Washington County, Oregon
An Analysis of Pedestrian Fatalities and Risk (2018)

Geospatial Information and GIS

Oregon State University

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May 28, 2021

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-Washington County, Oregon-

Washington County, Oregon, is located in the northwestern corner of Oregon. It lies between the coastal Tillamook County on the west, with the urban Multnomah County to the east. Washington County is home to a wide variety of different landscapes, consisting of wild forestland, rolling fields of produce, suburban sprawl, and more densely populated town centers. Originally founded in 1843 as the Tuality District, one of the four original counties of Oregon, Washington County has shifted and transformed into the population and commercial hub it is today (Oregon Secretary of State). Boasting a population of over 596 thousand people as of 2018, growth has shown no signs of stopping.

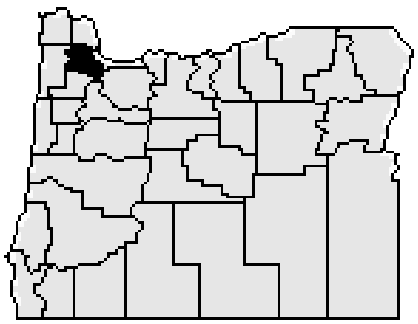


Figure 1. Washington County, Oregon

With such recent and rapidly occurring growth taking place, there is a significant chance that hastily designed roadways and development along once rural highways poses a significant risk to the lives of the community members that live and travel there.

WC-ROADS, also known as WashCoRoads, is one of the primary roadway departments in Washington County.

Figure 2. WC-ROADS

Oregon Department Of Transportation, the owner and maintainer of a few select state highways in Washington County.

Figure 3. Oregon Department of Transportation

-Objective-

The primary goal of this project is to identify the areas that pose the most danger to pedestrians in Washington County, as well as the potential causes for this danger. Crashes will be analyzed based on whom they involved, and whether they were killed as a result of the crash. Pedestrian injuries and deaths will be displayed on a final map of Washington County, along with information regarding poverty level, ethnicity, and the distance from a bus stop. The need for this project stems from the recent growth in pedestrian deaths in Washington County, nearly tripling in rate since 2009 (Figure 4). This follows a national trend, where pedestrian fatalities have increased 46% between 2009 and 2016 (Hu, Wen).

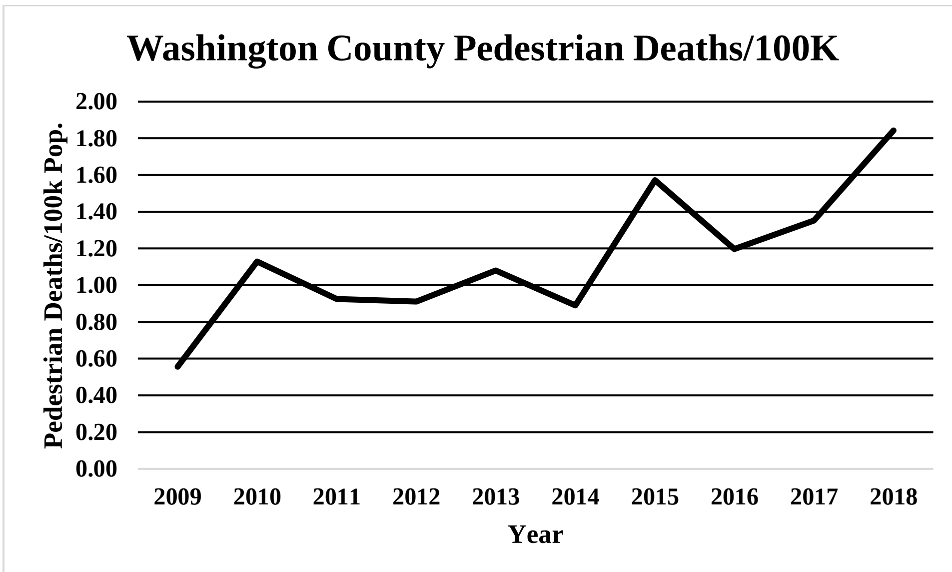


Figure 4. Washington County Pedestrian Death Rate, 2009-2018
(Data: OregonDOT Crash Tables, 2009-2018, US Census Bureau)

-Data-

Oregon Transportation Network- A comprehensive list of roadways within the State of Oregon, along with roadway length, ownership, classification, and route designation. Provided by OregonDOT.

Name	Oregon Transportation Network (2019)
Description	GIS Road Centerline Dataset (2019)
Type	Vector- Line
Map Projection	Lambert Conformal Conic
Unit	Foot
Author	ODOT
Web Address	https://navigator.state.or.us/arcgis/rest/services/Framework/Trans_GeneralMap_WM/MapServer/3
Attributes Used	SHAPE_Length, RoadOwner

Table 1. Oregon Transportation Network (2019)

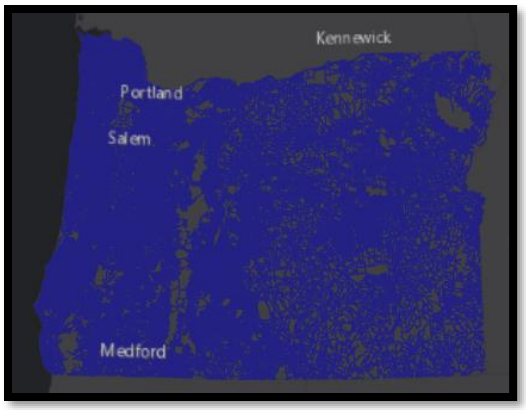


Figure 5. Oregon Transportation Network (2019)

Figure 6. Washington County Spatial Crash Data (2018)

Washington County Spatial Crash Data (2018)- A log of all crashes occurred in Washington County during 2018. Information given includes location, parties involved, speed limit, fault, time of day, and other information related to traffic crashes and the factors they involve.

Name	Washington County Spatial Crash Data (2018)
Description	2018 Crash Data
Type	Vector- Point
Map Projection	Lambert Conformal Conic
Unit	Foot
Author	ODOT
Web Address	https://tvc.odot.state.or.us/tvc/
Attributes Used	Total Fatality Count, Total Pedestrian Fatality Count, Total Pedestrian Count

Table 2. Washington County Spatial Crash Data (2018)

-Data-

Major Arterials- A dataset derived from Metro, displaying the locations of major arterials in the area. This data includes information on road name, location, and length.

Name	Major Arterials
Description	Major regional arterial streets derived from the streets layer for the Metro region.
Type	Vector- Line
Map Projection	Lambert Conformal Conic
Unit	Foot
Author	Metro
Web Address	http://rlisdiscovery.oregonmetro.gov/?action=viewDetail&layerID=596
Attributes Used	None

Table 3. Major Arterials

Figure 7. Major Arterials

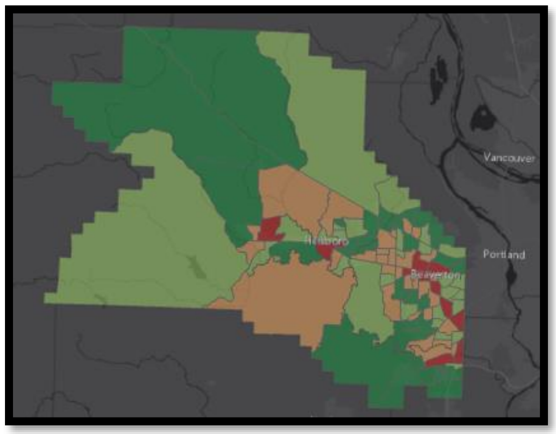


Figure 8. Ratio of Income to Poverty Level in the Past 12 Months

Ratio of Income to Poverty Level in the Past 12 Months- This dataset displays the percentage of people earning a certain level above or below the poverty line. This information is provided by the US Census Bureau, and is categorized by census tract.

Name	Ratio of Income to Poverty Level in the Past 12 Months
Description	Income vs Poverty Level by Census Tract
Type	Vector- Polygon
Map Projection	Lambert Conformal Conic
Unit	Foot
Author	U.S. Census Buearu
Web Address	https://censusreporter.org/data/table/?table=C17002&geo_ids=05000US41067,140|05000US41067,060|05000US41067&primary_geo_id=05000US41067#valueType|percentage
Attributes Used	Under .50, .50 to .99

Table 4. Ratio of Income to Poverty Level in the Past 12 Months

-Data-

Transit Stops- This dataset displays all transit stop locations in the Portland Metropolitan area, that are served by TriMet, a regional transit agency. Information includes what line services the stop, frequency, location, Stop ID, and others.

Name	Transit Stops
Description	Transit Stop Locations in Portland Metro Area
Type	Vector- Point
Map Projection	Lambert Conformal Conic
Unit	Foot
Author	Metro
Web Address	https://trimet.org/
Attributes Used	None

Table 5. Transit Stops

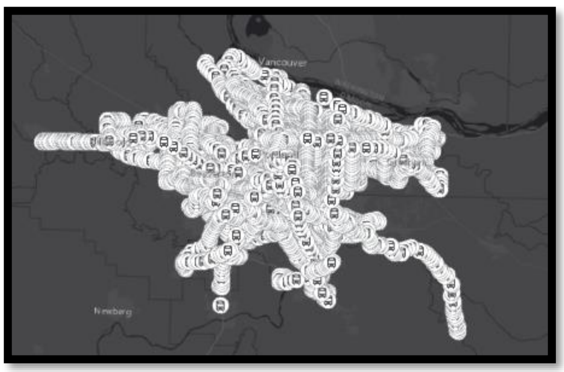


Figure 9. Transit Stops

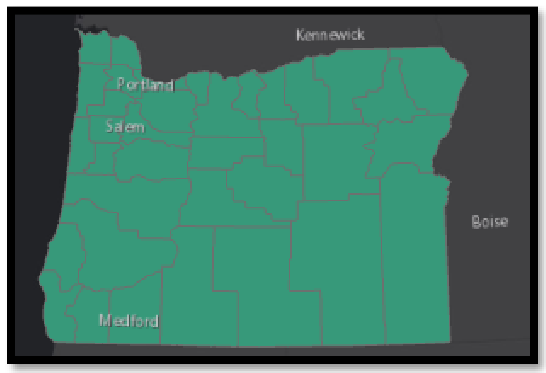


Figure 10. Oregon Counties (2000)

Oregon Counties (2000)- This dataset displays the location and boundaries of Oregon Counties. Attribute information includes county name and area.

Name	Oregon Counties (2000)
Description	Counties in Oregon
Type	Vector- Polygon
Map Projection	Lambert Conformal Conic
Unit	Foot
Author	Oregon State University Rural Studies Program
Web Address	https://oregonexplorer.info/
Attributes Used	INSTNAME

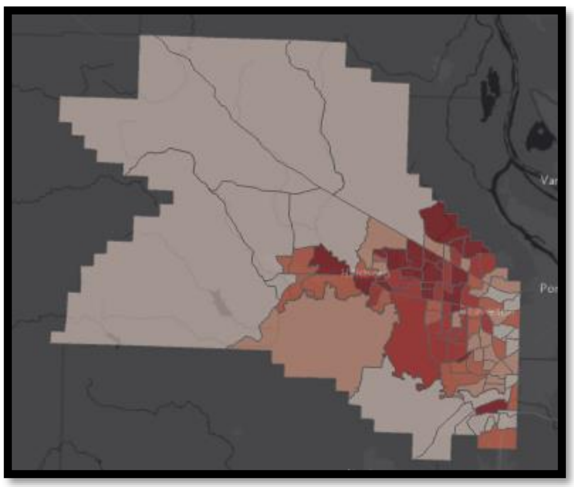
Table 6. Oregon Counties (2000)

-Data-

Race- This dataset compiles information of the race that citizens identify as in census tracts within Washington County. Data is represented as a percentage of the population that identifies as white.

Name	Race
Description	Race Makeup of Washington County
Type	Vector- Polygon
Map Projection	Lambert Conformal Conic
Unit	Foot
Author	U.S. Census Buearu
Web Address	https://censusreporter.org/data/table/?table=B02001&geo_ids=05000US41067,140|05000US41067&primary_geo_id=05000US41067
Attributes Used	White

Table 7. Race



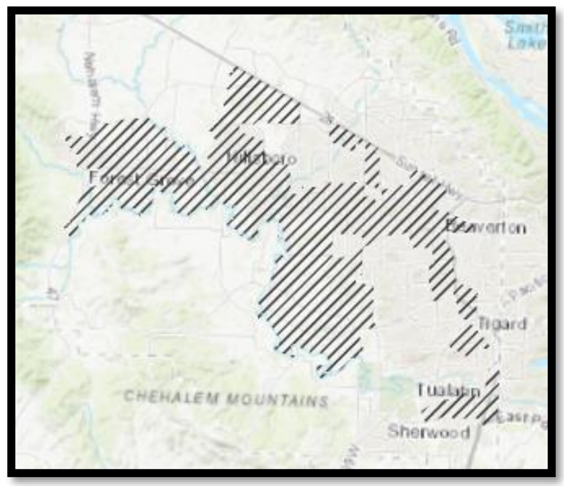


Figure 11. Race

Figure 12. Ethnicity

Ethnicity- This dataset shows areas that have a higher than average percentage of people with a Hispanic or Latino origin.

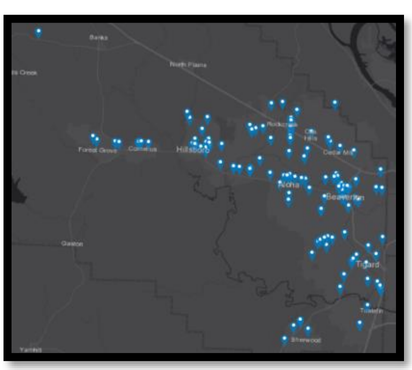
Name	Ethnicity
Description	Ethnic Makeup of Washington County ACS data. (2019)
Type	Vector- Polygon
Map Projection	Lambert Conformal Conic
Unit	Foot
Author	U.S. Census Bureau
Web Address	https://censusreporter.org/tables/B03003/
Attributes Used	Hispanic

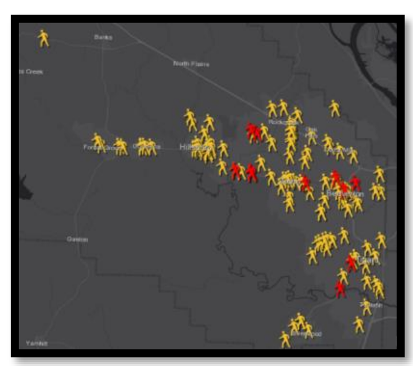
Table 8. Ethnicity

-GIS Methodology-

The main objective of this analysis is to identify any correlation found between people hit, killed, or injured by drivers, and the geographic area they are in. Factors hypothesized to affect pedestrian injury and fatality rates are thought to be income, race, ethnicity, and the presence of transit facilities. In order to perform this analysis, it becomes necessary to import spatial crash data from Oregon DOT, which records and uploads this data, 2 years following the crash date. Imported from the TDS crash reports site, found at https://tvc.odot.state.or.us/tvc/ , one obtains a Excel table with data such as crash location, persons involved, time of day, road condition, and other information. Crash data within the tables is obtained from DMV crash reports and police reports. It is possible to import this table into ArcGIS using the “Add Data” function and importing the crash data file. One will then convert the DMS format of the crash data location into DD, allowing the information to be properly plotted on the map (Figure 6).

To obtain crashes involving pedestrians, the select by attribute tool needs to be used. Once open, the user can filter out crashes that do not involve pedestrians, using the “total pedestrian count” attribute, as they are not of concern in this study. The “create new layer form selection” tool is also utilized, to separate these crashes into their own specific layer. (Figure 13) After obtaining the pedestrian-involved crashes, it is important to designate those that resulted in the victim being killed. This is done by selecting the cases in which pedestrians were killed using the “total pedestrian fatality count” attribute. After separating non-fatal and fatal crashes involving pedestrians, one can then assign symbols to each one, to make it easier to designate between the two. (Figure 14) This is done by modifying the symbology and changing the symbol to a “picture marker”, and then selecting the icon that is to be used.





(Left) Figure 13. Pedestrian Crashes in Washington County (2018)
(Right) Figure 14. Fatal (red) and Nonfatal (yellow) Ped. Crashes

-GIS Methodology-

After calculating and displaying where pedestrian crashes and deaths are happening, it is necessary to display those crashes that have occurred 200', or one city block, away from a transit station. This was done by importing the transit stops dataset provided by Oregon Metro (figure 9), and creating a 200' buffer from the stop. I then selected all pedestrian crashes and fatalities within this buffer and classified them as being within 200' of a transit station, forming a new layer. I then changed the symbology for this layer to add the distinct TriMet roundel to make these crashes more visible.

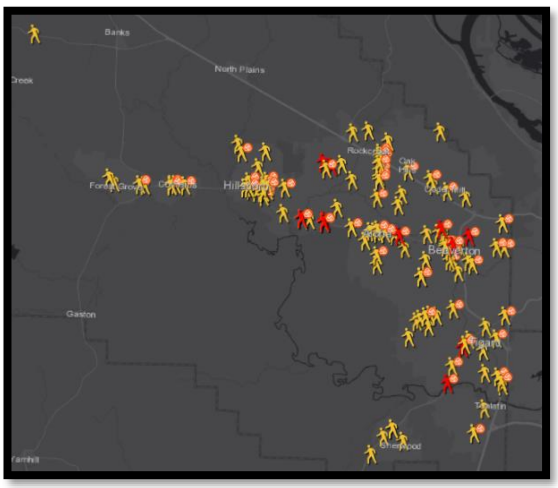


Figure 15. Pedestrian Crashes, Denoted by Severity and distance from Transit Stops

Next, I need to show the income, race, and ethnicity status of the people living in the area, to see if there is a correlation between any one of these, and pedestrian fatalities/collisions. Beginning with income, I then imported the dataset from Metro, and using information provided with the dataset, to calculate a percentage value for the amount living under the poverty line (the average percentage of people living below the poverty line is 9%). I found the mean of this data and assigned colors to it to display areas that had a higher or lower than average population living under the poverty line. (Figure 8) I then used the same procedure to display the race information, after calculating the percentage of people that identify as white (the average white-identifying population in the county is 75%). (Figure 12)

I then calculated the average population in the county that identifies with being Hispanic or Latino (17%) and displayed census tracts with an above average population of Hispanic or Latinos with a hatched pattern, overlaid on the percentage of those identifying as white living in the area.

-GIS Methodology-

To provide a clearer, and easier to read map, the Oregon Transportation Network and Arterials layers were used to provide a useful point of reference to make viewing easier. The Washington County polygon and the intersect command were used to only display the roadways in Washington County.

This flowchart displays the processes used to create the maps, with only processing steps displayed. Symbology processes have been omitted. Red lines indicate the final processes used to create the Race/Ethnicity Maps, and the green shows the final processes used to create the Income Maps.

The Process to Analyze Pedestrian Crashes Against Income, Race, and Ethnicity Status

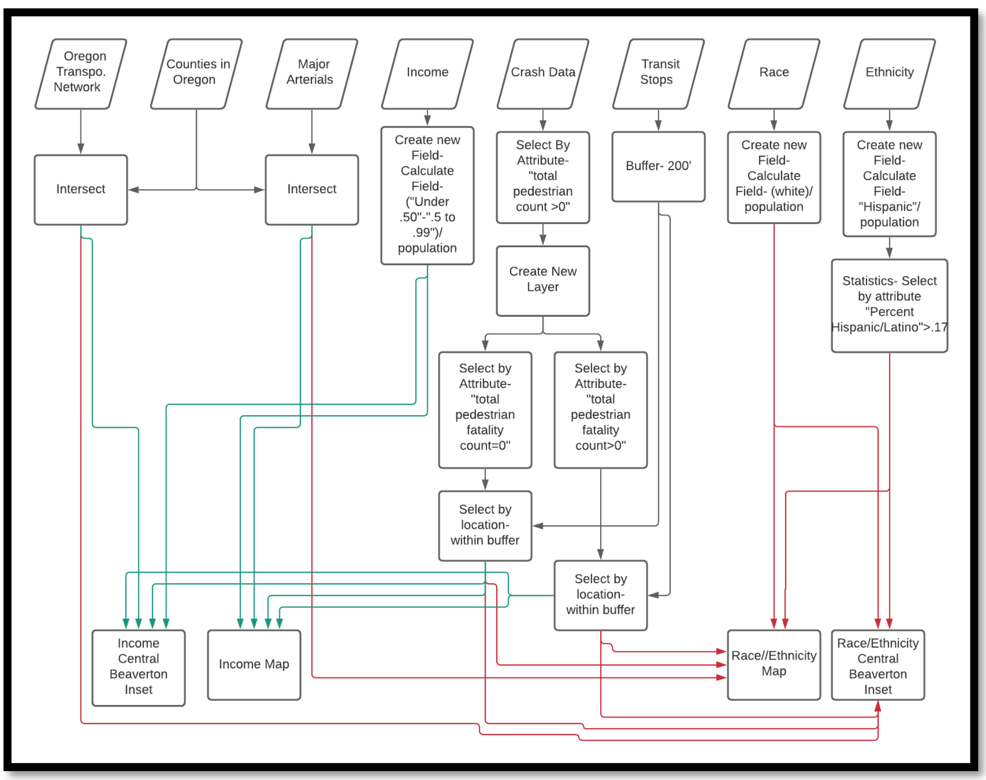


Figure 16. Flowchart

-Model Builder-

This model displays how one would determine how many fatal and non-fatal crashes wherein a pedestrian was hit by a driver operating a vehicle. Two input layers are used, “CrashData” and “WashCobusstops”. These layers, combined with geoprocessing tools, were used to find the counts of pedestrians killed within 200’ of a transit stop, pedestrians hit within 200’ of a transit stop, pedestrians hit not within 200’ of a transit stop, and pedestrians killed not within 200’ of a transit stop.

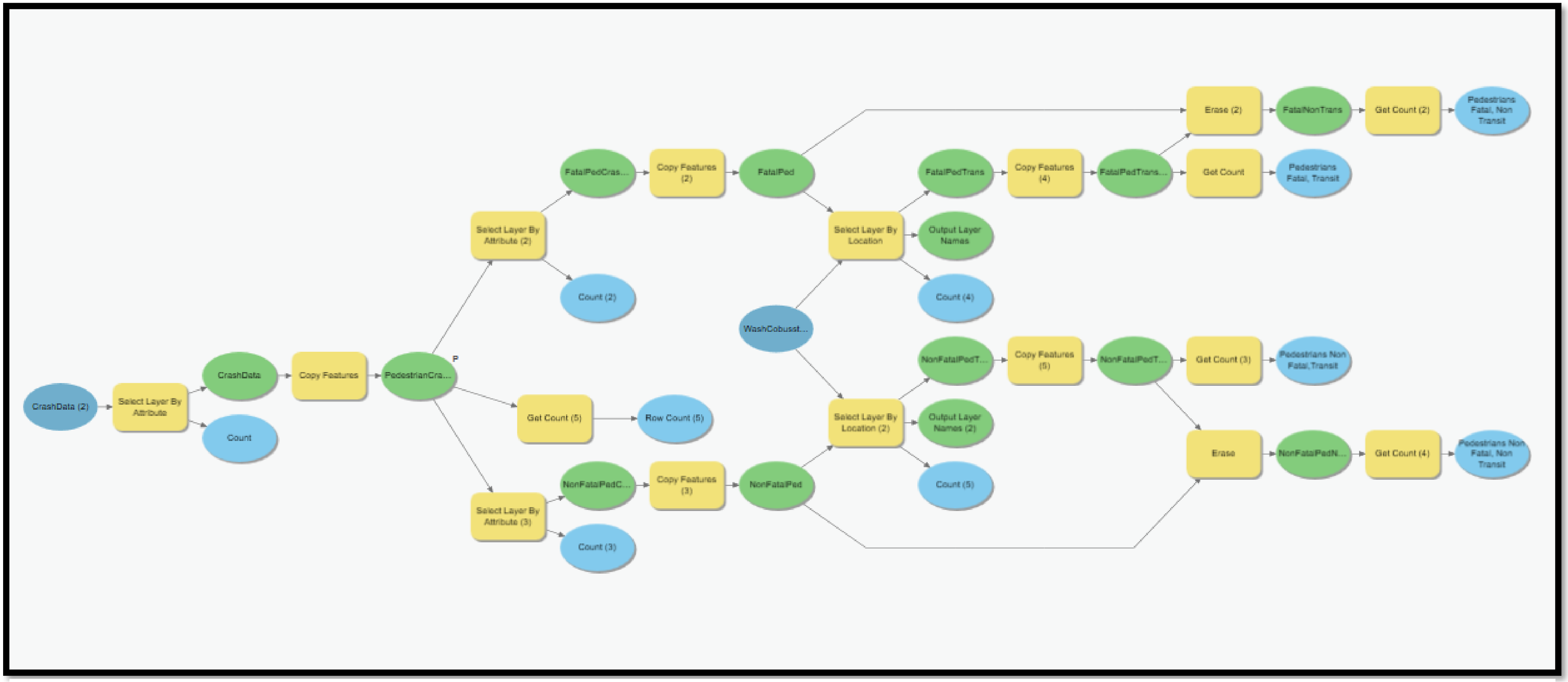


Figure 17. Model Builder

-Outcomes-

Following the results of my analysis, upon preliminary analysis, it seemed that pedestrian involved crashes, within urban areas, gravitated toward bus stops and transit stations.

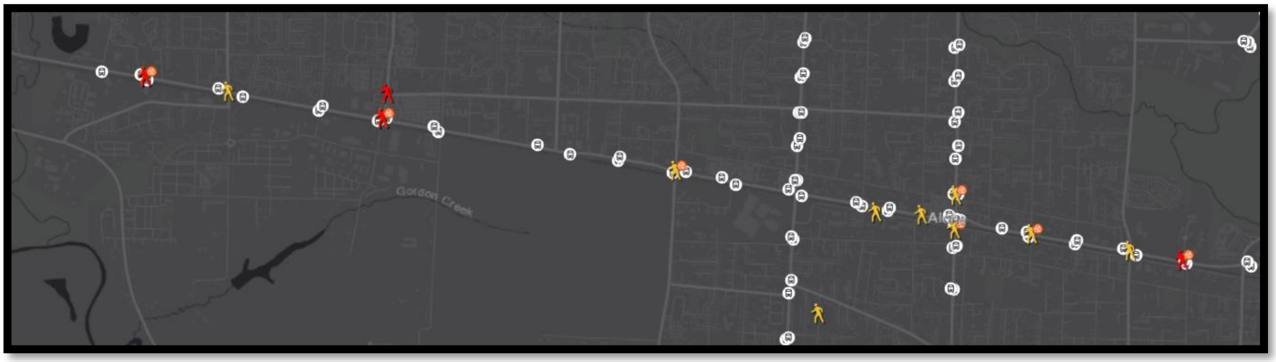


Figure 18. Pedestrian Crashes, TV Highway

Within this one area on TV Highway, which saw 4 pedestrians killed while walking, all 4 of these people were killed within one block of a bus stop, representing 57% of the fatalities that occurred near a bus stop. Three of those are displayed in figure 18.

Figure 19. Pedestrian Crashes in Central Beaverton

Figure 20. Pedestrian Crashes in Central Hillsboro

Also apparent on preliminary examination was the clustering of pedestrian crashes around the central "downtown" areas of Beaverton (figure 19) and Hillsboro (figure 20), both of which have significant pedestrian activity, and transit service. The downtowns of these towns are far from what one would call "full of people walking", but they are more active than the areas outside of it. I find it interesting that within these areas, we see more pedestrians reported to be hit, but relatively fewer fatalities. As I will mention later in this report, it is difficult to determine what this can be attributed to, as Washington County fails to maintain even the simplest of GIS databases on the roadways within their jurisdiction. Whilst pedestrian activity in these areas appears to be high, the high pedestrian traffic alone, does not contribute to fatalities.

-Outcomes-

Upon taking a closer look at fatalities, without utilizing a GIS tool, as there is no data available to perform said analysis, roadway design appears to a significant contributing factor in these collisions. In the four collisions occurring along TV Highway, which is "one of the deadliest roads in the region" (Maus, 2020), a common theme is seen.

Among the 4 people killed walking on TV Highway in 2018, all 4 of them occurred within a block of a transit stop, and 3 of them occurred at a location where a traffic light is not present. Motorist yield behavior has been shown to improve considerably with crossing improvements (Bella), and such improvements could include the installation of a traffic light. Additional measures could include the reduction of speed limit and roadway design, staggering of traffic, and the addition of pedestrian islands (Schroeder). If these safety improvements, and vehicle speeds were decreased, these lives very well could have been saved.

Figure 21. (Top) 26-year-old Jordan William Lamb was killed, here, on September 9th. (Photo: Google)

Figure 22 (Second from top) 24-year-old Uriel Santiago-Sarabia was run over 3 times, by separate drivers, on October 1st. Only one stopped. (Photo: Google)

Figure 23. (Second from bottom) A 22-year-old woman, was run over here, on December 30th. Her name was not released. (Photo: Google)

Figure 24. (Bottom) No information can be obtained regarding this collision. No news release was provided. May 4, 2018. (Photo: Google)

-Outcomes-

Outside of just TV Highway, other patterns were also observed, most markedly within areas that have a higher-than-average amount of people living below the poverty line. When overlaid, the income as a ratio to the poverty line, the higher-than-average poverty levels are displayed in orange. The average amount of people living under poverty at the time the ACS 2019 survey was taken, was 9%. Areas in red have roughly twice, or more, the fraction of people in that census tract that are below the poverty line. It appears that deaths are somewhat centered on these areas, with some outliers. Pedestrians being hit, happen to be more scattered around the map, and have a roughly even distribution.

Figure 25. An image of pedestrian crashes and fatalities, overlaid on income information.

Figure 26. An image showing South Washington County, where people are being hit in more affluent areas.

-Outcomes-

Given this information, drivers seem to be hitting pedestrians at similar rates in richer areas than they are in less affluent regions, however, they are killing them much more often in lower-income areas, as shown by charts 1 and 2.

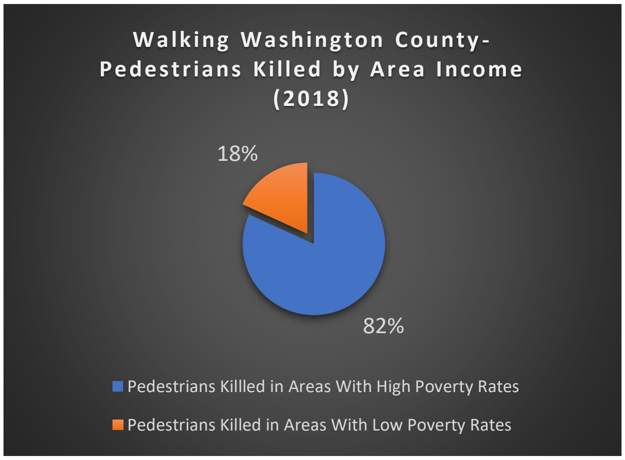


Chart 1. Pedestrians Killed by Area Income

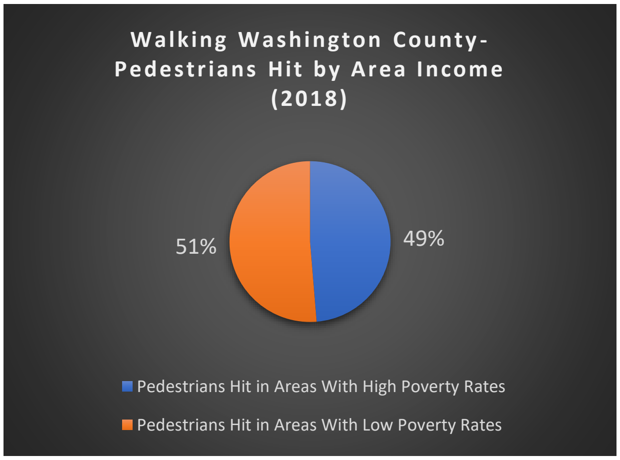


Chart 2. Pedestrians Hit by Area Income

With just these percentages, one can ascertain that those walking within lower-income areas, have a significantly higher chance of getting run over than those walking in richer areas.

Shifting the lens toward race and ethnicity, it appears that those living in areas with higher-than-average populations of Latinos and Hispanics are also at a higher risk of getting killed by drivers, as they are also being hit at the same rates, but are being killed significantly more often. This is shown in charts 3 and 4.

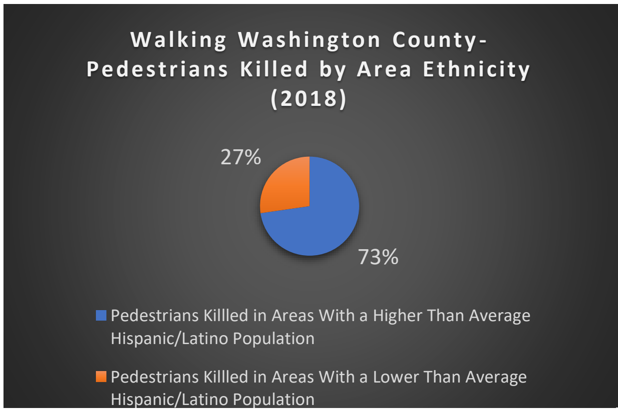


Chart 3. Pedestrians Killed by Area Ethnicity

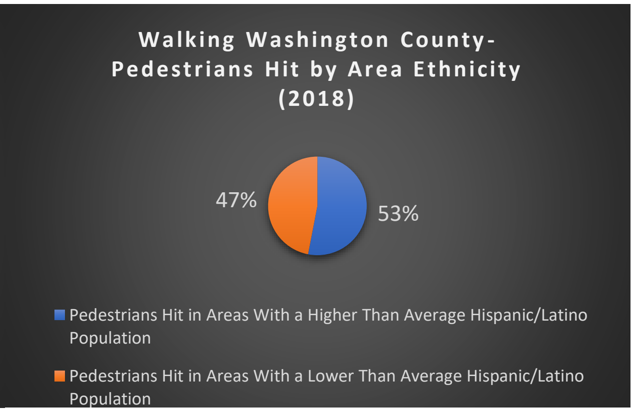
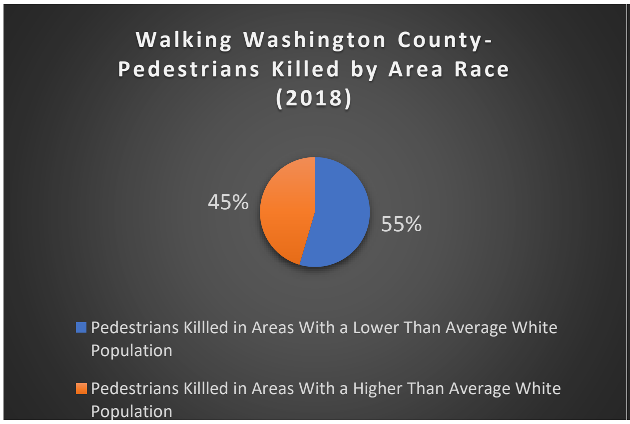


Chart 4. Pedestrians Hit by Area Ethnicity

-Outcomes-

Despite seeing differences in pedestrian deaths and the rates at which these crashes occur in lower income areas, and in areas with higher-than-average populations of Hispanics/Latinos, no difference was observed based on race. In 2018, 6 people walking were killed by drivers in areas that had a lower-than-average white population. 5 people were killed in areas with higher-than-average white populations. While there is an imbalance, this number is insignificant, and there is no relative difference shown with pedestrians being hit. This is shown in charts 5 and 6.



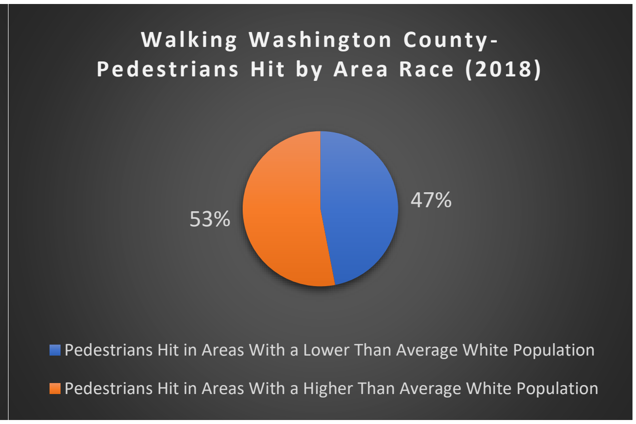


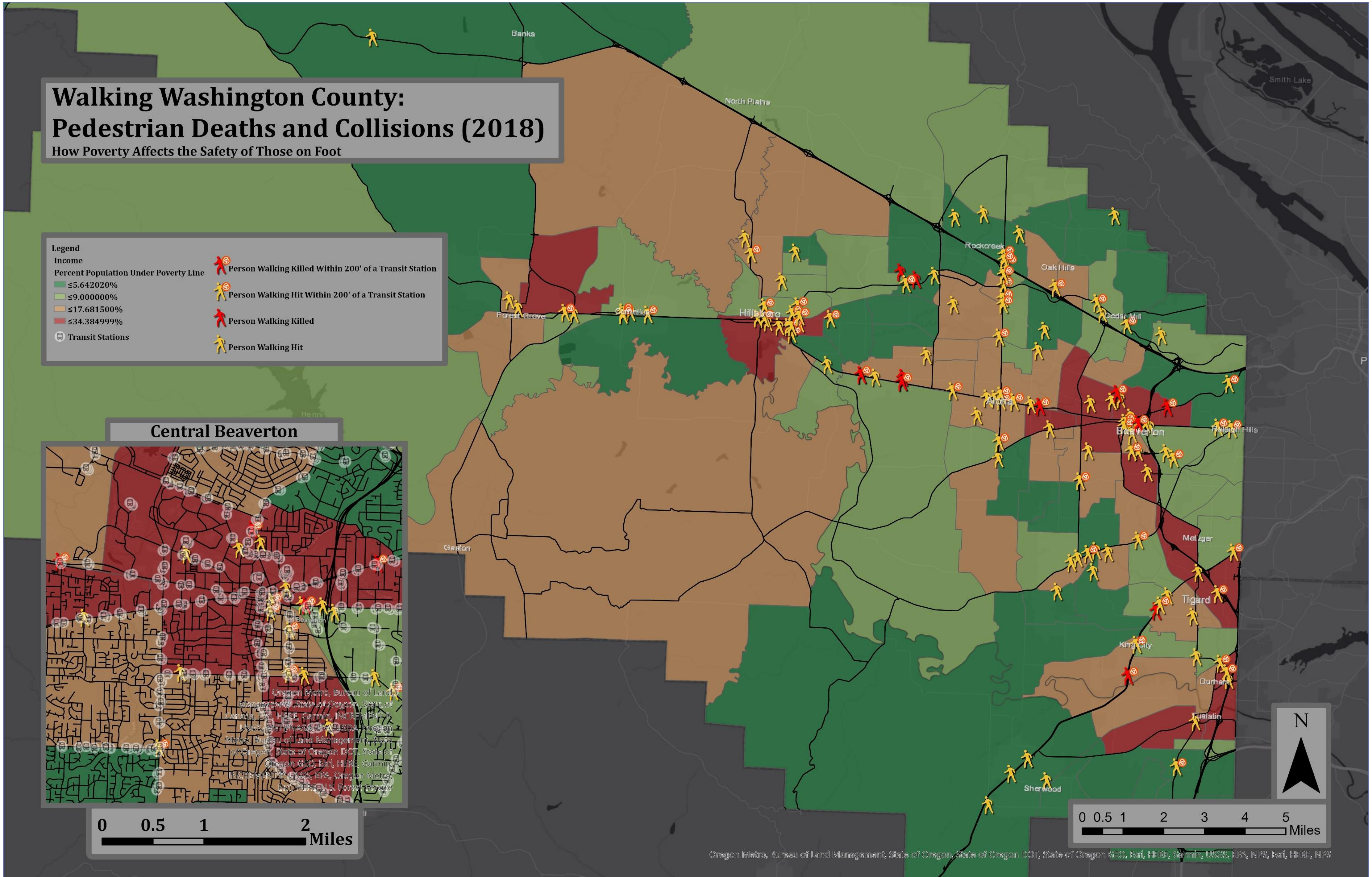
Chart 5. Pedestrians Killed by Area Race

Chart 6. Pedestrians Hit by Area Race

This study, by no means, is comprehensive, and is just the beginning of a discussion on the areas where pedestrians are most likely to be hit and killed. I would have liked to delve further into analysis, and study more of why pedestrians are being killed more often in specific areas, but due to the lack of publicly available data on the matter, I cannot. I believe that this in it of itself is a contributor to this crisis, as the cities and counties I have contacted regarding their GIS database of roadway features do not have one, maintain one, or have even responded to my inquiry. Furthermore, within the CrashData dataset, there were numerous cases wherein information regarding a specific crash, such as speed limit, lane count, and conditions, were simply left blank, as if they were not recorded at the time of the crash. This is due to the crashes being self-reported by the person who has crashed, or a responding officer to the scene of the crash. For accurate analysis, it is imperative for this data to be recorded. Additionally, crashes involving pedestrians that did not result in a fatality, are historically underreported, and this underreporting can skew traffic safety measures, or this very analysis. Estimates of reporting levels have ranged from 44 percent to 75 percent, displaying a serious source for error in this study, and suggests that the amount of pedestrian involved crashes could be significantly higher (Doggett). Another shortfall within this study is that this data only encompassed data for 2018, the most recent year, and there is not enough data to gather any significant conclusions from one year, but each year, bring more road construction and more, and newer cars, so it is difficult to pin down one cause, since there are so many changing variables in the world of transportation.

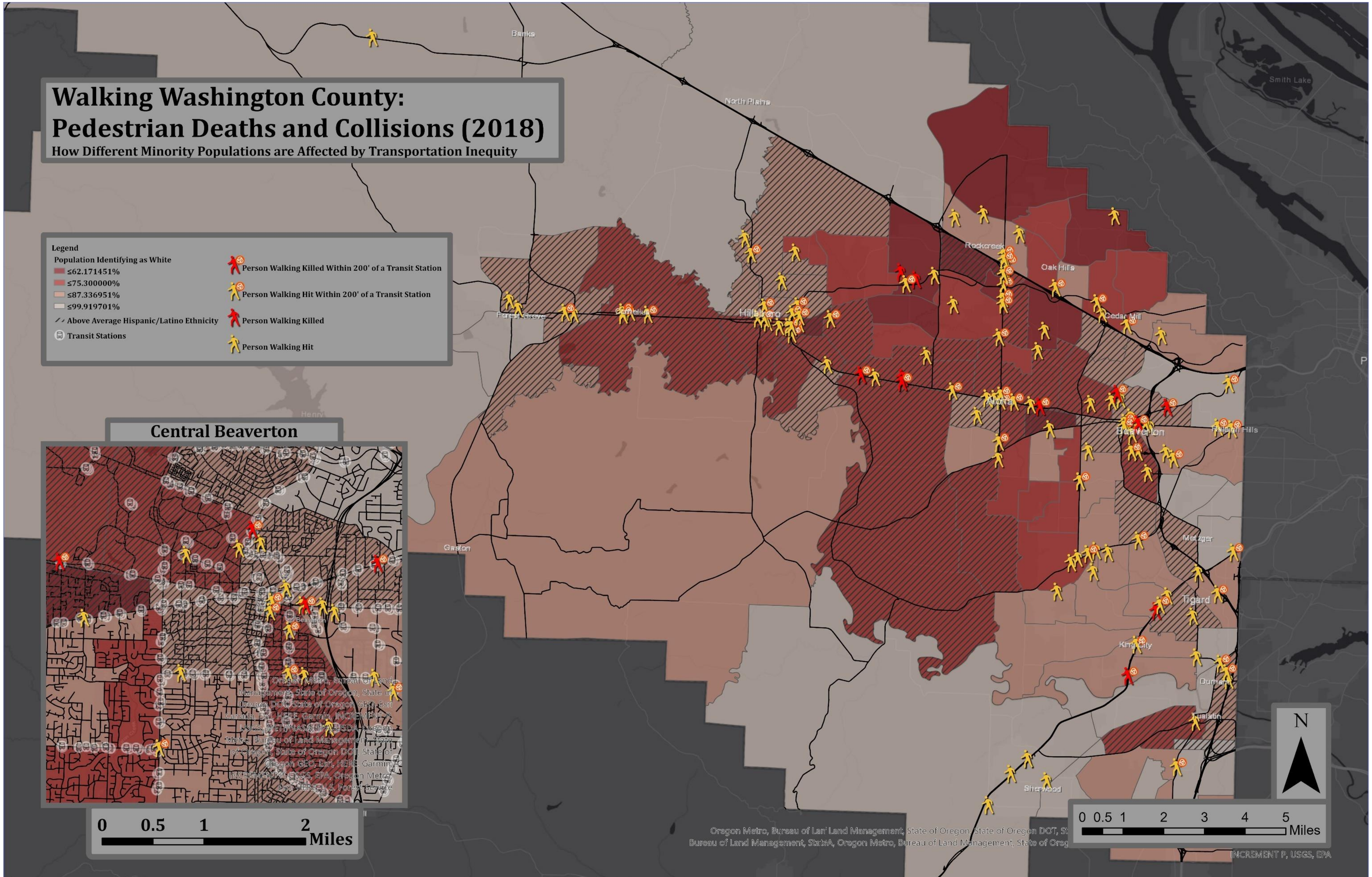
Future studies on the contributing factors of pedestrian crashes should consider this severe under reporting issue, as well as collect roadway information, such as speed limit, average actual speed, roadway geometry, and the character of the neighborhood which the roadway travels through. It is suspected that pedestrian deaths are higher in lower income areas, especially near transit, because those living in lower income neighborhoods have a higher likelihood of taking transit, as it is a cheaper transportation option (Lin). Combined with the historic disinvestment of transportation infrastructure in lower income areas, this seems like a disaster, but this cannot be confirmed without further analysis. An effort also should be made to quell and isolate some of the variables seen throughout data collection, such as isolating vehicle types, and processing collisions by year, and then comparing the years, to observe any apparent change prior to combining all data. In recent years, the pedestrian fatality rate in Washington County has nearly tripled (figure 4), and it would be inappropriate to combine this past data with the new data, as current crashes may have different contributing factors than past ones. Care should be taken performing future studies, as the outcomes and influences they have could have significant effects on the lives of the people that travel on public roadways.

-Appendix A-



Walking Washington County:
Pedestrian Deaths and Collisions (2018)
How Poverty Affects the Safety of Those on Foot
Legend
Income
Percent Population Under Poverty Line
≤5.642020%
≤9.000000%
≤17.681500%
≤34.384999%
Transit Stations
Person Walking Killed Within 200' of a Transit Station
Person Walking Hit Within 200' of a Transit Station
Person Walking Killed
Person Walking Hit
Central Beaverton
0 0.5 1 2 Miles
Banks
North Plains
Rockcreek
Oak Hills
Cedar Mill
Hillsboro
Forest Grove
Cornelius
Aloha
Beaverton
Raleigh Hills
Gaston
Metzger
Tigard
King City
Durham
Tualatin
Sherwood
Smith Lake
N
0 0.5 1 2 3 4 5 Miles
Oregon Metro, Bureau of Land Management, State of Oregon, State of Oregon DOT, State of Oregon GEO, Esri, HERE, Garmin, USGS, EPA, NPS, Esri, HERE, NPS

-Appendix B-



Walking Washington County:
Pedestrian Deaths and Collisions (2018)
How Different Minority Populations are Affected by Transportation Inequity
Legend
Population Identifying as White
≤62.171451%
≤75.300000%
≤87.336951%
≤99.919701%
Above Average Hispanic/Latino Ethnicity
Transit Stations
Person Walking Killed Within 200' of a Transit Station
Person Walking Hit Within 200' of a Transit Station
Person Walking Killed
Person Walking Hit
Central Beaverton
0 0.5 1 2 Miles
0 0.5 1 2 3 4 5 Miles
N
Banks
North Plains
Hillsboro
Beaverton
Tigard
Sherwood
Tualatin
Metzger
Oak Hills
Cedar Mill
Rockcreek
Gaston
Durham
King City

-Bibliography-

Sources Cited

Bella, F., and Silvestri, M. (2015). "Effects of safety measures on driver's speed behavior at pedestrian crossings." Accident Analysis & Prevention, 83, 111–124.

Doggett, S., Ragland, D. R., and Felschundneff, G. (2018). *Evaluating Research on Data Linkage to Assess Underreporting of Pedestrian and Bicyclist Injury in Police Crash Data*, rep., UC Berkeley, Berkeley, CA, 10–12.

Hu, W., and Cicchino, J. B. (2018). "An examination of the increases in pedestrian motor-vehicle crash fatalities during 2009–2016." *Journal of Safety Research*, 67, 37–44.

Lin, P.-S., Guo, R., Bialkowska-Jelinska, E., Kourtellis, A., and Zhang, Y. (2019). "Development of countermeasures to effectively improve pedestrian safety in low-income areas." *Journal of Traffic and Transportation Engineering (English Edition)*, 6(2), 162–174.

Maus, J. (2020). "This morning's death on TV Highway underscores need for reform, investment." *BikePortland.org*, <https://bikeportland.org/2020/01/14/this-mornings-death-on-tv-highway-underscores-need-for-reform-investment-309625#:~:text=This%20tragic%20narrative%20is%20far,deadliest%20roads%20in%20the%20region.&text=According%20to%20Washington%20County%2C%20the,fatalities%20between%202010%20and%202014.> (Jun. 4, 2021).

"Oregon Secretary of State." (n.d.). *State of Oregon: County Records Guide - Washington County History*, Oregon Secretary of State, <https://sos.oregon.gov/archives/records/county/Pages/washington-history.aspx> (Jun. 4, 2021).

Schroeder, B. J., and Rouphail, N. M. (2011). "Event-Based Modeling of Driver Yielding Behavior at Unsignalized Crosswalks." *Journal of Transportation Engineering*, 137(7), 455–465.

Cover Photo: Benjamin Fryback