USE INFORMATION AND AIR MONITORING RECOMMENDATIONS FOR THE PESTICIDE ACTIVE INGREDIENT DIAZINON

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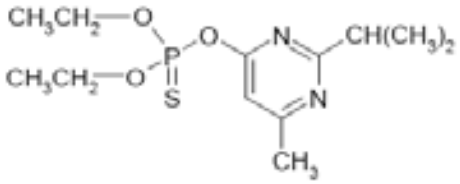
A. BACKGROUND

This recommendation contains general information regarding the physico-chemical properties of the pesticide active ingredient diazinon and its reported historical use in California. The Department of Pesticide Regulation (DPR) provides this information to assist the Air Resources Board (ARB) in their selection of appropriate locations for conducting pesticide air monitoring operations.

Table 1. The physico-chemical properties of diazinon

Property	Information
Chemical Name	O,O-Diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate
Chemical Formula	$C_{12}H_{21}N_2O_3PS$
Chemical Structure	
Molecular Weight	304.35
CAS Registry	333-41-5
Color	Colorless
Physical State	Liquid
Odor	Faint ester-like odor
Solubility	40 mg/l @ 20° C
Log K_{ow}	3.81
Log K_{oc}	1.602 –2.635
Vapor Pressure	$9.01X10^{-5}$ mm Hg @ 20° C $1.1X10^{-3}$ mm Hg @ 40° C
Henry's Law Constant	$1.17\ X10^{-7}$ atm-m^3/mol
Data Source	Agency for Toxic Substances and Disease Registry (ATSDR, 2008)

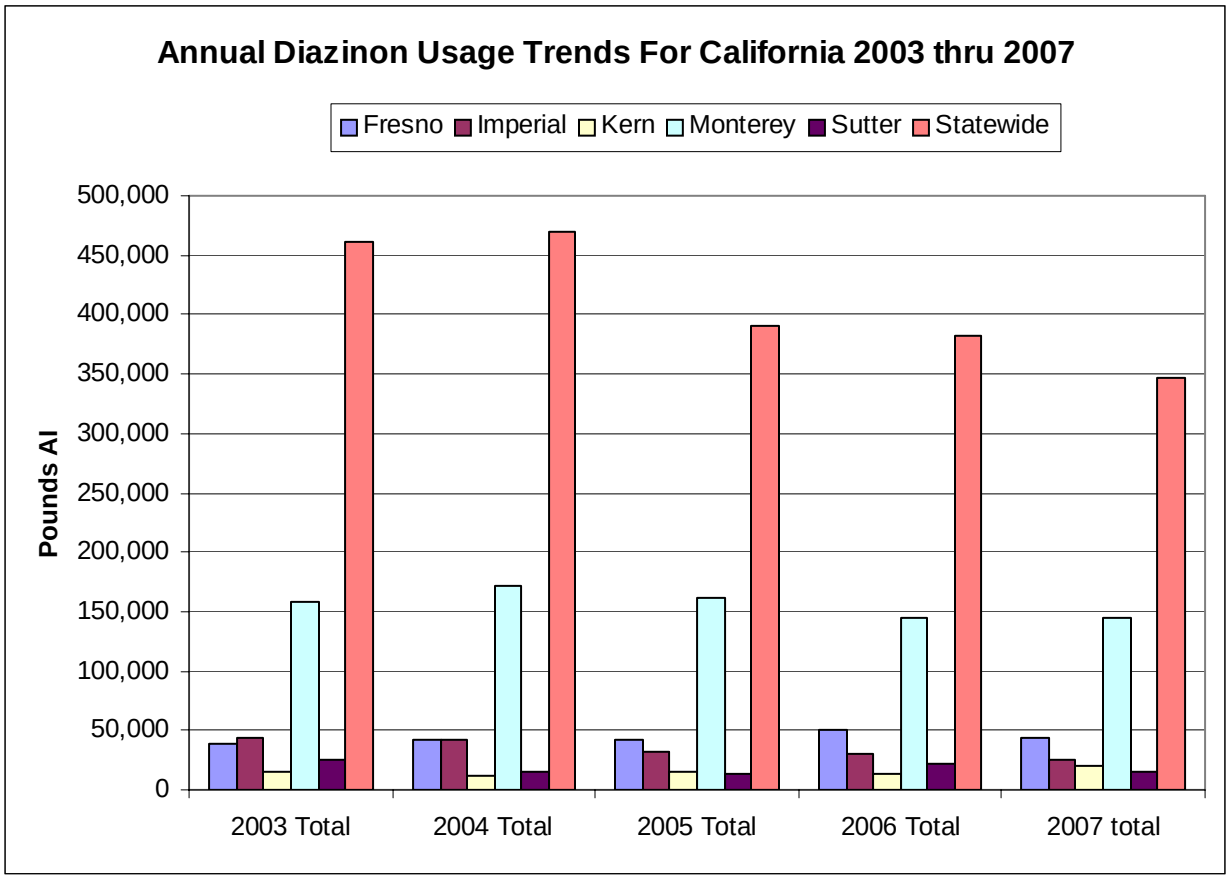
† Disclaimer: The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

Diazinon is an organophosphate pesticide. The environmentally important physico-chemical properties of diazinon are listed in table 1. It is moderately toxic to humans and laboratory animals. The principle toxic effect of diazinon is the inhibition of acetylcholinesterase (AchE). The inhibition of AchE leads to both central nervous system and neuromuscular dysfunction. The toxic effects of diazinon are reversible and tend to dissipate after exposure ceases (ATSDR, 2008). The primary atmospheric degradate of diazinon is diazoxon. It has been suggested that diazoxon is at least as toxic as the parent product to humans and birds (EPA, 1999).

B. CHEMICAL USES IN CALIFORNIA

Agricultural usage data for diazinon in California for the years 2003 through 2007 were extracted from the Pesticide Use Reporting Database (PUR) maintained by the Department of Pesticide Regulation (DPR). During this five-year period 2,205,691 pounds of diazinon were used statewide. There was diazinon use reported in 47 of California's 58 counties. Marin County had the lowest reported usage of less than one pound over the period. Monterey County reported usage of 776,238 pounds, which was the highest of any county within the state. The five counties with the highest usage of diazinon over this period, from high to low, were Monterey, Fresno, Imperial, Sutter and Kern (table 2). Taken together they accounted for 63 percent of the statewide usage (CDPR, 2009).

Figure 1. Trends in diazinon usage from 2003 through 2007

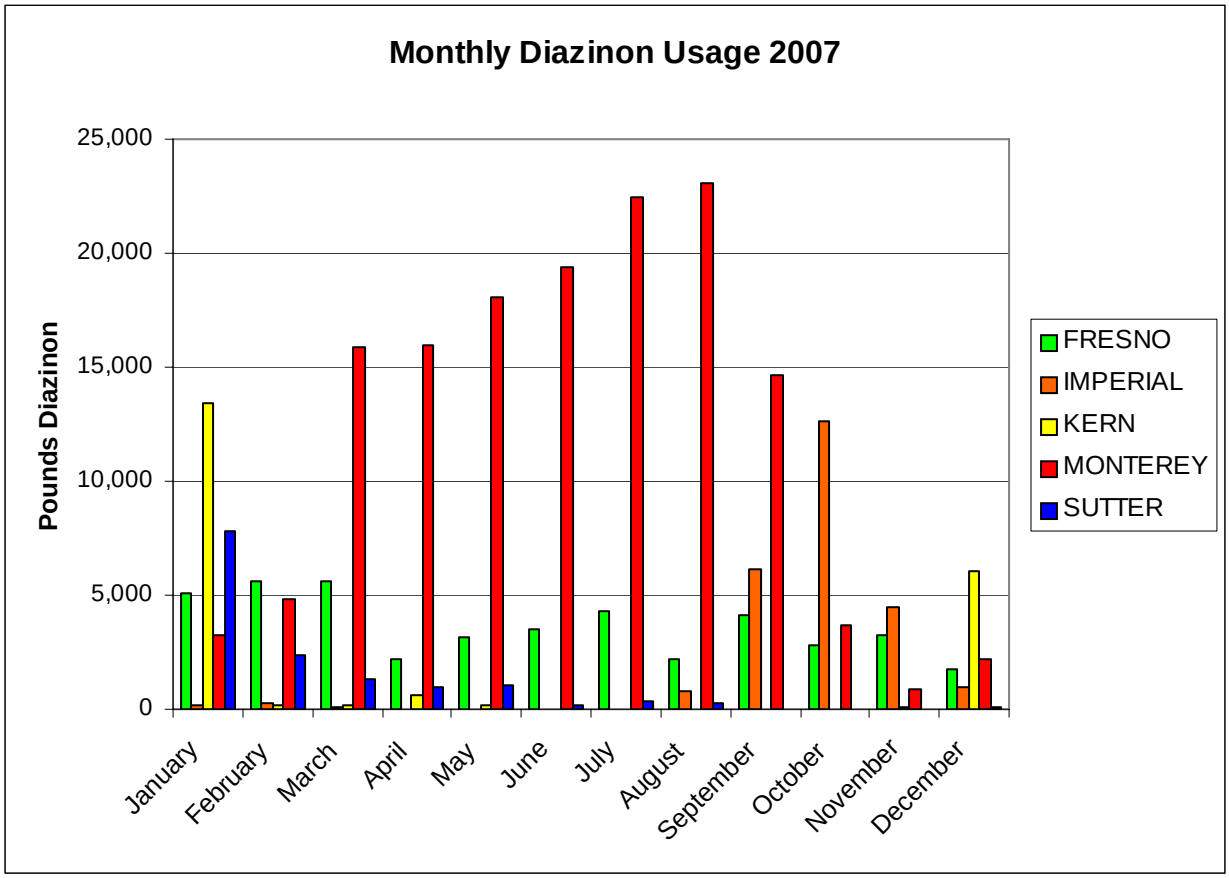


It can be seen from figure 1 that statewide diazinon usage showed a downward trend from 2003 through 2007. While the statewide usage dropped by approximately 23 percent, usage within the top five counties remained relatively flat. The monthly usage patterns (figure 2) vary considerably across the top five counties. Monterey County shows some usage every month with peak usage occurring during the summer months. Fresno County also shows a year-round usage pattern, but the pattern reveals no distinct seasonality. Imperial County shows peak usage during the fall months with very little used at other times. Sutter County is dominated by winter usage with little or no usage the rest of the year. The Kern County usage pattern is similar to that of Sutter County.

Table 2. Top five counties for diazinon use during the years 2006 and 2007

County	2006 Diazinon Use (lbs)	2007 Diazinon Use (lbs)	Statewide Ranking
MONTEREY	144,306	144,376	1
FRESNO	51,231	43,683	2
IMPERIAL	30,752	25,556	3
SUTTER	21,605	14,463	4
KERN	13,424	20,667	5

Figure 2. Monthly diazinon usage within the top five California counties



The seasonal distribution of usage within the different counties can be explained by climate and cropping patterns. Monterey County has a cool coastal climate that allows the growth of greens and crucifers year round with peak growth during the summer months. Head and leaf lettuce dominate diazinon usage in Monterey County. Fresno County has a cool wet climate in the winter and a hot dry climate in the summer. The dominant use of diazinon during the winter months is the dormant season spraying of peaches and plums with leaf lettuce dominating in the summer. The climate in Imperial County is very hot and dry in the summer and warm and dry in the winter. The predominant use of diazinon in Imperial County is on broccoli and head lettuce during the winter months. Sutter County has hot dry summers and cool wet winters. Diazinon usage is dominated by dormant season spraying of peaches and prunes. The climate in the agricultural areas of Kern County is similar to that of Fresno County. Virtually all diazinon used in Kern County is applied to almonds during the dormant season. Figures 3 through 7 illustrate the diazinon use patterns for each of the top five counties during 2006.

C. APPLICATION SITE AIR MONITORING RECOMMENDATIONS

Within the five counties showing the highest diazinon use in California during the period from 2003 through 2007 there are two distinctly different application scenarios. The greatest amount of diazinon was applied to row crops, with lettuce being the dominant crop. Diazinon is generally applied to these crops with a ground sprayer. According to the DPR PUR diazinon was applied to these crops at a rate of approximately one-half pound AI per acre. The next greatest amount of diazinon was applied to orchards of stone fruit trees. Orchards are sprayed with air blast sprayers—a method known to be more drift prone than any other. Diazinon was applied to these orchard crops at approximately two pounds per acre and is applied during the dormant season. The combination of a higher application rate and a high-drift application method indicates that application site air monitoring should be done at an orchard. Three of the top five diazinon usage counties experience dormant season orchard spraying: Sutter County, Kern County and Fresno County. It is suggested that the monitoring be performed in one of these counties. Application sites range from 10 acres to approximately 600 acres with a median size of approximately 100 acres. Ideally, application to an orchard of approximately 100 acres should be monitored. If this is not feasible a smaller site is acceptable, but should be at least 10 acres in size. Plots of the cumulative distribution functions, and quantiles for both “acres treated” and “application rate” across all diazinon applications in the top five counties for the years 2006 and 2007 are shown in tables 3 and 4. Figure 4 shows a map of Fresno County illustrating the spatial diazinon use distribution for 2007. Figure 6 shows the same for Sutter County and figure 7 is for Kern County. DPR recommends coordination with the county agriculture commissioner while selecting the best site. If the site is on private property permission must be obtained from the owner before sampling.

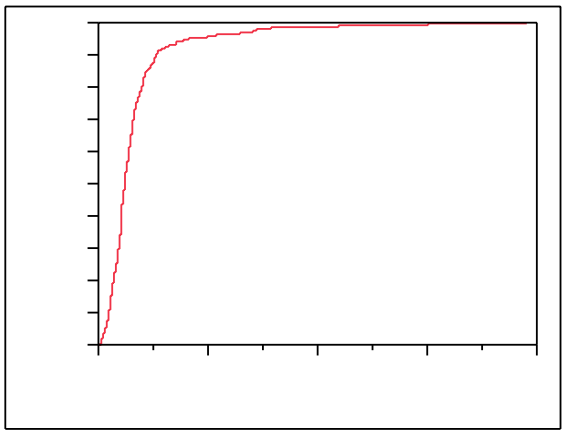
DPR requests that ARB monitor for diazinon and its oxygen-analog, diazoxon. The required environmental quantization level (EQL) is 13 ng/m^3. Please note that the required EQL is one-tenth of the acute screening level for diazinon.

DPR requests that the application air monitoring be performed twice—once during the dormant season and again during the summer (Reardon, 2009). Both application air-monitoring studies should be completed at the same location. Both studies should use the same application rate and the same or similar application equipment. The sampling schedule and reporting requirements

are the same for both studies. Label restrictions prevent both dormant and summer applications to almonds—only dormant applications are allowed. Also be aware that it was not a common practice to spray diazinon during the dormant season and during the summer (on any orchard crops) in the years from 2003 through 2007. Application-site monitoring of a summer orchard application can be dropped if a suitable orchard cannot be located. In this event, ARB staff should notify DPR and include a short description of the attempts to locate a summer orchard site.

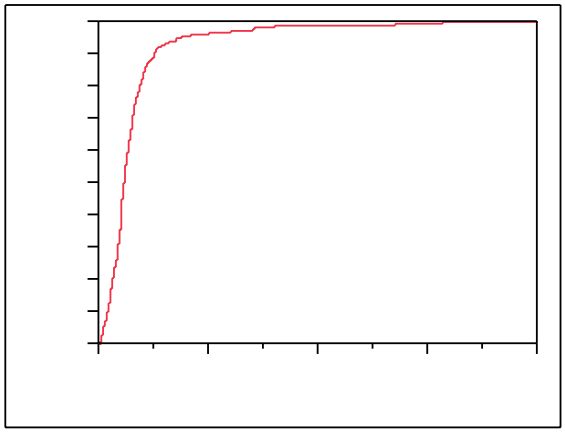
Table 3. Cumulative distribution function plots and quantiles for "acres treated" for the years 2006 and 2007.

Cumulative Distribution Function	Quantiles



Acres Treated 2006

100.0%	maximum	195.00
99.5%		140.00
97.5%		70.00
90.0%		25.90
75.0%	quartile	17.00
50.0%	median	11.50
25.0%	quartile	7.70
10.0%		4.20
2.5%		1.50
0.5%		0.50
0.0%	minimum	0.10



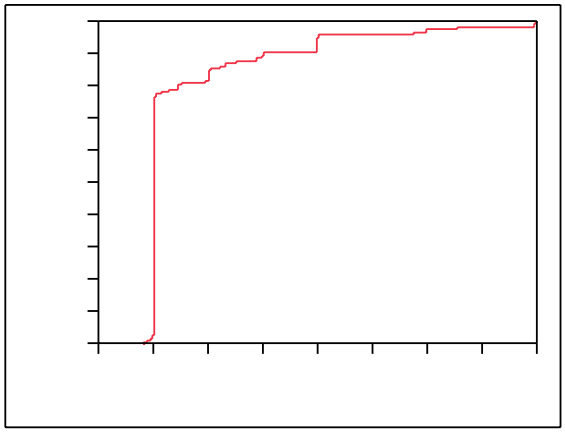
Acres Treated 2007

100.0%	maximum	619.00
99.5%		152.00
97.5%		70.00
90.0%		25.00
75.0%	quartile	16.60
50.0%	median	11.23
25.0%	quartile	7.50
10.0%		3.80
2.5%		1.08
0.5%		0.50
0.0%	minimum	0.09

A minimum of eight samplers should be placed around the application site—one at each corner and one midway along each side. A ninth sampler should be collocated as a replicate. The samplers should be placed within twenty meters of the orchard. Air samples should be taken before, during and after application and during three Daytime/Overnight sampling periods thereafter. The required sampling schedule is given in table 3. Field blanks should be prepared in the laboratory and ran in the field with the samples for quality control purposes.

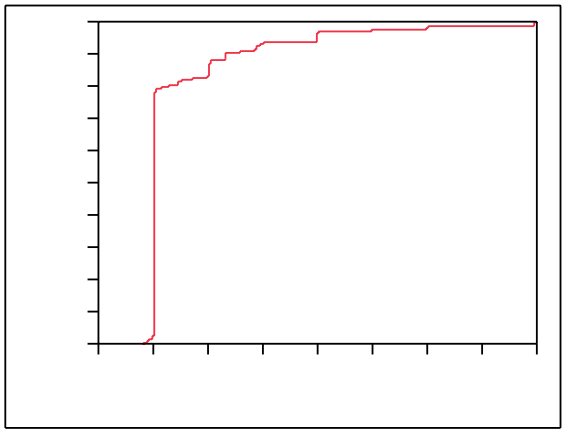
Table 4. Cumulative distribution function plots and quantiles for “application rate” for the years of 2006 and 2007.

Cumulative Distribution Function	Quantiles



Application Rate 2006

100.0%	maximum	4.0000
99.5%		3.9688
97.5%		2.9788
90.0%		1.4945
75.0%	quartile	0.5019
50.0%	median	0.4980
25.0%	quartile	0.4961
10.0%		0.4956
2.5%		0.4900
0.5%		0.4141
0.0%	minimum	0.4000



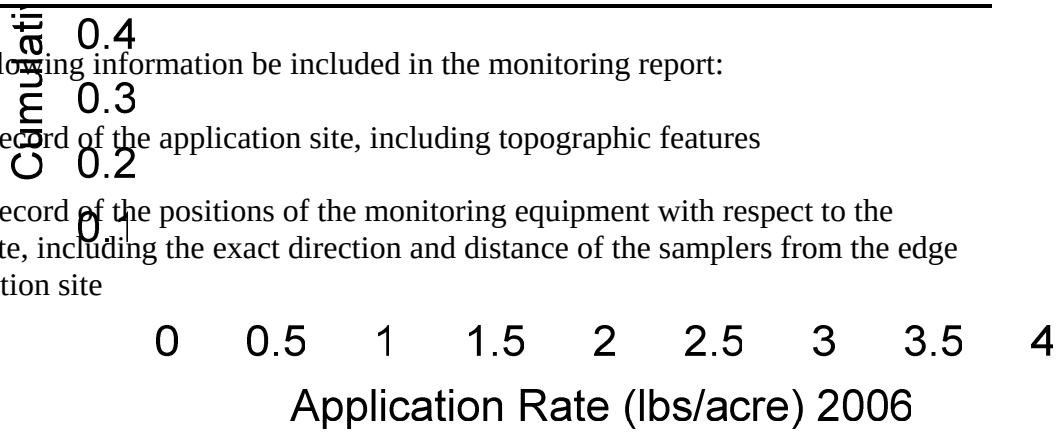
Application Rate 2007

100.0%	maximum	3.9984
99.5%		3.9688
97.5%		2.4805
90.0%		1.1440
75.0%	quartile	0.5000
50.0%	median	0.4974
25.0%	quartile	0.4961
10.0%		0.4954
2.5%		0.4874
0.5%		0.4163
0.0%	minimum	0.4000

DPR requests the following information be included in the monitoring report:

1) An accurate record of the application site, including topographic features

2) An accurate record of the positions of the monitoring equipment with respect to the application site, including the exact direction and distance of the samplers from the edge of the application site



3) An accurate record of pesticide application, including application dosage or quantity of pesticide applied, application starting and ending time, method and application rate, etc.

4) An accurate drawing of the monitoring site showing the precise location of the meteorological equipment, trees, buildings, and other obstacles with respect to North (identified as either true or magnetic North)

5) Meteorological data collected at 1-minute intervals including wind speed and direction, humidity, air temperature, and comments regarding degree of cloud cover. If available, atmospheric pressure and solar radiation would also be useful.

Table 5. Sampling schedule for application air monitoring

Sample period:	Sample period duration:
Background	Minimum 12-24 hours pre-application
Application	Start of application until 1 hour after end of application
Post Application	One hour after end of application until one hour before sunset
First Overnight[1]	One hour before sunset until one hour after sunrise
Second Daylight	One hour after sunrise until one hour before sunset
Second Overnight	One hour before sunset until one hour after sunrise
Third Daylight	One hour after sunrise until one hour before sunset
Third Overnight	One hour before sunset until one hour after sunrise

[1] All overnight samples must include the period from 1 hour before sunset to 1 hour after sunrise

D. AMBIENT AIR MONITORING RECOMMENDATIONS

Ambient air monitoring was not originally requested. However, if resources allow an ambient monitoring study will provide valuable data, and it is likely that DPR will request an ambient study for 2010. DPR recommends ambient air monitoring of diazinon and diazoxon in rural communities to address the environmental risk factors that impact children's health.

Because they are generally located closer to agricultural fields, California rural communities may have higher concentrations of diazinon in ambient air compared to urban communities. The

selection of communities to be monitored is based on objective data, using criteria that can be quantified, validated and verified. This provides a more transparent and fair selection process. Analysis of diazinon usage in California for the five-year period from 2003 through 2007 revealed the top five counties to be: Monterey, Fresno, Imperial, Sutter and Kern. DPR selected 81 communities located within the five counties for evaluation based on their proximity to diazinon applications. The communities are identified by name in the 2000 U.S. Census and are also included in a geospatial dataset distributed by the U.S. Census Bureau for use in a Geographic Information System (GIS).

Each of the 81 communities were ranked based upon factors contained within the following categories and subcategories:

- Census factors
    - Population density of children (less than 18 years of age)
    - Median family income
    - Hispanic population percentage
    - Non-white population percentage
- Pesticide use factors
    - Regional (within 5 miles) use density of diazinon during 2006
    - Local (within 1 mile) use density of diazinon during 2006
    - Regional (within 5 miles) use density of diazinon during 2007
    - Local (within 1 mile) use density of diazinon during 2007

Most of the subcategory rankings are based on density or percentage in an attempt to avoid biasing the results toward large communities. All pesticide usage is calculated as pounds of diazinon per square mile. Population of children is also calculated as an area density—the number of children divided by the area of the community. Both Hispanic population and non-white population are given as simple percentages of total community population. Median family income is the only factor that is used as given in the census data.

Each of the communities was ranked in descending order by median family income and in ascending order by population density of children, Hispanic population percentage and non-white population percentage. The resulting ranks were combined and divided into four rank categories—the census rank.

A GIS was used to create two buffer zones around the boundaries of each community. One buffer zone encompassed all of the area within one mile of the community boundary. The second buffer zone encompassed all of the area within five miles of the community boundary. The diazinon usage within each buffer zone was summed and divided by the area of the zone to yield diazinon use density. Both local (1 mile) and regional (5 mile) diazinon use density was calculated for 2006 and separately for 2007. Community diazinon use density was ranked in ascending order for each of the four pesticide use factors. The resulting ranks were combined and divided into four rank categories—the pesticide rank.

The census rank and the pesticide rank were combined and divided into four rank categories. This ranking system gives equal weight to each of the eight factors. This ranking system gives high rankings to communities with low median family income, high Hispanic population percentage, high non-white population percentage, high population density of children and high

local and regional diazinon use. In addition a rank of zero was assigned to any community that was considered that had no diazinon use within five miles of its boundary in either 2006 or 2007. The community rankings are shown along with the county diazinon usage patterns in figures 3 through 7.

Of the 81 communities considered 16 were assigned ranks of four (table 4), of these 15 communities, 11 are located within the Salinas Valley in Monterey County. It is suggested that the Salinas Valley would be an appropriate area in which to perform ambient air monitoring. Six sampling locations (5 air monitoring locations and 1 urban background location) should be selected in relatively high-population areas or in areas frequented by people (e.g., schools and other public buildings). The background sampling location should be distant to applications of diazinon. DPR recommends close coordination with county agriculture commissioners, local school districts and state/local fire jurisdictions to select the best sampling locations. The ambient air monitoring should be performed over an 8-week period during the months of highest diazinon use—May, June, July and August. At each sampling location, four 24-hour samples should be collected per week during the sampling period. The EQL given for application monitoring (13 ng/m^3) is appropriate for ambient monitoring as well.

Table 6. Communities with rankings of four (highest ranking)

Community	County	Census Rank	Pesticide Rank
Boronda	Monterey	3	4
Calwa	Fresno	4	3
Castroville	Monterey	4	4
Chualar	Monterey	3	4
Gonzales	Monterey	3	4
Greenfield	Monterey	4	4
Heber	Imperial	4	3
Huron	Fresno	4	3
King City	Monterey	3	4
Las Lomas	Monterey	3	4
Live Oak	Sutter	3	4
Pajaro	Monterey	4	4
Parlier	Fresno	4	3
Salinas	Monterey	3	4
Sanger	Fresno	4	3
Soledad	Monterey	3	4

Figure 3. Map of Monterey County 2007 diazinon usage with the combined 2006 - 2007 environmental justice community rankings

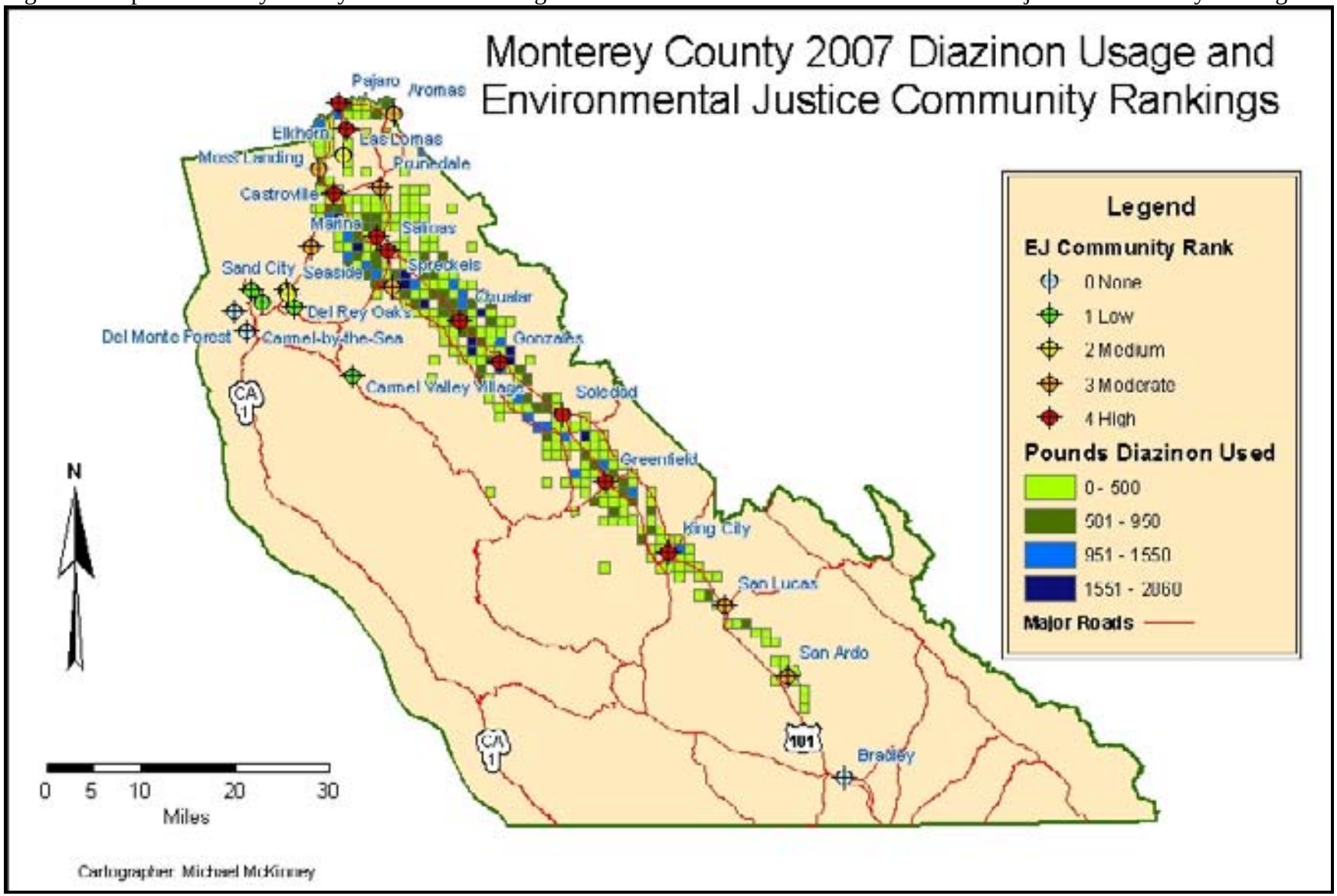


Figure 4. Map of Fresno County 2007 diazinon usage with the combined 2006 - 2007 environmental justice community rankings

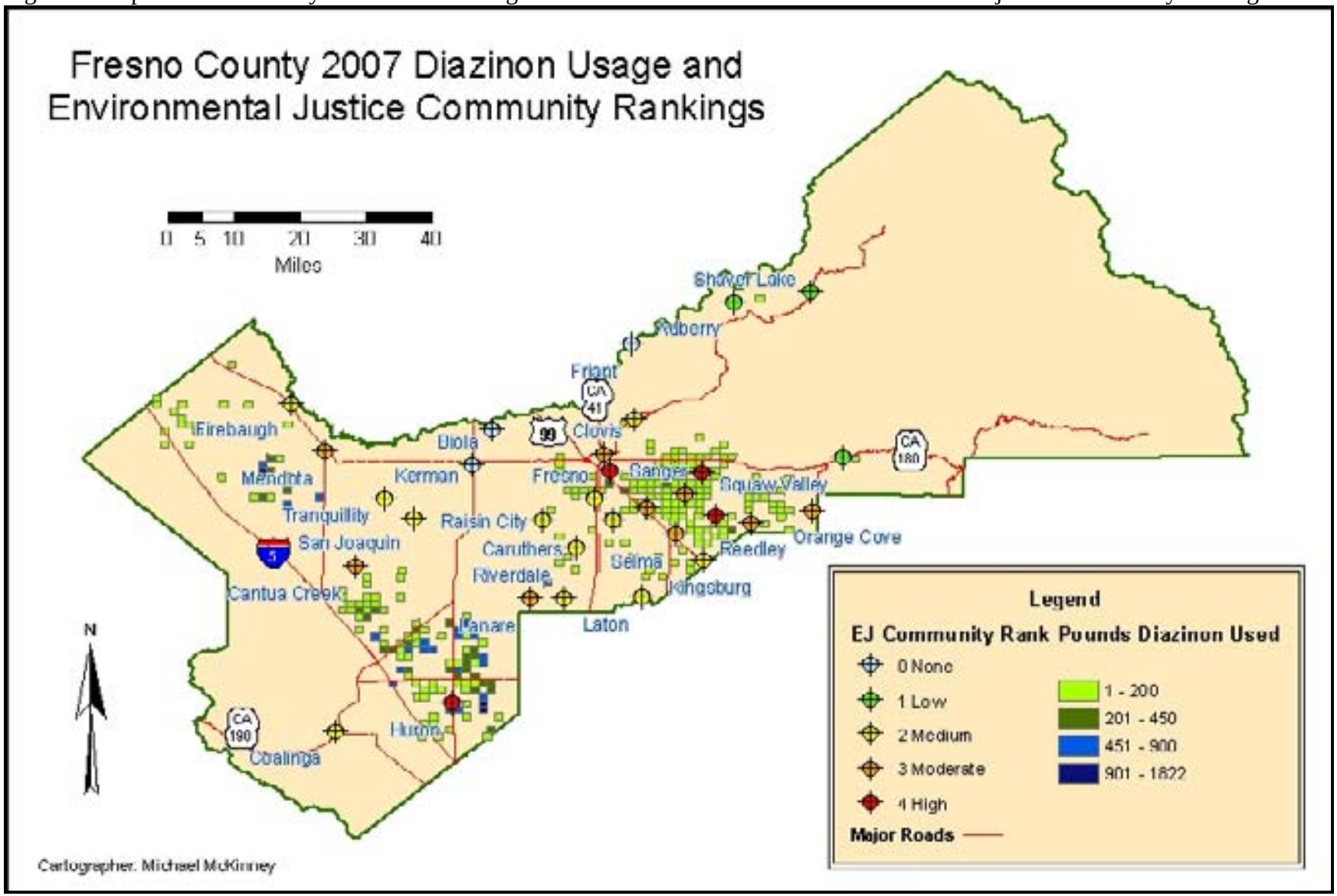


Figure 5. Map of Imperial County 2007 diazinon usage with the combined 2006-2007 environmental justice community rankings

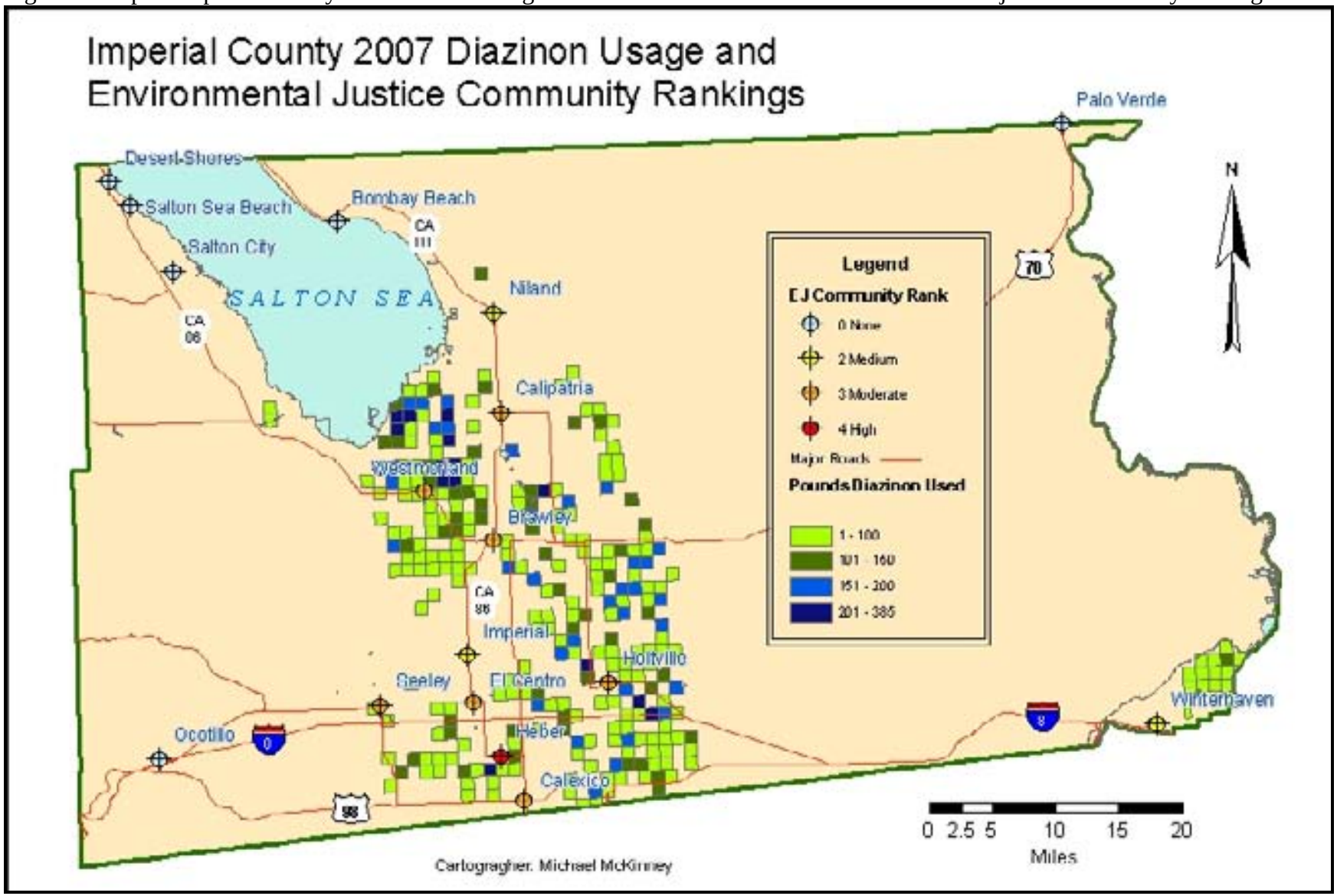


Figure 6. Map of Sutter County 2007 diazinon usage with the combined 2006-2007 environmental justice community rankings

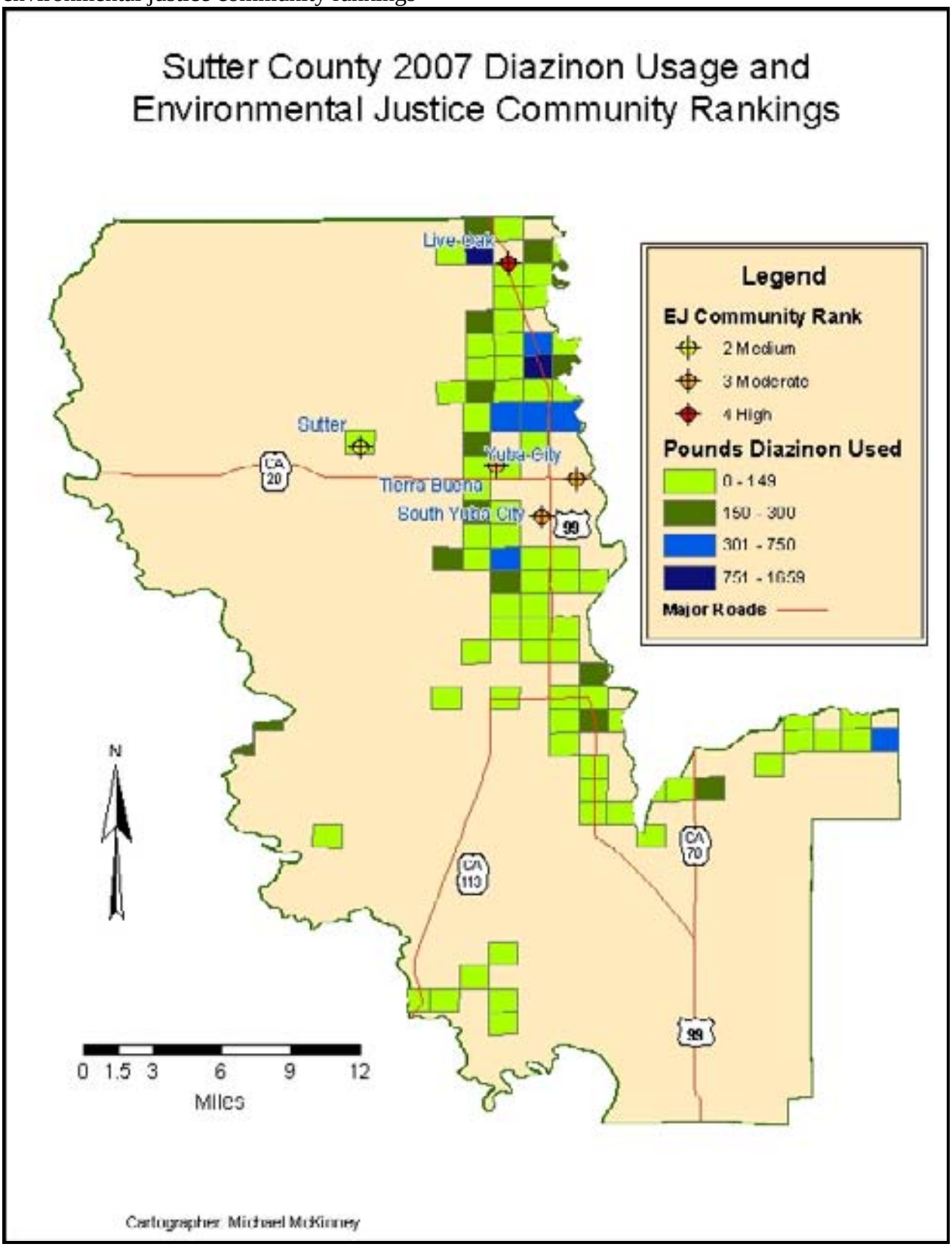
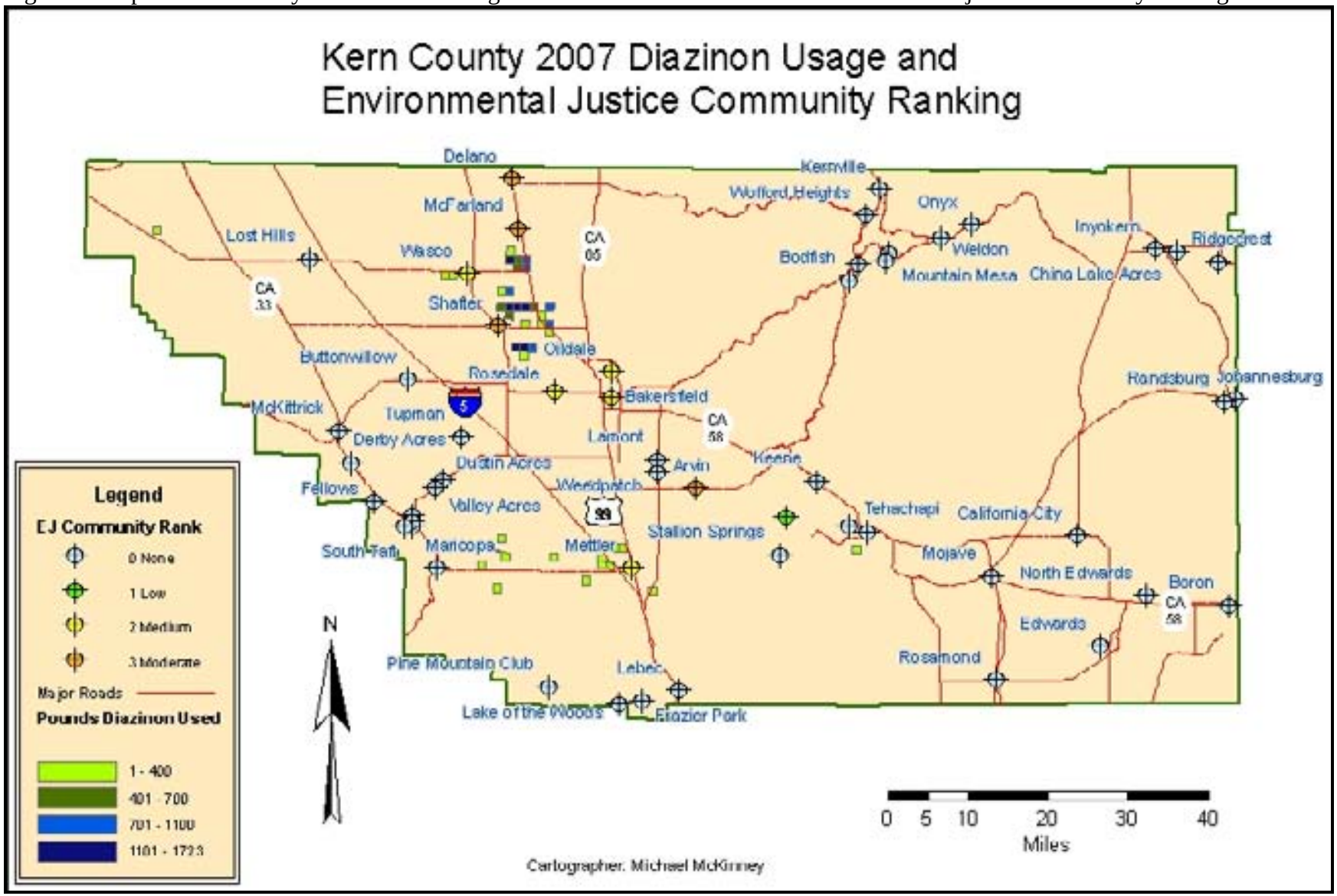


Figure 7. Map of Kern County 2007 diazinon usage with the combined 2006-2007 environmental justice community rankings



E. SAFETY CONSIDERATIONS

Diazinon products carry the signal word caution. Diazinon can enter the body through ingestion, inhalation or dermal absorption. Symptoms of high exposure to diazinon include headache, dizziness, weakness and blurred vision. Exposure to very high levels of diazinon can lead to more severe symptoms, including: nausea, vomiting, diarrhea, difficulty breathing and passing out (ATSDR, 2008).

Mixers, loaders and applicators are required to wear personal protective equipment (PPE) including a long sleeved shirt, long pants, shoes with socks and chemical resistant gloves. Gloves such as barrier laminate, butyl or nitrile rubber and viton are acceptable. All gloves should be at least 14 mils thick. All protective clothing should be washed separately from other laundry. Any protective clothing that becomes drenched or otherwise contaminated with diazinon should be discarded.

REFERENCES

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