



# Vegetation Mapping Inventory Project

## *National Park of American Samoa*

Natural Resource Report NPS/PACN/NRR—2015/984



**ON THE COVER**

The forests of the south side of Mt. Lata on Ta'ū Island in the National Park of American Samoa.  
Photograph by: Kass Green

---

# **Vegetation Mapping Inventory Project**

## *National Park of American Samoa*

Natural Resource Report NPS/PACN/NRR—2015/984

Kass Green<sup>1</sup>, Gwen Kittel<sup>2</sup>, Chad Lopez<sup>3</sup>, Alison Ainsworth<sup>4</sup>, Meagan Selvig<sup>5</sup>, Visa Vaivai<sup>4</sup>, Kathryn Akamine<sup>5</sup>, Mark Tukman<sup>6</sup> and Greg Kudray<sup>4</sup>.

<sup>1</sup>Kass Green & Associates  
1101 High Court  
Berkeley, CA 94708

<sup>2</sup>NatureServe  
2108 55th Street, Suite 220  
Boulder, CO 80301

<sup>3</sup>Quantum Spatial  
10033 Martin Luther King Street, Suite 200  
St. Petersburg, Florida 33716

<sup>4</sup>National Park Service  
Pacific Island Network – Inventory and Monitoring  
PO Box 52  
Hawaii National Park, HI 96718

<sup>5</sup>Pacific Cooperative Studies Unit (PCSU)  
University of Hawaii at Hilo  
200 W. Kawili St.  
Hilo, HI 96720

<sup>6</sup>Tukman Geospatial LLC  
2700 Bennett Ridge Road,  
Santa Rosa, CA

July, 2015

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

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate comprehensive information and analysis about natural resources and related topics concerning lands managed by the National Park Service. The series supports the advancement of science, informed decision-making, and the achievement of the National Park Service mission. The series also provides a forum for presenting more lengthy results that may not be accepted by publications with page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from The Pacific Island Network website (<http://science.nature.nps.gov/im/units/pacn/>), and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpn/>). To receive this report in a format optimized for screen readers, please email [irma@nps.gov](mailto:irma@nps.gov).

Please cite this publication as:

Green, K., G. Kittel, C. Lopez, A. Ainsworth, M. Selvig, V. Vaivai, K. Akamine, M. Tukman, and G. Kudray. 2015. Vegetation mapping inventory project: National Park of American Samoa. Natural Resource Report NPS/PACN/NRR—2015/984. National Park Service, Fort Collins, Colorado.

# Contents

|                                                                              | Page |
|------------------------------------------------------------------------------|------|
| Figures.....                                                                 | vii  |
| Tables.....                                                                  | ix   |
| Appendices or Appendixes .....                                               | x    |
| Executive Summary .....                                                      | xi   |
| Acknowledgments.....                                                         | xiii |
| Introduction.....                                                            | 1    |
| Vegetation Classification and Mapping, National Park of American Samoa ..... | 1    |
| National Park Service Inventory and Monitoring Program.....                  | 2    |
| Overview .....                                                               | 2    |
| NPS Guidance for Vegetation Inventories .....                                | 3    |
| National Vegetation Classification Standard.....                             | 4    |
| Project Partners' Roles and Responsibilities.....                            | 6    |
| Pacific Island Network, Inventory and Monitoring Program.....                | 6    |
| NatureServe .....                                                            | 8    |
| Kass Green & Associates .....                                                | 9    |
| National Park of American Samoa .....                                        | 9    |
| Location and Setting.....                                                    | 9    |
| History .....                                                                | 16   |
| Vegetation Studies at the National Park of American Samoa .....              | 16   |
| Vegetation Classification and Mapping Methods.....                           | 19   |
| Development of the Proposal and Study Plan (Steps 1-3).....                  | 19   |
| Classification Sampling Design and Data Collection (Step 4).....             | 19   |
| Sampling Design .....                                                        | 19   |
| Field Data Collection.....                                                   | 20   |
| Quality Control.....                                                         | 21   |

## Contents (continued)

|                                                                                                    | Page |
|----------------------------------------------------------------------------------------------------|------|
| Development of Vegetation Classification, Vegetation Type Descriptions and Field Key (Step 5)..... | 24   |
| Acquire and Prepare Imagery (Step 7) .....                                                         | 28   |
| Imagery Analysis / Classification (Step 8) / GIS Project Preparation (Step 9).....                 | 28   |
| Image Segmentation .....                                                                           | 30   |
| Collect and Process Ancillary Data.....                                                            | 30   |
| Calibration Trip .....                                                                             | 32   |
| Creation of the Classification and Regression Tree (CART) Sample Database .....                    | 34   |
| CART Modeling.....                                                                                 | 34   |
| Editing .....                                                                                      | 35   |
| Draft Map and Digital Database Production .....                                                    | 35   |
| Formal Accuracy Assessment (Step 11).....                                                          | 36   |
| Sampling Design .....                                                                              | 40   |
| Field Data Collection.....                                                                         | 41   |
| Quality Control.....                                                                               | 45   |
| Analysis .....                                                                                     | 45   |
| Validation (Step 10) .....                                                                         | 46   |
| Develop the Mapping Model (Step 6).....                                                            | 46   |
| Final Map, Reports, and GIS Database (Step 12).....                                                | 47   |
| Results.....                                                                                       | 49   |
| Vegetation Sampling .....                                                                          | 49   |
| Vegetation Classification.....                                                                     | 49   |
| Vegetation Mapping.....                                                                            | 52   |
| Accuracy Assessment.....                                                                           | 58   |
| Vegetation Distribution .....                                                                      | 61   |

## Contents (continued)

|                                                                                                  | Page |
|--------------------------------------------------------------------------------------------------|------|
| Discussion .....                                                                                 | 63   |
| Classification Sampling Design and Data Collection (Step 4).....                                 | 63   |
| Develop Vegetation Classification, Vegetation Type Descriptions, and Field Key<br>(Step 5) ..... | 64   |
| Acquire and Prepare Imagery (Step 7) .....                                                       | 64   |
| Imagery Analysis and Classification (Step 8) .....                                               | 65   |
| Accuracy Assessment (Step 11) .....                                                              | 65   |
| Map Model (Step 6).....                                                                          | 66   |
| Research Opportunities .....                                                                     | 66   |
| Literature Cited .....                                                                           | 69   |



# Figures

|                                                                                                                                                                                                                                                                                                                                                 | Page |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>Figure 1.</b> National Park Service Networks.....                                                                                                                                                                                                                                                                                            | 3    |
| <b>Figure 2.</b> Map of PACN National Parks within the Pacific Island Network. ....                                                                                                                                                                                                                                                             | 7    |
| <b>Figure 3.</b> The islands of NPSA. ....                                                                                                                                                                                                                                                                                                      | 11   |
| <b>Figure 4.</b> The Tutuila portion of NPSA. ....                                                                                                                                                                                                                                                                                              | 12   |
| <b>Figure 5.</b> The Ofu and Ta‘ū portions of NPSA. ....                                                                                                                                                                                                                                                                                        | 12   |
| <b>Figure 6.</b> Pola Uta Ridge on Tutuila with its foot of <i>Pisonia grandis</i> , <i>Barringtonia asiatica</i> , <i>Hibiscus tiliaceus</i> coastal strand backed by <i>Dysoxylum</i> spp. forests, cliffs of scattered <i>Pisonia grandis</i> and <i>Diospyros samoensis</i> trees, and thick forests of <i>Syzygium inophylloides</i> ..... | 13   |
| <b>Figure 7.</b> Vatia town on Tutuila with coastal strand of <i>Cocos nucifera</i> , <i>Merremia peltata</i> and <i>Mikania micrantha</i> invaded fields behind the village, and diverse forested slopes.....                                                                                                                                  | 13   |
| <b>Figure 8.</b> <i>Pisonia grandis</i> coastal strand of the eastern shore of Olosega. ....                                                                                                                                                                                                                                                    | 14   |
| <b>Figure 9.</b> <i>Terminalia samoensis</i> and <i>Cocos nucifera</i> coastal strand of Ofu.....                                                                                                                                                                                                                                               | 14   |
| <b>Figure 10.</b> <i>Pandanus tectorius</i> backed by <i>Dysoxylum</i> spp. and <i>Hibiscus tiliaceus</i> on Ta‘ū.....                                                                                                                                                                                                                          | 15   |
| <b>Figure 11.</b> Coastal strand of <i>Ipomoea pes-caprae</i> and <i>Scaevola taccada</i> , with <i>Cocos nucifera</i> forest backed by <i>Dysoxylum</i> spp. forested cliffs on Ta‘ū. ....                                                                                                                                                     | 15   |
| <b>Figure 12.</b> Distribution of classification plots of Tutuila.....                                                                                                                                                                                                                                                                          | 22   |
| <b>Figure 13.</b> Distribution of classification plots on Ofu.....                                                                                                                                                                                                                                                                              | 23   |
| <b>Figure 14.</b> Distribution of classification plots on Ta‘ū. ....                                                                                                                                                                                                                                                                            | 23   |
| <b>Figure 15.</b> Agglomerative Cluster Analysis for entire NPSA vegetation dataset. ....                                                                                                                                                                                                                                                       | 27   |
| <b>Figure 16.</b> Calibration field data entry at NPSA on a Trimble Yuma.....                                                                                                                                                                                                                                                                   | 33   |
| <b>Figure 17.</b> Conceptual illustration of the CART data mining and rule creation process. ....                                                                                                                                                                                                                                               | 35   |
| <b>Figure 18.</b> Draft NPSA vegetation map – Tutuila.....                                                                                                                                                                                                                                                                                      | 37   |
| <b>Figure 19.</b> Draft NPSA vegetation map – Ofu and Olosega. ....                                                                                                                                                                                                                                                                             | 38   |
| <b>Figure 20.</b> Draft NPSA vegetation map – Ta‘ū.....                                                                                                                                                                                                                                                                                         | 39   |
| <b>Figure 21.</b> Distribution of accuracy assessment sites (red circles) on Tutuila.....                                                                                                                                                                                                                                                       | 42   |
| <b>Figure 22.</b> Distribution of accuracy assessment sites (red circles) on Ta‘ū.....                                                                                                                                                                                                                                                          | 43   |
| <b>Figure 23.</b> Distribution of accuracy assessment sites (red circles) on Olosega. ....                                                                                                                                                                                                                                                      | 44   |
| <b>Figure 24.</b> Distribution of accuracy assessment sites (red circles) on Ofu. ....                                                                                                                                                                                                                                                          | 45   |
| <b>Figure 25.</b> Crater Marsh and Cliff Scrub map classes on Ta‘ū.....                                                                                                                                                                                                                                                                         | 52   |

## Figures (continued)

|                                                                     | Page |
|---------------------------------------------------------------------|------|
| <b>Figure 26.</b> Final NSPA vegetation map – Tutuila.....          | 55   |
| <b>Figure 27.</b> Final NSPA vegetation map – Ofu and Olosega. .... | 56   |
| <b>Figure 28.</b> Final NSPA vegetation map – Ta‘ū.....             | 57   |
| <b>Figure 29.</b> Percentage of NSPA vegetated areas by type.....   | 58   |

## Tables

|                                                                                                           | Page |
|-----------------------------------------------------------------------------------------------------------|------|
| <b>Table 1a.</b> Summary of USNVC upper hierarchy levels and criteria for natural vegetation. ....        | 5    |
| <b>Table 1b.</b> Summary of USNVC mid hierarchy levels and criteria for natural vegetation. ....          | 5    |
| <b>Table 1c.</b> Summary of USNVC lower hierarchy levels and criteria for natural vegetation.....         | 5    |
| <b>Table 2.</b> Roles and responsibilities for the NPSA vegetation inventory project. ....                | 8    |
| <b>Table 3a.</b> Vegetation strata.....                                                                   | 20   |
| <b>Table 3b.</b> Cover classes.....                                                                       | 21   |
| <b>Table 4.</b> Imagery available to the NPSA vegetation mapping project by island.....                   | 29   |
| <b>Table 5.</b> eCognition parameters used to segment the Quickbird imagery.....                          | 30   |
| <b>Table 6.</b> Independent variables used to develop the vegetation map with sources and descriptions. . | 31   |
| <b>Table 7.</b> VIP sampling protocol for AA points.. ....                                                | 40   |
| <b>Table 8.</b> USNVC hierarchical classification of vegetation at NPSA .....                             | 51   |
| <b>Table 9.</b> USNVC associations and the map classes found at NPSA. ....                                | 54   |
| <b>Table 10.</b> Error matrix for the NPSA draft maps.. ....                                              | 60   |
| <b>Table 11.</b> NPSA draft map class user's and producer's accuracies. ....                              | 61   |

## Appendices or Appendixes

|                                                                                             | Page |
|---------------------------------------------------------------------------------------------|------|
| Appendix A: Classification Plot Form.....                                                   | A-1  |
| Appendix B: Plant Species Found within Sample Plots at National Park of American Samoa..... | B-1  |
| Appendix C: Vegetation Map Key.....                                                         | C-1  |
| Appendix D: Vegetation Association Descriptions .....                                       | D-1  |
| Appendix E: Field Plot Crosswalk to National Vegetation Classification Associations .....   | E-1  |
| Appendix F: Accuracy Assessment Form.....                                                   | F-1  |
| Appendix G: Map Classes with <i>Post-Hoc</i> Changes.....                                   | G-1  |
| Appendix H: Map Class Descriptions.....                                                     | H-1  |

## Executive Summary

This report details the methods used and results of the vegetation inventory for The National Park of American Samoa (NPSA). NPSA's unique ecosystems span 5500 ha (13,590 ac) on the Samoan Islands of Tutuila, Ofu, and Ta'ū and include approximately 1600 ha (4000 ac) acres of coral reef and ocean. While Congress has authorized the inclusion of portions of Olosega into the park, the Olosega lands have not yet been added to the current land lease agreement. However, because this project included mapping the proposed park areas of Olosega, the report also includes the work done on Olosega. The park's dynamic landscape, 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 Inventory and Monitoring Program (PACN), and staffed by personnel from the NPS, University of Hawaii (UH), Cogan Technology, Inc., 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 136 vegetation classification plots and observation sites. NatureServe used these data to create a key and descriptions for 17 vegetation

associations at NPSA. To ensure data compatibility throughout the NPS and other agencies the National Vegetation Classification Standard, Version 2 was used to characterize NPSA's vegetation.

Quickbird, Ikonos, Worldview2 and digital airborne optical and lidar imagery of NPSA were obtained from NOAA and 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 manual edits based on the comments were made to the preliminary map to create NPSA's draft vegetation map.

PACN personnel collected 249 accuracy assessment (AA) samples of NPSA's vegetation. The sample reference labels were compared to the draft map labels at each sample location to create an error matrix. Because of confusion in the registration of the imagery and in the AA, a validation trip was undertaken by KGA, NPSA, UH, and PACN staff. As a result, the draft map was reregistered to the 2012 airborne imagery. Overall draft map accuracy of NPSA is 68% using the primary reference label, and 70% when the secondary label is accepted. Using the AA results and the results of the validation trip, PACN and KGA personnel decided which associations would be collapsed into map classes for creation of NPSA's final vegetation map, resulting in 23 vegetated and three unvegetated map classes. The draft map was extensively manually edited using the new high resolution airborne imagery for errors discovered during AA and the validation trip, and the final map was delivered.

## Acknowledgments

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

We are grateful to the staff at the National Park of American Samoa (NPSA) 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 sometimes daunting logistics, to trekking across distant reaches of NPSA, to reviewing the results and suggesting valuable changes.

We would like to specifically thank Sean Eagan, Carlo Caruso, Michael Reynolds, Jim Bacon, and all the NPSA NPS staff and volunteers who collected data (James Gurr, Lafaele Alosio, Samson Atoe, Muaoina Tupu, Ricky Misaalefua, Tanu Iosefa, Salamanesa Eliu, Anthony Wyberski), provided excellent advice and input, guided us through impenetrable vegetation, and welcomed us into their community. Roger Meyer of the Territory of Samoa also shared his field photography which was very helpful to the project. A very special thanks to the family of Visa Vaivai who welcomed us into their home to share delicious Samoan delicacies and the laughter of their children.

Eseta Kese and the folks at Vaoto Lodge introduced us to life on the Maun'a Islands, fed us well, and provided comfortable lodging in beautiful settings.

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 and Dr. Patrick Hart, the principal investigator for the University of Hawaii-NPS cooperative agreement who 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 and NOAA purchased high resolution satellite imagery used in the project. We want to especially thank Quantum Spatial (formerly Photo Science) for providing us with early versions of both the airborne LIDAR and 1 foot optical imagery they captured for American Samoa for NOAA, and for processing the LIDAR data into a vegetation height layer.

We are appreciative to all who provided mapping support which was integral to the production of the NPSA vegetation map. Gene Forsburg of Kass Green & Associates provided support during calibration and validation field data collection as well as access to numerous publications on the vegetation of the Pacific Islands from his personal library. Art Whistler, the premier expert on Samoan vegetation, introduced us to the classification of Samoa vegetation, provided expert advice, reviewed the draft map, and supplied us with good cheer.

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.

Fa‘afetai lava

# Introduction

## **Vegetation Classification and Mapping, National Park of American Samoa**

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 NPSA. The park's dynamic landscape, huge expanse, and extreme range of elevation and climate combine to create a distinctive and exciting national park. NPSA also supports a wide range of ecological conditions. Spanning four islands spread over 136 kilometers (85 miles), NPSA's unique vegetation ranges from the futu (*Barringtonia asiatica*), pu'a vai (*Pisonia grandis*), and niu (*Cocos nucifera*) forests and to'ito'i (*Scaevola taccada*)/ateate (*Wedelia biflora*) shrublands on the coasts, to the tavai (*Rhus taitensis*), atone (*Myristica* spp.), and mamala (*Dysoxylum samoense*) lowland rain forests, to the mountain top fena vao (*Syzygium samoense*) forests and montane shrublands at the highest elevations. Unique among the National Parks, one third of NPSA is comprised of spectacular coral reefs and deep ocean.

This report on the vegetation of NPSA 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 NPSA vegetation inventory.
- The second section provides a brief summary of the setting and history of NPSA 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

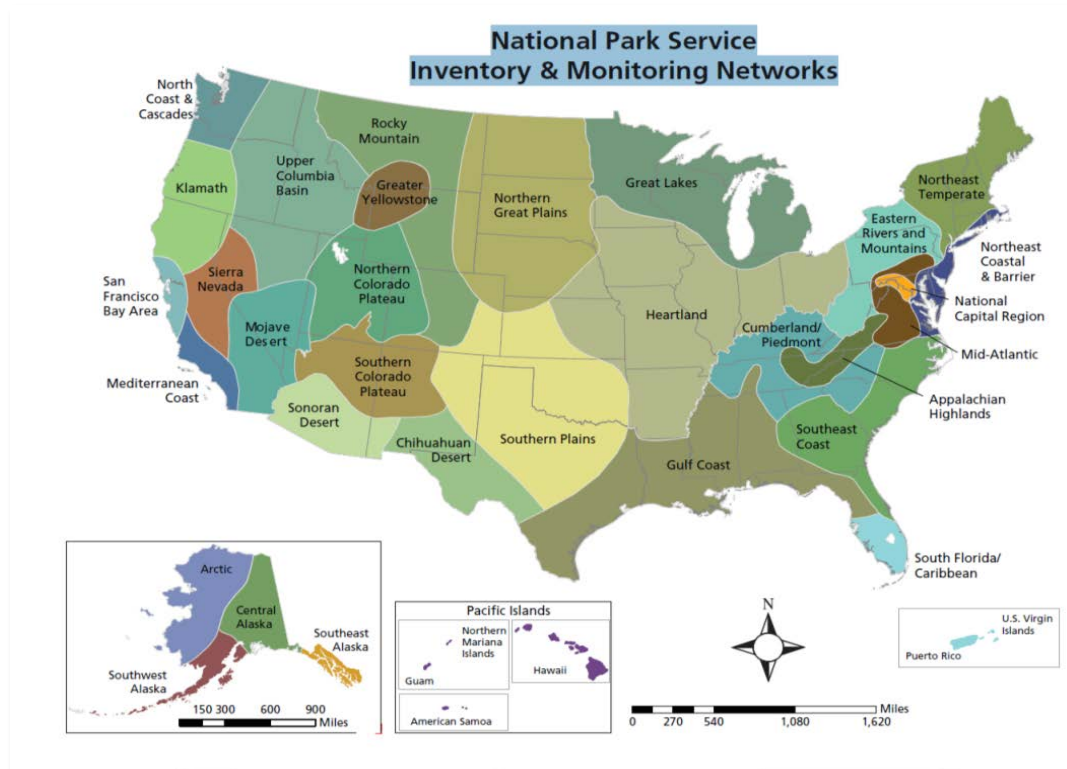


**Figure 1.** National Park Service Networks. Source [http://science.nature.nps.gov/im/assets/docs/IM\\_Program\\_Brief.pdf](http://science.nature.nps.gov/im/assets/docs/IM_Program_Brief.pdf)

### ***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 1994; 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](http://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.

USNVC 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 NPSA 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 NPSA vegetation inventory.

### ***Pacific Island Network, Inventory and Monitoring Program***

PACN (<http://science.nature.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 four 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.

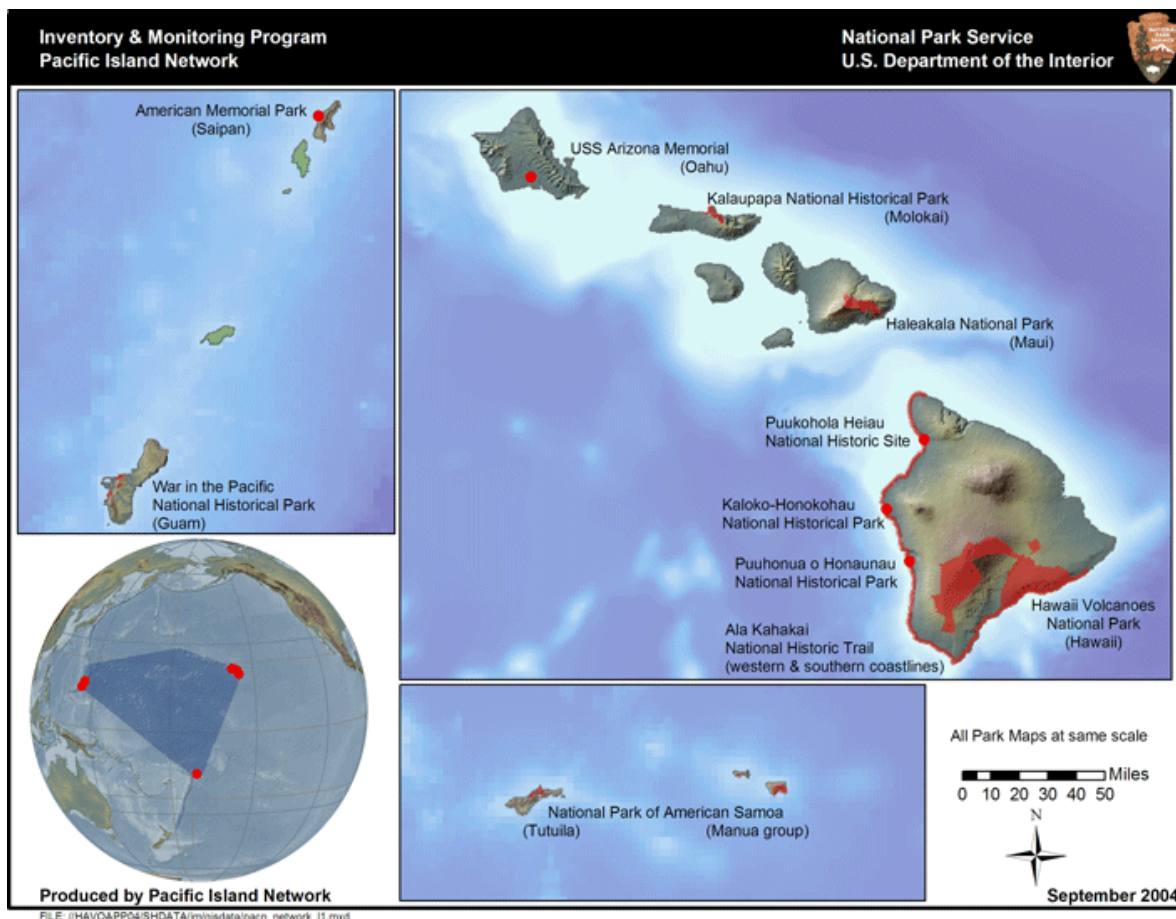


**Figure 2.** Map of PACN National Parks within the Pacific Island Network. Source: <http://science.nature.nps.gov/im/units/pacn/parks/index.cfm#map>.

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 NPSA 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.nps.gov/im/units/pacn/index.cfm>.

**Table 2.** Roles and responsibilities for the NPSA vegetation inventory project.

| <b>Roles</b>                                           | <b>NPS PACN</b> | <b>NatureServe</b> | <b>Kass Green &amp; Associates</b> | <b>Cogan Technologies</b> |
|--------------------------------------------------------|-----------------|--------------------|------------------------------------|---------------------------|
| 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 NPSA 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 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 NPSA 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 NPSA mapping project, KGA designed the classification sampling (part of Step 4), collaborated with PACN to develop the mapping model (Step 6), worked with PACN, the US Department of Agriculture Natural Resource Conservation Service (USDA NRCS), NOAA and Quantum Spatial to acquire and prepare the satellite and airborne 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).

### **National Park of American Samoa**

#### **Location and Setting**

The Samoan Archipelago is located in the southern hemisphere of the Pacific Ocean, 2575 km (1600 mi) northeast of New Zealand and roughly 3700 km (3700 mi) southwest of Hawaii. The archipelago is politically divided into the Independent State of Samoa in the west and American Samoa in the east. Most of the islands are the result of volcanic activity and were formed by basaltic lava rising from the Pacific Ocean floor starting over two million years ago. Tutuila is the oldest of the American Samoa islands having been formed approximately 1.26 million years ago. The islands get progressively younger to the east as the result of the Pacific plate moving west over a “hot spot” in the earth’s crust. At 100,000 years of age, Ta’ū is the youngest of the lava formed islands (Whistler 1994 and 2002).

As the only U.S. national park in the southern hemisphere, NPSA spans portions of three of the five islands of American Samoa: Tutuila, Ofu, and Ta’ū. While Congress has authorized the inclusion of portions of Olosega into the park, the Olosega lands have not yet been added to the current land lease agreement (NPS 2015). However, at the request of the NPS, KGA agreed to map the proposed lands pro bono, and Olosega’s NPSA lands are included in this report. Figure 3 shows the islands of NPSA. Figures 4 and 5 show NPSA’s current park boundaries.

The climate of NPSA is tropical marine. Temperatures vary little throughout the year, averaging 27°C. Rainfall is slightly higher in the winter versus the summer months (Dec. – March), but is heavy throughout the year averaging 2400 mm/year (94 in/year). Humidity averages 80% and is highest in the summer months (Whistler 2002). NPSA is also strongly affected by hurricanes which periodically wreak havoc on the islands.

NPSA’s topography is dramatic with tall knife sharp ridges seemingly rising directly from the sea at slopes over 90%. Gentle slopes are a rarity in American Samoa with 50% of the land exceeding 70% slope (Cole et al 1988). NPSA’s vegetation is almost exclusively forest and varies from coastal strands of *Cocos nucifera*, *Barringtonia asiatica*, *Pisonia grandis*, and *Hibiscus tiliaceus*; to upland

expanses of mixed multiple species forests often including *Alphitonia zizyphoides*, *Myristica inutilis*, and *Dysoxylum* ssp.; to *Syzygium inophylloides* forests on ridges, and *Syzygium samoense* forests blanketing the tops and shoulders of Mount 'Alava (Tutuila) and Mt. Lata (Ta'ū). Slides and abandoned agricultural areas are quickly covered in vine such as *Merremia peltata* or *Mikania micrantha* which are then reforested, often with *Rhus taitensis* forests. The tops of rare, trachyte plug remnants of volcanoes are vegetated in montane scrub (Whistler 2002). Figures 6 through 11 illustrate the diversity of NPSA's vegetation.



**Figure 3.** The islands of NPSA. Tutuila is separated by more than 120 km (75 mi) of open ocean from the Manu'a Islands of Ofu, Olosega, and Ta'u. Imagery source: esri true color World Imagery satellite imagery.



**Figure 4.** The Tutuila portion of NPSA. Imagery source: esri true color World Imagery satellite imagery.



**Figure 5.** The Ofu and Ta'ū portions of NPSA. Note that NPSA's Olosega boundaries are not shown because this portion of the park is not yet under lease. Imagery source: esri true color World Imagery satellite imagery.



**Figure 6.** Pola Uta Ridge on Tutuila with its foot of *Pisonia grandis*, *Barringtonia asiatica*, *Hibiscus tiliaceus* coastal strand backed by *Dysoxylum* spp. forests, cliffs of scattered *Pisonia grandis* and *Diospyros samoensis* trees, and thick forests of *Syzygium inophylloides*.



**Figure 7.** Vatia town on Tutuila with coastal strand of *Cocos nucifera*, *Merremia peltata* and *Mikania micrantha* invaded fields behind the village, and diverse forested slopes.



**Figure 8.** *Pisonia grandis* coastal strand of the eastern shore of Olosega.



**Figure 9.** *Terminalia samoensis* and *Cocos nucifera* coastal strand of Ofu.



**Figure 10.** *Pandanus tectorius* backed by *Dysoxylum* spp. and *Hibiscus tiliaceus* on Ta'ū.



**Figure 11.** Coastal strand of *Ipomoea pes-caprae* and *Scaevola taccada*, with *Cocos nucifera* forest backed by *Dysoxylum* spp. forested cliffs on Ta'ū.

## **History**

It is believed that Samoa was generally covered in rain forests prior to the arrival of Polynesians 3000 years ago (NPS 2015) when they converted two thirds of the islands' forests to agriculture (Amerson and Whistler 1982).

The first European siting of the islands was made in 1722 by a Dutch explorer, Jacob Roggeveen (American Samoa 2015). During the 1800's European countries and the United States vied for control of the islands which lead to the Tripartite Convention of 1899 which established the western islands as territory of Germany and the eastern islands under the control of the US Navy (NPS 1988). However, during this period the land and waters of Samoa remained in the control of the Samoan people. In 1900, the High Chiefs of Tutuila signed the first of two Deeds of Cession for the islands to the U.S. which Congress ratified in 1929. However, to this day, the land and coastal regions of American Samoa are managed by local villagers under the Samoan *matai* governance system.

In 1965, the NPS completed a study requested by the governor of American Samoa and the Director of Office of Territories which recommended the establishment of a national park in American Samoa (NPS 1965). In 1986, Congress directed the NPS to study the feasibility of establishing a national park in American Samoa (NPS 1988) and in 1988 the NPS completed negotiations with several *matai* for a 50 year lease of land and coastal areas of Tutuila, Ofu, and Ta'ū to create NPSA (NPS 1988) so as to protect the culture of the American Samoan people (NPS 1965 and 1988) and "the area's tropical rain forest on the islands of Tutuila and Ta'ū" (American Samoa 2015). Unique to the National Park Service, NPSA is the only U.S. park where areas under NPS management are not owned by a government entity, but are leased from the villages (National Parks Conservation Organization 2015). The lease provides that in certain areas of the park, Samoans may continue to practice traditional methods of farming and reef fishing (American Samoa 2015). In 2002, Congress approved expansion of NPSA to additional inland and coastal areas of Ofu and Olosega. However, as of the date of this report, the lease agreements have not been finalized.

## ***Vegetation Studies at the National Park of American Samoa***

While flora collections have been conducted in American Samoa since 1787 (Whistler 2002), the vegetation of Samoa remained largely unstudied until Whistler began his career investigating first the wetlands of American Samoa (Whistler 1976), the wildlife and wildlife habitat (Amerson et al 1982), the proposed protected areas (Whistler 1994) and then all of the vegetation of the Samoa islands (Whistler 1980, 2002, 2004, and 2009).

The vegetation of NPSA has been mapped multiple times beginning with the *Vegetation Survey and Forest Inventory, American Samoa* (Cole 1988) which relied on 1994 stereo 1:10,000 black and white photography to map forest type, size class, and density, secondary vegetation, agroforest, grasslands, strand, marsh, cropland, urban, barren, and water. Predominant species were identified where possible. NOAA mapped general land use/cover of Tutuila in 2003 and Ofu, Olosega, and Ta'ū in 2004 using high resolution satellite imagery. These maps were updated in 2010 (NOAA 2015) from Quickbird imagery and maps of land cover and land use change were produced. In 2007 the USDA Forest Service used Ikonos 2002-2004 satellite imagery to map the land use/cover of American Samoa using a classification scheme similar to Cole's (Liu and Fischer 2007). The Forest

Service map was updated to incorporate Whistler's (2002) classification scheme using 2003-2007 Quickbird 60 cm (24 in) pan sharpened satellite imagery (Liu et al 2011). Classes mapped included littoral strand, marshes, mangroves, freshwater swamps, rain forest, summit scrub, montane scrub, agriculture, urban cultivated, secondary scrub, *Rhus* secondary forest, sand beach / bare rocks, quarry/land fill, urban built-up, and water.



## **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 NPSA. 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 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)**

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 NPSA 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 1994). “Representative polygons” were developed using image segmentation and GIS modeling. The resulting sampling design coverage is a GIS shape file 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 Ikonos high resolution imagery in eCognition software. 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 NPSA personnel to identify locations for field sampling.

### **Field Data Collection**

The field methods used for collecting the classification plots at NPSA followed the methodology outlined by the VIP (TNC and ESRI 1994). 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 plant association within the NPSA 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 variation within each association. 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 m<sup>2</sup> 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. Vegetation within the plot was also recorded on the field form (Appendix A). Vegetation was visually divided into strata (Table 3a), with the height and canopy cover of the dominant vegetation estimated for each stratum. Additionally, within each stratum, all taxa were identified and assigned a cover class based on ocular foliar cover estimates (Table 3b).

**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%          |

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;
- 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 NPSA 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.

### **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 NPSA'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. Figures 12-14 show the distribution of classification plots at NPSA.



**Figure 12.** Distribution of classification plots (green circles) on Tutuila. Imagery source: 2012 Quantum Spatial/USGS airborne infrared imagery.

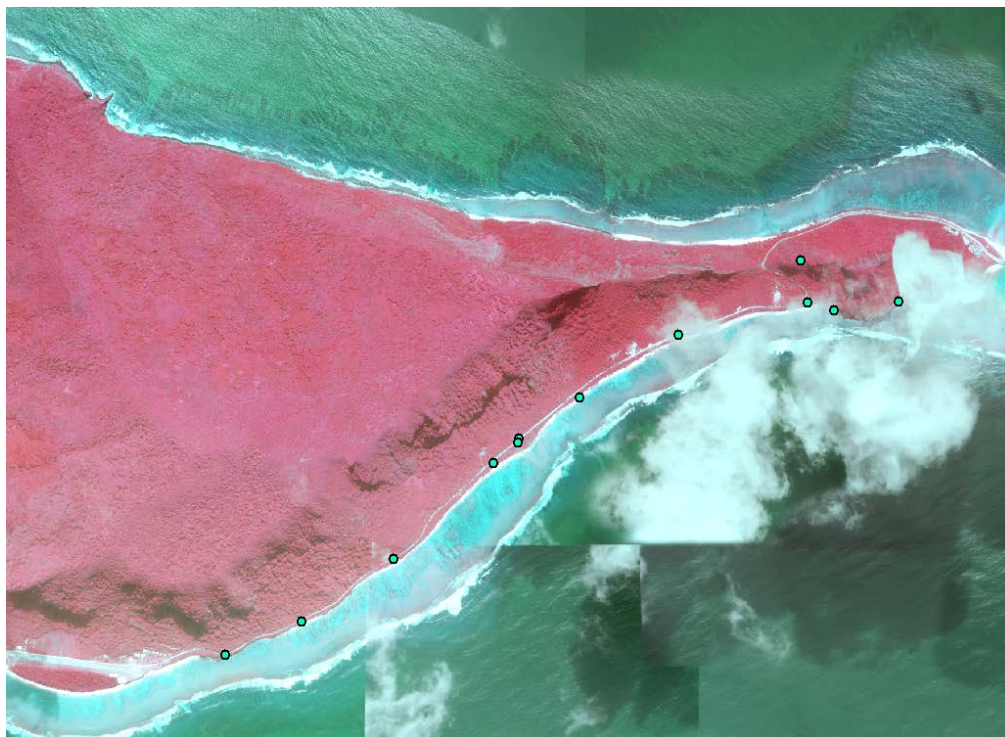


**Figure 13.** Distribution of classification plots (green circles) on Ofu. Note there are no classification plots on Olosega. Imagery source: 2012 Quantum Spatial/USGS airborne infrared imagery.



**Figure 14.** Distribution of classification plots (green circles) on Ta'u. Imagery source: 2012 Quantum Spatial/USGS airborne infrared imagery.

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

Classification of NPSA's vegetation started with an initial classification of vegetation types for American Samoa from Whistler (2009) which set the *a priori* expectation of the number and diversity of vegetation types including littoral strand, lowland rain forest, montane rain forest, summit scrub, montane scrub, secondary forest managed land vegetation and successional vegetation. The primary dataset used for the vegetation classification of NPSA included 105 classification plots and 31 observation points collected during 2009, 2010, and 2011 by PACN and NPSA staff (Figures 12-14). These data consisted of 221 taxa and eleven strata for a total of 476 unique species-strata records that were classified using standard quantitative techniques including cluster analysis, ordination, summary statistics, and indicator species analysis using PC-ORD software (McCune and Mefford 2011). Prior studies outlined in Whistler (2009) did not have quantitative plot data available for inclusion in these analyses.

Each sample from the NPSA dataset was reviewed, analyzed and assigned to an USNVC association when possible and when not, a new USNVC association or local community type was developed. Several additional vegetation types from map calibration work were also identified. These were added to the final classification, but not used in quantitative analyses.

### **Data Preparation and Screening**

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 was 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 document (FGDC 2008). For more discussion on strata see Jennings et al. (2009) and Tart et al (2005).

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 "unknown species", species identified only to genus or family, or some taxa if recorded only once with low cover value. In some cases, cover of a woody species can be recorded with multiple strata codes (T1, T2, T3) or (S1, S2, S3) within a single plot. While this reflected the canopy structure of the plot, for analysis these strata were simplified into a single T or S abundance measure with cover values combined using the method outlined below. The formulae used to combine cover values and account for overlapping canopies:  $A' = A + (B * (1 - A))$  to combine two layers and  $A' + (C * (1 - A'))$  to combine a third, where A, B, and C equaled species percent cover in each strata (National Park Service 2011). A simple summation, especially in tropical rain forests, would have

resulted in an overestimate of the total tree cover. An algorithm was written in Microsoft Access to facilitate this step. The dataset was exported in list format from the database, and 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***

Initial classification analyses were run with an *a priori* cut off at ten groups, to see if the data would match Whistler's (2009) classification of nine native plant community types. Agglomerative Cluster analysis was run using Euclidean distance and Ward's Method Group Linkage. Initial data had 136 plots or observation points and 221 species (with additional "pseudo-species" that were seedlings of tree species). Cluster Analysis creates a distance matrix where the number of dimensions is equal to the number of species in the analysis. It merges the two most similar plots (most similar in terms of species composition and abundance) plots and recalculates the matrix, and repeats the process until no plots are left to be merged. The resulting dendrogram shows plots that are similar are combined at lowest levels. These analyses only used the vegetation cover data.

Of the initial ten groups, eight groups closely matched one of Whistler's types, one was an outlier group, and one group was large and heterogeneous. Further analysis was needed for this last group, so a second Cluster Analysis was run on the large heterogeneous group, using the same parameters as above, resulting in an additional four groups.

Indicator species analysis was conducted to see which species had high fidelity to each of the 14 groups. Indicator species analysis was run to determine the frequency and relative abundance of species by group (multiplied together this value becomes the Indicator Value). A Monte Carlo test was run to see the significance of the indicator value (null hypothesis =  $IV_{\max}$  is no larger than would be expected by chance). A species must have both high fidelity and high abundance to be significant. Nine of the groups had statistically significant indicator species (Figure 15), and one additional group only had significant indicators when analyzed alone.

### ***Development of Vegetation Association Key and Descriptions***

NatureServe used the classification to draft a dichotomous field key for plant associations in NPSA (Appendix C), which was designed to assist users in identifying vegetation associations in the field. Dichotomous keys consisted of a series of two choices per step that leads the user to the correct association name based on vegetative cover. However field keys need to be more inclusive, as the plot data collected between 2009-2010 are only a small selection of the total range of variation one may see in the field. Therefore, while the key is based on the classified information, it is not restricted to maximum or minimum percent cover, and allows for new associations to be described. Keys were field tested by the mappers and PACN staff and comments and edits were incorporated by NatureServe.

All the vegetation associations were forested types, with the key based on the dominant tree and understory species within a stand. 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. For other parks, field keys are often divided into sections based on physiognomic type, such as herbaceous vegetation

and shrub types. Environment and elevation information were not used in the key couplets, because of the wide overlap in species composition and inability to use elevation as a consistent predictor of vegetation associations.

NatureServe used the classification to draft park specific (called “local”) plant association descriptions based on plot information collected for each type. Descriptive information included the range in cover of consistently present species along with a list of commonly recorded species that may not always be present in every stand. Environmental data were also used to describe the typical setting including the range of elevation, slope, aspect and soil characteristics for each association. Plant common names (non-scientific names) were standardized by park staff and inserted into the final classification association names and where appropriate in the descriptions. Therefore the association names and descriptions posted on NatureServe website ([www.natureserve.org/explorer](http://www.natureserve.org/explorer)) may not have the same NPSA preferred common names. Final descriptions were reviewed by park staff and edits incorporated by NatureServe and park staff.

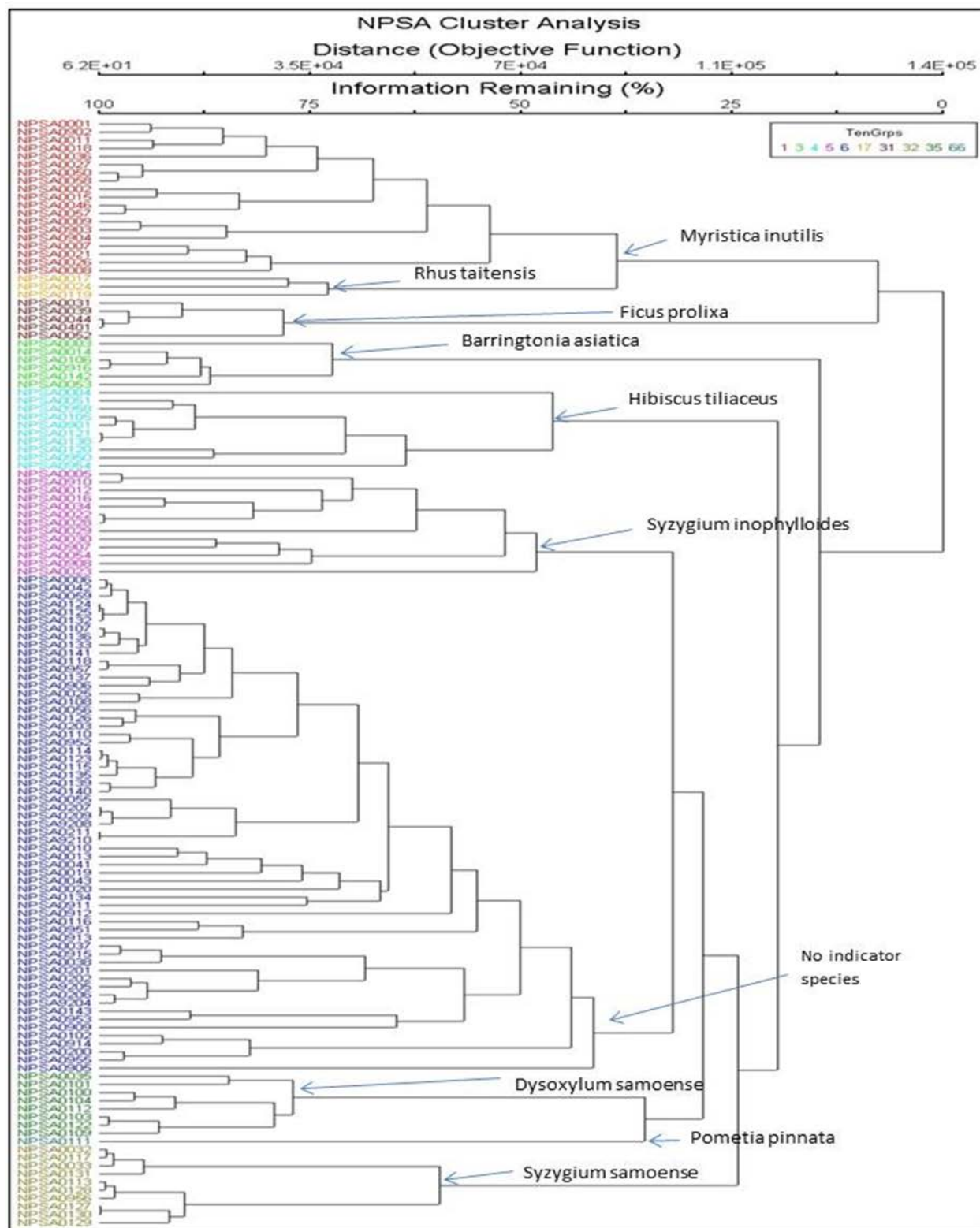


**Figure 15.** Agglomerative Cluster Analysis for entire NPSA vegetation dataset with statistically significant ( $p$  value  $<0.05$ ) indicator species annotated for each of the ten, color coded groups.

### **Acquire and Prepare Imagery (Step 7)**

More high resolution imagery has been collected over NPSA (Table 4) than any other PACN park, as evidenced by the number of mapping projects conducted in American Samoa over the last ten years. Unfortunately, the Quickbird imagery initially available for this project in 2009 was misregistered and the IKONOS had clouds blocking sections of the islands. While Digital Globe 1:12,000 product standards maintain no more than 10-12 m (33-40 ft) positional error for Quickbird data, it was quickly discovered that the Ikonos and Quickbird imagery were not registered to one another. All of the available imagery data sources were inspected, the NPS was informed of the registration issues, and it was decided to proceed with the Quickbird imagery because it had the least clouds and was the most recent complete data set for the islands, even though its positional accuracy was known to be problematic.

Fortunately, USGS retained Photo Science (now Quantum Spatial) to collect 1-foot multispectral optical and LIDAR imagery over American Samoa in 2012 for NOAA (<http://coast.noaa.gov/digitalcoast/data/highresortho>). Photo Science established their own control while in American Samoa and as a result the registration of their imagery is outstanding. Accordingly, the NPSA draft vegetation map was then registered to and manually checked against the 2012 Quantum Spatial/USGS imagery. While incorporating 2012 Quantum Spatial/USGS imagery into the NPSA vegetation mapping project delayed the delivery of the maps, the benefit in spatial accuracy and vegetation detail compensated for the delay. Later in the project, NRCS created a mosaic of Worldview 2 imagery captured in 2010-12. It was co-registered to the DigitalGlobe Worldview-2 orthoimagery for Tutuila, Rose Atoll, Swain Island, and East and West Manua. These islands were collected with mostly 2010-2011 orthoimagery from DigitalGlobe Worldview-2 satellite. The dataset available is 0.5 meter ground resolution with 8 multispectral bands. Tutuila, East and West Manua were transformed to match the NOAA Ikonos 2002 satellite orthoimagery. Erik Hund (NOAA) reviewed and approved the new ortho correction applied to the Quickbird and Worldview-2 imagery. This was useful in the identification of map classes in areas where the 2012 Quantum Spatial/USGS imagery was clouded or saturated. Table 4 summarizes the high resolution imagery available to this project.

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

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.

**Table 4.** Imagery available to the NPSA vegetation mapping project by island.

| Image Source                               | Spatial /Spectral Resolution  | Ofu-Olosega   | Ta'ū                    | Tutuila       |
|--------------------------------------------|-------------------------------|---------------|-------------------------|---------------|
| 2009 Quickbird                             | 2.4 m MS (4-bands) /0.6 m PAN | NA            | NA                      | 0-10% clouds  |
| 2005/2006 Quickbird                        | 2.4 m MS (4-bands) /0.6 m PAN | 0-10% clouds  | 10-25% clouds           | NA            |
| 2002 Ikonos                                | 4 m MS/1 m PAN                | 10-25% clouds | 0-10% clouds            | 10-25% clouds |
| 2012 Quantum Spatial/USGS airborne imagery | 1 foot 4-band MS              | 0-10% clouds  | 0-10% clouds            | 0-10% clouds  |
| 2012 Quantum Spatial/USGS airborne LIDAR   | NA                            | yes           | not collected over NPSA | yes           |
| Worldview-2 2010-12 NRCS mosaic            | 0.5 m 8-band pan sharpened    | 0-10% clouds  | 0-10% clouds            | 0-10% clouds  |

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 NPSA.

### **Image Segmentation**

In 2009, KGA employed Trimble's (formally Definiens) eCognition software (<http://www.ecognition.com/>) to segment pan sharpened Quickbird imagery for the NPSA portion of each island 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 5 presents the inputs and eCognition parameters used to create the NPSA segments from the Quickbird imagery. The normalized difference vegetation index (NDVI) is the ratio of the near infrared band minus the red band divided by the near infrared band plus the red band. It is used to quantify the density of plant cover (NASA 2015). Texture is the measure of spectral variance across the defined window (in this case 20 x 20 pixels). Adaptive texture is an interpretative approach which chooses the lowest value of variance for all 20 possible variance calculations of each pixel (Woodcock and Strahler 1987).

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 5.** eCognition parameters used to segment the Quickbird imagery for the NPSA vegetation map.

| Input Image Bands                 | Weight | Shape | Compactness | Scale | Segmentation cycles |
|-----------------------------------|--------|-------|-------------|-------|---------------------|
| NDVI                              | 1      | 0.3   | 0.7         | 100   | 10                  |
| Adaptive texture (20 x 20 kernel) | 1      |       |             |       |                     |

### **Collect and Process Ancillary Data**

While many of the indicators of vegetation variation 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 data sets and created several ancillary data layers. Measures of each segment's color, tone, and texture were derived from the Quickbird 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 6 summarizes the independent variables used in the NPSA 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.

Next, 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, and the vegetation maps by Cole et al (1988), Liu and Fisher (2007), Lui et al (2011) and NOAA.

**Table 6.** Independent variables used to develop the vegetation map with sources and descriptions.

| Variable             | Source                   | Description                                  |
|----------------------|--------------------------|----------------------------------------------|
| Asymmetry index      | eCognition segment       | eCognition asymmetry index                   |
| Band 1 mean (0.6 m)  | Quickbird pansharpenned  | Mean band 1, 0.6 meter imagery               |
| Band 1 mean (2.4 m)  | Quickbird                | Mean band 1, 2.4 meter imagery               |
| Band 1 stdev (0.6 m) | Quickbird pansharpenned  | Standard deviation band 1, 0.6 meter imagery |
| Band 1 stdev (2.4 m) | Quickbird                | Standard deviation band 1, 2.4 meter imagery |
| Band 2 mean (0.6 m)  | Quickbird pansharpenned  | Mean band 2, 0.6 meter imagery               |
| Band 2 mean (2.4 m)  | Quickbird                | Mean band 2, 2.4 meter imagery               |
| Band 2 stdev (0.6 m) | Quickbird pansharpenned: | Standard deviation band 2, 0.6 meter imagery |
| Band 2 stdev (2.4 m) | Quickbird                | Standard deviation band 2, 2.4 meter imagery |
| Band 3 mean (0.6 m)  | Quickbird pansharpenned  | Mean band 3, 0.6 meter imagery               |
| Band 3 mean (2.4 m)  | Quickbird                | Mean band 3, 2.4 meter imagery               |
| Band 3 stdev (0.6 m) | Quickbird pansharpenned  | Standard deviation band 3, 0.6 meter imagery |
| Band 3 stdev (2.4 m) | Quickbird                | Standard deviation band 3, 2.4 meter imagery |
| Band 4 mean (0.6 m)  | Quickbird pansharpenned  | Mean band 4, 0.6 meter imagery               |
| Band 4 mean (2.4 m)  | Quickbird                | Mean band 4, 2.4 meter imagery               |
| Band 4 stdev (0.6 m) | Quickbird pansharpenned  | Standard deviation band 4, 0.6 meter imagery |
| Band 4 stdev (2.4 m) | Quickbird                | Standard deviation band 4, 2.4 meter imagery |
| Border index         | eCognition segment       | eCognition border index                      |
| Border length        | eCognition segment       | eCognition border length                     |
| Compactness          | eCognition segment       | eCognition compactness                       |
| Density              | eCognition segment       | eCognition density                           |
| Elliptical fit       | eCognition segment       | eCognition elliptical fit                    |

**Table 6 (continued).** Independent variables used to develop the vegetation map with sources and descriptions.

| Variable              | Source                       | Description                                     |
|-----------------------|------------------------------|-------------------------------------------------|
| Length-width ratio    | eCognition segment           | eCognition length: width                        |
| Direction             | eCognition segment           | eCognition main direction                       |
| NDVI mean             | Quickbird                    | Mean NDVI                                       |
| NDVI stdev            | Quickbird                    | Standard deviation NDVI                         |
| Large ellipse         | eCognition segment           | eCognition radius of largest enclosing ellipse  |
| Small ellipse         | eCognition segment           | eCognition radius of smallest enclosing ellipse |
| Ridgeline             | RIDGE                        | Ridgelines of each island                       |
| Rectangle             | eCognition segment           | eCognition rectangular fit                      |
| Roundness             | eCognition segment           | eCognition roundness                            |
| Shape                 | eCognition segment           | eCognition shape index                          |
| Texture mean (2.4 m)  | TXT20_24_M                   | Mean texture, 2.4 meter imagery                 |
| Texture stdev (2.4 m) | TXT20_24_S                   | Standard deviation texture, 2.4 meter imagery   |
| Texture mean (0.6 m)  | TXT20_MN                     | Mean texture, 0.6 meter imagery                 |
| Texture stdev (0.6 m) | TXT20_STD                    | Standard deviation texture, 0.6 meter imagery   |
| Island                | NPS shapefile                | Island name                                     |
| Slope mean            | USGS Digital Elevation Model | Mean slope percent                              |
| Slope stdev           | USGS Digital Elevation Model | Standard deviationslope percent                 |
| Aspect                | USGS Digital Elevation Model | Majority aspect class                           |
| Slope/aspect index    | USGS Digital Elevation Model | Majority slope/aspect index                     |
| Elevation mean        | USGS Digital Elevation Model | Mean elevation                                  |
| Elevation stdev       | USGS Digital Elevation Model | Standard deviation elevation                    |
| Ridge distance        | manually derived ridgelines  | Majority ridge proximity                        |
| Shore distance        | NOAA lifeform map            | Majority distance from shore                    |
| Solar radiation mean  | solar0MN                     | Mean solar radiation                            |
| Solar radiation stdev | solar0STD                    | STD solar radiation                             |
| Park boundary         | NPS shapefile                | Majority park boundary                          |
| Precipitation mean    | prec0MN                      | Mean average annual precipitation               |
| Precipitation stdev   | prec0STD                     | STD average annual precipitation                |

### ***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 NPSA 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 December of 2011, a seven day calibration trip was made to NPSA. One five person crew (composed of NPSA, PACN, and KGA personnel) collected sample segments throughout accessible portions of the park. Helicopter access is not available at NPSA and trails are few, with plants quickly revegetating previously opened paths. As a result, significant portions of the park were not visited in the field by NPS or KGA classification, calibration, validation, or accuracy assessment crews.

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 classification plots and/or were spectrally interesting. Field sample data were collected on Trimble Yumas (Figure 16) 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 NPSA 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 16.** Calibration field data entry at NPSA 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 also run through the autolabeler to check for consistency and errors.

### ***CART Modeling***

The initial NPSA 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. NPSA was divided into 3 processing regions: Tutuila, Ta‘ū, and Ofu/Olosega. With a park that spans as large a geographic region as NPSA, processing regions allow constraining the occurrence of map classes to only the regions where they are known to exist. 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 17 provides a conceptual illustration of how CART analysis works.

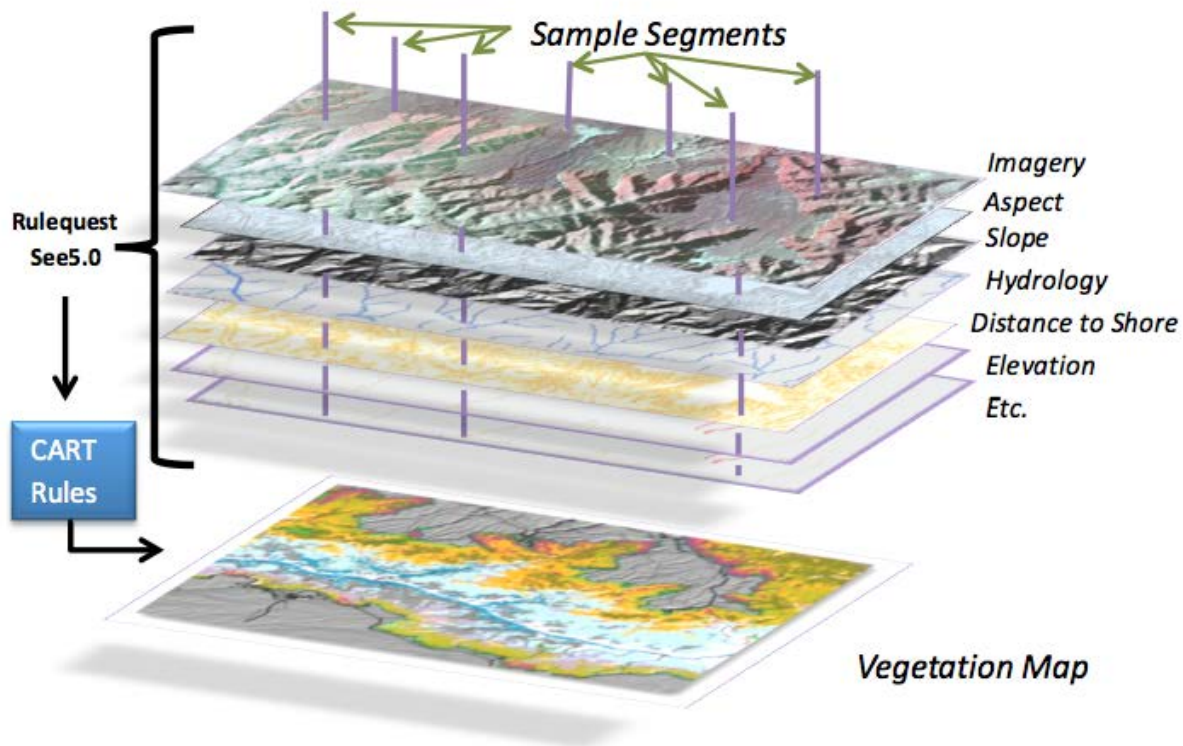


**Figure 17.** Conceptual illustration of the CART data mining and rule creation process.

### ***Editing***

Manual edits were conducted to improve the accuracy of the map resulting from CART modeling (Appendix G). 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 NPSA draft vegetation map.

### ***Draft Map and Digital Database Production***

In March of 2012, KGA delivered the NPSA draft vegetation map (Figures 18-20) and geodatabase 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. USNVC\_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 with map class code.
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

### **Formal Accuracy Assessment (Step 11)**

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 ( $\pm 9$  m; 30 ft). However, for NPSA, it soon became clear that this assumption was incorrect in the case of the Quickbird imagery.

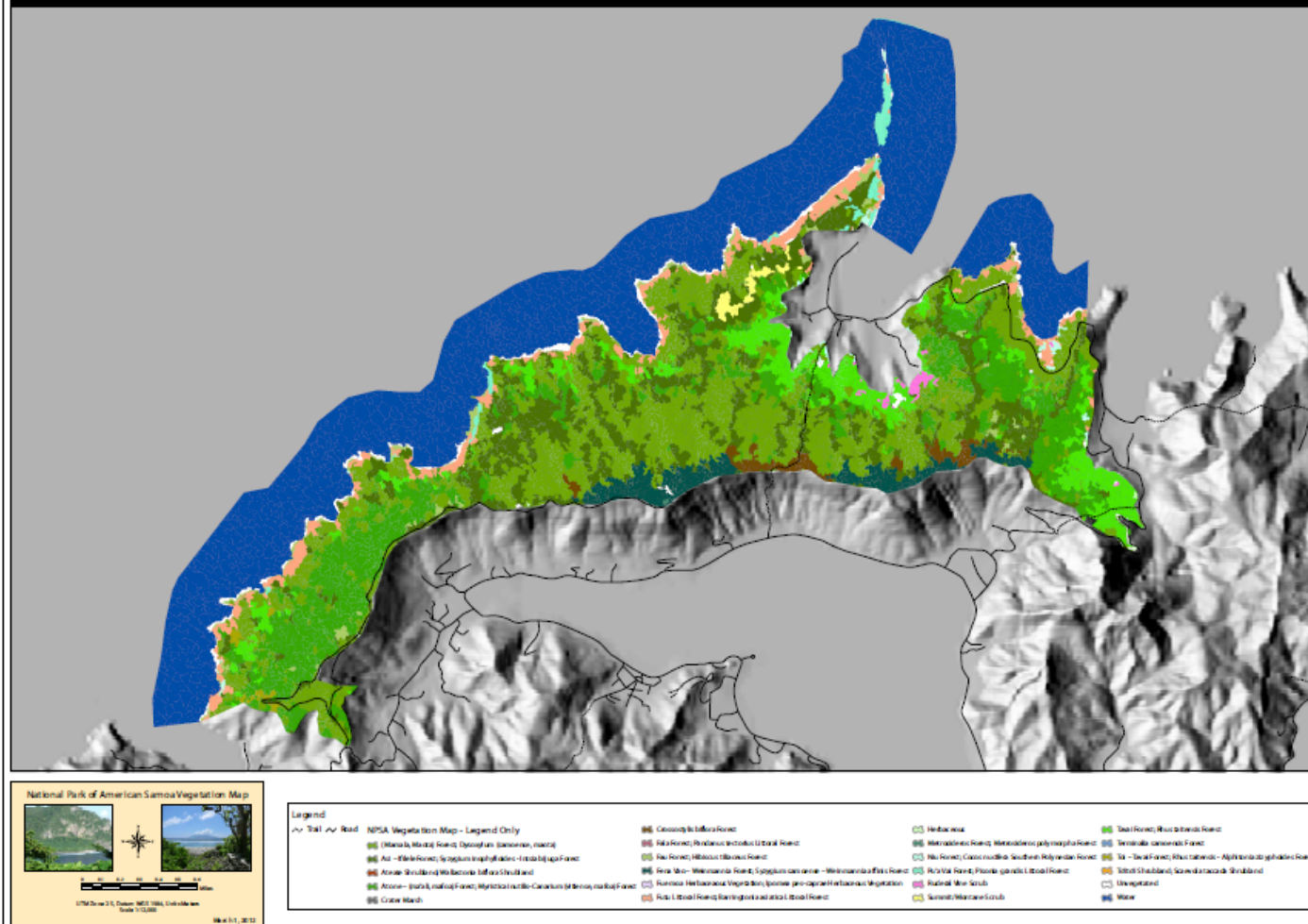


**Figure 18.** Draft NPSA vegetation map – Tutuila.

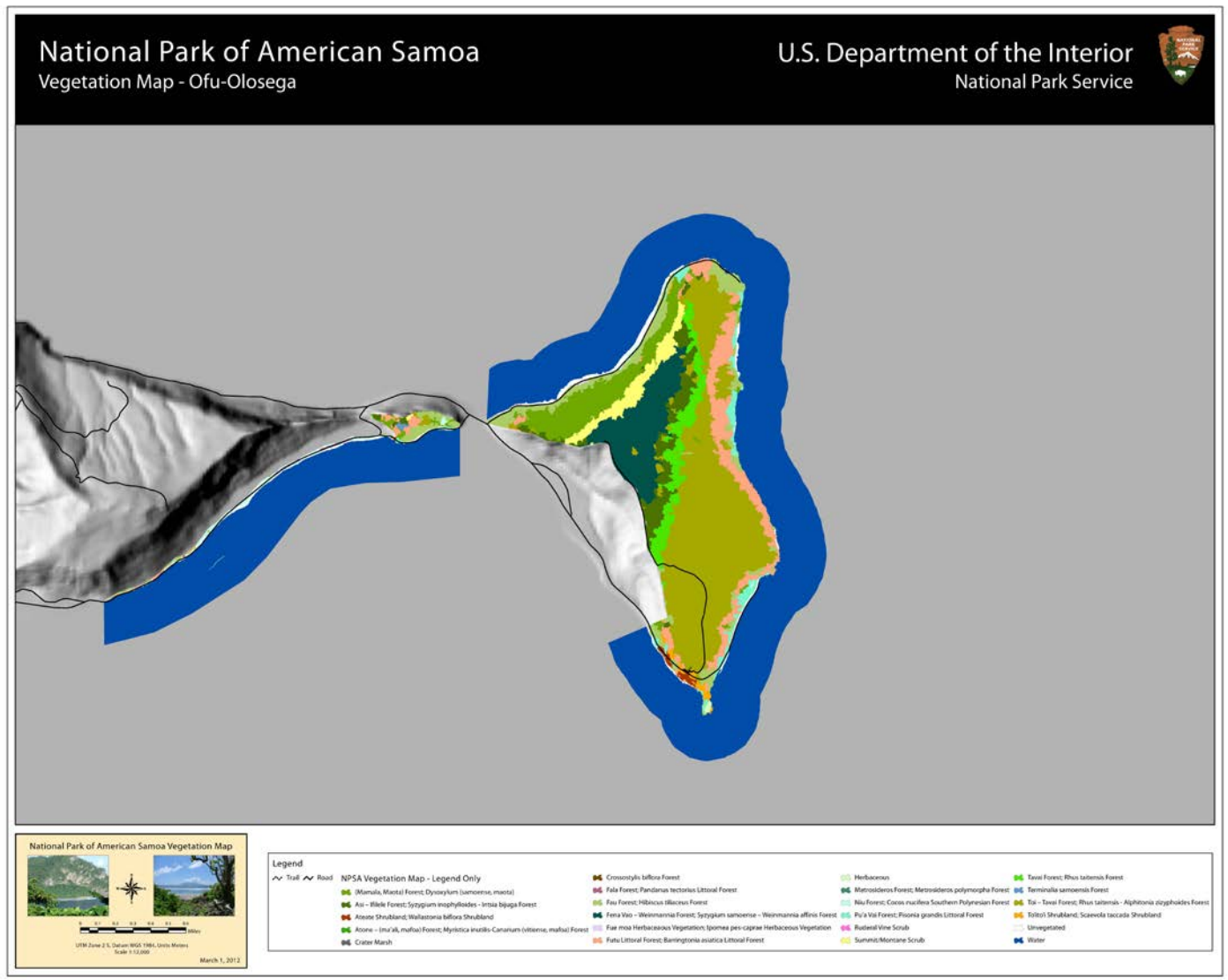


Figure 19. Draft NPSA vegetation map – Ofu and Olosega.

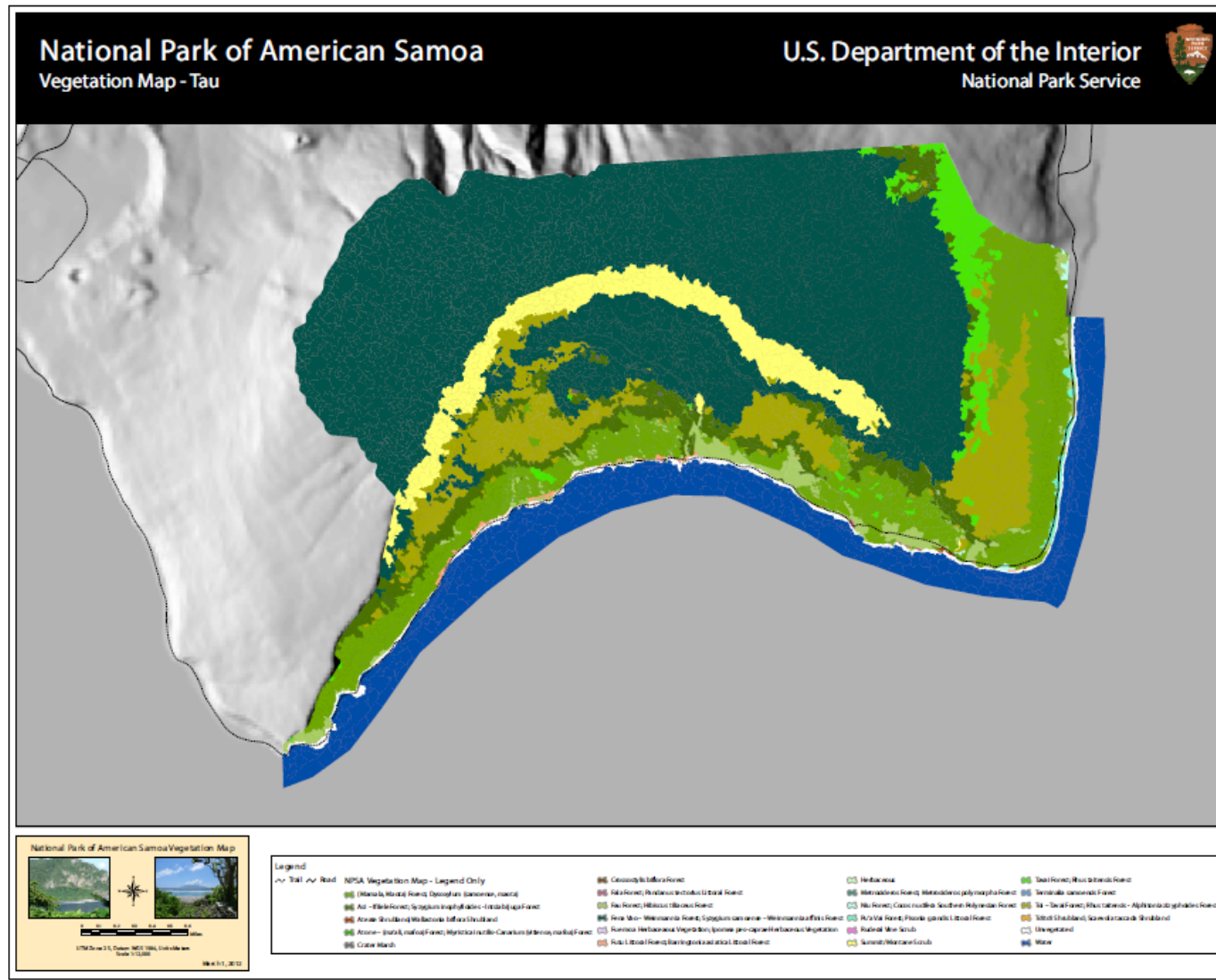


**Figure 20.** Draft NPSA vegetation map – Ta'ū.

Thematic maps capture the spatial variation of one or a small number of themes such as climate, soil type, population density, or vegetation. The NPSA vegetation map is a thematic map of vegetation and land use as defined by the NPSA 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 NPSA 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 7).

**Table 7.** 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.

AA sample segments were generated for each map class using ArcGIS. A geodatabase of candidate AA segments was created from the undissolved draft map segments which were deemed “accessible” based on a GIS analysis of slope and distance from trails or roads. Segments were used for AA sample units as opposed to polygons because most of NPSA’s polygons were too large to constitute one sample. Segments classified as water or human-made features were removed. An accessibility filter was run to identify segments that were reasonably accessible by road or trail and not on extremely steep slopes. This filter required that any portion of the segment must be within 100 m (333 ft) of a road/trail and that the average slope of the segment is not greater than 70 percent. A feasible set of 2.5 to 3 times the number of suggested AA sample per class (Table 7) were then generated for each map class using a random number generator. Final candidate segments were then manually chosen for each map class to ensure sites were reasonably grouped for easier field accessibility. Only segments well within the map polygon boundaries were selected as candidates. Center of gravity centroids were then generated for candidate segments to develop the final AA site target locations. Due to the steep terrain and odd shaped segments, many centroids were very close together resulting at times in overlapping AA plot boundaries.

### ***Field Data Collection***

From March to August 2012, PACN staff and NPSA volunteers collected 249 AA samples (Figures 21-24). Using GPS units, field maps, and compasses, field crews navigated to the target location (segment centroid) and assessed the vegetation of the MMU sample (0.5 ha; 1.2 ac), typically as a circular plot (40 m radius). In areas of extremely heterogenous vegetation (e.g. transition zones) where circular plots did not fit, crews assessed smaller areas, often as rectangular or square plots to provide information of the vegetation. These sites were not used in the analysis because they were below the MMU. 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, and/or recent disturbance were also recorded. If the crew encountered a vegetation type that was new to the NPSA 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.

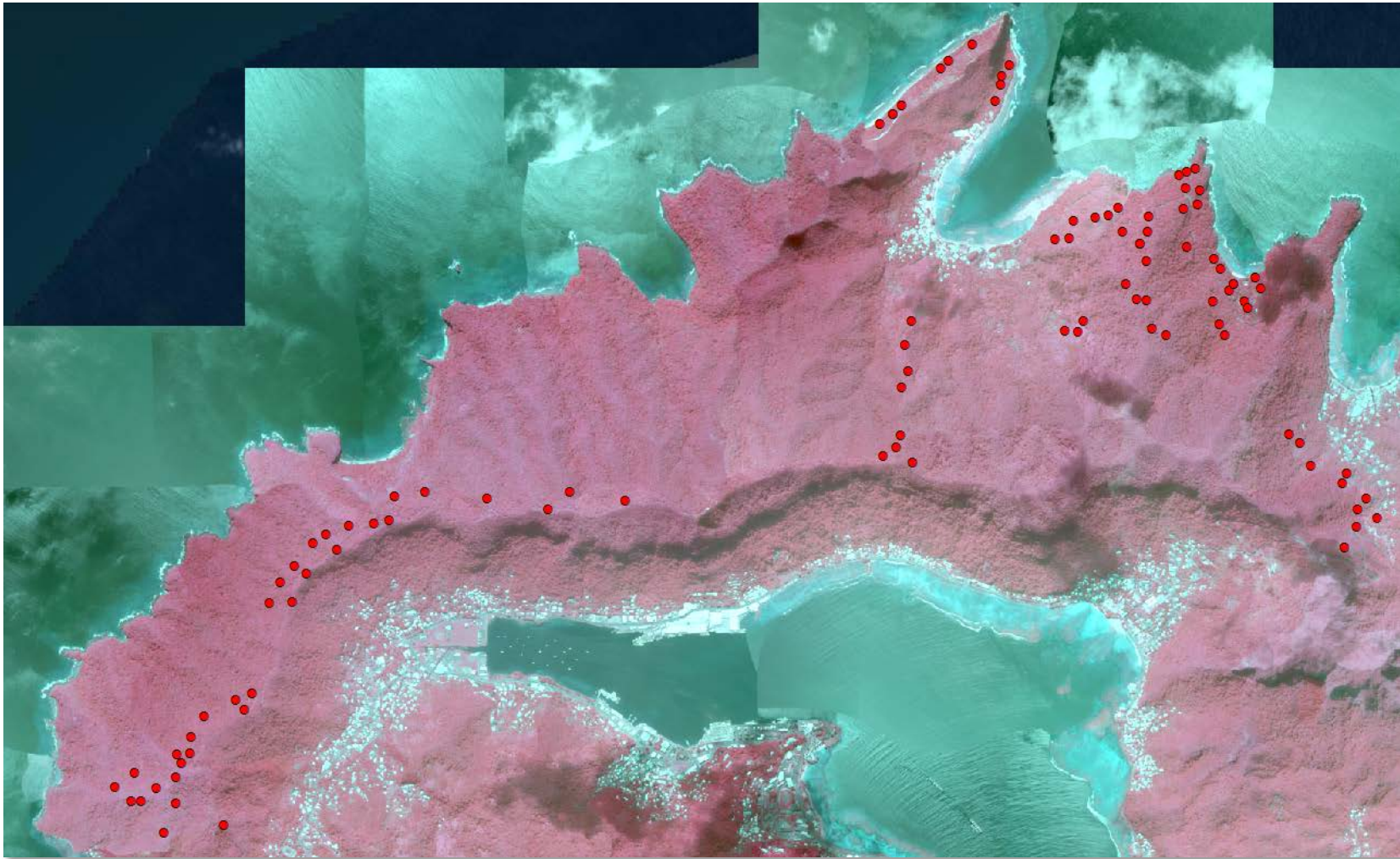


**Figure 21.** Distribution of accuracy assessment sites (red circles) on Tutuila. Imagery source: 2012 Quantum Spatial/USGS airborne infrared imagery.

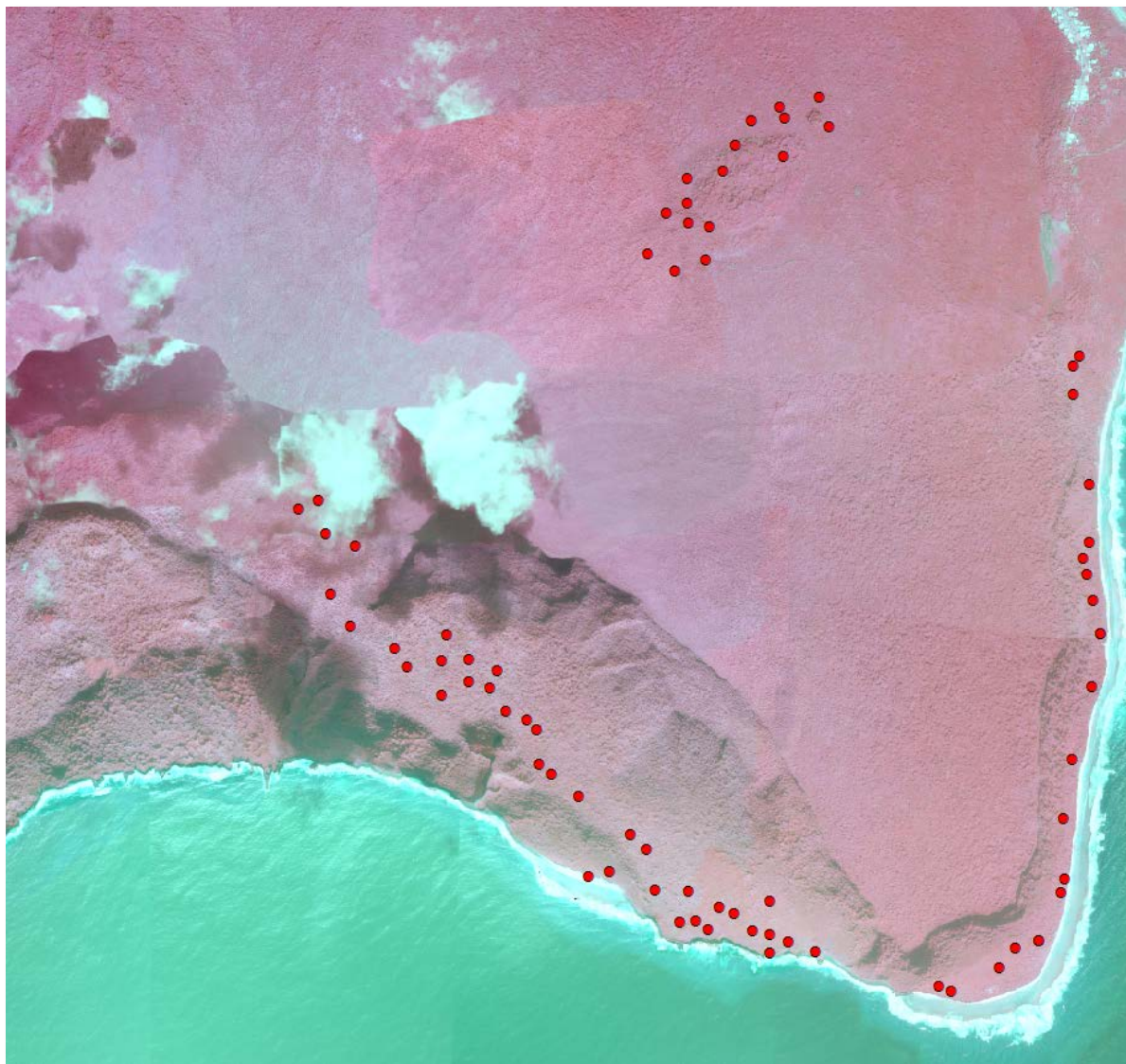


**Figure 22.** Distribution of accuracy assessment sites (red circles) on Ta'ū. Imagery source: 2012 Quantum Spatial/USGS airborne infrared imagery.

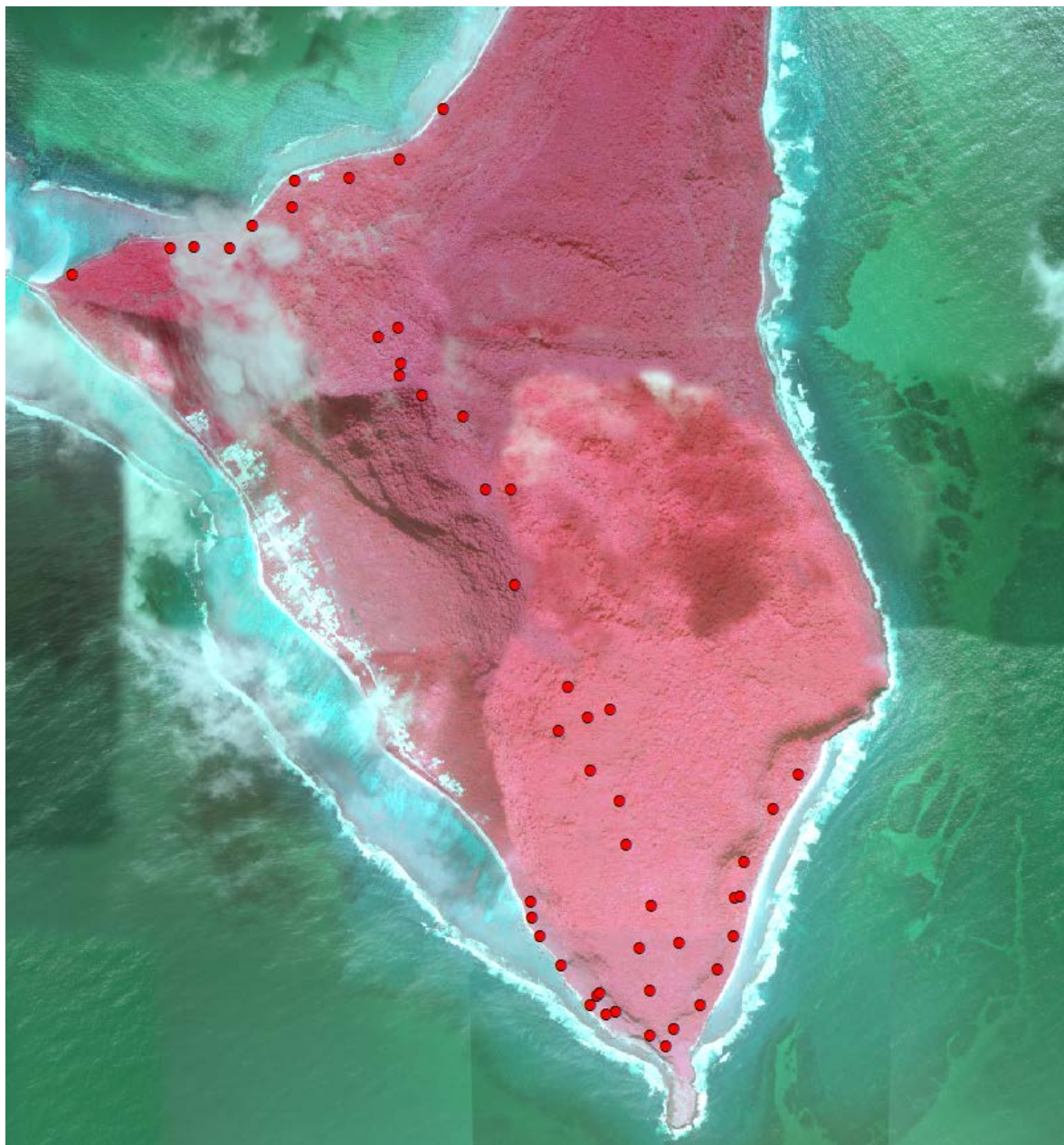


**Figure 23.** Distribution of accuracy assessment sites (red circles) on Olosega. Imagery source: 2012 Quantum Spatial/USGS airborne infrared imagery.

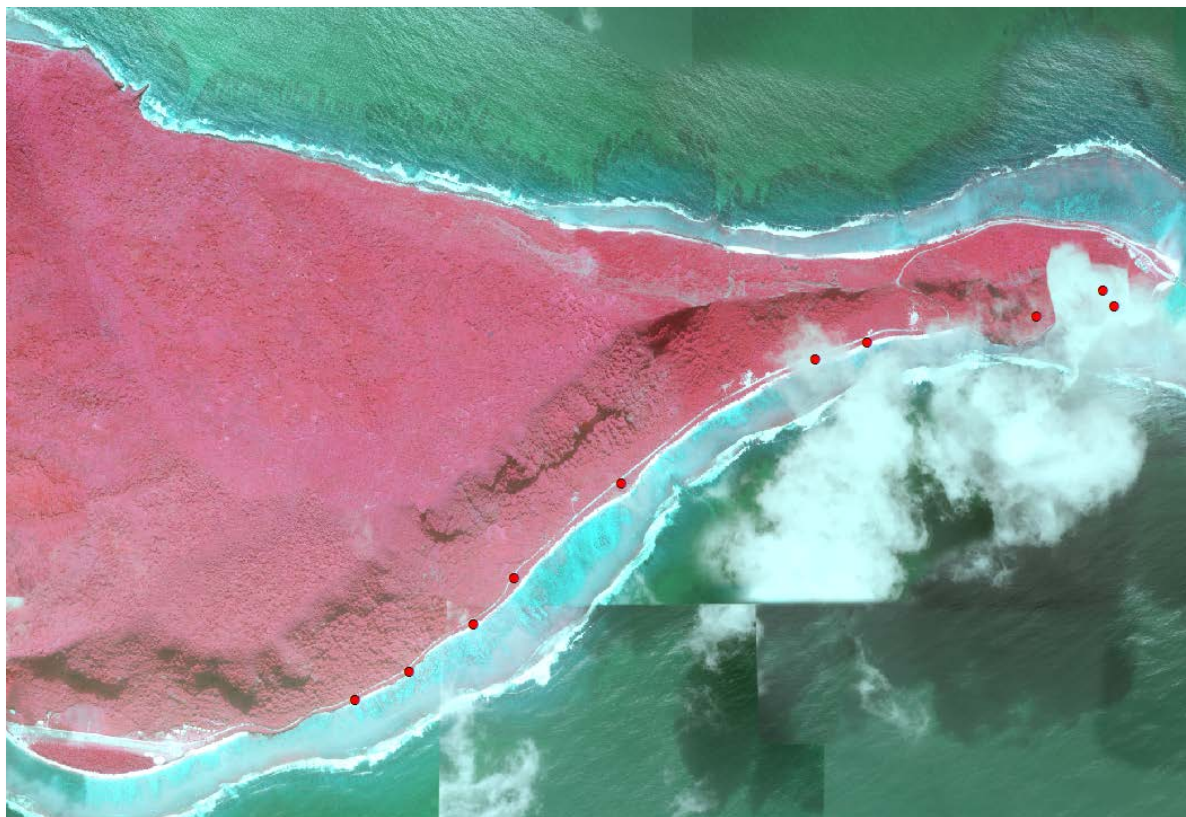


**Figure 24.** Distribution of accuracy assessment sites (red circles) on Ofu. Imagery source: 2012 Quantum Spatial/USGS airborne infrared imagery.

### **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 the PLOTS 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.

### **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 any changes to the data were warranted. The analysis confirmed that the Quickbird imagery used to create the maps had serious registration problems, especially in coastal strands. It was also discovered that several of the AA samples in the AA geodatabase had incorrect coordinates (i.e., in the water or outside of the park),

and that several were significantly smaller than the map MMU. The areas in Ofu and Ta'ū coastal strand only landed in the ocean in the mis-registered imagery. When the imagery was corrected, the Ofu and Ta'ū coastal strand survey points were located correctly. During the field survey, the field crew discovered that these target locations were located west of the park boundary in Ofu and west of the coastal strand community on Ta'ū. The field crew adjusted their survey points to the west, placing them inside the park boundary and located correctly in the coastal strand community. It was decided by KGA that a validation trip would be conducted to Tutuila, where most of the confused sites were located. Any *post-hoc* changes to AA field calls are identified in Appendix G. Error matrices were developed as detailed in the NPS National Vegetation Mapping Program's 1994 (NPS 1994) standards.

### **Validation (Step 10)**

In April of 2014, KGA personnel returned to Tutuila to check the draft map. One four person crew (KGA, PACN, and NPSA personnel) spent five days evaluating the draft map. Corrections to the map were made in the field on a Trimble Yuma. Upon return from the field, the draft map was further edited in the office and sent to the NPS for review.

### **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 NPSA project was the translation of the NPSA 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) several associations were added which were not sampled as part of the classification work and some were removed because they were not encountered again in the field. 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 and the validation trip, KGA and PACN staff worked together to develop 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 NPSA 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 analysis and the validation trip, the NPSA draft map was completely revised based on the 2012 Quantum Spatial/USGS airborne imagery and the NRCS Worldview2 imagery to correct registration errors, map label and delineation errors discovered during AA and the validation trip, and add more detail to the map which could be supported by the increased spatial resolution of the airborne imagery (1 ft) over that of the satellite imagery.

The registration errors were corrected by spatially adjusting the Quickbird satellite imagery to the 2012 Quantum Spatial/USGS airborne imagery. For each island, the linear offset in both the X and Y directions was determined by comparing multiple photo interpretable locations in each set of imagery and calculating the average shift difference in each direction. The average X and Y shift per island was applied to the upper left X and upper left Y bounding coordinates of the Quickbird mosaic to align the imagery with the aerial ortho imagery. The same photo interpreted locations were reviewed in the shifted Quickbird imagery and original aerial imagery to ensure good alignment. The same shift was then applied to the upper left X and upper left Y bounding coordinates of the vegetation map to realign it with the newly shifted Quickbird imagery and the 2012 aerial ortho imagery.

Each island was manually reviewed using the 2012 Quantum Spatial/USGS aerial imagery and the new Worldview2 8 band satellite imagery which was acquired over American Samoa by USDA. Labels and polygon lines were edited where needed. Comments on the map from NPSA and PACN staff were then reviewed, additional edits were made where appropriate, and the final map was created. The result is that the final map is a very different and more accurate map than the draft map. Details of edits per map class can be found in Appendix H. Finally, a modifier was added to *Merremia peltata* - *Mikania micrantha* Semi-natural Vine Scrub map polygons if the polygon appeared to be in current agricultural use or abandoned agricultural use.

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.
- Map\_Class – String field, populated with the vegetation map class name.
- Map\_Class\_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 NPSA was completed by PACN and NPS staff. Given the extreme ruggedness of the terrain, it was a challenging landscape to sample. One hundred and thirty-six plots were sampled at NPSA which resulted in the identification of 17 associations. Each association is represented by 1-25 classification plots with six associations receiving two or less plots. NatureServe recommends 3-5 plots of each type to capture some of the range of variability.

### Vegetation Classification

The draft associations were carefully reviewed in the context of their range of variation within their species composition, environmental setting (elevation, slope, soil, and landform), littoral influence, and time since disturbance. NatureServe ecologists, NPS ecologists, and the mappers reviewed the draft classification and individual plots were re-assigned where needed. For example, five plots were dominated by *Ficus prolixa*. The plots in the group were actually samples of large individual trees that nearly filled the sample area. Each plot was examined and then re-classified into lowland rain forest types based on the remaining species composition. Another group of eight plots had an indicator species of *Thespesia populnea*. Upon close examination, this species was often present in disturbed areas along the littoral zone, and were determined to be more similar in species composition with the *Barringtonia asiatica* Littoral Forest (seven plots) or the *Pandanus tectorius* Littoral Forest (one plot). A similar process shifted plots between other groups: the *Scaevola taccada* group (Figure 14) was re-assigned as the *Pandanus tectorius* Littoral Forest and the *Barringtonia samoensis* plot (Table 8) was included with the *Dysoxylum (samoense, maota)* Forest type. A few more types emerged that were not identified by indicator species analysis because while having very high cover in single plots, the species also occurred in other groups. These types are *Alphitonia zizyphoides* Forest [Park Special], *Fagraea berteriana* Forest [Park Special], *Metrosideros* spp. Forest [Park Special], and *Planchonella garberi* Forest [Park Special]. The *Pometia pinnata* Group was a dominant species that did not occur in other plots. The final classification resulted in 17 plant associations (Table 8).

Many of the lowland plots had non-native tree species that are primarily cultivated for fruit, forage and other anthropogenic uses. Abundance within sampled areas was directly related to the proximity of active and abandoned agricultural fields, the intensity of past disturbance, and the amount of time since disturbance. The classification development process focused on the native trees present in a sample, since cultivation was no longer occurring in some sites and non-native cultivated fruit trees were unlikely to persist. As a result, some stands of native forest types on the map, have substantial amounts of non-native species present.

The USNVC divides vegetation into two major sections, Natural and Cultivated Vegetation. Plant associations that are represented by non-native species or a mix of native and non-native species are called “semi-natural” because these vegetation types are not a direct product of human hands (although indirect) and respond to the climate and disturbances regimes that their native counter-parts

also respond to. Semi-natural types reside within the “Natural” section of the USNVC, which means they are not completely natural nor are they a “cultivated” vegetation type.

**Table 8.** USNVC hierarchical classification of vegetation at NPSA organized by macrogroup, group, and association.

| USNVC Association                                                                         | Common Name                                                      | ELCODE     | USNVC Group                                                     | USNVC Macrogroup                                              |
|-------------------------------------------------------------------------------------------|------------------------------------------------------------------|------------|-----------------------------------------------------------------|---------------------------------------------------------------|
| <i>Barringtonia asiatica</i> Littoral Forest                                              | Futu Littoral Forest                                             | CEGL008705 | Central & Southern<br>Polynesian Lowland<br>Rainforest          | Central & Southern<br>Polynesian Lowland<br>Rainforest        |
| <i>Crossostylis biflora</i> Forest                                                        | Saitamu Forest                                                   | CEGL008707 |                                                                 |                                                               |
| <i>Dysoxylum (samoense, maota)</i> Forest                                                 | (Mamala, Maota) Forest                                           | CEGL008708 |                                                                 |                                                               |
| <i>Hibiscus tiliaceus</i> Forest                                                          | Fau Forest                                                       | CEGL008710 |                                                                 |                                                               |
| <i>Myristica inutilis</i> - <i>Canarium (vitiense, mafoa)</i> Forest                      | Atone - (ma'ali, mafoa) Forest                                   | CEGL008711 |                                                                 |                                                               |
| <i>Pandanus tectorius</i> Littoral Forest                                                 | Fala Littoral Forest                                             | CEGL008712 |                                                                 |                                                               |
| <i>Pisonia grandis</i> Littoral Forest                                                    | Pu'a Vai Littoral Forest                                         | CEGL008713 |                                                                 |                                                               |
| <i>Rhus taitensis</i> Forest                                                              | Tavai Forest                                                     | CEGL008715 |                                                                 |                                                               |
| <i>Syzygium inophylloides</i> - <i>Intsia bijuga</i> Forest                               | Asi - Ifilele Forest                                             | CEGL008716 |                                                                 |                                                               |
| <i>Fagraea berteriana</i> Forest [Park Special]                                           | Pualulu Forest [Park Special]                                    | CEPS009637 |                                                                 |                                                               |
| <i>Metrosideros</i> spp. Forest [Park Special]                                            | <i>Metrosideros</i> spp. Forest [Park Special]                   | CEPS009640 |                                                                 |                                                               |
| <i>Alphitonia zizyphoides</i> Forest [Park Special]                                       | Toi Forest [Park Special]                                        | CEPS009641 |                                                                 |                                                               |
| <i>Pometia pinnata</i> Forest [Park Special]                                              | Tava Forest [Park Special]                                       | CEPS009642 |                                                                 |                                                               |
| <i>Planchonella garberi</i> Forest [Park Special]                                         | 'Ala'a Forest [Park Special]                                     | CEPS009643 |                                                                 |                                                               |
| <i>Merremia peltata</i> - <i>Mikania micrantha</i> Semi-natural Vine Scrub [Park Special] | Fue Lautetele - Fue saina Semi-natural Vine Scrub [Park Special] | CEPS009638 | Polynesian Semi-natural Lowland Rainforest                      | Polynesian Semi-natural Lowland Rainforest                    |
| <i>Syzygium samoense</i> - <i>Weinmannia affinis</i> Forest                               | Fena Vao - <i>Weinmannia</i> Forest                              | CEGL008717 | Central & Southern Polynesian Montane Rainforest                | Central & Southern Polynesian Montane & Cloud Forest          |
| <i>Cocos nucifera</i> Southern Polynesian Forest                                          | Niu Southern Polynesian Forest                                   | CEGL008718 | Central & Southern Polynesian Scrub & Herb Coastal Strand Group | Central & Southern Polynesian Scrub & Herb Coastal Vegetation |

## Vegetation Mapping

Following AA, KGA and PACN personnel determined that 23 vegetated and three unvegetated map classes exist at NPSA. Table 9 compares NPSA's USNVC associations to the final map classes. The final NPSA map model is a result of the following actions or conditions:

- Six map classes were evident on the imagery, but did not receive classification plots because they were either inaccessible to NPS crews or were found on the proposed NPSA portions of Olosega which were not included in the classification sampling. They include:
  - Montane Shrub map class on the top of trachyte plugs on Tutuila which was inaccessible to the classification crews but which has been sampled by Whistler (2002).
  - Crater Marsh (on Ta'ū) and Cliff Scrub (on Ofu, Olosega, and Ta'ū) map classes which are inaccessible and have never been sampled, but are clearly recognizable on the imagery (Figure 25).
  - *Alphitonia zizyphoides* - *Rhus taitensis* Forest, *Ipomoea pes-caprae* Herbaceous Vegetation and *Wedelia biflora* - *Scaevola taccada* Shrubland map classes which are primarily found in the proposed Olosega portions of NPSA.
- Two additional map classes were discovered during the calibration trip:
  - Agriculture which is only found on Tutuila.
  - *Terminalia samoensis* Littoral Forest which is restricted to a small area of Ofu.

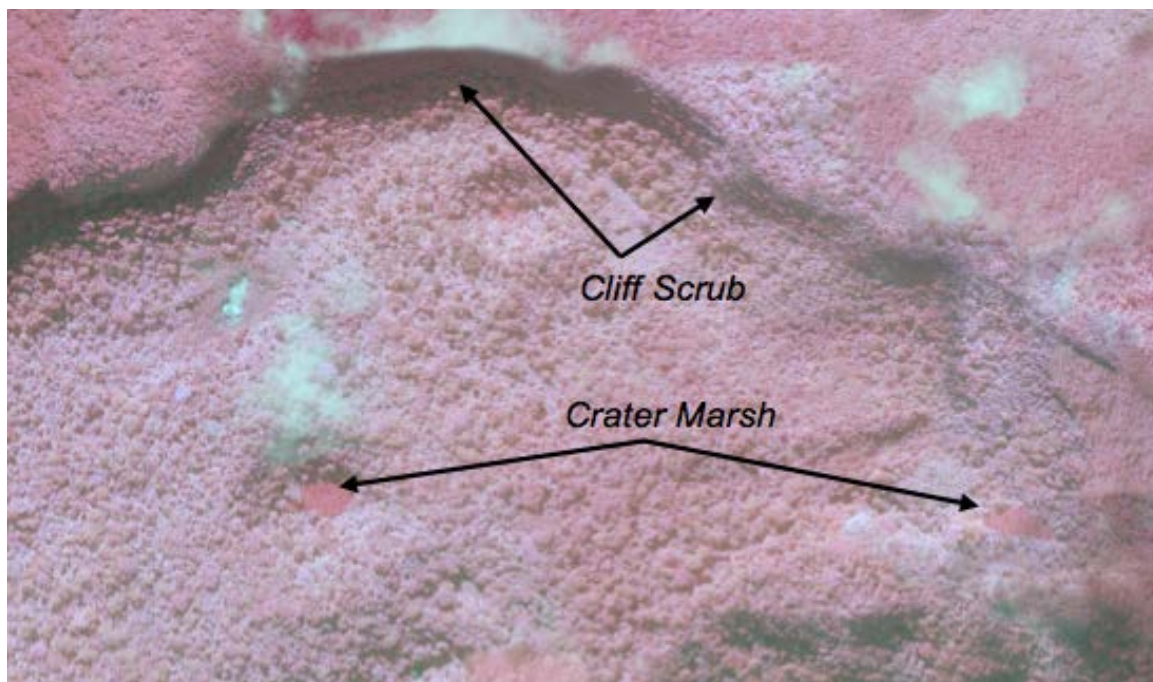


**Figure 25.** Crater Marsh and Cliff Scrub map classes on Ta'ū.

- Seven associations were collapsed into three map classes because the associations were indistinguishable on the imagery and could not be modeled with GIS data:
  - *Dysoxylum (samoense, maota)* Forest, *Rhus Taitensis* Forest with less than 50% T2 cover of *Rhus Taitensis* trees, *Alphitonia zizyphoides* Forest [Park Special] and *Myristica inutilis* - *Canarium (vitiense, mafoa)* Forest form the *Dysoxylum* spp. - *Rhus* - *Alphitonia* - (*Myristica*, *Canarium* spp.) Forest map class on Tutuila only.
  - *Syzygium inophylloides* - *Intsia bijuga* Forest and *Planchonella garberi* Forest [Park Special] form the *Syzygium inophylloides* - (*Calophyllum* spp.) Forest map class on all islands. However the *Planchonella garberi* Forest map class was only encountered once on Tutuila during the life of the project.
  - *Crossostylis biflora* Forest and *Syzygium samoense* - *Weinmannia affinis* Forest form the *Syzygium samoense* - (*Crossostylis biflora*) Forest map class on Tutuila only.

Figures 26-28 show the final NPSA vegetation map. Most (92%) of NPSA is forested (Figure 29) and of the forested areas, 6% is coastal forest, 49% is lowland rain forest and 45% is montane rain forest.

**Table 9.** USNVC associations and the map classes found at NPSA. For each association, the table shows the resulting map classes, total map class size in hectares, and the number of classification plots per association.

| USNVC Association                                                                         | ELCODE     | Map Class                                                                                                   | Map Code | Size (ha) | Plot |
|-------------------------------------------------------------------------------------------|------------|-------------------------------------------------------------------------------------------------------------|----------|-----------|------|
| None                                                                                      | NA         | Agriculture                                                                                                 | B_AG     | 3.4       | 0    |
| None                                                                                      | NA         | <i>Alphitonia zizyphoides</i> - <i>Rhus taitensis</i> Forest                                                | F_ALRH   | 184.2     | 0    |
| <i>Barringtonia asiatica</i> Littoral Forest                                              | CEGL008705 | <i>Barringtonia asiatica</i> Littoral Forest                                                                | F_BAAS   | 25.2      | 15   |
| None                                                                                      | NA         | Cliff Scrub                                                                                                 | SC_CLIFF | 156.4     | 0    |
| <i>Cocos nucifera</i> Southern Polynesian Forest                                          | CEGL008718 | <i>Cocos nucifera</i> Southern Polynesian Forest                                                            | F_CONU   | 17.2      | 3    |
| None                                                                                      | NA         | Crater Marsh                                                                                                | B_CM     | 1         | 0    |
| <i>Dysoxylum (samoense, maota)</i> Forest                                                 | CEGL008708 | <i>Dysoxylum (samoense, maota)</i> Forest                                                                   | F_DYSO   | 326.6     | 16   |
| <i>Alphitonia zizyphoides</i> Forest [Park Special]                                       | CEPS009641 | <i>Dysoxylum</i> spp. - <i>Rhus</i> - <i>Alphitonia</i> - ( <i>Myristica</i> , <i>Canarium</i> spp.) Forest | F_DYRHAL | 1103.1    | 1    |
| <i>Myristica inutilis</i> - <i>Canarium (vitiense, mafoa)</i> Forest                      | CEGL008711 |                                                                                                             |          |           | 25   |
| <i>Dysoxylum (samoense, maota)</i> Forest                                                 | CEGL008708 |                                                                                                             |          |           | 16   |
| <i>Rhus taitensis</i> Forest                                                              | CEGL008715 |                                                                                                             |          |           | 5    |
| <i>Hibiscus tiliaceus</i> Forest                                                          | CEGL008710 | <i>Hibiscus tiliaceus</i> Forest                                                                            | F_HITI   | 146.4     | 15   |
| None                                                                                      | NA         | <i>Ipomoea pes-caprae</i> Herbaceous Vegetation                                                             | H_IPPE   | 3.1       | 0    |
| None                                                                                      | NA         | <i>Mangifera indica</i> Forest                                                                              | F_MAIN   | 1.6       | 0    |
| <i>Merremia peltata</i> - <i>Mikania micrantha</i> Semi-natural Vine Scrub [Park Special] | CEPS009638 | <i>Merremia peltata</i> - <i>Mikania micrantha</i> Semi-natural Vine Scrub                                  | V_MEMI   | 37.3      | 2    |
| <i>Metrosideros</i> spp. Forest [Park Special]                                            | CEPS009640 | <i>Metrosideros</i> spp. Forest                                                                             | F_MESP   | 0.2       | 1    |
| None                                                                                      | NA         | Montane Scrub                                                                                               | SC_MON   | 6.7       | 0    |
| <i>Pandanus tectorius</i> Littoral Forest                                                 | CEGL008712 | <i>Pandanus tectorius</i> Littoral Forest                                                                   | F_PATE   | 0.4       | 6    |
| <i>Pisonia grandis</i> Littoral Forest                                                    | CEGL008713 | <i>Pisonia grandis</i> Littoral Forest                                                                      | F_PIGR   | 18.6      | 4    |
| <i>Pometia pinnata</i> Forest [Park Special]                                              | CEPS009642 | <i>Pometia pinnata</i> Forest                                                                               | F_POPI   | 0.8       | 1    |
| <i>Rhus taitensis</i> Forest                                                              | CEGL008715 | <i>Rhus taitensis</i> Forest                                                                                | F_RHTA   | 24.6      | 5    |
| <i>Planchonella garberi</i> Forest [Park Special]                                         | CEPS009643 | <i>Syzygium inophylloides</i> - ( <i>Calophyllum</i> spp.) Forest                                           | F_SYCA   | 362.6     | 1    |
| <i>Syzygium inophylloides</i> - <i>Intsia bijuga</i> Forest                               | CEGL008716 |                                                                                                             |          |           | 24   |
| <i>Syzygium samoense</i> - <i>Weinmannia affinis</i> Forest                               | CEGL008717 | <i>Syzygium samoense</i> - <i>Weinmannia affinis</i> Forest                                                 | F_SYWE   | 1097.8    | 12   |
| <i>Crossostylis biflora</i> Forest                                                        | CEGL008707 | <i>Syzygium samoense</i> - ( <i>Crossostylis biflora</i> ) Forest                                           | F_SYCB   | 14.4      | 3    |
| <i>Syzygium samoense</i> - <i>Weinmannia affinis</i> Forest                               | CEGL008717 |                                                                                                             |          |           | 12   |
| None                                                                                      | NA         | <i>Terminalia samoensis</i> Littoral Forest                                                                 | F_TESA   | 0.9       | 0    |
| None                                                                                      | NA         | <i>Wedelia biflora</i> - <i>Scaevola taccada</i> Shrubland                                                  | S_WBST   | 9.9       | 0    |
| <i>Fagraea berteriana</i> Forest [Park Special]                                           | CEPS009637 | Rare class. Not found on map.                                                                               | NA       | 0         | 1    |

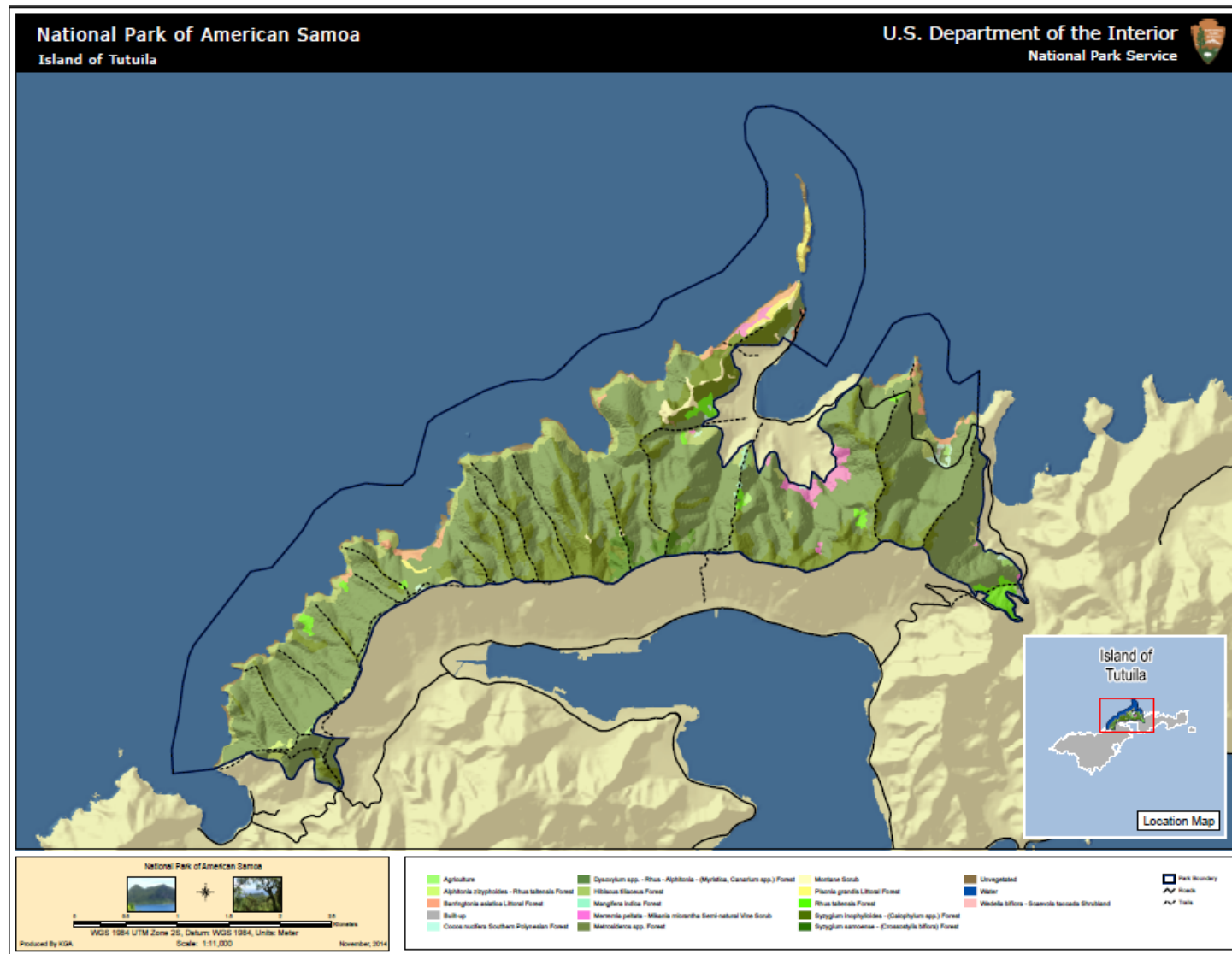


**Figure 26.** Final NSPA vegetation map – Tutuila.

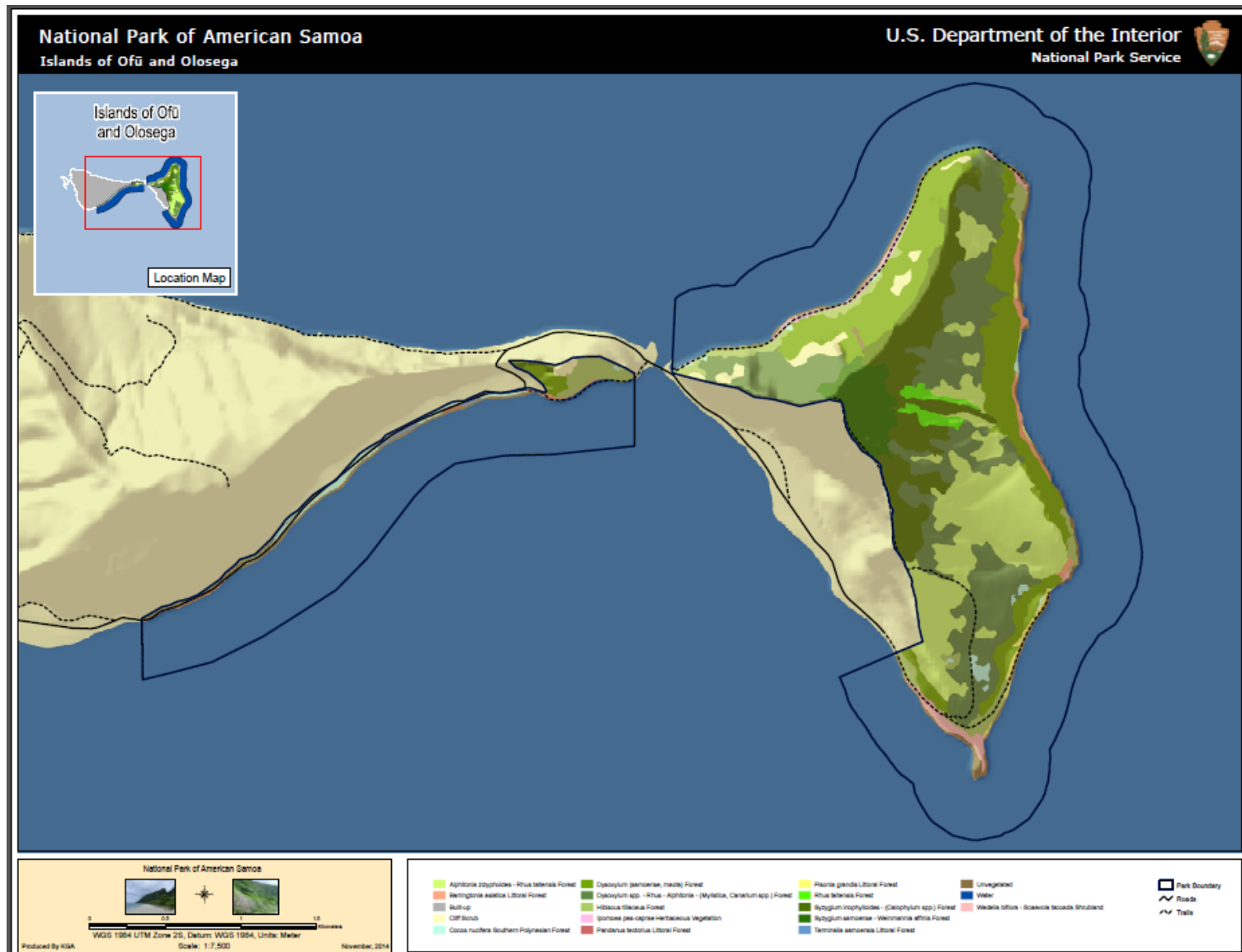


**Figure 27.** Final NPSA vegetation map – Ofu and Olosega.

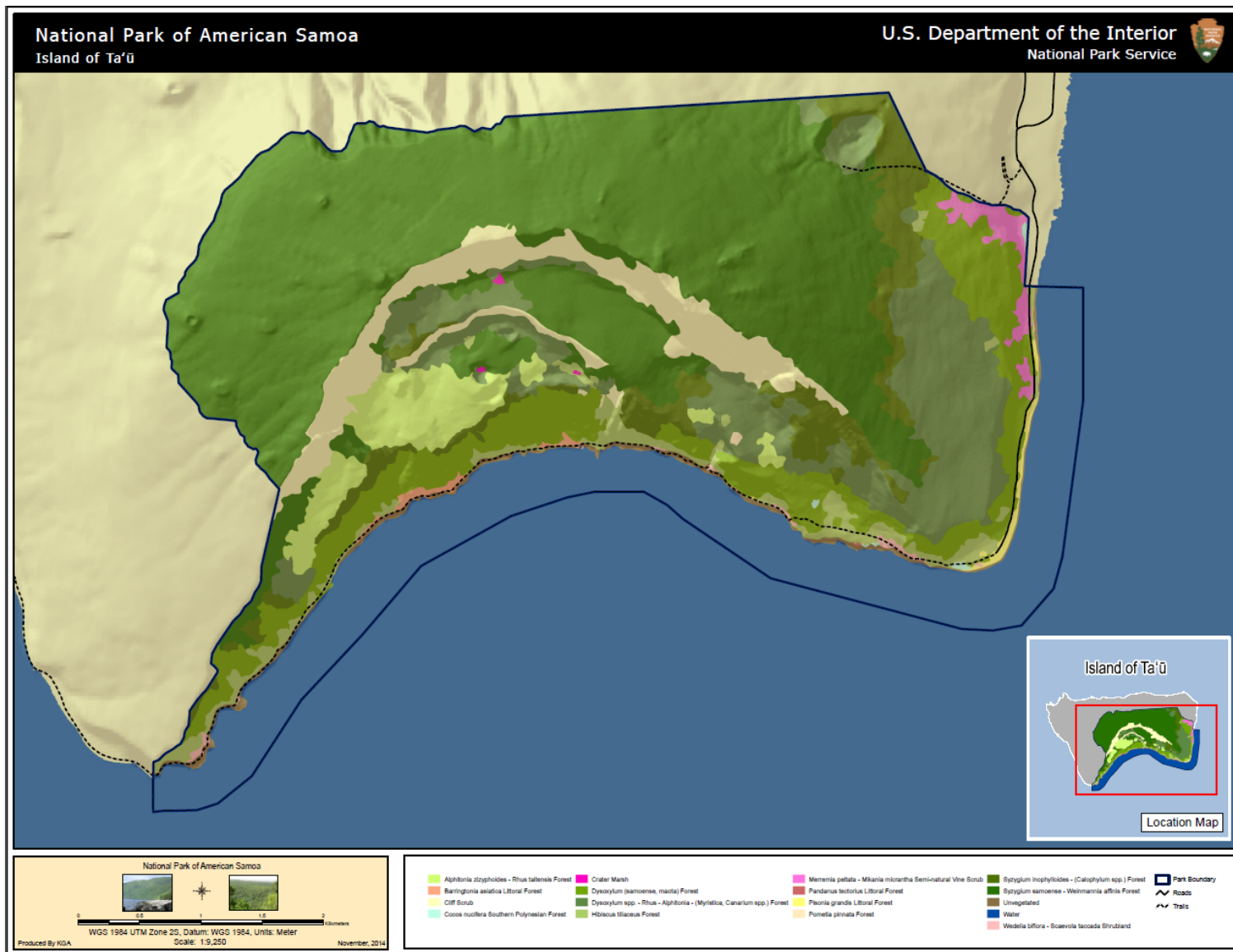


**Figure 28.** Final NPSA vegetation map – Ta'ū.

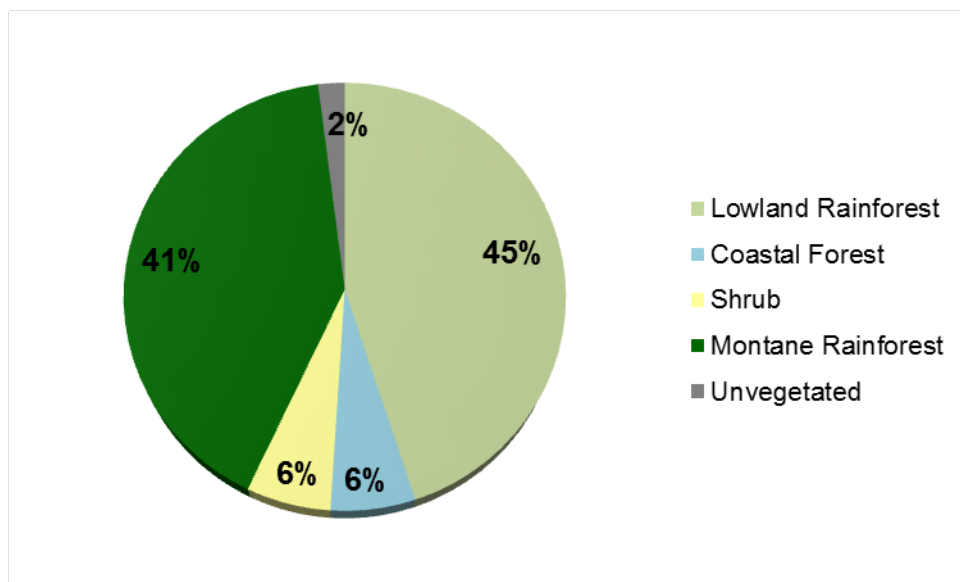


**Figure 29.** Percentage of NPSA vegetated areas by type.

### Accuracy Assessment

Fifteen of NPSA's 23 vegetated map classes were assessed for accuracy. Classes not assessed include:

- Montane scrub, cliff scrub, and crater marsh which are inaccessible.
- Agriculture, *Metrosideros* spp. Forest, *Pometia pinnata* Forest, *Terminalia samoensis* Littoral Forest and *Mangifera indica* Forest which all occupy a very small area of NPSA and were mapped only where field verified.

AA analysis requires examination of each AA sample's map label and field 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 249 AA samples 24 were omitted from the analysis because they had incorrect coordinates, did not receive a label, had missing forms, or sampled areas which were significantly smaller than the MMU.

Overall draft map accuracy of NPSA is 68% using the primary reference label, and 70% when the secondary labels are accepted. Table 10 presents the error matrix for the NPSA draft map. The yellow highlighted cells on the diagonal represent samples where the reference primary labels and the map labels match.

Table 11 shows the draft map user and producer's accuracies for the map classes. For each AA plot, the map label is the map class according to the draft vegetation map whereas the reference or plot label is the map class that the field crew labeled the plot based on the key and descriptions. Ideally, the field reference label matches the map label (yellow highlighted cell). User's accuracy for each map class is calculated from Table 10 by dividing the yellow highlighted cell (field AA reference or

plot label matches map class) by the total number of samples in each row (all field AA plots visited that should have been labeled this map class). Producer's accuracies for each map class are calculated by dividing the yellow highlighted cell (field AA reference or plot label matches map class) 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).

It is important to remember that the draft NPSA map was totally revised when the 2012 Quantum Spatial/USGS aerial imagery became available, and, therefore, the AA is not an assessment of the final map. The most significant changes between the draft map and the final map are as follows:

- The width of the *Barringtonia asiatica* Littoral Forest strand was reduced in most areas.
- Forests covered in vines were relabeled *Merremia peltata* - *Mikania micrantha* Semi-natural Vine Scrub instead of their forest class.
- More areas of *Hibiscus tiliaceus* Forest were added because this map class became much easier to identify with the high resolution imagery.
- The extent of the montane forest types was reduced on Tutuila and Ta'ū but increased on Olosega.

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 (Appendix H)

**Table 10.** Error matrix for the NPSA draft maps. 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 Labels                                                                                                  | <i>Alphitonia zizyphoides</i> - <i>Rhus taitensis</i> Forest | <i>Dysoxylum</i> ( <i>samoense</i> , <i>maota</i> ) Forest | <i>Dysoxylum</i> spp. - <i>Rhus</i> - <i>Alphitonia</i> - ( <i>Myristica</i> , <i>Canarium</i> spp.) Forest | <i>Pandanus tectorius</i> Littoral Forest | <i>Hibiscus tiliaceus</i> Forest | <i>Ipomoea pes-caprae</i> Herbaceous Vegetation | <i>Barringtonia asiatica</i> Littoral Forest | <i>Merremia peltata</i> - <i>Mikania micrantha</i> Semi-natural Vine Scrub | <i>Cocos nucifera</i> Southern Polynesian Forest | <i>Pisonia grandis</i> Littoral Forest | <i>Rhus taitensis</i> Forest | <i>Syzygium inophylloides</i> - ( <i>Calophyllum</i> spp.) Forest | <i>Syzygium samoense</i> - ( <i>Crossostylis biflora</i> ) Forest | <i>Syzygium samoense</i> - <i>Weinmannia affinis</i> Forest | <i>Wedelia biflora</i> - <i>Scaevola taccada</i> Shrubland | Grand Total |
|-------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------|----------------------------------|-------------------------------------------------|----------------------------------------------|----------------------------------------------------------------------------|--------------------------------------------------|----------------------------------------|------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------|-------------|
| <i>Alphitonia zizyphoides</i> - <i>Rhus taitensis</i> Forest                                                | 6*                                                           |                                                            | 3                                                                                                           |                                           | 3                                |                                                 |                                              |                                                                            |                                                  |                                        |                              |                                                                   |                                                                   |                                                             |                                                            | 12          |
| Bare ground                                                                                                 |                                                              |                                                            |                                                                                                             |                                           |                                  | 2                                               |                                              |                                                                            |                                                  |                                        |                              |                                                                   |                                                                   |                                                             | 1                                                          | 3           |
| <i>Dysoxylum</i> ( <i>samoense</i> , <i>maota</i> ) Forest                                                  |                                                              | 17*                                                        |                                                                                                             |                                           | 4                                |                                                 | 1                                            | 1                                                                          |                                                  |                                        |                              | 2                                                                 |                                                                   | 1                                                           |                                                            | 26          |
| <i>Dysoxylum</i> spp. - <i>Rhus</i> - <i>Alphitonia</i> - ( <i>Myristica</i> , <i>Canarium</i> spp.) Forest |                                                              |                                                            | 41*                                                                                                         |                                           | 7                                |                                                 | 1                                            |                                                                            |                                                  |                                        |                              | 7                                                                 |                                                                   |                                                             |                                                            | 56          |
| <i>Pandanus tectorius</i> Littoral Forest                                                                   |                                                              |                                                            |                                                                                                             | 3*                                        |                                  |                                                 |                                              |                                                                            |                                                  |                                        |                              |                                                                   |                                                                   |                                                             |                                                            | 3           |
| <i>Hibiscus tiliaceus</i> Forest                                                                            |                                                              |                                                            | 2                                                                                                           |                                           | 20*                              |                                                 | 2                                            | 3                                                                          |                                                  |                                        |                              |                                                                   |                                                                   |                                                             | 1                                                          | 28          |
| <i>Ipomoea pes-caprae</i> Herbaceous Vegetation                                                             |                                                              |                                                            |                                                                                                             |                                           |                                  | 1*                                              |                                              |                                                                            |                                                  |                                        |                              |                                                                   |                                                                   |                                                             |                                                            | 1           |
| <i>Barringtonia asiatica</i> Littoral Forest                                                                |                                                              |                                                            | 4                                                                                                           |                                           | 3                                | 1                                               | 8*                                           | 3                                                                          |                                                  |                                        |                              | 2                                                                 |                                                                   |                                                             |                                                            | 21          |
| <i>Merremia peltata</i> - <i>Mikania micrantha</i> Semi-natural Vine Scrub                                  |                                                              |                                                            |                                                                                                             |                                           |                                  |                                                 |                                              | 2*                                                                         |                                                  |                                        |                              |                                                                   |                                                                   |                                                             |                                                            | 2           |
| <i>Cocos nucifera</i> Southern Polynesian Forest                                                            |                                                              |                                                            | 1                                                                                                           |                                           |                                  |                                                 |                                              |                                                                            | 3*                                               |                                        |                              |                                                                   |                                                                   |                                                             |                                                            | 4           |
| <i>Pisonia grandis</i> Littoral Forest                                                                      |                                                              | 2                                                          | 1                                                                                                           |                                           | 2                                |                                                 |                                              |                                                                            |                                                  | 3*                                     |                              |                                                                   |                                                                   |                                                             |                                                            | 8           |
| <i>Rhus taitensis</i> Forest                                                                                |                                                              |                                                            |                                                                                                             |                                           |                                  |                                                 |                                              |                                                                            |                                                  |                                        | 7*                           |                                                                   |                                                                   |                                                             |                                                            | 7           |
| <i>Syzygium inophylloides</i> - ( <i>Calophyllum</i> spp.) Forest                                           |                                                              |                                                            | 5                                                                                                           |                                           | 3                                |                                                 |                                              |                                                                            |                                                  |                                        |                              | 14*                                                               |                                                                   |                                                             |                                                            | 22          |
| <i>Syzygium samoense</i> - ( <i>Crossostylis biflora</i> ) Forest                                           |                                                              |                                                            |                                                                                                             |                                           |                                  |                                                 |                                              |                                                                            |                                                  |                                        |                              |                                                                   | 1*                                                                |                                                             |                                                            | 1           |
| <i>Syzygium samoense</i> - <i>Weinmannia affinis</i> Forest                                                 |                                                              |                                                            |                                                                                                             |                                           | 1                                |                                                 |                                              |                                                                            |                                                  |                                        |                              | 2                                                                 |                                                                   | 18*                                                         |                                                            | 21          |
| <i>Wedelia biflora</i> - <i>Scaevola taccada</i> Shrubland                                                  |                                                              |                                                            |                                                                                                             |                                           |                                  |                                                 |                                              |                                                                            |                                                  |                                        |                              |                                                                   |                                                                   |                                                             | 7*                                                         | 7           |
| Grand Total                                                                                                 | 6                                                            | 19                                                         | 57                                                                                                          | 3                                         | 43                               | 4                                               | 12                                           | 9                                                                          | 3                                                | 3                                      | 7                            | 27                                                                | 1                                                                 | 19                                                          | 9                                                          | 222         |

**Table 11.** NPSA draft map class user's and producer's accuracies.

| Map Class                                                                                                   | User's Accuracy | Producer's Accuracy |
|-------------------------------------------------------------------------------------------------------------|-----------------|---------------------|
| <i>Pandanus tectorius</i> Littoral Forest                                                                   | 100%            | 100%                |
| <i>Rhus taitensis</i> Forest                                                                                | 100%            | 100%                |
| <i>Syzygium samoense</i> - <i>Weinmannia affinis</i> Forest                                                 | 86%             | 95%                 |
| <i>Wedelia biflora</i> - <i>Scaevola taccada</i> Shrubland                                                  | 100%            | 78%                 |
| <i>Cocos nucifera</i> Southern Polynesian Forest                                                            | 75%             | 100%                |
| <i>Dysoxylum</i> ( <i>samoense</i> , <i>maota</i> ) Forest                                                  | 65%             | 89%                 |
| <i>Alphitonia zizyphoides</i> - <i>Rhus taitensis</i> Forest                                                | 50%             | 100%                |
| <i>Dysoxylum</i> spp. - <i>Rhus</i> - <i>Alphitonia</i> - ( <i>Myristica</i> , <i>Canarium</i> spp.) Forest | 73%             | 72%                 |
| <i>Pisonia grandis</i> Littoral Forest                                                                      | 38%             | 100%                |
| <i>Ipomoea pes-caprae</i> Herbaceous Vegetation                                                             | 100%            | 50%                 |
| <i>Merremia peltata</i> - <i>Mikania micrantha</i> Semi-natural Vine Scrub                                  | 100%            | 22%                 |
| <i>Hibiscus tiliaceus</i> Forest                                                                            | 71%             | 47%                 |
| <i>Syzygium inophylloides</i> - ( <i>Calophyllum</i> spp.) Forest                                           | 64%             | 50%                 |
| <i>Barringtonia asiatica</i> Littoral Forest                                                                | 38%             | 67%                 |
| <i>Syzygium samoense</i> - ( <i>Crossostylis biflora</i> ) Forest                                           | 0%              | 0%                  |

### Vegetation Distribution

NPSA's vegetation follows similar patterns from island to island. Along the edge of the littoral zone, near sea level are the coastal forest, shrub and herbaceous types: *Barringtonia asiatica* Littoral Forest, *Pandanus tectorius* Littoral Forest, *Wedelia biflora* - *Scaevola taccada* Shrubland, and *Ipomoea pes-caprae* Herbaceous Vegetation. While *Pisonia grandis* Littoral Forest usually occurs on the coast, it can also appear inland and at higher elevations such as on the steep trachyte plugs of Tutuila.

The *Hibiscus tiliaceus* Forest and *Cocos nucifera* Southern Polynesian Forests are usually also found in coastal areas, with *Hibiscus tiliaceus* Forest often occurring at short stature and in narrow strips at the water's edge within the spray zone. However, these two map classes are also found where cultivated by humans and, therefore, can appear at higher elevations well inland. For example, the gentle slopes east of Mataalā Ridge on Olosega support large stands of *Cocos nucifera* Southern Polynesian Forest and patches of *Hibiscus tiliaceus* Forest.

Three lowland rain forest map classes, *Dysoxylum* spp. - *Rhus* - *Alphitonia* - (*Myristica*, *Canarium* spp.) Forest on Tutuila, *Dysoxylum* (*samoense*, *maota*) Forest on Olosega and Ta'ū, and *Syzygium inophylloides* - (*Calophyllum* spp.) Forest on Olosega, Tutuila, and Ta'ū make up most of the matrix of forests that blanket the hill slopes of NPSA. All of these map classes have diverse tree species with considerable overlap in their species composition. The main difference between them is high constancy of their dominant species with *Syzygium inophylloides* - (*Calophyllum* spp.) commonly found on ridgetops and high slopes and the other two classes found below ridges. As Whistler (2002) states, "The division of Samoan rainforests into different "communities" or "associations" is a difficult and unrewarding task. The primary problem is that the process involves the creation of artificial categories that are imposed on natural phenomena. These categories are formed for our

convenience and understanding; and although they may look nice and neat on paper, they are often not so nice and neat in reality.”

That said, lowland rain forest map classes are distinctive in the field and on the imagery. The *Rhus taitensis* Forest map class is an early seral or secondary forest type that represents a recovering forest. Again, many of the same tree species from more mature lowland rain forest communities occur within the *Rhus taitensis* forests, but are of lower stature and generally lower abundance than *Rhus taitensis*. The *Rhus taitensis* trees appear to be of a common age and therefore, their upper canopies are of similar heights – forming a bright red mat on the infrared imagery. This map class is found on the midslope areas of Tutuila and Ta‘ū. From the imagery, it appears that it also occurs on Olosega; however, the area where it is mapped from the imagery was not visited or visible through binoculars by any of the field crews. We recommend prioritizing this area for validation in the future.

The *Alphitonia zizyphoides* - *Rhus taitensis* Forest is similar to the *Rhus taitensis* Forest, but it has larger and taller *Alphitonia zizyphoides* trees that loom over the *Rhus taitensis* dominated understory. The *Alphitonia zizyphoides* trees stand out on the imagery because of their height and their distinctive brownish red color in the infrared imagery. This map class occurs extensively on the gentle slopes below Mata‘alā Ridge on Olosega, on the western portions of the Liu Bench of Ta‘ū, and in smaller polygons in the southwestern portion of NPSA on Tutuila.

The mountain tops of NPSA are dominated by the two montane forest classes, the *Syzygium samoense* - *Weinmannia affinis* Forest on Ta‘ū and Olosega and the *Syzygium samoense* – (*Crossostylis biflora*) Forest on Tutuila. Both classes are heavily laden with epiphytes which help define this community.

Throughout NPSA, recently disturbed areas often are occupied by trees covered in non-native and native vines, to the point where one could not see the trees. The map class is the *Merremia peltata* - *Mikania micrantha* Semi-natural Vine Scrub which appears to match Whistler’s (2009) “Successional Vegetation” type. Semi-natural refers to the fact that *Mikania micrantha* is not native to American Samoa.

Of Whistler’s major eight vegetation types (2009), two native types were not sampled for classification, but they were mapped: Montane Scrub on the top of trachyte plugs on Tutuila, and Littoral Herbaceous zone which is mapped as *Ipomoea pes-caprae* Herbaceous Vegetation. Classification plot data showed that Whistler’s Summit Scrub was not significantly different from the *Syzygium samoense* - *Weinmannia affinis* Forest map class. Two new map classes were identifiable on the imagery but inaccessible to all field crews – Cliff Scrub on Olosega and Ta‘ū (referred to by Whistler (2013) as “the Lord knows what association”), and Crater Marsh on Ta‘ū.

## 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)

The major portion of the classification is made up of 14 lowland rain forest types. This is the most diverse group, as it occurs immediately adjacent to the coast and continues up in elevation along ridgelines, slopes, and valley floors. Along the edge of the littoral zone, near sea level, two communities were sampled, the *Barringtonia asiatica* Littoral Forest and *Pandanus tectorius* Littoral Forest. *Barringtonia asiatica* is a species also found at higher elevations, but has a greater abundance at lower elevations along with other consistently present companion species, such as *Phymatosorus grossus*. The *Pandanus tectorius* type is often described as a scrubby community, often found on rocky or sandy shores (Whistler 2009).

Three forest communities, *Dysoxylum (samoense, maota)* Forest, *Myristica inutilis - Canarium (vitiense, mafoa)* Forest, and *Syzygium inophylloides - Intsia bijuga* Forest make up most of the matrix of forests that blanket the hill slopes of NPSA. All three associations have diverse tree species with considerable overlap in their species composition. The main difference between them is their dominant species. The remaining lowland forest types were poorly sampled, often with only one plot representing a type. These forest types had an overwhelming strong dominance by their nominal tree species. More samples are recommended to better define these associations.

The *Rhus taitensis* Forest Community is an early seral or secondary forest type that represents a recovering forest from hurricane disturbance. Again, many of the same tree species from more mature lowland rain forest communities occur within the *Rhus taitensis* forests, but were of lower stature and generally lower abundance than *Rhus taitensis*. A major driving force in forest composition appears to be the amount of time since the last hurricane disturbance.

The *Syzygium samoense - Weinmannia affinis* Forest is the only community sampled which represents forests of the upper montane elevations ranging from 108-296 m (353-972 ft). Upper montane forests are heavily laden with epiphytes which help define this community.

The iconic swaying coconut palm tree woodland along the beach and rocky shores is a very open and patchy type of vegetation. The individual trees can be quite tall, but rarely do they form a true upper canopy in the forested sense and are thus included as Scrub & Herb Coastal Vegetation Macrogroup of the USNVC, rather than a Lowland Rainforest type. These scattered tall trees with coastal scrub subcanopy are represented in the *Cocos nucifera* Forest community type.

Two samples had trees covered in non-native and native vines, to the point where one could not see the trees, and the trees were of short stature due to hurricane damage. These two samples represent the *Merremia peltata - Mikania micrantha* Semi-natural Vine Scrub. This type appears to match Whistler's "Successional Vegetation" type. Semi-natural refers to the fact that *Mikania micrantha* is not indigenous to American Samoa.

Of Whistler's major 8 vegetation types (2009), three native types were not sampled (Summit Scrub, Montane Scrub, and Littoral Herbaceous zone (a subset of the Littoral Strand). A fourth type, Managed Vegetation, was not a target for this classification effort and therefore not sampled. The summit and montane scrub are very inaccessible types on the upper elevations of Ta'ū.

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

Seventeen vegetation associations were created for NPSA. Of these, six were represented by only one or two classification plots and/or observation points. Of those six, three were never encountered again during the mapping project and were designated as rare associations which are not found on the map. Conversely, several classes were discovered during review of the imagery or during the calibration trip, especially on Olosega which did not receive classification plots.

NPSA's forests are tropical and highly diverse with very few clear and distinct boundaries even between seemingly simple classes due to lack of visibility and high overlap in species composition. For example, a forest which is clearly dominated by *Cocos nucifera* from above, can appear to be dominated by *Hibiscus tiliaceus* by field crews when the upper canopy is difficult to view from the ground because of the density of the *Hibiscus tiliaceus*. This points to a need for perhaps a higher reliance on the imagery for species cover estimates. As Spurr (1948) states in his seminal text on photo interpretation, "Because the interpreter, working with aerial photographs can see the entire stand in literally a birds-eye view, he can generally estimate stand density ocularly more accurately than it can be done on the ground."

### **Acquire and Prepare Imagery (Step 7)**

The various satellite imagery data sets initially available for this project were impossible to accurately register to the ground to national standards because at that time it was not yet identified that there was ground control point data for American Samoa. This factor coupled with NPSA's extreme topographic relief resulted in none of the image data sets being registered accurately to the ground or to one another. It is not surprising, therefore, that there were registration issues between the classification plots, AA samples, and the draft map created from the satellite imagery. Fortunately, USGS acquired Photo Science's high resolution aerial imagery in 2012 with simultaneous surveyed ground control. The spatial accuracy of the 2012 imagery in most areas of NPSA is exceptional. However, because Photo Science was unable to establish ground control or capture LIDAR data for all of Ta'ū, there is still no adequate ground control and only a coarse DEM for the center of Ta'ū and Mt. Lata. As a result, the positional accuracy of the final map may have errors, especially near the cliffs of Mt. Lata. Additionally, the misregistration of earlier maps made from the satellite imagery means that any map to map comparisons between the NPSA map and earlier NOAA or USDA maps will be problematic (i.e., cannot compare vegetation classifications), especially in areas of high relief.

All of the imagery data sets are mosaics of mostly cloud free imagery captured over multiple dates. While cloud free in most areas of NPSA, mosaic lines and sun angle shifts are apparent (especially in the aerial imagery) within the mosaicked products and clouds obscure some of the portions of Mt. Lata.

### **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, but not cost effective for a park of NPSA's size where few economies of scale are realized. The final map is the product of segmentation, CART modeling and a thorough review of the entire park using the 2012 Quantum Spatial/USGS aerial imagery. Future projects should probably rely on manual interpretations for a small park such as NPSA.

Additionally, the factors which lead to difficulty in the classification of several of NPSA's associations also translated into those associations being undistinguishable using the imagery or GIS data. For example, while *Myristica inutilis* may be an important indicator species for separating several associations, it cannot be used to distinguish map classes from one another because it grows primarily beneath the canopy of other forest trees.

### **Accuracy Assessment (Step 11)**

Accuracy assessment of NPSA's draft map was particularly challenging because of the registration issues in the original imagery. Because of NPSA's extreme relief, vegetation classes can change radically across small areas. As a result, small spatial inaccuracies can result in confusion between map and reference labels which is caused by registration issues and not by map error. Additionally, in the U.S. Pacific Islands, the only publicly available network of radio towers transmitting real-time differential correction information is the U.S. Coast Guard (USCG)-operated Maritime Differential GPS (DGPS) Service. This system consists of a network of beacons set up in coastal areas to provide real-time information. Unfortunately, there are currently no DGPS network beacons providing real-time differential correction in American Samoa. Since 2003, the EGNOS (European Geostationary Navigation Overlay Service) or ESTB (Egnos System Test Bed) signal has been transmitted in WAAS (Wide Area Augmentation System) compatible data format [SBAS (Satellite Based Augmentation System) mode 0/2] enabling Garmin receivers to use these data, but this signal does not reach Guam or Saipan and most likely not American Samoa. Further, the geographical reference, NAD83PA11 (North American Datum 83 Pacific plate), should be used to define coordinates in Hawaii, American Samoa, the Marshall Islands and other US territories on the Pacific plate. As NAD83 is the official NPS datum, the NPS PACN has since adopted geographical reference NAD83PA11 for all PACN parks in Hawaii and American Samoa. The combination of imagery registration issues and lack of real-time differential correction services in American Samoa compounded spatial inaccuracies during accuracy assessment. 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 *Dysoxylum* spp. - *Rhus* - *Alphitonia* - (*Myristica*, *Canarium* spp.) Forest and *Hibiscus tiliaceus* Forest classes, but rarely between the coastal forest types. The error matrix also shows the number of accuracy samples collected per map class. Producer's and user's 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 NPSA were inaccessible for all vegetation inventory field efforts (i.e. classification plots, calibration, validation, and AA samples). Some of these areas were viewed through binoculars from trails and overlooks during the calibration and validation trips to determine their vegetation classes. Other areas, were completely inaccessible and were mapped based solely on image interpretation, GIS modeling, and NPSA 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 Liu Bench 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 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.



## Literature Cited

- American Samoa. 2105. American Samoa Geography. <http://amsamoa.net/geography>. (Accessed Jan 2015)
- Amerson, A., W.A. Whistler, T.D. Schwaner Environmental Consultants. 1982. Wildlife and Wildlife Habitat of American Samoa. II. Accounts of Flora and Fauna. USDI Fish and Wildlife Service. Washington DC. 150pp.
- Breiman, L., J.H. Friedman, R.A. Olsen, and C.J. Stone. 1984. Classification and Regression Trees. Chapman & Hall. International Thomson Publishing. 358pp.
- Cogan, D. 2007. Vegetation Classification and Mapping Recommendations. Pacific Island Inventory and Monitoring Network. Pacific Island Inventory and Monitoring Network. Unpublished Report. 76 pp. 172 pp.
- Cogan, D., and G. Kudray. 2009. Vegetation Classification and Inventory Work Plan. Pacific Island Inventory and Monitoring Network. Pacific Island Inventory and Monitoring Network Unpublished Report.
- Cole, T.G., N. McDAy, C. Whitesell, A. Ambacker, and W. Whistler. 1988. Vegetation Survey and Forest Inventory, American Samoa. USDA Forest Service Resource Bulletin PSW-25. 14pp.
- Congalton, R., and K. Green. 2009. Assessing the Accuracy of Remotely Sensed Data – Principles and Practices. 2009. CRC Press. Taylor and Francis Group. 183pp.
- Grossman, D.H., D. Faber-Langendoen, A.S. Weakley, M. Anderson, P.S. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International Classification of Ecological Communities: terrestrial Vegetation of the United States. Volume I. The national vegetation classification system: development, status, and applications. The Nature Conservancy, Arlington, Virginia, USA.
- Jennings, M.D., Faber-Langendoen, D., Loucks, O.L., Peet, R.K., Roberts, D. 2009. Standards for associations and alliances of the U.S. National Vegetation Classification. Ecological Monographs, 79(2): 173-199.
- Lui, Z. and L. Fischer. 2007. American Samoa vegetation Mapping Using Very High Spatial Resolution Imagery. USDA Forest Service. Pacific Southwest Region.
- Liu, Z., N.E. Gurr, M.A. Schmaedick, W.A. Whistler, and L. Fischer. 2011. Vegetation Mapping of American Samoa. USDA Forest Service. American Samoa Community College. R5-TP-033. October, 2011. 19pp.
- McCune, B. and M. J. Mefford. 2011. PC-ORD. Multivariate Analysis of Ecological Data. Version 6.0. MjM Software, Gleneden Beach, Oregon, U.S.A.

- Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, New York, New York, USA.
- NASA. 2015. Measuring Vegetation.  
<http://earthobservatory.nasa.gov/Features/MeasuringVegetation/>. Accessed Feb. 2015
- National Oceanic and Atmospheric Administration. 2015. 2003 American Samoa Tutuila High Res Land Cover. 2003-2010 American Samoa Tutuila High Res Land Cover Change. 2004 American Samoa East Manua High Res Land Cover. 2004 American Samoa West Manua High Res Land Cover. 2004-2010 American Samoa East Manua High Res Land Cover Change. 2004-2010 American Samoa West Manua High Res Land Cover Change. Available at  
<http://coast.noaa.gov/digitalcoast/dataregistry/#/> (accessed Jan. 2015)
- National Parks Conservation Organization. 2015. National Park of American Samoa.  
<http://www.npca.org/exploring-our-parks/travel-with-npca/samoa.html> (accessed Jan. 2015)  
[http://usparks.about.com/od/thepacificsouthwest/tp/park\\_list.--3B.htm](http://usparks.about.com/od/thepacificsouthwest/tp/park_list.--3B.htm)
- National Park Service. 1965. A Park Program for American Samoa Proposed by American Samoa Study Team. National Park Service. US Department of the Interior.
- National Park Service. 1994. Final Draft Accuracy Assessment Procedures. USGS/NPS Vegetation Mapping Program. esri, Redlands, CA; National Center for Geographic Information and Analysis, Santa Barbara, CA; The Nature Conservancy, Arlington Virginia.
- National Park Service. 2011. PLOTS version 3.2 (MS Access 2007 version) User's Manual. Colorado Natural Heritage Program for National Park Service. 53pp. Available at:  
<http://science.nature.nps.gov/im/inventory/veg/plots.cfm> (accessed April 2015).
- National Park Service. 2013a. IM Program Brief. Available at:  
[http://science.nature.nps.gov/im/assets/docs/IM\\_Program\\_Brief.pdf](http://science.nature.nps.gov/im/assets/docs/IM_Program_Brief.pdf) (accessed July 2013).
- National Park Service. 2013b. 12-Step Guidance for NPS Vegetation Inventories. Available at:  
[http://science.nature.nps.gov/im/inventory/veg/docs/Veg\\_Inv\\_12step\\_Guidance\\_v1.1.pdf](http://science.nature.nps.gov/im/inventory/veg/docs/Veg_Inv_12step_Guidance_v1.1.pdf) (accessed July 2013).
- National Park Service. 2013c. Inventory Brief: Vegetation Inventory. Available at:  
<http://science.nature.nps.gov/im/inventory/FactSheets/InventoryFactSheets.pdf>. (accessed July 2013).
- National Park Service. 2013d. Focus on Pacific Island National Parks. Available at:  
<http://science.nature.nps.gov/im/units/pacn/parks/index.cfm#map> (accessed July 2013).
- National Park Service. 2015. Personal communication with James Bacon, Jan.
- Spurr, S. 1948. Photogrammetry and Photo-Interpretation. The Ronald Press Company. New York. New York. 472pp

- Tart, D.; Williams, C.; DiBenedetto, J.; Crowe, E.; Girard, M.; Gordon, H.; Sleavin, K.; Manning, M.; Haglund, J.; Short, B.; and Wheeler, D. 2005. Section 2: Existing Vegetation Classification Protocol. In: Brohman, R; Bryant, L. eds. Existing Vegetation Classification and Mapping Technical Guide. Gen. Tech. Rep. WO-67. Washington, DC. U.S. Department of Agriculture Forest Service, Ecosystem Management Coordination Staff.
- The Nature Conservancy and ESRI. 1994a. NBS/NPS Vegetation Mapping Program: Standardized National Vegetation Classification System. Arlington, VA.
- The Nature Conservancy and ESRI. 1994b. Field Methods for Vegetation Mapping. USGS/NPS Vegetation Mapping Program. United States Department of the Interior: United States Geologic Survey and National Park Service. Available at:  
<http://www1.usgs.gov/vip/standards/fieldmethodsrrpt.pdf>
- Trimble. 2013. eCognition. Available at: <http://www.ecognition.com/>. (accessed December 2013).
- Whistler, W.A. 1976. Wetlands of American Samoa. U.S. Army Corps of Engineers. Honolulu, Hawaii. 74pp.
- Whistler, W.A. 1980. The Vegetation of Eastern Samoa. Allertonia. Vol 2, No. 2. 190pp.
- Whistler, W.A. 1992. Vegetation of Samoa and Tonga. Pacific Science. Vol. 46. No. 2: 159-178.
- Whistler, W.A. 1994. Botanical Inventory of the Proposed Tutuila and Ofu Units of the National Park of American Samoa. Technical Report 87. Department of Botany, University of Hawai'i at Manoa. Honolulu, Hawaii. 142pp.
- Whistler, W.A. 2002. The Samoan Rainforest. A Guide to the Vegetation of the Samoan Archipelago. Isle Botanica. Honolulu, Hawaii. 168pp.
- Whistler, W.A. 2004. Rainforest Trees of Samoa. Isle Botanica. Honolulu, Hawaii. 210pp
- Whistler, W. A. 2009. Vegetation Classification Support for the National Park of American Samoa (NPSA) in American Samoa. University of Hawaii, Manoa. 22pp.
- Whistler, W.A. 2013. Personal communication.
- Woodcock, C.E. and Strahler, A.H. 1987. The factor of scale in remote sensing. Remote Sensing of the Environment. 21, 311-32.



## 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 _____                                                                                                                                                                       |                                |                                        |         |              |                      |
| <b>Datum:</b> WGS 84 <i>NAD 83</i> Other _____ <b>Field X/UTME</b> _____ <b>Field Y/UTM N</b> _____<br><b>GPS UNIT:</b> Garmin 76 Garmin 60CSx Other: _____ <b>Error: +/-</b> _____ m |                                |                                        |         |              |                      |
| GPS Comments: _____                                                                                                                                                                   |                                |                                        |         |              |                      |
| Directions to Plot:                                                                                                                                                                   |                                |                                        |         |              |                      |
| Circ. Plot (100 m <sup>2</sup> , 400 m <sup>2</sup> , 1000m <sup>2</sup> )                                                                                                            | 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                             |                                |                                        |         |              |                      |
| <b>Plot representativeness</b> (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   Interfluvium                                                                                                |                              |                                                                                                                  |              |
| <b>Landform:</b> Alluvial Fan, Colluvium, Rockpile, Drainage Channel, Valley Bottom Fill, Side Slope, Interfluvium, Intermittent Stream, Ridge, Terrace, Butte, Cliff, Talus, Sand Dune, Plateau, Beach, Recent Lava Flow, Other: _____ |                              | <b>Geology:</b> 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%)<br><div style="display: flex; flex-wrap: wrap;"> <div style="width: 33%;"><input type="checkbox"/> Bare soil (&lt;0.1 mm)</div> <div style="width: 33%;"><input type="checkbox"/> Litter/Duff (dead plant material &lt;3 cm diameter)</div> <div style="width: 33%;"><input type="checkbox"/> Lichen (ground)</div> <div style="width: 33%;"><input type="checkbox"/> Sand (0.1-2 mm)</div> <div style="width: 33%;"><input type="checkbox"/> Coarse woody debris (dead wood 3-10 cm)</div> <div style="width: 33%;"><input type="checkbox"/> Moss (ground)</div> <div style="width: 33%;"><input type="checkbox"/> Gravel (2 mm - 6.4 cm)</div> <div style="width: 33%;"><input type="checkbox"/> Woody debris structure (dead &gt;10 cm deep &amp; wide)</div> <div style="width: 33%;"><input type="checkbox"/> Microbiotic soil crust</div> <div style="width: 33%;"><input type="checkbox"/> Rock (&gt; 6.4 cm)</div> <div style="width: 33%;"><input type="checkbox"/> Live veg (litter / wood)</div> <div style="width: 33%;"><input type="checkbox"/> Water</div> <div style="width: 33%;"><input type="checkbox"/> Bedrock (solid surface)</div> <div style="width: 33%;"><input type="checkbox"/> Other: _____</div> </div> |  |                                                                                                                                                                                                                                                                                                                                          |
| Soil Texture (optional - see soil key): modify to fewer classes<br><input type="checkbox"/> sand <input type="checkbox"/> loam <input type="checkbox"/> silt <input type="checkbox"/> clay <input type="checkbox"/> peat <input type="checkbox"/> muck                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                          |
| Surface Water w/in 25m? YES/NO   Seep, Spring, Stream, Pothole, River, <del>Archaeological</del> Pond, Ocean, Estuary                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  | Soil Moisture: dry   moist   saturated   standing water                                                                                                                                                                                                                                                                                  |
| Animal Use Evidence:<br><div style="display: flex; flex-wrap: wrap;"> <div style="width: 33%;"><input type="checkbox"/> Burrows</div> <div style="width: 33%;"><input type="checkbox"/> Animal / Game Trails</div> <div style="width: 33%;"><input type="checkbox"/> Animal Sighting</div> <div style="width: 33%;"><input type="checkbox"/> Scat (Whose? _____)</div> <div style="width: 33%;"><input type="checkbox"/> Vegetation Damage (animal)</div> <div style="width: 33%;"><input type="checkbox"/> Other: _____</div> <div style="width: 33%;"><input type="checkbox"/> Browsing Evidence</div> <div style="width: 33%;"><input type="checkbox"/> Bedding Sites</div> <div style="width: 33%;"><input type="checkbox"/> Grazing Evidence</div> <div style="width: 33%;"><input type="checkbox"/> Nests (Whose? _____)</div> </div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |                                                                                                                                                                                                                                                                                                                                          |
| Anthropogenic Disturbances:<br><div style="display: flex; flex-wrap: wrap;"> <div style="width: 33%;"><input type="checkbox"/> Campsite Evidence</div> <div style="width: 33%;"><input type="checkbox"/> Vegetation Damage (human)</div> <div style="width: 33%;"><input type="checkbox"/> Trails</div> <div style="width: 33%;"><input type="checkbox"/> ORV Evidence</div> <div style="width: 33%;"><input type="checkbox"/> Rock Cairns</div> <div style="width: 33%;"><input type="checkbox"/> Historic Feature</div> <div style="width: 33%;"><input type="checkbox"/> Archaeological Feature</div> <div style="width: 33%;"><input type="checkbox"/> Other: _____</div> </div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  | Natural disturbances:<br><input type="checkbox"/> Drought (tree & shrub die-back)<br><input type="checkbox"/> Fire<br><input type="checkbox"/> Flood<br><input type="checkbox"/> Mass Wasting<br><input type="checkbox"/> Water gullies<br><input type="checkbox"/> Vegetation Damage (natural)<br><input type="checkbox"/> 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)<br><input type="checkbox"/> Broad-leaved<br><input type="checkbox"/> Needle-leaved<br><input type="checkbox"/> Microphyllous<br><input type="checkbox"/> Graminoid<br><input type="checkbox"/> Forb<br><input type="checkbox"/> Pteridophyte<br><input type="checkbox"/> Non-vascular<br><input type="checkbox"/> Mixed (describe) | Physiognomic Class (see cheat sheet)<br><input type="checkbox"/> Forest<br><input type="checkbox"/> Woodland<br><input type="checkbox"/> Shrubland<br><input type="checkbox"/> Wooded Shrubland<br><input type="checkbox"/> Dwarf Shrubland<br><input type="checkbox"/> Shrub Herbaceous<br><input type="checkbox"/> Wooded Herbaceous<br><input type="checkbox"/> Herbaceous<br><input type="checkbox"/> Nonvascular<br><input type="checkbox"/> Sparsely Vegetated |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## Plot Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Provisional Community Name:

**Species/Strata:** 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<br>Class                         | %<br>Cover         | Spec<br>✓         |  | State / Species Scientific Name           |                    | Cover<br>Class        | %<br>Cover        | Spec<br>✓    |  |  |
| <b>Whole Plot:</b>                                                                                                                                                                                                                                                           |                  | <b>Total Vegetation Cover ____ (%)</b> |                    |                   |  | <b>Maximum Vegetation Height ____ (m)</b> |                    |                       |                   |              |  |  |
| <b>T1</b>                                                                                                                                                                                                                                                                    | <b>EMERGENT</b>  |                                        | Strata Height ____ | Strata Cover ____ |  | <b>Hr HERBACEOUS</b>                      |                    | Sum of H1, H2, H3, H4 | Strata Height     | Strata Cover |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  | <b>H1 GRAMINOIDS</b>                      |                    | Strata Height ____    | Strata Cover ____ |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
| <b>T2</b>                                                                                                                                                                                                                                                                    | <b>CANOPY</b>    |                                        | Strata Height ____ | Strata Cover ____ |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
| <b>T3</b>                                                                                                                                                                                                                                                                    | <b>SUBCANOPY</b> |                                        | Strata Height ____ | Strata Cover ____ |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  | <b>H2 FORBS</b>                           | Strata Height ____ | Strata Cover ____     |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
| <b>S1 TALL SHRUB (&gt;2m)</b>                                                                                                                                                                                                                                                |                  | Strata Height                          | Strata Cover       |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
| <b>S2 SHORT SHRUB (&lt;2m)</b>                                                                                                                                                                                                                                               |                  | Strata Height                          | Strata Cover       |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  | <b>H3 FERNS &amp; ALLIES</b>              | Strata Height      | Strata Cover          |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  | <b>H4 TREE SEEDLINGS</b>                  | Strata Height      | Strata Cover          |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
| <b>S3 DWARF SHRUB (&lt;0.5m)</b>                                                                                                                                                                                                                                             |                  | Strata Height                          | Strata Cover       |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  | <b>N NON-VASCULAR</b>                     | Strata Height      | Strata Cover          |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
|                                                                                                                                                                                                                                                                              |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
| <b>Cover Scale for Species</b><br>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%<br>P = 1-5%    1b = 10.01 ->15%    3 = 25.01 ->35%    5 = 45.01 ->55%    7 = 65.01 ->75%    9 = 85.01 ->95% |                  |                                        |                    |                   |  |                                           |                    |                       |                   |              |  |  |
| <b>Height Scale for Strata</b><br>01 = <0.5 m    03 = 1.01 ->2 m    05 = 5.01 ->10 m    07 = 15.01 ->20 m    09 = 35.01 ->50 m<br>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 National Park of American Samoa

At least two hundred and eighteen plant species were encountered while sampling field plots, observation points, and accuracy assessment plots. An additional twelve 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), and Whistler (2004) for flowering plants and Palmer (2003) for ferns and Wagner et al. (2012) updates for all. Common names listed were selected primarily from Whistler (2004), Wagner et al. (1999), and Palmer (2003) by PACN and used throughout the document.

| Family        | Scientific Name                                                                                                 | Common Name          | Origin     |
|---------------|-----------------------------------------------------------------------------------------------------------------|----------------------|------------|
| Acanthaceae   | <i>Ruellia prostrata</i> Poir.                                                                                  | vaouli               | Non-Native |
| Amaranthaceae | <i>Achyranthes aspera</i> L.                                                                                    | tamatama             | Non-Native |
| Anacardiaceae | <i>Buchanania merrillii</i> Christoph.                                                                          | gasu                 | Native     |
| Anacardiaceae | <i>Mangifera indica</i> L.                                                                                      | mago                 | Non-Native |
| Anacardiaceae | <i>Rhus taitensis</i> Guill.                                                                                    | tavai                | Native     |
| Anacardiaceae | <i>Spondias dulcis</i> Parkinson<br><i>Cananga odorata</i> (Lam.) Hook. f. & T. Thomson                         | vī                   | Non-Native |
| Annonaceae    | <i>Centella asiatica</i> (L.) Urb.                                                                              | moso'oi              | Non-Native |
| Apiaceae      | <i>Centella asiatica</i> (L.) Urb.                                                                              | togo                 | Non-Native |
| Apocynaceae   | <i>Allamanda cathartica</i> L.                                                                                  | pua Ta'ūnofo         | Non-Native |
| Apocynaceae   | <i>Alstonia pacifica</i> (Seem.) A.C. Smith                                                                     | Alstonia pacifica    | Native     |
| Apocynaceae   | <i>Alyxia bracteolosa</i> Rich. ex A. Gray<br><i>Alyxia stellata</i> (J. R. Forst. & G. Forst.) Roem. & Schult. | lau maile            | Native     |
| Apocynaceae   | <i>Cerbera manghas</i> L.                                                                                       | maile                | Native     |
| Apocynaceae   | <i>Hoya australis</i> R. Br. ex J. Traill                                                                       | leva                 | Native     |
| Apocynaceae   | <i>Hoya pottsii</i> Traill                                                                                      | lau māfiafia         | Native     |
| Apocynaceae   | <i>Plumeria obtusa</i> L.                                                                                       | fue selela           | Native     |
| Araceae       | <i>Alocasia macrorrhizos</i> (L.) G. Don                                                                        | white plumeria       | Non-Native |
| Araceae       | <i>Epipremnum pinnatum</i> (L.) Engl.                                                                           | ta'amu               | Non-Native |
| Araceae       | <i>Philodendron</i> spp.<br><i>Meryta macrophylla</i> (Rich. ex A. Gray) Seem.                                  | fue laufao           | Native     |
| Araliaceae    | <i>Polyscias lanutoensis</i> (Hochr.) Lowry & G. M. Plunkett                                                    | philodendron         | Non-native |
| Araliaceae    | <i>Polyscias lanutoensis</i> (Hochr.) Lowry & G. M. Plunkett                                                    | fagufagu             | Native     |
| Araliaceae    | <i>Polyscias reineckeii</i> Harms                                                                               | vī vao               | Native     |
| Araliaceae    | <i>Polyscias samoensis</i> (A. Gray) Harms                                                                      | tagitagi vao         | Native     |
| Araliaceae    | <i>Polyscias</i> spp.                                                                                           | tagitagi vao         | Native     |
| Arecaceae     | <i>Cocos nucifera</i> L.                                                                                        | vī vao               | Native     |
| Asparagaceae  | <i>Cordyline fruticosa</i> (L.) A. Chev                                                                         | niu                  | Native     |
| Aspleniaceae  | <i>Asplenium horridum</i> Kaulf.                                                                                | lauti                | Non-Native |
| Aspleniaceae  | <i>Asplenium multifidum</i> Brack.                                                                              | 'iwa                 | Native     |
| Aspleniaceae  | <i>Asplenium multifidum</i> Brack.                                                                              | Asplenium multifidum | Native     |

| Family          | Scientific Name                                                                | Common Name              | Origin     |
|-----------------|--------------------------------------------------------------------------------|--------------------------|------------|
| Aspleniaceae    | <i>Asplenium nidus</i> L.                                                      | laugapapa                | Native     |
| Asteraceae      | <i>Bidens alba</i> (L.) DC.                                                    | Bidens alba              | Non-Native |
| Asteraceae      | <i>Mikania micrantha</i> Kunth                                                 | fue saina                | Non-Native |
| Asteraceae      | <i>Wedelia biflora</i> (L.) DC.                                                | ateate                   | Native     |
| Blechnaceae     | <i>Blechnum orientale</i> L.                                                   | Blechnum orientale       | Non-Native |
| Blechnaceae     | <i>Blechnum vulcanicum</i> (Blume) Kuhn                                        | Blechnum vulcanicum      | Native     |
| Boraginaceae    | <i>Tournefortia argentea</i> L. f.                                             | Ta'ūsuni                 | Native     |
| Burseraceae     | <i>Canarium mafoa</i> Christoph.                                               | mafoa                    | Native     |
| Burseraceae     | <i>Canarium vitiense</i> A. Gray                                               | ma'ali                   | Native     |
| Burseraceae     | <i>Garuga floribunda</i> Decne.                                                | vī vao                   | Native     |
| Caricaceae      | <i>Carica papaya</i> L.                                                        | esi                      | Non-Native |
| Clusiaceae      | <i>Calophyllum inophyllum</i> L.                                               | feTa'ū                   | Native     |
| Clusiaceae      | <i>Calophyllum neo-ebudicum</i> Guillaumin                                     | tamanu                   | Native     |
| Clusiaceae      | <i>Garcinia myrtifolia</i> A.C. Smith                                          | Garcinia myrtifolia      | Native     |
| Combretaceae    | <i>Terminalia catappa</i> L.                                                   | talie                    | Non-Native |
| Combretaceae    | <i>Terminalia richii</i> A. Gray                                               | malili                   | Native     |
| Combretaceae    | <i>Terminalia samoensis</i> Richinger                                          | talie                    | Native     |
| Convolvulaceae  | <i>Ipomoea littoralis</i> Blume                                                | palulu                   | Native     |
| Convolvulaceae  | <i>Ipomoea pes-caprae</i> (L.) R. Br.                                          | fue asaga                | Native     |
| Convolvulaceae  | <i>Ipomoea</i> spp.                                                            | morning glory            | Non-Native |
| Convolvulaceae  | <i>Merremia peltata</i> (L.) Merr.                                             | fue lautetele            | Native     |
| Cunoniaceae     | <i>Weinmannia affinis</i> A. Gray                                              | Weinmannia affinis       | Native     |
| Cyatheaceae     | <i>Cyathea lunulata</i> (Forst. f.) Copel.                                     | olioli                   | Native     |
| Cyatheaceae     | <i>Cyathea</i> spp.                                                            | olioli                   | Native     |
| Cyperaceae      | <i>Cyperus cyperoides</i> (L.) Kuntze                                          | Pacific Island flatsedge | Native     |
| Cyperaceae      | <i>Cyperus javanicus</i> Houtt.                                                | 'ahu'awa                 | Native     |
| Cyperaceae      | <i>Cyperus polystachyos</i> Rottb.                                             | Cyperus polystachyos     | Native     |
| Cyperaceae      | <i>Cyperus</i> spp. L.                                                         | umbrella sedge           | Non-Native |
| Cyperaceae      | <i>Cyperus stoloniferus</i>                                                    |                          | Native     |
| Cyperaceae      | <i>Fimbristylis dichotoma</i> (L.) Vahl                                        | Fimbristylis dichotoma   | Native     |
| Cyperaceae      | <i>Kyllinga nemoralis</i> (J. R. Forst. & G. Forst.) Dandy ex Hutch. & Dalziel | whitehead spikesedge     | Non-Native |
| Cyperaceae      | <i>Mapania macrocephala</i> K. Schum. ex Warb                                  | Mapania macrocephala     | Native     |
| Cyperaceae      | <i>Scleria polycarpa</i> Boeck.                                                | selesele                 | Native     |
| Davalliaaceae   | <i>Davallia epiphylla</i> (Forst. f.) Spreng.                                  | Davallia epiphylla       | Native     |
| Davalliaaceae   | <i>Davallia solida</i> (Forster f.) Swartz                                     | laugasese                | Native     |
| Davalliaaceae   | <i>Davallia</i> spp.                                                           | Davallia spp.            | Unknown    |
| Dioscoreaceae   | <i>Dioscorea bulbifera</i> L.                                                  | ufi                      | Non-Native |
| Dioscoreaceae   | <i>Tacca leontopetaloides</i> (L.) Kuntze                                      | masoa                    | Native     |
| Dryopteridaceae | <i>Lomagramma cordipinna</i> Holttum                                           | Lomagramma cordipinna    | Native     |
| Dryopteridaceae | <i>Oleandra neriiformis</i> Cav.                                               | Oleandra neriiformis     | Native     |

| Family           | Scientific Name                                                                                           | Common Name                                         | Origin     |
|------------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------|------------|
| Ebenaceae        | <i>Diospyros samoensis</i> A. Gray                                                                        | 'au'auli                                            | Native     |
| Elaeocarpaceae   | <i>Elaeocarpus floridanus</i> Hemsley                                                                     | 'a'amati'e                                          | Native     |
| Elaeocarpaceae   | <i>Elaeocarpus ulianus</i> Christoph.<br><i>Aleurites moluccana</i> (L.) Willd. Var. katoi                | 'a'amati'e                                          | Native     |
| Euphorbiaceae    | O. Deg., I. Deeg. & B. C. Stone                                                                           | kukui                                               | Non-Native |
| Euphorbiaceae    | <i>Baccaurea taitensis</i> Muell. Arg.                                                                    | saitamu                                             | Native     |
| Euphorbiaceae    | <i>Codiaeum variegatum</i> (L.) Juss.                                                                     | garden croton                                       | Non-Native |
| Euphorbiaceae    | <i>Glochidion cuspidatum</i> Pax                                                                          | masame vao                                          | Native     |
| Euphorbiaceae    | <i>Glochidion ramiflorum</i> Forst. f.                                                                    | masame                                              | Native     |
| Euphorbiaceae    | <i>Macaranga harveyana</i> Muell. Arg.                                                                    | lau papata                                          | Native     |
| Euphorbiaceae    | <i>Macaranga stipulosa</i> Muell. Arg.                                                                    | lau fatu                                            | Native     |
| Fabaceae         | <i>Adenanthera pavonina</i> L.                                                                            | lopa                                                | Non-Native |
| Fabaceae         | <i>Canavalia cathartica</i> Thouars                                                                       | maunaloa                                            | Native     |
| Fabaceae         | <i>Canavalia rosea</i> (Sw.) BC.                                                                          | fue fai va'a                                        | Native     |
| Fabaceae         | <i>Dendrolobium umbellatum</i>                                                                            | lala                                                | Native     |
| Fabaceae         | <i>Derris trifoliata</i> Lour.                                                                            | fue o'ona                                           | Native     |
| Fabaceae         | <i>Desmodium triflorum</i> (L.) DC.                                                                       | Desmodium triflorum                                 | Non-Native |
| Fabaceae         | <i>Erythrina</i> spp.                                                                                     | gatae                                               | Unknown    |
| Fabaceae         | <i>Erythrina subumbrans</i> (Hassk.) Merr.<br><i>Falcataria moluccana</i> (Miq.) Barneby & Grimes         | gatae pālagi                                        | Non-Native |
| Fabaceae         | <i>Inocarpus fagifer</i> (Parkinson) Fosb.                                                                | tamaligi                                            | Non-Native |
| Fabaceae         | <i>Intsia bijuga</i> (Colebr.) Kuntze                                                                     | ifi                                                 | Non-Native |
| Fabaceae         | <i>Intsia bijuga</i> (Colebr.) Kuntze                                                                     | ifilele                                             | Native     |
| Fabaceae         | <i>Leucaena leucocephala</i> (Lam.) de Wit                                                                | koa haole                                           | Non-Native |
| Fabaceae         | <i>Mucuna gigantea</i> (Willd.) DC.                                                                       | fue inu                                             | Native     |
| Fabaceae         | <i>Sophora tomentosa</i> L.                                                                               | lalatai                                             | Native     |
| Fabaceae         | <i>Vigna adenantha</i> (G. Mey.) Maréchal,<br>Mascherpa & Stainier                                        | Vigna adenantha                                     | Native     |
| Fabaceae         | <i>Vigna marina</i> (Burm.) Merr.                                                                         | fue sina                                            | Native     |
| Flacourtiaceae   | <i>Casearia samoense</i> Whistler, sp. nova<br><i>Erythrospermum acuminatissimum</i> (A. Gray) A.C. Smith | Casearia samoense<br>Erythrospermum acuminatissimum | Native     |
| Flacourtiaceae   | <i>Flacourtia rukam</i> Zoll. & Moritzi ex Moritzi                                                        | filimoto                                            | Native     |
| Gentianaceae     | <i>Fagraea berteriana</i> A. Gray ex Benth.                                                               | pua lulu                                            | Native     |
| Gesneriaceae     | <i>Cyrtandra samoensis</i> A. Gray                                                                        | momolea                                             | Native     |
| Gesneriaceae     | <i>Cyrtandra</i> spp.                                                                                     | ha'iwale                                            | Native     |
| Gleicheniaceae   | <i>Dicranopteris linearis</i> (Burm. f.) Underw.                                                          | asaua                                               | Native     |
| Goodeniaceae     | <i>Scaevola taccada</i> (Gaertn.) Roxb.                                                                   | to'ito'i                                            | Native     |
| Heliconiaceae    | <i>Heliconia laurfao</i> Kress                                                                            | laurfao                                             | Native     |
| Hernandiaceae    | <i>Hernandia moerenhoutiana</i> Guillemain                                                                | pipi                                                | Native     |
| Hernandiaceae    | <i>Hernandia nymphaeifolia</i> (Presl) Kub.                                                               | pu'a                                                | Native     |
| Hymenophyllaceae | <i>Trichomanes boryanum</i> Kuntze.                                                                       | Trichomanes boryanum                                | Native     |
| Hymenophyllaceae | <i>Trichomanes intermedium</i> van den Bosch                                                              | Trichomanes intermedium                             | Native     |

| Family           | Scientific Name                                                                                     | Common Name             | Origin     |
|------------------|-----------------------------------------------------------------------------------------------------|-------------------------|------------|
| Icacinaceae      | <i>Citronella samoensis</i> (A. Gray) Howard                                                        | Citronella samoensis    | Native     |
| Lamiaceae        | <i>Clerodendrum inerme</i> (L.) Gaertn.                                                             | aloalo tai              | Native     |
| Lamiaceae        | <i>Faradaya amicorum</i> (Seem.) Seem.                                                              | mamalupe                | Native     |
| Lauraceae        | <i>Endiandra elaeocarpa</i> Gillespie                                                               | Endiandra elaeocarpa    | Non-Native |
| Lecythidaceae    | <i>Barringtonia asiatica</i> (L.) Kurz                                                              | futu                    | Native     |
| Lecythidaceae    | <i>Barringtonia samoensis</i> A. Gray                                                               | falagā                  | Native     |
| Lindsaeaceae     | <i>Lindsaea harveyi</i> Carruthers ex Seem.                                                         | Lindsaea harveyi        | Native     |
| Loganiaceae      | <i>Geniostoma rupestre</i> Forst.                                                                   | lau mafatifati          | Native     |
| Lomariopsidaceae | <i>Nephrolepis biserrata</i> (Sw.) Schott                                                           | giant sword fern        | Native     |
| Lomariopsidaceae | <i>Nephrolepis hirsutula</i> (G. Forst.) C. Presl<br>'Superba'                                      | vao tuanui              | Native     |
| Lomariopsidaceae | <i>Nephrolepis</i> spp.                                                                             |                         | Unknown    |
| Malvaceae        | <i>Hibiscus tiliaceus</i> L.                                                                        | fau                     | Native     |
| Malvaceae        | <i>Sida rhombifolia</i> L.                                                                          | mautofu                 | Non-Native |
| Malvaceae        | <i>Sterculia fanaiho</i> Setchell                                                                   | fana'io                 | Native     |
| Malvaceae        | <i>Thespesia populnea</i> (L.) Sol. ex Corrêa                                                       | milo                    | Native     |
| Malvaceae        | <i>Triumfetta procumbens</i> G. Forst.                                                              | mautofu tai             | Native     |
| Marattiaceae     | <i>Angiopteris evecta</i> (G. Forst.) Hoffm.<br><i>Astronidium pickeringii</i> (A. Gray) Christoph. | nase                    | Native     |
| Melastomataceae  | <i>Clidemia hirta</i> (L.) D. Don                                                                   | Astronidium pickeringii | Native     |
| Melastomataceae  | <i>Melastoma denticulatum</i> Labill.                                                               | Koster's curse          | Non-Native |
| Melastomataceae  |                                                                                                     | fua lole                | Native     |
| Meliaceae        | <i>Aglaia samoensis</i> A. Gray                                                                     | laga'ali                | Native     |
| Meliaceae        | <i>Dysoxylum huntii</i> Merrill                                                                     | maota mea               | Native     |
| Meliaceae        | <i>Dysoxylum maota</i> Reinecke                                                                     | maota                   | Native     |
| Meliaceae        | <i>Dysoxylum samoense</i> A. Gray<br><i>Hedycarya denticulata</i> (A. Gray) Perk. & Gilg            | mamala                  | Native     |
| Monimiaceae      |                                                                                                     | fatimatao               | Native     |
| Moraceae         | <i>Artocarpus altilis</i> (Parkinson) Fosberg                                                       | 'ulu                    | Non-Native |
| Moraceae         | <i>Ficus godeffroyi</i> Warb.                                                                       | mati                    | Native     |
| Moraceae         | <i>Ficus obliqua</i> Forst. f.                                                                      | āoa                     | Native     |
| Moraceae         | <i>Ficus prolixa</i> Forst. f.                                                                      | āoa                     | Native     |
| Moraceae         | <i>Ficus scabra</i> Forst. f.                                                                       | mati vao                | Native     |
| Moraceae         | <i>Ficus</i> spp.                                                                                   | Ficus spp.              | Unknown    |
| Moraceae         | <i>Ficus tinctoria</i> Forst. f.                                                                    | mati                    | Native     |
| Musaceae         | <i>Musa nana</i> Lour.                                                                              | fa'i pālagi             | Non-Native |
| Musaceae         | <i>Musa</i> spp.                                                                                    | mai'a                   | Non-Native |
| Myristicaceae    | <i>Myristica hypargyrea</i> A. Gray                                                                 | 'atone 'ulu             | Native     |
| Myristicaceae    | <i>Myristica inutilis</i> Rich ex A. Gray                                                           | 'atone                  | Native     |
| Myrsinaceae      | <i>Embelia vaupelii</i> Mez                                                                         | Embelia vaupelii        | Native     |
| Myrsinaceae      | <i>Rapanea myricifolia</i> (A. Gray) Mez                                                            | togo vao                | Native     |
| Myrtaceae        | <i>Metrosideros</i> sp.                                                                             | Metrosideros sp.        | Native     |
| Myrtaceae        | <i>Syzygium aqueum</i> (Burm. f.) Alston                                                            | Syzygium aqueum         | Non-native |

| Family          | Scientific Name                                                     | Common Name                | Origin     |
|-----------------|---------------------------------------------------------------------|----------------------------|------------|
| Myrtaceae       | <i>Syzygium clusiifolium</i> (A. Gray) C. Muell.                    | asi vai                    | Native     |
| Myrtaceae       | <i>Syzygium dealatum</i> (Burkill) A. C. Smith                      | asi vai                    | Native     |
| Myrtaceae       | <i>Syzygium inophylloides</i> (A. Gray) C. Muell.                   | asi                        | Native     |
| Myrtaceae       | <i>Syzygium samarangense</i> (Bi.) Merr. & Perry                    | nonu vao                   | Non-Native |
| Myrtaceae       | <i>Syzygium samoense</i> (Burkill) Whistler                         | fena vao                   | Native     |
| Nyctaginaceae   | <i>Pisonia grandis</i> R. Br.                                       | pu'a vai                   | Native     |
| Nyctaginaceae   | <i>Pisonia umbellifera</i> (G. Forst.) Seem.                        | papala                     | Native     |
| Ophioglossaceae | <i>Ophioglossum pendulum</i> ssp. <i>falcatum</i> L.                | laukahi                    | Native     |
| Orchidaceae     | <i>Bulbophyllum polypodioides</i> Schltr.                           | Bulbophyllum polypodioides | Native     |
| Orchidaceae     | <i>Calanthe hololeuca</i> Rchb. f.                                  | Calanthe hololeuca         | Native     |
| Orchidaceae     | <i>Coelogyne lycastoides</i> F. Muell. & Kraenzl                    | Coelogyne lycastoides      | Native     |
| Orchidaceae     | <i>Dendrobium biflorum</i> (G. Forst.) SW.                          | Dendrobium biflorum        | Native     |
| Orchidaceae     | <i>Dendrobium dactylodes</i> Rchb.f.                                | Dendrobium dactylodes      | Native     |
| Orchidaceae     | <i>Flickingeria comata</i> (Blume) P.F. Hunt & Summerh              | Flickingeria comata        | Native     |
| Orchidaceae     | <i>Phaius</i> spp.                                                  | Phaius spp.                | Unknown    |
| Orchidaceae     | <i>Phaius terrestris</i> (L.) Ormerod                               | Phaius terrestris          | Native     |
| Orchidaceae     | <i>Pseuderia ramosa</i> L.O. Williams                               | Pseuderia ramosa           | Native     |
| Pandanaceae     | <i>Freycinetia</i> spp.                                             | 'ie'ie                     | Native     |
| Pandanaceae     | <i>Pandanus reineckei</i> Warb.                                     | fasa                       | Native     |
| Pandanaceae     | <i>Pandanus tectorius</i> Parkinson ex Z                            | fala                       | Native     |
| Phyllanthaceae  | <i>Antidesma sphaerocarpum</i> Muell. Arg.                          | laau fai vaitusi           | Native     |
| Phyllanthaceae  | <i>Bischofia javanica</i> Blume                                     | o'a                        | Native     |
| Phyllanthaceae  | <i>Flueggea flexuosa</i> Muell. Arg.                                | poumuli                    | Non-Native |
| Piperaceae      | <i>Piper graeffei</i> Warb.                                         | fue manogi                 | Native     |
| Poaceae         | <i>Axonopus compressus</i> (Sw.) P. Beauv.                          | broadleaf carpetgrass      | Non-native |
| Poaceae         | <i>Chrysopogon aciculatus</i> (Retz.) Trin.                         | pilipili'ula               | Native     |
| Poaceae         | <i>Eriochloa procera</i> (Retz.) C. E. Hubb.                        | cupgrass                   | Non-Native |
| Poaceae         | <i>Lepturus repens</i> (G. Forster) R. Br.                          | Lepturus repens            | Native     |
| Poaceae         | <i>Miscanthus floridulus</i> (Labill.) Warburg ex Schum. & Lauterb. | swordgrass                 | 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 paniculatum</i> L.                                      | panic grass                | Non-Native |
| Poaceae         | <i>Paspalum setaceum</i> Michx.                                     | sand paspalum              | Non-Native |
| Poaceae         | <i>Paspalum vaginatum</i> Sw.                                       | seashore paspalum          | Non-Native |
| Poaceae         | <i>Schizostachyum glaucifolium</i> (Rupr.) Munro                    | 'ohe                       | Non-Native |
| Poaceae         | <i>Zoysia tenuifolia</i> Willd. ex Trin.                            | temple grass               | Non-Native |
| Polygalaceae    | <i>Polygala paniculata</i> L.                                       | milkwort                   | Non-Native |
| Polypodiaceae   | <i>Phymatosorus grossus</i> (Langsd. & Fisch.) Brownlie             | laua'e                     | Native     |
| Portulacaceae   | <i>Portulaca samoensis</i> Poelln.                                  | tamole                     | Native     |

| Family           | Scientific Name                                                  | Common Name            | Origin     |
|------------------|------------------------------------------------------------------|------------------------|------------|
| Pteridaceae      | <i>Acrostichum aureum</i> L.                                     | sa'ato                 | Native     |
| Pteridaceae      | <i>Pteris littoralis</i> Reichinger                              | Pteris littoralis      | Native     |
| Rhamnaceae       | <i>Alphitonia zizyphoides</i> (Spreng.) A. Gray                  | toi                    | Native     |
| Rhamnaceae       | <i>Colubrina asiatica</i> (L.) Brongn.                           | fisoa                  | Native     |
| Rhizophoraceae   | <i>Crossostylis biflora</i> Forst.                               | saitamu                | Native     |
|                  | <i>Cyclophyllum barbatum</i> (Forst. f.) Halle & Florence        |                        |            |
| Rubiaceae        |                                                                  | ola                    | Native     |
| Rubiaceae        | <i>Guettarda speciosa</i> L.                                     | pu'apu'u               | Native     |
| Rubiaceae        | <i>Gynochtodes epiphytica</i> (Rechinger) A.C. Smith & S. Darwin | Gynochtodes epiphytica | Native     |
| Rubiaceae        | <i>Ixora samoensis</i> A. Gray                                   | filofiloa              | Native     |
| Rubiaceae        | <i>Morinda citrifolia</i> L.                                     | nonu                   | Non-Native |
| Rubiaceae        | <i>Mussaenda raiateensis</i> J.W. Moore                          | aloalo vao             | Native     |
|                  | <i>Neonauclea forsteri</i> (Seem. Ex Havil.) Merr.               |                        |            |
| Rubiaceae        |                                                                  | afa                    | Native     |
| Rubiaceae        | <i>Psychotria forsteriana</i>                                    | Psychotria forsteriana | Native     |
| Rubiaceae        | <i>Psychotria insularum</i> A. Gray                              | matalafi               | Native     |
| Rubiaceae        | <i>Psydrax merrillii</i> (Setchell) Whistler, comb. nova         | olasina                | Native     |
| Rubiaceae        | <i>Sarcopygme pacifica</i> (Reinecke) Setchell & Christoph.      | 'u'unu                 | Native     |
|                  | <i>Citrus aurantifolia</i> (Christm.) Swingle, orth. var.        |                        |            |
| Rutaceae         |                                                                  | key lime               | Non-Native |
| Rutaceae         | <i>Melicope latifolia</i> (DC.) T. Hartley                       | so'opine               | Native     |
| Rutaceae         | <i>Melicope</i> spp.                                             | alani                  | Native     |
|                  | <i>Tarenna sambucina</i> (Forst. F.) Durand in Drake             |                        |            |
| Rutaceae         |                                                                  | ma'anunu               | Native     |
| Sapindaceae      | <i>Arytera brackenridgei</i> (A.Gray) Radlk.                     | taputo'i               | Native     |
| Sapindaceae      | <i>Elattostachys falcata</i> (A. Gray) Radlk.                    | taputo'i               | Native     |
| Sapindaceae      | <i>Pometia pinnata</i> Forst.                                    | tava                   | Native     |
| Sapotaceae       | <i>Manilkara dissecta</i> (L.f.) Dubard                          | pani                   | Native     |
| Sapotaceae       | <i>Palaquium stehlinii</i> Christoph.                            | gasu                   | Native     |
| Sapotaceae       | <i>Planchonella garberi</i> Christoph.                           | 'ala'a                 | Native     |
| Sapotaceae       | <i>Planchonella grayana</i> St. John                             | 'ala'a                 | Native     |
|                  | <i>Planchonella samoensis</i> H. J. Lam ex Christoph.            |                        |            |
| Sapotaceae       |                                                                  | māmālava               | Native     |
| Selaginellaceae  | <i>Selaginella whitmeei</i> Baker                                | Selaginella whitmeei   | Native     |
| Sterculiaceae    | <i>Kleinhovia hospita</i> L.                                     | lau fu'afu'a           | Native     |
| Tectariaceae     | <i>Tectaria dissecta</i> (G. Forst.) Lellinger                   | Tectaria dissecta      | Native     |
| Tectariaceae     | <i>Tectaria setchellii</i> Maxon                                 | Tectaria setchellii    | Native     |
| Thelypteridaceae | <i>Cyclosorus harveyi</i> (Mett.) Holttum                        | Cyclosorus harveyi     | Native     |
| Thymelaeaceae    | <i>Phaleria disperma</i> (Forst. f.) Baill.                      | sunu vao               | Native     |
| Tiliaceae        | <i>Trichospermum richii</i> (A.Gray) Seem.                       | ma'o sina              | Native     |
| Urticaceae       | <i>Pipturus argenteus</i> (G. Forst.) Wedd.                      | soga                   | Native     |
| Verbenaceae      | <i>Premna serratifolia</i> L.                                    | aloalo                 | Native     |
| Verbenaceae      | <i>Stachytarpheta urticifolia</i> (Salisb.) Sims                 | nettleleaf velvetberry | Unknown    |
| Violaceae        | <i>Melicytus samoensis</i> (Christophersen)                      | Melicytus samoensis    | Native     |

| Family        | Scientific Name                              | Common Name         | Origin     |
|---------------|----------------------------------------------|---------------------|------------|
|               | A.C. Smith                                   |                     |            |
| Woodsiaceae   | <i>Diplazium harpeodes</i> Moore             | Diplazium harpeodes | Native     |
| Zingiberaceae | <i>Alpinia purpurata</i> (Vieill.) K. Schum. | teuila              | Non-Native |
| Zingiberaceae | <i>Alpinia samoensis</i>                     | Alpinia samoensis   | Native     |
| Zingiberaceae | <i>Zingiber zerumbet</i> (L.) Sm.            | 'avapui             | Non-Native |
| Zingiberaceae | <i>Zingiberaceae</i> spp.                    | Zingiberaceae spp.  | Unknown    |

## Literature Cited

Integrated Taxonomic Information System (ITIS) on-line database, <http://www.itis.gov>. (accessed June 2010).

Palmer D. 2003. Hawaii's ferns and fern allies. University of Hawaii Press, Honolulu, Hawaii.

The Taxonomic Name Resolution Service, versions 3. Online, <http://tnrs.iplantcollaborative.org>. (accessed February 2012).

Wagner, W. L., D. R. Herbst, N. Kahn, and T. Flynn. 2012. Hawaiian vascular plant updates: A supplement to the *Manual of the flowering plants of Hawaii* and *Hawaii's ferns and fern allies*. University of Hawai'i Press and Bishop Museum Press, Honolulu. 126 pp. Available from <http://botany.si.edu/pacificislandbiodiversity/hawaiianflora>

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

Whistler, W. A. 2004. Rainforest Trees of Samoa: A guide to the common lowland and foothill forest trees of the Samoan Archipelago. Isle Botanica, Honolulu. 210 pp.

Whistler, W. A. 2002. The Samoan Rainforest: A guide to the vegetation of the Samoan archipelago. Isle Botanica, Honolulu. 168 pp.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2007. The PLANTS Database. Online, <http://plants.usda.gov>. (accessed June 2010).



# Appendix C: Vegetation Map Key

## DRAFT FIELD KEY TO THE VEGETATION TYPES OF

### National Park of American Samoa, on the islands of Tutuila, Ta'ū and Ofū.

The vegetation of National Park of American Samoa (NPSA) was characterized using field data collected in 2009 and 2010 under the National Park Service's National Vegetation Mapping Program. To assist in the accurate field identification of the 23 map classes this dichotomous key has been developed from plot data.

This key is structured to facilitate identification of vegetation types with one or a combination of “dominant species” -which are species with the greatest absolute cover, usually in the tallest (upper most) canopy layer, and “key indicator species” also called “diagnostic species”— which are species that are consistently present and have a high fidelity to one association. By upper most canopy layer we are referring to primarily the T2, the main tree canopy layer. However for shrublands then the tallest layer may be S2 and so on. In some cases, the key may also refer to the physical habitats and location within the Park. During AA, crews may be obligated to go to randomly selected points that may fall within ecotones— boundary or transition zones between vegetation types where diagnostic species intermix, and it may be difficult to determine a definitive type. Be aware that a map polygon may have small inclusions of other vegetation types.

### Special instructions for AA Crews

1. The key relies on the absolute percent cover of individual species. Stands with an “overwhelming dominance” (highest absolute cover is more than double any other species in that layer) of a single species are keyed by that dominant species. These types are keyed out first. Percent cover in parentheses in this key are from 2009/2010 plot data. These are included for guidance in comparing types. Canopy cover values are expected to vary more widely with more data/observations.

2. Where we had a mix of native and non-native species in the upper canopy we ignored the cover of non-native species [such as lopa (*Adenantha pavonina*), moso'oi (*Cananga odorata*), lau ti (*Cordyline fruticosa*), ifi (*Inocarpus fagifer*), nonu (*Morinda citrifolia*) and nonu vao (*Syzygium samarangense*)] and classified the stand based on the presence on native tree species. For example when the combined cover of several native canopy tree species is equal to or greater than the absolute cover of the most abundant non-native canopy tree [e.g., 25% lau ti (*Cordyline fruticosa*)], we keyed based on native tree cover as opposed to the non-native dominant. However when a stand is overwhelmingly dominated (more than twice the absolute cover) by non-native tree species and any forest canopy natives present are very few and far between (or not present), such that we cannot tell what the native analogue might be, the stand is classified as a “Semi-natural” type.

3. The more common situation is high tree species diversity with no clear dominance by any one or two or three species. In this context the presence of a “key indicator” or “diagnostic” species is very helpful. There are a number of closely related lowland rain forest types with many of the same species and many stands did not have a single overwhelming dominant species (more than double any other species absolute cover). We relied on tree species that occurred consistently in all stands classified as a single type and generally had high cover (referred to as the “key indicator” or “diagnostic” species). We use the term “key indicator” or “diagnostic” species because they may not have the highest absolute cover in the stand, but other species with higher cover are only higher by a few percent.

4. Percent cover in parentheses in the key are ranges of absolute cover in the 2009–2010 plot data. Percent cover for AA points may vary considerably, and as AA is a plot-less method, crews will need to imagine an area before estimating the absolute canopy coverage for each species.

5. Five plots in the 2009/2010 data were dominated by *Ficus prolixa*, however it was decided that these represent large individual trees and not plant associations. So if you encounter a large *Ficus*, try and key with the surrounding forest as part of the area, and not just the one large tree canopy.

6. If vegetation does not key, assume it is a new vegetation type and collect as much data as possible. At a minimum fill out an observation point form, ideally a full plot form if possible—so the data and field notes can be reviewed and the stand classified at a later date.

**Key to National Park of American Samoa (NPSA) Plant Associations--June 2, 2011 Updated w/ classification changes March 1, 2012**

- 1a.** Land is developed or vegetation is absent or very sparse <5% cover e.g., barren lava, rocky or sandy shoreline..... **Unvegetated Map Class**
- 1b.** Vegetation is present with sparse to dense cover ( $\geq 5\%$  total vegetation cover)..... **2**
- 2a.** Site is sparsely vegetated (5-9% total vegetation cover). Site is too sparse to be considered an open grassland, shrubland or woodland..... **Undescribed Sparse Vegetation**
- 2b.** Vegetation is present with 10% or more total vegetation cover ..... **3**
- 3a.** Vegetation is forested: dominated by tree species, usually in mature form, but may show signs of hurricane damage or occur as young trees. Canopy cover of tree species regardless of their size class (i. e. T1, T2, T3, S1, S2, H) is at least 5% ..... **4**
- 3b.** Vegetation is dominated by shrubs, tree ferns, or herbaceous species or stunted trees (not stunted from human or hurricane disturbance but from extreme environments such as rocky or sandy substrates, high elevations, etc.) ..... **22**
- 4a.** Forest is dominated in the upper canopy by futu (*Barringtonia asiatica*), or if not the most dominant (highest absolute cover) tree, it is present as a mature tree often with near equal cover of any other tree present.....**Futu Littoral Forest; *Barringtonia asiatica* Littoral Forest (F\_BAAS)**
- 4b.** Forest not as described above ..... **5**
- 5a.** Forest is dominated by pu'a vai (*Pisona grandis*, 15–40%).....  
..... **Pu'a Vai Littoral Forest; *Pisonia grandis* Littoral Forest (F\_PIGR)**
- 5b.** Forest not as described above ..... **6**
- 6a.** Forest is without futu (*Barringtonia asiatica*) as a mature tree, seedlings may be present. The tallest and most dominant species is niu (*Cocos nucifera*, 12-19% cover). If fala (*Pandanus tectorius*) is present it is a subcanopy component with usually less than 5% cover.....  
..... **Niu Forest; *Cocos nucifera* Southern Polynesian Forest (F\_CONU)**
- 6b.** Forest not as described above ..... **7**
- 7a.** Forest occurs within 150 m distance or elevation from the coast and is dominated by fala (*Pandanus tectorius*, 1–25%). Many other tree species are often present, but fala generally has about 2 x the cover of any other single species, although niu (*Cocos nucifera*) can be near equal.....  
..... **Fala Forest; *Pandanus tectorius* Littoral Forest (F\_PATE)**
- 7b.** Forest not as described above ..... **8**
- 8a.** Forest dominated by mamala (*Dysoxylum samoense*, 0-35%) or maota (*Dysoxylum maota*, 0-19%). Generally lowland forests between 16–331 m in elevation, with very diverse species composition, such that other native species may have high cover, usually with less than half that of mamala or maota. Two exceptions are falaga (*Barringtonia samoensis*) (0-58%), and *Ficus prolixa* (30%). When a large *Ficus* tree is present increase the assessment area to key the surrounding forest.....  
..... **(Mamala, Maota) Forest; *Dysoxylum (samoense, maota)* Forest (F\_DYSO)**
- 8b.** Forest not as described above ..... **9**

- 9a.** Forests dominated by asi (*Syzygium inophylloides*, 0–28%) and/or ifilele (*Intsia bijuga*, 0–55%), occurring on steep, high to mid position slopes, often but not limited to ridges. Other tree species present with high cover, but are usually never more than these two indicator species. One exception is some stands have emergent and very large individual *Ficus prolixa*. When a large *Ficus* is present increase the assessment area to key the surrounding forest. ....  
**Asi – Ifilele Forest; *Syzygium inophylloides* - *Intsia bijuga* Forest (F\_SYCA)**
- 9b.** Forest not as described above ..... **10**
- 10a.** Forests dominated by saitamu (*Crossostylis biflora*, 7–29%), occurring at upper-mid elevations (330–450 m), often heavy with epiphytes (with up to 20% cover).....  
**Saitamu Forest; *Crossostylis biflora* Forest (F\_SYCB)**
- 10b.** Forest not as described above ..... **11**
- 11a.** Forests dominated by pualulu (*Fagraea berteriana*, 24%). This community was represented by only one plot .....  
**Pualulu Forest; *Fagraea berteriana* Forest (not mapped)**
- 11b.** Forest not as described above ..... **12**
- 12a.** Forests dominated by ala'a (*Planchonella garberi*, 40%). This type was represented by only one plot .....  
**Ala'a Forest; *Planchonella garberi* Forest (F\_SYCA)**
- 12b.** Forest not as described above ..... **13**
- 13a.** Forests dominated by tava (*Pometia pinnata*, 68%). This type was represented by only one plot.....  
**Tava Forest; *Pometia pinnata* Forest (F\_POPI)**
- 13b.** Forest not as described above ..... **14**
- 14a.** Forests dominated by fena vao (*Syzygium samoense*, 0–12%) and/or Weinmannia (*Weinmannia affinis*, 0–20%), often with *Astronidium pickeringii* (0–11%), and occur above 350 m in elevation. Strong epiphytic species cover also characterizes this type with such species as *Freycinetia* spp. with up to 40% cover.....  
**Fena Vao – Weinmannia Forest; *Syzygium samoense* – *Weinmannia affinis* Forest (F\_SYCB)**
- 14b.** Forest not as described above ..... **15**
- 15a.** Forests dominated by atone (*Myristica inutilis*, 6–45%). Many native tree species are present and abundant, most often are ma'ali (*Canarium vitiense*, 0–28%) and mafoa (*Canarium mafoa*, 0–35%). Some stands have emergent and very large individual *Ficus prolixa*. When a large *Ficus* tree is present increase the assessment area to key the surrounding forest. ....  
**Atone – (ma'ali, mafoa) Forest; *Myristica inutilis*-*Canarium (vitiense, mafoa)* Forest (F\_DYRHAL)**
- 15b.** Forest not as described above ..... **16**
- 16a.** Forest dominated by fau (*Hibiscus tiliaceus*, 10–46%). Other tree species present may include *Buchanania merrillii* (0–10%), and au'auli (*Diospyros samoensis*, 0–12%), and the shrub ateate (*Wedelia biflora*, 0–40%).....  
**Fau Forest; *Hibiscus tiliaceus* Forest (F\_HITI)**
- 16b.** Forest not as described above ..... **17**
- 17a.** Forest dominated by *Metrosideros polymorpha*, (40%). This type was represented by only one plot .....  
**Metrosideros Forest; *Metrosideros* spp. Forest (F\_MESP)**
- 17b.** Forest not as described above ..... **18**

|                                                                                                                                                                                                                                                                                        |                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| 18a. Forests dominated by a combination of Tavai ( <i>Rhus taitensis</i> ) and Toi ( <i>Alphitonia zizyphoides</i> ) .....                                                                                                                                                             |                                    |
| ..... <b>Toi-Tavai Forest; <i>Alphitonia zizyphoides</i> – <i>Rhus taitensis</i> Forest (F_ALRH)</b>                                                                                                                                                                                   |                                    |
| 18b. Forest not as described above .....                                                                                                                                                                                                                                               | 19                                 |
| 19a. Forests dominated by tavai ( <i>Rhus taitensis</i> , 9-55%). Many tree species can be present, but tavai shows a clear dominance or co-dominance. Toi, <i>Alphitonia zizyphoides</i> , absent or if present is less than half the cover of tavai ( <i>Rhus taitensis</i> ). ..... |                                    |
| ..... <b>Tavai Forest; <i>Rhus taitensis</i> Forest (F_RHTA)</b>                                                                                                                                                                                                                       |                                    |
| 19b. Forest not as described above .....                                                                                                                                                                                                                                               | 20                                 |
| 20a. Forest dominated by toi ( <i>Alphitonia zizyphoides</i> , 5%). Tavai, <i>Rhus taitensis</i> , absent, or if present is less than half the cover of toi ( <i>Alphitonia zizyphoides</i> ). This type was represented by only one plot.....                                         |                                    |
| ..... <b>Toi Forest; <i>Alphitonia zizyphoides</i> Forest (F_DYRHAL)</b>                                                                                                                                                                                                               |                                    |
| 20b. Forest not as described above .....                                                                                                                                                                                                                                               | 21                                 |
| 21a. Forest dominated by talie'ula ( <i>Terminalia samoensis</i> ) .....                                                                                                                                                                                                               |                                    |
| ..... <b>Talie Littoral Forest; <i>Terminalia samoensis</i> Littoral Forest (F_TESA)</b>                                                                                                                                                                                               |                                    |
| 21b. Forest dominated by species not as described above.....                                                                                                                                                                                                                           |                                    |
| ..... <b>New Undescribed Type to NPSA Classification</b>                                                                                                                                                                                                                               |                                    |
| <b>Non-Forest Vegetation</b>                                                                                                                                                                                                                                                           |                                    |
| 22a. Vegetation not forested. Vegetation is a shrubland, vine dominated or vine covering other species, dominated by tree ferns or dominated by herbaceous species, .....                                                                                                              | 23                                 |
| 22b. Vegetation not as above.....                                                                                                                                                                                                                                                      | 27                                 |
| 23a. Vegetation is dominated by to'ito'i ( <i>Scaevola taccada</i> ) .....                                                                                                                                                                                                             |                                    |
| ..... <b>To'ito'i Shrubland; <i>Scaevola taccada</i> Shrubland (S_WBST)</b>                                                                                                                                                                                                            |                                    |
| 23b. To'ito'i ( <i>Scaevola taccada</i> ) not present, vegetation dominated by other species.....                                                                                                                                                                                      | 24                                 |
| 24a. Vegetation dominated by vine-like, slightly woody ateate ( <i>Wedelia biflora</i> ), which may be covering other species .....                                                                                                                                                    |                                    |
| ..... <b>Ateate Shrubland; <i>Wedelia biflora</i> Shrubland (S_WBST)</b>                                                                                                                                                                                                               |                                    |
| 24b. Vegetation not as above .....                                                                                                                                                                                                                                                     | 25                                 |
| 25a. Herbaceous vegetation dominated by fue moa ( <i>Ipomoea pes-caprae</i> ) .....                                                                                                                                                                                                    |                                    |
| ..... <b>Fue moa Herbaceous Vegetation; <i>Ipomoea pes-caprae</i> Herbaceous Vegetation (H_IPPE)</b>                                                                                                                                                                                   |                                    |
| 25b. Vegetation not like above .....                                                                                                                                                                                                                                                   | 26                                 |
| 26a. Vegetation dominated by vines-- fue lautetele ( <i>Merremia peltata</i> , 25-30%) and the non-native vine fue saina ( <i>Mikania micrantha</i> , 15-25%) .....                                                                                                                    |                                    |
| ..... <b>Fue lautelele – Fue saina Semi-natural Vine Scrub; <i>Merremia peltata</i>-<i>Mikania micrantha</i> Semi-natural Vine Scrub (V_MEMI)</b>                                                                                                                                      |                                    |
| 26b. Vegetation not as above.....                                                                                                                                                                                                                                                      | 27                                 |
| 27a. Vegetation dominated by tree ferns <i>Cyathea spp</i> and occurring at high elevations, on or immediately below mountain summits .....                                                                                                                                            |                                    |
| ..... <b>Summit/Montane Scrub (SC_MON)</b>                                                                                                                                                                                                                                             |                                    |
| 27b. Vegetation not as described above.....                                                                                                                                                                                                                                            | <b>Undescribed Vegetation Type</b> |



# **Appendix D: Vegetation Association Descriptions**

## **NATIONAL VEGETATION CLASSIFICATION**

### **Vegetation Associations of National Park of American Samoa**

16 March 2012

by

NatureServe

1101 Wilson Blvd., 15<sup>th</sup> floor  
Arlington, VA 22209

4001 Discovery, Suite 270  
Boulder, CO 80303

This subset of the International Ecological Classification Standard covers vegetation associations attributed to National Park of American Samoa. 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](mailto:mary_russo@natureserve.org)>, and/or Gwen Kittel, Regional Vegetation Ecologist, Boulder, CO <[gwen\\_kittel@natureserve.org](mailto:gwen_kittel@natureserve.org)>.



Copyright © 2011 NatureServe, 1101 Wilson Blvd, 15<sup>th</sup> floor  
Arlington, VA 22209, U.S.A. All Rights Reserved.

**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. 2011. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of 31 May 2011.

**Restrictions on Use:** Permission to use, copy and distribute these data is hereby granted under the following conditions:

1. The above copyright notice must appear in all documents and reports;
2. Any use must be for informational purposes only and in no instance for commercial purposes;
3. Some data may be altered in format for analytical purposes, however the data should still be referenced using the citation above.

Any rights not expressly granted herein are reserved by NatureServe. Except as expressly provided above, nothing contained herein shall be construed as conferring any license or right under any NatureServe copyright.

**Information Warranty Disclaimer:** All data are provided as is without warranty as to the currentness, completeness, or accuracy of any specific data. The absence of data in any particular geographic area does not necessarily mean that species or ecological communities of concern are not present. NatureServe hereby disclaims all warranties and conditions with regard to these data, including but not limited to all implied warranties and conditions of merchantability, fitness for a particular purpose, and non-infringement. In no event shall NatureServe be liable for any special, indirect, incidental, consequential damages, or for damages of any kind arising out of or in connection with the use of these data. Because the data in the NatureServe Central Databases are continually being updated, it is advisable to refresh data at least once a year after receipt.

NatureServe  
1101 Wilson Blvd, 15<sup>th</sup> floor  
Arlington, VA 22209

---

These data are extracted from:

NatureServe. 2011. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of 31 May 2011.

---

This document may be generally cited as follows:

NatureServe<sup>1</sup>. 2011. International Ecological Classification Standard: Terrestrial Ecological Classifications. Vegetation Associations of National Park of American Samoa. NatureServe Central Databases. Arlington, VA. Data current as of 31 May 2011.

<sup>1</sup> 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 Program, 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.

## TABLE OF CONTENTS

|                                                                           |    |
|---------------------------------------------------------------------------|----|
| 1. FOREST & WOODLAND.....                                                 | 5  |
| 1.A.2. Tropical Lowland Evergreen Rainforest .....                        | 5  |
| 1.A.2.Oa. Polynesian Lowland Rainforest .....                             | 5  |
| M188. Central & Southern Polynesian Lowland Rainforest .....              | 5  |
| G619. Central & Southern Polynesian Lowland Rainforest .....              | 5  |
| Toi Forest [Park Special] .....                                           | 5  |
| Futu Littoral Forest .....                                                | 5  |
| Saitamu Forest .....                                                      | 6  |
| (Mamala, Maota) Forest.....                                               | 7  |
| Pualulu Forest [Park Special].....                                        | 8  |
| Fau Forest.....                                                           | 9  |
| Metrosideros spp. Forest [Park Special] .....                             | 10 |
| Atone-(ma'ali, mafoa) Forest.....                                         | 10 |
| Fala Littoral Forest.....                                                 | 11 |
| Pu'a Vai Littoral Forest .....                                            | 12 |
| 'Ala'a Forest [Park Special] .....                                        | 13 |
| Tava Forest [Park Special] .....                                          | 14 |
| Tavai Forest .....                                                        | 14 |
| Asi - Ifilele Forest .....                                                | 15 |
| M190. Polynesian Semi-natural Lowland Rainforest.....                     | 17 |
| G390. Polynesian Semi-natural Lowland Rainforest.....                     | 17 |
| Fue lautetele - Fue saina Semi-natural Vine Scrub [Park Special].....     | 15 |
| 1.A.3. Tropical Montane Rainforest .....                                  | 16 |
| 1.A.3.Oa. Polynesian Montane & Cloud Forest.....                          | 17 |
| M195. Central & Southern Polynesian Montane & Cloud Forest.....           | 17 |
| G620. Central & Southern Polynesian Montane Rainforest .....              | 17 |
| Fena Vao - Weinmannia Forest.....                                         | 17 |
| 2. SHRUBLAND & GRASSLAND.....                                             | 18 |
| 2.A.3. Tropical Scrub & Herb Coastal Vegetation .....                     | 18 |
| 2.A.3.Ob. Polynesian Scrub & Herb Coastal Vegetation.....                 | 18 |
| M232. Central & Southern Polynesian Scrub & Herb Coastal Vegetation ..... | 18 |
| G621. Central & Southern Polynesian Scrub & Herb Coastal Strand .....     | 18 |
| Niu Southern Polynesian Forest.....                                       | 18 |

## 1. Forest & Woodland

### 1.A.2. Tropical Lowland Evergreen Rainforest

#### 1.A.2.Oa. Polynesian Lowland Rainforest

#### M188. Central & Southern Polynesian Lowland Rainforest

#### G619. Central & Southern Polynesian Lowland Rainforest

---

##### Toi Forest [Park Special]

*Alphitonia zizyphoides* Forest [Park Special]

Identifier: CEPS009641

---

##### USNVC CLASSIFICATION

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | Toi Forest [Park Special]                               |

##### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** This community was sampled only once in the park. It occurs at 317 m elevation on a recent lava flow and the lower level of a 10-degree slope. Litter covers 80% of the ground surface.

##### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This community is described from only one sample. The total canopy coverage is low, with *Alphitonia zizyphoides* and *Ficus tinctoria* with 5% cover each. Other tree species present are *Cyathea* spp. (4%) and *Macaranga stipulosa* (4%). Epiphytic cover totals 9% with *Lomagramma cordipinna* and *Freycinetia* spp.

##### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

##### CLASSIFICATION

**Status:** Nonstandard

##### ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** This community was sampled at upper Laufuti.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

##### ELEMENT SOURCES

**National Park of American Samoa Plots:** 1 plot: NPSA.0132.

**Local Description Authors:** G. Kittel

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.

---

##### Futu Littoral Forest

*Barringtonia asiatica* Littoral Forest

Identifier: CEGl008705

---

##### USNVC CLASSIFICATION

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | Futu Littoral Forest                                    |

### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** This association occurs on beaches, sides and occasionally lavaflows at low level, midslopes and high slopes ranging from 8-80 m in elevation. Slopes are variable and range from nearly flat to very steep (1-70 degrees) on all aspects. Substrates can be very rocky or gravelly with exposed sand. Soils are dry to moist and composed of clay or sand.

### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This broad-leaved association is a forest or woodland dominated in the upper canopy by *Barringtonia asiatica* which may range from 2-60% cover. Other canopy associates include *Thespesia populnea*, *Hibiscus tiliaceus*, *Terminalia catappa*, and *Pandanus tectorius*. Shrub and herbaceous species have low constancy and cover. Shrubs may include *Wedelia biflora*, *Scaevola taccada*, and *Guettarda speciosa*. The dominant cover in the herbaceous stratum is seedlings of woody species dominant in the canopy, but herbaceous species present at low cover may include *Vigna marina*, *Phymatosorus grossus*, and *Ipomoea pes-caprae*. Vines common at low cover include *Epipremnum pinnatum*, *Mikania micrantha*, *Merremia peltata*, *Faradaya amicornum*, and *Mucuna gigantea*.

### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (17-May-2011).

### CLASSIFICATION

**Status:** Standard

### ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** Vatia Pola, Vatia east, Northside of Polauta, Polauta ridge, Amalau Valley, Lower Sauma Ridge, Fitiuta, Saua, Sauma Trail East, and Ofu.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

### ELEMENT SOURCES

**National Park of American Samoa Plots:** 11 plots: NPSA.0003, NPSA.0014, NPSA.0037, NPSA.0038, NPSA.0053, NPSA.0056, NPSA.0106, NPSA.0140, NPSA.0142, NPSA.0201, NPSA.0206; and 4 observation points: NPSA.0915, NPSA.0916, NPSA.9204, NPSA.9205.

**Local Description Authors:** M.E. Hall

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.

---

### Saitamu Forest

***Crossostylis biflora* Forest**

**Identifier:** CEGl008707

---

### USNVC CLASSIFICATION

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | Saitamu Forest                                          |

### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** This association occurs on sideslopes, ridges and high slopes with elevations ranging from 337-452 m. Slopes are steep, ranging from 32-50 degrees on all aspects. Soils are moist and composed of clay. The unvegetated surface is composed mostly of litter and live vegetation litter.

### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This forest and woodland association is dominated by *Crossostylis biflora* at usually less than 30% cover. Other trees present include *Aglaia samoensis*, *Calophyllum neo-eudicium*, *Dysoxylum* spp., *Myristica inutilis*, *Palaquium stehlinii*, and *Syzygium inophylloides*. Shrubs are sparse, but *Clidemia hirta* is prevalent at low cover. Herbaceous diversity is high, but no single species is dominant or attains high cover individually. Species with high constancy include *Zingiber zerumbet*, *Phymatosorus grossus*,

*Angiopteris evecta*, *Dioscorea bulbifera*, *Davallia epiphylla*, and *Flickingeria comata*. The epiphyte *Lomagramma cordipinna* may attain high cover in some stands.

#### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

#### CLASSIFICATION

**Status:** Standard

#### ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** East side of Fagatuitui, Maugaloa ridge and Alava Trail.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

#### ELEMENT SOURCES

**National Park of American Samoa Plots:** 3 plots: NPSA.0010, NPSA.0013, NPSA.0041.

**Local Description Authors:** M.E. Hall

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.

---

### (Mamala, Maota) Forest

*Dysoxylum (samoense, maota)* Forest

**Identifier:** CEG008708

---

#### USNVC CLASSIFICATION

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | (Mamala, Maota) Forest                                  |

#### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** This association occurs on sideslopes, cliffs, ridges and lavaflows at low-, mid- and high-slope positions at elevations ranging from 16-331 m. It was also observed within the littoral zone on the coast during mapping reconnaissance sessions. Slopes range from gentle to very steep (15-90 degrees) on all aspects. Soils are moist and mostly composed of clay, but may be alluvial or younger and layered by cinders. The unvegetated surface is mostly composed of litter, but bare soil may be prevalent at some sites.

#### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This forest or woodland association is nearly always dominated by *Dysoxylum samoense* or *Dysoxylum maota*. Other common canopy associates include *Ficus scabra*, *Myristica inutilis*, *Neonauclea forsteri*, and *Planchonella garberi*. Some stands may include very large emergent individual *Ficus prolixa* trees. In the understory, shrub species have low constancy and cover with no one species dominating or indicative of the community. The herbaceous layer is diverse with *Tectaria dissecta* dominating most stands with abundant woody species regeneration composing much of the remaining cover. Other herbaceous species with high constancy include *Angiopteris evecta* and *Christella harveyi*, but both occur at low cover. Epiphytic species are important with *Lomagramma cordipinna* attaining upwards of 15% total cover in some stands. Vine species have high constancy but occur at low average cover. Species include *Piper graeffei*, *Faradaya amicorum*, *Mikania micrantha*, *Epipremnum pinnatum*, and *Alyxia bracteolosa*.

#### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

#### CLASSIFICATION

**Status:** Standard

#### ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** Alava Trail, Siu Point, Saua, Ta'ū Mefu cove, Maia, Fitiuta, Maefu cove, Manua (Ta'ū), Upper Laufuti, Leuosoalii, Sauma Trail, and west side of Sauma Ridge.

**Global Range:****Global Range:** Information not available.**Nations:** AS**Federal Lands:** NPS (American Samoa)**ELEMENT SOURCES****National Park of American Samoa Plots:** 15 plots: NPSA.0035, NPSA.0052, NPSA.0100, NPSA.0101, NPSA.0103, NPSA.0104, NPSA.0107, NPSA.0108, NPSA.0109, NPSA.0112, NPSA.0122, NPSA.0125, NPSA.0133, NPSA.0136, NPSA.0141; and 1 observation point: NPSA.0905.**Local Description Authors:** M.E. Hall**Global Description Authors:****References:** Western Ecology Working Group n.d.

---

**Pualulu Forest [Park Special]*****Fagraea berteroa* Forest [Park Special]****Identifier:** CEPS009637

---

**USNVC CLASSIFICATION**

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | Pualulu Forest [Park Special]                           |

**ENVIRONMENTAL DESCRIPTION****National Park of American Samoa Environment:** This association is known only from one location on a plateau at an elevation of 275 m. Slope at this site is 25 degrees with a southwest aspect. Soils are moist and composed of clay.**VEGETATION DESCRIPTION****National Park of American Samoa Vegetation:** This forest association is dominated by *Fagraea berteroa* with *Bischofia javanica*, *Hibiscus tiliaceus*, and *Freycinetia* spp. as canopy associates. The shrub species *Mikania micrantha* and *Merremia peltata* are present at very low cover. The herbaceous layer is dominated by *Diplazium harpeodes* at 15% cover. *Tectaria dissecta*, *Phymatosorus grossus*, *Epipremnum pinnatum*, *Dysoxylum samoense*, and *Davallia solida* are present but at very low cover.**CONSERVATION STATUS RANK****Global Rank & Reasons:** GNR (19-May-2011).**CLASSIFICATION****Status:** Nonstandard**ELEMENT DISTRIBUTION****National Park of American Samoa Range:** Upper Laufuti.**Global Range:****Global Range:** Information not available.**Nations:** AS**Federal Lands:** NPS (American Samoa)**ELEMENT SOURCES****National Park of American Samoa Plots:** 1 plot: NPSA.0134.**Local Description Authors:** M.E. Hall**Global Description Authors:****References:** Western Ecology Working Group n.d.

---

## Fau Forest

### *Hibiscus tiliaceus* Forest

Identifier: CEGLO08710

---

#### USNVC CLASSIFICATION

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | Fau Forest                                              |

#### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** This forest association is found on sideslopes and terraces, rock piles and cliffs between 14 and 428 m elevation. Sites occur on level to steep slopes (1-60 degrees) with northeast, south, and west aspects. Stands of this type were also observed well within the littoral zone on the coast during mapping field reconnaissance sessions. Slope positions include low, middle and high slopes with substrates composed of aa or pahoehoe lava or obscured by soil. Soils range from a clayey texture to lava and are moist, with one site including part of a stream. Soil surface cover is a variable mix of dead leaf litter (13-68%), rock (0-38%), bedrock (0-50%), live (green) litter (10-45%), and generally low cover of bare ground (<20%).

#### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This community is characterized by a moderately dense to closed tree canopy typically 8-13 m tall (one stand near Tainamu point is only 4 m tall) that are dominated by *Hibiscus tiliaceus* (10-46% cover) with many other tree species present. The most constant and abundant trees are *Diospyros samoensis* (0-12%), *Ficus scabra* (0-8%), *Cordyline fruticosa* (0-5%), *Dysoxylum samoense* (0-5%), and *Myristica inutilis* (0-6%). Also present may be *Rhus taitensis* (0-15%), *Morinda citrifolia* (0-3%), *Sterculia fanaiho* (0-6%), *Artocarpus altilis* (0-16%), *Cocos nucifera* (0-15%), *Buchanania merrillii* (0-10%), and over two dozen other tree species with lower cover. Shrubs and sapling trees such as *Clidemia hirta* (0-15%), *Scaevola taccada* (0-25%), or *Wedelia biflora* (0-40%) are sometimes present and may form a shrub layer. Vines and/or lianas such as *Alyxia bracteolosa*, *Epipremnum pinnatum*, *Faradaya amicornum*, *Freycinetia* spp., *Hoya australis*, *Mikania micrantha*, and *Piper graeffei* are common, and *Gynochthodes epiphytica* is occasionally abundant. Herbaceous cover is low to moderate and typically composed of tree seedlings, along with a few graminoids, forbs and ferns such as *Acrostichum aureum*, *Angiopteris evecta*, *Asplenium horridum*, *Christella harveyi*, *Fimbristylis dichotoma*, *Lepturus repens*, *Miscanthus floridulus*, *Oplismenus hirtellus*, *Phymatosorus grossus*, and *Tectaria dissecta*.

#### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

#### CLASSIFICATION

**Status:** Standard

#### ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** This association is known from both Tutuila and Manu'a islands. Stands were sampled near Fitiuta Quarry, upper Laufuti, Leusoalii, south Luaiti, Pola Vatia, Polauta side, Saua, Fitiuta, near Tainamu Point, near Siu Point, near Aufotu Cove, by the coast near Fagasa village, and Laufuti Spring near Maefu Cove.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

#### ELEMENT SOURCES

**National Park of American Samoa Plots:** 9 plots: NPSA.0051, NPSA.0105, NPSA.0115, NPSA.0120, NPSA.0121, NPSA.0123, NPSA.0126, NPSA.0135, NPSA.0138; and 6 observation points: NPSA.0901, NPSA.0909, NPSA.0950, NPSA.0952, NPSA.0954, NPSA.0958.

**Local Description Authors:** K.A. Schulz

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.

---

**Metrosideros spp. Forest [Park Special]*****Metrosideros* spp. Forest [Park Special]****Identifier: CEPS009640**

---

**USNVC CLASSIFICATION**

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | <i>Metrosideros</i> spp. Forest [Park Special]          |

**ENVIRONMENTAL DESCRIPTION**

**National Park of American Samoa Environment:** This forest association is found on a ridge 484 m elevation. The site is on the upper part of a moderate slope (15 degrees) with a western aspect. Soil surface has low cover of mosses (6% cover), moderately high cover of litter (30%), and high cover of live (green) litter (60%).

**VEGETATION DESCRIPTION**

**National Park of American Samoa Vegetation:** This community is described by only one observation point and is characterized by a moderately dense tree canopy 7 m tall that is dominated by *Metrosideros* spp. (40% cover) with several other trees species including *Fagraea berteriana* (5%), *Dysoxylum huntii* (3%), and *Cordia alliodora* (3%). Orchids and lianas included *Bulbophyllum polypodioides* (5%), and *Freyinetia arborea* (3%). The open shrub layer is codominated by *Bidens alba* (8%) and *Allamanda cathartica* (6%), and the open herbaceous layer is dominated by the graminoids *Axonopus compressus*, *Chrysopogon aciculatus*, *Paspalum paniculatum*, and *Paspalum setaceum*.

**CONSERVATION STATUS RANK**

**Global Rank & Reasons:** GNR (19-May-2011).

**CLASSIFICATION**

**Status:** Nonstandard

**ELEMENT DISTRIBUTION**

**National Park of American Samoa Range:** This association is known from Alava Ridge.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

**ELEMENT SOURCES**

**National Park of American Samoa Plots:** 1 observation point: NPSA.0912.

**Local Description Authors:** K.A. Schulz

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.

---

**Atone-(ma'ali, mafoa) Forest*****Myristica inutilis* - *Canarium (vitiense, mafoa)* Forest****Identifier: CEG008711**

---

**USNVC CLASSIFICATION**

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | Atone Forest                                            |

**ENVIRONMENTAL DESCRIPTION**

**National Park of American Samoa Environment:** This forest association is found on sideslopes and ridges between 80 and 334 m in elevation. Sites occur on steep slopes (2-90 degrees) on all aspects. Slope positions include low, middle and high slopes with substrates obscured by soil. Soils have a clayey texture and are generally moist to saturated, with three sites including part of a stream. Soil surface has low cover of bare ground (1-16% cover), rock and bedrock with moderately high cover of dead litter (22-83%) and live (green) litter (2-60%).

## VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This community is characterized by a moderately dense to closed tree canopy 6-8 m tall that is dominated by *Myristica inutilis* (6-45% cover). Many native tree species are present and abundant, such as *Barringtonia asiatica* (0-10%) but occur well away from the coastal and littoral zones. Occasionally there are species that can be of equal or greater abundance, such as *Planchonella samoensis* (0-20%) or *Canarium vitiense* (0-28%), or more commonly several other native tree species may occur with equal or, in combination, greater abundance, such as *Buchanania merrillii* (0-15%) or *Canarium vitiense* (0-28%). However, in most sampled stands (15 of 21) *Myristica inutilis* is the most abundant native tree species. *Ficus prolixa* is absent or has low cover. The tree canopy is very diverse. Other abundant tree species (10% or more cover) with over 50% constancy include *Aglaia samoensis*, *Cananga odorata*, *Canarium mafoa*, and *Cordyline fruticosa*. Less constant abundant species include *Adenanthera pavonina*, *Bischofia javanica*, *Diospyros samoensis*, *Dysoxylum maota*, *Elaeocarpus ulianus*, *Ficus prolixa* (which can be a very large emergent tree), *Inocarpus fagifer*, *Macaranga stipulosa*, *Neonauclea forsteri*, *Rhus taitensis*, and *Syzygium inophylloides*. There are over 40 additional trees species with lower constancy and cover recorded in various stands of this forest type. Vines such as *Alyxia bracteolosa*, *Epipremnum pinnatum*, *Faradaya amicornum*, *Freycinetia* spp., *Hoya australis*, and *Piper graeffei* and epiphytes such as *Asplenium nidus*, *Lomagramma cordipinna*, and *Davallia solida* are often present. The herbaceous cover is variable but typically lower cover and composed of tree seedlings and a few constant or abundant herbs such as *Angiopteris evecta*, *Asplenium acuminatum*, *Christella harveyi*, *Heliconia laurfao*, *Tectaria dissecta*, and *Zingiber zerumbet*.

## CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

## CLASSIFICATION

**Status:** Standard

## ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** This association is known from both Tutuila and Manu'a islands. It was sampled at Afono-Tutuila (Olo ridge), near Afono village, Alava ridge (east, north and northwest), Agasavili, Faiga stream, Fagasa village (north), Lalofutu (off Alava Trail), and near Vatia village (Amalau valley, near Sauma and TiaTa'ual ridges).

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

## ELEMENT SOURCES

**National Park of American Samoa Plots:** 22 plots: NPSA.0001, NPSA.0002, NPSA.0007, NPSA.0008, NPSA.0009, NPSA.0015, NPSA.0016, NPSA.0018, NPSA.0021, NPSA.0024, NPSA.0025, NPSA.0026, NPSA.0027, NPSA.0036, NPSA.0039, NPSA.0042, NPSA.0044, NPSA.0046, NPSA.0050, NPSA.0057, NPSA.0058, NPSA.0059; and 3 observation points: NPSA.0902, NPSA.0903, NPSA.0904.

**Local Description Authors:** K.A. Schulz

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.

---

## Fala Littoral Forest

*Pandanus tectorius* Littoral Forest

**Identifier:** CEG008712

---

## USNVC CLASSIFICATION

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | Fala Forest                                             |

### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** These are littoral forests that occur within 25 m in elevation (range 17-25 m) of sea level, usually on beaches but they can occur on cliff faces and terraces. When on slopes they occupy the lower third of the slope. Ground surface is bare soil, bedrock or sand; plots have high litter cover (30-50%). Soil texture is sand when on beaches or clay when on weathered volcanic slopes.

### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This is a low-statured forest (4-5 m in height) with a fairly open canopy (32-90% coverage). Main dominant canopy trees are *Pandanus tectorius* (5-22% cover) and *Cocos nucifera* (0-5%). *Thespesia populnea*, *Terminalia samoensis*, *Pisonia grandis*, *Ficus* spp., *Hibiscus tiliaceus*, and *Terminalia catappa* may be present with up to 12% cover, but these are never more than half as abundant as *Pandanus*. Shrubs that may be present include *Scaevola taccada* and *Wedelia biflora* with 0-9% canopy coverage. Herbaceous cover is generally low but occasionally one or two species gain significant coverage such as *Zoysia tenuifolia* which is present in one plot with 12% cover.

### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

### CLASSIFICATION

**Status:** Standard

### ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** This type was sampled on Ofu near Siu, near the airport and near To'aga.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

### ELEMENT SOURCES

**National Park of American Samoa Plots:** 4 plots: NPSA.0139, NPSA.0143, NPSA.0202, NPSA.0211; and 2 observation points: NPSA.0953, NPSA.9210.

**Local Description Authors:** G. Kittel

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.

---

### Pu'a Vai Littoral Forest

*Pisonia grandis* Littoral Forest

**Identifier:** CEGLO08713

---

### USNVC CLASSIFICATION

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | Pu'a Vai Forest                                         |

### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** This is a lowland rain forest type that occurs below 200 m (10-195 m) elevation, on sideslopes and beaches. Ground cover is mostly bedrock, rock or gravel. Soils identified from one plot are of clay texture. Slopes are low (8-15 degrees), however, one plot occurs on a 80-degree slope.

### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This type is described from three observation points and one full plot. Total canopy coverage is high (52-70%). Stands are dominated by high coverage of *Pisonia grandis* with 15-40% canopy coverage. Other tree species present may include *Hibiscus tiliaceus*, *Barringtonia asiatica*, *Diospyros samoensis*, *Hernandia nymphaeifolia*, *Macaranga harveyana*, and *Ficus obliqua* (0-12%). There are no shrubs and only a few vines and epiphytes, such as *Epipremnum pinnatum*, *Hoya pottsii*, and *Asplenium nidus* with 0-9% cover. The herbaceous cover is very low due to heavy shading by the upper canopy.

### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

### CLASSIFICATION

**Status:** Standard

### ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** This type occurs in the following locations: Saua, Manu'a; Ofu; Polauta, Vatia; and Maefu cove.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

### ELEMENT SOURCES

**National Park of American Samoa Plots:** 2 plots: NPSA.0102, NPSA.0200; and 2 observation points: NPSA.0914, NPSA.0955.

**Local Description Authors:** G. Kittel

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.

---

### 'Ala'a Forest [Park Special]

***Planchonella garberi* Forest [Park Special]**

**Identifier:** CEPS009643

---

### USNVC CLASSIFICATION

Division

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

Macrogroup

Central & Southern Polynesian Lowland Rainforest (M188)

Group

Central & Southern Polynesian Lowland Rainforest (G619)

Association (English name)

'Ala'a Forest [Park Special]

### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** This type description is based on only one plot. It occurs at 62 m in elevation, along the lower portion of a ridgeline on a 40-degree slope. Litter covers 100% of the ground surface. Soils are clay-textured.

### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This is a densely forested community described from just one location within the park. *Planchonella garberi* has the highest cover of any other single tree species present with 40% canopy cover. Other trees present include *Syzygium clusiifolium* (23% cover), *Hibiscus tiliaceus* (20%), *Canarium vitiense* (17%), *Planchonella grayana* (8%), and *Dysoxylum samoense* (5%). The herbaceous layer is dominated by tree seedlings and few shrubs are present; no vines or epiphytes were reported.

### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

### CLASSIFICATION

**Status:** Nonstandard

### ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** This type was sampled only once, along the Sauma Ridge, on Tutuila within the park boundaries.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

### ELEMENT SOURCES

**National Park of American Samoa Plots:** 1 plot: NPSA.0004.

**Local Description Authors:** G. Kittel

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

---

**Tava Forest [Park Special]*****Pometia pinnata* Forest [Park Special]****Identifier:** CEPS009642

---

**USNVC CLASSIFICATION**

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | Tava Forest [Park Special]                              |

**ENVIRONMENTAL DESCRIPTION**

**National Park of American Samoa Environment:** This community is described from only one sample. It occurs at 293 m elevation high up on a 20-degree sideslope. Litter covers the ground surface (70%), along with some rocks (18%) and bare soil (7%). Soil is clay in texture.

**VEGETATION DESCRIPTION**

**National Park of American Samoa Vegetation:** This community is described from just a single plot. It is densely forested with *Pometia pinnata* at 68% canopy coverage, far greater than any other tree species individually or combined. Other tree species present with >2% cover include *Syzygium inophylloides*, *Dysoxylum samoense*, *Macaranga stipulosa*, *Piper graeffei*, *Ficus scabra*, and *Myristica inutilis* plus several other species with lower percent cover. Tree ferns and lianas are also present: *Freycinetia* spp., *Cyathea* spp. A few shrubs are present and include *Clidemia hirta*, *Cyrtandra samoensis*, *Alyxia bracteolosa*, and *Psychotria insularum*. The herbaceous layer is dominated by *Lomagramma cordipinna* and seedlings of the canopy tree species.

**CONSERVATION STATUS RANK**

**Global Rank & Reasons:** GNR (19-May-2011).

**CLASSIFICATION**

**Status:** Nonstandard

**ELEMENT DISTRIBUTION**

**National Park of American Samoa Range:** This community was sampled only one time along the Sauma Ridge, on Tutuila, within park boundaries.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

**ELEMENT SOURCES**

**National Park of American Samoa Plots:** 1 plot: NPSA.0111.

**Local Description Authors:** G. Kittel

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.

---

**Tavai Forest*****Rhus taitensis* Forest****Identifier:** CEGl008715

---

**USNVC CLASSIFICATION**

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | Tavai Forest                                            |

### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** This forest community is considered a seral or secondary type that can occur in a variety of environmental settings. It was sampled from 83-345 m in elevation on 15- to 45-degree slopes; landforms include sideslopes, ridges, interfluvies and plateaus. Ground cover is mostly litter with bare soil and rocks comprising about 10-15% cover. Soils are of clay texture.

### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This community has high cover of *Rhus taitensis* (11-55% cover) and signs of recent disturbance. Many native tree species are present including *Neonauclea forsteri*, *Myristica inutilis*, *Bischofia javanica*, *Cyathea* spp., and *Dysoxylum samoense* with up to 20% cover, but these are subordinate to *Rhus* in terms of canopy coverage individually and with their combined covers. Up to 31 other tree species were recorded in these 5 examples with cover ranging from <1 to 10%. Many vines may be present including *Mikania micrantha*, *Alyxia bracteolosa*, and *Merremia peltata* with 8-17% cover. Shrubs are non-existent and the herbaceous cover is very low.

### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

### CLASSIFICATION

**Status:** Standard

### ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** This type was sampled on Manu'a and Tutuila islands. It occurs on Sauma Ridge, near Vatia, Luatele crater, Utuloala, and along upper Laufuti Trail.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

### ELEMENT SOURCES

**National Park of American Samoa Plots:** 5 plots NPSA.0011, NPSA.0017, NPSA.0116, NPSA.0119, NPSA.0137.

**Local Description Authors:** G. Kittel

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.

---

### Asi - Ifilele Forest

***Syzygium inophylloides* - *Intsia bijuga* Forest**

**Identifier:** CEG008716

---

### USNVC CLASSIFICATION

|                            |                                                         |
|----------------------------|---------------------------------------------------------|
| Division                   | Polynesian Lowland Rainforest (1.A.2.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Lowland Rainforest (M188) |
| Group                      | Central & Southern Polynesian Lowland Rainforest (G619) |
| Association (English name) | Asi - Ifilele Forest                                    |

### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** This forested community occurs from 49 to 386 m in elevation, on steep slopes (12-90 degrees), often on ridges and the high to midpoint of sideslopes. Soils are moist to saturated and composed of clay. Ground cover is nearly all litter (18-84% cover) with some bare soil (0-12%), rocks (0-30%) and gravel (0-12%).

### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This is a thickly forested community dominated by tall broad-leaved evergreen trees. The dominant tree is *Syzygium inophylloides* with up to 28% cover and/or *Intsia bijuga* with up to 55% cover. Other tree species present include (with 0-20% cover) *Barringtonia asiatica*, *Buchanania merrillii*, *Calophyllum inophyllum*, *Calophyllum neo-eubodum*, *Canarium mafoa*, *Canarium vitiense*, *Cyathea* spp., *Diospyros samoensis*, *Elaeocarpus ulianus*, *Glochidion ramiflorum*, *Hibiscus tiliaceus*, *Intsia bijuga*, *Myristica inutilis*, *Planchonella garberi*, *Psychotria insularum*, *Rhus taitensis*, *Syzygium clusiifolium*. Some stands may include very

large and emergent *Ficus prolixa* individuals. Shrubs have low constancy with cover ranging up to 25% or they may be absent. The only shrubs documented include *Mapania macrocephala* and the non-native *Clidemia hirta*. Vine cover can be high with *Alyxia bracteolosa* or *Erythrospermum acuminatissimum* (0-17%). Epiphytic cover ranges from 0-20% cover and includes the epiphytic spleenwort *Asplenium nidus*, *Freycinetia* spp. and others. The herbaceous layer is often dominated by seedlings of the canopy tree species, total herbaceous cover is often low, although *Tectaria dissecta* does occur with as much as 20% cover. Other herbs include *Zingiber zerumbet* and *Angiopteris evecta*.

#### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

#### CLASSIFICATION

**Status:** Standard

#### ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** This type was sampled on Ofu and Tutuila, at Vatia near Plauta Ridge; Vatia Matavalu ridge; Matavalu ridge ; Alva ridge; Luaiti; and Luatelel.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

#### ELEMENT SOURCES

**National Park of American Samoa Plots:** 18 plots: NPSA.0005, NPSA.0006, NPSA.0012, NPSA.0019, NPSA.0020, NPSA.0022, NPSA.0023, NPSA.0028, NPSA.0029, NPSA.0030, NPSA.0031, NPSA.0034, NPSA.0043, NPSA.0054, NPSA.0114, NPSA.0118, NPSA.0203, NPSA.0401; and 6 observation points: NPSA.0906, NPSA.0907, NPSA.0908, NPSA.0910, NPSA.0911, NPSA.0957.

**Local Description Authors:** G. Kittel

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.

### M190. Polynesian Semi-natural Lowland Rainforest

### G390. Polynesian Semi-natural Lowland Rainforest

---

#### Fue lautetele - Fue saina Semi-natural Vine Scrub [Park Special]

*Merremia peltata* - *Mikania micrantha* Semi-natural Vine Scrub [Park Special]

**Identifier:** CEPS009638

---

#### 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 (English name) | Fue lautetele - Fue saina Semi-natural Vine Scrub [Park Special] |

#### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** This vine scrub association was sampled in two places in the park. It is found on a sideslopes from 4- 14 m elevation on low and high slopes (4-20 degrees). Soils have a clayey texture and are moist, with one site including part of a stream. Substrates include colluvium. Soil surface has low cover of mosses (1% cover) and moderate cover of gravel (6%), rock (18%), dead leaf litter (36%) and live (green) litter (32%).

#### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This type consists of trees with heavy vine cover. It is dominated by a native vine *Merremia peltata* (15%) and non-native vine *Mikania micrantha* (15 - 27% cover) on native or non-native trees such as *Macaranga harveyana* (16%), and *Artocarpus altilis* (11% cover). Other tree species present include *Pipturus argenteus* (7%), *Ficus scabra* (5%), *Kleinhovia hospita* (7%) and *Musa* spp. (3%). *Hibiscus tiliaceus* may be present with low cover. Herbaceous layer may include *Bidens alba* (10%) or *Nephrolepis hirsutula*

(10%). More minor species likely occur in this type, but because it was represented by only two observation points, those species were not recorded.

#### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

#### CLASSIFICATION

**Status:** Nonstandard

#### ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** This association is known from Ta'u Manu'a and near Vatia village.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

#### ELEMENT SOURCES

**National Park of American Samoa Plots:** 2 observation points: NPSA.0913, NPSA.0951.

**Local Description Authors:** K.A. Schulz, G. Kittel

**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

#### M195. Central & Southern Polynesian Montane & Cloud Forest

#### G620. Central & Southern Polynesian Montane Rainforest

---

#### Fena Vao - Weinmannia Forest

*Syzygium samoense* - *Weinmannia affinis* Forest

**Identifier:** CEGLO08717

---

#### USNVC CLASSIFICATION

|                            |                                                             |
|----------------------------|-------------------------------------------------------------|
| Division                   | Polynesian Montane & Cloud Forest (1.A.3.Oa)                |
| Macrogroup                 | Central & Southern Polynesian Montane & Cloud Forest (M195) |
| Group                      | Central & Southern Polynesian Montane Rainforest (G620)     |
| Association (English name) | Fena Vao - Weinmannia Forest                                |

#### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** This forest community occurs at the highest elevations sampled in the park, ranging from 353 to 972 m. Stands occur on a range of slopes from 5-90 degrees, often on high sideslopes, ridges or along intermittent streambeds. Bare soil and litter cover the ground layer.

#### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** The vegetation is forested by lower-statured trees (4-6 m in height); epiphytic cover is always present and generally high (5-40%). Dominant tree species include either *Astronidium pickeringii* or *Syzygium samoense* present in every stand, along with *Fagraea berteroana*, *Weinmannia affinis*, and *Reynoldsia lanutoensis* with 0-20% cover. Vine cover ranges from 0-8% and is present in only 60% of the stands. Herbaceous cover is highly variable. The most abundant species is *Dicranopteris linearis*. Epiphytic cover is very high and distinguishes this forest from its lower-elevation counterparts. Epiphytic cover ranges from 5-40+% and includes *Freycinetia* spp., *Asplenium nidus*, *Lomagramma cordipinna*, *Dendrobium dactylodes*, and *Dendrobium biflorum*.

#### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

#### CLASSIFICATION

**Status:** Standard

#### ELEMENT DISTRIBUTION

**National Park of American Samoa Range:** This community was sampled mostly on upper Laufuti and Lata Mountain in Manu'a. Two stands occur on Tutuila along the Alava ridge.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

#### ELEMENT SOURCES

**National Park of American Samoa Plots:** 11 plots: NPSA.0032, NPSA.0033, NPSA.0110, NPSA.0113, NPSA.0117, NPSA.0124, NPSA.0127, NPSA.0128, NPSA.0129, NPSA.0130, NPSA.013; and 1 observation point: NPSA.0956.

**Local Description Authors:** G. Kittel

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.

## 2. Shrubland & Grassland

### 2.A.3. Tropical Scrub & Herb Coastal Vegetation

#### 2.A.3.Ob. Polynesian Scrub & Herb Coastal Vegetation

#### M232. Central & Southern Polynesian Scrub & Herb Coastal Vegetation

#### G621. Central & Southern Polynesian Scrub & Herb Coastal Strand

---

### Niu Southern Polynesian Forest

*Cocos nucifera* Southern Polynesian Forest

**Identifier:** CEGLO08718

---

#### USNVC CLASSIFICATION

|                            |                                                                      |
|----------------------------|----------------------------------------------------------------------|
| Division                   | Polynesian Scrub & Herb Coastal Vegetation (2.A.3.Ob)                |
| Macrogroup                 | Central & Southern Polynesian Scrub & Herb Coastal Vegetation (M232) |
| Group                      | Central & Southern Polynesian Scrub & Herb Coastal Strand (G621)     |
| Association (English name) | Niu Southern Polynesian Forest                                       |

#### ENVIRONMENTAL DESCRIPTION

**National Park of American Samoa Environment:** This strand forest occurs on beaches at low level positions at elevations less than 25 m. Slopes are gentle and range from 10-15%. Substrates are sandy with abundant litter and occasionally exposed corral. Soils are composed of well-drained, dry sand.

#### VEGETATION DESCRIPTION

**National Park of American Samoa Vegetation:** This forest and woodland vegetation has a canopy dominated by *Cocos nucifera* averaging about 15% cover. *Hernandia nymphaeifolia* is a constant canopy associate, but averages about half the average cover of *Cocos nucifera*. Other canopy associates may include *Pisonia grandis*, *Tarennia sambucina*, *Macaranga harveyana*, and *Hibiscus tiliaceus*. Shrubs are always present but at low covers and may include *Guettarda speciosa*, *Premna serratifolia*, *Sophora tomentosa*, *Clerodendrum inerme*, and *Colubrina asiatica*. The most abundant species in the herbaceous layer are woody seedlings of canopy dominants. *Phymatosorus grossus* is a constant forb in this community at low cover. Other herbs that may be present at low cover include *Lepturus repens*, *Vigna marina*, and *Nephrolepis hirsutula*. Vine species are prevalent and may comprise up to 10% total vegetation cover. Species may include *Piper graeffei*, *Mikania micrantha*, *Derris trifoliata*, *Canavalia rosea*, *Epipremnum pinnatum*, *Ipomoea littoralis*, and *Hoya australis*.

#### CONSERVATION STATUS RANK

**Global Rank & Reasons:** GNR (19-May-2011).

#### CLASSIFICATION

**Status:** Standard

#### **ELEMENT DISTRIBUTION**

**National Park of American Samoa Range:** Vatia Polauta, Toaga Ofu and Ofu.

**Global Range:**

**Global Range:** Information not available.

**Nations:** AS

**Federal Lands:** NPS (American Samoa)

#### **ELEMENT SOURCES**

**National Park of American Samoa Plots:** 2 plots: NPSA.0055, NPSA.0207; and 1 observation point: NPSA.9208.

**Local Description Authors:** M.E. Hall

**Global Description Authors:**

**References:** Western Ecology Working Group n.d.



## Appendix E: Field Plot Crosswalk to National Vegetation Classification Associations

At the National Park of American Samoa, plots were assigned to USNVC associations and park specials. Element codes (ELCODES) are used by NatureServe and state Natural Heritage Programs to track nomenclature and status of rare plants, rare animals, and communities.

**Table. E.1.** USNVC associations and classification field plots.

| USNVC Association                                                                             | ELCODE     | Supporting Plots/Observation Points, and Observations                                                                                                                                                                                                                             | Number of Samples |
|-----------------------------------------------------------------------------------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Toi Forest: <i>Alphitonia zizyphoides</i> Forest [Park Special]                               | CEPS009641 | NPSA.0132                                                                                                                                                                                                                                                                         | 1                 |
| Futu Littoral Forest: <i>Barringtonia asiatica</i> Littoral Forest                            | CEGL008705 | NPSA.0003, NPSA.0014, NPSA.0037, NPSA.0038, NPSA.0053, NPSA.0056, NPSA.0106, NPSA.0140, NPSA.0142, NPSA.0201, NPSA.0206, NPSA.0915, NPSA.0916, NPSA.9204, NPSA.9205                                                                                                               | 15                |
| Saitamu Forest: <i>Crossostylis biflora</i> Forest                                            | CEGL008707 | NPSA.0010, NPSA.0013, NPSA.0041                                                                                                                                                                                                                                                   | 3                 |
| (Mamala, Maota) Forest: <i>Dysoxylum (samoense, maota)</i> Forest                             | CEGL008708 | NPSA.0035, NPSA.0052, NPSA.0100, NPSA.0101, NPSA.0103, NPSA.0104, NPSA.0107, NPSA.0108, NPSA.0109, NPSA.0112, NPSA.0122, NPSA.0125, NPSA.0133, NPSA.0136, NPSA.0141, NPSA.0905                                                                                                    | 16                |
| Pualulu Forest: <i>Fagraea berteriana</i> Forest [Park Special]                               | CEPS009637 | NPSA.0134                                                                                                                                                                                                                                                                         | 1                 |
| Fau Forest: <i>Hibiscus tiliaceus</i> Forest                                                  | CEGL008710 | NPSA.0051, NPSA.0105, NPSA.0115, NPSA.0120, NPSA.0121, NPSA.0123, NPSA.0126, NPSA.0135, NPSA.0138,                                                                                                                                                                                | 15                |
| <i>Metrosideros</i> spp. Forest: <i>Metrosideros</i> spp. Forest [Park Special]               | CEPS009640 | NPSA.0912                                                                                                                                                                                                                                                                         | 1                 |
| Atone - (ma'ali, mafoa) Forest: <i>Myristica inutulis - Canarium (vitiense, mafoa)</i> Forest | CEGL008711 | NPSA.0039, NPSA.0044, NPSA.0001, NPSA.0002, NPSA.0007, NPSA.0008, NPSA.0009, NPSA.0015, NPSA.0016, NPSA.0018, NPSA.0021, NPSA.0024, NPSA.0025, NPSA.0026, NPSA.0027, NPSA.0036, NPSA.0042, NPSA.0046, NPSA.0050, NPSA.0057, NPSA.0058, NPSA.0059, NPSA.0902, NPSA.0903, NPSA.0904 | 25                |
| Fala Littoral Forest: <i>Pandanus tectorius</i> Littoral Forest                               | CEGL008712 | NPSA.0139, NPSA.0143, NPSA.0202, NPSA.0211, NPSA.0953, NPSA.9210                                                                                                                                                                                                                  | 6                 |
| Pu'a Vai Littoral Forest: <i>Pisonia grandis</i> Littoral Forest                              | CEGL008713 | NPSA.0102, NPSA.0200, NPSA.0914, NPSA.0955                                                                                                                                                                                                                                        | 4                 |
| 'Ala'a Forest: <i>Planchonella garberi</i> Forest [Park Special]                              | CEPS009643 | NPSA.0004                                                                                                                                                                                                                                                                         | 1                 |
| Tava Forest: <i>Pometia pinnata</i> Forest [Park Special]                                     | CEPS009642 | NPSA.0111                                                                                                                                                                                                                                                                         | 1                 |

**Table. E.1 (continued).** USNVC associations and classification field plots.

| USNVC Association                                                                                                    | ELCODE     | Supporting Plots/Observation Points, and Observations                                                                                                                                                                                                                  | Number of Samples |
|----------------------------------------------------------------------------------------------------------------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Tavai Forest: <i>Rhus taitensis</i> Forest                                                                           | CEGL008715 | NPSA.0011, NPSA.0017, NPSA.0116, NPSA.0119, NPSA.0137                                                                                                                                                                                                                  | 5                 |
| Asi - Ifilele Forest: <i>Syzygium inophylloides</i> - <i>Intsia bijuga</i> Forest                                    | CEGL008716 | NPSA.0019, NPSA.0020, NPSA.0043, NPSA.0031, NPSA.0401, NPSA.0005, NPSA.0006, NPSA.0012, NPSA.0022, NPSA.0023, NPSA.0028, NPSA.0029, NPSA.0030, NPSA.0034, NPSA.0054, NPSA.0114, NPSA.0118, NPSA.0203, NPSA.0906, NPSA.0907, NPSA.0908, NPSA.0910, NPSA.0911, NPSA.0957 | 24                |
| Fena vao - <i>Weinmannia affinis</i> Forest: <i>Syzygium samoense</i> - <i>Weinmannia affinis</i> Forest             | CEGL008717 | NPSA.0032, NPSA.0033, NPSA.0110, NPSA.0113, NPSA.0117, NPSA.0124, NPSA.0127, NPSA.0128, NPSA.0129, NPSA.0130, NPSA.0131, NPSA.0956                                                                                                                                     | 12                |
| Niu Southern Polynesian Forest: <i>Cocos nucifera</i> Southern Polynesian Forest                                     | CEGL008718 | NPSA.0055, NPSA.0207, NPSA.9208                                                                                                                                                                                                                                        | 3                 |
| Fue Lautetele - Fue saina: <i>Merremia peltata</i> - <i>Mikania micrantha</i> Semi-natural Vine Scrub [Park Special] | CEPS009638 | NPSA.0913, NPSA.0951                                                                                                                                                                                                                                                   | 2                 |

# 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> <u>N/A</u> ...of association to description: |                                 |
| 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:                                                                             |                                 |

Date: \_\_\_\_\_

|                    |                   |  |                                               |
|--------------------|-------------------|--|-----------------------------------------------|
| Height Class Scale | Cover Class Scale |  | MMU=0.5 ha                                    |
| 01 <0.5 m          | T <1%             |  | <b>Circle: r=40m</b>                          |
| 02 0.5-1 m         | P 1-5%            |  | <b>*Rectangle: 50m x 100m</b>                 |
| 03 1-2 m           | 1a 5.01-10%       |  | <b>*Square: 71m x71m</b>                      |
| 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%      |  |                                               |
|                    | 10 > 95%          |  |                                               |
|                    |                   |  | *Only sample if cannot sample a circular plot |

If other: **Size:** **Shape:**

| Stratum<br>Code | Height<br>Class | Cover<br>Class | Dominant species in stratum<br>(mark diagnostic species with a * ) | %Cover |
|-----------------|-----------------|----------------|--------------------------------------------------------------------|--------|
| _____           | _____           | _____          | _____<br>_____<br>_____<br>_____<br>_____                          | _____  |
| _____           | _____           | _____          | _____<br>_____<br>_____<br>_____                                   | _____  |
| _____           | _____           | _____          | _____<br>_____<br>_____<br>_____                                   | _____  |
| _____           | _____           | _____          | _____<br>_____<br>_____<br>_____                                   | _____  |

|                                   |                                     |                          |                          |
|-----------------------------------|-------------------------------------|--------------------------|--------------------------|
| <b>T1</b> Emergent (above canopy) | <b>S1</b> Tall shrub (>2 m)         | <b>H1</b> Graminoids     | <b>H4</b> Tree Seedlings |
| <b>T2</b> Canopy                  | <b>S2</b> Short Shrub (>0.5 m- 2 m) | <b>H2</b> Forbs          | <b>N</b> Nonvascular     |
| <b>T3</b> Sub-canopy              | <b>S3</b> Dwarf-shrub (< 0.5 m)     | <b>H3</b> Ferns & Allies | <b>V</b> 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                                                                                                                       |                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                  |
| <b>Landform:</b> 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: _____        |                                                                                                                                                                                                                                                                                 | <b>Geology:</b> A 'a lava, Pahoehoe Lava, Ash, Cinder, Coral, Limestone, Pumice, Obscured by soil, Other: _____                                                                                                  |
| <b>Ground Cover:</b> (please estimate to the nearest percentage. Sum = 100%)                                                                                                                                                                |                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                  |
| <input type="checkbox"/> Bare soil (<0.1 mm)<br><input type="checkbox"/> Sand (0.1-2 mm)<br><input type="checkbox"/> Small Rock (2mm-6.4cm)<br><input type="checkbox"/> Rock (> 6.4 cm)<br><input type="checkbox"/> Bedrock (solid surface) | <input type="checkbox"/> Litter/Duff (dead plant material <3 cm diameter)<br><input type="checkbox"/> Coarse woody debris (dead wood 3-10 cm)<br><input type="checkbox"/> Woody debris structure (dead >10 cm deep & wide)<br><input type="checkbox"/> Live veg (litter / wood) | <input type="checkbox"/> Lichen (ground)<br><input type="checkbox"/> Moss (ground)<br><input type="checkbox"/> Microbiotic soil crust<br><input type="checkbox"/> Water<br><input type="checkbox"/> 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 Kass Green & Associates (KGA) and the Pacific Island Inventory & Monitoring Program (PACN). The tables include map classes composed of multiple U. S. National Vegetation Classification (USNVC) associations (Table G.1), new classes with no comparable USNVC associations (Table G.2), and classes of special park interest that include smaller than 0.5ha polygons (Table G.3) and plots where secondary reference labels or map labels were accepted as correct (Table G.4).

**Table G.1.** Composite map classes containing multiple USNVC associations.

| Map Class                                                                                                   | USNVC Association                                                                            | Description                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Dysoxylum</i> spp. - <i>Rhus</i> - <i>Alphitonia</i> - ( <i>Myristica</i> , <i>Canarium</i> spp.) Forest | <i>Dysoxylum</i> ( <i>samoense</i> , <i>maota</i> ) Forest                                   | The classification rules to distinguish between these types are poor and are indistinguishable in the imagery.                                                                                                                            |
|                                                                                                             | <i>Rhus</i> <i>Taitensis</i> Forest                                                          |                                                                                                                                                                                                                                           |
|                                                                                                             | <i>Alphitonia</i> <i>zizyphoides</i> Forest [Park Special]                                   |                                                                                                                                                                                                                                           |
|                                                                                                             | <i>Myristica</i> <i>inutilis</i> - <i>Canarium</i> ( <i>vitiense</i> , <i>mafoa</i> ) Forest |                                                                                                                                                                                                                                           |
| <i>Syzygium</i> <i>inophylloides</i> - ( <i>Calophyllum</i> spp.) Forest                                    | <i>Syzygium</i> <i>inophylloides</i> - <i>Intsia</i> <i>bijuga</i> Forest                    | <i>Calophyllum</i> spp. is more commonly found co-dominating with <i>Syzygium</i> <i>inophylloides</i> then <i>Intsia</i> <i>bijuga</i> . Also, <i>Planchonella</i> <i>garberi</i> is more commonly found co-dominating in these forests. |
|                                                                                                             | <i>Planchonella</i> <i>garberi</i> Forest [Park Special]                                     |                                                                                                                                                                                                                                           |
| <i>Syzygium</i> <i>samoense</i> - ( <i>Crossostylis</i> <i>biflora</i> ) Forest                             | <i>Crossostylis</i> <i>biflora</i> Forest                                                    | The classification rules to distinguish between these two types are poor. Map class is restricted to Tutuila because <i>Crossostylis</i> does not occur in Manu'a.                                                                        |
|                                                                                                             | <i>Syzygium</i> <i>samoense</i> - <i>Weinmannia</i> <i>affinis</i> Forest                    |                                                                                                                                                                                                                                           |

**Table G.2.** Map classes with no comparable USNVC association. These vegetation types were missed during classification and are of interest to park management.

| Map Class                                                                  | Description                                                                                                                                                                                  |
|----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Agriculture                                                                | Active agriculture occurs within the NPSA and is valuable information on how the park lands are being used.                                                                                  |
| <i>Alphitonia</i> <i>zizyphoides</i> - <i>Rhus</i> <i>taitensis</i> Forest | <i>Alphitonia</i> and <i>Rhus</i> co-dominate in forests of Manu'a predominantly, but also occurs in the SW region of Tutuila. Both of these species are common in mature secondary forests. |
| Cliff Scrub                                                                | Found on the inaccessible cliff faces on Olosega and Ta'u. Described by Whistler (2009).                                                                                                     |
| Crater Marsh                                                               | Found in the inaccessible marshes on Ta'u. Described by Whistler (2009).                                                                                                                     |
| <i>Ipomoea</i> <i>pes-caprae</i> Herbaceous Vegetation                     | <i>Ipomoea</i> <i>pes-caprae</i> is a common vine along the coastal strand in the Pacific Islands.                                                                                           |
| <i>Mangifera</i> <i>indica</i> Forest                                      | Scattered mango trees occur along previously terraced land. The tree tops are spectrally unique some individual trees mapped.                                                                |
| Montane Scrub                                                              | Found on the inaccessible cliff faces and ridges on Tutuila. Described by Whistler (2009)                                                                                                    |
| <i>Terminalia</i> <i>samoensis</i> Littoral Forest                         | Indigenous tree that occurs in small, thin bands along the shores of Ofu at NPSA.                                                                                                            |
| <i>Wedelia</i> <i>biflora</i> - <i>Scaevola</i> <i>taccada</i> Shrubland   | Common shrub species found along coastal strands in the Pacific Islands.                                                                                                                     |

**Table. G.3.** Map classes with polygons below the MMU retained because they are of special interest to park management and were either evident on the imagery or field verified. Mapped ranges may not adequately represent the full distribution of small (<MMU) populations for these classes.

| Map Class                                                                  | Description                                                                                                                                                                                                           |
|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Agriculture                                                                | Easily identifiable in the imagery and provides information on current land use.                                                                                                                                      |
| Built-up                                                                   | Easily identifiable in the imagery.                                                                                                                                                                                   |
| Cliff Scrub                                                                | Described by Whistler (2009) and is restricted to the Manu'a islands on the map.                                                                                                                                      |
| Crater Marsh                                                               | Easily identifiable in the imagery in an inaccessible region.                                                                                                                                                         |
| <i>Cocos nucifera</i> Southern Polynesian Forest                           | Indicator of where and when people have lived, often in farmed lands. Used for food, and weaving baskets/mats.                                                                                                        |
| <i>Ipomoea pes-caprae</i> Herbaceous Vegetation                            | Vegetation only occurs in small, narrow bands along the coast.                                                                                                                                                        |
| <i>Mangifera indica</i> Forest                                             | Easily identifiable in the imagery and gives valuable information on how the land was used historically.                                                                                                              |
| <i>Merremia peltata</i> - <i>Mikania micrantha</i> Semi-natural Vine Scrub | Only polygons with a modifier of agriculture were retained below the MMU. This modifier is easily identifiable in the imagery and provides valuable information on past land use.                                     |
| <i>Metrosideros</i> spp. Forest                                            | Rare type. Encountered only once in the field during classification field work. Mapped only where field verified.                                                                                                     |
| Montane Scrub                                                              | Described by Whistler (2009) and is restricted to Tutuila on the map.                                                                                                                                                 |
| <i>Pandanus tectorius</i> Littoral Forest                                  | Cultural significance for use in plaiting fine and other mats. Also used in medicinal remedies.                                                                                                                       |
| <i>Pisonia grandis</i> Littoral Forest                                     | Distribution often coincides with seabird colonies. Historically used to make canoes.                                                                                                                                 |
| <i>Pometia pinnata</i> Forest                                              | Rare type, although previously abundant in lowland areas. Encountered only once in the field during classification field work. Mapped only where field verified. The hard wood was used for house posts and firewood. |
| <i>Terminalia samoensis</i> Littoral Forest                                | Vegetation only occurs in small, narrow bands along the coast.                                                                                                                                                        |
| Unvegetated                                                                | Easily identifiable in the imagery.                                                                                                                                                                                   |
| Water                                                                      | Easily identifiable in the imagery.                                                                                                                                                                                   |
| <i>Wedelia biflora</i> - <i>Scaevola taccada</i> Shrubland                 | Vegetation only occurs in small, narrow bands along the coast.                                                                                                                                                        |

**Table G.4.** Plots with secondary or tertiary field calls accepted as correct.

| Plot        | Second/Tertiary Field Call                                           | Reason for Accepting the Secondary Label                                           | Notes                                                                                                                     |
|-------------|----------------------------------------------------------------------|------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| TUT.AA.0174 | <i>Myristica inutilis</i> - <i>Canarium (vitiense, mafoa)</i> Forest | Crew notes that it was a tough decision between primary and secondary field calls. | The primary field call is rare on Tutuila in the final map.                                                               |
| TUT.AA.0069 | <i>Hibiscus tiliaceus</i> Forest                                     | Field data and notes more strongly support the secondary field call.               | Highly disturbed area due to landslides. Many native and non-native vines overgrowing downed vegetation.                  |
| OFU.AA.0057 | <i>Hibiscus tiliaceus</i> Forest                                     | Crew notes and photos support the secondary field label.                           | West facing slope with transitory vegetation with high cover of <i>Wedelia biflora</i> and <i>Barringtonia asiatica</i> . |
| OFU.AA.0024 | <i>Syzygium samoense</i> - <i>Weinmannia affinis</i> Forest          | Field notes state that primary label vegetation captures a low-lying ravine.       | Draft map label was accepted as correct because the AA site included small inclusions of different vegetation.            |

## Appendix H: Map Class Descriptions

This appendix describes the vegetated map classes for the National Park of American Samoa. The purpose of the 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 primarily from the calibration, and validation photos captured over the life of the vegetation inventory project.
- A representative portion of the high resolution aerial imagery (shown in infrared) of the map class captured at approximately 1:6000 scale. 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 association descriptions for NPSA were used as the map class description. When two associations comprise one map class, the USNVC association descriptions are combined. 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. Each map class description discusses the characteristics of the map class on imagery and how AA sites were employed to correct draft map errors to produce the final map.
- The map class's distribution and location at NPSA.
- For each map class, the final map class's hectares, number of classification plots, draft map user's accuracy, draft map producer's accuracy, number of AA map samples, and number of AA reference samples are provided. 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 NPSA are based on the USNVC plant associations and additional vegetation types discovered during the calibration 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. Other USNVC associations were combined into one map class because they were impossible to distinguish from one another using remote sensing methods, prioritized field reconnaissance, or GIS modeling. 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 9](#) of the main body of the report, provides information about how map classes and USNVC associations relate to one another.

## NPSA Map Classes

**MAP CODE:** B\_AG

**ELCODE:** NA

|                                    |                                 |
|------------------------------------|---------------------------------|
| <b>Map Class Name:</b> Agriculture | <b>Common Name:</b> Agriculture |
|------------------------------------|---------------------------------|



Ground View - Tutuila



Aerial View (Airborne Infrared Imagery) - Tutuila

**USNVC Association:** None

**Description:** This map class has no classification plots and therefore no association description. It was created to label areas within NPSA which are being actively cultivated for agricultural. This map class was mapped using field reconnaissance, image segmentation and manual interpretation. It is distinguished on the optical imagery by its bright pink smooth spectral response compared to surrounding vegetation and the agricultural crops planted. It is distinguished on the LIDAR imagery by the short height of the vegetation.

**Most Abundant Species:** Unknown

**Distribution/Location:** While areas evidencing past agricultural use exist throughout NPSA, this map class of active agricultural cultivation only occurs on isolated polygons on Tutuila.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 0           | <b>Hectares:</b> 3.43                            |
| <b>User's Accuracy:</b> Not Assessed       | <b>Producer's Accuracy:</b> Not Assessed         |
| <b>Accuracy Assessment Map Samples:</b> NA | <b>Accuracy Assessment Reference Samples:</b> NA |

**MAP CODE: F\_ALRH****ELCODE: NA**

|                                                                                     |                                        |
|-------------------------------------------------------------------------------------|----------------------------------------|
| <b>Map Class Name:</b> <i>Alphitonia zizyphoides</i> - <i>Rhus taitensis</i> Forest | <b>Common Name:</b> Toi - Tavai Forest |
|-------------------------------------------------------------------------------------|----------------------------------------|



Ground View - Olosega

Aerial View (Airborne Infrared Imagery) - Olosega

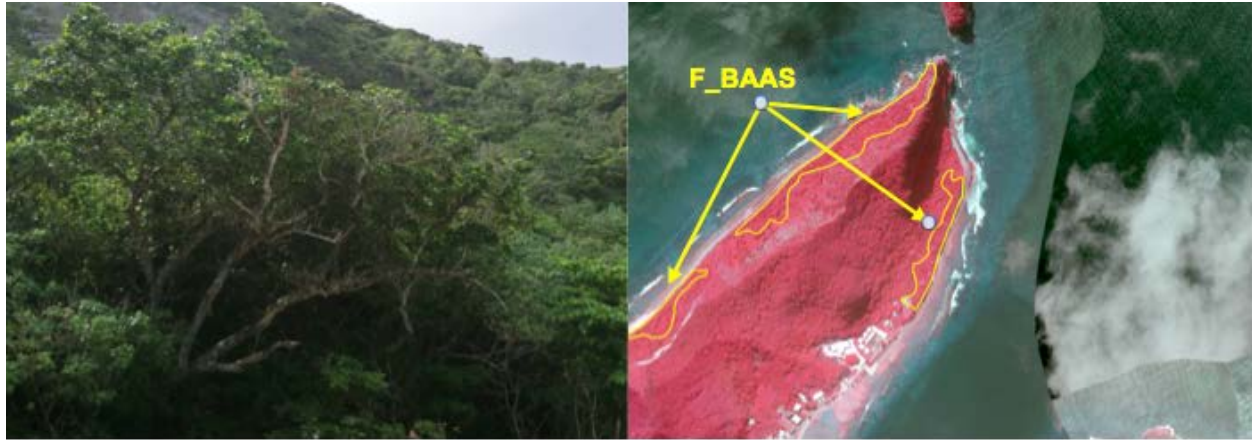
**USNVC Association:** None

**Description:** This map class was created following the calibration trip to account for areas viewed on the imagery and in the field through binoculars on Olosega and Ta'ū where large *Alphitonia zizyphoides* trees appeared to be dominating the canopy. It has no classification plots and, therefore, no association description. AA samples confirmed that this class is unique with *Alphitonia zizyphoides* (58-69%) and *Rhus taitensis* (12-47%) co-dominating, and few other species present in the canopy. This class was mapped using field reconnaissance, image segmentation and manual interpretation. It is distinguished on the infrared imagery by the height, density and brownish tint of the *Alphitonia zizyphoides* trees. On the draft map, this class was over committed with three reference samples of *Dysoxylum* spp. - *Rhus* - *Alphitonia* - (*Myristica*, *Canarium* spp.) Forest and three reference samples of *Hibiscus tiliaceus* Forest. The areas of five of the confused samples were edited to *Dysoxylum* spp. - *Rhus* - *Alphitonia* - (*Myristica*, *Canarium* spp.) Forest in the final map, with the remaining sample not edited because the *Hibiscus tiliaceus* was not evident in the imagery in areas above the MMU.

**Distribution/Location:** This class is primarily located on the south and west facing slopes of Piumafua Mountain on Olosega and on the western portions of the Liu Bench of Ta'ū. It also occurs in two polygons in the southwestern portion of NPSA on Tutuila.

|                                            |                                                 |
|--------------------------------------------|-------------------------------------------------|
| <b>Classification Samples:</b> None        | <b>Hectares:</b> 184.18                         |
| <b>User's Accuracy:</b> 50%                | <b>Producer's Accuracy:</b> 100%                |
| <b>Accuracy Assessment Map Samples:</b> 12 | <b>Accuracy Assessment Reference Samples:</b> 6 |

|                                                                     |                                          |
|---------------------------------------------------------------------|------------------------------------------|
| <b>Map Class Name:</b> <i>Barringtonia asiatica</i> Littoral Forest | <b>Common Name:</b> Futu Littoral Forest |
|---------------------------------------------------------------------|------------------------------------------|



Ground View - Tutuila

Aerial View (airborne Infrared Imagery)- Tutuila

**USNVC Association:** *Barringtonia asiatica* Littoral Forest

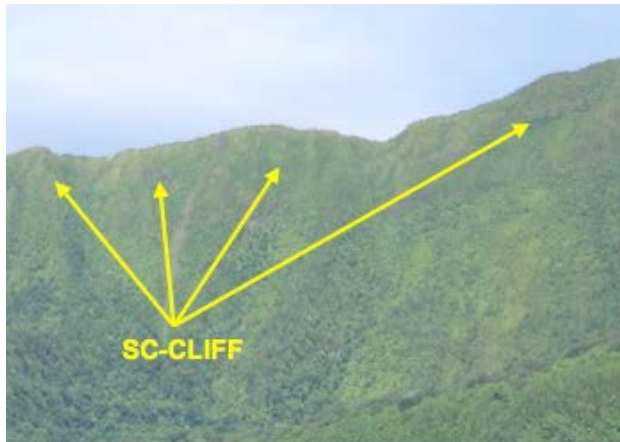
**Description:** This broad-leaved association is a forest or woodland dominated in the upper canopy by *Barringtonia asiatica* which may range from 2-60% cover. Other canopy associates include *Thespesia populnea*, *Hibiscus tiliaceus*, *Terminalia catappa*, and *Pandanus tectorius*. Shrub and herbaceous species have low constancy and cover. Shrubs may include *Wedelia biflora*, *Scaevola taccada*, and *Guettarda speciosa*. The dominant cover in the herbaceous stratum is seedlings of woody species dominant in the canopy, but herbaceous species present at low cover may include *Vigna marina*, *Phymatosorus grossus*, and *Ipomoea pes-caprae*. Vines common at low cover include *Epipremnum pinnatum*, *Mikania micrantha*, *Merremia peltata*, *Faradaya amicornum*, and *Mucuna gigantea*. This class was mapped using field reconnaissance, image segmentation and manual interpretation. It is distinguished on the optical imagery by its location near the coast and its dark green spectral response in true color imagery. It is indistinguishable from other forest classes on the LIDAR imagery. On the draft map it was over mapped, with the coastal strand often too wide. This class was completely remapped when the airborne imagery became available and all errors were corrected for the final map.

**Distribution/Location:** This map class occupies coastal strands in portions of NPSA on all four islands. It occurs on beaches, slides and occasionally lava flows at low level, midslopes and high slopes ranging from 8-80 m in elevation. Slopes are variable and range from nearly flat to very steep (1-70 degrees) on all aspects.

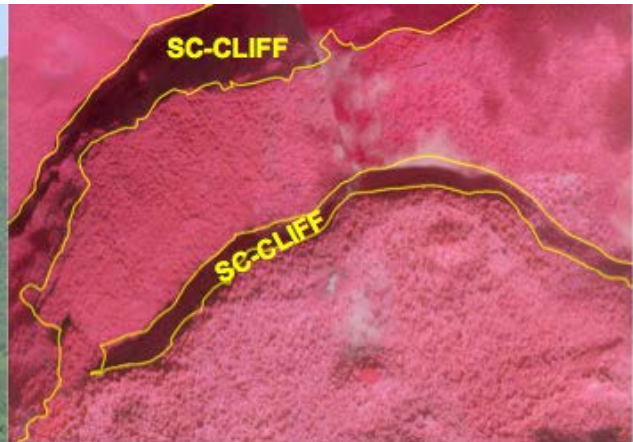
|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 15          | <b>Hectares:</b> 25.23                           |
| <b>User's Accuracy:</b> 38%                | <b>Producer's Accuracy:</b> 67%                  |
| <b>Accuracy Assessment Map Samples:</b> 21 | <b>Accuracy Assessment Reference Samples:</b> 12 |

**MAP CODE: SC\_CLIFF****ELCODE: NA**

|                                    |                                 |
|------------------------------------|---------------------------------|
| <b>Map Class Name:</b> Cliff Scrub | <b>Common Name:</b> Cliff Scrub |
|------------------------------------|---------------------------------|



Ground View - Ta'ū



Aerial View (Airborne Infrared Imagery) - Ta'u

**USNVC Association:** None

**Description:** This map class has no classification plots and, therefore, no NatureServe description. It was created to label the inaccessible vegetated cliffs of Olosega and Ta'u. It was mapped using a combination of image segmentation manual interpretation. Because this class is terrain driven (only on steep cliffs), it was completely remapped when the aerial imagery became available to ensure that the class boundaries matched the new imagery. It is distinguished on the imagery by its location and its smooth pink spectral response. It was not assessed for accuracy.

**Most Abundant Species:** Unknown**Distribution/Location:** On cliff faces of Piumafua Mountain on Olosega and Mount Lata on Ta'ū.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> None        | <b>Hectares:</b> 157.36                          |
| <b>User's Accuracy:</b> Not Assessed       | <b>Producer's Accuracy:</b> Not Assessed         |
| <b>Accuracy Assessment Map Samples:</b> NA | <b>Accuracy Assessment Reference Samples:</b> NA |

**MAP CODE: F\_CONU****ELCODE:CEGL008718**

|                                                                         |                                |
|-------------------------------------------------------------------------|--------------------------------|
| <b>Map Class Name:</b> <i>Cocos nucifera</i> Southern Polynesian Forest | <b>Common Name:</b> Niu Forest |
|-------------------------------------------------------------------------|--------------------------------|



Ground View - Olosega

Aerial View (Airborne Infrared Imagery) - Ta'ū

**USNVC Association:** *Cocos nucifera* Southern Polynesian Forest

**Description:** This forest and woodland vegetation has a canopy dominated by *Cocos nucifera* averaging about 15% cover. *Hernandia nymphaeifolia* is a constant canopy associate, but averages about half the average cover of *Cocos nucifera*. Other canopy associates may include *Pisonia grandis*, *Tarennia sambucina*, *Macaranga harveyana*, and *Hibiscus tiliaceus*. Shrubs are always present but at low covers and may include *Guettarda speciosa*, *Premna serratifolia*, *Sophora tomentosa*, *Clerodendrum inerme*, and *Colubrina asiatica*. The most abundant species in the herbaceous layer are woody seedlings of canopy dominants. *Phymatosorus grossus* is a constant forb in this community at low cover. Other herbs that may be present at low cover include *Lepturus repens*, *Vigna marina*, and *Nephrolepis hirsutula*. Vine species are prevalent and may comprise up to 10% total vegetation cover. Species may include *Piper graeffei*, *Mikania micrantha*, *Derris trifoliata*, *Canavalia rosea*, *Epipremnum pinnatum*, *Ipomoea littoralis*, and *Hoya australis*. This map class was mapped using field reconnaissance and manual image interpretation. It is distinguished on the imagery by the star shaped crowns of the coconut trees which are very distinctive and easy to identify on the high resolution optical airborne imagery.

**Distribution/Location:** This map class is found on the coastal strand of the NPSA portions on all of the islands of American Samoa at low level positions at elevations less than 25 m. Slopes are gentle and range from 10-15%. Substrates are sandy with abundant litter and occasionally exposed coral. Soils are composed of well-drained, dry sand.

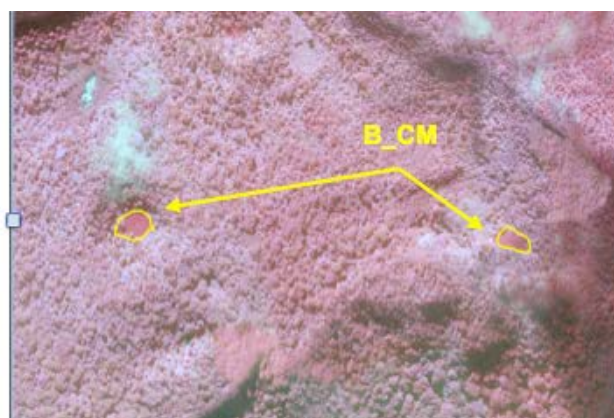
|                                           |                                                 |
|-------------------------------------------|-------------------------------------------------|
| <b>Classification Samples:</b> 3          | <b>Hectares:</b> 17.21                          |
| <b>User's Accuracy:</b> 75%               | <b>Producer's Accuracy:</b> 100%                |
| <b>Accuracy Assessment Map Samples:</b> 4 | <b>Accuracy Assessment Reference Samples:</b> 3 |

**MAP CODE: B\_CM**

**ELCODE: NA**

|                                     |                                  |
|-------------------------------------|----------------------------------|
| <b>Map Class Name:</b> Crater Marsh | <b>Common Name:</b> Crater Marsh |
|-------------------------------------|----------------------------------|

No Ground Photo Available



Aerial View (Airborne Infrared Imagery)

**USNVC Association:** None

**Description:** This map class has no classification plots and, therefore, no association description. It was created to label the unique but inaccessible crater marshes of the Liu Bench of Mount Lata on Ta'ū. Its vegetation may be similar to the crater marsh vegetation described by Whistler (2002) from other Samoan islands. This class was mapped using manual interpretation. It is distinguishable on the imagery by its location in known craters, its oval to circular shape, and its dark red, smooth, and short vegetation.

**Distribution/Location:** This map class occurs in three polygons on the Liu Bench of Mount Lata on Ta'ū.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 0           | <b>Hectares:</b> 0.97                            |
| <b>User's Accuracy:</b> Not Assessed       | <b>Producer's Accuracy:</b> Not Assessed         |
| <b>Accuracy Assessment Map Samples:</b> NA | <b>Accuracy Assessment Reference Samples:</b> NA |

**MAP CODE: F\_DYSO****ELCODE: CEG008708**

|                                                                  |                                            |
|------------------------------------------------------------------|--------------------------------------------|
| <b>Map Class Name:</b> <i>Dysoxylum (samoense, maota)</i> Forest | <b>Common Name:</b> (Mamala, Maota) Forest |
|------------------------------------------------------------------|--------------------------------------------|



Ground View - Ta'ū

Aerial View (Airborne Infrared Imagery) - Ta'ū

**USNVC Association:** *Dysoxylum (samoense, maota)* Forest

**Description:** This forest or woodland association is nearly always dominated by *Dysoxylum samoense* or *Dysoxylum maota*. Other common canopy associates include *Ficus scabra*, *Neonauclea forsteri*, and *Planchonella garberi*. In the understory, shrub species have low constancy and cover with no one species dominating or indicative of the community. The herbaceous layer is diverse with *Tectaria dissecta* dominating most stands with abundant woody species regeneration composing much of the remaining cover. Other herbaceous species with high constancy include *Angiopteris evecta* and *Christella harveyi*, but both occur at low cover. Epiphytic species are important with *Lomagramma cordipinna* attaining upwards of 15% total cover in some stands. Vine species have high constancy but occur at low average cover. Species include *Piper graeffei*, *Faradaya amicum*, *Mikania micrantha*, *Epipremnum pinnatum*, and *Alyxia bracteolosa*. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. On the draft map it was most often confused with *Hibiscus tiliaceus* Forest (four samples). The areas of all four samples were edited to *Hibiscus tiliaceus* Forest in the final map.

**Distribution/Location:** This map class is found in NPSA only on the Islands of Olosega and Ta'ū in low-, mid- and high-slope positions at elevations ranging from 16-331 m. In isolated places it also can reach down into the littoral zone. Slopes range from gentle to very steep (15-90 degrees) on all aspects.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 16          | <b>Hectares:</b> 326.57                          |
| <b>User's Accuracy:</b> 65%                | <b>Producer's Accuracy:</b> 89%                  |
| <b>Accuracy Assessment Map Samples:</b> 26 | <b>Accuracy Assessment Reference Samples:</b> 19 |

**MAP CODE: F\_DYRHAL**

**ELCODE: C EGL008708, C EGL008715,  
CEPS009641, C EGL008711**

|                                                                                                                                    |                                                                          |
|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| <b>Map Class Name:</b> <i>Dysoxylum</i> spp. - <i>Rhus</i> - <i>Alphitonia</i> - ( <i>Myristica</i> , <i>Canarium</i> spp.) Forest | <b>Common Name:</b> Mamala, Maota - Tavai - Toi - (Atone, Ma'ali, Mafoa) |
|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|



Ground View - Tutuila

Aerial View (Airborne Infrared Imagery) - Tutuila

**USNVC Association:** *Dysoxylum* (samoense, maota) Forest, *Rhus Taitensis* Forest, *Alphitonia zizyphoides* Forest [Park Special], *Myristica inutilis* - *Canarium* (vitiense, mafoa) Forest

**Description:** This map class is a combination of several associations on Tutuila which were combined because they were indistinguishable from one another on the infrared imagery or using GIS modeling in areas larger than the MMU. This highly diverse forest map class is dominated by a mix of *Dysoxylum samoense* or *Dysoxylum maota*, *Myristica inutilis*, *Canarium* spp., *Rhus taitensis*, and *Alphitonia zizyphoides*. The mix of which species are dominant changes over the landscape and is unrelated to slope, aspect, or elevation. Some stands may include very large emergent individual *Ficus prolixa* trees. Other common canopy associates include *Hibiscus tiliaceus*, *Ficus scabra*, *Neonauclea forsteri*, *Buchanania merrillii*, *Ficus scabra*, *Macaranga stipulosa*, *Syzygium inophylloides*, and *Planchonella garberi*. There are over 40 additional trees species with lower constancy and cover recorded in various stands of this forest type. In the understory, shrub species have low constancy and cover with no one species dominating or indicative of the community. The herbaceous cover is variable but typically lower cover and composed of tree seedlings and a few constant or abundant ferns and herbs such as *Angiopteris evecta*, *Asplenium acuminatum*, *Christella harveyi*, *Heliconia laufao*, *Tectaria dissecta*, and *Zingiber zerumbet*. Some stands will have upwards of 15% total cover in epiphytic species. Vines such as *Piper graeffei*, *Faradaya amicornum*, *Mikania micrantha*, *Merremia peltata*, *Epipremnum pinnatum*, *Freycinetia* spp., *Hoya australis*, and *Alyxia bracteolosa* are usually present. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. Because of its extreme diversity in species and in spectral response, this class is distinguished on the imagery by what it is not (e.g. it usually is not found on the top of steep ridges or in the coastal strand, the height of its vegetation in the LIDAR imagery is not short, the spectral response is not smooth). On the draft map this class was most often confused with *Hibiscus tiliaceus* Forest (seven samples) and *Syzygium inophylloides* - (*Calophyllum* spp.) Forest (seven samples). Most of these errors were corrected on the final map, except

for confusion with *Hibiscus tiliaceus* Forest if the *Hibiscus tiliaceus* Forest appeared to be below the MMU on the imagery.

**Distribution/Location:** This is the largest map class on Tutuila. It usually appears on sideslopes, cliffs, and gentle ridges at low-, mid- and high-slope positions at elevations ranging from just above the littoral zone to 345 m. In isolated areas, it may reach into the littoral zone to the ocean's edge. Slopes range from gentle to very steep (15-90 degrees) on all aspects.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 47          | <b>Hectares:</b> 1103.12                         |
| <b>User's Accuracy:</b> 73%                | <b>Producer's Accuracy:</b> 72%                  |
| <b>Accuracy Assessment Map Samples:</b> 56 | <b>Accuracy Assessment Reference Samples:</b> 57 |

|                                                    |                         |
|----------------------------------------------------|-------------------------|
| Map Class Name: : <i>Hibiscus tiliaceus</i> Forest | Common Name: Fau Forest |
|----------------------------------------------------|-------------------------|



Ground View - Tutuila

Aerial View (Airborne Infrared Imagery) - Ta'ū

**USNVC Association:** *Hibiscus tiliaceus* Forest

**Description:** This highly variable map class is characterized by a moderately dense to closed tree canopy typically 4-13 m tall trees that are dominated by *Hibiscus tiliaceus* (10-46% cover) with many other tree species present. The most constant and abundant other trees are *Barringtonia asiatica*, *Diospyros samoensis* (0-12%), *Ficus scabra* (0-8%), *Cordyline fruticosa* (0-5%), *Dysoxylum samoense* (0-5%), and *Myristica inutilis* (0-6%). Also present may be *Rhus taitensis* (0-15%), *Morinda citrifolia* (0-3%), *Sterculia fanaiho* (0-6%), *Artocarpus altilis* (0-16%), *Cocos nucifera* (0-15%), *Buchanania merrillii* (0-10%), and over two dozen other tree species with lower cover. Shrubs such as *Clidemia hirta* (0-15%), *Scaevola taccada* (0-25%), or *Wedelia biflora* (0-40%) are sometimes present. Vines and/or lianas such as *Alyxia bracteolosa*, *Epipremnum pinnatum*, *Faradaya amicornum*, *Freycinetia* spp., *Hoya australis*, *Mikania micrantha*, and *Piper graeffei* are common, and *Gynochthodes epiphytica* is occasionally abundant. Herbaceous cover is low to moderate and typically composed of tree seedlings, along with a few graminoids, forbs and ferns such as *Acrostichum aureum*, *Angiopteris evecta*, *Asplenium horridum*, *Christella harveyi*, *Fimbristylis dichotoma*, *Lepturus repens*, *Miscanthus floridulus*, *Oplismenus hirtellus*, *Phymatosorus grossus*, and *Tectaria dissecta*. This class was mapped using a combination of field reconnaissance, image segmentation and manual interpretation. The class is difficult to distinguish on the imagery because of its highly variable nature. When dense and homogeneous in *Hibiscus tiliaceus* cover, it has a smooth red spectral signature unless it is continually affected by the seaspray which may result in a smooth gray spectral response. When codominant with other tree species, it is indistinguishable from most other upland forest map classes. In the draft map it was most commonly confused with the *Dysoxylum* spp. forest classes (11 errors of omission). The increased spatial resolution of the airborne imagery made it possible to correct most of the errors of omission for the final map when they occurred in areas larger than the MMU.

**Distribution/Location:** While the classification plots of this class are mostly within the littoral zones of NPSA, the accuracy assessment samples showed that it is also found on all slopes, elevations and aspects.

Whistler (2002) points out that *Hibiscus tiliaceus* often occurs in small patches in former agricultural plots, gaps in climax forests in openings where a large trees have fallen, and in areas of continual disturbance caused by landslides, erosion, or wave action. Whistler suggests that *Hibiscus tiliaceus* was planted by the Samoans near their homes which may explain its wide distribution.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 15          | <b>Hectares:</b> 146.37                          |
| <b>User's Accuracy:</b> 71%                | <b>Producer's Accuracy:</b> 47%                  |
| <b>Accuracy Assessment Map Samples:</b> 28 | <b>Accuracy Assessment Reference Samples:</b> 43 |

**MAP CODE: H\_IPPE**

**ELCODE: NA**

|                                                                           |                                                        |
|---------------------------------------------------------------------------|--------------------------------------------------------|
| <b>Map Class Name:</b> <i>Ipomoea pes-caprae</i><br>Herbaceous Vegetation | <b>Common Name:</b> Fue asaga Herbaceous<br>Vegetation |
|---------------------------------------------------------------------------|--------------------------------------------------------|



Ground View - Olosega

Aerial View (Airborne Infrared Imagery) - Olosega

**USNVC Association:** None

**Description:** This map class has no classification plots and, therefore, no association description. It was created to provide a label for the *Ipomoea pes-caprae* covered beaches on the northwest side of Olosega. It is characterized by usually dense *Ipomoea pes-caprae* cover often mixed with other vines such as *Vigna marina* and *Mikania micrantha*. Scattered trees such as *Hibiscus tiliaceus* or *Cocos nucifera* may occur but never exceeding 10% cover. On the draft map, this class was confused with unvegetated (beach) because of the registration errors in the original satellite imagery. These errors were corrected in the final map with the airborne imagery.

**Distribution/Location:** This map class appears as two long thin polygons on the northwest beaches of Olosega. While *Ipomoea pes-caprae* is found on other beaches in NSPA, it never reaches an area above the MMU.

|                                           |                                                 |
|-------------------------------------------|-------------------------------------------------|
| <b>Classification Samples:</b> 0          | <b>Hectares:</b> 3.13                           |
| <b>User's Accuracy:</b> 100%              | <b>Producer's Accuracy:</b> 25%                 |
| <b>Accuracy Assessment Map Samples:</b> 1 | <b>Accuracy Assessment Reference Samples:</b> 4 |

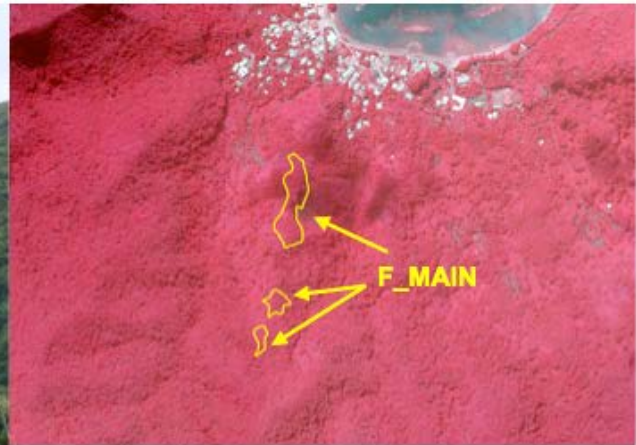
**MAP CODE: F\_MAIN**

**ELCODE: NA**

|                                                       |                                 |
|-------------------------------------------------------|---------------------------------|
| <b>Map Class Name:</b> <i>Mangifera indica</i> Forest | <b>Common Name:</b> Mago Forest |
|-------------------------------------------------------|---------------------------------|



Ground View - Tutuila



Aerial View (Airborne Infrared Imagery) - Tutuila

**USNVC Association:** None

**Description:** This map class has no classification plots and, therefore, no association description. It was created to label the small but culturally significant *Mangifera indica* forests on the Vatia trail. This class was mapped using field reconnaissance and manual interpretation. It is distinguished on the infrared imagery by the round bright pink spectral signature of the *Mangifera indica* trees. The class was not assessed for accuracy.

**Distribution/Location:** This map class occurs in three small polygons along the Vatia trail on the ridge above the village of Vatia.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 0           | <b>Hectares:</b> 1.59                            |
| <b>User's Accuracy:</b> Not Assessed       | <b>Producer's Accuracy:</b> Not Assessed         |
| <b>Accuracy Assessment Map Samples:</b> NA | <b>Accuracy Assessment Reference Samples:</b> NA |

**MAP CODE: V\_MEMI****ELCODE: CEPS009638**

|                                                                                                   |                                                                       |
|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| <b>Map Class Name:</b> <i>Merremia peltata</i> - <i>Mikania micrantha</i> Semi-natural Vine Scrub | <b>Common Name:</b> Fue lautelele - Fue saina Semi-natural Vine Scrub |
|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|



Ground View

Aerial View (Airborne Infrared Imagery)

**USNVC Association:** *Merremia peltata* - *Mikania micrantha* Semi-natural Vine Scrub [Park Special]

**Description:** This map class consists of trees with heavy vine cover. It is dominated by a native vine *Merremia peltata* (15%) and non-native vine *Mikania micrantha* (15 - 27% cover) on native or non-native trees such as *Macaranga harveyana* (16%), and *Artocarpus altilis* (11% cover). Other tree species present include *Pipturus argenteus* (7%), *Ficus scabra* (5%), *Kleinhovia hospita* (7%) and *Musa* spp. (3%). *Hibiscus tiliaceus* may be present with low cover. Herbaceous layer may include *Bidens alba* (10%) or *Nephrolepis hirsutula* (10%). This class was mapped using field reconnaissance and manual interpretation. In the infrared imagery, the class is characterized by the bright pink smooth reflectance of the mats of vines dotted with darker pink or red spots of the portions of tree canopies not covered in vine. In the Lidar data, this class is significantly shorter than the surrounding non-vine covered forest vegetation. In the draft map, this class was confused with the forested classes which were covered in the vines (three *Barringtonia asiatica* Littoral Forest and three *Hibiscus tiliaceus* Forest samples). All areas of error were corrected in the final map.

**Distribution/Location:** This map class occurs in areas of forest disturbance caused by abandoned agriculture or slides. On Tutuila, it is found behind primarily in old agricultural plots behind the village of Vatia and on slides on the northwest side of Polauta Ridge. On Ta'ū it is found on the cliffs of the eastern side of the island.

|                                           |                                                 |
|-------------------------------------------|-------------------------------------------------|
| <b>Classification Samples:</b> 2          | <b>Hectares:</b> 37.33                          |
| <b>User's Accuracy:</b> 100%              | <b>Producer's Accuracy:</b> 22%                 |
| <b>Accuracy Assessment Map Samples:</b> 2 | <b>Accuracy Assessment Reference Samples:</b> 9 |

**MAP CODE: F\_MESP**

**ELCODE: CEPS009640**

|                                                        |                                                |
|--------------------------------------------------------|------------------------------------------------|
| <b>Map Class Name:</b> <i>Metrosideros</i> spp. Forest | <b>Common Name:</b> <i>Metrosideros</i> Forest |
|--------------------------------------------------------|------------------------------------------------|



Ground View - Tutuila

Aerial View (Airborne Infrared Imagery) - Tutuila

**USNVC Association:** *Metrosideros* spp. Forest [Park Special]

**Description:** This unique map class is characterized by a moderately dense tree canopy seven meters tall that is dominated by *Metrosideros* spp. (40% cover) with several other trees species including *Fagraea berteriana* (5%), *Dysoxylum huntii* (3%), and *Codiaeum variegatum* (3%). Orchids and lianas include *Bulbophyllum polypodioides* (5%), and *Freycinetia arborea* (3%). The open shrub layer is codominated by *Bidens alba* (8%) and *Allamanda cathartica* (6%), and the open herbaceous layer is dominated by the graminoids *Axonopus compressus*, *Chrysopogon aciculatus*, *Paspalum paniculatum*, and *Paspalum setaceum*. This class was mapped using field reconnaissance and manual interpretation. It was not assessed for accuracy.

**Distribution/Location:** This map class is found in one polygon near the radio towers on Mount 'Alava on Tutuila.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 1           | <b>Hectares:</b> 0.15                            |
| <b>User's Accuracy:</b> Not Assessed       | <b>Producer's Accuracy:</b> Not Assessed         |
| <b>Accuracy Assessment Map Samples:</b> NA | <b>Accuracy Assessment Reference Samples:</b> NA |

**MAP CODE: SC\_MON**

**ELCODE: NA**

|                                      |                                   |
|--------------------------------------|-----------------------------------|
| <b>Map Class Name:</b> Montane Scrub | <b>Common Name:</b> Montane Scrub |
|--------------------------------------|-----------------------------------|



Ground View - Tutuila

Aerial View (Airborne Infrared Imagery) - Tutuila

**USNVC Association:** None

**Description:** This map class has no classification plots and, therefore, no association description. It was created to label the inaccessible montane scrub areas on Tutuila. The class is described by Whistler (2002) as occurring on the “upper slopes and ridges of trachyte plugs and dikes” on Tutuila. His work characterizes the class as dominated by *Dicranopteris linearis* with scattered, short trees which may include *Pandanus reineckei*, *Metrosideros* spp., *Rapanea myricifolia*, *Astronidium pickeringii* and *Spiraeanthemum samoense*. Other herbaceous vegetation includes *Dipteris conjugata*, *Machaerina falcate*, *Freycinetia storchii* and *Davallia epiphylla*. This class was mapped using field reconnaissance and manual interpretation. It is distinguishable on the imagery by its location on the trachyte plugs and the greyish pale pink spectral response and short height of its vegetation. It was not assessed for accuracy.

**Distribution/Location:** This map class only occurs on the Tutuila portions of NPSA. The largest polygons are located on Maugaotula Peak, Si‘uono Ridge and Polauta Ridge.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 0           | <b>Hectares:</b> 6.67                            |
| <b>User’s Accuracy:</b> Not Assessed       | <b>Producer’s Accuracy:</b> Not Assessed         |
| <b>Accuracy Assessment Map Samples:</b> NA | <b>Accuracy Assessment Reference Samples:</b> NA |

**MAP CODE: F\_PATE****ELCODE: CEGl008712**

|                                                                  |                                          |
|------------------------------------------------------------------|------------------------------------------|
| <b>Map Class Name:</b> <i>Pandanus tectorius</i> Littoral Forest | <b>Common Name:</b> Fala Littoral Forest |
|------------------------------------------------------------------|------------------------------------------|



Ground View - Ta'ū

Aerial View (Airborne Infrared Imagery) - Ta'ū

**USNVC Association:** *Pandanus tectorius* Littoral Forest

**Description:** This is a low-statured forest (4-5m in height) with a fairly open canopy (32-90%). The main dominant canopy trees are *Pandanus tectorius* (5-22% cover) and *Cocos nucifera* (0-5%). *Thespesia populnea*, *Terminalia samoensis*, *Pisonia grandis*, *Ficus* spp., *Hibiscus tiliaceus*, and *Terminalia catappa* may be present with up to 12% cover, but these are never more than half as abundant as *P. tectorius*. Shrubs that may be present include *Scaevola taccada* and *Wedelia biflora* with 0-9% canopy coverage. Herbaceous cover is generally low but occasionally one or two species gain significant coverage such as *Zoysia tenuifolia* which is present in one plot with 12% cover. This class was mapped only where field verified. Therefore, other occurrences of this class may exist in the park.

**Distribution/Location:** These littoral forests occur within 25 m in elevation (range 17-25 m), usually on beaches but they can occur on cliff faces and terraces. While individual *Pandanus tectorius* plants can be found on all of NPSA's islands, they occur in greater than MMU sized polygons only on Ofu (near the middle of the coastal strand) and Ta'ū (near Aufotu Cove).

|                                           |                                                 |
|-------------------------------------------|-------------------------------------------------|
| <b>Classification Samples:</b> 6          | <b>Hectares:</b> 0.36                           |
| <b>User's Accuracy:</b> 100%              | <b>Producer's Accuracy:</b> 100%                |
| <b>Accuracy Assessment Map Samples:</b> 3 | <b>Accuracy Assessment Reference Samples:</b> 3 |

|                                                               |                                              |
|---------------------------------------------------------------|----------------------------------------------|
| <b>Map Class Name:</b> <i>Pisonia grandis</i> Littoral Forest | <b>Common Name:</b> Pu'a Vai Littoral Forest |
|---------------------------------------------------------------|----------------------------------------------|



Ground View - Ta'ū

Aerial View (Airborne Infrared Imagery) - Ta'ū

**USNVC Association:** *Pisonia grandis* Littoral Forest

**Description:** This map class is characterized by high total canopy coverage (52-70%). Stands are dominated by *Pisonia grandis* with 15-40% canopy coverage. Other tree species present may include *Hibiscus tiliaceus*, *Barringtonia asiatica*, *Diospyros samoensis*, *Hernandia nymphaeifolia*, *Macaranga harveyana*, and *Ficus obliqua* (0-12%). There are no shrubs and only a few vines and epiphytes, such as *Epipremnum pinnatum*, *Hoya pottsii*, and *Asplenium nidus* with 0-9% cover. The herbaceous cover is very low due to heavy shading by the upper canopy. This map class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is distinguished on the infrared imagery by the pale whitish spectral response of the *Pisonia grandis* crowns. This map class was overmapped in the draft map, resulting in low user's accuracies. All areas of error were corrected in the final map.

**Distribution/Location:** This is a lowland rain forest type that occurs below 200 m (10-195 m) elevation, on sideslopes, beaches, and sometimes cliffs. It is found primarily on east facing beaches on the NPSA portions of Tutuila, Olosega, and Ta'ū. It is also found on the trachyte plug ridges and cliff faces of Polauta Ridge and Pola Island.

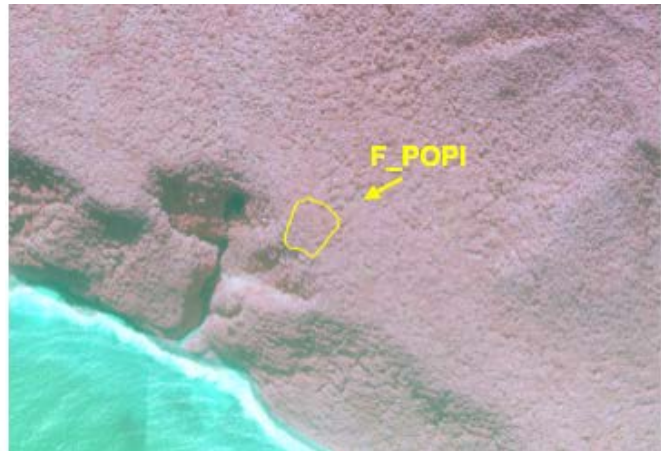
|                                           |                                                 |
|-------------------------------------------|-------------------------------------------------|
| <b>Classification Samples:</b> 4          | <b>Hectares:</b> 18.55                          |
| <b>User's Accuracy:</b> 38%               | <b>Producer's Accuracy:</b> 100%                |
| <b>Accuracy Assessment Map Samples:</b> 8 | <b>Accuracy Assessment Reference Samples:</b> 3 |

**MAP CODE: F\_POPI**

**ELCODE: CEPS009642**

|                                                      |                                 |
|------------------------------------------------------|---------------------------------|
| <b>Map Class Name:</b> <i>Pometia pinnata</i> Forest | <b>Common Name:</b> Tava Forest |
|------------------------------------------------------|---------------------------------|

No Ground Photo Available



Aerial View (Airborne Infrared Imagery) - Ta'ū

**USNVC Association:** *Pometia pinnata* Forest [Park Special]

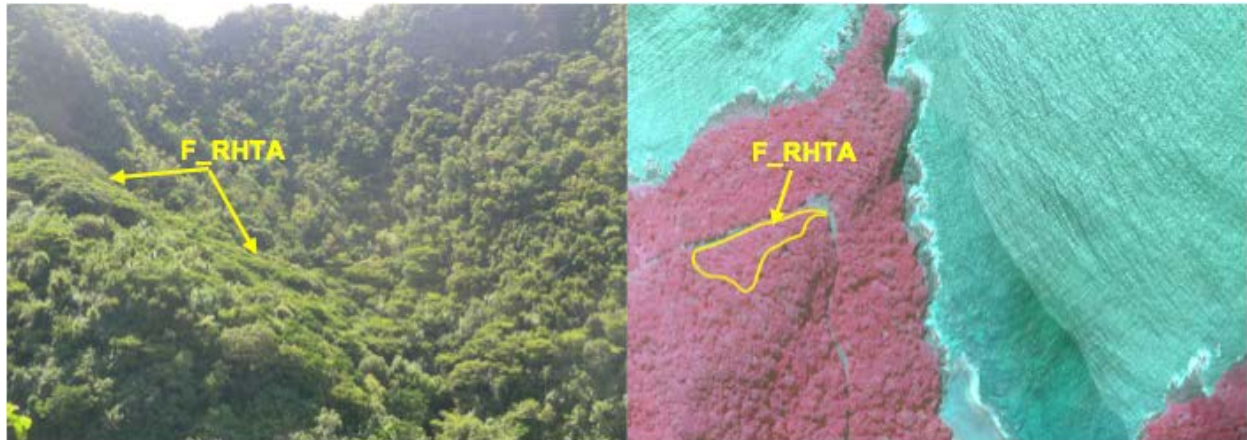
**Description:** This map class is densely forested with *Pometia pinnata* at 68% canopy coverage, far greater than any other tree species individually or combined. Other tree species present with >2% cover include *Syzygium inophylloides*, *Dysoxylum samoense*, *Macaranga stipulosa*, *Piper graeffei*, *Ficus scabra*, and *Myristica inutilis* plus several other species with lower percent cover. Tree ferns and lianas are also present: *Freycinetia* spp., *Cyathea* spp. A few shrubs are present and include *Clidemia hirta*, *Cyrtandra samoensis*, *Alyxia bracteolosa*, and *Psychotria insularum*. The herbaceous layer is dominated by *Lomagramma cordipinna* and seedlings of the canopy tree species. This map class was only encountered once, during the entire mapping project. It is mapped at the location of the one classification plot. It was not assessed for accuracy.

**Distribution/Location:** The one polygon of this map class occurs just southeast of Laufuti on Ta'ū.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 1           | <b>Hectares:</b> 0.76                            |
| <b>User's Accuracy:</b> Not Assessed       | <b>Producer's Accuracy:</b> Not Assessed         |
| <b>Accuracy Assessment Map Samples:</b> NA | <b>Accuracy Assessment Reference Samples:</b> NA |

**MAP CODE: F\_RHTA****ELCODE: CEG008715**

|                                                     |                                  |
|-----------------------------------------------------|----------------------------------|
| <b>Map Class Name:</b> <i>Rhus taitensis</i> Forest | <b>Common Name:</b> Tavai Forest |
|-----------------------------------------------------|----------------------------------|



Ground View - Tutuila

Aerial View (Airborne Infrared Imagery) - Tutuila

**USNVC Association:** *Rhus taitensis* Forest

**Description:** *Rhus taitensis* overwhelmingly dominates this map class (above 50%). Many native tree species may be present including *Neonauclea forsteri*, *Myristica inutilis*, *Bischofia javanica*, *Cyathea* spp., and *Dysoxylum samoense* with up to 20% cover, but these are subordinate to *Rhus* in terms of canopy coverage individually and with their combined covers. Up to 31 other tree species were recorded in the five classification plots, with cover ranging from <1 to 10%. Many vines may be present including *Mikania micrantha*, *Alyxia bracteolosa*, and *Merremia peltata* with 8-17% cover. Shrubs are non-existent and the herbaceous cover is very low. This class was mapped using a combination of field reconnaissance and manual interpretation. It is distinguishable on the infrared satellite imagery by the smooth deep red spectral signature of closed canopy *Rhus taitensis* trees of similar heights.

**Distribution/Location:** This map class is usually found in areas which have recently regenerated to trees following disturbance such as clearing for agriculture. It occurs on the NPSA portions of Tutuila and Olosega.

|                                           |                                                 |
|-------------------------------------------|-------------------------------------------------|
| <b>Classification Samples:</b> 5          | <b>Hectares:</b> 24.63                          |
| <b>User's Accuracy:</b> 100%              | <b>Producer's Accuracy:</b> 100%                |
| <b>Accuracy Assessment Map Samples:</b> 7 | <b>Accuracy Assessment Reference Samples:</b> 7 |

**MAP CODE: F\_SYCA****ELCODE: CEGl008716, CEPS009643**

|                                                                                          |                                           |
|------------------------------------------------------------------------------------------|-------------------------------------------|
| <b>Map Class Name:</b> <i>Syzygium inophylloides</i> - ( <i>Calophyllum</i> spp.) Forest | <b>Common Name:</b> Asi - (Tamanu) Forest |
|------------------------------------------------------------------------------------------|-------------------------------------------|



Ground View - Tutuila



Aerial View (Airborne Infrared Imagery) - Tutuila

**USNVC Association:** *Syzygium inophylloides* - *Intsia bijuga* Forest, *Planchonella garberi* Forest [Park Special]

**Description:** This map class is a combination of the *Syzygium inophylloides* - *Intsia bijuga* and *Planchonella garberi* Forest associations on Tutuila only. It is an open to closed canopy dominated by *Calophyllum neo-ebudicum*, and/or *Syzygium inophylloides*, and/or *Intsia bijuga*. Other tree species present include *Barringtonia asiatica*, *Buchanania merrillii*, *Calophyllum neo-ebudicum*, *Glochidion ramiflorum*, *Hibiscus tiliaceus*, *Planchonella garberi*, *Myristica inutilis*, *Canarium mafoa*, *Canarium vitiense*, *Cyathea* spp., *Diospyros samoensis*, *Elaeocarpus ulianus*, *Psychotria insularum*, *Rhus taitensis*, or *Syzygium clusiifolium*. Shrubs have low constancy with cover up to 25% or they may be absent and include *Mapania macrocephala* and the invasive *Clidemia hirta*. Vine cover can be high with *Alyxia bracteolosa* or *Erythrospermum acuminatissimum* (0-17%). The herbaceous layer is often dominated by seedlings of canopy tree species. Herbaceous species have high constancy with low cover and may include *Tectaria dissecta*, *Zingiber zerumbet*, and *Angiopteris evecta*. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is distinguished by its location (often on ridgetops), the dark red spectral signature of the *Syzygium inophylloides* crowns in the infrared imagery, and typically short height of trees. In the draft map, this class was most confused with the *Dysoxylum* spp. - *Rhus* - *Alphitonia* - (*Myristica*, *Canarium* spp.) Forest. The areas of most of these errors were corrected in the final map.

**Distribution/Location:** This map class occurs only on Tutuila. It occurs from 49 - 386 m elevation, on mainly steep slopes (12-90 degrees) with gradients on all aspects. It often appears on ridges and the high to midpoint of sideslopes.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 25          | <b>Hectares:</b> 382.62                          |
| <b>User's Accuracy:</b> 64%                | <b>Producer's Accuracy:</b> 50%                  |
| <b>Accuracy Assessment Map Samples:</b> 22 | <b>Accuracy Assessment Reference Samples:</b> 28 |

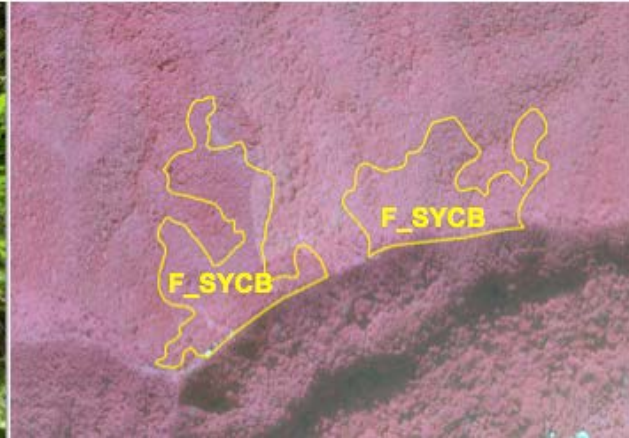
**MAP CODE: F\_SYCB**

**ELCODE: CEGl008707, CEGl008717**

|                                                                                          |                                                 |
|------------------------------------------------------------------------------------------|-------------------------------------------------|
| <b>Map Class Name:</b> <i>Syzygium samoense</i> - ( <i>Crossostylis biflora</i> ) Forest | <b>Common Name:</b> Fena Vao - (Saitamu) Forest |
|------------------------------------------------------------------------------------------|-------------------------------------------------|



Ground View - Tutuila



Aerial View (Airborne Infrared Imagery) - Tutuila

**USNVC Association:** *Crossostylis biflora* Forest, *Syzygium samoense* - *Weinmannia affinis* Forest

**Description:** This map class is a combination of the *Crossostylis biflora* or *Syzygium samoense* - *Weinmannia affinis* Forest associations on Tutuila only. It is characterized by forests dominated by *Crossostylis biflora*, *Astronidium pickeringii*, and/or *Syzygium samoense*. Other tree species which may be present include *Aglaia samoensis*, *Calophyllum neo-ebudicum*, *Dysoxylum* spp., *Myristica inutilis*, *Palaquium stehlinii*, *Syzygium inophylloides*, *Fagraea berteriana*, and *Reynoldsia lanutoensis*. Shrubs are sparse, but *Clidemia hirta* may be prevalent at low cover. Herbaceous diversity is high, but no single species is dominant or attains high cover individually. Vines may be present. Epiphytic cover ranges from 0 to over 40% cover and includes *Freycinetia* spp., *Asplenium nidus*, *Lomagramma cordipinna*, *Dendrobium dactyloides*, and *Dendrobium biflorum*. This map class is distinguished by its location on the higher ridgetops of the NPSA portions of Tutuila. It was overclassed on the draft map and completely remapped using the new aerial imagery and field information captured during the validation trip. The area of the one accuracy assessment sample was corrected in the final map.

**Distribution/Location:** This map class occurs on the highest elevations of the NPSA portions of Tutuila on the sideslopes, ridges of Mt. 'Alava, ranging from 337-490 m. Stands occur on a range of slopes from 5-90 degrees, often on high sideslopes, ridges or along intermittent streambeds.

|                                           |                                                 |
|-------------------------------------------|-------------------------------------------------|
| <b>Classification Samples:</b> 15         | <b>Hectares:</b> 14.39                          |
| <b>User's Accuracy:</b> 0%                | <b>Producer's Accuracy:</b> 0%                  |
| <b>Accuracy Assessment Map Samples:</b> 1 | <b>Accuracy Assessment Reference Samples:</b> 0 |

**MAP CODE: F\_SYWE****ELCODE: CEG008717**

|                                                                                    |                                                  |
|------------------------------------------------------------------------------------|--------------------------------------------------|
| <b>Map Class Name:</b> <i>Syzygium samoense</i> - <i>Weinmannia affinis</i> Forest | <b>Common Name:</b> Fena Vao - Weinmannia Forest |
|------------------------------------------------------------------------------------|--------------------------------------------------|



Ground View - Olosega



Aerial View (Airborne Infrared Imagery) - Ta'u

**USNVC Association:** *Syzygium samoense* - *Weinmannia affinis* Forest

**Description:** The vegetation of this map class is forested by lower-statured trees (4-6 m in height); epiphytic cover is always present and generally high (5-40%). Dominant tree species include either *Astronidium pickeringii* or *Syzygium samoense* present in every stand, along with *Fagraea berteriana*, *Weinmannia affinis*, and *Reynoldsia lanutoensis* with 0-20% cover. Vine cover ranges from 0-8% and is present in only 60% of the stands. Herbaceous cover is highly variable. The most abundant species is *Dicranopteris linearis*. Epiphytic cover is very high and distinguishes this forest from its lower-elevation counterparts. Epiphytic cover ranges from 5 to over 40% and includes *Freycinetia* spp., *Asplenium nidus*, *Lomagramma cordipinna*, *Dendrobium dactyloides*, and *Dendrobium biflorum*. This class was mapped using a combination of field reconnaissance, CART modeling, and manual interpretation. It is distinguishable on the imagery by its location, the smaller crowns of the trees, and the abundance of light pink small star shaped crowns of the *Cyathea* spp..

**Distribution/Location:** This map class occurs only on Olosega and Ta'u at the highest elevations of both islands, from 350 to above 970 m. Stands occur on a range of slopes from 5-90 degrees, often on high sideslopes, ridges or along intermittent streambeds. Bare soil and litter cover the ground layer.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 12          | <b>Hectares:</b> 1096.79                         |
| <b>User's Accuracy:</b> 86%                | <b>Producer's Accuracy:</b> 95%                  |
| <b>Accuracy Assessment Map Samples:</b> 21 | <b>Accuracy Assessment Reference Samples:</b> 19 |

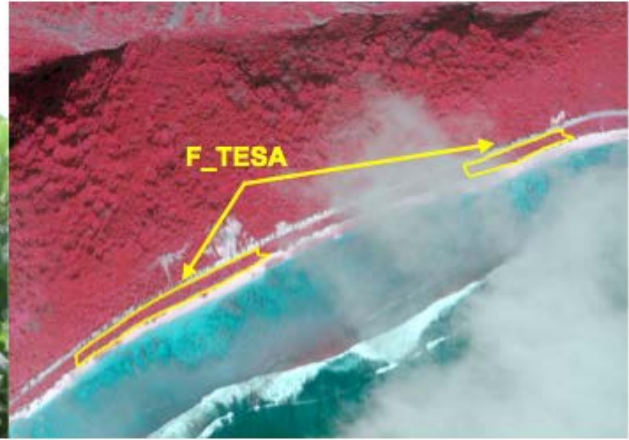
**MAP CODE:** F\_TESA

**ELCODE:** NA

|                                                                    |                                           |
|--------------------------------------------------------------------|-------------------------------------------|
| <b>Map Class Name:</b> <i>Terminalia samoensis</i> Littoral Forest | <b>Common Name:</b> Talie Littoral Forest |
|--------------------------------------------------------------------|-------------------------------------------|



Ground View - Ofu



Aerial View (Airborne Infrared Imagery) - Ofu

**USNVC Association:** None

**Description:** This map class has no classification plots and, therefore, no association description. It was created to label the *Terminalia samoensis* forests on Ofu. It was mapped exclusively from field reconnaissance and both polygons are field verified.

**Distribution/Location:** This map class occurs only on the Ofu portions of NPSA, where it forms dense stands from the road down to the beach.

|                                            |                                                  |
|--------------------------------------------|--------------------------------------------------|
| <b>Classification Samples:</b> 0           | <b>Hectares:</b> 0.86                            |
| <b>User's Accuracy:</b> Not Assessed       | <b>Producer's Accuracy:</b> Not Assessed         |
| <b>Accuracy Assessment Map Samples:</b> NA | <b>Accuracy Assessment Reference Samples:</b> NA |

**MAP CODE: S\_WBST****ELCODE: NA**

|                                                                                   |                                               |
|-----------------------------------------------------------------------------------|-----------------------------------------------|
| <b>Map Class Name:</b> <i>Wedelia biflora</i> - <i>Scaevola taccada</i> Shrubland | <b>Common Name:</b> Ateate-To'ito'i Shrubland |
|-----------------------------------------------------------------------------------|-----------------------------------------------|



Ground View - Ta'u



Aerial View (Airborne Infrared Imagery) - Ta'u

**USNVC Association:** None

**Description:** This map class has no classification plots and, therefore, no association description. It was created to label the coastal shrubs areas of NPSA. It is dominated by dense cover of either *Wedelia biflora*, *Scaevola taccada* or both. *Hibiscus tiliaceus* can be absent to high cover (0-45%). Other species which may be present include *Ipomoea forsteri*, *Barrintonia asiatica*, and *Pandanus tectorius*. This class was mapped using image segmentation and manual interpretation. It is distinguished by its location on the coast, the short stature of the vegetation, and its smooth bluish pink spectral response in the infrared imagery.

**Distribution/Location:** This map class occurs on the NPSA portions of Tutuila, Olosega and Ta'u, but it is most prevalent on Olosega and Ta'u.

|                                           |                                                 |
|-------------------------------------------|-------------------------------------------------|
| <b>Classification Samples:</b> 0          | <b>Hectares:</b> 9.93                           |
| <b>User's Accuracy:</b> 100%              | <b>Producer's Accuracy:</b> 78%                 |
| <b>Accuracy Assessment Map Samples:</b> 7 | <b>Accuracy Assessment Reference Samples:</b> 9 |



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 126/128944, July, 2015

**National Park Service**  
**U.S. Department of the Interior**



---

**Natural Resource Stewardship and Science**

1201 Oakridge Drive, Suite 150  
Fort Collins, CO 80525

[www.nature.nps.gov](http://www.nature.nps.gov)

EXPERIENCE YOUR AMERICA™