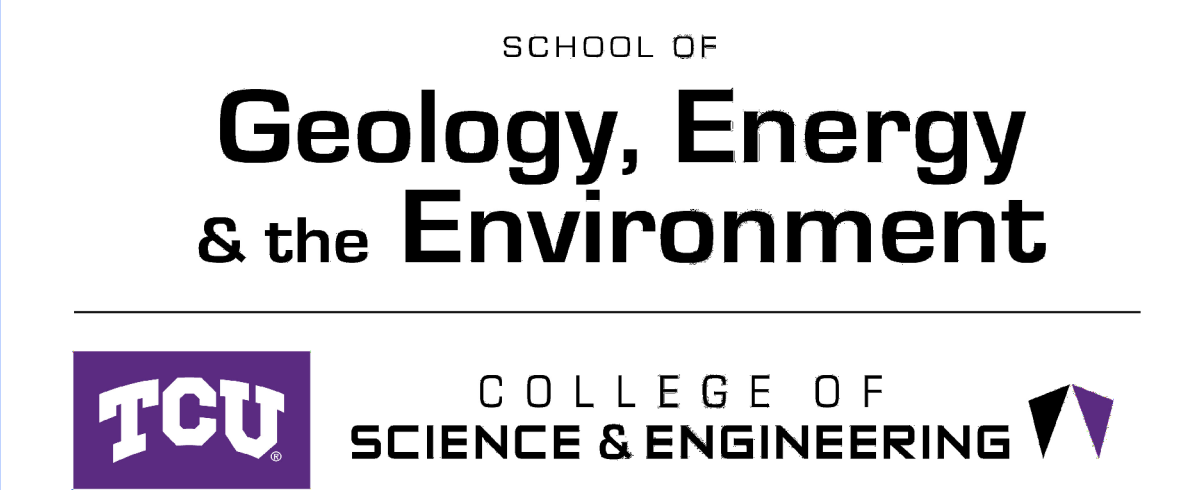


COBALT CACHE: Meeting Cobalt Demand

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INTRODUCTION

Public awareness of human rights violations in cobalt-rich mines of the Democratic Republic of Congo have American cobalt consumers scrambling for reliable suppliers to meet rising demand, with uncertainties about futures in cobalt's supply chain. Global cobalt production supply forecast falls short of global demand forecast for the next ten years, even with the completions of major planned mined projects. The exponential increase in demand for cobalt results from its utility in personal electronics batteries, electric vehicle batteries, and jet engine construction. Chemical extracting operations whose sole purposes are to extract cobalt are not profitable in the status quo, leaving a window of opportunity for reclaimed cobalt to take hold in the market. This project analyzes geography and census data to find untapped "urban mines" in Texas. The resulting analysis exists to be cross-applied to other states to determine target regions best suited for cobalt reclamation strategies in hopes of securing America's geopolitical mineral stability.

METHODOLOGY

Most lithium-ion batteries contain cobalt. Despite the batteries' ubiquity, no georeferenceable consumer data could be found detailing volumes of lithium-ion batteries purchased and used in Texas. This data void spurred a more creative approach to determining suitable recycle drop-off sites.

- Locations of currently operating recycling facilities were mapped (TCEQ)
- Income by block group was layered over to search for trends
- Locations of drop-off points were mapped (Call2Recycle)
- City limits were mapped, cities without any drop-off locations were selected out
- The resulting selections were spatially joined with block group data and symbolized into three groups determined by population per square mile

Income was hypothesized to be the driving factor behind the placement of new recycle drop-off facilities, though analysis showed no reliable correlation existed.

RECOMMENDATIONS

The only other factor that seemed to be significant in the placement of the drop-off facilities was population density. The block group data from the U.S. Census Bureau provided population per square mile, and when spatially joined to the Texas cities data, could be used to rank cities by population density. By selecting the Texas cities that do not currently have a Call2Recycle registered recycle drop-off facility and graduating the selection into three categories based on population density, three classifications of proposed drop-off locations were made: "Primary", "Secondary", and "Tertiary".

These recommendations could be refined using lithium-ion battery waste volumes data. The strategies used in creating this recommendation could also be applied to all other states in the United States, and any region measuring population and recycling metrics.

Global Cobalt Production 2015

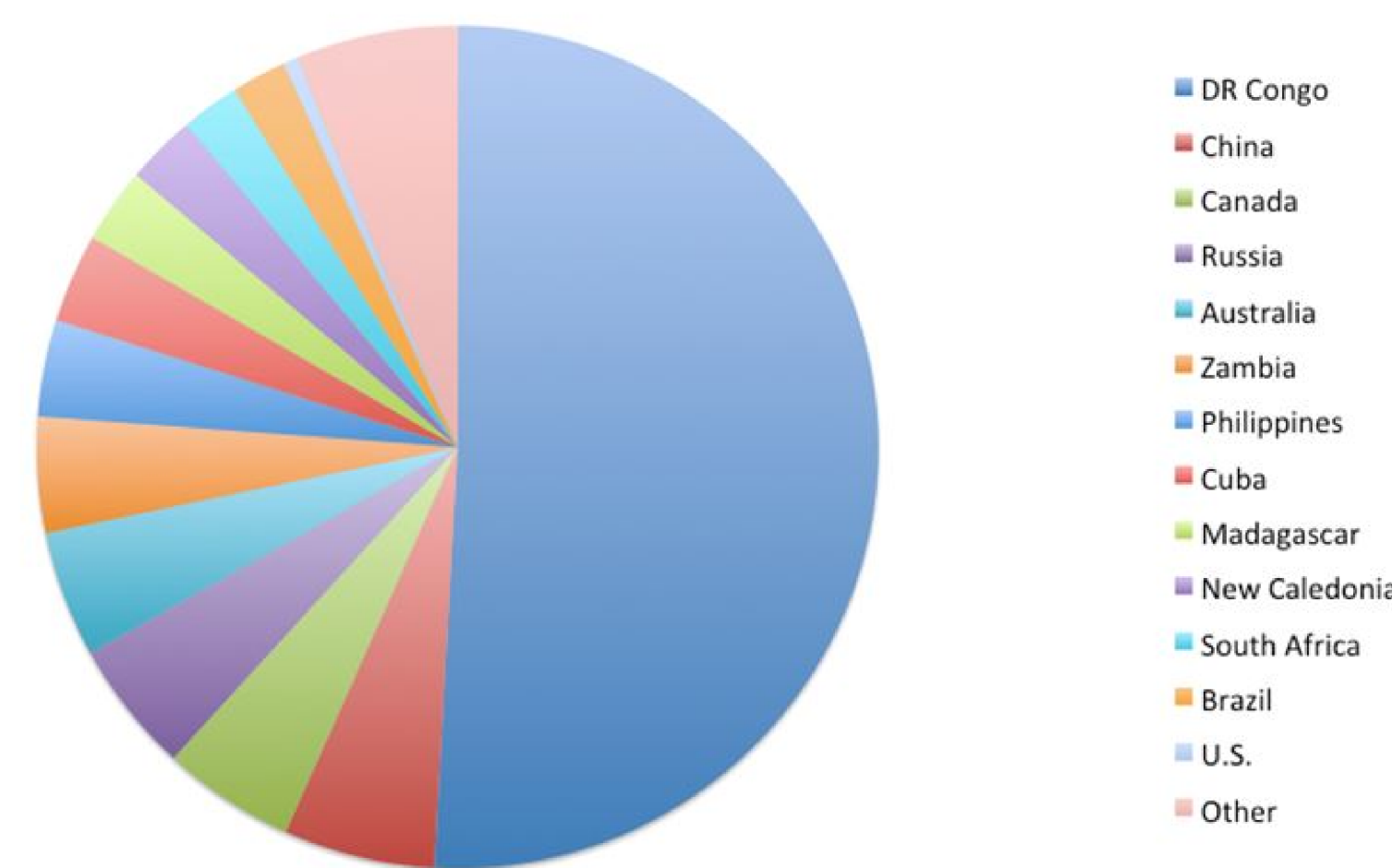


Photo: The Carter Center/G. Dubourthoumieu

Source: U.S. Geological Survey

Income by Block Group

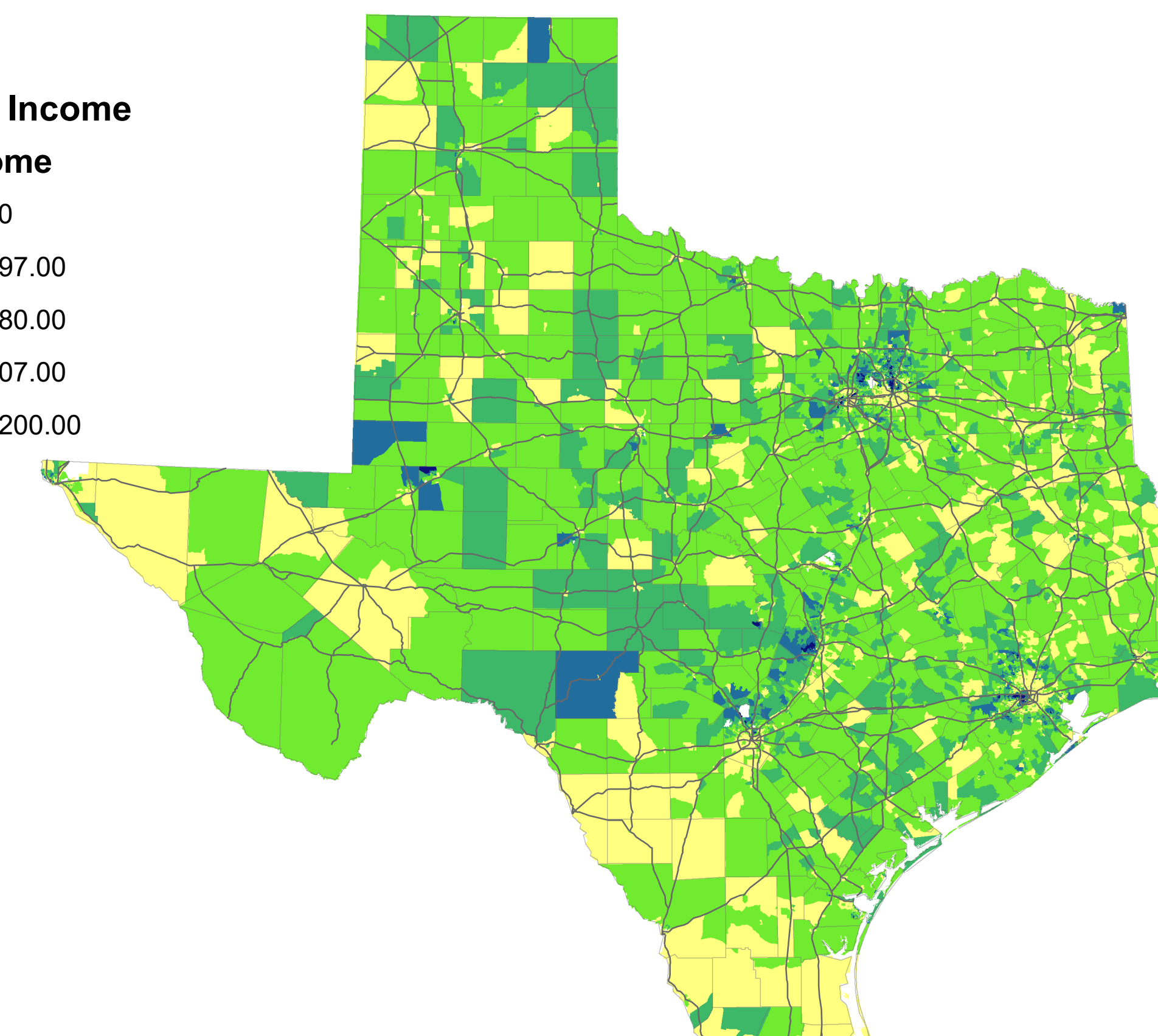
Legend

- Major Roads
- Counties

Texas Block Group Income

ACS Per Capita Income

- \$84.00 - \$18,712.00
- \$18,712.01 - \$30,897.00
- \$30,897.01 - \$48,280.00
- \$48,280.01 - \$81,407.00
- \$81,407.01 - \$246,200.00



2016 Data from the American Community Survey by the U.S. Census Bureau

Proposed Recycle Drop-Off Locations

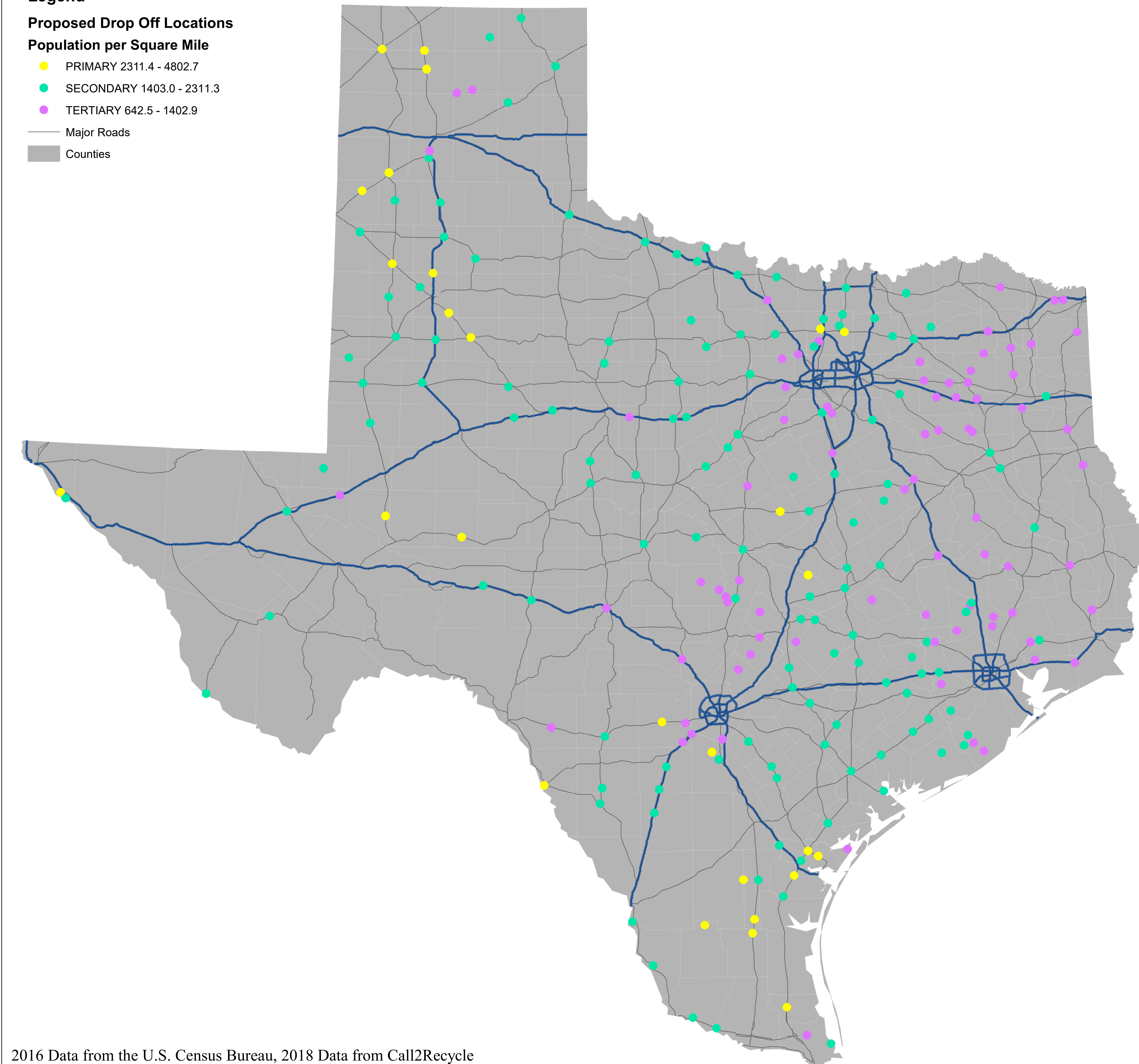
Legend

Proposed Drop Off Locations

Population per Square Mile

- PRIMARY 2311.4 - 4802.7
- SECONDARY 1403.0 - 2311.3
- TERTIARY 642.5 - 1402.9

- Major Roads
- Counties

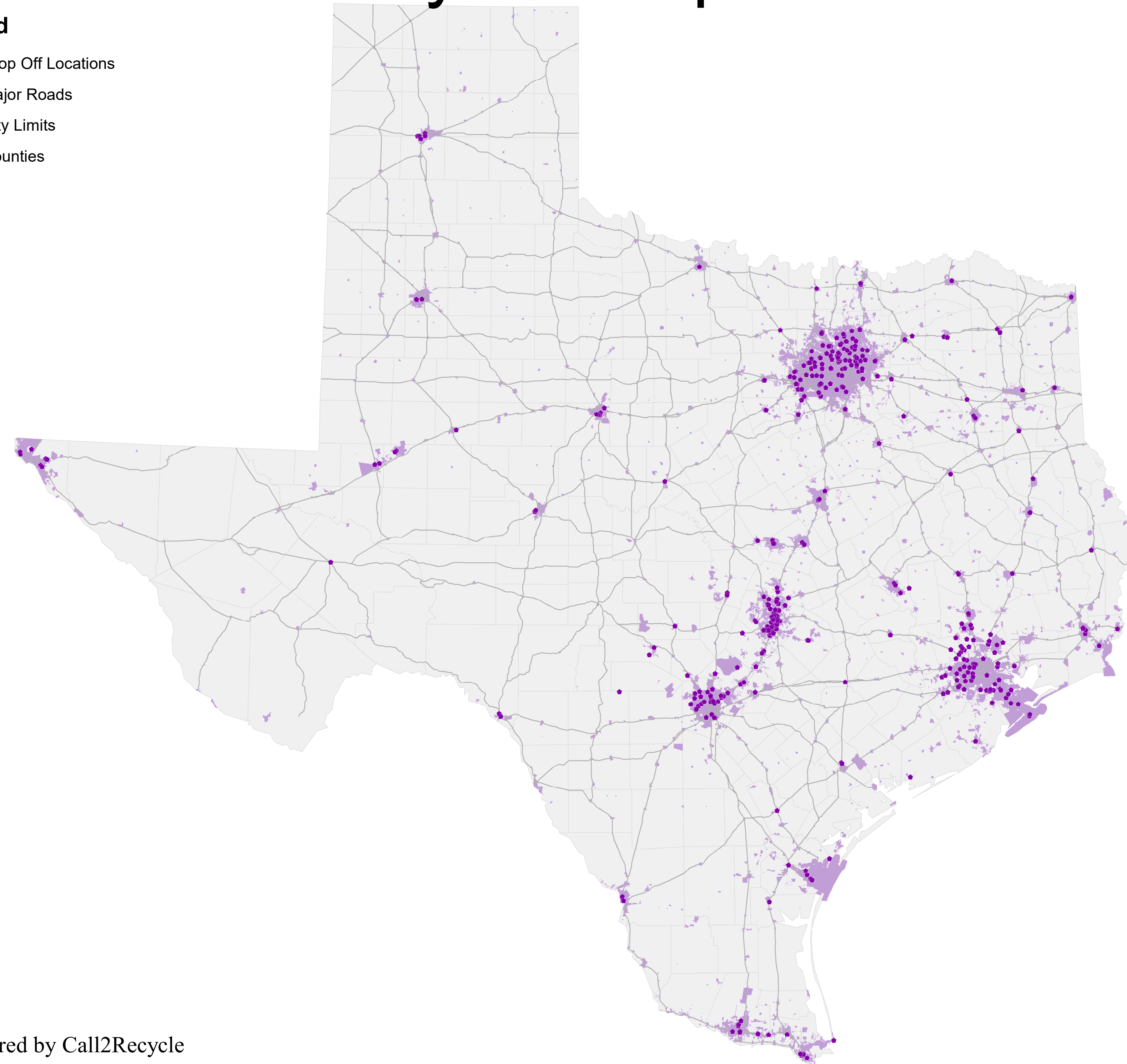


2016 Data from the U.S. Census Bureau, 2018 Data from Call2Recycle

Texas Call2Recycle Drop-Off Locations

Legend

- Drop Off Locations
- Major Roads
- City Limits
- Counties



2018 Data shared by Call2Recycle

Drop-Off Location Concentrations

Legend

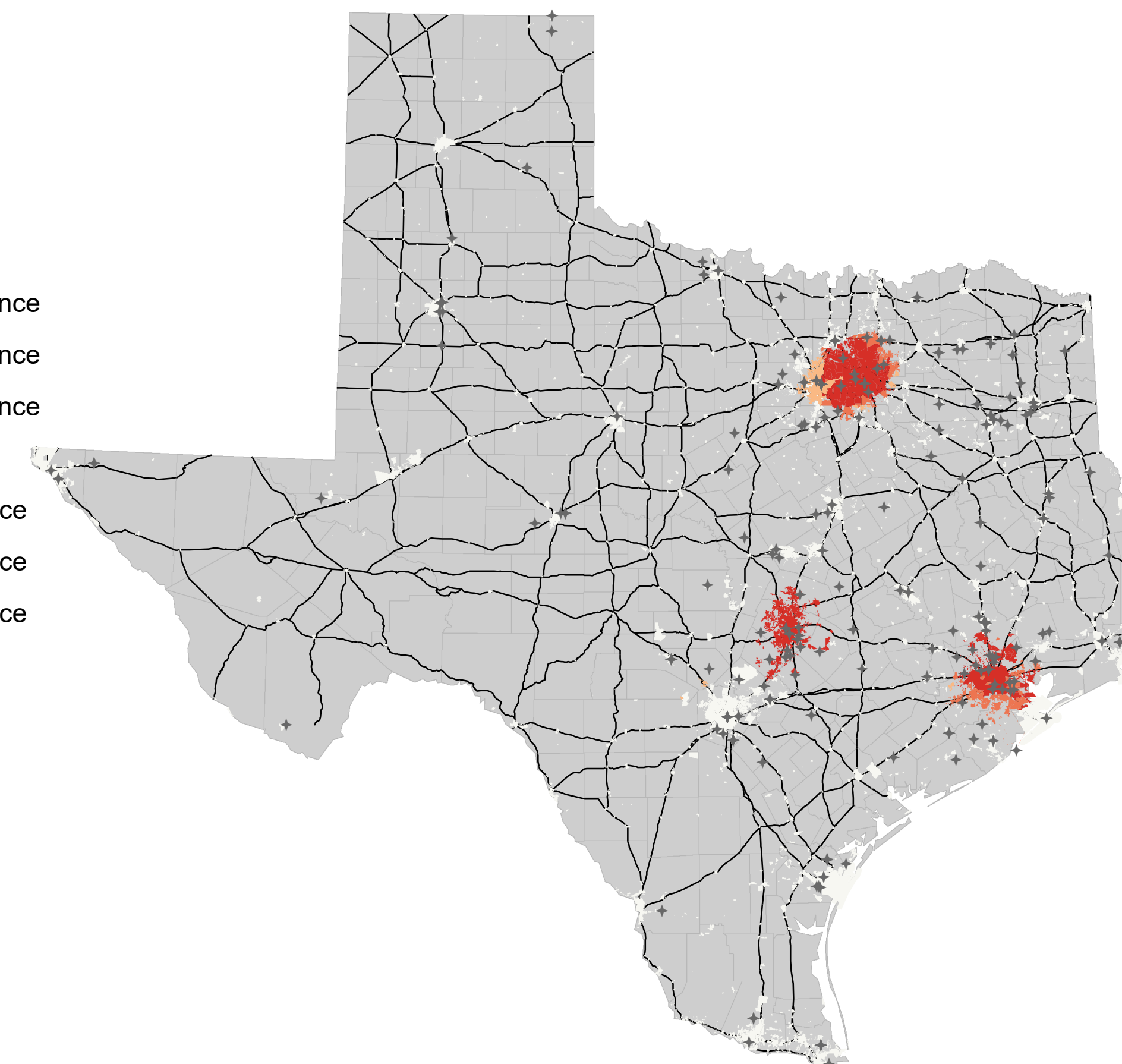
- Recycle Facilities

Drop-Off Hot Spots

Gi_Bin

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

- Major Roads
- Counties



2018 Data shared by Call2Recycle and the Texas Commission on Environmental Quality