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Pesticides in Urban Surface Water

Urban Pesticides Use Trends Annual Report 2005

Prepared for the
San Francisco Estuary Project

March 2005

PREFACE

This is a report of research performed by TDC Environmental, LLC for the San Francisco Estuary Project. This report was prepared for the San Francisco Estuary Project to fulfill the annual reporting requirements in Task 2.2.2 and 2.2.5 of its grant agreement with the State Water Resources Control Board (Agreement Number 04-076-552-0) for the Urban Pesticides Pollution Prevention Project (UP3 Project). Views or information expressed in this report may not necessarily reflect those of the funding agencies.

ACKNOWLEDGEMENTS

The author appreciates the information and assistance provided by many organizations that have assembled and made public data on pesticide use. Pesticide sales and use data from the California Department of Pesticide Regulation were particularly useful in the preparation of this report.

The members of the project review panel provided invaluable assistance in the preparation of this report:

- Geoff Brosseau, Bay Area Stormwater Management Agencies Association
- Raymond Chavira, U.S. EPA Region 9
- Chris Geiger, San Francisco Department of the Environment
- Ann Heil, Los Angeles County Sanitation Districts
- Bill Johnson, San Francisco Bay Regional Water Quality Control Board
- Gina Purin, Marin County Stormwater Pollution Prevention Program
- Nan Singhasemanon, California Department of Pesticide Regulation
- Laura Speare, UP3 Project Manager

The author also wishes to acknowledge the grant management team—Regional Water Quality Control Board grant manager Bill Johnson, San Francisco Estuary Project (SFEP) UP3 Project Manager Laura Speare, and SFEP Project Manager Marcia Brockbank—who provided invaluable assistance to TDC Environmental with this project.

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1.0 INTRODUCTION

1.1 Background

The presence of pesticides in urban surface water and their environmental effects are topics of great interest to research scientists, regulatory agencies, municipalities, and the general public. Future trends in water quality depend, in part, on trends in use of urban pesticides. This report is intended to assist California water quality agencies—including municipalities—by analyzing urban pesticide use trends.

This is one of three reports prepared annually by the Urban Pesticide Pollution Prevention (UP3) Project. (The other two reports are a review of California water quality agencies' urban pesticide water quality regulatory activities and a summary of recent scientific findings that are relevant to urban surface water quality management activities). The purpose of the UP3 Project is to provide education, outreach, and technical assistance for implementation of the Diazinon and Pesticide-Related Toxicity in Bay Area Urban Creeks Water Quality Attainment Strategy and Total Maximum Daily Load (WQAS/TMDL) (Johnson 2004).[1] The project is structured to mirror the three major elements of the WQAS/TMDL Implementation Strategy: Outreach and Education, Science (Research and Monitoring), and Proactive Regulation. The San Francisco Estuary Project (SFEP) has been awarded California water bond grant funds from the State Water Resources Control Board to implement the UP3 Project through March 2007. TDC Environmental is providing technical support for the project.

1.2 Scope of This Report

This is the first annual urban pesticide sales and use trends report prepared by the UP3 Project. It presents the results of the project's analysis of data and reports relevant to urban pesticide use trends for pesticides that have the potential to cause adverse effects in urban surface waters. While much of the information in the report is relevant throughout California, the report focuses on the San Francisco Bay Area and on pesticides that may be released to urban creeks, as the UP3 Project is designed specifically to support the San Francisco Bay Area urban creeks WQAS/TMDL. This report considers not only sales and use patterns, but also potential for adverse effects on urban surface waters in its analysis, with the intent of making it a more complete and useful resource than reports that simply address pesticide market availability or pesticide use patterns.

Although this is the first annual urban pesticide use trends report prepared for the UP3 Project, it builds on previous related work, particularly a 2003 review of the water quality implications of the shift in urban insecticide use patterns resulting from the phase out of most urban uses of diazinon and chlorpyrifos (TDC Environmental 2003). That report found that use of commonly available insecticides—particularly pyrethroids—as substitutes for diazinon and chlorpyrifos in urban areas may cause adverse effects in aquatic ecosystems receiving urban runoff. The 2003 report also identified priorities for urban pesticide toxicity reduction activities. The recommendations in this urban pesticide use trends report specifically address how new scientific and pesticide use information can be used to improve the effectiveness of California water quality agency efforts to prevent pesticide-related toxicity in surface waters, urban runoff, and municipal wastewater discharges.

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[1] References are in Section 7.

1.3 Data Sources

This report is based on a review of information relating to trends in use of urban pesticides. Information in this report was obtained from a variety of sources:

- Pesticide sales and use data collected by the California Department of Pesticide Regulation (DPR);
- Pesticide retail shelf surveys;
- Pesticide product line information on manufacturer Internet sites;
- Pesticide use surveys conducted by universities and government agencies; and
- Interviews with agency staff and researchers.

Since it builds on previous reports, the focus of this report is on the most recently available information (*i.e.*, information that became available in 2004).

For purposes of this report, the San Francisco Bay Area is defined to include the nine Bay Area counties: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Sonoma, and Solano Counties.

1.4 Report Organization

This report is organized as follows:

- *Section 1* (this section) provides the background and scope of the report.
- *Section 2* describes the approach to the analysis of pesticide use.
- *Section 3* summarizes pesticide user surveys, retail store shelf surveys, and reviews of the current products from popular retail pesticide product manufacturers.
- *Section 4* provides estimates of the San Francisco Bay Area use of pesticides most likely to threaten urban surface water quality and looks at trends in the use of these pesticides.
- *Section 5* gives this report's conclusions on the sales and use trends for pesticide of interest for urban surface water quality.
- *Section 6* provides recommendations to improve urban pesticide toxicity reduction activities. These recommendations are based not only on this report, but also on the UP3 Project's *Annual Research and Monitoring Update 2005* (TDC Environmental 2005) and annual update on improving pesticide regulatory activities to protect water quality (TDC Environmental 2004c).
- *Section 7* lists the references cited in the body of the report.

2.0 SELECTION OF PESTICIDES OF INTEREST

To identify which pesticides have the potential to cause adverse effects in urban surface waters or to cause compliance problems for municipal wastewater treatment plants and urban runoff programs, it would be desirable to have watershed specific information about pesticide use, including information about which pesticides are used, who is using them, and where (specifically) they are being applied (e.g., to water, to impervious surfaces, to drains, underground). This type of detailed information is not available. Various types of available information (sales data, use reports, user surveys, and retail surveys) can be pieced together in a manner that is sufficient to identify threats to water quality.

With more than 900 pesticide active ingredients registered for use in California, it is not feasible to analyze urban use patterns for every pesticide. This report focuses on pesticides that are known to pose the greatest potential threat to California's urban surface waters and to compliance with requirements for discharges to surface waters. The specific list of pesticides selected for detailed analysis is called the "study list." This section explains how the study list was selected.

2.1 Potential for a Pesticide to Cause Adverse Effects

The potential for use of a pesticide to cause adverse effects in urban surface waters, runoff, and municipal wastewater effluent depends on where it is used (does it have the potential to flow to surface water?) and how toxic it is (once it reaches surface water, can it harm the ecosystem?).

A report prepared for DPR assessed the relative potential for release of two urban insecticides (diazinon and chlorpyrifos) to surface water, considering sites of use, urban usage data, and the chemical and physical properties of formulations (TDC Environmental 2001). This methodology, when applied more broadly to urban pesticide use shows that the urban pesticide applications (or other pesticide releases) with the greatest potential to release pesticides to surface water are applications to:

- Surface waters (directly)
- Storm drains
- Outdoor impervious surfaces
- Other outdoor locations
- Sewers (including sewer discharges of treated solutions [e.g., cooling water], spill cleanup, and washing of treated items [e.g., clothing, pets, and skin])

It should be noted that applications to outdoor impervious surfaces have higher potential for runoff than lawn and garden applications. Application locations that are less important for water quality include underground injection and indoor applications in areas not cleaned with water.

When applied outdoors or to drains, formulations with the potential to release an environmentally meaningful quantity of pesticide active ingredient include concentrates, dusts and powders, ready to use liquids, and granules. Formulations that are less important for water quality are containerized baits, impregnated materials, and aerosols (which contain a relatively small quantity of active ingredient).

Use of relatively large quantities of pesticides (whether through numerous small applications or one large one) also has the potential to affect water quality, simply because of the magnitude of the discharge. This means that the most commonly used pesticides are among the most likely to appear in urban surface waters and urban discharges.

Once a pesticide reaches surface waters, it has the potential to affect the ecosystem. Some pesticides, like the pyrethroids, are extremely toxic to aquatic organisms (concentrations as low as a few parts per trillion may be harmful); others are far less toxic. Those pesticides that are the most toxic are the most likely to pose adverse effects if they reach surface waters.

2.2 Pesticide Study List

The UP3 Project recently published a report (the *Pesticides in Urban Surface Water Annual Research and Monitoring Update 2005*) that used available research and monitoring information to identify which pesticides are most likely to threaten urban surface water quality and municipal wastewater and urban runoff permit compliance (TDC Environmental 2005). This report evaluated information in the scientific literature, including pesticide monitoring data, findings of pesticide-related toxicity in water bodies, and previous evaluations of pesticide threats to urban surface water quality. Its findings built on a previous evaluation of insecticide replacements for urban uses of diazinon and chlorpyrifos, which also identified pesticides of potential concern for urban surface water quality (TDC Environmental 2003). These two reports found that the following pesticides have the greatest potential to cause adverse effects in aquatic ecosystems that receive urban discharges:

- Pesticides associated with recent urban water quality problems—*diazinon* and *chlorpyrifos*.
- Pesticides that have the greatest potential to threaten urban surface water quality—*pyrethroids*, *carbaryl* and *malathion*. (This report uses recent survey data and the results of previous studies of pyrethroids [TDC Environmental 2003] to identify the specific pyrethroids receiving detailed evaluation.)
- A new swimming pool biocide that has the potential to cause surface water toxicity, but for which there is little information—*Polyhexamethylenebiguanide (PHMB)*
- Other alternatives to diazinon and chlorpyrifos for which the potential for water quality impacts is not yet understood because available data are limited—*imidacloprid*, *pyrethrins*, and *fipronil*.

Together, the pesticides above are called the “study list.” Note that all but one of the study list pesticides are insecticides, which is why the remainder of the report focuses primarily on insecticides.

Although the UP3 Project Annual Research and Monitoring Update included copper-containing pesticides among the pesticides of interest in urban surface waters, this report does not look closely at urban use of copper-containing pesticides, as a recently completed report evaluated these uses in some detail (TDC Environmental 2004b).

3.0 QUALITATIVE DATA

3.1 Background

Home and garden pesticide use and most industrial, commercial, and institutional pesticide applications not made by professional applicators do not need to be reported to the State of California. Pesticide user surveys have long been used to characterize the pesticide use patterns of these groups. Such surveys tend to be more helpful in providing information about sites of use, target pests, and retailers purchased from than they are in providing data about active ingredients applied. Nevertheless, surveys shed light on activities that are otherwise difficult to quantify.

Since non-reporting pesticide users purchase their pesticides at retail outlets, pesticide retail shelf surveys and pesticide product manufacturer product line surveys have been used in the last few years as low-cost methods to identify trends in the pesticide retail market. While reviewing retail shelf contents and manufacturer product lines is useful in establishing the latest trends in retail product formulation, like user surveys, it does not provide any actual sales or use information. Nevertheless, this trend information is useful, particularly when market changes are occurring, as pesticide sales and use data are not released by DPR until 1-2 years after the sales and use actually occur.

3.2 Urban Pesticide User Surveys

Many residential pesticide sales and use surveys have been conducted in the last decade in California. Most surveys (e.g., Cooper 1996; Scanlin and Cooper 1997; URS 2000; Wilen 2001; Wilen 2002) predate the diazinon and chlorpyrifos regulatory changes initiated in 2001, and thus do not indicate the market shifts currently underway. The primary benefit of these surveys is to provide information about the characteristics of pesticide users, as this information can be used to develop effective outreach and education programs.

These surveys provided a critical finding for water quality agencies—the most common way that insecticides are used in California is to keep ants out of buildings. They also identified where pesticides are most commonly purchased, which is useful in designing pesticide retail store surveys (see Section 3.3). They have not typically included swimming pool biocides.

In 2002 and 2003, the University of California Integrated Pest Management (IPM) Program (U.C. IPM) completed a telephone survey of residents in the San Francisco Bay Area and in selected watersheds in Sacramento and Stockton (Flint 2003). The survey included renters and owners of both single family and multifamily dwellings in a ratio representative of the surveyed communities. Among the key results of the survey were the following:

- The survey's findings reinforced previous findings that ants are the most common pest treated by Northern Californians.
- About 60% of Bay Area survey respondents reported that outdoor areas surrounding their homes had been treated with pesticides at least once in the previous 6 month period.
- About 60% of outdoor pesticide applications were to hard surfaces such as building exteriors or sidewalks.

- Large home supply stores like Home Depot accounted for 42-55% of pesticide purchases among those surveyed.[2]
- Of those residents who reported that a professional pest control company treated their residence (about 30% of those surveyed, with higher fractions in rental and multifamily units than in owner-occupied single family homes), 60% reported that ants were the reason for the application and 92% reported that the application included outdoor hard surfaces.

3.3 San Francisco Bay Area Retail Store Shelf Surveys

A straightforward method of examining the pesticides on the retail marketplace is to visit pesticide retailers to conduct shelf surveys. By targeting surveys to retailers known to sell the greatest volumes of pesticide active ingredients, the information obtained can be assumed to be generally indicative of which active ingredients are most commonly used by retail pesticide purchasers.

Residential pesticide purchasing data from telephone surveys indicates that most of the applied insecticides are purchased at a relatively small number of retail outlets—these are large volume retailers like Orchard Supply Hardware and Home Depot (TDC Environmental 2001; Wilen 2001; Wilen 2002). These surveys found that 44 to 78% of residential pesticide sales occur at Home Depot and Orchard Supply Hardware (results vary, apparently depending on the presence or absence of these two specific chains in the survey area). On the basis of this finding, limited shelf surveys have been used in recent years to assess San Francisco Bay Area pesticide retail market trends.

The most recent survey of San Francisco Bay Area pesticide retail stores was conducted in May 2004 (TDC Environmental 2004a). That shelf survey focused on outdoor insecticides, herbicides, fungicides, and molluscicides; it did not include disinfectants and cleaning products, pool products, drain clearing products, rodent (or other mammal) control products, non-chemical insect controls, enclosed baits, soaps, petroleum oils, or unregistered "safer substitutes."

Outdoor Insecticide Use

The 2004 survey found the following insecticides in products labeled for outdoor use and formulated with formulation types that are most capable of releasing environmentally meaningful quantities of the active ingredient when applied outdoors (see Section 2):

- Pyrethroids: beta-cyfluthrin, bifenthrin, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, permethrin
- Carbamate: carbaryl
- Organophosphorous pesticides (OPs): acephate, disulfoton, malathion
- Other insecticides: canola oil, disodium octaborate tetrahydrate, hydramethylnon, imidacloprid, S-methoprene, potassium salts of fatty acids, pyrethrins

In general, the results of the 2004 survey reflect the continued trend in the insecticide market away from OPs and to pyrethroids. Most of the insecticide shelf space at surveyed stores was populated with pyrethroids. While up to one-third of insecticide products did not contain pyrethroids, non-pyrethroid insecticides were more likely to be specialty products—like products for house plants, cockroaches, mosquitoes, or snails—

[2] The survey included one of the major pesticide retailers—Orchard Supply Hardware—in a different category, mixed in with small hardware stores (which have previously been shown to comprise a relatively small fraction of the volume of retail pesticide sales in the Bay Area).

and thus given limited shelf space. Among non-aerosol products with uses most important for water quality (outdoor structural pest control uses), permethrin was the most common insecticide (in almost half of such products), followed by cyfluthrin, esfenvalerate, and bifenthrin.

Insecticides Subject to Wastewater Discharge

The following insecticides were labeled for pet applications, which can lead to sewer discharges when the pet is washed:

- Permethrin
- Carbaryl

Though not included in the survey, it should be noted that pet care retailers often sell insect control pet products with several other active ingredients, including imidacloprid, fipronil, and S-methoprene.

3.4 Retail Pesticide Brand Product Line Review

Since most pesticide products at San Francisco Bay Area pesticide retailers are from a small number of pesticide product brands, information available on the Internet can also be reviewed to obtain information about product trends. The purpose of such a review is to identify the most popular active ingredients in new products (as there is a time delay moving products through distributors) and to obtain an inventory of the active ingredients in popular products.

In past retail shelf surveys, only four brands have dominated retail stocks of products in the categories of greatest interest for water quality (insecticides; see Section 2): Ortho, Spectracide, Scotts, and Bayer. The insecticide products sold under each brand name are reviewed below. Aerosol, fogger, and containerized bait products were excluded from the review because their use typically does not release meaningful quantities of pesticide active ingredients to outdoor surfaces or drains. The review also excluded active ingredients in products that would not be used in Northern California, such as products designed for fire ants. Table 1 presents the results of the review.

Table 1. Insecticide Active Ingredients in Popular Insecticide Brand Products

Brand	Most Common Insecticide Active Ingredients	Other Insecticide Active Ingredients
Ortho	Acephate Bifenthrin Esfenvalerate Permethrin	d-Limonene, Gamma-lactone, Fenbutatin oxide, Malathion, Spinosad
Spectracide	Lambda-cyhalothrin Permethrin Tralomethrin	*Bacillus thuringiensis* subspecies *israelensis* (Bti), Disodium octaborate tetrahydrate, Halofenozide, Malathion, Nylar (pyriproxyfen), Orthoboric acid, Pyrethrins
Bayer	Cyfluthrin Imidacloprid	Beta-cyfluthrin, Deltamethrin, Disulfoton, Permethrin, *Bacillus thuringiensis* subspecies *israelensis* (Bti), Tebuconazole, Trichlorfon
Scotts	Bifenthrin	Imidacloprid

Source: Manufacturer Internet sites.

4.0 USE OF STUDY LIST PESTICIDES IN THE SAN FRANCISCO BAY AREA

4.1 Background

The only source of quantitative data about pesticide use is DPR. Using DPR data, it is possible to develop a gross estimate of pesticide use in the San Francisco Bay Area. The estimate uses pesticide sales data, reported pesticide use data, and a calculation of unreported use as described below. To ensure consistency with other pesticide data, this analysis follows DPR's convention of describing pesticide use pounds of pesticide "active ingredient." Pesticides in this section are grouped by chemical families—pyrethroids, OPs, and other pesticides.

Based on the surveys described in Section 3 and a 2003 evaluation of the insecticide marketplace (TDC Environmental 2003), the following pyrethroid pesticides were selected for inclusion in the quantitative estimates in this section: bifenthrin, cyfluthrin, beta-cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, permethrin, and tralomethrin.

4.2 Pesticide Sales

While not all pesticides sold are used (some are stored indefinitely or disposed of), over the long term, there is likely to be a correlation between pesticide sales and pesticide use. The State of California annually compiles statewide pesticide sales volumes, by amount of active ingredient, based on the payment of a fee that funds DPR. DPR sales data are based on a tax paid by the pesticide manufacturer when products are shipped. Data are generally released 10 to 12 months after the end of the reporting year.

These data are available only as annual aggregate data; no time of year information or regional breakdowns are publicly available. Data are only made public for pesticides for which more than three companies ("registrants") had registered products during the calendar year for which sales are reported (these data include about 90% of the quantity of pesticide active ingredients sold). If proposed regulations are approved, starting with calendar year 2004 data DPR will disclose sales volumes for all pesticide active ingredients.

Aside from the DPR data, sales data from specific pesticide manufacturers, distributors, and retailers are usually considered confidential and are generally unavailable to water quality agencies. Occasionally, individual retailers and distributors have disclosed specific sales figures, but such disclosure is unusual. Although market data firms do occasionally sell such data, the price has proven prohibitive for water quality agencies.

Table 2 (on the next page) presents California statewide sales of study list pesticides from 1999-2003 (the most recent data available). These data include all pesticide sales, whether for urban or agricultural use. Note that sales of pyrethroids, pyrethrins, fipronil, PHMB, and malathion have generally increased since 1999, while sales of diazinon, chlorpryifos, and carbaryl have generally decreased in that time period. The recent rapid increase in fipronil sales is particularly notable.

Uncertainty

Since DPR sales data are based on fees, they have been thought to be relatively accurate, but there are uncertainties in these data. Shipment scheduling practices and tax payment

Table 2. Sales of Study List Pesticides in California, 1999-2003 (Pounds of Pesticide Active Ingredient)

Pesticide	1999	2000	2001	2002	2003
Pyrethroids					
Bifenthrin	NR[a]	NR	31,626	32,179	70,759
Cyfluthrin	30,579	47,338	46,610	50,525	44,567
Beta-Cyfluthrin	NR	NR	NR	NR	41,779
Cypermethrin	43,757	50,436	49,690	64,596	81,840
Deltamethrin	2,103	8,326	3,189	4,386	4,926
Esfenvalerate	41,163	43,011	35,972	43,478	53,580
Lambda-Cyhalothrin	NR	NR	NR	24,061	27,892
Permethrin	290,714	437,901	276,144	427,960	480,572
Tralomethrin	1,922	1,924	34,438	175,383	63,897
OPs					
Chlorpyrifos	2,316,601	2,347,494	1,977,141	1,697,022	1,951,083
Diazinon	1,539,574	1,430,665	1,361,507	916,438	751,376
Malathion	1,501,547	1,054,078	1,124,940	1,018,961	1,662,673
Other					
Carbaryl	639,600	563,605	412,635	421,528	329,782
Fipronil	NR	1,857	19,002	32,191	913,530[b]
Imidacloprid	106,710	245,758	157,438	151,396	142,517
PHMB	NR	27,179	NR	NR	55,863
Pyrethrins	41,704	44,420	41,436	54,427	71,767

Source: DPR Sales data reports (DPR 2000a, 2001a, 2002a, 2003a, 2005a)
[a]NR = Not Reported. Sales of products with fewer than four registrants are not disclosed to the public.
[b]The accuracy of this value was confirmed with DPR.

timing may cause sales to appear to fluctuate in a manner that does not reflect use patterns. (For example, the spike in permethrin sales in 2000 may reflect timing of sales that would actually have occurred in 1999 or 2001, as this data point is inconsistent with the 10 year trend in permethrin sales). Sales may be higher than use in situations where purchasers are stockpiling products (e.g., those where manufacturing is phasing out but use may continue until stocks are exhausted).

A recent audit of the DPR sales data program suggested that sales data may understate actual sales of urban products (DPR 2004). Based on this audit, DPR estimates that its past sales data are at least 10% below actual total pesticide sales, not including unregistered products (Brank 2005). This is an aggregate error estimate—the error in the data for the study list pesticides is not known. Since this error is systematic, it is not expected to affect evaluation of past trends. (Stepped up enforcement of sales and registration requirements in 2005 may affect evaluation of trends that include data prior to and after 2005).

4.3 Pesticide Use Reports

Certain pesticide applications are required to be reported to the County Agricultural Commissioner, who, in turn, reports the data to DPR. [3] In general, the pesticide uses that require reporting are agricultural uses or urban applications done by licensed pest control operators. DPR prepares annual summary reports on the basis of these data. While the summary reports lack the detail necessary to allow a detailed tally of reported urban pesticide applications, they are sufficiently detailed to allow selection of "urban" categories (like structural pest control and landscape maintenance) to create an estimate of the urban portion of the reported pesticide use.[4] It should be noted that the structural pest control reporting category includes both aboveground applications (e.g., spraying around a building to control ants) and underground injection (e.g., injection of pesticides into holes drilled into the ground to control termites).

Table 3 (on the next page) presents San Francisco Bay Area reported use of study list pesticides in 2003 (the most recent data available). Note that the majority of pyrethroid, fipronil, imidacloprid, and pyrethrins reported use was for structural pest control. The majority of carbaryl reported use was on landscaping. For OPs, use quantities for structural pest control and landscaping were about equal.

Uncertainty

Pesticide use reports are generally considered relatively reliable as compared to other data sources. The reporting requirements and enforcement systems are intended to ensure that most pesticide applications that require reporting are reported. An unknown amount of non-reporting certainly occurs. Because DPR has never completed a field verification of the pesticide use reporting system, a quantitative estimate of non-reporting is not available. A recent Pesticide Action Network (PAN) analysis suggests that non-reporting may be significant. PAN compared four years of reported sales and reported use for 5 pesticides for which all uses are reportable, finding reporting rates from 9% to 138% (PAN 2004). DPR completed a similar analysis for a larger group of reportable pesticides, also finding a rather large variation in reporting among pesticides (Wilhoit 2005). Overall, DPR found in its analysis that on average, about 90% of the sales of the analyzed pesticides (for which all uses are reportable) was reported used over a 5 year period (Wilhoit 2005). The error rate for individual pesticides—and for urban reportable uses (which could not be explored with this analytical method)—may differ significantly from the 10% underreporting average suggested by this DPR analysis.

Prior to releasing its annual report, DPR does a quality assurance review of the data, which should eliminate data entry errors that are likely to have a significant effect on the data from the water quality perspective. After a 2001 audit of the data management system (Wilhoit et al. 2001), DPR implemented error handling processes that are believed to keep errors to less than 1-2% (Wilhoit 2002; Wilhoit 2005).

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[3] The following pesticide uses must be reported: pesticide uses for the production of any agricultural commodity, except livestock; for the treatment of post-harvest agricultural commodities; for landscape maintenance in parks, golf courses, and cemeteries; for roadside and railroad rights-of-way; for poultry and fish production; any application of a restricted material; any application of a pesticide designated by DPR as having the potential to pollute ground water when used outdoors in industrial and institutional settings; and any application by a licensed pest control operator must be reported.

[4] For purposes of this analysis, the following categories of use from DPR's annual compilation reports were defined as urban uses: landscape maintenance, public health, regulatory pest control, rights of way, structural pest control, vertebrate control, uncultivated non-agricultural sites, and food processing plants. Some typically agricultural categories may include some applications in urban areas (*e.g.*, nurseries, greenhouses, sod/turf), so this "urban" estimate is likely to understate actual reported use in urban areas.

Table 3. San Francisco Bay Area Study List Pesticides Reported Urban Use, 2003 (Pounds of Pesticide Active Ingredient)

Pesticide	Total	Structural	Landscaping	Rights of Way	Public Health
Pyrethroids					
Bifenthrin	4,447	3,613	833	0	0
Cyfluthrin	4,779	4,511	266	1	1
Beta-Cyfluthrin	631	624	7	0	0
Cypermethrin	15,193	14,144	1,049	0	0
Deltamethrin	1,372	1,204	168	0	0
Esfenvalerate	8	8	0	0	0
Lambda-Cyhalothrin	463	457	6	0	0
Permethrin	21,702	13,109	8,555	0	37
Tralomethrin	10	10	0	0	0
OPs					
Chlorpyrifos	1,034	435	598	0	0
Diazinon	10,444	3,638	6,780	25	0
Malathion	2,953	1,505	1,448	0	0
Other					
Carbaryl	8,368	883	7,483	2	0
Fipronil	2,880	2,822	58	0	0
Imidacloprid	7,372	5,729	1,444	199	0
Pyrethrins	413	287	18	0	107
PHMB	0	0	0	0	0

Source: DPR's California Pesticide Information Portal (CalPIP) database,[5] which is based on pesticide use reports (DPR 2005b).
Note: Use of less than 5 pounds of one or more study list pesticides was also reported for: vertebrate pest control, regulatory pest control, uncultivated non-agricultural sites, and food processing plants.

4.4 Quantitative Pesticide Use Estimates

The primary exceptions to California's pesticide use reporting requirements are home and garden use and most industrial, commercial, and institutional pesticide applications not made by professional applicators.[6] Because these activities occur primarily in urban areas, it is reasonable to assume that essentially all unreported uses of the study list pesticides are urban. This assumption allows a rough estimate to be made of urban pesticide use by persons not required to report pesticide use. Since sales data are only available on a statewide basis, such estimates can only be made statewide; they are usually extrapolated to a smaller region on a per-capita basis.

Uncertainty

Estimates of unreportable urban use made in this manner combine uncertainties in the reporting and sales data described above. Since both sales and use data are believed to be underreported by about the same fraction, these errors may—on average—be relatively less important than other sources of error (because they may effectively cancel

[5] Accessible on the Internet: http://calpip.cdpr.ca.gov/cfdocs/calpip/prod/main.cfm
[6] Pesticides incorporated into consumer products (e.g., treated wood, pet collars, insecticidal clothing) are often unreported, or reported as applied at the product manufacturing site rather than at the site where the products are used.

out). The effect of this is variable, depending on the pesticide. For example, for a few pesticides, reported use has exceeded reported sales for at least 5 years (see below). Since these errors are systematic, they affect quantitative estimates more than they affect trends. These uncertainties must be kept in mind while reviewing this section, as errors for individual pesticides are unknown and may differ significantly from these average estimates.

Extrapolation of statewide pesticide sales data to the San Francisco Bay Area creates highly uncertain pesticide sales estimates. Estimates do not account for climate, lot size, regional pest problems or other reasons that pesticide use per person might vary across the state.

To reflect the uncertainties in the quantitative estimates in this section, this report utilizes significant figures. While sales and use data from DPR are presented as reported by DPR, calculation results are rounded to provide the appropriate number of significant figures.

Statewide Urban Pesticide Use

In 2003, DPR reports indicate that 644,538,202 pounds of pesticide active ingredient were sold (DPR 2005a) and 175,127,171 pounds of pesticide active ingredients were used in manners requiring reporting (DPR 2005b). Assuming that on average, an amount equivalent to pesticide sales is used each year, about 73% of California pesticide use in 2003 did not require reporting.

According to DPR, 14,576,713 pounds of pesticide active ingredient were applied for reported urban uses in 2003 (DPR 2005c). This represented about 8.3% of all reported pesticide use.

Assuming all unreported pesticide use is urban and adding this to reported urban use gives a total of about 500,000,000 pounds of pesticide active ingredient used in urban areas in California in 2003, about 75% of total use. Given the uncertainties in the data sources, this estimate is not exact; nevertheless, it certainly indicates that at least half of California pesticide use occurs in urban areas.

Table 4 (on the next page) provides statewide sales, reported use, estimated unreported use, and the fraction of the use that is estimated to be unreported for study list pesticides in 2003.

For several pesticides, specific factors should be considered when reviewing Table 4 and subsequent tables:

- Organophosphorous pesticides. The low percentage of reported use (versus total estimated use) of OPs could reflect professionals and consumers stocking up on OPs prior to phase out of many allowable uses. It could also reflect under-reporting of the agricultural and urban uses of these pesticides, which have lost popularity since the U.S. EPA released risk information about them in 1999 and 2000. The chlorpyrifos unreported use estimate is particularly unlikely to represent urban use, because sales of products for almost all non-reportable urban uses ended in December 2001.
- Fipronil. In 2003, fipronil products fully entered the market; however, they were not observed on retail shelves. It is possible that these new products were purchased by professional pest control operators for future use.

Table 4. Statewide Study List Pesticides Unreported Use, 2003 (Pounds of Pesticide Active Ingredient)

Pesticide	Sales	Reported Use	Unreported Use[a]	% of Use That Is Unreported
Pyrethroids				
Bifenthrin	70,759	62,125	9,000	12%
Cyfluthrin	44,567	47,610	Limited[b]	0%
Beta-Cyfluthrin	41,779	3,523	40,000	92%
Cypermethrin	81,840	186,101	Limited	0%
Deltamethrin	4,926	18,302	Limited	0%
Esfenvalerate	53,580	33,614	20,000	37%
Lambda-Cyhalothrin	27,892	27,143	700	3%
Permethrin	480,572	443,676	40,000	8%
Tralomethrin	63,897	2,391	60,000	96%
OPs				
Chlorpyrifos	1,951,083	1,546,481	400,000	21%
Diazinon	751,376	523,786	200,000	30%
Malathion	1,662,673	654,151	1,000,000	61%
Other				
Carbaryl	329,782	205,080	100,000	38%
Fipronil	913,530	32,756	900,000	96%
Imidacloprid	142,517	148,553	Limited	0%
PHMB	55,863	0[c]	60,000	100%
Pyrethrins	71,767	6,538	60,000	91%
All Pesticides	***644,538,202***	***175,127,171***	***500,000,000***	***73%***

Source: DPR sales data (DPR 2005a), pesticide use reports (DPR 2005b) and TDC Environmental calculations.
[a]Unreported use values reflect only 1 significant figure to reflect the uncertainty in these values.
[b]When reported use exceeds sales, unreported use is assumed to be relatively limited.
[c]This pesticide is only registered for urban uses that do not require reporting.

- Cyfluthrin, Cypermethrin, Deltamethrin, and Imidacloprid. For all four of these pesticides, statewide reported use exceeded statewide reported sales; therefore, unreported use was assumed to be approximately zero. Annual variations in sales data can cause these data anomalies to occur; however, cypermethrin and deltamethrin are notable in that reported sales average less than 50% of reported use between 1999 and 2003. Since imidacloprid and cyfluthrin were found in a few products observed in retail shelf surveys, the unreported use was probably not zero. These data should be interpreted to suggest that retail sales for non-professional uses were probably not a significant part of the use of these pesticides.
- Organophosphorous pesticides, Carbaryl, and Permethrin. Unreported use estimates for these pesticides are quite large, but rely on the differences between rather large sales and reported use values. Relatively small errors in sales and/or reported use values would significantly change the unreported use estimate.

San Francisco Bay Area Study List Pesticides Use Estimates

Assuming all pesticides sold are used within a particular year, unreported pesticide use is (approximately) equal to the difference between statewide pesticide sales and statewide reported pesticide use. (In a few cases, reported pesticide use actually exceeds pesticide sales [see above]). Population data from the California Department of Finance (DOF 2005) were used to develop the Bay Area unreported pesticide use estimate. Total estimated San Francisco Bay Area pesticide use is the sum of Bay Area reported use (see Table 3 above) and estimated unreported use.

Table 5 presents an estimate of the total use of study pesticides in the San Francisco Bay Area in 2003. These data should be interpreted with the understanding that the margin of error in the estimates may be greater than 10%. Note that for most pyrethroids, most use is reported, while for the OPs, most use is not reported.

Table 6 (on the next page) provides a summary of who probably uses the study list pesticides (consumers or professionals) and where they are applied. This analysis, combined with the factors listed in the description of Table 5, shows the following:

Table 5. San Francisco Bay Area Study List Pesticides Estimated Urban Use, 2003 (Pounds of Pesticide Active Ingredient)

Pesticide	Reported Urban Use	Estimated Unreported Urban Use[a]	Total Estimated San Francisco Bay Area Urban Use[b]
Pyrethroids			
Bifenthrin	4,447	2,000	6,000
Cyfluthrin	4,779	0	4,800
Beta-Cyfluthrin	631	8,000	8,000
Cypermethrin	15,193	0	15,000
Deltamethrin	1,372	0	1,400
Esfenvalerate	8	4,000	4,000
Lambda-Cyhalothrin	463	100	600
Permethrin	21,702	7,000	30,000
Tralomethrin	10	10,000	10,000
OPs			
Chlorpyrifos	1,034	80,000	80,000
Diazinon	10,444	40,000	50,000
Malathion	2,953	200,000	200,000
Other			
Carbaryl	8,368	20,000	30,000
Fipronil	2,880	200,000	200,000
Imidacloprid	7,372	0	7,400
PHMB	0	10,000	10,000
Pyrethrins	413	10,000	10,000

Source: TDC Environmental calculations based on data in Tables 2 and 3 and the Bay Area fraction of the state population (19.5%) (DOF 2005).
[a]Unreported use values reflect only 1 significant figure to reflect uncertainty in these values.
[b]Total estimated use values reflect 1 or 2 significant figures, assuming that reported urban use values are accurate to two significant figures. Totals may not add up due to rounding.

Table 6. San Francisco Bay Area Study List Pesticides Major Urban Use Types, 2003
(Pounds of Pesticide Active Ingredient)

Pesticide	Estimated San Francisco Bay Area Urban Use	% Applied by Professionals	Most Common Applications/Notes*
Pyrethroids			
Bifenthrin	6,000	73%	Professional—structures Professional—landscape (<20% of use) Consumer—both landscape & structures
Cyfluthrin	4,800	Almost 100%	Professional—structures
Beta-Cyfluthrin	8,000	8%	Consumer—both landscape & structures *It is possible these data reflect stockpiling of new product.*
Cypermethrin	15,000	Almost 100%	Professional—structures
Deltamethrin	1,400	Almost 100%	Professional—structures
Esfenvalerate	4,000	Almost 0%	Consumer—both landscape & structures
Lambda-Cyhalothrin	600	76%	Professional—structures Consumers—both landscape & structures
Permethrin	30,000	75%	Professional—structures (about 60%) Professional—landscape (about 40%) Consumer—both landscape & structures
Tralomethrin	10,000	Almost 0%	Consumer—both landscape & structures
OPs			
Chlorpyrifos	80,000	1%	Consumer—both landscape & structures *It is possible these data reflect purchase of product for future use.*
Diazinon	50,000	19%	Consumers—both landscape & structures *It is possible these data reflect purchase of product for future use.*
Malathion	200,000	1%	Consumer—both landscape & structures
Other			
Carbaryl	30,000	26%	Consumer—both landscape & structures Professional—landscape
Fipronil	200,000	2%	Unknown–*It is possible these data reflect stockpiling of new product.* Professional—structures Consumer—containerized baits
Imidacloprid	7,400	Almost 100%	Professional—structures Professional—landscape (<20% of use)
Pyrethrins	10,000	3%	Consumer—both landscape & structures
PHMB	10,000	0%	Swimming pools—Use not required to be reported

Source: TDC Environmental analysis based on DPR reported use data (DPR 2005b) and sites of use recorded in Bay Area retail shelf surveys (TDC Environmental 2004a).
*This analysis assumes that indoor uses, which are most commonly aerosol, did not involve significant quantities of any pesticide.

- In urban areas, most pyrethroids are applied by professionals for structural pest control (based on quantity of pesticide active ingredient). For most pyrethroids, reported uses (applications by professionals) represent most or nearly all of the estimated use. There are a few exceptions, however. Esfenvalerate and tralomethrin appear primarily in consumer products. Esfenvalerate has relatively low estimated use; its relative contribution to overall pyrethroid use is relatively small. Because tralomethrin appears in many aerosol products that are unlikely to be used in environmentally meaningful quantities on outdoor surfaces or on indoor locations washed to drains, it is unclear whether its use is environmentally important. Beta-cyfluthrin, which has rarely been observed in shelf surveys, was entering the market in this time frame, so the “unreported use” is likely to reflect initial purchase and stockpiling of new products.
- Professionals have generally moved away from older pesticides. Professionals used only a fraction of the OPs and carbaryl sold in 2003. They also avoided pyrethrins, which decompose quickly.

When reviewing Table 6, it is important to remember that the fraction of the structural pest control uses of pyrethroids and OPs that were underground injections (and therefore relatively unimportant for urban surface water quality) is not known.

Since the pyrethroids are a family of pesticides with similar mechanisms of toxicity, they are believed to have additive effects on aquatic organisms (Weston et al. 2004). The aquatic toxicity of pyrethroids differs among the individual pesticides. Toxicity differences among pyrethroids is a factor that must be taken into account to compare relative use to relative potential for water quality effects. Recent research indicates that toxicity to the sediment-dwelling organism *Hyalella azteca* is an important environmental endpoint (Weston et al. 2004; Amweg et al. 2005). Comparing toxicity to *Hyalella azteca* of various pyrethroids is a convenient method of expressing their toxicity differences. Table 7 summarizes the average sediment 10-day LC50s (lethal concentration 50%) for pyrethroids toxicity to *Hyalella azteca*. The table also shows the relative toxicity of the pyrethroids, expressed as the ratio of the toxicity of each pyrethroid to the toxicity of permethrin.

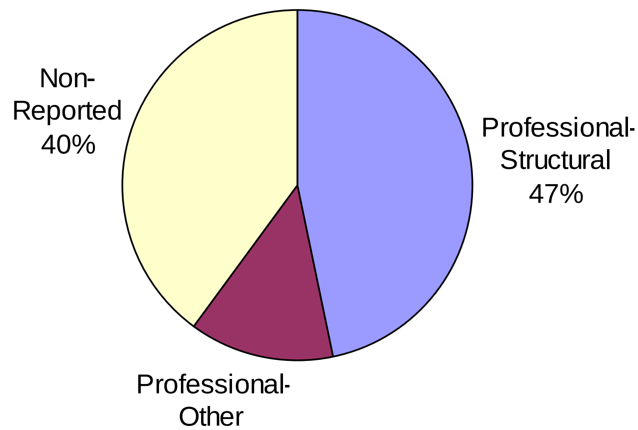
Table 7. Toxicity of Pyrethroids to *Hyalella azteca*

Pyrethroid	Average sediment 10-Day LC50 (µg/g organic carbon)	Ratio to Permethrin LC50
Bifenthrin	0.52	21
Cyfluthrin	1.08	10
Beta-Cyfluthrin	1.08	10
Cypermethrin	0.38	29
Deltamethrin	0.79	14
Esfenvalerate	1.54	7.03
Lambda-Cyhalothrin	0.45	24
Permethrin	10.83	1.00
Tralomethrin	*	*

Source: Maund et al. 2002 (cypermethrin); Amweg et al. 2005 (all others).
*No data available. Based on relative toxicity to other aquatic species, the ratio was assumed to be 1.0 for purposes of this report.

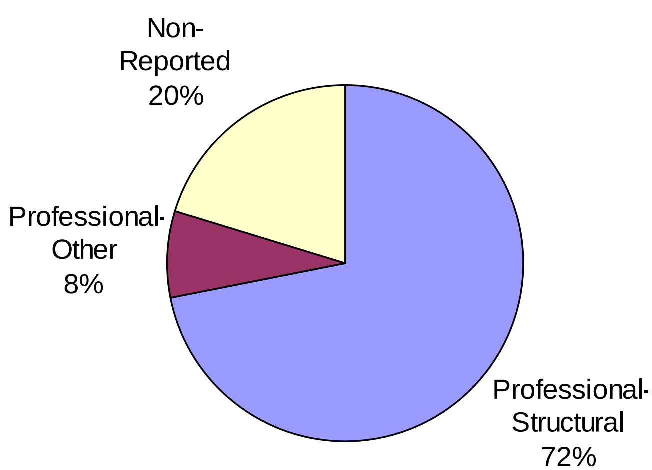
Figures 1 and 2 show how considering the toxicity of the pyrethroids can change the interpretation of pesticide use data. As shown in Figure 1, about half of estimated urban pyrethroid use (on the basis of pounds of active ingredient) is by professional pest control operators for structural pest control. However, the pyrethroids selected by professional pest control operators are, on average, more toxic than those used for non-reported uses. As Figure 2 shows, professional pest control operator applications of pyrethroids for structural pest control comprises more than 70% of the amount of toxicity in pyrethroids used in the San Francisco Bay Area.

Figure 1. San Francisco Bay Area Study List Pyrethroids Urban Uses, 2003 (Pounds of Pesticide Active Ingredient)



Source: Table 5.

Figure 2. Toxicity of San Francisco Bay Area Study List Pyrethroids Urban Uses, 2003 (Permethrin Equivalents)



Source: Table 5, adjusted for the relative aquatic toxicity of each pyrethroid with values in Table 7.

4.5 Trends

Table 8 (on the next page) shows the trends in estimated San Francisco Bay Area urban use (both reported and unreported) of study list pesticides from 1999-2003. This reflects the most recent available data (2003) and most of the time period during which the market was transitioning in response to U.S. EPA's year 2000 announcements of the termination of most urban uses of diazinon and chlorpyrifos. Until data are available to reflect the final end of sales of diazinon urban use products (December 2004) and chlorpyrifos termiticide products (December 2005), the effect of the transition may not be fully understood.

To evaluate the effect of the transition, it is necessary to look at the trend between 2001 (the first reporting year after the phase-out announcements) and 2003 (the most recent year for which data are available). The data in Table 8 show the following trends between 2001 and 2003:

- Use of pyrethroids, malathion, fipronil, pyrethrins, and PHMB <u>increased</u>. Two individual pyrethroids did not exhibit the trend of the group: lambda-cyhalothrin (no meaningful change) and cyfluthrin (sales appear to be shifting to the beta form). Since the malathion increase reflects only the most recent year of data, a second year should be evaluated to determine if the increase reflects an anomaly.
- Use of diazinon, chlorpyrifos, and imidacloprid <u>decreased</u>.

These data suggest that pyrethroids, fipronil, pyrethrins, and perhaps malathion are replacing diazinon and chlorpyrifos in the urban pesticide use market. Estimating how this shift affects urban runoff is not simple, as some of the previous uses of diazinon and chlorpyrifos and the new uses of these products are not outdoor surface applications.

The following recent changes are notable:

- <u>Fipronil</u> sales increased significantly in 2003. Fipronil is a relatively new insecticide—it was first registered in California in the late 1990s. Fipronil is available in professional products and in containerized baits and pet flea control products for consumers. Fipronil is labeled for underground injection to control termites, which colloquial information suggests was its primary initial use. The label was recently amended to allow for application around structures to control ants, which could expose it to runoff.
- <u>Tralomethrin</u> use increased significantly between 2000 and 2003. It was first observed in multiple non-aerosol products intended for applications around structures and on landscaping (liquid ready to use and granule formulations) in 2003. While this involved a relatively small number of products from one supplier, sales data suggest that the application quantity has the potential to be meaningful, if these new products—rather than aerosols—comprise a significant fraction of the quantity of active ingredient sold.
- <u>Beta-cyfluthrin</u> use appeared to grow significantly. Sales data for beta-cyfluthrin, which is a refined form of cyfluthrin that is more concentrated in the most toxic isomers, first became public in 2003. If beta-cyfluthrin sales for prior years correlate with reported use, total use has increased significantly.

Table 8. San Francisco Bay Area Study List Pesticides Estimated Urban Use 1999-2003[a] (Pounds of Pesticide Active Ingredient)

Pesticide	1999	2000	2001	2002	2003
Pyrethroids					
Bifenthrin	***600***	***1,400***	2,000	5,000	6,000
Cyfluthrin	5,400	7,000	5,300	7,900	4,800
Beta-Cyfluthrin	0	<1	***73***	***360***	8,000
Cypermethrin	11,000	12,000	9,500	10,000	15,000
Deltamethrin	400	1,000	600	1,200	1,400
Esfenvalerate	2,000	2,000	2,000	3,000	4,000
Lambda-Cyhalothrin	***540***	***650***	***530***	740	600
Permethrin	30,000	40,000	10,000	30,000	30,000
Tralomethrin	300	200	7,000	10,000	10,000
OPs					
Chlorpyrifos	100,000	100,000	80,000	60,000	*80,000*[b]
Diazinon	200,000	100,000	100,000	90,000	50,000
Malathion	200,000	100,000	100,000	80,000	200,000
Other					
Carbaryl	50,000	40,000	30,000	70,000	30,000
Fipronil	***1***	310	3,000	5,000	200,000
Imidacloprid	20,000	40,000	20,000	7,400	7,400
Pyrethrins	5,000	9,000	8,000	10,000	10,000
PHMB	***0***	5,000	***0***	***0***	10,000

Source: TDC Environmental calculations based on DPR sales (DPR 2000a, 2001a, 2002a, 2003a, 2005a) and reported use data (DPR 2000b, 2001b, 2002b, 2003b, 2005b) and the Bay Area fraction of the state population (19.5%) (DOF 2005).
[a]Values in bold italics do not include any estimate of unreported use, as sales data were not available (sales of products with fewer than four registrants are not disclosed to the public.).
[b]Likely to be incorrect as sales of products for almost all non-reportable urban uses ended 12/2001.
Note uncertainties discussed in Section 4.4.
Note: Values reflect one or two significant figures, depending on the accuracy of the input data.

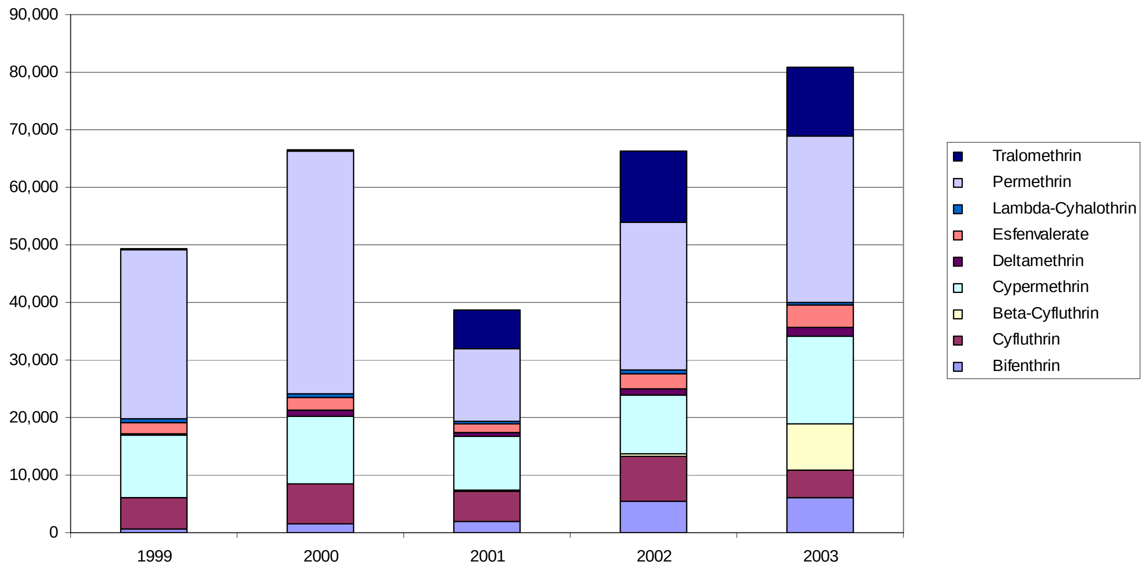
Trends in Pyrethroids Use

While the total quantity of pyrethroids estimated used in 2003 (about 80,000 pounds) is lower than the total quantity of diazinon and chlorpyrifos applied in 1999 (about 295,000 pounds), comparing quantities is not sufficient to gain an understanding of the potential surface water quality impact of pesticide use. In general, pyrethroids are significantly more toxic to the most sensitive aquatic species than diazinon and chlorpyrifos (TDC Environmental 2003), which means that much lower concentrations—and therefore much lower use rates—can adversely affect surface water quality.

Figures 3 and 4 summarize pyrethroid use trends from 1999-2003. Figure 3 shows the total use of the study pyrethroids based on pounds of active ingredient. Between 2001 and 2003, use increased by 110%. Figure 4 presents these data on the basis of permethrin equivalents, adjusting for the aquatic toxicity of each pyrethroid using the data from Table 7. In 2003, pyrethroid applications comprised the equivalent of the application of almost 800,000 pounds of permethrin, a 91% increase since 2001. While

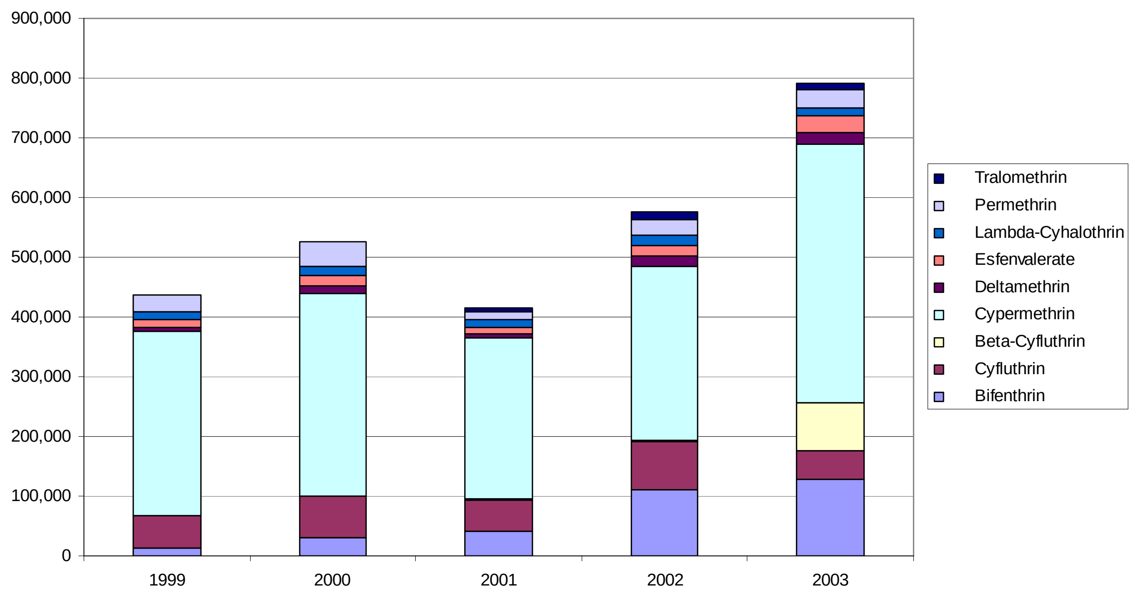
Figure 3 shows that the most heavily used pyrethroids are permethrin and cypermethrin. Figure 4 shows that cypermethrin and bifenthrin applications contain the most toxicity.

Figure 3. San Francisco Bay Area Study List Pyrethroids Estimated Urban Use 1999-2003 (Pounds of Active Ingredient)



Source: Table 8.

Figure 4. Toxicity of San Francisco Bay Area Study List Pyrethroids Estimated Urban Use 1999-2003 (Permethrin Equivalents)

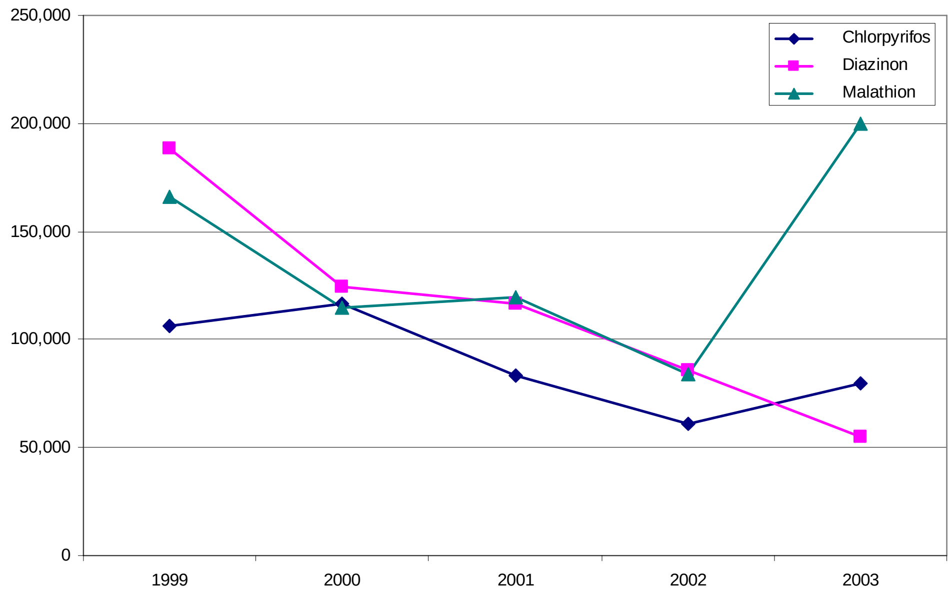


Source: Table 8, adjusted for the relative aquatic toxicity of each pyrethroid with values in Table 7.

Trends in Organophosphorous Pesticides Use

Figure 5 shows recent trends in estimated use of selected organophosphorous pesticides in the San Francisco Bay Area from 1999 through 2003. As explained above, Figure 3 shows the decline in diazinon and chlorpyrifos use. The recent increase in malathion use may or may not represent a trend; data for subsequent years should be analyzed to determine if urban malathion use is indeed increasing.

Figure 5. San Francisco Bay Area Study List Organophosphorous Pesticides Estimated Urban Use 1999-2003 (Pounds of Active Ingredient)



Source: Table 8.

5.0 CONCLUSIONS

Conclusion 1: *Urban use of diazinon, chlorpyrifos, and imidacloprid decreased from 2001 to 2003.* Phase out of most urban uses of diazinon and chlorpyrifos in response to U.S. EPA agreements with manufacturers is evident.

Conclusion 2: *Urban use of pyrethroids, malathion, fipronil, pyrethrins, and PHMB increased from 2001 to 2003. Pyrethroids, fipronil, pyrethrins, and perhaps malathion are replacing diazinon and chlorpyrifos in the urban pesticide use market.* Estimating how this shift affects urban runoff is not simple, as some of the previous uses of diazinon and chlorpyrifos and the new uses of substitute products involve underground applications and containerized baits, neither of which are likely to be important for surface water quality. While the total quantity of pyrethroids estimated used in 2003 (about 80,000 pounds) is somewhat lower than the total quantity of diazinon and chlorpyrifos applied in 1999 (about 295,000 pounds), these applications have great potential to be environmentally relevant, as pyrethroids are significantly more toxic to aquatic species than diazinon and chlorpyrifos.

Conclusion 3: *Control of pests around buildings by professional pest control operators is the major urban use of pyrethroids.* Reported use represents about 60% of estimated San Francisco Bay Area pyrethroid use on a weight basis (pounds of active ingredient)—but more than 80% on a toxicity basis (based on toxicity to *Hyalella azteca* in sediments). More than 75% of reported urban pyrethroid use (by pounds of active ingredient)—and 90% of the toxicity in the total reported urban use (based on toxicity to *Hyalella azteca* in sediments)—is for structural pest control. It is unclear what fraction of these reported applications involve underground injection (which is not a major concern for water quality) and what fraction involves above ground applications, such as the use around structures to control ants.

Conclusion 4: *Fipronil use is increasing very rapidly.* It is uncertain what fraction of this use is for underground injection and containerized baits (which are not a major concern for water quality) and what fraction involves above ground applications, such as the newly allowed use around structures to control ants.

Conclusion 5: *Tralomethrin is now being formulated into non-aerosol consumer products with outdoor uses*. Tralomethrin consumer outdoor use products may have enough use to have the potential to contribute to surface water quality impacts from pyrethroids.

Conclusion 6: *Beta-cyfluthrin use grew significantly in 2003*. Since beta-cyfluthrin is one form of cyfluthrin (which has previously been identified as among the pyrethroids that have the potential to cause adverse effects in aquatic ecosystems possible), it has already been included in monitoring recommendations.

Conclusion 7: *In 2003, at least half of California pesticide use was in urban areas.* Although only about 8% of reported pesticide use is urban, about 73% of pesticide use is not reported. Almost all pesticide uses that do not require reporting are urban. The total of urban reported use and unreported use was about 75% of pesticide sales in California in 2003.

6.0 MITIGATION IMPROVEMENT RECOMMENDATIONS

The following are recommendations to improve urban pesticide toxicity reduction activities. These recommendations are not only based on this report—they are also based on the information in the UP3 Project's recent regulatory and research and monitoring updates (TDC Environmental 2004c and 2005). This section includes a set of general recommendations, followed by specific recommendations for outreach and education, monitoring and research, regulatory activities, and funding. The recommendations below are not directed only at California water quality agencies—U.S. EPA, DPR, and others should play a significant (if not leading) role in their implementation.

<u>Recommendation 1</u>: *Target structural use of pyrethroids in pesticide toxicity reduction programs.*

<u>Recommendation 2</u>: *Seek to change the way ants are kept out of buildings in California.* Ant control around buildings is the most common urban insecticide application in California. Surfaces around buildings are often impervious surfaces, from which meaningful fractions of pesticides can wash off when it rains (or when non-rainwater discharges occur). Spraying pesticides on and around buildings to control ants is among the most problematic pesticide uses for water quality. Shifting ant control methods away from perimeter sprays and to IPM-based methods that minimize pesticide releases to surface waters (e.g., use of containerized baits and barriers like caulking) may be the only way to end recurring surface water quality problems from urban insecticide use.

<u>Recommendation 3</u>: *Avoid recommending against or terminating use of a particular insecticide without promoting or requiring a less environmentally problematic substitute.* History continues to show that simply substituting one group of pesticides for the previous one creates new environmental problems. In the near term, this recommendation will be particularly important in developing management strategies for pyrethroid-related sediment toxicity and copper releases from marine antifouling paint.

<u>Recommendation 4</u>: *Recognize that widespread use of any pesticide in an urban watershed can have significant adverse cumulative impacts on surface waters receiving runoff and wastewater treatment plant discharges*. Adverse effects of pesticides on water quality involve a combination of pesticide toxicity and the quantity of pesticide used in manners that lead to releases to surface water bodies.

<u>Recommendation 5</u>: *Continue to focus programs intended to prevent urban pesticide-related surface water toxicity on insecticides*. U.S. Geological Survey (USGS) data show that insecticides are more likely to be associated with surface water toxicity in urban areas than herbicides. (The USGS study only compared insecticides and herbicides; it did not address disinfectants, fungicides, or any other class of pesticides).

Outreach and Education

<u>Recommendation 6</u>: *Continue to discourage use of pyrethroids, carbaryl, and malathion as replacements for urban uses of diazinon and chlorpyrifos.*

<u>Recommendation 7</u>: *Continue to exercise discretion with recommendation of alternative pesticides for urban outdoor applications, particularly imidacloprid, pyrethrins, and fipronil.*

Monitoring and Research

<u>Recommendation 8</u>: *Support activities to improve chemical analytical and toxicity testing capabilities for pesticides in surface water (water column and sediment), urban runoff,*

and municipal wastewater treatment plant effluent. The following are suggested near-term priorities:

- Try methods for chemical analysis of pyrethroids in various environmental water and sediment samples.
- Create standard written procedures for surface water and sediment sample collection, storage, and handling appropriate for samples containing pyrethroids. Methods should be designed to minimize losses of pyrethroids on sampling equipment and container surfaces.
- Develop chemical analysis methods for other pesticides and pesticide degradates that have the potential to cause toxicity incidents (e.g., PHMB and fipronil).

Longer-term priorities include development of straightforward methods to evaluate the potential for pesticides to contribute to adverse effects on ecosystems from exposure to combinations of stressors.[7]

Recommendation 9: *Conduct surveillance monitoring of California urban surface waters (including sediment) for toxicity and for specific pesticides that have the potential to cause adverse effects in aquatic ecosystems (e.g., pyrethroids, carbaryl, malathion, PHMB, and fipronil).* Toxicity monitoring should be conducted with standard aquatic toxicity test species. The pyrethroids of greatest interest for urban surface water quality are bifenthrin, cyfluthrin (including beta-cyfluthrin), cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, permethrin, and possibly tralomethrin. The standard test species most sensitive to pyrethroids are: fresh water water column—*Pimephales promelas* and *Ceriodaphnia dubia*; fresh water sediment—*Hyalella azteca*; salt water—*Americamysis bahia.*

Recommendation 10: *Identify a stable funding source for pesticide-related urban surface water quality surveillance monitoring.*

Recommendation 11: *Share monitoring results with others.* The results from monitoring of urban surface waters and discharges to those surface waters for pesticides and pesticide-related toxicity are difficult to find as they are generally published only in grey literature government agency technical reports. Reports of pesticide-related water quality monitoring should be published in professional journals. Articles could present the results of an individual monitoring program or review monitoring data from multiple agencies (e.g., San Francisco Bay Area municipal wastewater treatment plants). If such publication is not possible, monitoring results should be packaged in reports that are readily identifiable as containing pesticide-related monitoring data and made readily available (e.g., on agency Internet sites).

Recommendation 12: *Report all pesticide-related toxicity incidents and provide all pesticide-related monitoring data to U.S. EPA and DPR.* Because monitoring data provide a strong basis for pesticide regulatory agency decisions, providing all data will help U.S. EPA and DPR use their regulatory authorities to protect water quality and prevent pesticide-related noncompliance with water quality standards and NPDES permits.

Recommendation 13: *Obtain additional information about pyrethroid use in urban areas.* Such information will allow toxicity reduction programs to more effectively target the

[7] Pesticides, in combination with each other and other pollutants, may add to or synergize toxicity to aquatic organisms. Stress from exposure to predators, in combination with pesticide exposures, can adversely affect organisms at concentrations below documented toxicity thresholds.

causes of anticipated toxicity in surface water sediments and to determine whether voluntary measures have the capability of achieving the reductions necessary to prevent toxicity.

Recommendation 14: *If the summer 2005 pesticide retail shelf survey identifies outdoor use products in formulations with environmentally meaningful quantities of tralomethrin, alert water quality agencies, chemical analytical laboratories, and researchers that they should consider adding it to the list of pyrethroids that have the potential to adversely affect urban surface water quality.*

Recommendation 15: *Assess the water quality implications of use of the insecticide fipronil in urban areas.*

Recommendation 16: *Complete evaluations of methods to keep ants out of buildings.* Implementation of Recommendation 2 would be facilitated by an evaluation of ant management strategies that was completed with the participation of statewide leaders from the pest control operator industry. DPR's pest management evaluation and pest management alliance program (which is currently unfunded) would be well positioned to complete such an evaluation.

Regulatory

Recommendation 17: *Continue to provide information to help improve U.S. EPA's and DPR's pesticide regulatory programs such that they protect urban surface water quality and prevent incidents of noncompliance with water quality standards and NPDES permits.* Continue to provide U.S. EPA and DPR with information to prevent potential water quality problems associated with urban pesticide use. Strengthen relationships between U.S. EPA and DPR regulatory programs and water quality agencies. Continue to press for consistency in implementation of water quality and pesticide regulatory programs within U.S. EPA and California EPA.

Recommendation 18: *Strengthen the regional, statewide and nationwide network of water quality agencies working on urban pesticides issues*.

Recommendation 19: *Develop a stable funding mechanism to continue technical support for California water quality agency participation in U.S. EPA and DPR regulatory activities affecting water quality*. Funding for the UP3 Project ends in March 2007.

Recommendation 20: *When implementing pesticide regulatory controls, consider the environmental properties of the pesticides likely to replace any pesticides proposed for phase out (or great reduction of) urban uses and design a program to avoid environmental impacts.* Past experience suggests that leaving these changes solely to the free market may not ensure protection of human health and the environment.

Recommendation 21: *Modify California pesticide use reporting forms to differentiate between outdoor pesticide applications around structures and underground or indoor pesticide applications to control pests in structures.* To estimate the amount of pesticides subject to runoff in urban areas, it is necessary to separate above ground and underground/indoor pesticide applications.

Recommendation 22: *Field verify California pesticide use reporting data.* While DPR's pesticide use reporting system can provide valuable information for managing pesticide related water quality problems, available information suggests that the error rate for reported data could be much greater than 10% for individual pesticide active ingredients. An audit that included field verification of reporting would be able to determine the level of error in the data. Auditing urban uses would be particularly helpful, given that this analysis identifies structural pest control applications as the major urban use of pyrethroids, which have been linked to adverse effects in aquatic ecosystems.

Funding

<u>*Recommendation 23*</u>*. California and Federal environmental agencies need to obtain the funding necessary to implement the above recommendations.* Many of the above recommendations have not been implemented due to lack of funds, rather than lack of interest among agencies capable of implementing them.

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