Updated Speed and Crash Analysis of Speed Limit Changes on Eastern Oregon Interstates and Highways

FINAL REPORT

by

Jason C. Anderson, Ph.D.
Christopher M. Monsere, Ph.D., PE (OR)
Department of Civil and Environmental Engineering
Portland State University

for

Oregon Department of Transportation
Traffic and Roadway Section
Salem OR 97301

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EXECUTIVE SUMMARY

Maximum speed limits for passenger vehicles and trucks was increased in March 2016 on approximately 1,400 miles of highways and interstates in Eastern Oregon. Specifically, speed limits were increased to 70 mi/hr (cars) and 65 mi/hr (trucks) on interstates and 65 mi/hr (cars) and 55 mi/hr (trucks) on a network of rural highways. This report presents the analysis of the changes in average vehicles speed, percentage of vehicles traveling over 65, 75, and 85 mi/hr, traffic volume, total crashes, and fatal and injury crashes for both vehicles and trucks after the speed limit increases. The before and after data on the segments where the speed limits were increased are compared to a data for segments in a control group. In addition, an Empirical-Bayes before and after safety analysis, recommended by AASHTO Highway Safety Manual as state-of-the-practice, was conducted for total crashes on interstate and non-interstate roadways.

The change in vehicle speeds was evaluated by comparing three years of before and after data available from 18 automated traffic recorders (ATRs) in control sections to 16 ATRs in the segments where the speeds were increased. By all measures, vehicle speeds have increased on the highways where the posted speed limits were increased. The average speeds have increased approximately 3 mi/hr, and these changes are statistically significant. More importantly, the percentage of fast vehicles has also increased. On the interstates where the speed limit was increased to 70 mi/hr, about 13% percent more vehicles were observed traveling faster than 75 mi/hr than before the speed limit change. On the control sections, the change over the same time period was only a 2.5% increase. For the network of rural highways where the speed limits were increased to 65 mi/hr, about 2% percent more vehicles were traveling faster than 75 mi/hr compared to only a 0.25% increase on the control sections in the same time period.

The safety performance of the 1,426.5 miles of highway where the speed limits were increased was compared to a selected control group of 691.2 miles of highway using three years of before and after crash data. On the interstates, where speed limits were increased to 70 mi/hr, the descriptive crash analysis suggests that the total number of crashes, fatal/injury A crashes, and truck-involved crashes have increased. Using the more robust Empirical Bayes before-after method, a crash modification factor (CMF) of 1.10 (1.0 to 1.2) was calculated, which suggests total crashes increased by 10% following the increase in speed limits. On the network of rural two-lane highways where speeds were increased from 55 mi/hr to 65 mi/hr, both the descriptive analysis of crash frequency and the Empirical Bayes before-after method suggest a much more significant increase of total crashes, fatal/injury A crashes, and truck-involved crashes in crashes. A CMF of 1.49, with a 95% confidence band of 1.40 to 1.58, suggests total crashes increased due to the speed limit increase by nearly 50%.

1.0 INTRODUCTION

This report is an updated analysis of speed and crash performance changes on Eastern Oregon highways and interstates. A preliminary analysis, using only one year of crash data after the changes were implemented, was conducted in 2018. A report was prepared and presented to the Oregon Transportation Commission (OTC). The analysis found that vehicle speeds increased on the highways where the posted speed limits increased, and the preliminary trend in crash performance warranted continued monitoring. This report is a follow-up, updating the analysis with a longer time series of data.

The speed limit changes became law and were effective March 1, 2016. The legislation raised maximum speed limits for passenger vehicles and trucks on approximately 1,400 miles of highways and interstates in Eastern Oregon. Specifically, speed limits were increased as follows: 70 mi/hr (cars) and 65 mi/hr (trucks), and 65 mi/hr (cars) and 55 mi/hr (trucks). The speed limit increases are detailed in Section 1 in ORS 811.111, where the corridors with speed limit increases are as follows (corridors visually shown in Figure 1.1):[1]

- (2) Interstate 84 beginning at the eastern city limit of The Dalles and ending at the Idaho border.
    - 65 mi/hr for trucks; 70 mi/hr for all other vehicles.
- (3) State Highway 95 beginning at the Idaho border and ending at the Nevada border.
    - 65 mi/hr for trucks; 70 mi/hr for all other vehicles.
- (4) State Highway 20 beginning in Bend and ending in Ontario.
    - 60 mi/hr for trucks; 65 mi/hr for all other vehicles.
- (5) State Highway 197 beginning in The Dalles and ending at the junction with State Highway 97, and State Highway 97 beginning at the junction with State Highway 197 and the California border.
    - 60 mi/hr for trucks; 65 mi/hr for all other vehicles.
- (6) State Highway 31 beginning in Valley Falls and ending in La Pine.
    - 60 mi/hr for trucks; 65 mi/hr for all other vehicles.
- (7) State Highway 78 beginning in Burns Junction and ending in Burns.
    - 60 mi/hr for trucks; 65 mi/hr for all other vehicles.
- (8) State Highway 395 beginning in Burns and ending in John Day
    - 60 mi/hr for trucks; 65 mi/hr for all other vehicles.
- (9) State Highway 395 beginning in Riley and ending at the California border.
    - 60 mi/hr for trucks; 65 mi/hr for all other vehicles.
- (10) Oregon Route 205 beginning in Burns and ending in Frenchglen.
    - 60 mi/hr for trucks; 65 mi/hr for all other vehicles.
- (11) State Highway 26 beginning in John Day and ending in Vale.
    - 60 mi/hr for trucks; 65 mi/hr for all other vehicles.

[1] Numbering starts at (2) to match the numbering scheme in ORS 811.111.

- (12) Interstate 82 beginning at the Washington border and ending at the junction with Interstate 84.
    - o 65 mi/hr for trucks; 70 mi/hr for all other vehicles.

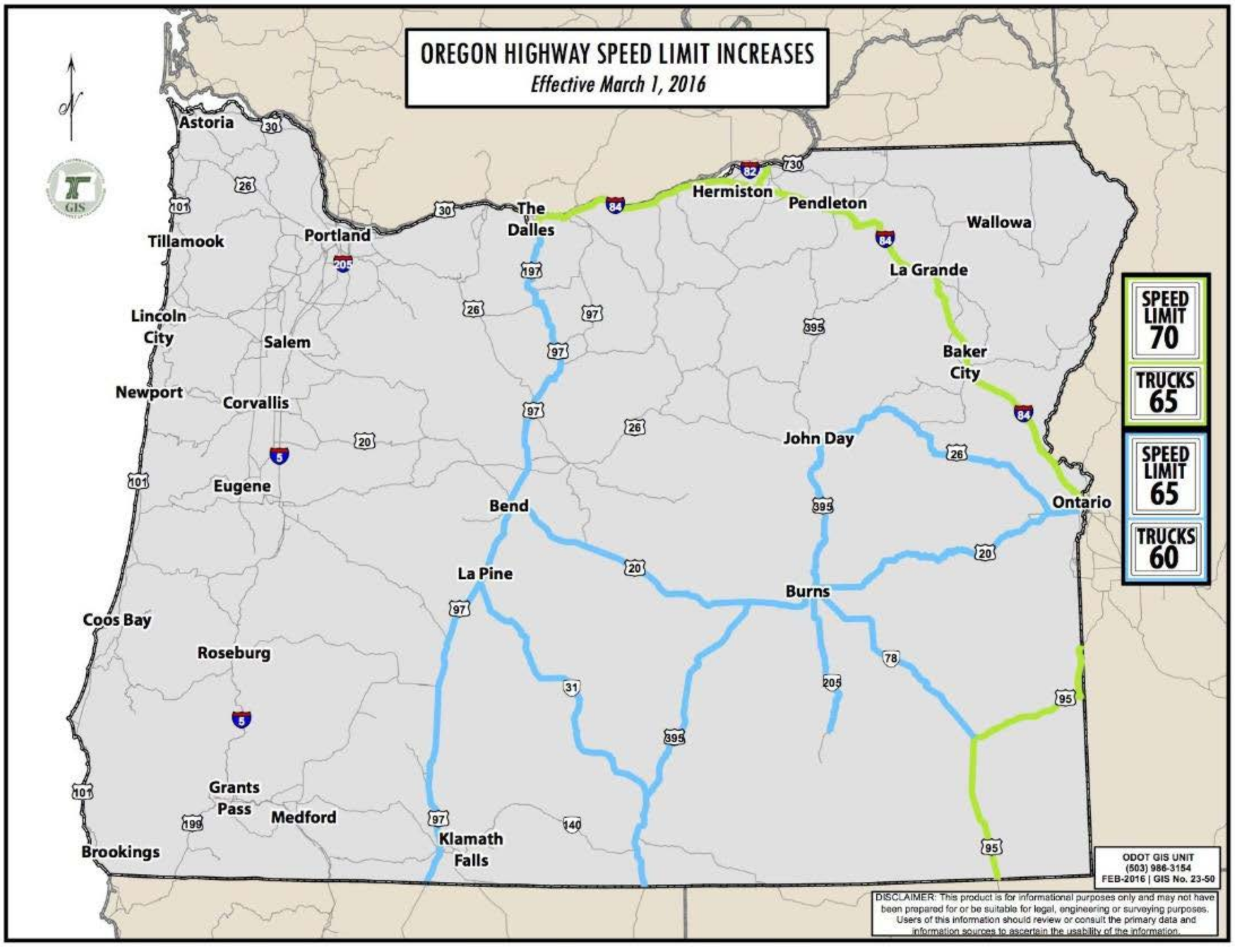


Figure 1.1: Corridors with a Speed Limit Change

Further, the Oregon Department of Transportation lowered speeds to 55 mi/hr (cars) and 55 mi/hr (trucks) on sections of the increased speed limit corridors following an engineering analysis. The speed reduction segments are as follows:

- US-97 - Dover Lane to Lower Bridge (MP 98.6 to MP 115, Madras to Terrebonne)
- US-20 - Dalton Street to Dodds Road (MP 3.17 to MP 9.19, east of Bend)
- US-97 - 6th Street to Masten Road (MP 168.8 to MP 169.87, south of La Pine)
- US-20 - Hawley Loop to Olds Ferry-Ontario (MP 246.84 to MP 258.20, Vale to Cairo)

2.0 DATA AND METHODS

The updated analysis compares speed, volume, and safety changes on segments where speed limits were increased. In addition to before-after comparisons, an Empirical Bayes approach to assess the impact of increased speed limits on safety through the use of a crash modification factor (CMF) was determined. For comparison purposes, a set of highways in which speed limits did not change were chosen as control segments. To compare before-after safety performance on segments where there was a speed limit increase and the control segments (no increase), three years of before data and three years of after data were used.

2.1 SPEED AND VOLUME DATA FROM ATR STATIONS

Throughout Oregon, the Department of Transportation operates and maintains a network of permanent traffic counting stations. These permanent stations continuously record the presence of vehicles and their corresponding speed, and dependent on the type of station (e.g., weigh-in-motion stations), record weight, axle counts, spacing, and vehicle classification. For this updated analysis, the same ATR stations assessed in the preliminary analysis are investigated with additional years of data after the speed limit increase. This includes both segments with increased speed limits and control segments. Portland State University obtained traffic and speed data at select ATRs from March 2013 to April 2019 through the Oregon Traffic Monitoring System website. This new platform was implemented after the previous study, resulting in changes in the traffic data file formatting (see Figure 2.1 for an example of the monthly report format). As a result, all data used in this updated analysis was obtained from the new platform.

As shown in Figure 2.1, the monthly report includes vehicle counts by day of the week for various speed bins, direction, and total vehicle counts for the month by speed bin. The monthly reports average all lanes and vehicle types (passenger vehicles and trucks). Due to trucks traveling at lower speeds and some stations having higher truck volumes, the overall (all vehicle) speed metrics may be lower due to the heavy volumes of lower speed trucks.

Oregon Traffic Monitoring System
01001: January 2018 SPEED Report

Location ID:	01001	Functional Class:	5
County:	Baker	Axle Factor Group:	
Community			
Description:	On LA GRANDE-BAKER HIGHWAY NO. 66 at UnionBaker County Line [4.84 miles]		

DATE	DIR/LANE	0 - 20 MPH	20 - 25 MPH	25 - 30 MPH	30 - 35 MPH	35 - 40 MPH	40 - 45 MPH	45 - 50 MPH	50 - 55 MPH	55 - 60 MPH	60 - 65 MPH	65 - 70 MPH	70 - 75 MPH	75 - 80 MPH	80 - 85 MPH	85+ MPH	TOTAL	QC STATUS
Mon 1	NB	0	0	0	0	0	0	5	24	78	62	33	11	4	0	0	217	Accepted
Mon 1	SB	0	0	0	0	1	1	4	22	63	72	27	10	4	1	0	205	Accepted
Tue 2	NB	0	0	0	0	1	0	6	34	147	143	55	13	4	2	0	405	Accepted
Tue 2	SB	0	0	0	0	3	5	4	58	149	126	54	18	4	0	0	421	Accepted
Wed 3	NB	0	0	0	0	0	1	17	47	148	118	32	16	7	1	0	387	Accepted
Wed 3	SB	0	0	0	0	0	1	8	51	173	117	51	13	4	0	0	418	Accepted
Thu 4	NB	0	0	0	0	0	1	15	47	160	113	46	19	4	0	0	405	Accepted
Thu 4	SB	0	0	0	0	0	2	9	50	150	143	38	13	2	3	0	410	Accepted
Fri 5	NB	0	0	0	0	0	2	11	39	123	97	46	22	3	0	0	343	Accepted
Fri 5	SB	0	0	0	0	1	2	8	42	127	134	44	15	3	0	1	377	Accepted
Sat 6	NB	0	0	0	0	2	3	13	47	122	80	34	5	4	0	0	310	Accepted
Sat 6	SB	0	0	0	0	3	7	7	39	105	117	38	9	3	0	0	328	Accepted
Sun 7	NB	0	0	0	0	2	2	3	23	83	69	15	14	4	0	1	216	Accepted
Sun 7	SB	0	0	0	0	1	3	6	13	75	62	34	4	1	0	1	200	Accepted
Mon 8	NB	0	0	0	0	2	0	14	41	141	117	38	21	3	0	1	378	Accepted
Mon 8	SB	0	0	0	0	1	1	9	37	131	138	46	18	3	1	1	386	Accepted
Tue 9	NB	0	0	0	0	3	0	7	53	148	127	41	19	2	1	0	401	Accepted
Tue 9	SB	0	0	0	0	0	0	15	44	153	128	33	15	5	0	0	393	Accepted
Wed 10	NB	0	0	0	0	1	1	9	39	154	127	38	12	4	0	1	386	Accepted
Wed 10	SB	0	0	0	0	1	2	7	36	125	143	49	13	4	0	0	380	Accepted
Thu 11	NB	0	0	0	0	6	19	39	84	131	69	22	3	0	0	0	373	Accepted
Thu 11	SB	0	0	0	0	11	23	34	67	125	96	32	14	1	1	0	404	Accepted
Fri 12	NB	0	0	0	0	3	2	17	52	163	123	35	8	1	0	0	404	Accepted
Fri 12	SB	0	0	0	0	2	3	10	47	156	132	59	13	2	1	3	428	Accepted
Sat 13	NB	0	0	0	0	1	2	12	32	127	98	39	13	4	1	0	329	Accepted
Sat 13	SB	0	0	0	0	0	1	4	35	125	117	32	7	5	1	1	328	Accepted
Sun 14	NB	0	0	0	0	0	2	5	24	111	72	40	13	1	0	0	268	Accepted
Sun 14	SB	0	0	0	0	0	1	5	21	92	85	30	10	4	0	0	248	Accepted
Mon 15	NB	0	0	0	0	1	3	9	43	139	86	44	12	1	1	0	339	Accepted
Mon 15	SB	0	0	0	0	0	1	10	36	131	114	40	9	5	2	0	348	Accepted
Tue 16	NB	0	0	0	0	1	5	4	34	148	136	42	18	4	1	0	393	Accepted
Tue 16	SB	0	0	0	0	3	0	6	30	127	165	35	11	5	1	1	384	Accepted
Wed 17	NB	0	0	0	0	1	2	12	45	159	110	36	11	1	1	0	378	Accepted
Wed 17	SB	0	0	0	0	2	4	8	44	130	147	36	7	3	1	1	383	Accepted
Thu 18	NB	0	0	0	0	0	5	8	44	144	115	50	11	1	0	1	379	Accepted
Thu 18	SB	0	0	0	0	1	5	8	45	140	151	47	15	2	2	0	416	Accepted
Fri 19	NB	0	0	0	0	0	3	7	45	144	142	45	15	6	2	1	410	Accepted
Fri 19	SB	0	0	0	0	0	3	10	45	143	151	52	24	8	1	2	439	Accepted
Sat 20	NB	0	0	0	0	2	5	11	39	115	96	54	14	1	2	0	339	Accepted
Sat 20	SB	0	0	0	0	0	2	8	28	116	121	42	8	3	2	1	331	Accepted
Sun 21	NB	0	0	0	0	7	11	15	36	66	76	20	8	2	2	0	243	Accepted
Sun 21	SB	0	0	0	0	6	7	22	29	83	70	22	3	1	0	1	244	Accepted
Mon 22	NB	0	0	0	0	7	15	39	61	115	81	31	5	1	0	0	355	Accepted
Mon 22	SB	0	0	0	0	2	14	26	50	126	81	37	10	3	0	0	349	Accepted
Tue 23	NB	0	0	0	0	2	4	12	57	148	97	42	11	0	2	1	376	Accepted
Tue 23	SB	0	0	0	0	2	9	13	44	120	137	33	13	6	0	1	378	Accepted
Wed 24	NB	0	0	0	0	8	21	42	59	141	64	15	2	1	0	0	353	Accepted
Wed 24	SB	0	0	0	0	10	13	38	59	128	96	29	10	1	0	1	385	Accepted
Thu 25	NB	0	0	0	0	3	4	14	45	149	104	32	8	4	0	0	363	Accepted
Thu 25	SB	0	0	0	0	2	3	15	43	138	131	54	12	5	1	3	407	Accepted
Fri 26	NB	0	0	0	0	1	3	14	44	129	119	48	15	7	0	1	381	Accepted
Fri 26	SB	0	0	0	0	2	1	9	32	152	145	64	12	3	0	0	420	Accepted
Sat 27	NB	0	0	0	0	29	28	47	52	86	48	12	3	0	0	0	305	Accepted
Sat 27	SB	0	0	0	0	44	50	55	48	64	39	17	2	0	0	0	319	Accepted
Sun 28	NB	0	0	0	0	0	5	10	27	79	61	37	5	1	2	0	227	Accepted
Sun 28	SB	0	0	0	0	5	6	4	20	50	76	33	18	7	1	0	220	Accepted
Mon 29	NB	0	0	0	0	1	1	8	39	142	116	36	19	4	2	0	368	Accepted
Mon 29	SB	0	0	0	0	1	1	7	34	119	139	50	20	1	3	0	375	Accepted
Tue 30	NB	0	0	0	0	0	2	8	58	144	116	47	18	5	1	0	399	Accepted
Tue 30	SB	0	0	0	0	1	3	11	30	130	157	49	21	8	1	1	412	Accepted
Wed 31	NB	0	0	0	0	3	2	14	40	158	113	49	5	6	2	0	392	Accepted
Wed 31	SB	0	0	0	0	1	1	10	29	157	146	51	9	3	1	1	409	Accepted

Percentages	**0%**	**0%**	**0%**	**0%**	**.88%**	**1.50%**	**3.81%**	**11.66%**	**35.71%**	**30.82%**	**10.98%**	**3.39%**	**.91%**	**.21%**	**.12%**	**100%**
Totals	**0**	**0**	**0**	**0**	**193**	**329**	**837**	**2562**	**7845**	**6771**	**2412**	**745**	**199**	**47**	**27**	**21967**

Figure 2.1: Sample ATR Station Report

All monthly reports have the same number/type of speed bins with the updated formatting. Following the preliminary analysis, computing estimated monthly average speed for each ATR was done by considering the number of vehicles in a given speed bin (n_{bin}) multiplying by the speed bins' midpoint assumed speed (s_{bin}). This computation was summed for each bin then divided by the total number of vehicles (n_{total}) to obtain an estimated monthly average speed:

$$\text{Estimated Average Speed} = \frac{\sum_{\forall \text{ bins}} (n_{bin})(s_{bin})}{(n_{total})} \tag{2.1}$$

The speed bins used for computing the average speed, as shown in Eq. (2.1), are detailed in Table 2.1.

Table 2.1: Bin Speeds Used for Computing Average Speed

Bin (mi/hr)	Midpoint Speed (s_{bin})
0 - 20	18
20 - 25	22.5
25 - 30	27.5
30 - 35	32.5
35 - 40	37.5
40 - 45	42.5
45 - 50	47.5
50 - 55	52.5
55 - 60	57.5
60 - 65	62.5
65 - 70	67.5
70 - 75	72.5
75 - 80	77.5
80 - 85	82.5
> 85	87.5

2.1.1 Control Locations

The same ATR stations in the preliminary analysis were considered for this updated analysis. Table 2.2 shows the selected ATRs, current speed limit, location (Oregon highway number), most current available AADT (2019), and the percentage of trucks. The control location ATRs are visually shown in Figure 2.2. Control locations were chosen on I-84 west of The Dalles at Rowena (33-001) and Cascade Locks (14-004), as well as I-5 at Wilsonville (03-011), North Albany (22-016), and Lake Creek (22-016). These stations were chosen to compare with the speed increase segments on I-84 east of The Dalles and on I-82.

The next set of locations was selected to match highways that most closely resemble the highways where speed limits were increased, including OR-58 near Oakridge (20-107), US-26 near Rhododendron (03-006), and US-20 near Black Butte (09-014). The final set of ATRs was located on US-97, where the speed limit is 45 mi/hr, to assess the effect of any carryover speeds in Madras (16-002) and North Redmond (09-023) from the increased speed limits on US-97. The remaining control locations include ATRs in Eastern Oregon on highways with no speed limit increase.

Table 2.2: Control Segment ATRs

ATR	Name	Speed Limit (mi/hr)	Location (Oregon Hwy. No.)	MP	AADT[a]	Percent Trucks
01-001	North Powder	55	LA GRANDE-BAKER (066)	37.7	820	39.9
03-006	Rhododendron	55	MT. HOOD (026)	46.38	10,200	16.8
03-011	Wilsonville	65	PACIFIC (001)	281.2	100,100	16.2
09-003	Lava Butte	55	THE DALLES-CALIFORNIA (004)	142.41	26,700	10.4
09-014	Sisters	55	SANTIAM (016)	93.12	9,200	10.4
09-023	North Redmond	45	THE DALLES-CALIFORNIA (004)	119.09	23,500	9.8
11-007	Shutler	55	JOHN DAY (005)	6.81	970	49.1
12-003	Dayville	55	JOHN DAY (005)	131.4	940	28.9
14-004	Cascade Locks	65	COLUMBIA RIVER (002)	45.53	25,400	25.8
15-013	Shady Cove	55	CRATER LAKE (022)	15.46	8,600	11.3
16-002	Madras	45	THE DALLES-CALIFORNIA (004)	97.11	15,100	15.4
20-005	Noti	55	FLORENCE-EUGENE (062)	43.86	6,800	21.6
20-017	Oakridge	55	WILLAMETTE (018)	37.36	3,200	42.4
22-005	North Albany	65	PACIFIC (001)	234.8	70,500	18.5
22-016	Lake Creek	65	PACIFIC (001)	214.56	42,500	23.4
25-007	Lexington	55	HEPPNER (052)	37.83	1,400	23.7
30-021	Milton	55	OREGON-WASHINGTON (008)	34.46	15,300	4.8
33-001	Rowena	65	COLUMBIA RIVER (002)	75.93	24,700	25.9

[a]All AADT values are for 2019

2.1.2 Increased Speed Limit Segments

A total of 16 ATR locations were selected to measure speeds at locations where there was a speed limit increase (these stations follow those in the preliminary analysis). Table 2.3 shows the selected ATRs, current speed limit, location (Oregon highway number), most current available AADT (2019), and the percentage of trucks.

Where speed limits were increased to 70 mi/hr, six ATRs on I-84 were selected (01-013 at South Baker, 23-016 at Huntington, 25-008 at Boardman Jct, 28-002 at Rufus, 30-004 at Pendleton, and 31-007 at North La Grande). Following ATR selections from the preliminary analysis, no ATRs were selected on US-95, a two-lane highway with a speed limit increase to 70 mi/hr.

Four ATRs on US-97 were selected where speed limits were increased to 65 mi/hr (09-020 at Redmond, 18-019 at Midland, 18-022 at Modoc Point, and 33-005 at Dufur). The remaining selected ATRs are on two-lane highway segments where speed limits were increased to 65 mi/hr.

Table 2.3: Increased Speed Limit Segment ATRs

ATR	Name	Speed Limit (mi/hr)	Location (Oregon Hwy. No.)	MP	AADT[a]	Percent Trucks
01-013	South Baker	70	OLD OREGON TRAIL (006)	309.02	10,600	44.2
09-005	Pilot Butte	65	CENTRAL OREGON (007)	6.28	3,200	29.7
09-020	Redmond	65	THE DALLES-CALIFORNIA (004)	124.39	36,800	9.7
12-009	Prairie City	65	JOHN DAY (005)	175.79	920	31.4
13-001	Burns	65	JOHN DAY-BURNS (048)	66.3	510	32.6
13-007	Steens	65	STEENS (442)	1.7	1,800	33.4
18-019	Midland	65	THE DALLES-CALIFORNIA (004)	289.44	4,200	43.7
18-022	Modoc Point	65	THE DALLES-CALIFORNIA (004)	254.3	6,600	39.5
19-008	New Pine Creek	65	FREMONT (019)	157.43	870	26.1
23-006	Cairo Junction	65	CENTRAL OREGON (007)	257.86	5,400	23.8
23-016	Huntington	70	OLD OREGON TRAIL (006)	353.47	11,900	44.0
25-008	Boardman Jct	70	OLD OREGON TRAIL (006)	168.55	17,900	26.1
28-002	Rufus	70	COLUMBIA RIVER (002)	109.51	13,000	40.3
30-004	Pendleton	70	OLD OREGON TRAIL (006)	203.34	17,500	30.3
31-007	North La Grande	70	OLD OREGON TRAIL(006)	260.12	10,800	42.9
33-005	Dufur	65	THE DALLES-CALIFORNIA (004)	10.3	2,800	19.0

[a]All AADT values are for 2019

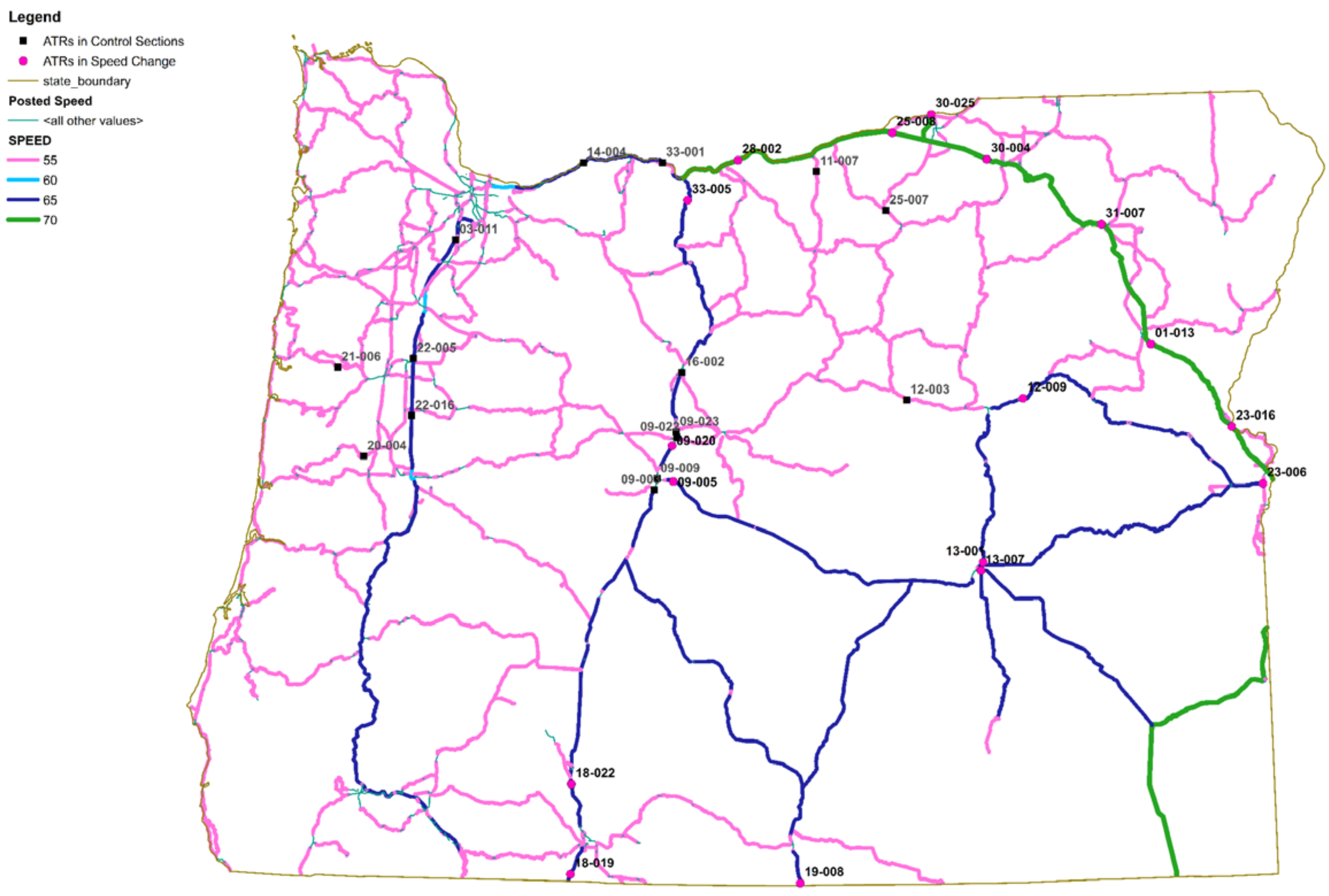


Figure 2.2: ATR Locations Used in Speed Analysis

2.2 SAFETY PERFORMANCE

Crash data used for this analysis was obtained from historical DECODE databases, provided by ODOT. Only crashes on the mainline were considered, and crashes were specifically queried based on milepost markers and highway name/number. This was visually and manually confirmed for each highway using geospatial locations of crashes and ArcGIS (i.e., any crash that was not on the mainline was removed). Routes, speed limits, highway name (Oregon highway number), and milepost information used for the queries are shown in Table 2.4 (control locations) and Table 2.5(speed limit increase locations). The crash data, total crashes, fatal and injury A crashes, and proportions of crash types were analyzed. Additionally, truck-involved crashes were analyzed, where truck-involved crashes were defined as any crash in which a truck was involved (i.e., at least one of the vehicles in the crash was a truck). From the DECODE databases, trucks were defined as the following: (1) Vehicle Type 2 - truck tractor with no trailer (bobtail), (2) Vehicle Type 4 - truck tractor with trailer/mobile home in tow, and (3) Vehicle Type 5 - truck with non-detachable bed, panel, etc.

It should be noted that the DECODE databases that are released annually may have small differences when compared to the official 10-year database maintained by ODOT. This is due to errors that are corrected after the publication of the annual data. It is expected that these differences are minor.

2.2.1 Control Segments

A set of control highway segments was selected to compare crash trends to locations in which there was no speed limit increase. Sections of highways that pass through cities, towns, or congested areas were not included. A total of 691.17 miles of highway were selected for comparison (see Table 2.4).

For interstates, a segment on I-84 from east of Portland to The Dalles (C-1) and a segment on I-5 from Wilsonville to just north of Eugene (C-11) were selected. On interstates, speed limits for trucks were raised to 60 mi/hr in late 2017, which is not explicitly accounted for in this analysis.

Highway segments, to the extent possible, were selected based on their representation as higher volume, higher speed, and two-lane highways, such as US-26 (C-3), US-20 (C-6), OR-58 (C-5), and OR-126 (C-7 and C-10). The remaining highway segments were selected based on them being the best comparison to Eastern Oregon, where speeds were not increased, including OR-19 (C-8), OR-3 (C-9), and OR-140 (C-12). As these Eastern Oregon highways were not being selected by the Oregon legislature as part of the speed limit increases, they are not necessarily an ideal comparison to the higher volume principal roads where the speeds were changed; however, they do best represent the lower volume speed limit change highways.

Table 2.4: Control Segments for Crash Analysis

Control Segment	Route	Trucks[a,b]	Passenger Vehicles[a]	Highway (Oregon Highway No.)	BMP	EMP	Length
C-1	I-84	55	65	COLUMBIA RIVER (002)	18.25	87.00	68.8
C-2	OR-11	55	55	OREGON-WASHINGTON (008)	17.80	26.59	8.8
	OR-11	55	55	OREGON-WASHINGTON (008)	0.52	16.15	15.6
C-3	US-26	55	55	OCHOCO (041)	20.75	65.68	44.9
	US-26	55	55	OCHOCO (041)	66.88	98.36	31.5
	US-26	55	55	JOHN DAY (005)	123.98	160.28	36.3
C-4	US-26	55	55	WARM SPRINGS (053)	72.00	102.83	30.8
	US-26	55	55	WARM SPRINGS (053)	105.64	115.81	10.2
C-5	OR-58	55	55	WILLAMETTE (018)	5.80	33.94	28.1
	OR-58	55	55	WILLAMETTE (018)	36.49	86.45	50.0
C-6	US-20	55	55	SANTIAM (016)	88.20	99.53	11.3
	US-20	55	55	MCKENZIE-BEND (017)	0.37	14.47	14.1
C-7	OR-126	55	55	MCKENZIE (015)	93.38	110.14	16.8
C-8	OR-19	55	55	JOHN DAY (005)	1.30	37.50	36.2
	OR-19	55	55	JOHN DAY (005)	36.68	57.58	20.9
	OR-19	55	55	JOHN DAY (005)	59.64	91.68	32.0
C-9	OR-3	55	55	ENTERPRISE-LEWISTON (011)	0.00	42.42	42.4
C-10	OR-126	55	55	BELTLINE (069)	0.00	2.28	2.3
	OR-126	55	55	FLORENCE-EUGENE (062)	47.04	52.69	5.7
	OR-126	55	55	FLORENCE-EUGENE (062)	32.80	46.76	14.0
C-11	I-5	55	65	PACIFIC (001)	260.85	288.60	27.8
	I-5	55	65	PACIFIC (001)	196.00	251.00	55.0
C-12	OR-140	55	55	KLAMATH FALLS-LAKEVIEW (020)	5.64	40.53	34.9
	OR-140	55	55	KLAMATH FALLS-LAKEVIEW (020)	41.33	53.17	11.8
	OR-140	55	55	KLAMATH FALLS-LAKEVIEW (020)	54.18	95.25	41.1

[a] All speeds in mi/hr
[b] Interstate speed limits were raised to 60 mi/hr on C-1 and C-11 in late 2017

2.2.2 Increased Speed Limit Segments

From the preliminary analysis, segments with an increase in speed limit were obtained. Sections of highways that pass through cities, towns, or congested areas were not included. The increased speed limit segments were based on the 12 segments identified in ORS 811.111. Table 2.5 shows details of these segments. A total of 1,426.5 miles of highway were considered for analysis.

Table 2.5: Increased Speed Limit Segments for Crash Analysis

ORS Segment	Route	Trucks[a]	Passenger Vehicles[a]	Highway (Oregon Highway No.)	BMP	EMP	Length
ORS-2	I-84	65	70	COLUMBIA RIVER (002)	87.00	167.58	80.6
	I-84	65	70	OLD OREGON TRAIL (006)	167.73	378.01	210.3
ORS-3	US-95	65	70	I.O.N. (456)	0.00	19.44	19.4
	US-95	65	70	I.O.N. (456)	21.64	117.65	96.0
ORS-4	US-20	60	65	CENTRAL OREGON (007)	3.17	42.50	39.3
	US-20	60	65	CENTRAL OREGON (007)	43.00	127.70	84.7
	US-20	60	65	CENTRAL OREGON (007)	132.72	245.48	112.8
	US-26/20	60	65	CENTRAL OREGON (007)	246.79	258.20	11.4
ORS-5	US-197	60	65	THE DALLES-CALIFORNIA (004)	2.32	42.90	40.6
	US-197/97	60	65	THE DALLES-CALIFORNIA (004)	46.35	89.40	43.1
	US-97	60	65	THE DALLES-CALIFORNIA (004)	98.60	114.90	16.3
	US-97	60	65	THE DALLES-CALIFORNIA (004)	124.40	133.32	8.9
	US-97	60	65	THE DALLES-CALIFORNIA (004)	142.52	164.19	21.7
	US-97	60	65	THE DALLES-CALIFORNIA (004)	168.80	183.80	15.0
	US-97	60	65	THE DALLES-CALIFORNIA (004)	187.14	202.45	15.3
	US-97	60	65	THE DALLES-CALIFORNIA (004)	204.23	209.05	4.8
	US-97	60	65	THE DALLES-CALIFORNIA (004)	209.41	270.50	61.1
	US-97	60	65	THE DALLES-CALIFORNIA (004)	279.04	291.73	12.7
ORS-6	OR-31	60	65	FREMONT (019)	0.00	46.58	46.6
	OR-31	60	65	FREMONT (019)	48.11	68.74	20.6
	OR-31	60	65	FREMONT (019)	70.50	97.98	27.5
	OR-31	60	65	FREMONT (019)	99.09	120.43	21.3
ORS-7	OR-78	60	65	STEENS (442)	0.90	91.60	90.7
ORS-8	US-395	60	65	JOHN DAY-BURNS (048)	2.72	24.55	21.8
	US-395	60	65	JOHN DAY-BURNS (048)	29.58	35.42	5.8
ORS-9	US-395	60	65	FREMONT (019)	120.57	139.68	19.1
	US-395	60	65	FREMONT (019)	145.70	157.24	11.5
	US-395	60	65	LAKEVIEW BURNS (049)	0.01	90.02	90.0
ORS-10	OR-205	60	65	FRENCHGLEN (440)	0.00	57.83	57.8
ORS-11	US-26	60	65	JOHN DAY (005)	163.69	174.51	10.8
	US-26	60	65	JOHN DAY (005)	176.04	211.47	35.4
	US-26	60	65	JOHN DAY (005)	213.15	230.55	17.4
	US-26	60	65	JOHN DAY (005)	231.33	253.73	22.4
	US-26	60	65	JOHN DAY (005)	255.09	266.26	11.2
	US-26	60	65	JOHN DAY (005)	267.34	277.44	10.1
ORS-12	I-82	65	70	MCNARY (070)	0.00	10.78	10.8

[a] All speeds in mi/hr

2.2.3 Speed Reduction Segments

In addition to assessing control locations and speed limit increase locations, a set of speed reduction segments were analyzed. Following an engineering analysis by ODOT, speed limits were lowered to 55 mi/hr for trucks and 55 mi/hr for all other vehicles in specific sections of the increased speed limit corridors.

Table 2.6: Speed Limit Reduction Segments

Segment	Route	Trucks[a]	Passenger Vehicles[a]	Highway (Oregon Highway No.)	BMP	EMP	Length
13	US-97	55	55	THE DALLES-CALIFORNIA (004)	168.80	169.87	1.1
14	US-97	55	55	THE DALLES-CALIFORNIA (004)	98.60	115.00	16.4
15	US-20	55	55	CENTRAL OREGON (007)	3.17	9.19	6.0
16	US-20	55	55	CENTRAL OREGON (007)	248.84	258.20	9.4

[a] All speeds in mi/hr

3.0 UPDATED ANALYSIS

The updated analysis builds on the preliminary analysis by using additional years of after data (traffic speed, volume, and crash data after the speed limit increase became effective). Therefore, this analysis compares the changes in speed, volume, and safety performance following the previous work using these additional years of after data. Comparisons are made between the control segments (no increase) and change segments (increased speed limit). A new empirical-bayes (EB) before after safety analysis is added. EB analysis is the recommended before-after safety approach in the AASHTO Highway Safety Manual.

3.1 ESTIMATED SPEED CHANGE

The estimated average speed and the percentage of vehicles exceeding 65 mi/hr, 75 mi/hr, and 85 mi/hr were determined and tabulated for each ATRs considered for analysis. The metrics were grouped by the posted speed limit for passenger vehicles at the ATR location. Speed data were compared for before and after the speed limit increase. All months in which speed data was available from January 2015 to March 2020 were compared. For the before period, this included January 2015 to February 2016. For the after period, this included April 2016 to March 2020, where the month in which the speed limit increase was enacted was excluded (March 2016).

To assess if there was a statistical difference in mean speeds, two tests were conducted: (1) a t-test assuming unequal variance and (2) a paired t-test. The results of these tests are presented as p-values in the tables, where significant levels of at least 95% are indicated by highlighted cells. For the t-test, the null hypothesis is that the means are equal ($\mu_{\text{Before}} = \mu_{\text{After}}$). If the reported p-value is less than the desired significance level (in this analysis, 95%, or a p-value of 0.05 or less), the null hypothesis is rejected in favor of the alternative hypothesis that the mean speeds are not equal. A paired t-test was also conducted. Due to this test required that the number of observations be the same in both periods, a random sample of before and after measurements was obtained to run this test.

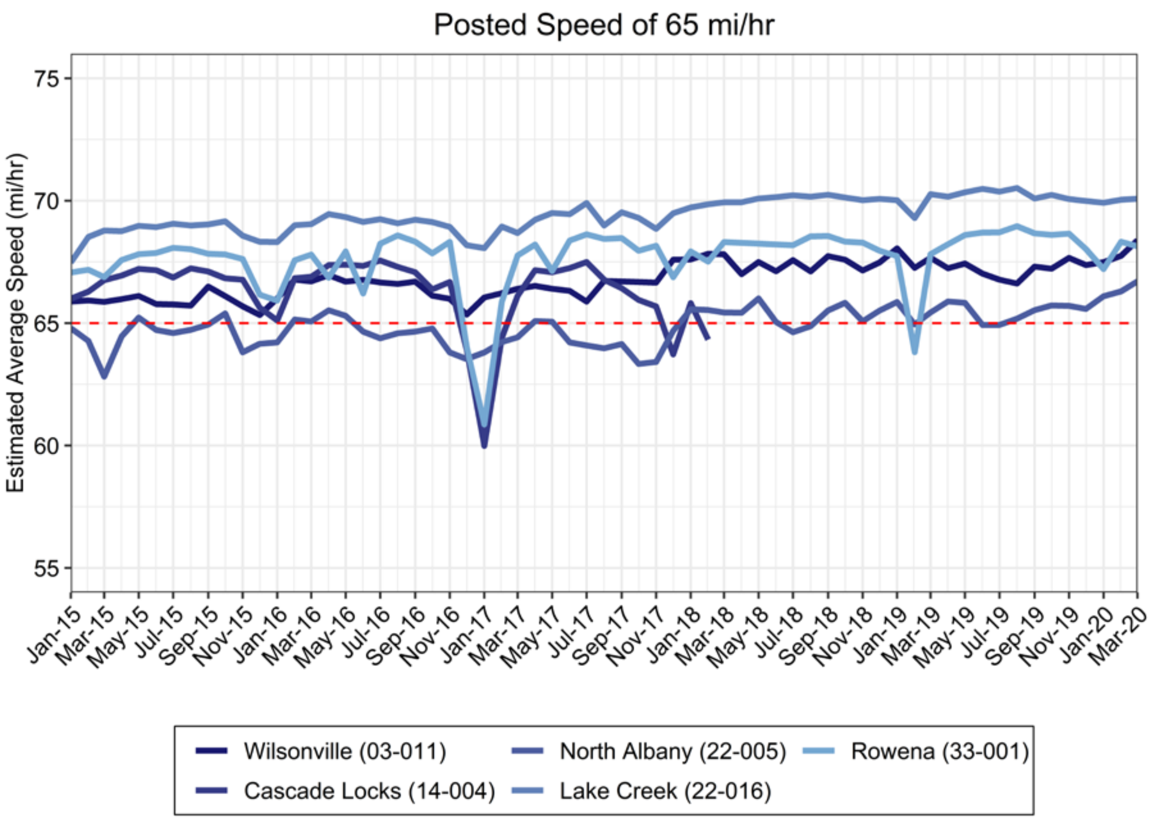
3.1.1 Estimated Change in Average Speed

3.1.1.1 Control Segments

A summary of analysis results for the control segments is shown in Table 3.1. Visually, Figure 3.1 shows the average monthly speed plots for all ATRs considered for analysis. As shown, about half of the control segments experienced a statistically significant change in mean speed for both t-tests (eight of 18), with just two ATRs seeing a change of greater than 1 mi/hr: Lava Butte and Wilsonville. Lave Butte has the highest change in speed but may be explained by its location (it is located near a segment where the speed limit was increased). The results shown in Table 3.1 may capture some carryover effect of increased speed limits in adjacent roadway sections. Overall, the average speed change for the sample is less than 1 mi/hr.

Table 3.1: Estimated Average Monthly Speed (mi/hr) at Control Locations

Speed Group	ATR	Jan. 2015 - Mar. 2020 (Excluding Mar. 2016)				
		Pre	**Post**	**Delta**	**Means (p-value)**	**Paired (p-value)**
45 mi/hr	Madras (16-002)	46.31	45.98	-0.33	0.027	0.060
	North Redmond (09-023)	56.91	57.46	0.55	0.078	0.061
	Average			**0.11**		
55 mi/hr	Dayville (12-003)	49.00	48.81	-0.19	0.375	0.920
	Lava Butte (09-003)	57.91	59.47	1.56	0.004	0.015
	Lexington (25-007)	59.66	59.71	0.05	0.826	0.873
	Milton (30-021)	54.61	54.92	0.30	0.078	0.900
	North Powder (01-001)	59.56	59.57	0.01	0.982	0.578
	Noti (20-005)	64.52	65.01	0.50	0.027	0.000
	Oakridge (20-017)	56.34	56.65	0.31	0.046	0.013
	Rhododendron (03-006)	53.34	53.20	-0.14	0.813	0.871
	Shady Cove (15-013)	59.94	60.51	0.57	0.000	0.001
	Shutler (11-007)	56.78	57.11	0.33	0.197	0.426
	Sisters (09-014)	57.75	58.39	0.65	0.328	0.944
	Average			**0.36**		
65 mi/hr	Cascade Locks (14-004)	66.62	66.05	-0.57	0.170	0.062
	Lake Creek (22-016)	68.70	69.67	0.96	0.000	0.000
	North Albany (22-005)	64.52	65.01	0.50	0.027	0.012
	Rowena (33-001)	67.38	67.71	0.32	0.265	0.008
	Wilsonville (03-011)	65.96	67.03	1.07	0.000	0.000
	Average			**0.46**		



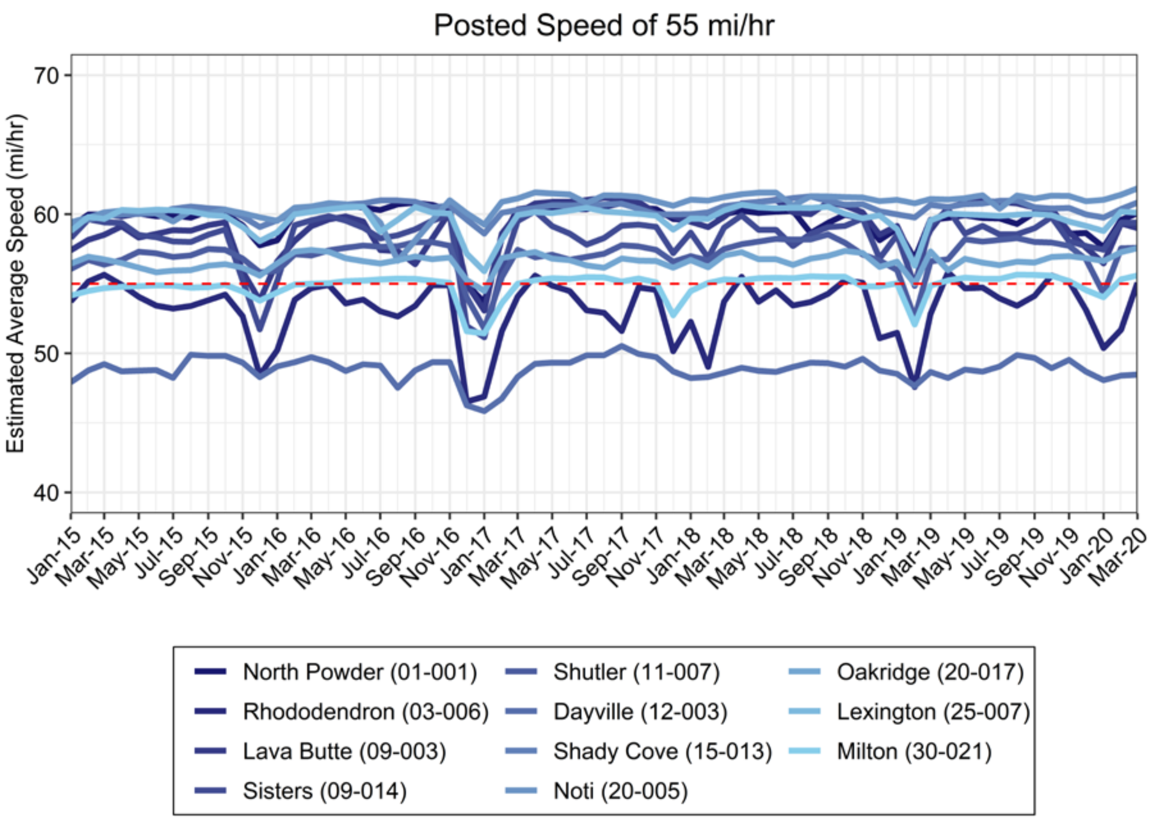


Figure 3.1: Average Monthly Speed Plots for Control Segments

3.1.1.2 Increased Speed Limit Segments

A summary of analysis results for the control segments is shown in Table 3.2. Figure 3.2 shows the average monthly speed plots for all ATRs considered for analysis, and Figure 3.3 and Figure 3.4 show ATRs that experienced an increase in observed speed. As shown in Table 3.2, all but two locations have statistically different mean speeds, with an average mean speed increase of greater than 3 mi/hr for the sample. Just one location has a decrease; the decrease is small at 0.10 mi/hr.

Some potential outliers to discuss are Cairo Junction, New Pine Creek, and Prairie City. In the previous analysis, it was found that Cairo Junction experienced a large increase due to problems with the station in the before period; it is unclear if that remains true with the newly formatted data obtained. Secondly, New Pine Creek is in a location where speeds are lower. Lastly, when obtaining the newly formatted data, there were no monthly files for Prairie City in the before period.

Table 3.2: Estimated Average Monthly Speed (mi/hr) at Speed Limit Change Locations

Speed Group	ATR	Jan. 2015 - Mar. 2020 (Excluding Mar. 2016)				
		Pre	Post	Delta	Means (*p*-value)	Paired (*p*-value)
65 mi/hr	Burns (13-001)	61.29	63.31	2.01	0.000	0.002
	Cairo Junction (23-006)	43.76	54.31	10.54	0.000	0.000
	Dufur (33-005)	60.89	65.04	4.15	0.000	0.000
	Midland (18-019)	59.53	64.68	5.16	0.000	0.000
	Modoc Point (18-022)	61.88	65.45	3.57	0.000	0.000
	New Pine Creek (19-008)	49.44	49.34	-0.10	0.676	0.396
	Pilot Butte (09-005)	60.34	61.07	0.73	0.064	0.171
	Prairie City (12-009)	-	-	-		
	Redmond (09-020)	60.08	62.93	2.85	0.000	0.000
	Steens (13-007)	52.63	55.71	3.08	0.000	0.051
	Average			**3.56**		
70 mi/hr	Boardman Jct (25-008)	67.91	71.13	3.22	0.000	0.000
	Huntington (23-016)	63.16	67.14	3.98	0.000	0.000
	North La Grande (31-007)	65.87	69.40	3.53	0.000	0.000
	Pendleton (30-004)	67.81	71.93	4.12	0.000	0.000
	Rufus (28-002)	68.86	70.29	1.43	0.005	-
	South Baker (01-013)	67.92	70.88	2.96	0.000	0.000
	Average			**3.21**		

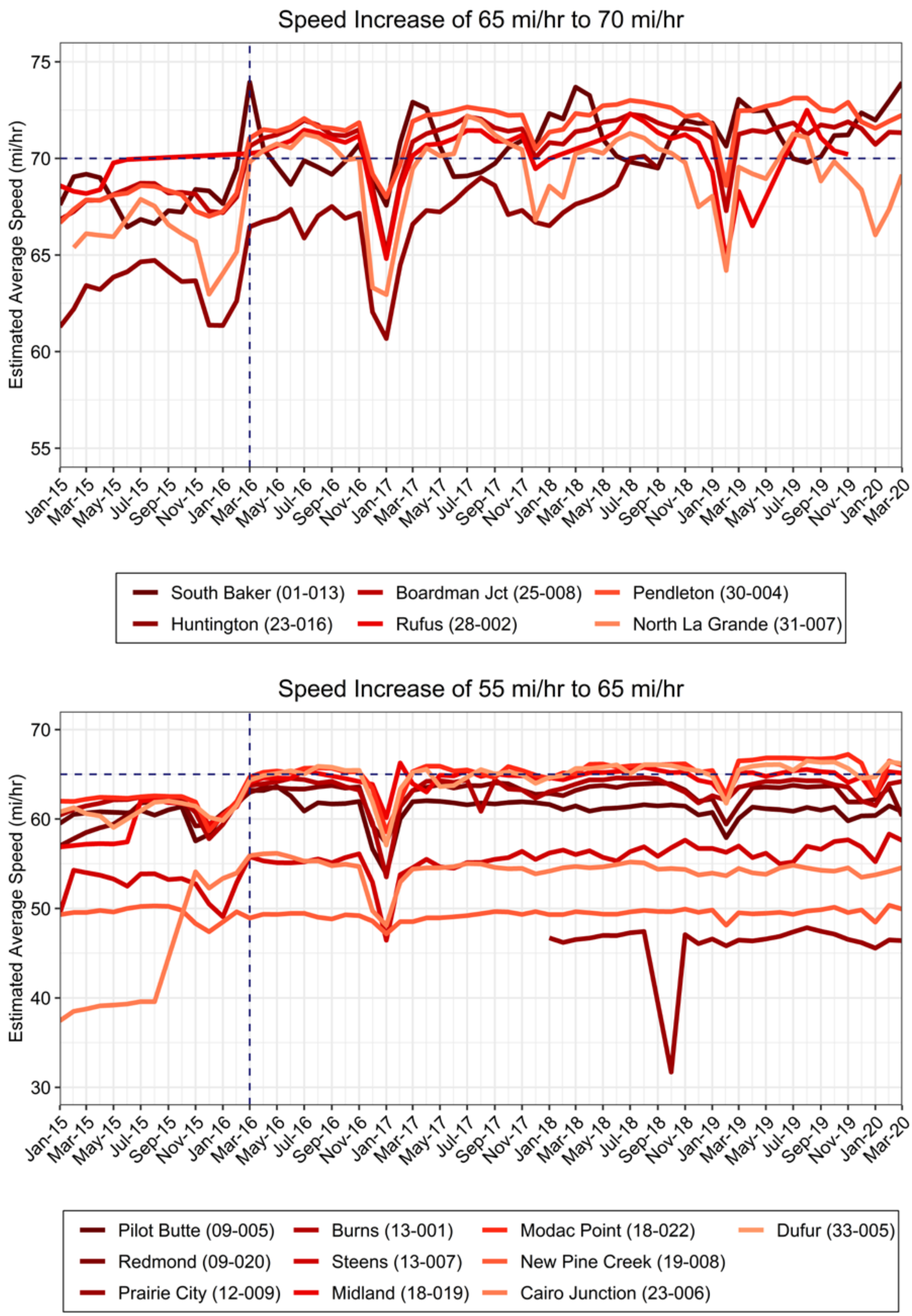


Figure 3.2: Average Monthly Speed Plots for Increased Speed Limit Segments

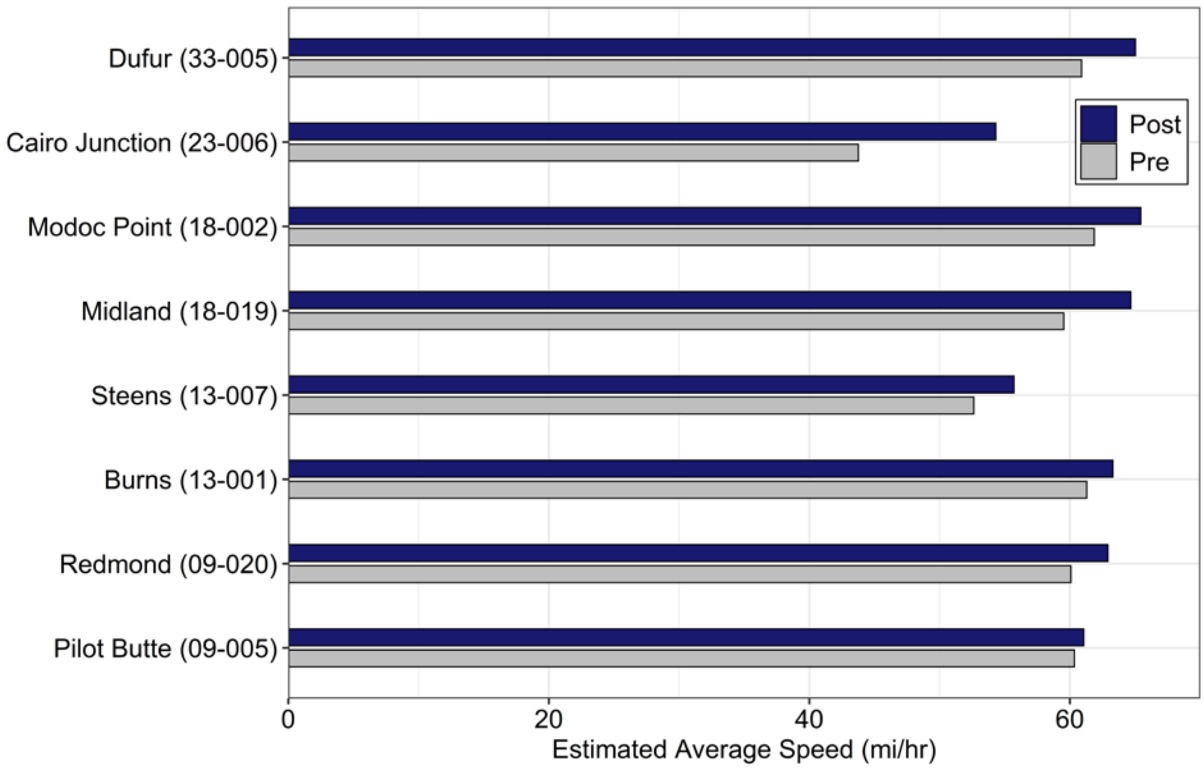


Figure 3.3: ATRs With Speed Increase from 55 mi/hr to 65 mi/hr

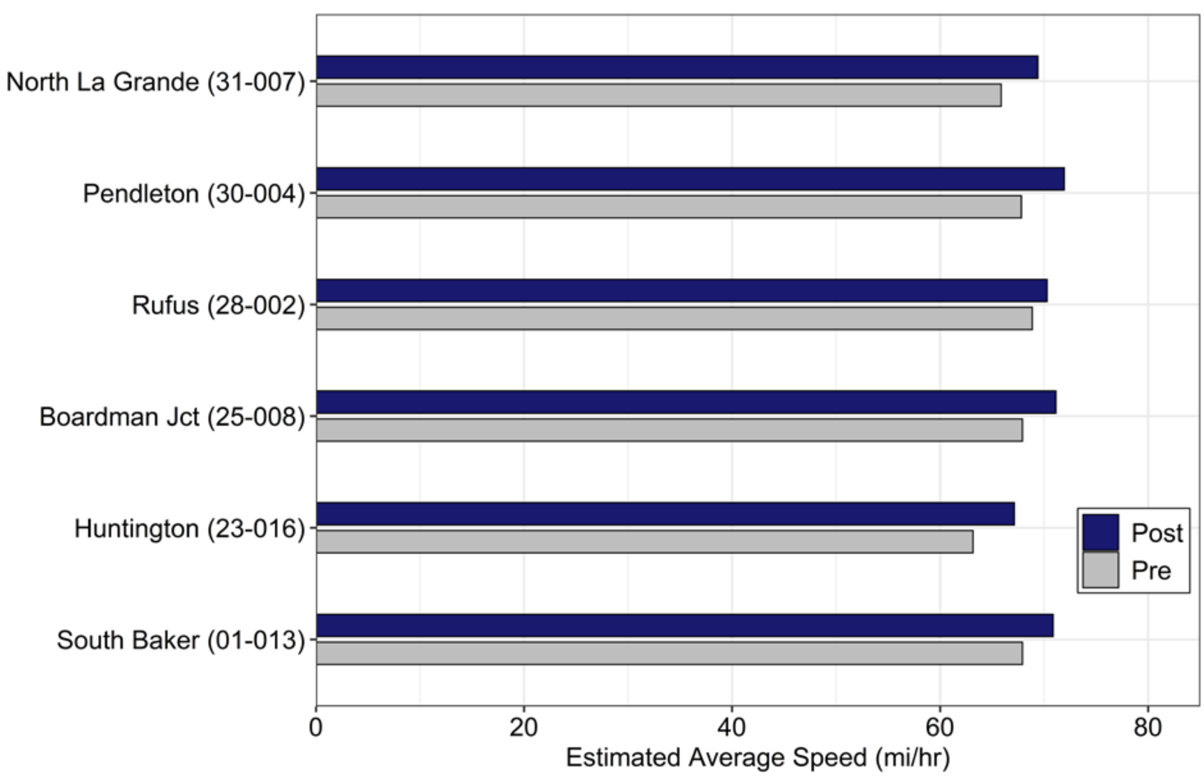


Figure 3.4: ATRs With Speed Increase from 65 mi/hr to 70 mi/hr

3.1.2 Average Percentage of Vehicles per Month Exceeding Speeds

3.1.2.1 Control Segments

Table 3.4 shows the analysis results for the percentage of vehicles exceeding 65 mi/hr. There is some variation in the results, but the majority of locations experienced a significant difference in the mean percentage of vehicles exceeding 65 mi/hr for both t-tests. In the 45 mi/hr group, there was no difference at Madras, while North Redmond experienced an increase of about 2.1%. In the 55 mi/hr group, the largest difference was at Noti (difference of 6.15%), and two locations experienced a decrease in mean percentage. Overall, however, there was an average increase of about 2.1%. In the 65 mi/hr group, large proportions of vehicles exceed 65 mi/hr in both the before and after periods.

Table 3.3 shows the percentage of vehicles exceeding 75 mi/hr at the control locations. As observed in both the 45 mi/hr and 55 mi/hr speed groups, small proportions of vehicles exceeded 75 mi/hr. The largest change was observed at Lave Butte (+0.66%) and Noti (+0.55%). However, more variation is observed in the 65 mi/hr group, with Lake Creek and Rowena experiencing a moderately high proportion of vehicles exceeding 75 mi/hr. Rowena and Wilsonville experienced the highest increase from before to after. On average, a 2.44% increase was observed in the 65 mi/hr group.

Table 3.5 shows the percentage of vehicles exceeding 85 mi/hr at the control locations. As observed, a very small proportion of vehicles exceeded this speed threshold in the 45 mi/hr and 55 mi/hr groups. In the 65 mi/hr group, the highest change was again observed at Lake Creek (+0.33%), but the increase, on average, of vehicles exceeding 85 mi/hr was slight at 0.12%.

Table 3.3: Average Percentage of Vehicles Exceeding 75 mi/hr at Control Sections

Speed Group	ATR	Jan. 2015 - Mar. 2020 (Excluding Mar. 2016)				
		Pre	Post	Delta	Means (*p*-value)	Paired (*p*-value)
45 mi/hr	Madras (16-002)	0.01	0.01	0.00	0.366	0.551
	North Redmond (09-023)	0.20	0.30	0.10	0.000	0.002
	Average			**0.05**		
55 mi/hr	Dayville (12-003)	0.09	0.10	0.01	0.053	0.115
	Lava Butte (09-003)	0.53	1.20	0.66	0.000	0.000
	Lexington (25-007)	1.18	1.19	0.01	0.855	0.889
	Milton (30-021)	0.07	0.09	0.02	0.000	0.000
	North Powder (01-001)	1.08	1.25	0.17	0.018	0.057
	Noti (20-005)	0.89	1.44	0.55	0.000	0.000
	Oakridge (20-017)	0.13	0.16	0.04	0.000	0.008
	Rhododendron (03-006)	0.15	0.17	0.02	0.271	0.551
	Shady Cove (15-013)	1.13	1.59	0.46	0.000	0.007
	Shutler (11-007)	0.76	1.01	0.25	0.001	0.051
	Sisters (09-014)	0.25	0.37	0.12	0.000	0.004
	Average			**0.21**		
65 mi/hr	Cascade Locks (14-004)	8.94	9.04	0.10	0.846	0.689
	Lake Creek (22-016)	14.69	19.72	5.04	0.000	0.000
	North Albany (22-005)	4.97	6.72	1.75	0.000	0.005
	Rowena (33-001)	8.29	10.04	1.75	0.001	0.624
	Wilsonville (03-011)	4.91	8.47	3.56	0.000	0.000
	Average			**2.44**		

Table 3.4: Average Percentage of Vehicles Exceeding 65 mi/hr at Control Sections

Speed Group	ATR	Jan. 2015 - Mar. 2020 (Excluding Mar. 2016)				
		Pre	Post	Delta	Means (*p*-value)	Paired (*p*-value)
45 mi/hr	Madras (16-002)	0.13	0.13	0.00	0.830	0.654
	North Redmond (09-023)	7.03	9.12	2.09	0.000	0.017
	Average			**1.04**		
55 mi/hr	Dayville (12-003)	1.70	1.68	-0.01	0.892	0.089
	Lava Butte (09-003)	13.28	21.03	7.75	0.000	0.001
	Lexington (25-007)	15.90	15.64	-0.26	0.671	0.153
	Milton (30-021)	1.32	1.90	0.57	0.000	0.000
	North Powder (01-001)	14.29	15.11	0.82	0.122	0.940
	Noti (20-005)	13.27	19.42	6.15	0.000	0.000
	Oakridge (20-017)	5.08	5.97	0.88	0.000	0.001
	Rhododendron (03-006)	3.12	3.46	0.34	0.330	0.473
	Shady Cove (15-013)	15.27	18.55	3.29	0.000	0.000
	Shutler (11-007)	10.00	11.11	1.11	0.030	0.019
	Sisters (09-014)	8.63	10.98	2.35	0.005	0.005
	Average			**2.09**		
65 mi/hr	Cascade Locks (14-004)	65.72	62.96	-2.75	0.138	0.267
	Lake Creek (22-016)	72.55	75.53	2.97	0.000	0.001
	North Albany (22-005)	51.84	54.48	2.64	0.016	0.028
	Rowena (33-001)	67.62	69.58	1.96	0.183	0.917
	Wilsonville (03-011)	60.79	68.05	7.25	0.000	0.000
	Average			**2.41**		

Table 3.5: Average Percentage of Vehicles Exceeding 85 mi/hr at Control Sections

Speed Group	ATR	Jan. 2015 - Mar. 2020 (Excluding Mar. 2016)				
		Pre	**Post**	**Delta**	**Means (*p*-value)**	**Paired (*p*-value)**
45 mi/hr	Madras (16-002)	0.00	0.00	0.00	0.258	0.464
	North Redmond (09-023)	0.02	0.03	0.01	0.000	0.016
	Average			**0.00**		
55 mi/hr	Dayville (12-003)	0.09	0.10	0.01	0.053	0.153
	Lava Butte (09-003)	0.05	0.08	0.03	0.000	0.000
	Lexington (25-007)	0.14	0.15	0.01	0.451	0.355
	Milton (30-021)	0.01	0.02	0.00	0.062	0.410
	North Powder (01-001)	0.13	0.16	0.02	0.145	0.282
	Noti (20-005)	0.11	0.16	0.05	0.000	0.002
	Oakridge (20-017)	0.01	0.01	0.00	0.368	0.413
	Rhododendron (03-006)	0.02	0.02	0.00	0.563	0.774
	Shady Cove (15-013)	0.13	0.17	0.05	0.000	0.008
	Shutler (11-007)	0.10	0.14	0.04	0.018	0.014
	Sisters (09-014)	0.02	0.02	0.01	0.019	0.411
	Average			**0.02**		
65 mi/hr	Cascade Locks (14-004)	0.30	0.29	-0.01	0.677	0.099
	Lake Creek (22-016)	0.50	0.82	0.33	0.000	0.000
	North Albany (22-005)	0.16	0.22	0.07	0.000	0.000
	Rowena (33-001)	0.27	0.32	0.05	0.141	0.121
	Wilsonville (03-011)	0.27	0.41	0.15	0.000	0.003
	Average			**0.12**		

3.1.2.2 Increased Speed Limit Segments

The percentage of vehicles exceeding 65 mi/hr, 75 mi/hr, and 85 mi/hr increased at each location in the increased speed limit sections. These changes in percentages are important because small changes in average speeds (measured in mi/hr) do not necessarily provide insight into changes in speed distributions. Results for the percentage of vehicles exceeding these speed thresholds are given in Table 3.6 (65 mi/hr), Table 3.7 (75 mi/hr), and Table 3.8 (85 mi/hr).

All differences were statistically significant in this group, with well over 99% confidence. In locations where the speed limit increased from 55 mi/hr to 65 mi/hr (for passenger vehicles), the percentage of vehicle exceeding 65 mi/hr increased, on average, about 16.1%. In locations where the speed limit increased from 65 mi/hr to 70 mi/hr (for passenger vehicles), the percentage of vehicles exceeding 65 mi/hr increased, on average, nearly 17%. In this group, all differences were statistically different, with well over 99% confidence.

Vehicles exceeding 75 mi/hr at locations where the speed limit increased from 55 mi/hr to 65 mi/hr the percentage increased, on average, approximately 1.9%. At the 65 mi/hr to 70 mi/hr increase segments, the percentage of vehicles exceeding 75 mi/hr increased, on average, nearly 13%. All differences were statistically significant with over 99% confidence, except for New Pine Creek ATR.

In locations where the speed limit increased from 55 mi/hr to 65 mi/hr, the percentage of vehicles exceeding 85 mi/hr increased, on average, 0.50%. In this group, all but three differences were statistically significant with a high level of confidence (Cairo Junction, New Pine Creek, and Pilot Butte). In locations where the speed limit increased from 65 mi/hr to 70 mi/hr, the percentage of vehicles exceeding 85 mi/hr increased, on average, 1%. With the exception of the paired test using random samples at South Baker, all differences were statistically significant with well over 99% confidence.

Table 3.6: Average Percentage of Vehicles Exceeding 65 mi/hr at Change Locations

Speed Group	ATR	Jan. 2015 - Mar. 2020 (Excluding Mar. 2016)				
		Pre	**Post**	**Delta**	**Means (*p*-value)**	**Paired (*p*-value)**
65 mi/hr	Burns (13-001)	29.87	44.48	14.61	0.000	0.000
	Cairo Junction (23-006)	0.49	2.20	1.71	0.000	0.001
	Dufur (33-005)	19.97	54.33	34.35	0.000	0.000
	Midland (18-019)	15.96	47.66	31.69	0.000	0.000
	Modoc Point (18-022)	23.60	53.81	30.21	0.000	0.000
	New Pine Creek (19-008)	2.02	2.44	0.43	0.001	0.008
	Pilot Butte (09-005)	20.77	26.59	5.82	0.000	0.001
	Prairie City (12-009)	-	-	-		
	Redmond (09-020)	24.01	39.82	15.81	0.000	0.000
	Steens (13-007)	25.34	35.52	10.18	0.000	0.000
	Average			**16.09**		
70 mi/hr	Boardman Jct (25-008)	69.86	83.15	13.29	0.000	0.000
	Huntington (23-016)	47.32	64.99	17.67	0.000	0.001
	North La Grande (31-007)	52.43	73.65	21.22	0.000	0.000
	Pendleton (30-004)	69.29	88.78	19.49	0.000	0.000
	Rufus (28-002)	69.32	79.64	10.33	0.001	-
	South Baker (01-013)	62.44	81.54	19.10	0.000	0.000
	Average			**16.85**		

Table 3.7: Average Percentage of Vehicles Exceeding 75 mi/hr at Change Locations

Speed Group	ATR	Jan. 2015 - Mar. 2020 (Excluding Mar. 2016)				
		Pre	**Post**	**Delta**	**Means (*p*-value)**	**Paired (*p*-value)**
65 mi/hr	Burns (13-001)	3.23	4.99	1.76	0.000	0.011
	Cairo Junction (23-006)	0.01	0.06	0.05	0.000	0.000
	Dufur (33-005)	1.77	4.06	2.29	0.000	0.000
	Midland (18-019)	1.26	5.53	4.27	0.000	0.012
	Modoc Point (18-022)	1.43	5.20	3.77	0.000	0.000
	New Pine Creek (19-008)	0.16	0.18	0.01	0.321	0.184
	Pilot Butte (09-005)	1.27	1.72	0.45	0.000	0.020
	Prairie City (12-009)	-	-	-	-	-
	Redmond (09-020)	0.51	1.95	1.44	0.000	0.000
	Steens (13-007)	3.72	6.86	3.14	0.000	0.000
	Average			**1.91**		
70 mi/hr	Boardman Jct (25-008)	10.94	28.32	17.38	0.000	0.000
	Huntington (23-016)	4.21	13.73	9.51	0.000	0.000
	North La Grande (31-007)	10.93	22.67	11.74	0.000	0.003
	Pendleton (30-004)	8.78	30.76	21.98	0.000	0.000
	Rufus (28-002)	16.92	24.40	7.48	0.001	-
	South Baker (01-013)	17.46	27.14	9.68	0.000	0.000
	Average			**12.96**		

Table 3.8: Average Percentage of Vehicles Exceeding 85 mi/hr at Change Locations

Speed Group	ATR	Jan. 2015 - Mar. 2020 (Excluding Mar. 2016)				
		Pre	Post	Delta	Means (*p*-value)	Paired (*p*-value)
65 mi/hr	Burns (13-001)	0.28	0.42	0.14	0.000	0.001
	Cairo Junction (23-006)	0.01	0.01	0.00	0.996	0.559
	Dufur (33-005)	0.22	0.37	0.14	0.000	0.001
	Midland (18-019)	0.11	1.00	0.90	0.013	0.103
	Modoc Point (18-022)	0.11	0.28	0.17	0.000	0.000
	New Pine Creek (19-008)	0.02	0.02	0.00	0.747	0.742
	Pilot Butte (09-005)	0.15	0.15	0.00	0.807	0.930
	Prairie City (12-009)	-	-	-	-	-
	Redmond (09-020)	0.03	0.08	0.04	0.000	0.000
	Steens (13-007)	3.72	6.86	3.14	0.000	0.000
	Average			**0.50**		
70 mi/hr	Boardman Jct (25-008)	0.52	1.17	0.64	0.000	0.000
	Huntington (23-016)	0.22	0.61	0.40	0.000	0.000
	North La Grande (31-007)	0.72	2.96	2.24	0.000	0.001
	Pendleton (30-004)	0.41	1.07	0.66	0.000	0.000
	Rufus (28-002)	0.80	1.10	0.30	0.006	-
	South Baker (01-013)	2.16	3.98	1.82	0.001	0.178
	Average			**1.01**		

3.2 ESTIMATED VOLUME CHANGE

An analysis of total monthly traffic volume was conducted to establish traffic volume changes. The volume data are presented as 100,000 vehicles. The index column represents the post-average volume divided by the pre-average volume (an index value of 1.1 would indicate a 10% increase in traffic volume).

3.2.1 Control Segments

Table 3.9 shows the before and after traffic volumes at the control locations according to the speed data. Regardless of speed group, the trend is increased volume in the after period. In both the 45 mi/hr and 55 mi/hr speed groups, the average index is approximately 1.1 (an estimated 10% increase in traffic volume). In these two groups, the differences were not statistically significant for the majority of locations. In the 65 mi/hr group, volume increases were marginal, with an average index of 1.06 (an approximate 6% increase in traffic volume). In this group, no differences were statistically significant.

Table 3.9: Estimated Average Monthly Volume (in 100,000) at Control Locations

Speed Group	ATR	Jan. 2015 - Mar. 2020 (Excluding Mar. 2016)				
		Pre	**Post**	**Delta**	**Means (*p*-value)**	**Paired (*p*-value)**
45 mi/hr	Madras (16-002)	4.09	4.46	1.09	0.078	0.064
	North Redmond (09-023)	6.23	6.99	1.12	0.006	0.067
	Average			**1.11**		
55 mi/hr	Dayville (12-003)	0.27	0.29	1.07	0.461	0.131
	Lava Butte (09-003)	7.18	7.71	1.07	0.300	0.212
	Lexington (25-007)	0.41	0.43	1.03	0.376	0.792
	Milton (30-021)	4.42	4.62	1.05	0.085	0.255
	North Powder (01-001)	0.25	0.25	1.03	0.510	0.279
	Noti (20-005)	1.88	1.96	1.05	0.423	0.978
	Oakridge (20-017)	0.83	0.96	1.16	0.162	0.436
	Rhododendron (03-006)	2.60	3.07	1.18	0.042	0.141
	Shady Cove (15-013)	2.34	2.59	1.10	0.032	0.173
	Shutler (11-007)	0.19	0.24	1.24	0.000	0.001
	Sisters (09-014)	2.55	2.65	1.04	0.717	0.279
	Average			**1.09**		
65 mi/hr	Cascade Locks (14-004)	6.57	6.98	1.06	0.482	0.668
	Lake Creek (22-016)	11.88	12.15	1.02	0.635	0.098
	North Albany (22-005)	19.26	20.41	1.06	0.112	0.999
	Rowena (33-001)	6.59	7.17	1.09	0.121	0.200
	Wilsonville (03-011)	27.47	29.05	1.06	0.069	0.217
	Average			**1.06**		

3.2.2 Increased Speed Limit Segments

Table 3.10 shows the before and after traffic volumes at the speed limit increase locations according to the speed data. Once more, the general trend is an increase in traffic volume in the after period. In both the 65 mi/hr speed group, the average index is approximately 1.1 (an estimated 10% increase in traffic volume). The difference is statistically significant for about half of the locations in this group. In the 70 mi/hr group, volume increases were similar to that of the 65 mi/hr group, with an average index of 1.1 (an approximate 10% increase in traffic volume). In this group, the majority of locations did not experience a statistically significant difference in traffic volume.

Table 3.10: Estimated Average Monthly Volume (in 100,000) at Change Locations

Speed Group	ATR	Jan. 2015 - Mar. 2020 (Excluding Mar. 2016)				
		Pre	**Post**	**Delta**	**Means (*p*-value)**	**Paired (*p*-value)**
65 mi/hr	Burns (13-001)	0.14	0.16	1.11	0.261	0.419
	Cairo Junction (23-006)	1.43	1.62	1.13	0.025	0.279
	Dufur (33-005)	0.72	0.86	1.18	0.001	0.031
	Midland (18-019)	1.12	1.19	1.06	0.454	0.260
	Modoc Point (18-022)	1.77	1.86	1.05	0.577	0.828
	New Pine Creek (19-008)	0.25	0.26	1.05	0.515	0.366
	Pilot Butte (09-005)	0.80	0.90	1.13	0.041	0.185
	Prairie City (12-009)	-	-	-	-	-
	Redmond (09-020)	9.28	10.46	1.13	0.001	0.002
	Steens (13-007)	0.45	0.50	1.13	0.017	0.173
	Average			**1.11**		
70 mi/hr	Boardman Jct (25-008)	4.63	5.15	1.11	0.074	0.503
	Huntington (23-016)	2.82	3.04	1.08	0.386	0.028
	North La Grande (31-007)	2.83	3.16	1.11	0.098	0.073
	Pendleton (30-004)	4.68	5.17	1.10	0.055	0.003
	Rufus (28-002)	3.33	3.58	1.08	0.480	-
	South Baker (01-013)	2.73	3.10	1.13	0.064	0.210
	Average			**1.10**		

3.3 DESCRIPTIVE CRASH ANALYSIS

Two crash analyses were conducted: (1) descriptive analysis based on crash frequencies and (2) Empirical Bayes analysis to assess the impact of the increased speed limits on the expected number of crashes. For this analysis, three years of before data and three years of after data were considered, excluding the month the increased speed limits were implemented (March 2016).

The crash data was aggregated to monthly crash counts in the control and speed increase segments. Counts considered include the total number of crashes, the number of fatal and injury A crashes, the number of truck-involved crashes, and the number of crashes by crash type. To ensure the before and after periods are equal in months, the following aggregations were used:

- **Before**
  - March 2013 to February 2014 (2013-2014)
  - March 2014 to February 2015 (2014-2015)
  - March 2015 to February 2016 (2015-2016)
- **After**
  - April 2016 to March 2017 (2016-2017)
  - April 2017 to March 2018 (2017-2018)
  - April 2018 to March 2019 (2018-2019)

The three-year before average and three-year after averages are presented in the succeeding tables. The “Delta” column indicates the difference in the number of crashes, where a negative value represents a decrease in crashes from before to after the speed limit increase. The index value presented divides the three-year after average by the three-year before average. For each group of segments (by speed group), a subtotal row is presented with a corresponding index value for the subtotals. A total row is also provided, representing the total number of crashes in a given year. An index value is computed for the total values as well. An index less than 1.0 indicates a decrease in the number of crashes, while an index greater than 1.0 indicates an increase in crashes. No statistical tests were conducted for this descriptive analysis as this simple analysis of crash frequencies is not robust.

3.3.1 Total Crashes

The total number of crashes are presented for the control segments, increased speed limit segments, and the speed limit reduction segments. These crashes include only mainline crashes within the milepost boundaries presented in Table 2.4, Table 2.5, and Table 2.6. To ensure this, a visual inspection of all crashes was conducted.

3.3.1.1 Control Segments

Table 3.11 shows the total number of crashes by segment for the control locations. In the 65 mi/hr group, an index value of 1.27 was computed, and the three-year average of crash counts in the after period increased by 216. In the 55 mi/hr group, an index value of 1.11 was computed and the three-year average of crash counts in the after period increased by 45. Figure 3.5 shows the total number of crashes for all control locations by year and posted speed limit.

Table 3.11: Total Crashes (Before-to-After) on Control Segments

Speed Group	Control Segment	Route	2013-2014	2014-2015	2015-2016	3-yr Average	2016-2017	2017-2018	2018-2019	3-yr Average	3-yr Index
65 mi/hr	C-1	I-84	198	231	229	219	269	242	191	234	1.07
	C-11	I-5	503	534	697	578	800	831	706	779	1.35
	Subtotal		**701**	**765**	**926**	**797**	**1,069**	**1,073**	**897**	**1,013**	**1.27**
55 mi/hr	C-2	OR-11	20	29	17	22	35	23	25	28	1.26
	C-3	US-26	31	35	63	43	54	46	37	46	1.06
	C-4	US-26	18	32	47	32	31	58	33	41	1.26
	C-5	OR-58	79	95	90	88	117	92	109	106	1.20
	C-6	US-20	53	48	66	56	53	48	62	54	0.98
	C-7	OR-126	27	36	31	31	33	27	34	31	1.00
	C-8	OR-19	11	16	11	13	10	14	8	11	0.84
	C-9	OR-3	5	10	4	6	5	3	10	6	0.95
	C-10	OR-126	70	53	76	66	77	78	66	74	1.11
	C-12	OR-140	58	46	54	53	47	72	59	59	1.13
	Subtotal		**372**	**400**	**459**	**410**	**462**	**461**	**443**	**455**	**1.11**
	Total		**1,073**	**1,165**	**1,385**	**1,208**	**1,531**	**1,534**	**1,340**	**1,468**	**1.22**

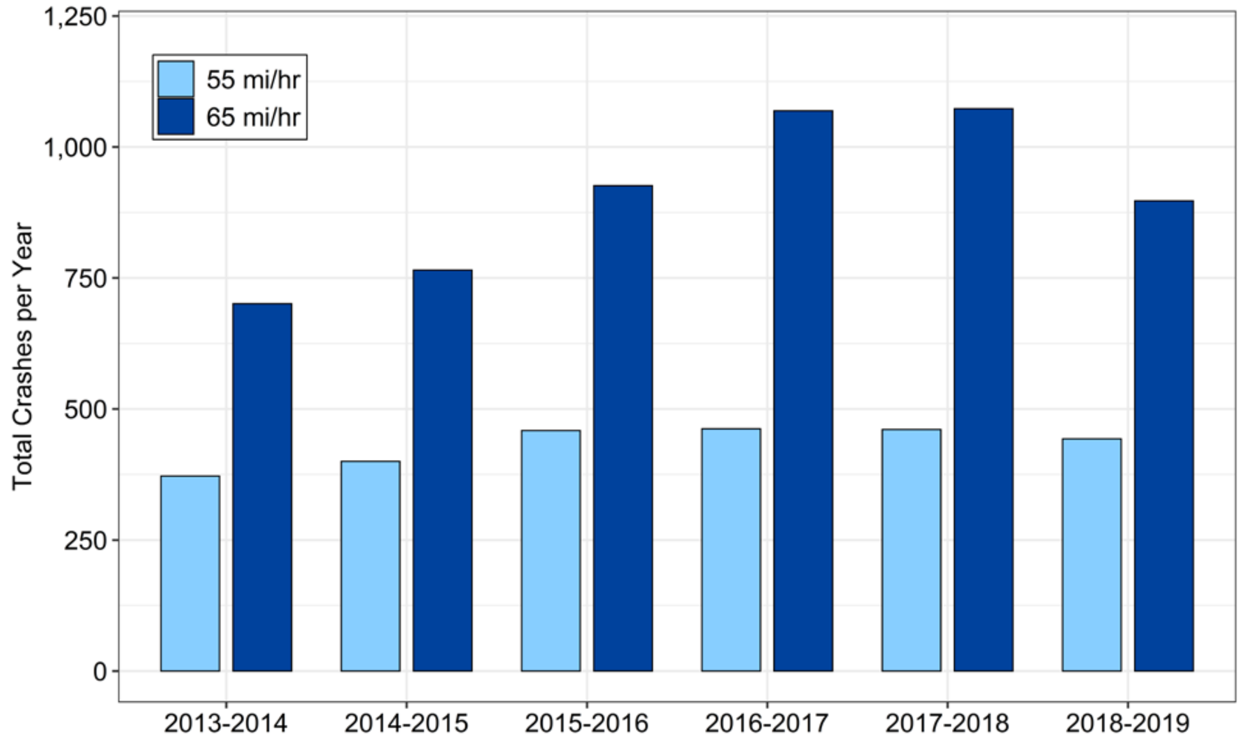


Figure 3.5: Total Crashes by Year and Speed Limit Group at Control Locations

3.3.1.2 Increased Speed Limit Segments

Table 3.12 shows the total number of crashes by segment for the increased speed limit locations. In the group where the speed limit was increased to 70 mi/hr, an index value of 1.34 was computed and the three-year average of crash counts in the after period increased by 172. The index computed for crash counts is much higher than that of the index computed for volume changes (1.1). I-84 experienced the highest increases in crash counts in the after years. In the group where the speed limit was increased to 65 mi/hr, an index value of 1.27 was computed and the three-year average of crash counts in the after period increased by 142. The computed crash index was greater than the index computed for volume changes (1.1). Figure 3.6 shows the total number of crashes for all control locations by year and posted speed limit.

Table 3.12: Total Crashes (Before-to-After) on Change Segments

Speed Group	Change Segment	Route	2013-2014	2014-2015	2015-2016	3-yr Average	2016-2017	2017-2018	2018-2019	3-yr Average	3-yr Index
70 mi/hr	ORS-2	I-84	424	471	466	454	789	503	482	591	1.30
	ORS-3	US-95	23	41	46	37	68	61	47	59	1.60
	ORS-12	I-82	12	22	20	18	48	22	19	30	1.65
	Subtotal		**459**	**534**	**532**	**508**	**905**	**586**	**548**	**680**	**1.34**
65 mi/hr	ORS-4	US-26/US-20	106	119	139	121	166	145	141	151	1.24
	ORS-5	US-97	260	287	368	305	426	370	358	385	1.26
	ORS-6	OR-31	14	28	29	24	40	27	30	32	1.37
	ORS-7	OR-78	6	17	12	12	22	31	21	25	2.11
	ORS-8	US-395	10	5	5	7	9	12	6	9	1.35
	ORS-9	US-395	20	12	18	17	36	24	19	26	1.58
	ORS-10	OR-205	9	8	5	7	5	9	5	6	0.86
	ORS-11	US-26	24	32	30	29	23	37	26	29	1.00
	Subtotal		**449**	**508**	**606**	**521**	**727**	**655**	**606**	**663**	**1.27**
Total			**908**	**1,042**	**1,138**	**1,029**	**1,632**	**1,241**	**1,154**	**1,342**	**1.30**

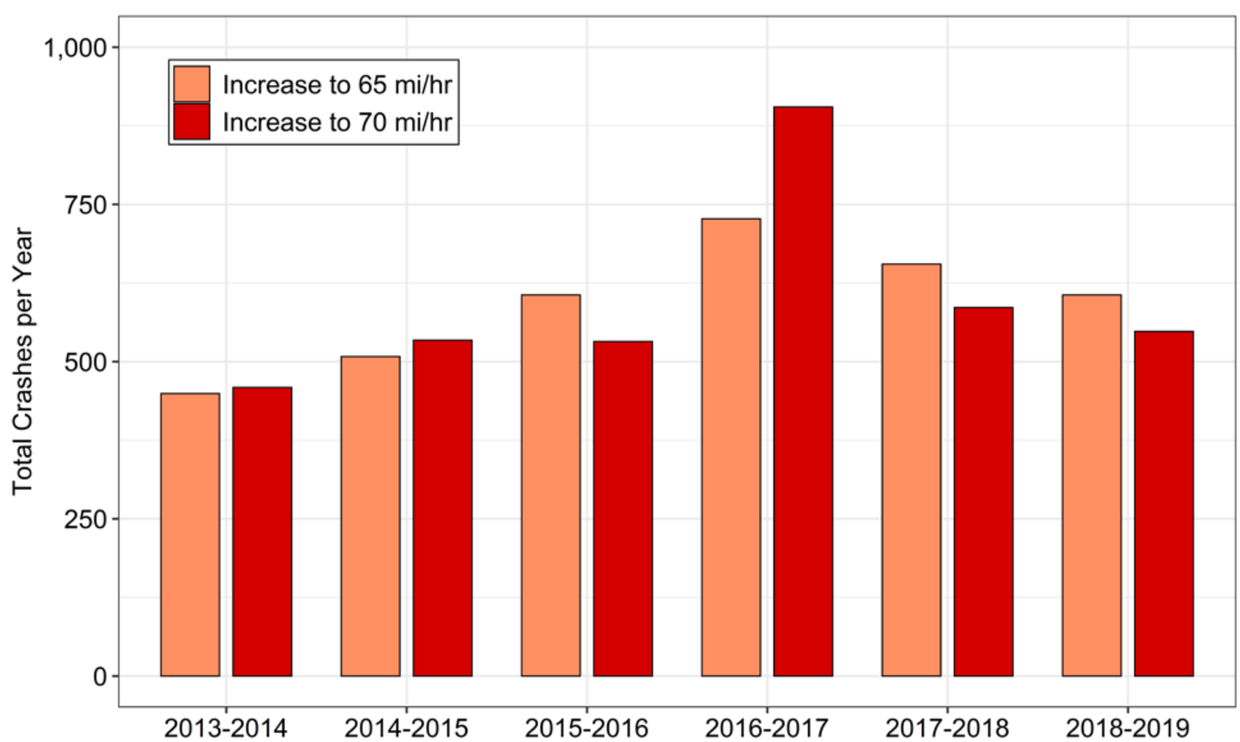


Figure 3.6: Total Crashes by Year and Speed Limit Group at Increased Speed Limit Locations

3.3.1.3 Temporary Speed Limit Reduction Segments

Table 3.13 shows the total number of crashes by segment for the speed reduction locations. Compared to the control and speed limit increase segments, these segments are short and experience fewer crashes. The computed index is 1.22, but it should be noted that one of the US-97 segments and one of the US-20 segments have indices of 0.55 and 1.02, respectively.

Table 3.13: Total Crashes (Before-to-After) on Reduction Segments

Reduction Segment	Route	2013-2014	2014-2015	2015-2016	3-yr Average	2016-2017	2017-2018	2018-2019	3-yr Average	3-yr Index
13	US-97	7	2	2	4	1	4	1	2	0.55
14	US-97	27	41	24	31	35	46	41	41	1.33
15	US-20	11	17	8	12	13	18	20	17	1.42
16	US-20	14	13	22	16	22	13	15	17	1.02
Total		**59**	**73**	**56**	**63**	**71**	**81**	**77**	**76**	**1.22**

3.3.2 Fatal and Injury A Crashes

Fatal and injury A crashes are presented for the control segments, increased speed limit segments, and the speed limit reduction segments. These crashes include only mainline crashes that occurred within the milepost boundaries presented in Table 2.4, Table 2.5, and Table 2.6. To ensure this, a visual inspection of all crashes was conducted.

3.3.2.1 Control Segments

Table 3.14 shows the total number of fatal and injury A (severe) crashes by segment for the control locations. In the 65 mi/hr group, an index value of 1.17 was computed and the three-year average of fatal/injury A crashes in the after period increased by 3. It should be noted that the index for I-84 was 1.0; therefore, the average index is capturing the increase along the I-5 segment (index of 1.23). In the 55 mi/hr group, an index value of 1.16 was computed and the three-year average of fatal/injury A crashes in the after period increased by 5. Figure 3.7 shows the total number of fatal and injury A crashes for all control locations by year and posted speed limit.

Table 3.14: Fatal and Injury A Crashes (Before-to-After) on Control Segments

Speed Group	Control Segment	Route	2013-2014	2014-2015	2015-2016	3-yr Average	2016-2017	2017-2018	2018-2019	3-yr Average	3-yr Index
65 mi/hr	C-1	I-84	7	4	5	5	8	4	4	5	1.00
	C-11	I-5	12	17	14	14	19	15	19	18	1.23
	Subtotal		**19**	**21**	**19**	**20**	**27**	**19**	**23**	**23**	**1.17**
55 mi/hr	C-2	OR-11	1	5	0	2	3	0	3	2	1.00
	C-3	US-26	3	4	5	4	5	3	0	3	0.67
	C-4	US-26	1	4	4	3	2	2	7	4	1.22
	C-5	OR-58	8	5	7	7	11	13	10	11	1.70
	C-6	US-20	4	3	6	4	5	3	3	4	0.85
	C-7	OR-126	2	3	0	2	3	3	3	3	1.80
	C-8	OR-19	2	2	1	2	2	2	0	1	0.80
	C-9	OR-3	2	1	1	1	0	0	3	1	0.75
	C-10	OR-126	9	4	7	7	7	7	6	7	1.00
	C-12	OR-140	6	3	1	3	4	5	6	5	1.50
	Subtotal		**38**	**34**	**32**	**35**	**42**	**38**	**41**	**40**	**1.16**
	Total		**57**	**55**	**51**	**54**	**69**	**57**	**64**	**63**	**1.17**

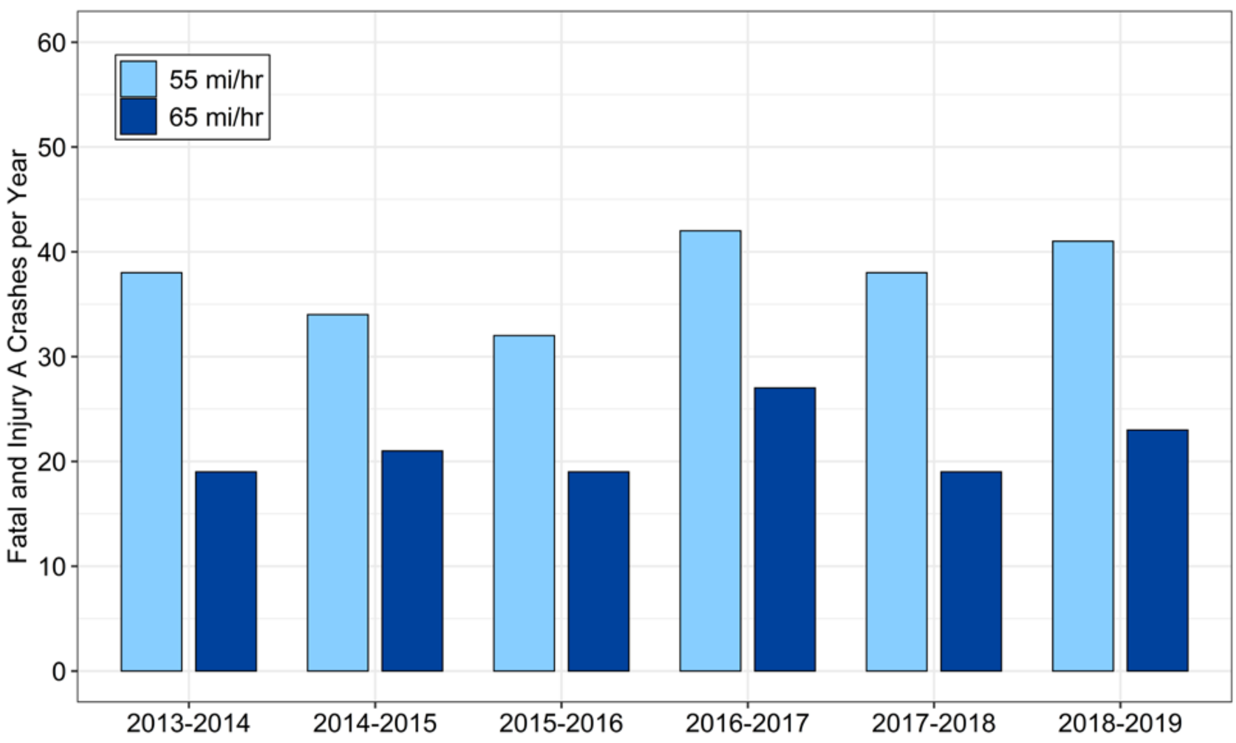


Figure 3.7: Fatal and Injury A Crashes by Year and Speed Limit Group at Control Locations

3.3.2.2 Increased Speed Limit Segments

Table 3.15 shows the total number of fatal and injury A crashes by segment for the increased speed limit locations. In the group where the speed limit was increased to 70 mi/hr, an index value of 1.20 was computed and the three-year average of fatal/injury A crashes in the after period increased by 5. I-82 experienced the highest increase with an index of 2.0. In the group where the speed limit was increased to 65 mi/hr, an index value of 1.55 was computed and the three-year average of fatal/injury A crashes in the after period increased by 16. OR-78 (index of 4.5), US-395 (index of 2.0), and OR-205 (index of 2.0) experienced the highest increase in fatal/injury A crashes. Figure 3.8 shows the total number of fatal and injury A crashes for all speed limit increase locations by year and posted speed limit.

Table 3.15: Fatal and Injury A Crashes (Before-to-After) on Change Segments

Speed Group	Change Segment	Route	2013-2014	2014-2015	2015-2016	3-yr Average	2016-2017	2017-2018	2018-2019	3-yr Average	3-yr Index
70 mi/hr	ORS-2	I-84	14	24	22	20	20	28	23	24	1.18
	ORS-3	US-95	4	5	3	4	4	5	4	4	1.08
	ORS-12	I-82	0	3	0	1	4	1	1	2	2.00
	Subtotal		**18**	**32**	**25**	**25**	**28**	**34**	**28**	**30**	**1.20**
65 mi/hr	ORS-4	US-26/US-20	11	7	6	8	9	13	9	10	1.29
	ORS-5	US-97	11	15	23	16	31	29	18	26	1.59
	ORS-6	OR-31	1	2	0	1	1	1	2	1	1.33
	ORS-7	OR-78	0	1	1	1	3	4	2	3	4.50
	ORS-8	US-395	1	0	0	0	1	1	0	1	2.00
	ORS-9	US-395	1	1	1	1	0	2	2	1	1.33
	ORS-10	OR-205	2	0	0	1	1	2	1	1	2.00
	ORS-11	US-26	0	2	2	1	1	2	1	1	1.00
	Subtotal		**27**	**28**	**33**	**29**	**47**	**54**	**35**	**45**	**1.55**
Total			**45**	**60**	**58**	**54**	**75**	**88**	**63**	**75**	**1.39**

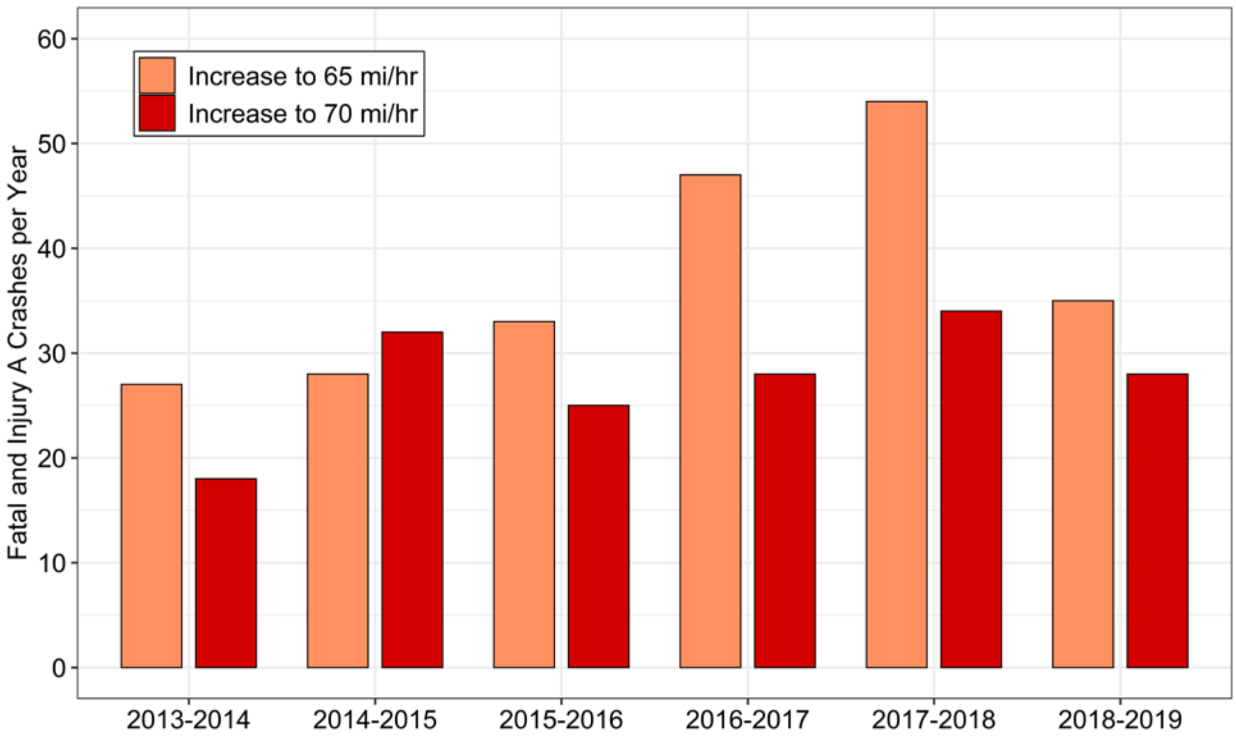


Figure 3.8: Fatal and Injury A Crashes by Year and Speed Limit Group at Increased Speed Limit Locations

3.3.2.3 Temporary Speed Limit Reduction Segments

Table 3.16 shows the total number of fatal and injury A crashes by segment for the speed reduction locations. Compared to the control and speed limit increase segments, these segments are short and experience fewer crashes. With such varying behavior between segments (e.g., index of 13, to an index of 0.17), it is difficult to draw conclusions with a high level of confidence. Further analysis into these speed reduction segments is recommended.

Table 3.16: Fatal and Injury A Crashes (Before-to-After) on Reduction Segments

Reduction Segment	Route	2013-2014	2014-2015	2015-2016	3-yr Average	2016-2017	2017-2018	2018-2019	3-yr Average	3-yr Index
13	US-97	0	0	0	0	0	1	0	0	-
14	US-97	0	0	1	0	7	4	2	4	13.00
15	US-20	1	2	0	1	1	2	4	2	2.33
16	US-20	4	2	0	2	0	0	1	0	0.17
Total		**5**	**4**	**1**	**3**	**8**	**7**	**7**	**7**	**2.20**

3.3.3 Total Truck-Involved Crashes

This section of the safety performance analysis focuses on the total number of truck-involved crashes on the control segments, the increased speed limit segments, and the speed reduction segments. Crashes considered include only mainline crashes within the milepost boundaries presented in Table 2.4, Table 2.5, and Table 2.6. To ensure this, a visual inspection of all crashes was conducted.

3.3.3.1 Control Segments

Table 3.17 shows the total number of truck-involved crashes on the control segments. In the 65 mi/hr group, an index value of 1.30 was computed and the three-year average of crash counts in the after period increased by 33. In this group, the most truck-involved crashes occurred on I-5. In the 55 mi/hr group, an index value of 1.02 was computed and the three-year average of crash counts in the after period increased by just one. In this group, three segments experienced a decrease in truck-involved crashes based on the three-year index. Figure 3.9 shows the total number of crashes for all control segments by year and posted speed limit.

Table 3.17: Total Truck-Involved Crashes (Before-to-After) on Control Segments

Speed Group	Control Segment	Route	2013-2014	2014-2015	2015-2016	3-yr Average	2016-2017	2017-2018	2018-2019	3-yr Average	3-yr Index
60 mi/hr	C-1	I-84	33	58	41	44	46	48	53	49	1.11
	C-11	I-5	64	58	76	66	81	99	101	94	1.42
	Subtotal		**97**	**116**	**117**	**110**	**127**	**147**	**154**	**143**	**1.30**
55 mi/hr	C-2	OR-11	0	4	1	2	3	0	2	2	1.00
	C-3	US-26	3	1	2	2	1	3	5	3	1.50
	C-4	US-26	1	4	13	6	4	7	3	5	0.78
	C-5	OR-58	18	22	12	17	20	16	21	19	1.10
	C-6	US-20	1	3	3	2	2	2	4	3	1.14
	C-7	OR-126	1	0	3	1	4	1	0	2	1.25
	C-8	OR-19	0	0	0	0	0	0	1	0	-
	C-9	OR-3	0	1	0	0	0	0	0	0	-
	C-10	OR-126	6	1	3	3	3	3	2	3	0.80
	C-12	OR-140	7	4	1	4	3	2	5	3	0.83
	Subtotal		**37**	**40**	**38**	**38**	**40**	**34**	**43**	**39**	**1.02**
Total			**134**	**156**	**155**	**148**	**167**	**181**	**197**	**182**	**1.22**

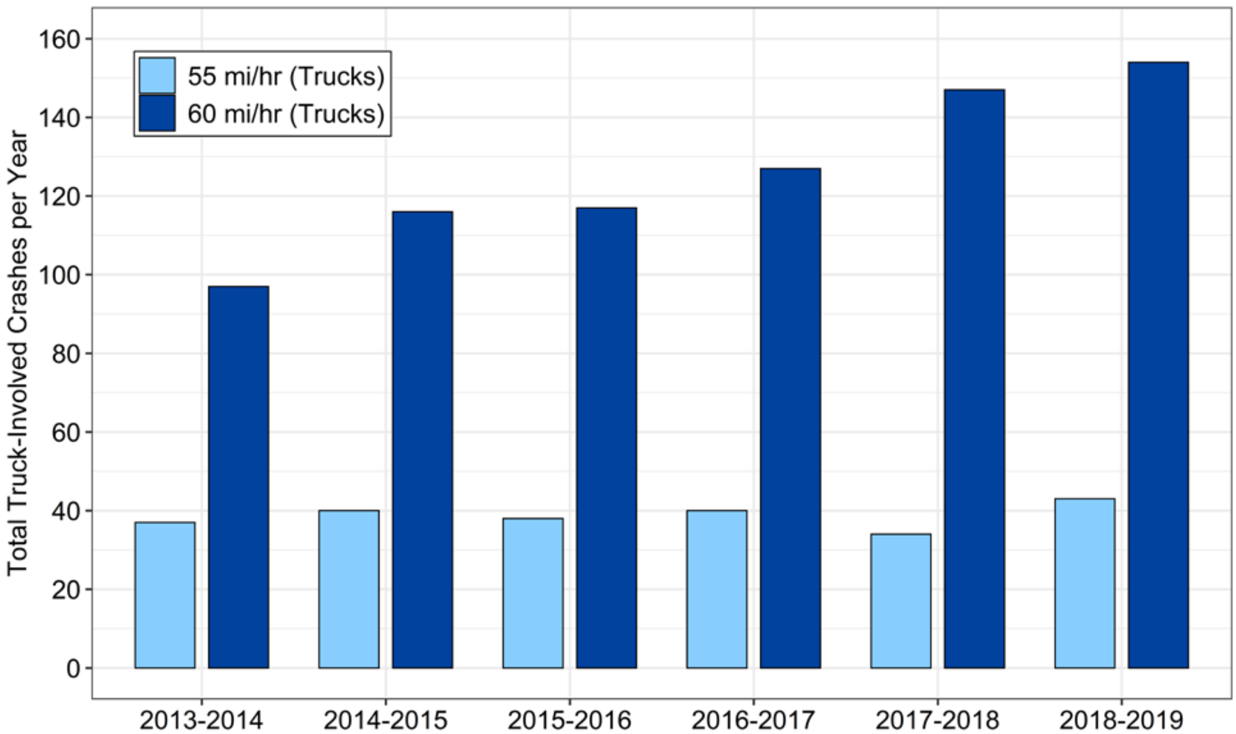


Figure 3.9: Total Truck-Involved Crashes by Year and Speed Limit Group on Control Segments

3.3.3.2 Increased Speed Limit Segments

Table 3.18 shows the total number of truck-involved crashes by segment for the increased speed limit segments. In the group where the speed limit was increased to 65 mi/hr, an index value of 1.58 was computed and the three-year average of truck-involved crash counts in the after period increased by 80. Each segment in this group experienced a moderate increase in truck-involved crashes, all with indices of 1.45 or greater. In the group where the speed limit was increased to 60 mi/hr, an index value of 1.24 was computed and the three-year average of truck-involved crash counts in the after period increased by 19. Based on the indices, the highest increases in this group were observed on OR-78 and US-395. Figure 3.10 shows the total number of crashes for all control locations by year and posted speed limit.

Table 3.18: Total Truck-Involved Crashes (Before-to-After) on Change Segments

Speed Group	Change Segment	Route	2013-2014	2014-2015	2015-2016	3-yr Average	2016-2017	2017-2018	2018-2019	3-yr Average	3-yr Index
65 mi/hr	ORS-2	I-84	129	115	131	125	255	151	179	195	1.56
	ORS-3	US-95	4	11	14	10	19	18	16	18	1.83
	ORS-12	I-82	4	6	5	5	12	6	4	7	1.47
	Subtotal		**137**	**132**	**150**	**140**	**286**	**175**	**199**	**220**	**1.58**
60 mi/hr	ORS-4	US-26/US-20	25	14	13	17	24	19	18	20	1.17
	ORS-5	US-97	42	48	67	52	79	54	58	64	1.22
	ORS-6	OR-31	1	4	2	2	3	3	3	3	1.29
	ORS-7	OR-78	1	2	2	2	5	6	3	5	2.80
	ORS-8	US-395	2	0	0	1	0	0	0	0	---
	ORS-9	US-395	2	0	1	1	3	4	1	3	2.67
	ORS-10	OR-205	0	1	0	0	0	0	1	0	1.00
	ORS-11	US-26	2	3	4	3	1	3	5	3	1.00
	Subtotal		**75**	**72**	**89**	**79**	**115**	**89**	**89**	**98**	**1.24**
Total			**212**	**204**	**239**	**218**	**401**	**264**	**288**	**318**	**1.45**

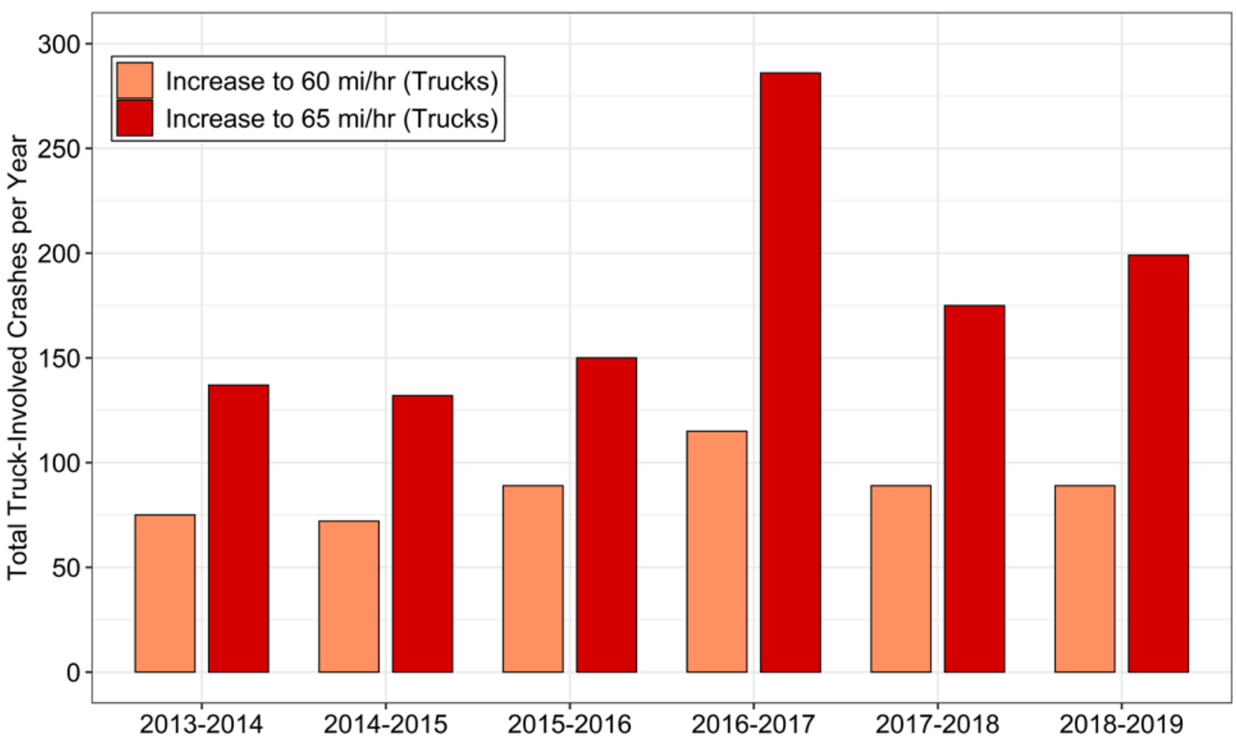


Figure 3.10: Total Truck-Involved Crashes by Year and Speed Limit Group on Increased Speed Limit Segments

3.3.3.3 Temporary Speed Reduction Segments

Table 3.19 shows the total number truck-involved crashes by segment for the speed reduction segments. Compared to the control and speed limit increase segments, these segments are short and experience fewer crashes. Overall, each segment experienced a decrease in truck-involved crashes and an index of 0.67 was computed.

Table 3.19: Total Truck-Involved Crashes (Before-to-After) on Reduction Segments

Reduction Segment	Route	2013-2014	2014-2015	2015-2016	3-yr Average	2016-2017	2017-2018	2018-2019	3-yr Average	3-yr Index
13	US-97	2	0	0	1	0	0	0	0	-
14	US-97	3	8	3	5	4	3	4	4	0.79
15	US-20	0	2	2	1	1	0	1	1	0.50
16	US-20	4	2	1	2	1	2	2	2	0.71
Total		**9**	**12**	**6**	**9**	**6**	**5**	**7**	**6**	**0.67**

3.3.4 Fatal and Injury A Truck-Involved Crashes

Fatal and injury A truck-involved crashes are presented for the control segments, increased speed limit segments, and the speed limit reduction segments. These crashes include only mainline crashes within the milepost boundaries presented in Table 2.4, Table 2.5, and Table 2.6. To ensure this, a visual inspection of all crashes was conducted.

3.3.4.1 Control Segments

Table 3.20 shows the total number of fatal and injury A truck-involved crashes on the control segments. In the 65 mi/hr group, an index value of 1.67 was computed and the three-year average of crash counts in the after period increased by 2. The most truck-involved crashes occurred in this group on I-5, but the greater index is on I-84 (4.0). In the 55 mi/hr group, an index value of 0.75 was computed and the three-year average of crash counts in the after period decreased by one. It should be noted that for these crash types, the number of crashes are small and indices for various segments could not be determined due to zero counts in the before or after period (denoted as “- in Table 3.20). Figure 3.11 shows the total number of crashes for all control segments by year and posted speed limit.

Table 3.20: Fatal and Injury A Truck-Involved Crashes (Before-to-After) on Control Segments

Speed Group	Control Segment	Route	2013-2014	2014-2015	2015-2016	3-yr Average	2016-2017	2017-2018	2018-2019	3-yr Average	3-yr Index
60 mi/hr	C-1	I-84	1	0	0	0	2	0	2	1	4.00
	C-11	I-5	5	2	1	3	4	4	3	4	1.38
	Subtotal		**6**	**2**	**1**	**3**	**6**	**4**	**5**	**5**	**1.67**
55 mi/hr	C-2	OR-11	0	1	0	0	1	0	0	0	1.00
	C-3	US-26	0	0	0	0	0	1	0	0	-
	C-4	US-26	0	1	1	1	0	1	0	0	0.50
	C-5	OR-58	3	2	0	2	2	1	1	1	0.80
	C-6	US-20	0	0	0	0	1	0	0	0	-
	C-7	OR-126	0	0	0	0	0	0	0	0	-
	C-8	OR-19	0	0	0	0	0	0	0	0	-
	C-9	OR-3	0	0	0	0	0	0	0	0	-
	C-10	OR-126	2	0	1	1	0	0	1	0	0.33
	C-12	OR-140	1	0	0	0	0	0	0	0	0.00
	Subtotal		**6**	**4**	**2**	**4**	**4**	**3**	**2**	**3**	**0.75**
	Total		**12**	**6**	**3**	**7**	**10**	**7**	**7**	**8**	**1.14**

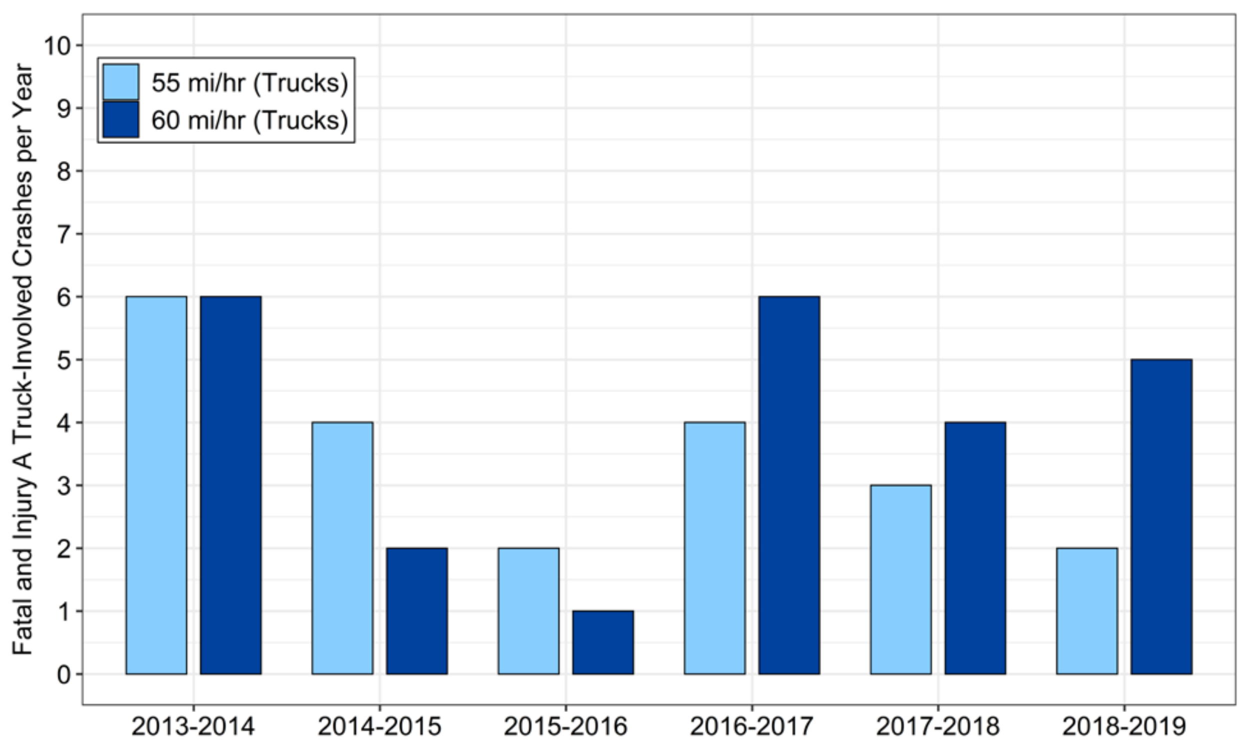


Figure 3.11: Fatal and Injury A Truck-Involved Crashes by Year and Speed Limit Group on Control Segments

3.3.4.2 Increased Speed Limit Segments

Table 3.21 shows the total number of fatal and injury A truck-involved crashes by segment for the increased speed limit segments. In the group where the speed limit was increased to 65 mi/hr, an index value of 1.24 was computed and the three-year average of fatal/injury A truck-involved crash counts in the after period increased by two. In the group where the speed limit was increased to 60 mi/hr, an index value of 1.27 was computed and the three-year average of truck-involved crash counts in the after period increased by one. Just two segments in this speed group had before and after crashes to compute an index. Figure 3.12 shows the total number of crashes for all control locations by year and posted speed limit.

Table 3.21: Fatal and Injury A Truck-Involved Crashes (Before-to-After) on Change Segments

Speed Group	Change Segment	Route	2013-2014	2014-2015	2015-2016	3-yr Average	2016-2017	2017-2018	2018-2019	3-yr Average	3-yr Index
70 mi/hr	ORS-2	I-84	3	9	6	6	5	9	7	7	1.17
	ORS-3	US-95	1	1	1	1	0	1	3	1	1.33
	ORS-12	I-82	0	0	0	0	1	0	0	0	---
	Subtotal		**4**	**10**	**7**	**7**	**6**	**10**	**10**	**9**	**1.24**
65 mi/hr	ORS-4	US-26/US-20	5	0	0	2	3	2	0	2	1.00
	ORS-5	US-97	1	4	5	3	4	4	3	4	1.10
	ORS-6	OR-31	0	0	0	0	0	0	0	0	---
	ORS-7	OR-78	0	0	0	0	0	1	0	0	---
	ORS-8	US-395	0	0	0	0	0	0	0	0	---
	ORS-9	US-395	0	0	0	0	0	0	1	0	---
	ORS-10	OR-205	0	0	0	0	0	0	1	0	---
	ORS-11	US-26	0	0	0	0	0	0	0	0	---
	Subtotal		**6**	**4**	**5**	**5**	**7**	**7**	**5**	**6**	**1.27**
Total			**10**	**14**	**12**	**12**	**13**	**17**	**15**	**15**	**1.25**

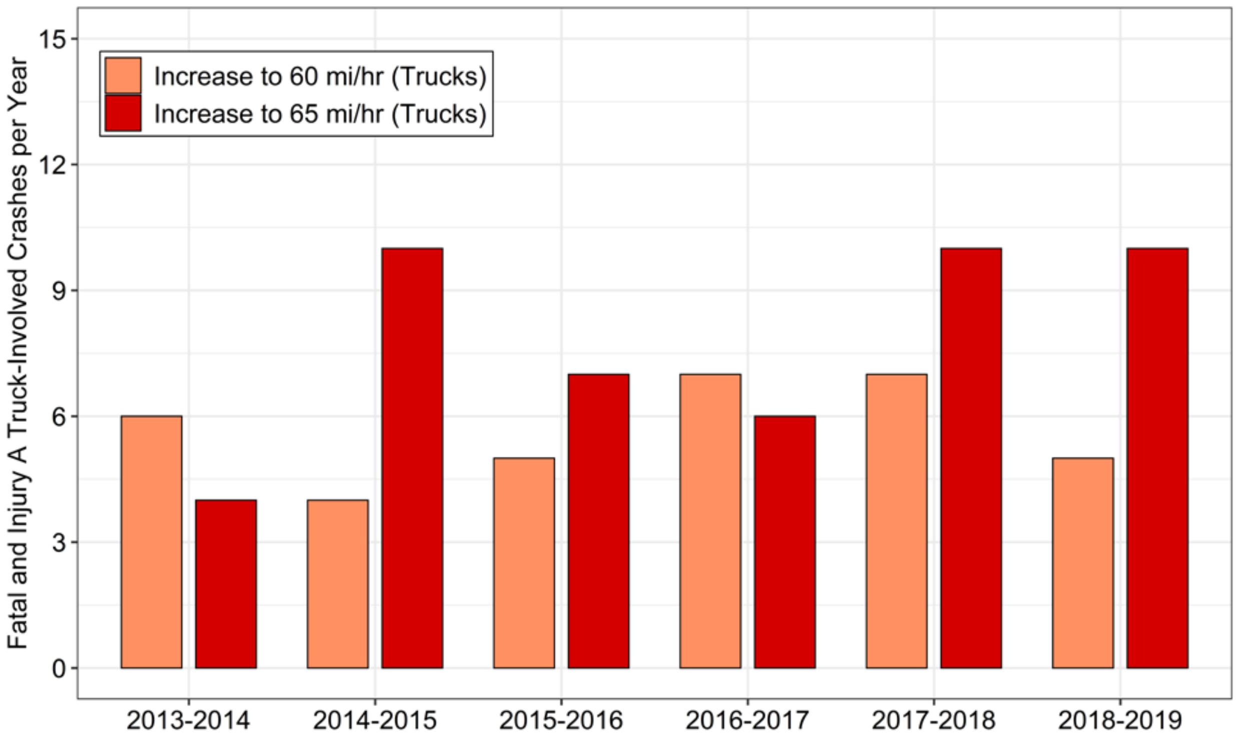


Figure 3.12: Fatal and Injury A Truck-Involved Crashes by Year and Speed Limit Group on Increased Speed Limit Segments

3.3.4.3 Temporary Speed Reduction Segments

Table 3.22 shows the total number of fatal and injury A truck-involved crashes by segment for the speed reduction segments. Compared to the control and speed limit increase segments, these segments are short and experience fewer crashes. Ultimately, it is difficult to draw any conclusion due to the small number of crashes.

Table 3.22: Fatal and Injury A Truck-Involved Crashes (Before-to-After) on Reduction Segments

Reduction Segment	Route	2013-2014	2014-2015	2015-2016	3-yr Average	2016-2017	2017-2018	2018-2019	3-yr Average	3-yr Index
13	US-97	0	0	0	0	0	0	0	0	-
14	US-97	0	0	0	0	1	1	0	1	-
15	US-20	0	0	0	0	0	0	0	0	-
16	US-20	4	0	0	1	0	0	0	0	-
Total		**4**	**0**	**0**	**1**	**1**	**1**	**0**	**1**	**0.50**

3.3.5 Crash Proportions by Crash Type (All Vehicles)

The total number of crashes by crash type were determined for all control segments, increased speed limit segments, and speed reduction segments. In this analysis, the control segments and speed reduction segments are considered together.

3.3.5.1 Control and Speed Reduction Segments

Table 3.23 shows the proportion of crashes by crash type on the control and speed reduction segments. In both the before and after periods, fixed-object crashes and rear-end crashes account for the largest proportion; however, the proportion of fixed-object crashes decreased 3.3% in the after period while the proportion of rear-end crashes increased 5.6%. All other changes were marginal in comparison. Still, the overall proportions remain fairly consistent in both the before and after periods.

Table 3.23: Proportions of Crashes by Crash Type on Control and Reduction Segments

	ANGL	BACK	FIX	HEAD	NCOL	OTH	PED	REAR	SS-M	SS-O	TURN	Total
Before	39	1	1,308	58	164	366	12	1,208	55	487	109	3,807
After	41	6	1,440	51	173	371	12	1,729	72	577	161	4,633
Before (%)	1.0%	0.0%	34.4%	1.5%	4.3%	9.6%	0.3%	31.7%	1.4%	12.8%	2.9%	100%
After (%)	0.9%	0.1%	31.1%	1.1%	3.7%	8.0%	0.3%	37.3%	1.6%	12.5%	3.5%	100%
Change	**-0.1%**	0.1%	**-3.3%**	**-0.4%**	**-0.6%**	**-1.6%**	**-0.1%**	5.6%	0.1%	**-0.3%**	0.6%	

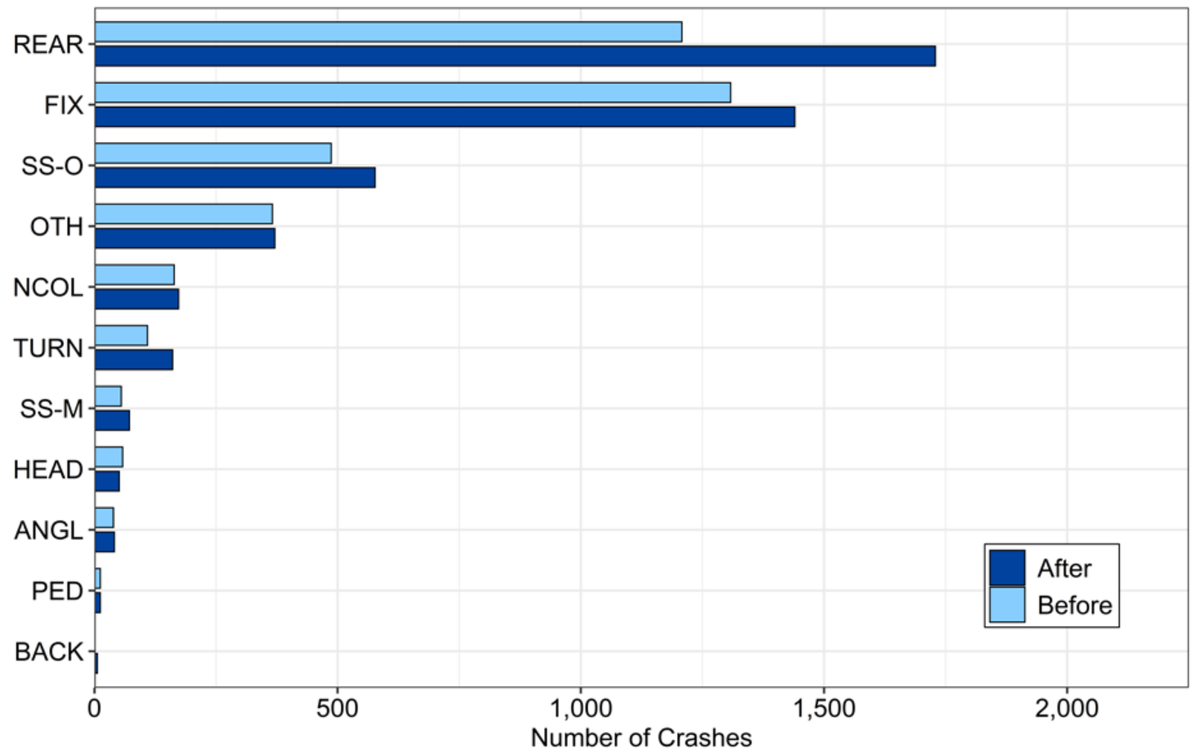


Figure 3.13: Number of Crashes by Crash Type on Control and Speed Reduction Segments

3.3.5.2 Increased Speed Limit Segments

Table 3.24 shows the proportion of crashes by crash type on the increased speed limit segments. Like the control and reduction segments, fixed-object crashes account for the largest proportion in both the before and after periods. However, unlike the control and reduction segments, non-collision accounts for the second-highest proportion, followed by rear-end crashes. Non-collision representing a higher proportion can be explained by these segments primarily being rural highways. Again, the overall proportions remain relatively consistent in both the before and after periods.

Table 3.24: Proportions of Crashes by Crash Type on Increased Speed Segments

	ANGL	BACK	FIX	HEAD	NCOL	OTH	PED	REAR	SS-M	SS-O	TURN	Total
Before	26	4	1211	68	526	547	9	333	92	185	85	3,086
After	49	10	1704	61	581	604	8	486	95	294	134	4,026
Before (%)	0.8%	0.1%	39.2%	2.2%	17.0%	17.7%	0.3%	10.8%	3.0%	6.0%	2.8%	100%
After (%)	1.2%	0.2%	42.3%	1.5%	14.4%	15.0%	0.2%	12.1%	2.4%	7.3%	3.3%	100%
Change	0.4%	0.1%	3.1%	**-0.7%**	**-2.6%**	**-2.7%**	**-0.1%**	1.3%	**-0.6%**	1.3%	0.6%	

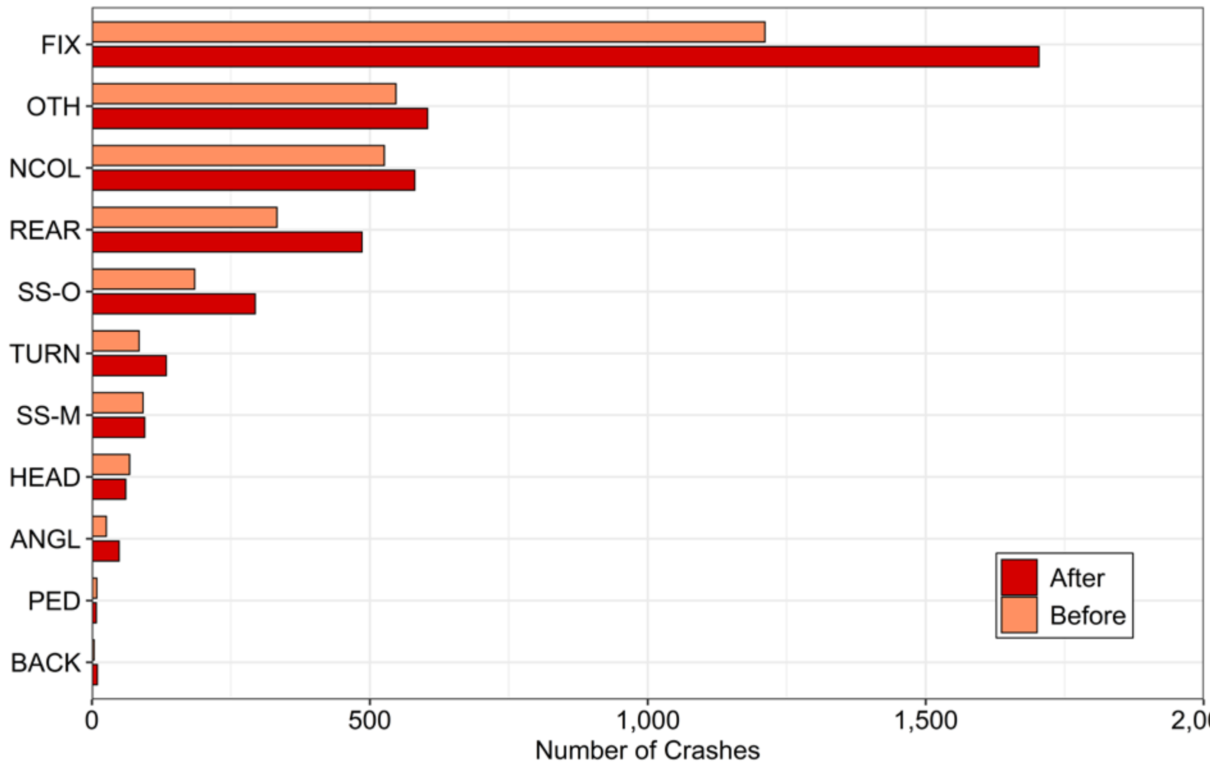


Figure 3.14: Number of Crashes by Crash Type on Increased Speed Limit Segments

3.4 Empirical-Bayes Crash Analysis

With additional years of ODOT crash data available, this updated analysis includes crash modifications factors (CMFs) computations. This is accomplished through an Empirical Bayes approach, in which a series of count-data models were estimated to generate safety performance functions. Due to differences in roadway characteristics, CMFs were computed for interstates and non-interstates. For this analysis, the following count-data model specifications were tested:

- Poisson and Negative Binomial pooled models.
- Zero-inflated Poisson and Negative Binomial models.
- Traditional Poisson and Negative Binomial models based on cross-sectional data.

This approach determined that the most reliable estimates were obtained from the traditional cross-sectional Negative Binomial model. This model being the preferred approach indicates data dispersion in the crash data. This was true for both interstate models and non-interstate models.

3.4.1 Interstates

Final SPF model specifications for interstates are shown in Table 3.25.

Table 3.25: Negative Binomial Model Specifications for Total Interstate Crashes

Variable	Coefficient	Std. Error	z-statistic
Constant	3.90	2.41	1.62
Natural Logarithm of AADT	-0.29	0.26	-1.13
Alpha	0.39	0.07	5.79
Model Summary			
Number of Observations	213		
Log-Likelihood at Convergence	-476.89		

Using the model specifications from Table 3.25, the following interstate SPF is obtained:

$$\text{Expected Crashes} = e^{(3.90-(0.29)\text{LNAADT})} \tag{3.1}$$

where Expected Crashes is the predicted number of crashes based on SPF estimates and $AADT$ is the average annual daily traffic. The Empirical Bayes summary is shown in Table 3.26.

Table 3.26: Empirical Bayes Summary for Total Interstate Crashes

Time Period	Observed Crashes	SPF Predicted Crashes
Before	689	702.67
After	977	900.69

The EB estimates are show in Table 3.27. From the SPF, an estimated CMF of 1.10 was determined using the Empirical Bayes before-after approach. This CMF indicates that the speed increase on interstates in Eastern Oregon is expected to increase the number of crashes. The standard error of the CMF is 0.048, and the 95% confidence interval ranges from 1.00 to 1.19 (although the range includes 1.00, it is the lower bound).

Table 3.27: Estimates for Empirical Bayes Interstate Crash Analysis

Parameter	Estimate
$N_{\text{Expected,T,B}}$	694.33
$N_{\text{Expected,T,A}}$	890.00
$\text{Var}(N_{\text{Expected,T,A}})$	695.90
CMF	1.10
Var(CMF)	0.002
SE(CMF)	0.048
$95\%\ \text{C.I.}$	1.00, 1.19

3.4.2 Non-Interstates

In addition to generating a CMF for interstates, non-interstate roadways were assessed independently. Final SPF model specifications for non-interstates are shown in Table 3.28.

Table 3.28: Negative Binomial Model Specifications for Total Non-Interstate Crashes

Variable	Coefficient	Std. Error	z-statistic
Constant	-2.54	0.36	-6.98
Natural Logarithm of AADT	0.50	0.05	9.93
Alpha	0.74	0.09	8.20
Model Summary			
Number of Observations	365		
Log-Likelihood at Convergence	-802.92		

Using the model specifications from Table 3.25, the following interstate SPF is obtained:

$$\text{Expected Crashes} = e^{(-2.54+(0.50)\text{LNAADT})} \tag{3.2}$$

where Expected Crashes is the predicted number of crashes based on SPF estimates and $AADT$ is the average annual daily traffic. The Empirical Bayes summary is shown in Table 3.29.

Table 3.29: Empirical Bayes Summary for Total Non-Interstate Crashes

Time Period	Observed Crashes	SPF Predicted Crashes
Before	1,199	1,213.12
After	1,748	1,709.48

The EB estimates for non-interstates are shown in Table 3.30. From the SPF, an estimated CMF of 1.49 was determined using the Empirical Bayes before-after approach. This CMF indicates that the speed increase on non-interstates in Eastern Oregon resulted in an increase in crashes. The standard error of the CMF is 0.0.044, and the 95% confidence interval ranges from 1.40 to 1.58 (this range does not include the value 1.00).

Table 3.30: Estimates for Empirical Bayes Interstate Crash Analysis

Parameter	Estimate
$N_{\text{Expected,T,B}}$	831.72
$N_{\text{Expected,T,A}}$	1,172.02
$\text{Var}(N_{\text{Expected,T,A}})$	429.41
CMF	1.49
Var(CMF)	0.002
SE(CMF)	0.044
$95\%\ \text{C.I.}$	1.40, 1.58

4.0 SUMMARY

This analysis compares the changes in speed, volume, and safety performance on highway segments where the speed limit was increased in Eastern Oregon, select control locations, and a small number of segments in which there was a speed limit reduction. Three years of before and after data were available and used to assess the changes for average speed, percent of vehicles traveling over 65, 75, and 85 mi/hr, traffic volume, total crashes, fatal and injury crashes for both total vehicles and trucks. An Empirical-Bayes before and after safety analysis was conducted for total crashes on interstates and non-interstate roadways. A summary of the analysis is provided in Table 4.1. The values in Table 4.1 are the change before to after for the speed measures and the index values for the safety measures. An index of 1.0 indicates no change, less than 1.0 indices a decrease, and greater than 1.0 indicates an increase. The change in frequency of crashes (denoted in parentheses) represents the difference in the three-year average. The results of the EB analysis are noted in the key observation section.

Table 4.1: Analysis Summary (Change in Measure or Index)

Speed Group		**Avg. Speed (mi/hr)**	**Pct. > 65 mi/hr**	**Pct. > 75 mi/hr**	**Pct. > 85 mi/hr**	**Total Monthly Volume**	**Total Crashes (All)**	**Fat/Inj. A Crashes (All)**	**Total Crashes (Trucks)**	**Fat/Inj. A Crashes (Trucks)**
	Control	0.46	2.41	2.44	0.12	1.06	1.27 (+ 216)	1.17 (+ 3)	1.30 (+ 33)	1.67 (+ 2)
	Change	3.21	16.85	12.96	1.01	1.10	1.34 (+172)	1.20 (+ 5)	1.58 (+ 80)	1.24 (+ 2)
Change		↑	↑	↑	↑	↑	↑	↑	↑	↓
Key Observation		There is an increase in speeds and higher proportion of vehicles traveling at higher speeds.					EB estimate for total crashes is 1.11 (1.00, 1.19, confidence interval). The descriptive analysis highlights the increase in total crashes and truck-involved crashes. There is a slight change in fatal/injury A crashes, and based on the index, a decrease in fatal/injury A truck-involved crashes.			
	Control	0.36	2.09	0.24	0.02	1.09	1.11 (+ 45)	1.16 (+ 5)	1.02 (+ 1)	0.75 (- 1)
	Change	3.56	16.09	1.91	0.50	1.11	1.27 (+ 142)	1.55 (+ 16)	1.24 (+ 19)	1.27 (+ 1)
Change		↑	↑	↑	↑	↑	↑	↑	↑	↓↑
Key Observation		There is an increase in speeds and higher proportion of vehicles traveling at higher speeds.					The safety performance decreased more on these roadways than the interstates. The EB estimate for total crashes is 1.49 (1.40, 1.58, confidence interval). The descriptive analysis highlights the increase in all considered crash types and severities.			

Concerning speed changes, the analysis in this report with the additional years of data confirms the findings of the preliminary analysis conducted in 2018. Vehicle speeds have increased on the highways where the posted speed limits were increased. The data show that the average and percentage of vehicles exceeding 65, 75, and 85 mi/hr have increased. The average speeds have increased approximately 3 mi/hr, and these changes are statistically significant. More importantly, the percentage of high-speed vehicles (e.g., over 85 mi/hr) has also increased. A significant increase in vehicles traveling at very high speeds (i.e., more than 15 mi/hr above the posted speed limit) is a concern since these are the vehicles typically associated with worse crash outcomes. The increases 1) in the stopping distance, 2) in the required detection distance to make reactions in time for collision avoidance, and 3) the kinetic energy in these vehicles can contribute to increased crashes and severity for vehicles traveling at higher speeds.

The safety performance also mostly confirms the preliminary analysis. On the interstates where speeds were increased to 70 mi/hr and on the network of rural two-lane highways where speeds were increased from 55 mi/hr to 65 mi/hr, the descriptive analysis of crash frequency suggests an increase in the total number of crashes, fatal/injury A crashes, and truck-involved crashes. The index change for fatal and injury A crashes more closely matched the trends on the control sections for the interstate speed changes but increased on the 55 mi/hr to 65 mi/hr increase sections.

The crash analysis finds that the total truck-involved crashes have increased at a rate higher than both the total traffic volume and the truck-related crash performance change on the control sections. On the sections where the speed limit was raised to 65 mi/hr for trucks (primarily the interstates), the index for truck-involved crashes was very close to the control sections. On the sections where the speed limit was increased to 60 mi/hr for trucks, crashes also increased more than the truck-involved crashes on the control sections. There are fewer fatal and injury A crashes that involve trucks. On the 65 mi/hr segments (interstates) the increase was similar to the control sections. On the 55 mi/hr segments, the increase was more than the control sections.

The more robust Empirical Bayes before-after method confirms the basic descriptive analysis for total crashes. To be consistent with roadway characteristics, a CMF was computed for interstates and for non-interstates. A CMF of 1.10 was calculated for interstates, with 1.00 being the lower bound of the 95% confidence interval. This suggests that total crashes increased due to the speed limit increase. This is in line with the descriptive analysis, where crashes increased on nearly all segments for all types of crashes. For non-interstates, a **CMF of 1.49** was computed, where the 95% confidence interval does not include 1.00. These results confirm that crashes increased due to the speed limit increase.

Overall, the changes observed in this updated analysis confirm the preliminary analysis and results of other speed changes found in the literature. The increase in crashes on the network of rural two-lane highways where speeds were increased from 55 mi/hr to 65 mi/hr was significantly more than the increase observed on the interstate segments.

4.1 LIMITATIONS

As stated in the previous analysis, a common limitation of using ATR data is the localized nature of ATRs (speeds are only recorded at the location of ATR and may not reflect behavior up- or downstream). Additionally, there were stations with missing data that had data in the previous analysis. It is anticipated that this may be a result of the change in the data interface. Although it may not have impacted the current analysis, this issue may exist at other ATRs across Oregon. Lastly, all speeds were averaged (e.g., passenger vehicles, trucks, etc.), which may result in speeds that overrepresent a specific vehicle type depending on the ATR location. In the data's current form, unless at a WIM station, parsing out vehicle types to assess speeds is difficult. This is particularly true in Eastern Oregon, where there are inherently fewer ATRs and just two WIM stations on the eastern portion of I-84. Finally, it should be noted that subtle differences were observed in some cases but may be a result of the new speed data format and updates made to the reported crash data

For the safety performance analysis, exposure-based data was limited to average annual daily traffic. It is expected that with additional exposure-based covariates, the generated SPFs can predict crashes at a higher rate. The EB analysis did not extend to the fatal and injury A crashes and only included total crashes.