National Park Service
U.S. Department of the Interior

Natchez Trace Parkway
Alabama, Mississippi, Tennessee

Natchez Trace Parkway
Bicycle Planning Study

Clockwise from top left: group bicycle ride, view of farmland from the road, bicycle signage, and shared lane marker on the Natchez Trace Parkway.

Source: Volpe Center photographs (April 2015)

July 21, 2016

Volpe The National Transportation Systems Center

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Contents

Report notes

This report was prepared by the U.S. Department of Transportation John A. Volpe National Transportation Systems Center, in Cambridge, Massachusetts. The project team was led by David Daddio, of the Transportation Planning Division, with support from Jaime Young of the Transportation Planning Division.

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Donna Holdiness

Adventure Cycling Association
Saara Snow, Travel Initiatives Coordinator

Over the Top Cycling
George Thomas, Owner/Vice President of Communications

Definitions

The following terms are used in this report:

AL	Alabama
DOT	Department of Transportation
FHWA	Federal Highway Administration
HSIS	Highway Safety Information System
HSRC	Highway Safety Research Center (University of North Carolina)
GLAC	Glacier National Park
MPH	Miles per hour
MPO	Municipal Planning Organization
MS	Mississippi
MUT	Multi Use Trail
MUTCD	Manual on Uniform Traffic Control Devices
NATR	Natchez Trace Parkway (Parkway/Park)
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NHTSA	National Highway Traffic Safety Administration
NTPA	Natchez Trace Parkway Association
NPS	National Park Service
OLYM	Olympic National Park
PTBA	Port Townsend Bicycle Association
SHPO	State Historic Preservation Office
TACC	Tour d'Attala Cycling Club
TN	Tennessee
USDOT	United States Department of Transportation
UVC	Uniform Vehicle Code

Introduction

The Natchez Trace Parkway (NATR/Parkway) is concerned with motor vehicle accidents involving bicyclists on the Parkway. As a recreation facility with exceptional scenic qualities, the Parkway is becoming increasingly popular among both long-distance touring and local recreational bicyclists. The combination of increased bicycle usage and high-speed vehicular traffic has led to greater risk exposure for bicyclists on the Parkway over time. Since 2006, law enforcement rangers have documented four bicyclist fatalities and 12 bicyclist injuries involving motor vehicles on the Parkway. There are a number of factors contributing to the danger, including limited visibility areas, lack of separated right-of-way for bicyclists, and unsafe behavior such as speeding, distraction, and limited awareness of proper road-sharing etiquette. To enhance Parkway users' safety, the National Park Service (NPS) tasked the Volpe National Transportation Systems Center with assessing existing conditions and recent NPS actions along the Parkway and making recommendations to improve safety for all user groups.

Purpose of this Study

The Natchez Trace Parkway has invested in a variety of measures to raise awareness of bicyclists on the Parkway and promote safe driving and bicycling behavior. The purpose of this study is to assess the effectiveness of these measures and provide recommendations to the Parkway to make further engineering, education, and enforcement improvements. Engineering improvements recommended in this study will require compliance pursuant to the National Environmental Policy Act (NEPA) and coordination with the appropriate state historic preservation office pursuant to the National Historic Preservation Act (NHPA).

Methodology

The project team relied upon existing data sources associated with bicycle activity on the Parkway, stakeholder interviews, conversations with experts and other NPS units, industry best practices, and observations from a site visit to assess safety conditions along the Parkway to develop recommendations. The project team conducted the site visit in April 2015 and experienced the Parkway during both normal and adverse weather conditions.

No new data was collected during the site visit, but recently, the park has begun collecting bicycle counts that will be useful for future analysis. Where data was not available or more information was needed, the project team made recommendations for future study and data collection. Where low-cost safety improvements were identified, that are in line with industry best practices and guidance, the project team made recommendations that can be made without further study.

Overview of location, geography, landscape

At 444 miles long, the Parkway leads visitors from the southern Appalachian foothills just outside of Nashville, TN to the lower Mississippi River at Natchez, MS (Figure 1). The Parkway crosses into three states, connects to around 500 state and local roadways, and passes through major urban areas including Tupelo and Jackson, MS where there can be heavy traffic.

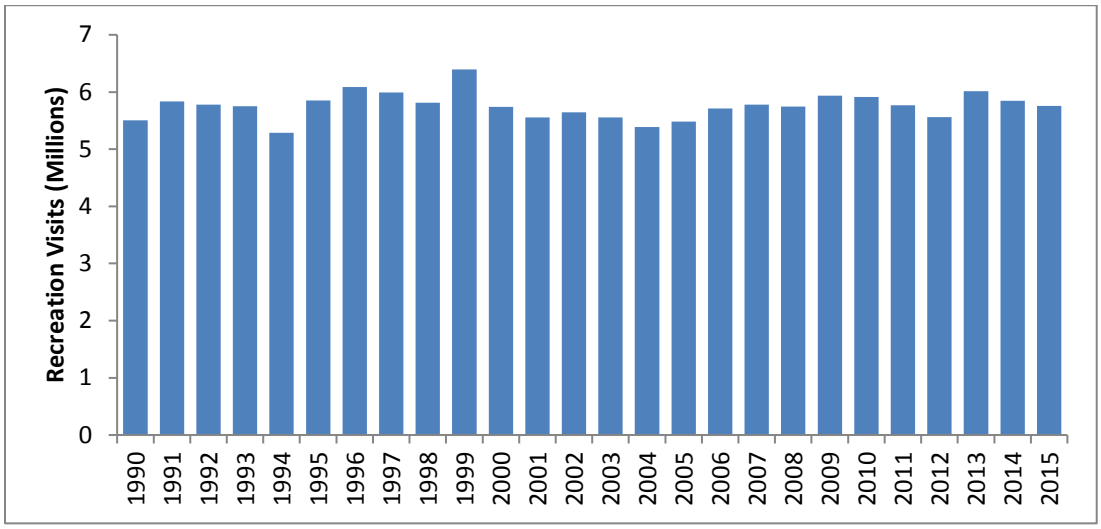
Figure 1: NATR Context Map[1]
Source: Saturday Evening Post

Use and Visitation

Visitation to the Natchez Trace Parkway has been relatively stable over the past 25 years. The park averages 5.7 million recreational visitors and 15 million total visitors every year. The visitation estimate is based on five traffic counters, manual counts at the Park's primary visitor center in Tupelo, MS, and documented overnight stays at three campgrounds (Figure 2). Anecdotally, bicycle use is on the rise. Data has not yet been compiled to show this in detail, but bicycle permit applications may support this at least for group riders. The Parkway recently purchased bicycle counters that have been installed and are currently collecting data.

[1] Source: http://www.saturdayeveningpost.com/2010/07/26/health-and-family/travel/hit-road.html/attachment/illustration_0710_natchez_trace_parkway

Figure 2: Annual Recreation Visitation at NATR
Source: Visitor Use Statistics Office



Stakeholder Groups

Stakeholders involved in the bicycle planning study included NPS staff as well as members of the public with an interest in bicycling on the Parkway (see Table 1). Stakeholders were initially engaged in group discussions during which the project team outlined the scope and purpose of the study. Stakeholders shared their concerns and ideas. Regular weekly communication continued throughout the study or as the need arose. These stakeholders will continue to be involved as the project team shares findings and solicits feedback.

Table 1: Stakeholder List

Name	Affiliation	Position
Mary Risser	NATR	Superintendent
Barry Boyd	NATR	Chief of Maintenance
Lisa McInnis	NATR	Chief of Resource Management
Sarah Davis	NATR	Chief of Visitor and Resource Protection
Terry Wildy	NATR	Chief of Interpretation and Partnerships
Calvin Farmer	NATR	Assistant Chief Ranger
Greg Smith	NATR	Landscape Architect
Kevin Downs	NATR	Civil Engineer
Saara Snow	Adventure Cycling Association	Travel Initiatives Coordinator
George Thomas	Over the Top Cycling	Owner/Vice President of Communications
Donna Holdiness	Gary Holdiness Cycling Fund/ Natchez Trace Parkway Association/ Tour d'Attala Cycling Club (TACC)	Events Coordinator, TACC NTPA Bicycling Lead/Liaison to the Natchez Trace Parkway

Prior to Volpe's involvement, the NPS conducted focus group interviews that solicited opinions and experiences regarding the bicycle-related interventions, including recently installed shared lane markings and accompanying signs along the Parkway. The full notes from these meetings can be seen in Appendix A.

Existing Conditions

The NPS has undertaken a comprehensive bicycle safety campaign. This has included a variety of steps to increase awareness of bicycling on the Parkway and encourage safe driving and bicycling behaviors. These measures include:

- **Engineering**: Installation of signage and pavement markings establishing bicyclists' right to use the full lane.
- **Education**: Dissemination of information about 3-foot passing laws and other bicycle-related information via the Parkway's AM radio station, websites, wayside signage, and outreach to law enforcement rangers and other NPS employees. A public service announcement is currently being developed for television and a broader radio audience. Information about bicycling permits, camping, general safety, and trip planning are also available through the Parkway's website (www.nps.gov/natr).
- **Enforcement**: Development of a permit program for bicycling groups exceeding eight people, and enforcement of posted speed limit for motor vehicles.

Road Conditions and Features

The main feature of the Natchez Trace Parkway is a 2-lane road with one 11-foot travel lane in each direction. There are no shoulders or separated bicycle lane facilities. Along the entire length, there are turn-offs to picnic areas, campgrounds, trailheads, scenic overlooks, and historic sites. The Parkway has bridges and overpasses with ramps and cloverleaf interchanges to cross over highways, rivers, and landscape features. With relatively few at-grade junctions, the smaller intersecting roads are primarily country roads, in addition to some roads leading to visitor sites that are a part of the cultural landscape.

The roadway averages 22 feet wide throughout, with a total average right-of-way width of 800 feet (total land area of 52,289 acres).[2] The land on either side of the roadway contains protected natural and cultural resources, including historic sites, landscapes, and protected scenic viewsheds. The Parkway was designed for vehicles traveling a maximum speed of 50 miles per hour (mph), which makes it challenging for bicycles and vehicles to safely share the roadway. There is not enough road width to separate the different modes of travel in to dedicated lanes, and sharing the lane is problematic given the speed differential between vehicles and bicycles. Nonetheless, the Parkway is a popular bicycling destination due to its fairly low traffic volume, idyllic natural setting, and variety of historic and cultural sites. It is a tour destination on many bicycle organization itineraries as it is a NPS-designated bicycle route.

Safety and Law Enforcement

Vehicles pose a serious danger to bicyclists at 50 mph. As shown in Figure 3, the likelihood of a bicyclist fatality increases dramatically as the posted speed increases. This graph was published by the USDOT's Bicycle Road Safety Audit Guidelines[3] based upon a study conducted in North Carolina.[4] As the graph shows, both disabling injuries and fatalities more than double as the posted speed increases between the ranges of 30-35, 40-45, and 50-55 mph. Vehicle speed and collisions with pedestrians have been studied to a much greater degree than with bicycles, and can be informative regarding crashes with all non-motorized road users. Figure 4 shows the likelihood of injury or death of a pedestrian when hit by a motor vehicle at a given speed. The higher speed the vehicle is traveling, the chance of fatality becomes more probable.

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[2] Natchez Trace Parkway Statistics. http://www.nps.gov/natr/learn/management/statistics.htm

[3] USDOT FHA Bicycle Road Safety Audit Guidelines and Prompt Lists http://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa12018/#ref22)

[4] The University of North Carolina Highway Safety Research Center. North Carolina Bicycle Crash Facts 2004 – 2008. August 2010. http://www.pedbikeinfo.org/pbcat/pdf/summary_bike_facts04-08.pdf

Consequently, posted speed and speed enforcement are both important conditions to take into consideration in this high-speed context.

Figure 3: Fatality and Severe Injury of Bicyclist in Crash by Posted Speed Limit
Source: USDOT FHWA Bicycle Road Safety Audit Guidelines and Prompt Lists

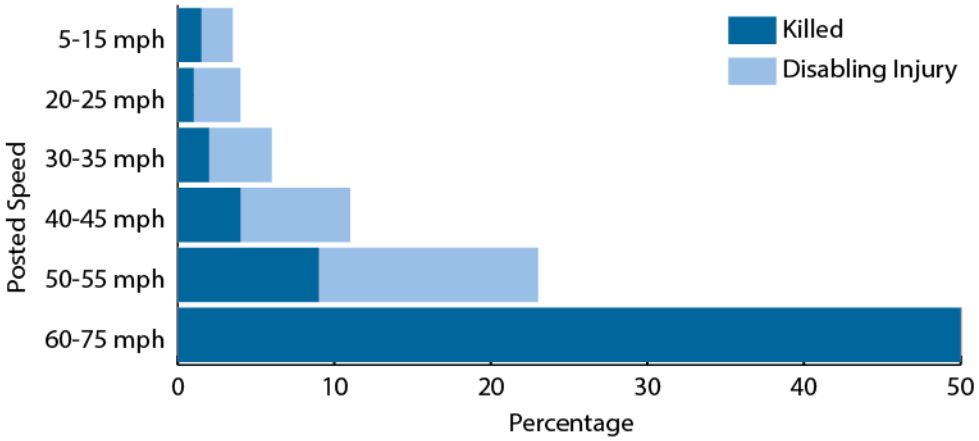
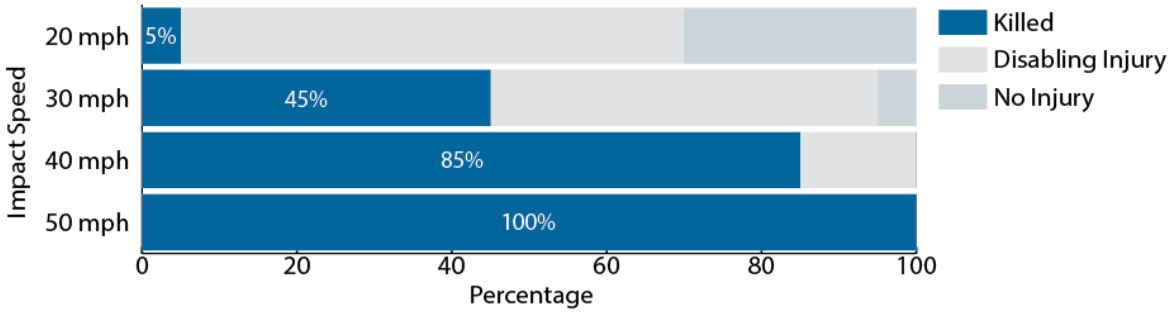


Figure 4: Pedestrian Injury at Impact Speed
Source: U.S. Department of Transportation[5]



Bicycles on an open, flat road generally travel around 15 mph with a maximum speed of about 20 mph. According to NPS staff, bicyclists are becoming more and more common on the Parkway and local roads. However, local motorists may not be accustomed to sharing the road with bicyclists, and there is a learning curve in terms of how to drive safely in such situations.

The Parkway is patrolled for speeding and other traffic violations by NPS law enforcement but speeding violations are the most common.

Pavement Markings and Signage

Heavy trucks and commercial vehicles are prohibited from using the Parkway, which contributes to the well-maintained asphalt-surface and relative comfort for bicycle riding.

[5] Moudon, Anne Vernez, Managing Pedestrian Safety I: Injury Severity. US Department of Transportation, 2007. http://www.wsdot.wa.gov/research/reports/fullreports/671.1.pdf

Striping consists of the center line and shoulder lane markers, which are bright and well-maintained. The Parkway does not have artificial lighting, rendering it all the more important for vehicles to use lights in inclement weather and for bicyclists to be well-lit and highly-visible. Signage in general is kept to a minimum on the Parkway to maintain the cultural landscape.

Speed Limit Signage

The posted speed on the Parkway throughout Mississippi is 50 mph. It is lower in some portions in Alabama and Tennessee where the roadway starts to wind and has more hills. There are posted speed limit signs in locations near the entrances to the Parkway, alerting drivers of the posted speed as they enter the Parkway. Along the Parkway, speed limit signs are not located at every entrance, nor in both directions at every entrance. Additionally, there are long stretches of road with no intersections and therefore no speed limit signs to remind drivers of appropriate driving speeds. Signage on the Parkway differs from that of a standard road due to cultural resource reasons having to do with scenic value.

Bicycle Signage

There are three types of bicycle-related signs on the Parkway. Each can be found in the Manual on Uniform Traffic Control Devices (MUTCD)[6] where their proper use is defined. The MUTCD is organized by Standards, Options, Guidance, and Support. A standard is "a statement of required, mandatory, or specifically prohibitive practice regarding a traffic control device." An option is "a statement of practice that is a permissive condition and carries no requirement or recommendation. Options may contain allowable modifications to a Standard or Guidance." Guidance is "a statement of recommended, but not mandatory, practice in typical situations, with deviations allowed if engineering judgment or engineering study indicates the deviation to be appropriate." See Appendix B for all bicycle-related MUTCD signage information.

Bike Route

The green "Bike Route" sign, D11-1 in the MUTCD, is commonly seen in both rural and urban areas and marks the road as a desirable route for bicycle travel.[7] Bike route signs on the Parkway are consistent with placement standards set in Section 9B.21 of the MUTCD (Figure 5).[8] According to Park staff, they were placed on the Parkway in the 1970s and 1980s. The signs indicate that NPS has designated the entire Parkway as a continuous bike route, which is consistent with the MUTCD option that states "Bicycle routes, which might be a combination of various types of bikeways, should establish a continuous routing." The project team documented relatively few of these signs along the 444-mile corridor.

Figure 5: Bike Route Sign (MUTCD D11-1
Source: MUTCD

[6] Manual on Uniform Traffic Control Devices. U.S. Department of Transportation, Federal Highway Administration. 2009 Edition with Revision Numbers 1 and 2 incorporated, dated May 2012. Washington D.C. 2009.

[7] ibid.

[8] ibid.

The MUTCD has an option to add wayfinding information in conjunction with sign D11-1. Currently, there is no directional or wayfinding information used with the bike route signs on the Parkway, such as mileage to a destination or names of towns. See Figure 13, in the Recommendations section for an example of this.

Bicycles May Use Full Lane

The second type of sign in use is an adaptation of the R4-11 "Bicycles may use full lane." Figure 6: MUTCD Sign R4-11 shows the basic sign as per MUTCD guidance. The altered version of this sign was installed in conjunction with a shared lane marking on the road surface in three locations. The first two locations were initially chosen as a pilot in both a rural and urban setting. One is placed near Leiper's Fork, TN, and the other is in Tupelo, MS. The third sign shared lane marking was installed by request of the residents of Kosciusko, MS. There has also been a request for this marking near the reservoir at Ridgeland, MS though none have been placed there to date.

Section 9B.06 of the MUTCD addresses the Bicycles May Use Full Lane Sign (R4-11):

- Option: 01 The Bicycles May Use Full Lane (R4-11) sign may be used on roadways where no bicycle lanes or adjacent shoulders usable by bicyclists are present and where travel lanes are too narrow for bicyclists and motor vehicles to operate side by side.
- 02 The Bicycles May Use Full Lane sign may be used in locations where it is important to inform road users that bicyclists might occupy the travel lane.
- 03 Section 9C.07 describes a Shared Lane Marking that may be used in addition to or instead of the Bicycles May Use Full Lane sign to inform road users that bicyclists might occupy the travel lane.
- Support: 04 The Uniform Vehicle Code (UVC) defines a "substandard width lane" as a "lane that is too narrow for a bicycle and a vehicle to travel safely side by side within the same lane."

In the case of the Parkway, standard sign R4-11 is combined with the text "Change lanes to pass" as in Figure 7: Bicycles May Use Full Lane Sign as Seen on the Parkway R4-11 is specified in the MUTCD as a stand-alone sign and the additional text below is considered an option with an additional stand-alone placard below, but it is not to be combined on the same sign. According to MUTCD staff, the "Change Lanes to Pass" text is a typical application of this placard option, although it is used more commonly on multi-lane roadways. A separate placard placed above the sign is also permissible for enhanced visibility, although these are not in use on the Parkway.

The R4-11 with text below on the same placard has been used in various states including Maine and Missouri, and is available from sign manufacturers as a stock item; however, the project team does not recommend this modification for the Parkway. The MUTCD advises that standard signage is used and not combined, so that motorist can recognize them by shape (in this case the square R4-11 sign) before they are close enough to read the words.

Figure 6: MUTCD Sign R4-11
Source: MUTCD

Figure 7: Bicycles May Use Full Lane Sign as Seen on the Parkway
Source: Think Bicycling Blog

Combination of Shared Lane Marking and Bicycles May Use Full Lane Sign

The combination of bicycle signage and markings on the Parkway is consistent with MUTCD options stating that the shared lane marking may be used to "encourage safe passing of bicyclists by motorists" and a Bicycles May Use Full Lane sign may be used in addition to or instead of the shared lane marking to inform road users that bicyclists might occupy the travel lane." However, Guidance in Section 9C.07 states that "the shared lane marking should not be placed on roadways that have a speed limit above 35 mph," and if used, the shared lane marking should be placed immediately after an intersection and spaced at intervals not greater than 250 feet thereafter." While Guidance in the MUTCD is not mandatory, the guidance indicates that shared lane markings are typically used in a sequence and also alludes to its typically urban application.

Rural applications of shared lane markings are rare but not unprecedented, and research to date is limited. Caltrans (California State DOT) guidelines have an option to use shared lane markings and Share the Road signs together on rural roads. The guidelines indicate that Share the Road signs should be installed after every major intersection and at one half mile intervals. Shared lane markings are specified to be located every +/- 200 feet.[9]

A 2014 study conducted in Florida evaluated the effect of shared lane markings on bicyclist and motorist behavior on high speed roads (above 35 mph).[10] In terms of the interventions on the Parkway, several of the findings from the Florida study are relevant, particularly if the Parkway decided to expand its use of shared lane markings:

- Installation of shared lane markings increased lateral separation between vehicles and bicycles with an analysis of variance indicating the difference before and after was significant in all study locations. On the two study sites with narrower lanes (10' and 11'), lateral separation increase was even more significant than with wider lanes (12'+).
- In some cases, lateral spacing between bicyclists and the edge of pavement was observed to increase after the installation of shared lane markings, with a difference ranging from 0.3 to 1.5 feet.
- Vehicles tended to slow down while overtaking a bicycle on both limited-access facilities and non-limited access facilities after installation of the shared lane markings.

Because of the high posted speed (50 mph) on much of the Parkway, one idea posed was to increase the size of the shared lane marking to accommodate the higher-speed vehicles in this context. The 2009 MUTCD presents an interpretation of the shared lane marking standard, in that it disallows "alterations of the shared lane marking symbol, including its chevrons."* Therefore to increase the size of the shared lane marking

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[9] "Bicycle Technical Guidelines." Santa Clara Transportation Authority. Santa Clara, CA. Second Revision: December 13, 2012.

[10] Sando, Thobias, Ph.D., P.E., PTOE (PI) "Operational Analysis of Shared Lane Markings and Green Bike Lanes on Roadways with Speeds Greater than 35 mph." Florida Department of Transportation Research Center. January 2014.

would go against the standard. It would also be providing accommodation for a practice that is against the guidance, of use on a road of greater than 35 mph speed. Another idea proposed was to keep the shared lane markings as-is and to not replace them as they wear out. Considered in this scenario is the fact that the shared lane markings were funded by the Natchez Trace Parkway Association (NTPA) and have a certain significance for the relationship between NATR and the community.

Three Feet Minimum

The third type of sign alerts motorists of the 3-foot minimum passing law (Figure 8). This is not a standard sign and park staff noted that they are phasing this sign out. The project team observed the southbound at mileposts 135, 115, and 103.5, but it may be present in other locations. The MUTCD notes that "The purpose of highway signing is not to create awareness, which is typically the intent of a sign conveying programmatic rules of the road. Other media—such as radio, television, and newspaper ads; notices on 511 travel information systems; postal mailings; and Web sites—are more appropriate for and conducive to promoting and/or marketing specific programs and new regulations."[11]

Figure 8: Three Feet Minimum Sign
Source: Project Team

The 3-foot passing law, or a variation thereof, is enacted in all three states the Parkway traverses. See Appendix C for Code of Federal Regulation rules governing bicycling on federal roads, Parkway guidelines for bicycling, and bicycling laws in all three states.[12]

- **Mississippi**: Pursuant to the "John Paul Frerer Bicycle Safety Act" enacted in 2010, while passing a bicyclist on a roadway, a motorist shall leave a safe distance of not less than three feet between his vehicle and the bicyclist and shall maintain such clearance until safely past the bicycle.
- **Tennessee**: the "Jeff Roth and Brian Brown Bicycle Protection Act of 2007" states similar stipulations to that of Mississippi, that a motorist must leave a 3-foot clearance between the vehicle and bicycle until the bicycle is safely passed.
- **Alabama**: the same legislation was proposed and taken a step further with the senate approving a 5-foot passing law in March of 2015.

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[11] MUTCD Frequently Asked Questions. http://mutcd.fhwa.dot.gov/knowledge/faqs/faq_part9.htm#signsq1.

[12] "Share the Road" http://www.nps.gov/natr/planyourvisit/upload/bicycling_safety_6-1-12_no-bleeds.pdf
"Rules of the Road" http://www.nps.gov/natr/upload/BIKERU.pdf
Alabama Code. http://www.alabike.org/images/ALCode_AlaBike_2010.pdf
Mississippi Code. http://mdot.ms.gov/documents/planning/BikePed/Laws/MS%20Bicycle%20Laws.pdf
Tennessee Code. http://www.tdot.state.tn.us/bikeped/bikelaws.htm

Bicyclists and motorists have noted that the "change lanes to pass" and “3 feet minimum” signs, though not in direct conflict with each other, may send a conflicting message. The “3 feet minimum” sign suggests to some drivers that they need only allow a 3-foot distance between the vehicle and bicyclists. A 3-foor distance may not may not be interpreted by some motorists as necessitating a complete change of lanes, depending on positioning of the bicycle. The “change lanes to pass” sign suggests to some drivers that they should allow a bicycle the entire lane as the driver passes (at a safe time) in full use of the oncoming lane, as it would pass a slower motorized vehicle. Though both scenarios would mean the vehicle crosses the yellow line, it may be unclear whether the driver should be making full use of the oncoming lane. This issue is noteworthy when considering areas with limited sight distance, especially in the northern section of the Parkway. In this type of environment, the motorist should be encouraged to allow the bicycle at least three feet, while spending as little time and space as possible in the oncoming lane, and signage should be clear with regards to this.

Each state may have slightly different laws governing bicycle riding and expected behavior of motorists with regards to bicyclists. However, in the case of NATR, as it traverses three states and is under Federal jurisdiction, the Code of Federal Regulations (CFR) supersedes state law. Where state laws allow bicyclists to ride two-abreast, the CFR prohibits all but single-file riding. Therefore single-file riding is required on the parkway and is especially important for bicyclists to adhere to in the case when a motor vehicles overtakes them and must cross the centerline.

Bulletin Board Signage

The project team observed that bicycling information for both motorists and drivers is present on bulletin board signs (Figure 9: Bulleting Board Sign with Bicycle Information). The 3-foot passing law is posted, as is information directed toward bicyclists. The designation of the Parkway as a bicycle route, the existence of bicycle-only campgrounds, and the suggestion to wear a helmet and high-visibility clothing are all presented.

Figure 9: Bulleting Board Sign with Bicycle Information
Source: Project Team

Bicycle Users of the Parkway

Bicycle use of the Parkway is on an upward trend, as noted by the Park staff, though data has not yet been collected to show this. This gives further support for the need to increase safety. Bicyclists on the Parkway can be categorized into to the following general types:

- **Local bicyclist**: A local person that generally rides alone or in a pair or small group for transportation, commuting, or regular exercise, and typically within a small geographic radius. This type of rider is likely more common in the more developed areas such as Ridgeland, MS.
- **Organized group bicyclists**: These may include eight or more people. While the groups are more visible to motorists because of their size, they pose more of a danger because of the need for the vehicle to pass multiple times consecutively. Groups often ride a longer distance or all 444 miles of

the Parkway. They are required to obtain a permit with the Parkway and must adhere to the conditions of the permit and the Parkway's safety guidelines, [13] including wearing lights, highly visible clothing, a helmet, and following the federal laws, which specify to ride single file.[14]

- **Individual or couple touring riders:** Those who are on the Parkway for tourist purposes and ride the entire length or a significant portion thereof.

In addition, there may be smaller groups who ride together that do not apply for a permit, fitting somewhere in between the three listed categories.

To get a better sense of the number of total bicycle users on the Parkway, NATR has installed three bicycle counters, placed at:

- Ridgeland, outside of Jackson, MS
- Tupelo, MS about two miles south of the Visitor Center
- Outside of Nashville, TN at Leiper's Fork

These devices use pneumatic loops placed 24 inches apart to calculate speed by recording the time it takes each wheel to pass over the tubes. The counters do not differentiate between bicycles and motorcycles, so the Park has determined a 25 mph threshold would such that less-than 25 mph is counted as a bicycle, while greater-than 25 mph is counted as a motorcycle.

The counters in Nashville and Ridgeland were installed in early September 2015, while the one in Tupelo began counting in the summer of 2015. There were 128 bicyclists during the month of August counted in the Tupelo location. The Park noted the probability that Tupelo may have fewer bicyclists than other areas of the Parkway because there are many other options for bicycling in the area. In addition, the local bike shop does not recommend the Parkway for bicycling and favors alternate routes; this opinion may have some bearing on those who visit the bike shop. It has also been observed that peak cycling season on the Parkway is fall and spring, and higher bicycle counts are expected during these seasons. These three counters will be very valuable over time to understand bicycle use by time of day, season, and year; however, the counters will not be able to distinguish local bicyclists from through bicyclists.

Crash Data

According to NPS records, there have been 17 crashes that involved a vehicle and bicycle over the last 10years. Four resulted in a bicyclist fatality. See Appendix D for specific dates of incidents and map of crash locations along the Parkway. The crash records show that there is no particular trend in location in terms or rural vs. urban. The vast majority of crashes occurred during daylight hours and between the months of April and October. This is likely because these are the times of day and year that most bicyclists are on the road.

Advocacy, Education, and Awareness

National Park Service

The Natchez Trace Parkway website has a page dedicated to bicycling for those exploring available activities along the Parkway. Links to information in the following categories is available for bicyclists planning a trip:

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[13] http://www.nps.gov/natr/planyourvisit/safety-guidelines-fro-bicyclists.htm

[14] Code of Federal Regulations. 36CFR 4.30– Bicycles. https://www.gpo.gov/fdsys/granule/CFR-2011-title36-vol1/CFR-2011-title36-vol1-sec4-30

rules, general camping information, bicycle-only campground information, public transportation, bicycle services, supplies/food/fuel, ranger offices, drinking water locations, and a link to the special use permit.[15] The website dictates that the special use permit is required for organized or group rides, and notes that eight bicyclists constitute a group necessitating a permit.[16] A phone number is provided for questions related to assistance with travel plans.

NPS law enforcement patrol the Parkway on a regular basis and stop bicyclists who are not equipped with proper attire (lights and high-visibility clothing), then warn them of the necessity of doing so and on occasion hand out a set of lights and a vest courtesy of the Gary Holdiness Cycling Fund (while supplies last). While some bicyclists may be unaware of the importance of using lights and bright colors for visibility, Parkway staff noted that some bicyclists are opposed to these rules. While there are requirements for bicyclists who are a part of an organized group to use lights, helmets, and high-visibility clothing, no such requirements exists for informal rides.

Bicycle Organizations

There are several bicycling organizations that provide information for and facilitate group rides on the Parkway. Adventure Cycling Association and Over the Top Cycling conduct organized rides on the Parkway. Adventure Cycling Association has partnered with the NTPA and NPS on their comprehensive bicycle safety campaign and has helped with outreach as well as funding for the bicycle safety signs and lane markings. The Tour d'Attala Cycling Club (TACC) is based in Kosciusko, MS at milepost 160 and conducts group rides and events throughout the region. TACC is involved with various efforts to promote bicycling, road safety, and raising funds for such activities in Attala County. The NTPA /Gary Holdiness Cycling Fund has also donated funds to support the current "bicycle safety program" that allows rangers to distribute lights and high-visibility vests to bicyclists who do not meet the visibility requirements. Numerous other groups, such as churches or charities, also conduct organized rides along the Parkway and may be useful to explore communication with in terms of enhancing safety awareness.

Focus Group Findings

Focus Group Findings

Park staff conducted focus groups, which in addition to other issues, evaluated perceptions of the shared lane markings and signs. Focus group meetings were conducted in September 2014 in Ridgeland, Tupelo, and Nashville (see Appendix A: Focus Group Responses). Many opinions were shared and several t consistent themes emerged. Most respondents believed that the shared lane markings and signs help to promote awareness of bicycles on the Parkway. Others felt that the shared lane markings or signs are confusing in some way, while others believed the combination to be powerful and effective. Enforcement and education were the repeated themes. There were opposing opinions but some of the other ideas that showed up repeatedly are:

- sign and shared lane marking make motorists more aware of bicycles
- sign is confusing--too much information
- sign is clear and enforces 3' law
- great signs—add more
- shared lane marking ("sharrow") is confusing and not understood
- sign and shared lane marking are effective combination and should be placed closer together
- shared lane marking is more clear than sign—people ignore signs
- add more shared lane markings
- sign and shared lane marking are better and more important than 3' passing sign
- need speed enforcement

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[15] http://www.nps.gov/natr/planyourvisit/bicyclinghome.htm

[16] http://www.nps.gov/natr/planyourvisit/special-use-permits-bicycling.htm

- bicycles riding in group are easier/safer to pass than single-file
- unclear who signs and shared lane markings are geared toward
- need education campaign for motorists/bicyclists

Initial Options Considered

- Add more shared lane markings and accompanying text signs
    - More frequent shared lane markings may help the motorist understand their meaning and would comply with MUTCD guidance in that they should be spaced at intervals not greater than 250 feet.
- Change location of shared lane markings and signs
    - Place at major entrances to Parkway
    - Place sign before shared lane marking so text is seen before symbol, thereby helping to interpret it
    - Place on both sides of road in a given location
- Remove shared lane markings and signs
    - Implement a different signage and striping scheme that is more appropriate to the high-speed road context. The use of shared lane markings here, though not against standard, is also not customary. Alternative options can be explored that would send a more clear message to motorists.
- Reduce Speed Limit
    - The best way to understand the effects of a lowered speed limit would be to create a model. Drivers tend to travel at a speed that is comfortable given the design of the road, and not necessarily at a posted speed if it does not coincide with design speed. Since the road is designed for 50 mph travel, motorists are likely to continue at this speed regardless of posted speed. If a lower speed limit were to be posted in a more congested area, it may be heeded due to the fact that there is more traffic, though it could also cause platooning which would not be desirable, causing frustration and distraction to the motorist and a potentially more dangerous situation. As for lawbreakers, the speeders who disobey the posted speed tend to do so regardless of what the posted speed limit is. This is unlikely to reduce instances of very excessive speeds.
- Additional law enforcement
- Education campaign for motorists and/or bicyclists
- Requirements for solo bicyclists/enforcement
- Megatron sign messaging (variable message board)
- Additional wayside signage
- Vehicle headlight requirement in inclement weather/enforcement
- Pavement and striping—paved shoulder/passing lanes

Observations

While on site, the project team encountered several small group or solo bicyclists and spoke with some from a large organized group. One complaint they voiced was with regards to vehicles passing at an unsafe time, while another vehicle was also on-coming. The Parkway continues to hear similar complaints from motorists and bicyclists—that vehicles do not wait until a safe straightaway to pass, do not wait for bicycles to align single file, or that bicycles should ride single file and are not. Though the law requires single-file riding, bicyclists may not always adhere.

Comparative Data

Since data is not readily available for bicycle ridership and crashes before the shared lane markings and signs were installed, it is difficult to quantify the effect of the intervention. Evaluation will rely on anecdotal evidence and best practices.

Rural Bicycle Safety Crash Factors

Rural areas have a very different set of crash factors than urban areas in terms of bicycle safety, which may affect the frequency and severity of crashes. The Parkway could generally be described as rural in context, marked by two-lanes, high-speed, and low-traffic volume. Exceptions to the rural nature of the Parkway are found in the Tupelo and Ridgeland areas where traffic counts are much higher. Much research has been carried out on urban bicycle safety, but in rural settings, research and implementation of bicycle-inclusive design is still in its infancy. Despite this shortage of research, some findings may prove helpful to understanding the context on the Parkway. A study done in 2006 by Daniel Carter on urban versus rural bicycle crashes has shown rural bicycle crashes to be three times as likely to result in a fatality as urban crashes of similar type.[17] Two-lane rural roads like the Parkway make up the majority of rural road infrastructure; they exhibit the greatest number of rural bicycle and pedestrian crashes, and have the highest overall crash frequency. The aforementioned study is quite illuminating regarding the typical conditions of these crash types. Crashes involving a vehicle and pedestrian, or vehicle and bicyclist in rural areas typically included the following factors:

- Two-lane roadways
- Non-intersection related
- Relatively high vehicle speeds
- Absence of shoulders along the roadway (and other space constraints)

Twenty-five percent of bicycle and pedestrian fatalities occur on rural highways,[18] and roadway classification is a key consideration. Table 2 below shows the number of rural bicycle crashes by roadway classification in the Carter study. Rural roadways are listed in the table according to the Highway Safety Information System (HSIS) classification system.[19]

- *Rural 2-lane roads* have partial or no access control, are located outside urbanized areas, and have two lanes.
- *Rural multilane divided non-freeway roads* have partial or no access control, are located outside urbanized areas, have three or more lanes, and are divided by some type of median.
- *Rural multilane undivided non-freeway roads* have partial or no access control, are located outside urbanized areas, have three or more lanes, and are not divided by any type of median.
- *Rural freeways* have full access control, are located outside urbanized areas, and have four or more lanes. Roads of this class are typically divided by a median.

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[17] Carter, Daniel L. and Forrest M. Council. Factors Contributing to Pedestrian and Bicycle Crashes on Rural Highways. UNC Highway Safety Research Center. June 2006.

[18] Carter, D. and Council, F. (2007). *Factors Contributing to Pedestrian and Bicycle Crashes on Rural Highways*, Transportation Research Board 86th Annual Meeting Paper #07-2457, Transportation Research Board, Washington, DC. Obtained from: http://tris.trb.org/view.aspx?id=802225.

[19] HSIS is a national database that contains crash, roadway inventory, and traffic volume data for a select group of US states. It is managed by the University of North Carolina Highway Safety Research Center (HSRC) under contract with the USDOT Federal Highway Administration. HSIS consolidates high quality data that are already collected by states and it is then used for research, summaries, and articles.

The values in the next three columns are separated by roadway classification and are explained as follows.

- The *crash frequency* value shows the number of bicycle crashes that occurred on the given road classification during the total six years of the study. As is evident in the data, rural two-lane roads such as the Parkway, have the highest frequency of crashes of all the road classification types.
- The *crashes per 1,000 roadway mile* value shows the rate of crashes per road mile in the state during the study. A low rate of crashes per mile indicates a low number of crashes occurring on a commonly used road classification. Without further data on specific locations that may have a particularly high number of crashes, it is useful as an indicator for cost of treatment. The low number on two-lane roads (23.9) means that given the high crash frequency (725), this is a very common roadway class and as such, would be more difficult to treat systematically.
- The *crashes per 100 million vehicle miles* value shows the rate of crashes per 100 million vehicle miles traveled per year during the course of the study. It calculates using average daily traffic (ADT) counts in HSIS. The value given accounts for vehicle exposure (traffic volume and miles traveled) but does not account for the bicycle exposure. It is an effective indicator of level of risk as it corresponds fairly well with the crash frequency value. This last column reveals the exceptional risk for bicyclists on rural two-lane roads.

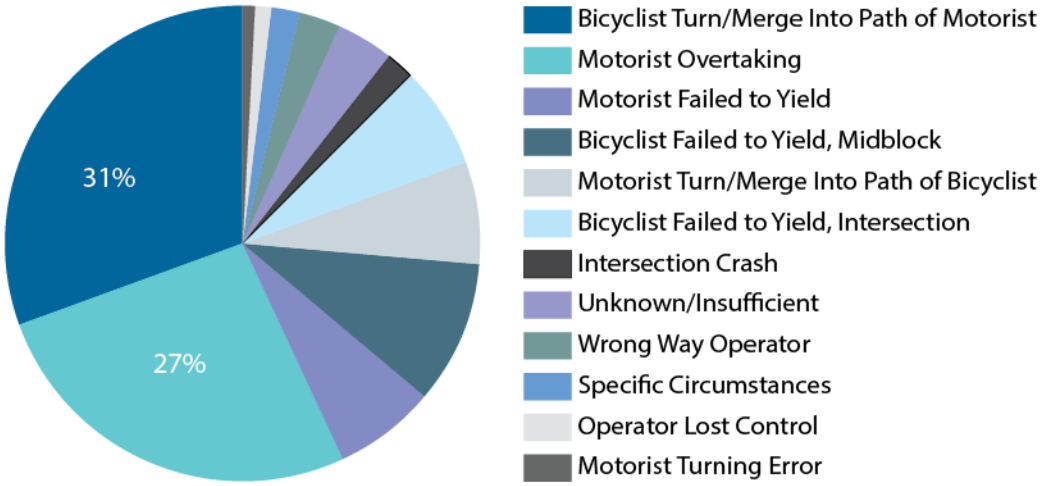
Table 2: Rural Bicycle Crashes by Roadway Classification[20]

Rural Roadway Classification	6-Year Crash Frequency	Crashes Per 1,000 Roadway-Mile	Crashes/100 Mil. Vehicle-Mi/Year
Two-lane Roads	725	23.9	0.51
Multilane Divided	43	52.2	0.17
Multilane Undivided	28	76.9	0.28
Freeways	3	3.3	0.01

Each crash in the study was categorized as a particular type according to how it occurred, with information taken from detailed police report narratives and diagrams. This information was combined with roadway classification to identify problematic situations. Figure 10 below shows types of bicycle crashes that occurred on rural roads as a percentage of all documented rural crashes. The two most common types of rural crashes involving bicycles in the study were "bicyclist turn/merge into path of motorist" (31%) and "motorist overtaking bicyclist" (27%). The latter seems to coincide with the common crash types in documented incidents on the Parkway.

[20] Ibid.

Figure 10: Factors in Rural Bicycle Crashes by Percentage
Source: UNC Highway Safety Research Center[21]



The Federal Highway Administration (FHWA)-sponsored project, BIKESAFE was developed with the intent to provide comprehensive information on bicyclist safety. The tool is "intended to provide practitioners with the latest information available for improving the safety and mobility of those who bicycle." [22] BIKESAFE has compiled a list of crash types in rural areas and paired each type with recommended safety countermeasures. The rural crash types are listed in Table 3 below.

Table 3: Crash Type and Associated Countermeasure[23]
Source: BIKESAFE

Crash type	Countermeasure
Bicyclists turning/merging into the path of the driver midblock	• Provide marked pavement space for bicyclists (locations with suitable pavement width)
Drivers overtaking midblock	• Provide marked pavement space for bicyclists (locations with suitable pavement width) • Improve roadway lighting
Bicyclists failing to yield midblock	• Reduce lane width to minimize crossing distance and slow vehicles
Bicyclists failing to yield at the intersection	• Improve sight distance • Improve school zones

The crash types listed here are likely applicable to the Parkway, but the countermeasures do not necessarily provide clear solutions in the case of the Parkway. The lack of detailed crash scenario data on the Parkway also precludes detailed recommendations using BIKESAFE; however, the project team was able to draw

[21] Carter, Daniel L. and Forrest M. Council. Factors Contributing to Pedestrian and Bicycle Crashes on Rural Highways. UNC Highway Safety Research Center. June 2006.
[22] Hunter, W.H., Thomas, L., and Stutts, J.C. (2005). BIKESAFE: Bicycle Countermeasure Selection System, Report No. FHWA-SA-05-006, Office of Safety, Federal Highway Administration, Washington, DC. Obtained from: http://www.bicyclinginfo.org/bikesafe. Site last accessed June 4, 2010.
[23] Ibid.

some broad conclusions. One is that pavement width is a key challenge. Lighting is a less salient issue, as the majority of bicycles seem to be using the Parkway during the day and the documented bicycle crashes occurred during daylight hours or dusk. The following section will examine crash factors more in depth in terms of road design and behavior.

Road Design and Physical Conditions

Design Speed and Excessive Speed

Speed is a major factor in severity of injury of the bicyclist in a crash with a vehicle (see Figure 3). More than half of all rural pedestrian and bicycle crashes occur on roads with a posted speed limit of 50 mph or greater. As an indicator, the probability of a pedestrian fatality as a result of a collision with a vehicle increases from 5 percent to 85 percent as vehicle speed increases from 20 to 40 mph.[24] The higher the speed, the less reaction time a driver has to identify a conflict, chose how to react, and then brake or swerve. Both the reaction distance and braking distance, measurable in feet, are correlated to vehicle speed such that if a vehicle at 20 mph takes 175 feet to stop, a vehicle going 40 mph takes approximately 350 feet to come to a complete stop. A crash at a speed of 50 mph therefore, has strong potential to result in fatality.

Another factor related to speed is the communication between motorists and bicyclists. A vehicle has built-in features such as turn signals, lights, and a horn, to communicate to others on the road. Bicyclists must rely on providing manual signals and ad-hoc equipment that drivers are much less likely to notice. While this is generally the case, excessive speed reduces the likelihood of noticing bicyclist signals and poses a demonstrably greater safety risk. Though the posted speed is typically 50 mph throughout the Parkway, anecdotal evidence suggests motorists do exceed this. Law enforcement is proven to be effective in reducing speed; however, with limited budget for ranger patrol, opportunity cost must be weighed with other measures. In addition, the legal speed is already very dangerous for bicyclists. Because the road has a design speed above its posted speed (generally 50 mph), lowering the limit poses other concerns and would not necessarily increase safety.

Road Width and Shoulders

The Parkway has 22 feet of pavement, with 11-foot lanes in either direction, without shoulders. This is standard lane width for a road of this type, but without paved shoulders, does not allow for separation between slow and fast-moving vehicles. Lack of separation between the motorized and non-motorized users is a significant concern on roads without shoulders. A shoulder allows safe space for vehicles traveling under the speed limit to safely operate without interfering with the faster traffic flow. The previously mentioned Carter study showed that the majority of rural bicycle crashes occurred on roads with unpaved shoulders, accounting for 80 percent of rural bicycle crashes.[25] The edge of the pavement is also factor because a bicyclist can easily lose control and crash when hitting a pavement drop-off, which can happen when forced too far to the side by a passing vehicle. As noted in the BIKESAFE countermeasures, suitable pavement width is a fundamental prerequisite to mitigating crashes of the type most often occurring on the Parkway, but this countermeasure is cost prohibitive at the present time.

Environment

In addition to roadway design, the larger landscape and environmental conditions are factors that affects safety. Some sections of the Parkway are designed with trees very close to the road. Both motorists and bicyclists may experience reduced visibility as they must quickly adjust their eyes between full-sun and full-

[24] Federal Highway Administration, *Road Safety Audits Guidelines (FHWA-SA-06 06):* http://safety.fhwa.dot.gov/rsa/guidelines/documents/FHWA_SA_06_06.pdf

[25] Carter, Daniel L. and Forrest M. Council. Factors Contributing to Pedestrian and Bicycle Crashes on Rural Highways. UNC Highway Safety Research Center. June 2006.

shade lighting due to the sporadic tree canopy. Transitions between sun, shade, and dappled light can happen quite quickly and though bicyclists experience this as well, they may not realize the reduced ability for drivers to see them in these conditions. In addition, glare is a common factor at certain times of the day and all road users should take precaution as visibility is reduced. The use of windshield wipers, sunglasses, lights, and other items meant to adapt to environmental conditions can have varying effects on visibility. Heavy rains also reduce visibility severely, and though vehicles may quickly turn on their headlights even in the daylight, bicyclists planning for strictly daytime travel may not be equipped with lights at all. Though bicyclists may choose to leave the road during especially heavy precipitation, and are required to do so if they do not use lights (according to the CFR, riding without lights is prohibited during periods of low visibility), some may remain on the road. Even with head and taillights, the luminosity on bicycle lights is typically far less than those on motor vehicles, rendering bicycles with lights still quite difficult to see by a motorist in a storm event.

Behavior

Behavioral factors play a critical role in bicycle crash occurrence and type. Behavior refers to actions taken by or condition of the driver, passengers, or bicyclist. This can include use of lights, horns, and vehicle equipment; effects of alcohol or drugs; drowsiness or distraction; and experience level that may affect decisions or reactions while operating a vehicle or bicycle. Understanding how the components of behavior, physical environment, roadway user profiles, and travel patterns interact, can offer key insight into crash factors.

Motorists' expectancy of encountering non-motorized users is generally very low in rural areas, but particularly important. A motorist who is traveling at 50 mph for an extended period of time is focusing on vehicular traffic and associated traffic controls; he or she does not expect bicyclists in the roadway and therefore may not give appropriate attention. Bicyclists may also be responsible for unsafe behavior, though experienced bicyclists tend to be very aware of vehicular traffic. In addition, bicyclists from out-of-town may be accustomed to traveling on roads where bicyclists are more common and where motorists are more aware. The most effective measures that can be taken to influence behavior are to increase awareness of non-motorized users on the roadway and ensure all users are apprised of the appropriate behavior expected of their mode.

Drugs and Alcohol

Alcohol-impaired driving crashes accounted for 10,076 deaths in 2013, or nearly one-third of all people killed on the U.S. roads.[26] The National Highway Traffic Safety Administration keeps data on pedestrian and bicycle crashes and injuries in the published Traffic Safety Facts. In 29 percent of crashes involving a bicyclist, either the driver or the bicyclist had blood alcohol concentrations of 0.08 g/dL or higher.[27]

In 18 percent of motor-vehicle-related deaths, other substances are a significant factor and are often combined with alcohol. Impaired driving is dangerous for all road users but particularly for non-motorized road users. Stringent enforcement of laws is paramount, as is recording impairment data and analyzing it. For example, if alcohol is a factor in 80 percent of crashes with bicycles on the parkway, we could surmise that behavior is much more of a problem than the roadway characteristics, and enforcement should be increased. However, if impairment is only a factor in 5 percent of crashes, we would know that engineering factors, such as signage and striping, need to be addressed. The crash data does not currently indicate the extent to which drugs and alcohol are a factor in bicycle-involved crashes on the parkway.

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[26] CDC, http://www.cdc.gov/motorvehiclesafety/impaired_driving/impaired-drv_factsheet.html

[27] National Highway Traffic Safety Administration. Pedestrian and Bicycle Crash Statistics. http://www.pedbikeinfo.org/data/factsheet_crash.cfm Accessed 21 October 2015.

Inattention, Drowsy, and Distracted Driving

Drowsiness and highway hypnosis are common factors in roadway crashes and tend to increase in severity in highway conditions versus roadways with many intersections and dense adjacent activities that demand driver attention. As the Parkway has many long, isolated stretches, this could be an important factor to consider.

Bicyclists killed by distracted drivers grew 30 percent between 2005 and 2010, from 56 to 73.[28] About half of these deaths occurred during daylight hours. While statistics are unknown for bicyclist injuries from accidents, it could be speculated that they also increased. Adjusting vehicle equipment such as radio or climate control, use of a mobile phone, and especially texting, are the most common causes in distracted driving collisions. Consequences are typically more severe for the bicyclist than motorist. While motorists may use a horn to alert if another driver is veering off the road or approaching too close, bicyclists do not have the ability to use loud sound as a warning. In addition, they are less visible so have several disadvantages from a sensory perspective. This highlights the importance of using lights and high visibility gear on the bicycle.

Mobile phone use and texting has increased markedly in the last decade, necessitating new laws in relation to permissible behavior while driving. In Mississippi, texting is prohibited for anyone driving a vehicle, but the use of a mobile phone is allowed except for bus drivers.[29] Alabama prohibits mobile phone use of any kind for novice drivers (age 16 or 17 with an intermediate license less than 6 months) and prohibits texting for drivers of all ages. Tennessee bans any type of mobile phone use for bus drivers and novice drivers (any age with a learner's permit or intermediate license) and texting is also not allowed for any driver. Enforcement in the case of distracted driving can only be as strong as the laws. While driving under the influence of alcohol has developed a social stigma, use of a mobile phone so far has not, resulting in cultural acceptance of distracted driving. As with substance abuse in crashes, the project team does not have access to distracted driving data and therefore cannot determine to what extent this is a factor in bicyclist deaths and injuries on the Parkway. Knowing more about distraction as a factor in accidents on the Parkway could help determine how significant a role it plays.

Because the Parkway is a destination road for both motorists and bicyclists, this visitor demographic may be less likely to be affected by drowsiness since they are there for the purpose of actively viewing the landscape. They may however be distracted by looking at a map, searching for directional signs, or taking in the view. Those who drive the parkway regularly and know the road intimately may have different factors leading to inattention to driving. This applies to both motorists and bicyclists and therefore it is useful to know how many are visitors as opposed to locals, for all types of road users. Safety and awareness campaigns should reach a targeted audience, requiring different types of interventions for a local demographic than a disparate set of visitors from different origins.

Motorist Inexperience with Bicyclists in the Roadways

It has been noted by Parkway staff that drivers in the Tupelo area are not accustomed to sharing roads with bicyclists. Though there may be bicyclists in many of the communities adjacent to the Parkway, it takes a critical level of bicyclists sharing the road space throughout the city and region for motorists to understand them as normal and legitimate users of the road. Bicyclists tend to be keenly aware of expected motorist behavior, but the reverse is not necessarily true. Because of this asymmetry, bicyclists may at times feel threatened and behave in a manner to assert their right to the road. Motorists may exhibit aggressive behavior in response to what they see as interference from bicyclists.

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[28] http://www.sciencedaily.com/releases/2013/11/131120100318.htm

[29] http://www.distraction.gov/stats-research-laws/state-laws.html

Familiarity with the surrounding environment is also a factor when considering experience. Because the Parkway is a tourist destination, both bicyclists and motorists may be first-time visitors and not familiar with state laws and federal regulations. As reported by the Park, both motorists and bicyclists have shown aggressive behavior toward one another. It is imperative to ensure that the laws of the road, as well as expected behavior, are clearly defined for each road user. Signs and messaging should not be ambiguous, and information on road rules should be widely available in many formats.

Underreporting

Studies have shown that crashes involving bicycles are underreported due to a variety of issues:

- Occurring outside of the main roadway
- Lacking sufficient injury or property damage to deem necessary to report
- Variety of other reasons

Non-motorized crashes do not necessarily involve damage to motorized vehicles; for example, a bicyclist may be run off the road by a motorist and hit a tree or other roadside obstacle. These types of incidents may not all be reported to the park if the bicyclist is not severely injured. Potential safety issues are often present in locations with minimal or no recorded crashes or fatalities. Mitigation of those safety issues should not dependent on recorded crashes or fatalities but can instead be preventive measures.

Examples from other National Parks

The project team reached out to a number of National Parks that are similarly situated to the Natchez Trace Parkway regarding bicycle safety measures. It is apparent to the project team that bicycle safety in national parks and other public lands is an emerging field of study and NATR appears to be at the leading edge on this issue.

The following parks have implemented some measures, although none quite to the extent of NATR.

Blue Ridge Parkway

The Blue Ridge Parkway is not a designated bicycling route, but bicycling is permitted under the recently completed General Management Plan for the Parkway. Signage specific to bicycling is minimal and there are no official bicycle route signs, share the road signs, or bicyclist may use full lane signs. The park is particularly concerned about bicycling safety around commuter zones in Roanoke, VA, Asheville and Boone NC, where traffic volumes are highest.

The park has 26 tunnels which can be very dangerous for bicyclists. Recently, the park posted the universal MUTCD symbol for bicyclists at the entrances of tunnels to ensure that motorists are aware that bicyclists may be present.

Rangers at the park enforce single file riding. They give warnings to bicyclists to wear visible clothing and have reflectors or lights mounted to improve visibility in fog conditions.

Glacier National Park

Bicycling is allowed on Going-to-the-Sun Road in Glacier National Park (with some restrictions between 11:00 AM and 4:00 PM in the eastbound direction between mid-June and Labor Day). These limitations are in place to minimize vehicle-bicycle conflicts during the peak season. The posted speed limit on lower elevations of the road is 40 mph and 25 mph on the alpine sections.

The Institute for Tourism and Recreation Research, based out of the University of Montana's College of Forestry program, completed a study that involved placing temporary signs along Going to the Sun Road and disseminating brochures with visitor information regarding rules, responsibilities, and share-the-road information at entrance gates. The signs stated that “bicyclists may use full lane, pass 3FT Min.” The purpose

of the study was to assess differences in attitudes towards bicyclists and understanding of laws with and without the intervention using a survey instrument.

This park road differs from NATR in several ways; one being its topography and mountainous terrain, and the other is the fact that it does not pass through urban or settled areas other than the national park boundary. Nonetheless, many of the challenges overlap and the two publications from the study and Glacier National Park may have relevance to the Parkway.[30, 31]

Olympic National Park

Olympic National Park (OLYM) is a popular bicycling destination not unlike the Natchez Trace Parkway. Many of the same challenges are present, such as high speed of vehicles, lack of shoulder in many areas, curvy, hilly conditions with limited visibility, with the added stress of large logging trucks. Unlike the Parkway, there is a network of roads at OLYM that bicyclists use and not all are on park property. Olympic National Park and the greater Olympic Peninsula are host to a number of small cities and towns, meaning there are also local bicyclists who use the roads for bicycle transportation in addition to the destination bicyclists. US Highway 101 is a popular bicycle route through the park. It is four lanes with a shoulder, but narrows to two lanes without a shoulder as it hugs the shore of Lake Crescent. Where the road narrows, the sign pictured below in Figure 11 is posted. Below it is a button that bicyclists may press to activate a flashing beacon light (in the background on the picture to the right in Figure 11). The light flashes for an hour, giving most bicyclists time to traverse the 12-mile lakeside route and a warning for motorists that bicycles are up ahead.

Figure 11: Bicycle Notice and Flashing Safety Light
Source: Washington Bikes[32] and Gene Bisbee[33]

[30] Battaglia, Brian and Nora P. Nickerson. Assessing Going-to-the-Sun Road Travelers' Attitudes, Knowledge, and Perceptions of Bicycling. The Institute for Tourism and Recreation Research. University of Montana, 2016. http://scholarworks.umt.edu/itrr_pubs/334

[31] Battaglia, Brian and Nora P. Nickerson. Comparing Bicyclists, Non-Bicyclists, and Bus Drivers in Glacier National Park. The Institute for Tourism and Recreation Research. University of Montana, 2016. http://scholarworks.umt.edu/itrr_pubs/335

[32] http://wabikes.org/2014/12/08/olympic-discovery-trail-car-free-route-around-lake-crescent/

[33] Bisbee, Gene. Signs of (Bicycling) Life on the Olympic Peninsula. Biking Bis Blog. http://www.bikingbis.com/2006/09/07/the-signs-of-bicycling-life-on-the-olympic-peninsula/

The Port Townsend Bicycle Association (PTBA) is a major advocacy group in the area and has worked to create bicycle maps of all the cities and counties around the national park and greater Olympic Peninsula. It offers this resource at local bike shops and online in a downloadable format. The PTBA advocates for correcting infrastructure issues, such as dangerous bridges and improperly placed rumble strips, as well as communicating with the state DOT, county jurisdictions, and the national park. They also organize weekly Sunday rides and various special event and benefit rides in coordination with other area bicycle groups as well as statewide bicycle advocacy groups on larger issues. All of these activities have helped to create awareness of cycling in the area by having a greater number present and thus increasing visibility to motorists. Partnering with local advocacy groups can be a key strategy in raising awareness. Many of these groups have a large social media following that could reach out to new audiences.

Recommendations

Based on the analysis of existing conditions and overview of crash factors, it is apparent that the physical design of the roadway is a key factor for multi-modal safety. Shared space for motorized and non-motorized vehicles as well as pedestrians was not a part of the original design. The road was designed primarily for automobiles to travel at a high-speed (high-speed relative to the speed of bicycles) and there is no shoulder or separated bicycle facility. This physical design is part of the reasons crashes are broadly distributed geographically. Statistics show that crash risk cannot be assigned to particular locations (See Appendix D Crash Data). Therefore, the project team recommends a focus on the risk factors that are common throughout the entire Parkway. This involves recommendations that are replicable and implementable throughout the Parkway as a whole. By identifying the risk factors that are associated with most or all crashes throughout the corridor, the recommendations take a systematic approach to the entire parkway. They include:

- Physical Roadway Interventions
- Campaigns and Community Engagement
- Data Collection

Physical Roadway Interventions

New Signage

Because the construction of a shoulder is not within the budget for the foreseeable future and such a change may also have historic resource implications, signage is the primary engineering approach to address. The project team found that speed limit signs are relatively infrequent on the Parkway, particularly in the northern section. There are long stretches in which no speed limit signs were seen, such that motorist may not see a speed limit sign for some time depending on where they enter the Parkway. As speed limit signs are damaged or removed over time, it is important to replace them such that they are easily visible at every location a vehicle has an opportunity to enter the parkway, in both directions. In addition, where speed limits decrease or there are curves in the road, it may be prudent to have advanced warning or advisory speed limit signs (Figure 12). If data shows that excessive speed is a particular problem, the Park could also use supplemental signage about enforcement.

Figure 12: High-Visibility Speed Limit Signs
Source: Wikipedia and MUTCD

As evidenced by the focus groups conducted by the Parkway, with regards to bicycle marking and signage, clear and consistent messaging is crucial. Altering of existing shared lane markings and signage scheme may be necessary to enhance clarity. The project team recommends that the Parkway conduct an inventory of all signage and then engage in a further study to create a signage plan. The combination of the "3-foot passing law" message and "change lanes to pass" may cause confusion about appropriate driver behavior. "Share the road" signs have typically been used for general awareness, but they have recently fallen out of favor because they are too vague.

"Bicycles may use full lane" may also be ambiguous since some state laws requires that bicycles move to the right for passing vehicles when it is safe to do so. That being said, these signs are still a good option for the Parkway. They alert motorists to the possibility of bicyclists on the roadway, assert their right to the road, but also state this as an option not a requirement. It is therefore necessary to ensure that all bicyclists are properly educated on state laws, their rights on the road, and the importance of courteous behavior, such as riding on the right.

The "change lanes to pass" sign is well-suited for the situation of the full-lane user bicyclist, but since bicyclists also ride on the right, it may be unnecessary to change lanes completely and could pose a safety problem given the increased potential for head on collisions. Therefore, the sign should not be placed in locations where there is limited sight distance (such as parts of the northern section of the Parkway) to ensure that the motorist is not encouraged to take excessive risk. A standard speed limit could be placed at any location a vehicle may enter onto the Parkway, before major bridges, and in areas that have long gaps between entrances. Given the high number of incidents on the Parkway, the project team suggests that signs be installed at least every 25 miles to ensure that motorists see them once every half hour. Figure 14, the same sign without the "change lanes to pass" text, could be placed in areas of limited visibility. To comply with the MUTCD, all signs and placards should be independent instead of combined into one sign. Changes in signage for purposes of safety would also need to be evaluated in terms of the cultural landscape. Since the Parkway is a designated cultural and historic resource, signage may not be treated in the same way as a standard road. In some cases, NPS may need to consider whether it is necessary to pass changes through the State Historic Preservation Office (SHPO).

Figure 13: High-Visibility Bicycles May Use Full Lane Sign with Additional Text Below
Source: Adapted from MUTCD

Figure 14: High-Visibility Bicycles May Use Full Lane Sign
Source: Adapted from MUTCD

Removing Shared Lane Markings

The project team recommends the existing shared lane markings remain until worn out and not be replaced. According to the focus groups, they are lauded by some and confusing to others, and though they have been helpful in alerting motorists of bicycles on the road, their installation in this context is somewhat atypical. According to MUTCD guidance, shared lane markings are typically:

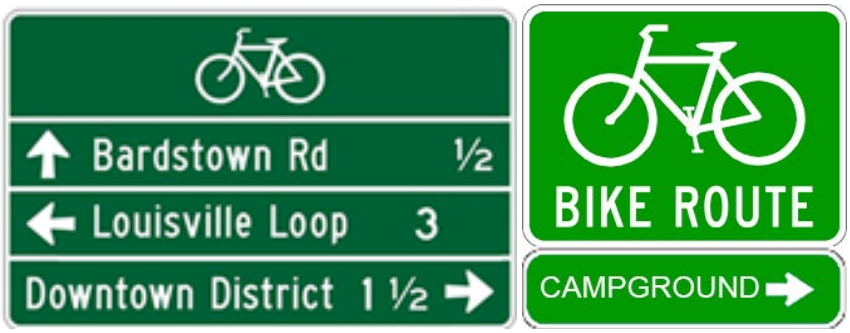
1. Used on roadways with a speed limit under 35 mph
    - Speeds above this limit are deemed dangerous for sharing of the lane
    - Visibility and comprehension to the driver is decreased at speeds about 35 mph
2. Used in urban settings
    - Where a bike lane ends to alert drivers that the lane is now shared with a bicycle
    - To alert bicyclists as to proper positioning on the road
3. Used in a series of at least three
    - Usually for a segment of road where the lane-share is necessary and not typically where the entire road is shared space

Other Signage

Other signage options to consider are green “bike route” signs of which there are already some on the Parkway. These are typically for information to the bicyclist but also assist with motorists’ understanding of the bicyclists’ right to the road. On the Parkway, it may be helpful to add more bike route signs along with wayfinding and mileage information, as in Figure 15. Those bicycling the entire Parkway may have common

locations to exit and do other activities, such as eat or stay overnight. Arrows and mileage to a nearby town or bicycle campground could support the message that this road is a formally designated bicycle route, and also alert motorists to which roads are more frequented by bicyclists. The Park may consider supplemental warning signage for areas with more automobile traffic, such as Tupelo and Jackson. Wayfinding information may be especially useful where the Multi-Use Trail (MUT) intersects with the Parkway. The MUT is well-signed for users on the trail, but motorists and bicyclists could both benefit from more signage on the Parkway alerting that access points to the MUT are approaching or intersecting.

Figure 15: Bike Route Signage
Source: MUTCD[34] and Project Team



The Natchez Trace Parkway is designated a bicycle route by NPS, but it is not an officially designated U.S. Bicycle Route. The Parkway is currently included in the U.S. Bicycle Route 35 corridor, which stretches from Natchez, Mississippi to Sault Ste. Marie, Michigan and could receive official designation if the Park were to opt to make it a part of the official network. Having this designation would promote and brand the park nationwide as part of the national network and would also include the official signage of the U.S. Bicycle Route network, as seen in Figure 16. The Park may want to explore this as an option and consider the potential implications that may include increased number of bicyclists, greater exposure, and greater awareness of bicyclists on the road, among other things.

Figure 16: U.S. Bicycle Route official sign
Source: bicycletouringroutes.com

Another sign to consider is one that alerts motorists where the Natchez Trace National Scenic Trail crosses an on/off ramp. The project team noted that there is no advance warning for the crossings, and when exiting the Parkway, the crosswalks come up quickly to motorist decelerating from 50 mph. A sign on the Parkway

[34] MUTCD. http://mutcd.fhwa.dot.gov/resources/interpretations/9_09_20.htm

that alerts road users of an upcoming crossing, in addition to signage at the crossing location would enhance safety for users of the multi-use trail (Figure 17).

Figure 13: Trail Crossing Signs in Advance of Parkway On-ramps
Source: Simcoe County Trails[35] and Stanley Rabinowitz[36]

Campaigns and Community Engagement

Key Messages

Considering that there are multiple safety issues and a multiplicity of road users, targeting the various groups is key. The Park can and is using a variety of communication channels to reach visitors:

- The NATR AM radio station
- The NATR website
- The group bicycle permit process
- Wayside signage
- Temporary variable message signs
- Safety campaigns with local and national partners
- Public service announcement on radio and television

The Parkway can use these communication channels to consistently relay key messages about safe driving and bicycling behaviors. These messages should emphasize that:

1) NATR is a recreational facility with motorists, bicyclists, and hikers
2) Bicyclists have the same rights and responsibilities on the roadway as motorists
3) All road users should practice a courteous and safe behavior to each other

The project team recommends that the Parkway and its stakeholders develop a simple campaign to convey these messages using words and graphics. One example message is "Our Parkway Belongs to Everyone: Be Smart, Be Safe, Be Civil." There are several similar state and local campaigns that the Parkway can draw from. A few examples are shown in Figure 18 below from federal, local jurisdiction, and non-profit safety campaigns focusing on various themes of road safety.

[35] http://simcoetrails.ca/2010/11/10/update-from-simcoe-county-trails/
[36] http://www.mathpropress.com/stan/crossings/

Figure 14: Safety Campaign Materials
Source: Various, see notes.

[37]

[38]

[39]

[40]

Targeting Specific Roadway Users

Out-of-town bicyclists in particular should be apprised of state laws and federal regulations applicable on the Parkway. A good way to reach this group is through messaging that coincides with the group bicycle permit process. Wayside signage can be an effective way to reach many visitors—both for motorists and bicyclists — and should display clearly what the laws and expected behavior are for each.

As for the local commuters and motorists in the region who occasionally or regularly drive the Parkway, outreach outside of the Parkway boundaries is also possible. Some of the cities along the Parkway, such as Jackson and Nashville, are experiencing growth in popularity of urban bicycling. Everything done in these adjacent communities to promote safety and awareness will have positive safety effects on the users of the Parkway. In addition, Park staff may find ways to partner with cities or states on campaigns, thereby bringing awareness to bicycle safety specifically on the Parkway. Motorists in the region who become more accustomed to bicycles on urban roads will have a spillover effect of general awareness of multi-user road sharing.

Partnerships with local bicycle shops, bicycle-related non-profits, visitor centers, and other area businesses can build more awareness. Joining and promoting municipal, state, or federal-level bicycle and pedestrian safety campaigns can further capitalize on awareness initiatives. Events, such as community bike rides on a stretch of the Parkway, Bike-to-work day/month, or bicycle activities in conjunction with other celebrations or holidays, can be simple ways to partner with community organizations in promoting bicycle awareness.

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[37] National Pedestrian Safety Campaign, FHWA. Obtained from http://safety.fhwa.dot.gov/local_rural/pedcampaign/graphic.cfm

[38] City of Spokane, WA. Obtained from http://www.spokesman.com/blogs/down-earth/2012/jun/04/another-green-monday-stickman-knows-campaign-expands-traffic-awareness-and-pedestrian-safety-week-kicks/

[39] Active Transportation Alliance, Chicago. Obtained from http://chi.streetsblog.org/2014/06/13/active-trans-and-aaa-chicago-launch-joint-road-safety-campaign/

[40] Napa County Bicycle Coalition

Data collection

In any treatment that is done, both on the roadway and in education, the project team recommends that statistics be kept from before and after implementation to help determine effectiveness. The Park is currently capturing bicycle count data in three locations and the project team recommends to continue this effort and explore specific ways to use the data to increase safety. In general, the purpose of collecting bicycle and pedestrian counts is to provide useful data to transportation planners, agencies, and professionals. There is currently a lack of non-motorized count data in general, due to the different technologies and methods required for counting non-motorized volumes as compared to counting motor vehicles. However, as non-motorized transportation continues to grow in volume, the importance of non-motorized count data will continue to increase as well. In 2014, the Transportation Research Board's National Cooperative Highway Research Program published Report 797: Guidebook on Pedestrian and Bicycle Volume Data Collection. The report is a comprehensive guidebook on currently available counting technologies, methods, and summary procedures.

Potential Applications

Count data has a wide range of important applications from cost-benefit analysis to safety analysis. Without accurate count data it is difficult to make data-driven decisions necessary for transportation projects. Here are some potential applications:

- Tracking changes in pedestrian and bicycle activity over time
- Evaluating the effects of new infrastructure on pedestrian and bicycle activity
- Prioritizing pedestrian and bicycle projects
- Modeling transportation networks and estimating annual volumes
- Conducting risk or exposure analyses
- Measuring facility usage at the city and state levels
- Evaluating before-and-after volumes after a new facility is opened, as performed by a metropolitan planning organization (MPO) and a city
- Monitoring travel patterns at automated count sites, for use in developing factors to expand short-term bicycle and pedestrian counts at other locations, as conducted by a county and an MPO
- Counting non-motorized volumes to quantify exposure and develop crash rates and to identify the before-and-after safety effects of upgrading a facility
- Identifying high-priority locations for pedestrian and bicycle facility improvements
- Developing and calibrating multimodal travel demand models

Data Adjustment and Considerations

Although there are well-established procedures and methods of collecting and analyzing traffic volumes for motorized vehicles, these methods are not applicable for non-motorized modes. Non-motorized modes are not only more difficult to detect, but are much more variable than motor vehicle volumes. Non-motorized volumes are more sensitive to factors such as time of day, season, temperature, precipitation, darkness, etc. Adjusting for these factors can be difficult. However, with the increasing count data available, there are a growing number of emerging procedures and methods.

Bicycle Counter Technology & Methods

There are a wide variety of counting technologies available for non-motorized vehicles. These technologies range in accuracy, time frame, and cost. Manual counting, although impractical for the long term, is the simplest form of counting and can be useful to get an immediate window of current volume. In contrast, permanent counters can offer a broad view of long term trend, but can be costly to install and difficult to maintain in the long run. Different technologies are suited for different project requirements and budgetary constraints:

- Manual in-field counting
- Manual counts from video
- Automated counts from video

- Pneumatic tubes
- Inductive loop detectors
- Passive infrared
- Active infrared
- Piezoelectric strips
- Radio beams
- Thermal
- Laser scanners
- Pressure and acoustic pads
- Magnetometers
- Fiberoptic pressure sensors

The pneumatic tube counters recently acquired by the Park are a useful method to collect traffic counts. Data on time of day, season, location, and volume of bicycles will help to understand patterns over time. This information combined with counts on motor vehicle traffic, park visitation, bicycle permit data, and more detailed crash scenario analysis, can in time provide a very clear picture of more specific safety concerns, enabling funding to be focused in the highest-need areas. The main goal of data collection is to make informed decisions and allocate funding accordingly.

Bicycle permits

Some of the aforementioned information is already collected but could be analyzed in different ways. Additional information from the permit-requestors could enhance the understanding of bicycle ridership and thus inform more nuanced treatments in terms of infrastructure or education.

- Number of bicycle permits granted
- Number of bicyclists in group
- Date(s)
- Planned mileage (full parkway or partial/which portion)
- Direction of travel
- Origin of bicyclists and if main purpose of trip is to bicycle the Parkway

Being able to get a sense of the number of bicyclists that ride under permits will help determine seasonal ridership fluctuation, annual increase in bicycle use, and visitor versus local bicycle traffic. Size of group will also be very useful in determining the bicyclist profile for highest risk (i.e. bicyclists in large groups, small groups, pairs, or solo). This information could help determine the growing popularity of the Parkway for out-of-state and foreign visitors, and the frequency of visitation in which bicycle riding is fundamental to the visit. The results could help the Park make policy or education interventions that are more targeted to the bicycling visitors' needs.

Crash Scenario

Keeping a database of all crash factors will help determine the main challenges, whether infrastructure or behavior-related. The following categories will be especially useful::

- Vehicle speed
- Vehicle position on road relative to bicycle
- Position of bicycle on road relative to shoulder/vehicle
- Event: passing/oncoming/intersection/turning left/right
- Direction of travel for all involved
- Drug/alcohol involvement
- Weather conditions, sun angle, visibility
- Use of lights and high-visibility clothing of bicyclist
- Single rider vs. group and size of group

Law Enforcement

Records of speeding tickets and other infraction related to road safety should be tracked over time to understand how behavior is responding to law enforcement.

- Number of law enforcement rangers on patrol
- Number of vehicles warned or cited for speeding
- Speed of vehicle if excessive
- DUIs and other substance-related violations
- Number of bicyclists warned for noncompliance with laws or guidelines

Much of the aforementioned data is already collected and could be put into a database to be easily accessed and analyzed. The project team recommends this data analysis be initiated before any new interventions occur so that their effectiveness can be backed by a data-driven analysis.

Appendix A: Focus Group Responses

Focus groups were conducted in three locations in an effort to understand the public's opinion and understanding of the recent safety interventions. The question posed was, "what are participants' impressions on the shared lane markings and signs?" Answers given by the participants are shown below.

Ridgeland

- Excellent way to point out to the motorists that cyclists are present
- Encourage cyclists to be aware of motorists
- Question in mind that cyclists could ride abreast
- Need someone in Ridgeland immediately
- For recumbent – sings are more effective
- Review compendium about number of riding abreast
- More signs
- Friendly/safe place to cycle
- For motorists, let them know that cyclists are present
- Are shared lane markers in no passing zones?
- Shared lane marking is confusing and sign is clearer
- Need a lot more signs
- Prefer the signs
- Biking is too dangerous
- Good education
- Group is easier for motorists to pass than single file
- Won't affect speed
- Respect from both important.
- Should ride in groups
- Separate bike trail
- Need more shared lane markings
- Need more signs the more specific verbiage on the sign is better
- Helps people know they are in the park
- People tend to ignore signs – shared lane markings will grab attention
- Put them on entrances to the Park
- Put it on a t-shirt
- More speeding enforcement
- Sign entrance to MUT
- Some motorists may expect "end of shared lane" sign
- Place shared lane marking in high traffic areas
- Does the average motorist know what the shared lane marking means?
- Signs are great
- Put sign icon on sign
- Shared lane marking should be in public service announcement
- Passing lane for cyclists (paved shoulder)
- Shared lane marking is much more important than 3' law
- Shared lane marking and sign complement each other
- Add rumble strip to shared lane marking
- No preference to urban or rural
- Sign is confusing, too much inform on sign

- Neither gives comfort to cyclist
- People will not understand the meaning of either
- Shoulder rust prevent cyclist an escape route
- Alerts them to the presence of cyclists
- Speed enforcement problem
- Maintenance needed on striping and shoulders
- Ineffective and should be together
- Add rumble strip to call attention to shared lane marking
- Like the sign
- Could monitor speed before and after
- Add flashing light that comes on if speed is excessive
- Sign looks like speed limit sign – ignored
- Put sign at all entrances
- We all like them
- Like sign
- Signs directing cyclists to MUT
- Together more effective
- Will not affect speed
- Motorists will not understand shared lane marking
- Sign is much better
- Shared lane markings on map
- More shared lane markings
- Cyclists should be respectful
- Sign could cause head-on collision
- Add sign “slow to pass cyclists”

Tupelo

- Need more of each at entrances
- Sign is a valuable education tool
- Signs on side roads
- Community interest could provide funds
- Will not affect speeding
- More enforcement
- Good first step
- Combined education
- Should have signage showing NATR is bike friendly
- Great and tastefully done
- Better than 3’ sign
- Signs and shared lane markings help to make NATR known as a National Park
- Could speeding tickets be increased?
- Put estimated driving time to locations base on posted speed limit
- Put shared lane markings at the same locations to grab drivers attention
- Don’t understand what they mean
- Who is the sign directed at
- Going to make people more aware
- Need media input
- Education is key and needs to be in schools
- People don’t know how they should pass cyclists

- Should say “cars” pass
- Change verbiage to “Bicycle” has full use of lane and remove the word “May”
- Makes signs high visible
- Flasher
- Motorists don’t respect cyclists
- Add shared lane markings
- Show on maps
- Increase enforcement
- Shared lane marking alerts motorist to cyclists
- Makes cyclists feel safer
- Sign message is clear
- Need more shared lane markings
- Reduce speed limit in urban areas
- Trace markings/signage will help to educate public about cyclists needs on all routes

Nashville

- Hi visibility clothing is an issue
- Signs are useless and will have no effect
- More enforcement; use cameras
- Sign is ambiguous
- Add to sign – “cyclists should be single file when car approaches”
- Separate sign for cyclists and motorists
- Sign reinforces the 3’ rule
- Like the lane markings
- Shared lane marking gives clear message; sign does not
- Signs for cyclists validates them as road users
- Sing seems to be working. Cars haven’t been changing lanes to pass cyclists
- Need more of both but don’t over-sign
- The do raise awareness
- Like the sign
- Locate at all entrances
- Hard to measure effectiveness
- They will have to help, on sign strike the word “May”
- Add bike lane
- Shared lane markings help people know they may encounter cyclists
- Something should inform them motorists are in a Park
- Great signs
- Add signs for cyclists to ride single file – from cyclists
- Education – pamphlet/map
- The two combined are very powerful
- Necessary to get the motorists informed that cyclists are present
- Educate public they are in a Park
- Signs won’t be effective
- Find the sign is offensive
- Enhance mutual respect

Appendix B: Applicable Standards from MUTCD

Section 9B.06 Bicycles May Use Full Lane Sign (R4-11)

Option:
01 The Bicycles May Use Full Lane (R4-11) sign (see Figure 9B-2) may be used on roadways where no bicycle lanes or adjacent shoulders usable by bicyclists are present and where travel lanes are too narrow for bicyclists and motor vehicles to operate side by side.
02 The Bicycles May Use Full Lane sign may be used in locations where it is important to inform road users that bicyclists might occupy the travel lane.
03 Section 9C.07 describes a Shared Lane Marking that may be used in addition to or instead of the Bicycles May Use Full Lane sign to inform road users that bicyclists might occupy the travel lane.
Support:
04 The Uniform Vehicle Code (UVC) defines a "substandard width lane" as a "lane that is too narrow for a bicycle and a vehicle to travel safely side by side within the same lane."

Section 9B.20 Bicycle Guide Signs (D1-1b, D1-1c, D1-2b, D1-2c, D1-3b, D1-3c, D11-1, D11-1c)

Option:
01 Bike Route Guide (D11-1) signs (see Figure 9B-4) may be provided along designated bicycle routes to inform bicyclists of bicycle route direction changes and to confirm route direction, distance, and destination.
02 If used, Bike Route Guide signs may be repeated at regular intervals so that bicyclists entering from side streets will have an opportunity to know that they are on a bicycle route. Similar guide signing may be used for shared roadways with intermediate signs placed for bicyclist guidance.
03 Alternative Bike Route Guide (D11-1c) signs may be used to provide information on route direction, destination, and/or route name in place of the "BIKE ROUTE" wording on the D11-1 sign (see Figures 9B-4 and 9B-6).
04 Destination (D1-1, D1-1a) signs, Street Name (D3) signs, or Bicycle Destination (D1-1b, D1-1c, D1-2b, D1-2c, D1-3b, D1-3c) signs (see Figure 9B-4) may be installed to provide direction, destination, and distance information as needed for bicycle travel. If several destinations are to be shown at a single location, they may be placed on a single sign with an arrow (and the distance, if desired) for each name. If more than one destination lies in the same direction, a single arrow may be used for the destinations.
Guidance:
05 *Adequate separation should be made between any destination or group of destinations in one direction and those in other directions by suitable design of the arrow, spacing of lines of legend, heavy lines entirely across the sign, or separate signs.*
Standard:
06 **An arrow pointing to the right, if used, shall be at the extreme right-hand side of the sign. An arrow pointing left or up, if used, shall be at the extreme left-hand side of the sign. The distance numerals, if used, shall be placed to the right of the destination names.**
07 **On Bicycle Destination signs, a bicycle symbol shall be placed next to each destination or group of destinations. If an arrow is at the extreme left, the bicycle symbol shall be placed to the right of the respective arrow.**
Guidance:
08 *Unless a sloping arrow will convey a clearer indication of the direction to be followed, the directional arrows should be horizontal or vertical.*
09 *The bicycle symbol should be to the left of the destination legend.*
10 *If several individual name signs are assembled into a group, all signs in the assembly should have the same horizontal width.*
11 *Because of their smaller size, Bicycle Destination signs should not be used as a substitute for vehicular destination signs when the message is also intended to be seen by motorists.*
Support:
12 Figure 9B-5 shows an example of the signing for the beginning and end of a designated bicycle route on a shared-use path. Figure 9B-6 shows an example of signing for an on-roadway bicycle route. Figure 9B-7 shows examples of signing and markings for a shared-use path crossing.

Section 9B.21 Bicycle Route Signs (M1-8, M1-8a, M1-9)

Option:
01 To establish a unique identification (route designation) for a State or local bicycle route, the Bicycle Route (M1-8, M1-8a) sign (see Figure 9B-4) may be used.
Standard:
02 **The Bicycle Route (M1-8) sign shall contain a route designation and shall have a green background with a retro-reflectorized white legend and border. The Bicycle Route (M1-8a) sign shall contain the same information as the M1-8 sign and in addition shall include a pictograph or words that are associated with the route or with the agency that has jurisdiction over the route.**
Guidance:
03 *Bicycle routes, which might be a combination of various types of bikeways, should establish a continuous routing.*
04 *Where a designated bicycle route extends through two or more States, a coordinated submittal by the affected States for an assignment of a U.S. Bicycle Route number designation should be sent to the American Association of State Highway and Transportation Officials (see Page i for the address).*
Standard:
05 **The U.S. Bicycle Route (M1-9) sign (see Figure 9B-4) shall contain the route designation as assigned by AASHTO and shall have a black legend and border with a retro-reflectorized white background.**
Guidance:
06 *If used, the Bicycle Route or U.S. Bicycle Route signs should be placed at intervals frequent enough to keep bicyclists informed of changes in route direction and to remind motorists of the presence of bicyclists.*
Option:
07 Bicycle Route or U.S. Bicycle Route signs may be installed on shared roadways or on shared-use paths to provide guidance for bicyclists.
08 The Bicycle Route Guide (D11-1) sign (see Figure 9B-4) may be installed where no unique designation of routes is desired.

Section 9C.07 Shared Lane Marking

Option:
01 The Shared Lane Marking shown in Figure 9C-9 may be used to:
A. Assist bicyclists with lateral positioning in a shared lane with on-street parallel parking in order to reduce the chance of a bicyclist's impacting the open door of a parked vehicle,
B. Assist bicyclists with lateral positioning in lanes that are too narrow for a motor vehicle and a bicycle to travel side by side within the same traffic lane,
C. Alert road users of the lateral location bicyclists are likely to occupy within the traveled way,
D. Encourage safe passing of bicyclists by motorists, and
E. Reduce the incidence of wrong-way bicycling.
Guidance:
02 *The Shared Lane Marking should not be placed on roadways that have a speed limit above 35 mph.*
Standard:
03 **Shared Lane Markings shall not be used on shoulders or in designated bicycle lanes.**
Guidance:
04 *If used in a shared lane with on-street parallel parking, Shared Lane Markings should be placed so that the centers of the markings are at least 11 feet from the face of the curb, or from the edge of the pavement where there is no curb.*
05 *If used on a street without on-street parking that has an outside travel lane that is less than 14 feet wide, the centers of the Shared Lane Markings should be at least 4 feet from the face of the curb, or from the edge of the pavement where there is no curb.*
06 *If used, the Shared Lane Marking should be placed immediately after an intersection and spaced at intervals not greater than 250 feet thereafter.*
Option: 07 Section 9B.06 describes a Bicycles May Use Full Lane sign that may be used in addition to or instead of the Shared Lane Marking to inform road users that bicyclists might occupy the travel lane.

Appendix C: Summary of State and NPS Laws on Bicycling

The following lists the bicycle-related laws that are most applicable to this study. For full text of the laws of each state, please see the references section.

National Park Service

Code of Federal Regulations (Pertaining to Bicycle Use) 36CFR 4.30– Bicycles

§ 4.30 Bicycles

(a) Parkroads
(1)The use of a bicycle is permitted on park roads and in parking areas that otherwise open for motor vehicle use by the general public.

(g) Other requirements.

(2) Unless specifically addressed by regulations in this chapter, the use of a bicycle within a park area governed by state law. State law concerning bicycle use that is now or may later be in effect is adopted and made a part of this section.

(h) Prohibited acts. The following are prohibited:

(1) Bicycle riding off of park roads and parking areas, except on administrative roads and trails that have been authorized for bicycle use.

(3) Operating a bicycle during periods of low visibility, or while traveling through a tunnel, or between sunset and sunrise, without exhibiting on the operator or bicycle a white light or reflector that is visible from a distance of at least 500 feet to the front and with a red light or reflector that is visible from at least 200 feet to the
rear.

(4) Operating a bicycle abreast of another bicycle except where authorized by the superintendent.

(5) Operating a bicycle while consuming an alcoholic beverage or carrying in hand an open container of an alcoholic beverage.

(6) Any violation of State law adopted by this section (Note: Federal laws supersede state laws.)

NATR Safety Guidelines for Cyclists

- Follow the same rules of the road as motorists. Cyclists have the same rights and responsibilities as drivers.
- Ride single-file and on the right (with traffic) at all times. Use hand signals to let motorists know what you will be doing next.
- Avoid the Tupelo, MS, and Jackson, MS, areas during weekday rush hours due to the high volume of vehicle traffic.
- Plan to be off of the Parkway between sundown and sunup. Use lights and reflectors in low-light conditions.
- Wear brightly-colored, high-visibility clothing and a properly fitting helmet.
  Carry identification and emergency medical information.
- Treat pedestrians with the same courtesy you would expect from motorists.
- Report all incidents involving cyclists or pedestrians to the Natchez Trace Parkway at 800-305-7417. In emergency situations, call 911.

Mississippi

Senate Bill No. 3014 of the Regular Session of the Mississippi Legislature also known as the "John Paul Frerer Bicycle Safety Act" enacted in 2010 requires that while passing a bicyclist on a roadway, a motorist shall leave a safe distance of not less than three (3) feet between his vehicle and the bicyclist and shall maintain such clearance until safely past the bicycle. The Act also states that it is unlawful to harass, taunt or maliciously throw an object at or in the direction of any person riding a bicycle. Full text of the Act is available online at www.gomdot.com.

House Bill No. 559 of the Regular Session of the Mississippi Legislature was an act to make bicyclists subject to the provisions of traffic law applicable to the drivers of motor vehicles amended to state that every person riding a bicycle upon a highway shall have all the rights and duties applicable to the driver of a vehicle except those provisions which by their nature have no application.

Section 63-3-603 was amended to place certain restrictions on persons riding bicycles on a roadway. Persons riding bicycles upon a roadway shall not ride more than two (2) abreast except on paths or parts of roadways set aside for the exclusive use of bicycles. Persons riding two (2) abreast shall not impede the normal and reasonable movement of traffic and, on a multilane roadway shall ride within a single lane.

Section 63-7-13 Requirements as to lighting equipment. (4) Lamps on bicycles. Every bicycle shall be equipped with a lighted white lamp on the front thereof visible under normal atmospheric conditions from a distance of at least five hundred feet in front of such bicycle and shall also be equipped with a reflex mirror reflector or lamp on the rear exhibiting a red light visible under like conditions from a distance of at least five hundred feet to the rear of such bicycle.

Section 63-7-65 Horns and other warning devices. (3) No vehicle shall be equipped with nor shall any person use upon a vehicle any siren, whistle, or bell, except as otherwise permitted in this section. No bicycle shall be equipped with nor shall any person use upon a bicycle any siren or whistle.

Bicycles are not allowed on any interstate highway or controlled access facility in the state.

Alabama

Section 32-5A-260 Traffic laws apply to persons riding bicycles. Every person riding a bicycle upon a roadway shall be granted all of the rights and shall be subject to all of the duties applicable to the driver of a vehicle by this chapter,

Section 32-5A-263 Riding on roadways and bicycle paths. (a) Every person operating a bicycle upon a roadway shall ride as near to the right side of the roadway as practicable, exercising due care when passing a standing vehicle or one proceeding in the same direction. (b) Persons riding bicycles upon a roadway shall not ride more than two abreast except on paths or parts of roadways set aside for the exclusive use of bicycles. (c) Wherever a usable path for bicycles has been provided adjacent to a roadway, bicycle riders shall use such path and shall not use the roadway.

Section 32-5A-265 Lamps and other equipment on bicycles. (a) Every bicycle when in use at nighttime shall be equipped with a lamp on the front which shall emit a white light visible from a distance of at least 500 feet to the front and with a red reflector on the rear. (b) Every bicycle shall be equipped with a brake which will enable the operator to make the braked wheels skid on dry, level, clean pavement.

Tennessee

Legal Status of Bicycles. A bicycle is defined as a vehicle and bicyclists are subject to the same rights and responsibilities of other drivers, except those provisions which by their nature can have no application to bicyclists. (55-8-101, 55-8-172)

Obedience to Official Traffic-Control Devices. All drivers, including bicyclists, must obey all official traffic-control devices. (55-8-109)

Driving on Right Side of Roadway. Upon all roadways of sufficient width, a vehicle shall be driven upon the right half of the roadway, except:

- When passing another vehicle proceeding in the same direction (pass on the left)
- When the right half of a roadway is closed because of construction
- On a roadway divided into three marked lanes for traffic under the rules applicable thereon; or
- On a one-way street (55-8-115)

Passing The operator of a motor vehicle when overtaking and passing a bicycle proceeding in the same direction on the roadway, shall leave a safe distance between the motor vehicle and the bicycle of not less than three feet (3') and shall maintain such clearance until safely past the bicyclist. (55-8-175) 4 Bicyclists must pass stopped or slower vehicles on the left, just as motorists do. Passing on the right is only allowed when the vehicle overtaken is making or about to make a left turn, on a road with unobstructed pavement not occupied by parked vehicles of sufficient width for two or more lines of moving vehicles in each direction; and on a one-way street where the roadway is free from obstructions and of sufficient width for two or more lines of moving vehicles. The driver of a vehicle may overtake and pass another vehicle upon the right only under conditions permitting such movement in safety. In no event shall such movement be made by driving off the pavement or main-traveled portion of the roadway (55-8-117, 55-8-118). We recommend that bicyclists not pass cars on the right, though it may be tempting. Motorists may suddenly turn right into a driveway, or pull out in front of you because they see a line of stopped cars, not you.

Road Position for Bicyclists. Bicyclists moving more slowly than other traffic should ride as close as practicable to the right-hand curb or edge of the roadway, except:

- When overtaking and passing another vehicle proceeding in the same direction;
- When preparing for a left turn at an intersection or into a private road or driveway; or
- When reasonably necessary to avoid conditions including, but not limited to, parked vehicles, animals, surface hazards, or a lane that is too narrow for a bicycle and another vehicle to travel safely side by side within the lane. (55-8-175)

Riding Side-by-side. Bicyclists shall not ride more than two abreast, except on paths or parts of roadways set aside for the exclusive use of bicycles. Persons riding two abreast shall not impede the normal and reasonable movement of traffic and, on a land roadway, shall ride within a single lane. (55-8-175)

Bicycle Lamps and Brakes. Every bicycle when used at night must be equipped with a front white headlight visible at a distance of 500 feet, and a red rear reflector visible at a distance of 50 feet. Bicycles must also be equipped with brakes that allow the bicyclist to stop within 25 feet at 10 mph on dry pavement. (55-8-177)

Appendix D: Crash Data

Crashes Involving Bicycles

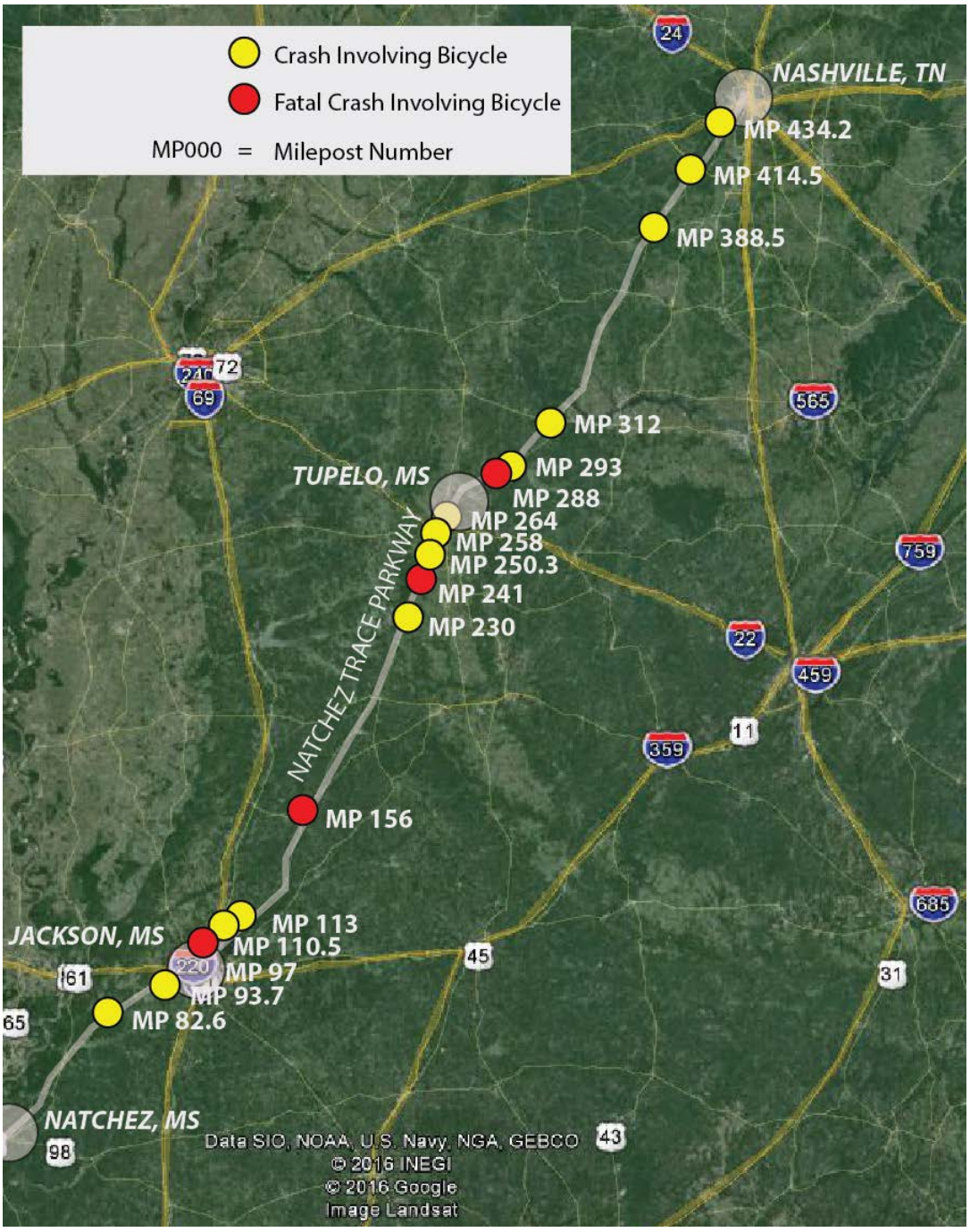
Data provided by NPS.

Ranger	MVA #	Date	Time	Mile-post	Injury	Fatality	Vehicle	Ambu-lance	Notes
	05A177	11/9/2005	1243	230	1	0	2	1	Veh vs. Bicycle
	06A085	4/2/2006	1125	93.7	1	0	2	1	Veh vs. Bicycle
	06A159	9/6/2006	1938	110.5	1	0	1	1	Veh vs. Bicycle - Sun in eyes
573 Davidson	07A124	9/8/2007	0751	97	1	1	2	1	Truck vs. Bicyclist
533 Franks	08A102	5/1/2008	1602	414.5	1	0	1	1	Veh vs. Bicycle
541 Penney	09C099	4/22/2009	1400	241	0	1	1	1	Veh hit Bicycle
544 Whitcomb	09C158	7/21/2009	0515	264	1	0	1	0	Veh Vs. Bicycle
541 Penney	09C198	10/9/2009	1130	288	0	1	1	1	Veh vs. Bicycle
521 Kelly	10C129	8/13/2010	1356	388.5	2	0	1	0	Veh vs. 2 Bicyclists
551 Mahle	10C160	10/8/2010	1310	293	1	0	1	0	Veh vs. Bicyclist
541 Penney	10C218	12/22/2010	1327	258	1	0	1	1	Bicyclist / Hit & Run
570 Mangino	11C161	5/29/2011	1600	113	1	0	1	0	Veh pushed Bicyclist off Rd
572 Hinchberger	12C068	5/6/2012	1245	156	0	1	1	1	Veh vs. Bicycle
510 Kimes		10/22/2012	1449	434.2	0	0	1		RV hit bike or poss ran off rd
542 Hearne		7/29/2014	1812	250.3	1	0	1	0	Veh hit Bicyclist with mirror
522 McDonald		8/6/2014	1737	312	0	0	1	0	Veh hit Bicycle
573 Davidson		8/24/2014	1748	82.6	1	0	1	1	Veh vs. Bicycle

Map of Crash Locations

As seen in the map below, crashes involving bicycles are not concentrated in a particular location, but have happened all along the Parkway. Labels on the map indicate date of crash and milepost, and correspond to the chart above. Red labels indicate bicyclist fatality and correspond to the red boxes in the chart above.

Map created by project team using NPS data.



Appendix E: Data Tables for Graphs

Table for Figure 15: Annual Recreation Visitation at NATR
Source: Visitor Use Statistics Office

Year	Recreation Visits
1990	5,505,253
1991	5,832,697
1992	5,776,191
1993	5,752,880
1994	5,287,801
1995	5,849,061
1996	6,088,610
1997	5,992,978
1998	5,810,094
1999	6,392,961
2000	5,737,183
2001	5,552,351
2002	5,643,170
2003	5,555,984
2004	5,389,227
2005	5,482,282
2006	5,713,583
2007	5,777,666
2008	5,747,235
2009	5,934,363
2010	5,910,950
2011	5,765,343
2012	5,560,668
2013	6,012,740
2014	5,846,474
2015	5,758,812

Table for Figure 3: Fatality and Severe Injury of Bicyclist in Crash by Posted Speed Limit
Source: USDOT FHWA Bicycle Road Safety Audit Guidelines and Prompt Lists

Posted Speed	Percent Killed	Percent with Disabling Injury
5-15 mph	2%	4%
20-25 mph	1%	5%
30-35 mph	3%	6%
40-45 mph	4%	11%
50-55 mph	9%	23%
60-75 mph	50%	No Data

Table for Figure 4: Pedestrian Injury at Impact Speed
Source: U.S. Department of Transportation[41]

Impact Speed	Percent Killed	Percent with Disabling Injury	Percent with No Injury
20 mph	5%	65%	30%
30 mph	45%	50%	5%
40 mph	85%	15%	0%
50 mph	100%	0%	0%

[41] Moudon, Anne Vernez, Managing Pedestrian Safety I: Injury Severity. US Department of Transportation, 2007. http://www.wsdot.wa.gov/research/reports/fullreports/671.1.pdf

Table for Figure 10: Factors in Rural Bicycle Crashes by Percentage
Source: UNC Highway Safety Research Center[42]

Factor	Percentage
Bicyclist Turn/Merge Into Path of Motorist	31%
Motorist Overtaking	27%
Motorist Failed to Yield	7%
Bicyclist Failed to Yield, Midblock	9%
Motorist Turn/Merge Into Path of Bicyclist	7%
Bicyclist Failed to Yield, Intersection	7%
Intersection Crash	2%
Unknown/Insufficient	4%
Wrong Way Operator	2%
Specific Circumstances	2%
Operator Lost Control	1%
Motorist Turning Error	1%

[42] Carter, Daniel L. and Forrest M. Council. Factors Contributing to Pedestrian and Bicycle Crashes on Rural Highways. UNC Highway Safety Research Center. June 2006.

REPORT DOCUMENTATION PAGE

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14. ABSTRACT

The Natchez Trace Parkway stretches through varied terrain for 444 miles from Nashville, Tennessee to Natchez, Mississippi. The National Parkway receives approximately fifteen million visitors each year, about six million of which are recreational visitors. Anecdotally, the number of bicyclists who use the Parkway is rising, in tourism, recreation, and commuting. In recent years there have been a number of crashes on the Parkway involving bicycles, four of which resulted in fatality. The Park staff has partnered with advocacy organizations in implementing safety interventions with bicycle-related signage and shared use lane markings. The Volpe Center conducted a study to evaluate the appropriateness and effectiveness of these interventions and make recommendations for the Park to continue their work in improving safety for bicyclists and other roadway users. This study looks primarily at the roadway corridor within the larger context of a safety campaign being conducted by staff and partners of Natchez Trace Parkway.

15. SUBJECT TERMS

Natchez Trace National Park, Bicycle Safety, Bicycle Signage, Transportation Study, Bicycling in National Parks

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