# The Crow Tribe Motor Vehicle Crash Site Identification Project

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## Introduction

Unintentional injuries are the leading cause of death for American Indians/Alaska Natives (AI/AN) ages 1 - 44 residing in Montana (2005 - 2007). Motor vehicle crashes account for 68% of these deaths, leading to a motor vehicle mortality rate for AI/AN in Montana that is 2.4 times the state's overall rate (64.7 per 100,000 vs. 26.6 per 100,000).[1] The Crow Reservation, headquartered in Crow Agency, is the largest reservation in Montana. Home to 8,143 (71.7%) of the 11,357 enrolled Apsáalooke tribal members, the reservation covers more than 2.2 million acres.[2]

The purpose of this project was to identify and prioritize locations (road segments and cluster sites) where crashes were occurring using transportation data and geographical information system (GIS) technology and software.[3,4] The results could then guide injury reduction efforts by the Crow Tribe and the state of Montana.

## Methods

Approval to conduct and publish this project was obtained from the Crow Tribe's Health and Human Services Subcommittee and the Crow Tribal Legislature. Permission to publish was also obtained from the Montana-Wyoming Tribal Leader's Council, the Institutional Review Board for the IHS Billings Area.

Lengths of road segments and average daily traffic counts for reservation roads were obtained from the Montana Department of Transportation, Traffic Safety Bureau. I defined a MVC cluster site as three or more MVCs occurring within a 0.5 miles radius of each other. Data on motor vehicle crashes (MVCs) were obtained from two sources: the Montana Highway Patrol (MHP) motor vehicle crash data list (via the Montana Department of Transportation); and the Crow Bureau of Indian Affairs (BIA) law enforcement MVC reports. The Crow Tribe has a cross-jurisdiction agreement with the state of Montana Highway Patrol. The MHP responds to the majority of crashes on the reservation, especially crashes involving fatalities or severe injuries. The tribe does not have its own police department. Instead, the BIA provides law enforcement services to the tribe, including traffic-related events.

The MHP data contained information on MVCs occurring within and surrounding the Crow Indian Reservation for the years 1996 - 2009. The fields in this dataset contain unique coded identifiers, including crash location (mile marker and Montana Public Land Survey System coordinates), date, time, number of vehicles, number of injuries, number of fatalities, and weather conditions. I defined an "injury crash" as a police-reported crash other than one classified as "property damage only." A total of 1,208 on-reservation MVCs were reported by the MHP from 1996 - 2009. Elimination of non-injury crashes reduced the number to 545. I obtained GPS coordinates for most of these by visiting the site of each crash. Because of safety concerns, I plotted crashes occurring on Interstate 90 (which runs directly through the Crow Indian Reservation) using GIS software to convert mile marker locations from the Highway Patrol reports to GPS coordinates. ArcView 9.3 software was used to plot crashes occurring on small rural roads without mile markers, using township, range, and section data from the Montana Public Land Survey System (PLSS).

The Crow BIA Law Enforcement MVC reports were the second source of MVC data. A total of 59 MVC police reports were reviewed for the period January 1, 2006, to September 30, 2008. Of these 59 reports, 20 (34%) were eliminated because the location of the crash was not recorded; and 13 or the remaining 39 reports (33%) were identified as duplicates within the MHP database. The 26 unduplicated BIA-reported MVCs were recorded, GPS plotted, and entered into GIS software for analysis, resulting in a combined (MHP and Crow BIA) total of 571 crashes plotted for the Crow Reservation for the years 1996-2009.

To determine the rate and severity of motor vehicle crash injuries on different types of Crow Reservation roads (interstate, primary and secondary, and non-interstate national highway system or NINHS roads), I calculated three indices: annual crash rate, severity index, and severity rate. To compare the Crow Reservation results with state of Montana data, all crashes, including those with property damage only, were used in the calculations.

Annual crash rates for individual road segments per million vehicle miles travelled (VMT) were calculated as follows (where AADT = annual average daily traffic count):

> Crash rate (CR) = [(number of crashes in time period) x 106] ÷ [(AADT x 365 days per year) x (number of years) x (length of road segment in miles)]

Police reports contain a field for recording the highest severity of injury in a crash. We adopted the Montana Department of Transportation (DOT) formula to calculate a "severity index" for individual road segments:

> Severity Index (SI) = [8 (number of K + A crashes) + 3 (number of B + C crashes) + (number of O crashes)]/(total number of crashes)
> Where K = crash with fatality, A = crash with an incapacitating injury, B = crash with a non-incapacitating injury, C = crash with a possible injury, and O = crash with property damage only.

Finally, a "severity rate" was calculated for each road segment to incorporate both the impact of crash rate and severity of injuries: Severity Rate (SR) = CR x SI. For example, a road segment X having a crash rate (CR) twice that of road segment Y, but a severity index (SI) half that of road segment Y, would have the same "severity rate" (SR) as road segment Y.

The GIS software used in this project was the Environmental Systems Research Institute's (ESRI) ArcMap version 9.3. I first created a geo-database file containing all the fields for the law enforcement reports. The file was then transferred into companion software (called ArcPad v7.0.1) for mobile GIS and field mapping applications using handheld and mobile.[5]

## Results

Among the 571 total eligible crashes, there were 83 fatalities and 910 injuries. The number of motor-vehicle crash fatalities per year ranged from one to eleven. The average number of annual MVC injuries was 91 between 1996 and 2001; and 51 between 2002 and 2008 (Figure 1).

Thirty-six MVC cluster sites were identified on the Crow Indian Reservation (Figure 2). Twenty-two (61%) of the cluster sites occurred along Interstate 90 and an additional six (17%) occurred along Secondary Route 313.

The crashes presented in Table 1 include those involving "property damage only" to maintain consistency with the state's transportation statistics. Secondary Route 87 had the highest crash rate at 1.1 per million vehicle miles traveled (VMT). US Highway 212 and Secondary Route 463 had the lowest crash rates: 0.14 per VMT. The road system with the highest severity rate (SR = 6.4) was also Secondary Route 87, followed by Secondary Route 451 (SR = 3.7) and Secondary Route 416 (SR = 3.2).

Compared to the statewide averages for rural roads in Montana, roads on the Crow Reservation had much lower crash rates (Table 1). The ratio of crash rates (Montana rural

**Figure 1. The Crow Tribe Motor Vehicle Crash Injuries by Year, 1996 - 2009 (2009 reflects a partial year's data).**

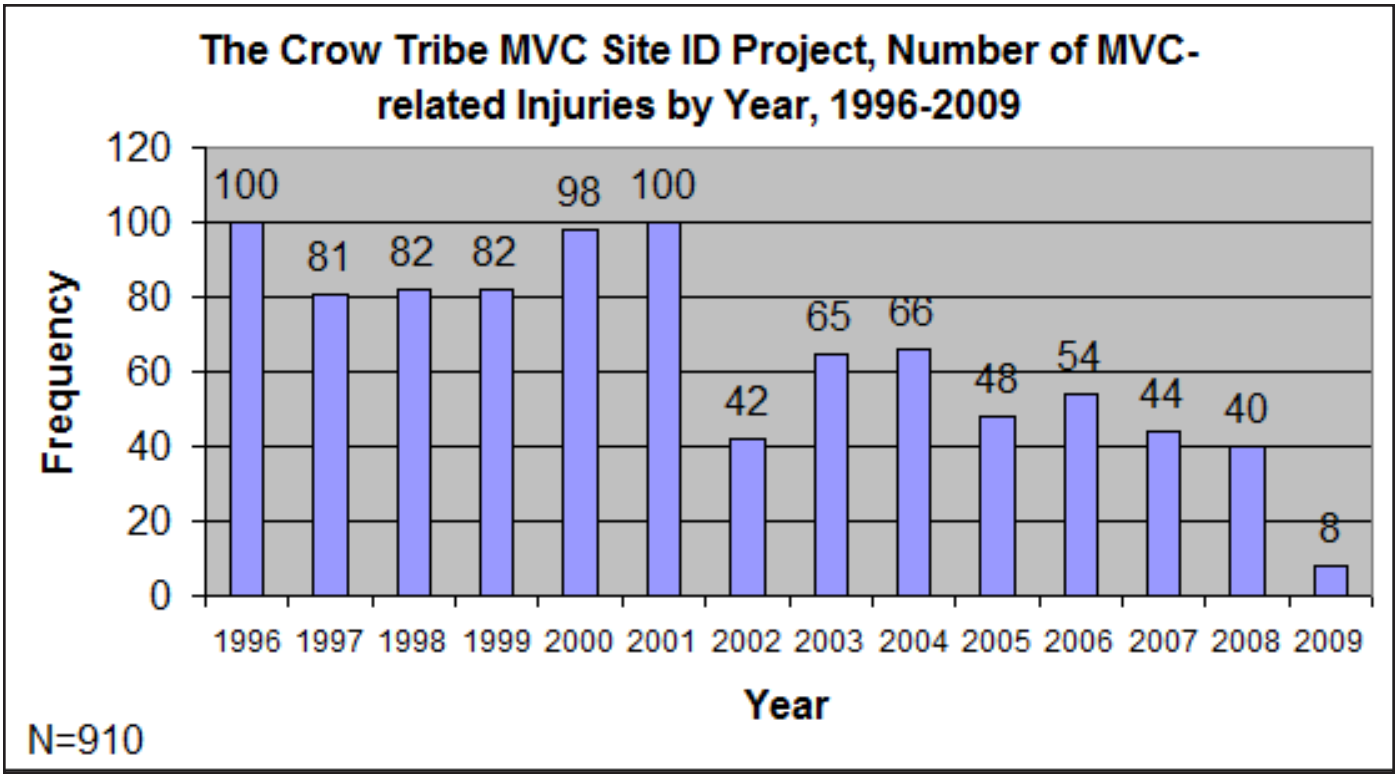
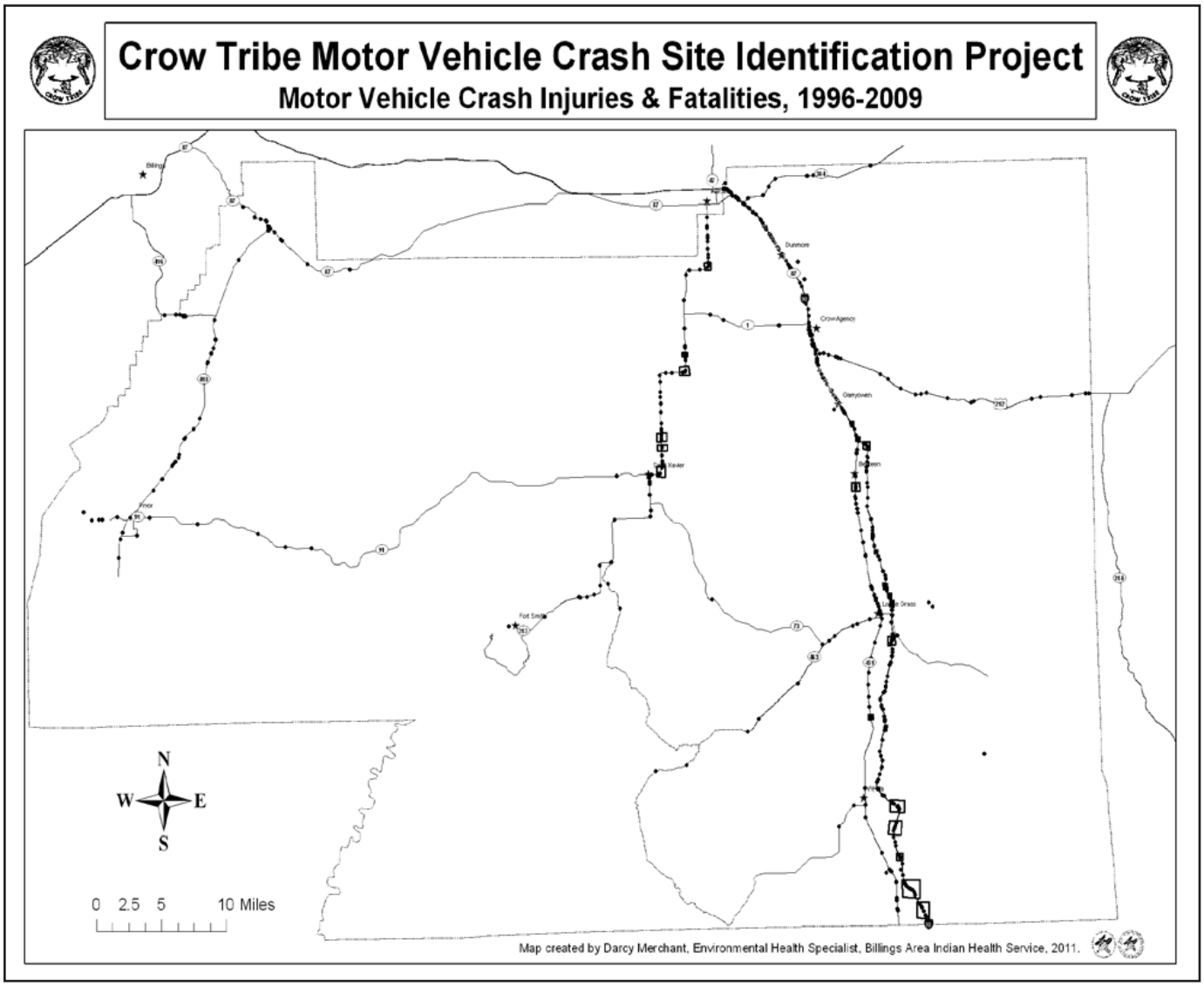


**Figure 2. Crow Tribe Reservation Motor Vehicle Crash Cluster Map.**




roads: Crow Reservation roads) was 2.8:1 for secondary roads, 5.2:1 for rural Interstate roads, and 7.6:1 for Non-Interstate National Highway System (NINHS) routes. The severity indices, however, were higher for Crow Reservation roads than for rural Montana roads: 1.8:1 for secondary routes, 1.4:1 for Interstate roads, and 1.6:1 for NINHS routes.

## Discussion

The Crow roads had much lower crash rates than the statewide average for rural roads, but higher severity indices. The lower crash rates may be due to under-reporting of property-damage-only (PDO) crashes on the Crow Reservation because of understaffing of local law enforcement; and/or unwillingness to report PDO crashes because of lack of insurance, expired licenses, or other disincentives to reporting. The higher severity indices on reservation roads may be due to lower rates of occupant restraint usage (seat belts and child passenger safety seats), excessive speeds, longer emergency response times, or most likely a combination of factors.

The findings of this report represent the best available geographic data on motor vehicle crashes occurring on the Crow Reservation. Nevertheless, this study has several weaknesses. First, the crash data are incomplete. Crow BIA Law Enforcement data were not available for 1996 - 2005 and for the last quarter of 2009. For the MHP reports, data were not available for 2008 and 2009. I did not obtain police reports from the county sheriff's department, which also responds to crashes on a portion of the reservation. Second, the number of MVC fatalities is under-reported in these data, because they are deaths occurring at the time of the crash, not in the first 30 days

**Table 1. Motor Vehicle Crash Rates* per Million Vehicle Miles Traveled, Severity Index, and Severity Rate by Roadway Within the Boundaries of the Crow Indian Reservation, 1996 - 2009.**

| Crow Reservation Roadways, 1996-2009 | Crash Rate (CR) | Severity Index (SI) | Severity Rate (CRxSI) |
|---|---|---|---|
| Secondary Route 87 | 1.1 | 5.84 | 6.4 |
| Secondary Route 451 | 0.77 | 4.79 | 3.7 |
| Secondary Route 416 | 0.6 | 5.30 | 3.2 |
| Secondary Route 313 | 0.48 | 3.38 | 1.6 |
| Secondary Route 418 | 0.39 | 3.44 | 1.3 |
| Secondary Route 384 | 0.2 | 2.61 | 0.5 |
| Secondary Route 463 | 0.14 | 3.75 | 0.5 |
| Interstate 90 | 0.18 | 2.60 | 0.5 |
| US Highway 212 (NINHS: Non-Interstate National Highway System route) | 0.14 | 3.38 | 0.5 |
| | | | |
| **Montana Rural Roads**** | **Crash Rate (CR)** | **Severity Index (SI)** | **Severity Rate (CRxSI)** |
| State Secondary | 1.47 | 2.33 | 3.43 |
| Interstate | 0.94 | 1.87 | 1.76 |
| NINHS (Non-Interstate National Highway System route) | 1.07 | 2.14 | 2.29 |
| State Primary | 1.22 | 2.32 | 2.83 |

*Includes "property damage only" crashes.
**Source: Montana Department of Transportation, 2010.

succeeding the crash (the definition used in state-reported highway fatalities). Third, the GPS-plotted crash locations had an estimated two-tenths of a mile margin of error because they were based on mile-marker data or public land survey system data, rather than on GPS coordinates recorded by officers at the crash scene.

This project led to a request by the Crow Tribe Department of Transportation (CDOT) in November 2010 for a Road Safety Audit (RSA). An RSA is a formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team.[6] At the Crow Tribe, the team included the CDOT, Crow Bureau of Indian Affairs Law Enforcement Services, Montana Department of Transportation, United States Department of Transportation's Indian Reservation Roads Program, Indian Health Service Injury Prevention program, United Tribes Technical College's Northern Plains Tribal Technical Assistance Program, and various Big Horn county entities. Team members analyzed available data (e.g., single- or multiple vehicle involvement, weather conditions, alcohol involvement, speed, use of occupants restraints); and conducted field review of several tribal road systems, analyzing such characteristics as road width, posted speeds, standard delineation measurements, right of way hazards, pavement markings, traffic signs, and cluster sites.[7] A final report has not yet been issued.

Future approaches to improve the completeness and quality of motor vehicle crash data on tribal roads include the installation of GPS units in police vehicles; and implementing computerized crash reporting via on-board computers. Closer collaboration between the state of Montana and the Crow Tribe could lead to the official recognition by state agencies of seven roadways on the reservation not currently recognized; and joint engineering analysis of crash data to target priority road improvements. The enhanced use of GIS data and mapping is an important step toward reducing motor vehicle injuries and deaths on Crow Tribe roadways.

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