Modeling Ecological Integrity Using High-Resolution Imagery and Lidar

SAN DIEGO MANAGEMENT AND MONITORING PROGRAM

MONTHLY COORDINATION MEETING

10/28/2020

EMILY PERKINS

History of Vegetation Monitoring in San Diego County

Doug Stow (SDSU) → Change detection mapping

Doug Deutschman (SDSU) → Field methods

Jay Diffendorfer (SDSU) → Index of Biological Integrity

MCBCP & SDMMP → Conceptual approach

SDMMP → MSP Roadmap monitoring objectives

SDMMP → Model to map landscape-scale ecological integrity

Guiding Research Question

What is the ecological integrity of coastal sage scrub & chaparral vegetation, is it changing over time & why?

Ecological integrity –
The ability of an ecological system to support & maintain a community of organisms that has species composition, diversity & functional organization comparable to those of natural habitats within a region.

Karr & Dudley 1981, Parrish et al. 2003

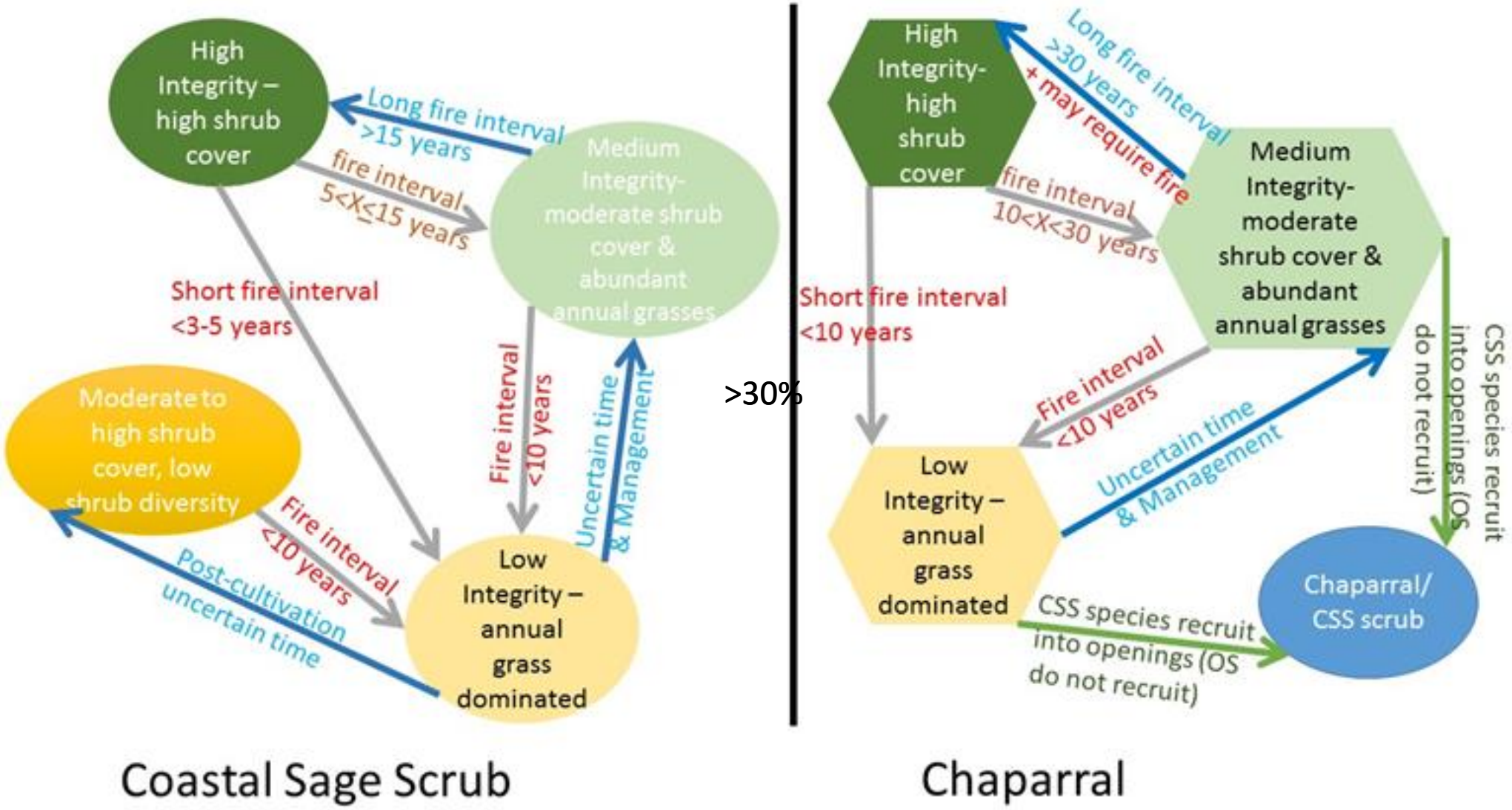
Overall Methods

1. What is the ecological integrity of coastal sage scrub and chaparral in San Diego County?
    1. Define variables for ecological integrity using historical data
    2. **Model variables across San Diego using remote sensing**
    3. **Validate model with ground data** and refine ecological integrity variables
2. Is it changing? (Future work)
    1. Identify areas of change from aerial imagery (historical and future)
    2. Use ground data to validate imagery and identify the type of change occurring
    3. Update remote sensing model and ground data at regular intervals into the future
3. Why? (Future work)
    1. Use covariates (fire, climate, etc) to explain and predict changes

Measuring Ecological Integrity

Integrity classes defined by:

- % cover & density of shrubs
- % cover of nonnative grasses


High Integrity – high shrub cover
Long fire interval >15 years
fire interval 5<X≤15 years
Medium Integrity- moderate shrub cover & abundant annual grasses
Short fire interval <3-5 years
Fire interval <10 years
Uncertain time & Management
Moderate to high shrub cover, low shrub diversity
Fire interval <10 years
Post-cultivation uncertain time
Low Integrity – annual grass dominated
Coastal Sage Scrub
>30%
High Integrity- high shrub cover
Long fire interval >30 years + may require fire
fire interval 10<X<30 years
Medium Integrity- moderate shrub cover & abundant annual grasses
Short fire interval <10 years
Fire interval <10 years
Uncertain time & Management
CSS species recruit into openings (OS do not recruit)
Low Integrity – annual grass dominated
CSS species recruit into openings (OS do not recruit)
Chaparral/ CSS scrub
Chaparral

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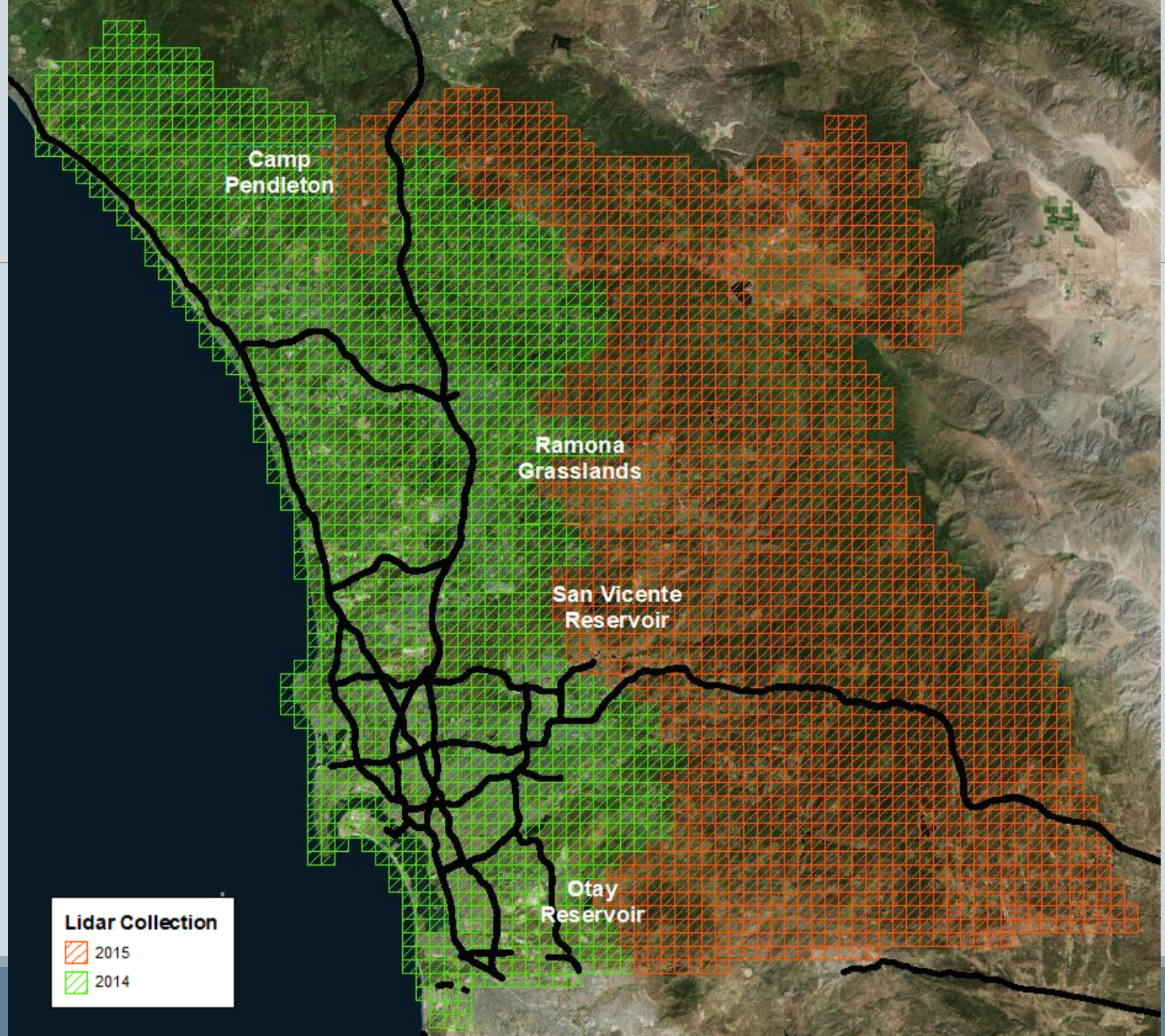
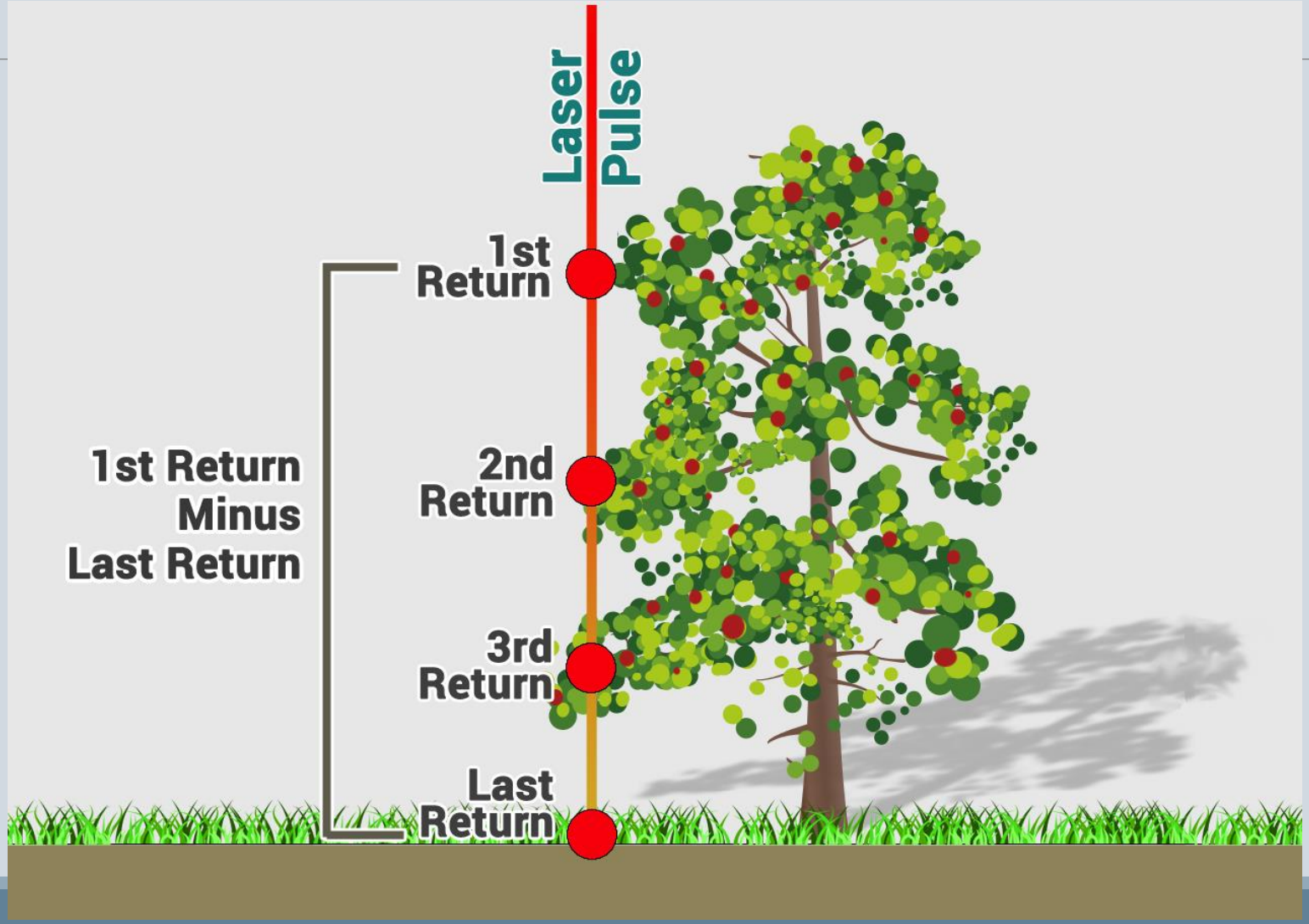
Modeling ecological integrity overview

Data

- NAIP 2014 4-band imagery
- Lidar 2014 & 2015

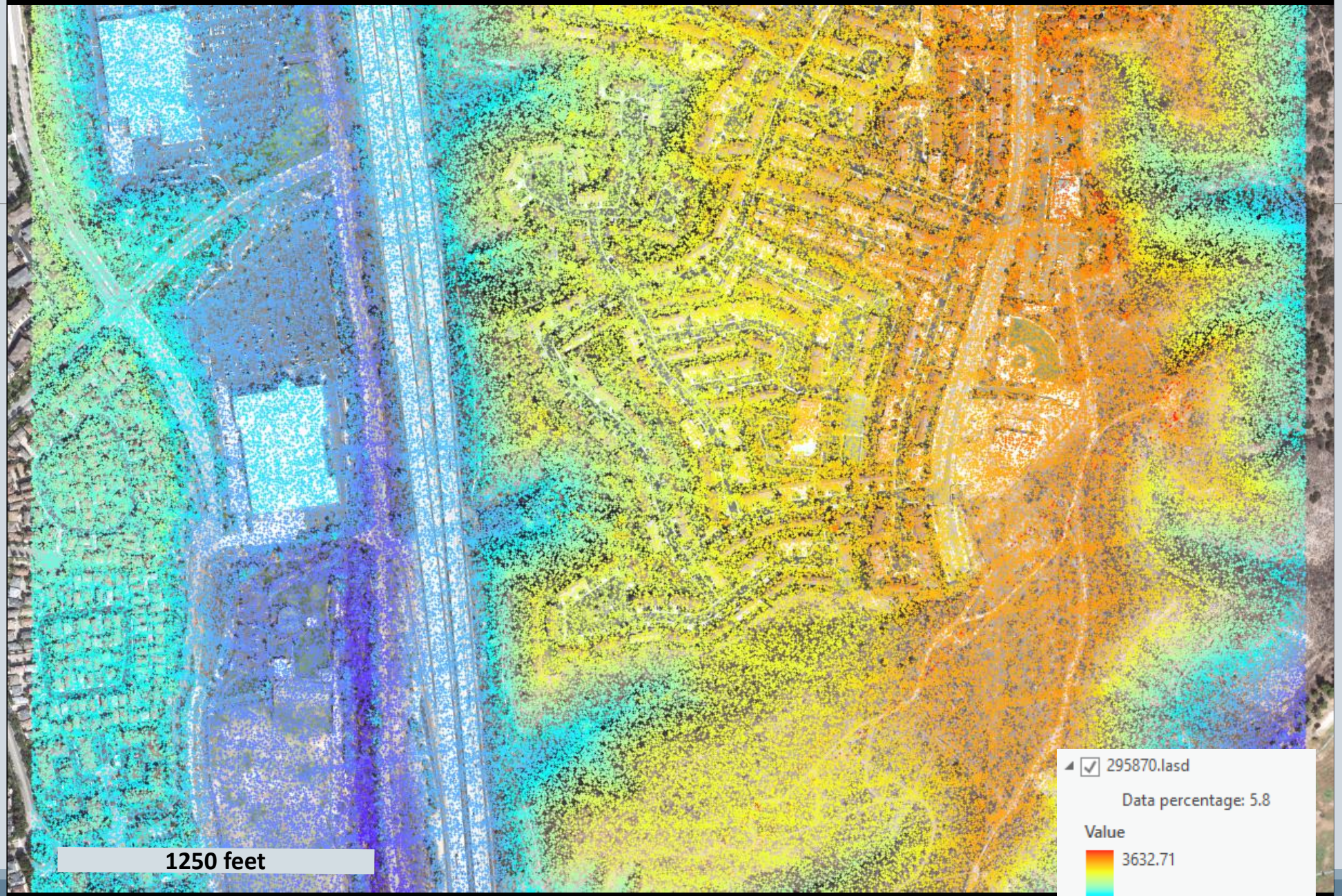

Camp
Pendleton
Ramona
Grasslands
San Vicente
Reservoir
Otay
Reservoir
Lidar Collection
2015
2014

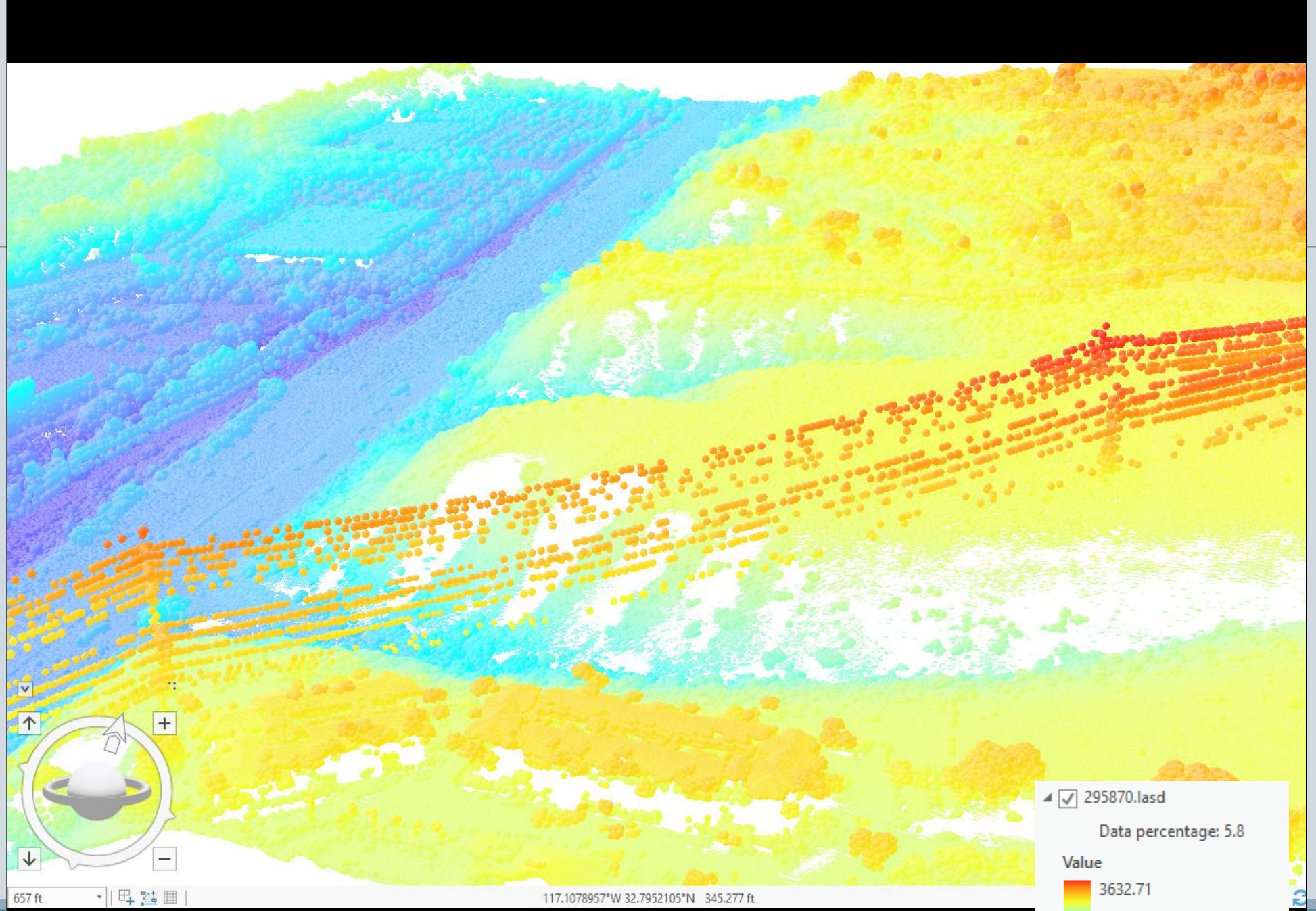
Lidar processing




Mission Trails
2
Miles


0.5
Miles
SANDAG Technical Services


1250 feet
295870.lasd
Data percentage: 5.8
Value
3632.71
79.41

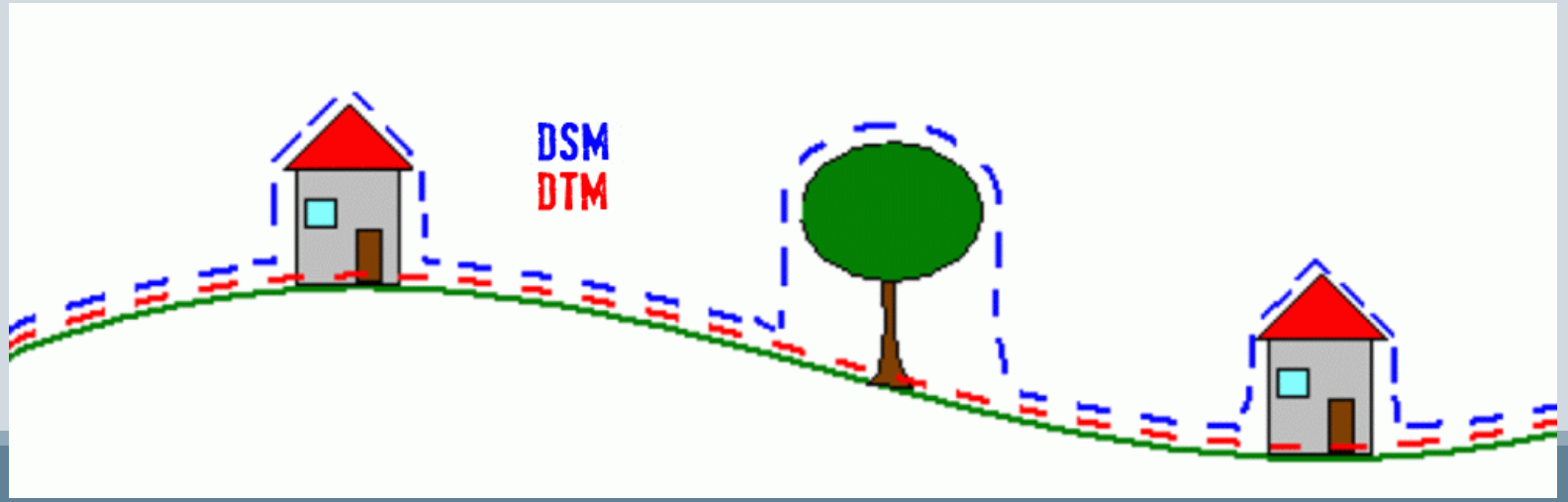

295870.lasd
Data percentage: 5.8
Value
3632.71
79.41
657 ft
117.1078957°W 32.7952105°N 345.277 ft

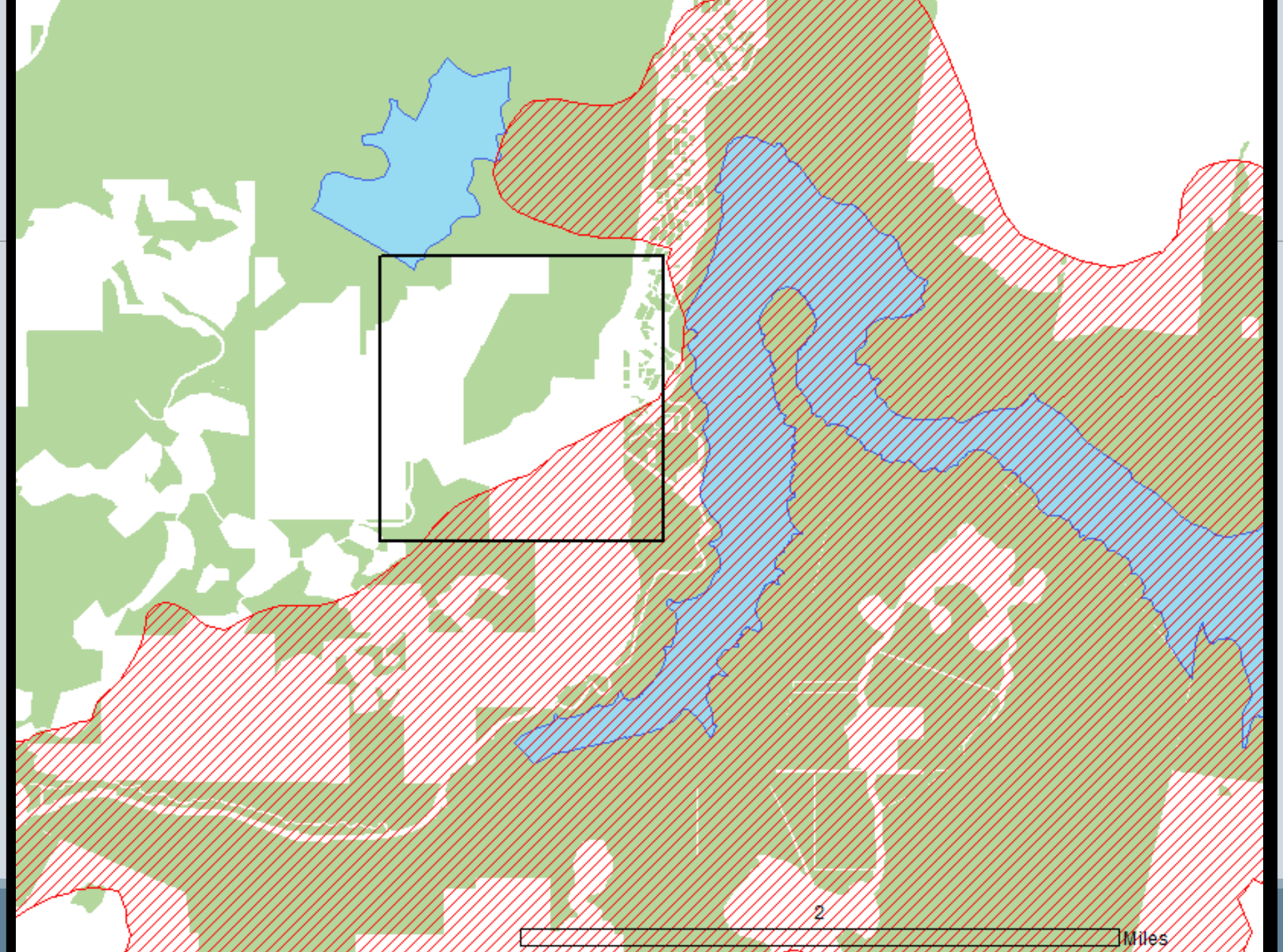
Lidar products

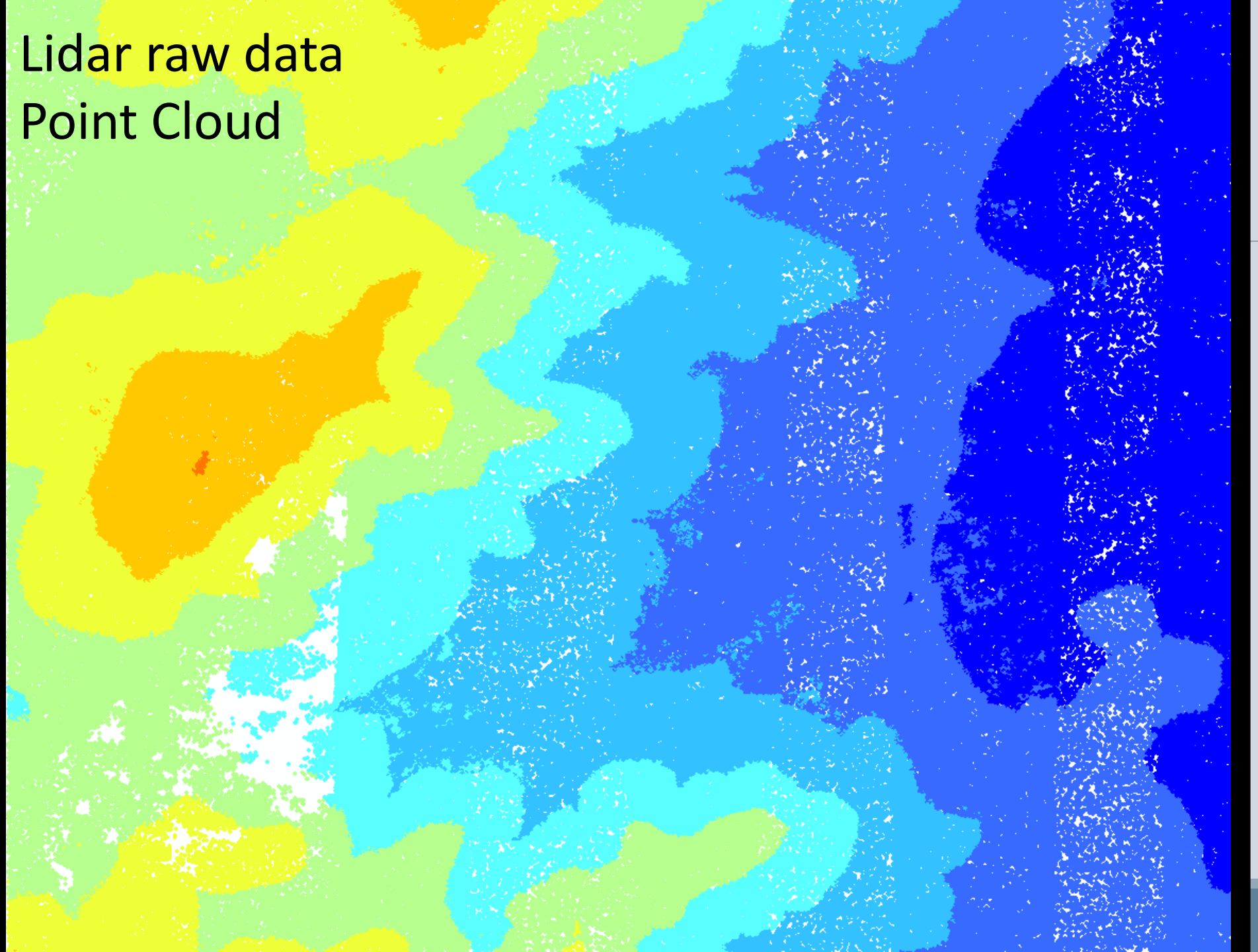
Digital Elevation Model (DEM)- bare ground elevation.

Digital Surface Model (DSM)- includes objects above the bare ground (trees, buildings)

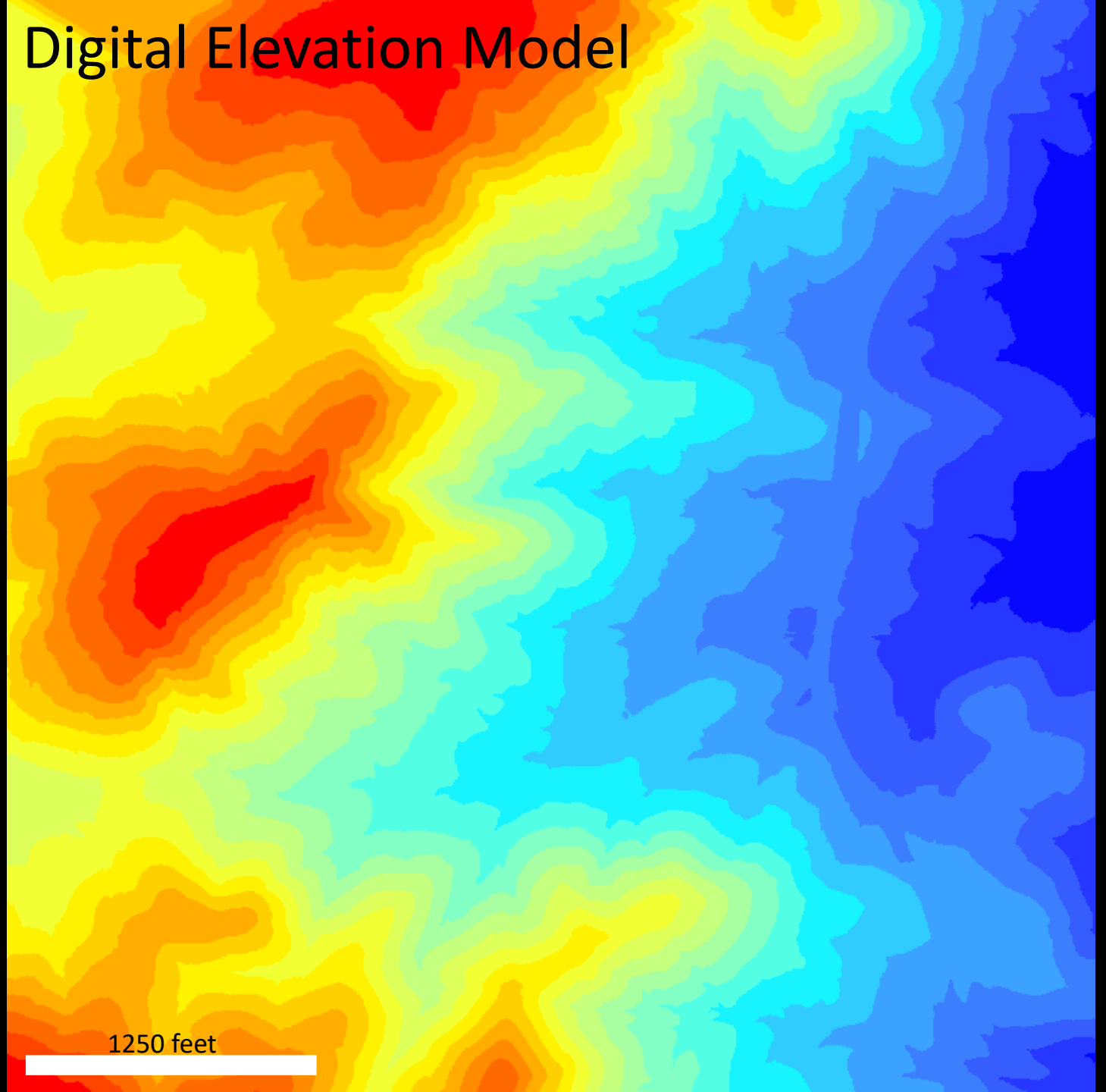
Normalized Digital Surface Models (nDSM)- difference between the DSM and DEM (aka height)

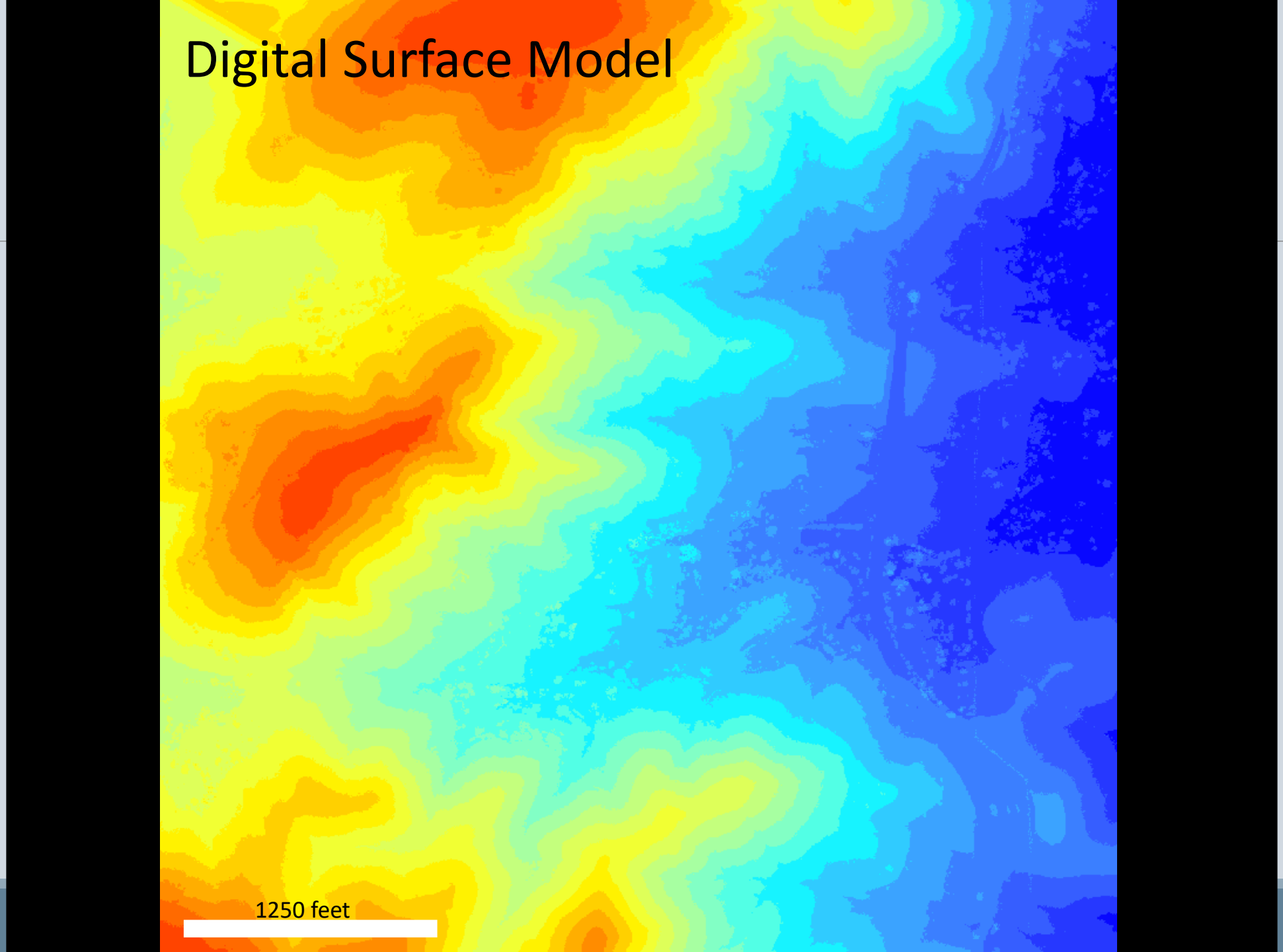



2
Miles

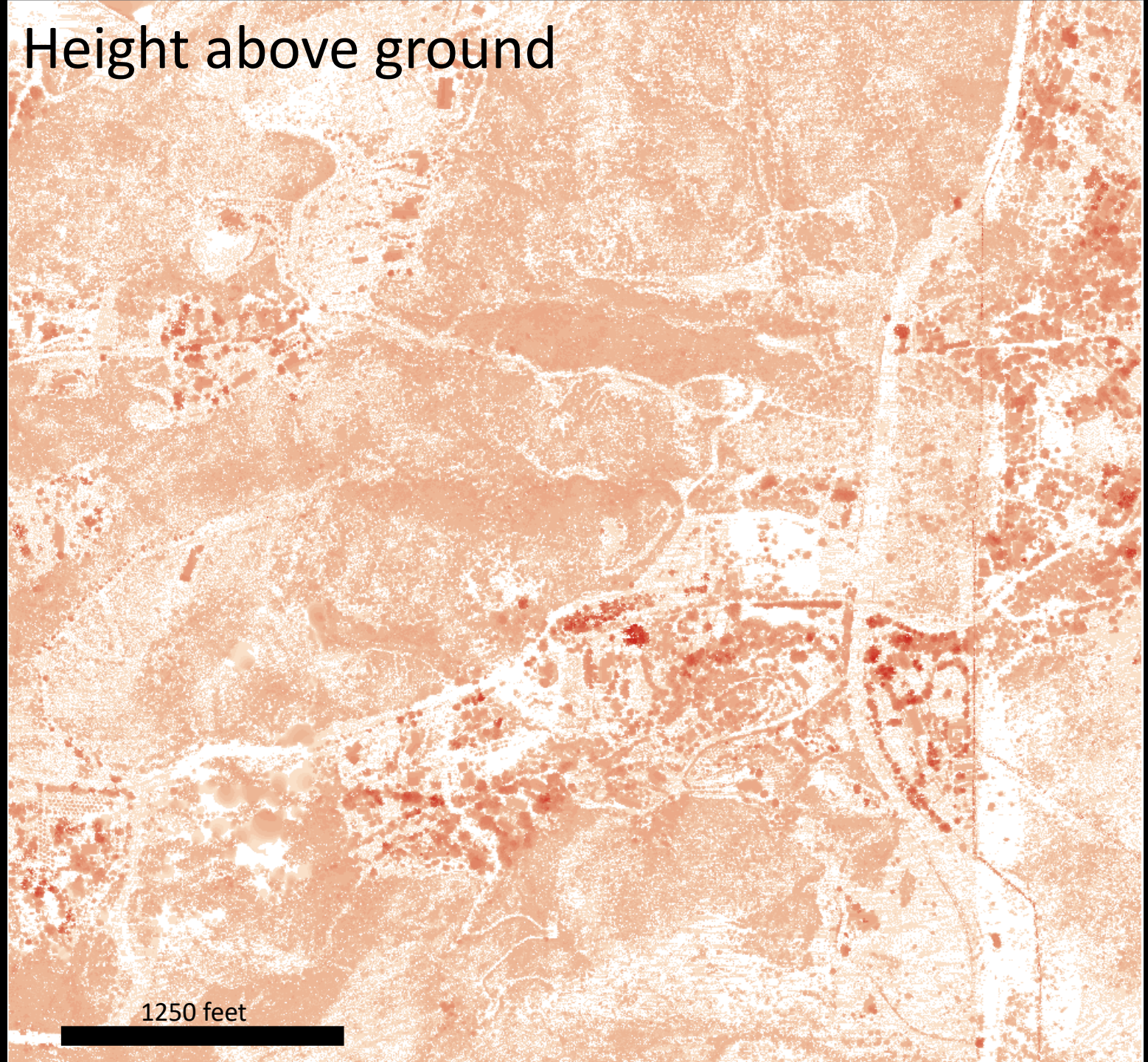

Lidar raw data
Point Cloud

Digital Elevation Model



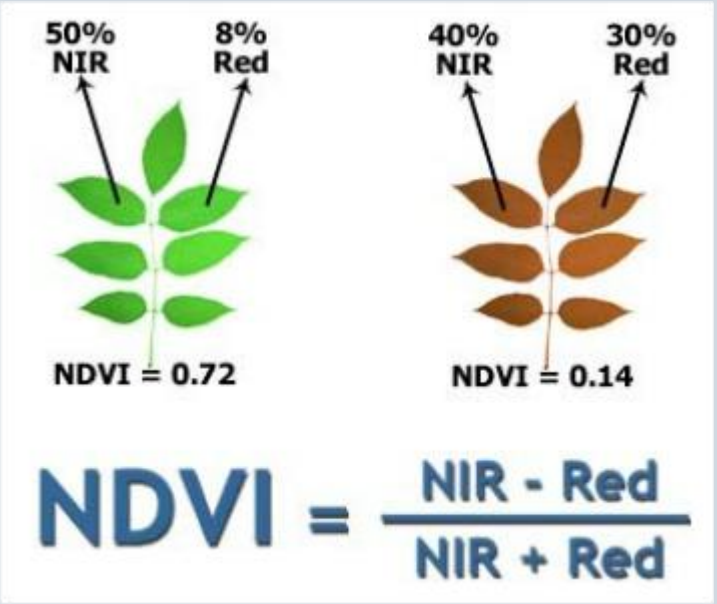

Digital Surface Model
1250 feet

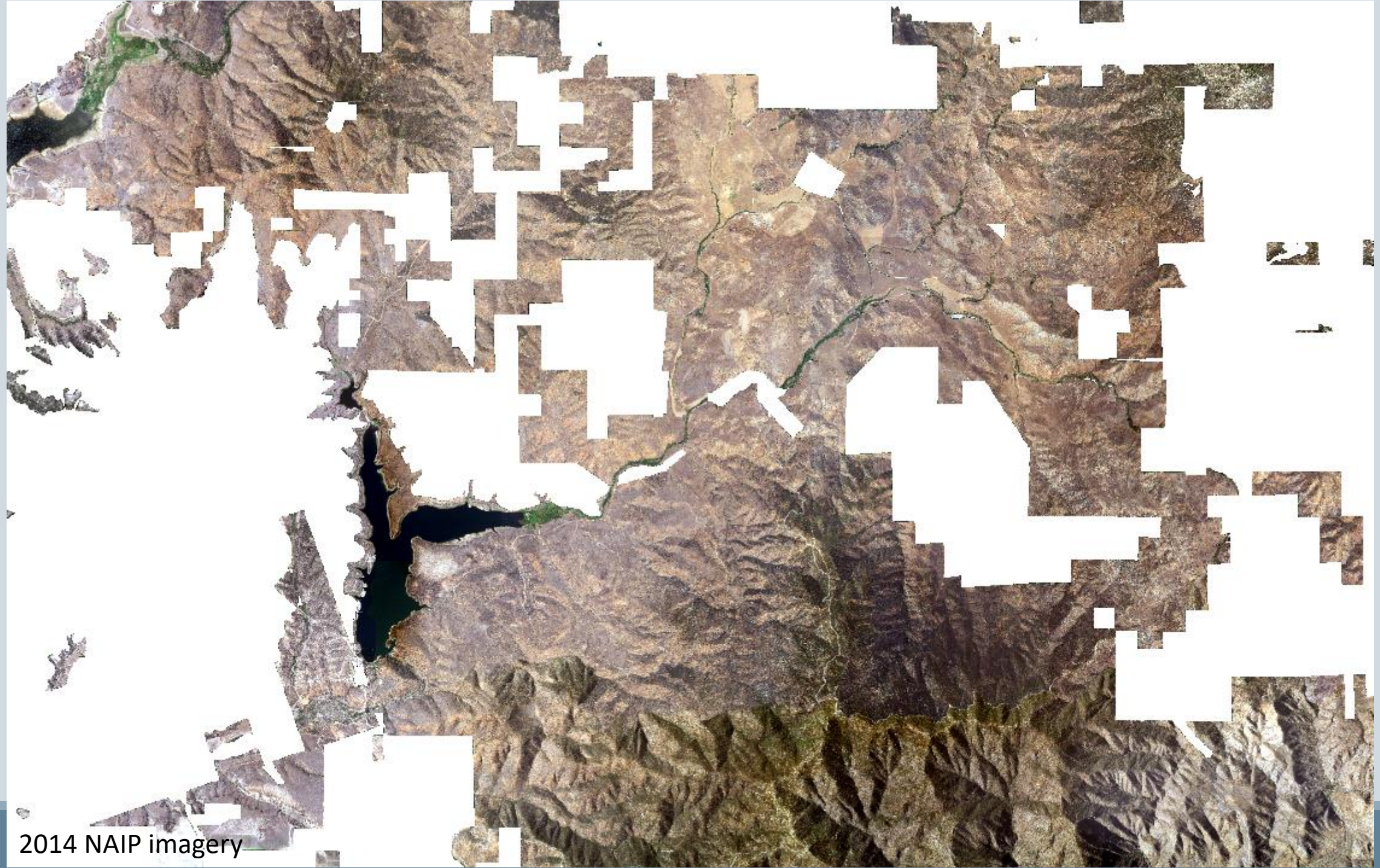
Height above ground



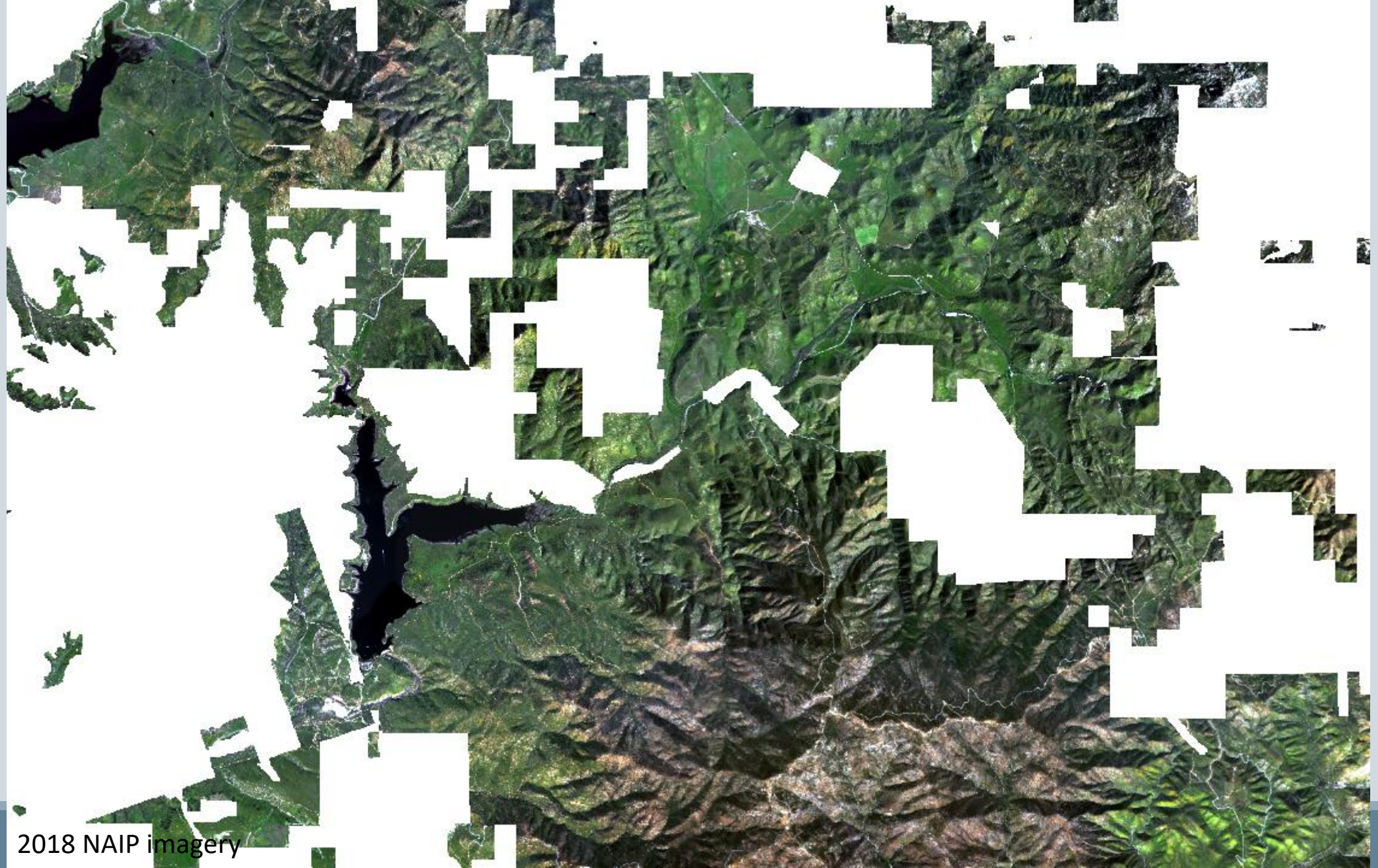
Normalized Difference Vegetation Index (NDVI)

- Measures the amount of photosynthetically active vegetation using near-infrared and red
- Ranges from -1 to 1
- Calculated from NAIP imagery (2ft resolution) and San Diego Regional Imagery (9in resolution)

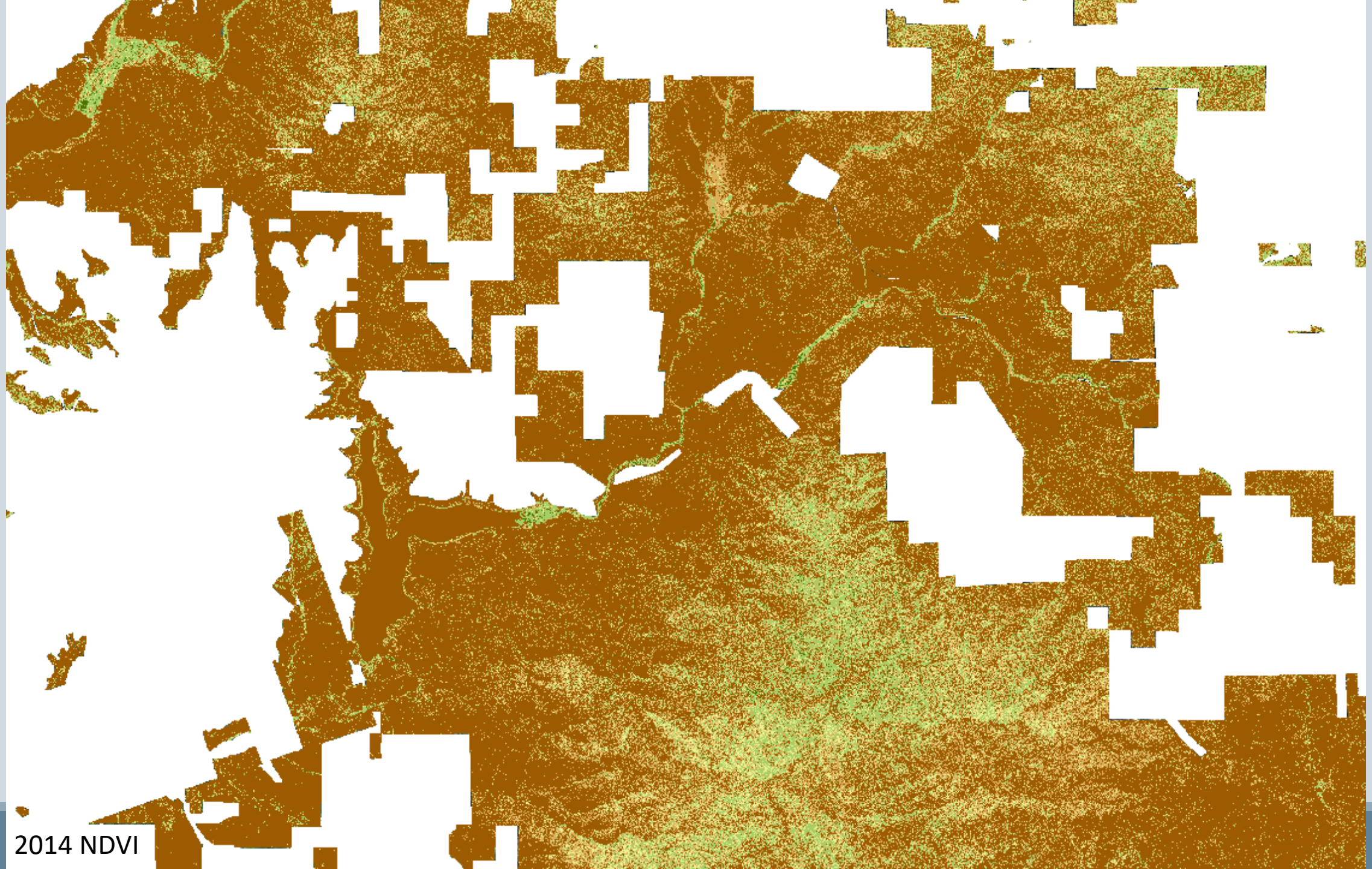




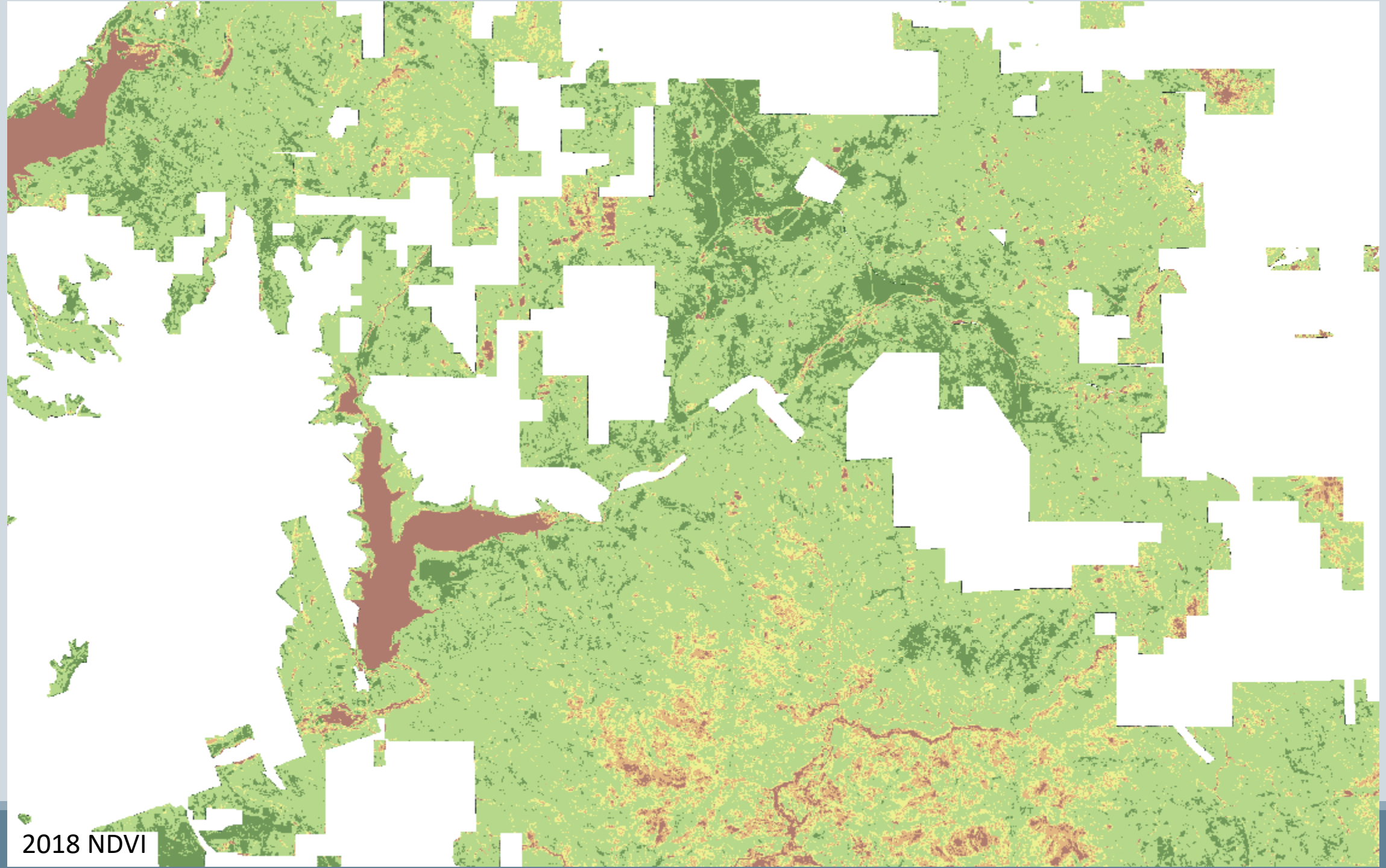
2014 NAIP imagery

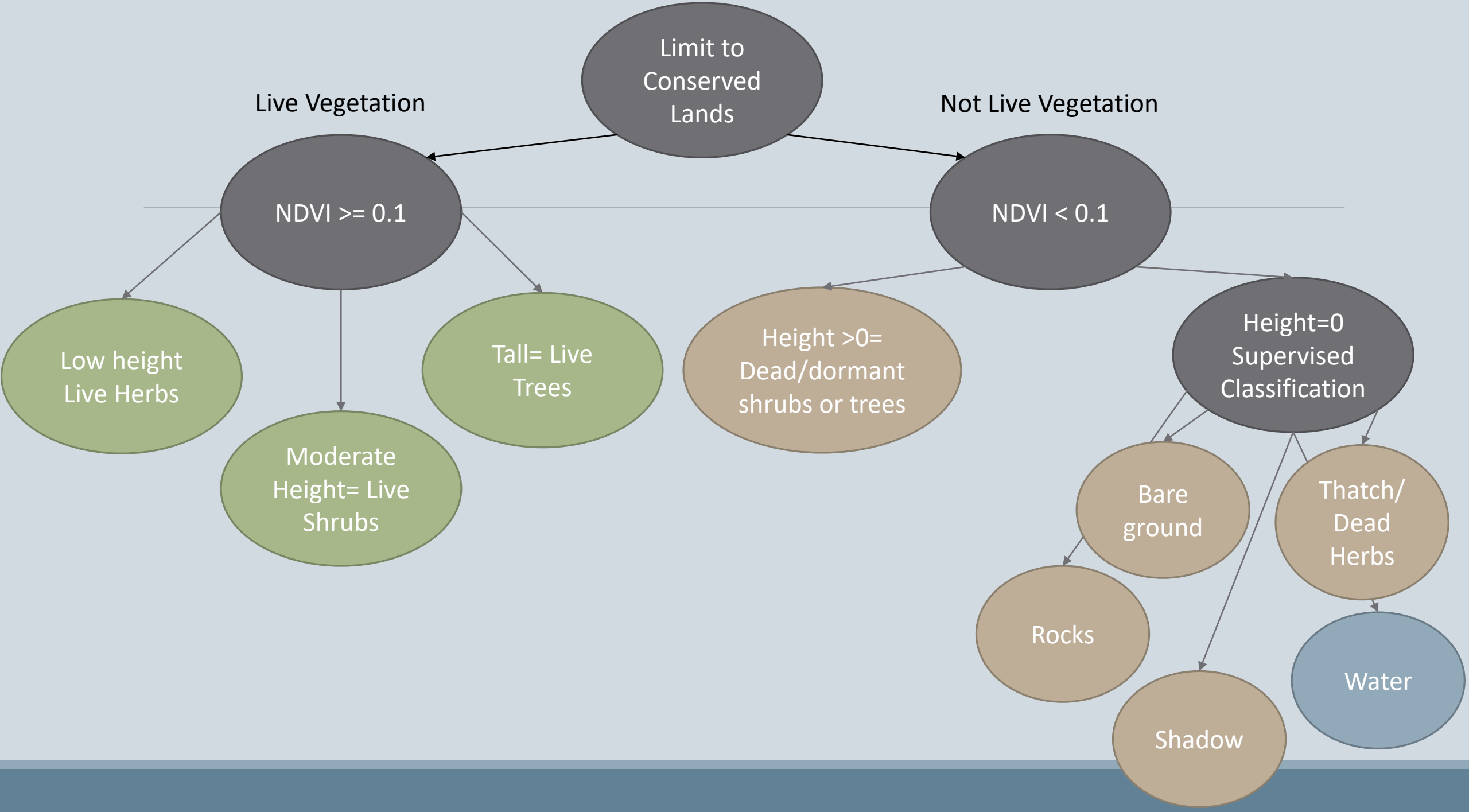


2018 NAIP imagery



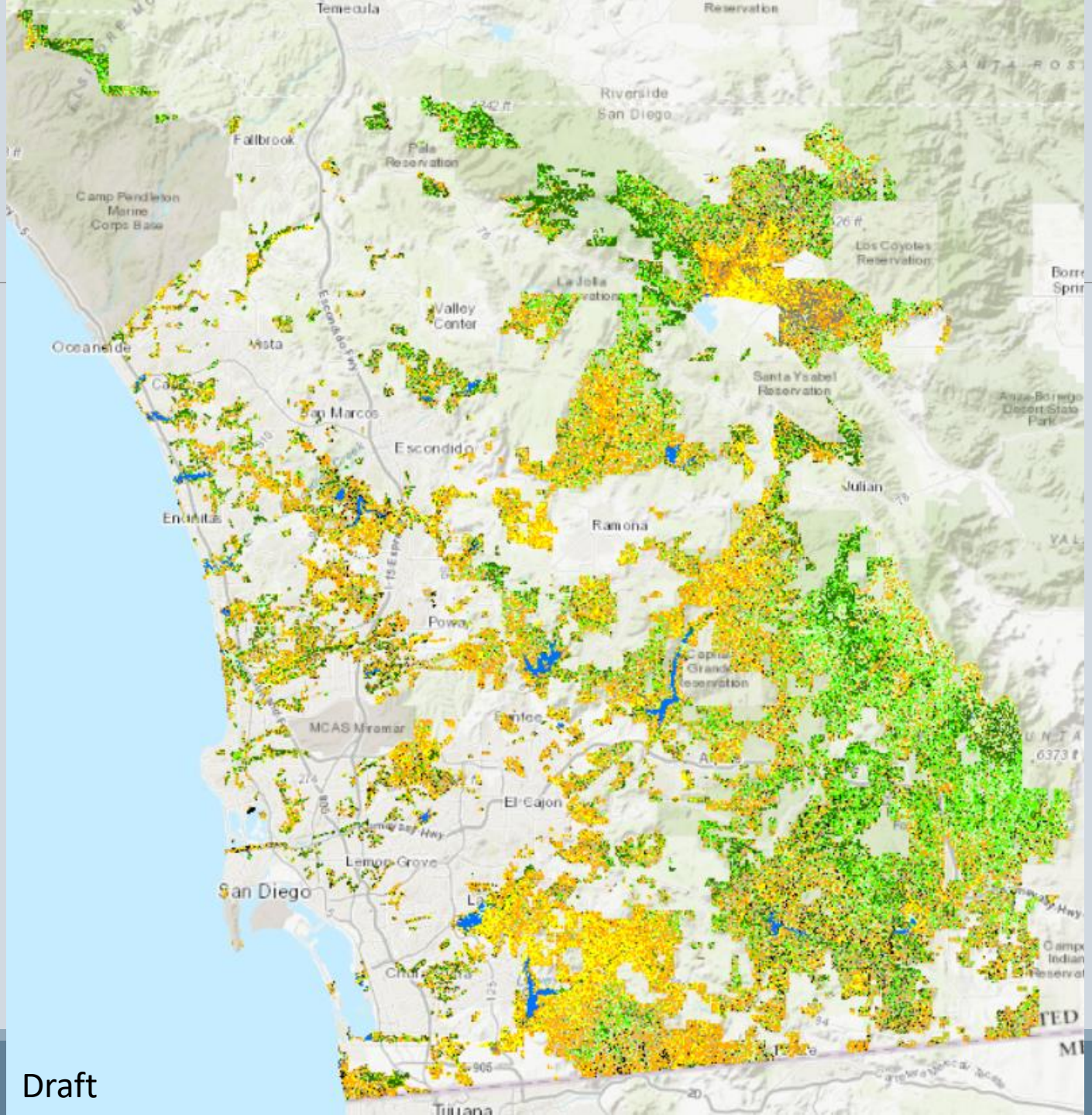
2014 NDVI


2018 NDVI

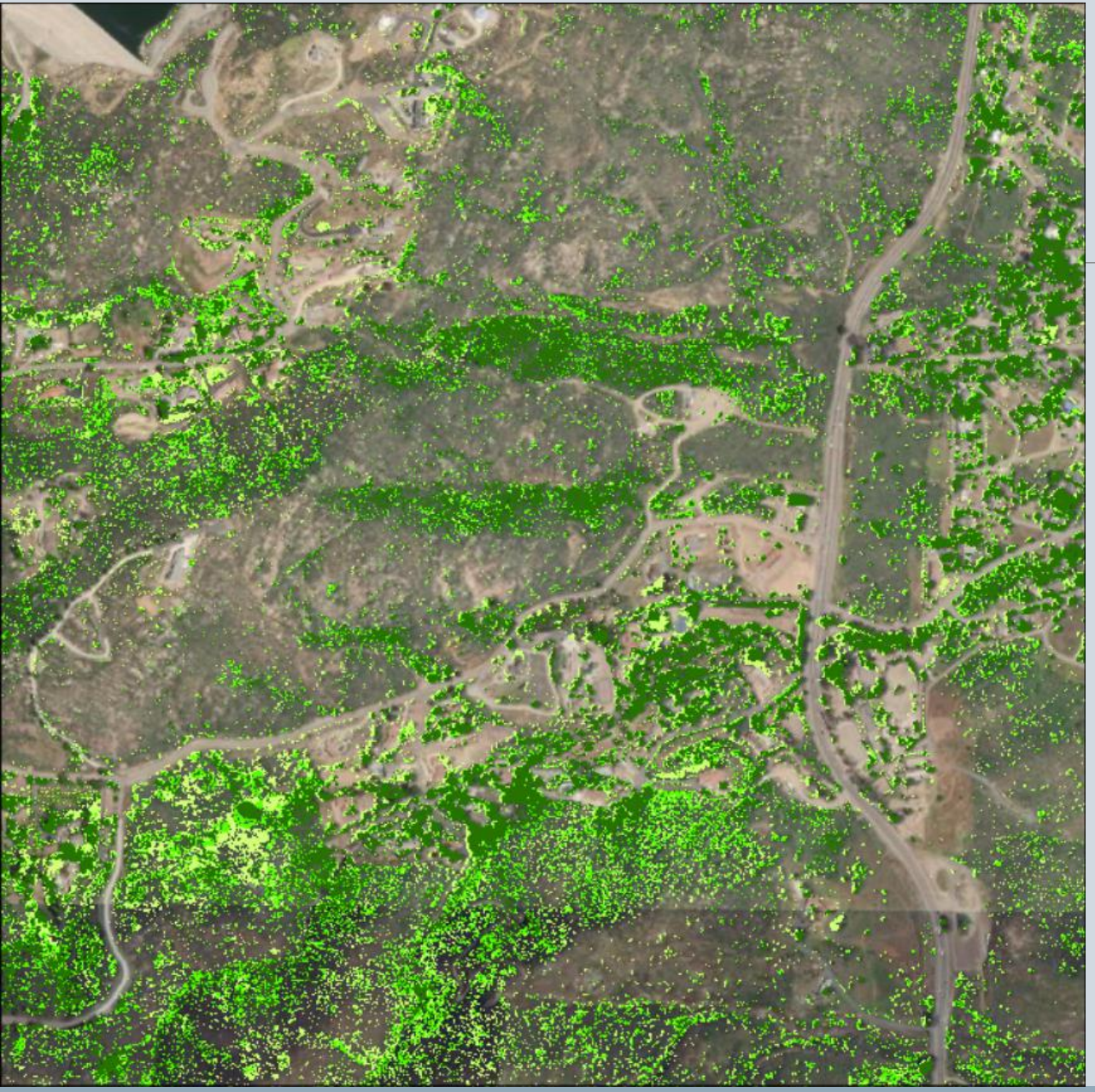

Limit to Conserved Lands
Live Vegetation
Not Live Vegetation
NDVI >= 0.1
NDVI < 0.1
Low height Live Herbs
Moderate Height= Live Shrubs
Tall= Live Trees
Height >0= Dead/dormant shrubs or trees
Height=0 Supervised Classification
Bare ground
Thatch/ Dead Herbs
Rocks
Shadow
Water

Supervised classification

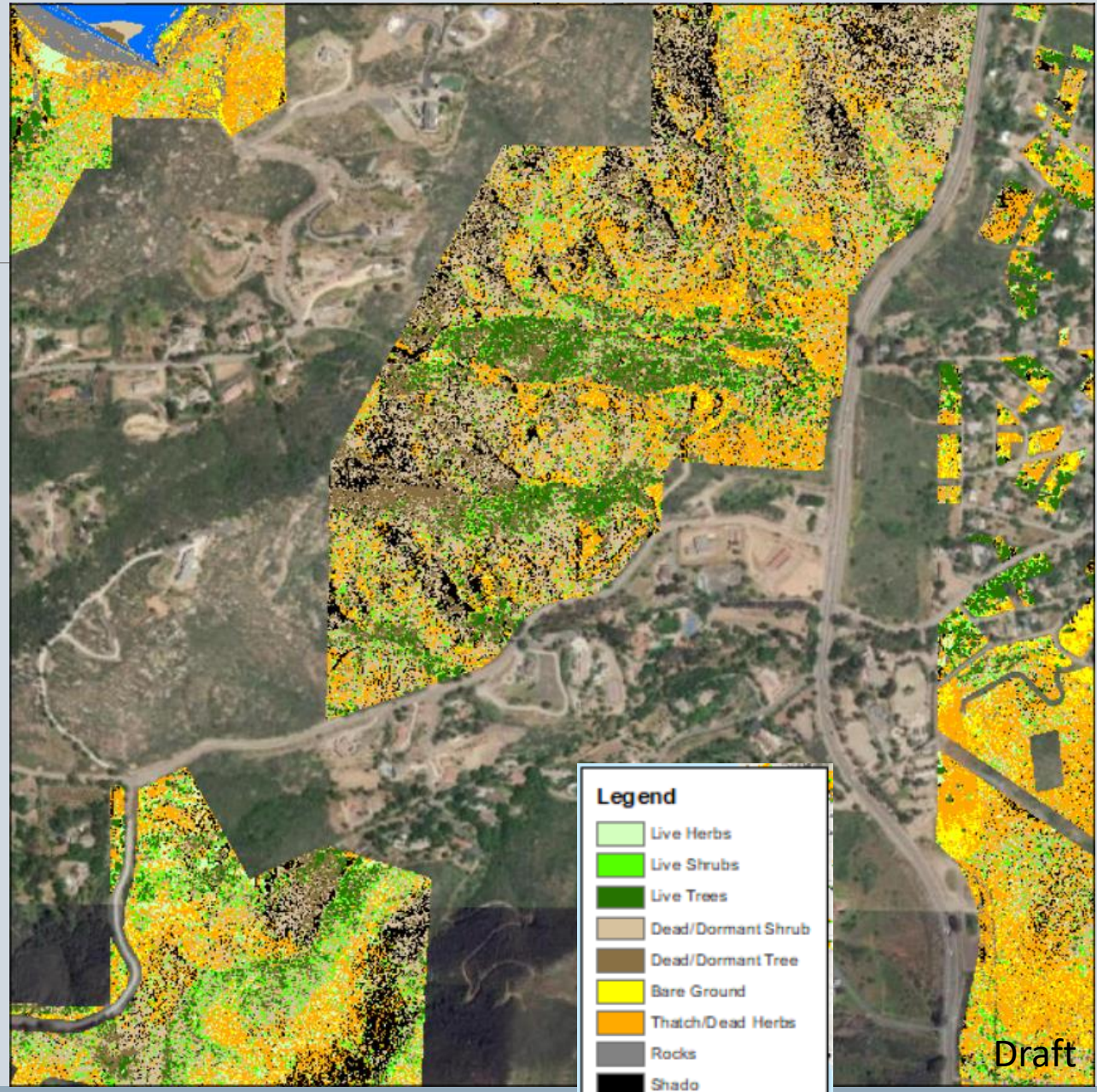
- Use training sites for each category
- Limited to only open space, non-vegetated areas without any vegetation structure
- Iterative process- refine training sites with results


Temecula
Reservation
Riverside
San Diego
Fallbrook
Pala
Reservation
Camp Pendleton
Marine
Corps Base
Los Coyotes
Reservation
Valley
Center
Oceanside
Vista
San Marcos
Escondido
Santa Ysabel
Reservation
Julian
Encinitas
Ramona
Poway
MCAS Miramar
El Cajon
Lemon Grove
San Diego
Tijuana
Legend
Live Herbs
Live Shrubs
Live Trees
Dead/Dormant Shrub
Dead/Dormant Tree
Bare Ground
Thatch/Dead Herbs
Rocks
Shado
Water
Thatch/Dead Herbs

Draft



Method 1



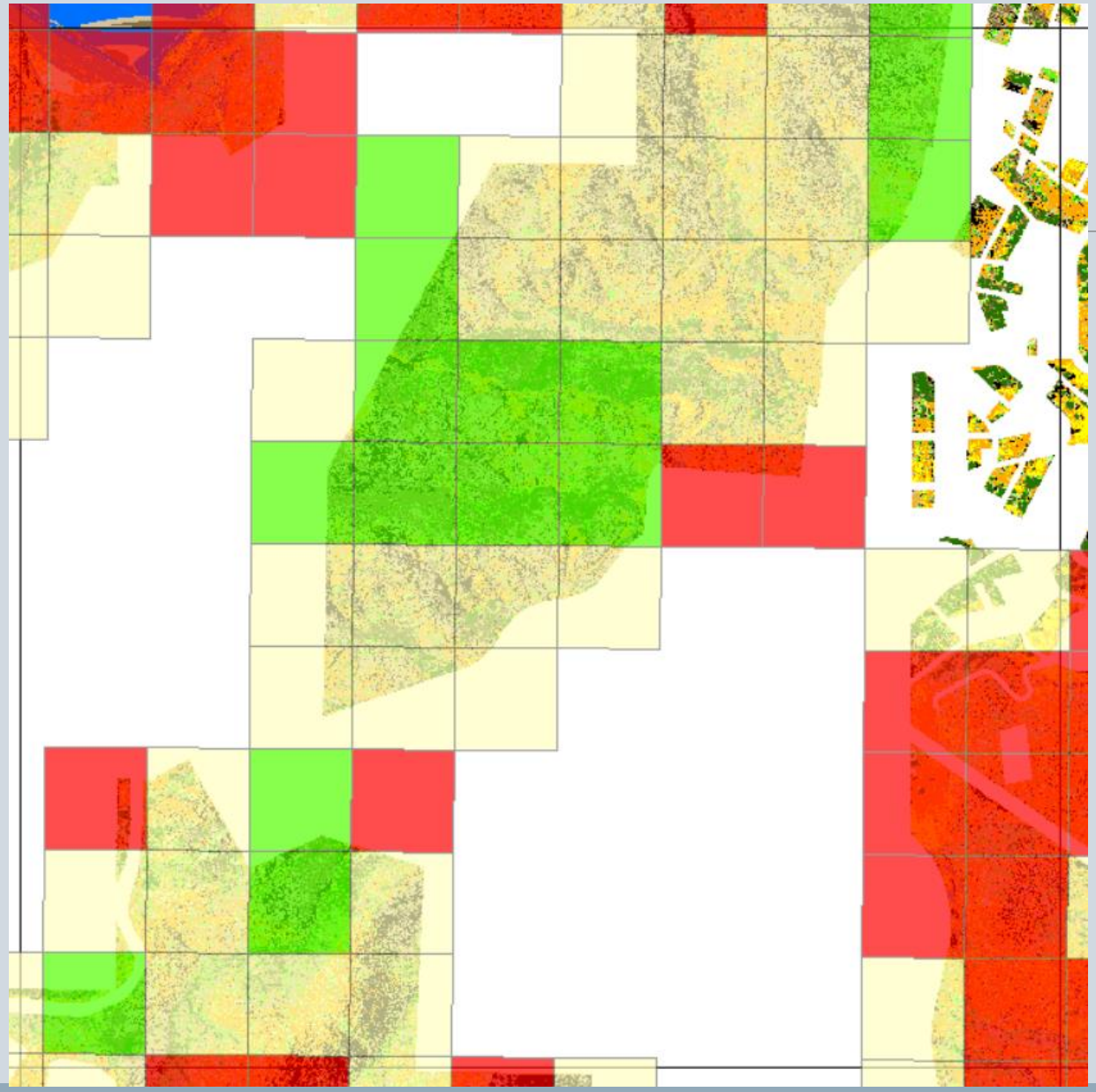
Method 2

Percent Cover

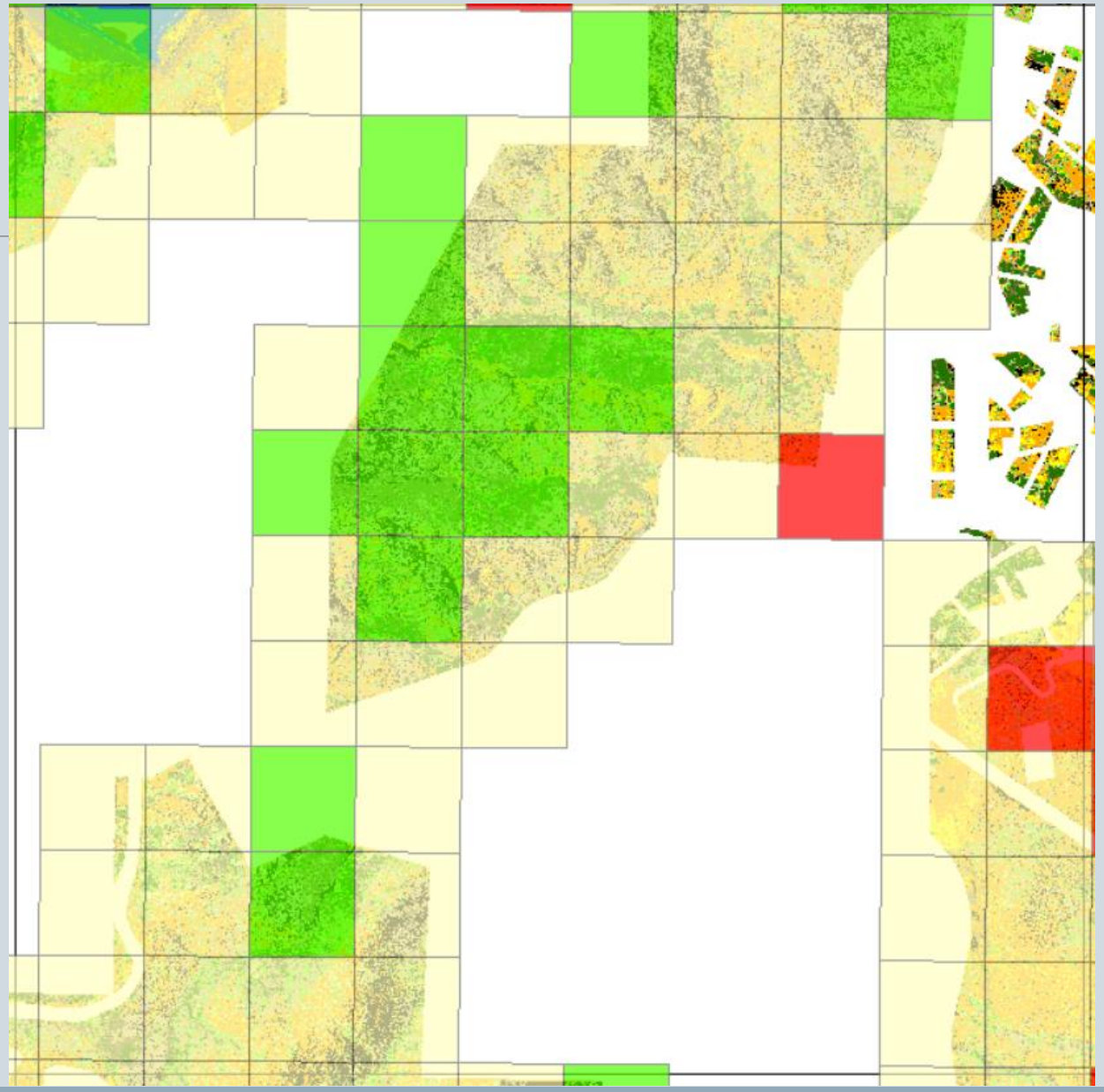
- Calculated at 150m plots
- Categorized into high, medium, and low integrity
- Cutoffs vary by vegetation type

	Coastal sage scrub		Chaparral	
	Shrub Cover	NNG Cover	Shrub Cover	NNG Cover
Low	<=30%	>70%	<=30%	>30%
Medium	31-65%	20-69%	31-80%	5-30%
High	>65%	<20%	>80%	<5%

Draft

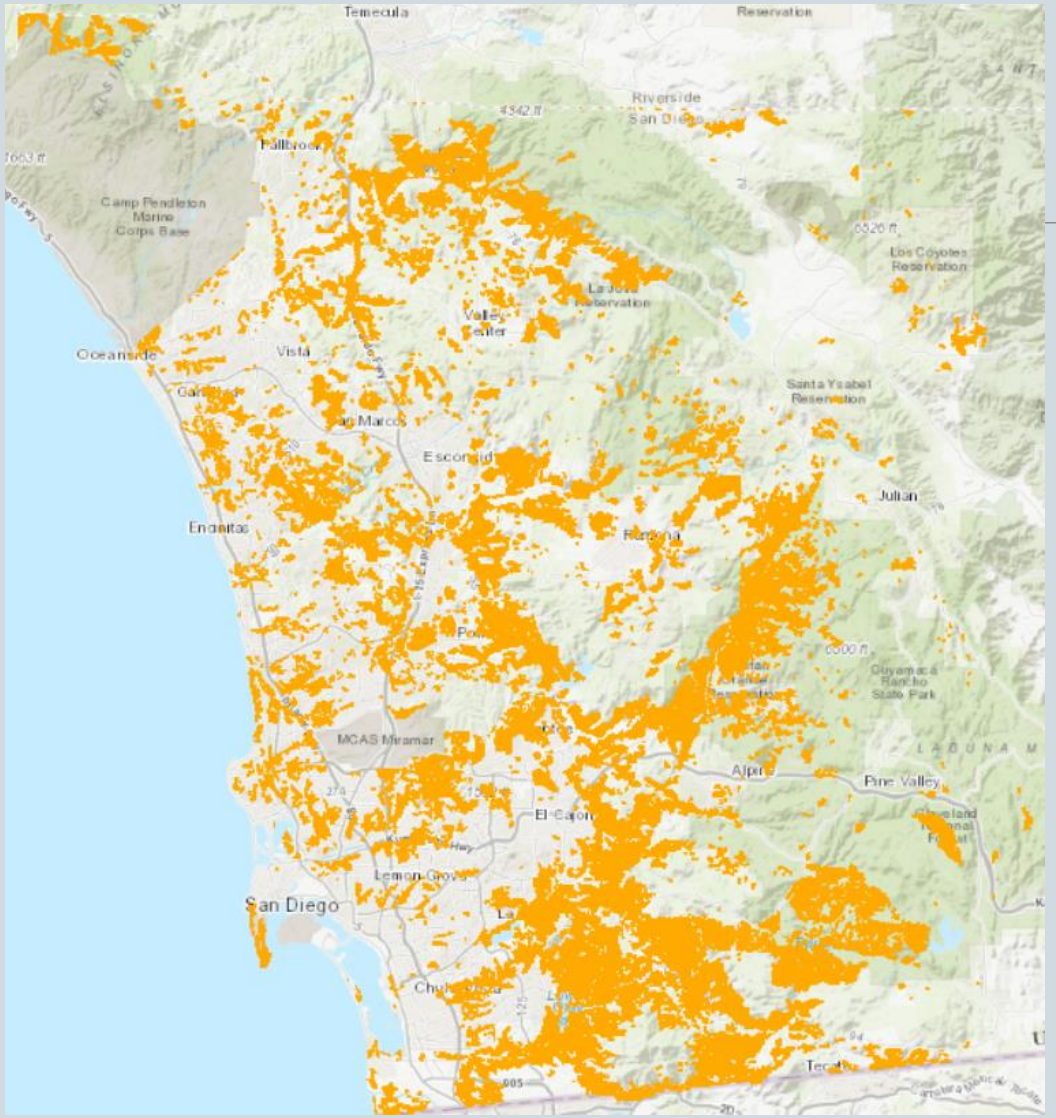


Percent Shrub

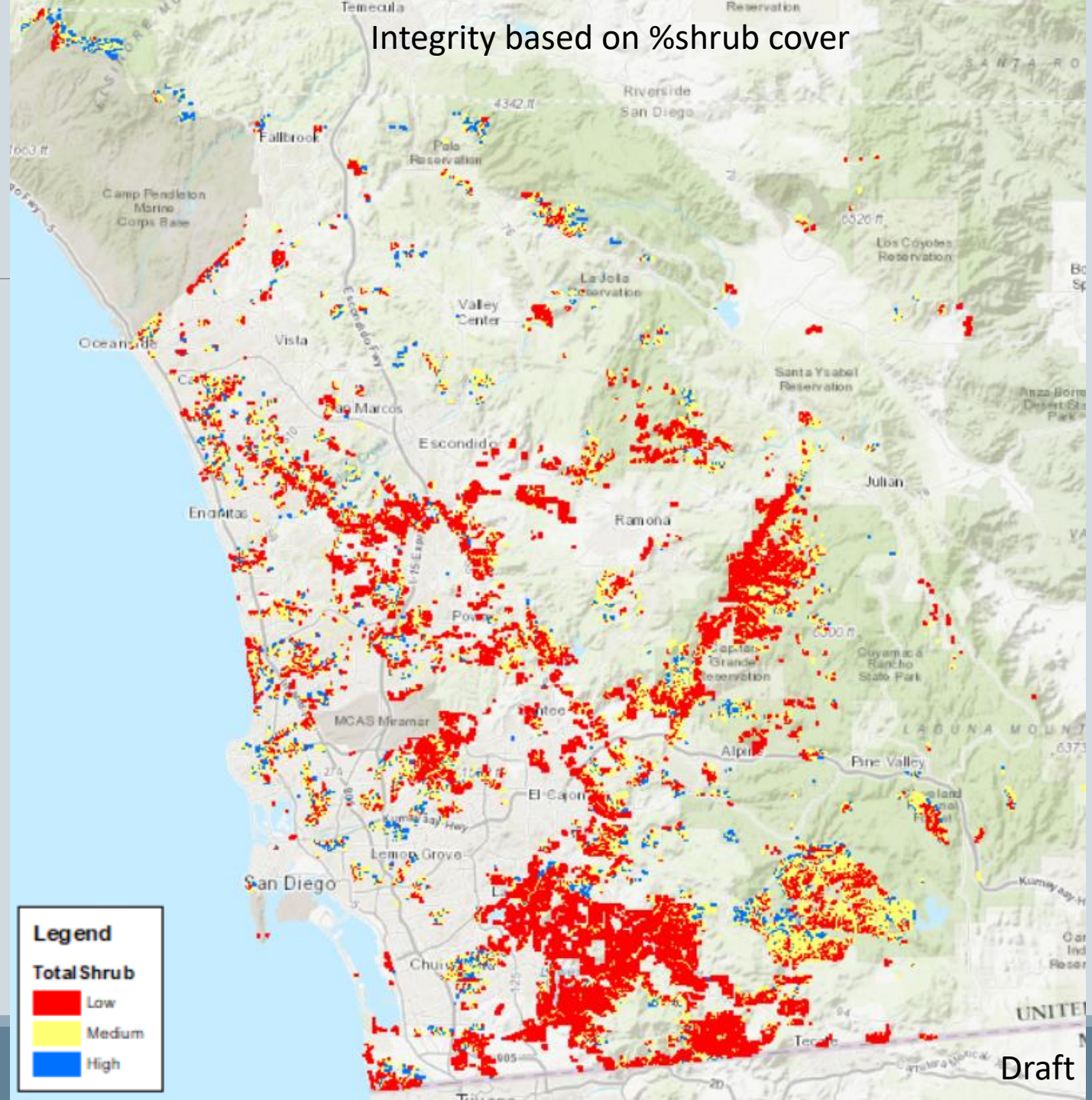


Percent Herbaceous

Mapped CSS



Integrity based on %shrub cover



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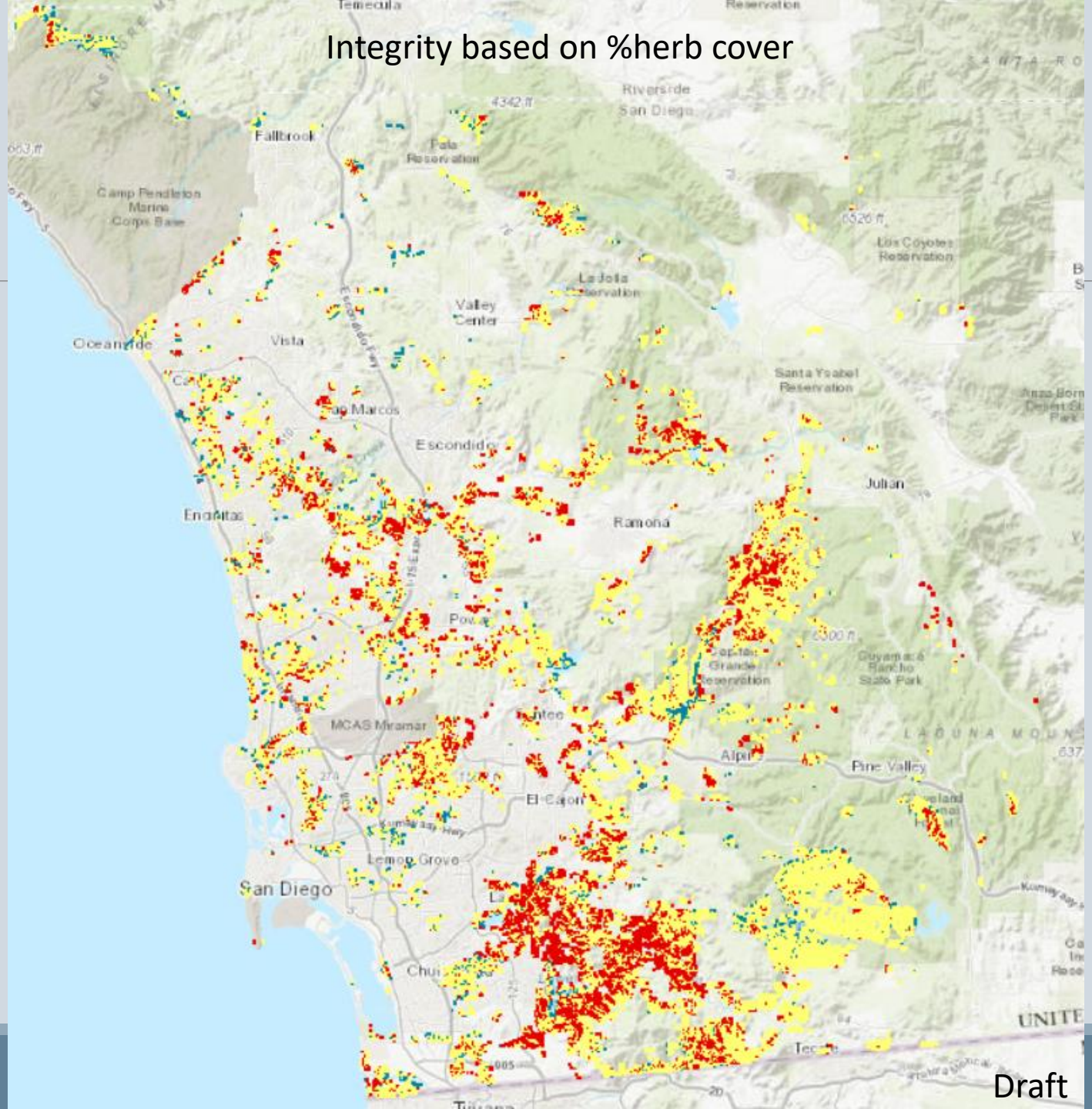
Integrity based on %herb cover



Draft

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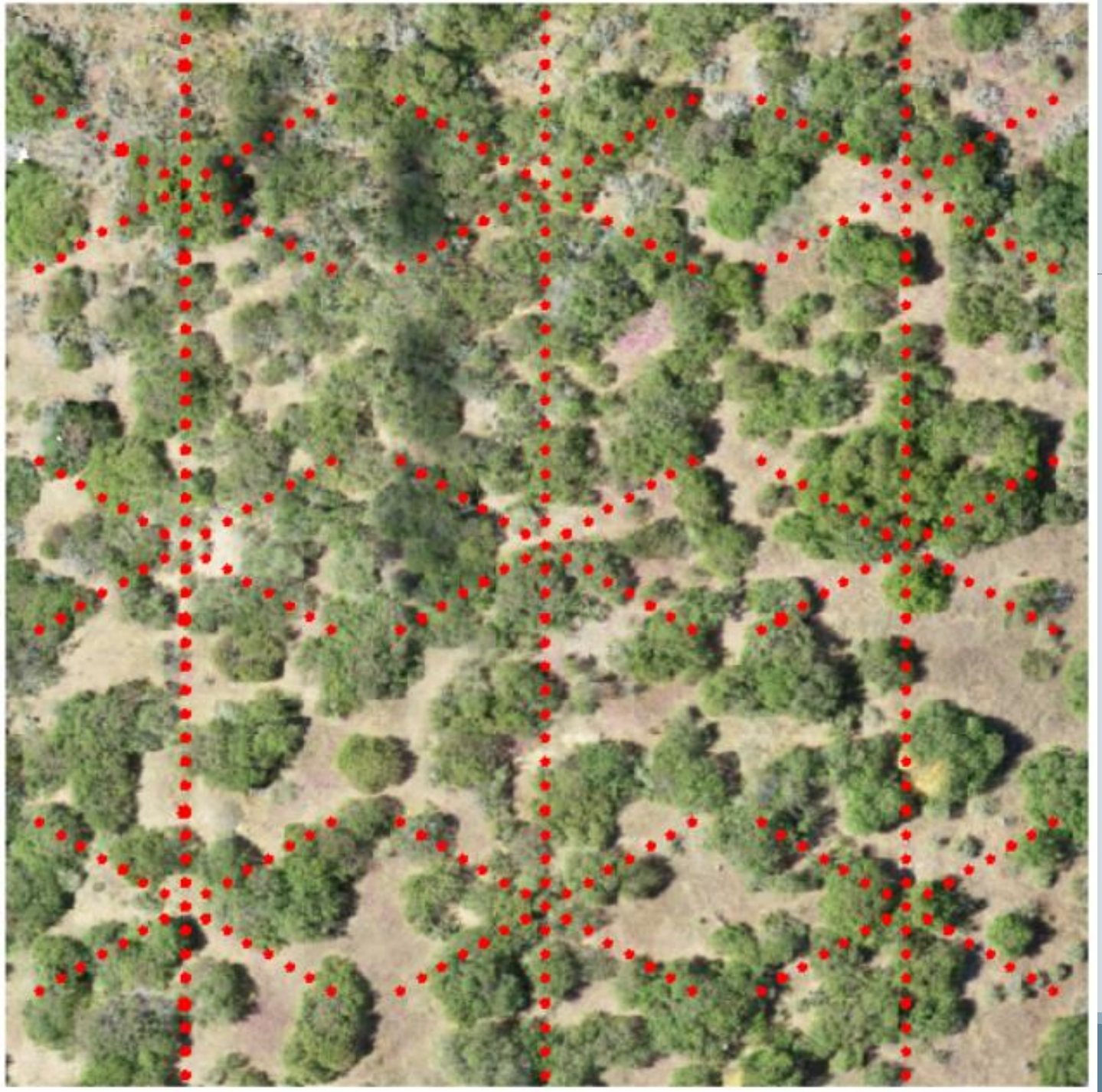
Field data collection (pilot study)

- Spring 2020 was a pilot study year to test field methods
- AECOM incorporated UAV imagery and field identification to map 63 plots
- SLATS survey design method was used to mark cover type (individual species or substrate) on 405 points in each plot (25,479 points total)
- Vegetation information was labeled using a combination of a species list compiled in the field for each plot and UAV imagery
- UAV allowed for access to site to be faster and less destructive while still providing species level identification



90m

AECOM

Future Steps

- Continue refinement of model and integrity cutoff values
- Use UAV and SLATS data to train LANDSAT imagery and identify areas of change
- Complete 2018 and 2020 NAIP land cover maps
- Expand pilot study for field data collection at regular intervals

Questions?