Using Empirical Bayes method to identify crash hot spots after implementing VSL system on a rural interstate corridor

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Overview

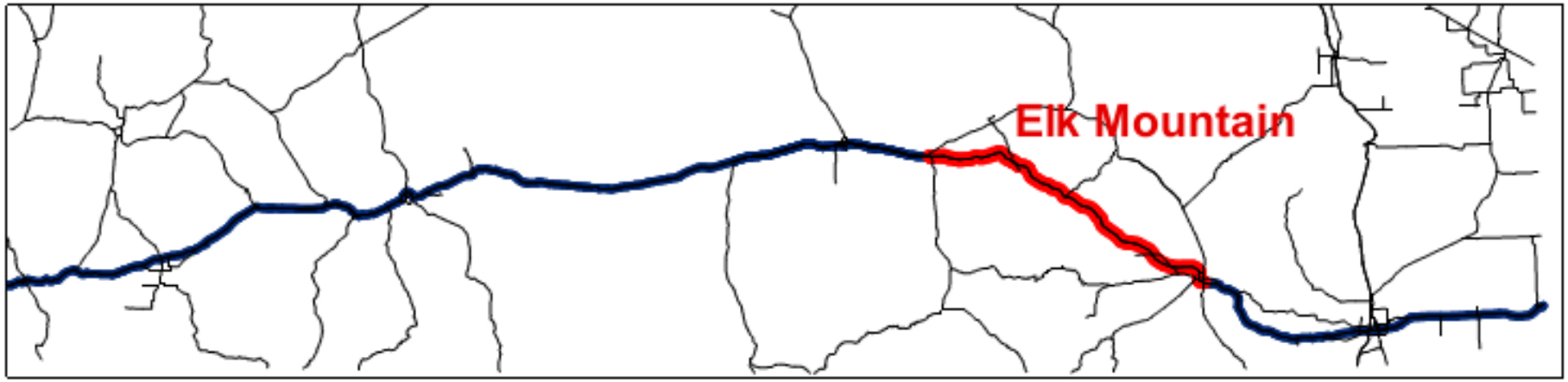
- Background
- Objective
- Study Area
- Research Tasks
- Literature Review
- Modeling Methodology
- Data Collection
- Data Analysis
  - Identify the effectiveness of VSL system
  - Identify Crash Hot Spots
- Summary

Objective

1. Identify the effectiveness of VSL system
2. Identify crash hot spots after implementing a safety scheme using Empirical Bayes Method.

Study Area

- Elk Mountain Corridor (MP 238- MP 291) on I-80



Study Area, Cont.

I-80 Background Information

- > 60% of the traffic in Wyoming is Commercial vehicles
- AADT: 11,000
- Frequent adverse weather conditions
  - Strong winds
  - Heavy snow
    - Visibility problems
    - Drifting of snow
  - Icy Conditions

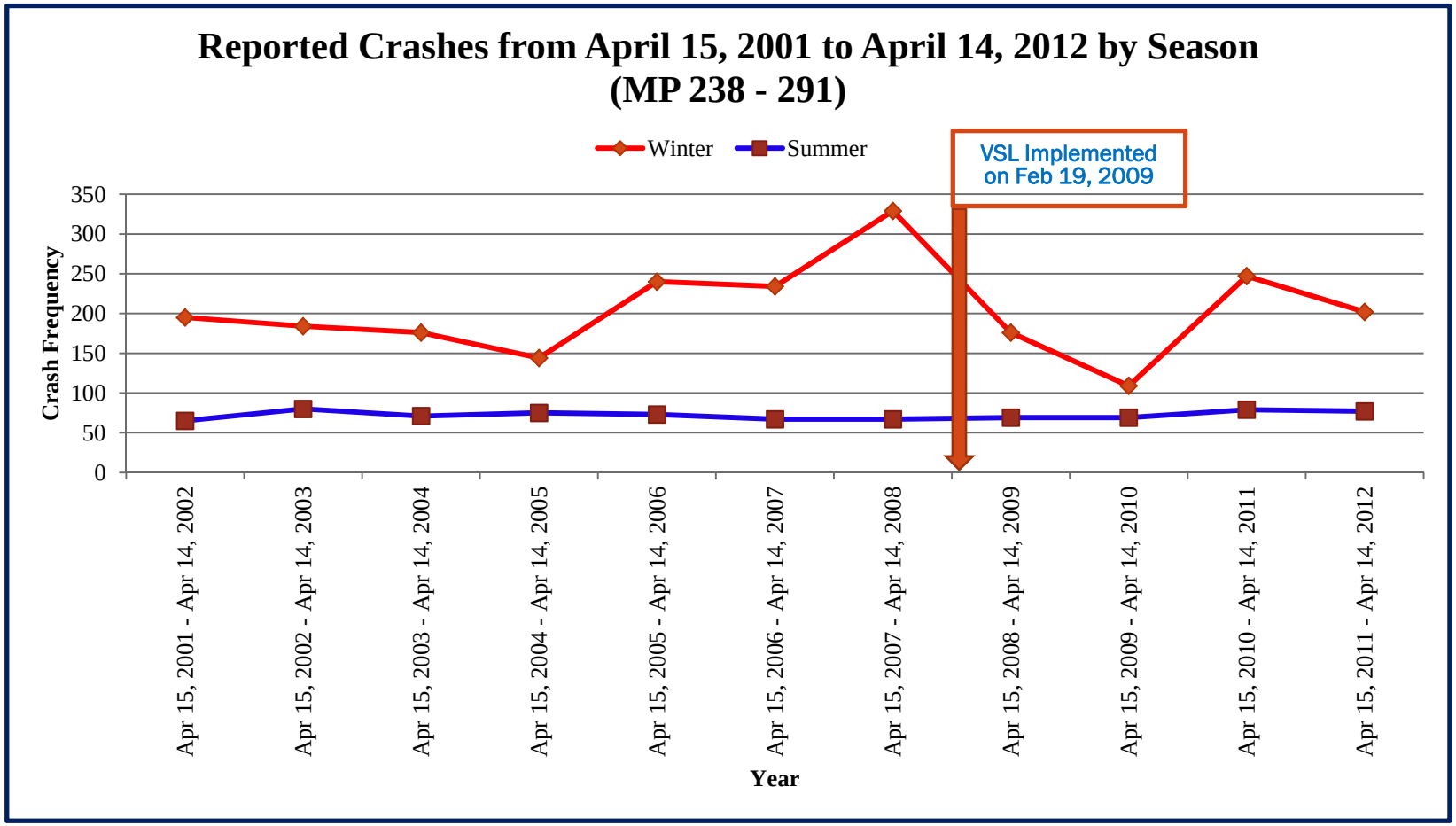
Study Area, Cont.

I-80 Background Information, Cont.

- Frequent closures
- Crash rate is higher than average in the VSL corridors

Study Area, Cont.

- Elk Mountain Corridor (MP 238- MP 291)



Research Tasks

Task 1: Development of SPF

Task 2: Identify the effectiveness of VSL system

Task 3: Identification of Crash Hot Spots

Literature Review

Characteristics of Crash Data in terms of Statistical Modeling

- Non-negative integer
- Count data
- Overdispersed
- Excess zero values in Response Variable

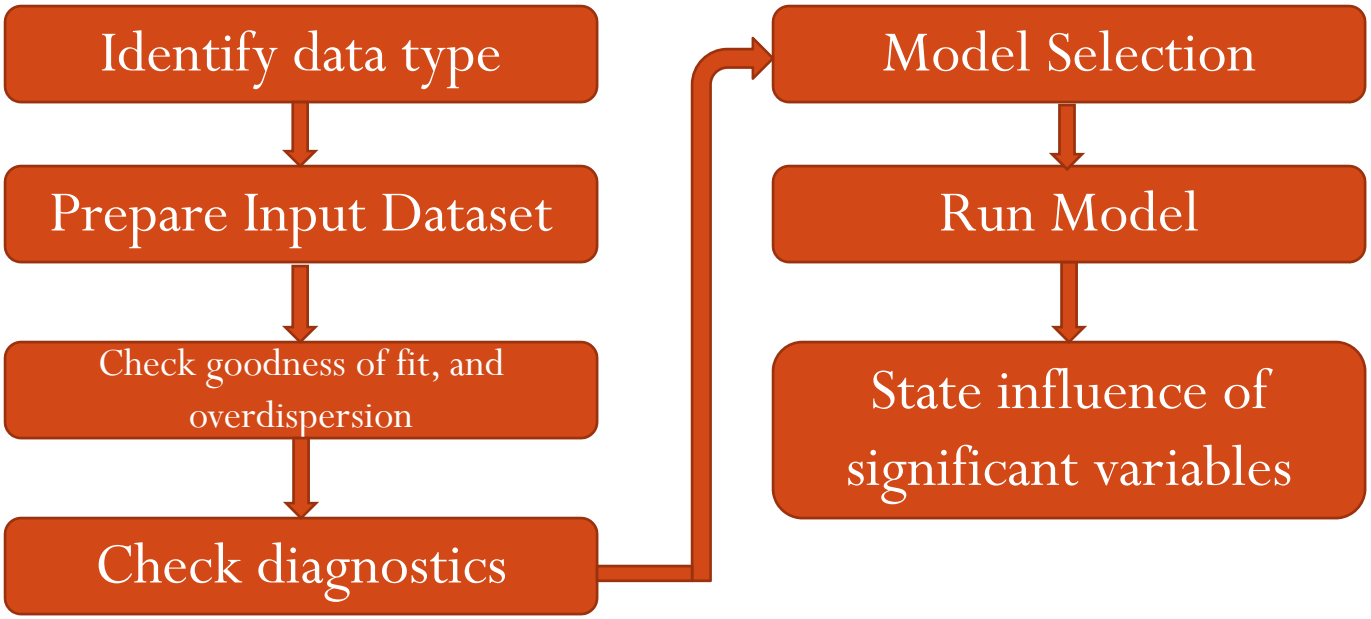
Literature Review, Cont.

Modeling Techniques of SPF

- Multiple Linear Regression
- Poisson Regression
- Zero Inflated Poisson Regression
- Negative Binomial
- Zero Inflated Negative Binomial

Modeling Methodology

Steps of Modeling SPF



Modeling Methodology, Cont.

- Empirical Bayes Method
  - Before-After studies
  - Regression to mean
  - SPF
  - Evaluate safety effectiveness
  - Crash hot spots

Data Collection

Data Types and Sources

1. Crash Data (Source: WYDOT)
2. VSL implementation dates (Source: WYDOT)
3. Weather Forecast Data (Source: NorthWest Weathernet)

Data Analysis

Task 1: Development of SPF

1. SPF considering weather as the explanatory variables.

2. SPF considering road conditions as the explanatory variable

Data Analysis, cont.

SPF considering weather as the explanatory variables.

Response Variable : Crash Frequency by 7 Days

Explanatory Variables: Snow, Ice, Frost, Wind, VSL (Binary), VSL Corridors (Laramie Cheyenne, Elk Mountain, Rock Springs, Evanston)

Ranking	Snow	Ice	Frost	Wind
0-2.5	Snow1	Ice1	Frost1	Wind1
2.5-5	Snow2	Ice2	Frost2	Wind2
5-7.5	Snow3	Ice3	Frost3	Wind3
7.5-10	Snow4	Ice4	Frost4	Wind4

Distribution: Negative Binomial

Data Analysis, cont.

Model Output : Negative Binomial (NB)

	Initial Model		Final Model	
Independent Variables	Estimate	Pr(>|z|)	Estimate	Pr(>|z|)
(Intercept)	8.9299	<0.001***	26.1017	<0.001***
Snow2	1.9178	<0.001***	1.9404	<0.001***
Snow3	1.3797	0.3297		
Snow4	NA	NA		
Ice2	1.1405	0.4153		
Ice3	1.1432	0.8145		
Ice4	NA	NA		
Frost2	-0.8119	0.7527		
Frost3	1.0825	0.9055		
Frost4	-0.3318	0.2383		
Wind2	1.3554	<0.05*	1.4174	<0.01**
Wind3	1.5563	<0.05*	1.5602	<0.01**
Wind4	1.0528	0.929		
VSL	**-0.7236**	**<0.01****	**-0.6736**	**<0.001*****
LaramieCheyenne	1.5989	0.4841	1.3656	<0.05*
Evanston	1.1395	0.4074		
RockSprings	1.5519	<0.05*	1.4071	<0.01**

Data Analysis, Cont.

SPF considering road conditions as the explanatory variables

Response Variable : Crash Frequency by One-mile segment

Explanatory Variables: Road Conditions (Dry, Ice/Frost, Slush, Wet)

Distribution: Negative Binomial

Data Analysis, cont.

Model Output : Negative Binomial (NB)

Independent Variable	Estimate	Pr(>|z|)
(Intercept)	1.6303	< 0.001 ***
Dry	0.0665	< 0.001***
Ice.Frost	0.0510	< 0.001***
Slush	0.0412	0.38
Snow	0.0852	0.001***
Wet	0.0976	0.1

$$log(\lambda_i) = 1.630268 + 0.066471 * (Dry) + 0.059970 * (Ice.Frost) + 0.085284 * (Snow)$$

Summary

1. VSL system helps to reduce crash frequency

(the expected crash frequency is expected to decrease by around 0.67 crashes per seven days.)

2. Crash Hot Spots

MP	Abs(Safety E./SE(safety E.))
251-252	0.82
252-253	1.10
271-272	0.76
263-264	0.78
256-257	0.61
288-289	**2.02**
269-270	0.57
273-274	0.54
259-260	0.35
247-248	0.32

260-261	0.28
286-287	1.13
245-246	0.21
287-288	**2.30**
243-244	0.20
276-277	0.21
283-284	0.72
279-280	0.46
254-255	0.08
277-278	0.05
275-276	0.00

Questions
and
Comments
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