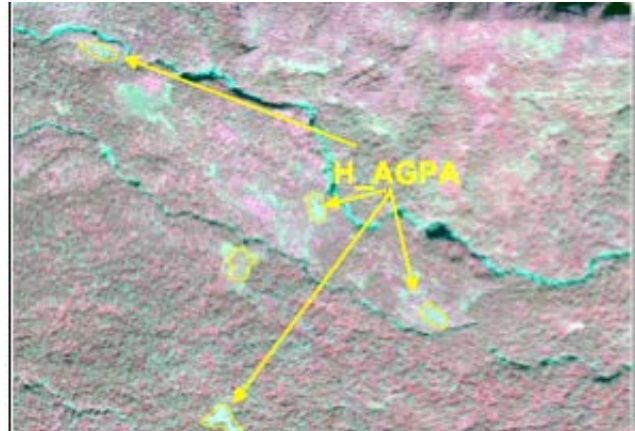
Classification Samples: 3	Hectares: 35.52
User's Accuracy: 100%	Producer's Accuracy: 100%
Accuracy Assessment Map Samples: 3	Accuracy Assessment Reference Samples: 3

MAP CODE: H_AGPA

ELCODE: CEPS009702

Map Class Name: <i>Ageratina adenophora</i> - <i>Paspalum conjugatum</i> Semi-natural Herbaceous Bog	Common Name: Maui Pamakani - Hilo Grass Semi-natural Herbaceous Bog
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No Ground Photo Available



Ground View

Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Ageratina adenophora* - *Paspalum conjugatum* Semi-natural Herbaceous Bog [Park Special]

Description: This map class is based on a single plot sample and is characterized by 50% cover of *Paspalum conjugatum* and 20% cover of *Ageratina adenophora*. A few scattered individuals of *Metrosideros polymorpha* and *Acacia koa* are present. Other graminoids present include *Sacciolepis indica*, *Cyperus haspan*, *Carex alligata*, and *Carex longii*. This class was mapped using manual interpretation. It is distinguishable on the imagery by its location and its smooth, light blue spectral signature. It received one accuracy assessment site of the draft map which was labeled *Metrosideros polymorpha* / *Carex alligata* - (*Machaerina angustifolia*) Wet Woodland by the accuracy assessment crews. This error was corrected in the final map.

Most Abundant Species: *Ageratina adenophora*, *Paspalum conjugatum*

Distribution/Location: This semi-natural herbaceous map class occurs in small isolated polygons exclusively in the Kīpahulu Valley on gentle southeast aspects along the Palikea Stream near Patti's Bog from 730 to 900m.

Classification Samples: 1	Hectares: 1.40
User's Accuracy: Not assessed	Producer's Accuracy: Not assessed
Accuracy Assessment Map Samples: 1	Accuracy Assessment Reference Samples: 0

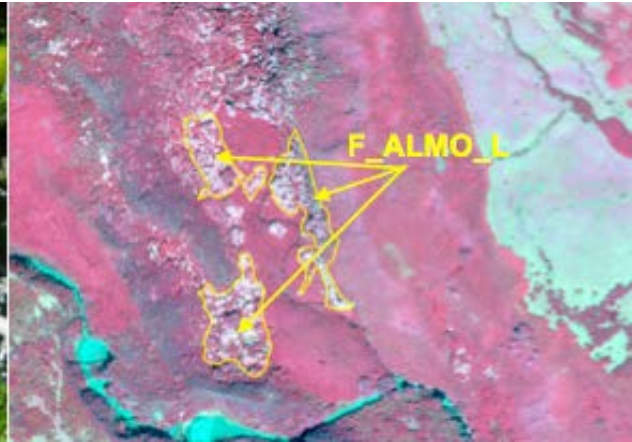
MAP CODE: F_ALMO_L

ELCODE: CEG008115

Map Class Name: <i>Aleurites moluccana</i> Lowland Wet Forest	Common Name: Kukui Lowland Wet Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Aleurites moluccana* Lowland Wet Forest

Description: This map class is characterized by a moderately dense canopy dominated by *Aleurites moluccana* (65-75%). No other canopy or sub-canopy associates occur with any constancy or at relevant cover. The shrub and herbaceous layers are poorly developed with low total cover. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. This highly accurate class is distinguishable on the imagery by its fluffy bright white canopies occurring at lower elevations.

Most Abundant Species: *Aleurites moluccana*

Distribution/Location: This lowland wet forest map class is known from Ka‘āpahu in Kālepa Gulch, Alelele Stream, Lelekea Stream, and from Lower Kīpahulu Valley along Pīpīwai Stream and Kaukau‘ai Gulch. Sites occur on gentle to moderately steep sideslopes with south and east facing aspects from 60-610m.

Classification Samples: 1	Hectares: 19.11
User’s Accuracy: 100%	Producer’s Accuracy: 100%
Accuracy Assessment Map Samples: 2	Accuracy Assessment Reference Samples: 2

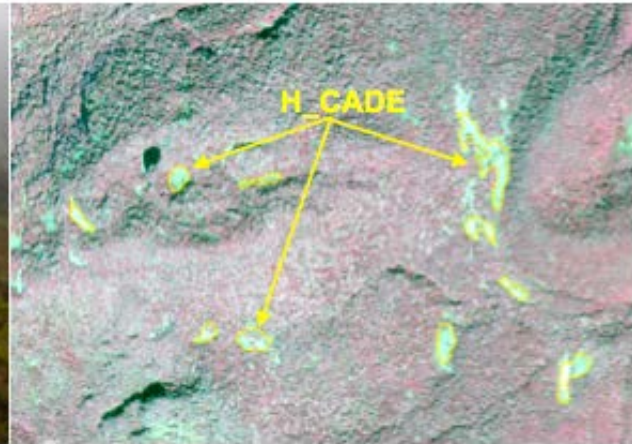
MAP CODE: H_CADE

ELCODE: CEG008190

Map Class Name: <i>Carex (alligata, echinata, montis-eeka, thunbergii) - (Deschampsia nubigena)</i> Mixed Herbaceous Montane Bog	Common Name: <i>Carex</i> spp. - (<i>Deschampsia nubigena</i>) Mixed Herbaceous Montane Bog
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Carex (alligata, echinata, montis-eeka, thunbergii) - (Deschampsia nubigena)* Mixed Herbaceous Montane Bog

Description: This map class is a diverse montane herbaceous bog characterized by a lush herbaceous layer with 65-90% cover dominated or codominated by *Carex alligata*, *Carex echinata*, *Carex montis-eeka*, and/or *Carex thunbergii*, which are indicator species of this type. *Argyroxiphium grayanum* and *Geranium hanaense* also have high diagnostic value, but exist at lower cover. *Athyrium microphyllum* and *Deschampsia nubigena* are prominent on some sites. Scattered trees or shrubs, especially *Metrosideros polymorpha*, *Cheirodendron trigynum ssp. trigynum*, *Rubus hawaiensis* or *Vaccinium calycinum*, may be present but do not form distinct layers. Disturbed sites may be codominated by *Holcus lanatus*. This map class was mapped using a combination of field reconnaissance, CART modeling and manual interpretation. This highly accurate class is characterized by its location and its pale blue, smooth herbaceous signature in the infrared imagery.

Most Abundant Species: *Carex alligata*, *Carex echinata*, *Carex montis-eeka*, *Carex thunbergii*

Distribution/Location: This native herbaceous wetland map class is known from near Smith Camp and far upper Kīpahulu Valley near Wai Anapanapa from 1645-2070 m in elevation. Sites are nearly level, sometimes with slight northern aspects. Positions are typically high level sites such as depressions on plateaus where the water table is very high with open water at the surface.

Classification Samples: 4	Hectares: 10.87
User's Accuracy: 100%	Producer's Accuracy: 100%
Accuracy Assessment Map Samples: 4	Accuracy Assessment Reference Samples: 4

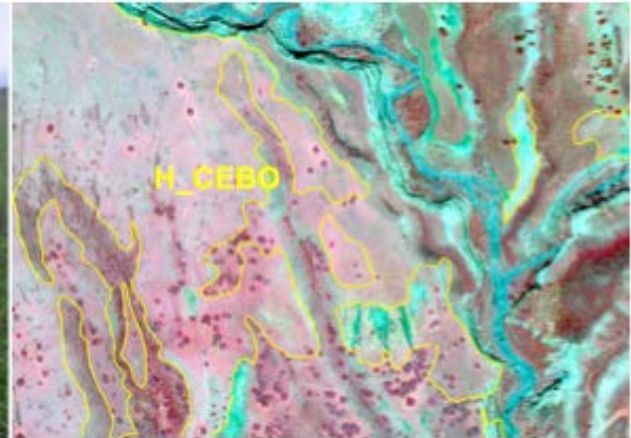
MAP CODE: H_CEBO

ELCODE: CEG008189, CEG005407

Map Class Name: <i>Cenchrus ciliaris</i> - <i>Bothriochloa pertusa</i> Semi-natural Herbaceous Vegetation	Common Name: Buffelgrass - Pitted Beardgrass Semi-natural Herbaceous Vegetation
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Bothriochloa pertusa* Semi-natural Grassland, *Cenchrus ciliaris* Semi-natural Herbaceous Vegetation¹

Description: This map class is a combination of the *Bothriochloa pertusa* Semi-natural Grassland and *Cenchrus ciliaris* Semi-natural Herbaceous Vegetation associations. It is dominated by non-native *Bothriochloa pertusa* and/ or *Cenchrus ciliaris* cover ranging from open to very dense. Other non-native herb and grass associates present may include *Spermacoce assurgens* and *Urochloa maxima*. The shrub *Lantana camara* is typically present, but does not exceed 5% cover. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is distinguished on the imagery from its location in the lower elevations of Nu‘u and its smooth pale pink spectral signature, devoid of trees or shrubs. On the draft map it was most commonly erroneously committed to *Lantana camara* Semi-natural Shrublands. Areas of all of these errors of commission were corrected in the final map.

Most Abundant Species: *Bothriochloa pertusa*, *Cenchrus ciliaris*

Distribution/Location: This semi-natural map class is known only from Nu‘u and occurs on gentle lowslopes with south, southeast and southwest aspects from 20-975m. Sites are disturbed and have been heavily grazed by goats.

Classification Samples: 6	Hectares: 176.97
User’s Accuracy: 73%	Producer’s Accuracy: 100%
Accuracy Assessment Map Samples: 40	Accuracy Assessment Reference Samples: 29

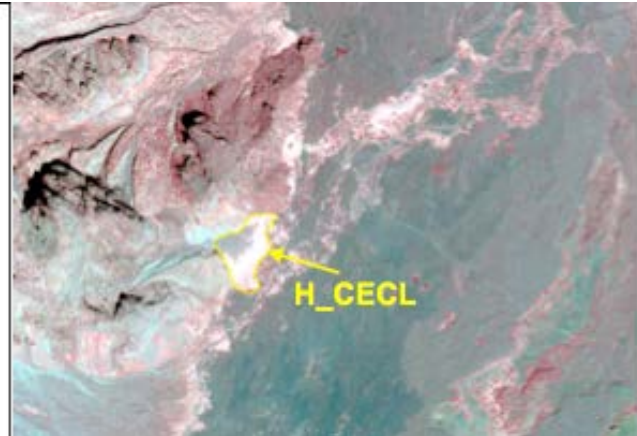
¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. 2012.

MAP CODE: H_CECL

ELCODE: CEG005408

Map Class Name: <i>Cenchrus clandestinus</i> Semi-natural Herbaceous Vegetation	Common Name: Kikuyu Grass Semi-natural Herbaceous Vegetation
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No Ground Photo Available



Ground View

Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Cenchrus clandestinus* Semi-natural Herbaceous Vegetation¹

Description: This herbaceous map class is characterized by two classification plots along Kaupō Trail and Kaupō A Trail. Those plots show it to have dense herbaceous layer that is strongly dominated by the non-native grass *Cenchrus clandestinus*, with up to 80% cover at times. Some stands in this class are transitioning to open woodland and typically have low cover of mixed trees or shrubs that sometimes exceeds 10% total cover, but do not form distinct tree or shrub canopies. In some cases, the canopy has significant cover from native trees such as *Myrsine lessertiana*, but this tree stand is overwhelmingly dominated by grasses. Many of these stands are likely transitioning from grassland to open woodlands; however, the dense herbaceous layer (80% cover) characterizes the vegetation, so they are classified as grasslands. This map class is mapped only where field verified. This rare map class is distinguished on the infrared imagery by its location and its pale white herbaceous signature. It received one accuracy assessment sample which was labeled *Holcus lanatus* Semi-natural Grassland and was edited to *Holcus lanatus* Semi-natural Grassland in the final map.

Most Abundant Species: *Cenchrus clandestinum*

Distribution/Location: This semi-natural herbaceous map class does not occur in polygons above the MMU in the area of the classification plots. Its one polygon occurs on a gentle south facing midslopes from 1150-1580 m elevation, near Hōlua. Please note that the northwest portion of polygon above includes a below the MMU area of *Ageratina adenophora* - (*Sporobolus africanus* - *Anthoxanthum odoratum*) Semi-natural Herbaceous Vegetation which was dissolved into the *Cenchrus clandestinus* Semi-natural Herbaceous Vegetation polygon.

Classification Samples: 1	Hectares: 1.20
User's Accuracy: 0	Producer's Accuracy: 0
Accuracy Assessment Map Samples: 1	Accuracy Assessment Reference Samples: 0

MAP CODE: H_CEPU

ELCODE: CEG008210

Map Class Name: <i>Cenchrus purpureus</i> Semi-natural Herbaceous Vegetation	Common Name: Napier Grass Semi-natural Herbaceous Vegetation
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Cenchrus purpureus* Semi-natural Herbaceous Vegetation¹

Description: This herbaceous map class is characterized by a dense herbaceous layer that is strongly dominated by the non-native grass *Cenchrus purpureus* with up to 90% cover. *Spermacoce assurgens*, *Urochloa maxima* and *Axonopus fissifolius* are common associates existing at low cover. *Schinus terebinthifolius*, and *Syzygium cumini* are usually present at low cover encroaching from adjacent non-native forests and woodlands. This map class was mapped using a combination of field reconnaissance, CART modeling and manual interpretation. It is distinguished by its location near the coast and its smooth pink herbaceous signature. This accurate map class confused with one *Pandanus tectorius* Coastal Mesic Forest sample on the draft map because of a below MMU island of *Pandanus tectorius* which occurred within the mostly grass polygon. The area was corrected for the final map.

Most Abundant Species: *Cenchrus purpureus*

Distribution/Location: This non-native herbaceous map class is known from ‘Ohe‘o near Kīpahulu Visitor Center and campground. Sites occur on gentle lowslopes with south and east aspects from 5-120m.

Classification Samples: 0	Hectares: 13.63
User’s Accuracy: 75%	Producer’s Accuracy: 75%
Accuracy Assessment Map Samples: 4	Accuracy Assessment Reference Samples: 4

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. 2012.

MAP CODE: W_CONU

ELCODE: CEG005402

Map Class Name: <i>Cocos nucifera</i> Strand Woodland	Common Name: Coconut Palm Strand Woodland
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USNVC Association: *Cocos nucifera* Strand Woodland

Description: The *Cocos nucifera* Strand Woodland map class was discovered during the calibration field trip. Because it occurs in areas below the minimum mapping unit, it was not sampled for classification or accuracy and does not have a HALE NatureServe description. However it was sampled at Kaloko-Honokōhau and Pu‘uhonua o Hōnaunau National Historical Parks where it was found to have an open tree canopy (20-30%) dominated by *Cocos nucifera* 5-10m tall. At those parks, trees found in the subcanopy may include *Thespesia populnea*, *Tournefortia argentea*, *Pandanus tectorius*, and *Morinda citrifolia*. At those parks, the shrub layer is absent to moderate and may include *Scaevola taccada* and *Passiflora suberosa*. It is distinguishable on the imagery by the distinct star like shape of the *Cocos nucifera* crowns.

Most Abundant Species: *Cocos nucifera*

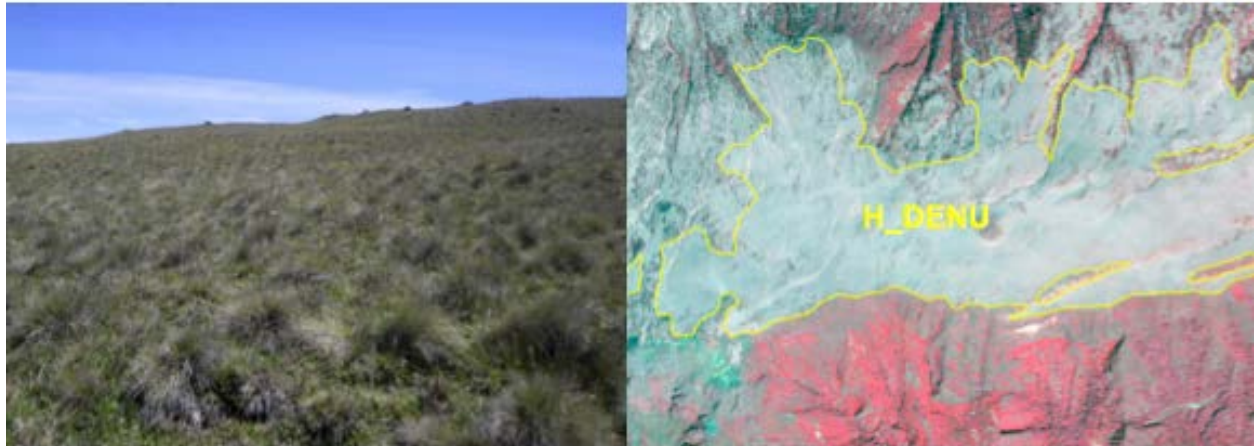
Distribution/Location: This map class occurs in one polygon on the coast at Ka‘āpahu Bay.

Classification Samples: 0	Hectares: 0.15
User’s Accuracy: Not Assessed	Producer’s Accuracy: Not Assessed
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 0

MAP CODE: H_DENU

ELCODE: CEG008085

Map Class Name: <i>Deschampsia nubigena</i> Montane and Subalpine Mesic Herbaceous Vegetation	Common Name: <i>Deschampsia nubigena</i> Montane and Subalpine Mesic Herbaceous Vegetation
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Ground View

Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Deschampsia nubigena* Montane and Subalpine Mesic Herbaceous Vegetation

Description: This map class is characterized by open to dense herbaceous vegetation dominated by *Deschampsia nubigena*. *Trisetum glomeratum* and/or *Pteridium aquilinum* ssp. *decompositum* may be present to codominant in some stands. Scattered shrubs, particularly *Leptecophylla tameiameiae* and *Vaccinium reticulatum*, may be present but do not form a layer. Non-native grasses are common associates and may include *Anthoxanthum odoratum*, *Holcus lanatus*, and *Poa pratensis*. *Holcus lanatus* is a codominant in some disturbed stands. This highly accurate map class was mapped using a combination of field reconnaissance, CART modeling and manual interpretation. It is distinguished on the imagery by its location and its smooth pale pink herbaceous signature in the infrared imagery.

Most Abundant Species: *Deschampsia nubigena*, *Holcus lanatus*

Distribution/Location: This map class is known from locations in South Crater at Kapāloa‘a, East Crater at Kaluanui, West Crater at base of Kalahaku Pali, Waikau, upper Kīpahulu Valley and Pōhaku āpālaha. Sites occur on flat to moderate high slopes (0-18 degrees) with northwest, north, east and southeast aspects from 2125-2800m. Sites range from dry to mesic. This map class also exists at lower elevations in the crater in isolated pockets to the west of Palikū Cabin.

Classification Samples: 8	Hectares: 134.53
User’s Accuracy: 100%	Producer’s Accuracy: 100%
Accuracy Assessment Map Samples: 20	Accuracy Assessment Reference Samples: 20

MAP CODE: S_DONI_M**ELCODE: CEPS009668**

Map Class Name: <i>Dodonaea viscosa</i> Montane Mesic Shrubland	Common Name: ‘A‘ali‘i Montane Mesic Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Dodonaea viscosa* Montane Mesic Shrubland [Park Special]

Description: This map class is characterized by a moderate to dense shrub layer that is dominated by almost tree sized *Dodonaea viscosa* from 25-80% with *Leptecophylla tameiameiae* commonly occurring from low to moderate cover. The occasional *Metrosideros polymorpha* and *Sophora chrysophylla* are present at low cover. The herbaceous understory is variable and can be well or poorly developed. Common herbaceous species include *Ageratina adenophora*, *Melinis minutiflora*, and *Holcus lanatus*. This uncommon map class was mapped from field reconnaissance and manual interpretation. It is characterized by its location along the Kaupō Trail and the bright red, roundish crowns of the *Dodonaea viscosa* intermixed with the bluish-pink *Leptecophylla tameiameiae* understory in the infrared imagery. In the draft map it is confused with *Leptecophylla tameiameiae* - *Dodonaea viscosa* Montane Shrubland (two samples- both edited in the final map to the correct label) and *Acacia koa* / *Leptecophylla tameiameiae* - (*Dodonaea viscosa*) Montane Woodland (one sample – not edited because the secondary reference label was *Acacia koa* / *Leptecophylla tameiameiae* - (*Dodonaea viscosa*) Montane Woodland).

Most Abundant Species: *Dodonaea viscosa*

Distribution/Location: This mesic montane shrub dominated map class is known from Kaupō south of Palikū along the Kaupō Trail and from isolated pockets elsewhere in the Crater from Honokahua extending down the Kaupō Gap near the southern boundary. Sites typically occur on gentle to moderate south facing slopes from 1200-2000m.

Classification Samples: 1	Hectares: 9.03
User's Accuracy: 75%	Producer's Accuracy: 60%
Accuracy Assessment Map Samples: 4	Accuracy Assessment Reference Samples: 5

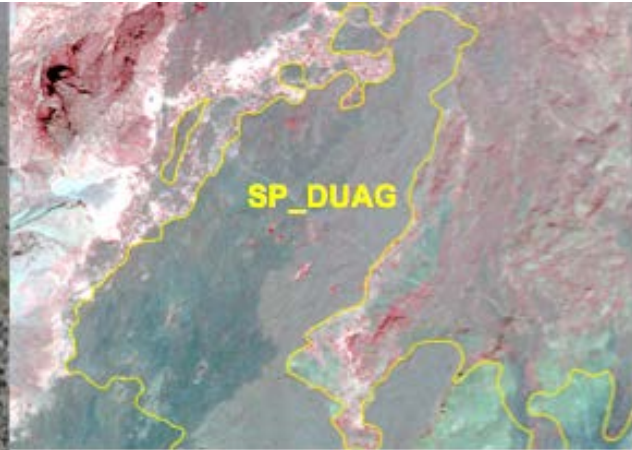
MAP CODE: SP_DUAG

ELCODE: CEG008192

Map Class Name: <i>Dubautia menziesii</i> - (<i>Argyroxiphium sandwicense</i>) Subalpine Sparse Vegetation	Common Name: Na'ena'e - ('Āhinahina) Subalpine Sparse Vegetation
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Dubautia menziesii* - (*Argyroxiphium sandwicense*) Subalpine Sparse Vegetation

Description: This subalpine map class is generally characterized by a sparse cover of shrub *Dubautia menziesii*, sometimes with scattered *Leptecophylla tameiameia*. *Argyroxiphium sandwicense* ssp. *macrocephalum* is a diagnostic forb species that ranges from present to 8% cover. Other characteristic dry subalpine taxa include *Tetramolopium humile* ssp. *haleakalae* and *Trisetum glomeratum*. *Rumex acetosella*, a non-native forb, is present in one plot. This sparse map class was mapped with a combination of field reconnaissance, CART modeling, and manual interpretation. It is distinguished on the infrared imagery by its location and the small red dots of vegetation scattered within grey expanses of unvegetated areas. In the draft map it was most commonly confused with unvegetated, with five samples having a draft map label of *Dubautia menziesii* - (*Argyroxiphium sandwicense*) Subalpine Sparse Vegetation and a reference label of unvegetated. All five samples were corrected for the final map.

Most Abundant Species: *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Dubautia menziesii*, *Tetramolopium humile* ssp. *haleakalae*, *Trisetum glomeratum*

Distribution/Location: This sparse vegetation map class is found in the dry subalpine zone near the Visitor Center at Pakaoao and in West Crater along Sliding Sands trail and in the Ko'olau Gap near Hōlua Cabin. It occurs from 2070-2825m on northern aspects on gentle to moderate slopes.

Classification Samples: 2	Hectares: 276.16
User's Accuracy: 70%	Producer's Accuracy: 88%
Accuracy Assessment Map Samples: 20	Accuracy Assessment Reference Samples: 16

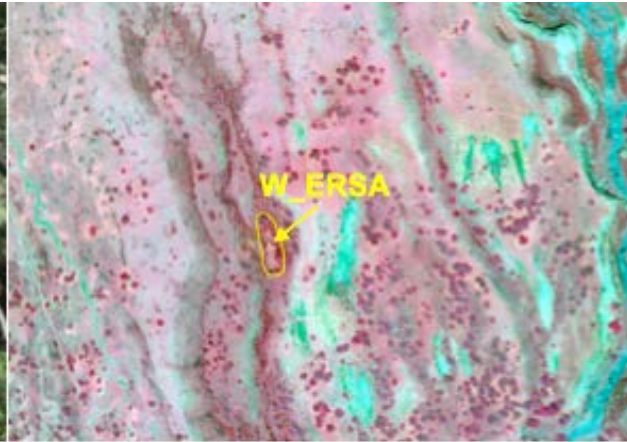
MAP CODE: W_ERSA

ELCODE: CEG008036

Map Class Name: <i>Erythrina sandwicensis</i> Lowland Dry Woodland	Common Name: Wiliwili Lowland Dry Woodland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Erythrina sandwicensis* Lowland Dry Woodland

Description: This coastal lowland map class is characterized by an open tree canopy dominated by *Erythrina sandwicensis*. Widespread, non-native tree *Prosopis pallida* is often present to codominant with a subcanopy or tall-shrub layer dominated by *Leucaena leucocephala*. The understory is characterized by a moderate to dense herbaceous layer dominated by non-native grasses *Urochloa maxima* and *Cenchrus ciliaris*. This rare map class was mapped using field reconnaissance and manual interpretation. Its accuracy is low. One of the samples mapped as *Erythrina sandwicensis* Dry Lowland Woodland in the draft map received a reference label of *Prosopis pallida* Coastal Dry Semi-natural Woodland and a secondary reference label of *Erythrina sandwicensis* Dry Lowland Woodland. Therefore, this area was not edited for the final map. The one sample which showed error of omission of this class was edited to *Erythrina sandwicensis* Dry Lowland Woodland in the final map.

Most Abundant Species: *Erythrina sandwicensis*

Distribution/Location: This woodland map class is uncommon and seen only in two polygons in the Western Nu'u Gulch between 120 and 200 meters in elevation.

Classification Samples: 1	Hectares: 1.18
User's Accuracy: 0%	Producer's Accuracy: 0%
Accuracy Assessment Map Samples: 1	Accuracy Assessment Reference Samples: 1

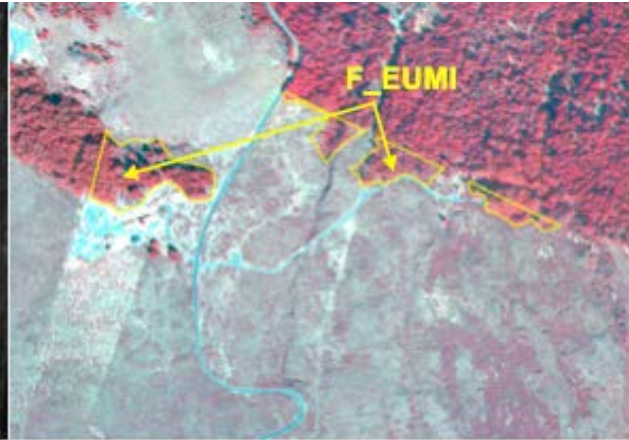
MAP CODE: F_EUMI

ELCODE: CEG008144, CEPS009672

Map Class Name: <i>Eucalyptus</i> spp. - Mixed Semi-natural Forest	Common Name: <i>Eucalyptus</i> spp. - Mixed Semi-natural Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Eucalyptus* spp. - Mixed Alien Semi-natural Forest/Plantation [Provisional], Mixed Forest Plantation [Park Special]

Description: This map class is a combination of the *Eucalyptus* spp. - Mixed Alien Semi-natural Forest/Plantation [Provisional] and the Mixed Forest Plantation [Park Special] associations. It is characterized by a moderately closed tree canopy of *Eucalyptus* spp. with 0-50% cover. Other species include *Pinus* spp., *Coprosma montana*, and *Sophora chrysophylla*. The shrub layer is poorly to moderately well developed (1-12%) and often dominated by *Leptecophylla tameiameiae* with *Dodonaea viscosa* less common. The herbaceous understory is typically sparse with up to 5% total cover. This highly accurate class was mapped using field reconnaissance, CART modeling, and manual interpretation. It is distinguished on the infrared imagery by the bright red crowns of the mostly closed canopy of tall, mature non-native trees.

Most Abundant Species: *Eucalyptus* spp., *Pinus* spp.

Distribution/Location: This non-native forest plantation map class occurs near park headquarters in large polygons of non-native forest and in one long, mostly continuous gully forested with *Eucalyptus* spp. in the southwest corner of the park. Despite the high accuracy of this map class, it is recommended that it be re-evaluated in future mapping efforts due to the rate of invasion of *Pinus* spp.. It is plausible that over time *Pinus* spp. will become the dominant species, changing the dynamics and description of this non-native map class.

Classification Samples: 2	Hectares: 8.68
User's Accuracy: 100%	Producer's Accuracy: 100%
Accuracy Assessment Map Samples: 4	Accuracy Assessment Reference Samples: 4

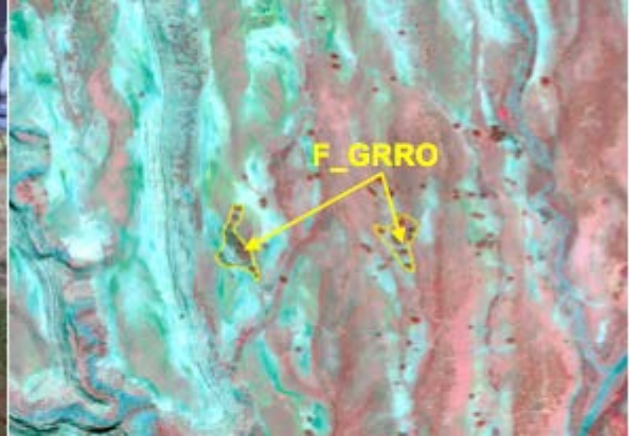
MAP CODE: F_GRRO

ELCODE: CEG008113

Map Class Name: <i>Grevillea robusta</i> Lowland Mesic Semi-natural Forest	Common Name: Silk Oak Lowland Mesic Semi-natural Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Grevillea robusta* Lowland Mesic Semi-natural Forest

Description: This map class is characterized by a moderately dense tree canopy dominated by *Grevillea robusta* with up to 30% cover. The shrub layer is comprised entirely of *Lantana camara* with up to 12% cover. The herbaceous layer is relatively well developed and consists primarily of *Spermacoce* spp. with up to 16% cover. This highly accurate map class was mapped using field reconnaissance and manual interpretation. It is distinguished on the imagery by its location and the tree crowns of *Grevillea robusta* which are smaller and darker red than nearby *Prosopis pallida*.

Most Abundant Species: *Grevillea robusta*

Distribution/Location: This lowland mesic forest map class is known only from one area in Nu'u. Sites occur on gentle to moderate sideslopes with southerly aspects at 260m. Sites are browsed by feral goats, deer, and pigs and show evidence of disturbance from its ranching history.

Classification Samples: 1	Hectares: 1.15
User's Accuracy: 100%	Producer's Accuracy: 100%
Accuracy Assessment Map Samples: 1	Accuracy Assessment Reference Samples: 1

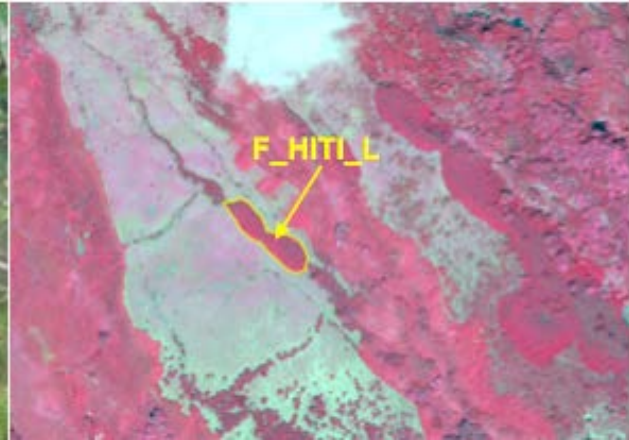
MAP CODE: F_HITI_L

ELCODE: CEG008163

Map Class Name: <i>Hibiscus tiliaceus</i> Lowland Wet Forest	Common Name: Hau Lowland Wet Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Hibiscus tiliaceus* Lowland Wet Forest [Provisional]

Description: This lowland map class is characterized by a dense tree canopy dominated by *Hibiscus tiliaceus*, possibly an early Polynesian introduction. Typically there is no or minimal understory layers because the high cover of *Hibiscus tiliaceus* shades out other species. Scattered non-native shrubs *Clidemia hirta* and *Rubus rosifolius* and the fern *Cyclosorus dentatus* may be present. This class was mapped using field reconnaissance and manual interpretation. It is distinguished on the infrared imagery by the smooth deep red spectral signature of the closed canopy of the *Hibiscus tiliaceus* trees. On the draft map, one polygon of *Hibiscus tiliaceus* Lowland Wet Forest was confused with *Psidium cattleianum* Lowland Wet Semi-natural Forest. This error was corrected in the final map.

Most Abundant Species: *Hibiscus tiliaceus*

Distribution/Location: This wet lowland forest map class exists in several locations in Kaumakani from ‘Ohe‘o Gulch to Pua‘alu‘u Gulch and in Kaapahu. It occurs on moderately steep sideslopes with a midslope topographic position from 120 to 340m.

Classification Samples: 1	Hectares: 4.56
User’s Accuracy: 100%	Producer’s Accuracy: 50%
Accuracy Assessment Map Samples: 1	Accuracy Assessment Reference Samples: 2

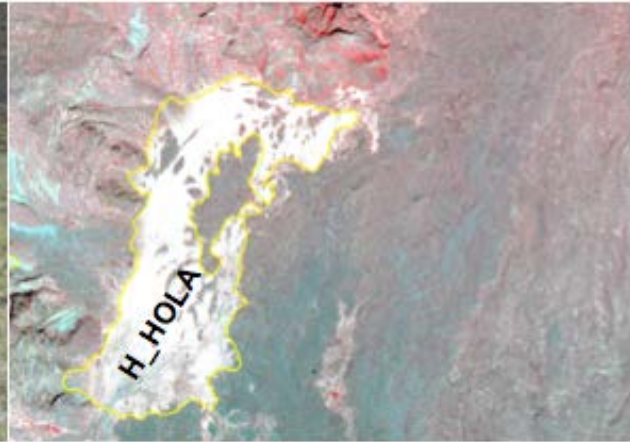
MAP CODE: H_HOLA

ELCODE: CEG008193

Map Class Name: <i>Holcus lanatus</i> Semi-natural Grassland	Common Name: Common Velvet Grass Semi-natural Grassland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Holcus lanatus* Semi-natural Grassland [Provisional]

Description: This map class is strongly dominated by non-native grass *Holcus lanatus*. Non-native grass *Poa pratensis* may be present to codominant in some stands. If native grasses are present, such as *Deschampsia nubigena*, then *Holcus lanatus* has over twice as much cover. *Rumex acetosella* is a common associate, but at low cover. This map class was mapped using field reconnaissance, CART modeling and manual interpretation. It is characterized by its high elevation location and its smooth bluish pink herbaceous spectral signature. This highly accurate map class was most often confused *Pteridium aquilinum* ssp. *decompositum* Herbaceous Vegetation (three samples) on the draft map. The areas of all three samples were edited to their correct label for the final map.

Most Abundant Species: *Holcus lanatus*, *Poa pratensis*

Distribution/Location: This semi-natural grassland map class is known from Waikau, Hōlua and the East Crater in the subalpine zone. Sites exist on high slopes and high level positions at elevations ranging from approximately 1950-2400m.

Classification Samples: 3	Hectares: 176.89
User's Accuracy: 80%	Producer's Accuracy: 92%
Accuracy Assessment Map Samples: 15	Accuracy Assessment Reference Samples: 13

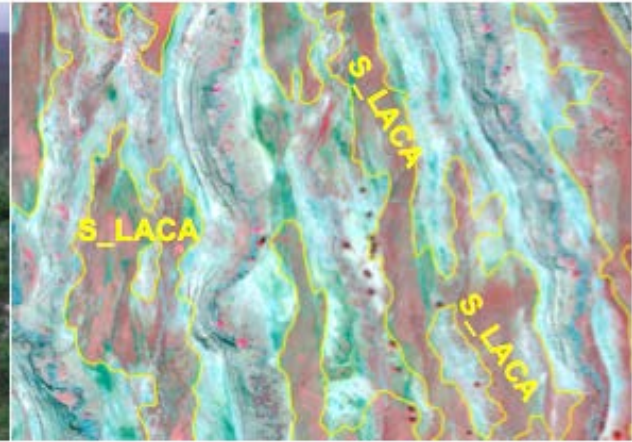
MAP CODE: S_LACA

ELCODE: CEG008145

Map Class Name: <i>Lantana camara</i> Semi-natural Shrubland	Common Name: <i>Lantana</i> Semi-natural Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Lantana camara* Semi-natural Shrubland [Provisional]

Description: This map class is characterized by an open, short shrub layer dominated by *Lantana camara*. *Leucaena leucocephala* may be present at low cover (<10 % cover). A variety of other shrubs may occur, such as *Indigofera suffruticosa*, but none codominate. The herbaceous layer is strongly dominated by non-native species, including *Ageratum conyzoides*, *Bothriochloa pertusa*, and *Spermacoce* spp.. This map class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is distinguished on the infrared imagery by its location, and its smooth buff coloured spectral signature in the infrared imagery. On the draft map, this class was often committed in error to either *Cenchrus ciliaris* - *Bothriochloa pertusa* Semi-natural Herbaceous Vegetation (nine samples) or *Leucaena leucocephala* Lowland Dry Semi-natural (three samples). The areas of these errors were extensively edited to *Lantana camara* Semi-natural Shrubland for the final map.

Most Abundant Species: *Lantana camara*, *Bothriochloa pertusa*

Distribution/Location: This semi-natural shrubland map class is known only from a few locations in Nu‘u on low, gentle to moderate slopes with southern aspects at elevations ranging from 100-900 m. All areas have been heavily grazed by goats.

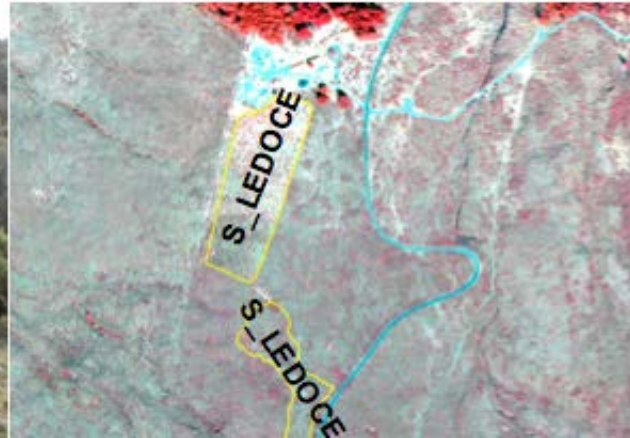
Classification Samples: 5	Hectares: 244.53
User’s Accuracy: 100%	Producer’s Accuracy: 59%
Accuracy Assessment Map Samples: 17	Accuracy Assessment Reference Samples: 29

MAP CODE: S_LEDOCE**ELCODE: CEG008194**

Map Class Name: <i>Leptecophylla tameiameiae</i> - (<i>Dodonaea viscosa</i>) / <i>Cenchrus clandestinus</i> Montane - Subalpine Mesic Semi-natural Shrubland	Common Name: Pūkiawe - ('A'ali'i) / Kikuyu Grass Montane - Subalpine Mesic Semi-natural Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Leptecophylla tameiameiae* - (*Dodonaea viscosa*) / *Cenchrus clandestinus*
Montane - Subalpine Mesic Semi-natural Shrubland¹

Description: This map class is characterized by open to moderately dense shrublands (10-30% cover) dominated by *Leptecophylla tameiameiae* with *Dodonaea viscosa* sometimes present to codominant. *Vaccinium reticulatum* is absent or has low cover. Herbaceous cover is moderately dense to dense (60-90% cover) and is strongly dominated by *Cenchrus clandestinus*. This class was mapped using field reconnaissance, CART modeling and manual interpretation. It is characterized on the infrared imagery by its location and by the scattered pinkish blue *Leptecophylla tameiameiae* shrubs with the dense, bright, off-white *Cenchrus clandestinus* cover in-between. This class is confused on the draft map with similar map classes such as *Leptecophylla tameiameiae* - *Dodonaea viscosa* Montane Shrubland (one sample) or *Sophora chrysophylla* - (*Coprosma montana* - *Leptecophylla tameiameiae* - *Dodonaea viscosa*) Subalpine Shrubland (one sample). These areas were not edited in the final map because map labels in this area of the park are easily affected by slight differences in estimates of species cover.

Most Abundant Species: *Dodonaea viscosa*, *Cenchrus clandestinus*, *Leptecophylla tameiameiae*

Distribution/Location: This map class is known from mesic montane and subalpine zones in currently used pastures in the Front Country and near Kaupō trail in East Kaupō. Sites are on midslopes with southeast to south aspects and gentle to moderate slopes (6-17 degrees) at elevations from 1100-2100m.

Classification Samples: 3	Hectares: 10.08
User's Accuracy: 75%	Producer's Accuracy: 75%
Accuracy Assessment Map Samples: 4	Accuracy Assessment Reference Samples: 4

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. 2012.

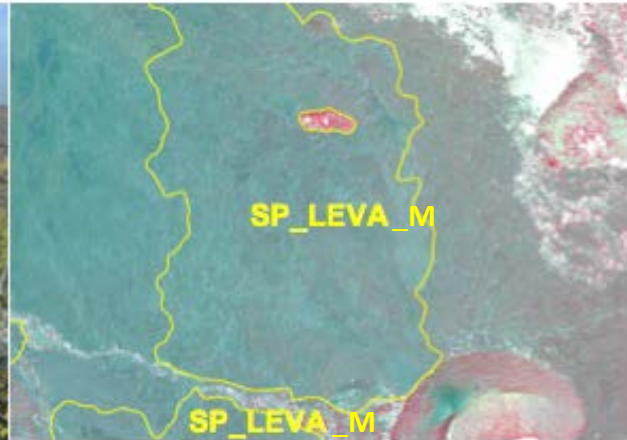
MAP CODE: SP_LEVA_M

ELCODE: CEG008178

Map Class Name: <i>Leptecophylla tameiameiae</i> - (<i>Vaccinium reticulatum</i>) Montane and Subalpine Sparse Vegetation	Common Name: Pūkiawe - (‘Ōhelo) Montane and Subalpine Sparse Vegetation
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Leptecophylla tameiameiae* - *Vaccinium reticulatum* Montane and Subalpine Sparse Vegetation¹

Description: Characterized by open to sparse shrublands dominated by *Leptecophylla tameiameiae* and codominated by *Vaccinium reticulatum*. *Dubautia menziesii*, *Coprosma ernodeoides*, and *Coprosma montana* are common shrub associates and exist at low cover. The herbaceous layer is represented by the fern *Pellaea ternifolia* which occurs at low cover and is the only herbaceous species of significance. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is distinguished by its location and its sparse scattering of reddish grey *Leptecophylla tameiameiae* shrubs. On the draft map, this highly accurate class was confused only with similar classes such as *Leptecophylla tameiameiae* - *Vaccinium reticulatum* Subalpine Mesic Shrubland (two samples) or *Dubautia menziesii* - (*Argyroxiphium sandwicense*) Subalpine Sparse Vegetation (one sample). It was not edited for the final map because the confused samples fell on ecotones between the confused classes.

Most Abundant Species: *Leptecophylla tameiameiae*

Distribution/Location: This sparse montane to subalpine map class is known from the Front Country west of Kalahaku Overlook and from Haleakala Crater in Ko‘olauKo‘olau Gap, along Halemau‘u Trail near ‘O‘ili Pu‘u, and along Sliding Sands Trail near Pu‘u Maile and south of Pu‘u o Pele. Sites occur on flat to gentle and moderately steep sideslopes with north, northwest and southeast aspects from 1820-2800m.

Classification Samples: 1	Hectares: 298.65
User’s Accuracy: 81%	Producer’s Accuracy: 93%
Accuracy Assessment Map Samples: 16	Accuracy Assessment Reference Samples: 14

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. 2012.

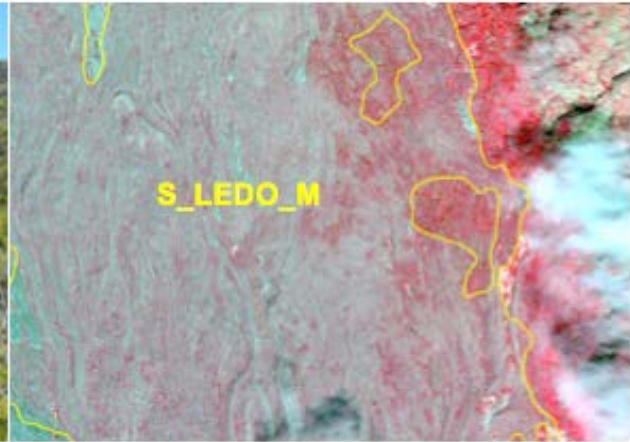
MAP CODE: S_LED0_M

ELCODE: CEG008172

Map Class Name: <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Shrubland	Common Name: Pūkiawe - 'A'ali'i Montane Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Leptecophylla tameiameiae* - *Dodonaea viscosa* Montane Shrubland¹

Description: This map class is characterized by open to moderately dense shrublands codominated by *Leptecophylla tameiameiae* and *Dodonaea viscosa*. Total shrub cover ranges from 10-80% cover, and either of the two nominal species may dominate or codominate with each species having 1/3 or more the cover of the other. *Osteomeles anthyllidifolia* is typically present to codominant and is a good indicator of montane shrublands. *Vaccinium reticulatum* is absent or has low cover. Herbaceous cover may be sparse or range up to 40% cover. This map class was mapped using field reconnaissance, CART modeling, and manual interpretation. It is characterized on the infrared imagery by its location and its red scattered crowns of *Leptecophylla tameiameiae* and *Dodonaea viscosa* with a sparse grey-blue herbaceous cover. On the draft map this class was confused only with similar map classes such as *Leptecophylla tameiameiae* Montane Mesic Shrubland (four samples) and *Leptecophylla tameiameiae* - *Dodonaea viscosa* Montane Shrubland (one sample). The areas of confusion was edited in some portions of the final map, but not when it was believed that the draft map label was correct.

Most Abundant Species: *Deschampsia nubigena*, *Dodonaea viscosa*, *Osteomeles anthyllidifolia*, *Leptecophylla tameiameiae*

Distribution/Location: This map class is known from dry to mesic montane and subalpine zones in East, Central and West Kaupō and the west facing sideslope below Kuiki. Sites are on gentle to moderate midslopes (6-17 degrees) with southeast, south and west aspects at elevations ranging from 1150-2100m.

Classification Samples: 8	Hectares: 620.09
User's Accuracy: 79%	Producer's Accuracy: 61%
Accuracy Assessment Map Samples: 14	Accuracy Assessment Reference Samples: 18

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. 2012.

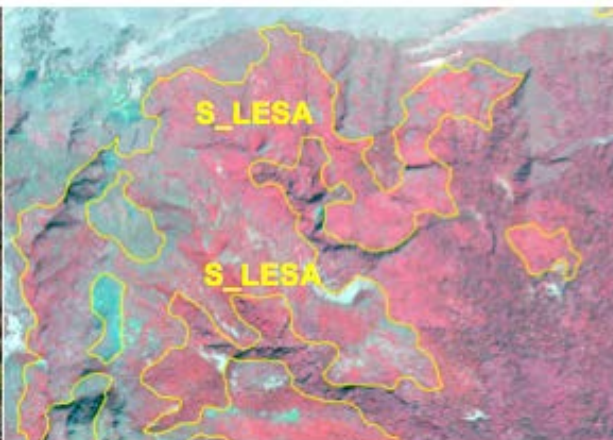
MAP CODE: S_LESA

ELCODE: CEG008196

Map Class Name: <i>Leptecophylla tameiameiae</i> - <i>Sadleria cyatheoides</i> Subalpine Mesic Shrubland	Common Name: Pūkiawe - 'Ama'u Subalpine Mesic Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Leptecophylla tameiameiae* - *Sadleria cyatheoides* Subalpine Mesic Shrubland

Description: This map class is characterized by shrublands dominated by *Leptecophylla tameiameiae* with the fern *Sadleria cyatheoides* dominating or sometimes co-dominating the understory with non-native grass *Anthoxanthum odoratum*. Scattered *Metrosideros polymorpha* may be present, but rarely exceeds 5% cover. Total shrub cover ranges from 10-30%. The moderate to dense herbaceous layer (50-80% cover) is dominated by a mix of ferns and grasses. Species with moderately high constancy with low cover (<10%) include *Vaccinium reticulatum*, *Pteridium aquilinum ssp. decompositum*, and *Coprosma ernodeoides*. Other native herbaceous species include *Deschampsia nubigena*, *Dryopteris wallichiana*, *Dubautia menziesii*, *Luzula hawaiiensis* var. *hawaiiensis*, and *Morelotia gahniiformis*. This map class was mapped using a combination of field reconnaissance, CART modeling and manual interpretation. It is distinguished by its location and by its lack of *Metrosideros polymorpha* cover > 10% and its mixture of blue-grey *Leptecophylla tameiameiae* shrubs with a fairly closed understory of bright red *Sadleria cyatheoides* on the infrared imagery. On the draft map it was confused with *Metrosideros polymorpha* / *Sadleria cyatheoides* Forest (five samples) and *Leptecophylla tameiameiae* - *Vaccinium reticulatum* - (*Geranium cuneatum*) / *Deschampsia nubigena* Mesic Shrubland (three samples). All areas of confusion were corrected in the final map.

Most Abundant Species: *Sadleria cyatheoides*, *Leptecophylla tameiameiae*

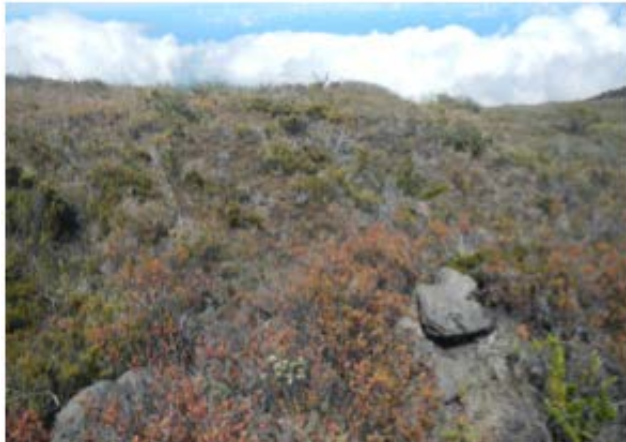
Distribution/Location: This map class is found in mesic subalpine sites in the Front Country near Halemau'u (Rainbow Bridge) and far Upper Kīpahulu Valley in Wainēnē and Kuiki. Sites are on steep (30-43 degrees) high slopes with north to southeast aspects at elevations ranging from 2000-2225m.

Classification Samples: 4	Hectares: 129.81
User's Accuracy: 50%	Producer's Accuracy: 60%
Accuracy Assessment Map Samples: 12	Accuracy Assessment Reference Samples: 10

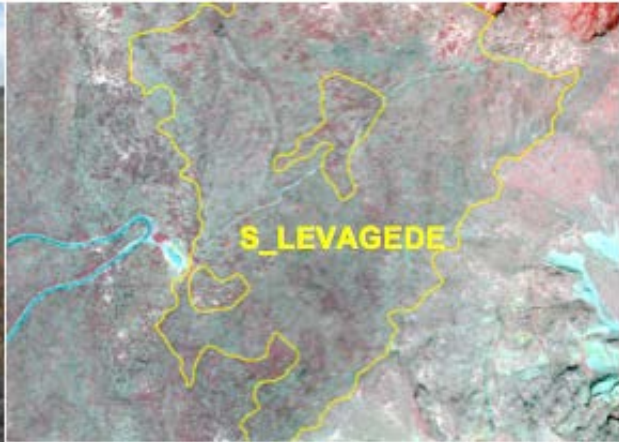
MAP CODE: S_LEVAGEDE

ELCODE: CEG008195

Map Class Name: <i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Geranium cuneatum</i>) / <i>Deschampsia nubigena</i> Mesic Shrubland	Common Name: Pūkiawe - ‘Ōhelo - (Nohoanu) / <i>Deschampsia nubigena</i> Mesic Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Leptecophylla tameiameiae* - *Vaccinium reticulatum* - (*Geranium cuneatum*) / *Deschampsia nubigena* Subalpine Mesic Shrubland¹

Description: Characterized by shrublands codominated by *Leptecophylla tameiameiae* and *Vaccinium reticulatum* with understory dominated or codominated by *Deschampsia nubigena*. Subalpine indicator species *Geranium cuneatum* is often present to codominant. Scattered *Sophora chrysophylla* small trees/tall shrubs may be present, but rarely exceed 5% cover. Total shrub cover ranges from 20-50%. The moderately dense herbaceous layer (50% cover) is dominated by grasses. This map class was mapped using field reconnaissance, CART modeling, and manual interpretation. It is distinguished by its location and its reddish grey crowns of *Leptecophylla tameiameiae* shrubs intermixed with light blue to beige herbaceous cover. Most commonly confused with similar classes such as *Leptecophylla tameiameiae* - *Vaccinium reticulatum* Subalpine Mesic Shrubland (six samples) and *Leptecophylla tameiameiae* Subalpine Dry Shrubland (two samples). These areas were not edited in the final map because map labels in this area of the park are easily affected by slight difference in estimates of species cover.

Most Abundant Species: *Deschampsia nubigena*, *Geranium cuneatum* var. *cuneatum*, *Leptecophylla tameiameiae*, *Vaccinium reticulatum*

Distribution/Location: This map class is found in mesic subalpine sites in front country and East Crater near the Supply and Lau ulu trails, park catchment, Upper Honomanu Gulch, and north slope of Kalapawili Ridge. Sites exist on gentle to moderate mid and high slopes with northerly aspects with one site observed on a south-facing slope of Kaluanui from 2230-2580m.

Classification Samples: 7	Hectares: 268.35
User's Accuracy: 55%	Producer's Accuracy: 79%
Accuracy Assessment Map Samples: 20	Accuracy Assessment Reference Samples: 14

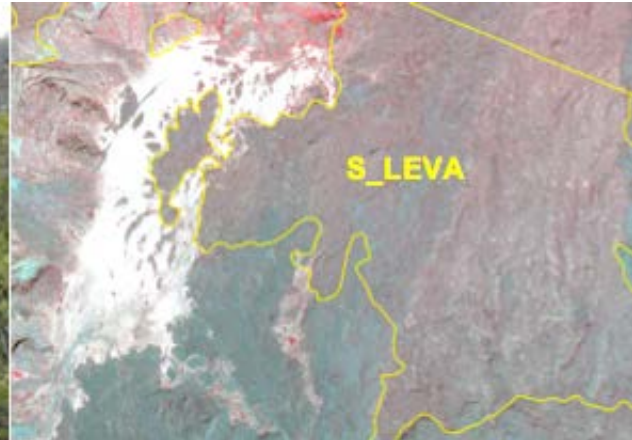
MAP CODE: S_LEVA

ELCODE: CEG008197

Map Class Name: <i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> Subalpine Mesic Shrubland	Common Name: Pūkiawe - 'Ōhelo Subalpine Mesic Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Leptecophylla tameiameiae* - *Vaccinium reticulatum* Subalpine Mesic Shrubland¹

Description: This map class is characterized by an open to moderately dense shrubland codominated by *Leptecophylla tameiameiae* and *Vaccinium reticulatum* with each species having 1/3 or more the cover of the other. *Dodonaea viscosa* is usually absent, but if present, then it has low cover (<1/3 cover of *Leptecophylla tameiameiae*). Scattered *Sophora chrysophylla* tall shrubs may be present, but rarely exceed 5% cover. Total shrub cover ranges from 20-60%. The herbaceous layer is variable, either sparse with several native species or moderate to dense and dominated by non-native grasses. This class was mapped using field reconnaissance, CART modeling and manual interpretation. It is distinguished on the infrared imagery by its location and its moderately dense reddish grey *Leptecophylla tameiameiae* shrubs. On the draft map, it was highly committed to other *Leptecophylla tameiameiae* map classes (13 samples). Most of these areas of confusion were edited to their reference label in the final map.

Most Abundant Species: *Leptecophylla tameiameiae*, *Vaccinium reticulatum*

Distribution/Location: Total shrub cover for this map class is notably variable, so this class is categorized into two density subclasses. The more dense subclass is found on mesic subalpine sites in East Crater near Halemau'u trail and Lau ulu trail and in West Crater at base of Switchbacks and on the upper southfacing slopes between Haleakalā and Haupa'akea peaks. The less dense subclass is seen in the Ko'olau Gap and in the subalpine zone west of Haupa'akea peak. Sites occur on gentle to steep mid and high slopes with southeast, southwest and north aspects from 1970-2900m

Classification Samples: 5	Hectares: 1116.43
User's Accuracy: 60%	Producer's Accuracy: 38%
Accuracy Assessment Map Samples: 15	Accuracy Assessment Reference Samples: 24

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. 2012.

MAP CODE: S_LETA_M

ELCODE: CEG008198

Map Class Name: <i>Leptecophylla tameiameiae</i> Montane Mesic Shrubland	Common Name: Pūkiawe Montane Mesic Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Leptecophylla tameiameiae* Montane Mesic Shrubland¹

Description: This map class is characterized by moderately dense shrublands dominated by *Leptecophylla tameiameiae* with *Dodonaea viscosa* absent or at low cover (less than 1/3 the cover of *Leptecophylla tameiameiae*). Total shrub cover ranges from 40-60% cover. *Osteomeles anthyllidifolia* is frequently present to codominant and is a good indicator of montane shrublands. *Vaccinium reticulatum* is absent or has low cover. Herbaceous cover is usually sparse and does not form a layer. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is distinguished on the imagery by its location, its reddish grey crowns of *Leptecophylla tameiameiae* shrubs, and its lack of bright red *Dodonaea viscosa* cover. On the draft map it is most commonly confused with *Leptecophylla tameiameiae* - *Dodonaea viscosa* Montane Shrubland (four samples). Areas of all four confused samples were edited for the final map.

Most Abundant Species: *Deschampsia nubigena*, *Osteomeles anthyllidifolia*, *Pteridium aquilinum* ssp. *decompositum*, *Leptecophylla tameiameiae*

Distribution/Location: This map class is known from mesic and dry montane zones near Waikane, west of Paliku as well as on the west facing palis below Kuiki. Sites are on gentle to moderate midslopes (10-20 degrees) with southeast to south aspects from 1540-1800m.

Classification Samples: 3	Hectares: 113.60
User's Accuracy: 22%	Producer's Accuracy: 100%
Accuracy Assessment Map Samples: 9	Accuracy Assessment Reference Samples: 2

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. 2012.

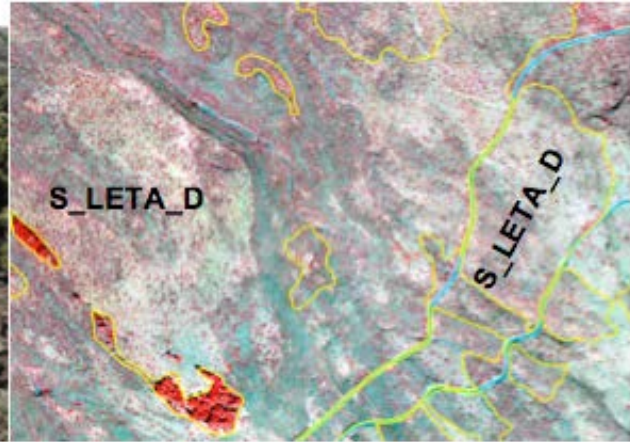
MAP CODE: S_LETA_D

ELCODE: CEG008063

Map Class Name: <i>Leptecophylla tameiameiae</i> Subalpine Dry Shrubland	Common Name: Pūkiawe Subalpine Dry Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Leptecophylla tameiameiae* Subalpine Dry Shrubland¹

Description: Subalpine map class characterized by a moderately open *Leptecophylla tameiameiae* dominated shrub layer (20-30% cover) with a depauperate understory. Shrub cover ranges from 10-70%. Scattered *Sophora chrysophylla* or *Coprosma montana* tall shrubs may be present, but rarely exceed 5% cover. *Dodonaea viscosa* may be present but not codominant (less than 1/3 the cover of *Leptecophylla tameiameiae*). *Vaccinium reticulatum* has high constancy, but relatively low cover (<10% cover). Native grass *Deschampsia nubigena* has fairly high constancy and ranges from 0-14% cover. Mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. Distinguished on the imagery by its location, reddish grey crowns of *L.tameiameiae*, and lack of significant *D. viscosa* cover. On the draft map it was most often confused with *Leptecophylla tameiameiae* - *Vaccinium reticulatum* Subalpine Mesic Shrubland (four samples) and *Sophora chrysophylla* - (*Coprosma montana* - *Leptecophylla tameiameiae* - *Dodonaea viscosa*) Subalpine Shrubland (five samples). Most of these areas were not edited in the final map because map labels in this area of the park are easily affected by slight difference in estimates of species cover.

Most Abundant Species: *Agrostis sandwicensis*, *Deschampsia nubigena*, *Dianella sandwicensis*, *Geranium cuneatum* var. *tridens*, *Hypochaeris glabra*, *Leptecophylla tameiameiae*, *Tetramolopium humile* ssp. *humile*

Distribution/Location: This widespread shrubland map class is found in the dry upper montane and subalpine zones in the front country and around the Haleakalā crater including the Visitor Center, Halemau‘u trail, Kalahaku, Kaukau‘ai , Upper Kaupō Gap and ‘O‘ili Pu‘u , Pu‘u Maile, as well as Haupa‘akea Ridge, East Kaupō, Ko‘olau Gap, and Hōlua. It can occur on flat to gentle slopes on of all aspects from 1915-2850m.

Classification Samples: 22	Hectares: 1196.90
User's Accuracy: 56%	Producer's Accuracy: 50%
Accuracy Assessment Map Samples: 16	Accuracy Assessment Reference Samples: 18

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. 2012.

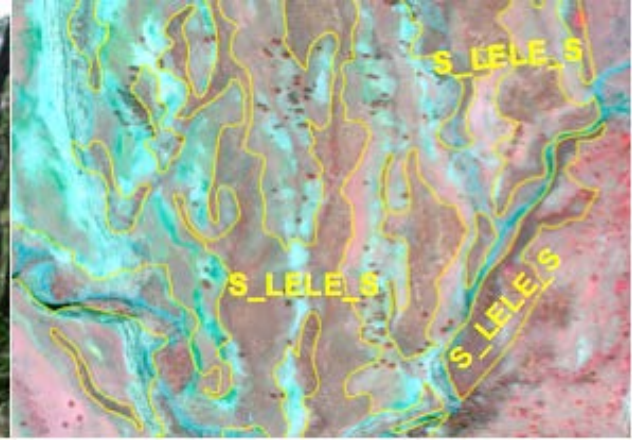
MAP CODE: S_LELE_S

ELCODE: CEGl008114, CEGl005404

Map Class Name: <i>Leucaena leucocephala</i> Semi-natural Shrubland	Common Name: Koa Haole Semi-natural Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Leucaena leucocephala* Lowland Dry Semi-natural Shrubland, *Leucaena leucocephala* / *Urochloa maxima* Semi-natural Shrubland

Description: This map class is characterized by the non-native, tall shrub *Leucaena leucocephala* that forms an open tall-shrub layer typically with 10% or more cover. The understory is variable and may be herb- or shrub-dominated. In one sample, *Lantana camara* forms a moderately dense short-shrub layer (40% cover) with a dense herbaceous layer of non-native grass *Digitaria insularis* and non-native forb *Spermacoce assurgens*. The other sample is herb-dominated by *Spermacoce assurgens* and *Momordica charantia*. This class was mapped using a combination of field reconnaissance, CART modeling and manual interpretation. It is distinguished by its location and the dull reddish, round, small and fairly dense crowns of the *Leucaena leucocephala*. This highly accurate class was only confused with *Lantana camara* Semi-natural Shrubland (three samples) in the draft map. The areas of two of the three confused samples were corrected for the final map. The third sample was not edited because it is believed to have been correctly mapped.

Most Abundant Species: *Leucaena leucocephala*

Distribution/Location: This map class is known only from Nu‘u on gentle and southeast-facing lowslopes at elevations ranging from approximately 170-300m. Stands in lower Nu‘u are currently browsed by feral goats, deer, and pigs and show evidence of disturbance from its ranching history as well.

Classification Samples: 3	Hectares: 111.27
User’s Accuracy: 81%	Producer’s Accuracy: 100%
Accuracy Assessment Map Samples: 21	Accuracy Assessment Reference Samples: 17

MAP CODE: F_MAIN_S**ELCODE: CEG008199**

Map Class Name: <i>Mangifera indica</i> Semi-natural Forest	Common Name: Mango Semi-natural Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Mangifera indica* Semi-natural Forest

Description: This map class is characterized by open to dense canopies dominated by *Mangifera indica* with cover ranging from 20-80%. *Schinus terebinthifolius* and *Psidium cattleianum* may codominate some stands. The understory is composed of a variety of non-native shrubs and herbs, none of which is considered characteristic of the association. This classed was mapped using field reconnaissance and manual interpretation. It is distinguished by its location near the coast and the large, round, fluffy pink crowns of the *Mangifera indica*. On the draft map, this accurate class was confused with *Syzygium cumini* Lowland Mesic Semi-natural Forest (two samples). The areas of both samples were edited to *Syzygium cumini* Lowland Mesic Semi-natural Forest in the final map.

Most Abundant Species: *Mangifera indica*

Distribution/Location: This semi-natural forest and woodland map class occurs in the lower slopes of 'Ohe'o and Ka'āpahu and is typically found on mesic and seasonally mesic areas from 150-400m. Slopes range from gentle to moderate and may occur on all aspects.

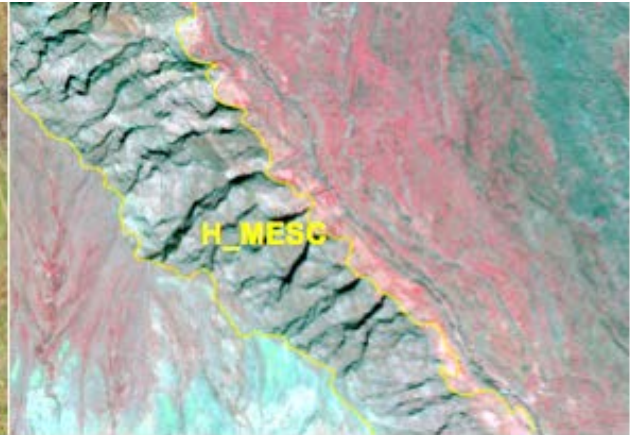
Classification Samples: 4	Hectares: 93.28
User's Accuracy: 79%	Producer's Accuracy: 94%
Accuracy Assessment Map Samples: 19	Accuracy Assessment Reference Samples: 16

MAP CODE: H_MESC**ELCODE: CEG008169**

Map Class Name: <i>Melinis minutiflora</i> - (<i>Schizachyrium condensatum</i>) Semi-natural Herbaceous Vegetation	Common Name: Molasses Grass - (Beardgrass) Semi-natural Herbaceous Vegetation
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Melinis minutiflora* - (*Schizachyrium condensatum*) Semi-natural Herbaceous Vegetation

Description: This map class was not sampled during classification sampling and therefore has no NatureServe description. It was sampled twice during accuracy assessment, however, one of the sites had more than 20% shrub and was mis-labeled an herbaceous class. The one correctly labeled AA sample shows the site to have heavy cover of herbaceous species (90%) which is dominated with *Melinis minutiflora* (50%) and 38% cover of *Cenchrus clandestinus*. Neither site had any *Schizachyrium condensatum* cover since this invasive grass is not currently found on Maui. The one large polygon where these two AA sites occur was mistakenly coded as mapped as *Melinis repens* - Mixed Semi-natural Sparse Vegetation in the draft map (a data entry error rather than a mapping error). Its label was corrected to *Melinis minutiflora*- (*Schizachyrium condensatum*) Semi-natural Herbaceous Vegetation in the final map. Otherwise the one sample was erroneously committed to *Melinis minutiflora*- (*Schizachyrium condensatum*) Semi-natural Herbaceous Vegetation when it was *Leptecophylla tameiameia* - *Dodonaea viscosa* Montane Shrubland. This area was not corrected in the map because it had a secondary label of *Melinis minutiflora*- (*Schizachyrium condensatum*) Semi-natural Herbaceous Vegetation. Although *Schizachyrium condensatum* does not exist at HALE, the parenthesis infers that the species may not be present and is the caveat for this type.

Most Abundant Species: *Melinis minutiflora*

Distribution/Location: This map class can be found in the higher elevations of Nu‘u and on the cliffs primarily west of the Kaupō Gap.

Classification Samples: 0	Hectares: 143.32
User’s Accuracy: 67%	Producer’s Accuracy: 100%
Accuracy Assessment Map Samples: 3	Accuracy Assessment Reference Samples: 2

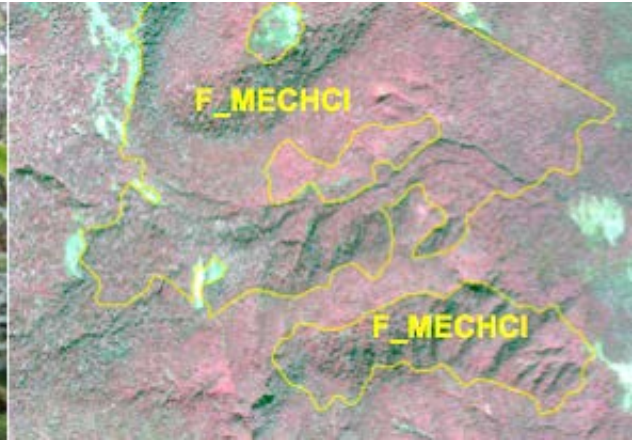
MAP CODE: F_MECHCI

ELCODE: CEG008008

Map Class Name: <i>Metrosideros polymorpha</i> - <i>Cheirodendron trigynum</i> / (<i>Cibotium</i> spp.) Montane Wet Forest	Common Name: ‘Ōhi‘a - ‘Ōlapa / (Hāpu‘u spp.) Montane Wet Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Metrosideros polymorpha* - *Cheirodendron trigynum* / (*Cibotium* spp.) Montane Wet Forest

Description: Montane wet forest map class characterized by moderate to dense tree cover codominated by *Metrosideros polymorpha* and *Cheirodendron trigynum* ssp. *trigynum* with 65-75% combined cover in tree canopy and subcanopy. *Acacia koa* may be present with less cover than 1/3 cover of *M. polymorpha*. Tree canopy may be diverse with low cover of *Ilex anomala*, *Melicope clusiifolia*, *Myrsine lessertiana*, or *Perrottetia sandwicensis*. *Cibotium* spp. (tree fern) cover is low (<10%). An open to moderately dense shrub layer is typically present. The non-native shrub *Clidemia hirta* is abundant at one plot. Herbaceous layer is moderate to dense. Mapped using a combination of classification plots and manual interpretation, as it was inaccessible to the mapping crew. It is distinguished on the infrared imagery by its almost closed canopy of dark red *M. polymorpha* trees with the brighter red *C. trigynum* canopies in-between. It has low accuracies on the draft map and was most often confused with *Metrosideros polymorpha* / *Dicranopteris linearis* Montane Wet Woodland (four samples) and *Acacia koa* - *Metrosideros polymorpha* Wet Montane Woodland (two samples). Most of the areas of confusion were corrected for the final map. However, the areas of two AA samples with the label of *Metrosideros polymorpha* / (*Dicranopteris linearis* - *Sticherus owhyhensis* - *Diplopterygium pinnatum*) Montane Wet Woodland in Manawainui were not changed (HALE.AA.0511 and 0519) because the spectral signature of the samples was very different from other field verified areas of this map class.

Most Abundant Species: *Broussaisia arguta*, *Cheirodendron trigynum* ssp. *trigynum*, *Coprosma foliosa*, *Diplazium sandwichianum*, *Metrosideros polymorpha*

Distribution/Location: Found in the Upper Hana Rain Forest, Smith Camp, Healani Camp, north of Wai Apapanapa, and on the steep west facing slopes east of Palikū. Sites tend to be gentle to steep sideslopes

with mid and high slope positions on moist to saturated substrates with south-eastern, eastern, and western aspects from 920-2100m.

Classification Samples: 7	Hectares: 266.12
User's Accuracy: 14%	Producer's Accuracy: 25%
Accuracy Assessment Map Samples: 7	Accuracy Assessment Reference Samples: 4

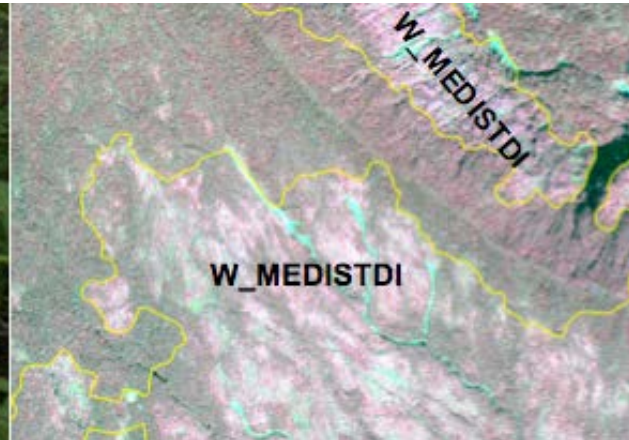
MAP CODE: W_MEDISTDI

ELCODE: CEG008041

Map Class Name: <i>Metrosideros polymorpha</i> / (<i>Dicranopteris linearis</i> - <i>Sticherus owbyhensis</i> - <i>Diplopterygium pinnatum</i>) Montane Wet Woodland	Common Name: ‘Ōhi‘a / (Uluhe spp.) Montane Wet Woodland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Metrosideros polymorpha* / *Dicranopteris linearis* Montane Wet Woodland

Description: This map class is characterized by a relatively short (2-10 m tall), moderate to dense tree canopy ranging from 60-80% cover that is dominated by *Metrosideros polymorpha*. Scattered *Cheirodendron trigynum* ssp. *trigynum*, *Cibotium glaucum*, or *Cibotium menziesii* may be present in the subcanopy with low (<10%) cover. If present, *Acacia koa* trees have low cover and are not codominant. Shrubs may be present, but typically do not form a layer (<10% total cover). The understory is characterized by a moderate to dense herbaceous layer (60-90% cover) dominated by the native mat-forming fern *Dicranopteris linearis*, often with very high cover. This class was mapped using a combination of field reconnaissance, CART modeling and manual interpretation. It is distinguished by its montane location and the bright pink spectral signature of the dense *Dicranopteris linearis* mats with overstories of dark red *Metrosideros polymorpha* trees. This highly accurate class was confused with *Metrosideros polymorpha* - *Cheirodendron trigynum* / (*Cibotium* spp.) Montane Wet Forest (three samples). The areas of two of the three samples were not edited because their location and spectral signatures were very dissimilar to other locations of this map class.

Most Abundant Species: *Dicranopteris linearis*, *Metrosideros polymorpha*

Distribution/Location: This montane woodland map class is known from Manawainui between Ohia and Kaapahu Camps, the east facing slopes above Kaukai Stream, and from Kīpahulu Valley near Kaumakani, Upper Kīpahulu Valley, and on the steep slopes east and north of Palikea Stream. Sites tend to occur on exposed, windy, very wet, and gentle to steep sideslopes from 1030-2000m.

Classification Samples: 2	Hectares: 689.84
User’s Accuracy: 93%	Producer’s Accuracy: 81%
Accuracy Assessment Map Samples: 14	Accuracy Assessment Reference Samples: 16

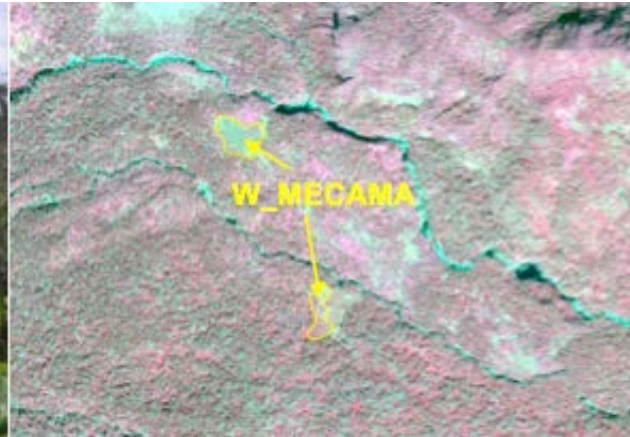
MAP CODE: W_MECAMA

ELCODE: CEG008201

Map Class Name: <i>Metrosideros polymorpha</i> / <i>Carex alligata</i> - (<i>Machaerina angustifolia</i>) Wet Woodland	Common Name: Ōhi'a / <i>Carex alligata</i> - ('Uki) Wet Woodland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Metrosideros polymorpha* / *Carex alligata* - (*Machaerina angustifolia*) Wet Woodland

Description: This montane wet woodland map class is characterized by an open to moderate tree canopy dominated by *Metrosideros polymorpha* with 10-60% cover. Tree canopy is typically 2-5m tall, but may be shorter on poorly drained, boggy sites (<2 m tall). *Cheirodendron trigynum ssp. trigynum* is frequently present in the tree subcanopy with low cover. Other subcanopy trees may include presence of *Melicope clusiifolia*, *Syzygium sandwicense*, or *Polyscias oahuensis*. The understory is characterized by a diverse, moderately dense to dense herbaceous layer dominated or codominated by *Carex alligata* and/or *Machaerina angustifolia*. This class was mapped using field verified manual interpretation. This rare map class is distinguished on the imagery by its strong light blue herbaceous signature dotted with tiny sparse dark reddish *Metrosideros polymorpha* crowns (when visible). This class's accuracy was zero in the draft map because the *Metrosideros polymorpha* are not apparent on the imagery. All errors were corrected for the final map and this class occurs only where field verified.

Most Abundant Species: *Carex alligata*, *Machaerina angustifolia*, *Metrosideros polymorpha*

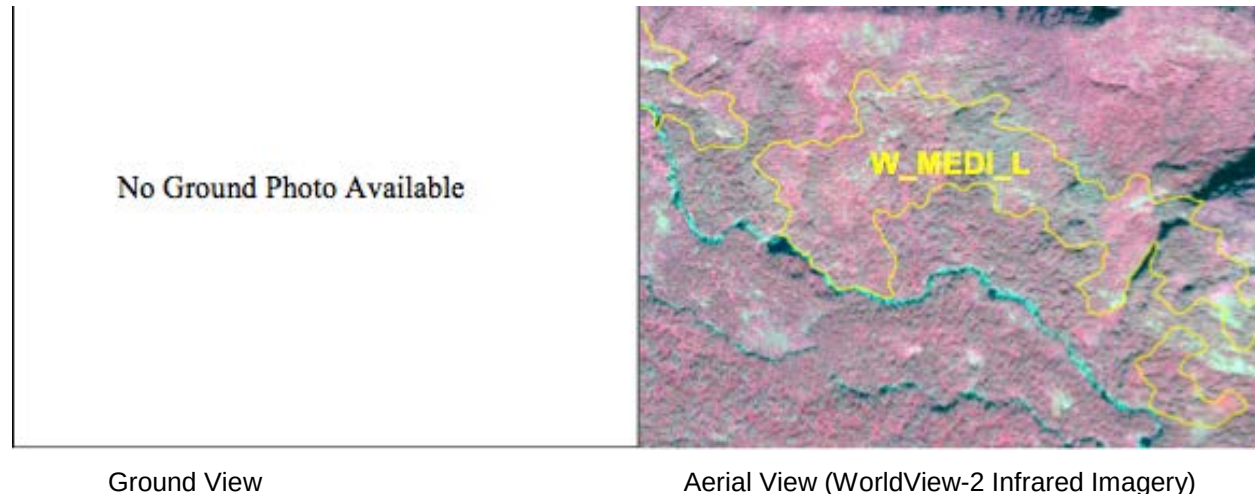
Distribution/Location: This montane forested wetland map class is seen in Kīpahulu Valley as well as along Kaumakani Ridge from 1230-1270m on southeastern and southern aspects. Sites are gentle (6-12 degrees) sideslopes and ridges on midslope topographic positions.

Classification Samples: 3	Hectares: 7.41
User's Accuracy: 0%	Producer's Accuracy: 0%
Accuracy Assessment Map Samples: 2	Accuracy Assessment Reference Samples: 2

MAP CODE: W_MEDI_L

ELCODE: CEG008039

Map Class Name: <i>Metrosideros polymorpha</i> / <i>Dicranopteris linearis</i> Lowland Mesic Woodland	Common Name: ‘Ōhi‘a / Uluhe Lowland Mesic Woodland
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USNVC Association: *Metrosideros polymorpha* / *Dicranopteris linearis* Lowland Mesic Woodland

Description: This map class is characterized by a moderately dense canopy dominated by *Metrosideros polymorpha* ranging from 50-65% cover. If present, *Acacia koa* trees have low cover (<10%) and are not codominant. Scattered *Cheirodendron trigynum* ssp. *trigynum* or *Cibotium* spp. may be present in the subcanopy with low (<10%) cover. The invasive non-native species *Psidium cattleianum* is frequently present. The understory is represented by a dense herbaceous layer strongly dominated by *Dicranopteris linearis* or other uluhe species with over 80% cover in some areas. Native *Lycopodiella cernua* may be present in wetter sites. The moderately dense herbaceous layer has been invaded by non-native species *Clidemia hirta*, *Tibouchina herbacea*, and *Ageratina adenophora* with *Hedychium gardnerianum*, *Nephrolepis multiflora*, and *Paspalum urvillei* often present. This class was mapped using a combination of CART modeling and manual interpretation based on the information gleaned from the classification samples gathered for this association. This class is distinguished by its lowland location and the bright pink spectral signature of the dense uluhe mats with overstories of dark red *Metrosideros polymorpha* trees. This class was not assessed for accuracy.

Most Abundant Species: *Dicranopteris linearis*, *Metrosideros polymorpha*

Distribution/Location: This woodland map class is known from in Kīpahulu Valley, along Kaumakani ridge, and along Palikea Stream. It occurs on windy, mesic to very wet sites ranging from 785-1000m elevation on moderate to steep (15-30 degrees) midslopes with southerly aspects. This mesic type occurs adjacent to wet types in Kīpahulu valley and these areas may be climatically wetter.

Classification Samples: 3	Hectares: 95.89
User's Accuracy: Not Assessed	Producer's Accuracy: Not Assessed
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 0

MAP CODE: F_MEDR

ELCODE: CEG008202

Map Class Name: <i>Metrosideros polymorpha</i> / <i>Dryopteris wallichiana</i> Mesic Forest	Common Name: ‘Ōhi‘a / ‘I‘o nui Mesic Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Metrosideros polymorpha* / *Dryopteris wallichiana* Subalpine Mesic Forest

Description: This mesic forest map class is characterized by a moderate to dense tree canopy dominated by *Metrosideros polymorpha* ranging from 40-90% cover. *Cheirodendron trigynum* ssp. *trigynum* is frequently present in the tree subcanopy with relatively low cover (not codominant). The understory is characterized by a moderately dense (30-50% cover) herbaceous layer typically strongly dominated by the fern *Dryopteris wallichiana* or with *Lycopodium venustulum* and *Dryopteris wallichiana* co-dominating. Shrubs are generally sparse, but range from absent to 10% cover, forming an open, mixed layer. Common species include *Astelia menziesiana*, *Coprosma foliosa*, *Ilex anomala*, *Leptecophylla tameiameia*, *Rubus hawaiiensis*, or *Vaccinium calycinum*. This class was mapped using a combination of field reconnaissance, CART modeling and manual interpretation. It is distinguished by its location and the bright red spectral signature of the *Dryopteris wallichiana* with small darker red overstories of *Metrosideros polymorpha*. On the draft map, this class was overcommitted, causing errors of omission of *Metrosideros polymorpha* / *Rubus hawaiiensis* Montane Wet Forest and *Metrosideros polymorpha* / *Vaccinium calycinum* - (*Broussaisia arguta*, *Coprosma foliosa*) / *Athyrium microphyllum* Montane Wet Forest. Most of the errors of commission were corrected for the final map.

Most Abundant Species: *Dryopteris wallichiana*, *Lycopodium venustulum*, *Metrosideros polymorpha*

Distribution/Location: This mesic subalpine forest map class occurs in Upper Kīpahulu Valley below Kalapawili Ridge and in Manawainui near Kuiki. It is typically seen on moderate to steep (15-30 degrees) upper sideslopes with east to south aspects from 2000-2150m. This type likely exists in pockets throughout the upper wet/mesic zones of HALE.

Classification Samples: 4	Hectares: 183.01
User's Accuracy: 54%	Producer's Accuracy: 88%
Accuracy Assessment Map Samples: 13	Accuracy Assessment Reference Samples: 8

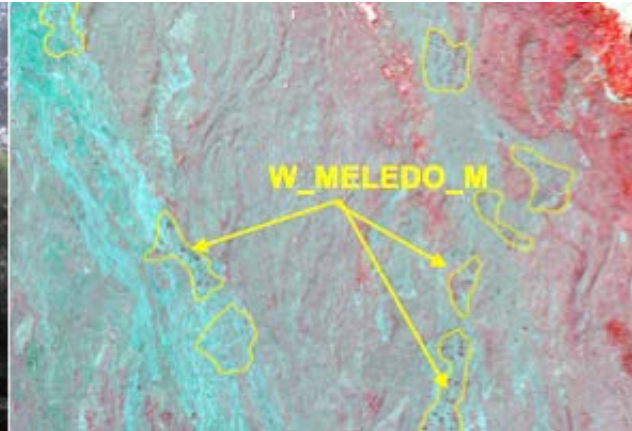
MAP CODE: W_MELEDO_M

ELCODE: CEG008135

Map Class Name: <i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i> Montane Woodland	Common Name: ‘Ōhi‘a / Pūkiawe - ‘A‘ali‘i Montane Woodland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Metrosideros polymorpha* / *Leptecophylla tameiameiae* - *Dodonaea viscosa*
Montane Woodland¹

Description: This map class is characterized by an open canopy of *Metrosideros polymorpha* ranging from 15-40% cover. Understories are shrub-dominated by open to dense *Leptecophylla tameiameiae* and *Dodonaea viscosa*, ranging from <15 to 75% cover. This class was mapped using a combination of field reconnaissance, CART modeling and manual interpretation. It is distinguished by its location and its scattered crowns of dark red *Metrosideros polymorpha* with open understories of grey blue *Leptecophylla tameiameiae* often dotted with bright red *Dodonaea viscosa* shrubs. The area of the one confused sample for this highly accurate class was edited to the correct label in the final map.

Most Abundant Species: *Dodonaea viscosa*, *Metrosideros polymorpha*, *Leptecophylla tameiameiae*

Distribution/Location: This woodland map class is known from Kaupō Gap, East Crater, and the Front Country downslope of Supply Trail, the Kaupō trail, and the upper slopes of Nu‘u‘. Sites tend to occur as isolated stringers on gentle to steep southeast, south and north facing mid to high slopes from 1500-2000m and are often confined to gullies.

Classification Samples: 2	Hectares: 114.99
User’s Accuracy: 100%	Producer’s Accuracy: 80%
Accuracy Assessment Map Samples: 4	Accuracy Assessment Reference Samples: 5

¹USNVC name modified based on Wagner et al. (1999) and Wagner et al. 2012.

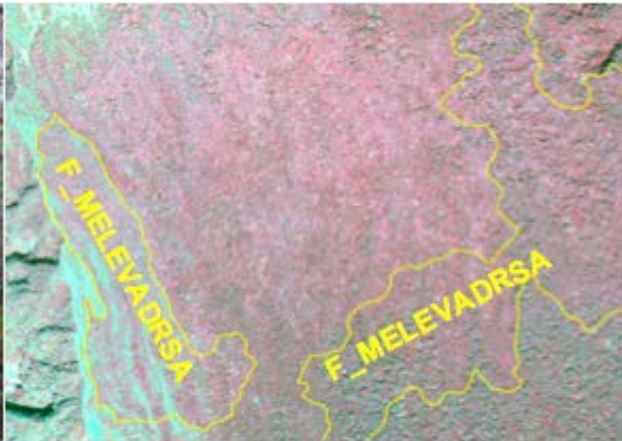
MAP CODE: F_MELEVADRSA

ELCODE: CEPS009712, CEGLO08202

Map Class Name: <i>Metrosideros polymorpha</i> / <i>Leptecophylla tameiameiae</i> - <i>Vaccinium reticulatum</i> - (<i>Dryopteris wallichiana</i> - <i>Sadleria cyatheoides</i>) Montane Mesic Forest	Common Name: ‘Ōhi‘a / Pūkiawe - ‘Ōhelo - (‘I‘o nui - ‘Ama‘u) Montane Mesic Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Metrosideros polymorpha* / *Sadleria cyatheoides* Forest [Park Special],
Metrosideros polymorpha / *Dryopteris wallichiana* Subalpine Mesic Forest

Description: This map class was created following accuracy assessment to capture a unique vegetation type in Kuiki. It is a combination of the the *Metrosideros polymorpha* / *Sadleria cyatheoides* Forest [Park Special], and *Metrosideros polymorpha* / *Dryopteris wallichiana* Subalpine Mesic Forest associations. It is heavily dominated by dense to closed canopies of *Metrosideros polymorpha* (46-93%). Other tree species are either absent or at trace levels. The shrub and herbaceous layers are very sparse with 1-3% cover of *Sadleria* spp., *Dryopteris wallichiana*, *Leptecophylla tameiameiae*, or *Vaccinium calycinum* (except for two samples with 14-15% *Leptecophylla tameiameiae*). This class was mapped using NPS direction and manual interpretation based on the locations of the NPS selected accuracy assessment samples. It is not distinguishable on the infrared imagery from other closed canopy *Metrosideros polymorpha* map classes in Kīpahulu.

Most Abundant Species: *Metrosideros polymorpha*

Distribution/Location: This class occurs as in two polygons in Kuiki. Because this type was developed after AA, it's exact distribution and species composition are not known. It was developed because there is a consistently higher cover of shrub species in the western portion of Kuiki.

Classification Samples: 4	Hectares: 20.54
User's Accuracy: 100%	Producer's Accuracy: 100%
Accuracy Assessment Map Samples: 5	Accuracy Assessment Reference Samples: 5

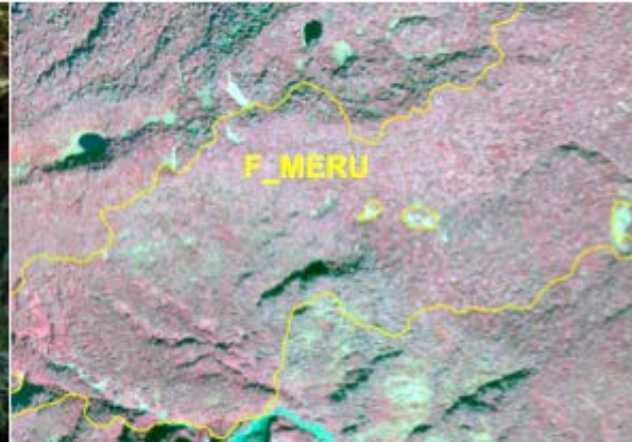
MAP CODE: F_MERU

ELCODE: CEG008203

Map Class Name: <i>Metrosideros polymorpha</i> / <i>Rubus hawaiensis</i> Montane Wet Forest	Common Name: ‘Ōhi‘a / ‘Ākala Montane Wet Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Metrosideros polymorpha* / *Rubus hawaiensis* Montane Wet Forest

Description: This forest map class is characterized by a moderate to dense tree canopy dominated by *Metrosideros polymorpha* ranging from 40-90% cover. *Cheirodendron trigynum* ssp. *trigynum* is frequently present in the tree subcanopy with relatively low cover (not codominant). The understory is characterized by a moderately dense (30-50% cover) shrub layer typically dominated by *Rubus hawaiensis* with *Vaccinium calycinum*, which may be present to codominant. Other common shrubs with low cover include *Coprosma foliosa* or *Leptecophylla tameiameia*. The herbaceous layer is moderate to dense (40-90% cover) with *Astelia menziesiana*, *Carex alligata*, and *Uncinia uncinata* with high constancy and *Peperomia globulanthera* with high cover in one plot. Much of the abundant herbaceous layer is composed of diverse ferns such as *Athyrium microphyllum*, *Dryopteris wallichiana*, *Diplazium sandwichianum*, or *Sadleria* spp. Mosses are also abundant. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. Because of its high *Metrosideros polymorpha* cover, it is indistinguishable from other high cover *Metrosideros polymorpha* map classes on the infrared imagery. The areas of its three AA sites were corrected in the final map.

Most Abundant Species: *Metrosideros polymorpha*, *Rubus hawaiensis*, *Vaccinium calycinum*

Distribution/Location: This wet, upper montane forest map class is known from Upper Kīpahulu Valley, Wainene trail, Healani trail, near New Greensword Bog and some isolated pockets near Palikū. It typically occurs on moderate to steep (11-22 degrees) sideslopes with southeast to southwest aspects from 1850-2080m. This map class proved to be problematic during AA and resulted in the creation of a new map class in areas of upper Kīpahulu valley that have a mixed fern and shrub understory.

Classification Samples: 3	Hectares: 86.46
User's Accuracy: 0%	Producer's Accuracy: 0%
Accuracy Assessment Map Samples: 3	Accuracy Assessment Reference Samples: 3

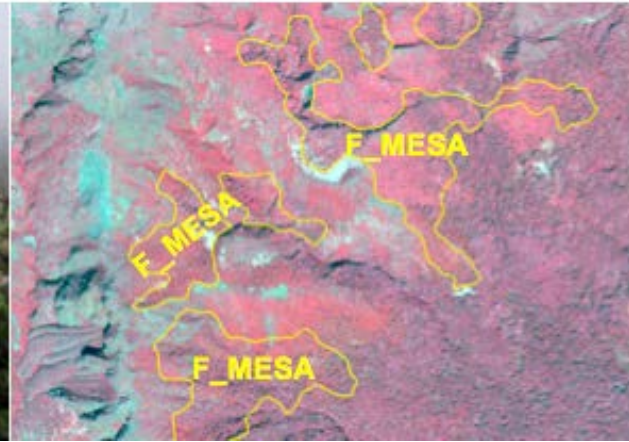
MAP CODE: F_MESA

ELCODE: CEPS009712

Map Class Name: <i>Metrosideros polymorpha</i> / <i>Sadleria cyatheoides</i> Forest	Common Name: ‘Ōhi‘a / ‘Ama‘u Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Metrosideros polymorpha* / *Sadleria cyatheoides* Forest [Park Special]

Description: Open to moderately closed tree canopy dominated by *Metrosideros polymorpha* ranging from 12-62% cover. The understory shrub layer is well developed and co-dominated by *Sadleria cyatheoides* (8-50% cover) and *Leptecophylla tameiameiae* (7-37% cover). Other shrubs common at low cover include *Vaccinium calycinum* and *Coprosma ernodeoides*. *Dodonaea viscosa* is occasionally present with high cover at times of up to 17%. The herbaceous layer is poorly developed with total cover typically not exceeding 3% cover. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is characterized on the infrared imagery by its location, and the scattering of dark red *Metrosideros* crowns over the mixture of deep red *Sadleria* and grey blue *Leptecophylla*. The class has low accuracies on the draft map primarily because of an area of errors of commission of *Acacia koa* / *Leptecophylla tameiameiae* - (*Dodonaea viscosa*) Montane Woodland (six samples) and errors of omission to *Leptecophylla tameiameiae* - *Sadleria cyatheoides* Subalpine Mesic Shrubland (four samples). Both types of errors were corrected in the final map.

Most Abundant Species: *Metrosideros polymorpha*, *Sadleria cyatheoides*, *Leptecophylla tameiameiae*

Distribution/Location: This forest map class is known from Upper Kīpahulu Valley along Kalapawili Ridge and Kuiki extending downslope towards Palikū Cabin and Healani. Sites occur on steep (30-43 degrees) high slopes with north to southeast aspects from 1500-2250m. This map class proved to be problematic during AA and was often confused with other types. The key only states that *Sadleria cyatheoides* ‘strongly dominates the understory’ and there was no further description for guidance. Often field crews would encounter a diverse understory as well as significant *Acacia koa* cover at these plots and gave multiple calls and comments in these areas. The distribution and location of this map class needs refinement and further description.

Classification Samples: 0	Hectares: 94.38
User's Accuracy: 27%	Producer's Accuracy: 50%
Accuracy Assessment Map Samples: 15	Accuracy Assessment Reference Samples: 8

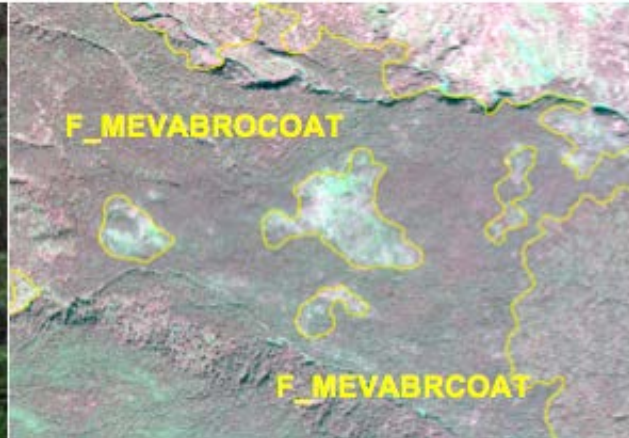
MAP CODE: F_MEVABRCOAT

ELCODE: CEG008200

Map Class Name: <i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - (<i>Broussaisia arguta</i> , <i>Coprosma foliosa</i>) / <i>Athyrium microphyllum</i> Montane Wet Forest	Common Name: ‘Ōhi‘a / ‘Ōhelo - (Kanawao, Pilo) / ‘Ākōlea Montane Wet Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Metrosideros polymorpha* / *Vaccinium calycinum* - (*Broussaisia arguta*, *Coprosma foliosa*) / *Athyrium microphyllum* Montane Wet Forest

Description: This montane wet forest map class is characterized by a moderate to dense tree canopy dominated by *Metrosideros polymorpha* with 65-75% cover. Tree canopy is typically 5-20 m tall, but may be shorter on poorly drained sites (<5 m tall). *Cheirodendron trigynum ssp. trigynum* is frequently present in the tree subcanopy with relatively low cover (not codominant). The understory is characterized by a diverse shrub layer codominated by *Vaccinium calycinum* often with *Broussaisia arguta* and/or *Coprosma foliosa* present to codominant. Epiphytes are abundant, dense, and diverse and moss typically has high cover (60-80% cover). This class was mapped using a combination of the classification sites, CART 51 modelling, and manual interpretation. It is distinguished by its location and the moderate to dense cover of greyish to dark red *Metrosideros polymorpha*. On the draft map it was erroneously committed to *Metrosideros polymorpha* – *Cheirodendron trigynum* / (*Cibotium spp.*) Montane Wet Forest (one sample), *Metrosideros polymorpha* / *Dryopteris wallichiana* Subalpine Mesic Forest (two samples), *Metrosideros polymorpha* / *Rubus hawaiensis* Montane Wet Forest (one sample), and *Metrosideros polymorpha* / *Vaccinium calycinum* – *Rubus hawaiensis* / (*Coprosma foliosa* – *Leptecophylla tameiameiae*) Montane Wet Forest (one sample). Most of these areas were corrected in the final map.

Most Abundant Species: *Athyrium microphyllum*, *Broussaisia arguta*, *Cheirodendron trigynum ssp. Trigynum*, *Coprosma foliosa*, *Metrosideros polymorpha*, *Uncinia uncinata*, *Vaccinium calycinum*

Distribution/Location: This montane rainforest map class commonly occurs in mid-elevation ranges in Kiahulu Valley and the Hana Rain Forest as well as Cable Ridge extending into Manawainui. Sites typically occur on southeastern, northern and southern aspects on gentle to steep (5-27 degrees) sideslopes from 1370-1960 m. Sites exist on midslope, highslope, and plateau topographic positions.

Classification Samples: 6	Hectares: 751.22
User's Accuracy: 89%	Producer's Accuracy: 57%
Accuracy Assessment Map Samples: 9	Accuracy Assessment Reference Samples: 14

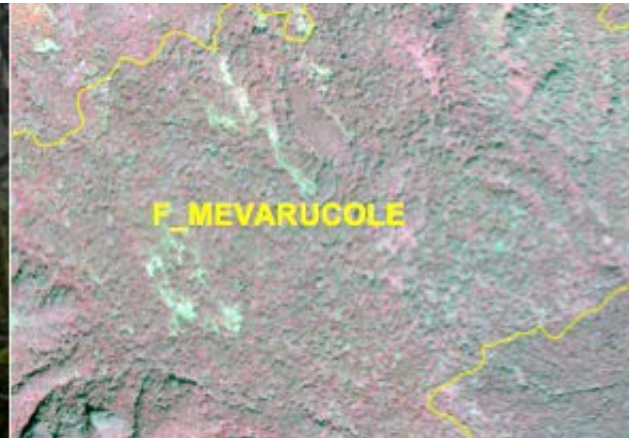
MAP CODE: F_MEVARUCOLE

ELCODE: CEG L008008, CEG L008203, CEG L008200

Map Class Name: <i>Metrosideros polymorpha</i> / <i>Vaccinium calycinum</i> - <i>Rubus hawaiensis</i> / (<i>Coprosma foliosa</i> - <i>Leptecophylla tameiameiae</i>) Montane Wet Forest	Common Name: ‘Ōhi‘a / ‘Ōhelo - ‘Ākala / (Pilo - Pūkiawe) Montane Wet Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Metrosideros polymorpha* - *Cheirodendron trigynum* / (*Cibotium* spp.) Montane Wet Forest, *Metrosideros polymorpha* / *Rubus hawaiensis* Montane Wet Forest, *Metrosideros polymorpha* / *Vaccinium calycinum* - (*Broussaisia arguta*, *Coprosma foliosa*) / *Athyrium microphyllum* Montane Wet Forest

Description: This map class was created following accuracy assessment to capture a unique vegetation type in upper Kīpahulu valley. It is a combination of the the *Metrosideros polymorpha* - *Cheirodendron trigynum* / (*Cibotium* spp.) Montane Wet Forest, *Metrosideros polymorpha* / *Rubus hawaiensis* Montane Wet Forest, and *Metrosideros polymorpha* / *Vaccinium calycinum* - (*Broussaisia arguta*, *Coprosma foliosa*) / *Athyrium microphyllum* Montane Wet Forest associations in a specific area of upper Kīpahulu Valley. It is composed of dense canopies of *Metrosideros polymorpha* (62-87%). Other canopy associates include *Cheirodendron trigynum* (1-8%). Shrub covers are generally moderate to low (10-27%) and may include *Broussaisia arguta*, *Astelia menziesiana*, and *Leptecophylla tameiameiae* and may include other species of *Coprosma* besides *Coprosma foliosa*. *Rubus hawaiensis* is always present (1-10%). The herbaceous layer is sparse and may contain *Diplazium sandwichianum* (0-7%) and *Athyrium microphyllum* (0-2%). This class was mapped using manual interpretation based on the locations of the NPS selected accuracy assessment samples. It is not distinguishable from other closed canopy *Metrosideros polymorpha* map classes in Kīpahulu .

Most Abundant Species: *Metrosideros polymorpha*

Distribution/Location: This class's one polygon is located in one polygon in Kīpahulu between on an east facing slope between 1500 and 2500m.

Classification Samples: 16	Hectares: 248.23
User's Accuracy: 100%	Producer's Accuracy: 92%
Accuracy Assessment Map Samples: 11	Accuracy Assessment Reference Samples: 11

MAP CODE: W_MEVALE

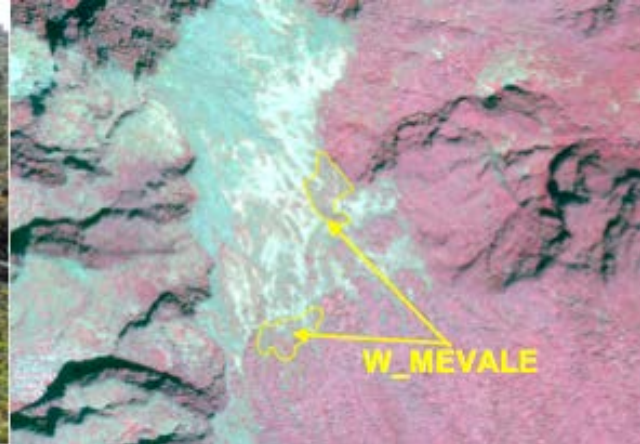
ELCODE: NA

Map Class Name: *Metrosideros polymorpha* / *Vaccinium reticulatum* - *Leptecophylla tameiameiae* Montane Mesic Dwarf Woodland

Common Name: ‘Ōhi‘a / ‘Ōhelo - Pūkiawe
Montane Mesic Dwarf Woodland



Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: None

Description: This rare map class was created following its discovery during accuracy assessment. It is represented by one accuracy assessment sample which show that it is comprised of an open stand of short *Metrosideros polymorpha* (20%) with half of the trees less than 2m in height. *Cheirodendron trigynum* occurs in trace amounts. The shrub layer is co-dominated by *Leptecophylla tameiameiae* and *Vaccinium reticulatum* (both 25%) and the herbaceous layer is dominated by *Deschampsia nubigena* (10%). This class was mapped using manual interpretation aided by the accuracy assessment sample.

Most Abundant Species: *Metrosideros polymorpha*, *Leptecophylla tameiameiae*, *Vaccinium reticulatum*

Distribution/Location: This class can be found in two small polygons in Kuiki on gentle slopes between 2100 and 2450m elevation.

Classification Samples: 0	Hectares: 1.60
User's Accuracy: Not Assessed	Producer's Accuracy: Not Assessed
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 0

MAP CODE: H_MIDI

ELCODE: NA

Map Class Name: Mixed Non-native Disturbed Herbaceous Vegetation	Common Name: Mixed Non-native Disturbed Herbaceous Vegetation
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: None Map Unit

Description: This map class was discovered during accuracy assessment and is based on one accuracy assessment sample. It is dominated by the herbaceous species *Urochloa mutica* (70%) with some *Paspalum conjugatum* (18%) and a scattering of trees *Psidium guajava* (1%), *Syzygium cumini* (2%) and *Terminalia catappa* (1%). This class was mapped using manual interpretation guided by the accuracy assessment sample.

Most Abundant Species: *Urochloa mutica*

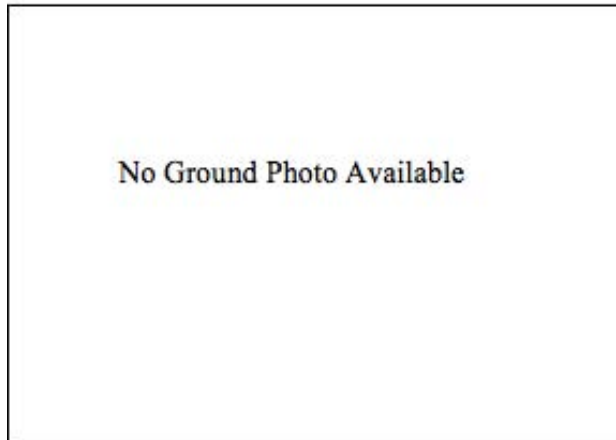
Distribution/Location: This class occurs in coastal polygons near Kukui Bay and in lower Nu'u.

Classification Samples: 0	Hectares: 12.07
User's Accuracy: Not Assessed	Producer's Accuracy: Not Assessed
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 0

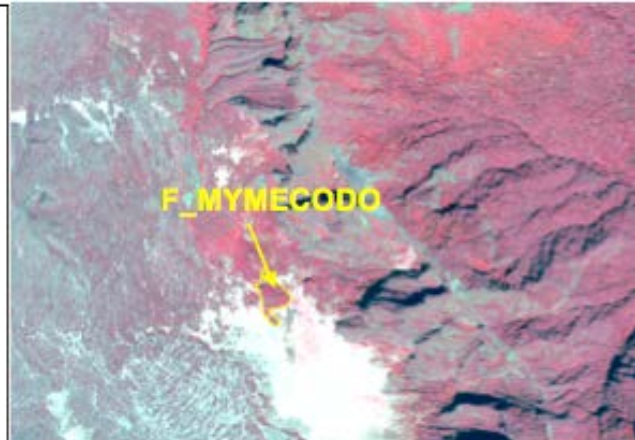
MAP CODE: F_MYMECODO

ELCODE: CEG008204

Map Class Name: <i>Myrsine lessertiana</i> - (<i>Metrosideros polymorpha</i>) / <i>Coprosma foliosa</i> - <i>Dodonaea viscosa</i> Montane Mesic Forest	Common Name: Kōlea lau nui - (‘Ōhi‘a) / Pilo - ‘A‘ali‘i Montane Mesic Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Myrsine lessertiana* - (*Metrosideros polymorpha*) / *Coprosma foliosa* - *Dodonaea viscosa* Montane Mesic Forest

Description: This map class is characterized by a moderately dense tree canopy dominated by *Myrsine lessertiana* with a moderately dense tall-shrub canopy codominated by *Coprosma foliosa* and *Dodonaea viscosa*. *Metrosideros polymorpha* may be present to codominant. Additional trees present with low cover include *Acacia koa* and *Sophora chrysophylla* (small tree/tall shrub). Other native species may be present, such as shrub *Lysimachia remyi* and vine *Alyxia oliviformis*. *Leptecophylla tameiameia* is absent or has low cover (<5%). The herbaceous layer is generally sparse because of dense shading from shrub and tree layers, although it may be diverse. This class was mapped in the draft map using field verified manual interpretation. However, its accuracy is zero. The one polygon containing the two AA samples mapped as *Myrsine lessertiana* - (*Metrosideros polymorpha*) / *Coprosma foliosa* - *Dodonaea viscosa* Montane Mesic Forest (containing the two classification samples) in the draft map were edited to their reference label (*Acacia koa* / *Coprosma foliosa* - *Dodonaea viscosa* Montane Mesic Woodland) in the final map.

Most Abundant Species: *Coprosma foliosa*, *Dodonaea viscosa*, *Metrosideros polymorpha*, *Myrsine lessertiana*

Distribution/Location: This forest map class occurs in one field verified polygon near the Palikū cabin.

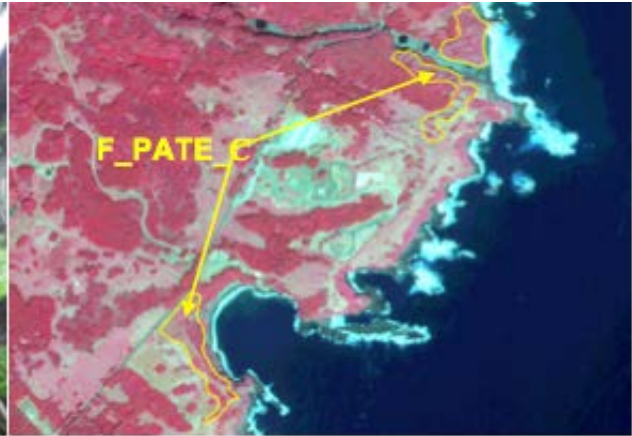
Classification Samples: 2	Hectares: 0.44
User's Accuracy: 0%	Producer's Accuracy: 0%
Accuracy Assessment Map Samples: 2	Accuracy Assessment Reference Samples: 0

MAP CODE: F_PATE_C**ELCODE: CEG008032**

Map Class Name: <i>Pandanus tectorius</i> Coastal Mesic Forest	Common Name: Hala Coastal Mesic Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Pandanus tectorius* Coastal Mesic Forest

Description: This map class is characterized by an open to closed tree canopy dominated by *Pandanus tectorius* from 15-80% cover. *Terminalia catappa* is present in the tree canopy at low cover. The shrub layer includes open to dense *Scaevola taccada*, from 5-70% cover. The herbaceous layer is typically sparse but can occur with up to 20% total cover and may include *Axonopus fissifolius*. This class was mapped using field reconnaissance and manual interpretation. It is characterized on the imagery by its location on the coast and the round light to dark pink crowns of the *Pandanus tectorius*. It was confused with one *Cenchrus purpureus* Semi-natural Herbaceous Vegetation site because of a small island of *Pandanus tectorius* within a large *Cenchrus purpureus* Semi-natural Herbaceous Vegetation polygon. The *Pandanus tectorius* of the island was not edited into the final map because it fell below the MMU of 0.5ha for this class.

Most Abundant Species: *Pandanus tectorius*

Distribution/Location: This coastal forest map class is known from the coast near Kīpahulu Visitor Center, along the Kuloa Point Loop Trail, the road to Heiau at Puhilele, and along lower Alelele Stream by Ka‘āpahu Bay. Sites occur along the coast on flat to gentle low levels and low slopes with slight south, southeast, and east aspects from 5-60m.

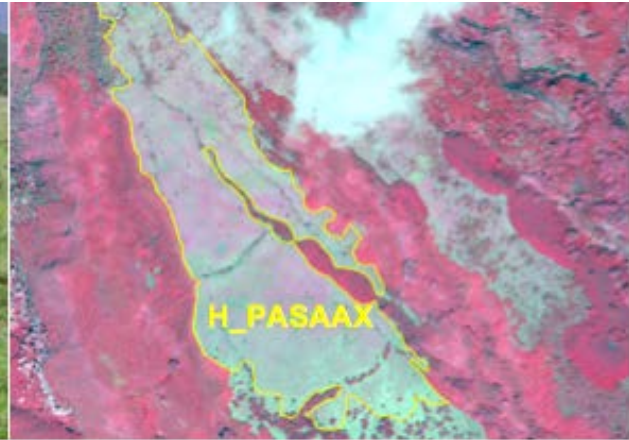
Classification Samples: 3	Hectares: 3.11
User’s Accuracy: 100%	Producer’s Accuracy: 67%
Accuracy Assessment Map Samples: 2	Accuracy Assessment Reference Samples: 3

MAP CODE: H_PASAAX**ELCODE: CEG008170**

Map Class Name: <i>Paspalum conjugatum</i> - <i>Sacciolepis indica</i> - <i>Axonopus fissifolius</i> Mixed Semi-natural Herbaceous Vegetation	Common Name: Hilo Grass - Glenwood Grass - Carpetgrass Mixed Semi-natural Herbaceous Vegetation
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Paspalum conjugatum* - *Sacciolepis indica* - *Axonopus fissifolius* Mixed Semi-natural Herbaceous Vegetation [Provisional]

Description: This map class is characterized by a dense herbaceous layer dominated by non-native grasses *Paspalum conjugatum* on one site and *Axonopus fissifolius* at another with total herbaceous cover >90%. Many other non-native herbaceous species are also present. Scattered shrubs and small trees may be present, including *Psidium cattleianum*, *Psidium guajava*, and *Rubus rosifolius*. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is characterized on the infrared imagery by its location and its smooth beige to light blue and light pink herbaceous spectral response. On the draft map it was confused with *Schinus terebinthifolius* Semi-natural Scrub Woodland in a former paddock near Pepeiaolepo Bay where the *Schinus terebinthifolius* is invading the former pasture land. These errors were corrected in the final map.

Most Abundant Species: *Axonopus fissifolius*, *Paspalum conjugatum*

Distribution/Location: This map class is known only from 'Ohe'o and Pu'u 'ahu'ula. Sites occur on gentle and southeast-facing lowslopes from 350-450 m. Sites are disturbed and in many cases support active cattle grazing.

Classification Samples: 2	Hectares: 58.70
User's Accuracy: 65%	Producer's Accuracy: 100%
Accuracy Assessment Map Samples: 20	Accuracy Assessment Reference Samples: 13

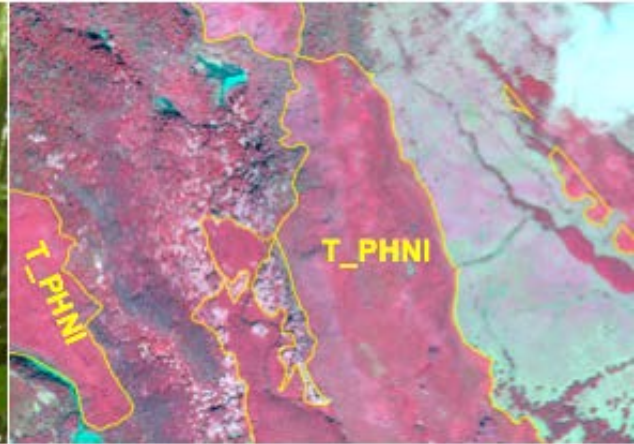
MAP CODE: T_PHNI

ELCODE: CEG008205

Map Class Name: <i>Phyllostachys nigra</i> Semi-natural Thicket	Common Name: Black bamboo Semi-natural Thicket
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Phyllostachys nigra* Semi-natural Thicket

Description: This map class is characterized by a 10 to 15m tall, dense tree canopy dominated by non-native *Phyllostachys nigra*, often in monotypic stands. A few scattered older *Aleurites moluccana* trees (<1% cover) are present in one stand. Shrub and herbaceous layers are absent as stands often form large, dense thickets with only a few scattered shrubs or herbs present. Other species information is not available. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. This highly accurate class is characterized by its location, its uniform bright to dark red spectral response, and its speckled texture.

Most Abundant Species: *Pandanus tectorius*

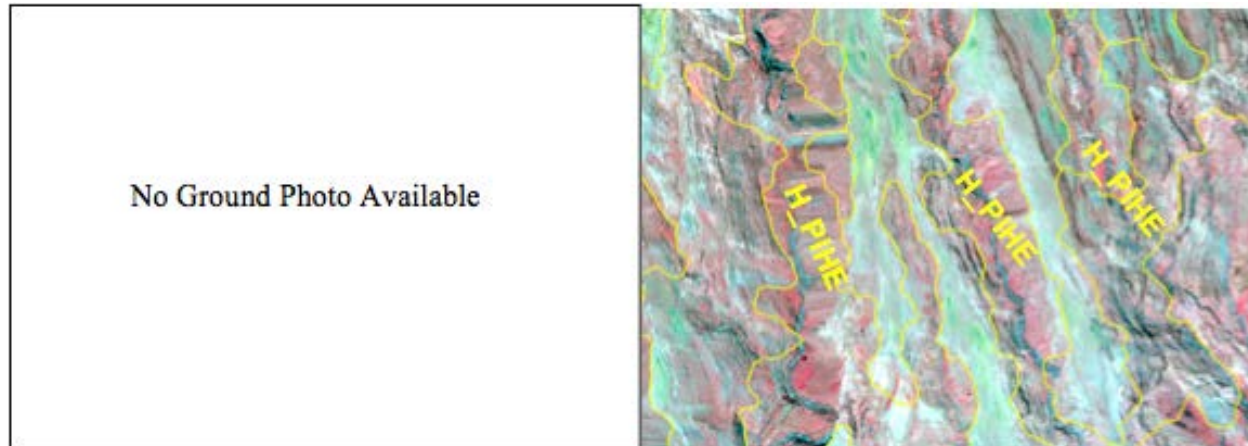
Distribution/Location: This lowland thicket map class is known from 'Ohe'o near Pīpīwai trail and found on moist to very wet gently sloping lowslopes from 100-210m. Aspects are variable, occurring on both northeast and southwest aspects.

Classification Samples: 2	Hectares: 68.45
User's Accuracy: 100%	Producer's Accuracy: 100%
Accuracy Assessment Map Samples: 14	Accuracy Assessment Reference Samples: 14

MAP CODE: H_PIHE

ELCODE: CEG008206

Map Class Name: <i>Pityrogramma austroamericana</i> - <i>Heterotheca grandiflora</i> Semi-natural Herbaceous Vegetation	Common Name: Gold Fern - Telegraphweed Semi-natural Herbaceous Vegetation
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Ground View

Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Pityrogramma austroamericana* - *Heterotheca grandiflora* Semi-natural Herbaceous Vegetation

Description: This map class is characterized by herbaceous vegetation dominated by the non-native fern *Pityrogramma austroamericana* and forb *Heterotheca grandiflora* at low cover, ranging from approximately 10-40% combined. *Lantana camara* is also common at low cover. Other herbaceous associates include *Ageratina riparia*, *Ageratum conyzoides*, *Bothriochloa pertusa*, *Festuca rubra*, *Hypochaeris radicata*, *Oxalis corniculata*, and *Spermacoce assurgens*. This class was mapped using a combination of classification sites, park knowledge, CART modeling, and manual interpretation. It is characterized by its location and its turquoise to bright red smooth spectral signature. This class was not assessed for accuracy.

Most Abundant Species: *Heterotheca grandiflora*, *Pityrogramma austroamericana*

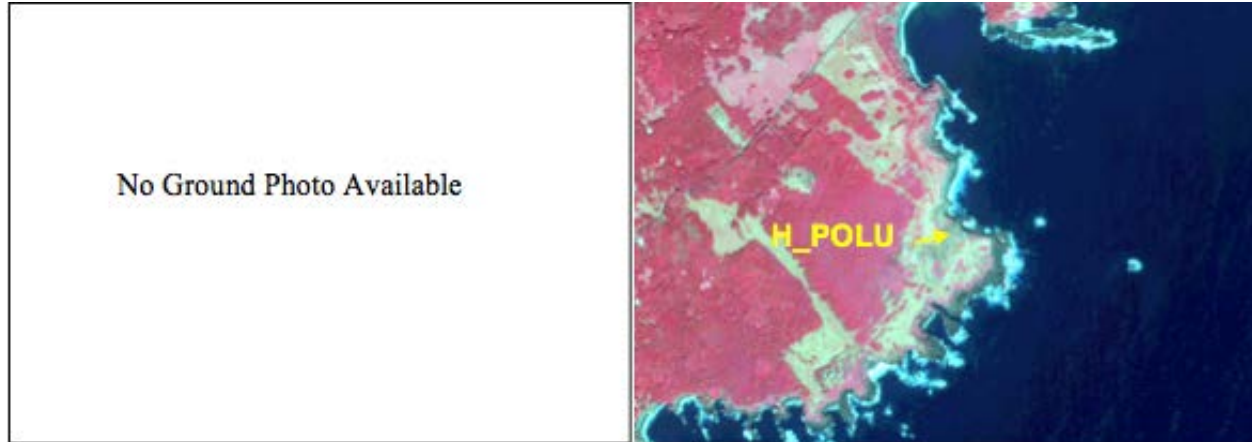
Distribution/Location: This montane herbaceous map class is only known from a few locations in Nu'u and occurs on mesic steep slopes and ridges with southern aspects from 700-1400m.

Classification Samples: 3	Hectares: 310.52
User's Accuracy: Not Assessed	Producer's Accuracy: Not Assessed
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 0

MAP CODE: H_POLU

ELCODE: CEPS009706

Map Class Name: <i>Portulaca lutea</i> Herbaceous Vegetation	Common Name: 'Thi Herbaceous Vegetation
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Ground View

Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Portulaca lutea* Herbaceous Vegetation [Park Special]

Description: The one polygon of this map class is was delineated based on the location of its classification observation site which was comprised of 62% *Portulaca lutea* cover. The site is dull grey brown on the infrared imagery. This class was not assessed for accuracy.

Most Abundant Species: *Portulaca lutea*

Distribution/Location: This map class occurs in one field verified polygon near Puhilele Point.

Classification Samples: 1	Hectares: 0.02
User's Accuracy: Not Assessed	Producer's Accuracy: Not Assessed
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 0

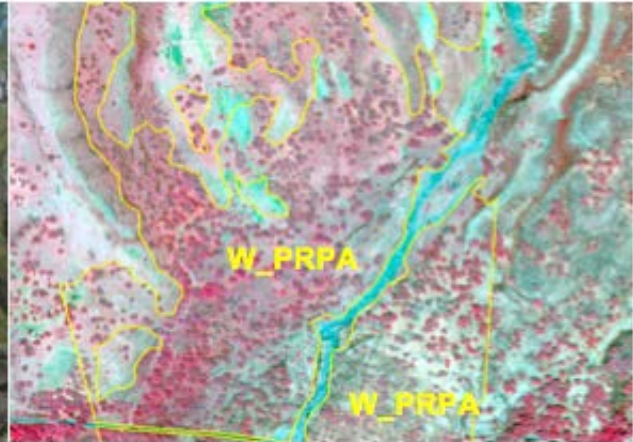
MAP CODE: W_PRPA

ELCODE: CEG008118

Map Class Name: <i>Prosopis pallida</i> Coastal Dry Semi-natural Woodland	Common Name: Kiawe Coastal Dry Semi-natural Woodland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Prosopis pallida* Coastal Dry Semi-natural Woodland

Description: This map class is composed of an open canopy dominated by the non-native tree *Prosopis pallida* ranging from 15-45% cover. No other consistent canopy associates occur; however, some stands have a subcanopy/tall-shrub layer composed of *Leucaena leucocephala*. The understory is strongly dominated by dense layers of the non-native grasses *Cenchrus ciliaris* and *Urochloa maxima* ranging from 50-100% cover. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is characterized by its location and the dense to scattered large, round greyish red crowns of the *Prosopis pallida* with a light pink herbaceous understory. This highly accurate class had two errors of omission. Both were corrected in the final map.

Most Abundant Species: *Prosopis pallida*

Distribution/Location: This semi-natural woodland map class is known from a few locations at Nu‘u on dry coastal lowslopes, topslopes and terraces. Sites occur on recently grazed gentle sideslopes with south and southwest aspects from 5-420m.

Classification Samples: 4	Hectares: 92.43
User’s Accuracy: 100%	Producer’s Accuracy: 87%
Accuracy Assessment Map Samples: 20	Accuracy Assessment Reference Samples: 23

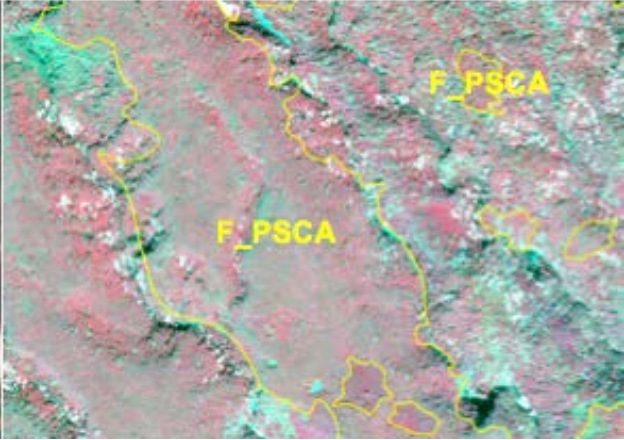
MAP CODE: F_PSCA

ELCODE: CEG008116

Map Class Name: <i>Psidium cattleianum</i> Lowland Wet Semi-natural Forest	Common Name: Strawberry Guava Lowland Wet Semi-natural Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Psidium cattleianum* Lowland Wet Semi-natural Forest

Description: This map class is characterized by dense canopies of the non-native tree *Psidium cattleianum* ranging from 60-90% cover and often in monotypic thickets. No other canopy associates are consistently present, although the native tree *Acacia koa*, as well as the non-native trees *Schinus terebinthifolius* and *Syzygium cumini*, may occur at lower coverage. Shrub layers are typically sparse and the understory is herbaceous dominated, although cover is low and no species have high consistency. Ferns are the most abundant species and include the non-native species *Cyclosorus dentatus*, *Nephrolepis multiflora*, and *Phymatosorus grossus*. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. This highly accurate class is characterized by its location and its dense, speckled brownish to bright red spectral signature.

Most Abundant Species: *Psidium cattleianum*

Distribution/Location: This semi-natural forest map class is known from Oheo, Ka'āpahu, Palikea flats, Lower Kīpahulu on both the Upper and Lower shelves, and Upper Shelf Kīpahulu. It typically occurs on gentle to steep low and midslopes, valley bottoms and low ridges from 200-1100m.

Classification Samples: 8	Hectares: 163.69
User's Accuracy: 95%	Producer's Accuracy: 95%
Accuracy Assessment Map Samples: 19	Accuracy Assessment Reference Samples: 19

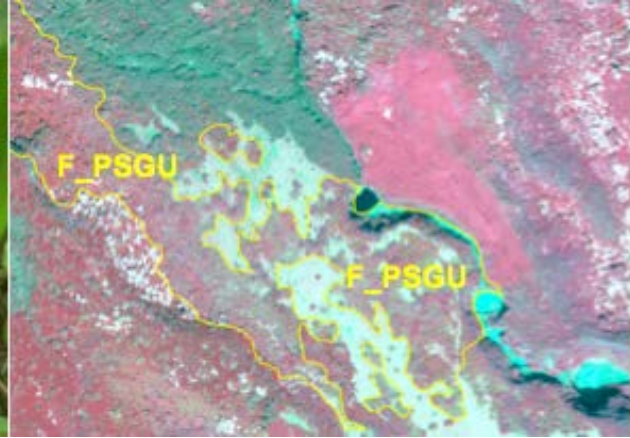
MAP CODE: F_PSGU

ELCODE: CEG008147

Map Class Name: <i>Psidium guajava</i> / Disturbed Understory Semi-natural Forest	Common Name: Common Guava / Disturbed Understory Semi-natural Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Psidium guajava* / Disturbed Understory Semi-natural Forest

Description: This map class is characterized by an open to dense tree canopy dominated by *Psidium guajava* with cover ranging from 10-80%. Stands tend to be monotypic or nearly so in the canopy. The understory is composed of a variety of non-native shrubs and herbs, none of which appears to have an affinity to this semi-natural community, although *Clidemia hirta* is found to be the overwhelming shrub dominant in two stands that were sampled. This class was mapped using a combination of field reconnaissance, CART modeling and manual interpretation. It is characterized by its location and its brownish red spectral signature. On the draft map, three samples were confused with *Paspalum conjugatum* - *Sacciolepis indica* - *Axonopus fissifolius* Mixed Semi-natural Herbaceous Vegetation. These areas were not edited because all three had a secondary label of *Paspalum conjugatum* - *Sacciolepis indica* - *Axonopus fissifolius* Mixed Semi-natural Herbaceous Vegetation.

Most Abundant Species: *Psidium guajava*

Distribution/Location: This semi-natural woodland and forest map class is found at Palikea Flats, 'Ohe'o, Pu'u 'ahu'ula, and the lower Kīpahulu Valley. It typically occurs on mesic to wet gentle to moderate lowslopes and valley bottoms on southwest and southeast aspects from 400-550m. All areas have been heavily impacted by cows and pigs.

Classification Samples: 4	Hectares: 38.21
User's Accuracy: 100%	Producer's Accuracy: 50%
Accuracy Assessment Map Samples: 4	Accuracy Assessment Reference Samples: 8

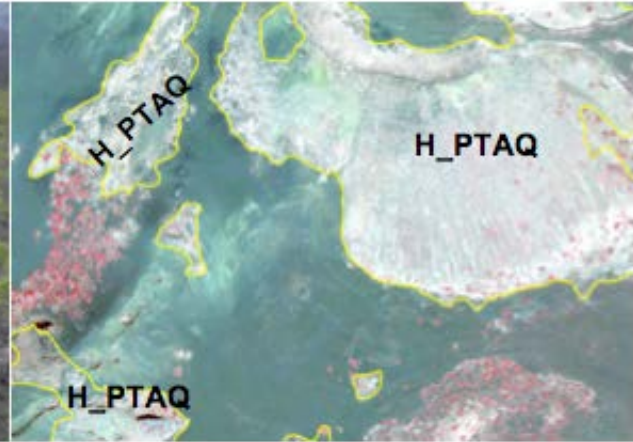
MAP CODE: H_PTAQ

ELCODE: CEPS009665

Map Class Name: <i>Pteridium aquilinum</i> ssp. <i>decompositum</i> Herbaceous Vegetation	Common Name: Kīlau Herbaceous Vegetation
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Pteridium aquilinum* ssp. *decompositum* Herbaceous Vegetation [Park Special]

Description: This map class is characterized by herbaceous vegetation dominated by the fern *Pteridium aquilinum* ssp. *decompositum*. The remainder of the herbaceous composition is variable and may include *Deschampsia nubigena*, *Hypochaeris radicata*, *Oenothera stricta*, and *Festuca rubra*. Scattered shrubs include *Leptecophylla tameiameiae* and *Coprosma montana*. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is distinguished by its location and its grey-white spectral signature in the infrared imagery. This highly accurate class was confused only with *Holcus lanatus* Semi-natural Grassland on the draft map (three samples). The areas of all three samples were corrected in the final map.

Most Abundant Species: *Pteridium aquilinum* ssp. *decompositum*

Distribution/Location: This herbaceous map class is known from the West Crater along lower Sliding Sands Trail and southwest of Hōlua Cabin, near the junction of Haleamau'u Trail and Crystal Cave Trail, and Kapalaoa Cabin extending east towards Kaupō. Sites occur on gentle to steep high level and side slopes with northeast and southeast aspects from 2250-2350m.

Classification Samples: 2	Hectares: 313.21
User's Accuracy: 100%	Producer's Accuracy: 85%
Accuracy Assessment Map Samples: 17	Accuracy Assessment Reference Samples: 20

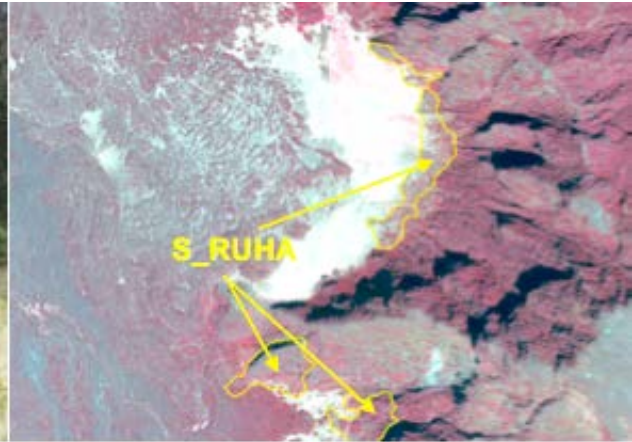
MAP CODE: S_RUHA

ELCODE: CEG008052

Map Class Name: <i>Rubus hawaiiensis</i> Montane Wet Shrubland	Common Name: ‘Ākala Montane Wet Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Rubus hawaiiensis* Montane Wet Shrubland

Description: This shrubland map class is characterized by a moderate to dense, tall-shrub canopy dominated by *Rubus hawaiiensis*. Scattered *Sophora chrysophylla* tall shrubs and low cover of other shrubs such as *Coprosma ernodeoides*, *Leptecophylla tameiameia*, and *Vaccinium reticulatum* may be present. The herbaceous layer is sparse to moderately dense with low cover of the native ferns *Athyrium microphyllum*, *Dryopteris wallichiana*, and *Pteridium aquilinum* ssp. *decompositum*, and low cover of native graminoids *Carex macloviana* and *Luzula hawaiiensis* var. *hawaiiensis*. Non-native species *Holcus lanatus* and *Rumex acetosella* frequently dominate the herbaceous layer. This class was mapped using a combination of field reconnaissance and manual interpretation. This highly accurate class is distinguished by its location and smooth brownish red spectral signature in the infrared imagery.

Most Abundant Species: *Rubus hawaiiensis*

Distribution/Location: This wet, upper montane shrubland map class is known from East Crater near Lau ulu, Palikū, and Kaupō Trail and near New Greenwood Bog. Sites occur on nearly flat to gently side slopes and in depressions on variable aspects from 1760-2110m.

Classification Samples: 2	Hectares: 8.96
User's Accuracy: 100%	Producer's Accuracy: 100%
Accuracy Assessment Map Samples: 3	Accuracy Assessment Reference Samples: 3

MAP CODE: S_SCTA

ELCODE: CEG008054

Map Class Name: <i>Scaevola taccada</i> Coastal Dry Shrubland	Common Name: Naupaka Kahakai Coastal Dry Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Scaevola taccada* Coastal Dry Shrubland

Description: This map class is characterized by a moderately dense shrub layer dominated by *Scaevola taccada* from 40-50% cover. No other shrubs occur but some sites may include open *Pandanus tectorius* trees with <10% cover. The herbaceous layer can be sparse to moderately dense (6-30%) and may include *Spermacoce assurgens* and *Axonopus fissifolius*. This class was mapped using a combination of field reconnaissance and manual interpretation. This highly accurate class is distinguished by its location on the coast and the bright red-pink round crowns of the *Scaevola taccada* shrubs.

Most Abundant Species: *Scaevola taccada*

Distribution/Location: This coastal shrubland map class is known from the coast near Kīpahulu Visitor Center and campground, along the Kuloa Point Loop Trail, the road to Heiau, Puhilele Point, and Ka‘āpahu Bay. Sites occur along the coast on flat to gentle low levels and low slopes with slight south, southeast, and east aspects from 5-60m.

Classification Samples: 1	Hectares: 5.66
User’s Accuracy: 100%	Producer’s Accuracy: 100%
Accuracy Assessment Map Samples: 3	Accuracy Assessment Reference Samples: 3

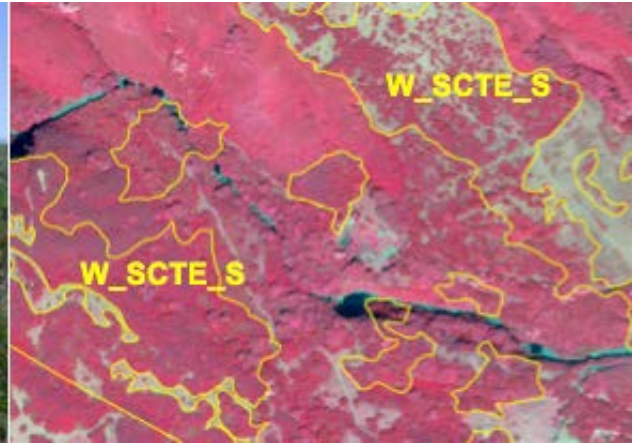
MAP CODE: W_SCTE_S

ELCODE: CEG008148

Map Class Name: <i>Schinus terebinthifolius</i> Semi-natural Scrub Woodland	Common Name: Christmas berry Semi-natural Scrub Woodland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Schinus terebinthifolius* Semi-natural Scrub Woodland

Description: This map class is strongly dominated by the non-native tree *Schinus terebinthifolius* with canopy cover ranging from 40-90%. *Psidium guajava* is often present to codominant. Although no understory species are consistent across stands, non-native grasses are the typical dominants and include *Axonopus fissifolius*, *Digitaria eriantha*, *Melinis minutiflora*, *Oplismenus hirtellus*, *Paspalum scrobiculatum*, *Sacciolepis indica*, *Stenotaphrum secundatum*, and *Sporobolus africanus*. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is distinguished by its location and its fine grained dark red texture on the infrared imagery. On the draft map, five samples of *Syzygium cumini* Lowland Mesic Semi-natural Forest were erroneously committed to this class. The areas of all five samples were edited to their correct label in the final map.

Most Abundant Species: *Schinus terebinthifolius*

Distribution/Location: This semi-natural forest and woodland map class is known from lower Kaumakani, Pipiwai trail, Palikea Flats, Puhilele in 'Ohe'o, the Kaupō Trailhead in Keaku Valley, and on the ridge east of Alelele in Ka'āpahu. It is typically found on mesic gentle to moderate sideslopes and low levels on all aspects from 50-350m. Most areas are noted to have been heavily impacted by ungulates.

Classification Samples: 7	Hectares: 124.29
User's Accuracy: 59%	Producer's Accuracy: 71%
Accuracy Assessment Map Samples: 17	Accuracy Assessment Reference Samples: 14

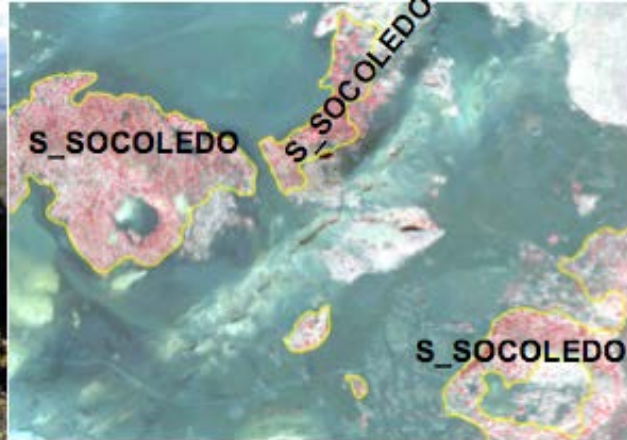
MAP CODE: S_SOLED0

ELCODE: CEG008209, CEP009721, CEG008191

Map Class Name: <i>Sophora chrysophylla</i> - (<i>Coprosma montana</i> - <i>Leptecophylla tameiameiae</i> - <i>Dodonaea viscosa</i>) Subalpine Shrubland	Common Name: Māmane - (Pilo - Pūkiawe - 'A'ali'i) Subalpine Shrubland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Sophora chrysophylla* - (*Coprosma montana*, *Leptecophylla tameiameiae*) Subalpine Shrubland¹, *Sophora chrysophylla* - *Dodonaea viscosa* - (*Leptecophylla tameiameiae*) Montane Shrubland [Park Special]¹, *Coprosma montana* / *Leptecophylla tameiameiae* Subalpine Shrubland [Provisional]¹

Description: This map class is characterized by an open to moderately dense tall-shrub (2-4m) canopy with 10-50% cover of *Sophora chrysophylla*. *Coprosma montana* is often present and may be codominant. An open to moderately dense short-shrub layer is frequently present that is composed of *Leptecophylla tameiameiae*, *Vaccinium reticulatum*, *Coprosma ernodeoides*, *Dubautia menziesii*, or *Rubus hawaiensis*. The herbaceous layer is variable and typically dominated by non-native grasses or the native fern *Pteridium aquilinum* ssp. *decompositum*. This class was mapped using a combination of field reconnaissance, CART modeling and manual interpretation. It is distinguished by the scattering of the bright red crowns of *Sophora chrysophylla* amid the dense grey blue *Leptecophylla tameiameiae* understory. On the draft map this class was confused with *Leptecophylla tameiameiae* Subalpine Dry Shrubland (six samples) and *Leptecophylla tameiameiae* - *Vaccinium reticulatum* Subalpine Mesic Shrubland (three samples). These areas were not edited for the final map because these three map labels are very sensitive to small differences in estimates of *Sophora chrysophylla* cover.

Most Abundant Species: *Coprosma montana*, *Sophora chrysophylla*, *Leptecophylla tameiameiae*, *Vaccinium reticulatum*

Distribution/Location: This subalpine shrubland map class is known from the Front Country and the slopes of West crater on the Lauulu Trail near Kaluaiki. Sites typically occur on gentle to moderately steep slopes on all aspects in seasonally mesic zones from 2100-2600m.

Classification Samples: 5	Hectares: 328.75
User's Accuracy: 74%	Producer's Accuracy: 85%
Accuracy Assessment Map Samples: 31	Accuracy Assessment Reference Samples: 27

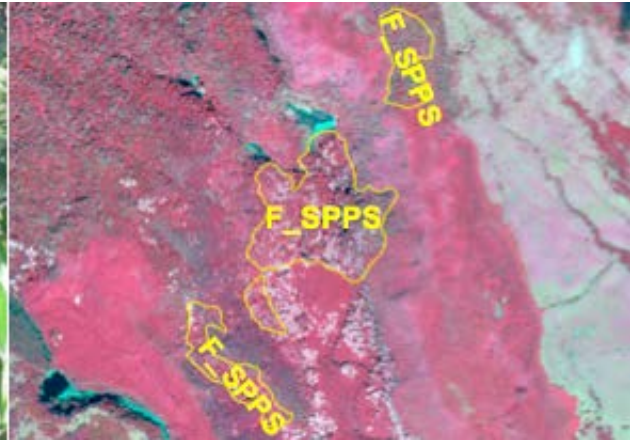
MAP CODE: F_SPPS

ELCODE: CEPS009708

Map Class Name: <i>Spathodea campanulata</i> - <i>Psidium</i> spp. Semi-natural Forest	Common Name: African Tuliptree - Guava species Semi-natural Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Spathodea campanulata* - *Psidium* spp. Semi-natural Forest [Park Special]

Description: This map class is characterized by moderate to dense cover (20-65%) of *Spathodea campanulata*. Other canopy associates may include *Aleurites moluccana* (0-8%) and *Psidium cattleianum* (0-15%). The shrub layer usually contains *Clidemia hirta* (2-10%) as well as *Coprosma foliosa* (0-10%). This class was mapped using a combination of field reconnaissance and manual interpretation. It is distinguished by its location and the dense canopy of bright red crowns of the *Spathodea campanulata* often mixed with white *Aleurites moluccana*. On the draft map, this accurate class was confused with one sample of *Psidium cattleianum* Lowland Wet Semi-natural Forest. This error was corrected for the final map.

Most Abundant Species: *Spathodea campanulata*

Distribution/Location: This map class is found on moderate to steep slopes in Haleakalā near Waimoku Falls between 150-550m in elevation. *Spathodea campanulata* is a highly invasive tree in this region and its range and distribution are expanding rapidly.

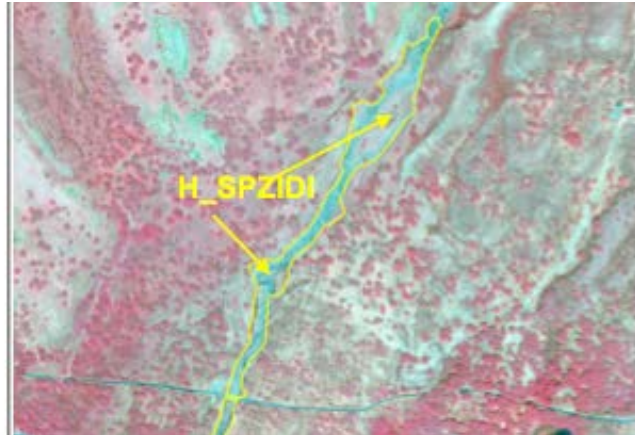
Classification Samples: 1	Hectares: 11.98
User's Accuracy: 100%	Producer's Accuracy: 75%
Accuracy Assessment Map Samples: 3	Accuracy Assessment Reference Samples: 4

MAP CODE: H_SPZIDI

ELCODE: CEG008207

Map Class Name: <i>Spermacoce assurgens</i> - <i>Zinnia peruviana</i> - <i>Digitaria insularis</i> Semi-natural Herbaceous Vegetation	Common Name: Buttonweed - Peruvian Zinnia - Sourgrass Semi-natural Herbaceous Vegetation
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No Ground Photo Available



Ground View

Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Spermacoce assurgens* - *Zinnia peruviana* - *Digitaria insularis* Semi-natural Herbaceous Vegetation [Provisional]

Description: This map class is dominated by *Spermacoce assurgens* which has 10-15% cover. Other herbaceous associates include *Crotalaria pallida*, *Zinnia peruviana*, and *Digitaria insularis*, which have about half the cover of *Spermacoce assurgens* individually. Scattered shrubs occur at low cover and include *Indigofera suffruticosa* and *Lantana camara*. This class was mapped using a combination of field reconnaissance and manual interpretation. It is distinguished by its location in Hawelewele Gulch and its bright light blue spectral signature in the infrared imagery. This class was not assessed for accuracy.

Most Abundant Species: *Digitaria insularis*, *Spermacoce assurgens*, *Zinnia peruviana*

Distribution/Location: This dry-site herbaceous map class is known only from Hawelewele Gulch in Nu'u. Sites occur in dry drainages on nearly flat lowslopes and lowlevels with variable aspects from 60-250m. Sites are confined to drainage channels and noted as being heavily impacted by ungulates. This type can present as unvegetated depending on the time of year and available moisture for these ephemeral forb species.

Classification Samples: 2	Hectares: 4.81
User's Accuracy: Not Assessed	Producer's Accuracy: Not Assessed
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 0

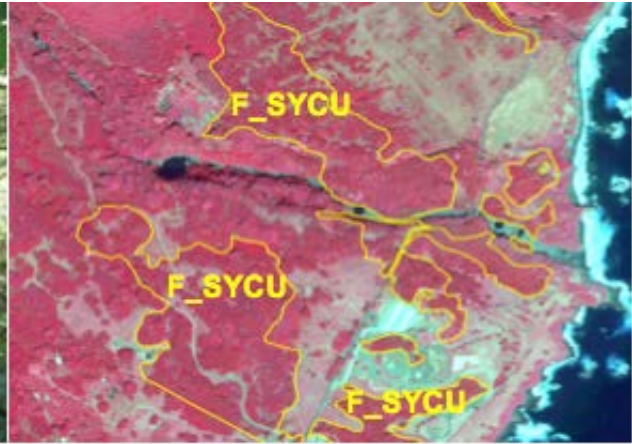
MAP CODE: F_SYCU

ELCODE: CEG008111

Map Class Name: <i>Syzygium cumini</i> Lowland Mesic Semi-natural Forest	Common Name: Java plum Lowland Mesic Semi-natural Forest
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Syzygium cumini* Lowland Mesic Semi-natural Forest

Description: This highly diverse map class is characterized by a dense canopy (57-91%) of trees dominated by *Syzygium cumini* (36-75%) but often mixed with other canopy associates such as *Schinus terebinthifolius* (0-31%), *Mangifera indica* (0-12%), *Aleurites moluccana* (0-12%), *Ficus microcarpa* (0-7%), *Psidium guajava* (0-5%), *Spathodea campanulata* (0-25%), and *Terminalia catappa* (0-7%). The understory is sparse to absent with few shrubs (0-5%) or herbaceous plants except for one sample which had 25% *Paspalum conjugatum* as well as other herbaceous species. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is distinguished by its location near the coast and the tall and deep red spectral signature of the *Syzygium cumini* trees in the infrared imagery. This class had low map accuracies on the draft map primarily because of significant confusion with map classes dominated by its canopy associates including *Schinus terebinthifolius* Semi-natural Scrub Woodland (five samples) and *Mangifera indica* Semi-natural Forest (two samples). All areas of confusion were corrected in the final map.

Most Abundant Species: *Syzygium cumini*

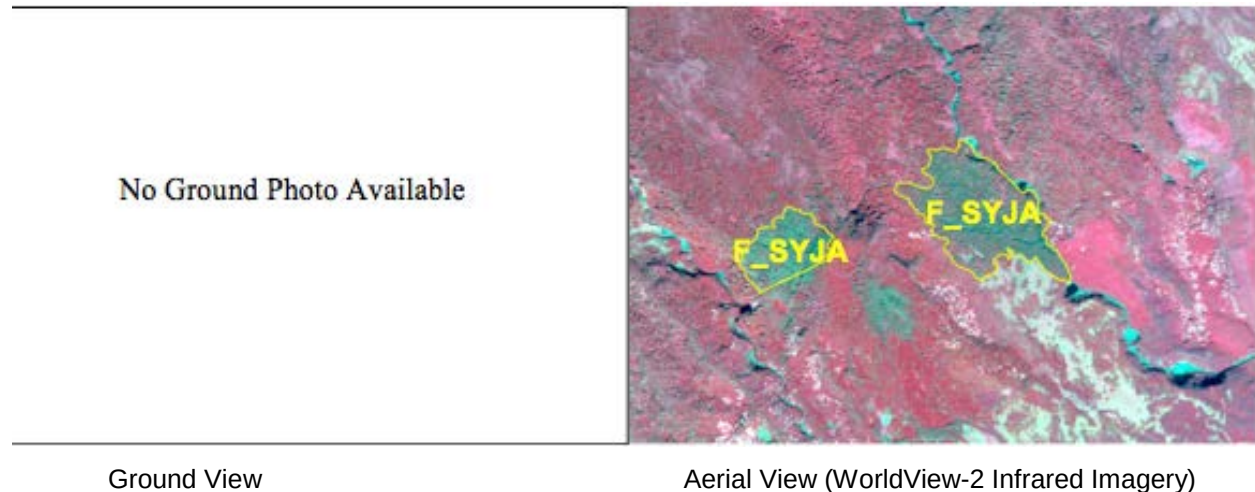
Distribution/Location: This map class occurs in coastal areas on either side of 'Ohe'o Gulch and in Ka'apahuu

Classification Samples: 1	Hectares: 59.33
User's Accuracy: 60%	Producer's Accuracy: 30%
Accuracy Assessment Map Samples: 5	Accuracy Assessment Reference Samples: 10

MAP CODE: W_SYJA

ELCODE: CEG008208

Map Class Name: <i>Syzygium jambos</i> Lowland Mesic Semi-natural Woodland	Common Name: Rose Apple Lowland Mesic Semi-natural Woodland
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USNVC Association: *Syzygium jambos* Lowland Mesic Semi-natural Woodland

Description: This map class is characterized by open woodland canopies of *Syzygium jambos* with 10-30% cover. *Acacia koa* and *Psidium spp.* may be present but not codominant. Understories are dense thickets of *Clidemia hirta* which has >70% cover. No herbaceous species are consistent across stands. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is characterized by its location and the dull bluish grey spectral signature of the dead *Syzygium jambos* trees. This class was not assessed for accuracy.

Most Abundant Species: *Clidemia hirta*, *Syzygium jambos*

Distribution/Location: This semi-natural woodland map class is known from a few locations in the Lower Kīpahulu Valley, Oheo, Alawainui Trail below Puu AhuulaPu'u 'ahu'ula, west of Kukui'ulaKuku' Ridge, and Kālepa Gulch. It is typically seen on gentle to moderate mesic lowslopes and valley bottoms on all aspects from 350-700m.

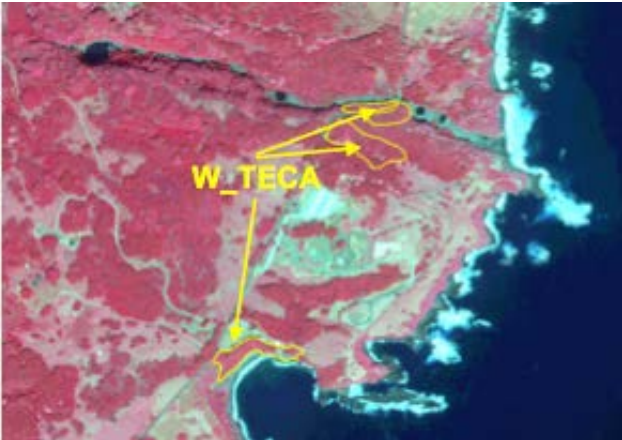
Classification Samples: 3	Hectares: 38.56
User's Accuracy: Not Assessed	Producer's Accuracy: Not Assessed
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 0

MAP CODE: W_TECA**ELCODE: CEPS009651**

Map Class Name: <i>Terminalia catappa</i> Semi-natural Woodland	Common Name: Pacific almond Semi-natural Woodland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Terminalia catappa* Semi-natural Woodland [Park Special]

Description: This map class is characterized by open to dense canopies dominated by *Terminalia catappa* which ranges from approximately 40-80% cover. *Syzygium cumini* is commonly present and occasionally codominant. Other non-native trees may be present, such as *Morinda citrifolia*, *Psidium guajava*, and *Cocos nucifera*. The understory can be nearly barren or heavily invaded by the non-native grass *Oplismenus hirtellus* and the non-native fern *Phymatosorus grossus*. This rare class was mapped using field verified manual interpretation and was only mapped where found in the field. On the draft map it has zero accuracy because its two samples were committed to other classes (*Schinus terebinthifolius* Semi-natural Scrub Woodland and *Syzygium cumini* Lowland Mesic Semi-natural Forest). One sample was not edited for the final map because it has a secondary label of *Syzygium cumini* Lowland Mesic Semi-natural Forest which matched the map label. The other site was edited to *Syzygium cumini* Lowland Mesic Semi-natural Forest because the sample was dominated by *Syzygium cumini*.

Most Abundant Species: *Syzygium cumini*, *Terminalia catappa*

Distribution/Location: This semi-natural woodland map class is known from 'Ohe'o on Kuloa Point Loop Trail, the bunkhouse at Kukui Bay, and an isolated stand on the coast at Ka'āpahu Bay. Sites typically occur on gentle to moderate lowslopes with southwest and eastern aspects from 5-60 m. Sites commonly indicate past grazing by cattle.

Classification Samples: 2	Hectares: 1.92
User's Accuracy: 0%	Producer's Accuracy: 0%
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 2

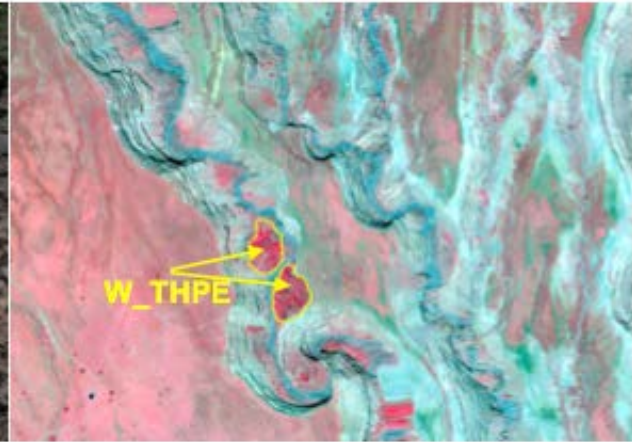
MAP CODE: W_THPE

ELCODE: CEPS009652

Map Class Name: <i>Thevetia peruviana</i> Semi-natural Woodland	Common Name: Lucky-nut Semi-natural Woodland
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Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: *Thevetia peruviana* Semi-natural Woodland [Park Special]

Description: This map class is characterized by dense canopies dominated by the non-native tree *Thevetia peruviana* (78% cover) with *Erythrina sandwicensis* present at much lower cover (12% cover). Total canopy cover is 90%. Scattered *Lantana camara* shrubs are present. The open herbaceous layer is composed of the non-native species *Ocimum gratissimum* and *Digitaria insularis*. This class was mapped using a combination of the classification samples and manual interpretation. This class is distinguished by its location in Kahalulu Gulch and the dense bright red spectral signature of the closed canopy *Thevetia peruviana* trees.

Most Abundant Species: *Thevetia peruviana*

Distribution/Location: This map class is known entirely from Kahalulu Gulch in Nu‘u. Sites typically occur on moderate to steep west and south facing colluvial lowslopes from 400-620m.

Classification Samples: 1	Hectares: 1.33
User’s Accuracy: 100%	Producer’s Accuracy: 100%
Accuracy Assessment Map Samples: 1	Accuracy Assessment Reference Samples: 1

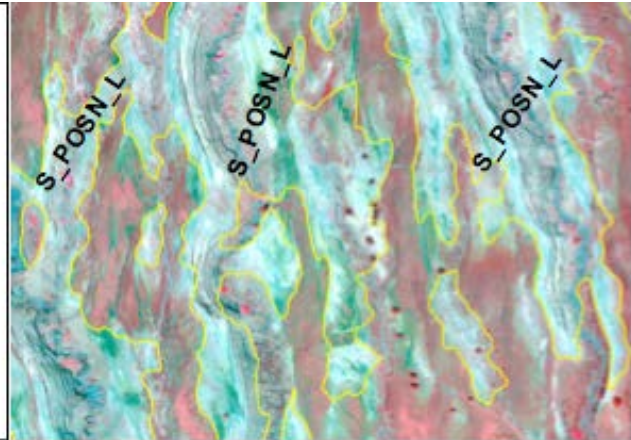
MAP CODE: S_POSN_L

ELCODE: NA

Map Class Name: Unclassified Polynesian Semi-natural Lowland Shrubland, Grassland, and Savanna

Common Name: Unclassified Polynesian Semi-natural Lowland Shrubland, Grassland, and Savanna

No Ground Photo Available



Ground View

Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: None

Description: This class has no classification plots or accuracy assessment samples and was inaccessible to the calibration and validation crews. Its label was developed by NPS personnel. It is distinguished on the infrared imagery by its location and its light blue herbaceous signature.

Most Abundant Species: Unknown

Distribution/Location: This class occurs in the middle elevations of Nu'u on moderately steep slopes between 180 and 900m.

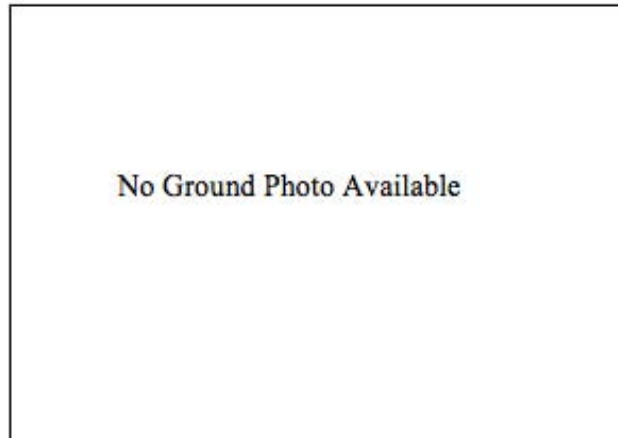
Classification Samples: 0	Hectares: 204.58
User's Accuracy: Not Assessed	Producer's Accuracy: Not Assessed
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 0

MAP CODE: S_POSN_SA

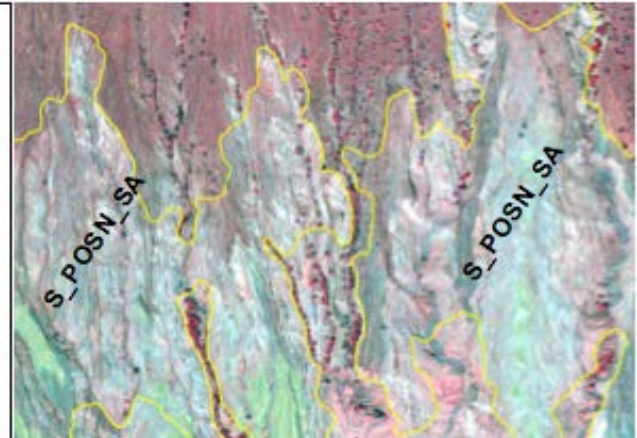
ELCODE: NA

Map Class Name: Unclassified Polynesian Semi-natural Montane and Subalpine Shrubland and Grassland

Common Name: Unclassified Polynesian Semi-natural Montane and Subalpine Shrubland and Grassland



Ground View



Aerial View (WorldView-2 Infrared Imagery)

USNVC Association: None

Description: This class has no classification plots or accuracy assessment samples and was inaccessible to the calibration and validation crews. Its label was developed by NPS personnel. It is distinguished on the infrared imagery by its location and its pinkish blue herbaceous signature.

Most Abundant Species: Unknown

Distribution/Location: This class occurs in the upper elevations of Nu'u on very steep slopes between 900 and 2100 m. Heavy browsing by goats, pigs, and deer, along with the resulting erosion, have eliminated most vegetation on these steep slopes.

Classification Samples: 0	Hectares: 313.23
User's Accuracy: Not Assessed	Producer's Accuracy: Not Assessed
Accuracy Assessment Map Samples: 0	Accuracy Assessment Reference Samples: 0

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 162/128974, July 2015

National Park Service
U.S. Department of the Interior



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