

# The Effects of Weather on Urban Trail Use: A National Study

Alireza Ermagun, Tracy Haden-Loh, Greg Lindsey

May 3, 2016

HUMPHREY SCHOOL  
OF PUBLIC AFFAIRS

---

UNIVERSITY OF MINNESOTA  
**Driven to Discover**<sup>SM</sup>

# Rails to Trails Conservancy

## Trail Modeling and Assessment Platform

### Objectives

- Monitor trail traffic at 45-50 locations in 12-13 cities in 7 climatic regions for  $\geq 1$  year
- **Describe patterns & variation in trail traffic**
- Develop hourly, day-of-week, monthly, and day-of-year factors
- Develop models for estimating trail use
- Support trail development efforts

# Paper Objectives

1. Describe monitoring results
  - a. Annual average traffic by mode
2. Estimate weather models
  - a. Cyclists
  - b. Pedestrians
  - c. Total (mixed-mode) trail traffic
3. Compare variation in effects of weather across climatic regions, by mode

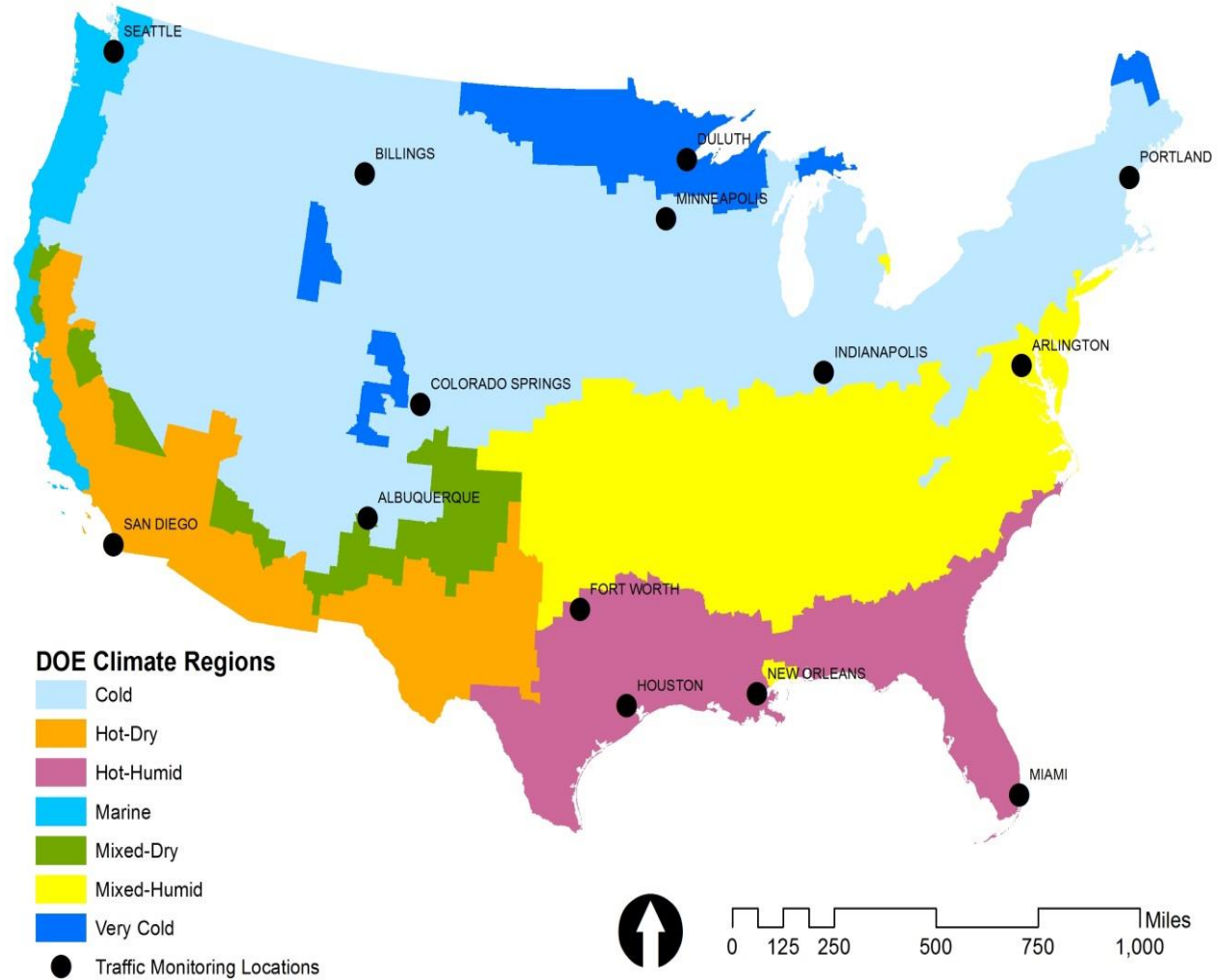
# Research Findings

1. AADB, AADP, AADTT vary over three orders of magnitude (< 100 to > 1,000)
2. Weather effects different for cyclists and pedestrians
3. Weather models differ by region
4. Models explain
  - a. Most in “very cold” region (Duluth)
  - b. Least in “hot dry” region (San Diego)

An aside: confirming the obvious? Trying to answer “how much” . . .

# Dept. of Energy Climate Regions

# TMAP Monitoring Locations



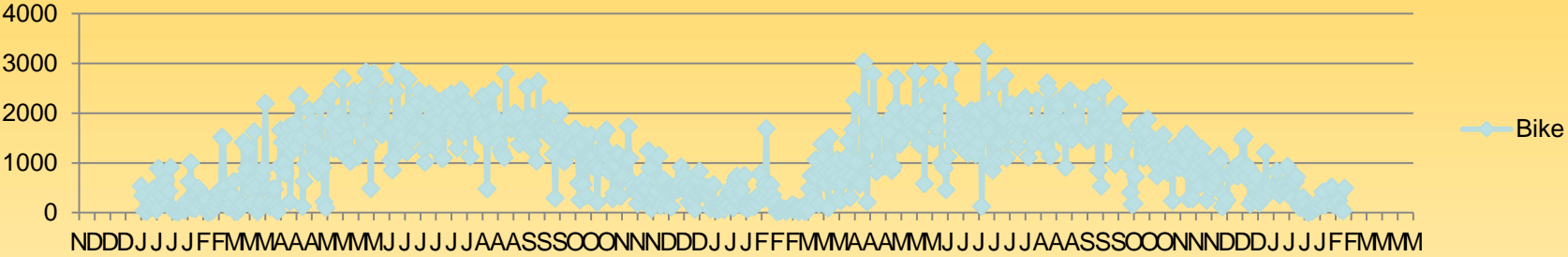
Data Source: Department of Energy Building America Climate Zones  
<http://energy.gov/eere/buildings/downloads/building-america-best-practices-series-volume-72-guide-determining-climate>

# Research Approach: Key Steps

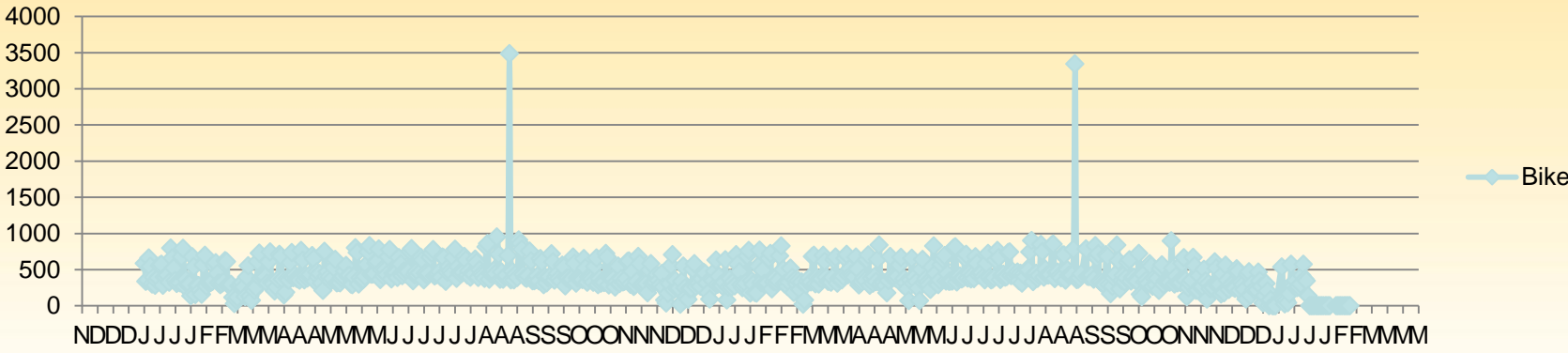
1. Data cleaning (QA/QC)
2. Model specification: variable selection
3. Modeling
  - a. Negative binomial models
  - b. Cragg & Uhler's Pseudo R-Squared to assess goodness of fit

# Some Challenges in QA/QC

## WOD Bon Air West



## Chula Vista Bayshore Bikeway NB & SB

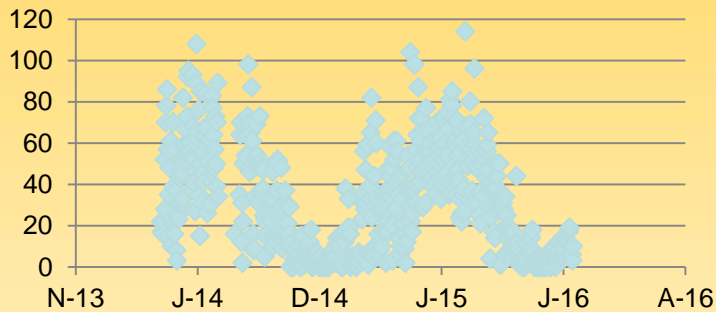


# Cycling is More Seasonal than Walking

(but not always)

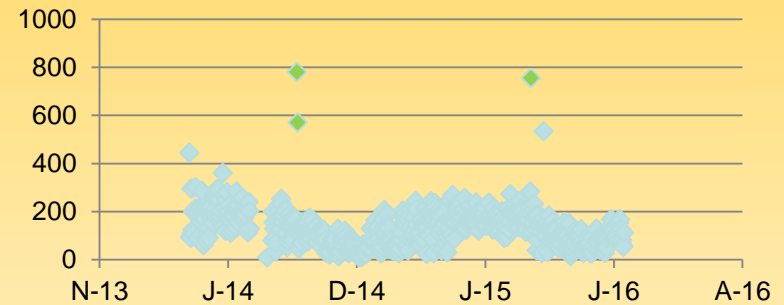
## Bikes

### Billings MT

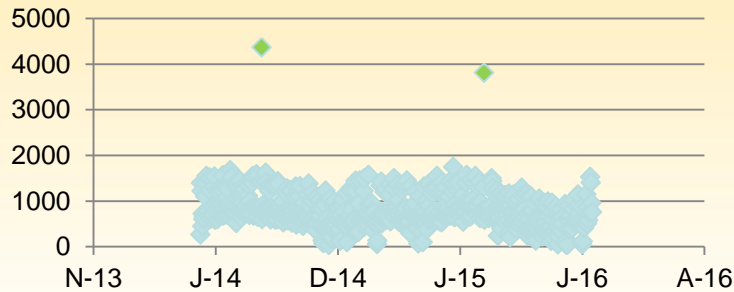


## Peds

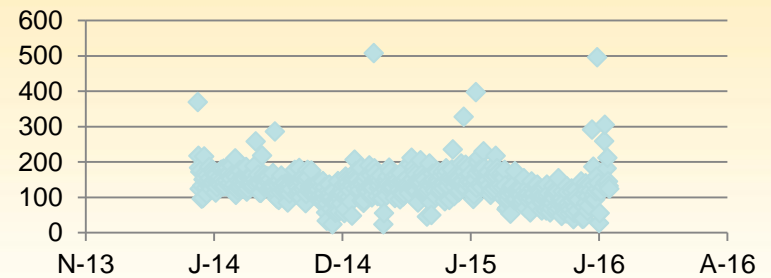
### Billings MT



## San Diego

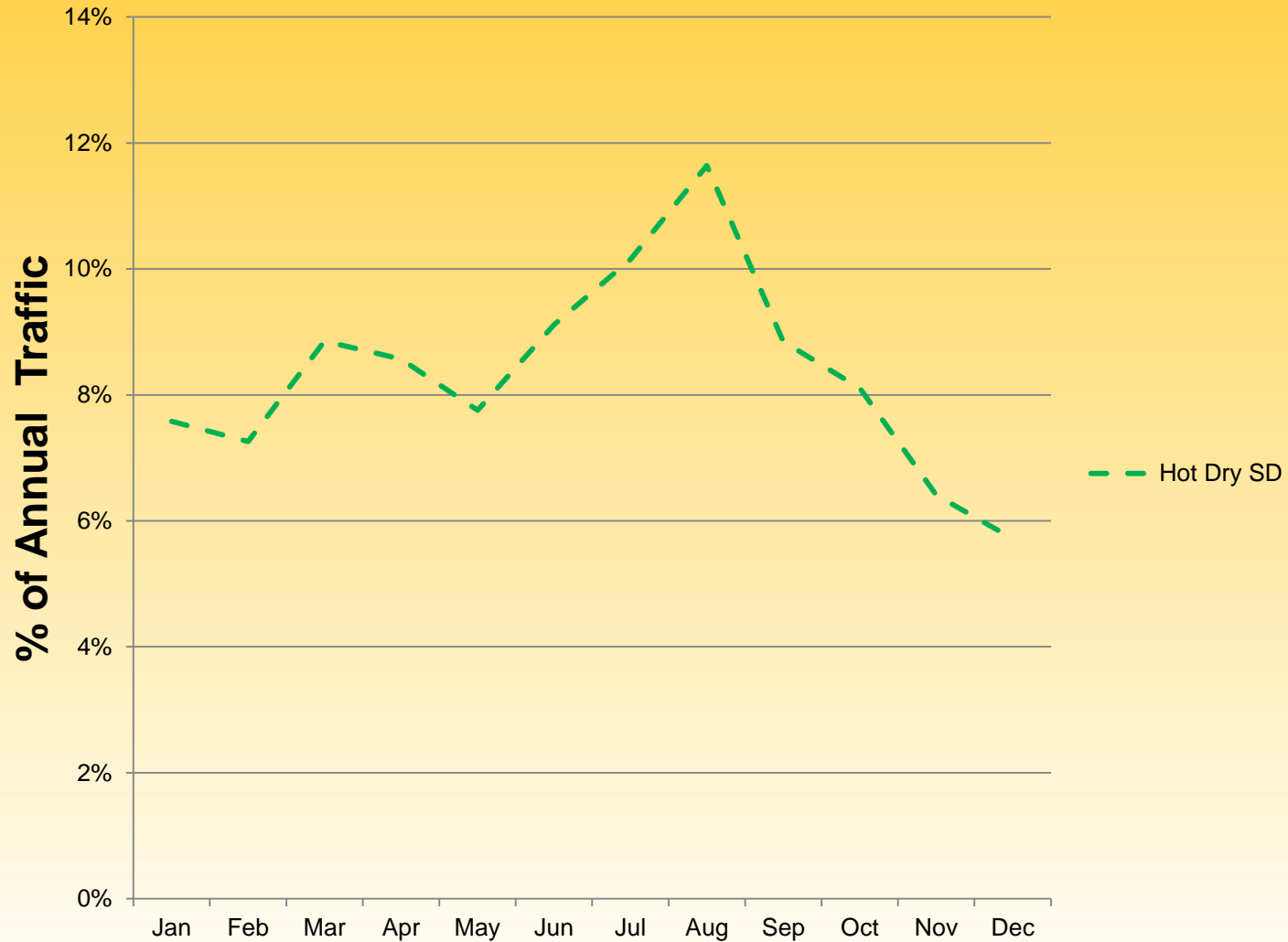


## San Diego

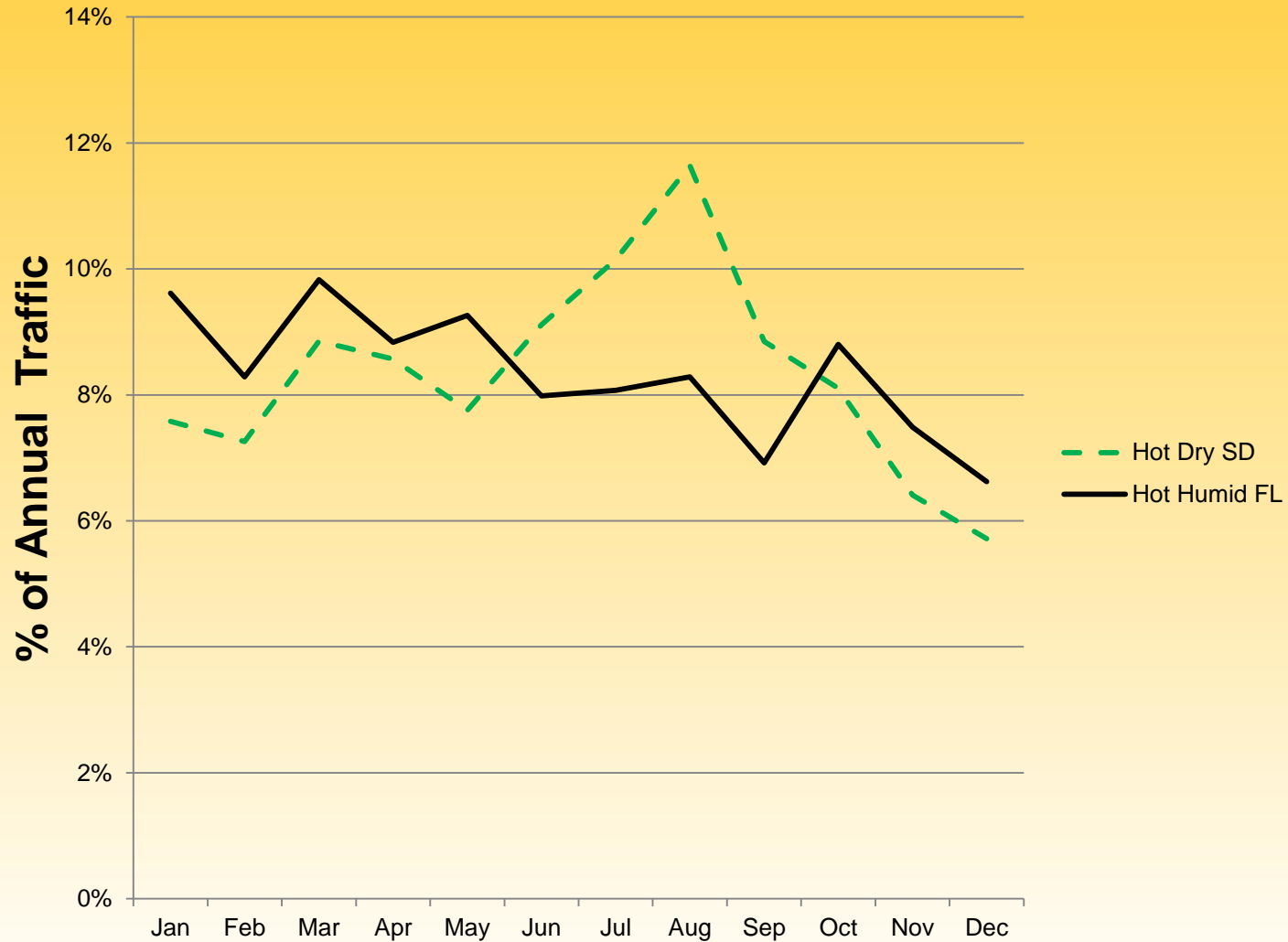




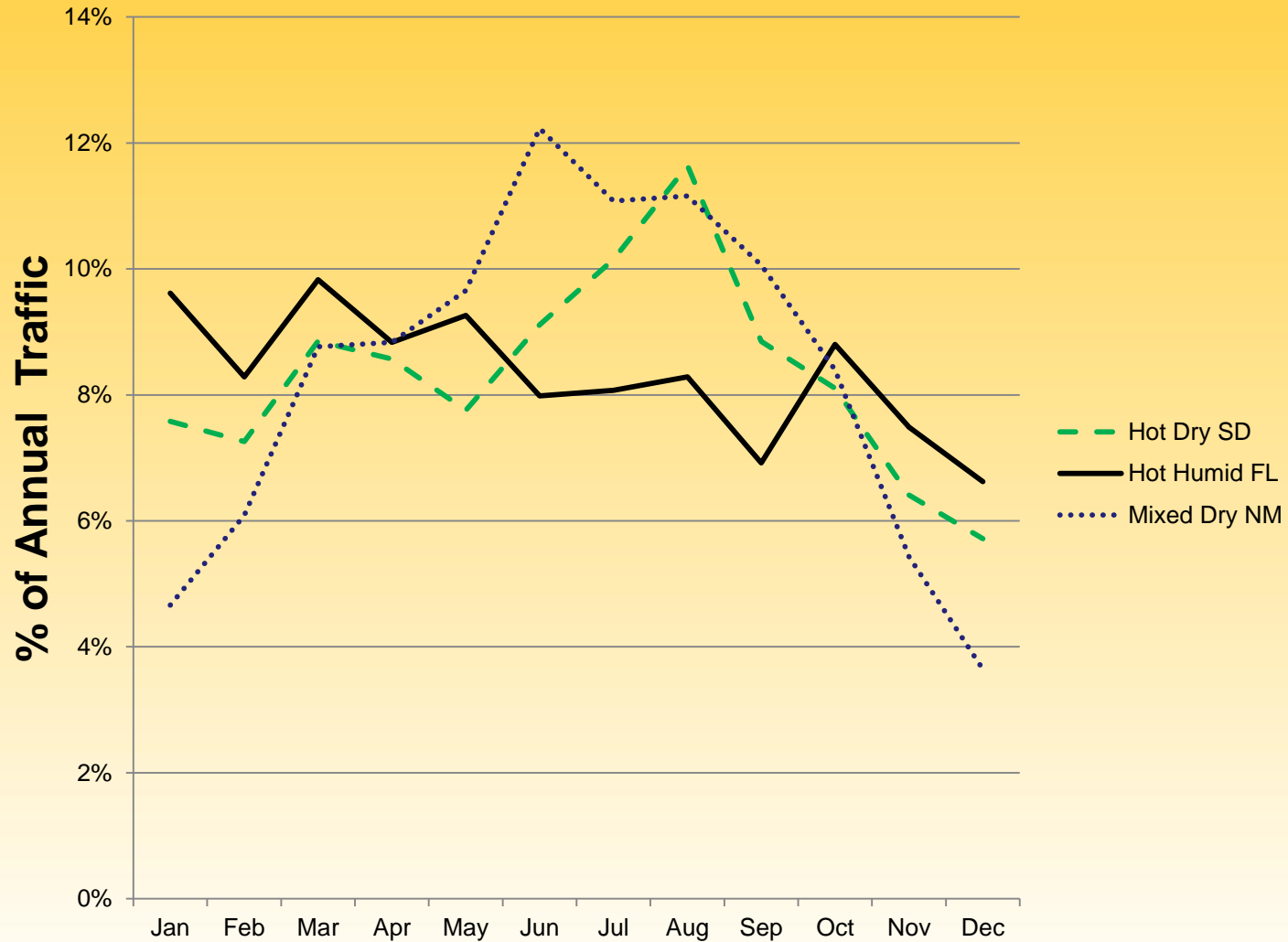
## Seasonality in Bike Traffic Varies by Region



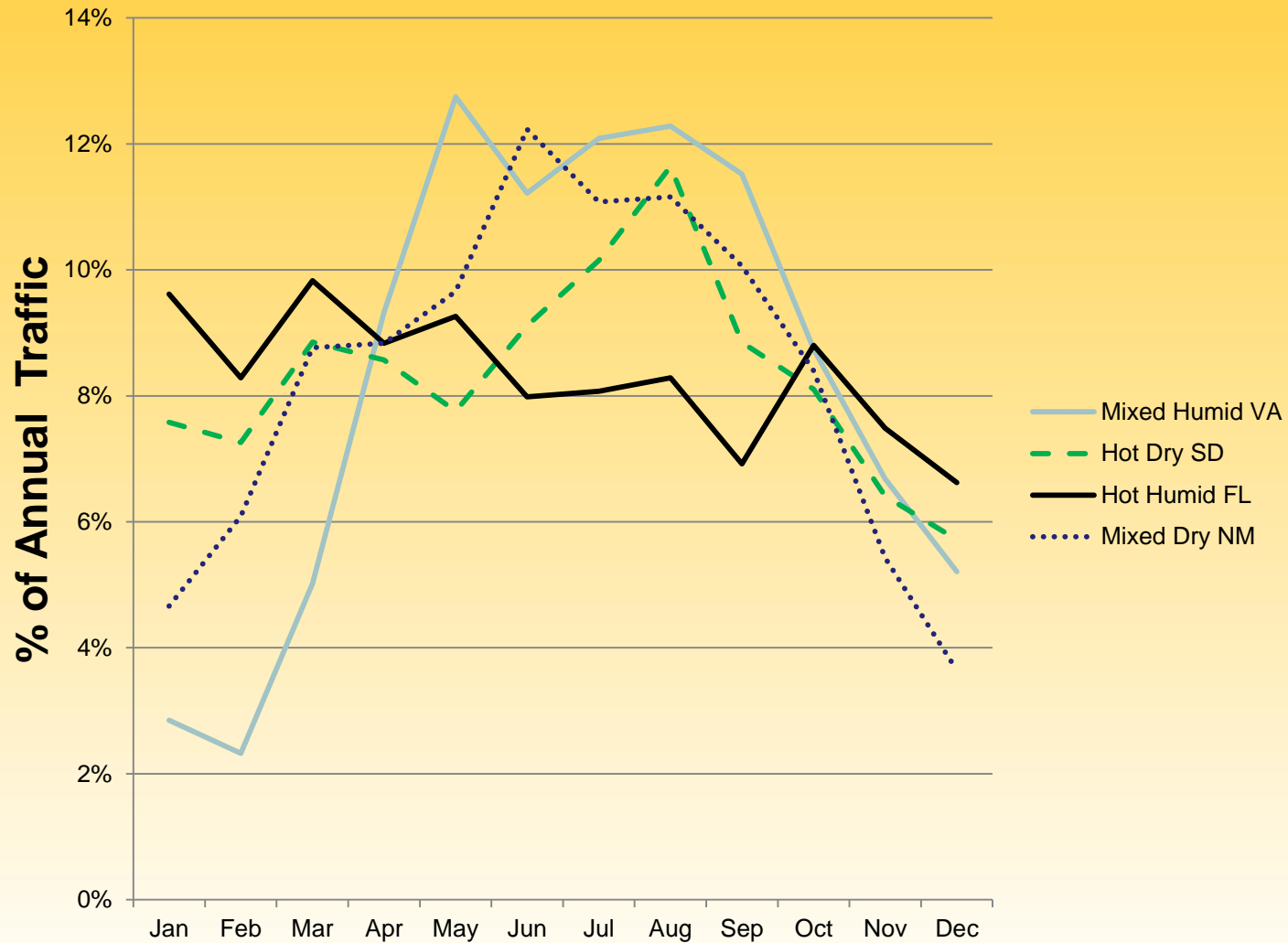
## Seasonality in Bike Traffic Varies by Region



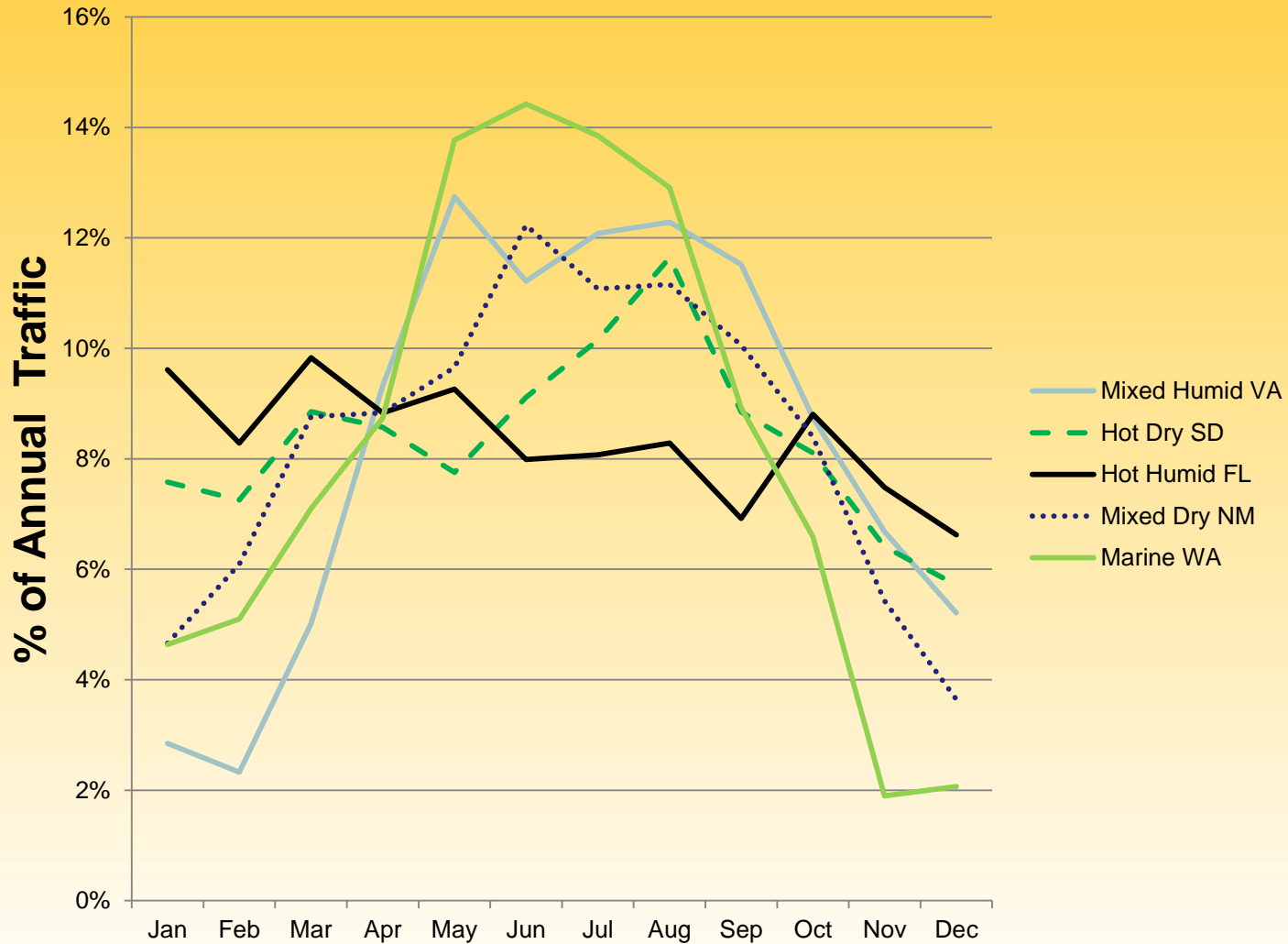
## Seasonality in Bike Traffic Varies by Region



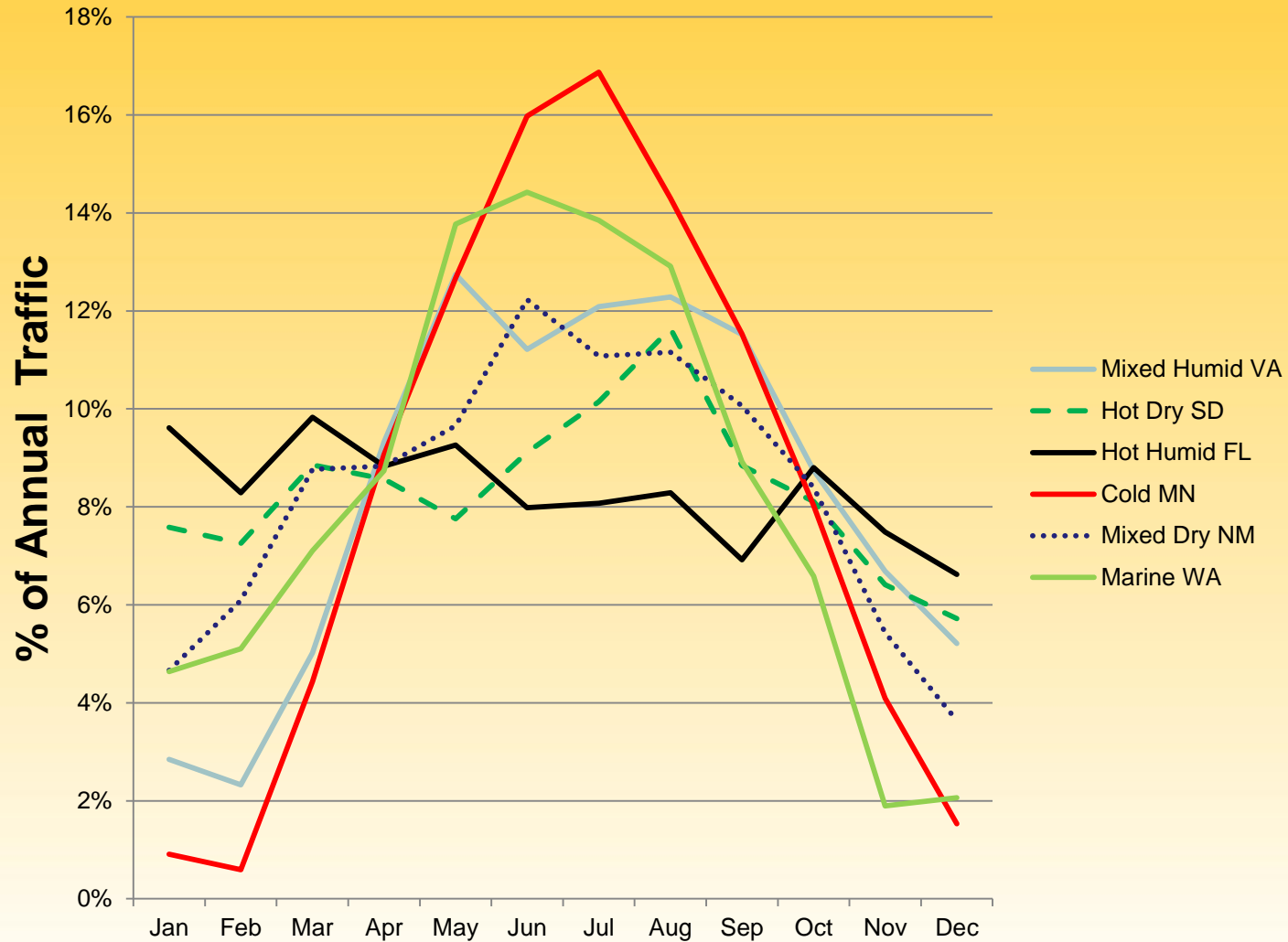
## Seasonality in Bike Traffic Varies by Region



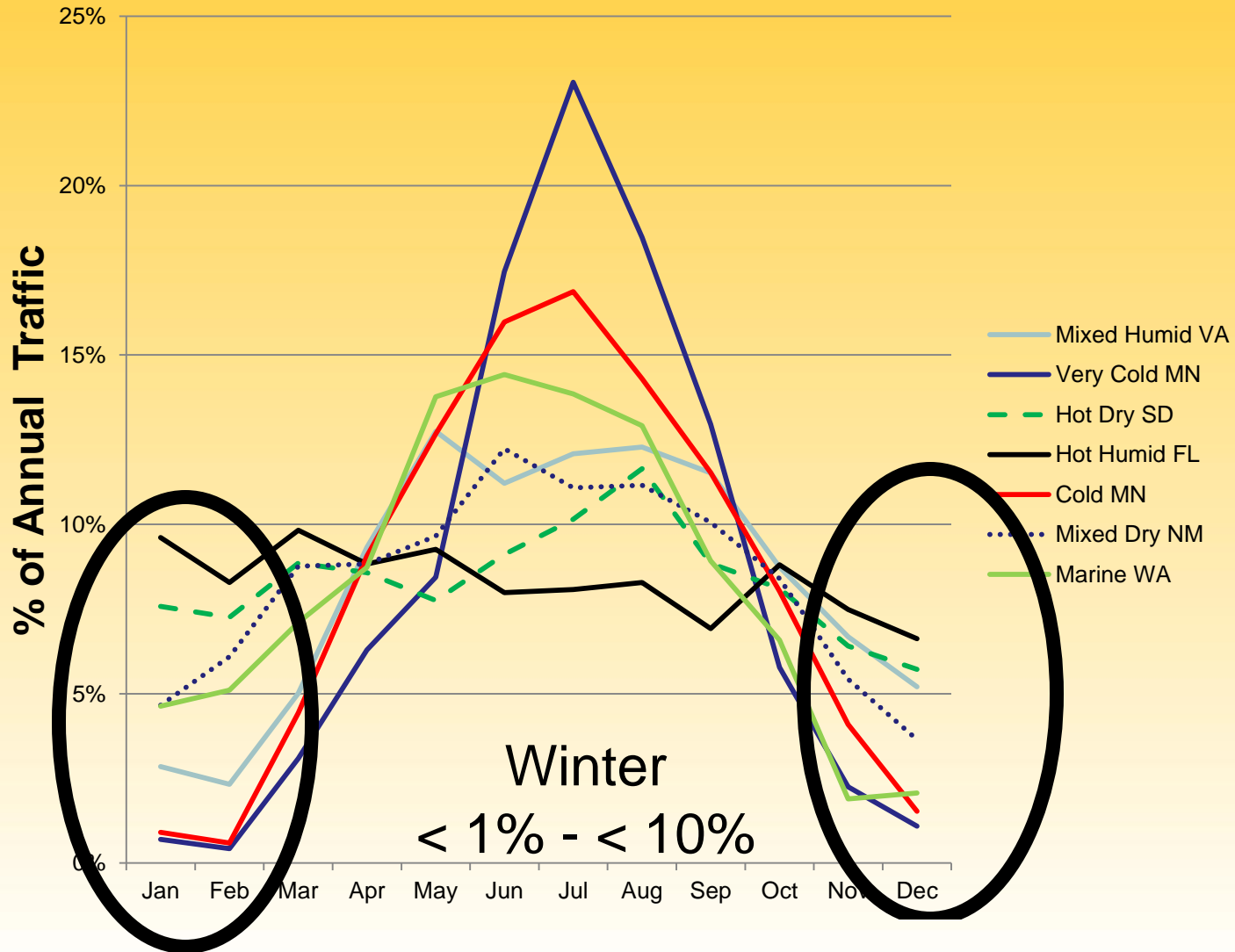
# Seasonality in Bike Traffic Varies by Region



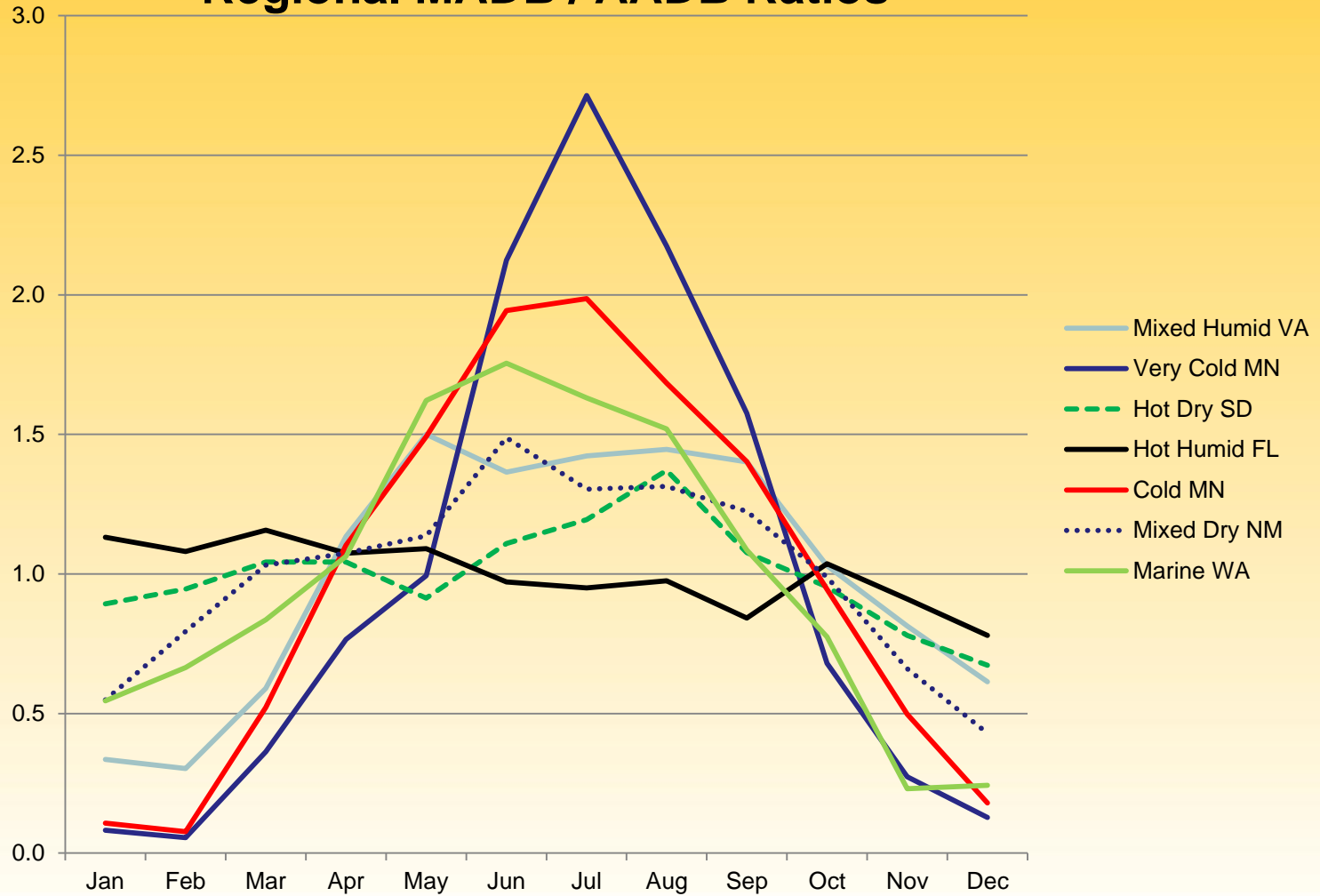
## Seasonality in Bike Traffic Varies by Region



# Seasonality in Bike Traffic Varies by Region

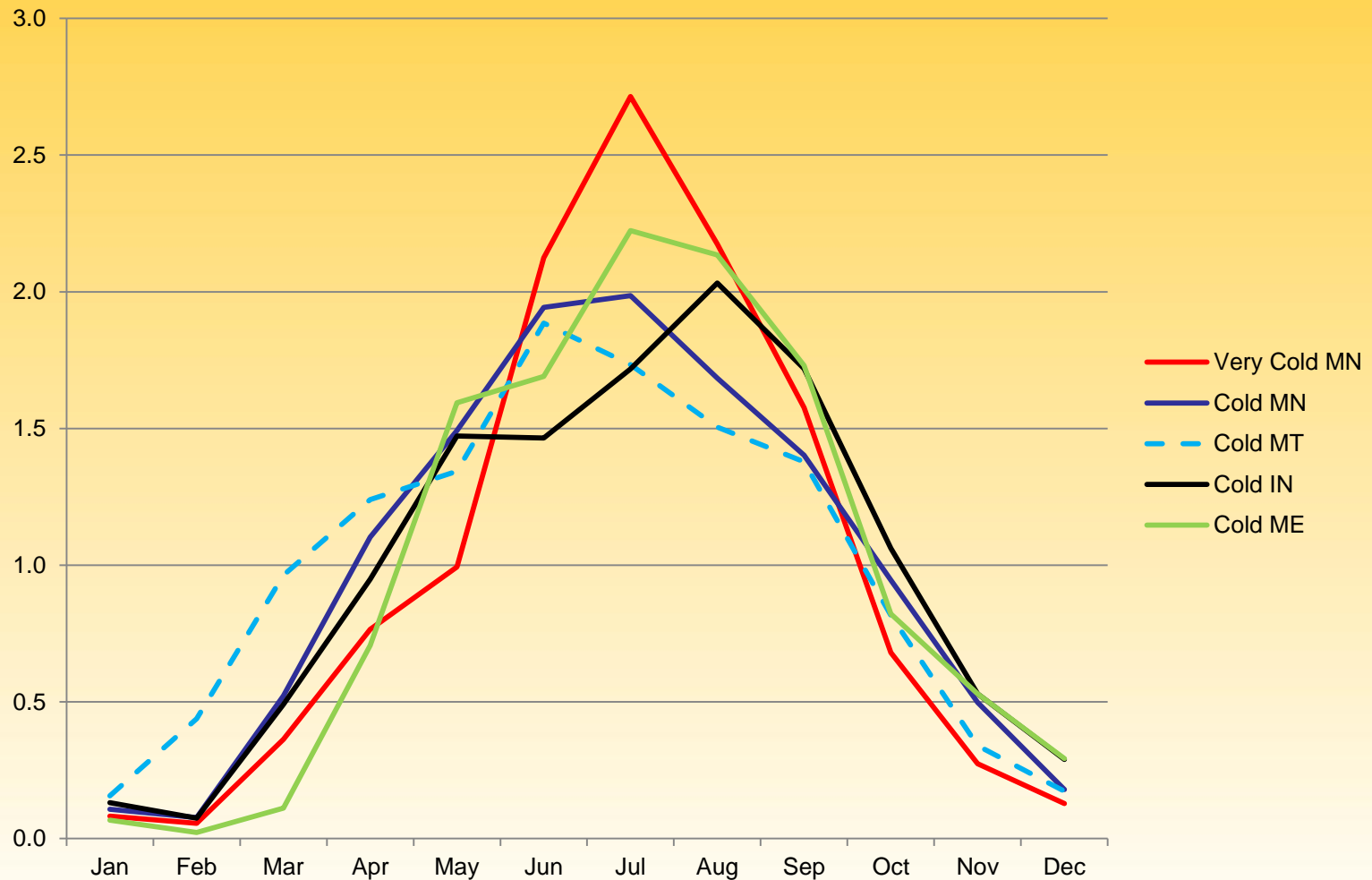


# Regional MADB / AADB Ratios





## MADB / AADB Ratios in Cold and Very Cold Regions



# Variables in Weather Models

Dependent variable = daily traffic volume (bike, ped, mixed-mode)

- Daylight hours
- Temperature
  - Ave, squared
- Precipitation
  - Dummy, interaction terms, squared
- Dew point
- Wind speed
- Snow depth
- Season
  - Winter, Fall, Spring
- Holiday
- Weekend

# Effects of Weather Vary by Region: Explanatory Power of Models Varies

Pseudo R-squared Value

<b>Region</b>	<b>Bike Models</b>	<b>Ped Models</b>	<b>Mixed-mode Models</b>
Very cold	0.91	0.82	0.88
Cold	0.52	0.43	0.52
Marine	0.66	0.14	0.38
Mixed dry	0.68	0.08	0.48
Mixed humid	0.56	0.48	0.56
Hot dry	0.21	0.05	0.19
Hot humid	0.45	0.19	0.36
National (all sites)	0.38	0.20	0.32

# Effects of Weather on Cycling Vary by Region

Weather Variable	Very Cold	Cold	Marine	Mixed Dry	Mixed Humid	Hot Dry	Hot Humid	Aggregate
Day Light	+		+	+	+	+	+	+
Winter		-		+	+	-		-
Fall		+			+	-	+	
Spring	-							-
Holiday	-					+	+	+
Weekend		+		+		+	+	+
Tavg	+	+	+	+	+	+	+	+
Tavg*Tavg		-	-	-	-	-	-	-
Precipitation=0	+	+	+	+	+	+	+	+
Precipitation	-	-	-	-	-	-	-	-
Precipitation*2	+	+	+	+	+	+	+	+
DewPoint	-		-	-	-	-	+	+
DewPoint*DewPoint		+	+	+		+	-	-
Avg Speed	-	-	-	-	-	-	-	-
Scow Depth=0	+	+	+	+	+		+	+
Constant	+	+	-	+	-	+	-	+
Cragg & Uhler's R2	0.91	0.52	0.66	0.68	0.56	0.21	0.45	0.38

# Research Findings

1. AADB, AADP, AADTT vary over three orders of magnitude (< 100 to > 1,000)
2. Weather effects different for cyclists, pedestrians
3. Weather models differ by region
4. Models explain
  - a. Most in “very cold” region (Duluth)
  - b. Least in “hot dry” region (San Diego)

# Limitations - Lots

1. Limited number of sites in regions
2. Limited distribution of sites within regions
3. Subjectivity in QA/QC
4. Challenges in variable specification
5. Not controlling for interaction effects of culture, land use that may moderate effects of weather

# Next Steps

- Review model specification
- Estimate general demand models

Questions?

Thank you!

# Extra Slides with Modeling Details





# Effects of Weather on Cycling Vary: Summary

Variable	Direction, Significance of Effect
Day Light	Positive, significant for all regions but cold
Season	Season: direction of effect varies by region (e.g., winter positive or negative)
Holiday	Varies, not significant in all regions
Weekend	Positive, but not significant in all regions
Tavg	Positive in all regions
Tavg*Tavg	Negative in all regions but very cold
Precipitation=0	Dry (no precipitation: positive in all regions)
Dew Point	Negative in all regions but hot humid
Ave wind speed	Negative in all regions
Snow Depth=0	No snow: positive (never snow in hot dry)
Cragg & Uhler's R2	Range: 0.21 - 0.91

# Effects of Weather on Walking Vary by Region

Variables	Very Cold	Cold	Marine	Mixed Dry	Mixed Humid	Hot Dry	Hot Humid	Aggregate
Day Light		+	+	+	+		+	+
Winter					+	-		-
Fall	-			+	+	-	+	
Spring		+						-
Holiday		+			+		+	+
Weekend	+	+	+	-	+	+	+	+
Tavg	+	+	+	+	+	+	+	+
Tavg*Tavg		-	-	-	-	-	-	-
Precepitation=0	+	+	+	+	+	+	+	+
Precipitation	-	-	-		-	-	-	-
Precipitation*2	+	+				+		+
DewPoint	-	-	-	-	-		+	+
DewPoint*DewPoint	-	+					-	-
Avg Speed	-	-		-	-	-	+	-
Scow Depth=0					+		+	+
Constant	+	+	+	+	+	-	-	+
Cragg & Uhler's R2	0.82	0.43	0.14	0.08	0.48	0.05	0.19	0.2

# Effects of Weather on Walking: Summary

Variable	Direction, Significance of Effect
Day Light	Positive, significant for all regions but very cold, hot dry
Season	Season: direction of effect varies region (e.g., winter positive or negative)
Holiday	Varies: positive in some regions, insignificant in others
Weekend	Positive, significant in all regions but mixed dry (negative)
Tavg	Positive in all regions
Tavg*Tavg	Negative in all regions but very cold
Precepitation=0	Dry (no precipitation: positive in all regions)
DewPoint	Negative in all regions but hot humid
Avg Wind Speed	Negative in all regions but hot humid
Snow Depth=0	No snow: varies, but positive in some regions
Cragg & Uhler's R2	Range: 0.05 - 0.82