UNIVERSITY OF CALIFORNIA

Los Angeles

TO LIVE AND RIDE IN LA

Do New Bike Lanes Make Angelenos Safer?

A comprehensive project submitted in partial
satisfaction of the requirements for the degree
Master of Urban & Regional Planning

by

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Executive Summary

Between 2009-2014, bicyclists in the City of Los Angeles were involved in 6% of roadway injuries and 4% of roadways deaths. Given recent increases in the number of bicyclists, it is important to examine how safety can be improved. This study analyzes crash rates along routes with newly-added bicycle lanes or shared lane markings (aka sharrows) in the City of Los Angeles to assess how these bikeway treatments affect bicyclist safety. The study relies on four years of bicyclist count data from the Los Angeles County Bicycle Coalition (LACBC), bicyclist-involved collision data from the Statewide Integrated Traffic Record System (SWITRS), and bikeway maps from the City of Los Angeles to determine the effect of these new facilities on crash rates. These data are used to analyze changes in crashes as a function of total ridership on 17 sites that installed bikeways and 18 control sites.

The study finds that the rate of crashes per bicyclist declined by 43% after the installation of bikeways. With respect to the control sites, ridership levels remained constant, while the number of crashes increased by 22%. These findings suggest that bicycle infrastructure investments are valuable not only for achieving higher levels of active transportation, but also for improving the safety of bicyclists. The City of Los Angeles can use these findings to inform their Vision Zero plan, a road safety policy intended to eliminate all roadway fatalities by 2020, and marshal the political will necessary to create additional bikeways.

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1. Introduction

As part of the City of Los Angeles 2010 Bicycle Plan Implementation Strategy, Mayor Villaraigosa pledged to build 40 miles of new bikeways per year for five years. These efforts started off strongly, with the City installing more than 200 miles of bike lanes between 2010 and 2014 (City of Los Angeles Department of Transportation, 2015). To choose where to install bikeways, the City put aside their 2010 Bike Plan priority list (which contained 328 proposed bikeways and bicycle-friendly streets) and developed a more concise high priority list containing 19 projects in year one and 16 in year two. The criteria for the new priority list were based on network connectivity, high levels of ridership, and/or high crash rates. I examined the original priority list and found that 46 miles of the bike lanes (or 22% of the list's proposed bike lanes) have since been built. In the new priority list, many of the routes required the removal of general travel lanes or parking, and thus all but eight of the year-one projects were either blocked by council members, or scrapped because of the necessity for expensive environmental studies and community outreach (Linton, 2015). None of the projects in the second year list were completed. So, most of the newly-installed bike lanes were not priority routes, but rather were chosen simply because bike lanes would fit without removing general travel lanes or on-street parking.

After fiscal year 2013-2014, the momentum to build new bicycle infrastructure fizzled, in part because the low-hanging fruit was picked (Linton, 2015). In fiscal year 2014-15, the City installed only 11 miles of bike lanes. But while the output decreased, the interest in building additional bicycle infrastructure by both the City and residents seems just as strong as ever. In 2015, the City published *Mobility Plan 2035*, the transportation element for the City of Los Angeles General Plan. The plan prioritizes public safety, and calls for 300 miles of new protected bike lanes. Additionally, the City recently adopted the Vision

Zero safety policy that aims to eliminate roadway deaths. Vision Zero LA bills itself as a "data-driven approach," launched by the City of Los Angeles alongside a careful analysis of high-risk corridors throughout the city (City of Los Angeles, 2016). This study will complement the City's data-driven efforts to design safe streets. If recent bicycling infrastructure investments make roads safer, then these findings may help to justify substantial new infrastructure investments.

While the City of Los Angeles, Los Angeles County, and the Southern California Association of Governments (SCAG) dedicate substantial effort and resources toward counting the number of vehicles traveling on the region's road network, they make almost no effort to count the number of bicyclists. So in 2009, the local nonprofit bicycling advocacy organization, the Los Angeles County Bicycle Coalition (LACBC), picked up the slack by implementing biannual bicyclist counts throughout the city. In previous studies, the data have been used to measure changes in ridership, changes in sidewalk riding, helmet use, wrong-way riding, and so on (LACBC, 2013). In this study, the data are now used to evaluate safety.

One goal of these counts was to demonstrate to the City the value of capturing ridership data and, in doing so, motivate the City to provide financial support for the counts. In San Francisco, LACBC's analog, SF Bike, launched bicyclist counts that were subsequently taken over by the City of San Francisco.

After six years of operation in Los Angeles, the City has failed to lend support or augment the data with their own measurements. The counts are a substantial undertaking. For the 2015 count over 300 people volunteered for 500 shifts at 164 locations throughout the city. Following each biannual count, the LACBC publishes an analysis of the data. The most recently-published report shows increased bicycle ridership across the entire city between 2009 and 2013, with the greatest increases along newly-added infrastructure (LACBC, 2013). However, the 2015 count (for which I conducted the data analysis) show a 9% decline in overall ridership since the 2013 count. Anecdotally, the decline in ridership mirrors the decline in infrastructure investments. Still, on bikeways, ridership in 2015 is greater than it was in 2009, though it declined since 2013 (see Figure 6 on page 25).

Presciently, bike count organizers collected initial counts at sites where bicycling infrastructure would soon be installed. The organizers repeated these counts at the same sites for each count cycle, providing the before-and-after ridership data that I use for this study. The longitudinal counts at non-bikeway locations provide control site data.

Terminology

This terminology section reviews some of the common terms used in this report.

Bikeway: a broad term denoting either a bike lane or a bike route containing a shared-lane marking stencil.

Bike Lane: a lane painted on the right-hand side of the road, which can be used by bicyclists (Figure 1). Bike lanes are generally between five- to six-feet wide. A stencil of a bicycle and a directional arrow are located in regular intervals within the bike lane. Another term for bike lane is “Class II Bikeway.” In this study, bike lanes are categorized as either a road diet or a squeeze (defined below).

Squeeze Bike Lane: a bike lane painted onto an existing roadway without the removal of lanes or parking (Figure 1). In order to fit the bike lanes, the width of general travel lanes may need to be reduced, hence the term “squeeze.”

Figure 1: *Example of a bike lane. Eagle Rock Boulevard. Source: Google Streetview.*

Road Diet: reducing four general travel lanes to two, and adding a center turn lane and two bike lanes (see Figure 2 below, and see before-and-after cross sections in Figures 12 & 13 in the Appendix). The Federal Highway Administration (2004) notes that road diets may reduce vehicle speeds, because vehicles cannot pass one another and are limited by the speed of the lead vehicle. On urban streets, road diets appear to reduce total collisions by 19-29% (FHWA, 2004 & Harkey et al., 2008).

Figure 2: *Example of a road diet. York Boulevard. Source: Google Streetview.*

Shared Lane Markings (Sharrows): roadway stencils applied on Class III bikeways. Class III bikeways, known as "Bike Routes," are shared roadways without discrete bike lanes. Until the introduction of sharrows (which began in Denver in 1993), cities delineated Class III bikeways by erecting roadside "Bike Route" signs only. Sharrow stencils are composed of the side view of a person riding a bicycle, topped with chevrons to indicate direction (Figure 3). They are placed within the right general travel lane at regular intervals. The FHWA approved the design in the Manual of Uniform Traffic Control Devices (MUTCD) in 2009 as an official traffic control device.

In this report, I frequently refer to the routes themselves as sharrows.

Figure 3: *Example of a shared lane marking (sharrow). Source: http://buylocalwausau.com*

Study Overview

For this project I analyze crashes along 17 bikeways built between 2010 and 2013. The study uses bicyclist count data (from the LACBC counts), bicyclist-involved collision data (from the Statewide Integrated Traffic Record System, aka SWITRS), and bikeway maps to develop crash rates – the ratio between crashes and ridership – before and after the installment of bikeways. Changes in crash rates along bikeways may simply reflect region-wide trends. Therefore, to determine whether these changes are similar to or different from those in other areas of the city, I also analyze crashes near 18 other bicyclist count sites.

The data show that crashes as a function of ridership decreased on bikeways by 43%. The severity of crashes did not change after the bikeways were installed. The three categories of bikeways in this study – road diets, bike lane "squeezes," and bike routes with sharrows – were first analyzed separately in order to determine if the different types of treatments were more or less effective than one another. However, they all showed a similar decline in collisions. These trends in the "control" sites were quite different. On these routes, ridership remained steady over the same period, and crashes increased by 22%. These findings illustrate that the new bikeways in Los Angeles have improved safety.

I recommend that the City of Los Angeles use these findings to help increase their implementation of bikeways, and to use their priority list, high injury network, and Mobility Plan 2035 list of proposed bikeways to guide these efforts. I also recommend the City complement the current bicyclist counts by conducting automated counts, before/after counts along new bikeways, and more frequent counts. I also recommend that they maintain their dataset of bikeways, so that analyses such as this one can be updated using the most current data.

The remainder of this report will be devoted to the following five sections:

- Literature review of relevant studies
- Methodology
- Findings & analysis
- Recommendations
- Appendix

2. Bicycle Infrastructure and Ridership: A Review of the Literature

Introduction

Many design and operational roadway conditions affect a bicyclist's exposure to risk on the streets; these risks include vehicle volumes and speeds, pavement conditions, lighting, and the presence of bicycle infrastructure. We do not yet understand the safety impacts of the City of Los Angeles's 2011-2013 expansion of bicycle infrastructure. Understanding how the built environment affects the safety of bicyclists will help the City evaluate past investments and recommend future ones. If injuries can be mitigated by building certain infrastructure – types of bikeways, locations of bikeways – then the City will have a better understanding of how and where to focus their efforts. Moreover, the data may provide the evidence needed to marshal the political will to build new bicycle infrastructure.

While the health benefits of bicycling are widely acknowledged (Active Living Research, 2009), injuries and fatalities from collisions comprise another health impact and are perhaps less widely studied. An understanding of the health impacts of bicycling must also include risk of injury or death. For example, if rates of collisions increase along routes with infrastructure, then the health benefits must be adjusted accordingly.

This literature review examines the relationship between infrastructure and ridership, and looks at the findings and methodologies of relevant crash rate studies. There are three key findings:

- Bicycle infrastructure increases perceptions of safety, which leads to greater ridership.

- Most studies find a decrease in crashes on bikeways.
- More studies analyze the value of protected bike lanes rather than studying the effects of painted bike lanes.

The Relationship Between Bicycle Infrastructure and Crash Rates

There are many studies examining the relationship between bicycle infrastructure and crashes. Most of them do not account for changes in ridership rates, but rather look at total numbers of crashes. For example, Turner et al. (2009), found a 10% reduction in all crashes at select sites in New Zealand after bike lanes were installed. However, they also note that the crash rate per bicyclist reduces as volume increases – a "safety in numbers" effect. Smith and Walsh (1988) found an increase in crash rates with bike lanes (particularly bike lanes on the left side of the street) though there was no statistically significant effect on the long-term crash rates. Rodgers (1997) found that the odds ratio of being a cyclist who had a collision or a fall in the last year was lower if the cyclist primarily used a bike path or lane, when compared to the roadway. Hamann and Peek-Asa (2013) found that bicycle-specific pavement markings (bike lanes and sharrows) and signage may reduce the number of bicycle-motor vehicle collisions. After Davis, California, added nearly 100 miles of bicycle lanes in the 1960s and 1970s, Lott & Lott (1976) evaluated crash rates in the city. Their report found that "the frequency of all accident types combined was reduced by 31% on bike lanes, demonstrating a positive effect of bike lanes on safety" (Lott & Lott, 1976). On a wider scale, Pucher (2000) notes that rates of cycling fatalities in the United States are five times higher than the rates in some European countries.

A few studies use ridership counts and crash reports to determine crash rates. Strauss et al. (2013), found, “more cyclists at an intersection translate into more cyclist injuries but lower injury rates due to the non-linear association between bicycle volume and injury occurrence.” In New York City, adding bicycle lanes reduced the rate of bicycle-motor vehicle crashes (Chen, et. al., 2012). The City of Memphis recently expanded their bicycle lane network, and (in a yet-to-be-published report) found that daily bicycling increased by 387% while the number of crashes rose by only 38% (Dayton, M, 2016). Lusk et al. (2011) analyzed ten years of emergency medical response records and police-recorded crashes, and compared them to average daily bicycle counts. The crash rates were used to determine the relative risk of injury on six protected bike lanes (especially the exposed intersections on these routes) and eight control streets in Montreal, Canada. Their findings indicate that the protected bike lanes resulted in a 28% lower risk of injury compared to the non-bikeways.[1] Moritz (1998) found that the relative danger index of on-road bike lanes was lower than major streets without bike lanes and minor streets without bike lanes.

As part of the Bicycle Injuries and the Cycling Environment study (BICE Study), Harris et al. (2013) evaluated exposure to risk along routes with bicycle infrastructure in Toronto and Vancouver, Canada. The analysis examined rates along different types of infrastructure and streets, and also separated out intersections and street segments. The authors found that the “benefits of cycling-specific infrastructure were apparent at non-intersection locations. At non-intersection locations, cycle tracks alongside major streets... and local streets with diverters that reduced motor vehicle traffic had much lower injury risk than routes with no bike infrastructure” (Harris et al., 2013).

One non-academic group consistently argues that bicycle infrastructure reduces safety. The group, dubbed “Vehicular Cyclists,” acknowledge that bicycle infrastructure increases perceptions of safety. But they claim that bicycle infrastructure provides riders

1. *Note that Los Angeles did not install protected bike lanes in this report’s study period.*

with a false sense of security. However, according to Pucher (2001), Forester (2001) and other “vehicular cyclists” largely rely on anecdotal reports of safety, rather than actual data and analysis. Indeed, high-quality studies that support these conclusions are lacking. Therefore, I do not include these reports in this summary of the literature.

More Comfortable Routes Experience Higher Ridership

In Portland, Oregon, 56% of adults categorize themselves as “interested but concerned” when it comes to bicycling (Geller, 2009). The concerns are largely related to perceptions of safety. That is, if streets seem like they would be safe to ride on, then more people will ride on them. What influences a person’s perception of safe routes for bicycling? Bike lanes have a positive effect on cycling safety, for one: “the presence of a striped lane or separated path can increase a cyclist’s perception of safety” (Dill & Carr, 2003). Many cities have used this “interested but concerned” categorization to “demonstrate why investments in bicycle facilities are worthwhile” (Dill & McNeil, 2013).

Since perceptions of safety improve with the addition of bicycle infrastructure, and perceptions of safety influence ridership rates, it would logically follow that additional infrastructure will contribute to increases in more ridership. Indeed, an analysis of 35 large cities across the US (not including predominantly “college towns”) found that, “Higher levels of bicycle infrastructure are positively and significantly correlated with higher rates of bicycle commuting” (Dill & Carr, 2003).

The Importance of Analyzing *Ridership Rates*

If researachers only analyzed the number of crashes without also analyzing “ridership rates,” it would be easy to incorrectly conclude that bikeways make bicyclists less safe. For example, if there was one crash per year on a route prior to installation, and then two crashes per year after the bikeway was installed, it would appear that the route became more dangerous because the number of crashes doubled. However, if ridership also doubled, then the crash rate *per bicyclist* would have remained the same. If ridership quadrupled, then the crash rate per bicyclist would have been reduced by half.

Sidewalk Riding

In the 2015 LACBC Bike Count data, 31% of bicyclists reported riding on sidewalks (LACBC, 2016). Aultman-Hall & Adams (1998) find that sidewalk riding (especially sidewalk wrong-way riding) is especially dangerous: “The most significant result of the analysis is that sidewalk cyclists have higher event rates on roads than nonsidewalk cyclists.” In the 2015 bicyclist count, 53% of bicyclists rode on sidewalks while on non-bikeways, while only 27% of bicyclists rode on sidewalks on routes with bike lanes. The declines in bicyclist-involved crashes on bikeways, as found in this study, may be partially-attributed to declines in sidewalk riding.[2]

2. *Sidewalk riding data are only available in the 2013 and 2015 counts.*

3. Data & Methods

I use a quasi-experimental design in which I use “before” and “after” measures of crash rates for a treated and comparison group. In this section I describe my data and methods in three parts: bikeways, bicyclist counts, and bicyclist-involved crashes. The parts can be summed up thusly: the studied bikeways consist of newly-installed infrastructure that is accompanied by before and after bicyclist counts, with bicyclist-involved crashes attached to each of these routes. Additionally, I assemble 18 control sites. The study and control routes are all within the City of Los Angeles. The bicyclist count data are from 2009, 2011, 2013, and 2015, and the crash data are from September 2009 to December 2014.

Routes: Bikeways

Using City of Los Angeles bikeways data compiled by the Southern California Public Radio KPCC Data Team (2015), I identified 13 streets with new bikeways, all with longitudinal bicyclist counts and 10 or more crashes (Figure 4). Bikeways are often installed at different times, so across these 13 streets are 17 distinct segments (a continuous bike lane might be separated into segments in the analysis because it was installed on different dates). Bicyclist-involved crashes are not terribly common, especially when looking at particular locations and within limited time frames. By choosing sites with 10 or more crashes, I assumed that these sites might illustrate more significant changes in rates. I excluded 24 unique bikeways because they contained fewer than 10 crashes during the study period. Additionally, each bikeway is a different physical length. For each individual route, the changes in crash rates may not always seem significant. Aggregating across all 17 bikeways provides a larger sample and a more reasonable indication of changes in crash rates.

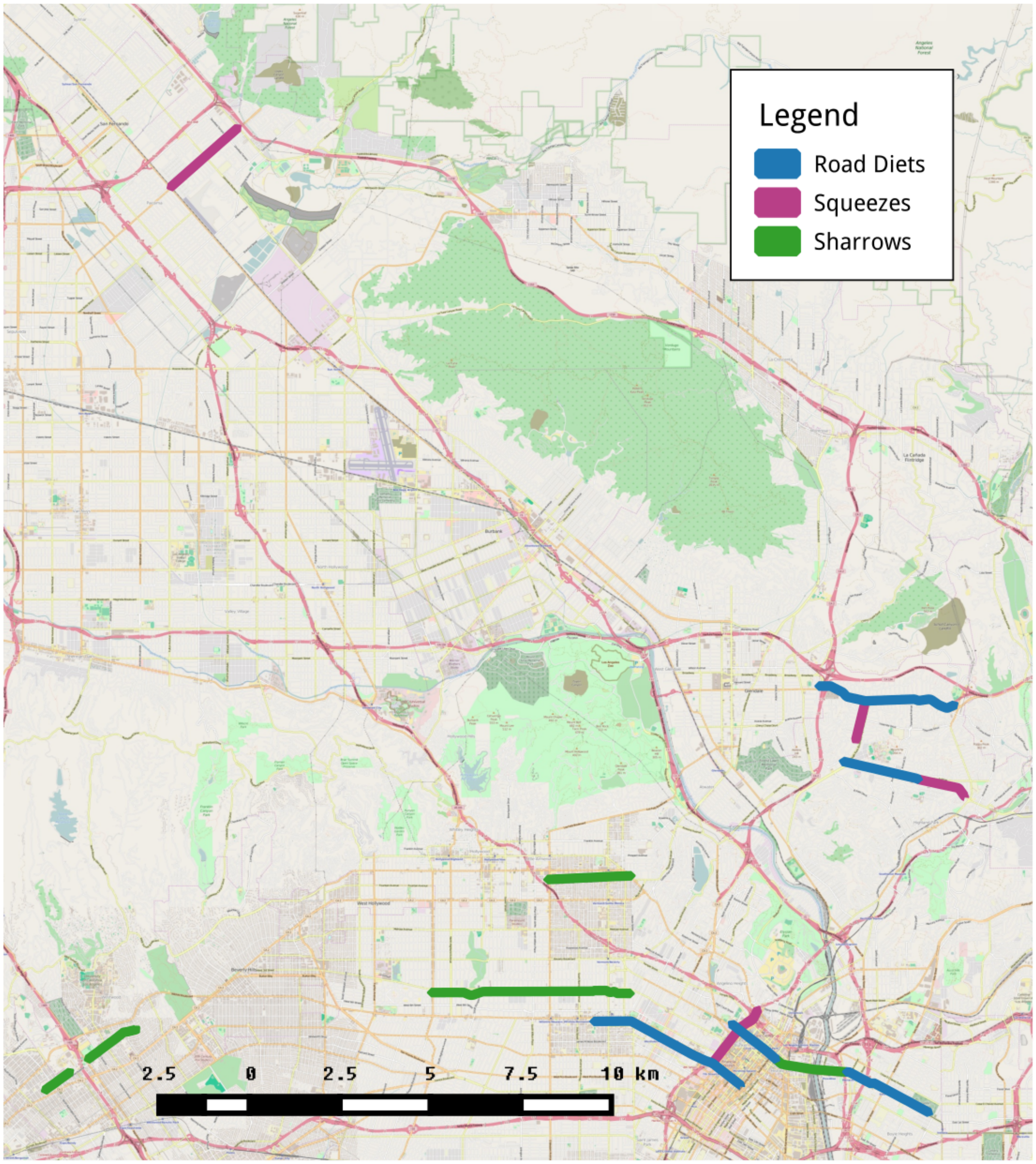

Figure 4: *Seventeen bikeway study routes (on 13 streets).*

The study routes all contain infrastructure that was built between 2010 and 2013; I chose the end of 2013 as a cut-off installation date to ensure a sufficient "after" period in which to measure crashes. The average "before" period in the study is 33 months and the average "after" period is 34 months.

Eleven of the bikeway segments are bike lanes (7 road diets and 4 squeezes), and six are sharrows. Of the more than 26 miles of bikeways, 7.5 miles are sharrows and 14.5 miles are bike lanes. The average length of each bikeway is 1.3 miles.

Control Routes: Non-Bikeways

I also identified 18 control sites with longitudinal bicyclist counts, but no bikeways (and 10 or more crashes) (Figure 5). To obtain these sites, I first identified all the count sites that have longitudinal data and were not on bikeways. Using this criterion, I identified 45 sites. Starting at the count sites, I then drew routes along the roads using Graphical Information Systems (GIS) software. In drawing these routes, I based the lengths on whether there were major cross-streets, and whether the distance would logically introduce deterioration of accuracy. The further distance an area is from the count site, the less accurate the data. And bicyclists are likely to exit onto major cross-streets (or enter from them). The sites were then narrowed to 18 based on the number of crashes within the routes.

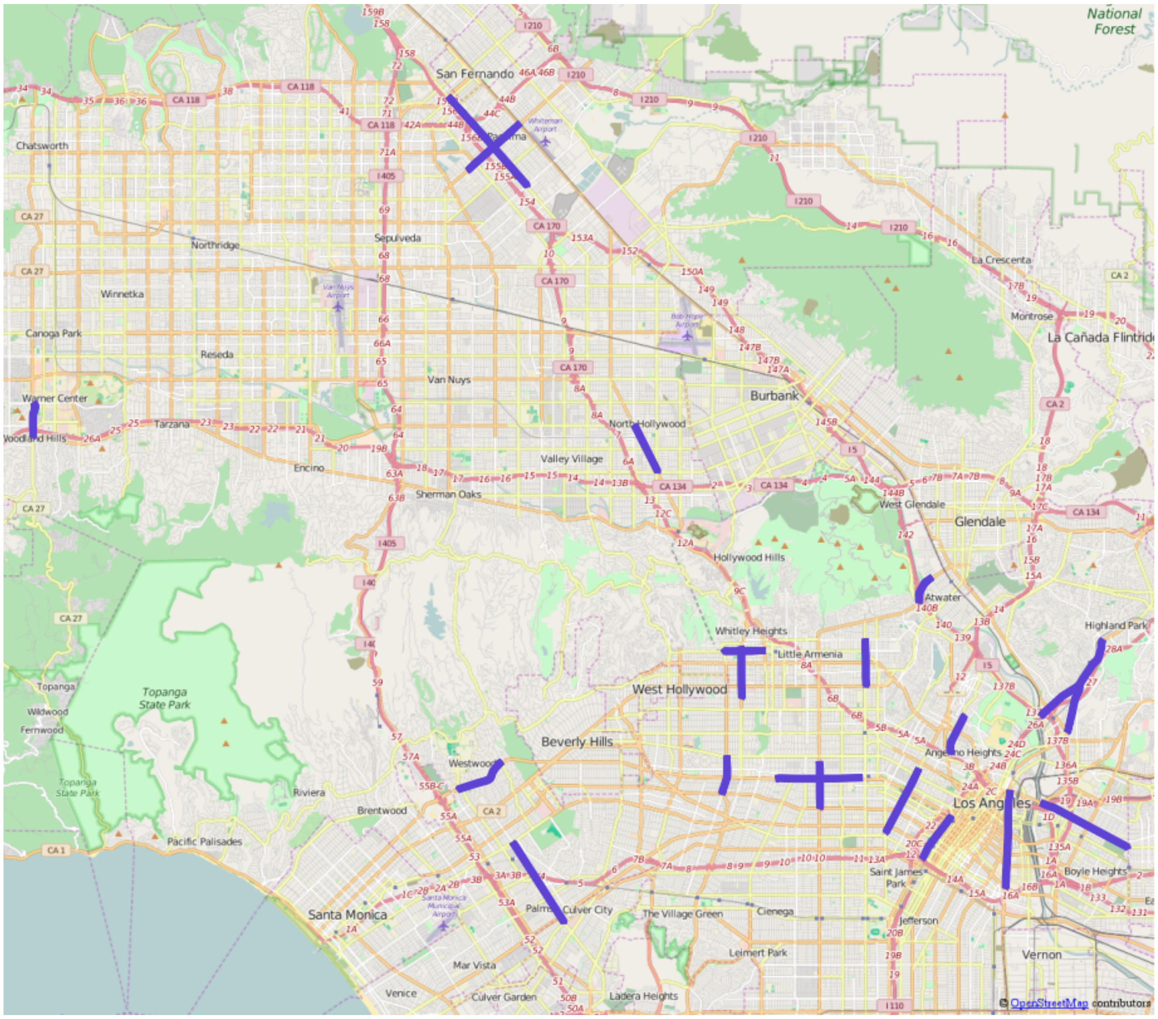

Figure 5: *Eighteen control routes.*

The control sites will illustrate underlying changes in crash rates over the study years. By comparing the routes with bicycle infrastructure to the control routes, I can determine whether changes in crash rates differ along the bikeways. Since these control routes do not have “installation dates,” I based the before/after periods on the average date of installation of the bikeways: June 2012.

Bicyclist Counts

LACBC collected ridership count data in 2009, 2011, 2013, and 2015. For each year, workers were stationed at designated sites and manually counted bicyclists from 7am-9am on a weekday, 4pm-6pm on a weekday, and 11am-1pm on a weekend. This totals six hours of counting per site every two years. The majority of the counts were completed in mid-September with the weekday counts typically done on Tuesdays and the weekend counts on Saturdays. Some make-up counts took place in late September and early October. The data are available on the UCLA Bike Clearinghouse website (UC Los Angeles, 2016).

The count data are separated into 15-minute intervals. So, each two-hour slot is eight intervals of count data. During the first two count years – 2009 and 2011 – the counts were less-consistently measured. Many sites have three or four hours of AM, PM, or weekend data (so, 12 – 16 intervals instead of eight). So that each count measures the same length of time, I normalized the data to eight intervals. For example, if an AM slot counted 60 bicyclists over the course of four hours (16 intervals), I divided 60 by 16, and then multiplied the result by eight.[3] For this example site, the normalized count of "x bicyclists per eight intervals" is 30. The normalized AM, PM, and weekend counts are then averaged for a biannual two hour total (I did not sum them because time slots are missing at some count sites).

I first conducted a descriptive analysis of these count data. The data show a significant increase in ridership (20%) across all sites between 2009 and 2011, followed by a more modest increase (2%) between 2011 and 2013, and then, finally, a decrease (9%) between 2013 and 2015 (see Figure 6).

3. *Count normalization calculation: (Count / Intervals) * 8*

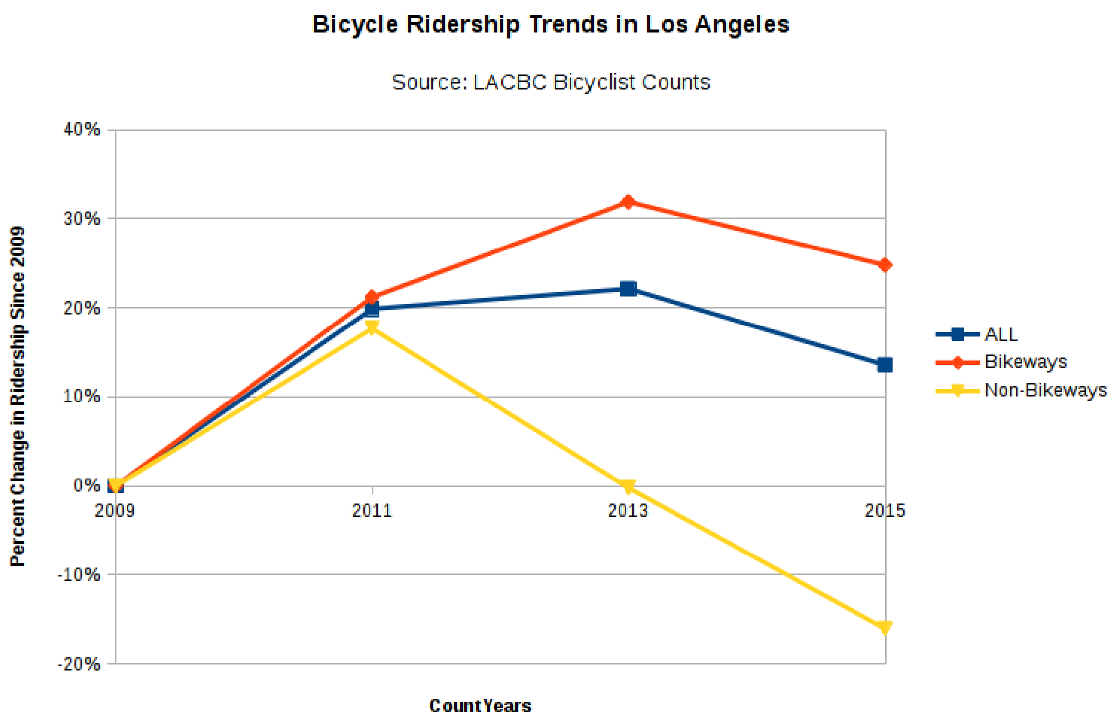

Figure 6: *Bicycle ridership trends in Los Angeles, 2009-2015.*

It is important to be cautious in interpreting these trends since six hours of observation every two years provides a rather limited set of observations. Without better baseline data, as could be supplied through more frequent counts as well as 24-hour automated counting at select locations, it is difficult to know whether the data truly measure a typical day. Factors such as weather can affect ridership levels. With high-quality baseline data, the values could be adjusted, or even expanded into annual rates. As of now, the data measure ridership for two hours during each time period; they do not measure daily, weekly, or annual ridership. While the data are not extensive, they are adequate for making basic comparisons across different count years.

An important finding from the count data analysis is that ridership on bikeways is increasing at a faster rate than on non-bikeways. Across all of the counts that are on bikeways built between 2010 and 2013, ridership increased 48% (see Figure 7).

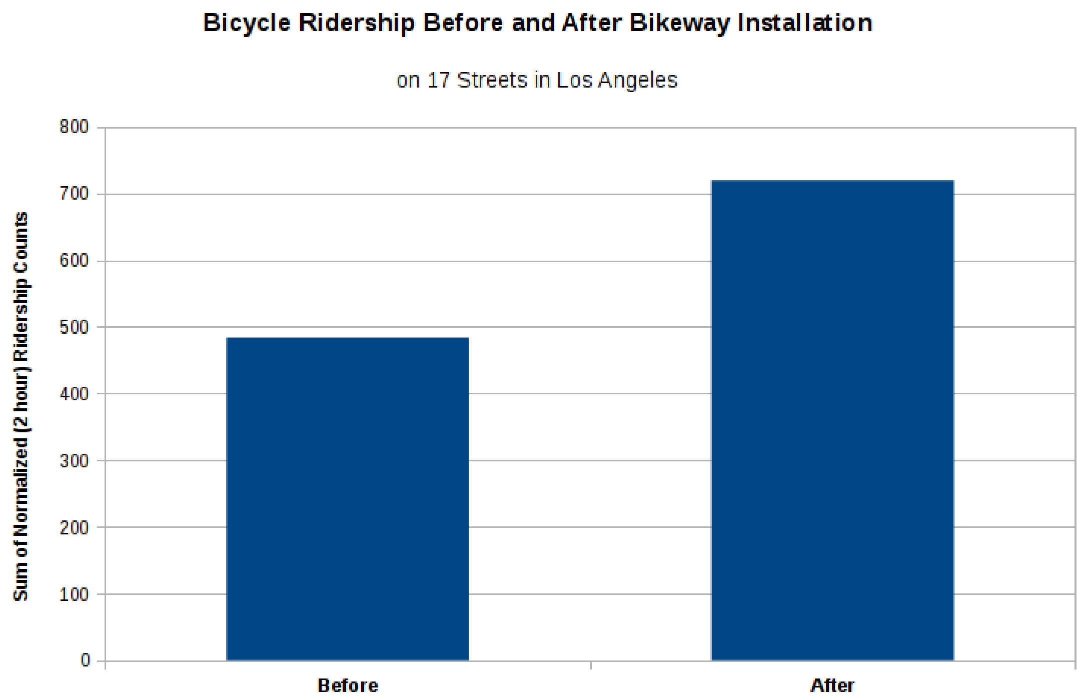

Figure 7: *Bicycle ridership along bikeways before and after installation.*

The installation date of each bikeway determines the "before" and "after" count periods. For example, if a bikeway was installed in June 2012, then the "before" count is an average of the 2009 and 2011 count data, and the "after" is an average of the 2013 and 2015 counts. Even though the 2015 counts are outside of my study period, the data are still useful for determining ridership rates within the study period. Ridership changes gradually, so averaging the 2013 and 2015 points of observation can provide an estimate of ridership levels over that period.

Crashes

Although the SWITRS crash dataset spans 2003-2014, I only included crashes from between the month of the first count. Thus the crashes are typically from September 2009 to December 2014, though for some sites they start in September 2011. I do not include crashes prior to September 2009 because I cannot determine ridership levels prior to the bicyclist counts. For this analysis I limited the data to crashes that involved a bicyclist because longitudinal volume data for pedestrians and vehicles are not available on these routes.

In their meta-analysis of 49 studies across 13 countries, Elvik & Mysen (1999) find that bicyclist crashes are often under-reported. A bicycle is less likely to cause damage to a vehicle, and thus insurance information may not be exchanged and a formal report may not be filed. For this reason, I found that some studies will seek crash data from hospitals rather than from police reports. My study uses data gathered by the California Highway Patrol. At present, the literature lacks formal methods to adjust for the under-reporting of crashes.

Capturing Crashes on Study Routes

In GIS, I created polygons around each bikeway that extend the width of the street. I then captured all the crashes within those polygons (see Figure 8). In total, there were 378 crashes along the study routes, and 460 on the control routes. These crashes are then exported to analysis software, and categorized as "before" or "after."

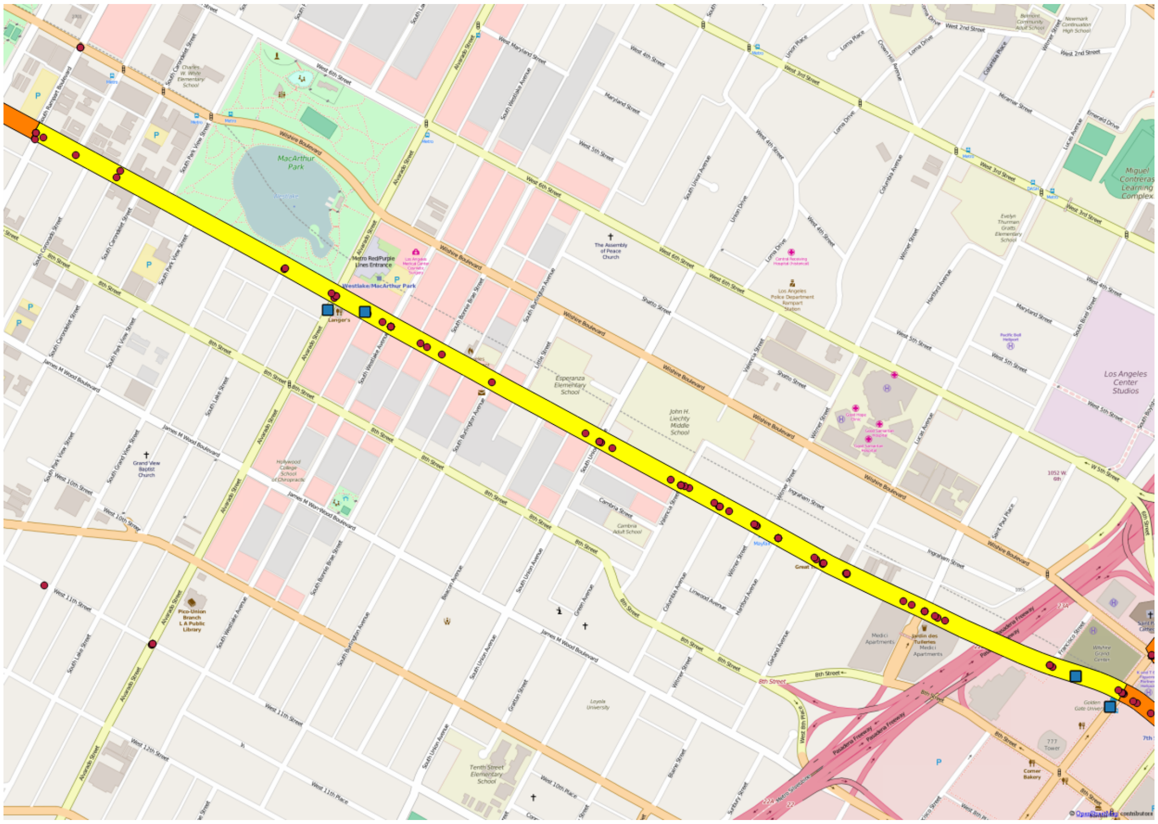

Figure 8: *Example of the GIS methodology used to capture crashes along a route.*

Categorizing Crashes as Before or After Installation

To establish the “before” crash rates, I calculated the number of months between September 2009 and the date each bikeway was installed. Crashes from the date of installation to December 2014 are considered “after.” I normalized these periods to 12 months. For example, for one site there are 39 months of “before” data, and 30 months of “after” data. There were 11 crashes in the before period, and 12 after. These crash rates can be normalized to “x per 12 months” by dividing the durations by 12, and then dividing the number of crashes by that result:

Crashes per Year calculation: Crashes / (Total Months / Months in a Year)

Before: 11 / (39 / 12) = 3.4

After: 12 / (30 / 12) = 4.8

Rates of Crashes Per Bicyclist, and Changes in Rates

In the above example, the crashes per year increased from 3.4 to 4.8. This change does not account for changes in ridership, though. I then find the crashes per rider before and after installation. For example, if there were an average of 30 bicyclists counted in a two hour period before installation, and 50 after, then the before ratio is 3.4 crashes per year to 30 bicyclists and the after ratio is 4.8 crashes per year to 50 bicyclists. Those ratios produce rates of crashes per bicyclist:

Before: 3.4 / 30 = 0.133

After: 4.8 / 50 = 0.096

When accounting for ridership, then, the rate of crashes per bicyclist decreased 28% after installation.

When analyzing all the sites together, the before rates are added together, and the after rates are added together. I then calculate the percent change between the two total values.

4. Findings and Analysis

This study aims to determine if there is a relationship between bicycling infrastructure and bicyclist-involved crashes. By aggregating data from multiple sites that share these characteristics and examining five years of crash data, I hope to identify an overall trend in crash rates. Further, by including ridership rates in the analysis, I can assess how the rate of crashes changes in relation to changes in ridership levels.

Crash Rates on Bikeways

I identified 13 streets that have longitudinal bicyclist counts *and* bikeways that were built between 2010 and 2013. Along those 13 streets are 17 unique bikeways (unique because they were built at different times, are separated by a gap, or are different types of bikeways). In the following sections, I categorize the bikeways into Road Diets, Squeezes, and Sharrows (as defined earlier), and present the overall findings for each category. I then aggregate them to produce overall findings. The detailed, individual findings for each segment are included in the Appendix.

Road Diets

Road diets are streets on which general travel lanes have been removed in order to fit new bike lanes. A typical road diet starts with a road that has two lanes in either direction, and removes one lane from each direction and adds a center turn lane and two bike lanes (see Figures 14 & 15). Road diets are considered safety-improving treatments that extend beyond the addition of bicycling amenities. Road diets generally reduce motorist travel speed and make for a safer pedestrian experience (Pawlovich, et al., 2005, Gates et al., 2007, Knapp et al., 2014). In this study, there are five road diets: 1st Street in the unincorporated city of Boyle Heights, 1st Street in Downtown Los Angeles, 7th Street in Downtown Los Angeles, Colorado Boulevard in the Eagle Rock neighborhood, and York Boulevard in Highland Park neighborhood (Figure 9).

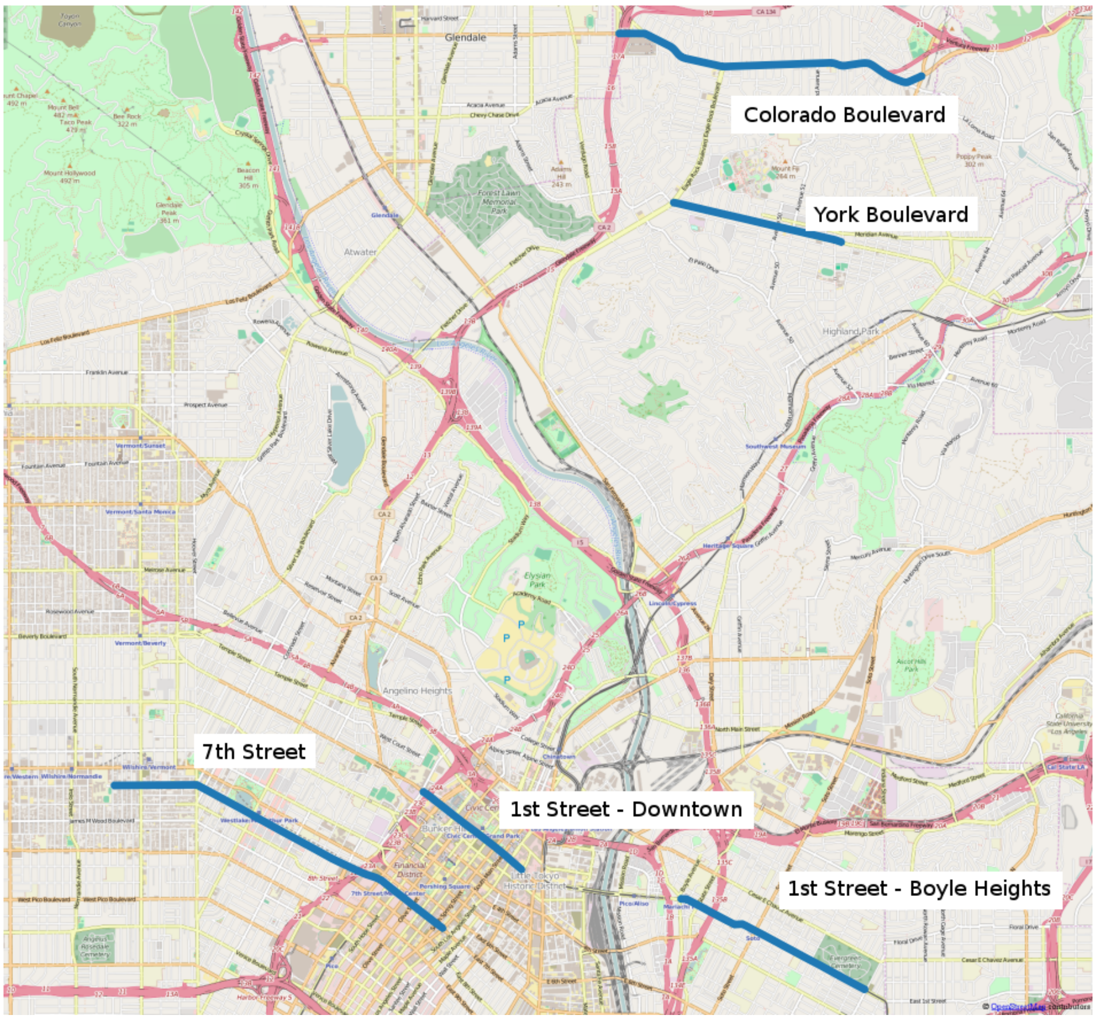

Figure 9: *Road diet bike lane study routes.*

Table 1: Road Diet Bike Lane Study Routes		
Street Name	**Length (miles)**	**Date Installed**
1st Street (Boyle Heights)	1.6	09/05/2011
1st Street (Downtown)	1	06/30/2012 & 04/18/2013
7th Street	2.8	8/30/2011 & 10/31/2013
Colorado Boulevard	2.4	10/04/2013
York Boulevard	1.3	11/19/2010 & 07/01/2012

The findings from each road diet segment can be combined to show an overall change in crash rates for the five road diets. Without accounting for ridership, there was a 21% increase in total crashes per year after the road diets were installed. But because of the increases in ridership along those routes, there was a 44% decrease in crashes per bicyclist.

Table 2: Road Diet Bike Lanes – Overall Changes in Crash Rates		
Sum of Crashes per Rider *Before*	**Sum of Crashes per Rider *After***	**Change in Crash Rate**
0.87	0.49	-44%

Ridership increased by 64% along streets that had installed the road diets.

"Squeeze" Bike Lanes

"Squeezes" are bike lanes that are installed without removing general travel lanes or parking. They often involve the slight narrowing of general travel lanes to fit in a five- to six-foot bike lane, hence the "squeeze." Because they are easier to implement than road diets, they are sometimes considered opportunistic bike lanes – that is, that they add miles to the bicycling network but are disconnected from other routes. However, the routes in this study all fit well into the existing network.

In this study, there are four squeezes: Eagle Rock Boulevard, Van Nuys Boulevard, Figueroa Street, York Boulevard (see Figure 10). Eagle Rock Boulevard closes a gap in the bike lane on that street and connects to the Colorado Boulevard bike lane; Figueroa Street has additional bike lanes in the planning phase (in Downtown), which will connect to this one; York Boulevard extends an existing bike lane, creating a 3-mile bike lane from the Eagle Rock Boulevard bike lane to the border of South Pasadena. Van Nuys Boulevard intersects the Glenoaks Boulevard bike lane. Furthermore, since 2013 the City has further filled out the network by installing additional bike lanes on Van Nuys Boulevard.

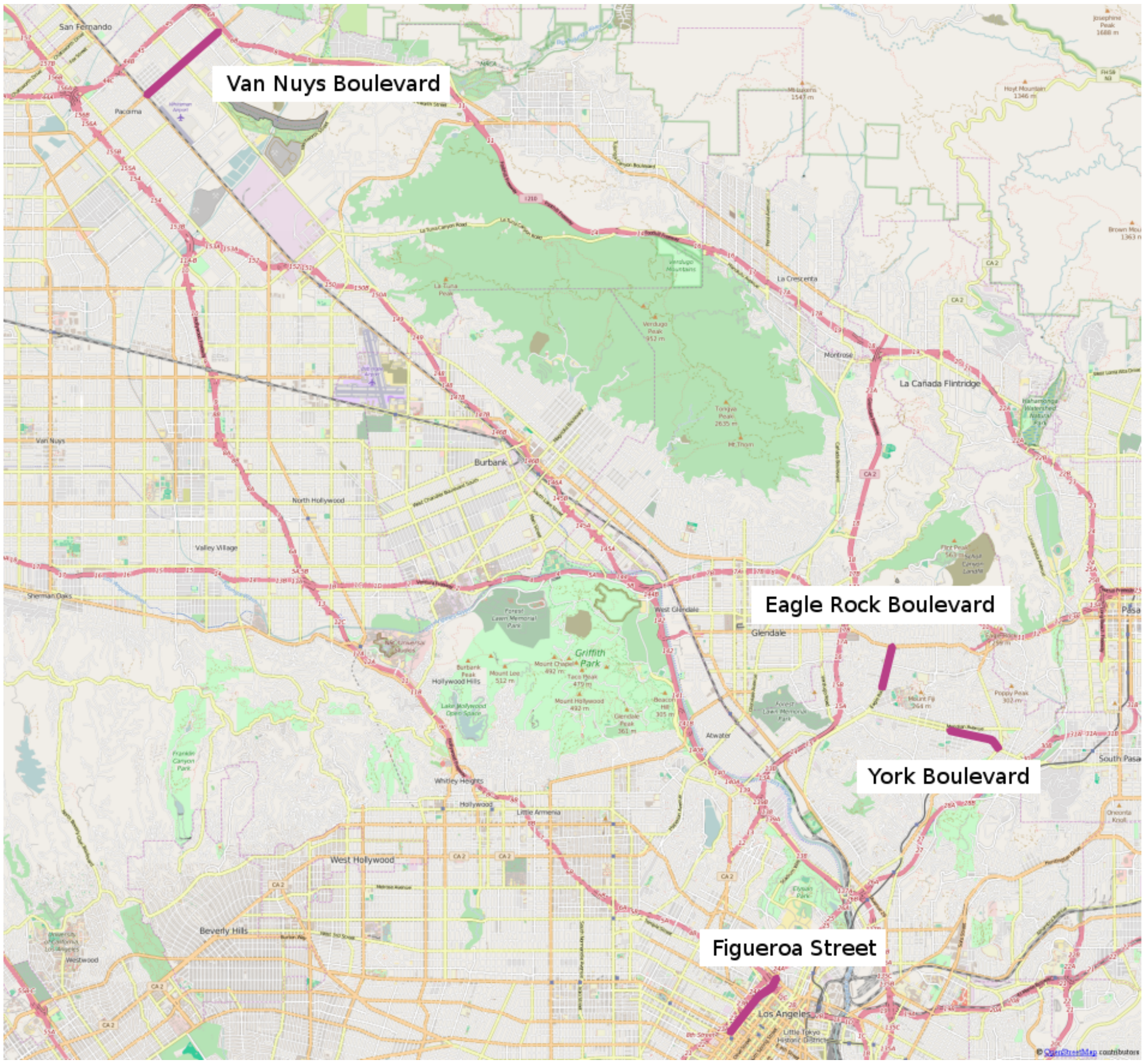

Figure 10: *"Squeeze" bike lane study routes.*

Table 3: Squeeze Bike Lane Study Routes		
Street Name	**Length (miles)**	**Date Installed**
Eagle Rock Boulevard	0.7	06/17/2013
Van Nuys Boulevard	1.5	12/28/2012
Figueroa Street	1.2	05/01/2013
York Boulevard	0.9	07/01/2012

The findings from each "squeeze" bike lane can be combined to show an overall change in crash rates for the four "squeeze" bike lanes. Without accounting for ridership, there was a 20% decrease in total crashes per year after the bike lanes were installed. Because of the changes in ridership along those routes, there was a 38.5% decrease in crashes per bicyclist.

Table 4: Squeeze Bike Lanes – Overall Changes in Crash Rates		
Sum of Crashes per Rider *Before*	**Sum of Crashes per Rider *After***	**Change in crash rate**
0.52	0.32	-38.5%

Ridership increased along the "squeeze" bike lanes 18% after installation.

Overall Bike Lane Findings

The nine bike lanes in this study can be combined to show an overall change in crash rates. Without accounting for ridership, there was a 7% increase in total crashes per year after the bike lanes were installed. But because of the increases in ridership along those routes, there was a 42% decrease in crashes per bicyclist.

Table 5: All Bike Lanes – Overall Changes in Crash Rates		
Sum of Crashes per Rider *Before*	Sum of Crashes per Rider *After*	Change in crash rate
1.4	0.8	-42%

Ridership increased 56% after installation of the bike lanes.

Sharrows

Sharrows are bike routes on which shared-lane markings are stenciled on the roadway. Sharrows sometimes fill gaps on routes with incomplete bike lanes, or they simply enhance existing Bike Routes (which are designed to have no on-street markings). Evaluations of sharrows have found that they reduce sidewalk riding, guide bicyclists further away from the door-zone of parked vehicles, and also cause motorists to give more room to bicyclist when passing (Alta Planning & Design, 2004). Critics contend that they are ineffective infrastructure because motorists do not notice them or know what they mean, and they are misused by cities by placing them on high-vehicle traffic routes (Lewis, 2015; Maus, 2009; Montgomery, 2015; van Veen, 2015).

In this study, there are four sharrows: 1st Street, 4th Street, Fountain Avenue, and Ohio Street (Figure 11).

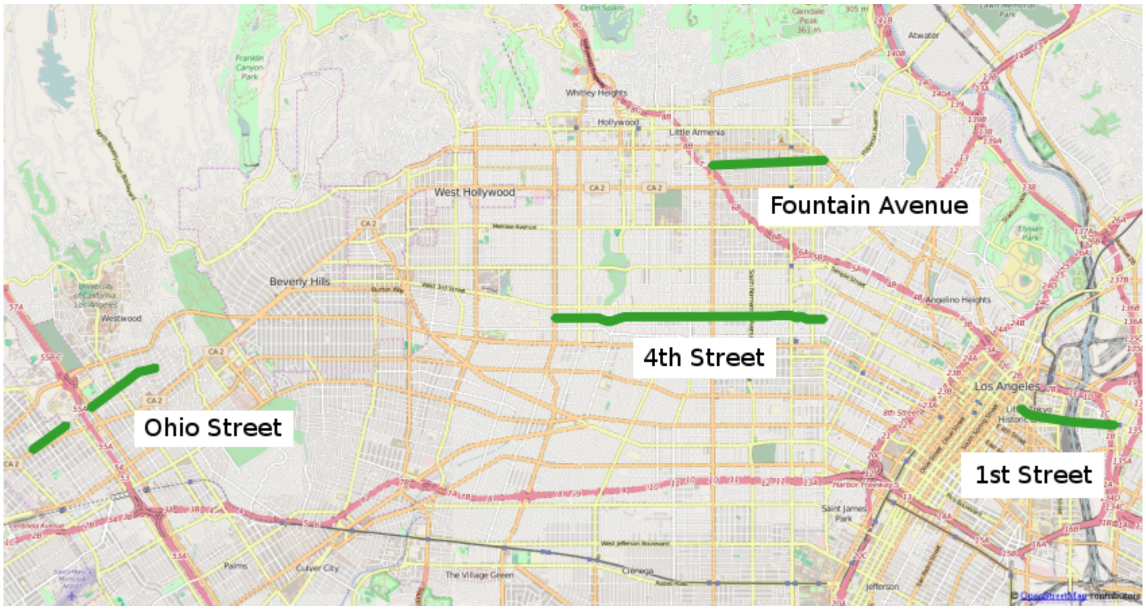

Figure 11: *Sharrows study routes.*

Table 6: Sharrows Study Routes		
Street Name	**Length (miles)**	**Date Installed**
1st Street	1.2	04/01/2013
4th Street	3.3	07/29/2010
Fountain Avenue	1.5	07/14/2010 & 10/02/2011
Ohio Street	1.5	04/04/2013 & 04/26/2013

The four sharrows in this study can be combined to show an overall change in crash rates. Without accounting for ridership, there was a 13% increase in total crashes per year after the sharrows were installed. But because of the increases in ridership along those routes, there was a 39% decrease in crashes per bicyclist.

Table 7: Sharrows - Overall Changes in Crash Rates		
Sum of Crashes per Rider *Before*	**Sum of Crashes per Rider *After***	**Change in crash rate**
0.67	0.41	-39%

Ridership increased after the installation of the sharrows by 54%.

Overall Bikeways Findings

The above findings can be combined to show an overall change in crash rates for the five road diets, four "squeeze" bike lanes, and four sharrows. As a reminder, there are 17 distinct segments throughout these 13 bikeways (distinct due to location or date of installation). Without accounting for ridership, there was a 9% increase in total crashes per year after the bikeways were installed. But because of the increases in ridership along those routes, there was a 43% decrease in crashes per bicyclist.

Table 8: All Bikeways - Overall Changes in Crash Rates		
Sum of Crashes per Rider *Before*	**Sum of Crashes per Rider *After***	**Change in crash rate**
1.99	1.14	-43%

Crash Rates on Non-bikeways (Control Routes)

On the 18 non-bikeway count sites, I drew routes along them that are between 0.5 and 2 miles long, and average 1.3 miles. These routes do not need to mirror the bikeway routes (by variables like length, type of streets, vehicle volume, etc.) since the gross number of crashes are not important; rather, the *changes* in rates are important.

Across all 18 non-bikeway routes, there were 74.2 crashes per year in the "before" period, and 87.6 crashes per year in the "after" period. These figures show an 18% increase in crashes per year.

Across the 18 non-bikeway routes, the number of bicyclists remained steady. There were 600 bicyclists every two hours in the "before" period, and 590 bicyclists every two hours in the "after" period. The change in ridership in this sample is less than the decrease on all non-bikeways (as seen in Figure 6)..

Therefore, on the control routes, the number of crashes increased while ridership remained the same. Factoring in both crashes and ridership, in the "before" period there was a sum of 2.37 crashes per year per two hour volume of bicyclists. In the "after" period, there were 2.89 crashes per year per two hour volume of bicyclists. This is an overall 22% increase in crashes per bicyclist on the control routes. The findings for each individual segment is included in Table 27 in the Appendix.

Table 9: Control Routes - Overall Changes in Crash Rates

Sum of Crashes per Rider *Before*	Sum of Crashes per Rider *After*	Change in crash rate
3.1	3.3	44%

Analysis

Despite the differences in design, there was little variation in rates of crashes per bicyclist between overall road diet bike lanes (-44%), overall "squeeze" bike lanes, (-39%) and overall sharrows (-43%) (Figure 12). Yes, there were variations/outliers in each grouping – segments that saw increases in crashes per bicyclist – but when combined, the variation was minimal (see Appendix).

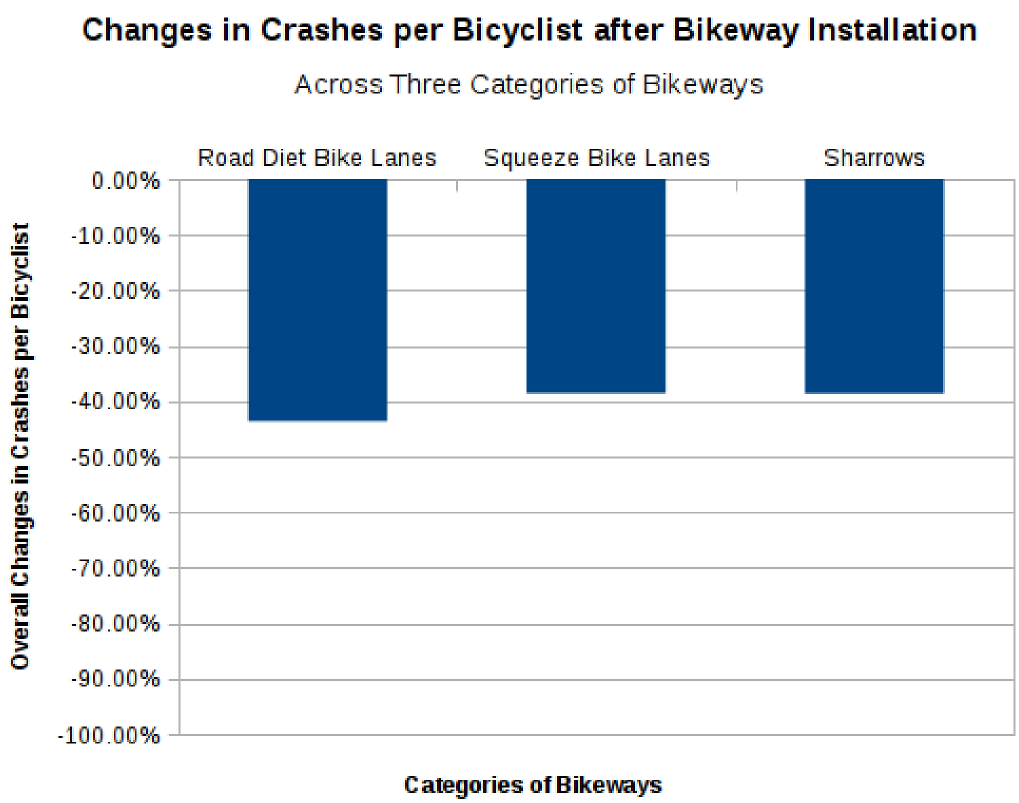

Figure 12: *Changes in crashes per bicyclist after bikeway installation.*

The findings for each individual site are sensitive due to small samples sizes (crashes, and ridership). For example, across all bikeways there was an average of only four crashes per year before installation, and 4.3 crashes per year after. A small fluctuation in crashes at a site can change the findings. The same is true for a relatively small fluctuation in crashes per year. With all of the routes aggregated, though, the findings are less sensitive to small variations.

The crash data are comprehensive for each location, but the ridership data are limited observations. Each site has one to three before and after ridership counts, and each of those counts is using four to six hours of observation. Therefore, each count relies completely on what was observed at those particular small points in time. Having more count data would strengthen the analysis, especially for each individual site.

The sum of crashes per bicyclist on the 17 bikeway routes before installation was similar to the sum on the 18 non-bikeway routes. Figure 13 illustrates how the findings on the two sets of data diverged after installation.

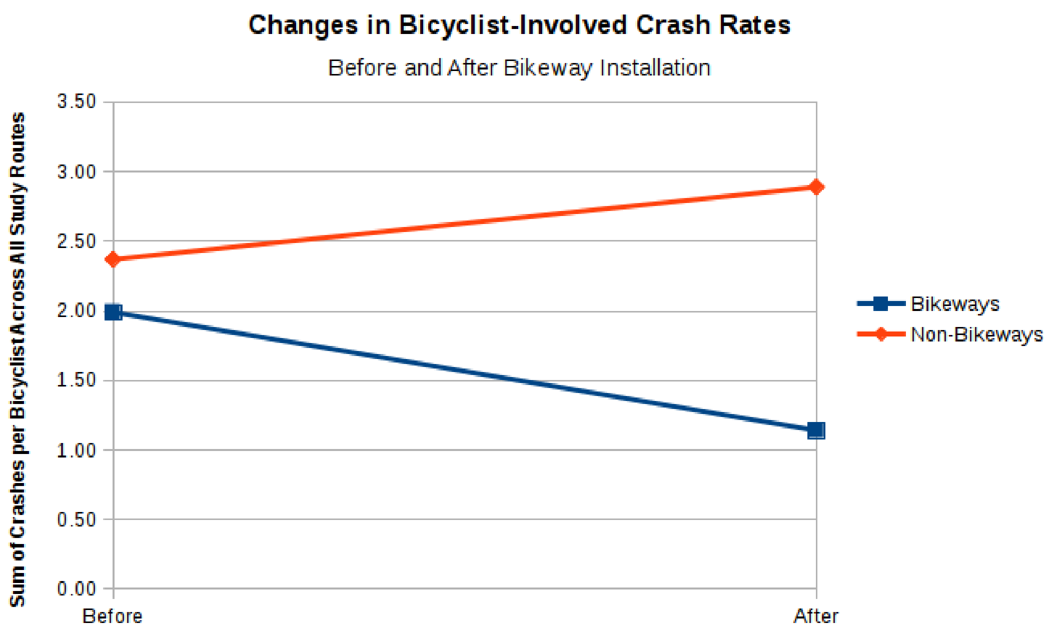

Figure 13: *Changes in bicyclist-involved crash rates - bikeways vs control routes.*

I do not have an explanation for why crashes on the control routes increased while ridership remained flat. To ensure that the June 2012 "installation" date for the non-bikeways is not influencing the results, I also calculated crash rates along those routes using each month in 2012 as the before/after cut-off. Changing the month that determines whether a crash is "before" or "after" did not change the overall results.

5. Recommendations

Based on my observations, as well as the findings, I cannot make a recommendation for where bikeways should be added, nor what type of bikeways should be added. All three categories of bikeways produced strong decreases in crashes. The City already has a list of 328 priority bikeways (lanes, routes, and bicycle friendly streets), as well as a second priority list that accompanied the 2010 Bicycle Plan Implementation Strategy. Ninety-eight of them have been implemented since the lists were created. These lists, coupled with Vision Zero LA's high injury network, can guide future implementation. My general recommendation, then, is for the City to use this report's findings to build political support for the installation of bikeways. The support of Council and community members will be necessary, particularly with respect to the implementation of some of the more controversial bikeway projects. If the installation of bikeways has indeed slowed because the low-hanging fruit has been picked, the findings from this study – linking bikeways to a reduction in crashes – can help the City get back on pace.

The Los Angeles County Bicycle Coalition's bi-annual bicyclist counts are valuable measurements, especially in a city that intends to invest in bicycling infrastructure, yet does not bother to count bicyclists. The LACBC's counts, and the UCLA Bike Clearinghouse's management of the data, provide ready opportunities for researchers to evaluate ridership. Without these data, five of the sites would simply be reporting an increase in crashes, with no other context provided. The ridership counts provide crucial context for evaluating safety. While no one wants to see greater numbers of crashes, it is reassuring that the injuries *per person* have decreased along bikeways.

I recommend the City of Los Angeles demonstrate their commitment to active transportation by sponsoring bicyclist counts on an annual basis, as well as implementing continuous automated counts throughout the city. These data collection efforts would provide additional data points and, therefore, strengthen this type of analysis. For the City, the three points of focus should be:

- ***Automated counts***, so as to develop 24-hour baseline counts.

- ***Before and after counts at bikeways***. The City knows the locations of new bikeways; and in every instance they should run counts before and after installation.

- ***Frequent counts***, run throughout the year. Data from multiple counts would allow researchers to analyze whether ridership fluctuated throughout the year, perhaps with the seasons. It would also allow researchers to assess whether previous September counts were representative of ridership throughout the year.

The bikeways data are also valuable. Midway through this analysis, the City of Los Angeles released up-to-date GIS data for the bikeways (including installation date). Prior to this release, these data were only available via third parties. (I used a GIS file compiled by the Southern California Public Radio KPCC data team.) The KPCC file was a lifesaver considering the only official datasets at the time were three years old. I applaud the City of Los Angeles for publishing their dataset, and I strongly recommend that they keep it up to date.

6. Acknowledgements

For her help in shaping the narrative, crafting the analysis, and carefully editing the report, I would like to thank Dr. Evelyn Blumenberg at the UCLA Luskin School for Public Affairs. For her insights into methods of analysis, I thank Herbie Huff at UCLA's Institute for Transportation Studies. For managing and cleaning the count data, I would like to thank Norman Wong (UCLA's Institute of Transportation Studies) and Hyeran Lee (LACBC).

7. Appendix

The Appendix includes additional contextual information for each study segment, as well as individual findings.

Detailed Before and After Road Diet Sections

Figures 14 and 15 depict a section view of a typical road diet.

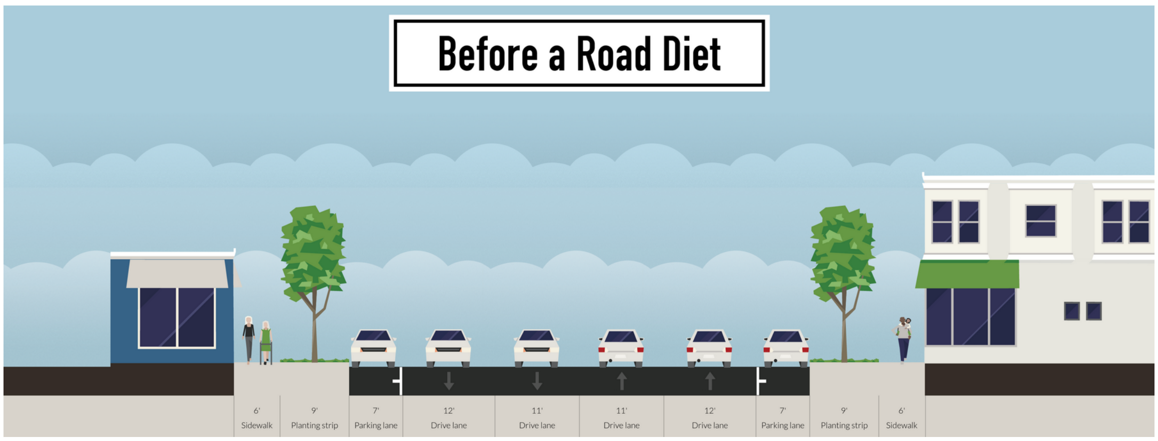

Figure 14: *Typical pre-road diet street section. Source: http://streetmix.net*

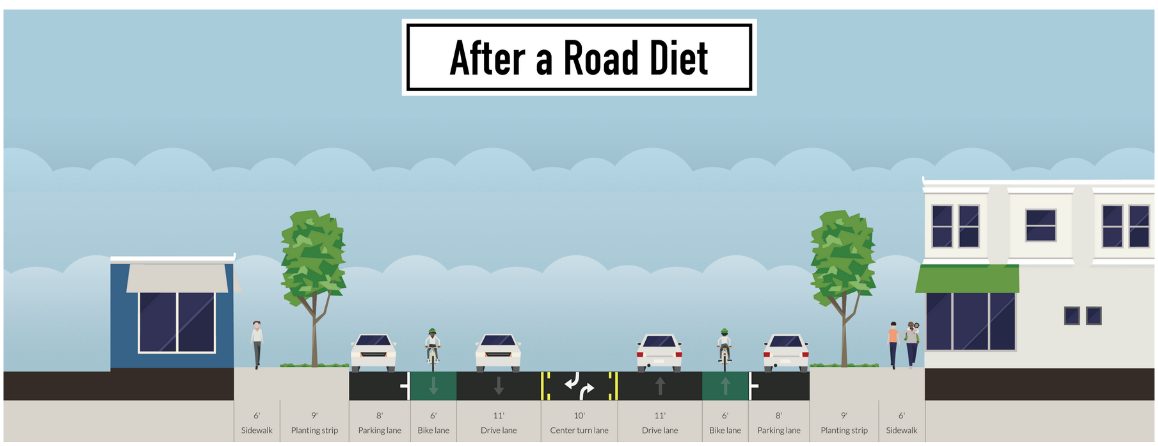

Figure 15: *Typical post-road diet street section. Source: http://streetmix.net*

Road Diets

1st Street (Boyle Heights)

This segment is a 1.6 mile long road diet in the unincorporated city of Boyle Heights, a community located to the immediate east of downtown Los Angeles. The road diet was installed on September 5, 2011.

Table 10 shows the before and after total crashes and average ridership (ridership is based on a two-hour period), the rates of crashes per rider before and after, and the change in rates. In the 24 months prior to the road diet on this segment of 1th Street, there were three total bicyclist-involved collisions, producing a rate of about 1.5 collisions per year. After the road diet, there were 13 collisions in 39 months, for a rate of four per year. Without accounting for ridership, this is a 167% increase in total crashes. Ridership along the route increased from 30 bicyclists per two- hour period, to 41. This is a 38% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was a 94% increase after the installation of the road diet.

Table 10: 1st Street (Boyle Heights) Road Diet Bike Lane. Installed September 5, 2011. Length: 1.6 miles.

Months *Before*	Months *After*	Average Riders *Before*	Average Riders *After*	Change in Ridership
24	39	30	41	38%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
1.5	4	0.05	0.1	94%

Figure 16 shows the 1st Street bike lane (in yellow). The red dots represent bicyclist-involved crashes during the study period. The blue square on the route represents the location where the bicyclist counting took place. Red dots outside of the highlighted route are bicyclist-involved crashes on other bikeways,[4] and blue squares outside of the highlighted route are other count locations.

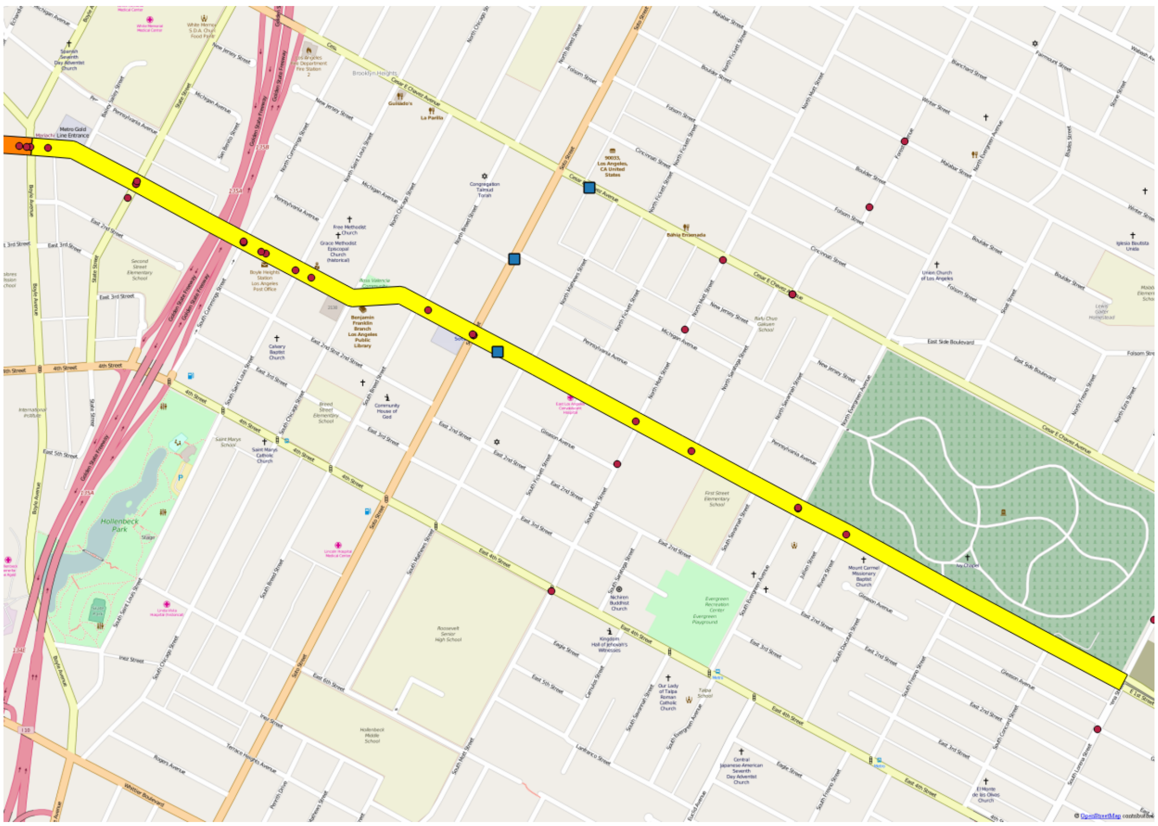

Figure 16: *Map of 1st Street (Boyle Heights) road diet bike lane, installed September 5, 2011. Length: 1.6 miles.*

4. *Other nearby bikeways, and their crash/count data are visible on some, but not all, of the maps in the Appendix.*

1st Street (Downtown Los Angeles)

This segment is 1.2 miles west of the 1st Street (Boyle Heights) segment (they are separated by a 1.2 mile long sharrow route, which is also analyzed in this study). The 1st Street (Downtown) segment is 1-mile long, and was constructed at two different times (June 30, 2012 & April 18, 2013). The analysis, then, considers each of those as a separate bikeway, with different before and after periods. But they both share the same bicyclist count location.

The June 30, 2012 segment of the 1st Street (Downtown) bike lane is 0.4 miles long (Figure 17). In the 33 months prior to the road diet on this segment of 1th Street, there were 7 total bicyclist-involved collisions, producing a rate of about 2.5 collisions per year. After the road diet, there were 9 collision in 30 months, for a rate of 3.6 per year. Without accounting for ridership, this was a 41% increase in total crashes. Ridership along the route increased from 25 bicyclists per two-hour period to 72. This is a 185% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was a 50% decrease after the installation of the road diet (Table 11).

Table 11: 1st Street (Downtown) Road Diet Bike Lane – June 30, 2012 Segment. Length: 0.4 miles.				
Months *Before*	**Months *After***	**Average Riders *Before***	**Average Riders *After***	**Change in Ridership**
33	30	25	72	185%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
2.5	3.6	0.1	0.05	-50%

Figure 17: *Map of 1st Street (Downtown) road diet bike lane. Installed June 30, 2012. Length: 0.4 miles.*

The April 18, 2013 segment of the 1st Street (Downtown) bike lane is 0.6 miles long (Figure 18). In the 43 months prior to the road diet on this segment of 7th Street, there were 4 total bicyclist-involved collisions, producing a rate of about 1.1 collisions per year. After the road diet, there was one collision in 20 months, for a rate of 0.6 per year. Without accounting for ridership, this is a 46% decrease in total crashes. Ridership along the route increased from 25 bicyclists per two hour period to 72. This is a 185% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was an 81% decrease after the installation of the road diet (Table 12).

Table 12: 1st Street (Downtown) Road Diet Bike Lane – April 18, 2013 Segment. Length: 0.6 miles.

Months *Before*	Months *After*	Average Riders *Before*	Average Riders *After*	Change in Ridership
43	20	25	72	185%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
1.1	0.6	0.04	0.01	-81%

Figure 18: *Map of 1st Street (Downtown) road diet bike lane. Installed April 18, 2013. Length: 0.6 miles.*

Figure 19 shows both 1st Street (Downtown) road diet bike lane segments together. The count location that was used to supply ridership data for these segments is not on either of the segments. It can be seen (the blue square) in the lower right corner. Because there are no major streets between the count site and the bike lane segments, I assumed that the count site documents ridership along the route. Note that this same count location is also used, in this study, to measure ridership along the 1st Street sharrow route.

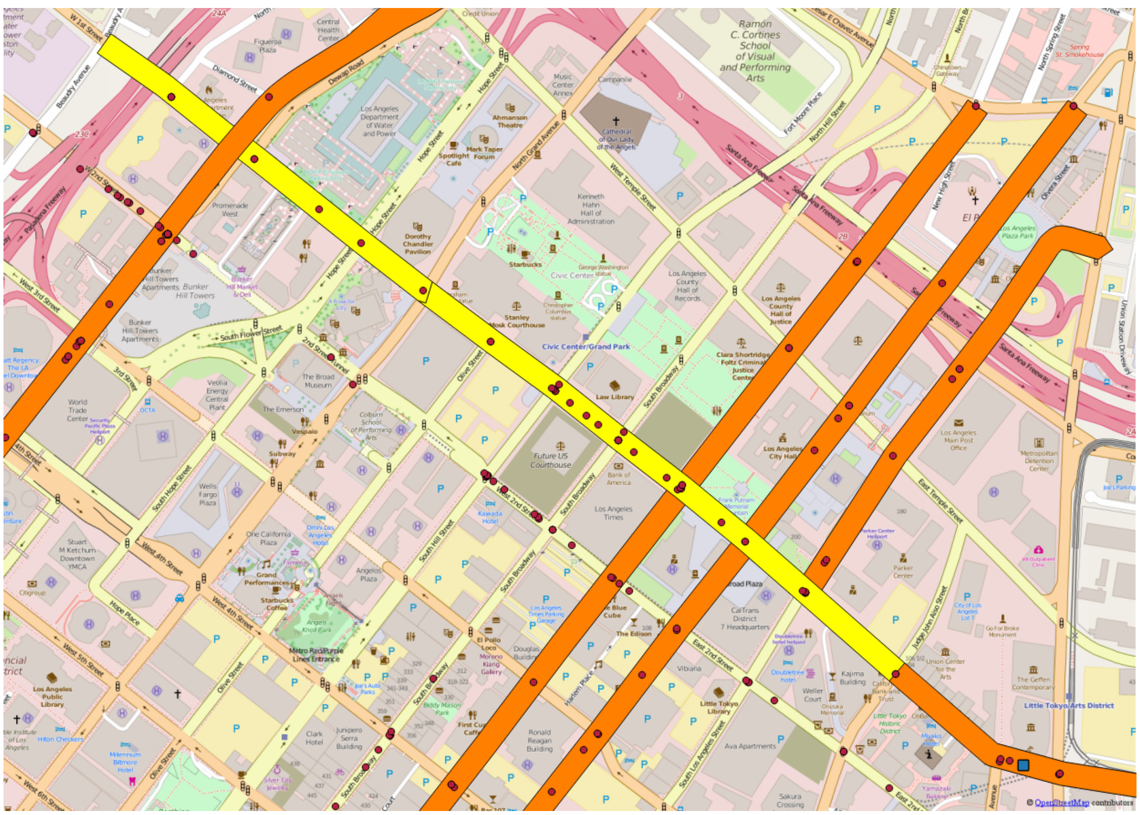

Figure 19: *Map of 1st Street (Downtown) combined road diet bike lane segments.*

7th Street

This 7th Street road diet segment is 2.8 miles long, and was constructed at two different times (August 30, 2011 & October 31, 2013). As can be seen in Figure 18, there are two bicyclist count locations on the August 30, 2011 7th Street bike lane. The count data of those two sites were averaged together.

The segment of 7th Street installed on August 30, 2011 is 2.2 miles long (Figure 20). In the 23 months prior to the road diet on this segment of 7th Street, there were 19 total bicyclist-involved collisions, producing a rate of about 9.9 collisions per year. After the road diet, there were 46 collisions in 40 months for a rate of 13.8 per year. Without accounting for ridership, this was a 39% increase in total crashes. Ridership along the route increased from 70 bicyclists per two-hour period to 118. This is a 70% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was an 18% decrease after the installation of the road diet (Table 13).

Table 13: 7th Street Road Diet bike Lane. Installed August 30, 2011. Length: 2.2 miles.

Months *Before*	Months *After*	Average Riders *Before*	Average Riders *After*	Change in Ridership
23	40	70	118	70%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
10	13.8	0.14	0.12	-18%

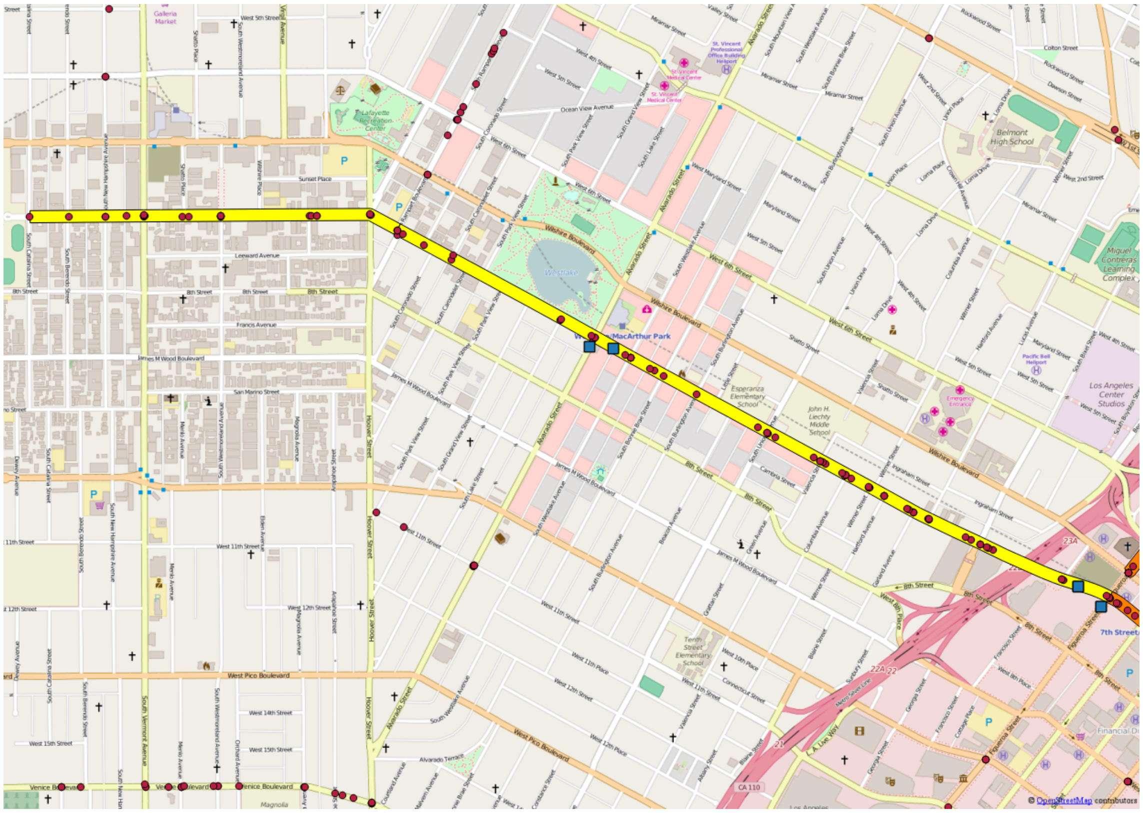

Figure 20: *Map of 7th Street road diet bike lane. Installed August 30, 2011. Length: 2.2 miles.*

This next segment of 7th Street, installed on October 31, 2013, is 0.6 miles long and connects with the previous section (Figure 21).[5] In theory, I could combine these two segments into an overall finding by averaging the ridership across it all. But I believe doing so would weaken the findings. I am already making assumptions by quantifying ridership throughout the length of the bikeway. Longer bikeways result in less precise counts.

In the 49 months prior to the road diet on this segment of 7th Street, there were 28 total

5. *There is a count site directly on this segment. The map does not display it because the count was only conducted in 2015. But I used the data when averaging ridership.*

bicyclist-involved collisions, producing a rate of about 6.9 collisions per year. After the road diet, there were 14 collisions in 14 months, a rate of 12 per year. Without accounting for ridership, this was a 75% increase in total crashes. Ridership along the route increased from 107 bicyclists per two hour period to 152. This was a 42% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was a 23% increase after the installation of the road diet (Table 14).

Table 14: 7th Street Road Diet Bike Lane. Installed October 31, 2013. Length: 0.6 miles.

Months *Before*	Months *After*	Average Riders *Before*	Average Riders *After*	Change in Ridership
49	14	107	152	42%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
6.9	12	0.06	0.08	23%

Figure 21: *Map of 7th Street road diet bike lane. Installed October 31, 2013. Length: 0.6 miles.*

Colorado Boulevard

Colorado Boulevard in the Eagle Rock neighborhood contains a 2.4-mile bike lane (Figure 22). It stretches from the border of the City of Glendale to Figueroa Street. Prior to the road diet, Colorado Boulevard had three lanes in either direction, plus a grassy median and on-street parking. The road diet removed one lane in each direction, and in parts added a painted buffer between the bike lane and the general vehicle lane.

In the 49 months prior to the Colorado Boulevard road diet, there were 21 total bicyclist-involved collisions, producing a rate of about 5.1 collisions per year. After the road diet, there was one collision in 14 months, for a rate of about 0.9 per year. Without accounting for ridership, this is an 83% decrease in total crashes. Ridership along the route increased from 27 bicyclists per two hour period, to 34. This is a 26% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was an 87% decrease after the installation of the road diet (Table 15).

Table 15: Colorado Boulevard Road Diet Bike Lane. Installed October 04, 2013 (Length: 2.4 miles)				
Months *Before*	**Months *After***	**Average Riders *Before***	**Average Riders *After***	**Change in Ridership**
49	14	27	34	26%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
5.1	.86	0.19	0.02	-87%

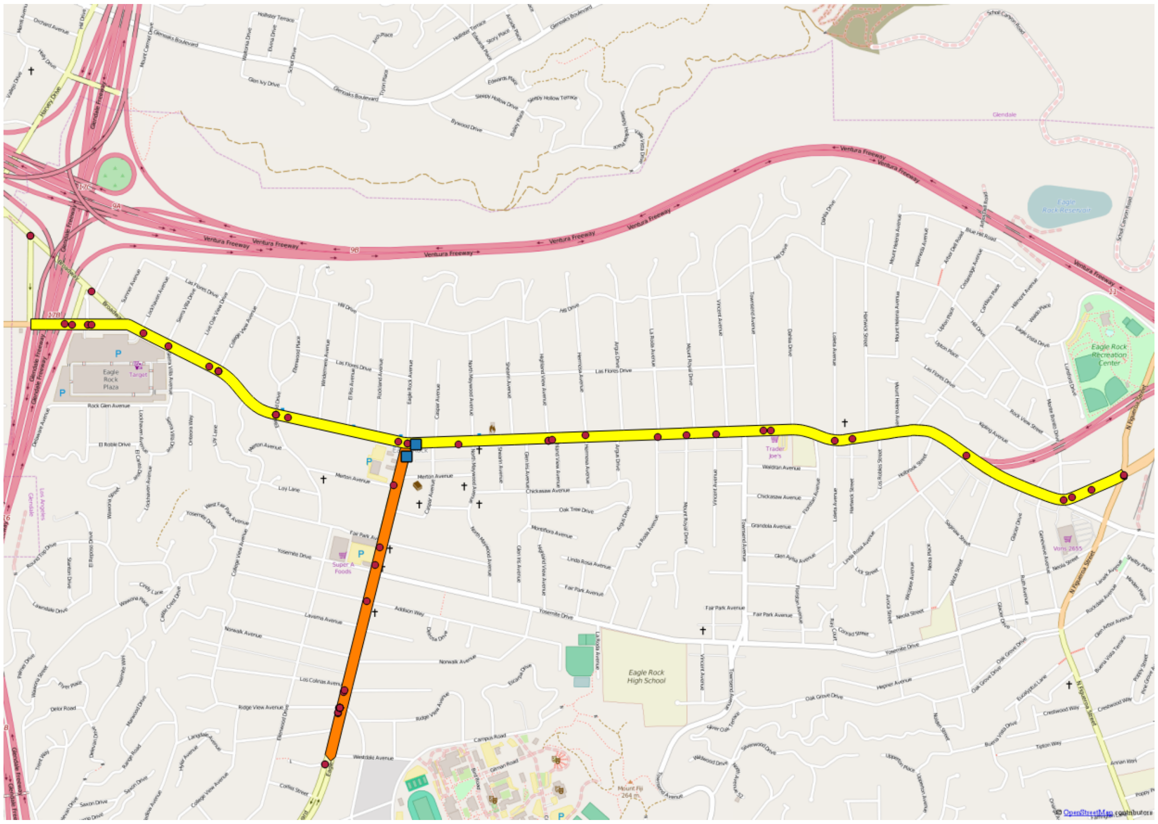

Figure 22: *Map of Colorado Boulevard road diet bike lane. Installed October 04, 2013. Length: 2.4 miles.*

York Boulevard

The York Boulevard bike lane, in the Highland Park neighborhood, is currently 3-miles long, extending from Eagle Rock Boulevard in the west to Arroyo Drive in South Pasadena. But it was constructed at three different times, and not all segments were road diets. This segment in this part of the analysis was a road diet (changing from two general vehicle lanes in each direction to one, plus a middle turn lane). It is 1.3 miles long, and runs through a recently-revitalized commercial corridor (Figure 23). In a subsequent section, I analyze the "squeeze" segment that is adjacent to the road diet.

Before the road diet on York Boulevard, there were six bicyclist-involved collisions in 14 months, and 17 after in 49 months. Without accounting for ridership, this is a 19% decrease in crashes per year. Ridership before and after changed from an average of 18 per two hours counted to 36. This is a 96% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was a 59% decrease after the installation of the road diet (Table 16).

Table 16: York Boulevard Road Diet Bike Lane. Installed November 11, 2010. Length: 1.3 miles.

Months *Before*	Months *After*	Average Riders *Before*	Average Riders *After*	Change in Ridership
14	49	18	36	96%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
5.1	4.2	0.28	0.12	-59%

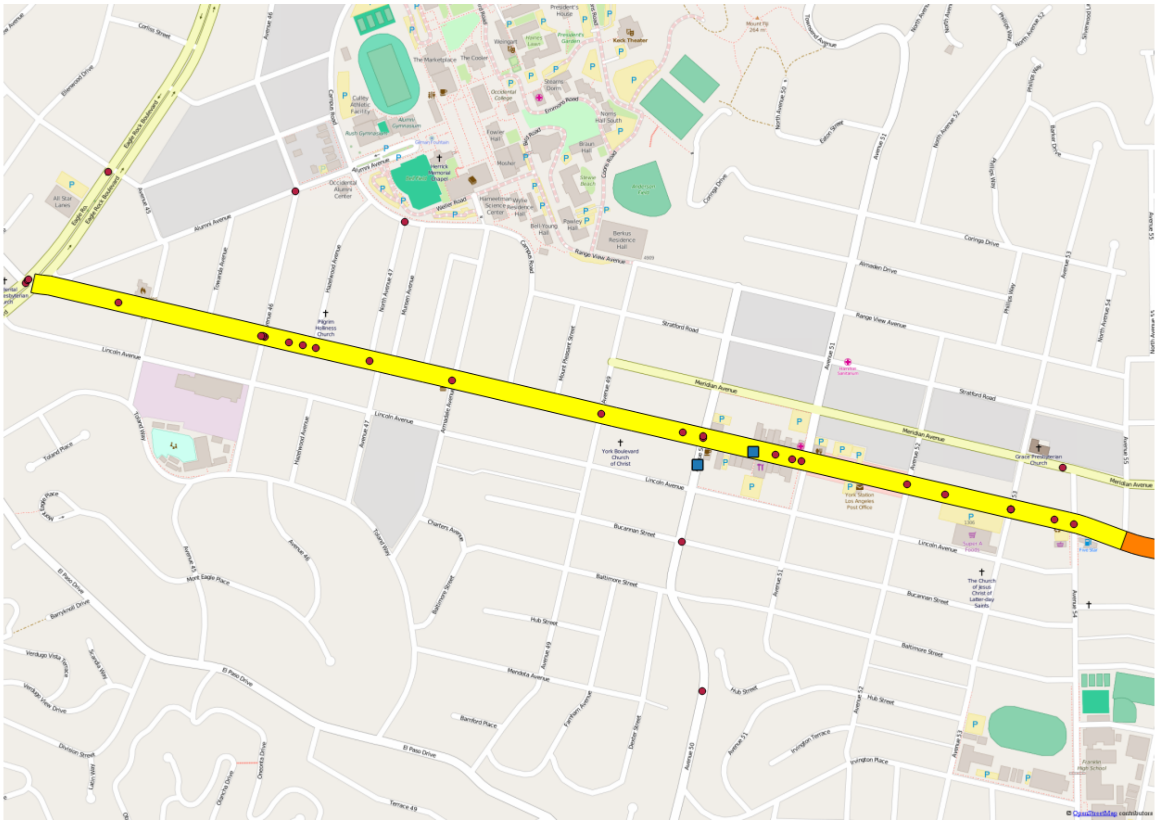

Figure 23: *Map of York Boulevard road diet bike lane. Installed November 11, 2010. Length: 1.3 miles.*

“Squeeze” Bike Lanes

Eagle Rock Boulevard

The Eagle Rock Boulevard bike lane is, in total, 4.7 miles long, spanning from Figueroa Street in Cypress Park through Glassell Park and ending at Colorado Boulevard in Eagle Rock (note that in Cypress Park, the street is called Cypress Avenue). It connects to the York Boulevard and the Colorado Boulevard bike lanes (Figure 24). But until June 17, 2013, there was a 0.7 mile gap on the north end of the bike lane. The segment of Eagle Rock Boulevard in this study filled this gap, and connected with the soon-to-be built (at the time) Colorado Boulevard bike lane.

Before the bike lane was installed on this segment of Eagle Rock Boulevard, there were 9 total bicyclist-involved collisions in 49 months, producing a rate of about 2.4 collisions per year. After the installation, there was one collision in 18 months, for a rate of about 0.67 per year. Without accounting for ridership, this is a 72% decrease in total crashes. Ridership along the route increased from 15 bicyclists per two hour period to 20. This is a 31% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was a 79% decrease after the installation of the bike lane (Table 17).

Table 17: Eagle Rock Boulevard Bike Lane. Installed June 17, 2013. Length: 0.7 miles.				
Months *Before*	Months *After*	Average Riders *Before*	Average Riders *After*	Change in Ridership
45	18	15	20	31%
Total Crashes per Year *Before*	Total Crashes per Year *After*	Crashes per Rider *Before*	Crashes per Rider *After*	Change in crash rate
2,4	0.6	0.16	0.03	-79%

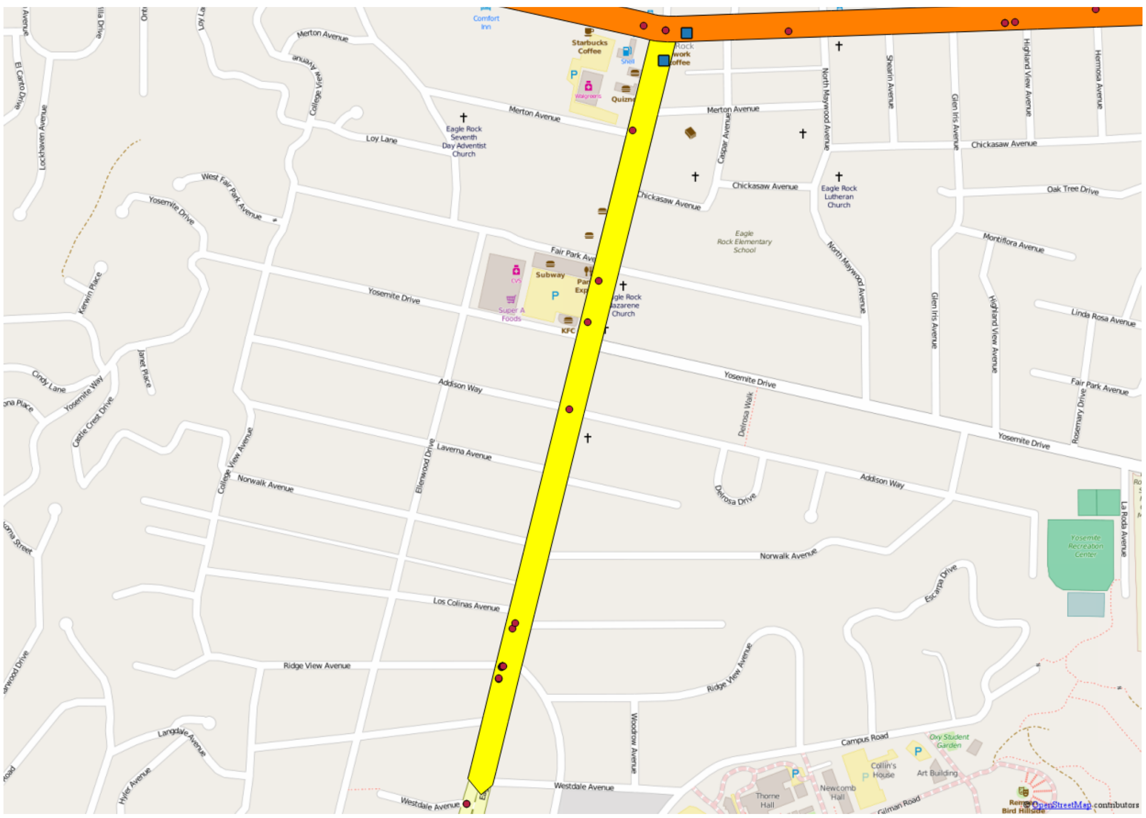

Figure 24: *Map of Eagle Rock Boulevard bike lane. Installed June 17, 2013. Length: 0.7 miles.*

Van Nuys Boulevard

There are bike lanes scattered along Van Nuys Boulevard in the San Fernando Valley. This segment was installed on December 28, 2012, and is 1.5 miles in length (Figure 25). After a two mile gap, this bike lane connects with another segment that was built on April 7, 2013. This segment intersects with the Glenoaks Boulevard bike lane.

In the 39 months prior to installation of the Van Nuys Boulevard bike lane, there were 18 total bicyclist-involved collisions on this segment, producing a rate of about 5.5 collisions per year. After the installation, there were eight collisions in 24 months, for a rate of about four per year. Without accounting for ridership, this is a 28% decrease in total crashes. Ridership along the route increased from 30 bicyclists per two hour period to 31. This is an insignificant increase in ridership. But still, when analyzing crashes while accounting for these ridership levels, there was a 32% decrease after the installation of the bike lane (Table 18).

Table 18: Van Nuys Boulevard Bike Lane. Installed December 28, 2012. Length: 1.5 miles.

Months *Before*	Months *After*	Average Riders *Before*	Average Riders *After*	Change in Ridership
39	24	30	31	6%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
5.5	4	0.19	0.13	-32%

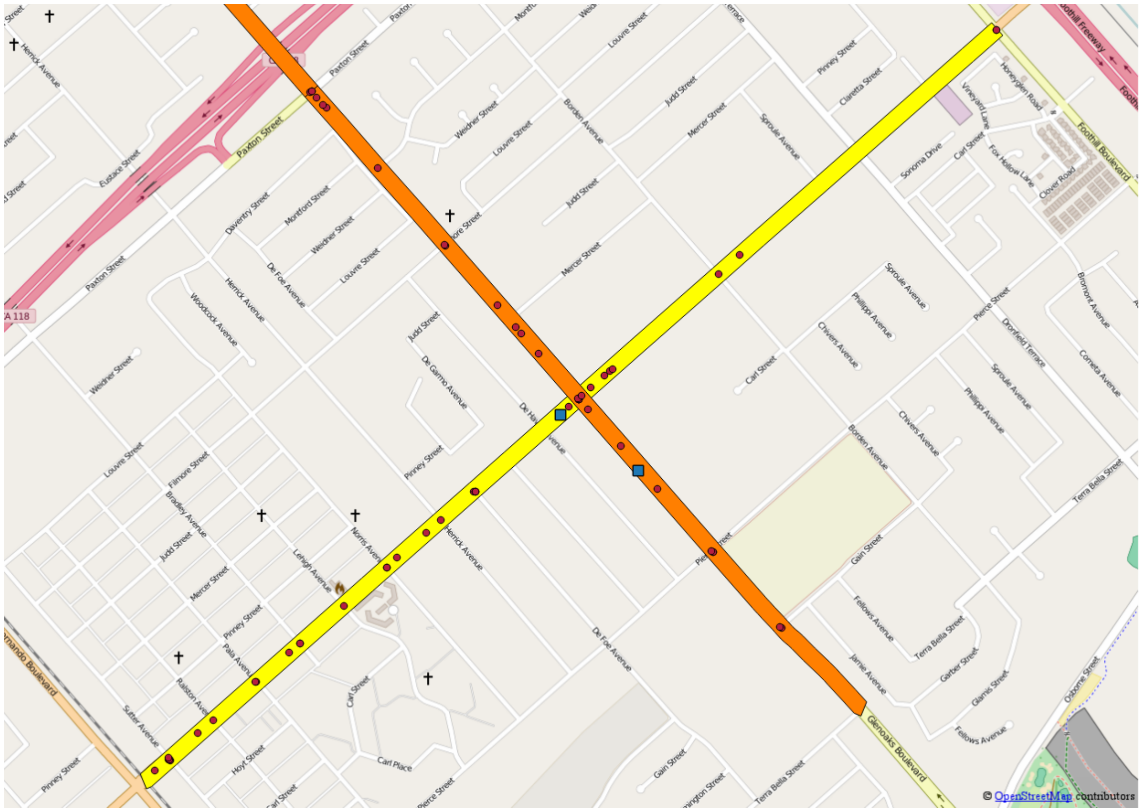

Figure 25: *Map of Van Nuys Boulevard bike lane. Installed December 28, 2012. Length: 1.5 miles.*

Figueroa Street

Figueroa Street is located in Downtown Los Angeles. This segment is a 1.2 mile bike lane, installed on May 1, 2013. Figueroa Street is a one-way street, northbound. The count location is just outside of the new bike lane, so the ridership numbers may not be entirely accurate for the route (Figure 26).

In the 44 months prior to the Figueroa Street bike lane, there were 22 total bicyclist-involved collisions, producing a rate of about 6 collisions per year. After the installation, there were 9 collisions in 19 months, for a rate of about 5.7 per year. Without accounting for ridership, this is a 5% decrease in total crashes. Ridership along the route increased from 56 bicyclists per two hour period, to 75. This is a 33% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was a 29% decrease after the installation of the bike lane (Table 19).

Table 19: Figueroa Street Bike Lane. Installed May 1, 2013. Length: 1.2 miles.

Months *Before*	Months *After*	Average Riders *Before*	Average Riders *After*	Change in Ridership
44	19	56	75	33%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
6	5.7	0.11	0.08	-29%

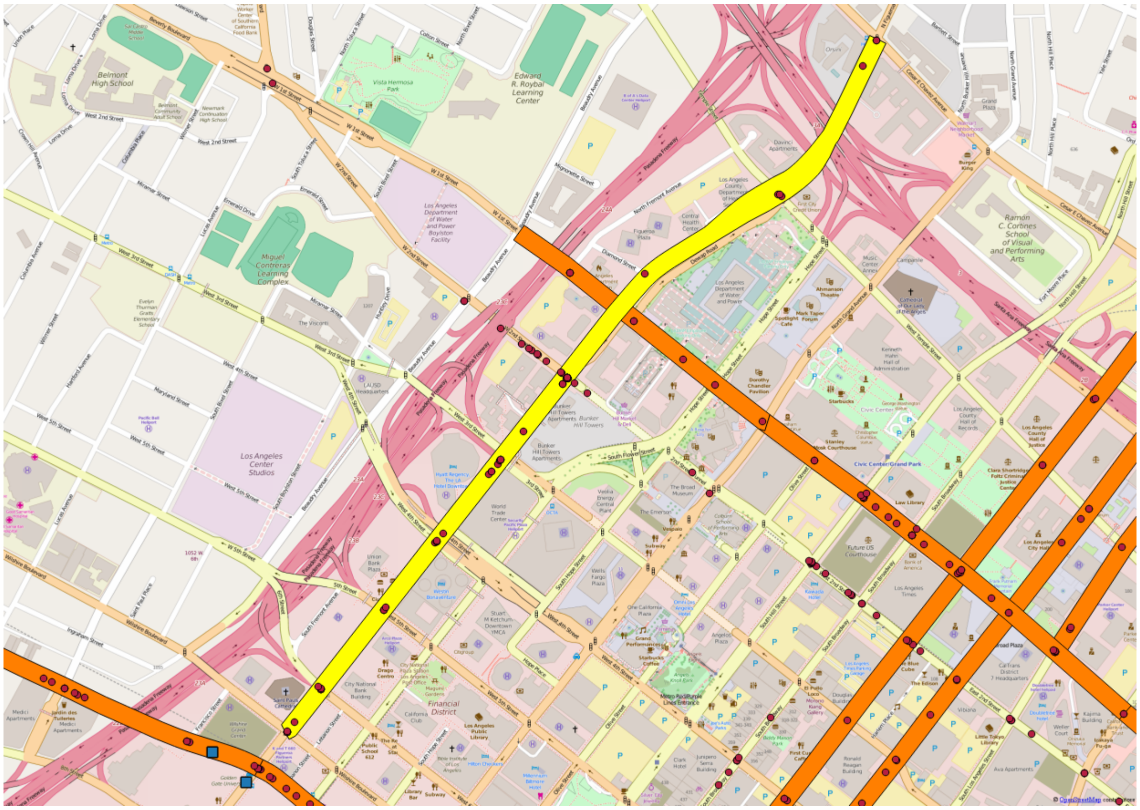

Figure 26: *Map of Figueroa Street bike lane. Installed May 1, 2013. Length: 1.2 miles.*

York Boulevard

This segment of the York Boulevard bike lane continues the road diet segment, and was installed on July 1, 2012 (Figure 27). At this point, the street is wider, accommodating two general travel lanes in the eastbound direction, one in the westbound direction, plus a center turn lane and on-street parking. This segment extends to Figueroa Street (an additional segment was installed later, that extends this bike lane to the border of South Pasadena).

In the 34 months prior to the installation of the bike lane on this segment of York Boulevard, there were six total bicyclist-involved collisions, producing a rate of about 2.1 collisions per year. After the installation, there were six collisions in 29 months, for a rate of about 2.5 per year. Without accounting for ridership, this is a 17% decrease in total crashes. Ridership along the route decreased from 32 bicyclists per two hour period to 30. This is an insignificant change in ridership. When analyzing crashes while accounting for these ridership levels, there was a 23% increase after the installation of the bike lane (Table 20).

Table 20: York Boulevard Bike Lane. Installed July 1, 2012. Length: 0.9 miles.

Months *Before*	Months *After*	Average Riders *Before*	Average Riders *After*	Change in Ridership
34	29	32	30	-5%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
2.1	2.5	0.07	0.08	23%

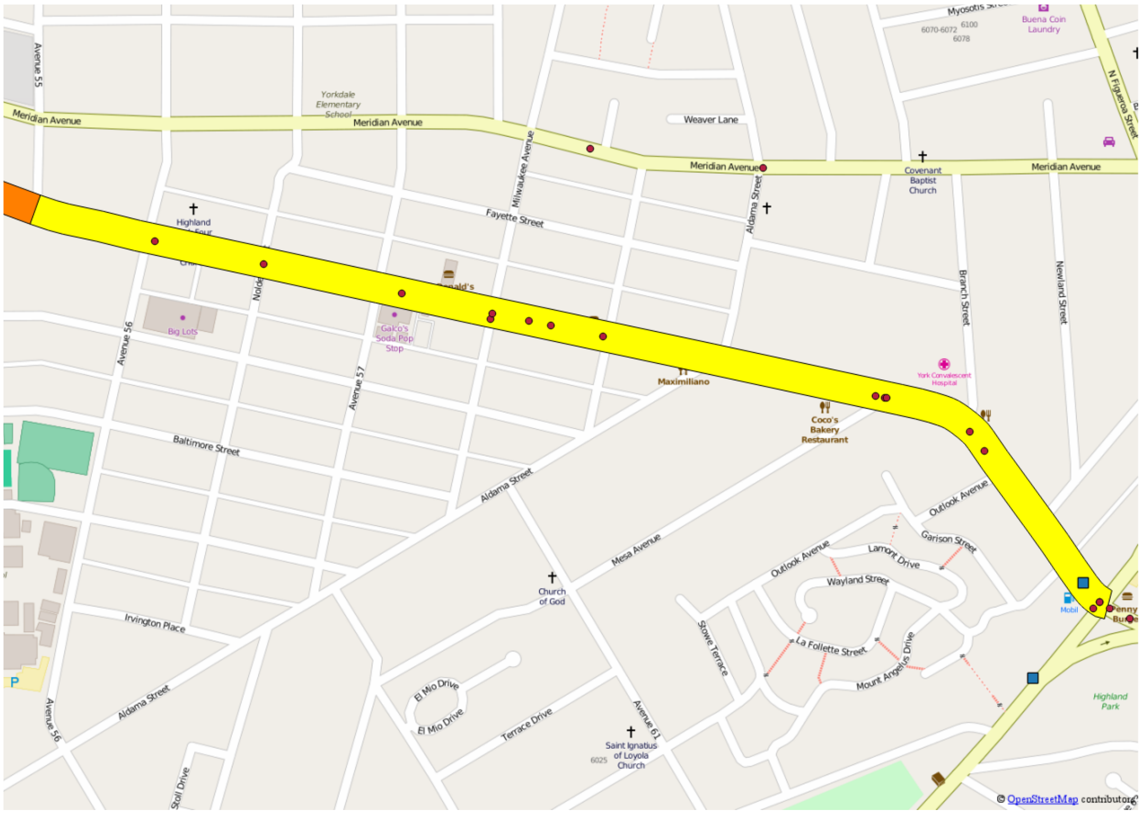

Figure 27: *Map of York Boulevard bike lane. Installed July 1, 2012. Length: 0.9 miles.*

Sharrows

1st Street (Boyle Heights to Downtown)

Here is a case of a sharrow filling a gap in a bike lane. On 1st Street, a sharrow route connects the bike lane downtown to the bike lane in Boyle Heights. It is a 1.2 mile long route, and much of it is a bridge over the Los Angeles River (Figure 28). It was built on April 1, 2013, which is the same month as part of the 1st Street road diet in downtown.

In the 43 months prior to the installation of the sharrows on this segment of 1st Street, there were nine total bicyclist-involved collisions, producing a rate of about 2.5 collisions per year. After the installation, there were four collisions in 20 months, for a rate of about 2.4 per year. Without accounting for ridership, this is a 4% decrease in total crashes. Ridership along the route increased from 25 bicyclists per two hour period, to 72. This is a 185% change in ridership. When analyzing crashes while accounting for these ridership levels, there was a 66% decrease after the installation of the sharrows (Table 21).

Table 21: 1st Street Sharrows. Installed April 1, 2013. Length: 1.2 miles.

Months *Before*	Months *After*	Average Riders *Before*	Average Riders *After*	Change in Ridership
43	20	25	72	185%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
2.5	2.4	0.10	0.03	-66%

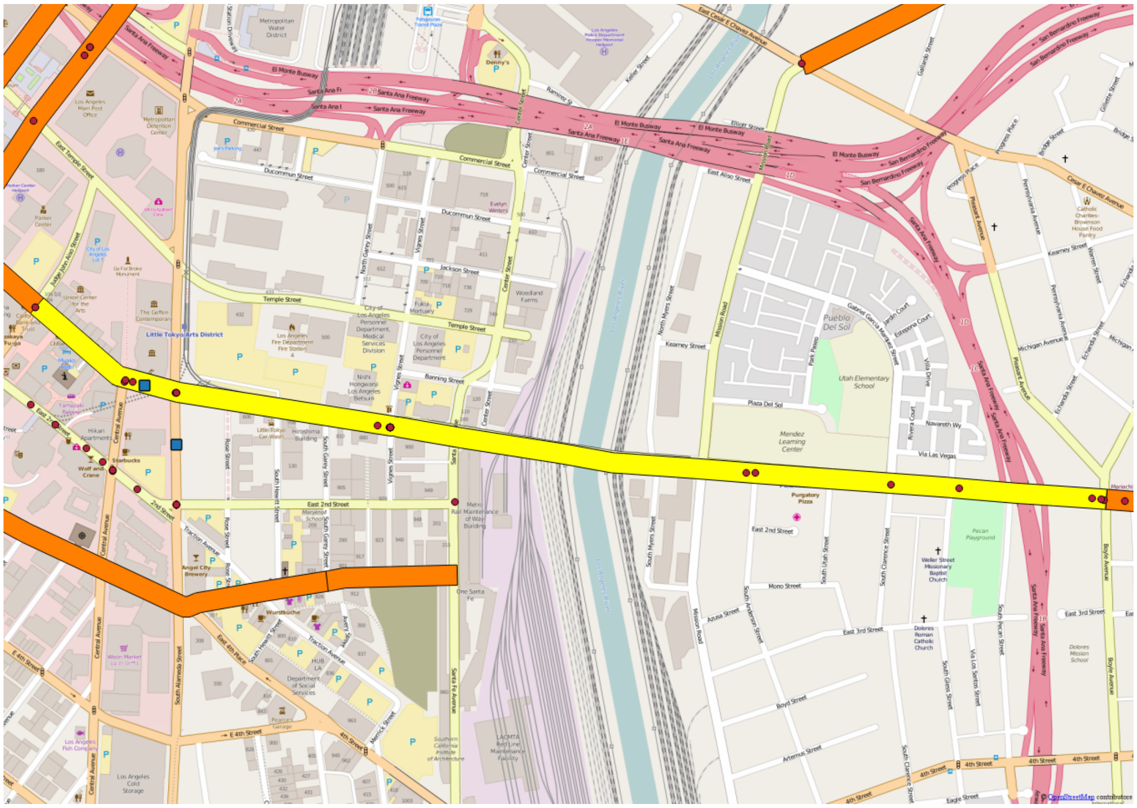

Figure 28: *Map of 1st Street sharrows. Installed April 1, 2013. Length: 1.2 miles.*

4th Street

The 4th Street sharrows is an east/west route in mid-town Los Angeles. It runs mostly through the neighborhoods of Koreatown and Hancock Park (Figure 29). The bicyclist count was conducted at the mid-point, near Wilton Place. Prior to being marked as a sharrow, 4th Street was a common route for bicycle commuters.[6] The sharrows codified it as a bicyclist-friendly route (though the treatment did not include any other bicyclist-friendly infrastructure changes aside from the stencils).

In the 10 months prior to the installation of the sharrows on this segment of 4th Street, there were eight total bicyclist-involved collisions, producing a rate of 9.6 collisions per year. After the installation, there were 37 collisions in 53 months, for a rate of about 8.4 per year. Without accounting for ridership, this is a 13% decrease in total crashes per year. Ridership along the route increased from 24 bicyclists per two hour period, to 48. This is a 102% increase in ridership (due to rounding). When analyzing crashes while accounting for these ridership levels, there was a 57% decrease after the installation of the sharrows (Table 22).

The sharrows were added on July 29, 2010, giving us only 10 months of before data. To see if the 10 months are truly capturing an average “per year” crash rate, I also looked at the quantity of crashes 12 months before installation, as well as 24 months before installation. Looking back 12 months, the rate was 9 per year (as opposed to 9.6 for 10 months). For 24 months, the rate was 7.5 per year. I also looked back 53 months, and the average was 5.2 per year. This indicates that the rate was steadily growing prior to installation, possibly due to increases in ridership. But, of course, we do not know the ridership levels more than 10 months before installation. Still, if I use 7.5 average crashes

6. *I not only grew up on this segment of 4th Street, but as an adult this was part of my daily commute.*

per year before installation, and assume that ridership was steady for 24 months prior (that is, 24 riders per two hours), then the decrease in crashes per rider after installation changes from 57% to 45%.

Table 22: 4st Street Sharrows. Installed July 29, 2010. Length: 3.3 miles.				
Months *Before*	**Months *After***	**Average Riders *Before***	**Average Riders *After***	**Change in Ridership**
10	53	24	48	102%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
9.6	8.3	0.4	0.18	-57%

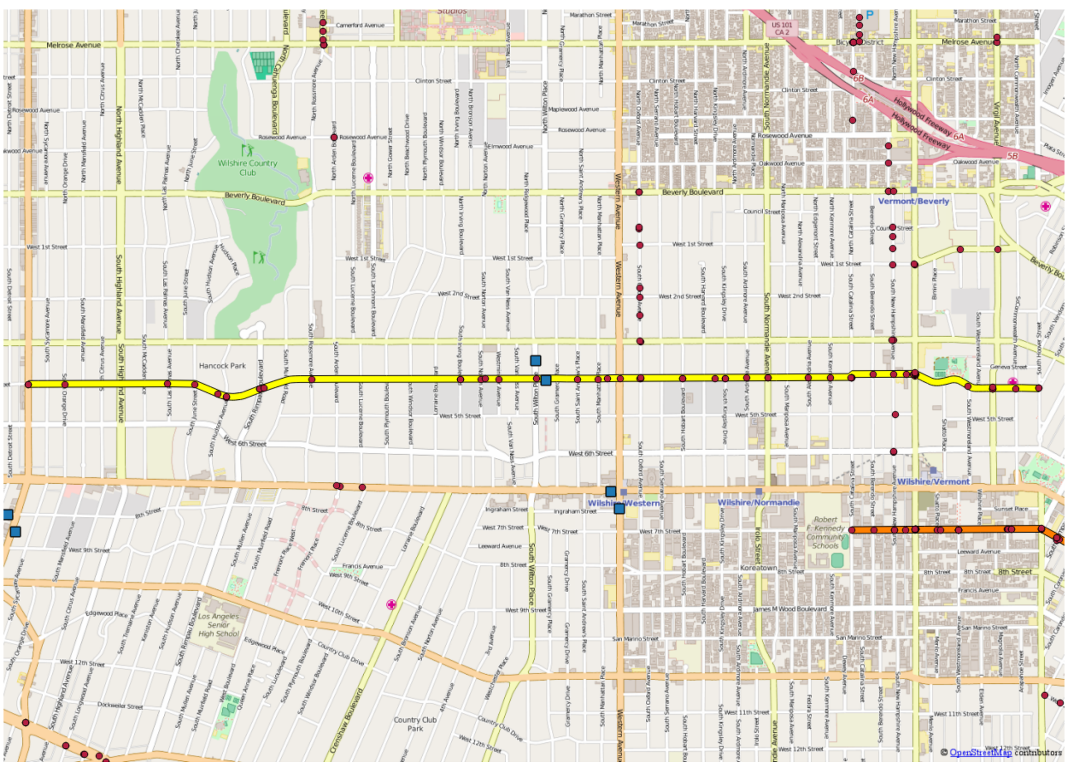

Figure 29: *Map of 4th Street sharrows. Installed July 29, 2010. Length: 3.3 miles.*

Fountain Avenue

Fountain Avenue, like 4th Street, is an east/west route that is a preferred by many bicyclists – preferred because no east/west streets nearby have any bicycling infrastructure and Fountain Avenue has comparably less vehicle traffic. The sharrows on Fountain Avenue were installed at two different times: one mile on July 14, 2010 & 2.3 miles on October 2, 2011. Of these 3.3 miles (Figure 30), 1.5 miles are included in this study (Figure 31). This is for two reasons. First, he bicyclist count location is located on the eastern end of the route. Second, in the middle of the route is a jog, wherein travelers have to turn off of Fountain Avenue, travel a block, and then turn back toward it. I determined that the count site cannot provide an accurate measurement of ridership west of the jog. Additionally, there were two distinct segments installed on October 2, 2011 east of the jog, which are separated from one another by the one mile-long July, 14 2010 segment. I decided not to combine these two separated segments in the analysis, and instead left out the 0.3 mile long segment that is just east of the jog. It only contains a total of five bicyclist-involved crashes in the study period, anyway.

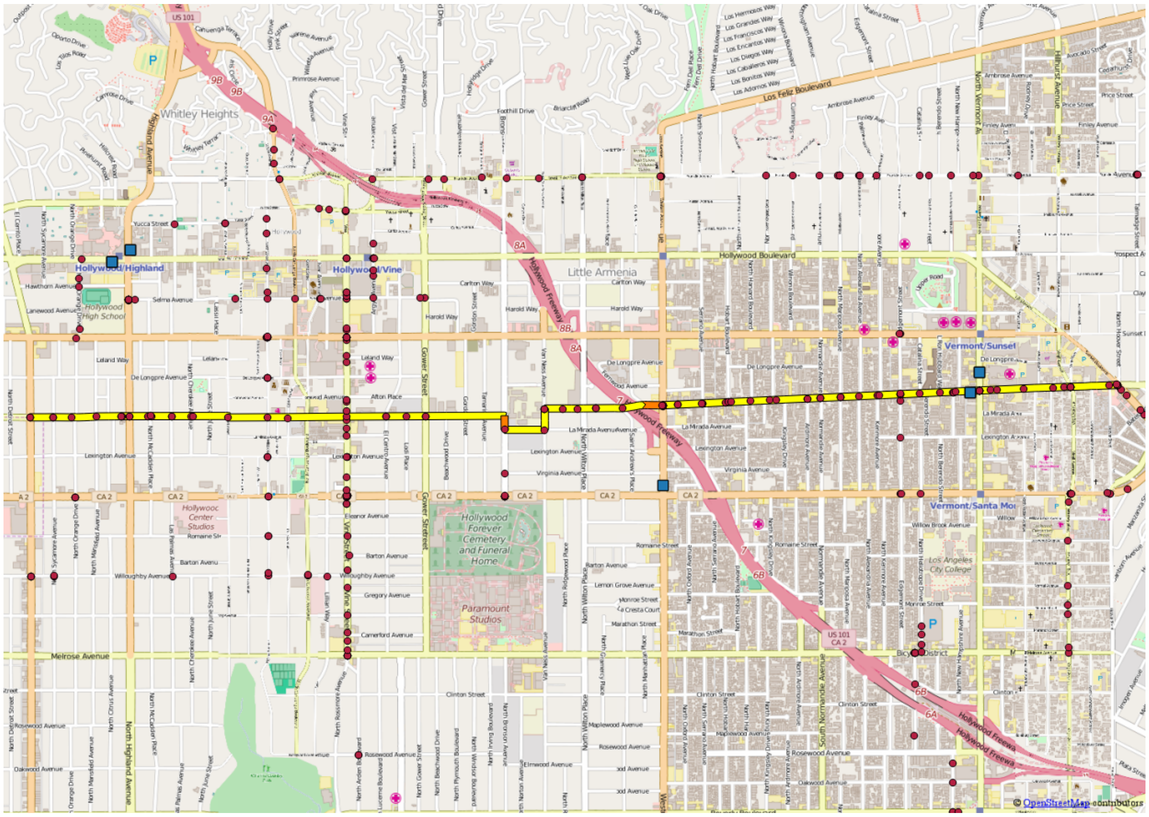

Figure 30: *Map of Entire Fountain Avenue sharrows route. Only the segments near the count site (blue square) are included in this study.*

Similar to 4th Street, the first Fountain Avenue segment in this analysis has only 10 months of before data. To see if the 10 months are truly capturing an average "per year" crash rate, I also looked at the quantity of crashes for a span of 12 months, 24 months, and 53 months before installation. Looking back 12 months, the rate was one per year, with only one bicyclist-involved crash occurring in that time. Looking back 24 months, the rate was two per year. Looking back 53 months, the average was 3.1 per year. Unlike the 4th Street sharrows (analyzed in the section prior to this), where the rate was steadily growing approaching the date of installation, on Fountain Avenue the rate was declining. Again, this could be due to changes in ridership levels. This assumption goes against what we know about changes in city-wide ridership rates during this period, but it is still possible. Another explanation is that the single collision in the 10 months prior to installation was below a normal level.

In the 10 months prior to the installation of the sharrows on this segment of Fountain Avenue, there was one bicyclist-involved collision, producing a rate of 1.2 collisions per year. After the installation, there were 19 collisions in 53 months, for a rate of about 4.3 per year. Without accounting for ridership, this is a 258% increase in total crashes per year. Ridership along the route increased from 30 bicyclists per two hour period, to 39. This is a 28% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was a 180% increase after the installation of the July 14, 2010 sharrows segment (Table 23).

On the other Fountain Avenue sharrows segment, installed on October 10, 2011, there were a total of five bicyclist-involved collisions in the 25 months prior to installation. This is a rate of 2.4 per year. After the installation, there were 6 collisions in 38 months, for a rate of about 1.9 per year. Without accounting for ridership, this is a 21% decrease in total crashes per year. Ridership along the route increased from 30 bicyclists per two hour period to 39. This is a 28% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was a 38% decrease after the installation of the October 10, 2011 sharrows segment (Table 24).

Table 23: Fountain Avenue Sharrows. Installed July 14, 2010. Length: 1 mile.				
Months *Before*	**Months *After***	**Average Riders *Before***	**Average Riders *After***	**Change in Ridership**
10	53	30	39	28%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
1.2	4.3	0.04	0.1	180%

Table 24: Fountain Avenue sharrows. Installed October 10, 2011. Length: 0.5 miles.				
Months *Before*	**Months *After***	**Average Riders *Before***	**Average Riders *After***	**Change in Ridership**
25	38	30	39	28%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
2.4	1.9	0.08	0.49	-38%

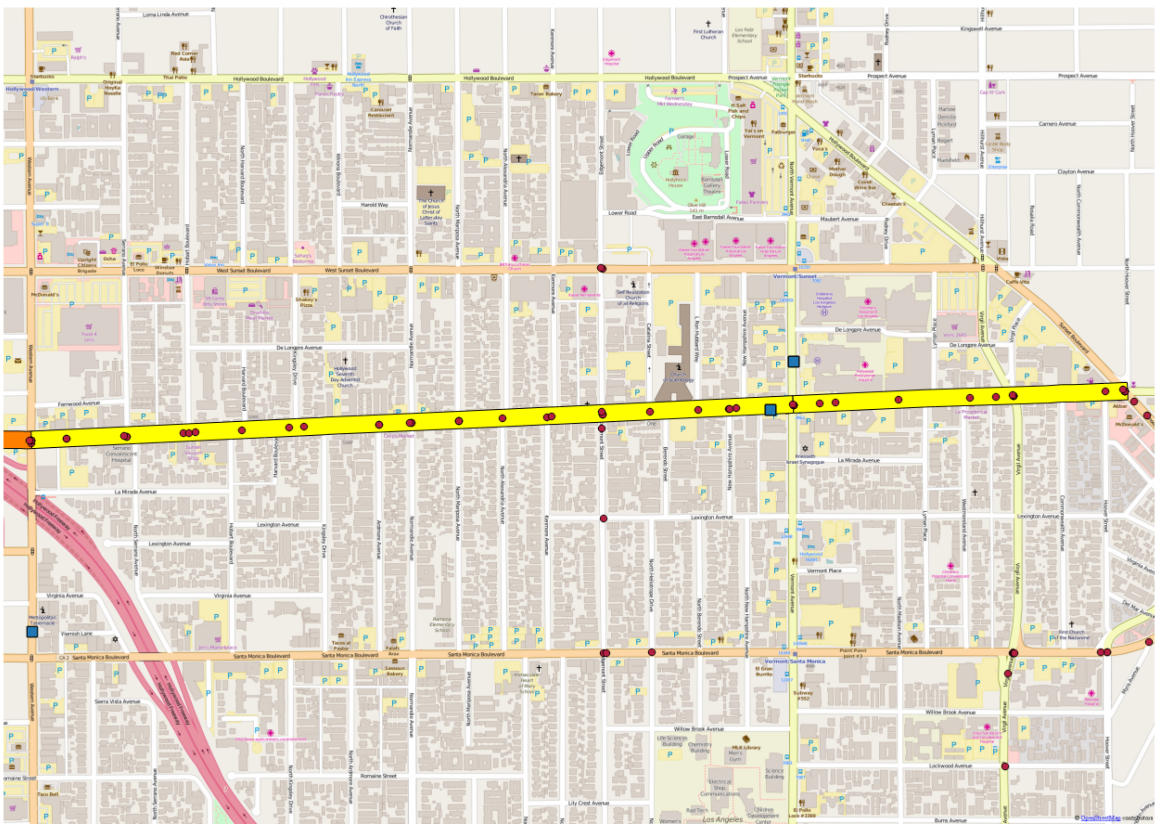

Figure 31: *Map of Fountain Avenue sharrows. Installed July 14, 2010 & October 10, 2011. Length: 1.5 miles.*

Ohio Avenue

Ohio Avenue is located in Westwood Village, near the UCLA campus. The two sharrows on Ohio Avenue were installed on different dates, and flank an existing 0.4 mile-long bike lane. They also connect bicyclists from sharrows on Westgate Avenue to Westholme Avenue. That is, the two sharrows segments close a network gap (Figure 34).

On the Ohio Avenue sharrows segment installed on April 4, 2013, there were a total of eight bicyclist-involved collisions in the 43 months prior to installation, for a rate of 2.2 per year (Figure 32). After the installation, there were three collisions in 20 months, for a rate of about 1.8 per year. Without accounting for ridership, this is a 19% decrease in total crashes per year. Ridership along the route increased from 84 bicyclists per two hour period to an average of 115. This is a 37% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was a 41% decrease after the installation of the April 4, 2013 sharrows segment (Table 25).

Table 25: Ohio Avenue Sharrows. Installed April 4, 2013. Length: 0.5 miles.				
Months *Before*	**Months *After***	**Average Riders *Before***	**Average Riders *After***	**Change in Ridership**
43	20	84	115	37%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in crash rate**
2.2	1.8	0.03	0.02	-41%

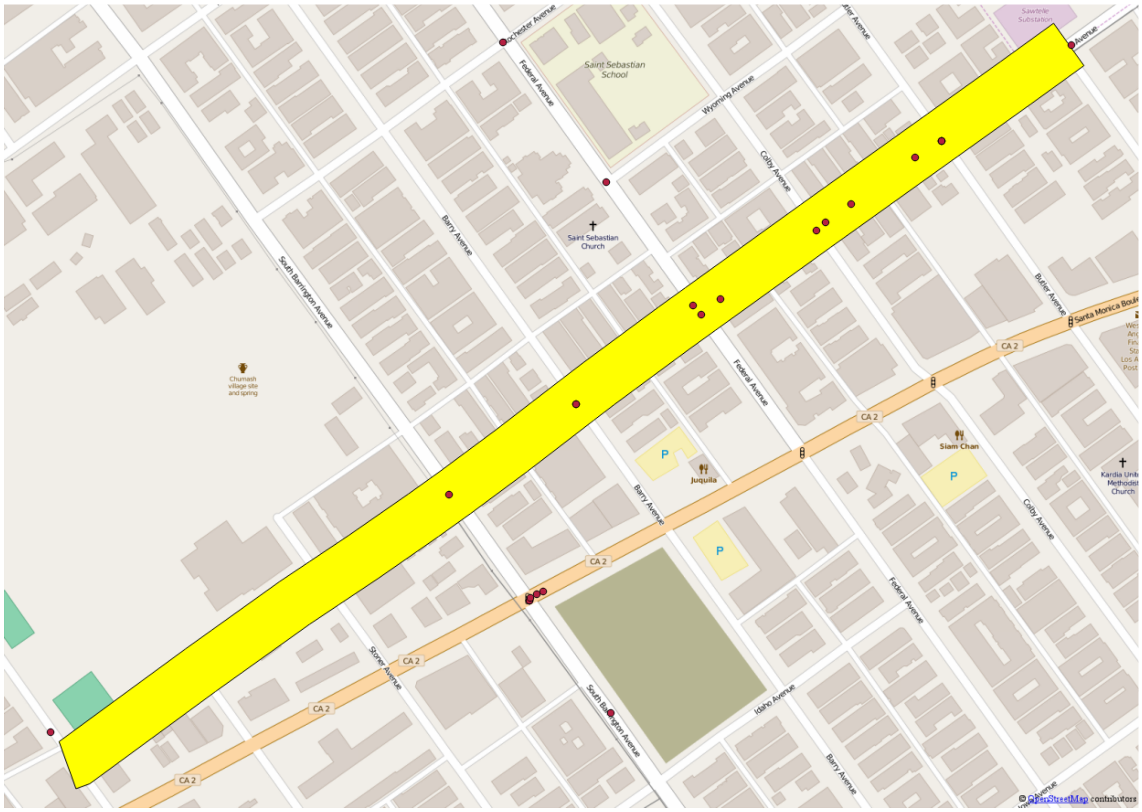

Figure 32: *Map of Ohio Avenue sharrows. Installed April 4, 2013. Length: 0.5 miles.*

On the Ohio Avenue sharrows segment installed on April 26, 2013, there were a total of five bicyclist-involved collisions in the 43 months prior to installation, for a rate of 1.4 per year (Figure 33). After the installation, there were five collisions in 20 months, for a rate of 3 per year. Without accounting for ridership, this is a 115% increase in total crashes per year. Ridership along the route increased from 84 bicyclists per two hour period, to an average of 115. This is a 37% increase in ridership. When analyzing crashes while accounting for these ridership levels, there was a 57% increase after the installation of the April 26, 2013 sharrows segment (Table 26).

Table 26: Ohio Avenue Sharrows. Installed April 26, 2013. Length: 1 mile.

Months *Before*	Months *After*	Average Ridership *Before*	Average Ridership *After*	Change in Ridership
43	20	84	115	37%
Total Crashes per Year *Before*	**Total Crashes per Year *After***	**Crashes per Rider *Before***	**Crashes per Rider *After***	**Change in Crash Rate**
1.4	3	0.02	0.03	57%

Figure 33: *Map of Ohio Avenue sharrows. Installed April 26, 2013. Length: 1 mile.*

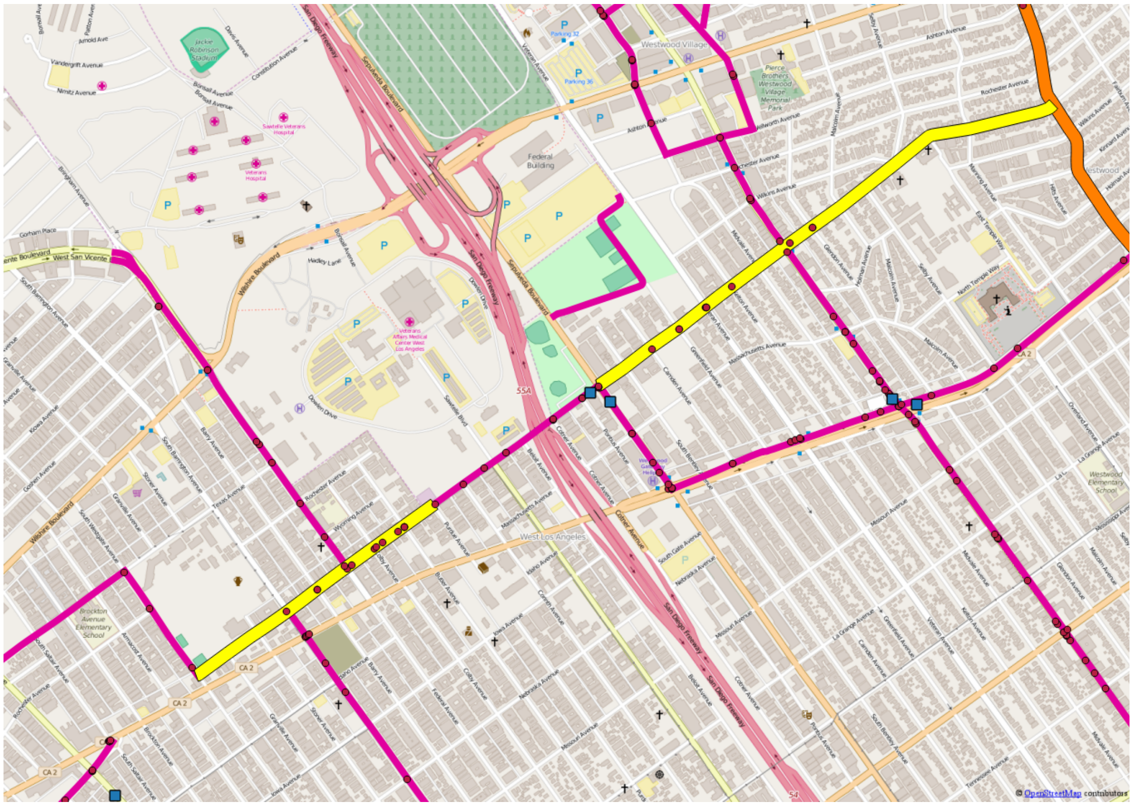

Figure 34: *Map of both Ohio Avenue sharrows segments (in yellow). The pink lines indicate other existing bikeways.*

Control Routes

Table 27: Control Routes								
Street	**Length (mileS)**	**Crashes Per Year *Before***	**Crashes Per Year *After***	**Average Ridership *Before***	**Average Ridership *After***	**Crashes Per Rider *Before***	**Crashes Per Rider *After***	**Change in Crash Rate**
Overland Ave	2.1	4.3	2.4	15	11	0.29	0.23	-22%
Pasadena Ave	1	0.9	2.8	31	18	0.03	0.15	405%
Alameda St	2.1	5.5	6.4	28	33	0.20	0.19	-2%
Cesar Chavez	2.1	6.5	6.8	48	28	0.14	0.25	82%
Echo Park Ave	0.9	1.5	2	23	20	0.07	0.10	55%
Figueroa St	2.2	6.5	5.6	41	33	0.16	0.17	9%
Figueroa St	1.1	3.7	6.8	56	75	0.07	0.09	38%
Hollywood Blvd	0.9	6.2	6	35	34	0.18	0.18	0%
Highland Ave	1.1	3.7	4.4	23	21	0.16	0.21	35%
La Brea	0.8	0.9	3.6	28	24	0.03	0.15	362%
Lankersheim	1.1	4.6	5.2	46	47	0.10	0.11	10%
Los Feliz Blvd	0.6	1.8	2	37	56	0.05	0.04	-28%
Topanga Canyon	0.8	1.2	1.2	17	12	0.07	0.10	37%
Vermont Ave	1	4	6.4	44	47	0.09	0.14	52%
Wilshire Blvd	1.9	9.8	12.8	49	53	0.20	0.24	21%
Wilshire Blvd	1.2	1.8	2	12	9	0.15	0.23	49%
Van Nuys Blvd	1.5	6.5	5.6	22	33	0.29	0.17	-43%
Western	1	4.6	5.6	45	40	0.10	0.14	40%
	Average	**Sum**						**Overall**
	1.3	74	88	600	591	2.4	2.9	22%

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