Crash Reduction Factors Resulting From the Installation of Active Advance Warning Flasher (AAWF)

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Presentation

- Introduction to the Project
- AAWF policies in Alaska
- Study Methods and Analysis (2008 Project)
- Highway Safety Manual Evaluation (2013)
- Conclusions

Project Introduction: HSIP CCRF

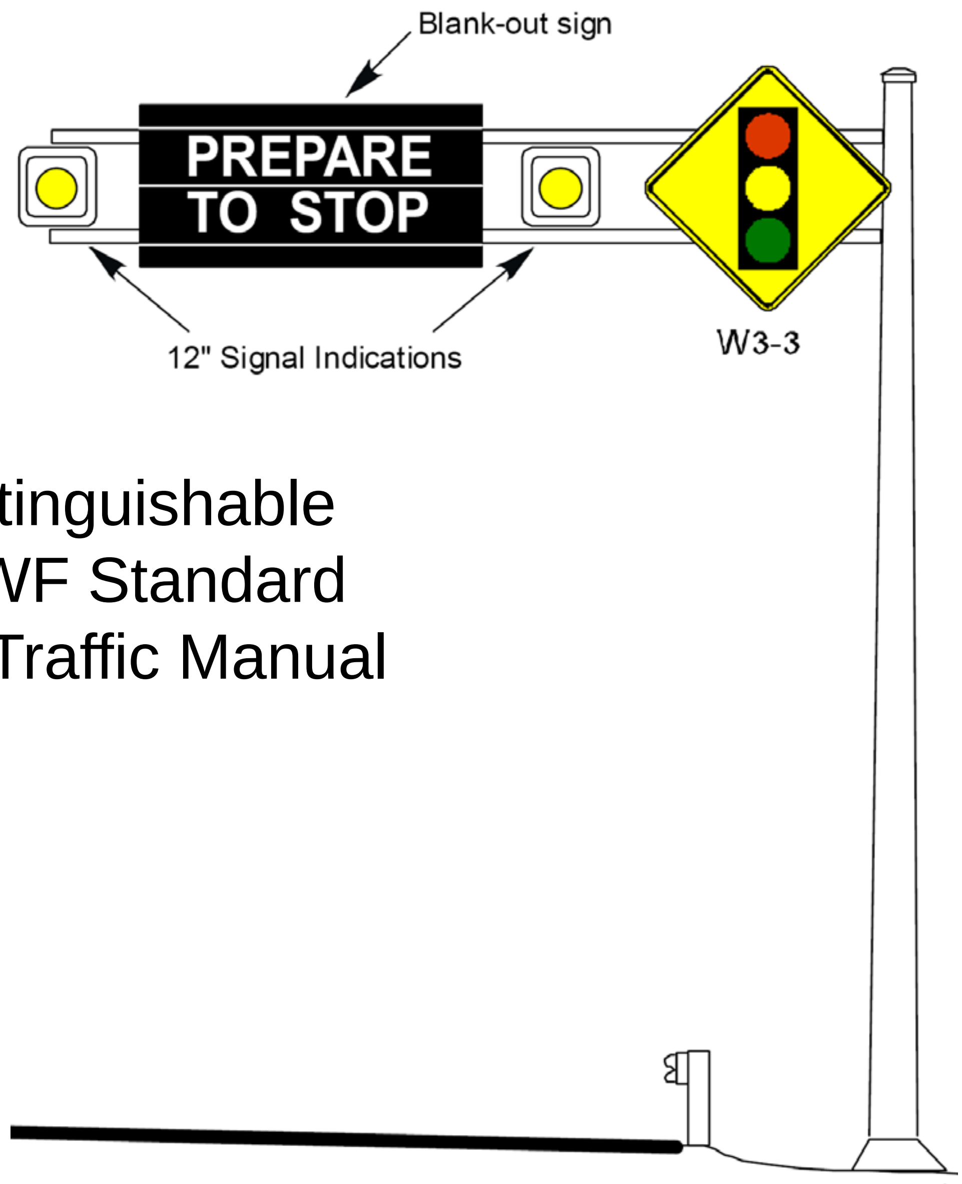
- Alaska Department of Transportation and Public Facilities (DOTPF) has a Highway Safety Improvement Program (HSIP).
- Publishes a Handbook, that includes treatment crash cost reduction factors (CCRF).
- Kinney Engineering, LLC was retained in 2008 to provide a comprehensive study to update CCRF.
  - *Review of Crash Reduction Factors (CRF) for use in the Highway Safety Improvement Program (HSIP)* Report No. FHWA-AD-RD-09-003. Completed in 2009.

- Emphasis of project was crash cost reduction factors for “target” crashes that are susceptible to improvement.
- Severity reduction was used as surrogate CCRF, when possible.
- Part of project was to confirm their published CCRF for AAWF facilities.
  - AAWF: 25% crash reduction on rear end and angle crashes after installation
  - No solid basis for this value.
- Note that Alaska uses CCRF, not Crash Modification Factor, but CMF= 1-CCRF

Alaska Policy on AAWF

- Alaska Traffic Manual 2005:
  - "Active Advance Warning Flashers (AAWFs) are a special type of highway traffic signal installed in advance of conventional traffic signals to provide advance notice of the onset of the yellow indication."

- AAWFs should only be installed when all of the following conditions are met:
  - High-speed (55 mph or higher) approaches;
  - At the first signalized intersection after 10 or more miles of uninterrupted highway; and,
  - Where sight distance to the conventional traffic signal indications meets or exceeds standards.
- AAWFs should be installed 500 feet in advance of the stop bar.



Cantilever Extinguishable Message AAWF Standard (from Alaska Traffic Manual 2005)

AAWF Installations in Alaska

- Used at "gateway" signals; the 1st signal encountered by a traveler entering a community, or after a long (10-mile) segment between signals.
- Intended to reduce rear-end crashes on the lead-in approach caused by:
  - Dilemma zone issues
  - Inattentive drivers (signal is unexpected)
- Intended to reduce right-angle crashes on the lead-in approach (red-light-running).

Study Methods

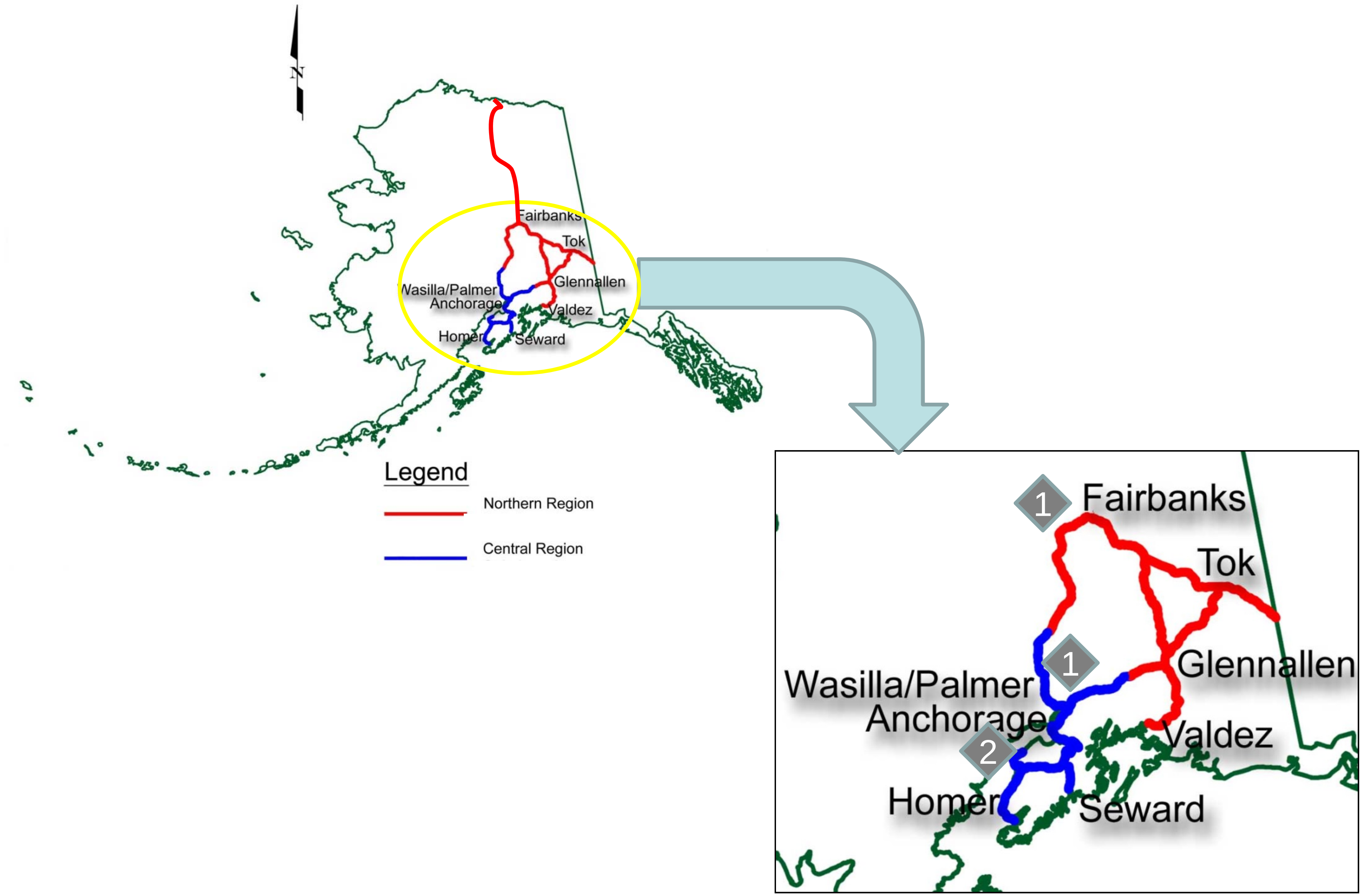
- Literature Survey
- Select AAWF locations
  - 14 in Alaska at the time of the study
  - 4 locations selected which:
    - Satisfied Alaska Traffic Manual Policies
    - Had a signal in place prior to the installation of AAWF
- Data Analysis
  - Before and after periods
  - Target crashes: rear end and angle
- Before After Study: HSIP Handbook Methods & Empirical Bayes (this presentation)

AAWF Performance Literature Survey

- Alaska: CCRF of 25% for target crashes in previous HSIP Manual
- Other CCRF for advanced warning flashers:
  - 25% reduction for all crashes (Kentucky)
  - 36% reduction for rear end crashes (FHWA Desktop Guide)
  - 62% reduction for right-angle crashes (FHWA Desktop Guide)

Study Locations

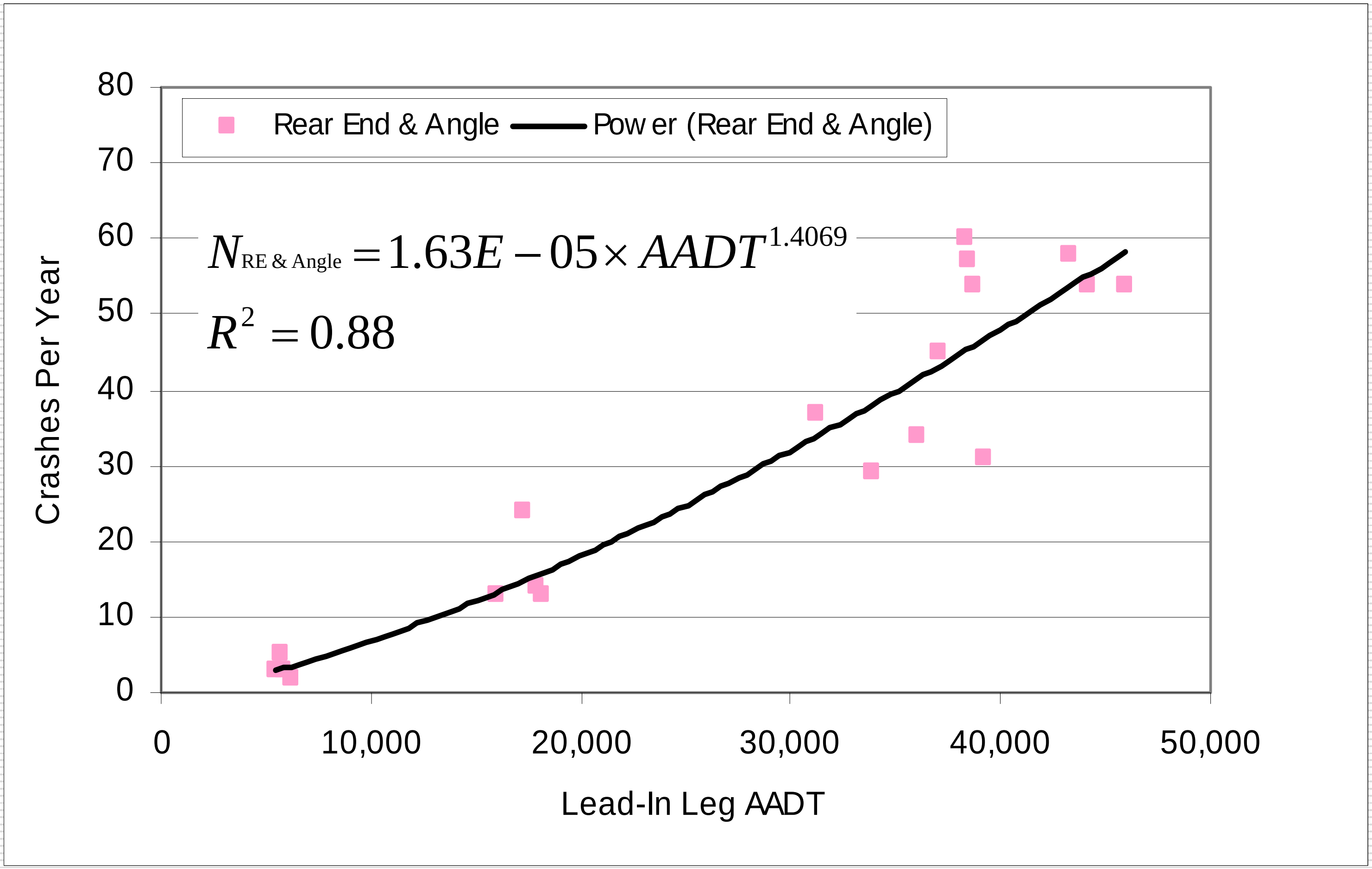
Location	*Year that Signal was Installed*	*Year that AAWF was installed*
Fairbanks: Richardson Highway/Airport Way/Gaffney Road (NB)	Before 1975	2002
Palmer: Glenn Highway/West Arctic Blvd./Old Glen (SB)	1987	1993
Anchorage: Glenn Highway / Bragaw St (WB)	Before 1980	1998
Anchorage: Seward Highway and 36th Avenue (NB)	Before 1980	1988


N
Fairbanks
Tok
Wasilla/Palmer
Anchorage
Glennallen
Valdez
Homer
Seward
Legend
Northern Region
Central Region
1
Fairbanks
Tok
1
Glennallen
Wasilla/Palmer
Anchorage
2
Valdez
Homer
Seward

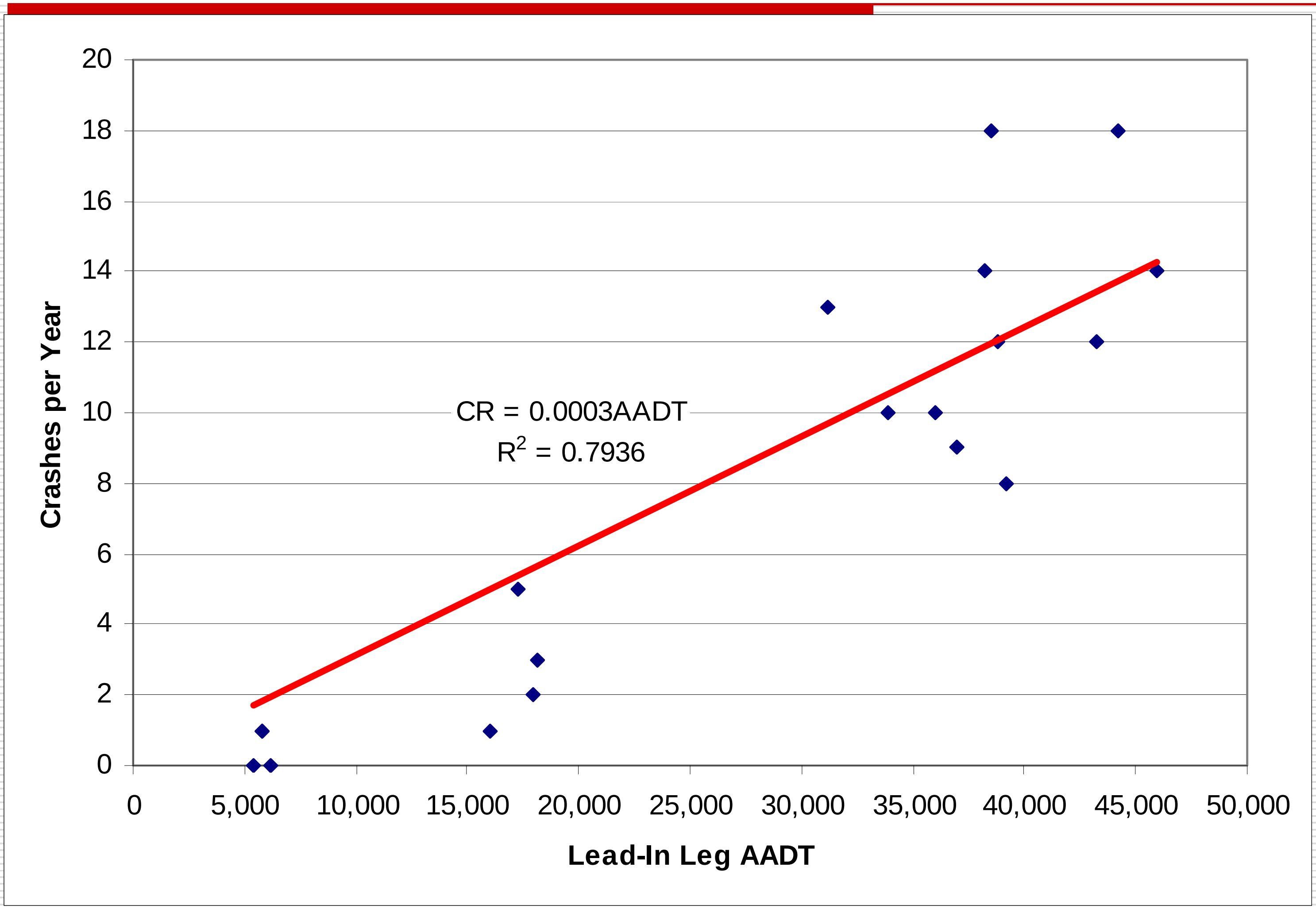
Data for EB Before-After Study

- Collected and synthesized data from DOTPF summaries (validated listed accident types)
- Crash data summaries prior to 1987 didn't report vehicle direction
  - Two of four intersections had before data in which we could not assign crashes to an approach.
  - As such, we used <u>total</u> rear end and angle crashes at intersection instead of AAWF approach
- Incomplete cross-street volume information.
- Developed Safety Performance Function (SPF)
  - Used AAWF approach AADT, and total rear-end, angle crashes

EB Safety Performance Function for Total Rear-End and Angle Crashes



EB Safety Performance Function for Injury and Fatality Rear-End and Angle Crashes



EB Analysis

- Used overdispersion parameter, k=3.1 (from literature)
  - Weights SPF predicted crashes with observed crashes to obtain expected crashes.
  - Used 3 years before and 3 years after at each of the four intersections.

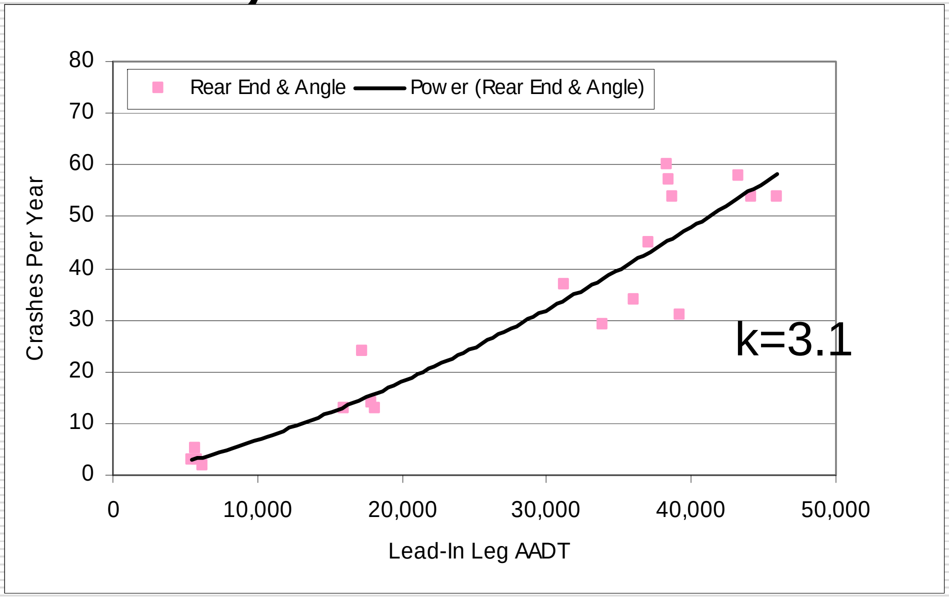
Results

- Total intersection rear end and angle crash reduction by the AAWF was 9.6%, 95% CI [-4%, 24%]
- Injury and fatality crash reduction was 9.2%, 95% CI [-18%,36%]
- Settled on CCRF of 10% for intersection rear-end and angle crashes attributed to installation of an AAWF (CMF of 0.9)
- To account for benefit occurring on the lead-in leg, 10% CCRF reduction of total rear end and angle crashes was further adjusted to 20% CCRF for target crashes on AAWF approach.

2013 Re-evaluation HSM Methods

What's different?

Primarily Safety Performance Functions....



$$N_{\text{RE \& Angle}} = 1.63E-05 \times AADT^{1.4069}$$ **vs.**

HSM SPF, Intersections, Multi-vehicle Collisions

$$N_{bimv} = exp(a + b \times In(AADT_{maj}) + c \times In(AADT_{min})) \quad (12\text{-}21)$$

Where:

$AADT_{maj}$ = average daily traffic volume (vehicles/day) for major road (both directions of travel combined);

$AADT_{min}$ = average daily traffic volume (vehicles/day) for minor road (both directions of travel combined); and

a, b, c = regression coefficients.

Table 12-10. SPF Coefficients for Multiple-Vehicle Collisions at Intersections

	Coefficients Used in Equation 12-21			
Intersection Type	Intercept (a)	$AADT_{maj}$ (b)	$AADT_{min}$ (c)	Overdispersion Parameter (k)
Total Crashes				
3ST	−13.36	1.11	0.41	0.80
3SG	−12.13	1.11	0.26	0.33
4ST	−8.90	0.82	0.25	0.40
4SG	−10.99	1.07	0.23	0.39
Fatal-and-Injury Crashes				
3ST	−14.01	1.16	0.30	0.69
3SG	−11.58	1.02	0.17	0.30
4ST	−11.13	0.93	0.28	0.48
4SG	−13.14	1.18	0.22	0.33
Property-Damage-Only Crashes				
3ST	−15.38	1.20	0.51	0.77
3SG	−13.24	1.14	0.30	0.36
4ST	−8.74	0.77	0.23	0.40
4SG	−11.02	1.02	0.24	0.44

HSM Analysis

- Used HSM Chapter 12 methods to compute expected right angle and rear end collisions in the before period.
- HSM Chapter 9, Appendix 9A publishes the EB before-after methodology. Guidelines for use:
  - 10 to 20 sites (failed, only 4)
  - 3 to 5 years before and after (used same 3 years at in 2009 work)
  - SPF required (used HSM Multivehicle SPF)
  - Can ignore crash modification factors (e.g. auxiliary turn lanes) and calibration factors.
- No Alaska Calibration of HSM SPF

HSM Results

- Before-after study computes an AAWF CMF of 1.01 for all intersection rear-end and angle collisions (compared to 0.9 in 2008).
- 95% CI [0.86,1.16]
- Shows a potential increase, or "no effect" (about 1.0). Not significant at the 95% confidence level.
- Disagreement between the 2009 and 2013 results is believed to be attributed to the uncalibrated SPF for the signals.
- Recall HSM EB Before After methods do not require a calibration or application of CMF

- Expected rear end and angle collisions computed by HSM SPF is about 20% to 25% observed collisions (calibration of 4 to 5 required).
- In this particular case, effect of this gap between predicted and observed caused by:
  - As w, weighting factor, f(k, $N_{p\ before}$), increases, this in turn reduces $N_{E\ after}$
  - CMF = $N_{O\ after}$ / $N_{E\ after}$

What-if analysis

- Calibrating HSM SPF with a C=4.4:
  - CMF=0.91
  - 95% CI [0.78,1.06]
- Calibration indicates that CMF would may be of benefit in reducing rear-end angle crashes, but we can't be sure (at a 95% confidence level).

Conclusions

- Effectiveness of AAWF in reducing rear-end and angle collisions on “gateway” signals:
  - 2009 study indicated a benefit, CMF 0.9, of AAWF installation in reducing target crashes, but was not significant at 95% confidence level.
  - 2013 HSM methods did not indicate improvement, CMF>1.
- Calibration of HSM SPF was likely <u>one</u> factor for difference between 2009 and 2013 results.
- In light of the above, CMF of 0.9 (angle & rear end) seems reasonable for AAWF installations.

Final Thoughts

- Before After Studies using HSM SPF and methods may be sensitive to calibration.
  - Low sites
  - Incomplete data
- The general SPF presented in the HSM may not apply to your case.

Thanks for your attention

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Alaska Policy on AAWF

- Appear distinctively different than standard flashing signal ahead signs/beacons to alert drivers to its different meaning (impending yellow indication)
- Communicate at a glance that the warning refers to a signal, not construction activity, pedestrian crossing, etc.
- When the power goes out, it should not imply to drivers that they may proceed through the intersection, as a non-flashing “Prepare to Stop When Flashing” sign does.
- Be easily visible from all lanes on the approach.
- AAWF will be “dark” during the green indication for the approaching movement. The Municipality of Anchorage uses 5 seconds prior to the change to yellow indication for the activation of the AAWF

- The revised CCRF in the HSIP Handbook was published as 20% for angle and rear end for AAWF approach. Assumes that these crashes are distributed proportional to leg AADT

$$CRF_{AAWF\_Approach} = 1 - \frac{PEV_{AAWF\_Approach} - 0.10}{PEV_{AAWF\_Approach}}$$

$PEV_{AAWF\_Approach}$ is the proportion of enter volume that enter the intersection on the AAWF lead-in approach.

PEV AAWF_Approach	CRF AAWF_Approach
0.25	40%
0.3	33%
0.4	25%
0.5	20%