Highway Safety Manual

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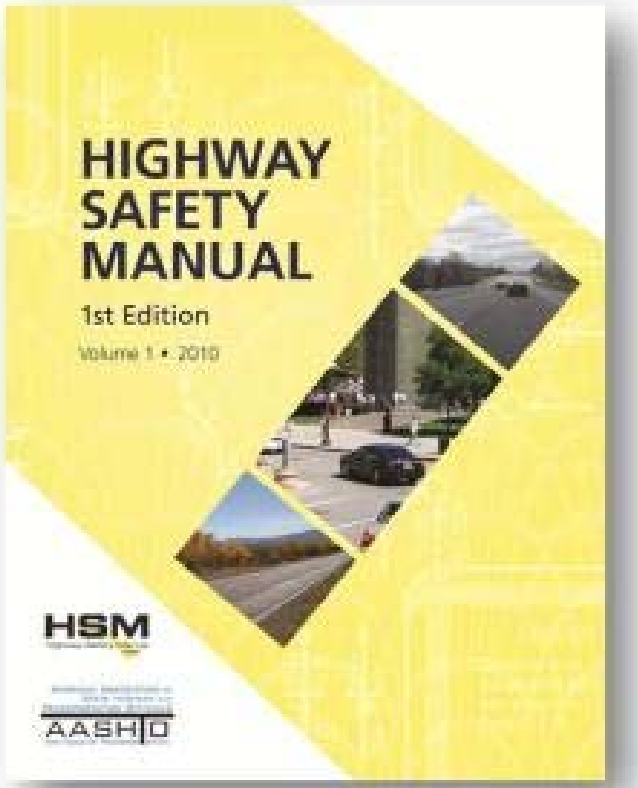
Federal Highway Administration

PA SAFETY SYMPOSIUM
toward zero deaths

Today I'll Cover

- What it is
- What it contains
- How it differs from the way we used to consider infrastructure safety
- Why it's beneficial to use



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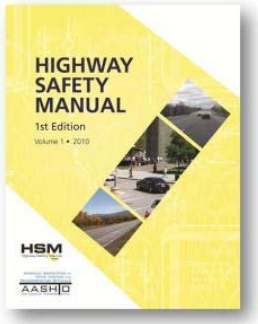
What is the HSM?



- AASHTO publication
- 1st Edition, dated 2010
- Periodically updated, 2014 Supplement
- 2nd Edition, targeted for 2019
- Developed with considerable technical input from the safety research community

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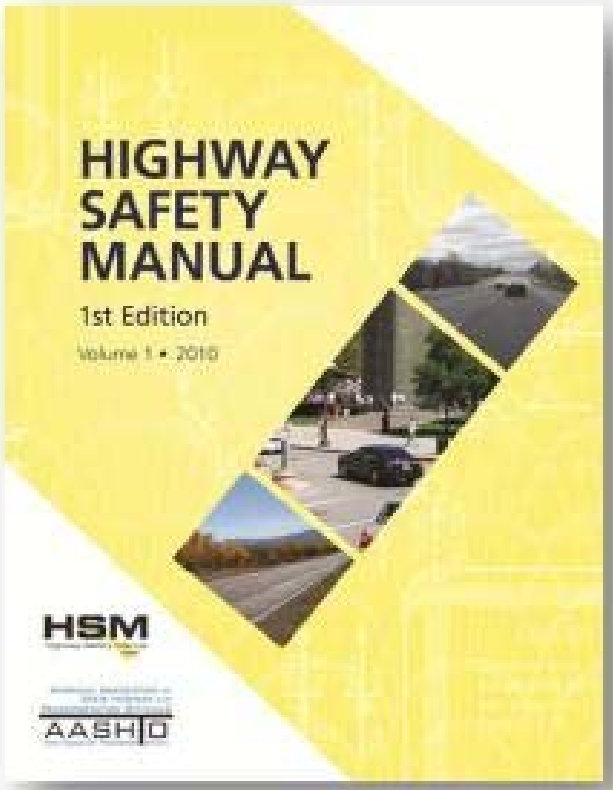
What is the HSM (like)?

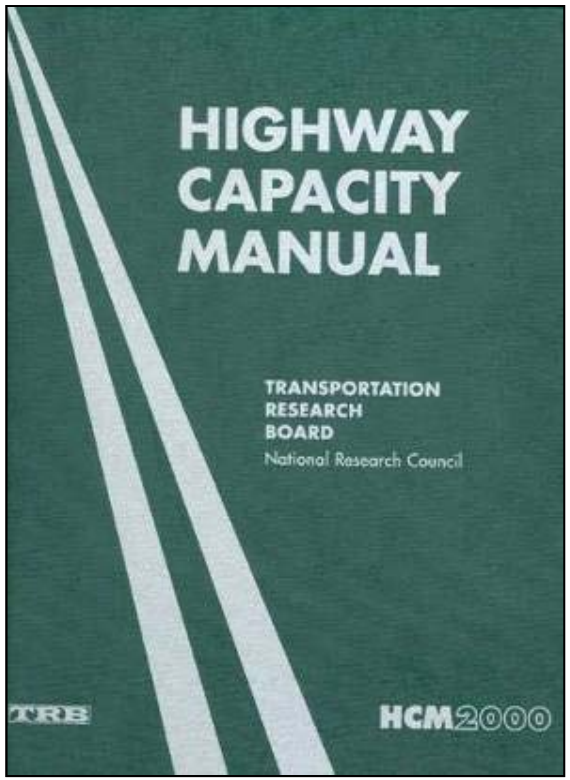
Akin to the HCM, but for safety…



Definitive; represents quantitative 'state-of-the-art' information

Widely accepted within professional practice of transportation engineering

Science-based; updated regularly to reflect research



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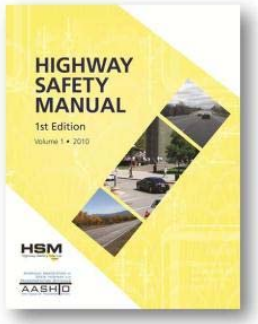
How the HSM describes itself…



- "…a resource that provides safety knowledge and tools in a useful form to facilitate improved decision making based on safety performance."
- "The focus … is to provide quantitative information for decision making."
- "…assembles currently available information and methodologies on measuring, estimating, and evaluating roadways in terms of crash frequency … and crash severity …."

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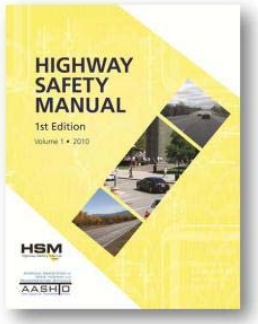
How the HSM describes itself…



- "…presents tools and methodologies for consideration of "safety" across the range of highway activities: planning, programming, project development, construction, operations, and maintenance."
- "The purpose is to convey present knowledge regarding highway safety information for use by a broad array of transportation professionals."

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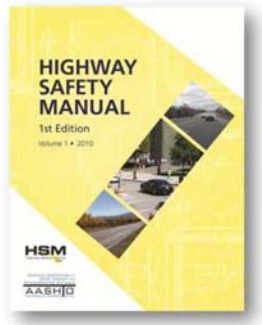
What it contains…



Part A Introduction, Human Factors, and Fundamentals

Part B Roadway Safety Management Process

Part C Predictive Methods

Part D Crash Modification Factors

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Part B Roadway Safety Management Process

- Ch. 4 Network Screening
- Ch. 5 Diagnosis
- Ch. 6 Countermeasure Selection
- Ch. 7 Economic Appraisal
- Ch. 8 Prioritization
- Ch. 9 Safety Effectiveness

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Part C Predictive Methods

- Ch. 10 Rural Two-Lane Highways
- Ch. 11 Rural Multilane Highways
- Ch. 12 Urban & Suburban Arterials
- Ch. 18 Freeways
- Ch. 19 Ramps

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Part D Crash Modification Factors

Ch. 13	Roadway Segments
Ch. 14	Intersections
Ch. 15	Interchanges
Ch. 16	Special Facilities and Geometric Situations
Ch. 17	Road Networks

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New Concepts

Traditional	HSM
"Nominal" Safety……	"Substantive" Safety
Observed Crash History…	Predicted/Expected Crash Frequency
Random……..	Predictable
Reactive……..	Proactive

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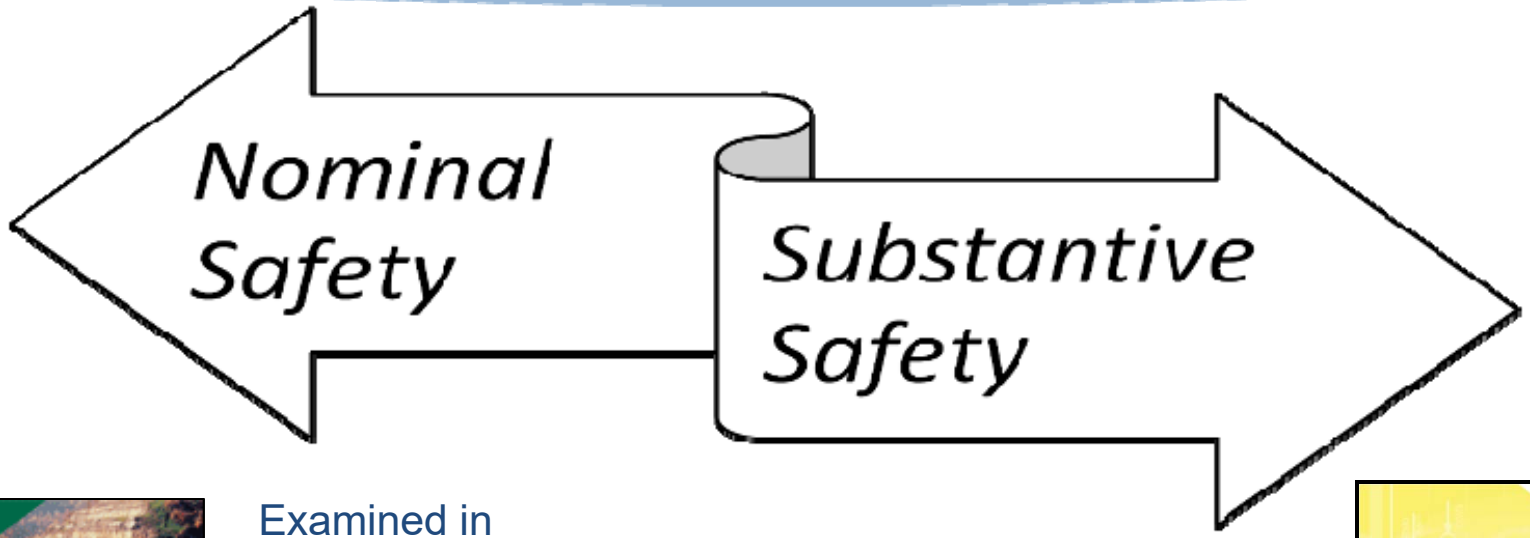
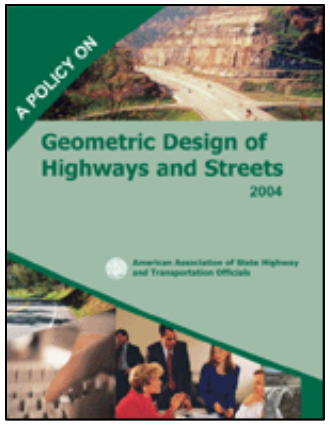
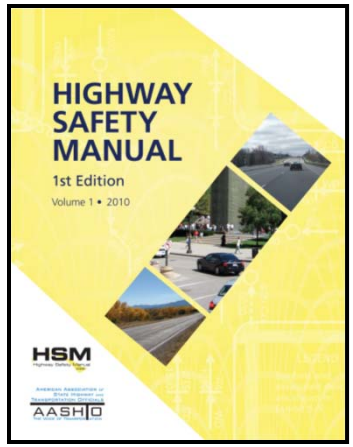
Nominal vs Substantive Safety





Examined in reference to compliance with standards, warrants, guidelines and sanctioned design procedures

The expected or actual crash frequency and severity for a highway or roadway



**Ezra Hauer, ITE Traffic Safety Toolbox Introduction, 1999*

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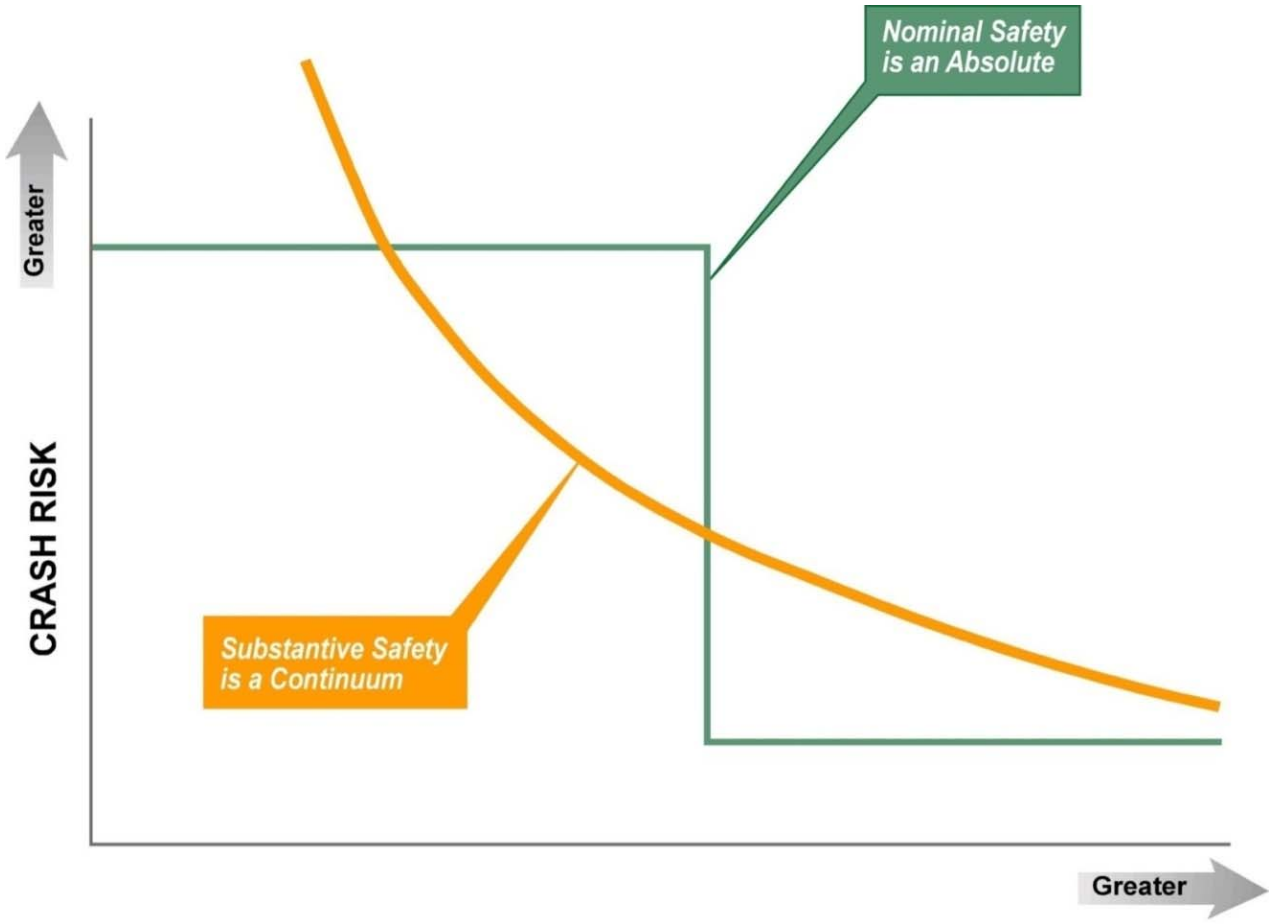
Nominal vs Substantive Safety



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Observed vs Predicted vs Expected

Ways to Estimate a Roadway's Safety Performance	
Observed Crash Frequency	Historical crash count
Predicted Crash Frequency	Estimate based upon roadway characteristics using a regression model
Expected Crash Frequency	Weighted average of observed and predicted crash frequencies

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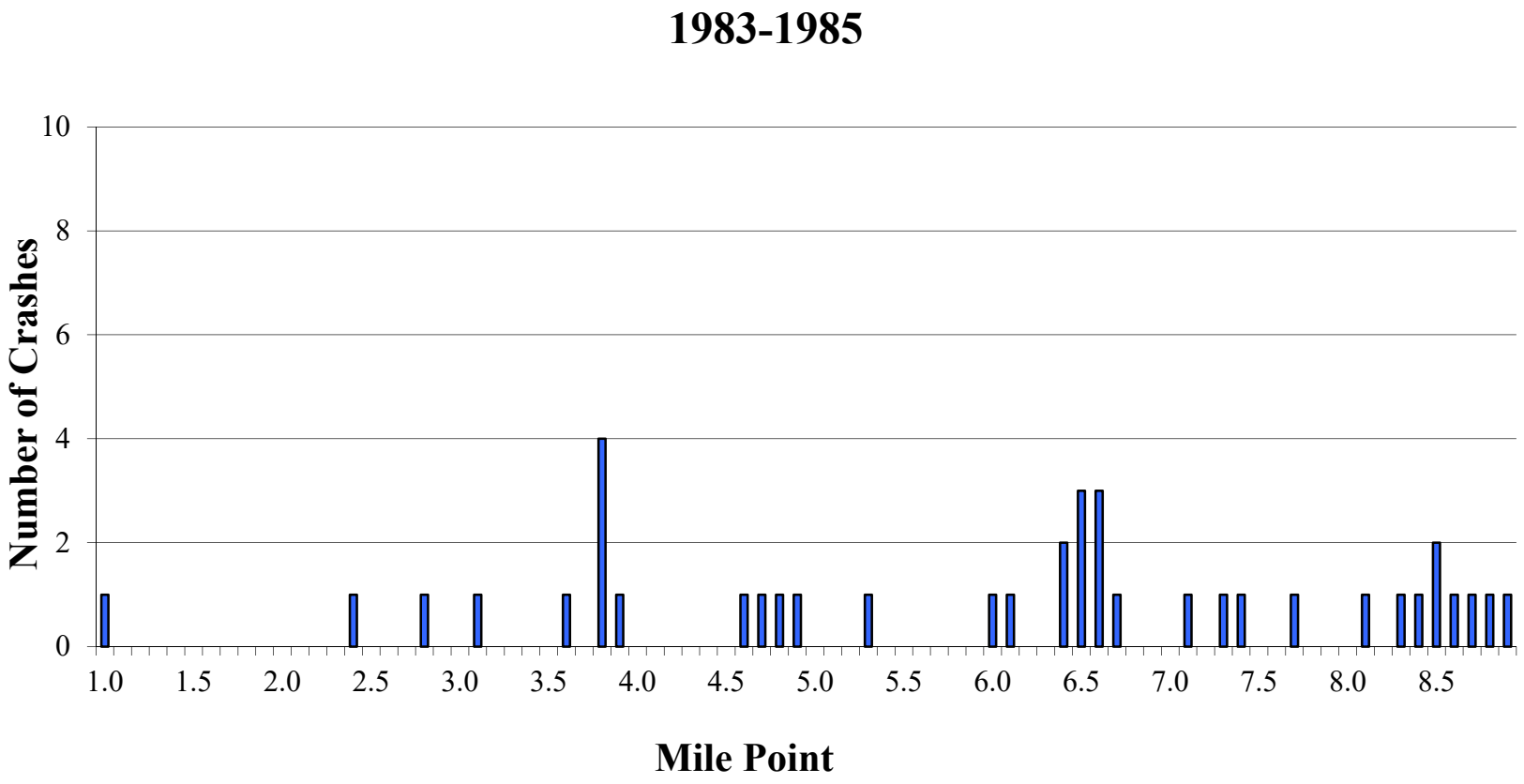
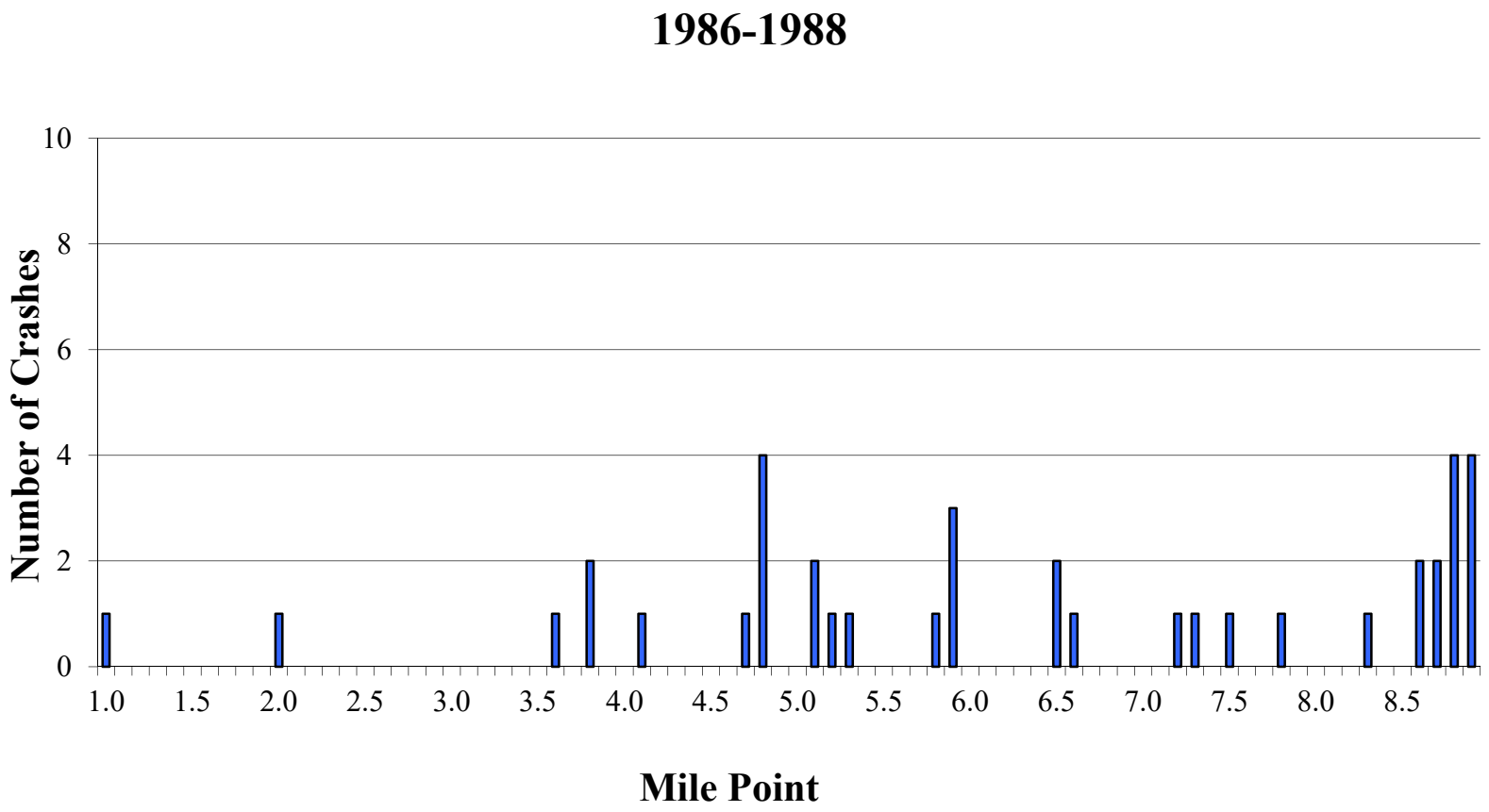
Observed Crash Frequency



Observed Crash Frequency



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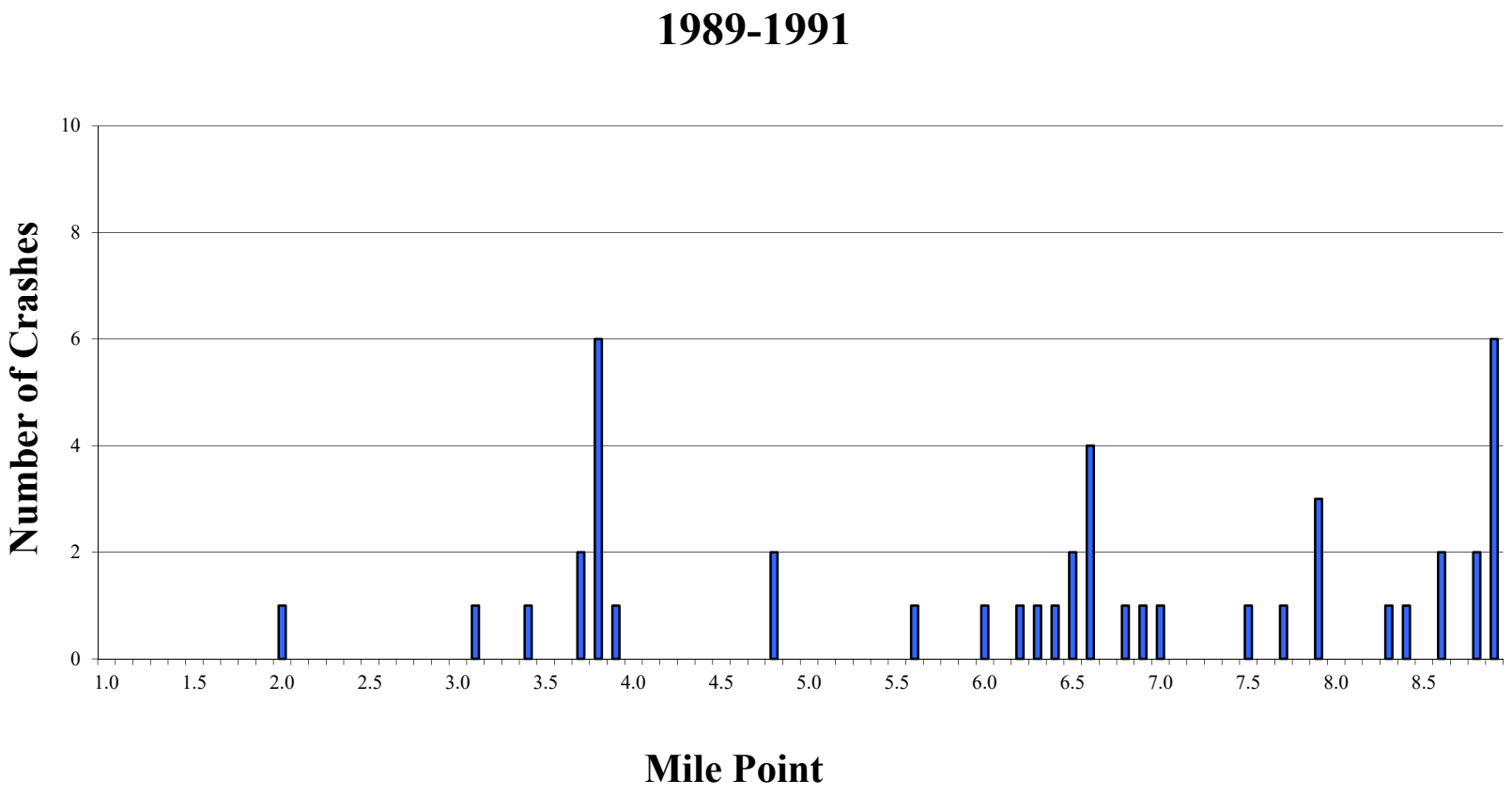
Observed Crash Frequency



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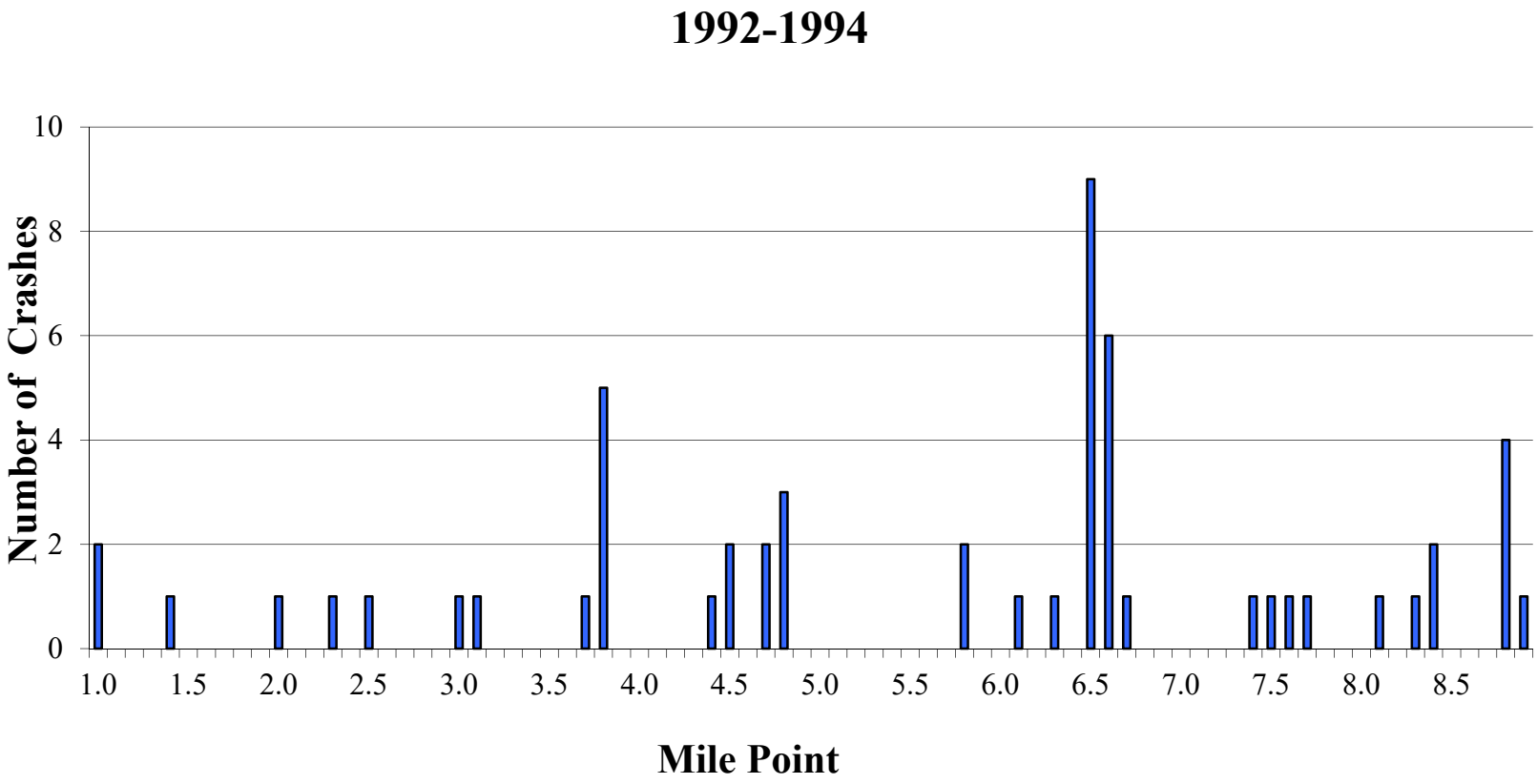
Observed Crash Frequency



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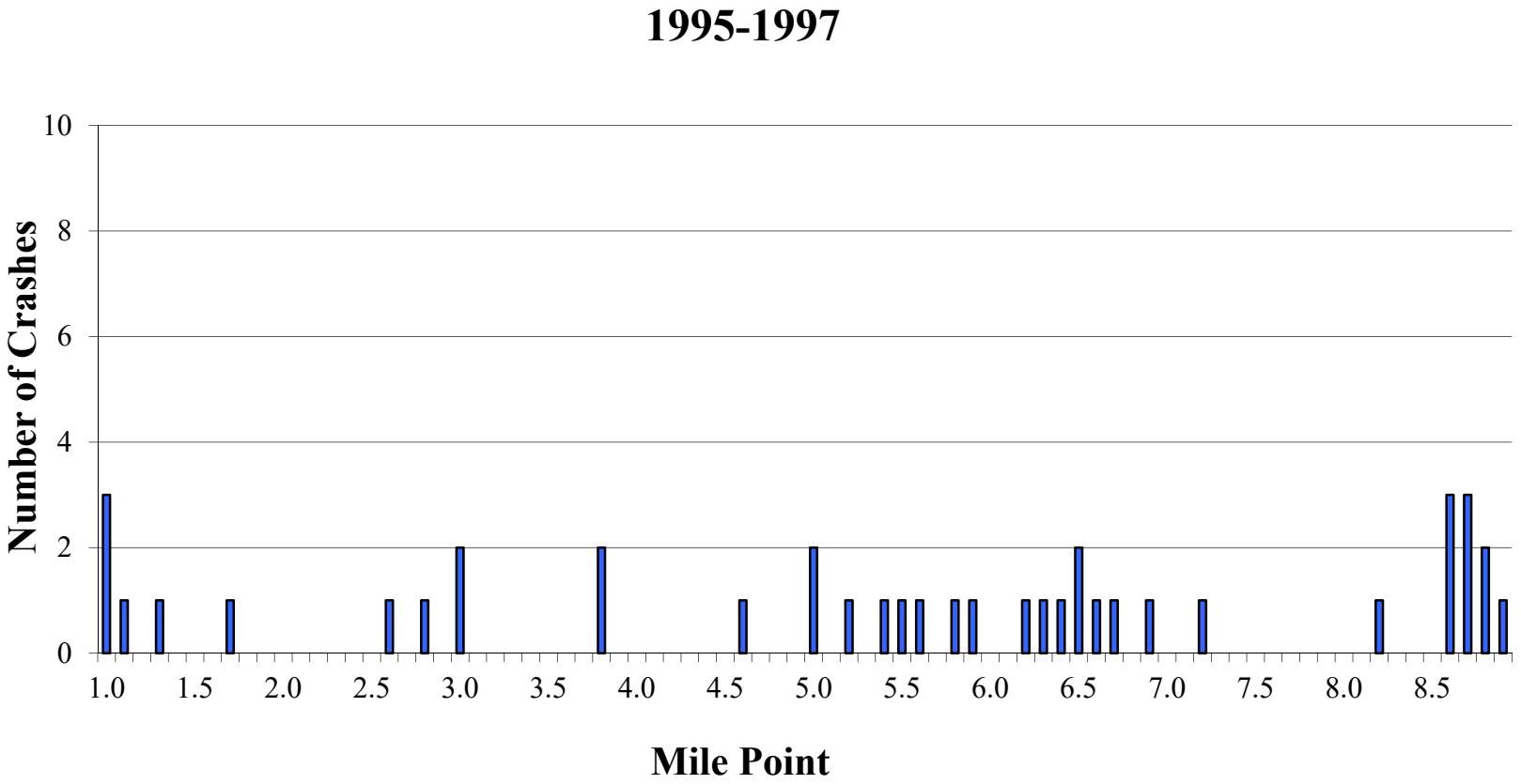
Observed Crash Frequency



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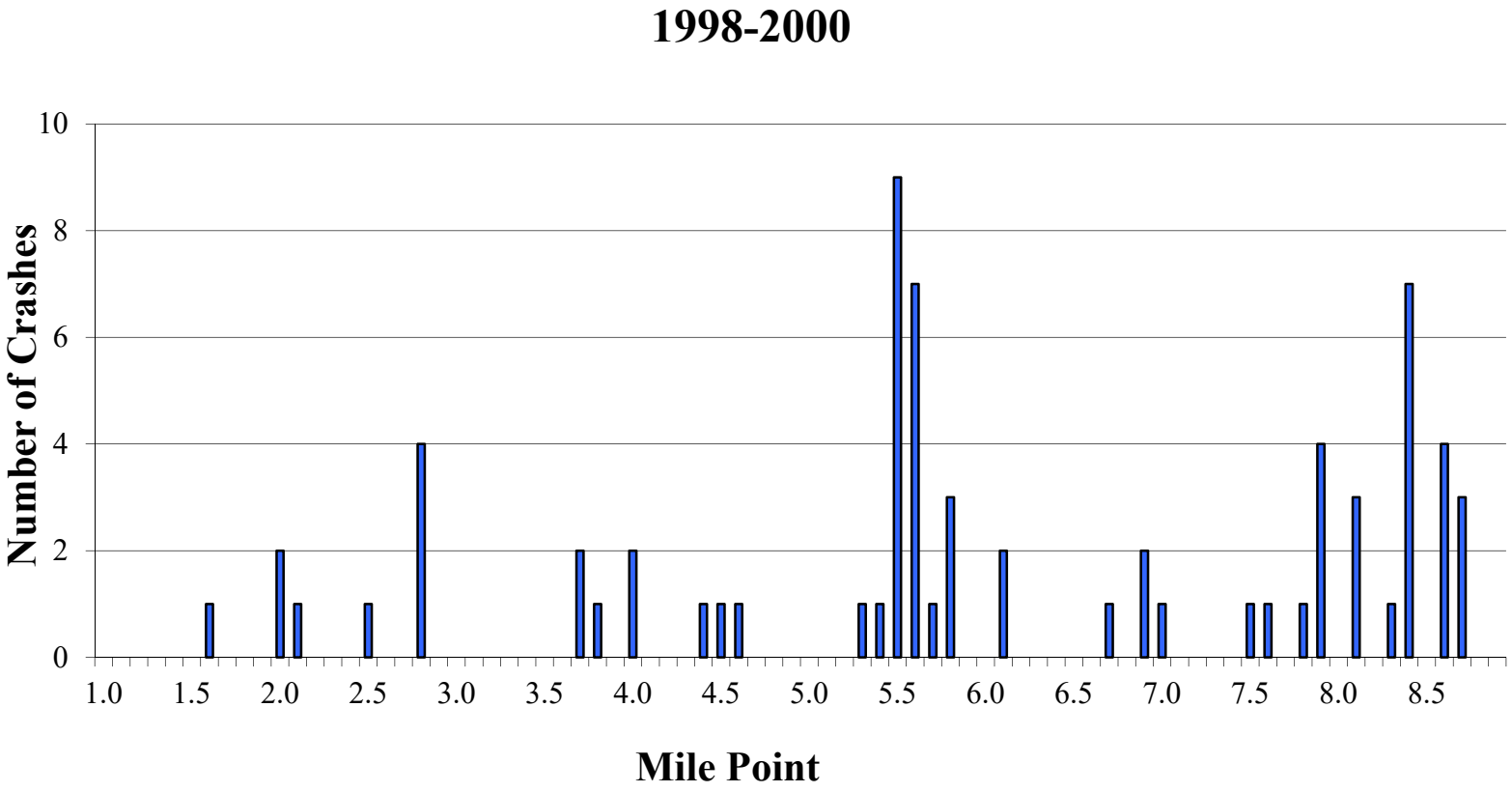
Observed Crash Frequency



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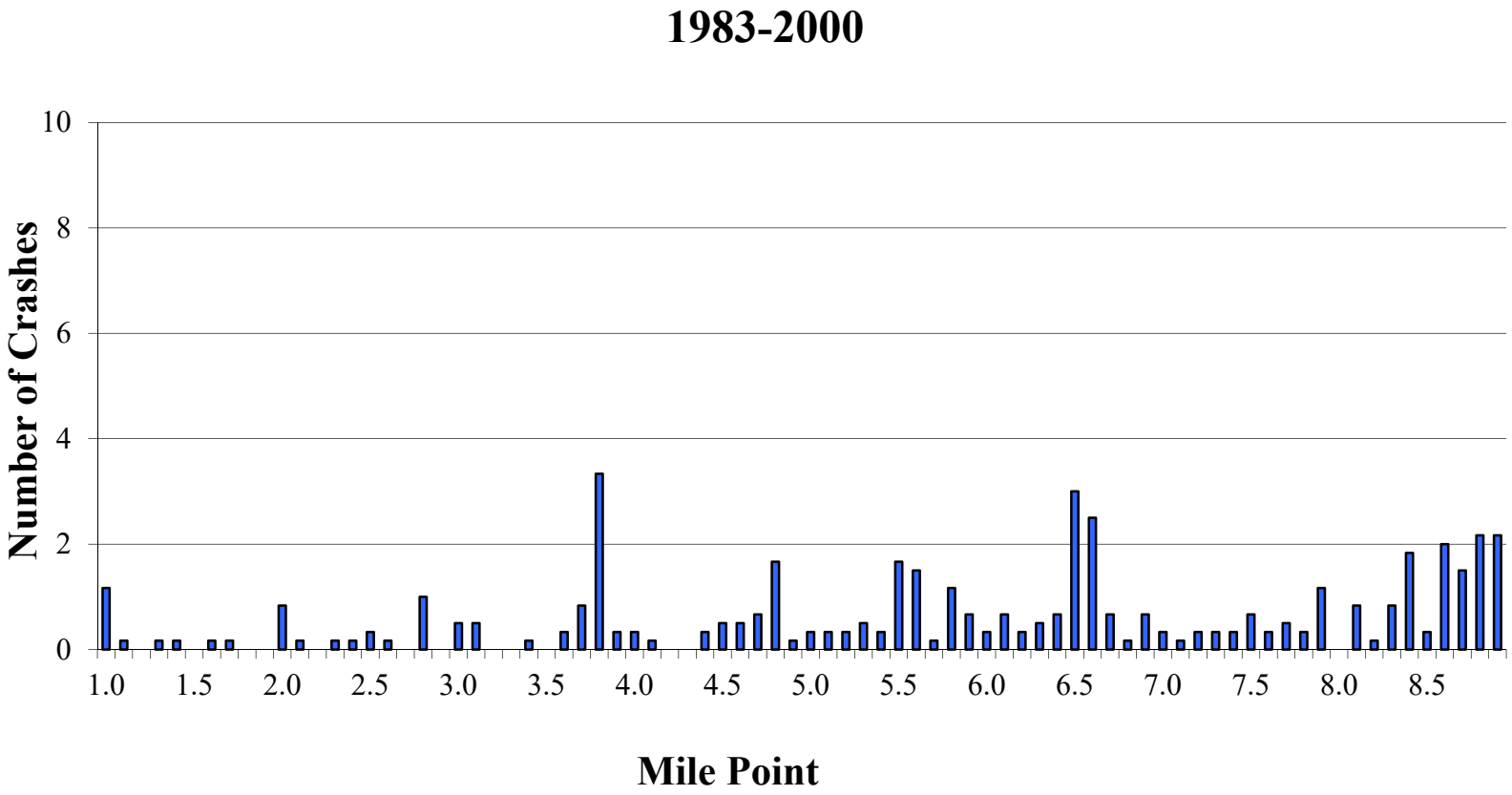
Long-term 3-Year Average Crash Frequency



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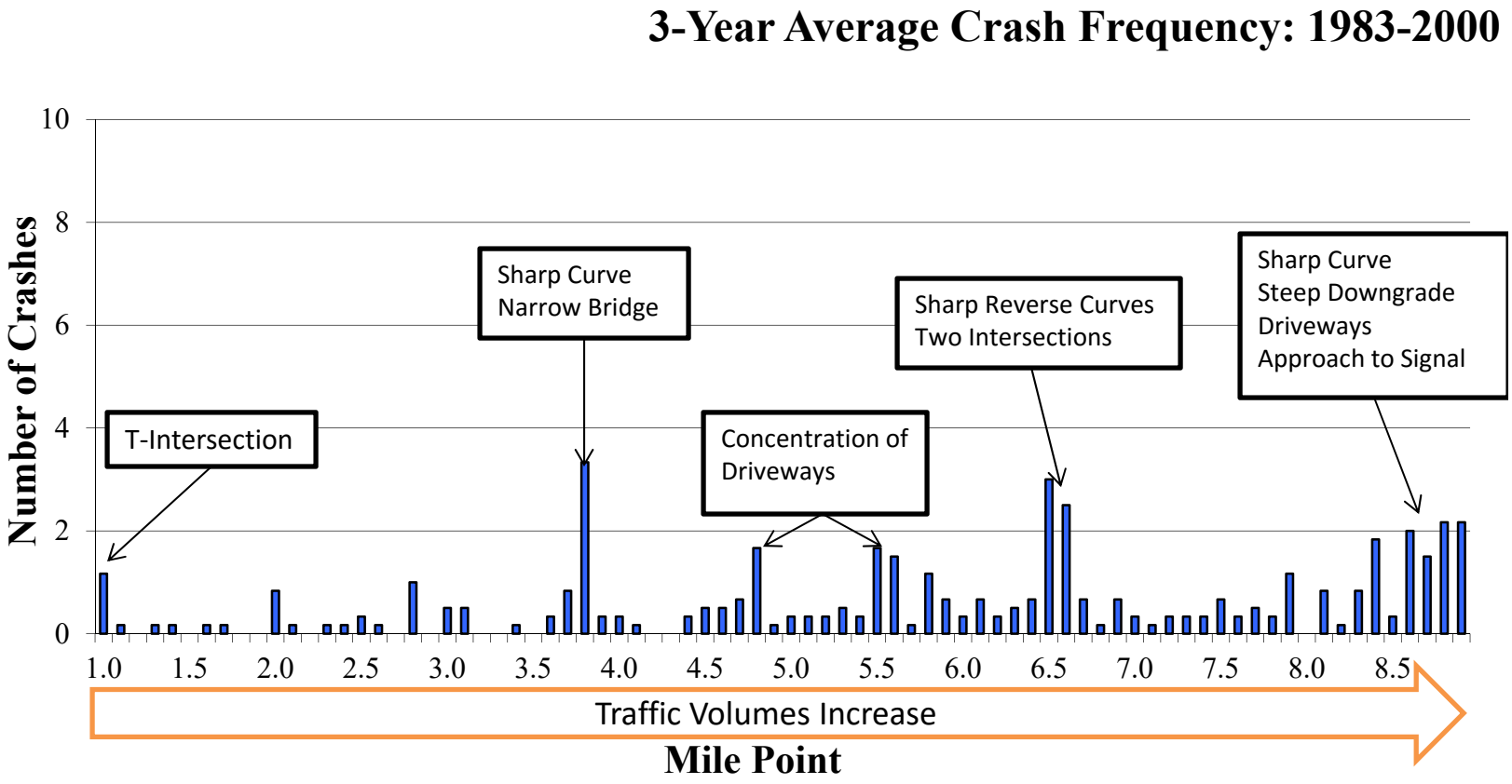
Random vs Predictable



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Random vs Predictable

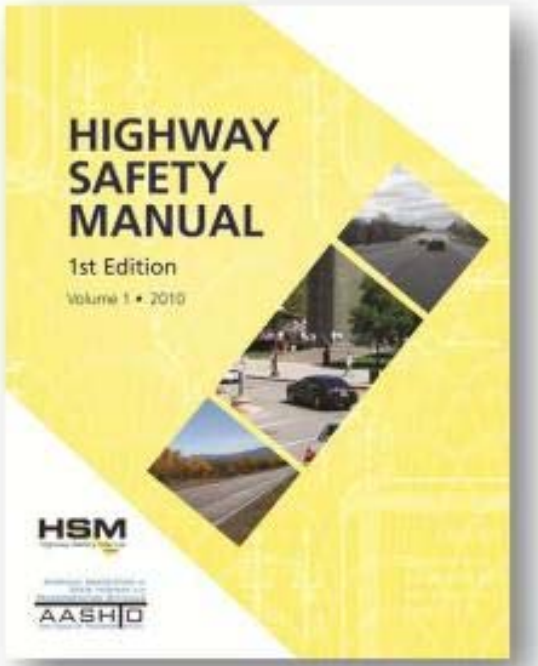
- There is (some) randomness in the location of crashes and, therefore, in crash frequency by location.
- But, crash frequency by location:
  - Is not totally random, but rather somewhat predictable
  - Can be explained (and, therefore, predicted) by roadway characteristics with some (not perfect) statistical reliability.

Observed vs Predicted vs Expected

- Short-duration observed crash frequency counts aren't a totally reliable estimator of either historical or future safety performance
- Predictive methods use additional relevant information (i.e., data from other similar sites) to improve estimates of future safety performance
- A weighted average of observed and predicted crash frequencies (i.e., "expected") uses the most information and provides the most reliable estimate

Predictive Methods

- Foundational Elements:
  - Safety performance functions (SPFs)
  - Crash modification factors (CMFs)
  - Calibration factors (C)



Predicted crash frequency =

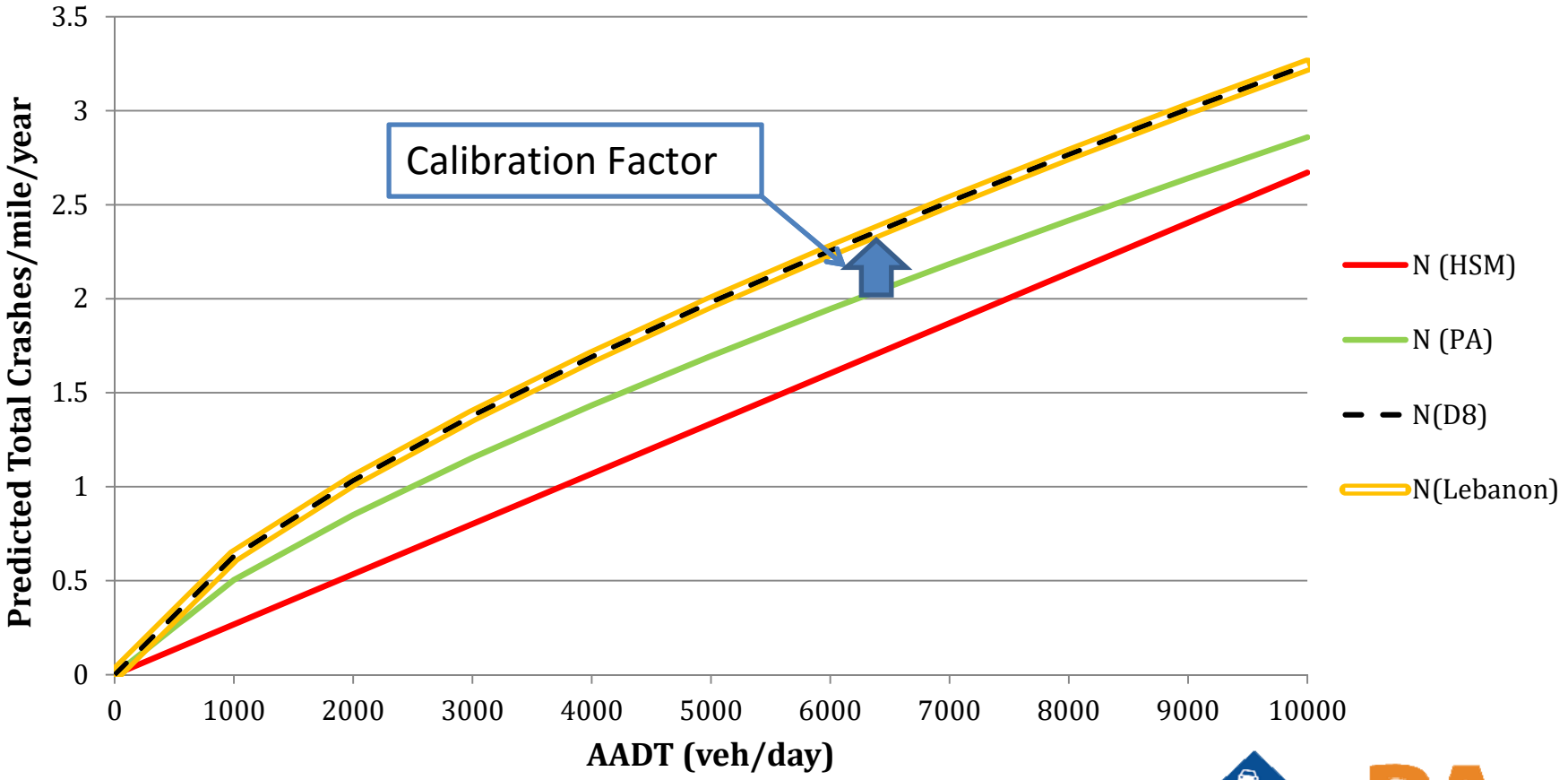
$$SPF(AADT)_{base\ conditions} \times CMFs \times C$$

Safety Performance Function (SPF)

Definition:

An (regression) equation to predict long-term average crash frequency on a particular type of roadway based on exposure—typically measured in terms of Average Annual Daily Traffic (AADT, vehicles per day)

SPFs for Two-Lane Rural Roadways



Crash Modification Factor (CMF)

Definition:

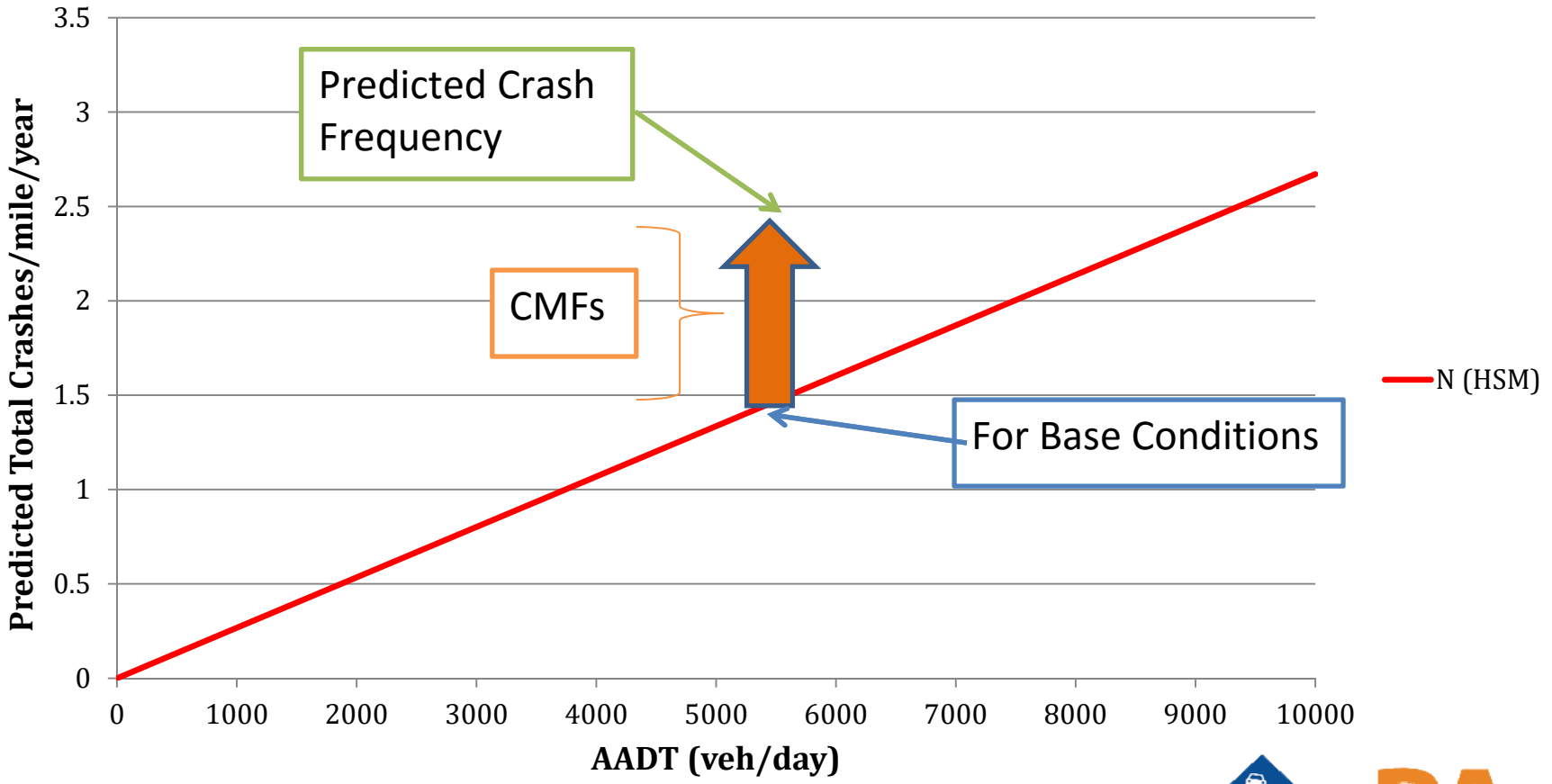
Relative change in crash frequency due to a change in one specific condition

$$CMF = \frac{Crash\ Frequency\ with\ Specified\ Condition}{Crash\ Frequency\ with\ Base\ Condition}$$

HSM CMFs for Two-Lane Rural Highways

- Segments
  - Lane Width
  - Shoulder Width/Type
  - Horizontal Curves
  - Grades
  - Driveway Density
  - Roadside Design
  - Passing Lanes
  - Two-way Left-Turn Lanes
- Intersections
  - Skew Angle
  - Left-Turn Lanes
  - Right-Turn Lanes

Predicted Crash Frequency for a Particular Two-Lane Rural Roadway



Expected Crash Frequency

Expected crash frequency =

w * Predicted crash frequency +

(1-w)* Observed crash frequency

Reactive vs Proactive

Reactive	Proactive
Rank high-crash locations based on observed crash frequency	Rank sites with potential for safety improvement based on expected crash frequency
Treat locations that had high observed crash frequencies in the past	Treat locations based upon the presence of high-risk roadway features

FHWA's Every Day Counts
Data-Driven Safety Analysis Initiative

- Goal: Integrate **safety performance** into **ALL** transportation investment decisions

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For more information…

- Contact me at Ray.Krammes@dot.gov or 202-366-2175
- Go to:
  - http://www.highwaysafetymanual.org
  - http://safety.fhwa.dot.gov/rsdp/hsm.aspx
  - http://www.fhwa.dot.gov/innovation/everydaycounts/edc-3/ddsa.cfm

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