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Preliminary Non-Registration Rates for On-Road Vehicles in California

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ABSTRACT

Accurate estimation of the contributions of on-road motor vehicles to the emissions inventory requires accurate estimation of the actual number of vehicles in use. In addition to the known population of registered vehicles there are an unknown number of unregistered vehicles and out-of-state vehicles. The College of Engineering, Center for Environmental Research and Technology (CE-CERT) has recently completed a statewide survey of vehicle registration in the state of California. This study estimated percentage of registered vehicles, unregistered vehicles, as well as, out of state vehicles in the in-use California fleet. With this information, the California Air Resources Board (CARB) can update emissions inventories and develop regulatory strategies to reduce emissions from this subset of the vehicle population. The non-registration rates were determined using extensive field surveys at random locations in each county in the state and encompassing over 120,000 vehicles collected between June 2000 and December 2000.

1.0 Introduction

Development of regional air pollution control strategies requires accurate estimation of the regional emissions inventory. Understanding and accurately portraying the in-use vehicle population is one of the most important aspects of obtaining accurate emission inventory estimates. Mobile sources, by their nature, are difficult to accurately account for in emissions inventories. For individual states, the registered vehicle population will account for a majority of the vehicles on the road. However, unregistered vehicles and out-of-state vehicles represent a significant proportion of the total inventory as well.

The importance of the unregistered population becomes even more significant if these vehicles represent high emission vehicles. It is speculated that in-state unregistered vehicles may have a disproportionate effect on the emissions inventory because of vehicle age and potentially higher proportions of high emitting vehicles. The need to show proof of emissions compliance for vehicle's 25 years of age or newer is one factor making it more likely for unregistered vehicles to be high emitters. Beginning in 1997, the State of California also began to require vehicle owners to show proof of insurance before it would issue or renew a vehicle's registration. When this law came into effect, a significant drop in the official DMV count of registered vehicles was observed relative to 1996. It is suspected that these two requirements may have increased the number of unregistered vehicles in the state, especially poorly maintained vehicles that cannot pass a Smog Test.

The issue of unregistered vehicles in California has been studied in the past. Hunstad conducted a study to characterize uninsured motorists and focused on estimating uninsured vehicles.[1] For this study, the primary source of data on total vehicle counts was the DMV database. In this process, the records for vehicles with expired registration were also considered. Hunstad also reviewed other estimates of unregistration including studies by the California Energy Commission, estimates based on California Highway Patrol (CHP) violations, DMV drivers license records, estimates based on surveys, and fatal accident reports. Although the methodologies for each approach were significantly different, results showed reasonable agreement. To incorporate the different perspectives from these approaches into one estimate, Hunstad presented a weighted yearly average of the estimated percent of unregistered vehicles for the period from 1988 to 1997. Rates varied between 11.7% and 8.5%. In most cases, the trends for unregistration rates were upward in 1997, the year in which new insurance laws came into effect.

The current emissions inventory for on-road motor vehicles is based primarily on the population of vehicles registered with the DMV. Estimates of the unregistered vehicle population were added to the EMFAC2000 vehicle population. In making these estimates, the California Air Resources Board (CARB) examined DMV records of unregistration rates that reported a rate of approximately 7.4% for passenger cars.[2] The files maintained by the DMV can contain vehicles that may have become inoperative or may be located outside of the county of record, however. Since these vehicles are not part of the in-use fleet that would actually be operated in the area designated, their inclusion would result in an overestimate of the actual on-road fleet. Separate field studies

conducted in 1991 found unregistration rates of about 7.8% and 0.56% for instantaneously and chronically unregistered vehicles, respectively, in the in-use fleet.[3] Only a small number of vehicles were sampled in the roadside pull over studies, however, and this information was collected over a limited geographical area. For EMFAC2000, the DMV-inferred unregistration rate of 7.44% was used for instantaneously unregistered passenger cars and a rate of 0.56% was used for chronically unregistered vehicles based on field study results.

The objective of this program is to obtain a better understanding of the population and use characteristics of unregistered vehicles. The primary component of this study was a statewide field survey conducted to provide an estimate of the State of California unregistered vehicle population. In total, photographic records were obtained for over 120,000 vehicles, including vehicles in every county in the state. This represents the most comprehensive study of vehicle unregistration rates to date and encompasses all regions of the state. In addition to the total unregistration rate, the following information was also sought:

- A breakdown of the time period of unregistration status into instantaneous (less than 3 months), prolonged (3 months to 2 years) and chronic (more than 2 years) categories by county for California.

- Characteristics of unregistered vehicles including, but not limited to, model year, make and fuel type by region or county for California.

- The percentage and identity in each county of non-California vehicles or vehicles which originated out of county.

This paper discusses the preliminary results of this field study based on over 76,000 records that have been analyzed to date.

2.0 Methodology

A comprehensive field survey was conducted to determine the population of unregistered vehicles throughout California. Sampling was conducted in all California counties, with the sampling in each county proportional to the county population. Population data from the 1990 Census was used since the 2000 Census was not yet available. Attempts were made to identify at least 200 vehicles for each county, although for a number of the smaller counties this was not feasible. The minimum number of sites to be sampled for each county was chosen to be 10 to ensure a reasonable distribution of destination types. Table 1 provides the population distribution as well as the minimum number of vehicles to be sampled in each county.

2.1 Site Selection

A critical component of the field survey was the selection of sites. To obtain a demographically representative sample, sampling within each county was resolved to the zip code level. Zip codes for sampling were selected randomly from the list of zip codes for each county. Sampling within zip codes was then proportional to population within the zip code with samples taken at as many sites within the zip code as practical.

Sites for this study were selected in the field and were restricted to destinations rather than residences. This ensured that with a high probability, the vehicles captured in the survey were driven on some regular basis. Safety was also a critical concern in site selection. Local law enforcement agencies were contacted prior to conducting surveys to provide additional guidance in ensuring safety throughout the project. In total, four zip codes were deleted from the sampling plan based on their recommendations. This had negligible impact on the overall statistics obtained from the field study.

2.2 Survey Teams and Field Equipment

Each survey team was composed of a driver and one or two photographers. The two photographer teams were used in high population density areas. The driver was responsible for all sampling related decisions as well as team safety, with identification of alternative sample sites mandatory if a site appeared unsafe.

Data collection was performed using Toshiba M-4 digital cameras. These cameras proved to be efficient and reliable, and most importantly, have a reload time between shots of less than a second. The speed and clarity of the pictures allowed for rapid gathering of data. This was critical to obtain the most robust sample possible and to minimize potential adverse contact with the public. Data was stored on flash ram cards. Cameras were powered by a 12-Volt inverter connected to the cigarette lighter for extended shooting time.

Table 1. Example Field Survey Distribution

County	Population	% of total CA Population	# of vehicles to sample
Los Angeles	8,863,164	29.8%	33,953
San Diego	2,498,016	8.4%	9,570
Orange	2,410,556	8.1%	9,235
Santa Clara	1,497,577	5.0%	5,737
San Bernardino	1,418,380	4.8%	5,434
Alameda	1,279,182	4.3%	4,901
Riverside	1,170,413	3.9%	4,484
Sacramento	1,041,219	3.5%	3,989
Contra Costa	803,732	2.7%	3,079
San Francisco	723,959	2.4%	2,774
Ventura	669,016	2.2%	2,563
Fresno	667,490	2.2%	2,557
San Mateo	649,623	2.2%	2,489
Kern	543,477	1.8%	2,082
San Joaquin	480,628	1.6%	1,841
Sonoma	388,222	1.3%	1,487
Stanislaus	370,522	1.2%	1,419
Santa Barbara	369,608	1.2%	1,416
Monterey	355,660	1.2%	1,363
Solano	340,421	1.1%	1,304
Tulare	311,921	1.0%	1,195
Marin	230,096	0.8%	882
Santa Cruz	229,734	0.8%	880
San Luis Obispo	217,162	0.7%	832
Butte	182,120	0.6%	698
Merced	178,403	0.6%	683
Placer	172,796	0.6%	662
Shasta	147,036	0.5%	563
Yolo	141,092	0.5%	541
El Dorado	125,995	0.4%	483
Humboldt	119,118	0.4%	456
Napa	110,765	0.4%	424
Imperial	109,303	0.4%	419
Kings	101,469	0.3%	389
Madera	88,090	0.3%	337
Mendocino	80,345	0.3%	308
Nevada	78,510	0.3%	301
Sutter	64,415	0.2%	247
Yuba	58,228	0.2%	223
Lake	50,631	0.2%	200
Tehama	49,625	0.2%	200
Tuolumne	48,456	0.2%	200
Siskiyou	43,531	0.1%	200
San Benito	36,697	0.1%	200
Calaveras	31,998	0.1%	200
Amador	30,039	0.1%	200
Lassen	27,598	0.1%	200
Glenn	24,798	0.1%	200
Del Norte	23,460	0.1%	200
Plumas	19,739	0.1%	200
Inyo	18,281	0.1%	200
Colusa	16,275	0.1%	200
Mariposa	14,302	0.0%	200
Trinity	13,063	0.0%	200
Mono	9,956	0.0%	200
Modoc	9,678	0.0%	200
Sierra	3,318	0.0%	200
Alpine	1,113	0.0%	200
Total State Population	29,760,021		116,000

2.3 Data Capture

The digital photographic records were stored on flash media cards during the daily surveys. For locally based teams, the images were downloaded at CE-CERT. For the teams in the field overnight, the flash media cards were downloaded to a laptop computer following the completion of each days sampling. Daily downloading of data and backup onto hard drive storage was part of the quality assurance protocol that governed the fieldwork. For each survey site, records were obtained including the date and time the site was visited and a description of the site and its location such as city, county, as well as zip code.

3.0 Data Processing

To optimize the field surveying time, all photographic records were post processed back at CE-CERT.

3.1 Data Entry

A separate MicroSoft (MS)^{TM} Excel spreadsheet was created for each zip code. The license plate data was entered into an MS^{TM} Excel spreadsheet along with the time and date of collection, driver's name, photographer's name, make of vehicle, location, location description, and ZIP code. Driver name, photographer name, location, location description, and ZIP code were all recorded on the first photograph of each site.

Given the nature of the rapid data collection in the field and the need to get large numbers of records, a percentage of the license plate photographs collected in the field were unreadable. The overall unreadable license plate rate averaged about 15% with a range from 1 or 2 to over 40% in some zip codes. The highest percentages of unreadable license plates were typically at sites surveyed during rain events or near sun-down. The files that were unreadable were simply left out of the spreadsheets since these records did not impact the determination of the unregistered vehicle rate or any other important statistics.

The vehicle make and model were determined for roughly half of the vehicles photographed. This information was primarily collected to estimate the rate of plate switching that might occur in the in-use fleet. While it is not expected that this type of registration cheating is common, it was decided that it could not be ruled out without collecting the observed make and model data on a significant portion of the vehicles.

3.2 Data Validation

Data validation consisted of double entry and cross-checking of a 5% sub-sample of the data. In addition, random spot checks of individual vehicles throughout the data set were conducted during the data entry process. Additional screening of the data will be conducted based on checking for unusual driving distances and for differences between the observed vehicle make/model and the VIN decoded make/model. License plate numbers identified in the screening process are checked by re-examining the photograph

and corrected if necessary. The error rate for license plate numbers was consistently less than 1%.

3.3 *DMV/VIN Decoding*

To determine the characteristics of the unregistered vehicles and determine out of county activity, the database from the field survey was cross-referenced with a DMV vehicle registration (VR) database. The VR reports are produced periodically and contain various types of VR information. For our analysis, the data was reduced to home zip code and vehicle model year, make and model. For this paper, the initial results from the VR database for Riverside County are presented.

4.0 Results

4.1 Observed Data

For this paper, all registration figures are taken from observed data. Future work will include DMV registration status of the vehicles as well. Comparison of the two will be used to establish the percentage of vehicles that may have tags that were not purchased for the observed vehicle.

4.1.1 County Registration Rates

To date, over 76,000 records have been analyzed from the field survey. These data are presented in Table 2 registered and unregistered vehicles categorized based on the photographic evidence collected. For Table 2, "Front" means the vehicle's License Plate Number (LPN) was captured from the front of the vehicle and thus no registration data is available from the picture while "Dealer" indicates the vehicle's LNP was a paper plate or a dealership plate of a newly purchased vehicle used before the issued license plate is received. The category "Unknown" was given to photographed vehicles for which either the picture quality prevented identification of the month if the vehicle had a registration year of 2000 or the year sticker was missing. For this study, a vehicle was considered registered if the year sticker was 2001 and unregistered if the year sticker is 1999 or older regardless of the month. For the vehicles with year 2000 stickers, the month of registration was evaluated against the time period when the vehicle was identified to determine the registration status. The percent unregistered was calculated by dividing the number of unregistered vehicles by the sum of registered vehicles, unregistered vehicles and dealer plates (registration is paid at the time of vehicle purchase, so it was assumed dealer plates are registered vehicles).

Preliminary findings suggest that the overall average unregistration rate in California is near 3.5% with a range of 0 to 6.45 % for different counties. These data are represented in Figure 1 in the form of a histogram of the number of counties with different registration rates. These data show that roughly 50% of the counties have unregistration rates ranging between 2-4%. Nearly all counties had unregistration rates below 5%. The data for the largest counties (population greater than 300,000) is shown separately in Figure 2. In general, the larger counties had a tendency toward higher unregistration rates than the overall distribution, with unregistration rates in larger counties generally ranging from 2-5%.

The counties with registration rates less than 1% were generally smaller counties with sample sizes of less than 500 vehicles. In some small counties, no unregistered vehicles were found in the field data. Alpine has the highest rate of unregistered vehicles at 6.45 %, however this figure may be due in part to the small number of samples that could be obtained in the county. Imperial, Calaveras and Riverside counties have the next highest unregistration rates of 5.37%, 5.22% and 5.13%, respectively.

County	Total	Registered	Unregistered	Dealer	Front	No Plate	Out of state	Unknown state	Unknown	% Unreg
Alameda	3529	2600	95	52	238	1	38	0	505	3.46
Alpine	54	29	2	0	0	0	16	1	6	6.45
Amador	142	118	3	1	8	0	3	0	9	2.46
Butte	561	427	11	3	57	0	9	0	54	2.49
Calaveras	159	127	7	0	10	1	2	0	12	5.22
Colusa	64	53	1	1	2	1	0	0	6	1.82
Contra Costa	2597	1929	42	44	131	3	21	1	426	2.08
Del Norte	234	150	0	1	29	2	30	0	22	0.00
El Dorado	496	379	17	6	33	2	27	1	31	4.23
Fresno	2059	1652	67	33	146	0	2	5	154	3.82
Glenn	132	107	1	0	1	0	0	0	23	0.93
Humboldt	393	288	6	1	37	0	3	0	58	2.03
Imperial	411	234	7	6	34	0	88	0	42	5.37
Inyo	168	130	3	0	11	0	14	1	9	2.26
Kern	1401	1042	46	16	130	1	4	0	162	4.17
Kings	313	204	3	1	23	1	32	3	46	1.44
Lake	153	104	1	1	24	0	3	0	20	0.94
Lassen	125	77	3	0	27	1	3	0	14	3.75
Los Angeles	9324	7209	311	185	702	9	66	29	813	4.04
Madera	323	251	12	3	11	0	6	1	39	4.51
Marin	901	735	13	3	33	1	4	0	112	1.73
Mariposa	155	117	3	1	6	0	2	0	26	2.48
Mendocino	312	242	3	1	26	0	3	0	37	1.22
Merced	699	546	24	7	41	0	12	0	69	4.16
Modoc	56	37	1	0	10	0	1	0	7	2.63
Mono	298	233	5	0	16	0	13	1	30	2.10
Monterey	1218	839	25	17	88	0	36	5	208	2.84
Napa	314	246	8	4	18	0	5	0	33	3.10
Nevada	253	166	5	2	23	0	34	5	18	2.89
Orange	7587	5933	200	153	551	16	115	4	615	3.18
Placer	689	502	16	5	48	0	25	0	93	3.06
Plumas	146	106	2	2	11	0	3	0	22	1.82
Riverside	4262	3026	144	238	94	6	123	20	617	5.13
Sacramento	3337	2573	90	53	233	12	37	3	336	3.31
San Benito	188	142	3	0	8	0	4	5	26	2.07
San Bernardino	4417	3115	117	89	314	11	148	15	608	3.47
San Diego	9584	7226	385	110	708	3	252	17	883	4.15
San Francisco	2840	2154	100	33	226	3	85	6	233	4.37
San Joaquin	1241	885	12	4	102	5	6	22	205	1.33
San Luis Obispo	1057	925	23	3	70	0	15	15	106	2.70
San Mateo	2705	2112	75	35	144	8	60	4	267	3.38
Santa Barbara	1464	1144	37	20	74	0	32	2	155	3.08
Santa Clara	4109	3084	91	74	271	6	43	5	535	2.80
Santa Cruz	484	359	12	4	27	0	7	1	74	3.20
Shasta	471	347	0	5	32	0	13	0	74	0.00
Sierra	36	20	0	0	5	0	6	0	5	0.00
Siskiyou	235	181	0	1	17	0	4	0	32	0.00
Solano	306	226	2	12	23	0	2	1	40	0.83
Sonoma	364	283	8	2	24	0	0	0	47	2.73
Stanislaus	547	448	12	2	37	1	4	5	38	2.60
Sutter	206	161	4	3	10	0	3	1	24	2.38
Tehama	250	185	2	1	23	0	4	0	35	1.06
Trinity	159	116	0	0	14	0	1	0	28	0.00
Tulare	476	360	2	1	15	0	1	7	90	0.55
Tuolumne	145	101	3	0	17	1	4	2	17	2.88
Ventura	2073	1574	61	43	120	1	22	1	251	3.64
Yolo	502	368	16	0	45	1	5	10	57	4.17
Yuba	218	158	3	1	9	1	4	0	42	1.85
Overall	76942	58085	2145	1283	5187	98	1505	199	8546	3.49

Table 2. Registration Rates by County.

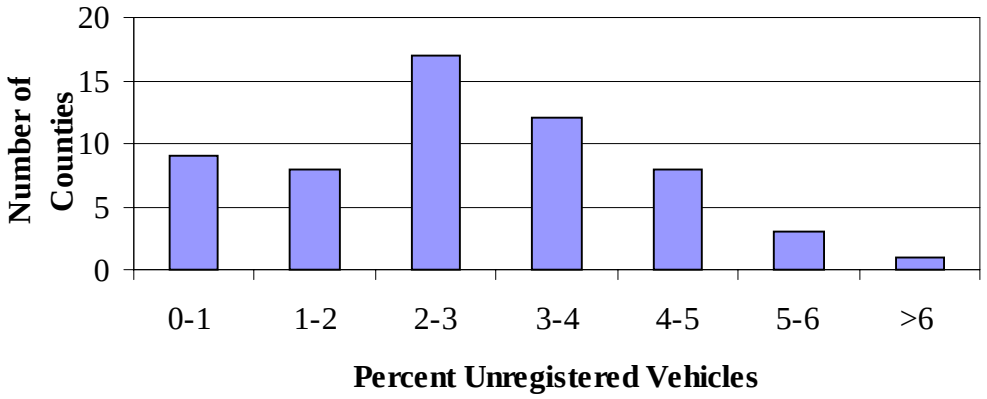

Figure 1. Percent Unregistered Vehicles Histogram by All Counties.

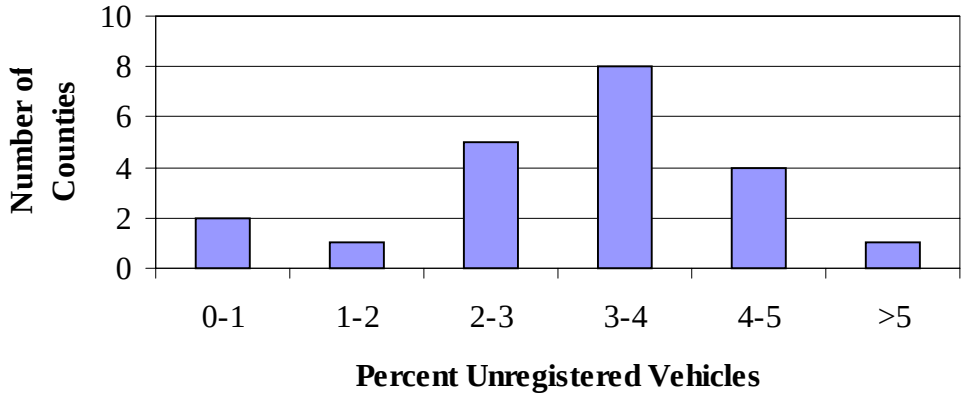

Figure 2. Percent Unregistered Vehicles Histogram by Large Counties.

Figure 3 shows how registration status varies throughout the state. In general, higher unregistration rates were found in Southern California as well as the counties surrounding the Bay Area. It is interesting to note that on a county basis the more rural northern California counties had a lower nonregistration rate than the more urban counties. Areas that only require emissions testing with change of ownership have unregistration rates ranging from 0 to 6.45%. Basic areas that have biennial testing have unregistration rates ranging from 0 to 4.5%. Unregistration rates for areas that are a mixture of enhanced, basic and change of ownership range from under 1% to 5.4%. Overall, there does not seem to be a correlation between smog check areas and registration status.

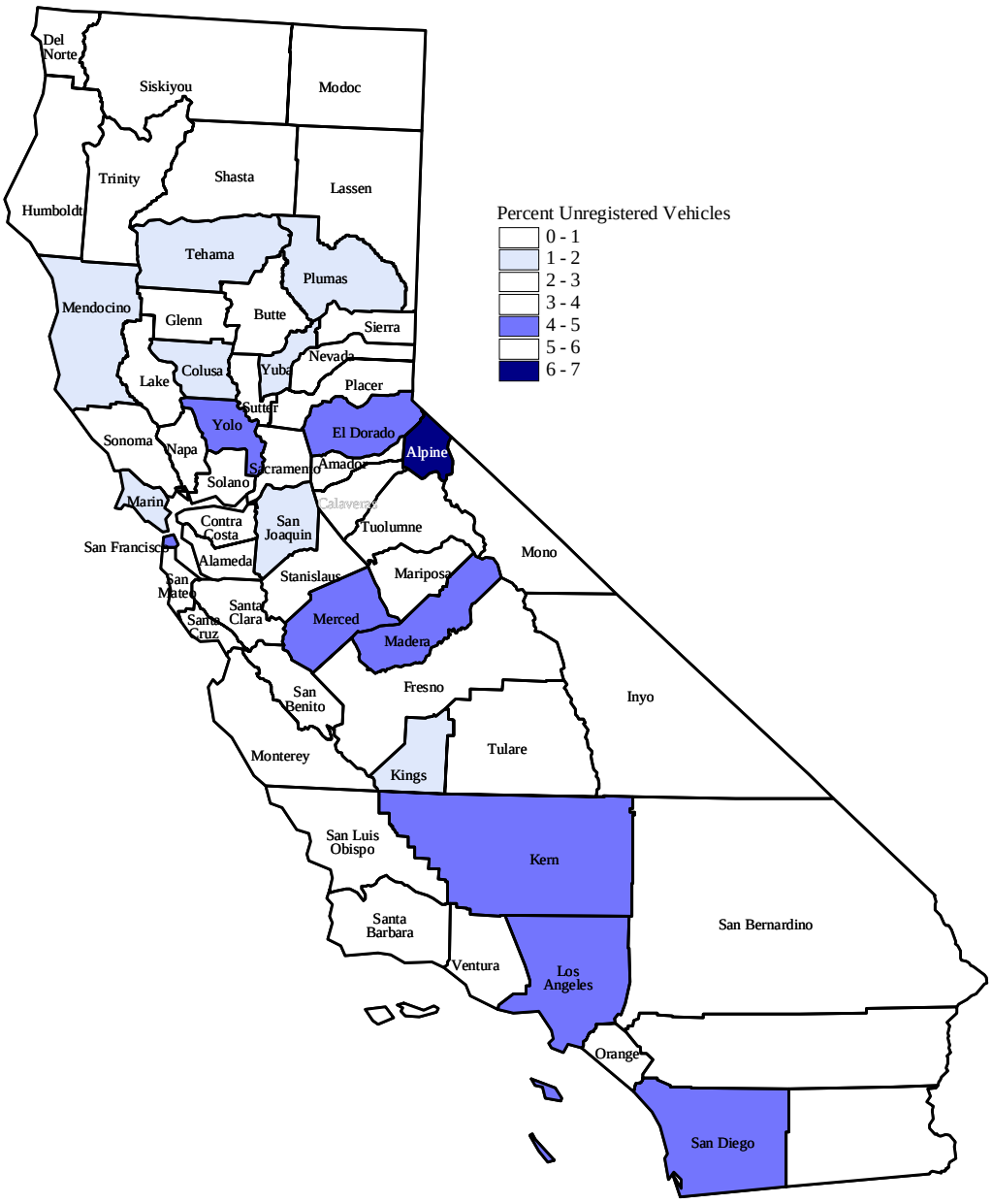

Figure 3. On-Road Registration Status of California Registered Vehicles by County.

The individual zip code data showed a wider range of unregistration rates than the overall county data. Alameda, Fresno, Imperial, Kern, Merced, Placer, Riverside, Sacramento, San Bernardino, San Diego, San Francisco, and San Joaquin counties all had at least one zip code with an unregistration rate above 10%. The highest unregistration rate for a single zip code was found in Kern County, with over 33% of the vehicles captured in that zip code being unregistered. Further investigation of these zip codes will be conducted to evaluate whether specific factors (i.e., socioeconomic data) may contribute to the high unregistration rates. Surprisingly, the highest unregistration rate found to date in Los Angeles County is 6% for a single zip code. Approximately half of the Los Angeles data (> 15,000) is still in the process of being entered, however.

Figure 4 presents the breakdown of the overall 3.49% unregistration rate by the length of time unregistered. 2.44% of the California licensed vehicles were classified as Instantaneous (less than 3 months) unregistered. 1.01% of the California licensed vehicles were classified as Long Term (3 months to 2 years) unregistered while Chronic unregistered accounted for 0.04% of the California licensed vehicles.

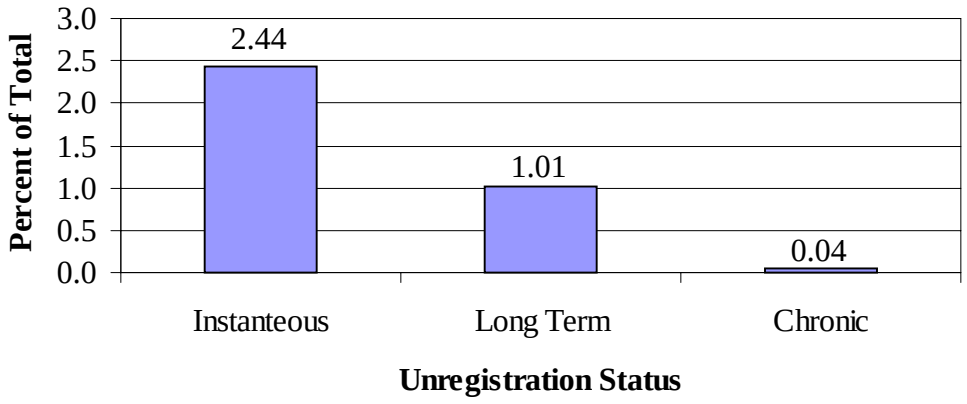

Figure 4. Length of Time for Vehicle Unregistration

4.1.2 Out-Of-State Vehicles

The proportion of out-of-state vehicles varied considerably from county to county as shown in Figure 5. In general, the higher proportions of out-of-state vehicles were found in the border counties and counties having well known tourist attractions. As seen in Figure 5, border counties such as Del Norte, Sierra, Nevada, Alpine, Inyo, and Imperial as well as Kings County in the Central Valley have relatively high proportions (≥ 10%) of out of state vehicles.

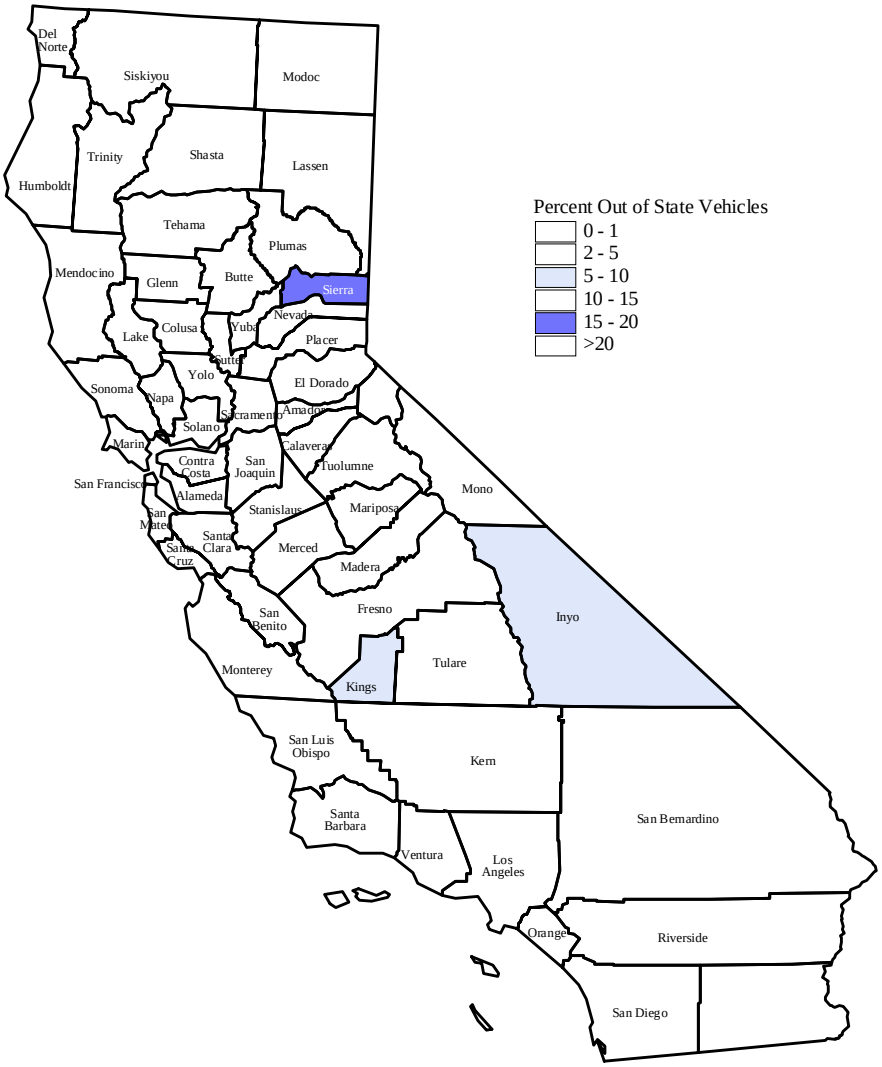

Figure 5. Proportion of Out-of-State Vehicles by County.

4.1.3 Proportion of Missed Vehicles

Taking into account the number of unregistered vehicles and out of state vehicles found in each county, the percent of vehicles that would not be accounted for in a typical inventory based on DMV registered vehicle data was calculated. These results are presented in Figure 6. These results show that in general, the percentage of vehicle not accounted for by DMV registration is typically 10% or less.

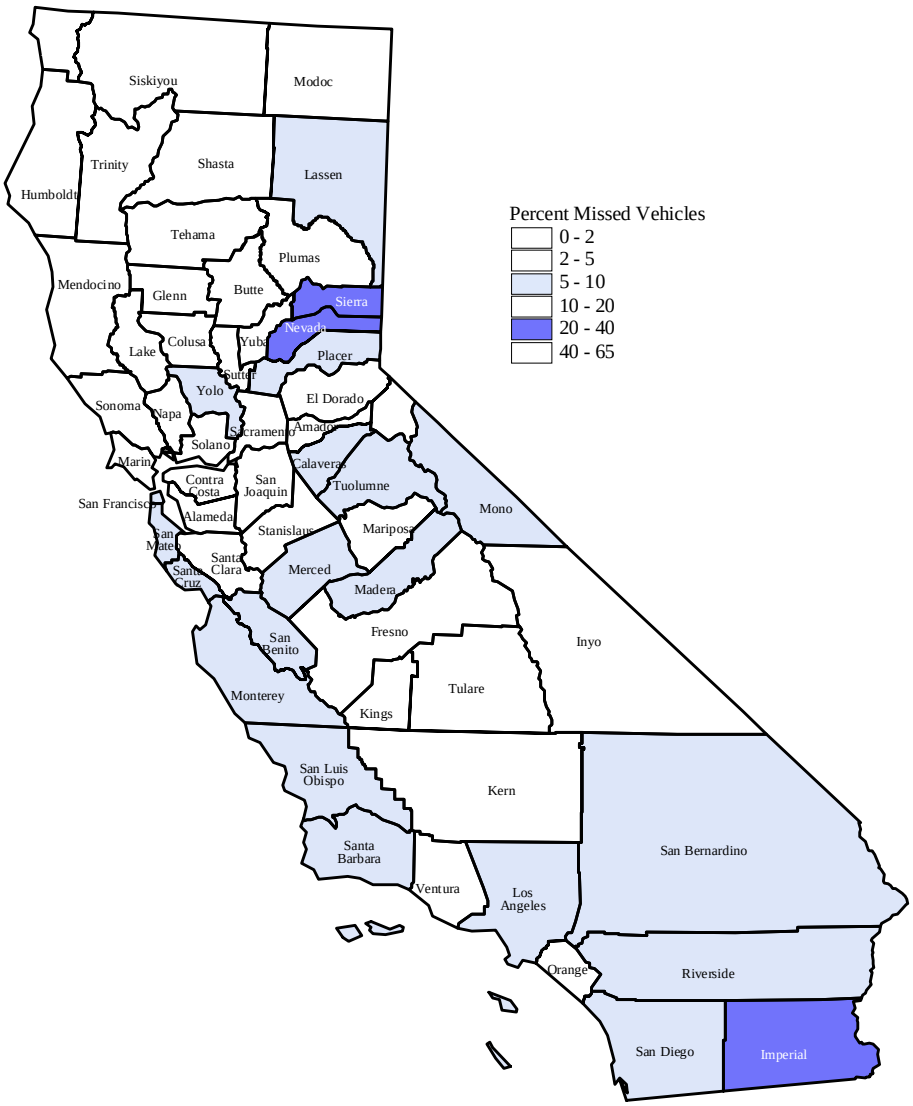

Figure 6. Proportion of Missed Vehicles by County.

4.2 Riverside DMV Data

The Riverside county license plates were VIN decoded to obtain the model year and home zip code of the vehicles. This data was used for the analysis in the following sections.

4.2.1 Vehicle Characteristics

The license plate data collected for Riverside County was run through the DMV database. The resulting database was cross-tabbed with the observed data to obtain model year data for all vehicles having readable California license plates. A model year distribution was created for all the collected vehicles in Riverside County, and presented in Figure 7. The model year distribution is heavily weighted to newer vehicles, as expected. It is likely that the majority of the paper dealer plates are 1999 and 2000 model year vehicles.

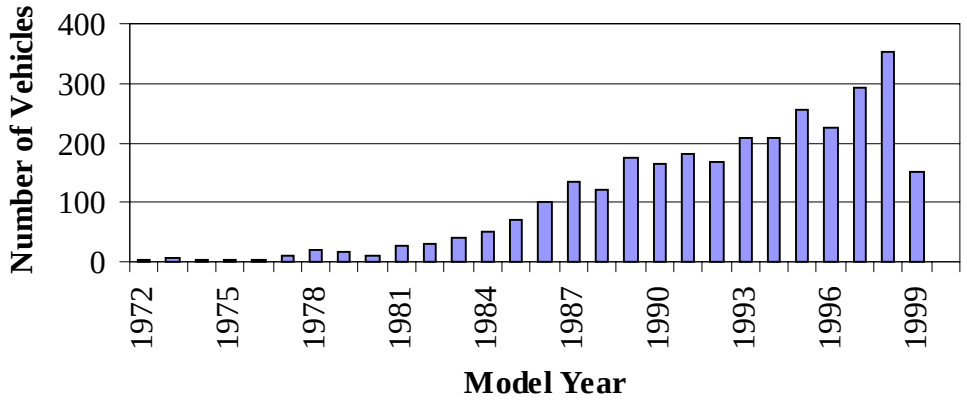

Figure 7. Model Year Histogram for all Vehicles Found in Riverside County.

The model year histogram for long term (>3 months, <2 years) and chronic (>2 years) unregistered vehicles is shown in Figure 8 as total number of unregistered vehicles found in Riverside County and Figure 9 shows the percent unregistered of the total found relative to the number in the model year category. Comparison of these Figures with Figure 7 shows that, unlike the vehicle population as a whole, the unregistered vehicle population is heavily weighted to the older model years. These results are consistent with unregistered vehicles being older and high emitter vehicles that would make a disproportionate contribution to the emissions inventory.

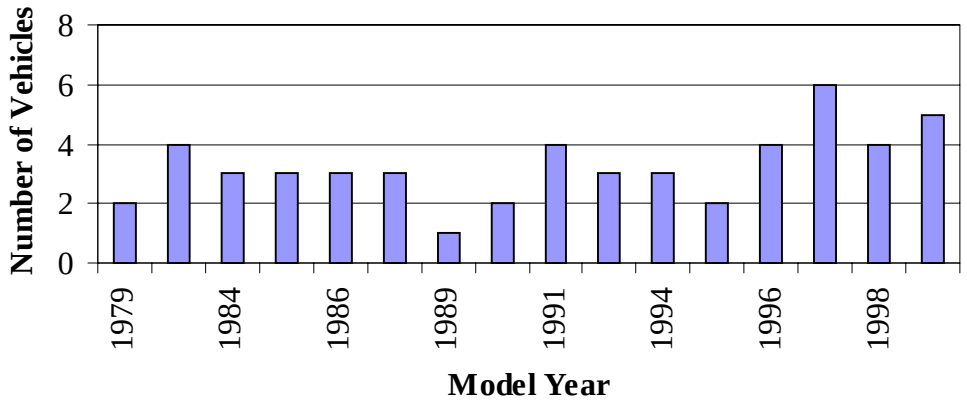

Figure 8. Number of Unregistered Vehicles > 3 Months Found in Riverside County.

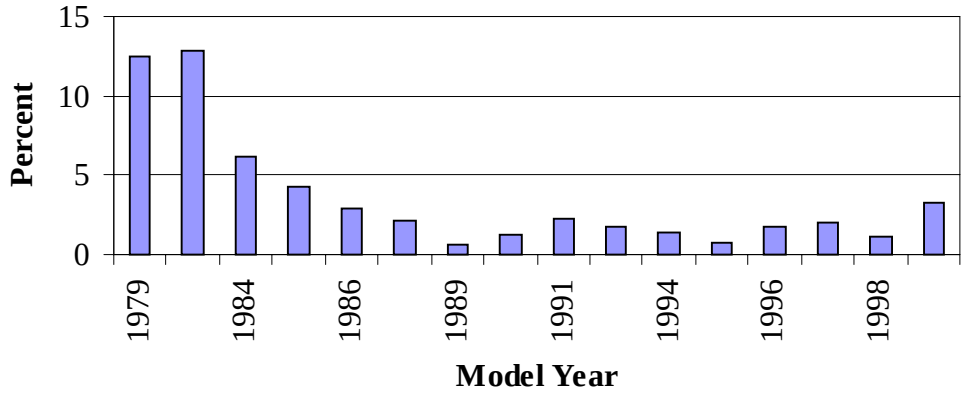

Figure 9. Percent of Unregistered Vehicles > 3 Months of Total Vehicles in Model Year for Riverside County.

5.0 Conclusions

A preliminary estimate of approximately 3.5% for the vehicle unregistration rate was obtained based on analysis of over 76,000 vehicle records collected in a field study in California. This included vehicles unregistered for a period of less than 3 months (2.44% of total), vehicles unregistered between 3 months and 2 years (1.01% of total), and vehicles unregistered for more than 2 years (0.04% of total).

About half of the counties had unregistration rates between 2-4%, with most counties having unregistration rates below 5%. In general, the larger counties (population greater than 300,000) had a tendency toward higher unregistration rates than the overall distribution, with unregistration rates in larger counties generally ranging from about 2-5%. Counties near the state border and those having well known tourist attractions also tended to have higher proportions of out of state vehicles.

For Riverside Country, the model year distribution for the total in-use fleet (registered and unregistered) was heavily weighted to newer vehicles. The unregistered vehicle population, on the other hand, had a significantly higher contribution from vehicles with older model years in comparison with the overall fleet. These results are consistent with unregistered vehicles being older and high emitter vehicles that would make a disproportionate contribution to the emissions inventory.

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6.0 References

1. Hunstad, Lyn, (1999) Estimating Uninsured Vehicle and Unregistered Vehicle Rates: Sensitivity to Data and Assumptions. Report by California Department of Insurance, July.

2. California Air Resources Board. (2000) Technical Support Document for a Public Meeting to Consider Approval of Revisions to the State's On-Road Moto Vehicle Emissions Inventory. May.

3. Dulla, R.D., Horie, Y., and Sidawi, S. (1991), Unregistered Vehicle Study – Field Study and Analysis. Report prepared for the California Air Resources Board (Contract No. A866-163) by Sierra Research, Sacramento, CA.