Poisoning the Air

Airborne Pesticides in California

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CALPIRG Charitable Trust

One in a series of reports by Californians for Pesticide Reform

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The CALPIRG Charitable Trust is the 501(c)(3) sister organization of the California Public Interest Research Group (CALPIRG), a non-profit, non-partisan research and advocacy organization working on behalf of consumers and the environment. With over 70,000 members and 14 offices statewide, CALPIRG is the largest consumer group in California.

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Californians for Pesticide Reform

Californians for Pesticide Reform (CPR) is a coalition of public interest organizations, including CALPIRG, committed to protecting public health and the environment from pesticide proliferation. CPR's mission is to 1) educate Californians about environmental and health risks posed by pesticides, 2) eliminate the use of the most dangerous pesticides in California, and 3) hold government agencies accountable for protecting public health and Californians' right to know about pesticide use and exposure.

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Executive Summary

Pesticide contamination of food and water has received the lion's share of public attention and regulatory oversight, both in California and around the nation. Unfortunately, this focus on food and water may come at the expense of understanding and regulating other potentially dangerous routes of pesticide exposure, particularly exposure to pesticides in the air. Research presented in this report indicates that current regulatory attention given to airborne pesticides in California is not adequate to protect human health.

Pesticides released in one location may be a source of human exposure or environmental contamination several hundred feet or several hundred miles away. Some of the older pesticides, such as DDT for example, have been found hundreds of miles from where they were used. While many of today's pesticides are less persistent than their predecessors, they too contaminate the air we breathe and travel great distances from target areas. Many pesticides commonly used in California have been detected far from the site of application—some as far as 25 to 50 miles—and at high elevations in the Sierra Nevada Mountains.

Although only limited air monitoring has been performed, studies in California consistently find pesticides in air, rain and even fog. Of the 26 pesticides monitored as part of the State's Toxic Air Contaminant Program, 19 were detected in ambient air in and around California communities between 1986 and 1998. These detection efforts have only scratched the surface. Monitoring for pesticide air contaminants as part of this program has not been done in 42 of California's 58 counties, and regulators have failed to monitor for nearly 100 pesticides prioritized by the state of California for their potential to be airborne contaminants.

Table I: Number of Californians within one half mile of known and suspected air contaminant pesticides

Known and suspected air contaminant pesticides*	No. of Californians living w/in 0.5 miles of heavy pesticide use**
All	3.9 million
Known or probable carcinogens	1.0 million
Reproductive or developmental toxins	2.2 million
Category I extremely toxic systemic poisons	2.3 million
Known or probable carcinogens, reproductive or developmental toxins or extremely toxic systemic poisons	2.8 million

*Pesticides identified as federal Hazardous Air Pollutants and California candidate Toxic Air Contaminants. Hazardous Air Pollutants are listed pursuant to 42 USC 7412 sec 112(b) and candidate Toxic Air Contaminants (TACs) are listed pursuant to FAC 14021(b) and sections 14022 through 14023(d).

**1000 lbs or more per square mile per year

Findings:

Millions of Californians live near heavy agricultural use of known or suspected air contaminants, including those that cause cancer, reproductive and developmental disorders or disrupt the brain and nervous system.

Agricultural pesticides are the greatest source of outdoor airborne pesticides. A spatial analysis of U.S. census data and state agricultural pesticide use data carried out by CALPIRG Charitable Trust indicates that nearly four million Californians live within one half mile of heavy annual applications of the 152 pesticides identified by state regulators as those most likely to contaminate air and threaten human health. Our analysis also found that more than 30% of these chemicals are designated by state or federal regulatory agencies as carcinogens, reproductive toxins or acute nerve poisons.

These findings are underscored by years of complaints and illness reports from communities living near agricultural lands. In 1995 alone, California's Pesticide Illness Surveillance Program reported 300 drift-related acute poisonings. This figure is generally accepted as a gross underestimate of actual acute poisonings and does not address the risk of cancer, immune system suppression, birth defects, intelligence loss, asthma and a wide array of other injuries that may result from long-term pesticide exposure.

Urban and suburban Californians may be exposed to dangerous pesticides in the air.

In the urban and suburban environment, structural fumigation is among the greatest sources of pesticides in the air. The total pounds of pesticides used for structural fumigation in 1995 was second only to agricultural uses. Structural fumigation involves covering a structure with a plastic "tarp" and filling it with a toxic gas, usually methyl bromide or Vikane (sulfuryl fluoride). This practice can lead to exposure of persons living close to the application site. According to studies by the California Department of Pesticide Regulation, airborne methyl bromide may exceed the safety levels 50 to 100 feet away and can penetrate into nearby houses even when doors and windows are closed.

The authors were unable to estimate numbers of people living in close proximity to structural fumigations due to limitations in the pesticide use data. Unlike agricultural applicators, urban and suburban applicators are not required to provide detailed information on location of use.

California regulators have ignored laws intended to protect the public from airborne pesticides.

Despite the potential increased risk of both short-term and long-term illness posed by airborne pesticides, the state agency charged with regulating these chemicals, the California Department of Pesticide Regulation (DPR), has virtually ignored legislation intended to protect Californians from pesticides in air.

Enacted in 1983 and 1984, the California Toxic Air Contaminant Program requires DPR to rank chemicals for their potential to contaminate the air and harm human health. The law then requires the department to create a public, peer-reviewed health effects report for each high priority pesticide based on extensive air monitoring and literature review. Finally, the agency is required to officially list and stringently regulate those pesticides found to pose significant risk.

In the 15 years since passage of the law, DPR has completed the process for just one chemical, ethyl parathion, which had already been

Table II: Use and health effects of the two most common structural fumigants

Known and Suspected Air Contaminant Pesticides Used in Structural Fumigations	Health Effect	Structural Fumigation Use in Pounds (1995)	Estimated Number of Single Family Home Fumigations (1995)
Methyl bromide	Category I extremely toxic systemic poison and known developmental toxin	598,656	9,978
Vikane	Category I extremely toxic systemic poison	1,746,320	349,264

banned for nearly all uses by the United States Environmental Protection Agency. Over the years the department has shuffled and reshuffled its pesticide priority rankings, but never completed the Toxic Air Contaminant process, which includes air monitoring, production of a health effects report and regulation, for any pesticides commonly used in California. Meanwhile, hundreds of millions of pounds of prioritized candidate Toxic Air Contaminants continue to be applied in California, many of which are carcinogens, reproductive toxins and acute nerve poisons.

Policy Recommendations

The widespread use of pesticides in and around California communities, combined with their startling mobility in air, suggests that millions of Californians may be exposed to these chemicals. These exposures may pose significant risk, particularly to pregnant women, children or chemically sensitive/immune system compromised individuals.

In light of these findings, piecemeal strategies to regulate one chemical at a time are inadequate, resulting in years of study and delay while millions of pounds of pesticides continue to be released. Regulators and policymakers should develop powerful incentives to move urban and agricultural pest management away from its current dependence on pesticides toward strategies for pest prevention and sustainable non-toxic alternatives.

CALPIRG Charitable Trust and Californians for Pesticide Reform (CPR) call on California regulators to:

- Create incentives to phase out the use of pesticides identified as carcinogens, reproductive and developmental toxins and acute nervous system toxins.
- Implement the California Toxic Air Contaminant Program to reduce public exposure to dangerous pesticides in the air.
- Expand right-to-know activities to include publicizing air monitoring results, timely release of pesticide use data and expansion of the pesticide use reporting system to include detailed information on urban pesticide applications (including location of use).
- Regulators should adopt a precautionary approach and establish buffers zones between pesticide intensive farmland and homes, schools or other sensitive areas until pesticides are proven not to drift or cause harm.

CALPIRG Charitable Trust and CPR call on individual Californians to:

- Use least toxic alternatives to fumigations.
- Demand pesticide air monitoring in local communities.
- Write and call state Assembly and Senate members and demand full implementation of AB 1807, the Toxic Air Contaminant Program.
- Contact CPR to find out how you and your community can reduce pesticide use.

CALPIRG Charitable Trust and CPR call on growers to:

- Use preventative pest management strategies and least toxic alternatives to pesticides.
- Notify neighbors in advance of pesticide applications.
- Write and call state Assembly and Senate members to request more funding to implement sustainable alternatives.

1 Background: Pesticides in Air

One of the jarring revelations of the industrial age has been the discovery that chemicals do not stay put. Instead, they migrate into lakes and rivers, drinking water, food and air with health and environmental consequences that are as far-ranging and as enduring as the chemicals themselves. Pesticides are no exception. Historically, water contamination has garnered the lion's share of public attention regarding the ultimate fate of pesticides. In contrast, air pollution has received relatively less notice and control even though, in the words of the United States Geological Survey (USGS): "Nearly every pesticide that has been investigated has been detected in air, rain, snow or fog throughout the country at different times of the year."[1]

Although pesticides have been recognized as potential air pollutants since at least 1946, research on the health impacts of airborne pesticides is scant.[2] The extent of pesticides in our atmosphere and their potential health effects is not well characterized.[3] Although food and water tests are required in the pesticide registration process, air tests are not required.[4] Furthermore, although we are constantly exposed to low levels of pesticides, we know very little about the possible effects of a lifetime of exposure to complex mixtures of carcinogens, hormone disrupters and toxic nerve poisons in our air.[5] Linking illnesses such as cancer, asthma, reproductive disorders and other potential impacts to particular pesticide exposures is notoriously difficult. A growing body of evidence, however, including pesticide illness reports and case studies of pesticide drift, suggest that airborne pesticides are indeed causing human injuries and illnesses.

Pesticides in the air are of particular concern in California, where 25% of the nation's pesticide use occurs.[6] All across the state, Californians are exposed to airborne pesticides in their homes, in communities and increasingly, at the urban-agricultural interface. Between 1991 and 1995 the state's population increased by 1.5 million people (5%), from 30,565,000 to 32,063,000.[7] During that same time, total pesticide use in California increased 31%, from 161 million pounds to 212 million pounds. Use of cancer causing pesticides more than doubled, rising 129%. Use of nerve toxins increased 52%. Given both the high mobility of these chemicals in air and the numbers of people living near pesticide applications, widespread exposures and resulting impacts on public health may be inevitable.[8]

Nearly every pesticide that has been investigated has been detected in air, rain, snow or fog throughout the country at different times of the year.

Airborne pesticides can travel for miles

Pesticides released in one location may be a source of human exposure or environmental contamination several hundred feet or several hundred miles away. Some of the older pesticides have been found hundreds, even thousands, of miles from use. Research in the 1960s, '70s and '80s, for example, has found the infamous pesticide DDT in Antarctic ice, penguin tissues and most species of whales.[9] Atmospheric transport of these pesticides is considered to be the primary source of this contamination.[10]

Inuit people in the Arctic have been particularly affected by the long-range transport of persistent pesticides, especially PCBs. Inuit infants, for example, have been shown to take in seven times more PCBs than the typical infant in Canada or the U.S. Abnormalities in their immune systems prevent these children from producing the antibodies needed when they are vaccinated for smallpox, measles, polio and other diseases. The failure of immunizations makes these children more vulnerable to disease. The PCBs and other chemicals that contaminate these infants are suspected to have arrived by a combination of wind and water currents.[11]

Drift

the movement of a portion of the airborne particles of a dust or spray away from an intended point of application.

Volatilization

to become a vapor, evaporate or give off fumes.[1]

1 Meister, RT. 1998. *Farm Chemicals Handbook*. Meister Publishing, Willoughby, OH.

While many of today's pesticides are less persistent than their predecessors, they too contaminate the air we breathe and can travel many miles from target areas. Accidental discoveries, monitoring as part of regulatory efforts and rare studies of long-distance transport, have all shown that pesticides can move great distances from intended sites. For example:

- Diazinon and chlorpyrifos have been found in air, rain and snow samples 25 miles or more from treated agricultural areas and at elevations of 1000 to 6000 feet in the Sierra Nevada Mountains—apparently the result of drift and volatilization losses from usage in California's Central Valley.[12]
- Monitoring as part of the Toxic Air Contaminant (TAC) Program in California detected at least nine pesticides at distances of one half mile or more from use.[13] Nearly 30 million pounds of these pesticides were used in California in 1995.
- Trifluralin, chlorothalonil and chlorpyrifos were found in fog near the Siberian Coast, likely hundreds of miles from nearest use.[14] More than six million pounds of these pesticides were used in California in 1995.
- The herbicide 2,4-D was found to have traveled 10-50 miles in central Washington State.[15] Nearly 700,000 pounds of 2,4-D were used in California in 1995.
- Carbaryl, used on oranges, apples and olives, traveled more than two miles from a Vermont apple orchard in a light wind.[16] Nearly 1.5 million pounds of carbaryl were used in California in 1995.

Pesticides are regularly detected in air

Although only limited research has been done on pesticides in air, studies in California consistently find pesticides in air, rain and fog. According to a recent national assessment survey by the USGS, the largest study of its kind, detections of airborne pesticides in California are commonplace.[17]

Table 1a: Pesticides monitored in at least ten California studies

Detection frequency includes all ambient air sites sampled.

Pesticide	Percent of California Sites with Detections[1]	Hazard and Toxicity	Pounds of Use in 1995[2]
Methidathion	Nearly 100%	Category I extremely toxic systemic poison[3]	322,221
Chlorpyrifos	Nearly 100%	Category II nerve toxin[4]	3,524,366
Diazinon	More than 90%	Category II nerve toxin[5]	2,376,883
Malathion	Nearly 90%	Hormone disrupting pesticide[6]	826,756
Parathion, Ethyl	More than 70%	Category I extremely toxic systemic poison[7] and hormone disrupting pesticide[8]	13,693[9]
Parathion, Methyl	Nearly 60%	Category I extremely toxic systemic poison[10]	160,094

Source: Majewski, MS and PD Capel. 1995. Pesticides in the Atmosphere: Distribution, Trends and Governing Factors. *U.S. Geological Survey, Sacramento, CA.*

1 Majewski, MS and PD Capel. 1997. *Pesticides in the Atmosphere: Distribution, Trends and Governing Factors.* Ann Arbor Press, Ann Arbor, MI, p. 100.
2 DPR. 1996. "Pesticide use report, annual 1995, indexed by chemical and by crop." DPR, Sacramento, CA.
3 Meister, RT. 1996. *Farm Chemicals Handbook*. Meister Publishing, Willoughby, OH.
4 Ibid.
5 Ibid.
6 Illinois Environmental Protection Agency. 1997. "Report on Endocrine Disrupting Chemicals." Illinois Environmental Protection Agency; Smolen, M. 1996. "Endocrine disruption: emerging threats." *Global Pesticide Campaigner* 6(2); Colborn, Theo, et al. 1996. *Our Stolen Future*. Penguin Books, NY.
7 Meister, RT, op cit.
8 Illinois Environmental Protection Agency, op cit.
9 Ethyl parathion was banned for most uses at the end of 1991.
10 Meister, RT, op cit.

In its survey of air monitoring studies by both regulators and academics, the USGS found that organophosphates, pesticides that can cause acute nervous system toxicity,[18] have been detected in California with greater frequency than any other state.[19] These pesticides have been found at air monitoring sites throughout the state including Brea, Garden Grove, San Fernando, Parlier, Corcoran, Lodi, Fresno, Monterey, North Central Stanislaus County, North and South San Joaquin Valley and Imperial Valley.[20] While the USGS did not summarize detection levels or average distances, the data demonstrate these widely used and dangerous pesticides are migrating far from their intended application sites.

An analysis based on state monitoring in support of the TAC Program also documents pesticides in communities near applications.[21] Of the 26 pesticides monitored under the state Toxic Air Contaminant Program, 19 were detected at schools or other public buildings near the application sites. In fact, over the 15 years of the TAC Program more than 30% of approximately 3,400 samples taken from California communities detected target pesticides.[22]

While most of these detections were below levels considered by the state to be "safe," this monitoring again demonstrates that pesticides regularly migrate from intended locations. Nearby communities may be exposed to multiple pesticides simultaneously, many of which are carcinogens, reproductive toxins and extremely toxic systemic poisons. Scientists and regulators don't know how these pesticides interact with one another in the air or in human bodies. Although the state has identified levels it considers "safe" for some individual pesticides, no such levels have been established for multiple combinations of pesticides (see Chapter 4).

Table 1b: Department of Pesticide Regulation air monitoring data

Most commonly detected pesticides with at least 10 samples.

Chemical	Toxicity	Samples (#)	Samples w/ detections*	Description of site location	Pounds of Use in 1995[1]
Metam Sodium[2]	Probable human carcinogen[3] and known reproductive toxin[4]	24	88%	Two schools, school district office	15,274,166
DEF	Restricted use pesticide[5]	254	78%	One school, day care center, two fire stations	883,857
Telone	Known carcinogen[6]	79	65%	Two schools, day care center, two fire departments	409,821
Parathion, methyl	Category I extremely toxic systemic poison[7] and hormone disrupting pesticide[8]	179	49%	Three schools, City Hall (Williams)	160,094
Azinphos-methyl	Category I extremely toxic systemic poison[9]	140	31%	Two schools, learning center, fire station, school district office	434,098

** Samples taken from communities near applications (ambient sampling).*

Source: Kollman, WS. 1995. "Summary of Assembly Bill 1807/3219: Pesticide Air Monitoring Results: conducted by the California Air Resources Board 1986-1995." DPR, Sacramento, CA.

1 DPR. 1996. "Pesticide use report, annual 1995, indexed by chemical and by crop." DPR, Sacramento, CA.

2 This includes monitoring for MITC, the primary breakdown product of metam sodium.

3 U.S. EPA. 1997. "List of Chemicals Evaluated for Carcinogenic Potential." Office of Pesticide Programs, Washington, DC.

4 OEHHA. 1998. "Chemicals known to the State to Cause Cancer or Reproductive Toxicity." www.calepa.cahwnet.gov/oehha/prop65.htm

5 40 FR 158. In an effort to decrease the drift problems associated with DEF the California Department of Food and Agriculture does not allow DEF to be applied within one-half mile of residential areas.

6 OEHHA, op cit.

7 Meister, RT. 1996. *Farm Chemicals Handbook*. Meister Publishing, Willoughby, OH.

8 Illinois Environmental Protection Agency. 1997. "Report on Endocrine Disrupting Chemicals." Illinois Environmental Protection Agency; Smolen, M. 1996. "Endocrine disruption: emerging threats." *Global Pesticide Campaigner* 6(2); Colborn, Theo, et al. 1996. *Our Stolen Future*. Penguin Books, NY.

9 Meister, RT, op cit.

2 Airborne Pesticides at the Urban-Agricultural Frontier

According to the United States Geological Survey (USGS), the greatest source of pesticide contamination of the atmosphere is agricultural use.[23] Although the actual amount of a pesticide that becomes airborne varies depending on weather, pesticide volatility, soil type and application method, all pesticide applications result in some air contamination.[24] Studies show that in some cases less than 1% of the applied pesticide actually reaches the target pest.[25] According to one study, even under ideal aerial application conditions, only about 50% of the pesticides applied aerially reach the target areas.[26]

Little is known about the extent of risk posed by airborne pesticides in and around California communities. As a proxy for actual exposure, however, it is possible to estimate the number of Californians living in close proximity to heavy pesticide use—close enough so that some level of exposure through the air is likely or inevitable. This analysis provides a statewide assessment of population proximity to heavy pesticide use. The proximity estimates presented below were created by mapping California state pesticide use data (1995) over population data available from the U.S. Bureau of the Census (1990). (See Appendix A for a complete discussion of this methodology and its limitations.)

Only those pesticides identified by federal agencies as Hazardous Air Pollutants or by state regulators as candidate Toxic Air Contaminants are included in this analysis. According to the federal law, Hazardous Air Pollutants (HAPs) "cause, or contribute to, air pollution which may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness."[27] Candidate Toxic Air Contaminants (TACs) are those pesticides prioritized by the Department of Pesticide Regulation for review and regulation under the state Toxic Air Contaminant Program. Table 2a provides statewide estimates for the numbers of Californians living in close proximity to HAPs and candidate TACs as well as those HAPs and candidate TACs that have been identified as carcinogens, reproductive and developmental toxins and acute nervous system toxins by state and federal agencies. (Toxicity classifications for each

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Table 2a: Number of Californians living in close proximity to heavy use of known and suspected air contaminant pesticides (statewide)

HAPs and candidate TACs	# Californians living within 0.5 miles of heavy use *	Number of pesticides	Pounds of Use in 1995[1]
All	3.9 million	152	159 million
Carcinogens	1.0 million	28	23 million
Repro + Develop.	1.7 million	8	33 million
Acute	1.7 million	37	35 million
High Hazard	2.8 million	62	59 million

**1000 lbs or more per square mile per year*

1 DPR. 1996. "Pesticide use report, annual 1995, indexed by chemical and by crop." DPR, Sacramento, CA.

Key to Tables 2a and 2b

All—All Hazardous Air Pollutants (HAPs) and candidate Toxic Air Contaminants (TACs).

High Hazard—Federal HAPs and candidate TACs that have been identified as carcinogens, Category I or II systemic nerve poisons or reproductive or developmental toxins.

Acute—Those HAPs and candidate TACs that have been identified by the U.S. EPA as Category I or II systemic nerve poisons.

Repro + Develop.—Those HAPs and candidate TACs that have been identified by the State of California as reproductive or developmental toxins.

Carcinogen—Those HAPs and candidate TACs that have been identified by the State of California or the U.S. EPA as "known" or "probable" human carcinogens.

Table 2b: Californians living in close proximity to heavy use of known and suspected air contaminant pesticides (by county)

County	Rank (All)	No. of Californians living w/in 0.5 miles of heavy pesticide use (1000 lbs or more per square mile per year)					
		All	High Hazard	Acute	Repro	Carcinogen	Population (1990)
Alameda	45	300	-	-	-	-	1,279,182
Alpine	-	-	-	-	-	-	1,113
Amador	40	1,000	-	-	-	-	30,039
Butte	19	64,100	32,800	14,200	10,300	19,100	182,120
Calaveras	42	700	-	-	-	-	31,998
Colusa	32	14,300	7,300	2,300	200	1,000	16,275
Contra Costa	17	67,100	13,900	6,700	12,500	7,700	803,732
Del Norte	37	2,000	1,800	1,200	1,800	1,800	23,460
El Dorado	41	1,000	-	-	-	-	125,995
Fresno	2	322,900	222,200	192,000	145,800	65,500	667,490
Glenn	34	8,600	4,400	1,200	300	3,200	24,798
Humboldt	35	6,200	6,100	6,100	6,100	5,400	119,118
Imperial	21	60,700	23,700	17,100	9,500	10,300	109,303
Inyo	-	-	-	-	-	-	18,281
Kern	9	147,300	124,600	70,300	84,100	88,400	543,477
Kings	47	100	100	100	-	-	101,469
Lake	33	9,700	4,800	3,300	-	2,300	50,631
Lassen	46	300	300	300	300	-	27,598
Los Angeles	11	132,100	130,800	130,500	108,800	-	8,863,164
Madera	22	57,000	14,200	5,400	1,600	6,600	88,090
Marin	48	100	-	-	-	-	230,096
Mariposa	-	-	-	-	-	-	14,302
Mendocino	26	35,000	12,500	2,800	1,300	8,700	80,345
Merced	14	104,500	82,800	64,300	60,000	30,400	178,403
Modoc	43	500	400	-	100	200	9,678
Mono	-	-	-	-	-	-	9,956
Monterey	8	178,800	173,200	133,100	109,200	121,800	355,660
Napa	15	93,500	22,000	17,000	16,400	7,400	110,765
Nevada	44	400	-	-	-	-	78,510
Orange	1	663,900	556,100	514,400	508,400	88,400	2,410,556
Placer	38	1,900	1,200	900	700	-	172,796
Plumas	-	-	-	-	-	-	19,739
Riverside	6	182,900	78,800	38,500	41,900	43,500	1,170,413
Sacramento	27	33,700	23,100	22,200	17,500	600	1,041,219
San Benito	29	23,000	18,900	17,900	16,900	7,000	36,697
San Bernardino	7	181,100	162,800	141,800	124,600	21,000	1,418,380
San Diego	10	136,200	118,900	98,600	99,800	18,300	2,498,016
San Francisco	-	-	-	-	-	-	723,959
San Joaquin	5	226,500	99,600	71,000	72,700	41,800	480,628
San Luis Obispo	18	64,500	39,600	30,800	30,300	7,400	217,162
San Mateo	30	19,000	17,400	17,400	17,400	600	649,623
Santa Barbara	13	130,300	88,800	76,000	80,200	62,400	369,608
Santa Clara	25	50,300	46,500	36,800	42,800	11,700	1,497,577
Santa Cruz	20	62,700	62,500	61,500	62,500	46,000	229,734
Shasta	36	4,900	4,800	3,400	3,400	200	147,036
Sierra	-	-	-	-	-	-	3,318
Siskiyou	39	1,400	800	200	100	200	43,531
Solano	23	55,500	25,700	16,900	20,800	-	340,421
Sonoma	12	131,600	60,200	49,500	40,300	13,900	388,222
Stanislaus	4	248,100	160,300	115,800	121,800	72,900	370,522
Sutter	24	51,900	35,000	31,800	22,500	4,000	64,415
Tehama	31	16,400	11,500	9,400	7,100	2,900	49,625
Trinity	-	-	-	-	-	-	13,063
Tulare	-	-	-	-	-	-	311,921
Tuolumne	-	-	-	-	-	-	48,456
Ventura	3	286,600	241,200	211,100	210,400	164,100	669,016
Yolo	16	77,800	53,400	4,700	51,100	51,500	141,092
Yuba	28	33,700	15,600	10,100	6,600	1,400	58,228

continued from page 4

of the 151 HAP and candidate TAC pesticides is provided in Appendix B and county estimates are provided in Table 2b).

Aerial and ground applications result in widespread drift

In general, applications by aircraft account for five times more drift than do most ground applications. Over 46 million pounds of pesticides were sprayed from aircraft in California in 1995, accounting for more than 20% of total pesticide use that year.[28] But drift from ground spraying may also be significant.[29] Researchers, for example, have measured drift from orchard sprayers (a type of ground application where applicators direct the spray upward in order to cover an entire tree) at distances six times further than aerial applications.[30]

Inversion layers can trap pesticide clouds

Layers of warmed air, called inversions, can magnify the problem of drift from both aerial and ground applications. Inversions act like ceilings, trapping pesticides and other air contaminants and effectively preventing their dispersion. Pesticides can drift under these inversion layers and contaminate crops great distances from original use. In 1995, for example, cotton growers in the Sacramento Valley blamed high cotton losses on drift from inversions.[31] Inversions were also partly responsible for what researchers called "areawide air contamination of California's Sacramento Valley" by pesticide use on rice.[32]

Volatilization and drift can contaminate non-target crops

Unfortunately, air contamination doesn't end when the application ends. Pesticides often continue to volatilize and drift for hours or even days following an application.[33] In some cases as much as 90% of a pesticide can volatilize from soil surfaces or plants within days of an application.[34] One study found that it took only seven hours for up to 50% of trifluralin (an herbicide used in California on tomatoes, carrots and cotton) to volatilize when applied to moist soil.[35] Nearly 1.5 million pounds of trifluralin were used in California in 1995, making it one of the most commonly used pesticides in the state.

Not surprisingly, volatilization and drift can result in contamination of non-target crops. Examples include:

- Pesticides were found regularly on unintended crops in a California Department of Food and Agriculture study. Researchers found the nerve toxins parathion, diazinon, chlorpyrifos and methidathion on vegetation at all test sites despite the fact that those pesticides had not been applied within 0.4 km of the sampling sites.[36] This study and a related study in 1993 found that regional transport of these pesticides resulted in contamination of non-target crops at least 0.4 km from application sites during *both* summer and winter.[37]
- Widespread damage of 20,000 to 30,000 acres of dry beans in Colorado was blamed on the volatilization of 2,4-D days after initial applications. Hot weather resulted in volatilization off sprayed fields where 2,4-D moved as much as five to ten miles in the gaseous phase and appeared to seriously damage non-target beans, trees, ornamentals and vegetables in both rural and urban settings.[38]
- Pesticide drift contributed to unusually low cotton yields in the Sacramento Valley in 1995. The *California-Arizona Farm Press* reported that drift from aerial applications to nearby rice, cotton and grain fields "really hammered yields." The drift severely damaged as much as a third of the cotton, rendering some fields as total losses.[39]

The presence of millions of Californians living close to areas where highly mobile airborne pesticides are used is cause for concern. As indicated in the previous chapter, current trends of increasing population growth and rising pesticide use are likely to exacerbate the health risks posed by these chemicals.

3 Structural Fumigations: Urban Source of Pesticides in the Air

Structural fumigation is an important urban source of air contamination by pesticides. This is a common practice where a home or other structure is covered with a plastic tent and filled with a toxic gas. Every year, thousands of California homes and businesses are fumigated with highly toxic pesticides to kill a variety of pests, particularly termites. The pesticides are applied as a gas and the two most common structural fumigants, Vikane (sulfuryl fluoride) and methyl bromide, are among the most toxic pesticides used today. These factors make structural fumigation a dangerous source of pesticidal air pollution that may result in unsafe exposures for people living nearby.

Methyl bromide, the second most common structural fumigant in California, is the best studied of the two. This chemical is a colorless, odorless gas, classified by the U.S. EPA as a Toxicity Category I compound—a designation reserved for the most hazardous substances. Human exposure to methyl bromide, even in small amounts, can produce nausea, headaches, tremors and other flu-like symptoms.[40] In larger amounts, methyl bromide has been linked to birth defects in laboratory animals and has been responsible for at least 19 deaths in California.[41] Methyl bromide is also a powerful ozone depleter. A United Nations scientific panel estimated that methyl bromide is responsible for 5-10% of worldwide ozone depletion.[42] Ozone depletion is linked to rising rates of skin cancer, eye cataracts and suppression of the immune system.[43] In 1995, almost 600,000 pounds of this chemical were injected into thousands of California homes and businesses. (See Appendix B).[44]

Deaths related to methyl bromide

Internal reports released by DPR indicate that structural use of methyl bromide may result in unsafe exposures to the airborne pesticide.[45,46] These reports concluded:

- Unsafe levels of hazardous vapors may drift through empty pipes into neighboring houses.
- Methyl bromide levels outside homes under fumigation may exceed the California safety standard by seven fold.
- Methyl bromide can be detected *inside* closed houses up to 100 feet away from the fumigated structure—even if the two buildings are not connected by pipes.
- Present work practices may not provide an adequate margin of safety in close proximity to a fumigated house.

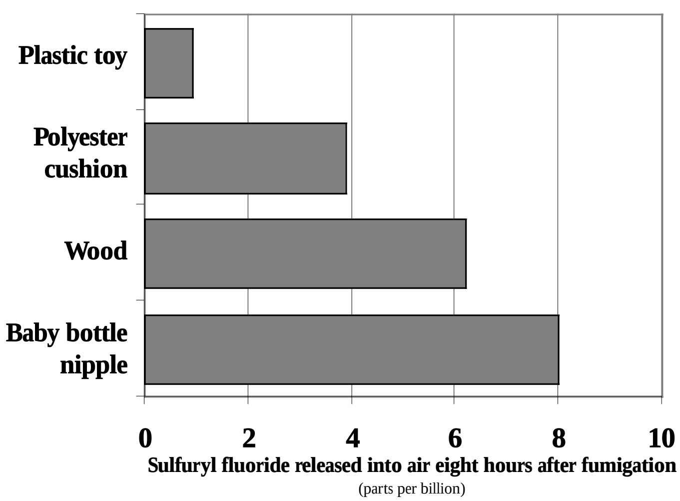
Since 1984, at least 19 people in California have died from methyl bromide exposure, many of them after entering homes fumigated with the pesticide methyl bromide.[47] The chemical's latest victim, Sandra Mero, died on March 25, 1997 when methyl bromide seeped into her house through electrical conduit wires from a fumigation next door.[48] A subsequent investigation conducted by Californians for Pesticide Reform and Environmental Working Group discovered that one year before Mero's death, DPR had completed an internal study of the dangers of methyl bromide, including the potential of traveling through pipes, but failed to publicize the studies and warn the public.[49]

In 1992, a Redwood City man died after methyl bromide seeped from the walls in his house even though post-fumigation tests indicated that indoor levels were "safe." Explaining the incident to the press, DPR communications director Veda Federighi said of methyl bromide, "the stuff stays in the walls. It oozes out of the walls."[50] Although fumigation regulations were changed to require a longer reentry interval following the death in Redwood City, methyl bromide is still regularly used for fumigations in California.

Use of another toxic fumigant increases dramatically

Vikane (sulfuryl fluoride) is the most frequently used structural fumigant in California. Use of Vikane to fumigate closed structures such as homes, garages and other buildings has increased 40% from 1991 to 1.5 million pounds in 1995. First registered in 1959, Vikane is an extremely toxic nerve poison. High concentrations of Vikane may cause respiratory irritation, pulmonary edema, nausea, abdominal pain and numbness in the extremities.[51] In its information for physicians, the manufacturer of Vikane, DowElanco, notes that slow speech and movement will be the first symptoms of Vikane exposure.[52] Vikane's neurotoxicity was first documented in a study by researchers with the National Institute for Occupational Safety and Health. They found that fumigators working with Vikane, compared with workers from the fumigation industry who did not work directly with Vikane or other fumigants, reported reduced performance on cognitive tests and increased symptoms that included muscle aching, fatigue, coordination problems, depression, slurred speech, dizziness and stumbling and staggering when walking.[53]

Figure 1: Off-gassing of Vikane from common household materials following fumigation



Source: Cox, C. 1997. "Sulfuryl fluoride." Journal of Pesticide Reform 17(2): 19 citing Scheffrahn, RH et al. 1987. "Desorption of residual sulfuryl fluoride from structural and household commodities by headspace analysis using gas chromatography." Bulletin of Environmental Contamination and Toxicology *39: 769-775.*

Vikane can also be absorbed and released for days by many household materials.[54] Researchers found that four materials (polystyrene insulation, latex baby bottle nipples, wood and polyester cushion fibers) released significant amounts of the fumigant and that some materials (wool fabric, polyester cushion fiber, plastic toy soldiers and polystyrene insulation) released Vikane for up to 40 days after fumigation (see Figure 1).[55]

Although the U.S. EPA currently requires that air levels of Vikane be below 5 parts per million (ppm) before occupants can re-enter a structure, in 1993 the agency stated it had "concern that the 5 ppm reentry level may not be appropriate." The agency explained that the safety standard should be lowered to 2 ppm, less than half the current standard, with an even more protective standard for children. Although the agency set a deadline of October 1994 to decide on lowering the reentry level, the U.S. EPA has yet to take action to reduce the safety level and protect public health.[56]

Despite U.S. EPA's concerns and Vikane's extensive use, it has been studied far less than methyl bromide. In fact, because of "uncertainty about neurotoxic effects due to long term exposure to [Vikane]," U.S. EPA requires workers to wear self contained breathing apparatus (also known as SCBA) gear as they reenter fumigated homes, regardless of air levels.[57]

Unlike agricultural pesticide use, structural pesticide use is not reported by location of application, making it impossible to estimate the number of Californians living in close proximity to these applications. The tables below translate reported pounds of fumigant used to numbers of single-family houses that might be fumigated. Thus these figures indicate the number of single-family homes that *could* have been fumigated based on average application rates and average sized homes—we don't know how many fumigated structures were actually single family homes, larger households, garages, offices, schools, businesses, etc. These figures provide an insight into the scale of use, rather than actual numbers of treated homes.

Table 3a: Estimated number of single family households fumigated with methyl bromide

County	Methyl Bromide (lbs.)	No. of Single Family Households*
Los Angeles	389,346	6,489
Orange	114,320	1,905
Riverside	13,990	233
Sacramento	9,504	158
San Bernardino	9,060	151
San Joaquin	7,792	130
Sonoma	7,696	128
San Mateo	5,231	87
Marin	5,148	86
Monterey	4,645	77
Alameda	4,610	77
Santa Cruz	3,196	53
Stanislaus	3,083	51
San Diego	2,294	38
Contra Costa	2,075	35
San Luis Obispo	1,739	29
Napa	1,458	24
Fresno	1,210	20
Mendocino	1,145	19
Placer	1,101	18
Solano	1,094	18
	598,656	9,978

Source: DPR. 1996. "Pesticide use report, annual 1995, indexed by chemical and by crop." DPR, Sacramento, CA.

**Capacity estimate based on average structure of 2,500 sq. ft. and methyl bromide applied at 3 lbs./1000 cu. ft.*

Table 3b: Estimated number of single family households fumigated with Vikane (sufuryl fluoride)

County	Sulfuryl fluoride (lbs.)	No. of Single Family Households*
Los Angeles	700,081	140,016
Orange	250,000	50,000
San Diego	212,638	42,528
Santa Clara	125,099	25,020
Riverside	84,273	16,855
Ventura	71,682	14,336
San Bernadino	48,525	9,705
Santa Barbara	43,953	8,791
Kern	37,088	7,418
Alameda	31,845	6,369
Monterey	27,224	5,445
San Mateo	21,275	4,255
Santa Cruz	20,548	4,110
San Luis Obispo	19,029	3,806
Fresno	13,632	2,726
Tulare	6,679	1,336
Sonoma	4,901	980
Sacramento	3,722	744
Kings	3,540	708
San Joaquin	3,004	601
Marin	2,838	568
San Benito	2,302	460
Stanislaus	2,282	456
Contra Costa	2,171	434
Mendocino	1,440	288
Merced	1,239	248
Napa	1,007	201
	1,746,320	349,264

Source: DPR. 1996. "Pesticide use report, annual 1995, indexed by chemical and by crop." DPR, Sacramento, CA.

**Capacity estimate based on average structure of 2,500 sq. ft. and Vikane applied at 2.5 lbs./10,000 cu. ft. The rates of Vikane used in a fumigation fluctuate dramatically depending on the size of structure, weather conditions and other factors. The number 2.5 lbs/10,000cu. ft. is an average based on discussions with County Commissioners offices in both Los Angeles County and San Francisco County.*

Pesticides in Indoor Air

Although beyond the scope of this report, indoor air contamination accounts for a large percentage of total daily exposure to airborne pesticides. [1,2]

Not surprisingly, indoor pesticide applications can pollute indoor air. However, indoor air pollution can also occur as a result of drift from nearby applications to farms, lawns or other buildings. Pesticides can be tracked indoors on clothes, toys or pets. Residues of many pesticides are found in and around the home even when there has been no known use of them on the premises.[3]

Research shows that pesticides persist in the home environment for many months or years after applications, evaporating indoors and lingering in rooms or hallways for hours or days after application.[4] Citing three important studies, the authors of *The Effects of Pesticides on Human Health* conclude that "at any given time, the air inside of the average dwelling in the U.S. contains several kinds of pesticides at levels that are typically 10-100 times higher than those found in the immediately surrounding outdoor air."[5]

Indoor applications of pesticides have also been linked to various adverse health effects. A study in Los Angeles County, for example, found four times higher rates of leukemia in children ten years and younger whose parents used pesticides in the home.[6] Three additional studies around the country found higher rates of cancer among children who had lived in homes where pesticides had been applied, including pesticide bombs and pesticides used to control termites and other structural pests. [7,8,9]

1 Gurunathan, S et al. 1998. "Accumulation of chlorpyrifos on residential surfaces and toys accessible to children." *Environmental Health Perspectives* 106(1): 9-16 citing Kiel, RF. 1969. "A pesticide use survey of urban households." *Agricultural Chemistry* 24: 10-12; and Savage, EP et al. 1981. "Household pesticide usage in the United States." *Archives of Environmental Health* 36: 304-309.

2 Lewis, RG et al. 1994. "Evaluation of methods for monitoring the potential exposure of small children to pesticides in the residential environment." *Archives of Environmental Contamination and Toxicology* 26: 37-46 citing Lewis, RG. 1988. "Measurement of atmospheric concentrations of common household pesticides: a pilot study." *Environmental Monitoring Assessment* 10: 59-73.

3 Lewis, RG et al. 1994. "Evaluation of methods for monitoring the potential exposure of small children to pesticides in the residential environment." *Archives of Environmental Contamination and Toxicology* 26: 37-46 p. 45.

4 Baker, SR and CF Wilkinson. 1990. *The Effects of Pesticides on Human Health*. Princeton Scientific Publishing Co, Inc. Princeton, NJ, p. 83.

5 Baker, SR and CF Wilkinson. 1990. *The Effects of Pesticides on Human Health*. Princeton Scientific Publishing Co, Inc. Princeton, NJ, pg 85 citing Lewis, RG and RE Lee. 1976. "Air pollution from pesticides: sources, occurrence, dispersion," in Lee, RE, ed. 1976. *Air Pollution from Pesticides and Agricultural Processes*, Boca Raton, FL: CRC Press 51-94.

6 Lowengart, R et al. 1987. "Childhood leukemia and parents' occupational and home exposures." *Journal of the National Cancer Institute* 79(1): 39-45.

7 Gold, E et al. 1979. "Risk factors for brain tumors in children." *American Journal of Epidemiology* 109(3): 309-319.

8 Davis, JR et al. 1993. "Family pesticide use and childhood brain cancer." *Archives of Environmental Contamination and Toxicology* 24: 87-92.

9 Ibid.

4 Health Effects of Pesticides in the Air

Numerous studies have found links between pesticides and adverse health effects including cancer, infertility and birth defects.[58] Unfortunately, identifying the specific route or routes of exposure—air, water, food—is notoriously difficult, particularly in the case of long-term, chronic health effects. Major gaps exist in our knowledge of the health effects of pesticide exposure at low levels over long periods of time.[59] With these effects, multiple causes, long delays before symptoms appear and inadequate data all confound efforts to pinpoint causes of specific illnesses.

Nevertheless, we can begin to assess the effects of airborne pesticides on human health using: 1) studies where air is a likely source of exposure; 2) pesticide illness data compiled by the State of California categorized by source of exposure and 3) the few studies that have investigated drift incidents and their impact on human health.

Epidemiologic studies

Epidemiologic studies (studies of disease and its causes) provide an important source of information on the long-term effects of pesticides on humans. While adverse health effects in the following examples were not directly attributed to pesticides in air, air was likely a significant route of exposure.

A recent study by the University of Minnesota found that families residing in predominantly agricultural regions of Minnesota are more likely to have children with birth defects. In fact, the birth defect rates for families in high pesticide use regions of Minnesota are approximately as high as those of pesticide applicators statewide.[60] The most consistent increases were found in regions with intensive use of 2,4-D and MCPA.

A recent study by the University of Minnesota found that families residing in predominantly agricultural regions of Minnesota are more likely to have children with birth defects.

In addition, three widely cited studies found higher rates of cancer among children who had lived in homes where pesticides had been applied, including pesticide bombs and flea collars on pets.[61,62,63] The study subjects in all three studies were most likely exposed to pesticides through multiple routes of exposure, including air.

Acute and Chronic Exposure to Pesticides[1]

There are two major ways that pesticides affect human health. They can cause short-term acute effects, or long-term chronic effects.

Acute Toxicity of Pesticides

Acute toxicity refers to short-term adverse health effects that occur after recent exposure to the toxic substance. Usually this is within a few minutes to a few hours—at the most a few days. Effects can include: stinging, burning, rashes, blisters, scarring, blindness, convulsions, nausea and dizziness.

Chronic Toxicity of Pesticides

Chronic toxicity refers to long-term health effects that occur months or years after the toxic exposure. Health effects may be delayed consequences of past exposures, or a result of continuing low-level exposures over time. Effects can include respiratory problems, cancer and other tumors, neurological damage, and reproductive effects such as birth defects, stillbirth, spontaneous abortion and infertility.

1 Language from Moses, M. 1995. *Designer Poisons*. Pesticide Education Center, San Francisco, CA.

A 1995 study in Washington State investigated pesticide exposure among children of agricultural workers. Not surprisingly, the study found that children living closest to an orchard had the highest levels of pesticide breakdown products in their urine. The researchers suggest drift as the major source of these pesticides.

Pesticide illness reports document poisonings

In 1995, the most recent year for which data is available, the California Department of Pesticide Regulation (DPR) determined that pesticide exposure was a possible contributing factor in 1,593 reported, short-term illnesses in California, with approximately 300 of these cases attributed to drift.[64,65] Virtually every credible source concedes that the actual number of pesticide-related illnesses is much higher than the number of reported cases. Scientists at the University of California, for example, estimate that up to 80% percent of pesticide illnesses go unreported in California.[66] Under-reporting of actual pesticide illnesses occurs for many reasons, including:

- Many illnesses, such as cancer, cannot be traced to specific exposures.
- Many doctors are inadequately trained to diagnose pesticide poisoning.
- Often the symptoms of pesticide exposure are virtually indistinguishable from flu symptoms, including nausea, vomiting and headaches.
- Many agricultural workers do not report illness for fear of losing work or even their jobs.
- Undocumented workers can't use the state health care system.
- Most physician reports are processed through worker compensation claims, resulting in under-reporting of non-worker injuries.

Case Studies: Additional evidence of injury

Case 1: Lompoc (near Santa Barbara)

For years, citizens of the town of Lompoc near Santa Barbara have complained that intensive pesticide use at nearby farms has caused an increase in community health problems including asthma, bronchitis, lung cancer, infant respiratory disease and neurological and reproductive difficulties. Continuous pressure by community residents helped convince the state to conduct a special investigation of illnesses in the Lompoc area, including a health study by the California Office of Environmental Health Hazard Assessment (OEHHA).

Finalized in June 1998, the report found that residents of Lompoc do in fact suffer from higher levels of respiratory illnesses and certain cancers compared to other counties in the survey. Lung and bronchus cancers, for example, were significantly elevated in Lompoc, with a lung cancer rate at 37% above expected incidence. In addition, infants in Lompoc were at least twice as likely to develop serious respiratory ailments requiring a hospital stay. Researchers also found an increase in bronchitis, asthma and perinatal respiratory disease.[67] Researchers did not attribute the health problems in Lompoc to any specific source but pesticides are assumed by many residents to be the cause.

Case 2: San Joaquin and Imperial Valleys

After 15 years of headaches, nausea, vomiting and other health problems, residents of the San Joaquin and Imperial Valley living near cotton fields finally convinced the OEHHA to conduct a study evaluating the effects of drifting cotton pesticides sprayed near their communities.

The researchers substantiated anecdotal reports of symptoms associated with spraying of cotton pesticides. They found that the group with a high probability of exposure to these pesticides reported experiencing a variety of illnesses 50-120% more frequently than the unexposed comparison group. Symptoms of the high probability exposure group included: fatigue, respiratory allergy symptoms, eye irritation, rhinitis, throat irritation, shortness of breath, wheezing, asthma symptoms, nausea and diarrhea.[68]

Case 3: San Benito County

In 1991, a helicopter applied the extremely toxic herbicide paraquat to two agricultural fields near Hollister in San Benito County. The drift passed over the local community and damaged foliage, leaving characteristic brown spots through one half mile of neighboring cropland and one third mile beyond the community.[69]

Community complaints about the drift led to a study to determine if there were any health consequences resulting from the drift. The study, also conducted by OEHHA, found that the paraquat-exposed group had a "significantly higher risk" for ten symptoms: cough, diarrhea, eye irritation, headache, nausea, rhinitis, throat irritation, trouble breathing, unusual tiredness and wheezing. According to the study, residents in the exposed community had symptom rates that ranged from 73% to 490% higher than unexposed communities.[70]

Case 4: Kern County

In 1996, an application of a mixture of pesticides including the extremely toxic nerve poison Danitol (fenpropathrin) to a nearby field led to the hospitalization of twenty farmworkers, including three pregnant women.

The workers were harvesting table grapes when a pilot employed by San Joaquin Helicopters applied a mixture of pesticides to a 39 acre cotton field immediately south of the grape fields. The farmworkers, ranging from 879 to 1897 feet from the cotton field, began experiencing symptoms including nausea, vomiting, dizziness and fainting.[71] They were rushed to the hospital where 15 were treated and released and eight, including the pregnant women, remained at the hospital for observation.

5 California Regulators Have Failed to Protect Us from Airborne Pesticides

DPR has failed to implement the Toxic Air Contaminant Program

In light of the clear and serious hazards associated with airborne pesticides, one might expect state regulators to have moved aggressively to reduce or at least strictly regulate airborne pesticides. Unfortunately, this has not occurred. In fact, regulators at DPR have virtually ignored laws passed in the mid-1980s that were intended to protect Californians from pesticides in air.

In the 15 years since passage of the original law, DPR has evaluated, peer-reviewed and designated only one pesticide as a TAC—a chemical that had already been virtually banned by the US EPA.

The laws, passed in 1983-1984 and collectively known as AB 1807, created the state's Toxic Air Contaminant (TAC) Program. They require DPR to 1) evaluate and prioritize pesticides; 2) produce a peer-reviewed health effects report for priority pesticides; 3) officially list dangerous pesticides as Toxic Air Contaminants (TACs) and 4) control and mitigate the use of these pesticides (for more detail on the law see sidebar).

In the 15 years since passage of the original law, however, DPR has evaluated, peer-reviewed and designated only one pesticide as a TAC. Even this pesticide, the extremely toxic systemic poison ethyl parathion, was only listed after it had been banned for nearly all uses by the U.S. EPA.[72] In contrast, the California Air Resources Board, which is responsible for non-pesticide chemicals, has completed the process and listed 19 compounds as TACs.[73]

Pesticides prioritized but never regulated

In accordance with the law, DPR has prioritized pesticides to be evaluated as TACs, producing a series of lists of the pesticides it considers most likely to contaminate the air and harm human health. These priority pesticides, called candidate TACs, have been ranked by toxicity, intensity of use, ability to evaporate or drift considerable distances and other criteria.[74] DPR has produced four candidate TAC lists over the years, shuffling and reshuffling its list in 1985, 1987, 1989 and 1996. Although approximately 150 pesticides have been identified as candidate TACs, DPR has produced a finalized health effects study and listed only one as a TAC. As indicated in Table 5a, none of the reviews of the first twelve candidate TAC pesticides have been completed (some of these pesticides have since been banned by U.S. EPA). Meanwhile, several hundred million pounds of these pesticides have been released in California since their designation as candidate TACs; millions more are released every year.[75]

Federally identified toxic air contaminant pesticides ignored

DPR has also failed to address the health risks posed by thirty-four pesticides identified by the federal government as the most dangerous pesticidal air pollutants. These chemicals, called Hazardous Air Pollutants (HAPs), are defined in federal law as those that "cause, or contribute to, air pollution which may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness."[76] Approximately half of these thirty-four chemicals are known or probable carcinogens, highly acute systemic poisons or reproductive toxins.[77] The law that created the TAC Program, AB 1807, explicitly recognizes the unique threat posed by HAPs and mandates that DPR *automatically* list them as Toxic Air Contaminants.

Remarkably, DPR's interpretation of this requirement effectively *prevents* these chemicals

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The Law that Could Help Protect Us: The Toxic Air Contaminant Program

In 1983 and 1984, in an effort to protect public health from airborne contaminants, the California Legislature passed Assembly Bill (AB) 1807 and AB 3219 creating the Toxic Air Contaminant (TAC) Program. These bills mandate the California Department of Pesticide Regulation (DPR) and California Air Resources Board (ARB) to 1) evaluate the health effects of chemicals emitted into the air, and 2) to reduce the exposure of such chemicals to the point "at which no significant adverse health effects are anticipated."[1] DPR bears the responsibility for pesticidal air contaminants and ARB regulates non-pesticidal air contaminants. The following discussion is limited to DPR's role.

The bills, collectively referred to as AB 1807, charge both agencies with the task of prioritizing, evaluating, and officially listing and controlling TACs. In addition to requiring specific procedures for evaluating and regulating airborne toxins, the legislation sought to insulate scientific evaluations from political pressures by building in public participation and independent scientific review.

The TAC Process

1. Evaluate and prioritize pesticides

The first step in the TAC process requires that DPR identify and prioritize pesticides emitted into the air which may "pose a present or potential hazard to human health."[2] These priority pesticides then become "candidates" for the full TAC review process.

2. Produce public health studies for peer-review by an independent scientific panel

Following prioritization and preliminary evaluation, DPR must produce a public report on the health effects of a candidate TAC. This document is to include risk assessments and exposure data based on air monitoring and must be formally reviewed by a scientific review panel (SRP made up of nine "highly qualified and professionally active" scientists who are not employees of the state.[3] The panel is expected to assess "the scientific data on which the report is based, the scientific procedures and methods used to support the data, and the conclusions and assessments on which the report is based."[4] This provision of the law was intended to separate politics from science and insure that the very best science is used to evaluate TACs.

3. Listing as a Toxic Air Contaminant

If the SRP finds the report acceptable, the director of DPR, in consultation with the Department of Health Services, the State Air Resources Board and the Air Pollution Control Districts, then decides if the pesticide should be listed as a TAC.[5] A TAC is defined in the law as an air pollutant "which may cause or contribute to an increase in mortality or an increase in serious illness, or which may pose a present or potential hazard to human health."[6] Listing as a TAC subjects a chemical to important mitigation and enforcement efforts designed to protect the public.

The only exceptions to the process outlined above are federally designated "hazardous air pollutants" (HAPs) which must be listed as TACs under AB 1807. Under the Federal Clean Air Act, the U.S. EPA is required to maintain a list of pollutants of which each "causes, or contributes to, air pollution which may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness."[7]

4. Control and mitigation

Once a pesticide is listed as a TAC, the director is required to determine the extent and type of control measures needed to reduce emissions and protect the public. [8,9] Mitigation measures may include but are not limited to label amendments, applicator training, restrictions on use patterns or locations, changes in application procedures, reclassification as a restricted material, or cancellation. Any person who violates TAC restrictions is subject to a fine of up to $10,000 per day per violation.

1 AB 1807, Legislative Counsel's Digest, (1)
2 FAC 14022(b)
3 FAC 39670 (b) SRP members receive a token stipend.
4 FAC 14023(b)
5 FAC 14023(e)
6 FAC 14021(b)
7 USC 7412(1)
8 FAC 14023(c)
9 FAC 14024(a)

Table 5a: Rankings of candidate TAC pesticides (1985–1995)

NOTE: Many of DPR's top ten priority pesticides for study and regulation as air contaminants went from high priority on lists in 1985, 1987 and 1989 to low priority in 1996 when DPR shuffled its prioritization criteria. For example, methyl parathion ranked 3 in 1985; 4 in 1987; 2 in 1989; and 38 in 1996.

Pesticide	Priority in 1985	Priority in 1987	Priority in 1989	Priority in 1996	Pounds of Use in 1995[1]	Health Effects
Ethylene dibromide	1	2	Cancelled for most uses by U.S. EPA	Cancelled for most uses by U.S. EPA	90	Known carcinogen[a] and Category I extremely toxic systemic poison[b]
Ethylene dichloride	2	3	Cancelled for most uses by U.S. EPA	Cancelled for most uses by U.S. EPA	<0.5	Known carcinogen[a]
Methyl Parathion	3	4	2	38	160,094	Category I extremely toxic systemic poison[b] and endocrine disrupting pesticide[c]
Carbon tetrachloride	4	5	Cancelled for most uses by U.S. EPA	Cancelled for most uses by U.S. EPA	0	Known carcinogen[a]
Ethylene oxide	5	6	Not Listed[2]	Not Listed	8	Known carcinogen;[a] known reproductive toxin[a] and extremely toxic systemic poison[b]
Methyl bromide	6	7	12	Listed as HAPTAC[3]	17,565,348	Category I extremely toxic systemic poison[b] and known developmental toxin[a]
Chloropicrin	7	8	9	11	2,811,628	Category I extremely toxic systemic poison[b]
Azinphos-methyl	8	9	4	23	434,098	Category I extremely toxic systemic poison[b]
DEF	9	10	13	4	883,857	Restricted use pesticide[4]
Methomyl	10	11	10	49	830,313	Category I extremely toxic systemic poison[b] and endocrine disrupting pesticide[c]
Paraquat	11	12	3	61	863,985	Category I extremely toxic systemic poison[b]
Inorganic arsenic	12	13	Not listed[5]	Listed as HAPTAC[6]	125,055	Known carcinogen[a] and extremely toxic systemic poison[b]

a OEHHA. 1998. "Chemicals known to the State to Cause Cancer or Reproductive Toxicity." www.calepa.cahwnet.gov/oehha/prop65.htm

b Meister, RT. 1996. *Farm Chemicals Handbook.* Meister Publishing, Willoughby, OH.

c Illinois Environmental Protection Agency. 1997. "Report on Endocrine Disrupting Chemicals." Illinois Environmental Protection Agency; Smolen, M. 1996. "Endocrine disruption: emerging threats." *Global Pesticide Campaigner* 6(2); Colborn, Theo, et al. 1996. *Our Stolen Future.* Penguin Books, NY.

1 DPR. 1996. "Pesticide use report, annual 1995, indexed by chemical and by crop." DPR, Sacramento, CA.

2 At time of publication DPR had not yet responded to inquiries about ethylene oxide's status on candidate TAC lists.

3 As mentioned in the shaded box on the AB 1807 process, DPR is required to automatically list as Toxic Air Contaminants all pesticides identified by the U.S. EPA as Hazardous Air Pollutants. When methyl bromide and arsenic acid were added to this list they were taken off the candidate Toxic Air Contaminant list.

4 40 FR 158. In an effort to decrease the drift problems associated with DEF the California Department of Food and Agriculture does not allow DEF to be applied within one-half mile of residential areas.

5 At time of publication DPR had not yet responded to inquiries about arsenic acid's status on the candidate TAC lists.

6 As mentioned in the shaded box on the AB 1807 process, DPR is required to automatically list as Toxic Air Contaminants all pesticides identified by the U.S. EPA as Hazardous Air Pollutants. When methyl bromide and arsenic acid were added to this list they were taken off the candidate Toxic Air Contaminant list.

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from being stringently regulated or mitigated as are TACs that are listed following the detailed process outlined above. The Department argues that HAPs are not required to be mitigated and regulated to protect public health under the TAC Program. In fact, DPR's interpretation of the law requires only that they *list* HAPs as TACs and that the Department has no other requirements to mitigate or control these chemicals under AB 1807. In a letter to Assemblyman Fred Keeley, for example, DPR explains that "there is no requirement to mitigate 'HAP-TACs'" in AB 1807.[78] DPR's narrow interpretation of the law has effectively isolated HAPs from the TAC process, avoiding public participation and independent scientific review. No health effects reports have been completed for any HAPs by DPR.

Pesticide monitoring is inadequate

Air monitoring for pesticides is a critical component of the TAC process. Because the law directs DPR to give priority to the evaluation and regulation of pesticides based on health risk and "amount or potential amount of emissions,"[79] air monitoring data can be a determining factor both in the decision to list a pesticide as a TAC and in any ensuing mitigation. Thus adequate monitoring of target pesticides is essential to protecting public health under the TAC Program.

The air monitoring data below is limited to monitoring conducted as part of the TAC Program. While DPR conducts limited air monitoring outside of the TAC Program, this monitoring may be less comprehensive. TAC monitoring is specifically designed to "document the level of airborne emissions" of pesticides potentially emitted into the air which pose a "present or potential hazard to human health." A preliminary review of DPR's available air monitoring outside of the TAC Program indicates that it is usually less extensive and, unlike TAC monitoring, fails to include a combination of monitoring near fields, within nearby communities and at urban background sites.[80]

Few pesticides have been monitored

DPR has failed to adequately monitor for most pesticides. In 1987, as part of the TAC Program, the Department of Food and Agriculture (DPR's predecessor agency[81]) published its intention to request monitoring for a

For most pesticides, DPR makes no effort to correlate detection levels with actual pesticide use. Low or "non-detect" levels may simply be the result of little or no local use of the target pesticide.

Table 5b: Pesticide air monitoring in support of the TAC Program

(includes monitoring near fields and in communities near applications)

Counties With More Than One Pesticide Monitored (# of monitoring studies completed)	Counties With One Pesticide Monitored	Counties With No Pesticide Monitoring
Fresno (9) Kern (8) Tulare (5) Monterey (3) San Joaquin (3) Imperial (3) Colusa (2)	Contra Costa Glenn Merced Siskiyou Sutter Ventura Humbolt Del Norte Butte	Alameda, Alpine, Amador, Calaveras, El Dorado, Inyo, Kings, Lake, Lassen, Los Angeles, Madera, Marin, Mariposa, Mendocino, Modoc, Mono, Napa, Nevada, Orange, Placer, Plumas, Riverside, Sacramento, San Benito, San Bernadino, San Diego, San Francisco, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Sierra, Solano, Sonoma, Stanislaus, Tehama, Trinity, Tuolumne, Yolo, Yuba
TOTAL = 7	TOTAL = 9	TOTAL = 42

Source: Air Resources Board. 1998. "Pesticide Monitoring Program Fact Sheet." ARB, Sacramento, CA. Based on completed air monitoring reports as of May 1998. Sixteen pesticides were monitored in one county, nine pesticides monitored in two counties; one in three counties; and one in four counties.

pesticide every two months (six per year).[82] As of 1998, however, instead of the expected monitoring of 72-78 pesticides (i.e. six pesticides every year for 12-13 years), only 26 final monitoring reports have been completed, leaving the public in the dark about more than 100 pesticides that have been identified by federal or state agencies as HAPs or candidate TACs.[83]

Forty-two out of California's 58 counties have never been monitored as part of the Toxic Air Contaminant Program.

Monitoring is not correlated with use

Presumably, levels of pesticide use would be a critical factor in establishing the source of high or low pesticide detections. For most pesticides, however, DPR makes no effort to correlate detection levels with actual pesticide use.[84] Low or "non-detect" levels may simply be the result of little or no local use of the target pesticide. As a result, important regulatory decisions affecting the health of local communities are made based on ambiguous data.

Pesticide monitoring is often limited to one region of one county. Forty-two out of California's 58 counties have never been monitored as part of the Toxic Air Contaminant Program.

In addition to the limited numbers of pesticides monitored, the scope of DPR's air monitoring under the TAC Program fails to address the widespread use of pesticides. DPR targets its monitoring efforts only on those counties of highest use. While we support DPR's efforts to target monitoring in high use counties, monitoring in just one county per pesticide ignores large segments of the state and ignores regional variabilities. For example, pesticides may react differently in a mid-size valley compared with the larger San Joaquin Valley. In all, DPR's limited air monitoring in the Toxic Air Contaminant Program has ignored nearly three quarters of all counties, including counties with intensive pesticide use. These ignored counties, a total of 42, accounted for more than 30% of statewide pesticide use in 1995 and include Madera (ranked 6th among counties of highest pesticide use), Kings (9th), Stanislaus (11th), Riverside (12th) and Sonoma (13th).[85,86]

6 Recommendations

As documented in this report, many pesticides become airborne on droplets of water, as a gas, adhered to dust particles or some combination of the three. Once airborne, these toxic chemicals can travel great distances, providing a potentially important source of exposure for millions of Californians. Of particular concern, a large and increasing number of Californians live in close proximity to intensive use of pesticides identified by state and federal agencies as carcinogens, reproductive and developmental toxins and nervous system toxins.

Recommendations for policy-makers:

- Create incentives to phase out the use of pesticides identified as carcinogens, reproductive and developmental toxins and acute nervous system toxins.
- Resuscitate the Toxic Air Contaminant Program. State agencies are not permitted to choose which laws they implement. Efforts were made to design the program to withstand political pressure and it must be implemented as enacted. Specifically, DPR should 1) expand air monitoring to include more pesticides and more counties; 2) produce required health effects reports; 3) determine which pesticides should be listed as Toxic Air Contaminants; 4) restrict pesticide use, create and enforce buffer zones and require additional mitigation measures as needed to ensure that airborne pesticides pose "no significant risk."
- Expand right-to-know activities to include publicizing air monitoring results through press releases, web pages and notices to local governments, timely release of pesticide use data (as of the printing of this report, 1996 pesticide use data had not been released) and expansion of the pesticide use reporting system to include detailed information on urban pesticide applications (including location of use).
- Regulators should adopt a precautionary approach and establish buffer zones between pesticide intensive farmland and homes, schools or other sensitive areas until pesticides are proven not to drift or cause harm.

Recommendations for individuals:

- Use least-toxic alternatives to fumigations.
- Contact CPR to find out how you and your community can reduce pesticide use.
- Request pesticide air monitoring in local communities.
- Write and call your state Assembly and Senate members and demand full implementation of AB 1807, the Toxic Air Contaminant Program.

Recommendations for growers:

- Use non-toxic alternatives to pesticides.
- Notify neighbors prior to applying pesticides.
- Write and call state Assembly and Senate members to request additional funding for the implementation of non-toxic alternatives.

Case Study: Telone

DPR's cancellation and subsequent reintroduction of the pesticide Telone II illustrates the pitfalls of regulating chemicals outside of the Toxic Air Contaminant (TAC) Program. By isolating its decisions on Telone II from peer-review and public comment, DPR ignored the mandates of the TAC Program and dismissed the intent of legislators who passed laws intended to protect Californians from the dangers of airborne contaminants.

Air contaminant and human carcinogen

Telone II (1,3-dichloropropene) is used to fumigate soil before planting carrots, tomatoes, broccoli, cotton and sweet potatoes. In 1988,[1] more than 16 million pounds of Telone II were used,[2] making it the second most used pesticide in California.[3]

Under the federal Clean Air Act, Telone II, which is applied as a gas, is considered a "Hazardous Air Pollutant."[4] The U.S. EPA lists Telone II as a "probable human carcinogen"[5] and it is listed as a chemical "known to the State of California to cause cancer."[6] Telone II's manufacturer, DowElanco, warns that "there are no protective clothing that are completely impervious to penetration by liquid Telone II."[7]

At the request of the California Department of Pesticide Regulation (DPR), the California Air Resources Board (ARB) conducted ambient air monitoring for Telone II in 1990. They chose five monitoring sites, including two schools in Merced County, the county with the highest projected use of Telone II. The studies revealed alarmingly high air concentrations of Telone II with levels up to 885 times the state safety standards.[8] All samples were above the safety standard with the highest level at Hilmar Junior High School. Alerting DPR to the high levels of Telone II found during air monitoring, ARB states, "Telone II was detected at very significant levels. Even the site designated as background had measurable levels of Telone II."[9]

Telone temporarily cancelled

Following confirmation of the extremely high concentrations found by ARB, the California Department of Food and Agriculture (DPR's predecessor agency[10]) took the highly unusual step of cancelling the permits of all users of Telone II, pending further investigation.[11] Use of Telone II in the years following the cancellation plummeted to just a fraction of use in the late 1980s.

At the time, a spokesperson for Telone II's manufacturer, DowElanco, the world's fifth largest producer of agricultural chemicals, stated, "We believe the levels that they found actually are of no concern...as far as risk posed to the people in Merced County. We're confident we can (soon) reinstate use of the product."[12]

DPR allows reintroduction of Telone II

Less than five years after DPR cancelled the use permits, DowElanco's $5 million investment in additional research, particularly on alternative application techniques, paid off.[13] In late 1994, DPR agreed to allow a reintroduction of Telone II under "controlled" conditions.[14] The conditions added modifications to application methods and reduced the number of counties authorized to apply Telone II. Use of Telone II, although well below 1988 levels, skyrocked from just over 2,000 pounds in 1994 to 409,821 pounds in 1995.

Air monitoring in 1995, following the reintroduction, found low levels of Telone II. ARB, however, stated that "unusually rainy weather" contributed to the low levels found.[15] Despite the acknowledged weaknesses of the 1995 air monitoring, at the beginning of 1996 DPR dramatically relaxed Telone II suggested permit conditions. DPR permitted Telone II use in all counties, up from just 13 counties the year before. In addition, instead of restricting the use of Telone II to once every three years, Telone II could now be used every year.

While DPR has yet to release 1996 use data, increasing the number of counties using Telone II from 13 to 58 and allowing use every year instead of once every three years, presumably will result in a drastic increase in Telone II use statewide.

The decision to reintroduce Telone II left some experts baffled. After reviewing the initial reintroduction assessment, Dr. William Pease, then a research toxicologist with the UC Berkeley School of Public Health hired by the *Los Angeles Times* to review DPR's proposal to reintroduce Telone II, said "it's a mystery to me why they are allowing its use."[16]

DPR's regulatory maneuvers ignored the mandates outlined in the Toxic Air Contaminant Program.

Telone II was first listed as a Candidate Toxic Air Contaminant (TAC) in 1989, but despite its toxicity, widespread use, volatility and the extremely high levels found in Merced County, DPR failed to voluntarily list Telone II as an official TAC.[17] In addition, DPR failed to produce and release to the public the required peer reviewed health effects report. Instead, prior to reintroduction, DPR "performed [their] own [internal] risk assessment on the proposed uses."[18] According to the *Los Angeles Times*, "the decision to allow resumption of Telone II was made with no formal public notifications of the proposal or public discussions."[19]

Telone II's reintroduction illustrates the limitations of regulating pesticide air contaminants outside of the TAC Program. Although at least one expert questioned the soundness of reintroducing Telone II, the public is still potentially exposed to hundreds of thousands of pounds of a very hazardous pesticide without the benefit of formal peer review or public input.

1 The most recent use data available when monitoring was conducted was 1988.
2 CDFA. 1990. "Use of Pesticide Suspended by CDFA." Release No. 90-45, April 13.
3 Baker, L. 1990. "Summary of Telone Monitoring." ARB, Sacramento, CA, April 23.
4 USC 7412(1).
5 U.S. EPA. 1997. "List of Chemicals Evaluated for Carcinogenic Potential." Office of Pesticide Programs, Washington, DC.
6 OEHHA. 1998. "Chemicals known to the State to Cause Cancer or Reproductive Toxicity." www.calepa.cahwnet.gov/oehha/prop65.htm.
7 DowElanco. 1995. "Telone II Soil Fumigant." Material Safety Data Sheet, January 25.
8 Sotero, R. "Pesticide found in Merced air, banned." *The Sacramento Bee*, April 21, 1990, A1.
9 ARB. 1991. "Telone Monitoring in Merced County." Pesticide Monitoring Report, January 4.
10 A state agency reorganization in 1990 created DPR. Pesticide regulation responsibilities were taken from the Department of Food and Agriculture and placed with DPR.
11 According to research by the *Los Angeles Times*, of the 10,000 pesticides and disinfectants approved for use in California "fewer than 50 have been banned over the past 25 years...only one of those earlier suspensions has been reversed." Jacobs, P. 1995. "Pesticides OKd for use in rare reversal of bans." *Los Angeles Times*, January 16, A1.
12 Sotero, R., op cit. Parentheses around "soon" in the original.
13 Jacobs, P. 1995. "Pesticides OKd for use in rare reversal of bans." *Los Angeles Times*, January 16, A18.
14 DPR. 1994. "DPR approves limited use of soil fumigant." Release No. 94-42, December 7.
15 ARB. 1995. "Ambient air monitoring in Merced County for Telone (1-3-Dichloropropene during DowElanco's commercial reintroduction, March-April, 1995." Sacramento, CA.
16 Jacobs, P., op cit.
17 In 1995 Telone was automatically added to the TAC list because of it's official federal designation as a Hazardous Air Pollutant, a distinction reserved for the most dangerous air pollutants. It did not, however, follow the full TAC process.
18 DPR, op cit.
19 Jacobs, P., op cit.

Table 6: Telone II use under "controlled conditions" 1995

(Counties with 1,000 lbs or more)

County Name	Use 1995
Kern	175,933
Fresno	63,387
Merced	61,711
Kings	29,447
Tulare	24,264
Santa Barbara	21,553
San Joaquin	12,040
Stanislaus	9,984
Monterey	8,365
Santa Cruz	2,236

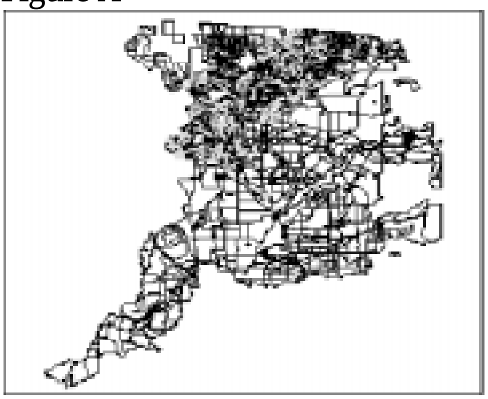
1 DPR. 1996. "Pesticide use report, annual 1995, indexed by chemical and by crop." DPR, Sacramento, CA.

Appendix A

Methodology for Assessing Population Proximity to Pesticide Use

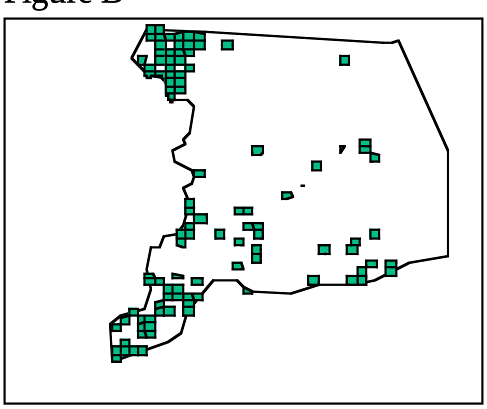
This analysis uses computer mapping software to over-lay California pesticide use data[1] on population data collected by the U.S. Bureau of the Census.[2] Population "Blocks", the highest resolution population data available from the U.S. Bureau of the Census, were loaded into ArcView 3.0 (for Macintosh), a vector (coordinate based) computer mapping software application. As indicated in Figure A, each block is defined geographically and includes the census count for the number of people residing there (darker blocks indicate greater populations in Figure A).

Figure A



Similarly, pesticide use reporting data maintained by the California Department of Pesticide Regulations is coded by township, range and section. This database enables the mapping of pesticide use to square mile blocks. For the purposes of this analysis, the presence of 1,000 pounds or more of reported pesticide use per year constitutes "heavy pesticide use." Square mile blocks of 1,000 pounds or more were mapped using ArcView 3.0 (Macintosh) (see Figure B).

Figure B



Both data sets were then imported into MapFactory 2.0.2 (Macintosh) for spatial analysis. Neither data set was projected and each was converted from decimal degrees to square miles using the measuring tool in ArcView 3.0. A 0.5 mile buffer was created around each square mile of "heavy" pesticide, creating "proximity zones". Maps of proximity zones were over-laid on the census block data map. Numbers of Californians living within the proximity zones were determined by taking the percent of each census block covered by one or more proximity zones and multiplying this percentile by the number of people living in that census block. These products were summed for each county to calculate the expected number of people in each county living within a proximity zone.

Assumptions and data limitations

This approach assumes that, on average, population is evenly distributed within each census block. In reality, of course, the data do not permit us to know where within the blocks the people live. The actual number of people living within 0.5 miles of pesticide use can be expressed as the expected value plus or minus some chance error. The chance error, however, is expected to be negligible because there are large numbers of affected census blocks in each county; most proximity zones encompassed entire census blocks leaving little room for chance; and the fact that smallest census blocks, which are more likely to be entirely covered by a proximity zone, contain relatively greater numbers of people. Table A provides numbers of affected blocks and average coverage percentiles for three randomly selected counties.

Similarly, the pesticide use data do not permit us to locate pesticide use beyond a resolution of one square mile. Obviously, actual pesticide applications may not be evenly distributed within each of these one mile squares. For the sake of simplicity, this analysis presumes any square mile where 1,000 pounds or more of listed pesticide use occurred is an "area of heavy pesticide use" and estimates numbers of people within 0.5 miles of this area. In fact, most one mile blocks of pesticide use contained substantially more than 1000. On average, people living within 0.5 miles of heavy candidate TAC and/or HAP use live near 10,569 lbs of pesticide use (with a range of 1000 lbs to 1,038,402 lbs and a standard deviation of 17,462 lbs).

A buffer of 0.5 miles was selected as a conservative estimate. As documented throughout this report, many pesticides have been detected at much greater distances from the application site. While some pesticides listed as HAPs or candidate TACs have not been found in ambient air 0.5 miles or greater from application, this may result from: 1) the fact that many have never been monitored for; and 2) because state pesticide monitoring is not correlated with actual pesticide use, low detection levels may result from little use. Given that pesticides may travel through the air in solution of water droplets, adhered to dust particles or as a gas, there are many vehicles for pesticide transport. While we know that many candidate TAC and HAP pesticides are highly mobile, the degree to which others are susceptible to these means of airborne transport is unknown.

Several conversions were made in the course of this analysis that had the potential to introduce some amount of error both in area (affecting numbers of people counted) and shape (affecting which people were counted). Conversions included: 1) rasterizing population data (converting from coordinate data to raster or image data); 2) converting decimal degrees to square miles; and 3) representing curved proximity zones on a grid of uniform squares. To estimate the effects of 1) and 2), the total population of each county was calculated from the rasterized data and compared with the vector (original data). For all counties, the rasterized estimates were slightly lower (approximately 2% to 7%) than the actual county populations (largely because limited resolution made it impossible to rasterize some of the smallest census blocks). Thus, because artificially lower population figures were used in the spatial analysis, this bias results in under-representing total numbers of people living near heavy pesticide use. Similarly with regard to 3), proximity zones were created from uniform squares on a grid that best approximated the curvatures of a sphere but were rounded downward to under-estimate actual zone size. Finally, the number of people counted is also likely to underestimate the actual number of people living near heavy use of these pesticides because population levels have increased since 1990, the data year used in this analysis.

1 DPR, Pesticide Use Reporting Data, 1995.

2 Census data was taken from Datamocracy BoundaryPack U.S. Volume II, Arizona, California, Nevada, TIGER 95/NAD83, 1997. This data was provided by the GreenInfo Network, a non-profit organization based in San Francisco.

Table A: Number of affected blocks and mean coverage percentiles for selected counties*

County	No. of census blocks fully or partially covered by a proximity zone*	Average percent each census block is covered by a proximity zone
Lake	304	87%
San Diego	840	84%
Ventura	1541	94%

**A "proximity zone" is a square mile of pesticide use with a 0.5 mile buffer; analysis is for all candidate TACs and HAPs.*

Appendix B

Release of Hazardous Air Pollutants and Candidate Toxic Air Contaminants in California (1995)

Pesticide	Use 1995	Health Effect
13 DICHLOROPROPENE	409,821	Known Carcinogen
24-D[1]	694,937	
ACEPHATE	481,759	
ACIFLUORFEN SODIUM SALT	6	Known Carcinogen
ACROLEIN	351,660	Category I Acute Toxin
ALACHLOR	41,119	Known Carcinogen
ALDICARB	359,494	Category I Acute Toxin
ALLETHRIN	<0.5	
ALUMINUM PHOSPHIDE	90,998	Category I Acute Toxin
AMITRAZ	77,198	
ARSENIC ACID[2]	125,056	Category I Acute Toxin and Known Carcinogen
ATRAZINE	38,140	
AZINPHOS-METHYL	434,098	Category I Acute Toxin
BENDIOCARB	21,742	Category II Carbamate Acute Toxin
BENOMYL	197,050	Developmental and Reproductive Toxin
BENTAZON SODIUM SALT	655	
BORIC ACID	164,769	
BROMACIL	223,126	
BROMOXYNIL OCTANOATE	119,836	Developmental Toxin
CAPTAN	772,332	Known Carcinogen
CARBARYL	858,340	and Category II Carbamate Acute Toxin
CARBOFURAN	248,065	Category I Acute Toxin
CARBOLIC ACID	300	
CARBOXIN	20,352	
CHLORINE	3,185,486	
CHLORONEB	32,530	
CHLOROPICRIN	2,811,628	Category I Acute Toxin
CHLOROTHALONIL	1,152,087	Known Carcinogen
CHLORPYRIFOS	3,524,366	Category II Organophosphate Nerve Toxin
CHLORSULFURON	6,172	
CHLORTHAL-DIMETHYL	575,820	
CHROMIC ACID	117,092	Category I Acute Toxin and Known Carcinogen

Pesticide	Use 1995	Health Effect
CREOSOTE	444,461	Known Carcinogen
CRYOLITE	2,460,788	
CYANAZINE	647,335	Developmental Toxin
CYCLOATE	49,897	
DAMINOZIDE	7,876	Known Carcinogen
DDVP	6,621	Category I Acute Toxin and Known Carcinogen
DEET	8	
DIAZINON	2,376,883	Category II Organophosphate Acute Toxin
DICAMBA DIETHANOLAMINE SALT	59283	
DICHLOBENIL	1,913	
DICLOFOP METHYL	16,540	
DICOFOL	598,301	
DIDECYL DIMETHYL AMMONIUM CHLORIDE	1,145	
DIETHATYL-ETHYL	22,150	
DIMETHOATE	596,791	Category II Organophosphate Acute Toxin
DIPHACINONE[1]	29	
DIPHENYLAMINE	4,325	
DIPROPYL ISOCINCHOMERONATE	1	Known Carcinogen
DIQUAT DIBROMIDE	87,336	
DIURON	1,073,681	
ENDOSULFAN	229,157	Category I Acute Toxin
ENDOTHALL MONO(NN-DIMETHYLALKYLAMINE)S	43,502	
EPTC	666,432	
ETHALFLURALIN	49,873	
ETHEPHON	1,025,905	
ETHOFUMESATE	11,102	
ETHOPROP	57,936	Category I Acute Toxin
ETHYL ALCOHOL	48	
FENAMIPHOS	190,814	Category I Acute Toxin
FENARIMOL	23,250	
FENTHION	413	Category II Organophosphate Acute Toxin
FOLPET	2	Known Carcinogen
FORMALDEHYDE	153,519	Category I Acute Toxin and Known Carcinogen
GLYPHOSATE ISOPROPYLAMINE SALT	4,150,232	

Appendix B continued

Pesticide	Use 1995	Health Effect
IMAZALIL	13,699	
IPRODIONE	588,600	Known Carcinogen
ISOPROPYL ALCOHOL	303,307	
LINDANE	4,654	Known Carcinogen
LINURON	85,931	
MALATHION	826,757	
MALEIC HYDRAZIDE POTASSIUM SALT	28,579	
MANCOZEB	679,286	Known Carcinogen
MANEB	1,309,283	Known Carcinogen
MEFLUIDIDE DIETHANOLAMINE SALT	3,558	
META-CRESOL	2	
METALDEHYDE	92,509	
METAM-SODIUM	15,274,166	Reproductive Toxin and Probable Carcinogen
METHANOL	27	Category I Acute Toxin
METHIDATHION	322,221	Category I Acute Toxin
METHOMYL	830,227	Category I Acute Toxin
METHOXYCHLOR	1,188	
METHYL BROMIDE	17,565,348	Category I Acute Toxin Developmental Toxin
METHYL PARATHION	160,093	Category I Acute Toxin
METHYLENEBIS (THIOCYANATE)	<0.5	
METOLACHLOR	184,917	
METRIBUZIN	30,953	
MOLINATE	1,427,055	
NALED	711,519	Category I Acute Toxin
NAPHTHALENE	<0.5	
NAPROPAMIDE	225,324	
NICOTINE	235	Category I Acute Toxin and Developmental Toxin
NITRAPYRIN	710	
NORFLURAZON	153,678	
OCTYL BICYCLOHEPTENEDICARBOXIMIDE	10,823	
ORTHO-BENZYL-PARA-CHLOROPHENOL AND SALTS[1]	1697	

Pesticide	Use 1995	Health Effect
ORTHO-PHENYLPHENOL SODIUM SALT	33,973	Known Carcinogen
ORYZALIN	595,119	
OXADIAZON	21,489	Developmental Toxin and Known Carcinogen
OXAMYL	68,197	Category I Acute Toxin
OXYDEMETON-METHYL	122,748	Category I Acute Toxin
OXYFLUORFEN	386,207	
OXYTHIOQUINOX	6,161	Probable Carcinogen
PARA-DICHLOROBENZENE	2	Known Carcinogen
PARAQUAT DICHLORIDE	863,985	Category I Acute Toxin
PCNB	109,920	
PCP	3	Known Carcinogen
PEBULATE	253,370	
PENDIMETHALIN	431,251	
PERMETHRIN	420,396	
PETROLEUM DISTILLATES[1]	2,571,990	
PHENOTHRIN	14	
PHORATE	135,887	Category I Acute Toxin
PHOSMET	267,886	Category II Organophosphate Acute Toxin
PHOSPHORIC ACID	238,016	
PHOSPHOROUS	802	
PINE OIL	69	
PIPERONYL BUTOXIDE TECHNICAL OTHER REL	10,376	
PROMETRYN	213,145	
PROPARGITE	1,813,831	Known Carcinogen
PROPOXUR	3,296	Category I Acute Toxin and Probable Carcinogen
PROPYLENE OXIDE	155,890	Known Carcinogen
PROPYZAMIDE	115,344	Known Carcinogen
PYRETHRINS	8,041	
RESMETHRIN	893	
ROTENONE	1252	
SIMAZINE	842,712	
SODIUM CYANIDE	1,347	Category I Acute Toxin
SSS-TRIBUTYL PHOSPHOROTRITHIOATE	883,857	
STREPTOMYCIN	13,071	
SULFUR	69,838,281	
SULFUR DIOXIDE	199,982	
SULFURYL FLUORIDE	1,746,320	Category I Acute Toxin
TAU FLUVALINATE	5,230	
TETRACHLORVINPHOS	7,489	
TETRAMETHRIN	1	

Appendix B continued

Pesticide	Use 1995	Health Effect
THIABENDAZOLE HYPOPHOSPHITE SALT	13	
THIOBENCARB	586,418	
THIOPHANATE-METHYL	122,955	
THIRAM	136,920	
TRIADIMEFON	22,996	
TRIBUTYLTIN OXIDE	46	Category I Acute Toxin
TRICHLORFON	4,552	Category II Organophosphate Acute Toxin
TRICHLORO-S-TRIAZINETRIONE	6,792	
TRICLOPYR	159,748	
TRIFLURALIN	1,433,999	
TRIFORINE	40,858	
VINCLOZOLIN	49,977	Probable Carcinogen
WARFARIN	<0.5	Category I Acute Toxin and Developmental Toxin
XYLENE	66,393	
ZIRAM	1,638,866	

1 The DPR Pesticide Use Reports specify a large number of related 2,4-D salts, amines and esters, all of which are included here.

2 This includes arsenic acid, arsenic pentoxide and arsenic trioxide.

3 This includes diphacinone and diphacinone sodium salt.

4 This includes ortho-benzyl-para-chlorophenol and the related potassium and sodium salts.

5 This includes petroleum distillates, petroleum distillates aromatic and petroleum distillates refined.

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