Appendix 1-3

MIP/OIP NATURAL RESOURCES MONITORING PROGRAM

Vegetation Response to the Release of Ungulate Pressure
For Opaeula and Koloa Management Units

Background and Justifications
Feral pigs are one of the main threats to native Hawaiian ecosystems. They have been documented to negatively affect the distribution and abundance of native vegetation, disperse non-native seeds, and create disturbed areas that are more vulnerable to invasive species establishment. For these reasons, fencing and ungulate eradication have become primary steps taken by the Oahu Army Natural Resource Program to stabilize managed species and the habitat in which they occur.

After conducting an extensive literature review focused on vegetation response to ungulate removal in Hawaiian forests, we noticed the results varied dramatically between studies. In some studies native vegetation significantly increased in species richness, total biomass, and percent cover (Cole, 2012) while in other studies no significant recovery of native vegetation was detected (Kellner, 2011). These results suggest that habitat resilience to ungulate disturbance varies between ecosystems and level of degradation.

The tipping point, when native vegetation no longer rebounds from the release of ungulate pressure, has not been studied in Hawaii thus far. For these reasons, there is limited data for land managers to use to predict the efficacy of fencing and ungulate eradication without implementing vegetation monitoring.

Monitoring Protocol
In 2014, a pilot study will be conducted to evaluate the efficacy of utilizing Worldview-2 (WV2) imagery to monitor vegetation response to ungulate removal for the Koolau summit plant community. We will use OANRP’s Opaeula management unit (MU) as the study site and the unfenced area directly north of the MU as the control site. Since Opaeula was fenced and became ungulate free in 2001, the results of the study will be used to quantify vegetation response to twelve years of ungulate exclusion. In addition, a baseline map will be generated for the Koloa MU to quantify ungulate impact prior to the completion of the 2012 fencing and ungulate eradication efforts. This will be accomplished by using May 2012 WV2 imagery for mapping and analysis purposes.
Monitoring Objectives

1. Quantify vegetation response to ungulate removal for the Koolau summit habitat. This will be accomplished using traditional field plots and remotely sensed data extraction and advanced statistical analysis.

2. Establish a baseline index of vegetation conditions prior to fencing and ungulate eradication for the Koloa MU.

Hypothesis

A significant difference will be detected between the two study areas, with the ungulate free area having a higher index of vegetation cover. The main difference in vegetation response to ungulate removal will occur within the ground cover stratum, 0-1 m.

Study Areas

1. Change detection analysis will be conducted, using the Opaeula MU (Figure 1) as the study area and the unfenced habitat directly to the north of the MU as the control site. Since Opaeula was fenced in 2001, the results of this study will show vegetation responds to twelve years of ungulate exclusion.

2. A baseline map will be established for the Koloa MU (Figure 2), utilizing WV2 imagery taken prior to fencing and ungulate removal.

Figure 1: Area #1: Change detection analysis will be conducted for the Opaeula MU (represented by the yellow polygon), using the adjacent area which is unfenced (represented by the red polygon) as the control site.
Technical Approach

1.1 Collecting vegetation measurements in the field

In the field, 20 point intercept transects measuring 20 meters long will be permanently installed, using PVC poles as beginning and end markers. The following data will be collected along each transect: 1) canopy cover, 2) understory cover 3) ground cover. In addition, we will set up two 2 x 1 meter plots along each transect. They will be spaced nine meters apart to ensure independence.

Canopy cover refers to the horizontal projection of canopy area in percentage and is typically used in forestry and ecology to characterize the light regime within a forest. However, by definition, canopy cover is mainly determined by the upper portion of the trees, which is not usually directly affected by ungulates. Ungulates more directly affect the ground cover and understory strata.

We expect a negative relationship between canopy cover and ground cover, but such relationships will differ between the unfenced and control sites because of ungulate impact.

1.2 Modeling and mapping vegetation structure using worldview-2

To test the cost-effectiveness of WV2 for characterizing vegetation structure, we will also model and map vegetation structure using WV2. We will perform image preprocessing (calibration, atmospheric correction, and topographic correction) and extract images features (including
vegetation indices, texture transformation, and principal component analysis). We will develop models based on the spectral reflectance and extracted image features.

1.3 Analyzing the impacts of fencing on vegetation conditions

We also will test the impacts of fencing on vegetation conditions using two approaches. The first approach is to analyze the vegetation structure maps derived from remotely sensed data and compare between unfenced and control sites. For example, we expect a lower mean ground cover, basal area, and tree density over the unfenced site. We can use ANOVA to test whether there is a statistically significant difference.

2.1 The second approach is to perform statistical modeling of vegetation structure at the plot level using environmental variables (such as elevation, precipitation, temperature, terrain slope, aspect, insolation, and soil moisture index). We will test whether fencing has impacts on vegetation structure by building 1) a multiple regression model with fencing as a dummy variable, and 2) a mixed-effect model with the random effects depending on fencing. The dummy regression model is commonly used, but the mixed-effects modeling is a more recent statistical technique and it is a better choice if the number of plots within each site is relatively small.

References: