All Models are Wrong, but Some are Useful

State Specific Calibration Factors and Safety Performance Functions

presented to

Louisiana Transportation Conference

presented by

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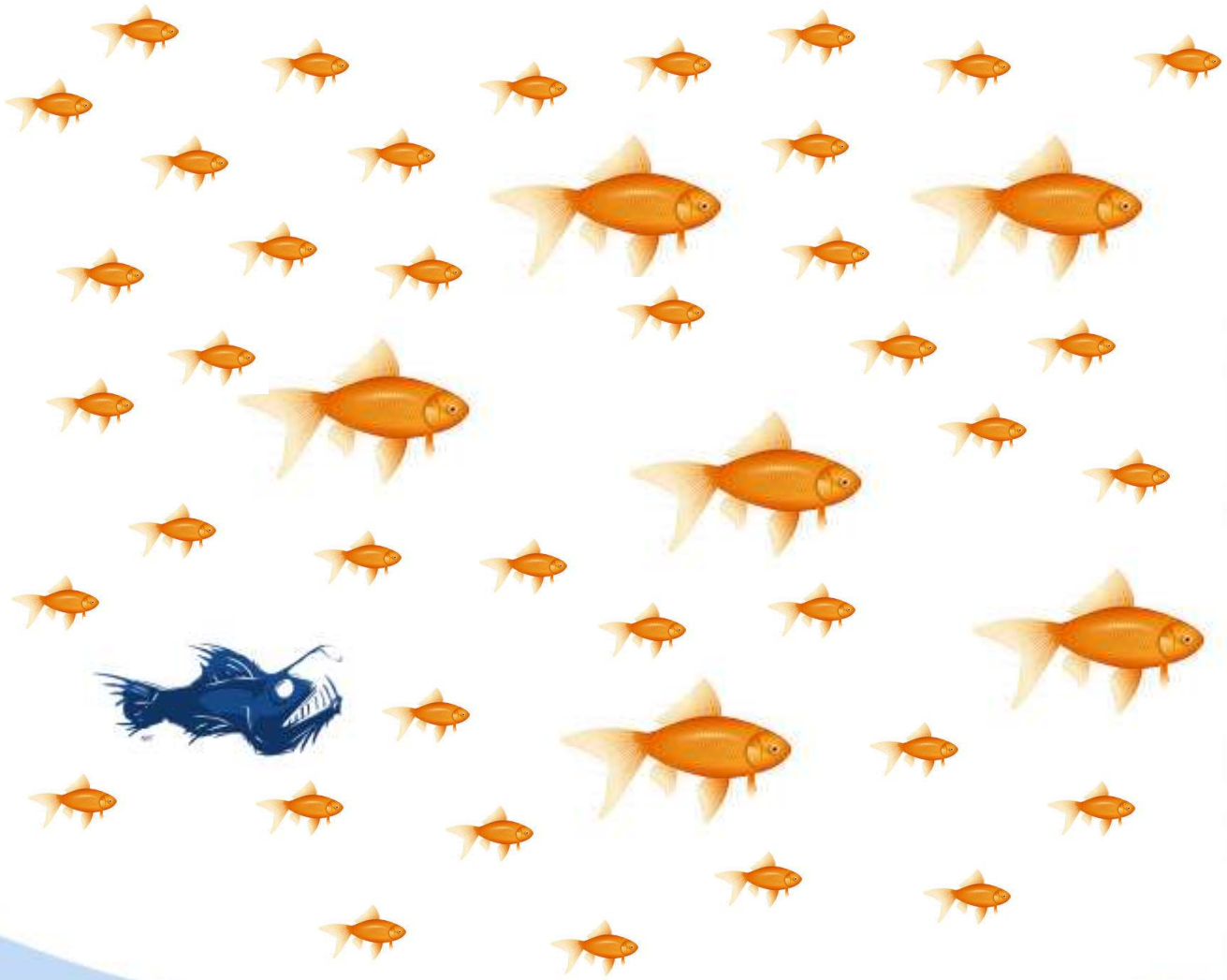
Process

- Network screening
- Problem Identification
- Alternatives Analysis & Countermeasure Selection
- Economic Evaluation
- Prioritization

NETWORK SCREENING

Network Screening



Network Screening

- **High PSI List**
  - » **Number-rate method**
  - » **Calibrated SPFs from the HSM**
  - » **State-specific SPFs**
- **Systemic Approach**
- **Other**

First man invented fire, then the

NUMBER-RATE METHOD

Number-Rate Method

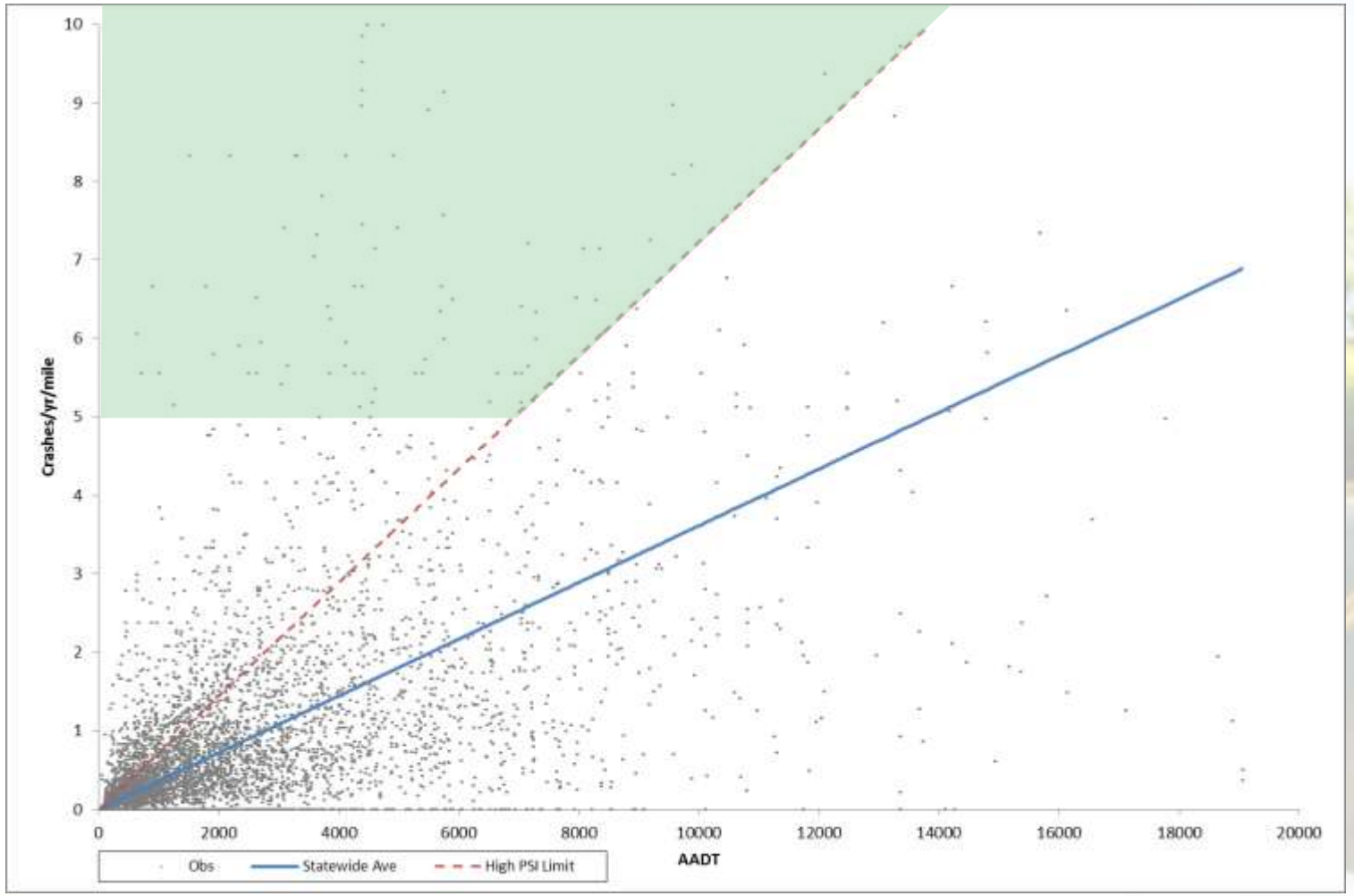
- **Statewide averages by roadway classification based on:**

- **AADT, Length and Crashes/yr**

$$Crash\ Rate = \frac{crashes}{yrs * Length * AADT} * 10^6$$

Conditions for High PSI (Potential for Safety Improvements):
- at least 5 crashes on the section per year
- at least 5 crashes per mile on the section per year
- The crash rate must be at least twice the state average

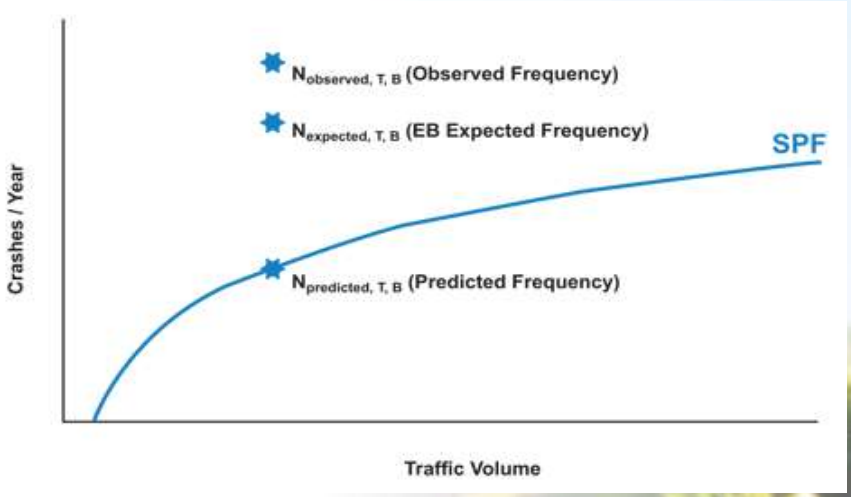
Number-Rate Method

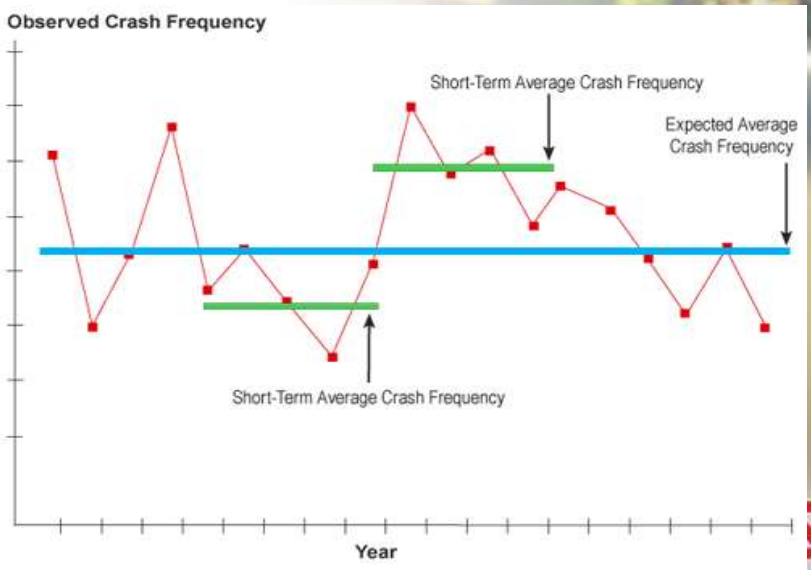


Fast forward to 2010…

HSM SPFs AND CALIBRATED MODELS

HSM SPFs and Calibrated Models





HSM SPFs and Calibrated Models

Data Element	Facility Type		
	Rural 2-lane	Rural 4-lane	Urban
Segment Length			
Average Annual Daily Traffic			
Lane Width			
Shoulder Type	*		
Shoulder Width			
Presence of Lighting	*	*	*
Driveway Density	*		
Presence of Center TWLTL			
Presence of Centerline Rumble Strip	*		
Roadside Hazard Rating	*		
Use of Automated Speed Enforcement	*	*	*
Sideslope		*	
Median Width			
Number of Through Traffic Lanes			
Presence of Median			
Number of Driveways by Land-Use Type			*
Low Speed vs. Intermediate or High Speed			*
Presence of On-Street Parking			*
Type of On-Street Parking			*
Roadside Fixed Object Density			*

	Not Applicable to this facility type
	Data element available in Louisiana Roadway Database
*	Data element gathered in additional data collection effort

- **Extensive data requirements**

HSM SPFs and Calibrated Models

- **First Calibration Efforts**

Calibration by Contract	1st Iteration			2nd Iteration		
Facility Type	**50' Removed**	**150' Removed**	**250' Removed**	**50' Removed**	**150' Removed**	**250' Removed**
Rural Two Lane	1.19	1.05	0.98	1.13	0.97	0.86
Rural Multilane Undivided	1.04	0.68	0.49	0.91	0.62	0.47
Rural Multilane Divided	3.27	2.39	1.73	2.41	1.92	1.62
Urban Two Lane	3.23	2.00	1.48	2.74	1.91	1.39
Urban Three Lane with TWLTL	0.25	0.14	0.03	0.49	0.26	0.18
Urban Four Lane Undivided	3.72	1.70	1.03	3.20	1.59	0.91
Urban Four Lane Divided	6.20	3.73	2.54	3.89	2.54	1.92
Urban Five Lane with TWLTL	0.05	0.04	0.02	0.07	0.06	0.05

HSM SPFs and Calibrated Models

- **In-House Calibration Efforts**

Facility Type	Out-house 1	Out-house 2	In-house 1
Rural Two Lane	1.19	1.13	0.97
Rural Multilane Undivided	1.04	0.91	0.97
Rural Multilane Divided	3.27	2.41	0.90
Urban Two Lane	3.23	2.74	2.11
Urban Three Lane with TWLTL	0.25	0.49	4.31
Urban Four Lane Undivided	6.20	3.89	2.47
Urban Four Lane Divided	3.72	3.20	1.65
Urban Five Lane with TWLTL	0.05	0.07	2.63

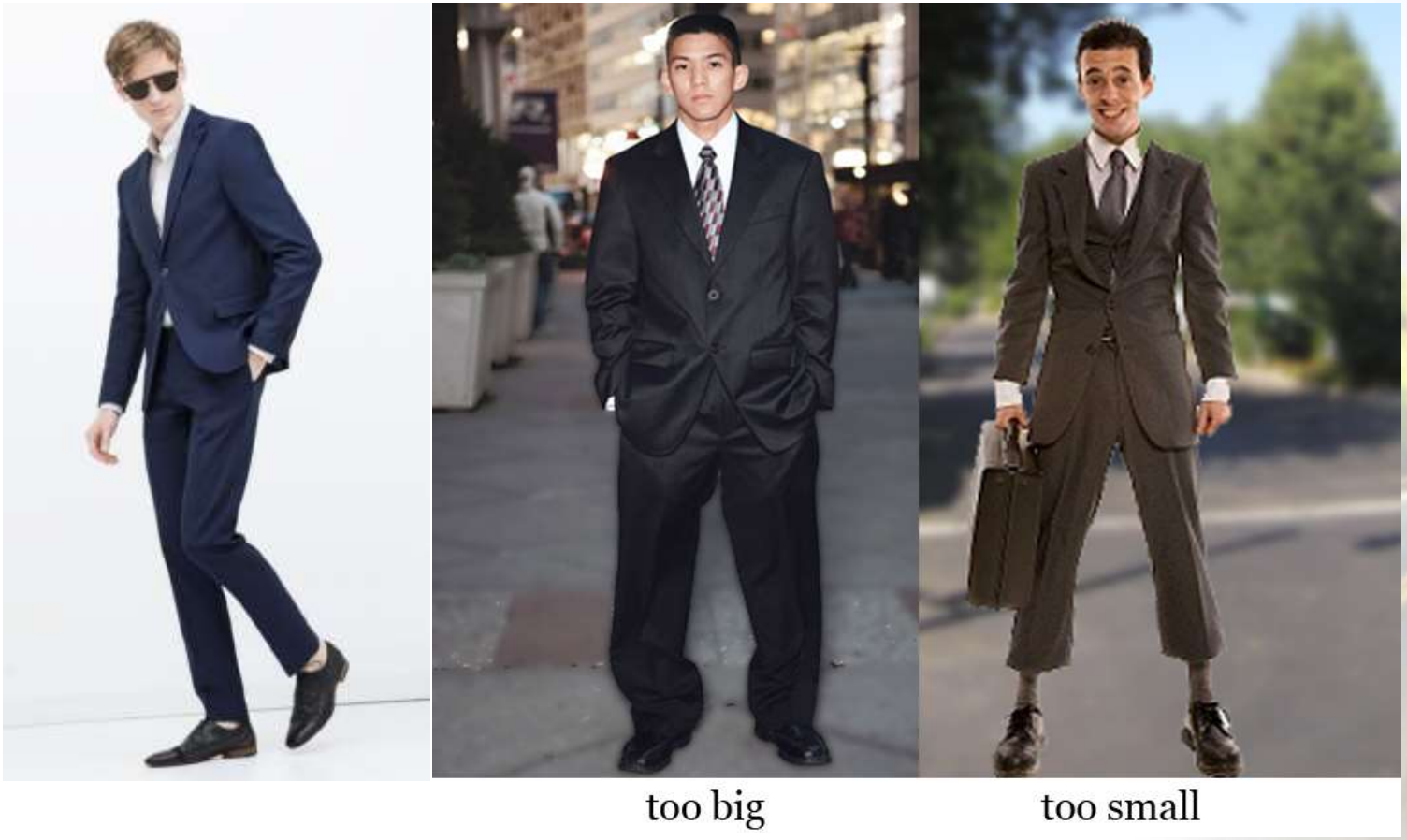
HSM SPFs and Calibrated Models

- **NCHRP 20-07 User's Guide to Calibration**

Facility Type	CF
Rural Two Lane	**0.93**
Rural Multilane Undivided	**1.06**
KABCO	1.06
KABC	0.59
KAB	0.36
Rural Multilane Divided	**1.22**
KABCO	1.22
KABC	0.63
KAB	0.27

Facility Type	Calibration Factors		
Urban Two Lane	**2.50**		
	M.V. n-dwy	**Single Veh**	**M.V. dwy**
KABCO	3.38	2.23	1.62
KABC	3.57	3.37	NA
PDO	3.31	1.86	NA
Urban Three Lane with TWLTL	**4.53**		
	M.V. n-dwy	**Single Veh**	**M.V. dwy**
KABCO	2.91	3.19	2.69
KABC	3.35	3.51	NA
PDO	2.76	3.07	NA
Urban Four Lane Undivided	**3.18**		
	M.V. n-dwy	**Single Veh**	**M.V. dwy**
KABCO	4.71	1.22	2.14
KABC	4.13	1.77	NA
PDO	4.96	1.04	NA
Urban Four Lane Divided	**2.14**		
	M.V. n-dwy	**Single Veh**	**M.V. dwy**
KABCO	2.51	2.06	1.12
KABC	2.49	2.64	NA
PDO	2.51	1.84	NA
Urban Five Lane with TWLTL	**3.03**		
	M.V. n-dwy	**Single Veh**	**M.V. dwy**
KABCO	3.45	0.64	3.55
KABC	3.82	0.97	NA
PDO	3.32	0.54	NA

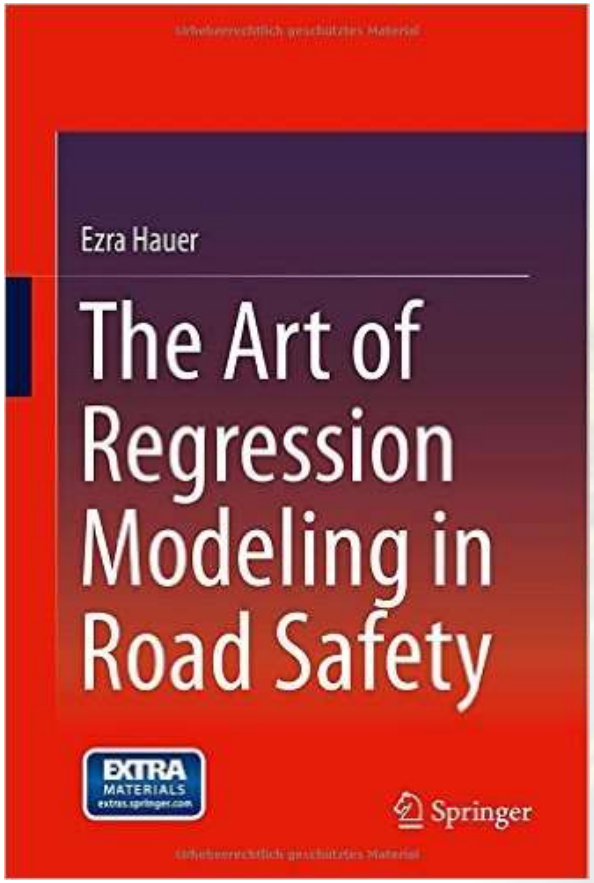
HSM SPFs and Calibrated Models



Now…

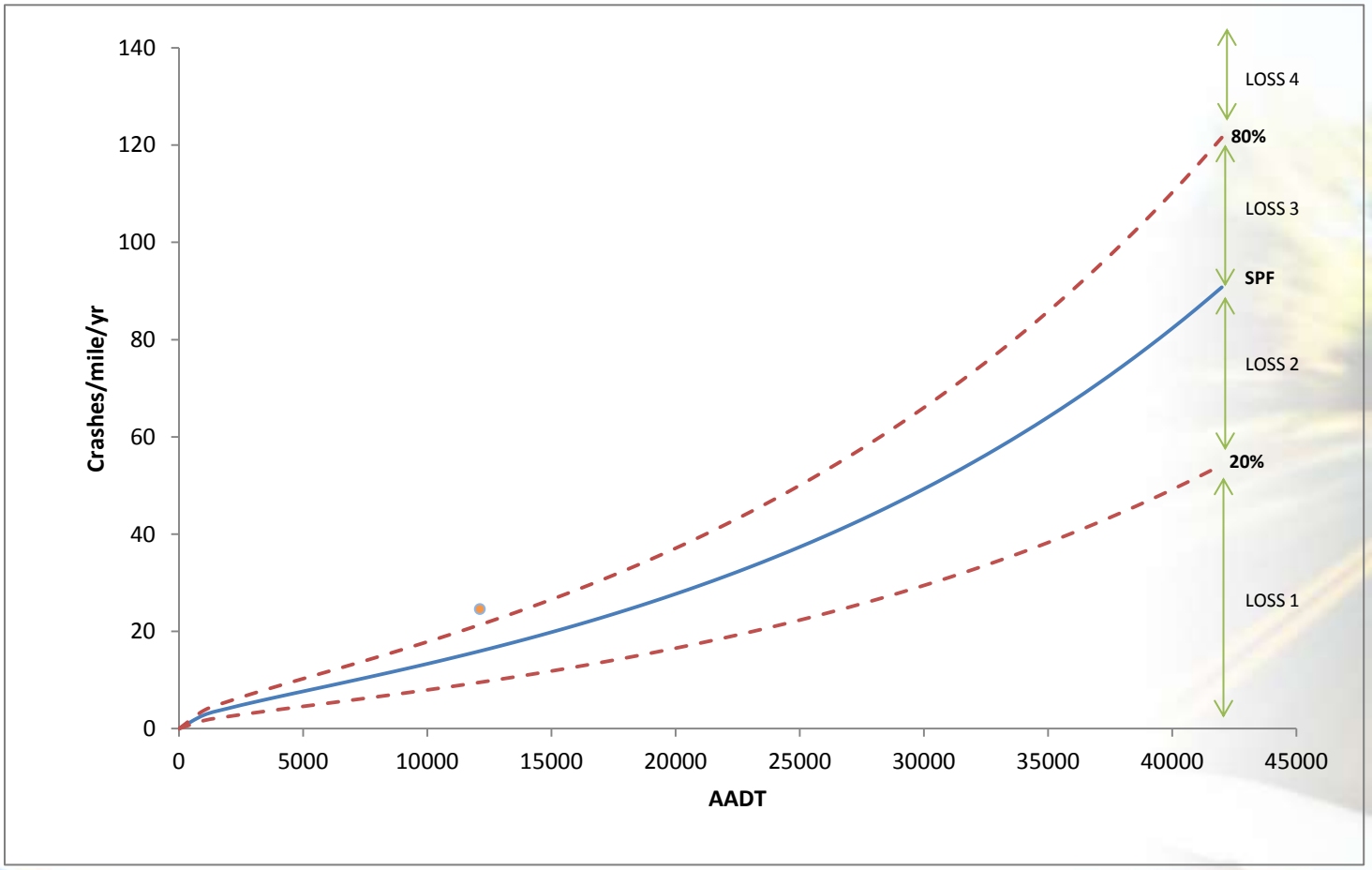
REGRESSION MODELING

Regression Modeling



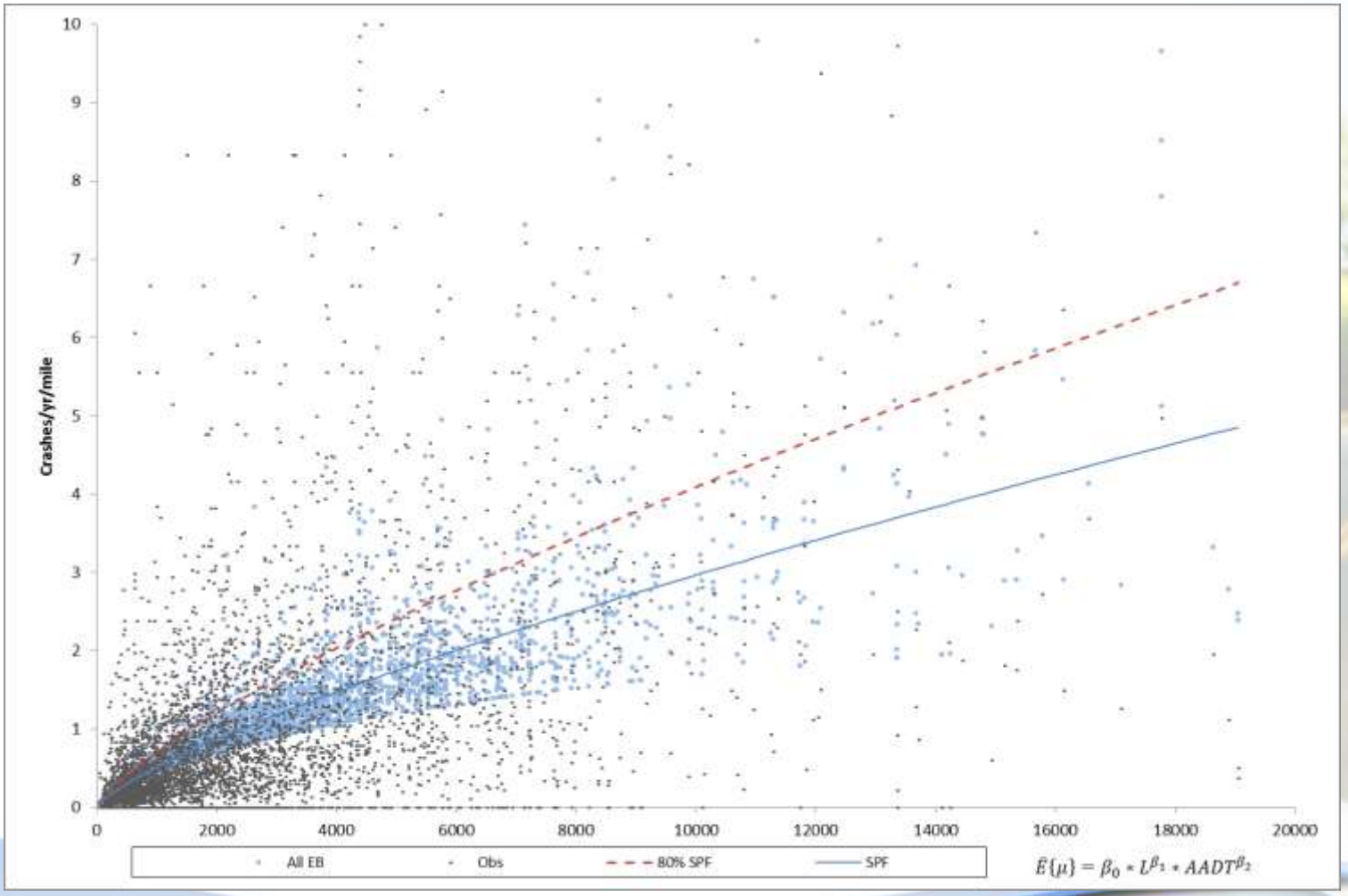
Regression Modeling

- Level of Service of Safety



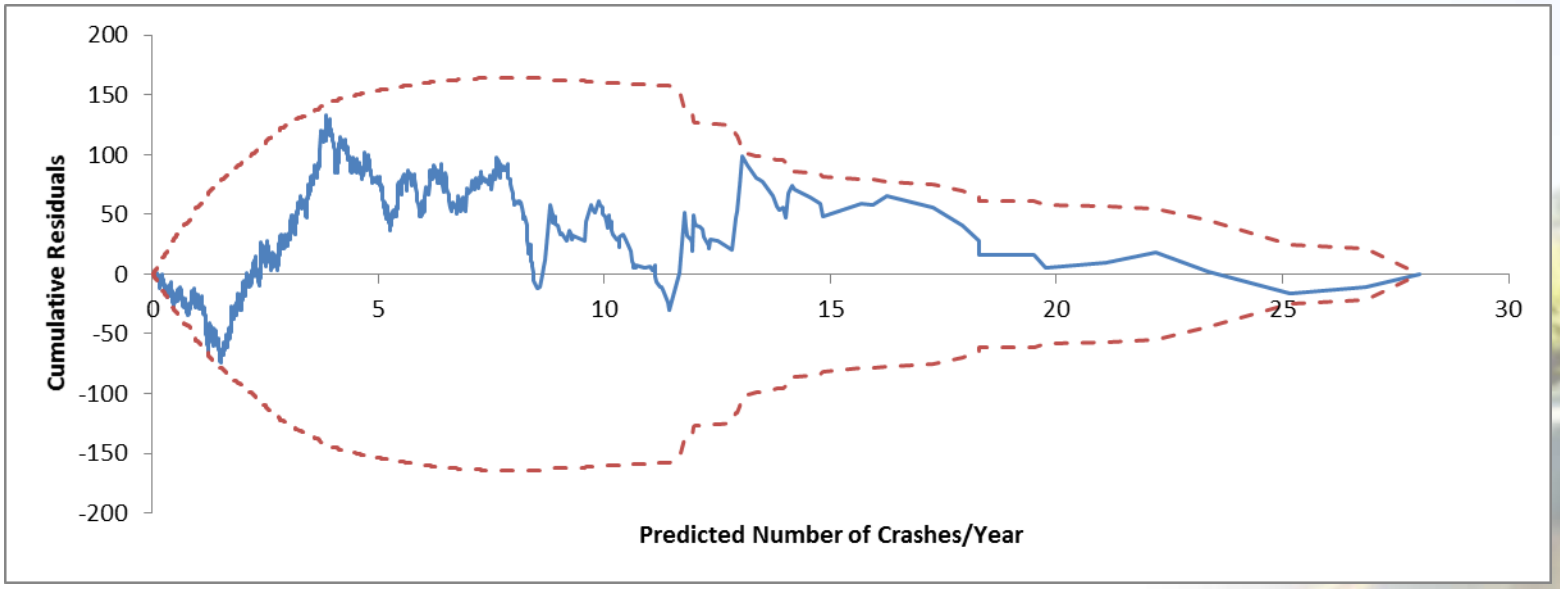
Regression Modeling

- **Louisiana Specific SPF - Rural 2 Lane - Roadway Segments**



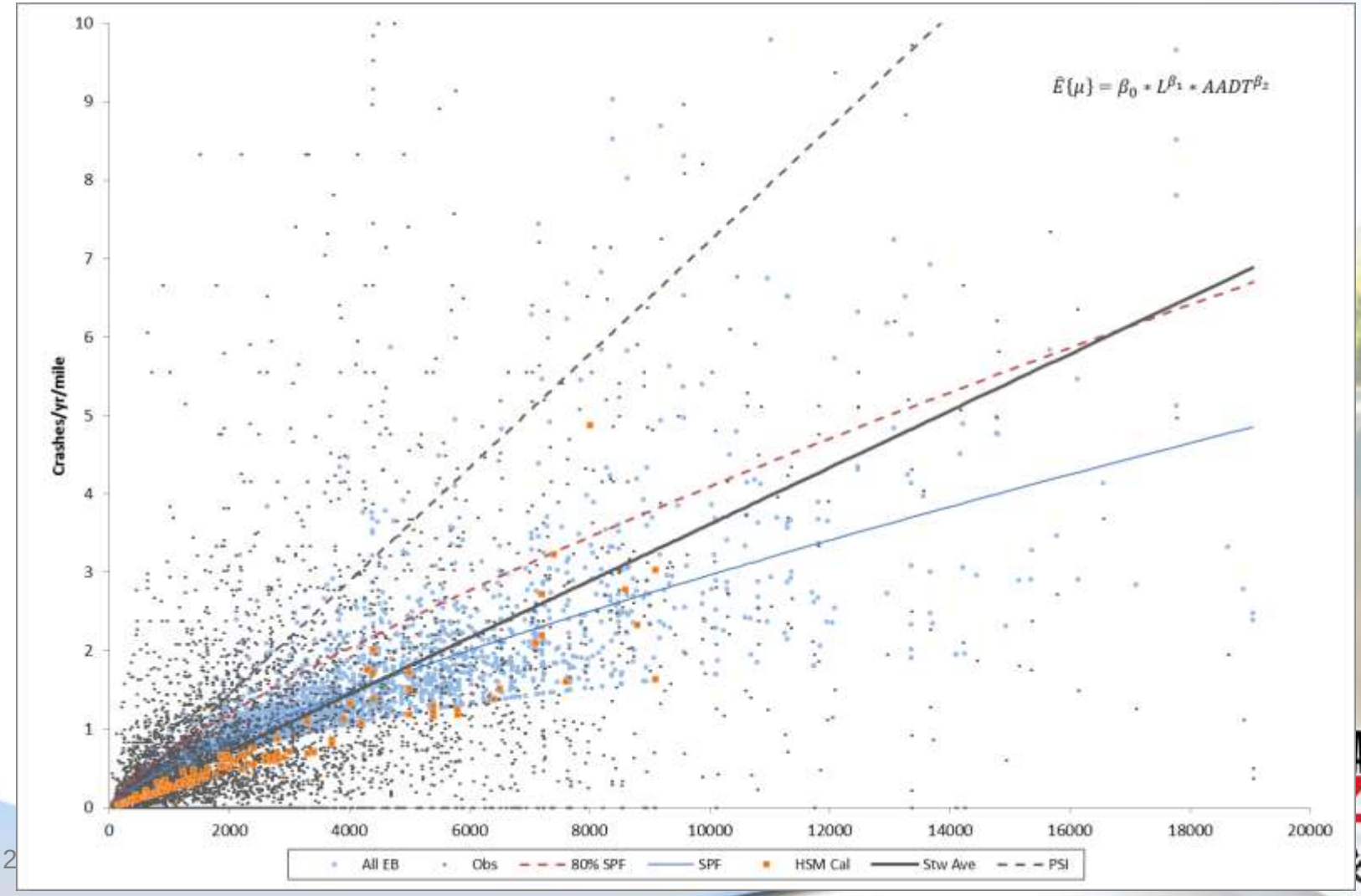
Regression Modeling

- **Rural 2 Lane SPF – CURE plot**



Regression Modeling

- **Number-Rate, Calibrated HSM SPFs, LA Specific SPF**



PROBLEM IDENTIFICATION

Problem Identification Issues

- **Hidden Over-representation**

	mile 1	mile 2	mile 3	mile 4	mile 5
Rwy Departures =	2	2	7	3	1
Other =	8	8	3	7	9
Total =	10	10	10	10	10

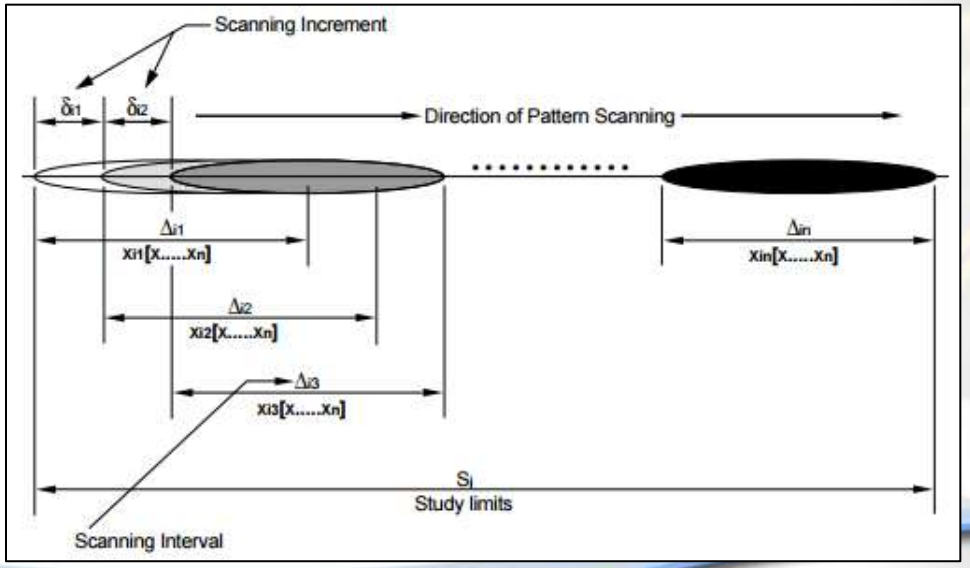
Rwy Departures =	15
Other =	35
Total =	50

Rwd state average = 32%

All segment = 15 out of 50 = 30%

“Mile 3” only = 7 out of 10 = 70%

PRA →



Problem Identification Issues

- **Crashes as Bernoulli or Binomial Trials**

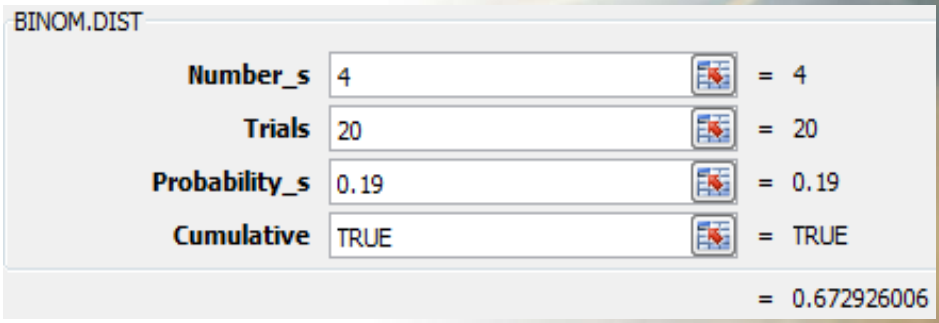
“Success” or “failure” →

Example:

- ✓ 1-mi long segment
- ✓ 4 rdw departures
- ✓ 20 total crashes
- ✓ 19% statewide average for rwds

Direct comparison = 4/20 = 20%

Direct comparison = 4/20 = 20%



CRASH DATA ANALYSIS
SPFs and PRA

Crash Data Analysis – SPFs and PRA

- **Similar to going to the doctor**
  - » **Paperwork and info about yourself**
  - » **Minimal measurements and habits**
  - » **Comparison to population (baselines)**
  - » **More comprehensive exams**

✓ **Issues**
✓ **Location**
✓ **Treatment options**

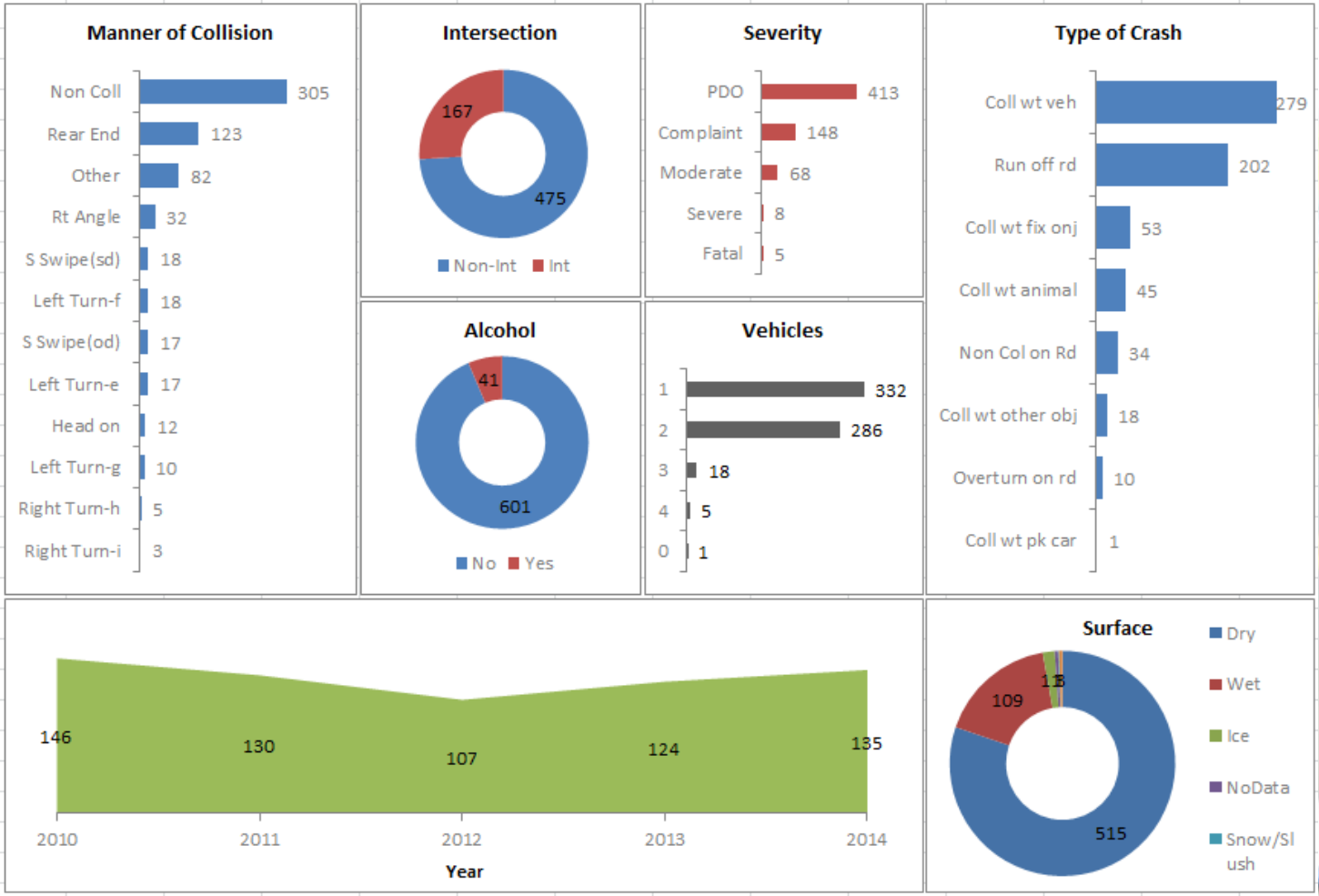
Crash Data Analysis – SPFs and PRA

- Know your location (paperwork)

Project Name/Number =	Example
Route =	LA 315
Control Section =	245-90
Logmile From =	4.05
Logmile To =	5.56
AADT =	1987
Highway Class =	Rural 2-Lane

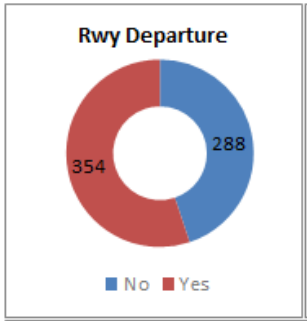
Crash Data Analysis – SPFs and PRA

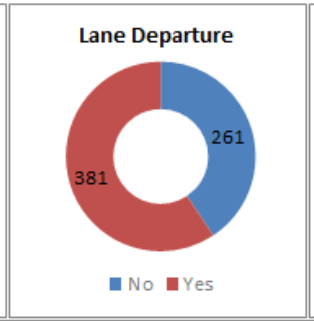
- **Crash History in CAT Scan (measurements and habits)**

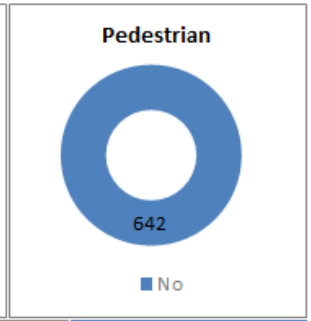


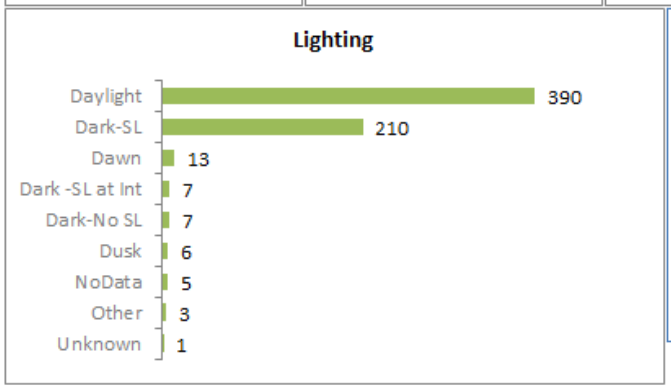
Crash Data Analysis – SPFs and PRA

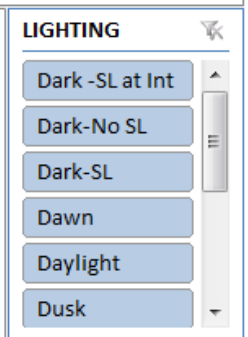
Hour Range	MON	TUE	WED	THU	FRI	SAT	SUN
NoData			1	1	1		
0-2	4	2	2	2	6	11	9
3-5	11	8	5	9	9	6	13
6-8	10	20	24	8	24	7	6
9-11	13	9	14	8	15	18	15
12-14	8	10	10	7	15	16	9
15-17	17	20	20	15	32	16	18
18-20	10	9	11	10	21	11	12
21-23	6	5	9	4	11	13	6

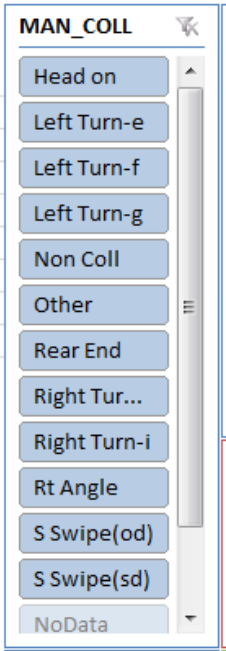


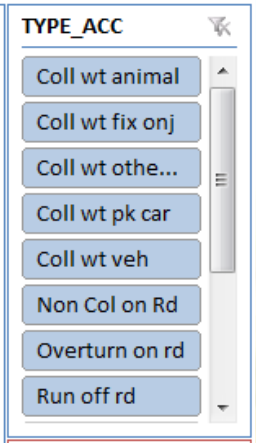


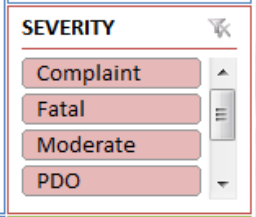


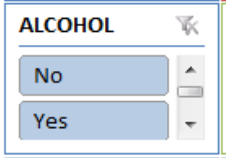


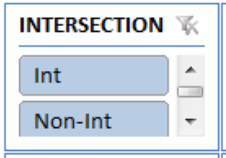


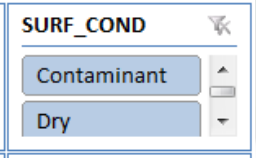


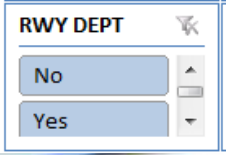


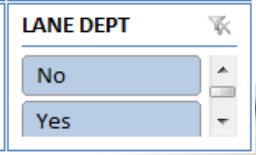












Crash Data Analysis – SPFs and PRA

- **Network Screening in CAT Scan (comparison to baselines)**

Network Screening

Project Name/Number =	Example	
Route =	LA 315	
Control Section =	245-90	(i.e XXX-XX)
Logmile From =	4.05	(i.e XX.XX)
Logmile To =	5.56	(i.e XX.XX)
AADT =	1987	(Average of last 3 yrs)
Highway Class =	Rural 2-Lane	

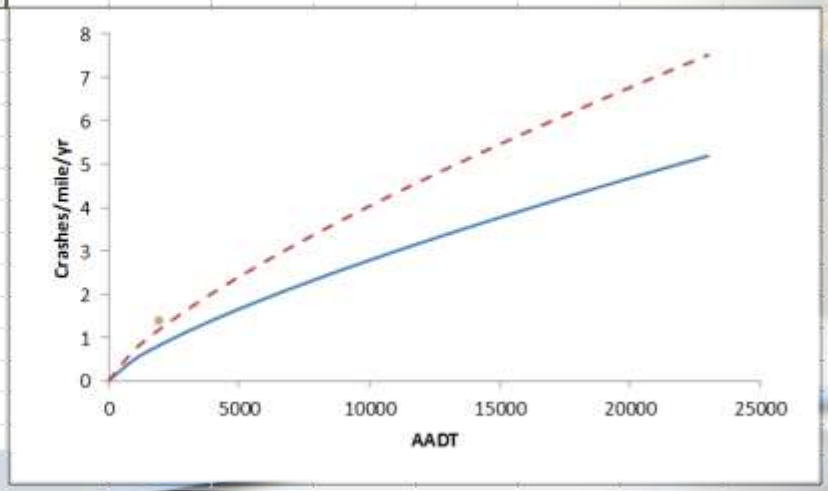
All Crashes - Safety Performance Function (SPF)

All Crashes - Rural 2-Lane SPF

$$\hat{E}\{\mu\} = \beta_0 * L^{\beta_1} * AADT^{\beta_2}$$

β_0	β_1	β_2	β_3	b
0.0028	0.9458	0.7489	0.0000	2.6400

Observed Crashes =	4.67	Crashes/yr
Predicted Crashes (SPF) =	1.22	Crashes/yr
Overdispersion Parameter =	0.26	
Weighted Adjustment =	0.76	
Segment Length =	1.51	mile
Observed Crashes =	3.09	Crashes/mile/yr
Predicted Crashes (SPF) =	0.83	Crashes/mile/yr
Expected Crashes (SPF + EB) =	1.39	Crashes/mile/yr
Statewide Average =	0.83	Crashes/mile/yr
80th Percentile =	1.20	Crashes/mile/yr
Level of Service of Safety =	LOSS 4	



Crash Data Analysis – SPFs and PRA

- **Pattern Recognition Analysis in CAT Scan**

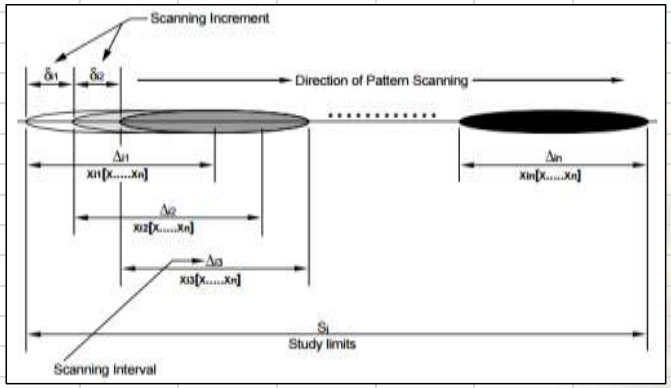
Pattern Recognition Analysis

Control Section =	245-90	(i.e XXX-XX)
Logmile From =	4.05	(i.e XX.XX)
Logmile To =	5.56	(i.e XX.XX)
AADT =	1987	(Average of last 3 yrs)
Highway Class =	Rural 2-Lane	

Δ =	0.50	miles
δ =	0.02	miles
Percent Cutoff =	95%	%
Possible Δs =	54	
AADT Group =	Low	

Run Deltas

Run Patter Recognition Analysis

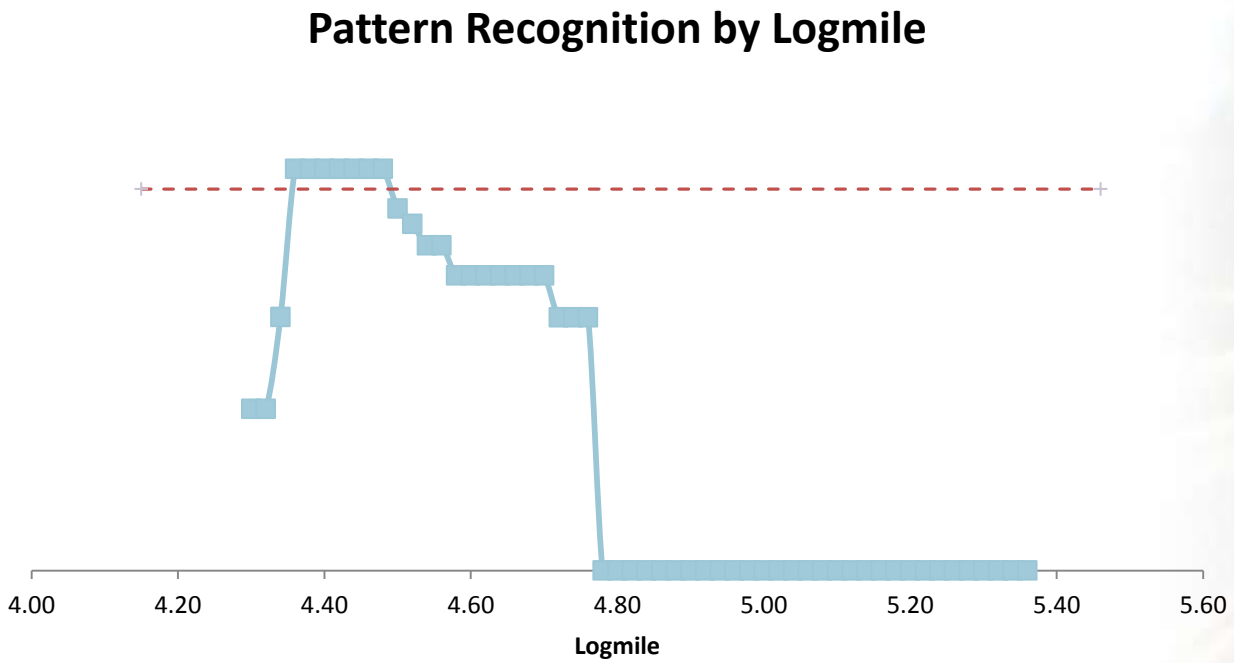


Code	Category	Obs %	State %	Δs > Cutoff	
A	Fatal	0.00%	1.99%	0	☐
B	Severe	0.00%	1.02%	0	☐
C	Moderate	14.29%	10.48%	3	☐
D	Complaint	35.71%	28.03%	5	☐
E	None	50.00%	58.47%	0	☐
A	Run off rd	50.00%	56.33%	0	☐
B	Overturn on rd	0.00%	0.64%	0	☐
C	Coll wt ped	0.00%	0.46%	0	☐
D	Coll wt veh	28.57%	24.62%	13	☐
E	Coll wt pk car	0.00%	0.32%	0	☐
F	Coll wt train	0.00%	0.06%	0	☐
G	Coll wt bicycle	0.00%	0.06%	0	☐
H	Coll wt animal	14.29%	10.29%	12	☐
I	Coll wt fix obj	0.00%	3.08%	0	☐
J	Coll wt other obj	0.00%	1.80%	0	☐
K	Non Col on Rd	7.14%	2.34%	0	☐

Code	Category	Obs %	State %	Δs > Cutoff	
A	Non Coll	42.86%	67.33%	7	☐
B	Rear End	14.29%	11.32%	0	☐
C	Head On	0.00%	1.62%	0	☐
D	Rt Angle	21.43%	3.36%	2	☐
E	Left Turn-e	0.00%	2.62%	0	☐
F	Left Turn-f	7.14%	1.36%	0	☐
G	Left Turn-g	0.00%	0.65%	0	☐
H	Right Turn-h	0.00%	0.27%	0	☐
I	Right Turn-i	0.00%	0.23%	0	☐
J	S Swipe(sd)	7.14%	2.49%	0	☐
K	S Swipe(od)	7.14%	3.77%	0	☐
Z	Other	0.00%	4.94%	0	☐
1	Roadway dept.	50.00%	71.78%	7	☑
1	Lane Dept.	85.71%	79.28%	10	☐
B	Night (Dark-B)	14.29%	37.60%	0	☐
1	Alcohol	0.00%	11.36%	0	☐
B	Wet surface	7.14%	18.23%	0	☐

Crash Data Analysis – SPFs and PRA

- Pattern Recognition Analysis in CAT Scan



Resources

- Guidelines:
  - Crash Data Analysis **using the Number-Rate Method and Over-represented Determination**
  - Crash Data Analysis **using Safety Performance Functions and Pattern Recognition Analysis**
- Tools:
  - **CAT Scan**
  - **DART**
  - **Vision Zero Suite**
  - **Crash 1**

Contact Information

- **Website:**
  - **http://www.dotd.la.gov/planning/highway_safety**
- **Email:**
  - **DOTD-HighwaySafety@la.gov**

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