

# Self-Updating Travel Demand Model – Is it Possible in the Era of Location Based Data?

Vamsee Modugula, Director, Travel Forecasting, TJKM

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# Introduction

- Travel Demand models are developed at great cost and time for forecasting future travel patterns
- Agencies update models every 3-5 years
- Some updates are minor, but some are major
- Household Surveys are being fast replaced by Location based Data (LBS).



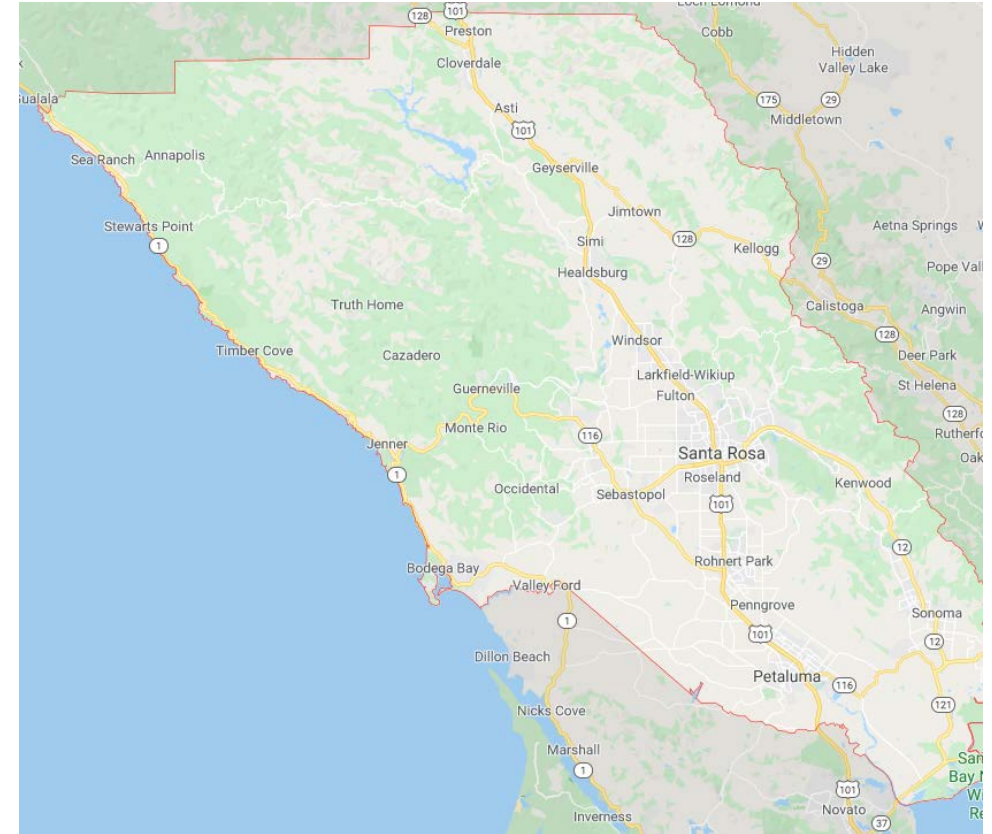
# Introduction...contd

- LBS can be made available in an ongoing basis unlike traditional datasets
- We use that to setup a process for a self-updating model
- An algorithm can be set up to process LBS data into usable trip summary tables.
- These can be used to automatically update the model parameters.



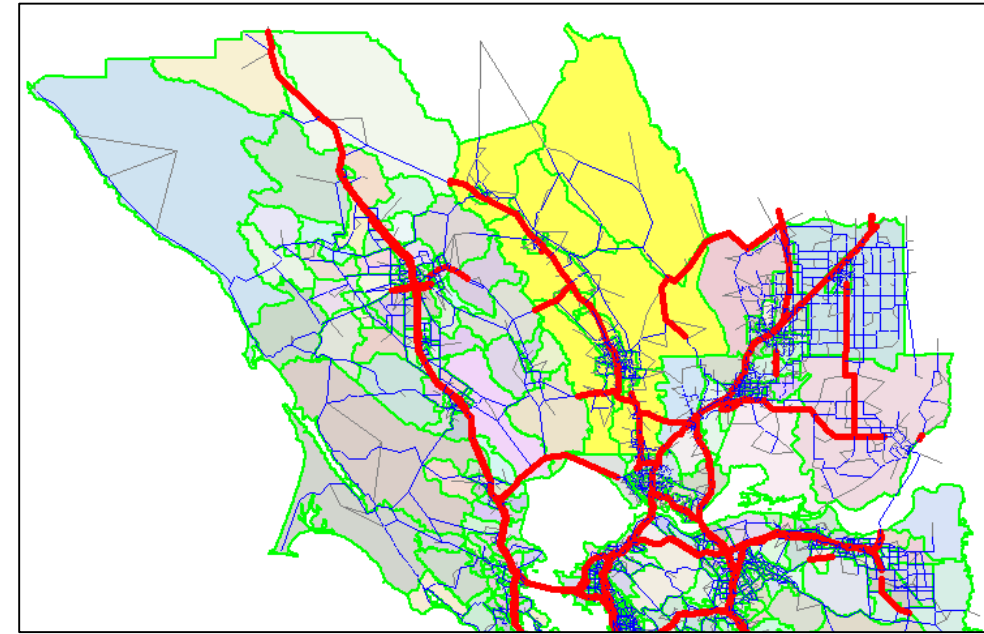
# Test Case – Sonoma County TDM

- Trip Based Travel Demand Model
- Last updated in 2012 to a 2010 base year using ODME.
- TJKM is updating the model to a 2015 base using updated data.
- Use findings from the Travel Behavior Study
- Calibrate and validate highway and transit



# Sonoma County TDM

- Model update was done in a traditional way.
- Updated land use and networks
- Updated trip rates to match trips per household
- Updated K factors and friction factors to calibrate distribution
- Validate Highway volumes and Transit ridership



## Model used LBS data for travel patterns

TBS	Model	Description
1,647,704	1,807,089	Vehicle trips touch Sonoma County
31%	28%	of all Sonoma County trips are Intra City of Santa Rosa trips
4%	13%	of all Sonoma County Gateway trips are between Petaluma and Novato
1%	1%	of all Sonoma County trips are passing through Sonoma County
13%	13%	of all trips touching a Sonoma County Gateway are passing through Sonoma County
10%	9%	of all Sonoma County trips are inter-county trips (one end within Sonoma County)
89%	91%	of all Sonoma County trips intra-county trips (both ends within Sonoma County)
34%	41%	of inter-county trips are to/from Marin County
18%	25%	of inter-county trips are to/from Napa County
21%	15%	of Sonoma County trips are work-related
61%	70%	of Sonoma County trips are less than 5 miles in length
6%	8%	of Sonoma County trips are more than 20 miles in length
6.9	6.7	miles is the average trip length of Sonoma County-generated trips
39%	35%	of inter-county trips are imported in the period
42%	35%	of inter-county trips are exported in the period



# Validation at Gateways

No	Description	Traffic Count	Model Volume	Difference	% Diff
1	US 101S Marin	35,591	33,905	(1,686)	-5%
2	US 101N Marin	35,591	35,753	162	0%
3	SR 37E Marin	18,500	19,799	1,299	7%
4	SR 37W Marin	18,500	19,985	1,485	8%
5	SR 37E Napa	18,360	17,044	(1,316)	-7%
6	SR 37W Napa	17,155	17,044	(111)	-1%
7	SR 12W Napa	15,500	16,781	1,281	8%
8	SR 12E Napa	15,500	16,781	1,281	8%
9	US101S Mendocino	8,234	9,226	992	12%
10	US101N Mendocino	8,234	9,138	904	11%
11	HWY128N Mendocino	1,617	1,582	(36)	-2%
12	HWY128S Mendocino	1,617	1,582	(36)	-2%
13	Hwy1 NB Marin	588	556	(32)	-5%
14	Hwy1 SB Marin	588	556	(32)	-5%
15	Hwy1 S Mendocino	2,157	2,026	(131)	-6%
16	Hwy1 N Mendocino	2,157	2,026	(131)	-6%
<b>Total</b>		<b>199,889</b>	<b>203,780</b>	<b>3,891</b>	<b>2%</b>

## Model vs Count Root Mean Square Error Check

	Counts	Model	% Difference	% RMSE
Freeway	1,557,746	1,508,319	-3%	24%
Highway	491,193	506,461	3%	27%
Arterial	1,255,522	1,174,997	-6%	35%
Expressway	98,408	89,847	-9%	26%
Collector	88,699	79,316	-11%	30%
Total	1,933,822	1,850,621	-4%	33%

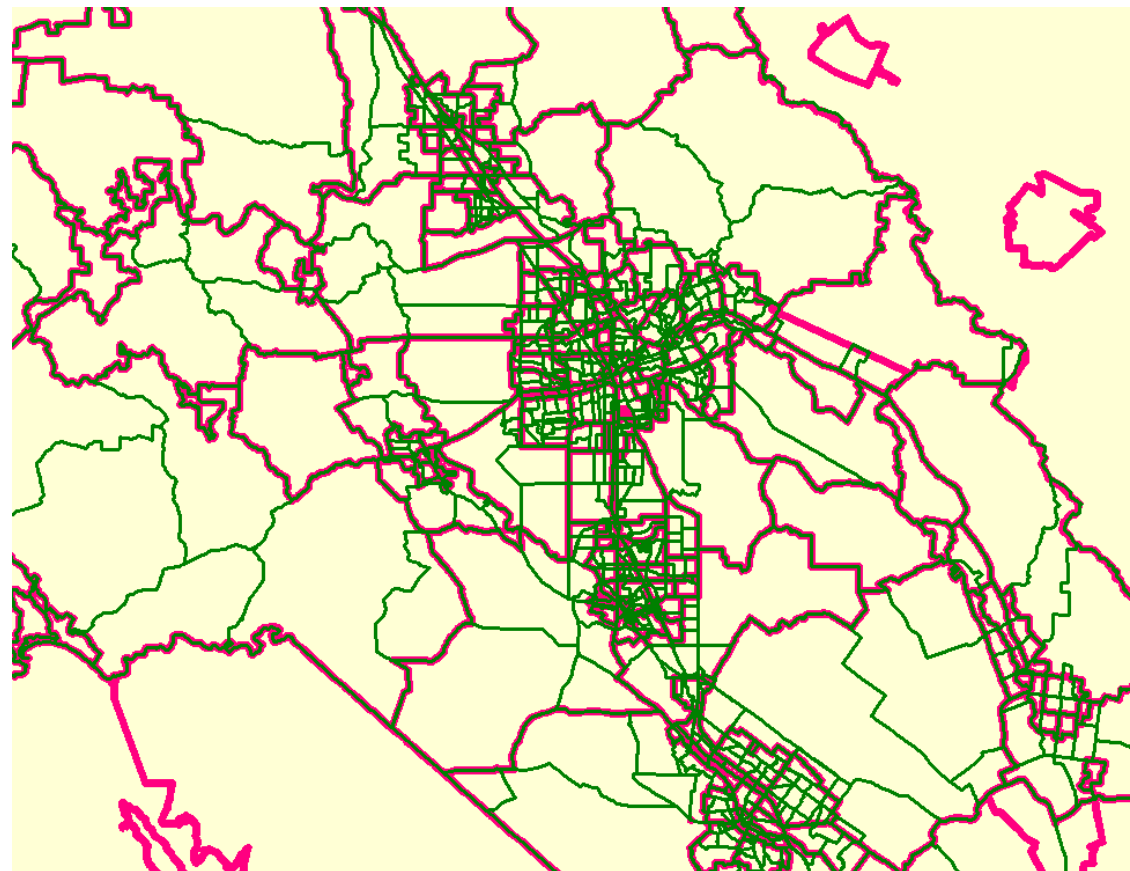


# Highway 101 Validation Count vs. Model

No	Description	Traffic Count	Model Volume	Difference	% Diff
1	US 101 N Marin Border	71,182	69,657	(1,525)	-2%
2	US 101 N after Lakeville Hwy	73,023	73,747	724	1%
4	US 101 N after Petaluma Blvd	90,190	81,165	(9,025)	-10%
5	US101N REDWOOD HWY	107,142	110,841	3,699	3%
6	US101N before Railroad Ave	95,109	105,283	10,174	11%
7	US 101N after W. Siera Ave	99,782	95,082	(4,700)	-5%
10	US 101N at W.3rd St	100,304	104,676	4,372	4%
13	US101N before Hearn Ave	106,454	123,546	17,092	16%
14	US101N after Hearn Ave	129,287	145,257	15,970	12%
16	US101N after 3rd St	123,602	120,026	(3,576)	-3%
17	US101N at Steele Ln	98,619	105,048	6,429	7%
18	US101N at Piner Rd	93,078	86,668	(6,410)	-7%
20	US 101N after River Rd	85,908	90,240	4,332	5%
21	US 101N at Airport Blvd	76,943	76,527	(416)	-1%
22	US 101N at Shiloh Rd	65,514	60,229	(5,285)	-8%
23	US 101N at Mill St	44,310	25,426	(18,884)	-43%
24	US 101N after Dutcher Creek Rd	26,272	16,536	(9,736)	-37%
25	US 101N at Mendocino Border	16,468	18,364	1,896	12%
<b>Total</b>		<b>1,503,187</b>	<b>1,508,319</b>	<b>5,132</b>	<b>0%</b>

# Trial 1 – Direct Assignment of LBS

- LBS data has a high sample size
- Let's directly assign the trip tables!
- Why do we even need models?
- LBS zones are much bigger than a model TAZ's. (220 versus 920 in the model)
- Disaggregated matrix to 920 zones and did an assignment



## Model vs Count Root Mean Square Error Check

	Counts	Model	% Difference	% RMSE
Freeway	1,447,768	1,638,403	13%	18%
Highway	491,193	511,552	4%	68%
Arterial	1,255,522	1,130,254	-10%	33%
Expressway	98,408	93,347	-5%	29%
Collector	88,699	83,880	-5%	40%
Total	3,381,590	3,457,437	2%	36%

# Validation at Gateways

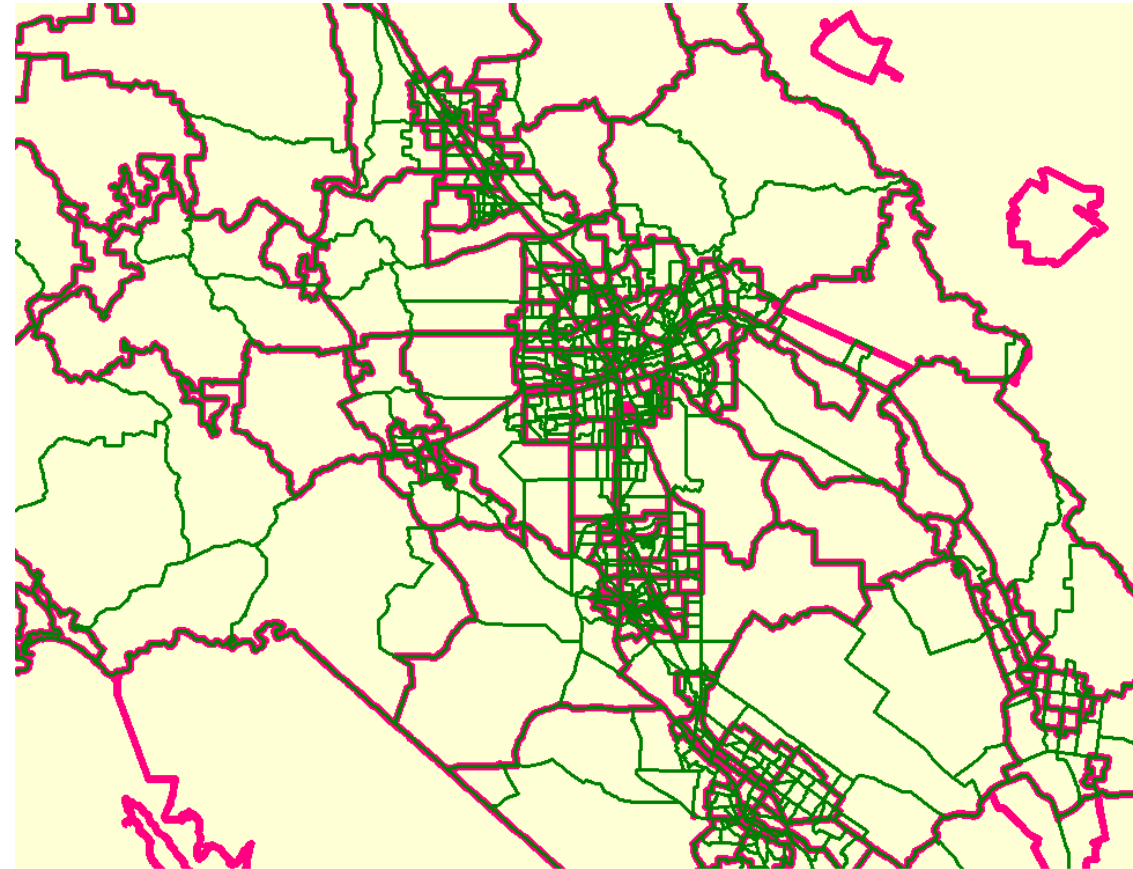
No	Description	Traffic Count	Model Volume	Difference	% Diff
1	US 101S Marin	35,591	36,195	604	2%
2	US 101N Marin	35,591	36,790	1,199	3%
3	SR 37E Marin	18,500	28,732	10,232	55%
4	SR 37W Marin	18,500	29,118	10,618	57%
5	SR 37E Napa	18,360	34,389	16,029	87%
6	SR 37W Napa	17,155	34,389	17,234	100%
7	SR 12W Napa	15,500	5,690	(9,810)	-63%
8	SR 12E Napa	15,500	5,690	(9,810)	-63%
9	US101S Mendocino	8,234	7,007	(1,227)	-15%
10	US101N Mendocino	8,234	6,993	(1,241)	-15%
11	HWY128N Mendocino	1,617	-	(1,617)	-100%
12	HWY128S Mendocino	1,617	-	(1,617)	-100%
13	Hwy1 NB Marin	588	-	(588)	-100%
14	Hwy1 SB Marin	588	-	(588)	-100%
15	Hwy1 S Mendocino	2,157	83	(2,074)	-96%
16	Hwy1 N Mendocino	2,157	83	(2,074)	-96%
<b>Total</b>	Total	199,889	225,160	25,271	13%

# Highway 101 Validation Count vs. Model

No	Description	Traffic Count	Model Volume	Difference	% Diff
1	US 101 N Marin Border	71,182	72,985	1,803	3%
2	US 101 N after Lakeville Hwy	73,023	89,702	16,679	23%
4	US 101 N after Petaluma Blvd	90,190	107,528	17,338	19%
5	US101N REDWOOD HWY	107,142	128,553	21,411	20%
6	US101N before Railroad Ave	95,109	127,523	32,414	34%
7	US 101N after W. Siera Ave	99,782	119,927	20,145	20%
10	US 101N at W.3rd St	100,304	123,227	22,923	23%
13	US101N before Hearn Ave	119,002	128,680	9,678	8%
14	US101N after Hearn Ave	131,902	150,532	18,630	14%
16	US101N after 3rd St	123,602	134,523	10,921	9%
17	US101N at Steele Ln	98,619	119,010	20,391	21%
18	US101N at Piner Rd	93,078	93,826	748	1%
20	US 101N after River Rd	85,908	99,692	13,784	16%
21	US 101N at Airport Blvd	76,943	84,912	7,969	10%
22	US 101N at Shiloh Rd	65,514	65,647	133	0%
23	US 101N at Mendocino Border	16,468	14,000	(2,468)	-15%
24	Total	<b>1,447,768</b>	<b>1,660,268</b>	<b>212,500</b>	15%

# Trial 1 – Conclusions

- LBS data might be good at an aggregate level but not at TAZ level
- The numbers might be good at showing % trips, but not actual trips
- How do we forecast future
- No transit information
- Trip purpose data is not reliable for VMT calculation



# Trial 2 –Update model, no calibration

- Update 2010 model to 2015 by updating land use and networks
- Keep all parameters unchanged
- This will give us a baseline of the model
- Other trials can be evaluated based on this



# Validation at Gateways

No	Description	Traffic Count	Model Volume	Difference	% Diff
1	US 101S Marin	35,591	35,085	(506)	-1%
2	US 101N Marin	35,591	35,999	408	1%
3	SR 37E Marin	18,500	23,544	5,044	<b>27%</b>
4	SR 37W Marin	18,500	23,576	5,076	<b>27%</b>
5	SR 37E Napa	18,360	18,860	500	3%
6	SR 37W Napa	17,155	18,860	1,705	10%
7	SR 12W Napa	15,500	11,504	(3,996)	<b>-26%</b>
8	SR 12E Napa	15,500	11,504	(3,996)	<b>-26%</b>
9	US101S Mendocino	8,234	8,279	45	1%
10	US101N Mendocino	8,234	8,099	(135)	-2%
11	HWY128N Mendocino	1,617	999	(618)	<b>-38%</b>
12	HWY128S Mendocino	1,617	999	(618)	<b>-38%</b>
13	Hwy1 NB Marin	588	514	(74)	-13%
14	Hwy1 SB Marin	588	514	(74)	-13%
15	Hwy1 S Mendocino	2,157	1,544	(613)	<b>-28%</b>
16	Hwy1 N Mendocino	2,157	1,544	(613)	<b>-28%</b>
<b>Total</b>	Total	199,889	201,426	1,537	1%

# Highway 101 Validation Count vs. Model

No	Description	Traffic Count	Model Volume	Difference	% Diff
1	US 101 N Marin Border	71,182	71,084	(98)	0%
2	US 101 N after Lakeville Hwy	73,023	86,613	13,590	19%
4	US 101 N after Petaluma Blvd	90,190	102,065	11,875	13%
5	US101N REDWOOD HWY	107,142	124,714	17,572	16%
6	US101N before Railroad Ave	95,109	117,592	22,483	24%
7	US 101N after W. Siera Ave	99,782	113,255	13,473	14%
10	US 101N at W.3rd St	100,304	121,134	20,830	21%
13	US101N before Hearn Ave	119,002	133,873	14,871	12%
14	US101N after Hearn Ave	131,902	149,977	18,075	14%
16	US101N after 3rd St	123,602	131,552	7,950	6%
17	US101N at Steele Ln	98,619	117,928	19,309	20%
18	US101N at Piner Rd	93,078	101,391	8,313	9%
20	US 101N after River Rd	85,908	108,298	22,390	26%
21	US 101N at Airport Blvd	76,943	98,594	21,651	28%
22	US 101N at Shiloh Rd	65,514	79,639	14,125	22%
23	US 101N at Mendocino Border	16,468	16,379	(89)	-1%
24	Total	<b>1,447,768</b>	<b>1,674,088</b>	<b>226,320</b>	<b>16%</b>

# Trial 3 – Self Updating Model

- Update land use and networks
- Setup the Location based data to produce summaries needed for model update
- Setup code to automatically revise model parameters to match LBS travel patterns

# Trial 3 – Self Updating Model

- Update Trip Generation Model by town to match LBS data
- Model was
  - under-predicting trips in Santa Rosa, Rohnert Park
  - Over predicting trips in Petaluma, Sonoma
  - Over predicting trips in rural areas

Town	Total TBS %	Total Model %
Santa Rosa	41.1%	37.9%
Petaluma	13.5%	15.7%
Rohnert Park	11.3%	9.5%
Rural Santa Rosa	7.3%	4.9%
Windsor	5.0%	4.8%
Rural Sonoma Valley	3.7%	4.6%
Sonoma	2.9%	3.2%
Healdsburg	2.3%	3.4%
Rural Petaluma	2.2%	1.6%
Sebastopol	2.1%	2.4%
Cotati	1.7%	1.8%
Cloverdale	1.3%	1.9%
Coastal-Gualala	1.1%	1.7%
Rural Sebastopol	1.1%	2.5%
Rural Healdsburg	0.9%	0.8%
Russian River	0.8%	1.7%
Rural North East	0.8%	1.2%
Rural RP-Cotati	0.6%	0.4%
Grand Total	100.0%	100.0%

# Update Trip Distribution

- Limited K-factors to make district-district trip% match LBS data.
- Update friction factors to match trip length distribution

Region	Santa Rosa-Auto Row	Petaluma-Fairgrounds	Rohnert Park-SOMO	Windsor-Downtown	SR 37 Napa	SR 37 marin	SR 12 Napa	Grand Total
Santa Rosa-Auto Row	-1.80%	-0.46%	-0.77%	-0.51%	0.39%	0.38%	0.33%	-2.88%
Petaluma-Fairgrounds	-0.39%	0.35%	-0.09%	0.01%	0.28%	0.62%	0.20%	1.12%
Rohnert Park-SOMO	-0.83%	-0.15%	-0.55%	-0.06%	0.20%	0.29%	0.14%	-0.51%
Windsor-Downtown	-0.56%	0.01%	-0.07%	0.26%	0.03%	0.02%	0.03%	-0.35%
Unincorporated	-0.17%	-0.08%	-0.06%	-0.01%	0.04%	0.08%	0.04%	-1.05%
SC Alexander Val Winery Zone	-0.31%	0.01%	0.01%	0.00%	0.02%	0.02%	0.01%	-0.18%
US 101 Marin	0.08%	0.22%	0.39%	0.00%	0.00%	0.00%	0.00%	0.54%
Healdsburg-Central	-0.13%	0.00%	-0.03%	-0.13%	0.01%	0.01%	0.00%	-0.50%
Cotati-Central Hub	-0.05%	0.02%	0.08%	0.00%	0.02%	0.03%	0.01%	0.22%
SR 37 Napa	0.44%	0.29%	0.22%	0.03%	0.00%	0.00%	0.00%	1.07%
SR 37 marin	0.36%	0.63%	0.30%	0.02%	0.00%	0.00%	0.00%	1.46%
SR 12 Napa	0.37%	0.18%	0.15%	0.02%	0.00%	0.00%	0.00%	0.79%
US 101 mendocino	0.16%	-0.01%	0.03%	0.01%	0.00%	0.00%	0.00%	0.31%
PFR Napa	-0.01%	0.00%	-0.01%	-0.01%	0.00%	0.00%	0.00%	-0.03%
Grand Total	-2.84%	0.99%	-0.41%	-0.38%	0.99%	1.45%	0.77%	0.00%

# Validation at Gateways

No	Description	Traffic Count	Model Volume	Difference	% Diff
1	US 101S Marin	35,591	36,685	1,094	3%
2	US 101N Marin	35,591	38,865	3,274	9%
3	SR 37E Marin	18,500	21,027	2,527	14%
4	SR 37W Marin	18,500	21,282	2,782	15%
5	SR 37E Napa	18,360	17,400	(960)	-5%
6	SR 37W Napa	17,155	17,400	245	1%
7	SR 12W Napa	15,500	17,523	2,023	13%
8	SR 12E Napa	15,500	17,523	2,023	13%
9	US101S Mendocino	8,234	9,232	998	12%
10	US101N Mendocino	8,234	8,941	707	9%
11	HWY128N Mendocino	1,617	1,583	(34)	-2%
12	HWY128S Mendocino	1,617	1,583	(34)	-2%
13	Hwy1 NB Marin	588	598	10	2%
14	Hwy1 SB Marin	588	598	10	2%
15	Hwy1 S Mendocino	2,157	1,842	(315)	-15%
16	Hwy1 N Mendocino	2,157	1,842	(315)	-15%
<b>Total</b>	Total	199,889	213,921	14,032	7%

# Highway 101 Validation Count vs. Model

No	Description	Traffic Count	Model Volume	Difference	% Diff
1	US 101 N Marin Border	71,182	75,550	4,368	6%
2	US 101 N after Lakeville Hwy	73,023	69,429	(3,594)	-5%
4	US 101 N after Petaluma Blvd	90,190	75,102	(15,088)	<b>-17%</b>
5	US101N REDWOOD HWY	107,142	98,057	(9,085)	-8%
6	US101N before Railroad Ave	95,109	96,198	1,089	1%
7	US 101N after W. Siera Ave	99,782	90,348	(9,434)	-9%
10	US 101N at W.3rd St	100,304	102,575	2,271	2%
13	US101N before Hearn Ave	119,002	118,176	(826)	-1%
14	US101N after Hearn Ave	131,902	139,877	7,975	6%
16	US101N after 3rd St	123,602	119,847	(3,755)	-3%
17	US101N at Steele Ln	98,619	106,674	8,055	8%
18	US101N at Piner Rd	93,078	87,013	(6,065)	-7%
20	US 101N after River Rd	85,908	93,046	7,138	8%
21	US 101N at Airport Blvd	76,943	78,436	1,493	2%
22	US 101N at Shiloh Rd	65,514	58,886	(6,628)	-10%
23	US 101N at Mendocino Border	16,468	18,173	1,705	10%
24	Total	<b>1,447,768</b>	<b>1,427,388</b>	<b>(20,380)</b>	-1%



# Conclusions

- **Self-updating model** takes a lot of upfront time, but it is possible
- Model is just as good as the manually updated model.
- Future year forecasts are quite similar
- Models will underestimate trips from areas with poor mobile connection
- Mode choice and transit is not possible at this time.

