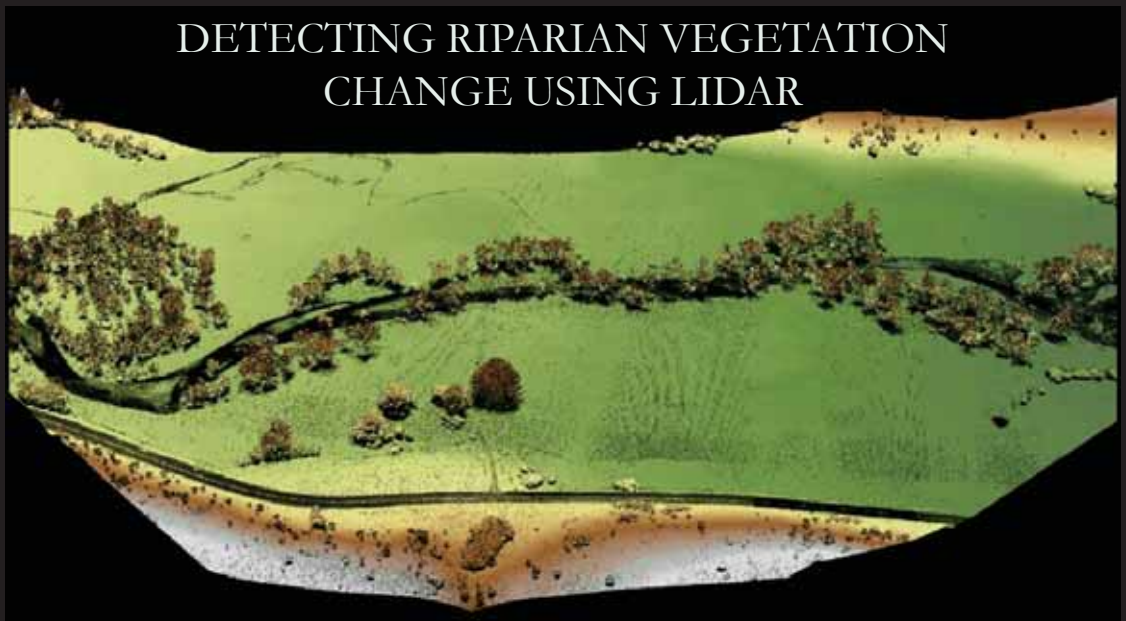
DETECTING RIPARIAN VEGETATION CHANGE USING LIDAR



WILLIAM SERCOMBE | ALEX THOMAS | GEOG 593

PRESENTATION OVERVIEW

- **Background Information**
  - Research Question
  - Study Area
- **Methods**
  - **Pre- Processing in ArcMap**
  - **Processing in Fusion**
- **Analysis**
  - Raster Analysis in ArcMap
  - Statistical Testing

BACKGROUND INFORMATION

PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

RESEARCH QUESTION

Can meaningful vegetation changes be derived between two LiDAR flight missions?

$H_0: \mu_1 = \mu_2$
$H_1: \mu_1 \neq \mu_2$

Where:
μ_1 = vegetation height difference
μ_2 = building height difference

BACKGROUND INFORMATION

PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

OUR OBJECTIVES

- Develop canopy height analysis workflow
  - Learn FUSION and ArcMap canopy metric best practices
- Derive statistical products from LiDAR data
- Compare means / variation between samples using t-test

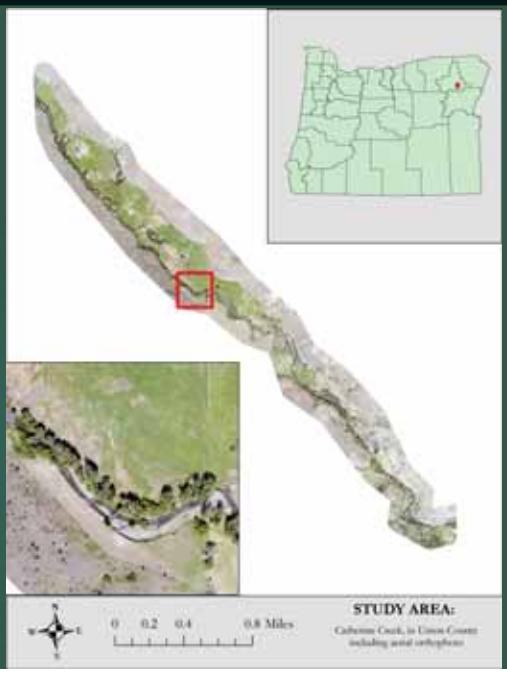
BACKGROUND INFORMATION

PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

STUDY AREA



- Riparian Zone in Union County
- Grande Ronde River Basin
- Currently being assessed and managed by Bureau of Reclamation.

BACKGROUND INFORMATION

PRE - PROCESSING

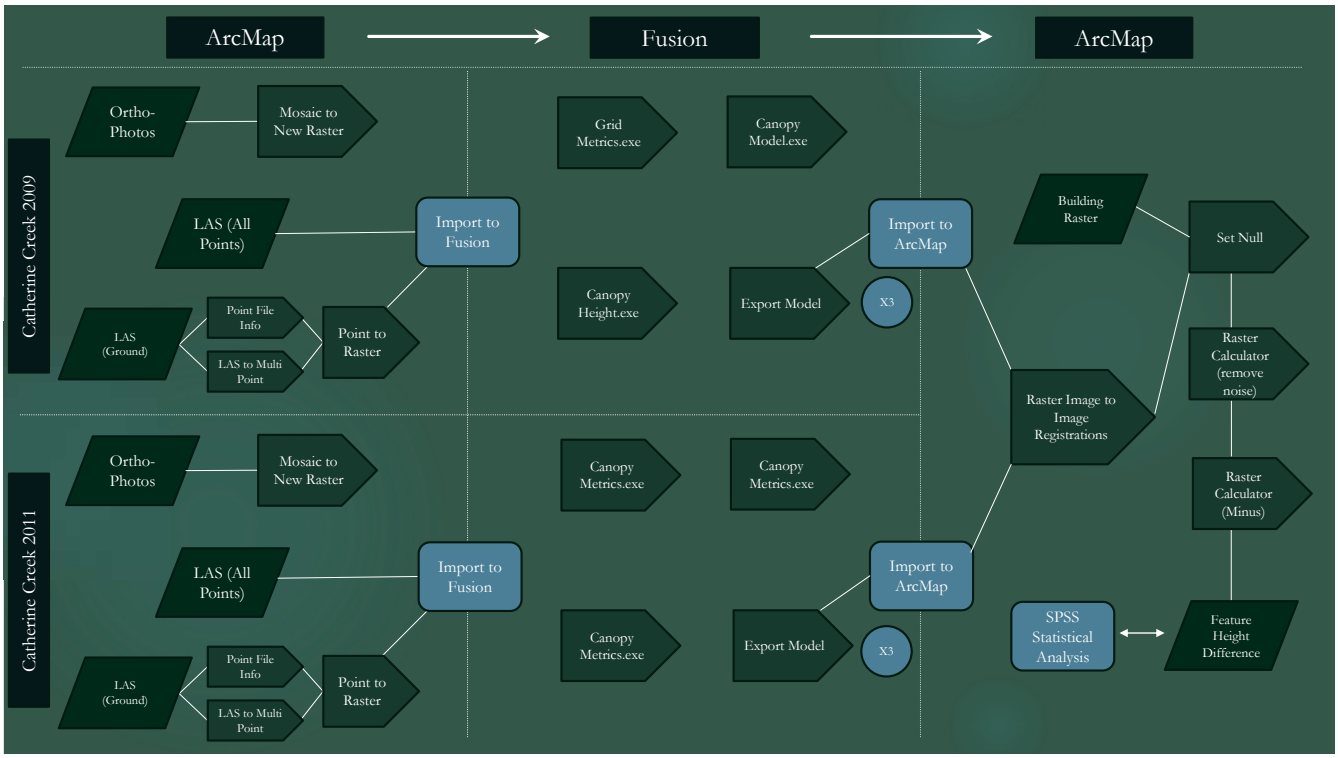
FUSION PROCESSING

ANALYSIS

DATA

- Catherine Creek (August 12-15th, 2009)
  - Point Density: 7.23 points / m^2
    0.70 points / ft^2
- Catherine Creek (September 29, 2011)
  - Point Density: 10.66 points / m^2
    0.99 points / ft^2

Factors to consider:
- Growth or effects of reclamation
- Seasonal change – leaf on/leaf off
- Disparity in sampling density



BACKGROUND INFORMATION

PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

ORTHOPHOTO MOSAIC

Mosaic to New Raster Tool

BACKGROUND INFORMATION

PRE - PROCESSING

FUSION PROCESSING

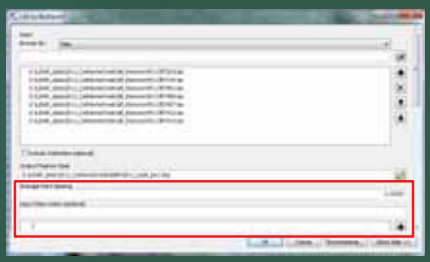
ANALYSIS

DEM CONSTRUCTION

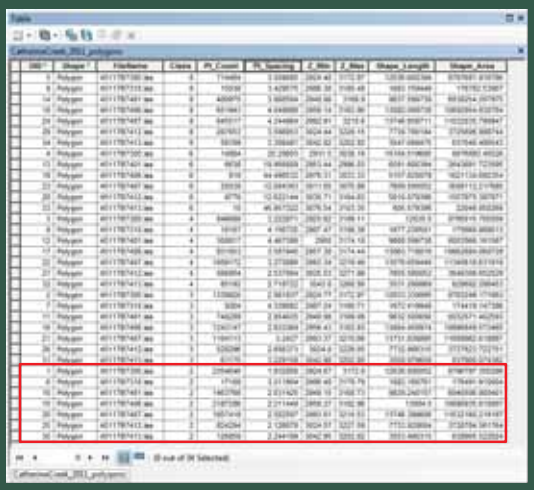
LiDAR Classification Codes

Classification Value	Description
0	Created (never classified)
1	Unclassified
2	Ground
3	Low Vegetation
4	Medium Vegetation
5	High Vegetation
6	Building
7	Low Point (noise)
8	Model Key Point (mass point)
9	Water

Source: Lidar Analysis in ArcGIS 10 for Forestry Applications



Point File Information Tool



BACKGROUND INFORMATION

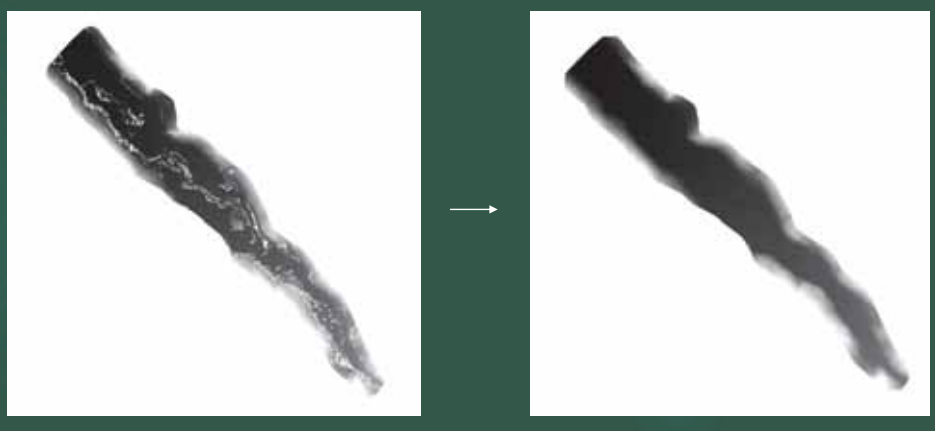
PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

DEM CONSTRUCTION (CONT'D)

```
Python
>>> from arcpy.sa import *
... outputfile = Con(IsNull("point2ras"),
 FocalStatistics("point2ras", NbrRectangle(3, 3,
 "CELL"), "MEAN", "DATA"), "point2ras")
```



BACKGROUND INFORMATION

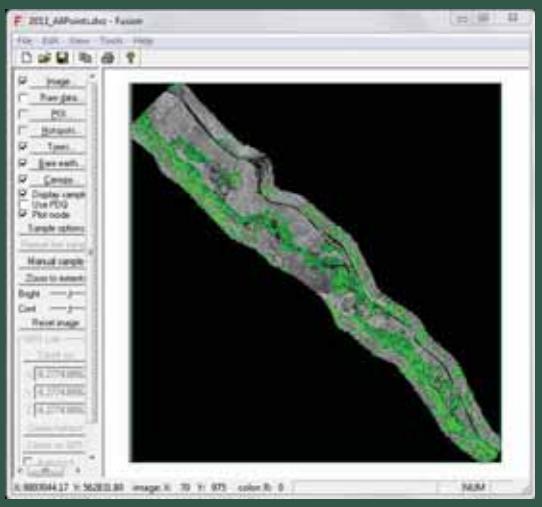
PRE - PROCESSING

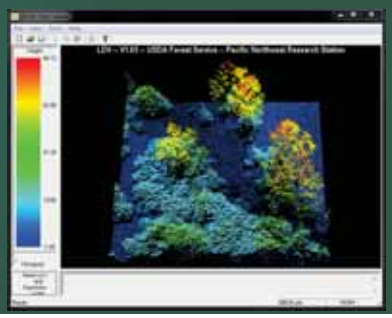
FUSION PROCESSING

ANALYSIS

FUSION SOFTWARE

- LiDAR viewing and analysis software suite.
- Developed by US Forest Service at Pacific Northwest Research Station
- Uses a GUI for viewing data models and a command line interface for executing analysis functions.





BACKGROUND INFORMATION

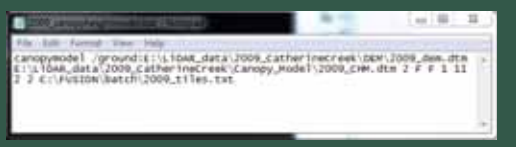
PRE - PROCESSING

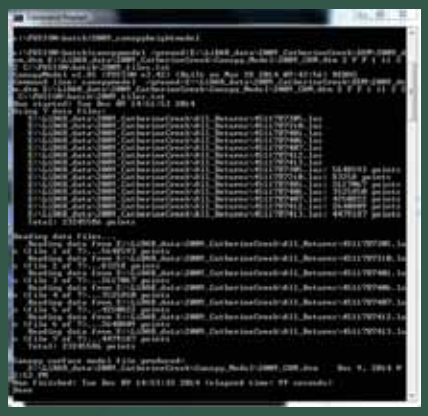
FUSION PROCESSING

ANALYSIS

USING THE COMMAND LINE IN FUSION

- Must first add Fusion.exe to your PC's system environment variables in order to use its command line utilities.
- Batch files (.bat) are created in Notepad to execute operations, following a syntax specific to each utility.
- In this example, the *canopymodel* utility is used to generate a Canopy Height Model, by using the bare earth DEM to normalize the LAS point cloud.





BACKGROUND INFORMATION

PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

FUSION WORKFLOW

Create / load reference image

Load LAS point clouds

Convert DEM to ASCII grid (.asc) in ArcMap

Convert ASCII grid to PLAN DTM format in Fusion

Import bare earth surface

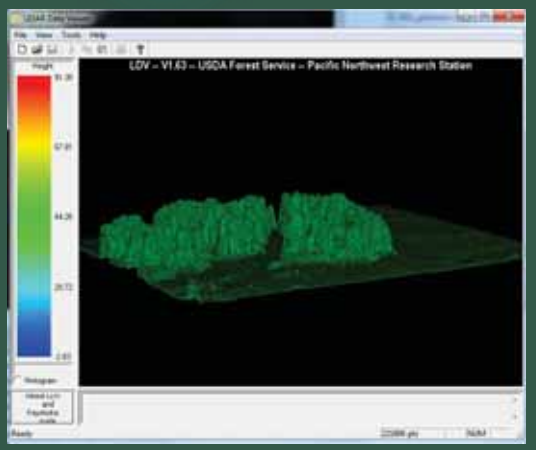
Compute "gridmetrics"

Create Canopy Surface Model

Create Canopy Height Model

Export canopy models (TINs) into ASCII grid format

Use *ASCII to Raster* in ArcMap



Canopy Surface Model

BACKGROUND INFORMATION

PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

BUILDING FEATURE HEIGHT MODEL

Point File Information (2011)

LAS Class Code 6 (Buildings)

LAS to Multi-Point

Point to Raster

Raster Calculator (Minus DEM)

Clip Floating Point Raster Expression

BACKGROUND INFORMATION

PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

REMOVE BUILDINGS FROM CHM

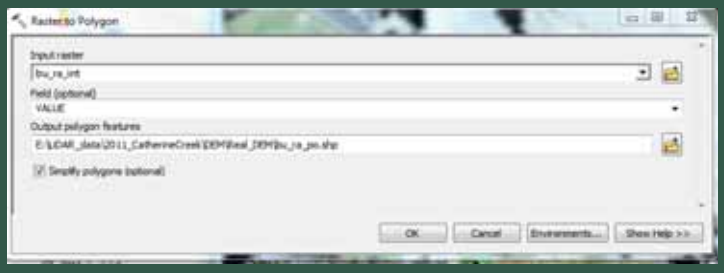
Convert Buildings Raster to Polygon

Buffer Polygon (4ft)

Convert Polygon to Raster

Set null values to 0; non null 1

Set CHM to Null if Buildings Raster = 0



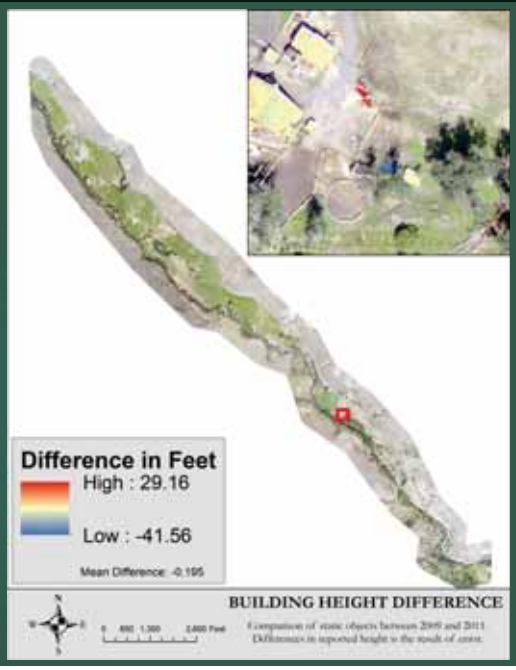
BACKGROUND INFORMATION

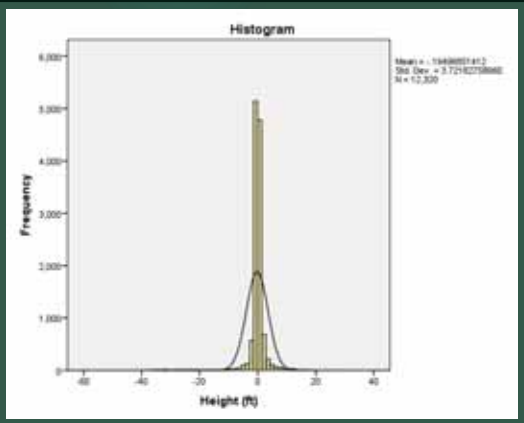
PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

BUILDING HEIGHT DIFFERENCE





Statistics

grid_code

N	Valid	12320
	Missing	0
Mean		-.194968514
Median		-.016239900
Std. Deviation		3.721827590
Variance		13.852
Minimum		-41.5585000
Maximum		29.16300000

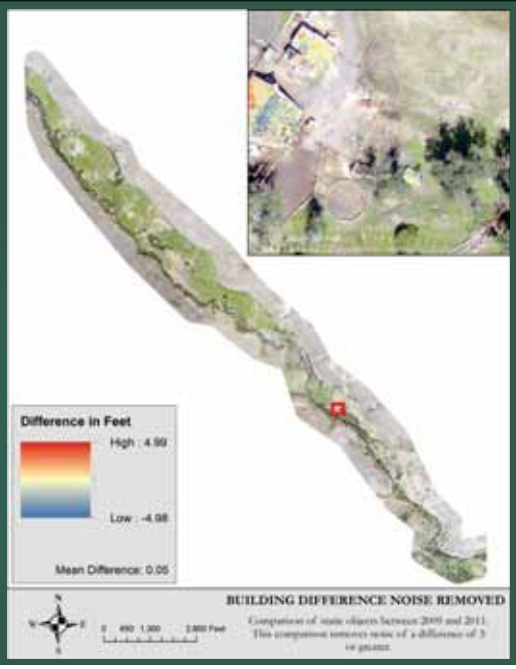
BACKGROUND INFORMATION

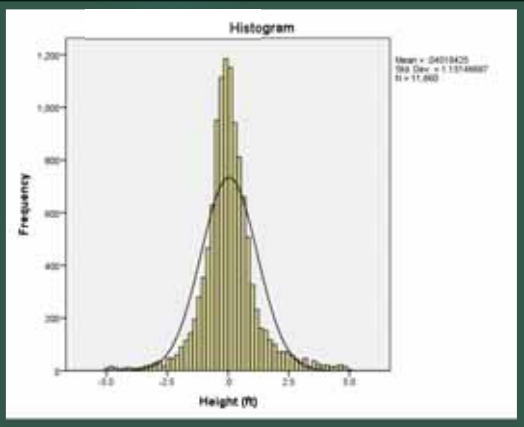
PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

BUILDING HEIGHT NOISE REMOVED





Statistics

Height

N	Valid	11660
	Missing	0
Mean		.0451842548
Median		-.0112295150
Std. Deviation		1.151466966
Variance		1.326
Minimum		-4.98836231
Maximum		4.98835182

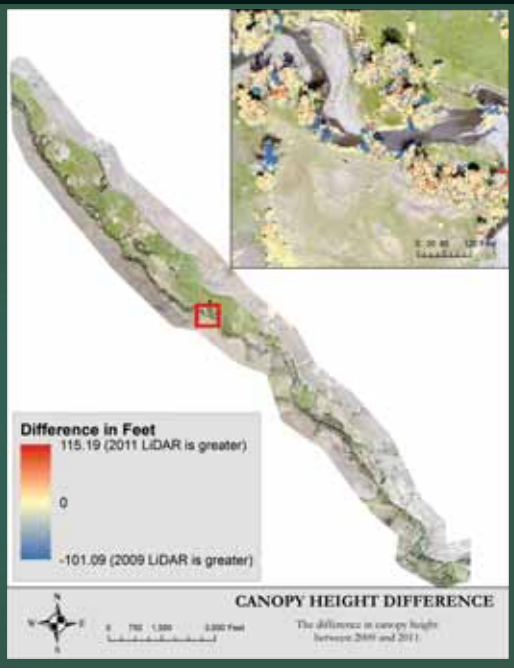
BACKGROUND INFORMATION

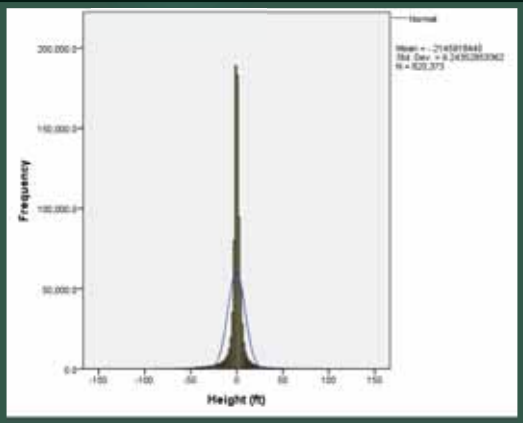
PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

CANOPY HEIGHT DIFFERENCE





Statistics

grid_code

N	Valid	820373
	Missing	0
Mean		-.2145918445
Median		.0953521700
Std. Deviation		9.243528534
Variance		85.443
Minimum		-101.089485
Maximum		115.1864471

BACKGROUND INFORMATION

PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

RESULTS

Export Height Models to SPSS

Raster to Point (buildings & canopy) → Export to DBF → Consolidate values into one column → **Run *Independent Samples T-Test* in SPSS**

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Heights	Equal variances assumed	2097.051	.000	-.335	832690	.814	-.019624391	.0833798182	-.183046017	.1437972358
	Equal variances not assumed			-.560	14705.092	.576	-.019624391	.0350499948	-.088326773	.0490779915

BACKGROUND INFORMATION

PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

RESULTS (CONT'D)

Failed to reject the null hypothesis.

$H_0: \mu_1 = \mu_2$

Not enough evidence to conclude that variation in vegetation heights is statistically significant.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Heights	Equal variances assumed	2097.051	.000	-.335	832690	.814	-.019624391	.0833798182	-.183046017	.1437972358
	Equal variances not assumed			-.560	14705.092	.576	-.019624391	.0350499948	-.088326773	.0490779915

BACKGROUND INFORMATION

PRE - PROCESSING

FUSION PROCESSING

ANALYSIS

LINKS

USFS Remote Sensing Applications Center
Lidar Training (includes Fusion Tutorial):
http://www.fs.fed.us/eng/rsac/lidar_training/

Lidar Analysis in ArcGIS 10 for Forestry Applications
http://www.esri.com/library/whitepapers/pdfs/lidar-analysis-forestry-10.pdf