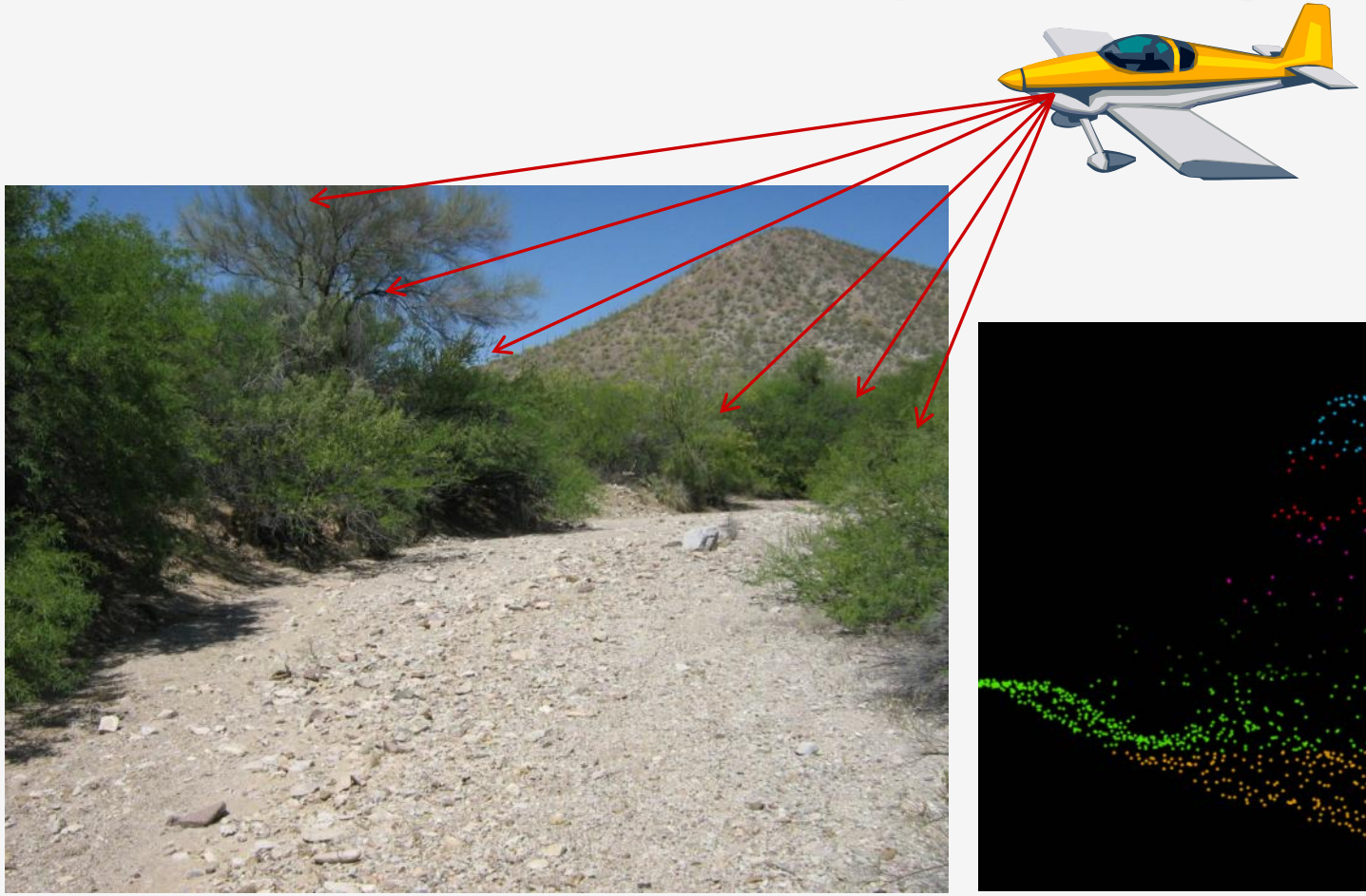
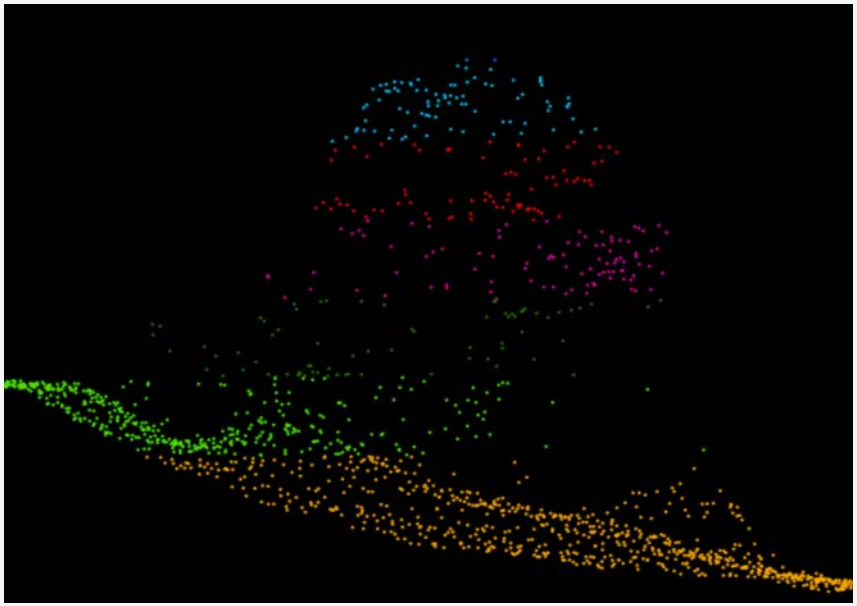
Use of LiDAR and Multi-spectral Imagery to Characterize Riparian Vegetation

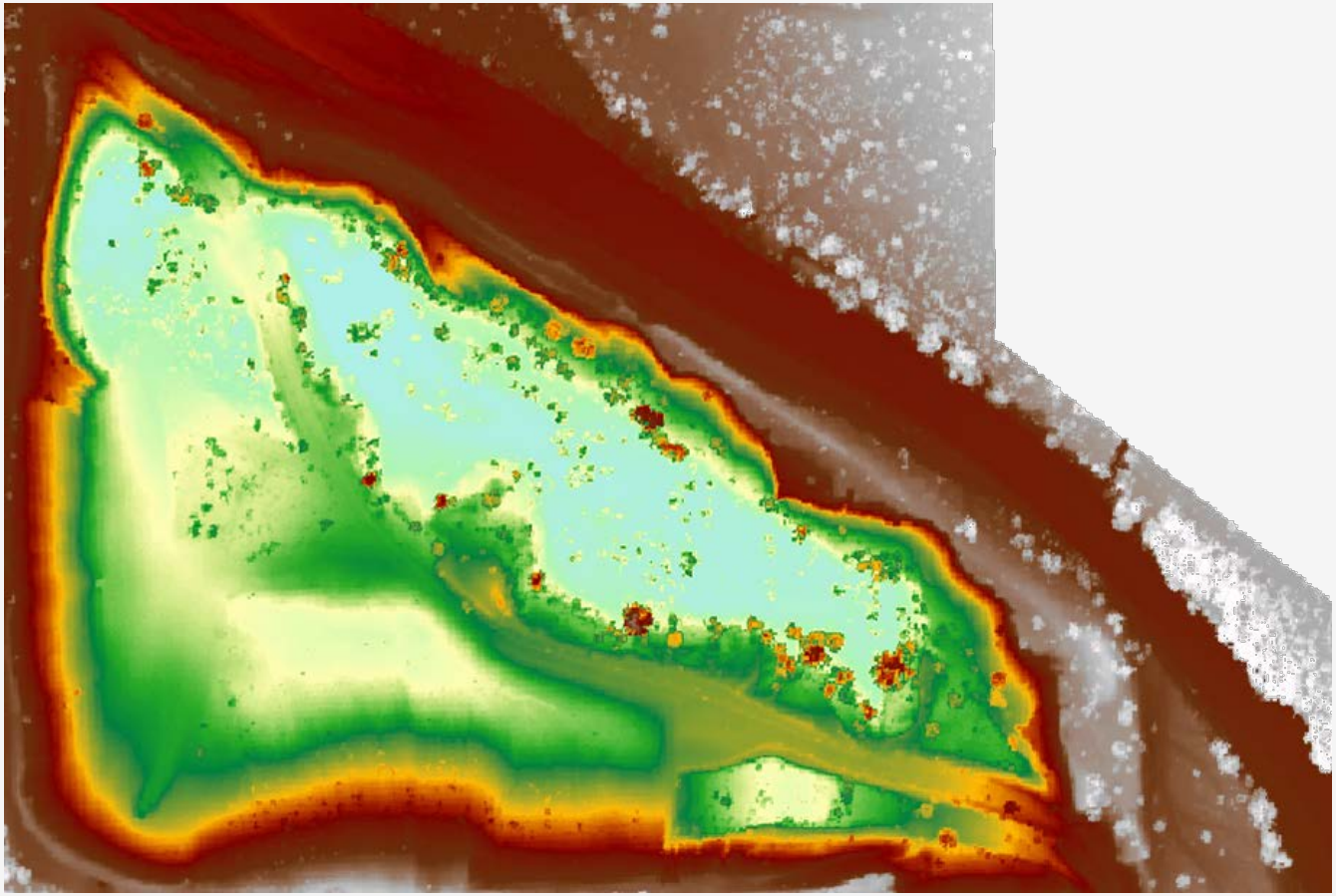




Leslie Carpenter
University of Arizona
MS-GIST, Dec 2012

Presentation Overview

- Background & Objectives
- Data Preparation
- Analysis & Results
- Conclusions & Recommendations



DSM from LiDAR

“Watercourse and Riparian Habitat Protection and Mitigation Requirements” Ordinance

Disturbance to Riparian - mitigation and 5 years monitoring

RFCD manages, protects, and ensures mitigation occurs

Can LiDAR data assist in riparian management ?

Mitigation tied to vegetation volume

Riparian Classification Map

Regulated Riparian Habitat

HydroMeso – perennial, intermittent or shallow groundwater

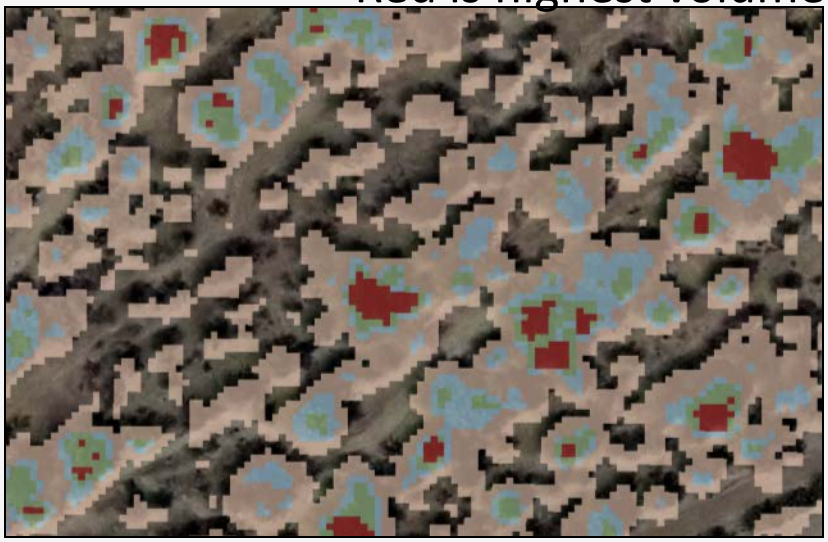
Xero A to D - ephemeral water

Decreasing volume →

NDVI as Vegetation Volume

The higher the NDVI the higher the leaf volume

Red is highest volume

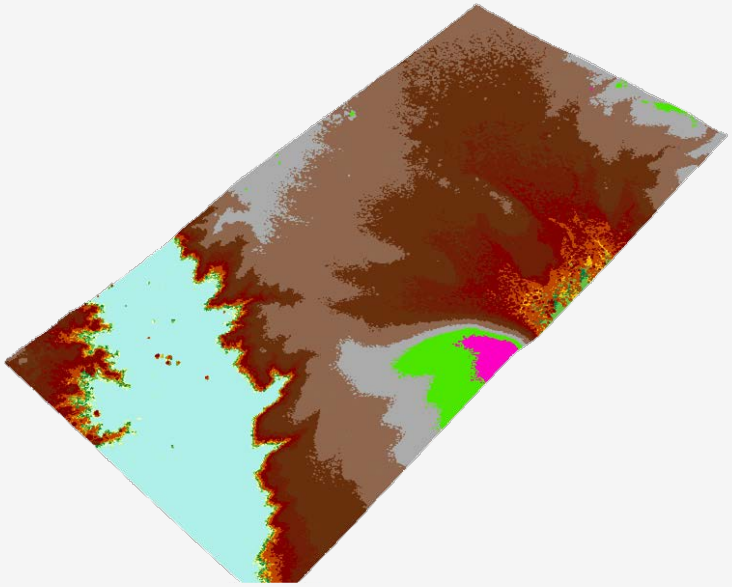


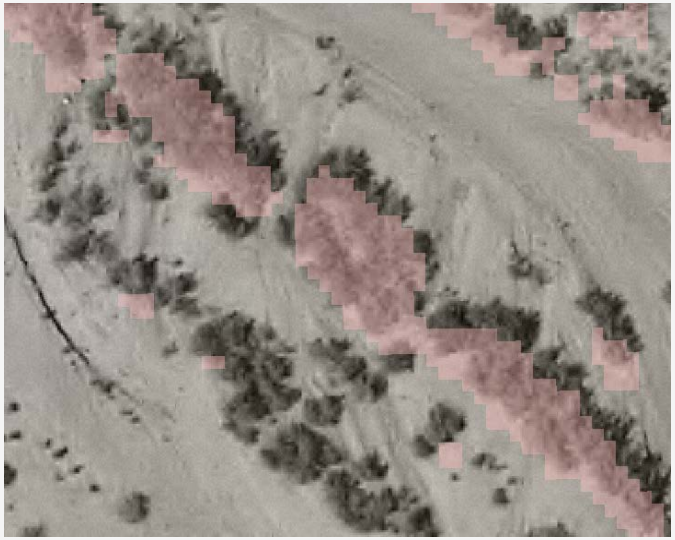
Class	1993 NDVI range	Vegetation Volume m^3/m^2
Xero A	$\geq$0.23	>0.856
Xero B	$\geq$0.19 and <0.23	>0.675 and $\leq$0.856
Xero C	$\geq$0.14 and <0.19	>0.500 and $\leq$0.675
Xero D	<0.14	$\leq$0.500

Objectives

- Use LiDAR data to describe % canopy cover and vegetation volume

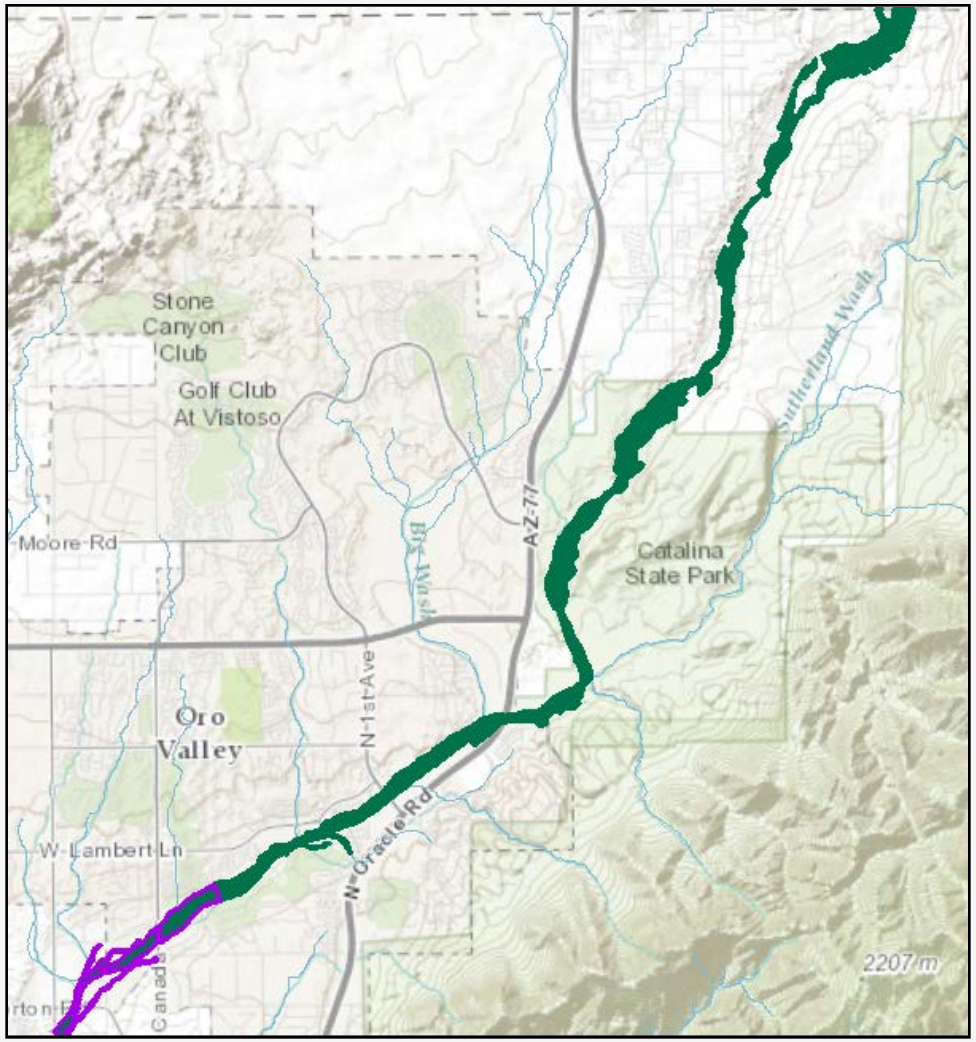
- Test whether LiDAR data or NDVI could be used to compliment field determined vegetation volume and class





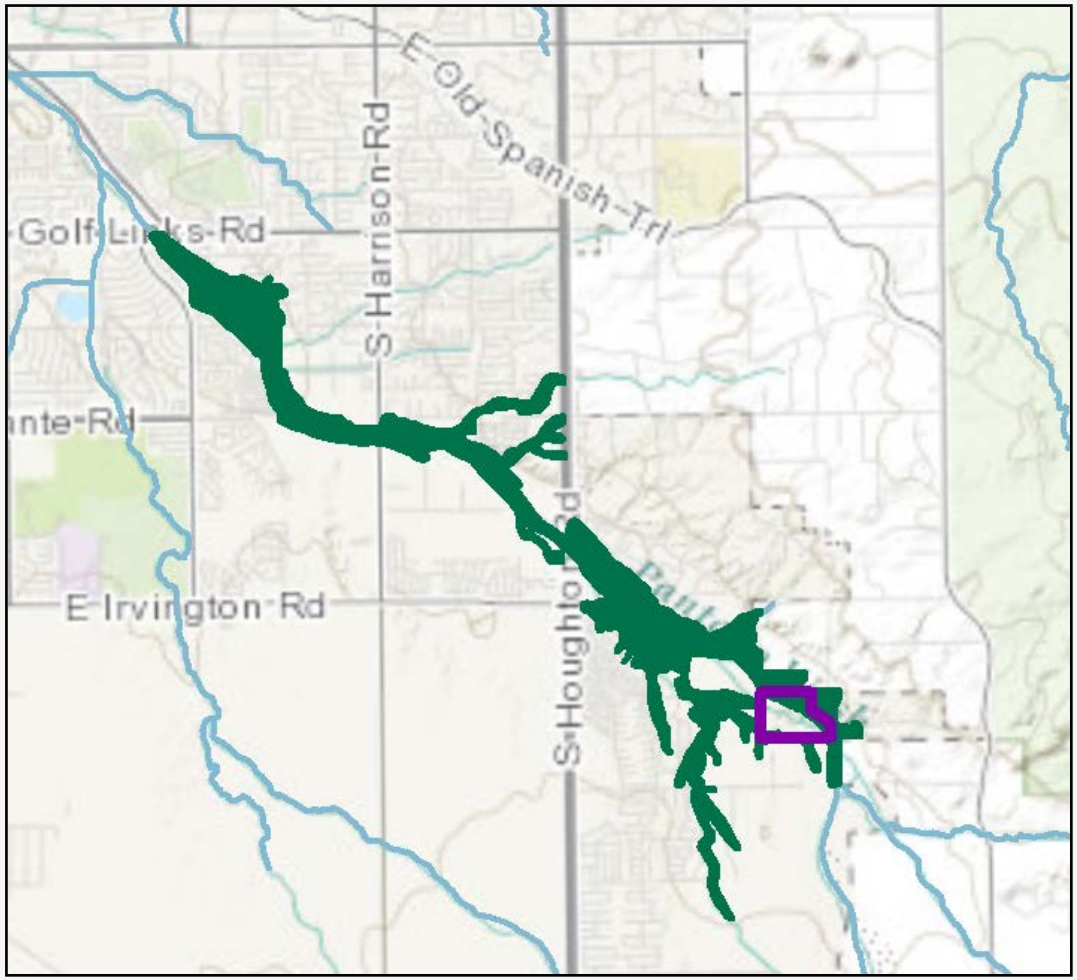
Canada del Oro Wash

- **28 km from County line to La Cholla Rd**
- **Oasis Parcel**



Pantano Wash

- **10 km from Rincon Creek to Golf Links Rd**
- **Melpomene Parcel**



Many Temporal Sources = Method Testing Only

Data Preparation

- **2005 Riparian classification shapefile**

  (NAD 1983 State Plane Az Central FIPS 0202 Inter'l Feet / N.A. 1983 HARN)

- **2008 Aerial LiDAR data (late Feb/early March)**

  (N.A. 1983 Transverse Mercator / NAD 1983)

- **2007 NDVI from NAIP imagery (June, 1 meter)**

  (N.A. 1983 Transverse Mercator UTM Zone 12N / NAD 1983)

- **2010 & 2012 field transects - GIS sampling areas**

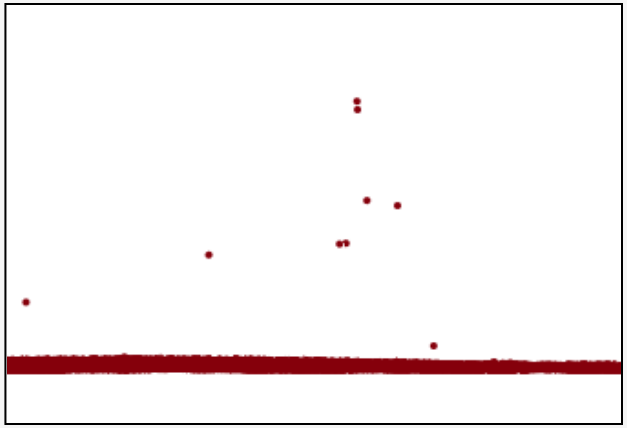
  (NAD 1983 State Plane Az Central FIPS 0202 Inter'l Feet / N.A. 1983 HARN)

Riparian Coverage

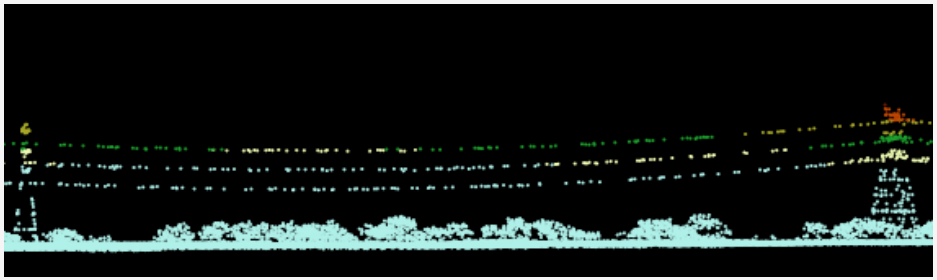
- **Edit back to natural zone from housing developments and roads, digitized a new section in Catalina State Park**
- **5 sections – UCDO, MCDO, Oasis, Pantano and Melpomene**
- **14 Riparian polygons**

LiDAR Data Clean Up and Point Spacing

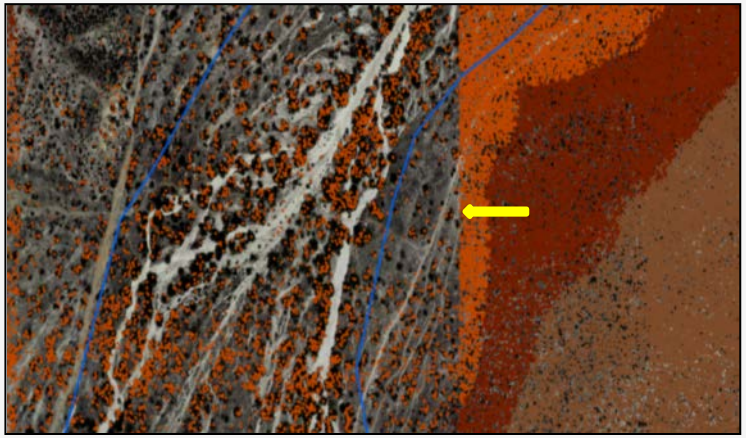
Recode outliers



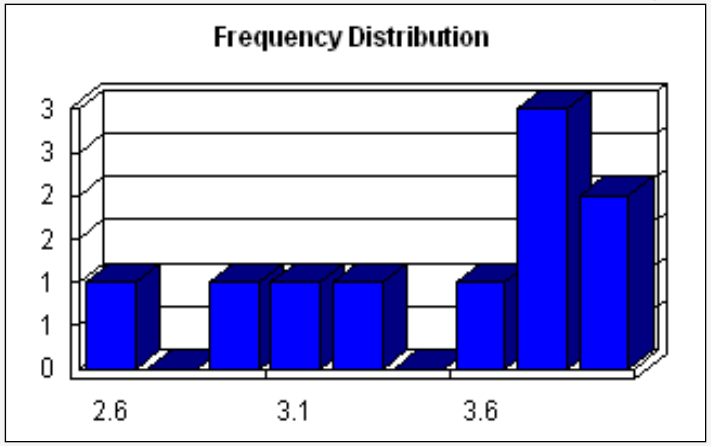
Change codes on above ground, non-vegetation points



Examine point distribution

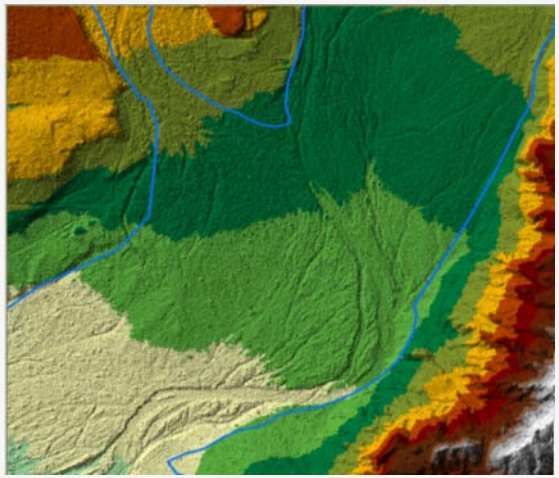


Determine point spacing

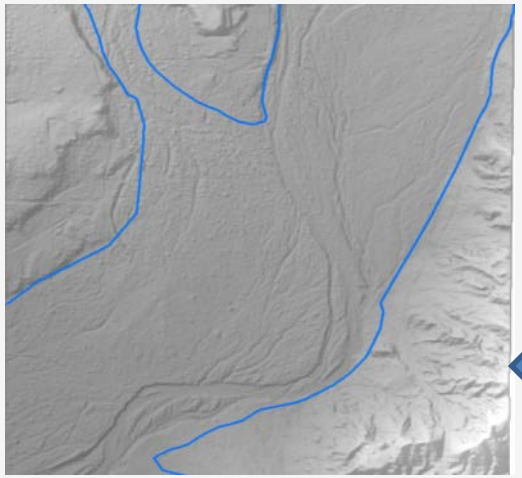


Data Preparation

Terrain DEM

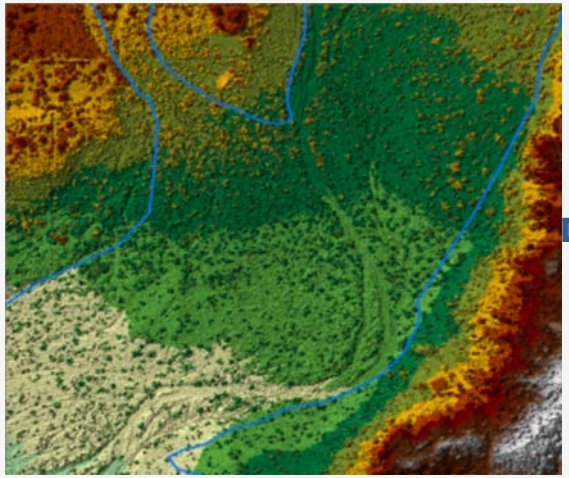


Raster DEM

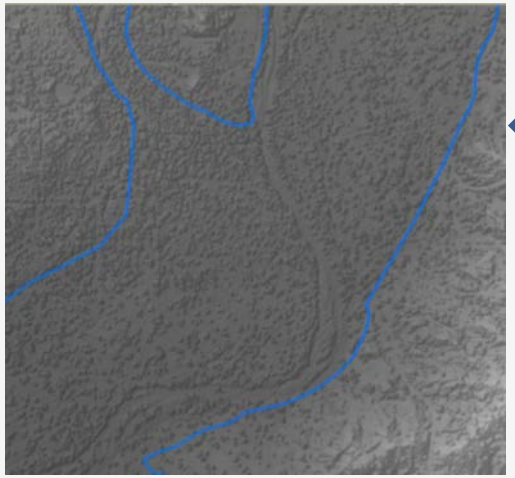


CHM clipped to riparian polygon

Terrain DSM

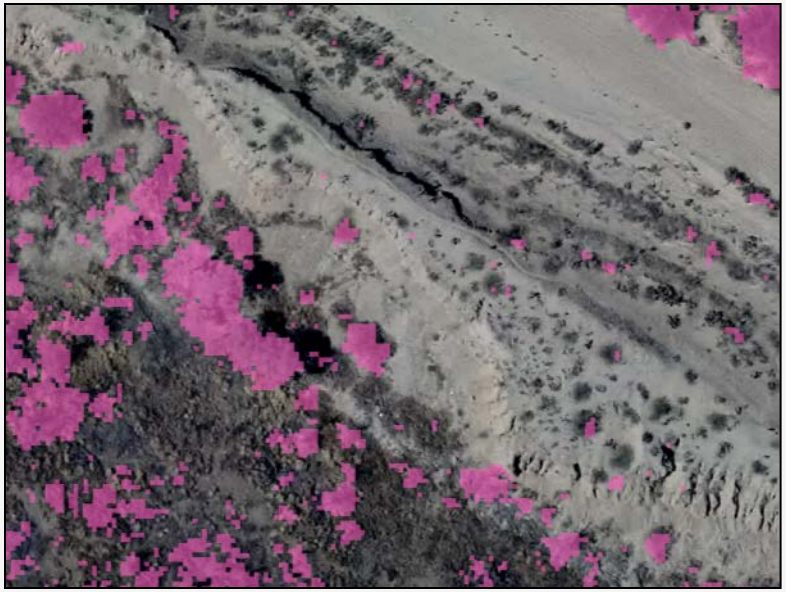


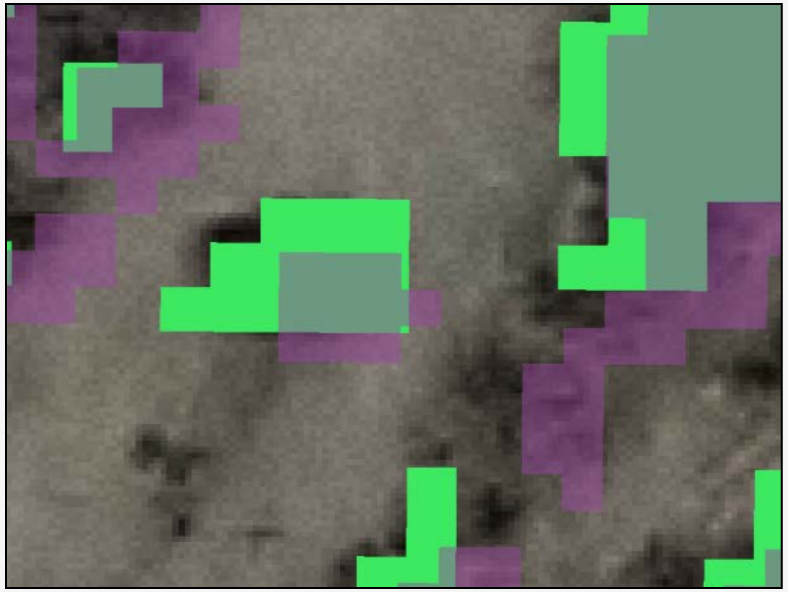
Raster DSM



NDVI

- **Determined vegetation threshold at ≥ 0.017**
- **Vegetation mask at Melpomene**
- **Reproject, resample, shift**
- **Con statement to create a CHM only at vegetation cells**





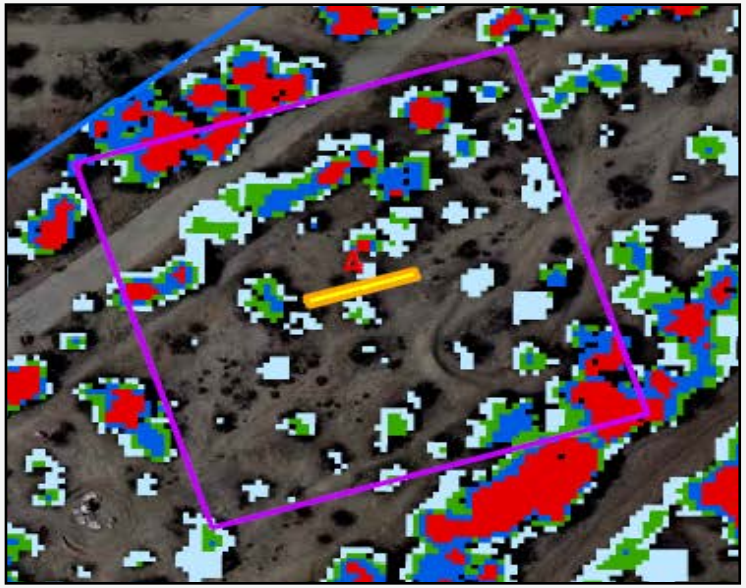
Fall Field Samples of Vegetation Volume

Melpomene 5 transects in 2010

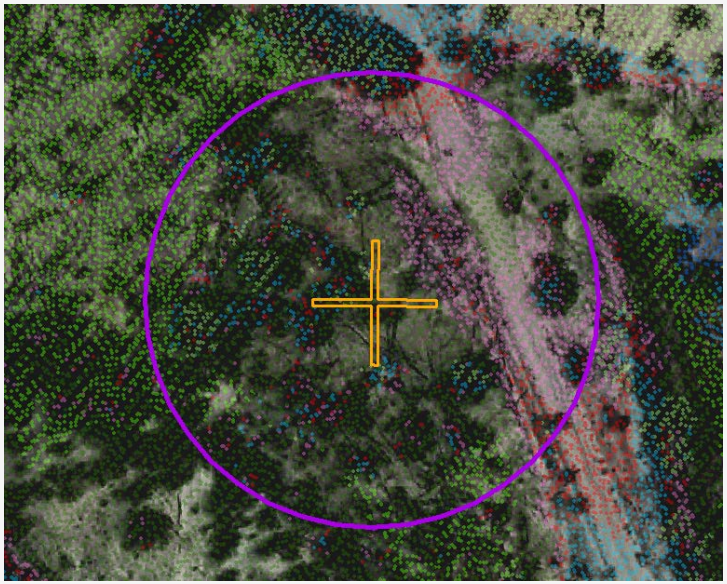
Oasis 6 transects in 2012

GIS Sampling at Field Sites

- **Transect – 25m x 2 cell wide (Oasis) and 20m x 1 cell (Melpomene)**
- **Quadrat - 100m^2 (Oasis) and 75m diameter circular (Melpomene)**



NDVI background

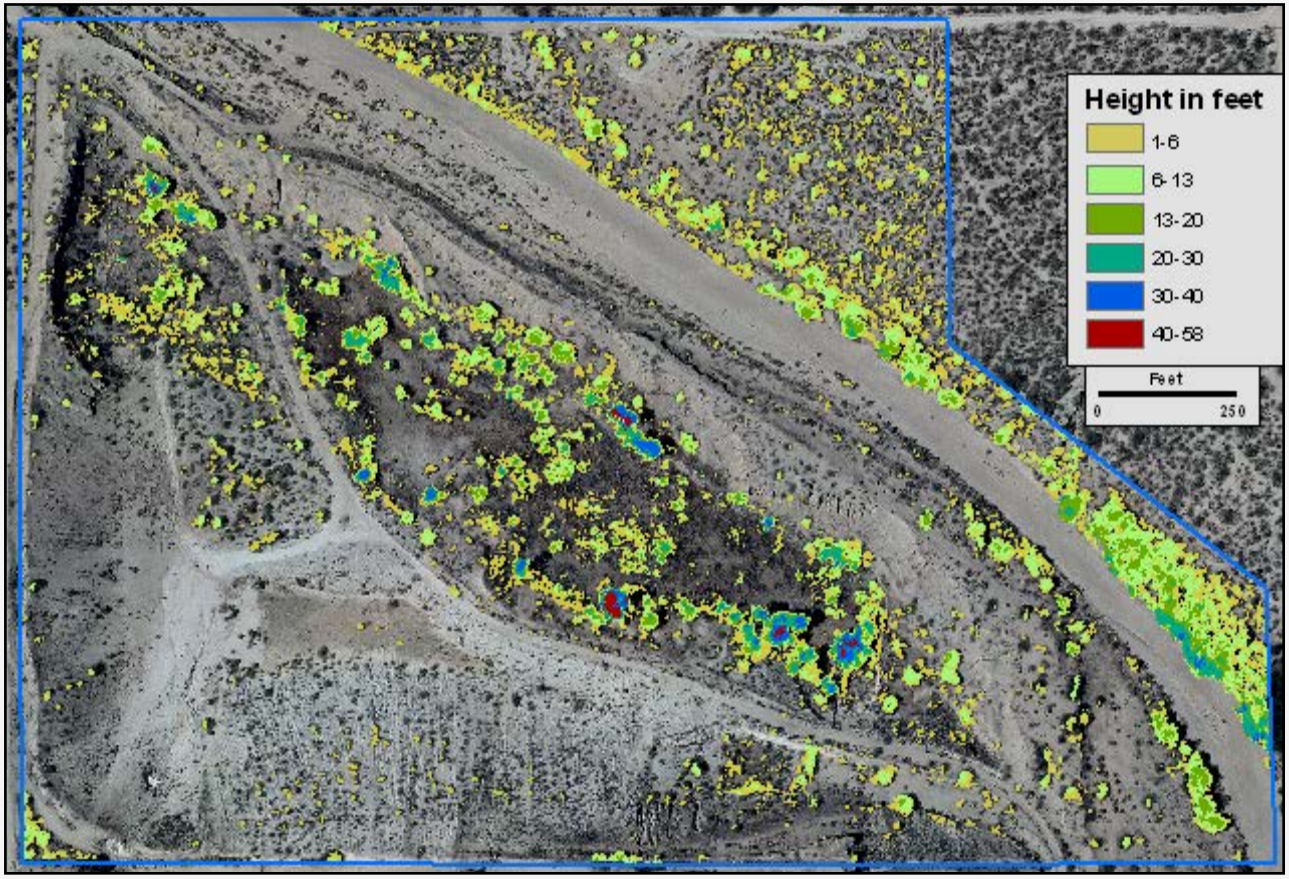


LiDAR background

Analysis and Results

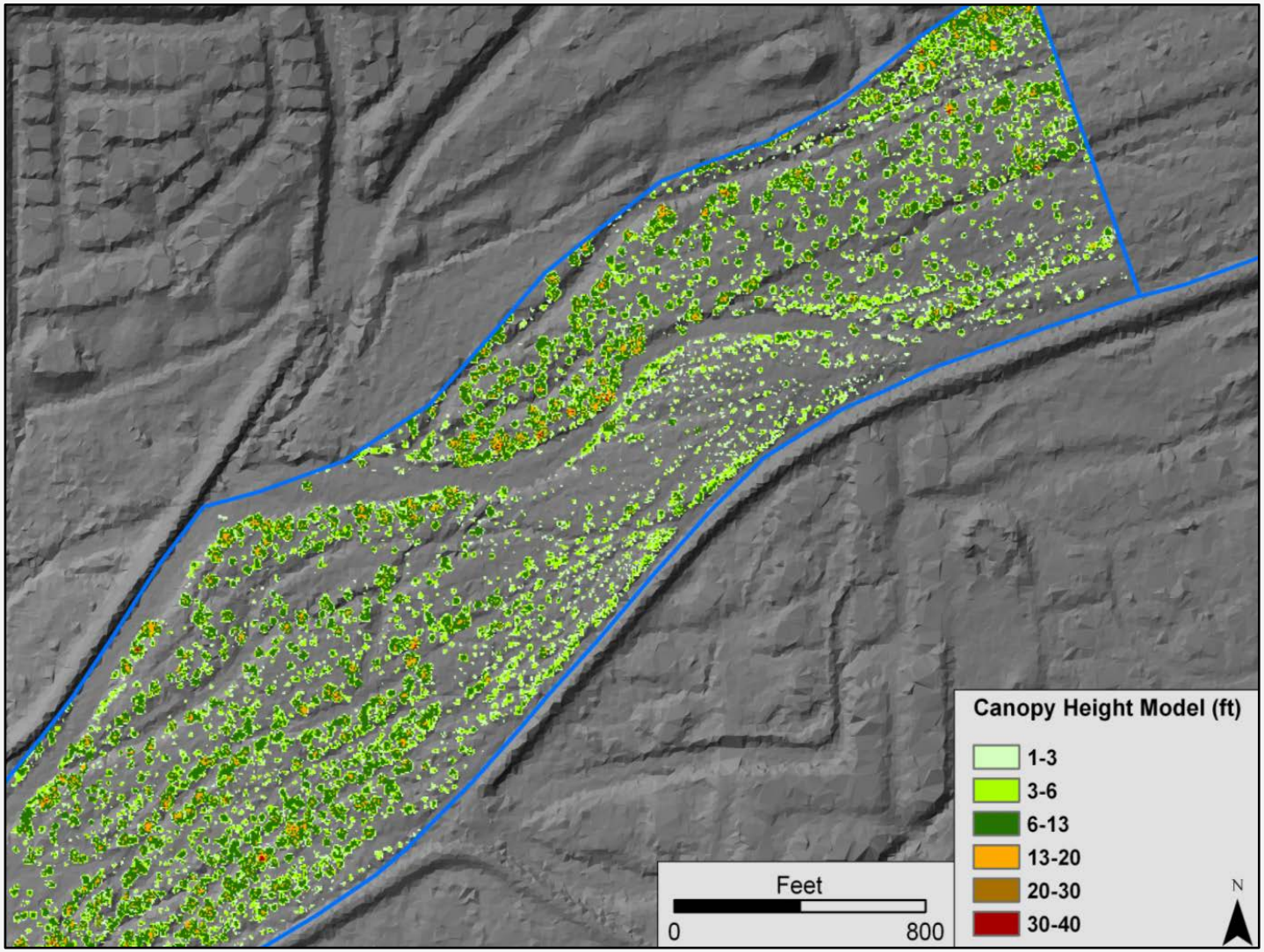
Canopy cover

- **Proportion of cells > 1 ft in height.**
- **Melpomene 13% Pantano 17%**

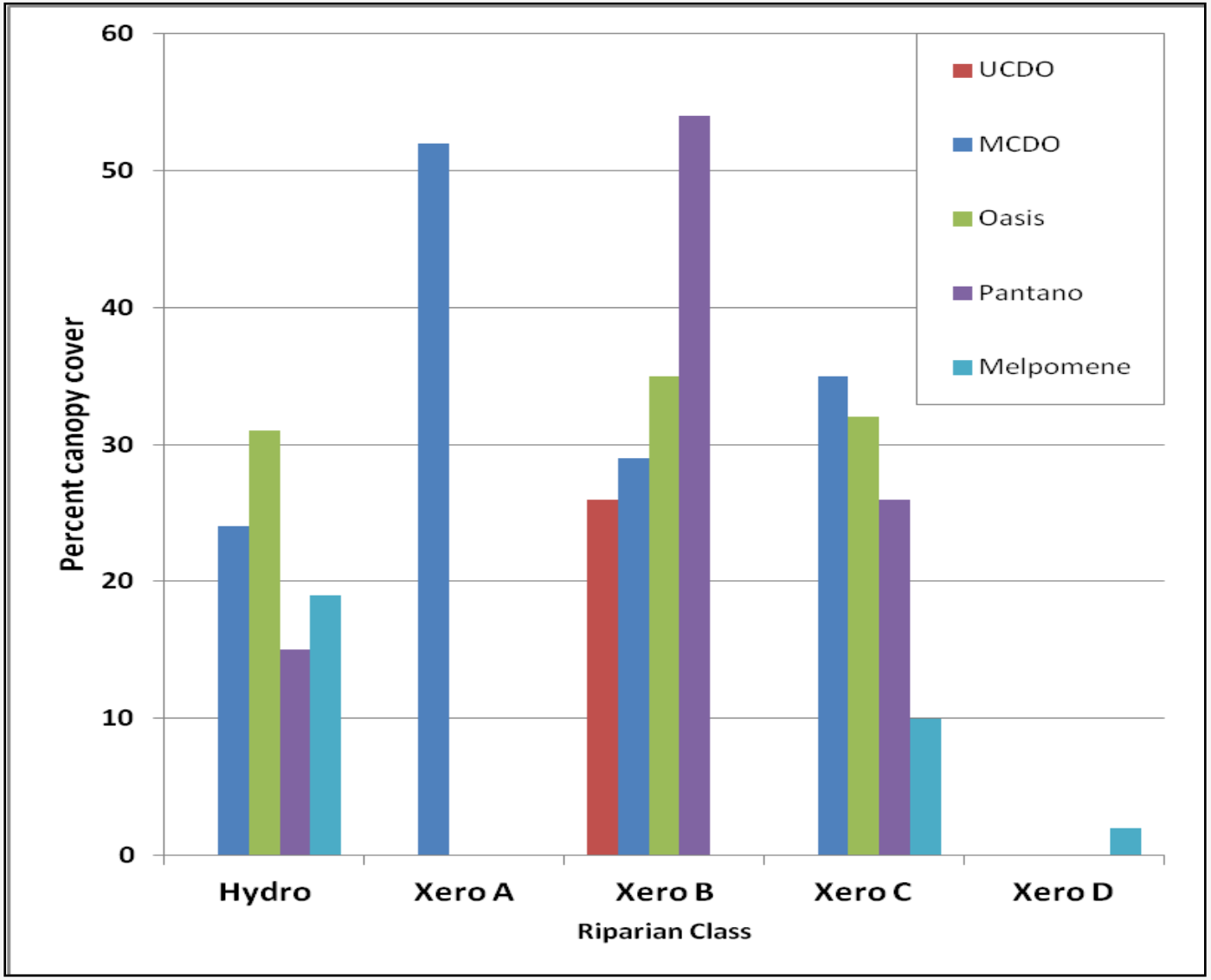


Canopy cover

- **Oasis 33% CDO 27%**



Percent Canopy Cover by Riparian Class

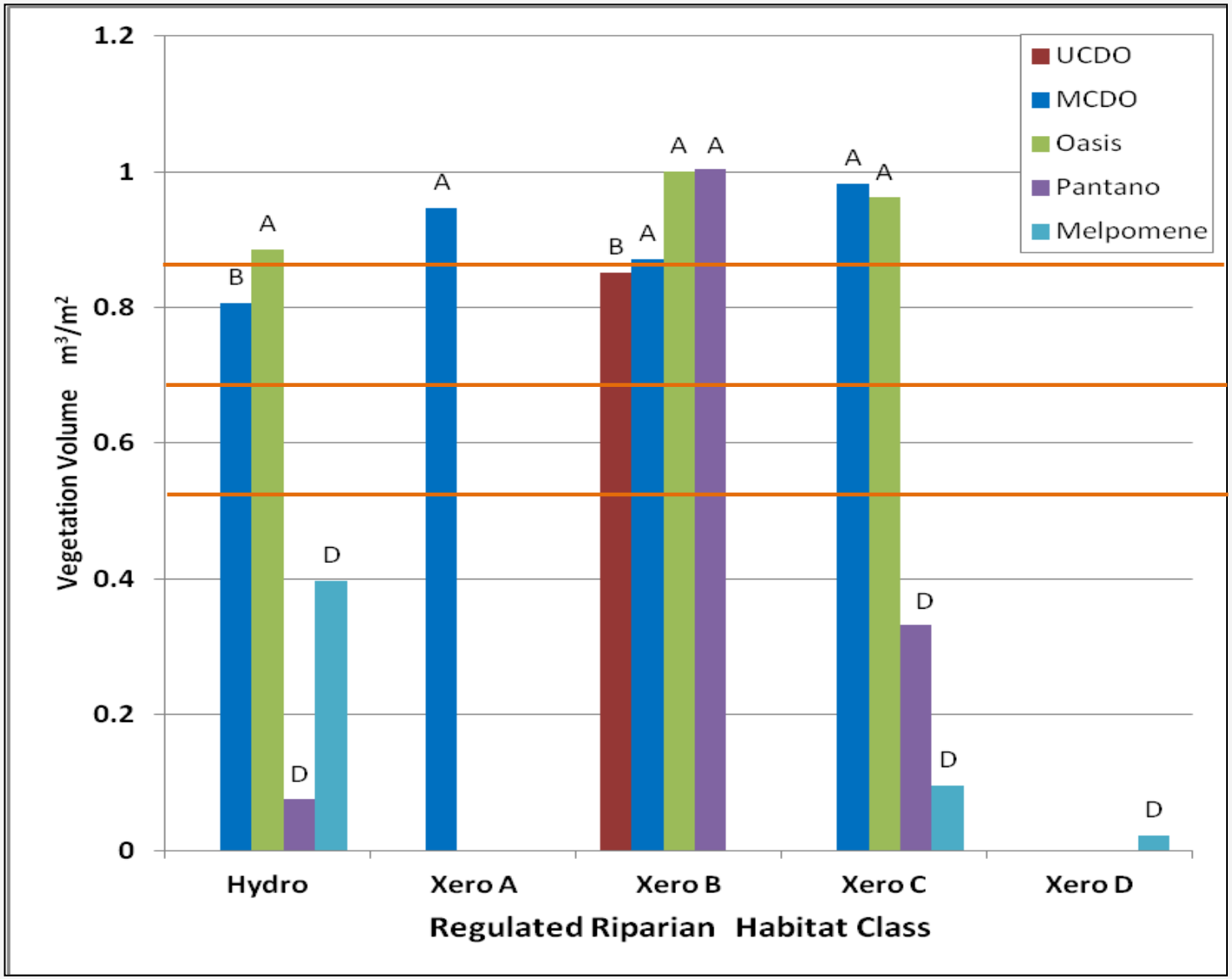


Vegetation Volume

- **Converted CHM raster to points to extract cell values**
- **Summed heights by class and divided by area to get m^3/m^2**
- **Hydromesoriparian not defined by vegetation volume**

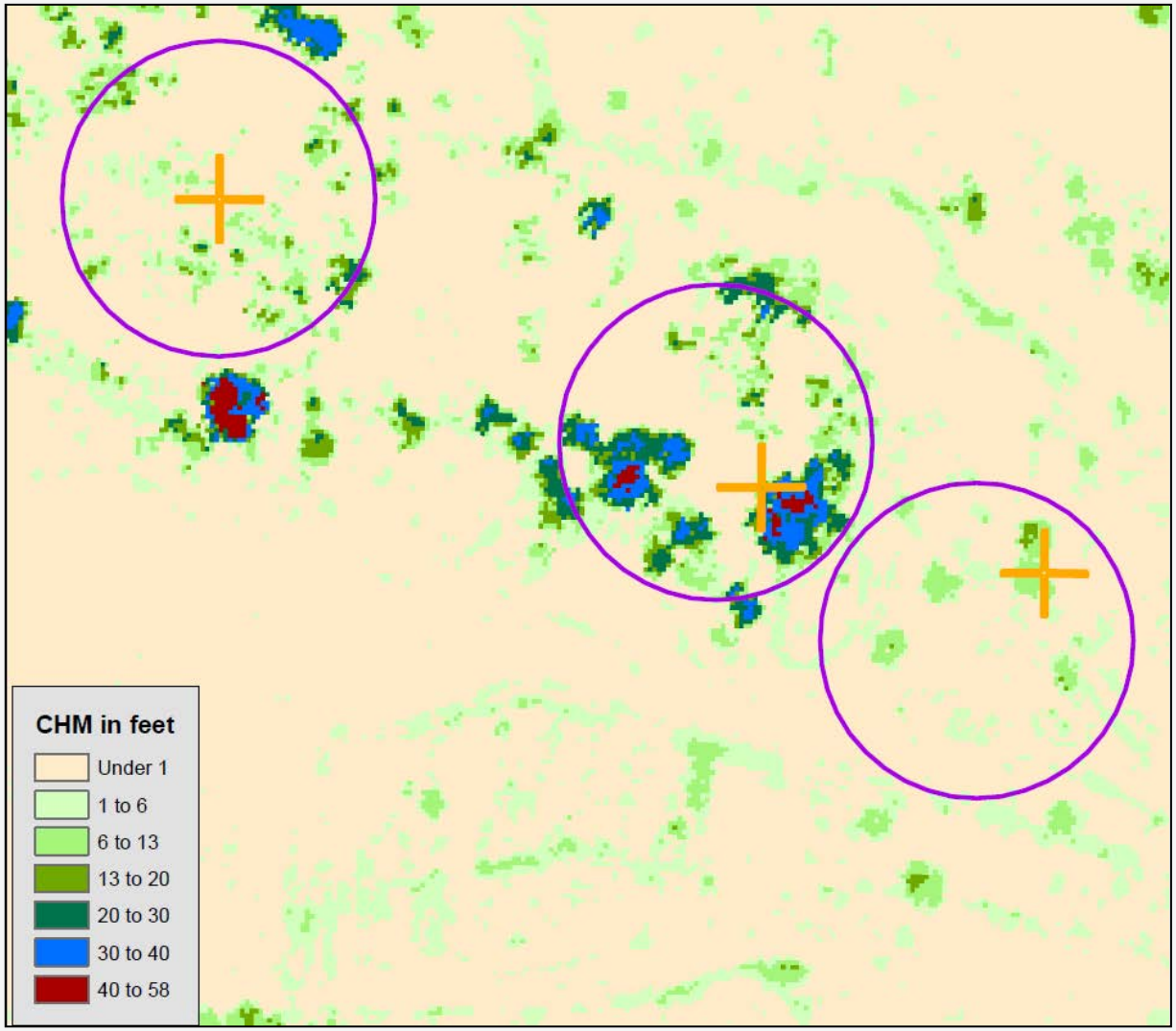
Class	Vegetation Volume m^3/m^2
Xeroriparian A	> 0.856
Xeroriparian B	> 0.675 and ≤ 0.856
Xeroriparian C	> 0.500 and ≤ 0.675
Xeroriparian D	≤ 0.500

Vegetation Volume by Riparian Map Class

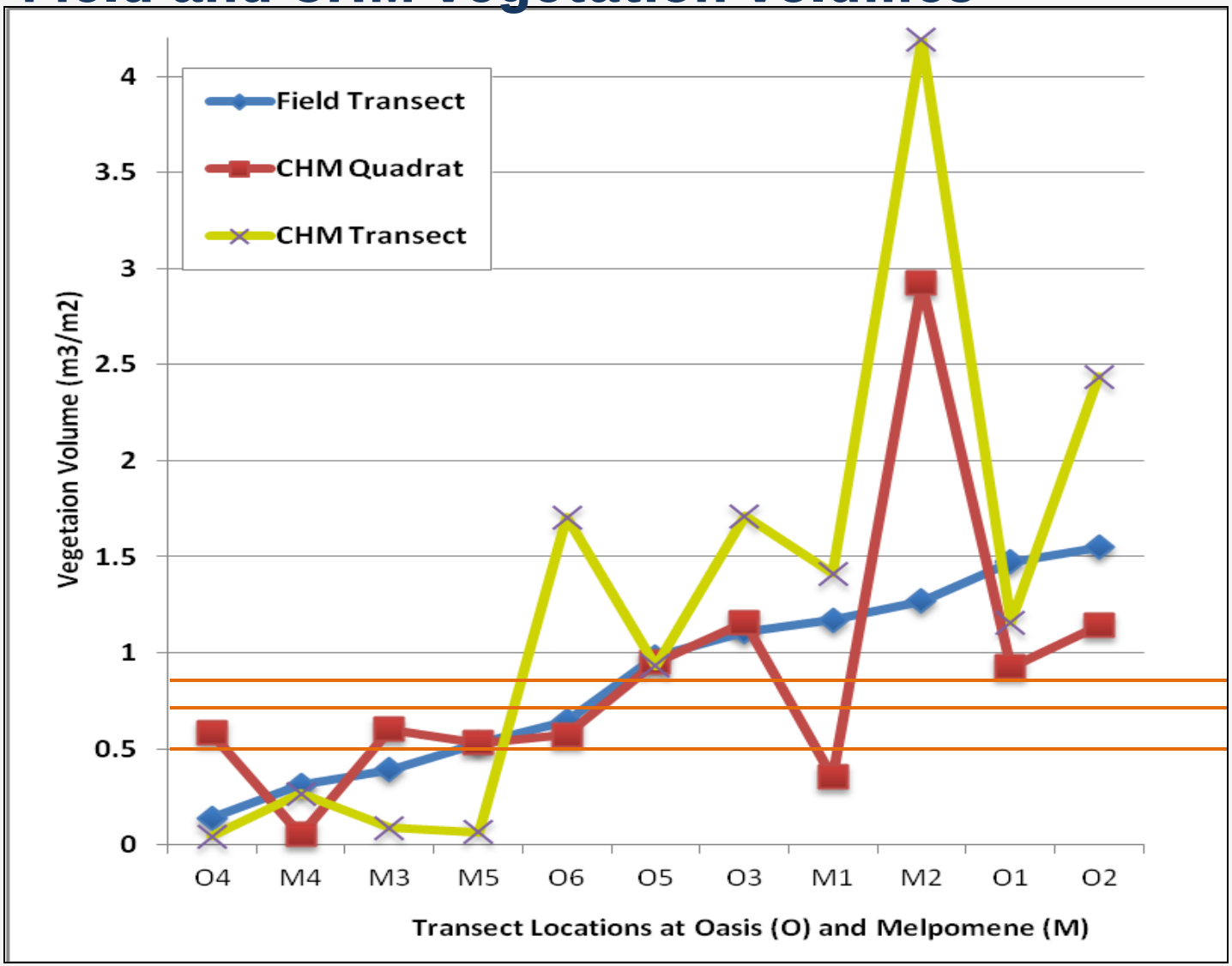


Analysis and Results

Relationship of Field Volume and CHM Transects/Quadrats

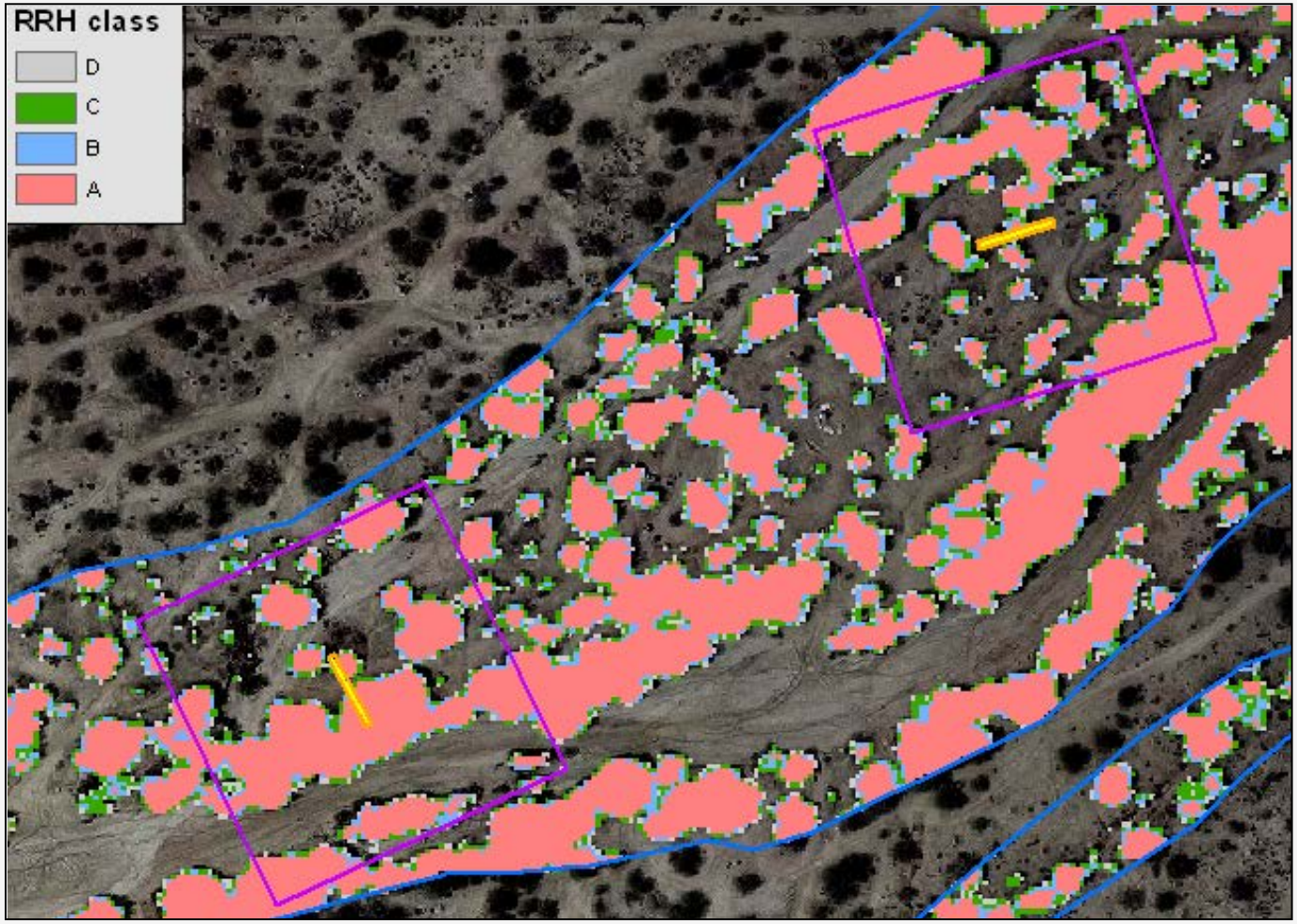


Field and CHM vegetation volumes

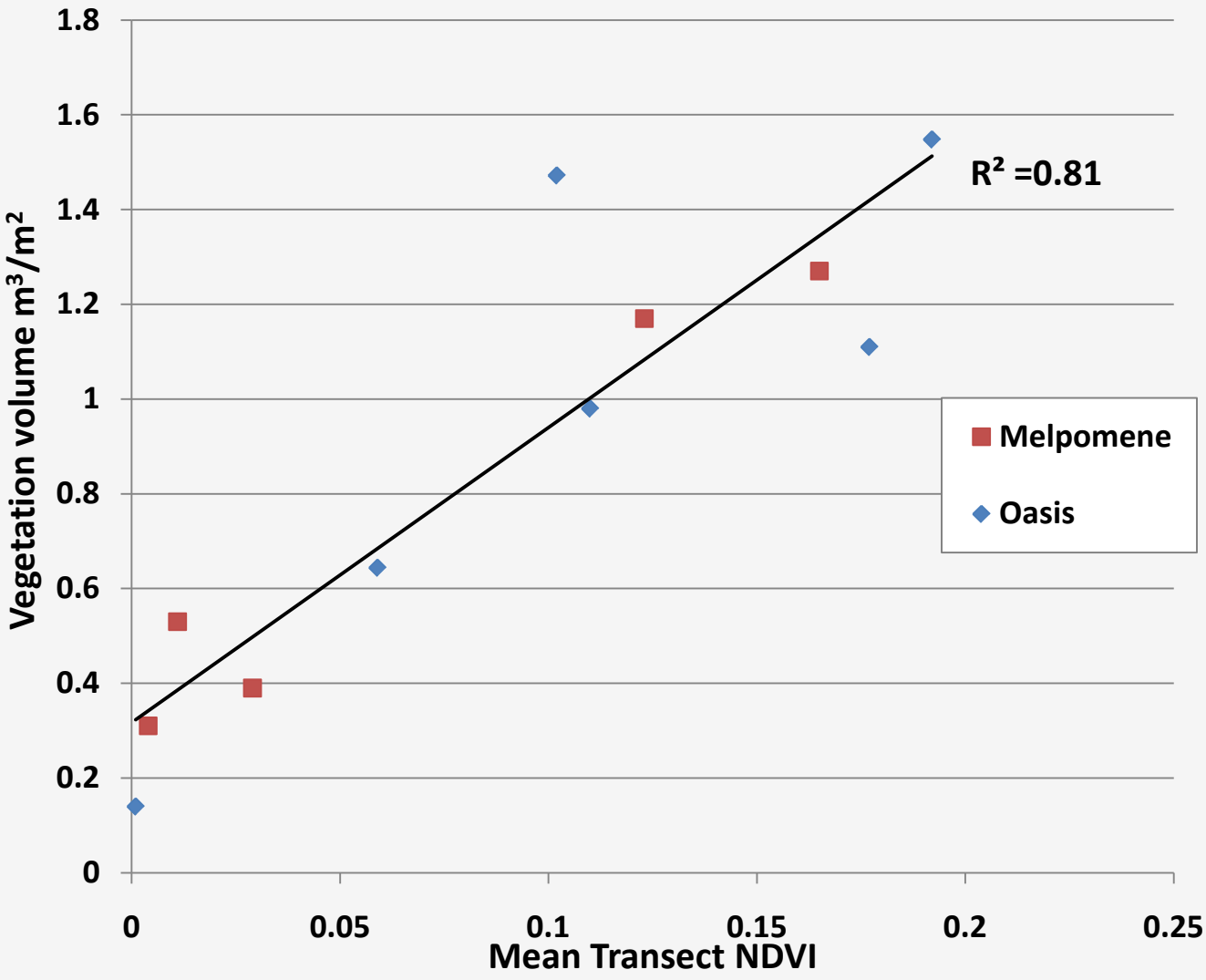


Relationship of Field Vegetation Volume and Mean NDVI

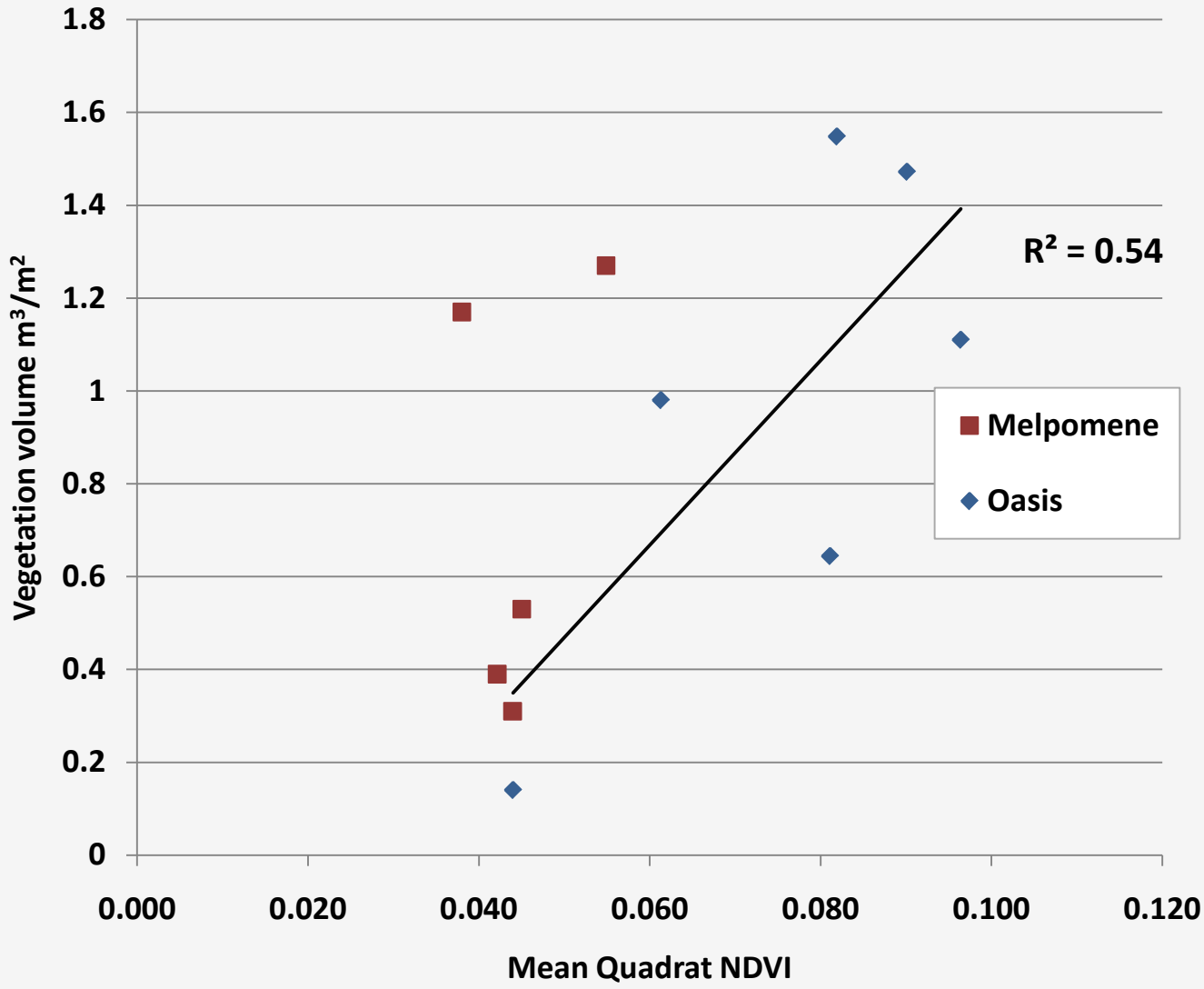
- Converted NDVI raster to points to extract cell values
- Summed heights by class and divided by area to get m^3/m^2



Mean NDVI at Transects vs Field Vegetation Volume



Mean NDVI at Quadrats vs Field Vegetation Volume



2007 Mean NDVI thresholds

- **Using the transect method equation**

$$y = 6.1353x + 0.3268$$

I assigned the NDVI transects to a Riparian class

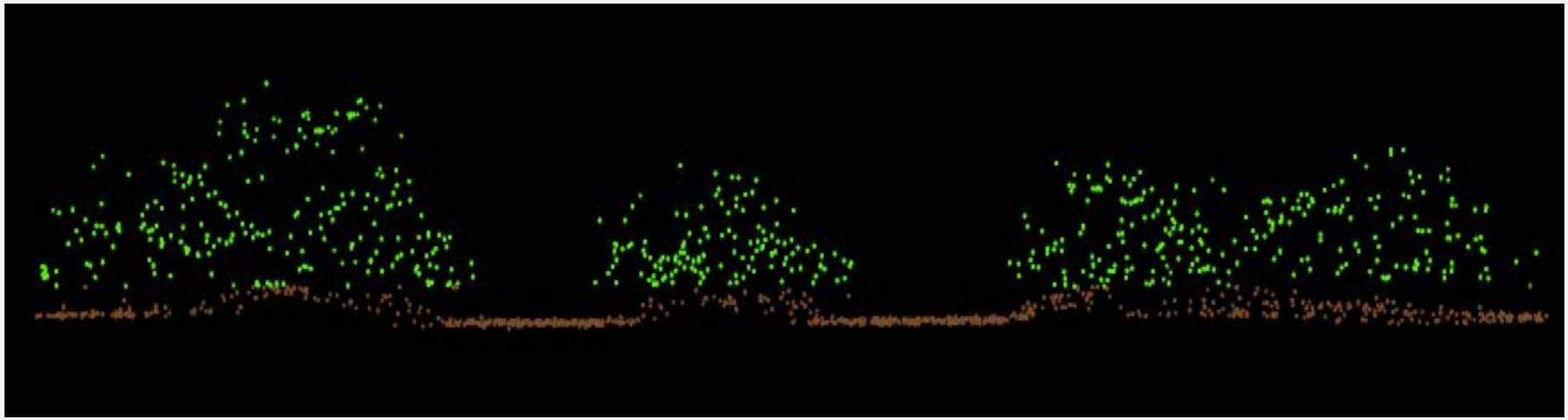
Class	2007 Mean NDVI	Vegetation Volume m^3/m^2
Xero A	$\geq$0.086	>0.856
Xero B	$\geq$0.057 and <0.086	>0.675 and $\leq$0.856
Xero C	$\geq$0.028 and <0.057	>0.500 and $\leq$0.675
Xero D	$\geq$0.017 and <0.028	$\leq$0.500

Comparison of classes at sites from CHMs and NDVI

Parcel	Transect	2010/2012 Field	2007 NDVI	2008 CHM-Q	2008 CHM-T
Melpomene	1	A	A	D	A
Melpomene	2	A	A	A	A
Oasis	1	A	A	A	A
Oasis	2	A	A	A	A
Oasis	3	A	A	A	A
Oasis	5	A	A	A	A
Melpomene	5	C	D	C	D
Oasis	4	C	D	C	D
Oasis	6	C	B	C	A
Melpomene	3	D	C	C	D
Melpomene	4	D	D	D	D

Conclusions - LiDAR

- CHMs describe canopy cover and vegetation volume well
- Transect and quadrat methods worked equally well to relate to field volume despite temporal differences
- Other metrics - mean heights, separate tree and shrub densities, individual tree growth



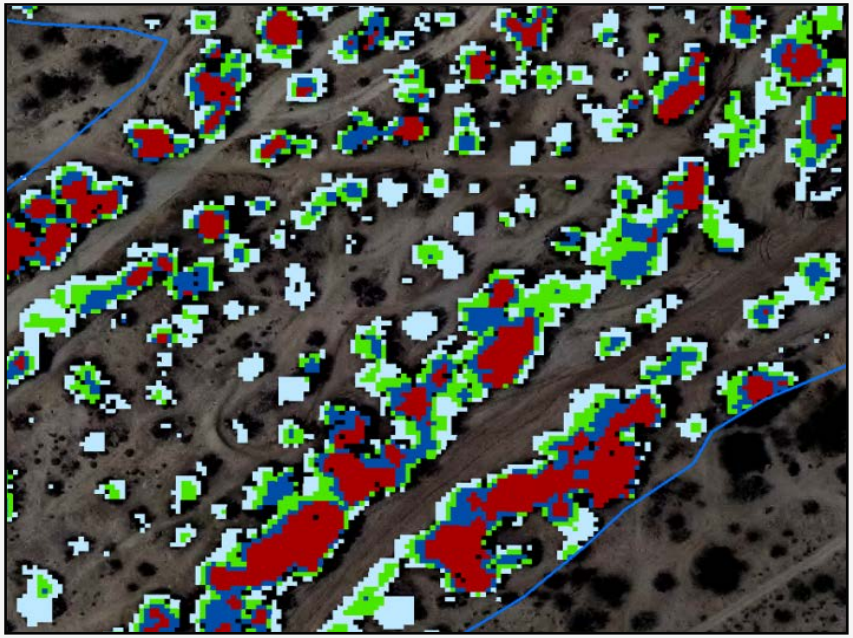
Conclusions - NDVI

- Mean NDVIs showed a close relationship to volume
- Works well as a visual display but the CHM is a more direct estimate of true vegetation volume
- Other vegetation indices might be tried:

SAVI - Soil Adjusted Veg Index

SARVI - Soil Adjusted and

Atmospheric Resistant Veg Index



Recommendations

- Use the fine visual detail of the NDVI to assess vegetation density for mitigation needs
- LiDAR/NDVI combo good for assessments when time doesn't allow field visits
- These tools provide the ability to assess large areas

Acknowledgements

- Data and Advice

Josh Pope, Marisa Rice,

Tyson Swetnam, Eve Halper

- Technical Assistance

Melanie Myers Colavito , Jennifer Psillias, Kyle Hartfield

- Software

and maps