Research on the Highway Safety Manual's Crash Prediction Model

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KCITE Chapter Meeting

Research Objective

- Create safety performance function (SPF) for rural, two-lane roads in Kansas

$$N_{predicted\,rs} = N_{spf\,rs} \times C_r \times (CMF_{1r} \times CMF_{2r} \times \ldots \times CMF_{12r})$$

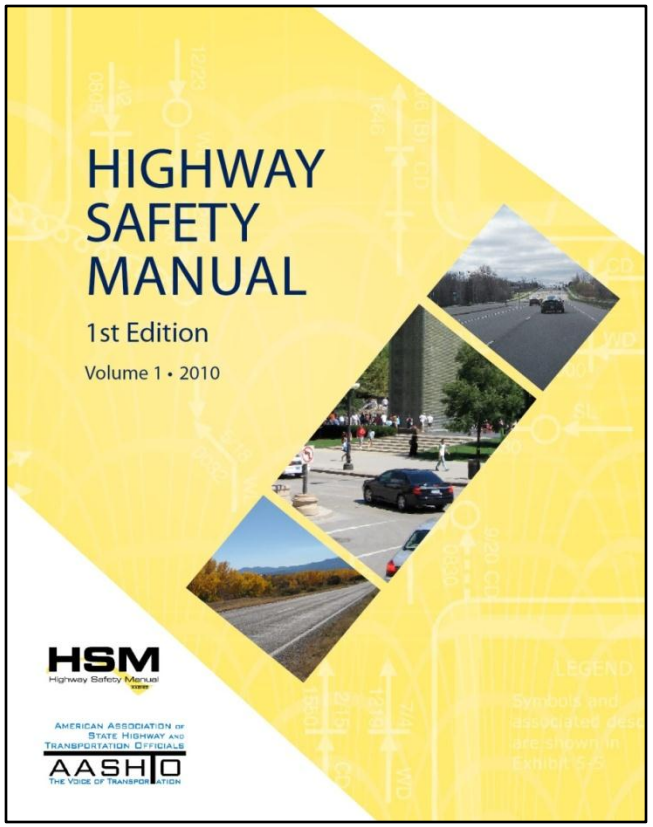
- Evaluate SPF vs. Calibration of Highway Safety Manual

Outline

- **What is the Highway Safety Manual?**
- Calibrating the HSM and creating a jurisdiction-specific safety performance function
- It’s not just theoretical

What is the Highway Safety Manual?

- First edition of the Highway Safety Manual
  - released April 2010
  - Crash Prediction Model



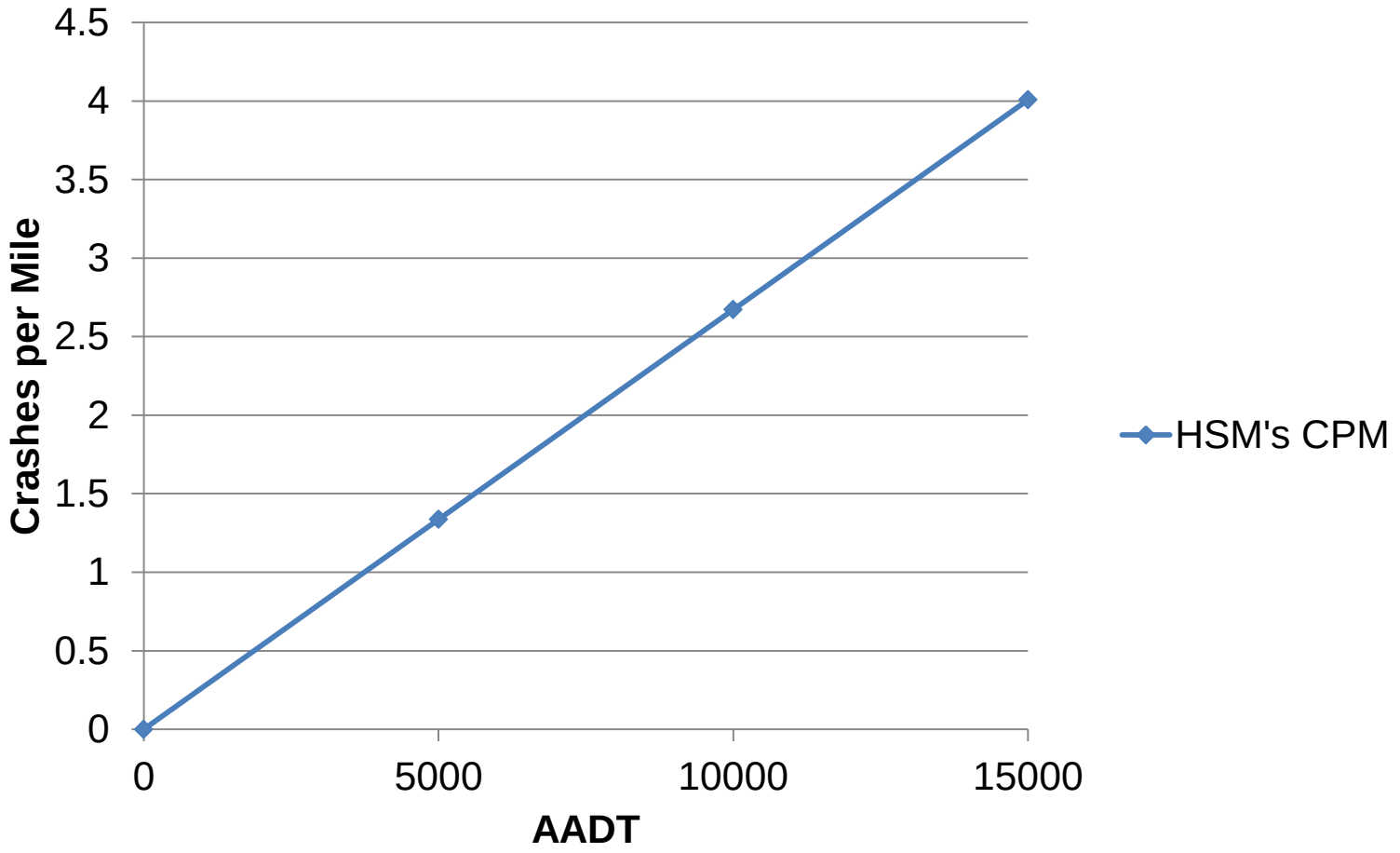
HSM's Crash Prediction Model

$$N_{spfrs} = AADT \times L \times 365 \times 10^{-6} \times e^{-0.312}$$

EXPO

- AADT – Traffic Volume
- L – Length

HSM's Crash Prediction Model



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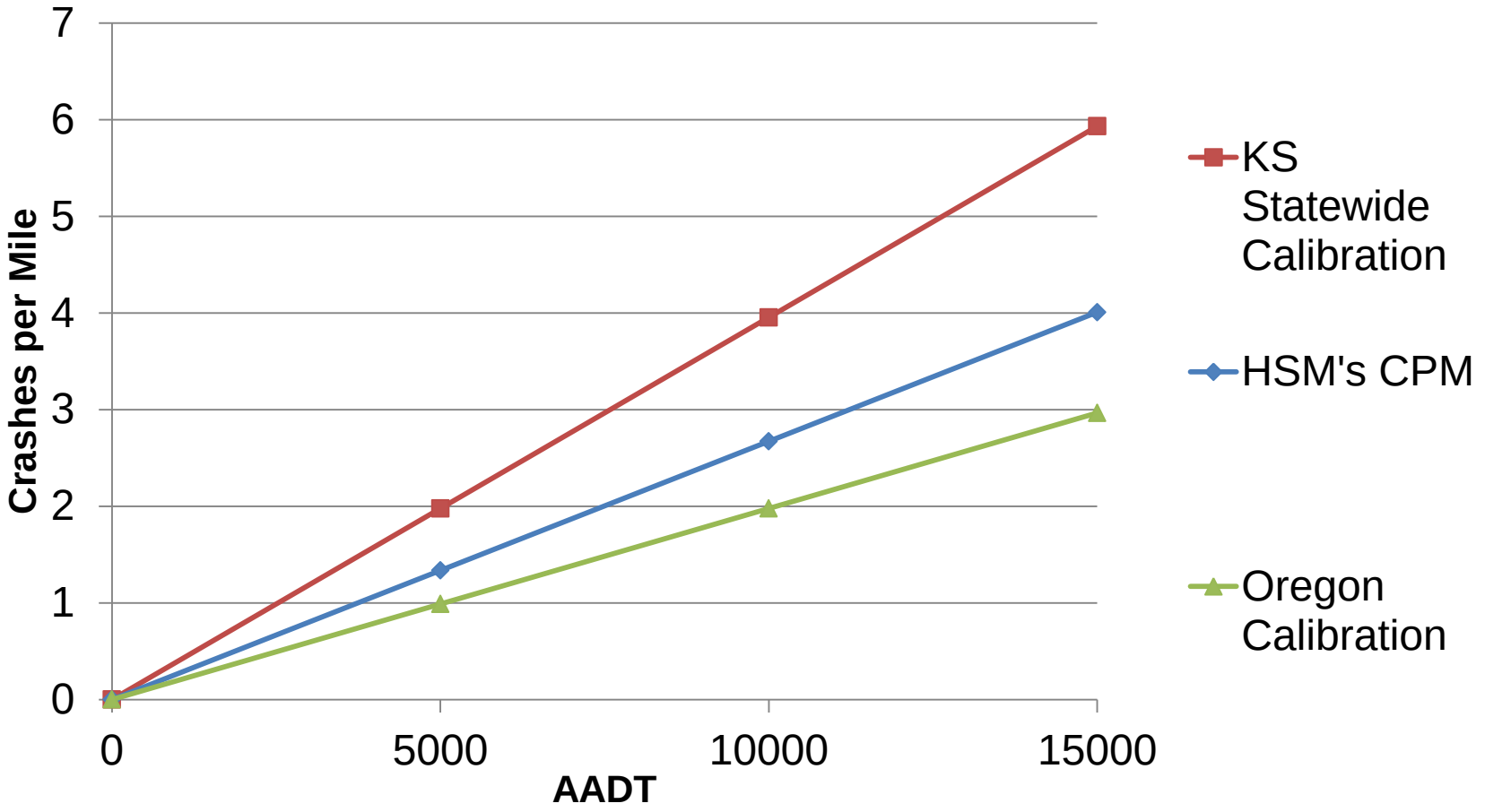
$$N_{predicted\,rs} = N_{spfrs} \times C_r \times (CMF_{1r} \times CMF_{2r} \times \ldots \times CMF_{12r})$$

- C_r – Calibration Factor
- CMF – Crash Modification Factor

Example Crash Modification Factors

- Lane width, AADT over 2000 veh/day
  - 9-ft or less: 1.5
  - 10-ft: 1.3
  - 11-ft: 1.05
  - 12-ft or more: 1
- Centerline Rumblestrips
  - None present: 1
  - Present: 0.94

Calibration Factors



Outline

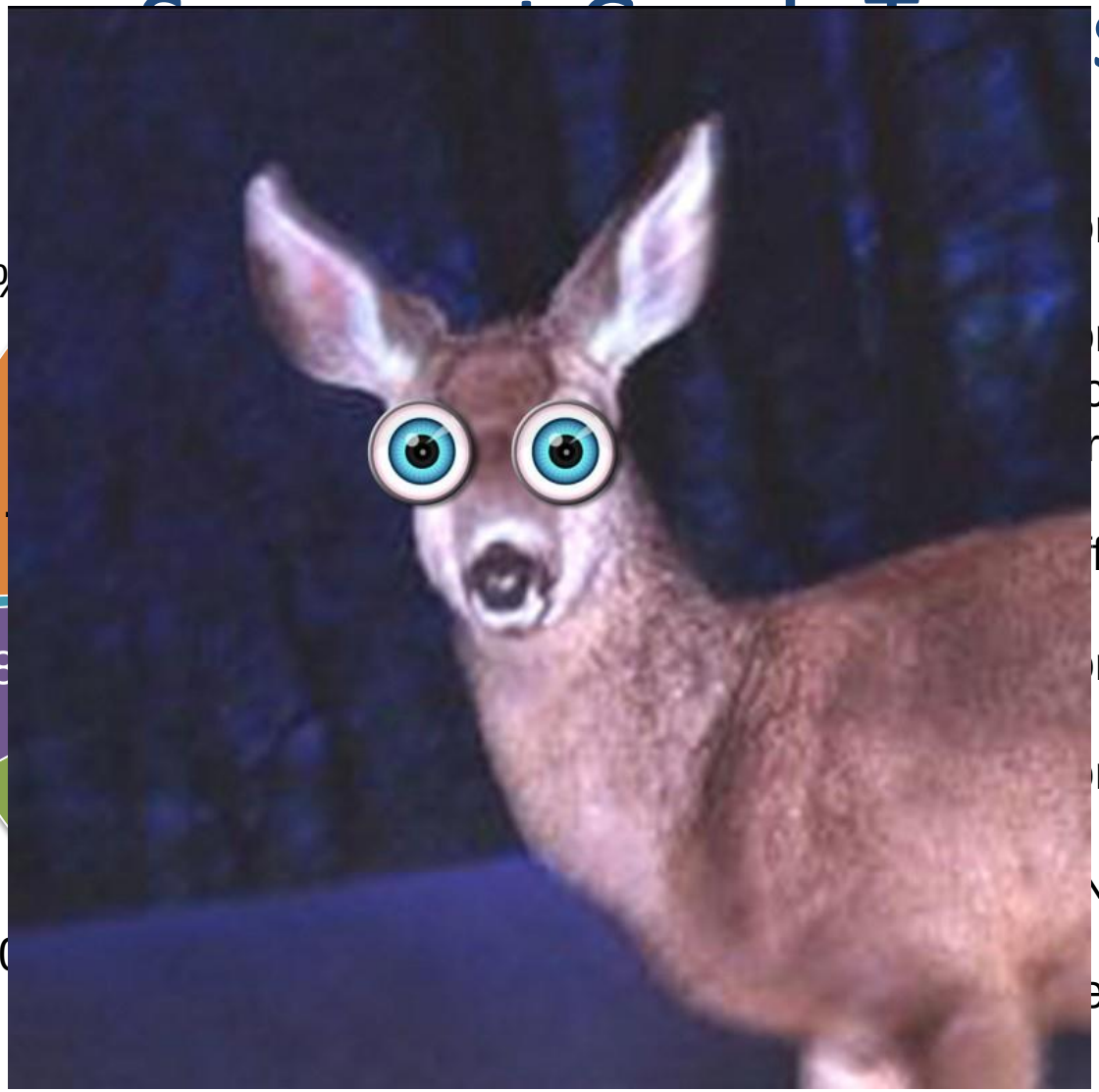
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Calibration for Kansas

- Data required
  - Full geometric details of the highways
    - Several sources needed
    - Everything from lane width to roadside data needed
- Find C_r:

$$Cr = \frac{\sum_{allsites} observed\ \ crashes}{\sum_{allsites} predicted\ \ crashes}$$

- Statewide calibration factor of 1.48
  - Worked well overall, but noticed a problem..





n with animal

n with pedestrian
clist
rned

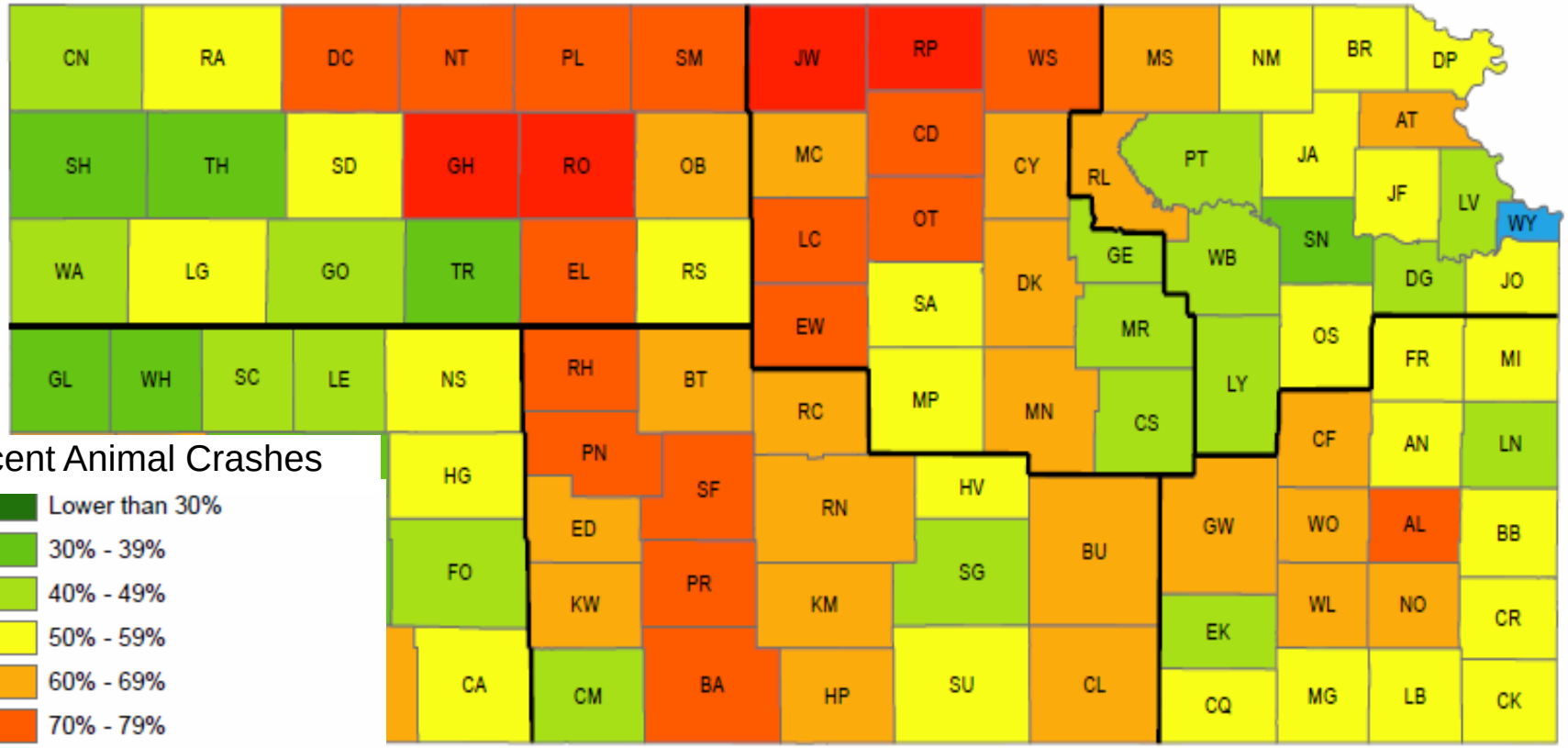
f Road

n with Legally
Vehicle
n with Object

Non-Collision

e-vehicle collisions

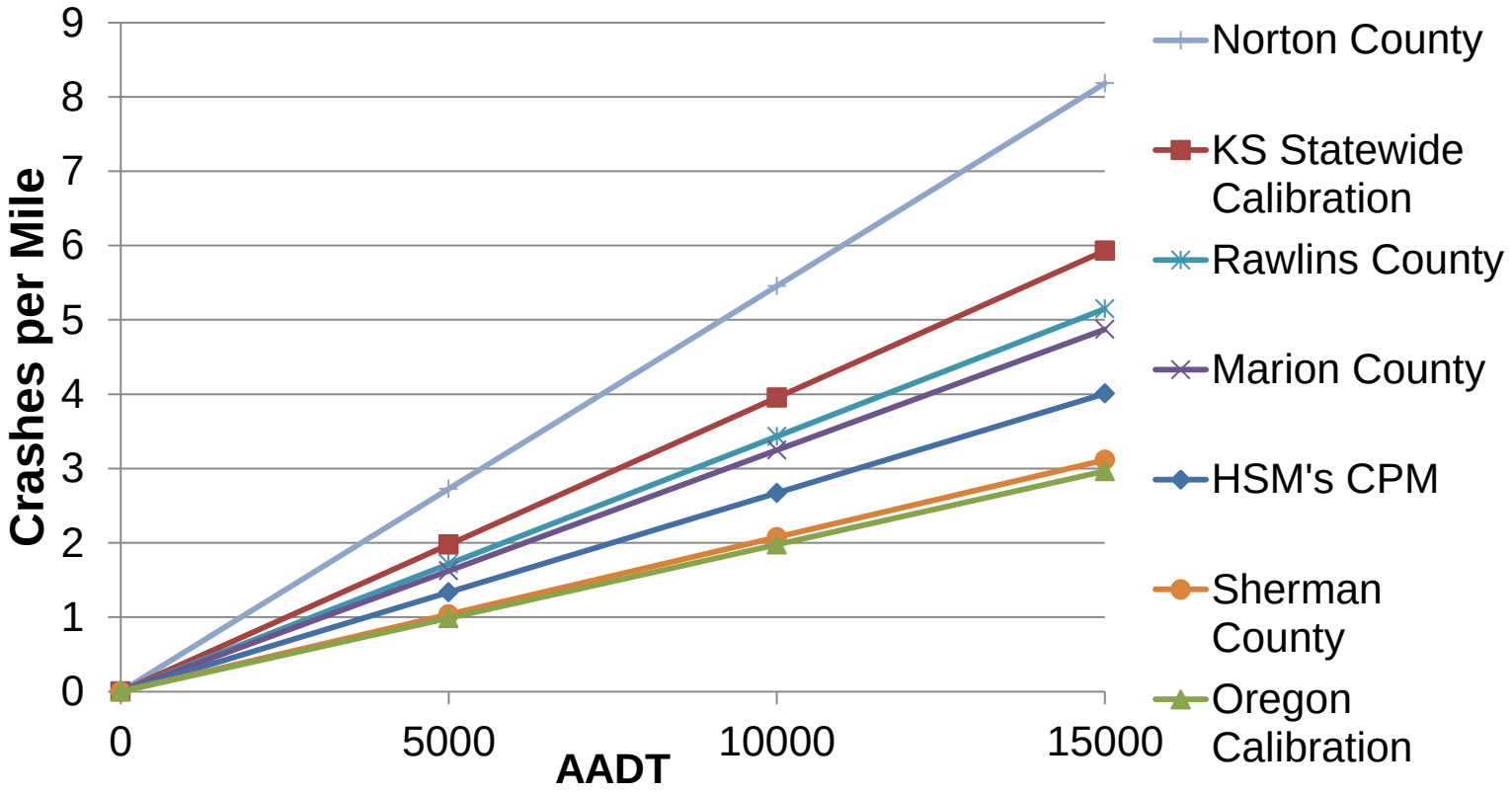
Finding a Way Around the Deer



Percent Animal Crashes

- Lower than 30%
- 30% - 39%
- 40% - 49%
- 50% - 59%
- 60% - 69%
- 70% - 79%
- 80% and Above
- No Rural Two-Lane Highways

Variable Calibration



Creating a Safety Performance Function

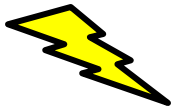
- More data needed than with calibration
- Less guidance on how to create one given by the Highway Safety Manual

Methodology

- Data collection
- Select statistical method
  - Negative binomial regression
- Create equations
- Validate equations

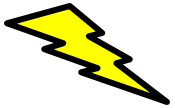
Equations!

- Kansas Crash Prediction Model – like HSM's



$$N_{KSCPM} = EXPO \times e^{-0.56} \times CMF_{combined}$$

- Kansas Model



$$N_{KSMod} = AADT^{0.82} L^{0.87} e^{(-7.16+0.4\times RHR)}$$

- Animal Only Model



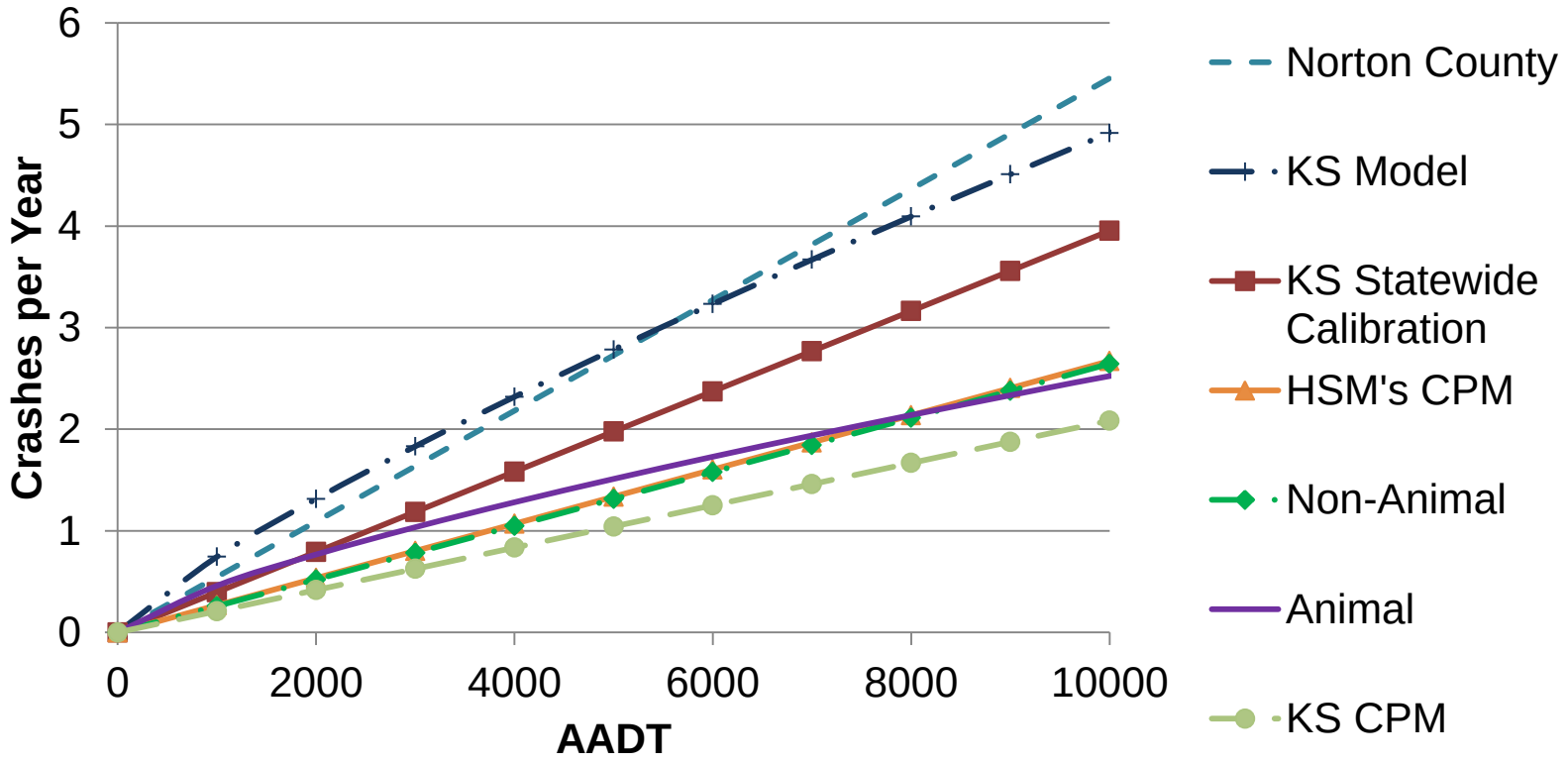
$$N_{pred-an} = AADT^{0.74} L^{0.87} e^{(-6.82+0.31\times RHR)}$$

- Non-Animal Model

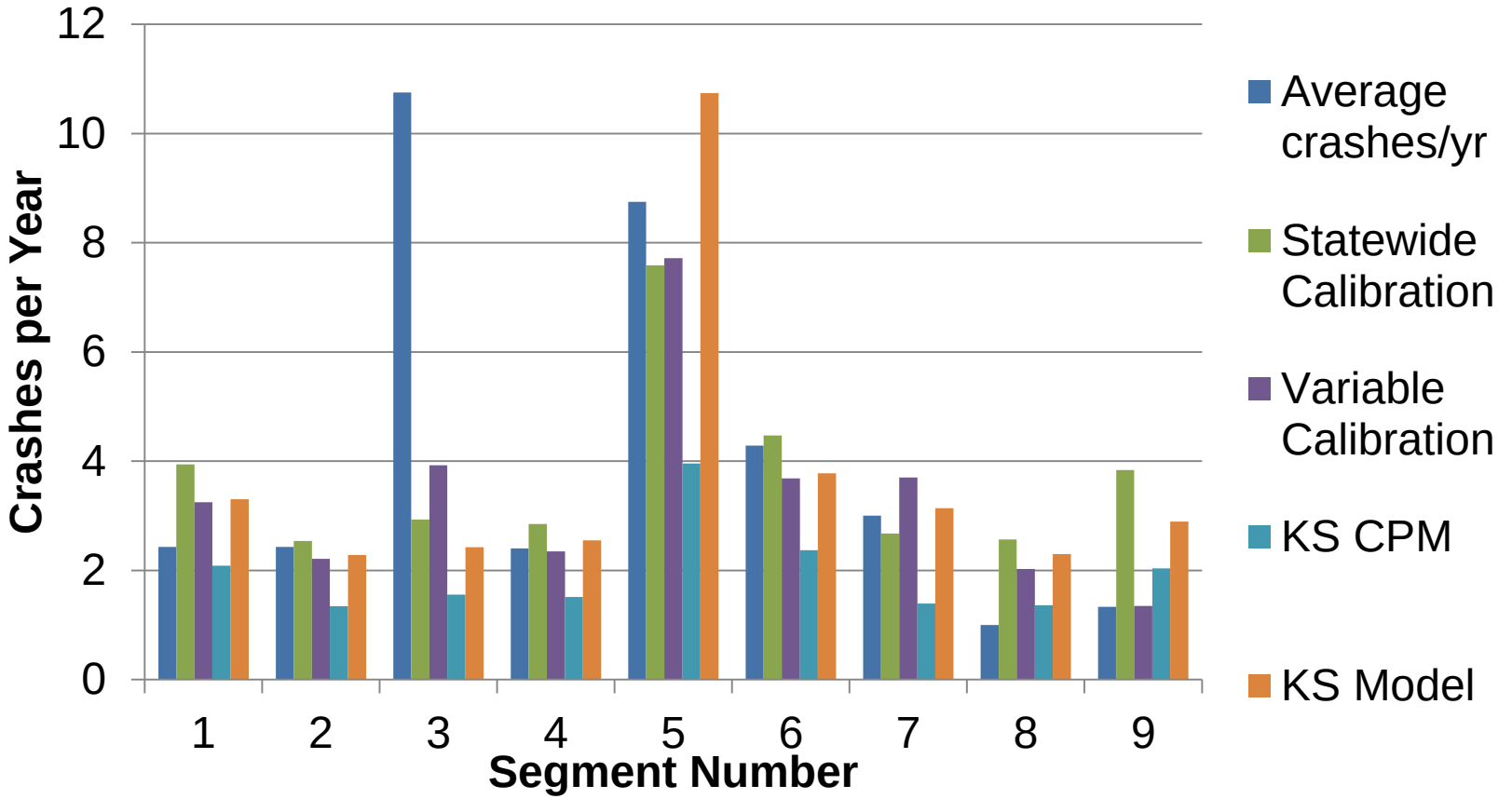


$$N_{pred-no-an} = AADT^{1.01} L^{0.85} e^{(-10.07+0.58\times RHR)}$$

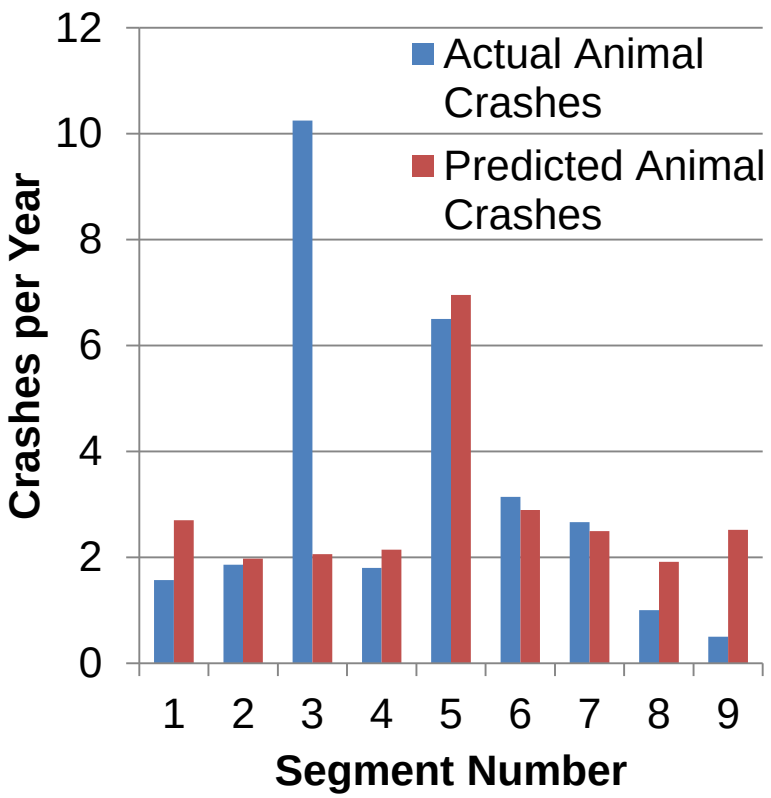
Kansas-Specific Safety Performance Functions

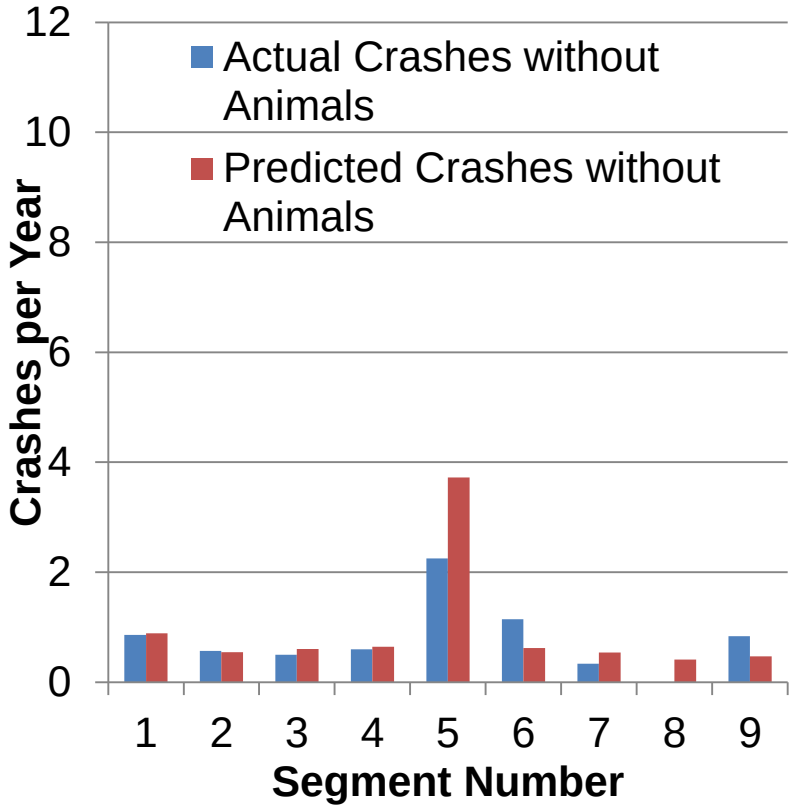


Total Crashes Predicted vs. Actual



Predicted Animal & Non-Animal Crashes vs. Actual





Validation

- Used five statistical tests
  - Looked for:
    - Correlation between predicted and actual crashes
    - Significant difference between predicted and actual crashes
    - Strength of new models
    - Average difference between predicted and actual crashes
  - Chose model that performed better overall

Conclusions and Recommendations

- Non-animal model and variable calibration performed the best
- Use calibrations in practice
  - More geometric options
- Make state-specific crash modification factors

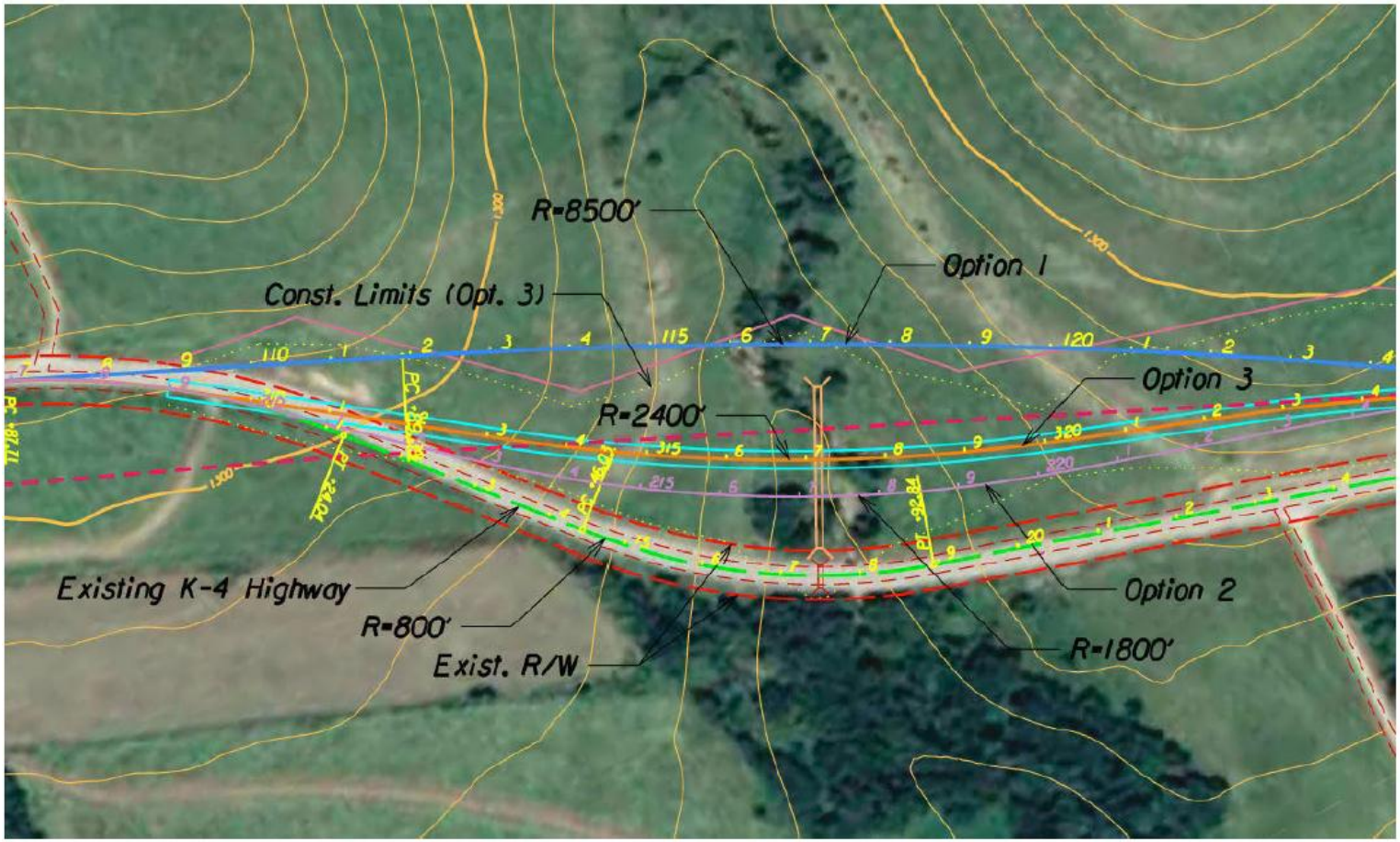
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Implementation: Rural Realignment (K-4)

- Low volume roadway
- Low priority for upgrade of entire alignment
- Replacing closely spaced drainage structures
  - Considering horizontal realignment between structures
- Fatal crash had occurred at project location

K-4 Realignment



K-4 Results

- Projected crash reductions over the design life of the project
  - 0.33 crashes over 20 years
    - 0.06 reduction in fatal & injury crashes
- Differential cost of improvements
  - $900,000
- Projected benefit
  - $12,300

Studies Underway

- $6 million Highway Safety Improvement Program (HSIP)
- T-WORKS
  - 10-year transportation plan
  - $95 million dedicated to projects that will design to a budget
    - Example: K-177
    - $25 million budgeted
    - 21 miles of roadway to be analyzed

K-177


40
70
177
57
4
Alta Vista
Dwight
Parkerville
Council Grove Lake
Council Grove
56


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Thank you! Questions?

Contact: cherylb@ksdot.org