



Potential Kiwikiu Habitat on Leeward Haleakala

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GIS 180 – Ecosystem Management

Introduction

The threats to native forest birds in the state of Hawaii are numerous and relentless. Hawaii has seen over two-thirds of its endemic forest bird species go extinct since human contact, many being after Western contact. This is a large part of how Hawaii has earned the notorious moniker of “the extinction capital of the world.” The introduction of invasive species, the introduction of avian disease, and habitat degradation have been major driving forces in the decimation of the endemic forest bird population, and it is expected that climate change will amplify this pressure in the coming years. It has been predicted that with the warming climate, the most lethal disease to the birds - avian malaria - will be present at higher elevations than it is currently. Avian malaria is limited by the cold temperatures that exist at higher elevation, but with warmer temperatures, the disease could spread much higher than at present. This can drastically shrink the available habitat remaining for the native Hawaiian forest birds. The upper limits of their habitat is well defined, and not likely to grow into much higher elevations given a warmer climate due to the limitations of converting sub-alpine shrub land into wet forest.

Maui Forest Bird Recovery Project (MFBRP) has a plan to help ensure the survival of Maui's most endangered forest bird, the Kiwikiu, by restoring forest in Nakula Natural Area Reserve on leeward Haleakala and reintroducing the bird in this location to create a second population with a much smaller chance of having such a large impact from avian malaria. I worked for MFBRP as a technician in 2014 in TNC's Waikamoi Preserve to aid in their studies of existing Kiwikiu habitat and home ranges. I wanted to continue to support their cause and coordinated with them on this project to help fulfill one of their GIS analysis needs.

Problem Statement

Kiwikiu core habitat is forested land. How much preferred Kiwikiu habitat currently exists in the land zoned as restoration areas on leeward Haleakala, and how much potential habitat has been created by the recent re-foresting efforts of Maui Forest Bird Recovery Project and the Department of Land and Natural Resources in Nakula Natural Area Reserve?



Methodology

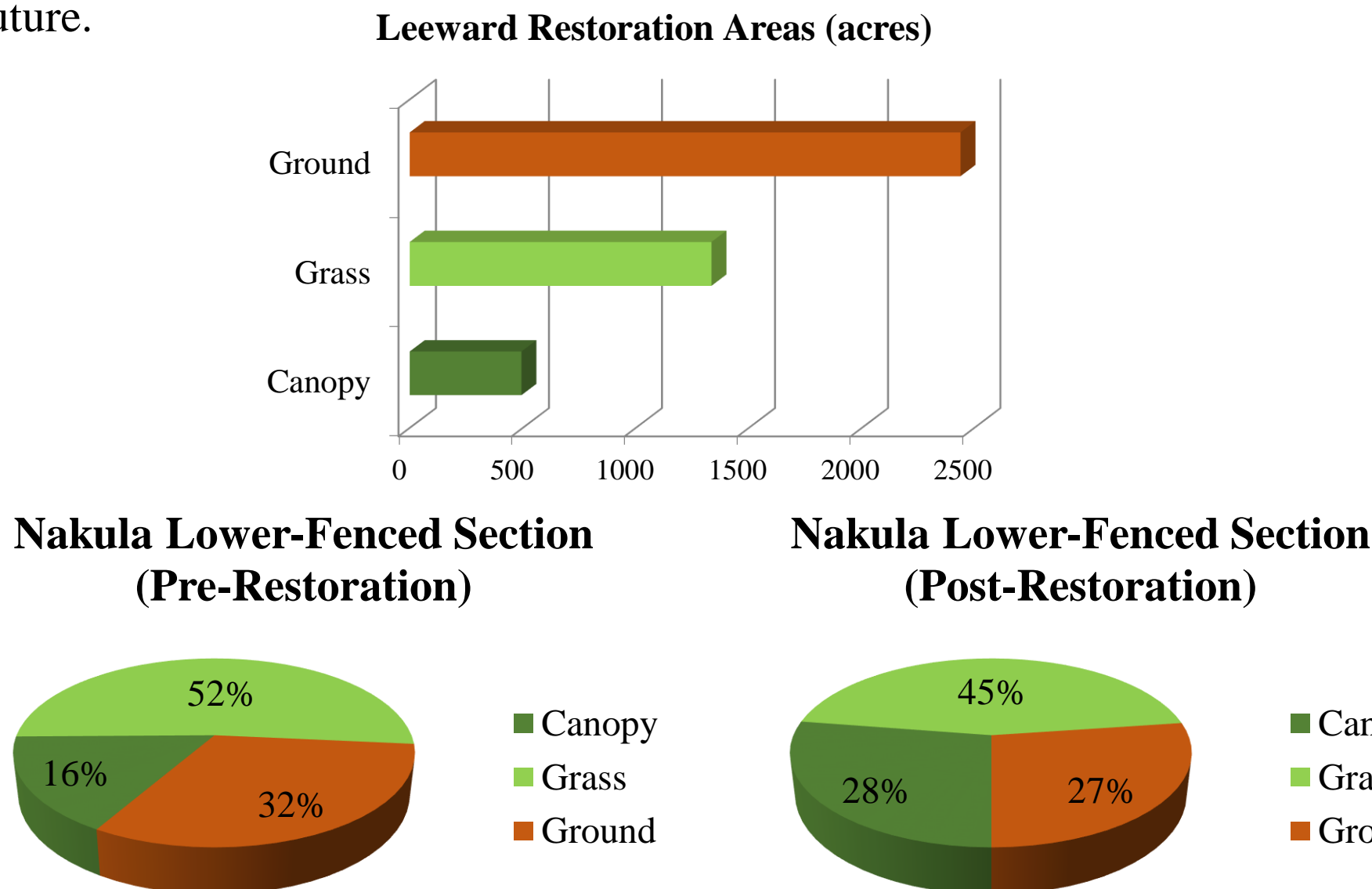
I have obtained eight-band satellite imagery of the land parcels in question from the World View 2 satellite, which has allowed me to estimate the approximate area of ground cover, canopy cover which is deemed as preferred Kiwikiu habitat, and grass which are prime areas for re-forestation efforts. The satellite imagery is from 2011 which is prior to any re-forestation efforts so I was able to determine both existing forest canopy as well as an estimation of how much area will become forest canopy as a result of re-forestation efforts as of April, 2015. I first clipped this data to the specific areas in question and subsequently combined the bands to create raster images that highlight the different levels of chlorophyll absorption in false color. Each cover type was highlighted best in different wavelength bands, so I had to identify each cover type in a separate raster. After identifying the unique color ranges for ground cover, canopy cover, grass, I was able to re-classify the pixel cells of the satellite imagery with these identifiers and merge them into a single raster file. I then was able to calculate the area for each cover type based on pixel size and calculated the area of the re-forestation areas by using the “calculate geometry” function for each of the polygons. I merged the re-forestation polygons with the existing canopy to find a new total canopy cover and erased the reforestation polygons from a “grass only” polygon to find the new area of grass and thus ground cover as well in the post restoration scenario.

References

Kiwikiu (Maui Parrotbill). "Maui Forest Bird Recovery Project. Maui Forest Bird Recovery Project, 2015. Web. 20 Apr. 2015.
Ziegler, Alan C. *Hawaiian Natural History, Ecology, and Evolution*. Honolulu: U of Hawai'i, 2002. Print.
World View 2
Satellite imagery courtesy of the County of Maui & Digital Globe – 2011.
Base imagery courtesy of the State of Hawaii.
Restoration areas, current Kiwikiu habitat, and existing re-forestation plots courtesy of Maui Forest Bird Recovery Project.
Photographs by Keith Burnett

Results, Discussion, & Conclusions

The three leeward restoration areas consisting of Department of Hawaiian Homelands (DHHL), Nakula Natural Area Reserve, and Kahikinui Natural Area Reserve totaled 4267.62 acres of land. Forest canopy was determined as being 494.18 acres of land (11.6%), grass was determined as being 1334.72 acres of land (31.3%), and ground cover was determined as being 2438.72 acres of land (57.1%). Within the lower fenced section of Nakula Natural Area Reserve where MFBRP is focusing re-forestation efforts and plans on reintroducing a second population of Kiwikiu, there is a total of 422.61 acres of land. Forest canopy was determined as being 69.53 acres of land (16.5%), grass was determined as being 218.49 acres of land (51.7%), and ground cover was determined as being 134.59 acres of land (31.8%). The combined efforts of the Department of Land and Natural Resources and Maui Forest Bird Recovery Project have potentially converted up to 46.55 acres of grass and ground cover to forest canopy, or 11.0% of the total area as of April, 2015. From this effort, approximately 27.5% of the lower fenced section of Nakula will be forest canopy, and more re-forestation effort is currently underway and planned for the future.



The classification of grass and canopy proved to be more difficult than anticipated. Even though the difference in coloration in both true color and false color was quite stark, there is no attribute table for those images. When I attempted to combine the three specific bands into one raster which had an attribute table, I found that there were similar values in the ranges for canopy and ground cover. However, I found that band 5 by itself had a very stark difference between canopy cover and the ground and grass cover and was able to determine canopy cover via that band alone. For the grass, I used a raster combination of the three bands that made up the false “vegetation” imagery, as the grass was clearly a stark white coloration compared to the other two cover classes. I could then by elimination figure out ground cover from the total area minus canopy and grass. Higher resolution imagery could have produced a slightly more accurate classification.

From this analysis we have a good idea of what the forest coverage will look like in this area in the next 10-15 years, however it is just a rough estimate. Not all of the re-forested plots are guaranteed to produce viable canopy cover, and now that the area is fenced off from ungulates, the existing viable trees should produce more surviving offspring and reclaim some of the surrounding grass and bare ground without any human intervention. The current estimates for Kiwikiu home ranges are based on data collected from mostly pristine native wet forest and may not translate well to accurate home ranges in the montane mesic forest on leeward Haleakala. Further research would need to be done to determine how much area an individual or pair of Kiwikiu would need to sustain themselves in such a montane mesic forest before an accurate estimation of the potential population could be generated. However, as has been evidenced at Hakalau Forest NWR on Hawaii, it does seem that with enough re-forestation effort and fence maintenance, a significant amount of the land in the restoration areas could be converted to forest in the next 10-20 years. That could prove the deciding factor in the fate of Maui's most endangered forest bird, the Kiwikiu.

Acknowledgements

Mahalo nui loa to MFBRP for providing the inspiration for this project as well as currently unpublished field data, and for all the hard work they and many volunteers have provided in protecting the native species of Hawaii. Mahalo to Sarah McLane for providing the satellite imagery and all her help in the analysis procedures.

Kiwikiu Current Range and Reintroduction Site

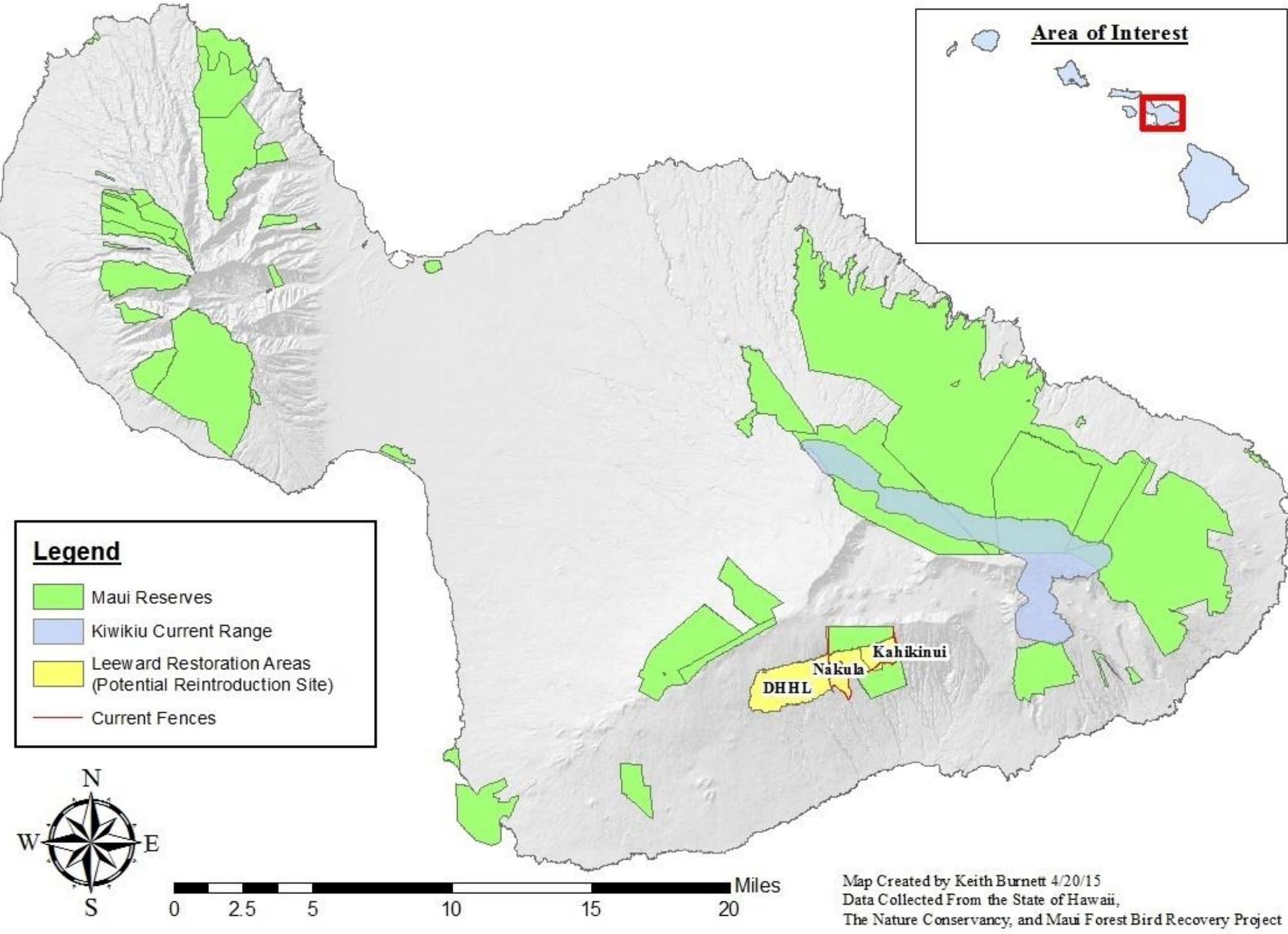


Figure 1: Kiwikiu Current Range and Leeward Haleakala Reintroduction Site

True Color and "Vegetation" False Color Satellite Imagery of Study Site

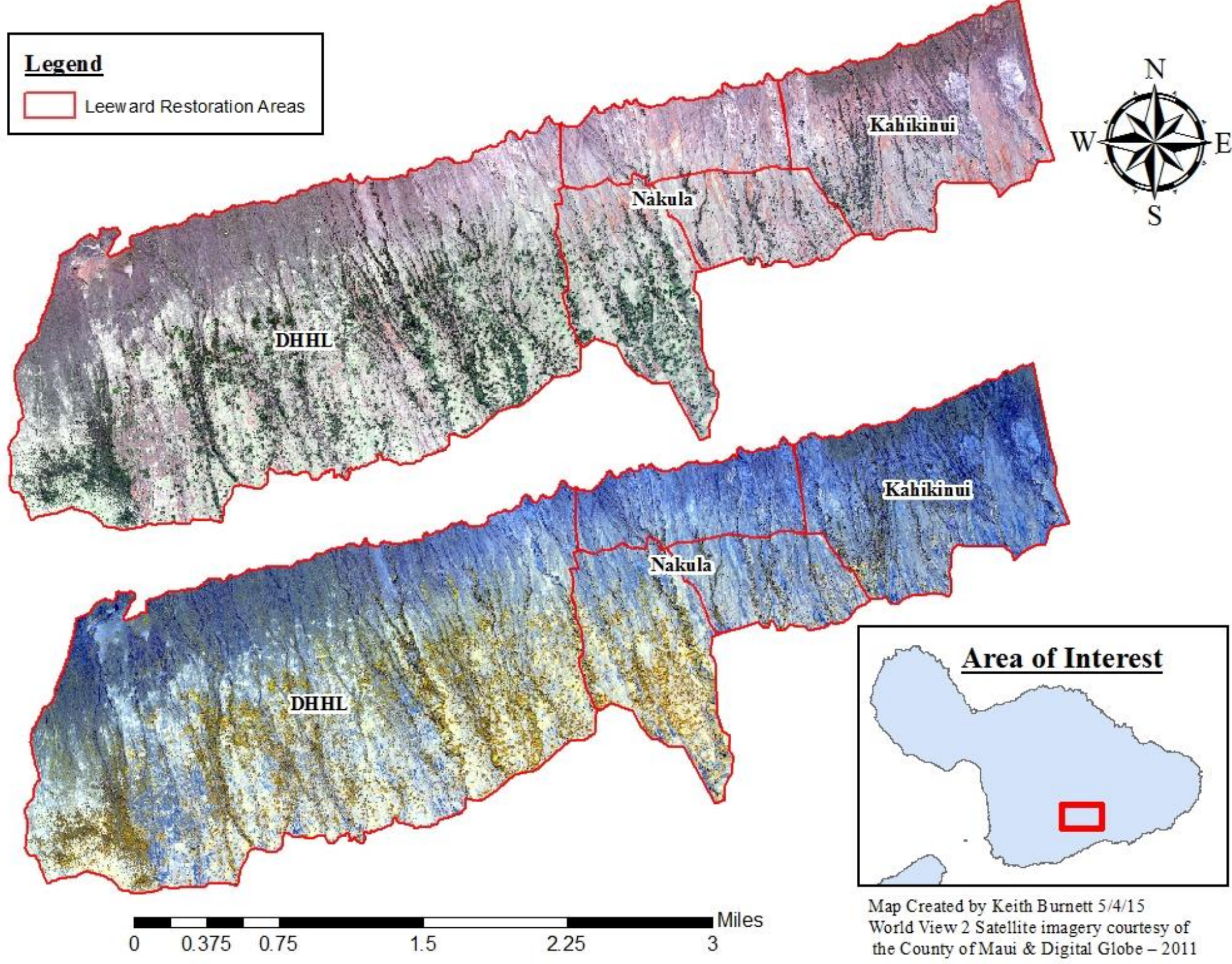


Figure 2: True and False Color Satellite Imagery

Leeward Restoration Areas Vegetation Cover Classification

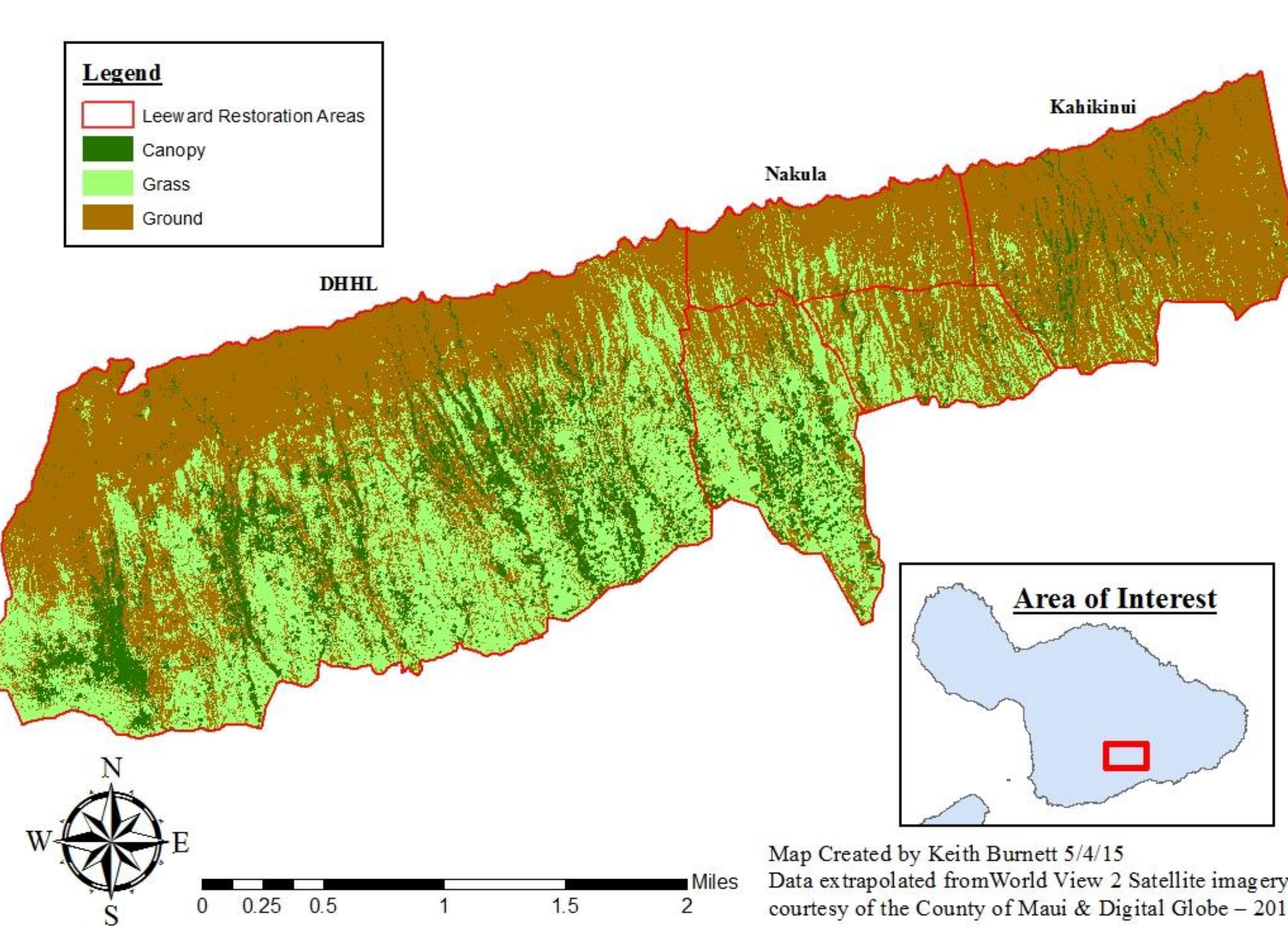


Figure 3: Leeward Restoration Areas Cover Classification

Kiwikiu Reintroduction Site Vegetation Cover Classification

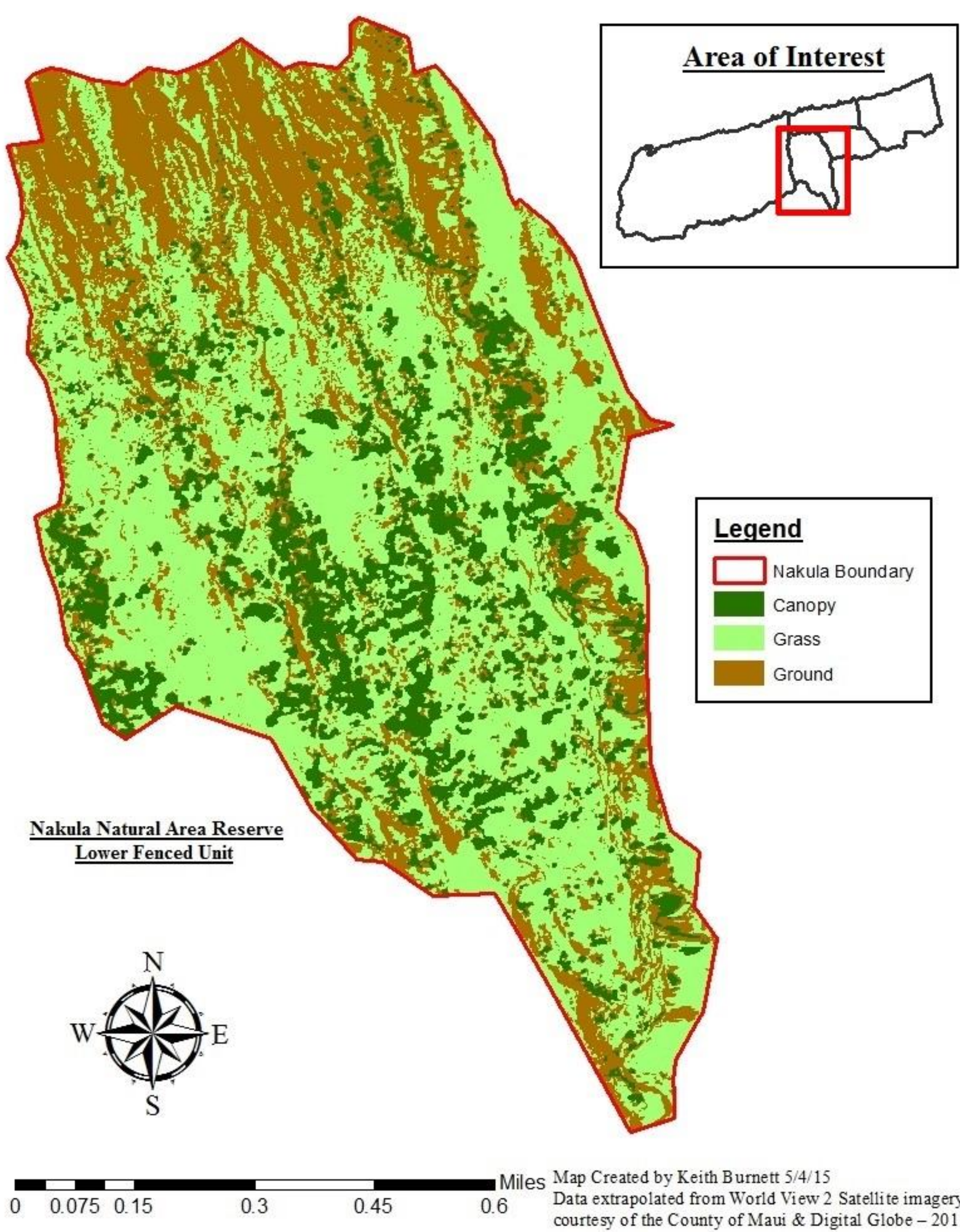


Figure 4a: Nakula NAR Lower Fenced Unit Land Cover Classifications

Kiwikiu Reintroduction Site Vegetation Cover Classification and Planting Sites

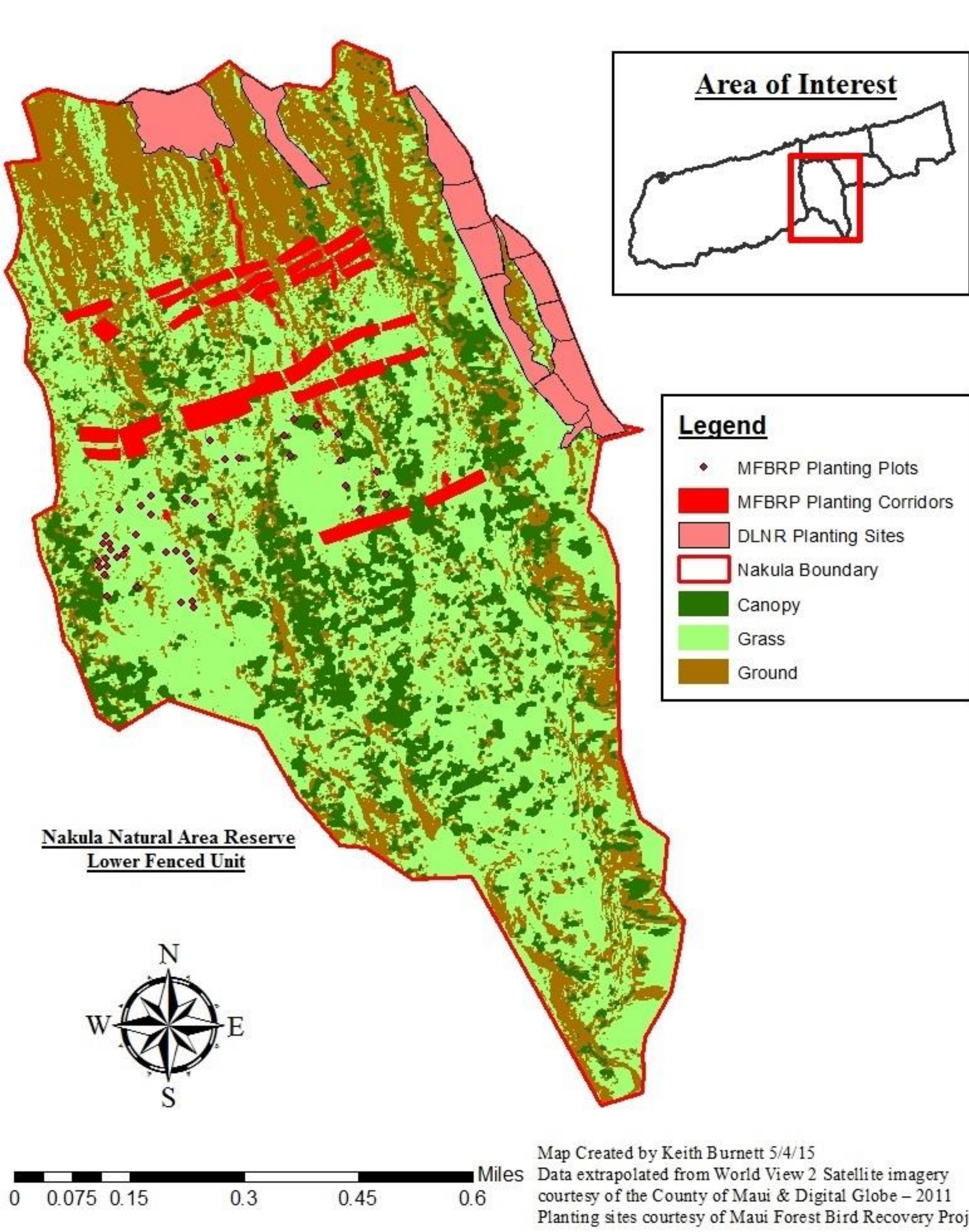


Figure 4b: Nakula NAR Lower Fenced Unit Land Cover Classifications and Re-forestation Plots