Safety Evaluation of the Variable Speed Limit System In British Columbia

BC Ministry of Transportation and Infrastructure

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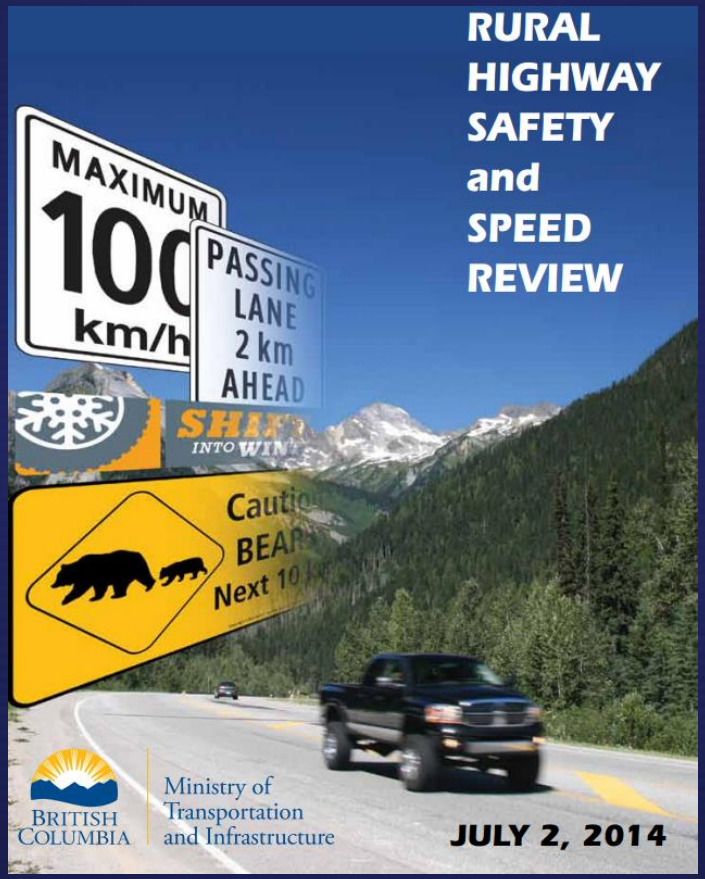
Outline

- Background
- System Overview
- Research Objective
- Methodology
- Results
- Conclusions

Background


RURAL
HIGHWAY
SAFETY
and
SPEED
REVIEW
MAXIMUM
100
km/h
PASSING
LANE
2 km
AHEAD
Ministry of
Transportation
and Infrastructure
JULY 2, 2014

Background

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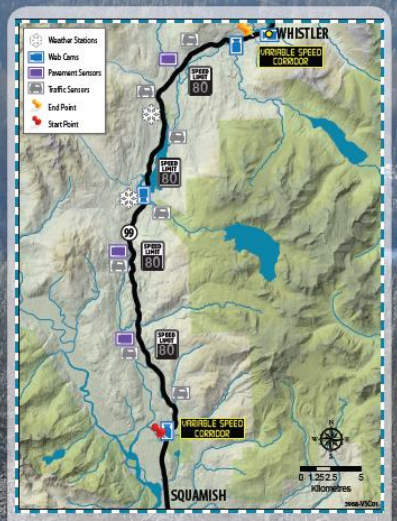
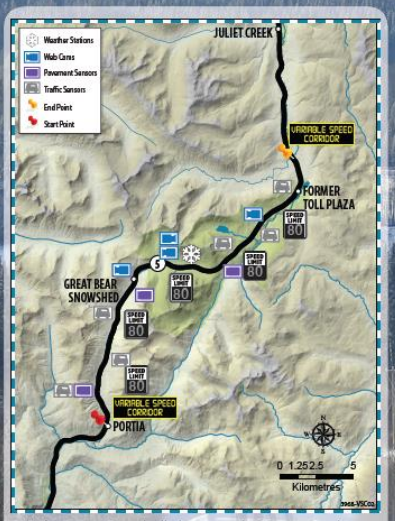
System Overview

VARIABLE SPEED LIMIT SYSTEMS



Highway 99 – Sea-to-Sky: between Squamish and Whistler



Highway 5 – Coquihalla between the Portia Interchange and the former toll booth plaza

Highway 1 – west of Revelstoke, between the Perry River Bridge and Highway 23 South interchange

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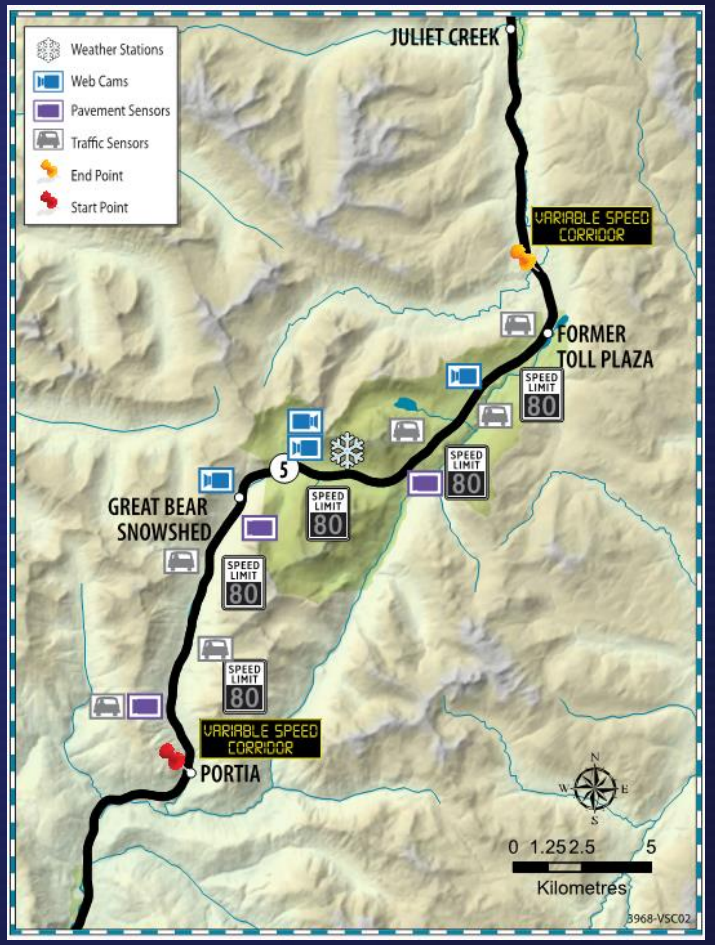
System Overview

Highway 1 – Perry River Bridge to Highway 23 Junction

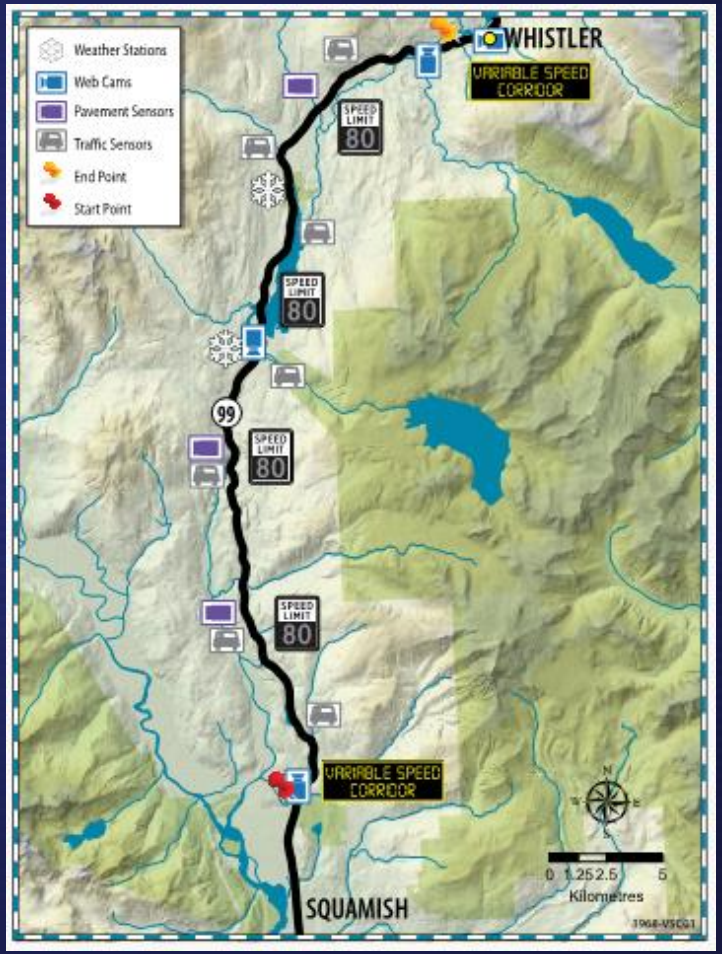
System Overview

Highway 5 –Portia Interchange to former Toll Plaza



System Overview

Highway 99- Squamish Valley Road to Function Junction



System Overview

Research Objective

Safety evaluation of the VSLSs

- Highway 1 from Perry River to Highway 23 Junction (Revelstoke)
- Highway 5 from Portia Interchange to the former Toll Plaza

Analysis Methodology

- Simple Before and After
- Empirical Bayes with Safety Performance Functions (SPFs)
- Data of three groups of sites were needed for the analysis:
  - Treatment/Evaluation Sites
  - Reference Sites
  - Comparison Sites

Analysis Methodology: *Data*

- **Evaluation Sites**
  - 23 sites on two corridors
  - 108.5 km total length
- **Reference Sites**
  - To develop SPFs needed for the evaluation
  - RAU2 and RFD4 highway segments
- **Comparison Sites**
  - Account for history and maturation

Analysis Methodology: *Data*

- **Collision Data**
  - Winter season serious collisions only (fatal + injury) before and after VSLS implementations
  - Five winter seasons before data
  - One winter season after data
- **Traffic Volumes**
  - Seasonal average of daily traffic volumes

Empirical Bayes Method

$$O.R. = \frac{D}{\hat{B}_{CG}}$$

$$E(O.R.) = \frac{O.R.}{(1 + \frac{Var\hat{B}_{CG}}{\hat{B}_{CG}^{\,2}})}$$

Where:

$\hat{B}_{CG}$ = EB safety estimate of collisions in the treatment group had no treatment taken place during post improvement period,

D = Observed number of collisions in the treatment group during post improvement period.

Empirical Bayes Method

$$(EB_i)_b = \gamma_i \cdot \mu_i + (1 - \gamma_i) \cdot y_i$$

$$Var(EB_i)_b = \gamma_i \cdot (1 - \gamma_i) \cdot \mu_i + (1 - \gamma_i)^2 \cdot y_i$$

$$\gamma_i = \frac{1}{1 + \frac{\mu_i}{k}}$$

Where:

y_i = Observed collisions in the before period for location *i*

γ_i = Weight assigned to the predicted value for location *I*

k = Dispersion parameter of the negative binomial model

μ_i = Expected collision frequency at location *i*

Empirical Bayes Method

$$\widehat{B} = (EB_i)_a = (EB_i)_b \times \frac{(\mu_i)_a}{(\mu_i)_b}$$

$$Var\widehat{B} = Var(EB_i)_a = Var(EB_i)_b \times \left[\frac{(\mu_i)_a}{(\mu_i)_b}\right]^2$$

Where:

$(EBi)_a$ = EB safety estimate of treated site *i* in the "after" period had no treatment taken place.

$(EBi)_b$ = EB safety estimate of treated site *i* in the "before" period.

$(\mu_i)_a$ = Expected mean collision frequency given by the SPF for a treated site

Empirical Bayes Method

$$\hat{B}_{CG} = \frac{\frac{C}{A} \times \hat{B}}{\left(1 + \frac{1}{A}\right)}$$

$$Var\hat{B}_{CG} = \hat{B}_{CG}^{\,2} \times \left[\frac{1}{A} + \frac{1}{C} + \frac{1}{\hat{B}}\right]$$

Where:

C = observed number of collisions in the comparison group during the after period

A = observed number of collisions in the comparison group during the before period

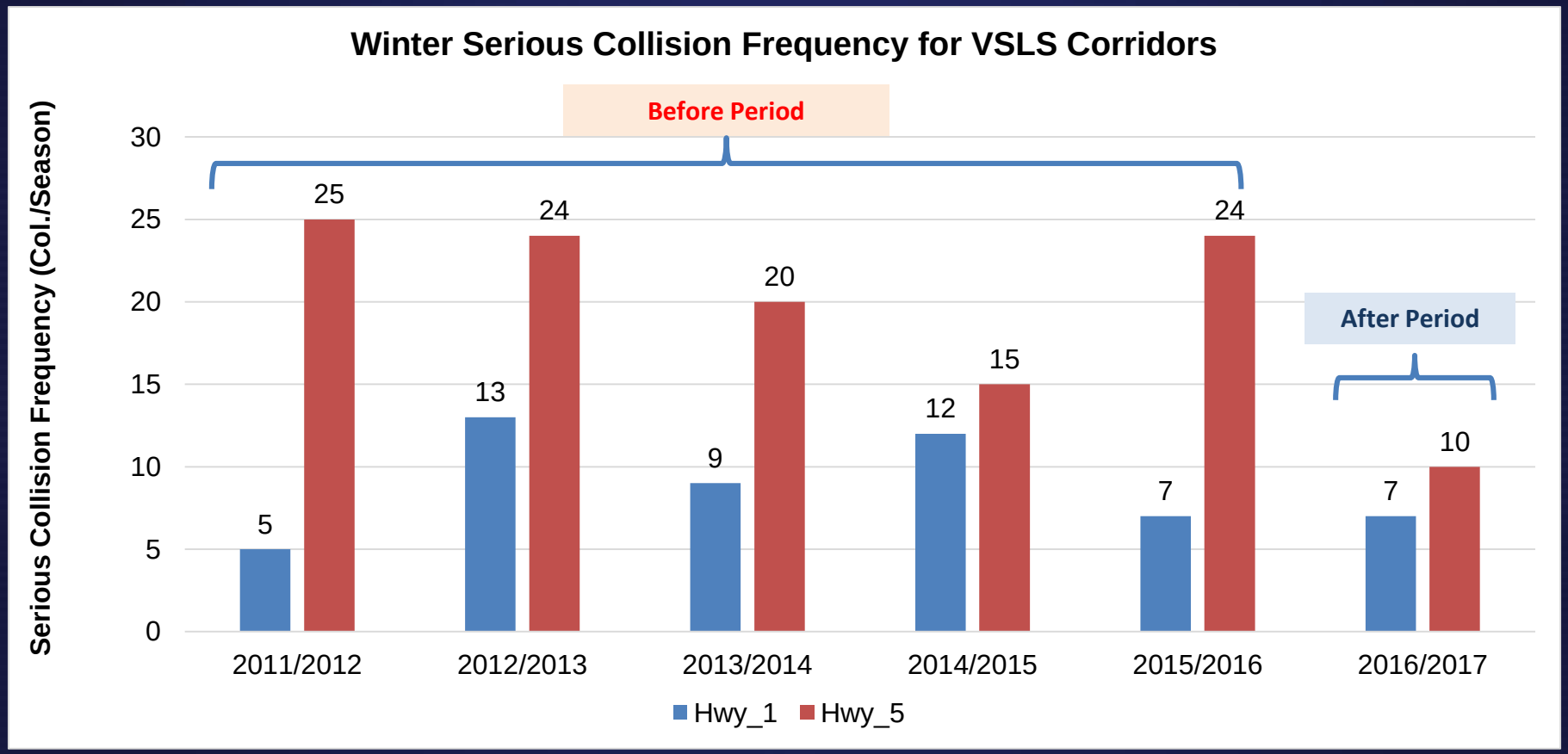
$\hat{B}_{CG}$ = corrected EB estimate of collisions in the treatment group during the after period

Results: *Comparison Groups*

- Comparison groups suitability test
- O.R. mean value

	O.R.	
	Mean	Variance
Hwy 1	1.06	1.569
Hwy 5	0.99	0.031

Results: *Simple Before and After*



Results: *Simple Before and After*

Without Comparison Group

Highway	Change in WSC *	Standard Error	T-statistic	95% Significance
1	-25.4%	0.306	0.83	Insignificant
5	-54.0%	0.153	3.54	Significant
Overall	-45.0%	0.141	3.20	Significant

With Comparison Group

Highway	Change in WSC	Standard Error	T-statistic	95% Significance
1	-1.0%	0.428	0.02	Insignificant
5	-63.1%	0.124	5.07	Significant
Overall	-49.8%	0.131	3.79	Significant

** Winter Serious Collisions*

Results: *Empirical Bayes Method*

Developed SPFs

RAU2 $\mu = 0.00263 \, V_i^{0.7349} * L_i^{0.8053}$ $k = 3.61$

RFD4 $\mu = 0.01826 * V_i^{0.4641} * L_i^{0.9442}$ $k = 3.00$

Where:

μ = Expected number of serious collisions in 5 winter seasons

V_i = SADT volume at a particular location

L_i = Length of a particular road section in km

k = Dispersion parameter of the negative binomial model

Results: *Empirical Bayes Method*

Highway	Change in WSC*	Standard Error	T-statistic	95% Significance
1	+8.5%	0.469	0.18	Insignificant
5	-52.3%	0.162	3.22	Significant
Overall	-37.4%	0.166	2.26	Significant

** Winter Serious Collisions*

Conclusions

- Significant reduction in WSC on Hwy 5
- Insignificant change in WSC on Hwy 1 with large standard error
- Small sample size – only one season of after data
- Further evaluation to be done upon data availability

Questions?