Tree Cover, Tree Health, and Greenspace Classification
Analyzed by Average Household Income

Research Objectives:

- Analyze the quantity and quality of tree cover and publicly available greenspace throughout Minneapolis and St. Paul
  - per census tract – prevalence of natural shade
  - Contiguous greenspace per census tract – availability of public parkland
  - Health of available natural shade (tree foliage density)
- Statistical analysis of the results of this analysis against mean income per census tract to see if they are correlated
- Evaluate greenspace and tree quantity change per census tract from 2008 to 2015

Methods

We obtained the following imagery of Minneapolis and St. Paul to complete our analysis: National Agriculture Imagery Program (NAIP) imagery from 2008, 2010, and 2015, downloaded from EarthExplorer.gov in 1 meter, four-band (RGB+NIR), 2011 nDSM from Joe Knight & the Remote Sensing and Geospatial Analysis Lab, LAZ LiDAR files from MNGeo
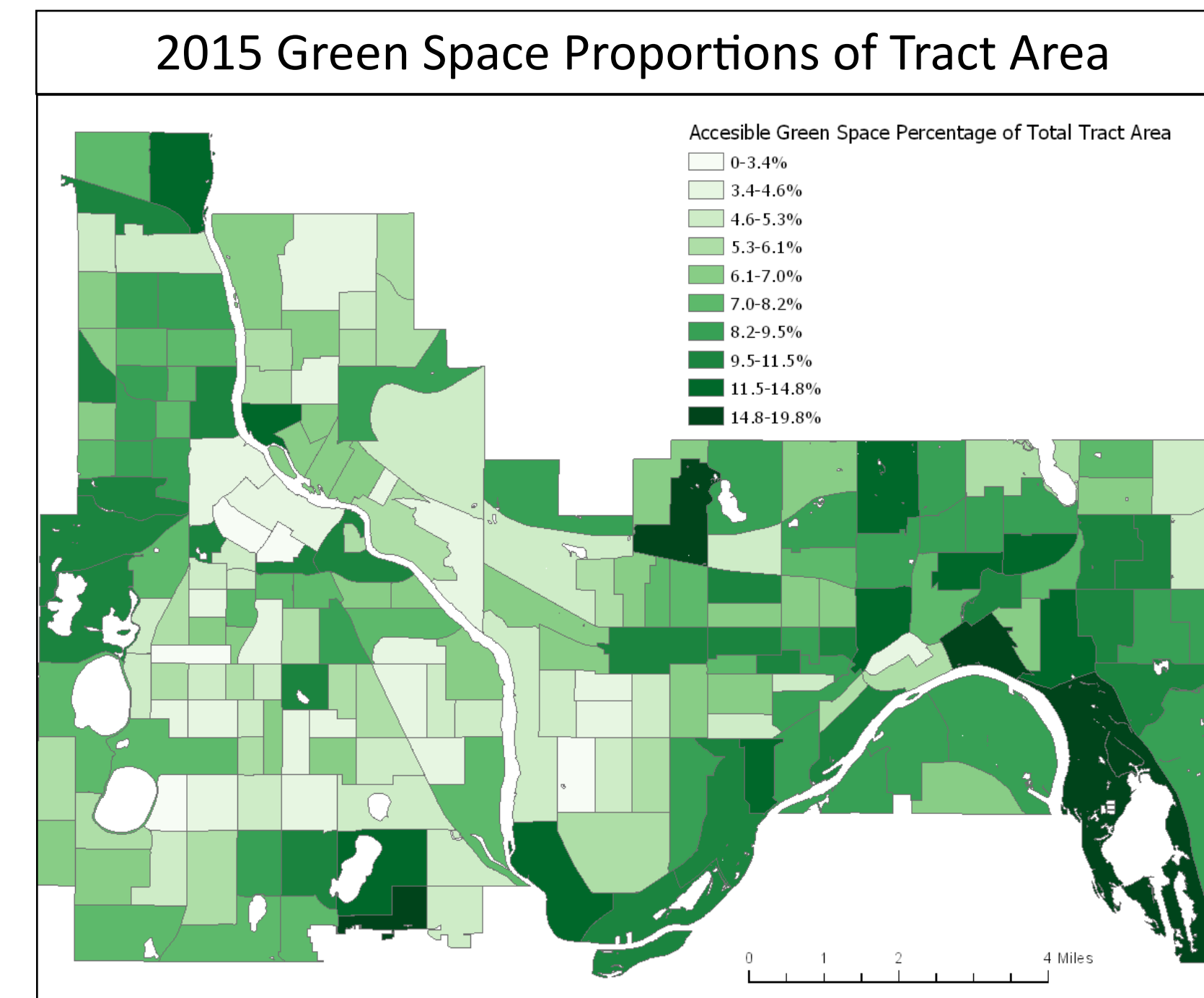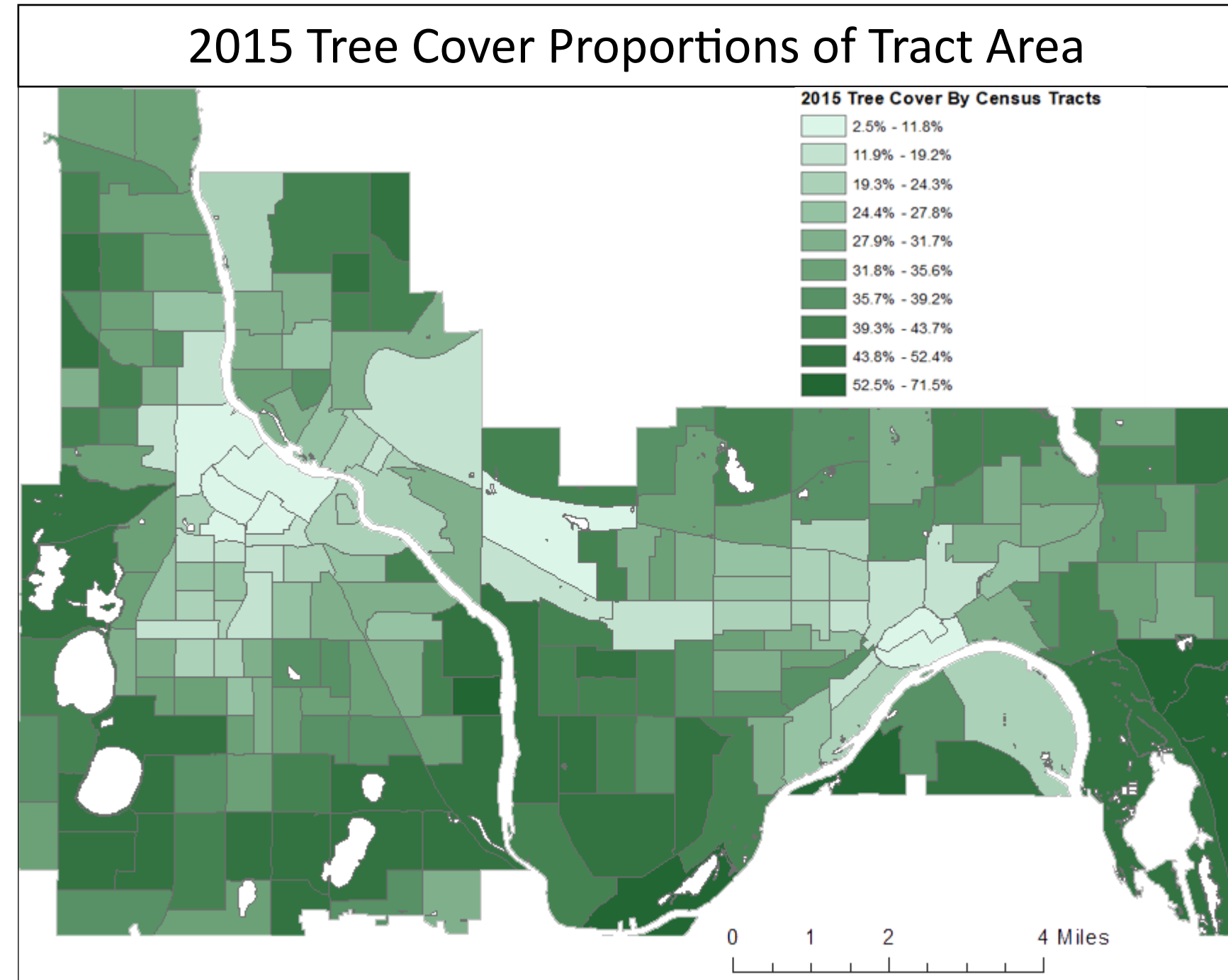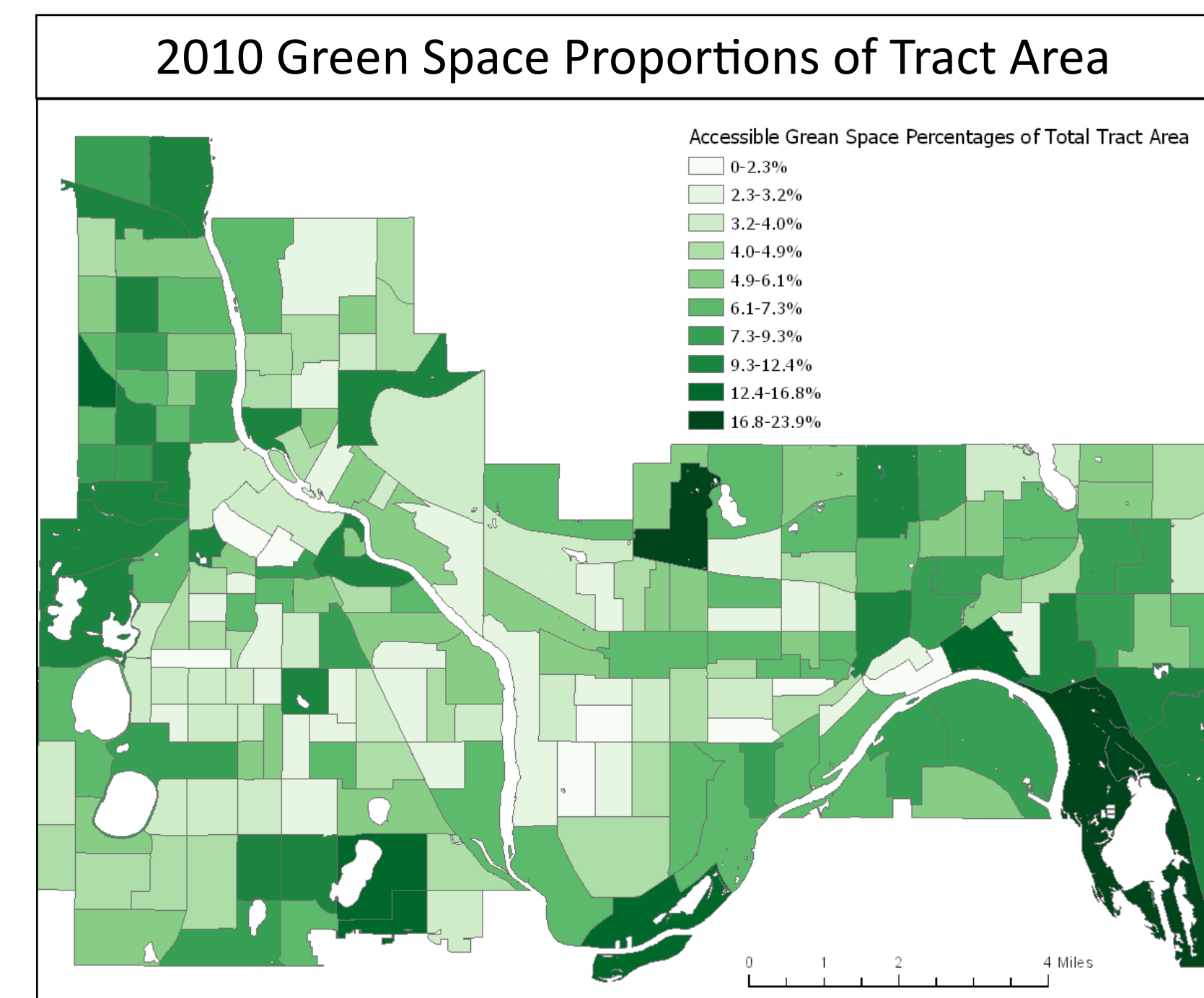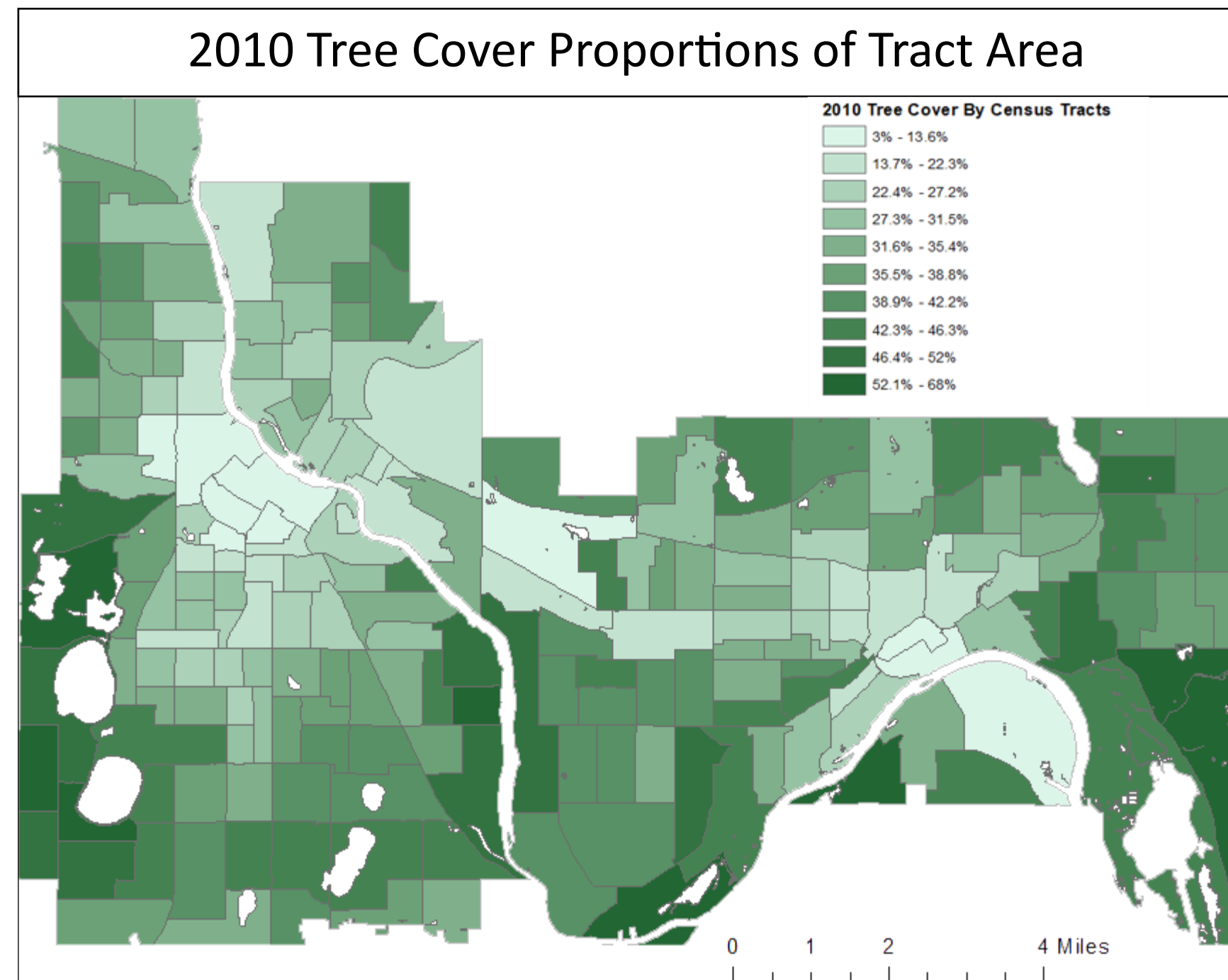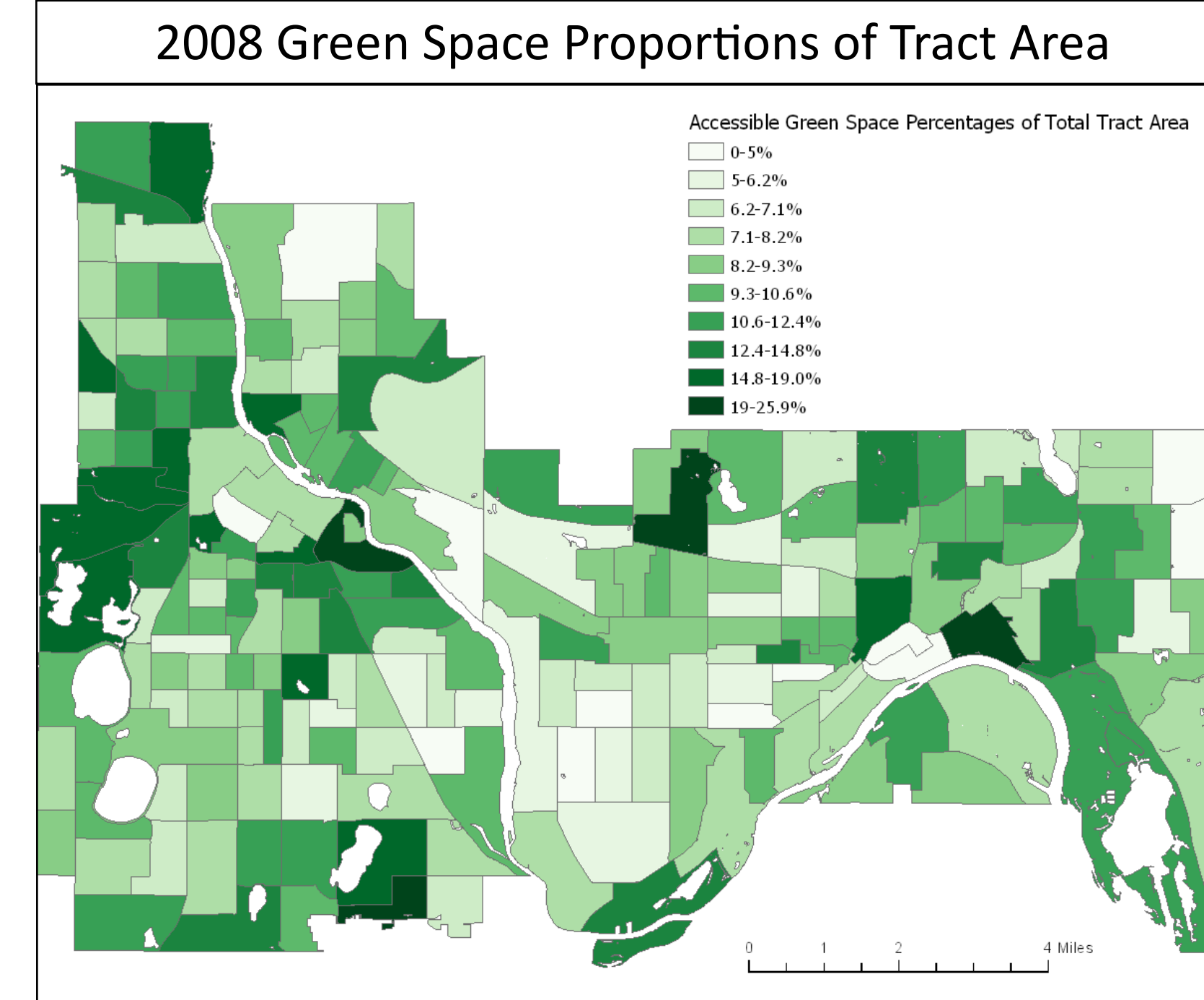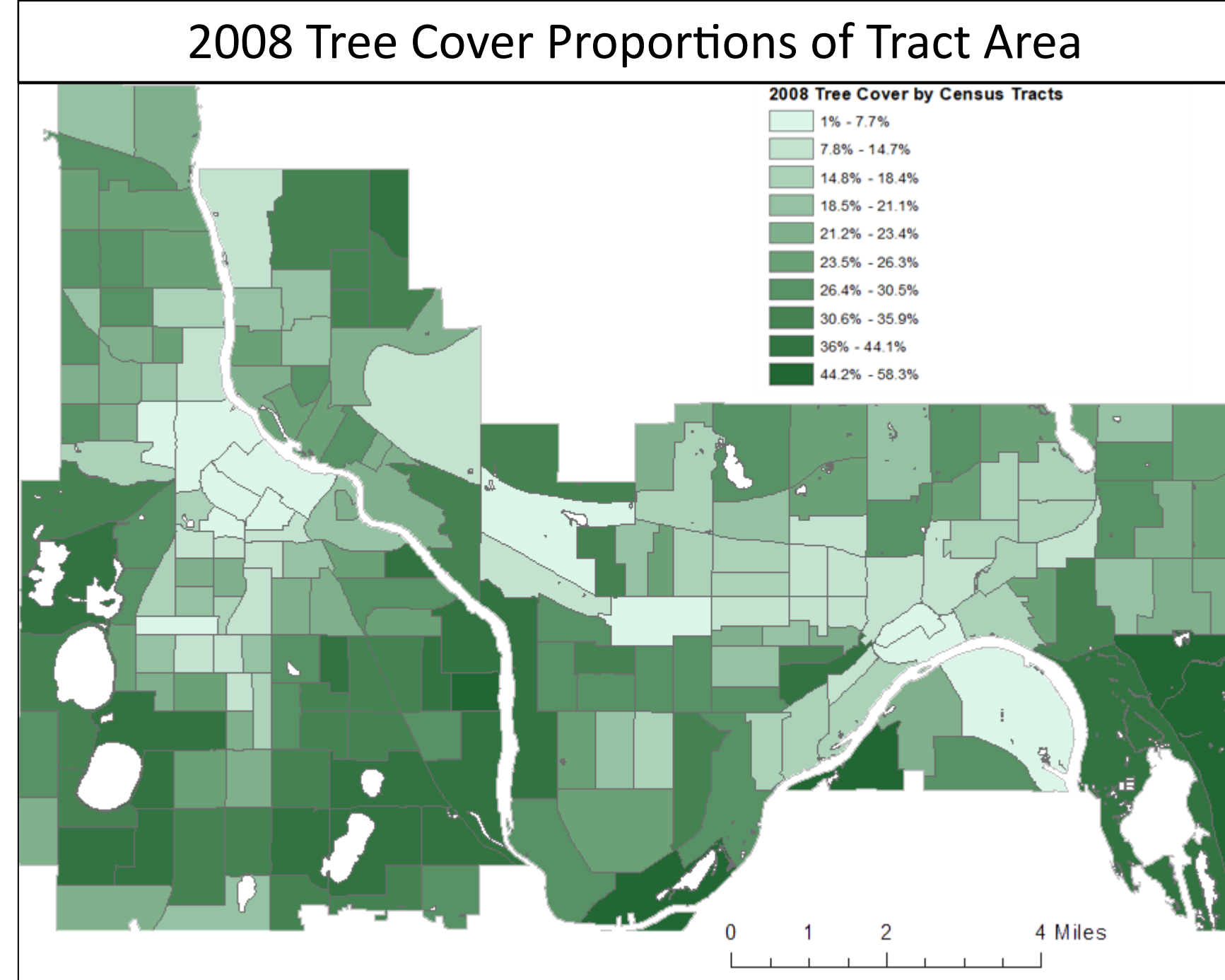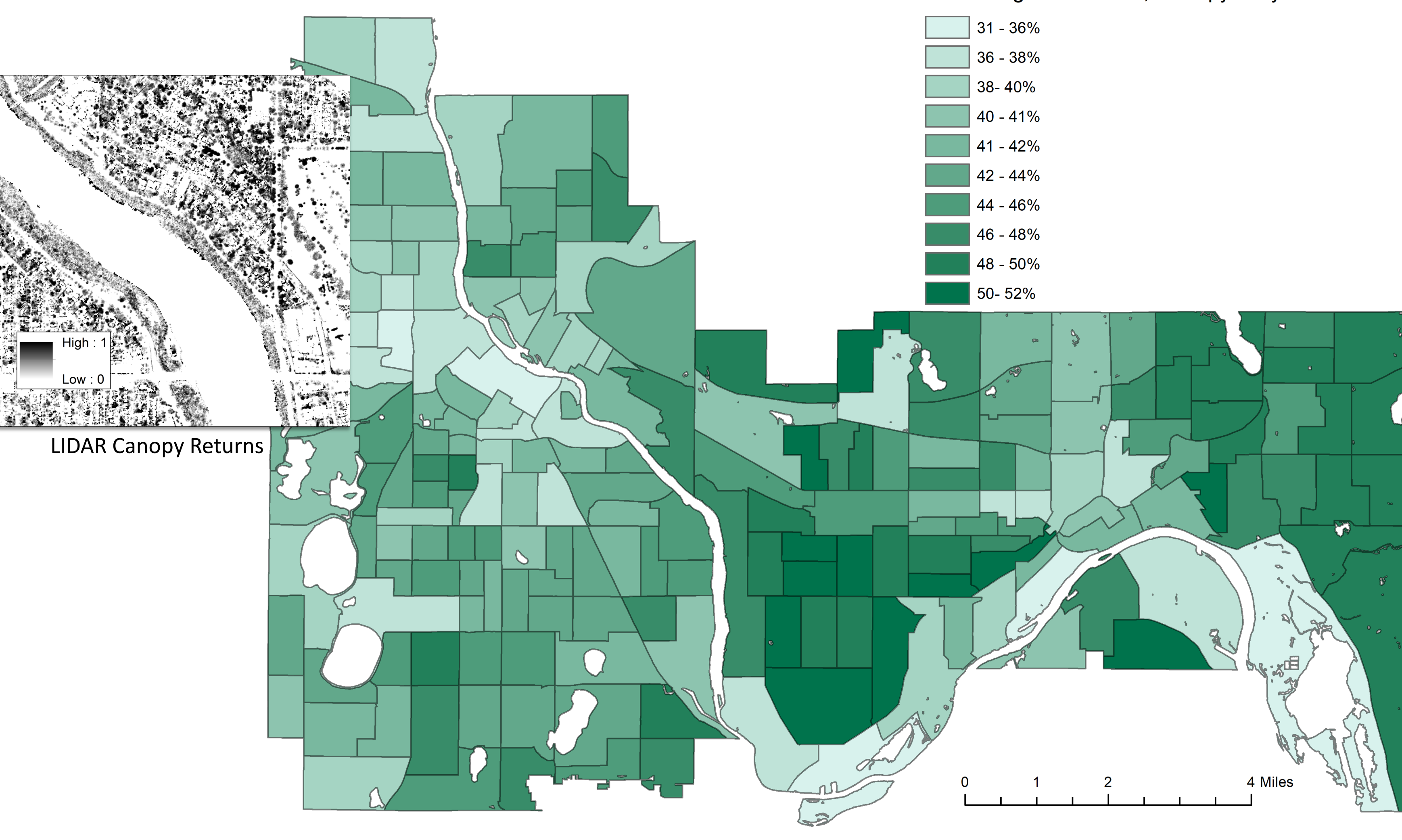
Greenspace and Tree Quantity
- Images were mosaicked and clipped using EDRAS Imagine
- Normalized Difference Vegetation Index (NDVI) was created for each year to assist in vegetation classification
- 2011 nDSM was added to 2010 Imagery
- Supervised Classification into four classes: trees, water, greenspace, and other
- Change analysis was completed by subtracting the classified 2008 image from the classified 2015 image

Tree Foliage Density using LiDAR
- ASPRS Class Codes 2 (Ground), and Class Codes 4 (Medium Vegetation) and 5 (High Vegetation) were separated from the rest of the data to create two new LiDAR data sets
- These datasets were then added together to get a total count of returns/points per cell
- Classes 4 and 5 were divided by the total count per cell, this produced values from 0.0 to 1.0
- Values that are 1.0 convey that no points hit the ground in that cell, meaning a denser tree canopy
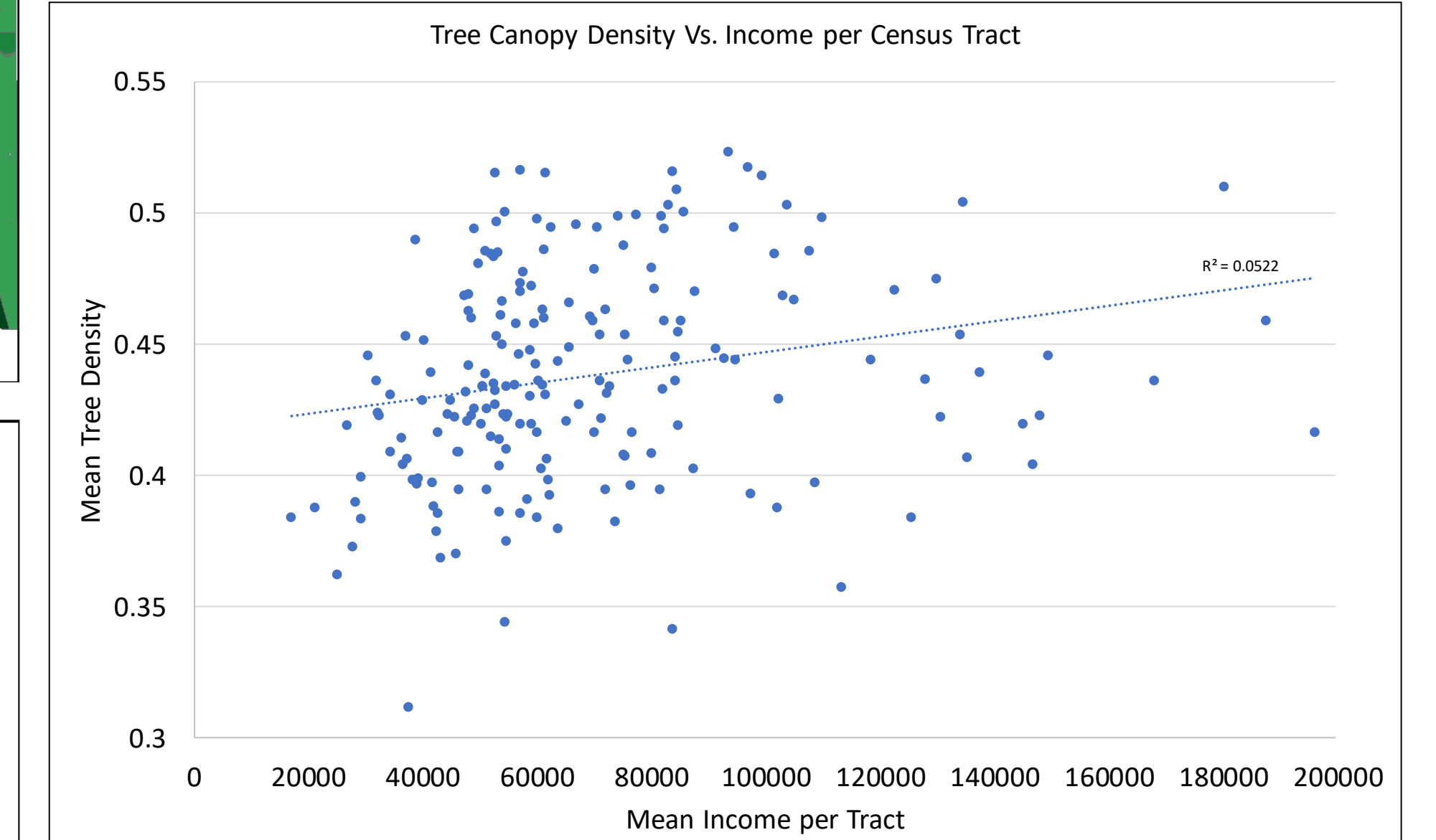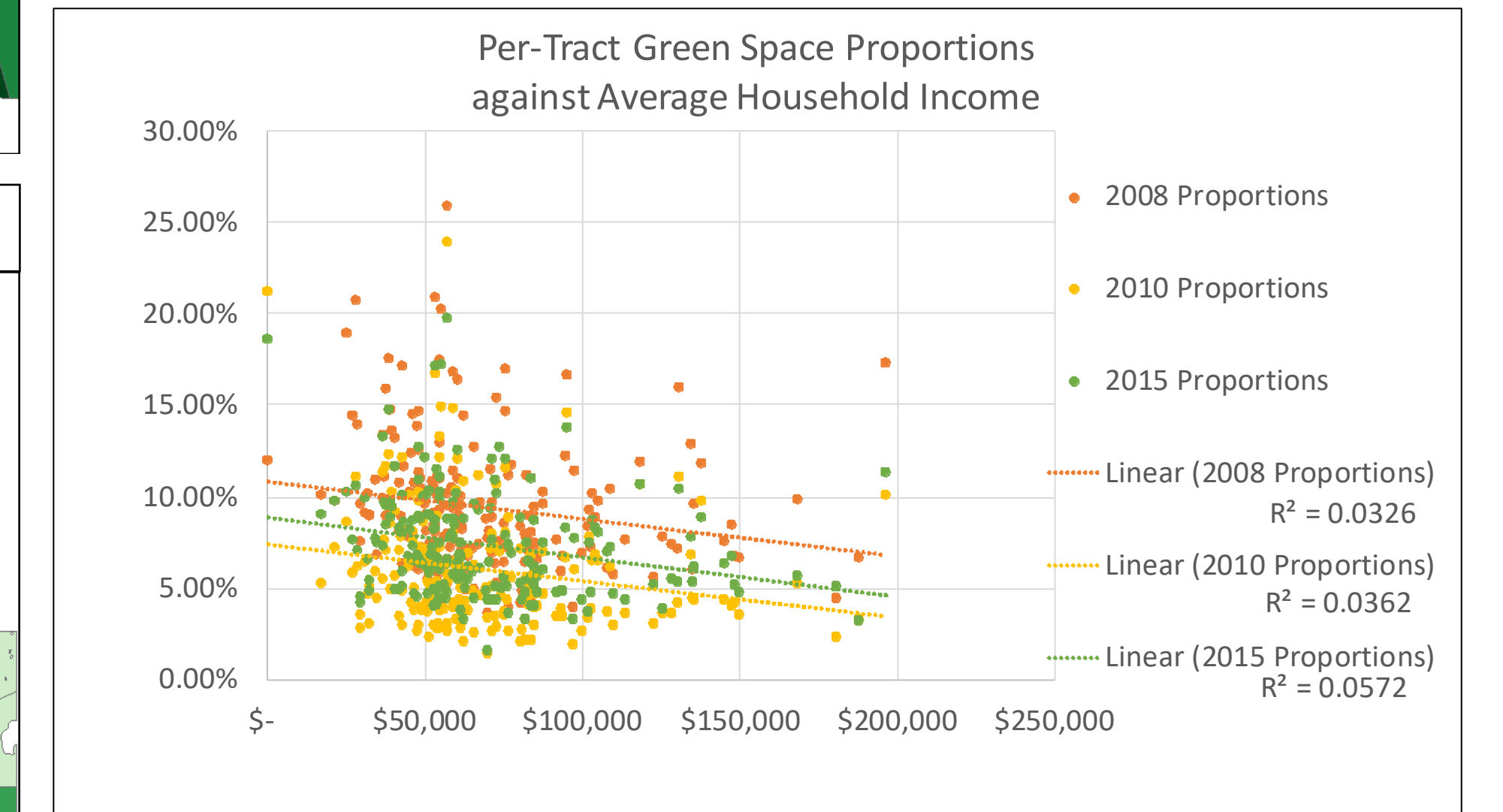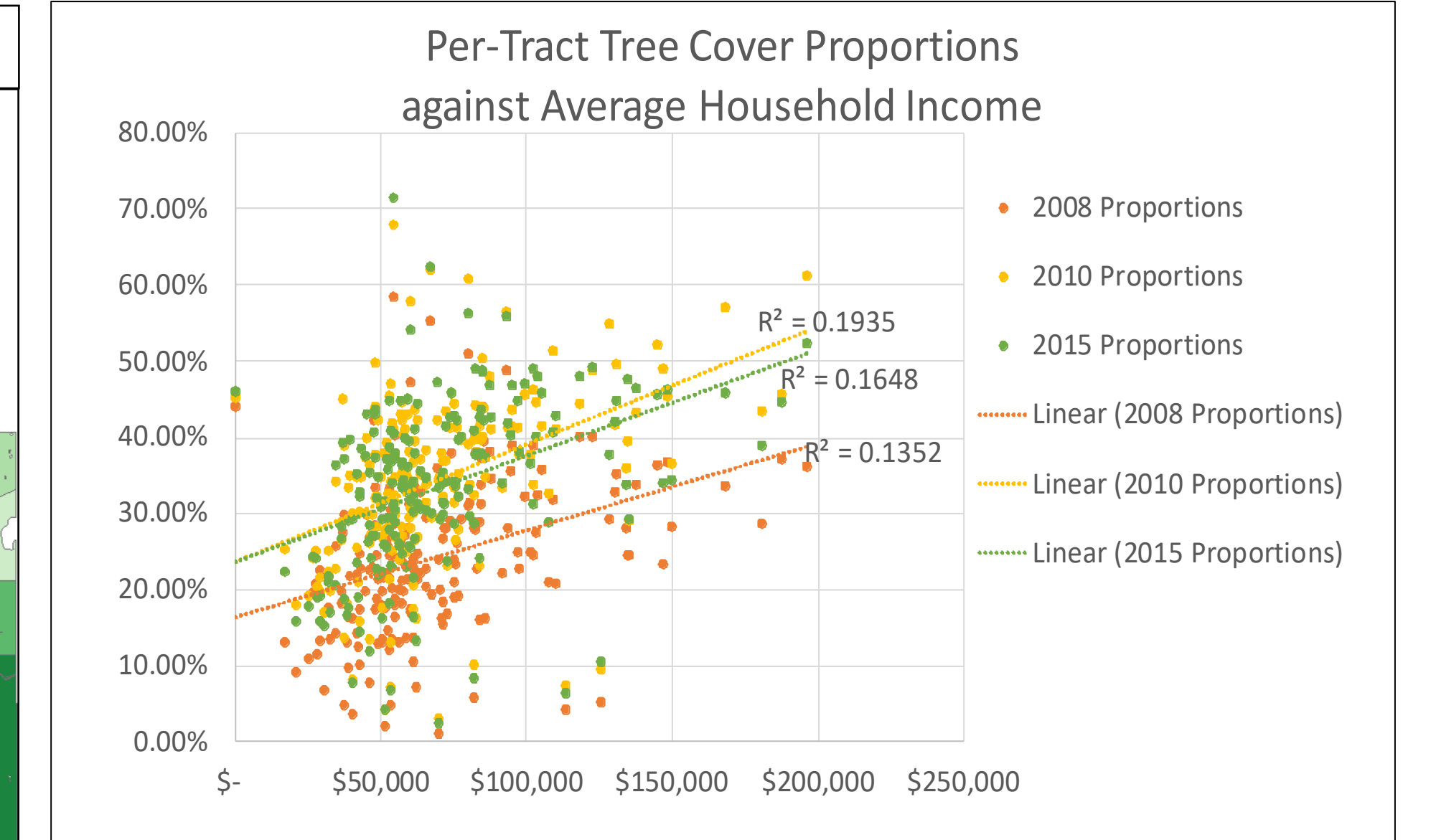
Results & Discussion

Our data does not support our initial hypothesis that Green space and Tree Foliage Density are related to income of a census tract. The low R² values shown in the scatterplots show that Tree Foliage Density and Greenspace cannot be explained by income level of the Census Tracts that they lie in. Tree Density correlates with average income. Tree density has R^2 values of 0.1352 for 2008, 0.1035 for 2010, 0.1643 for 2015.

The Lidar data we obtained from our tree foliage density was collected from 11/2/11 to 11/15/11. This is a possible limitation to our study due to the fact that many tree lose their leaves before of this time. This could lead to areas with a large proportion of non-deciduous trees to have a higher density per tract than those with a smaller proportion.

A significant drawback to using the supervised classification method stemmed from the fact that we only had lidar data for one of the three years we chose to classify and analyze.

2010 Tree Canopy Density Proportions

Percentage of Returns, Canopy Only
31 - 36%
36 - 38%
38 - 40%
40 - 41%
41 - 42%
42 - 44%
44 - 46%
46 - 48%
48 - 50%
50 - 52%

LIDAR Canopy Returns

2008 Tree Cover Proportions of Tract Area

2008 Green Space Proportions of Tract Area

2010 Tree Cover Proportions of Tract Area

2010 Green Space Proportions of Tract Area

2015 Tree Cover Proportions of Tract Area

2015 Green Space Proportions of Tract Area

Per-Tract Tree Cover Proportions against Average Household Income
R² = 0.1935
R² = 0.1648
R² = 0.1352

Per-Tract Green Space Proportions against Average Household Income
Linear (2008 Proportions) R² = 0.0326
Linear (2010 Proportions) R² = 0.0362
Linear (2015 Proportions) R² = 0.0572

Tree Canopy Density Vs. Income per Census Tract
R² = 0.0522

ERROR MATRIX

Classified Data	Water	Other	Lowgreen	Trees
Water	5	24	0	4
Other	3	64	2	0
Lowgreen	0	1	24	7
Trees	0	0	2	64
Column Total	8	89	28	75

ACCURACY TOTALS

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Water	8	33	5	62.50%	15.15%
Other	89	69	64	71.91%	92.75%
Lowgreen	28	32	24	85.71%	75.00%
Trees	75	66	64	85.33%	96.97%
Totals	200	200	157		
Overall Classification Accuracy =	78.50%				

KAPPA STATISTICS

Class Name	Kappa
Water	0.1162
Other	0.8694
Lowgreen	0.7093
Trees	0.9515
Overall Kappa Statistics =	0.6901

We used NAIP 2015 as the reference data for Accuracy Assessment with 200 stratified random points. Our overall accuracy is 78.50% with high accuracy for tree and greenspace classes. The least accurate classification is Water. Building shadows were often classified as Water.

Tree Cover Gain and Loss in Square Meter
-42,441 - -20,000
-19,999 - -10,000
-9,999 - -1,000
-999 - 0
+1 - +100,000
+100,001 - +150,000
+150,001 - +250,000
+250,001 - +350,000
+350,001 - +450,000
+450,001 - +820,400

Accessible Green Space Gain/Loss in Sq. Meters
150K - 500K gain
60K - 150K gain
20K - 60K gain
0 - 60K gain
0 net gain/loss
0 - 14K loss
14K - 30K loss
30K - 55K loss
55K - 80K loss
80K - 140K loss

Average Household Income
$125K +
$88K - $125K
$55K - $88K
$55K - $70K
$45K - $55K
$32K - $45K
$0 - $32K