A Case for Implementing Cycle Tracks: Analysis of Concentrations of Bicycle Collisions in the City of Los Angeles

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Abstract

Described by the Intergovernmental Panel on Climate Change as a means to decrease greenhouse gas emissions[1] -- cycling -- and bicycle infrastructure as a whole, is gaining increasing relevance in today's policy world. Cities such as Los Angeles[2] or San Francisco[3] provide direct examples of this trend, as in recent years they have built cycle tracks (protected bike lanes) along with other bicycle infrastructure. However, large scale investments in bicycle infrastructure are not the norm, as investments are usually created reactively and focused hyper locally. Using a macro analysis, this paper provides a guide as to where large-scale cycle track infrastructure should be built in the City of Los Angeles. Using a dataset comprised of severe or fatal collisions from 2006-2019, this paper demonstrates where the highest density of bicycle collisions have been located, the amount of collisions per census tract, and two hot-spot analyses, one regarding bicycle collisions on pre-existing bicycle lanes, the other the general location of bicycle collisions. With the benefits of increased cycling worth approximately four to five times the cost of investing in new cycling infrastructure[4], Los Angeles should actively incentivize citizens to commute via bicycle and reverse their trend of decreasing money allocated to bicycle infrastructure since 2013[5].

[1] Reid, Carlton. "Bicycling Could Help Save The Planet, Says IPCC Climate Report." *Forbes*, Forbes Magazine, 13 Oct. 2018, www.forbes.com/sites/carltonreid/2018/10/08/bicycling-could-help-save-the-planet-says-ippc-climate-report/#46f405e42795.

[2] Newton, Damien, and Joe Linton. "LA's First Two-Way Protected Bike Lane Will Open in Downtown Los Angeles This Weekend." *Streetsblog Los Angeles*, 26 Apr. 2019, la.streetsblog.org/2019/04/26/las-first-two-way-protected-bike-lane-will-open-in-downtown-los-angeles-this-weekend/.

[3] Monsere, Christopher, et al. "Lessons from the Green Lanes: Evaluating Protected Bike Lanes in the U.S." 2014, doi:10.15760/trec.115.

[4] Reynolds, Conor Co, et al. "The Impact of Transportation Infrastructure on Bicycling Injuries and Crashes: a Review of the Literature." *Environmental Health*, vol. 8, no. 1, 2009, doi:10.1186/1476-069x-8-47.

[5] Figure 7: Los Angeles Annual Bikeway Implementation. *Appendix*

Introduction

One of the fundamental concerns with modern day public transportation is how to efficiently move people between short distances. While public transportation has been successful in moving people large distances, or from node to node, it largely struggles in getting people from their house or work to the closest node of the public transportation system. This phenomenon, most commonly known as the last-mile gap, has seen its fair share of solutions arise, most recently the employment of electric scooters and other dock-less vehicles[6]. Simultaneously, bicycling, long a solution to the last mile gap issue of traveling short distances, is increasingly gaining policy relevance. Designated as a initiative that governments must seriously consider as a means to decrease greenhouse gas emissions by the Intergovernmental Panel on Climate Change[7], cycling is increasingly being promoted in the public policy world. In addition to the potential effects cycling could have on greenhouse gas reduction[8], cycling is also seen as a means to reduce congestion, noise, traffic dangers and other harmful impacts associated with car use[9]. Although the associated health benefits of cycling far exceed the health risks[10], cyclists incur a greater probability of injuries requiring hospitalization than those involved in car accidents[11].

Only ranked behind New York as the City with the most bicycle collisions in the United States[12], bicycle infrastructure is an issue the City of Los Angeles must address. In a City where bikeway implementation rates have been decreasing since 2013[13], Los Angeles must take concrete steps to address this infrastructure concern. This paper addresses this issue, by using bicycle collision data from the City of Los Angeles to propose large-scale cycle track (protected bike lanes) infrastructure investments in areas where there are high densities of collisions, and where there is a statistically significant relationships between these agglomerations of collisions. This is accomplished through using ArcGIS to create density maps, as well as hot spot analyses graphics, to make policy recommendations regarding where large-scale cycle track infrastructure should be proposed within the City.

Literature Review

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[6] Khan, Roomy. “Electric Scooters: Last-Mile Mobility, Thrill Rides, Public Nuisance Or Hazard.” *Forbes*, Forbes Magazine, 2 Jan. 2019, www.forbes.com/sites/roomykhan/2018/12/24/electric-scooters-last-mile-mobility-thrill-rides-public-nuisance-or-hazard/#197ef5b03ccb.

[7] Reid, Carlton. “Bicycling Could Help Save The Planet, Says IPCC Climate Report.” *Forbes*, Forbes Magazine, 13 Oct. 2018, www.forbes.com/sites/carltonreid/2018/10/08/bicycling-could-help-save-the-planet-says-ippc-climate-report/#46f405e42795.

[8] “Cities100: Mexico City - Public Transit Integration Catapults Bike-Share.” *C40*, 30 Oct. 2015, www.c40.org/case_studies/cities100-mexico-city-public-transit-integration-catapults-bike-share

[9] Pucher, John, et al. “Infrastructure, Programs, and Policies to Increase Bicycling: An International Review.” *Preventive Medicine*, vol. 50, 2010, doi:10.1016/j.ypmed.2009.07.028.

[10] Pucher, John, et al. “Infrastructure, Programs, and Policies to Increase Bicycling: An International Review.” *Preventive Medicine*, vol. 50, 2010, doi:10.1016/j.ypmed.2009.07.028.

[11] Reynolds, Connor co, et al. “The Impact of Transportation Infrastructure on Bicycling Injuries and Crashes: a Review of the Literature.” *Environmental Health*, vol. 8, no. 1, 2009, doi:10.1186/1476-069x-8-47.

[12] National Highway Traffic Safety Administration. .“NCSA Publications & Data Requests.” *{{PageFactory.title}}*, crashstats.nhtsa.dot.gov/.

[13] Newton, Damien, and Joe Linton. “LA's First Two-Way Protected Bike Lane Will Open in Downtown Los Angeles This Weekend.” *Streetsblog Los Angeles*, 26 Apr. 2019, la.streetsblog.org/2019/04/26/las-first-two-way-protected-bike-lane-will-open-in-downtown-los-angeles-this-weekend/.

Cycle tracks, otherwise known as protected bike lanes, are designated lanes for cycling or dock-less vehicle use, separated via barriers from adjacent streets containing car traffic[14]. This specific aspect of bicycle infrastructure has been increasingly gaining attention within the academic field, as a means to not only reduce the total amount of collisions, but also as a way to increase rates of cycling within jurisdictions. As cycle tracks have been shown to reduce crashes and injuries among cyclists[15], research has increasingly turned to public attitudes regarding cycle tracks, to analyze whether their construction can incentivize more individuals to commute via cycling. In a study conducted on cycling infrastructure in Dublin, it was found that after surveying residents, facilities that were segregated from traffic were the preferred form of cycling infrastructure, regardless of cycling confidence[16]. This finding, buoyed by research which demonstrates that protected facilities improved the perception of safety for people on bicycles[17], provides evidence that by simply existing, cycle tracks could incentivize more individuals to cycle. This theory of increasing cycling ridership was further supported by a study which analyzed the impacts of cycle track implementation in various cities, as after a year of a cycle track being installed, there was a noted increase in ridership ranging from 21 percent to 171 percent[18]. This increase in ridership caused by cycle tracks, corroborated by additional studies[19], has its own subsequent effects, as when cycling rates have increased, there has been an observed decrease in injury rates[20]. As cycle tracks have a potential to decrease collision rates and increase ridership simultaneously, this paper focuses on where cycle tracks should be implemented in the City of Los Angeles.

In contrast to current reactive proposals on where bicycle infrastructure should be constructed, this paper takes a different approach, analyzing the macro trends within the City as a whole, distinguishing problem areas in the process. As analysis on where to implement bike infrastructure has tended to focus on the hyperlocal, most commonly the specific streets where the highest amount of bicycle collisions take place[21], this paper aims to address this issue from a macro perspective. Largely based on the fact that the majority of cyclist fatalities do not occur at intersections[22], this paper instead argues that large-scale bicycle infrastructure is needed to address high collision rates. Primarily because there are seldomly trips in which individuals take only one street, bicycle infrastructure needs to encompass the needs of many to travel to a variety of different endpoints, incentivizing commuting via cycling in the process. Because of this unique perspective of analysis, I do not know of any other current research which proposes cycle tracks through an analysis of collisions. Looking at maps created in regards to collision data in Los Angeles, I was only able to find geospatial analyses based on where collisions happened, and the relative densities of collisions per community planning area.

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[14] Figure 8 : Cycle Track (Protected Bike Lane) Visualization

[15] Reynolds, Connor co, et al. "The Impact of Transportation Infrastructure on Bicycling Injuries and Crashes: a Review of the Literature." *Environmental Health*, vol. 8, no. 1, 2009, doi:10.1186/1476-069x-8-47.

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[18] Monsere, Christopher, et al. "Lessons from the Green Lanes: Evaluating Protected Bike Lanes in the U.S." 2014, doi:10.15760/trec.115.

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[22] National Highway Traffic Safety Administration. ."NCSA Publications & Data Requests." *{{PageFactory.title}}*, crashstats.nhtsa.dot.gov/.

Background and Data

To research where large scale cycle track investments should be made, I created and analyzed a dataset of 25,912 bicycle collisions over a time period of 2006 to 2019 in the City of Los Angeles. My original dataset regarding collision data in the City of Los Angeles came from the Statewide Integrated Traffic Records Systems (SWITRS), which only takes into account severe or fatal collisions. This is an important point, as my analysis is limited by the fact that the collision data I am using has to be reported by a police officer. As a result, this analysis most likely underestimates the amount of bicycle collisions that happen in the City of Los Angeles as not all collisions are severe. In this analysis however, I assume that the areas with the most severe or fatal collisions areas of concern that probably have a higher amount of regular collisions as well.

It is important to note that the SWITRS collision dataset includes collisions involving pedestrians, cars, motorcycles or bikes. Consequently, I had to modify the original dataset to only demonstrate the collision data for bicycle accidents. This was achieved through selecting only data that represented bicycle collisions and creating a new dataset with that information. In my analysis, I also used various datasets concerning the City of Los Angeles which included: boundaries of the City, a census tract specification and where the pre-existing bikeways are located.

As I made four distinct maps to conclude where large scale cycle track investment should be undertaken, using density and hot spot analyses, I first had to project all of my data from WGS 1984 to California Teale Albers 1983-2011. This is primarily because my analysis was dependent on the most accurate geographic depictions of where these collisions were located. As a result, I needed to be certain that the projection in which I was working in correctly gave me the best insight. Additionally, it was important to change the datum from decimal degrees to meters as this also affected the subsequent hot spot analyses, because of the need to set a distance band. After changing the projection of the initial layers, my analysis proceeded in the following four ways to create each respective maps:

<u>Figure 1:</u>

To create this map I employed the spatial join tool found in ArcGIS. As I had the datasets on both bicycle collisions in the City of Los Angeles as well as the census tract designations, I simply joined the two datasets, creating a count of collisions per tract. I then displayed this data surrounding the severe or fatal bicycle collisions from 2006-2019, by census tract.

<u>Figure 2:</u>

To visually represent the historic density of bicycle collisions, I applied the ArcGIS kernel density tool to my data concerning bicycle collisions, as well as data on pre-existing bikeways and the boundaries of the City of Los Angeles. As I had a point layer on bicycle collisions, I simply ran the kernel density tool, demonstrating where the highest number of collisions are found within the city boundaries of Los Angeles.

<u>Figure 3:</u>

To analyze where the relative amount of bicycle collisions are the highest based on the total amount of collisions in a specified area, I employed the use of the ArcGIS hot-spot analysis tool. By looking at each collision point within the context of its neighboring points, and then comparing them to proportionality to the sum of all features, I was able to determine which areas had higher concentrations of bicycle accidents than expected. I ran the hot-spot analysis tool on the collision dataset once again, and demonstrated the results of the analysis on my boundaries and pre-existing bikeways maps. It is important to note that the hot-spot analysis was run with a selected distance band of 1635 meters determined by a moran's test.

<u>Figure 4:</u>

As I wanted to analyze where the highest relative amount of bicycle collisions on pre-existing cycling infrastructure was located, I created this map primarily employing the hot-spot analysis tool. To create this map, I had to first determine what specific collisions took place on cycling lanes. To achieve this, I first created a raster of my pre-existing cycling lanes and then used the extract multi-values to points tool to identify which collisions occurred on cycle lanes. Once isolating the collisions that occurred on cycling tracts, I then ran my hot spot analysis. After adding the boundaries of the City of Los Angeles, and the pre-existing bicycle tracts, my map demonstrates where the highest concentrations of collisions are found on pre-existing bicycle lanes. It is important to note that the hot-spot analysis was run with a selected distance band of 1635 meters determined by a moran's test.

Figure 1

Amount of Severe or Fatal Collisions per Census Tract Designation in the City of Los Angeles

Years 2006-2019

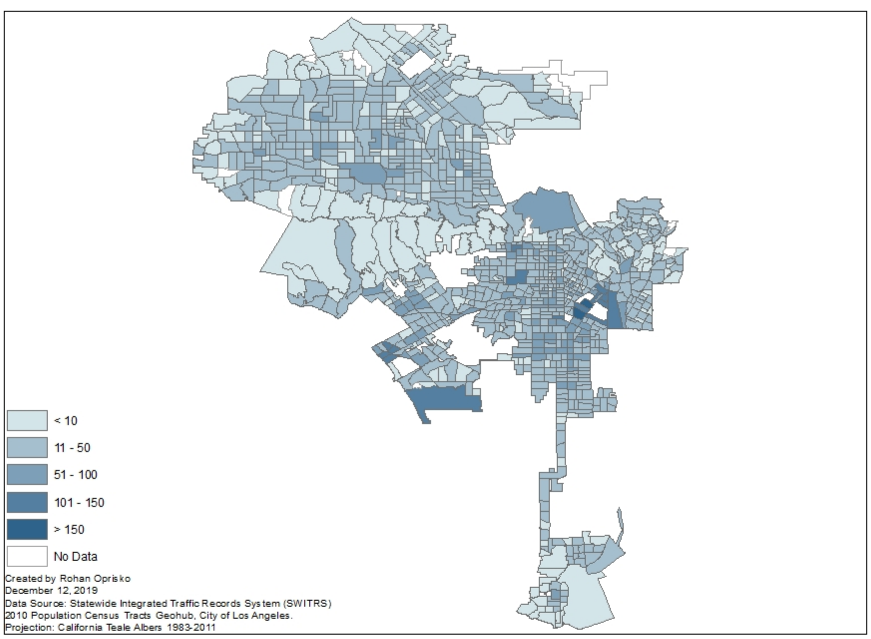


Figure 2

Density of Severe or Fatal Bicycle Collisions in the City of Los Angeles

Years 2006-2019

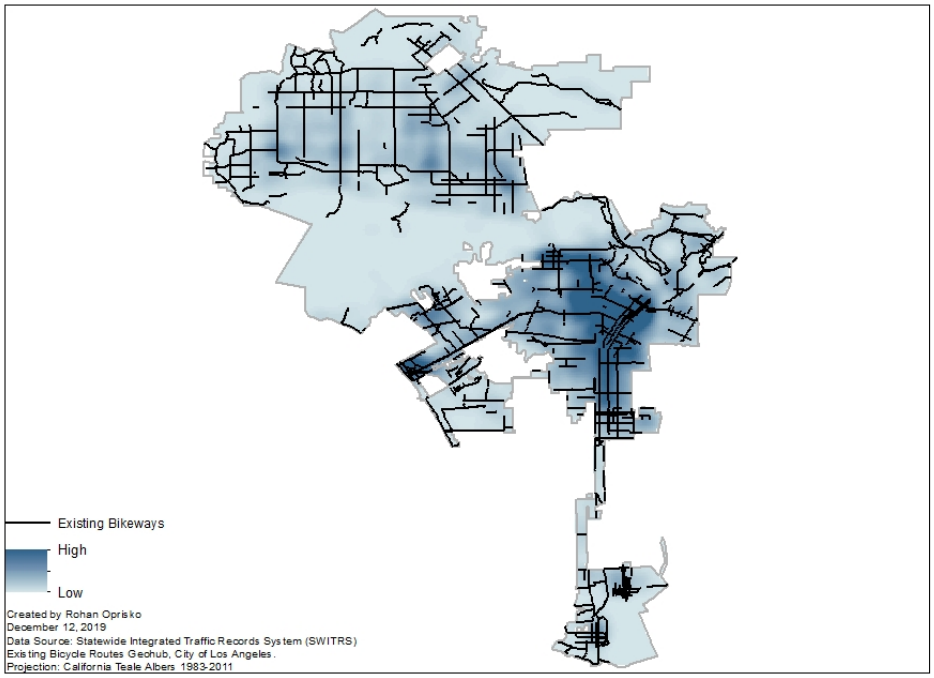


Figure 3

Hot Spot Analysis of Severe or Fatal Bicycle Collisions in the City of Los Angeles

Years 2006-2019

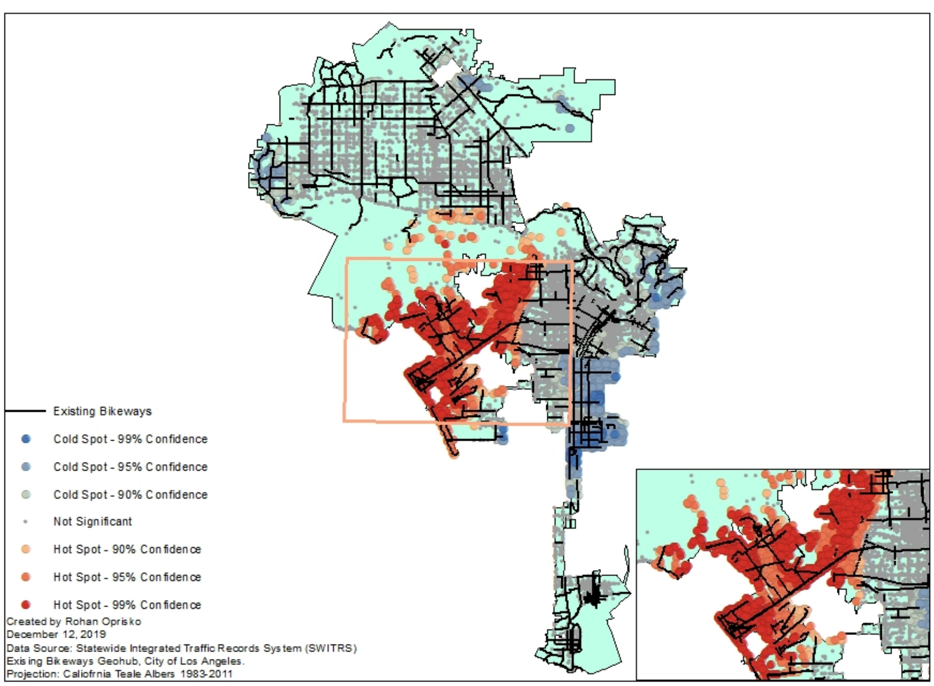
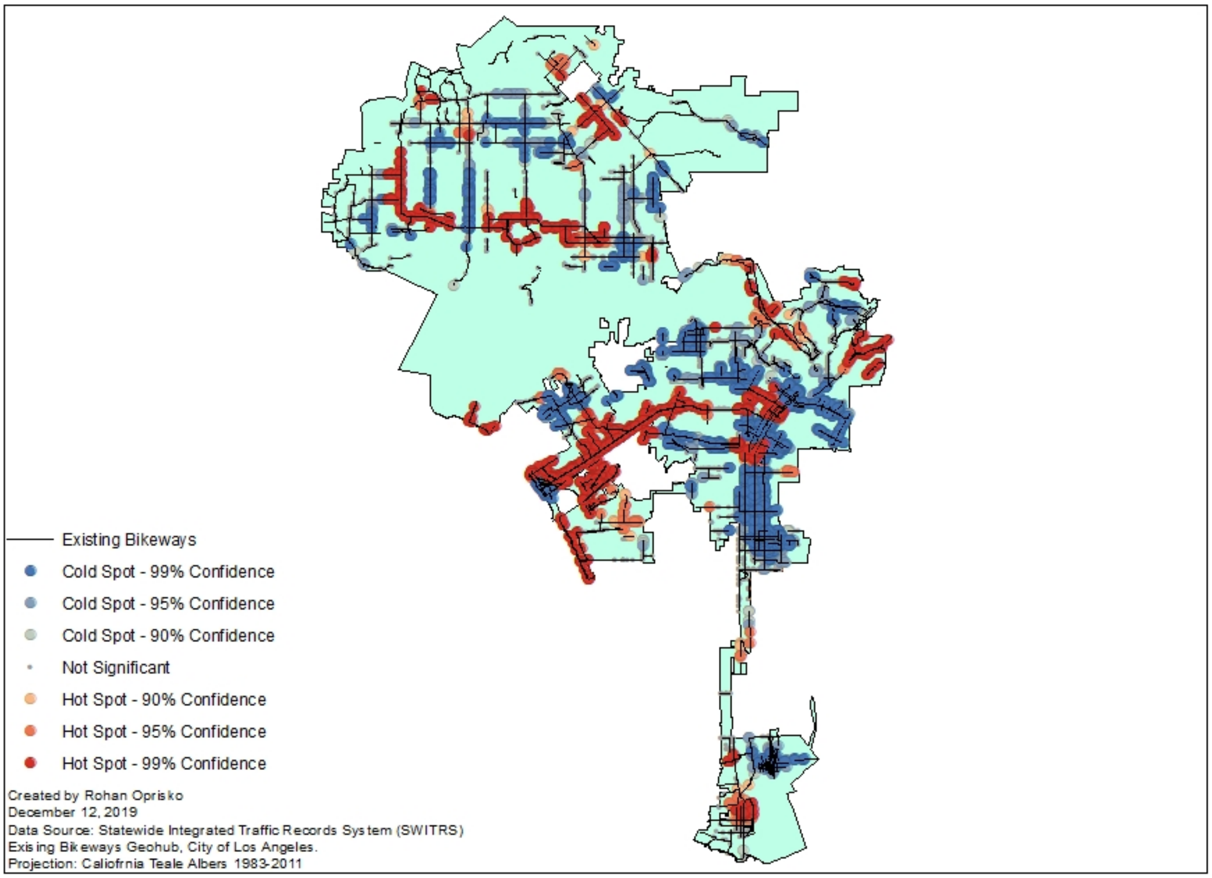


Figure 4

Hot Spot Analysis of Severe or Fatal Bicycle Collisions on Existing Bikeways in the City of Los Angeles

Years 2006-2019



Results

The previous four figures present differing analyses of the same critical problem, severe or fatal cycling collisions in the City of Los Angeles. These graphics demonstrate where the highest historic density of collisions are found, the amount of collisions per census tract, and the relative hot spots of collisions exclusively on pre-existing cycling routes and on non-specified routes. As the theme of this analysis is based at the macro level, I chose to represent the amount of collisions by census tract in *Figure 1*. This is primarily because after analyzing the designated community planning areas of the City of Los Angeles I wanted a more local measurement. While I did not want to conduct a street level analysis, I believe that the census tract designation is large enough in size to capture a cycle network which enables citizens to access various endpoints. The following table demonstrates the census tracts with the highest amount of historic collisions:

Table 1: Highest 3 Census Tract Districts in Terms of Severe of Fatal Cycling Collisions

Census Tract District Containing	Number of Collisions (Years 2006-2019)
Los Angeles St and 9^{th} Street, Los Angeles CA	376
7th St and Hill St, Los Angeles CA	244
30 th St and University Ave, Los Angeles CA	208

As I wanted to geographically represent the distribution of cycling collisions in the City of Los Angeles, I plotted the density of these collisions in *Figure 2*. As observed, the highest density of collisions are found in the Central area of the City of Los Angeles and spread out subsequently with decreasing densities. Additionally, it is important to note that the beach communities of West Los Angeles also demonstrate a high density of collisions. From the graph it appears that the City of Los Angeles has tried to identify where the highest demand for cycle infrastructure is, as in Central Los Angeles there are bike lanes, but has still a ways to go, as some high density areas of collisions are located in zones with cycle infrastructure is still lacking. It is also critical to note that in north Los Angeles, higher densities appear to be located in areas with limited cycle infrastructure. These conclusions directly point to why cycle track infrastructure should be done from a macro analysis rather than a micro analysis. Although it is important to limit the amount of collisions on a specific streets, one has to realize that to use a bicycle one has to identify a traffic network. This network, encompassing multiple roads and distinct routes can all be dangerous, so simply dealing with one street will not solve the issue.

While determining the overall density of collisions was my primary goal, I also wanted to analyze whether the day of analysis would change where densities were located. Suspecting that there would be higher collisions on weekdays compared to weekends, as people commute to work, I created density maps for both cycling collisions on Mondays and Saturdays to analyze the difference. These maps seen in *Figure 5*[23] and *Figure 6*[24], demonstrate that in fact the densities of cycling collisions follow a similar pattern independent of the day. This supports the theory in this paper of bicycle networks, as collisions are located in the same primary locations, independent of the day.

As *Figure* 2 demonstrated where the highest concentrations of bicycle collisions were located on the map, I also wanted to determine where the most statistically significant agglomerations of collisions were located. In essence, where the majority of collisions were found in areas that had high amounts of collisions. This would demonstrate where the City should specifically look to implement large scale cycle track infrastructure. The hot spot analysis, presented in *Figure 3* represents this, as it demonstrates, where the highest amount of collisions have occurred, relative to the amount of neighboring collisions. This map clearly demonstrates that there is a high number of collisions in areas that have limited cycle infrastructure and points to the fact that a bicycle network is being plainly ignored. As seen in the closeup graph, the agglomeration of statistically significant points is located primarily in the West Los Angeles beach communities. As the agglomerations are too large to be captured by census tracts, the areas in which there are the highest numbers of statistically significant hotspots can be analyzed by community planning areas. These areas include, Palms-Mar Vista-Del Rey, Venice and greater West Los Angeles. It is also important to contrast the graph given by the hot spot analysis to that of pure density. This is because the zones in which there are the highest

[23] Figure 5: Density of Severe or Fatal Bicycle Collisions in the City of Los Angeles on Mondays. *Appendix*
[24] Figure 6: Density of Severe or Fatal Bicycle Collisions in the City of Los Angeles on Saturdays. *Appendix*

densities of collisions are not statistically significant. This is primarily because although there are a multitude of collisions in that area, after analyzing the amount of collisions in comparison to the expected value of that area this is a lower number. As a result, although Central Los Angeles can be seen as needing large scale cycle track infrastructure, the need may be more pressing in areas of the map with high concentrations of hotpots.

While *Figure 3* analyzed the relative hotspots in the entire City of Los Angeles, I also wanted to identify high concentrations of severe or fatal cycling collisions on pre-existing bike lanes. *Figure 4* does this, as it demonstrates where large scale cycle tracks investment should take place on the pre-existing bike lane infrastructure. In the map, there are clear segments of pre-existing bike lanes with hotspots and clear areas with cold spots, demonstrating exactly where in the bicycle network there is a higher amount of collisions than there would be expected. This analysis is particularly interesting because it demonstrates specific networks of bicycle lanes in which there are higher historical rates of collisions. Largely complementing *Figure 2*, this map sheds further light on where cycle track infrastructure should be constructed in the highest density areas of Los Angeles. Of note, is how in the most dense collision area of Central Los Angeles, there are two specific areas in which there is a high prevalence of hotspots. These two zones point to the fact that they are more heavily used networks for cycling than the surrounding bike lanes indicating that there is a higher need for investment in these areas. Compounding these findings, the map also points to the fact that there is a dire need for investment in cycle tracks in West Los Angeles. As seen in *Figure 4*, there is a huge amount of hotspots on the Venice Boulevard bike lanes as well as other bike lanes traversing from Central Los Angeles to West Los Angeles. This high concentration, echoing what was found in *Figure 3* reinforces the idea that there is a desperate need for bicycle infrastructure. It is also important to note the high concentrations found in north Los Angeles, while only barely visible in *Figure 2*, *Figure 4* demonstrates that there is a need for large scale cycle track infrastructure among these pre-existing bikeways.

Policy Recommendations

As the City of Los Angeles budget for Fiscal Year 2019-2020 did not list any local transportation fund money designated for cycle track infrastructure[25], it is imperative that things change. As specified in the literature section of this paper, there are significant studies that prove that cycle tracks improve the perception of safety, increase ridership, and decrease the number of cycling collisions. This, in addition to the overall health benefits of cycling, is the basis for the following three policy recommendations on where this infrastructure should be built and what kind of plan should address it. I propose that the City should invest in large scale cycle track infrastructure in: pre-existing bike lane networks with high hotspot concentrations identified in *Figure 4*, in the areas that lacked bicycle infrastructure demonstrated in *Figure* 3, and in bicycle networks with historic high amounts of collisions as seen in the density *Figure 1*.

Through identifying the locations in which there are high agglomerations of collisions on pre-existing bike lanes, *Figure 4* provides the most cost-effective policy solution to improve the safety of biking and to decrease collisions. I propose that the City of Los Angeles invest in large scale cycle track infrastructure primarily in the networks of Central Los Angeles and the West

[25] "2019-2020 Proposed City of Los Angeles Budget." *City of Los Angeles*, 14 Nov. 2019, cao.lacity.org/budget19-20/2019-20Proposed_Budget.pdf.

Los Angeles beach communities. With their historic tendency of cyclist injuries, these bike network locations can be considered among the most used in that specific area, as cyclists could have been incentivized to find another way to commute they consistently choose to use that bike lane. Because of this built in feature of already belonging to active bike networks, large scale investment in cycle track infrastructure would only serve to decrease the amount of collisions on an important bikeway, at the same time incentivizing other possible bike commuters who were previously disincentivized to commute, because of the dangers of getting into a collision. As seen in *Figure 4* these areas would be concentrated in Central Los Angeles and the West Los Angeles beach communities, especially on the bike lane on Venice Boulevard. These areas with the presence of hotspots, and the added fact that they contain some of the highest densities of collisions as seen in *Figure 1*, are critical in improving the safety conditions of cycling in the City of Los Angeles. Additionally, building cycle track infrastructure in pre-existing bikeways would also be cost effective as you would not have to make grand infrastructure investments.

My second policy recommendation concerns addressing the areas in which there is a lack of bicycle infrastructure. I propose that the City of Los Angeles, taking into account the relative amount of severe or fatal collisions, should invest in large-scale cycle track infrastructure in areas highlighted by the close up graph in *Figure 3*. These areas with a significant presence of hotspots, indicate that individuals are already biking on surface streets. As these surface streets have become part of their bike network, it is critical to build infrastructure to protect this network in the process decreasing collisions rates and increasing ridership rates.

My final policy recommendation concerns focusing on areas which have historic trends of bicycle collisions. I propose that the City of Los Angeles invest significant funds into large-scale cycle track infrastructure in Central Los Angeles. With the highest densities of collisions in the City, it is evident there is a demand for cycling, as there are historic cycling networks that have been ignored for at least a decade. As the most expensive of the three policy recommendations, I believe that this topic should be addressed after the previous two recommendations.

Conclusion

This paper presented four principal figures which were created in ArcGIS using a dataset of 25,912 bicycle collisions over a time period of 2006 to 2019 in the City of Los Angeles. With the explicit goal of analyzing where large-scale cycle track infrastructure should be proposed in the City of Los Angeles, the paper made three policy recommendations based off of results presented in the figures. These policy recommendations constitute building cycle track infrastructure on specified areas containing pre-existing bikeways, that lack adequate cycle infrastructure, and in areas that have historically high density rates of collisions. Cycling is gaining prominence in the policy world. With the State government sponsoring e-bike programs[26], its purported benefits to health[27], and a need to move away from activities that lead to greenhouse gas emissions, it is imperative that the City of Los Angeles address cycle infrastructure by investing in cycle tracks, increasing the safety and potentially increasing the cycle ridership in the city.

[26] "New California Law Provides Funding for e-Bike Purchases." *PeopleForBikes*, 11 Sept. 2019, peopleforbikes.org/blog/new-california-law-provides-funding-for-ebike-purchases/.

[27] Reynolds, Conor Co, et al. "The Impact of Transportation Infrastructure on Bicycling Injuries and Crashes: a Review of the Literature." *Environmental Health*, vol. 8, no. 1, 2009, doi:10.1186/1476-069x-8-47.

Appendix

Figure 5

Density of Severe or Fatal Bicycle Collision in the City of Los Angeles on Mondays

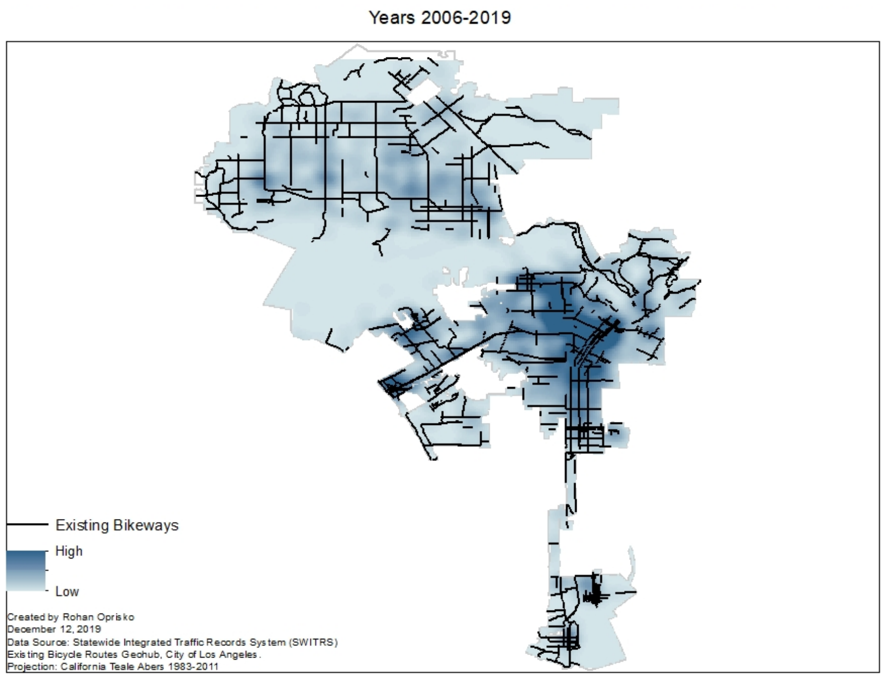


Figure 6

Density of Severe or Fatal Bicycle Collision in the City of Los Angeles on Saturdays

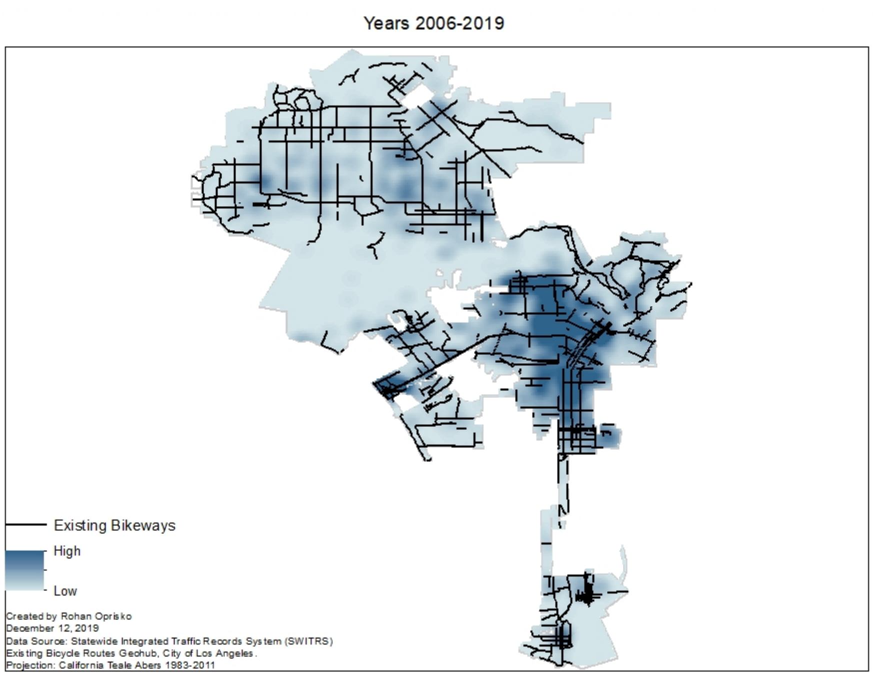
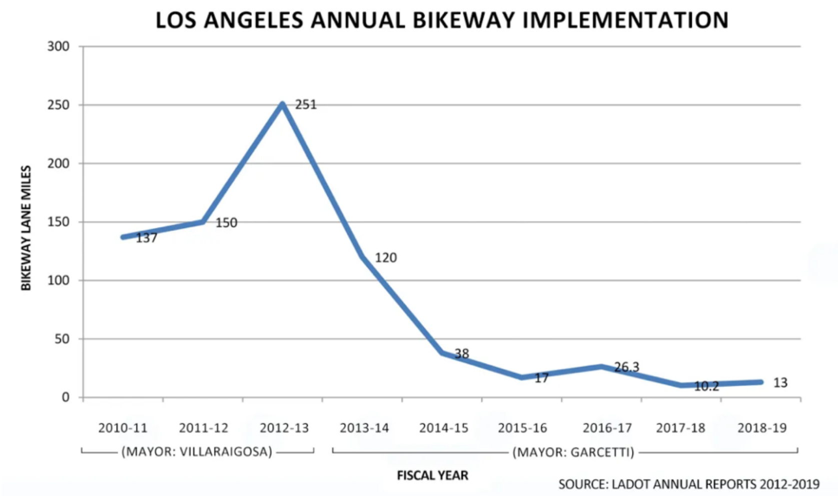
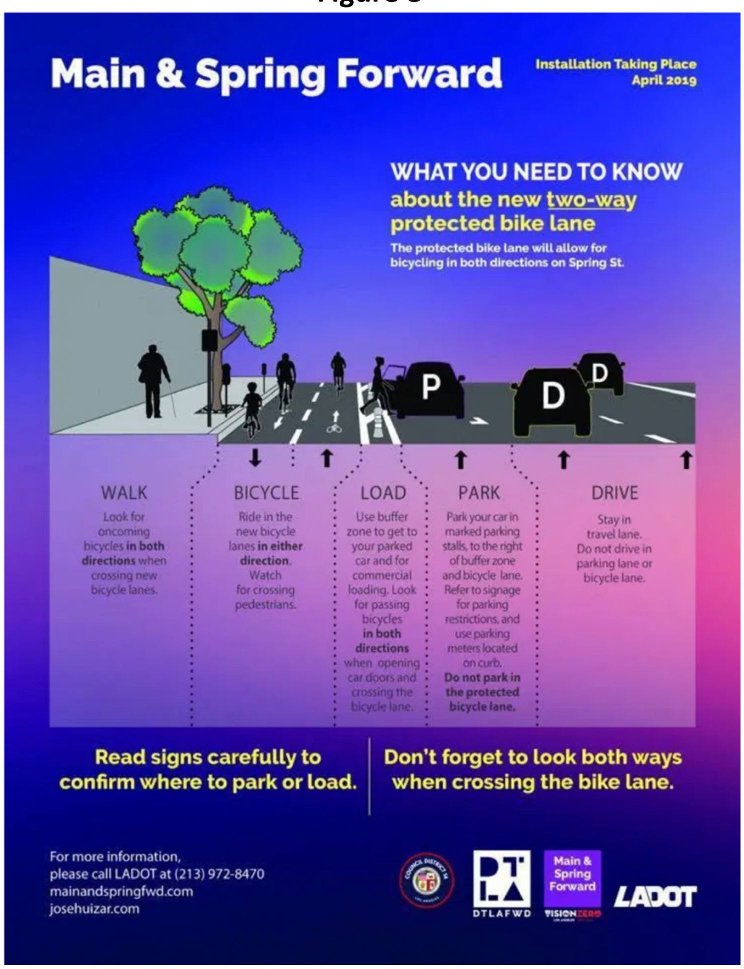


Figure 7



Annual LADOT bikeway mileage graph – by Michael MacDonald

Figure 8



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