National Center for Rural Road Safety

THE UNIVERSITY OF NORTH CAROLINA HIGHWAY SAFETY RESEARCH CENTER

ARC APPALACHIAN REGIONAL COMMISSION

Examining Rural Traffic Safety Culture: An Appalachia Case Study

Presented by:

- Dr. Wes Kumfer, RSP1, UNC Highway Safety Research Center

Webinar Logistics

- Duration is 11:00 AM - 12:30 PM Mountain
- Webinar – recorded and archived on website. For quality of recording, phone will be muted during presentation
- If listening on the phone, please mute your computer
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- At the end of each section, there will be time for Q&A
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Course *cex 280717 Pedestrian Treatments for Uncontrolled Locations - Live* Location *Online*

Date *01/18/18 - 01/18/18* REGISTRATION FEE *$0.00* # OF CEU's *0.150* GENDER: M / F

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VERIFICATION OF COMPLETION

February 2, 2018

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ID #:		CEU	Hours
18SCEX280717	Pedestrian Treatments for Uncontrolled Locations - Live January 18, 2018	0.150	1.50
18SCEX280720	Primer on the Joint Use of the HSM and the HFG for February 13, 2018 - February 13, 2019	0.150	1.50
TOTAL:		**0.300** CEU's	**9.00** Hours

Today's Presenter

Dr. Wes Kumfer,
UNC Highway Safety
Research Center

Goals of this Webinar

Once you have completed this webinar, you will have:

an understanding of a recently completed project examining traffic safety in the Appalachian Region.

Learning Outcomes

To achieve the webinar goal, you will learn to:

- Identify potential risks to rural road safety as identified in the literature.
- Characterize the traffic safety profile of the Appalachian Region using crash data.
- Describe engineering methods used to improve safety and how to evaluate those methods
- Characterize rural road traffic safety culture using crash data.

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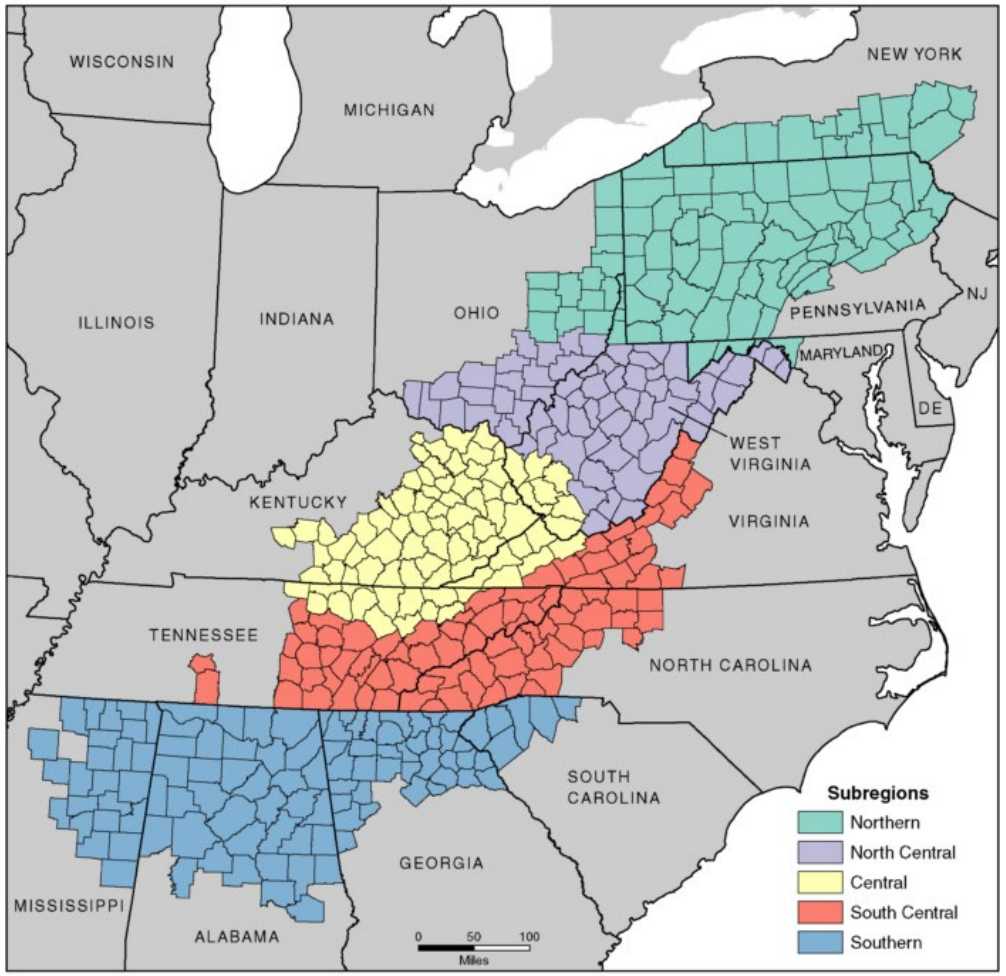
Project Overview

- The Appalachian Region consists of parts of 12 states plus one entire state.
- Appalachia is characterized by rural regions, mountainous and curved terrain, and dense forests exposed to extreme weather.



Map by: Appalachian Regional Commission, November 2009.

Project Tasks

In order to characterize traffic safety in the Appalachian Region, we undertook five tasks:

1. Synthesis of Existing Research Related to Traffic Safety in Appalachia
2. Characteristics of Traffic Fatalities in Appalachia
   a. Examine Regional Differences among Appalachian Traffic Fatalities
   b. Compare Appalachian Traffic Fatalities to Non-Appalachian Traffic Fatalities
   c. A Closer Look at Drug Impaired Driving
3. North Carolina Case Study
4. Impact of the ADHS on Traffic Safety
5. Discussion of Findings, Policy Implications, & Strategic Recommendations

Project Team

- Principal Investigator: Wes Kumfer
- Co-Investigators:
  - Arthur Goodwin
  - Raghavan Srinivasan
- Analysts:
  - Katie Harmon
  - Bo Lan
  - Mike Vann
  - Yudan Wang
- Project Support:
  - Chris Gomola Mullin
  - Jonathon Weisenfeld

Literature Review – Methods

- Performed systematic literature review using electronic journal catalogs (e.g., TRID, PubMed, Google Scholar).
- Performed in-depth search of “gray literature” based on subject matter expertise (e.g., ARC, AAA, CDC).
- Looked for gaps in literature and identified common variables to steer statistical analysis.

Literature Review – Results

- Indexed 288 total references
- Included >125 in literature synthesis
- There is little research describing the unique aspects of traffic safety culture in the Appalachian Region.
- Appalachia compares unfavorably to the rest of the United States for many leading causes of mortality, including traffic crashes.

Literature Review – Results

- Identified six research gaps in the literature
  1. How does roadway geometry (specifically curvature) affect the roadway departures identified by all Appalachian states as a key focus area?
  2. How does the isolation of Appalachian roadways interplay with roadway lighting and EMS access affect the severity of crashes in Appalachia?
  3. How dangerous are rural roads in Appalachia?
  4. What is the existing traffic safety culture in Appalachia?
  5. What poor driving behaviors are perpetuated by the existing traffic safety culture in Appalachia?
  6. What other variables that may be less tangible aspects of safety culture in Appalachia still affect safety in the Region?

Literature Review – Results

- Demographics in Appalachia
  - 42% of Appalachian residents live in rural areas (compared to 19% of US).

Population by Age Group	Total Population, July 1, 2016	Median Age (Years)
United States	323,127,513	38.0
Appalachian Region	25,552,573	40.9
Subregions		
Northern Appalachia	8,235,997	42.6
North Central Appalachia	2,413,170	41.3
Central Appalachia	1,877,400	41.8
South Central Appalachia	4,845,592	42.2
Southern Appalachia	8,180,414	38.4
County Types		
Large Metros (pop. 1 million +)	6,073,724	39.5
Small Metros (pop. <1 million)	10,811,590	40.6
Nonmetro, Adjacent to Large Metros	2,194,785	41.5
Nonmetro, Adjacent to Small Metros	3,959,266	43.2
Rural (nonmetro, not adj. to a metro)	2,513,208	41.6

Pollard and Jacobsen (2018)

Literature Review – Rural Concerns

- The literature highlights many specific traffic safety concerns for rural areas:
  - Long driving distances
  - Lower population densities
  - High speed limits
  - Hazardous roadway designs
  - Poor clearance zones
  - Decreased access to emergency medical care

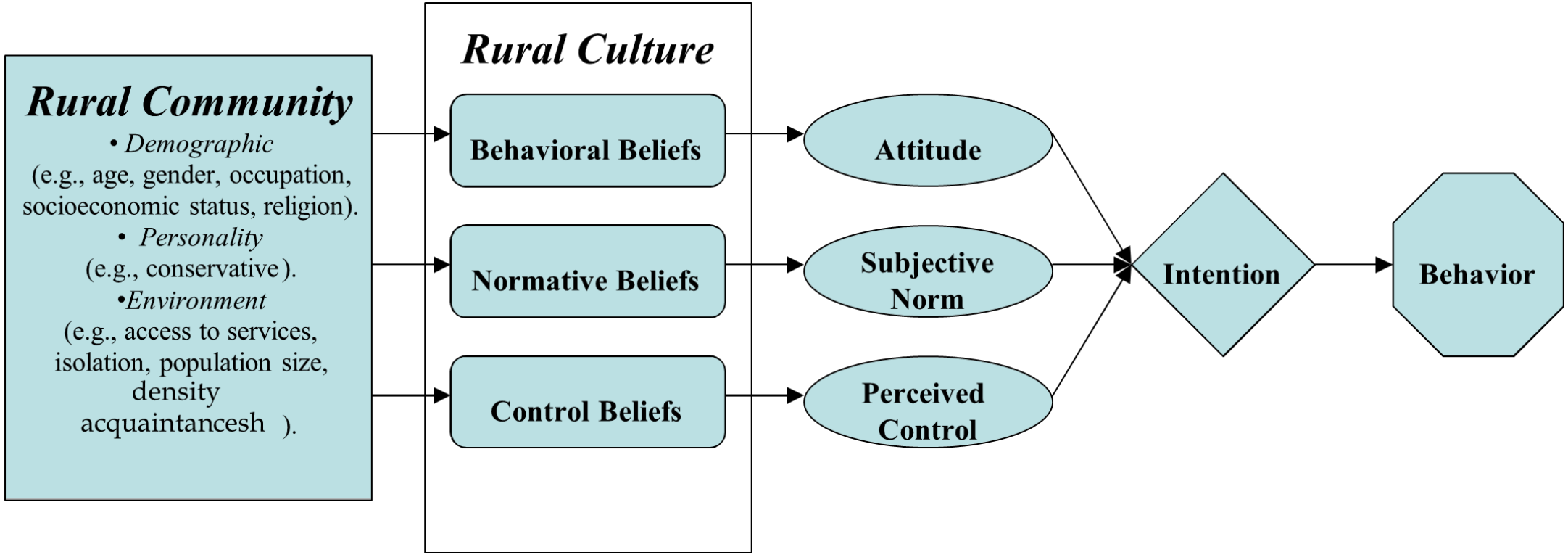
Literature Review – Rural Concerns

- The Strategic Highway Safety Plans (SHSPs) of the Appalachian States list several primary concerns related to rural roads.
  - Roadway departures connected to speeding and impaired driving.
  - Aggressive driving, especially on horizontal curves where roadway lighting and signage may be poor.
  - Need for improved EMS access.
  - Lack of data infrastructure for collecting and reporting quality data to allocate funding resources.

Literature Review – Traffic Safety Culture

- Traffic safety culture literature tends to examine certain behavioral variables to measure perceptions toward those behaviors.
  - Distracted driving
  - Speeding
  - Impaired driving
  - Drowsy driving
  - Occupant protection
  - Red-light running
  - Wrong-way driving
  - Vehicle size choice

Literature Review – Traffic Safety Culture



Ward (2007)

Working Definition of Appalachian Traffic Safety Culture

"Traffic safety culture in Appalachia is the collective force of social norms, behaviors, and values that determine the average person's posture toward engaging or not engaging in road use behaviors that can influence their safe or unsafe use of the unique roadway environments that characterize the Region."

Directing Your Questions via the Chat Pod

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Identify potential risks to rural road safety as identified in the literature.

Characterize the traffic safety profile of the Appalachian Region using crash data.

Describe engineering methods used to improve safety and how to evaluate those methods

Characterize rural road traffic safety culture using crash data.

Traffic Fatalities in Appalachia – Methods

- Data sources:
  - Traffic fatalities: FARS
  - Population: NCHS
  - Urban-rural classifications: NCHS
  - Appalachian geographic classifications: ARC
- Study population:
  - Trends: All US traffic fatalities during 1994-2017
  - All other analyses: All US traffic fatalities during 2013-2017
- FARS definition of a “traffic fatality”:
  - Must involve a motor vehicle
  - Most occur on a public roadway
  - Must result in a death ≤30 days of crash

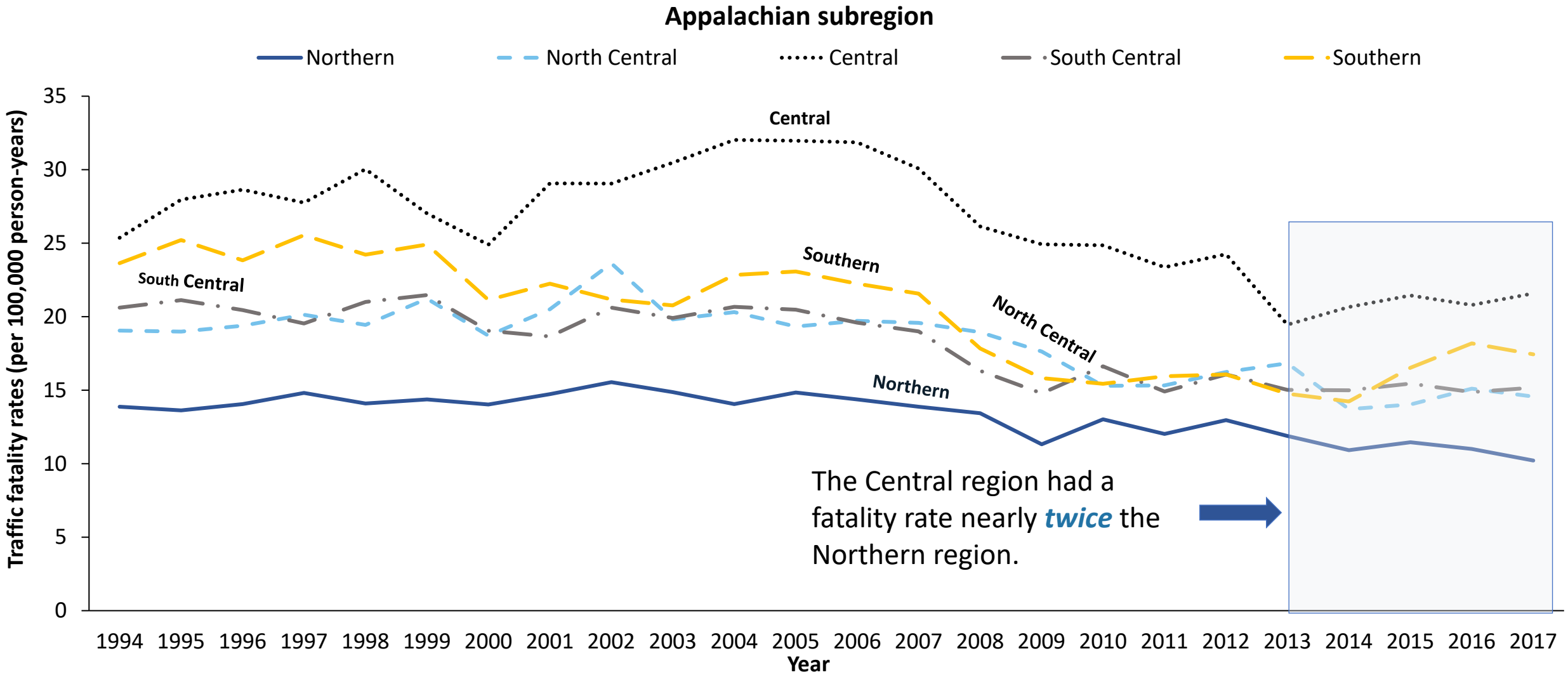
Traffic Fatalities in Appalachia – Methods

- Summary statistics:
  - Calculated frequencies (counts, proportions)
  - Calculated fatality rates and rate ratios (adjusted for age, sex, and urban/rural county of crash) using Poisson regression
  - Calculated odds ratios using logistic regression
  - For all analyses, considered non-overlapping Wald 95% confidence intervals as indicating “statistical significance”

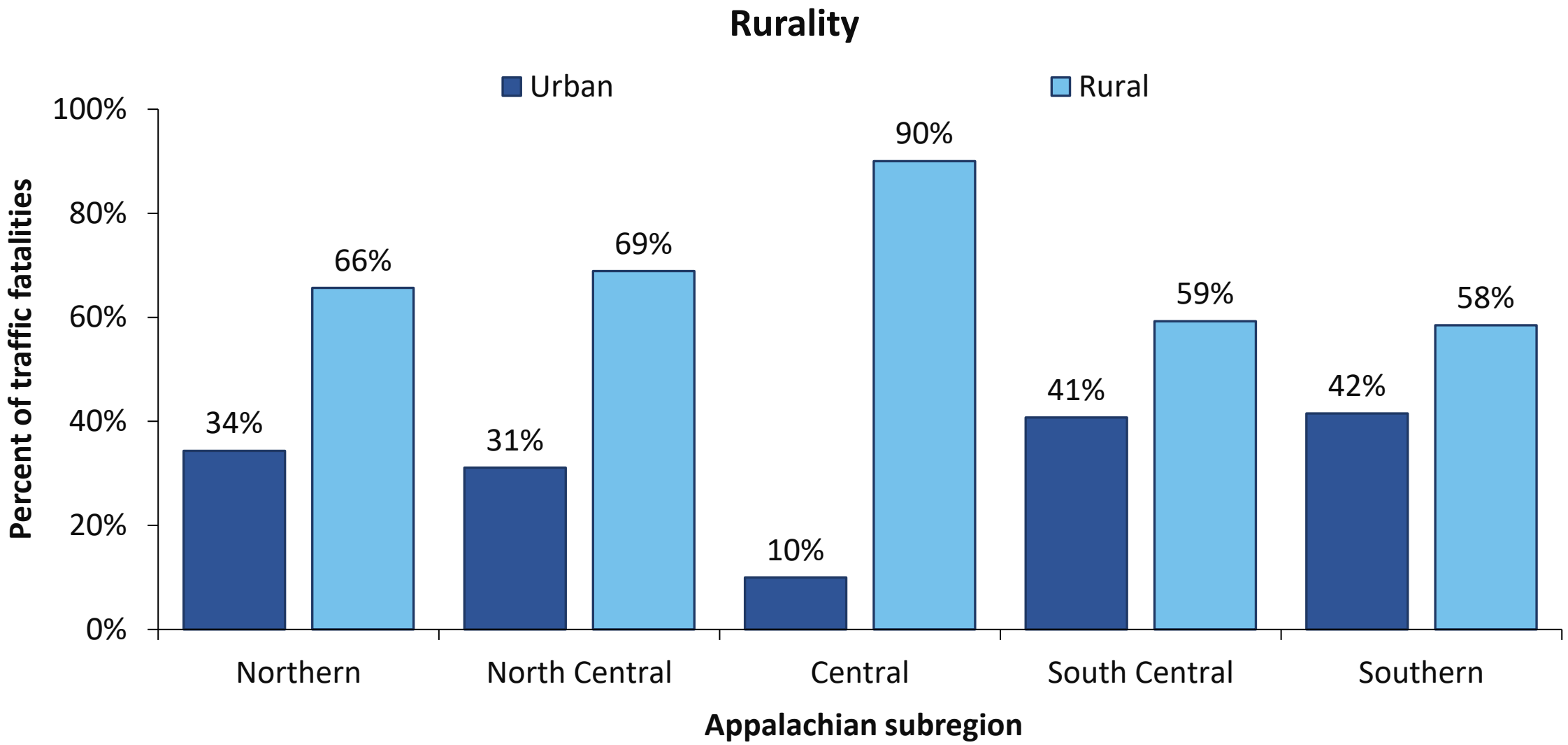
Traffic Fatalities in Appalachia – Guiding Questions

- Are there behavioral variables common to traffic fatalities in Appalachia (e.g., alcohol involvement, excessive speed) that can tell us about the traffic safety culture of the Region?
- Are there differences between Appalachian subregions?
- Are there differences between rural and urban Appalachia?
- Are there differences between Appalachia and the rest of the United States?

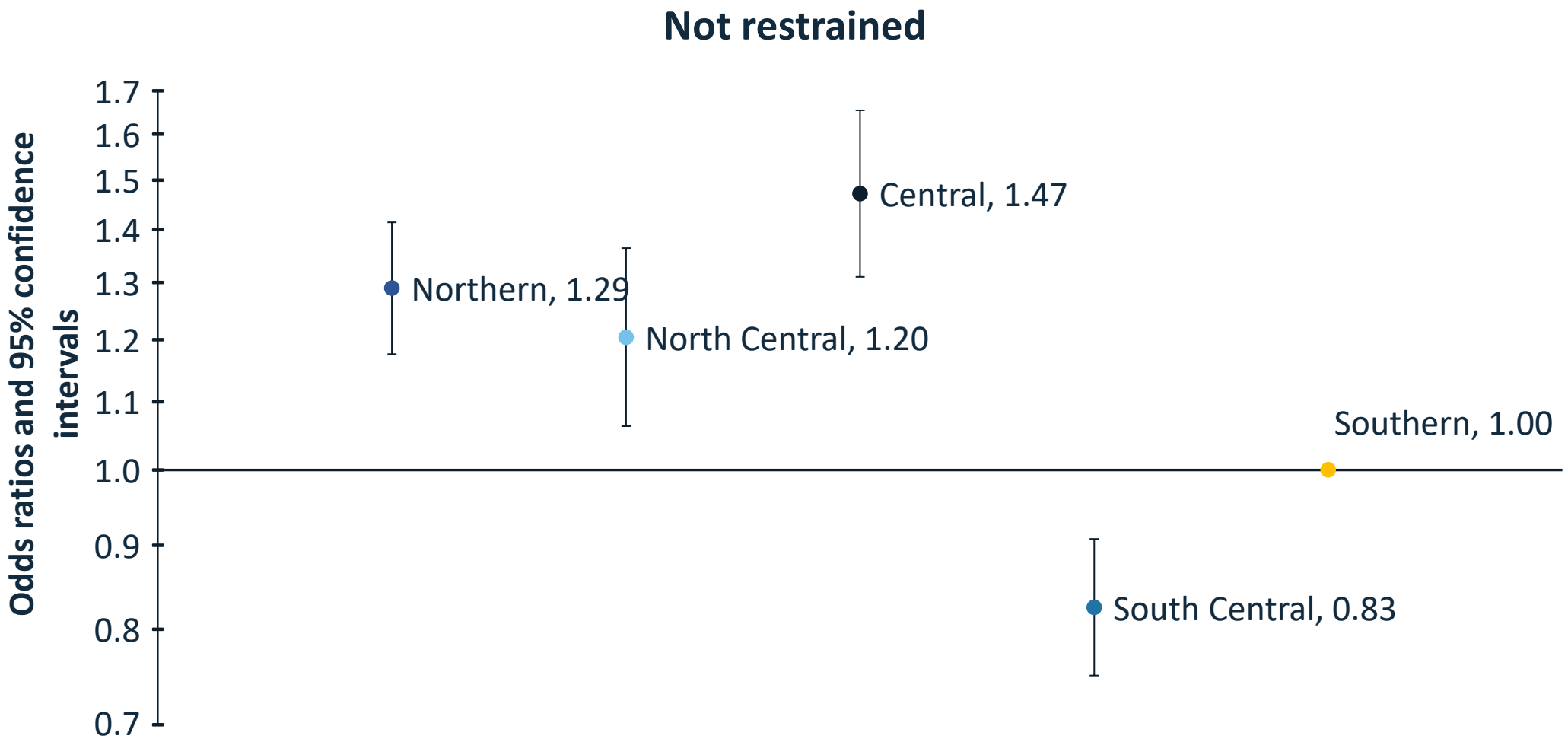
Traffic Fatalities in Appalachia – Regional Differences



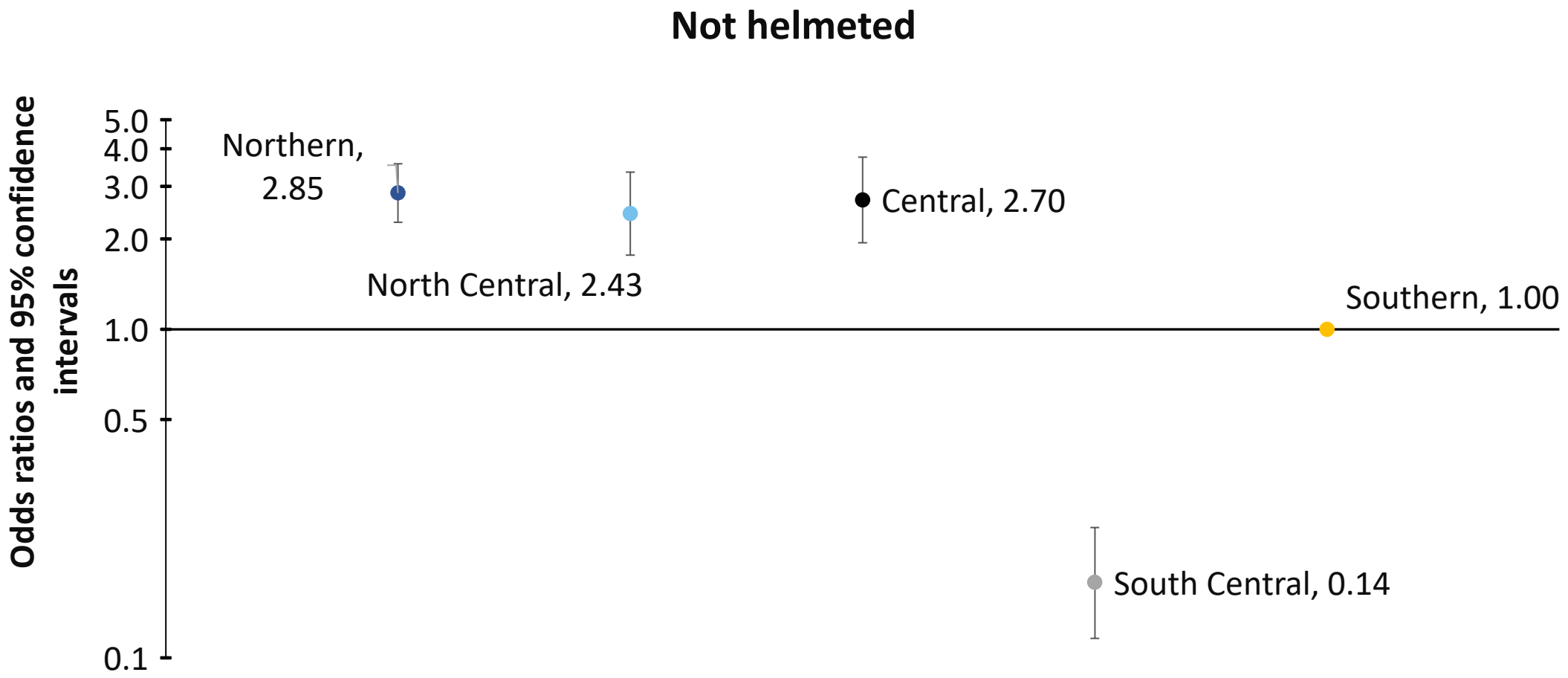
Traffic Fatalities in Appalachia – Regional Differences



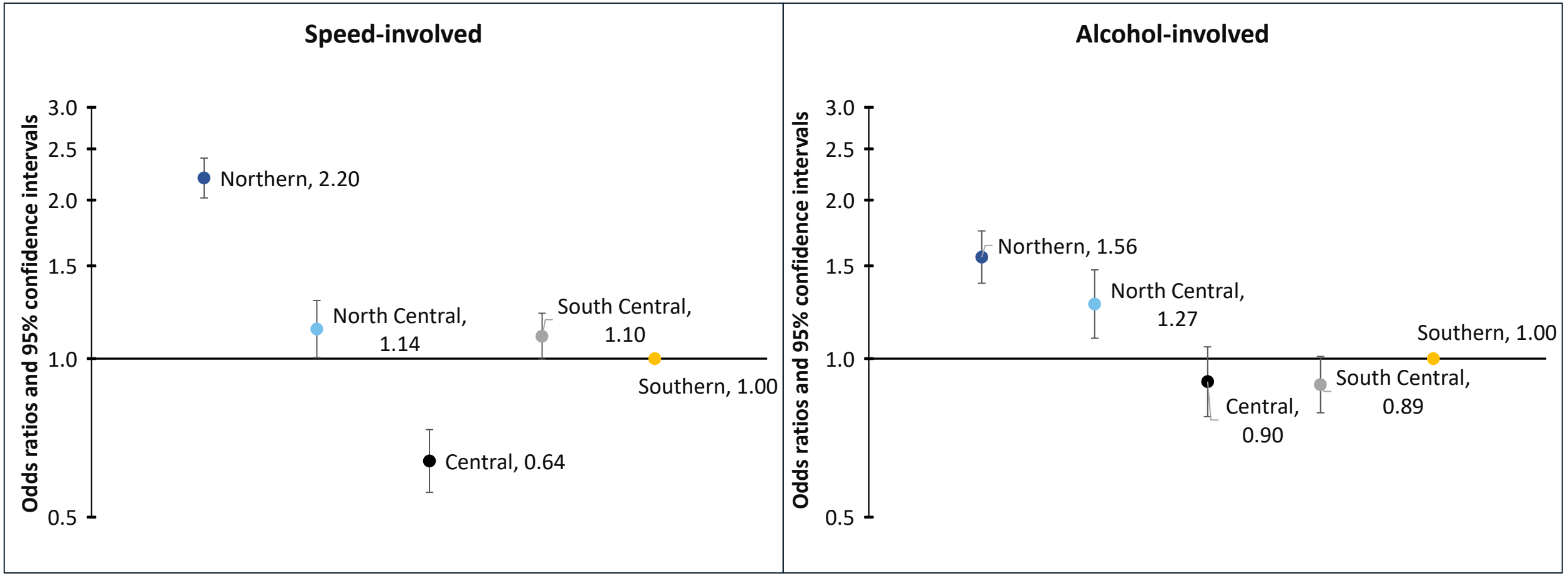
Traffic Fatalities in Appalachia – Regional Differences



Traffic Fatalities in Appalachia – Regional Differences

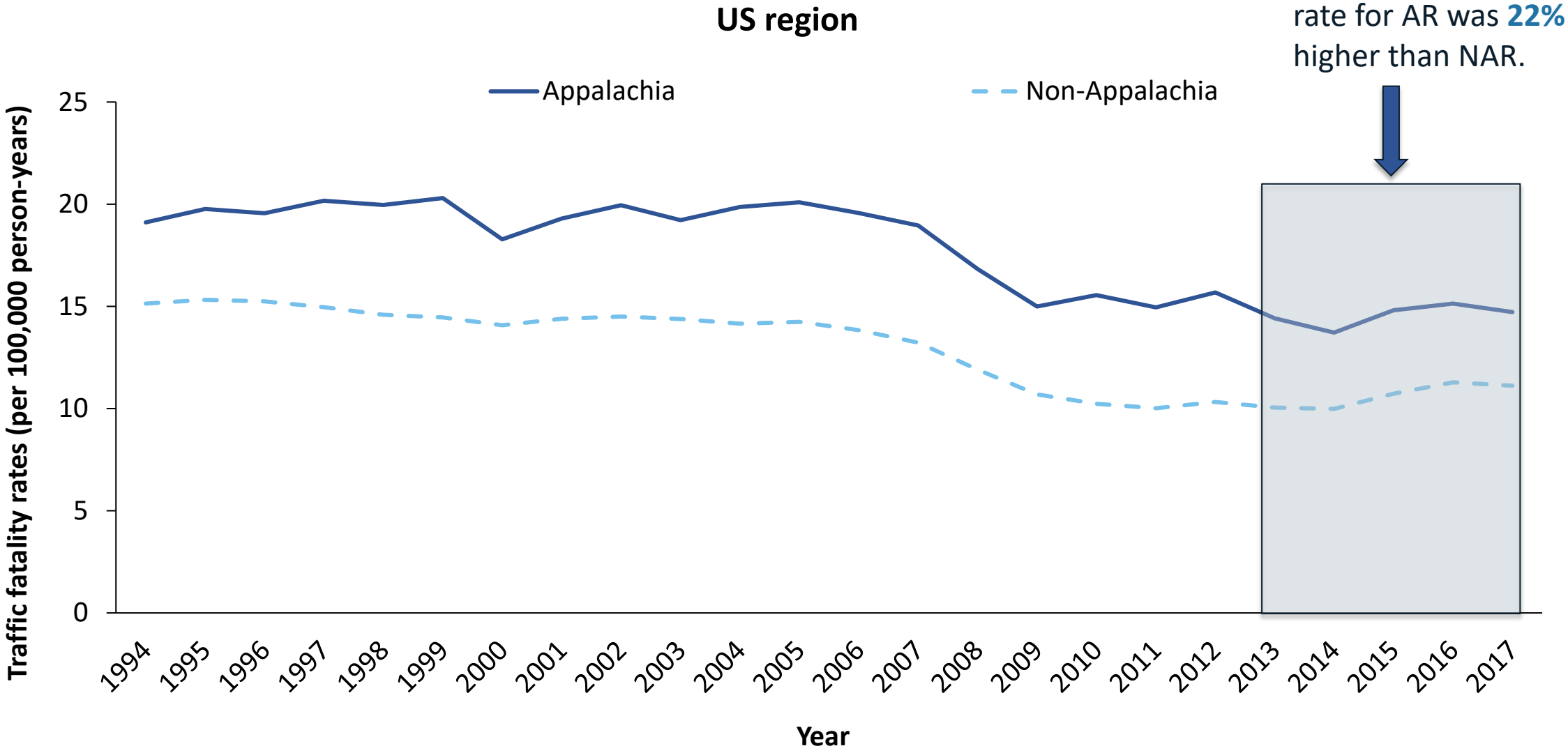


Traffic Fatalities in Appalachia – Regional Differences

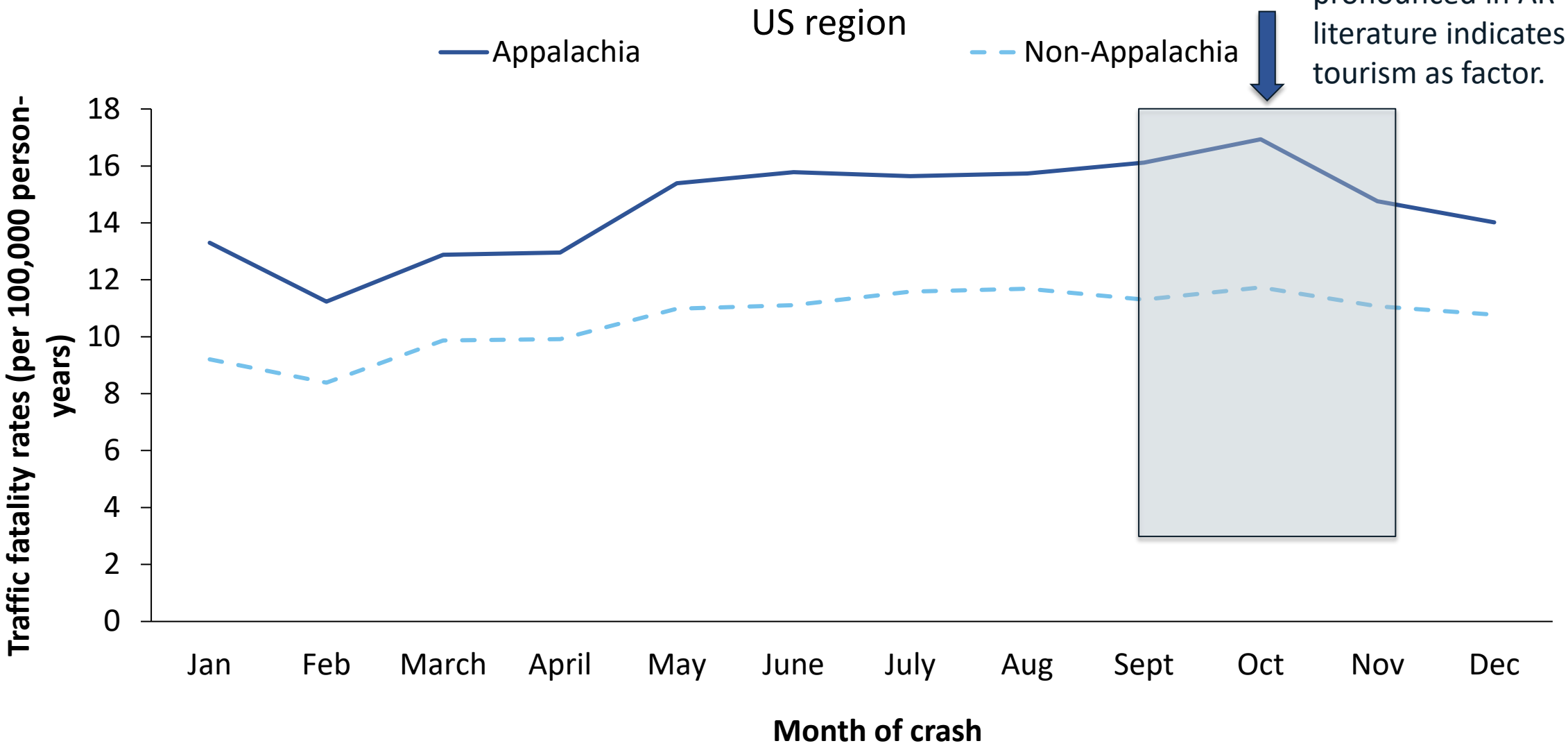


Traffic Fatalities in Appalachia – Regional Comparison

After adjustment, the traffic fatality rate for AR was **22%** higher than NAR.



Traffic Fatalities in Appalachia – Regional Comparison



The Fall peak is more pronounced in AR – literature indicates tourism as factor.

Traffic Fatalities in Appalachia – Regional Comparison

Characteristic		Appalachia	Non-Appalachia
Number of lanes			
	Two lanes	84.7%	73.0%
Alignment			
	Curved road	39.5%	27.0%
Grade			
	Some grade	40.6%	26.1%
Vehicle age			
	>20 years	10.0%	8.0%
Safety restraint			
	No restraint	54.9%	48.2%
Motorcycle helmet			
	No helmet	31.9%	40.1%
Speed-involved			
	Yes	29.0%	29.3%
Alcohol-involved			
	Yes	22.7%	30.8%

Traffic Fatalities in Appalachia – Drug and Impaired Driving

- FARS data have numerous and significant limitations.
- Many classes of drugs influence driving ability
  - Not just psychotropic drugs (e.g. hypoglycemic agents)
- Different classes of drugs impact of the body in different ways
  - E.g opioid analgesics versus hallucinogens
- No dose-response curve relating level of substance and level of impairment for most classes of drugs
  - Except for alcohol, FARS does not provide level of drug detected
- Does not collect data on the methods/composition of toxicology screen
  - E.g. Date/time of screen, type of test used, test composition

Traffic Fatalities in Appalachia – Drug and Impaired Driving

Drug testing characteristic		Appalachia	Non-Appalachia
Drug test status			
	Test given	44.0%	37.8%
	Test not given/refused	50.4%	51.8%
	Unknown if tested/not reported	5.6%	10.4%
Type of drug test given			
	Test not given/refused	50.4%	51.8%
	Blood	40.2%	33.4%
	Urine	1.8%	1.7%
	Blood and urine	1.3%	1.7%
	Other/unknown test type	0.7%	1.0%

Out of 25,259 Appalachian & 217,775 non-Appalachian motor vehicle drivers involved in fatal crashes, less than half had drug test results.

Traffic Fatalities in Appalachia – Drug and Impaired Driving

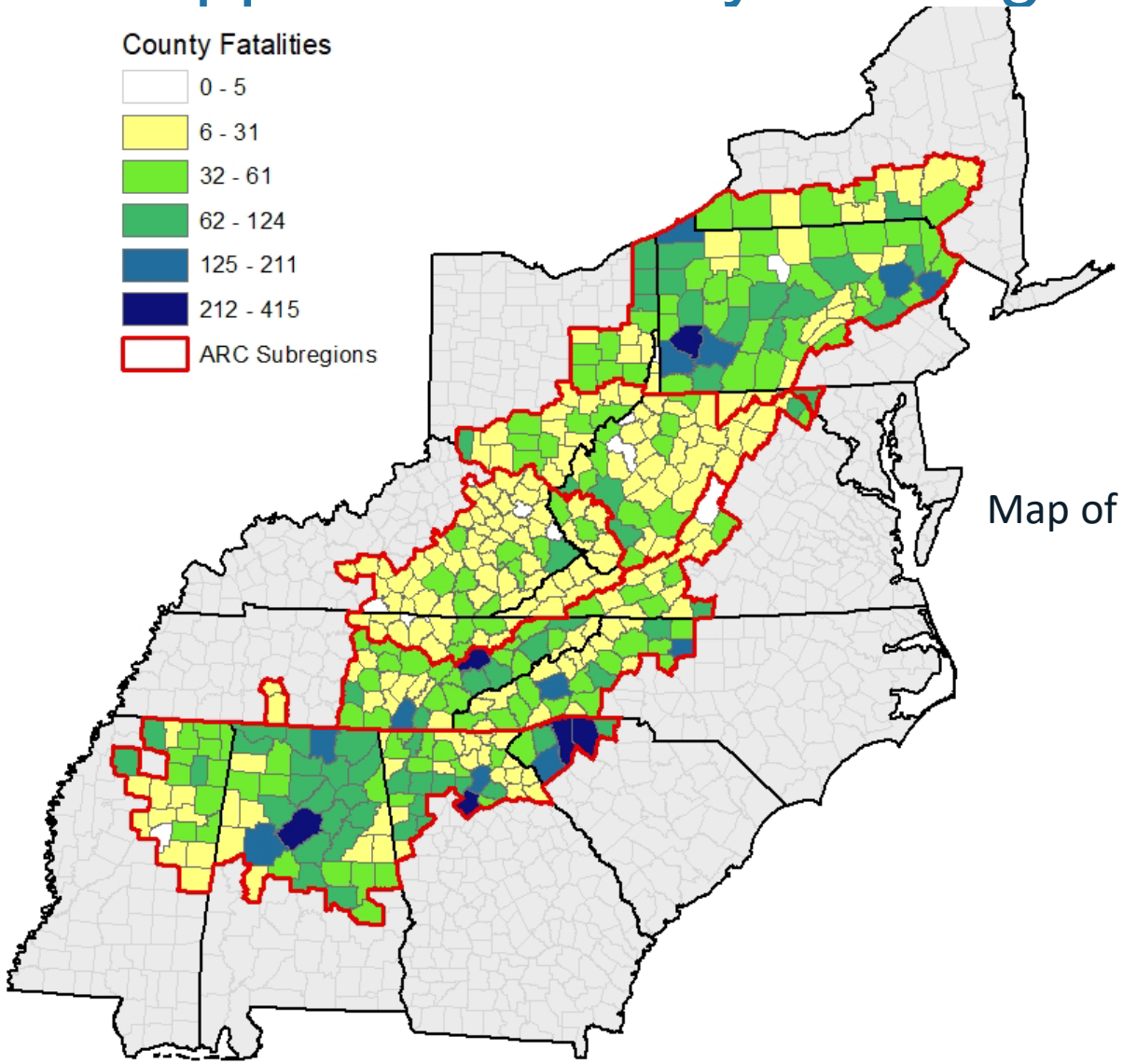
Drug test result		Appalachia	Non-Appalachia
Positive toxicology screen*		**49.7%**	**43.8%**
	Cannabinoids	12.7%	16.6%
	Stimulants	8.5%	10.0%
	Tranquilizers/Sedatives/Other non-narcotic CNS depressants	12.1%	7.8%
	Narcotics	11.3%	7.8%
	Hallucinogens	0.4%	0.5%
	Other/Unknown drugs	0.1%	0.3%
Negative toxicology screen		**50.3%**	**56.2%**

*Drivers can test positive for more than one class of drugs; column totals do not sum to 100 percent.

Traffic Fatalities in Appalachia – Key Findings

- Fatality trends are different across subregions, so individual subregions may vary from a broader Regional traffic safety culture.
- However, Appalachia is clearly a unique region in the United States.
- Many Appalachian traffic fatalities are more likely to occur on rural, two-lane trafficways with curves/grades.
- Appalachia's traffic safety profile has bright spots, with fatalities less likely to be not helmeted and killed in crashes involving alcohol.
- A slightly higher proportion of Appalachian versus non-Appalachian motor vehicle drivers involved in fatal traffic crashes test positive for drugs, although FARS data are severely limited.

Traffic Fatalities in Appalachia – Key Findings



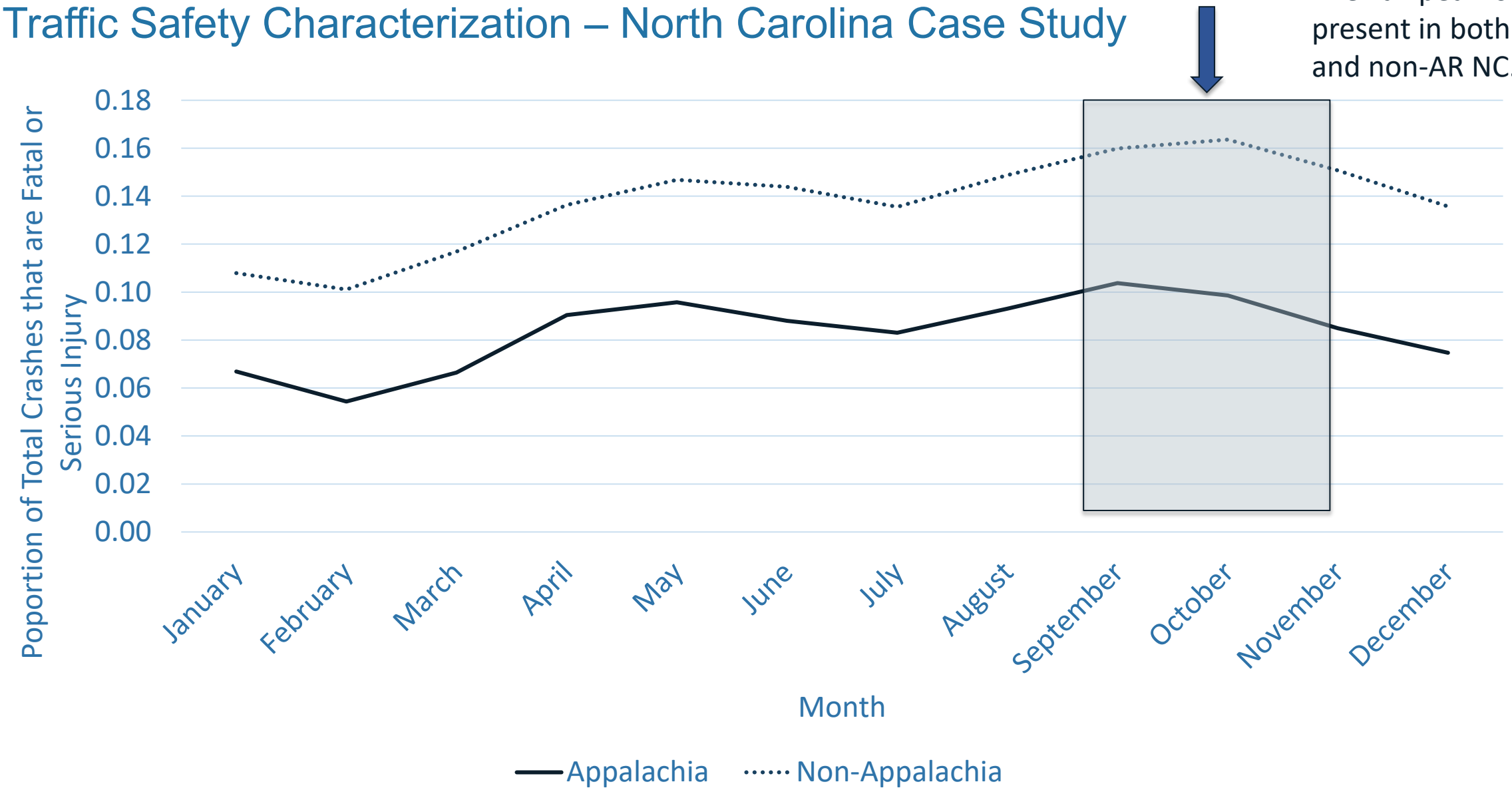
Map of Fatality Counts by Appalachian County, 2013-2017

Traffic Safety Characterization – North Carolina Case Study

- Data sources:
  - Crash data (all severities): NCDOT
  - Appalachian geographic classifications: ARC
- Study population:
  - Trends: All N.C. police-reported crashes from 2013-2017
  - Proportionate Rates: All N.C. police-reported crashes from 2013-2017
- Summary statistics:
  - Calculated frequencies (fatal and severe injury crash counts - KABCO)
  - Proportionate rates (proportion of fatal and severe injury crashes in total crash counts)
  - Calculated odds ratios using logistic regression
  - For all analyses, considered non-overlapping Wald 95% confidence intervals as indicating “statistical significance”

Traffic Safety Characterization – North Carolina Case Study

The Fall peak is present in both AR and non-AR NC.



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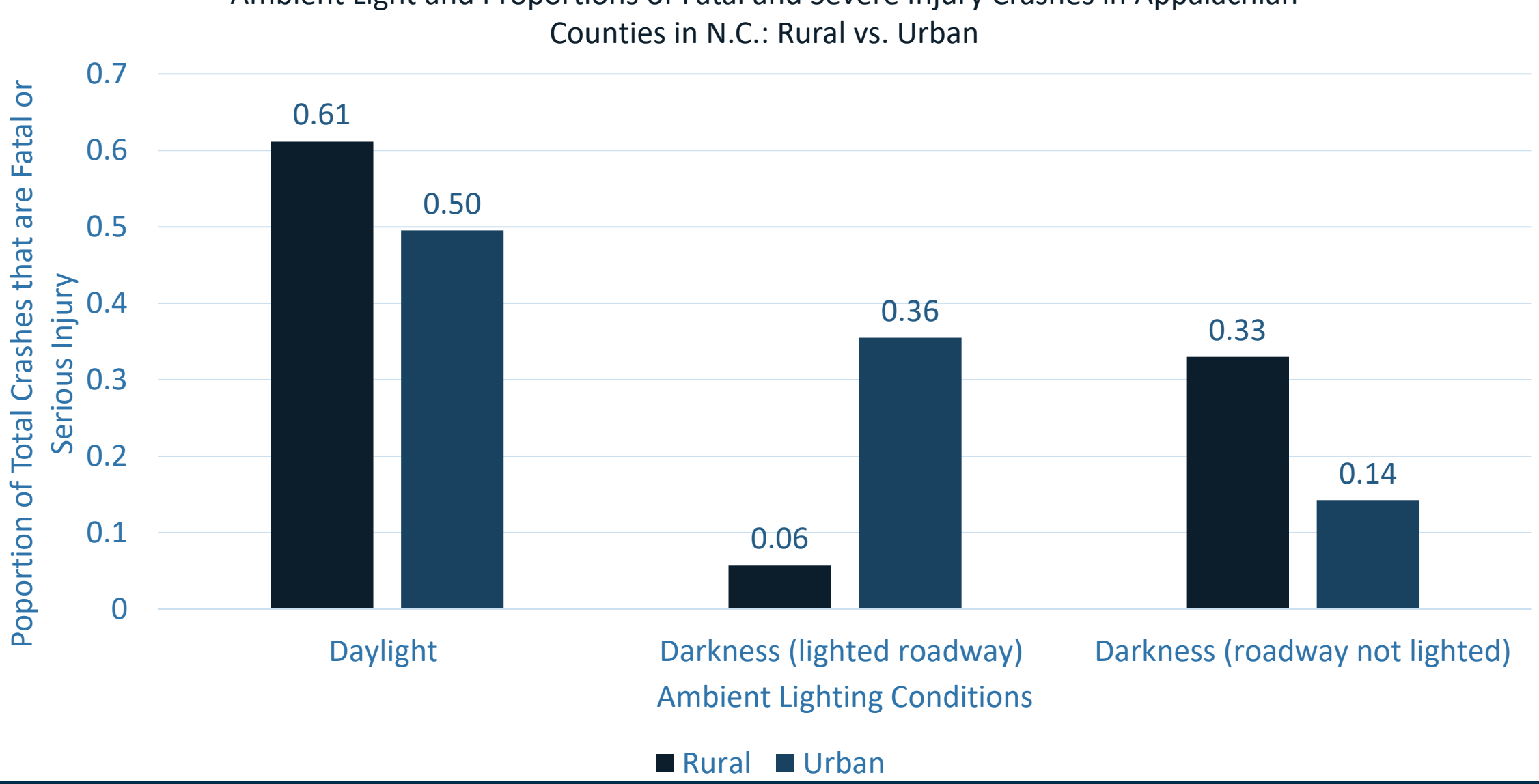

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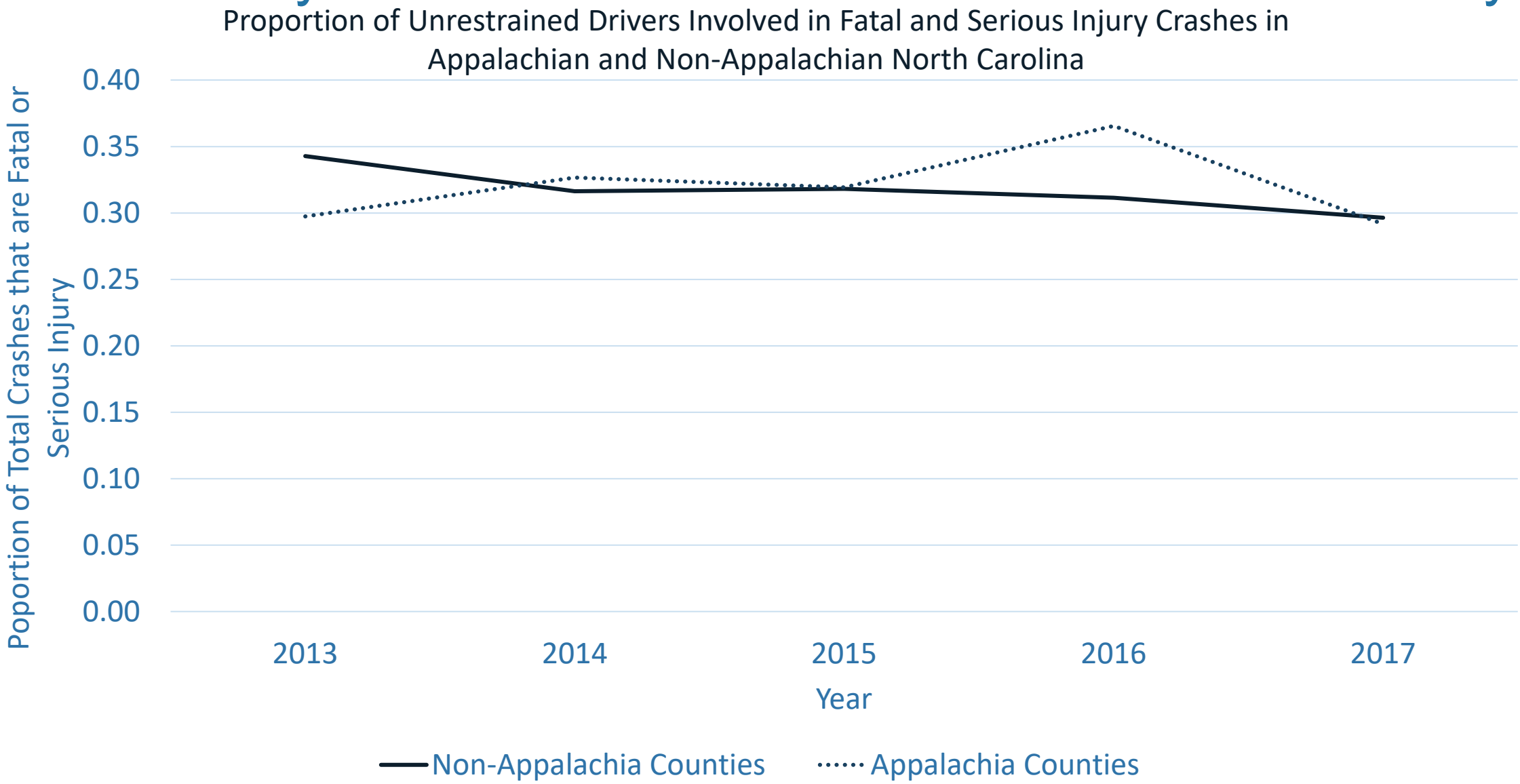
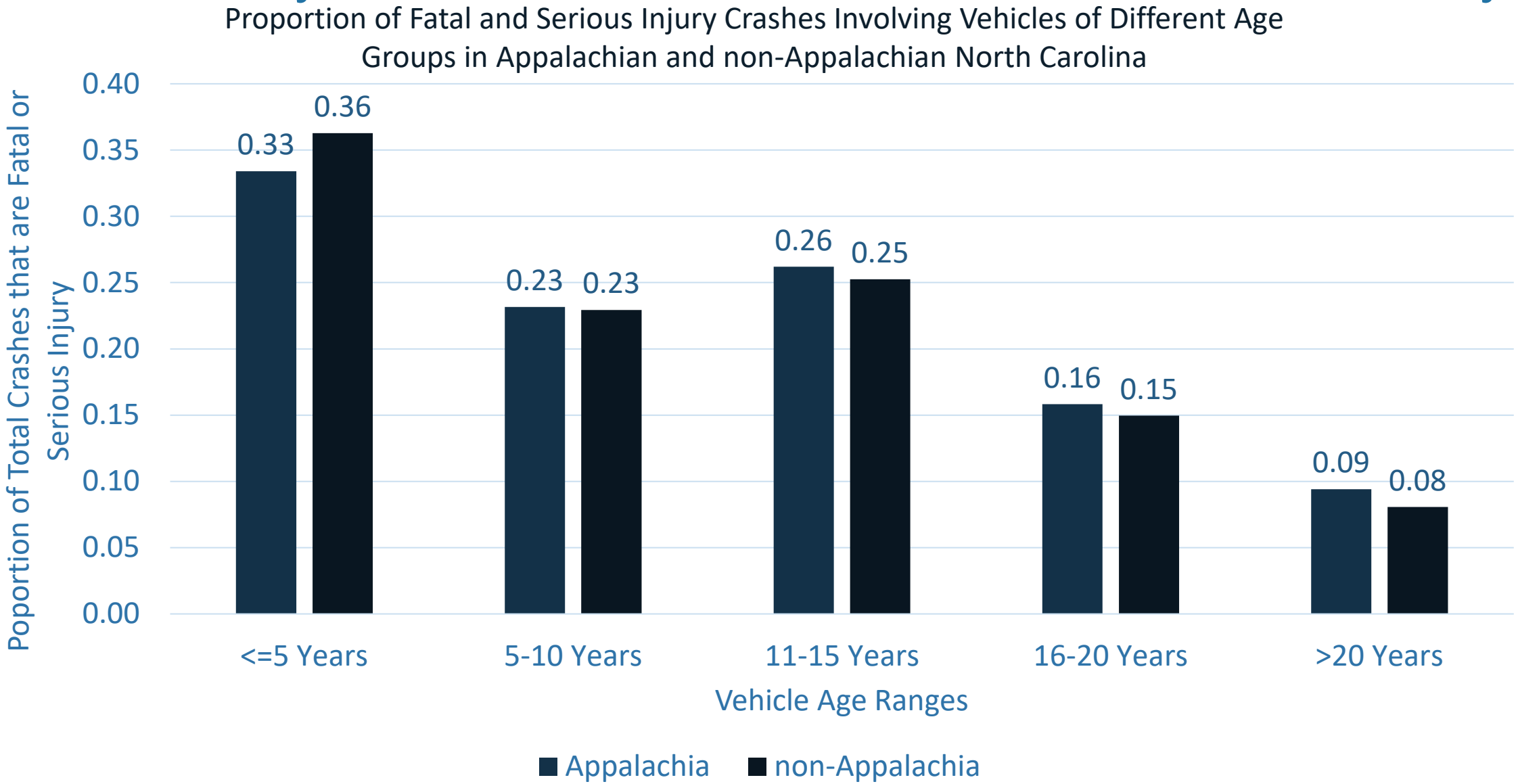


Traffic Safety Characterization – North Carolina Case Study



Traffic Safety Characterization – Key Findings

- The North Carolina case study verifies several findings from the FARS analysis:
  - Severe crashes in Appalachia seem to peak in Fall.
  - Lack of roadway lighting is a concern for Appalachia.
  - There is a need for universal restraint laws in Appalachia.
- A question to consider: Are these traffic safety concerns embedded within the culture, and if so, can they be mitigated by a change in organizational safety culture?

Directing Your Questions via the Chat Pod

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Describe engineering methods used to improve safety and how to evaluate those methods

Characterize rural road traffic safety culture using crash data.

Engineering Evaluation - Methods

- Data sources:
  - ADHS Corridors: ARC
  - Crash data (all severities): Kentucky State Police Department, State DOTs,
  - Traffic volume data: State DOT websites, Kentucky Planning Highway Information System, HPMS
  - Roadway data: ARC, State DOTs, Google Maps®
- Study population:
  - Crash, traffic volume, and roadway data: various years (approximately 2001-2018)
- Corridor Selection
  - 13 Treatment corridors
  - 40 Reference corridors

Engineering Evaluation - Methods

- Summary statistics:
  - Crash types
    - Total crashes
    - Injury crashes
    - Multi-vehicle crashes
    - Single-vehicle crashes
    - Night-crashes
  - Crash rates (RMV)
  - Predicted crashes (via SPF)
  - CMFs (based on B-A variable)

Engineering Evaluation – Identifying Countermeasures

- Some of the traffic fatality data indicated a need for “behavioral countermeasures.”
  - E.g., universal seat belt laws
- However, some of the crash factors can be addressed through engineering measures.
  - Two-lane roads
  - Curved and graded roads
  - Low light conditions
- One method used in the Appalachian Region is the ADHS upgrade.

Engineering Evaluation – Identifying Countermeasures

- The ADHS upgrade entails two types of treatments to address roadway design issues.
  - Improved alignment: addition of lanes, addition of median, (potential) widening of shoulder, access control, (potential) speed limit change
  - New alignment: construction of lanes, construction of median, construction of shoulder, access control

Example old alignment (KY-1426) and new alignment treatment (ADHS Corridor G).

Appalachian Regional Commission

Engineering Evaluation – Evaluating a Countermeasure

- CMF Considerations
  - Cross-sectional method selected to compare new alignment + improved existing alignment to old alignment
    - Lack of data before and after project completion made before-after Empirical Bayes methodology difficult
  - Initially two assumptions for cross-sectional method
    1. Traffic is entirely routed onto new alignment (in the case new alignment was constructed rather that improvement to existing alignment).
    2. Traffic is distributed onto both the new alignment and old alignment, so a systemic comparison is merited.

Based on analysis results, only CMF results corresponding to a systemic comparison of the new and old alignments are presented in this report.

Engineering Evaluation – Evaluating a Countermeasure

Summary Statistics for Crashes by Corridor Type for Full Dataset

Corridor Type	Crash Type	Mean Annual Crash Count	Sum
Improved Alignment Treatment Corridors (Before Period)	Total	6.8	27
	Injury	2.5	10
	Single-Vehicle	6.3	25
	Multi-Vehicle	0.5	2
	Nighttime	0.8	3
Improved Alignment Treatment Corridors (After Period)	Total	1.2	26
	Injury	0.3	7
	Single-Vehicle	0.8	16
	Multi-Vehicle	0.5	10
	Nighttime	0.2	4
New Alignment Treatment Corridors (Before Period)	Total	17.2	859
	Injury	6.7	337
	Single-Vehicle	13.1	655
	Multi-Vehicle	4.1	204
	Nighttime	3	148
New Alignment Treatment Corridors (After Period)	Total	14.3	900
	Injury	4.6	292
	Single-Vehicle	7.3	462
	Multi-Vehicle	7	438
	Nighttime	3.3	209

Engineering Evaluation – Changes in Crash Trends

Crash Rate per 100 Million Vehicle Miles Traveled for Study Corridors

Average Crash Rate per Alignment Type	Alignment Type	Total Crash rate (per 100 MVM)	Injury Crash Rate (per 100 MVM)	Multi-Vehicle Crash Rate (per 100 MVM)	Single-Vehicle Crash Rate (per 100 MVM)	Night Crash Rate (per 100 MVM)
	Old	133.34	64.91	72.85	60.49	38.01
	New	70.69	23.36	39.12	31.57	15.37

Engineering Evaluation – Efficacy of the ADHS Treatment

CMF for Various Crash Types Indicating Efficacy of ADHS Treatments

Crash Type	CMF for ADHS Treatment	Standard Error of CMF
Total Crashes	0.764*	0.127
Injury Crashes	0.702*	0.147
Multi-Vehicle Crashes	0.639*	0.130
Single-Vehicle Crashes	1.00	-
Nighttime Crashes	1.00	-

* indicates statistical significance

Engineering Evaluation – Further Considerations

- The ADHS treatment improves safety performance for most crash types at locations by addressing geometric design.
- Changes in travel patterns and vehicular volumes may change the efficacy of the treatment in the future.
- This treatment does not take into account the needs of pedestrians or bicyclists.

Engineering Evaluation – Further Considerations

- Pedestrians and bicyclists in Appalachia are currently killed at a lower rate than in non-Appalachia.
  - This may change as tourism and population densities change.

Traffic Fatalities and Traffic Fatality Rates (per 100,000 person-years), by Person Type: Appalachia & non-Appalachia, 2013-2017

Person type		United States region N= 175,715			
		Appalachia		Non-Appalachia	
		N	Rate	N	Rate
Vehicle occupant					
	Driver**	10,927	10.42	77,014	6.44
	Passenger	3,300	2.59	27,156	1.84
	Subtotal	14,270	11.20	104,671	7.08
Motorcyclist**					
	Subtotal	2,348	2.24	22,431	1.88
Non-motorist					
	Pedestrian	1,700	1.33	25,447	1.72
	Pedal cyclist	176	0.14	3,754	0.25
	Subtotal	1,943	1.52	30,052	2.03
TOTAL		**18,561**	**14.56**	**157,154**	

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Dr. Wes Kumfer
UNC Highway Safety
Research Center

National Center for Rural Road Safety

Identify potential risks to rural road safety as identified in the literature.

Characterize the traffic safety profile of the Appalachian Region using crash data.

Describe engineering methods used to improve safety and how to evaluate those methods

Characterize rural road traffic safety culture using crash data.

Characterizing Rural Traffic Safety Culture – Summary

- Synthesizing all of the results of this study, we know:
  - The traffic safety profile of the Appalachian Region is unique when compared to the rest of the United States.
  - The literature indicates that some of Appalachia's uniqueness is due to its rural expanses and population distribution.
  - Factors related to the rural nature of the Region (e.g., location of crashes, time of crashes, etc.) contribute to the uniqueness of the Region's traffic safety profile.
  - Other cultural elements likely interact with the rural nature of many crashes in the Region.

Characterizing Rural Traffic Safety Culture – Refined Definition

"Traffic safety culture in Appalachia is the collective force of social norms, behaviors, and values that determine the average person's posture toward engaging in positive road use behaviors (like helmet use or not drinking and driving) or negative road use behaviors (like not wearing restraints) while navigating older (on average) vehicles on (frequently rural) roadways (often) characterized by two-lane, curved alignments with minimal lighting."

Characterizing Rural Traffic Safety Culture – Refined Definition

- Is this definition sufficient?
- Probably not. While we can say more about the kinds of crashes that involve Appalachian drivers and speculate about the rural attitudes (broadly) and Appalachian attitudes (specifically) that inform them, we need to study Regional values to arrive at a more precise definition.
- We also need to account for the organizational culture of agencies in Appalachia that influence safety.

Characterizing Rural Traffic Safety Culture – Next Steps

- General recommendations:
  - Improve roadway lighting (especially in rural areas).
  - Consider tourist destinations for project prioritization.
  - Implement the ADHS treatment on old two-lane corridors if traffic will remain stable.
  - Implement other countermeasures for single-vehicle crashes along ADHS alignments.

Characterizing Rural Traffic Safety Culture – Next Steps

- Recommendations related to organizational safety culture:
  - More research is needed to characterize the traffic safety culture of Appalachia.
  - Need to consider Appalachian needs in State Strategic Highway Safety Plans.
  - Economic development programs to inject newer, safer vehicles into the vehicle fleet.
  - Social marketing programs may be needed to address lack of restraint use.
  - Improved drug testing data is needed to understand drug use and its relation to driving while impaired so systemic solutions can be implemented.

Characterizing Rural Traffic Safety Culture – Conclusions

- To counteract traffic safety problems seen in the crash data, agencies may consider organizational changes that:
  - Activate the same values responsible for lower incidence of speeding and alcohol-impaired driving.
  - Instill a place-based identity linked to safe driving behaviors (e.g., “Appalachians care about their loved ones and buckle up.”)
  - Prioritize local engagement rather than pass-through travel that increases traffic on ADHS corridors.

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Learning Outcomes

In this webinar, you have learned to:

- Identify potential risks to rural road safety as identified in the literature.
- Characterize the traffic safety profile of the Appalachian Region using crash data.
- Describe engineering methods used to improve safety and how to evaluate those methods
- Characterize rural road traffic safety culture using crash data.

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- December 17, 2020:
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Contact Information

If you have any questions related to this presentation, please contact:

Wes Kumfer - kumfer@hsrc.unc.edu

Or contact the National Center for Rural Road Safety Help Desk at:

(406) 994-7368 or info@ruralsafetycenter.org

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