Identifying weather-related factors affecting crash severity and consequent response actions : a comparative analysis of the multinomial logit and ordered probit model forms
by Daniel Thomas Blomquist

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering
Montana State University

Abstract:
This investigation, focused on a mountainous pass corridor in southern Montana, considers the twofold problem of: (1) subjectivity in action-based decision-making related to adverse weather conditions by response personnel and (2) debate over the appropriate statistical form for modeling crash severity.

To address these problems, researchers developed a statistical model relating weather and roadway conditions to crash severity. Interpretation of the model findings were intended to aid response personnel by defining predetermined courses of action dependent on those weather and roadway conditions deemed to result in the lowest levels of safety. Further, modeling severity data with both multinomial logit and ordered probit methods, a direct comparison would allow the most appropriate model form for this application to be determined.

Results of this effort show all model coefficients are plausible in magnitude and direction of effect with both models having reasonable goodness of fit. Independent variables found to have a significant effect on crash severity for the ordered probit model included the year 1999, sideswipe same direction collision type, the presences of right-side guardrail, the presence of a spiral curve, a posted speed limit of 75 mph for cars/65 mph for trucks and wind speed. Independent variables significant in the multinomial logit model are van vehicle type, sideswipe same direction collision type, the presence of right-side guardrail, the presence of a spiral curve, damp roadway surface conditions and wind speed.

The lack of significant weather-related variables in the final models limits the conclusions made to guide action-based decision-making related to adverse weather conditions. Increased wind speed has the effect of decreasing crash severity so no safety-related threshold can be set to guide response activities. Damp roadway surface conditions increase the probability of a more severe crash so it may be justifiable to include damp road warnings with other traditional roadway surface condition warnings given to motorists entering the corridor. Road closures are likely not warranted under these conditions.

The overall agreement in quantitative results between the two model forms used indicates the more appropriate model form must be decided on by qualitative assessments such as ease of use and interpretation of model results. Based on these assessments, the most appropriate statistical form for modeling crash severity is the ordered probit model.

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APPROVAL

Of a thesis submitted by

Daniel Thomas Blomquist

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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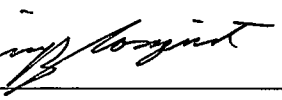
Signature 

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CHAPTER 1

INTRODUCTION

> "The impact that traffic crashes have on society is significant. Individuals injured (or killed) in traffic crashes must deal with pain and suffering, medical costs, wage loss, higher insurance premium rates and vehicle repair costs. For society as a whole, traffic crashes result in enormous costs in terms of lost productivity and property damage. Clearly, efforts to improve our understanding of the factors that influence crash severity are warranted (1)."

The relationship between a multitude of risk factors and crash severity has long been a major concern in highway travel safety. One risk factor of special concern, especially in rural areas, is weather condition. Adverse weather can significantly change the condition of the roadway within a short period of time, often with little or no warning to motorists or response personnel charged with protecting the public safety. This Chapter elaborates on the scope of this problem, provides background information related to the SAFE-PASSAGE Project, which this investigation complements, and details this report's content and organization to assist the reader in navigating the document.

Problem Description

Located along Interstate-90 between Bozeman, Montana and Livingston, Montana, Bozeman Pass faces challenges in providing safe travel for motorists (see Figure 1). During winter months, Bozeman Pass often experiences heavy snows and ice formation, conditions that are generally unpredictable and sudden. High winds present year-round

concerns. Crash statistics from January 1995 to December 1998 show an average of approximately 137 total crashes per year through this corridor with up to 68 percent having weather or weather-related pavement conditions as a contributing factor (see Figure 2).

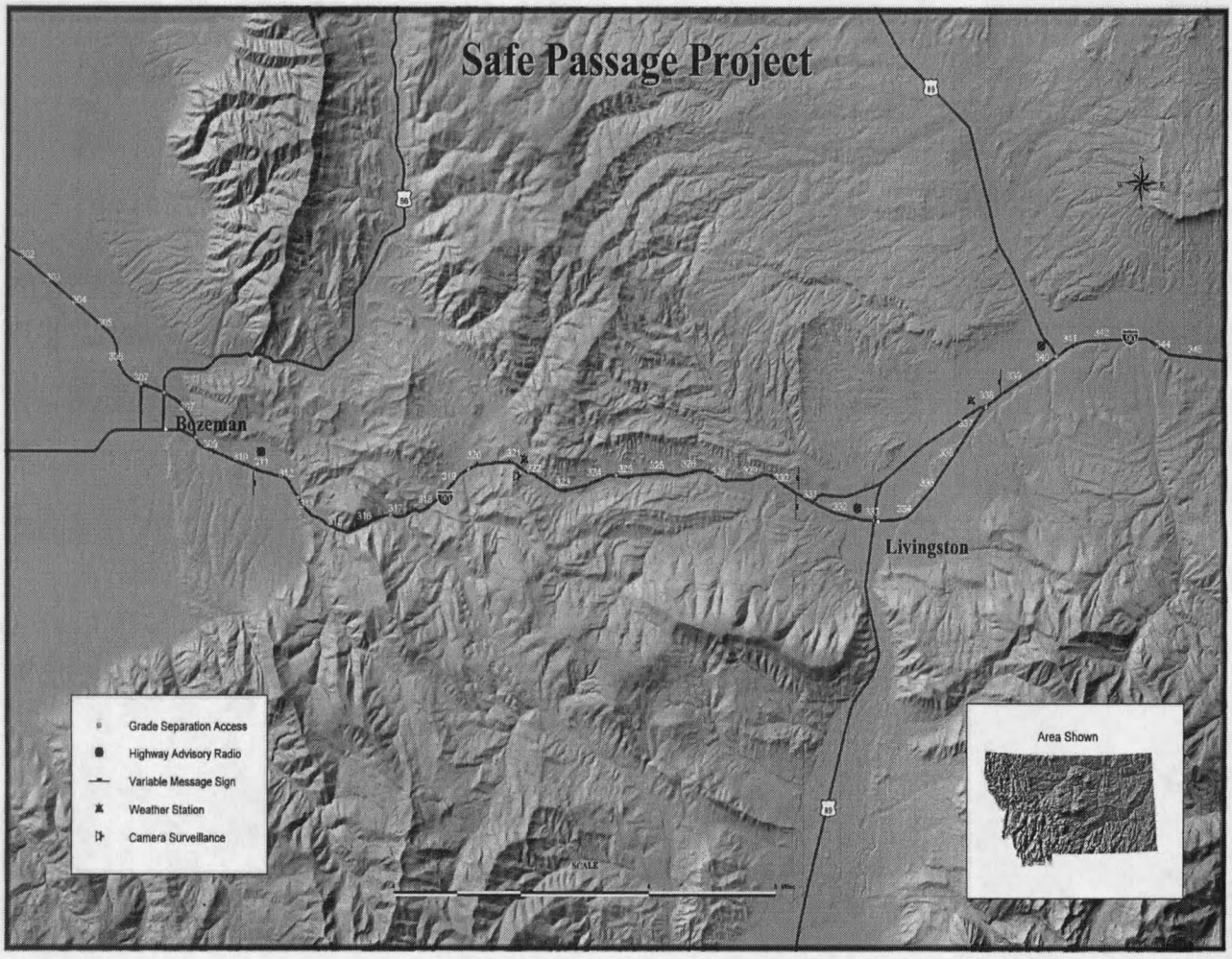

Figure 1. SAFE-PASSAGE Project Corridor.