

# Transit Dependency Likelihood Index (TDLI)

## A Transit System Analysis for Salem-Keizer Transit

### Introduction

Salem-Keizer Transit, operating mass transit in the metropolitan areas of Salem and Keizer, currently provides the area with bus service Monday through Friday through 22 bus lines. Due to limited funds, the agency has struggled to maintain extensive bus service coverage for the entire Salem-Keizer area. However, it is crucial for the agency to ensure equitable coverage for populations that are or have the potential to be transit dependent, especially the elderly. This study examines the existing bus service, cross-referencing it with areas determined to have population that are likely to be transit dependent in order to ensure the equitable distribution of the limited bus service.

### TDLI Inputs

The Transit Dependency Likelihood Index (TDLI) is a metric created for this project in order to illustrate potential transit-dependent populations while taking into account multiple factors. The index is called a "likelihood" index because not all of these populations are necessarily transit dependent. The demographic variables measured, however, are common indicators of people who have the potential of being transit dependent if they have access to a transit network, making them the likely transit-dependent groups of a metropolitan population that has low levels transit-dependent riders due to its inadequate service.

Four different ACS demographic variables were used in creating the TDLI: share of youth (10-18 years of age), share of seniors (65+ in age), share of families in poverty, and share of carless households. For each of these variables, a scale from 0 to 1 was created in order to normalize the variables for comparison. A score of 0 represents everything less than one standard deviation below the mean. A score of 1 represents everything more than one standard deviation above the mean. Anything between one standard deviation below and above the mean receive a score between 0 and 1 relative to their how far they are below or above the mean. A value equal to the mean would receive a score of 0.5. The four blue maps show these normalized scores for each variable along with the percent share of total population that falls within each range for each given variable.

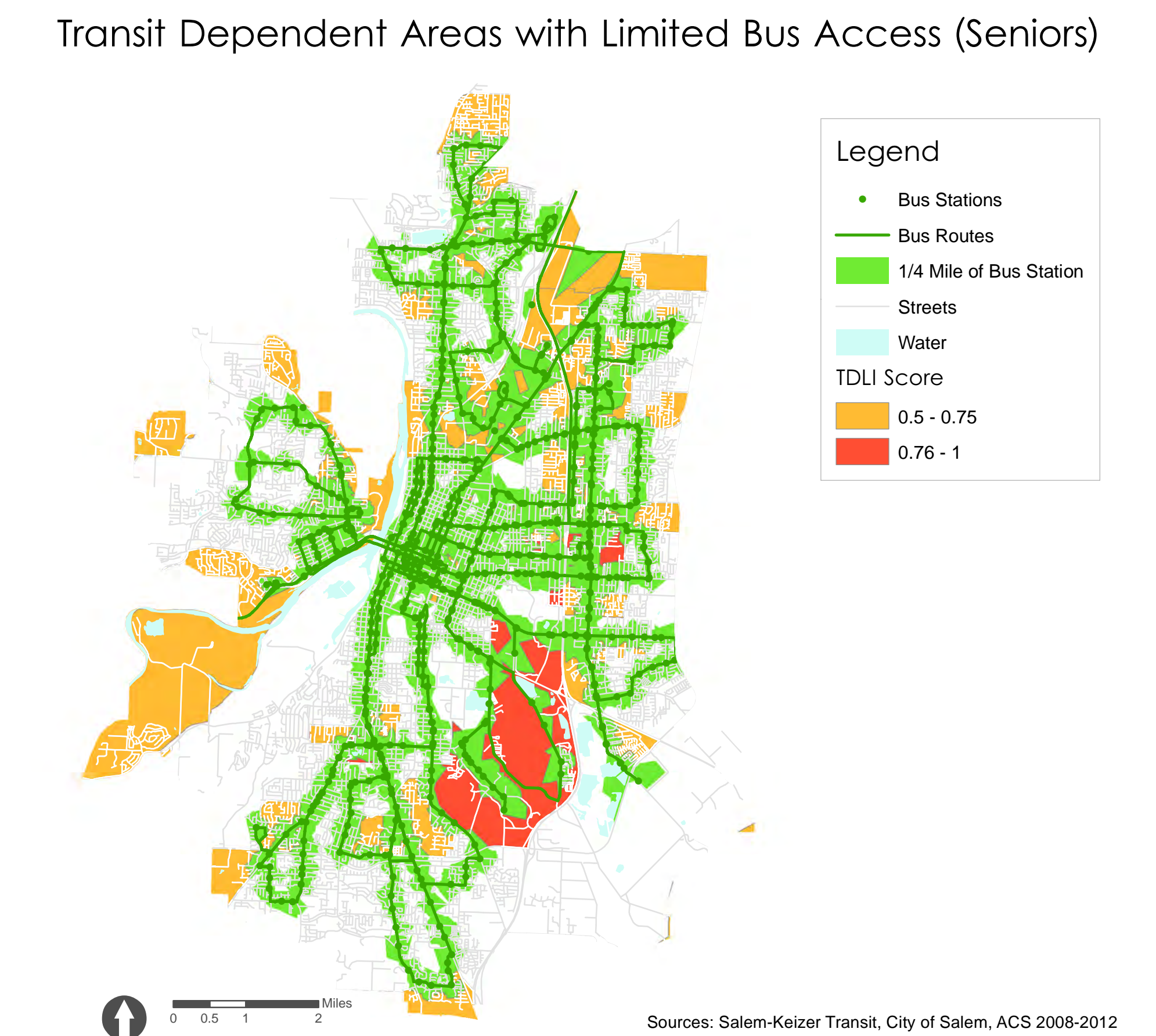
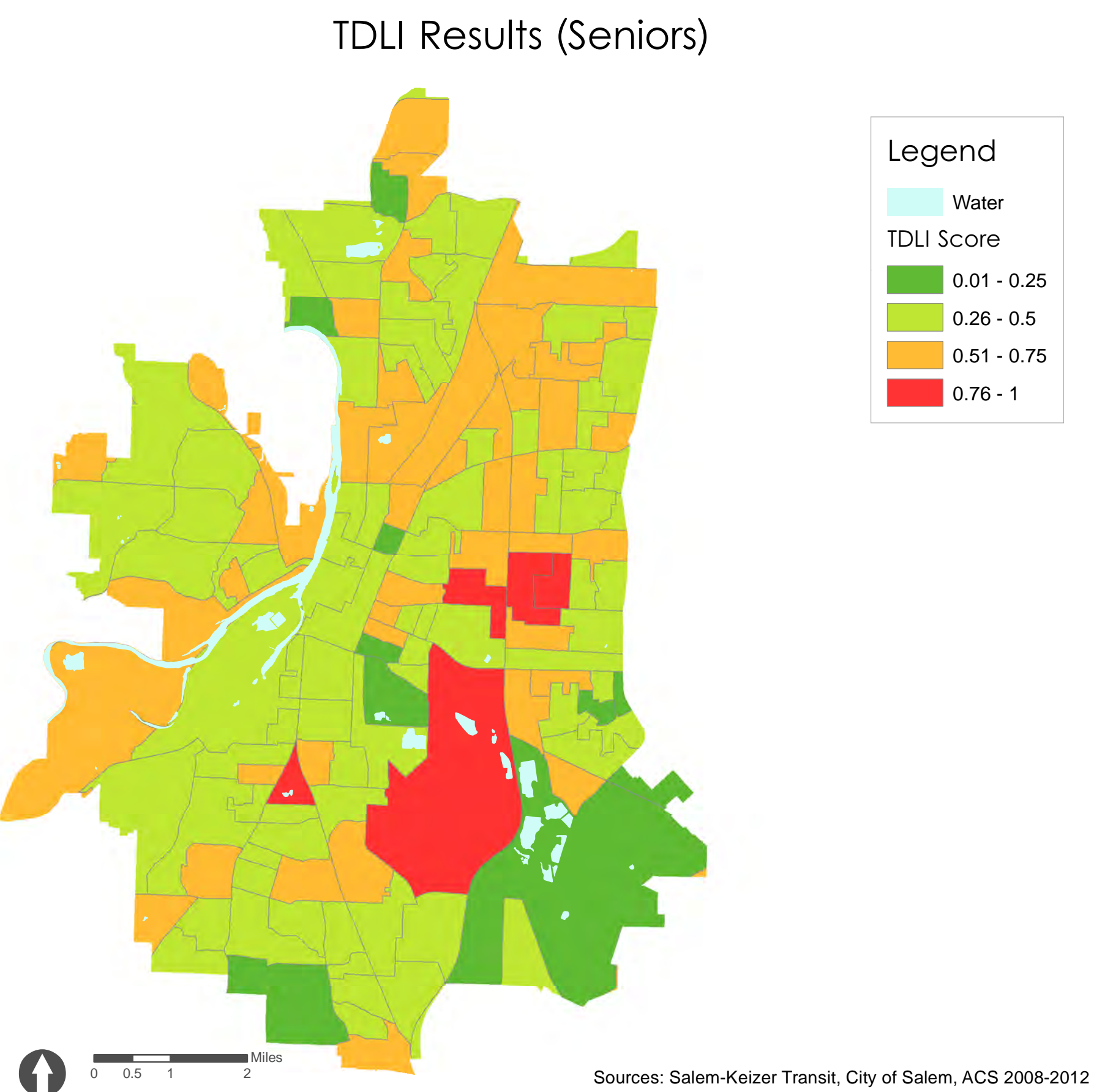
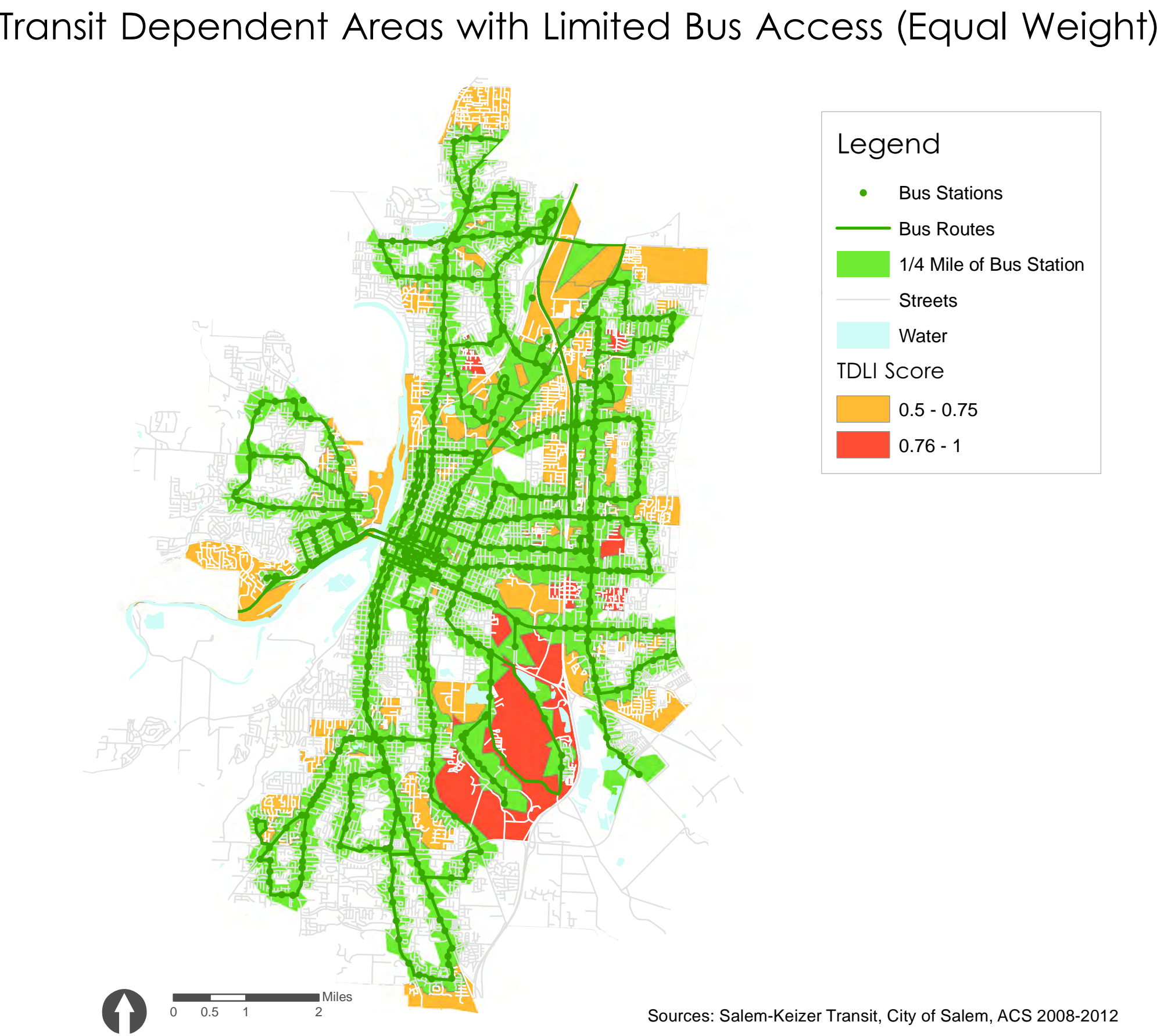
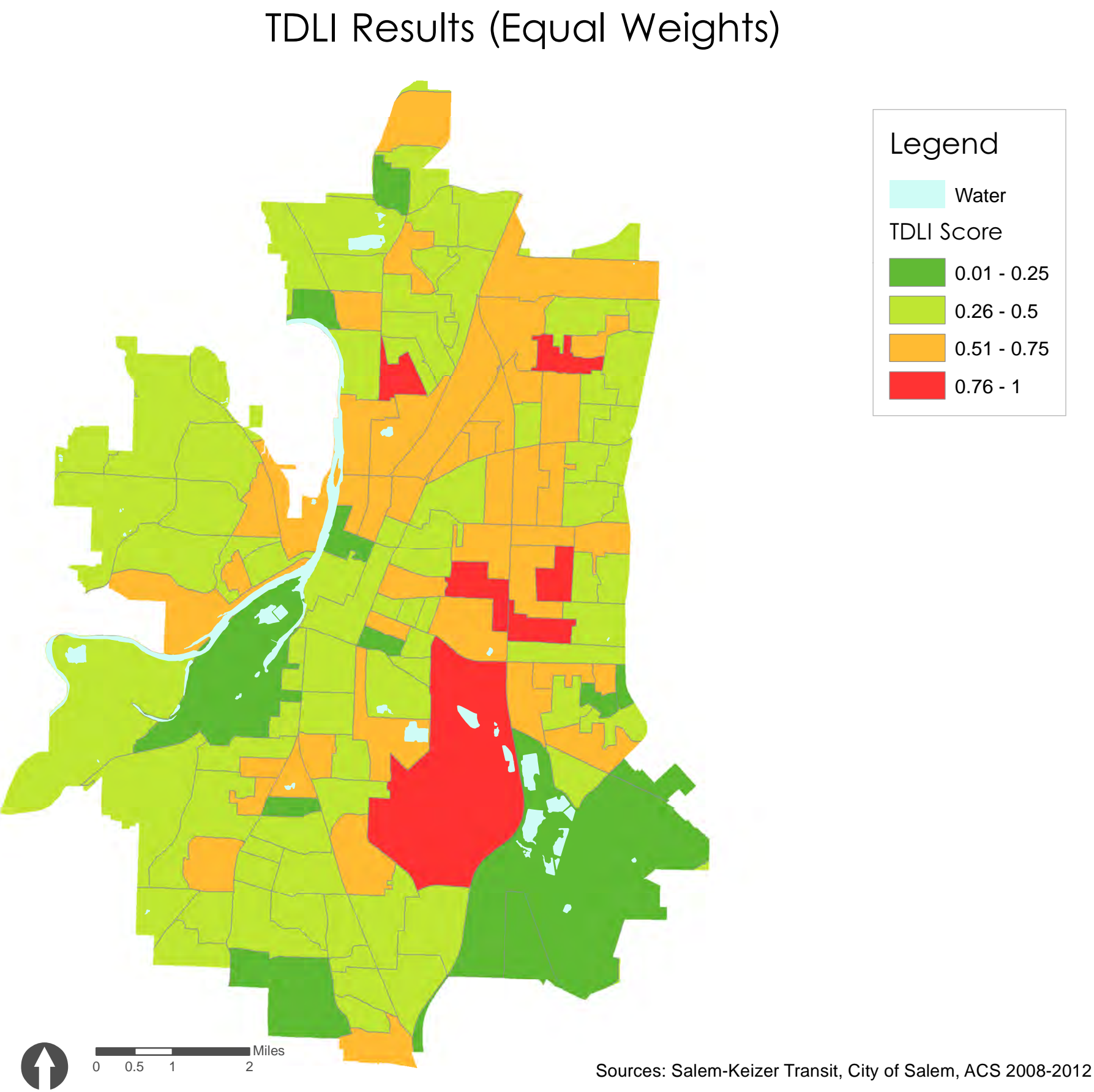
### Creating the TDLI

Once the four variables were comparable, we created two indices: one with equal weights (each variable accounted for one fourth of the index), and one with twice the emphasis put on the seniors (the seniors variable is two fifths of the index). The weighted senior populations index was created due to the desire from the agency to ensure coverage for seniors populations. Here are the equations for how to add the 0 to 1 scaled scores for each variable:

Equal Weight Index= (Youth Score + Senior Score + Poverty Score + No Car Score)/4

Senior Weighted Index= (Youth Score + Senior Score\*(2)+ Poverty Score + No Car Score)/5

Data Normalization Scale	1 Less Standard Deviation	Mean	1 More Standard Deviation
<b>TDLI Score</b>	<b>0</b>	<b>0.5</b>	<b>1</b>
% Youth (10-17)	9.79%	17.36%	24.92%
% Elderly (65+)	3.92%	13.11%	22.29%
% Families in Poverty	0.64%	14.63%	28.63%
% HH with No Vehicle	0%	8.70%	18.00%



### Process for Applying TDLI

Once the TDLI scores had been created, scores were mapped by census block group. For both the index with equal weights and the index where seniors were more heavily weighted, the block groups which had a TDLI of 0.5 or higher were exported into their own shapefile. These block groups are more likely to be transit-dependent when compared to the rest of the city since they had an above average makeup of vulnerable populations.

In order to determine which areas of the Salem-Keizer area were currently being served by transit, quarter mile buffers around each of the bus stops were created. A quarter mile buffer was chosen rather than a half mile or one mile buffer due to the presence of elderly and youth populations within our indices. These populations may have a more barriers to walking longer distances than the general population. Instead of using Euclidian distance to create buffers, network distance was used in order to get a more accurate representation of how far a quarter mile was from each stop. Using the Salem-Keizer area's street network, a network dataset was created. Next, Network Analyst was used to create service areas around each stop representing a quarter mile network distance from each stop. Once each service area was created, they were all dissolved in order to get an output of areas served by Salem's bus system.

Our next step was to determine which sections of the street network within each of the transit-dependent areas were not within a quarter mile of a bus stop. In order to accomplish this, first a symmetrical difference was created of the transit-dependent areas and the areas served by transit, and then it was clipped to the bounds of the transit-dependent areas. Finally, the street network was clipped to the clipped symmetrical difference output. The results was a shapefile of streets within transit-dependent areas that are not being served by Salem's bus system.

### TDLI Unserved Hot-Spots Results

Our results show that there are indeed areas that are not being served by transit that house populations that might be transit dependent. There are 301.7 miles of streets in TDLI-Senior weighted areas that are not served (54.3 square miles of TDLI land), and 177.5 miles of streets not served in the equal weight TDLI (17.9 square miles of land). It is important to note that the varying block group sizes may appear misleading when mapped since some areas may have high land area but not necessarily higher populations than smaller neighboring block groups. However, it is still important to show total land area that is unserved since many of the lower density areas around Salem-Keizer may later be developed as populations expand, making it useful to know what TDLI areas are in need of service regardless of current densities.

The area with the highest TDLI score is mostly industrial. Although the population density here is not high because of this, the populations that do live here include a high concentration of youth and very high concentration of seniors and families in poverty. Northern portions of Keizer as well as Northeast Salem are also lacking service and have populations that could benefit from an extension of service. The same can be said for portions of West Salem, which lacks a substantive bus network. The southern portion of West Salem, which is not served at all by transit, registers as transit dependent on the Senior Index and would benefit from added transit coverage.

This analysis can help inform planning decisions by providing a starting point for further investigation of potential service expansions. Levels that register high on the TDLI index would be good candidate study areas to analyze if and when future expansion of the system becomes a possibility.

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GIS II Final Project  
3/10/14

Data Sources Used: US Census 2010 (block groups), Salem-Keizer Transit (bus routes, bus stops, street centerlines), City of Salem (water), ACS 2008-2012 (youth, senior, families in poverty, no car households).

Tools Used: Join, Clip, Network Analyst-create network dataset, Network Analysts-create service area, Dissolve, Symmetrical Difference.

