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# Understanding and Mitigating Pedestrian Crashes at Crosswalks – Selection of Treatments that Work

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# Presentation Outline

- Background and Motivation
- Objectives
- Identification of Pedestrian Crash Causes (Study #1)
- Selection of Crossing Treatments (Study #2)
- Conclusions and Recommendations

# Background and Motivation

- Pedestrian fatalities **are increasing worldwide**
- Pedestrian fatalities account for 23% of all road traffic fatalities worldwide (WHO Global Status Report on Road Safety 2023)
  - The Americas Region: 23%
  - European Region: 19%
  - Eastern Mediterranean Region: 24%
  - African Region: 27%
  - South-East Asia Region: 15%
  - Western Pacific Region: 29%
- To reduce pedestrian fatalities:
  1. The root causes of vehicle-pedestrian crashes must be well understood
  2. Appropriate treatments of crosswalks should be implemented

# Objectives

1. Understanding the root causes of vehicle-pedestrian crashes (Study #1 using state of Michigan, USA as a case study)
2. Developing a framework for selecting appropriate crosswalk treatments (Study #2 using state of Michigan, USA as a case study)

**STUDY #1**  
**Understanding the Causes of  
Pedestrian Crashes**

# Study #1 Overview

- Funded by the Michigan Office of Highway Safety (OHSP)
- Focused on driver and pedestrian behaviors and infrastructure-related causes
- Five-year crash data covering the entire state of Michigan – focused on Fatal and Incapacitating (K & A) crashes



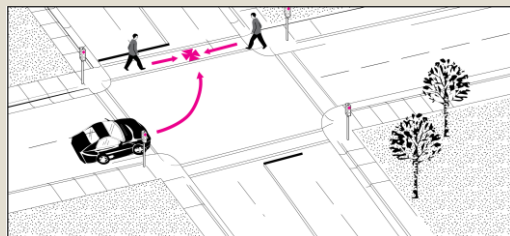
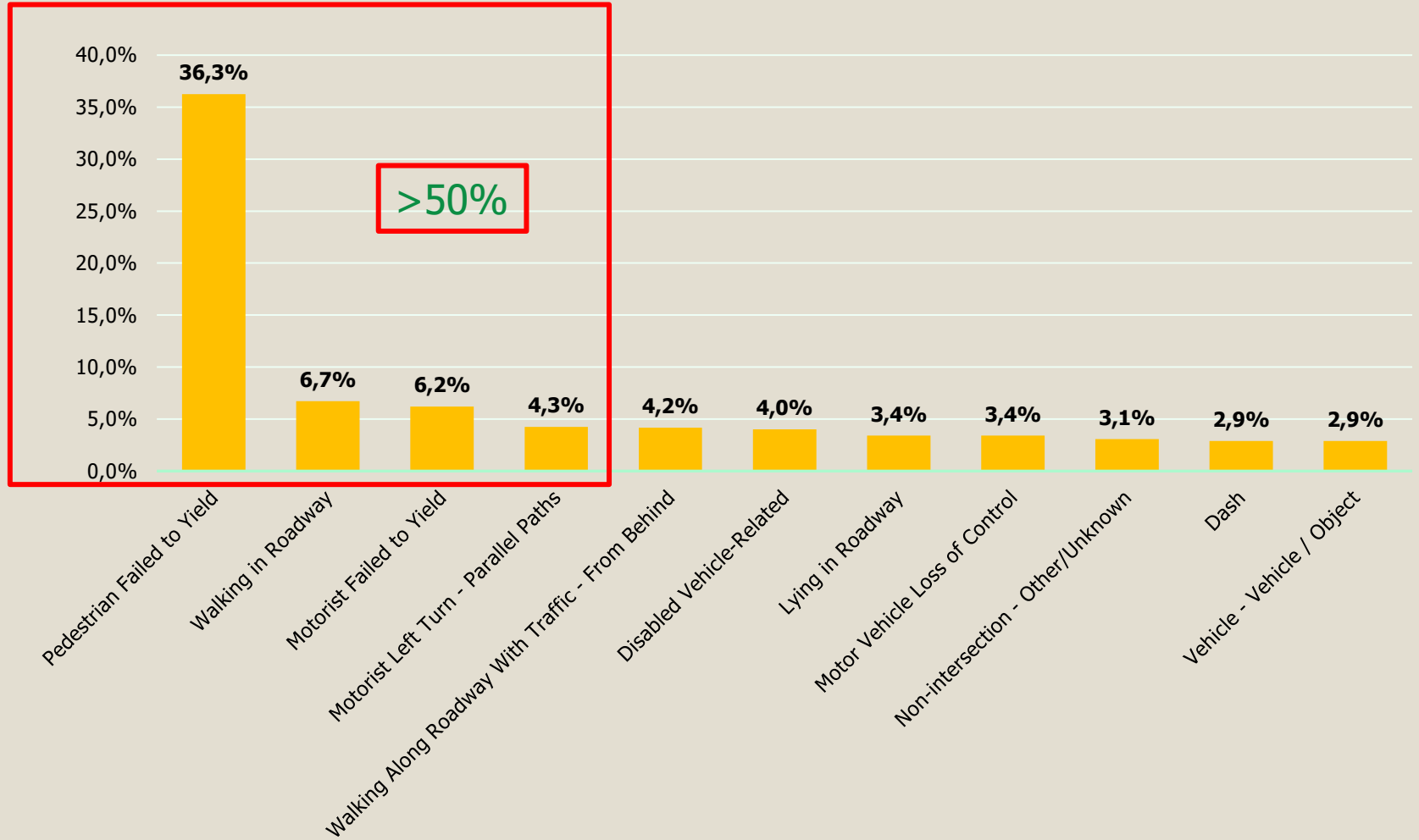
# Summary of Study Methods and Data

- Utilized Pedestrian and Bicycle Crash Analysis Tool (PBCAT) to identify causes of pedestrian crashes
  - It requires specific information from the “narrative” section and crash diagram of crash report (UD-10)
  - Summary of reviewed crashes

Crash category	# of UD-10 Reviewed
Fatal Crashes (K)	675 (100% of all five-year fatal crashes)
Incapacitating Injury Crashes (A)	500 (26% from the total of A ped. crashes )
Total (K&A)	1,175

- Conducted a detailed analysis of those crashes
- Surveyed engineers, law enforcement officers, and advocacy groups on potential countermeasures

# Crash Causes Related to Pedestrian and Driver Behavior

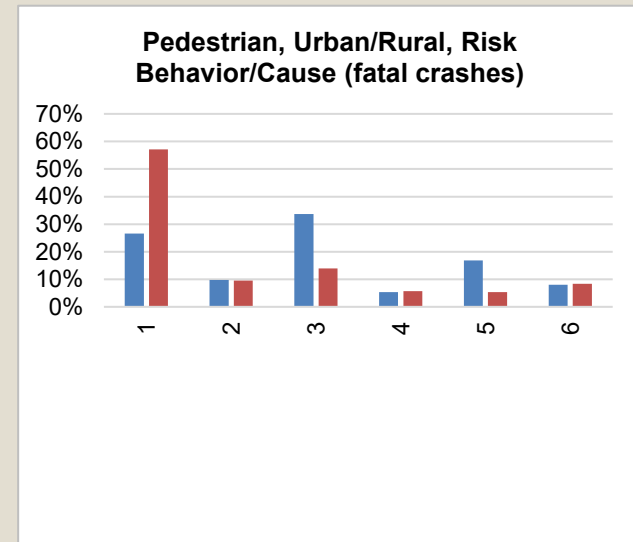
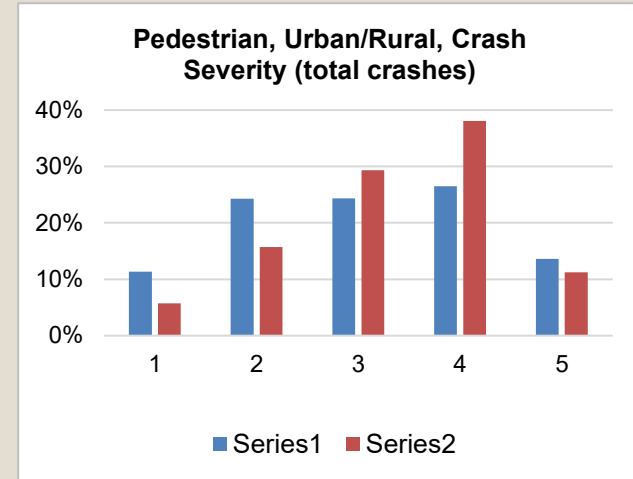




# Analysis of Behaviors by Area Type

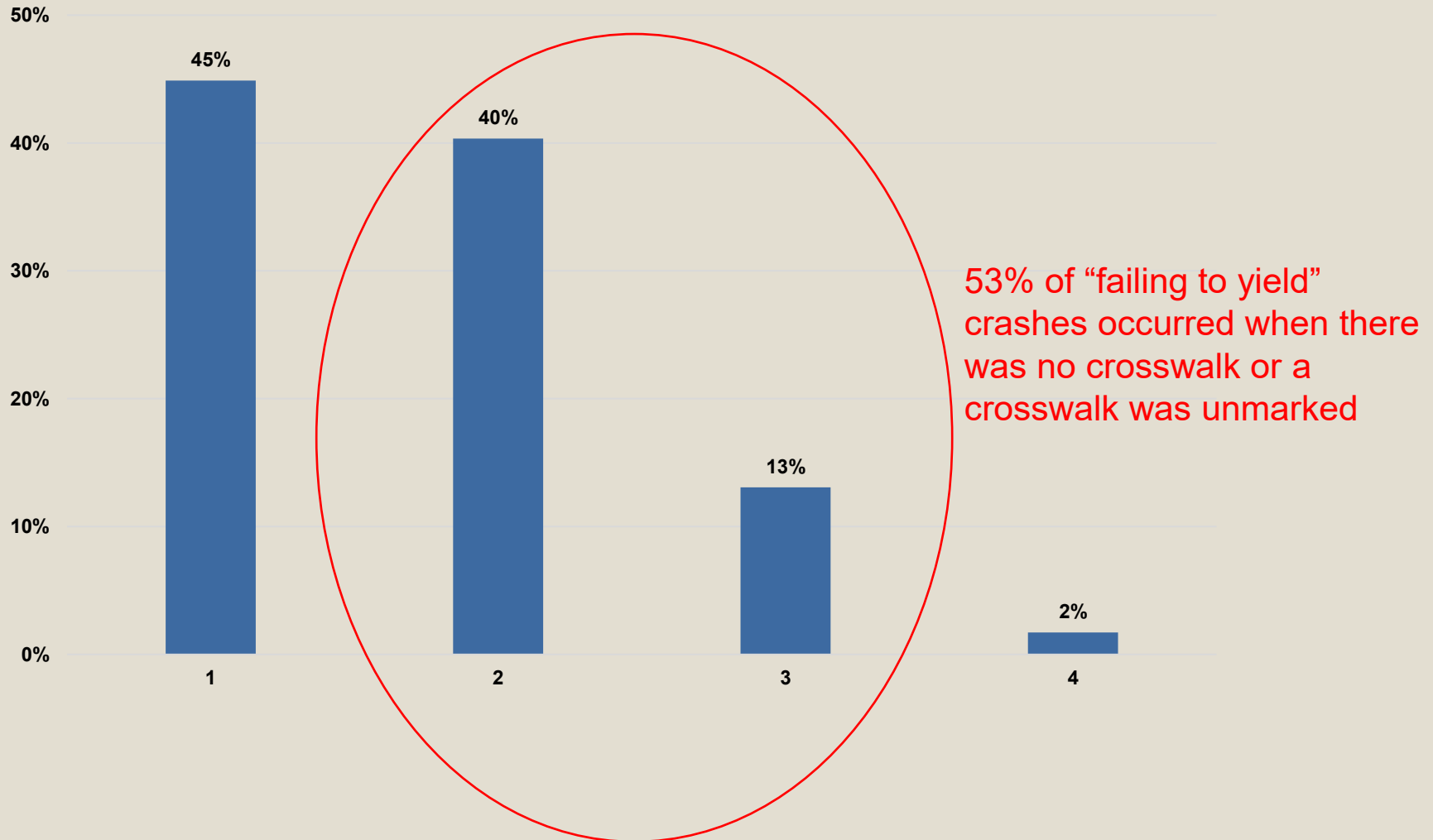
## Rural vs Urban

- Higher proportion of fatal and incapacitating crashes occurred in rural areas
- Failure to yield had a higher proportion in urban areas
- Pedestrians in roadway and walking along roadway proportions are relatively higher in rural areas

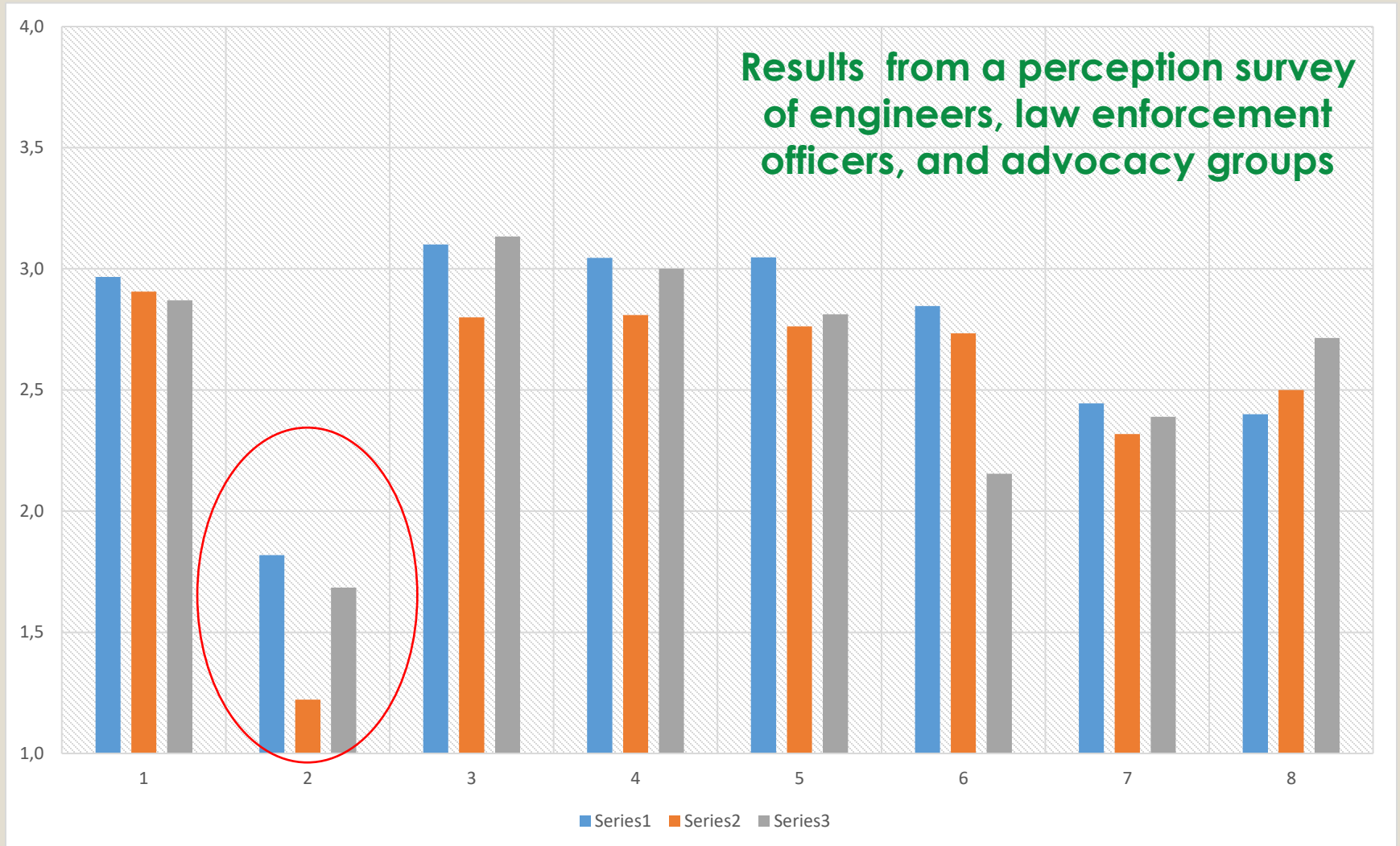


# Failing to Yield in Relation to Crosswalk Presence

Pedestrian Crashes; Failing to Yield; Crosswalk Presence



# Rating of Potential Pedestrian Safety Treatments



# Key Takeaways on Ped Crash Causes (Study #1)

- Failing to yield to one another is linked to high percentage of fatal and incapacitating (K & A) pedestrian crashes
- Presence and treatment of pedestrian crosswalks play an important role in mitigating pedestrian fatal and severe injury crashes

**STUDY #2**  
**Selections of Effective Pedestrian  
Crosswalk Treatments**

# Study #2 Overview and Data

- Funded by the Michigan Department of Transportation (MDOT)
- Focused on non-motorized (pedestrian and bicycle) safety along higher speed roads - speed limit of 45+ mph (70+ kph)
- The goal was to recommend effective treatments of pedestrian crosswalks.

# Criteria for Selecting Treatments for Pedestrian Crossings

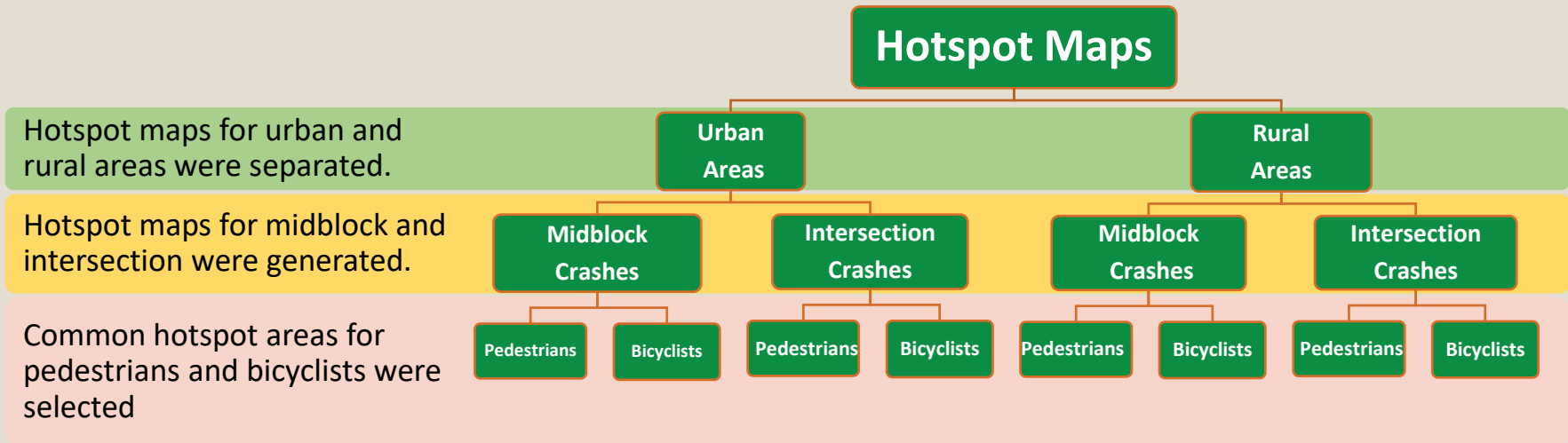
- Pedestrian Volume
- Vehicle Volume and Speed
- Roadway Characteristics
- Crash History
- Sight Distance
- Proximity to Other Crossing Destinations
- Pedestrian Demographics
- Environmental Context
- Funding and Maintenance
- Community Input (Preference)
- Regulatory and Policy Requirements

# Summary of Study Methods and Data

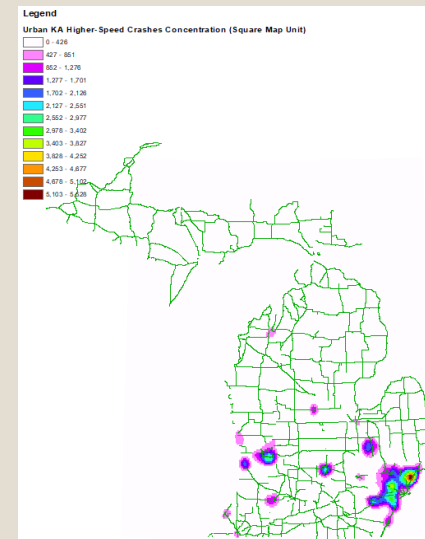
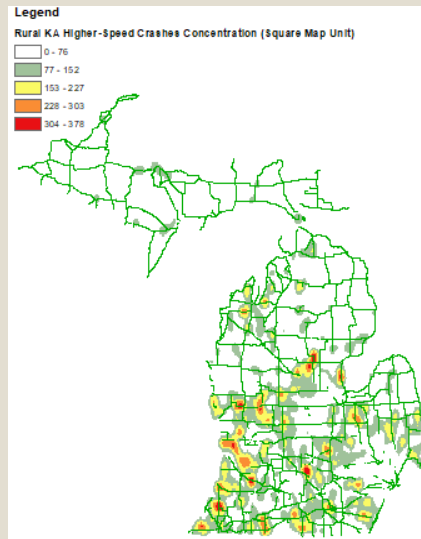
- Ten-year crash data covering the entire state of Michigan – focused on Fatal and Incapacitating (K & A) crashes.
- Used GIS to identify high-risk higher speed corridors based on crashes per mile.
- Site visits to examine crash causation using the crash narrative and diagram form the police crash reports.
- Light readings data were collected at night to examine lighting conditions.
- Assessment of appropriateness and effectiveness of potential countermeasures was done.
- A tool for selecting crosswalk treatments along higher speed roads was developed



# Identification of High-Risk Corridors for Non-Motorized Traffic



All corridors in “hot” areas were selected for further analysis.

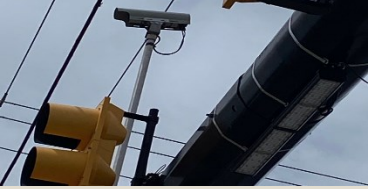


# Examining Lighting Levels at High-Risk Locations




- More than 70% of pedestrian fatalities occur at night
- Crosswalk lighting was examined:
  - Light readings were taken 1 hour after sundown
  - One Lux is equal to one lumen per square meter.
  - A vertical illuminance of 20 lux (at 5 feet from the ground) is necessary for motorists to see pedestrians
- Most high-risk locations had extremely low levels of lighting (1-12 Lux)
- Lighting treatments are necessary to mitigate pedestrian crashes




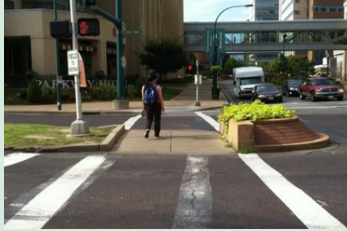




# Treatments for Crosswalks at Signalized Intersections

Treatment/Countermeasure	Justification/Remarks
Installing Leading Pedestrian Interval (LPI)	<ul style="list-style-type: none"><li>✓ Appropriate on high-speed corridors involving left or right-turning vehicles.</li><li>✓ May reduce pedestrian crashes by 13%.</li></ul>
Tightening intersection turning radius	<ul style="list-style-type: none"><li>✓ Appropriate on high-speed corridors involved right-turning vehicles.</li><li>✓ May reduce pedestrian crashes by up to 59%.</li></ul>
Installing LED lighting on the existing mast arm 	<ul style="list-style-type: none"><li>✓ The lighting of 20 lux may reduce nighttime crashes by 20%</li></ul>
Installing High Visibility Crosswalks	<ul style="list-style-type: none"><li>✓ High visibility crosswalks may reduce pedestrian crashes by 23-48%</li></ul>

# Top Treatments for Crosswalks at Unsignalized Intersections and Midblock

Treatment/Countermeasure	Justification/Remarks
<p>Advanced stop/ yield markings and sign</p> 	<p>✓ Advanced stop/yield markings and sign may reduce pedestrian crashes by 25%</p>
<p>Rectangular rapid flashing beacon (RRFB)</p> 	<p>✓ RRFB may reduce pedestrian crashes by 47.4%</p>
<p>Pedestrian hybrid beacon (PHB)</p> 	<p>✓ PHB may reduce pedestrian crashes by 45.7%</p>
<p>Refuge island or raised median</p> 	<p>✓ Refuge island may reduce pedestrian crashes by 31.5%</p>
<p>Provide improved lighting</p>	<p>✓ <b>Research is ongoing to determine best lighting practices</b></p>

# Overview of the Tool for Selecting Crosswalk Treatments along Higher Speed Corridors

## Non-motorized crash data input

Non-motorized Crash Data (in a year)	Day	Night	Total
K	0	0	0
A	0	0	0
B	0	0	0
C	0	0	0
O	0	0	0
<b>TOTAL</b>	<b>0</b>	<b>0</b>	<b>0</b>

## Selection of a treatment

Countermeasure Details	
Select applicable countermeasure	High Visibility Crosswalk
Tightening the radius from (feet)	Leading Pedestrian Interval Tightening the Turning Radius LED Lighting on Existing Mast Arm
Tightening the radius to (feet)	High Visibility Crosswalk
Initial Cost	\$4,023
Yearly Operation Cost	\$0
Service Life (years)	\$5
CRF	0.23
Calculations	
Expected Crash Reduction (yearly)	4.6
Benefit /year	\$16,185,986
Total Benefit/year within the service life	\$76,291,989
Total Cost/year within the service life	\$4,023
<b>BCR</b>	<b>18964.0</b>

- Applicable to four types of locations:
  - Urban Intersection,
  - Rural Intersection,
  - Urban Midblock, and
  - Rural Midblock.
- Need crash records for a location
- Recommendation is based on cost-benefit analyses
- Applicable to US – but replication is possible

# General Conclusions

- Pedestrian and driver behaviors must be well understood to select crosswalk type and treatments.
- Speed of motor vehicle is among the major reasons for pedestrian fatalities.
- The likelihood of a pedestrian to die in a vehicle crash is relatively higher at night.
- Adequate (**and proper**) crosswalk lighting could reduce pedestrian fatalities resulting from crashes.

# Acknowledgements

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Thank You!