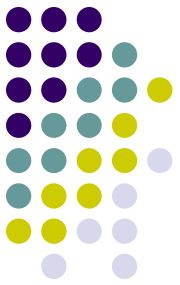
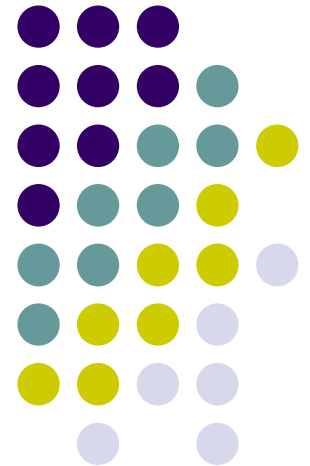


SANDAG



Transportation Modeling Forum



June 13, 2018

Forum Agenda

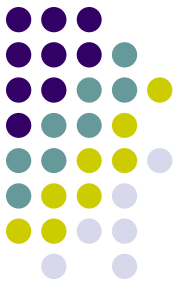


Travel Behavior Survey Summary

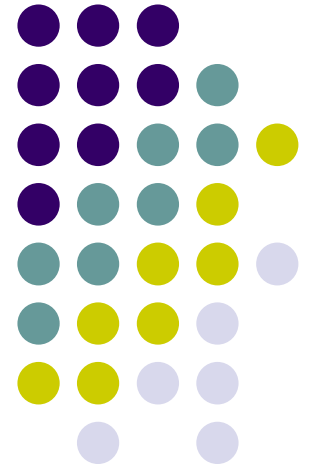
ABM2

Induced Travel

Travel Behavior Survey Summary



Ziying Ouyang
zou@sandag.org



Travel Behavior Survey Summary



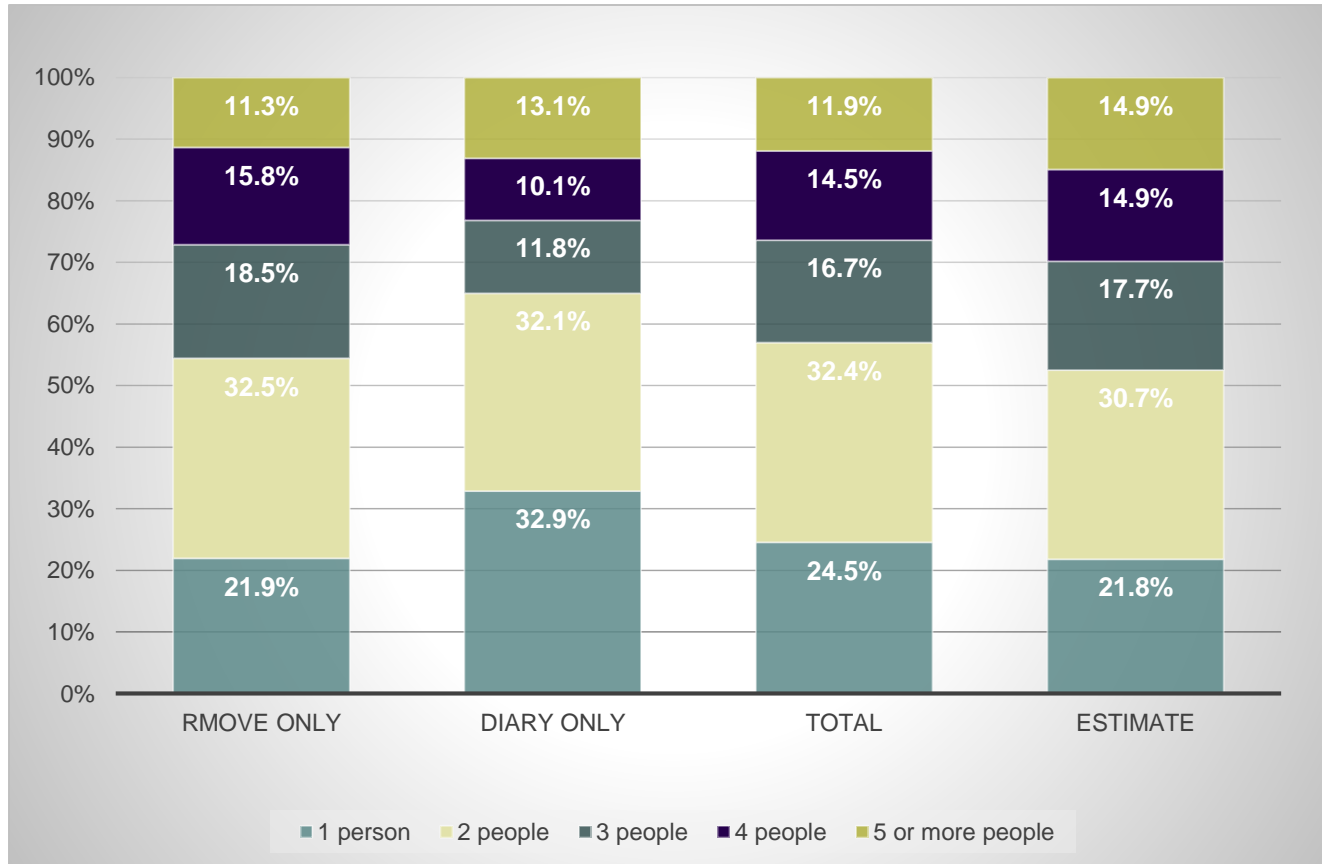
	Unweighted*	Weighted
Households	6,139	1,113,624
Persons	12,089	2,922,537
Person Trips	208,943	11,665,894
Trips/Household		10.48
Trips/Person		3.69

(* Weekday Only)

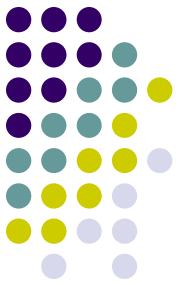
Travel Behavior Survey Summary



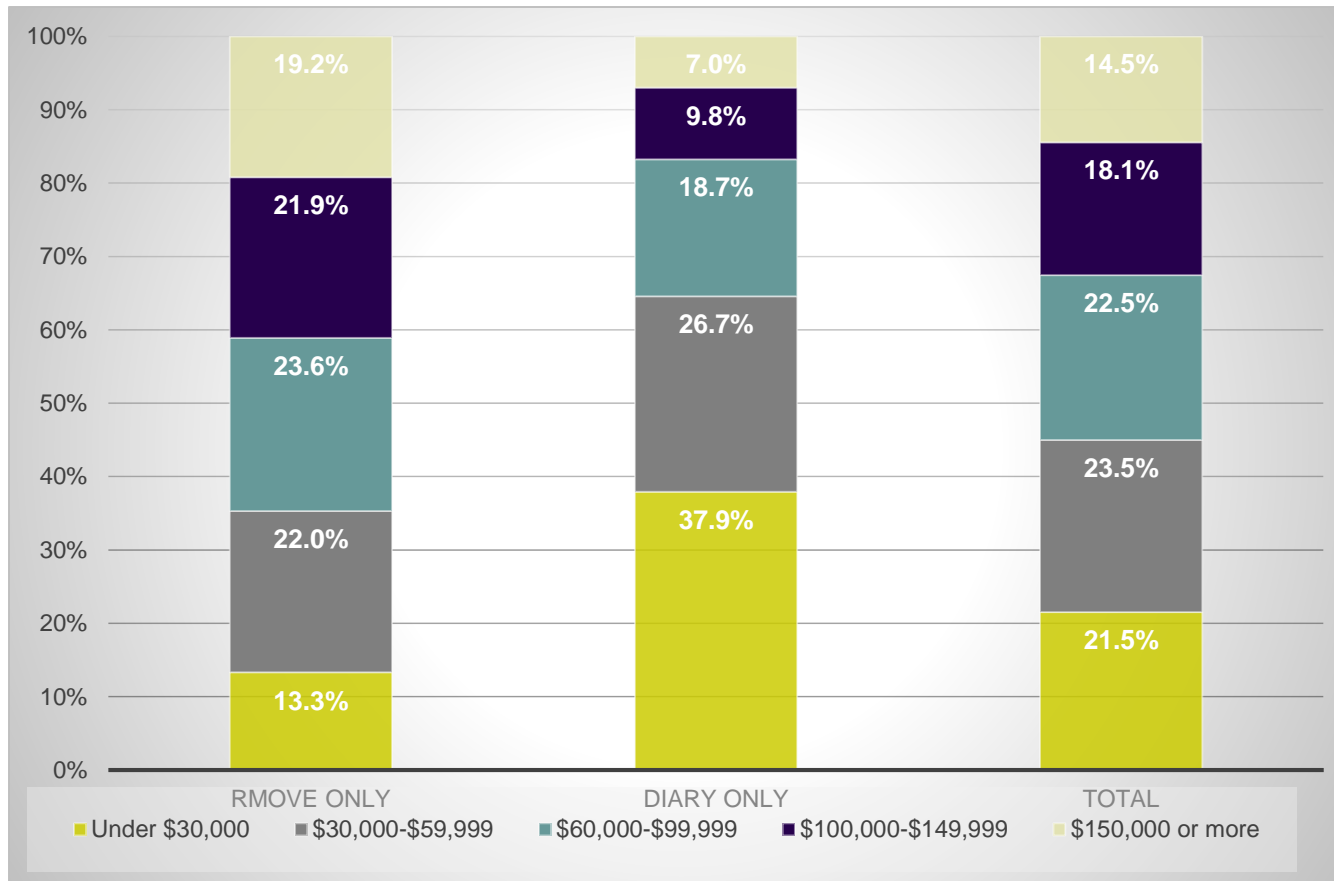
Household Size



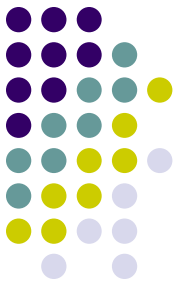
Travel Behavior Survey Summary



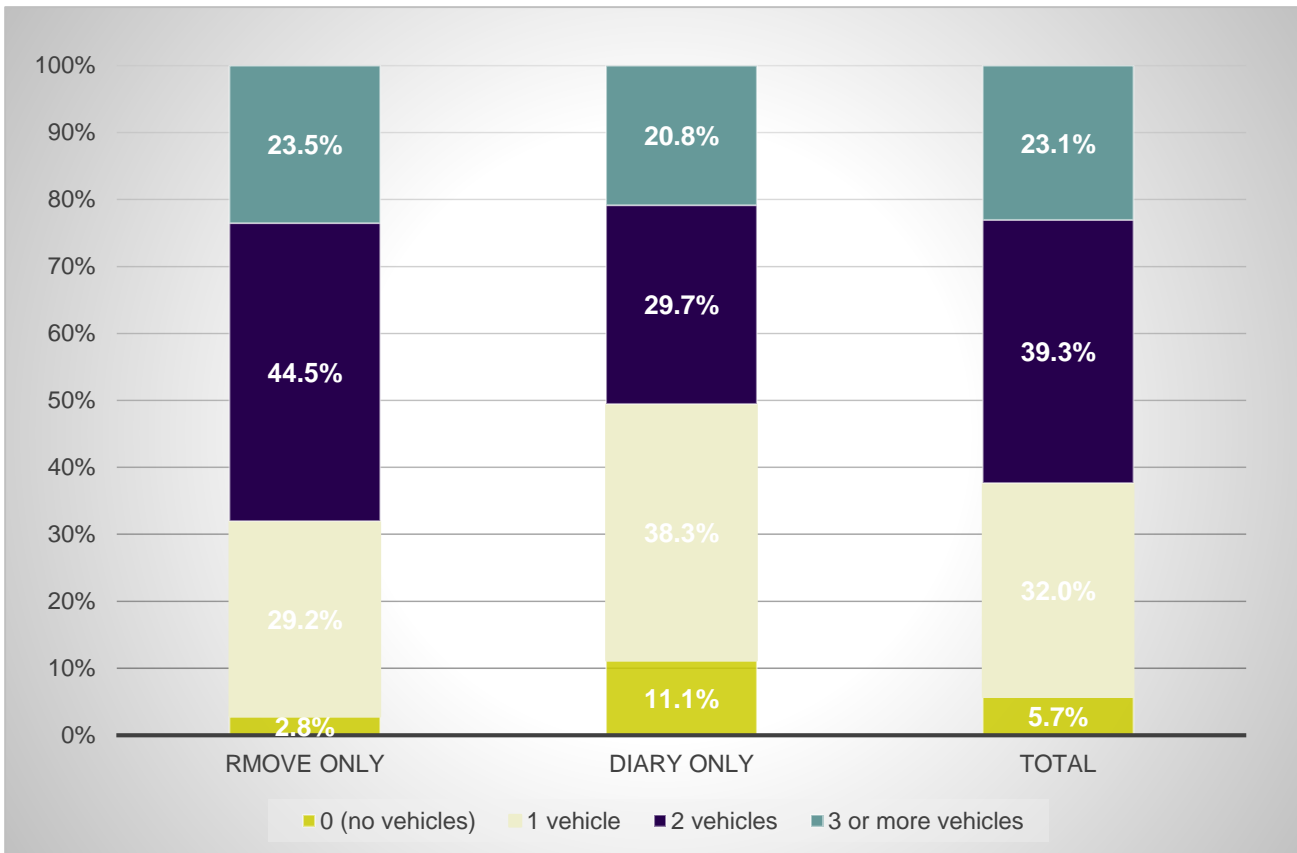
Household Income



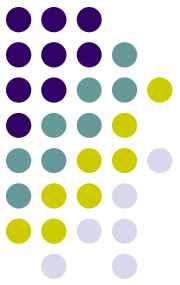
Travel Behavior Survey Summary



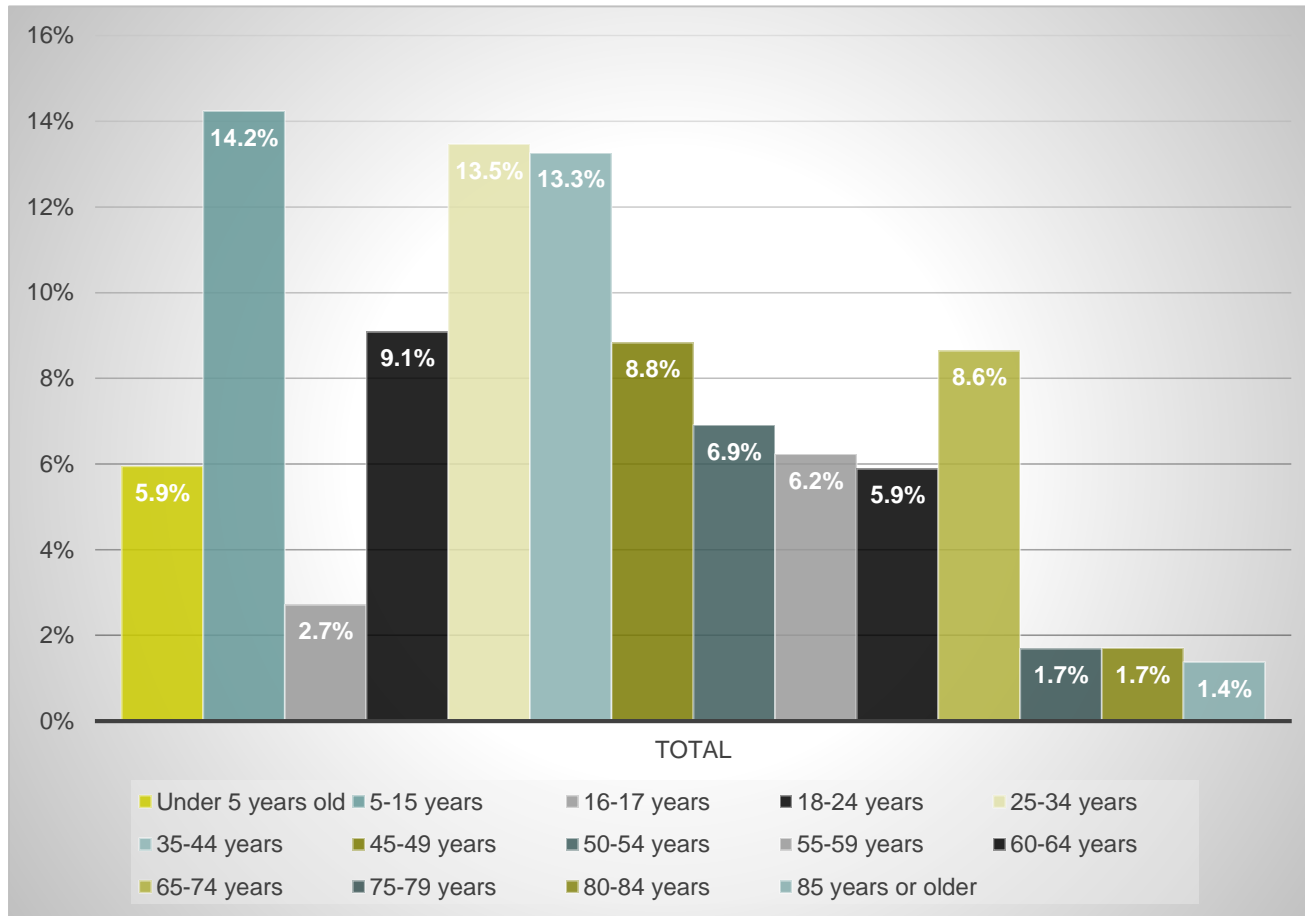
Household Vehicles



Travel Behavior Survey Summary



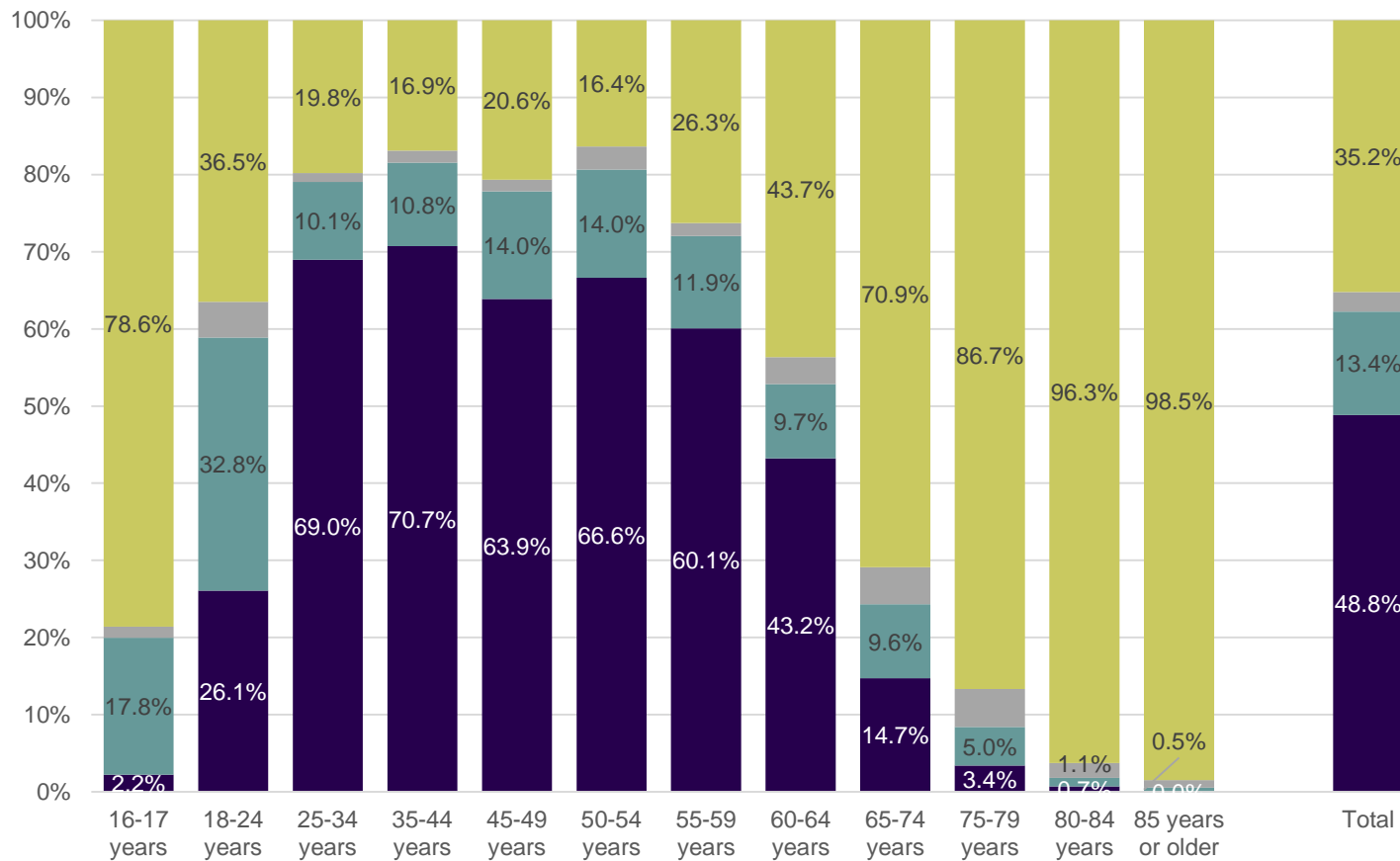
Age Distribution



Travel Behavior Survey Summary

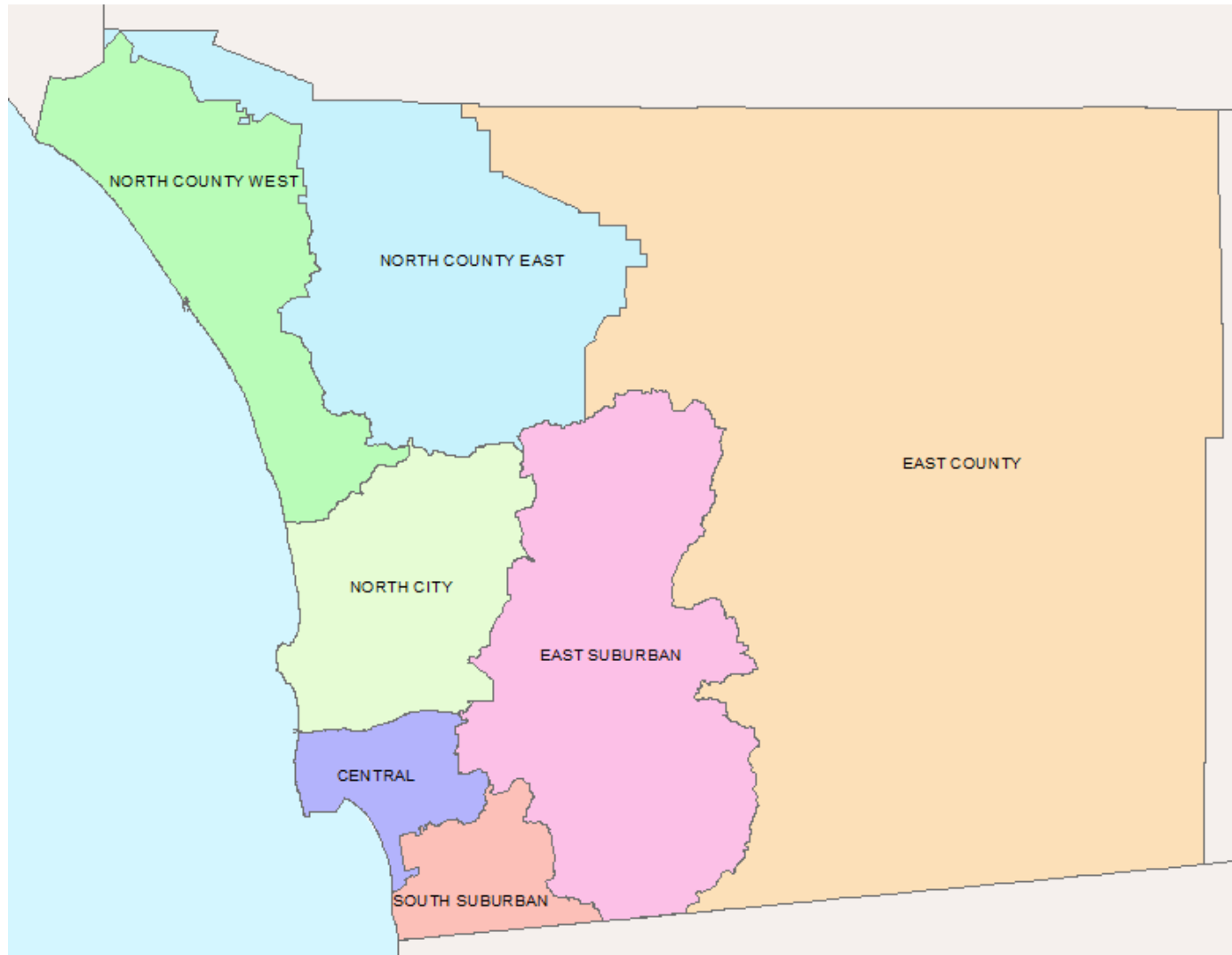


Employment Status

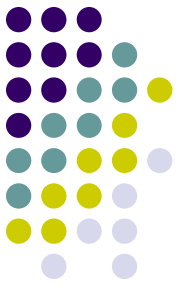


■ Not currently employed
 ■ Unpaid volunteer or intern
 ■ Employed part-time (paid) up to 35 hours/week
 ■ Employed full-time (paid) 35+ hours/week

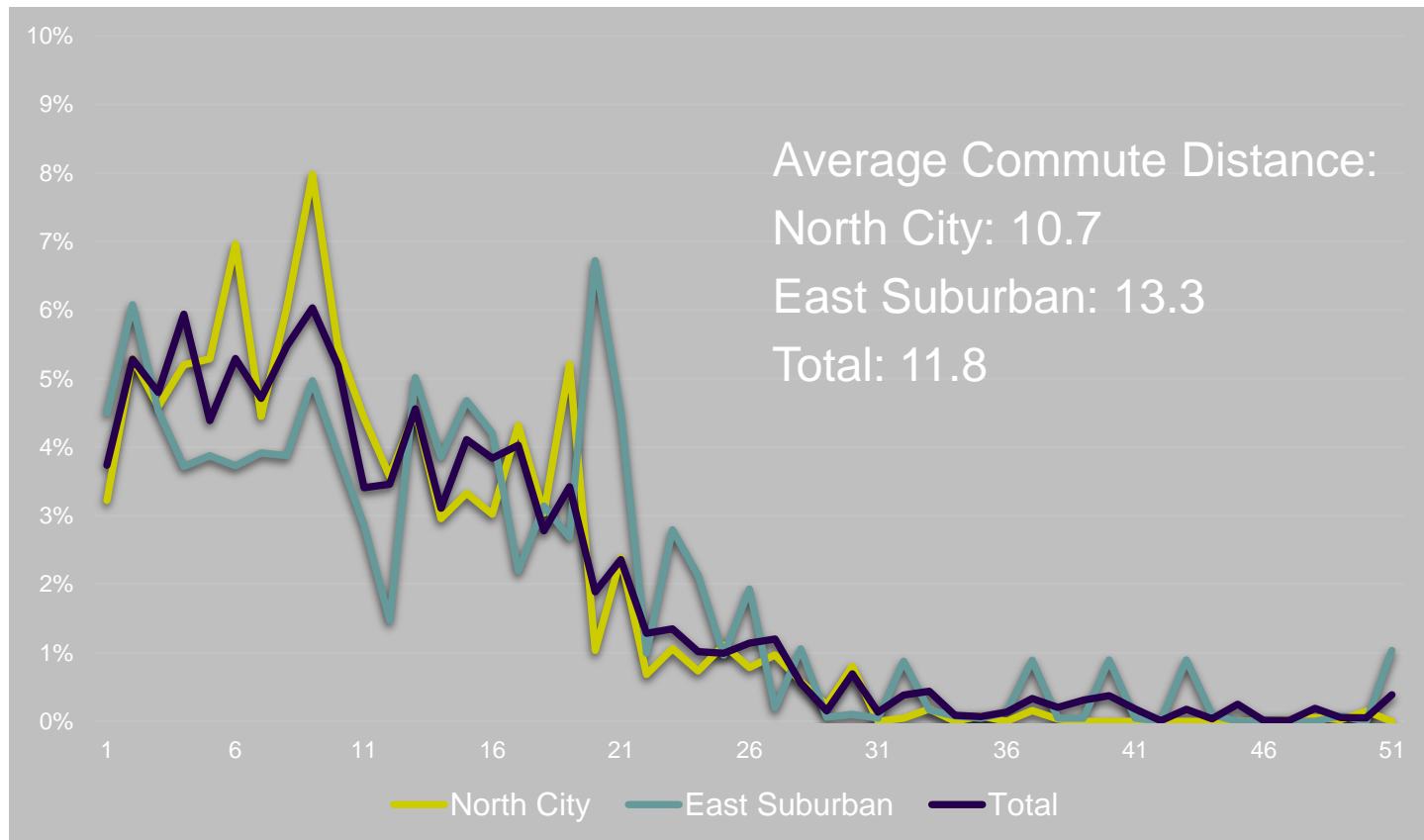
Travel Behavior Survey Summary



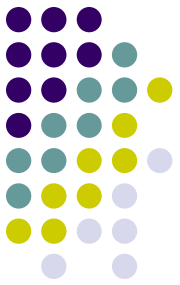
Travel Behavior Survey Summary



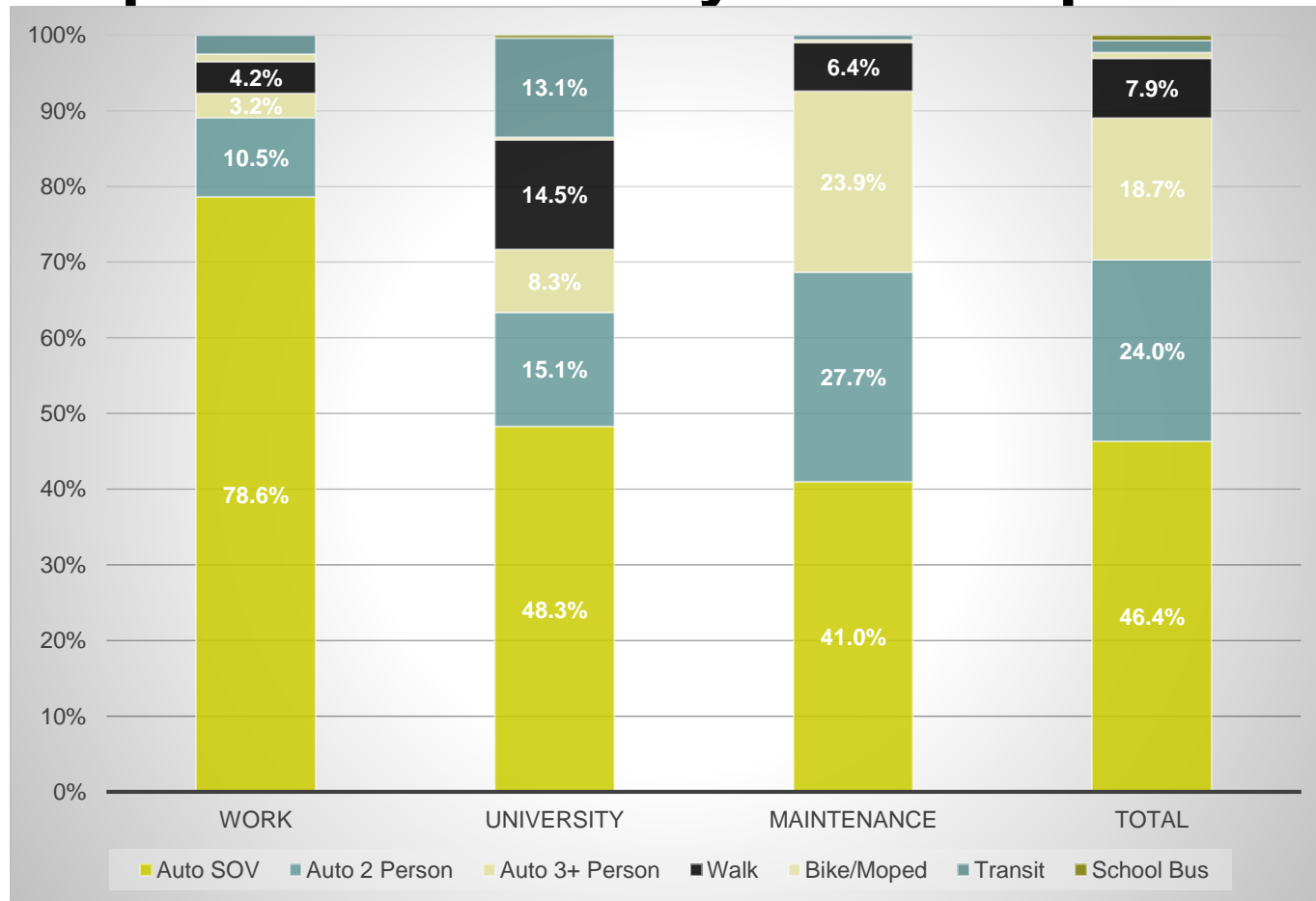
Miles to Work by MSA



Travel Behavior Survey Summary



Trip Mode Choice by Tour Purpose



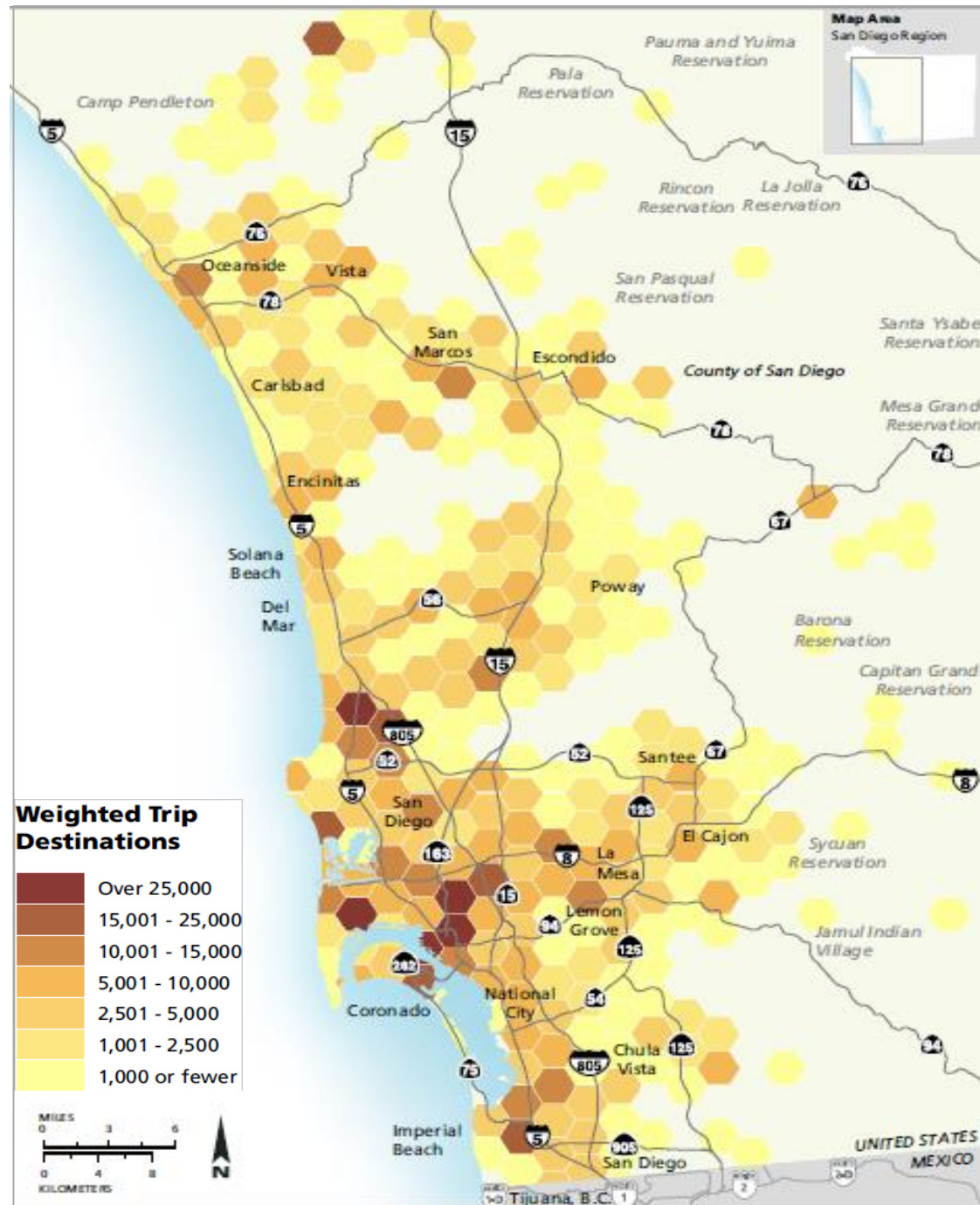
Travel Behavior Survey Summary



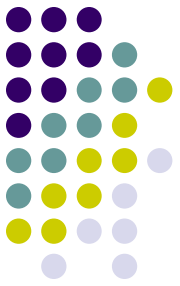
Trip Departure



Active Transportation Trip Destinations



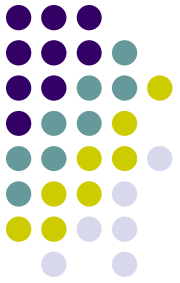
Travel Behavior Survey Summary



Survey Report Available

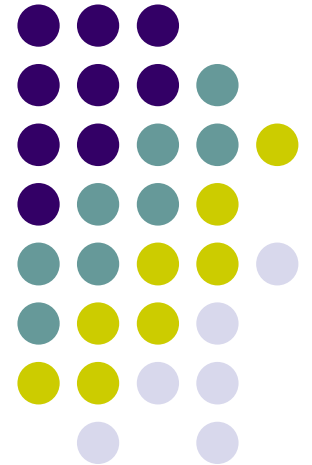
[http://www.sandag.org/index.asp?classid=13
&projectid=540&fuseaction=projects.detail](http://www.sandag.org/index.asp?classid=13&projectid=540&fuseaction=projects.detail)

ABM2



Wu Sun

wsu@sandag.org



ABM2



Background

- 2016/2017 Household Travel Behavior Survey
- 2015 Transit OnBoard Survey
- Focus: calibration and validation
- For 2019 Regional Plan

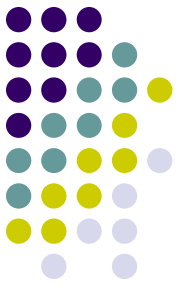
ABM2



A Suite of Travel Models

- Core model
 - San Diego resident model
- Special market models:
 - Airport passenger models- two of them
 - Visitor model
 - Crossborder model
 - Tour-based commercial travel model (CTM)
 - External models
 - Truck model

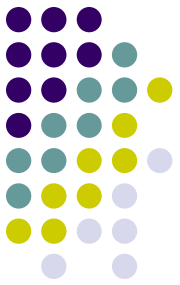
ABM2



Differences: ABM1 vs. ABM2

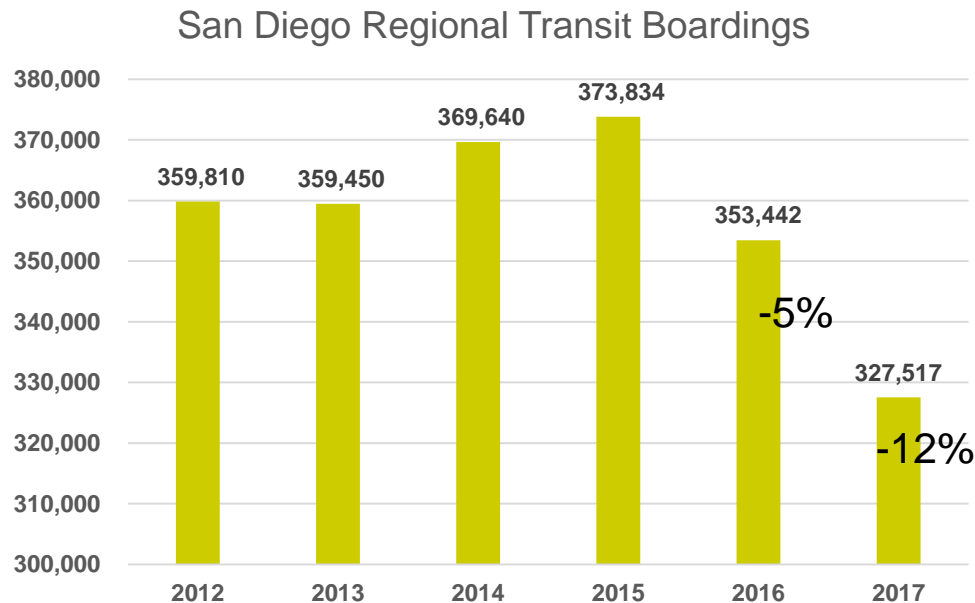
		ABM1	ABM2
Base Year		2012	2016
Surveys	HHTS	2006	2016/2017
	OnBoard	2009	2015
CTM		Trip-Based	Tour-Based
Travel Time Reliability		No	Yes
Escort Model		No	Yes
Assignment/Skimming		TransCAD	EMME

ABM2



Observed travel trend changes

- Higher trip/tour rates
- Declining transit boarding's



ABM2



Calibration & Validation

- Observed data sources
- Goal: hitting multiple targets simultaneously
 - By model component
 - By modeling segmentation
 - By geography
 - By data source

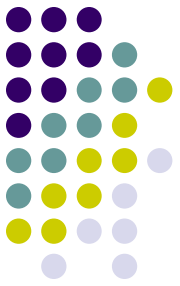
ABM2



Quality Assurance/Quality Control (QA/QC)

- Plan of Excellence
- Calibration & Validation is QA/QC
- QA/QC is NOT only calibration & validation
- Additional QA/QC
 - Population/households
 - Land use (employment etc.)
 - Networks

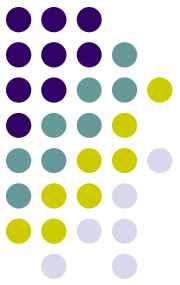
ABM2



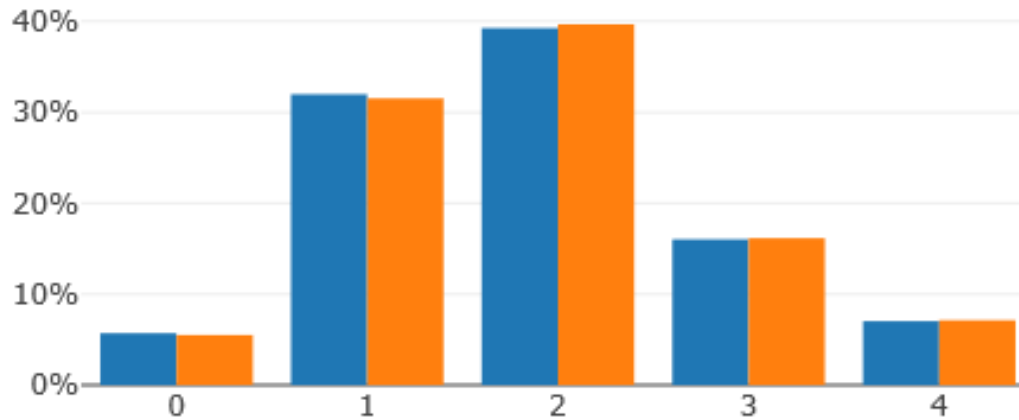
Draft results



- Not final
- Example results
 - A lot more in final report
 - Results by travel market, trip purpose, person type, time of day, geography, etc.
- Production mode
 - July 2018

ABM2

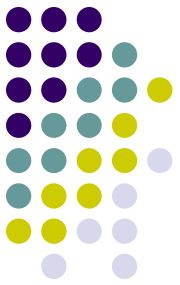


Draft results - Auto Ownership

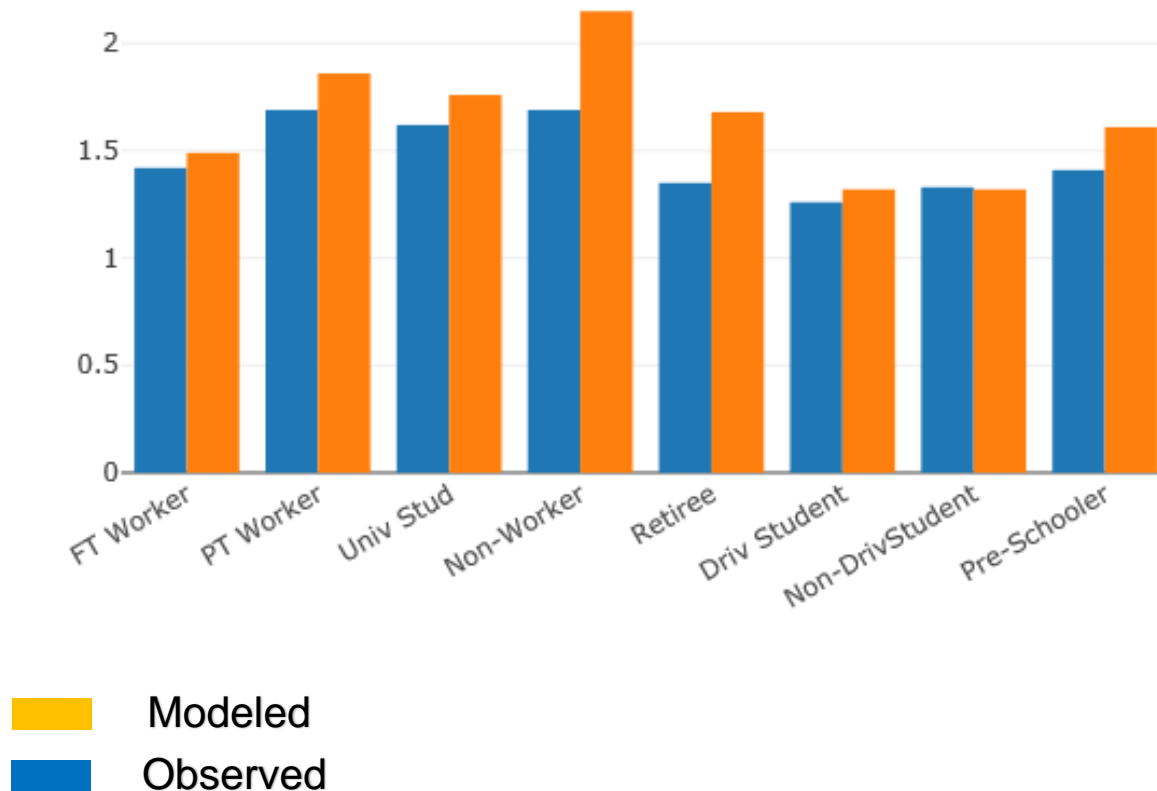


 Modeled
 Observed

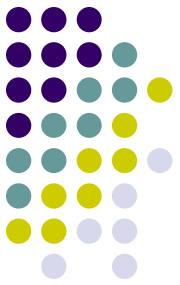
ABM2



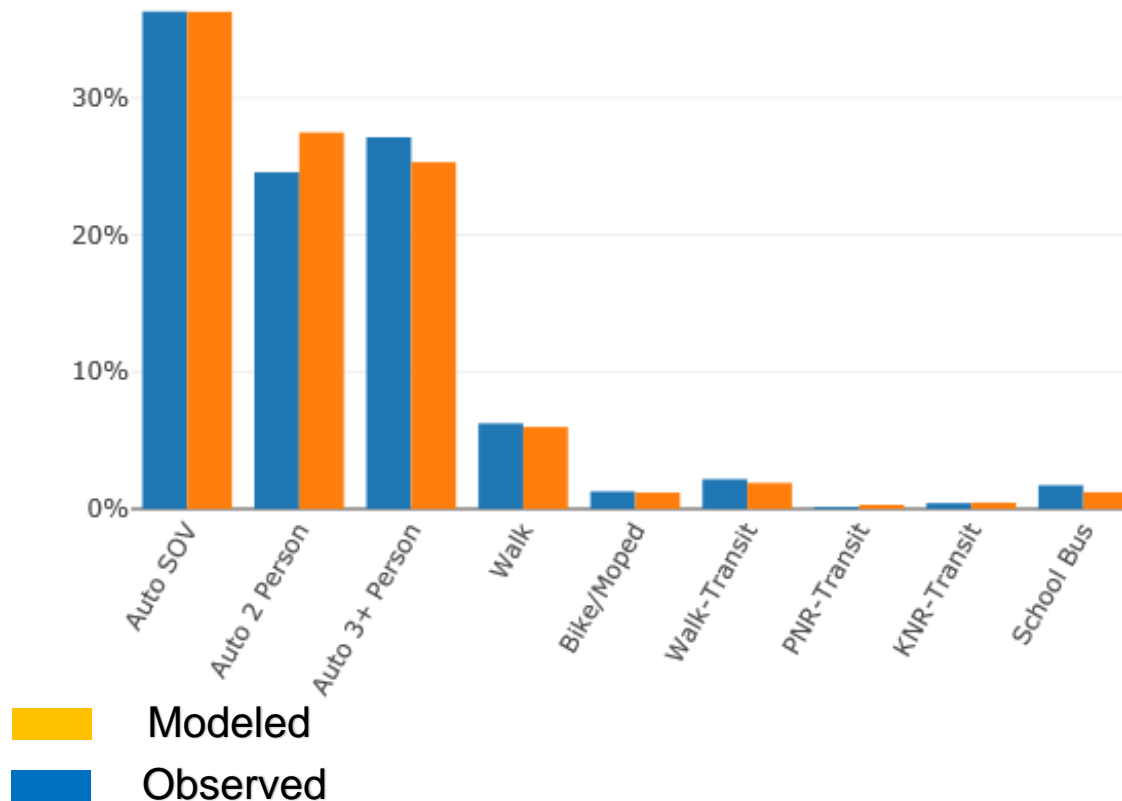
Draft results - Tour Rates



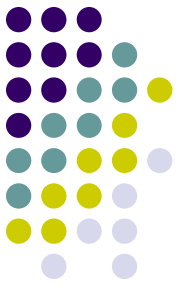
ABM2



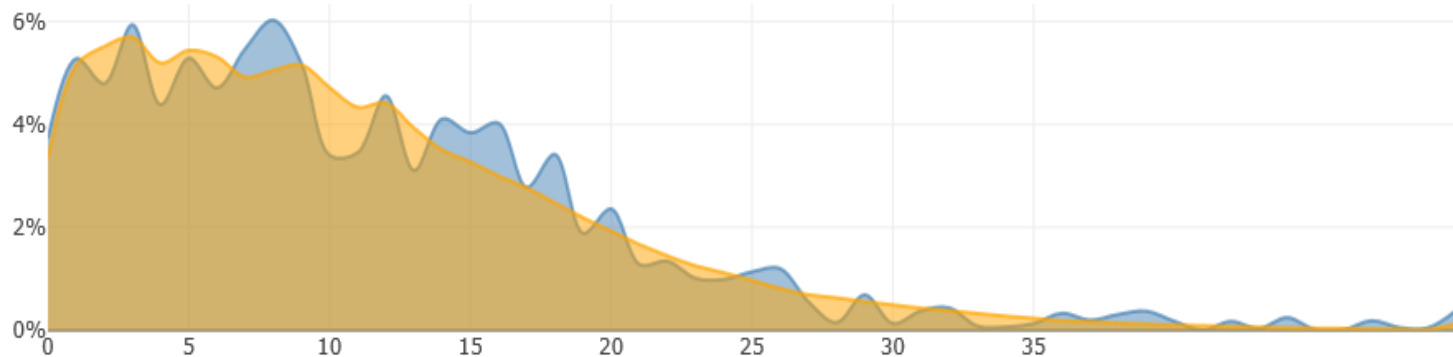
Draft results - Tour Mode Choice



ABM2

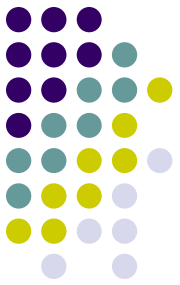


Draft results - Home to Work Distance

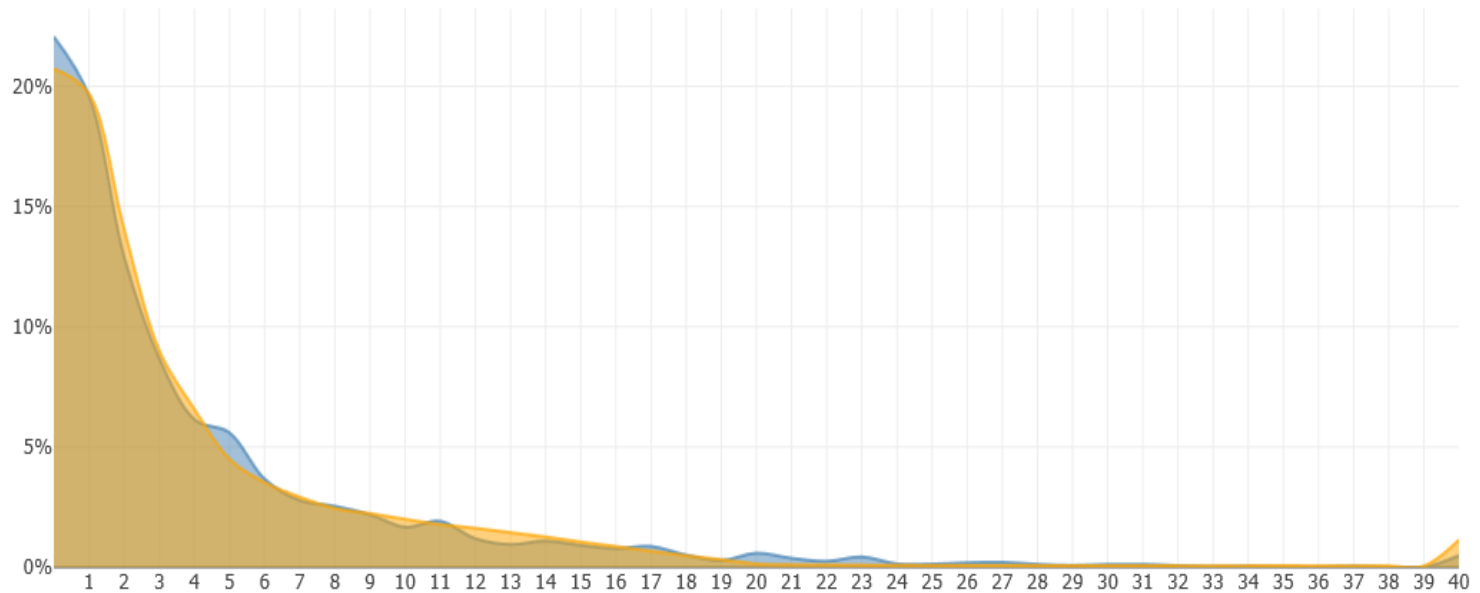


Modeled
Observed

ABM2

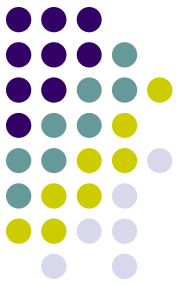


Draft results - Non Mandatory Tour Length

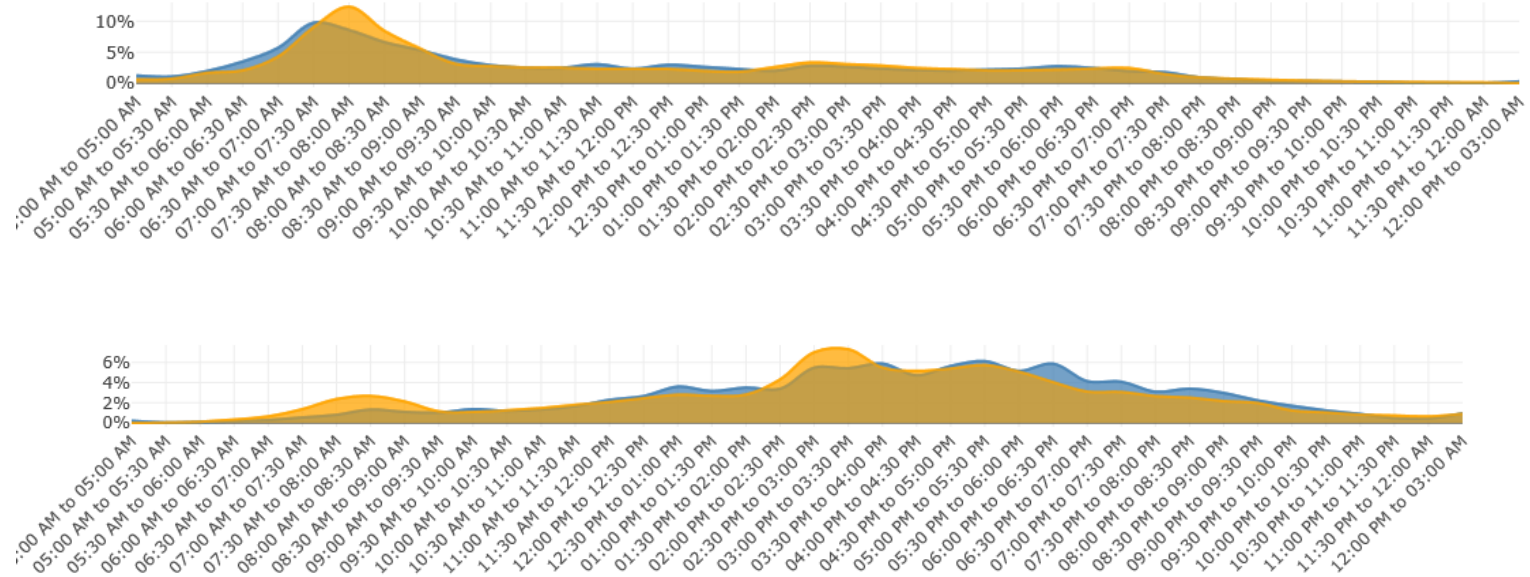




Modeled
Observed

ABM2

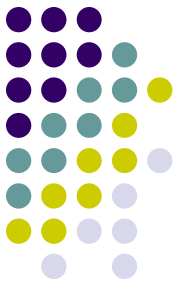


Draft results - Tour Time of Day Choices

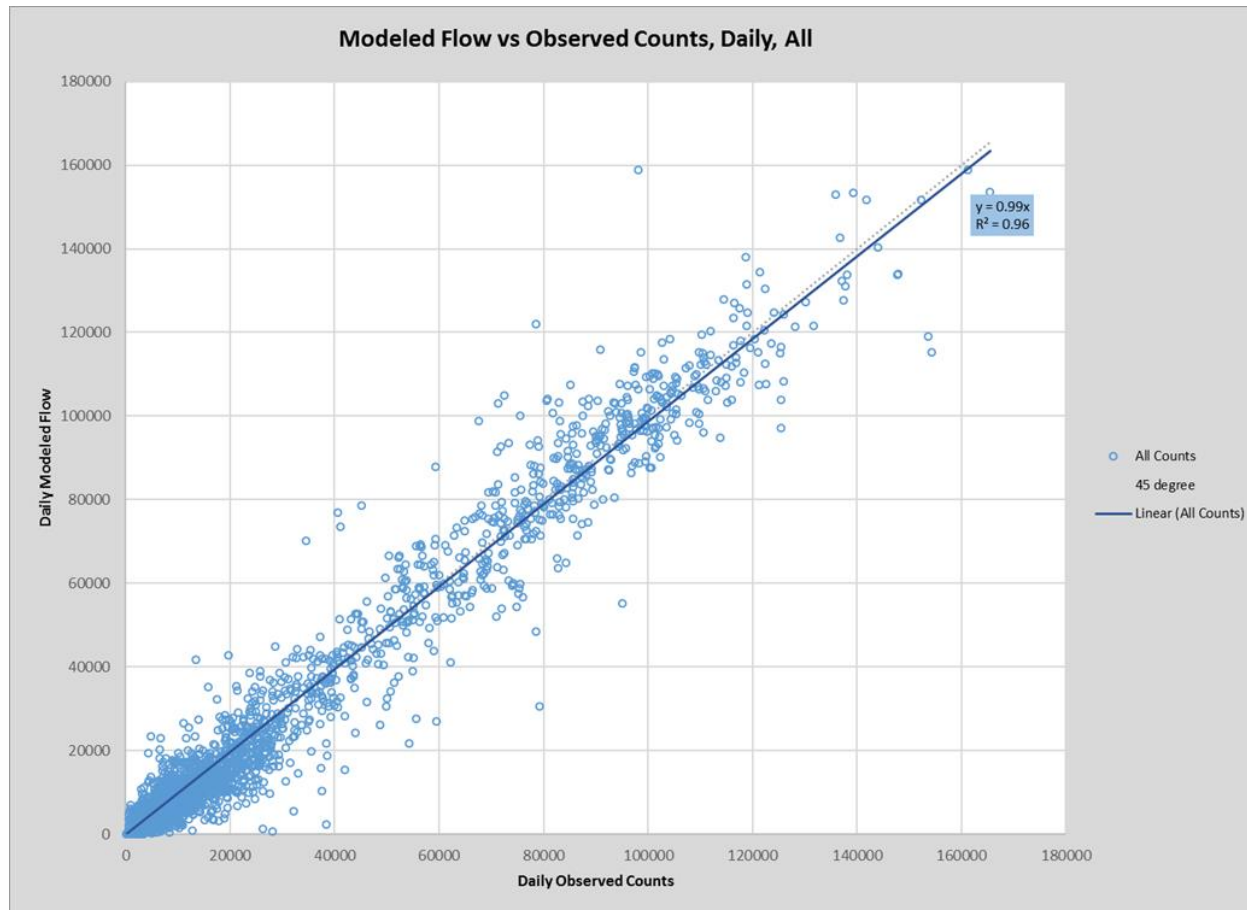


 Modeled
 Observed

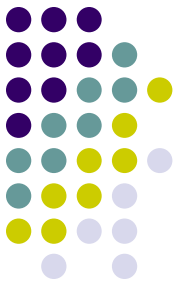
ABM2



Draft results - Assignment



ABM2



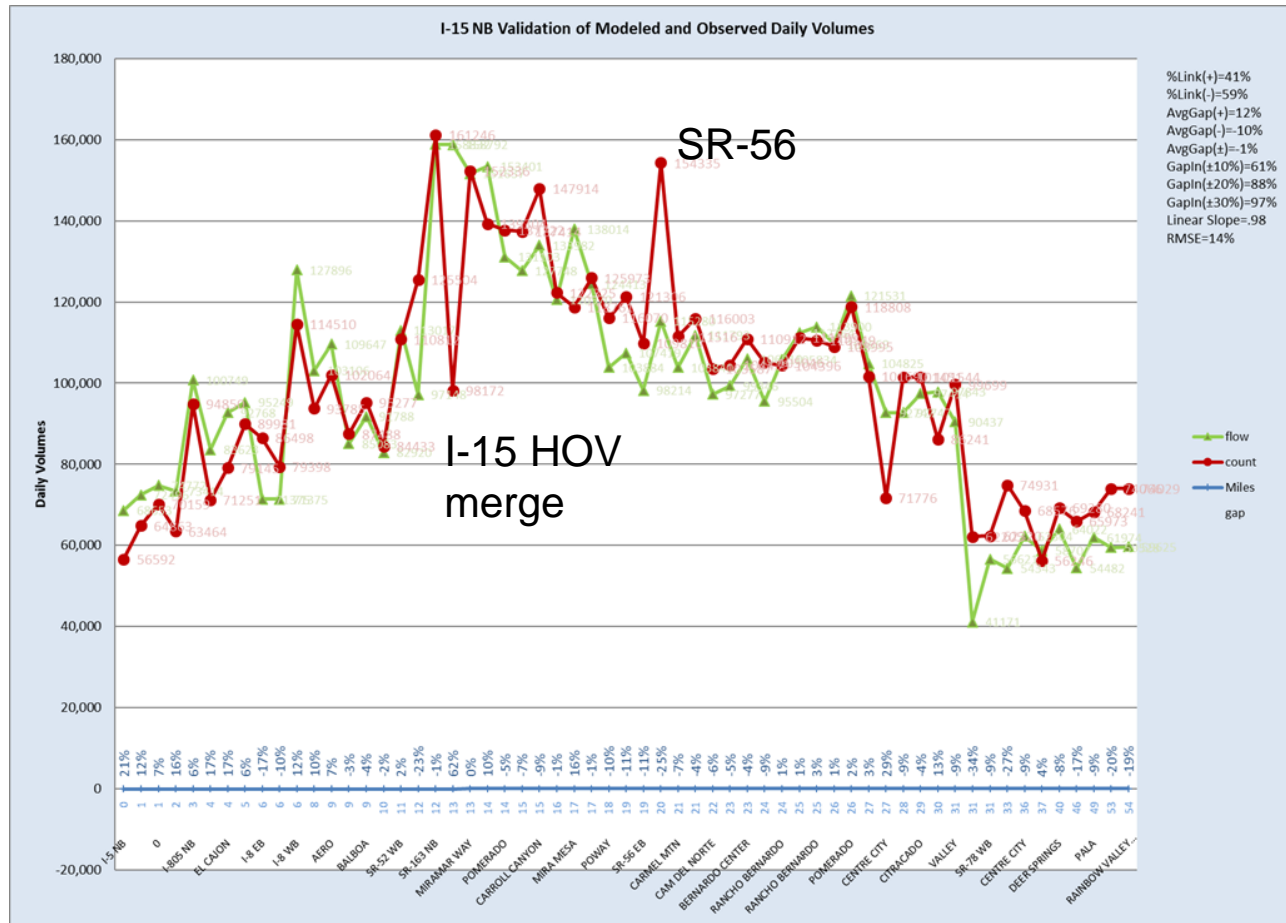
Draft results - Assignment

Gap Range	Number of links within Gap Range				
	by Link Classes				
	freeways	ramps	arterials	collectors	all
	1	2	3	4	
-10% ~ +10%	417	102	126	95	740
-20% ~ +20%	564	176	241	184	1165
-30% ~ +30%	615	271	366	247	1499
total links	657	438	583	598	2276
Root Mean Square Error (RMSE)					
RMSE percent	13%	39%	37%	60%	23%
Trend Line Slope					
Slope	1.00	0.94	0.88	0.77	0.99

ABM2



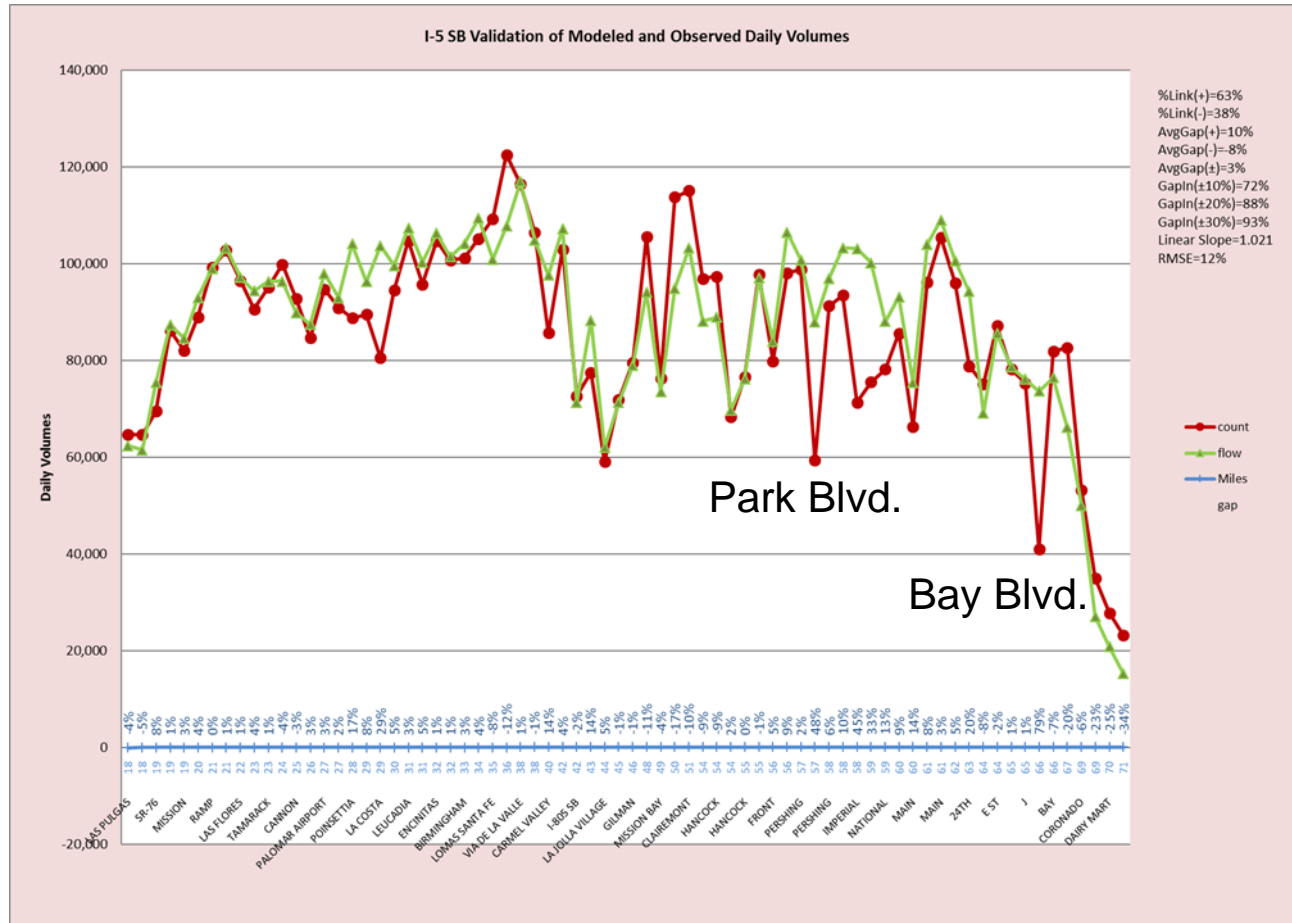
Draft results - Assignment (NB I-15)



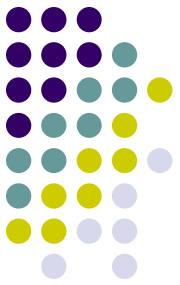
ABM2



Draft results - Assignment (SB I-5)



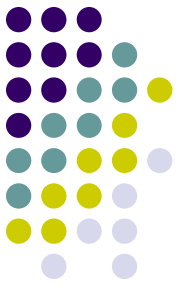
ABM2



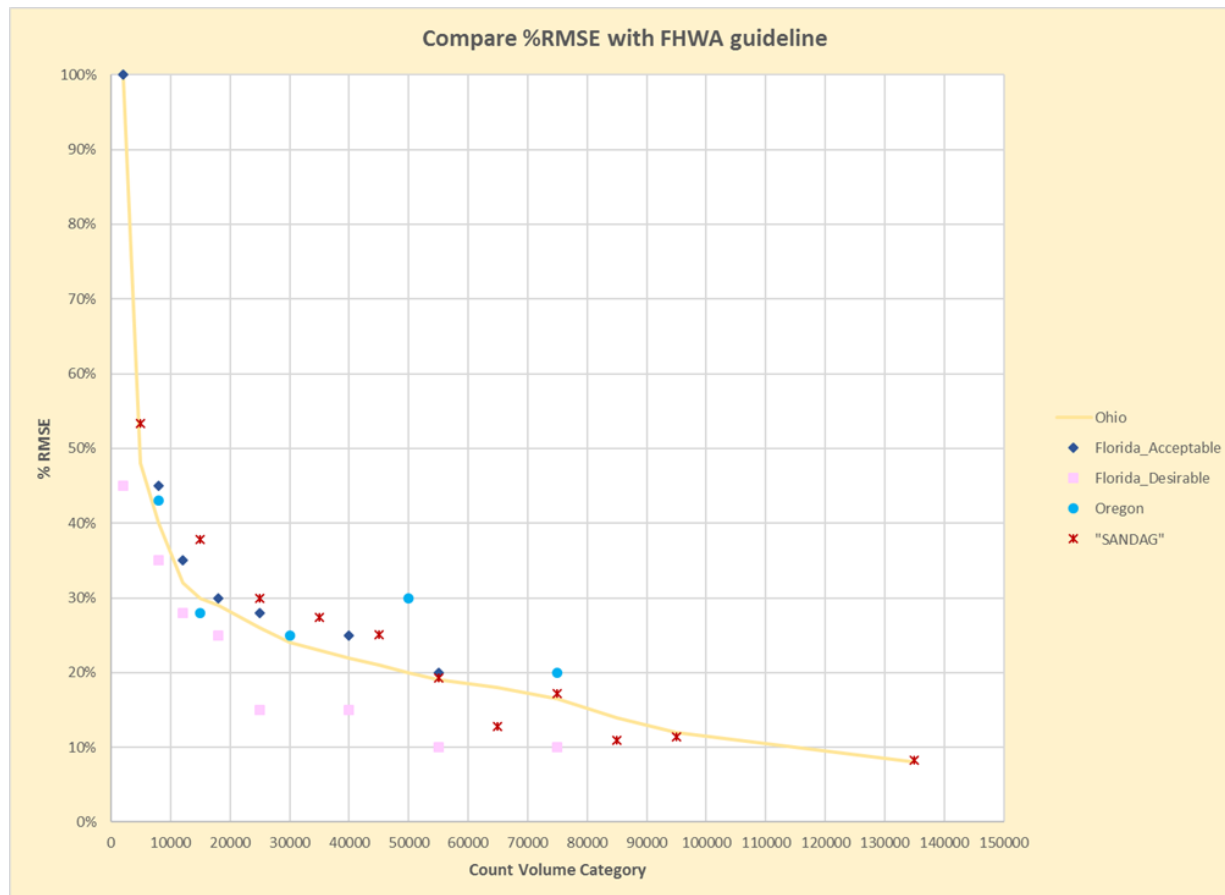
Draft results - VMT

	VMT Regional Total	VMT per capita
Observed	83,763,007	25.49
Modeled	82,538,860	25.20
Modeled/Observed	99%	99%

ABM2



Travel Model Validation and Reasonability Checking Manual 2nd Edition (TMIP)



ABM2



What's Next?

- Between now and July 2018
 - Wrapping up calibration & validation
 - Sensitivity tests
 - Final report
- July 2018 to Fall 2019
 - 2019 RP application
- Spring 2019
 - Model re-estimation
 - Model for 2023 Regional Plan

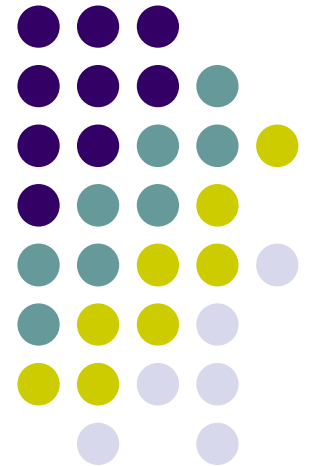
Induced Travel

Rick Curry

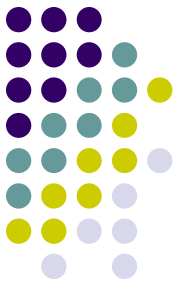
rcu@sandag.org

Mike Calandra

mca@sandag.org



Induced Travel



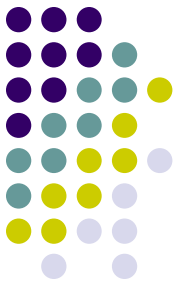
What is Induced Travel?

- A widely used term to describe the observed increase in traffic volume that occurs soon after a new highway is opened or a previously congested highway is widened

Is Induced Travel real?

- Additional demand to travel can occur as a result of decreasing generalized cost of travel
 - Travel Time
 - Out-of-Pocket cost

Induced Travel

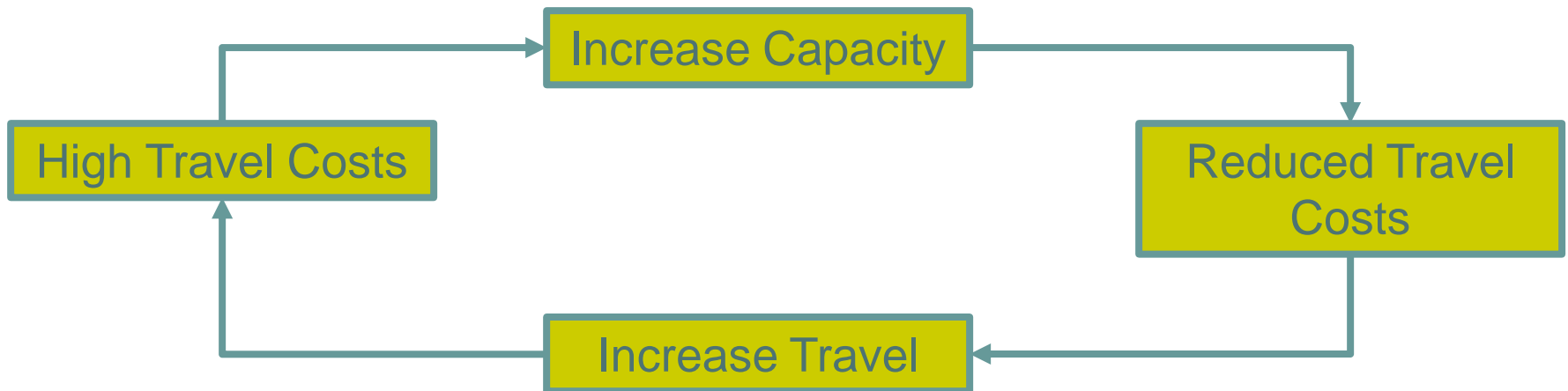


What is Latent Demand?

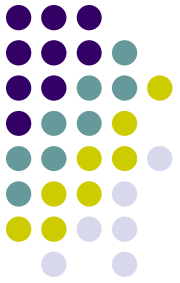
- Trips that have been suppressed due to the high cost of travel

Is Latent Demand Induced Travel?

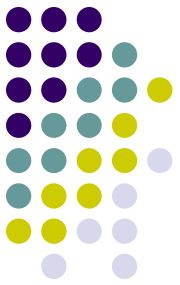
- Lowering the generalized cost of travel can convert previously suppressed trips to actual trips



Induced Travel



Induced Travel



Is Induced Travel only associated with highway capacity improvements?

- No: reducing generalized cost to any transportation system can lead to changes in behavior that will result in increased use of that system

Where does the additional travel come from?

- Behavioral changes
- Relocation of people and economic activity
- Increase in commercial vehicle activity

Induced Travel



What does research in this area tell us?

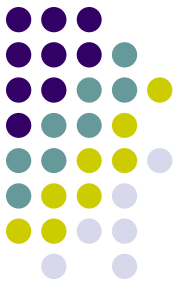
● FHWA

- ‘The term "Induced Travel" is highly controversial but typically misunderstood by both highway advocates and opponents.’
- ‘Induced travel can have both positive and negative consequences.’
- ‘...use of any single demand elasticity value to estimate induced travel is highly unreliable.’
 - <https://www.fhwa.dot.gov/planning/itfaq.cfm>

● Duranton & Turner

- ‘High levels of induced demand do not necessarily imply that improvements to the highway system are not in the public interest’
 - *The Fundamental Law of Road Congestion*
 - <http://www.nber.org/papers/w15376>

Induced Travel



What does research in this area tell us?

- Milam, Birnbaum, Ganson, Handy & Walters
 - ‘In general, almost all of the induced vehicle travel effect can be accounted for by using advanced travel forecasting models that account for the feedback effects of travel time (or travel cost) savings on travel behavior and long-term land use allocation.’
 - ‘The induced vehicle travel effect size is influenced by other costs associated with driving, such as parking and fuel prices.’
 - ‘The induced vehicle travel effect is influenced by the starting level of congestion.’
 - *Closing the Induced Vehicle Travel Gap Between Research and Practice*
 - <https://trrjournalonline.trb.org/doi/abs/10.3141/2653-02>

Induced Travel



What does research in this area tell us?

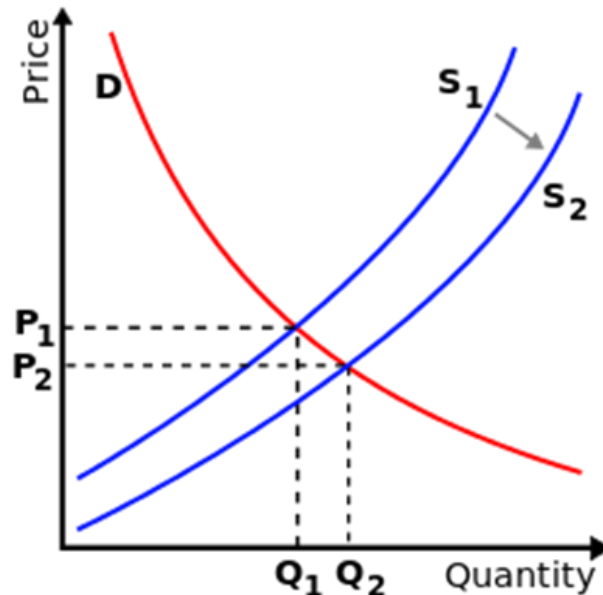
- SB743 Technical Advisory
 - ‘Most of these studies express the amount of induced vehicle travel as an “elasticity,” which is a multiplier that describes the additional vehicle travel resulting from an additional lane mile of roadway capacity added’
 - http://opr.ca.gov/docs/20171127_Transportation_Analysis_TA_Nov_2017.pdf
- CARB
 - ‘...found no evidence that public transit service affects VMT, suggesting that whatever interactions do occur tend to cancel each other out.’
 - Short-run impacts have an elasticity range of 0.3-0.6, long-run impacts have an elasticity range of 0.6-1.0.
 - https://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_brief.pdf

Induced Travel

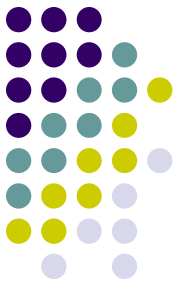


What is Demand Elasticity?

- An indicator used to measure how much consumption of a good or service to expect in response to a change in other factors, such as cost



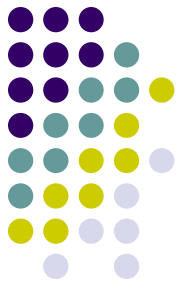
Induced Travel



Are Demand Elasticities Reliable?

- Elasticity calculations can change depending on
 - Study area definition
 - Time frame of the analysis
- Challenging with different levels of congestion
- Using one demand elasticity value is not reliable
- Indiscriminate application can over-estimate impacts

Induced Travel



What other factors can influence travel?

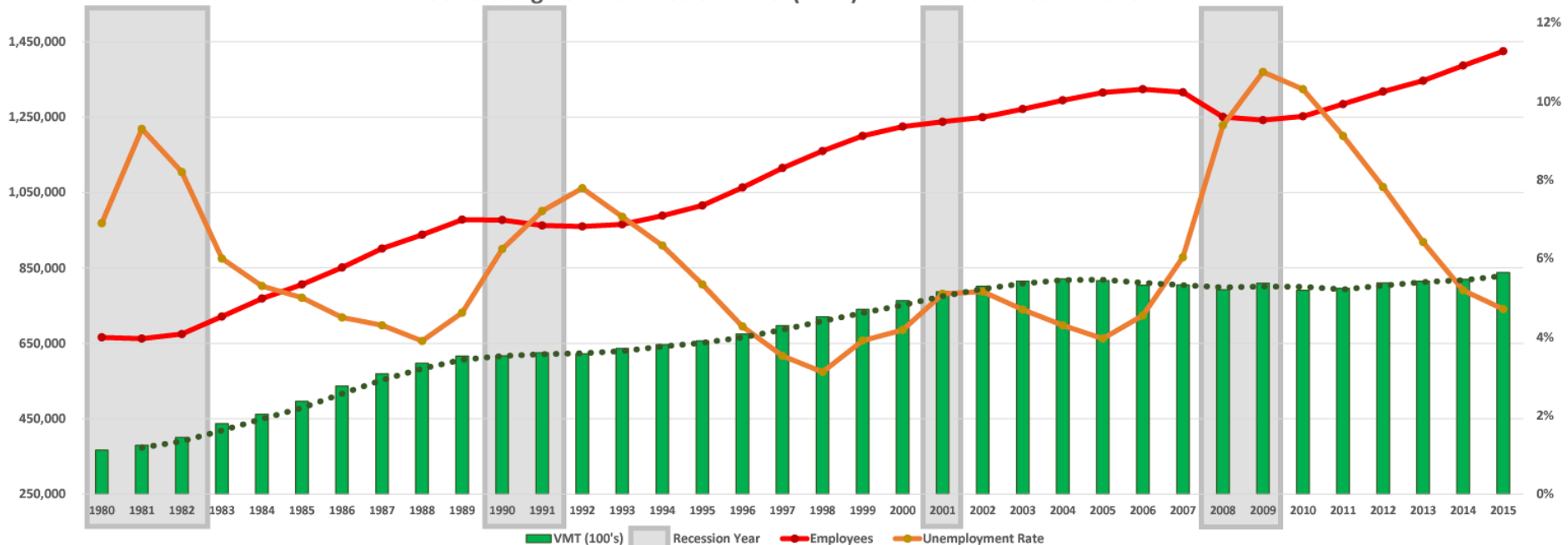
Energy / Savings
& Loan Crises

Mid-East War &
Oil Price Shock

Dot-Com Bust

Subprime
Mortgage Crisis

Correlating Vehicle Miles of Travel (VMT) with Economic Conditions



Sources: CA EDD LMI (Unemployment 1990-2017, Total Nonfarm* 1970-2017), FHWA (Highway Performance Monitoring System), SANDAG Series 13 DEFM (Unemployment 1970-1989)

Induced Travel



What other factors can influence travel?

- Income
- Land use quality
- Work location
- School location
- Auto ownership
- Development accessibility

MISTER *A's*



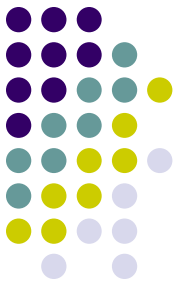
Induced Travel



What are the impacts of enhancing capacity?

- Short Term – *shifting equilibrium*
 - New path, destination, mode, and/or departure time
- Mid Term – *stable environment*
 - New capacity gets consumed but an offset is observed on parallel routes and/or other modes
- Long Term – *eventual decay*
 - Observed offset ultimately consumed by continued population and employment growth
 - Potential to induce new development

Induced Travel



What components of travel can be induced?

- Mode Choice
- Destination Choice
- Path Choice
- Departure Time Choice
- Trip / Tour Generation

- Development

Induced Travel



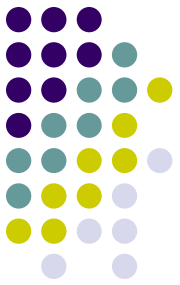
Mode Choice

- Investments in the transit network that reduce costs and travel times can induce new travelers from other transit routes as well as other modes of travel
 - *I used to drive alone to work, but now I ride the Purple Line because it saves me time and money*

Destination Choice

- Investments in the transportation system can lead to travelers changing a destination to satisfy the same trip purpose
 - *I used to grocery shop at the local Walmart, but now I can get to Vons in the same amount of time*

Induced Travel



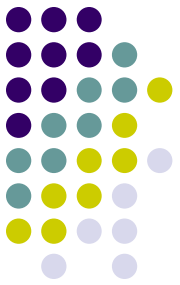
Path Choice

- Investments in new network connections can induce a new route that leads to the same destination
 - *It used to take me 30 minutes to drive 15 miles to the office, but now it takes 20 minutes to drive 10 miles to the office*

Departure Time Choice

- Investments in the transportation system can lead to travelers changing the time they depart to the same destination
 - *I used to leave home at 7:00 am to get to the office, but now I can leave home at 7:10 am and still get to the office at the same time*

Induced Travel



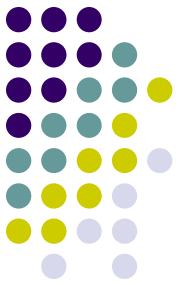
Trip / Tour Generation

- Investments in the transportation can result in new trips being made (only applicable to discretionary trip purposes)
 - *Now that I have some additional free time (and income), I can make a new trip to go surfing*

Development

- Investments in new transportation facilities that provide accessibility to green fields can result in leap frog developments to otherwise isolated areas
 - *As a developer, it is my job to maximize profits by speculating land value*

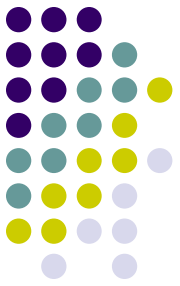
Induced Travel



Are Travel demand models sensitive to induced travel?

Inducement Type	4-Step Model	ABM
Mode Choice	Yes	Yes
Destination Choice	Yes	Yes
Path Choice	Yes	Yes
Departure Time Choice	No	Yes
Trip / Tour Generation	No	Yes
Development	Yes *	Yes *

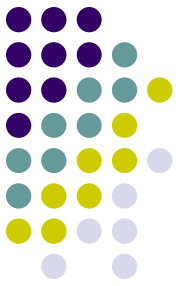
Induced Travel



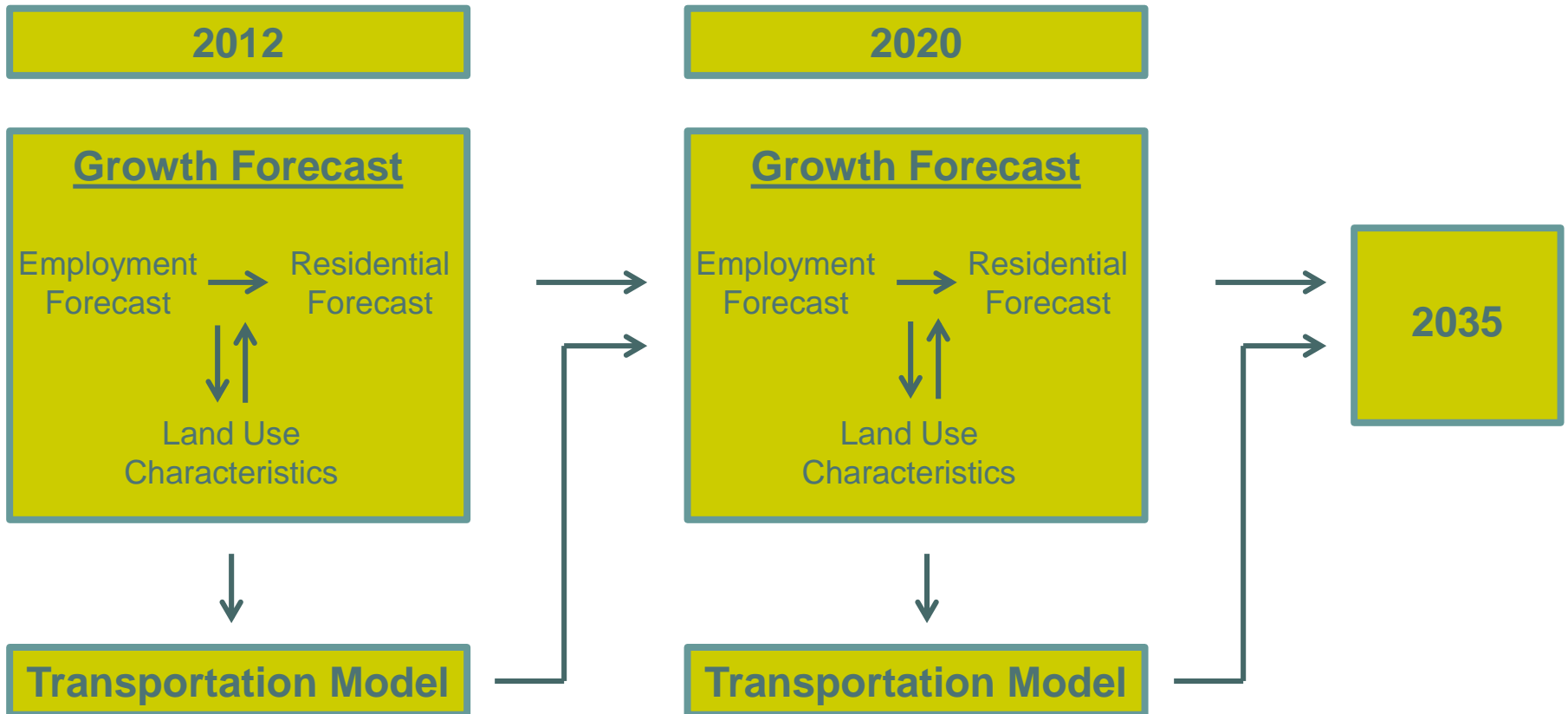
Development is not a travel component, how can “Induced Development” be analyzed via a travel model?

- Feedback Loop
 - Iteratively running the Growth Forecast and the ABM through horizon years can result in *leap frog* development

Induced Travel



Feedback Loop



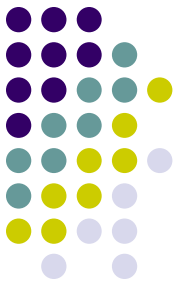
Induced Travel



Yes * travel models can analyze “Induced Development” with the following limitations

- General Plan
 - Induced development will not exceed the underlying General Plan of any jurisdiction
- Feedback Lag
 - The network being fed back into the Growth Forecast is from the previous Regional Transportation Plan
 - Need an adopted Regional Plan to feed back
 - Need a stable Growth Forecast for Alternatives Analysis

Induced Travel

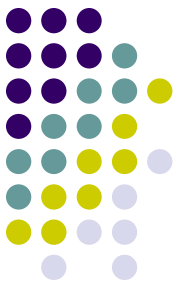


Has the ABM undergone sensitivity testing?

- 2015 Request by California Air Resource Board
- SB 375 CARB-defined elasticities
 - Freeway Capacity
 - Auto Operating Costs
 - Transit Fares
 - Transit Frequency
 - Land Use Density

http://www.sandag.org/uploads/publicationid/publicationid_1983_19754.pdf

Induced Travel



Capacity and Auto Operating Costs

Table 1 Summary of VMT and Elasticity of VMT to Freeway Capacity and AOC

Scenario	VMT	% of VMT Difference	Elasticity	Elasticity in CARB White Paper
2012 baseline	79,554,226			
Reduce Freeway Capacity by 50%	72,624,153	-8.71%	1.3	0.3 to 1.0
Double freeway Capacity	82,891,012	4.19%	0.3	
Increase AOC by 50%	78,317,785	-1.55%	-0.03	-0.02 to -0.1
Increase AOC by 25%	78,781,407	-0.97%	-0.04	
Reduce AOC by 25%	80,424,737	1.09%	-0.04	
Reduce AOC by 50%	81,525,803	2.48%	-0.05	

Induced Travel

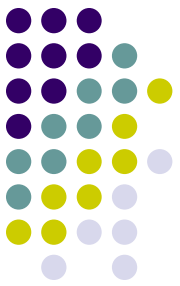


Transit Fares and Frequencies

Table 2 Summary of Transit Trips, Boardings and Elasticity to Frequency and Fare

Scenario	Transit Trips	% Diff of Transit Trips	Elasticity (Transit Trips)	Boardings	% Diff of Boardings	Elasticity (Boardings)	Elasticity in CARB White Paper
2012 Baseline	225,985			359,485			
Reduce fare by 50%	329,375	46%	-0.9	525,691	46%	-0.9	-0.4 to -1.0
Reduce fare by 25%	271,859	20%	-0.8	432,605	20%	-0.8	
Increase fare by 25%	190,282	-16%	-0.6	301,797	-16%	-0.6	
Increase fare by 50%	161,681	-28%	-0.6	255,684	-29%	-0.6	
Increase frequency by 50%	287,526	27%	0.5	493,718	37%	0.7	0.5
Increase frequency by 25%	252,414	12%	0.5	413,869	15%	0.6	
Decrease frequency by 25%	210,624	-7%	0.3	328,012	-9%	0.4	
Decrease frequency by 50%	198,027	-12%	0.6	303,610	-16%	0.6	

Induced Travel



Mode Shift

Table 3 Mode Share for 2012 Tests and Baseline

Scenario	Drive Alone	Carpool	Transit	Walk & Bike	Other
2012 Baseline	42.02%	42.93%	1.91%	11.74%	1.39%
Increase AOC by 50%	41.56%	42.28%	2.08%	12.68%	1.40%
Increase AOC by 25%	42.01%	42.74%	1.99%	11.85%	1.38%
Reduce AOC by 25%	42.04%	43.12%	1.84%	11.62%	1.37%
Reduce AOC by 50%	42.06%	43.33%	1.78%	11.49%	1.30%
Reduce fare by 50%	41.74%	42.54%	2.79%	11.63%	1.30%
Reduce fare by 25%	41.89%	42.76%	2.30%	11.70%	1.35%
Increase fare by 25%	42.13%	43.09%	1.61%	11.76%	1.41%
Increase fare by 50%	42.23%	43.21%	1.37%	11.78%	1.42%
Increase frequency by 50%	41.69%	42.73%	2.43%	11.76%	1.39%
Increase frequency by 25%	41.88%	42.86%	2.14%	11.74%	1.38%
Decrease frequency by 25%	42.10%	42.99%	1.78%	11.74%	1.39%
Decrease frequency by 50%	42.17%	43.05%	1.67%	11.71%	1.39%

Induced Travel



Land Use

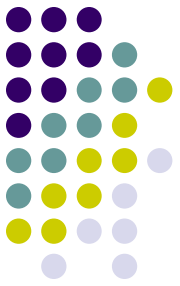
Table 5 Resident VMT and VMT Difference in 2035 Land Use Density Tests

Scenario	Resident VMT	Resident VMT Difference	% Difference
Baseline - Series 13 Growth Forecast	60,989,959		
Alternative Land Use - Multiple Dense Core	59,833,247	(1,156,711)	-1.9%
Alternative Land Use - Smart Growth	60,647,442	(342,517)	-0.6%

Table 6 Mode Share Summary for 2035 Land Use Density Tests

Scenario	Drive Alone	Carpool	Transit	Walk & Bike	Other
Baseline - Series 13 Growth Forecast	39.5%	42.3%	3.1%	13.3%	1.7%
Alternative Land Use - Multiple Dense Core	39.3%	42.4%	3.1%	13.5%	1.7%
Alternative Land Use - Smart Growth	39.0%	42.5%	3.3%	13.6%	1.7%

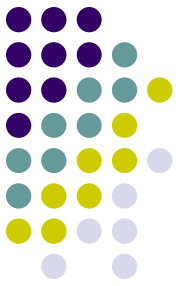
Induced Travel



What are the limitations of using a travel demand model to analyze induced travel?

- Based on observed travel behavior
 - Travel models require empirical data for estimation
- Not a crystal ball
 - Best practice is for Alternatives Analysis
- Resources
 - Agency priorities, processing time, and staff costs limit the number of model scenarios that can be run

Induced Travel



Conclusions

- Use an Activity Based Model
- Incorporate a Feedback Loop between Growth Forecast models and Travel Demand Models
- Carefully define study areas
- Analyze existing congestion levels
- Understand if latent demand exists
- Use elasticities discriminately

Forum Agenda



Travel Behavior Survey Summary

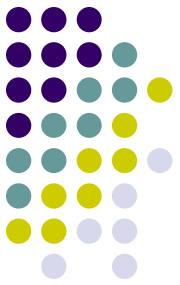
ABM2

Induced Travel

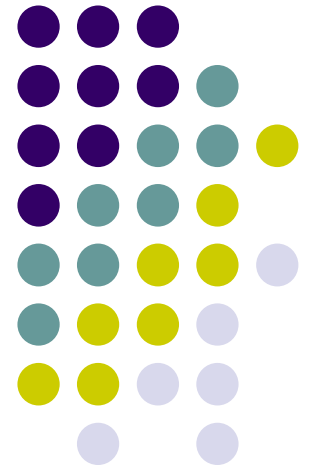
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