Determining the Safety Impacts of Bicycling and Walking Investments

Daniel Carter

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UNC Highway Safety Research Center

December 11, 2017

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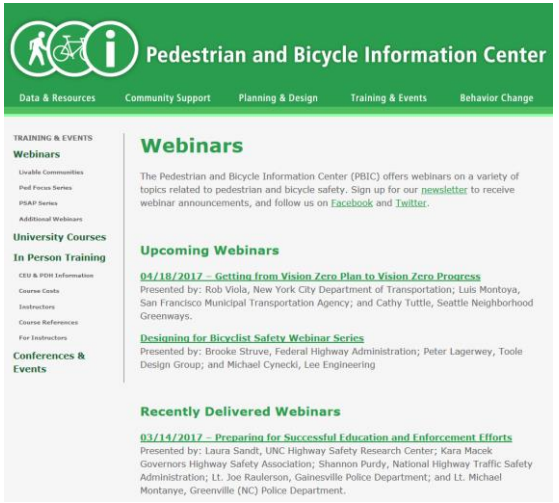

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Safety Performance Measures for Bicyclists and Pedestrians

December 14, 2:00 – 3:00 PM Eastern

Amy Schick
National Highway Traffic Safety Administration

Dave Kopacz
Federal Highway Administration

Determining the Safety Impacts of Bicycling and Walking Investments

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Raghavan Srinivasan, Ph.D.
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THE UNIVERSITY OF NORTH CAROLINA
HIGHWAY SAFETY RESEARCH CENTER

www.hsrc.unc.edu

Monday, December 11, 2017

WHAT WE'LL COVER…

1. Safety Effectiveness of Countermeasures
2. Evaluating Safety Countermeasures
3. Where to Find and How to Use Crash Modification Factors
4. Challenges for Bicycle and Pedestrian CMF Development

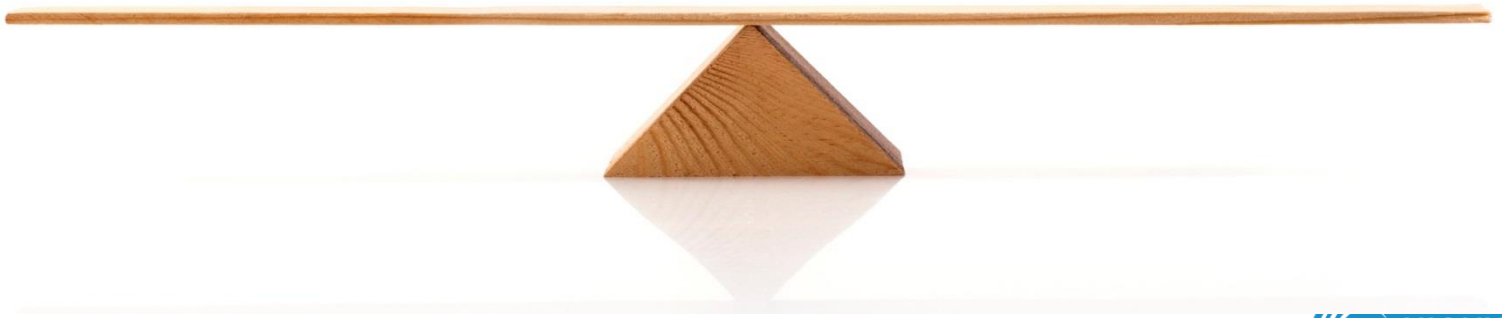
Challenge for Transportation Agencies:

Make the best decisions about safety improvements given a range of options and limited resources.

BENEFITS AND COSTS

When faced with many potential countermeasures, how do we determine the best "bang for the buck"?

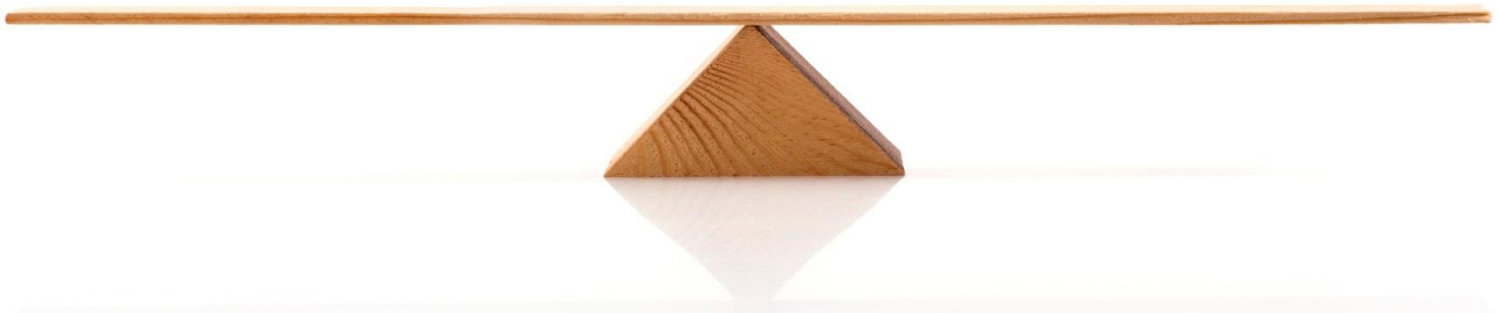
Countermeasure Benefits	Countermeasure Costs



BENEFITS AND COSTS

When faced with many potential countermeasures, how do we determine the best "bang for the buck"?

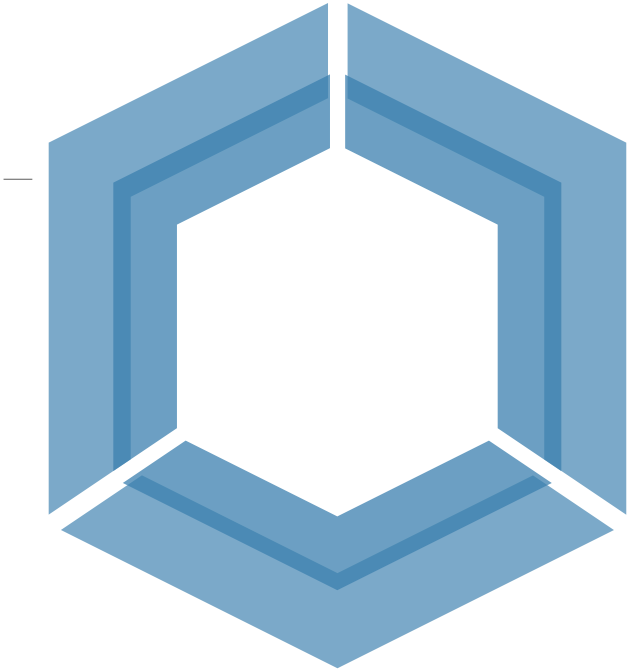
Countermeasure Benefits	Countermeasure Costs
▪ Safety (crash reduction) ▪ Mobility ▪ Congestion reduction ▪ Others?	▪ Installation ▪ Maintenance ▪ Operation ▪ Others?



COUNTERMEASURE BENEFITS

CRASHES PREVENTED

- Use CMFs to estimate if available



CHANGES IN CRASH SEVERITY

- Traffic Signals
- Red Light Photo Enforcement

OTHER BENEFITS INDIRECTLY RELATED TO SAFETY

- e.g., Improved mobility, comfort

COUNTERMEASURE BENEFITS:
Crash Modification Factors

Crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site.

$$CMF = \frac{\text{Expected crashes with countermeasure}}{\text{Expected crashes without countermeasure}}$$

CMF > 1	CMF < 1
Indicates an expected increase in crashes	Indicates an expected decrease in crashes

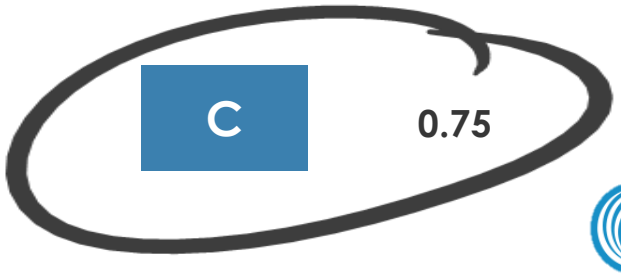
COUNTERMEASURE BENEFITS:
Crash Modification Factors

Crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site.

$$\text{CMF} = \frac{\text{Expected crashes with countermeasure}}{\text{Expected crashes without countermeasure}}$$

Which of the following CMFs would indicate an expected crash reduction of 25% ?

A	0.25
B	1.25
C	0.75



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COUNTERMEASURE BENEFITS:
Crash Modification Factors

Crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site.

$$\text{CMF} = \frac{\text{Expected crashes with countermeasure}}{\text{Expected crashes without countermeasure}}$$

If a treatment with a CMF of 1.25 were applied at a given site, how would the crashes at the site change?

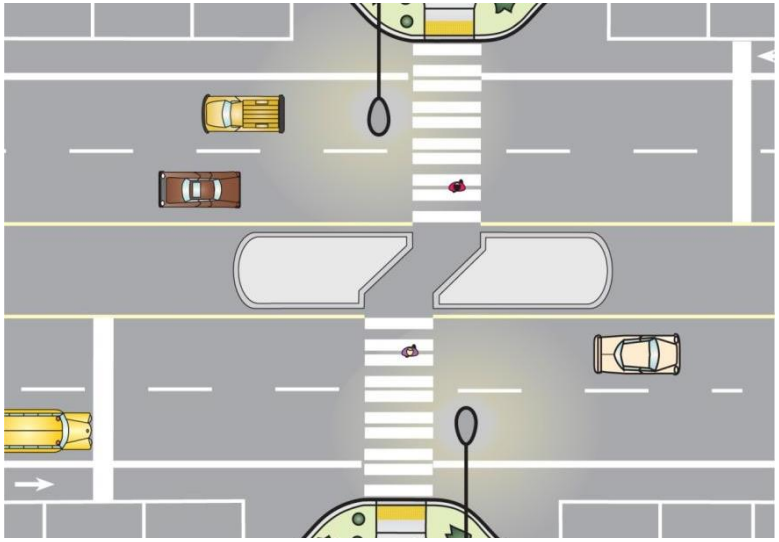
- **A** Decrease by 25%
- **B** Increase by 25%
- **C** Increase by 75%

Ongoing and Recent Studies

- Leading Pedestrian Interval
  - Before-after study
  - Treatment sites in Chicago, New York, Charlotte

- Protected Left Turn Phasing
  - Before-after study
  - Treatment sites in Chicago, New York, Toronto

Recently Completed NCHRP CMF Study (Report 841)



WHERE DO CMFs COME FROM?

CMF Development is Based on Safety Evaluation

Evaluation is essential to establish countermeasure effectiveness

Funds should be set aside for good evaluation (more on that later)

Why should we evaluate our projects?

CMF Development is Based on Safety Evaluation

Evaluation is essential to establish countermeasure effectiveness

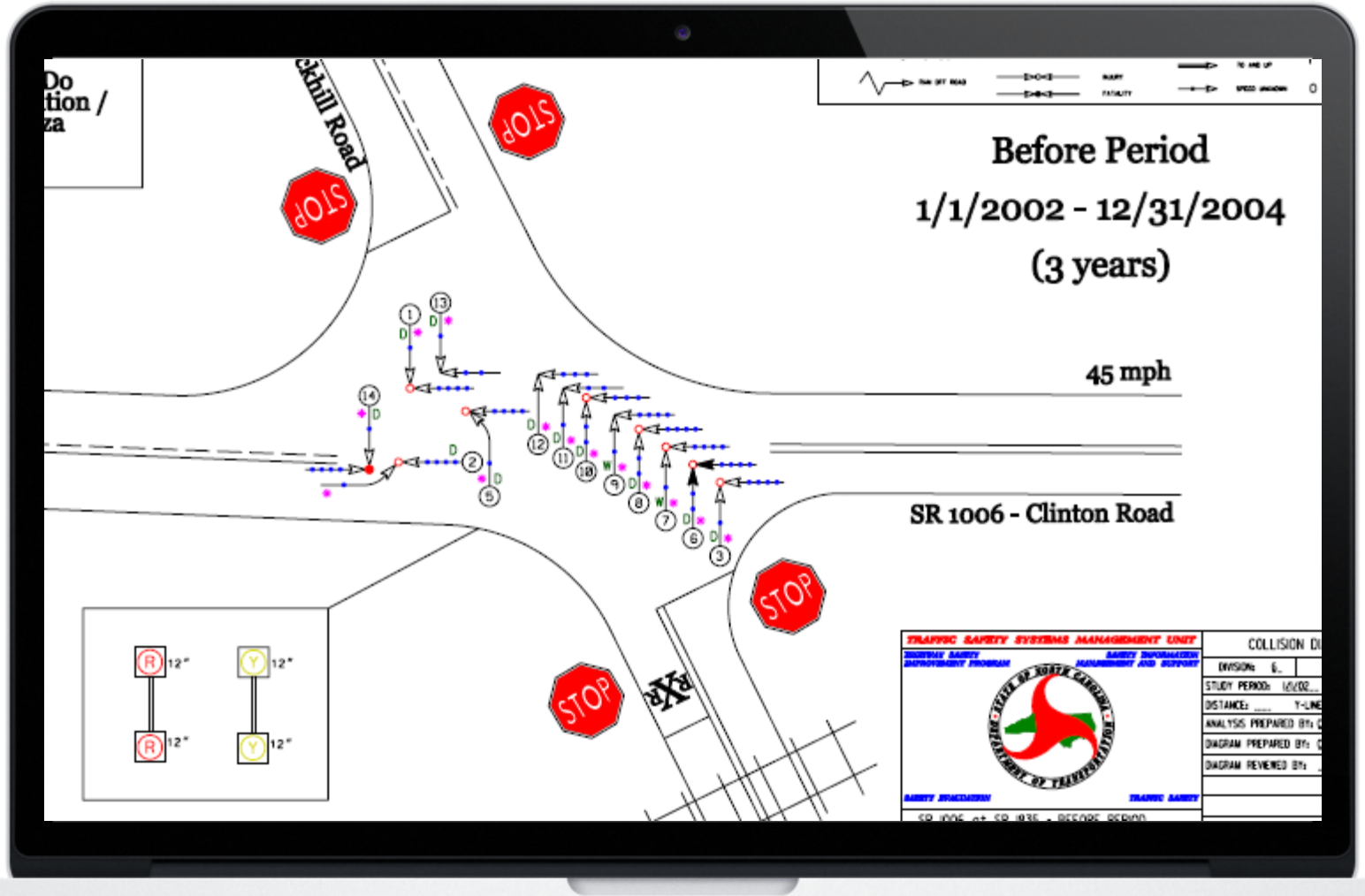
Funds should be set aside for good evaluation

Why should we evaluate our projects?

- Prove effectiveness
- Demonstrate program value to decision makers
- Contribute new scientific knowledge
- Improve decisions and optimize future investment

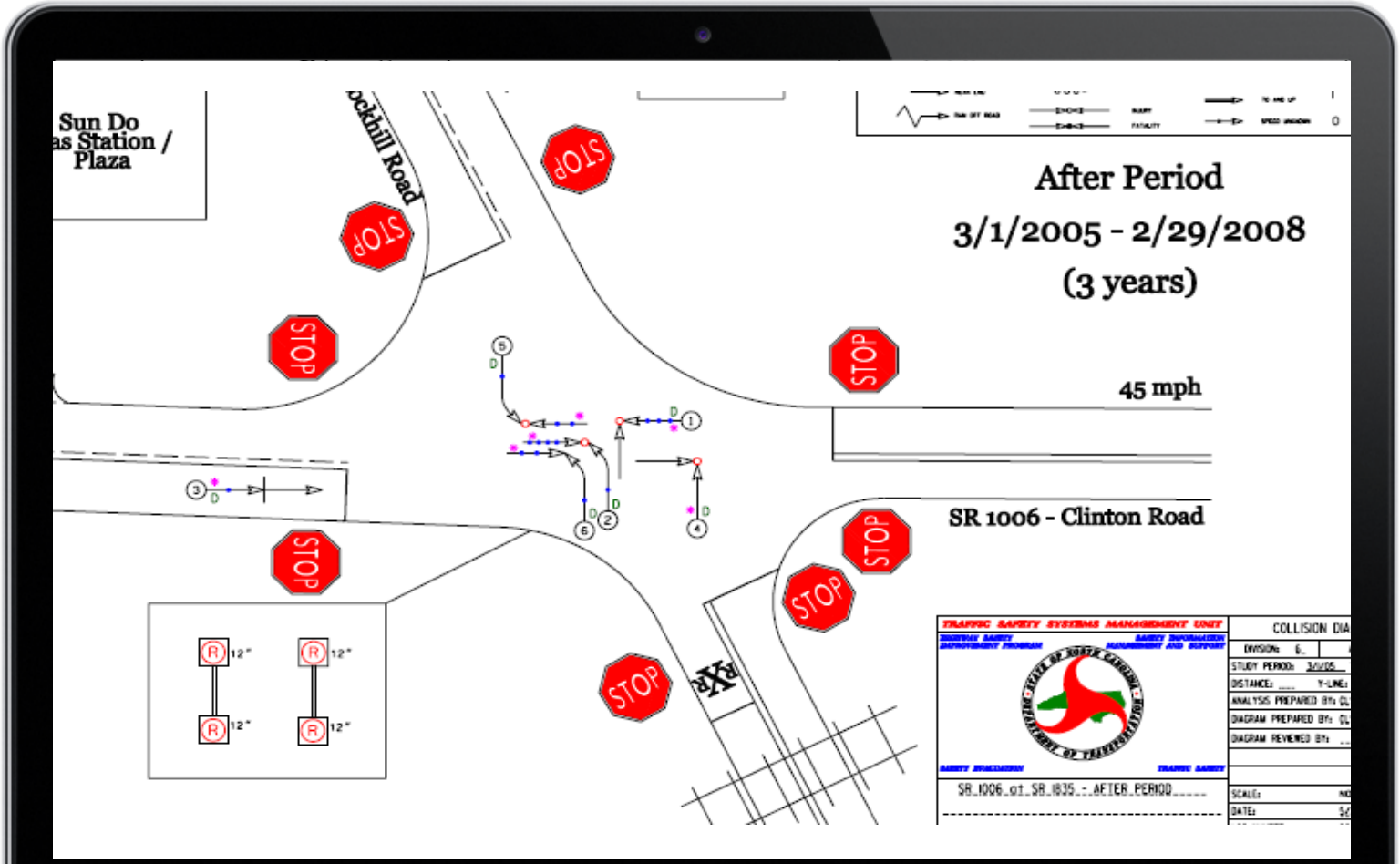
Example Collision Diagram

Before Countermeasure Installation



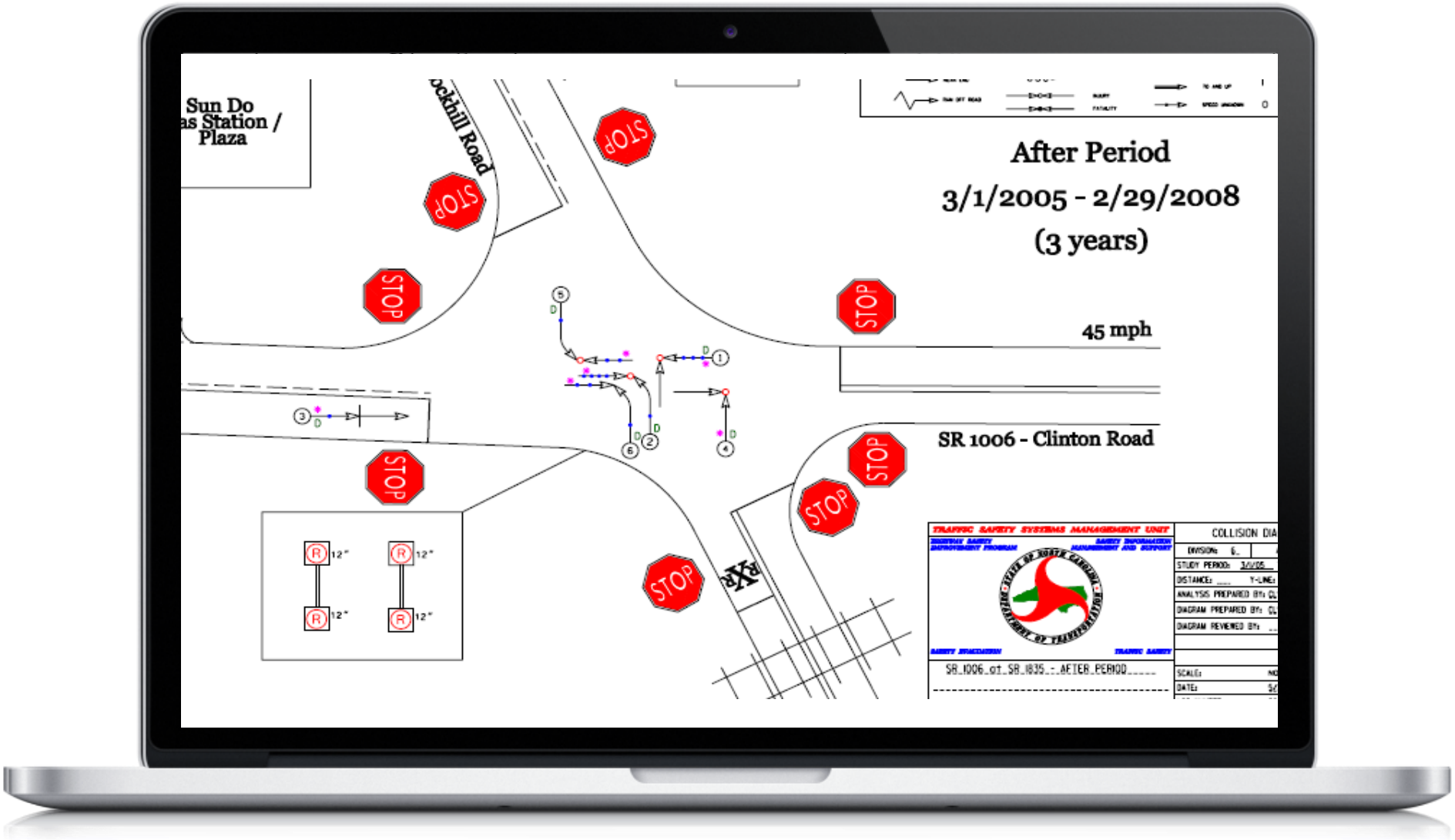
Example Collision Diagram

After Countermeasure Installation



Crashes Decreased

…but was the decrease due to the countermeasure installation?



Safety Effectiveness Evaluation Basics

- Goal – Measure true effect of a countermeasure
- We want to be sure that the observed change is due to the countermeasure alone
- What other factors could cause the change?

Safety Effectiveness Evaluation Basics

- Goal – Measure true effect of a countermeasure
- We want to be sure that the observed change is due to the countermeasure alone
- What other factors could cause the change?
  - Other "treatments" at the same time (e.g., speed enforcement at the same time as road diet conversion)
  - Changes in traffic volume (AADT, ped/bike volumes)
  - Regression to the mean
  - Underlying trends in crashes (e.g., economy-related changes)
  - Others?
- How do we account and control for these other factors?

REGRESSION TO THE MEAN

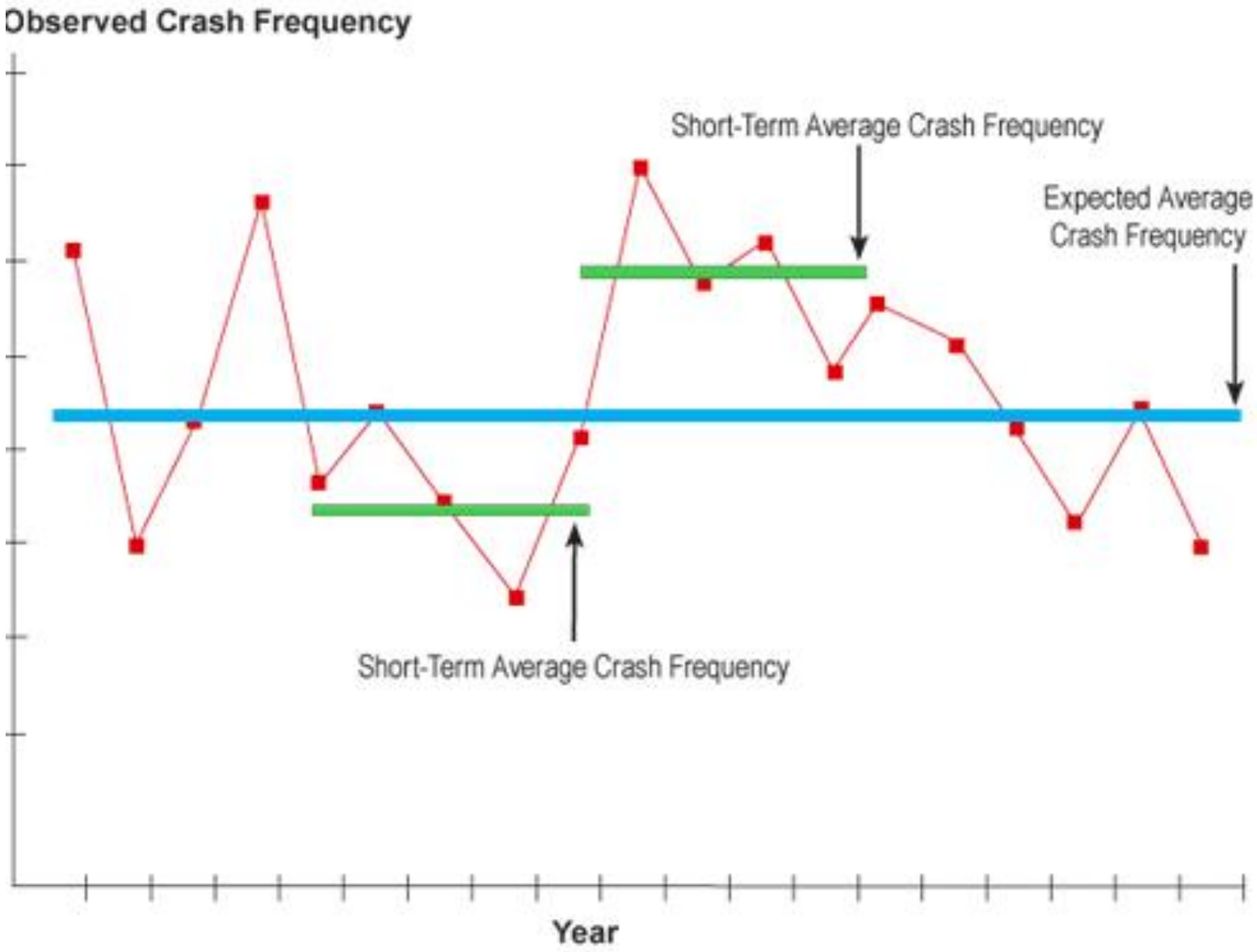
Crashes are random events that naturally fluctuate over time.

Regression to the mean (RTM) refers to the phenomenon of 'averaging out' in statistics

May lead us to confuse *random change* with *real change*

Crashes are artificially high during the before period and would have been reduced even without any improvement to the site

REGRESSION TO THE MEAN



TWO BASIC STUDY DESIGNS

1

Before/After Studies

2

Cross-Sectional Studies

TWO BASIC STUDY DESIGNS

1

Before/After Studies

2

Cross-Sectional Studies

Choice of method is affected by:

- Nature of Treatment
- Site Type
- Available Data

1

Before/After Studies

- Examines crash data before and after the treatment is installed

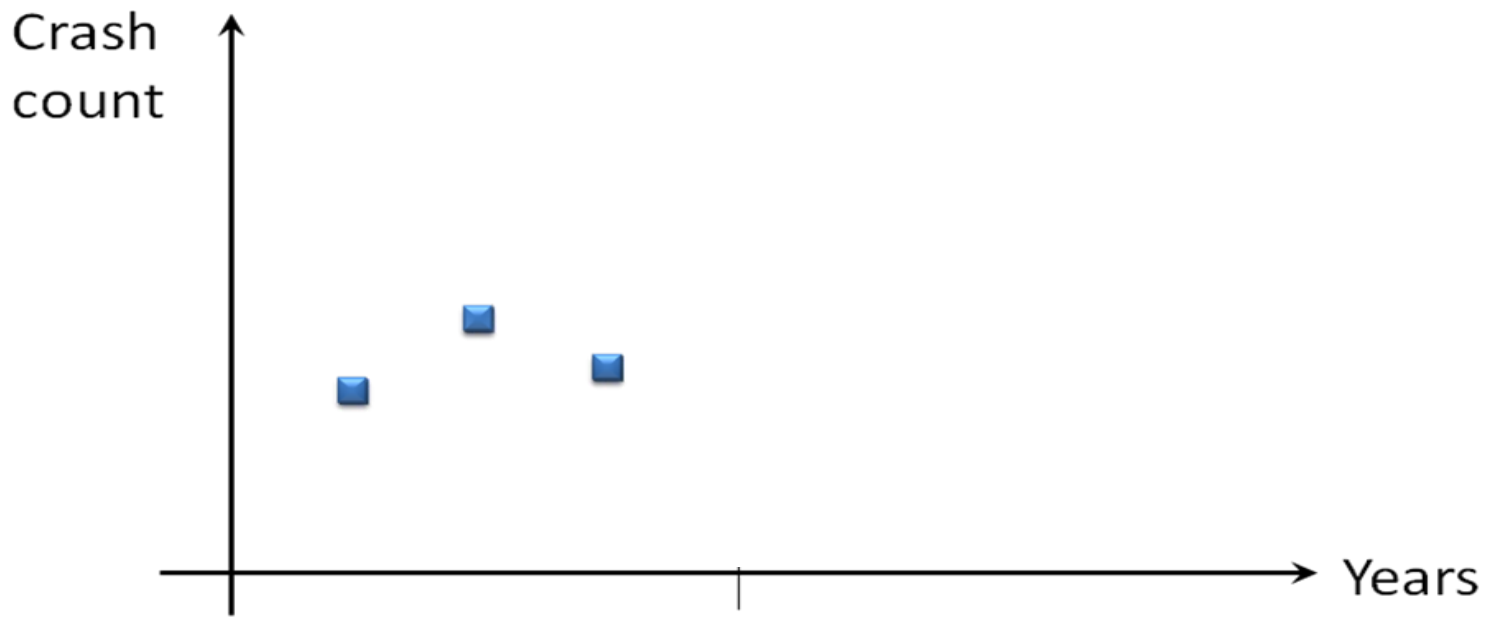
Simple Before/After

Does not account for certain biases

Before/After with Reference or Comparison Groups

Represents a group of methods that account for changes in volumes and other factors

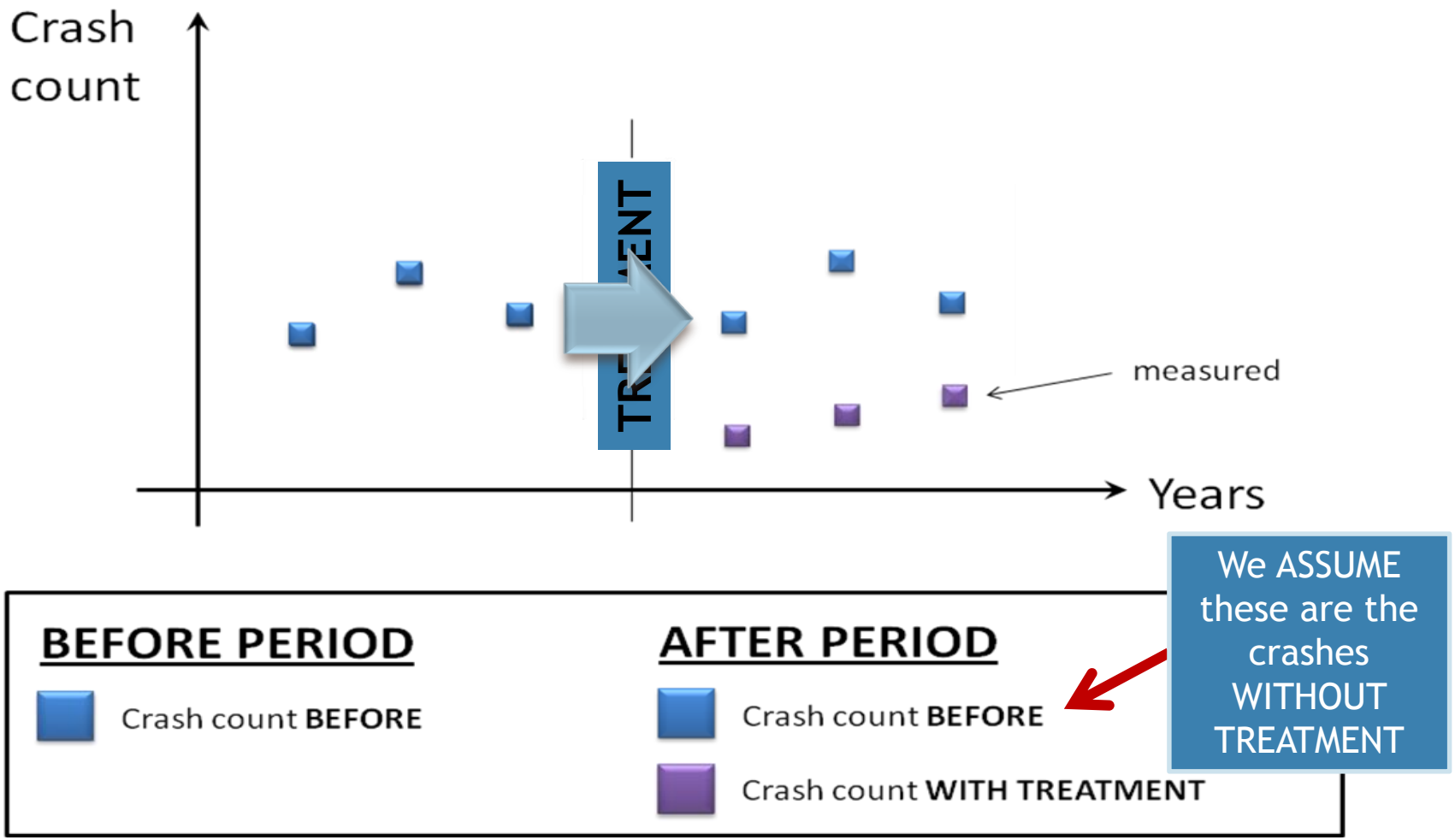
SIMPLE BEFORE-AFTER



BEFORE PERIOD **AFTER PERIOD**

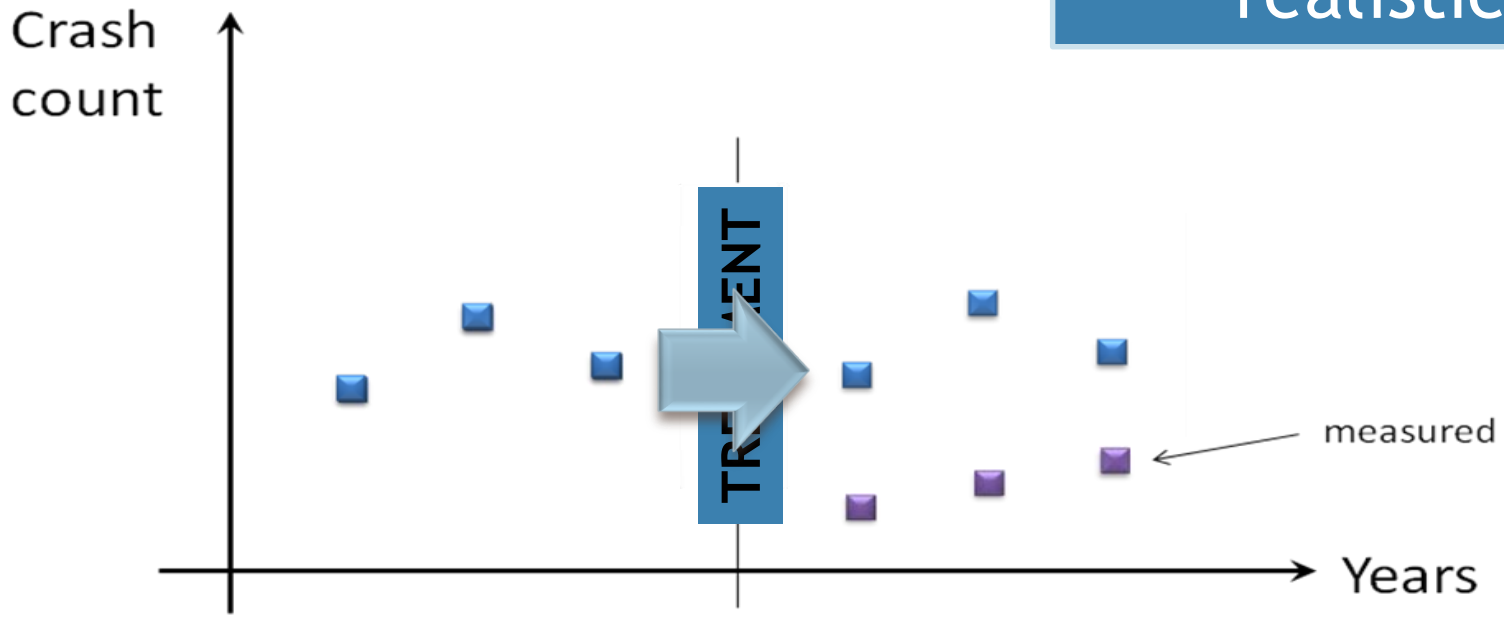
Crash count **BEFORE**

SIMPLE BEFORE-AFTER



SIMPLE BEFORE-AFTER

Is this assumption realistic?



BEFORE PERIOD

Crash count **BEFORE**

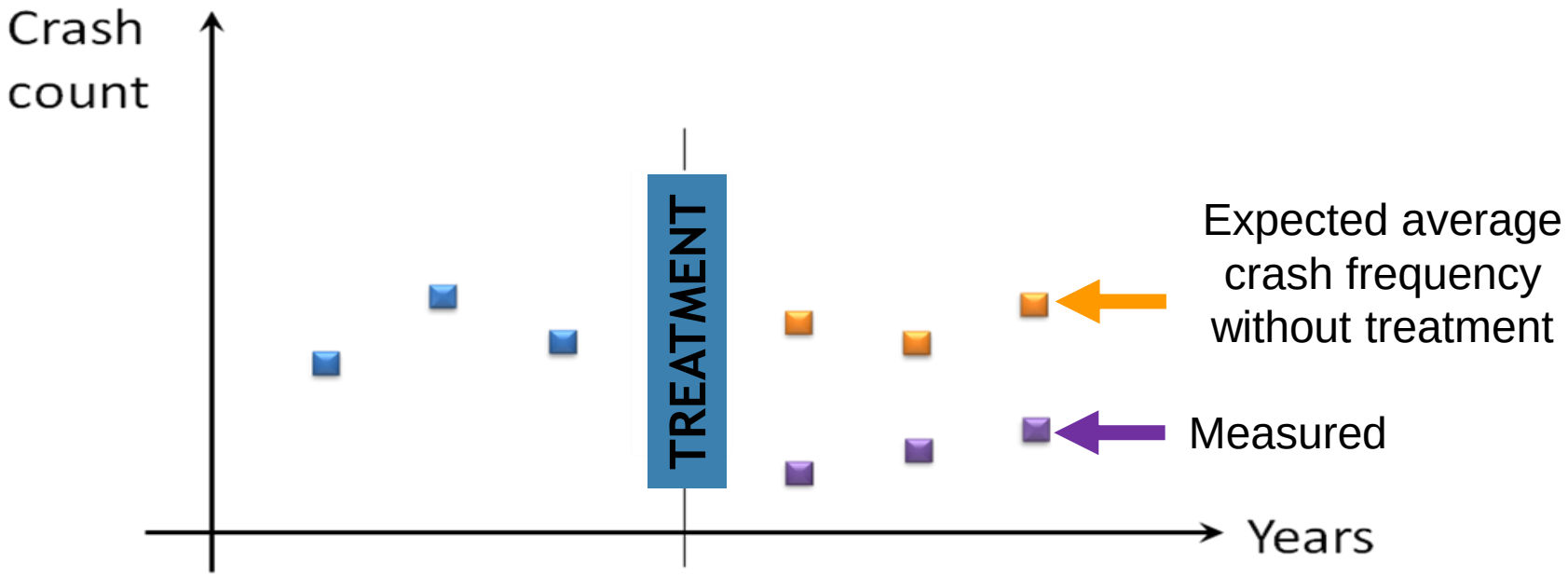
AFTER PERIOD

Crash count **BEFORE**

Crash count **WITH TREATMENT**

We ASSUME these are the crashes WITHOUT TREATMENT

BEFORE-AFTER WITH REFERENCE/COMPARISON GROUP



BEFORE PERIOD

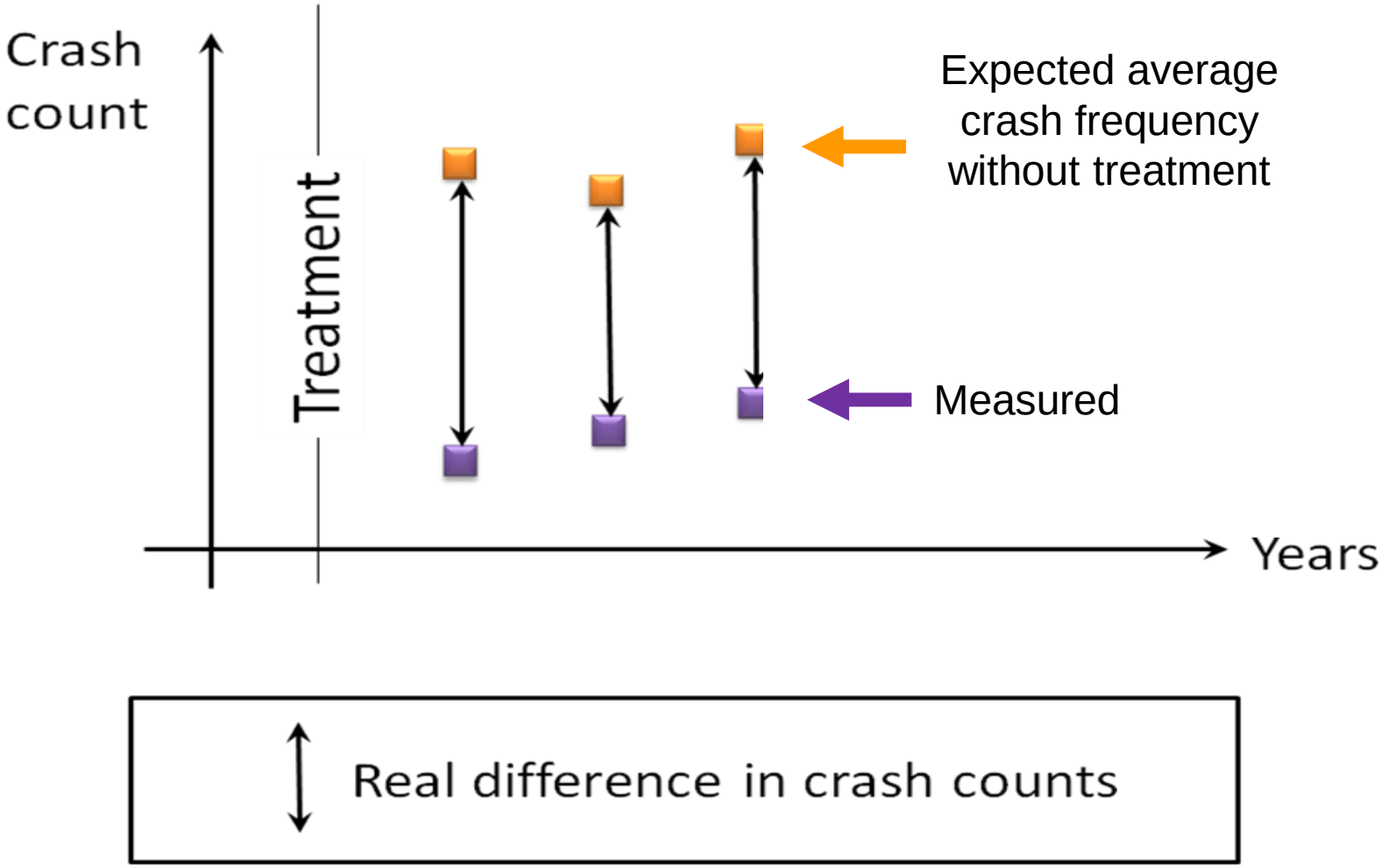
Crash count **BEFORE**

AFTER PERIOD

Expected average crash count without treatment (empirical Bayes estimate)

Crash count **WITH TREATMENT**

BEFORE-AFTER WITH REFERENCE/COMPARISON GROUP



Evaluation Result Example (hypothetical)

- Expected crashes without treatment = 96.2 crashes

TWO BASIC STUDY DESIGNS

1

Before/After Studies

2

Cross-Sectional Studies

CROSS-SECTIONAL STUDIES

2

Cross-Sectional Studies

- Compare crash data for sites with and without treatment over same time period
- Why do a cross-sectional study?
  - Installation dates unknown
  - Volumes and crash counts in before period unknown

CROSS-SECTIONAL STUDIES

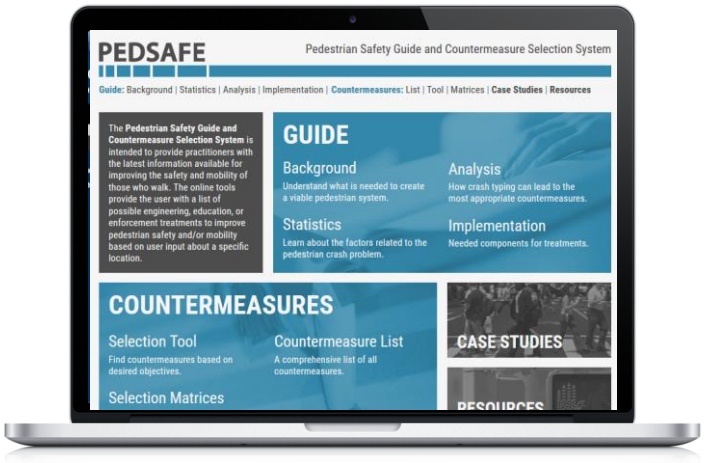
2

Cross-Sectional Studies

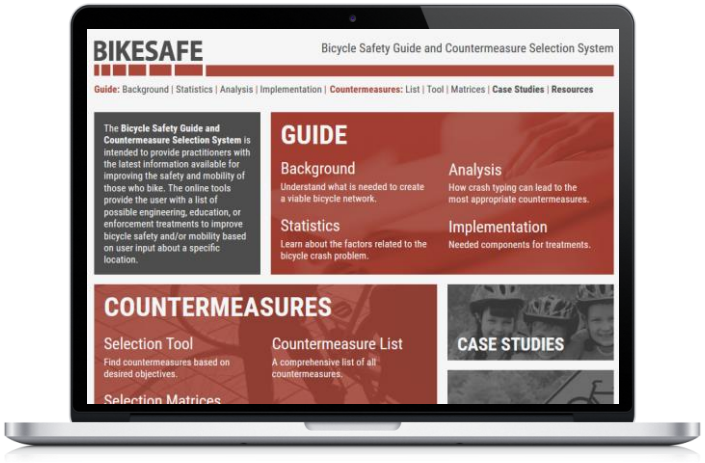
- Work underway to improve methods for cross-sectional studies by selecting sites using **Propensity Score Matching**

Where to Find (and how to use) Crash Modification Factors?

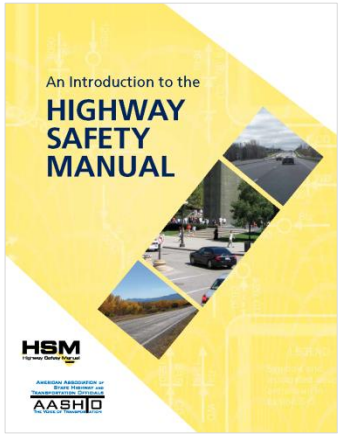
COUNTERMEASURE SOURCES:
Tools and Resources for CMFs



PEDSAFE

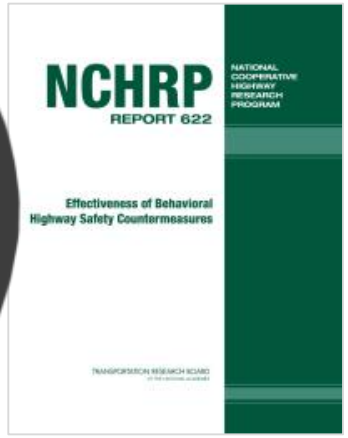


BIKESAFE



Highway Safety Manual

CMF Clearinghouse



NCHRP Reports

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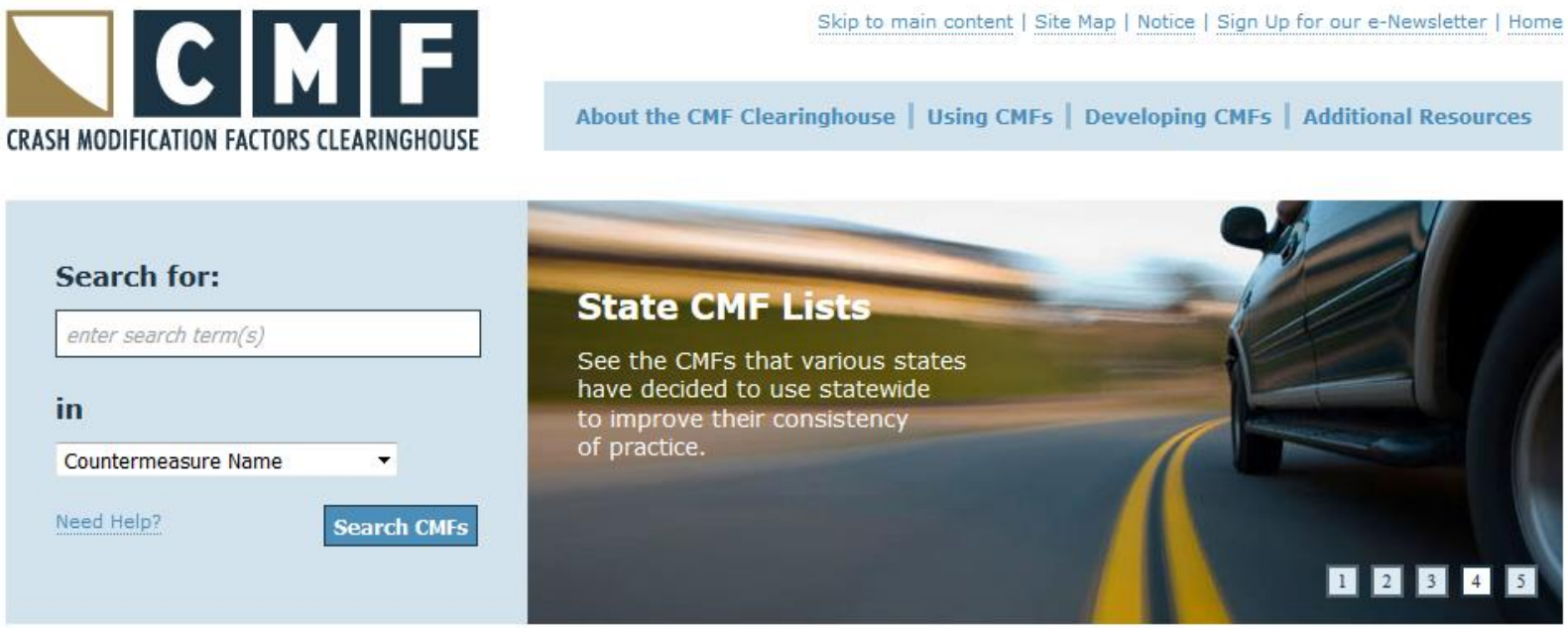
Quick Tour of the CMF Clearinghouse



www.cmfclearinghouse.org

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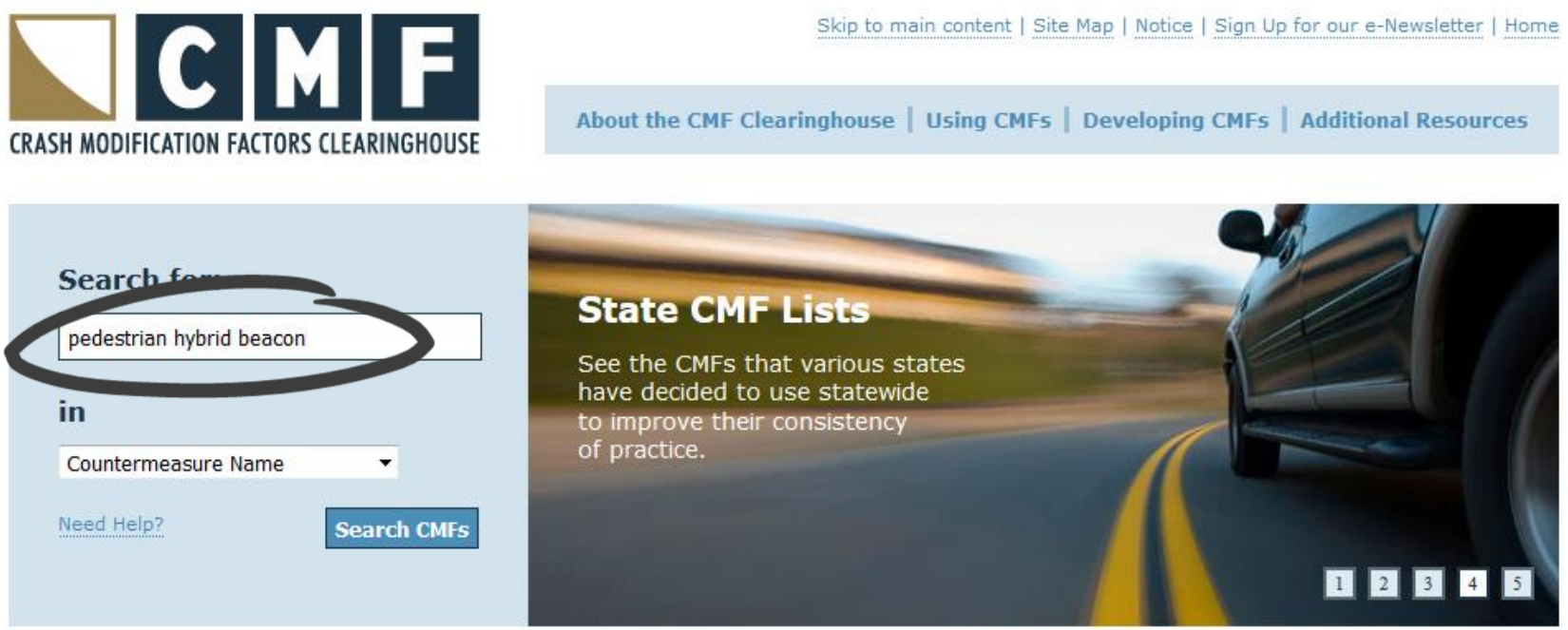
Quick Tour of the CMF Clearinghouse



A crash modification factor (CMF) is used to compute the expected number of crashes after implementing a countermeasure on a road or intersection. The Crash Modification Factors Clearinghouse provides a searchable online database of CMFs along with guidance and resources on using CMFs in road safety practice. It also provides guidance to researchers on best practices for developing high quality CMFs.

Recently Added CMFs

Provide a raised median
CMF: 0.49
CRF: 51
Crash type: Other
Crash severity: All

Install w-beam guardrail and concrete barrier
CMF: 0.92
CRF: 8
Crash type: Run off road,Other

Install intersection conflict warning systems (ICWS) for two-lane at two-lane intersections
CMF: 0.7
CRF: 30

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Quick Tour of the CMF Clearinghouse

▼ Countermeasure: Install a pedestrian hybrid beacon (PHB or HAWK)

Compare	CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
☐	0.712	29	★★★★☆	All	All	Urban and suburban	Fitzpatrick, K., and Park, E.S., 2010	The authors of this study ... [*read more*]
☐	0.453	54.7	★★★★☆	Vehicle/pedestrian	All	Urban and suburban	Zegeer et al., 2017	Methodology used was a combination ... [*read more*]
☐	0.849	15	★★★☆☆	All	K,A,B,C	Urban and suburban	Fitzpatrick, K., and Park, E.S., 2010	The authors of this study ... [*read more*]
☐	0.309	69	★★★☆☆	Vehicle/pedestrian	All	Urban and suburban	Fitzpatrick, K., and Park, E.S., 2010	The authors of this study ... [*read more*]

Compare | Reset Compare

**NOTE: You can compare CMFs across countermeasures, subcategories, and categories.*

MORE INFO ↘

www.cmfclearinghouse.org

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Quick Tour of the CMF Clearinghouse

Applicability	
Crash Type:	Vehicle/pedestrian
Crash Severity:	All
Roadway Types:	Minor Arterial
Number of Lanes:	2 to 8
Development Details	
Date Range of Data Used:	2004 to 2013
Municipality:	
State:	AZ, FL, IL, MA, NY, NC, OR, VA, WI
Country:	USA
Type of Methodology Used:	Regression cross-section
Sample Size (crashes):	350 crashes
Sample Size (site-years):	3495 site-years

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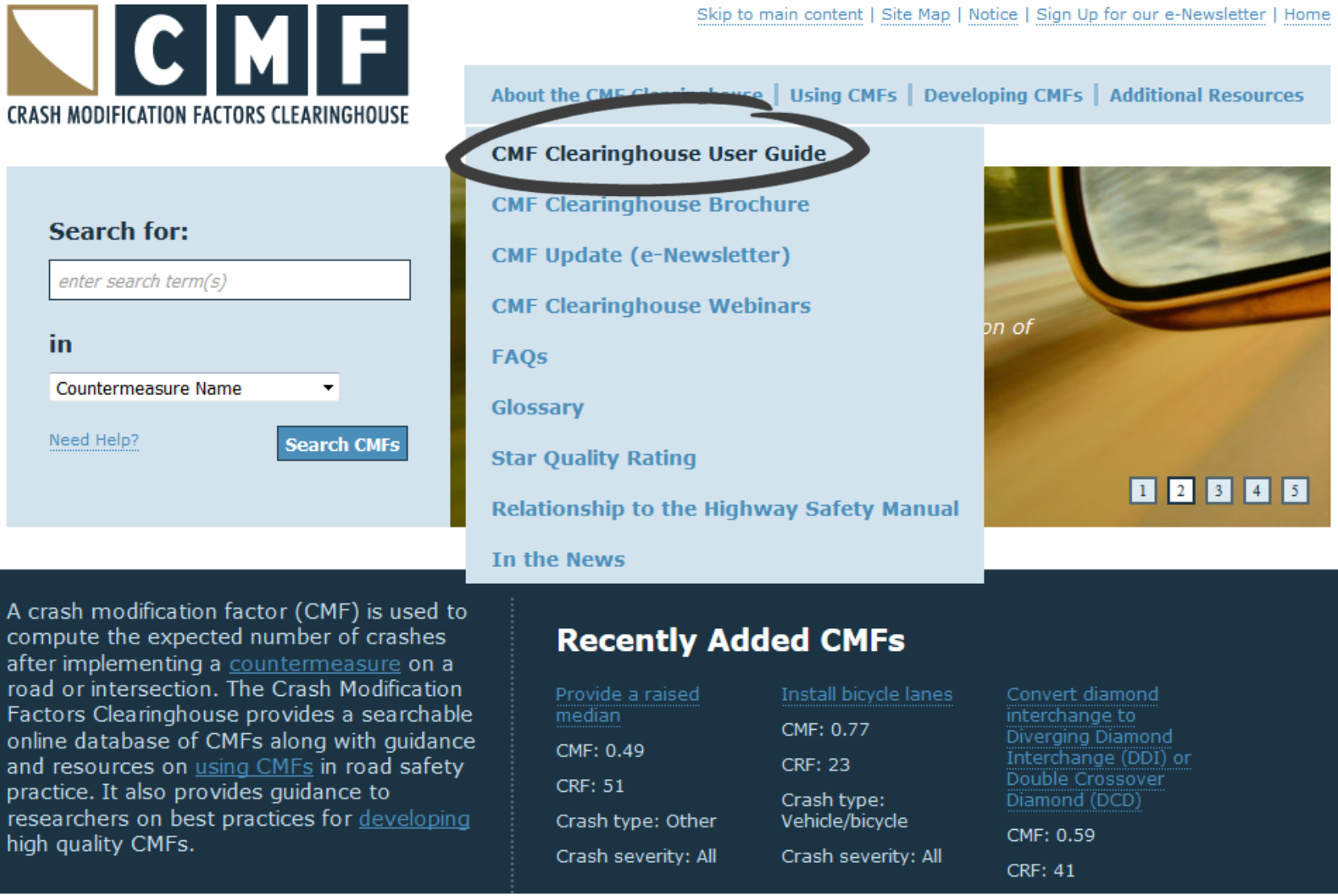
Other Features of the CMF Clearinghouse



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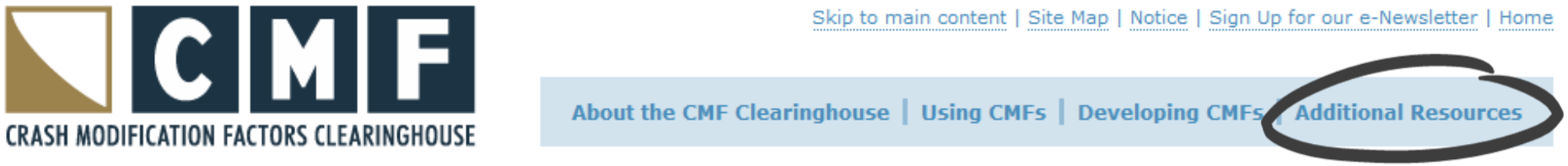
Other Features of the CMF Clearinghouse



- How to Develop and Use CMFs
- How to Develop and Use SPFs
- Resources for Cost Benefit Analysis
- Resources for Behavioral Countermeasures
- Others

Want to Learn More?

The Right Fit: Finding and Applying the Right CMF for the Job

Dec 12, 2:00 – 3:30 PM Eastern

Sophia Azam
New Jersey DOT

Daniel Carter
UNC Highway Safety Research Center

http://www.cmfclearinghouse.org/webinars.cfm

Data Needs and Challenges

6,142 CMFs in the Clearinghouse

59 CMFs for ped treatments

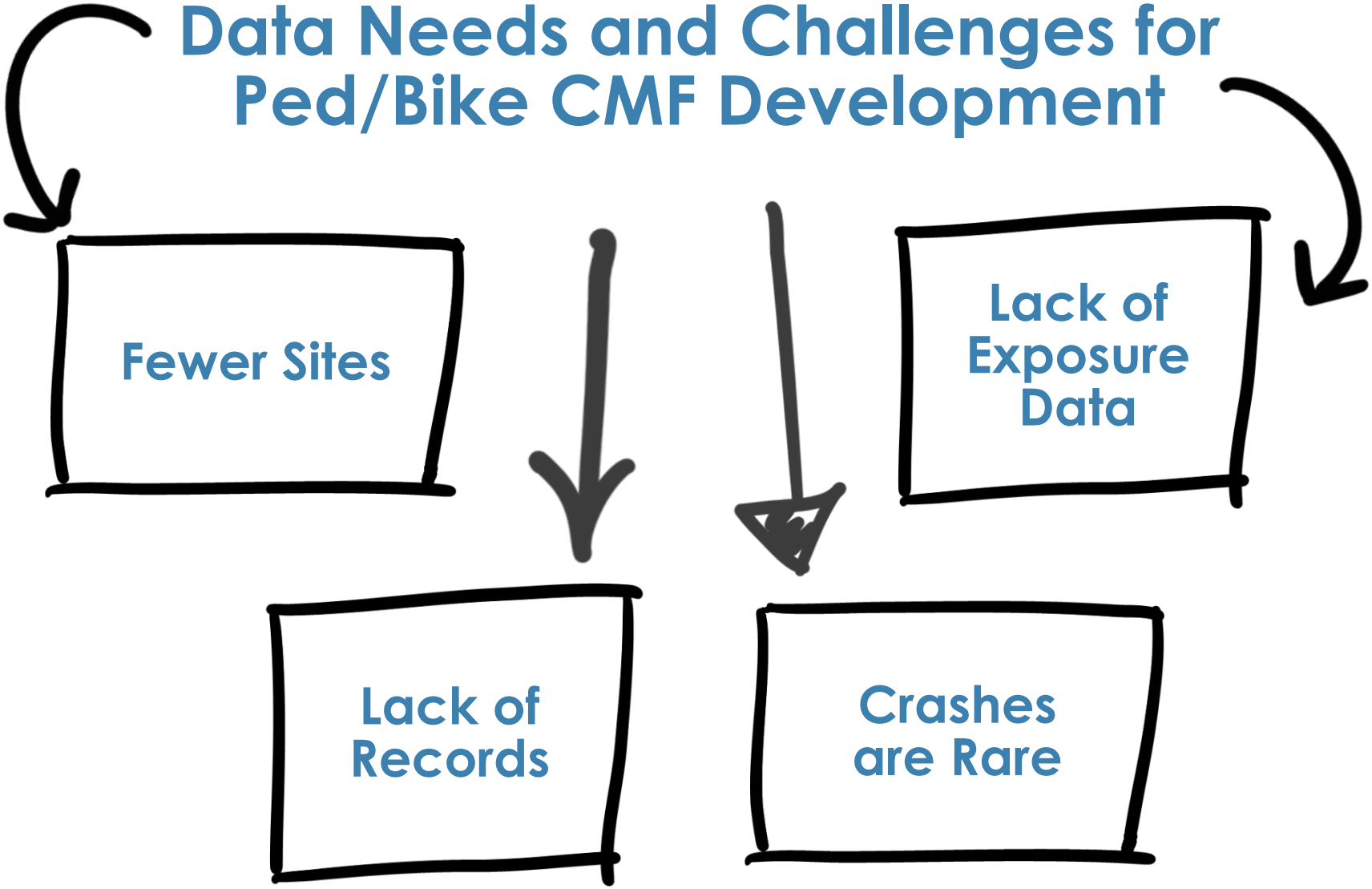
179 CMFs for bike treatments

Why aren't there more CMFs for pedestrian and bicycle countermeasures?

Demand for Ped/Bike CMFs

"We are running into issues with [state] defunding our Highway Safety Improvement Program project because there are no star rated CMF's for Intersection Bulbouts."

Data Needs and Challenges for Ped/Bike CMF Development



Data Needs and Challenges: Few Sites

- Many of these treatments are relatively new
- Not many states and cities trying them
- Those that have them installed them recently

Source: www.pedbikeimages.org / Laura Sandt

Data Needs and Challenges: Lack of Records

Source: www.pedbikeimages.org / Toole Design Group

- Low cost treatments aren't tracked well/centrally (PCS addition, LPI timing change, crosswalk type change)
- Date of installation difficult to determine (need multiple years of signal timing plans)

Data Needs and Challenges: Lack of Volume Data

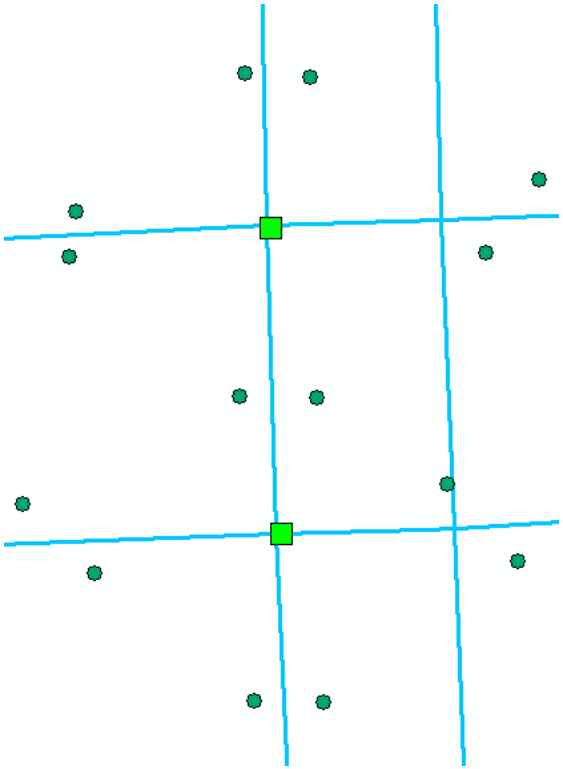
- Ped/bike counting is still not a regular activity for many cities and states
- If done, focus is typically signalized intersections or downtown areas
- Can be done by research team, but…
  - Expensive
  - Can't go back to count in before period

Data Needs and Challenges: Lack of Volume Data

- Intersection Crossing Counts

(Charlotte and Toronto)

- Midblock Sidewalk Counts



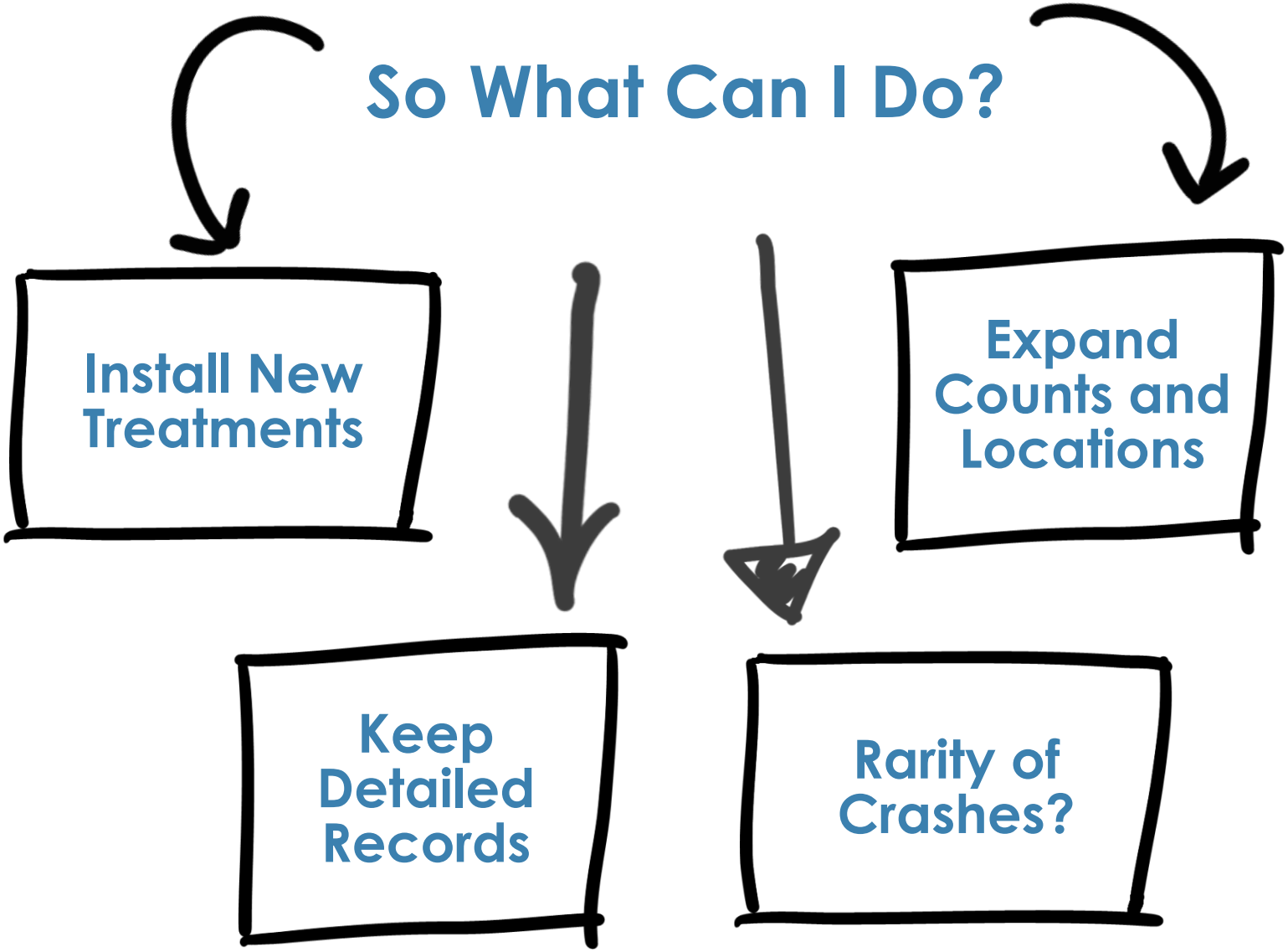
(Chicago and Philadelphia)

Data Needs and Challenges: Crashes are Rare

- Crashes involving bicyclists or pedestrians are relatively rare events
- As a result, sample sizes are typically lower
- Need more years of data and/or more sites

Source: www.pedbikeimages.org / New York City DOT

So What Can I Do?



Discussion

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