

# Off-Highway Recreational Vehicle (OHRV) Red Sticker Program

Emissions Inventory Workshop

April 11, 2018

El Monte



# Outline

- **Background**
- **Assessment Overview**
- **Emissions Inventory**
- **Next Steps**

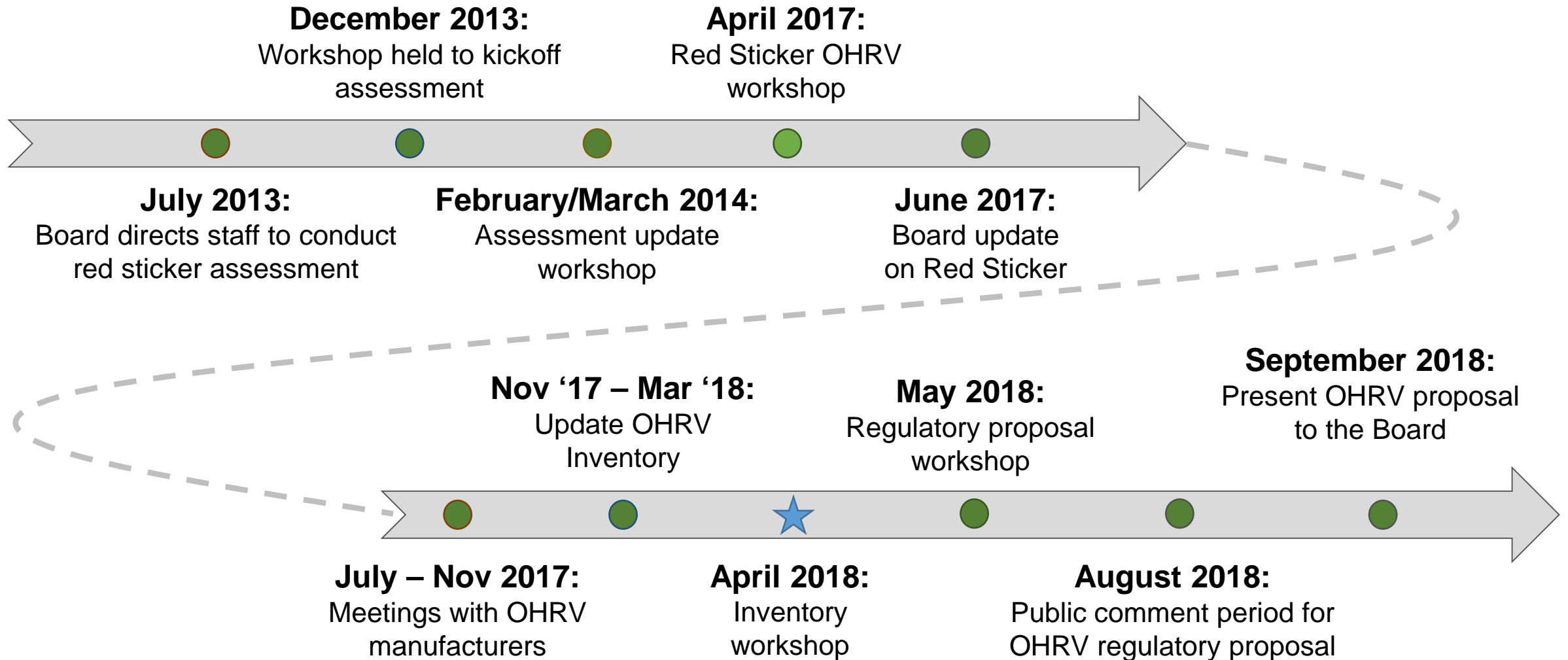
# Purpose of Workshop

Present updated OHRV emissions inventory, which is a critical component of upcoming rule amendment proposal that would:

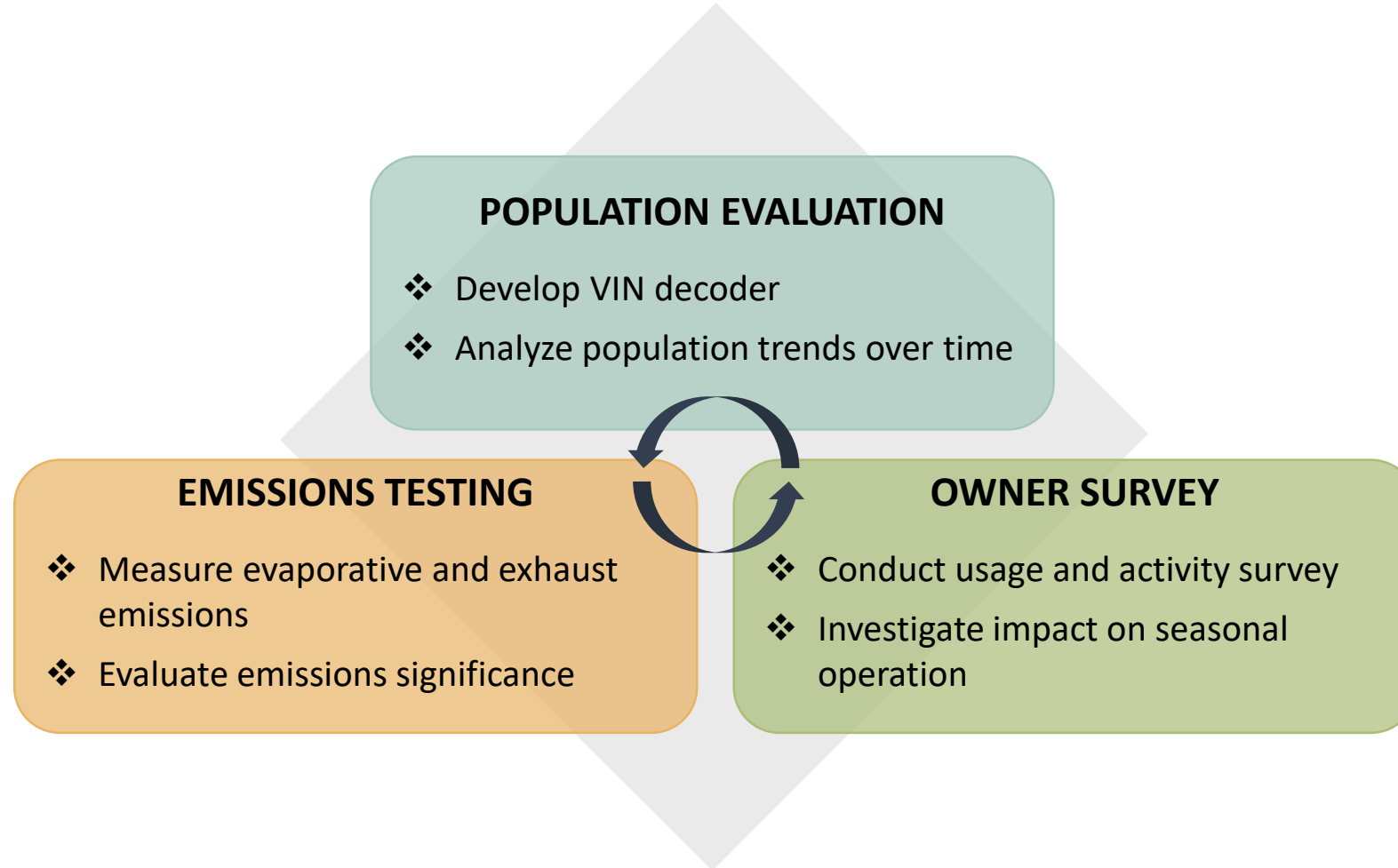
- Provide additional emission reductions from the OHRV category
- Reduce reactive organic gas (ROG) emissions in ozone non-attainment areas
- Help satisfy mobile source strategy commitments
  - *“...meet air quality standards, achieve greenhouse gas emission reduction targets, decrease health risk from transportation emissions, and reduce petroleum consumption over the next 15 years.”*



# Timeline and Next Steps

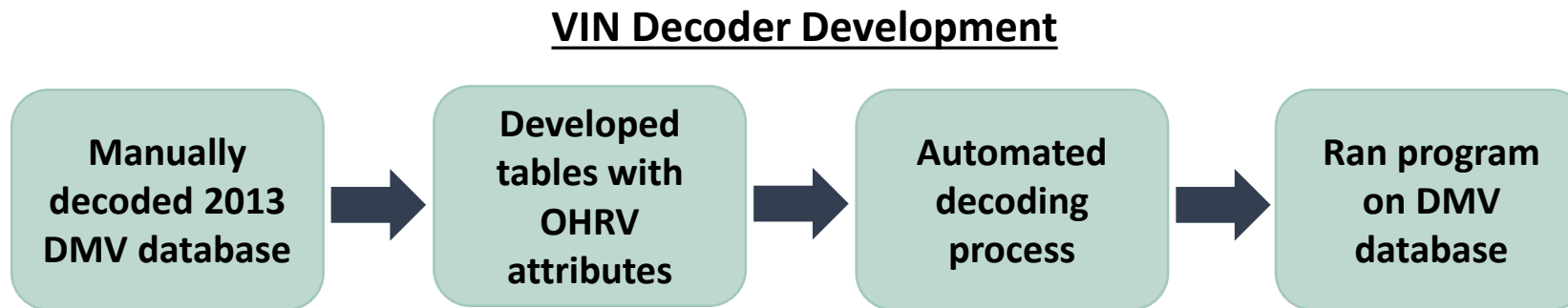


# Assessment Overview



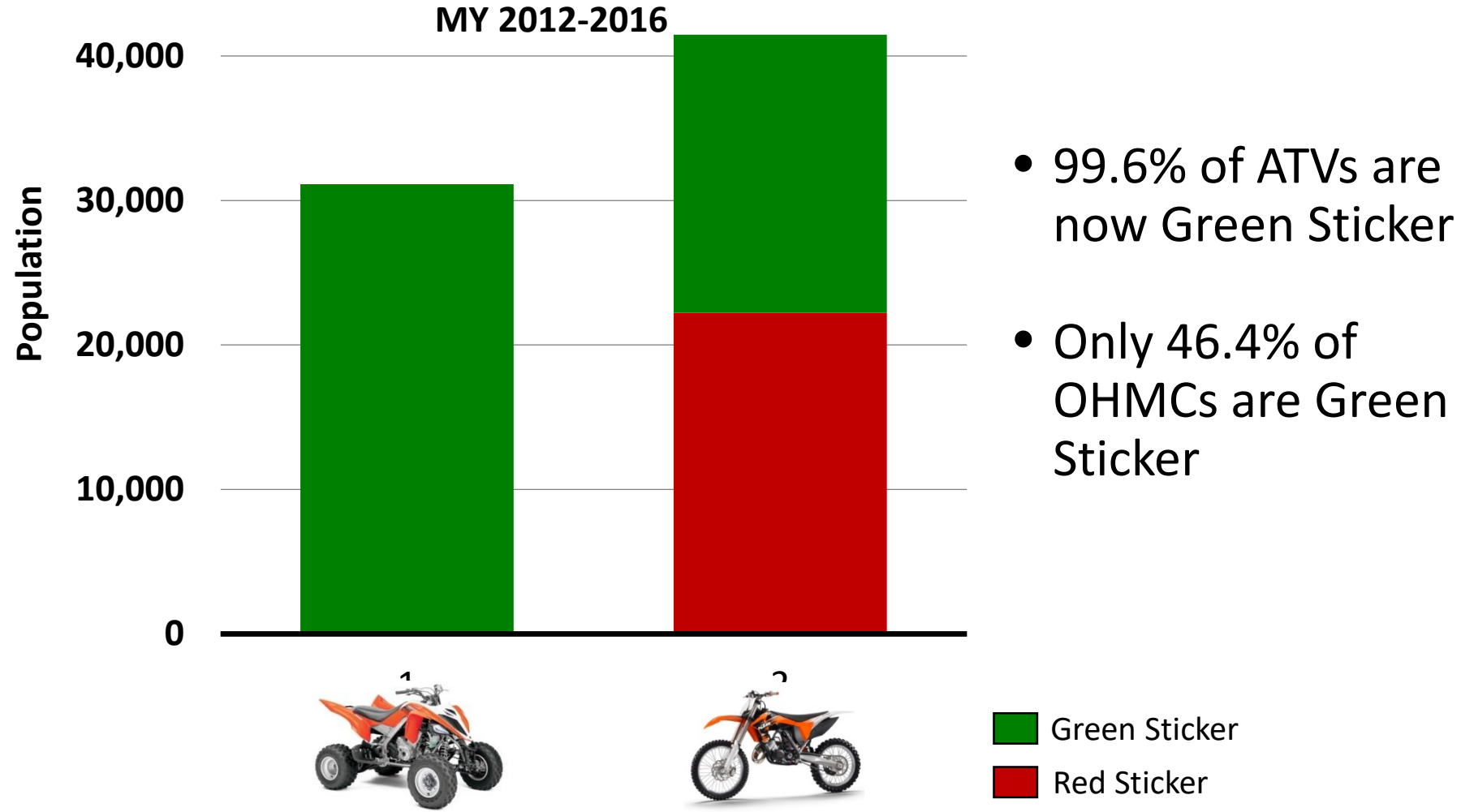
# Population Evaluation Methodology

- Enhanced ability to analyze OHRV population and certification data
  - Developed VIN decoder for DMV registration data
- Evaluated population, certification, and technology trends



- More accurate count of total population, vehicle types, sticker types, 2-stroke, 4-stroke, carbureted, and fuel injected

# Red Sticker Primarily OHMCs



<sup>1</sup>Source: 2015 DMV database



# OHMC Owner Survey

Passionate about off-highway recreation?



Share your views to receive a **FREE** California SVRA day pass!

The image shows two children, a girl and a boy, sitting on their dirt bikes on a grassy trail. The girl is on the left, wearing a black and red riding suit, and the boy is on the right, wearing a red and black riding suit. The background features a wooden fence and lush green trees under a bright sky.

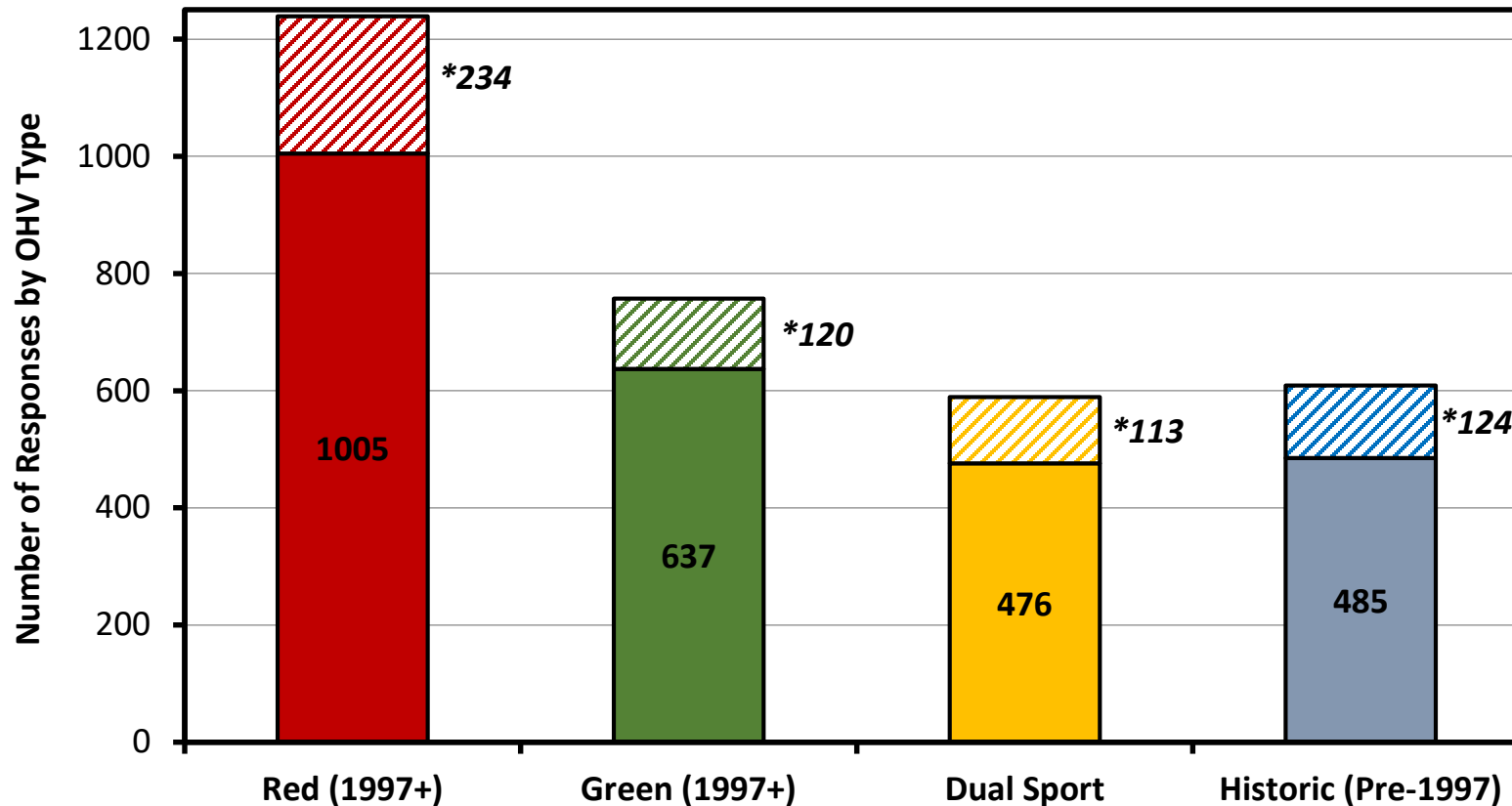
- Conducted statewide OHMC owner survey
- Online survey hosted by UC Davis
- Nearly 3,000 respondents
- State Parks provided 2,274 day use passes as incentive
- Questions developed with extensive input from industry



# Survey Purpose and Methodology

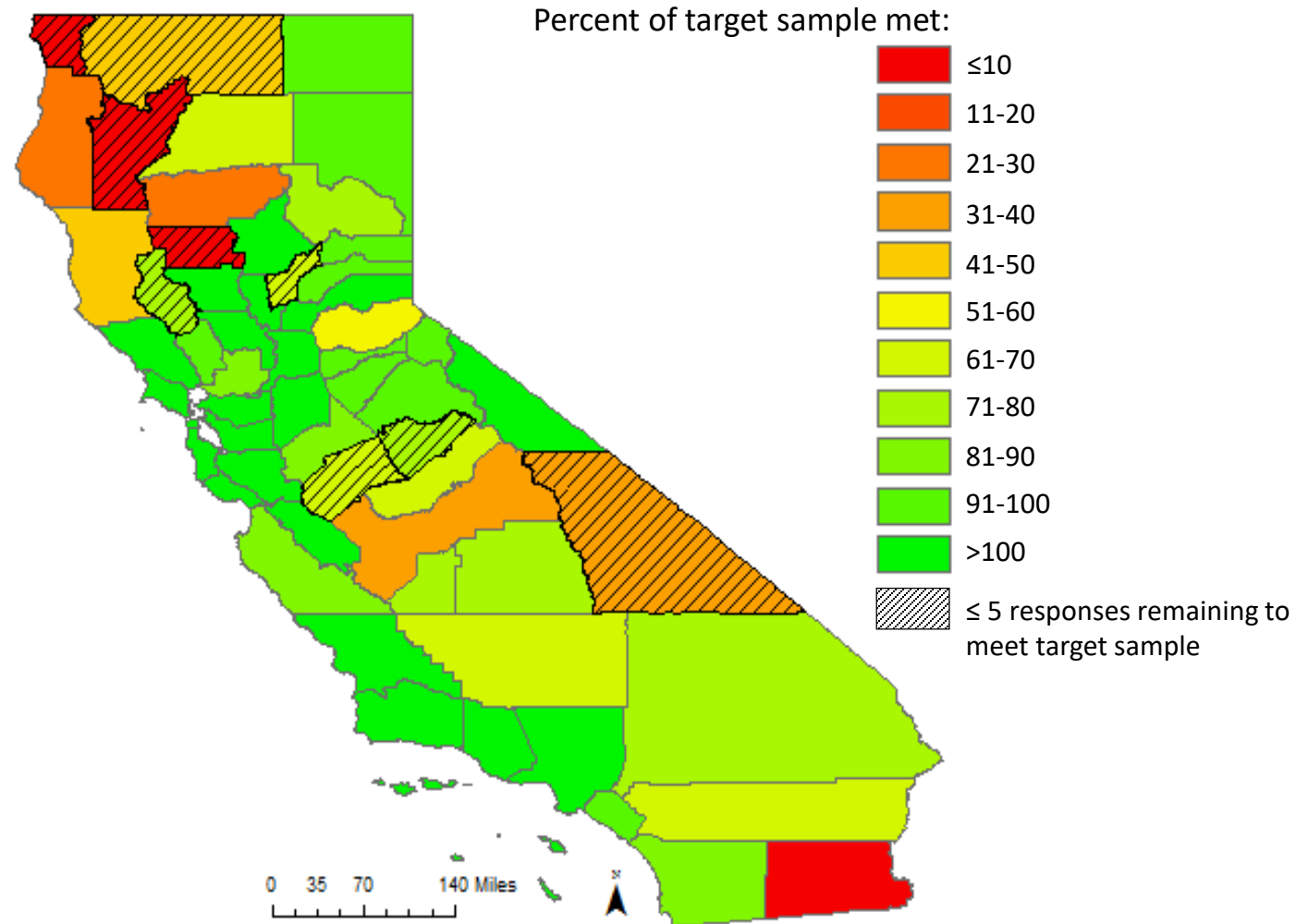
- Purpose:
  - Quantify OHMC usage and activity
  - Understand differences in seasonal operation
  - Evaluate the effectiveness of the red sticker program
  - Update emissions inventory
- Methodology:
  - Survey population based on 2013 DMV database
  - Representative sample of riders selected based on location, DMV registration status, and sticker type
  - Initial and final reminder postcard sent to each surveyed rider

# Survey Response Breakdown by Type



\*Partial responses received

# Spatial Distribution of Survey Respondents



# Inventory

**Background**

Population

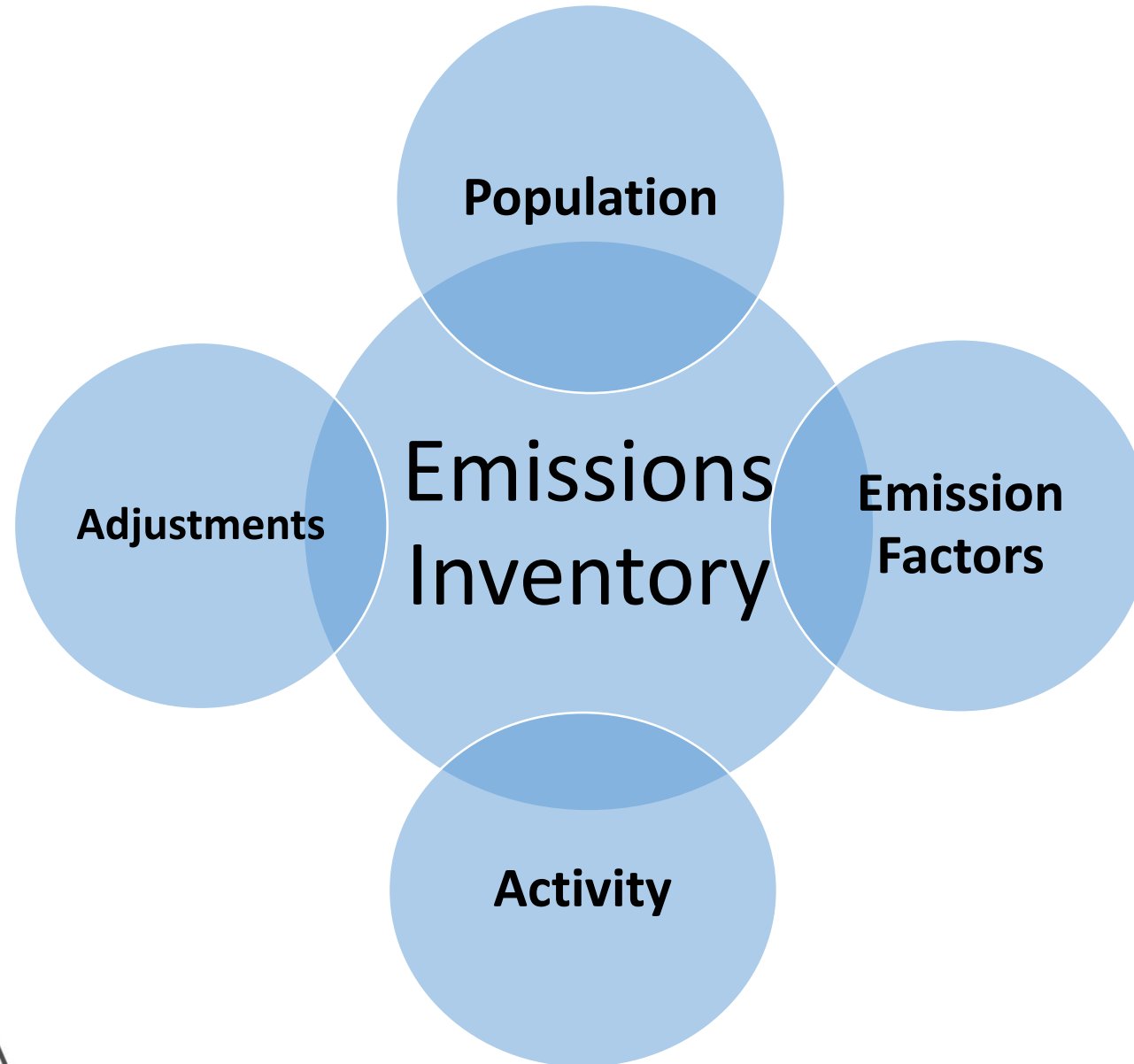
Activity

Emission Factors

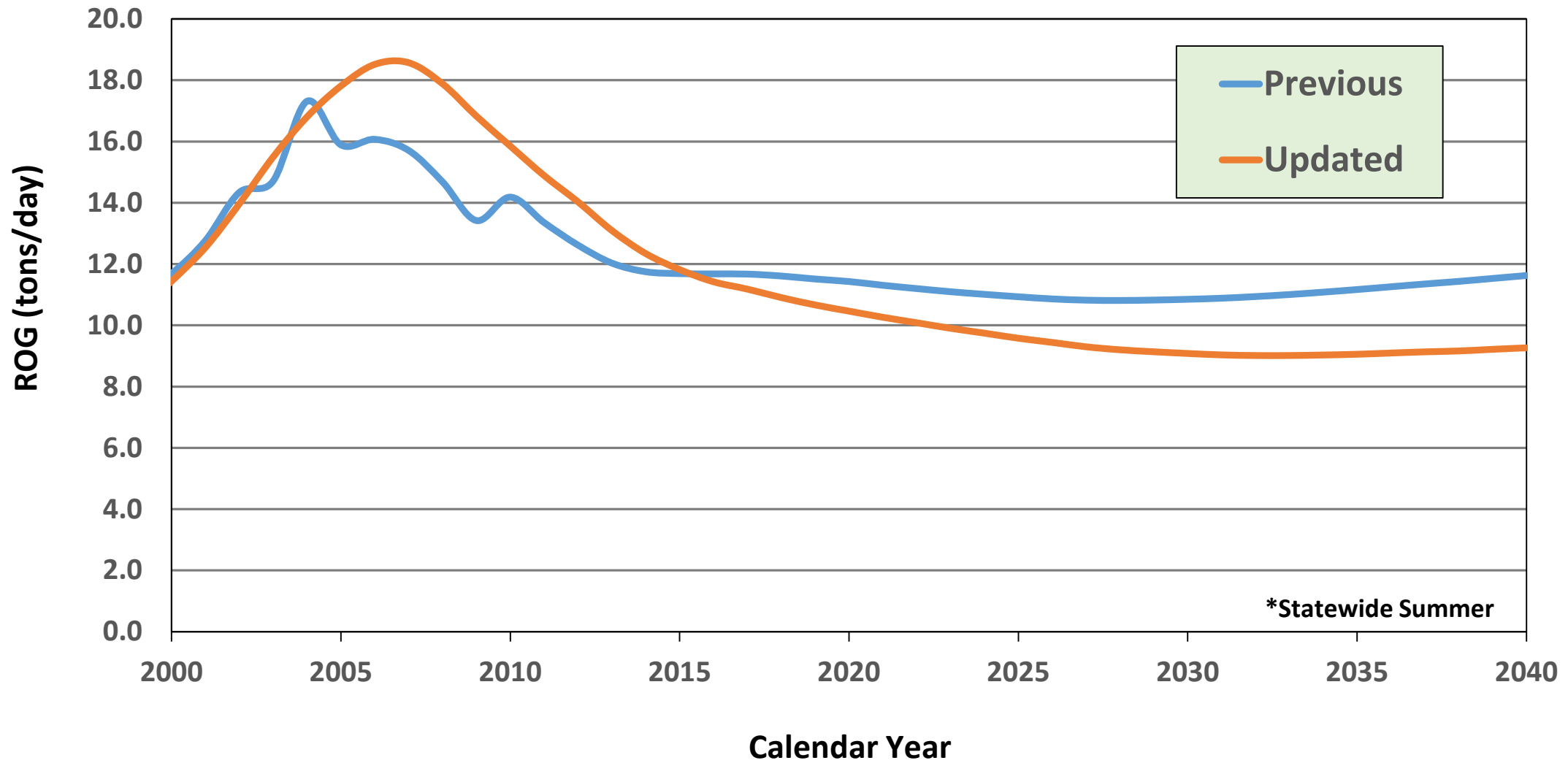
Adjustment Factors

Summary

# Factors Affecting Emissions Inventory



# Comparison of OHMC Baseline ROG (tpd)\*



# Inventory

Background

**Population**

Activity

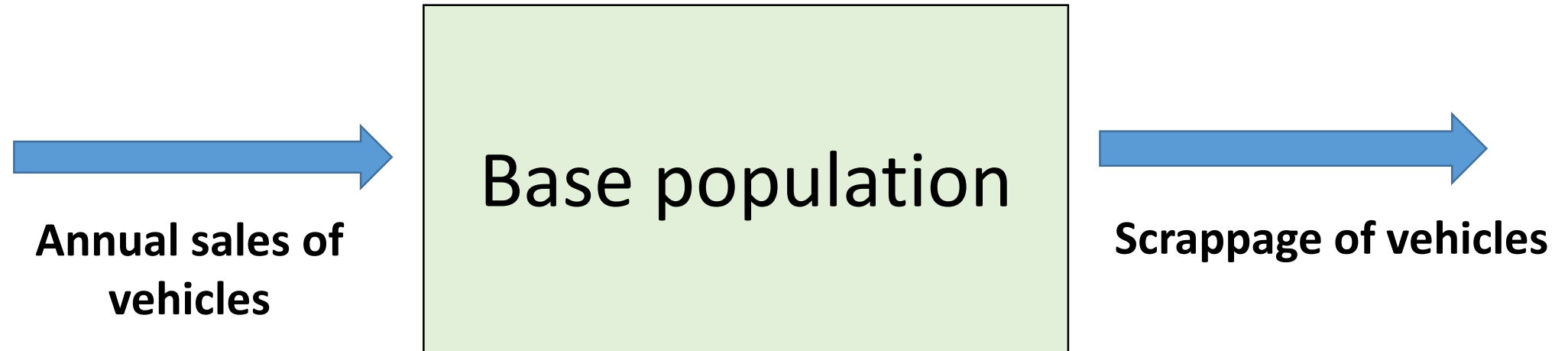
Emission Factors

Adjustment Factors

Proposed OHMC Baseline



# Population Estimate



$$\text{Population} = \text{Base population} + \text{Annual sales} - \text{Vehicle scrappage}$$

# Development of Scrappage Rate

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	22564	29531	45004	50817	50000	39847	35245	23302	11888	4387
1	11345	24294	32942	41791	58106	56045	53282	48261	32821	16572
2	9985	11932	24934	33809	42928	66852	57948	54788	52225	35594
3	11698	10286	12391	25210	34589	43089	67467	58151	54953	52568
4	8599	11850	10587	12716	25422	34473	43469	67643	58239	55045
5	6939	8387	11591	10429	13044	24639	33637	41934	63695	56406
6	6767	6511	8024	11204	10592	12069	23119	31637	39580	58291
7	6518	6478	6307	7823	11372	9727	11693	22224	30536	37746
8	6026	6222	6311	6140	7904	10485	9315	11164	21093	28850
9	6524	5787	6113	6153	6246	7250	10084	8927	10686	20240
10	8621	6216	5608	5944	6277	5768	7030	9674	8477	10161
11	7575	8302	6049	5482	6089	5780	5618	6717	9270	8064
12	5916	7152	8078	5898	5633	5565	5546	5359	6403	8851
13	9581	5663	7026	7909	6016	5115	5337	5325	5094	6124
14	12404	8957	5494	6797	8074	5503	4897	5047	5053	4772
15	22461	11874	8770	5340	6961	7302	5301	4689	4809	4802
16	19279	20486	11466	8481	5467	6320	6938	5040	4388	4493
17	16439	18096	19848	11201	8687	4927	6070	6632	4789	4166
18	12677	14518	16990	18893	11415	7842	4653	5685	6272	4483
19	8015	11865	14210	16390	19317	10306	7497	4427	5394	5912
20	5824	7001	11200	13279	16706	17211	9731	7061	4116	4994
21	5300	5442	6904	10780	13608	14693	16444	9286	6663	3855
22	4013	4815	5182	6396	10998	11922	13574	15371	8720	6190
23	2850	3741	4696	4987	6541	9589	11417	12779	14496	8282
24	2088	2540	3593	4445	5098	5660	8817	10408	11617	13330
25	2217	1924	2490	3453	4586	4417	5396	8350	9853	10890
26	2215	2066	1827	2366	3554	4024	4088	4871	7572	8888
27	1358	2114	2042	1773	2431	3082	3827	3871	4617	7010
28	1093	1308	2058	1941	1817	2142	2865	3567	3505	4106
29	1021	1055	1280	1997	2003	1596	2047	2675	3365	3229
30	1033	998	1031	1261	2044	1746	1486	1894	2435	3048
31	437	1010	973	1010	1289	1830	1667	1394	1785	2276
32	167	427	995	956	1041	1157	1719	1568	1290	1625
33	10	172	439	976	978	930	1092	1626	1504	1191
34	9	7	168	428	997	878	878	1041	1526	1387
35	0	9	7	161	438	904	820	846	953	1429
36	0	0	9	7	169	409	857	782	772	887
37	0	0	0	11	7	165	404	829	711	723
38	0	0	0	0	11	5	157	383	786	683
39	0	0	0	0	0	11	6	155	364	736
40	0	0	0	0	0	0	9	6	151	349

- Based on DMV registration database
- Vehicle population declines with age due to scrappage

# OHMC Annual Sales Forecast

- Short Term

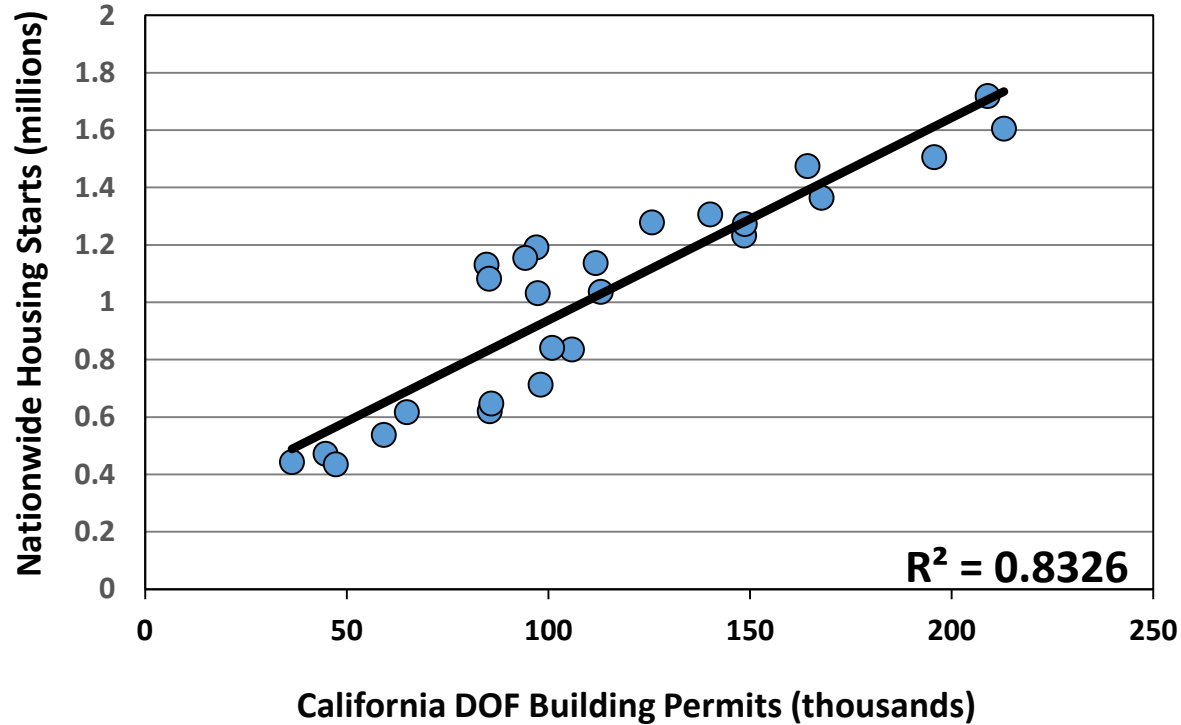
- CY 2017 to 2020
- OHMC annual sales has good correlation with nationwide housing starts
- Nationwide housing starts has good correlation with California DOF building permits (which do not have future forecast)
- Annual sales for OHMC is based on forecast of California DOF building permits

- Long Term

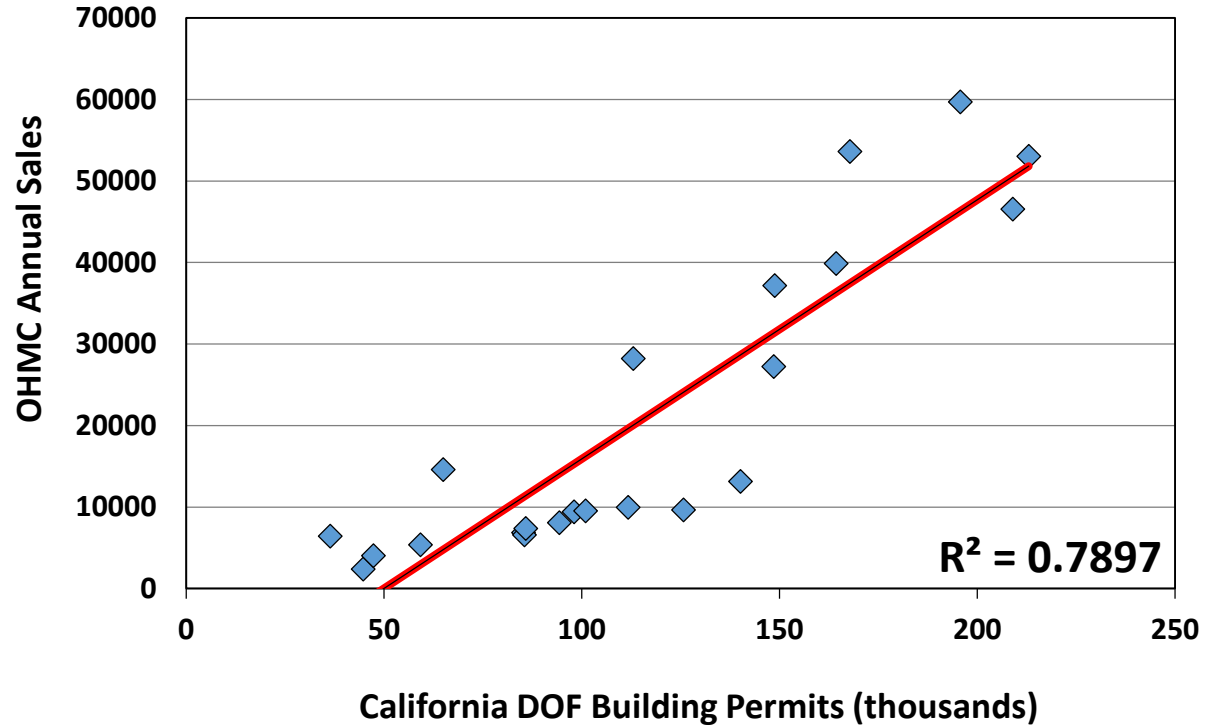
- CY2021 and later
- Based on California human population growth of 1.2% per year

# Economic Forecast for Annual Sales

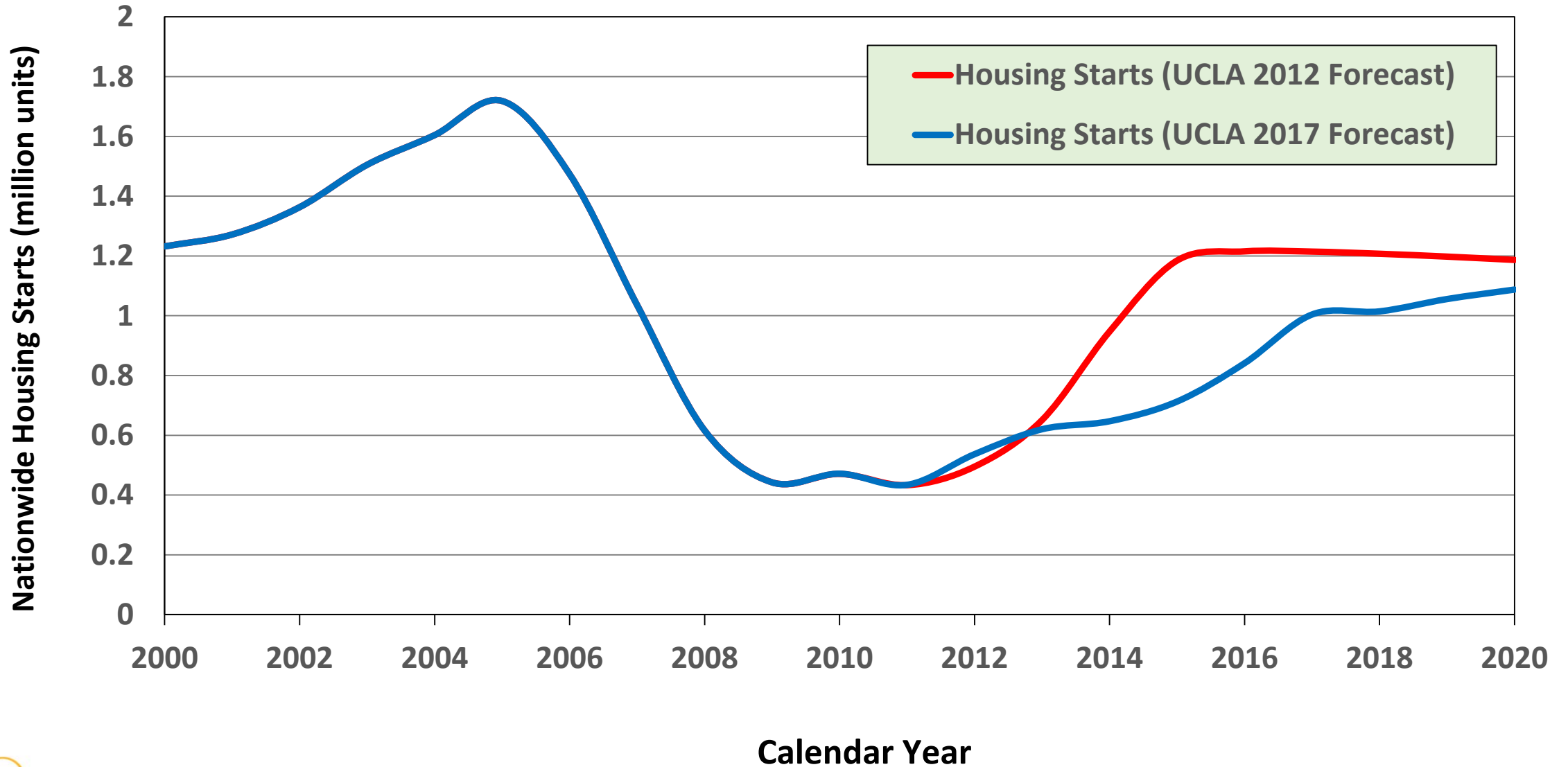
## California DOF Permit vs. Nationwide Housing Starts



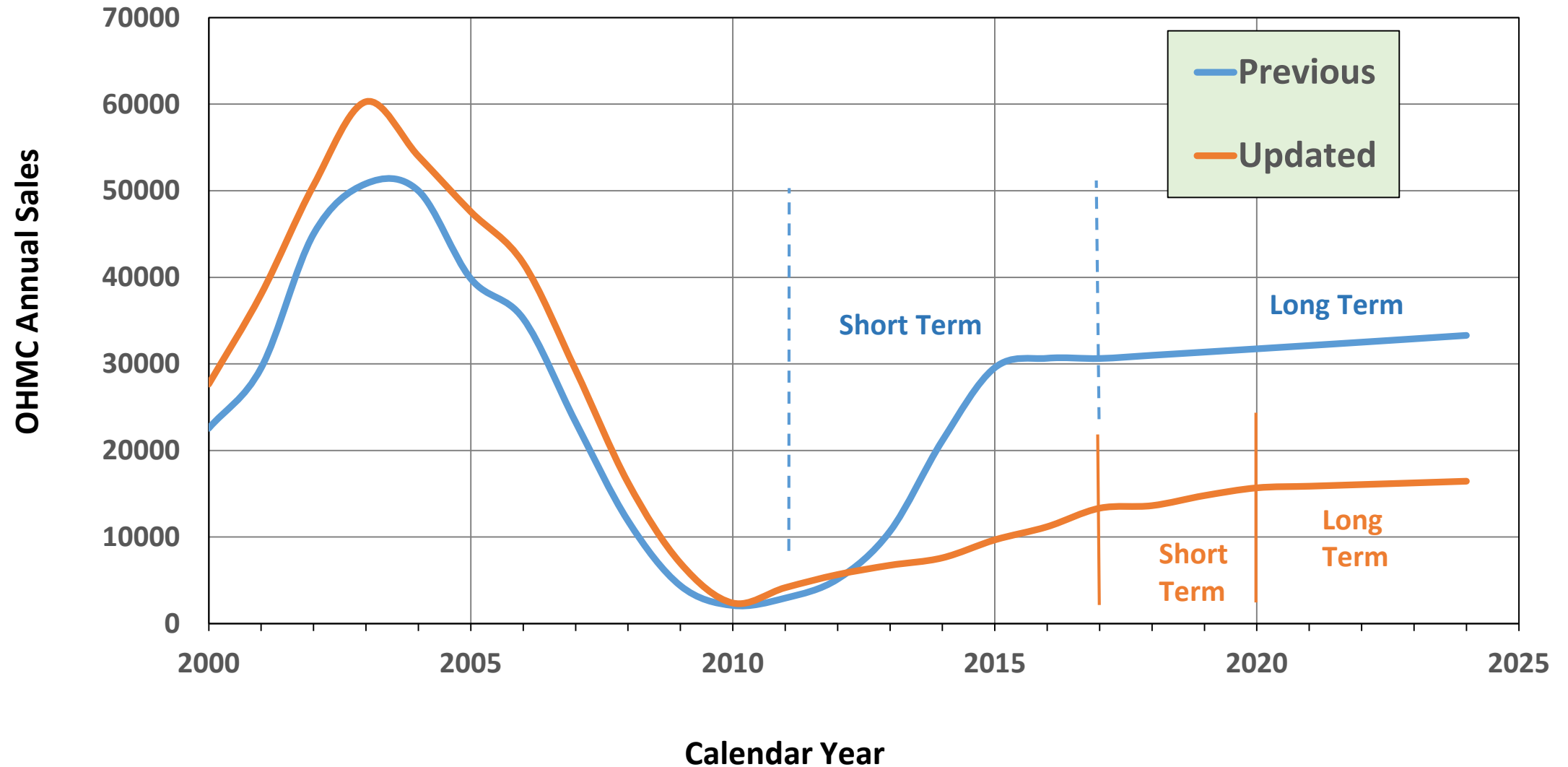
## California DOF Building Permit vs. OHMC Annual Sales



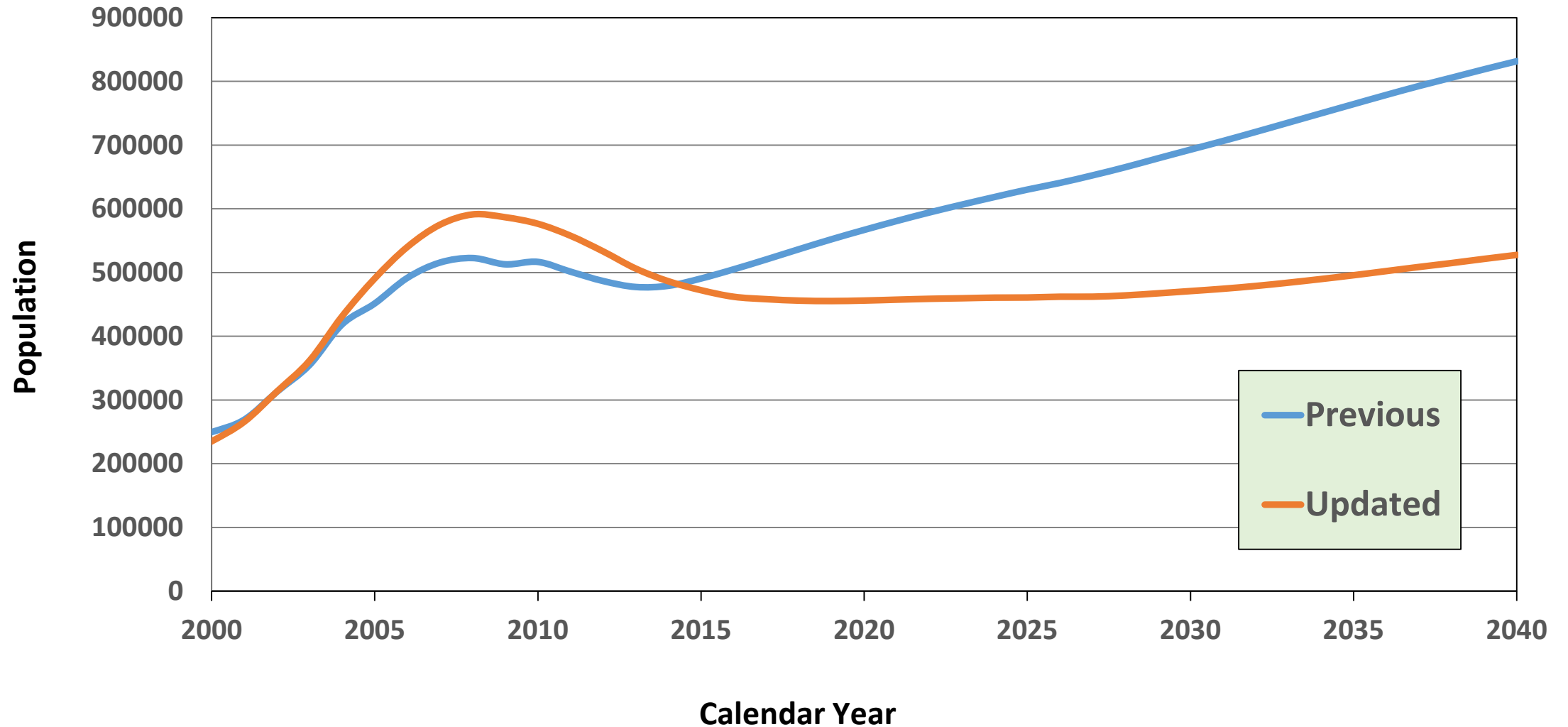
# Comparison of UCLA Economic Forecast



# OHMC Annual Sales Projection (Previous vs. Updated)

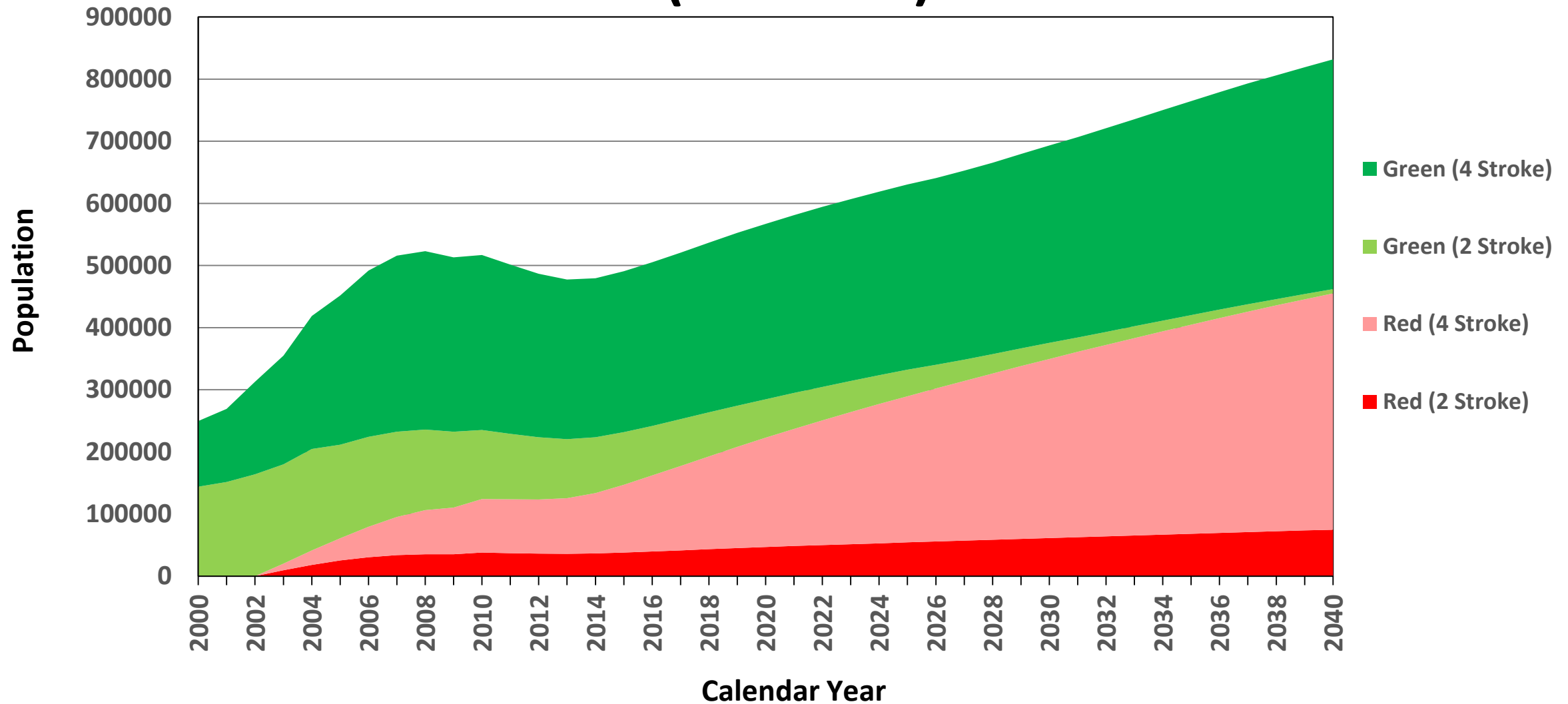


# OHMC Population (Previous vs. Updated)

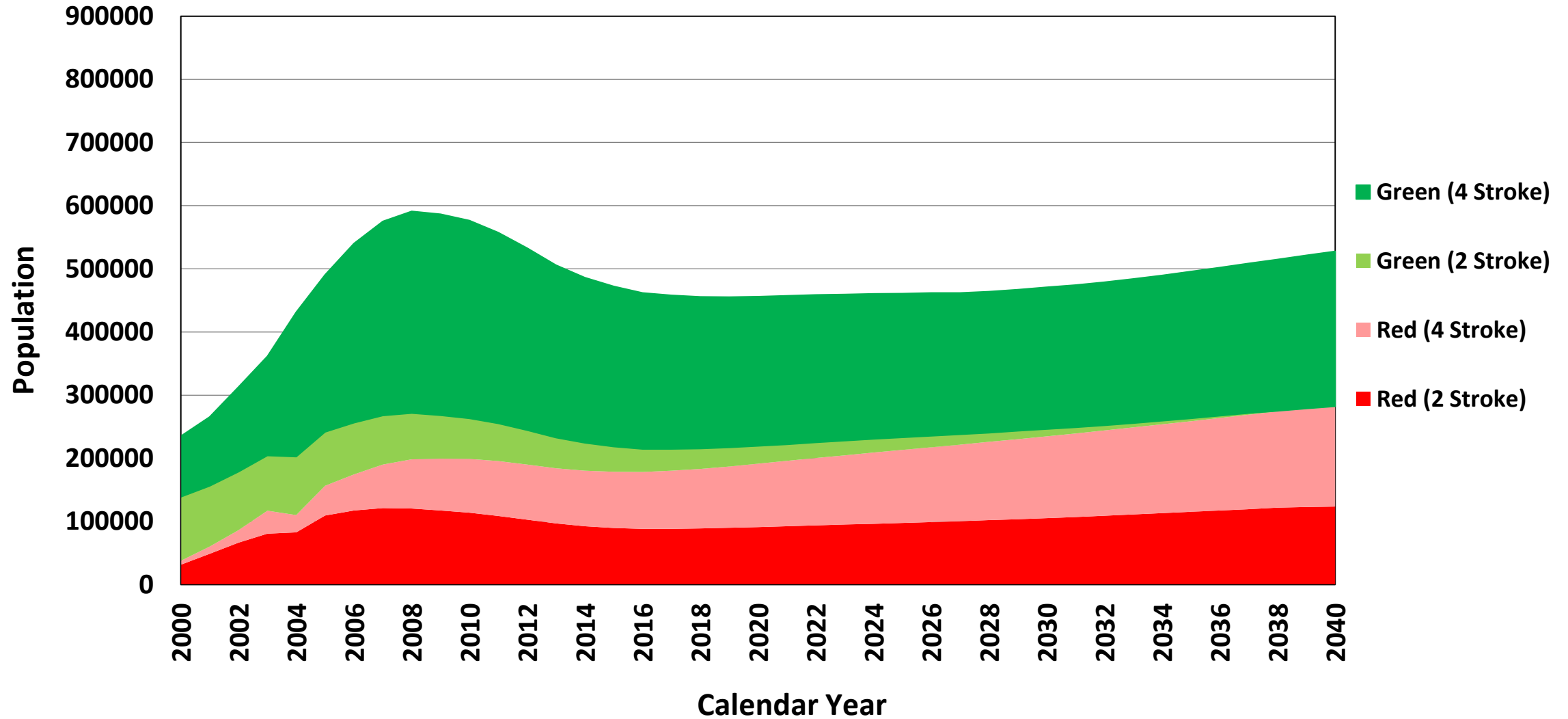




# Distribution of OHMC Green and Red Stickers (Previous)



# Distribution of OHMC Green and Red Stickers (Updated)



# Inventory

Background

Population

**Activity**

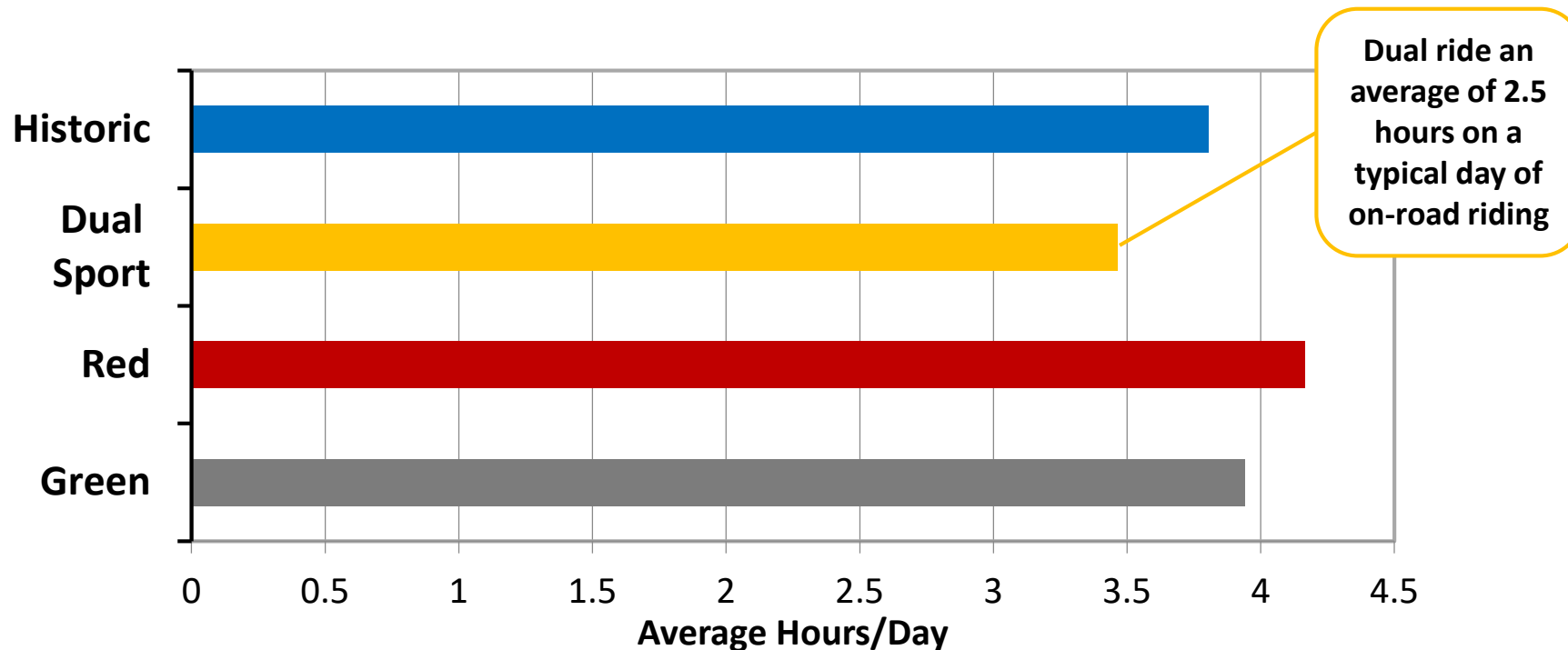
Emission Factors

Adjustment Factors

Summary

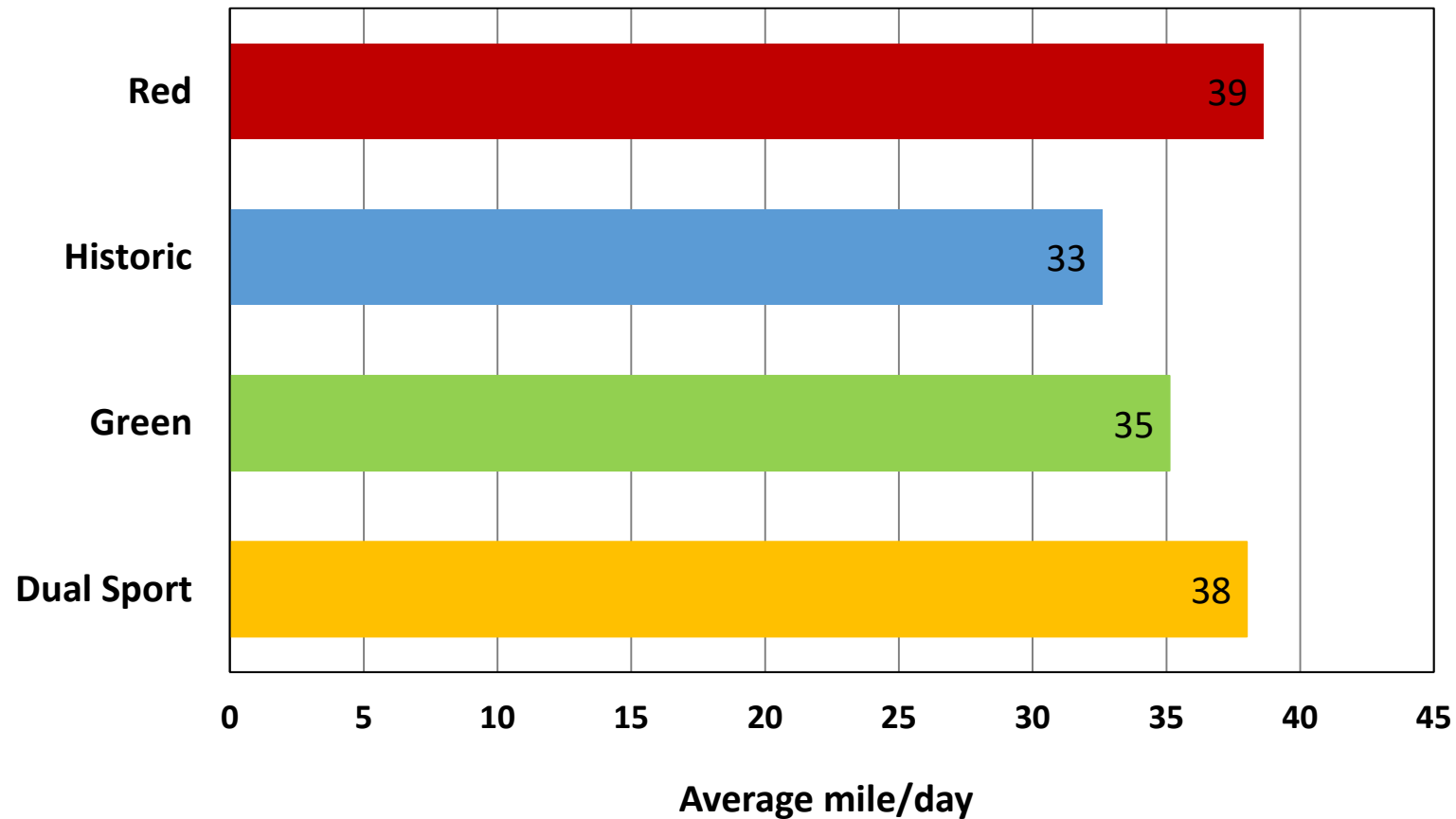
# Q2: How many hours is this OHV ridden on a typical day of off-highway riding, not including stopping/resting time?

Status Code	Average Hours/Day	Percent of Survey Population
Active	4.04	84%
Inactive	3.98	16%



# Q3: How many miles do you ride this OHV on a typical day of off-highway riding?

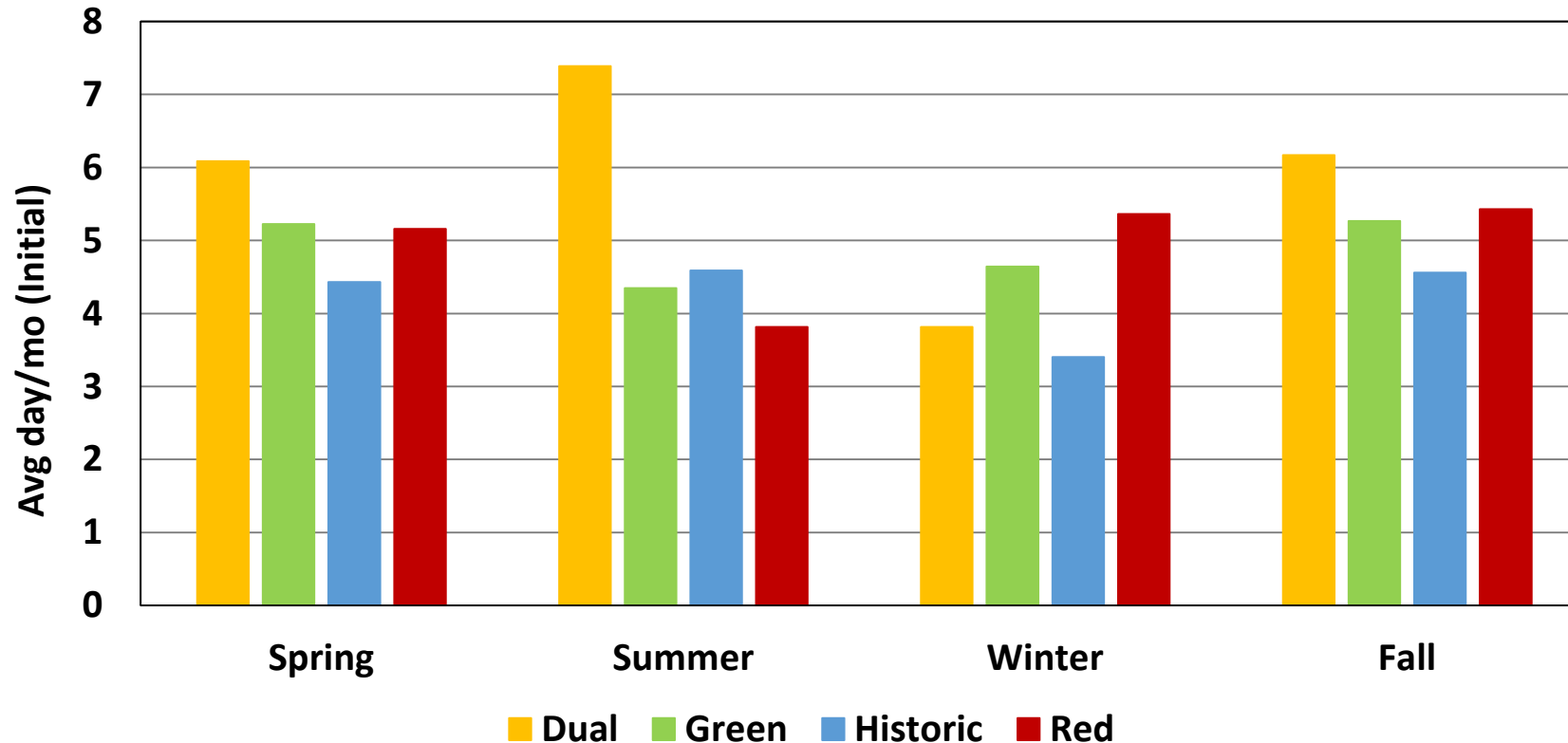
On a typical day of off-highway riding, the average activity was 36.5 miles/day.



# Q4: What are the average number of days per month you ride this OHV off-highway during each of the following seasons?

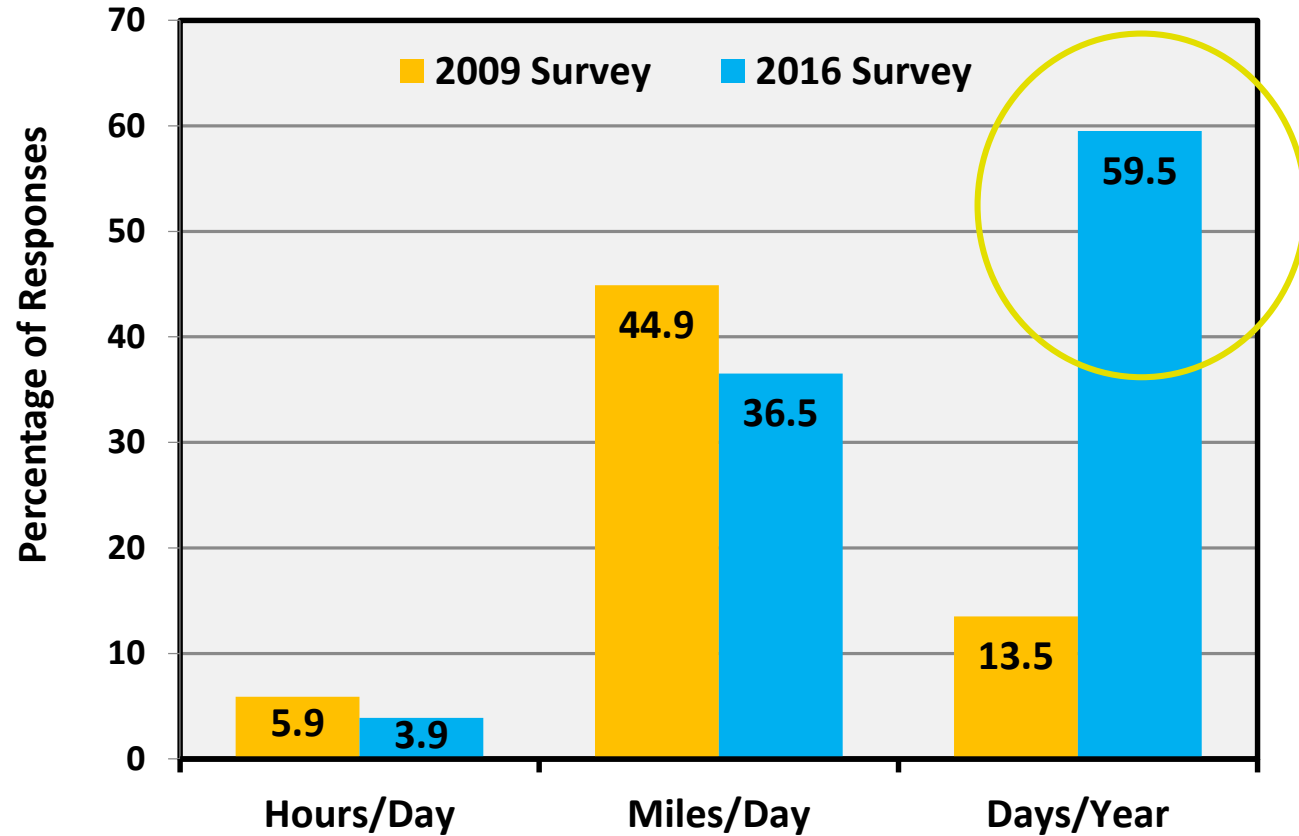
*(Enter a number from 0-31)*

From the initial survey, on average, the monthly activity was 5 days/month for each season or 60 days/year of riding.



# Q4 (Continued): Need for supplemental data

Average Survey Responses 2009 vs. 2016



## Q4 Observations:

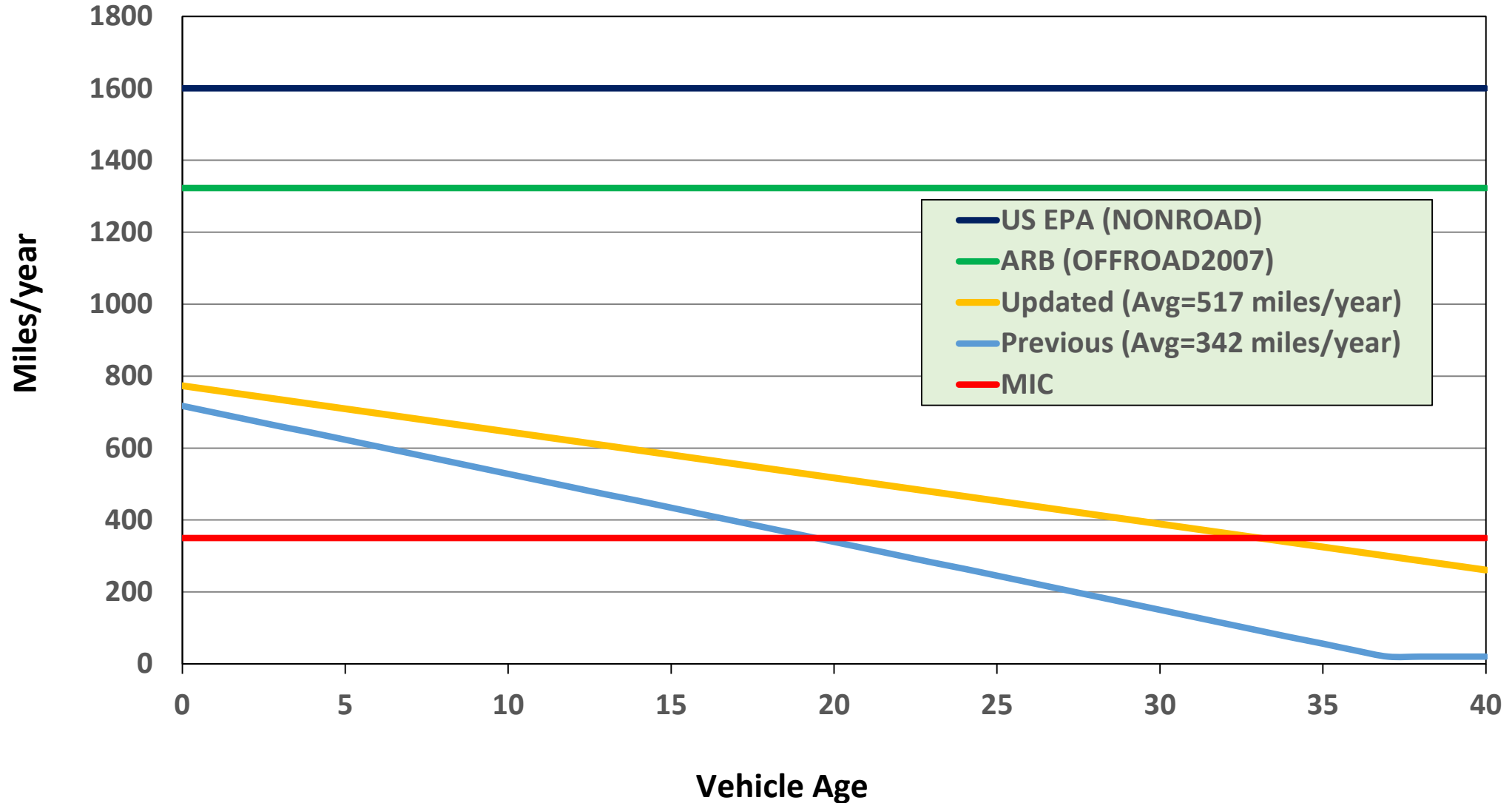
- Abnormal distribution
- Poor correlation with 2009 OHV survey
- Potential confusion (per season vs. per month)



# Activity Analysis

- Adjust the number of operation days per year
  - Round 1: Answers to “*number of operation days per month per season*” are about 60 days/year (participants likely misread the question)
  - Round 2: Sent a follow-up question to participants (n=310) and the average is about 13 days/year
  - Round 1 data adjusted by a correction factor from Round 2/ Round 1
- Zero activity adjustment
  - 2009 OHMC survey has 10% reported zero activity
  - 2016 OHMC survey has 2% reported zero activity
  - Assume 2016 OHMC survey also has 10% zero activity

# OHMC Annual Activity (miles/day)



# Inventory

Background

Population

Activity

**Emission Factors**

Adjustment Factors

Summary

# Types of Emissions

## Exhaust Emissions



## Evaporative Emissions



Running Loss (Operation)



Hot Soak (Immediately After Operation)



Diurnal (Storage)

# Sources of Emissions Data

## Exhaust Emissions

- CARB certification data
- U.S. EPA test data
- 2015 CARB in-house test data



Motorcycle/ATV Dynamometer (Exhaust Emissions)

## Evaporative Emissions

- 2003 ATL study
- 2009 CARB in-house study
- 2015 CARB in-house study



Sealed Housing for Evaporative Determination (Evaporative Emissions) 34

# Two-Stroke OHMC Exhaust Emissions

- HC from an 85 cc 2-stroke Red Sticker is 12.38 g/mile
- Difficult to test 2-stroke OHMCs (> 5 hp) because they are high emitting

Source	HC Exhaust Emissions
2016 CARB Test Results <sup>1</sup>	> 30 g/km (> 48.3 g/mile)
2010 U.S. EPA Emissions Factor <sup>2</sup>	33.5 g/km (53.9 g/mile)
2010 Southwest Research Test Results <sup>3</sup>	25.7g/km – 26.2g/km (41.4 g/mile – 42.2 g/mile)
2000 CARB Emissions Factor <sup>4</sup> (RV2013 and OFFROAD2007)	21.3 g/km (34.2 g/mile)



**Contamination of CARB emissions lab sample train**

<sup>1</sup> Excludes 85 cc 2-stroke OHMC test result

<sup>2</sup> Source: 2010 U.S. EPA Exhaust Emissions Factors for NONROAD Engine Modeling

<sup>3</sup> Source: Broad Emissions Testing Support for In-Use Vehicles and Engines

<sup>4</sup> Source: Emissions Estimation Methodology for Off-Highway Recreation Vehicles

# Emission Factors for Red Sticker OHMC

## Exhaust EF

HP Group	Engine		MY Group	HC (g/mi)	
				Previous	Updated
0 - 5	2 Stroke	Carburetor	1997 ≤	34.2	12.38
			≥ 1998	34.2	12.38
		Fuel Injection	1997 ≤	34.2	12.38
			≥ 1998	34.2	12.38
	4 Stroke	Carburetor	1997 ≤	3.59	3.59
			≥ 1998	3.59	2.59
		Fuel Injection	1997 ≤	3.59	3.59
			≥ 1998	3.59	2.59
5+	2 Stroke	Carburetor	1997 ≤	34.2	34.2
			≥ 1998	34.2	34.2
		Fuel Injection	1997 ≤	34.2	21.3
			≥ 1998	34.2	21.3
	4 Stroke	Carburetor	1997 ≤	3.59	3.59
			≥ 1998	3.59	2.59
		Fuel Injection	1997 ≤	3.59	3.59
			≥ 1998	3.59	2.59

## Evaporative EF

Technology	Hot Start (g/event)		Diurnal (g/day)		Running (g/mile)	
	Previous	Updated	Previous	Updated	Previous	Updated
Carburetor (all model year)	3.12	3.12	12.23	12.23	1.07	1.07
Fuel Injection (all model year)	3.12	3.12	12.23	2.18	1.07	1.07



# Inventory

Background

Population

Activity

Emission Factors

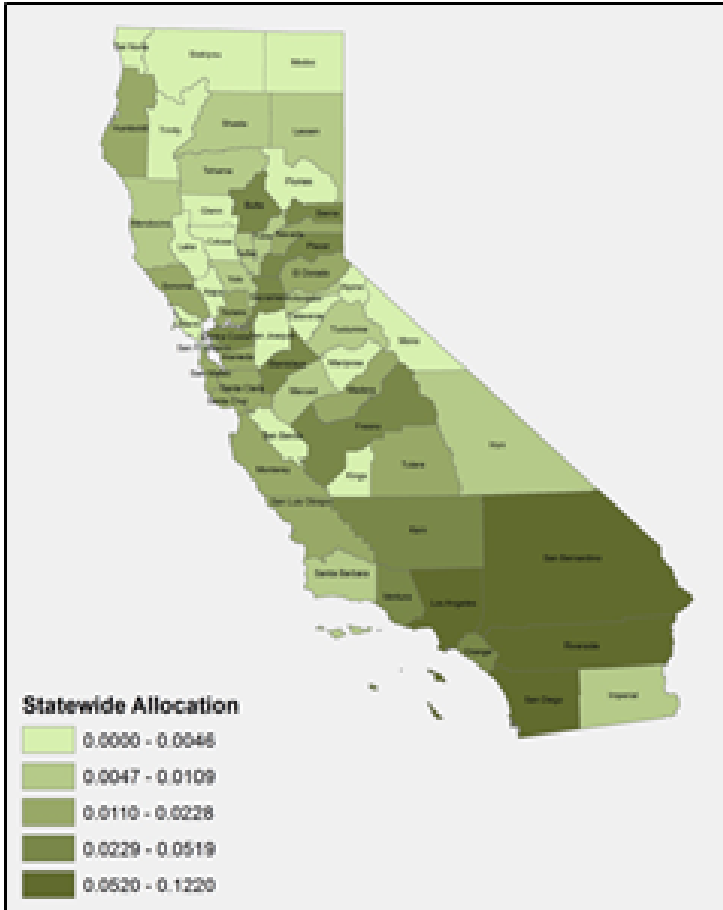
**Adjustment Factors**

Proposed OHMC Baseline

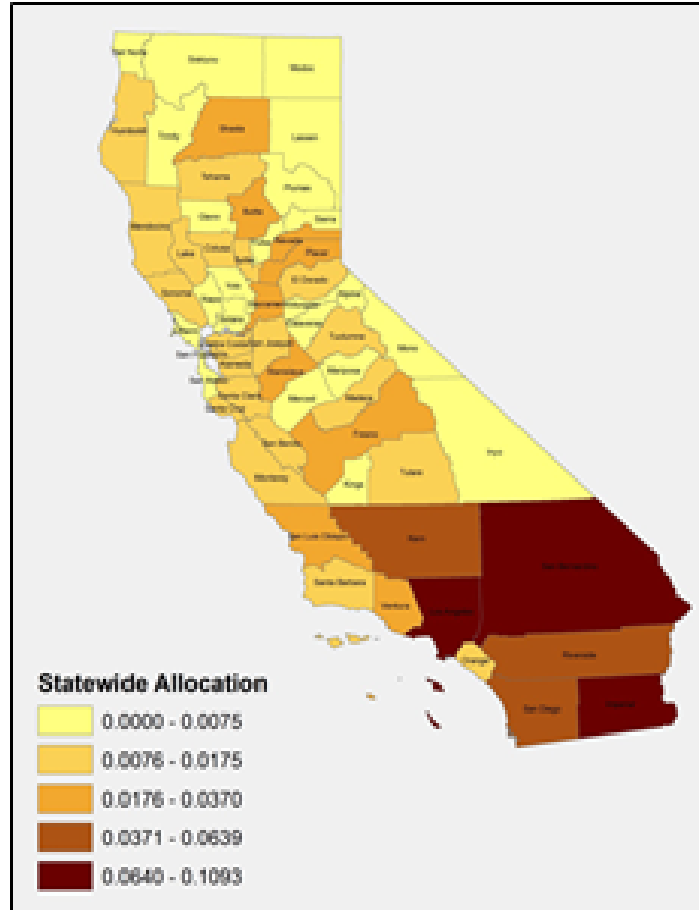


# Spatial Allocation

## Area of Storage



## Area of Operation



## Area of Storage

- Evaporative emissions (diurnal)
- Based on DMV registration

## Area of Operation

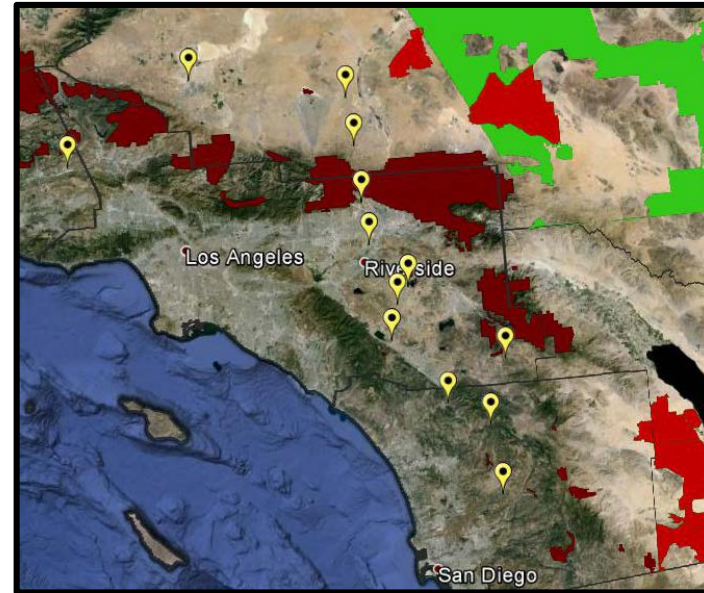
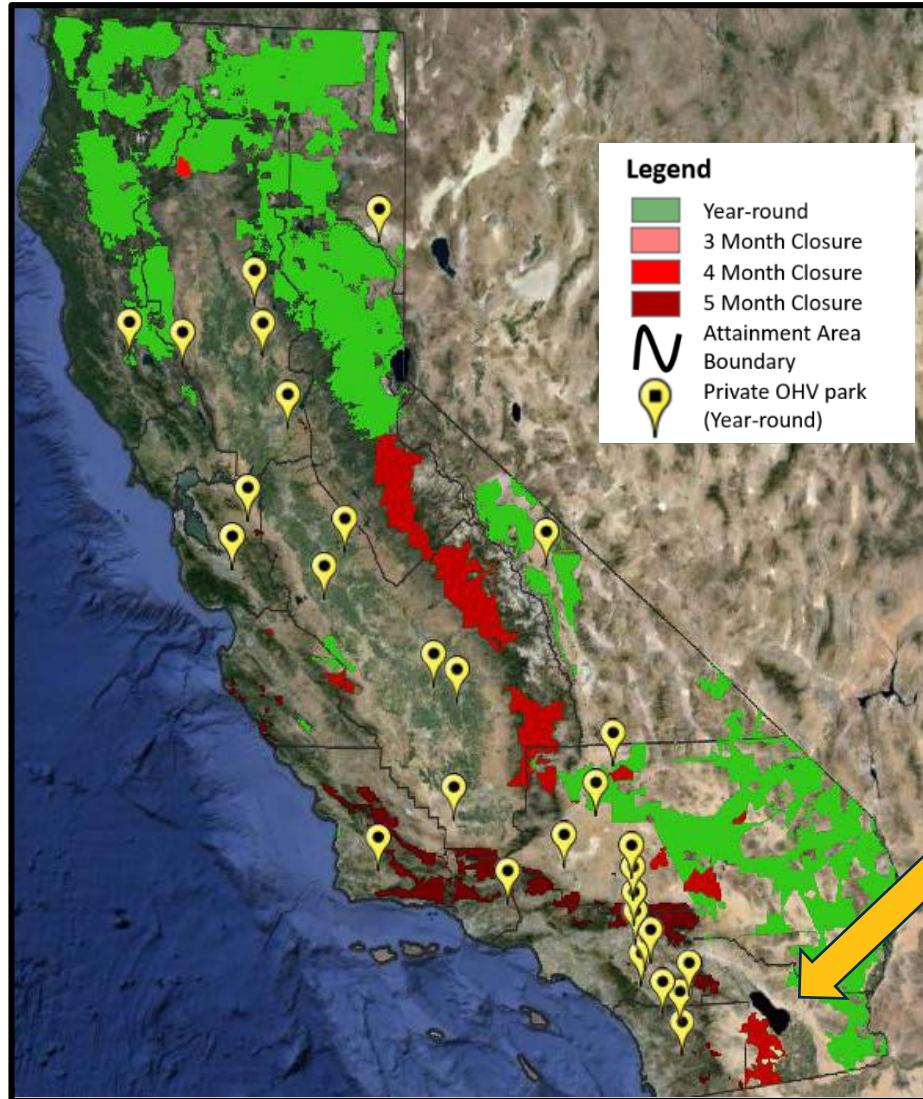
- Exhaust emissions
- Evaporative emissions (running loss and hot soak)
- Based on 2016 OHMC survey

# Corrections Based on Regional Conditions

- Adjust the typical 72 to 96 F temperature profile to local temperature profile and fuel requirements through RVP/Temp correction
- Assume most OHMC are stored inside garage, further adjust the local ambient temperature with typical range of garage temperature

Area	Season	Gasoline RVP (psi)	Standard Diurnal Profile (F)			Ambient Temp. (F)			Garage Temp.(F)			Correction
			Min.	Max.	Diff.	Min.	Max.	Diff.	Min.	Max.	Diff.	
Riverside County	Summer	7	72	96	24	65	94.1	29.1	73.6	88.9	15.2	0.835
	Winter	9				53.2	76.7	23.5	62.4	74.7	12.3	0.648
Sacramento County	Summer	7	72	96	24	67	98.6	31.6	75	93.1	18.1	0.884
	Winter	9				39.6	58	18.4	41.7	52.9	11.2	0.305

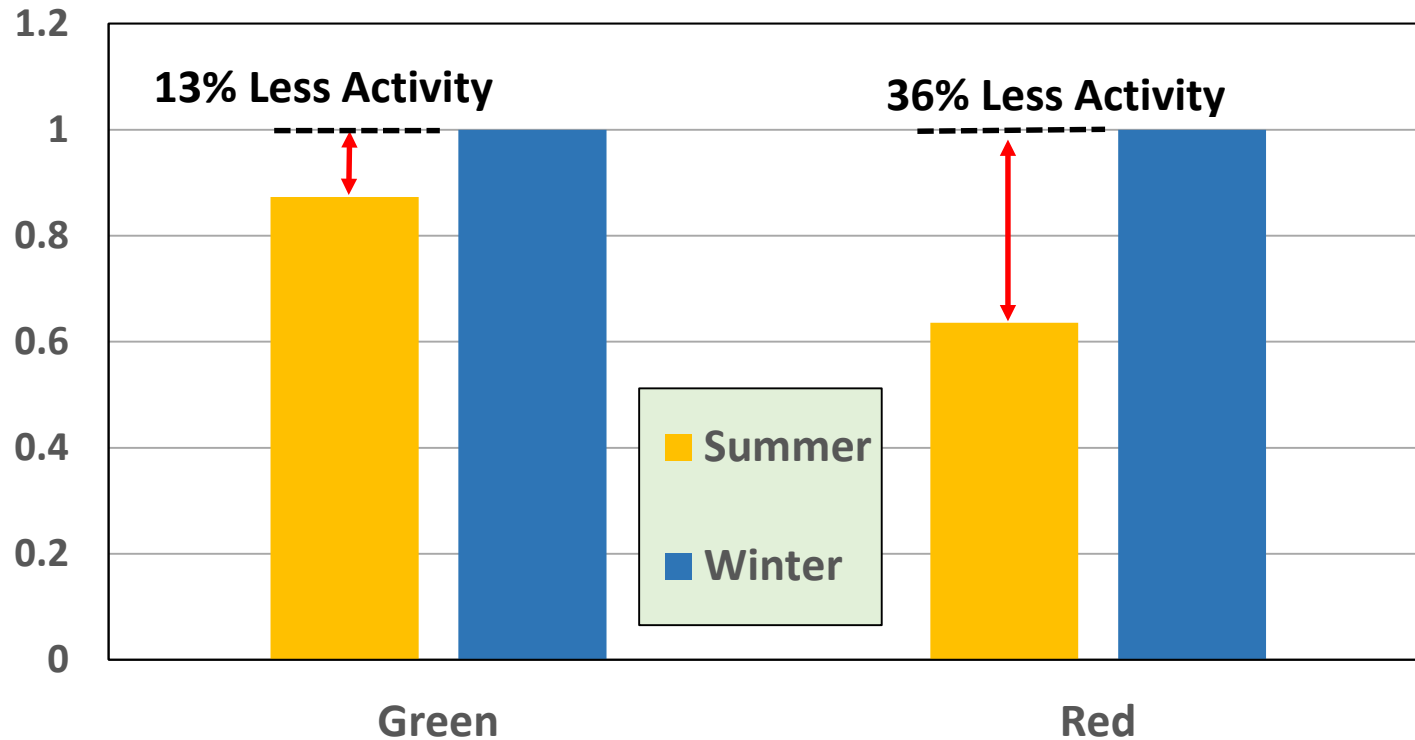
# Red Sticker Riding Calendar Does Not Limit Use



Private tracks and property are often located within non-attainment areas

# Estimated Emissions Reduction from the Red Sticker Program

Activity in Non-Attainment Areas (Normalized)



- Red Sticker program does not achieve full benefits
- Summer activity for Green Stickers is 13% less than winter activity
- Summer activity for Red Stickers is 36% less than winter activity
- Net reduction of summer activity for Red Stickers is 23%

Estimated emissions reduction from the Red Sticker program ranges from 0.7 tpd (2017) to 1 tpd (2040)

# Inventory

Population

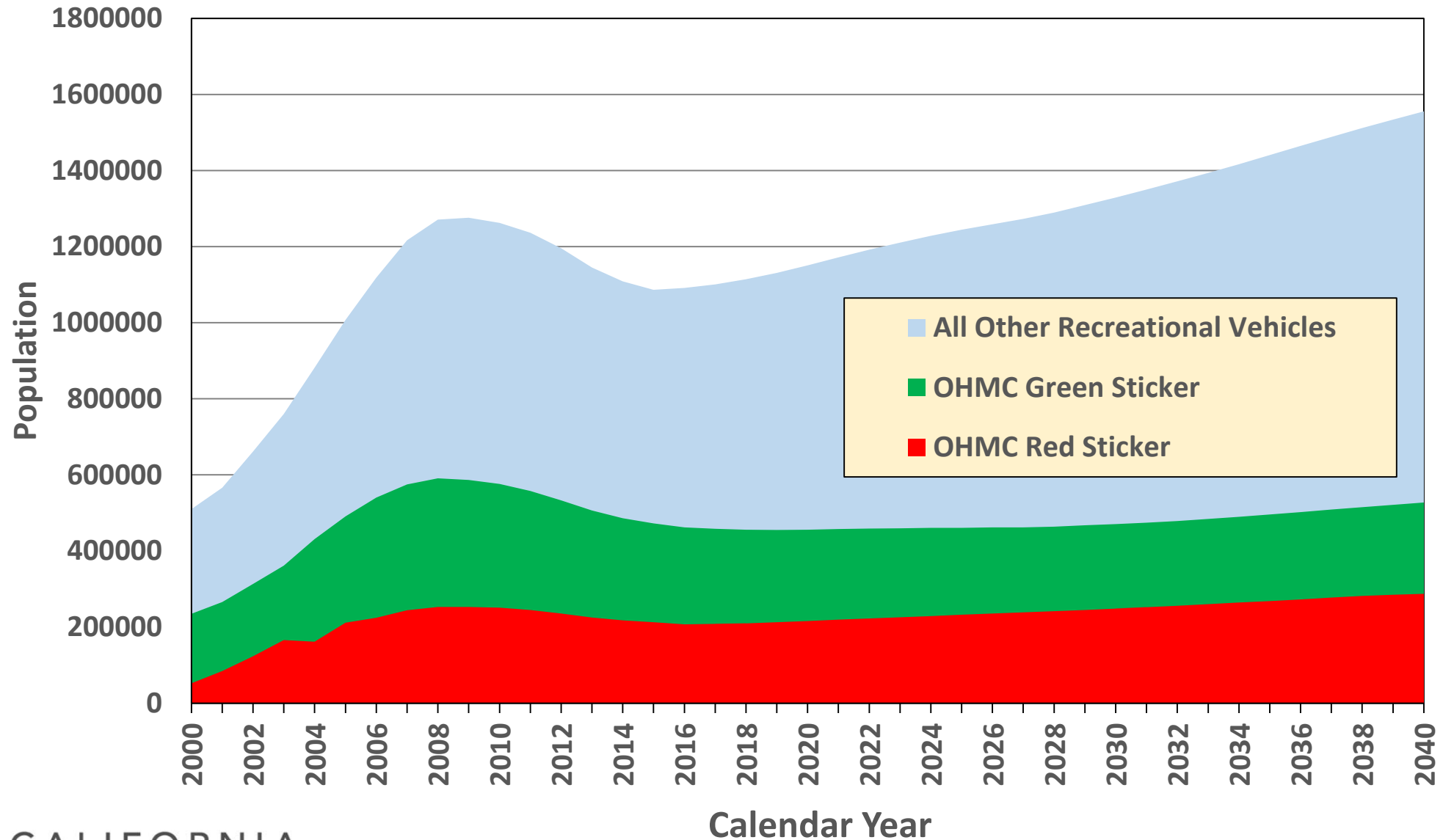
Activity

Emission Factors

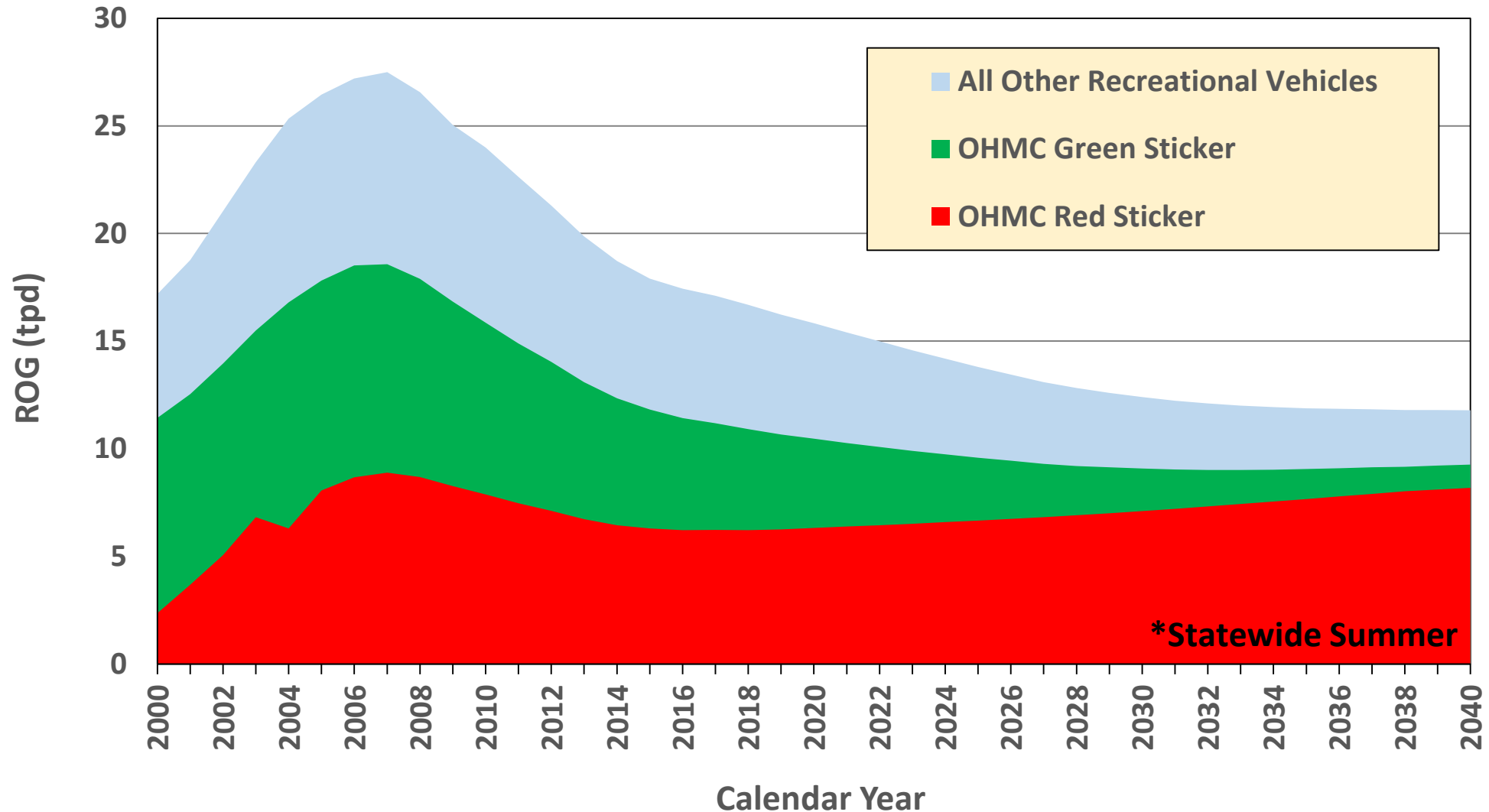
Adjustment Factors

**Summary**

# Updated Population Distribution of Recreational Vehicles



# Updated Distribution of ROG (tpd) from Recreational Vehicles\*





# Summary

- Reasonable annual sales projection and population growth
- Activity estimate similar to previous inventory, with robust sample size (n=3000) and inputs from industry
- Emission factors improved with additional testing
- Two stroke Red Sticker emission factors are conservative
- Major improvements for updated OHMC emissions inventory
- Red Sticker OHMC emissions projected to increase in coming years
  - 37% of total OHRV summertime ROG emissions in 2018
  - 69% of total OHRV summertime ROG emissions in 2035



# Emissions Inventory Next Steps

- Receive feedback from the inventory workshop
- Release inventory package for public comments: August 13, 2018
- Board hearing: September 27, 2018

# CARB Staff Contacts

- OHRV inventory:
  - Dr. David Chou, Manager
  - Off-Road Gasoline Inventory Section
  - Air Quality Planning and Science Division
  - [david.chou@arb.ca.gov](mailto:david.chou@arb.ca.gov)
  - (626) 450-6136
- OHRV Red Sticker assessment and rule amendments:
  - Scott Monday, P.E.
  - Engineering and Regulation Development Section
  - Monitoring Laboratory Division
  - [scott.monday@arb.ca.gov](mailto:scott.monday@arb.ca.gov)
  - (916) 445-9319