



CENTRAL VALLEY REGIONAL
WATER QUALITY CONTROL BOARD

Relative-Risk Evaluation
for Pesticides Used
in the
Central Valley Pesticide Basin Plan
Amendment Project Area

Public Review Draft Report

April 2008



CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY



State of California
Arnold Schwarzenegger, Governor

California Environmental Protection Agency
Linda S. Adams, Secretary for Environmental Protection

**REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION**

Karl E. Longley, Chair
Kate Hart, Vice- Chair
Paul Betancourt, Member
Cheryl Maki, Member
Sandra Meraz, Member
Sopac Mulholland, Member
Dan Odenweller, Member

—————
Pamela C. Creedon, Executive Officer

—————
11020 Sun Center Drive #200
Rancho Cordova, CA 95670

—————
Phone: (916) 464-3291
email: info5@waterboards.ca.gov
Web site: <http://www.waterboards.ca.gov/centralvalley/>

DISCLAIMER

*This publication is a technical report by staff of the
California Regional Water Quality Control Board, Central Valley Region.
No policy or regulation is either expressed or intended.*

Relative-Risk Evaluation
for Pesticides Used
in the
Central Valley Pesticides Basin Plan
Amendment Project Area

Public Review Draft Report

April 2008

REPORT PREPARED BY:

Zhimin Lu, Ph.D. Water Resource Control Engineer
Gene Davis, Engineering Geologist

**REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION**

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

ACKNOWLEDGEMENTS:

The authors would like to thank Joe Karkoski for his early guidance in scoping this report.

The authors would like to thank Ms. Kelly Moran (TDC Environmental LLC) and Mr. Keith Starner (California Department of Pesticide Regulation) for expert review of an earlier version of this document and for their constructive comments.

The authors would also like to thank Ms. Theresa Schultz (Schultz Consulting) for her masterly review and valuable comments.

TABLE OF CONTENTS

Executive Summary	i
1.0 INTRODUCTION	1
1.1 Project Area	1
1.2 Background	2
2.0 DATA SOURCES	3
2.1 Pesticide Use Report Database	3
2.2 Pesticide Chemical and Physical Properties Databases	3
2.2.1 ARS Database	4
2.2.2 EXTOXNET Database	4
2.2.3 PAN Database	4
2.2.4 Unpublished DPR Database	4
2.3 Pesticide Toxicity Database	4
2.4 Pesticide Concentration Database	4
3.0 METHODOLOGY	5
3.1 Initial Pesticide List Creation	5
3.2 Target Pesticide List Creation	6
3.3 Target Pesticide List Prioritization	7
3.3.1 Water Solubility Values	7
3.3.2 Pesticide Use Amount Trends	8
3.3.3 Pesticide Concentration Data	8
3.3.4 Synthesis of Prioritization Parameters	8
3.4 Sediment Risk Evaluation	9
4.0 RESULTS AND LIMITATIONS	10
5.0 REFERENCES	12

LIST OF FIGURES

Figure 1. Lower Sacramento River Watershed (SacR)	15
Figure 2. Lower San Joaquin River Watershed (SJR)	16
Figure 3. Lower Delta Watershed (Delta)	17
Figure 4. Flow Chart of the Relative-Risk Evaluation Process	18
Figure 5. Flow Chart Showing Designation of High Toxicity Value Pesticides to Overall Relative-Risk Levels	18
Figure 6. Flow Chart of Overall Relative-Risk Evaluation Process for Pesticides with High or Moderate Toxicity	19

LIST OF TABLES

Table 1. Criteria for Relative-Risk Ranking, by Parameter	20
Table 2A. High Overall Relative-Risk Level Pesticides	21
Table 2B. Moderate Overall Relative-Risk Level Pesticides	22
Table 3. Toxicity Values for Selected Herbicides	22

APPENDICES

Appendix A. High Overall Relative-Risk Level Pesticides	A2
Appendix B. Moderate Overall Relative-Risk Level Pesticides	A57

Executive Summary

This Relative-Risk Evaluation report describes a process for identifying a target list of pesticides that pose the highest overall relative risk to aquatic life beneficial uses in surface water within the Central Valley Pesticide Basin Plan Amendment Project Area. The Project Area includes the Sacramento River, San Joaquin River, and Delta watersheds below the major reservoirs in California's Central Valley.

The target list contains 38 pesticides that are highly toxic to aquatic organisms and have had high total annual reported use amounts. The 38 target pesticides were prioritized into either a high (29 pesticides) or a moderate (9 pesticides) overall relative-risk level. All 38 target pesticides were also ranked according to their relative risk to impact sediment quality.

The target pesticides list will be used in the development of the Central Valley Pesticide Basin Plan Amendment and may find other uses in developing future Basin Plan amendments, and monitoring and compliance programs within the Central Valley Region.

1.0 INTRODUCTION

This Relative-Risk Evaluation report is one component of the Central Valley Pesticide Basin Plan Amendment (CVPBPA) Project¹ (Project). The report is organized into the following sections: Data Sources (Section 2.0), Methodology (Section 3.0), and Results and Limitations (Section 4.0).

This report describes the process steps, and presents the results, of a screening-level evaluation methodology for identifying and prioritizing a target list of current-use pesticides that pose the greatest overall relative risk to aquatic life in surface water in the Project Area (described below). This report does not describe a rigorous and comprehensive risk assessment for pesticides used in the Project Area.

Rather, this report is a higher-level relative risk evaluation designed to help the Regional Water Board determine priorities for further pesticide evaluation and development of water quality objectives.

For the sake of brevity in this report, “surface water quality” is used to mean surface water and benthic sediment quality and, particularly, beneficial uses associated with aquatic and benthic organisms.

Mention of trade names, commercial products, or specific chemicals in this report does not constitute endorsement or recommendation for or against use.

1.1 Project Area

The CVPBPA Project Area is composed of three subareas: the Lower Sacramento River Watershed (Sacramento Subarea, SacR), the Lower San Joaquin River Watershed (San Joaquin Subarea, SJR), and the Lower Delta Watershed (Delta Subarea, Delta). Together, the three subareas encompass 19,473 square miles, or 32% of the entire Central Valley Region (60,000 square miles).

The Sacramento Subarea includes the watersheds downstream of major reservoirs in the Sacramento River and Feather River basin within the Central Valley Region boundary (Figure 1). The water from this area flows to the Sacramento-San Joaquin Delta (“legal Delta”, as defined in California Water Code, Section 12220). The total size of this subarea is 9,170 square miles (5,869,138 acres).

The San Joaquin Subarea includes the watersheds downstream of major reservoirs in the San Joaquin River basin within the Central Valley Region boundary (Figure 2). The water from this area flows to the legal Delta. The total size of this subarea is 5,054 square miles (3,234,447 acres).

¹ See

http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_pesticide_s/index.html for more information on the Central Valley Pesticide Basin Plan Amendment Project.

The Delta Subarea includes the legal Delta and its direct tributaries downstream of major reservoirs (excluding the Sacramento and San Joaquin Subareas; Figure 3). The total size of this subarea is 5,248 square miles (3,359,003 acres).

1.2 Background

Several hundred pesticides have reportedly been applied in the Project Area (DPR, 2005). Most of these have not been evaluated for their risk to (potential to impact) surface water quality in the Project Area. Several pesticides have been identified as causing water quality impairment in the Project Area and are included in the current Clean Water Act Section 303(d) list (SWRCB, 2006).

This Relative Risk Evaluation report will provide information that will allow staff to identify, prioritize, and focus resources for the CVPBPA on the 5 to 10 pesticides that pose the greatest risk to the freshwater aquatic life uses, which are generally the uses that are most sensitive to pesticides in surface water in the Central Valley (Hann *et al.* 2007; McClure *et al.* 2006).

In developing the methods used in preparing this report for evaluating the relative risks of pesticides, the results of two previous efforts that addressed the same goal were reviewed. These projects, from the 1980's, were conducted by the State Water Resource Control Board (SWRCB) and the California Regional Water Quality Control Board, Central Valley Region (Regional Water Board) to assess the risks of two rice herbicides (molinate and thiobencarb) to the Sacramento River water system (SWRCB, 1984; SWRCB, 1990). The reports associated with the two projects presented reviews of existing monitoring data, evaluations of toxicity data for aquatic species, determinations of water quality criteria for the rice pesticides, and recommendations of control measures for reducing pesticide discharges from rice fields.

In addition, information presented in several annual reports prepared by the Urban Pesticide Pollution Prevention (UP3) Project for the San Francisco Estuary Project was reviewed (http://www.up3project.org/up3_documents.shtml#doc_sales). These reports evaluated state-wide urban pesticide use trends and water quality in urban areas. The state-wide urban pesticide use trend evaluations are based on state-wide sales and retail shelf surveys.

Monitoring data for surface water and sediment samples collected from rural and urban waterbodies throughout the Project Area that was reviewed for this report has shown the presence of detectable levels of approximately one hundred pesticides.

2.0 DATA SOURCES

The methodology described in this report evaluated pesticide use report data (Section 2.1), chemical and physical property data for pesticides (Section 2.2), aquatic life toxicity values (Section 2.3), and water column pesticide concentration data (Section 2.4). These data sources are described below.

2.1 Pesticide Use Report Database

The DPR maintains a pesticide use report (PUR) database which includes the records of reported individual applications (uses) of registered pesticides for agricultural and some non-agricultural purposes in California. At the time the technical work for this Relative-Risk Evaluation report was being prepared, the publicly available version of the PUR database contained data only from 1990 to 2004 (DPR, 2005).

Under the PUR program, all agricultural pesticide applications must be reported monthly to the county agricultural commissioner, who in turn, reports the data to DPR. Based on the legal definition of "agricultural use," the reporting requirements apply to pesticide applications "to parks, golf courses, cemeteries, rangeland, pastures, and along roadside and railroad rights-of-way. In addition, all postharvest pesticide treatments of agricultural commodities must be reported, along with all pesticide treatments in poultry and fish production, as well as some livestock applications. The primary exceptions to the full use reporting requirements are home and garden use and most industrial and institutional uses" (DPR, 2007). Therefore, the PUR does not adequately represent urban pesticide use. Urban pesticide use information is discussed further in Section 4.0.

For each of agricultural pesticide application record, the PUR database includes the application date (day, month, and year), the amount applied (typically in pounds), the area treated (typically in acres), the crop type, and the application location described to the square-mile section. Records associated with reported non-agricultural pesticide applications include only the month and year for the application date, and only the county for the location information. These differences in the PUR application data were used to evaluate the reported agricultural pesticide applications separately from the reported non-agricultural pesticide applications (Section 3.1).

2.2 Pesticide Chemical and Physical Properties Databases

Four databases were consulted for chemical and physical property data, including:

- (1) Agricultural Research Service (ARS database; ARS, 2004),
- (2) Extension Toxicology Network (EXTOXNET database; EXTOXNET, 2003),
- (3) Pesticides Action Network (PAN pesticides database; PAN, 2005), and
- (4) An unpublished DPR chemical/physical database (for DPR internal use).

The ARS database was the primary source of chemical and physical property data. The EXTOXNET, PAN, and unpublished DPR databases were used to identify physical and chemical properties when no data were available in the ARS database.

The chemical and physical properties values typically range widely because of different testing conditions associated with each data source.

2.2.1 ARS Database

The ARS database was selected as the main data source for the chemical and physical property values because it contains data for the parameters used in evaluating the relative risks of the “target” pesticides. The ARS database was developed for predicting the potential for pesticides to move into groundwater and surface water. The ARS database includes values of 16 chemical and physical properties for over 300 pesticides. The database includes original values and references and also provides suggested values for modeling purposes when multiple values are listed.

2.2.2 EXTOXNET Database

The EXTOXNET database includes environmental fate and toxicity data for more than 100 commonly used pesticides. The database includes brief summaries of the ecological effects on non-target animals and aquatic organisms, and very limited physical properties data for some pesticides.

2.2.3 PAN Database

The PAN database contains pesticide information from many sources, providing human toxicity (chronic and acute), ecotoxicity, and regulatory information for about 6,400 pesticide active ingredients and their transformation products, as well as adjuvants and solvents used in pesticide products.

2.2.4 Unpublished DPR Database

The DPR maintains a pesticide property database for internal staff use. It contains some data that are not available in the published databases. Therefore, data for some pesticides of interest were provided by the DPR for this project.

2.3 Pesticide Toxicity Database

The USEPA Ecotoxicity Database contains over 14,000 acute and chronic pesticide toxicity results for aquatic invertebrates, amphibians, fish, plants, insects, and birds (USEPA, 2003). The database has been reviewed by the USEPA Office of Pesticide Programs, Ecological Effects Branch biologists and deemed acceptable for ecological risk assessment use. Two types of acute toxicity values were used for relative-risk evaluation: the 96-hour LC₅₀ (lethal concentration that kills 50% of tested organisms in a 96-hour period) and the 96-hour or 120-hour EC₅₀ (effect concentration in 50% of organisms in a 96-hour or 120-hour period). The lowest aquatic life toxicity values for each pesticide were considered in this Relative-Risk Evaluation report in order to be protective of all aquatic organisms.

2.4 Pesticide Concentration Database

The DPR developed and maintains a database (the surface water database, SWDB) that contains pesticide concentration data for rivers, creeks, urban streams, agricultural drains, and urban stormwater runoff in California. The database has over

183,000 chemical analysis records from nearly 7,000 samples collected from 285 samples sites from 1992-2003. Samples were collected by federal, state, and local agencies, private industries, and environmental groups.

3.0 METHODOLOGY

The screening-level, relative-risk evaluation methodology used to create and prioritize a target list of pesticides that pose the greatest overall risk to surface water quality consists of three process steps, as described below.

- 1) An initial list of those pesticides (of the over 300 pesticides reportedly used in the Project Area) was created, based on the total annual reported amounts of pesticides used in the Project Area (Section 3.1).
- 2) The initial list was narrowed to a target list, based on aquatic life toxicity data and other parameter information (Section 3.2).
- 3) The pesticides in the target list were prioritized into two sublists – one each for moderate and high overall relative-risk levels - based on water solubility data, water concentration data, and pesticide use trends (Section 3.3).

Figures 4 through 6 are flow charts that illustrate the methodology process.

Since some pesticides have a tendency to adsorb to sediments and, therefore, could pose a higher risk to benthic aquatic organisms, pesticides in the target list were also evaluated and ranked by their relative risk to sediments (Section 3.4).

3.1 Initial Pesticide List Creation

The first process step consisted of sorting the total annual reported amounts of the hundreds of pesticides used in the Subareas and creating a short list of pesticides with relatively high total annual use amounts as reported by pounds or acres in the PUR Database.

Major differences in how the locations of pesticide applications are reported were used to initially evaluate agricultural use records separately from non-agricultural use records. Agricultural pesticide application records include information specifying the county, township, and section of each application. Non-agricultural pesticide application records specify only the county associated with each application. Further, non-agricultural pesticide application records specify only the month associated with each application.

Two “working” lists were created using the pesticide application data from the DPR PUR database for agricultural pesticide applications in each of the three subareas that comprise the Project Area. One “working” list consists of the 30 pesticides that were applied in the greatest amounts *by pounds of pesticide applied* between 1998 and 2004 (DPR, 2005). The other “working” lists consists of the 30 pesticides that were applied in the greatest amounts *by total areas (acres) to which the pesticides were applied* for each year for 1998 to 2004. The two “working” lists of agricultural

pesticides were combined into one list and replicate entries were removed. Only the “top 30” pesticides were identified in each “working” list in order to rapidly reduce the total number of all pesticides to a manageable number for further relative-risk evaluation. The “top 30” pesticides account for more than half of the total reported pesticide use (by weight) for agricultural applications in the Project Area.

Another “working” list was created using the pesticide application data from the DPR PUR database for non-agricultural pesticide applications in each of four counties (Butte, Sacramento, San Joaquin, and Stanislaus). These four counties were selected because they each contain representative urban areas. This “working” list consists of the 60 pesticides that were applied in the greatest amounts *by pounds of pesticide applied* between 1998 and 2004 (DPR, 2005). Only the “top 60” pesticides were identified in this “working” list in order to rapidly reduce the total number of all pesticides to a manageable number for further relative-risk evaluation. The “top 60” pesticides account for more than half of the total reported pesticide use (by weight) for non-agricultural applications in the Project Area.

The agricultural and non-agricultural pesticide application “working” lists were combined (and duplicate entries were removed) to create the initial list.

3.2 Target Pesticide List Creation

The second process step resulted in narrowing the initial list to a smaller target list of those pesticides that have high or very high relative-risk toxicity values and for which additional pesticide property parameter data is readily available for further prioritizing the target list pesticides (see Sections 3.3 and 3.4).

To create the target list, pesticides were removed from the initial list if they met any of the following conditions:

- 1) Their lowest associated aquatic life LC₅₀ or EC₅₀ values are greater than 99 micrograms per liter (µg/L; i.e., they have very low, low, or moderate toxicity values [Table 1]).
- 2) They are generally known to be used as adjuvants (chemicals that augment the effectiveness of pesticides) or inert ingredients.
- 3) Aquatic life LC₅₀ or EC₅₀ data are not readily available.
- 4) Chemical and physical properties data are not readily available.

Condition 1) is based on the assumption that the relative risks that pesticides pose to surface water quality are proportional to their toxicity. Toxicity values from the Ecotoxicity database are concentrations causing toxicity. Therefore, lower toxicity values indicate higher toxicity. In general, the lowest aquatic life toxicity values, obtained from the Ecotoxicity Database, were used for ranking the relative risks that pesticides pose to surface water quality due to toxicity. For insecticides and fungicides, the lowest 96-hour (acute) LC₅₀ values (typically reported for aquatic animal species) were used. For most herbicides, the lowest 5-day or 4-day EC₅₀ values (typically reported for aquatic plant species) were used. However, if the lowest LC₅₀ value for a given pesticide is less than its lowest EC₅₀ value, the LC₅₀

value was used for ranking purposes. LC₅₀ and EC₅₀ toxicity values for the target herbicides are provided in Table 3.

Pesticides with aquatic life toxicity values less than, or equal to, 99 µg/L were included in the target list because they have either high or very high toxicity values (see Table 1). Target pesticides ranked as having *very high toxicity* values were designated to the high overall relative-risk level (see Figure 5). These pesticides were further evaluated for their potential to impact sediments (see Section 3.4). Target pesticides ranked as having *high toxicity* values were designated to either the moderate or high overall relative-risk levels, based on further evaluation (Section 3.3).

Condition 2) is based on the assumption that adjuvants and inert ingredients are less toxic than the pesticides with which they are applied and, therefore, they pose a lower relative risk to surface water quality. In addition, evaluation of the toxicity of adjuvants after they have mixed with pesticides was beyond the scope of this report.

Conditions 3) and 4) precluded some pesticides from further evaluation because they lack appropriate pesticide properties data.

3.3 Target Pesticide List Prioritization

The third process step involved designating the high toxicity target pesticides to either the moderate or high overall relative-risk level based on a prioritization synthesis of three additional pesticide property parameters (see Figure 6):

1. Water solubility values
2. Annual and seasonal total reported use trends
3. Comparison of available water column sample concentration data to LC₅₀ or EC₅₀ values

Each of these parameters are discussed below (Section 3.3.1 – 3.3.3), followed by a discussion of the synthesis of these factors (Section 3.3.4).

3.3.1 Water Solubility Values

Water solubility values indicate how much pesticide can be dissolved in a specified amount of water (typical at environmentally relevant conditions). For the purposes of this report, it was assumed that the water solubility values are proportional to relative risks that pesticides pose to surface water quality (i.e., higher water solubility indicates higher risk). Water solubility values were ranked as very high, high, moderate, low, or very low based on the ranges of the logarithms of the water solubility values, as shown in Table 1.

The higher the water solubility of a given pesticide, the higher is its risk to dissolve into irrigation or precipitation water and to move from the application site into a surface waterbody.

3.3.2 Pesticide Use Amount Trends

Total annual and monthly reported pesticide use amounts (DPR, 2005) were calculated and compared over a seven-year period (1998 to 2004). Pesticide use trends are discussed for each target pesticide in Appendices A and B.

The total annual reported use amounts for each target pesticide were evaluated to identify strong and consistent increasing or decreasing total annual use amount trends over the seven-year period. Pesticides with decreasing total annual reported use amount trends were assigned a lower priority than pesticides with increasing total annual reported use trends.

The total monthly reported use amounts for each target pesticide were evaluated to identify the months (and associated seasons) with the highest use amounts for each pesticide. Studies have shown that high concentrations of organophosphate pesticides were found in surface waters (due to runoff from orchards) during winter storms (Kuivila and Foe, 1995; Holmes *et al.*, 2000; Nordmark *et al.*, 1998). Therefore, for the purposes of this report, it was assumed that pesticides with greater total monthly use amounts during winter (storm season) months pose a higher risk to surface water quality than pesticides with greater total monthly use amounts during other seasons.

3.3.3 Pesticide Concentration Data

For the purposes of this report, pesticide concentrations in water-column samples reported in the DPR SWDB were used (DPR, 2004). The SWDB database contains data from 1992 to 2003. Although the SWDB does not contain concentration data for all of the target pesticides, for those pesticides having concentration data, their maximum concentration values were compared to their lowest aquatic life toxicity values (reported in Appendices A and B).

Target pesticides with maximum concentration values that exceed their lowest aquatic life toxicity values are considered higher priority (i.e., they pose a higher risk) than target pesticides with maximum concentration values that are below their lowest aquatic life toxicity values.

3.3.4 Synthesis of Prioritization Parameters

Based on a qualitative synthesis of the relative-risk ranking and prioritization of the three parameters discussed in the previous three subsections, the high-toxicity target pesticides were designated to either the moderate or high overall relative-risk level (see Figure 6). Synthesis discussions for each of these target pesticides are presented in Appendices A and B.

Concentration data was not evaluated for designating the overall relative-risk levels of those target pesticides already identified with high aquatic life toxicity values. However, the moderate or high overall relative-risk levels were determined for those target pesticides with low or very low water solubility values based on their total

annual reported use amount trends and their predominant application season, (see Figure 6).

It should be noted that some pesticides (e.g., pyrethroids) have low water solubility values, yet may have high potential to indirectly impact aquatic organisms (particularly benthic organisms) via exposure to contaminated sediments.

Pesticides with high toxicity and high water solubility are ranked into the high overall relative-risk level. Pesticides (e.g., pyrethroids) with high toxicity values, but low water solubility values, might also pose an overall high relative-risk to aquatic organisms. For example, pyrethroid insecticides have very low water solubility values, but they may pose a high relative-risk due to their typically high toxicity values to impact benthic organisms exposed to contaminated sediments. For this reason, water solubility was not used to further evaluate pesticides already in the very high relative-risk toxicity rank (and, therefore, they were designated directly to the high overall relative-risk level).

The comparison of water column sample pesticide concentration data to the lowest toxicity values was used for designating target pesticides with high toxicity values and moderate, high, or very high water solubility values to overall relative-risk levels. For example, hexazinone, Malathion, and propanil were designated to the high overall relative-risk level because their water column concentrations are higher than their lowest toxicity values. Similarly, bromacil was designated to the moderate overall relative-risk level because its water column concentrations are less than its lowest toxicity value.

3.4 Sediment Risk Evaluation

For the purposes of this report, it was assumed that pesticides that are strongly absorbed by organic carbon pose a greater risk to benthic aquatic organisms than pesticides that preferentially remain dissolved in the water column, since sediments can accumulate organic carbon. Therefore, the target pesticides were further evaluated and ranked according to their relative potentials to impact sediment quality based on their relative tendencies to adsorb to organic carbon.

The unitless soil/sediment organic carbon water partitioning coefficient (Koc) value is a ratio of how much chemical (e.g., pesticide) adheres to the organic fraction of sediment relative to how much chemical remains dissolved in water, under equilibrium conditions. A pesticide with a high Koc value will tend to adsorb to sediment rather than remain dissolved in water. Koc values were ranked as very high, high, moderate, low, or very low based on the ranges of the Koc values, as shown in Table 1.

For the purposes of this report, the 19 target pesticides that have Koc values within either the high or the very high Koc value ranks were designated as “potential” risks to impact sediment quality. The 12 target pesticides that have Koc values within the moderate Koc value rank were designated as “possible” risks to impact sediment

quality. The 5 target pesticides with KOC values within either the low or the very low Koc value ranks were designated as “unlikely” risks to impact sediment quality.

4.0 RESULTS AND LIMITATIONS

The 29 high overall relative-risk level target pesticides and the 9 moderate overall relative-risk level target pesticides (38 target pesticides in all) are listed in Table 2A and Table 2B, respectively. These tables include the name, DPR “chem code”, CAS number, type, lowest aquatic life toxicity value and the associated relative-risk rank, the water solubility relative-risk rank, the Koc relative-risk rank, and the relative-risk rank to impact sediment quality for each of the target pesticides.

Pesticide use information, and toxicological, chemical, physical property, water quality data, and discussions of multi-parameter prioritization syntheses are summarized for each of the high or moderate overall relative-risk level target pesticides in Appendices A and B, respectively.

TDC Environmental reported that more than half of the total amount of pesticides sold in California is for urban applications that are not reported in the PUR database (TDC, 2007). Of the total amount of pesticides reported as used statewide (in the PUR database), only 8% were reported for urban uses. Thus, the PUR database significantly under-reports all pesticide use, and particularly urban pesticide use.

TDC Environmental (TDC, 2007) identifies “Study-List Pesticides” composed of “pesticides of concern for urban surface water quality” that are typically applied by non-professionals (i.e., unlicensed applicators). All but two of the “Study-List Pesticides” (tralomethrin and PHMB) were initially identified as target pesticides in this report. Although tralomethrin and PHMB were not included in the initial pesticide list (or in the subsequent target pesticide list) for this report because of their relatively low total annual reported use amounts, they were added to the target list of high risk pesticides at the recommendation of TDC Environmental (Kelly Moran, pers. comm. 2007).

Pesticide toxicity might be additively or synergistically increased if it is combined with other surface water contaminants. In addition, the toxicity might be increased by cumulative effects, toxic degradates, or other environmental effects. However, as data for these factors are not readily available for all of the pesticides, consideration of these factors was beyond the scope of this report.

Other factors that might influence the risk that pesticides pose to surface water quality include:

- Environmental persistence
- Weather (precipitation, wind, temperature)
- Hydrology (river velocity, mixing effects)
- Geography (land slope, distance from the point of application to a surface water)
- Human management (irrigation and drainage system operations, spatial and frequency distributions of pesticide applications)
- Water temperature (and other chemical-physical parameters of waterbodies and their sediment)

Although these factors can be important, analyses of all these factors were beyond the scope of this report.

By creating an initial pesticide list based on the relative total annual use amounts reported, the target pesticide list created using the methodology described in this report might have excluded some pesticides that have relatively low total annual reported use amounts, but have high toxicity values and, thus, might pose a risk to surface water quality in the locations where they are used.

Despite the limitations inherent in the approach used for this report, this effort has successfully identified 29 pesticides that appear to have a high overall relative risk level to aquatic life in surface water. This list can be used to focus future efforts towards toxic effects of pesticides in surface water in the Central Valley.

5.0 REFERENCES

- ARS (Agricultural Research Service). 2004. USDA ACSL. The ARS Pesticides Properties Database. Available at:
<http://www.ars.usda.gov/Services/docs.htm?docid=6433>
- CDFG (California Department of Fish and Game). 2003. Surface Water Hazard Assessments to Aquatic Organisms reports. Available at:
www.cdpr.ca.gov/docs/sw/hazasm.htm
- DPR (Department of Pesticide Regulation). 2003. Preliminary results of study #214: monitoring the occurrence and concentration of esfenvalerate and permethrin pyrethroids.
- DPR. 2004. Surface water database (SWDB). Available at:
<http://www.cdpr.ca.gov/docs/sw/surfdatab.htm>
- DPR. 2005. Pesticide use reporting (PUR) database. Available at:
<http://www.cdpr.ca.gov/docs/pur/purmain.htm>
- DPR. 2006. Notice of decision to begin reevaluation of certain products containing pyrethroids. Available at: <http://www.cdpr.ca.gov/docs/sw/ca2006-13.pdf>
- DPR. 2007. Description of PUR database contents on the DPR web site at:
<http://www.cdpr.ca.gov/docs/pur/purmain.htm>
- EXTOXNET. 2003. Pesticides information by Extension Toxicology Network. Available at: <http://pmep.cce.cornell.edu/profiles/extoxnet/>
- Hann, P., Davis, G., and J. Karkoski. 2007. Basin Plan Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Diazinon and Chlorpyrifos Runoff into the Sacramento and Feather Rivers. California Regional Water Quality Control Board, Central Valley Region. May 2007 Final Staff Report. Sacramento, CA.
- Holmes, R., V. D. Vlaming, and C. Foe. 2000. *Sources and concentrations of diazinon in the Sacramento watershed during the 1994 orchard dormant spray season*. CVRWQCB. Sacramento, CA.
- Kuivila, K.M. and C. Foe. 1995. Concentrations, transport and biological effects of dormant pesticides in the Sacramento estuary, California. *Env. Toxic. and Chemi.* Vol.14. No. 7. 1141-1150.
- Kuivila, K.M. and D. Weston, I. Werner, W. Jennings, and K. Eder. 2004. *Assessment of pesticides effects on fish and the food resources in the Sacramento-San Joaquin Delta*. (Unpublished).

- Marshack, J.B. 2003. A Compilation of Water Quality Goals. Central Valley Regional Water Quality Control Board. Sacramento, California.
- McClure, D., Davis, G., Karkoski, J., and P. Lee. 2006. Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Diazinon and Chlorpyrifos Runoff into the Sacramento-San Joaquin Delta. California Regional Water Quality Control Board, Central Valley Region. June 2006 Final Staff Report. Sacramento, CA.
- Nordmark, C.E., K.P. Bennet, H. Feng, J. Hernandez, and P. Lee. 1998. Occurrence of aquatic toxicity and dormant-spray pesticides detection in the Sacramento River watershed, Winter 1996-97. California EPA, Department of Pesticides Regulation, Environmental hazard assessment program. EH98-01. February 1998.
- PAN (Pesticides Network). 2005. Pesticide Action Network pesticides database. Available at: <http://www.pesticideinfo.org/Index.html>
- SWRCB (State Water Resource Control Board). 1984. *Rice herbicides: molinate and thiobencarb*. Special projects report No. 84-4sp. April 1984.
- SWRCB. 1990. Sacramento River Toxic Chemical Risk Assessment project. 90-11WQ. October 1990.
- SWRCB. 2006. The Section 303(d) List of Water Quality Limited Segments. Available at: http://www.waterboards.ca.gov/tmdl/303d_lists2006.html
- TDC. 2007. Pesticides in Urban Water. Urban Pesticides Use Trends Annual Report, 2007. Prepared for the San Francisco Estuary Project. Available at: http://www.up3project.org/documents/Final_UP3_Use_Report_2007.pdf
- USEPA (United States of Environmental Protection Agency). 1976. Water Quality Criteria. (The RED book) Washington DC. Available at: <http://www.epa.gov/waterscience/criteria/aqlife.html#final>
- USEPA. 2003. Office of Pesticide Programs, Ecological Effects Branch Pesticide Ecotoxicity Database. Obtained from Brian Montague July 26, 2007.

USEPA. 2005. EBDC Fungicides Mancozeb, Maneb, and Metiram; Notice of Receipt of Requests to Voluntarily Cancel, Amend, or Terminate Uses of Certain Pesticide Registrations. Available at: <http://www.epa.gov/fedrgstr/EPA-PEST/2005/June/Day-01/p10577.htm>

USEPA. 2006. Federal Register Notices on Organophosphate Pesticides. Available at: <http://www.epa.gov/pesticides/op/fedreg.htm>

Weston, D.P., R.W. Holmes, J. You, and M.J. Lydy. 2005. Aquatic Toxicity Due to Residential Use of Pyrethroid Insecticides. Environ. Sci. Technol. 39 (Dec.15):9778-9784.

Figure 1. Lower Sacramento River Watershed (SacR)

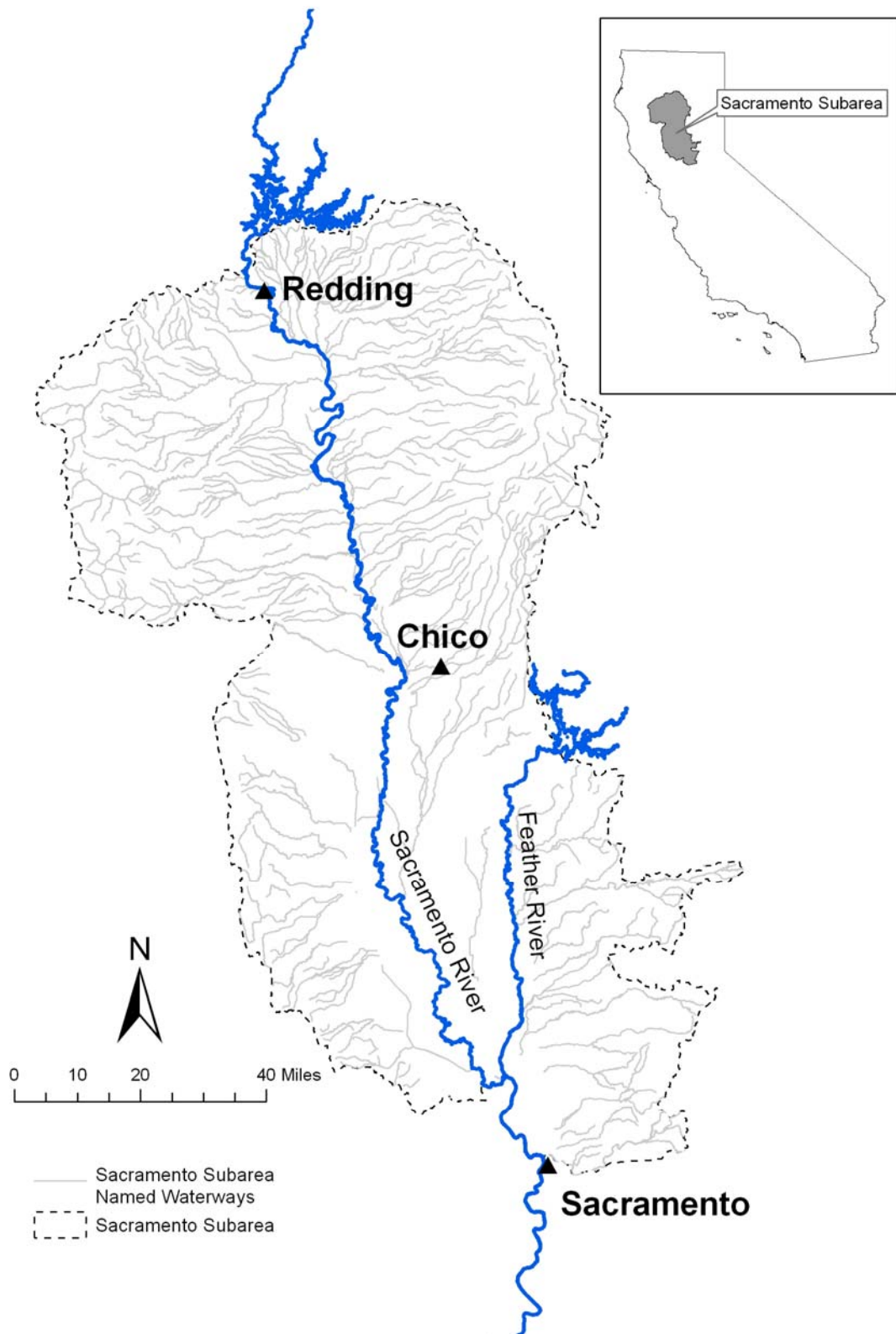


Figure 2. Lower San Joaquin River Watershed (SJR)

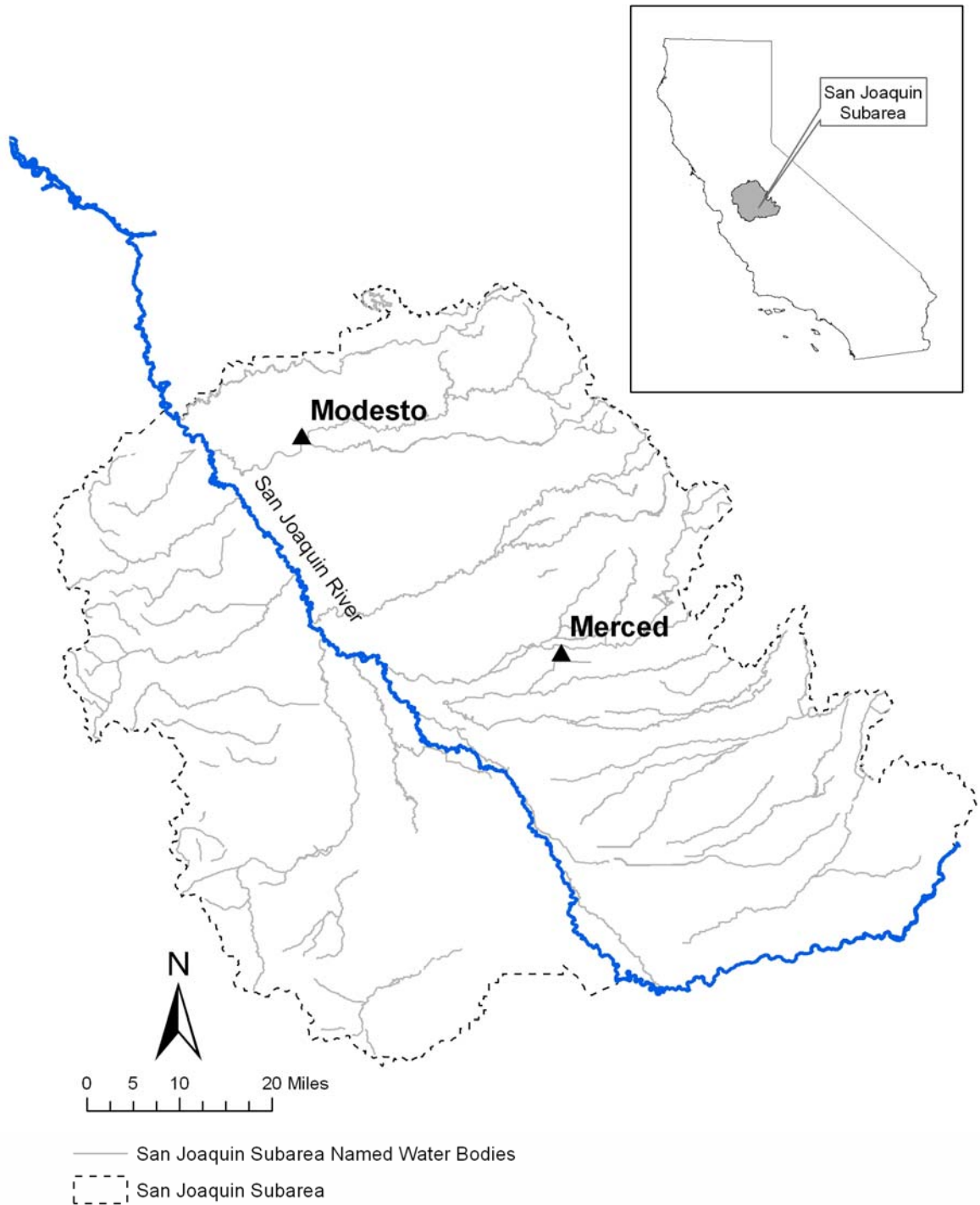


Figure 3. Lower Delta Watershed (Delta)

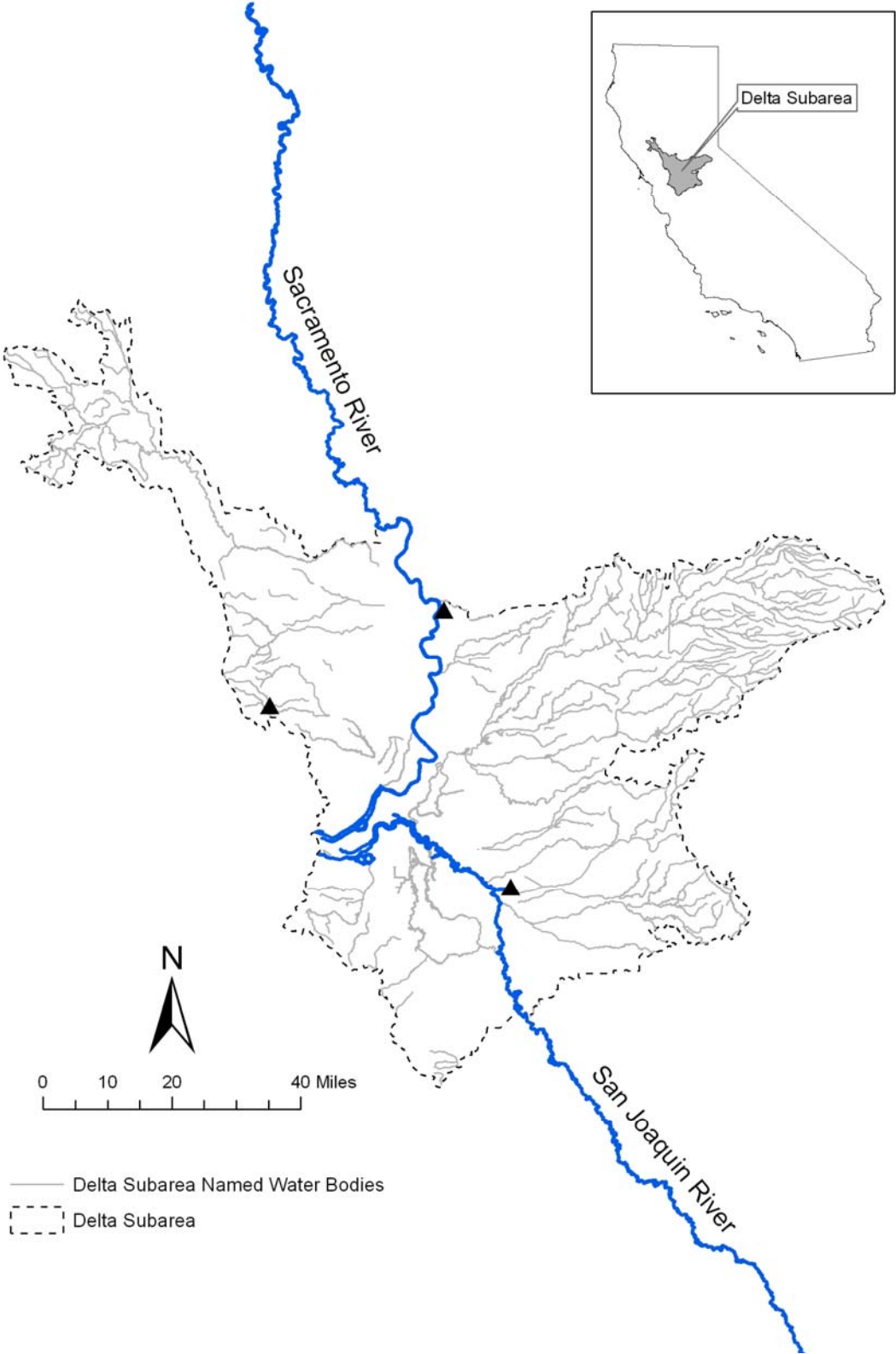


Figure 4. Flow Chart of the Relative-Risk Evaluation Process

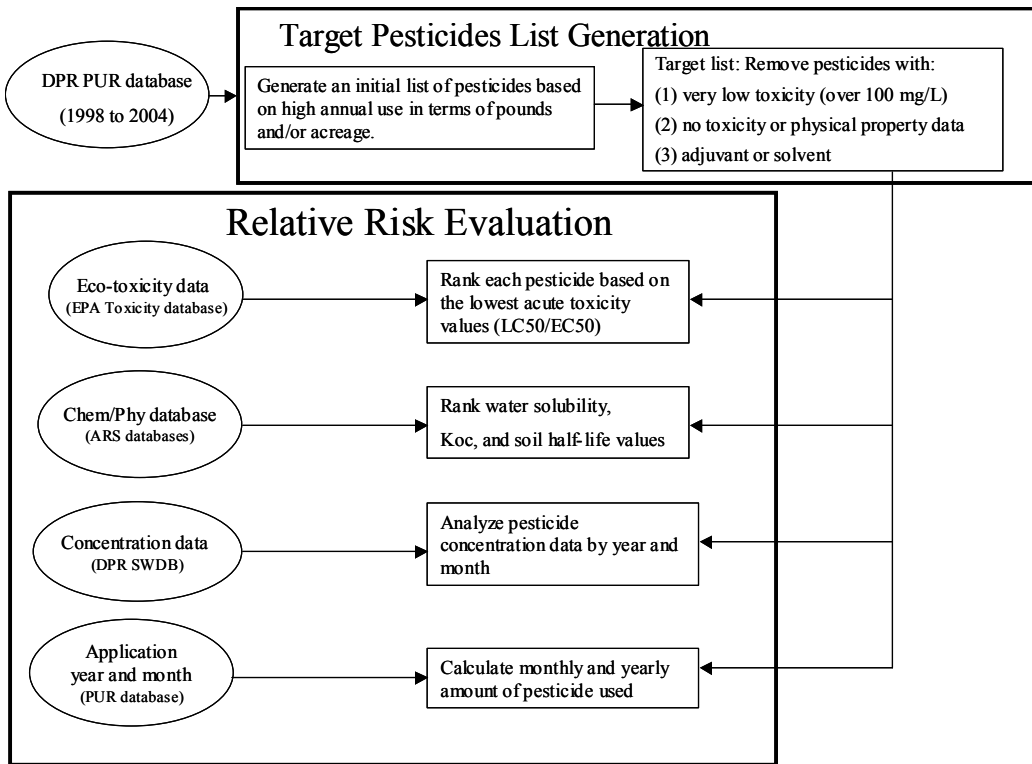


Figure 5. Flow Chart Showing Designation of High and Very High Toxicity Value Pesticides to Overall Relative-Risk Levels

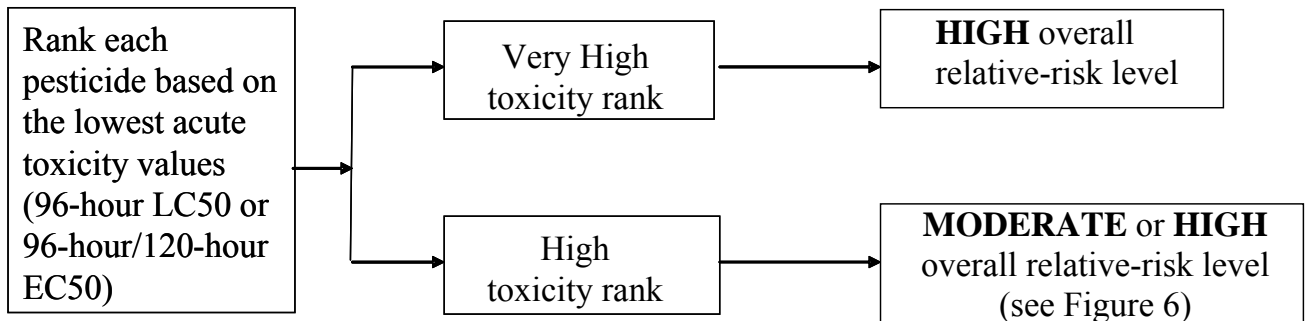


Figure 6. Flow Chart of Overall Relative-Risk Evaluation Process for Pesticides with High Toxicity Rank

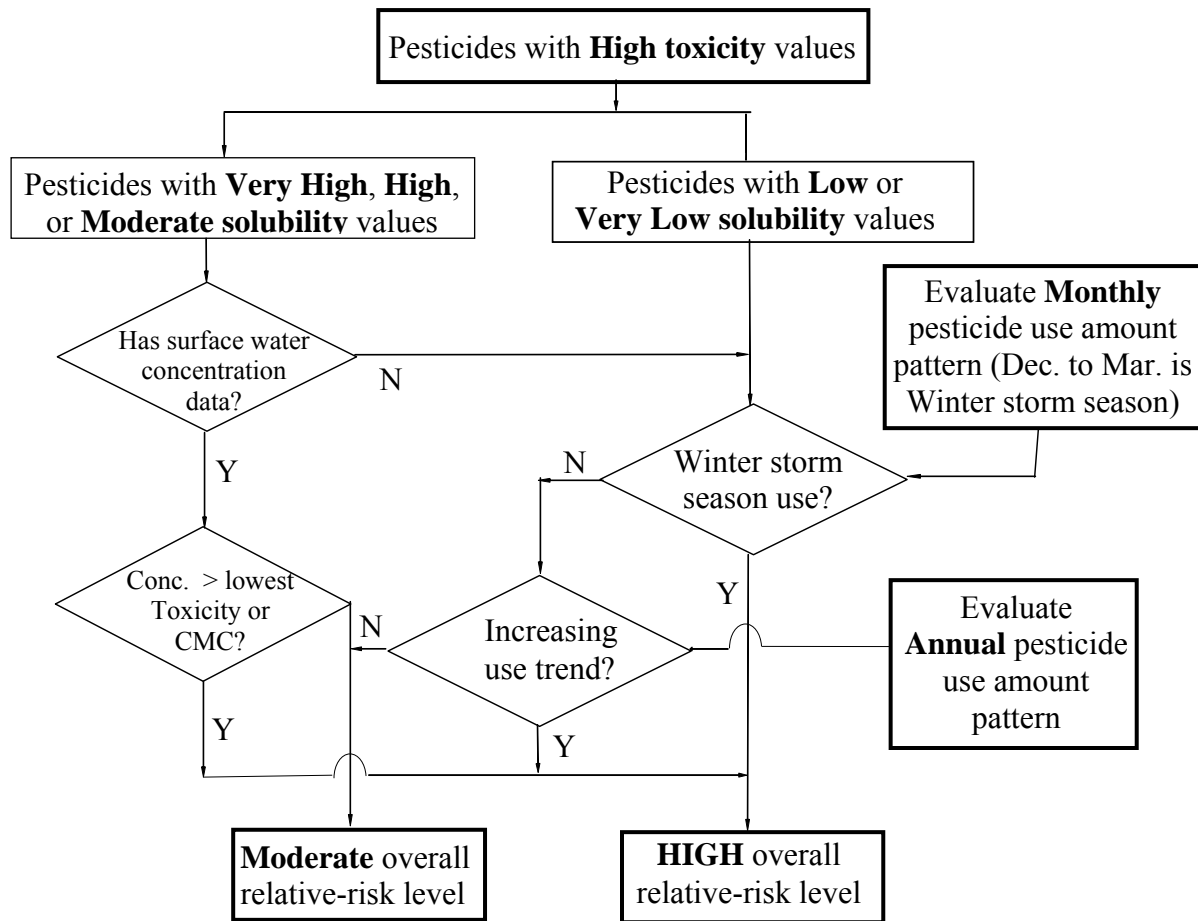


Table 1. Criteria for Relative-Risk Ranking, by Parameter

Parameter	Ranking				
	Very high	High	Moderate	Low	Very low
Toxicity (96 hour LC50 or EC50)	<1 µg/L	1 to 99 µg/L	100 to 999 µg/L	1 to 99 mg/L	>100 mg/L
Log(water solubility (mg/L))	≥ 3	≥2 and <3	≥1 and <2	≥0 and <1	<0
Koc	>10,000	1,000 to 9,999	100 to 999	10 to 99	<10

Table 2A. High Overall Relative-Risk Level Pesticides

ChemName	Chem Code	CAS NUMBER	Pesticides Type	Toxicity (ug/L)	Rank of Toxicity	Rank of Water solubility	Rank of Koc	Rank of Sediment
(S)-METOLACHLOR	5133	87392-12-9	Herbicide	8	High	High	Moderate	Possible
ABAMECTIN	2254	71751-41-2	Insecticide	0.022	Very high	Low	High	Potential
BIFENTHRIN	2300	82657-04-3	Insecticide	0.00397	Very high	Very Low	Very High	Potential
CHLOROTHALONIL	677	1897-45-6	Fungicide	26.3	High	Very Low	High	Potential
CHLORPYRIFOS	253	2921-88-2	Insecticide	0.035	Very high	Low	High	Potential
CYFLUTHRIN	2223	68359-37-5	Insecticide	0.002	Very high	Very Low	Very High	Potential
CYPERMETHRIN	2171	52315-07-8	Insecticide	0.0047	Very high	Very Low	Very High	Potential
DELTAMETHRIN	3010	52918-63-5	Insecticide	0.0017	Very high	Very Low	High	Potential
DIAZINON	198	333-41-5	Insecticide	0.2	Very high	Moderate	High	Potential
DIURON	231	330-54-1	Herbicide	2.4	High	Moderate	Moderate	Possible
ESFENVALERATE	2321	66230-04-4	Insecticide	0.07	Very high	Very Low	High	Potential
FIPRONIL	3995	120068-37-3	Insecticide	0.056	Very high	Moderate	Moderate	Possible
HEXAZINONE	1871	51235-04-2	Herbicide	6.8	High	Very high	Low	Unlikely
LAMBDA-CYHALOTHRIN	2297	1465-08-6	Insecticide	0.0041	Very high	Very Low	High	Potential
MALATHION	367	121-75-5	Insecticide	0.5	Very high	High	High	Potential
MANCOZEB	211	8018-01-7	Fungicide	9.5	High	Low	High	Potential
MANEB	369	12427-38-2	Fungicide	33	High	Low	Moderate	Possible
OXYFLUORFEN	1973	42874-03-3	Herbicide	0.29	Very high	Very Low	Very High	Potential
PARAQUAT DICHLORIDE	1601	1910-42-5	Herbicide	0.55	Very high	Very high	Very High	Potential
PENDIMETHALIN	1929	40487-42-1	Herbicide	5.2	High	Very Low	Very High	Potential
PERMETHRIN	2008	52645-53-1	Insecticide	0.018	Very high	Very Low	Very High	Potential
PROPANIL	503	709-98-8	Herbicide	16	High	High	Moderate	Possible
PROPARGITE	445	2312-35-8	Insecticide	31	High	Very Low	High	Potential
PYRACLOSTROBIN	5759	175013-18-0	Fungicide	4.16	High	Moderate	Low	Unlikely
SIMAZINE	531	122-34-9	Herbicide	36	High	Low	Moderate	Possible
TRIFLURALIN	597	1582-09-8	Herbicide	8.4	High	Very Low	High	Potential
ZIRAM	629	137-30-4	Fungicide	8	High	Moderate	Moderate	Possible
PHMB*	2258	32289-58-0	Fungicide	25.4	High	Very high	Unknown	Unlikely
Tralomethrin*	2329	66841-25-6	Insecticide	1.6	High	Very Low	Very High	Potential

*Recommended by TDC Environmental, LLC

Table 2B. Moderate Overall Relative-Risk Level Pesticides.

ChemName	Chem Code	CAS NUMBER	Pesticides Type	Toxicity (ug/L)	Rank of Toxicity	Rank of Water solubility	Rank of Koc	Rank of Sediment
BROMACIL	83	314-40-9	Herbicide	6.8	High	High	Low	Unlikely
CAPTAN	104	133-06-2	Fungicide	26.2	High	Low	Moderate	Possible
CARBARYL	105	63-25-2	Insecticide	1.7	High	High	Moderate	Possible
DIMETHOATE	216	60-51-5	Insecticide	43	High	Very high	Low	Unlikely
IMIDACLOPRID	3849	105827-78-9	Insecticide	55	High	High	Moderate	Possible
INDOXACARB	5331	173584-44-6	Insecticide	24	High	Low	High	Potential
METHOMYL	383	16752-77-5	Insecticide	90	High	Very high	Low	Unlikely
NALED	418	300-76-5	Insecticide	8	High	Low	Moderate	Possible
NORFLURAZON	2019	27314-13-2	Herbicide	13	High	Moderate	Moderate	Possible

22

Table 3. Toxicity Values for Selected Herbicides

ChemName	Chem Code	CAS NUMBER	Test Time and Range	Lowest Toxicity Value (ug/L)	EC50 Ranges	96hr LC50 Range (ug/L)	Species (Lowest value tested on)
(S)-METOLACHLOR	5133	87392-12-9	120 hr(48 to 120hr)	8	8 to 10	1,410 to 11,900	Green algae
BROMACIL	83	314-40-9	120 hr	6.8	6.8 to 69.9	32,000 to 180,000	Green algae
DIURON	231	330-54-1	96hr (48 to 260 hr)	2.4	2.4 to 8,400	160 to 300,000	Green algae
HEXAZINONE	1871	51235-04-2	120hr (48 hr to 21D)	6.8	6.8 to 151,600	78,000 to 1,000,000	Green algae
NORFLURAZON	2019	27314-13-2	120hr(120hr to 14D)	13	13 to 86	5,530 to 16,300	Green algae
OXYFLUORFEN	1973	42874-03-3	96hr (48 to 240 hr)	0.29	0.29 to 1,500	31.7 to 1,000,000	Green algae
PARAQUAT DICHLORIDE	1601	1910-42-5	96hr (48hr to 14D)	0.55	0.55 to 50,000	11,000 to 156,000	Freshwater diatom
PENDIMETHALIN	1929	40487-42-1	120hr (120hr to 14D)	5.2	5.2 to 174	138 to 90,400	Marine diatom
PROPANIL	503	709-98-8	120hr (120 hr to14D)	16	16 to 110	400 to 16,000	Freshwater diatom
SIMAZINE	531	122-34-9	120hr (48 hr to 14D)	36	36 to 5,000	3,000 to 1,000,000	Bluegreen algae
TRIFLURALIN	597	1582-09-8	96hr	8.4	15.4 to 5,000	8.4 to 2,800	Bluegill sunfish

Shaded: toxicity rank is based on the lowest LC50, not the lowest EC50

Appendices

Appendix A. High Overall Relative-Risk Level Pesticides.....A-2

Appendix B. Moderate Overall Relative-Risk Level Pesticides.....A-57

Appendix A. High Overall Relative-Risk Pesticides

(S)-metolachlor

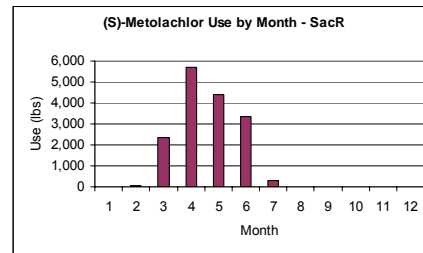
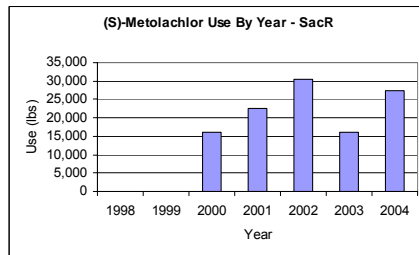
Use: Herbicide

Physical properties: High water solubility (480 mg/L) and moderate Koc (150).

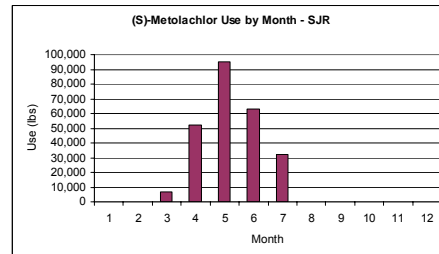
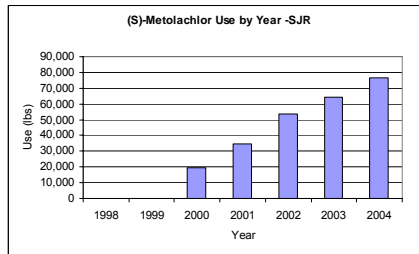
Toxicity: The 96-hour LC₅₀ ranges from 1,410 to 11,900 µg/L. The lowest LC₅₀ was for mysid (*Mysidopsis bahia*). The 5-d EC₅₀ ranges from 8 to 110 µg/L. The lowest EC₅₀ was for green algae (*Selenastrum capricornutum*).

Usage: Selected as a target pesticide because of its relatively high amount of applications for agricultural uses in three sub-areas: Sacramento River Watershed (SacR), San Joaquin River Watershed (SJR), and Delta Watershed (Delta).

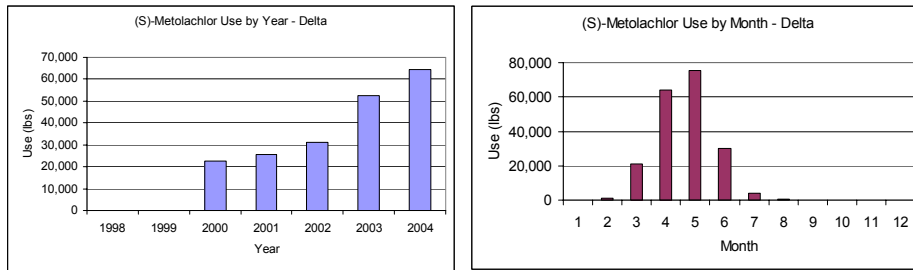
SacR: The average annual use was 22,550 lbs between 2000 and 2004 with no use reported in 1998 and 1999. The highest annual use was 30,580 lbs in 2002. The relatively high monthly uses were between April and July with the highest use in May. The major applications were to tomato (54%), corn (15%), and cotton (13%). The annual average area of applications was 19,313 acres from 2000 to 2004.



SJR: The average annual use was 49,741 lbs between 2000 and 2004 with no use reported in 1998 and 1999. The highest annual use was 76,425 lbs in 2004. The annual uses had in an increased trend from 2000 and 2002. The relatively high monthly uses were between April and July with the highest use in May. The major reported applications were to tomato (34%), cotton (29%), and corn (16%). The annual average area was 40,958 acres from 2000 to 2004.



Delta: The average annual use was 39,202 lbs between 2000 and 2004 with no use reported in 1998 and 1999. The highest use was 64,350 lbs in 2004. The annual uses had an increased trend from 2000 to 2004. The relatively high monthly uses were between March and June with the highest use in May. The major applications were to tomato (52%) and corn (29%). The annual average area was 40,958 acres from 2000 to 2004.



Water quality data: No (S)-metolachlor data were available in the SWDB.

Conclusion: (S)-metolachlor is ranked as high overall risk because of its high toxicity, high water solubility, and increased trend of annual use. The risk to sediment contamination is ranked as “possible” because of its moderate Koc.

Abamectin (Avermectin or Ivermectin)

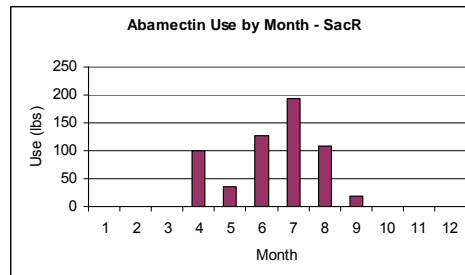
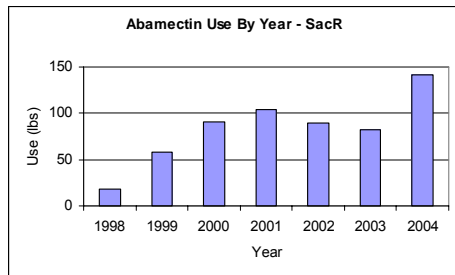
Use: Insecticide

Physical properties: Low water solubility (5 mg/L) and high Koc (5,000).

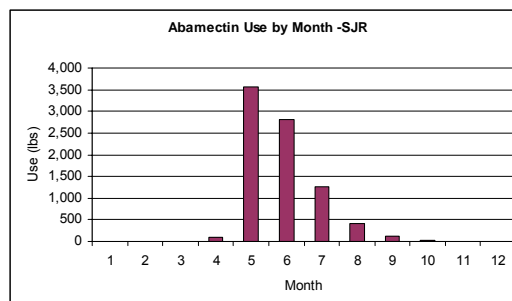
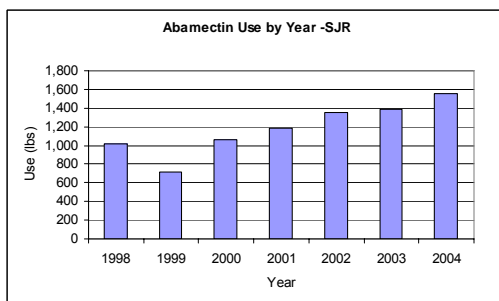
Toxicity: The 96-hour LC₅₀ ranges from 0.022 to 42 µg/L. The lowest LC₅₀ was for mysid (*Mysidopsis bahia*).

Usage: Selected as a target pesticide because of its relatively high acreages (not amount) of applications for agricultural uses in three sub-areas: Sacramento River Watershed (SacR), San Joaquin River Watershed (SJR), and Delta Watershed (Delta).

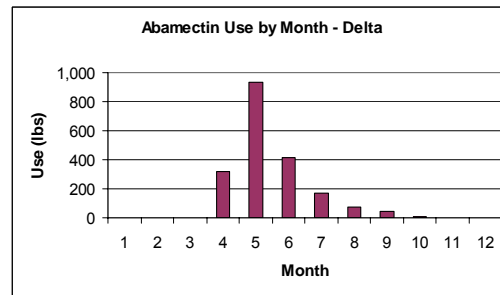
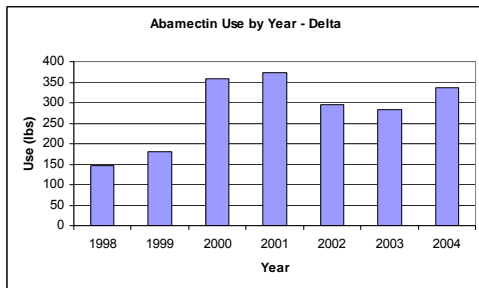
SacR: The average annual use was 84 lbs from 1998 to 2004 with the highest annual use (142 lbs) in 2004. The annual uses had an increased trend from 1998 to 2004 except for 2002 and 2003. The relatively high monthly uses were from April to August with the highest use in July. The major applications were to almond (58%), cotton (16%), and tomato (5%). The annual average area of application was 21,298 acres from 1998 to 2004.



SJR: The average annual use was 1,183 lbs from 1998 to 2004 with the highest amount used (1,549 lbs) in 2004. The annual use had an increased trend from 1999 to 2004. The relatively high monthly uses were from May to July with the highest use in May. The major applications were to almond (44%), cotton (41%), and cantaloupe (4%). The annual average area of applications was 161,143 acres from 1998 to 2004.



Delta: The average annual use was 282 lbs from 1998 to 2004 with the highest annual use (374 lbs) in 2001. The annual uses had an increased trend from 1998 to 2004 except in 2000 and 2001. The relatively high monthly uses were from April to July with the highest use in May. The major applications were to pear (25%), grape (21%), and almond (16%). The annual average area of application was 21,223 acres.



Water quality data: No concentration data were available in the SWDB.

Conclusion: Abamectin is ranked as relatively high overall risk because of its very high toxicity. The risk to surface water may be reduced because of its low solubility and relatively rapid degradation in water (4 days). Abamectin has very low application rate but very high application area. The risk to sediment contamination is ranked as "potential" because of its high Koc.

Bifenthrin

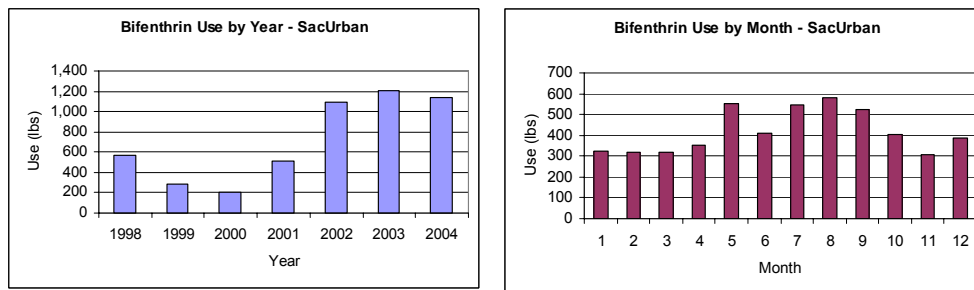
Use: Insecticide, one of pyrethroids.

Physical properties: Very low water solubility (0.1 mg/L) and very high Koc (237,000).

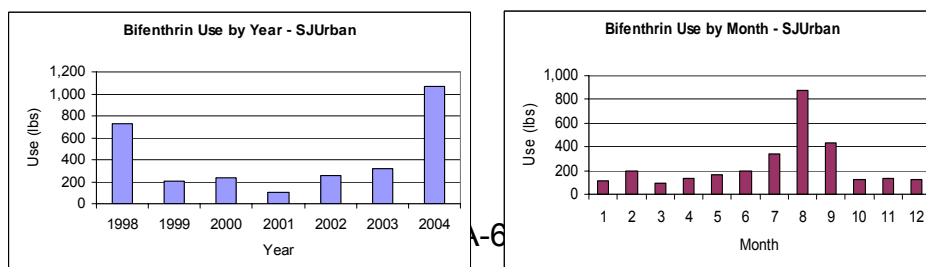
Toxicity: The 96-hour LC₅₀ for bifenthrin ranges from 0.00397 to 17.5 µg/L. The lowest toxicity value for mysid (*Mysidopsis bahia*).

Usage: The total annual amounts of bifenthrin associated with agricultural uses in the three Subareas (as reported in the PUR database) were not high enough to include bifenthrin in the initial short list (see Section 3.1). Bifenthrin was added to the target pesticide list because of the relatively high total annual amounts reported for non-agricultural uses in three counties: Sacramento (SacUrban), San Joaquin (SJUrban), and Stanislaus (StanUrban). It should be noted that, since the total annual amounts of bifenthrin reported for agricultural uses in the three Subareas are higher than total annual amounts reported for non-agricultural uses in the three counties, bifenthrin runoff from agricultural use areas should still be considered as a potential source of bifenthrin concentrations measured in surface water samples.

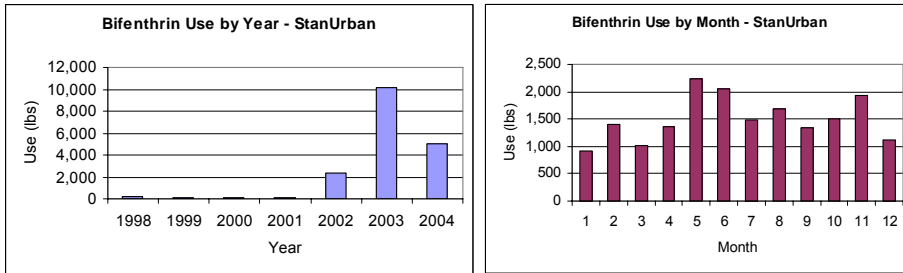
SacUrban: The average annual use was 716 lbs between 1998 and 2004 with the highest use (1,204 lbs) in 2003 for non-agricultural applications. The amounts of annual use increased between 2000 and 2003. The monthly use shows that the applications were year-round with the relatively high uses between May and September.



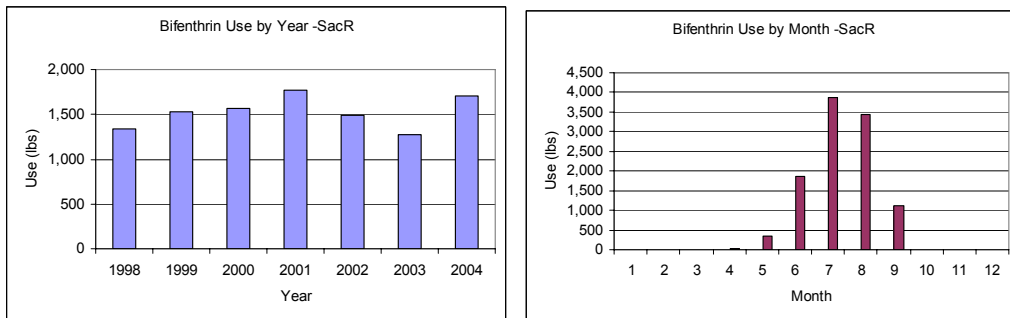
SJUrban: The average annual use was 417 lbs between 1998 and 2004 with the highest use (1,070 lbs) in 2004 for non-agricultural applications. The annual uses were in an increased trend from 2001 to 2004. The monthly uses of bifenthrin were year-round with the highest use in August.



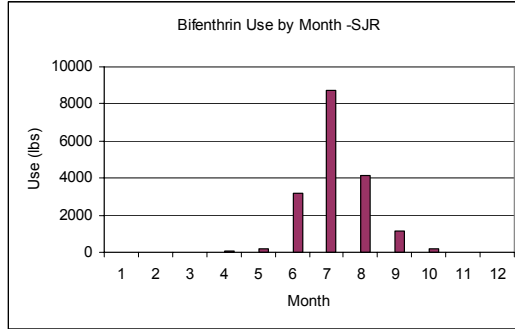
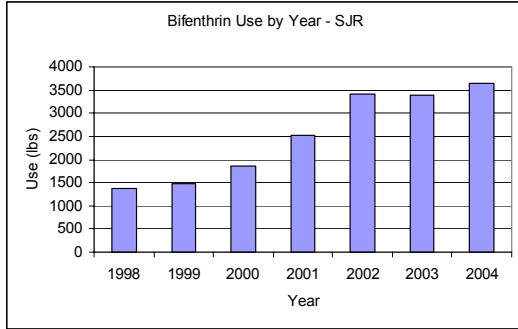
StanUrban: The average annual use was 2,579 lbs between 1998 and 2004 with the highest use (10,192 lbs) in 2003 for non-agricultural applications. The annual uses were very low between 1998 and 2001. The monthly uses were year-round with the highest use in May. The highest use was to structural use in 2003.



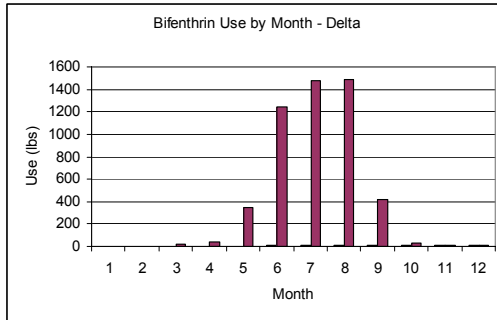
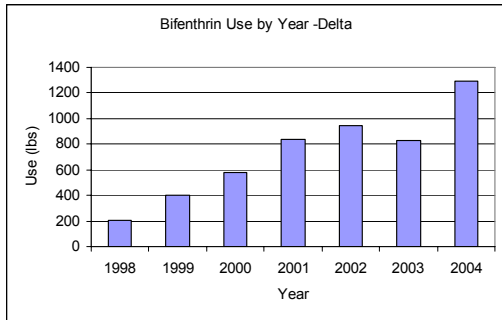
SacR: The average annual use was 1,525 lbs between 1998 and 2004 with the highest use (1,777 lbs) in 2001 for agricultural applications. The annual uses increased from 1998 to 2001, then decreased slightly from 2001 to 2003, but increased again in 2004. The monthly uses show that relatively high uses were between June and August with the highest use in July. The average annual area of application was 16,681 acres.



SJR: The average annual use was 2,526 lbs between 1998 and 2004 with the highest use (3,636 lbs) in 2004 for agricultural applications. The annual uses were increasing from 1998 to 2004. The monthly uses show that relatively high uses were between June and August with the highest use in July. The average annual area of application was 29,017 acres.



Delta: The average annual use was 727 lbs between 1998 and 2004 with the highest use (1,294lbs) in 2004 for agricultural applications. The annual uses increased from 1998 to 2004 in general. The monthly uses show that relatively high uses were between June and August with the highest uses in July and August. The average annual area of application was 7,311 acres.



Water quality data: There were 68 concentration data and about 15% of them exceeded LOQ (0.005 µg/L). The highest concentration was 0.0554 µg/L in July 2003.

Conclusion: Bifenthrin is ranked as high overall risk to the surface water because of its very high toxicity. The amounts of applications were in increased trend for both of non-agricultural and agricultural uses. The risk to sediment contamination is ranked as “potential” because of its high Koc.

Chlorothalonil

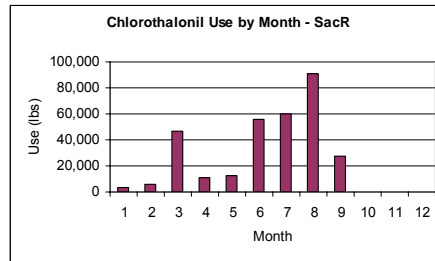
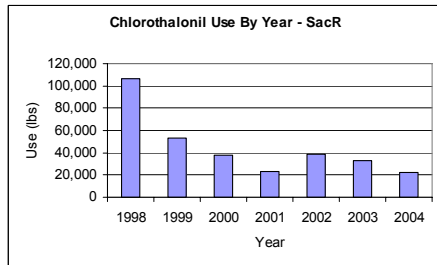
Use: Fungicide.

Physical properties: Very low water solubility (0.6 mg/L) and high Koc (5,000).

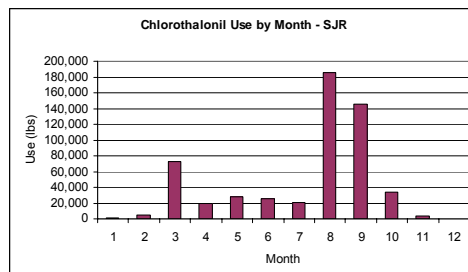
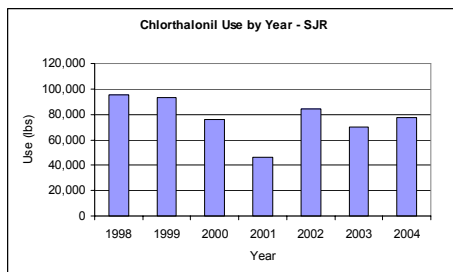
Toxicity: The 96-hour LC₅₀ for chlorothalonil ranges from 26 to 195 µg/L for fishes and crustacean. The lowest LC₅₀ (26 µg/L) was for Eastern oyster (*Crassostrea virginica*).

Usage: Selected as a target pesticide because of its relatively high amount of annual uses for both agricultural and non-agricultural uses. The relatively high uses for agricultural applications were in three project sub-areas: Sacramento River Watershed (SacR), San Joaquin River Watershed (SJR), and Delta Watershed (Delta). The relatively high uses for non-agricultural applications were in two counties: Sacramento (SacUrban) and San Joaquin (SJUrban).

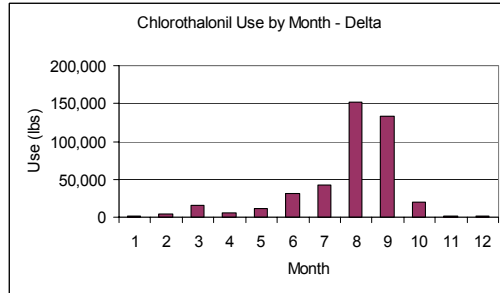
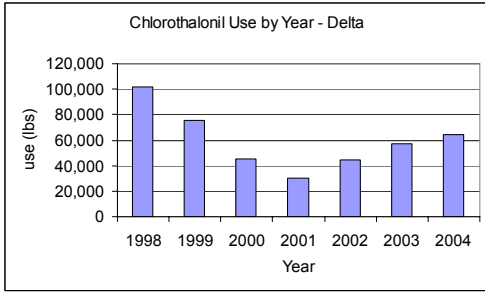
SacR: The average annual use was 44,860 lbs with the highest use (106,399 lbs) in 1998. The annual uses decreased from 1998 to 2004. The monthly use shows that the relatively high uses were between June and August with the highest use in August. The major applications were to tomato (78%). The average annual area of application was 25,538 acres.



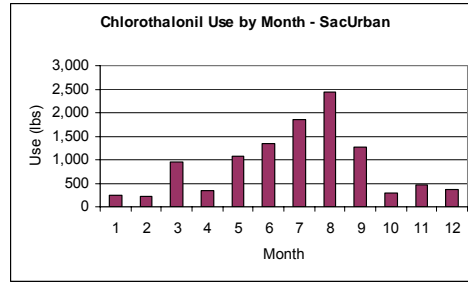
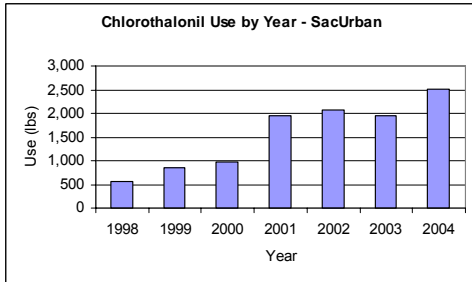
SJR: The average annual use was 77,538 lbs between 1998 and 2004 with the highest use (95,461 lbs) in 1998. The annual uses decreased from 1998 to 2001 and then increased from 2002 to 2004. The monthly use shows that the highest uses were in August and September. The major applications were to tomato (78%). The average annual area was 41,293 acres.



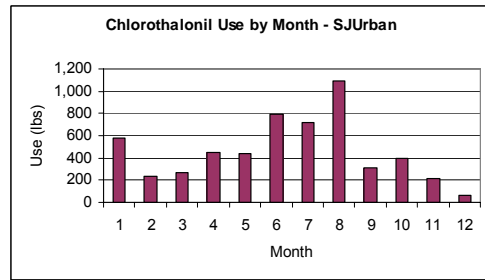
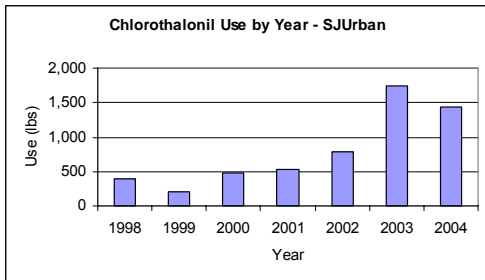
Delta: The average annual use was 59,783 lbs between 1998 and 2004 with the highest use (101,816 lbs) in 1998. The annual uses decreased from 1998 to 2001 and then increased from 2001 to 2004. The monthly use shows that the highest uses were in August and September. The major applications were to tomato (86%). The average annual area of applications was 37,230 acres.



SacUrban: The average annual use was 1,553 lbs between 1998 and 2004 with the highest use (2,560 lbs) in 2004. The annual uses increased from 1998 to 2004. The monthly use shows that the highest use was in August. The major applications were to landscaping.



SJUrban: The average annual use was 795 lbs between 1998 and 2004 with the highest use (1,744 lbs) in 2003. The annual uses increased from 1998 to 2003 and then decreased slightly in 2004. The monthly use shows that the highest use was in August. The major applications were to landscaping.



Water quality data: There were 75 concentration data points collected from 1996 to 1998 in the SWDB. None of the samples exceeded the LOQ (0.035 and 0.48 µg/L).

Conclusion: Chlorothalonil is ranked as high overall risk because of its high toxicity and increased annual uses. Because chlorothalonil has very low water solubility, the observed concentrations in water column were very low. The risk to sediment contamination is ranked as “potential” because of its high K_{oc}.

Cyfluthrin

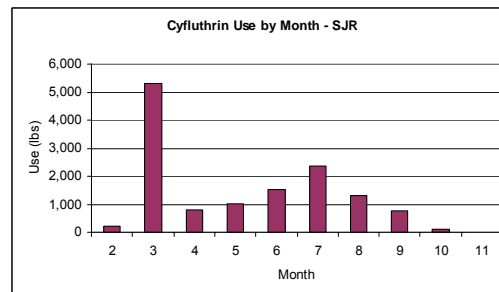
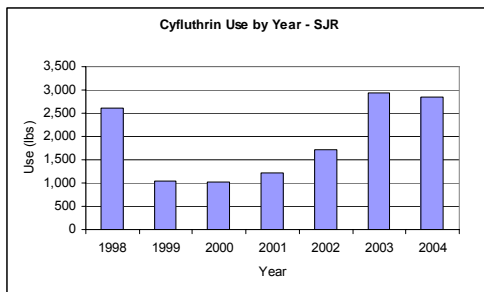
Uses: Insecticide, one of pyrethroids insects.

Physical properties: Very low water solubility (0.02 mg/L) and very high Koc (31,000).

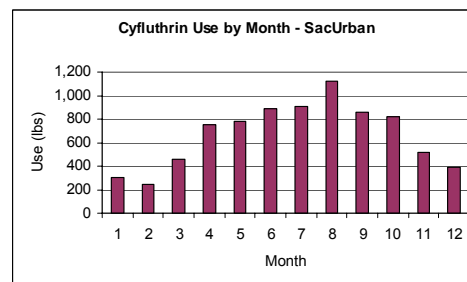
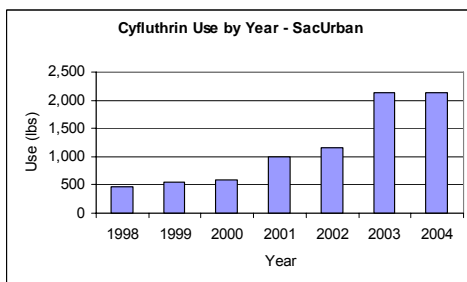
Toxicity: The 96-hour LC₅₀ for cyfluthrin ranges from 0.0022 to 0.998 µg/L (USEPA, 2003). The lowest LC₅₀ was for mysid (*Mysidopsis bahia*).

Usage: Cyfluthrin was selected as a target pesticide due to the relatively high uses on agricultural use in San Joaquin watershed (SJR) and non-agricultural uses in three counties: Sacramento (SacUrban), San Joaquin (SJUrban), and Stanislaus (StanUrban).

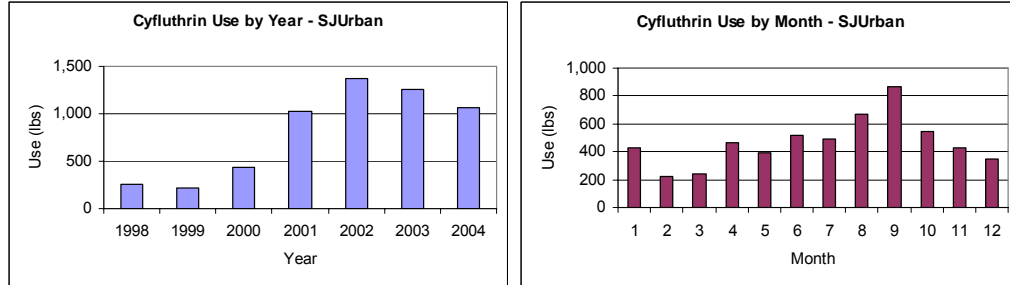
SJR: The average annual use was 1,913 lbs with the highest use (2,936 lbs) in 2003. From 1999 to 2003, the amounts of annual use increased. The reported monthly use of cyfluthrin showed that the highest use was in March. The average annual application area is 45,840 acres from 1998 to 2004. The major reported crops of use include alfalfa (50%), cotton (33%), and nursery (8%).



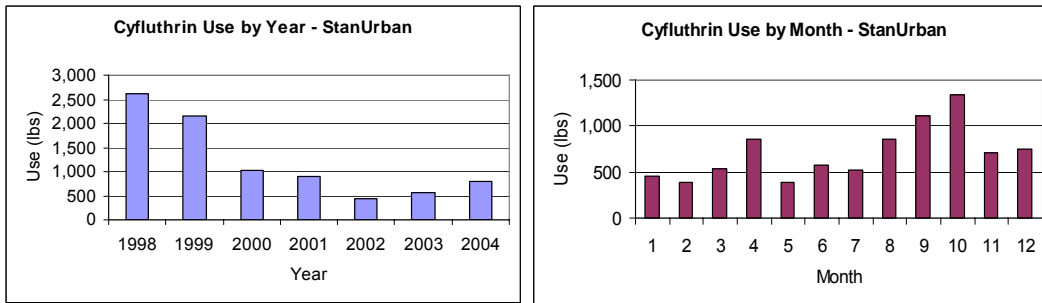
SacUrban: The average annual use was 1,146 lbs with the highest use (2,140 lbs) in 2003. From 1998 to 2003, the amounts of annual use increased. The reported monthly use of cyfluthrin showed that the applications were yearly around with relatively high uses between April and October.



SJUrban: The average annual use was 804 lbs between 1998 and 2004 with the highest use (1,370 lbs) in 2002. From 1999 to 2002, the amounts of annual use increased and then decreased from 2002 to 2004. The reported monthly use showed that the highest use was in September.



StanUrban: The average annual use was 1,214 lbs between 1998 and 2004 with the highest use (2,624 lbs) in 1998. The annual use decreased from 1998 to 2002, and then increased slightly from 2002 to 2004. The reported monthly use of cyfluthrin showed that the applications were yearly around with the highest use in October.



Water quality data: The SWDB has no concentration data.

Conclusion:

Cyfluthrin is ranked as high risk to the surface water because of its very high toxicity to aquatic organisms. The annual uses showed increase trend for agricultural uses for San Joaquin River watershed and non-agricultural uses for Sacramento and San Joaquin Counties but not for Stanislaus County. There is no concentration data available in SWDB. Since cyfluthrin has very low water solubility, the concentration in water column is expected to be very low. However, there is a high potential risk for sediment contamination because of its high Koc.

Cypermethrin

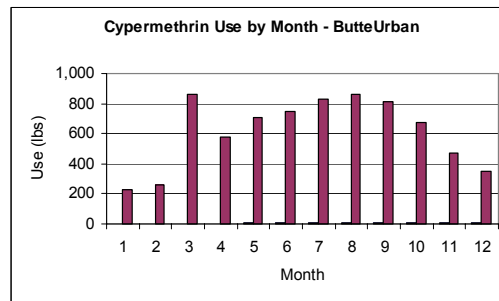
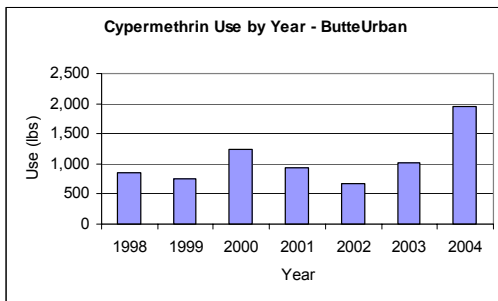
Use: Insecticide, one of pyrethroids.

Physical properties: Very low water solubility (0.004 mg/L) and very high Koc (61,000).

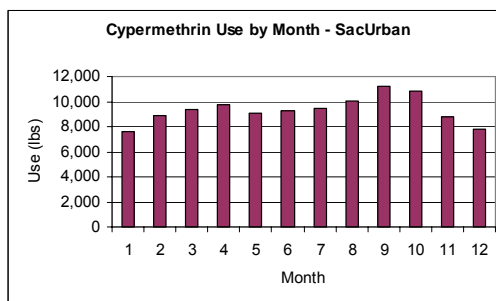
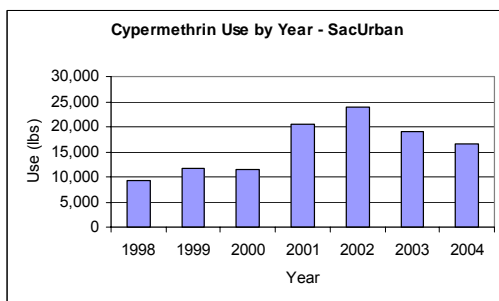
Toxicity: The 96-hour LC₅₀ for cypermethrin ranges from 0.0047 to 36,300 µg/L. The lowest LC₅₀ was for mysid (*Mysidopsis bahia*).

Usage: Selected as a target because of the relatively high amounts of annual use for non-agricultural uses in four counties: Butte (ButteUrban), Sacramento (SacUrban), San Joaquin (SJUrban), and Stanislaus (StanUrban).

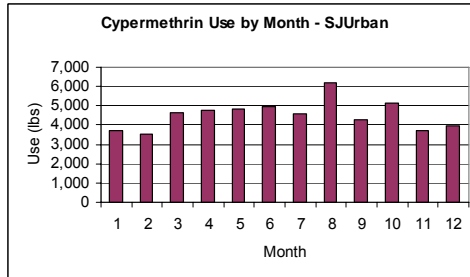
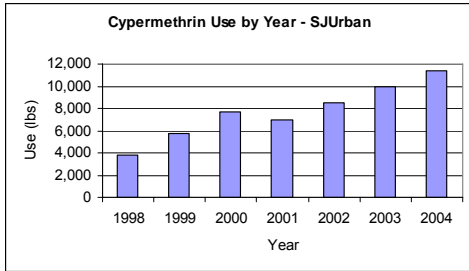
ButteUrban: The average annual use was 1,057 lbs between 1998 and 2004 with the highest use (1,954 lbs) in 2004. From 2002 to 2004, the annual uses were in an increased trend. The monthly use shows that the applications were year-round with the highest use in March.



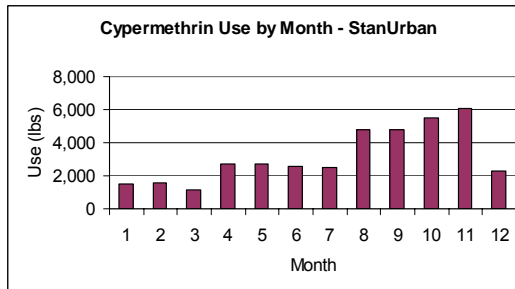
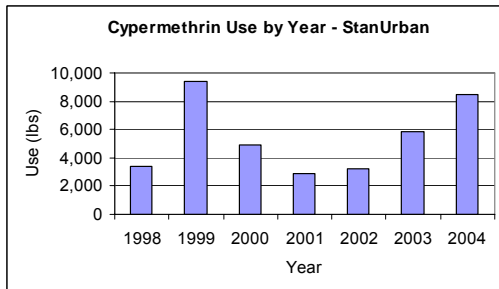
SacUrban: The average annual use was 16,036 lbs with the highest use (23,885 lbs) in 2002. From 1998 to 2002, the amounts of annual use increased but then slightly decreased from 2002 to 2004. The monthly use shows that the applications were year-round with relatively higher use in September and October.



SJUrban: The average annual use was 7,742 lbs between 1998 and 2004 with the highest use (11,748 lbs) in 2004. The annual use has an increased trend from 1998 to 2004. The monthly use shows that the applications were year-round with relatively higher use in August.



StanUrban: The average annual use was 5,454 lbs between 1998 and 2004 with the highest use (9,424 lbs) in 1999. The annual use increased from 2001 to 2004. The monthly use shows that the applications were year-round with relatively higher uses between August and November. The high annual use in 1999 was to structural pest control.



Water quality data: There were 70 concentration data available in the SWDB, and none of them exceeded LOQ (0.08 µg/L).

Conclusion: Cypermethrin is ranked as high overall risk to the surface water because of its very high toxicity to aquatic organisms and increased annual uses. Cypermethrin is one of pyrethroid insecticides, so it has very low water solubility and very high K_{oc}. The risk to sediment contamination is ranked as “potential” because of its high K_{oc}.

Deltamethrin

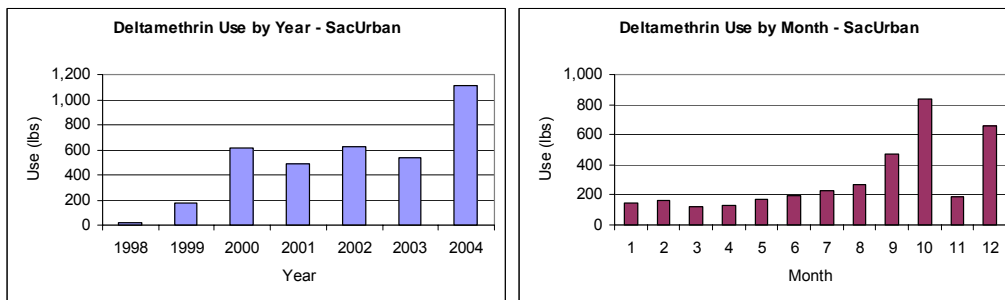
Uses: Insecticide, one of pyrethroids.

Physical properties: Very low water solubility (0.0002 mg/L) and high Koc (6291).

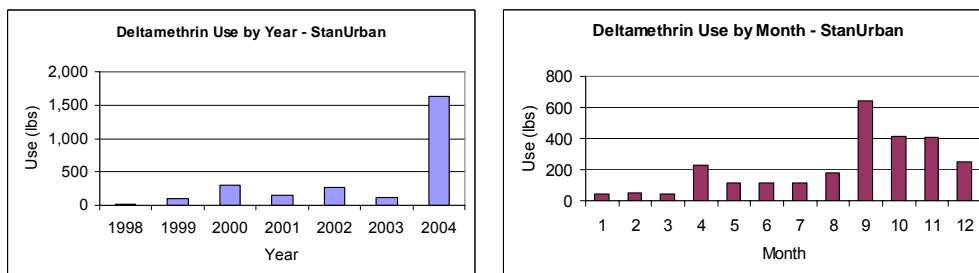
Toxicity: The 96-hour LC₅₀ for deltamethrin ranges from 0.0017 to 1.5 µg/L. The lowest LC₅₀ was for mysid (*Mysidopsis bahia*).

Usage: Selected as a target because of the relatively high applications for non-agricultural uses in two counties: Sacramento (SacUrban) and Stanislaus (StanUrban). The applications of deltamethrin for agricultural uses are not presented because very low annual uses were reported (less than 50 lbs for one sub-area in seven years).

SacUrban: The average annual use was 509 lbs between 1998 and 2004 with the highest use (1,115 lbs) in 2004. The amounts of annual use had an increased trend from 1998 to 2004. The monthly uses were year-round with the highest uses in October. The main applications were to structural pest control.



StanUrban: The average annual use was 371 lbs between 1998 and 2004 with the highest use (1,638 lbs) in 2004. The annual uses were low from 1998 to 2004 but very high use was in 2004. The monthly use shows that the applications were year-round with the highest use in September. The main applications were to structural pest control.



Water quality data: No concentration data were available in the SWDB.

Conclusion: Deltamethrin is ranked as high overall risk to the surface water because of its very high toxicity to aquatic organism. Deltamethrin is one of pyrethroid insecticides. Comparing to the amounts of other pyrethroid insecticides, the amounts of deltamethrin use were relatively low. The major applications were to non-agricultural uses. There were almost no uses for agricultural use in the project area. The risk to sediment contamination is ranked as “potential” because of its high Koc.

Diuron

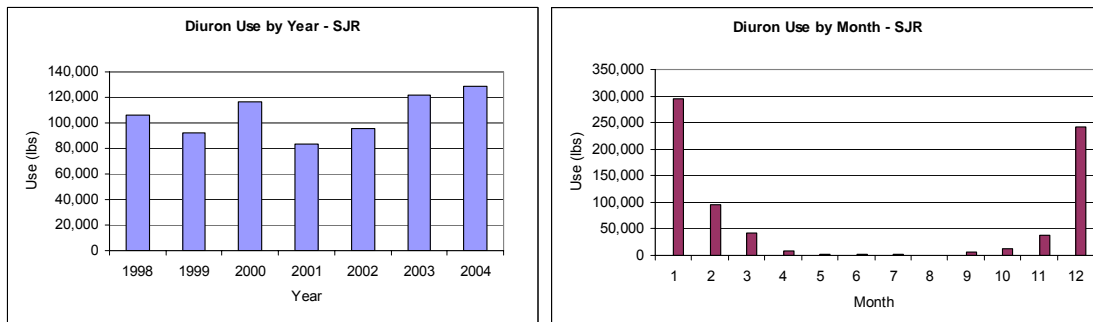
Use: Herbicide.

Physical properties: Moderate water solubility (42 mg/L) and moderate Koc (477).

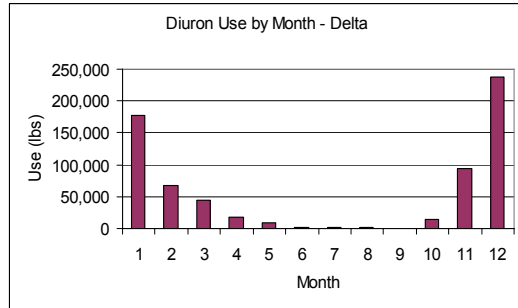
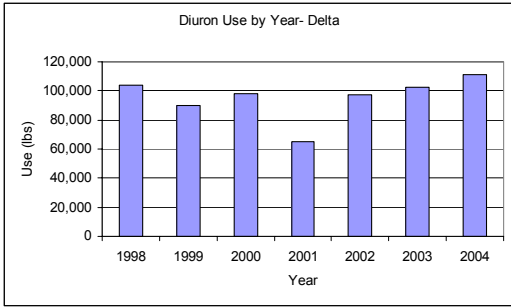
Toxicity: The 96-hour LC₅₀ ranges from 160 to 300,000 µg/L for fishes and crustaceans. The lowest LC₅₀ value was for scud (*Gammarus fasciatus*). For mysid (*Mysidopsis bahia*), the lowest 96-hour LC₅₀ was 560 µg/L. The EC₅₀ ranges from 2.4 to 95 µg/L for aquatic plants between 72 hours and 14 days. The lowest 96-hour EC₅₀ value was 2.4 µg/L for green algae (*Selenastrum capricornutum*).

Usage: Selected as a target pesticide because of the relatively high amounts of applications for both agricultural and non-agricultural uses. The relatively high agricultural uses were in two sub-areas: San Joaquin River Watershed (SJR), and Delta Watershed (Delta). For non-agricultural uses, the relatively high uses were in four counties: Butte (ButteUrban), Sacramento (SacUrban), San Joaquin (SJUrban), Stanislaus (StanUrban).

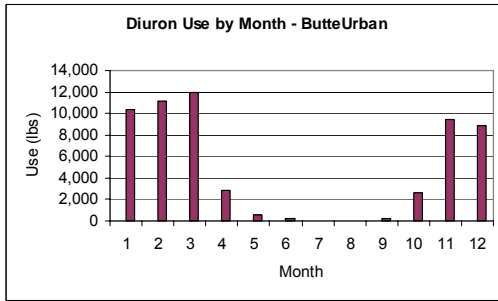
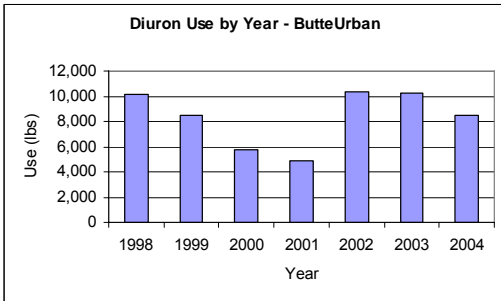
SJR: The average annual use was 106,328 lbs from 1998 to 2004 with the highest use (128,983 lbs) in 2004. The amount of annual use increased from 2001 to 2004. The monthly use shows that relatively high uses occurred during the storm season with the highest uses in December and January. The major applications were to cotton (43%), alfalfa (39%) and grape (7%). The average annual area application was 152,185 acres.



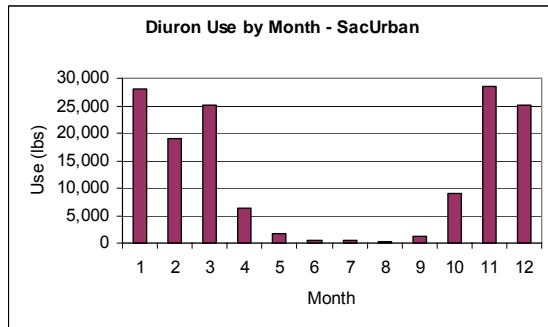
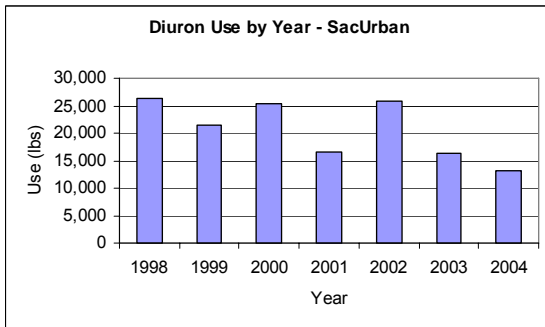
Delta: The average annual use was 95,574 lbs from 1998 to 2004 with the highest use (111,557 lbs) in 2004. The amount of use increased from 2001 to 2004. The monthly use shows that relatively high uses occurred during the storm season, and the highest use was in December. Diuron is mainly applied to alfalfa (52%), grape (21%), and asparagus (9%). The average annual area application was 152,185 acres.



ButteUrban: The average annual use was 8,322 lbs from 1998 to 2004 with the highest use (10,333 lbs) in 2002. The amounts of annual use decreased from 1998 to 2001, and then increased in 2002, but decreased again from 2002 to 2004. The monthly use shows that relatively high uses occurred during the storm season, and the highest use was in March.

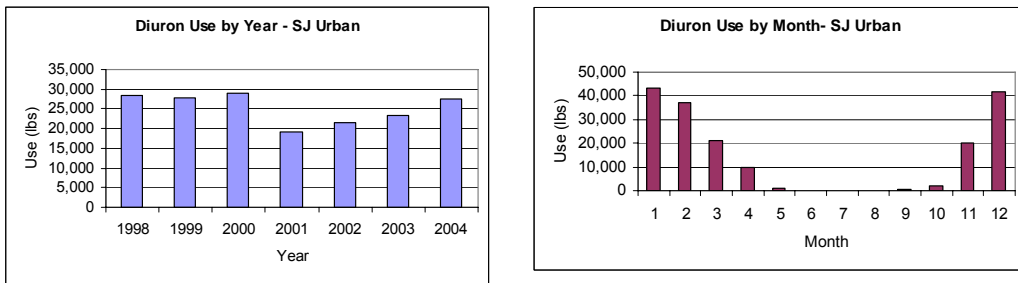


SacUrban: The average annual use was 20,719 lbs from 1998 to 2004 with the highest use (26,243 lbs) in 1998. The annual uses had a decreased trend from 1998 to 2004, but the amount of use in 2000 and 2002 were high. The monthly use shows that relatively high uses occurred during the storm season, and the highest use was in November.

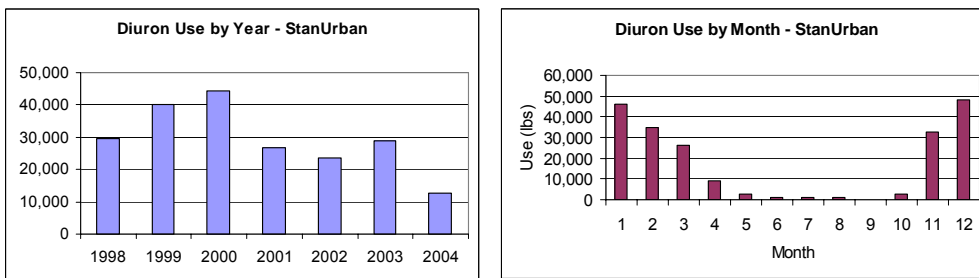


SJUrban: The average annual use was 25,261 lbs from 1998 to 2004 with the highest use (29,043 lbs) in 2000. The amounts of annual use increased from

2001 to 2004. The monthly use shows that relatively high uses occurred during the storm season, and the highest use was in January.



StanUrban: The average annual use was 29,461 lbs from 1998 to 2004 with the highest use (44,474 lbs) in 2000. The amounts of annual use increased from 1998 to 2000, and then decreased from 2000 to 2004. The monthly use shows that relatively high uses occurred during the storm season, and the highest use was in December.



Water quality data: There were 528 records of diuron concentration in the SWDB and 44% of the data exceeded the LOQ (0.01 to 1 µg/L). The highest observed concentration in surface water was 30.6 µg/L observed in February 1992. The highest observed concentration was lower than the lowest 96-hr LC₅₀ (160 µg/L) but higher than the lowest EC₅₀ value (2.4 µg/L).

Conclusion: Diuron is ranked as high overall risk because of its high toxicity, high observed concentration in surface water, and high uses in the winter storm season. The annual applications had an increased trend for agricultural use, but a decreased trend for non-agricultural use recent years.

Diuron is ranked as “possible” to contaminate sediment because of its moderate K_{oc}. Diuron has been detected in groundwater in low concentrations (2 to 3 µg/L).

Esfenvalerate

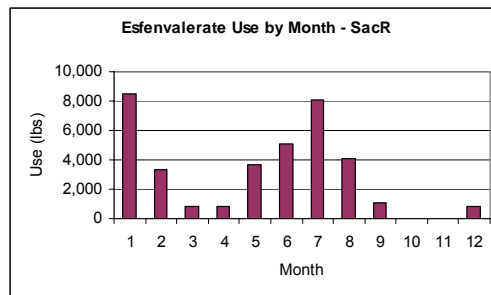
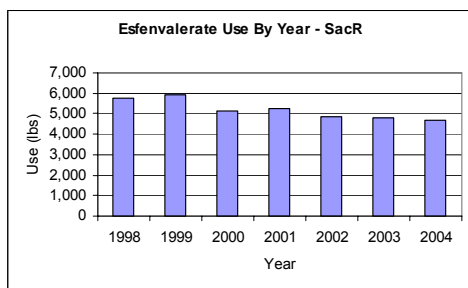
Use: Insecticide, one of pyrethroids.

Physical properties: Very low water solubility (0.002 mg/L) and high Koc (5,273).

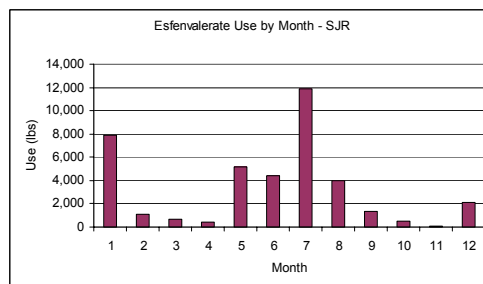
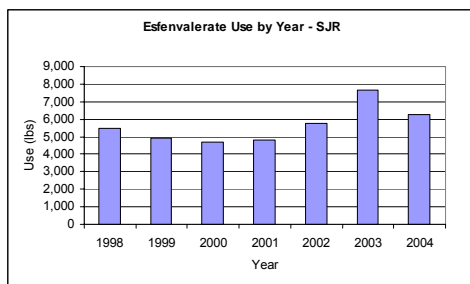
Toxicity: The 96-hour LC₅₀ for esfenvalerate ranges from 0.07 to 0.23 µg/L. The lowest toxicity value was for rainbow trout (*Oncorhynchus mykiss*).

Usage: Selected as a target pesticide because of the relatively high uses for agricultural uses in Sacramento River Watershed (SacR), San Joaquin River Watershed (SJR), and Delta Watershed (Delta).

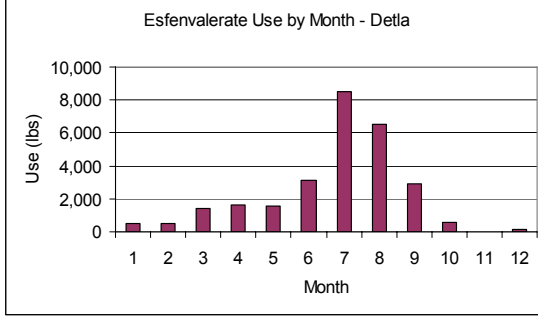
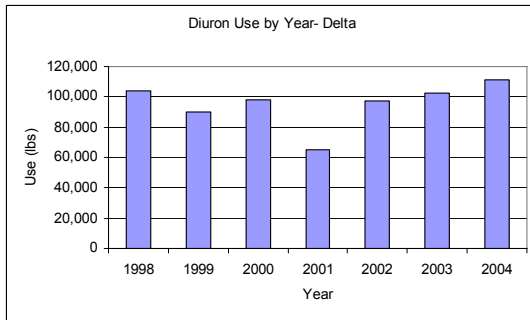
SacR: The average annual use was 5,204 lbs with the highest use (5,940 lbs) in 1999. The amounts of annual use had a slightly decreased trend from 1998 to 2004. The monthly use shows that relatively high uses were in January and July. The major applications were to prune (26%), almond (17%), and peach (15%). The average annual application area was 105,967 acres from 1998 to 2004.



SJR: The average annual esfenvalerate use was 5,660 lbs between 1998 and 2004 with the highest use (7,667 lbs) in 2003. The amounts of annual use increased from 2000 to 2003, and then decreased in 2004. The monthly use shows that the relatively high uses were in January and July. The major applications were to almond (44%), peach (14%), and tomato (11%). The average annual application area was 121,230 acres from 1998 to 2004.



Delta: The average annual use was 3,913 lbs from 1998 to 2004 with the highest use (5,184 lbs) in 1998. The amounts of annual use were in an increased trend from 2001 to 2004. The monthly use shows that relatively high uses were in July and August. The major applications were to tomato (41%) and cherry (18%). The average annual application area was 83,921 acres from 1998 to 2004.



Water quality data: The SWDB had 204 concentration data, and 3 of them exceeded LOQ (0.019 and 0.05 µg/L). The highest concentration was 0.166 µg/L.

Conclusion: Esfenvalerate is ranked as high overall risk to the surface water because of its very high toxicity. The major applications were in winter storm and irrigation seasons. The risk to sediment contamination is ranked as “potential” because of its high Koc.

Fipronil

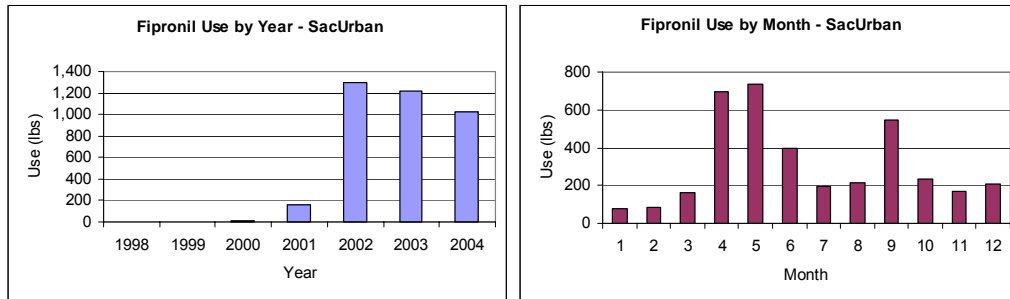
Use: Insecticide.

Physical properties: Moderate water solubility (22 mg/L) and moderate Koc (749).

Toxicity: The 96-hour LC₅₀ ranges from 0.056 to 560,000 µg/L for fishes and crustaceans. The lowest value was for mysid (*Mysidopsis bahia*).

Usage: Selected as a target pesticide because of the relatively high applications for non-agricultural uses in Sacramento County (SacUrban).

SacUrban: The average annual use was 530 lbs from 1998 to 2004 with the highest use (1,299 lbs) in 2002. The amounts of annual uses were very low from 1998 to 2001 but increased in 2002, and then decreased slightly from 2002 to 2004. The monthly uses shows that the highest uses were in April and May.



Fipronil is used to control cockroaches, ants, fleas, mole crickets, ticks, mites, subterranean termites, and flea treatments for cats and dogs for non-agricultural applications. Fipronil is also used outdoors for ornamentals and lawns.

Water quality data: There were no concentration data available in the SWDB.

Conclusion: Fipronil is ranked as high overall risk because of its very high toxicity. Although fipronil is selected as a target for non-agricultural use, fipronil is an alternate of carbofuran for rice field. However, the applications for agricultural use in the project area were very low. Fipronil is ranked as “possible” because of its moderate Koc.

Hexazinone

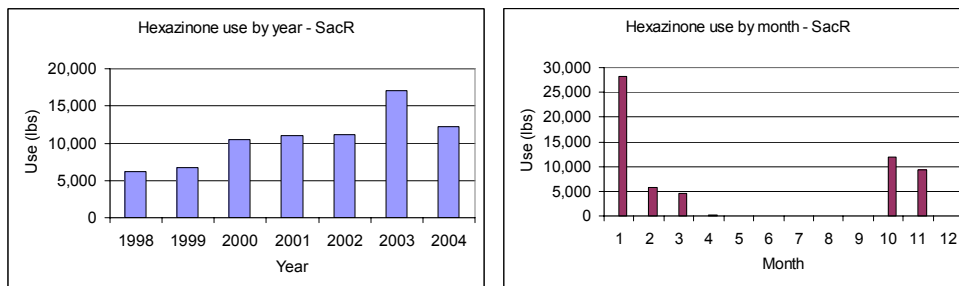
Use: Herbicide. A triazine.

Physical properties: Very high solubility (29,800 mg/L) and low Koc (41).

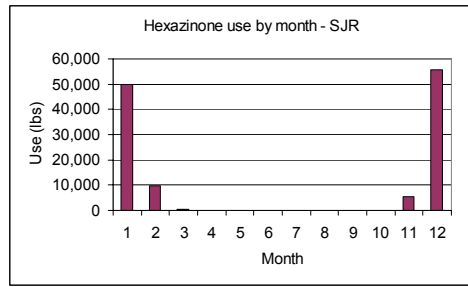
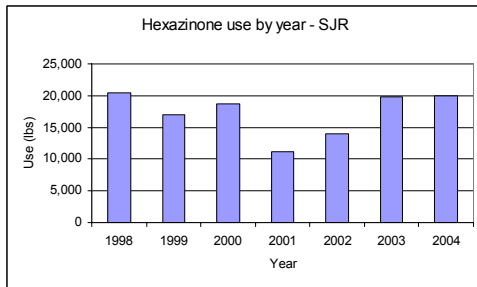
Toxicity: The 96-hour LC₅₀ ranges from 78 to 1,000,000 µg/L. The lowest 96-hour LC₅₀ value was for grass shrimp (*Palaemonetes pugio*), and the highest value was for fiddler crab (*Uca pugilator*). The EC₅₀ ranges from 6.8 to 151,600 for aquatic plants. The lowest EC₅₀ (6.8 µg/L) was for green algae (*Selenastrum capricornutum*) for a 120-hour. A 48-hour EC₅₀ had only one value that was 151,600 µg/L for water flea (*Daphnia magna*).

Usage: Selected in the target list because of the agricultural use in Delta Watershed (Delta). Although hexazinone was not selected for agricultural use in Sacramento River Watershed (SacR) and San Joaquin Watershed (SJR), the amounts of use were relatively high. The summaries of use in SacR and SJR are also presented.

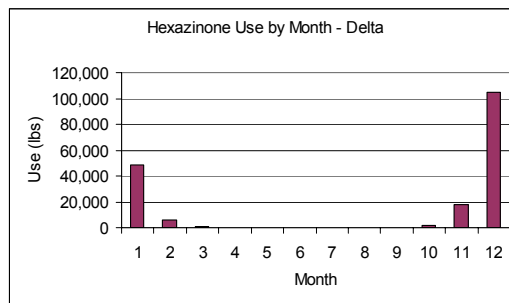
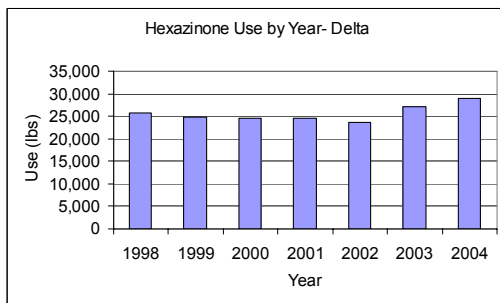
SacR: The average annual use was 10,677 lbs between 1998 and 2004 with the highest use (17,051 lbs) in 2003. The amounts of annual use increased from 1998 to 2003, and then decreased in 2004. The monthly use shows that the relatively high uses were in the winter storm season with the highest use in January. The major applications were to alfalfa (63%) and forest tree (37%). The average annual application area was 11,908 acres from 1998 to 2004.



SJR: The average annual use was 17,300 lbs between 1998 and 2004 with the highest use (20,392 lbs) in 1998. The annual use decreased from 1998 to 2001, and then increased from 2001 to 2004. The month use shows that the relatively high uses were in the winter storm season with the highest monthly uses in December and January. The major applications were to alfalfa (99%). The average annual application area was 39,533 acres from 1998 to 2004.



Delta: The average annual use was 25,635 lbs between 1998 and 2004 with the highest use (28,900 lbs) in 2004. The annual use had a slightly increased trend from 2002 to 2004. The month use shows that the relatively high uses were in the winter storm season with the highest monthly uses in December and January. The major applications were to alfalfa (99%). The average annual application area was 39,987 acres.



Water quality data: The SWDB database had 439 concentration data and the samples were collected between 1997 and 2002. Eleven of the concentration data were over the LOQ (0.05 and 0.2 µg/L), and the highest concentration was 0.581 µg/L.

Conclusion: Hexazinone is ranked as a high overall risk because of its high toxicity, increased trend of annual use, heavy applications during the storm season, and the relatively high observed concentration. The risk to sediment contamination is ranked as “unlikely” because of its low Koc.

Lambda-cyhalothrin

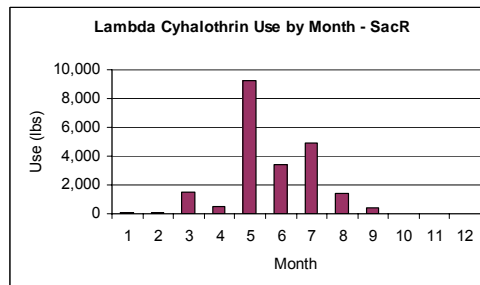
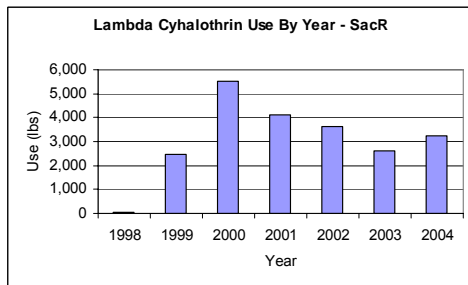
Use: Insecticide, one of the pyrethroids.

Physical properties: Very low water solubility (0.006 mg/L) and high Koc (2,341).

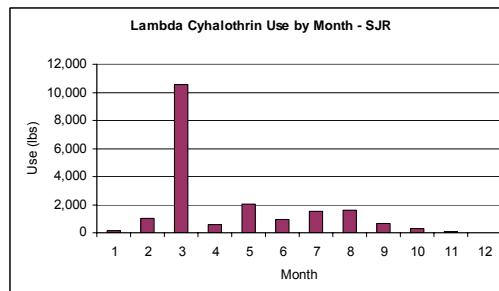
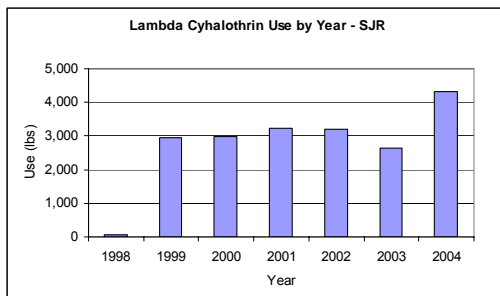
Toxicity: The 96-hour LC₅₀ values ranged from 0.0041 to 13 µg/L. The lowest value was for mysid (*Mysidopsis bahia*).

Usage: Selected as a target pesticide because the relatively high amounts of applications for agricultural uses were in the three project sub-areas: Sacramento River Watershed (SacR), San Joaquin River Watershed (SJR), and Delta Watershed (Delta).

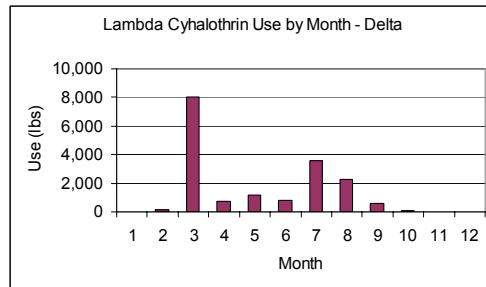
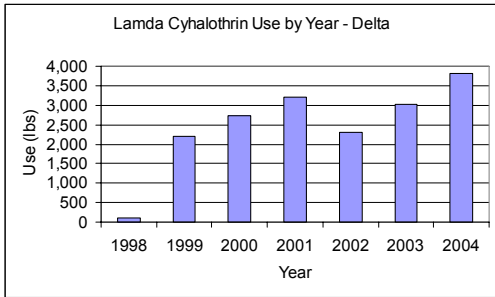
SacR: The average annual use was 3,090 lbs from 1998 to 2004 with the highest use (5,530 lbs) in 2000. The annual use had a decreased trend from 2000 to 2003, but it slightly increased in 2004. The monthly uses shows that the relatively high uses were between May and July with the highest use in May. The major applications of lambda cyhalothrin were to rice (56%), tomato (23%), and alfalfa (10%). The average annual use area was 93,491 acres from 1998 to 2004.



SJR: The average annual use was 2,775 lbs from 1998 to 2004 with the highest use (4,319 lbs) in 2004. The amounts of annual use were similarly from 1999 to 2002 but decreased in 2003, and then increased in 2004. The monthly uses shows that very high use was in March. The major applications were to alfalfa (66%), tomato (8%), and almond (8%). The average annual use was 84,810 acres from 1998 to 2004.



Delta: The average annual use was 2,482 lbs from 1998 to 2004 with the highest use (3,802 lbs) in 2004. The annual uses had increased trends from 1998 to 2001, and then from 2002 to 2004. The monthly uses shows that the highest use was in March. The major applications of lambda cyhalothrin were to alfalfa (54%), tomato (30%), and corn (5%). The average annual use was 72,471 acres.



Water quality data: The SWDB had 86 concentration data, and none of them exceeded the LOQ (0.01 and 0.02 µg/L).

Conclusion: Lambda cyhalothrin is ranked as high risk because of its very high toxicity, increased annual use trend, and relatively high uses in the winter storm season. Because of its very low water solubility and very high Koc value, the concentrations in water were difficult to be detected. The risk of sediment contamination is ranked as “potential” because of its very high Koc value.

Malathion

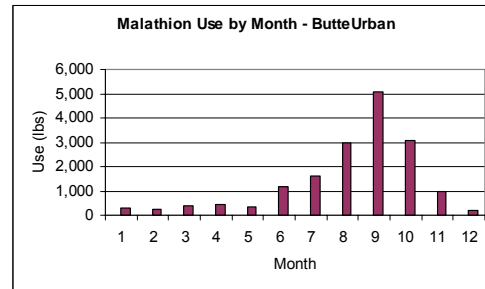
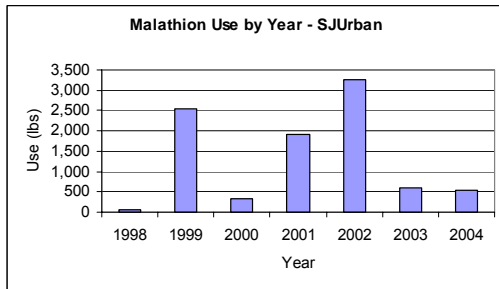
Use: Insecticide.

Physical properties: High water solubility (130 mg/L) and high Koc (1,200).

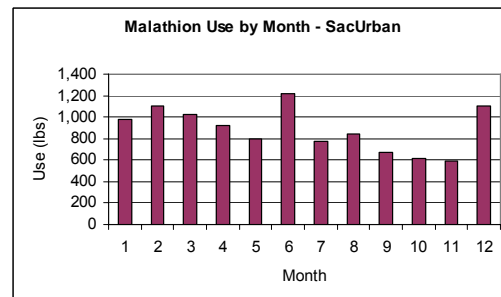
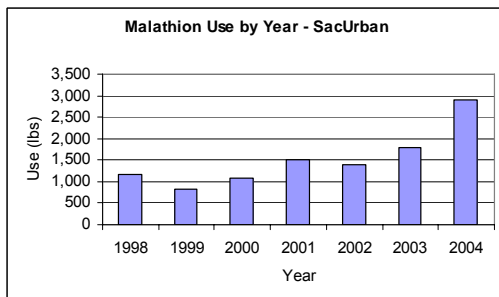
Toxicity: The 96-hour LC₅₀ ranges from 0.5 to 11,700 µg/L. The lowest LC₅₀ (0.5 µg/L) was for scud (*Gammarus fasciatus*).

Usage: Selected as a target pesticide because of relatively high amount of applications for non-agricultural uses in four counties: Butte (ButteUrban), Sacramento (SacUrban), San Joaquin (SJUrban), and Stanislaus (StanUrban). Although malathion was not selected as a target for agricultural use, the amounts used for agricultural uses were much higher than the non-agricultural uses. Therefore, malathion used for agricultural in Sacramento River Watershed (SacR) and San Joaquin River Watershed (SJR) were presented.

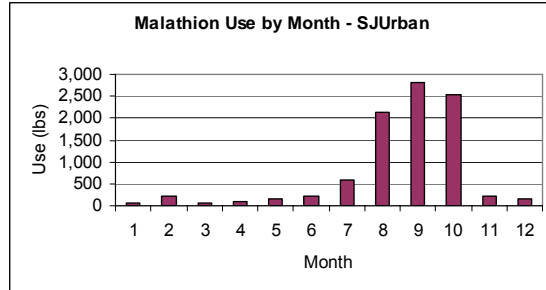
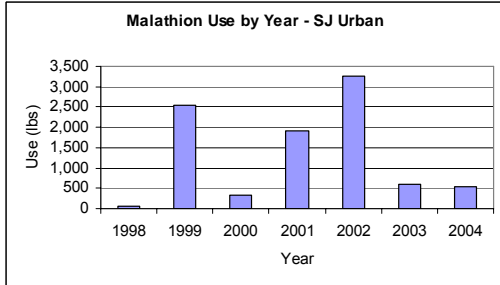
ButteUrban: The average annual use was 2,396 lbs between 1998 and 2004 with the highest use (3,589 lbs) in 2002. The annual uses had an increase trend from 1999 to 2002, but the annual uses decreased in 2003 and 2004. The monthly use shows that the relatively high applications were between July and November with the highest use in September.



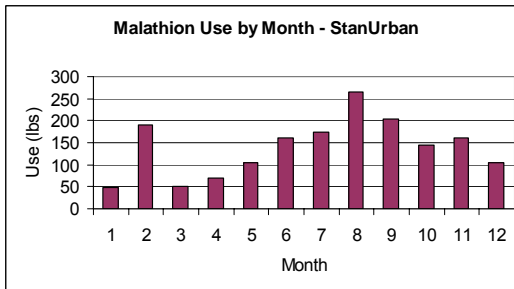
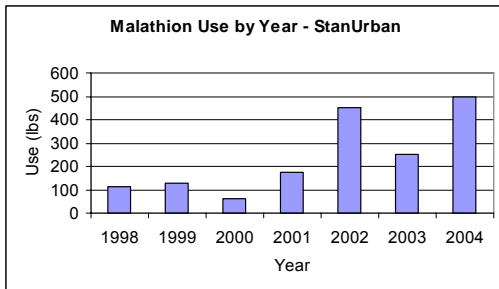
SacUrban: The average annual use was 1,521 lbs between 1998 and 2004 with the highest use (2,890 lbs) in 2004. The annual uses had an increased trend from 1999 to 2004. The monthly use shows that the applications were year-round with the highest uses in June and December.



SJUrban: The average annual use was 1,323 lbs between 1998 and 2004 with the highest use (3,247 lbs) in 2002. The annual uses varied without clear trend. The monthly application shows that the relatively high uses were between August and October with the highest use in September.

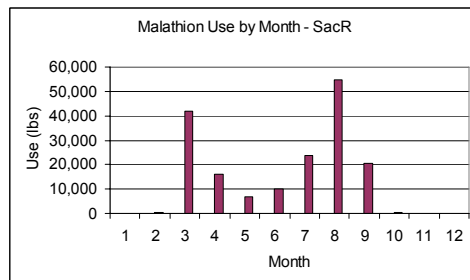
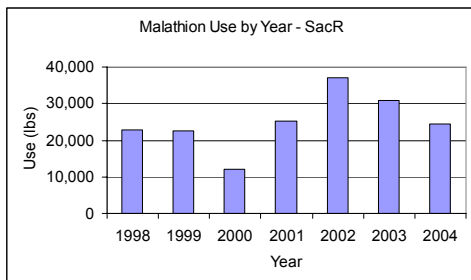


StanUrban: The average annual use was 240 lbs between 1998 and 2004 with the highest use (500 lbs) in 2004. The annual uses had an increased trend between 2000 and 2004 except for 2003. The monthly application were year-round with the relatively high uses in February, August, and September.

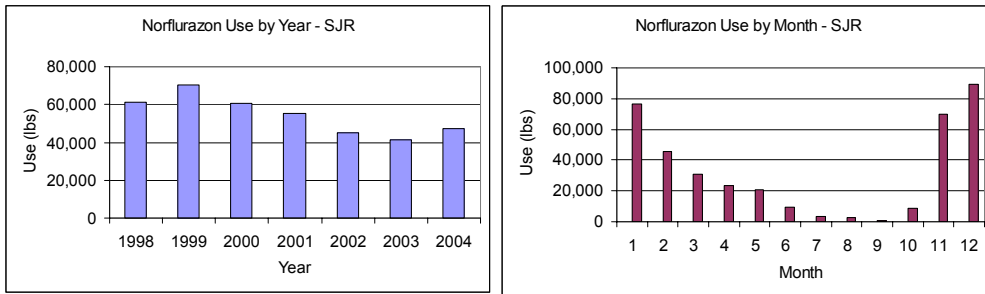


The major applications were to structural use for non-agricultural application. Malathion is also used for agricultural applications, such as alfalfa and walnut.

SacR: The average annual use was 24,960 lbs between 1998 and 2004 with the highest use (37,089 lbs) in 2002. The annual uses increased from 2000 to 2002, and then decreased from 2002 to 2004. The monthly use shows that the relatively high applications were between March and September with the highest uses in March and August.



SJR: The average annual use was 32,402 lbs between 1998 and 2004 with the highest use (40,265 lbs) in 1998. The annual uses had a decreased trend between 1999 and 2003. The monthly use shows that the applications were year-round with the relatively high uses in the winter storm season. The highest uses were in December and January.



Water quality data: The SWDB had 2,886 concentration data, and approximately 3% of concentration data exceeded LOQ (0.005 to 0.4 µg/L). The data were collected from 1991 to 2002 with the highest concentration (6 µg/L) observed in May 1996.

Conclusion: Malathion is ranked as high overall risk to surface water quality because it has very high rank of toxicity and the observed concentrations exceeded the CMC. Although malathion was not selected as a target pesticide for agricultural use, the amounts of malathion used for agricultural use in SacR and SJR were much higher than the amounts applied for non-agricultural use. Malathion is ranked as "potential" risk to contaminate sediments because of its high Koc.

Mancozeb

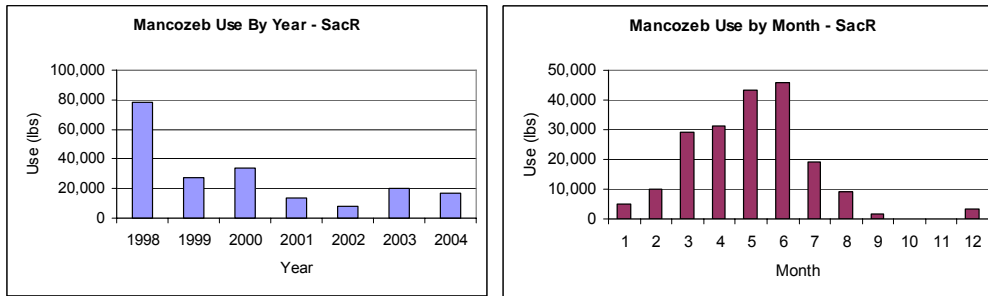
Use: Fungicide

Physical properties: Low water solubility (6 mg/L) and high Koc (6,000).

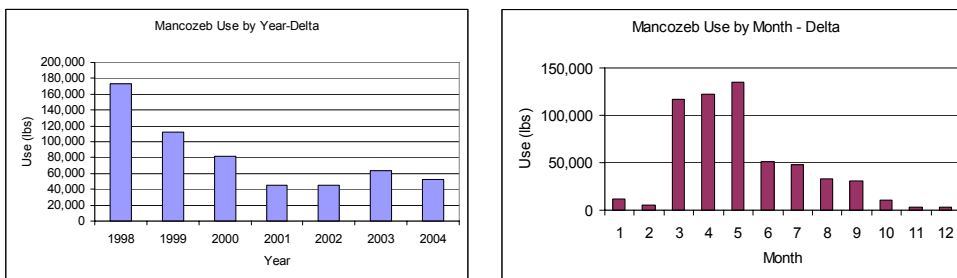
Toxicity: The toxicity data showed that 96-hour LC₅₀ values range from 9.5 to 2,040 µg/L. The lowest value was for mysid (*Mysidopsis bahia*).

Usage: Selected as a target pesticide because of its relatively high amounts of applications for agricultural and non-agricultural uses. The uses for agricultural were in the two sub-areas: Sacramento River watershed (SacR) and Delta watershed (Delta). The uses for non-agricultural applications were in Sacramento County (SacUrban).

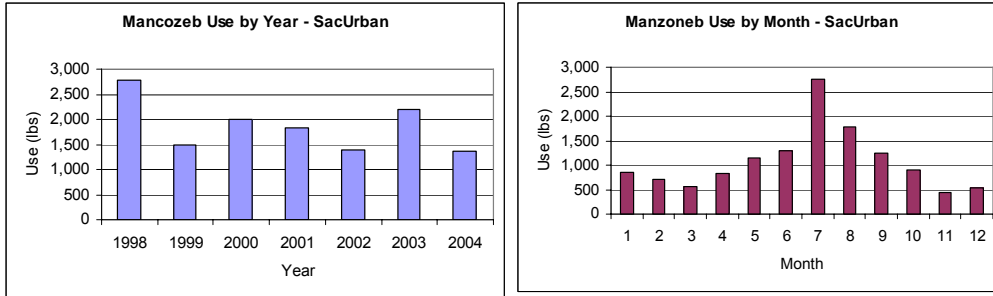
SacR: The average annual use was 28,327 lbs with the highest use (78,557 lbs) in 1998. The amount of use decreased from 1998 to 2004. The monthly uses shows that relatively high uses were between March and July with the highest use in June. The major applications were to tomato (71%), onion (18%), and pear (5%). The average annual applications area was 20,547 acres.



Delta: The average annual use was 81,805 lbs with the highest use (173,670 lbs) in 1998. The amount of use was in a decreased trend from 1998 to 2004. The monthly use shows that the relatively high uses were between March and May with the highest use in May. The major applications were to tomato (26%), potato (13%), and pear (12%). The average annual application area was 47,827 acres.



SacUrban: The average annual use was 1,864 lbs with the highest use (2,781 lbs) in 1998. The amount of use was in a decrease trend in general from 1998 to 2004. The monthly use shows that the applications were year-round with the highest use in July.



Water quality data: There were no concentration data in the SWDB.

Conclusion: Mancozeb is ranked as high overall risk to surface water quality because of its high toxicity and relatively high applications during the winter storm season (in March). However, the overall risk could be reduced because the annual uses reduced significantly in recently years. In addition, its low water solubility and short half-life in water (less than 1.5 days) may pose lower risk to contaminate in water column. The DPR has a report for environmental fate of mancozeb (DPR, 2004). The risk to sediment contamination is ranked as "potential" because of its high Koc.

Maneb

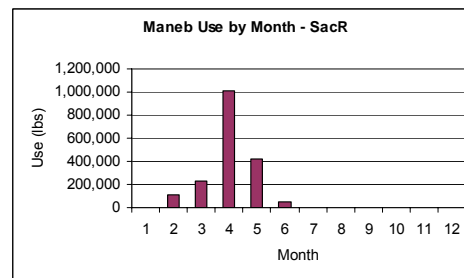
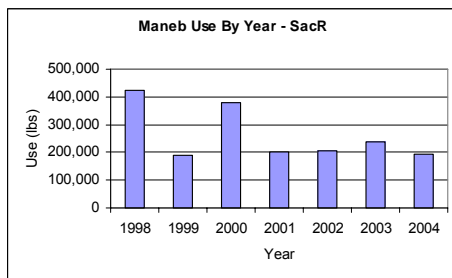
Use: Fungicide.

Physical properties: Low water solubility (6 mg/L) and moderate Koc (240).

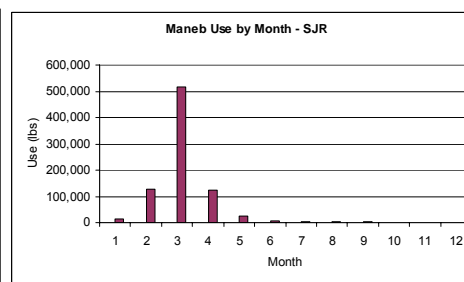
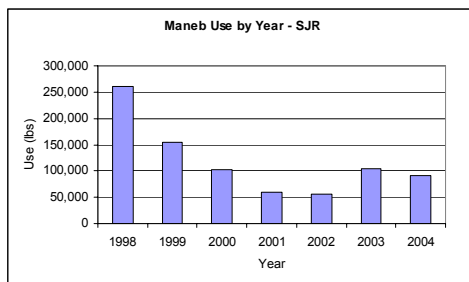
Toxicity: The 96-hour LC₅₀ ranged from 33 to 1,000 µg/L. The lowest LC₅₀ was for mysid (*Mysidopsis bahia*).

Usage: Selected as a target pesticide because of its relatively high applications for agricultural uses in Sacramento River Watershed (SacR), San Joaquin River Watershed (SJR), and Delta Watershed (Delta).

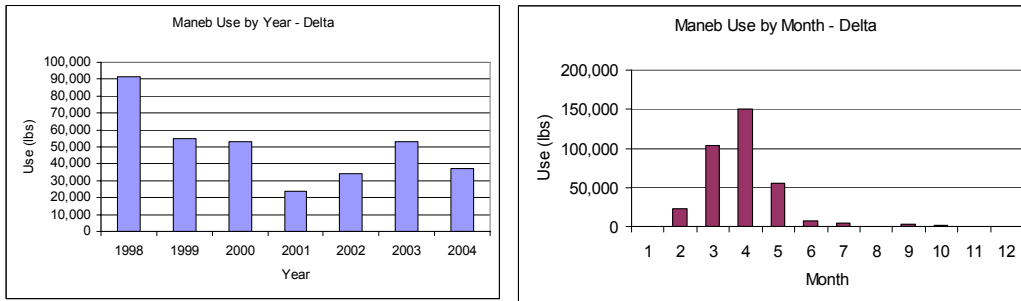
SacR: The average annual use was 261,282 lbs between 1998 and 2004 with the highest use (442,443 lbs) in 1998. The annual uses decreased from 2001 to 2004 except for 2000. The monthly use shows that the relatively high applications were between March and May with the highest use in April. The major applications were to walnut (84%) and almond (12%). The average annual application area was 128,882 acres.



SJR: The average annual use was 118,150 lbs between 1998 and 2004 with the highest use (261,543 lbs) in 1998. The annual uses had a decreased trend between 1998 and 2002. The annual uses in 2003 and 2004 were slightly higher than the amount used in 2002. The monthly use shows that the highest use was in March. The major crops applied were to almond (75%), walnut (17%), and tomato (3%). The average annual application area was 41,339 acres.



Delta: The average annual use was 49,721 lbs between 1998 and 2004 with the highest use (91,673 lbs) in 1998. The annual uses decreased from 1998 to 2001, and then increased from 2001 to 2003. The amount of annual use in 2004 was lower than that used in 2003. The monthly use shows that the relatively high uses were between March and May with the highest use in April. The major crops applied were to walnut (68%), almond (21%), and tomato (6%). The average annual application area was 26,302 acres.



Water quality data: There were no concentration data in the SWDB.

Conclusion: Maneb is ranked as high overall risk to surface water quality because of its high toxicity, and the relatively high amount used in the storm season (March). The rank of risk could be lower if considering the reduction of annual use and low water solubility. The sediment contamination risk is ranked as "possible" because of its moderate Koc.

Oxyfluorfen

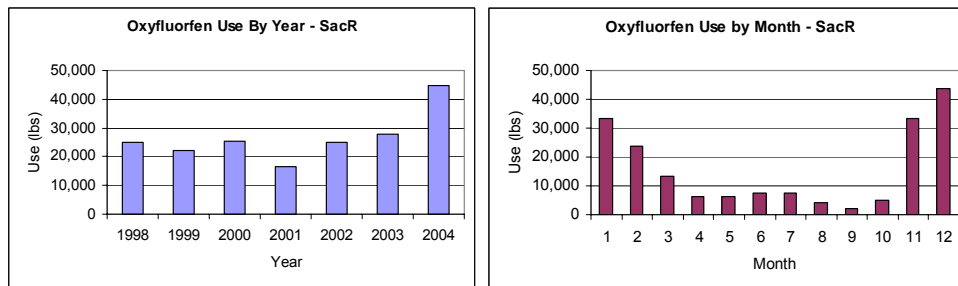
Use: Herbicide.

Physical properties: Very low water solubility (0.1 mg/L) and very high Koc (100,000).

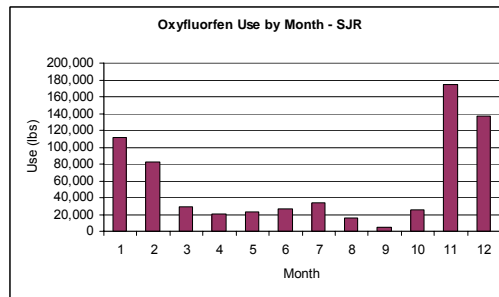
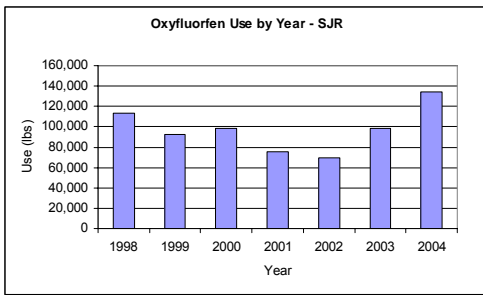
Toxicity: The 96-hour LC₅₀ ranges from 31.7 to 1,000,000 µg/L. The lowest LC₅₀ was for grass shrimp (*Palaemonetes pugio*). The EC₅₀ ranges from 0.29 to 2.9 µg/L for aquatic plants between 96 hours and 10 days. The lowest 96-hour EC₅₀ value was for green algae (*Selenastrum capricornutum*).

Usage: Selected as a target pesticide because of its relatively high amounts of applications for agricultural uses in three sub-areas, and for non-agricultural uses in two counties. The three sub-areas are Sacramento River Watershed (SacR), San Joaquin River Watershed (SJR), and Delta Watershed (Delta). The two counties are San Joaquin (SJUrban) and Stanislaus (StanUrban).

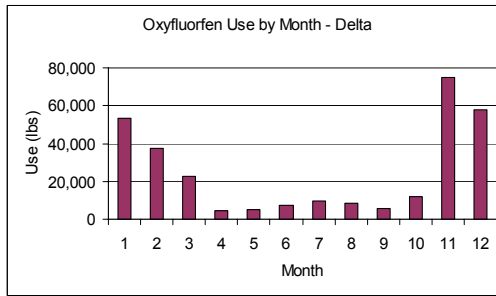
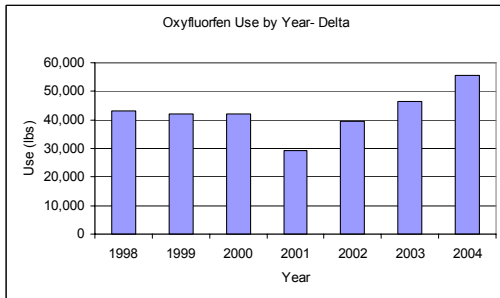
SacR: The average annual use was 26,615 lbs from 1998 to 2004 with the highest use (44,601 lbs) in 2004. The annual uses had an increase trend between 2001 and 2004. The relatively high use months were November, December, January, and February. The major applications were to almond (45%), walnut (18%), and uncultivated agricultural area (9%). The average annual application area was 149,900 acres.



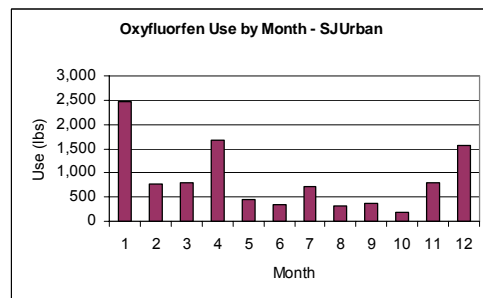
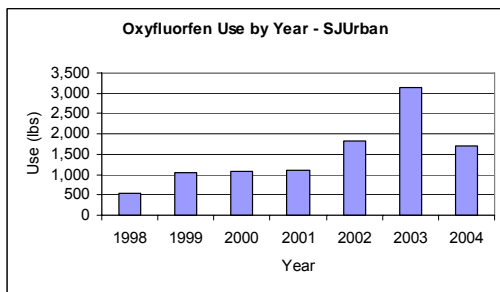
SJR: The average annual use was 97,477 lbs from 1998 to 2004 with the highest use (134,626 lbs) in 2004. The annual uses decreased slightly from 1998 to 2001, and then increased from 2001 to 2004. The relatively high use months are November, December, January, and February. The highest monthly use was in December. The major applications were to almond (51%), cotton (13%), and grape (11%). The average annual application area was 338,679 acres.



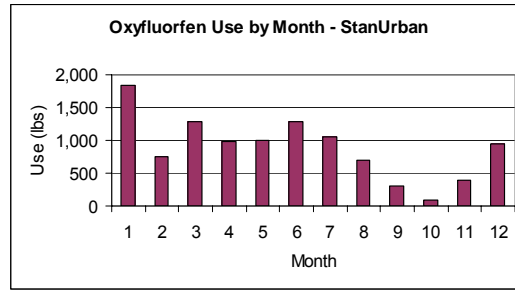
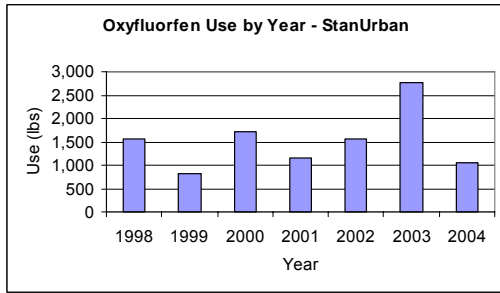
Delta: The average annual use was 42,629 lbs from 1998 to 2004 with the highest use (55,616 lbs) 2004. The annual uses decreased from 1998 to 2001, and then increased from 2001 to 2004. The relatively high use months were November, December, January, and February. The highest use was in November. The major applications are to grape (38%) and walnut (17%). The average annual application area was 159,478 acres.



SJUrban: The average annual use was 1,490 lbs from 1998 to 2004 with the highest use (3,131 lbs) in 2003. The annual uses increased from 1998 to 2003, and then decreased in 2004. The monthly use shows that the applications were year-round with the highest use in January.



StanUrban: The average annual use was 1,519 lbs from 1998 to 2004 with the highest use (2,776 lbs) in 2003. The annual use had an increased trend from 1999 to 2003. The monthly use shows that the applications were year-round with the highest use in January.



Water quality data: There were no concentration data in the SWDB.

Conclusion: Oxyfluorfen is ranked as high overall risk because of its very high toxicity. The annual uses had increased trends for both of agricultural and non-agricultural uses. The risk to water column may be lower because oxyfluorfen has very low water solubility and short half-life in water. The risk to sediment contamination is ranked as “potential” because of its high Koc.

Paraquat dichloride

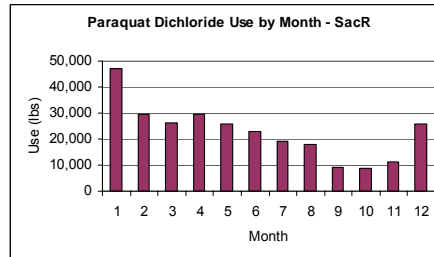
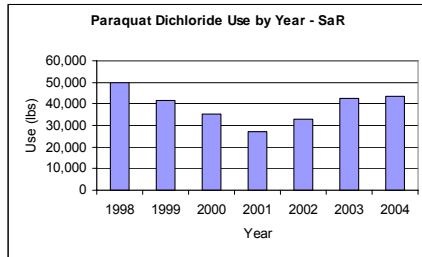
Use: Herbicide.

Physical properties: Very high water solubility (620,000 mg/L) and very high Koc (162,000).

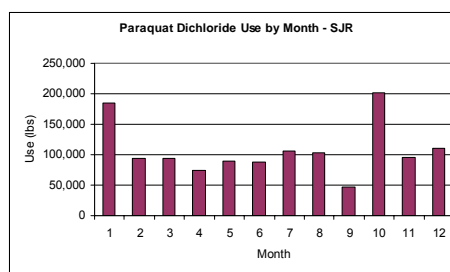
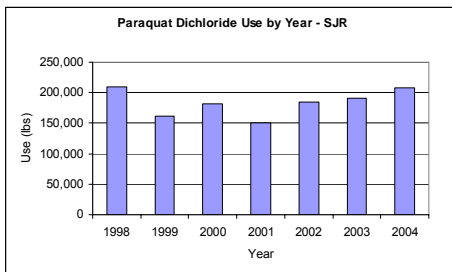
Toxicity: The 96-hour LC₅₀ ranges from 11,000 to 156,000 µg/L. The lowest LC₅₀ was for scud (*Gammarus fasciatus*). The E C₅₀ ranges from 0.55 to 50,000 µg/L for aquatic plants between 96 hours and 14 days. The lowest 96-hour EC₅₀ value was for freshwater diatom (*Navicula pelliculosa*).

Usage: Selected as a target pesticide because of the relatively high uses for agricultural applications in three sub-areas: Sacramento River Watershed (SacR), San Joaquin River Watershed (SJR), and Delta Watershed (Delta).

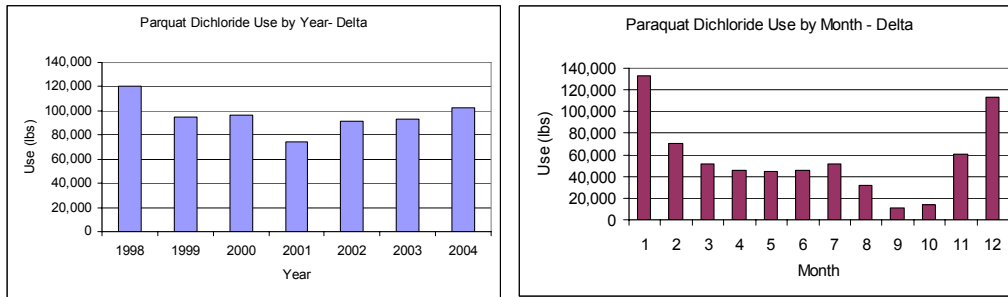
SacR: The average annual use was 38,999 lbs with the highest use (4,978 lbs) in 1998. The annual use decreased from 1998 to 2001, and then increased from 2001 to 2004. The monthly use shows the applications were almost year-round with the highest use in January. The major applications were to alfalfa (28%), almond (22%), and walnut (11%). The average annual area of applications was 52,936 acres.



SJR: The average annual use was 184,083 lbs with the highest use (209,602 lbs) in 1998. The annual uses were in a slightly increased trend between 2001 and 2004. The monthly uses were year-round, and the highest uses were in October and January. The major applications were to almond (26%), cotton (25%), and alfalfa (19%). The average annual area of application was 292,804 acres.



Delta: The average annual use was 96,194 lbs with the highest use (120,697 lbs) in 1998. The annual use decreased from 1998 to 2001, and then slightly increased from 2001 to 2004. The monthly applications were almost year-round with the highest uses in January and December. The major applications were to grape (37%) and alfalfa (31%). The average annual area of application was 158,685 acres.



Water quality data: There were no concentration data available in the SWDB.

Conclusion: Paraquat dichloride is ranked as high overall risk because of its high toxicity, high water solubility, increased trends in annual applications, and relatively high amount uses in the winter storm season. Paraquat dichloride is an herbicide, so it is highly toxic to aquatic plants but slightly toxic to aquatic animals. Sediment contamination risk is ranked as "potential" because of its high Koc.

Pendimethalin

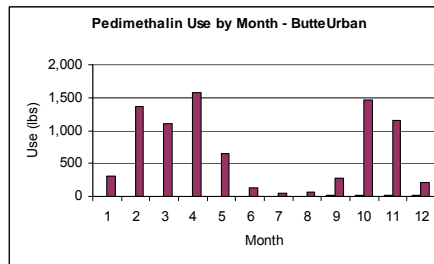
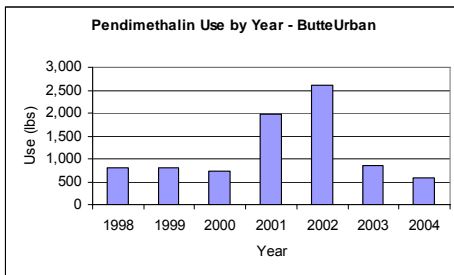
Use: Herbicide

Physical properties: Very low water solubility (0.225 mg/L) and very high Koc (13,400).

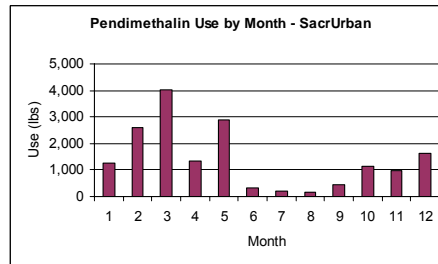
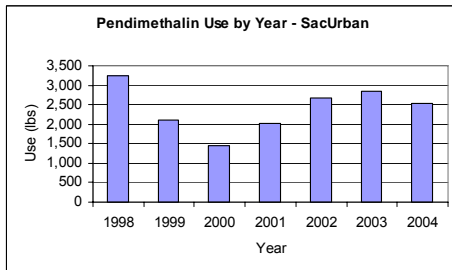
Toxicity: The 96-hr LC₅₀ ranges from 400 to 1,600 µg/L. The 5-d EC₅₀ ranges from 5.2 to 174 µg/L for aquatic plants. The lowest EC₅₀ was for marine diatom (*Skeletonema costatum*).

Usage: Selected as a target pesticide because of its relatively high uses for non-agricultural applications in three counties: Butte (ButteUrban), Sacramento (SacUrban), and San Joaquin (SJUrban).

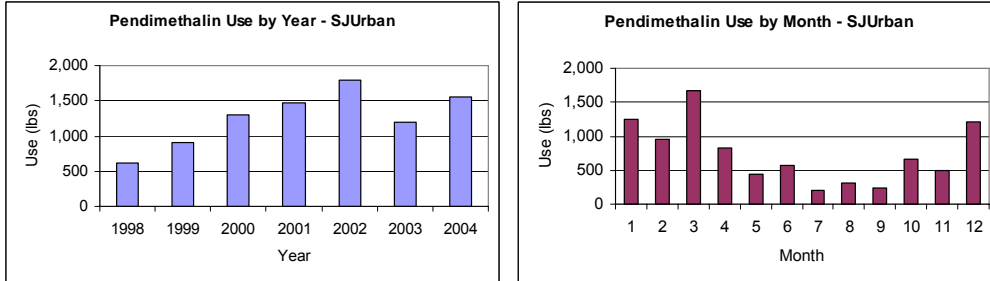
ButteUrban: The average annual use was 1,193 lbs from 1998 to 2004 with the highest use (2,598 lbs) in 2002. The annual uses increased from 2000 to 2002, and then decreased from 2002 to 2004. The monthly use shows that relatively high uses were in February, March, April, October, and November.



SacUrban: The average annual use was 2,413 lbs from 1998 to 2004 with the highest use (3,255 lbs) in 1998. The annual use increased from 2000 to 2003, and then slightly decreased in 2004. The monthly use shows that the highest use was in March.

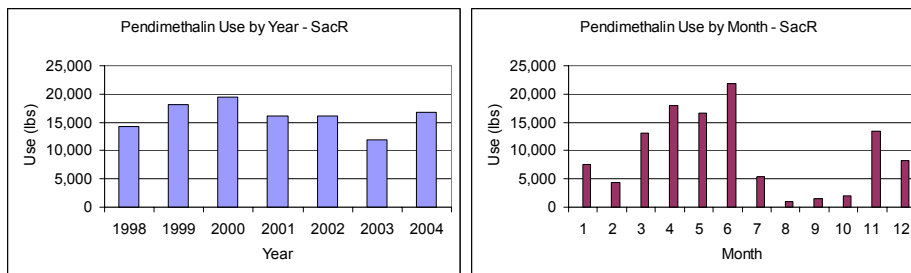


SJUrban: The average annual use was 1,262 lbs from 1998 to 2004 with the highest use (1,790 lbs) in 2002. The annual use increased from 1998 to 2002, and then slightly decreased in 2003 and 2004. The monthly use shows that the highest use was in March.

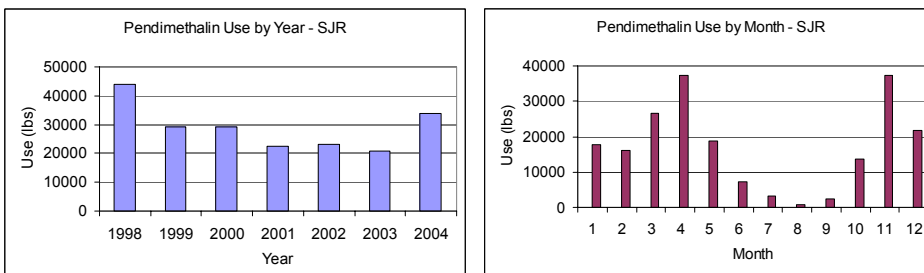


Pendimethalin was mainly applied for “rights of way” for control grasses and broadleaf weeds. Pendimethalin was also used for agricultural applications and the amounts of annual uses were much higher than that for non-agricultural uses. The main uses were to almond, walnut, and rice field.

SacR: The average annual use was 16,113 lbs from 1998 to 2004 with the highest use (1,790 lbs) in 2002. The annual use decreased from 2000 to 2003, and then slightly increased in 2003 and 2004. The monthly use shows that the applications were year-round with relatively high uses between March to June. The highest use was in June.



SJR: The average annual use was 28,962 lbs from 1998 to 2004 with the highest use (44,097 lbs) in 1998. The annual use decreased from 1998 to 2003, and then slightly increased in 2004. The monthly use shows that the applications were year-round with relatively low uses between June and September. The highest uses were in April and November.



Water quality data: There were over 500 pendimethalin concentration data in the SWDB and about 11% of data exceeded LOQ (0.004 to 0.1 µg/L). The highest concentration was 0.7 µg/L observed in January 1996. The highest concentration was lower than the lowest toxicity value (5.2 µg/L).

Conclusion: Pendimethalin is ranked as high overall risk to surface water because of its high toxicity, relatively high use in the winter storm season (November to March), and slightly increased annual uses in recent years in some sub-areas. In addition, pendimethalin has very low water solubility, but the observed concentration had over 11% of data detected. The annual use may be expected to be lower in the future because the US EPA issued a notice to cancel the use of pendimethalin voluntarily. The risk to sediment contamination is ranked as “potential” because of its high K_{oc}.

Permethrin

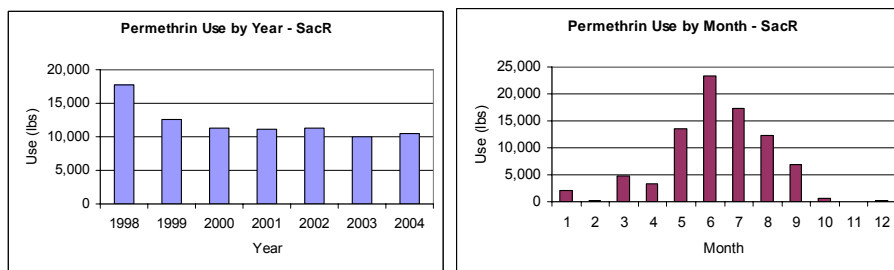
Use: Insecticide, one of the pyrethroids.

Physical properties: Very low water solubility (0.006 mg/L) and very high Koc (393,000).

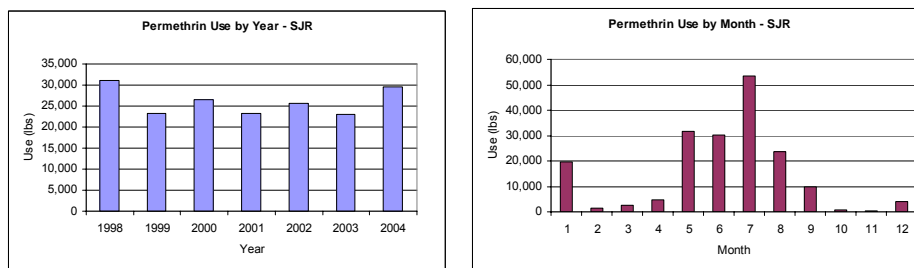
Toxicity: The 96-hour LC₅₀ ranges from 0.019 to 300 µg/L. The lowest LC₅₀ was for mysid (*Mysidopsis bahia*).

Usage: Selected as a target pesticide because of its relatively high amounts of application for agricultural uses in three sub-areas and for non-agricultural uses in four counties. The three sub-areas are Sacramento River Watershed (SacR), San Joaquin River Watershed (SJR), and Delta Watershed (Delta). The four counties are Butte (ButteUrban), Sacramento (SacUrban), San Joaquin (SJUrban), and Stanislaus (StanUrban).

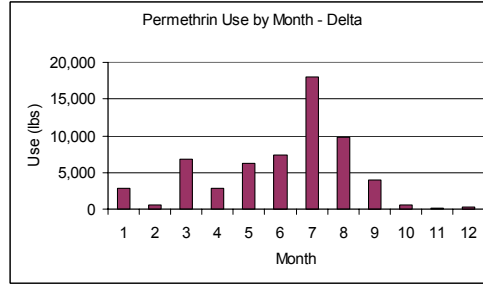
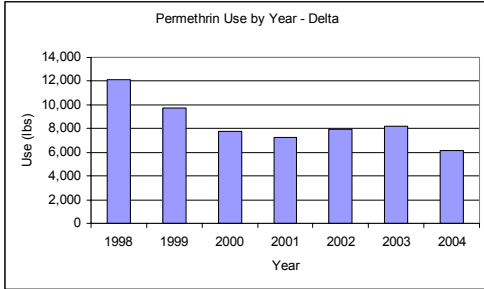
SacR: The average annual use was 12,075 lbs with the highest use (17,697 lbs) in 1998. The annual uses had a decreased trend from 1998 to 2004. The relatively high monthly uses were from May to September with the highest use in June. The major applications were to peach (31%), walnut (19%), and alfalfa (13%). The average annual area of applications was 59,212 acres.



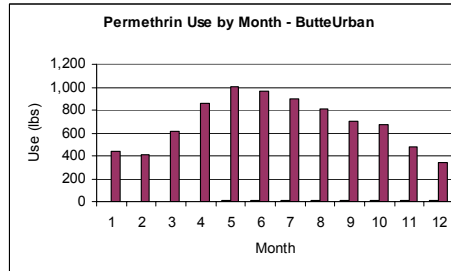
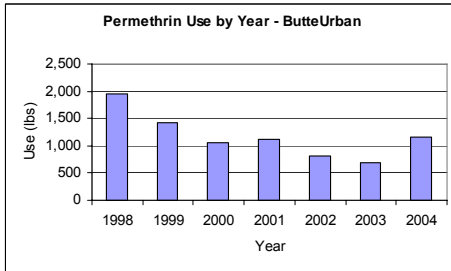
SJR: The average annual use was 26,055 lbs with the highest use (31,102 lbs) in 1998. The annual uses had a slightly decreased trend from 1998 to 2003 but 2004. The relatively high monthly uses were in January and from May to August. The highest use was in July. The major applications were to almond (46%), pistachio (27%), and peach (7%). The average annual area of application was 124,536 acres.



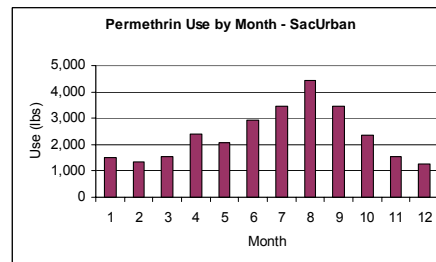
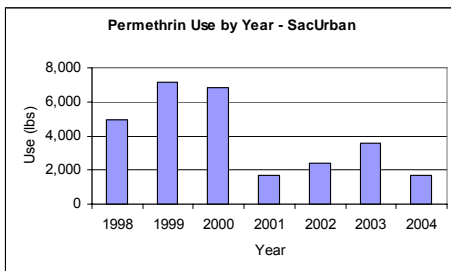
Delta: The average annual use was 8,448 lbs with the highest use (12,116 lbs) in 1998. The annual uses had a decreased trend from 1998 to 2004. The monthly use shows that the relatively high uses were from March to September with the highest use in July. The major applications were to alfalfa (23%), almond (22%), and tomato (15%). The average annual application area was 47,843 acres.



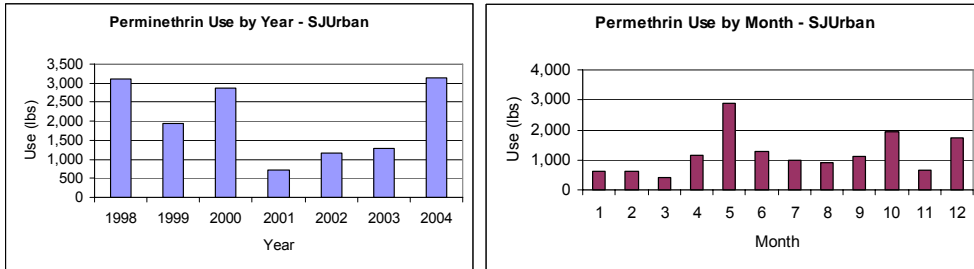
ButteUrban: The average annual use was 1,172 lbs with the highest use (1,954 lbs) in 1998. The annual uses had a decreased trend from 1998 to 2003 but slightly higher in 2004. The monthly use were year-round with relatively high uses from March to October, and the highest use was in May.



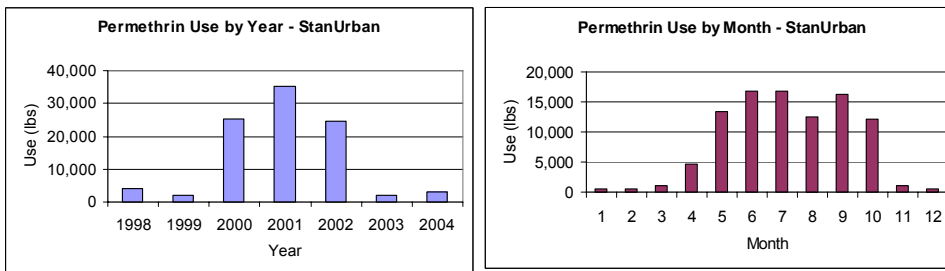
SacUrban: The average annual use was 4,048 lbs with the highest use (7,165 lbs) in 1999. The annual uses were much lower between 2001 and 2004 than the period of 1998 to 2000. The monthly uses were year-round with the highest use in August.



SJUrban: The average annual use was 2,038 lbs with the highest use (3,142 lbs) in 2004. The annual uses had an increased trend from 2001 to 2004. The monthly use shows that the applications were year-round with the highest use in May.



StanUrban: The average annual use was 13,763 lbs with the highest use (35,214 lbs) in 2001. The annual uses between 2000 and 2002 were much higher than the other years'. The monthly use shows that relatively high uses were between May and October with the highest uses in June and July.



Water quality data: There were over 400 concentration data in the SWDB, and none of them exceeded the LOQ (0.0005 to 0.05 µg/L). The data were from six monitoring studies between 1994 and 2003.

Conclusion: Permethrin is ranked as high risk because of its very high toxicity. The annual uses had increased trends in SJR and SJUrban but decreased trends in Delta and StanUrban. Like other pyrethroid insecticides, permethrin has very low water solubility and very high Koc. The sediment risk is ranked as “potential” because of its high Koc.

Propanil

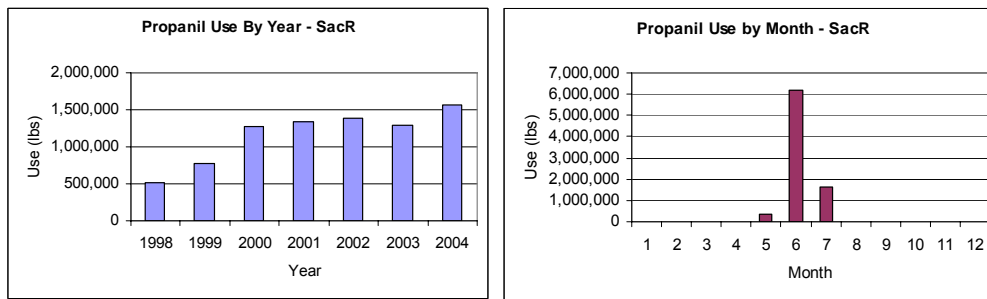
Use: Herbicide.

Physical properties: High water solubility (152 mg/L) and moderate Koc (400).

Toxicity: The 96-hour LC₅₀ ranges 400 to 16,000 µg/L for aquatic animals, and the lowest LC₅₀ was for mysid (*Mysidopsis bahia*). The EC₅₀ ranges from 16 to 110 µg/L for aquatic plants between 5 and 14 days. The lowest 5-day EC₅₀ was for freshwater diatom (*Navicula pelliculosa*).

Usage: Selected as a target pesticide because of its relatively high amounts of use for agricultural applications in Sacramento River Watershed (SacR).

SacR: The average annual use was 1,167,069 lbs from 1998 to 2004 with the highest use (1,564,306 lbs) in 2004. The annual uses had an increased trend from 1998 to 2004. The monthly use shows that the highest use was in June. Over 99% of applications were to rice. The average annual area was 274,496 acres.



Water quality data: There were 406 concentration data in the SWDB, and almost 10% of data exceeded LOQs (0.004 to 0.25 µg/L). The highest concentration (20.6 µg/L) was detected in May 2001. The highest concentration was far below the lowest LC₅₀ (400 µg/L) for aquatic animals but higher than the lowest EC₅₀ (16 µg/L) for aquatic plants.

Conclusion: Propanil is ranked as high overall risk because it has high toxicity to aquatic plant and the amounts of annual use have been increased in recent years. Propanil is an herbicide used on rice field. It is highly toxic to aquatic plant but moderately toxic to aquatic animals. The risk to sediment is ranked as "possible" because propanil has moderate Koc.

Propargite

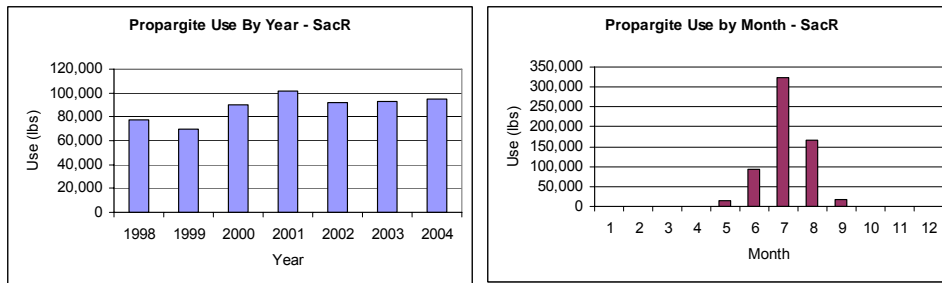
Use: Insecticide.

Physical properties: Very low solubility (0.6 mg/L) and high Koc (5,578).

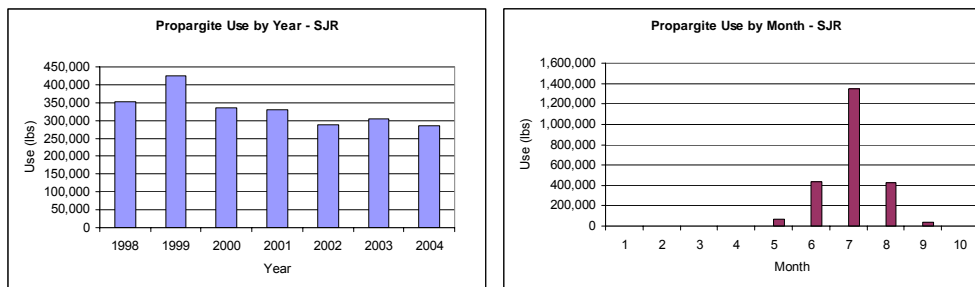
Toxicity: The 96-hour LC₅₀ ranged from 31 to 3,700 µg/L. The lowest LC₅₀ was for bluegill sunfish (*Lepomis macrochirus*).

Usage: Selected as a target pesticide because of its relatively high amount of applications for agricultural uses in the three project sub-areas: Sacramento River Watershed (SacR), San Joaquin River Watershed (SJR), and Delta Watershed (Delta).

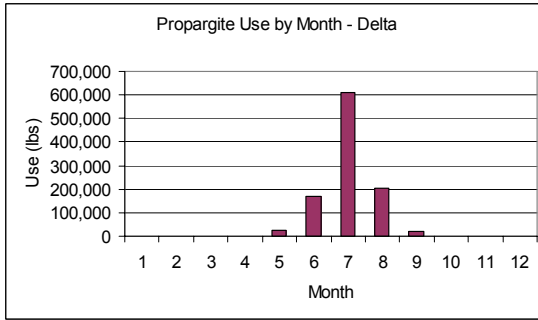
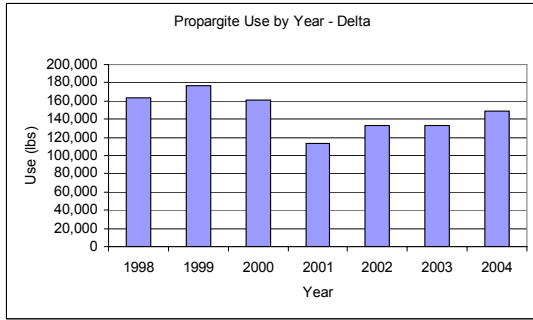
SacR: The average annual propargite use was 88,129 lbs from 1998 to 2004 with the highest use (101,261 lbs) in 2001. The annual use had a slight increased trend from 1998 to 2004. The monthly use shows that the applications were between June and August with the highest use in July. The major applications were to almond (43%), walnut (23%), and cotton (9%). The average annual application area was 59,777 acres.



SJR: The average annual propargite use was 331,618 lbs from 1998 to 2004 with the highest use (424,962 lbs) in 1999. The annual uses had a decreased trend from 1999 to 2004. The monthly use shows that the relatively high uses were between June and August with the highest use in July. The major applications were to almond (35%), corn (34%), and grape (7%). The average annual application area was 180,899 acres.



Delta: The average annual use was 147,001 lbs from 1998 to 2004 with the highest use (177,435 lbs) in 1999. The annual use decreased from 1999 to 2001, and then increased from 2001 to 2004. The monthly use shows that the relatively high uses were between June and August with the highest use in July. The major applications were to corn (21%), walnut (21%), and grape (20%). The average annual application area was 81,703 acres.



Water quality data: The SWDB had 324 concentration data and 11% of data exceeded LOQ (0.013, 0.014, and 0.023 µg/L). The highest concentration (20 µg/L) was detected in August 2001.

Conclusion: Propargite is ranked as high overall risk because of its high toxicity and increased trends of annual uses. There are almost no uses in the winters. The risk to sediment contamination is ranked as “potential” because of its high Koc.

Pyraclostrobin

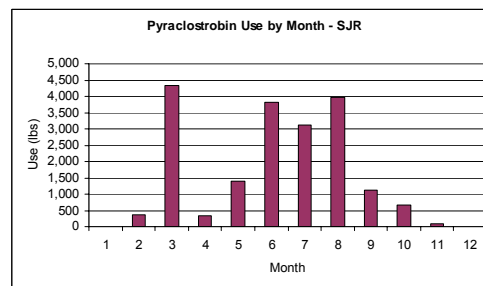
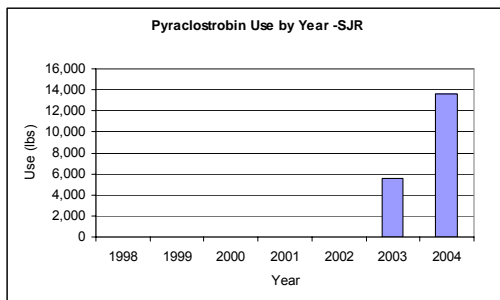
Use: Fungicide

Physical properties: Moderate solubility (19 mg/L) and low Koc (93).

Toxicity: The 96-hour LC₅₀ ranges from 4.16 to 99,180 µg/L. The lowest 96-hour LC₅₀ was for mysid (*Mysidopsis bahia*) and the highest value was for rainbow trout (*Oncorhynchus mykiss*).

Usage: Selected as a target pesticide because of the applications for agricultural use in San Joaquin River Watershed (SJR).

SJR: The PUR database has only two years (2003 and 2004) data reportedly during the seven-year period (1998 to 2004). The annual average use was 9,611 lbs between 2003 and 2004 with the highest use (13,642 lbs) in 2004. The annual use in 2004 was about twice of used in 2003. The monthly use shows that relatively high uses were in March, and between June and August. The major applications were to pistachio (28%), almond (24%), and tomato (22%). The annual average application area was 75,522 acres between 2003 and 2004.



Water quality data: There were no concentration data available in the SWDB.

Conclusion: Pyraclostrobin is ranked as a high overall risk because of its high toxicity and high amount of applications in the winter storm season (March). Pyraclostrobin is a relatively new pesticide and only have two years pesticides use data. Monitoring may be needed. The sediment contamination risk is ranked as “unlikely” because of its low Koc.

Simazine

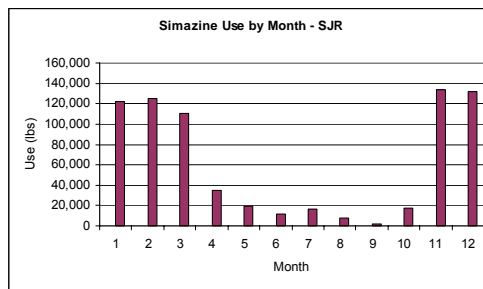
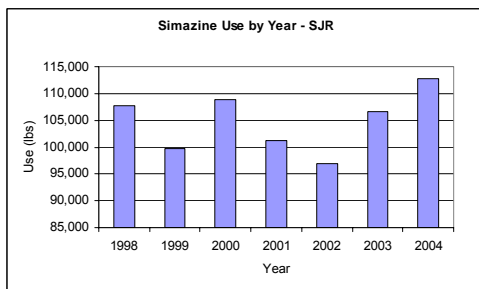
Use: Herbicide.

Physical properties: Low solubility (6.2 mg/L), moderate Koc (140).

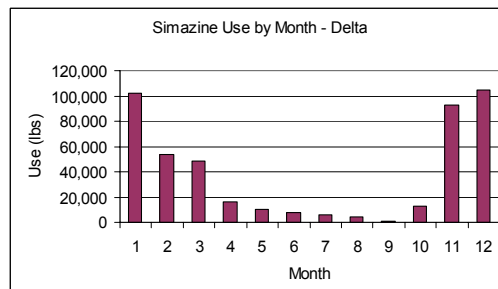
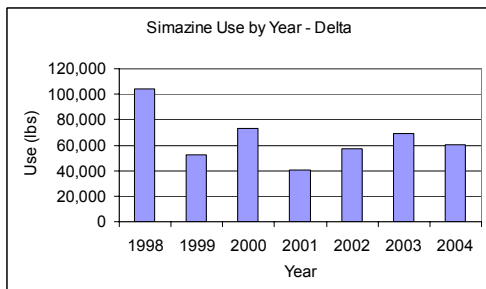
Toxicity: The 96-hour LC₅₀ ranges from 4,300 to 1,000,000 µg/L for aquatic animals. The lowest LC₅₀ was for sheepshead minnow (*Cyprinodon variegates*). The EC₅₀ ranges from 36 to 5,000 µg/L for aquatic plants between 5 and 14 days. The lowest 5-day EC₅₀ was for bluegreen algae (*Anabaena flos-aquae*).

Usage: Selected as a target pesticide because of the relatively high applications for both agricultural and non-agricultural uses. The agricultural uses are in two sub-areas: San Joaquin River Watershed (SJR) and Delta Watershed (Delta). The non-agricultural uses are in three counties: Sacramento (SacUrban), San Joaquin (SJUrban), and Stanislaus (StanUrban).

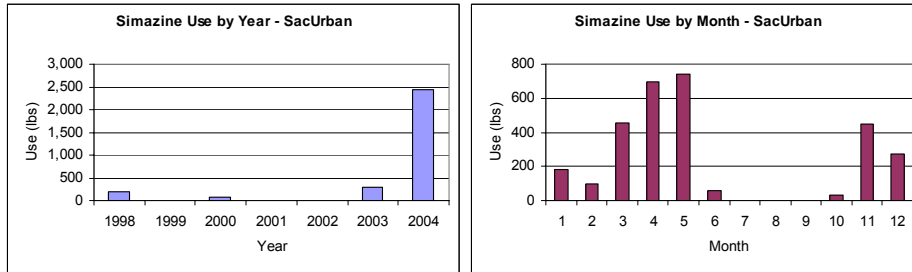
SJR: The annual average use was 104,800 lbs from 1998 to 2004 with the highest amount of use (112,786 lbs) in 2004. The annual uses decreased from 2000 to 2002 and then increased from 2002 to 2004. The relatively high monthly applications were in the winter storm season, and the highest use was in November. The major applications were to almond (54%) and grape (33%). The average annual area of use was 151,596 acres.



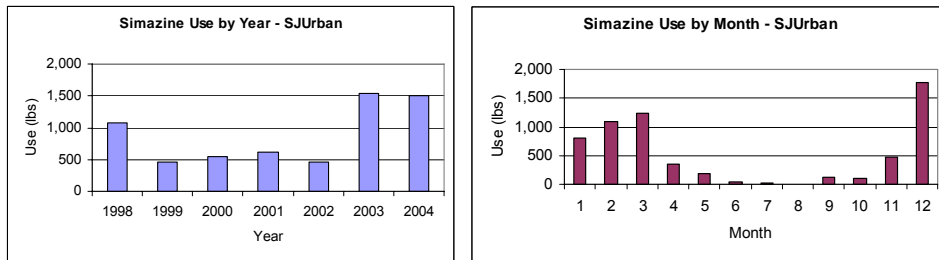
Delta: The annual average use was 65,370 lbs from 1998 to 2004 with the highest amount of use (103,873 lbs) in 1998. The annual uses decreased from 1998 to 2001, and then slightly increased from 2001 to 2003. The relatively high monthly uses were in the winter storm season, and the highest use was in December. The major applications were to grape (68%) and almond (15%). The average annual area of use was 61,235 acres.



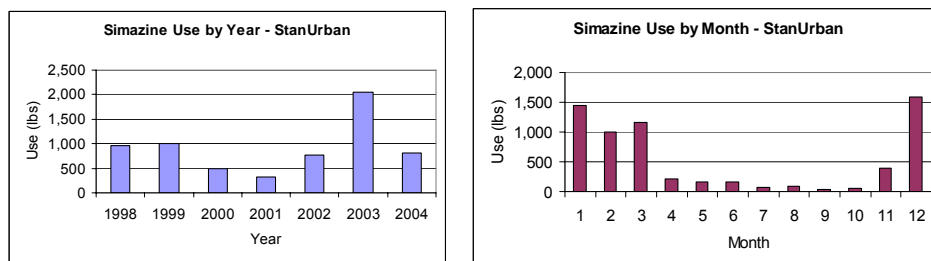
SacUrban: The annual average use was 498 lbs from 1998 to 2004 with the highest amount of use (2,428 lbs) in 1998. The annual use in 2004 was much higher than the other years'. The monthly use shows that the relatively high uses were between March and May with the highest use in May.



SJUrban: The annual average use was 885 lbs from 1998 to 2004 with the highest use (1,542 lbs) in 2003. The annual uses in 2003 and 2004 were much higher than the other years'. The monthly use shows that the relatively high uses were in the winter season with the highest use in December.



StanUrban: The annual average use was 912 lbs from 1998 to 2004 with the highest use (2,047 lbs) in 2003. The annual use in 2003 was much higher than the other years'. The monthly use shows that the relatively high uses were in the winter season with the highest use in December.



Water quality data: The SWDB had 1,848 concentration data, and 35% of data exceeded LOQ (0.005 to 0.5 µg/L). The highest concentration was 6.1 µg/L observed in April 1996. The highest observed concentration (6.1 µg/L) was lower than the lowest LC₅₀ (4,300 µg/L) and EC₅₀ (36 µg/L).

Conclusion: Simazine is ranked as high overall risk for the surface water quality. The overall risk ranked as high because the major applications were during the winter storm season and the annual uses had increased trend for both agricultural and non-agricultural applications. Simazine has low water solubility, so observed concentration is not used as a factor in overall risk ranking. Sediment contamination is ranked as possible because of its moderate Koc.

In addition, the DPR staff recommended including simazine in the target list because it has been detected.

Trifluralin

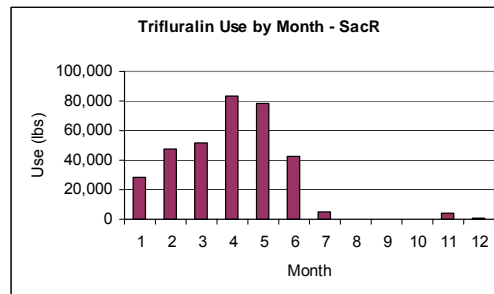
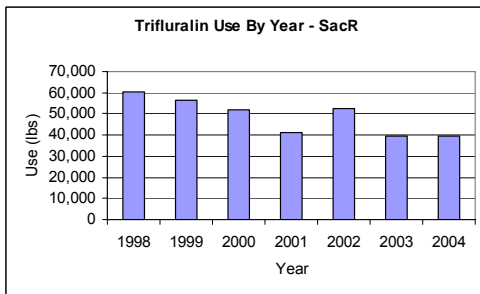
Use: Herbicide.

Physical properties: Very low water solubility (0.3 mg/L) and high Koc (8,000).

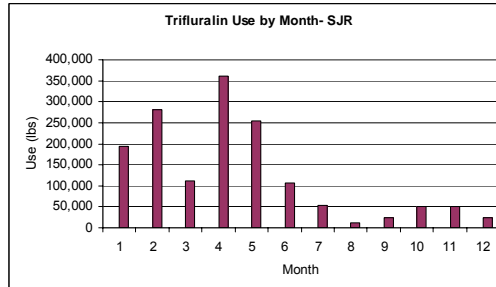
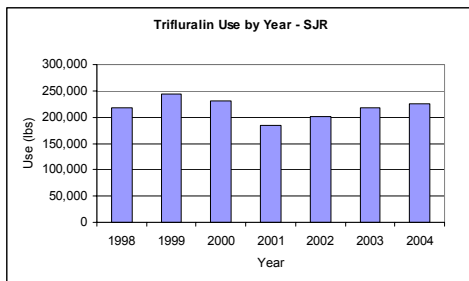
Toxicity: The 96-hour LC₅₀ ranges from 8.4 to 22,000 µg/L for fishes and crustaceans. The lowest LC₅₀ was for bluegill sunfish (*Lepomis macrochirus*). The EC₅₀ ranges from 15.3 to 5,000 µg/L for aquatic plants between 5 and 14 days. The lowest 5-day EC₅₀ value was for freshwater diatom (*Navicula pelliculosa*).

Usage: Selected as a target pesticide because of its relatively high amounts of uses for agricultural and non-agricultural applications. The relatively high uses for agricultural applications are in three sub-areas: Sacramento River Watershed (SacR), San Joaquin River Watershed (SJR), and Delta Watershed (Delta). The non-agricultural applications are in Sacramento County (SacUrban).

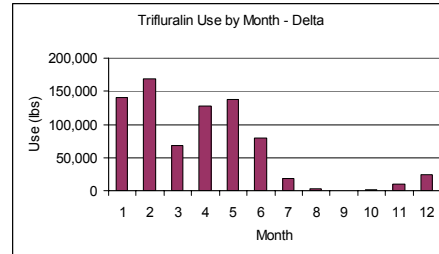
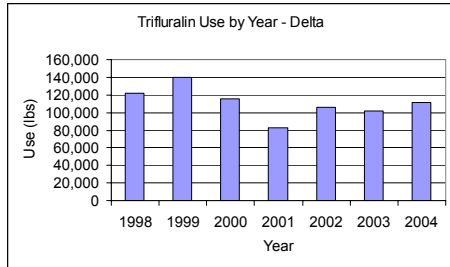
SacR: The average annual use was 48,844 lbs with the highest use (60,164 lbs) in 1998. The annual use had a decreased trend from 1998 to 2004 except for 2002. The monthly use shows that relatively high uses were from January to June with the highest uses in April and May. The major applications were to tomato (51%), safflower (18%), and alfalfa (9%). The average annual application area was 63,142 acres.



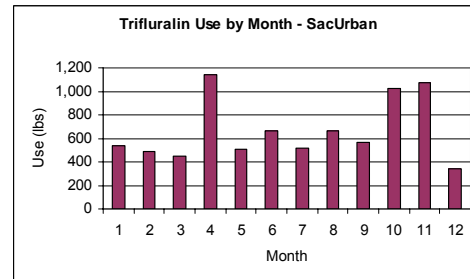
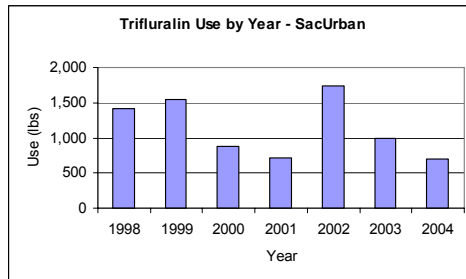
SJR: The average annual use was 217,512 lbs with the highest use (245,029 lbs) in 1999. The annual use had a slightly increased trend from 2001 to 2004. The monthly use shows that the relatively high uses were from January to June with the highest use in April. The major applications were to alfalfa (37%), cotton (24%), and tomato (17%). The average annual area was 63,142 acres.



Delta: The average annual use was 111,221 lbs with the highest use (139,904 lbs) in 1999. The annual use had a slightly increased trend from 2001 to 2004. The monthly use shows that the relatively high uses were from January to June with the highest use in February. The major applications were to tomato (45%), alfalfa (27%), and safflower (12%). The average annual area was 63,142 acres.



SacUrban: The average annual use was 1,139 lbs with the highest use (1,741 lbs) in 2002. The annual use had a slightly decreased trend from 2002 to 2004. The monthly use shows that the applications were year-round with the highest use in April.



Water quality data: The DPR SWDB had 1,279 concentration data, and about 11% of data exceeded LOQ (0.002 to 0.1 µg/L). The highest concentration was 1.74 µg/L observed in May 2001.

Conclusion: Trifluralin is ranked as high overall risk because of its high toxicity value, and relatively high uses in the storm season. The low water solubility could result in low observed concentration in water column. The risk for sediment contamination is ranked as “potential” because trifluralin has high Koc.

Ziram

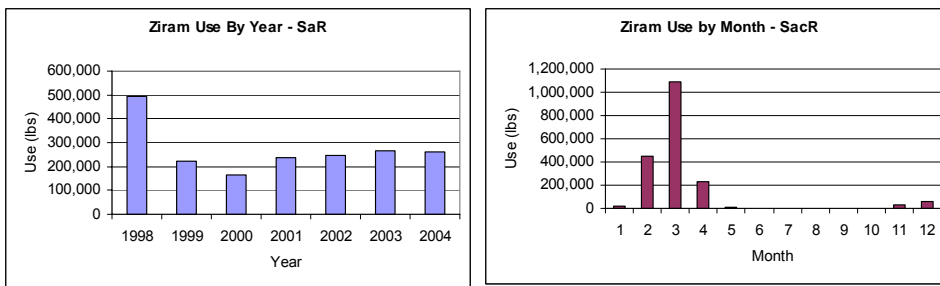
Use: Fungicide.

Physical properties: Moderate solubility (65 mg/L) and moderate Koc (400).

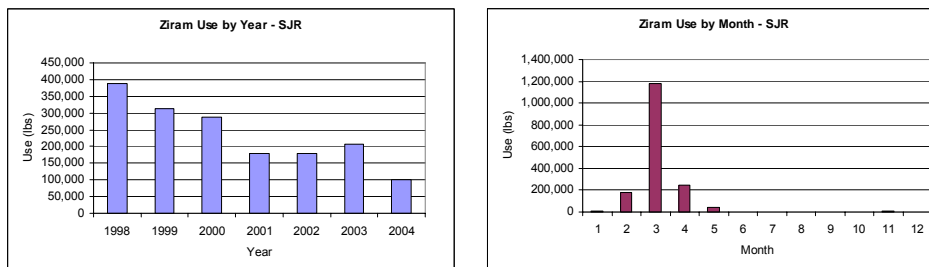
Toxicity: The 96-hour LC₅₀ ranges from 8 to 1,700 µg/L. The lowest value was for fathead minnow (*Pimephales promelas*).

Usage: Ziram was selected as a target pesticide because of its relatively high applications for agricultural applications in Sacramento River Watershed (SacR) and San Joaquin River Watershed (SJR).

SacR: The average annual use was 270,515 lbs with the highest amount of use (494,527 lbs) in 1998. The annual use had a slightly increased trend from 1999 to 2004. The monthly use shows that relatively high applications were between February and April with the highest use in March. The major applications were to almond (68%), peach (26%), and pear (5%). The average annual application area was 52,671 acres.



SJR: The average annual use was 236,447 lbs with the highest amount of use (389,423 lbs) in 1998. The annual uses were in a decreased trend between 1998 and 2004. The monthly use shows that the highest use was in March. The major applications were to almond (76%), peach (7%), and grape (7%). The average annual application area was 52,671 acres.



Water quality data: There was no concentration data in the SWDB.

Conclusion: Ziram is ranked as high overall risk for surface water quality because of its high toxicity and the winter runoff potential. The annual use trend varies with locations. The SacR has increased trend but the SJR has decreased trend. The sediment contamination is ranked as “possible” because of its moderate Koc.

Appendix B. Moderate Overall Relative-Risk Pesticides

Bromacil

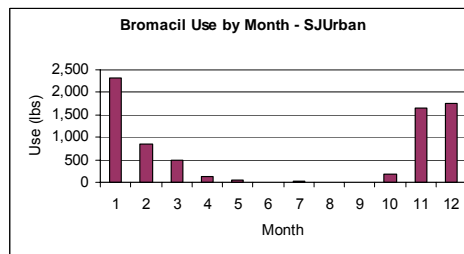
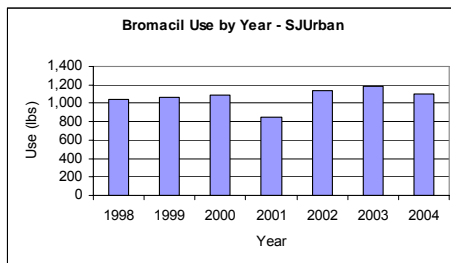
Use: Herbicide

Physical properties: High water solubility (700 mg/L) and low Koc (14).

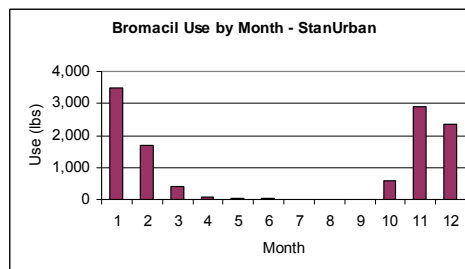
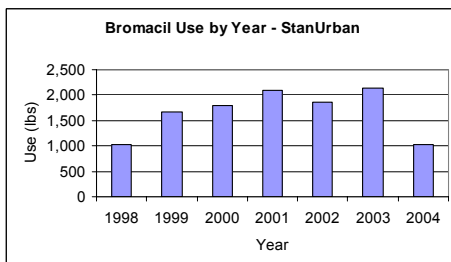
Toxicity: The 96-hour LC₅₀ range from 32,000 to 180,000 µg/L. The lowest value was for bluegill sunfish (*Lepomis macrochirus*). The 5-d EC₅₀ ranges from 6.8 to 69.9 µg/L for aquatic plants. The lowest value was for green algae (*Selenastrum capricornutum*).

Usage: Selected as a target pesticide because of its relatively high uses for non-agricultural applications in two counties: San Joaquin (SJUrban) and Stanislaus (StanUrban).

SJUrban: The average annual use was 1,066 lbs from 1998 to 2004 with the highest use (1,182 lbs) in 2004. The annual uses increased slightly from 2001 to 2003. The monthly use shows that relatively high uses were in the winter storm season and the highest use was in January.

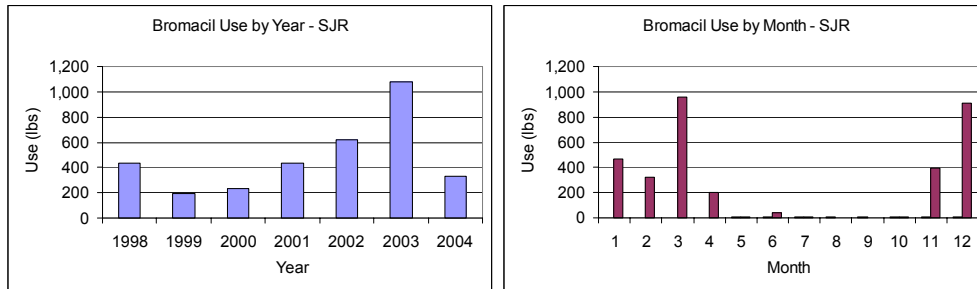


StanUrban: The average annual use was 1,654 lbs from 1998 to 2004 with the highest use (2,132 lbs) in 2003. The annual uses had slightly increased trend from 1998 to 2003. The monthly use shows that the relatively high uses were in the winter storm season, and the highest use was in January.



The major applications of bromacil were to “right of way” brush control for non-agricultural use. Bromacil was also applied for agricultural use but the amount of use was much lower than the non-agricultural uses. The annual use in San Joaquin River Watershed (SJR) is presented.

SJR: The average annual use was 476 lbs from 1998 to 2004 with the highest use (1,083 lbs) in 2003. The annual uses had an increased trend from 1999 to 2003, and then decreased in 2004. The monthly use shows that the relatively high uses were in the winter storm season with the highest use in March.



Water quality data: There were more than 600 concentration data in the SWDB, and 7% of data exceeded LOQ (0.035 to 5 µg/L). The highest concentration (1 µg/L) was detected in October 2000.

Conclusion: Bromacil is ranked as moderate overall risk because of the highest observed concentrations (1 µg /L) in surface water below the lowest toxicity value (6.8 µg /L). However, the overall risk could be ranked as high because bromacil has high water solubility and its major application time is in the winter storm season. The risk to sediment contamination is ranked as “unlikely” because of low Koc.

Captan

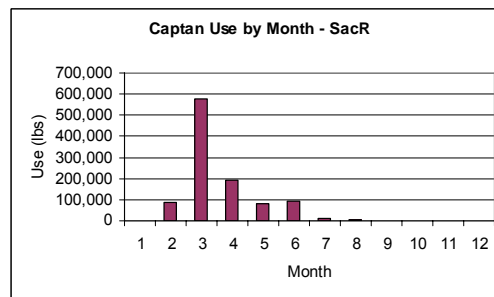
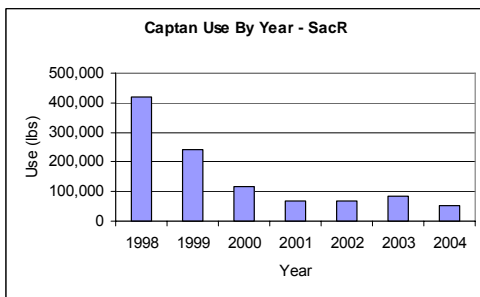
Use: Fungicide.

Physical properties: Low water solubility (5.1 mg/L) and moderate Koc (151).

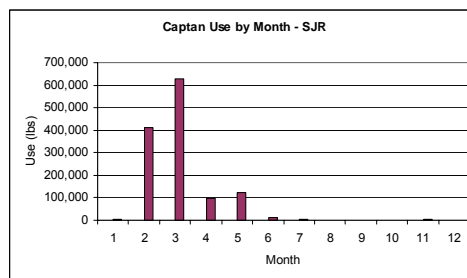
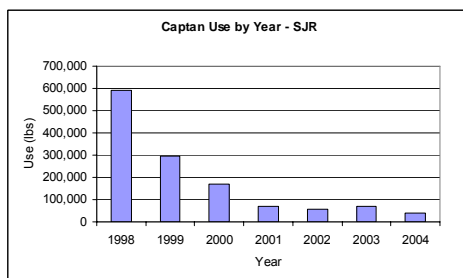
Toxicity: The 96-hour LC₅₀ ranges from 26 to 8,400 µg/L for fishes and crustaceans. The lowest value was for brown trout (*Salmo trutta*).

Usage: Selected as a target pesticides because of its relatively high uses in both agricultural and non-agricultural applications. The relatively high amount uses for agricultural uses are in Sacramento River Watershed (SacR) and San Joaquin River Watershed (SJR). The two counties with relatively high uses for non-agricultural applications are Butte (ButteUrban) and Stanislaus (StanUrban).

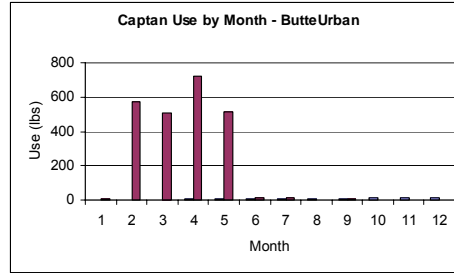
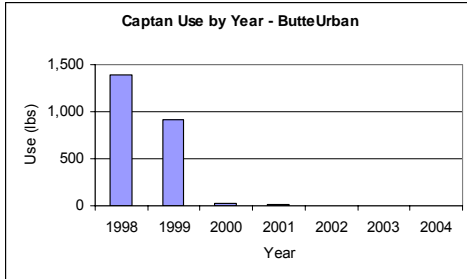
SacR: The average annual use was 150,086 lbs from 1998 to 2004 with the highest use (418,150 lbs) in 1998. The amounts of annual use were in a decreased trend from 1998 to 2004. The monthly use shows the relatively high uses were between February and June with the highest use in March. The major applications were to almond (51%), prune (42%), and corn (3%). The average annual use was 50,358 acres.



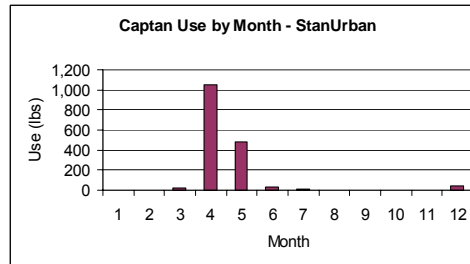
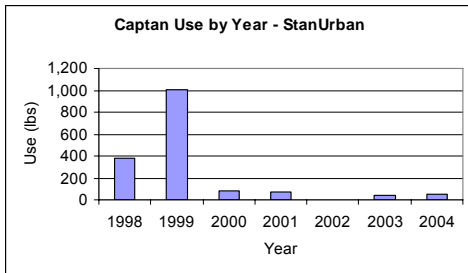
SJR: The average annual use was 184,363 lbs from 1998 to 2004 with the highest use of 590,450 lbs in 1998. The annual use was in a decreased trend from 1998 to 2004. The monthly use shows that the relative high uses were in February and March with the highest use in March. The major applications were to almond (82%), peach (5%), and corn (4%). The average annual use was 70,655 acres.



ButteUrban: The average annual use was 470 lbs from 1998 to 2004 with the highest use of 1,393 lbs in 1998. The amounts of annual use were in a decreased trend with no any uses from 2002 to 2004. The relative high uses were between February and May with the highest use occurring in April.



StanUrban: The average annual use was 272 lbs from 1998 to 2004 with the highest use of 1,009 lbs in 1999. The amounts of annual uses were very low from 2000 to 2004. The relative high uses were in April and May with the highest use occurring in April.



Water quality data: There were no concentration data in the SWDB.

Conclusion: Captan is ranked as moderate overall risk to surface water quality because of its high reduction of use. Although relatively high use was in the storm water, the detected concentration in the surface water could be low because of its low water solubility. The risk to sediment contamination is ranked as “possible” because of its moderate Koc.

Carbaryl

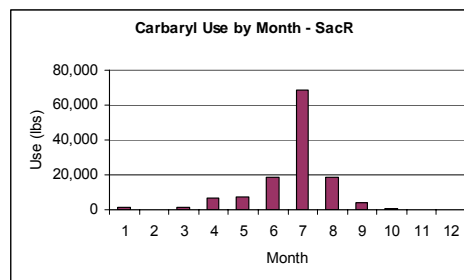
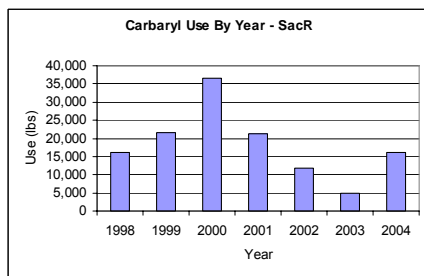
Use: Insecticide.

Physical properties: High water solubility (110 mg/L) and moderate Koc (288).

Toxicity: The 96-hour LC₅₀ ranged from 1.9 to 20,000 µg/L. The lowest value was for crayfish (*Procambarus sp.*).

Usage: Selected in the target list because of the relatively high amount of use for agricultural applications in Sacramento River watershed (SacR).

SacR: The annual average use was 18,335 lbs between 1998 and 2004 with the highest amount of use (36,645 lbs) in 2000. The amount of annual use decreased from 2000 to 2003, and then slightly increased in 2004. The monthly use shows that the relatively high uses were from June to August with the highest use in July. The major applications were to melon (29%), rice (23%), and tomato (11%). The average annual area was 17,179 acres.



Water quality data: The SWDB had almost 2,000 concentration data and about 4% of the data exceeded LOQ (0.003 to 1 µg/L). The highest concentration was 0.5 µg/L observed in May 1997. The highest concentration was lower than the CDFG proposed CMC and CCC values (2.53 µg/L), and also lower than the lowest LC₅₀ value (1.9 µg/L).

Conclusion: Carbaryl is ranked as moderate overall risk to the surface water quality because the observed concentrations are lower than the lowest toxicity value and proposed CMC. Since Carbaryl has high water solubility, the risk to contaminate water column is high if runoff occurs. Carbaryl is ranked as “possible” because of its moderate Koc.

Dimethoate

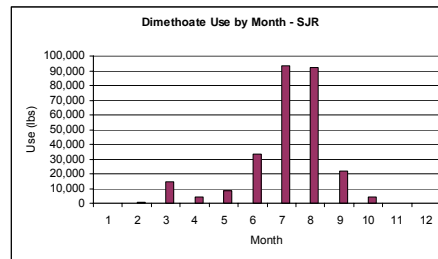
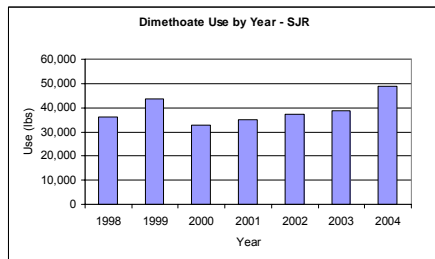
Use: Insecticide, in class of organophosphates.

Physical properties: Very high solubility (39,800 mg/L) and low Koc (20).

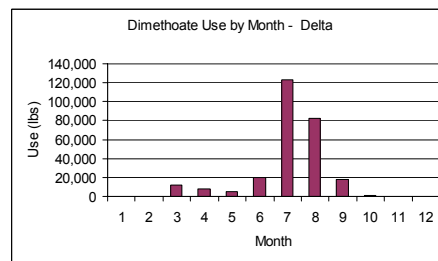
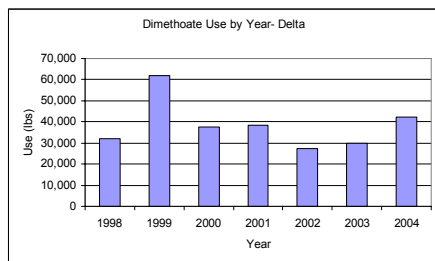
Toxicity: The 96-hour LC₅₀ ranges from 43 to 111,000 µg/L. The lowest value was for stonefly (*Pteronarcys californica*) and the highest value was for sheepshead minnow (*Cyprinodon variegatus*). The 96-hour LC₅₀ for rainbow trout (*Oncorhynchus mykiss*) was 6,200 µg/L (EXTOXNET has 6.2 µg/L but it maybe wrong).

Usage: Dimethoate has been selected as a target pesticide because of the relatively high use for agricultural applications in two sub-areas: San Joaquin River Watershed (SJR), and Delta Watershed (Delta).

SJR: The average annual use of dimethoate was 38,902 lbs with the highest annual use (48,889 lbs) in 2004. The amounts of annual use had a slightly increased trend from 2000 to 2004. The monthly use shows that relatively high amounts were applied in July and August. The major reported applications were to bean (27%), tomato (19%), and alfalfa (14%). The annual average area was 92,289 acres.



Delta: The average annual use was 38,438 lbs with the highest annual use (61,700 lbs) in 1999. The annual use decreased from 1999 to 2002, and then increased from 2002 to 2004. The relatively high monthly uses were in July and August. The major applications were to tomato (70%) and bean (8%). The average annual application area was 76,055 acres.



Water quality data: The SWDB had over 1,000 concentration data, and about 12% of data exceeded LOQ (0.024 to 0.1 µg/L). The highest observed concentration (7.73 µg/L) was observed in September 2003, and it was lower than the lowest 96-hour LC₅₀ value (43 µg/L).

Conclusion: Dimethoate is ranked as moderate overall risk because of low observed concentrations in the surface water. The overall risk may increase because the annual use had increased trend recent years. However, the annual uses are expected to be lower because the US EPA granted the request of cancellation and amendments to terminate the use of certain products containing dimethoate. The cancellations are effective July 20, 2005 (<http://www.epa.gov/pesticides/op/dimethoate.htm>). The relatively risk to sediment contamination is ranked as “unlikely” because of its low Koc.

Imidacloprid

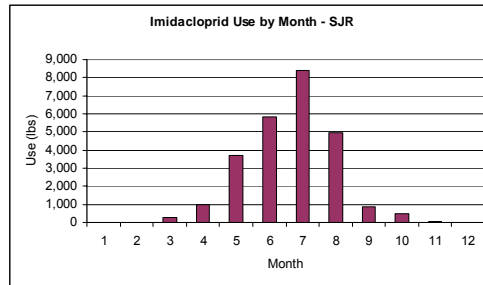
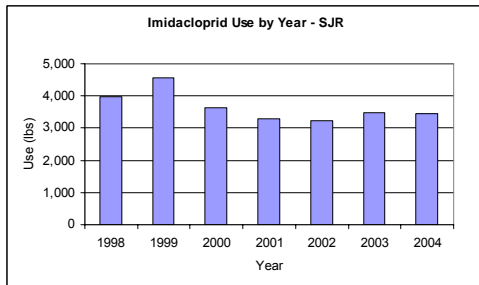
Use: Insecticide.

Physical properties: High water solubility (514 mg/L) and moderate Koc (256).

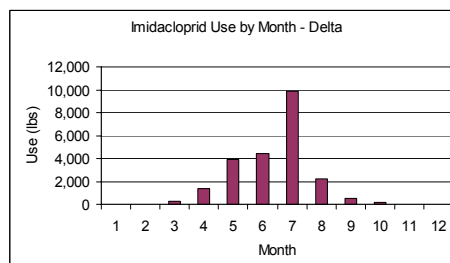
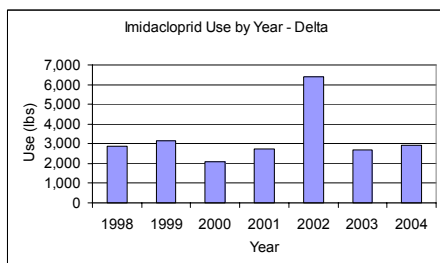
Toxicity: The 96-hour LC₅₀ values for imidacloprid range from 38 to 229,100 µg/L. The lowest LC₅₀ was for mysid (*Mysidopsis bahia*), and the highest LC₅₀ was for rainbow trout (*Oncorhynchus mykiss*).

Usage: Selected as a target pesticide because of the relatively high applications for both agricultural and non-agricultural uses. The relatively high uses for agricultural uses were in San Joaquin River Watershed (SJR) and Delta Watershed (Delta). The relatively high uses for non-agricultural uses were in three counties: Butte (ButteUrban), Sacramento (SacUrban), and San Joaquin (SJUrban).

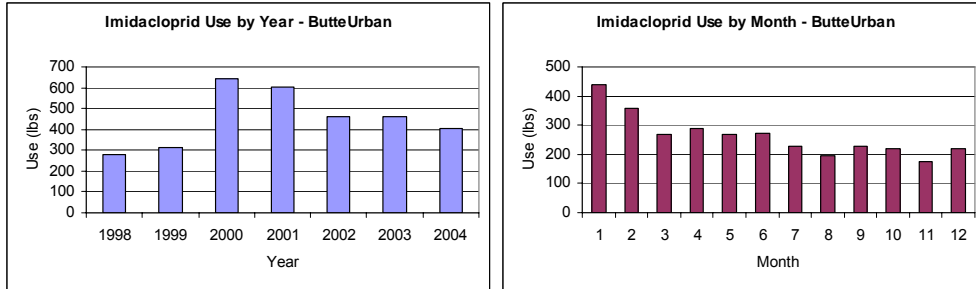
SJR: The average annual use was 3,662 lbs between 1998 and 2004 with the highest use (4,561 lbs) in 1999. The annual use had a slightly decreased trend between 1999 and 2004. The relatively high monthly uses were between May and August with the highest use in July. The major uses of pesticide were to grape (56%) and cotton (26%). The average annual application area was 66,860 acres.



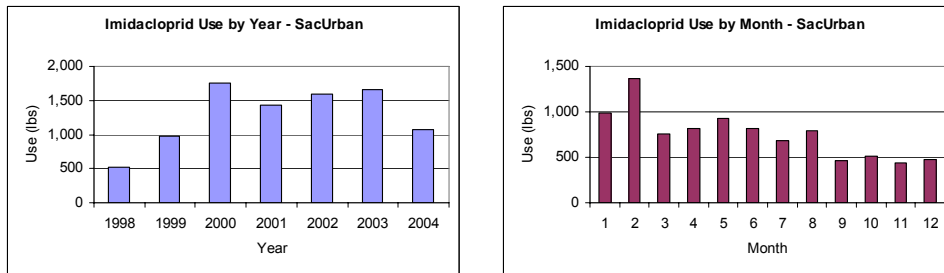
Delta: The average annual use was 3,265 lbs between 1998 and 2004 with the highest use (6,410 lbs) in 2002. The annual use shows slightly increased trend from 2000 to 2004 except for very high use in 2002. The relatively high monthly uses were between April and August with the highest use in July. The major uses of pesticide were to grape (85%). The average annual area was 46,256 acres.



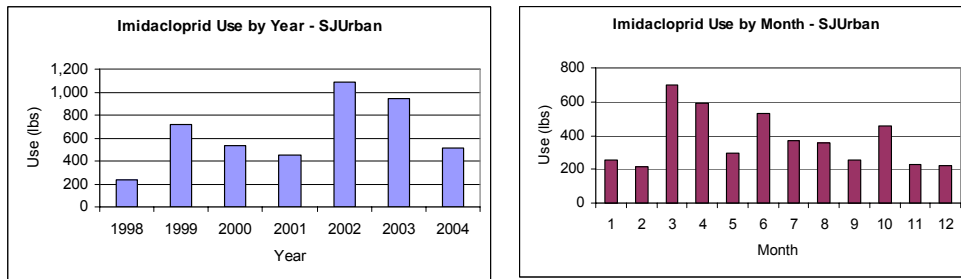
ButteUrban: The average annual use was 481 lbs between 1998 and 2004 with the highest use (641 lbs) in 2000. The annual use had a decreased trend from 2000 to 2004. The monthly use shows that the applications were year-round with the highest use in January.



SacUrban: The average annual use was 1,288 lbs between 1998 and 2004 with the highest use (1,751 lbs) in 2004. The annual uses increased from 1999 to 2003 except for 2000 and 2004. The monthly application shows that the applications were year-round with the highest use in February. The main applications were to structural and landscaping.



SJUrban: The average annual use was 638 lbs between 1998 and 2004 with the highest use (1,086 lbs) in 2002. The annual use had a decreased trend between 2002 and 2004. The monthly use shows that the use were year-round with the highest use in March.



Water quality data: No concentration data were available in the SWDB.

Conclusion: Imidacloprid is ranked as moderate overall risk because the major applications for agricultural applications are not in the winter storm season and

slightly decreased use in recent years. However, the relatively high amount of uses for non-agricultural were in the winter storm season. In addition, imidacloprid has high water solubility and relatively long half-life in water. The risk in urban area may be higher than the agricultural area. The risk of sediment contamination is ranked as “possible” because of its moderate Koc.

Indoxacarb

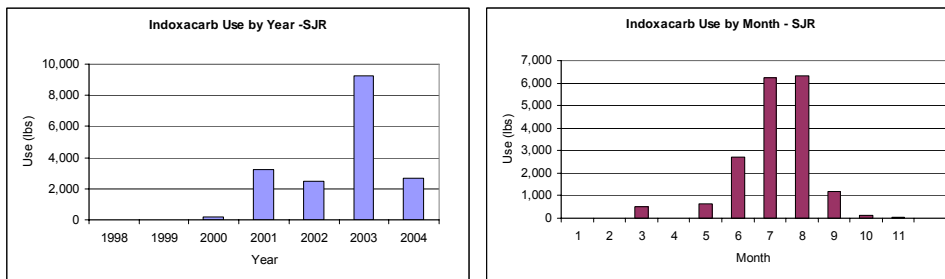
Use: Insecticide

Physical properties: Very low water solubility (0 mg/L) and high Koc (9,400).

Toxicity: The 96-hour LC₅₀ values for indoxacarb range from 24 to 1,300 µg/L (USEPA, 2003). Both of the highest and lowest toxicity values were for rainbow trout (*Oncorhynchus mykiss*) because the test conditions were different at fish age and method. The 96-hour LC₅₀ for mysid (*Mysidopsis bahia*) was 54.2 µg/L.

Usage: Selected as a target pesticide because of its applications for agricultural uses in San Joaquin watershed (SJR).

SJR: The average annual use was 3,563 lbs with the highest use in 2003. The amount of use in 2003 was about three times of the used in other annual use. The monthly use shows that the relatively high applications were between June and September with the highest uses in July and August. The major uses were to alfalfa (41%), cotton (28%), and tomato (17%). The average annual area of application was 41,429 acres.



Water quality data: There were no concentration data in the SWDB.

Conclusion: Indoxacarb is ranked as moderate overall risk because of no heavy uses during the winter storm season, and no clear increased trend in applications. However, indoxacarb is a relatively new pesticide that is considered as an organophosphate replacement. The overall risk may be ranked as high. The risk of sediment contamination is ranked as “potential” because of its high Koc.

Methomyl

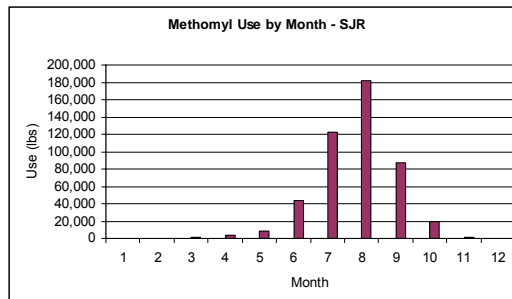
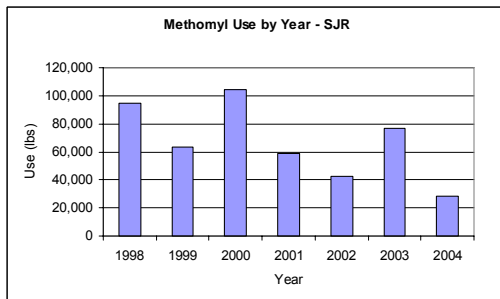
Use: Insecticide

Physical properties: Very high solubility (58,000 mg/L) and low Koc (59).

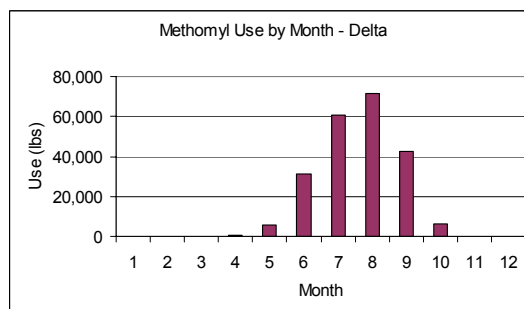
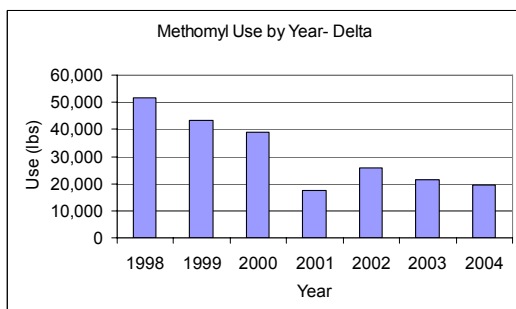
Toxicity: The 96-hour LC₅₀ range from 19 to 2,380 µg/L. The lowest 96-hour LC₅₀ was for pink shrimp (*Penaeus duorarum*) and the highest 96-hour LC₅₀ value was for fiddler crab (*Uca pugilator*). The 96-hour LC₅₀ for mysid (*Americamysis bahia*) was 230 µg/L.

Usage: Selected as a target pesticide because of its applications for agricultural uses in San Joaquin River Watershed (SJR) and Delta Watershed (Delta).

SJR: The average annual use was 67,002 lbs with the highest use (104,491 lbs) in 2000. The annual uses had a decreased trend from 1998 to 2004 except for 2000 and 2003. The monthly use shows that relatively high amounts were applied between June and September with the highest use in August. The major reported applications were to alfalfa (45%), tomato (11%), and sugarbeet (9%). The annual average area was 130,559 acres from 1998 to 2004.



Delta: The average annual use was 31,299 lbs with the highest use (51,830 lbs) in 1998. The annual use was in a decreased trend from 1998 to 2004. The monthly use shows that high amounts were applied between June and September with the highest use in August. The major reported applications were to corn (36%), tomato (11%), and alfalfa (11%). The annual average area was 64,452 acres from 1998 to 2004.



Water quality data: The SWDB had 661 concentration data that were collected between 1991 and 2002. There were 119 of the concentrations over the LOQ (0.17 and 1 µg/L). The highest concentration (5.4 µg/L) observed in January 1992. The highest observed concentration was lower than CMC.

Conclusion: methomyl is ranked as a moderate overall risk because the highest observed concentration is lower than CMC, reduction of annual use, and no uses in winter storm season. Methomyl has very high water solubility, so runoff from field pose higher risk to surface water. The risk of runoff during the irrigation season from row crops fields may need to be concerned because of high amount of use in June and July.

The sediment contamination risk is ranked as “unlikely” because of the low Koc.

Naled

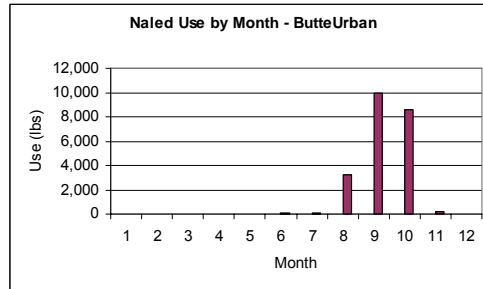
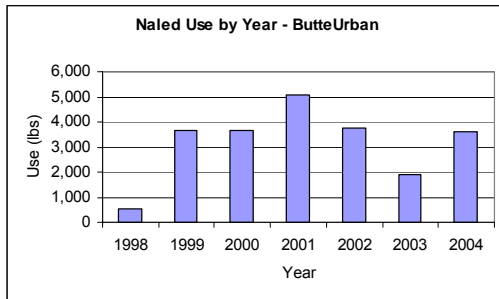
Use: Insecticide, an organophosphate (OP) pesticide.

Physical properties: Low water solubility (1.5 mg/L) and moderate Koc (157).

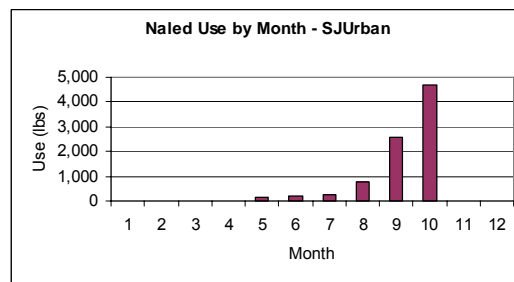
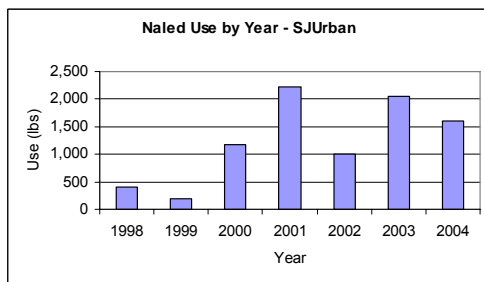
Toxicity: The 96-hour LC₅₀ ranges from 8.0 µg/L to 16,300 µg/L for fishes and crustaceans. The lowest value was for stonefly (*Pteronarcys californica*).

Usage: Selected as a target pesticide because of the relatively high application for non-agricultural uses in three counties: Butte (ButteUrban), San Joaquin (SJUrban), and Stanislaus (StanUrban).

ButteUrban: The average annual use was 3,167 lbs from 1998 to 2004 with the highest use (5,074 lbs) in 2001. The annual uses decreased from 2001 to 2003, and then increased in 2004. The monthly use shows that the highest uses were in September and October.

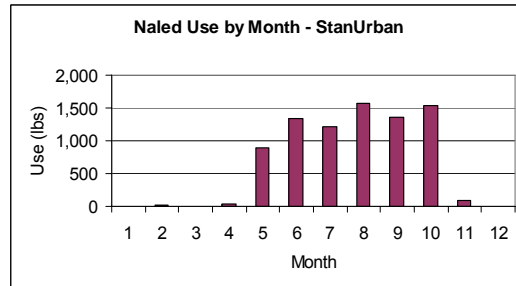
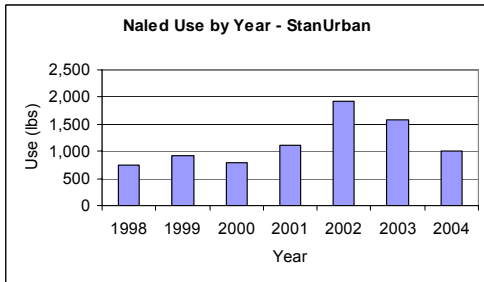


SJUrban: The average annual use was 1,236 lbs from 1998 to 2004 with the highest use (2,223 lbs) in 2001. The annual uses increased from 1999 to 2001, and then decreased from 2001 to 2004. The monthly use shows that the highest use was in October.



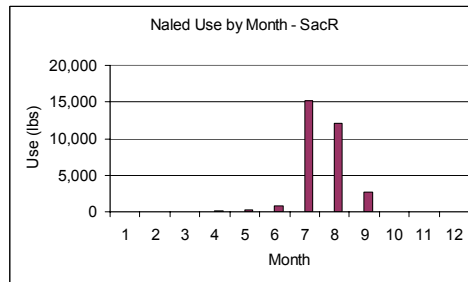
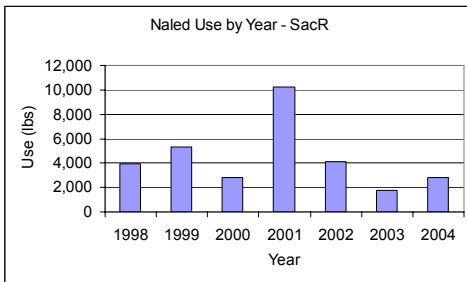
StanUrban: The average annual use was 1,154 lbs from 1998 to 2004 with the highest use (1,918 lbs) in 2002. The annual uses increased from 1998 to 2002, and then decreased from 2002 to 2004. The monthly use shows that the

relatively high uses were between May and October with the highest use in August.

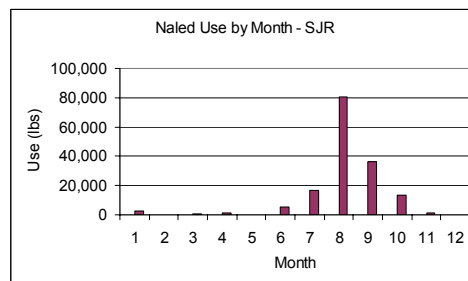
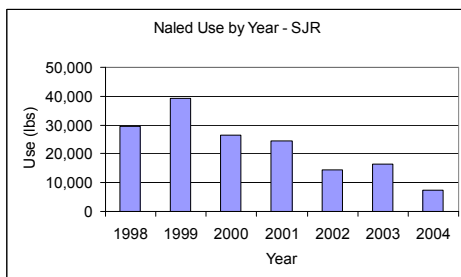


Naled was mainly applied on public health use (mosquito's control) for non-agricultural application. Naled was also used for agricultural application, and the annual use for agriculture was higher than the non-agricultural uses.

SacR: The average annual use was 4,441 lbs from 1998 to 2004 with the highest use (10,254 lbs) in 2001. The annual uses decreased from 2001 to 2004. The monthly uses shows that the relatively high uses were in July and August. The major applications were to cotton and beans.



SJR: The average annual use was 22,586 lbs from 1998 to 2004 with the highest use (39,153 lbs) in 1999. The annual uses decreased from 1998 to 2004. The monthly use shows that the highest use was in August.



Water quality data: There were 273 naled concentration data in the SWDB and none of them exceeded LOQ (0.5 µg/L).

Conclusion: Naled is ranked as moderate overall risk to surface water because of low use in winter storm season and reduction of annual use. Concentration was not used as a factor in ranking naled because naled has low water solubility. There are over two hundreds concentration data, but none of them exceeded LOQ. Naled first registered in 1959 in the US. In 2006, it was in the list of OP insecticides used by US EPA as interim re-registration. Naled is ranked as “possible” to sediment risk because of its moderate Koc.

Norflurazon

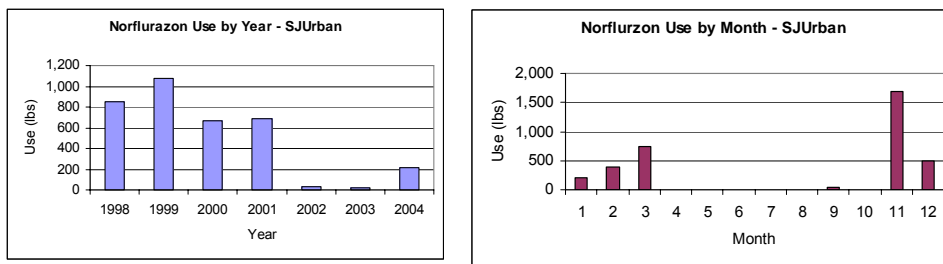
Use: Herbicide.

Physical properties: Moderate water solubility (34 mg/L) and moderate Koc (353).

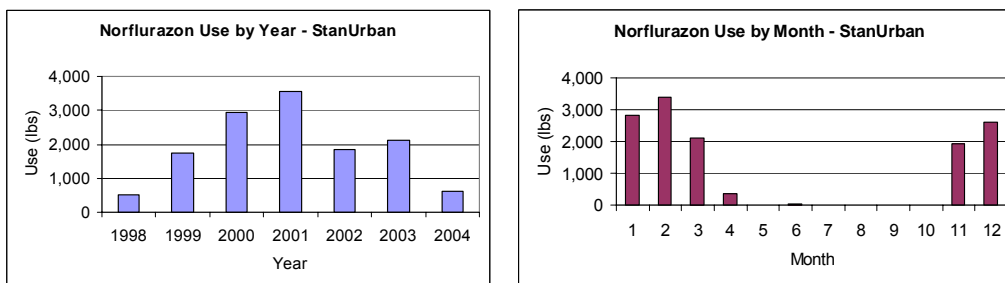
Toxicity: The 96-hour LC₅₀ ranges from 3,800 µg/L to 16,300 µg/L for fishes and crustaceans. The lowest value was for eastern oyster (*Crassostrea virginica*). For mysid (*Mysidopsis bahia*), the lowest 96-hour LC₅₀ was 5,530 µg/L. The EC₅₀ ranges from 13 to 86 µg/L for aquatic plants between 5 and 14 days. The lowest EC₅₀ was a 5-day test for green algae (*Kirchneria subcapitata*).

Usage: Selected as a target because of the annual uses for non-agricultural applications in two counties: San Joaquin (SJUrban) and Stanislaus (StanUrban).

SJUrban: The average annual use was 507 lbs from 1998 to 2004 with the highest use (1,077 lbs) in 1999. The annual uses decreased from 1999 to 2003. The monthly use shows that the relatively high uses were in the winter with the highest use in November.



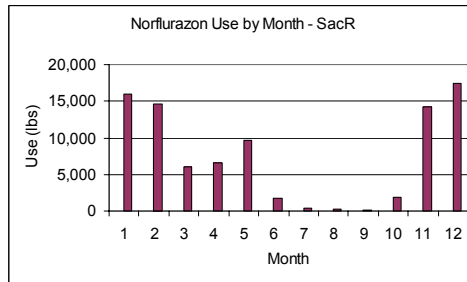
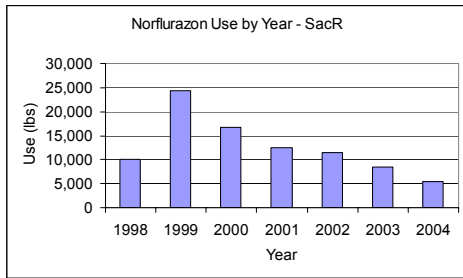
StanUrban: The average annual use was 1,894 lbs from 1998 to 2004 with the highest use (3,543 lbs) in 2001. The annual uses increased from 1998 to 2001 and then decreased from 2001 to 2004. The monthly use shows that the relatively high uses were in the winter with the highest use in February.



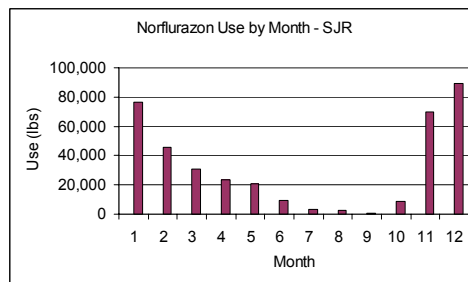
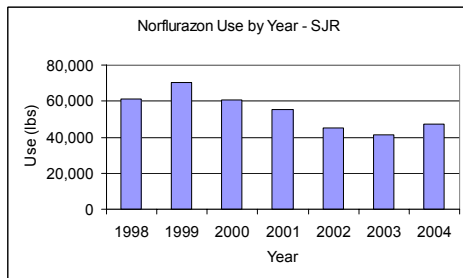
Norflurazon is mainly applied on “right of way” for non-agricultural uses. Norflurazon is also used for agricultural applications like almond and alfalfa.

SacR: The average annual use was 12,723 lbs from 1998 to 2004 with the highest use (24,341 lbs) in 1999. The annual uses decreased from 1999 to

2004. The monthly uses showed that the relatively high uses were in the winter storm season with the highest uses in January, February, November, and December.



SJR: The average annual use was 1,894 lbs from 1998 to 2004 with the highest use (3,543 lbs) in 2001. The annual uses increased from 1998 to 2001 and then decreased from 2001 to 2004. The monthly use shows that the relatively high applications were in the winter storm season with the highest uses in January, November, and December.



Water quality data: There were 268 concentration data in the SWDB and 13% of the data exceeded LOQ. The highest concentration was 1.49 µg/L observed in January 2001. The highest observed concentration (1.49 µg/L) was lower than the lowest EC₅₀ value (13 µg/L) and much lower than the lowest 96-hr LC₅₀ (3,800 µg/L).

Conclusion: Norflurazon is ranked as moderate overall risk because of its high toxicity to aquatic plants, and low detected concentration in surface water. The runoff risk is potential because relatively high amounts of norflurazon are applied during the winter storm season. The risk of sediment contamination is ranked as “possible” because of its moderate Koc.