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Ridership and Residential Density within the Gold Line Stations

Introduction

The Los Angeles County Metropolitan Transportation Authority (Metro) is heavily investing in light rail projects around the County and consequently, travel behavior in Los Angeles County is transforming from auto-dependency to more public transit patronage. Besides physical transportation infrastructure facilitating the transformation, there are other environmental factors contributing to the increase in public transit usage. Travel behavior research indicates a direct relationship between housing, population, and employment density on increase transit use. Early studies from researchers Jeffery Zupan and Boris Pushkarev found that auto use declines and transit use increases as a function of both residential density and nonresidential floor space around transit stops (Dittmar & Poticha, 2004). The Institute of Transportation Engineers combines residential and employment densities and suggests that an average overall minimum density of 7 to 8 dwelling units (DU) per acre, and 9 DU per residential acre of commercial/office space are required to support light rail and feeder bus service (CA DOT). Most recently, renowned researcher Robert Cervero suggested a staggering 20-30 DU per residential acre within a quarter mile to half a mile radius of a light rail station to support high transit use (CA DOT).

The project's focus is to use GIS tools to map out and test Cervero's measurement against four Gold Line Phase 1 stations. GIS is an effective tool because it can use the same metric to create a map to show the various degrees of residential density and ridership within one light rail line. Additionally, GIS is a great tool for the analysis because it can calculate the total area within the transit station.

The Gold Line Phase 1 route opened in 2003 with a terminal station at Union Station and heads east towards passing through the City of Los Angeles, South Pasadena and Pasadena with a total of thirteen stations. Not all thirteen stations were analyzed because stations like Allen, Lake and Sierra

Madre are located in the middle of the I-210, a ten-lane freeway so residential units within a quarter to half mile radius of these stations are nonexistent. Stations were selected on a two par basis - based on its intended use and station character and on total ridership numbers from Metro's fiscal year 2011 (July 2010 to June 2011). The first criteria is that the station must be transit oriented development with surrounding retail use and residential use, and the second criteria is that it must either have significantly high or low riders. The stations are: Chinatown, Southwest Museum, Highland Park, and Del Mar stations. Table 1 below lists the thirteen stations from Union Station to Pasadena; and the stations highlighted in yellow are the stations being analyzed.

Table 1: FY2011 Total Ridership for Gold Line Station

Gold Line Station	FY11 Total Ridership
UNION STATION	6,049,093
CHINATOWN	909,538
CYPRESS PARK	660,666
HERITAGE SQUARE	415,205
SOUTHWEST MUSEUM	453,600
HIGHLAND PARK	1,378,881
MISSION	899,835
FILLMORE	761,522
DEL MAR	785,803
MEMORIAL PARK	1,339,919
LAKE AVENUE	957,407
ALLEN	801,554
SIERRA MADRE VILLA	1,774,484

Process and Procedure

Data Information

In order to map out my analysis, several different types of data was retrieved and later joined together. The data I used included: 1. 2010 Census TIGER shapefile for Los Angeles County by block group 2. Number of Occupied Housing Units within a quarter mile to half a mile radius of a station by 2010 block group in Excel format and retrieved from American Fact Finder 3. Gold Line Station shapefile retrieved from LA County GIS Data Portal; 4. Gold Line Station Ridership Numbers for FY2011 in Excel format requested from Metro; and 5. a ArcMap default basemap. Ridership data is only available by Metro's fiscal year. Since the Census Tract shapefile and the housing units data were from 2010, the most compatible ridership data was from FY 2011 (July 2010- June 2011). FY 2010 (July 2009 - June 2010) was incompatible because in November 2009, the Metro opened a southern Gold Line extension from Union

Station. FY 2011 would account for the full operation of the southern extension, while FY 2010 would not, so FY 2011 is more representative of the ridership pattern for 2010.

Steps to Creating the Map

The following are the steps I took to amend the data and to create the resulting four station maps.

Step 1 Calculating Area of Block Group: In order to calculate the housing density of each block group, I needed to figure out the area of each block group. To make such calculations, I used the "Calculate Geometry" tool in the Attributes Table of the 2010 Census TIGER shapefile. To calculate the area of each polygon, it was necessary to use the Reprojection Tool to change the projection from geographic projection to projected coordinate system. I then created a new column titled Acre and used the "Calculate Geometry" tool to calculate the acre of each polygon/ block group.

Step 2 Joining **Table**: I later joined the TIGER file with the Number of Occupied Housing Units per block group Excel file and selected the option to keep only the matching records. Doing so deleted all the polygons within the TIGER file that were not relevant to my analysis.

Step 3 Calculating Housing Density: I created a new column in the joined table called Density to calculate the housing density per block group. I used the Calculate Field with the formula of: Occupied Housing Units divide by Acre to come up with the housing density value.

Step 4 Mapping Housing Density: With housing density calculated in the Attributes Table, it is ready to be mapped out as a choropleth map. See Table 2 for the outcome of the TIGER file attribute table.

OBJECTID*	Shape*	GEOIDisplay-label	Station	Shape_Area	Acre	Occupied	Density	TRACTCE10	STATEFP10	NAMELSAD10
5348	Polygon	Block Group 1, Census Tract 2060.10, Los Angeles County, California	Chinatown	12092208.317769	277.800037	558	2	206010	06	Block Group 1
6100	Polygon	Block Group 2, Census Tract 2060.10, Los Angeles County, California	Chinatown	3393280.511217	77.898312	432	6	206010	06	Block Group 2
6111	Polygon	Block Group 1, Census Tract 2060.20, Los Angeles County, California	Chinatown	9376515.199846	215.268033	253	1	206020	06	Block Group 1
1480	Polygon	Block Group 2, Census Tract 4636.02, Los Angeles County, California	Del Mar	2832022.716879	65.014551	1354	21	463602	06	Block Group 2
1481	Polygon	Block Group 3, Census Tract 4636.02, Los Angeles County, California	Del Mar	1452601.86062	33.347267	657	20	463602	06	Block Group 3
1590	Polygon	Block Group 1, Census Tract 4619.02, Los Angeles County, California	Del Mar	3092130.260628	70.985828	207	4	461902	06	Block Group 1
1742	Polygon	Block Group 2, Census Tract 4636.02, Los Angeles County, California	Del Mar	2611064.800256	59.942045	678	11	463602	06	Block Group 1
1743	Polygon	Block Group 4, Census Tract 4636.02, Los Angeles County, California	Del Mar	3088325.170522	70.398479	426	6	463602	06	Block Group 4
2400	Polygon	Block Group 2, Census Tract 4619.02, Los Angeles County, California	Del Mar	5886851.032795	135.35066	792	6	461902	06	Block Group 2
5235	Polygon	Block Group 2, Census Tract 4637, Los Angeles County, California	Del Mar	10041626.879585	230.524954	636	3	463700	06	Block Group 2
2495	Polygon	Block Group 3, Census Tract 1837.01, Los Angeles County, California	Highland Park	1716213.170963	39.398098	401	10	183701	06	Block Group 3
2804	Polygon	Block Group 2, Census Tract 1836.10, Los Angeles County, California	Highland Park	2782277.89475	63.872561	696	11	183610	06	Block Group 2
4590	Polygon	Block Group 1, Census Tract 1835.20, Los Angeles County, California	Highland Park	2775176.080653	63.709572	542	9	183520	06	Block Group 1
4592	Polygon	Block Group 2, Census Tract 1836.10, Los Angeles County, California	Highland Park	2543357.890889	58.387696	666	11	183610	06	Block Group 2
4594	Polygon	Block Group 1, Census Tract 1836.10, Los Angeles County, California	Highland Park	1532170.540246	35.173937	268	8	183610	06	Block Group 1
4824	Polygon	Block Group 1, Census Tract 1836.20, Los Angeles County, California	Highland Park	3751790.436456	86.129652	729	8	183620	06	Block Group 1
4826	Polygon	Block Group 2, Census Tract 1836.20, Los Angeles County, California	Highland Park	1817996.442792	41.735819	233	6	183620	06	Block Group 2
1187	Polygon	Block Group 2, Census Tract 1851, Los Angeles County, California	Southwest Museum	8773436.37571	201.411052	1078	5	185100	06	Block Group 2
1564	Polygon	Block Group 1, Census Tract 1994, Los Angeles County, California	Southwest Museum	1993090.125796	45.755235	352	8	199400	06	Block Group 1

Step 5 Amend Ridership Data*:* Metro's ridership data was split by boarding and alighting, by weekday, Saturday and Sunday trips. To process the data for the map, the three sets of numbers were added to come up with the annual ridership data for each station.

Step 6 Joining Gold Line Station shapefile with Ridership Numbers Excel file*:* The Gold Line Station shapefile had no similar attributes with the Ridership Numbers Excel file so it was unable to join. To create a similarity, I created a new column called "Station ID" in the Excel file. The shapefile included Station ID, so I typed in the respective ID for the four stations of interest. Now, the two files can join under Station ID, and again, I selected the option to only join matched records.

Step 7 Mapping Ridership Numbers: Total ridership was used to create a point map showing the intensity of station patronage.

Step 8 Add Basemap: To provide a sense of what each block group encompass, I included a basemap that is provided by the ArcMap software. I have also changed the transparency of the housing density layer so the readers can see the basemap.

Step 9 Export 4 Maps*:* Exported housing density vs. ridership numbers for Chinatown, Highland Park, Southwest Museum and Del Mar station with the same scale for easy comparison. They are included below.

Figure 1: Chinatown Ridership vs. Housing Density

Figure 2: Southwest Museum Ridership vs. Housing Density

Ridership
Total
- 500,000 Riders and below
- 500,001 - 800,000
- 800,001 and above

Housing Density
Density
- 1 - 10 Dwelling Units/Acre
- 11 - 19
- 20 - 21

0 0.05 0.1 0.2 0.3 0.4
Miles

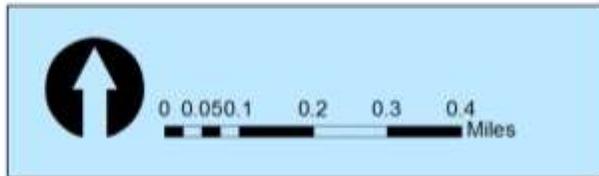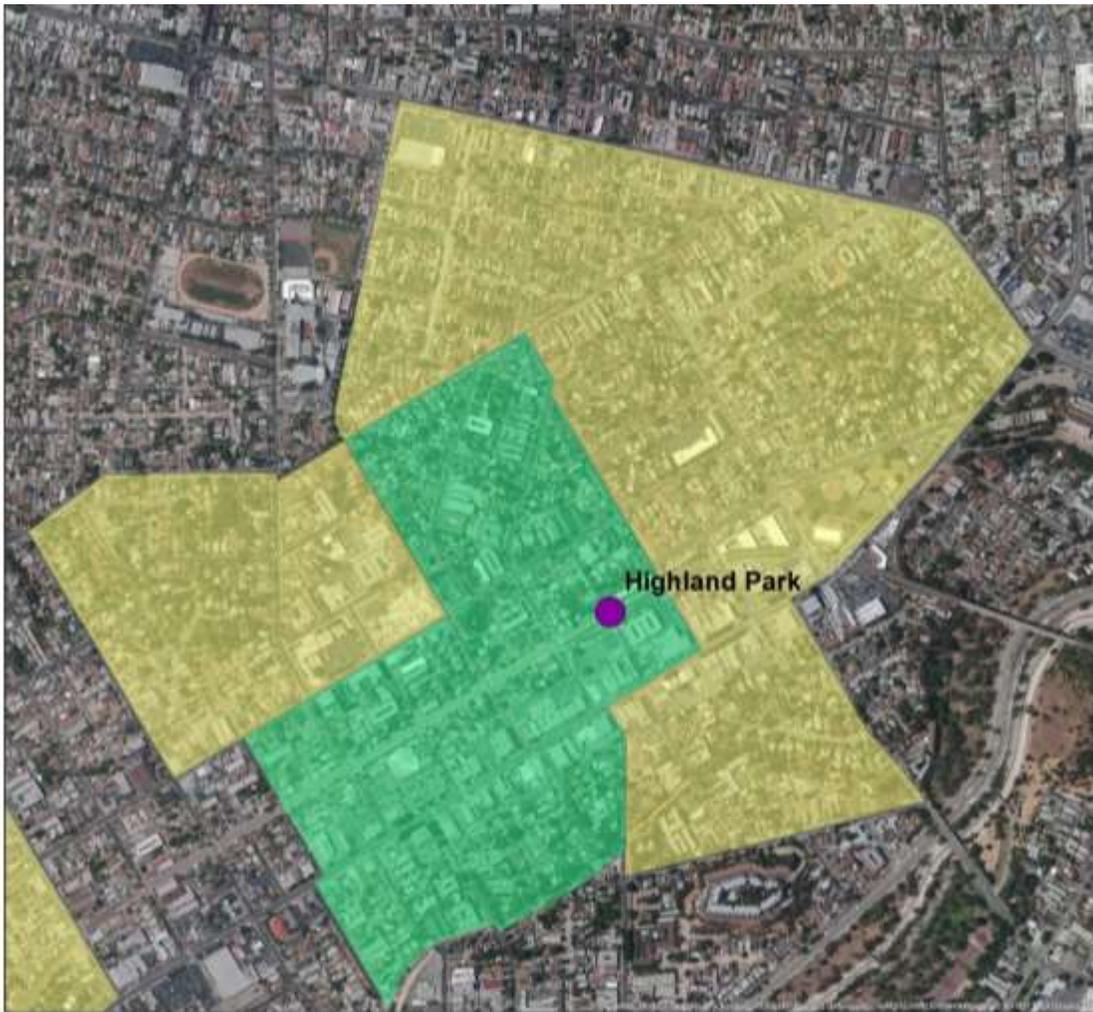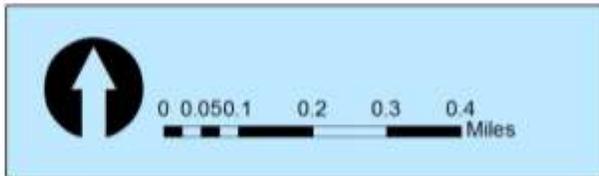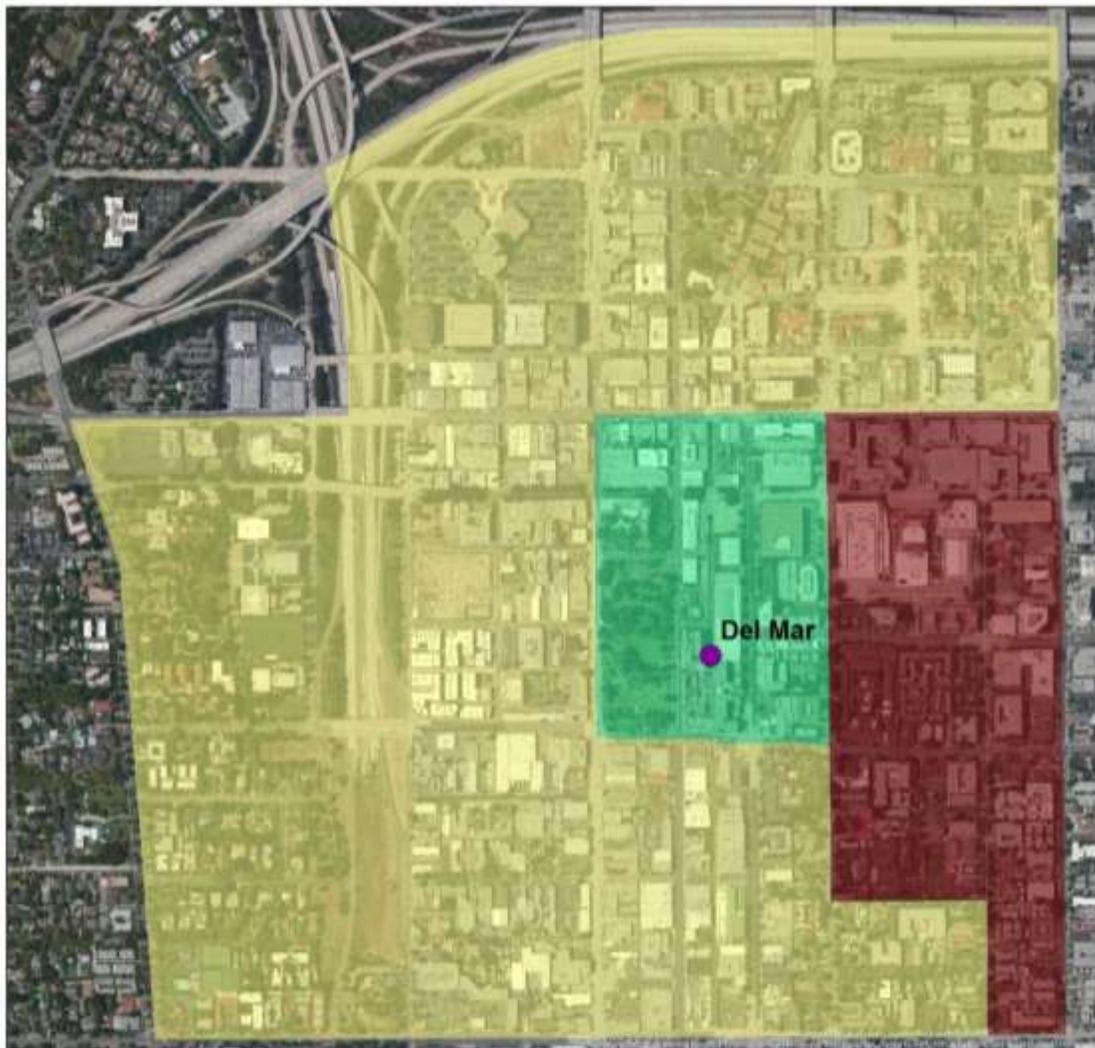**Figure 3: Highland Park Ridership vs. Housing Density**

Figure 4: Del Mar Ridership vs. Housing Density

Ridership
Total
• 500,000 Riders and below
● 500,001 - 800,000
● 800,001 and above
Housing Density
Density
1 - 10 Dwelling Units/Acre
11 - 19
20 - 21

0 0.050.1   0.2   0.3   0.4
Miles

Conclusion

From the four maps, it appears that housing density does not have a strong correlation to ridership numbers. Highland Park Station has the most riders at 1.3 million riders yet, housing density is at the low end. The same is true for Chinatown station, with 900K riders, the second highest ridership numbers yet housing density is low. Del Mar station is the only station with housing density between 20-21 dwelling units, the closest to Cerveo's 25 dwelling units, yet ridership is not the highest but in the mid-range compared to all the other twelve stations and third in this analysis. The only station that fits into Cerveo's theory is Southwest station with low residential density and the lowest riders.

A possible reason as to why the data did not correspond to Cerveo's theory is because some block group extended beyond the half mile radius of the transit station, like the Chinatown station. Block groups are designated by the U.S. Census Bureau and I could not cut a block group in half to make sure it is within a half mile radius to the station. Data for housing units encountered the same problem because data was only available by block group and there is no way of telling if the units fall within half a mile of the station or not. An example is the Del Mar station. Three of the block group extended north to capture a portion of the 210 freeway. I could not cut the block group to only calculate the area where housing development is possible. Consequently, because the poor calculation of the block group and housing units, the housing density is at the very low range. If time permitted, I would have conducted my own field study and walked a quarter to half a mile north, south, east and west of each station to calculate the area.

I did however analyzed the available data further and calculated the total housing density within each station by dividing the sum of the block group areas by the sum of occupied housing units as shown in Table 3. Highland Park station is the most dense at 9 DU, then Del Mar at 7 DU, Southwest at 5 DU, and Chinatown station at 2 DU. Again, the housing density does not relate to actual ridership. Chinatown has the lowest housing density, yet experiences the second most riders. Southwest Museum has 50% less riders than Chinatown yet is twice as dense as Chinatown. In conclusion, it is likely that housing density is not a significant factor to the number of riders at a station. Another possible factor to look into is employment density. Chinatown and Highland Park stations are located next to major retail centers which can explain why the two stations experience the most amount of riders within the thirteen stations. Additionally, Southwest Museum station does not have major retailers surrounding the station and can explain the lack of riders from the station. If I had more time, I would like to create another set of maps analyzing the relationship between retail density to ridership numbers for the four stations.

Table 3: Total Residential Density

Station	Acre	Occupied	Density
Chinatown	227	558	2.45815
	77	432	5.61039
	215	253	1.176744
TOTAL	519	1243	2.39499
Del Mar	65	1354	20.83077
	33	657	19.90909
	70	267	3.814286
	59	678	11.49153
	70	426	6.085714
	135	792	5.866667
	230	630	2.73913
TOTAL	662	4804	7.256798
Highland	39	401	10.28205
	63	686	10.88889
	63	542	8.603175
	58	666	11.48276
	35	268	7.657143
	86	729	8.476744
	41	233	5.682927
TOTAL	385	3525	9.155844
Southwest	201	1070	5.323383
	45	352	7.822222
TOTAL	246	1422	5.780488

Reference

California Department of Transportation, September 2002, "Statewide Transit-Oriented Development Study: Factors for Success in California," Caltrans.

Dittmar, H. and Poticha, S. (2004), "Defining Transit-Oriented development: The New Reginal Building Block", pp. 19-39, in Dittmar, H. and Ohland, G. (ed.), "The New Transit Town, Best Practices in Transit-Oriented Development", Island Press.