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Assessing the Safety and Usage of Lewiston-Auburn Streets

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Executive Summary

This project was completed in collaboration with the Lewiston-Auburn Complete Streets Committee and with guidance from George Peterson, an active member of the committee and a local project engineer. The focus of this project was to develop a state of the streets report to aid in the ongoing efforts of the Complete Streets Committee to improve street safety and transit experience in Lewiston-Auburn, Maine. This report includes graphics displaying our findings along with recommendations for municipal scale interventions for the Complete Streets Committee to consider in their future projects.

Before beginning our research, we paused to acknowledge the privilege we have to be able to navigate the Lewiston-Auburn community as Bates College students. We discussed the implicit biases we have in our perception of street safety in Lewiston-Auburn due to this privilege. With this guiding our work, we aimed to work towards a comprehensive understanding of the street user experiences of other communities in Lewiston-Auburn.

High rates of car crashes and a loss of community in car-oriented cities stem from the strong hold that the automobility paradigm has over urban form and street design. In cities across the globe, the safety of street users other than automobiles is often overlooked and results in nearly 1.3 million deaths in car crashes annually (Scheller 2018). To inform the goals of the Lewiston-Auburn Complete Streets Committee to implement effective street redesigns, our project aimed to answer questions about trends in street safety and usage in Lewiston-Auburn as compared to state and national statistics.

Through our project, we compared trends in total crashes, vehicle miles traveled, and mode share across local, state, and national scales to situate Lewiston-Auburn within a broader context of street usage and safety. Further, we identified eight intersections with the highest crash rates in Lewiston-Auburn. In conjunction with our data analysis, we found that road curvature, gas prices, and automobile-centered planning contributed to the analytical results of our project. Seeing as these factors fell into the broader category of traffic speed, we developed recommendations to address traffic speed. Building off of these recommendations, we also devised recommendations to address traffic volume that provide a framework for long-term transformation. The figures, analyses, causal factors, and recommendations of our report create a holistic view of Lewiston-Auburn streets and suggest next steps for the Lewiston-Auburn Complete Streets Committee to create more safe and accessible streets in this community.

Table of Contents

List of Figures

Introduction

Street transportation crashes are a leading cause of injury and death in the United States. In 2019, over 38,800 people were killed in motor vehicle crashes in the US, with 48% of those crashes taking place at night (Beltz 2021). From 2019 to 2020, the number of deaths per 100 million vehicle miles traveled increased 24% despite the number of vehicle miles traveled decreasing 13% amidst the COVID-19 pandemic (National Safety Council, 2021). The need for intervention to improve street safety is more apparent than ever before.

As the United States developed, a cycle of automobile dependency was initiated that continues to promote individuality while creating a stigma surrounding public transportation. This cycle, the automobility paradigm, has heavily influenced urban form, notably in motivating urban sprawl (Scheller 2018). When exploring automobility safety, it is critical to recognize the constraints that the automobility paradigm places on street redesign. Our project aims to address local issues of street safety and usage, but a broader systems-level movement towards Transit Oriented Development is necessary to move away from automobile dependence.

The need to implement street redesigns to improve street safety raises the question of who has a right to the streets and who has a claim to street safety. Narrowing lane widths through road dieting is one of many examples of street redesigns to support safer pedestrian and bicyclist experiences in cities (Banerjee and Welle, 2016). When deciding where to target change, it is important to understand local-level street usage and consider the distribution of safety issues to minimize crashes in the future and create a more holistic and vibrant community for all street users.

The term “complete streets” was coined by America Bikes in 2003, defining the following Complete Streets policy initiative as “ensuring that the entire right of way is routinely designed and operated to enable safe access for all users. Pedestrians, bicyclists, motorists and transit riders of all ages and abilities must be able to safely move along and across a complete street” (McCann and Rynne, 2010). Following this, representatives from America Bikes and other organizations formed the Complete Streets Task Force to lobby for the inclusion of Complete Streets policy in federal transportation legislation (McCann and Rynne, 2010). By 2006, this task force had evolved into the National Complete Streets Coalition. Complete Streets policies address issues including traffic volume, street safety, and accessible transportation by seeking to “provide meaningful transportation choices for all people to elevate all users of the street onto an equitable playing field” (Complete Streets: A Guide to Best Management and Design Practice). Such policies can reduce pedestrian risk by up to 28 percent and traffic crashes between 18 and 43 percent (McCann and Rynne, 2010). By the end of 2012, nearly 500 Complete Streets policies had been implemented across the nation, from single-page ordinances to comprehensive guidelines (Zehngebot and Peiser, 2014).

Between the years 2000 and 2016, there were a total of 224 crashes involving pedestrians, including 5 fatalities, and 30 incapacitating injuries in Lewiston-Auburn alone. The collaboration of members of the legislative delegation, city council, and school committee in response to these alarming street safety statistics resulted in the adoption of identical Complete Streets policies in Lewiston and Auburn in 2013 to transition towards safer streets in Lewiston-Auburn (Lewiston Press Release, 2014). In the same year, Lewiston and Auburn were recognized as national leaders “in making streets safer and more convenient for everyone who uses them” according to the National Complete Streets Coalition (Lewiston Press Release 2014). The Complete Streets Committee has made significant progress ever since, working amidst the policy landscape in Lewiston-Auburn and Maine to implement municipal scale

interventions to lower the number of crashes across the streets. They work in conjunction with the Maine Department of Transportation (DOT) and the Androscoggin Transportation Resource Center. The committee has also set up consistent maintenance of the streets of Lewiston-Auburn in areas such as mowing, plowing, and spot repair to improve the objective safety of the streets for all users.

Between the years 2018 and 2020, Lewiston-Auburn accounted for 702 or 9.9% of Maine's 7087 total automobile crashes, while their population makes up only 8% of Maine's total population. Auburn and Lewiston were the towns with the highest number of intersection car crashes in the state. In this same time frame, Lewiston-Auburn's 34 bicycle crashes made up 7.2% of Maine's 474 total bicycle crashes. Auburn led in Maine for the most automobile intersection crashes between 2018 and 2020, and Lewiston came in at a close second. Over the past four years, The Lewiston-Auburn Complete Streets Committee has implemented street redesigns across a multitude of streets in the area, from Lisbon Street in Lewiston to Poland Road in Auburn.

Moving forward, the Complete Streets Committee is interested in understanding the trends in the usage and safety of Lewiston-Auburn streets as compared to that of state and national statistics. Alongside knowledge of factors that might motivate the patterns of mode share and crash rates across Lewiston-Auburn streets, the Complete Streets Committee is interested in a "State of the Streets Report" to inform street redesign initiatives. Our project, with feedback and guidance from George Peterson to ensure that our work aligned with the goals of the Lewiston-Auburn Complete Streets Committee, aimed to develop such a report for the Complete Streets Committee that assessed the usage and safety of Lewiston-Auburn streets and supported the work of the Complete Streets Committee to improve safety in the future. We summarized usage patterns and identified high crash areas in the streets of Lewiston-Auburn to compare these trends with state and national statistics. Further, we identified potential causal factors, from development projects to economic factors like gas prices, that may inform the patterns from our data analysis. Finally, we proposed recommendations to improve the safety of Lewiston-Auburn streets based on our findings. We hope that this report will complement the work of the local Complete Streets Committee by helping members of the committee decide where to focus their efforts for improved street safety.

Methodological Approach

We utilized both quantitative and qualitative methods to achieve our aim and produce our deliverable in this project. We began by collecting data from a multitude of sources that we later analyzed to assess the safety and usage of Lewiston-Auburn streets. For our spatial safety analyses, we acquired raw crash counts and turning movement counts for intersections in Lewiston-Auburn from the Maine Public Crash High Crash Location Query Tool and the Androscoggin Transportation Resource Center. For our temporal safety analyses, we gathered crash count statistics for Lewiston-Auburn across the years of 2013 to 2017 from the MaineDOT Crash Query Tool. Finally, for our mode share analyses, we located charts on computer transportation more share for Lewiston and Auburn that we were able to export as datasheets. We then compiled this data in Google Sheets spreadsheets to readily conduct analyses and create figures of our findings.

After exploring the available data, we determined that our analyses would fall into crash rate analyses or mode share analyses. For our spatial safety analyses, we identified the total number of automobiles, pedestrians, and bicycles that passed through a given intersection in each 12-hour sample. We then used a standardization coefficients tool that allowed us to extrapolate from that sample to estimate the traffic volume through a given intersection annually. We were able to standardize the raw annual crash counts for a given intersection by dividing the number of crashes by the annual traffic volume, thus producing crash rates for the intersections in Lewiston-Auburn. We aligned the years of the data for our temporal safety analyses such that the comparisons across local, state, and national scales could be readily made. We calculated the percent increase between the first and last year of data for Lewiston-Auburn, Maine, and the United States to accompany these trend comparisons. Lastly, we calculated the number of fatal crashes in both Lewiston and Auburn between 2005 and 2018 from the number of crashes in these cities during that time. Then, for our mode share analyses, we calculated the average mode share for each mode of transportation across Lewiston and Auburn to estimate a mode share for the twin cities between 2014 and 2018. For trends in vehicle miles traveled, we once again aligned the years across the compiled data and calculated the percent increase for the local, state, and national scale.

Next, we explored literature on street safety and Complete Streets to identify potential causal factors of the street safety and usage trends that we saw in our analyses. The first article that we analyzed focused on the influence of road curvature on fatal crashes in New Zealand. We then looked at another article that investigated the relationship between gasoline prices and fatal crashes. Finally, we looked at two other sources that gave an overview of the impacts of traffic calming in urban environments and the safety of urban cycle tracks. Upon completion of analyzing these sources, we decided to look for what we could extract from the literature and gather for developing causal factors. When analyzing all of the literature altogether, we specifically looked for commonalities between each article, which assisted us in developing a causal factor from each reading.

Upon completion of both quantitative and qualitative analyses, we decided to frame our findings through a multitude of figures. We utilized line graphs to illustrate temporal trends in crashes and vehicle miles traveled. To visualize crash fatalities and crash rates, we turned to simple bar graphs. Finally, we used pie charts to best allow for mode share comparison across spatial scales. These visualizations in turn framed our recommendations for municipal scale interventions in Lewiston-Auburn.

Results and Discussion

Through our data analyses, we were able to illustrate trends in the total number of crashes between 2013 and 2017 in Lewiston-Auburn, Maine, and the United States. The figures of these trends are shown in Figures 1, 2, and 3.

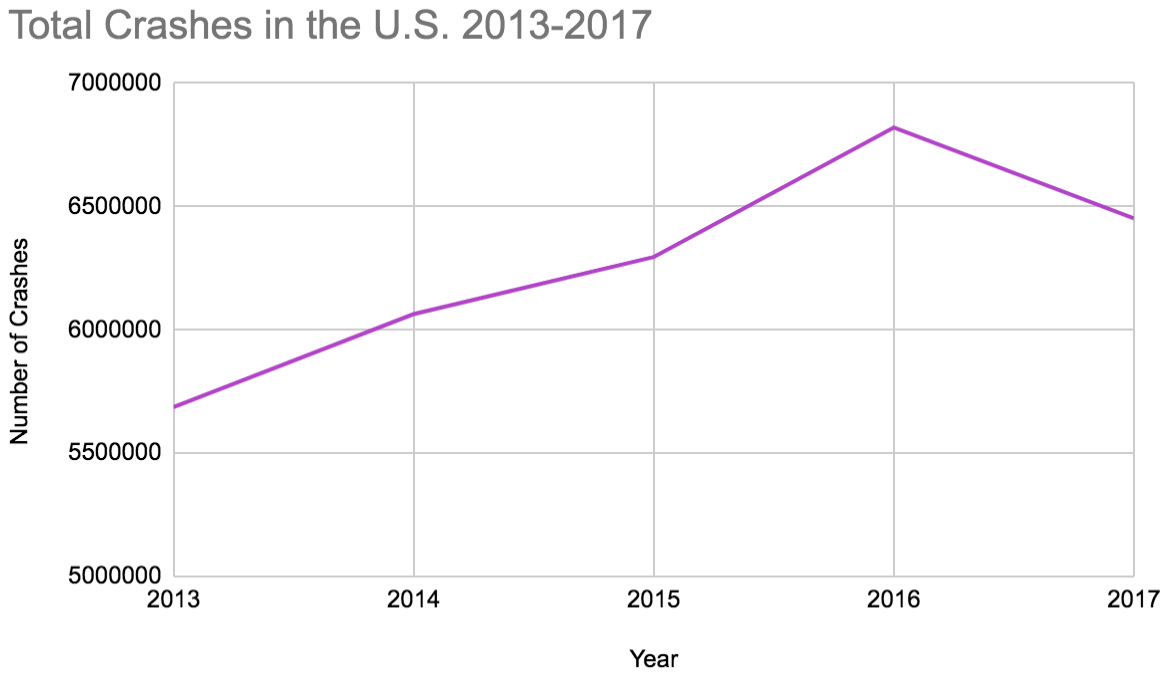


Figure 1: The total number of crashes in the United States based on annual data from 2013 to 2017.

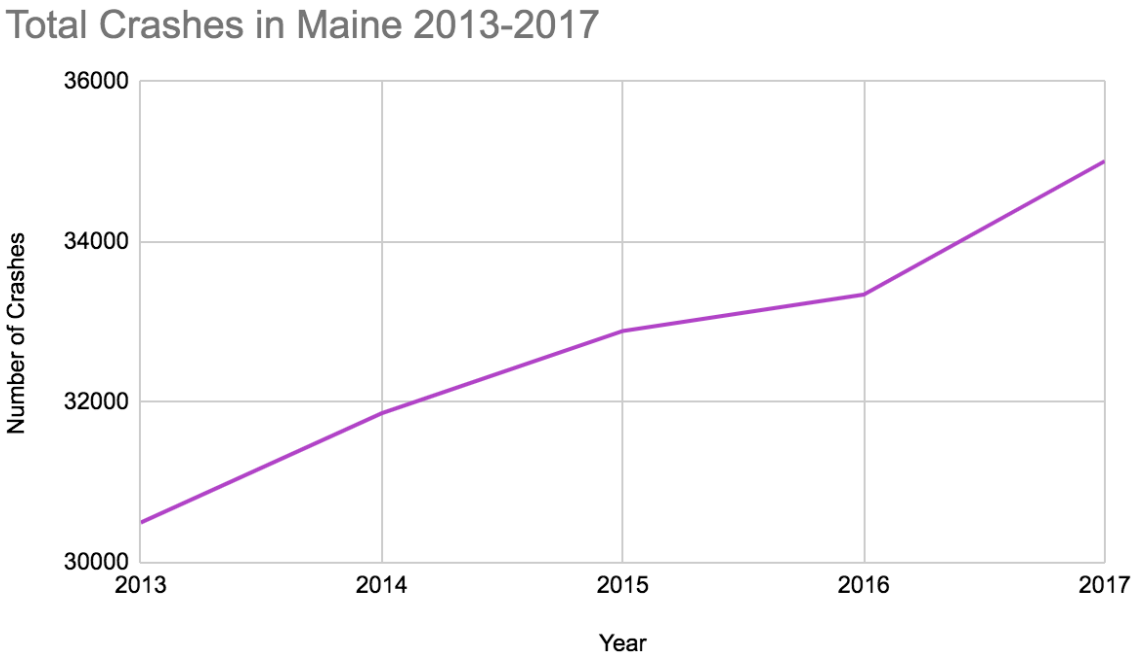


Figure 2: The total number of crashes in Maine based on annual data from 2013 to 2017.

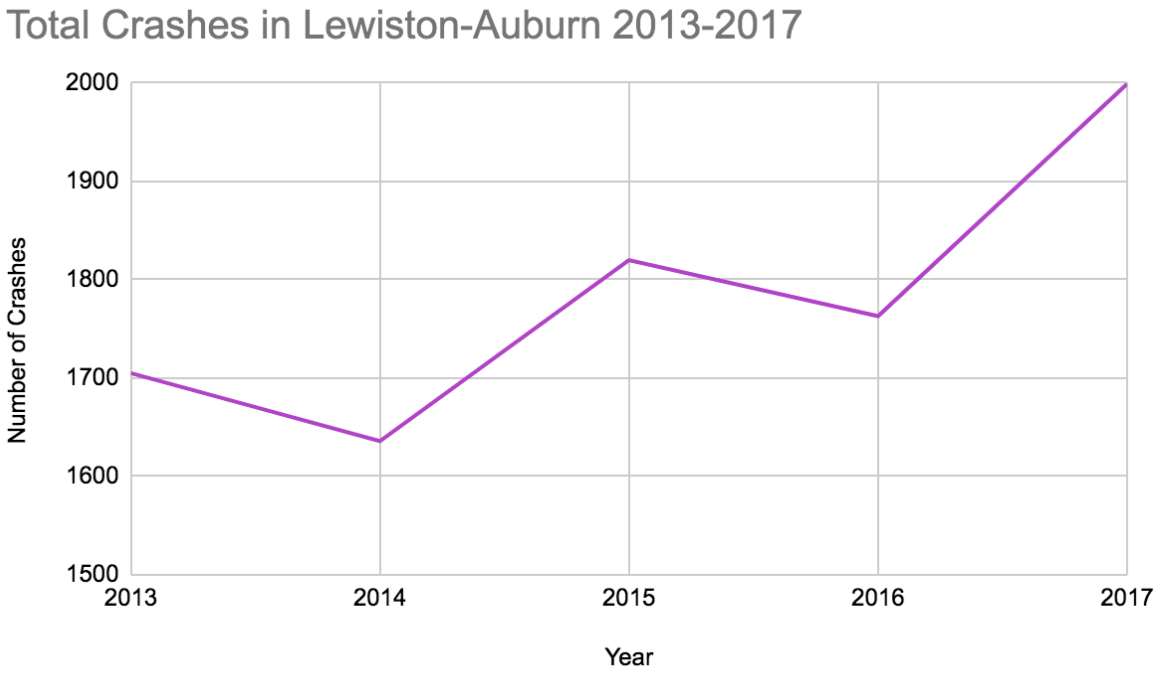


Figure 3: The total number of crashes in Lewiston-Auburn based on annual data from 2013 to 2017.

It was clear from these three trend figures that the crashes in Lewiston-Auburn mapped significantly better onto those in Maine than in the United States. The nationwide trend since 2016 has been a decrease in the total number of crashes, with a percent increase of 13.5% between 2013 and 2017. Yet in Maine and Lewiston-Auburn crashes have continued to rise, with percent increases of 14.8% and 17.2% respectively across those years. Notably, the increase in crashes between 2016 and 2017 in Lewiston-Auburn is far steeper than the trend in Maine in that year. To contextualize the number of crashes across these scales with the amount of driving that occurred, we created figures of trends in vehicle miles traveled between 2015 and 2019. The figures of these trends are shown in Figures 4, 5 and 6.

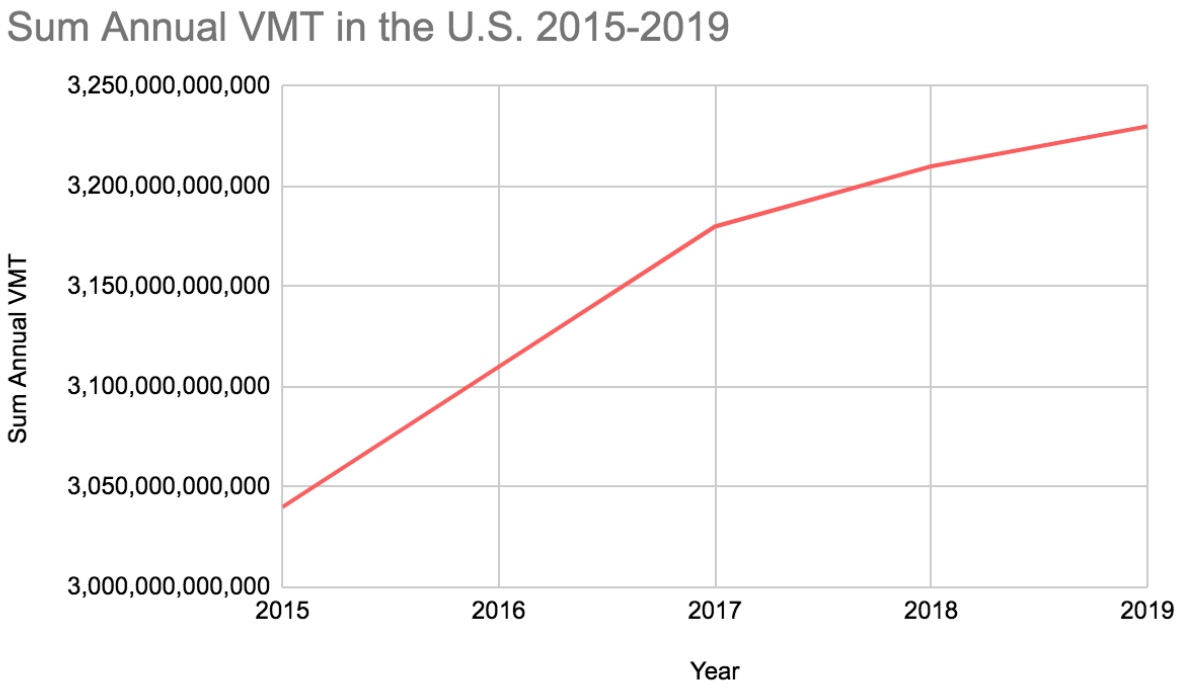


Figure 4: The sum annual vehicle miles traveled in the United States based on annual data from 2015 to 2019.

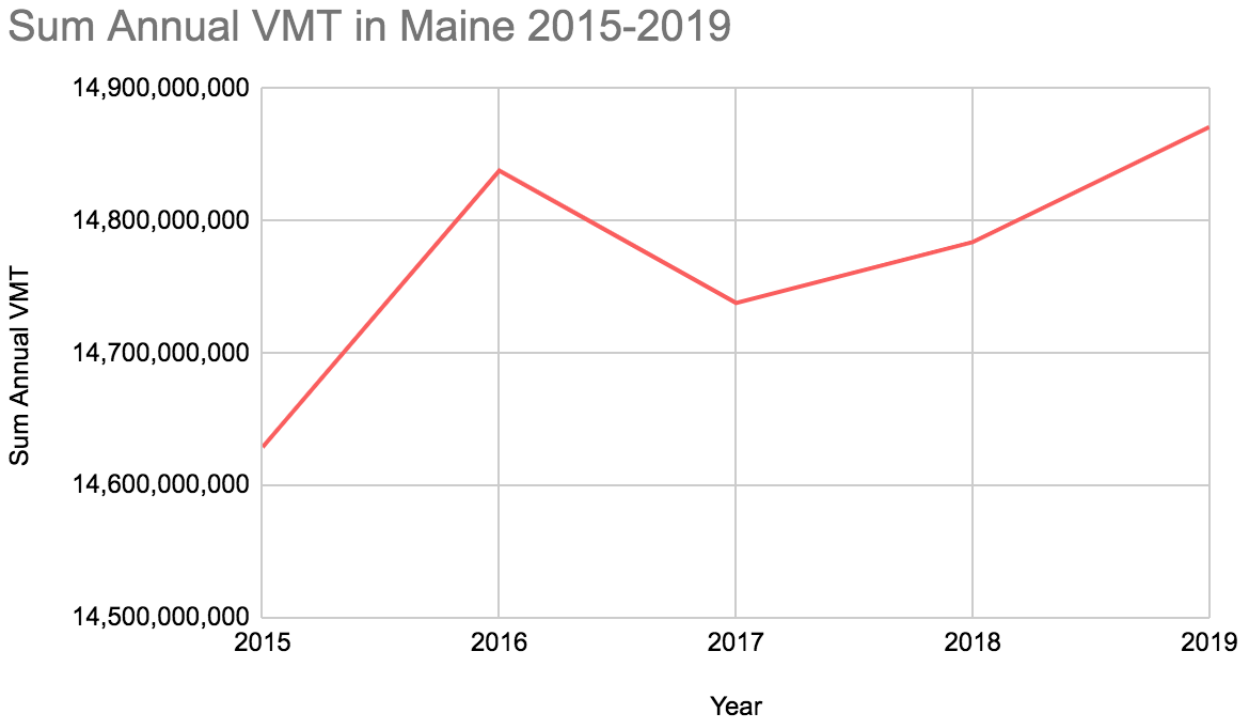


Figure 5: The sum annual vehicle miles traveled in Maine based on annual data from 2015 to 2019.

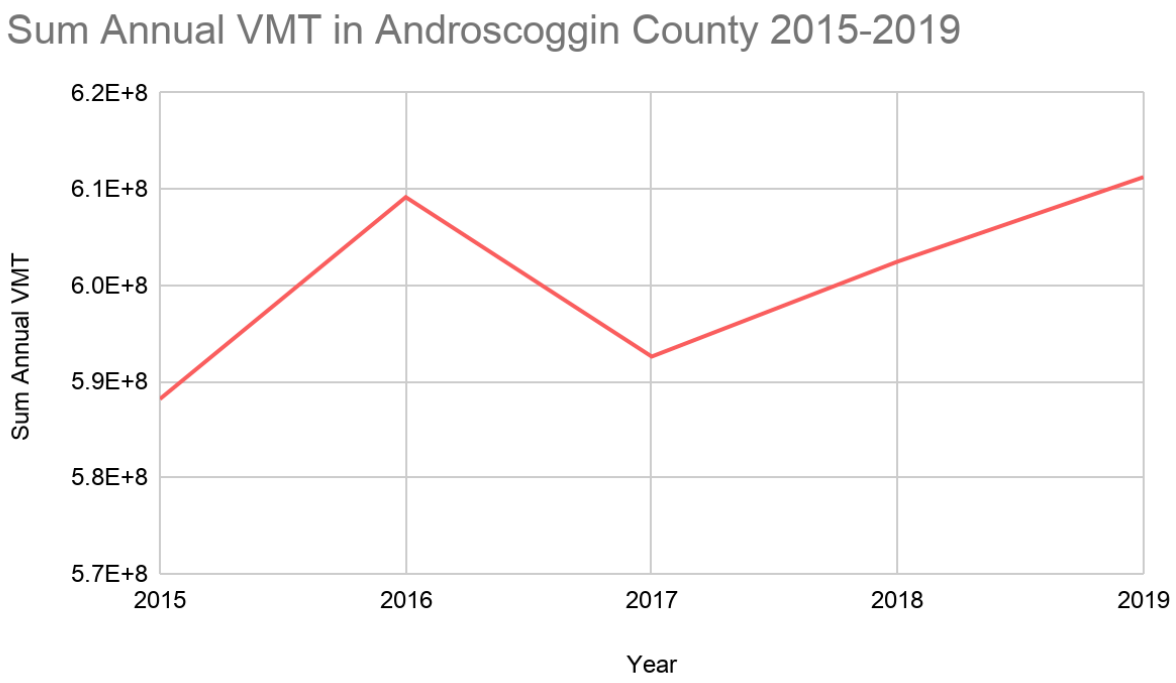


Figure 6: The sum annual vehicle miles traveled in Androscoggin County based on annual data from 2015 to 2019.

From these analyses, we observed that the sum annual vehicle miles traveled in the United States have increased steadily between 2015 and 2019, although less steeply in the years since 2017. The percent increase in sum annual vehicle miles traveled in the United States between 2015 and 2019 was 6.3%. Interestingly, there was some fluctuation in the sum annual vehicle miles traveled in Maine that matched the trend in Androscoggin County during these years. The percent increase in sum annual vehicle miles traveled in Maine and Androscoggin County between 2015 and 2019 was 1.7% and 3.9% respectively. Thus, while vehicle miles traveled in the United States have continued to increase, the total number of crashes has decreased since 2016. In contrast, the total number of crashes in Maine and Lewiston-Auburn has increased along with vehicle miles traveled in recent years.

Having analyzed trends in automobile use and safety across time and space, we then turned to an estimation of mode share for Lewiston-Auburn to compare to that of Maine and the United States. Using commuter transportation mode share for Lewiston and Auburn between 2014 and 2018, we were able to average the number of households who utilized differing modes of transportation and create a figure of the mode share breakdown for Lewiston-Auburn during these years, seen in Figure 7.

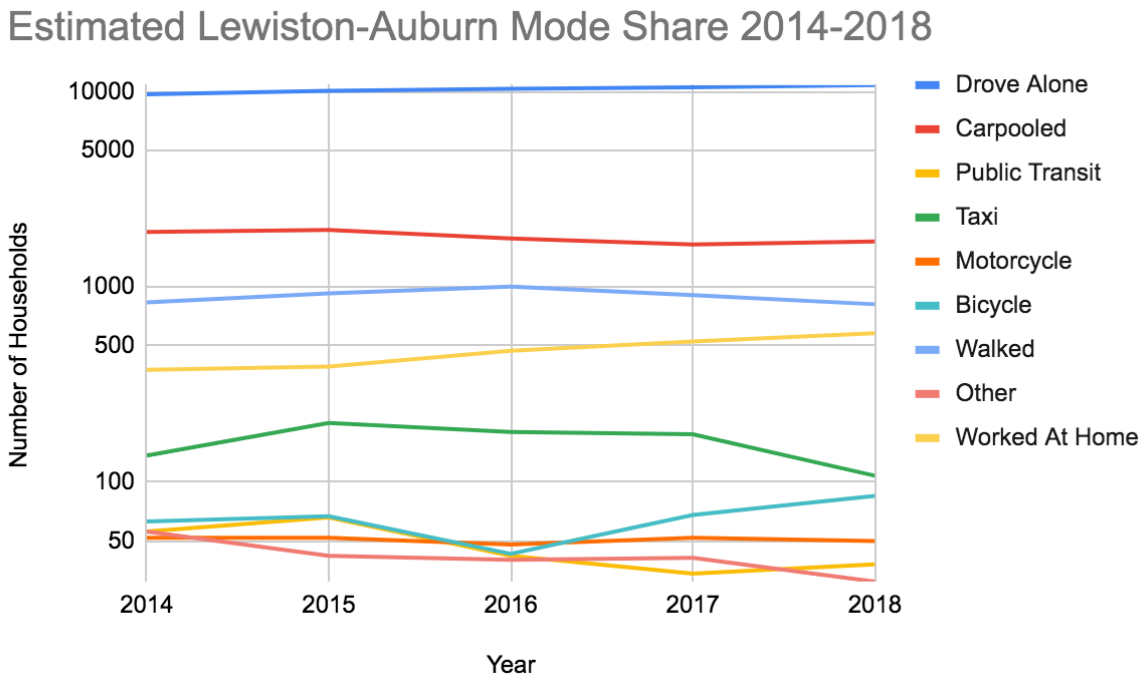


Figure 7: The estimated mode share for Lewiston-Auburn between 2014 and 2018.

As to be expected seeing as we are operating within a framework of automobile dependence, the vast majority of households in Lewiston-Auburn drove alone or carpooled to work during these years. Trends in bicycle use fluctuated, but it was only walking to work that a significant number of households relied on to get to work beyond automobile use in the forms of driving alone, carpooling, and taxis. To compare the mode share breakdown for Lewiston-Auburn to that of Maine and the United States, we decided to create figures of the most recent year in data to visualize the similarities and differences. The figures of these trends from 2018 can be seen in Figures 8, 9, and 10.

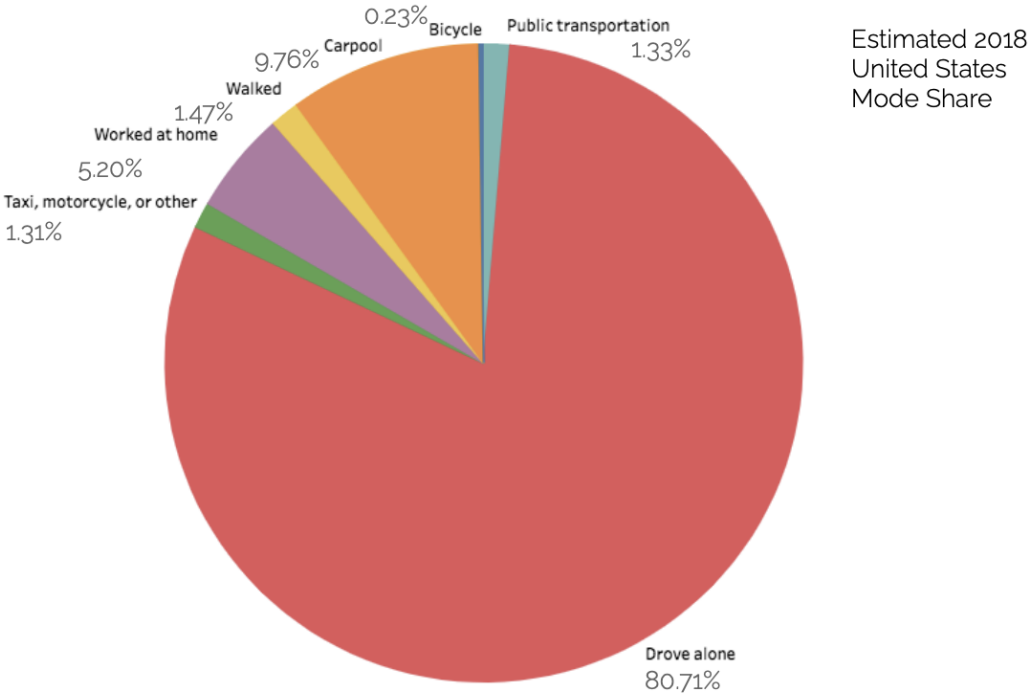


Figure 8: Estimated 2018 mode share for the United States.

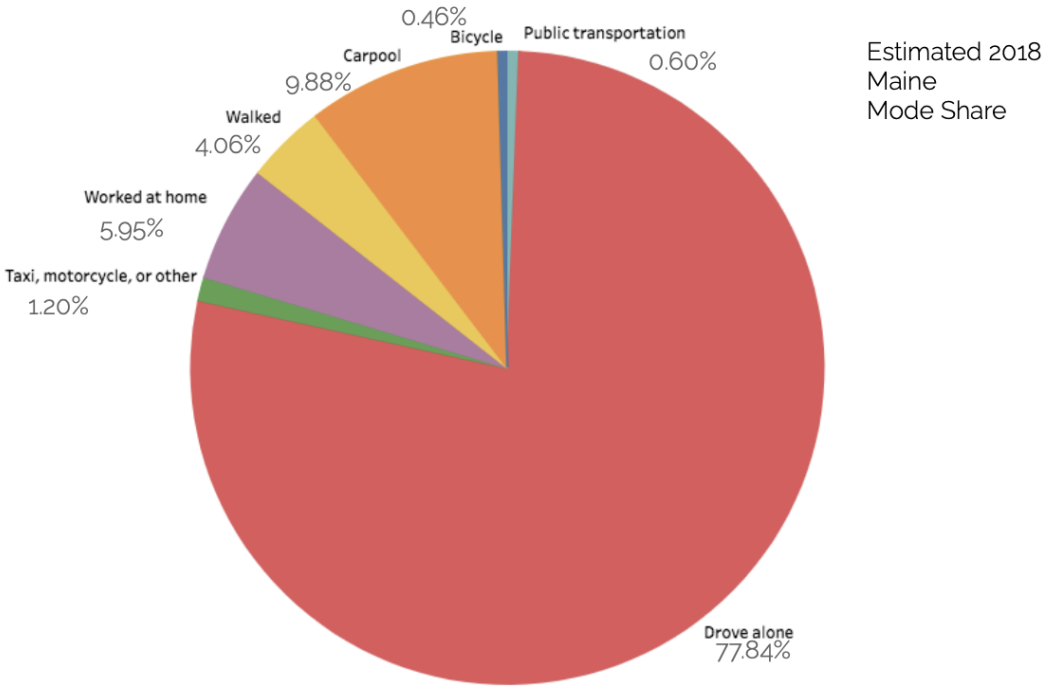
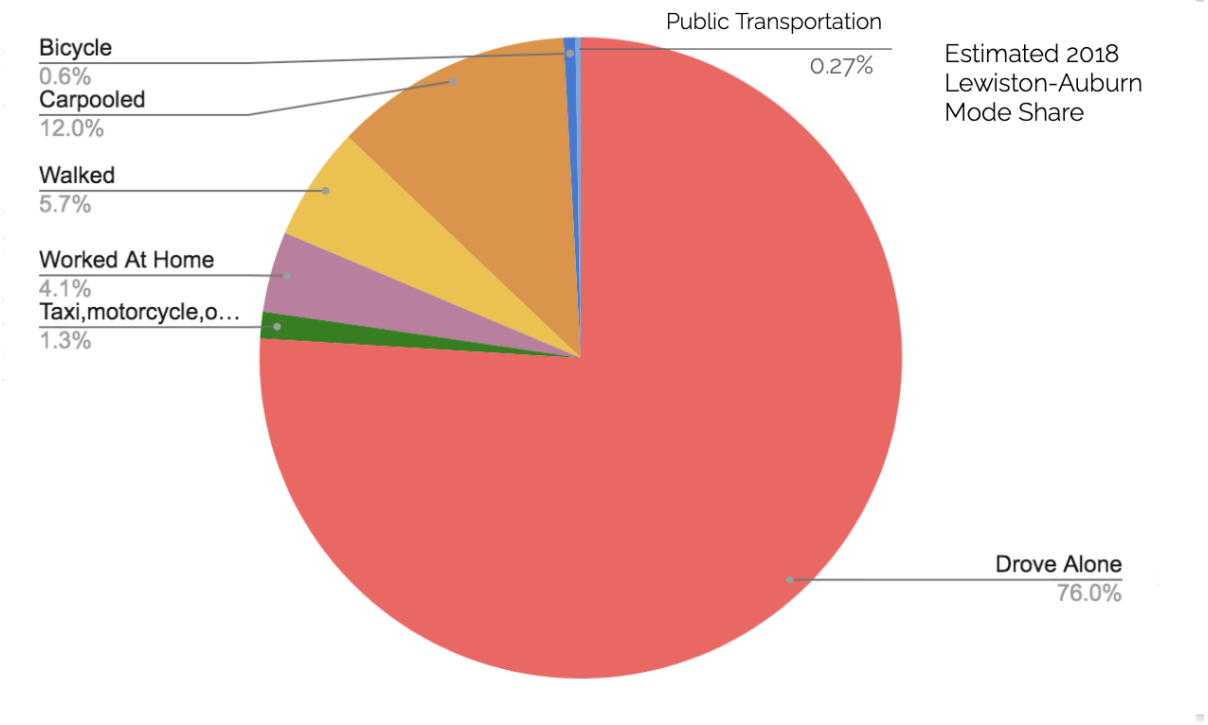


Figure 9: Estimated 2018 mode share for Maine.
Figure 10: Estimated 2018 mode share for Lewiston-Auburn.



In examining these figures, we noted that in Lewiston-Auburn over 75% of households drove alone to work in 2018. There were a significant number of households who carpooled to work but we categorized that as automobile use nonetheless. While roughly 5% of households walked to work, only a combined 1% chose to bike or ride public transportation during that year. Between Lewiston-Auburn and Maine, we observed that there was only a slight increase, about 1%, in the proportion of households who drove alone to work. However, the proportion of households taking public transportation to work in 2018 nearly tripled at the state level. Notably, the proportion of households who biked or walked to work decreased, from 0.6% to 0.46% and 5.7% to 4.06% respectively. At the national level, 80% of households drove alone to work in 2018. Between Maine and the United States, the proportion of households who biked or walked to work decreased from 0.46% to 0.23% and 4.06% to 1.47% respectively. However, the proportion of households who took public transportation to work in 2018 more than doubled from 0.6% to 1.33% between Maine and the United States. The proportion of households in Lewiston-Auburn in 2018 who carpooled or walked to work was higher than that of the United States. Additionally, the proportion of households who drove alone, took public transportation, biked, carpooled, or walked to work was lower than that of the United States.

After analyzing trends in crashes, vehicle miles traveled, and mode share, we decided to explore street usage specific to the streets of Lewiston-Auburn. This analysis connected street design to street usage. Using vehicle, bicycle, and pedestrian counts from the 12-hour samples at intersections in Lewiston-Auburn, we constructed pie charts that estimate intersection-specific mode share. Two

intersections with contrasting mode share are the intersection of Court Street and Goff Street in Auburn, Maine and the intersection of Ash Street and Bates Street in Lewiston, Maine, shown in Figures 11 and 12.

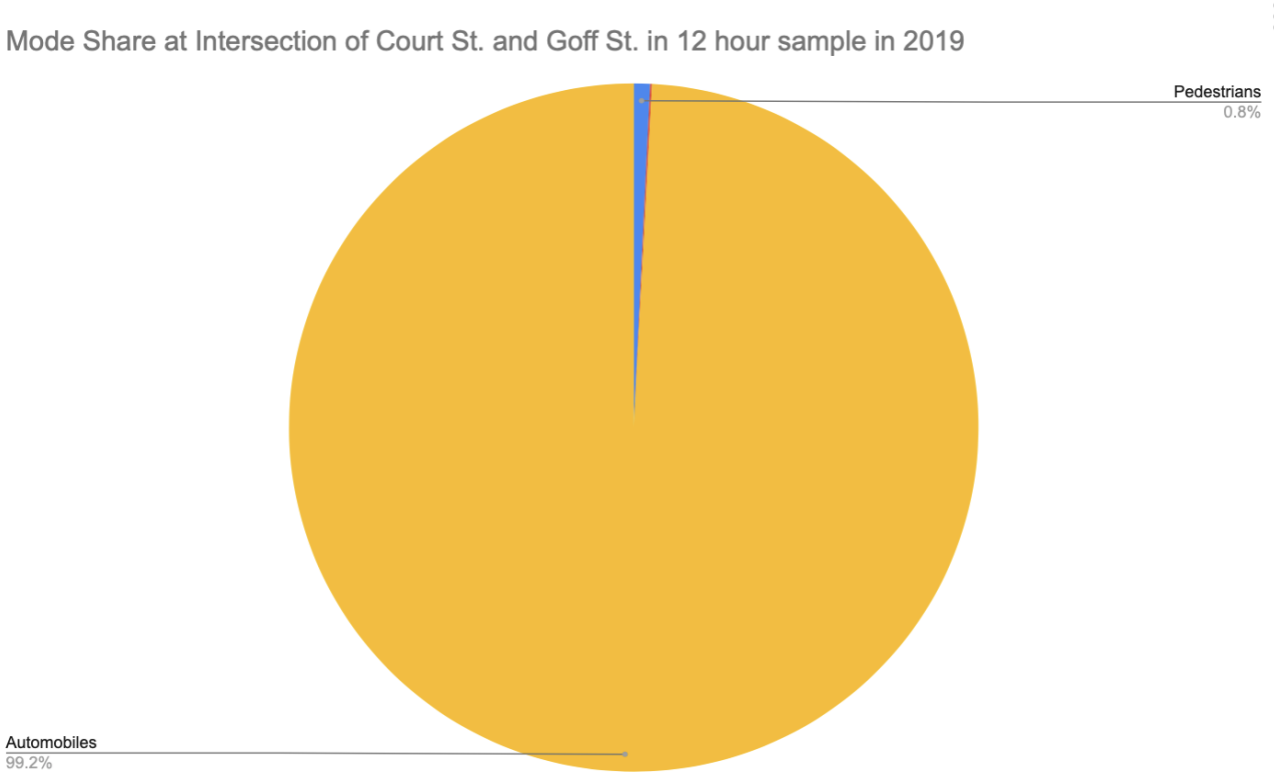


Figure 11: Mode share from 2019 12-hour sample at the Court St. and Goff St. intersection.

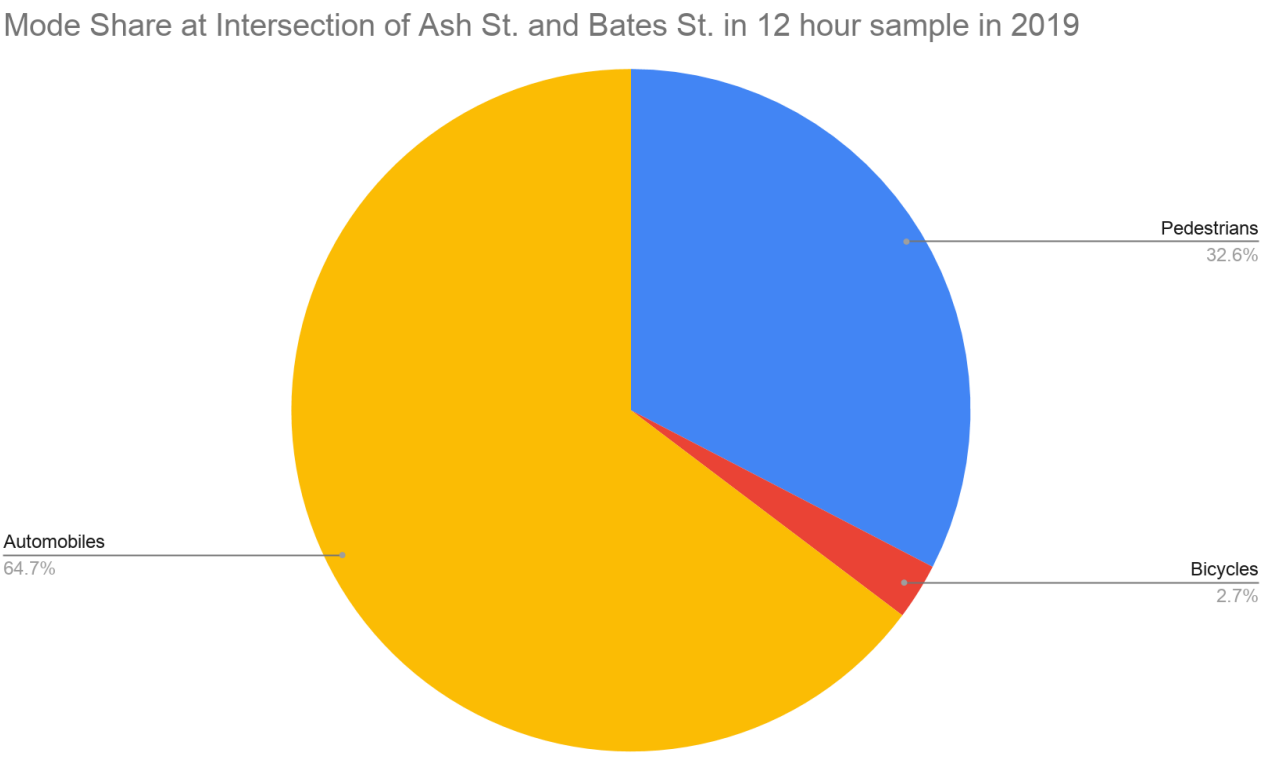


Figure 12: Mode share from 2019 12-hour sample at the Ash St. and Bates St. intersection.

It is critical to note that these figures are only estimates of mode share for these intersections, and a more holistic gathering of temporal data across days and years will produce a more accurate mode share for intersections in Lewiston-Auburn. The Court Street and Goff Street intersection is characterized by two lanes of traffic and vehicles parked up to the edge of the street. The lack of a cycle lane or a crosswalk aids in contextualizing the mere 0.8% pedestrian mode share as opposed to the 99.2% automobile mode share. The mode share for the Ash Street and Bates Street intersection, with both a cycle lane and a crosswalk, is a far more equal distribution. Automobiles at this intersection accounted for less than ⅔ of the mode share during the 12-hour sample in 2019 while pedestrians accounted for almost a ⅓.

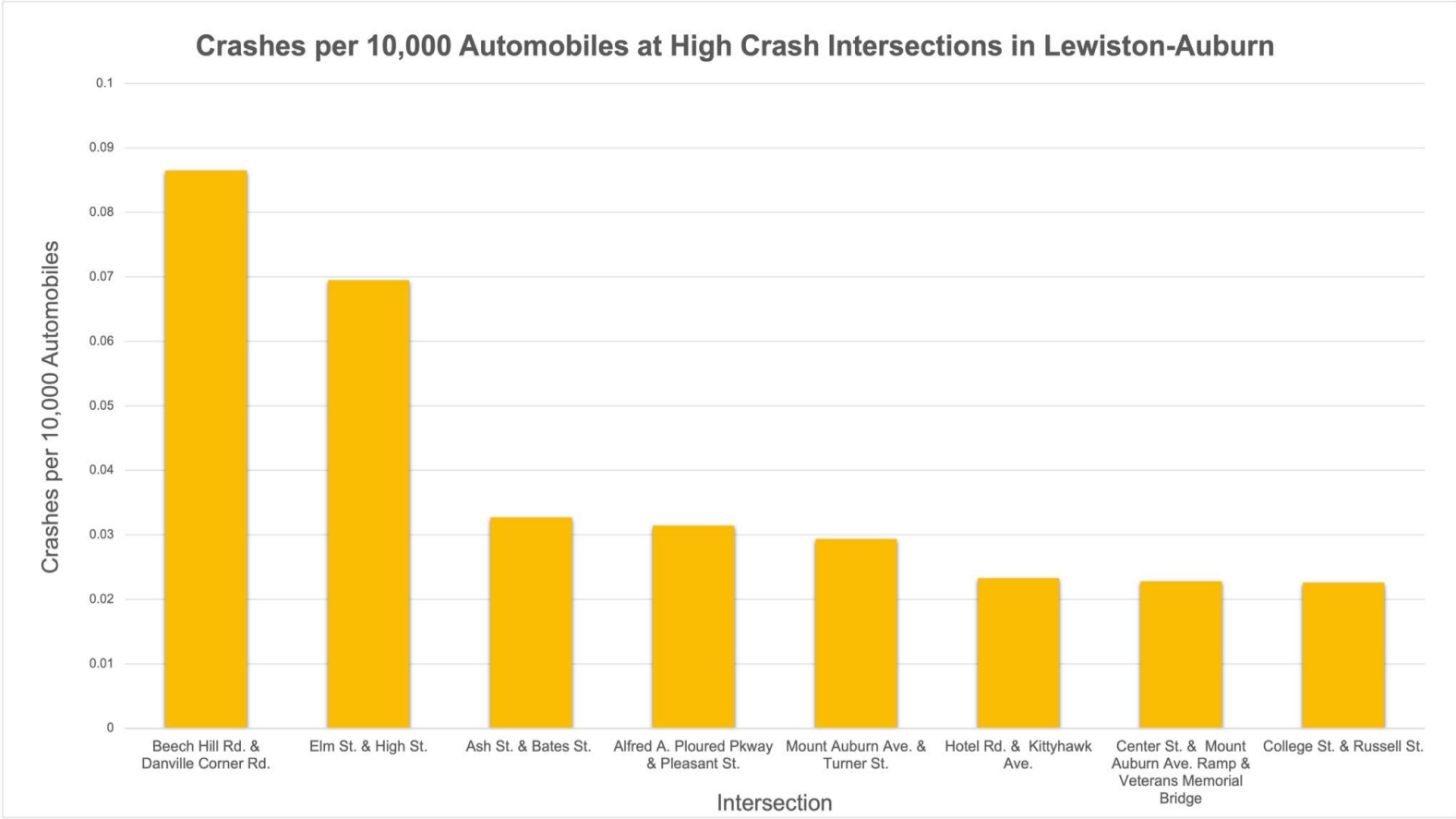


Figure 13: High crash rate intersections in Lewiston-Auburn in descending order based on the standardized unit crashes per 10,000 automobiles.

We can see that the intersection of Beech Hill Rd. and Danville Corner Rd. had the highest crash rate for automobiles in 2019, with 0.087 crashes per 10,000 automobiles. Elm St. and High St. came in as the second-highest, with 0.069 crashes per 10,000 automobiles in 2019. Pinpointing intersections with the highest crash rates allowed us to be specific with our recommendations to best improve street safety in the future. Crashes at both of these intersections were primarily rear-ends and sideswipes in 2019. It is worthwhile to note that while these intersection crash rate analyses were thoughtfully conducted, there were considerable limitations in data availability. Raw crash counts for specific intersections were accessible for 2019, but data for turning movement counts for a given intersection varied in the year of documentation. Next steps for data collection should include turning movement counts at intersections in Lewiston-Auburn for the year in question to build a more holistic database of traffic volume in the area.

In addition to the quantitative analyses that we conducted, we also performed a qualitative analysis through the reading of scholarly literature to identify potential causal factors of street safety and usage patterns. The first article titled *"Traffic Calming" from Sustainability and Cities: Overcoming Automobile Dependence* by Peter Newman and Jeffrey Kenworthy discussed the impacts of traffic

calming. It highlighted traffic calming as the process of slowing down traffic to ensure safer street environments for pedestrians, cyclists, shoppers, etc. The major objectives of traffic calming include: reducing the number of accidents, Reducing pollution, improving the urban street environment of non-car users, reducing car's dominance on roads by reclaiming road space for living space, and enhancing local economic activity by creating a better environment for people. The article found that it was best done by physically altering street environments through different road textures and changing the geometry of roads through the incorporation of chicanes. Furthermore, they found the implementation of speed bumps and plateaus to be useful, and that incorporating more street furniture would create a more human and safe environment. All of these suggestions would altogether cause drivers to slow down as they will perceive it as a road that is to be shared with pedestrians which would foster an urban environment. Furthermore, the implementation of traffic calming is a community process which would allow local residents to have a strong input into the traffic system. Additionally, the majority of the traffic calming schemes have been sponsored by national and local governments. Traffic calming reduces accidents, and particularly the severity of them too because speed is the most critical factor (Newman, 2015).

The second article we analyzed titled *Gasoline prices and their relationship to the number of fatal crashes on US* roads discussed gasoline prices and their relationship to the number of fatal crashes on U.S. roads. From analyzing the relationship between the two variables, the paper was able to conclude that the higher gasoline prices led to lower fatal motorcycle crashes. However, when looking at automobiles, they did not find any differences in terms of the fatal crash rate when increasing the gas price. According to their study, increasing the retail gas price will not improve traffic safety. However, it is important to note that this does indicate that it will not lead to potential benefits. For example, the increase of the gas price could lead to people driving less, which could lead to decreasing gasoline demand and increasing the health of the environment while encouraging shifts towards alternate forms of transportation such as buses, and trains. Finally, a limitation when looking at this study is that it only focuses on the fatal crash data. This indicates that other crashes that were not as fatal were not included within the data that was analyzed for this study (Safei, 2021).

The third article we researched titled *Influence of road curvature on fatal crashes in New Zealand* focused on the relationship between fatal crashes and road curvature. When analyzing the different areas in regards to road curvature, they found that from looking at 16 areas, that 14 out of the 16 curvature coefficients were negative. The study concluded that road curvature had little to no correlation to fatal crashes. However, when looking at the 2 associations which showed more significant data (which both were in urban settings), they found that crashes on urban roads were inversely related to the cumulative angle turned per kilometer. As a result, they were able to hypothesize and support the idea that road curvature might be protective in urban settings. Limitations to this study include how it was conducted in New Zealand which is a country that has different traffic regulations, making it challenging to directly apply their findings to that of the US street system (Haynes, 2008).

Although the gas price and road curvature studies lacked significant data, both of these articles brought up relevant points in regards to how both of these factors could indirectly lead to improved street safety. For example, curvier roads in urban areas tend to lead to slower driving speeds, which in turn leads to lower crash rates (Haynes, 2008). On the other hand, in terms of the gas price article, the authors found that increased gas prices correlate to slower driving speeds, and as mentioned earlier, leads to lower crash rates as well (Safei, 2021). It is interesting to note how both of these inferences made from the two articles line up with the overall goal of traffic calming which is to lower driving speeds as they noted that it was a critical factor when it comes to crash rates.

Recommendations for Next Steps

Using the high crash intersections in Lewiston-Auburn that we identified through our crash rate analyses coupled with the potential causal factors that we identified through our literature synthesis, we developed traffic speed and traffic volume recommendations to inform the next steps of the Lewiston-Auburn Complete Streets Committee. These recommendations stemmed from a framework based on past projects and Lewiston-Auburn Complete Streets Policy.

We primarily referenced the past interventions completed by the Lewiston-Auburn Complete Streets Committee as we considered which recommendations to make, as that history helped us to determine which street redesigns would be feasible for the committee moving forward. We also referenced Lewiston-Auburn Complete Streets Policy, most notably 3 components that we believe to be critical in holistic street redesigns. First, we framed our recommendations through the tenet of intergovernmental cooperation that the Complete Streets Policy describes as ensuring that the transportation network flows seamlessly between the two communities in accordance with local and regional road, transit, bicycle, and pedestrian plans and mutually agreed-upon design criteria. Next, we situated our recommendations within the broader network of Lewiston-Auburn, as the Complete Streets Policy promotes projects that enhance the overall transportation system and its connectivity. Lastly, we referred to the theme of community context that the Complete Streets Policy upholds by identifying recommendations that will enhance the context and character of the surrounding built and natural environments. Due to the constraints placed on the Lewiston-Auburn Complete Streets Committee as a local body operating within the automobility paradigm, we first recommend street redesigns that address issues of traffic speed that are feasible for the committee to implement:

1. We recommend the implementation of a traffic light at the intersection of Elm Street and High Street in Lewiston, Maine. This was the intersection with the second-highest crash rate in 2019. The primary types of crashes occurring at this intersection are rear-end/sideswipes and intersection movements. A traffic light will help to control traffic and reduce speeds as automobiles approach the intersection, which will lead to reduced crash rates.

2. We recommend the addition of street furniture, whether it be speed plateaus, bus stops, or traffic barriers at the intersection of Danville Corner Road and Beech Hill Road in Auburn, Maine. This will aid in traffic calming to slow down drivers and reduce crash rates.

3. We recommend the addition of bike paths and sidewalks to increase street accessibility and mode share distribution at the intersection of Court Street and Goff Street in Auburn, Maine. This will create more spaces for pedestrians to safely walk and cyclists to ride their bicycles.

While we recognize the limitations of the Lewiston-Auburn Complete Streets Committee to address issues of traffic volume, we also acknowledge that street safety and usage are influenced by traffic volume in addition to traffic speed. Therefore, we have included broader, structural recommendations to reduce traffic volume for Lewiston-Auburn to consider:

1. We recommend the implementation of parking restrictions, as parking lot requirements reinforce the automobility paradigm and take up significant space alongside streets. These restrictions would limit car access in cities and allow other street users to access the streets more readily.

2. We recommend limiting major road-building that encourages other processes such as urban sprawl and the dependency on automobiles. This would limit car access in cities and encourage individuals to invest in other modes of transport.

3. We recommend implementing policies that tax fuels or price traffic. This will incentivize street users to seek out other modes of transportation.

4. We understand the challenges that the automobility paradigm places on our transportation systems on local, state, and national levels as expressed through accessibility and safety issues. We recommend a shift towards Transit Oriented Development to create compact, people-oriented communities that reduce dependence on the automobile for mobility. Such a shift will create more accessible streets, sustainable cities, and safe communities.

References Cited

"Auburn, ME". Data USA. https://datausa.io/profile/geo/auburn-me/.

Banerjee, Subha Ranjan, and Ben Welle. "Bigger Isn't Always Better: Narrow Traffic Lanes Make Cities Safer." World Resources Institute, December 7, 2016. https://www.wri.org/insights/bigger-isnt-always-better-narrow-traffic-lanes-make-cities-safer.

Beltz, Brian. 2021. "100+ Car Accident Statistics [Updated for 2021]." Safer America. https://safer-america.com/car-accident-statistics/.

Complete Streets: A Guide to Best Management and Design Practice. 2014. Androscoggin Transportation Resource Center.

Complete Streets Policy. Lewiston, Maine. 2013. https://www.lewistonmaine.gov/DocumentCenter/View/3285/095-Complete-Streets-Policy?bidId=.

"CITY OF LEWISTON PRESS RELEASE," February 18, 2014. City of Lewiston. http://www.ci.lewiston.me.us/ArchiveCenter/ViewFile/Item/2188.

"Commute Mode". Bureau of Transportation Statistics. https://www.bts.gov/browse-statistical-products-and-data/state-transportation-statistics/commute-mode.

Crash Stats US 2019. NHTSA. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813060

Haynes, Robin, Iain R. Lake, Simon Kingham, Clive E. Sabel, Jamie Pearce, and Ross Barnett. "The Influence of Road Curvature on Fatal Crashes in New Zealand." *Accident Analysis & Prevention* 40, no. 3 (2008): 843–50. https://doi.org/10.1016/j.aap.2007.09.013.

"Lewiston, ME". Data USA. https://datausa.io/profile/geo/lewiston-me/.

Maine Public Crash Query Tool. MaineDOT. https://mdotapps.maine.gov/MaineCrashPublic/PublicQueryStats

Maine Weekly Group Mean Factors. MaineDOT.https://www.maine.gov/mdot/traffic/docs/ytc/2020/2018%20Weekly%20Group%20Mean%20Factors.pdf

McCahill, Chris. 2017. "VMT growth continued, slowed in 2016". State Smart Transportation Initiative.

McCann, Barbara, and Suzanne Rynne. 2010. "Complete Streets: Best Policy and Implementation Practices." American Planning Association.

"Motor Vehicle Deaths in 2020 Estimated to Be Highest in 13 Years, Despite Dramatic Drops in Miles Driven." National Safety Council. Accessed May 27, 2021. https://www.nsc.org/newsroom/motor-vehicle-deaths-2020-estimated-to-be-highest.

Newman, Peter, and Jeffrey Kenworthy. "Overcoming Barriers to the End of Automobile Dependence." *The End of Automobile Dependence*, 2015, 169–200. https://doi.org/10.5822/978-1-61091-613-4_6.

NHTSA. "PDF." NHTSA's National Center for Statistics and Analysis, September 2019.

Pedestrian Safety Report. Lewiston, Maine. http://www.lewistonmaine.gov/DocumentCenter/View/7109/PEDESTRIAN-SAFETY-REPORT---FINAL-PER-KRISTEN-ON-4-7-17?bidId=

Safaei, Nima, Chao Zhou, Babak Safaei, and Arezoo Masoud. "Gasoline Prices and Their Relationship to the Number of Fatal Crashes on U.S. Roads." Transportation Engineering 4 (2021): 100053. https://doi.org/10.1016/j.treng.2021.100053.

Sheller, Mimi. 2018. "Beyond Automobility and Transport Justice" in *Mobility Justice: The Politics of Movement in an Age of Extremes*. 68-94.

"Turning Movement Counts." Turning Movement Counts | Androscoggin Valley Council of Governments, ME. Accessed May 27, 2021. https://www.avcog.org/1008/Turning-Movement-Counts.

Zehngebot, Corey, and Richard Peiser. 2014. "Complete Streets Come of Age." *APA Planning Magazine.* American Psychiatric Association.

Appendices

Appendix A: Total VMT and VMT per capita trends between 1990 and 2015

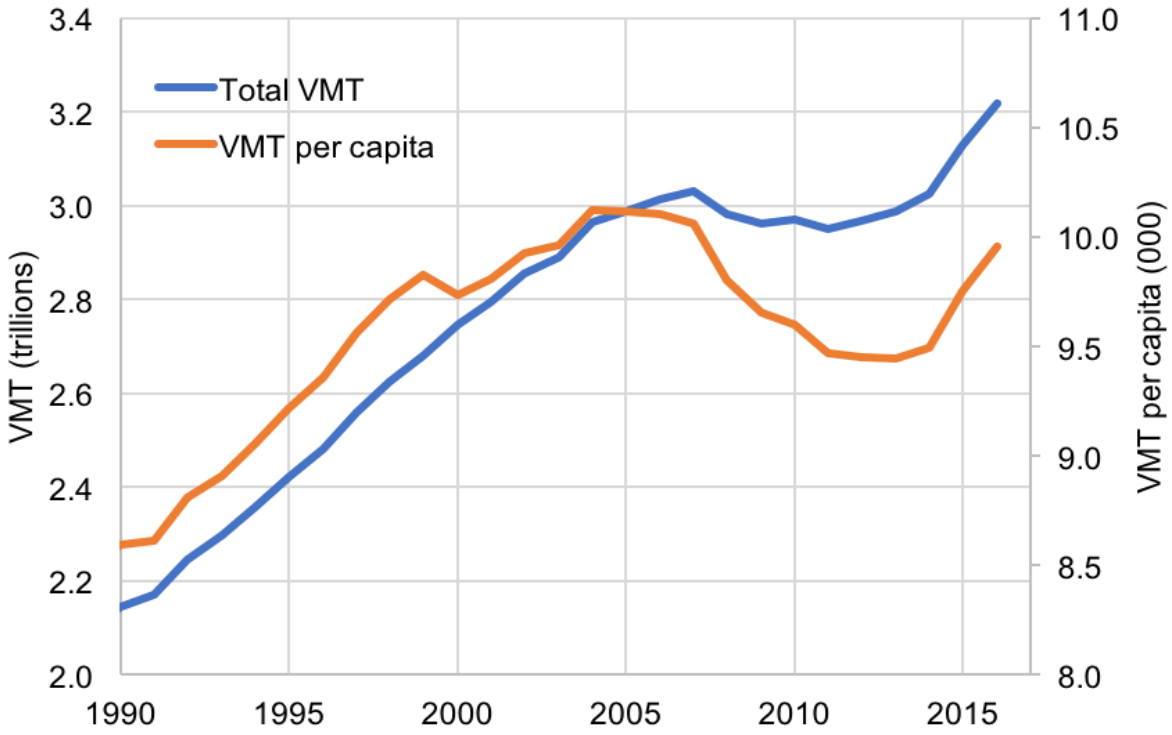


Figure 14: Total VMT (in trillions) and VMT per capita (in thousands) between 1990 and 2015. Figure from McCahill 2017.

This figure contextualizes recent trends in VMT in Lewiston-Auburn, Maine, and the United States. Further, vehicle miles traveled across these years situates trends in automobile use within a broader context of automobile dependency.

Appendix B: Crash fatalities in Lewiston-Auburn between 2005 and 2018

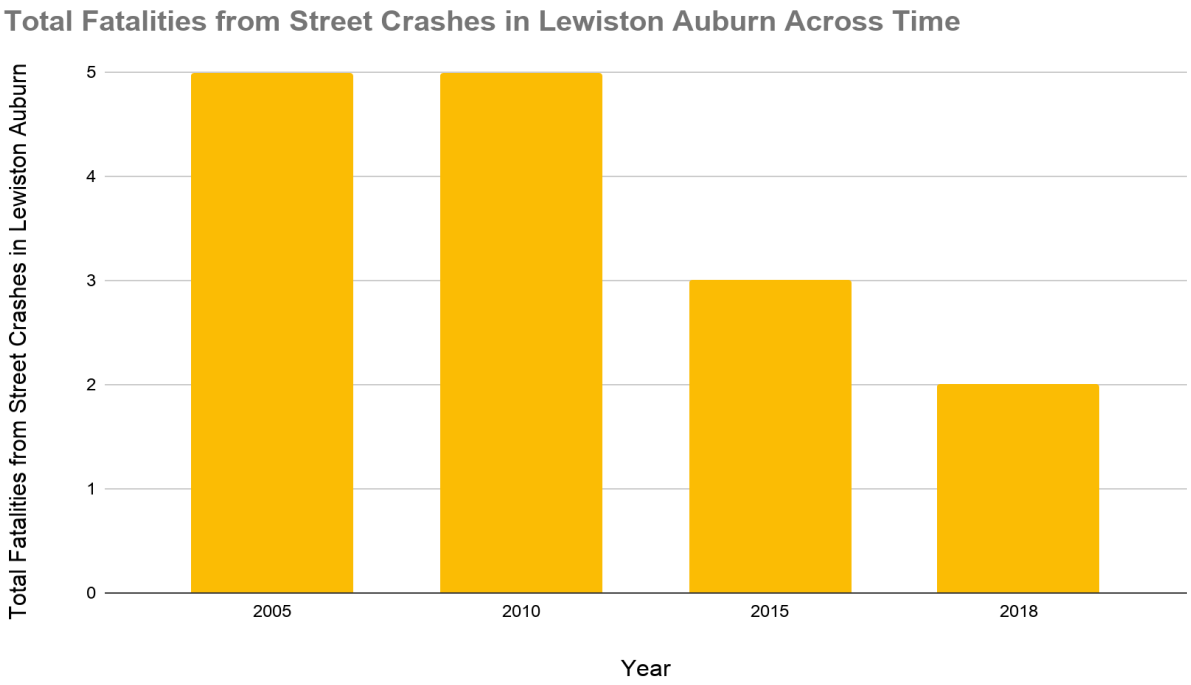


Figure 15: The total number of fatalities from street crashes in Lewiston-Auburn between 2005 and 2018.

This figure illustrates a decreasing trend in fatalities from vehicle crashes in Lewiston-Auburn. This is positive seeing as vehicle miles traveled in Androscoggin County has continued to increase, although the total number of crashes in Lewiston-Auburn is increasing. We can deduce that the number of non-fatal vehicle crashes must be increasing. Street redesign measures that address street safety and usage are still critical to reducing the number of non-fatal vehicle crashes.

Appendix C: Deaths Per 100 Million Motor Vehicle Miles Traveled

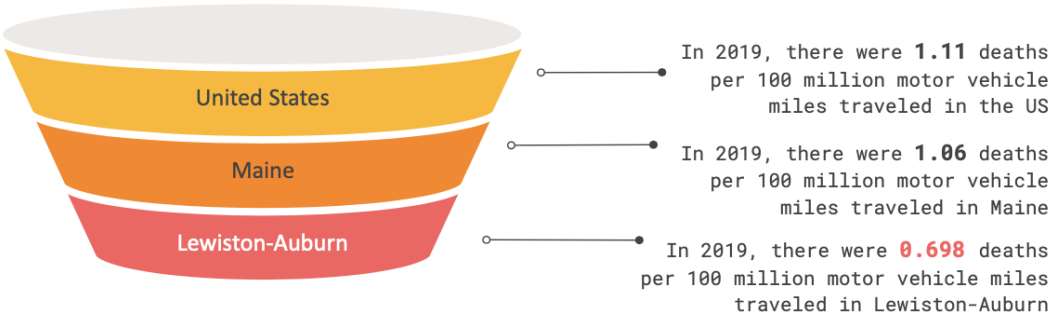


Figure 16: Deaths per 100 million vehicle miles traveled in L-A, Maine, and the United States.

This figure for 2019 puts the 3 scales of street safety that this project discusses in conversation with one another. While the number of deaths per 100 million motor vehicle miles traveled in Lewiston-Auburn did not vastly outnumber that statistic for Maine or the United States, this figure frames the issue of street safety, specifically fatalities, within broader spatial scales.

Appendix D: Estimated 2014 mode share for Lewiston-Auburn

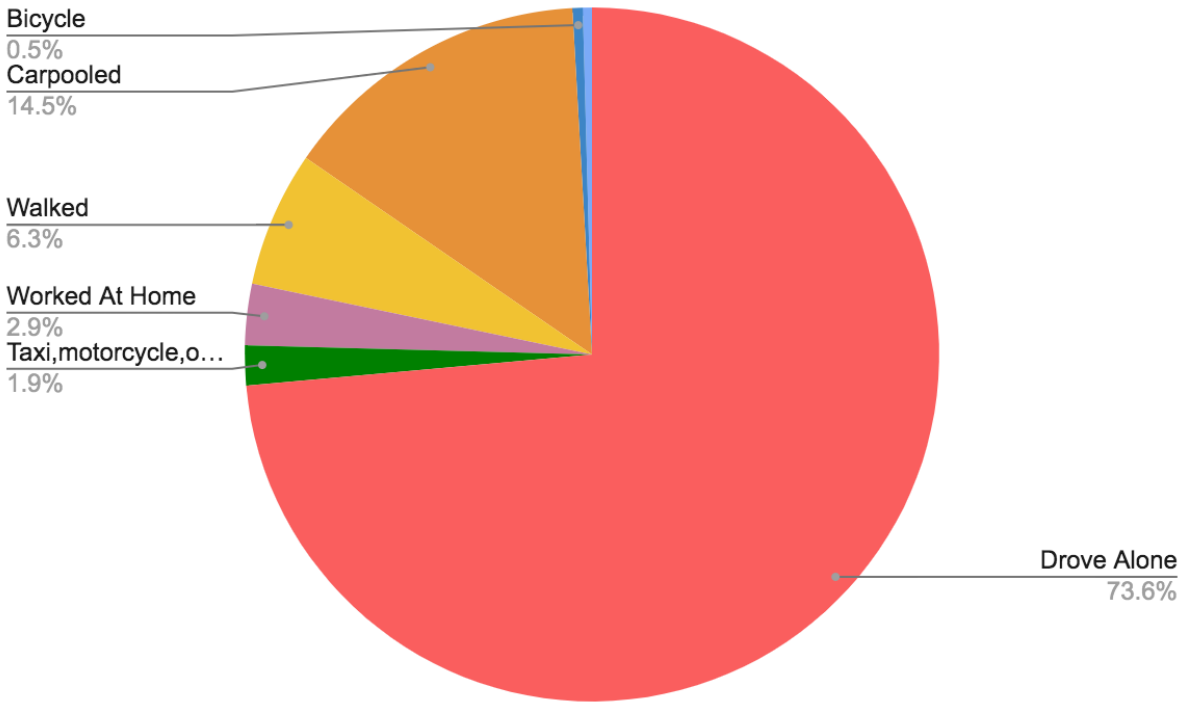


Figure 17: Estimated 2014 mode share for Lewiston-Auburn.

This figure provides an estimate of the Lewiston-Auburn mode share 4 years prior to the 2018 estimate that our analysis used to compare the most recent mode share of Lewiston-Auburn, Maine, and the United States. Comparing mode share across time may also produce fruitful insights, and as such, this report includes this 2014 Lewiston-Auburn estimate to compare to the 2018 estimate.

Appendix E: Estimated 2014 mode share for Maine

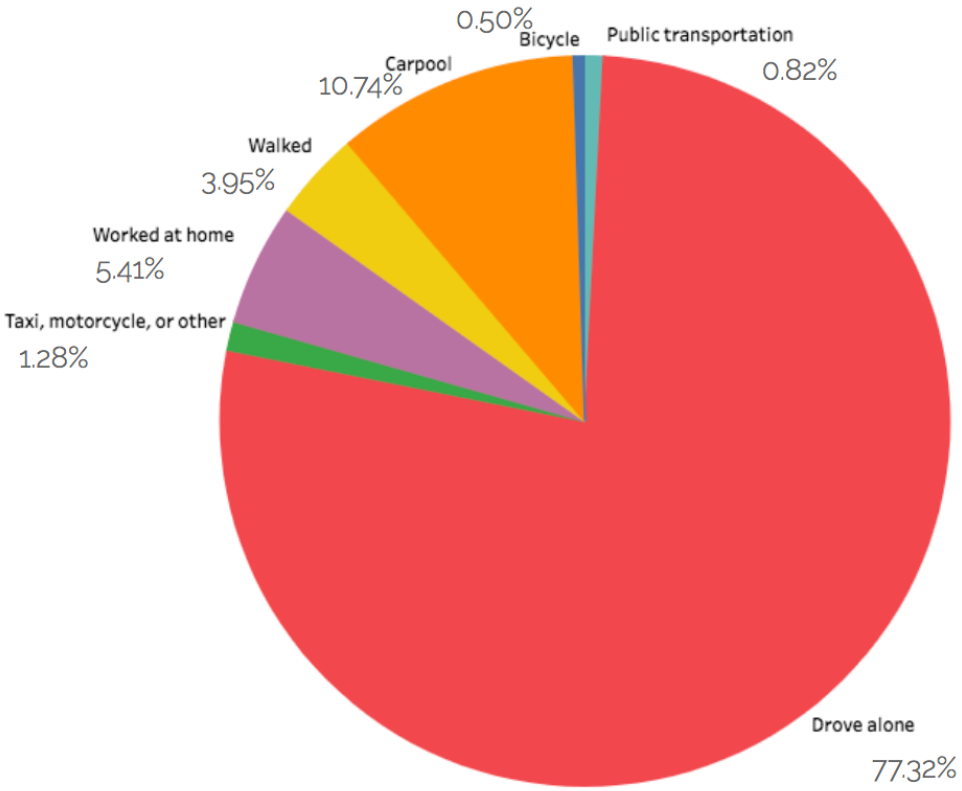


Figure 18: Estimated 2014 mode share for Maine.

This figure provides an estimate of Maine mode share 4 years prior to the 2018 estimate that our analysis used to compare the most recent mode share of Lewiston-Auburn, Maine, and the United States. This figure may be used alongside the 2018 Maine mode share estimate to identify significant changes in mode share distribution in recent years.

Appendix F: Estimated 2014 mode share for the United States

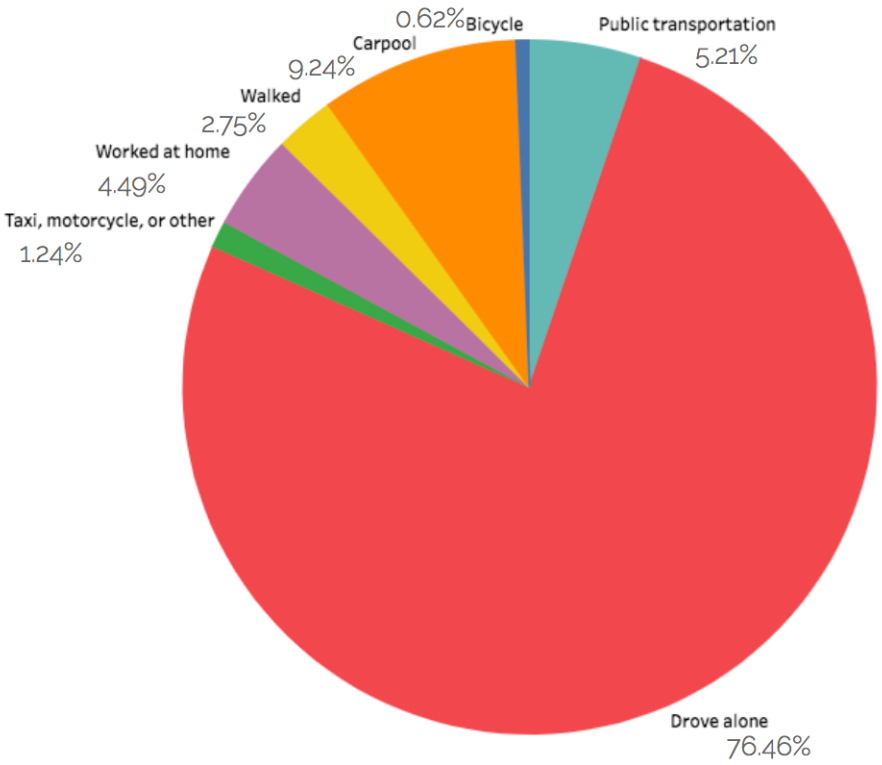


Figure 19: Estimated 2014 mode share for the United States..

This figure provides an estimate of the United States mode share 4 years prior to the 2018 estimate that our analysis used to compare the most recent mode share of Lewiston-Auburn, Maine, and the United States. Similarly to the previous 2014 mode shares, this figure may be used to make temporal comparisons to the 2018 United States mode share estimate.