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Pesticides in Urban Surface Water

Urban Pesticides Use Trends Annual Report 2007

Prepared for the
San Francisco Estuary Project

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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).

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Pesticides in Urban Surface Water
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TABLE OF CONTENTS

Page

1.0 Introduction 1
- 1.1 Background 1
- 1.2 Scope of This Report 1
- 1.3 Data Sources 3
- 1.4 Report Organization 3

2.0 Estimated Urban Use of Study-List Pesticides 4
- 2.1 Background 4
- 2.2 Pesticide Sales 4
- 2.3 Pesticide Use Reports 7
- 2.4 Quantitative Pesticide Use Estimates 9
- 2.5 Pyrethroids Urban Use 14
- 2.6 Trends 27

3.0 Conclusions 30

4.0 Mitigation Improvement Recommendations 32

5.0 References 43

Tables

1. Pesticides of Concern for Urban Surface Water Quality ("Study-List Pesticides") and Their Common Names 2
2. Sales of Study-List Pesticides in California, 1999-2005 5
3. California Study-List Pesticides Reported Use, 2005 8
4. California Study-List Pesticides Unreported Use, 2004-2005 12
5. California Study-List Pesticides Estimated Urban Use, 2004-2005 13
6. California Study-List Pesticides Agricultural and Estimated Urban Usage Percentages, 2004-2005 14
7. Toxicity of Pyrethroids to *Hyalella azteca* 16
8. California Study-List Pyrethroids Urban Use Overview, 2004-2005 18
9. California Study-List Pyrethroids Structural Pest Control Use, 2004-2005 20
10. Study-List Pesticides Estimated Urban Use 2000-2005 29

Figures

1. Primary Pathways for Pyrethroids to Flow to Urban Surface Waters 15
2. California Study-List Pyrethroids Estimated Use, 2004-2005 (Pounds of Pesticide Active Ingredient) 17

TABLE OF CONTENTS (CONTINUED)

Figures (Continued) Page

3. California Study-List Pyrethroids Estimated Use, 2004-2005 (Permethrin Equivalents)........ 17
4. Study-List Pyrethroids Estimated Used in California Urban Areas, 2004-2005 (Permethrin Equivalents)........ 19
5. California Study-List Pyrethroids Reported Landscape Maintenance Applications by Month in 2004 (Pounds of Active Ingredient) 23
6 California Study-List Pyrethroids Reported Landscape Maintenance Applications by Month in 2005 (Permethrin Equivalents)........ 23
7. California Study-List Pyrethroids Reported Structural Pest Control Applications by Month in 2004 (Pounds of Active Ingredient) 24
8 California Study-List Pyrethroids Reported Structural Pest Control Applications by Month in 2005 (Permethrin Equivalents)........ 24
9. Total California Bifenthrin Use 2004-2005 25
10. Urban Bifenthrin Use in California 2004-2005 – by Category 25
11. California Urban Bifenthrin Use 2004-2005 26
12. Bifenthrin Reported Landscape Maintenance Applications by Month in 2005 28
13. Bifenthrin Reported Structural Pest Control Applications by Month in 2005 28

1.0 INTRODUCTION

1.1 Background

The presence of pesticides in urban surface water and the environmental effect of pesticides that are found in water bodies 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 report provides water quality agencies with information on the "big picture" of urban pesticide use in California, particularly the use of pesticides of concern for urban surface water quality.

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 2005).[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 2009. TDC Environmental is providing technical support for the project.

1.2 Scope of This Report

This is the third 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. This report looks exclusively at urban pesticide use. It 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.

As explained in the UP3 Project *Annual Review of New Scientific Findings 2007* (TDC Environmental 2007b), use of pyrethroid insecticides in California urban areas is causing adverse effects in aquatic ecosystems receiving urban runoff. This report includes a section (Section 2.5) that focuses on how pyrethroids are used in urban areas to assist water quality managers and their colleagues with their response to this problem.

Based on previous analysis of pesticide sales and use (TDC Environmental 2006) and pesticide retail shelf surveys (most recently in the summer of 2005; see TDC Environmental 2005) the following pyrethroids are of greatest concern for urban surface water quality and therefore are included in this analysis: bifenthrin, cyfluthrin (including beta-cyfluthrin), cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, permethrin, and tralomethrin. This report also includes information relevant to the other pesticides of concern for water quality identified in the UP3 Project *Annual Review of New Scientific Findings 2007*—carbaryl, malathion, polyhexamethylene biguanadine

[1] References are in Section 5.

(PHMB), and fipronil—and information about two pesticides associated with recent (now believed to be past) urban water quality problems—the organophosphorous pesticides diazinon and chlorpyrifos. Together, the pesticides above comprise the list of pesticides that the UP3 Project has identified as being of concern for urban surface water quality. In this report, this list is called the "study-list." (Note that all but one of the study-list pesticides is an insecticide, which is why the remainder of the report focuses primarily on insecticides.)[2] Table 1 lists the study-list pesticides and their other commonly used names for these substances.

Table 1. Pesticides of Concern for Urban Surface Water Quality ("Study-List Pesticides") and Their Common Names

Name	Synonyms and Trade Names (Examples)
Pyrethroids	
Bifenthrin	Biphenthrin, Bifenthrine, Biflex, Brigade, Capture, Onyx, Talstar
Cyfluthrin	Baythroid, Tempo, Cykick, Renounce
Beta-Cyfluthrin	Tempo Ultra, Cylence
Cypermethrin	Ammo, Cynoff, Demon, Cymbush
Deltamethrin	Decamethrin, Deltadust, Deltaguard, Suspend SC
Esfenvalerate	(S)-Fenvalerate, Asana
Lambda-Cyhalothrin	Scimitar, Demand
Permethrin	Ambush, Nix, Pounce
Tralomethrin	Saga
Organophosphorous Pesticides (OPs)	
Chlorpyrifos	Dursban, Lorsban
Diazinon	Diazol
Malathion	Cythion, Carbophos, Fyfanon
Other	
Carbaryl	Sevin
Fipronil	Termidor, Maxforce FC, Frontline, Chipco Choice
PHMB	Baquacil, Revacil, Vantocil, Chlorine Free Splashes Sanitizer, Clear Comfort Sanitizer, Clorox Readymop Advanced Floor Cleaner, Free, Soft Soak Sanitizer

Source: DPR Product/Label database.

This report builds on previous related work, particularly last year's urban pesticide sales and use trends annual report (TDC Environmental 2006), the UP3 Project *Annual Review of New Scientific Findings 2007* (TDC Environmental 2007b) and 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). The recommendations in this report specifically address how new scientific and pesticide use information can be used to improve the effectiveness of California water

[2] Pesticide-related surface water problems in urban areas have historically been most commonly linked to insecticides (rather than herbicides or fungicides). USGS National Water Quality Assessment data suggest that insecticides are more likely than herbicides to be linked to pesticide-related toxicity in urban surface waters (see Hoffman et al. 2000 for more information).

quality agency efforts to prevent pesticide-related toxicity in surface waters, urban runoff, and municipal wastewater discharges.

1.3 Data Sources

This report is based on a review of information relating to trends in urban use of 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 labels;
- 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 2006 and early 2007).

1.4 Report Organization

This report is organized as follows:

- *Section 1* (this section) provides the background and scope of the report.
- *Section 2* provides estimates of the California use of pesticides most likely to threaten urban surface water quality and looks at trends in the use of these pesticides.
- *Section 3* gives this report's conclusions on the sales and use trends for pesticide of interest for urban surface water quality.
- *Section 4* 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 Review of New Scientific Findings 2007* (TDC Environmental 2007b) and annual update on improving pesticide regulatory activities to protect water quality (TDC Environmental 2007a).
- *Section 5* lists the references cited in the body of the report.

2.0 ESTIMATED URBAN USE OF STUDY-LIST PESTICIDES

2.1 Background

The only public source of quantitative data about California pesticide use is DPR. Using DPR data, it is possible to develop gross estimates of pesticide use statewide and in the San Francisco Bay Area. The estimation process 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 in terms of pounds of pesticide "active ingredient." Pesticides in this section are grouped by chemical families—pyrethroids, organophosphorous pesticides (OPs), and other pesticides.

2.2 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 provides the majority of California's pesticide regulatory funding. California pesticide sales data are based on a report that accompanies payment of a fee on the first sale of a pesticide into or within California.[3] Using information on the fee payment reports, DPR compiles pesticide sales volumes, in pounds of pesticide active ingredient, into an annual report. Data are generally released 10 to 12 months after the end of the reporting year. The most recent data available are for calendar year 2005 (DPR 2007b).[4]

These sales data are available only as annual aggregate data; no time of year information or regional breakdowns are publicly available. Prior to 2005, data were 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 included about 90% of the quantity of pesticide active ingredients sold). In 2003 and 2004, all study-list pesticide had more than three registrants; therefore sales data were made public for all study-list pesticides. In 2005, DPR adopted new regulations that make statewide pesticide sales volumes available for all pesticide active ingredients, starting with year 2005 data.

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 manufacturers, 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 1999-2005 (the most recent data available). These data include all pesticide sales, whether for urban or agricultural use. Note that sales of pyrethroids, fipronil, and PHMB have generally increased since 1999, while sales of diazinon and carbaryl have generally decreased in that time period.

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[3] The fee is paid by whatever entity is responsible for the first sale in California—this may be a pesticide manufacturer, distributor, or other entity. DPR currently collects fees from about 1,700 entities each quarter (Farnsworth 2007).

[4] DPR makes these data available on the Internet: http://www.cdpr.ca.gov/docs/mlassess/nopdsold.htm

Table 2. Sales of Study-List Pesticides in California, 1999-2005 (Pounds of Pesticide Active Ingredient)

Pesticide	1999	2000	2001	2002	2003	2004	2005
Pyrethroids							
Bifenthrin	NR[a]	NR	32,000	32,000	71,000	110,000	44,000
Cyfluthrin	31,000	47,000	47,000	51,000	45,000	46,000	37,000
Beta-Cyfluthrin	NR	NR	NR	NR	4,300	16,000	5,500
Cypermethrin	44,000	50,000	50,000	65,000	82,000	78,000	91,000
Deltamethrin	2,100	8,300	3,200	4,400	4,900	3,900	4,000
Esfenvalerate	41,000	43,000	36,000	43,000	54,000	57,000	50,000
Lambda-Cyhalothrin	NR	NR	NR	24,000	28,000	26,000	38,000
Permethrin	290,000	440,000	280,000	430,000	480,000	470,000	480,000
Tralomethrin	1,900	1,900	34,000	?[b]	3,200	4,200	1,500
OPs							
Chlorpyrifos[c]	2,300,000	2,400,000	2,000,000	1,700,000	2,000,000	2,300,000	2,400,000
Diazinon[d]	1,500,000	1,400,000	1,400,000	920,000	750,000	810,000	500,000
Malathion	1,500,000	1,100,000	1,100,000	1,000,000	1,700,000	1,600,000	1,100,000
Other							
Carbaryl	640,000	560,000	410,000	420,000	330,000	390,000	410,000
Fipronil	NR	1,900	19,000	32,000	14,000	18,000	22,000
PHMB	NR	27,000	NR	NR	56,000	36,000	69,000

Source: DPR Sales data reports (DPR 2000a, 2001a, 2002a, 2003a, 2005a, 2006a, 2007b) Note that data in this table reflect corrected year 2003 and 2004 reports issued in 2007. Data are rounded to reflect their estimated accuracy (assumed to be two significant figures).
[a]NR = Not Reported. Sales of products with fewer than four registrants are not disclosed to the public.
[b]Reported value is known to be inaccurate due to an internal database error that was corrected in 2003-2005 DPR pesticide sales data reports.
[c]Retail sales of almost all non-professional use chlorpyrifos products ended in December 2001.
[d]Retail sales of diazinon products for urban use ended in December 2004

Uncertainty

Since DPR sales data are based on fees from pesticide sellers, they have been generally considered by researchers to be relatively accurate, as it is reasonable to assume that most pesticide sellers comply with state fee requirements. Errors are known to come from the following sources:

- Failure to pay required fees. A 2004 audit of Long's Drugs sales data suggested that sales data may understate actual sales, particularly for urban products (DPR 2004; Brank 2006). 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). The understatement of sales data is believed to apply primarily to non-agricultural products. DPR has estimated that prior to its 2004-2005 enforcement activities, non-agricultural pesticide retail sales may have been underestimated by an average of 20%, based on a limited number of individual audits (Brank 2006). This is an aggregate error estimate—the error in the data for the specific pesticides on the study list is not known. Relative errors in pesticide sales data are likely to differ among pesticides, since this error is based on non-compliance by particular categories of retailers (e.g., "big box" stores) and since the non-agricultural sales fractions differ among pesticides.

This error may extend beyond the non-professional sector for some pesticides. For example, as explained below, reported sales of cypermethrin and deltamethrin averaged less than 50% of the reported use of these pesticides between 1999 and 2005. This error could be explained by non-payment of fees, or it could be due to errors in reporting (see below).

Since the error associated with non-payment of fees is systematic, it is not expected to affect evaluation of past trends. Stepped up enforcement of sales and registration requirements in 2005 and subsequent years may affect evaluation of trends that include data prior to and after 2005.

- Data errors. Prior to releasing its annual report, DPR does a quality assurance review of the data, with the intent of eliminating major data errors (e.g., errors in data entry or units) (Owen 2006). However, neither registrants nor DPR rely on the pesticide product volumes reported by registrants for any fee or regulatory purpose, so the level of review given these numbers is not always high (fees are based on dollar sales, not quantity sales).

  Data entry errors also exist in DPR's internal database that is used to calculate the quantity of active ingredient sold. In 2006, DPR reviewed these values for pyrethroid products that contained high concentrations of active ingredient and corrected several significant data entry errors. One bifenthrin product manufacturer also completed such a review and identified additional smaller data entry errors. DPR issued corrected sales reports for 2003, 2004, and 2005;[5] these corrections are reflected in this report.

  The UP3 Project has worked with DPR and registrants to review unusual data for study-list pesticides and correct errors identified. Such cooperation has greatly improved the data. Because this has been on a case-by-case basis, it is likely that a few data errors continue to be reflected in the data in this report.

- Shipment timing. Pesticide shipment scheduling practices and tax payment 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 existing product sales and/or use may continue until a later date or until existing stocks are exhausted). Evaluation of multiple years of sales data is necessary to ensure that apparent trends are meaningful. It is also important to recognize that pesticide use depends on environmental factors—such as the weather and pest populations—making year-to-year variations normal for the data set.

[5] When DPR corrects errors in its sales reports, it posts the revised reports on the Internet.

2.3 Pesticide Use Reports

Certain pesticide applications[6] are required to be reported to the County Agricultural Commissioner who, in turn, reports the data to DPR. In general, the pesticide uses that require reporting are agricultural uses or urban applications done by professional applicators.[7] DPR prepares annual summary reports on the basis of these data. While the required reporting and the annual summary reports lack the detail necessary to allow a detailed tally of reported urban pesticide applications, they are sufficiently detailed to allow selection of reporting categories like structural pest control and landscape maintenance that are predominately urban to create an estimate of the urban portion of the reported pesticide use.[8] Required reporting includes (but is not limited to) the registration number of the product that was applied and the month it was applied; these data are available from an Internet database of pesticide use reports that is maintained by DPR.[9] The structural pest control reporting category includes aboveground applications (e.g., spraying around a building to control ants), indoor applications, pre-construction termiticide treatments (e.g., treatment of soil prior to foundation construction), and underground injection (e.g., injection of pesticides into holes drilled into the ground to control termites).

Table 3 (on the next page) summarizes statewide reported use of study-list pesticides in 2005 (the most recent data available). Note that the majority of pyrethroid reported use was for structural pest control.

Fipronil data are not included in Table 3 because a significant reporting problem was identified by DPR in response to questions from the UP3 Project. While exploring the question of why reported fipronil use exceeded reported sales, DPR discovered that a few professional structural pest control applicators were apparently reporting the amount of diluted product applied, rather than the amount of actual formulated product used. Because fipronil concentrate is typically diluted 150 times, this reporting error caused use to be over-reported by some 150 times. This seemingly minor error had significant consequences—nearly 30% of the entire reported use of fipronil in California in 2005 was reported under one professional applicator’s license number. With the assistance of the appropriate County Agricultural Commissioner, DPR was able to confirm that this applicator was indeed reporting use of diluted material rather than the product itself (Farnsworth 2007).

DPR has notified County Agricultural Commissioners of the identified reporting errors. DPR’s reported use data for fipronil is currently in the process of being updated to reflect

[6] 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 person engaged for hire in the business of pest control (e.g., a licensed pest control operator).

[7] In this report, “professional” refers to “[a]ny person engaged for hire in the business of pest control” (Title 3, California Code of Regulations, Section 6624). Professional applications can only be made by a trained person who works under the supervision of a licensed pesticide applicator or pest control operator.

[8] 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.

[9] DPR’s California Pesticide Information Portal (CalPIP) database is accessible on the Internet: http://calpip.cdpr.ca.gov/cfdocs/calpip/prod/main.cfm

Table 3. California Study-List Pesticides Reported Use, 2005 (Pounds of Pesticide Active Ingredient)

Pesticide	Total (Agricultural and Urban)	Total (Urban Only)	Structural Pest Control	Landscape Maintenance
Pyrethroids				
Bifenthrin	65,000	45,000	40,000	2,100
Cyfluthrin	50,000	32,000	31,000	730
Beta-Cyfluthrin	6,400	5,200	4,900	270
Cypermethrin	210,000	200,000	200,000	1,300
Deltamethrin	14,000	14,000	13,000	350
Esfenvalerate	33,000	260	250	8
Lambda-Cyhalothrin	37,000	14,000	14,000	140
Permethrin	550,000	400,000	390,000	11,000
Tralomethrin	42	42	39	3
OPs				
Chlorpyrifos	2,000,000	75,000	70,000	3,700
Diazinon	400,000	12,000	11,000	1,300
Malathion	430,000	59,000	32,000	1,900
Other				
Carbaryl	190,000	14,000	7,300	6,400
Fipronil	--[a]	--[a]	--[a]	--[a]
PHMB	0[b]	0	0	0

Source: DPR's California Pesticide Information Portal (CalPIP) database (DPR 2007a).
Notes: Only malathion had significant reported urban uses other than structural pest control and landscaping: 15,608 pounds for regulatory pest control and 9,446 pounds for use for public health protection. Less than 10% of the total volume of other study-list pesticides was reported for urban uses not listed in the table.
[a]Fipronil is not included in this table for reasons explained in the text.
[b] PHMB is only registered for uses that do not require reporting.

revised reports of fipronil use. Because the revisions are still in progress, fipronil reported use data are not included in this report.

Uncertainty

Pesticide use reports are generally considered relatively reliable as compared to other data sources. DPR's reporting requirements and DPR's and County Agricultural Commissioners' enforcement systems are intended to ensure that most pesticide applications that require reporting are reported. Potential sources of error include:

- Non-compliance with reporting requirements. 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. DPR completed an analysis comparing reported sales and reported use for a group of pesticides for which all uses are reportable (this analysis involved a small subset of all pesticides). DPR found a rather large variation in reporting among pesticides (Wilhoit 2005). In this analysis, DPR found that on average about 90% of the sales of the analyzed pesticides (for which all uses are reportable) was reported as used over a 5 year period; however, since there was a large variation in results for individual pesticides, this average is very uncertain (Wilhoit 2005; Brank 2006). The error rate for individual pesticides—and for urban reportable uses (which could not be explored separately from agricultural uses with this analytical method)—may differ significantly from the aggregate underreporting suggested by this DPR analysis.

- Reporting errors. As mentioned above, professionals may occasionally err in making reports, e.g., by reporting diluted product volumes rather than concentrated product volumes. If dilutions are high, like they are for fipronil, errors by only a small number of individuals can significantly change statewide data sets, as they did in the case of fipronil. Several other study-list pesticides may also be subject to this error, which is a possible explanation for finding that cypermethrin and deltamethrin reported use consistently significantly exceeds reported sales. Recognizing the importance of accurate pesticide use reporting, the Pest Control Operators of California, which is the professional organization for structural pest control applicators, is making its members aware of this issue (Van Steenwyk 2007). This should improve reporting accuracy for structural pest control applications starting in 2007.
- Data handling errors. Prior to releasing its annual report, DPR has always completed 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 an audit of the data management system (Wilhoit et al. 2001), DPR implemented improved error handling processes and has continued efforts to improve the system; DPR believes these improvements keep errors to less than 1-2% (Wilhoit 2002; Wilhoit 2005).

2.4 Quantitative Pesticide Use Estimates

Using data from DPR, it is possible to develop gross quantitative estimates of pesticide use statewide and in the San Francisco Bay Area. The estimates use pesticide sales data, reported pesticide use data, and a calculation of pesticide use that does not require reporting. Assuming all pesticides sold are used within a particular year, pesticide use that does not require reporting ("unreported pesticide use") can be estimated to be approximately equal to the difference between statewide pesticide sales and statewide reported pesticide use—which should be approximately equal to over-the-counter sales. In other words, this estimation method is based on the assumption that urban use of a pesticide by non-professionals is approximately equal to over-the-counter sales of that pesticide.

Mathematically, this approach to estimating urban pesticide use can be expressed as follows:

$$\text{Urban Use} \approx \text{Reported Urban Use} + \text{Over-the-Counter (OTC) Sales}$$

$$\text{Statewide OTC Sales} \approx \text{Statewide Sales} - \text{Statewide Reported Use}$$

The main assumption behind this urban pesticide use estimation method is that all unreported pesticide use occurs in urban areas. 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.[10] Because these activities occur primarily in urban areas—and essentially all agricultural use[11] requires reporting—the assumption that essentially all unreported uses of the study-list pesticides are urban is reasonable.

Another important assumption is that all pesticides sold are used—and used in the year they are sold. Some pesticides are stored and used in years after the year of purchase. If the market is stable, the effect of storage may not be very important—in a steady state market, use of past purchases may be offset by current purchases stored for future use. However, when the market changes—as it has due to phase out of previously popular diazinon and chlorpyrifos, for example—the stored products may have different active ingredients than current purchases that are stored for future use. In times of market change, assuming that all pesticides sold are used in a given year would tend to overstate use of the active ingredient and understate use of the formerly popular active ingredient. Since some pesticides that are sold are never used, this approach generally overestimates non-professional use to an unknown degree. The unused amount cannot be quantitatively estimated. It should be assumed that estimated over the counter sales are an upper bound on annual use quantities by non-professionals.

Generally, it is reasonable to assume that pesticide use correlates with pesticide sales. Market factors may, however, cause this to not be the case for individual active ingredients. In addition to incidental storage of over-the-counter purchase noted above, professionals may also store products for future use. For example, pesticides newly introduced into the market may be sold in one calendar year, but not applied until the next year. When allowable pesticide uses are changed, sometimes users (both professional and non-professional) stockpile pesticides with the "old" label, which are generally allowed to be applied for the previously allowable use until stocks with labels allowing this use are exhausted.

Uncertainty

Errors in source data. Estimates of unreported 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, on average, these errors offset each other). The effect of errors in the source data is variable, depending on the pesticide. For example, for two pesticides, reported use has exceeded reported sales for at least 5 years (see below). If a pesticide has agricultural uses, any underreporting of those uses would cause unreported use to be overestimated.

Since the primary identified errors in pesticide sales and reported use data 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.

In light of the uncertainties detailed above, this report focuses on general trends and conclusions that can be supported by the available data. To reflect the uncertainties in the quantitative estimates in this section, this report utilizes significant figures when presenting estimates. Sales data and use data from DPR and estimates based on calculations are rounded to provide the appropriate number of significant figures.

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[10] 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. Use of biocides to treat drinking water and wastewater are also usually not reported.

[11] Except livestock treatment.

Statewide Urban Pesticide Use Estimates—All Pesticides

Data from DPR indicate that at least half of California pesticide use occurs in urban areas. In 2005, DPR reports indicate that about 610 million pounds of pesticide active ingredient were sold (DPR 2007b) and 190 million pounds of pesticide active ingredients were reported to have been used in manners requiring reporting (DPR 2006b). Assuming that on average, an amount equivalent to pesticide sales is used each year, about 68% of California pesticide use in 2005 did not require reporting.[12] For 2005, the sum of estimated unreported pesticide use (about 420 million pounds [see equations above]) and reported urban use (about 16 million pounds) is about 440 million pounds, about 70% of total use. Given the uncertainties in the data sources, this urban pesticide use estimate is not exact; nevertheless, it indicates that at least half of California pesticide use occurs in urban areas.

Reported urban pesticide use, however, comprises only a small fraction of all reported pesticide use (most reported pesticide use is associated with agriculture). According to DPR, 16 million pounds of pesticide active ingredient were applied for reported urban uses in 2005 (DPR 2006b). This represented about 8% of all reported pesticide use in 2005.

Statewide Urban Pesticide Use Estimates—Study-List Pesticides

Study-list pesticides have use patterns that differ from the statewide averages for all pesticides. Most use of most of these pesticides is in urban areas—and most of that use is by professionals. Table 4 (on the next page) provides an overview of the use patterns of study-list pesticides. Table 4 provides statewide sales, reported use, estimated unreported use, and the fraction of the use that is unreported for study-list pesticides.

Table 4 and subsequent tables presents these data as two-year averages for the years 2004 and 2005. Two year averages are used in this analysis to average out data variations due to shipment timing (see Section 2.2 above). Use of multi-year averages for data analysis is generally preferred, but has not been possible due to the strong year-to-year changes in the market as it has responded to the phase out of most urban uses of diazinon and chlorpyrifos. Use of a two-year average for 2004 and 2005 was judged reasonable in light of the near completeness of the phase out of almost all urban uses of these two insecticides.

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

- Diazinon and Chlorpyrifos. The difference between total sales and reported use of diazinon and chlorpyrifos likely reflects professionals stocking up on these two insecticides prior to phase out of many allowable uses. (It could also possibly reflect under-reporting of the agricultural and remaining allowable urban uses of these pesticides, which have lost popularity since the U.S. EPA released risk information about them in 1999 and 2000.) The difference between sales and reported use is very unlikely to represent actual urban use in this case, because sales of chlorpyrifos products for almost all non-reportable urban uses ended in December 2001 and retail sales of diazinon products for urban use ended in December 2004.

[12] Note that most use of biocides like chlorine (sales of >69 million pounds in 2005) and sodium hypochlorite (sales of 141 million pounds in 2005) do not require reporting. These two biocides are used in large quantities to treat drinking water and wastewater. Sodium hypochlorite is also sold over the counter in bleach, which is registered as a pesticide.

Table 4. California Study-List Pesticides Unreported Use, 2004-2005
(Pounds of Pesticide Active Ingredient, 2-Year Average)

Pesticide	Sales	Reported Use	Estimated Unreported Use[a]	Estimated % of Use That Is Unreported
Pyrethroids				
Bifenthrin	77,000	64,000	10,000	17%
Cyfluthrin	42,000	49,000	Limited[b]	Small
Beta-Cyfluthrin	11,000	11,000	Limited	Small
Cypermethrin	85,000	210,000	Limited	Small
Deltamethrin	3,900	13,000	Limited	Small
Esfenvalerate	53,000	33,000	20,000	39%
Lambda-Cyhalothrin	32,000	37,000	Limited	Small
Permethrin	480,000	510,000	Limited	Small
Tralomethrin	2,800	89	3,000	97%
OPs				
Chlorpyrifos	2,300,000	1,900,000	?[c]	?[c]
Diazinon	660,000	450,000	?[d]	?[d]
Malathion	1,300,000	460,000	800,000	65%
Other				
Carbaryl	400,000	220,000	200,000	46%
Fipronil	20,000	--[e]	--[e]	--[e]
PHMB	52,000	0[f]	50,000	100%
All Pesticides	***700,000,000***	***180,000,000***	***500,000,000***	***74%***

Source: DPR sales data (DPR 2007b), pesticide use reports (DPR 2007a) and mathematical calculations.
[a]Total estimated use values have only one significant figure to reflect uncertainty in these estimates. Totals may not add up due to rounding.
[b]When reported use exceeds sales, unreported use is assumed to be relatively limited.
[c]Essentially all registered uses required reporting. It is not known why sales exceed reported use.
[d]In 2004, over the counter sales were legal, but in 2005, all registered uses required reporting in 2005.
[e]Fipronil reported use data are not included in this table for reasons explained in the text
[f]PHMB is only registered for urban uses that do not require reporting.

- Cyfluthrin, Beta-Cyfluthrin, Cypermethrin, Deltamethrin, Lambda-Cyhalothrin, and Permethrin. For all of these pesticides, statewide reported use exceeded statewide reported sales; therefore, unreported use was assumed to be small. Annual variations in sales data can cause these data anomalies to occur; however, cypermethrin and deltamethrin are notable in that reported sales averaged less than 50% of reported use between 1999 and 2005. Since all were found in a few products in 2005 retail shelf surveys (TDC Environmental 2005) the unreported use was almost certainly not zero. These data can be interpreted to suggest that retail sales for non-professional uses were probably not a significant part of the overall use of these pesticides.
- Carbaryl and Permethrin. Unreported use estimates for these pesticides rely on the differences between rather large sales and reported use values. Errors in sales and/or reported use values that are small relative to these individual totals could be large relative to the unreported use estimate. For these two insecticides, errors within the uncertainty of the sales and reported use data could significantly change the unreported use estimate.

Total estimated statewide urban pesticide use is the sum of urban reported use (see Table 3 above) and estimated unreported use (all of which is assumed to be urban, as explained above). Table 5 presents an estimate of the total urban use of study pesticides in the California in 2004-2005. These data should be interpreted with the understanding that the margin of error in the estimates is likely to be more than 10% (as explained in the discussions of uncertainties in Sections 2.2 and 2.3).

Table 5. California Study-List Pesticides Estimated Urban Use, 2004-2005 (Pounds of Pesticide Active Ingredient, 2-Year Average)

Pesticide	Reported Urban Use	Estimated Unreported Urban Use[a]	Total Estimated Urban Use[b]
Pyrethroids			
Bifenthrin	45,000	10,000	60,000
Cyfluthrin	33,000	Limited[b]	30,000
Beta-Cyfluthrin	11,000	Limited	10,000
Cypermethrin	200,000	Limited	200,000
Deltamethrin	13,000	Limited	10,000
Esfenvalerate	180	20,000	20,000
Lambda-Cyhalothrin	15,000	Limited	10,000
Permethrin	370,000	Limited	400,000
Tralomethrin	87	3,000	3,000
OPs			
Chlorpyrifos	100,000	?[c]	?[c]
Diazinon	18,000	?[c]	?[c]
Malathion	72,000	800,000	900,000
Other			
Carbaryl	24,000	200,000	200,000
Fipronil	--[d]	--[d]	20,000[d]
PHMB	0[e]	50,000	50,000

Source: TDC Environmental calculations based on data in Tables 3 and 4.
[a]Unreported use values reflect only 1 significant figure to reflect uncertainty in these values.
[b]Total estimated use values reflect 1 significant figure to reflect uncertainty in these values. Totals may not add up due to rounding.
[c]Estimates made according to the methodology are very unlikely to represent actual urban use, as they are based primarily on estimated retail sales, which were essentially prohibited for chlorpyrifos and were phasing out in 2004 and prohibited in 2005 for diazinon. Therefore, values have not been included in the table. Please see the discussion in the text above.
[d] Fipronil reported use data are not included in this table for reasons explained in the text. Since all allowable uses are urban, total urban use was assumed to equal sales.
[e]PHMB is only registered for urban uses that do not require reporting.

In Table 6 (on the next page), pesticide sales and reported agricultural pesticide use data are used to estimate the fraction of the total statewide use of each study-list pesticide that occurs in agricultural and in urban areas. Note that most study-list pyrethroids are used primarily in urban areas, as is most malathion, and all fipronil and PHMB.

Table 6. California Study-List Pesticides Agricultural and Estimated Urban Usage Percentages, 2004-2005 (Pounds of Pesticide Active Ingredient, 2-Year Average)

Pesticide	Sales	Reported Agricultural Use	% of Use that is Agricultural	% of Use that is Urban
Pyrethroids				
Bifenthrin	77,000	19,000	25%	75%
Cyfluthrin	42,000	17,000	40%	60%
Beta-Cyfluthrin	11,000	900	8%	92%
Cypermethrin	85,000	4,400	5%	95%
Deltamethrin	3,900	96	2%	98%
Esfenvalerate	53,000	33,000	61%	39%
Lambda-Cyhalothrin	32,000	22,000	69%	31%
Permethrin	480,000	140,000	30%	70%
Tralomethrin	2,800	3	0%	100%
OPs				
Chlorpyrifos	2,300,000	1,800,000	?[a]	?[a]
Diazinon	660,000	430,000	?[a]	?[a]
Malathion	1,300,000	390,000	30%	70%
Other				
Carbaryl	400,000	190,000	48%	52%
Fipronil	20,000	0	0%	100%
PHMB	52,000	0	0%	100%

Source: DPR sales data (DPR 2007b), pesticide use reports (DPR 2007a) and mathematical calculations.

[a]Estimates made according to the methodology are very unlikely to represent actual urban/agricultural use breakdowns, as urban use estimates would be based primarily on estimated retail sales of chlorpyrifos, which were essentially prohibited for chlorpyrifos and were phasing out in 2004 and prohibited in 2005 for diazinon. Therefore, values have not been included in the table. Please see the discussion in the text above.

2.5 Pyrethroids Urban Use

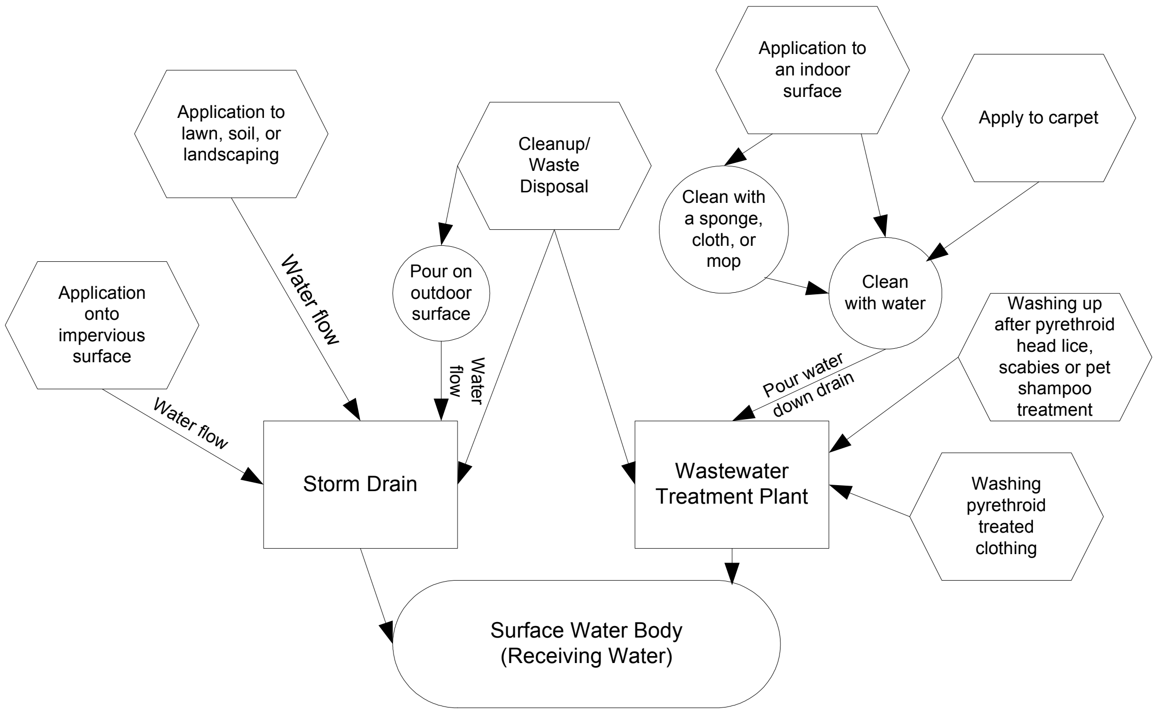
As explained in the UP3 Project *Annual Review of New Scientific Findings 2007* (TDC Environmental 2007b), there is strong scientific evidence that use of pyrethroid insecticides in Northern California urban areas is causing adverse effects in aquatic ecosystems receiving urban runoff. Ending this toxicity is a priority for California water quality agencies. Understanding how pyrethroids are used in urban areas will help agencies develop management strategies to respond to this problem. This section explores how pyrethroids are used in urban areas.

Background

All uses of pyrethroids are as pesticides (i.e., there are no pyrethroid-containing products that are not registered pesticides). Pyrethroids are not formed by decomposition of other chemicals in the environment. Because pyrethroids are not very volatile and because urban uses comprise a very significant fraction of all pyrethroids use, air transport of pyrethroids from agricultural areas into urban areas is unlikely to be a significant source of pyrethroids in urban runoff. Most Northern California urban creeks do not receive agricultural runoff. Thus, it is reasonable to assume that the only significant source of pyrethroids in most Northern California urban creeks is urban pesticide use.

A 2001 report prepared for DPR explores how pesticides used in urban areas can flow to surface waters (TDC Environmental 2001). Figure 1, below, summarizes the connections between common pyrethroid uses and surface waters.

Figure 1. Primary Pathways for Pyrethroids to Flow to Urban Surface Waters



Source: TDC Environmental summary based on TDC Environmental 2001 and pyrethroid use data.

When it rains (or when water is discharged for other reasons in urban areas), urban runoff flows through storm drains into urban creeks. Water drains from urban areas to storm drains from a variety of miscellaneous non-rain flows—examples of such non-rain water discharges include excess irrigation runoff; washwater from cleaning outdoor surfaces (like buildings, driveways, and walkways); water from emptying swimming pools, spas, and fountains; vehicle wash water; and water released while flushing drinking water systems. In almost all of California, stormwater does not receive any type of treatment before it is discharged.[13] Urban runoff carries pollutants from urban surfaces into storm drains and creeks. These pollutants may be dissolved in the water or attached to fine particles that flow with the water through the storm drain system (given pyrethroids low solubility, the latter is the most likely pathway for pyrethroid transport). Only a small fraction of the total quantity of pesticides that are applied outdoors wash off. Washoff fractions from pesticide applications to impervious surfaces appear (on the basis of limited data) to be significantly higher than washoff fractions from "pervious" surfaces like lawns and landscaped areas (see TDC Environmental 2003 for more information).

[13] A few areas, like most of the city of San Francisco, have combined sewer systems that flow to municipal wastewater treatment plants. Innovative stormwater treatment projects and requirements to treat runoff from new development sites provide treatment for a very small fraction (<5%) of California's urban runoff.

In California, most wastewater treatment plants discharge to rivers, bays, or the ocean; only a few discharge to urban creeks. None of the urban creeks where pyrethroid-related sediment toxicity has been found receives wastewater treatment plant discharges upstream of or in the area where toxicity test samples were collected (Amweg et al. 2006; Weston et al. 2005). Because there is not an identified link between wastewater discharges and currently identified toxicity, this analysis focuses on outdoor pyrethroids use.

Permethrin Equivalents

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). To understand the environmental importance of the pyrethroids, it is necessary to look at them as a group. Simply adding up the total quantity of pyrethroids is not sufficient, because the aquatic toxicity of pyrethroids differs among the individual pesticides—some are more than twenty times more toxic than others. Toxicity differences among pyrethroids must be taken into account to understand potential for pyrethroids to cause aquatic toxicity. To address their toxicity, pyrethroids can be summed on the basis of “permethrin equivalents,” which are calculated based on the toxicity of each pyrethroid, as explained below.

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 to 50% of organisms) 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. The number of “permethrin equivalents” is calculated by multiplying the quantity of a pyrethroid by the listed “Ratio to Permethrin LC50” listed in Table 7.

Table 7. Toxicity of Pyrethroids to *Hyalella azteca*

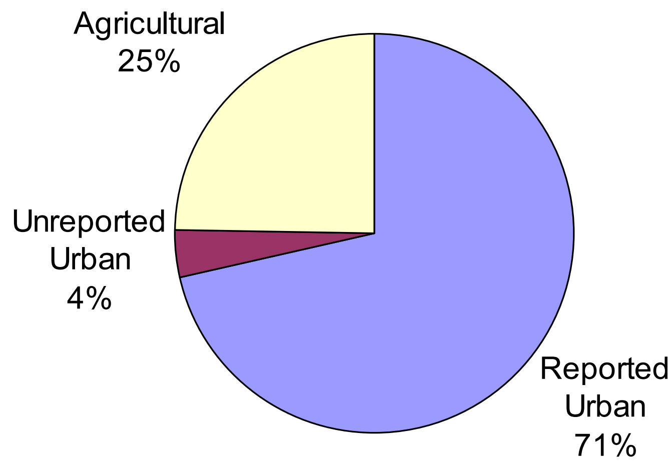
Pyrethroid	Average sediment 10-Day LC50 (µg/g organic carbon)	Ratio to Permethrin LC50
Bifenthrin	0.52	21
Cyfluthrin	1.08	10
Beta-Cyfluthrin	1.08*	10*
Cypermethrin	0.38	29
Deltamethrin	0.79	14
Esfenvalerate	1.54	7.03
Lambda-Cyhalothrin	0.45	24
Permethrin	10.83	1.00
Tralomethrin	*	*

Source: Maund et al. 2002 (cypermethrin); Amweg et al. 2005 (all others).
*No data available. Because it is a subset of Cyfluthrin isomers, Beta-cyfluthrin was assumed to have the same toxicity as cyfluthrin. Based on relative toxicity to other aquatic species, Tralomethrin was assumed to have the same toxicity as permethrin.

California Pyrethroid Use

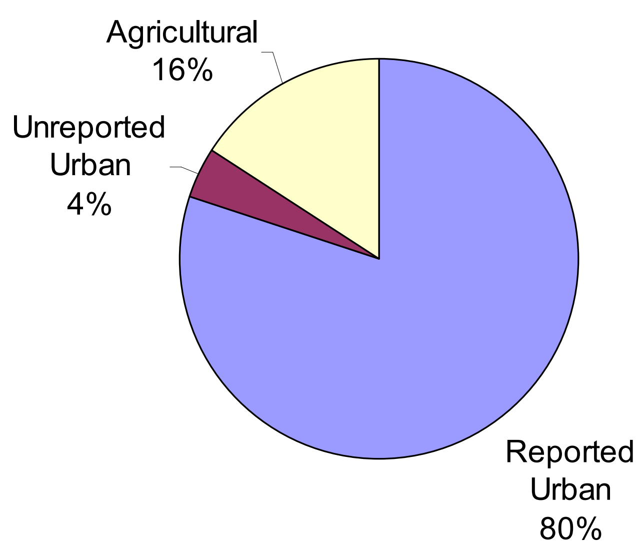
Figures 2 and 3 provide an overview of how study-list pyrethroids are used in California. These two figures are based on DPR pesticide sales data (DPR 2007b), DPR pesticide use reports (DPR 2007a) and mathematical calculations (see Table 4). Figure 2 is based on the total quantity of study-list pyrethroids applied, without consideration of the toxicity of the individual pyrethroids. In these and subsequent figures, "reported urban" indicates pyrethroid applications by professional applicators and "unreported urban" indicates estimated non-professional urban use. By comparing Figure 2 to Figure 3 (which uses the permethrin equivalents listed in Table 7 to account for the toxicity of each pyrethroid), it is apparent that the specific study-list pyrethroids applied for agricultural and unreported urban uses are, in aggregate, less toxic to aquatic life (as represented by *Hyalella azteca*) than those applied by professionals for urban use.

Figure 2. California Study-List Pyrethroids Estimated Use, 2004-2005 (Pounds of Pesticide Active Ingredient, 2-Year Average)



Source: DPR pesticide sales data (DPR 2007b), DPR pesticide use reports (DPR 2007a) and mathematical calculations (see Table 4)

Figure 3. California Study-List Pyrethroids Estimated Use, 2004-2005 (Permethrin Equivalents, 2-Year Average)



Source: DPR pesticide sales data (DPR 2007b), DPR pesticide use reports (DPR 2007a) and mathematical calculations (see Table 4). Conversion to permethrin equivalents based on values in Table 7.

Table 8 provides an overview of estimated urban pyrethroids use. Most urban use of study-list pyrethroids is for structural pest control. Exceptions are beta-cyfluthrin, esfenvalerate, and tralomethrin. It is important to remember that some pyrethroids applied for structural pest control are applied by underground injection—and therefore relatively unimportant for urban surface water quality (this topic is explored further later in this section). Because it is possible that these data may be affected by reporting errors similar to that identified for fipronil, without further pesticide-specific analysis, conclusions are best limited to qualitative statements (i.e., "relatively large fraction" and "relatively small fraction") rather than quantitative estimates.

Table 8. California Study-List Pyrethroids Urban Use Overview, 2004-2005 (2-Year Average)

Pesticide	Estimated Urban Use[a] (lb a.i.)	Reported Structural Pest Control Use[b]		Other Reported Urban Use		Estimated Fraction of Use That Is Unreported
		(lb a.i.)	Fraction	(lb a.i.)	Fraction	
Pyrethroids						
Bifenthrin	60,000	41,000	Majority	3,900	Small	<One-fifth
Cyfluthrin	30,000	32,000	Most	750	Small	Small
Beta-Cyfluthrin	10,000	5,000	About half	5,700	About half	Small
Cypermethrin	200,000	200,000	Most	7,100	Small	Small
Deltamethrin	10,000	13,000	Most	380	Small	Small
Esfenvalerate	20,000	170	Small	10	Small	<Half
Lambda-Cyhalothrin	10,000	15,000	Most	140	Small	Small
Permethrin	400,000	350,000	Most	20,000	Small	Small
Tralomethrin	3,000	85	Small	2	Small	Most

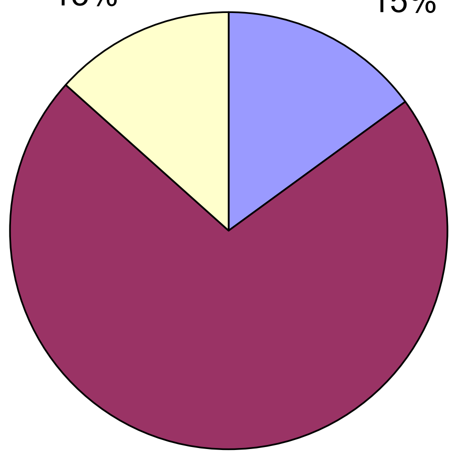
Source: DPR pesticide sales data (DPR 2007b), DPR pesticide use reports (DPR 2007a) and mathematical calculations (see Table 5).
[a]Total estimated use values reflect 1 significant figure to reflect uncertainty in these values. Totals may not add up due to rounding.
[b]Reported use values have 2 significant figures to reflect uncertainty in these values. "Small" means <10%. "Majority" means >50%. "Most'" means >80%.

Figure 4 (on the next page), shows that two pyrethroids—cypermethrin and bifenthrin—contain almost 90% of the pyrethroid-related toxicity (expressed in permethrin equivalents) that was used in California urban areas in 2004-2005. Three pyrethroids—cypermethrin, cyfluthrin (including beta-cyfluthrin) and bifenthrin—have been most commonly found to contribute to toxicity in urban creeks (Amweg et al. 2006; Weston et al. 2005). When reviewing pyrethroid usage data, keep in mind that usage quantity alone does not determine contributions to aquatic toxicity. Other factors—such as application location, transport processes, and environmental degradation rates—must also be considered.

Underground Applications

The pesticide reporting form used in California for structural pest control applications does not provide a way to distinguish among applications above ground (e.g., around buildings to control ants), indoors (e.g., baseboard sprays and flea foggers), and those made by underground injection (e.g., to control termites). Because applications by underground injection are unlikely to contribute significantly to aquatic toxicity—and

Figure 4. Study-List Pyrethroids Estimated Use in California Urban Areas, 2004-2005 (Permethrin Equivalents, 2-Year Average)



Source: DPR pesticide sales data (DPR 2007b), DPR pesticide use reports (DPR 2007a) and mathematical calculations (see Table 5). Conversion to permethrin equivalents based on values in Table 7.

applications indoors would affect sewer discharges rather than urban runoff—it would be preferable to be able to distinguish among these applications.

Pesticide application reports require applicators to identify the specific pesticide product that was applied. Assuming that professionals use products according to their label directions, it is possible to identify potential application types (outdoor, indoor, underground) based on a review of the labels for the applied products. Copies of product labels are available on the Internet in the U.S. EPA's Pesticide Product Label System (PPLS) (U.S. EPA 2007). PPLS labels may differ slightly from California-approved labels; however, differences are not common (because California cannot control pesticide labels directly) and are expected to be unusual for urban uses of pyrethroid products (because DPR does not normally examine urban uses in detail during its registration process).

The PPLS labels for study-list pyrethroid products that account for more than 99% of the reported use of each active ingredient for structural pest control in the California in 2005 were reviewed to determine whether allowable uses included aboveground outdoor uses, indoor uses, and/or underground injection applications. Where multiple labels were in the database, the label applicable in 2005 was selected. All products were found to allow application aboveground outdoors for structural pest control. Nearly all products (except granular formulations) allowed indoor applications. Only a portion of the products were labeled for underground injection—these included some bifenthrin products, one cypermethrin product, and all permethrin products. No cyfluthrin, beta-cyfluthrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, or tralomethrin product labels allowed underground injection applications.

As shown in Table 9, more than three-quarters of the quantity of bifenthrin, 85% of the quantity of cypermethrin, and all of the quantity of permethrin reported applied for structural pest control applications in California in 2005 were from products where labels allow underground injection. Overall, about 85% of the total quantity (75% when expressed as permethrin equivalents) of study-list pyrethroids that were applied were of products where labels allow underground injection. While it is unlikely that all of this was applied underground, this analysis method identifies the minimum (0%) and the maximum (85%) fraction of the reported structural pest control pyrethroids use that could have been applied underground. The actual fraction of underground applications is likely between these two extremes.

Table 9. California Study-List Pyrethroids Structural Pest Control Use, 2004-2005 (2-Year Average)

Pesticide	Reported Structural Pest Control Use (lb a.i.)	Portion of Estimated Urban Use Represented by Reported Structural Pest Control Use[b]	Fraction of Structural Pest Control Use that Could Have Been Applied Underground[c]
Pyrethroids			
Bifenthrin	41,000	Majority	0% - 77%
Cyfluthrin	32,000	Most	0%
Beta-Cyfluthrin	5,000	About half	0%
Cypermethrin	200,000	Most	0% - 85%
Deltamethrin	13,000	Most	0%
Esfenvalerate	170	Small	0%
Lambda-Cyhalothrin	15,000	Most	0%
Permethrin	350,000	Most	0% - 100%
Tralomethrin	85	Small	0%

Source: Pesticide product labels in PPLS (U.S. EPA 2007), DPR pesticide use reports (DPR 2007a) and mathematical calculations based on these data and values in Table 5.
[a]Total estimated use values reflect 1 significant figure to reflect uncertainty in these values.
[b]Reported use portion described qualitatively to reflect uncertainty in these values (see Table 8). "Small" means <10%. "Majority" means >50%. "Most'" means >80%.
[c]For cypermethrin and permethrin, percentage is based only on 2005 reported use data. Although not analyzed in detail, 2004 percentages are expected to be similar.

Some of the unreported pyrethroids use may involve applications by "trenching," which is the typical non-professional method for applying termite-control pesticides. This method, if properly implemented, would cause most of the pesticide to be applied below the ground surface and thus not be subject to runoff. The fraction of unreported applications of pyrethroids made in this manner is not known, but is anticipated to be relatively small, as pesticide applications to control termites by residents (rather than a professionals) appear to be rare based on surveys of consumer pesticide use (Wilen 2001; Wilen 2002; Flint 2003).

Indoor Applications

Professional structural pest control applications can be made indoors. As mentioned above, nearly all study-list pyrethroid products reported applied for structural pest control (except granules, only a few percent of reported use) allow indoor application. Neither reporting nor labels provide a means to estimate quantitatively the fraction applied indoors. Consumer surveys can, however, provide a qualitative indication of the extent of indoor applications. Recognizing the need for this type of information (and other information about residential pesticide use), DPR funded three sets of surveys (described below) that provide California-specific qualitative information about indoor pesticide use. Available surveys cover residents, but not businesses, and thus may not fully reflect application patterns.

In 2002-2003, the University of California Integrated Pest Management program (U.C. IPM) completed detailed telephone surveys of residents in the San Francisco Bay Area and the Central Valley (Sacramento and Stockton areas) (Flint 2003). These surveys, which were designed to collect representative samples of residents in each region, included a question about how professional pest control operators hired by the resident applied pesticides. Only 4% of San Francisco Bay Area respondents who hired professional pest control applicators said that the professional applied pesticides indoors. For the surveyed Central Valley regions, indoor applications by professionals were reported by fewer than 6% of respondents who hired professionals.

In 2000 and 2001, U.C. IPM conducted similar surveys in Southern California (in the San Diego Creek and Delhi Channel areas of Orange County and in the Chollas Creek watershed of San Diego County) (Wilen 2001; Wilen 2002). These surveys also found that indoor pesticide applications by professionals were relatively uncommon, but perhaps slightly more common than in Northern California. In these surveys, fewer than 2% of respondents reported hiring a professional pest control company to apply pesticides indoors; however, 10-16% said that a building manager handled pest control, including any indoor applications that might be needed.

Based on these survey data, it is reasonable to assume that indoor applications by professionals occur, but that these applications represent a relatively small fraction of the total quantity of pyrethroids applied for structural pest control. This small quantity falls in the range of the error of the estimates. Omitting consideration of indoor applications of study-list pyrethroids by professional structural pest control applicators should have little effect on interpretation of data on pesticide use quantities with regard to outdoor applications.

For unreported applications, the surveys do not provide a clear basis for estimating the fraction of pyrethroids use that occurs indoors. Although the Northern California surveys did not address indoor self-applications, the Southern California surveys did ask residents if they applied pesticides indoors. About 60% of respondents to these surveys reported indoor pesticide applications by household members (in contrast, only about 25% to 45% reported outdoor pesticide applications by household members). More than half of these applications were aerosol sprays, which generally contain very small quantities of pesticide active ingredients. However, formulations that may have more substantial quantities of pyrethroid active ingredients (ready-to-use pump sprays, other liquids, concentrates, and powders) were used indoors by more than 20% of respondents in the Delhi Channel area of Orange County and the Chollas Creek watershed of San Diego County (the only regions where this question was asked).

Pyrethroid Application Timing

Urban pyrethroids applications occur at all times of the year. The following figures summarize monthly applications of study-list pyrethroids by professional pest control operators. The figures cover reported applications for landscape maintenance and structural pest control (other applications together comprise <1% of total study-list pyrethroids reported urban use). Data are not available to generate similar figures for non-professional use.

These figures present the data in two manners—in terms of *total pounds of active ingredient*, and in terms of *permethrin equivalents*. As explained above, use of permethrin equivalents provides a convenient way to look at the data in a manner that accounts for differences in aquatic toxicity.

As shown in Figures 5 and 6 (on the next page), in 2005, professional applications of study-list pyrethroids for landscape maintenance peaked in the summer and were low during the winter, which is the rainy season. In contrast, professional structural pest control application rates were relatively more consistent throughout the year (particularly when aquatic toxicity is considered and the data are expressed in permethrin equivalents), as Figures 7 and 8 (on the following page) show.

Bifenthrin Urban Use

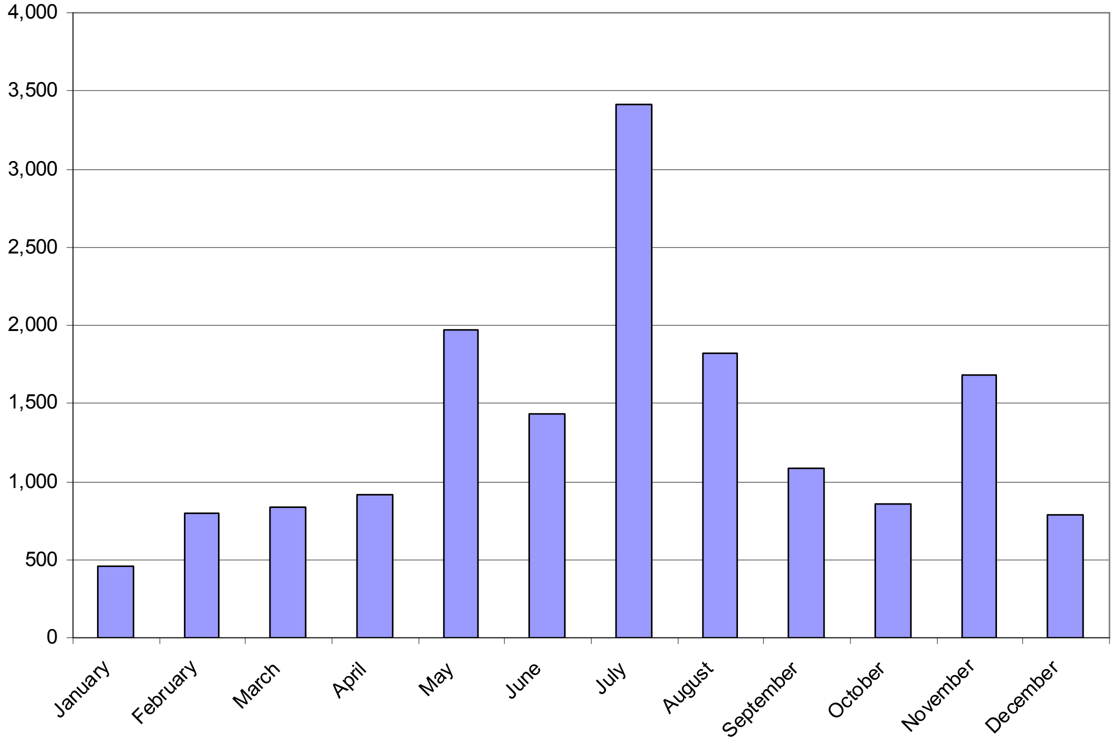
Of the study-list pyrethroids, the one most commonly associated with toxicity to aquatic organisms in urban creek sediments is bifenthrin (Amweg et al. 2006; Weston et al. 2005). This section summarizes data on California bifenthrin use in 2004-2005. Unless otherwise noted, all data in this section are 2-year averages for 2004 and 2005.

In 2004 and 2005, Scotts Miracle-Gro was the only manufacturer of bifenthrin products for non-professionals. Scotts provided its actual sales data for these products in 2004 and 2005 to the UP3 Project (Scotts Miracle-Gro 2006).[14] The actual sales (2004-2005 average of 11,000 pounds of bifenthrin active ingredient) are relatively close to the non-reported use estimate above (2004-2005 average of 13,000 pounds of bifenthrin active ingredient). The difference is well within the uncertainty of the estimate (see discussion of uncertainties in Sections 2.2, 2.3, and 2.4). The comparison provides support for use of the estimation approach described in this report (which is based on the assumption that the difference between statewide pesticide sales and statewide reported pesticide use is approximately equal to over-the-counter sales) when better information is not available. Since the actual quantity of bifenthrin sold to non-professionals is available, this value is used for the remainder of this analysis. Like the estimates above, the bifenthrin use estimates below rely on the assumption that urban use of a pesticide by non-professionals is approximately equal to over-the-counter sales of that pesticide (see Section 2.4).

As shown in Figure 9 (on page 25), about three-quarters of California bifenthrin use in 2002-2005 was in urban areas. Figure 10 (on page 25), which focuses only on urban bifenthrin use, shows that more than four-fifths of urban bifenthrin use in 2004-2005 was

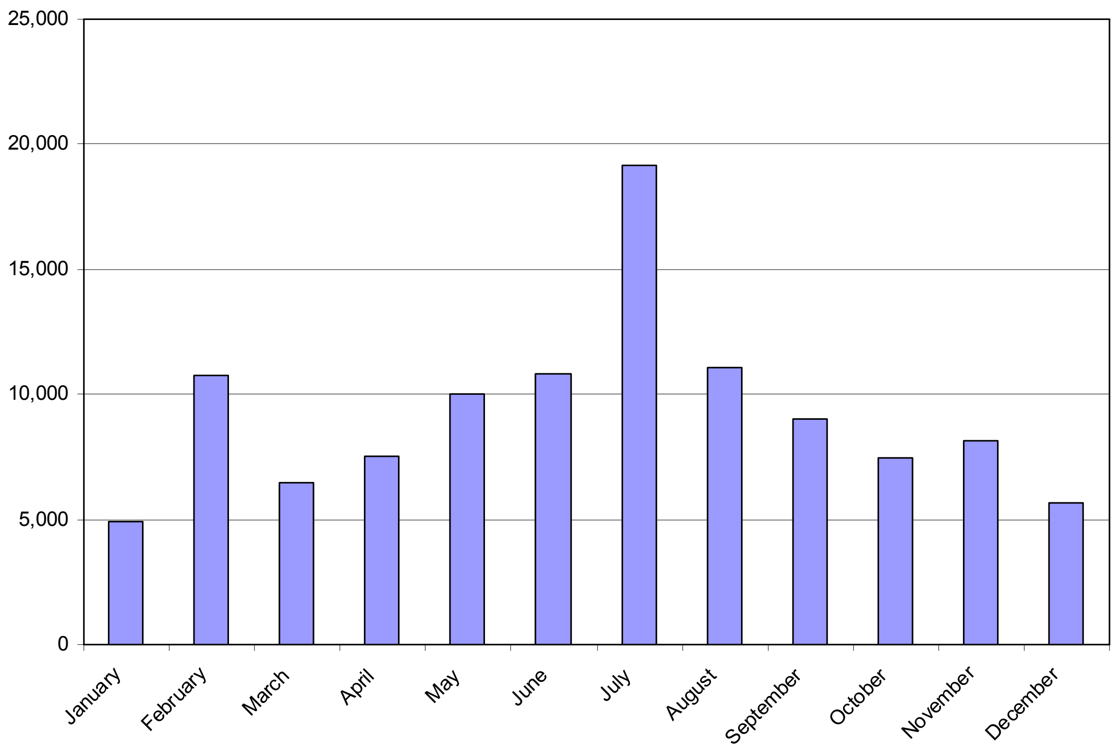
[14] Scotts Miracle-Gro (SMG) requested that the following statement be included in this report (Moses 2007): "The facts in the report represent Scotts Miracle-Gro's most accurate assessment of sales information for all SMG Products in CA containing Bifenthrin. SMG is not responsible for any loss or liability that results from use of this information. With that in mind, SMG anticipates that the use of this information in proper context, without distortion. SMG does not endorse any scientific, toxicological, environmental, or other conclusion derived from the plain facts presented unless expressly stated and agreed to by the appropriate SMG representative. SMG is providing the information to the UP3 Project in good faith and with a continued interest in partnership and cooperation."

Figure 5. California Study-List Pyrethroids Reported Landscape Maintenance Applications by Month in 2005 (Pounds of Pesticide Active Ingredient)



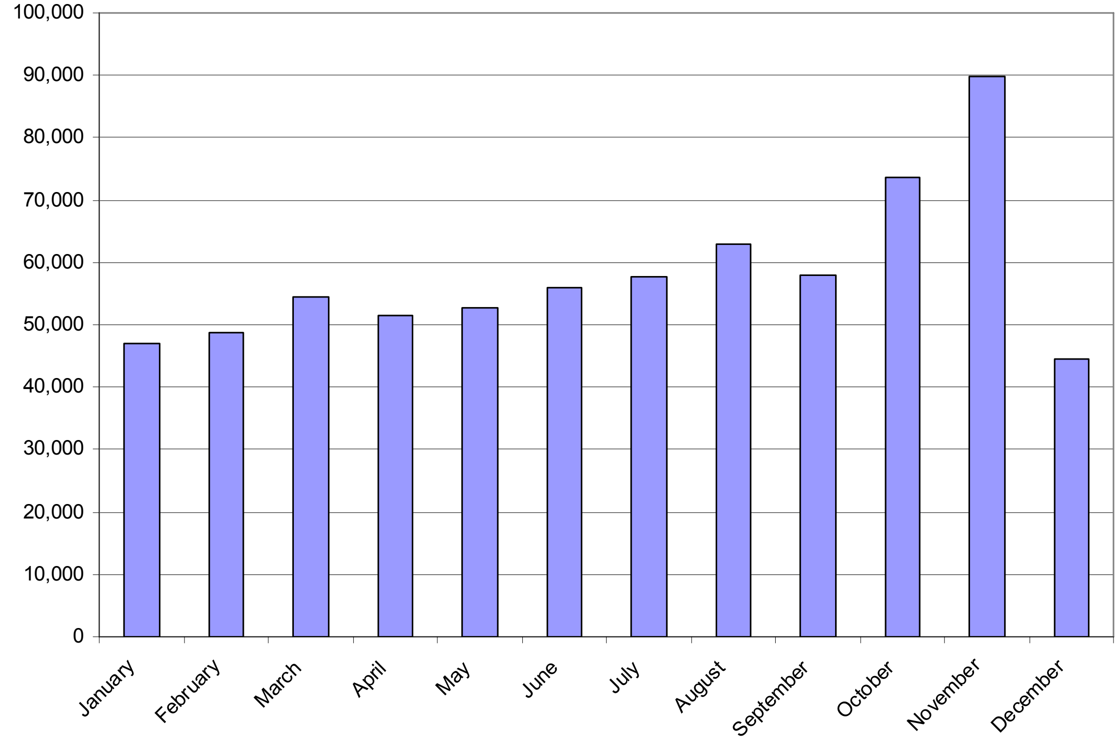
Source: DPR pesticide use reports (DPR 2007a).

Figure 6. California Study-List Pyrethroids Reported Landscape Maintenance Applications by Month in 2005 (Permethrin Equivalents)



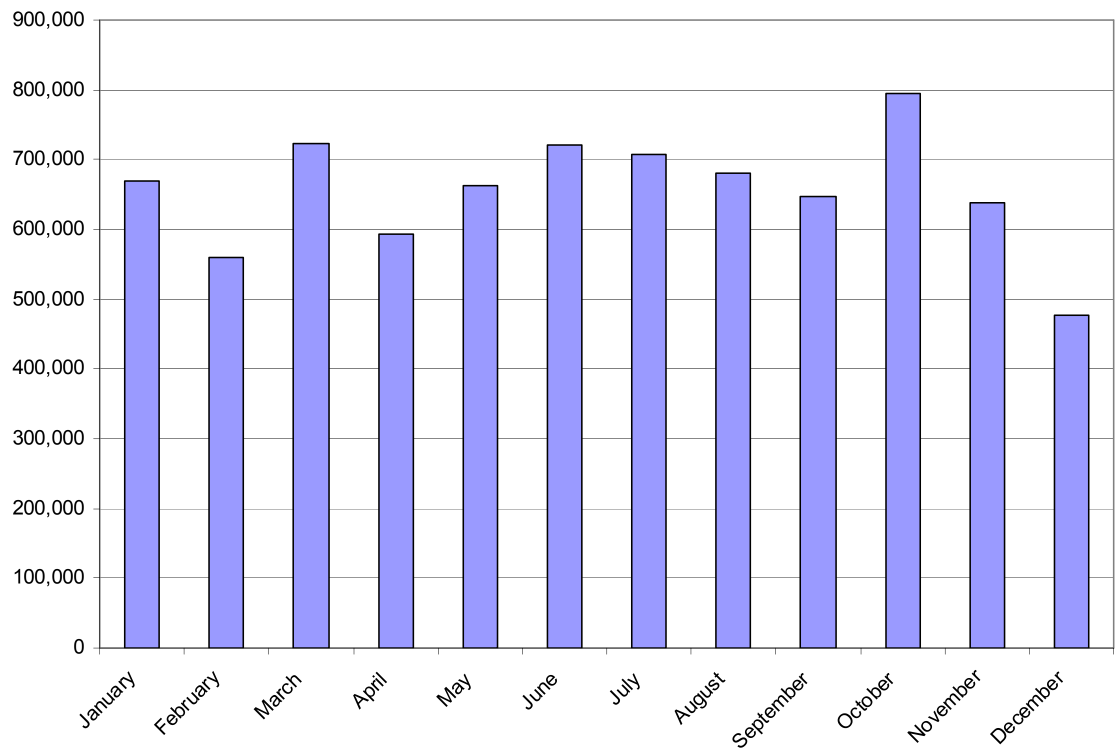
Source: DPR pesticide use reports (DPR 2007a). Permethrin equivalents calculated with values in Table 7.

Figure 7. California Study-List Pyrethroids Reported Structural Pest Control Applications by Month in 2005 (Pounds of Pesticide Active Ingredient)



Source: DPR pesticide use reports (DPR 2007a).

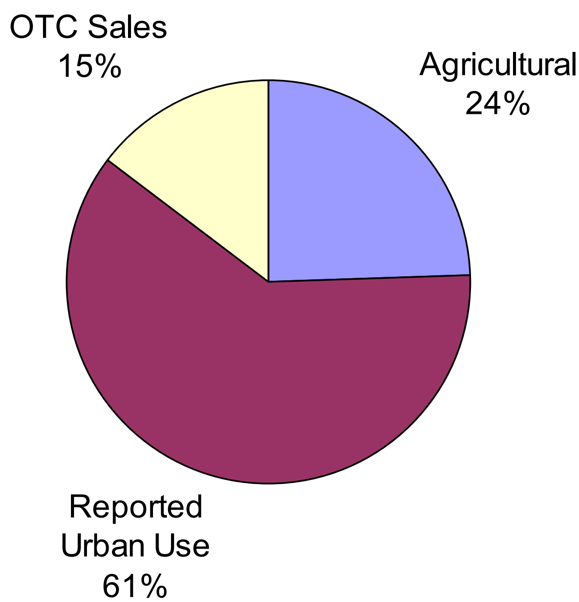
Figure 8. California Study-List Pyrethroids Reported Structural Pest Control Applications by Month in 2005 (Permethrin Equivalents)



Source: DPR pesticide use reports (DPR 2007a). Permethrin equivalents calculated with values in Table 7.

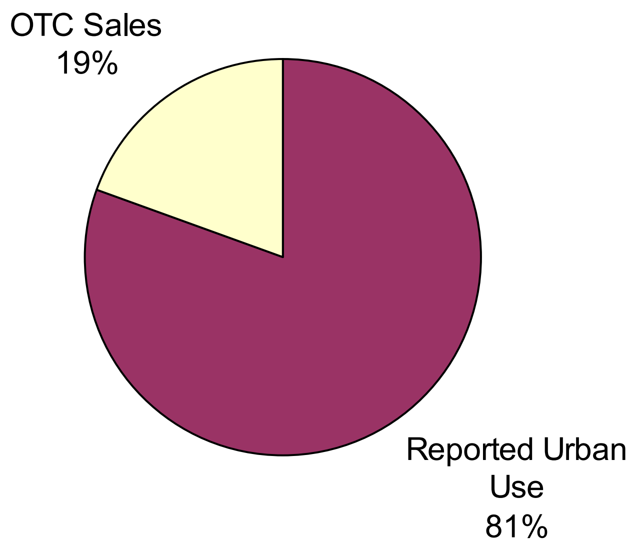
by professional applicators. In Figures 9 and 10, "reported urban use" indicates pyrethroid applications by professional applicators and "OTC Sales" indicates estimated non-professional urban use.

Figure 9. Total California Bifenthrin Use 2004-2005
(Pounds of Pesticide Active Ingredient, 2-Year Average)



Source: DPR pesticide use reports (DPR 2007a) and Scotts Miracle-Gro sales data (Scotts Miracle-Gro 2006). Note: Data accuracy warrants only one significant figure. Additional digits provided to simplify category tracking between figures.

Figure 10. Urban Bifenthrin Use in California 2004-2005
(Pounds of Pesticide Active Ingredient, 2-Year Average)



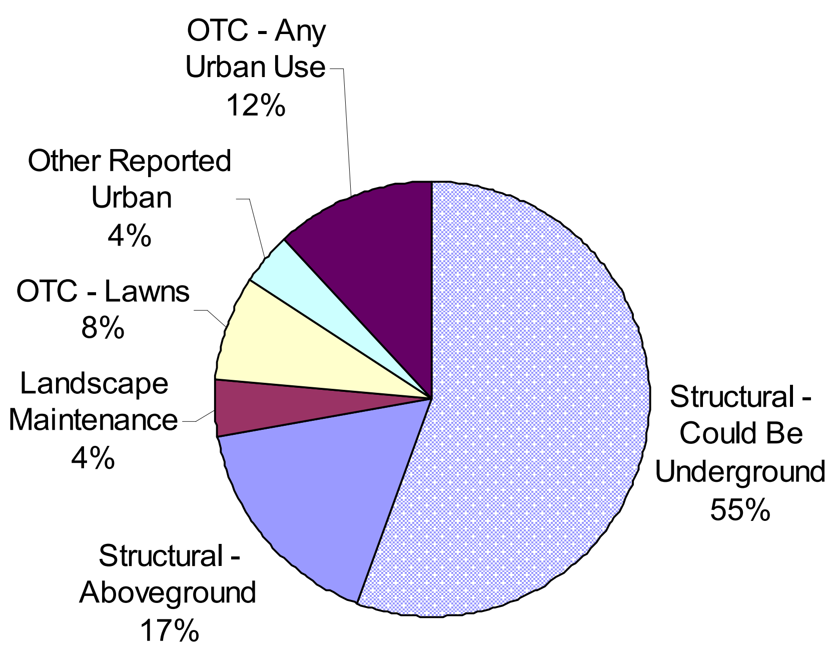
Source: DPR pesticide use reports (DPR 2007a) and Scotts Miracle-Gro sales data (Scotts Miracle-Gro 2006). Note: Data accuracy warrants only one significant figure. Additional digits provided to simplify category tracking between figures.

Figure 11 provides a detailed breakdown of urban bifenthrin use in 2004-2005. The largest single category of urban bifenthrin use, comprising more than 70% of urban bifenthrin use, was applications by professionals for structural pest control. A large fraction of these applications (up to three-quarters of the total quantity) were of products for which the label allows underground injection applications. With currently available data (see the discussion of underground applications above), it is not possible to determine how much of this bifenthrin was applied underground (where it would not be subject to runoff). Similarly, it is not possible to estimate quantitatively the amount of this bifenthrin applied indoors; however, as noted above, it is reasonable to assume that this quantity is relatively small.

Product information supplied by Scotts Miracle Gro (Scotts Miracle-Gro 2006), was divided into two categories: lawns (a granular product) and "any urban use" (liquid concentrate and ready to use products). The "any urban use" category may include outdoor structural, outdoor landscaping, or indoor applications of bifenthrin by non-professionals. (A portion of the "any urban use" category may have been applied below the ground surface to control termites; however, as mentioned above, survey data suggest this use is infrequent.)

Three categories—landscape maintenance, non-professional applications to lawns ("OTC – Lawns"), and other reported urban (primarily rights of way and soil treatment) involve applications to outdoor pervious surfaces. Since some of the "any urban use" non-professional applications were also likely made on outdoor pervious surfaces, these data suggest that between about one sixth and one quarter of urban bifenthrin use was on lawns, landscaping, and other pervious outdoor surfaces.

Figure 11. Urban Bifenthrin Use in California 2004-2005 – by Category (Pounds of Pesticide Active Ingredient, 2-Year Average)



Source: DPR pesticide use reports (DPR 2007a), U.S. EPA PPLS (U.S. EPA 2007), and Scotts Miracle-Gro sales data (Scotts Miracle-Gro 2006). Note: Data accuracy warrants only one significant figure. Additional digits provided to simplify category tracking between figures.

Of the categories in Figure 11, only two—Structural and "any urban use"—are likely to involve intentional applications to impervious surfaces (as well as to pervious surfaces). The fraction of these applications that occurred on impervious surfaces cannot be estimated with available data.

Like other urban pyrethroids, bifenthrin is applied at all times of the year. The following figures summarize monthly applications of bifenthrin by professional pest control operators. Figures 12 and 13 (on the next page) show monthly reported applications for landscape maintenance and structural pest control. These data are similar to data for other pyrethroids, which show landscaping applications peak in the summer, but structural applications occur more steadily year-round. Although 2005 data are not available to generate similar figures for non-professional use, Scotts Miracle-Gro provided the following information:

- Typically, about 70% of its non-professional bifenthrin product sales in California occur between June and September (Moses 2007).
- Information collected by the company suggests that consumer use patterns for products depend on the nature of the product, however, generally it is reasonable to assume that consumers who purchase bifenthrin products would ordinarily use them relatively soon after purchase (Martinez 2007).

This information suggests that non-professional applications peak in the summer months.

2.6 Trends

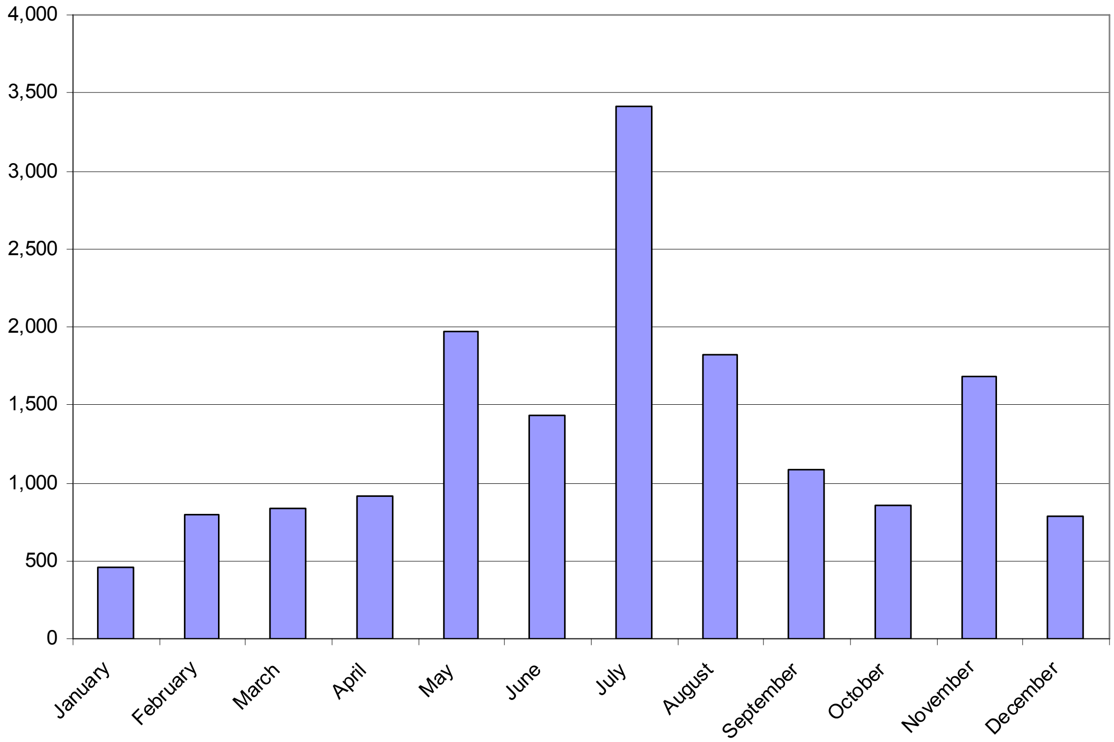
Table 10 (on page 29) shows the trends in estimated California urban use (both reported and unreported) of study-list pesticides from 2000-2005. This reflects the most recent available data (2005) and most of the time period during which the market was transitioning in response to U.S. EPA's year 2000 announcements of the termination of most urban uses of diazinon and chlorpyrifos. Until several years of data are available to reflect the period after 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 2000 (the year of the phase-out announcements) and 2005 (the most recent year for which data are available). The data in Table 10 show the following trends between 2000 and 2005:

- <u>Use of pyrethroids, malathion, fipronil, and PHMB increased</u>. Estimated use of bifenthrin and beta-cyfluthrin, increased significantly. Estimated use of permethrin and cypermethrin increased; however, it is not yet clear if this apparent increase is significant or just a reflection of ordinary fluctuations in use. Estimated use of several other pyrethroids (cyfluthrin, esfenvalerate, and lambda-cyhalothrin) changed significantly during this time period. (Due to database problems, the trend for tralomethrin cannot be evaluated).
- <u>Use of diazinon and chlorpyrifos decreased</u>.

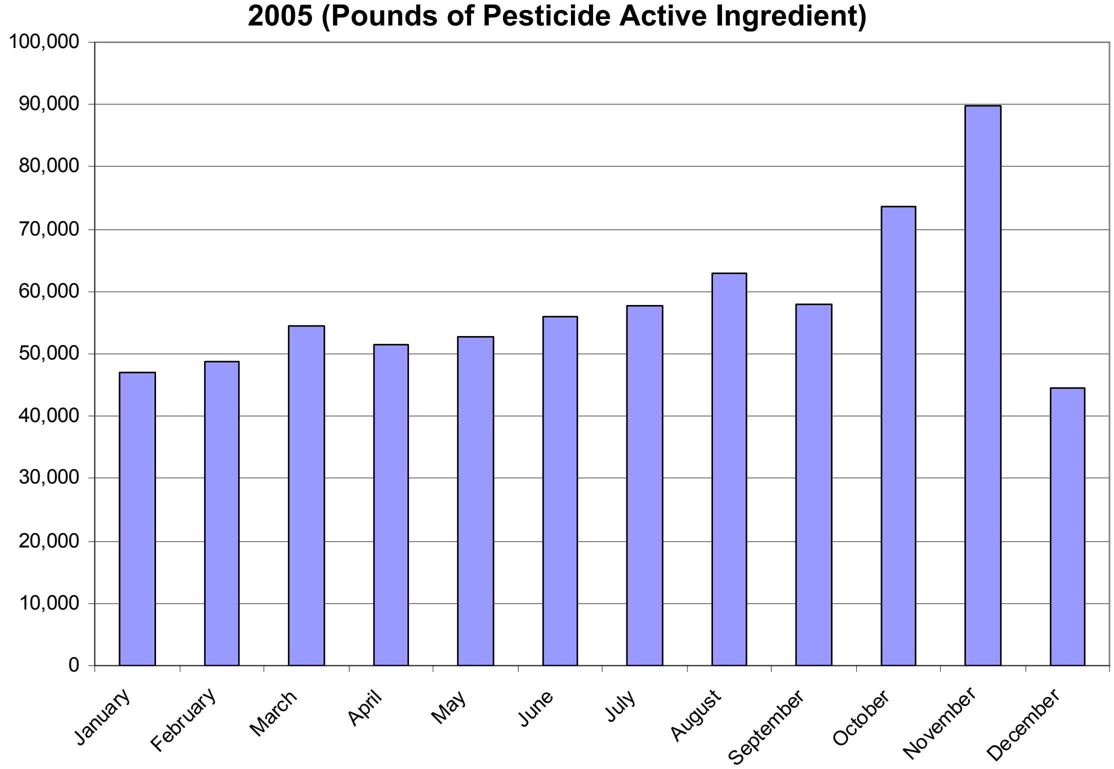
These data suggest that pyrethroids, fipronil, and perhaps malathion are replacing diazinon and chlorpyrifos in the urban pesticide use market. Estimating how this shift affects urban runoff is not simple, as some of the previous uses of diazinon and chlorpyrifos and the new uses of these products are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

Figure 12. Bifenthrin Reported Landscape Maintenance Applications by Month in 2005 (Pounds of Pesticide Active Ingredient)



Source: DPR pesticide use reports (DPR 2007a).

Figure 13. Bifenthrin Reported Structural Pest Control Applications by Month in 2005 (Pounds of Pesticide Active Ingredient)



Source: DPR pesticide use reports (DPR 2007a).

Table 10. Study-List Pesticides Estimated Urban Use 2000-2005[a] (Pounds of Pesticide Active Ingredient)

Pesticide	2000	2001	2002	2003	2004-2005 (2-Year Average)
Pyrethroids					
Bifenthrin	*10,000*[a]	20,000	30,000	50,000	60,000
Cyfluthrin	40,000[b]	30,000	40,000	30,000	30,000
Beta-Cyfluthrin	*>0*	*1,000*	*3,000*	4,000	10,000
Cypermethrin	100,000	200,000	200,000	200,000	200,000
Deltamethrin	10,000	20,000	10,000	20,000	10,000
Esfenvalerate	10,000	10,000	10,000	20,000	20,000
Lambda-Cyhalothrin	*10,000*	*10,000*	10,000	10,000	10,000
Permethrin	300,000	200,000	300,000	300,000	400,000
Tralomethrin	?[c]	?[c]	?[c]	3,000	3,000
OPs					
Chlorpyrifos	800,000	600,000	?[d]	?[d]	?[d]
Diazinon	900,000	900,000	400,000	300,000	?[d]
Malathion	600,000	700,000	600,000	1,00,000	900,000
Other					
Carbaryl	200,000	100,000	200,000	100,000	200,000
Fipronil[e]	2,000	20,000	30,000	10,000	20,000
PHMB	30,000	?[f]	?[f]	60,000	50,000

Source: TDC Environmental calculations based on DPR sales (DPR 2001a, 2002a, 2003a, 2005a, 2006a, 2007b) and reported use data (DPR 2001b, 2002b, 2003b, 2005b, 2007a).
[a]Values in italics do not include any estimate of unreported use, as sales data were not available (sales of products with fewer than four registrants were not disclosed to the public until 2005).
[b]More than half of the shaded estimates was estimated unreported use.
[c]Tralomethrin sales data from DPR for 2000-2002 likely reflect an error in an internal DPR database that was corrected starting with 2003 data.
[d]Estimates made according to the methodology described in the text are very unlikely to represent actual urban use, as they are based primarily on estimated retail sales, which were essentially prohibited for chlorpyrifos starting in 2002 and were phasing out in 2004 and prohibited in 2005 for diazinon. Therefore, 2004-2005 values have not been included in the table. See Section 2.4.
[e] Fipronil reported use data are not included in this table for reasons explained in the text . Since all allowable uses are urban, total urban use was assumed to equal sales.
[f]No PHMB uses require reporting, so use cannot be estimated for years when sales data are not available (2001 and 2002).
Notes: Uncertainties are discussed in Section 2.4. Values reflect one significant figure.

While the total quantity of pyrethroids estimated used in California urban areas in 2004-2005 (about 700,000 pounds) is lower than the total quantity of diazinon and chlorpyrifos estimated used in 2000 (about 1.8 million 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 (see TDC Environmental 2003), which means that much lower concentrations—and therefore much lower use rates—can adversely affect surface water quality.

3.0 CONCLUSIONS

Conclusion 1: *Urban use of diazinon and chlorpyrifos decreased from 2000 to 2005.* 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, PHMB, and fipronil increased from 2000 to 2005. Pyrethroids, fipronil, and (to a lesser extent) malathion are replacing diazinon and chlorpyrifos in the urban pesticide use market.* Estimating how this shift affects water quality is not simple, as the primary aquatic toxicity endpoints are different and 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 California urban areas in 2004-2005 (two-year average of about 700,000 pounds) is lower than the total quantity of diazinon and chlorpyrifos estimated used in 2000 (about 1.8 million pounds), these applications have greater potential to be environmentally relevant, as pyrethroids are significantly more toxic to aquatic species than diazinon and chlorpyrifos.

Conclusion 3: *Urban use of pyrethroids that could be transported to surface water falls into several categories: professional structural pest control applications, other outdoor professional applications, and non-professional (primarily residential) applications.* Both professionals and non-professionals apply pyrethroids outdoors. Professionals apply pyrethroids to control pests in and around structures and in landscaped areas (such as lawns and rights-of-way). Non-professionals (probably primarily residents) also apply pesticides around buildings and in landscaped areas. Although the majority of pyrethroid use statewide is for structural pest control, the specific fraction of these applications that involves underground injection (which is not a major concern for water quality) cannot be estimated with available information (the only possible estimate is an upper bound quantity). Of the various outdoor pyrethroid application categories, professional structural pest control applications likely comprise most of the quantity of pyrethroids applied to outdoor impervious surfaces.

Conclusion 4: *Two pyrethroids—cypermethrin and bifenthrin—account for almost 90% of the pyrethroid-related toxicity (expressed in permethrin equivalents) that is used in California*. These two pyrethroids are among those that have most often been linked (as significant contributors) to pyrethroid-related toxicity to sediment dwelling organisms in Northern California urban creeks.

Conclusion 5: *A significant fraction of the pyrethroids reported applied by professionals for structural pest control may be injected underground, where they cannot be transported readily to surface water.* As much as 85% of the study-list pyrethroids applied by professionals in the San Francisco Bay Area for structural pest control could have been applied underground. The actual fraction of underground applications is likely less than 85%, but greater than zero. Based on consumer surveys, it is unlikely that a meaningful fraction of unreported (non-professional) pyrethroid use involves underground applications.

Conclusion 6: *Indoor applications are unlikely to comprise a significant fraction of professional structural pest control use of study-list pyrethroids, but may comprise a meaningful fraction of pyrethroid use by non-professionals*. Omitting consideration of indoor use of study-list pyrethroids by professional structural pest control applicators should not significantly affect interpretation of pesticide use data.

<u>Conclusion 7</u>: *In 2005, at least half of all California pesticide use was in urban areas.* Although only about 8% of reported pesticide use is urban, about 68% of all pesticide use is not reported. Essentially all pesticide uses that do not require reporting are urban in nature. The sum of urban reported pesticide use and estimated unreported pesticide use was about 70% of pesticide sales in California in 2005.

<u>Conclusion 8</u>: *Malathion, fipronil, PHMB, and most pyrethroids are used primarily in urban areas*. Of the study-list pesticides, only diazinon, chlorpyrifos, and the pyrethroids lambda-cyhalothrin and esfenvalerate are used more in agricultural areas than in urban areas. About 75% of the use of study-list pyrethroids occurred in California urban areas in 2004-2005.

<u>Conclusion 9</u>. *Urban pyrethroids applications occur at all times of the year*. In 2005, landscaping applications by professionals peaked in the summer. Professional structural pest control applications did not vary significantly by season.

4.0 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 scientific findings updates (TDC Environmental 2007a and 2007b). 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.

This list of recommendations draws from collaboration among organizations working on urban pesticide toxicity reduction. The growing number of recommendations and the increasing specificity of those recommendations reflects improved communication among organizations (particularly between DPR and water quality agencies) and improved mutual understanding of challenges and potential means for overcoming those challenges.

Recommendation 1: *Target outdoor, above ground use of pyrethroids in pesticide toxicity reduction programs.* Any outdoor use of pyrethroids that is subject to storm water (or other water) runoff could contribute to the pyrethroid-related toxicity that has been identified in Northern California urban creeks.

Recommendation 2: *Seek to change the way Argentine ants are kept out of buildings in California.* Argentine 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 Argentine ants has historically been among the most problematic pesticide uses for water quality. Shifting Argentine 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 an important element in ending recurring surface water quality problems from urban insecticide use. Consideration should also be given to identifying building methods, materials, and landscaping practices that can reduce Argentine ant problems inside buildings.

Recommendation 3: *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.

Recommendation 4: *Recognize that widespread use of any pesticide active ingredient in an urban watershed has the potential to 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. Cumulative impacts are a possible consequence when a large number of pesticide applications occurs in a watershed. Developing and implementing pest control and pesticide application methods that provide effective pest control while minimizing pesticide runoff (e.g., mechanical controls, containerized baits, restriction of urban outdoor pesticide applications to spot treatments) would reduce the potential for pest control to create water quality problems.

<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).

<u>Outreach and Education</u>

The highest priorities for outreach and education are Recommendations 1 through 5 above. The additional recommendations below focus on potential hazards of specific insecticides to aquatic life. An excellent set of recommendations addressing all priorities for outreach and education to urban pesticide users (particularly non-residential users) to reduce water quality impacts has been prepared by the University of California in the report *Tracking Non-Residential Pesticide Use in Urban Areas of California* (Wilen et al. 2005).[15]

<u>Recommendation 6</u>: *Continue to discourage use of outdoor broadcast pesticide applications in general, and uncontainerized uses of pyrethroids, carbaryl, fipronil, and malathion as replacements for urban uses of diazinon and chlorpyrifos.* Instead, encourage IPM-based insect control methods that minimize pesticide releases to surface waters (e.g., use of containerized baits and barriers like caulking). Because containerized baits are unlikely to release significant quantities of pesticide active ingredients into runoff, it is not necessary to avoid fipronil in containerized baits (however, above ground outdoor application of uncontainerized fipronil products should be avoided).

<u>Recommendation 7</u>: *Continue to exercise discretion with recommendation of alternative pesticides for urban outdoor applications, particularly imidacloprid and pyrethrins.* Instead, as explained in Recommendation 6, encourage IPM-based insect control methods that minimize pesticide releases to surface waters. When uncontained pesticides are needed to manage a pest problem, spot treatments pose the least risk for water quality, because with spot treatments the total quantity of active ingredient that is released to the environment is relatively small.

<u>Monitoring and Research</u>

<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 suggested near-term priority that is not currently being addressed is development of chemical analysis methods with environmentally meaningful detection limits for PHMB. Methods for measuring environmentally relevant concentrations of individual pyrethroid isomers are also needed, at least for research purposes to determine if isomer difference are environmentally significant. In general, creating methods that are feasible for commercial laboratories is particularly important, since contractors (rather than state agency or university laboratories) perform the chemical analysis of most surface water quality samples collected in California.

<u>Recommendation 9</u>: *Ask laboratories to clarify whether data reported for deltamethrin and tralomethrin represent these individual pyrethroids or the sum of both chemicals.* Although typical chemical analysis methods capable of measuring environmentally relevant concentrations of pyrethroids cannot distinguish tralomethrin from deltamethrin, laboratory reports often list only one of these two pyrethroids.

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[15] Available on the Internet: http://www.up3project.org/documents/dpr_ucipm_non-residential_pesticide_use.pdf or http://www.ipm.ucdavis.edu/PDF/PUBS/ucdavisrep.pdf.

<u>Recommendation 10</u>: *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., currently used pyrethroids[16], carbaryl, malathion, PHMB, and fipronil and its degradates).* A long-term surveillance monitoring program is needed. Specific monitoring recommendations are as follows:[17]

- <u>Toxicity monitoring</u> should be conducted with standard aquatic toxicity test species and should (in the near term) include the standard test species most sensitive to pyrethroids (water column—*Oncorhynchus mykiss* and *Ceriodaphnia dubia*; sediment—*Hyalella azteca)*. Because aquatic toxicity is a key indicator and monitoring tool in surface waters that can quickly identify the presence of contaminant stressors, it is a recommended element of any surveillance monitoring program. Consideration should be given to completing some tests at actual creek temperature, if that temperature is significantly lower than the laboratory aquatic toxicity test temperature, since the toxicity of some pesticides (e.g., pyrethroids) increases as temperature decreases.
- <u>Pyrethroids monitoring</u> in urban areas should include bifenthrin, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, permethrin, and tralomethrin. (Agricultural monitoring should include additional pyrethroids.) When analysis includes deltamethrin and/or tralomethrin, it is important to clarify with the laboratory whether the method used can distinguish between these two compounds (distinguishing is not necessary as long as the results are properly reported).
- <u>Monitoring of pyrethroids in sediments is a higher priority than monitoring for them in the water column</u>. Because pyrethroid toxicity is inversely correlated with organic carbon concentration, when monitoring for pyrethroids in sediments, organic carbon concentrations should also be measured.
- <u>Recommended detection limits</u>[18] are as follows:
  - Each individual pyrethroid in water—as close to 1 nanogram/liter as available
  - Each individual pyrethroid in sediment—1 nanogram/gram (dry weight) (0.1 nanogram/gram is preferred, but is not readily available)
  - Carbaryl in water—0.5 micrograms/liter
  - Malathion in water—0.1 micrograms/liter
  - PHMB in water—10 micrograms/liter
  - Fipronil and degradates in water—0.002 micrograms/liter
  - Fipronil and degradates in sediment—30 nanogram/gram (dry weight)

The Clean Estuary Partnership designed a monitoring program that—if implemented—would fulfill these recommendations for the San Francisco Bay Area (Ruby 2006).

[16] The pyrethroids of greatest interest for urban surface water quality are bifenthrin, cyfluthrin (including beta-cyfluthrin), cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, permethrin, and tralomethrin. Additional pyrethroids are of interest in agricultural areas.

[17] Toxicity test species and detection limit recommendations are based on aquatic toxicity data and (where available) water quality criteria (see section 4, TDC Environmental 2003 and Oros and Werner 2005) and best professional judgment. The pyrethroids selection is based on this report's evaluation of urban pesticide use (see Section 1.2).

[18] Recommendations are based on available aquatic toxicity data.

Monitoring programs should be adjusted every few years to reflect pesticide market changes.

Recommendation 11: *Procedures for sample collection and storage for samples being analyzed for pyrethroids should be checked to ensure they reflect the latest scientific information available at the time the sampling is conducted.* Sampling procedures for pyrethroids are slightly different than procedures for other pesticides and other pollutants commonly monitored in urban runoff and municipal wastewater. Different procedures are needed to minimize loses of pyrethroids. Research in progress is the basis for the following recommendations.

For water samples:

- Glass containers are preferred.
- Samples should be collected directly into the sample container that will be taken to the laboratory. Transfers and use of tubing should be avoided.
- Samples collected should be analyzed quickly—preferably within 24 hours of collection and definitely no later than 3 days after collection, unless appropriate steps are taken to extract or preserve the sample.

For sediment samples:

- Sample collection procedures used by U.C. Berkeley are recommended (see Amweg et al. 2006). (Note that these procedures avoid use of Teflon—stainless steel is preferred.)
- Appropriate sediments to collect are from deposition areas that include fine organic material. Gravel should be avoided. Sediment grain size should be measured and reported.
- Ensure that the laboratory is aware that excess sulfur needs to be removed to avoid interferences with analysis of pyrethroids concentrations.

Recommendation 12: *Submit all pesticide-related water quality monitoring data to U.S. EPA and to DPR. Consideration should also be given to submitting data to the appropriate local node of the California Environmental Data Exchange Network (CEDEN).* All entities that conduct surface water monitoring in California should submit reports containing pesticide-related data to both the California Department of Pesticide Regulations and U.S. EPA. Submitting data will help pesticide regulators respond to—and prevent—water quality problems from pesticides, which will help all agencies comply with the Clean Water Act.

Both U.S. EPA and DPR have specific recommendations for the information that should be collected by monitoring programs and included in monitoring data reports. These recommendations are straightforward—most monitoring programs are probably incorporating these recommendations already. Nevertheless, the UP3 Project recommends that monitoring programs consult the two sets of recommendations below when designing surface water monitoring plans:

- DPR: http://www.cdpr.ca.gov/docs/sw/caps/req.htm
- U.S. EPA: See pages 3-4 of "OPP Standard Operating Procedure," which is available on the Internet, see: http://www.epa.gov/oppsrrd1/registration_review/water_quality_sop.htm

Submitting data:

- DPR: Send to Keith Starner, DPR, P.O. Box 4015, Sacramento, CA 95812 (916-324-4167 kstarner@cdpr.ca.gov). The UP3 Project recommends a quick call to Keith before submitting data to discuss submittal formats any format is acceptable, but some formats are more convenient). For more information see: http://www.cdpr.ca.gov/docs/sw/surfdata.htm
- U.S. EPA: Please contact Patti TenBrook at U.S. EPA Region 9 (415-947-4223, TenBrook.Patti@epamail.epa.gov) for assistance with identifying where to send the data you have collected.

<u>Recommendation 13</u>: *Report all pesticide-related toxicity incidents to U.S. EPA and DPR.* Any incident—whether related to aquatic toxicity or human health—should be reported. Because incident 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.

<u>Recommendation 14</u>: *Encourage publication of pesticide monitoring data in professional journals.* Data that have been published in professional journals are more broadly accessible and have more credibility for use by regulatory agencies (particularly pesticide regulatory agencies). Since one year's worth of a single program's data may be insufficient for complete interpretation, preparation of regional data reviews every few years is recommended (e.g., a multi-year version of the recent Clean Estuary Partnership Analysis of Bay Area Urban Creeks Monitoring, 2004-05) (Ruby 2005).

<u>Recommendation 15</u>: *Obtain information to fill aquatic toxicity data gaps for pyrethroids and for other commonly used pesticides.* The most critical data gaps for pyrethroids include:

- <u>Aquatic toxicity data</u>. Gaps include *Hyalella azteca* LC50 data for tralomethrin, LC50 data for estuarine organisms (all pyrethroids), LC50 data for individual pyrethroid isomers, and sublethal toxicity data (EC50s) for both fresh water and estuarine organisms (all pyrethroids).
- <u>Aquatic sediment half life values</u> for all pyrethroids except bifenthrin and permethrin.

<u>For all pesticides, obtaining sufficient aquatic toxicity data to allow development of water quality criteria in accordance with U.S. EPA methods (U.S. EPA 1985) is desirable.</u>

<u>Recommendation 16</u>: *Characterize the influence of ambient surface water temperatures on pyrethroid toxicity.* Laboratory tests of field samples are conducted at standard laboratory temperatures, which are warmer than typical surface waters. Most pyrethroids are more toxic at lower temperatures. The lower temperatures in surface water may result in greater toxicity than would be predicted based on laboratory tests.

<u>Recommendation 17</u>: *Support efforts to complete development and standardization of Toxicity identification evaluation (TIE) methods for pyrethroids.* Based on the success of current method development work, funding development of Phase II (toxicant removal and identification) procedures would be appropriate.

<u>Recommendation 18</u>: *When incidents of toxicity in municipal wastewater treatment plant effluent, urban runoff, or surface waters occur, evaluate the potential for pyrethroids and other pesticides (e.g., PHMB, fipronil) to be the source of the toxicity*.

Recommendation 19: *Avoid over-interpretation of non-detect chemical analytical results for pyrethroids.* Because commonly used methods (e.g., U.S. EPA Method 1660) cannot detect environmentally relevant concentrations of pyrethroids, non-detect results from chemical analyses by these methods do not mean that pyrethroids are not present at concentrations sufficient to cause aquatic toxicity.

Recommendation 20: *Provide a regular (annual or semi-annual) forum for scientists involved in surface water quality monitoring for pesticides and toxicity to exchange information relevant to method development and monitoring plan design.* With State Water Board grant funding that is now exhausted, SFEI hosted two productive ad hoc meetings of chemists, aquatic toxicologists, and government agency staff to exchange information about recent research findings, challenges, and priorities for monitoring for pyrethroids in California's surface waters. These focused meetings facilitated information transfer among scientists and identified priorities for future research (priorities were based both on scientific challenges of such monitoring and regulatory agencies' key scientific questions for their pesticide risk assessment and risk management functions). Similar meetings, preferably expanded to include other pesticides of concern, would facilitate communication and help both California and Federal agencies ensure that their research and monitoring funds are spent efficiently and effectively.

Recommendation 21: *Obtain additional information about the linkage between pyrethroid use and presence in surface waters in urban areas.* Such information will allow toxicity reduction programs to more effectively target the causes of toxicity in surface water sediments. Both monitoring and modeling will likely be needed to determine whether any one specific pyrethroid use pattern (e.g., around buildings or on lawns) is the most significant contributor to pyrethroid levels in creek sediments.

Recommendation 22: *Explore inconsistencies in DPR sales and reported use data for cypermethrin and other study-list pyrethroids*. For several study-list pyrethroids, sales quantities reported to DPR are less than reported use quantities. These discrepancies prevent more detailed analysis of urban use patterns. Of particular interest is cypermethrin, for which reported use has exceeded sales since 1999, because of its large estimated urban use, high toxicity to aquatic organisms, and documented contribution to toxicity to sediment-dwelling organisms in urban creeks. Increased enforcement of DPR fees on pesticide sales should improve the quality of sales data for 2006 and future years, which will assist with the exploration of the data inconsistencies (if these inconsistencies remain).

Recommendation 23: *Encourage and support development of methods to evaluate the potential for pesticides to contribute to adverse effects on ecosystems from exposure to combinations of stressors*. 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. Development of methods to evaluate these cumulative adverse effects is critical to addressing them in pesticide regulatory processes.

Recommendation 24: *Complete evaluations of methods to keep Argentine ants out of buildings.* Implementation of Recommendation 2 would be facilitated by an evaluation of Argentine 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 would be well positioned to complete such an evaluation.

Recommendation 25: Explore the way that the current market and regulatory framework for urban pest control relates to surface water quality protection. Institutional, legal, and market frameworks can inadvertently create incentives or disincentives for actions that can benefit or threaten water quality. An evaluation could identify potential opportunities to modify existing frameworks related to urban pesticide use to help ensure that systems provide incentives for managing urban use of pesticides in manners that are consistent with water quality protection.

Recommendation 26: Develop benchmarks to facilitate evaluation of pesticide monitoring data. Because water quality criteria do not exist for most currently used pesticides, agencies find interpretation of pesticide monitoring data challenging. Development of water quality criteria—or scientifically robust benchmarks if criteria development is not possible—would help agencies with appropriate interpretation of monitoring data and with selection of priorities for follow-up action based on monitoring results. Gaps in available aquatic toxicity data (see Recommendation 15) can make development of scientifically robust benchmarks difficult.

Regulatory

Recommendation 27: *Continue to provide U.S. EPA and DPR with information to prevent potential water quality problems associated with urban pesticide use and to press for consistency in implementation of water quality and pesticide regulatory programs within U.S. EPA and California EPA.* U.S. EPA and DPR staff have recommended that water quality agencies continue to communicate information and recommendations to U.S. EPA and DPR and expand efforts to meet in person and via teleconference directly with agency management. Regular communication is important to ensure that U.S. EPA OPP staff (including chemical review managers) and DPR more fully appreciate water quality issues. Regular communication appears to be the most likely way to encourage U.S. EPA management to continue to make progress toward addressing the costly regulatory gaps created by uncoordinated implementation of Federal water quality and pesticide laws. At the state level, regular communication can facilitate sharing of scientific information that has the potential to improve the effectiveness of both pesticide and water quality agency regulatory processes.

Recommendation 28: *Continue to strengthen the network of water quality agencies working on urban pesticides issues*. Priorities include involving national organizations and state and local agencies elsewhere in the United States (see Recommendation 27). There is particularly a need to determine whether coordination with urban runoff and water quality regulatory agencies elsewhere in the United States is possible.

Recommendation 29: Increase efforts to raise urban pesticide surface water quality issues at the national level. It is unlikely that California's experience with pesticide-related surface water quality problems in urban areas is unique.[19] Water quality agency staff should increase efforts to participate in public forums (such as national advisory committees and national conferences) to enhance nationwide understanding of managing urban pesticides to prevent surface water quality problems. Participation in different types of events will be important, as pesticide regulators and industry representatives participate in different conferences than water quality regulators. Becoming involved in U.S. EPA's Pesticide Program Dialog Committee (PPDC) is a priority, because U.S. EPA seeks advice on pesticide regulatory, policy and program implementation issues from this committee. (The PPDC does not currently include any

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[19] Data from the USGS National Water Quality Assessment suggest that California is not unique (USGS 2006).

water quality agency representatives or any local government representatives.)[20] While budgets may limit travel, opportunities may exist for scholarships, U.S. EPA-funded travel, attending meetings in California, or participation by teleconference.

Recommendation 30: *Continue efforts to determine possible approaches and next steps toward developing practical methods for U.S. EPA and DPR to address the environmental effects of all ingredients in individual pesticide products when those products are registered or re-registered*. Continuing to facilitate the process of finding ways to fill methodology gaps needs to be a priority for California water quality agencies. Conceptual models of pesticide fate and transport in urban environments may be useful tools to facilitate dialogue between water quality and pesticide regulators.

Although the focus has been on U.S. EPA development of methods, better opportunities may be available at the state level. While working with the San Francisco Bay Water Board on the Bay Area Urban Creeks diazinon and pesticide-related toxicity TMDL, in 2005, DPR began to modify its regulatory process to prevent future pesticide-related violations of water quality standards. Such restructuring has the potential to achieve the goal of preventing future pesticide-related urban surface water quality problems.

Recommendation 31: *Improve the pesticide registration public involvement process*. At both the state and Federal levels, pesticide registration and re-registration are governed by formalized processes that do not always facilitate sharing of information relevant to identification of and mitigation of urban surface water quality problems. Cooperation among agencies could be improved if pesticide regulatory agencies were able to provide more transparent and straightforward public involvement processes within the constraints of laws and regulations that control their programs.

The most significant opportunities for improvement exist at the state level. DPR's pesticide registration process currently provides public input opportunities, but these opportunities are structured in a way that makes providing meaningful input very difficult. DPR's public notices provide little information about products entering DPR's registration process and do not explain how to provide scientific information or other comments to assist it during the registration process.[21] When a pesticide product is proposed for registration, DPR's normal procedure does not involve making its assessment of the product's potential water quality impacts readily available (in contrast to U.S. EPA, which posts its assessments on the Internet). It is possible to obtain documents associated with DPR's registration water quality review (those that do not contain confidential business information) upon written request. The time required for the written request makes it difficult for an agency to make such requests regularly and makes it difficult for agencies to obtain the documents and provide meaningful comments on proposed registrations within DPR's standard 30-day comment period.

Making changes could be challenging, because DPR's public involvement process is constrained by current laws and regulations. For example, DPR must protect confidential business information, must carefully document its decisions, and is required to process registration applications in a timely manner. These requirements constrain opportunities for process improvement.

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[20] State Water Board member Art Baggett serves on a spray drift work group under the PPDC's umbrella (but is not a member of the PPDC).

[21] DPR registers every individual pesticide product separately. U.S. EPA focuses on registering pesticide active ingredients. U.S. EPA registers individual products after active ingredient registration, primarily by reviewing and approving their labels. When a pesticide enters DPR's registration process, the public notice usually provides relatively limited information: the product name, manufacturer name, a simplified one-sentence description of the general type of use proposed for the product, the name of the registration action being considered, and the pesticide active ingredient.

Recommendation 32*: Restore and enhance DPR staffing and funding for programs that prevent or solve pesticide-related urban surface water quality problems*. DPR's ongoing resource limitations could restrict its ability to complete actions necessary to protect water quality. For example, DPR currently must redirect staff from other activities to support its scientific involvement in pesticide re-evaluations, because it has no dedicated funding for the labor-intensive activities it needs to conduct to support a re-evaluation. DPR does not currently have staff that routinely conduct environmental risk assessments or urban watershed modeling. These functions are necessary for predicting water quality problems from pesticides.

In 2007, DPR is planning to revive its pest management alliance grant program (pending approval of the California state budget). This grant programs was previously DPR's primary method of developing and promoting less toxic pest control methods.

DPR has convened an Urban Pest Management workgroup to provide it with recommendations; it has also been exploring on its own initiative how it might modify its programs to more effectively address urban pesticide issues, including water quality. At this point, it is unknown whether DPR would need additional funds to implement changes that could ensure protection of water quality.

Recommendation 33: *Actively seek to strengthen communication between California water quality agencies and California and U.S. EPA pesticide regulators*. Enhanced communication will increase pesticide regulator appreciation for and consideration of the scientific and regulatory issues around pesticides and water quality. Water quality agencies can facilitate communication by initiating requests for dialogue and becoming familiar with pesticide regulatory processes and terminology.

The UP3 Project recommends that the following communications strategies be considered, because it appears that these activities would enhance cooperative efforts to address water quality problems from urban pesticide use.

- Establish working groups to provide focused scientific dialogue on pyrethroids in California. Regular interagency meetings on marine antifouling coatings convened by DPR have afforded valuable opportunity for water quality and pesticide regulatory agencies to share scientific information and to improve stakeholder understanding of the regulatory context for managing water quality problems associated with marine antifouling coatings. These meetings have demonstrated the value of communication and collaboration for both pesticide and water quality agencies—both in enhancing the value and quality of the scientific information they are collecting and in designing their work to address regulatory needs. Similar regular opportunities for productive engagement of pesticide regulatory agencies, water quality agencies, and other interested parties (e.g., pesticide registrants, environmental community members) could enhance the effectiveness of agency and industry responses to water quality problems from pyrethroids. A working group is currently being initiated to address scientific questions about pyrethroids in municipal wastewater. A second group focused specifically on addressing scientific questions about pyrethroids in urban runoff is recommended.
- Increase engagement of DPR's Pesticide Registration and Evaluation Committee (PREC) in the effort to prevent water quality problems from pesticides. The PREC is an interagency advisory committee that includes

representatives from both the State Water Board and U.S. EPA.[22] Its mission is to foster communication about cross-agency pesticides issues and to provide advice and guidance to DPR on regulatory initiatives, scientific information, and public policy options. DPR expects the PREC to develop practical approaches to addressing pesticide issues. One of the PREC's major roles is provide interagency consultation to DPR on pesticide registration.

- Identify mechanisms for regular communication with U.S. EPA OPP. Communication between California water quality agencies and U.S. EPA has primarily been in writing. In some cases, U.S. EPA responses to comments have appeared off-topic or inappropriate from the water quality agency perspective; this may be the result of difficulties interpreting written comments., Physical distance and programmatic differences are barriers to improving communication quality. Forms of engagement other than letters will be helpful in working with U.S. EPA to address systemic issues like how U.S. EPA can assess urban surface water risks in pesticide environmental risk assessments.

  Structuring interactions around individual regulatory decisions is somewhat limiting, as this is not the context where U.S. EPA normally considers procedure changes. U.S. EPA obtains advice for the design and operation of its pesticide regulatory programs from committees that do not currently include urban water quality agency representatives or urban surface water quality scientific experts. California agencies should evaluate potential options for participation in one of the groups that currently advise U.S. EPA OPP and/or collaboration with national organizations (e.g., NACWA) to create a new forum for engaging OPP on urban surface water quality issues.

Recommendation 34: When implementing pesticide regulatory controls, consider the environmental properties and relative toxicity 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. Both U.S. EPA and DPR have evaluated selected pesticides based on usage category (e.g., fumigants, rodenticides, marine antifouling coatings) to ensure consideration of potential environmental effects of replacement pesticides. Past experience suggests that leaving these changes solely to the free market may not ensure protection of human health and the environment.

Recommendation 35: 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 36: 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

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[22] PREC membership currently includes a representative of county agricultural commissioners, but does not include representatives of other types of local government agencies that are engaged in pesticides issues (e.g., wastewater treatment plants, urban runoff programs, IPM programs). The DPR Director has the authority to appoint a representative of any other public agency that she deems appropriate after consultation with the existing committee membership.

analysis identifies structural pest control applications a significant urban use of pyrethroids, which have been linked to adverse effects in aquatic ecosystems.

Recommendation 37: Ask Agricultural Commissioners to work with professional applicators to minimize reporting errors. For some pesticides, simple administrative errors by a small number of professional applicators (e.g., reporting the quantity of diluted solution rather than the quantity of pesticide product used) have the potential create significant errors in statewide data sets. A voluntary education program could prevent such errors in the future. Initially targeting correct reporting of liquid formulations appears warranted based on errors identified in fipronil reporting.

Recommendation 38: Enforce requirements to report pesticide sales quantities accurately. Errors in data reported to DPR have, on occasion, created significant inaccuracies in DPR's pesticide sales data reports.

Recommendation 39: *Explore potential approaches to obtain pesticide sales and use data by region.* Currently, pesticide sales data are available only on a statewide basis. The data set cannot be broken down by county, city, or watershed. While agricultural pesticide use reports include application location, urban reports only specify the county of application. Water quality managers could more effectively design water quality protection programs if they had access to regional or local pesticide sales and use data; however, creating systems that would generate such data would involve new approaches, new participants, and the time and energy of many organizations.

Funding

Recommendation 40:. California and Federal environmental agencies need to obtain the staff and 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.

Recommendation 41: Identify a stable funding source for pesticide-related urban surface water quality surveillance monitoring.

Recommendation 42: *Develop a stable funding mechanism to continue scientific and regulatory support for California water quality agency participation in U.S. EPA and California DPR regulatory activities affecting water quality*. Funding is also needed for interagency coordination and communication functions, such as those provided by the Urban Pesticides Committee and the UP3 Project web site. While the UP3 Project has secured additional grant funds, funding gaps and shortfalls are possible. A long-term strategy is needed to provide stable, continuing funding for work on urban pesticides and water quality.

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