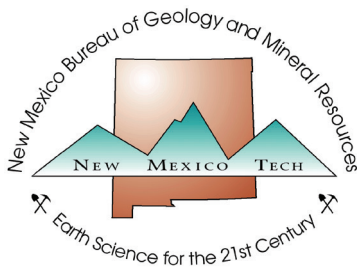# APPENDIX C

Estimating Canopy Cover using 4-Band NAIP and eCognition Software in the Sacramento Mountains for the years 2003 and 2014

This document describes GIS analyses by NMFWRI staff to calculate percent canopy cover from aerial photographs.

Estimating Canopy Cover using 4-Band NAIP and eCognition Software in the Sacramento Mountains for the years 2003 and 2014.

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Introduction

At the New Mexico Forest and Watershed Restoration Institute (NMFWRI), one of our missions is to provide information for better land management practices. Knowing the spatial distribution and density of vegetation across a landscape can aid in decision making for habitat restoration or for providing a baseline estimate for future land cover changes over time. This current study area is focused in the Coleman Ranch area of the Sacramento Mountains.

eCognition- Object Oriented Image Analysis

Object based image classification systems, such as eCognition software, allows for a semi-automated analysis of high resolution images. This approach divides the image into meaningful homogenous regions, known as image objects. These image objects are groups of pixels that are adjacent to each other and are spectrally similar. Once image objects are created, they provide a great deal of information from which an image classification can be developed. Full use can be made of the various kinds of information contained in the image objects, such as spectral, size, shape, texture, pattern, shadow, site, and association characteristics (Lizarazo and Elsner 2009). Object based image classification is especially suited for high-resolution imagery. Processing image objects instead of working at the pixel level can remove redundant details found in higher spatial resolution images (Y. Tang, 2011).

Estimating Canopy Cover using NAIP imagery
NAIP Imagery

The National Agriculture Imagery Program (NAIP) is a USDA/FSA program to acquire 'leaf on' aerial imagery during the peak growing season. NAIP imagery for New Mexico can be downloaded by Quarter Quadrangle extent in an uncompressed TIFF format via RGIS –Resource Geographic Information System (http://rgis.unm.edu/). While other years are available, coverage for the Coleman Ranch area was collected in 2003 and 2014 with the near infrared (NIR) spectral band. The 4 band imagery (Red, Green, Blue, and NIR) was collected at 1 meter cell size. Having the NIR band allows for a greater analysis of vegetation and the calculation of the Normalized Difference Vegetation Index (NDVI).   NDVI is a band ratio of the visible red and the near infrared spectral bands and is calculated using the following formula:
(NIR – Red)/(NIR+Red).   Having these two years with the NIR spectral bands allow for comparisons of vegetation change over time using NDVI. This makes vegetation change monitoring and analysis feasible over large areas at no cost for image collection. Figure 1

shows how the NIR band distinguishes vegetation from non-vegetative areas and can identify change in vegetation over time. Significant tree thinning was done in 2011 and trees were removed in the study area indicated by the yellow boundary.
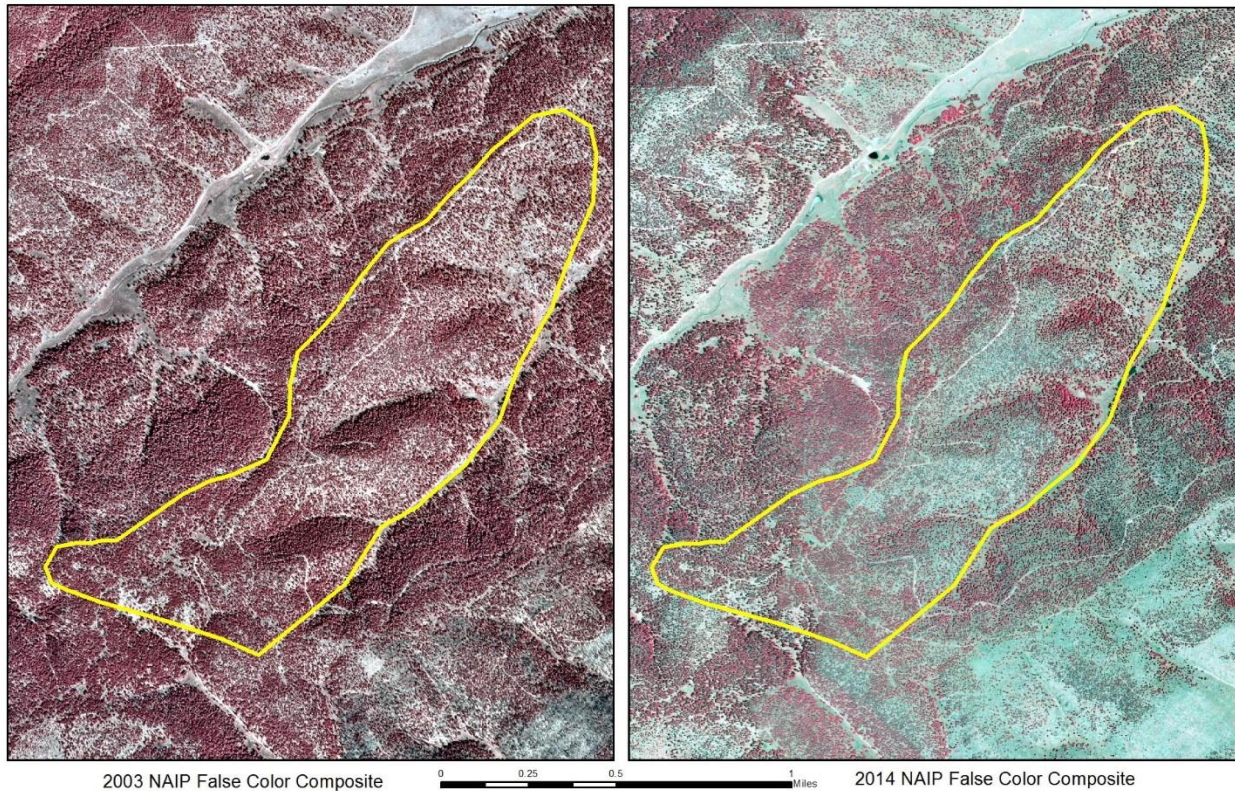

2003 NAIP False Color Composite   0   0.25   0.5   1 Miles   2014 NAIP False Color Composite

Figure 1. 2003 and 2014 NAIP, 1 meter Imagery

Canopy Classification

After 2003 and 2014 NAIP imagery were downloaded for the study area, the images were subset and the 2003 image was rectified using the 2014 as the source layer. This was done to make sure both images were spatially accurate to each other.   Within eCognition separate projects were created for each year as each date of imagery will have separate vegetation thresholds due to differences in image date acquisitions.

Using eCognition a multi-resolution image segmentation was performed dividing the image into homogenous image objects. Rule sets were then developed to classify the images as canopy or non-canopy. Rule sets are the processing script that eCognition uses to automate the classification (see the Process Tree in the top right corner of Figure 2). Rule sets can be complicated and are set to flow sequentially so that when the rule set is executed it goes through many steps before resulting in a final classification. For this study area we were trying to separate out Forest and Woodland trees from the background vegetation of grasslands and

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bare soil. Tree species include; White fir, Ponderosa Pine, Douglas Fir, SW White Pine, Gamble Oak, Pinon Pine and Alligator Juniper.

First the image was divided into two classes, shadow and non-shadow areas. Shadow areas were distinguished between non-shadow areas based on image brightness values and Normalized Difference Vegetation Index (NDVI) values. Resulting areas of non-shadow were split into two categories, highly vegetative areas and low vegetative areas based on Hue, Saturation, and Intensity values and NDVI values found in the image objects. The low vegetative/sparse class were mainly areas of grassland and bare ground. Highly vegetative areas were mainly forest and woodland tree species. Shadow classified areas were then re-segmented and then reclassified. If a shadow area shared a border with a highly vegetative area and had a relatively high NDVI value (compared to other shadow areas) it was reclassified as highly vegetative. If a shadow area had a relatively low NDVI value it was classified as low vegetative\sparse.   The final classification was then recoded into two classes Canopy (highly vegetative areas) and No-Canopy (low vegetative/sparse areas)
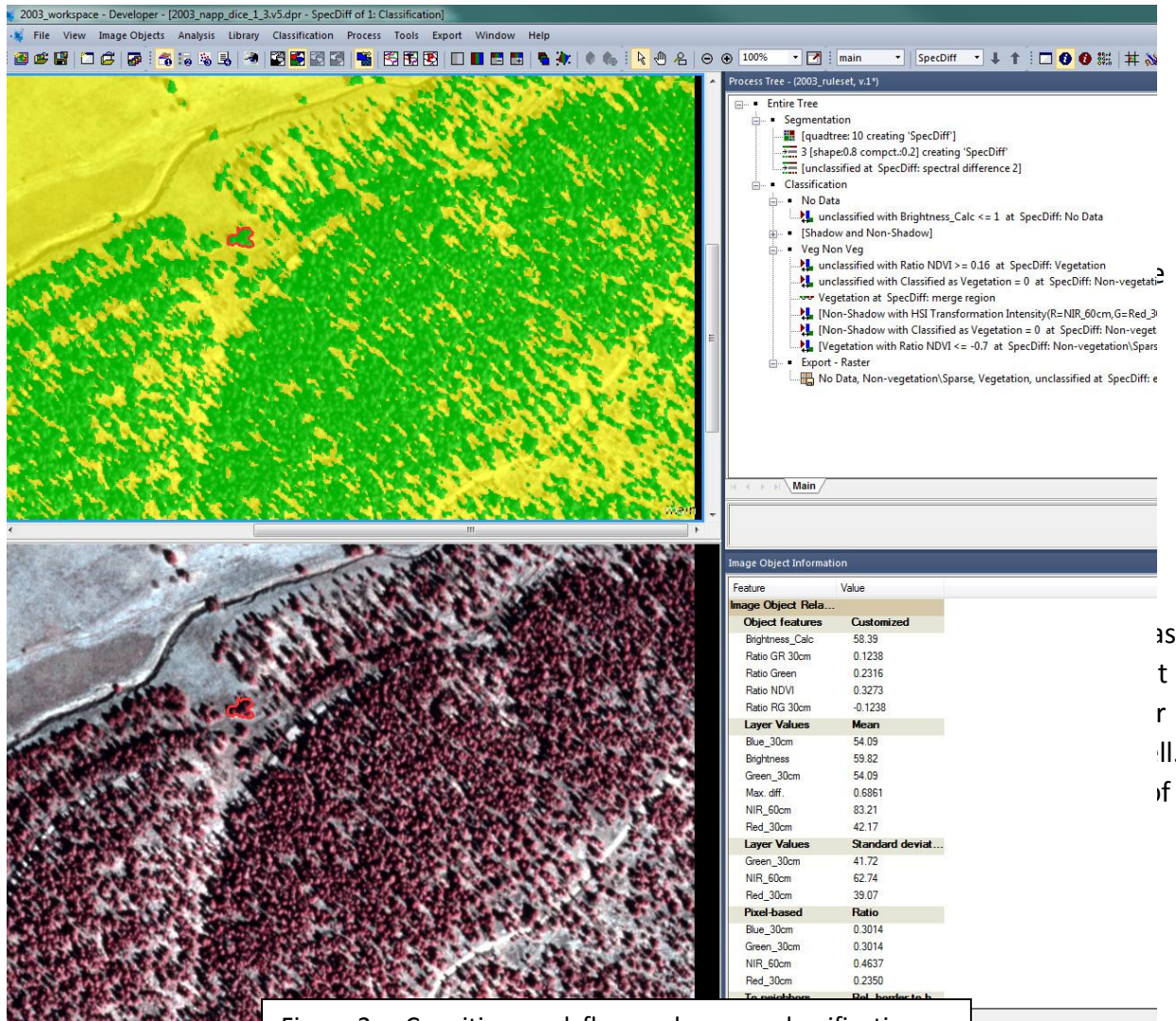

Figure 2. eCognition work flow and canopy classification

The classification was based on finding the right threshold values for each feature. To determine specific threshold values, information about each image object could be displayed and tested to determine if those values were appropriate for the given land cover feature (see the image object information box in the bottom right corner of Figure 2).

Percent Canopy Cover

Once canopy was classified for each year, the results were exported from eCognition into Erdas Imagine format and then canopy acreage was calculated. The image classification was done at a 1 meter cell size but often it is important to look at a larger scale to determine percent cover of canopy. To do this the 1 meter canopy pixels were summarized within a larger 10 meter cell (see Figure 3). An empty 10x10 meter vector lattice was created and then using zonal statistics the number of 1 meter canopy grid cells were summarized within that 10x10 meter square area. This was used to determine what percent of canopy was included in the 10x10m square area. This vector lattice was then converted to a raster so that the raster grid cell value represents percent canopy cover.
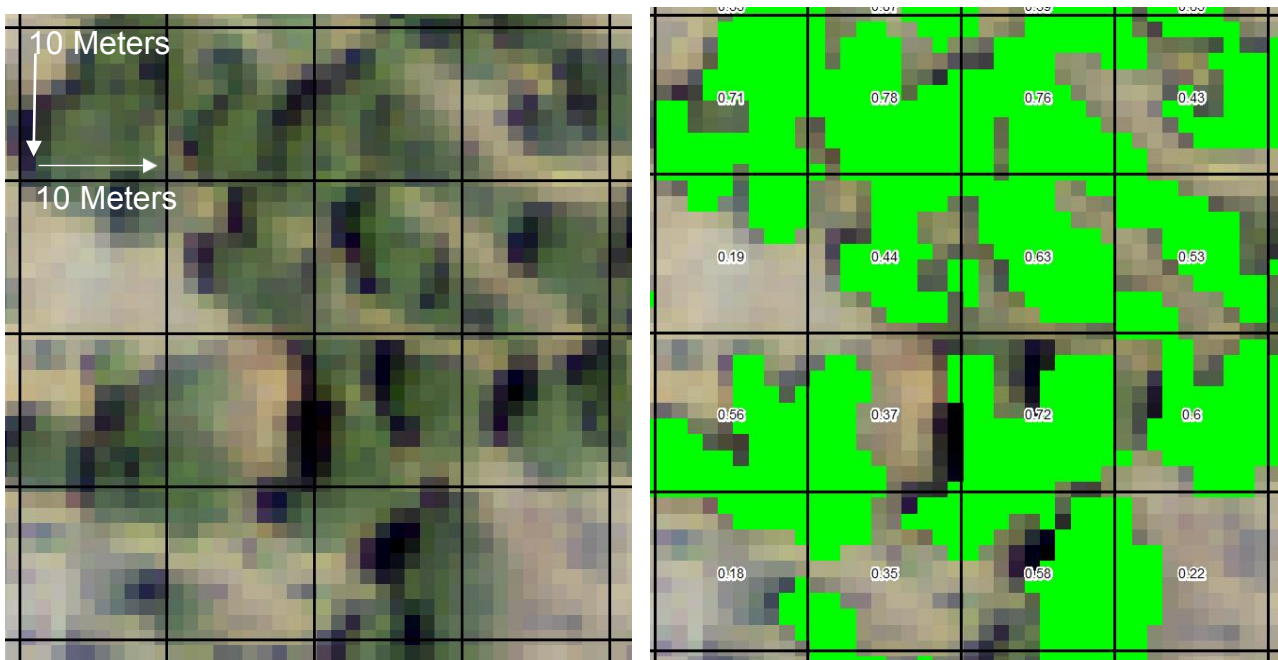

Figure 3. Estimating Percent Canopy at 10x10 meter

Results

Using the methods outlined here, a canopy classification and canopy percent cover was performed on the Coleman Ranch Pre and Post Treatment Study Area. These results are found in Appendix 1-3.

References

Lizaraxo I. and Elsner, P., "Fuzzy segmentation for object-based image classification. *International Journal of Remote Sensing*," Vol 30, 2009.
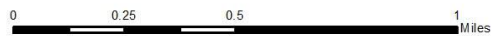
Tang, Y, Liangpei Z., and Hauan X., "Object-oriented change detection based on the Kolmogorov–Smirnov test using high-resolution multispectral imagery," *International Journal of Remote Sensing*, Vol. 32, No. 20, 2011.

Appendix 1 : Preliminary Results for the Coleman Ranch Treatment Area Canopy Classification (1 meter grid cells)
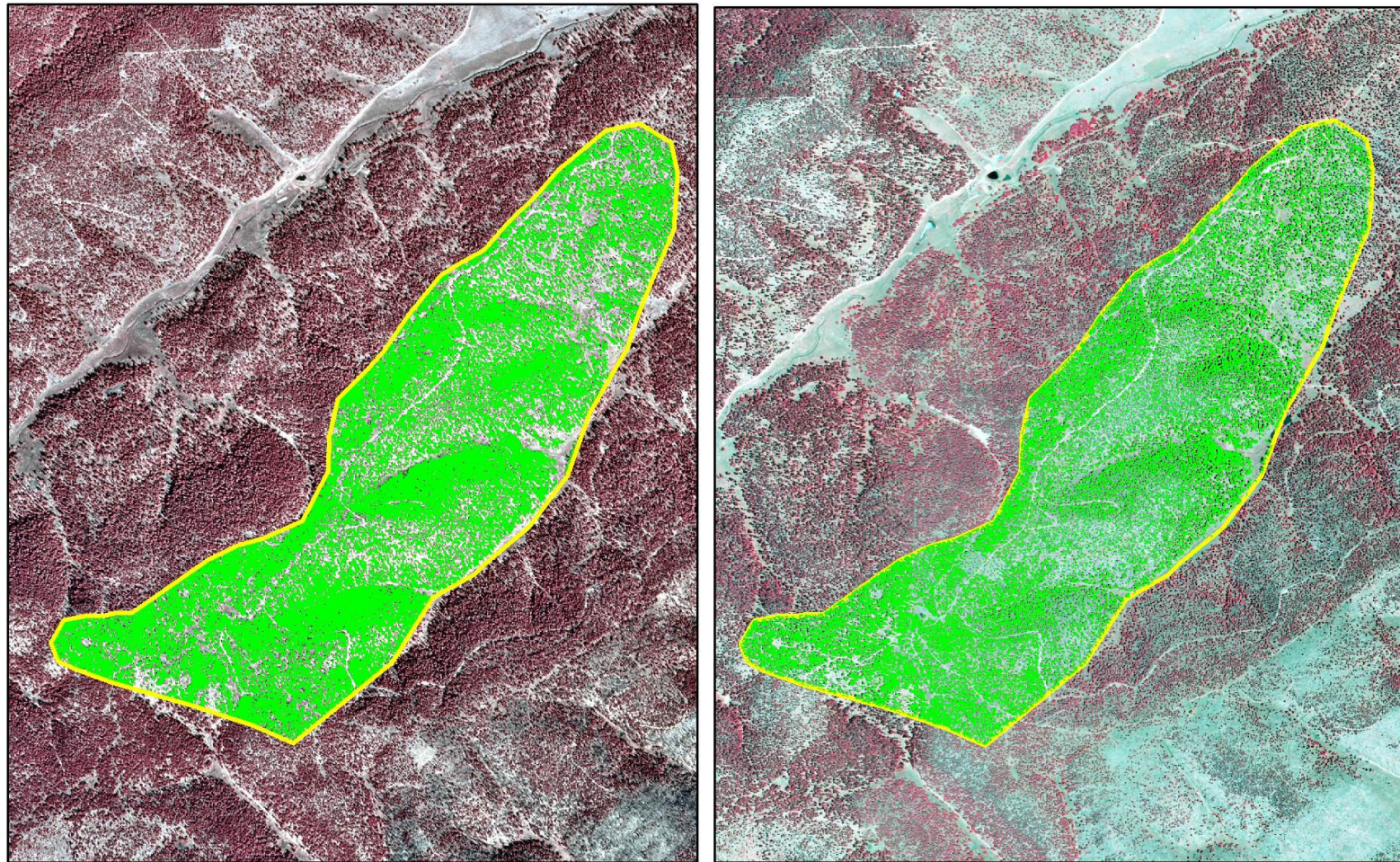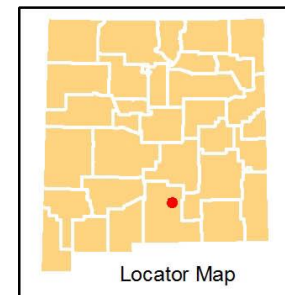

2003 Canopy Classification
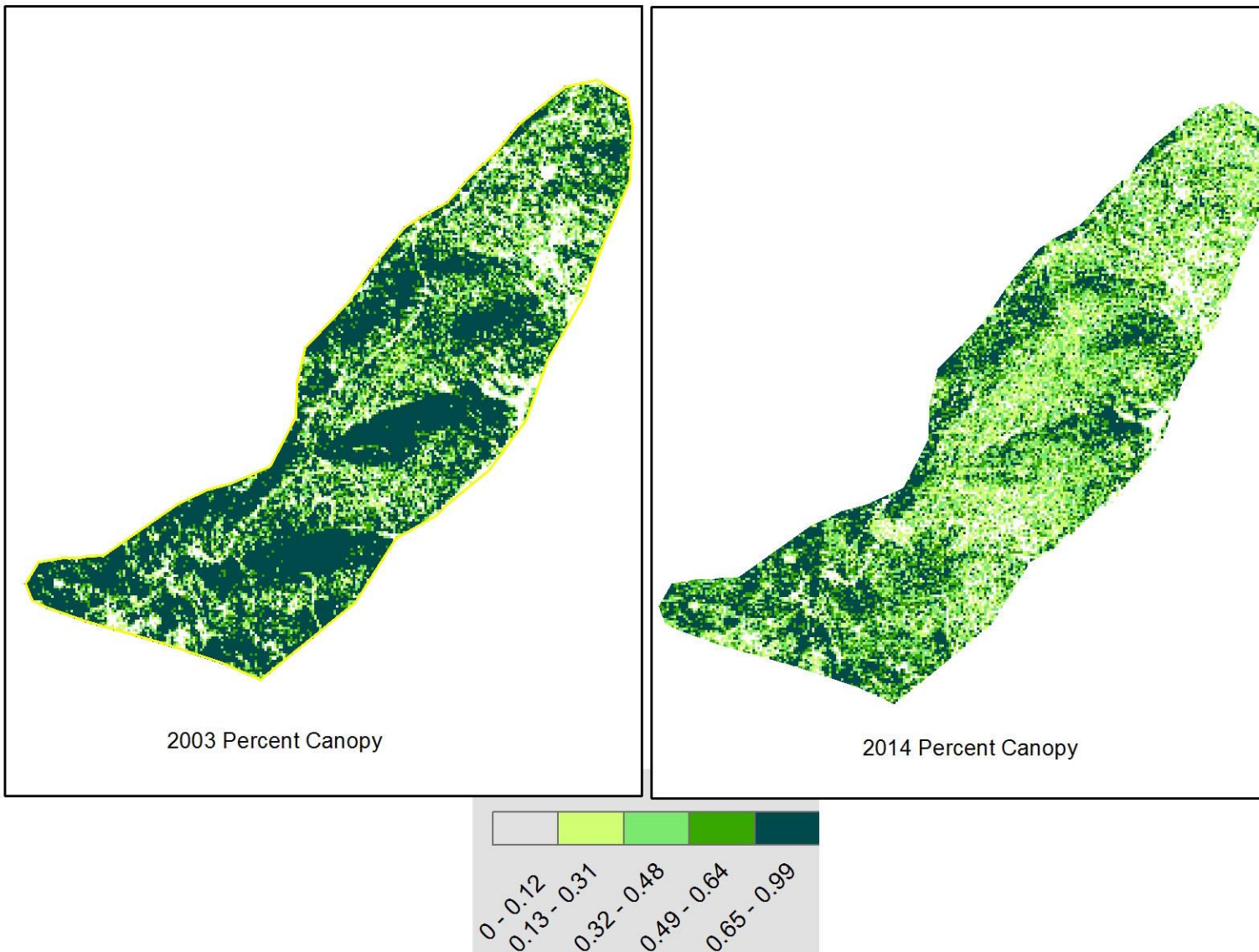
2014 Canopy Classification

Coleman Ranch Treatment Area		
	Acres	Percent of Study Area
2003 Canopy Classification	340.2	61.35%
2014 Canopy Classification	236.1	42.58%
Difference	104.1	18.77%

Locator Map

Appendix 2. Percent Canopy Cover Summarized at 10 meter pixels

2003 Percent Canopy

2014 Percent Canopy

0 - 0.12 0.13 - 0.31 0.32 - 0.48 0.49 - 0.64 0.65 - 0.99

Appendix 3. Percent Cover Image Differencing: Comparing Change 2003-2014

No change greater than 30%

Decreased more than 30%

Increased more than 30%