

Appendix 1: Meeting Interview Memorandum

Memorandum

To: Penny Latham NPS I&M Coordinator
CC: NPS Representatives for Parks in the Pacific Island Network
From: Dan Cogan, Cogan Technology Inc.
Date: 8/1/2007
Re: Outline for vegetation mapping interviews and existing data evaluations

Background

During the weeks of 8/20 – 9/21 Dan Cogan with Cogan Technology Inc. (BOR/CTI) will be visiting all of the NPS units on the Hawaiian Islands in the NPS Pacific Island Network regarding vegetation classification and mapping projects. The Pacific Island network is anticipating getting funding from the National USGS-NPS Vegetation Mapping Program over the next five years to complete detailed vegetation classification and mapping studies at each of the parks. As needed, this may include collecting representative plot data in all of the plant associations (communities), developing descriptions of the associations through the National Vegetation Classification System, using these associations as the base for the vegetation mapping, conducting vegetation mapping using a combination of aerial photo interpretation and image classification/segmentation, and developing standard reports, maps, and GIS layers for each park.

To secure funding the national program would like a detailed work plan that outlines the tasks and associated costs needed to complete each park. Critical to the work plan is determining the level of effort needed. This can range from simply modifying existing vegetation maps to conducting a full blown project. Also important is identifying potential partners, staff and contractors that would be interested in helping to complete the projects.

Purpose

The purpose of these meetings is two-fold. First, they will allow time for the NPS Resource Staff to interact with the BOR/CTI and I&M representatives regarding the vegetation mapping projects. Second, they will include a review of the existing data, identification of potential partners and cooperators, and provide the necessary information to prepare a final summary report. This report will evaluate the existing data for usefulness (see **Attachment**) and develop the best strategy for how to best complete the vegetation classification and mapping for each park. This report will form the basis for the overall network work plan.

Meeting Topics and Specifics

The meetings will be informal and are open to anyone interested in the vegetation mapping program. This may include NPS Resource Staff, existing cooperators that have worked or are actively working on vegetation studies in the park, and employees or contractors that would like to work on these projects.

During the meetings it would be helpful to review the following topics and glean the following information (including securing copies of any of the following items):

1. Copies of previous vegetation studies. These include past reports and maps on any vegetation or fire mapping work, vegetation classification efforts, dissertations/theses on vegetation in the park, plant community lists, and reports on threatened/endangered and introduced/exotic plant species. In lieu of hard copies, a list of scientific citations may be submitted for readily available peer reviewed documents.
2. Copies of past or on-going vegetation sampling data. This could include electronic databases, GIS layers, or paper copies of the field forms. Of particular interest would be any data that includes plant community data, estimates of species cover, and GPS referenced locations.
3. Lists of contacts that either have worked in the park on the vegetation or would be good candidates to do the vegetation work. Typically these include local botanists, ecologists, and GIS professionals. Also contacts for any potential partners that might be able to help with logistics (provide housing, supplies etc...) and neighboring lands that might be interested in having similar work done on their lands (i.e. State Parks, other federal agencies, TNC, large private land-owners, other non-for-profit lands etc...).
4. A summary of all important items for the resource staff that could be addressed by the vegetation classification and mapping work. This could include things like lists of critical native plant and exotic plant communities to be mapped, location of sensitive areas, and lists of other needed projects that could be potentially incorporated with this one (e.g. fire fuel sampling, rare plant surveys, etc...).
5. Document and address any concerns, questions or comments that the NPS staff might have regarding future vegetation classification and mapping work.

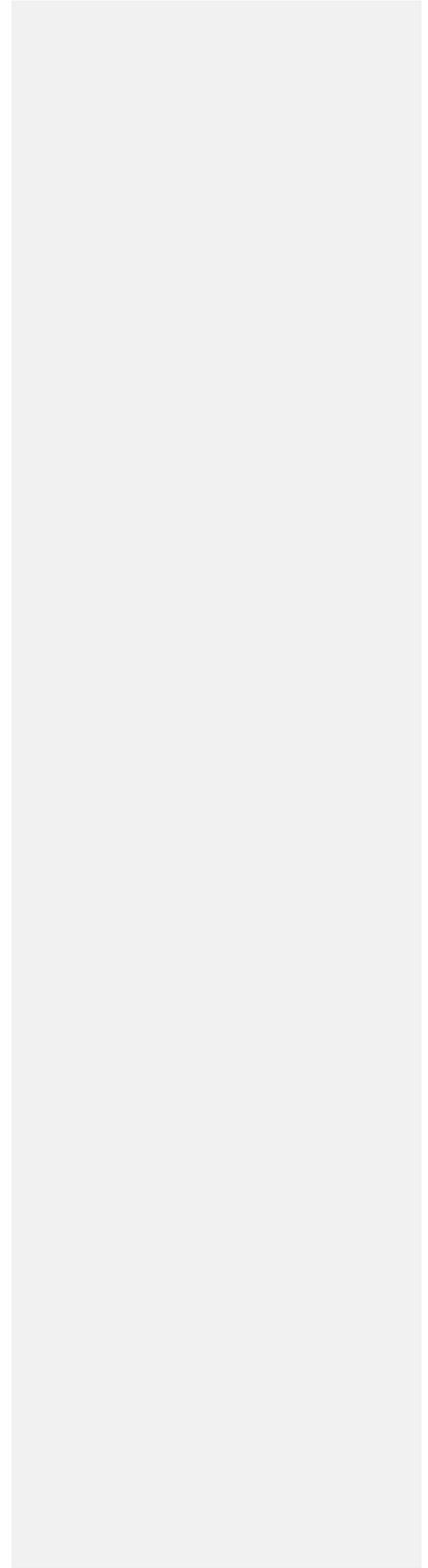
Potential Meeting Dates, Times and Locations

- | | |
|-------------|---|
| Aug. 23-24 | Honolulu, work with Sandy Margriter. |
| Aug. 27-30 | Travel to HAVO and work with Penny and NPS Staff at 8 am on 8/27. |
| Sept. 5-7 | Travel to KALA, meet with NPS staff on Sept. 5 at 2 pm and continue Sept. 6. |
| Sept. 10-14 | Travel to Hawaii (big island) and visit with staff from <u>Ala Kahakai National Historic Trail (ALKA)</u> , <u>Kaloko-Honokohau National Historical Park (KAHO)</u> , <u>Puuhonua o Honaunau National Historical Park (PUHO)</u> , and <u>Puukohola Heiau National Historic Site (PUHE)</u> .
Meet with PUHO on Sept. 10 at 10 am
Meet with KAHO and ALKA on Sept. 12 at 10 am
Meeting with PUHE on Sept 11 at 10 am |
| Sept. 17-21 | Travel to HALE and meet with NPS and USGS staff either on 9/18 afternoon or 9/19 morning. |

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Attachment

Figure 1 presents a step-by-step process to evaluate existing data sets according to these seven components for their utility in vegetation mapping. Starting from the top of the figure, data sets are assessed and placed into appropriate categories of utility, which are characterized in Table 1. Each step of the process, as it is linked to the five factors, is further described below.

Figure 1. Flow chart for evaluating existing datasets.

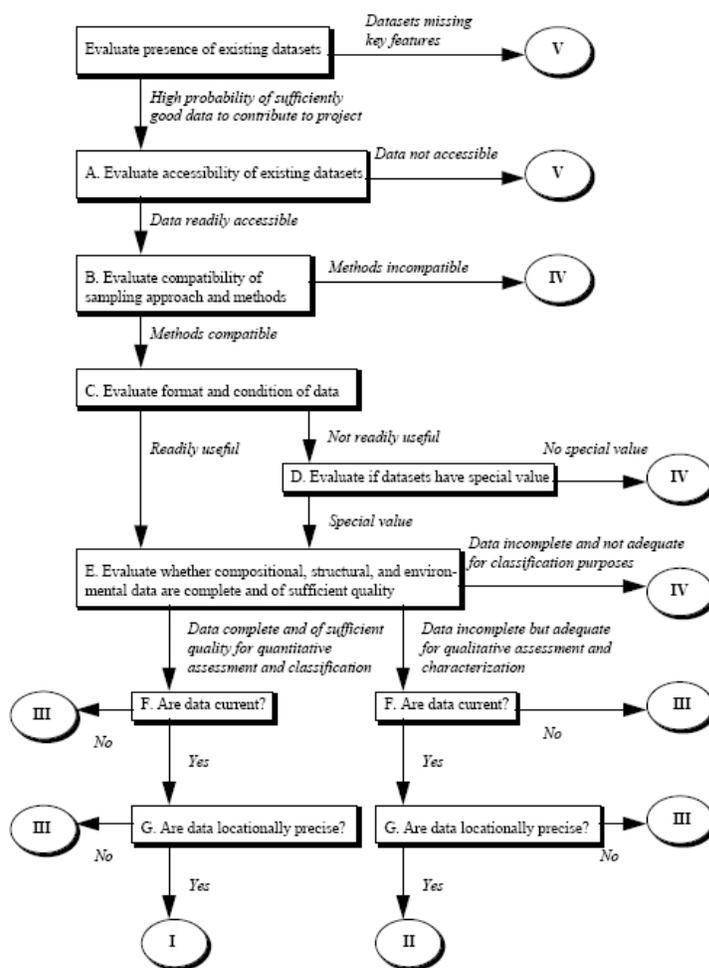
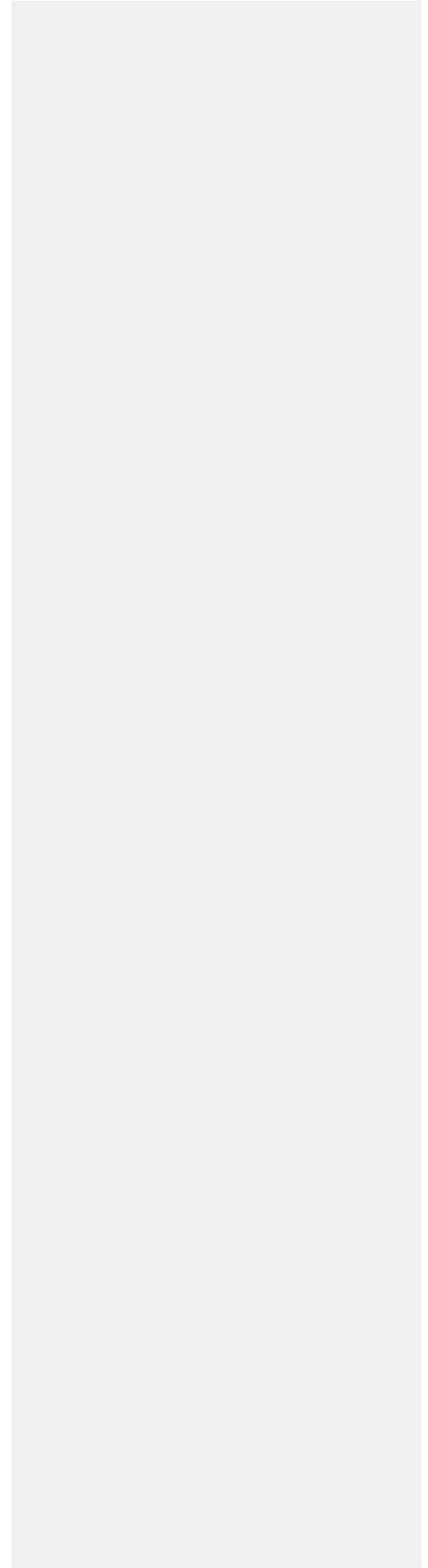


Table 1. Categories of Utility for Existing Data Sets.
(Final Classification of the Existing Data into these classes will be completed by the Classification Team, i.e. NatureServe or the State Heritage Program)

Category Description

- I. Samples are adequate for classification and mapping (i.e., the data are geo-referenced, represent existing vegetation, and contain sufficient structural, compositional and site information to place the sample within the standard classification framework).
- II. Data are adequate to assist in photo interpretation, photographic signature key development, or map accuracy assessment (i.e., the vegetation and site information are of lower quality, but the samples represent existing vegetation and are geo-referenced with reasonable confidence).
- III. Data can be used for vegetation classification and characterization of a vegetation type within the park, but not for mapping or analysis because the sample is not adequately geo-referenced, contains inadequate detail in the vegetation information, and/or may not represent existing vegetation at the sample location.
- IV. Data set was assessed and not found to be useful at any level.
- V. Data set not was not available for assessment.



Appendix 2: Meeting Notes

Thursday 8/24/07

Meeting place: NPS Honolulu Office

Meeting Participants: Dan Cogan, Sandy Margriter, Melia Lane-Kamahele

Dan, Sandy and Malia discussed the vegetation mapping program and its implications with the Pacific Island Network (PACN). Dan presented examples of existing projects including Zion, Grand Teton and Fort Larned products. After the initial presentation the group discussed how the program could be implemented in PACN. A focused discussion ensued regarding the existence of imagery and aerial photography. Melia mentioned that most of the aerial photography is dated (circa 1990's and later). Also she mentioned how difficult it has been to get good imagery for a decent cost due to the logistics and small number of contractors working on the islands. The two contractors that Melia and Sandy were aware of include Air Flight Service and R.M. Towell. Other options include off-island contractors but NPS has limited experience due to the difficulty in getting them to fly over and wait for cloud-free days. Also imagery would likely be very expensive. Regarding the existing imagery Melia mentioned that most of the existing aerial photography is at least 15 years old, is poor quality, has cloud cover issues and probably won't be suitable for mapping purposes.

At this point the discussion turned to digital imagery and the availability of Ikonos and Quickbird products. Sandy mentioned that Ikonos imagery is available for all of the Hawaiian parks but is approaching 4-5 years old. Examples of this imagery were placed on a DVD and given to Dan for review.

Potential cooperators on these projects will likely be numerous due to the common interest of the major land holders. The NPS currently has good relations with all of the other agencies and adjacent landowners. The large landowners that would make excellent candidates for cooperation includes the Forest Service, The Nature Conservancy, State Parks, other State-owned Lands, the Hawaiian Energy Company (HECO), various private ranches, and Department of Defense lands (Army, Navy, etc.) Malia and Sandy also identified three organizations of land owners with similar interests that would be helpful for vegetation mapping cooperation. These include: 1) the Hawaii Island Geographic Information Coordinating Council, (HIGICC) <http://www.higicc.org>, 2) the Hawaiian Conservation Alliance, (HCA) <http://www.hawaiiconservation.org>, and 3) the Hawaii Island Consortium for acquisition of IKONOS imagery (<http://hbmp.hawaii.edu/website/hic>). Of these, the HCA sounds very promising since it's comprised of the large landowners in Hawaii that meet every quarter to discuss common conservation issues. These meetings would likely be a good forum to discuss vegetation mapping efforts and explore possible partnerships. Dan suggested that this would be an ideal setting for a presentation by Karl and the National Program. The image consortium was also discussed as a place to solicit cooperation. The consortium is a group of state and federal agencies that share image acquisition costs and products. Sandy mentioned that the downside to working with them is the difficulty in coordinating everyone's schedule and getting product that meet everyone's needs.

For classification work, Sandy identified Sam Gon with the Hawaiian Heritage Program as an excellent contact for vegetation classification efforts. Dan mentioned that other networks have worked with State Heritage Programs and NatureServe to classify the plot data and help maintain consistency across multiple parks.

Friday 8/25/07

Meeting place: Hawaiian Biodiversity Center, University of Hawaii

Meeting Participants: Dan Cogan, Sandy Margriter, Barbara Gibson

In the morning Dan and Sandy met with Barbara Gibson with the Hawaiian Biodiversity and Mapping Program. Barbara has experience working in the islands and is affiliated with the University of Hawaii. She has limited field people but is working with Sandy developing a Land Cover and Cover Change protocol for the parks in the PACN. This effort will help monitor change in the vegetation using land change detection techniques. Currently this will involve working at a few pilot areas with the idea that it will be fully implemented in 5 years. Depending on funding, Barbara would be willing to help collect additional data at her field sites for this effort to support the vegetation mapping program. This would at a minimum mean collecting observation point data at each site.

At this point Dan briefed Barbara on the overall purposes of the vegetation mapping program and how the steps might dovetail with her work. Barbara expressed interest in the project and would like to be involved with the field work, mapping or both. She is especially interested in the western Hawaii parks and HAVO. Barbara has limited staff but would be willing to explore hiring field and GIS students through the University. This might be helpful especially if mapping is done by manually digitizing.

Dan, Barbara, and Sandy discussed the strategy for working in the PACN and all thought that grouping the parks into stages for starting made sense. One scenario would be grouping the western Hawaii parks together as one project, keeping HALE, HAVO, KALA, and American Samoa as separate starts, and grouping the other outer parks into one unit. Dan mentioned that this is usually necessary and has been done in other networks due to funding constraints and the limitations of the field and GIS staff.

Regarding imagery, Barbara has had poor experiences with Air Survey and would not recommend them. Dan mentioned that one of his colleagues used a Japanese firm called PASCO and had good results (they can be located on the web at <http://www.pasco.co.jp/global/english/index.html>). Barbara mentioned that sometimes clear conditions exist for up to two weeks at the higher elevations in December. This may be a time to acquire cloud free imagery. However, most imagery that she is aware of is usually timed for May and June.

Barbara discussed field data collection and a few issues that we might encounter in Hawaii. First, diameter at breast height (DBH) can not be used to measure age since growing conditions are year around, change depending on the wet/dry seasons and are not reliable except for estimating biomass. Second, she mentioned that the non-native plant associations are not well described and can often invade sites fairly rapidly –these may need more classification work than the natives. Third, the minimum mapping units for past mapping projects are varied and depend on the environment. In some locations individual native or non-native trees may need to be mapped. Conversely large heterogeneous rainforests may have to be mapped as a whole unit since it may be impossible to split them out any finer.

According to Barbara, field logistics are extremely important and finding experienced local botanists is very important. Safety is of course paramount due the steep slopes, thick canopy, and the presence of hidden ravines (i.e. old lava tubes) that are obscured by vegetation. One aid to field sampling is the use of helicopters. They are typically available and are widely accepted by the parks. Another option would be to use GPS ranging equipment that would allow you to find a location remotely. Barbara mentioned that she has a GPS rangefinder, a rugged tablet PC and a GPS antenna that attaches to it. Dan mentioned that he has worked at other large parks where the field crews worked one field season on foot and the following field season was spent working from a helicopter to fill in any holes in the plot distribution.

Friday 8/25/07

Meeting place: NPS Honolulu Office

Meeting Participants: Dan Cogan, Sandy Margriter, Andy Hood

In the afternoon, Dan and Sandy met with Andy Hood co-owner of Sustainable Resources Group International, Inc. (SRGII). SRGII is a small company that provides environmental and water resources consulting throughout the islands. Andy has worked on vegetation and GIS projects in the past and is interested in helping on this one. Andy mentioned that his company can offer all kinds of services including field work, map production and support services. Andy feels that his company has an excellent reputation and would provide references if needed. He mentioned that he likes to help write the scope of work for contracts, as it helps clear confusion and makes sure that the contractor and client are on the same page.

Specifically regarding vegetation mapping work, Andy mentioned that if awarded he would like to work with Stephen Ambagis on the project. Also he would hire local botanists for each island since the vegetation can greatly differ among the various islands. One important consideration is the ability to change the mapping protocols as you change islands. Andy thought that each island is slightly different both structurally and floristically and as such, different mapping techniques may be needed. Also Andy mentioned the importance of understanding the effects of the non-native vegetation. He discussed how invasives can become prevalent in relatively short time spans and how they are related to very subtle environmental changes. He wanted to make sure everyone understood the challenges related to sampling and classifying these situations.

On the contract side, SRGII is on the GSA schedule and also partners with larger companies that have existing indefinite delivery/indefinite quantity (ID/IQ) contracts. These allow federal agencies to directly contract with them without having to go through the normal bid process. Andy would propose to work closely with the NPS including helping to write the scope of work, hire people recommended by the park and work with each park to customize the mapping.

After Andy left, Dan and Sandy examined some of the existing vegetation GIS layers for HAVO and KALA. Dan mentioned that the KALA map is a raster product (image classification) and the HAVO is a vector product. Each map was quickly viewed at its largest extent and more time was spent zooming into select sites. In combination with the GIS layer the Ikonos and other base imagery was displayed. This was used to compare the vegetation apparent on the imagery to the vegetation polygons/pixels. Sandy mentioned that the attributes for the KALA map were fairly coarse and Dan will check on these with Stephen Ambagis and Guy Hughes to insure that these were not the final classification. Sandy also mentioned that the HAVO map was created by Rhonda Loh and that she tried to use the NVC. Dan mentioned that this would probably meet the national standards. All of the GIS data was put on a CD and given to Dan for further review including representative image samples.

After the review of the GIS data, Dan and Sandy discussed how there needs to be accountability for the project deliverables including withholding payment if no product is delivered. Dan also noted that cost comparisons will probably be made if new imagery is proposed. This was done at similar projects in order to determine the best value. Dan can follow-up with his contacts at the USGS who purchase imagery regularly for their help if new imagery is needed.

Monday 8/27/07

Meeting place: NPS Hawaii Volcanoes – I&M Office

Meeting Participants: Dan Cogan, Penny Latham

Dan and Penny met in Penny's office where Dan presented an overview of the national vegetation mapping program. Penny also discussed the PACN and their needs for vegetation mapping products. Penny stated that the existing vegetation mapping work in this network has been closely tied to the USGS. USGS is also assisting with development of vegetation monitoring protocols that focus on three components. These include: 1) Focal Communities, 2) Focal Species, and 3) Status/Trends of Invasive Plants. Dan will meet with USGS representatives in the coming weeks to explore these efforts.

On other existing efforts in the network, Penny noted that the land cover/land trend analysis with Barbara Gibson is funded at the \$30,000 level. Also Lloyd Loope with the USGS has been funded to provide early detection of invasive plants outside the park. His procedure would be to drive roads and trails and quickly document their occurrence. Penny noted that this method was a little controversial and has met with some resistance in I&M because it is not looking at trends as other monitoring protocols are. In addition, working outside of the parks to this extent has not been approved by the Board of Directors.

Penny mentioned that she would like Dan to assess the KALA map and help blend it into the national program. Also she thought HAVO and HALE will be considered among the first projects to be started in the network due to the presence of existing data. Penny and Dan also discussed at length the desire of the park's to get association level data although the program standard is the alliance. Dan thought that the alliance level only applied to the mapping but he would check with Chris Lea to verify.

Tuesday 8/28/07

Meeting place: NPS Hawaii Volcanoes - Natural Resource Management Office

Meeting Participants: Dan Cogan, Rhonda Loh, David Benitez

Dan presented an overview of the national vegetation mapping program including examples of products from other completed parks. Dan also discussed his role in the PACN and how he is tasked with making recommendations and creating a comprehensive work plan. The ultimate goal of this is to secure NPS funding and complete the vegetation classification and mapping for all of the parks in the network that have a natural resource component.

Rhonda and David gave an overview of past vegetation mapping and sampling efforts at HAVO. There efforts revolved around mapping approximately 40% of the park through photo interpretation on 1992 color infrared aerial photos provide by the NPS Fire Program. The resulting lines were scanned and geo-referenced onto 1:24,000 USGS digital ortho-quadrangles. To support the mapping effort Rhonda collected data at numerous releve type verification sites. These samples were a walk through effort and Rhonda did not collect GPS reference locations but instead marked their location on the aerial photos. Some of the plot information that she recorded is contained in a digital spreadsheet but some of it is still on the paper forms. A thorough review of these data will be undertaken in the future to determine if they can be geo-located and used for the classification efforts.

In addition to the portion of the park that Rhonda sampled and mapped, David has been working as part of his research on mapping and collecting samples in the newly acquired Kahuku portion of HAVO. In this area David collected 177 GPS-referenced releve plots that will have all of the necessary information needed for classification. At a minimum these plots can be used for mapping validation. David used these samples to conduct an image classification exercise for Kahuku's eastern section. David used a

2007 SPOT scene to conduct a supervised classification. Some of the mapping work that David conducted could be used to help offset or supplement any further mapping in this area.

One of Rhonda's concerns about the national program was the level of detail provided in the standard mapping. If the alliance level is used at HAVO, a large amount of detail necessary for management would be lost. This is due to the relatively low number of dominant overstory species compared to the high diversity in the understory, especially considering non-native species. Of particular importance is getting an accurate estimate of what's under the 'ohi'a and other native trees for succession, disturbance, fire and alien species management efforts. In addition many of the native and alien trees/shrubs occur in patches below the minimum mapping unit (mmu) of ½ hectare. Dan mentioned that many parks have gone below the mmu for critical communities such as wetlands. These park specials are common and will be mapped where they are known to occur or mapped extensively if they can be reliably seen on the imagery. Also, Dan stated that the alliance level was the new nominal standard adopted by the program due to cost and time constraints. However there is flexibility in this standard and every effort would be made at the planning meeting and during the mapping to insure that as much detail as possible is contained in the mapping products for HAVO. One way that this could be achieved would be for the park to provide additional support for ground-truthing to help provide the extra mapping detail.

Based on the previous sampling work at HAVO, Rhonda thought it would be appropriate to keep her and David actively involved with the future sampling. One scenario she presented would be to have David continue with plot sampling and possibly having the program provide a temporary assistant. Dan thought that this was a good idea and mentioned that large parks such as HAVO usually have a sampling design effort. This might entail stratifying the park into sampling units and excluding the area already sampled by David and Rhonda. In addition a bio-physical map is usually created. For HAVO, Rhonda thought that the annual rainfall, geology and elevation would be the most important factors driving the vegetation. Dan mentioned that he would be willing to work with the new Program Manager to help provide support for the sampling design including helping to create the bio-physical map. It is important to remember that new or acting program manager would ultimately be the one responsible for overseeing implementation of all the tasks at HAVO including hiring and contracting all of the support staff.

At this time the mapping efforts at HAVO were discussed. This included reviewing the GIS vegetation layer that Rhonda created and overlaying it on the most recent IKONOS imagery. Dan mentioned that he thought the level of detail in the linework was good and matched up well with similar mapping efforts at other parks. In addition having the NVC information in the GIS layer will allow the attribute information to be easily cross-walked to any new mapping scheme. After viewing the map, Dan speculated that some additional editing and up-dating will occur but most of the polygons fit well to the imagery. Dan presented a mapping scenario where the existing map would be updated and edited through a manual process using the IKONOS or latest imagery as a base. Once this was done, the map in conjunction with the field work could be grown outwards into the areas of HAVO not already completed. This could be accomplished through on-screen digitizing, photo interpretation (PI) or a hybrid approach. A hybrid approach would involve taking the new areas and having them segmented in eCognition by a GIS consulting firm or the USGS-BRD. These lines would then be manually matched to the existing map and edited and supplemented with PI as necessary. David expressed interest in working on the GIS portion as well as the field work but would likely need some support.

In addition to working at HAVO, Rhonda stated that her staff also provides botanical and ecological support to the other parks on the big island of Hawaii. In fact, all of the other parks have very little natural resource staff. Rhonda thought that it won't be a problem for her staff to help collect the field data and map these parks in addition to HAVO.

In summary, Rhonda Loh and the NPS HAVO Natural Resource Management staff would like to be actively involved with all of the future vegetation mapping work at HAVO. They would like to take the lead on sampling in the park and with support, help create a sampling design that accounts for all of the existing plot data and stratifies the remaining areas into meaningful bio-physical units. In addition they would like to work closely with contracted or federal GIS support to complete the mapping. This could involve updating the existing map and filling-in the missing pieces. In addition to work at HAVO, Rhonda and her staff would like to assist with the work at the other parks on the big island.

Wednesday 8/29/07

Meeting place: USGS-BRD Research Office – Hawaii Volcanoes National Park

Meeting Participants: Dan Cogan, Stephen Ambagis, Paul Berkowitz

Dan presented an overview of the national vegetation mapping program including examples of products from other completed parks. Dan also discussed his role in the PACN and how he is tasked with making recommendations and creating a comprehensive work plan.

Stephen explained how the BRD center was set-up as a research provider and that they were 100% soft money with no base funding. Stephen and Paul both work closely with Jim Jacobi to support his work on vegetation mapping, bird habitat, and other projects in the islands. Their involvement with vegetation mapping came from Jim's participation in the Hawaii GAP project. Based on this experience Jim felt that higher resolution imagery and new image processing technology would greatly enhance and improve vegetation mapping efforts. This interest led to Stephen's work at KALA and similar projects in Hawaii. Their approach uses IKONOS 4-band imagery, eCognition software and extensive ground truthing using state-of-the-art GPS linked videography acquired from a helicopter. In this manner, large areas can be validated by reviewing the video to identify species (that might not be visible from the ground) and linking it through the GPS coordinates. Stephen has developed new techniques with eCognition version 5 that allows the land-cover and vegetation to be split into very fine, discreet units.

Regarding the KALA map, Stephen mentioned they are still waiting on one more IKONOS scene to complete the basemap imagery. This is anticipated to arrive very soon. Stephen has been working closely with Guy Hughes at KALA to create map units that are necessary for management. However, individual exotics are difficult to pull out including separating the different guava species and mapping individual exotic palm locations. Stephen pointed out that he is strictly tasked with completing the map using image processing techniques related to the BRD's on-going research. He does not have funding to supplement the map with PI or manual editing. However, Stephen did feel that this would greatly add to the detail and accuracy of the map. At this time, Dan mentioned how a few of the recent vegetation mapping projects in the national program have been going to a hybrid approach. This involves combing image processing/segmentation, PI and manual digitizing. Basically this technique uses the efficiency of the processing/segmentation to pull out the obvious features and relies on PI and editing to tease out the more confused signatures. Both Paul and Stephen thought that this approach will be explored at KALA and the other parks in the network.

Stephen gave a brief overview of KALA and the vegetation distribution. This includes the presence of most of the native plant communities in the steep valleys and ridgelines. The majority of the flat peninsula has been hammered by past human activities. Paul mentioned that the coastal stand vegetation is important to this park and most of the others but it only occurs as very narrow bands. As such, these areas may need to be mapped to a different level with a smaller mmu.

At this point a discussion ensued regarding the existing imagery available for all the parks in the PACN. In the Hawaiian Islands, a consortium of users purchased a full set of IKONOS satellite imagery in 2004.

This is a 4-band product with 4-meter multi-spectral resolution and 1-meter panchromatic resolution. If pan-sharpened this produces a 2.4-meter pixel resolution product. Issues with this imagery include cloud cover, cloud shadows, topographic relief shadow, sun angle (10 am acquisition time) and subtle changes in the imagery from one island to the next. They felt that this product is superior to the other existing sets since it does contain the infrared band and is relatively current. Other imagery they were aware of included: 1) 2003 Emerge 3-band, 1-meter resolution -patchy distribution across the islands -project was not completed; 2) 2007 Quickbird 3-band 2.6-meter resolution imagery for the entire big island; and 3) 2007 Quickbird imagery for all of the Hawaiian Islands currently being acquired by NOAA. Stephen noted that not having the infrared band in some of this imagery greatly inhibits the ability to detect slight changes in the vegetation between similar species.

Based on their work, Stephen and Paul felt that invasive plant species are a real issue for mapping. This is due to their patchy distribution, their hard to detect presence in the understory, and their similar signatures -especially between similar species like common and strawberry guava. In addition some of the native species of concern are difficult to accurately map for some of the same reasons. In particular, one native tree species that is important for bird habitat can not be mapped with the IKONOS imagery due to the orientation of its leaves. In this species the leaves are pointed down and present minimal reflectance area. However this species is apparent on better resolution imagery.

In addition to the existing imagery, Paul presented examples of existing vegetation mapping products. This included a vegetation layer done for the big island by Jim Jacobi in 1997. This layer was created as part of their bird habitat research. It encompasses most of the vegetation on the island and is supported by numerous, regularly spaced transects. Paul feels that this map is the most widely used map on the island and may greatly aid in the up-coming work at HAVO and the Kona parks. Also Paul presented a vegetation map for American Samoa that was completed in 2004 by the U.S. Forest Service.

Stephen has also been working closely with HALE helping them create a vegetation map. This has involved preliminary evaluation of the IKONOS imagery and meeting with the park. HALE staff has outlined to Stephen areas of the park that are important for management. This includes the presence of rare and non-native vegetation. Unfortunately, some of these plant communities of concern are not readily apparent on the imagery and more work is needed before mapping can begin.

Paul and especially Stephen would like to be involved with the up-coming vegetation mapping efforts. Stephen felt that his work with eCognition and image processing would greatly aid and speed-up the mapping process. He also pointed out that with additional funding for adding a PI/manual editing step and higher resolution imagery such as Quickbird or Emerge he could likely meet the goals of the national program. Stephen and Paul also noted the importance of having someone with intimate knowledge of the ecology involved with the mapping. This is due in part to the differences in distribution and composition of the vegetation among the islands and the need to capture these in the mapping. Having extensive ground data and validation provided by local experts would greatly improve the mapping by filling in difficult to see understories and assisting with delineating similar communities that have the same photo signature.

Dan suggested that a mapping team will likely be created for each park in the PACN. This would involve local experts, NPS staff, GIS and Remote Sensing Professionals and technicians. Although the exact implementation will be decided by the network program manager, Dan could foresee using a hybrid mapping approach for each park. This would involve creating relatively quick image segmentation maps from the IKONOS imagery (similar to KALA's). These would be used for the sampling design and given to the field crews as field maps. Once these were created, experts for each park would supplement them with PI and on-screen digitizing to create the final map.

Thursday 8/30/07

Meeting place: Institute for Pacific Islands Forestry

Meeting Participants: Dan Cogan, Greg Asner (Carnegie Laboratory)

Dan met with Greg at the University of Hawaii –Hilo in the Institute for Pacific Islands Forestry building. The meeting began with introductions and an overview of the national vegetation mapping program provided by Dan. Dan explained his role in creating a network-wide work plan and helping to facilitate future mapping and classification efforts.

Following the introductions, Greg presented a background on his work and how these evolved into his current approach. In summery, Greg worked on past remote sensing efforts in Hawaii using various imagery products such as IKONOS to classify vegetation. He encountered numerous problems and had some failures using these techniques. Most of the difficulty was due to the limitations of the multi-spectral imagery (i.e. 4-bands) to identify individual species, cloud cover, and the steep terrain of the islands. Based on these experiences he developed his own remote sensing platform. His platform combines waveform LiDAR (3D laser scanner) with hyperspectral imaging spectrometer sensors such as AVIRIS. This system is mounted on a fixed wing aircraft, either a Twin Otter or a Navajo plane. During the overflight, the sensors are continuously sending and receiving data from the ground. By using this combination, Greg is able to get the full-spectrum of reflectance allowing for the precise identification of individual plant species and also the full range of heights and volumes in and below the canopy.

Among the many innovations created by Greg and his team are developing a system that automatically correlates and geo-corrects all remotely sensed data. This is done by employing an internal, complex system of gyros and on-board GPS units initially used in Tomahawk cruise missiles. This system continuously corrects the returning data by accounting for the plane's movement and relative position on the ground. Another innovation is correcting the data for sun angle-related shadows and distortion. This approach allows for precise estimates of tree canopy structure by species without having shadow classes. Finally his team has developed an automatic stitching routine that allows data collected along multiple flight lines to be seamlessly put together. The resulting mosaics do not need to be edge-matched or color balanced.

Greg's current remote sensing systems have been in service since November and are supported by computers and staff in Hilo and by super computers in Palo Alto, California. The actual sensors are based in Hilo and Greg usually places them in a local, contracted plane. During the flight he uses three team members to record the digital data. Greg has two different configurations depending on the resolution required. His alpha system collects nearly 50,000 acres per hour at a spatial resolution of 1-2 meters. If larger areas need to be covered, his beta system can collect 2-4 meter data from higher flight elevations.

Greg's current projects have focused on mapping native and introduced species in the Hawaiian Islands including accurately detecting their presence in the understory, calculating fuels loading and creating fire fuel models. Greg has collected imagery using his system for portions of HAVO State Lands in the DLNR Division of Forestry and Wildlife, and Forest Service Lands on the big island. To support this work, Greg and his team have created a comprehensive library of unique spectral signatures for all of the Hawaiian plant species (both native and non-native). These unique signature values allow for automated classification of all the incoming data. In this manner, Greg can accurately match up the image pixels with their corresponding plant species. Based on-going work, Greg feels confident that he can map vegetation in Hawaii to the species level with 93% accuracy.

At this point, Dan expressed his interest in pursuing more cooperation with Greg and his staff to further the mapping efforts at all the parks in PACN. Greg noted that they already have a considerable amount of

data for HAVO and this might be a great location for a pilot project. Dan pointed out that part of his recommendations will be to have Greg produce a product for a small site (100 acres or so) that meets the requirements of the national program. Greg didn't think this would be a problem at HAVO and in fact it would mean dumbing-down the current data. Greg thought that it would just take the creation of a simple routine that groups the individual species pixel data into larger groupings to get to the community (i.e. association) level. This could be based on a majority filter that counts the number of species pixels and groups them into polygons using threshold values.

Another offshoot of the pilot project would be to gather information on cost per acre for Greg's products. This would allow for cost comparisons with the other mapping methods. Greg thought that he would likely be cheaper than most other imagery acquisition and mapping options. He noted that if he entered into a long-term agreement with NPS he would only be looking to recoup the costs for three staff members and the flying time. Since the Carnegie Laboratory is a not-for-profit organization he is not interested in making a profit from the NPS. Conversely he would be actively looking for partnerships to help offset the costs. Potential partners could include his contacts at NASA. Further since he is actively acquiring imagery for other parts of the islands additional flightlines over NPS lands could be included reducing the overall airplane and processing costs. Dan noted that presenting a sample product with associated costs to the NPS would greatly enhance his opportunities for partnering with the NPS national vegetation mapping program.

In summary, Greg demonstrated how together the LiDAR and hyperspectral sensor provide detailed, high spatial resolution 3D information on the structure, biochemistry, and physiology of vegetation and ecosystems. Greg also noted that all of his publications and examples for this technology can be found on his websites. These include one on their airborne mapping efforts in Hawaii at <http://cao.stanford.edu> and one highlighting some of the early info on their species detection methods at <http://spectranomics.stanford.edu>.

Wednesday 9/5/07

Meeting place: Kalaupapa National Historic Site

Meeting Participants: Dan Cogan, Guy Hughes

Dan arrived at KALA in the afternoon and met Guy at his office. Guy and Dan proceeded on a tour of the facility with stops at the volcano crater, Kalaupapa village and the eastern coast. Guy pointed out some of the historical significant areas including historical churches, cemeteries and housing locations. All of the recent historical structures can be traced directly back to the forced settlement of Hansen Disease patients in Hawaii. There are currently still patients on the island that are cared for by the state health department. Guy mentioned that the state has a long-term lease with NPS to manage the natural resources at KALA.

KALA lies on the northern portion of the island of Molokai. It is a relatively flat peninsula that was created by a small volcano. This area is separated from the rest of the island by a steep cliff wall that rises up to 3000 feet. KALA encompasses about 10,000 acres with 8,404 being terrestrial. Of the 8,404 acres, approximately 3,000 acres comprise the peninsula and the remaining are cliff faces and major valleys. KALA is surrounded on three sides by the ocean and is bordered on the south by a mixture of private and state lands. The Nature Conservancy is a large bordering land owner to the southeast. Here, TNC helps protect significant portions of the North Shore Cliffs of Molokai – a world recognized natural resource site. KALA can only be accessed by plane, a steep 45-minute hike down from the upper portion of Molokai, or by donkey rides provided by a concessionaire. Since it is isolated, visitation is low, although the site has been continuously inhabited for over a hundred years by numerous patients, state employees, contractors, and recently NPS employees. This continuous and at sometimes intense presence of humans on the peninsula has drastically altered the vegetation resulting in mostly non-native species.

Guy went on to further summarize the current state of the vegetation at KALA as being a mix of pristine native communities and large areas overrun by exotic plants. The introduced species are widespread and occur throughout the relatively flat peninsula and the western cliffs and valleys. On the east side of KALA are some very pristine valleys and one plateau of about 1000 acres in size. These areas are considered the “crown jewels” of KALA by Guy and are actively monitored. Another area of importance are the coastal spray zones that contain native plants. Of special importance, are the populations of Hawaii’s only native palm. These short-statured plants are isolated on two of the three small islands that occur off the northeast coast. Currently, KALA is re-introducing the palm and some other rare species in other eastern coastal areas through propagation, planting, fencing, and irrigation. The overall trend of the park’s vegetation follows from native plants in the east to non-native to the west. This also corresponds to the moisture regime, with the eastern side receiving significantly more rain than the west. Concerning the non-native vegetation, Guy believes that there are only four common, dominant species. However these four intermix and present various combinations that might be considered separate associations.

Around the dry settlement area on the western side are large stands of exotic Christmasberry shrubs and trees. These form dense thickets that are prone to fire under dry conditions. With the current dry conditions, Guy ranks the fire danger as extremely high. Although Guy feels that prescribed fires would be a good management tool, there is currently no fire plan. A fire fuels inventory and map created in conjunction with the vegetation map would be an extremely valuable tool for Guy to help plan for both prescribed and wildland burns. Guy feels that it is critical to demonstrate to management how destructive a fire would be in and around the settlement due to the possible loss of historically important buildings.

Presently, Guy has five permanent and three temporary staff in the natural resource division. Guy would like to use the vegetation mapping effort to help support getting additional staff especially field botanists and a GIS specialist. NPS staff is currently housed in some of the old settlement buildings and the natural resource office is located in an old nursing home complex.

Guy pointed out the difficulty in mapping the vegetation at KALA. Issues here include, the steep cliff walls, the inability to see through the canopy, and the difficulty in getting cloud and shadow free imagery. To work around these issues Guy has experimented with oblique photography, laser range finders, and conducting field verification using helicopters and hand-held video cameras linked to tracking GPS.

Past vegetation work at KALA has varied from rapid assessment plots (similar to observation points) where he only collected data on the top three dominants in both the upper canopy and the canopy openings. Guy also sampled with more intensive plots where they collected cover class data on all the different strata. Guy has 42 of these more intensive plots and of those 19 have GPS coordinates and will be useful for classification efforts. GPS was not collected for all due to difficulty acquiring signals on the cliff walls and sheltered valleys (Guy may be able to relocate these sites if needed). All 42 have ground photos associated with them. Guy speculates that he sampled about 23 different alliances working from the ocean up to the cliff ridge. Of those eight could probably be collapsed into one or two alliances. Of the 23, about 15 or 16 represent native species communities. Guy has the park split into 15 management units that were used to stratify his sampling efforts. These are based on watershed boundaries and areas that have been fenced for ungulate control.

In addition to Guy’s plots, there also exists 31 transects in the park. These were surveyed by botanists and every species encountered were recorded. Based on previous work by Jim Jacobi, Guy believes that KALA has examples of all six Hawaiian life zones. All of these were likely sampled during the transect work.

Thursday 9/6/07

The meeting at KALA continued on Thursday with the same participants. Guy allowed Dan access to their GIS data. This was thoroughly explored by Dan including reviewing the existing IKONOS and Emerge imagery along with the GAP vegetation map, the USGS vegetation map and the Molokai landowner data. At this time Dan and Guy discussed the USGS map. Guy mentioned that the park paid \$50,000 for this effort and they have received a draft GIS coverage. This map created by Stephen Ambagis with the USGS-BRD was based on classifying and segmenting IKONOS imagery. Ground truthing was performed using a helicopter and videography. Guy would like to see the rest of the USGS contract met, including the delivery of the remaining products. Guy feels like the USGS effort is good start but more work needs to be done. This includes collapsing some of the confetti-like distribution of pixels into larger, more workable units. Dan speculated that this could be done by Stephen through standard GIS routines such as dissolving, vectorizing and smoothing.

After discussing the current USGS product Guy theorized about his expectations for the new vegetation map and how it could possibly proceed. First, he would like to either build off the USGS product by possibly improving it with more photo interpretation and manual digitizing. If this is not feasible, he would like to see a whole new effort planned and implemented. Dan presented some examples of how other parks have leveraged their mapping efforts to meet other objectives. Of these Guy was extremely interested in gathering fire fuels information. This could be done with the new fire fuel photo series that was created for Hawaii. Dan promised to track down this product from Rhonda Loh at HAVO. Also Guy would like to experiment with using data loggers and linking them directly to a GPS receiver. It would also be helpful if the plot photos were imprinted with GPS locations and azimuth readings for future monitoring efforts. Guy would also like to see a protocol developed for recording minimal species information as the crews travel between plots. This may include simply logging GPS coordinates for certain rare or exotic species that are encountered. For data recording, Guy would recommend that standard pick lists be created and plot codes be standardized. Regarding the pick list, Guy surmised that this may already be available at KALA from past projects. Further Guy would like to see the final database that the plot data is entered into made fully compatible with his previous plot data. This may include cross-walking fields and coordinating the cover class values.

To better understand the vegetation diversity at KALA Dan logged on the NatureServe website and queried their database for known plant associations that occur in Hawaii. Guy was able to rapidly pull out the associations that likely occur at KALA. After this review, Dan questioned Guy about his ability to assist with the vegetation mapping project. Guy thought that he would like to be actively involved as time permits. This would include helping with the planning, setting-up meetings and logistical support. Currently the NPS at KALA has vehicles and dormitory space that could be used to support vegetation crews. Also Guy would entertain actually hiring the crews as temporary employees provided the funding and support from the network was in place. Finally Guy would like to take the lead with the classification efforts working closely with Heritage or NatureServe. This would include creating the preliminary list of plant associations/alliances and actually writing the local descriptions and helping to create the field key.

Tuesday 9/11/07

Meeting place: Kaloko-Honokohau National Historic Park

Meeting Participants: Dan Cogan, Sallie Beavers, Aric Arakaki, Rick Gmirkin, Mandy Johnson

Dan met with representatives from KAHO and Ala Kahakai National Historic Trail. The meeting was started with introductions followed by a review of the National Vegetation Mapping Program and Dan's involvement with the Pacific Island Network. Sallie proceeded to give a description of KAHO. KAHO is located on the dry, western coast of the big island near the town of Kailua-Kona. KAHO totals 1160 acres comprised of sandy beaches, fishponds, lava flows and Hawaiian cultural sites. Approximately 596 acres of the park lay in the ocean and barren lava likely covers over half the remaining land. KAHO is surrounded on all sides by encroaching industrial and residential development. To the north, a new subdivision is currently under construction. This project starts directly on the park boundary, where they have stripped most of the vegetation and leveled the lava flows for lots. To the east the park is accessed by Highway 11, which forms its eastern boundary. Directly across the highway lies a light industrial park containing the park headquarters. The ocean is on the west side and some state land occurs to the south.

Sallie and Rick described the vegetation at KAHO as being influenced by the lava substrate, the presence of non-natives, and the proximity to the ocean. Rick explained that throughout Hawaii the plants generally fall into three categories, native, indigenous and non-native. The distinction being their life histories, with the natives evolving in Hawaii, the indigenous species brought to Hawaii historically by the first Polynesians, and the non-natives representing more recent introductions. Of these, the non-natives pose the greatest risk due to their out-competing the native flora and their threat to the archeological sites. Rick and Mandy explained that roots of non-native trees such as kiawe (mesquite) and koaia (acacia) uproot the rock walls, foundations, and other ancient structures. This happens both as they're growing in the rock spaces and also when they topple over. Currently the park monitors the non-natives and performs some control and maintenance on them in critical areas such as the southern half of the park. Due to staffing and funding limitations control is only performed in areas that either directly threaten archeological sites or on areas having very problematic species.

In conjunction with the control, the park also works closely with volunteers, a local high school, and other organizations to perform native plant restoration. This includes getting seeds and plants from a tropical reforestation group, propagation of the plants in a high school green house, and planting using high school and local volunteers. Currently the park is also exploring creating an ethno-botanical garden that highlights the indigenous species brought here by the early Polynesians. In general, Sallie explained that restoration is difficult due to a lack of staff, funds and information on the native plant communities that occurred here before settlement. Currently the park has been exploring historical data from pollen cores taken from their main fish ponds. In addition they are also looking at the vegetation growing on similar sites outside of the park and exploring oral traditions of the early Hawaiian people. For this restoration and control work a new vegetation GIS layer would be helpful to document the existing vegetation, select management areas and monitor change over time.

Next, Sallie and the park highlighted some of the past vegetation and mapping work that might be useful for this project. First, Sallie mentioned the vascular plant survey that was conducted at KAHO. This documented 6 rare plants and also identified some of the plant communities occurring at KAHO. Sallie further explained that she thought the list of non-natives in this report may be incomplete since only one species of *Acacia* was documented and there are likely three occurring on the site. Also Sallie thought that some of the data collected during this effort might be useful for the vegetation mapping effort. Currently the park also has a new resource management plan that is available. This includes both the terrestrial and marine environments. Another potential useful data set for KAHO includes site

descriptions collected during non-native control efforts. These include descriptions of the vegetation before and after the non-natives were eradicated.

Relatively current imagery also exists for the park. This includes a combination of IKONOS, and airborne photography. The most up-to-date photography was acquired by NOAA at 1:2400-scale and also by Pat Chavez using a customized system at a very fine scale. Dan mentioned that he will follow-up with Sandy and evaluate all of the existing imagery for KAHO.

For KAHO, Sallie and Rick thought that it would be important for the park to obtain as detailed a vegetation map as possible, possibly down to the species level (i.e. individual trees) for some areas. This would indicate where non-native trees and possibly rare and endangered plants occur. Also this detail would help capture the subtle micro-climates that influence the vegetation on the park. The park has limited staff and would probably not be able to help support this project directly. Sallie mentioned that they rely on Sandy Margriter for GIS support and Linda Pratt for botanical work. KAHO has successfully worked in the past with TNC, the Hawaii State Heritage program, and University students and would encourage this program to look at them as possible resources. In particular, Lloyd Loope and Jerald Carr where mentioned as good contacts for botanical work. Sallie also thought that it would be important for the project to include the state lands to the south since they are managed in a similar fashion as KAHO. Finally all agreed that the field work could happen at any time throughout the year due to the dry and fairly stable climate.

At this point, the meeting shifted to the Ala Kahakai National Historic Trail (ALKA). This part of the meeting involved Dan discussing the potential vegetation mapping efforts at ALKA with Aric. Aric began by giving a brief overview of the trail. ALKA was designated a National Historic Trail in 2000 and was staffed in 2002. Currently the staff consists only of Aric at this point. The trail follows primarily along the coast of the big island and is based on a historical complex of trail corridors used by the native Hawaiians. Currently AKLA encompasses existing roads, routes and private trails. A total of 175 miles of trails have been documented so far and continued work and out-reach may add to that number over time. Currently Aric is working on the final draft of the comprehensive management plan and is developing environmental impact statements (EISs) prior to the opening of each segment. Aric mentioned that all along the trail are numerous significant cultural sites. These include heaius (Hawaiian temples), ancient villages, agricultural artifacts (walls, fishponds, etc) and areas that have spiritual significance. The trail also offers many scenic vistas of the coast and includes dramatic lava flows, cliff walls, and tidal pools.

ALKA is a unique National Park Service unit since it encompasses the entire big island and crosses through private, state, and federal lands, with 17% of the trail occurring in HAVO, PUHE, PUHO, and KAHO (50% private and 33% other). Aric mentioned that under Hawaii law, all land up to the high water mark is considered state land and is open to the public. Due to the varied ownership of the land, Aric is actively reaching out to private land-owners, public and not-for-profit organizations, state land managers, and local communities for their support and to ultimately seek their help in managing the trail. ALKA faces many challenges related to management and access. Aric's approach has been to create multiple partnerships and include as many interested individuals as possible in the planning stage. Aric would like to see the trail be community-based with segments of the trail managed by different entities. Of particular importance to Aric is involving the native Hawaiians and land-owners that have historical ties to the land. This may include having a permitting system and having the land-owners provide guided interpretive hikes.

For vegetation mapping purposes, Dan mentioned that the segments of the trail occurring on NPS lands (HAVO, PUHE, PUHO and KAHO) will be mapped as part of these other projects. However, Aric would still like to see a protocol developed for the remaining lands in and around the trail. Of particular

importance would be those segments that cross through lands containing native and non-native vegetation. Dan and Aric thought that a reasonable approach might be to include a 1000-2000 foot environs (buffer) around these segments. Also the mapping might need to occur in intervals as various segments are brought on-line. This could occur during the EIS stage. Currently Aric is working on two pilot projects, one a 15-mile stretch in the north that goes through tourist resorts and another in the south that follows coastal strand vegetation. Dan thought that mapping in these areas may be appropriate at this time.

Dan speculated that a possible approach might include using the classification of the plant communities based on the field work conducted in the other parks on the island. Preliminary maps for the remaining trail segments would then be created as needed. Once the maps are drafted, a field crew could quickly walk the vegetated portions noting any changes on the map. During the surveys, the field crews would only sample any new vegetation communities they encountered. Aric thought that sampling could easily occur on TNC, state and public lands. All of this ownership information could be given to the field crews by including a land ownership overlay on the field maps. In summary Dan speculated that mapping ALKA would be an on-going process that would start with work in the other NPS parks. Based on that work a mapping scheme would be created and new portions added in a systematic approach. Mapping could occur for the entire trail but ground verification and sampling work would have to wait until the segments are opened and public access is granted.

Wednesday 9/12/07

Meeting place: Pu'ukohola Heiau National Historic Site

Meeting Participants: Dan Cogan, Ben Saldua

The meeting began with introductions and a brief summary of Dan's responsibilities and the goals of the National Vegetation Mapping Program. Ben then presented an overview of PUHE. Currently the NPS manages 85 acres, including 62 NPS-owned acres and 23 acres that are leased from the State of Hawaii. This lease is on a 5-year rotation. Surrounding PUHE to the north are State lands, county lands to the south, private lands to the east and a mix of state and private lands to the southeast. The park has good relationships with all of its neighbors and works closely with the soil conservation district to help manage the Makahuna Gulch located just north of the park. This Gulch along with Highway 270 that bisects the park, are import vectors for the introduction of non-native species.

Ben described PUHE as a very important cultural, historical, and religious site that preserves ancient Hawaiian temples and royal residences. PUHE contains three important Heiaus or temples and this location was used by many of the Hawaiian Kings as a ceremonial site, a place to greet visitors and to hold councils. It also preserves the homesite of John Young a British sailor who became a trusted military advisor to the king.

The vegetation at PUHE consists primarily of the non-native bufflegrass and Kiawe trees/shrubs. In the past Ben noted that NPS employees used herbicide to control some of the non-natives and some inventories and mapping of the vegetation was completed. Dan promised to follow-up with the Inventory and Monitoring program to obtain copies of these technical reports including the PUHE vascular flora report and the vegetation management plan.

Since the park is relatively small, Ben mentioned that there is limited staff located on site to conduct scientific endeavors. Instead PUHE relies heavily on volunteers, University and State cooperators and NPS employees from other parks in the network. He has worked very successfully in the past on vegetation projects with Rhonda Loh from HAVO and other HAVO and PACN staff. Dan mentioned that Rhonda expressed interest in helping on this project as well.

Ben is very interested in the National Vegetation Mapping Program and would like to be the point of contact for the project. Dan mentioned that all of his work would come to him for review and all future work will be coordinated through Ben. Ben further mentioned that if a buffer or environs was mapped around PUHE, he would suggest including the Samuel M. Spencer Park to the south and significant portions of the Makahuna Gulch to the North.

Thursday 9/13/07

Meeting place: Pu'uhonua o Honaunau National Historic Park

Meeting Participants: Dan Cogan, Malia Labor

Dan met with Malia Labor at her office in PUHO and also accompanied her on a short hike through a portion of the park. The meeting started with Dan explaining the national program and his role with the PACN. Malia then proceeded to give a brief overview of the park. Malia explained that PUHO consists of 420 acres contained in two adjoining parcels. The original parcel encompasses 182 acres and was established to protect and preserve aspects of traditional Hawaiian life. This includes Honaunau Bay, which features a canoe landing site and former residence of Hawaiian royalty. Adjacent to this site and separated by a large stone wall is the pu'uhonua, a place of refuge for defeated warriors, noncombatants during times of war and for people that violated the sacred laws of kapu. This area was established as national historic park in 1961. A recent addition to the park in 2006 includes 238 adjoining acres to the south. This site was acquired to protect historically important cultural sites including villages that helped support the pu'uhonua and the royal residence.

PUHO lies on the southwestern coast of the big island and is boarded by the ocean to the west. On the east, north and south are primarily private lands belonging to the Bishop Estate. The park has limited natural resource staff due to recent changes in personnel. At this time Malia is the primary natural resource contact at the park although a new natural resource manager is likely to be hired shortly. Most of Malia's time has been spent recently on non-native species control and re-vegetation efforts. Malia mentioned that the park has many important and rare plant communities that she focuses on. This includes the coastal strand vegetation along the coast. Other areas that likely contain good examples of native vegetation are mesic cliff refuge areas that are tucked in and under the coastal sea walls and the upland forested areas on the newly acquired site. Non-native trees such as kiave (mesquite) and koaia (acacia) are dominant throughout most of the original site where they uproot the rock walls, foundations, and other ancient structures. Christmasberry trees are also present but do not seem to pose as big a threat as the other non-natives. In addition to the trees, KAHO also contains many non-native forbs and grasses including Guinea grass that likely resulted from past grazing activity on the park and on-going ranching in the neighboring lands. Malia and the park have worked with restoration teams and volunteer groups to help control and restore some of the areas that contain these non-native species. Past efforts have included eradication and control using herbicides and one controlled burn. Unfortunately many of the non-natives have re-established in these areas. Along the coast, Malia is actively engaged in planting native species. This includes clearing, planted and irrigation to promote establishment.

Due to staff and funding limitations, the natural resources at the park have been somewhat overlooked. Malia would like to see the vegetation mapping efforts help promote the need for protection of the native species, help plan for future non-native control and help inventory the vegetation on the new portion of the park. This would help create a baseline for future monitoring and restoration efforts. Malia is extremely interested in contributing to the vegetation mapping effort by perhaps helping with the sampling and sampling design. Malia would like to be involved with the sampling strategy to assist with instructing the crews on how to work in culturally significant areas. Also Malia would like to leverage the data collection to also obtain useful fire fuels and non-native species data. Malia went on to identify

some of the past vegetation work that might be useful for this project. This included a vascular plant survey and an existing vegetation map for the original park. This map was created by Leishmann in 1986 and contains 26 map units. Dan mentioned that he reviewed this map product and it appeared to have some registration issues and was fairly coarse.

During the hiking portion of the meeting Malia showed Dan examples of her re-vegetation work and some of the dominant plant communities. This included coastal strand, upland non-native woodlands and cliff refuge communities. Dan mentioned that the location of the cliff refuge communities below and underneath cliff overhangs will pose a challenge for mapping and for acquiring good GPS signals. Some potential work-arounds would be to map these areas on the ground using laser rangefinders and possibly creating a different GIS layer just for this type. Also during this hike, Malia explained the need to have very detailed mapping of some of the vegetation, possibly down to individual trees. This would be important information for management especially documenting any non-natives in the rare communities. Also of importance would be getting an adequate representation of the understory. In the new addition of the park, some of the higher elevation sites contain very thick and lush tree canopies. It would be important for the park to better understand the understory diversity in these sites including the presence of any non-native species.

Thursday 9/13/07

Meeting place: USGS Building Hawaii Volcanoes National Park

Meeting Participants: Dan Cogan, Marcos Gorresen

Dan met with Marcos at HAVO to discuss his past vegetation mapping work on the big island. Marcos gave an overview of his project, which included building off past vegetation mapping efforts completed by Jim Jacobi. Both Marcos' and Jim's efforts were undertaken to document bird habitat locations for Hawaiian forest bird inventories including most of HAVO and surrounding lands. Marcos specifically used Jacobi's mapping convention to classify vegetated areas on LandSat imagery. He accomplished this by creating a signature library in Imagine software and performing a supervised classification of recent LandSat scenes. Although the classes were relatively coarse, Marco felt that his accuracy was pretty high.

Marcos explained some of the lessons he learned while mapping the vegetation in Hawaii. First, the vegetation can be very diverse and complicated, especially in mesic environments. Some of the native tree species such as koa are extremely difficult to distinguish on coarse-scale imagery. Also, native ohia trees can occur across multiple landscapes where they vary from short, sparse woodlands to tall dense forests. To adequately map this diversity a mapping scheme needs to be created that takes into account structure and density along with the floristics. Another big challenge is access and logistics for ground-truthing. Marcos used a helicopter to perform ground-truthing. This allowed him to rapidly check signatures and verify them using an on-board GPS system.

Marcos' recommendations for the PACN project included: 1) acquire fine-scale imagery with high detail, 2) use local botanists/biologists, 3) use lidar to better map structure of the vegetation, 4) use helicopters for field work and to provide ground-truthing, and 5) think about crosswalking our map products to Jacobi's and others by using similar map classes and conventions. Marcos also explained that we will be thinking about using a biologist that is very familiar with the vegetation to help with the mapping. This will allow us to help tease out difficult map signatures like koa. Also Marcos thought that maybe we will produce multiple GIS layers instead of one. This would involve splitting out things like density, height, and cover into individual GIS layers that could be linked. Marcos thought that this might help avoid some error and reduce the number of polygons. Finally Marcos identified some existing data that might

be helpful. This included the Hawaii Gap accuracy assessment data, Jacobi's vegetation map of the big island, and eventually 200 plots that Marcos is proposing to collect to monitor change.

Friday 9/14/07

Meeting place: Hawaii Volcanoes National Park (Telephone Conversation)

Meeting Participants: Dan Cogan, Linda Pratt

Dan and Linda discussed on the phone Linda's work at PUHO, KAHO, and PUHE. At these parks she placed releve type plots at regular intervals along linear transects. In these plots she collected plot data similar to that collected in the NPS National Vegetation Mapping Program. Unfortunately no GPS coordinates were recorded but Linda feels confident that she could find them again if needed. All of this data was recorded in an Excel spreadsheet that is available.

Linda also mentioned that she helped compile a pretty thorough list of past vegetation projects in the parks as an appendix for a comprehensive Inventory and Monitoring report. This report resulted from Linda's involvement in a vegetation work group as part of the PACN. Linda also thought that Rhonda Loh and David Benitez would be excellent sources of existing data for HAVO. Dan mentioned that he had already met with them. Linda further recommended David and Rhonda as good candidates for future mapping and field work.

Finally Linda concluded by cautioning that vegetation classification models created on the mainland often don't work without being modified in Hawaii. This is due in part to the unique plants that are found nowhere in North America. Since this is a tropical system it is important to understand the complex interactions that create plant associations. Linda warned that past efforts to classify the vegetation in Hawaii struggled with placing the non-native vegetation and coping with the vast intermixing of similar species.

Friday 9/18/07

Meeting place: Haleakala National Park, Resource Management Office

Meeting Participants: Dan Cogan, Steve Anderson, Patti Welton, Shaun Berney

The meeting began with introductions and a brief summary of Dan's work and what he is tasked to accomplish for the PACN. This was followed by an overview of HALE by Steve. Steve explained that HALE encompasses about 30,000 acres and is in the process of acquiring another 3000 acres to the south of the park. HALE extends from the top of the crater (10,000 feet) all the way to the ocean. The vegetation is very diverse ranging from dry, high elevation sparse communities to very mesic cloud forests. The park has approximately 40 different plant communities with 30% of the vegetation comprised of non-native species. About 90% of the park is considered wilderness and a large portion of this is contained in the Kipahulu Valley, which is closed to entry as a biological reserve.

To begin the meeting, Steve mentioned that he has been championing for a vegetation map for several years. This has included meeting with Mike Story from the national program and setting-up a contract for a vegetation map with Stephen Ambagis at the USGS. Currently, this mapping effort is still in an early stage. Based on some meetings and review of the IKONOS imagery, it appears that the imagery will not be able to provide enough detail and as such the project is tentatively on hold pending more discussions with the USGS. In addition to the vegetation mapping, Steve has also been pushing to get the monitoring program started at HALE, with the idea that the field work could be linked to the vegetation mapping.

Concerning working at HALE, Steve mentioned some of the difficulties and his expectations for this project. HALE is very rugged with large tracts that have no access. In the past, HALE has used a

helicopter to ferry NPS field crews into remote areas and he would like to see this planned for the vegetation mapping as well. Currently, the NPS resource staff is short-handed with only Steve, Patti Welton (botanist), Shaun Berney (GIS), and a bio-tech. Depending on this project and others, Steve expects to be hiring a staff ecologist and possibly more bio-techs. Steve would like to have his staff involved with this project but expects that contracted or other NPS staff would be needed to do the bulk of the field work. Similar to other parks in the PACN, Steve feels that accurately mapping the location of non-native plants and some native plants such as koa are resource priorities. Having a map with this information would greatly help them to plan control efforts for the non-natives, monitor key bird and wildlife habitat (the best examples in the state are at HALE) related to koa, and to document the need for more funds and staff. Steve pointed out that HALE contains the largest percentage of endangered and endemic plants in the NPS. Due to these endemic species, Steve would like to see field crews hired that have local experience with the botany on the island of Maui.

Past vegetation studies at HALE besides the USGS effort have included other vegetation mapping projects and plant community monitoring and classification work. This includes vegetation maps created by Jacobi, Whitiker, and Williams (all are available as Technical Reports). Jacobi's work concentrated on areas that provide bird habitat and Patti and Steve feel that this product is accurate but too coarse. To round out the park, Williams built off this product and included weedy areas in the lower elevations that were not mapped. Concurrent to this, Williams created a vegetation map just for the crater portion of HALE that contains very sparse vegetation. Together these products were compiled by the park into one map at the formation level that covers all of HALE. In addition to the mapping efforts, Patti has been actively involved with collecting plant data throughout the park. This has included 700 plots with 170 placed in the Kipahula area. Patti will provide this data to the program to be assessed for its usefulness. Patti speculated that some of the data will be equivalent to the standard releve plots and some might be more like an observation point.

HALE has very good relations with its neighbors and Steve thought there exists good potential for cooperation with them and other conservation agencies on Maui. Of particular importance might be the TNC and the East Maui watershed partnership. Dan mentioned that it would be good for HALE to contact all of these entities and present the project. This could be facilitated by examining the ownership GIS layer and finding the owners of land surrounding the park. If they seem interested they could be invited to the scoping and kick-off meeting. Further, if they would like to contribute funds or in-kind support additional areas surrounding HALE could be incorporated into this project.

To wrap up the meeting, Dan, Steve and Patti discussed the timing of the project and possible limitations. From HALE's standpoint, they would like to see the project started sooner rather than later. However they are cognizant of funding and staff limitations. Patti mentioned that the field work can happen any time throughout the year but depends daily on the weather. She also noted that the park has many existing cabins and shelters in the back country that the field crews can work from but reservations need to be made way in advance. Also if a helicopter is used, this needs to be approved and coordinated ahead of time. Steve also mentioned that if a helicopter is needed, the park may be able to use it for other tasks to better take advantage of the flight time and help offset some of costs. Concerning funding, Dan mentioned that he helped PACN solicit some initial start-up funds that could be used to help start the field work and conduct the planning meeting at HALE in FY08. However the bulk of the work will likely start in FY09. Dan speculated that the field work would probably happen across multiple 7-10 day sessions. These would be dependent on whether contractors or NPS botanists were used. Regardless, this strategy would allow the crews to start the first session in easily assessable locations and then progressing to the more remote sites. In the interim between sessions, the plots collected could be plotted and holes in the distribution could be addressed. If more time was needed between sessions the field crews could be sent to other parks.