Agricultural Pesticide Use Near Public Schools in California

California Environmental Health Tracking Program

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Contents

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Executive Summary

California agriculture produces nearly half of all fruits and vegetables grown in the Unites States. These foods are essential components of a healthful diet and help promote public health here and throughout the country. However, agricultural production frequently relies on the application of pesticides that, under some circumstances, can be hazardous to human health. Compared with adults, children are more susceptible to the effects of pesticide exposure. Because of the potential public health risks to children, we examined the use of selected agricultural pesticides near public schools in the top 15 counties by agricultural pesticide use in California for 2010. Our goals were to improve the methodology for the ongoing surveillance of agricultural pesticides to understand pesticide use patterns and provide information that can be used to assess and inform efforts to minimize potential pesticide exposures among schoolchildren.

In 1990, California established the Pesticide Use Reporting (PUR) program, a world-class system administered by the California Department of Pesticide Regulation (CDPR) to collect and disseminate data on pesticide use. For this study, we utilized the most accurate data available from PUR and other sources to estimate pesticide applications within ¼ mile of school property boundaries. The pesticides included in this study were selected for their public health relevance and categorized based on their known health effects or regulatory status. The six categories of pesticides considered are carcinogens, reproductive and developmental toxicants, cholinesterase inhibitors, toxic air contaminants, fumigants, and priority pesticides for assessment and monitoring. These chemicals, many of which are of regulatory interest in California, are considered in this report to be **pesticides of public health concern**.

For this study, we assessed 2,511 public schools, attended by over 1.4 million students, in the 15 counties with the highest total reported agricultural pesticide use in 2010. We linked geographic school data to over 2.3 million pesticide use records. We found:

- **Most schools did not have any pesticides of public health concern applied nearby.** In 2010, the majority of schools in this study (64% or 1,612 schools) did not have any pesticides of public health concern applied within ¼ mile. For the remaining 36% of schools, pesticide use within ¼ mile ranged from 0.01–28,979 lb.
- **A small percentage of schools had many pounds of pesticides of public health concern applied nearby.**
  - The top 5% of schools with any pesticide use nearby (45 schools attended by over 35,000 students) had amounts of pesticides applied within ¼ mile ranging from 2,635–28,979 lb.
  - The top 25% of schools with any use nearby (226 schools attended by over 118,000 students) had at least 319 lb of pesticides applied within ¼ mile.
- **Pesticide use near schools varied among counties.**
  - Fresno County had the highest number of schools (131) with any pesticides applied nearby, whereas Tulare County had the highest percentage of its schools (63.4%) with any pesticides applied nearby.
  - Ventura County had the highest number of schools (12) and the highest number of students (13,045) in the top 5% of schools. Monterey County had the highest percentage of its schools (8%) and highest percentage of its students (13%) in the top 5% of schools.
- **Hispanic children were more likely to attend schools near the highest use of pesticides of public health concern.** Hispanic children were 46% more likely than White children to attend schools with any pesticides of concern applied nearby and 91% more likely than White children to attend schools in the highest quartile of use.

- **Household income did not consistently differ for children attending schools with the highest use of pesticides of public health concern, compared to schools with no use nearby.** However, differences existed within some individual counties.
- **An estimated 538,912 lb of pesticides of public health concern were applied within ¼ mile of public schools in the 15 counties in 2010.** Of the top 10 pesticides of public health concern used near schools, by pounds applied:
  - The top three pesticides of public health concern were chloropicrin, 1,3-dichloropropene, and methyl bromide.
  - Six are designated by CDPR as "restricted materials," which require special permits and are eligible for additional regulation at the local level.
  - Eight have a chemical persistence (measured as half-life in soil) of more than a week. Only one (chloropicrin) has a chemical persistence of less than 24 hours.
- **Of the pesticides used near schools, many belonged to multiple categories, and use by categories differed.**
  - Of the six categories of pesticides assessed, priority pesticides for assessment and monitoring were used near the most schools (33.8%), while fumigants were used near the fewest schools (12.7%). However, both had similar ranges of use, from zero to over 27,000 lb applied within ¼ mile of a school.
  - Priority pesticides for assessment and monitoring had the greatest poundage (523,566 lb) applied within ¼ mile of all schools, while cholinesterase inhibitors had the lowest (37,455 lb).

This study methodology does not attempt to measure schoolchildren's exposures to pesticides and, therefore, study results cannot be used to predict possible health impacts. Additional information would be needed regarding chemical decay, transport, and routes of exposure, all of which are beyond the scope of this report. However, the study methodology and results can help guide current and future pesticide monitoring and exposure assessment efforts — such as air monitoring, soil sampling, and biomonitoring — as well as epidemiologic studies.

We also hope the study methodology and results will be used by school officials, local environmental and public health officials, county agricultural commissioners, pesticide regulators, exposure assessment scientists, and others to inform policies that may impact public health, such as school-siting decisions and pesticide application permitting regulations.

Overall, we found that the data and technology exist to accurately and efficiently assess pesticide use near potentially sensitive populations with a high degree of geographic resolution. However, some relevant data are not collected and disseminated in a standardized manner throughout California.

In conducting this study, the researchers found a need for:

- Routine and standardized collection, digitization, and reporting of data on agricultural field locations of each pesticide use permit, which could then be made publicly accessible via the PUR system in a format convenient for Geographic Information Systems
- An accurate, complete, and publicly accessible database on pesticides applied on school properties
- An accurate, complete, and publicly accessible database of school property boundaries in California
- Ongoing surveillance of the use of pesticides of public health concern near schools and other potentially sensitive locations, in order to understand trends and usage patterns

Introduction

Agriculture in California

Agriculture is a major industry in California and plays a vital role in the state's economy and the nation's food supply. According to the U.S. Department of Agriculture, California is the largest producer and exporter of agricultural products in the U.S.[1] California farmers produce nearly half of all U.S.-grown fruits, nuts, and vegetables, greatly benefiting public health statewide and nationally. In 2010, California was the leading state in cash farm receipts, with $37.5 billion in revenue. The state accounted for 16% of national crop receipts and 7% of U.S. revenue from livestock products.[2]

In 2007, California accounted for 23% of all agricultural pesticides used in the U.S.[3,4] In 2010, over 160 million pounds were applied in California.[5]

What are Pesticides?

A **pesticide** is any substance used to kill or repel insects (insecticides), weeds (herbicides), rodents/small mammals (rodenticides), mold (fungicides), bacteria, or viruses. Pesticides are used in many settings, including agricultural fields, forests, recreational areas such as parks and golf courses, landscaping, and commercial and private buildings.

This report is focused on pesticides used in agricultural production in California in 2010. Pesticide use can vary greatly over time, as new pesticides are introduced and old pesticides are phased out, agricultural methods change, and pest populations shift. Because agricultural pesticides are dispersed in an outdoor environment, they are subject to variable conditions that may affect their transport, persistence, and chemical decomposition in the environment. More information about pesticides is available from the California Department of Pesticide Regulation (CDPR).[6]

Pesticides and Children

Compared with adults who do not work in agricultural settings, children are more likely to be exposed to pesticides and more susceptible to the health effects of pesticides.[7,8,9] Reasons for this increased susceptibility include:

- **Behavior** Certain childhood behaviors — such as spending more time outdoors, playing on the ground, and putting objects in their mouths — can increase children's risk for pesticide exposure.
- **Physiological development** Children's bodies are still maturing, so their physiology undergoes rapid changes, leaving them vulnerable to interruptions or delays in key developmental milestones.
- **Body size** Relative to their weight, children eat, drink, and breathe more than adults, increasing their exposure on a per pound basis.

The Need for Better Information

Over the past decades, California has experienced substantial growth and the extension of the agricultural-urban interface. Many suburban communities are built on past agricultural lands and are located close to agricultural fields where pesticides are applied.[10] Within these communities, many schools have been built close to this interface. Although the use of pesticides near a location does not mean that individuals are exposed, ongoing use may increase the probability of exposure. It is important to develop sound information on the location, types, and quantities of pesticides applied near schools and other locations of human activity.

Purpose of the Report

Using new datasets that accurately identify boundaries of school properties, combined with datasets on statewide agricultural pesticide use and the locations of agricultural fields, the California Environmental Health Tracking Program (CEHTP) of the California Department of Public Health (CDPH) and the Public Health Institute (PHI) estimated the location and amount of pesticides of public health concern applied near public schools in the 15 counties in California with the highest agricultural pesticide use for 2010, the most recent year for which statewide data were available at the time of the study.

California has some of the most stringent policies in the nation for restricting the use of agricultural pesticides near schools. However, these policies are primarily intended to prevent risks of acute pesticide exposure, not risks of chronic pesticide exposure.* Although many pesticide applications are conducted before and after ordinary school hours, many agricultural pesticides or their byproducts may remain in the environment after they are applied. This chemical persistence can have implications for chronic exposure risks and delayed or chronic health outcomes.

This study aims to demonstrate an improved methodology for the ongoing surveillance of agricultural pesticides to understand pesticide use patterns and to provide information to those who strive to improve children's health in their community by:

- Quantifying the amount of pesticides of public health concern used in agricultural applications near public schools
- Describing the populations that attend schools near the most intensive agricultural pesticide use and investigate whether they differ from populations attending other schools

* Chronic exposure refers to repeated exposure over a long period of time, even in very small amounts.

The California Environmental Health Tracking Program

The California Environmental Health Tracking Program (CEHTP) works to improve public health by delivering science-based information on the trends and distributions of diseases and environmental threats. CEHTP integrates environmental and health data to provide the information needed to improve the health of a community. To accomplish this, CEHTP has three core goals:

- Advance technology infrastructure
- Improve the availability and utility of environmental public health data and information
- Inform policies, practices, and other public health actions

CEHTP also conducts surveillance on other environmental hazards such as traffic, air pollution, and water pollution, as well as surveillance on health outcomes known or suspected to be associated with environmental hazards.[11]

For more information on CEHTP, visit www.CEHTP.org. Visit www.cdc.gov/ephtracking to learn about the National Environmental Public Health Tracking Program and other initiatives throughout the nation.

While the results of the study can be used to inform future exposure and health studies, **this assessment does not measure pesticide exposure in schoolchildren nor does it attempt to predict health outcomes.**

Rather, the methodology used in this study could support ongoing surveillance of agricultural pesticide use near sensitive populations and could be expanded statewide. The methodology could also be used to guide further investigations (e.g., hazard assessments such as air monitoring and soil or dust sampling) and to inform the development of epidemiologic research studies. This report also provides new information that might be useful to pesticide regulators, school developers, and other decision-makers.

Regulating Agricultural Pesticide Use Near Schools

Certain pesticides can be especially hazardous to human health and the environment. California law requires that CDPR place special regulatory controls on these "restricted materials," which are typically determined based on their active ingredients, concentration, container size, or designated use as described on the labeling (see Appendix 1: Restricted Materials Requirements). Only CDPR can designate a pesticide as a restricted material.

Use of restricted materials is limited by law to trained individuals. Users must apply for site-specific permits from their county agricultural commissioners (CACs), noting any sensitive locations nearby, such as schools. CACs evaluate each application and may require additional conditions before granting the permit — such as buffer zones (forbidding use within a specified distance of a location), time restrictions, or a combination of both — for applications near sensitive locations. Permit conditions vary by county, which may reflect local use conditions and other factors. Once the permit is obtained, applicators must notify their CAC at least 24 hours in advance of using the restricted material. CACs can also require a permit for a non-restricted material if the application would present an "undue hazard."

Establishing restrictions on agricultural pesticide use near school properties is one way in which counties can reduce the potential for exposure among schoolchildren and school workers. Current school pesticide restrictions (from September 2013) for the 15 counties are summarized in Appendix 2: School Pesticide Restrictions by County. As shown in Appendix 2, restricted materials are commonly subjected to additional regulations near school properties, and each county currently restricts some pesticide applications (the listed restrictions do not necessarily reflect restrictions in place in 2010, the year of this study). The information provided in Appendix 2 may not be comprehensive, and individual CACs should be contacted for further details about their school pesticides restrictions and other related policies.

This study does not assess the impact of school pesticide restrictions on pesticide applications near schools. However, with improved data, future studies specifically designed to assess the efficacy of these restrictions could adapt the study methodology. Many of the pesticides assessed in this study are not considered restricted materials. For this report, restricted material classification by CDPR has been noted only for the highest use pesticides. CDPR should be contacted for further details on restricted materials and related regulations.

Pesticide Use Inside School Properties

In addition to agricultural applications, pesticides are also used in homes, workplaces, child care centers, and on school properties to control pests such as insects, rodents, and invasive plants. Records for pesticide use in schools are not readily available or complete at the statewide level. Pesticides used in school buildings and on school grounds may be applied by licensed contractors or by school maintenance staff. However, only pesticides applied by licensed contractors are required to be reported to CDPR, and only specific pesticides must be reported.[12] Therefore, routine pesticide use by school maintenance crews and/or use of certain pesticides may go undocumented. Although the use of pesticides in schools is of potential public health concern, the lack of data makes it difficult to conduct a comprehensive and meaningful analysis. See Appendix 3: Existing Policies Related to Pesticides and Schools for more details on reporting requirements for pesticides used on school grounds. More information on CDPR's Integrated Pest Management Program (IPM) can be found online at http://apps.cdpr.ca.gov/schoolipm/main.cfm.

CDPR Air Monitoring Network

In 2011, the California Department of Pesticide Regulation implemented an air monitoring program in three communities. There were 226 communities eligible for inclusion, and the three communities were chosen based on local and regional pesticide use, demographic data, and the availability of health and exposure data. A total of 34 pesticides and 5 breakdown products were selected to be monitored at the air monitoring site within each community.

One 24-hour sample was collected each week at each of the three monitoring sites, and sampling days were randomly selected and varied by week. Of 5,676 analyses produced from February to December 2011, only 3% (173) contained quantifiable concentrations. Based on results from the three sites, CDPR found a low health risk to people near the monitoring sites in these communities. Air monitoring will last for at least two years.

For more information, please visit www.cdpr.ca.gov/docs/emon/airinit/air_network.htm

Methods

The key steps for this study included identifying a subset of counties with high pesticide use, creating groupings of pesticides likely to be hazardous to children's health, and linking together geographically-enhanced pesticide use reports with geographically-enhanced school location data.

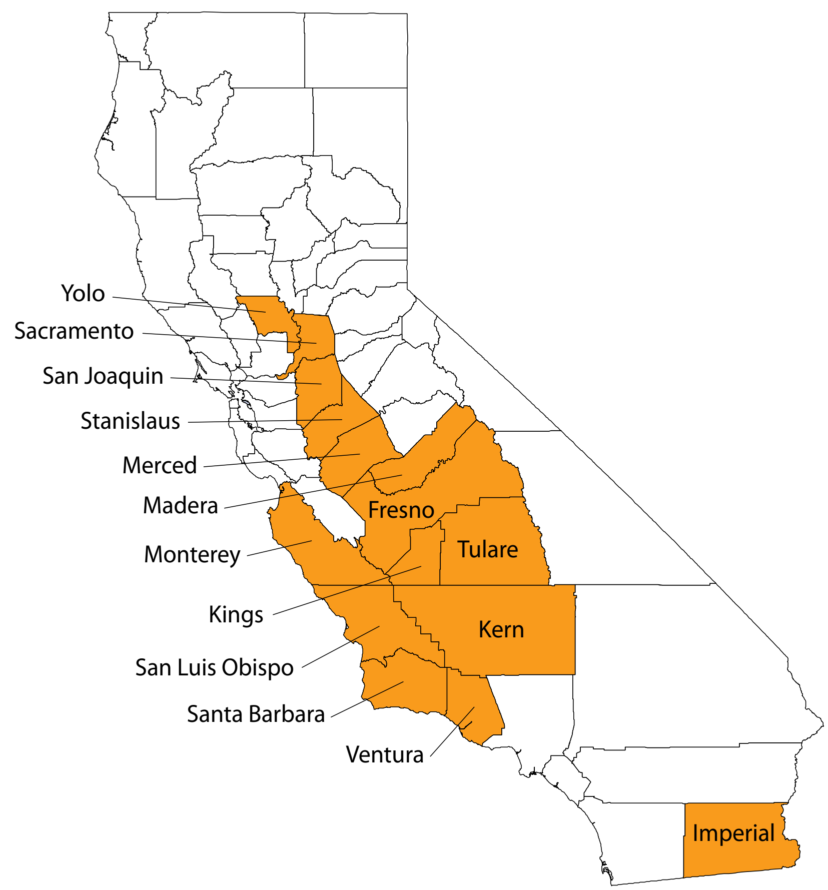
Step 1: County Selection

The CDPR Pesticide Use Reporting (PUR) program was established in 1990 to provide "more realistic and comprehensive pesticide use data."[13] The PUR program is recognized as the most comprehensive in the world. For this study, data from the 2010 PUR were obtained for all 58 counties in California. Counties were ranked by agricultural pesticide use (by pounds of active ingredients applied; active ingredients are the chemicals in pesticides designed to kill, control, or repel pests).[14] The top 25% of counties (15 out of 58) with the greatest pesticide usage were selected for the analysis (Figure 1 and Table 1). These 15 counties accounted for nearly 85% of all agricultural pesticides applied (by pounds of active ingredients) in California in 2010.

Step 2: Pesticide Selection

The pesticides considered in this study were selected for their public health relevance and categorized based on known health effects or regulatory status. In total, 635 active ingredients were deemed eligible for the study. In 2010, 815 distinct active ingredients were used in agricultural pesticide applications in California, and 201 of these were active ingredients on the study list. In this subgroup of 201 active ingredients, 144 were applied within ¼ mile of a public school

Figure 1. Locations of counties with highest agricultural pesticide use in 2010



located within one of the 15 counties. These pesticides belong to one or more of the pesticide categories listed in Table 2. A complete list of the 144 active ingredients used near public schools is shown in Appendix 4.

Table 1. Pounds of active ingredients applied for agricultural use in the top 15 counties, 2010

County	Pounds applied (2010)
Fresno	27,777,500
Kern	21,454,117
Tulare	8,867,756
San Joaquin	8,687,822
Madera	8,582,823
Monterey	8,203,711
Merced	7,180,641
Ventura	6,495,235
Kings	6,105,752
Stanislaus	5,072,403
Imperial	4,163,596
Santa Barbara	4,109,958
Sacramento	3,291,915
San Luis Obispo	2,570,651
Yolo	2,496,139

Step 3: Data Enhancement

Enhancing School Boundary Data

This study considered agricultural pesticide use near public schools for the 15 selected counties. Currently, statewide data for school location are reported as addresses and geocoded points (latitude and longitude locations). This provides little useful information about the actual boundaries of school properties. Additionally, the reported geocoded points are often erroneous, likely due to errors in geocoding or address reporting, or misreporting of administrative offices as school locations. CEHTP took the following steps to improve the accuracy and resolution of the school location data:

- Obtain data Data for public school locations in California were downloaded from the California Department of Education (CDE) in November 2011.[15]
- Geocode addresses The CEHTP Geocoding Service was used to increase the completeness of geocoded locations, as some schools in the CDE data did not have this information.[16] Geocoding is the process of finding the geographic coordinates of a location, such as an address. More information on geocoding can be found at www.cehtp.org/p/geocoding.
- Visual verification The geocoded points of school locations were then imported into ArcGIS and overlaid with county assessors' parcel data.[17] The geocoded points were used to determine the general location of the schools. Google Street View, as well as basemap and satellite imagery from Google and Bing, were then used to verify the existence and boundaries of school properties.
- Finalize school boundaries Parcel data were assigned to each school to serve as the school boundary. If parcel data were misaligned with the school boundary based on satellite imagery, the parcel was redrawn before assigning the school boundary.

Table 2. Pesticide categories and methodology used to select active ingredients for each category*

Pesticide category	Description and selection criteria
Carcinogens	For this study, carcinogens include: (1) active ingredients in the CDPR database that are "Known," "Probable," or "Likely" to be carcinogenic in humans, based on evaluations by the Health Effects Division of the United States Environmental Protection Agency (U.S. EPA) Office of Pesticide Programs (i.e., U.S. EPA Category A, B1, or B2); and (2) chemicals "known to the State of California to cause cancer" under Proposition 65.[18,19] There are differing weights of evidence for specific chemicals that summarize our confidence that they, in fact, can cause cancer in humans. For this reason, our list includes "Likely" or "Probable" carcinogens, for which the evidence is relatively strong for their cancer-causing potential. Other chemicals are considered suspected or possible carcinogens based on animal studies, but these chemicals were not included in this category.
Reproductive and Developmental Toxicants	Reproductive and developmental toxicants were selected from CDPR's list of pesticide active ingredients that have been identified through Proposition 65 as chemicals "known to the State of California to cause reproductive or developmental toxicity."[20]
Cholinesterase Inhibitors	These chemicals inhibit acetylcholinesterase or plasma cholinesterase enzymes (which are essential for regulating nerve cell activity), either as part of their primary toxicological mechanism of action, or as a secondary effect, as shown in one or more experimental studies. Inhibition of these enzymes can lead to an overstimulation of nerve receptors and possibly lead to longer-term neurological deficits.[21] Sources from U.S. EPA, CDPR, or the World Health Organization (WHO) provided the basis for inclusion on this list.[22,23,24, 25,26]
Toxic Air Contaminants	The compounds on this list are chemicals in the CDPR database that are also listed as California Toxic Air Contaminants (TACs) or U.S. EPA Hazardous Air Pollutants (HAPs). Additional information on the prioritization and identification of TACs and HAPs is available from the California Air Resources Board (www.arb.ca.gov/toxics/background.htm) and the U.S. EPA (www.epa.gov/ttn/atw/index.html).
Fumigants	The compounds on this list are chemicals used as agricultural fumigants that have been identified by CDPR or U.S. EPA as volatile substances or substances which degrade to volatile active substances.[27]
Priority Pesticides for Assessment and Monitoring	These pesticides are: • Active ingredients (and compounds that break down into these active ingredients) identified as high priority chemicals for risk assessment on the CDPR priority risk assessment list (July 2011). These chemicals will undergo, or are currently in process of undergoing, a formal risk assessment by CDPR. Each has been identified by an expert committee as high priority for risk assessment due to concerns about health effects in safety studies that may include carcinogenicity, genotoxicity, reproductive and developmental effects, neurotoxicity, or other chronic adverse effects.[28] • Active ingredients from the CDPR database that are on the CDPR air monitoring list (Feb 2011). These chemicals are currently monitored by CDPR in the air in selected locations because of concerns about potential exposures due to off-target drift.[29] • Active ingredients of high use in California (top 100 by pounds applied, 2010) that are categorized by the European Commission Directorate General for Health and Consumers[30] as carcinogens, mutagens, reproductive toxicants, or sensitizers and are not already listed in this study's other pesticide categories.

* Pesticide active ingredients may belong to one or more categories.

The analysis focuses on public schools, grades K-12. We excluded data for schools coded as adult schools, licensed preschools, or private schools. If a school was coded as closed, merged, or pending, it was also excluded from the analysis. We also excluded 347 schools that did not have any enrollment data; upon further inspection, many of these appeared to be non-K-12 schools or administrative offices that had been miscoded. The final geographic school data used in this report include 2,511 schools and 2,338 unique school boundaries. There are fewer boundaries than schools because some properties contain more than one school, such as an elementary school and a middle school.

Increasing the Resolution of Pesticide Use Reporting Data

CDPR's PUR data contain records of agricultural pesticide applications in California. Pesticide applicators must submit reports to the CACs, who then submit the data to CDPR. The records include information about the date of application, type and amount of active ingredient applied, and type of crop. PUR data also include information about where the application occurred, such as county, township, range, Public Land Survey (PLS) section, and field. CDPR, however, does not regularly collect, maintain, or distribute electronic Geographic Information System (GIS) data with better spatial resolution than the PLS section, an area of roughly one square mile. Therefore, using PUR data alone, it is impossible to know where pesticides were applied within a given square-mile section.

By linking the PUR data with other GIS datasets, CEHTP has been able to spatially refine the 2010 PUR data to geographic areas more likely to represent where pesticides were actually applied. The process is described in more detail below.

- Primary refinement method Through collaboration with CACs, CEHTP was able to obtain and utilize CAC agricultural field location GIS data. Of the 15 counties considered in this study, 14 provided GIS data that included pesticide use permit numbers and/or field identifiers, which could then be used to link to and refine the PUR data to the field-level (or ranch-level, for Monterey County). The remaining county (Tulare) did not have a pesticide permit GIS database at the time of the study.

  CDPR does not provide CAC GIS data with its PUR data. Furthermore, counties are not legally mandated to collect GIS data on the locations of agricultural fields. Thus, the completeness of CAC GIS data and the ability to link them to the PUR data varies by county. This refinement method provides the greatest spatial resolution possible.

- Secondary refinement method For PUR records that could not be refined using CAC GIS data, a secondary refinement method was used. The Department of Water Resources (DWR) has historically conducted land use surveys in one to six counties per year.[31] Tulare County, the only county in the study for which no CAC GIS data were available at the time of the study, was last surveyed in 2007. Geared towards enumerating agricultural land uses, the DWR land use maps provide individual parcels identified by agricultural crop, as well as parcels for other non-agricultural land uses, like native vegetation and urban areas. By linking DWR land use maps with crop identification information from the PUR records, pesticide applications were matched to more refined geographic locations within a PLS section.

  Following methods developed by Rull and Ritz, if multiple fields with the same crop code are co-located within a PLS section, then the related application from the PUR database was apportioned among those fields.[32] Matching PUR crop codes to DWR crop codes employed the following hierarchy of steps:

  - In the first pass of the hierarchy, records having codes for crops/sites that are unlikely to change between years, such as orchards, were matched one-to-one between PUR records and DWR land use observations within a section.
  - In the second step, PUR and DWR crop codes were matched on all crop/site types that are more likely to rotate or change between years, such as truck and field crops (generally, truck crops are vegetables; field crops are non-pasture, non-grain crops such as cotton, safflower, and sugar beets).

- For the remaining unmatched PUR records, the third pass matched the record with any agricultural crop/site in the PLS section.

Though the DWR land use spatial refinement method has better resolution than refinement using the PLS section, due to the inexact nature of the method, PUR records matched to DWR parcels in any given step may include additional field areas outside the true geographic location of a given pesticide application. PUR records matched in the first step are more likely to reflect the true geography of the pesticide application than those matched in the second and third steps.

When CAC or DWR data were not available or could not be matched to a PUR record, no spatial enhancement was possible, and the methodology defaulted to the geography of the PLS section (as shown in the section *Data Linkage Statistics*, this occurred for only 1% of pesticide applications across all 15 counties).

Step 4: Data Linkage

Once the school boundary and PUR data were refined, the datasets were linked by geographic area to determine what kinds and how many pounds of pesticides were applied near public schools. The linkage process is described in detail below.

- **Create final school polygons** A ¼-mile radius was drawn around each school boundary, creating a school polygon that included the actual school property plus a ¼-mile distance around the school boundary. The ¼-mile distance was chosen to capture agricultural activity near the school, as it provides a reasonable "drift" distance in the absence of more rigorous microclimatic modeling and because ¼ mile is a common distance used for pesticide permitting regulations near schools.
- **Link school polygon with PUR data** The resulting school polygon was overlaid with the spatial results of the final PUR datasets, described in Step 3 above.
- **Apportionment** If the school polygon overlapped an area where pesticides were applied, the amount of chemical applied within the school polygon was calculated by apportionment based on the amount of overlap between the school polygon and the area where pesticides were used (area weighted average). The apportionment assumes that pesticides were applied evenly across an entire application area.

Only pesticides included in the categories previously described in Step 2 were quantified and reported. Pesticides applied at any time of the day were included in the analysis (see *Time of Application and Pathways of Exposure* on page 13 for more details). When assessing poundage for an individual school, pesticides used within ¼ mile of the school property were included, regardless of whether those pesticides were also used within ¼ mile of another school. However, when reporting total pounds applied for a pesticide or pesticide category, pesticide applications were not double-counted when school boundaries overlapped.

Data Linkage Statistics

Overall, across the 15 counties, the PUR enhancement and data linkage processes were successful.

- CAC GIS data were used to geographically refine 80% of all PUR records that were linked to schools.
- DWR land use survey data were used to geographically refine 19% of the PUR records.
- Only 1% of PUR records could not be geographically refined. These applications were apportioned to PLS sections, the lowest geographic resolution possible in this methodology.

The ability to geographically refine the PUR records varied by county (Table 3). When examining pesticide use by poundage applied (Table 4), the results across the 15 counties were similar to linkage results as reported by number of records. Overall, the majority of PUR records used in this study were captured at a very high spatial resolution.

Table 3. Number (and percent) of PUR records linked to schools by various geographic refinement methods

County	CAC GIS Data N (%)		DWR Land Use Surveys N (%)		PLS Section N (%)		All Records N (%)	
Fresno	4,925	(85.8)	740	(12.9)	78	(1.4)	5,743	(100.0)
Imperial	305	(79.8)	77	(20.2)	0		382	(100.0)
Kern	2,108	(99.4)	0		12	(0.6)	2,120	(100.0)
Kings	416	(45.2)	471	(51.2)	33	(3.6)	920	(100.0)
Madera	788	(95.6)	35	(4.2)	1	(0.1)	824	(100.0)
Merced	1,341	(62.7)	790	(36.9)	9	(0.4)	2,140	(100.0)
Monterey	15,517	(82.4)	3,112	(16.5)	201	(1.1)	18,830	(100.0)
Sacramento	138	(73.4)	33	(17.6)	17	(9.0)	188	(100.0)
San Joaquin	3,460	(91.0)	231	(6.1)	110	(2.9)	3,801	(100.0)
San Luis Obispo	4,351	(93.8)	290	(6.2)	0		4,641	(100.0)
Santa Barbara	10,249	(84.6)	1,803	(14.9)	66	(0.5)	12,118	(100.0)
Stanislaus	7,602	(91.5)	677	(8.1)	32	(0.4)	8,311	(100.0)
Tulare	3	(0.1)	5,924	(99.7)	16	(0.3)	5,943	(100.0)
Ventura	9,378	(97.3)	211	(2.2)	46	(0.5)	9,635	(100.0)
Yolo	362	(87.4)	11	(2.7)	41	(9.9)	414	(100.0)
All 15 Counties	60,943	(80.2)	14,405	(19.0)	662	(0.9)	76,010	(100.0)

Table 4. Absolute (and percentage of) PUR poundage linked to schools by various geographic refinement methods

County	CAC GIS Data N (%)		DWR Land Use Surveys N (%)		PLS Section N (%)		Total Poundage N (%)	
Fresno	16,410	(56.5)	4,359	(15.0)	8,271	(28.5)	29,041	(100.0)
Imperial	1,985	(89.0)	246	(11.0)	0		2,231	(100.0)
Kern	20,965	(100.0)	0		0		20,966	(100.0)
Kings	1,682	(35.0)	1,471	(30.6)	1,649	(34.3)	4,802	(100.0)
Madera	7,527	(98.4)	125	(1.6)	0		7,652	(100.0)
Merced	34,509	(78.7)	9,329	(21.3)	6	(0.0)	43,844	(100.0)
Monterey	92,987	(70.8)	38,374	(29.2)	57	(0.0)	131,418	(100.0)
Sacramento	1,089	(94.0)	69	(6.0)	0		1,158	(100.0)
San Joaquin	21,438	(92.6)	874	(3.8)	851	(3.7)	23,163	(100.0)
San Luis Obispo	1,272	(93.6)	87	(6.4)	0		1,359	(100.0)
Santa Barbara	57,823	(93.7)	3,845	(6.2)	34	(0.1)	61,702	(100.0)
Stanislaus	27,006	(82.7)	5,644	(17.3)	12	(0.0)	32,662	(100.0)
Tulare	0		33,628	(100.0)	8	(0.0)	33,636	(100.0)
Ventura	132,694	(94.4)	3,039	(2.2)	4,792	(3.4)	140,525	(100.0)
Yolo	4,702	(99.6)	20	(0.4)	0		4,723	(100.0)
All 15 Counties	422,089	(78.3)	101,110	(18.8)	15,682	(2.9)	538,881	(100.0)

Step 5: Analysis

Pesticide Use

Because the majority of schools had no pesticide use within ¼ mile, while relatively few schools had very large amounts of pesticides applied within ¼ mile, we report the data in quartiles for schools with any use within ¼ mile to better highlight those schools at the upper end of the distribution. Reporting county averages, for example, would effectively conceal those schools with large amounts of pesticide use within ¼ mile.

To report pesticide use near schools, the values for each school (i.e., pounds of pesticides applied within ¼ mile of that school) were first aggregated across the 15 counties assessed. Schools with no pesticide use within ¼ mile — 64% of all schools — were then excluded. The remaining schools were divided into quartiles based on the pounds of pesticides applied within ¼ mile of their boundaries, and quartile breakpoints were determined. Schools were then assigned to a quartile for reporting.

The top 10 pesticides by poundage used within ¼ mile of schools are reported for each pesticide category. Because the ¼-mile distance established around schools could overlap when schools were in close proximity to one another, an additional linkage was performed with all geocoded schools represented as a single polygon to avoid double-counting pesticide applications. Many pesticides appear in multiple categorical lists (see Appendix 4) and may be of public health concern from multiple perspectives, but values are not double-counted when reporting poundage for all pesticides assessed.

Demographic Analysis

Using demographic data to describe populations at risk is a routine function of public health, and it is an integral step in preventing health disparities that result from social, economic, and environmental disadvantages.[33]

Table 5. Number of schools included in demographic analysis, by data source

	2010 enrollment dataset	2010 FRPM dataset	2011 enrollment dataset	2011 FRPM dataset	No records available	Total number of schools
Total enrollment analysis	2,424	17	70	0	0	2,511
Race/ ethnicity analysis	2,424	0	86	0	1	2,510
FRPM analysis	0	2,328	0	170	13	2,498

In order to understand who attended schools nearest to pesticide use, we examined the total number of enrolled students, their racial/ethnic distribution, and the percentage of students eligible to participate in the Free and Reduced Price Meals Program (FRPM), which was used as a proxy for family socioeconomic status.

To estimate total number of students enrolled in public schools during 2010, we employed a tiered approach, using multiple datasets in order to compensate for missing data. Records from the 2010 CDE enrollment dataset were first used to determine student enrollment.[34] If a school was missing enrollment data in the 2010 CDE enrollment dataset, we then used records from the 2010 FRPM dataset. If data for that school were also missing from the 2010 FRPM dataset, we then used records from the 2011 enrollment dataset. Similarly, we employed a tiered approach for examining racial/ethnic distribution (2010 enrollment data, followed by 2011 enrollment data) and for FRPM eligibility (2010 FRPM data, followed by 2011 FRPM data). See Table 5 for more information.

These demographic data were merged with the linkage results for school boundaries and pesticide use to describe the demographics of the student populations in schools where pesticides were applied within ¼ mile.

Limitations

This study methodology has several limitations. It assumes that pesticides are applied evenly across a field. The study does not account for pesticide application modifications that may have been made in observance of local pesticide regulations in place in 2010. Therefore, if an application in some portion of a field did not occur because it fell within a school buffer zone during a restricted time period as established by CACs, this would not be accounted for in our methodology. Also, the completeness of CAC GIS data and the ability to link them to PUR data varies by county; therefore, the potential for erroneous attribution of pesticide applications to field locations may vary by county.

This study does not attempt to estimate and cannot be used to infer actual exposure. The methodology does not account for factors related to exposure, such as meteorology, wind patterns, potential drift, or chemical persistence. Routes of exposure were not assessed, and for the reasons stated above, pinpoint precision of pesticide use near students is not possible. Despite these limitations, this study describes agricultural pesticide use near schools in California in much greater detail and with higher geographic resolution than would have previously been possible, and it provides a framework to plan future studies and evaluate potential exposures.

Time of Application and Pathways of Exposure

Agricultural pesticide applicators typically do not perform applications near schools during school hours; in some areas, county regulations forbid it. CACs set important restrictions regarding the use of many pesticides near sensitive locations, such as schools, to protect public health. All 15 counties assessed in this study currently have some level of restriction on pesticide use near schools (see Appendix 2).

While current restrictions may not be applicable for 2010, the year of this study, it is likely that some applications included in this study did not occur when school was in session or while children were present. However, this study was not limited to applications that occurred when schools were in session for a variety of reasons.

- **Use of school properties when school is not in session:** According to CDE, school grounds are often occupied when school is not in session. Children and adults are often at school before and after class for extracurricular activities. Many sports events occur on weekends on school athletic fields, and some schools are used for activities during summer months.
- **Potential for pesticides to drift onto school property:** Pesticides that are applied at night or in the early morning may drift to school property and persist for hours or much longer. According to CDPR, although the goal of all pesticide applications is that pesticides reach their target and remain there, scientists recognize that “almost every pesticide application produces some amount of drift”, even though it may not be harmful or illegal.[35]
- **Potential for pesticides with high chemical persistence to result in exposures:** Some pesticides can take weeks or months to degrade in the environment, and there is a higher risk of exposure for pesticides that do not break down quickly. While the inhalation of pesticides through drift is a potential pathway for exposure during or shortly after an application, other routes of exposure (including skin contact and hand-to-mouth contact) also can occur after airborne chemicals have deposited onto surfaces (e.g., playground equipment). In such cases, the environmental persistence is a major factor in the likelihood of exposure. The rate of breakdown of the parent chemical into degradation products — some toxic and some not — varies by chemical, with half-lives ranging from a few hours to several months. Soil and environmental conditions, including pH, water content, and exposure to sunlight and rain, all affect the rate of breakdown once residual pesticides have drifted and deposited onto surfaces.

Because of public health concern about possible low-level exposures and chronic health outcomes, this study did not limit the assessment by time of day, day of the week, or season.

Summary Findings for All Pesticide Categories

We assessed 2,511 schools, attended by 1,457,230 students, from the top 15 counties by agricultural pesticide use in California for 2010.

Table 6 shows the range of pesticide poundage by category. Some chemicals belong to more than one category; these applications are not double-counted when reporting quartiles of usage by pounds (see Appendix 4 for pounds of pesticides applied, by active ingredient).

- Many schools (64%) did not have any pesticide use within ¼ mile. For the remaining schools, the pounds of pesticides, per school, applied within ¼ mile ranged from less than 0.01 lb to over 28,000 lb.
- Pesticide use near schools also varied among the six pesticide categories. For example, 33.8% of the schools had applications of priority pesticides for assessment and monitoring nearby, while 12.7% had fumigants applied nearby.
- Of the six categories, priority pesticides for assessment and monitoring had the highest poundage (523,566 lb) applied within ¼ mile of all schools in the 15 counties, while cholinesterase inhibitors had the lowest (37,455 lb).

Table 6. Range of pounds of pesticides applied within ¼ mile of schools, 2010

Pesticide category	Lowest poundage of pesticides applied near a school	Largest poundage of pesticides applied near a school	Number (%) of schools with no use within ¼ mile		Number (%) of schools with use within ¼ mile		Total pounds applied within ¼ mile of all schools in the 15 counties
Carcinogens	<0.01	18,082	1,828	(72.8)	683	(27.2)	228,019
Reproductive and Developmental Toxicants	<0.01	18,092	1,833	(73.0)	678	(27.0)	149,279
Cholinesterase Inhibitors	<0.01	1,345	1,873	(74.6)	638	(25.4)	37,455
Toxic Air Contaminants	<0.01	28,448	1,859	(74.0)	652	(26.0)	454,202
Fumigants	<0.01	27,038	2,192	(87.3)	319	(12.7)	428,834
Priority Pesticides for Assessment and Monitoring	<0.01	28,920	1,662	(66.2)	849	(33.8)	523,566
All Pesticides Assessed	**<0.01**	**28,979**	**1,612**	**(64.2)**	**899**	**(35.8)**	**538,912***

* Some chemicals belong to multiple categories, but were not double-counted, so the sum of the total pounds applied for each category does not match the total pounds applied for the All Pesticides category.

Table 7 lists the top 10 pesticides with the highest application (by pound) within ¼ mile of a public school.

- Each of these compounds is classified as a priority pesticide for assessment and monitoring. Each compound listed is on CDPR's complete risk assessment list and/or it is currently being monitored by CDPR in the air in selected locations.
- Of these compounds, six are considered restricted materials by CDPR, including each of the top five compounds. Special permits are required for application of restricted materials, and counties may further restrict use by location or time.
- The chemical persistence of these compounds is also shown and will vary depending on soil and climatic conditions.* Of the 10 pesticides, only one (chloropicrin) has a chemical persistence (measured as half-life in soil) less than 24 hours; most have a chemical persistence greater than a week.

Fumigants are prominent in many of the categories assessed in this report and comprise the top five pesticides applied, illustrating their higher rate of usage on a pounds per acre basis. Because they are more prone to drift, special application restrictions are placed on fumigant use; yet fumigants can still pose a hazard potential. In order to better view the relative contributions of non-fumigant pesticides, it may be of interest in future reports to exclude fumigants from the other categories to more readily assess the hazard potential of non-fumigants.

Table 7. Top 10 pesticide active ingredients, by pounds applied within ¼ mile of schools in the 15 counties assessed, 2010

	Name	Total pounds applied	Restricted material	Chemical persistence†	Pesticide category‡
1	Chloropicrin	150,285	Yes	Low: 4-day half-life in soil, 8 hours in air[36]	PRIOR, TAC, FUM
2	1,3-Dichloropropene	136,241	Yes	Moderate to high: 69 days[37]	PRIOR, TAC, FUM, CARC
3	Methyl bromide	85,112	Yes	Moderate: 50 days[38]	PRIOR, TAC, FUM, REP/DEV
4	Metam-sodium	37,920	Yes	Low to moderate: 7–14 days[39]	PRIOR, TAC, FUM, CARC, REP/DEV
5	Potassium n-methyldithiocarbamate	19,141	Yes	Low to moderate: 7–14 days[40]	PRIOR, TAC, FUM, CARC, REP/DEV
6	Captan	8,790	No	Moderate: 20 days[41]	PRIOR, TAC, CARC
7	Pendimethalin	8,198	No	Moderate: 40 days[42]	PRIOR
8	Chlorpyrifos	7,769	No	High: 60–120 days[43]	PRIOR, CHOIN
9	Paraquat dichloride	6,543	Yes	Highly persistent: 1,000 days[44]	PRIOR
10	Malathion	6,322	No	Low to moderate: 3–7 days[45]	PRIOR, CHOIN

† Classification of chemical persistence as "low", "moderate", "high", or "highly persistent" based on the U.S. EPA PBT Final Rule (40 CFR 372, 1999) (www.epa.gov/fedrgstr/EPA-WASTE/1999/October/Day-29/f28169.htm) and the related PBT profiler criteria (www.pbtprofiler.net/criteria.asp). Variable soil and climate conditions influence chemical persistence. Unless otherwise noted, the classification is based on the compound's reported half-life in soil.

‡ PRIOR=priority pesticides for assessment and monitoring; TAC=toxic air contaminants; FUM=fumigants; CARC=carcinogens; REP/DEV=reproductive and developmental toxicants; CHOIN=cholinesterase inhibitors

* Soil half-life has been used to provide a qualitative indication of relative persistence of the pesticides in this report. However, soil half-life is only one way to characterize the environmental fate and persistence of a chemical, and a range of environmental factors (sunlight exposure, soil moisture, soil pH, etc) will influence the rate at which the chemical degrades.

Appendix 4 lists the estimated pounds of pesticides applied for every active ingredient used near schools. See Appendix 5 for the top 10 pesticides applied near schools within each county.

Table 8 lists the percent and number of schools with no pesticide use within ¼ mile of the school property boundary, the percent and number of schools with any pesticide use within ¼ mile, and the percent and number of schools by quartile based on pounds of pesticides applied within ¼ mile. Quartiles were calculated after excluding schools with no pesticides applied within ¼ mile.

- Of the 2,511 schools assessed in this study, 1,612 (64.2%) had no pesticides of public health concern applied within ¼ mile.
- Tulare County had the highest percentage of schools with any pesticides applied within ¼ mile (63.4%), and Fresno County had the most schools (131).
- Sacramento County had the lowest percentage of schools with any pesticide applied within ¼ mile (8.0%), and Kings County had the fewest schools (18).

Table 8. Schools (percent and number) by pounds of pesticides applied within ¼ mile, by county, 2010

County	Schools with no use nearby % (N)	Schools with any use nearby % (N)	Schools in the 1st quartile* (0.01–<8 lb) % (N)	Schools in the 2nd quartile* (8–<64 lb) % (N)	Schools in the 3rd quartile* (64–<319 lb) % (N)	Schools in the 4th quartile* (319–28,979 lb) % (N)	Total number of schools
Fresno	61.1 (206)	38.9 (131)	6.5 (22)	9.8 (33)	11.0 (37)	11.6 (39)	337
Imperial	69.6 (48)	30.4 (21)	7.2 (5)	13.0 (9)	7.2 (5)	2.9 (2)	69
Kern	80.4 (209)	19.6 (51)	2.3 (6)	8.1 (21)	5.4 (14)	3.8 (10)	260
Kings	71.0 (44)	29.0 (18)	4.8 (3)	6.5 (4)	11.3 (7)	6.5 (4)	62
Madera	57.5 (46)	42.5 (34)	16.3 (13)	11.3 (9)	11.3 (9)	3.8 (3)	80
Merced	38.8 (40)	61.2 (63)	9.7 (10)	17.5 (18)	16.5 (17)	17.5 (18)	103
Monterey	53.3 (73)	46.7 (64)	10.2 (14)	5.8 (8)	9.5 (13)	21.2 (29)	137
Sacramento	92.0 (347)	8.0 (30)	5.0 (19)	1.9 (7)	0.5 (2)	0.5 (2)	377
San Joaquin	52.5 (117)	47.5 (106)	17.9 (40)	10.3 (23)	10.8 (24)	8.5 (19)	223
San Luis Obispo	70.7 (58)	29.3 (24)	9.8 (8)	14.6 (12)	3.7 (3)	1.2 (1)	82
Santa Barbara	54.6 (65)	45.4 (54)	16.8 (20)	13.4 (16)	3.4 (4)	11.8 (14)	119
Stanislaus	48.6 (89)	51.4 (94)	11.5 (21)	8.2 (15)	15.3 (28)	16.4 (30)	183
Tulare	36.6 (71)	63.4 (123)	9.3 (18)	18.6 (36)	24.7 (48)	10.8 (21)	194
Ventura	69.7 (154)	30.3 (67)	8.6 (19)	4.5 (10)	3.2 (7)	14.0 (31)	221
Yolo	70.3 (45)	29.7 (19)	9.4 (6)	6.3 (4)	9.4 (6)	4.7 (3)	64
All 15 Counties	64.2 (1,612)	35.8 (899)	8.9 (224)	9.0 (225)	8.9 (224)	9.0 (226)	2,511

* Calculations of quartiles exclude schools with no use of pesticides of public health concern within ¼ mile.

Table 9 lists the percent and number of schools and students in the highest (4th) quartile based on pounds of pesticides applied, per school, within ¼ mile (excluding schools with no pesticides applied nearby). The pounds of pesticides applied for the top quartile ranged from 319–28,979 lb. For the top quartile by poundage:

- There were 226 schools in the 15 counties, attended by 118,864 students.
- Monterey County had the highest percentage of schools (21.2%) in the top quartile, while Fresno County had the highest number of schools (39) in the top quartile.
- Sacramento County had the lowest percentage of schools (0.5%), and San Luis Obispo had the fewest schools (1).
- Monterey County had the highest percentage of students (25.1%) in the top quartile, while Ventura County had the highest number of students (21,193).
- Sacramento County had the lowest percentage of students (0.1%) and lowest number of students (202).

Table 9. Schools and enrolled students (percent and number) in the top quartile* by pounds (319–28,979 lb) of pesticides applied within ¼ mile, by county, 2010

County	Schools in the top quartile %	(N)	Students in the top quartile %	(N)	Total number of schools	Total number of students
Fresno	11.6	(39)	9.0	(17,790)	337	197,283
Imperial	2.9	(2)	2.3	(863)	69	37,343
Kern	3.8	(10)	3.7	(6,437)	260	173,336
Kings	6.5	(4)	8.1	(2,267)	62	27,856
Madera	3.8	(3)	3.5	(1,047)	80	29,993
Merced	17.5	(18)	17.8	(9,873)	103	55,345
Monterey	21.2	(29)	25.1	(18,525)	137	73,876
Sacramento	0.5	(2)	0.1	(202)	377	239,666
San Joaquin	8.5	(19)	7.0	(9,520)	223	136,803
San Luis Obispo	1.2	(1)	0.9	(298)	82	34,282
Santa Barbara	11.8	(14)	13.7	(9,036)	119	65,842
Stanislaus	16.4	(30)	12.1	(12,725)	183	105,176
Tulare	10.8	(21)	8.8	(8,587)	194	97,621
Ventura	14.0	(31)	13.9	(21,193)	221	152,703
Yolo	4.7	(3)	1.7	(501)	64	30,105
All 15 Counties	9.0	(226)	8.2	(118,864)	2,511	1,457,230

* Calculations of quartiles exclude schools with no use of pesticides of public health concern within ¼ mile.

Table 10 lists the percent and number of schools and students in the top 5% of schools, based on pounds of pesticides applied per school within ¼ mile (excluding schools with no pesticides applied nearby). The pounds of pesticides applied near schools in the top 5% ranged from 2,635–28,979 lb. For the top 5% of schools by poundage:

- There were 45 schools in the 15 counties, attended by 35,358 students.
- Monterey County had the largest percentage of schools (8%) in the top 5%, while Ventura County had the largest number of schools (12).
- Monterey County had the largest proportion of students (13%) attending schools in the top 5%, while Ventura County had the largest number of students (13,045).
- Imperial, Kings, Sacramento, San Luis Obispo, and Yolo counties had no schools in the top 5%.

Table 10. Schools and enrolled students (percent and number) in the top 5%* of schools by pounds (2,635–28,979 lb) of pesticides applied within ¼ mile, by county, 2010

County	Schools in the top 5% % (N)		Students in the top 5% % (N)		Total number of schools	Total number of students
Fresno	0.3	(1)	0.2	(355)	337	197,283
Imperial	0.0	(0)	0.0	(0)	69	37,343
Kern	0.8	(2)	0.7	(1,237)	260	173,336
Kings	0.0	(0)	0.0	(0)	62	27,856
Madera	1.3	(1)	0.7	(203)	80	29,993
Merced	3.9	(4)	4.0	(2,220)	103	55,345
Monterey	8.0	(11)	13.3	(9,820)	137	73,876
Sacramento	0.0	(0)	0.0	(0)	377	239,666
San Joaquin	0.4	(1)	0.3	(443)	223	136,803
San Luis Obispo	0.0	(0)	0.0	(0)	82	34,282
Santa Barbara	5.0	(6)	7.4	(4,890)	119	65,842
Stanislaus	2.2	(4)	1.5	(1,548)	183	105,176
Tulare	1.5	(3)	1.6	(1,597)	194	97,621
Ventura	5.4	(12)	8.5	(13,045)	221	152,703
Yolo	0.0	(0)	0.0	(0)	64	30,105
All 15 Counties	1.8	(45)	2.4	(35,358)	2,511	1,457,230

* Calculations exclude schools with no use of pesticides of public health concern within ¼ mile.

Demographic Analysis

To better understand the demographics of student populations attending public schools near the most agricultural pesticide use, data for student race/ethnicity and a proxy for student family income (eligibility for FRPM) were obtained from CDE. Information regarding eligibility scales for FRPM is available from CDE.[46]

Race/Ethnicity

The race/ethnicity distribution of the public school student population by county can be found in Table 11.

Student population by race/ethnicity is reported by pesticide use within ¼ mile of schools in Table 12. Student demographics are reported for those schools with no pesticide use within ¼ mile, schools with any pesticide use within ¼ mile, and schools within the highest quartile of pesticide use (by poundage within ¼ mile of schools). The demographic breakdown of all public schools (grades K-12) in California is also shown.

While Hispanic children made up 54.1% of the population for all public schools in the 15 counties, they comprised 61.3% of the population for schools with any pesticide use within ¼ mile of the school boundary, and 67.7% of the population for schools in the highest quartile of pesticide use. Hispanics were the only racial/eth-

Table 11. Students (percent and number) enrolled in public schools, by race/ethnicity and county, 2010

County	Hispanic % (N)		White % (N)		Asian/Pacific Islander % (N)		African American % (N)		Other % (N)		Total Number*
Fresno	60.2	(118,714)	20.7	(40,754)	10.9	(21,607)	6.0	(11,933)	2.2	(4,347)	197,355
Imperial	89.1	(33,258)	7.1	(2,634)	1.0	(358)	1.1	(416)	1.8	(677)	37,343
Kern	61.0	(105,750)	25.9	(44,934)	4.0	(6,874)	6.0	(10,412)	3.1	(5,371)	173,341
Kings	62.6	(17,445)	25.4	(7,077)	4.0	(1,123)	5.2	(1,458)	2.7	(753)	27,856
Madera	68.2	(20,454)	24.9	(7,458)	1.5	(447)	2.2	(665)	3.2	(969)	29,993
Merced	66.4	(36,771)	20.0	(11,081)	7.9	(4,369)	3.6	(2,011)	2.0	(1,117)	55,349
Monterey	74.1	(54,764)	15.7	(11,574)	5.0	(3,680)	2.1	(1,533)	3.1	(2,321)	73,872
Sacramento	27.8	(66,734)	35.7	(85,479)	17.3	(41,362)	13.9	(33,268)	5.4	(12,823)	239,666
San Joaquin	47.1	(64,391)	23.8	(32,555)	16.7	(22,899)	9.3	(12,656)	3.1	(4,302)	136,803
San Luis Obispo	34.5	(11,839)	57.5	(19,710)	3.1	(1,048)	1.4	(478)	3.5	(1,207)	34,282
Santa Barbara	64.4	(42,408)	26.6	(17,522)	3.4	(2,250)	1.5	(1,014)	4.0	(2,648)	65,842
Stanislaus	53.9	(56,658)	33.4	(35,090)	6.0	(6,269)	3.4	(3,555)	3.4	(3,607)	105,179
Tulare	71.4	(70,719)	20.5	(20,307)	3.3	(3,239)	1.8	(1,744)	3.0	(2,982)	98,991
Ventura	49.6	(75,777)	38.4	(58,689)	6.7	(10,256)	2.5	(3,890)	2.7	(4,091)	152,703
Yolo	44.5	(13,394)	38.9	(11,718)	10.4	(3,134)	2.9	(865)	3.3	(994)	30,105
All 15 Counties	54.1	(789,076)	27.9	(406,582)	8.8	(128,915)	5.9	(85,898)	3.3	(48,209)	1,458,680

* Race/ethnicity data from 2011 were used for schools missing data from 2010. Therefore, the total number of students for each county (denominator) is different from other tables in this report (see Table 5).

nic group whose representation in the student population increased as pounds of pesticides used near schools increased. In the 15 counties assessed, Hispanic children were 46% more likely than White children to attend schools with any use of pesticides within ¼ mile, compared to children attending schools with no pesticide use within ¼ mile. This difference was more pronounced with increased pesticide use, as Hispanic children were 91% more likely than White children to attend a school in the top quartile of pesticide usage, when compared to children attending schools with no pesticide use nearby. The corresponding odds ratios are reported in Appendix 6.

Table 12. Students (percent and number) enrolled in public schools by race/ethnicity, 2010

	Students in schools with no pesticide use within ¼ mile		Students in schools with any pesticides used within ¼ mile		Students in schools in highest quartile of pesticide use (319–28,979 lb)		All students in schools assessed in the 15 counties*		All students in public schools in California	
	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)
African American	7.1	(68,141)	3.5	(17,757)	2.7	(3,168)	5.9	(85,898)	6.7	(416,098)
Asian/Pacific Islander	9.5	(90,616)	7.6	(38,299)	6.6	(7,892)	8.8	(128,915)	11.7	(724,335)
Hispanic	50.3	(479,175)	61.3	(309,901)	67.7	(80,742)	54.1	(789,076)	51.4	(3,197,384)
Other	3.5	(33,584)	2.9	(14,625)	2.2	(2,679)	3.3	(48,209)	3.6	(223,587)
White	29.6	(282,023)	24.7	(124,559)	20.8	(24,849)	27.9	(406,582)	26.6	(1,655,598)
Total	100.0	(953,539)	100.0	(505,141)	100.0	(119,330)	100.0	(1,458,680)	100.0	(6,217,002)

* Race/ethnicity data from 2011 were used for schools missing data from 2010. Therefore, the total number of students (denominator) for each county is different from other tables in this report (see Table 5).

Eligibility for Free and Reduced Price Meals

Household income data were not available for students. However, data on student eligibility for FRPM were available from CDE and served as a proxy for household income (Table 13). Eligibility for FRPM is based on household income and household size. Student eligibility is reported for schools with no pesticide use within ¼ mile, schools within ¼ mile of any pesticide use, and schools within the highest quartile of pesticide use (by poundage within ¼ mile of schools).

As shown in Table 13, we found no difference overall in schools with no pesticide use (59.4%), with any pesticide use (59.4%), and in the top quartile of pesticide use (59.4%) for student population eligible for FRPM. By comparison, 57.7% of all public school students in California were eligible for FRPM in 2010.

However, differences were seen within individual counties. For example, the student populations in the highest quartile of use for Kings, San Joaquin, and San Luis Obispo counties had markedly lower eligibility for FRPM (or higher income) compared to schools with no pesticides used within ¼ mile. The student populations in the highest quartile of use for Sacramento and Santa Barbara counties had notably higher eligibility for FRPM (or lower income) compared to schools with no pesticides used within ¼ mile.

Table 13. FRPM-eligible students (percent and number) enrolled in public schools by county, 2010

County	FRPM-eligible students in schools with no pesticide use within ¼ mile % (N)		FRPM-eligible students in schools with any pesticides used within ¼ mile % (N)		FRPM-eligible students in schools in highest quartile of pesticide use (319 – 28,979 lb) % (N)		FRPM-eligible students in all public schools* % (N)	
Fresno	72.6	(87,031)	65.3	(46,522)	61.8	(10,532)	69.9	(133,553)
Imperial	66.1	(17,921)	77.0	(7,419)	79.2	(689)	69.0	(25,340)
Kern	63.6	(85,515)	62.7	(22,533)	54.6	(3,436)	63.4	(108,048)
Kings	68.7	(12,298)	45.6	(4,203)	32.4	(736)	60.8	(16,501)
Madera	65.9	(8,143)	81.5	(13,734)	79.3	(866)	74.9	(21,877)
Merced	72.3	(15,828)	73.0	(23,623)	77.8	(7,572)	72.7	(39,451)
Monterey	62.6	(23,360)	64.7	(22,794)	58.5	(10,746)	63.6	(46,154)
Sacramento	56.2	(116,323)	37.6	(9,754)	77.2	(152)	54.2	(126,077)
San Joaquin	55.6	(37,138)	43.6	(29,095)	37.7	(3,584)	49.6	(66,233)
San Luis Obispo	45.1	(10,699)	37.3	(3,720)	24.7	(74)	42.8	(14,419)
Santa Barbara	56.7	(20,739)	61.7	(17,219)	80.2	(7,141)	58.9	(37,958)
Stanislaus	66.1	(34,847)	56.3	(27,510)	58.0	(7,588)	61.4	(62,357)
Tulare	66.0	(28,997)	76.9	(40,394)	73.2	(6,239)	71.9	(69,391)
Ventura	40.1	(42,953)	46.6	(20,265)	49.4	(10,451)	42.0	(63,218)
Yolo	48.9	(10,243)	56.0	(4,697)	45.1	(269)	51.0	(14,940)
All 15 Counties†	59.4	(552,035)	59.4	(293,482)	59.4	(70,075)	59.4	(845,517)

* FRPM data from 2011 were used for schools missing data from 2010. Therefore, the total number of students (denominator) for each county is different from other tables in this report (see Table 5).

† The percentages are not averages of the individual counties; they were calculated by comparing the number of FRPM-eligible students with the total number of students within that category. The percentages displayed for the four categories are correct and are merely an artifact of the data.

Carcinogens

What are Carcinogens?

Carcinogens are chemicals or physical agents (such as ionizing radiation) that can cause cancer. Cancer is the general name of a large group of diseases characterized by cells that grow out of control and have the potential to spread to other parts of the body. If left untreated, many forms of cancer lead to serious illness and death. The majority of cancers take years, or even decades, to develop.

Use of Carcinogens Near Public Schools

Table 14 lists the 10 carcinogens with the highest use (by pounds applied) within ¼ mile of a public school. Of these compounds, three are designated as restricted materials. Special permits are required for application of restricted materials, and counties may further restrict use by location or time.

Table 14. Top 10 pesticide active ingredients classified as carcinogens, by pounds applied within ¼ mile of schools in the 15 counties assessed, 2010

	Name	Total pounds applied	Restricted material
1	1,3-Dichloropropene	136,241	Yes
2	Metam-sodium*	37,920	Yes
3	Potassium n-methyldithiocarbamate*	19,141	Yes
4	Captan	8,790	No
5	Chlorothalonil	5,975	No
6	Maneb	5,497	No
7	Mancozeb	3,627	No
8	Iprodione	2,414	No
9	Diuron	2,191	No
10	Propargite	1,964	No

* Metam-sodium and potassium n-methyldithiocarbamate both generate MITC soon after application. MITC is not listed under Proposition 65, but metam-sodium and potassium n-methyldithiocarbamate are, and thus are included in the analysis. MITC has not been subjected to a complete set of carcinogenicity tests.

Table 15 shows the distributions of schools and students by county for the highest quartile (top 25%) of carcinogenic pesticide use in 2010. Quartiles were calculated after excluding schools (1,828) that had no carcinogenic pesticides applied within ¼ mile.

For pesticide active ingredients listed as carcinogens, the range of pounds applied within ¼ mile for highest quartile of schools was 143–18,082 lb.

- Monterey County had the highest percentage of schools (16.8%) in the highest quartile, while Stanislaus County had the highest number of schools (28) in the highest quartile.
- Sacramento County had the lowest percentage of schools (0.8%) in the highest quartile, while Imperial, San Luis Obispo, and Yolo counties had the fewest number of schools (1) in the highest quartile.
- Monterey County had the highest percentage of students (19.5%) in the highest quartile, while Ventura County had the highest number of students (17,023).
- Sacramento County had the lowest percentage (0.1%) and fewest number (209) of students in the highest quartile.

Among all 15 counties, 6.8% of schools (170) and 6.5% of students (94,673) fell within the highest quartile.

Table 15. Schools and enrolled students (percent and number) in the top quartile* of schools by pounds (143–18,082 lb) of carcinogenic pesticide applied within ¼ mile, by county, 2010

County	Schools in the top quartile %	(N)	Students in the top quartile %	(N)	Total number of schools	Total number of students
Fresno	5.9	(20)	4.0	(7,971)	337	197,283
Imperial	1.4	(1)	1.0	(373)	69	37,343
Kern	3.1	(8)	3.4	(5,940)	260	173,336
Kings	6.5	(4)	8.1	(2,267)	62	27,856
Madera	2.5	(2)	1.2	(352)	80	29,993
Merced	16.5	(17)	15.3	(8,446)	103	55,345
Monterey	16.8	(23)	19.5	(14,432)	137	73,876
Sacramento	0.8	(3)	0.1	(209)	377	239,666
San Joaquin	5.8	(13)	5.8	(7,897)	223	136,803
San Luis Obispo	1.2	(1)	0.9	(298)	82	34,282
Santa Barbara	11.8	(14)	13.7	(9,036)	119	65,842
Stanislaus	15.3	(28)	13.1	(13,729)	183	105,176
Tulare	7.2	(14)	6.5	(6,357)	194	97,621
Ventura	9.5	(21)	11.1	(17,023)	221	152,703
Yolo	1.6	(1)	1.1	(343)	64	30,105
All 15 Counties	6.8	(170)	6.5	(94,673)	2,511	1,457,230

*Calculations of quartiles exclude schools with no use of pesticides classified as carcinogens within ¼ mile.

Reproductive and Developmental Toxicants

What are Reproductive and Developmental Toxicants?

Reproductive toxicants are chemical, physical, or biological agents that may impact the reproductive health of women or men, or hinder the ability of couples to have healthy children. A specific reproductive toxicant may affect male or female reproductive organs in a transient or irreversible manner. These hazards may result in infertility or miscarriage. The effect of low dose exposures to reproductive toxicants on the future fecundity of developing children is not known.[47]

Developmental toxicants affect children's ability to develop normally and at a normal pace during pregnancy, infancy, and early childhood. These hazards may result in growth retardation and birth defects.

Use of Reproductive and Developmental Toxicants Near Public Schools

Table 16 lists the 10 reproductive and developmental toxicants with the highest use (by pounds applied) within ¼ mile of a public school. Of these compounds, five are designated as restricted materials by CDPR. Special permits are required for application of restricted materi-

Table 16. Top 10 pesticide active ingredients classified as reproductive and developmental toxicants, by pounds applied within ¼ mile of schools in the 15 counties assessed, 2010

	Name	Total pounds applied	Restricted material
1	Methyl bromide	85,112	Yes
2	Metam-sodium	37,920	Yes
3	Potassium n-methyldithiocarbamate	19,141	Yes
4	Propargite	1,964	No
5	Oxydemeton-methyl	1,173	Yes
6	Carbaryl	1,007	Yes
7	Thiophanate-methyl	658	No
8	Linuron	528	No
9	Myclobutanil	485	No
10	EPTC	371	No

als, and counties may further restrict use by location or time.

Table 17 shows the distributions of schools and students by county for the highest quartile (top 25%) of use in 2010 for pesticides classified as reproductive and developmental toxicants. Quartiles were calculated after excluding schools (1,833) that had no pesticides classified as reproductive and developmental toxicants applied within ¼ mile.

For pesticide active ingredients listed as reproductive and developmental toxicants, the range of pounds applied within ¼ mile for the highest quartile of schools was 34–18,092 lb.

- Monterey County had the highest percentage of schools (19.0%) in the highest quartile, and Ventura County had the highest number of schools (28) in the highest quartile.
- Sacramento County had the lowest percentage of schools (1.1%) in the highest quartile, while San Luis Obispo County had the fewest number of schools (1) in the highest quartile.
- Monterey County had the highest percentage of students (22.1%) in the highest quartile, while Ventura County had the highest number of students (20,433).
- Sacramento County had the lowest percentage of students (0.3%) in the highest quartile, and Yolo County had the fewest number of students (403) in the highest quartile.

Among all 15 counties, 6.8% of schools (171) and 6.1% of students (89,414) fell within the highest quartile.

Table 17. Schools and enrolled students (percent and number) in the top quartile* of schools by pounds (34–18,092 lb) of reproductive and developmental toxicant pesticides applied within ¼ mile, by county, 2010

County	Schools in the top quartile %	(N)	Students in the top quartile %	(N)	Total number of schools	Total number of students
Fresno	5.9	(20)	3.7	(7,321)	337	197,283
Imperial	2.9	(2)	1.5	(545)	69	37,343
Kern	4.6	(12)	4.2	(7,337)	260	173,336
Kings	4.8	(3)	2.8	(767)	62	27,856
Madera	3.8	(3)	3.4	(1,011)	80	29,993
Merced	13.6	(14)	10.0	(5,560)	103	55,345
Monterey	19.0	(26)	22.1	(16,361)	137	73,876
Sacramento	1.1	(4)	0.3	(731)	377	239,666
San Joaquin	7.6	(17)	5.4	(7,379)	223	136,803
San Luis Obispo	1.2	(1)	1.7	(584)	82	34,282
Santa Barbara	10.1	(12)	10.7	(7,036)	119	65,842
Stanislaus	7.7	(14)	7.7	(8,100)	183	105,176
Tulare	6.7	(13)	6.0	(5,846)	194	97,621
Ventura	12.7	(28)	13.4	(20,433)	221	152,703
Yolo	3.1	(2)	1.3	(403)	64	30,105
All 15 Counties	6.8	(171)	6.1	(89,414)	2,511	1,457,230

*Calculations of quartiles exclude schools with no use of pesticides classified as reproductive and developmental toxicants within ¼ mile.

Cholinesterase Inhibitors

What are Cholinesterase Inhibitors?

Cholinesterase inhibitors are chemicals that block the normal breakdown of an important chemical in the body — acetylcholine — that regulates nerve cell activity. This can lead to an overstimulation of nerve receptors and possibly lead to longer-term neurological deficits.[48]

Use of Cholinesterase Inhibitors Near Public Schools

Table 18 lists the 10 cholinesterase inhibitors with the highest use (by pounds applied) within ¼ mile of a public school. Of these compounds, two are designated as restricted materials by CDPR. Special permits are required for application of restricted materials, and counties may further restrict use by location or time.

Table 18. Top 10 pesticide active ingredients classified as cholinesterase inhibitors, by pounds applied within ¼ mile of schools in the 15 counties assessed, 2010

	Name	Total pounds applied	Restricted material
1	Chlorpyrifos	7,769	No
2	Malathion	6,322	No
3	Diazinon	1,785	No
4	Bensulide	1,718	No
5	Methomyl	1,539	Yes
6	Acephate	1,493	No
7	Naled	1,352	No
8	Propamocarb hydrochloride*	1,321	No
9	Dimethoate	1,259	No
10	Oxydemeton-methyl	1,173	Yes

* This pesticide has been shown to exhibit weak cholinesterase-inhibiting activities in vitro or in animals and to cause nervous system pathology in one or more studies. However, cholinesterase inhibition is not its primary toxicological mode of action.

Table 19 shows the distributions of schools and students by county for the highest quartile (top 25%) of use in 2010 for pesticides classified as cholinesterase inhibitors. Quartiles were calculated after excluding schools (1,873) that had no pesticides classified as cholinesterase inhibitors applied within ¼ mile.

For pesticide active ingredients listed as cholinesterase inhibitors, the range of pounds applied within ¼ mile for the highest quartile of schools was 63–1,345 lb.

- Monterey County had the highest percentage of schools (24.8%) and the highest number of schools (34) in the highest quartile.
- Sacramento County had the lowest percentage of schools (0.5%) in the highest quartile, while Imperial County and Madera County had the fewest number of schools (1) in the highest quartile.
- Monterey County had the highest percentage of students (28.5%) and the highest number of students (21,079) in the highest quartile.
- Sacramento County had the lowest percentage of students (0.1%) in the highest quartile, while Imperial County had the lowest number of students (172) in the highest quartile.

Among all 15 counties, 6.3% of schools (159) and 5.4% of students (78,135) fell within the highest quartile.

Table 19. Schools and enrolled students (percent and number) in the top quartile* of schools by pounds (63-1,354 lb) of cholinesterase inhibitor pesticides applied within ¼ mile, by county, 2010

County	Schools in the top quartile %	(N)	Students in the top quartile %	(N)	Total number of schools	Total number of students
Fresno	6.2	(21)	3.6	(7,131)	337	197,283
Imperial	1.4	(1)	0.5	(172)	69	37,343
Kern	3.5	(9)	2.0	(3,499)	260	173,336
Kings	6.5	(4)	7.4	(2,069)	62	27,856
Madera	1.3	(1)	1.8	(529)	80	29,993
Merced	3.9	(4)	8.1	(4,483)	103	55,345
Monterey	24.8	(34)	28.5	(21,079)	137	73,876
Sacramento	0.5	(2)	0.1	(202)	377	239,666
San Joaquin	4.0	(9)	2.1	(2,903)	223	136,803
San Luis Obispo	2.4	(2)	7.2	(2,470)	82	34,282
Santa Barbara	9.2	(11)	12.0	(7,908)	119	65,842
Stanislaus	7.1	(13)	3.2	(3,395)	183	105,176
Tulare	16.5	(32)	12.9	(12,618)	194	97,621
Ventura	6.3	(14)	6.1	(9,271)	221	152,703
Yolo	3.1	(2)	1.3	(406)	64	30,105
All 15 Counties	6.3	(159)	5.4	(78,135)	2,511	1,457,230

*Calculations of quartiles exclude schools with no use of pesticides classified as cholinesterase inhibitors within ¼ mile.

Toxic Air Contaminants

What are Toxic Air Contaminants?

Chemicals classified as Toxic Air Contaminants (TACs) and Hazardous Air Pollutants (HAPs) are known to cause or contribute to an increase in mortality or an increase in cancer or other serious illness, or may otherwise present a potential hazard to human health.[49] Other serious health impacts may include cancer, birth defects, adverse reproductive outcomes, or effects on the immune, nervous, or respiratory systems.[50] The primary concern with TACs and HAPs is to reduce inhalation exposures. However, some of these toxic air pollutants can also deposit onto soils or surface waters, where they can come into contact with humans, be taken up by plants, or be ingested by animals and concentrated up through the food chain.

Assembly Bill 1807 enables the California Air Resources Board to identify and control air toxics through consideration of "the risk of harm to public health, amount or potential amount of emissions, manner of, and exposure to, usage of the substance in California, persistence in the atmosphere, and ambient concentrations in the community." The law was later amended in 1993 to adopt all U.S. Hazardous Air Pollutants as TACs. For implementing the law for pesticides, CDPR must determine, through public and Scientific Review

Table 20. Top 10 pesticide active ingredients classified as toxic air contaminants, by pounds applied within ¼ mile of schools in the 15 counties assessed, 2010

	Name	Total pounds applied	Restricted material
1	Chloropicrin	150,285	Yes
2	1,3-Dichloropropene	136,241	Yes
3	Methyl bromide	85,112	Yes
4	Metam-sodium	37,920	Yes
5	Potassium n-methyldithiocarbamate	19,141	Yes
6	Captan	8,790	No
7	Maneb	5,497	No
8	Mancozeb	3,627	No
9	2,4-D, dimethylamine salt	2,054	No
10	Naled*	1,352	No

* Dichlorvos, a metabolite of naled, is a toxic air contaminant and a hazardous air pollutant.

Panel review, the levels of human exposure in the environment (ambient air) and estimate the potential human health risk from those exposures.[51]

Use of Toxic Air Contaminants Near Public Schools

Table 20 lists the 10 toxic air contaminants with the highest use (by pounds applied) within ¼ mile of a public school. Of these compounds, five are designated as restricted materials by CDPR. Special permits are required for application of restricted materials, and counties may further restrict use by location or time.

Table 21 shows the distributions of schools and students by county for the highest quartile (top 25%) of use in 2010 for pesticides classified as toxic air contaminants. Quartiles were calculated after excluding schools (1,859) that had no pesticides classified as toxic air contaminants applied within ¼ mile.

For pesticide active ingredients listed as toxic air contaminants, the range of pounds applied within ¼ mile for the highest quartile of schools was 240–28,448 lb.

- Merced County had the highest percentage of schools (14.6%) in the highest quartile, and Ventura County had the highest number of schools (29) in the highest quartile.
- Sacramento County had the lowest percentage of schools (0.5%) in the highest quartile,

Table 21. Schools and enrolled students (percent and number) in the top quartile* of schools by pounds (240-28,448 lb) of toxic air contaminant pesticides applied within ¼ mile, by county, 2010

County	Schools in the top quartile % (N)		Students in the top quartile % (N)		Total number of schools	Total number of students
Fresno	6.8	(23)	4.9	(9,629)	337	197,283
Imperial	1.4	(1)	1.0	(373)	69	37,343
Kern	3.5	(9)	3.6	(6,170)	260	173,336
Kings	6.5	(4)	8.1	(2,267)	62	27,856
Madera	1.3	(1)	0.7	(203)	80	29,993
Merced	14.6	(15)	14.7	(8,156)	103	55,345
Monterey	12.4	(17)	18.0	(13,314)	137	73,876
Sacramento	0.5	(2)	0.1	(202)	377	239,666
San Joaquin	5.4	(12)	5.2	(7,154)	223	136,803
San Luis Obispo	1.2	(1)	0.9	(298)	82	34,282
Santa Barbara	10.9	(13)	12.5	(8,247)	119	65,842
Stanislaus	11.5	(21)	10.1	(10,575)	183	105,176
Tulare	6.7	(13)	5.8	(5,633)	194	97,621
Ventura	13.1	(29)	13.3	(20,268)	221	152,703
Yolo	3.1	(2)	1.3	(403)	64	30,105
All 15 Counties	6.5	(163)	6.4	(92,892)	2,511	1,457,230

*Calculations of quartiles exclude schools with no use of pesticides classified as toxic air contaminants within ¼ mile.

while Imperial, Madera, and San Luis Obispo counties had the fewest number of schools (1) in the highest quartile.

- Monterey County had the highest percentage of students (18.0%) in the highest quartile, and Ventura County had the highest number of students (20,268) in the highest quartile.
- Sacramento County had the lowest percentage of students (0.1%) and the lowest number of students (202) in the highest quartile.

Among all 15 counties, 6.5% of schools (163) and 6.4% of students (92,892) fell within the highest quartile.

Fumigants

What are Fumigants?

Fumigants are pesticides used in gaseous form. They account for about 20% of all agricultural pesticides used in California. These chemicals are potent toxicants against insects or other invertebrate animal pests. The fumigants most often used include chemicals that are reproductive or developmental toxicants, toxic air contaminants, and chemicals classified as carcinogens. Many fumigants and some of their breakdown products are also irritating to the eyes and the respiratory tract. Because fumigants are gaseous, there is a high potential for measurable amounts to distribute into the air and drift away from their original application site. Pesticide drift into areas where people can be exposed is of potential public health concern and is therefore an area of active research and monitoring.[52] CDPR develops and implements the nation's strictest regulatory requirements to control the impacts of fumigants as both volatile organic compounds and toxic air contaminants.[53]

Use of Fumigants Near Public Schools

Table 22 lists the fumigants with the highest use (by pounds applied) within ¼ mile of a public school. Only eight pesticides classified as fumigants were measured within ¼ mile of all pub-

Table 22. Nine pesticide active ingredients classified as fumigants, by pounds applied within ¼ mile of schools in the 15 counties assessed, 2010

	Name	Total pounds applied	Restricted material
1	Chloropicrin	150,285	Yes
2	1,3-Dichloropropene	136,241	Yes
3	Methyl bromide	85,112	Yes
4	Metam-sodium	37,920	Yes
5	Potassium n-methyldithiocarbamate	19,141	Yes
6	Aluminum phosphide	120	Yes
7	Sodium tetrathiocarbonate	15	Yes
8	Oxythioquinox	<.01*	No

* Because the linkage is based on area weighted averages, apportioning a small fraction of an application may occur because the ¼ mile area around a school boundary could, for example, only very slightly intersect with a field, resulting in a very small measurement of pounds applied.

lic schools assessed. Of these eight compounds, seven are designated as restricted materials by CDPR. Special permits are required for application of restricted materials, and counties may further restrict use by location or time.

Table 23 shows the distributions of schools and students by county for the highest quartile (top 25%) of use in 2010 for pesticides classified as fumigants. Quartiles were calculated after excluding schools (2,188) that had no pesticides classified as fumigants applied within ¼ mile.

For pesticide active ingredients listed as fumigants, the range of pounds applied within ¼ mile for the highest quartile of schools was 1,071–27,038 lb.

- Monterey County had the highest percentage of schools (10.9%) in the highest quartile, and Ventura County had the highest number of schools (19) in the highest quartile.
- Imperial, Sacramento, and San Luis Obispo counties did not have any schools within the highest quartile.
- Monterey County had the highest percentage of students (16.4%) in the highest quartile, and Ventura County had the highest number of students (17,311) in the highest quartile.
- Imperial, Sacramento, and San Luis Obispo counties did not have any students within the highest quartile.

Among all 15 counties, 3.2% of schools (81) and 3.6% of students (52,671) fell within the highest quartile.

Table 23. Schools and enrolled students (percent and number) in the top quartile* of schools by pounds (1,071–27,038 lb) of fumigant pesticides applied within ¼ mile, by county, 2010

County	Schools in the top quartile % (N)		Students in the top quartile % (N)		Total number of schools	Total number of students
Fresno	0.9	(3)	0.5	(955)	337	197,283
Imperial	0.0	(0)	0.0	(0)	69	37,343
Kern	2.3	(6)	1.6	(2,713)	260	173,336
Kings	1.6	(1)	2.1	(584)	62	27,856
Madera	1.3	(1)	0.7	(203)	80	29,993
Merced	8.7	(9)	5.5	(3,023)	103	55,345
Monterey	10.9	(15)	16.4	(12,112)	137	73,876
Sacramento	0.0	(0)	0.0	(0)	377	239,666
San Joaquin	1.8	(4)	1.8	(2,468)	223	136,803
San Luis Obispo	0.0	(0)	0.0	(0)	82	34,282
Santa Barbara	5.0	(6)	7.4	(4,890)	119	65,842
Stanislaus	5.5	(10)	5.5	(5,800)	183	105,176
Tulare	2.6	(5)	2.3	(2,209)	194	97,621
Ventura	8.6	(19)	11.3	(17,311)	221	152,703
Yolo	3.1	(2)	1.3	(403)	64	30,105
All 15 Counties	3.2	(81)	3.6	(52,671)	2,511	1,457,230

*Calculations of quartiles exclude schools with no use of pesticides classified as fumigants within ¼ mile.

Priority Pesticides for Assessment and Monitoring

What are Priority Pesticides for Assessment and Monitoring?

Priority pesticides for assessment and monitoring are chemicals that — due to evolving understanding of their toxicological properties, exposure pathways, health effects and/or their increasing use — have been identified by CDPR as priorities for additional risk assessment or monitoring.[54,55] Also included in this category are chemicals of high use in California which have been identified as carcinogens, mutagens, reproductive toxicants, or sensitizers by the European Commission Directorate General for Health and Consumers[56], but were not already listed in this study's other pesticide categories. These chemicals may be, but are not necessarily, new to California and have been evaluated previously. All pesticides registered for use in California must first undergo risk assessment by the U.S. EPA. CDPR scientists may identify possible adverse health effects when they review toxicology data, which can trigger a risk assessment before a decision is made to register a product.[57]

Table 24. Top 10 active ingredients classified as priority pesticides for assessment and monitoring, by pounds applied within ¼ mile of schools in the 15 counties assessed, 2010

	Name	Total pounds applied	Restricted material
1	Chloropicrin	150,285	Yes
2	1,3-Dichloropropene	136,241	Yes
3	Methyl bromide	85,112	Yes
4	Metam-sodium	37,920	Yes
5	Potassium n-methyldithiocarbamate	19,141	Yes
6	Captan	8,790	No
7	Pendimethalin	8,198	No
8	Chlorpyrifos	7,769	No
9	Paraquat dichloride	6,543	Yes
10	Malathion	6,322	No

Use of Priority Pesticides for Assessment and Monitoring Near Public Schools

Table 24 lists the 10 priority pesticides for assessment and monitoring with the highest use (by pounds applied) within ¼ mile of a public school. Of these compounds, six are designated as restricted materials by CDPR. Special permits are required for application of restricted materials, and counties may further restrict use by location or time.

Table 25 shows the distributions of schools and students by county for the highest quartile (top 25%) of use in 2010 for pesticides classified as priority pesticides for assessment and monitoring. Quartiles were calculated after excluding schools (1,662) that had no priority pesticides for assessment and monitoring applied within ¼ mile.

For priority pesticides for assessment and monitoring, the range of pounds applied within ¼ mile for the quartile of schools was 308–28,920 lb.

- Monterey County had the highest percentage of schools (19.0%) in the highest quartile, and Fresno County had the highest number of schools (35) in the highest quartile.
- Sacramento County had the lowest percentage of schools (0.5%) in the highest quartile, while San Luis Obispo County had the fewest number of schools (1) in the highest quartile.

Table 25. Schools and enrolled students (percent and number) in the top quartile* of schools by pounds (308–28,920 lb) of priority pesticides for assessment and monitoring applied within ¼ mile, by county, 2010

County	Schools in the top quartile % (N)		Students in the top quartile % (N)		Total number of schools	Total number of students
Fresno	10.4	(35)	8.4	(16,609)	337	197,283
Imperial	2.9	(2)	2.3	(863)	69	37,343
Kern	3.8	(10)	3.7	(6,437)	260	173,336
Kings	6.5	(4)	8.1	(2,267)	62	27,856
Madera	3.8	(3)	3.5	(1,047)	80	29,993
Merced	17.5	(18)	17.8	(9,873)	103	55,345
Monterey	19.0	(26)	24.7	(18,250)	137	73,876
Sacramento	0.5	(2)	0.1	(202)	377	239,666
San Joaquin	6.7	(15)	6.4	(8,712)	223	136,803
San Luis Obispo	1.2	(1)	0.9	(298)	82	34,282
Santa Barbara	10.9	(13)	12.9	(8,504)	119	65,842
Stanislaus	14.8	(27)	11.1	(11,640)	183	105,176
Tulare	10.3	(20)	8.3	(8,145)	194	97,621
Ventura	14.0	(31)	13.9	(21,193)	221	152,703
Yolo	4.7	(3)	1.7	(501)	64	30,105
All 15 Counties	8.4	(210)	7.9	(114,541)	2,511	1,457,230

*Calculations of quartiles exclude schools with no use of priority pesticides for assessment and monitoring within ¼ mile.

- Monterey County had the highest percentage of students (24.7%) in the highest quartile, and Ventura County had the highest number of students (21,193) in the highest quartile.
- Sacramento County had the lowest percentage of students (0.1%) and the lowest number of students (202) in the highest quartile.

Among all 15 counties, 8.4% of schools (210) and 7.9% of students (114,541) fell within the highest quartile.

Discussion

Key Findings

In this study of 2,511 public schools in the top 15 counties by agricultural pesticide use in California, we found that 36% (899) of schools had applications of pesticides of public health concern (i.e., those with potential to cause adverse health effects) within ¼ mile of the school boundary. These pesticides included carcinogens, reproductive and developmental toxicants, cholinesterase inhibitors, toxic air contaminants, fumigants, and priority pesticides for assessment and monitoring. We additionally found that there were 226 schools in the top quartile of poundage (calculated after excluding schools with no pesticides applied nearby) for all pesticides studied, representing over 118,000 students. The amounts of pesticides applied in the top quartile ranged from 319–28,979 lb.

Pesticides of public health concern applied near schools were not applied equally among the 15 counties analyzed. Of the counties assessed, Ventura and Monterey counties frequently had the most pesticide use near schools, based on different metrics.

Counties with the most pesticides of public health concern used near public schools, 2010

	Top county by number of schools in the top quartile of use*	Top county by percentage of its schools in the top quartile of use*	Top county by number of students attending schools in the top quartile of use*	Top county by percentage of its students attending schools in the top quartile of use*
Carcinogens	Stanislaus (28)	Monterey (16.8%)	Ventura (17,023)	Monterey (19.5%)
Reproductive and Developmental Toxicants	Ventura (28)	Monterey (19.0%)	Ventura (20,433)	Monterey (22.1%)
Cholinesterase Inhibitors	Monterey (34)	Monterey (24.8%)	Monterey (21,079)	Monterey (28.5%)
Toxic Air Contaminants	Ventura (29)	Merced (14.6%)	Ventura (20,268)	Monterey (18.0%)
Fumigants	Ventura (19)	Monterey (10.9%)	Ventura (17,311)	Monterey (16.4%)
Priority Pesticides for Monitoring and Assessment	Fresno (35)	Monterey (19.0%)	Ventura (21,193)	Monterey (24.7%)
All pesticides (all categories)	Fresno (39)	Monterey (21.2%)	Ventura (21,193)	Monterey (25.1%)

*Calculations of quartiles exclude schools with no use of pesticides within ¼ mile.

The pesticides examined in this study were ranked by pounds applied within ¼ mile of a school boundary. The top three pesticides of public health concern used near schools were chloropicrin, 1,3-dichloropropene, and methyl bromide; classifications that the three had in common were toxic air contaminants, fumigants, and priority pesticides for assessment and monitoring. Of the top 10 pesticides used near schools, six are listed by CDPR as restricted materials, which require special permits and are eligible for additional regulation at the local level. Additionally, eight of the top 10 pesticides have a chemical persistence (measured as half-life in soil) of more than a week. Only one (chloropicrin) has a half-life of less than 24 hours.

Of the six categories of pesticides assessed, priority pesticides for assessment and monitoring were used near the most schools (33.8%) and fumigants were used near the fewest schools (12.7%). However, both of these pesticide categories had similar ranges of use, from zero to over 27,000 lb applied within ¼ mile of a school. Priority pesticides for assessment and monitoring had the greatest poundage (523,566 lb) applied within ¼ mile of all schools in the 15 counties, while cholinesterase inhibitors had the lowest (37,455 lb). Many pesticides included in the study belong to more than one category; therefore the categories are not mutually exclusive.

Hispanics were the only racial/ethnic group whose representation increased as pesticide use increased. While Hispanic children made up 54.1% of the population in the public schools in the 15 counties, they comprised 50.3% of the population in schools with no pesticide use within ¼ mile, 61.3% of the population in schools with any pesticide use within ¼ mile, and 67.7% of the population in schools in the highest quartile of pesticide use. In the 15 counties, Hispanic children were 46% more likely than White children to attend schools with any pesticides of concern applied nearby and 91% more likely than White children to attend schools in the highest quartile of pesticide use.

Finally, there was no overall difference in household income levels between students that attended schools with no pesticides applied nearby, compared to those who attended schools with any pesticides applied nearby and those who attended schools in the top quartile of pesticide use. However, differences in household income level were apparent within individual counties. In some cases, student populations attending schools in the top quartile of pesticide use had higher household incomes as compared to students in the same county attending schools with no pesticide use nearby; in other cases, the reverse situation was observed.

Utility and Limitations of Study Methodology

The methodology used in this study has several features that may be applied in future efforts. For the first time, highly accurate field location data were linked with agricultural pesticide application data to assess pesticide use near sensitive populations in multiple counties across California. School boundary data were also vastly improved in relation to past efforts, using parcel-level data and satellite imagery to resolve inaccuracies in school geographic data. We were able to systematically and accurately link over 2.3 million PUR records for the 15 counties using state-of-the-art GIS spatial linkage tools. Taken together, these technological improvements greatly enhance the utility of existing public data on pesticide use.

There were also several limitations to the study methodology. Although we were able to use highly accurate field location data for 80% of all pesticide applications, the remaining application locations were estimated primarily using less geographically specific survey data from DWR, which allow us to link crop and land use data to the PUR. These survey data are not collected every year.

Some pesticides included in this study are designated as restricted materials and may have had time and/or distance restrictions on their use near schools during 2010. However, we did not limit our study to applications that occurred when schools were in session for several reasons, including (1) the use of school properties by children and adults before and after classes, on weekends, and during the summer; (2) the potential for pesticides applied at night or in the early morning to drift onto school property; and (3) the potential for pesticides with high chemical persistence to result in exposures. Furthermore, the methodology assumed uniform application of pesticides in the field in which it was applied. This would not account for situations where any portion of the field overlapping the ¼-mile boundary of the school was not treated, for example in compliance with a distance restriction.

Finally, in investigating potential data sources for this study, CDPH contacted CDPR and obtained a preliminary dataset of (non-agricultural) pesticides used in schools in the 15 counties as required by the Healthy Schools Act (more information on policies related to pesticides and schools can be found in Appendix 3). However, we were unable to obtain information on the completeness of the dataset or any evaluation data on the compliance by schools in submitting the annual School Site Pesticide Use Reporting forms to the CACs. Additionally, since schools are not required to report non-restricted pesticide applications by school staff, we concluded that we could not adequately evaluate the quality and representativeness of the data on pesticides used on school properties, and therefore could not present summary data on these compounds in this report. These data would be important to understand the total potential for pesticide exposure among children in school settings.

Future Directions

This report provides information on the patterns of use for pesticides of public health concern applied near public schools in California's top 15 counties by agricultural pesticide use. The study methodology and results could be used to:

- Target and expand pesticide monitoring and exposure assessment efforts, such as air monitoring, soil sampling on school properties, or biomonitoring studies (measurement of pesticides in biological samples, such as blood or urine) of schoolchildren
- Inform epidemiological studies that examine the relationship between pesticide use and health effects
- Understand what kinds of pesticides are being applied near schools, which in turn may inform future decision-making around school siting, pesticide permitting regulations, or other policies with the potential to affect public health

This study does not determine if schoolchildren were actually exposed in these areas. We did not evaluate whether pesticides applied were transported by air, soil, water, or other media to a location where children could come into contact with them. Pesticide transport is influenced by a number of factors, including application method and meteorology. Furthermore, we did not assess potential exposure routes (such as skin contact or inhalation). An assessment of exposure pathways is beyond the scope of this study, though the study methodology and report results may be informative for designing future assessments.

This study demonstrates that ongoing annual statewide surveillance studies could be performed to assess trends in agricultural pesticide use near schools, if standardized datasets of field-level pesticide data and geographically accurate school boundaries are made available.

In conducting this study, we have identified the need for:

- Routine and standardized collection, digitization, and reporting of data on agricultural field locations of each pesticide use permit, which could then be made publicly accessible via the PUR system in a format convenient for Geographic Information Systems
- An accurate, complete, and publicly accessible statewide database on all pesticides applied on school properties, including those pesticides applied by school maintenance staff

- An accurate, complete, and publicly accessible database of school property boundaries in California
- Ongoing surveillance of the use of pesticides of public health concern near schools and other sensitive populations and land uses (e.g., women of reproductive age and childcare centers, respectively) in order to understand trends and usage patterns

Conclusions

California's agricultural production and related activities greatly contribute to the state's economy and employment. Many state and local agencies, non-governmental organizations, farmers, and community members must work together to maintain a vibrant agricultural economy and a healthy and prosperous population. The state's Division of Occupational Health and Safety, Department of Food and Agriculture, Department of Pesticide Regulation, and Department of Public Health, along with the county agricultural commissioners, are all committed to achieving this standard.

The California Environmental Health Tracking Program, housed in the California Department of Public Health in partnership with the Public Health Institute and funded by the Centers for Disease Control and Prevention, conducts surveillance on statewide environmental health hazards. CDPH carries out essential public health activities such as monitoring the health status of Californians to identify and investigate health problems, hazards, and disparities within communities and throughout the state. This study is in line with CEHTP's goal to improve existing public data resources and to increase the utility of the data for the surveillance of environmental hazards and the protection of public health.

This study demonstrated that the data are available — though not yet collected and disseminated in a standardized manner throughout California — to accurately assess the use of pesticides near sensitive populations, such as schoolchildren. This study found that most public schools in the 15 counties did not have pesticides of public health concern applied nearby. However, a small percentage of schools had many pounds of these pesticides applied nearby, and pesticide use near schools varied by county. We also found that Hispanic students were overrepresented in schools with more pesticide use nearby compared to other ethnic/racial groups.

We hope that the information in this report and the assessment methods presented will be used by school officials, county agricultural commissioners, pesticide regulators, exposure assessment scientists, and others in their current and future efforts to better understand sensitive populations' proximity to applications of pesticides of public health concern. This information may be useful for informing pesticide monitoring and exposure assessment efforts — such as air monitoring, soil sampling, or biomonitoring — and epidemiologic research studies. Finally, state and local officials can use this information to better evaluate and tailor policies and activities to minimize potential pesticide exposures near schools.

Acronyms

CAC	California Agricultural Commissioner
CDE	California Department of Education
CDPH	California Department of Public Health
CDPR	California Department of Pesticide Regulation
CEHTP	California Environmental Health Tracking Program
DWR	California Department of Water Resources
FRPM	Free and Reduced Price Meal Program
GIS	Geographic Information System
HAP	Hazardous Air Pollutant
IPM	Integrated Pest Management
PHI	Public Health Institute
PLS	Public Land Survey
PUR	Pesticide Use Reporting
TAC	Toxic Air Contaminant
U.S. EPA	United States Environmental Protection Agency
WHO	World Health Organization

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Appendix 1: Restricted Materials Requirements

More information on restricted materials is available from the California Department of Pesticide Regulation at www.cdpr.ca.gov/docs/enforce/permitting.htm and www.cdpr.ca.gov/docs/enforce/dpr-enf-013a.pdf, last accessed October 1, 2013.

CALIFORNIA RESTRICTED MATERIALS REQUIREMENTS

A FEDERAL RESTRICTED USE PESTICIDES

(Included by reference as California Restricted Materials)
PESTICIDES DISPLAYING THE STATEMENT SHOWN HERE > > > OR A SIMILAR STATEMENT ON THE PRODUCT CONTAINER

RESTRICTED USE PESTICIDE
DUE TO (reason for restricted use classification)
For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification.

PRODUCTS BEARING THE "PHYSICALLY PRESENT" STATEMENT ON THE LABEL ARE REQUIRED TO HAVE A CERTIFIED APPLICATOR PHYSICALLY PRESENT AT THE USE SITE.

B CALIFORNIA RESTRICTED MATERIALS

TRADE NAMES ARE INCLUDED IN THE INTEREST OF SIMPLICITY; OTHER PRODUCTS WITH THE SAME COMPOUND AS AN ACTIVE INGREDIENT ARE ALSO SUBJECT TO THE PERMIT REQUIREMENTS. REFER TO TITLE 3, CALIFORNIA CODE OF REGULATIONS (3 CCR) SECTION 6400.

Acrolein, when labeled for use as an aquatic herbicide
Aldicarb (Temik)
All dust (except those products containing only exempt pesticides)**
Aluminum phosphide (Phostoxin)
Any pesticide containing active ingredients listed under section 6800(a), when labeled for agricultural, outdoor institutional, or outdoor industrial use[1]
Any pesticide pursuant to section 18 of FIFRA (Emergency exemption)
4-Amino pyridine (Avitrol)
Azinphos-methyl (Guthion)
Calcium cyanide
Carbaryl (Sevin)**
Carbofuran (Furadan)
Chloropicrin
3-Chloro-p-toluidine hydrochloride (Starlicide)
Dazomet (Basamid), when labeled for production of agricultural plant commodities
Dicamba (Banvel)*
2,4-dichlorophenoxyacetic acid (2,4-D)*
2,4-dichlorophenoxybutyric acid (2,4-DB)*
2,4-dichlorophenoxypropionic acid (2,4-DP)*
1,3-dichloropropene (Telone II)
Disulfoton (Di-Syston)**
Endosulfan (Thiodan)**
Ethoprop (Mocap), when labeled for turf use
Fenamiphos (Nemacur)
Lindane**
Magnesium phosphide
Metam sodium, when labeled for the production of agricultural plant commodities
Methamidophos (Monitor)
Methidathion (Supracide)
Methomyl (Lannate)**
Methyl bromide
2-methyl-4-chlorophenoxyacetic acid (MCPA)*
Methyl iodide
Methyl isothiocyanate (MITC), when labeled for the production of agricultural plant commodities
Mevinphos (Phosdrin)
~~Molinate (Ordram)~~[2]
Oxydemeton-methyl (Metasystox-R)
Paraquat (Gramoxone)
Parathion-methyl
Phorate (Thimet)
Phosphine gas
Potassium n-methyldithiocarbamate (metam-potassium), when labeled for the production of agricultural plant commodities
Propanil (3,4-dichloropropionanilide)
Sodium cyanide
Sodium fluoroacetate (compound 1080)
Sodium tetrathiocarbonate (Enzone)
Strychnine**
Sulfotepp
Sulfuryl fluoride
Thiobencarb (Bolero)
Tribufos (DEF, Folex)
Tributyltin, organotin, or a tri-organotin compound formulated as an antifouling paint, coating, or compound and labeled for the control of fouling organisms in an aquatic environment
Zinc phosphide**

EXCEPTIONS FROM RESTRICTION

**Products labeled only for home, structural, industrial, institutional, or public agency vector control district uses

- Carbaryl formulated as a bait
- Fly bait containing 1% or less Methomyl
- Use on livestock or poultry
- Diluted, ready-to-use solution of certain restricted herbicides
- One quart or less of a product containing certain restricted herbicide in a liquid formulation
- 2,4-D products labeled only for use as a plant growth regulator
- One gallon or less of a product containing the following percentages of restricted herbicide in a liquid formulation:
  - 15% or less Dicamba
  - 15% or less MCPA
  - 15% or less 2,4-D
  - 15% or less 2,4-DB, OR
  - 15% or less 2,4-DP
- 50 pounds or less of a certain restricted herbicide (Phenoxy and Dicamba) containing 10% or less of active ingredient prepared for use without further dilution
- One pound or less of a product containing certain restricted herbicide (Phenoxy and Dicamba) in a dry formulation

APPLICATORS WHO HAVE MET THE CERTIFICATION REQUIREMENTS FOR RESTRICTED MATERIALS PURSUANT TO FOOD AND AGRICULTURAL CODE §14015

CERTIFIED COMMERCIAL APPLICATORS

(PERSONS OTHER THAN PRIVATE APPLICATORS USING RESTRICTED PESTICIDES)

- Journeyman Pilots
- Qualified Applicator Licensees
- Qualified Applicator Certificate Holders
- Structural Pest Control Field Representatives
- Structural Pest Control Operators
- Vector Control Technicians

A PESTICIDES ONLY IN "A" ABOVE -- NO PERMIT REQUIRED
B PESTICIDES ONLY IN "B" ABOVE -- PERMIT REQUIRED; EXCEPTIONS APPLY

CERTIFIED PRIVATE APPLICATORS

(GROWERS, NURSERYMEN, AND OTHERS USING RESTRICTED PESTICIDES TO PRODUCE AGRICULTURAL COMMODITIES)

- Private Applicator Certificate Holders

A PESTICIDES ONLY IN "A" ABOVE -- NO PERMIT REQUIRED
B PESTICIDES ONLY IN "B" ABOVE -- PERMIT REQUIRED; EXCEPTIONS APPLY

EXCEPTIONS FROM PERMIT REQUIREMENT

[1] PESTICIDES LISTED UNDER 3 CCR SECTION 6800(a) (POTENTIAL TO POLLUTE GROUND WATER): NO PERMIT REQUIRED FOR CERTIFIED APPLICATORS USING THESE MATERIALS OUTSIDE OF A GROUND WATER PROTECTION AREA.
Atrazine Bentazon (Basagran®) Bromacil Diuron Norflurazon Prometon Simazine

[2] U.S. EPA issued *Molinate; Product Cancellation Order and Amendment to Terminate Uses* which indicated the stop use date of August 31, 2009. Molinate (Ordram) will be deleted from this listing after the regulation change occurs.

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DEPARTMENT OF PESTICIDE REGULATION
ENFORCEMENT BRANCH

Appendix 2: School Pesticide Restrictions, by County

California law allows the California Department of Pesticide Regulation (CDPR) to classify certain pesticides as restricted materials. County Agricultural Commissioners (CACs) issue permits for the use of restricted materials, which can only be applied by trained individuals. CACs may further limit the application of restricted materials to specific times and places. These conditions are typically applied to mitigate risks based on local or site-specific needs, including sensitive sites such as schools. These conditions are enforceable under state law. More information on the restricted materials permitting process is available at www.cdpr.ca.gov/docs/dept/factshts/permitting.pdf.

The following table includes pesticide restrictions as of September 2013 related to schools for the 15 counties in this study. The table was provided by the 15 CACs. These restrictions may not be comprehensive, and additional specific conditions are likely applied on a case-by-case or county-by-county basis.

While this table provides an overview, in order to fully assess and interpret the pesticide restrictions, it is necessary to communicate with one's CAC. **This table does not necessarily indicate the policies in place during 2010, the focus year of this study.**

County	Pesticide Application Restrictions	Restrictions Apply to	Application Type	Buffer Zone	Additional Conditions	School Notified
Fresno	School in session or school grounds occupied	All pesticides	All methods	⅛ mile		
	During the regular and summer school session	Pesticides with worker safety interval greater than 48 hours	All methods	⅛ mile		
Imperial	No application within 12 hours of when school or daycare is in session or grounds are occupied	CA restricted materials only	Air	¼ mile		Notification is voluntary and arranged between the school and grower or applicator.
	No application when school or daycare is in session or grounds are occupied	CA restricted materials only	Ground	½ mile		Notification is voluntary and arranged between the school and grower or applicator.
		CA restricted materials only	Air	1 mile		Notification is voluntary and arranged between the school and grower or applicator.
	School **not** in session or children **not** present for at least 36 hours following the fumigation	Fumigants: CA Restricted only	Fumigations require signing specific county use permit conditions.	½ mile as with any CA restricted material	Fumigants containing 1,3-D cannot be applied within 100 feet of a structure that will be occupied during the application and within 6 days following the application. Sprinkler applications of Metam products are prohibited countywide.	Notifications of use are based on label requirements. Notification for uses outside label requirements and County Conditions of Use Restrictions is voluntary and arranged between the school and grower or applicator.
Kern	School in session or during school sponsored activities when children are present.	Restricted materials	All applications	¼ mile		24 hour NOI to the CAC
		Restricted materials	Applications on school grounds		No applications allowed	24 hour NOI to the CAC
Kings	School in session or due to be in session within 24 hours	Restricted materials	Aerial	¼ mile	No pesticide application by ground or air shall be made or continued if: • There is any reasonable hazard of drift to nontarget property • There is any reasonable hazard of drift to persons not involved with the application	

County	Pesticide Application Restrictions	Restrictions Apply to	Application Type	Buffer Zone	Additional Conditions	School Notified
Kings, cont.	School in session	Restricted cotton defoliant materials	Aerial	¼ to ½ mile		
			Ground	⅛ to ½ mile		
	School out for 24 hours	Restricted cotton defoliant materials	Aerial and ground	⅛ mile		
Madera	School in session or children present	CA restricted materials only	Ground	500 ft	Some exceptions for spot spraying and vertebrate control (below ground) Confirmed approval of NOI	Grower/applicator voluntarily work with individual school on application timing
			Air	¼ mile	Confirmed approval of NOI	Grower/applicator voluntarily work with individual school on application timing
		CA restricted fumigants	Fumigation	Minimum ⅛ mile if label BZ is <300 ft Minimum ¼ mile if label BZ is >300 ft	Applications of straight Chloropicrin or in combination with 1,3-D (>2%): 96 hour NOI; maximum rate 175 lbs/ac w/in ¼ mile; 10 acre maximum/24 hrs w/in ¼ mile; tarp required if w/in ¼ mile (except for replants <1acre) Fumigants per label and more restrictive permit conditions on a case-by-case basis Confirmed approval of NOI	Grower/applicator voluntarily work with individual school on application timing.
	School **not** in session or children **not** present	CA restricted materials only	Ground	Label restrictions (if present) apply	More restrictive permit conditions on a case-by-case basis Confirmed approval of NOI	N/A
			Air	Label restrictions (if present) apply	More restrictive permit conditions on a case-by-case basis Confirmed approval of NOI	N/A
	School **not** in session or children **not** present for minimum 36 hours following the fumigation	CA restricted fumigants	Fumigation	Based on label and determined by application method, tarp type (if applicable) and rate per acre	Fumigants containing only 1,3-D cannot be applied w/in minimum 100 ft of a structure that will be occupied w/in 7 days following the application Applications of straight Chloropicrin or in combination with 1,3-D (>2%): w/TIF tarp minimum 60 ft buffer; minimum 100 ft buffer for all other applications (except for replants & raised tarp nursery both <1 ac, other specific sites on a case-by-case basis) Confirmed approval of NOI	N/A

County	Pesticide Application Restrictions	Restrictions Apply to	Application Type	Buffer Zone	Additional Conditions	School Notified
Merced	May be prohibited when school is in session or due to be in session or when grounds are occupied	Restricted materials	Aerial	¼ mile		Applications may not commence until the notice of intent is verbally authorized by the CAC.
			Ground air-blast	⅛ mile		Applications may not commence until the notice of intent is verbally authorized by the CAC.
		Fumigants	Ground	Buffer restrictions for all fumigant labels apply	All label restrictions apply for hard to evacuate facilities	Notification requirements for all fumigant label restrictions apply for hard to evacuate facilities
		Chloropicrin	Ground	¼ mile	Rate per acre cannot exceed 175 lbs a.i. within ¼ mile	Maximum of 10 acres per 24 hours may be treated and tarped except for tree and vine replants less than 1 contiguous acre
Monterey	During school hours and 1 hour before or after school hours	CA restricted materials only	Ground	500 ft	Individual permits may contain conditions that are more restrictive.	Notification is voluntary and arranged between the school and the adjacent grower.
		All pesticides	Ground	500 ft	Long-established practice (20+ years) for growers and applicators to leave a 500 ft buffer zone between target field and school property whenever any pesticide is applied.	Notification is voluntary and arranged between the school and the adjacent grower
	At all times	CA restricted materials only	Air – fixed wing	1,000 ft	Individual permits may contain conditions that are more restrictive.	Notification is voluntary and arranged between the school and the adjacent grower.
			Air – helicopter	120 ft	When application is between 120 and 600 feet of a school pest control business must have a person stationed on the ground between the treatment site and the school in two-way radio communication with pilot. Individual permits may contain conditions that are more restrictive.	Notification is voluntary and arranged between the school and the adjacent grower
	During school hours or when children are present or when either will occur within 36 hours following the end of the application	CA restricted fumigants	Fumigation	No application w/in ⅛ mile if label BZ is <300 ft No application w/in ¼ mile if label BZ is >300 ft	Individual permits may contain conditions that are more restrictive.	Label requires notification at least 7 days in advance of schools that fall w/in sliding scale on the fumigant label based upon the BZ size. If field is within ¼ mile of school must notify Pajaro Valley School District or North Monterey County School District 5 days prior to fumigation

County	Pesticide Application Restrictions	Restrictions Apply to	Application Type	Buffer Zone	Additional Conditions	School Notified
Monterey, cont.	School **not** in session or children **not** present	CA restricted materials only	Ground	Label restrictions (if present) apply	Individual permits may contain conditions that are more restrictive.	N/A
	School **not** in session or children **not** present for at least 36 hours following the fumigation	CA restricted fumigants	Fumigants	Based on label and determined by application method, tarp type and rate per acre	Application of fumigants containing 1,3-D cannot be applied w/in 100ft of a structure that will be occupied w/in 7 days following the application.	Label requires notification at least 7 days in advance of schools that fall w/in sliding scale on the fumigant label based upon the BZ size.
Sacramento	While children are present	Restricted materials			No applications adjacent to schools	Permits are restricted by case by case conditions.
		Non-restricted Materials	Ground or air	Buffers Recommended	Recommended to be applied when children are not present.	
	When school is **not** in session	Non-restricted materials	Aerial	Buffers Recommended	Applications are flown in a pattern parallel to the school property and none are allowed adjacent to the school.	
			Ground	Buffers Recommended		
		Fumigants	Ground		All Label Restrictions apply for hard to evacuate facilities	Notification requirements for all fumigant label restrictions apply for hard to evacuate facilities
San Joaquin	School in session or school sponsored event	CA restricted materials only	Ground	660 ft	Does not apply to: vertebrate pest control, back pack applications, equipment where nozzles pointing down AND wind direction is moving away from school site	Notification is voluntary
			Air	660 ft		Notification is voluntary
		CA restricted fumigants	Fumigation	No application w/in ⅛ mile if label BZ is <300 ft No application w/in ¼ mile if label BZ is >300 ft		Label requires notification at least 7 days in advance of schools that fall w/in sliding scale on the fumigant label based upon the BZ size. Grower is required to contact and work with the individual schools on application timing.
	School **not** in session, **no** school sponsored event	CA restricted materials only	Ground	Label restrictions apply		N/A

County	Pesticide Application Restrictions	Restrictions Apply to	Application Type	Buffer Zone	Additional Conditions	School Notified
San Joaquin, cont.	School **not** in session, **no** school sponsored event	CA restricted materials only	Air	Label restrictions apply		N/A
	School **not** in session or children **not** present for at least 36 hours following the fumigation	CA restricted fumigants	Fumigation	Based on label and determined by application method, tarp type and rate per acre	Application of fumigants containing 1,3-D cannot be applied w/in 100ft of a structure that will be occupied w/in 7 days following the application.	Label requires notification at least 7 days in advance of schools that fall w/in sliding scale on the fumigant label based upon the BZ size.
San Luis Obispo	School in session or children present	CA restricted materials only	Spray and dust by ground	500 ft	Exceptions may be made for spot treatments.	Notification may be required between the school and the adjacent grower.
			Spray and dust by air	½ mi (2640 ft)		Notification may be required between the school and the adjacent grower.
		CA restricted fumigants	Fumigation	No application w/in ⅛ mile if label BZ is <300 ft No application w/in ¼ mile if label BZ is >300 ft	During application and buffer zone duration	The Certified Applicator is required to contact and work with the individual schools on application timing.
		General use non-restricted pesticides	All		Additional mitigations may be recommended including; BZ, air flow away, timing etc.	Grower may voluntarily notify the adjacent school.
Santa Barbara	School in session or children present	CA restricted materials only	Ground	500 ft		Notification is voluntary and arranged between the school and the adjacent grower.
			Air	750 ft		Notification is voluntary and arranged between the school and the adjacent grower.
		CA restricted fumigants	Fumigation	No application w/in ⅛ mile if label BZ is <300 ft No application w/in ¼ mile if label BZ is >300 ft		Label requires notification at least 7 days in advance of schools that fall w/in sliding scale on the fumigant label based upon the BZ size. Grower is required to contact and work with the individual schools on application timing.

County	Pesticide Application Restrictions	Restrictions Apply to	Application Type	Buffer Zone	Additional Conditions	School Notified
Santa Barbara, cont.	School **not** in session or children **not** present	CA restricted materials only	Ground	Label restrictions (if present) apply		N/A
			Air	200 ft		N/A
	School **not** in session or children **not** present for at least 36 hours following the fumigation	CA restricted fumigants	Fumigants	Based on label and determined by application method, tarp type and rate per acre	Application of fumigants containing 1,3-D cannot be applied w/in 100ft of a structure that will be occupied w/in 7 days following the application. Sprinkler application of Metam products are prohibited countywide.	Label requires notification at least 7 days in advance of schools that fall w/in sliding scale on the fumigant label based upon the BZ size.
Stanislaus	School in session or during school sponsored activities when children are present.	Restricted materials	All applications	¼ mile		24 hour NOI to CAC. 48 hour NOI for Penncap applications.
	School **not** in session or children **not** present for at least 36 hours following the fumigation	CA restricted fumigants	Fumigants	Based on label and determined by application method, tarp type and rate per acre	Application of fumigants containing 1,3-D cannot be applied w/in 100ft of a structure that will be occupied w/ in 7 days following the application. Chloropicrin over 2% applications: rate cannot exceed 175 lbs. a.i. per acre within ¼ mile. Maximum of 10 acres per 24 hours may be treated within ¼ mile. Applications within ¼ mile must be tarped. Additional restrictions may apply based on the evaluation of the site.	Label requires notification at least 7 days in advance of schools that fall w/in sliding scale on the fumigant label based upon the BZ size.
Tulare	School in session	Restricted material	Aerial	¼ mile		24 hour NOI to the CAC
Ventura	School in session	CA restricted materials	All applications	¼ mile	Follow recommendations contained in the "Farming Near Schools. A Community-based Approach to Protecting Children" publication.	
		Chlorpyrifos	Foliar applications only	Use within 300 ft	Requires a permit. Cannot be used in any portion of the block adjacent to a school between 6:00a.m. – 6:00 p.m. ("Adjacent" means: shares at least a common boundary with a school, the block is located across the street from a school or the block is less than 300 ft. from a school with no other crop or structure between the block and the school.) Applicators must be certified.	48 hours NOI to CAC.

County	Pesticide Application Restrictions	Restrictions Apply to	Application Type	Buffer Zone	Additional Conditions	School Notified
Ventura, cont.	School **not** in session	CA restricted materials	All applications	Use within 300 ft	Follow recommendations contained in the "Farming Near Schools. A Community-based Approach to Protecting Children" publication.	Contact school to determine appropriate time of application to avoid school activities. This information shall be included in the NOI. This does not apply to vertebrate pest control.
		Chlorpyrifos	Foliar applications only	No use between 6:00 am and 6:00 pm	Requires a permit. Applicators must be certified.	48 hour NOI to CAC
Yolo	At any time	Restricted use pesticides only Industry follows school conditions for non-restricted also.	Air	¼ mile		Notification is voluntary and arranged between the school and the adjacent grower
	School in session	Restricted use pesticides only Industry follows school conditions for non-restricted also.	Ground	¼ mile except fumigants which have additional requirements and restriction.		Notification is voluntary and arranged between the school and the adjacent grower

Appendix 3: Existing Policies Related to Pesticides and Schools

Many state and federal policies related to pesticides and health are in place to protect the health of farmworkers, communities, and sensitive populations near agricultural production. It is beyond the scope of this report to provide a full review of all policies, regulations, and their history, but below is a brief review of major policies.

Agricultural Pesticide Use Near Schools in California

Many California counties have policies that restrict pesticide use near schools. In 2002, Assembly Bill (AB) 947 (Jackson) was signed into law by Governor Gray Davis. This bill authorizes the agricultural commissioners to apply special restrictions on certain pesticides with respect to the timing, notification, and method of application near schools. The restrictions vary on a county-by-county basis by pesticide; there is no statewide regulation establishing uniform restriction zones near schools. The bill allows the Director of Pesticide Regulation to disapprove restrictions within 30 days of their submission. AB 1721 (Swanson), which would prohibit certain types of pesticides from being applied within ¼ or ½ mile from a school boundary, was referred to the Assembly Committee on Agriculture with no further action in 2010.

Pesticides Applied on School Grounds

Pesticides are also applied within school grounds (buildings and outdoor spaces) by school personnel and licensed applicators. In January 2001, the Healthy Schools Act of 2000 (AB 2260) enacted right-to-know requirements for pesticide use on school grounds, including notification, posting, and recordkeeping. The law also put into code CDPR's existing school integrated pest management (IPM) program and newer, more detailed pesticide use reporting.

Under AB 2260 a school designee is required to give parents and staff annual written notification about pesticide products expected to be used at a school that year. Each school must keep records of almost all applications for four years after the application occurred. Products used as self-contained baits or traps; gels or pastes used as crack-and-crevice treatments; pesticides exempted from regulation by the U.S. EPA; and antimicrobial pesticides, including sanitizers and disinfectants, are not required to be recorded.

Applications made by school personnel are not required to be reported to the county agricultural commissioner, except when a restricted material is applied. Pest control businesses contracted by schools must submit two reports regarding application of pesticides on school properties:

1. The Monthly Summary Pesticide Use Report, submitted to the county agricultural commissioner, includes pesticides used at schools
2. The School Site Pesticide Use Reporting form, required to be submitted to the county agricultural commissioner annually

The Healthy Schools Act contains no specific enforcement authority for these requirements.

More information about the Healthy Schools Act is available at apps.cdpr.ca.gov/schoolipm/school_ipm_law/main.cfm.

Appendix 4: Estimated Pounds of Pesticide Active Ingredients Applied Within ¼ Mile of a School, by Active Ingredient

Of the 635 chemicals considered in this study, 144 were applied within ¼ mile of a school in the 15 counties assessed. Many of these chemicals belong to multiple pesticide categories, as indicated by checkmarks in the list below. Of the 144 chemicals, 82 are priority pesticides for assessment and monitoring (PRIOR), 40 are toxic air contaminants (TAC), 8 are fumigants (FUM), 35 are carcinogens (CARC), 27 are reproductive and developmental contaminants (REP/DEV), and 38 are cholinesterase inhibitors (CHOIN). Summing the total pounds applied for each pesticide category will not match the total pounds applied for the All Pesticides (ALL) category (as in Table 6 on page 15 of this report) because of the fact that some chemicals belong to several categories. A complete list of the pesticide active ingredients considered for this study is available at www.cehtp.org/projects/ehss01/pesticides_and_schools/chem_list.xlsx.

		Category						Pounds applied
Chemical Code	Name	PRIOR	TAC	FUM	CARC	REP/DEV	CHOIN	ALL
	Total pounds applied (by category)	523,566	454,202	428,834	228,019	149,279	69,426	538,912
00136	Chloropicrin	•	•	•				150,285
00573	1,3-Dichloropropene	•	•	•	•			136,241
00385	Methyl bromide	•	•	•		•		85,112
00616	Metam-sodium	•	•	•	•	•		37,920
00970	Potassium n-methyldithiocarbamate	•	•	•	•	•		19,141
00104	Captan	•	•		•			8,790
01929	Pendimethalin	•						8,198
00253	Chlorpyrifos	•					•	7,769
01601	Paraquat dichloride	•						6,543
00367	Malathion	•					•	6,322
00677	Chlorothalonil	•			•			5,975
00369	Maneb		•		•			5,497

Chemical Code	Name	Category						Pounds applied
		PRIOR	TAC	FUM	CARC	REP/DEV	CHOIN	ALL
00629	Ziram	•						4,507
00211	Mancozeb	•	•		•			3,627
03946	Glufosinate-ammonium	•						3,371
01973	Oxyfluorfen	•						3,091
01868	Oryzalin	•						2,690
02081	Iprodione	•			•			2,414
00531	Simazine	•						2,366
00231	Diuron	•			•			2,191
00806	2,4-D, dimethylamine salt		•					2,054
00445	Propargite	•			•	•		1,964
00198	Diazinon	•					•	1,785
00070	Bensulide	•					•	1,718
00383	Methomyl						•	1,539
01685	Acephate	•					•	1,493
00418	Naled	•	•				•	1,352
04022	Propamocarb hydrochloride						•	1,321
00216	Dimethoate	•					•	1,259
00179	Chlorthal-dimethyl	•						1,190
02008	Permethrin	•			•			1,174
00382	Oxydemeton-methyl	•				•	•	1,173
04000	Cyprodinil	•						1,124
01626	Ethephon						•	1,074
05759	Pyraclostrobin	•						1,058

Chemical Code	Name	Category						Pounds applied
		PRIOR	TAC	FUM	CARC	REP/DEV	CHOIN	ALL
00335	Phosmet	•					•	1,038
00597	Trifluralin	•	•					1,035
00105	Carbaryl	•	•		•	•	•	1,007
02238	Hydrogen cyanamide	•						961
05133	S-metolachlor	•						858
00694	Propyzamide	•						786
01696	Thiophanate-methyl	•			•	•		658
00361	Linuron	•				•		528
02245	Myclobutanil					•		485
01138	2,4-D, triethylamine salt		•					434
00575	Aldicarb	•					•	431
01689	Methidathion	•	•				•	398
05858	Spiromesifen	•						371
00264	EPTC	•				•	•	371
05802	Flumioxazin	•						353
00394	Methyl parathion	•	•				•	341
01910	Oxamyl						•	335
00516	Cycloate					•	•	268
03850	Tebuconazole	•						248
01598	Coconut diethanolamide				•			236
02297	Lambda-cyhalothrin	•						232
02019	Norflurazon	•						217
00111	Formetanate hydrochloride						•	210

Chemical Code	Name	Category						Pounds applied
		PRIOR	TAC	FUM	CARC	REP/DEV	CHOIN	ALL
00834	Bromoxynil octanoate	•				•		207
02303	Hexythiazox				•			204
90104	Captan, other related		•		•			198
00587	Thiabendazole				•			192
05331	Indoxacarb	•						187
05857	Spirodiclofen	•			•			185
05451	Kresoxim-methyl				•			182
00276	Ethylene glycol		•					163
00636	2,4-D	•	•					144
02254	Abamectin					•		135
00810	2,4-D, isopropyl ester		•					130
00484	Aluminum phosphide		•	•				120
05036	Bromoxynil heptanoate	•				•		115
05754	Novaluron	•						108
05007	Diglycolamine salt of 3,6-dichloro-o-anisic acid	•						104
05886	Flonicamid	•						84
00007	Daminozide	•			•			79
00375	Methiocarb	•					•	76
03905	Fenbuconazole	•						74
05232	Pymetrozine				•			65
00346	Dicofol	•						64
03832	Oxytetracycline, calcium complex					•		62
00263	EPN						•	62

Chemical Code	Name	Category						Pounds applied
		PRIOR	TAC	FUM	CARC	REP/DEV	CHOIN	ALL
01933	Thiobencarb						•	61
02223	Cyfluthrin	•						61
00259	Endosulfan	•	•					59
05057	Dicamba, sodium salt	•						54
05598	Thiamethoxam	•						47
05983	Metconazole	•						45
00849	Dicamba, dimethylamine salt	•						44
03834	Streptomycin sulfate					•		43
05955	Spirotetramat	•						38
05815	Fluazifop-p-butyl					•		34
00503	Propanil	•						26
00230	Disulfoton						•	23
05878	Famoxadone	•						23
00678	Alachlor				•			22
00464	PCNB	•	•		•			22
00478	Phorate						•	20
01582	Ethylene glycol monomethyl ether		•			•		18
02118	Acrylic acid		•					18
02017	Oxadiazon	•			•	•		18
90394	Methyl parathion, other related		•				•	18
00805	2,4-D, diethanolamine salt		•					16
02273	Sodium tetrathiocarbonate	•	•	•				15
00089	2-Butoxyethanol		•					14

Chemical Code	Name	Category						Pounds applied
		PRIOR	TAC	FUM	CARC	REP/DEV	CHOIN	ALL
01622	2,4-D, 2-ethylhexyl ester		•					14
02195	Tau-fluvalinate					•		13
00314	Azinphos-methyl						•	11
01697	Methamidophos						•	7
00658	Manganese sulfate		•					5
05939	Tetraconazole				•			5
00675	Phenmedipham						•	5
00459	Parathion		•				•	5
00034	MSMA				•			4
01857	Fenamiphos	•					•	3
00802	2,4-D, butoxyethanol ester		•					3
04020	Emamectin benzoate	•						3
00480	Mevinphos						•	2
01748	Desmedipham						•	2
02505	Diethylene glycol monoethyl ether		•			•		2
05865	Pyraflufen-ethyl				•			2
02171	Cypermethrin	•						2
00404	Ethoprop				•		•	2
02202	Thiodicarb				•		•	2
00200	Dicamba	•						2
90480	Mevinphos, other related						•	2
00223	Dioctyl phthalate		•		•	•		1
00626	Zinc phosphide		•					1

Chemical Code	Name	Category						Pounds applied
		PRIOR	TAC	FUM	CARC	REP/DEV	CHOIN	ALL
00176	Calcium cyanide		•					1
01275	2,4-D, propyl ester		•					1
00238	Dinoseb					•		1
02133	Triadimefon	•				•		<1
02143	Chlorsulfuron					•		<1
00580	Terrazole				•			<1
90459	Parathion, other related						•	<1
02129	Vinclozolin	•			•	•		<1
00190	S,S,S-tributyl phosphorotrithioate	•	•		•		•	<1
05457	Tralkoxydim	•						<1
05020	2,4-DB acid		•					<1
05763	Milbemectin	•						<1
03995	Fipronil	•						<1
00410	Oxythioquinox			•	•	•		<1
02218	Acifluorfen, sodium salt				•			<1
05885	Trifloxysulfuron-sodium	•						<1
00622	Xylene		•					<1

Appendix 5: Top 10 Pesticide Active Ingredients by Pounds Applied Near Public Schools, by County, for All Pesticides Assessed

The following tables show the top 10 pesticide active ingredients of public health concern applied, by pounds, within ¼ mile of schools in each of the 15 counties included in this study. The chemical name, pounds applied, restricted material status, and pesticide category are included in each table. Special permits are required for application of restricted materials, and counties may further restrict use by location or time.

Table A5.1. Top 10 pesticide active ingredients, by pounds applied, in Fresno County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
1,3-Dichloropropene	7,723	Yes	PRIOR, TAC, FUM, CARC
Ziram	3,095	No	PRIOR
Methyl bromide	2,050	Yes	PRIOR, TAC, FUM, REP/DEV
Pendimethalin	2,026	No	PRIOR
Metam-sodium	1,852	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Chlorpyrifos	1,127	No	PRIOR, CHOIN
Paraquat dichloride	1,057	Yes	PRIOR
Chloropicrin	992	Yes	PRIOR, TAC, FUM
Glufosinate-ammonium	708	No	PRIOR
Iprodione	684	No	PRIOR, CARC

Table A5.2. Top 10 pesticide active ingredients, by pounds applied, in Imperial County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
Metam-sodium	1,041	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Pendimethalin	384	No	PRIOR
Chlorpyrifos	124	No	PRIOR, CHOIN
Permethrin	123	No	PRIOR, CARC
Trifluralin	84	No	PRIOR, TAC
Propargite	61	No	PRIOR, CARC, REP/DEV
Dimethoate	51	No	PRIOR, CHOIN
Malathion	47	No	PRIOR, CHOIN
Bromoxynil octanoate	45	No	PRIOR, REP/DEV
EPTC	36	No	PRIOR, REP/DEV, CHOIN

Table A5.3. Top 10 pesticide active ingredients, by pounds applied, in Kern County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
1,3-Dichloropropene	6,859	Yes	PRIOR, TAC, FUM, CARC
Metam-sodium	2,804	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Potassium n-methyldithiocarbamate	2,655	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Methyl bromide	1,078	Yes	PRIOR, TAC, FUM, REP/DEV
Chlorpyrifos	971	No	PRIOR, CHOIN
Pendimethalin	935	No	PRIOR
Paraquat dichloride	915	Yes	PRIOR
Glufosinate-ammonium	507	No	PRIOR
Diuron	438	No	PRIOR, CARC
Chlorothalonil	420	No	PRIOR, CARC

Table A5.4. Top 10 pesticide active ingredients, by pounds applied, in Kings County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
1,3-Dichloropropene	3,137	Yes	PRIOR, TAC, FUM, CARC
Pendimethalin	234	No	PRIOR
Chlorpyrifos	213	No	PRIOR, CHOIN
Ethephon	156	No	CHOIN
Propargite	137	No	PRIOR, CARC, REP/DEV
Paraquat dichloride	118	Yes	PRIOR
Glufosinate-ammonium	118	No	PRIOR
Aldicarb	91	Yes	PRIOR, CHOIN
Trifluralin	84	No	PRIOR, TAC
Hydrogen cyanamide	82	No	PRIOR

Table A5.5. Top 10 pesticide active ingredients, by pounds applied, in Madera County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
1,3-Dichloropropene	4,421	Yes	PRIOR, TAC, FUM, CARC
Hydrogen cyanamide	454	No	PRIOR
Glufosinate-ammonium	384	No	PRIOR
Pendimethalin	339	No	PRIOR
Oryzalin	291	No	PRIOR
Oxyfluorfen	216	No	PRIOR
Propargite	193	No	PRIOR, CARC, REP/DEV
Chlorothalonil	164	No	PRIOR, CARC
Simazine	157	No	PRIOR
Iprodione	143	No	PRIOR, CARC

Table A5.6. Top 10 pesticide active ingredients, by pounds applied, in Merced County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
1,3-Dichloropropene	22,665	Yes	PRIOR, TAC, FUM, CARC
Potassium n-methyldithiocarbamate	7,123	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Metam-sodium	4,555	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Methyl bromide	3,102	Yes	PRIOR, TAC, FUM, REP/DEV
Chloropicrin	2,070	Yes	PRIOR, TAC, FUM
Paraquat dichloride	859	Yes	PRIOR
Pendimethalin	497	No	PRIOR
Aldicarb	268	Yes	PRIOR, CHOIN
2,4-D, dimethylamine salt	243	Yes	TAC
Glufosinate-ammonium	200	No	PRIOR

Table A5.7. Top 10 pesticide active ingredients, by pounds applied, in Monterey County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
Chloropicrin	53,860	Yes	PRIOR, TAC, FUM
Methyl bromide	33,542	Yes	PRIOR, TAC, FUM, REP/DEV
1,3-Dichloropropene	25,555	Yes	PRIOR, TAC, FUM, CARC
Maneb	3,235	No	TAC, CARC
Malathion	2,112	No	PRIOR, CHOIN
Captan	1,533	No	PRIOR, TAC, CARC
Methomyl	1,105	Yes	CHOIN
Oxydemeton-methyl	1,028	Yes	PRIOR, REP/DEV, CHOIN
Diazinon	888	No	PRIOR, CHOIN
Chlorthal-dimethyl	768	No	PRIOR

Table A5.8. Top 10 pesticide active ingredients, by pounds applied, in Sacramento County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
Mancozeb	567	No	PRIOR, TAC, CARC
Carbaryl	155	Yes	PRIOR, TAC, CARC, REP/DEV, CHOIN
2,4-D, dimethylamine salt	90	Yes	TAC
Paraquat dichloride	89	Yes	PRIOR
Trifluralin	60	No	PRIOR, TAC
Oxytetracycline, calcium complex	45	No	REP/DEV
Streptomycin sulfate	26	No	REP/DEV
Norflurazon	21	No	PRIOR
Thiophanate-methyl	19	No	PRIOR, CARC, REP/DEV
Captan	18	No	PRIOR, TAC, CARC

Table A5.9. Top 10 pesticide active ingredients, by pounds applied, in San Joaquin County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
Chloropicrin	5,341	Yes	PRIOR, TAC, FUM
1,3-Dichloropropene	4,438	Yes	PRIOR, TAC, FUM, CARC
Metam-sodium	1,990	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Chlorothalonil	1,592	No	PRIOR, CARC
Methyl bromide	1,231	Yes	PRIOR, TAC, FUM, REP/DEV
Mancozeb	973	No	PRIOR, TAC, CARC
Potassium n-methyldithiocarbamate	886	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Pendimethalin	733	No	PRIOR
Malathion	645	No	PRIOR, CHOIN
Paraquat dichloride	633	Yes	PRIOR

Table A5.10. Top 10 pesticide active ingredients, by pounds applied, in San Luis Obispo County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
Chloropicrin	285	Yes	PRIOR, TAC, FUM
1,3-Dichloropropene	169	Yes	PRIOR, TAC, FUM, CARC
Maneb	110	No	TAC, CARC
Oxyfluorfen	108	No	PRIOR
Malathion	88	No	PRIOR, CHOIN
Chlorthal-dimethyl	84	No	PRIOR
Chlorpyrifos	65	No	PRIOR, CHOIN
Bensulide	62	No	PRIOR, CHOIN
Glufosinate-ammonium	44	No	PRIOR
2,4-D, dimethylamine salt	43	Yes	TAC

Table A5.11. Top 10 pesticide active ingredients, by pounds applied, in Santa Barbara County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
Metam-sodium	18,652	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Chloropicrin	15,591	Yes	PRIOR, TAC, FUM
Methyl bromide	15,371	Yes	PRIOR, TAC, FUM, REP/DEV
Malathion	2,415	No	PRIOR, CHOIN
1,3-Dichloropropene	2,036	Yes	PRIOR, TAC, FUM, CARC
Captan	1,588	No	PRIOR, TAC, CARC
Maneb	1,547	No	TAC, CARC
Propamocarb hydrochloride	464	No	CHOIN
Acephate	380	No	PRIOR, CHOIN
Propyzamide	379	No	PRIOR

Table A5.12. Top 10 pesticide active ingredients, by pounds applied, in Stanislaus County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
1,3-Dichloropropene	20,972	Yes	PRIOR, TAC, FUM, CARC
Potassium n-methyldithiocarbamate	2,126	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Chlorothalonil	1,490	No	PRIOR, CARC
Pendimethalin	1,172	No	PRIOR
Paraquat dichloride	929	Yes	PRIOR
Chlorpyrifos	866	No	PRIOR, CHOIN
Metam-sodium	668	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Glufosinate-ammonium	473	No	PRIOR
Oxyfluorfen	437	No	PRIOR
Iprodione	434	No	PRIOR, CARC

Table A5.13. Top 10 pesticide active ingredients, by pounds applied, in Tulare County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
1,3-Dichloropropene	17,275	Yes	PRIOR, TAC, FUM, CARC
Methyl bromide	2,310	Yes	PRIOR, TAC, FUM, REP/DEV
Chlorpyrifos	1,881	No	PRIOR, CHOIN
Pendimethalin	1,269	No	PRIOR
Diuron	1,186	No	PRIOR, CARC
Simazine	1,087	No	PRIOR
Paraquat dichloride	1,067	Yes	PRIOR
Ziram	756	No	PRIOR
Carbaryl	642	Yes	PRIOR, TAC, CARC, REP/DEV, CHOIN
Chloropicrin	605	Yes	PRIOR, TAC, FUM

Table A5.14. Top 10 pesticide active ingredients, by pounds applied, in Ventura County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
Chloropicrin	71,453	Yes	PRIOR, TAC, FUM
Methyl bromide	24,986	Yes	PRIOR, TAC, FUM, REP/DEV
1,3-Dichloropropene	20,989	Yes	PRIOR, TAC, FUM, CARC
Metam-sodium	6,301	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Captan	5,450	No	PRIOR, TAC, CARC
Potassium n-methyldithiocarbamate	3,524	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Chlorothalonil	1,393	No	PRIOR, CARC
Mancozeb	856	No	PRIOR, TAC, CARC
Chlorpyrifos	746	No	PRIOR, CHOIN
Bensulide	618	No	PRIOR, CHOIN

Table A5.15. Top 10 pesticide active ingredients, by pounds applied, in Yolo County, 2010

Name	Pounds applied	Restricted material	Pesticide Category
Potassium n-methyldithiocarbamate	1,661	Yes	PRIOR, TAC, FUM, CARC, REP/DEV
Methyl bromide	1,219	Yes	PRIOR, TAC, FUM, REP/DEV
Pendimethalin	466	No	PRIOR
S-metolachlor	263	No	PRIOR
Oryzalin	173	No	PRIOR
Chlorothalonil	122	No	PRIOR, CARC
Malathion	118	No	PRIOR, CHOIN
Chlorpyrifos	103	No	PRIOR, CHOIN
Mancozeb	98	No	PRIOR, TAC, CARC
Oxyfluorfen	79	No	PRIOR

Appendix 6: Comparison of Students Attending Schools with No Pesticide Use, Any Pesticide Use, and the Highest Pesticide Use Within ¼ Mile, by Race/Ethnicity

The odds ratio (OR) is calculated as a measure of effect size, describing the strength of association between two binary variables. The odds ratio describes the odds of an event happening for one group compared to the odds of the same event happening for another group.

An odds ratio of greater than one means that the characteristic of interest (in this case, race/ethnicity of students) may increase the risk of an event occurring (attending a school with pesticide use nearby), and an odds ratio of less than one means that the characteristic of interest may reduce the risk of the event occurring.

We calculated all odds ratios using White students as the reference group. Therefore, for White students, OR=1. Table A6.1 and A6.2 display the odds ratios comparing students attending schools with any pesticide use (A6.1) and in the highest quartile of use (A6.2) to students attending schools with no pesticide use nearby.

Table A6.1. The odds of students of different race/ethnicity attending schools with pesticide use within ¼ mile compared to white students

Race/ethnicity	Odds ratio	Lower limit†	Upper limit†
White	1.00*		
Hispanic	1.46	1.45	1.48
African American	0.59	0.58	0.60
Asian Pacific Islander	0.96	0.94	0.97
Other	0.99	0.97	1.01

* reference
† 95% Confidence Interval

Table A6.2. The odds of students of different race/ethnicity attending schools in the top 25% of pesticide use within ¼ mile compared to white students

Race/ethnicity	Odds ratio	Lower limit†	Upper limit†
White	1.00*		
Hispanic	1.91	1.88	1.94
African American	0.53	0.51	0.55
Asian Pacific Islander	0.99	0.96	1.01
Other	0.91	0.87	0.94

* reference
† 95% Confidence Interval

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