Safe Main Street Highways Part I: Washington State Collision Data and Geocoding

WA-RD 862.1

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September 2017

Washington State Department of Transportation
Office of Research & Library Services

WSDOT Research Report

17-09-0362

Research Report
Agreement WSDOT T1461 Task 20
SMSH
PacTrans DTRT13-G-UTC40
PacTrans Budget No. 62-9153

SAFE MAIN STREET HIGHWAYS PART I: WASHINGTON STATE COLLISION DATA AND GEOCODING

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Prepared for

The State of Washington
Department of Transportation
Roger Millar, Secretary

Pacific Northwest Transportation Consortium
Region 10 University Transportation Center
University of Washington, Seattle, Washington

September 2017

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
WA-RD 862.1		

4. TITLE AND SUBTITLE	5. REPORT DATE
SAFE MAIN STREET HIGHWAYS PART I: WASHINGTON STATE COLLISION DATA AND GEOCODING	September 2017
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Anne Vernez Moudon, Mingyu Kang	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. WORK UNIT NO.
Washington State Transportation Center (TRAC) University of Washington, Box 354802 University District Building; 1107 NE 45th Street, Ste 535 Seattle, Washington 98105-4631	11. CONTRACT OR GRANT NO. WSDOT T1461-20 PacTrans DTRT13-G-UTC40
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
Research Office Washington State Department of Transportation Transportation Building, MS 47372 Olympia, Washington 98504-7372 Project Manager: Jon Peterson, 360-705-7499	Research Report
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

16. ABSTRACT:

This project contributes to the Washington State Strategic Highway Safety Plan, whose goals are to achieve zero road fatality and serious injury by 2030 and to reduce the number of pedestrians and bicyclists involved in motor-vehicle collisions on state highways. The study focused on "main street highways" (MSHs), which are stretches of State Routes that also act as main streets for the local populations. This report covers Part I of this study, which collected an inventory of collision data in Washington state from 2001 to 2012. The project tallied those collisions that had been geocoded, and the report describes the various methods used for geocoding. More than 90 percent of the collisions had been geocoded for 2010, 2011, and 2012, but only pedestrian and bicyclist collisions had been geocoded for the years between 2001 and 2009.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
Washington state collisions inventory; inventory of geocoded collisions; geocoding methods	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22616

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
None	None		

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Summary of Geocoded Collisions

Motor-vehicle collision data related to different projects were consolidated from different data sets available at the Washington State Transportation Center (TRAC). The data sets were reviewed to determine how many collisions had already been geocoded. We found that from 2001 to 2012 the geocoding rate of all collisions in Washington State was 22.6 percent (Table 1). However, after 2010 the geocoding rate was much higher, at more than 94.0 percent. Over the entire period, the geocoding rate of pedestrian and bicyclist collisions was high, at 91.7 percent (Table 2). The geocoding rates are illustrated in Figure 1.

Table 1. Geocoding Rates by Year, Road Type

Year	All Collisions				State Routes				Non State Routes			
	Total		Geocoded		Sub Total		Geocoded		Sub Total		Geocoded	
001	26,449	100.0%	,802	3.2%	9,399	100.0%	41	1.1%	7,050	100.0%	,261	3.9%
002	28,825	100.0%	,987	3.1%	0,229	100.0%	60	1.1%	8,596	100.0%	,427	3.4%
003	24,905	100.0%	,006	3.2%	8,491	100.0%	14	1.3%	6,414	100.0%	,392	3.4%
004	27,722	100.0%	,096	3.2%	9,375	100.0%	96	3.2%	8,347	100.0%	,500	3.5%
005	38,448	100.0%	,229	3.1%	4,469	100.0%	47	3.0%	3,979	100.0%	,682	3.4%
006	37,373	100.0%	,601	3.3%	5,211	100.0%	55	3.0%	2,162	100.0%	,046	3.9%
007	33,431	100.0%	,265	3.2%	3,764	100.0%	48	3.0%	9,667	100.0%	,717	3.7%
008	23,610	100.0%	,104	3.5%	9,713	100.0%	68	3.1%	3,897	100.0%	,536	3.4%
009	06,174	100.0%	,292	3.1%	4,057	100.0%	44	3.5%	2,117	100.0%	,648	3.3%
010	05,187	100.0%	9,382	4.5%	4,093	100.0%	2,925	7.4%	1,094	100.0%	6,457	2.4%
011	02,650	100.0%	7,263	4.8%	3,679	100.0%	2,575	7.5%	8,971	100.0%	4,688	2.7%
012	03,932	100.0%	8,055	4.3%	4,833	100.0%	3,689	7.4%	9,099	100.0%	4,366	2.0%
Total	,458,706	100.0%	29,082	2.6%	87,313	100.0%	34,362	2.9%	71,393	100.0%	94,720	2.3%

* Some collisions did not have any information about time (year, date variables in the database). There were 78,718 collisions without this information (5.1 percent of the total number of collisions). They're not included in this table.

Table 2. Geocoding Rates by Year, Collision Type

Year	All Collisions				Pedestrians and Bicyclists				Non- Pedestrians and Bicyclists			
	Total		Geocoded		Sub Total		Geocoded		Sub Total		Geocoded	
001	26,449	100.0%	,802	.2%	,200	00.0%	,802	7.6%	23,249	100.0%		.0%
002	28,825	100.0%	,987	.1%	,336	00.0%	,947	8.3%	25,489	100.0%	,040	.8%
003	24,905	100.0%	,006	.2%	,359	00.0%	,979	8.7%	21,546	100.0%	,027	.8%
004	27,722	100.0%	,096	.2%	,396	00.0%	,023	9.0%	24,326	100.0%	,073	.9%
005	38,448	100.0%	,229	.1%	,529	00.0%	,109	8.1%	34,919	100.0%	,120	.8%
006	37,373	100.0%	,601	.3%	,666	00.0%	,280	9.5%	33,707	100.0%	,321	.0%
007	33,431	100.0%	,265	.2%	,485	00.0%	,067	8.0%	29,946	100.0%	,198	.9%
008	23,610	100.0%	,104	.5%	,513	00.0%	,101	8.3%	20,097	100.0%		.0%
009	06,174	100.0%	,292	.1%	,383	00.0%	,292	7.3%	02,791	100.0%		.0%
010	05,187	100.0%	9,382	4.5%	,569	00.0%	,529	8.9%	01,618	100.0%	5,853	4.3%
011	02,650	100.0%	7,263	4.8%	,427	00.0%	,352	7.8%	9,223	100.0%	3,911	4.6%
012	03,932	100.0%	8,055	4.3%	,572	00.0%	,511	8.3%	00,360	100.0%	4,544	4.2%
otal	,458,706	100.0%	29,082	2.6%	1,435	00.0%	7,992	1.7%	,417,271	100.0%	91,090	0.5%

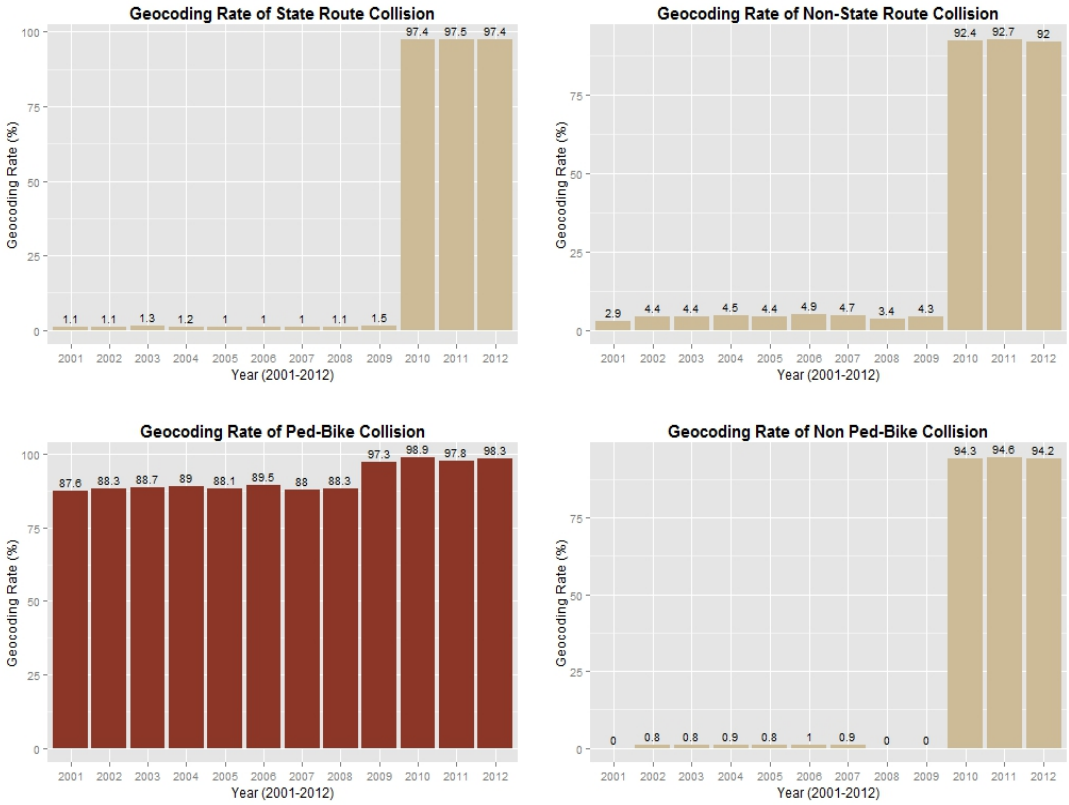


Figure 1. Geocoding Rates by Year

Geocoding Methods

The University of Washington Urban Form LAB (UFL) identified four different sources for 2001 through 2012 pedestrian and bicyclist collision data. The sources corresponded to four geocoding methods:

- a point system for each collision location using ArcGIS online street network routing
- an intersection location system using ArcGIS online street network routing
- a linear referencing system
- a combination of methods used when WSDOT, TRAC, and the UFL have geocoded collisions for past projects.

Together, these sources yielded 37,992 collision points, or 91.7 percent of all pedestrian-bicyclist collisions (41,435) in Washington state during the study period. Table 3 shows the number of collisions by data source.

Table 3. Geocoded Pedestrian and Bicyclist Collisions with Motor-Vehicles by Data Source

Year	(i) Reference Point Data	(ii) Intersection Data	(iii) LRS Data	(iv) Pre-geocoded Data	Total
001	245	406	153	1,998	,802
002	178	303	83	2,383	,947
003	160	282	75	2,462	,979
004	131	235	58	2,599	,023
005	76	122	384	2,527	,109
006	53	139	404	2,684	,280
007	28	95	391	2,556	,067
008	81	207	422	2,391	,101
009	38	104	85	3,090	,292
010	47	116	38	3,328	,529
011	75	139	22	3,116	,352
012	77	149	35	3,250	,511
Total	1,189	2,297	2,150	32,356	7,992

* (i) X:\Research\SMSH_wsdot_collisions\bike_ped_ref_points (source: WSDOT, geocoding reference: Arcgis Online street network)
* (ii) X:\Research\SMSH_wsdot_collisions\bike_ped_intersections (source: WSDOT, geocoding reference: Arcgis Online street network)
* (iii) X:\Research\SMSH_wsdot_collisions\bike_ped_state_route_collisions (source: WSDOT, method: Linear Referencing System)
* (iv) X:\Research\SMSH_wsdot_collisions\bike_ped_collisions_geocoded (source: WSDOT, TRAC, UFL previous projects)

Point System and Intersection Location System

The UFL geocoded collision points that had not been previously geocoded with the ArcGIS online street network. These data sets came from WSDOT and had x, y coordinate information about pedestrian and bicyclist collision reference points (i) and intersections (ii). The ArcGIS online street network offers an address locator named 'World'. This was automatically generated in the GIS Servers (on the ArcGIS catalog) after we obtained access to the ArcGIS

online street network. We used five different categorical variables to geocode additional collision points: Country (USA), Region (Washington, not WA), (County (county name of each collision), City (city name for each collision), and Address (intersection; names of two different streets linked by 'and'). Table 4 summarizes the geocoding matching rates of these two data sets. Basically, we could geocode all missing collision points. The rate for perfectly matching missing collision points was 89 percent for the point system and 88 percent for the intersection location system (total 88.5 percent). The street network data (ArcGIS online street network) had higher resolution than two raw datasets (i, ii). So, some geocoded collisions had less accurate x, y coordinate information (e.g., a collision had x, y in between northbound and southbound roads). Most of these cases went into the 'Tied Match' group in ArcGIS's geocoding process. To confirm this, we checked collision points in a Tied Match group with the built-in base maps in ArcGIS (Streets, Open Street Map).

Table 4. Matching Rates of Missing Collision Points

Database	Perfect Match	Tied Match	Unmatched	Total
(i) ref_points	1,063 (89.0%)	126 (11.0%)	0 (0.0%)	1,189 (100%)
(ii) intersections	2,021 (88.0%)	276 (12.0%)	0 (0.0%)	2,297 (100%)
Total	3,084 (88.5%)	402 (11.5%)	0 (0.0%)	3,486 (100%)

Linear Referencing System

The UFL geocoded these collision points by using the Linear Referencing System (LRS) toolbox in ArcGIS and the State Route and milepost data provided by WSDOT. The WSDOT State Route data contained route measures (distances along each line segment) that were stored in feet. These measures were converted into miles and then calibrated by using the milepost data. These data sets were matched by using the State Route ID number. Only the inbound (i) or bidirectional (b) milepost data were used in the calibration process, as the route data

corresponded to the state roadways in the inbound direction. The LRS tools where then used to place each collision along the state routes on the basis of the State Route number and mile marker information contained in the collision records.

Combination of Methods

This data set was derived directly from WSDOT and previous collision projects. The geocoded collision data came from three different sources: earlier projects conducted by the UFL (1,914 collisions), a pedestrian and bicycle collision project conducted by TRAC (20,887 collisions), and WSDOT's new geocoding tool, which was implemented in 2010 (9,583 collisions).

2. Geocoding Results (Snapshots)

Figure 2 shows the results of geocoding. Pedestrian and bicyclist collisions on State Routes are geocoded in red, and green points represent non-state route pedestrian-bicyclist collisions. Non-state route collisions included crashes on county roads, city streets, and miscellaneous roadways.

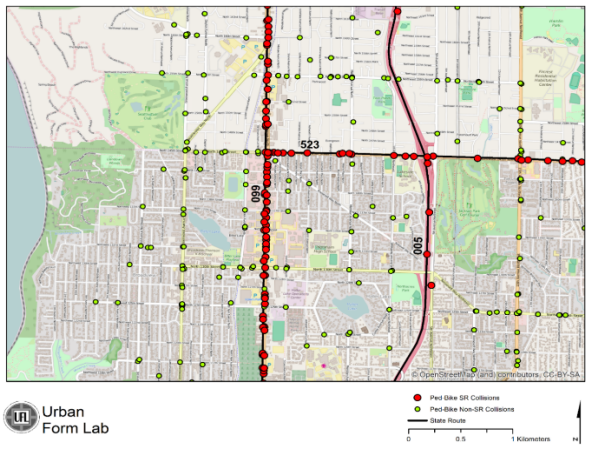
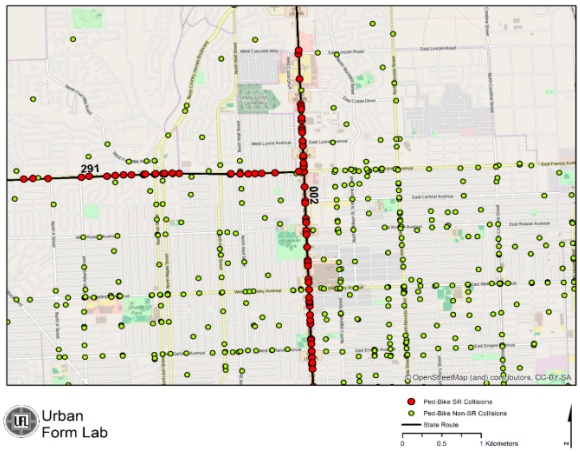
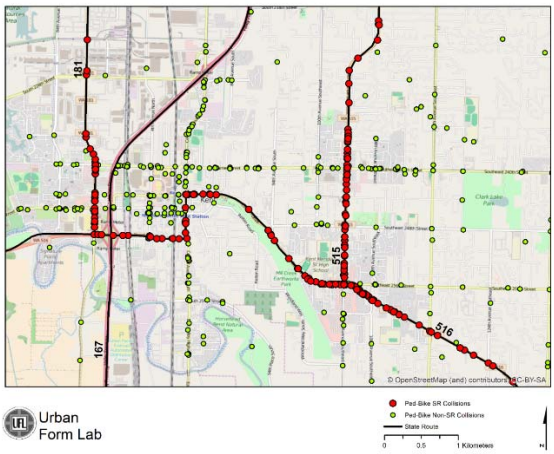
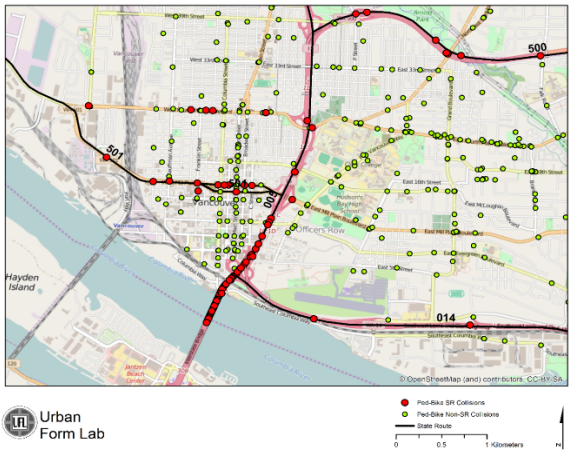
Seattle (State Route 99)	Spokane
	
Kent	Vancouver
	

Figure 2. Details of Geocoded Pedestrian and Bicyclist Collisions on State and non-State Routes in Seattle, Spokane, Kent, and Vancouver

II. Descriptive Statistics of Collision Data

1. Total Collisions

Pedestrian-cyclist collisions were 2.7 percent of all collisions (Table 5). The geocoding rate of pedestrian-cyclist collisions was much higher than the rate of non-pedestrian-cyclist collisions. Table 6 also shows the summary statistics of all collisions by severity and road type.

Table 5. Summary by Collision Type, Road Type

	Category	All Collisions				State Routes				Non-State Routes			
		Total		Geocoded		Sub Total		Geocoded		Sub Total		Geocoded	
Collision Type	With Pedestrian	23,793	1.5%	21,928	6.6%	4,934	0.8%	4,618	3.4%	18,859	2.0%	17,310	8.8%
	With Cyclist	17,531	1.1%	15,959	4.8%	2,748	0.5%	2,519	1.9%	14,783	1.6%	13,440	6.9%
	With Ped & Cyclist	111	0.0%	105	0.0%	6	0.0%	4	0.0%	105	0.0%	101	0.1%
	Non Ped-Cyclist	1,495,989	97.3%	292,089	88.5%	579,625	98.7%	127,221	94.7%	916,364	96.4%	164,868	84.2%
	Total	1,537,424	100.0%	330,081	100.0%	587,313	100.0%	134,362	100.0%	950,111	100.0%	195,719	100.0%

* State Route-related collisions were identified by the collision report type listed in the collision database.
** 111 collisions included both a pedestrian and bicyclist.

Table 6. Summary by Collision Injury Severity, Road Type

	Category	All Collisions				State Routes				Non State Routes			
		Total		Geocoded		Sub-Total		Geocoded		Sub-Total		Geocoded	
Collision Severity	Fatal	6,095	0.4%	2,782	0.8%	2,937	0.5%	785	0.6%	3,158	0.3%	1,997	1.0%
	Serious Injury	27,748	1.8%	13,863	4.2%	10,375	1.8%	2,707	2.0%	17,373	1.8%	11,156	5.7%
	Evident Injury	142,426	9.3%	36,923	11.2%	55,392	9.4%	12,532	9.3%	87,034	9.2%	24,391	12.5%
	Possible Injury	323,693	21.1%	71,194	21.6%	143,159	24.4%	30,632	22.8%	180,534	19.0%	40,562	20.7%
	No Injury No Information	1,037,462	67.5%	205,319	62.2%	375,450	63.9%	87,706	65.3%	662,012	69.7%	117,613	60.1%
	Total	1,537,424	100.0%	330,081	100.0%	587,313	100.0%	134,362	100.0%	950,111	100.0%	195,719	100.0%

* In many collisions, a single collision included more than one casualty. In that case, the collision was coded as the most severe level of injury (or fatality). Fatal collisions include 'Died at Hospital', 'Dead on Arrival' and 'Dead at Scene' in police records.

2. Pedestrian and Bicyclist Collisions

Figures 3 and 4 show all the pedestrian and bicyclist collision locations in Washington state between 2001 and 2012. State Route and Non-State Route collisions are presented in red and green, respectively. Figure 5 shows the pedestrian and bicyclist fatalities on State Routes.

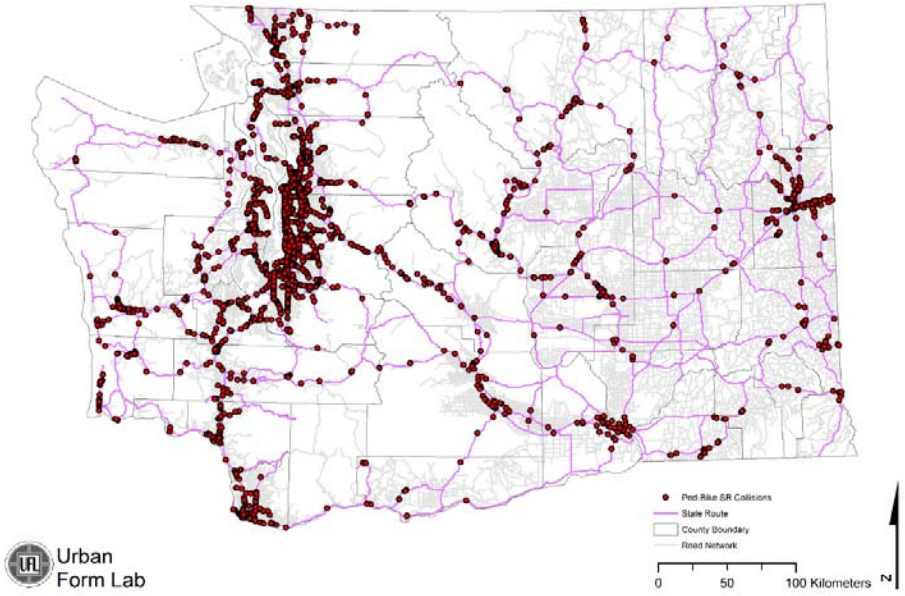


Figure 3. Pedestrian and Bicyclist Collisions on State Routes

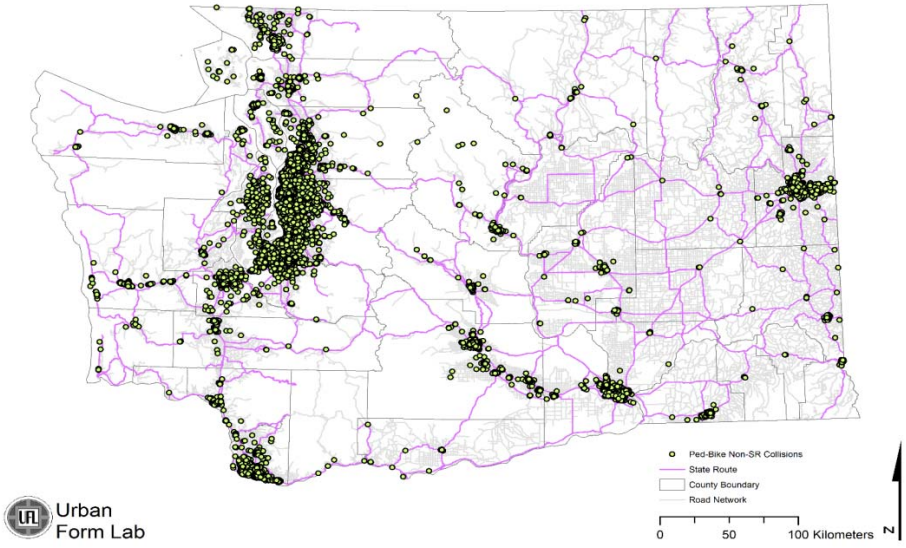


Figure 4. Pedestrian and Bicyclist Collisions on Non-State Routes

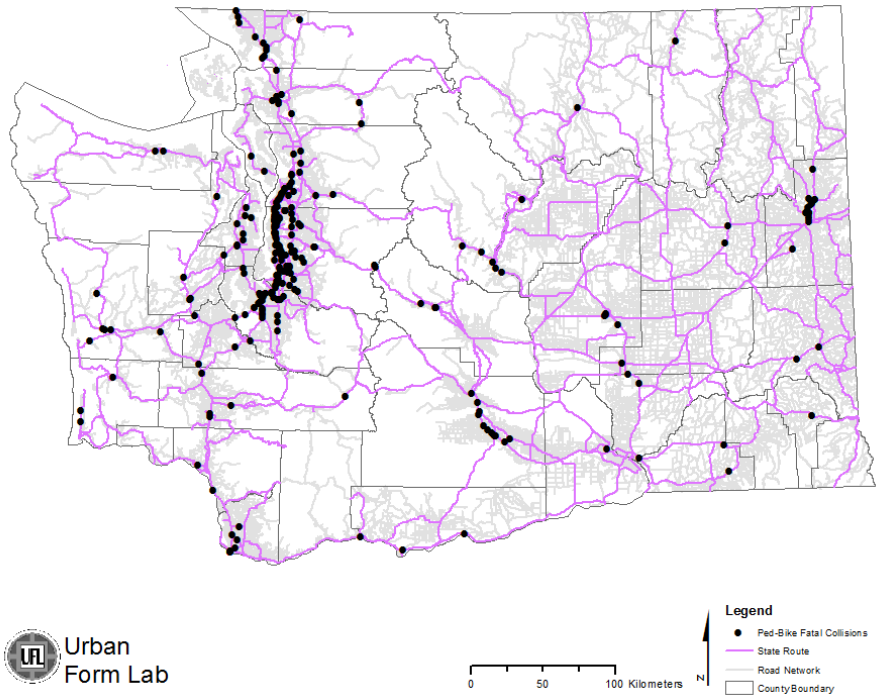


Figure 5. Pedestrian and Bicyclist Fatalities on State Routes

In most cases, just one pedestrian (or cyclist) casualty was involved in a single collision. Those instances made up 96.5 percent of all geocoded pedestrian and bicyclist collision data. However, 3 percent of all collisions involved two casualties, and collisions with more than three pedestrians and/or cyclists composed less than 1 percent of all the data. Table 7 shows the numbers and percentages of collisions involving different numbers of pedestrians and/or cyclists.

Table 7. Number of Pedestrians and/or Cyclists Involved in a Collision

Number of Pedestrians and/or Cyclists in a Collision	Number of Collisions (%)	
1	36,678	96.50%
2	1,151	3.00%
3	127	0.30%
4	20	0.10%
5 +	16	0.04%
Total	37,992	100.0%

Police reports on pedestrian-bicyclist injury type use seven categories of severity: No Injury, Possible Injury, Evident Injury, Serious Injury, Died at Hospital, Dead on Arrival, Dead at the Scene. In this study, seven levels of collision severity were collapsed into five, three, and two categories for analyses. Table 8 and Figure 6 show the rates of pedestrian-bicyclist collisions by their severity classification.

Table 8. Distribution of Pedestrian and Bicyclist Collisions by Severity of Injury

7 Classes			5 Classes			3 Classes			2 Classes		
Dead at Scene	296	1.0%	Fatal	710	2.3%	Fatal / High	4,527	14.7%	Fatal/high	4,527	14.7%
Dead on Arrival	29	0.1%									
Died at Hospital	385	1.2%									
Serious Injury	3,817	12.4%	Serious Injury	3,817	12.4%						
Evident Injury	13,625	44.2%	Evident Injury	13,625	44.2%	Medium	13,625	44.2%	Low	26,274	85.3%
Possible Injury	10,335	33.6%	Possible Injury	10,335	33.6%	Low	12,649	41.1%			
No Injury	2,314	7.5%	No Injury	2,314	7.5%						
Total	30,801	100.0%	Total	30,801	100.0%	Total	30,801	100.0%	Total	30,801	100.0%

* Observations with 'Non-Traffic Fatality', 'Non-Traffic Injury' and 'Unknown' are removed from this table.

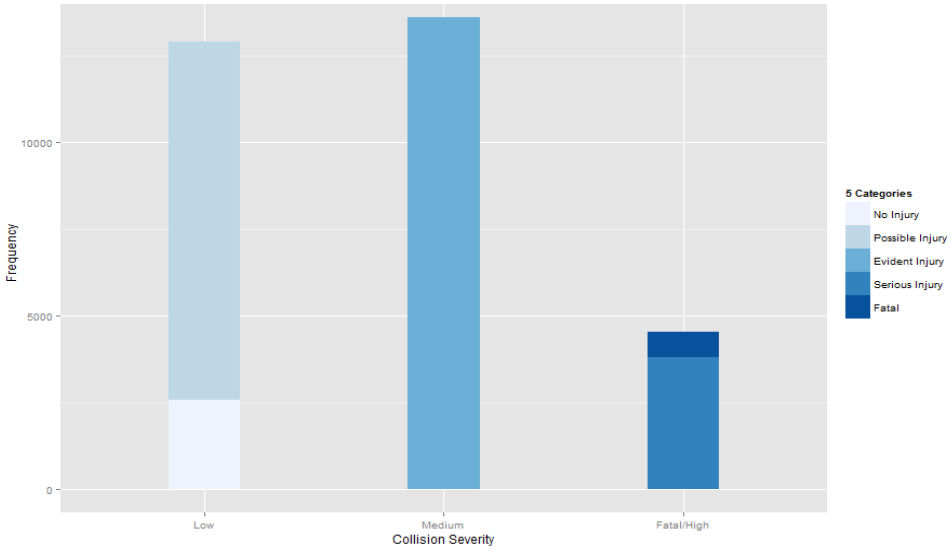


Figure 6. Pedestrian and Bicyclist Collision Frequency by Severity of Injury

Figure 7 shows the mean collision severity by State Route. The upper plot shows the most dangerous 30 roads, and the lower plot represents the safest 30 State Routes in terms of severity classification. Since these plots do not take into account collision frequency, only limited interpretation is possible.

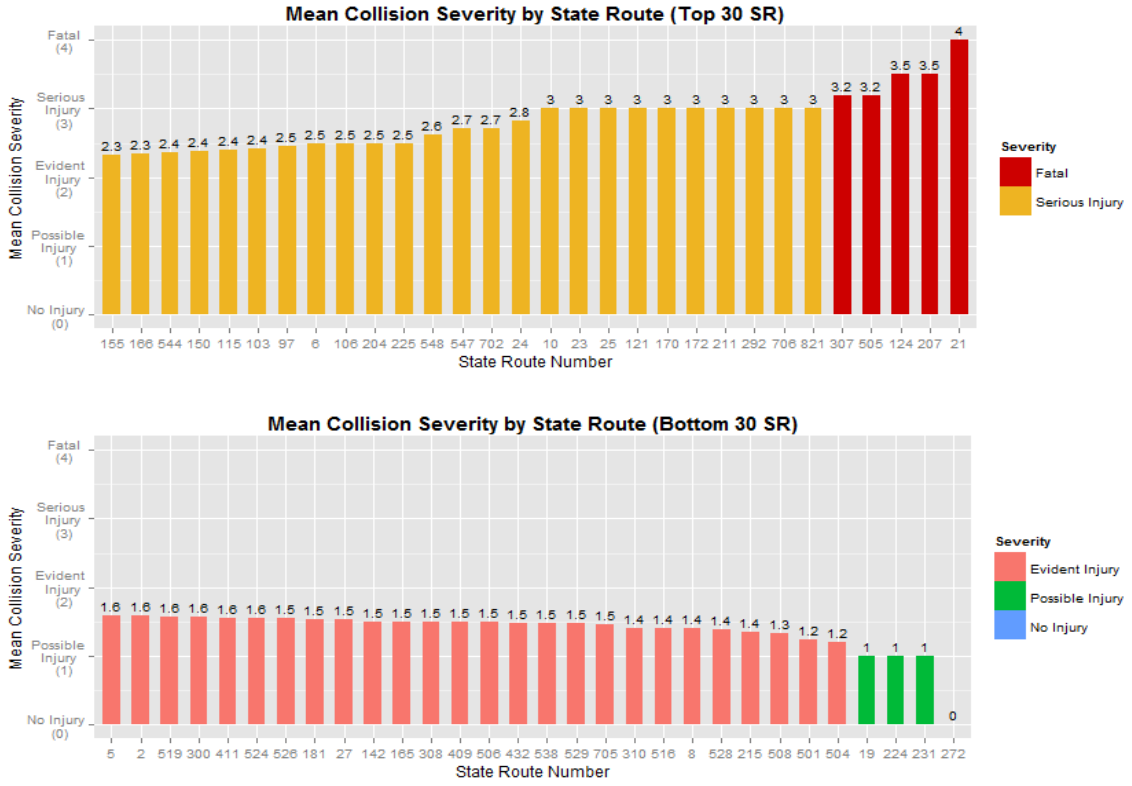


Figure 7. Mean Collision Injury Severity by State Route

III. Conclusion

A complete inventory of collisions for Washington state exists from 2001 to 2012. Most of the collisions involving pedestrians and bicyclists have been geocoded. However, collisions involving only motor vehicles have not been geocoded for 2001 to 2009.

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