Evaluation of Iowa's 70 mph Speed Limit – Four Year's Later

Final Report
December 2010

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16. Abstract

On July 1, 2005, the State of Iowa implemented a 70 mph speed limit on most rural Interstates. This document reports on a 4 year update of a study of the safety effect of this change. Daytime and nighttime serious crashes were studied for a period of 14 years prior to the change and 4 years afterwards. Cross median crashes were studied for 4 years before and 4 years after.

Simple descriptive statistics reveal increases in most crash severity categories for the 4 year period following the speed limit increase when compared to the 4year period prior to the increase. When compared to longer term trends, the increases were less pronounced in some severity levels and types, and for a few severity levels, the average crash frequencies were observed to decrease. Few of the changes in crash frequency were larger than the normal year to year variation is these statistics. Three types of crash were found to have increased by amounts larger than might be expected by normal variation: nighttime fatal crashes (52%), serious cross median crashes (25%) and all (total) crashes (25%). Only the increase in all (total) crashes was found to be statistically significant at the 90% confidence level. While not statistically significant at a high level of confidence, the results suggest that further study should be undertaken to understand and consider actions to mitigate nighttime and cross-median crashes.

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Final Report
December 2010

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INTRODUCTION

On July 1, 2005, the State of Iowa implemented a 70- mph speed limit on most rural Interstates. Concern has been expressed that the change may have resulted in a decrease in safety, reflected in an increase in crashes.

An early study (Lund et al, 2007; Lund 2007) reported the preliminary safety effect of the speed limit change using eighteen months of after period data (June 2005 – December 2006). That study described how the speed limit change may have affected speeds and safety on other categories of highways in Iowa. Those roadways included parallel (to the rural Interstates) routes, expressways, primary highways, urban Interstates, and rural other highways. The study also examined specific portions of the rural Interstates, namely, those within 20 miles of a metropolitan area. The safety performance of I-80 east and west as well as I-35 north and south was examined. The initial study was later updated using 2.5 years of data (Souleyrette et al, 2009).

This report presents the results of a study of the impacts of that speed limit increase, comparing 4 years of after-period crash data to 14 years of data from before the change.

Descriptive Crash analysis is presented for the following crash types:

- Total crashes
- Crashes by severity
- Cross-median crashes
- Day-night crashes

METHODOLOGY

To examine the effect of speed limit change, it is important to isolate the effect of the change from other variables that systematically might affect crash frequency. Typically, traffic level (ADT, VMT) is the most significant predictor of crash rate. The analysis presented in this report was simplified as VMT changed very little on the study roads (rural Iowa Interstate) over the 4 year before and after study period. Other effects can be policy changes (DWI, seatbelt laws), enforcement, vehicle technology changes, etc. There were no significant policy changes that would have affected crash likelihood on Iowa Interstates during the period, and enforcement levels and vehicle technologies were assumed as constant for this study.

Figure 1 shows the annual vehicle miles traveled on rural interstates in Iowa in millions of vehicle miles traveled. The four year average VMT preceding the change to 70 mph (2001-2004) was 5020 million vehicle miles traveled compared to 5100 million vehicle miles traveled for the average four year after period (2006-2009). The change in traffic volume from the before to after period is only an increase of 1.6%.

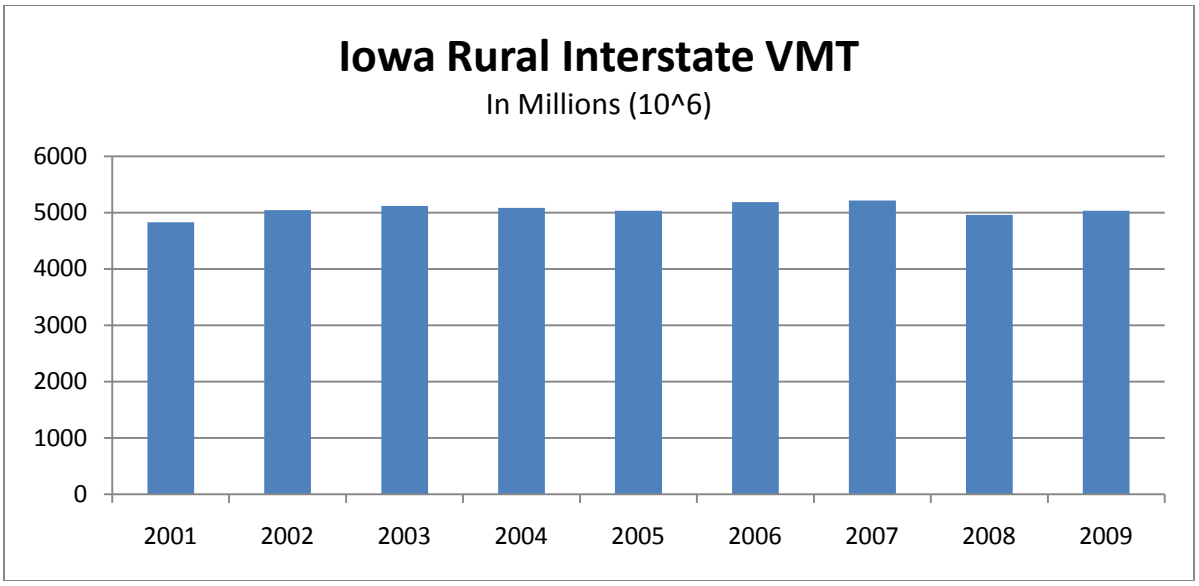

Figure 1: Annual VMT on Iowa Rural Interstates

Crash Data Assembly and Processing

Crash data were obtained from the Iowa DOT Office of Traffic and Safety. The data included the period 1991 to 2009, covering 14 years before and 4 years after the year of the speed limit change (2005). Highway data and attributes were extracted from the Iowa DOT's statewide Geographic Information Management System (GIMS) data base.

The procedures to identify interstate crashes for the 1991-1999 subset (pre-GIMS) involved linking crash information records to point crash locations, and using spatial and attribute records to select crashes on the interstates. Sections with 70-mph speed limits were identified using 2006 GIMS data. These sections were also identified in older versions of GIMS that more closely match the recorded locations of crashes in the before period. Using GIS selection methods, crashes in these areas were selected.

Cartographic representation of the highway system in Iowa changed significantly over the time frame of this study. As such, there are many crash locations that do not match perfectly with any one GIS representation of the roadway system. The distance from each crash location to both the nearest rural interstate segment and to the closest "other type" road was established. Crashes were then classified into four groups:

1. Crashes greater than 100 meters from the Interstate (70 mph sections, or INT70)
2. Crashes within 10 meters of INT70
3. Crashes between 10 and 100 meters of INT70 where distance to the Interstate is **less** than the distance to other roads
4. Crashes between 10 and 100 meters of INT70 where distance to the Interstate is **more** than the distance to other roads

The second and third groupings were classified as study area crashes (those that occurred on segments that now have a 70 mph speed limit). Figure 2 presents the urban and rural Interstates in Iowa. Red segments indicate the sections where speed limit was raised to 70 MPH.

A statewide list of locations of possible/probable cross median crashes was provided by the Iowa DOT Office of Traffic Safety (TAS). This list was used in the present study and merged to the list of crashes occurring on segments where the speed limit was changed to 70 MPH. While the overall magnitude of cross median crashes could be significantly different (most likely higher) from the reported number, the methodology used by TAS was applied equally in the before and after periods. Therefore, more confidence should be placed on the magnitude of the change expressed as a percent, rather than the absolute numbers of crashes.

To identify nighttime crashes, a table of sunrise and sunset times was constructed covering the 1991 to 2009 period, based on Ames observations (as an average for the state)[1]. This table was joined to the crash data base and used to select nighttime crashes (crashes before sunrise or after sunset on any given day). The time of day was available on all but 237 of the 35,733 total crashes in the database.

Detailed steps of the data collection, preparation and processing may be found in Appendix A of the 2.5 year update (Souleyrette et al, 2009).

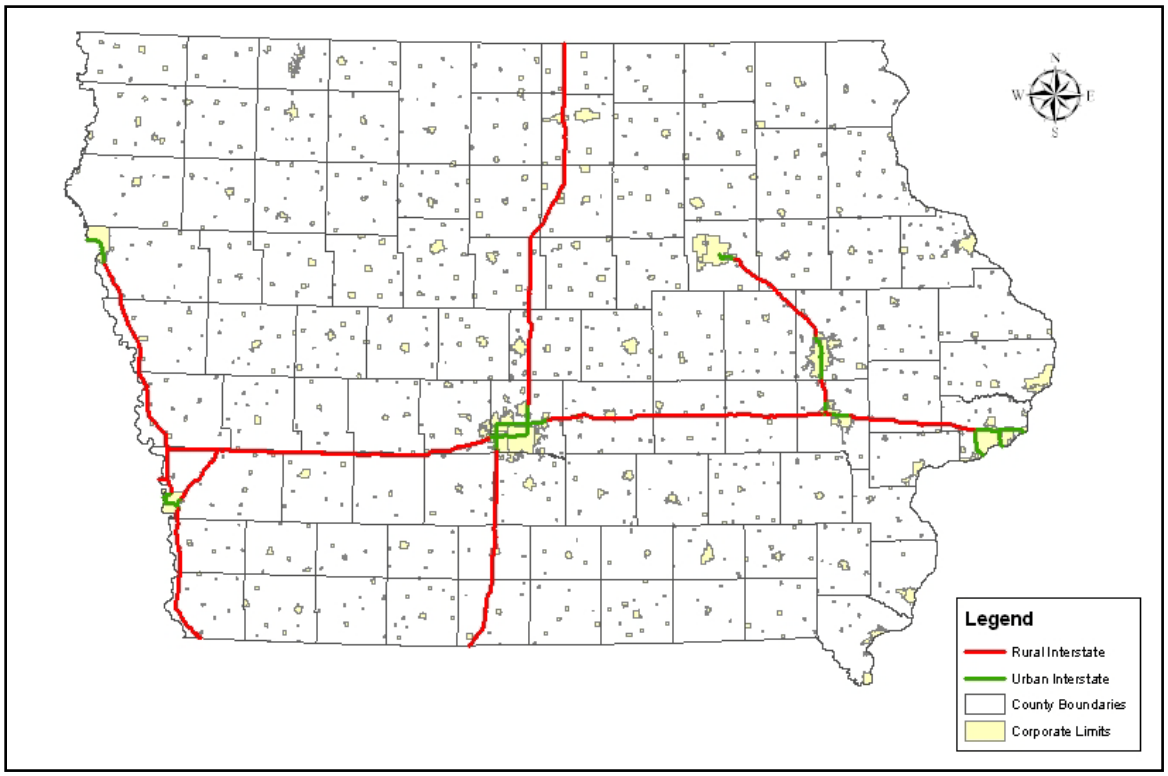

Figure 2: Iowa Interstate Study Sections

[1] U.S. Naval Observatory (http://aa.usno.navy.mil/data/docs/RS_OneYear.php)

Crash Analysis

Simple measures of crash performance including averages and standard deviations were prepared from the assembled crash data. Daytime and nighttime serious crashes were studied for a period of 14 years prior to the change and 4 years afterwards. Due to limitations of data, cross median crashes were studied for 4 only years prior to the change. Mean changes by crash severity categories for the 14 and 4 year before and 4 year after periods were computed and compared to 14 or 4 year standard deviations to indicate the most important changes. 2005 data were excluded to eliminate the impact of temporary changes and to provide equal number of seasons in the before and after periods.

Paired T-tests were performed on the crash types experiencing larger increases using data from the 30 counties which contain rural expressway sections. The results of this test indicate which increases are statistically significant. Additional information about the t-tests may be found in the appendix to this report.

RESULTS

Descriptive Statistics

Fatal crashes increased on average from 19.5 to 25.3 (5.8) per year resulting in a 29.5 percent increase when compared to the 4 year before period. Compared to the average crash frequency over the entire 14 year before period, fatal crashes increased from 20.8 to 25.3 (4.5 or a 21.2 percent increase). However, these increased are on the order of the annual variability (standard deviation) in crash frequencies over the longer period (21.3 percent of the mean value or about 4.4 crashes per year). Therefore, while the increase in fatalities is tragic in terms of the additional 5 lives lost per year, the changes are similar to what might be expected from random variation in the data (see Figure 3).

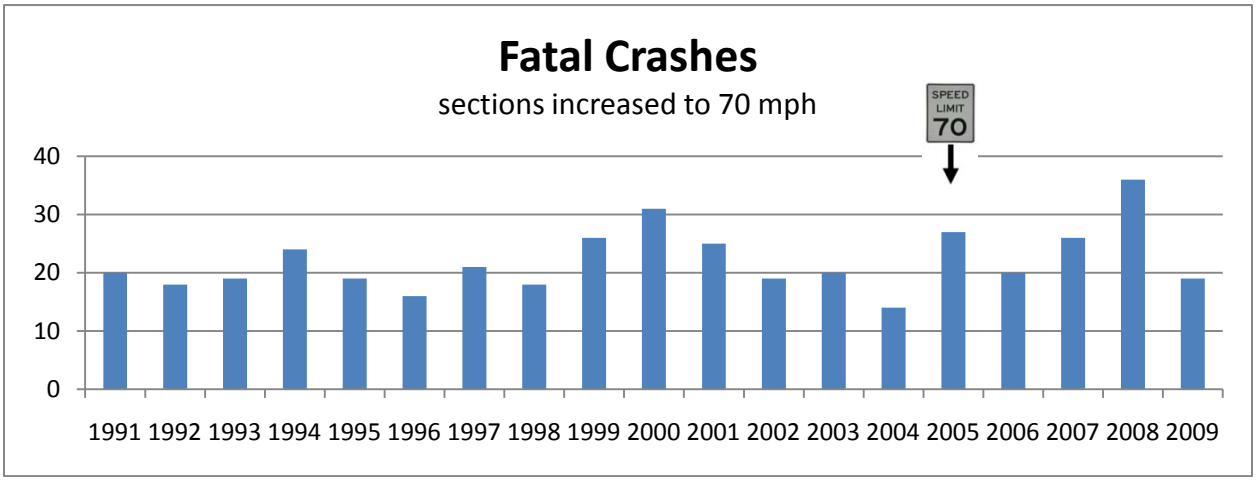

Figure 3: Annual Fatal Crash History

Serious (fatal and major injury) crashes increased on average from 80.0 to 87.3 (7.3) per year resulting in a 9.1 percent increase when compared to the 4 year before period. However, compared to the average crash frequency over the entire 14 year before period, serious crashes *decreased* from 104 to 87.3 (16.7 or a 16.1 percent *decrease*). The annual variability (standard deviation) in crash frequencies of this severity over the longer period (20.7 percent of the mean value or 21.5 crashes per year) is also on the order of these changes. See figure 4.

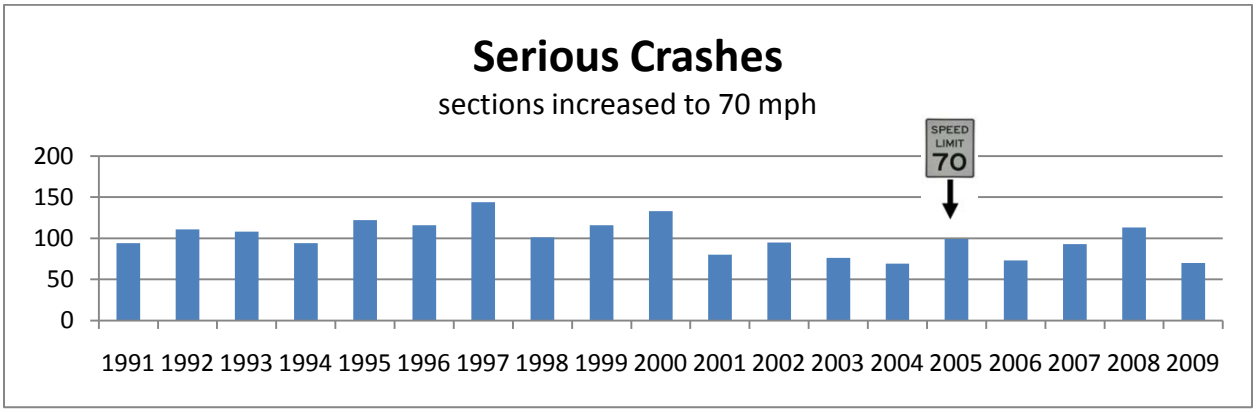

Figure 4: Annual Serious Crash History

Nighttime fatal crashes increased, although to a lesser extent than all fatal crashes. This type of crash increased on average from 6.75 to 10.25 (3.5) per year resulting in a 51.9 percent increase when compared to the 4 year before period. However, compared to the average crash frequency over the entire 14 year before period, fatal crashes increased from 8.34 to 10.25 (1.91 or a 22.8 percent increase). The annual variability (standard deviation) in nighttime fatal crash frequencies over the longer period is 28.5 percent of the mean value or 2.38 crashes per year. Therefore, while compared to the 14 year before period, the increase is on the order of what might be expected due to random variation, compared to the 4 years before the speed limit change, the increase is more significant. See figure 5.

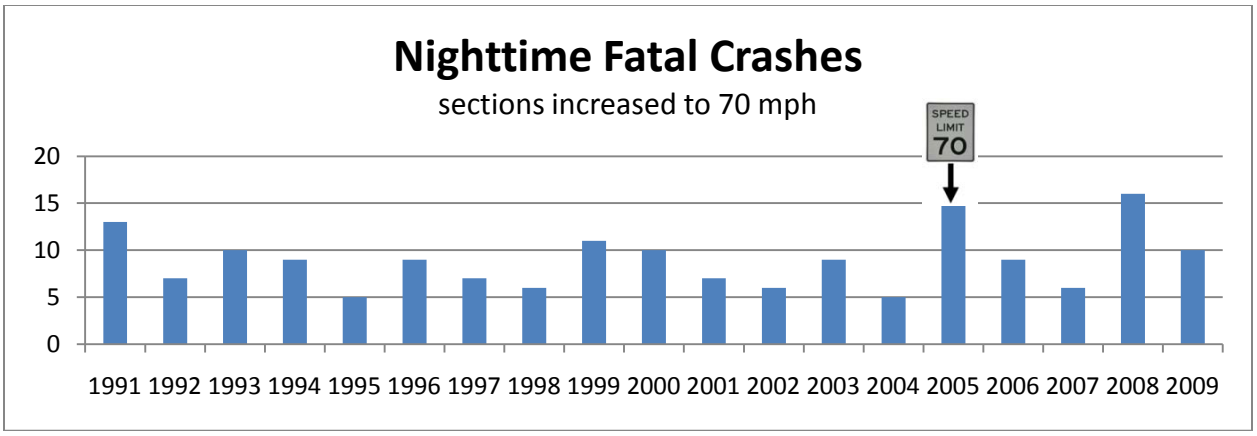

Figure 5: Annual Nighttime Fatal Crash History

Serious nighttime crashes increased slightly from 30.3 to 31.0 (0.7) per year resulting in a 2.5 percent increase when compared to the 4 year before period. But, compared to the average crash frequency over the entire 14½ year before period, serious nighttime crashes *decreased* from 43.0 to 31.0 (8.0 or a 27.8 percent reduction). Again, however, the annual variability (standard deviation) in serious nighttime crash frequencies over the longer period (23.3 percent of the mean value or 10.0 crashes per year) is on the order of magnitude of this change. See figure 6.

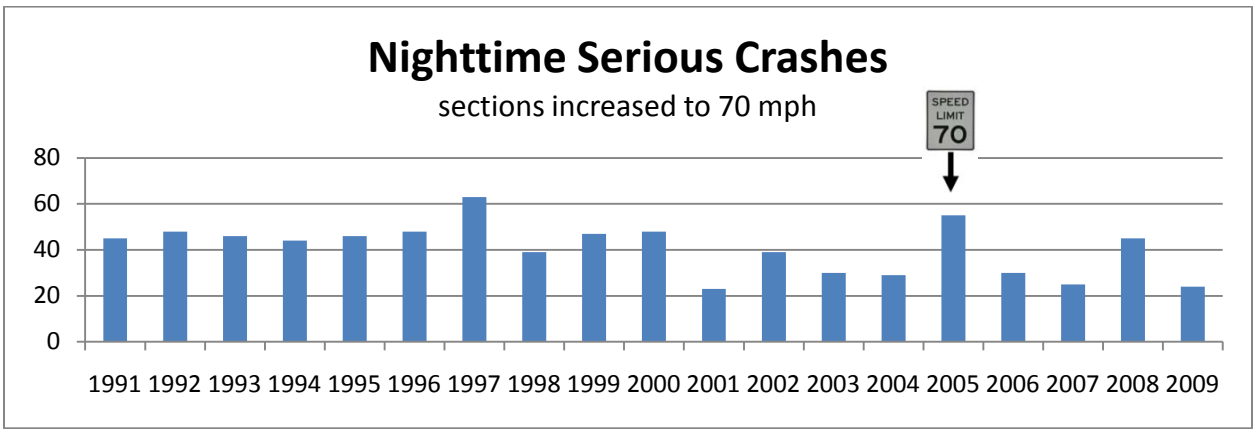

Figure 6: Annual Nighttime Serious Crash History

Fatal cross-median crashes increased on average from 5.5 to 8.0 (2.5) per year resulting in a 45.5 percent increase when compared to the 4 year before period. However, the annual variability (standard deviation) in fatal cross median crash frequencies over the 4 year before period is 43.3 percent of the mean value or 2.38 crashes per year. See figure 7.

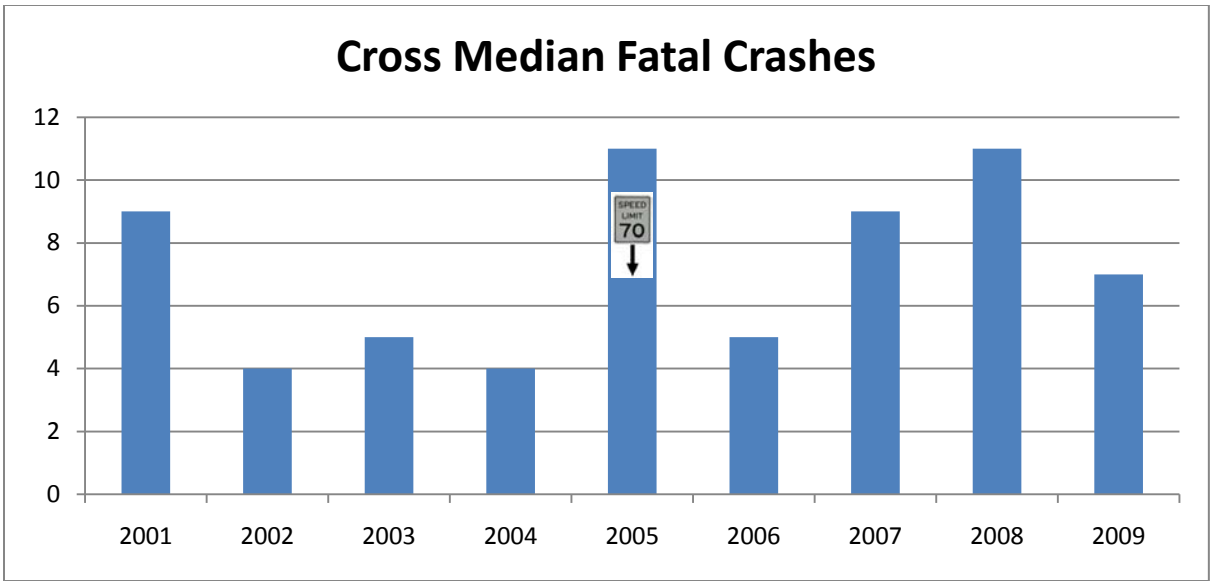

Figure 7: Annual Cross-Median Fatal Crash History

Serious cross-median crashes increased on average from 10.0 to 12.5 (2.5) per year resulting in a 25.0 percent increase when compared to the 4 year before period. The annual variability (standard deviation) in serious cross median crash frequencies over the 4 year period (14.1 percent of the mean value or 1.41 crashes per year) is much less than the observed increases, indicating a more significant finding. See Figure 8.

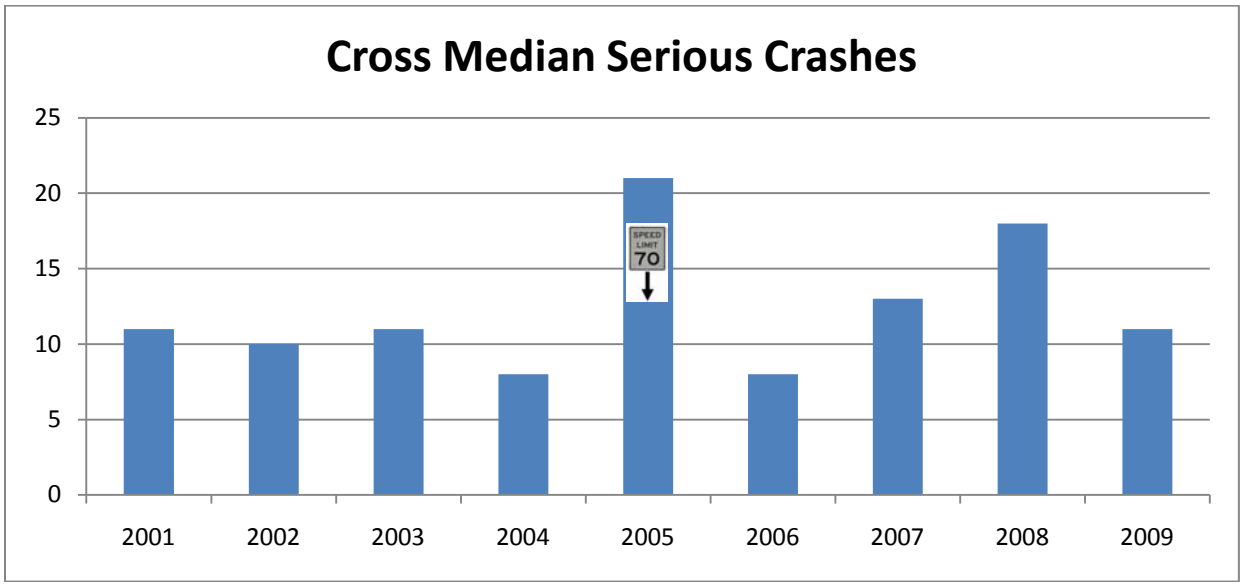

Figure 8: Annual Cross-Median Serious Crash History

All cross-median crashes (total of all severity levels) increased on average from 46.3 to 55.5 (9.2) per year resulting in a 20.0 percent increase when compared to the 4 year before period. The annual variability (standard deviation) in total cross median crash frequencies over the 4 year before period (15.3 percent of the mean value or 7.09 crashes per year) is on the order of the observed increases. See Figure 9.

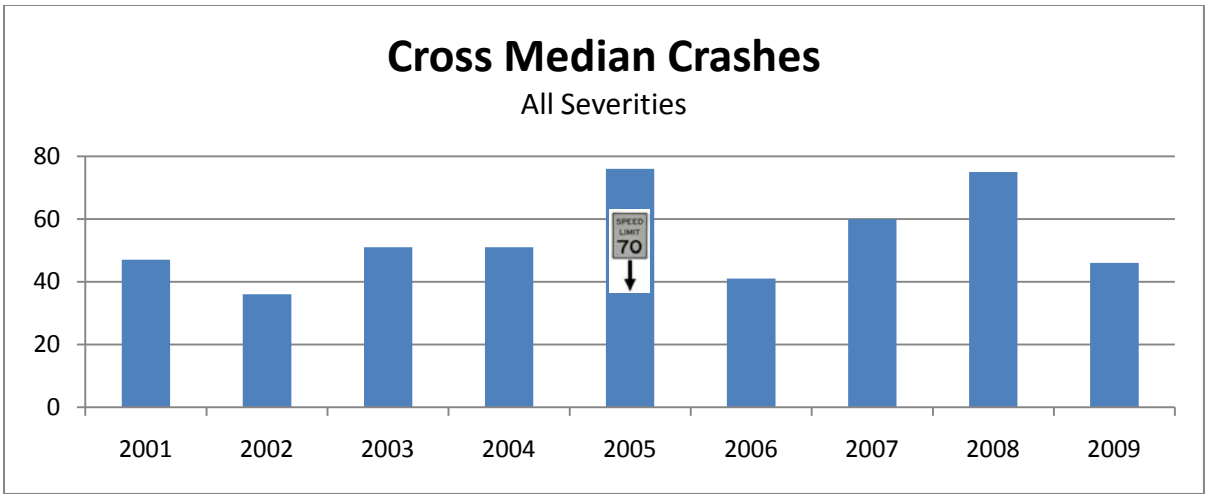

Figure 9: Annual All Severities Cross Median Crash History

All nighttime cross-median crashes (total of all severity levels) increased on average from 15.5 to 16.8 (1.3) per year resulting in an 8.1 percent increase when compared to the 4 year before period. The annual variability (standard deviation) in total cross median crash frequencies over the 4 year period (16.3 percent of the mean value or 2.52 crashes per year) is greater than the observed increases, indicating the change in crashes is within the expected variability. See Figure 10.

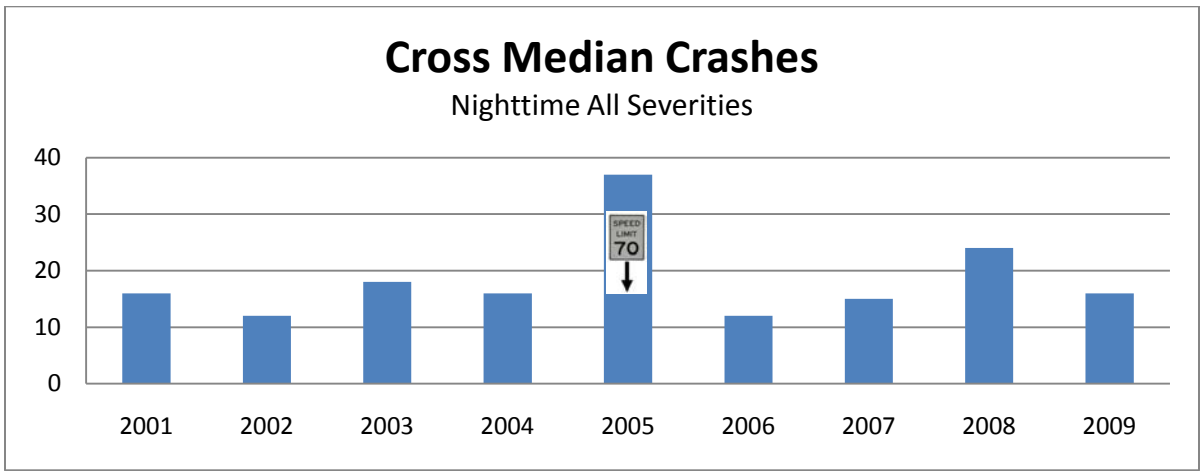

Figure 10: Annual All Severities Nighttime Cross Median Crash History

All (total) crashes increased from 1747 to 2187 (440) per year resulting in a 25.2 percent increase when compared to the 4 year before period. Compared to the average crash frequency over the entire 14 year before period, all crashes increased from 1785 to 2187 (402 or a 22.5 percent increase). The annual variability (standard deviation) in total crash frequencies over the longer period (6.8 percent of the mean value or 121.8 crashes per year) is much smaller than magnitude of these changes indicating significant increase. See figure 11.

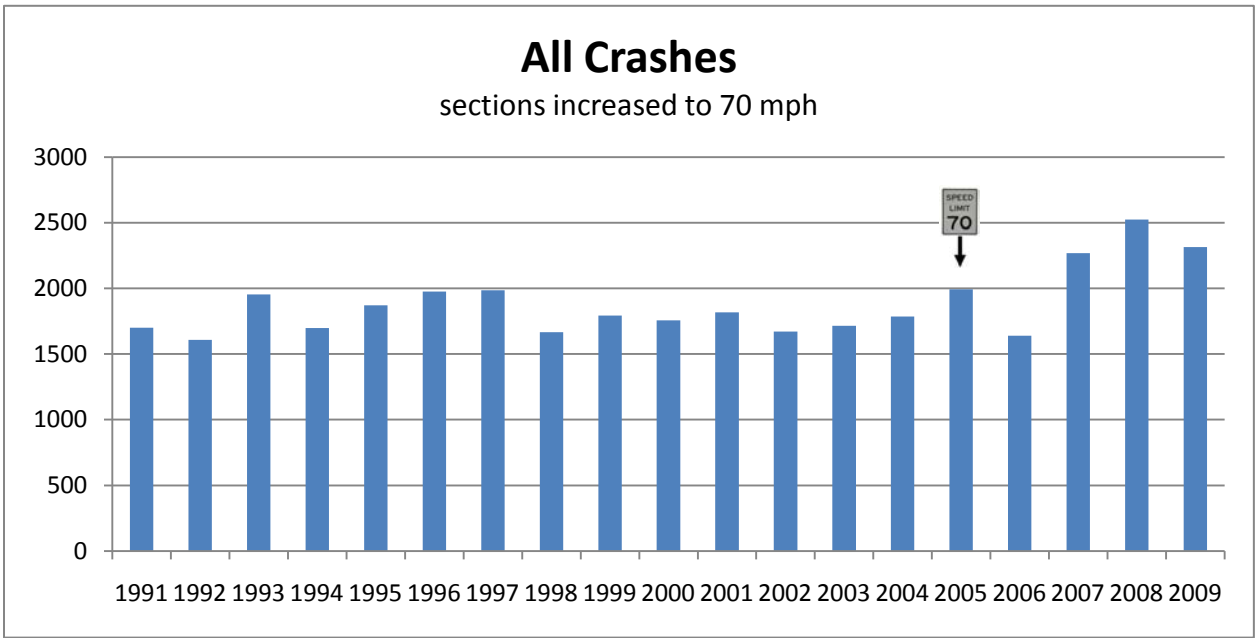

Figure 11: Annual All Severities Crash History

Analysis of off-system (non- rural interstate and other) roads was conducted earlier during the study, using 18 months of before and after data. Results from that analysis are presented in Appendix C of the 2.5 year update report (Souleyrette et al, 2009).

Table 1 reports increases in the crash severity categories for the 4 year period following the speed limit increase (2006-2009) as compared to the 4 year period prior to the increase (2001-2004). Mean changes that are large compared to standard deviation are highlighted in yellow.

Rural Interstate crashes before and after 70MPH speed limit		Annual Average for 14 years before	Annual Average for 4 years before***	Annual Average for 4 years after?	change ** (compared to 4 year avg)	change ** (compared to 14 year avg.)	annual standard deviation (14 yrs. before)	% annual standard deviation (14 yrs. before)
Fatal crashes and fatalities	Fatal crashes	20.8	19.5	25.3	29.5%	21.2%	4.43	21.3%
	Fatalities	27.2	26.8	30.0	12.1%	na	5.31	19.5%
	Cross-median crashes	*	5.50	8.00	45.5%	*	2.38*	43.3%*
	Night-time crashes	8.34	6.75	10.25	51.9%	22.8%	2.38	28.5%
Serious (fatal plus major injury crashes)	All serious crashes	104	80.0	87.3	9.1%	-16.1%	21.5	20.7%
	Serious Cross-median crashes	*	10.0	12.5	25.0%	*	1.41*	14.1%*
	Serious Night-time crashes	43.0	30.3	31.0	2.48%	-27.8%	10.0	23.3%
All crashes	All Crashes	1785.4	1747.0	2186.5	25.16%	22.5%	121.8	6.8%
	All Cross-median crashes	*	46.3	55.5	20.0%	*	7.09*	15.3%*
	Night-time cross-median crashes	*	15.5	16.8	8.1%	*	2.52*	16.3%*

* cross median crash data only available for 4 years of the "before" period
** change should be large compared to standard deviation for high statistical confidence
*** previous 4 year period Jan 2001 - Dec 2004
? after 4 year period Jan 2005 - Dec 2009

Table 1: Descriptive Statistics and Results

Paired T-test

Paired T-tests were performed on the crash types experiencing larger increases using data from the 30 counties which contain rural expressway sections (night-time fatal crashes, serious cross-median crashes, and all crashes. The results of this test indicate that only total (all) crashes

increased significantly. Additional information about the t-tests may be found in the appendix to this report.

SUMMARY AND CONCLUSION

This study investigated the safety effect of the July 1, 2005 70mph speed limit in Iowa. Crash statistics for sections of rural Interstate were compared using 14 years of data before and 4 years after data. Three types of crash were found to have increased by amounts larger than might be expected by normal variation: nighttime fatal crashes (52%), serious cross median crashes (25%) and all (total) crashes (25%). Only the increase in all (total) crashes was found to be statistically significant at the 90 percent confidence level. However, while not statistically significant at a high level of confidence, the results suggest that further study should be undertaken to understand and consider actions to mitigate nighttime and cross-median crashes.

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Souleyrette, R., T. Stout and A. Carriquiry (2009). Evaluation of Iowa's 70 mph Speed Limit – 2.5 Year Update, Iowa DOT, CTRE Project 06-247, January. 45 pp.

APPENDIX: PAIRED T-TEST COMPUTATIONS

Comparing only serious crashes (fatal and major injury crashes)

Before period: 2001-2004
After period: 2006-2009

Note: n=30 counties with rural interstate

$\mu_d = \mu_{after-before}$

$H_0 : \mu_d = 0$

$H_a : \mu_d \neq 0$

$n = 30$

$\alpha = 0.05$

$\bar{d} = 0.9667$

$s_d = 6.0940$

$t_{\alpha/2} = 2.045$

$$t - statistic = \frac{\bar{d} - D_0}{s_d / \sqrt{n}} = \frac{0.9667 - 0}{6.0940 / \sqrt{30}} = 0.8688$$

Reject H_0 if $|t\text{ - }statistic| \geq t_{\alpha/2}$

$|0.8688| < t_{\alpha/2} \therefore$ Cannot Reject H_0

Result:

p-value = between 0.1 and 0.25 (greater than alpha)

There is no significant increase or decrease of serious crashes from 65 mph segments to 70 mph segments.

Comparing ALL crashes

Same definitions as before

$\mu_d = \mu_{after-before}$

$H_0 : \mu_d = 0$

$H_a : \mu_d \neq 0$

$n = 30$

$\alpha = 0.05$

$\bar{d} = 58.5333$

$s_d = 62.1942$

$t_{\alpha/2} = 2.045$

$$t - statistic = \frac{\bar{d} - D_0}{s_d / \sqrt{n}} = \frac{58.5333 - 0}{62.1942 / \sqrt{30}} = 5.1548$$

Reject H_0 if $|t\text{ - }statistic| \geq t_{\alpha/2}$

$|5.1548| > t_{\alpha/2} \therefore$ Reject H_0

Result:

p-value < 0.0005

There is a significant change of total crashes from 65 mph segments to 70 mph segments.

$\mu_d = \mu_{after-before}$

$H_0 : \mu_d \leq 0$

$H_a : \mu_d > 0$

$n = 30$

$\alpha = 0.05$

$t_\alpha = 1.699$

$$t - statistic = \frac{\bar{d} - D_0}{s_d / \sqrt{n}} = \frac{58.5333 - 0}{62.1942 / \sqrt{30}} = 5.1548$$

Reject H_0 if $t\text{ - }statistic \geq t_\alpha$

$5.1548 > t_\alpha \therefore$ Reject H_0

Result:

p-value < 0.0005

There is a significant increase of total crashes from 65 mph segments to 70 mph segments.

<u>Comparing SERIOUS Cross-Median Crashes</u>

Same definitions as before

$\mu_d = \mu_{after-before}$

$H_0 : \mu_d = 0$

$H_a : \mu_d \neq 0$

$n = 30$

$\alpha = 0.05$

$\bar{d} = 0.3333$

$s_d = 1.6259$

$t_{\alpha/2} = 2.045$

$$t - statistic = \frac{\bar{d} - D_0}{s_d / \sqrt{n}} = \frac{0.3333 - 0}{1.6259 / \sqrt{30}} = 1.1229$$

Reject H_0 if $|t\text{ - }statistic| \geq t_{\alpha/2}$

$|1.1229| < t_{\alpha/2}$ $\therefore$ Cannot Reject H_0

Result:

p-value = between 0.1 and 0.25 (greater than alpha)

There is no significant increase or decrease of serious cross-median crashes from 65 mph segments to 70 mph segments.

<u>Comparing FATAL Nighttime Crashes</u>

Same definitions as before

$\mu_d = \mu_{after-before}$

$H_0 : \mu_d = 0$

$H_a : \mu_d \neq 0$

$n = 30$

$\alpha = 0.05$

$\bar{d} = 0.3333$

$s_d = 1.655$

$t_{\alpha/2} = 2.045$

$$t - statistic = \frac{\bar{d} - D_0}{s_d / \sqrt{n}} = \frac{0.3333 - 0}{1.655 / \sqrt{30}} = 1.544$$

Reject H_0 if $|t\text{ - }statistic| \geq t_{\alpha/2}$

$|1.544| < t_{\alpha/2}$ $\therefore$ Cannot Reject H_0

Result:

p-value = between 0.1 and 0.25 (greater than alpha)

There is no significant increase or decrease of fatal nighttime crashes from 65 mph segments to 70 mph segments.