Analysis of the Effect of Green Colored Cycling Lanes on Daily Cycling Collisions in Santa Monica, California

By:

Clark Addison Carlson Easley

A Master's Thesis
Submitted to the department of Spatial Economics
Vrije University Amsterdam
June 29, 2023

Supervisor: Professor Erik Verhoef

Special thanks to:
Joris Klingen (City of Amsterdam),
Jason Kligier (Department of Transportation, city of Santa Monica),
Jason Hoang (Department of Public Works, city of Santa Monica),
and Kieran Marray (Vrije University Amsterdam)

1. Introduction and Context

As cities around the world are beginning to realize the benefits of cycling as a form of urban transportation, they are beginning to devote more resources to creating safer and more inviting cycling environments. While some cities, notedly Copenhagen and Amsterdam, have been developing and mastering safe cycling environments for years now, many other cities still have a lot to learn. Los Angeles is one of these cities. With a moderate year round climate and a generally flat landscape, many of the trips currently being made by automobiles could become trips made by bikes.

The main issue preventing Los Angeles from becoming a major cycling city is safety, with 26 cycling fatalities occurring in 2022 alone (Los Angeles Times, 2023). Although the city is taking steps in the right direction, it still has a lot of work to be done. One area of Los Angeles that has made an accelerated effort to create a safer cycling environment is Santa Monica.

Santa Monica, although commonly referred to as part of Los Angeles, is technically its own city, which is what allowed it to break away from the relatively slow cycling infrastructure development in the greater Los Angeles urban area. In 2011, the city of Santa Monica passed the Santa Monica Bike Action plan. In the words of the city itself, “The plan outlined a 5-year strategy and 20-year vision to build a culture and community that embraces cycling as a way of life, and the citywide bike network that supports it.” (Kozar, 2021) After more than ten years have passed, and more than 100 miles of bike facilities have been created (Kozar, 2021), the vision imagined in 2011 is now much closer to reality.

One major component of this has been the upgrading of existing, white-lined, cycling lanes into bright-green colored cycling lanes. The goal of this is to make the distinction between a driving lane and cycling lane much more clear, with a goal of increased safety for both cyclists and drivers.

A green cycling lane painted in Santa Monica (Peterson, 2019)

In this paper, I will be evaluating to what extent painting existing cycling lanes green has done for the safety of cyclists in Santa Monica by using a fixed effects Poisson model with location fixed effects, and with safety as measured by the frequency of cyclist collisions.

According to the city of Santa Monica website, “Green lanes are a proven strategy to make streets safer by making bikes and scooters in the lanes more visible, and clarifying the use of road space for drivers.” (Morales, 2018) However, previous academic literature on this topic is relatively limited, and largely focused on observed behavioral changes of both cyclists and motor vehicle drivers rather than direct effects on collisions between the two.

2. Related Literature

The literature surrounding colored cycling lanes largely falls into two main categories. The first of these being site-specific analyses of the effects of colored bike lanes, and the latter being studies related to perceived safety as well as color choices of the lanes.

Site-specific research on the effect of colored cycling lanes in the US has been done in Portland, Oregon, in 2000, in St. Petersburg, Florida, in 2008, in Austin, Texas, in 2010, in New York City, in 2011, and in Auburn, Alabama, in 2019. One major commonality among all of this research has been the use of data collection through observation before and after the colored cycling lane treatment. With the exception of the research done in New York City, videotaping was used to record both cyclist and driver behavior in all of these places. In New York, observations were collected in person.

Of these five studies, those conducted in Portland, St. Petersburg, and Austin, were specific to weaving areas, where cars are meant to cross over the cycling path. It is also worth mentioning that in each of these three studies the colored lane was accompanied by ‘YIELD TO CYCLIST’ roadside signage, so the treatment involved a mixture of a colored cycling lane and related signage.

In Portland, researchers found a significant increase of motorists yielding to cyclists in the treated areas, however, motorists were also found to use their turn signals less after the treatment was installed (Hunter et al., 2000). In terms of cyclist behavior, it was observed that cyclists were both less likely to turn their head around to check for cars and less likely to signal after the treatment was installed, which the authors attributed to a false sense of safety that may have been created by the colored lanes. (Hunter et al., 2000). While some might call this a false sense of safety, it can also be seen through a more positive lens as an increase in the perceived safety of the cyclists. In a follow-up survey done by the researchers, the majority of cyclists surveyed reported feeling more safe as a result of the colored lanes (Hunter et al., 2000).

Somewhat similar results were found in St. Petersburg and Austin. In St. Petersburg, a significantly higher number of drivers yielded to cyclists, but opposite of the research in Portland, drivers were observed using their turn signals at significantly greater rates in the period after the treatment was installed (Hunter et al., 2008). The researchers in St. Petersburg also analyzed conflicts between motorists and cyclists, defined as sudden changes in speed or direction. They found that a lower percentage of conflicts occuring after the treatment was installed, however this change was not found to be statistically significant (Hunter et al., 2008).

In Austin, Texas, two locations were treated and studied. In both of the locations, researchers found an increase in turn signal use from mororits (Brady et al., 2010). However, in terms of motorists yielding to cyclists, one location experienced an increase in yielding, while the other location experienced a decrease in yielding. (Brady et al., 2010) However, the authors attributed this to ‘unfavorable’ sign placement of the ‘YIELD TO CYCLIST’ sign which was mentioned earlier.

In Auburn and New York City, researchers were focused less on yielding and signaling, and more on other behaviors. In Auburn, a suburban area of Alabama, an existing bike lane was painted green for experimentation purposes, with observational data collected before and after the date of treatment. During periods when cyclists were not present, researchers observed both a statistically significant decrease in vehicle speeds, as well as a statistically significant increase in drivers’ distance from the curb after the treatment took effect. (LaMondia et al., 2019) Although the distance from the curb was not found to be statistically significant when cyclists were present, the authors state that visual observations “indicated that motorists did give more space to bicyclists when traffic in the opposing lane was not present” (LaMondia et al., 2019). Lastly, it was found that cyclists rode significantly farther away from the curb while being passed by a motorist after the colored lane was painted, which the researchers attributed to a possible increase in confidence on behalf of the cyclists. (LaMondia et al., 2019)

Finally, in New York City, researchers were focused primarily on incidences of motor vehicles encroaching on cycling lanes. In their study, they found that 7% of motorists drove in the colored cycling lanes, compared to 16% of motorists observed driving in the non-colored cycling lanes (City of New York, 2011). The researchers also aimed to study the effect of the green lanes on bicycle use in New York City, however, they were not able to separate the effect of the green lanes from other factors causing an overall increase in cyclist ridership in New York.

With these five site-specific studies in mind, it is clear that the overall effects of colored lanes are largely positive. Some findings were mixed, specifically the turn signal use of motorists decreasing in Portland while increasing in Austin and St. Petersburg. Among the five studies, none reported significant downsides to the colored lane painting. It is also important to recognize the main similarity between all of these articles, which is that they are all focused on behavioral changes that were observed and recorded. None of the studies focused on how the colored lines affected safety over a longer time period as measured by actual cycling collisions.

Other research surrounding colored cycling lanes deals mainly with the psychological aspects of the treatment, including both the preferred color choices of the lanes themselves, as well as perception of safety related to the colored lanes. In the case of Santa Monica, green was the chosen color due to possible confusion that could arise from colors such as red, yellow, or blue, which may clash with other traffic and parking demarcations (Peterson, 2019).

To study psychological effects, researchers in Chile used survey data completed by 424 adults to investigate the perception of safety related to different colored cycling lanes. Regarding fully painted lanes, green, red, blue, and yellow were all perceived to be more safe than a white lane. (Vera-Villarroel et al., 2016) These results have been corroborated by researchers in Norway who, in 2020, conducted a survey of 560 people from the four largest cities in the country. In this case, the respondents were classified as either a cyclist or motorist based on their cycling frequency. Unsurprisingly, they found that compared to colored lanes, the uncolored lane was rated lowest in perceived safety by both cyclist and motorist respondents (Karlsen et al., 2020).

Both of these studies also corroborate the findings of the site-specific research conducted in Portland, where respondents of the post-treatment survey reported feeling safer using the colored lanes (Hunter et al., 2000). Taken all together, the research surrounding colored cycling lanes, whether site-specific or survey based, points to a generally positive effect.

The main research gap surrounding colored cycling lanes is the lack of research investigating the direct statistical effect on safety, rather than on behavior or perceived safety. Furthermore, more research needs to be done on the site-specific effect of green lanes painted as a network, rather than as small, individual sections which was the case of each of the five previously mentioned site-specific studies. In this paper, I aim to fill these research gaps, utilizing a Poisson fixed effects model with geocoded data on daily cycling collisions as well as daily data on the completion of the green bike lane network within Santa Monica.

3. Data and Methodology

The data used in this analysis consists of collision data provided by the California Highway Patrol and geocoded by TIMS at UC Berkeley, infrastructure data provided by the city of Santa Monica, Bikeshare trip data provided by Metro Los Angeles, and weather data provided by Weather.gov. These various sources were cleaned, processed, and combined to create one cohesive dataset that was used in the final statistical analysis. In this section, I will detail the ways in which this process took place.

3.1. Metro Data:

The data from Los Angeles Metro Bikeshare is used as a proxy for overall cycling levels. Because one would expect cycling collisions to correlate with the overall amount of cycling, it is important to control for this in the regression model. Unfortunately, there is no actual cycling count data available at the resolution needed for this analysis, so metro bike share data is the next best option.

The bike share data collected from Los Angeles Metro is available on a quarterly basis. To complete this analysis, I appended each of the four quarterly datasets available from 2017, 2018, and 2019, resulting in 831,491 total trips completed during the period from January 1st 2017 to December 31st 2019. This dataset contains information describing which stations each trip started and ended at, the date of each trip, and very importantly, the membership type of the individual who made the trip.

For use in my analysis, I have filtered this data to include only trips made by those who have either monthly or yearly memberships. This is an important step as it creates a dataset that is more representative of overall cycling levels, by including people who are using the Metro Bike Share bikes on a consistent basis, and likely as a substitute for owning their own bike. After the filtering by membership, there are 535,663 of the original trips remaining.

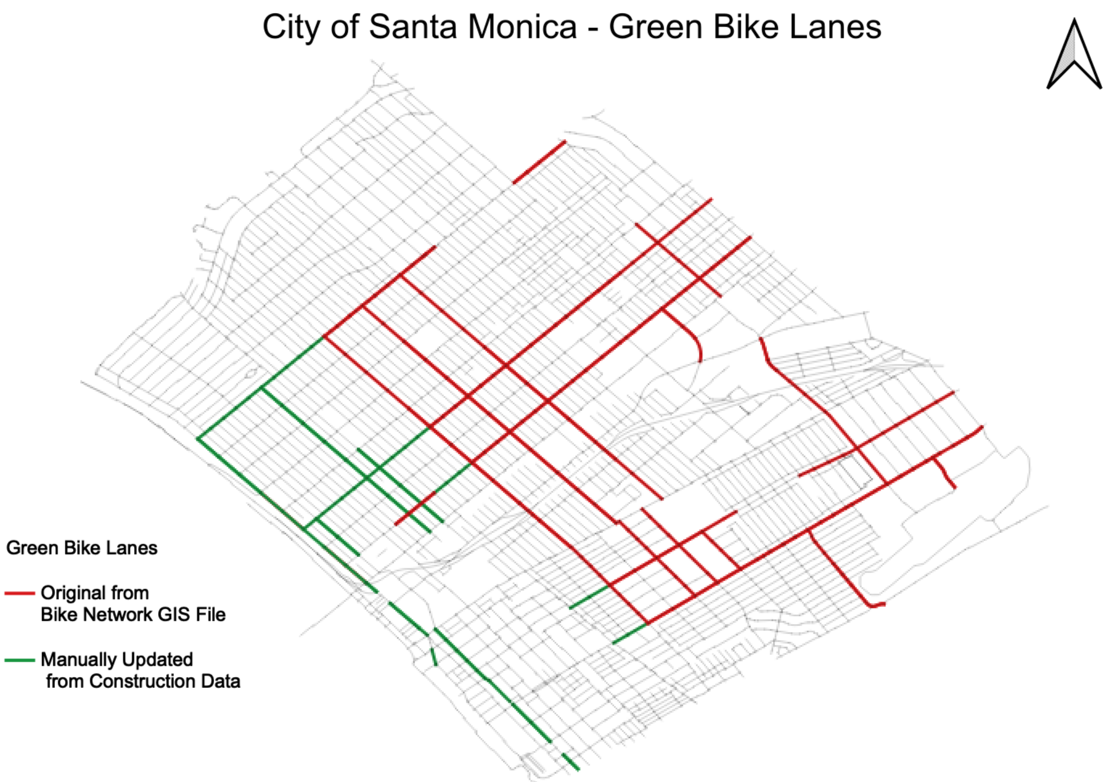
These trips are divided between Metro bikeshare stations in different areas of Los Angeles, primarily between Downtown Los Angeles and the westside of the city, which includes stations within and surrounding Santa Monica. In order to account for the opening of the westside stations on September 7th, 2017, a dummy variable is included in the model specification set equal to 1 on days following the opening date.

3.2. Santa Monica Bike Lane Data:

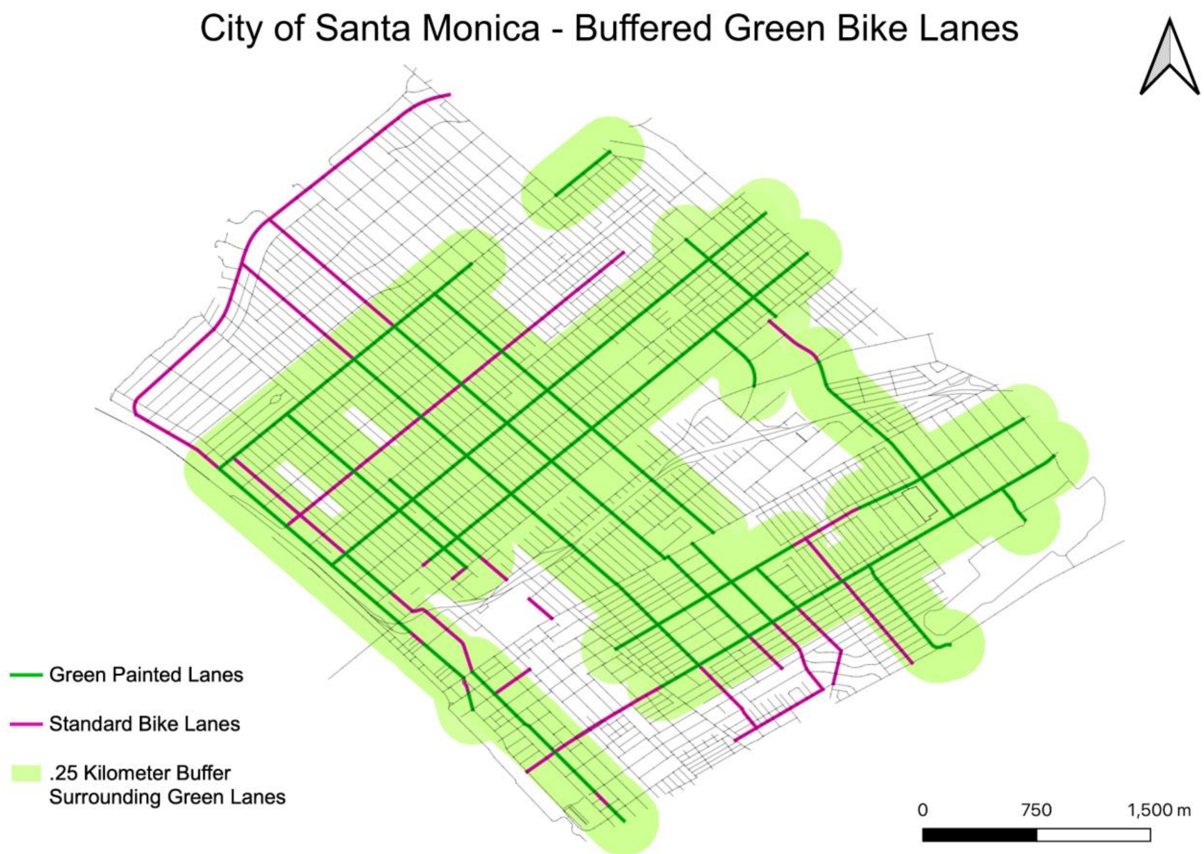
A combination of two data sources were used to construct an accurate measure of the green bike lane painting progress. First off was the Santa Monica bike network GIS shapefile, which contains geographical information for the entire bike network. Other information is also included, such as the class of each segment, whether or not a segment was painted green, and most importantly, the date for which each segment was painted green.

Unfortunately, it became clear that this dataset was incomplete, specifically in regards to the green-painted sections. Using Google Earth, It was quickly realized that a large part of the city did in fact have green lanes painted during the same time period as the other green lanes, but that they were not accounted for in the dataset. There was also one road segment that appeared as green in the dataset, but was not green in real life.

After getting in touch with officials at the city of Santa Monica, I was able to get ahold of a construction document that accurately reported each street that was painted green and the specific date it was painted, as well as the length in feet of each of the individual segments. Using this document, I manually edited the GIS bike network data to reflect the accurate information I had. This process can be seen depicted below.



To account for the potential rerouting of cyclists as a result of the green lanes being painted, buffered areas were created surrounding the network of green lanes. By doing this, the treatment area will not just be the affected streets themselves, but the area surrounding these streets. The idea behind this is that if more people begin to ride on the newly painted green lanes rather than alternate nearby routes, the amount of collisions may actually increase on the streets with green lanes. In turn, because fewer people may be riding on nearby streets, collisions on those streets are likely to decrease. By setting the treatment area as a .25 kilometer buffer surrounding the green lanes, this effect is controlled for. This size was chosen as it is the smallest buffer that captures adjacent streets with one large city block on either side of a given green bike lane. Any larger buffer would overestimate the effect of the treatment area, and any smaller buffer would not account for rerouting on adjacent roads.

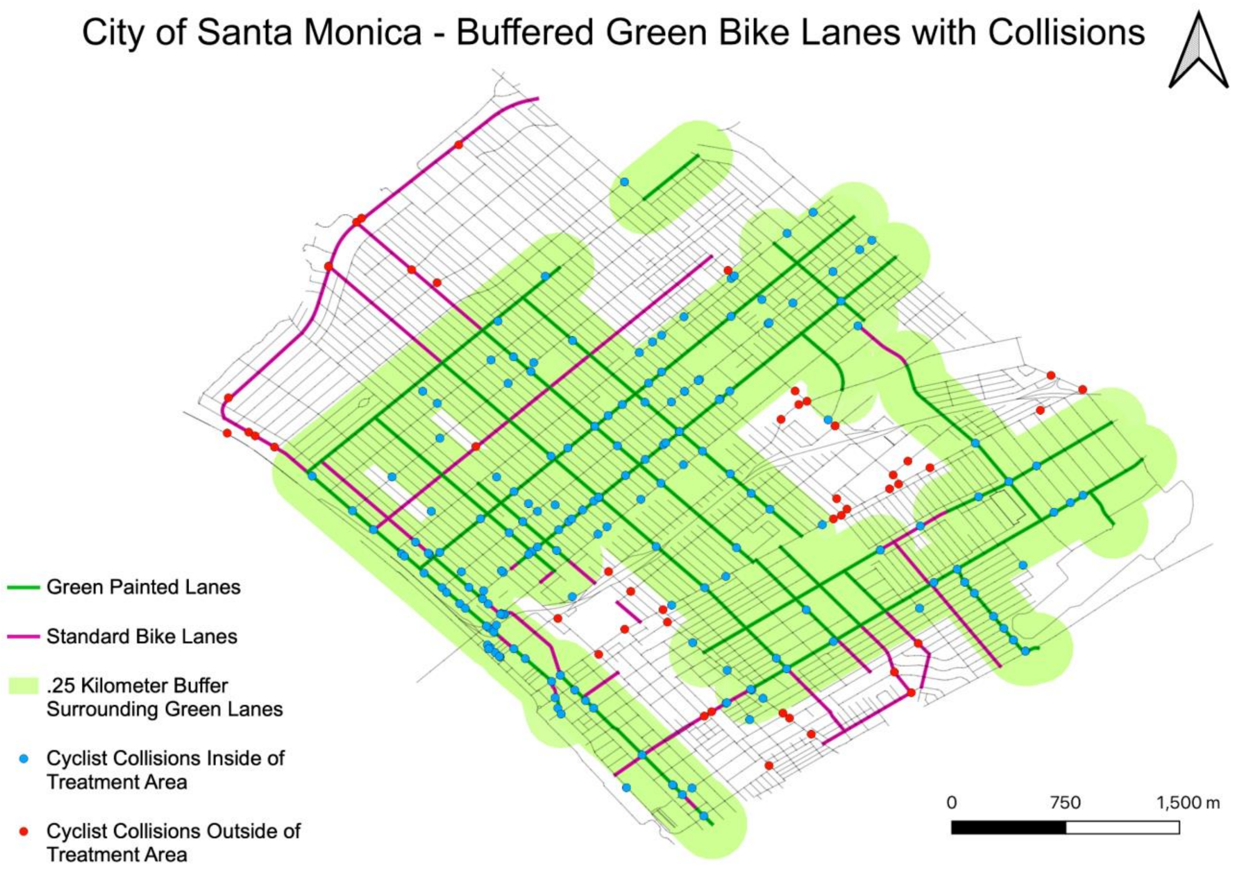


In order to turn this geographical data into a measurement of completion of the green cycling lanes, I used information on the date each segment was painted as well as the length in feet of each segment. First, the total length of all segments was calculated to be 116,665.36 feet. I then cumulated the daily amounts of street segments that were painted each day and divided it by the total length of the green lane segments to get a daily measurement of the percentage completion of the green lanes, ranging from 0 to 1. This percentage is what is used in the final analysis as a measurement of the completion of the green lanes.

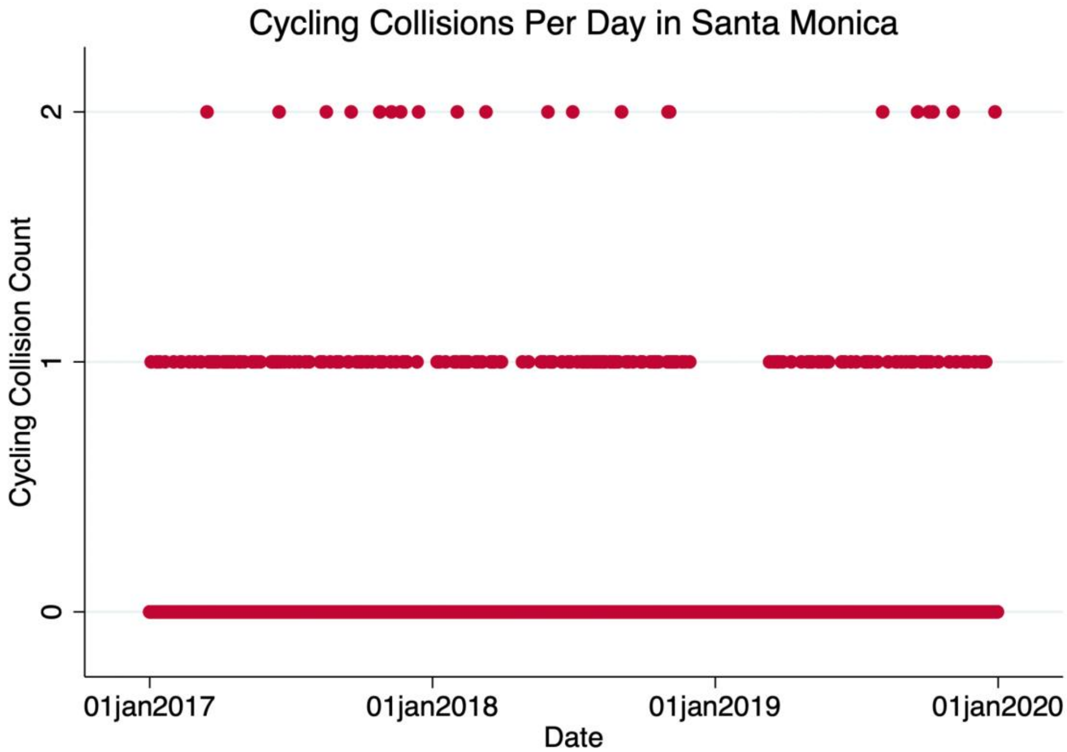
3.3 Collision Data:

Collision data was downloaded from the UC Berkeley Transportation Injury Mapping System, also known as TIMS. This data is originally provided by the California Statewide Integrated Traffic Records System, also known as SWITRS, and is then geocoded. Collisions data was downloaded from the period of January 1, 2017, to December 31, 2019, and filtered by bicycle-involved collisions. Unfortunately, no data was available on cycling collisions in Santa Monica in 2020, which limits the timeline of the analysis, however, this also means that COVID-19 related issues are of no concern in the analysis.

The data, when downloaded, was also filtered to contain only collisions within the city of Santa Monica. From this, there were 242 observations (collisions), however, seven of these, once viewed in GIS software, could be seen to be located far outside of Santa Monica. Because it is unclear where exactly those seven collisions took place, they have been omitted from the dataset, resulting in a total 235 collisions over the three year period. It is also worth mentioning that this number is likely underestimating the true number of cycling collisions that took place as not all cycling collisions are formally called in and reported. As a final step, collisions were split between the area within and outside of the .25 kilometer buffer surrounding the green lanes.



For the final analysis, collisions are measured as the number of collisions per day, both inside and outside of the treatment area. This transformation from geographical to daily data can be seen in the plot below, depicting the total daily cycling collisions in Santa Monica plotted against time.



It can be observed that from the period of November 30th 2018 to March 11,2019, there is a suspiciously long period of 102 days in which no collisions occur. Other than this time period, the two longest stretches of time without any collisions are December 15, 2017, to January 6, 2018, a period of 23 days, and April 1, 2018, to April 26, 2018, a period of 26 days. Considering how much longer the period of days is from November 30, 2018, to March 11, 2019, this period could be considered to have missing data in the form of unreported collisions. Upon contacting the California Statewide Integrated Traffic Records System to inquire about this, they made it clear that individual police agencies report collision data to them, so there was nothing they could say with confidence as to if these days did or did not contain missing collisions. Considering the entire year of 2020 was also unreported for the city of Santa Monica, it is likely that this too could be a reporting issue. As a result of this, the model will be run both with the original, unaltered collision data, and with missing values to replace the potential unreported values from November 30, 2018, to March 11, 2019.

3.4 Weather Data:

Data on daily precipitation accumulation in Santa Monica was taken from weather.gov using the KSMO Santa Monica weather station. This gives a measurement of the accumulation of rain in inches every day from January 1, 2017, to December 31, 2019. Rain levels are an important control variable for the analysis as people in Santa Monica are much less likely to ride a bike on a rainy day, which in turn could affect collisions,

3.5 Final dataset:

The final dataset is composed of 2,190 observations, with two observations for each day, from January 1, 2017, to December 31, 2019. The two daily observations are used to separate the number of collisions each day between the treatment and non-treatment areas, which is an essential step for the fixed effects estimation. Besides the number of collisions and area dummy, the values for all other variables are identical for both of their corresponding daily observations.

4. Poisson Fixed Effects Model

To estimate the effect of the green painted lanes on cycling collisions, a Poisson model is estimated with location fixed effects. The locations used as fixed effects are delineated as the area within the buffered green lanes, the treatment area, and the area lying outside of the buffer. By using these location fixed effects, the model controls for any structural differences between the treated and untreated areas.

In order to make sure a Poisson model was appropriate, overdispersion of the data must be taken into account. This is due to the fact that a key assumption of a Poisson distribution is the equality of the variance of the distribution and its mean, known as equidispersion. To check for this, an overdispersion test was run in Stata using the Overdisp package at a 95% confidence level, where the null hypothesis indicates equidispersion. After running the test, a P value of 0.572 was calculated, concluding in a failure to reject the null hypothesis of equidispersion. With this taken into account, the Poisson model can confidently be used over alternative models meant to account for overdispersion, such as the negative binomial model or the zero inflated Poisson model.

4.1 Model Specification:

$$Y_a = \beta_0 P_a + \beta_1 M_a + \beta_2 O_a + \beta_3 R_a + \beta_4 S_a + \beta_5 t_a + \beta_6 A + \varepsilon_a$$

Where a denotes the area, Y denotes the daily number of collisions, P denotes the percentage completion of the green lane painting, M denotes the daily number of Metro bikeshare trips made, O is a dummy variable denoting the opening of the Metro bikeshare stations on the westside of Los Angeles, R denotes the daily accumulation of rain in mm, S denotes a seasonal indicator to control for unobserved seasonal trends, t denotes the overall passage of time to control for unobserved long term time trends, A denotes the area fixed effect, and ε_a denotes an error term which is clustered by area.

5. Results and Analysis

The previously specified Poisson fixed effects model was run two times, once with unaltered collisions data in regards to the period of potentially unreported collisions from November 30, 2018, to March 11, 2019, and a second time with the collisions during this period replaced by missing values, to account for the fact that this data was likely misreported. It is also worth noting that incident rate ratios (IRRs), are presented for the sake of interpretation.

Poisson fixed effects model	Potentially unreported days included (1)	Potentially unreported days set as missing (2)
VARIABLES	IRR	IRR
Percentage Completion of Green Lanes	0.545*	0.414**
	(0.275 - 1.077)	(0.208 - 0.827)
Daily Metro Trip Frequency	1.001	1.001
	(1.000 - 1.002)	(1.000 - 1.002)
Westside Metro Stations Open	0.614*	0.587*
	(0.365 - 1.031)	(0.344 - 1.002)
Daily Rain Accumulated in mm	1.007	1.016
	(0.978 - 1.038)	(0.989 - 1.043)
Season = Summer	1.252	1.188
	(0.866 - 1.812)	(0.826 - 1.709)
Season = Autumn	1.458*	1.323
	(0.992 - 2.144)	(0.905 - 1.935)
Season = Winter	0.600**	0.830
	(0.369 - 0.974)	(0.514 - 1.343)
t	1.000	1.001*
	(0.999 - 1.001)	(1.000 - 1.002)
Area	3.896***	3.896***
	(2.838 - 5.347)	(2.840 - 5.344)
Constant	0.0393***	0.0359***
	(0.0228 - 0.0679)	(0.0207 - 0.0620)
Observations	2,190	1,986

Robust 95% confidence interval in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Based on the results, the completion of the green cycling lanes has a questionable effect on the rate of daily collisions within the treatment area. The scale of the percentage completion variable is measured from 0 to 1, meaning a 1-unit increase in the variable is the equivalent of the percentage completion going from 0% to 100% complete.

In regards to the IRRs, these numbers are representative of the multiplicative effect of a given variable on the rate of collisions per day in the treatment area. This means that the completion of the green lanes going from 0% to 100% in column 1 is associated with a multiplicative effect of .545 on the daily number of collisions in the treatment area, holding all other variables constant.

This IRR can also be transformed by subtracting 1, which produces the effect as expressed as a percentage. In this case, .545 - 1 = -.455, a 45.5% decrease in the number of daily collisions in the area of effect, holding all other variables constant Although the direction of the effect is as expected, the effect is only significant at a 10% significance level. Furthermore, based on the confidence interval, we can be 95% certain that the IRR lies between .275 and 1.077. Expressed in percentage terms, we can be 95% certain that the effect is between -72.5% (.274-1) and 7.7% (1.077-1). This is concerning not only because of how wide the confidence interval is, but also due to the fact that the upper end of the confidence interval suggests that the completion of the bike lanes may lead to an increase in collisions per day.

When replacing the potentially unreported collisions from November 30, 2018, to March 11, 2019 with missing values, both the significance level and confidence interval improve for the completion of the green lanes. Under the new conditions, the completion of the green lanes is associated with a multiplicative effect of 0.414 times the daily number of collisions, at a 5% significance level, holding all other variables constant. In percentage terms, this can be expressed as the completion of the green lanes being associated with a -58.6% (0.414-1) change in the daily number of collisions, holding all other variables constant. Although the confidence interval is still considerably wide, it is much more reasonable than when including the potentially unreported days in column 1. The new confidence interval suggests with 95% confidence that the IRR lies between 0.208 and 0.827. Expressed as percentages, the confidence interval suggests with 95% confidence that the effect of the green lane completion on the number of daily collisions is between -79.2% (.274-1) and -17.3% (.827-1). Although this is a more reliable interval as both boundaries represent a negative effect, rather than opposite effects, the width of the interval is still wide enough to elicit concern about the reliability of the estimate.

Taking both models into account, it is difficult to confidently place a specific numerical value on the effect of the completion of the green cycling lanes on the number of daily collisions. Although both models point to a negative effect, the fact that the outcomes changed so much based on the potentially unreported period is concerning. This period of 102 days makes up 9.4 percent of the total observations in the analysis, which is a significant enough amount to seriously affect the outcomes of the regression. Unfortunately, there was no way to confirm if this data was indeed underreported, but the length of time without a collision was far too long to assume it was reported entirely correctly with confidence. Not only this, but the low statistical significance of the IRR in column 1 and the wide confidence intervals of both IRRs lead to low confidence in the model estimates.

Despite this, the suggestions from the model estimates do match up with the raw data. In the 109 days following the completion of the green lanes, there were 26 cycling collisions, compared to 40 cycling collisions in the 109 days that preceded the beginning of the green lane painting. The reason 109 days is used in this case is because that is the total number of days from the completion of the green lanes to the end of the available collision data on December 31, 2019. Although this is in no way conclusive evidence that the green lanes were the direct cause of this decrease in collisions, it is worth mentioning as it corroborates the estimated negative direction of the effect of the green lanes on daily collisions as shown in the Poisson fixed effects model.

Overall, more research must be done to accurately and confidently identify the effect of the green lanes on cycling collisions. This could likely be accomplished with access to a wider and more reliable range of collision data in Santa Monica, as this was the main weakness of the model estimation.

6. Strengths, Limitations, and Future Research Suggestions

This analysis aimed to fill the research gap surrounding the effectiveness of colored cycling lanes at reducing cycling collisions. In doing so, major steps have been taken beyond observing behavioral changes made by motorists and cyclists. While behavior is of course an important determinant of overall safety, it itself does not represent safety as an outcome. In this analysis, the use of cyclist collisions offers a direct and explicit representation of safety for cyclists that has strong real world relevance. However, the use of collision data also offers serious drawbacks, both in general and in Santa Monica specifically.

Overall, cycling collisions will be underreported because people do not always feel the need to call the police or local authorities to report a collision. This is something that cannot be controlled for, as people are inherently unpredictable. Santa Monica specifically had its drawbacks in terms of the collision data, both in the potentially underreported data from November 30, 2018, to March 11, 2019, as well as the non-reported data for the entire year of 2020, which could have allowed for more observations after the green lanes were finished being painted. With this being said, it must be made very clear that this is in no way implying that the city of Santa Monica or its police department have done anything wrong, as the reasons behind the data underreporting are entirely unknown.

Another significant limitation of this analysis was the use of metro bikeshare data rather than actual cycling counts. Although the bikeshare data is the best available replacement, there is not enough information on cycling counts in Santa Monica or Los Angeles to confidently prove that one could be used accurately as a proxy for the other. A request was made to use Strava Streets data, which offers information on cycling activity at great resolutions powered by the GPS-based exercise tracking app, however this request was declined.

Future research should aim to seek out other places in which colored lanes have been implemented where adequate and reliable data on cycling counts and collisions are available. As more and more cities are adopting and experimenting with different forms of cycling infrastructure, it is important for researchers to attempt to quantify the benefits, or lack thereof, of these investments.

7. Conclusion and Policy Implications

Overall, the Poisson fixed effects model used in this analysis was not able to confidently quantify the exact effect of the completion of the green bike lane network in Santa Monica on the daily number of collisions in the city. However, this does not mean that the green lanes themselves were a failure. Going off of the results from the surveys conducted in Portland, Chile, and Oslo, the colored lanes in Santa Monica are also possibly associated with an increased perception of safety. To quantify this, it would be useful for the city of Santa Monica to conduct its own follow-up survey on the attitudes and perceptions of safety that both motorists and cyclists feel towards the green lanes. Although it has been a few years since the installation of the green lanes, such a survey would still be extremely valuable as the point in time will come when the city needs to discuss whether or not to repaint the lanes once the color has been worn down.

Another major effect that is not accounted for in the number of collisions is the overall attitude towards cycling in Santa Monica. Apart from safety, this attitude is representative of how cycling is viewed in general within the city. By devoting time and resources into making Santa Monica a more pleasant place to bike, the attitude towards cycling in the area has likely improved. This can potentially lead to increased ridership, as well as a greater sense of a cycling community within the area, which the city is actively trying to achieve. Santa Monica took a great leap by painting so much of its bike network green in an effort to increase safety and visibility for cyclists and motorists alike. However, with that being said, more research needs to be done on the effect of colored bike lanes on safety before other cities can be confident in the benefits of such an investment.

References

Brady, J., Mills, A., Loskorn, J., Duthie, J., & Machemehl , R. (2010). (rep.). *Effects of Colored Lane Markings on Bicyclist and Motorist Behavior at Conflict Areas* . Austin , Texas: The City of Austin Bicycle Team.

City of New York. (2011). (rep.). *EVALUATION OF SOLID GREEN BICYCLE LANES TO INCREASE COMPLIANCE AND BICYCLE SAFETY* . New York, New York.

Hunter, W. W., Harkey, D. L., Richard Stewart, J., & Birk, M. L. (2000). Evaluation of blue bike-lane treatment in Portland, Oregon. *Transportation Research Record: Journal of the Transportation Research Board*, *1705*(1), 107–115. https://doi.org/10.3141/1705-16

Hunter, W., Srinivasan, R., & Martell, C. (2008). (rep.). *EVALUATION OF A GREEN BIKE LANE WEAVING AREA IN ST. PETERSBURG, FLORIDA* .

Karlsen, K., & Fyhri, A. (2020). Is Red the New Black? A quasi-experimental study comparing perceptions of differently coloured cycle lanes. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.554488

Kozar, K. (2021, December 13). *Celebrating 10 years of the Santa Monica Bike Action Plan*. Celebrating 10 Years of the Santa Monica Bike Action Plan. https://www.santamonica.gov/blog/celebrating-10-years-of-the-santa-monica-bike-action-plan

LaMondia, J., McGhee, J., Fisher, M., & Cordero, F. (2019). Evaluating the safety and behavioral impacts of green bike lanes in suburban communities. *Transportation Research Record: Journal of the Transportation Research Board*, *2673*(11), 671–679. https://doi.org/10.1177/0361198119855605

Los Angeles Times. (2023, February 15). *This is when cycling in L.A. becomes deadly*. Los Angeles Times. https://www.latimes.com/california/story/2023-02-15/report-dangers-to-cyclists-los-angeles#:~:text=BikeLA%2C%20formerly%20the%20Los%20Angeles,roadways%2C%20and%20poor%20street%20lighting.

Morales, C. (2018, September 13). *Green Lanes and safe streets get the green light*. Green Lanes and Safe Streets Get the Green Light. https://www.santamonica.gov/blog/green-lanes-and-safe-streets-get-the-green-light

Peterson, J. (2019, May 1). *Green Bike Lanes: A bright idea to keep us all safe*. Green Bike Lanes: A Bright Idea To Keep Us All Safe. https://www.santamonica.gov/blog/green-bike-lanes-a-bright-idea-to-keep-us-all-safe

Vera-Villarroel, P., Contreras, D., Lillo, S., Beyle, C., Segovia, A., Rojo, N., Moreno, S., & Oyarzo, F. (2016). Perception of safety and liking associated to the colour intervention of bike lanes: Contribution from the Behavioural Sciences to Urban Design and Wellbeing. *PLOS ONE*, *11*(8). https://doi.org/10.1371/journal.pone.0160399