

Safety Effects of a Variable Speed Limit System During Fog Events

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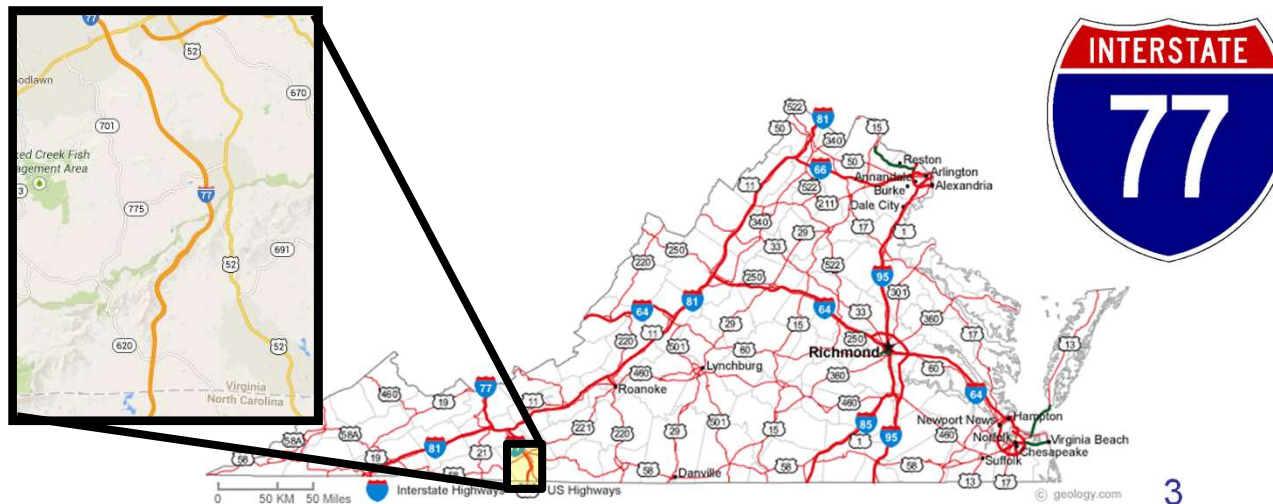
Safety Issues on I-77 in Virginia

- Frequent, dense fog creates dangerous driving conditions for motorists on I-77 in rural southwest Virginia
- Low visibility can lead to chain-reaction rear-end crashes
 - 95 vehicle crash event with 3 fatalities March 30, 2013
 - 28 vehicle crash event on October 3, 2014



I-77 Fog VSL Site Description

- 18,000 AADT with 27% trucks
- 65 mph base speed limit
- Sustained -4% grade for 6 miles in southbound direction
- Multiple signing and delineation efforts have been deployed by VDOT



I-77 VSL System

- A \$7.5 million VSL system was activated in October 2016
 - 13 DMSs
 - 36 full matrix VSL signs (60"x60")
 - 8 VSL cutout signs (48"x60")
 - 25 CCTV cameras
 - 22 Wavetronix sensors
 - 14 Vaisala RWIS stations
- Signs are dual indicated with an average spacing of about 1 mile for 12 miles

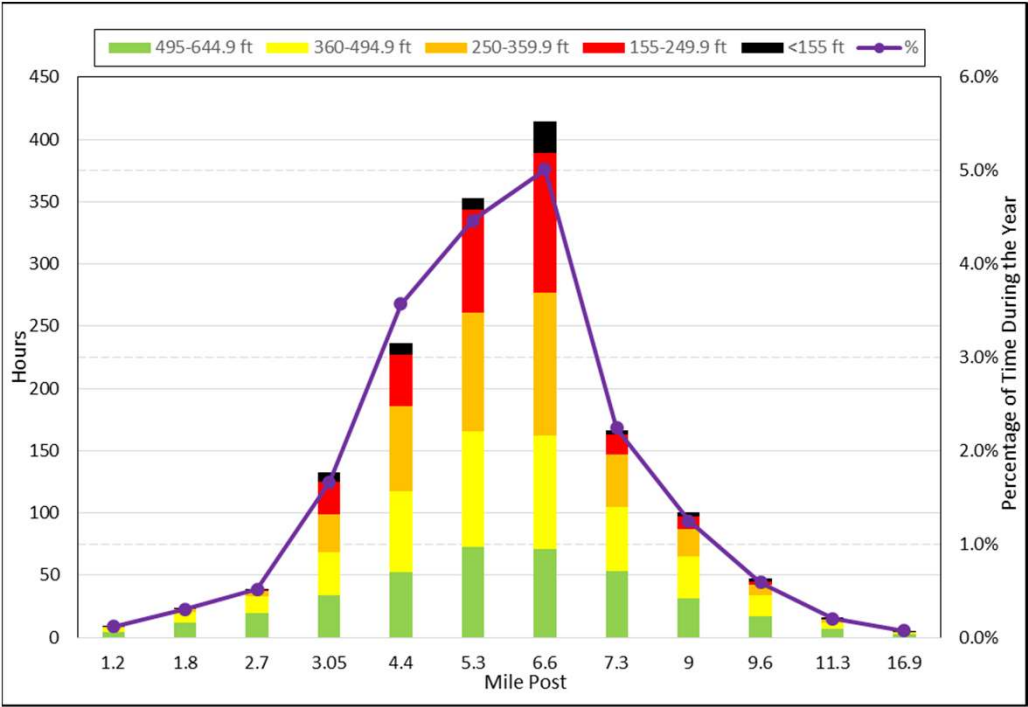


Project Objectives

- Determine safety and driver behavior before system activation
- Define a control algorithm for the VSL system
- Assess effectiveness of the system post-activation



Fog Distribution 2010-2015

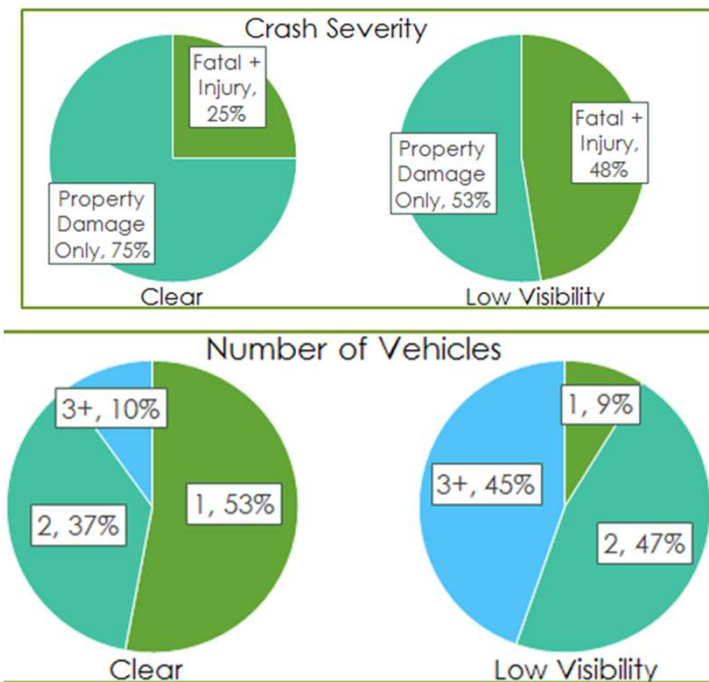


Visibility Range	Safe Speed	
> 645 feet	65 MPH	
495 - 645 feet	55 MPH	LOW VISIBILITY
360 - 495 feet	45 MPH	
255 - 360 feet	35 MPH	
155 - 250 feet	25 MPH	
< 155 feet	< 25 MPH	

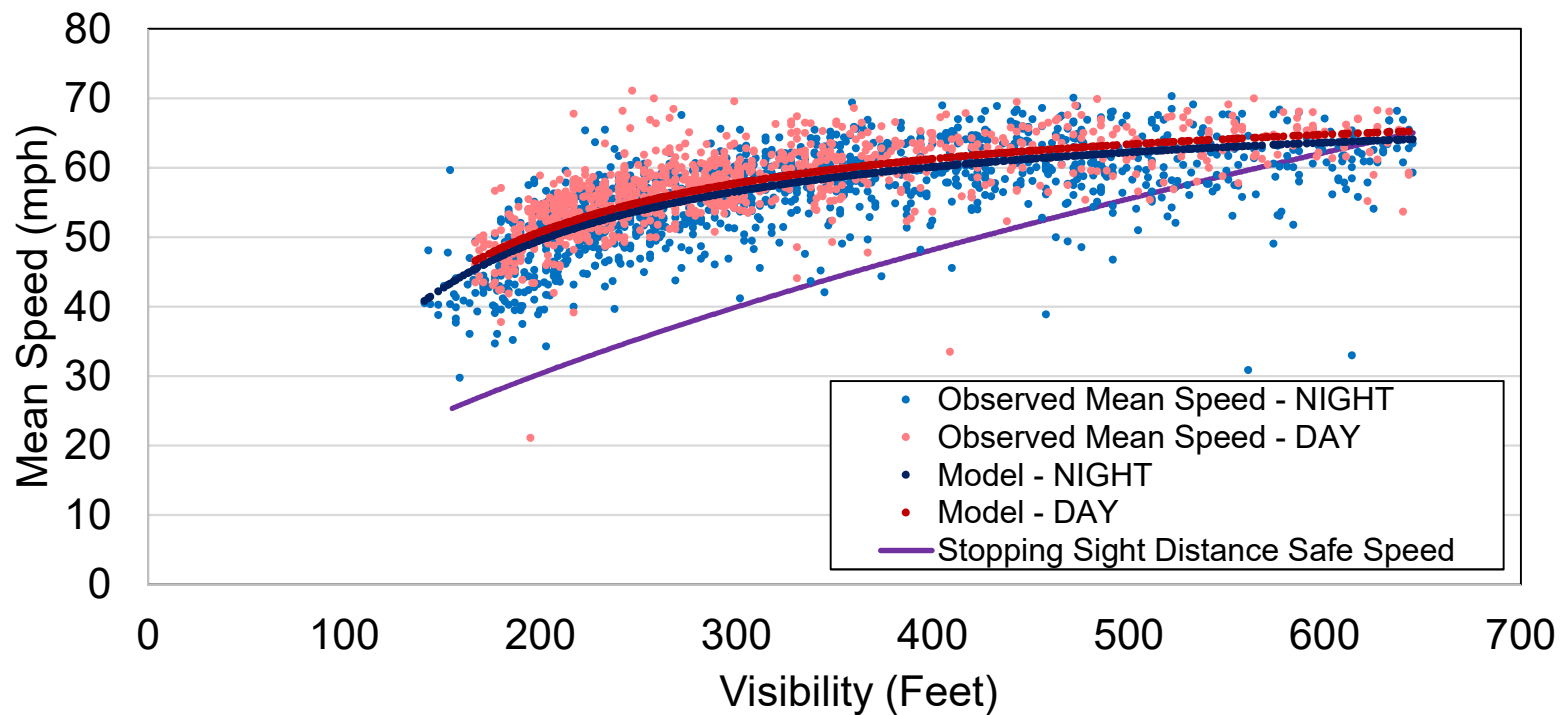


I-77 “Before” Crash Data

- 11% of crashes during fog
- 84% of fog crashes in SB (downhill) direction
- Crash rate more than double that during clear conditions

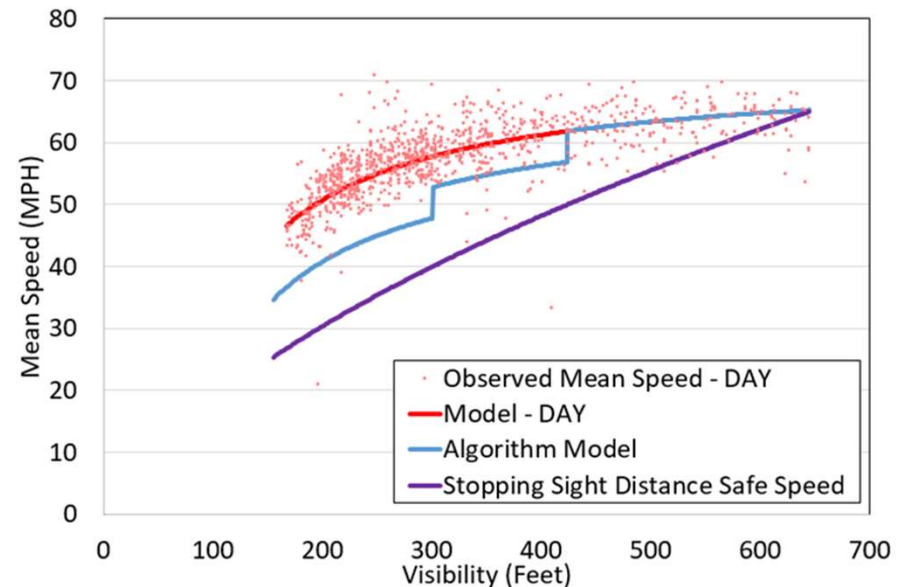


I-77 SB “Before” Speed vs. Visibility



I-77 VSL Control Algorithm

- “Before” data showed drivers traveled significantly faster than visibility warranted during fog
- Concern that posting SSD based speed would increase variance, so step function created
- VSLs are smoothed and grouped to transition into and out of fog
- Semi-automated system
- 10 mph step down, 6 minute update frequency, 30 mph minimum

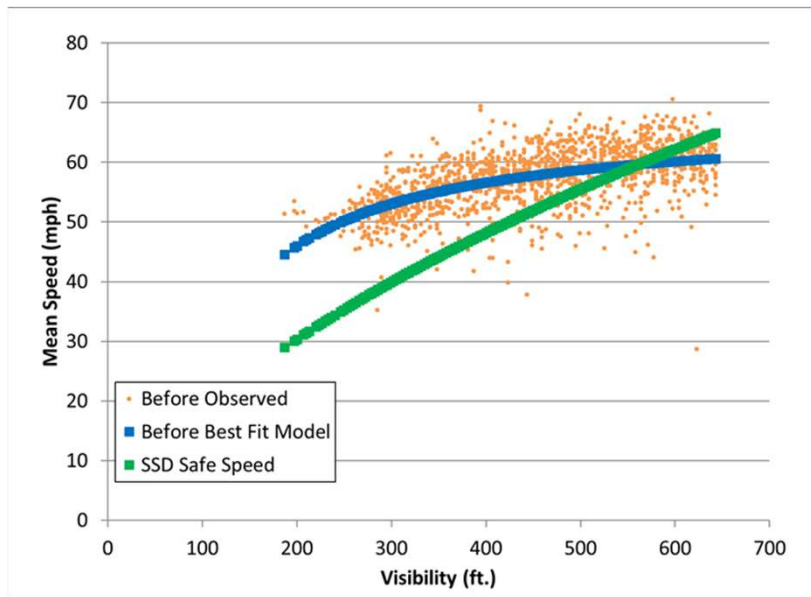


Education and Outreach

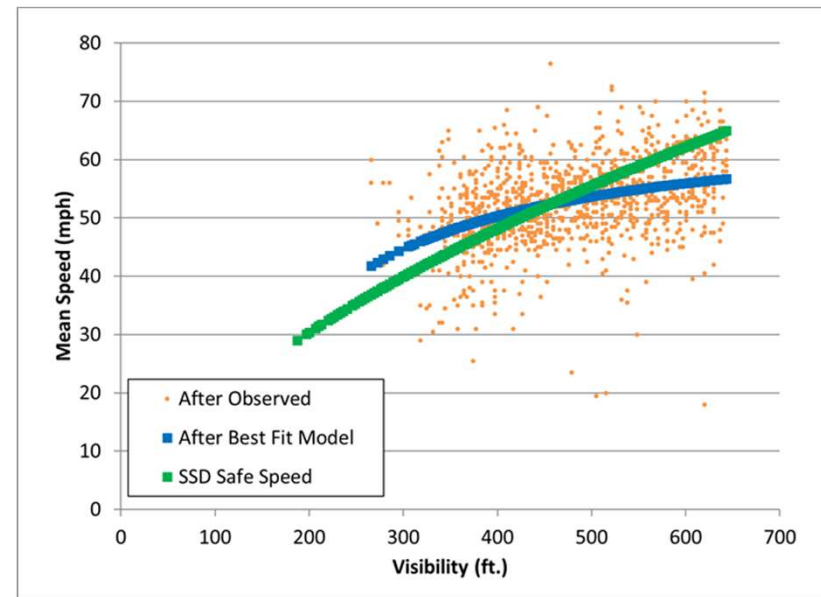
- Enforcement during fog events is limited due to concerns about officer safety
- App for officers to view PSLs, archived at TOC
- Outreach
 - Outreach to local media
 - Rural area, most traffic is not local
 - Focused on advance warning signing for unfamiliar drivers



System Effectiveness - MP 4.4



Before



After

Based on 106 "after" fog events



Before vs. After at MP 4.4

Statistically significant reductions of about 5-6 mph

Visibility Bin (ft.)	SSD Safe Speed (mph)	Before		After	
		No. of Intervals	Mean Speed (mph)	No. of Intervals	Mean Speed (mph)
495-645	55-65	513	59.9	451	54.1
360-495	45-55	524	56.6	543	50.3
250-360	35-45	297	52.4	74	46.5
155-250	25-35	22	49.8	0	-
<155	<25	0	-	0	-



Before vs. After Crash Data

(2013-2015 vs. 2017-2019)

Weather	Severity	Change
All	All	+9.6%
	Fatal + Injury	-11.1%
Fog	All	-73.4%
	Fatal + Injury	-78.3%

- Crash Modification Factors (CMFs) calculated using Empirical Bayes Method:
 - Fog crashes: $CMF=0.238$ ($p<0.05$)
 - Fog fatal and injury crashes: $CMF = 0.167$ ($p<0.05$)



Effectiveness and Lessons Learned

- Issues affecting compliance to posted VSL:
 - Drivers do not decelerate significantly until they actually reach the fog – creates noncompliance in reduction zone approaching critical section. This impacts sign spacing.
- Speed changes were less pronounced than changes in crashes
- Other factors being examined for future VSL usage: snow/ice, high winds, and work zones



Questions?

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http://www.virginiadot.org/vtrc/main/online_reports/pdf/17-r4.pdf

