Estimating Temporary Loss of Capacity

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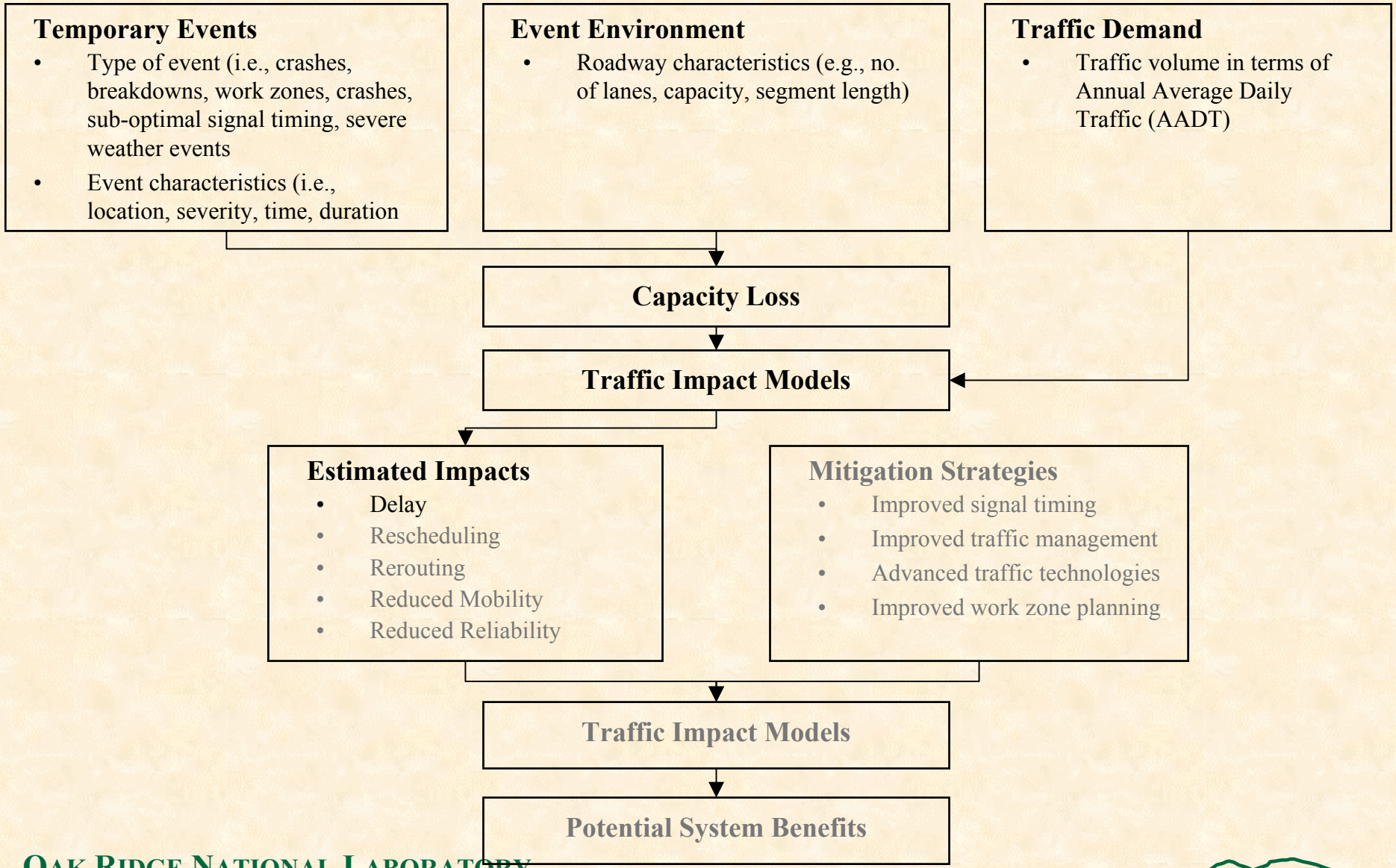
Objective & Scope

- **Objective**
  - Develop nation-wide estimates of losses of highway capacity and delay caused by transitory events, such as construction work zones, crashes, breakdowns, extreme weather conditions, and sub-optimal traffic controls
- **Scope**
  - Freeways and principal arterials only
  - 1999 calendar year

A general framework has been developed for analyzing temporary losses of capacity and impacts.



Approach: Crashes

- **Assign crashes to the highway system**
  - Fatal crash locations specified in FARS (i.e., county, route number/name, mile point)
  - Non-fatal crashes determined using GES & Monte Carlo simulation
- **Estimate capacity reductions based on crash type, number & type of vehicles involved, crash location, crash time & duration**
- **Estimate delay based on capacity reduction, traffic volume & duration of the capacity reduction**

Approach: Vehicle Breakdowns

- Roughly estimate total breakdowns using ratio of breakdowns to crashes. Literature sources indicate a ratio of approximately eight.
- Simulate breakdown locations and time of day of each breakdown using a Monte Carlo simulation method.
- Simulate location of vehicle on each selected segment (e.g., right-hand shoulder, left-hand shoulder, right-most lane, etc.) based on statistics in the literature and from data provided by a few highway service patrols.
- Estimate delay based on capacity reduction, traffic volume on the segment & the duration of the capacity reduction.

Approach: Work Zones

- Identify work zone locations, times & durations using Rand-McNally highway construction data
- Estimate capacity reduction based on work zone location, time & duration of work zone, lanes open, lanes closed
- Estimate delay based on capacity reduction, traffic volume & duration of the capacity reduction
- Note: This estimate does not take into account driver behavior in reaction to the work zone, such as re-routing, re-scheduling, or trip canceling.

Crashes are estimated to cause the most delay, improved work zone and weather estimates may change this.

Event	Total Capacity (billion vehicles)	Total Delay (million veh-hours)	Delay/Driver (hours)	Delay/Event (hours)
Crashes	1.9	772.6	4.1	289.5
Breakdowns	5.9	217.1	1.2	10.2
Work Zones *	3.1	482.1	2.6	824,023.2
Adverse Weather	24.0	543.9	2.9	362,117.2
Signal Timing	172.9	296.4	1.6	2,773.7
Total	207.8	2,312.1	12.4	95.8
Non-recurring Delay **	34.9	2,015.7	10.8	83.9

* Includes freeways only; does not include principal arterials

** Includes all sources but signal timing

Freeway crashes were estimated to cause significantly more delay than crashes on principal arterials.

Highway Type	Fatal/Non-fatal	Crashes	Capacity Lost (million vehicles)	Delay (million veh-hours)	Delay/Crash (veh-hours)
Freeways	Fatal	5,944	12.7	2.7	447.6
	Non-fatal	880,624	1,042.5	505.5	574.0
	All	886,568	1,055.2	508.2	573.2
Principal Arterials	Fatal	7,781	9.3	4.2	534.1
	Non-fatal	1,194,604	813.7	260.3	217.9
	All	1,202,385	823.0	264.4	219.9
Freeways & Principal Arterials		2,088,953	1,878.2	772.6	369.8

Snow caused 90% of estimated weather delays

Impact/Highway Type	Fog	Snow	Ice	All
No. of Events	76	1,326	100	1,502
Licensed Drivers Impacted	24,048,405	106,942,050	26,107,731	157,098,187
Capacity Reduction (million vehicles)				
Urban Freeways	247.8	3,226.2	246.0	3,720.1
Urban Principal Arterials	622.1	7,406.3	453.4	8,481.8
Rural Freeways	151.1	3,698.3	250.5	4,100.0
Rural Principal Arterials	372.3	6,915.0	370.5	7,657.7
Total Capacity Reduction	1,393.4	21,245.8	1,320.4	23,959.6
Delay (million veh-hours)				
Urban Freeways	8.8	161.5	29.3	199.5
Urban Principal Arterials	6.1	302.4	8.6	317.1
Rural Freeways	0.5	10.9	0.7	12.1
Rural Principal Arterials	0.5	13.9	0.7	15.2
Total Delay	15.8	488.7	39.4	543.9
Delay per Impacted Driver (hrs)	0.66	4.57	1.51	3.46

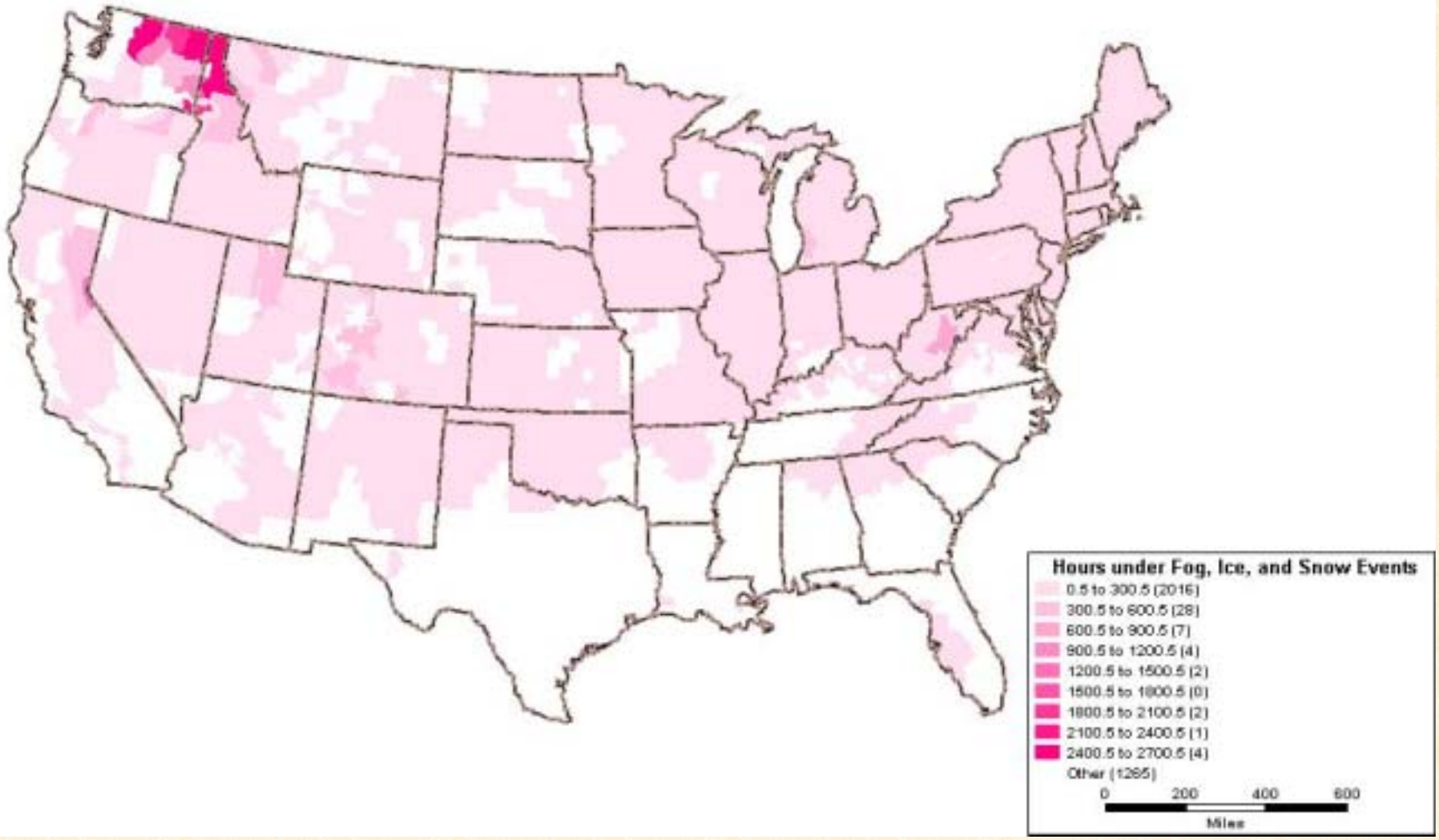
Preliminary Observation

The TLC Study has produced plausible nationwide estimates of the magnitudes of temporary capacity losses and delay for freeways and principal arterials in 1999.

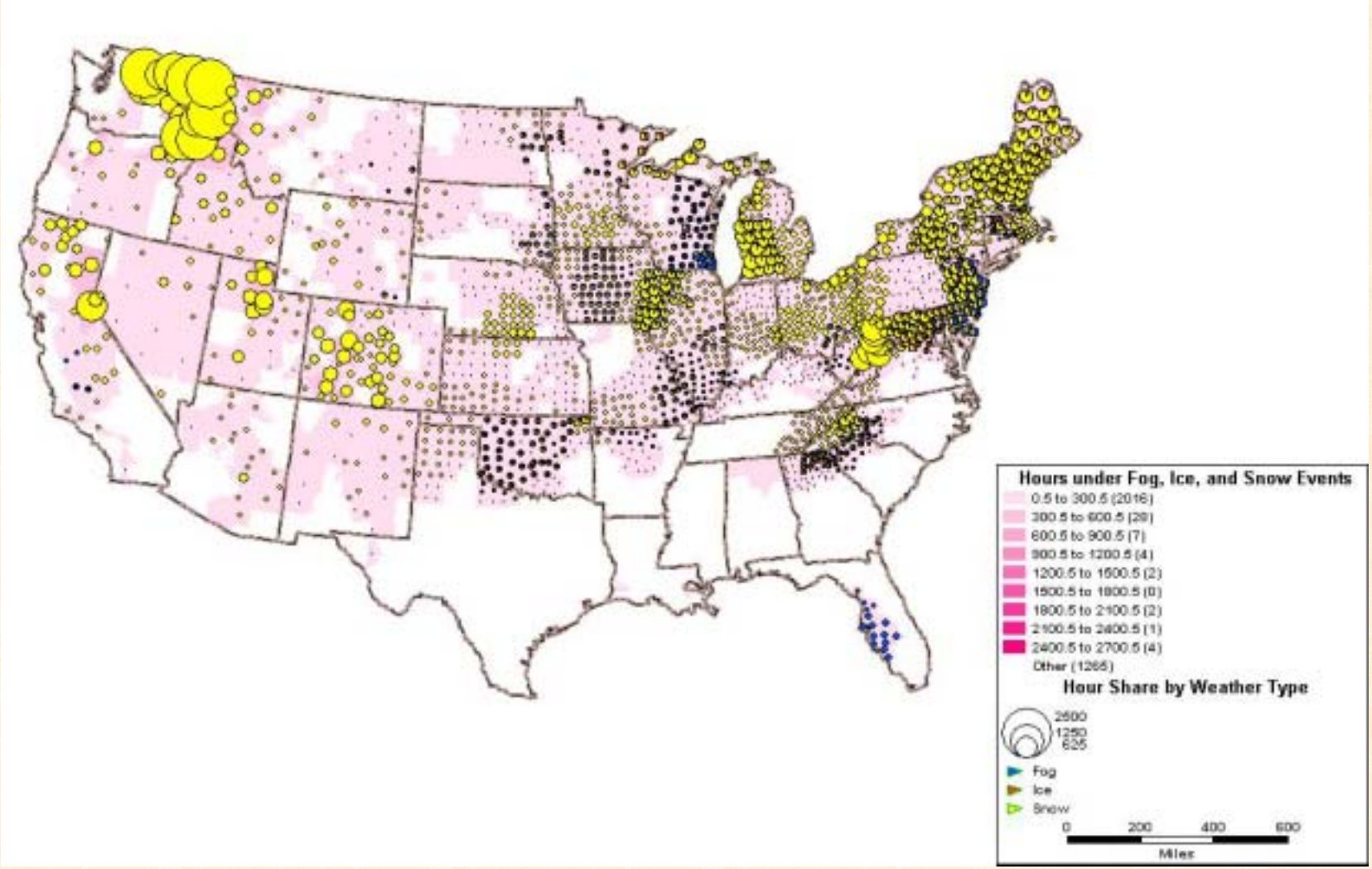
Impacts due to Adverse Weather such as Fog, Ice, and Snow

- American drivers experienced approximately 544 million hours of traffic delay on major U.S. highways due to adverse weather conditions such as fog, ice, and snow storms in 1999.
  - adverse weather conditions covered around 65% of the U.S. territory
  - impacted around 68% of the total population
  - impacted areas accounts for 59% of the nation's traffic
    - 1% of traffics in the impacted area
    - 0.6% of the total traffics in the U.S.

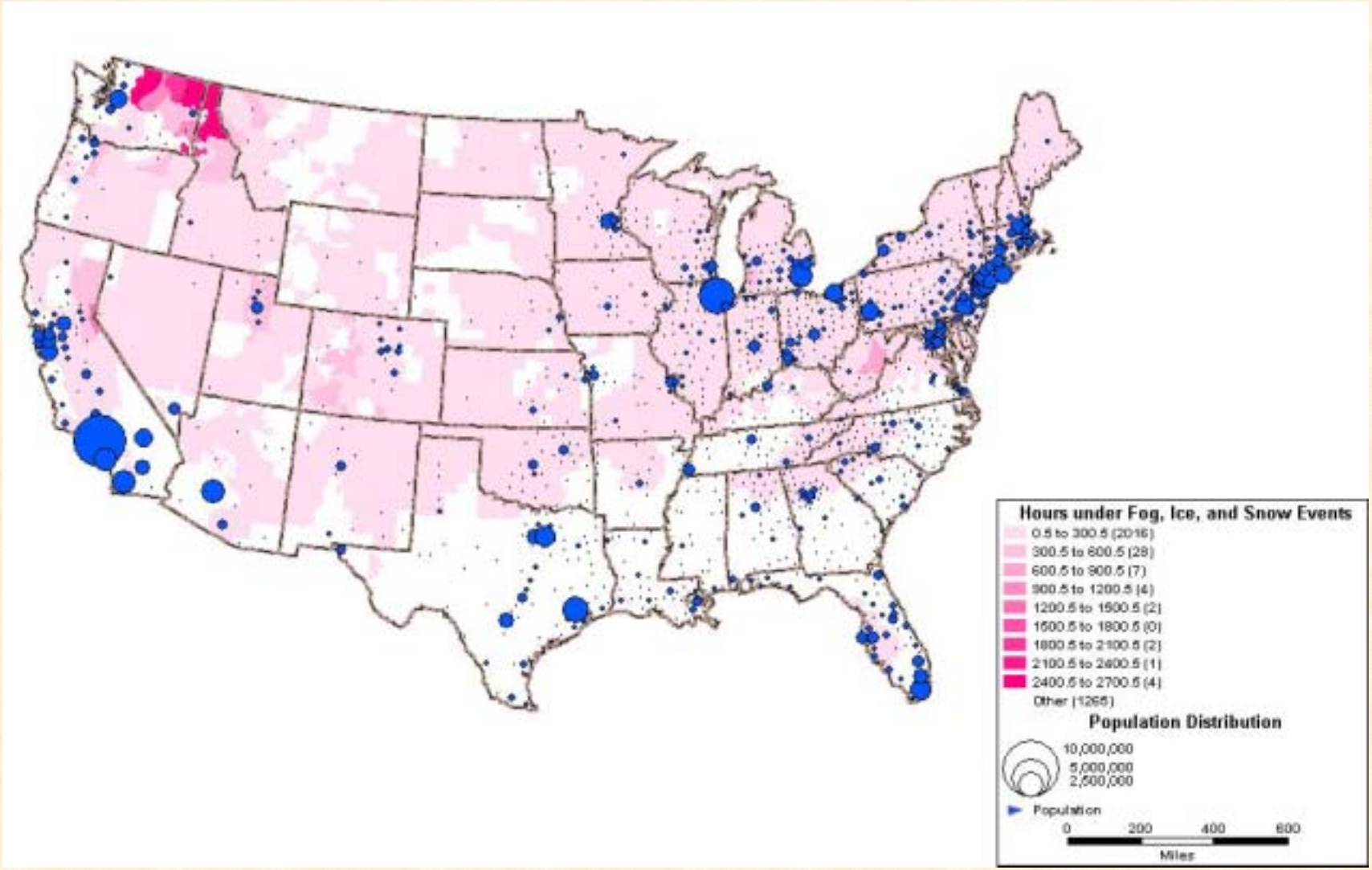
Areas Impacted by Weather Events



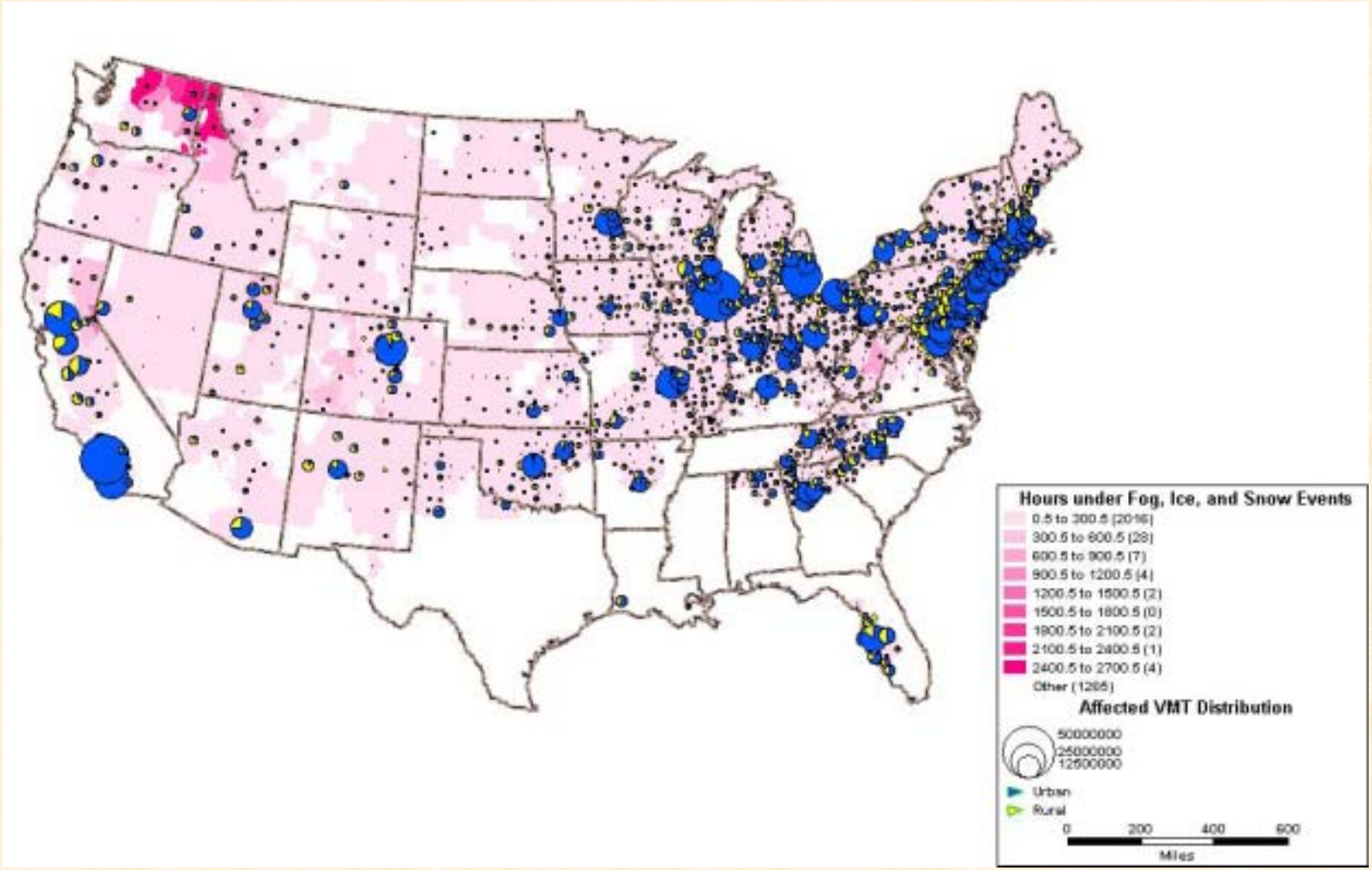
Impacted Areas by Weather Event Type



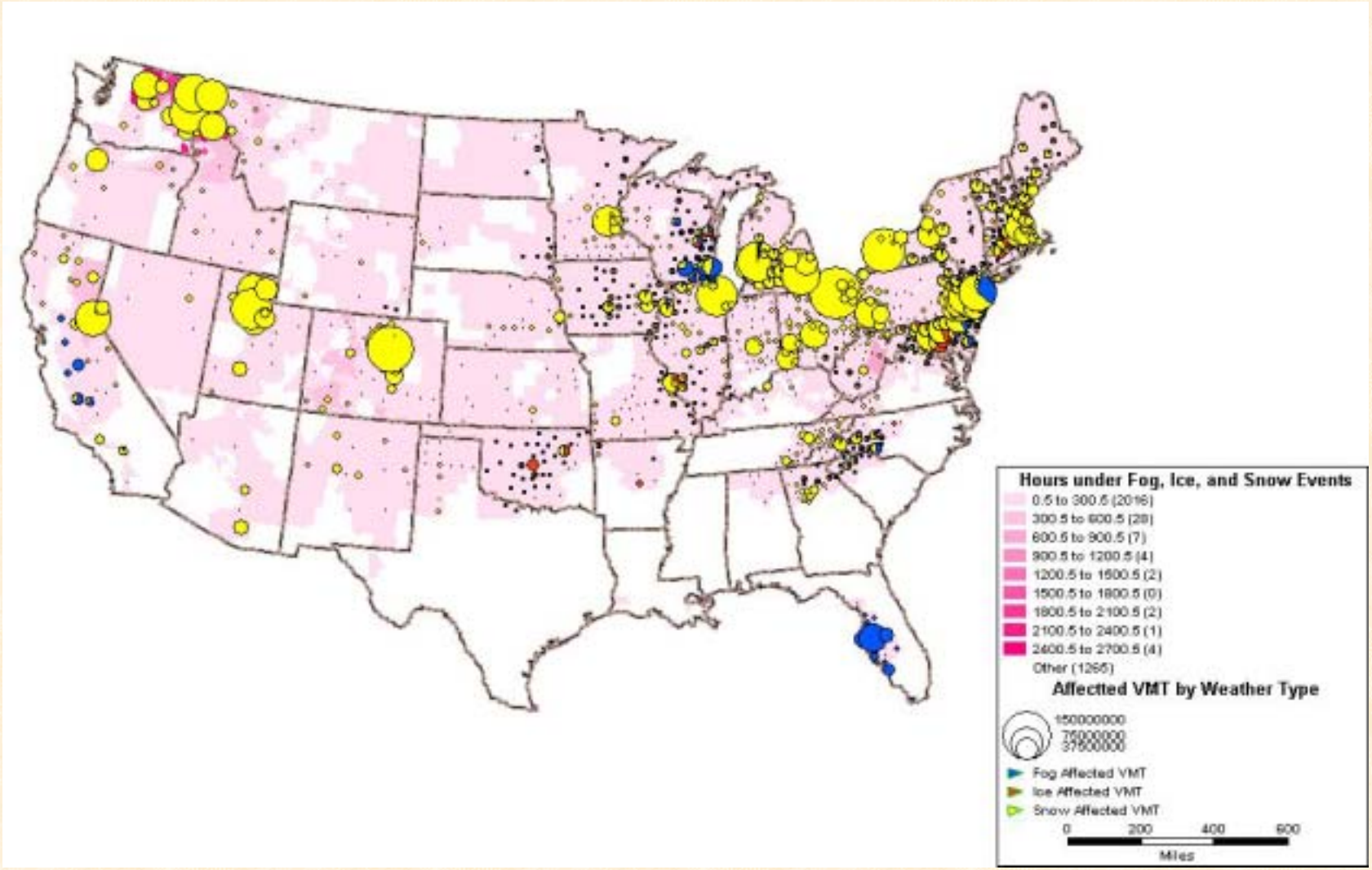
Population Distribution



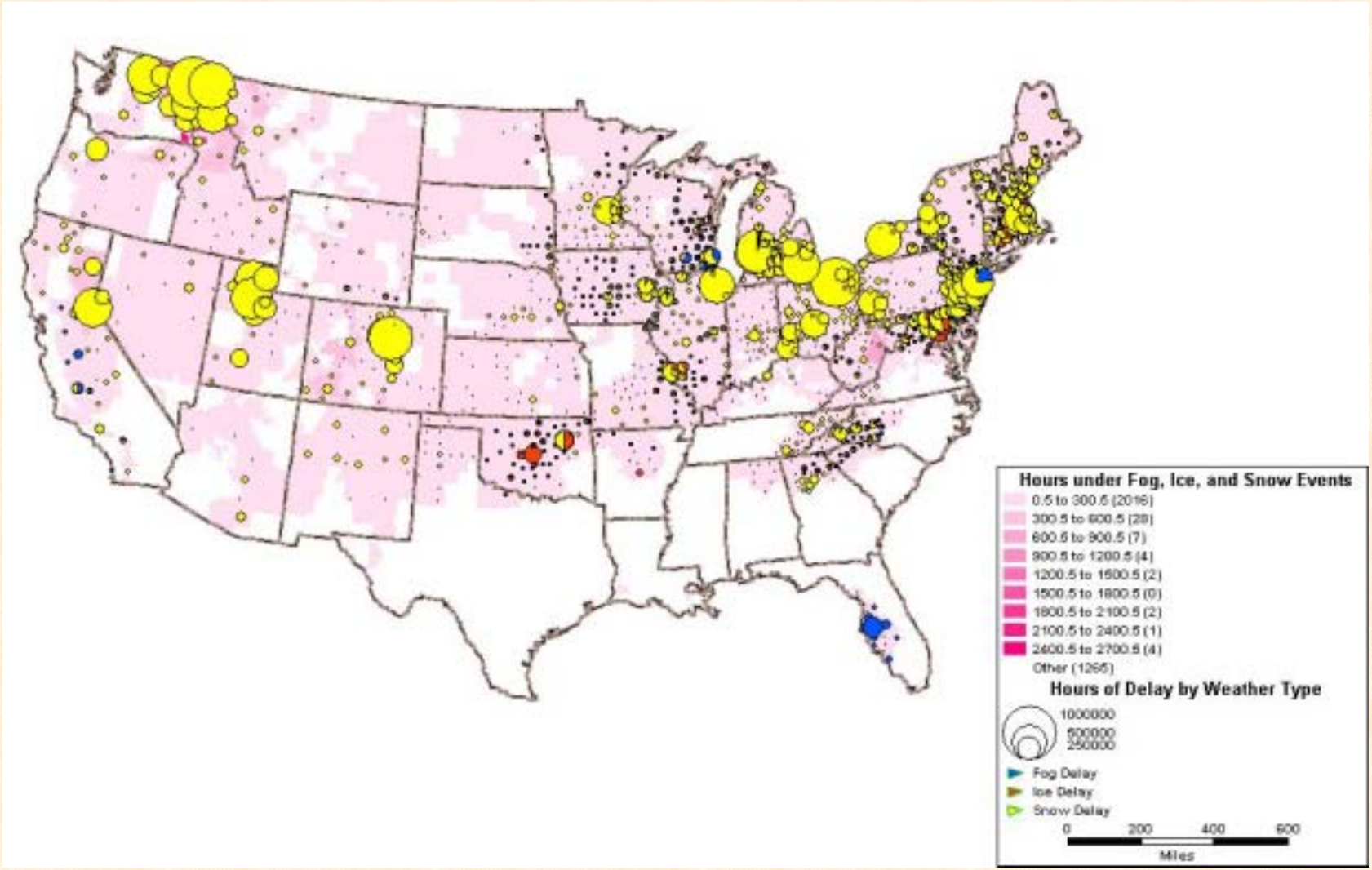
Total VMT in Weather Impacted Area



Affected VMT by Weather Type



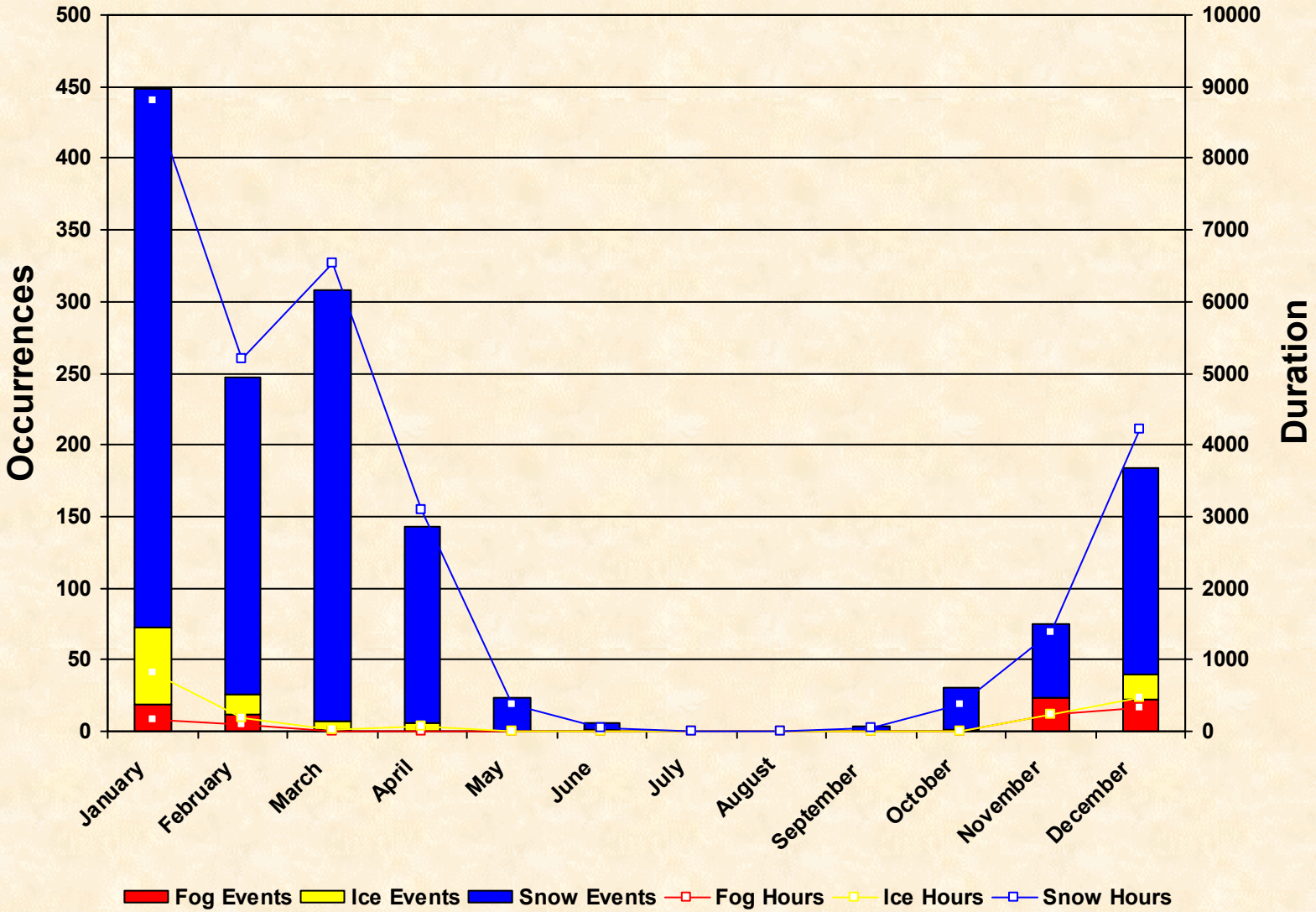
Traffic Delay Due to Weather



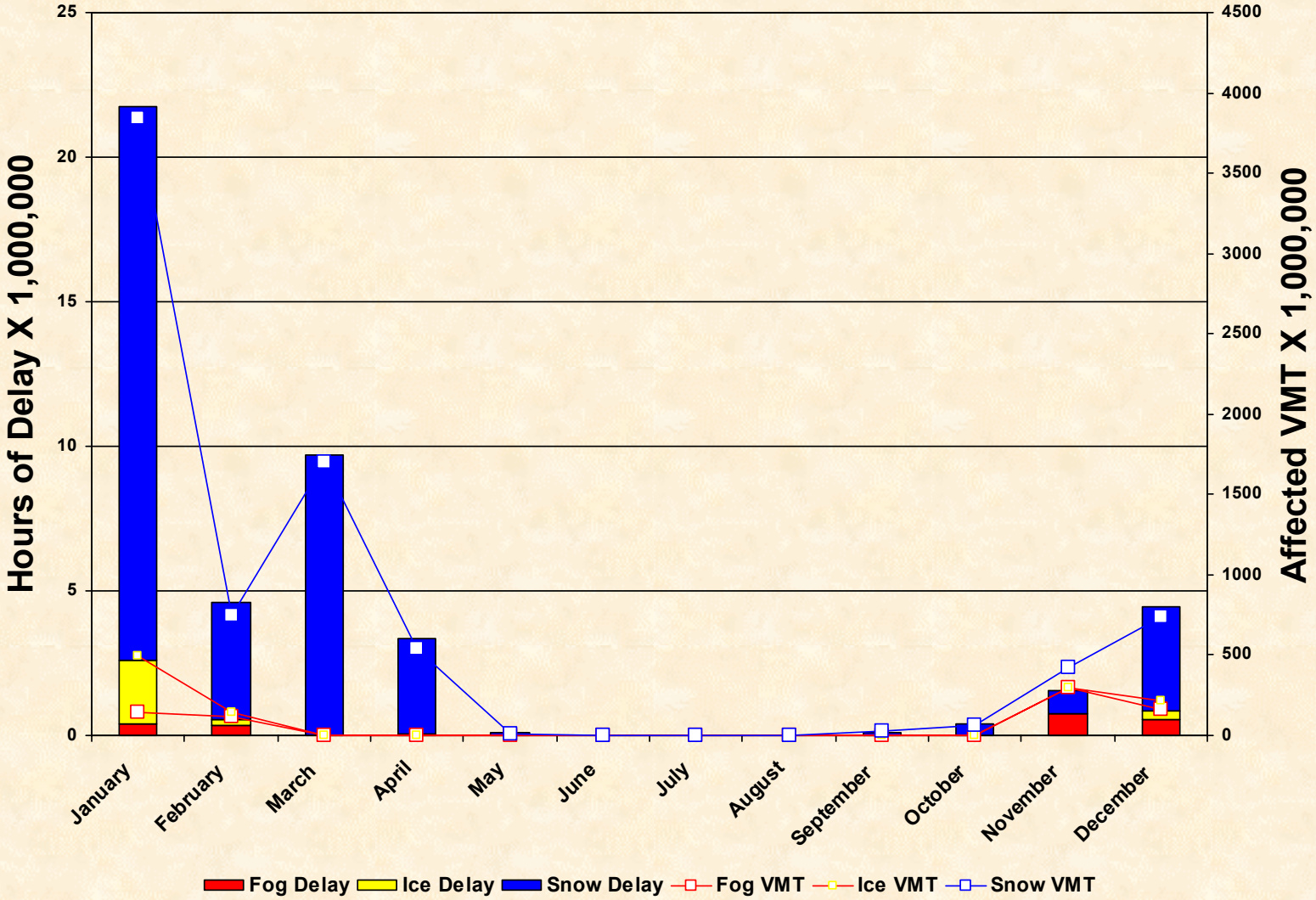
Seasonality

- Fog, ice and snow adverse weather events are highly seasonal.
- Mostly happen during winter time (60% by occurrences, or 61% by duration in 1999) and early spring (26% by occurrences, or 27% by duration in 1999).
- During winter time, it affect more traffic (66% of the total affected traffic in 1999) and drivers are more likely to experience longer delays (67% of the total delay in 1999).

Occurrences and Duration of Weather Events



Weather-Induced Delay and Affected VMT



Travel Delay

- Depends on the time of the day, day of the week (weekday or weekend), and location of the travel (within urbanized or non-urbanized area),
  - a typical trip is about 7 to 12 miles long in the U.S.,
  - it takes about 12.5 to 19.3 minutes to reach the destination,
  - traffic delay adds approximately 1 to 6 minutes of travel time.
- An increase of 7 - 36% to the normal travel time.

Likelihood of Encountering Weather-related Delays

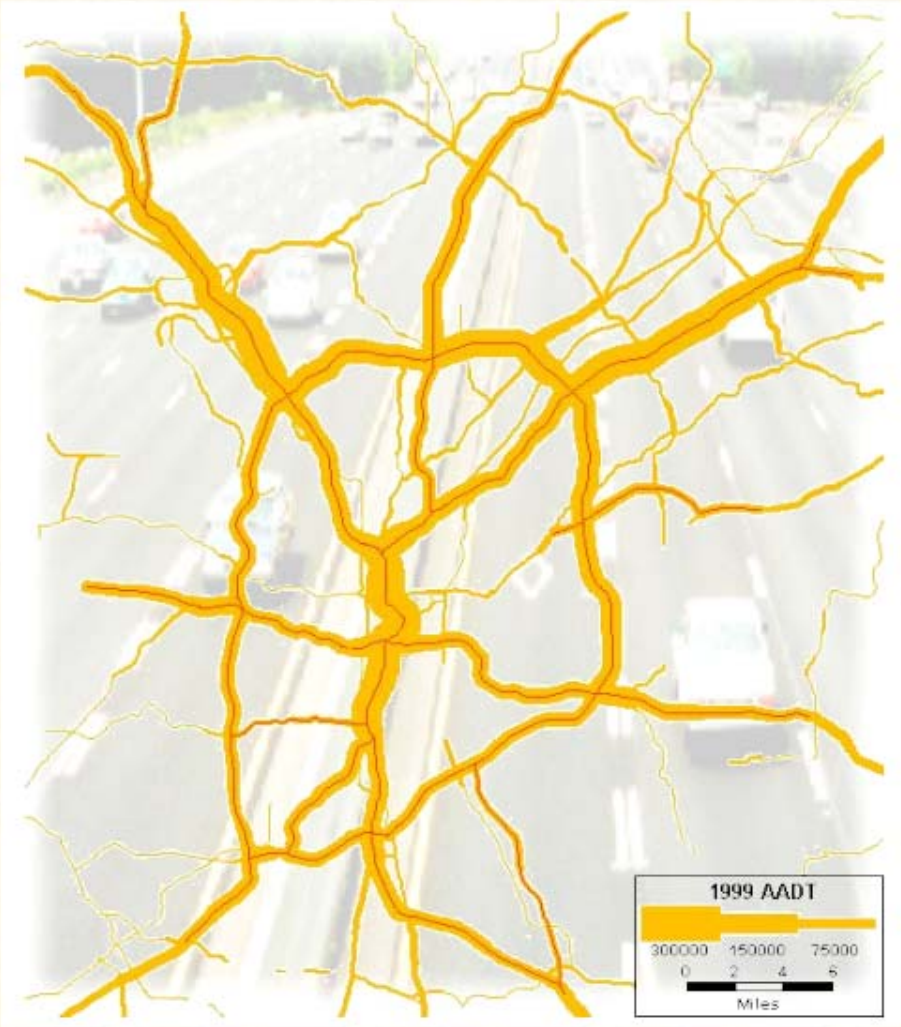
- In 1999, drivers in the U.S. had a very small chance (i.e., 0.6%) of a moderate travel delay (1 to 6 minutes of delay, or 7 to 36% increase in travel time) due to adverse weather conditions (fog, ice or snow).
- For drivers who reside in areas prone to have these weather conditions, their chances of experiencing this type of travel delay are almost doubled (~1%).
- The chance for a typical trip that would encounter a fog, ice, or snow weather event increases about 2.6 times during the winter season.

A Regional Example:

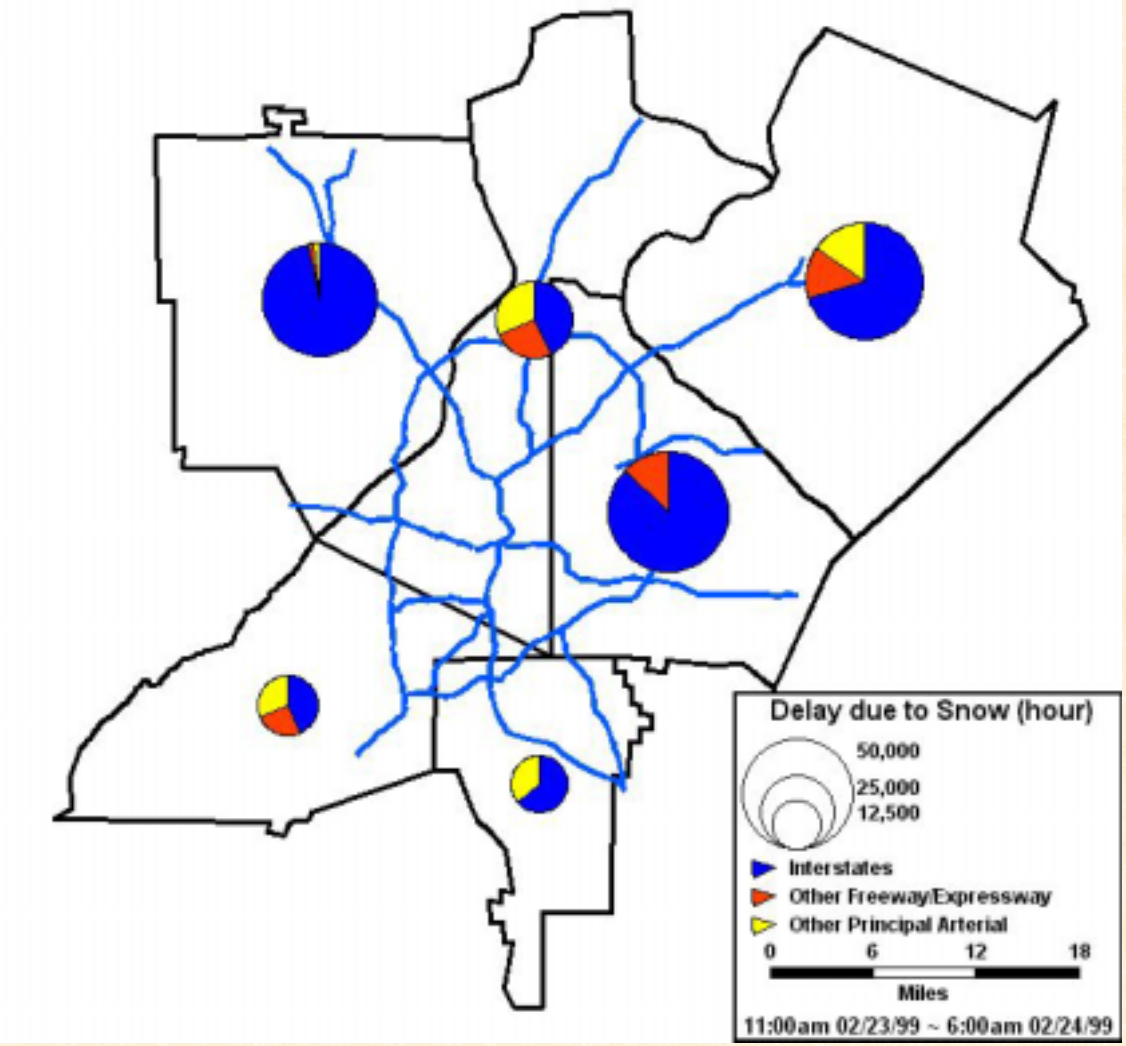
Atlanta, Georgia

National Highway Planning Network 4.0

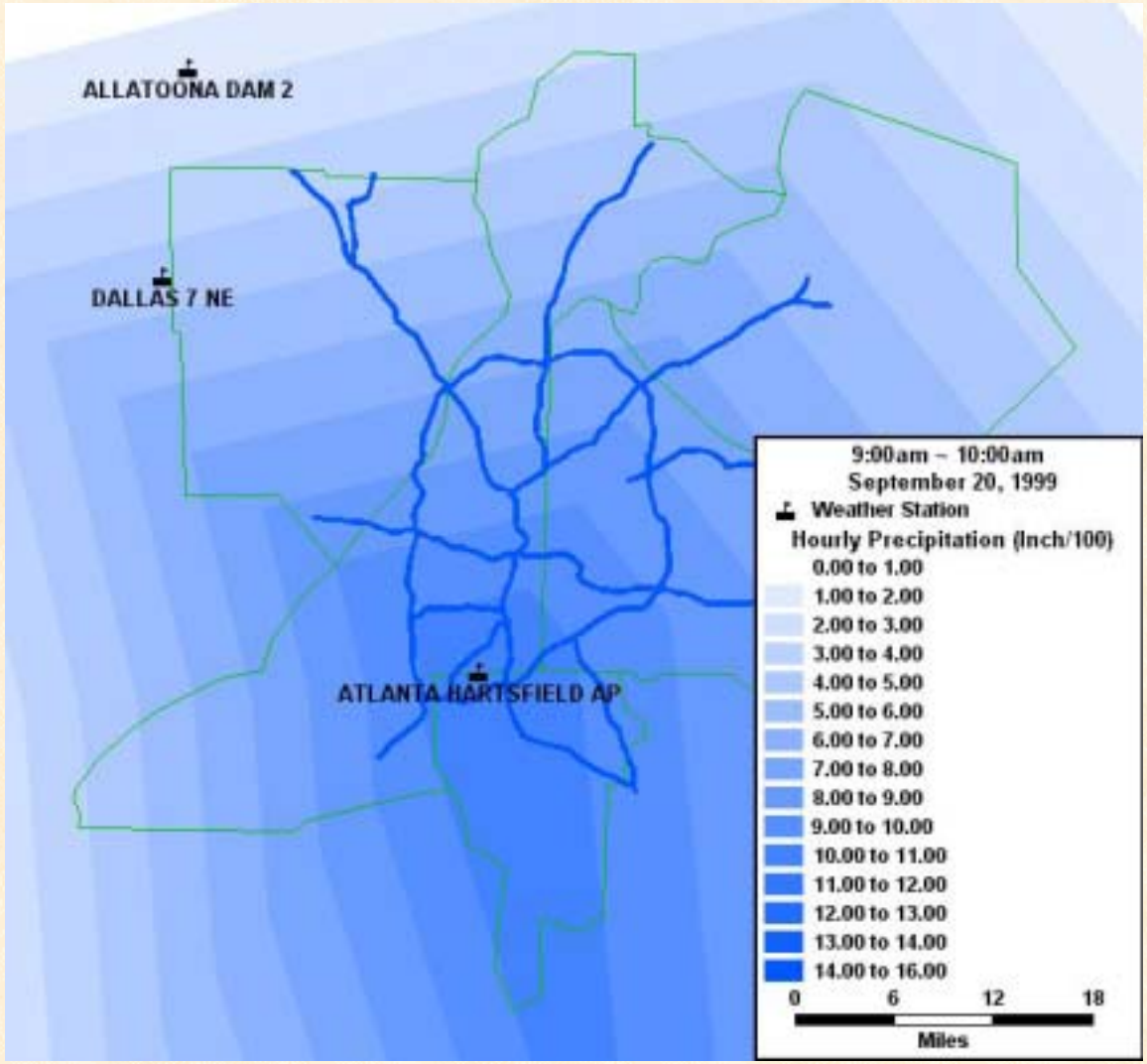
Highway Performance Monitoring System
AADT



Traffic Delay due to Snow



Hourly Precipitation



Summary

- Methods are reasonable, sound, and consistent with traffic engineering practices.
- The best available data was used, except where indicated (FMIS data).
- Assumptions were made for many parameters, but these were based on Highway Capacity Manual values or guided by other studies in the literature.
- There are areas where data are weak (total no. of breakdowns) or incomplete (work zones).
- The study only estimates delay and not associated impacts such as re-scheduling, re-routing, reduced reliability, and reduced mobility.