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An Overview of Traffic Safety in America's National Parks

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Executive Summary

The National Park Service (NPS), in cooperation with the Federal Highway Administration Federal Lands Highway (FHWA FLH), has been working to establish a Safety Management System (SMS) for the NPS Transportation Program. The National Park System consists of 391 park units which encompass 10,000 miles of paved and unpaved roadway infrastructure, and includes 84 million acres of land in 49 states, the District of Columbia, and several U.S. Territories. The NPS, created in 1916 was the first of its kind in the world, serves as a worldwide model for the parks and preservation community and the sites represent “treasures that have been set aside by the American people to preserve, protect, and share” for future generations.

The NPS, from the onset of their effort to study and evaluate the safety of their roadway facilities, has made a conscious effort to gain a thorough knowledge of the safety issues and make assessments within the context of the sensitive and unique issues that exist in national parks. The NPS SMS effort that is somewhat unique and multidimensional in nature -- as it will attempt to balance transportation and safety needs with the NPS core mission of preservation of park resources.

The safety effort is using many of the latest traffic safety approaches developed in the U.S., particularly those that are sensitive to the contextual issues of parks, which depart from the more traditional, nominal “design standard” derived safety analyses and project approaches. The NPS has an extensive crash database which dates back to 1989. As the first step in the evolution of the SMS, the NPS recently used this database to perform their first ever national system-wide study of the traffic crashes.

The system-wide study used a data-driven process to comprehensively review safety issues on national, regional, and park levels. The national data analysis provided for the identification of system-wide safety issues and strategies. Overrepresentations of total crashes were identified and, in particular, for severe (fatal and injury) crashes. The resultant system-wide study report provides a comprehensive description of traffic safety issues within the NPS roadway system by reviewing and summarizing crash data for over 220 park units; describing recent crash trends; and comparing the trends to available comparable data at national and state levels.

The second level of analysis is a more detailed study of NPS regions. Patterns identified from the analyses were grouped in Safety Emphasis Areas (SEAs) to begin the process of systematically addressing the traffic safety problems.

At the third level of analysis in the evolution of the SMS is a traffic safety study of a specific park, the Delaware Water Gap National Recreation Area. This pilot study is the first ever for an entire individual park unit.

The conclusions and recommendations are in draft form and are being presented to upper National Parks Service Management in May 2010.

Introduction

The National Park Service (NPS) in cooperation with the Federal Highway Administration (FHWA) Federal Lands Highways (FLH) is in the process of establishing a Safety Management System called a Transportation Safety Management System (TSMS). The initial step in this effort has been to analyze crash trends and patterns using a tiered study approach starting at the national level, with recommendations to improve traffic safety on the NPS roadway system (service wide) and is the first of its kind. A Safety Management System (SMS) is required by the U.S. Congress based on a Federal Rule.

The TRB report, entitled *Safety Management Systems* NCHRP Synthesis 322¹, summarizes a safety management system as:

“... a process whereby members of the highway safety community collectively improve safety on the roadway system. It is an effective avenue for stimulating cooperation, coordination, and increased communication among highway safety stakeholders, as well as improving strategic planning and data sharing.”

The NPS TSMS effort which was initiated in 2004 has been an evolutionary process. The process and considerations to establish a TSMS are unique in this circumstance due to the context of the National Park System and as the process must consider transportation safety with respect to the NPS' core mission of natural and cultural resource preservation for the American people and visitors from around the world. This mission of preservation dates back since the late 1880s. Since the creation of the NPS in 1916, the NPS has long been recognized as a worldwide model in attaining this mission for its parks by the preservation community.

This paper documents the approach followed to conduct the safety study, and presents findings from the data analysis. Preliminary recommendations are outlined as the document is in review by the NPS and FHWA FLH.

Background

The NPS manages 391 units in 49 states, the District of Columbia, and several U.S. Territories². Altogether, these units comprise over 84 million acres of land, an estimated 5,500 miles of paved roads, and 4,500 miles of non-paved roads². This existing service wide network of roadways are planned, constructed, maintained, and evaluated through a joint effort by the NPS with the support of FLH. The NPS transportation network is heavily used and accommodated over 435 million recreational and non-recreational visits in 2008³. Non-recreational visits include several trip types such as commuting to work or transporting freight (where permitted) along NPS roadways.

NPS roadways are distinctive in many ways and encompass a broad range of facility types, including historic two-lane rural roads, urban arterials, and heavily traveled parkways. NPS roads traverse some of the most scenic and environmentally sensitive lands in the United States; thus, the primary purpose of many of the roadways is to promote and complement

an exceptional park experience and not necessarily to facilitate user mobility and traffic safety.

Established by the U.S. Congress, the National Park Service Organic Act (Title 23 C.F.R. §970.212) on August 25, 1916, state the core mission of the NPS:

To conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

The roadways in the park units provide access for the public to the culture, history, scenery, and wildlife preserved within the park units for current and future generations.

Unfortunately, traffic crashes occur along these roadways just as they do on urban and rural roadways throughout the country. To address traffic safety concerns these two agencies are partnering together to develop the TSMS. The first step in developing the NPS TSMS was to conduct of a servicewide assessment in the form of a traffic safety study to provide a comprehensive description of traffic safety issues along the NPS roadways.

Safety Study Approach

The overall goal of the NPS and FLH is to develop a TSMS that reduces the total number and severity of traffic crashes on NPS roadways in a manner that is consistent with the Congressional mandate, utilizing current industry practices and consistent with the mission of NPS. With this goal in mind, CH2M HILL, under contract by the NPS, performed a servicewide (system-wide) assessment of the traffic crash history on NPS roadways. The initial step in the study used a data-driven approach similar to that used by State Departments of Transportation. Consistent with industry standards and practices, the study followed guidelines from U.S. Department of Transportation (USDOT)/FHWA Strategic Highway Safety Plan (SHSP) techniques, American Association of State Highway and Transportation Officials (AASHTO) SHSP, and Transportation Research Board (TRB) National Cooperative Highway Research Program (NCHRP) 500 guides. Reported traffic crash data were available for 220 of the 391 park units for a 16-year period. Those park units that have no data may not have any roadways, or crash data may not be reported by a park unit to the central NPS office. Also, in some of the parks, law enforcement personnel from jurisdictions adjacent to the park respond to and report on traffic crashes. These crash reports are not included in the NPS crash database. Based on anecdotal information, level of reporting did vary on an annual basis in some instances, primarily due to staff resources available for a park. There did not seem to be a large variation between urban and rural park reporting. When appropriate data were available, the study also compared the NPS crash trends to national and state trends.

In recognition of the park attributes and the NPS crash database, the study approach was carefully tailored within the context of the issues and concerns unique to the NPS. The NPS is concerned about the safety of visitors and employees and the impacts to wildlife, but this concern must be considered in the context of the core mission of the NPS. Thus, the study used Context Sensitive Solutions (CSS) approaches from a national perspective and their applicability to safety analyses. The TSMS ultimately seeks to provide a multidimensional balance between transportation and safety needs while honoring the NPS' core mission of preservation of park resources for all visitors.

Safety Study

This servicewide study was not only the first of its kind for the NPS, it was also the first to take a comprehensive look at the information contained in the NPS crash database and extensively use the data to identify and analyze crash issues on NPS roadways. The servicewide (national) study analyzed the NPS system as a whole, as well as each of its seven regions.

Data Sources

The Servicewide Traffic Accident Record System (STARS) database, which contains crash records for roads within NPS, stores 74 data fields that provide information on various crash characteristics such as date, time, location, type, contributing circumstances (weather, lighting, roadway geometry, etc.), drivers, passengers, seat belt use, and vehicle type. This wealth of information allows crashes to be analyzed at any level from park-wide to isolated locations. The STARS database contains 110,067 crash records for the 16-year period from 1990 to 2005. All seven NPS regions are represented in the STARS database. No crash data from outside sources or agencies were used in the analysis.

In addition to the STARS records, the study used vehicle miles traveled (VMT) data for 33 key park units that was collected by the FHWA Eastern Federal Lands Highway Division (EFLHD) in the year 2004⁴. The data provides average daily traffic (ADT) estimates and VMT data at multiple locations per roadway for most of the primary roadways in these 33 park units. These volumes are seasonally adjusted. VMT data were used in crash rate estimates for park routes within the 33 parks.

Data Analysis

Since a goal of the TSMS is to reduce not only the total number of crashes but also the severity of crashes, the data analysis looked at general servicewide crash trends according to crash severity (defined for the NPS study as reported fatal and injury crashes) and total number of crashes. The crash data for each of the seven NPS regions was also analyzed in this manner to review specific trends at a regional level.

The crash records were exported from the STARS Access database into a Microsoft Excel® spreadsheet. The crash data in the spreadsheet was used to sort, categorize, chart, graph, summarize, and perform calculations. The use of spreadsheets also provided the ability to look at crash data separately for severe (fatal and injury) and total crashes for selected locations such as intersections, roadway segments, and parking lots.

The crash data were also used to estimate the societal cost of crashes using cost data developed by the FHWA and the National Highway Safety Traffic Administration (NHTSA). This is a means to quantify in dollars the cost of an automobile crash. These cost estimates include, for fatal and injury crashes, estimates of costs related to medical, emergency services, lost productivity, insurance, and legal costs. Non-injury components such as delay and property damage are included on a per-vehicle basis. Consulting several sources^{5, 6} the following cost data were used in the study (2008 dollars):

- \$5,800,000 for a fatality
- \$21,960 for an injury
- \$3,120 per vehicle for a property damage crash

Pattern Identification

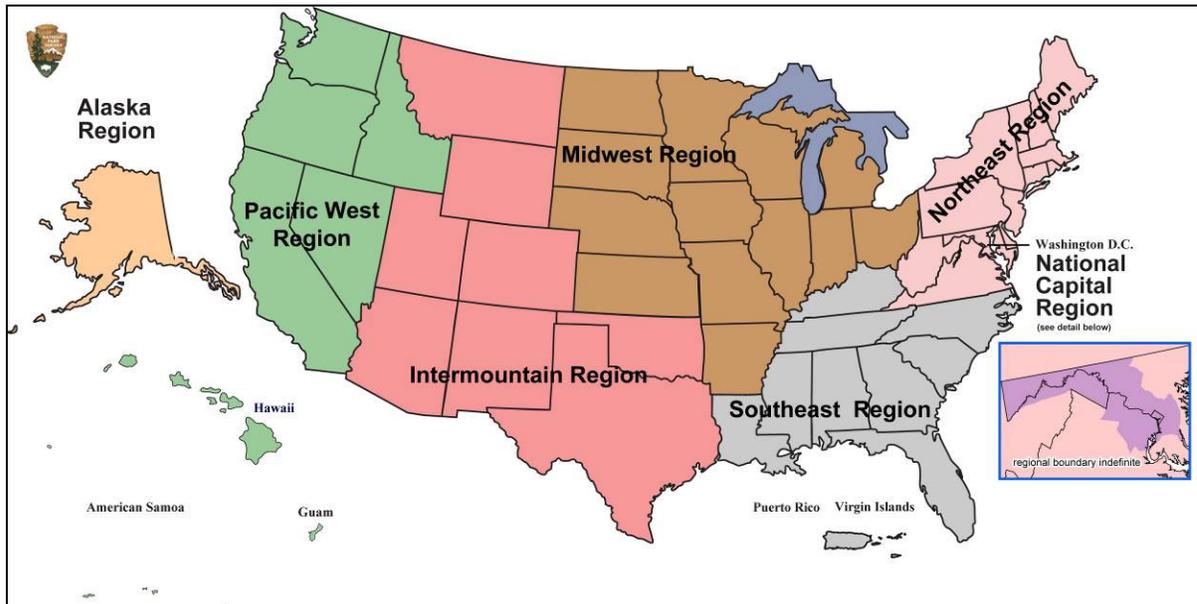
To better understand crash issues, to identify patterns that would suggest appropriate and context sensitive recommendations for countermeasures (strategies) that could reduce total and severe crashes on NPS roadways, crash data were reviewed separately for roadway segments (those areas outside the influence of intersections or not located in parking lots), intersections, and parking lots. After stratifying the data into each of these elements of the roadway network, the data were sorted and summarized by collision type including type of object struck for fixed-object crashes, and by various other contributing circumstances. These include time (day, month), lighting conditions, weather/surface conditions, driver condition, roadway geometry, seat belt use, and driver age. Summarizing the data by crash characteristic and contributing circumstance permitted the identification of patterns, such as lane-departure crashes occurring along horizontal curves on wet pavement during a rain event.

Once summarized by crash characteristic, where possible, the trends identified from the data were compared to available national and state data. The study team recognized early on that such comparisons were limited due to the unique nature of the National Park System, its context, and to some extent, limitations of state and national data. For example, alcohol impairment was compared to trends at the national level, and horizontal curve crash proportions were compared to a study of two-lane rural roads across the state of Texas (the best comparable data available).

Regional Analyses

After completing the servicewide analysis, the STARS crashes were stratified by region to study the crash history and identify crash patterns for each region. Figure 1 shows the NPS regions. Severe and total crash analyses and societal cost calculations were performed for each of the seven regional datasets using the national study methodology. Spreadsheets for each of the seven regions were created from the system-wide spreadsheet to perform the analyses. The resultant statistics were then compared among the regions.

FIGURE 1
Regions of the National Park Service



Crash Rates

The regional analyses went one step beyond the servicewide (national) analysis and estimated average crash and fatality rates based on five years of crash data (2001 through 2005) for each of the 33 parks which had VMT data available. For each of these parks, the crash rates were estimated on a park-wide basis using only those specific routes counted rather than for all routes within the park. From a statistical viewpoint, the 33 parks represent approximately 63 percent of the paved miles, 74 percent of the reported motor vehicle accidents, and 47 percent of visitation (the number of people who travel to the park for recreational purposes or commuting purposes). According to NPS sources, the primary reason for selecting the 33 parks to be included for the VMT sampling was to have a diverse set of parks, to some extent include those with larger paved mileage and those that were assumed to have, to some degree, more traffic. Visitation was another consideration, but to a lesser extent.

In the 33-park sample, two regions are not represented (Alaska and Midwest) because VMT data were not collected for any parks in these regions. Statistical analysis indicates that the crash situation for the overall NPS is overrepresented by the total number of crashes in the 33-park sample (if only crashes are considered). However, when the total crashes were adjusted by VMT to develop “crash rates,” this numerical overrepresentation was mitigated due to the inclusion of traffic volume data, thus reducing the bias in the analysis results. Based on available data, these estimated crash rates are currently the best available representative statistics for the NPS.

Average estimated total and fatal crash rates were compared to State Departments of Transportation rates for comparable route (functional) classes as appropriate. Comparing this information gave some insights as to whether individual park crash rates are below, at, or above the average statewide crash rates in corresponding states. Knowing how park

crash rates compare to statewide rates can highlight potential areas where further study might be beneficial within the NPS (for example, above-average crash rates compared to a state estimate). It is of interest that most units in the NPS report all known crashes on roads under their jurisdiction within the park boundaries, whereas states have varying thresholds for reporting crashes. Therefore, the NPS crash rates likely provide a more comprehensive estimate of crash history than the statewide crash rates.

Safety Study Findings and Current Efforts

The following presents a comprehensive list of findings from the servicewide study that assists with focusing the NPS' phased efforts to develop a TSMS. The findings represent both the national and regional analyses. These findings have been organized into topical areas to better discuss related issues.

Summary of Servicewide Crash Data

- **Fatal Crashes:** In the 16 years from 1990 through 2005, there were 673 fatal crashes with a total of 800 people killed on roadways throughout the NPS. This is an average of 50 fatalities per year.
- **Injury Crashes:** Between 1990 and 2005, there were 21,448 injury crashes that resulted in 32,894 injuries.
- **Property Damage Only (PDO) Crashes:** Between 1990 and 2005, there were 87,946 crashes that resulted in property damage only.
- **Total Crashes:** In the 16 years from 1990 through 2005, there were a total of 110,067 crashes. From 1997 to 2004, the total number of crashes was consistent with over 6,000 per year. Prior to 1997, there were more crashes. Based on anecdotal information this higher level of crashes may have been due to changes in reporting practices and data management systems that began in 1997.
- **Societal Cost of Crashes:** The total cost of crashes to visitors and employees was \$5.6 billion (2008 dollars) from 1990 to 2005. Fatal and injury crashes combined are the most significant factor in determining this cost.

Crash Types

This report presents crash trends for the NPS in terms of both "severe crashes" (the set of both fatal and injury crashes) and "total crashes" (fatal, injury, and PDO crashes). Severe crashes are delineated because of the impact to society overall. In addition, the USDOT and State Departments of Transportation tend to focus safety improvement efforts on severe crashes because they have a higher societal cost than PDO crashes.

On NPS roads from 1997 to 2004, the average number of severe crashes was 1,442 per year.

Figure 2 shows the annual number of fatal crashes and injury crashes throughout the NPS. It appears that the annual number of severe crashes throughout the NPS dropped after 1996. From 1990 to 1996, the average annual total number of fatal and injury crashes is 1,442. This annual average is fairly consistent with each year's total during the referenced time. From 1997 to 2004, the average annual total number of fatal and injury crashes is 1,359, which is also consistent with each year's total during the referenced time. This stepped-down average crash reporting is seen in Figure 2.

NPS staff has reported that there was likely a change in crash reporting practices from individual park units after 1996.

FIGURE 2
Severe Crashes by Year
(22,121 Crashes Systemwide 1990-2005)

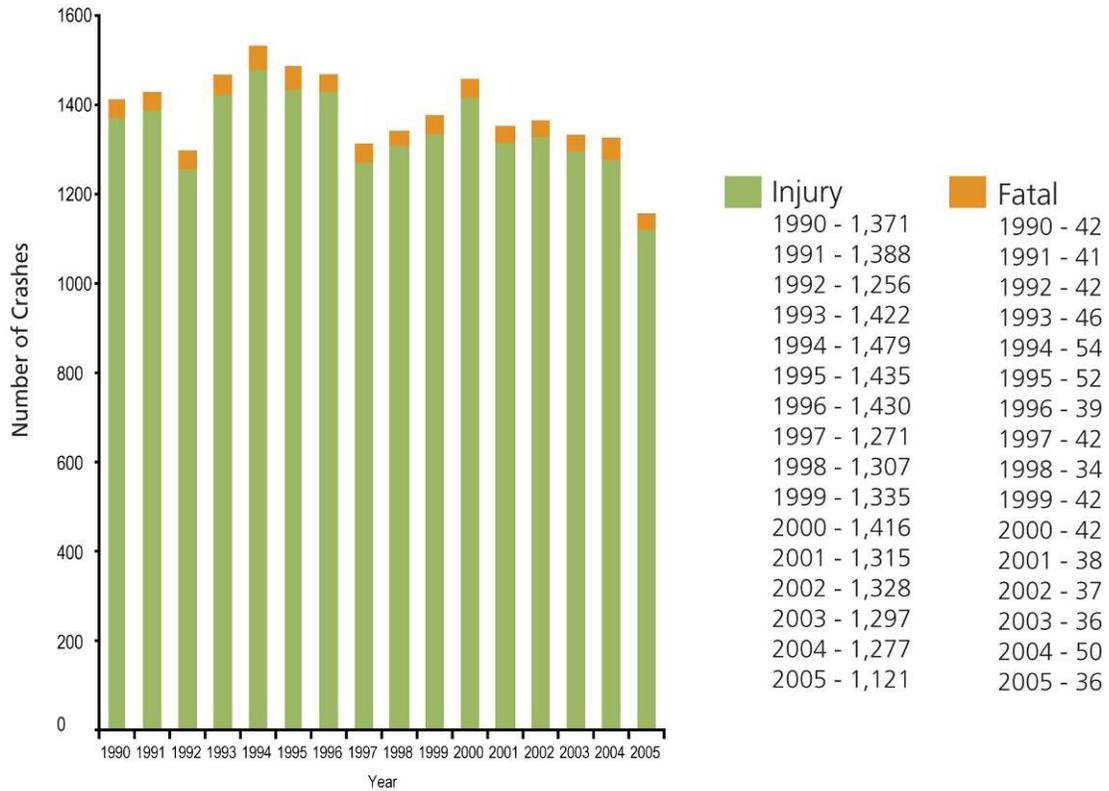
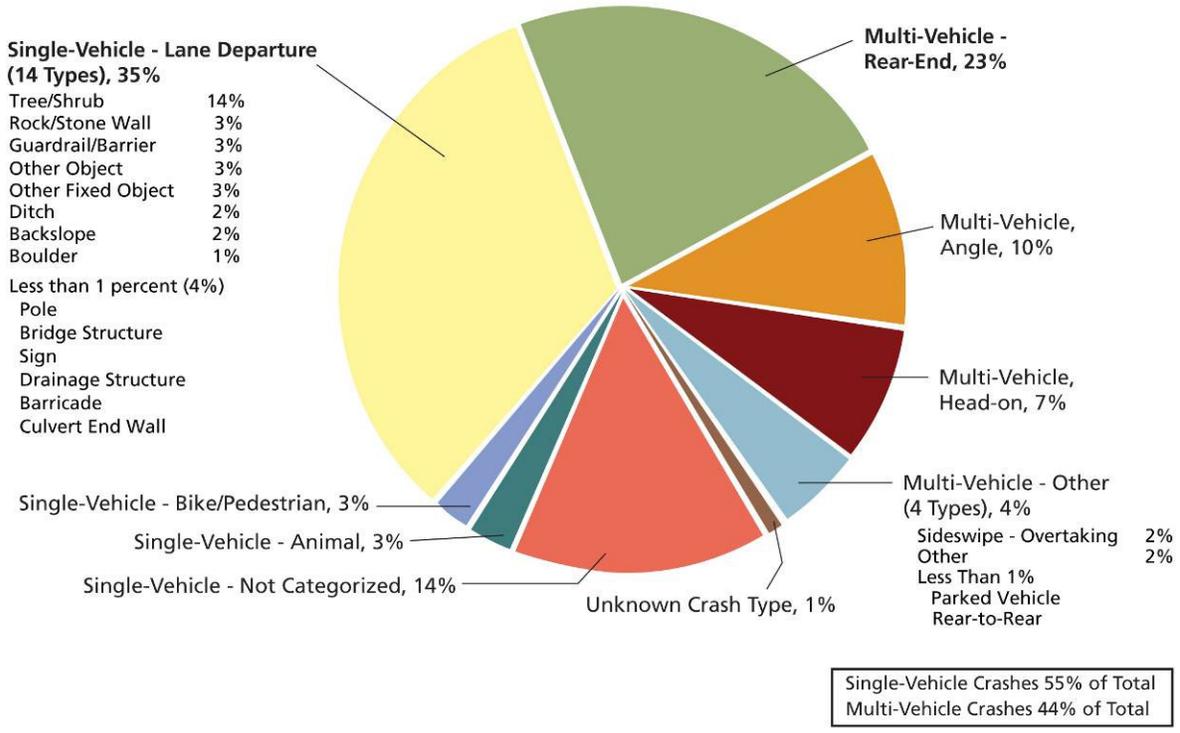


Figure 3 illustrates the statistics for severe (fatal and injury) crashes in the NPS from 1990 to 2005. Some of the prominent statistics relating to these crashes and total crashes are discussed below.

FIGURE 3
Type of Collision for Severe Crashes
 (22,121 Crashes Systemwide 1990-2005)

May Not Add Up to 100% Due To Rounding



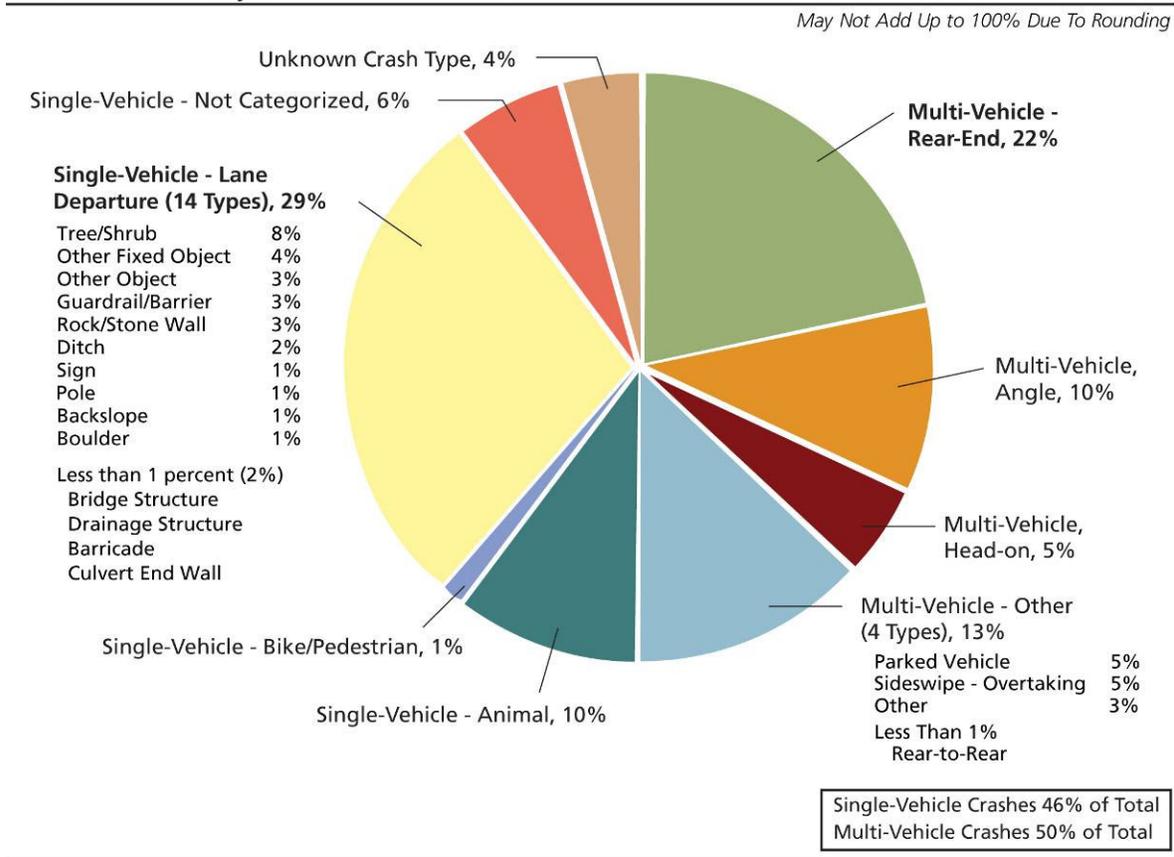
- Lane Departure Crashes:** For 220 units of the NPS servicewide road network that reported crashes, 35 percent of all severe (fatal and injury) crashes (that could be categorized) are of this type, and 29 percent of total crashes are related to lane departures (single vehicle, off right side of road). With the exception of the National Capital Region, this crash type is the most significant in terms of proportion throughout the NPS. The proportion lane departure crashes is similar to that of many states and is considered to be a prominent pattern.
- Rear-End Collisions:** Rear-end collisions account for the highest proportion of multiple-vehicle crashes, both for severe (23 percent) and total crashes (22 percent). For the National Capital Region, rear-end collisions are more significant, representing 42 percent of severe crashes and 40 percent of total crashes. The National Capital Region in the Washington DC area has a high proportion of parkways (controlled access routes) and is heavily urbanized.
- Collisions with Animals:** For all parks, collisions with animals account for 10 percent of total crashes for all routes. Of the crashes on road segments (non-intersection), 14 percent are with an animal. For the Northeast Region, 11 percent of severe crashes

and 29 percent of total crashes are related to animals. In the Southeast Region, 5 percent of severe crashes and 19 percent of total crashes are related to animals. This high proportion of animal crashes in the NPS is an example of one of the unique crash patterns that identified, is indicative of the environmental sensitivities in many parks and such crashes are prevalent in parks with larger populations of animals.

- **Head-On Collisions:** For all parks, head-on and sideswipe-opposing collisions accounted for 8 percent of severe crashes. The Intermountain Region experienced the highest proportion (at 9 percent) of severe crashes in this category. Due to the severe nature of these crashes, this pattern is considered to be prominent.

Figure 4 illustrates the statistics for total crashes in the NPS from 1990 to 2005 including parking areas. Over 110,000 total crashes occurred in the NPS from 1990 to 2005.

FIGURE 4
Type of Collision for All Crashes Including Parking
 (110,067 Crashes Systemwide 1990-2005)



Other Crash Patterns

- **National Park Crash Rate Comparison to State Crash Rates:** Compared to state crash rates, 22 parks (of 33) have total crash rates higher than their corresponding states for similar road types and locations. Rates for 15 of these parks appear to be significantly greater than equivalent state roads.
- **Fatality Rates:** Fatality crash rates for seven parks are estimated to be significantly higher than the rates for the states in which the parks reside.
- **Fixed-Object Crashes:** Fixed-object crashes are typically related to lane departure crashes, as they result from a vehicle leaving its lane and the roadway. Fixed-object crashes with trees or shrubs account for the highest proportion of severe lane departure crashes at 14 percent. The Midwest (25 percent), Southeast (23 percent), and Northeast (16 percent) regions have a significant percentage of severe crashes involving a tree or shrub.
- **Crashes in Parking Lots:** Nine percent of all crashes occur in parking lots. These crash types typically have a low severity. The regions with the highest proportions of parking lot crashes are Alaska (32 percent), Midwest (30 percent), and Intermountain (18 percent).
- **Monthly Variation:** One third of all crashes in the NPS occurred in the summer months of June, July, and August, which corresponds to the peak visitation period for most of the parks. Like park visits, crashes are not distributed evenly over the year.
- **Alcohol and Drug Impairment during Crashes:** Three percent of total crashes and, more significantly, 7 percent of severe crashes involved alcohol and/or drug impairment, which is low compared to state proportions. The reason for the low proportion of crashes is not entirely understood, but typically there are few, if any, businesses within or near national parks that sell or dispense liquor.
- **Service-wide Societal Costs of Crashes:** Annually, traffic crashes on NPS roads cost society (the traveling public) between \$290 million and \$430 million. The additional cost of crashes to NPS wildlife and facilities (including loss of animal life and environmental/cultural damage) is not known at this time.
- **National Park Crash Rates:** Crash rates vary from park to park. On a regional basis, the Northeast Region and Pacific Region have the highest rates of total crashes and severity. The lowest crash rates are found on urban parkways.
- **Contributing Factors:** The two most prominent contributing factors reported for crashes are:
 - Driver inattention at 41 percent
 - Speed violations and speed-related violations at 17 percent

Analysis of Programmatic and Institutional Issues

In addition to crash patterns, this study provided insights as to the NPS' current practices in using existing data and resources to identify safety issues; track progress; and develop economical, efficient, and effective safety strategies. Information from the latest industry standards and research was also considered, including that from TRB and the FHWA. The following conclusions are based not only on the project findings but also on information gained from extensive interactions and reviews by NPS staff and the FHWA.

- **Reporting Levels of Crashes:** The NPS has made an extraordinary effort to collect and compile crash reports into the STARS database and currently has data for 220 units through 2005.
- **Enhancement of Data Quality:** The crash reporting form does not capture all accident types and responders may have selected "Not Applicable" on the form. For example, there is not a code for "Overturn" crashes and it is speculated that "Not Applicable" may have been coded for this event. Data quality assurance and quality control measures based on industry standards are currently being developed and will improve coding of crashes.
- **Enhancement of Data Capability:** The NPS is looking to the future and is part of the team developing new systems to enhance crash data analysis and overall data capabilities. For example, while not within the purview of this study, the U.S. Department of Interior is developing a comprehensive incident reporting system that will include crash data.
- **Traffic Data and VMT Estimates:** The most recent comprehensive traffic counts are from 2004. The NPS is working in coordination with the FLH to refine traffic count metrics, include counts for several parks in regions not counted, and develop a more cost-effective, data-driven program for counting routes.
- **State of the Industry and Practice:** Safety practices on our national highways have advanced dramatically in recent years due to an increased concern of the significant societal cost of traffic crashes. The FHWA and U.S. Congress have focused attention on reducing severe vehicular crashes and decreasing associated crash rates. The NPS is currently following a systematic approach to vehicular safety, working in conjunction with the FHWA to develop a TSMS that incorporates techniques and tools to effectively use safety data to identify problems, develop solutions, implement strategies, and evaluate the effectiveness of these solutions and strategies.

Evolution of the Transportation Safety Management System (TSMS)

The national safety study was the first step in the development of the NPS' TSMS. Future traffic safety studies will bring light to new challenges and a capability to implement programs and projects to improve safety. This process will suggest additions or modifications to incorporate into the TSMS. Once developed and fully functional, the TSMS will be a dynamic process that is updated as necessary to maintain currency with industry standards.

Since the TSMS will accommodate the entire NPS roadway system, it will need to function on many levels to address traffic safety issues from a specific location on a roadway or at an

intersection up to broader servicewide issues. All these levels play a part in achieving the goal of reduced crashes on NPS roadways. Furthermore, based on the organization of the NPS and available funding, projects at the various levels are typically funded from various sources. Therefore, a tiered study approach was developed. A discussion of each tier of traffic safety studies follows:

- **Servicewide:** A service-wide study, such as the one discussed, identifies general patterns and trends at a national level. Proposed safety strategies based on this analysis may be applicable to most if not all park units, but at a minimum, it serves as a basis for further analysis.
- **Region-Wide:** A region-wide study identifies general patterns and trends among the traffic crash data for the region. At this time, all seven NPS regions are being studied. From these regional assessments a set of specific safety areas, called Safety Emphasis Areas (SEAs), which parallel the AASHTO emphasis areas⁷, is being developed. From the resultant SEAs, proposed safety strategies are developed that are applicable to most if not all park units in the region. A regional study may also analyze individual parks at a park wide level at least to a limited extent as an initial step to identify general safety issues such as higher crash rates for routes in a park. The proposed strategies are similar to servicewide strategies, but would typically do not address programmatic and institutional issues other issues related to quality and frequency of crash reporting.

As a regional study is a more focused analysis than a system-wide study, a regional study provides more focused strategies that reflect unique regional attributes. The smaller dataset provides the ability to perform limited quality control checks on crash data and make adjustments prior to using the data for analysis - higher quality data can lead to more accurate analysis conclusions and resultant recommendations. Furthermore, the strategies can be developed in the context of an NPS region.

- **Individual Park:** A park study focuses on one park and reviews crash patterns and trends in detail. A park wide study looks at the crash data on several levels - park wide, individual roadway sections, intersections, and specific locations. The resultant proposed strategies include park wide law enforcement, cultural, and natural resources programs, as well as specific transportation projects to reduce crashes. In a number of instances, recommended park traffic safety strategies can reduce crashes, but they may not meet design guidelines recommended in AASHTO documents such as a *Policy on Geometric Design*⁸ (Green Book). For example, a park traffic safety strategy may not meet guidance contained in the Green Book for recommended shoulder width. In a park setting, attaining the recommended shoulder width may not be feasible due to significant impacts to historical and cultural features. Also, due to the context of many parks, strategies such as increasing the clear zone by removing trees that are considered a resource is not an option. Strategies that may keep a vehicle from leaving its lane are more acceptable and appropriate in a park setting.

The CSS approach used in prototype NPS studies to date resulted in some modifications and additions to some of the safety strategies that may be traditionally used by State Departments of Transportation. These strategies that address context sensitivities (based on park mission, values, etc.) are developed cooperatively among the region and individual park staff.

Identification of specific transportation safety projects requires a more detailed study that is possible when focusing on one park rather than a region or the whole National Park System. Specific park studies are conducted within the regional planning framework so proposed traffic safety projects can be requested, funded, and implemented. An advantage to conducting the study within the regional planning framework is that the framework provides the ability to incorporate some of the engineering strategies into other planned projects such as repaving, bridge repair and replacement, drainage, or other capital improvements and offers a more efficient use of funds.

Focusing on one park gives the ability to obtain a more thorough understanding of the park roadway network, the usage of the roads by recreational and non-recreational visitors, and potential safety relationships between the network and crash patterns. The concentrated effort from a park study also permits consideration of engineering and non-engineering safety strategies which are called the 4Es (education, enforcement, engineering, and emergency medical services). For example these strategies can include enforcement and emergency response measures, and how they work together to respond to crashes. Discussions with the park rangers provide insight into the crash reporting process that can assist with interpretation and quality control checks of the data. Also, the smaller dataset at a park level allows for a higher level of quality control and corrections in the crash dataset.

The park staff has extensive local knowledge of the park and issues/relationships with stakeholders and adjoining communities. A stakeholder or public involvement process is conducted during a specific park study. The staff knowledge and stakeholder input along with their familiarity with the roadway network enables the development and design of safety strategies can more effectively address needs of the visitors and stakeholders, and meet context issues of a park due to impacts of implementation of strategies.

- **Specific Route:** A route study is the most highly focused study conducted by the NPS at this time. The purpose is to look at patterns and trends in detail for a specific route and recommend projects for specific locations or on a route-wide basis including potential non-engineering strategies for a route. Generally, the route with the highest traffic volumes in a park experiences a significant percentage of the total park crashes. Addressing the crash issues along these individual routes may be the most efficient means to address a large share the park crashes and effectively help to meet a park's overall goal to reduce severe or total crashes. As part of a prototype NPS regional safety study effort, specific route studies are conducted within the regional planning framework to expedite the funding of proposed safety projects. Similar to an individual park study, some of the engineering strategies can be incorporated into other planned projects for routes in the same park.

The conduct of these studies is very similar to that for a specific park; the one difference is that a specific route study relies on information about stakeholders and adjoining communities that is provided by region or park staff rather than on a stakeholder involvement process that is conducted during a park study. Like the park study, many of the principles used in a CSS-based process may be used to identify the needs of the visitors and stakeholders and context sensitivities for a route.

The regional, park, and specific route studies are performed in cooperation with the region planning staff. Working with the region staff provides specific knowledge about the region's traffic safety issues and practices and, to some extent for some individual parks within the region. Region staff is also able to provide local knowledge about the region and has working relationships with park staff. Typically, projects to implement proposed strategies must go through a region's planning and project development processes to be funded and administered.

Planned Next Steps

The current steps underway with respect to safety analysis efforts by NPS is to continue, where resources permit, with regional, park, and route studies, and to discuss with regional and park management the need to conduct park and route studies. As new information is obtained from these studies it will enhance the ability of NPS to move toward a full fledged TSMS. Also NPS and FLH are actively engaging in efforts to jointly develop a partnered effort to develop a TSMS incorporating lessons learned, including improved crash data management practices; new insights into issues encountered and their resolution; and the incorporation of new safety strategies developed that can be used in the development of projects.

Once strategies have been in place for a period of time (such as 5 years), it should be feasible to conduct an evaluation of the safety effectiveness of strategies. The evaluations will likely be quantitative as well as qualitative. These results can feed into the TSMS by providing feedback on the effectiveness of strategies for future use.

Recommendations to Date from the Servicewide Study

At the time of the preparation of this paper, the servicewide study was in final draft form with recommendations for next steps, and is being reviewed and discussed by upper NPS management. The draft recommendations are being presented in May 2010. From this review and discussion the future direction of the NPS TSMS effort will be defined and implemented as resources permit.

Summary and Conclusion

The findings of the study provide an approach to successfully achieving the NPS' objective for ultimately reducing fatalities and injury crashes based on industry-accepted practices, data-driven approaches, and context-sensitive solutions. A collaborative partnership documented and supported between the two agencies, and the systematic development and implementation of a TSMS would provide the greatest opportunity for NPS success in these areas, while meeting the spirit of Title 23 C.F.R. §970.212.

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