

Characterizing High Crash Locations Involving DUI:

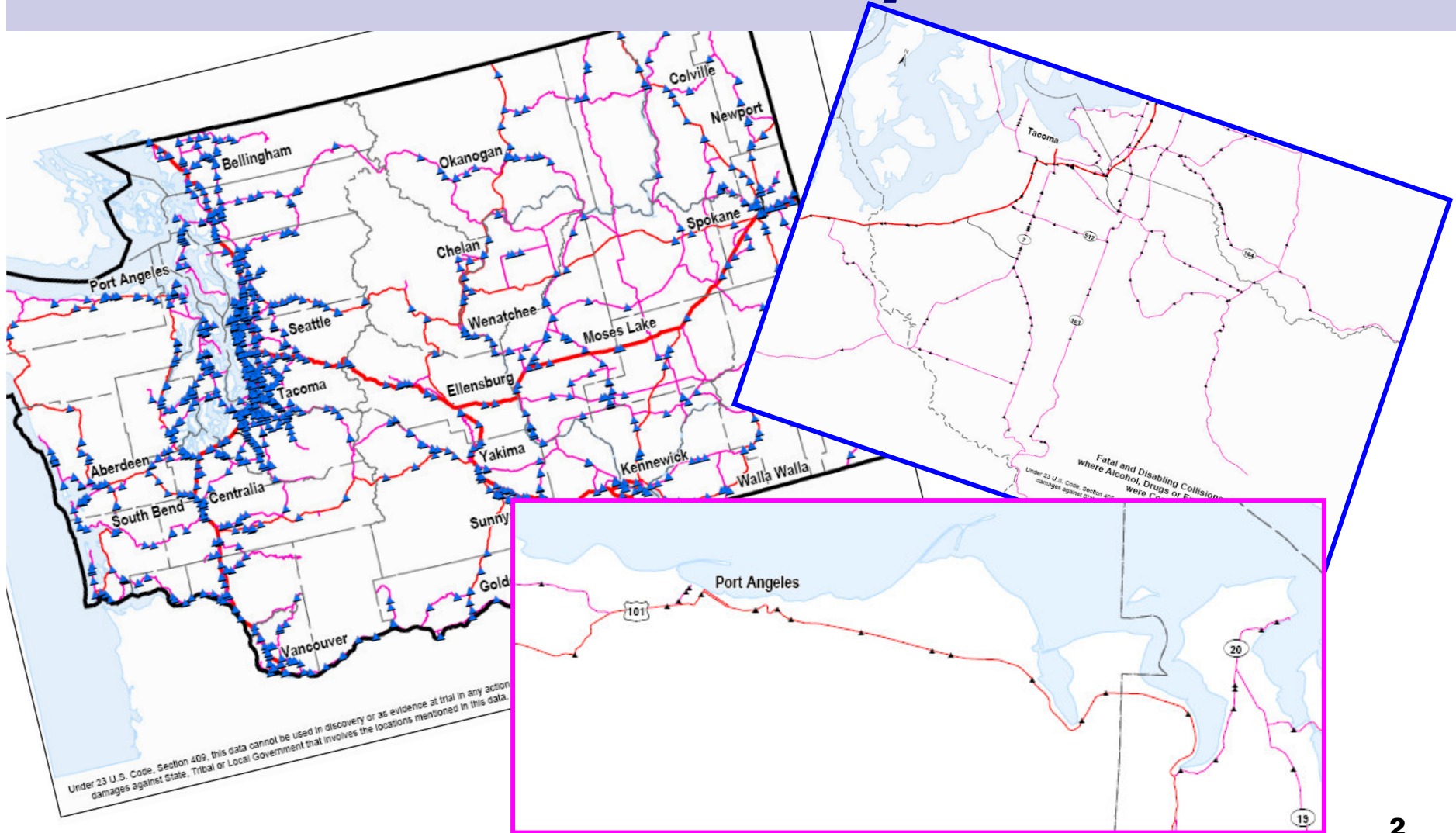
*Using GIS-based Visualization and Spatial
Analysis to Determine Appropriate Safety
Strategies*

July 23, 2007

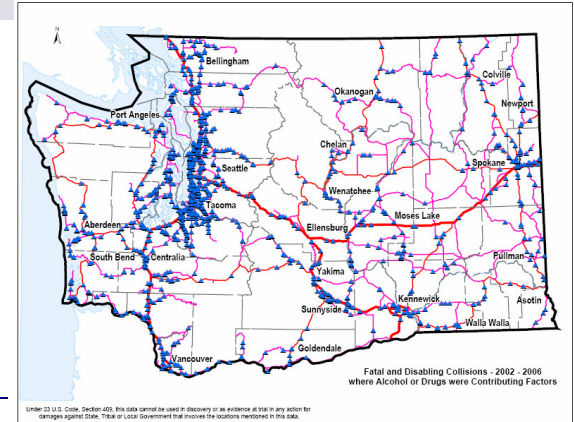
**Presented to International Traffic Records
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Anna Yamada, Washington State DOT
Mike Bernard, Washington State DOT
Roger E. Horton, Washington State DOT

How do we look beyond DOTS on the Maps?



Identifying High Crash Locations



- 1. Investigated influential factors to DUI Collisions (Spatial/Non-spatial data)**
- 2. “Explore” methods of identifying hot spots**
- 3. Characterize DUI hot spots**



1. Influential Factors



DUI Collisions in Washington State Highways: Overview

- All reportable collisions (no citizens reports)
- State Routes – Mainlines (incl. CO, SP, AR)
- Total 200,956 collisions during 2002 through 2006
- A total of 11,938 DUI-involved collisions (1,166 were F&D, and 2,829 were evident injury collisions)



Seasonality

- ❑ Only fatal and disabling injury DUI crashes showed seasonality (i.e., summer time 23% higher than the average non-summer months)
- ❑ Evident injury or lesser severity DUI crashes *did not* have definite seasonal pattern.

Time of Day

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Time of Day and Day of Week DUI Collisions (All Severities): 2002 - 2006

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Total
Midnight	46	40	66	72	71	149	148	592
1AM	59	49	49	57	93	209	188	704
2AM	47	41	49	71	99	222	216	745
3AM	18	17	24	31	39	131	113	373
4AM	20	14	20	19	24	60	92	249
5AM	12	11	14	17	19	49	57	179
6AM	12	7	16	12	17	38	58	160
7AM	19	12	12	21	16	28	29	137
8AM	8	13	16	13	23	25	22	120
9AM	16	13	11	14	12	24	17	107
10AM	12	13	14	15	22	26	19	121
11AM	10	22	18	13	32	16	18	129
Noon	20	18	20	29	34	31	24	176
1PM	28	17	27	19	25	35	34	185
2PM	33	18	30	30	44	48	41	244
3PM	42	48	35	35	54	61	37	312
4PM	52	57	46	60	73	86	56	430
5PM	66	70	63	61	120	82	82	544
6PM	77	64	62	86	130	105	82	606
7PM	72	59	66	68	107	123	86	581
8PM	66	68	71	102	88	115	79	589
9PM	71	69	88	72	125	122	86	633
10PM	66	67	63	73	148	132	82	631
11PM	64	51	68	82	128	146	60	599
Total	936	858	948	1,072	1,543	2,063	1,726	9,146

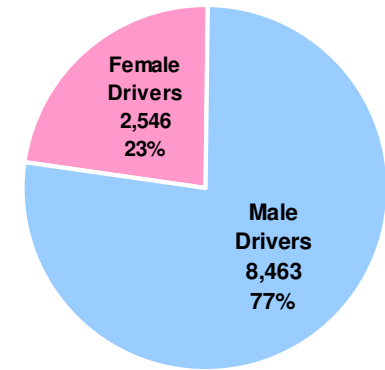
From Happy
Hours through
early morning

Starting Friday
evening and
ending early
Sunday
morning

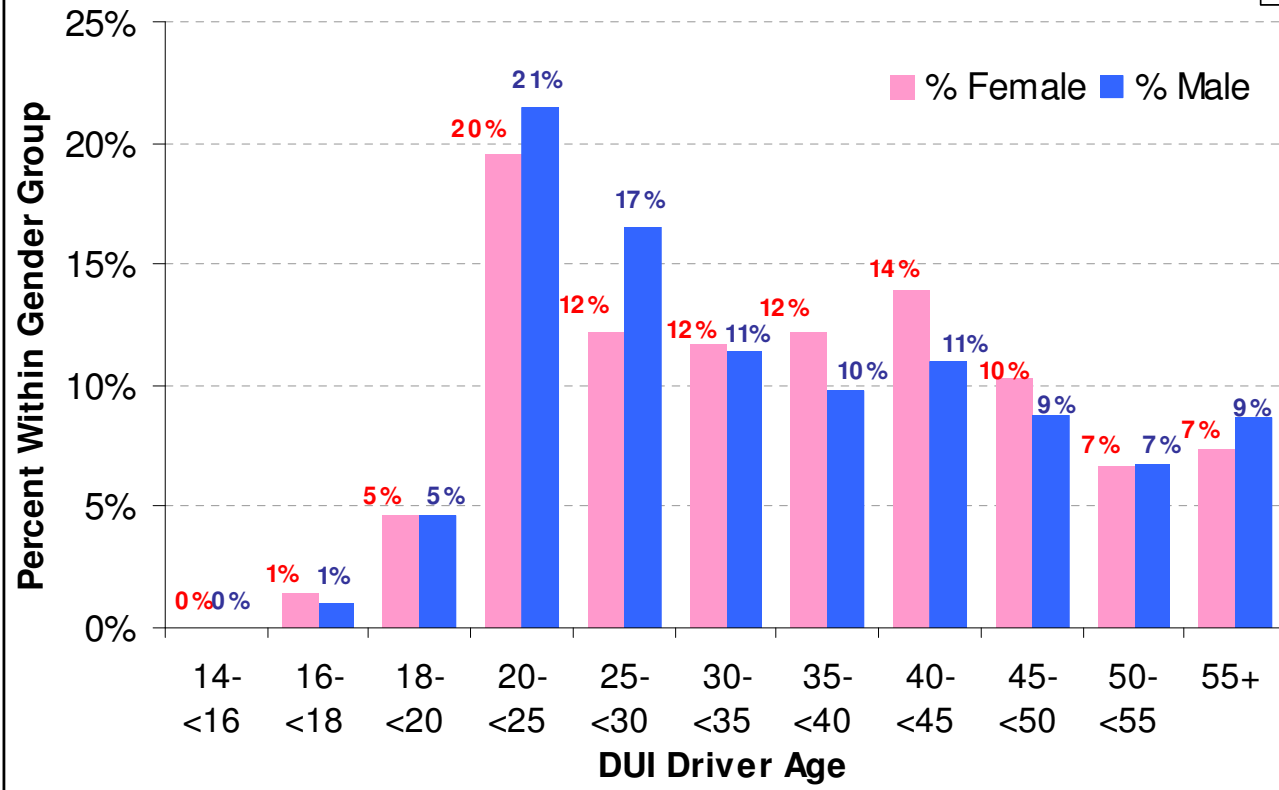
The worst hour is
2 AM

DUI Driver Demographics

DUI Drivers by Gender
All DUI Involved Collisions
2002 - 2006



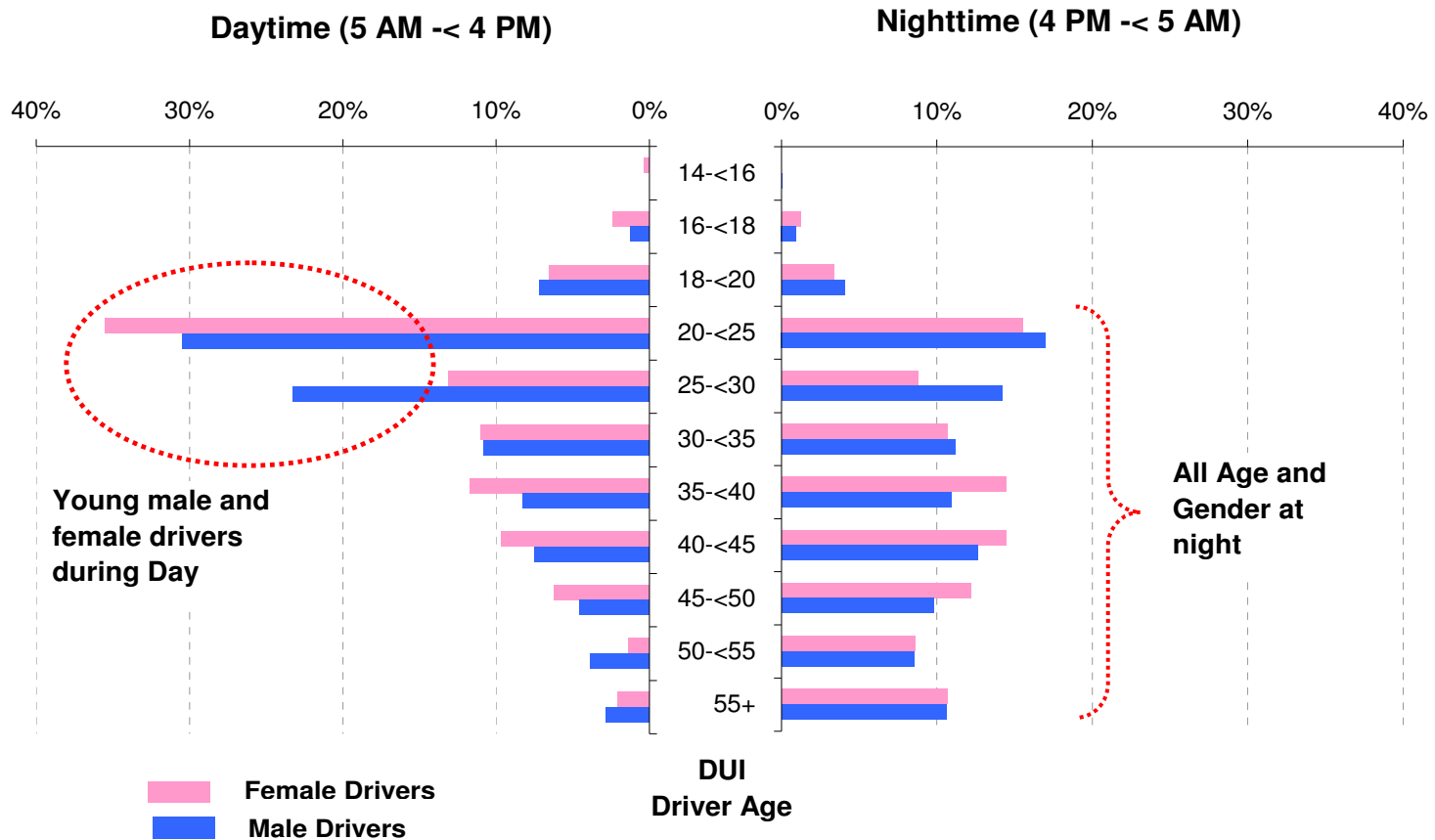
Proportion of DUI Drivers in All DUI Involved Collisions
By Age and Gender: 2002 - 2006



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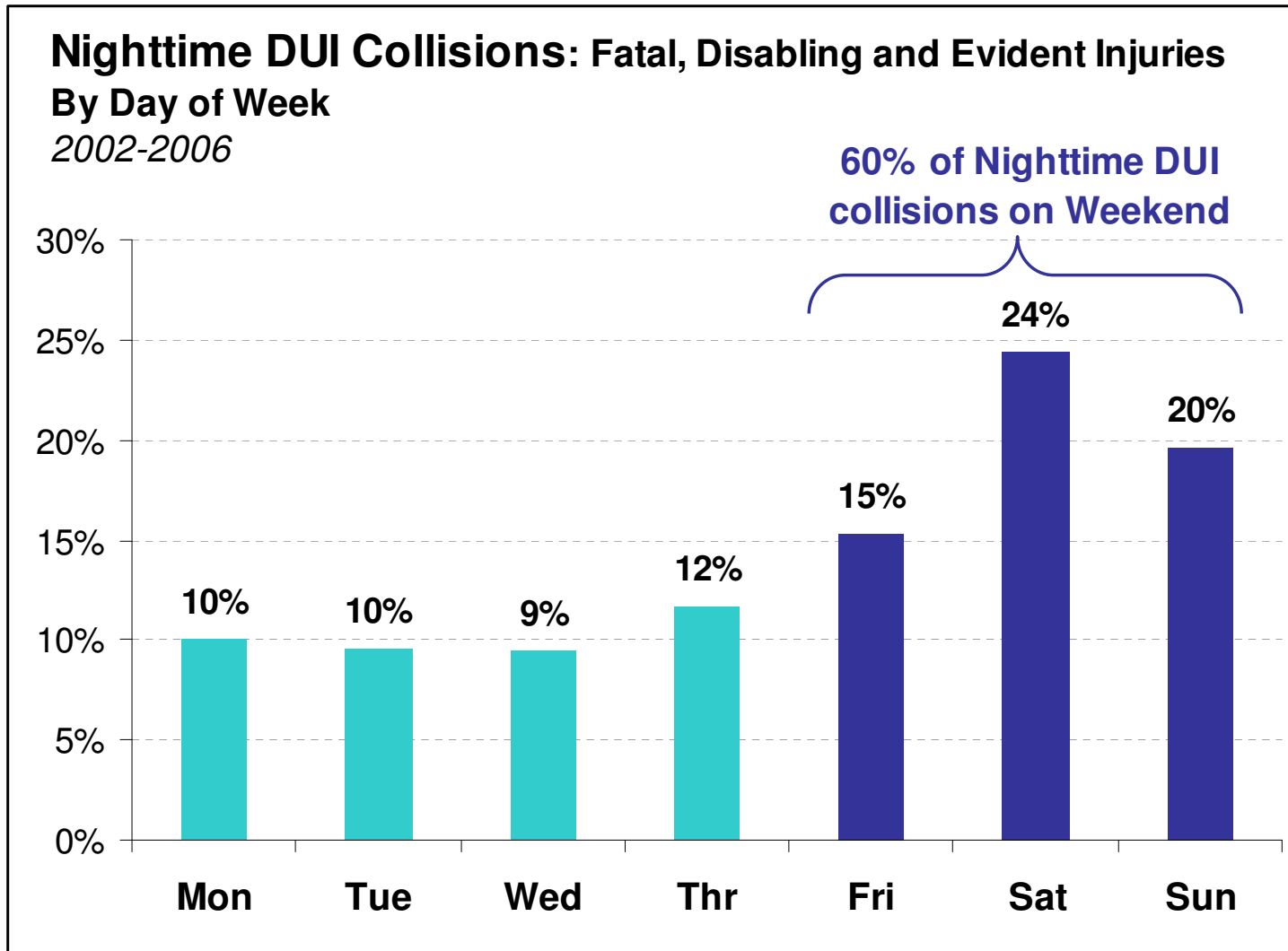
DUI Drivers: By TOD, Age & Gender

DUI Driver Involvement By Time of Day By Age and Gender 2002-2006



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Day of Week and Nighttime

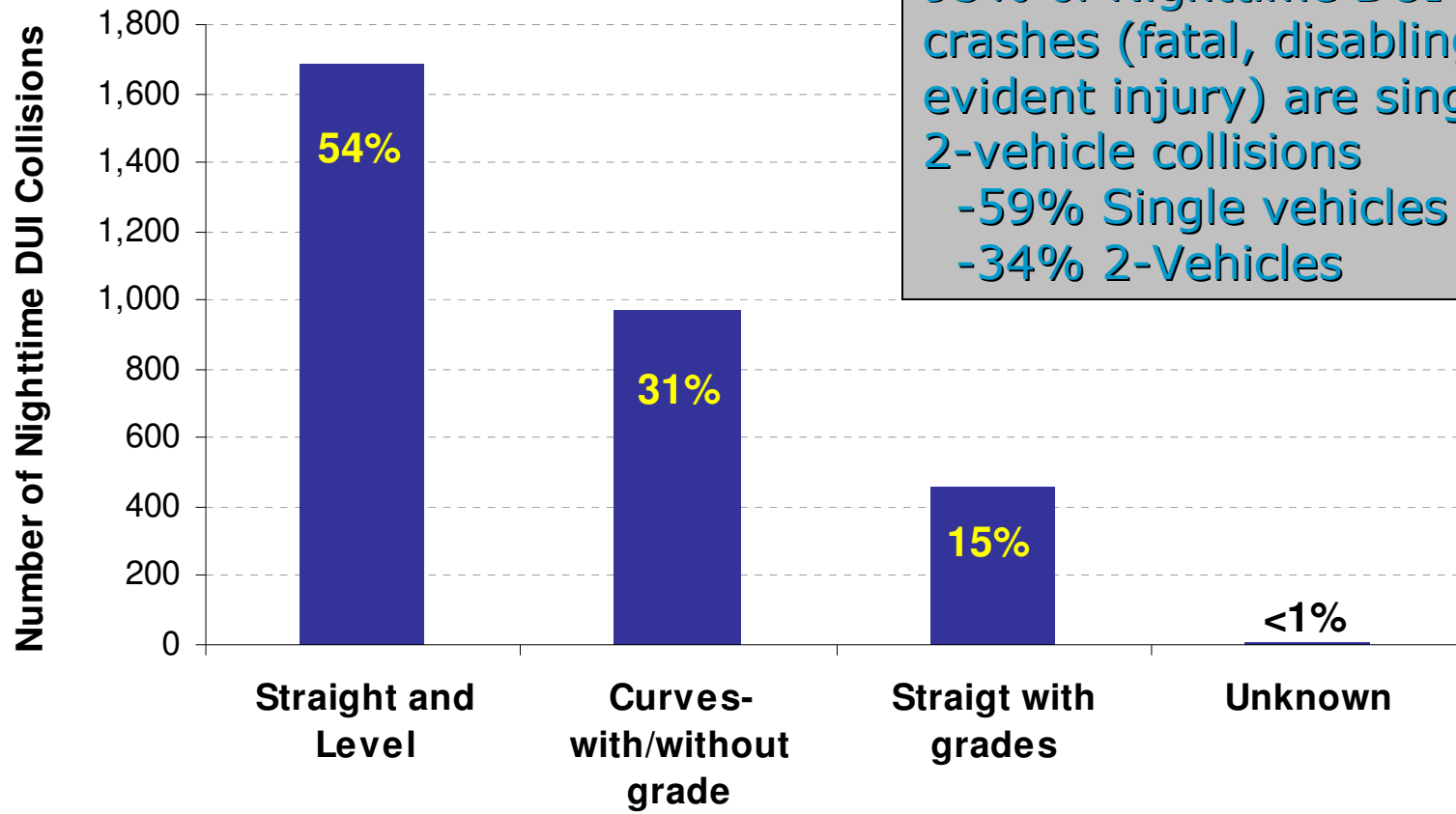


Roadway Characteristics

Roadway Characteristics

Night Time DUI Collisions, Involving Fatal, Disabling and Evident Injuries

2002 - 2006



93% of Nighttime DUI crashes (fatal, disabling, and evident injury) are single or 2-vehicle collisions

- 59% Single vehicles
- 34% 2-Vehicles



Selecting Analysis Data:

Daytime vs. Nighttime


Fatality, Disabling or Evident Injuries

- ❑ Nighttime crash patterns are similar between F&D and EVIDENT injury crashes
- ❑ Hot spots identified by nighttime data do not correlate well with daytime crashes



2. Method of Identifying High Crash Locations

~ Experiments

- 
- **Systematic**—may be replicated to other problem areas
 - **Unbiased**
 - **Stable**—identify persistent problem areas



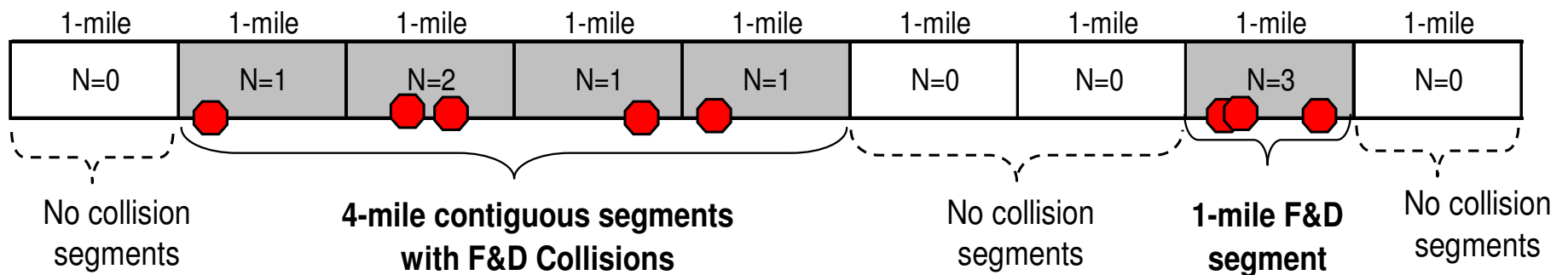
We looked at 3-methods:

#1: Segmentation--Histogram-type approach

#2: Density--Kernel Density Estimation (KDE)
using ArcGIS Spatial Analyst[®] tool

#3: Combination of both above (*hybrid approach*)—Contiguous distance-based segmentation assisted by Spatial Analyst

#1: Methodology Experiment with Segmentation: *Histogram Approach*



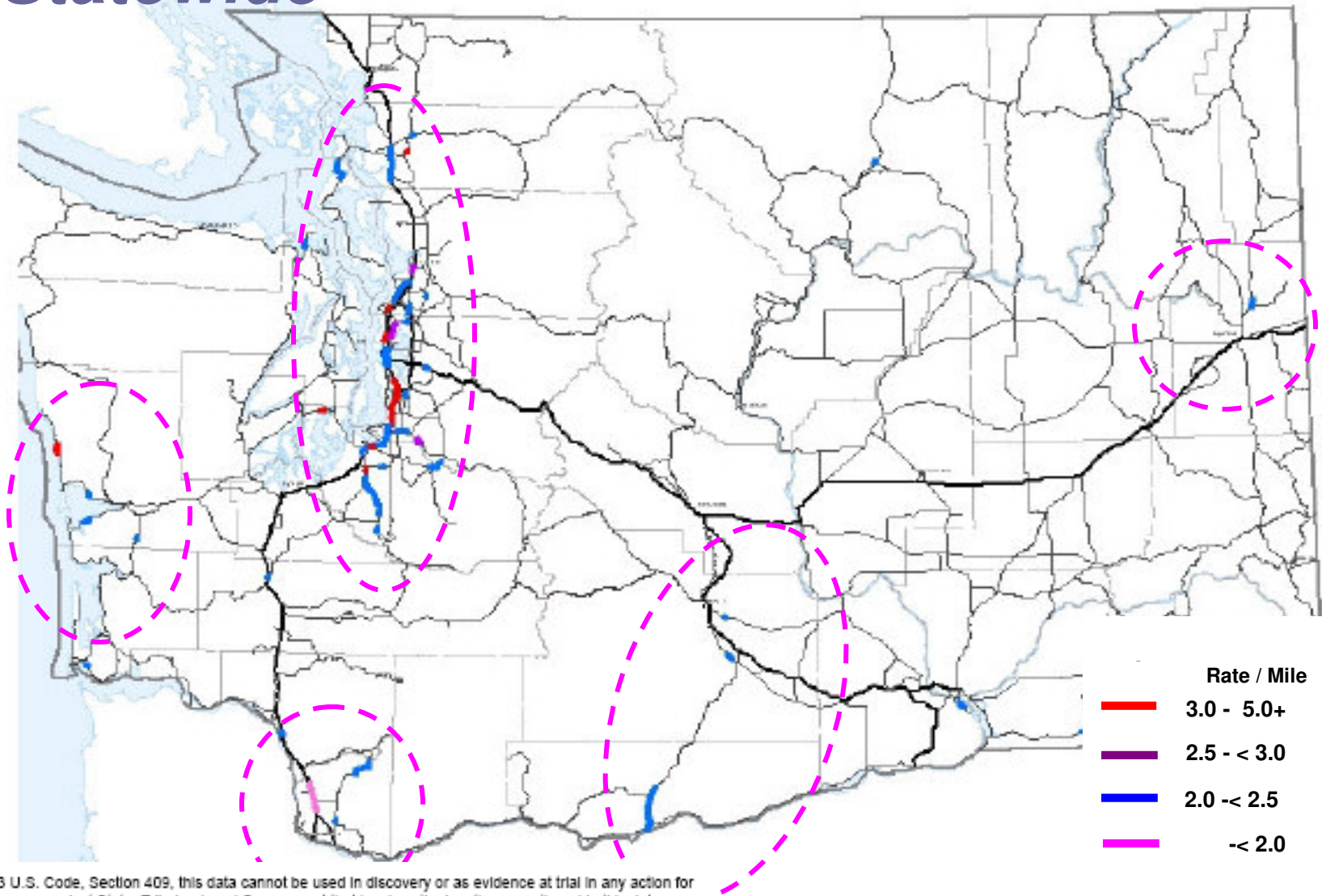
Pros: Easy to apply statewide

Specific line segments (by milepost) can be identified

Cons: Choosing “right” width of segments is critical

Produces line segments that are limited to single facility

Top 47 Segments for DUI Collisions *Statewide*



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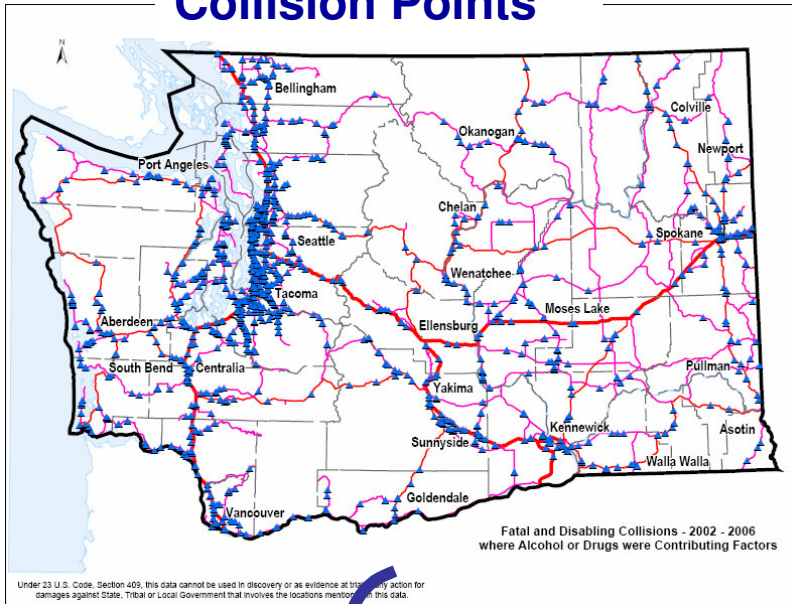


#2: Methodology Experiment with Kernel Density Estimation

Arc GIS Spatial Analyst tool

- Kernel Density Estimation (KDE) is designed to solve problems associated with histogram (e.g., band width selection)
- A smoothing technique
- Applied this to see how KDE would work on spatial data (tool was readily available through Arc GIS)

Collision Points

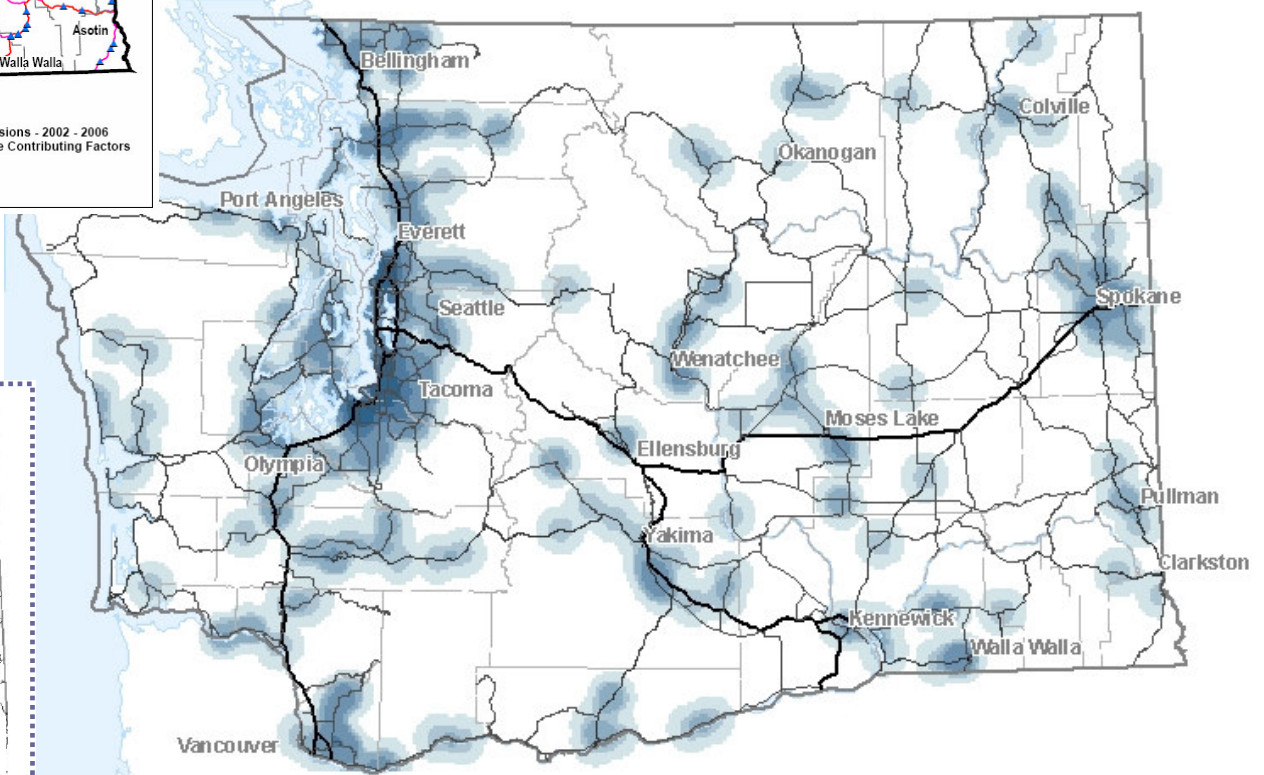


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Nighttime DUI Fatal, Disabling and Evident Injury Collisions

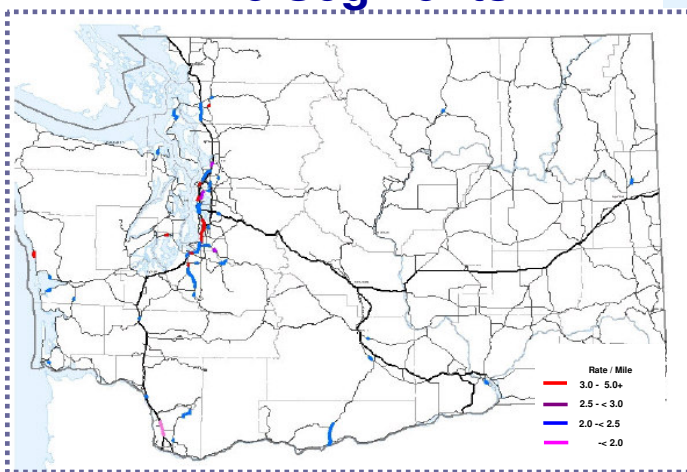
5-Years: 2002-2006

Density Map



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Line Segments





Kernel Density Map

Arc GIS Spatial Analyst tool

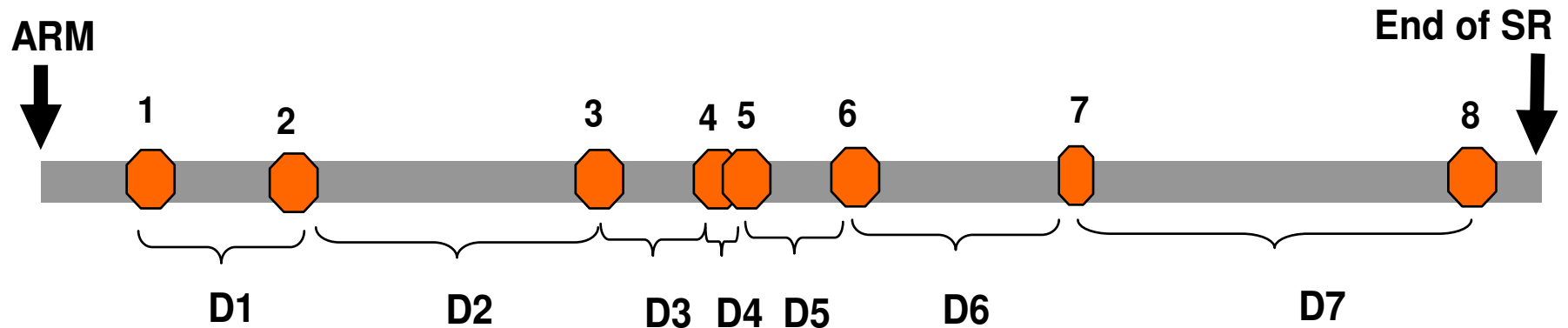
Pros: Linear distance-based; thus, multiple-facilities can be pooled together

An easy to use tool in Arc GIS

Useful for “at-a-glance” visualization of hot spots

Cons: Choosing right search radius and color classification scheme to show accurate presentation of underlying data may take a while

#3: Experiment in Defining Segments by Contiguous Crash Distance-based Segmentation



Segmentation Rule (example):

1-Mile Segmentation: $D < 1$

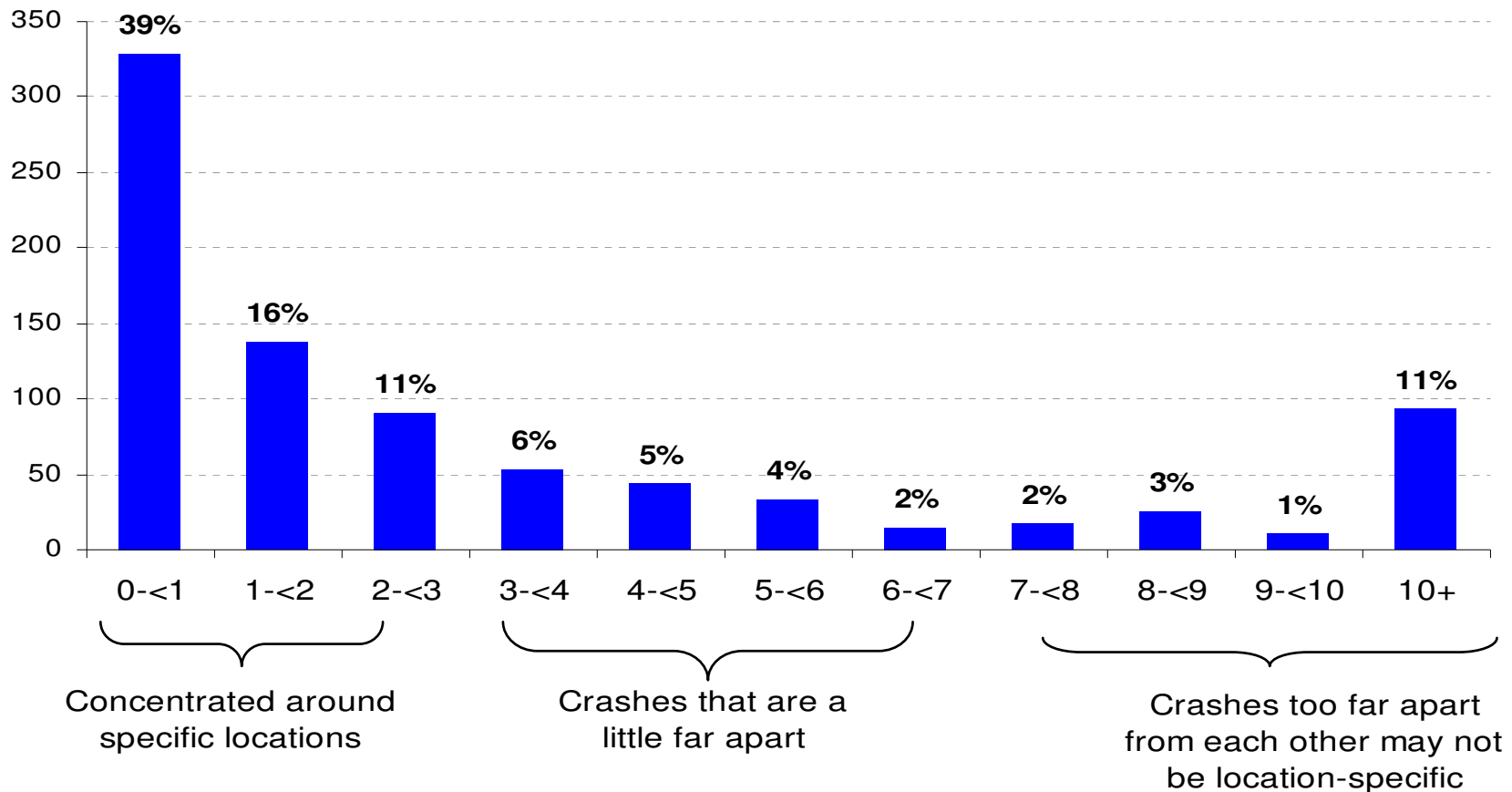
2-Mile Segmentation: $D < 2$

x-Mile: $D < x$

Nighttime DUI Collisions: Fatal, Disabling and Evident Injuries

Distance Between Adjacent Collisions:
Non-Interstate Highways

Most Recent Two Year Period: 2005-2006



Distance between Adjacent Collisions (in miles)

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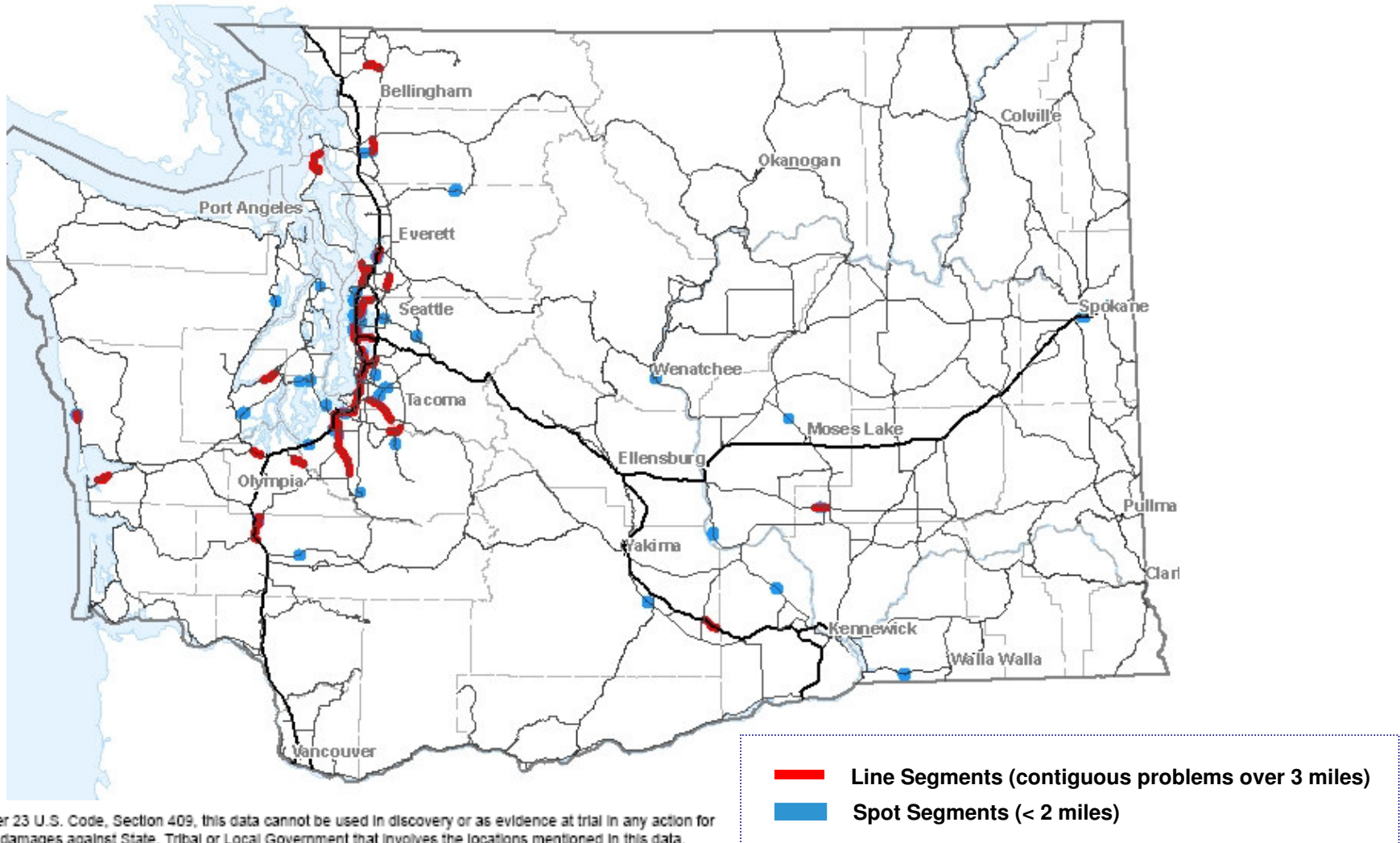
Patterns of DUI Crash Locations

~Based on distribution of distance between adjacent collision locations~

- ❑ Nighttime DUI crashes tend to *cluster* at certain geographical locations—approximately half of them are less than a few miles from each other
- ❑ This may make it easier to target enforcement or to identify underlying factors to impact collision reductions *if reliable hot spots or segments could be identified*

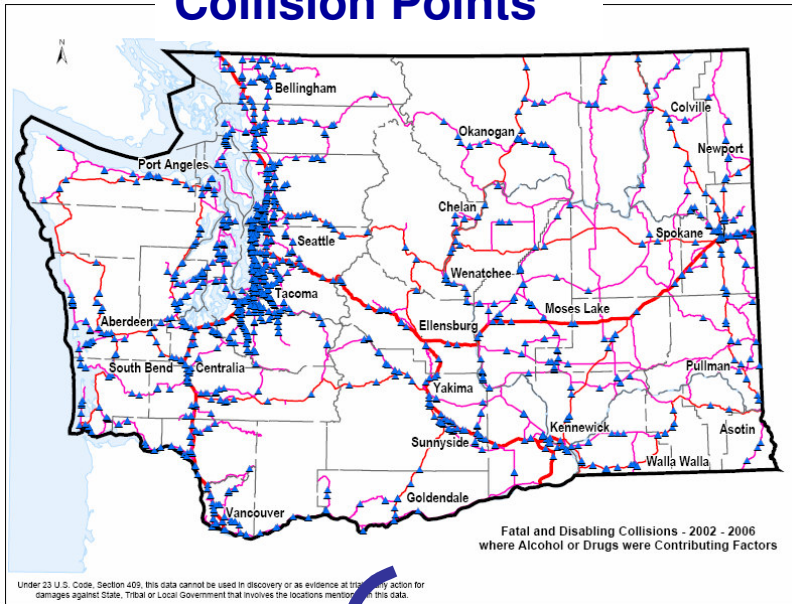
DUI Problem Segments

Based on 5-year (2002-2006) F, D, & E Injury Crashes,
Using 1-mile Contiguous Segmentation Method



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Collision Points

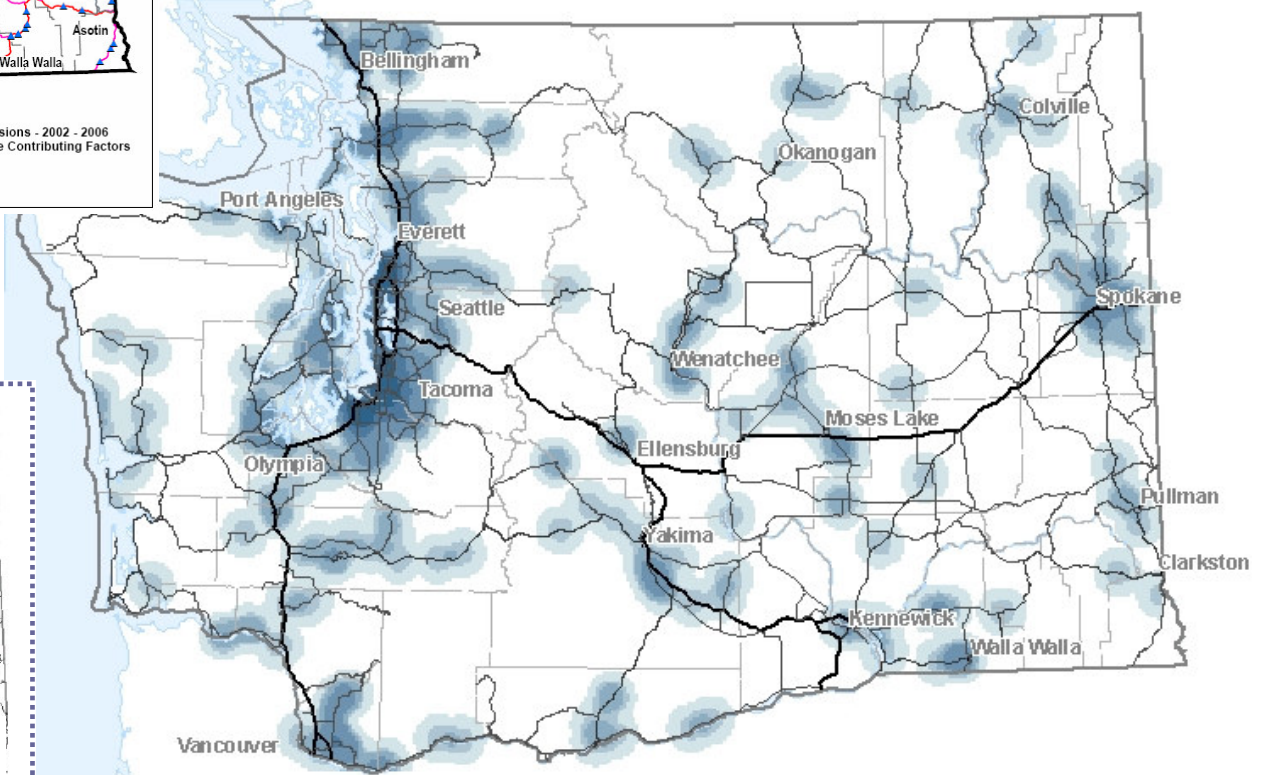


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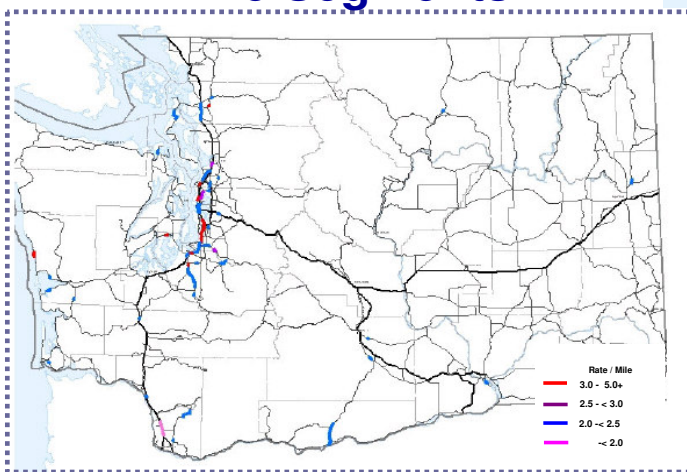
Nighttime DUI Fatal, Disabling and Evident Injury Collisions

5-Years: 2002-2006

Density Map



Line Segments

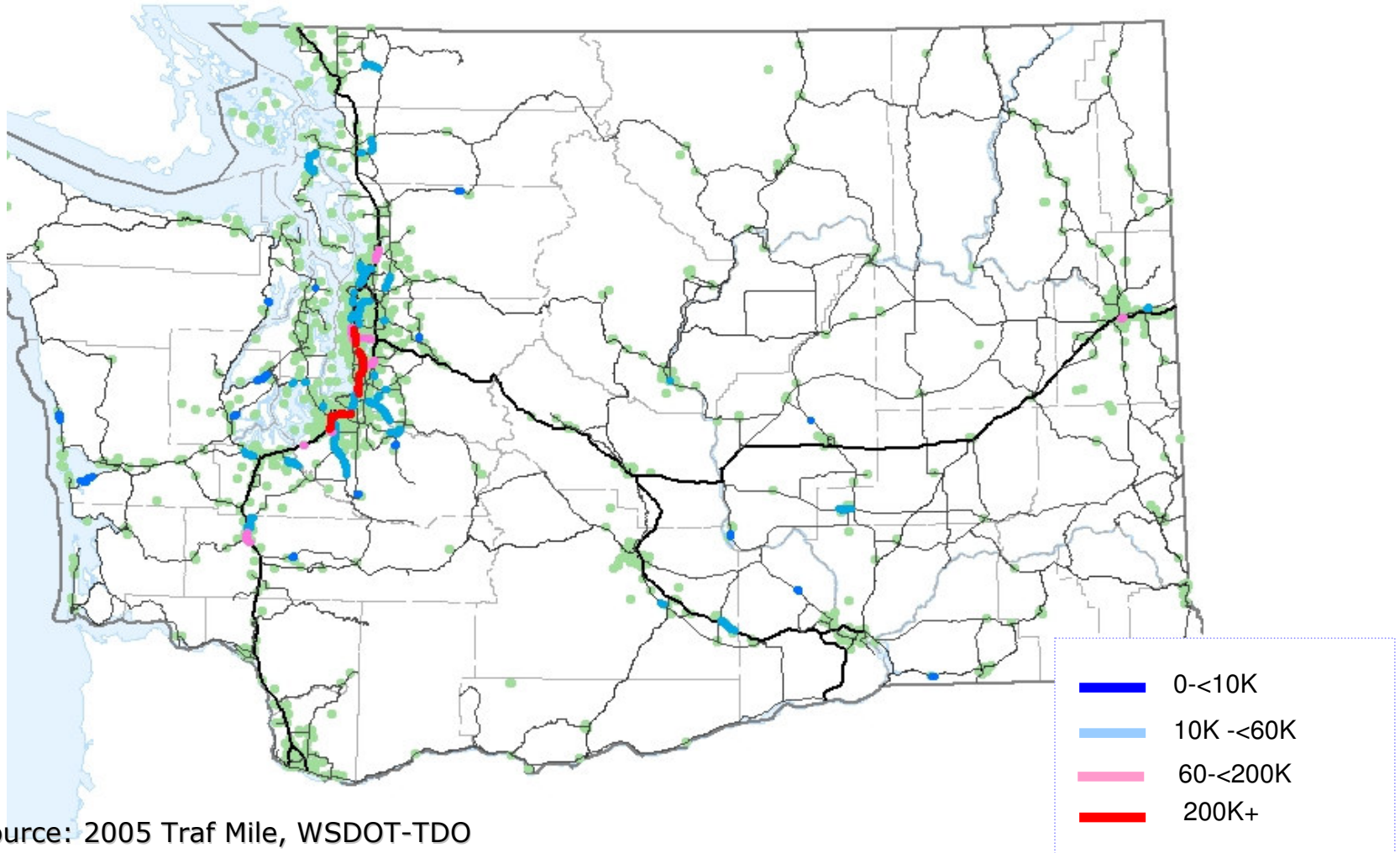


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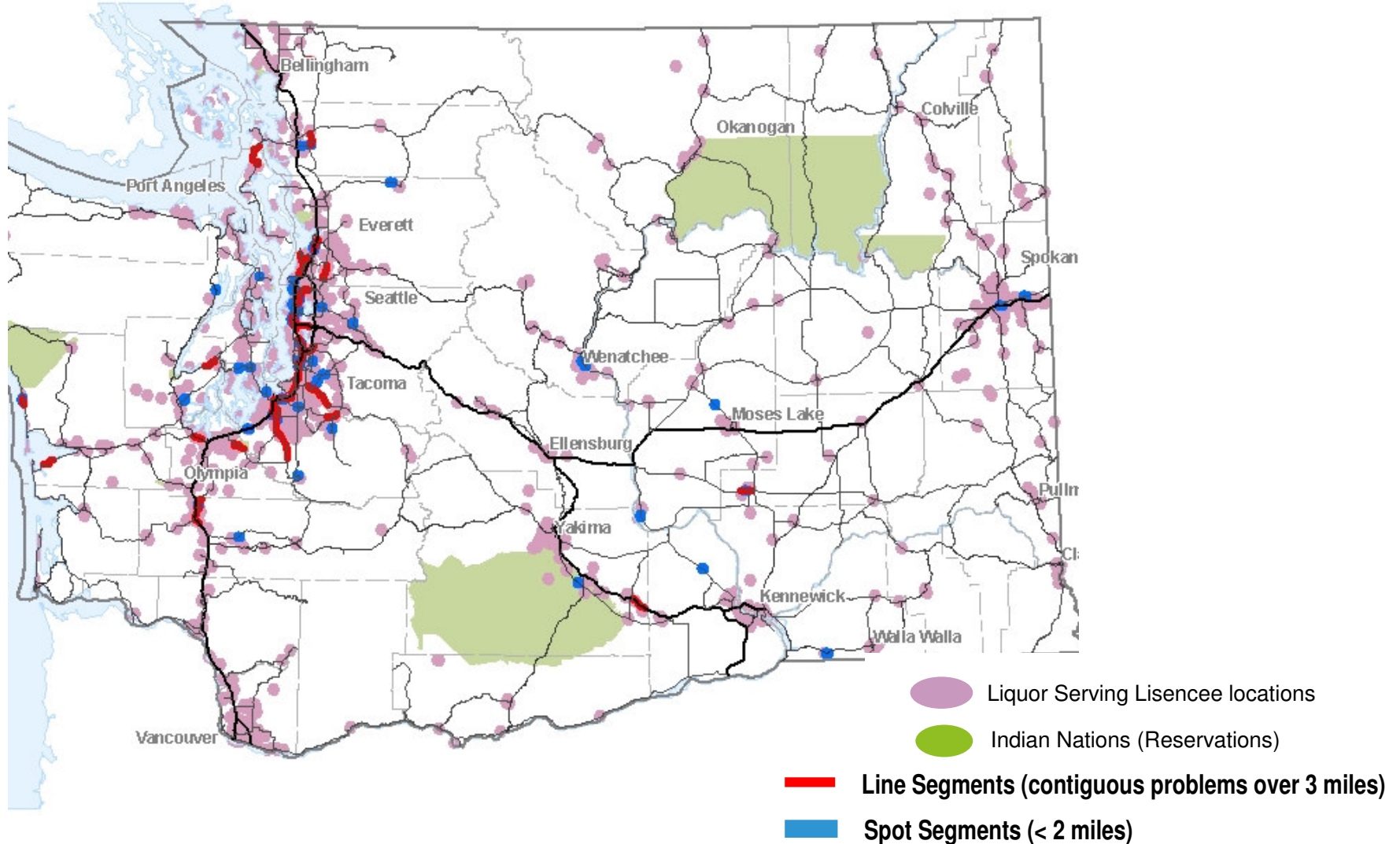
3. Characteristics of High DUI Crash Locations

Traffic Volume (est. ADT) and Nighttime DUI Crashes



Data Source: 2005 Traf Mile, WSDOT-TDO

Bars/Tavern Locations and Nighttime DUI Crashes

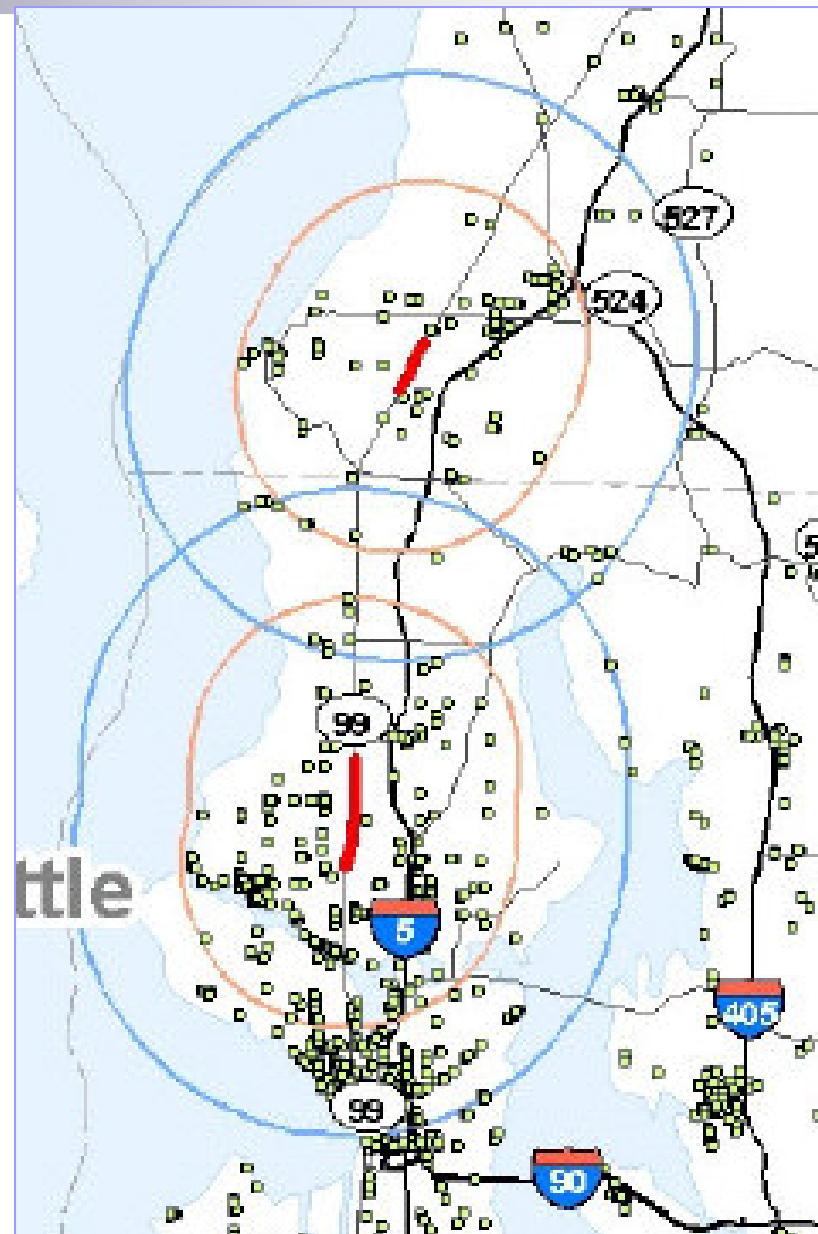


Data Source: Liquor Control Board (2003 data, geo-coded by WSDOT-CGIS)

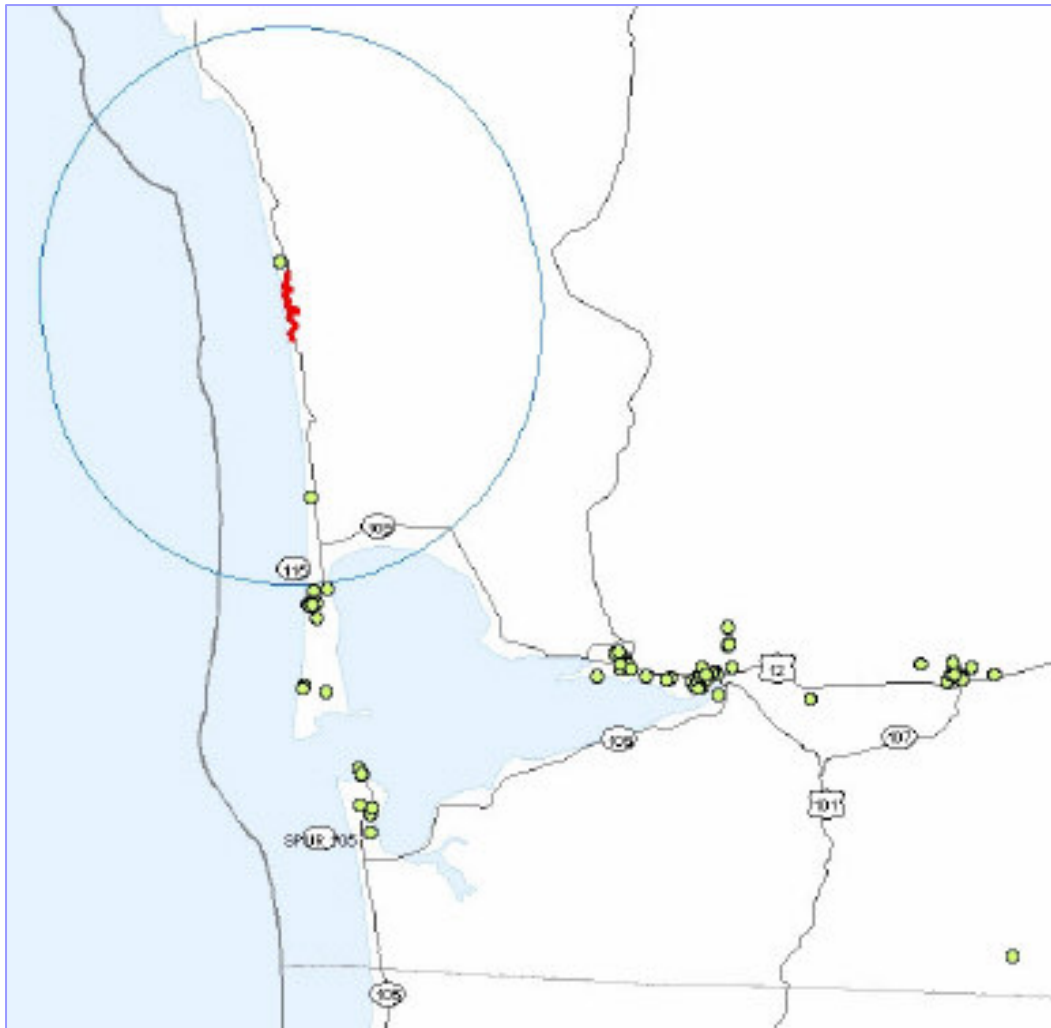
Many Bars/Taverns

SR 99 segments:

- Segments (ARM 30-32): Total of 767 bars within 5-miles, or 1,310 bars within 10-miles
- Segments (ARM 44-46): Total of 135 bars within 5-miles, or 533 bars within 10-miles



Few Bars/Taverns



- 2 bars within 1-mile
- No other bars until 8-mile away
- Total of 3 bars within 10-miles
- Cluster of bars are at least 11 miles away

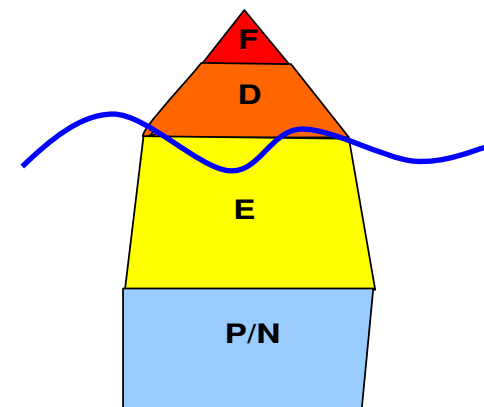


Bar-Tavern Locations and Nighttime DUI Collisions

- ❑ Stronger correlation to DUI Collisions than ADT
- ❑ Roughly two-groups
 - In City/Town centers—*where you drink, you crash*
 - 3-10 Miles away from city-town bar clusters with challenging roadway geometrics—*did they manage to drive awhile before crashing or did they drink elsewhere?*

EMS Response Time and Nighttime DUI Fatal Collisions

- ❑ EMS Response Time data is only available in Fatal Crash data (FARS)
- ❑ 1993 – 2005 Fatal crash data were examined for the high DUI crash segments
- ❑ ~ Inconclusive at this point





Summary of Findings and Discussions: On DUI Crash Location Patterns

- Most (50%) nighttime DUI crashes occur on straight, level roadway segments
- Approx. 30% appear to be on challenging roadway geometric sections
 - A need to incorporate horizontal and vertical characteristics for roadways into crash analysis
 - A need to apply intervention to DUI drivers **before** they reach challenging geometric segments (possible 30% injury DUI crash reduction!)



Summary of Findings and Discussions: *On Methods*

- All three methods experimented seem appropriate for use and could be complemented to each other
- Marginal spots that show up intermittently may need attention



Summary of Findings and Discussions: *On Methods* (continued)

- If using multi-year of data, it may be useful to weigh recent years' crash locations heavier than the older ones to emphasize emerging problems in the area



Next Agenda...*(in progress)*

- Evaluate stability of the hot spot/corridor lists obtained by 5-year data—**sensitivity from one year to another**



Thank you very much!

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This study has been presented for peer review as well as internal WSDOT groups; however, neither the study nor this presentation have been finalized by formal agency review for publication. Until that time, this presentation remains to be a draft. I, Anna Yamada, am solely responsible for all errors, analysis, opinions or any other matters presented here. I request you notify me in the event you are interested in using any of the materials presented here.



Contributors:

Never a complete list, but thank you, everyone!

- Geneva Hawkins, WSDOT-TDO for cutting base data and advising on collision data
- Joe St. Charles, WSDOT-TDO for many, valuable advise in traffic volume and for obtaining estimated ADT data
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- WSDOT-TDO Data Council members for reviewing Phase III report and for feedback
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- Don Fernandes, DOH-EMS, for advising on EMS data and for providing valuable insights
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Contact Information

Anna Yamada

Transportation Research, Transportation Data Office
Washington State Dept. of Transportation

YamadaA@wsdot.wa.gov

Mike Bernard

Collision Branch, Transportation Data Office
Washington State Dept. of Transportation

BernarM@wsdot.wa.gov

Roger E. Horton

Former Director (Retired), Transportation Data Office
Washington State Dept. of Transportation