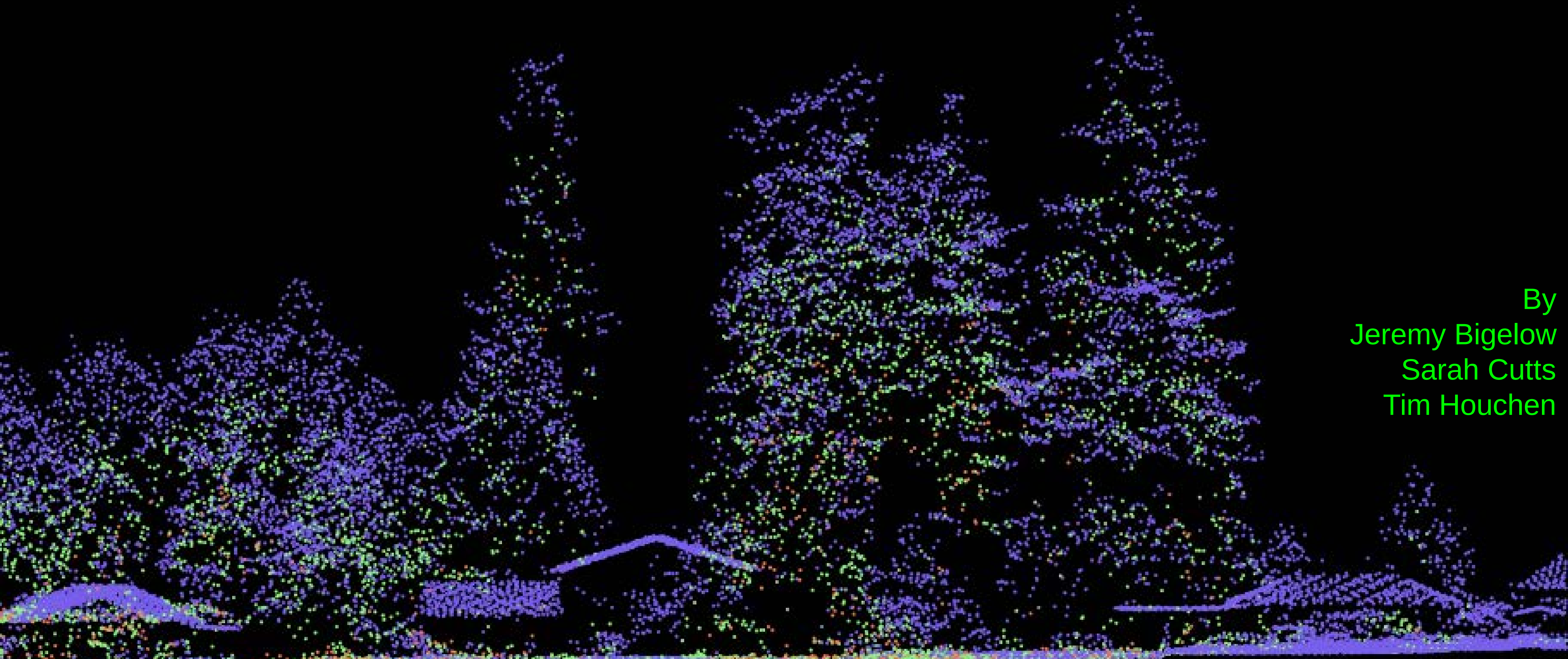
Tree Canopy Extraction and Classification In an Urban Environment



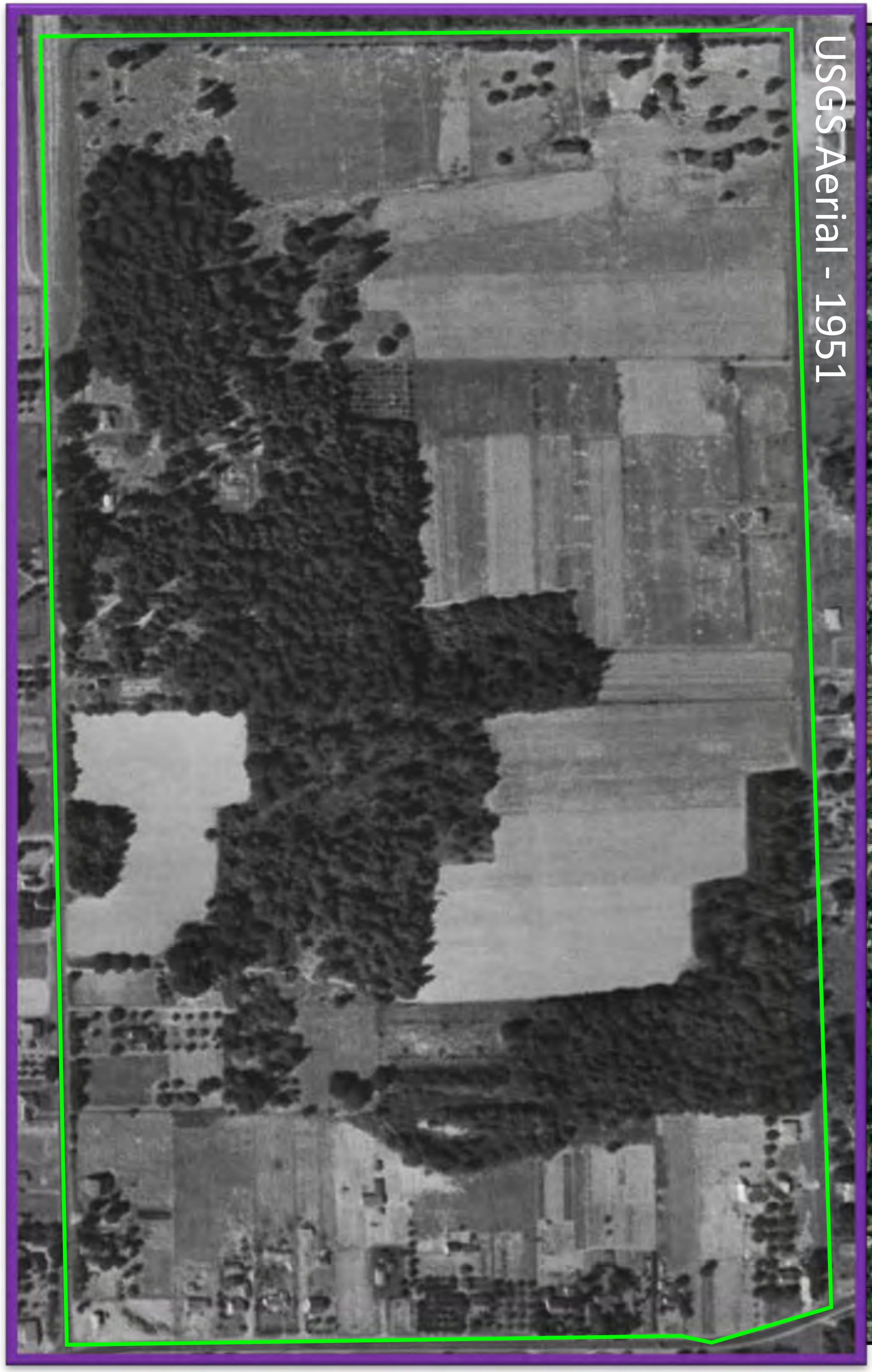
By
Jeremy Bigelow
Sarah Cutts
Tim Houchen

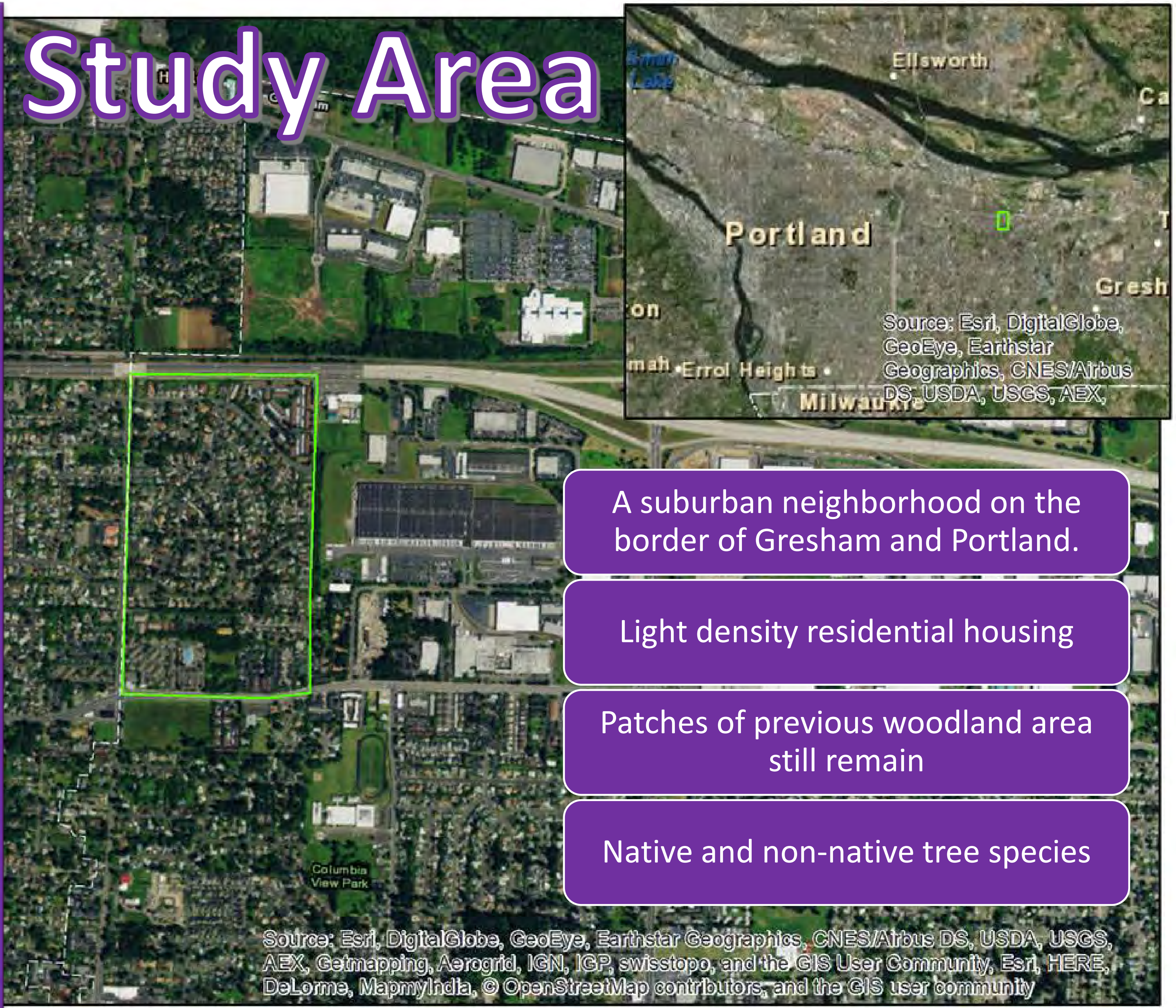
Intro

- What is the potential role for LiDAR data in characterizing trees, as a resource in monitoring trees in an urban environment?

- Can manipulation of LiDAR data, using GIS tools and methods to characterize point cloud data, further analysis of elevation relationships to group, parse, and evaluate data?

Study Area





A suburban neighborhood on the border of Gresham and Portland.

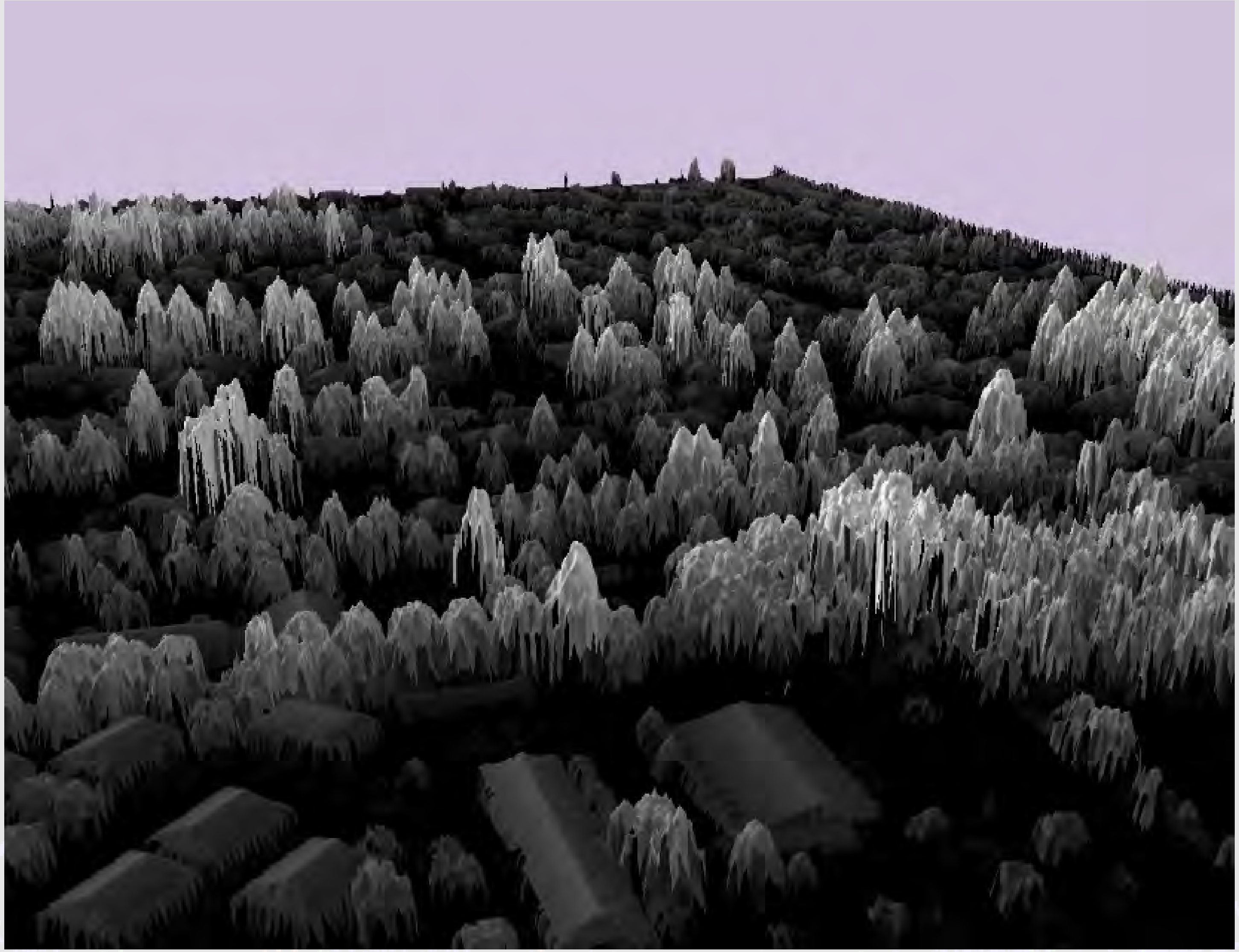
Light density residential housing

Patches of previous woodland area still remain

Native and non-native tree species

Methods Elevation Models and Feature Height

- .las to LAS Dataset
- Filter LAS Dataset point cloud
- Ground Returns (average) = DEM
- First Returns (maximum) = DSM
- "LAS Dataset to Raster" tool
- DSM – DEM = Feature Height



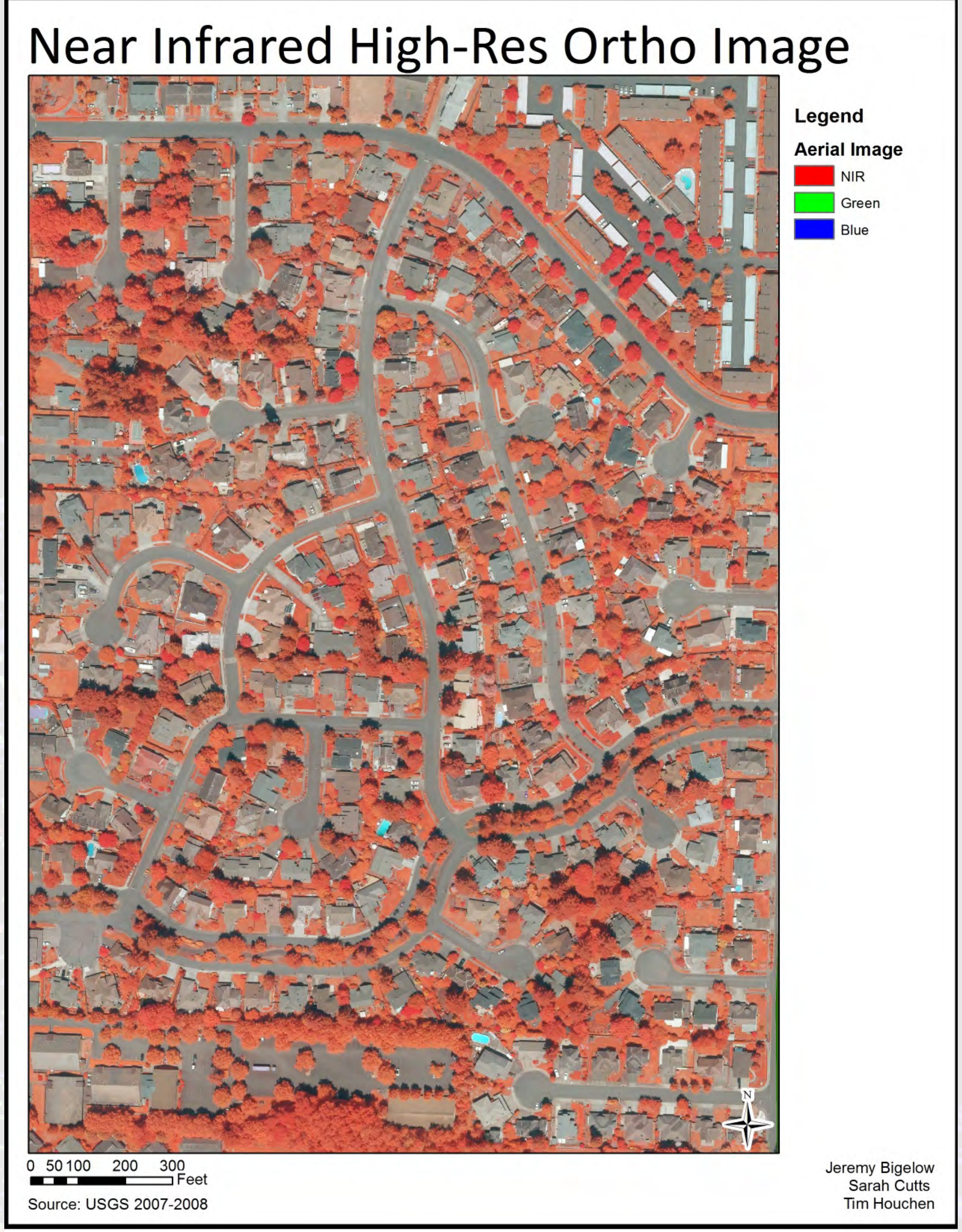
Derived feature height layer displayed in ArcScene

Methods Vegetation Feature Extraction

- High Resolution 4 band aerial image
- Load band 1 & band 4
- Raster calculator

float (band 4 - band 1) / float (band 4 + band 1) = NDVI

- Determine threshold of NDVI values for vegetation vs non-vegetation



Methods

Vegetation Feature Extraction

- Use set threshold with Conditional tool to extract vegetation layer
- Assign value of 1 to vegetation, and 0 to non-vegetation
- Raster Calculator

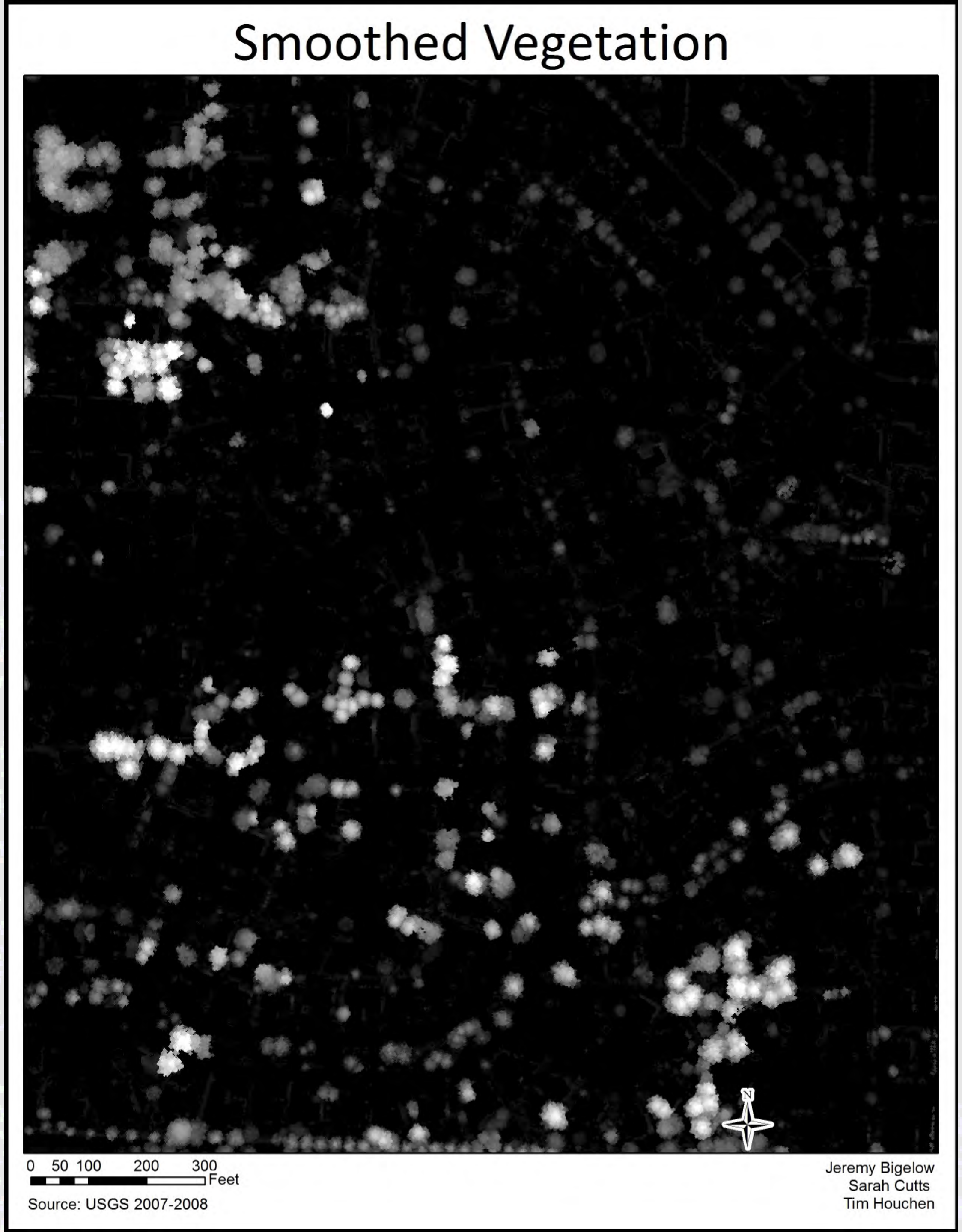
Vegetation Layer * Feature Height = Vegetation Only Feature Height

Methods

Tree Canopy Delineation

- Smoothed vegetation layer using Focal Statistics

- Creates a more continuous surface



Methods

Tree Canopy Delineation

- Low lying vegetation was removed
- Tree only layer was inverted

Methods

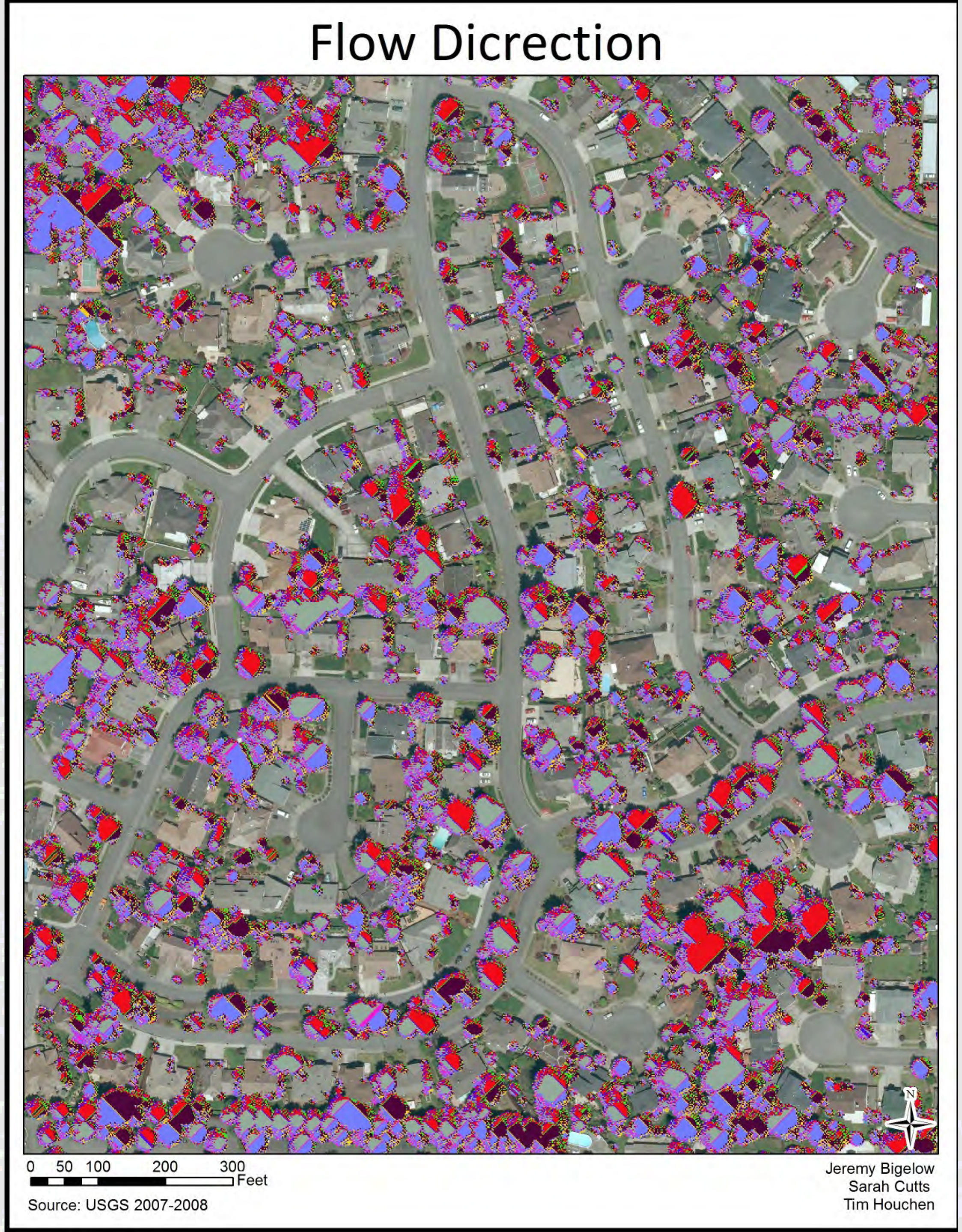
Tree Canopy Delineation

- Found Sinks (tree tops)
- Tree tops became pour points
- Fill sinks

Methods

Tree Canopy Delineation

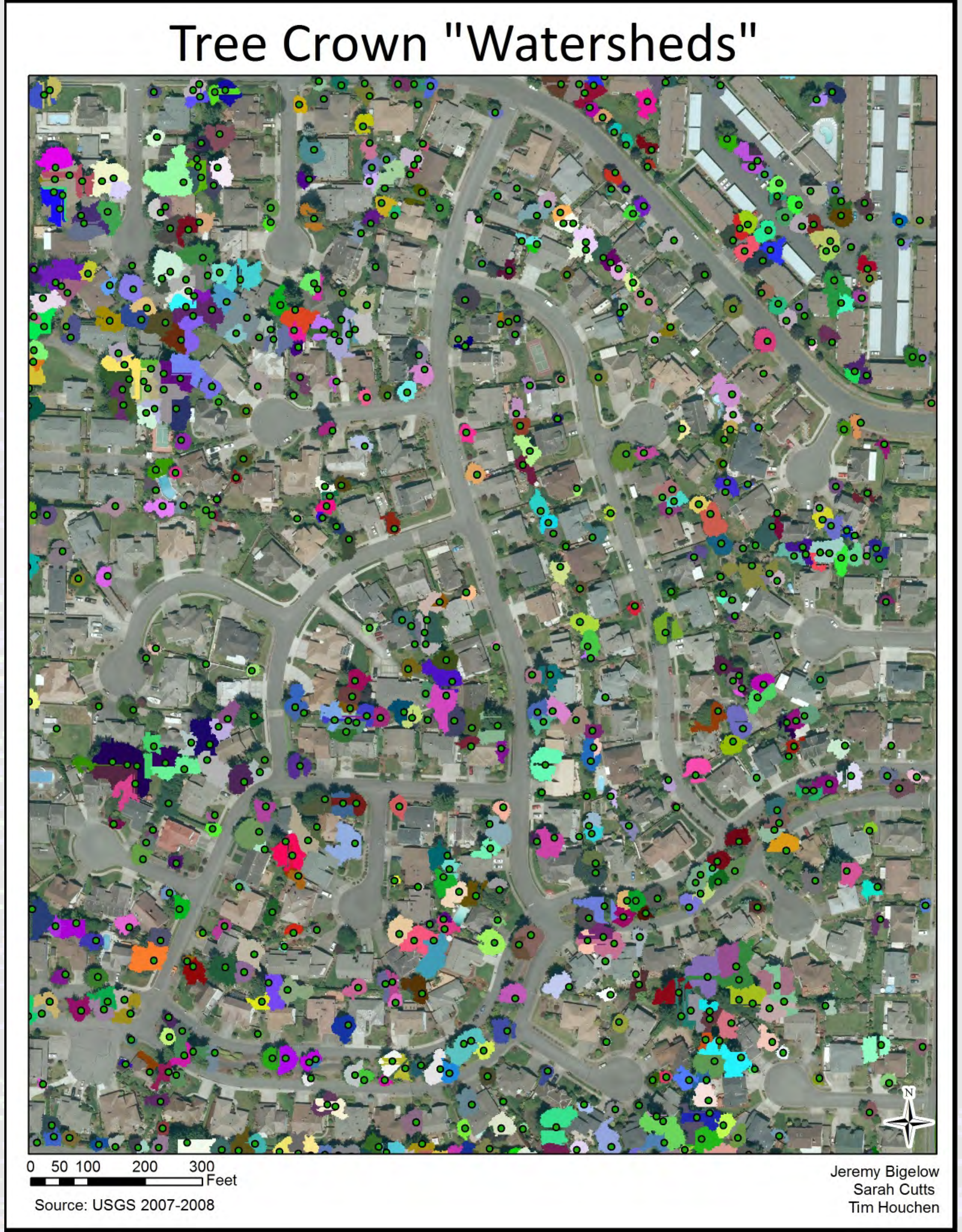
- Flow direction
- Flow accumulation



Methods

Tree Canopy Delineation

- Snap to Pour Points
- Snapped Pour Points and Flow Direction used to create “watersheds”



Methods

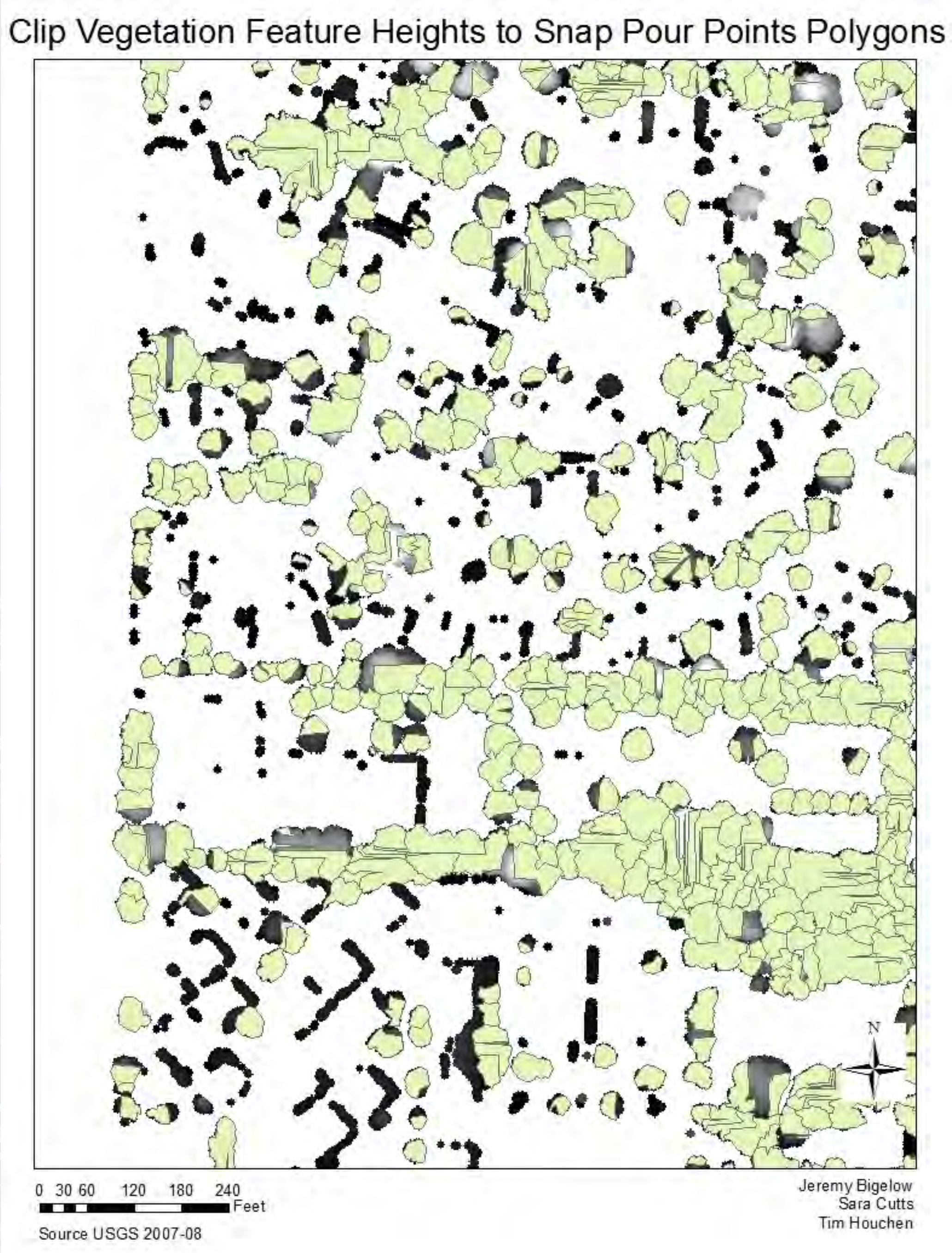
Tree Canopy Delineation

- Tree Crowns Converted to polygons
- Counted Polygons
- Compared to tree peak count

Methods

Geometric Tree Classification

- Clipped Feature Heights raster to Snap Pour Points polygon layer
- Removed non-tree vegetation
- Executed Spatial Join of remaining points to polygons
- Selected Sample



Methods

Geometric Tree Classification

- Calculated Vertical point Distribution
- Delineated base to top crown height
- Allocated points to deciles, etc. (cumulative)
- Calculated polygon geometry

Results

Feature Extraction and Height

Number of trees:

1121

Tallest Tree Feature:

126.8 Feet

Mean Tree Height:

44.8 Feet

Median Tree Height:

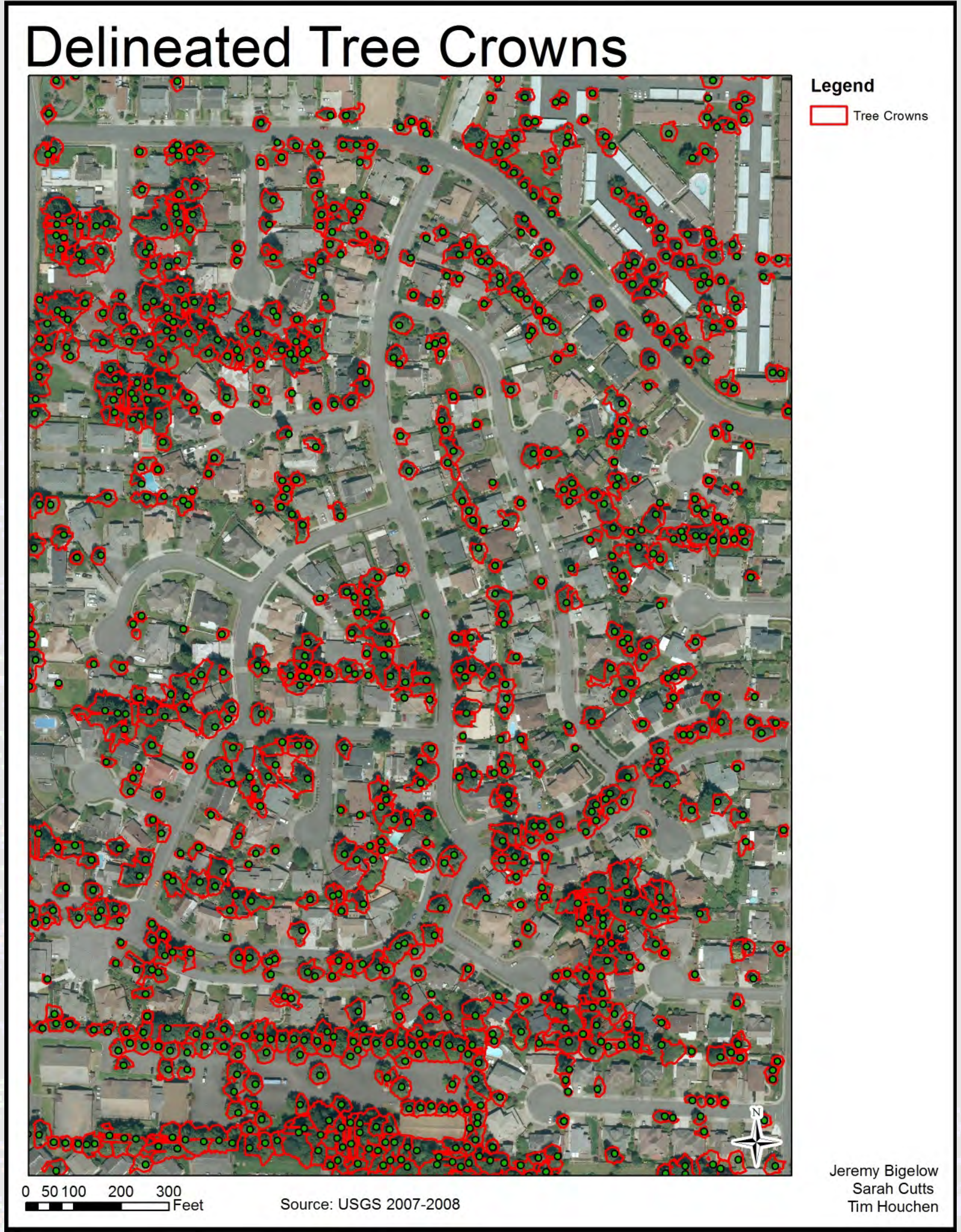
57.4 feet

Mode Tree Height:

22 feet

Standard Deviation:

22.7 feet



Results Classification

- **Differences in LiDAR point density:** Inadequate to distinguish coniferous from deciduous trees

	Deciduous Average	Conifer Average	Student's t p-value
Top 10 pct.	0.1689	0.2780	0.7572
Top 20 pct.	0.2784	0.3928	0.9761
Top 25 pct.	0.3642	0.3814	0.6352
Top 30 pct.	0.4313	0.3759	0.4180
Top Third	0.4693	0.4365	0.5266
Top 40 pct.	0.5537	0.4527	0.3666

Results Classification

- **Differences in Height to Area Ratios** Significant, even in this small sample

Coniferous/ Deciduous Ratio	Student's t p-value
1.8417	0.00001923

Height to Area Ratio		
Tree	**Coniferous**	**Deciduous**
649	0.0668	
650		0.0239
669	0.0665	
784	0.0586	
794	0.0554	
1027		0.0310
1039		0.0316
1062		0.0403
1230	0.0587	
1234		0.0324
1368		0.0403
Average	**0.0612**	**0.0332**

Recommendations

- **Tree Climbing Algorithm** - A treetop detection algorithm to determine highest points of individual trees
- **Donut Expanding and Sliding Method** - A tree crown delineation algorithm used to determine estimated tree crown size and shape
- **Leaf Off Conditions** – Collect LiDAR data at leaf off and classify based on point intensity
- **Discriminant Analysis** -- A generalized classification tool, permits analyzing several attributes depending on species, canopy type, and other factors

Sources

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