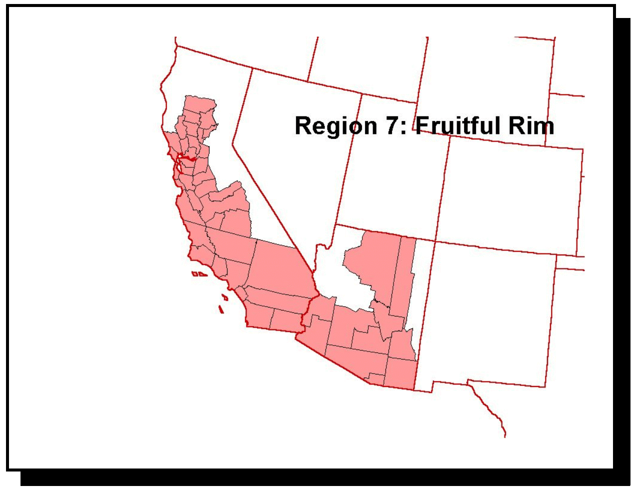
II. Regional Assessments

G. Region 7A - Fruitful Rim NCV Assessment

1. Executive Summary

This module of the Organophosphate (OP) cumulative risk assessment focuses on risks from OP uses in the Fruitful Rim NCV (North Central Valley) (area shown to right). Information is included in this module only if it is specific to the Fruitful Rim NCV, or is necessary for clarifying the results of the Fruitful Rim NCV assessment. A comprehensive description of the OP cumulative assessment comprises the body of the main document; background and other supporting information for this regional assessment can be found there.



This module focuses on the two components of the OP cumulative assessment which are likely to have the greatest regional variability: drinking water and residential exposures. Dietary food exposures is likely to have significantly less regional variability, and is assumed to be nationally uniform. An extensive discussion of food exposure is included in the main document. Pesticides and uses which were considered in the drinking water and residential assessments are summarized in Table II.G.1 below. The OP uses included in the drinking water assessment generally accounted for 95% or more of the total OPs applied in that selected area. Various uses that account for a relatively low percent of the total amount applied in that area were not included in the assessment.

Table II.G.1. Pesticides and Use Sites/Scenarios Considered in Fruitful Rim NCV Residential/Non-Occupational and Drinking Water Assessment

Pesticide	OP Residential Use Scenarios	OP Drinking Water Scenario Uses
Acephate	Ornamental Gardens	Beans, Tomatoes
Azinphos-methyl	None	Almonds (Walnuts), Apples (Pears)
Bensulide	Golf Courses	None

Pesticide	OP Residential Use Scenarios	OP Drinking Water Scenario Uses
Chlorpyrifos	None	Alfalfa, Almonds (Walnuts), Apples (Pears), Asparagus, Field Corn, Grapes, Peaches (Apricots, Nectarines) Sugarbeets, Tomatoes,
DDVP	Indoor Uses	None
Diazinon	None	Almonds (Walnuts), Apples (Pears), Cantaloupes (Melons), Grapes, Peaches, Tomatoes, Broccoli, (Apricots, Nectarines)
Dimethoate	None	Alfalfa, Apples (Pears), Broccoli, Cantaloupe (Melons), Beans, Field Corn, Grapes, Peaches (Apricots, Nectarines), Tomatoes
Disulfoton	Ornamental Gardens	Asparagus, Field Corn
Fenamiphos	Golf Courses	Grapes, Peaches (Apricots, Nectarines)
Fonofos	None	Asparagus, Beans, Tomatoes
Malathion	Lawn Applications, Home Fruit & Vegetable Gardens, Ornamental Gardens	Alfalfa, , Asparagus, Beans, Field Corn, Grapes, Tomatoes
Methamidophos	None	Broccoli, Sugarbeets, Tomatoes
Methidathion	None	Apples (Pears), Peaches (Apricots, Nectarines), Almonds (Walnuts)
Methyl-parathion	None	Alfalfa
Naled	None	Almonds (Walnuts), Beans, Grapes, Peaches (Apricots, Nectarines), Sugarbeets
Oxydemeton-methyl	None	Broccoli, Cantaloupe (Melons), Sugarbeets
Phorate	None	Field Corn, Sugarbeets
Phosmet	None	Almonds (Walnuts), Apples (Pears), Peaches (Apricots, Nectarines), Alfalfa,
Terbufos	None	None
Trichlorfon	Golf Courses, Lawn applications	None

This module will first address residential exposures. The residential section describes the reasons for selecting or excluding various use scenarios from the assessment, followed by a description of region-specific inputs. Detailed information regarding the selection of generic data inputs common to all the residential assessments (e.g., contact rates, transfer coefficients, and breathing rate distributions, etc.) are included in the main document.

Drinking water exposures are discussed next. This will include criteria for the selection of a sub-region within the Fruitful Rim – NCV to model drinking water residues, followed by modeling results, and finally characterization of the available monitoring data which support use of the modeling results. This assessment accounted for all OP uses within the selected location that are anticipated to contribute significantly to drinking water exposure.

Drinking water exposures are discussed next. This will include criteria for the selection of a sub-region within the Fruitful Rim NCV for modeling drinking water residues, followed by modeling results, and finally characterization of the available monitoring data which support use of the modeling results. This characterization of monitoring data includes a justification for assuming surface water sources of drinking water for the entire population within the region rather than ground water sources, since surface water sources represent a high-end of potential residues. While some OP-crop uses were not included in the model estimates, the estimates are still considered high-end. This is discussed in more detail in the drinking water section below.

Finally a characterization of the overall risks for the Fruitful Rim NCV region is presented, focusing on aspects which are specific to this region.

In general, the risks estimated for the Fruitful Rim NCV show a similar pattern to those observed for other regions. Drinking water does not contribute to the risk picture in any significant way at the upper percentiles of exposure. At these higher percentiles of population exposure, residential exposures are the major source of risk - in particular inhalation exposure. These patterns occur for all population sub-groups, although potential risks appear to be higher for children than for adults regardless of the population percentile considered.

2. Development of Residential Exposure Aspects of Fruitful Rim NCV Region 7A

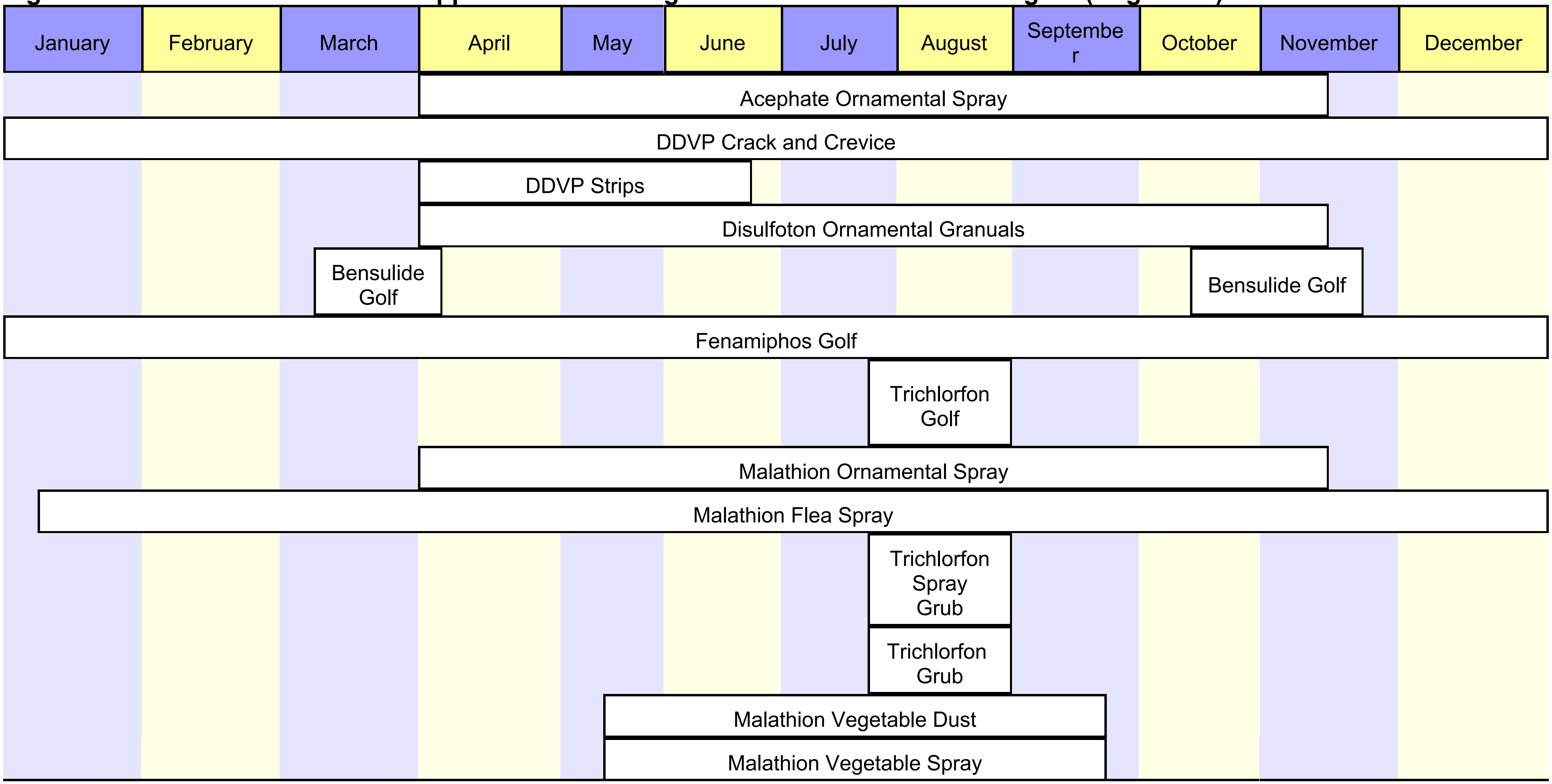
In developing this aspect of the assessment, the residential exposure component of Calendex was used to evaluate predicted exposures from residential uses. Except for golf course uses, this assessment is limited to the home as are most current single chemical assessments. The residential component of the assessment incorporates dermal, inhalation, and non-dietary ingestion exposure routes which result from applications made to residential lawns (dermal and non-dietary ingestion), golf courses, ornamental gardens, home fruit and vegetable gardens, and indoor uses. These scenarios were selected because they are expected to be the most prominent contributors to exposure in this region. Public health uses were not expected to be a significant contributor to cumulative risk in this region, and were therefore not included in this assessment. Additional details regarding the selection of the scenario-pesticide pairs can be found in Part I of this document. OPP believes that the majority of exposures (and all significant exposures) in this region have been addressed by the scenarios selected.

The data inputs to the residential exposure assessment come from a variety of sources including the published, peer reviewed literature and data submitted to the Agency to support registration and re-registration of pesticides. Generic scenario issues and data sources are discussed in Part I of this report. However, a variety of additional region-specific ancillary data was required for this assessment of the Fruitful Rim NCV. This information includes region-specific data on pesticide application rates and timing, pesticide use practices, and seasonal applications patterns, among others. The Gaant chart shown in Figure II.G.1 displays and summarizes the various region-specific residential applications and their timing (including repeated applications) over the course of a year which were used in this assessment. Specific information and further details regarding these scenarios, the Calendex input parameters, and the pesticides for which these scenarios were used are presented in Table II.G.2 which summarizes all relevant region-specific scenarios.

Table II.G.2. Use Scenarios and Calendex Input Parameters for Fruitful Rim NCV Residential Exposure Assessment

Chemical	Use Scenario and Pest	Appln. Method	Amount Applied lb ai/A	Maximum Number and Frequency of Applns.	Seasonal Use	% use LCO	% use HO	% users	Active Exposure Period (days)	Exposure Routes
Acephate	Ornamentals	hand pump sprayer	0.934-2	4/yr	April-Nov.	--	100	7	1	dermal, inhalation
Bensulide	Golf Courses	NA	12.5	2/yr	March-April Oct-Nov.	100	--	2.44	14	dermal
DDVP	Crack/Crevice	spray can	0.72-2.5 mg	1/mth	Jan-Dec.	--	100	1	1	inhalation
	Pest Strips	strip	NA	2/yr	April-June	NA	100	2.5	90	inhalation
Disulfoton	Ornamentals	granular	8.7	3/yr	April-Nov.	--	100	7	1	dermal, inhalation
Fenamiphos	Golf Courses	NA	116	1/wk	Jan-Dec.	100	--	1	2	dermal
Malathion	Lawns	hose end spray	5 lb ai	2/yr	Jan-Dec.	19	81	4	4 1	dermal, oral inhalation
	Ornamentals	hand pump spray	0.94-2 lb/A	4/yr	April-Nov.	--	100	3.7	1	dermal, inhalation
	Vegetable Gardens	hand duster	1.5 lb/A	5/yr	May-Sept.	--	100	1.04	14 1	dermal, inhalation
		hand pump sprayer	1.5 lb/A	5/yr	May-Sept.	--	100	1.1	14 1	dermal inhalation
Trichlorfon	Golf Courses	NA	8 lb ai	1/yr	July-Aug.	100	--	1	2	dermal
	Lawns Granular	rotary spreader	8 lb ai	1/yr	July-Aug.	19	81	1	1 2	inhalation dermal, oral
	Lawns Spray	hose end sprayer	8 lb ai	1/yr	July-Aug.	19	81	1	1 2	inhalation dermal, oral

Figure II.G.1 Residential Scenario Application and Usage Schedules for the NCV Region (Region 7a)



a. Dissipation Data Sources and Assumptions

i. Acephate

A residue dissipation study was conducted on Bahia grass in Florida with multiple residue measurements collected for 10 days after treatment (Days 0, 1, 2, 3, 5, 7, and 10 days). No half-life value or other degradation parameter was used, with the current assessment based instead on the time-series distribution of actual residue measurements. The uniform distribution reflects a range of spray and granular treatments.

ii. Bensulide

A residue dissipation study was conducted with multiple residue measurements collected for up to 14 days after treatment. For each day following application, a residue value from a uniform distribution bounded by the low and high measurements was selected (the day zero distribution consisted of measurements collected immediately after application and 0.42 day after treatment). No half-life value or other degradation parameter was used, with the current assessment based instead on the time-series distribution of actual measurements. Residues measured at day 7 were assumed to be available and to persist to day 10 and day 10 measurements to persist to day 14.

iii. Malathion

For western regions a residue degradation study was based on a 3 day study conducted in California (application rate of 5 lb ai/acre). These measured residue values were entered into the Calendex software as a time series distribution of 4 values (Days 0, 1, 2, and 3). For use on home lawns for assessing non-dietary ingestion for children, these values were multiplied by a value selected from a uniform distribution bounded by 1.5 and 3 to account for wet hand transfer.

For the vegetable gardening scenario in western regions 7,8, and 10, a residue dissipation study was conducted in California with multiple residue measurements collected up to 14 days after treatment. A uniform distribution bounded by the low and high residue measurements was used for each day after the application. The study was conducted at one pound ai per acre. The residues were adjusted upwards to account for the 1.5 pound ai per acre rate for vegetables.

iv. Fenamiphos

Snyder et al., 1999 collected residue dissipation data on the day of and day after application following the application of fenamiphos on a golf course. Only mean measurements were collected.

v. Trichlorfon

Residue values from a residue degradation study for the granular and sprayable formulations were collected for the “day of” and “day following” the application. A uniform distribution bounded by the low and high residue measurements was used, with these residue values adjusted proportionately upwards to simulate the higher active ingredient concentrations in use (i.e., adjusted to 0.5% and 1% for granular and sprayable formulations respectively). These distributions reflect actual measurements including those based on directions to water in the product. For use on home lawns for assessing non-dietary ingestion for children, these values were multiplied by a value selected from a uniform distribution bounded by 1.5 and 3 to account for wet hand transfer.

3. Development of Water Exposure Aspects of Fruitful Rim NCV Region/ North-Central Counties of the Central Valley

Because of the localized nature of drinking water exposure, the water exposure component of this assessment focused on a specific geographic area within the Fruitful Rim NCV. The selection process considers OP usage, the locations and nature of the drinking water sources, and the vulnerability of those sources to pesticide contamination. An extensive discussion of the methods used to identify a specific location within the region is included in the main document. The following discussion provides the details specific to the Fruitful Rim NCV regional assessment for drinking water exposure with respect to cumulative exposure to the OP pesticides. The discussion centers on four main aspects of the assessment: (1) the selection criteria for the specific locations in the Central Valley of California used for the drinking water assessment for the Fruitful Rim NCV, (2) highlights of the results of the model outputs (predicted cumulative concentrations of OPs in surface water) for those OP-crop uses included in this regional assessment, (3) a summary and comparison of the predicted concentrations used in the Fruitful Rim NCV assessment with actual surface water monitoring data for the region, and (4) a summary of water monitoring data used for site selection and evaluation of the estimated drinking water concentrations for the region.

a. Selection of the Central Valley of California for Drinking Water Assessment

OPP selected the Central Valley of California as the specific location to represent the region based on organophosphorus (OP) pesticide usage within the Fruitful Rim NCV region (the region) in relation to the source, location, and vulnerability of the drinking water sources in the region, and on available monitoring data for the region. An evaluation of OP usage, drinking water sources, vulnerability of those sources to OP pesticide contamination, and available monitoring data indicates that (1) surface water sources of drinking water are likely to be more vulnerable than ground water sources, and (2) a surface water assessment based in the Central Valley will represent one of the more vulnerable sources of drinking water in the region.

As discussed below, while the southern Central Valley (Fresno County and south) is less vulnerable to runoff because of the low rainfall, total OP use in this area is roughly an order or magnitude greater than it is in the counties north of Fresno County (Merced, San Joaquin, and Stanislaus). A summary of MCL exceedances for pesticides in California shows that the southern counties generally had more exceedances than did the northern counties (California Department of Health Services, Drinking Water Quality Monitoring Data, 1984-2000; http://www.dhs.ca.gov/ps/ddwem/chemicals/monitoring/results84-00). Even though no OP pesticides have established MCLs and were not included in the monitoring, the frequency of MCL exceedances is an indication of the relative vulnerability of the drinking water sources to pesticide contamination. Therefore, the Agency generated two distributions of estimated drinking water concentrations for this region, one representing OP use in the southern Central Valley and one representing OP use in the central and northern Central Valley. This assessment (II.G) focuses on the resulting distribution generated for the central/northern portion of the Central Valley. The next assessment (II.H) focuses on the southern Central Valley.

Total OP usage is greater in the Fruitful Rim CA than in any other region. In 1997, approximately 9.4 million pounds (ai) of OPs were applied in on agricultural crops in this region, approximately 17 percent of total agricultural OP use in the United States. The major OP use crops in the region are cotton (35 percent of total OP use), alfalfa (14 percent), nut trees (13 percent), citrus (9 percent), fruit orchards (8 percent), and vegetables (10 percent) (Table II.G.3).

Table II.G.3. General Overview of OP Usage in the Fruitful Rim –CA

Crops	Primary Production Areas	Total Pounds Applied	Percent of Total OP Use
Cotton	Southern CA, south-central AZ	3,311,000	35
Alfalfa	CA	1,319,000	14
Nut Trees	Central Valley	1,263,000	13
Citrus	Southern Central Valley	882,000	9
Orchard	Central Valley	734,000	8
Lettuce	CA Coastal Valleys	366,000	4
Brassicas	CA Coastal Valleys	384,000	4
Sugar beets	Central Valley	175,000	2
Other vegetables	CA	415,000	4
Grapes	Central Valley	215,000	2
		9,404,000	96

(1) Source: NCFAP, 1997.

Figure II.G.2 shows high OP-use areas in Central and Coastal Valleys of California and in southern California extending into south-central Arizona. Cotton is the dominant OP use crop in southern California (little or no OP use on cotton is reported north of Fresno County) and in south-central Arizona. OP use on vegetables is dominant in the coastal valleys of California. OP use on all of the major agricultural uses listed in Table II.G.3 occurs within the Central Valley. In the drier southern portion of the Central Valley, the dominant OP use crops are cotton, nut trees, citrus, alfalfa, and grapes. OP use on cotton and citrus drop out north of Fresno County, where the dominant use crops are nut and fruit orchards, several vegetables (in particular, legumes, tomatoes, and asparagus), alfalfa, and field corn (Table II.G.4).

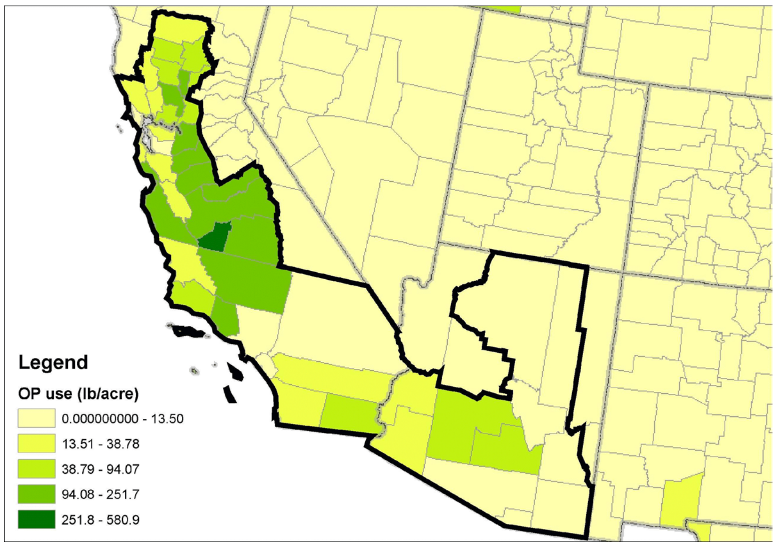


Figure II.G.2. Total OP usage (pounds per area) in the Fruitful Rim CA (source: NCFAP, 1997)

Table II.G.4 compares agricultural OP usage in the Central Valley between the southern and central/northern counties. OP use on cotton, nut trees, citrus, alfalfa, and grapes accounted for more than 80 percent of agricultural usage in the southern part of the Central Valley. In the north/central counties in the Central Valley, OP use on nut trees, vegetables, alfalfa, and field corn accounted for more than 80 percent of total agricultural use. Based on data collected by the California Department of Pesticide Regulation, the total pounds of OP pesticides used in the four southern counties of the Central Valley (Fresno, Kern, King, and Tulare) was an order of magnitude greater than the amount used in the three counties to the immediate north (Merced, San Joaquin, and Stanislaus) (Table II.G.4).

Table II.G.4. OP Usage on Agricultural Crops in the Central Valley of California

	North/Central Central Valley (San Joaquin, Stanislaus counties)			Southern Central Valley (Fresno, Kern, King, Tulare counties)		
Crop/Use	OP Pesticides Used	Ttl lbs OP Used (Pct)	Crop Acres	OP Pesticides Used	Ttl lbs OP Used	Crop Acres
Cotton				acephate, chlorpyrifos, dimethoate, disulfoton, malathion, methamidophos, naled, phorate, profenofos, tribufos	1,257,548 (44%)	880,748
Almonds, walnuts	Azinphos methyl, chlorpyrifos, diazinon, methidathion, naled, phosmet	104,305 (34%)	123,907	Azinphos methyl, chlorpyrifos, diazinon, malathion, methidathion, naled, phosmet	389,598 (14%)	202,471
Alfalfa	Chlorpyrifos, dimethoate, malathion, methyl parathion, phosmet	43,305 (14%)	88,940	Chlorpyrifos, dimethoate, malathion, methamidophos, methidathion, naled, ODM, phosmet, methyl parathion	323,796 (11%)	331,211
Oranges				Acephate, chlorpyrifos, dimethoate, fenamiphos, malathion, methidathion, naled	380,124 (13%)	174,314
Grapes	Chlorpyrifos, diazinon, dimethoate, fenamiphos, malathion, naled	7,857 (2%)	94,485	Chlorpyrifos, diazinon, dimethoate, fenamiphos, malathion, naled, phosmet	155,389 (6%)	410,184
Apples, pears	Azinphos methyl, chlorpyrifos, diazinon, dimethoate, methidathion, phosmet	26,809 (9%)	7,089	Azinphos methyl, chlorpyrifos, diazinon, fenamiphos, methidathion, phosmet	62,112 (2%)	10,292
Peaches, apricots, nectarines	Chlorpyrifos, diazinon, dimethoate, fenamiphos, methidathion, naled, phosmet	16,855 (5%)	10,537	Azinphos methyl, chlorpyrifos, diazinon, fenamiphos, methidathion, phosmet	77,162 (3%)	36,229
Plums, prunes				Azinphos methyl, chlorpyrifos, diazinon, methidathion, phosmet	64,925 (2%)	35,555
Sugarbeet	Chlorpyrifos, methamidophos, naled, ODM, phorate	3,474 (1%)	8,607	Chlorpyrifos, diazinon, malathion, methamidophos, naled, ODM, phorate	46,980 (2%)	49,457
Lettuce				Acephate, bensulide, diazinon, dimethoate, disulfoton, malathion, ODM	48,386 (2%)	41,131
Brassicas	Diazinon, dimethoate, methamidophos, ODM	1,369 (<1%)	3,306	Bensulide, chlorpyrifos, diazinon, dimethoate, disulfoton, malathion, methamidophos, naled, ODM	23,865 (1%)	13,031
Tomato	Acephate, chlorpyrifos, diazinon, dimethoate, malathion, methamidophos	24,476 (8%)	57,374	Diazinon, dimethoate, malathion, methidathion, phorate	9,830 (<1%)	134,416
Asparagus	Chlorpyrifos, disulfoton, malathion	21,342 (7%)	22,633	Chlorpyrifos, disulfoton	4,925 (<1%)	3,677
Melons	Diazinon, dimethoate, ODM	267 (<1%)	1,464	Bensulide, diazinon, dimethoate, malathion, naled, ODM	4,626 (<1%)	30,875
Legumes	Acephate, dimethoate, malathion, naled	33,222 (11%)	22,312			

	North/Central Central Valley (San Joaquin, Stanislaus counties)			Southern Central Valley (Fresno, Kern, King, Tulare counties)		
Crop/Use	OP Pesticides Used	Ttl lbs OP Used (Pct)	Crop Acres	OP Pesticides Used	Ttl lbs OP Used	Crop Acres
Field Corn	Chlorpyrifos, dimethoate, disulfoton, malathion, phorate	28,507 (9%)	95,151			
Totals		311,788	535,805		2,849,266	2,353,591
(1) Source: California, Department of Pesticide Regulation, Pesticide Use Reporting (PUR) data						

Surface water sources of drinking water are scattered throughout the region, with clusters in the northern and southern ends of California (Figure II.G.3). While many of the surface water intakes for the Central Valley are located in the mountainous regions outside of the agricultural areas, a few intakes do occur within the valley. Runoff vulnerability in the Fruitful Rim NCV is generally low in comparison to other regions of the country, although some areas with a moderate runoff potential do exist in the region. In the Central Valley, runoff tends to be greater to the north, where more rainfall occurs. Timing of application is particularly critical in this region. Pesticide applications during the rainy season will potentially have a greater impact on water resources than applications during drier times of the year.

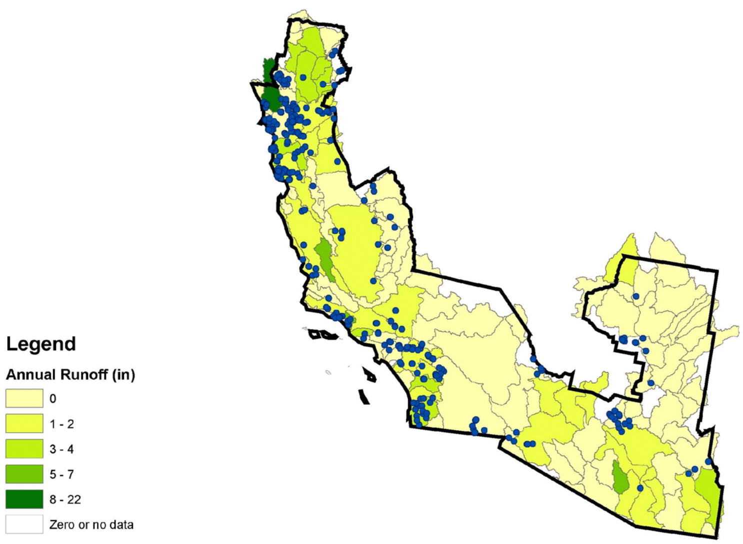


Figure II.G.3. Locations of surface water intakes of drinking water (shown as dots) in relation to average annual runoff (color gradation) in the Fruitful Rim CA Region

Irrigation consumes the greatest amount of surface water and ground water in the basin by far. Water in the rivers in the basin is highly regulated, and the irrigation system includes a series of canals to bring water to and from irrigated fields. Surface water is the main source of drinking water in the northern part of the Central Valley, but ground water is the more important source in the southern San Joaquin river basin. The portions of Arizona in the fruitful Rim, SW derive their drinking water from ground water.

The amount of pesticide usage in the Central Valley contributes to the vulnerability of surface water to pesticide contamination, even with a lower runoff potential. Thus, drinking water sources in the Central Valley are among the watersheds more vulnerable to pesticide runoff in the U.S. (Kellogg et al, 1999).

Similarly, the vulnerability of ground water to pesticide leaching (Figure II.G.4) is strongly impacted by the amount of pesticide used in the area and irrigation practices in the region. Figure II.G.4 indicates that ground water in the Central Valley may be potentially vulnerable to pesticide leaching.

The Central Valley aquifer is unconfined to a few hundred feet in depth, becoming confined in the south of the valley under “numerous overlapping lens-shaped clay beds”(USGS Hydrologic Investigations Atlas 730-B). The installation of thousands of wells in the San Joaquin Valley over time, some of which are screen throughout their length, has compromised the ability of the clay lenses to confine deeper aquifers, making them vulnerable to contamination through these wells. Overdevelopment of the ground-water resource has led in part to land subsidence in portions of the Central valley.

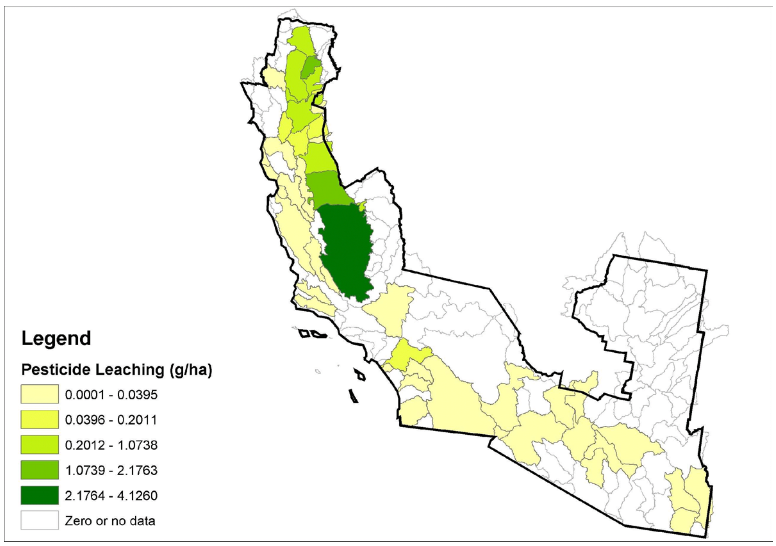


Figure II.G.4. Vulnerability of ground water resources to pesticide leaching in the Fruitful Rim CA, adapted from USDA (Kellogg, 1998).

An evaluation of OP usage, drinking water sources, vulnerability of those sources to OP pesticide contamination, and available monitoring data indicates that (1) surface water sources of drinking water are likely to be more vulnerable than ground water sources in the Fruitful Rim NCV, and (2) a surface water assessment based in the Central Valley is representative of the more vulnerable areas within the Fruitful Rim NCV region. The surface-water exposure assessment should be considered a conservative surrogate for the portion of the population deriving its drinking water from ground water. While surface water sources north of Fresno County are likely to be more vulnerable to runoff contamination, monitoring suggests that surface water sources in the southern Central Valley may also be vulnerable because of the greater magnitude of OP use in this region. Thus, the Agency used location-specific usage and weather patterns to provide estimated OP concentrations in both the central/northern Central Valley, discussed below, and the southern Central Valley, discussed in the next assessment (II.H).

b. Cumulative OP Concentration Distribution in Surface Water

The Agency estimated drinking water concentrations in the Fruitful Rim NCV cumulative assessment using PRZM-EXAMS output with various input parameters that are specific, where possible, to the Central Valley of California. Table II.G.5 presents pesticide use statistics for the OP-crop combinations which were modeled in this regional assessment. Chemical-, application- and site-specific inputs into the assessments are found in Appendices III.E.5-7.

Table II.G.5. Application Information for the OP-Crop Combinations Included in the Fruitful Rim CA Assessment (Central/North Central Valley)

Chemical	Crop/Use	Total Acre Treatments/ Acres Planted	Rate, lb/A	Application Method	Application Dates
AzinphosMethyl	Almonds, walnuts	3	1.54	Airblast	Jul 12, Jul 19, Jul 20, Jul 26, Jul 27
Chlorpyrifos	Almonds, walnuts	23	1.69	Foliar/ airblast	May 10, May 17, Jun 07, Jul 26, Aug 02
Diazinon	Almonds, walnuts	10	1.86	Foliar/ airblast	Jan 11, Jan 18, Feb 01, Feb 02, Feb 08
Methidathion	Almonds, walnuts	10	0.96	Foliar/ airblast	Jan 11, Jan 18, Jan 19, Jan 25, Feb 01
Naled	Almonds, walnuts	1	1.59	Foliar/ airblast	Jan 18, Jan 24, Jan 25, Jan 26, Feb 01
Phosmet	Almonds, walnuts	4	2.83	Foliar/ airblast	Mar 22, Jul 19, Jul 26, Aug 02, Aug 09
Chlorpyrifos	Alfalfa	65	0.56	Aerial	Mar 08, Mar 15, Mar 22, Apr 26, Aug 30
Dimethoate	Alfalfa	3	0.35	Aerial/broadcast	Mar 08, Mar 15, Mar 22, Mar 29, May 17
Malathion	Alfalfa	2	1.13	Aerial/broadcast	Mar 22, Mar 29, Apr 05, Apr 12, Apr 19
MethylParathion	Alfalfa	1	0.83	Aerial/broadcast	Mar 07, Mar 08, Mar 09, Mar 15, Mar 22
Phosmet	Alfalfa	10	0.71	Aerial/broadcast	Mar 08, Mar 15, Mar 16, Mar 22, Mar 29
AzinphosMethyl	Apples, pears	30	1.04	Airblast	May 24, Jun 14, Jun 21, Jul 19, Aug 23
Chlorpyrifos	Apples, pears	46	1.30	Airblast	Mar 08, Apr 26, May 03, May 24, Jun 21
Diazinon	Apples, pears	16	1.49	Airblast	Jan 25, Mar 08, Mar 09, Mar 15, Aug 16
Dimethoate	Apples, pears	2	0.57	Airblast	Apr 18, Apr 19, Apr 20, May 10, Jun 07
Methidathion	Apples, pears	30	1.14	Airblast	Jan 18, Jan 25, Feb 22, Mar 01, Mar 08
Phosmet	Apples, pears	76	2.99	Airblast	May 17, May 31, Jul 05, Jul 26, Aug 23
Chlorpyrifos	Peaches, apricots, nectarines	4	1.81	Airblast	Jan 25, Jan 26, Feb 01, Dec 16, Dec 17
Diazinon	Peaches, apricots, nectarines	17	2.09	Airblast	Nov 22, Nov 23, Dec 07, Dec 21, Dec 28
Dimethoate	Peaches, apricots, nectarines	0.1	3.58	Airblast	Jun 05, Jun 06, Jun 07, Jun 08, Jun 09

Chemical	Crop/Use	Total Acre Treatments/ Acres Planted	Rate, lb/A	Application Method	Application Dates
Fenamiphos	Peaches, apricots, nectarines	1	3.50	Banding, 2-cm incorp	May 31, Jun 01, Sep 20, Oct 11, Oct 12
Methidathion	Peaches, apricots, nectarines	19	1.16	Airblast	Jan 18, Mar 01, Dec 06, Dec 20, Dec 21
Naled	Peaches, apricots, nectarines	2	1.63	Airblast	Jan 04, Jan 05, Jan 17, Jan 18, Jan 19
Phosmet	Peaches, apricots, nectarines	32	2.76	Airblast	May 31, Jun 07, Jun 14, Jul 05, Jul 19
Acephate	Legume (dry/ succulent beans)	109	0.86	Aerial broadcast	Aug 02, Aug 09, Aug 16, Aug 30, Sep 06
Dimethoate	Legume (dry/ succulent beans)	102	0.40	Aerial broadcast	Jul 19, Aug 02, Aug 09, Aug 30, Sep 13
Malathion	Legume (dry/ succulent beans)	5	1.06	Aerial broadcast	Jun 28, Aug 02, Aug 09, Aug 10, Aug 16
Naled	Legume (dry/ succulent beans)	10	0.87	Aerial broadcast	Aug 30, Sep 06, Sep 13, Sep 14, Sep 27
Acephate	Tomato	1	0.81	Aerial broadcast	Aug 09, Aug 10, Aug 30, Aug 31, Sep 06
Chlorpyrifos	Tomato	0	0.60	Foliar broadcast; unincorp.	Jul 12, Aug 02, Aug 03, Aug 23, Aug 24
Diazinon	Tomato	2	1.10	Ground broadcast; no incorp	Mar 08, May 03, May 17, May 24, Jul 12
Dimethoate	Tomato	68	0.44	Aerial broadcast	Jul 05, Jul 19, Jul 26, Aug 02, Aug 23
Malathion	Tomato	0.2	1.18	Aerial broadcast	Jul 26, Jul 27, Aug 02, Aug 03, Aug 16
Methamidophos	Tomato	11	0.85	Aerial broadcast	Jul 12, Jul 26, Aug 16, Sep 06, Sep 27
Diazinon	Broccoli, brassicas	1	1.00	Ground broadcast; no incorp	Aug 16, Aug 17, Aug 18, Aug 19, Aug 20
Dimethoate	Broccoli, brassicas	39	0.36	Aerial broadcast	Aug 16, Aug 30, Sep 06, Sep 13, Oct 11
Methamidophos	Broccoli, brassicas	14	1.49	Aerial broadcast	Sep 06, Sep 26, Sep 27, Sep 28, Oct 18
ODM	Broccoli, brassicas	12	0.50	Aerial broadcast	Jan 11, Feb 15, Oct 17, Oct 18, Oct 19
Chlorpyrifos	Asparagus	19	0.64	Aerial broadcast	Jul 05, Jul 26, Aug 02, Sep 13, Oct 18
Disulfoton	Asparagus	71	1.05	Aerial broadcast	Aug 09, Sep 06, Sep 20, Oct 04, Oct 11
Malathion	Asparagus	8	0.99	Aerial broadcast	Jun 06, Jun 07, Jun 08, Jun 21, Jun 28
Chlorpyrifos	Sugarbeet	47	0.62	Aerial broadcast	Mar 17, May 26, Jun 16, Jul 07, Jul 14
Methamidophos	Sugarbeet	11	0.73	Aerial broadcast	May 10, Aug 02, Aug 09, Aug 16, Oct 04
Naled	Sugarbeet	1	1.01	Aerial broadcast	Sep 18, Sep 19, Sep 20, Sep 21, Sep 22
ODM	Sugarbeet	6	0.44	Aerial broadcast	Apr 19, Apr 20, Apr 26, Sep 06, Sep 20
Phorate	Sugarbeet	2	0.24	Incorporation	Apr 10, Apr 11, Apr 12, Apr 13, Apr 14
Diazinon	Cantaloupe	28	0.34	Aerial broadcast	May 17, May 24, Aug 01, Aug 02, Aug 03

Chemical	Crop/Use	Total Acre Treatments/ Acres Planted	Rate, lb/A	Application Method	Application Dates
Dimethoate	Cantaloupe	15	0.48	Aerial broadcast	Aug 02, Aug 03, Aug 09, Aug 10, Aug 17
ODM	Cantaloupe	4	0.38	Aerial broadcast	Jul 24, Jul 25, Jul 26, Jul 27, Jul 28
Chlorpyrifos	FieldCorn	8	1.13	Ground	May 17, Jun 07, Jun 14, Jun 28, Jul 12
Dimethoate	FieldCorn	0.1	0.32	Aerial broadcast	Mar 13, Mar 14, Mar 15, Mar 16, Jun 14
Disulfoton	FieldCorn	0.2	1.01	Aerial broadcast	Aug 14, Aug 15, Aug 16, Aug 17, Aug 18
Malathion	FieldCorn	0.1	0.50	Aerial broadcast	Mar 22, Mar 23, Apr 05, Aug 16, Aug 23
Phorate	FieldCorn	18	1.17	Ground; incorporation	May 03, May 17, May 31, Jun 07, Jun 14
Chlorpyrifos	Grapes	0.4	1.86	Airblast/ vineyard	Mar 07, Mar 08, Mar 09, Mar 15, Mar 16
Diazinon	Grapes	1	0.34	Airblast/ vineyard	May 17, Aug 08, Aug 09, Aug 10, Aug 11
Dimethoate	Grapes	1	0.29	Airblast/ vineyard	Jul 17, Jul 18, Jul 19, Jul 20, Jul 21
Fenamiphos	Grapes	3	1.62	Banding, 2-cm incorp	May 10, Jun 28, Jul 05, Nov 01, Nov 15
Malathion	Grapes	1	1.50	Airblast/ vineyard	Jun 19, Jun 20, Jun 21, Jun 22, Jun 23
Naled	Grapes	1	0.67	Airblast/ vineyard	Jun 21, Jul 19, Aug 02, Aug 09, Sep 06

The Agency used California Department of Pesticide Regulation's Pesticide Use Reporting (PUR) data in these Central Valley assessments. The PUR data contains detailed information on all commercial pesticide applications made on each date, to every field within the State of California. This detailed data provided a temporal resolution to application timing not available with the USDA NASS data. While this adjustment is different than the Cumulative Adjustment Factors (CAF) developed for other regional assessments; the intended effect is similar. As explained below, the PUR data enabled the Agency to obtain application dates directly from actual pesticide usage patterns rather than determining application dates indirectly through the construction of pesticide use windows.

For any particular use (e.g., chlorpyrifos applied to cotton), many users may treat many different fields throughout the use season. Therefore, there will be many days when at least one grower is applying that pesticide to that particular crop on some field, located somewhere within the assessment area. To account for this diversity in actual use patterns, the Agency first calculated a temporal distribution for each particular use over the calendar year. This temporal distribution indicates the percent of all acre treatments that were made throughout the calendar year (e.g., we could say that x% of all acre treatments were made between January 1st and February 28th). The Agency approximated that temporal distribution by calculating quintiles, and used the midpoints for each quintile to determine five application dates, with each date representing 20% of the total acre treatments made that year. To further illustrate, suppose that there were a total of 350,000 acre treatments of chlorpyrifos made to cotton during the Calendar year, and that all of this use occurred during a 5 week (35 days) period - beginning the 1st week of August and extending into the 1st week of September. Also, suppose that this chlorpyrifos use (total pounds ai, total acre treatments) were uniform throughout this five week period. With such uniformity, it is straightforward to calculate a temporal distribution for chlorpyrifos use on cotton: the Agency would assume that 70,000 acres were treated on five dates, beginning in August and spaced one week apart into the first week of September.

The availability of PUR data provided for a slightly different approach than what was applied in the other regional assessments. The conventional pesticide use statistics that were used in those assessments (base acres treated, and percent of crop treated), were not needed for this regional assessment. Being able to generate a temporal distribution for each OP use obviates the need to know the base acres treated and the average number of applications. In the hypothetical example illustrated above, it does not matter whether 350,000 acres received only one application over that five week period, or if 175,000 base acres were treated twice. What is relevant is that approximately 70,000 acres were treated on or about each of those five midpoint dates; the base acres treated are not all treated on the same date. As far as the PRZM-EXAMS model is concerned, the number of times a base acre is treated does not affect the environmental fate of these OPs. The pesticide use statistics that we are primarily concerned with are the application date, the total area treated (relative to total area), and the average application rate. While it is possible to 'chop' up such a temporal distribution into smaller pieces (e.g., 35 application dates), the Agency determined that it could adequately capture the majority of the temporal variability in pesticide usage reported among growers (users) in the region by approximating these distributions with five application dates. In contrast, if the Agency were to have developed a pesticide use window, then approximately 2 applications would have made to 175,000 base acres treated; and two application dates would have been modeled.

Figures II.G.5 and II.G.6 depict total usage of OPs in the North-Central Central Valley in 1998, by crop and by active ingredient, respectively. Approximately 580,000 lbs ai of OPs were applied in this location (San Joaquin, Stanislaus counties) during the 1998 calendar year. Most of the OP usage in this area occurred between weeks 19 and 40; with over 42,000 lbs ai applied during week 30. As Figure II.G.5 indicates, some early applications (dormant season use of diazinon) occur on almonds during January, followed by some spring applications (chlorpyrifos) on alfalfa (first cuttings). Various crop-OP uses contributed to overall use during this period, including applications to walnuts, almonds, corn and tomatoes.

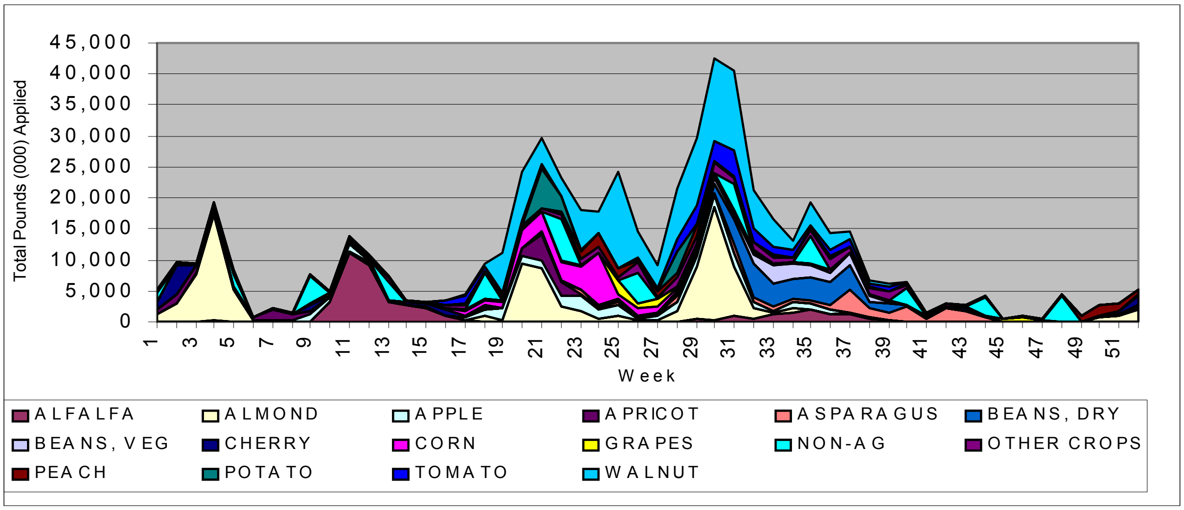


Figure II.G.5. Total OP Usage for North Central Valley, By Crop, 1998

As Figure II.G.6 indicates, chlorpyrifos accounted for the greatest usage among OPs with 180,000 lbs ai applied; some of which were applied to alfalfa during the early season, and most of which were applied to almonds and walnuts during the summer months. There was also a considerable amount of phosmet (96,000 lbs ai) applied, as well as diazinon (58,000 lbs ai) and acephate (33,000 lbs ai).

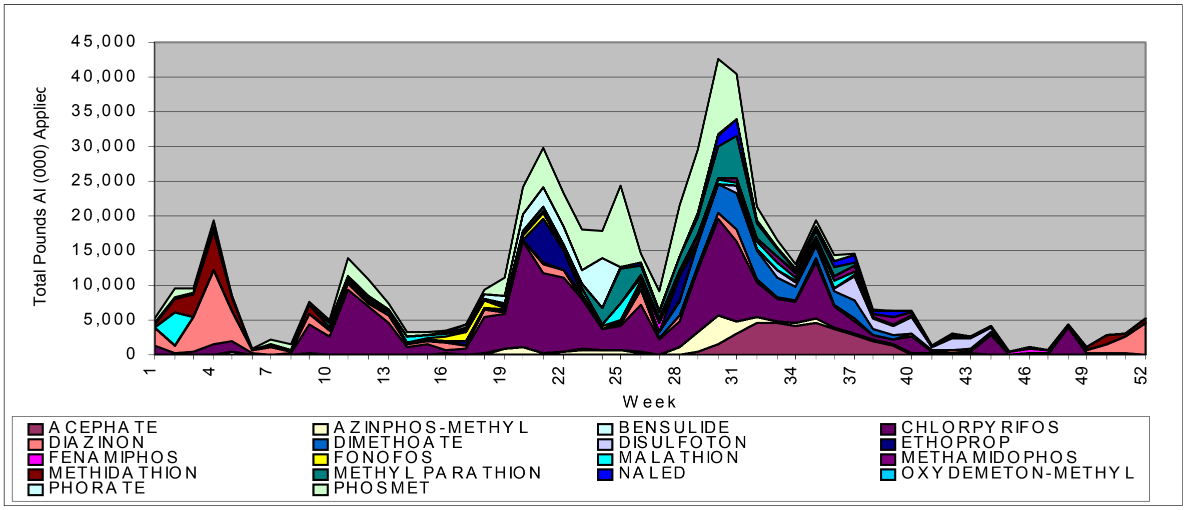


Figure II.G.6. Total OP Usage in North Central Valley, By Active Ingredient, 1998

Figure II.G.7 depicts total usage of OPs on walnuts. Approximately 122,000 lbs ai of OPs were applied to walnuts in 1998; with almost 16,000 lbs ai applied during week 25. The primary OPs contributing to overall usage were: chlorpyrifos (42,000 lbs ai, treat for coddling moth, scale), phosmet (34,500 lbs ai, coddling moth), methyl parathion (24,600 lbs ai, post-bloom applications), azinphos-methyl (8,000 lbs ai, post-bloom applications) and naled (6,000 lbs ai). As discussed below, this information was used to determine the application dates for various crop-op uses within this area.

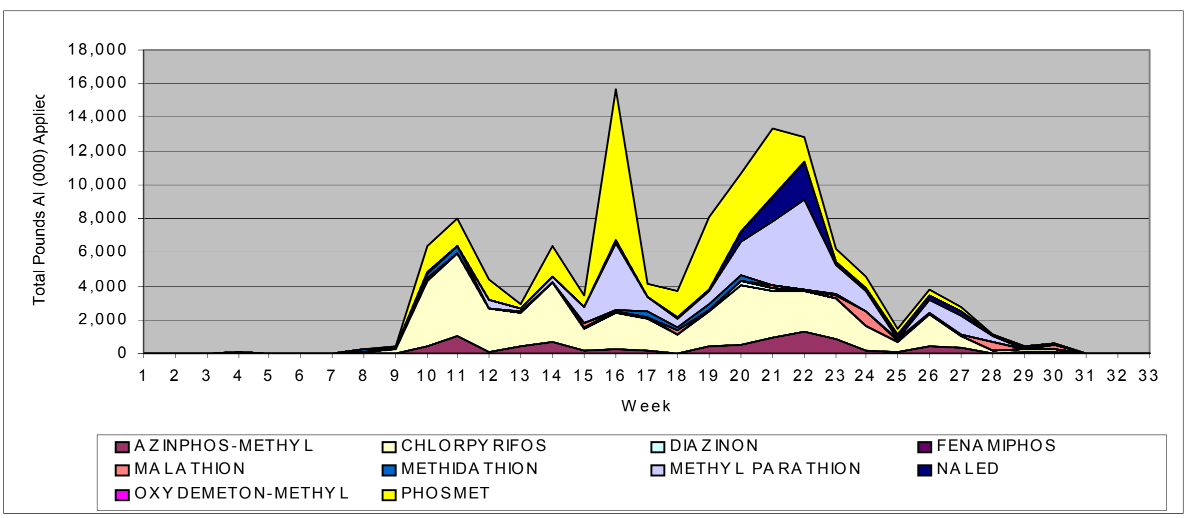


Figure II.G.7. Total OP Usage on Walnuts in the North Central Valley, By AI, 1998

Figure II.G.8 displays 35 years of predicted OP cumulative concentrations for the central/northern counties of the Central Valley of California. This chart depicts OP cumulative concentrations were relatively flat throughout the 35 years modeled. The OP cumulative concentration levels generally remained below 0.1 ppb, and did not exceed 0.3 ppb in methamidophos equivalents in any of the 35 years modeled.

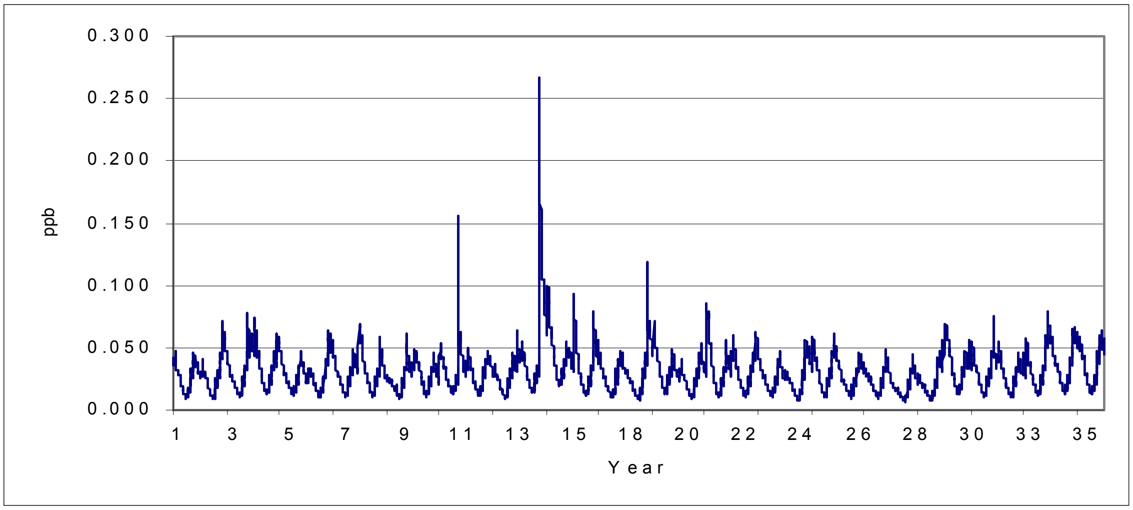


Figure II.G.8. Cumulative OP Distribution in Water in the Fruitful Rim NCV (Methamidophos equivalents)

Figure II.G.9 overlays all 35 years of predicted values over the Julian calendar. Here, for example, each of the 35 yearly values associated with February 1st (i.e., Julian Day 32) are graphed such that the spread of concentration associated with February 1st (over all years) can readily be seen. This chart indicates that OP concentrations are generally low throughout the year, with a small peak occurring about week 40.

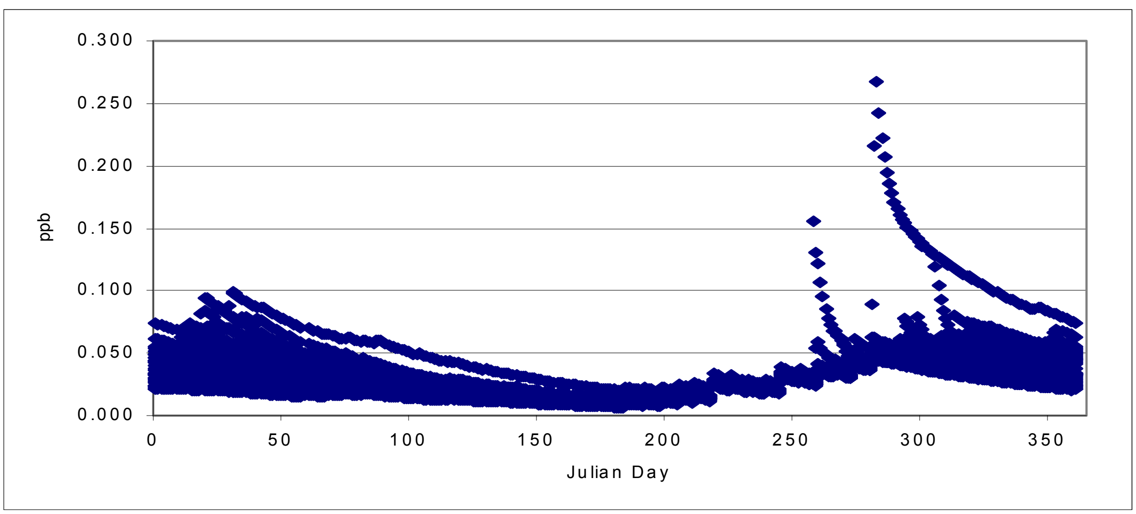


Figure II.G.9. Cumulative OP Distribution in Water (Methamidophos Equivalents) in the Fruitful Rim NCV, summarized on a daily basis over 35 years

Figure II.G.10 depicts the predicted OP cumulative concentration for uses that made significant contributions during Year 14, the year in which the highest modeled concentration (0.27 ppb methamidophos equivalents) occurred. Disulfoton use on asparagus and phorate use on corn were the two contributors to that late season peak. These low concentrations are due primarily to low rainfall in this region. It is important to note that these concentrations are converted to methamidophos equivalents based on relative potency factors. Thus, the relative contributions are the result of both individual chemical concentrations in water and the relative potency factor of each of the OP chemicals found in the water.

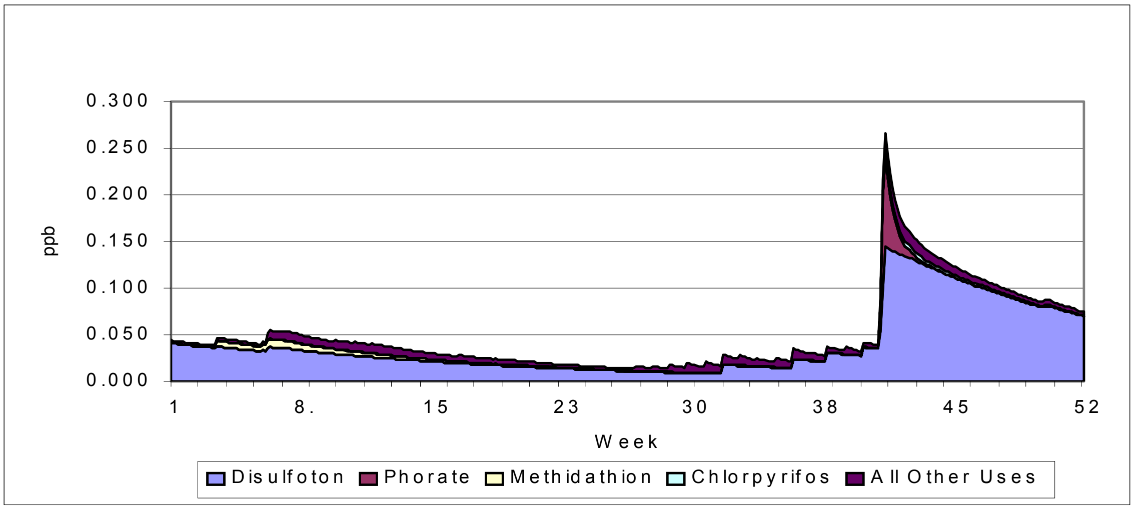


Figure II.G.10. Cumulative OP Distribution for an Example Year (Year 14) in the Fruitful Rim NCV Region Showing Relative Contributions of the Individual OPs in Methamidophos Equivalents

c. A Comparison of Monitoring Data versus Modeling Results

A comparison of estimated concentrations for individual OP pesticides (Table II.G.6) with NAWQA monitoring (summarized below and in Appendix III.E.1) indicate that the estimated concentrations of chlorpyrifos and disulfoton were similar to reported detections in surface water in the San Joaquin-Tulare Basin. The highest reported detections of azinphos methyl, diazinon, malathion, and methyl parathion were an order of magnitude greater than the maximum estimated concentrations used in this assessment. The maximum estimated concentration of azinphos methyl was equivalent to the 90th percentile concentration found in the NAWQA study. When compared to detections from streams in agricultural watersheds only, the estimated concentrations of chlorpyrifos and malathion were similar to reported NAWQA detections while diazinon concentrations were still an order of magnitude lower. Phorate was not detected in the NAWQA study; approximately 95 percent of the estimated concentrations for phorate fell below the USGS analytical limit of detection.

The Agency has not yet compared the drinking water assessment with other monitoring data available for California. This effort is planned prior to the release of the final assessment in August 2002.

Table II.G.6. Percentile Concentrations of Individual OP Pesticides and of the Cumulative OP Distribution in the Central/Northern Central Valley, 35 Years of Weather

		Concentration in ug/L (ppb)						
Chemical	Crop/Use	Max	99th	95th	90th	80th	75th	50th
Acephate	Legumes, Tomato	1.6e-02	1.3e-02	8.5e-03	5.0e-03	3.7e-04	1.0e-04	3.7e-06
Azinphos Methyl	Apples, pears; nuts (almonds, walnuts)	3.8e-02	5.7e-03	2.5e-03	1.8e-03	1.3e-03	1.1e-03	4.7e-04
Chlorpyrifos	Nuts; fruit trees; alfalfa; sugarbeets; corn; grapes; tomato; asparagus	1.3e-01	5.4e-02	3.7e-02	3.0e-02	2.3e-02	2.0e-02	1.2e-02
Diazinon	nuts; fruit trees; grapes; brassicas; tomato; cantaloupe	2.3e-01	1.4e-01	8.1e-02	5.6e-02	3.2e-02	2.5e-02	9.9e-03
DDVP	Naled degradate	1.3e-03	1.9e-04	9.4e-06	6.3e-07	2.6e-09	1.4e-10	8.2e-13
Dimethoate	Fruit trees; alfalfa; corn; grapes; legumes; tomatoes; brassicas; Cantaloupe	8.4e-02	2.2e-02	1.6e-02	1.3e-02	8.0e-03	5.4e-03	1.4e-03
Disulfoton	Corn; asparagus	1.2e-01	5.0e-02	3.8e-02	3.4e-02	2.9e-02	2.6e-02	1.7e-02
Fenamiphos	fruit trees; grapes	3.9e-02	3.1e-02	2.0e-02	1.5e-02	1.0e-02	9.0e-03	4.9e-03
Malathion	Alfalfa; corn; grapes, legumes; tomatoes; asparagus	8.3e-03	1.9e-03	1.2e-03	7.9e-04	3.0e-04	1.2e-04	2.8e-08
Methamidophos	Acephate degradate; tomato; sugarbeet; legume; brassicas	1.3e-02	3.0e-03	1.6e-03	9.6e-04	3.6e-04	2.3e-04	4.6e-06
Methyl Parathion	Alfalfa	5.3e-03	2.6e-03	1.4e-03	8.6e-04	1.4e-04	4.7e-05	4.3e-08
Methidathion	Nut trees; fruit trees	1.5e-01	6.5e-02	3.5e-02	2.0e-02	8.4e-03	5.8e-03	7.6e-04
Naled	Nut trees; fruit trees; sugarbeets; grapes; legumes	4.4e-03	9.0e-04	5.3e-05	1.0e-05	2.3e-07	1.2e-08	2.1e-12
ODM	Sugarbeet; brassicas; melons	3.8e-03	2.2e-03	1.1e-03	6.7e-04	3.9e-04	3.2e-04	1.4e-04
Phorate	Sugarbeet, corn	2.6e-01	1.0e-02	5.1e-04	4.2e-05	3.5e-07	3.2e-08	3.5e-12
Phosmet	nut trees; fruit trees; alfalfa	3.2e-02	3.0e-03	6.1e-04	6.3e-05	1.4e-06	2.3e-07	1.2e-11
OP cumulative Concentrations (in Methamidophos equivalents, ppb)		2.7e-01	8.0e-02	5.7e-02	5.0e-02	4.2e-02	3.9e-02	2.8e-02

In evaluating these comparisons, it is important to realize that the estimated cumulative OP concentrations used in the exposure assessment represent concentrations that would occur in a reservoir, and not in the streams and rivers represented by the NAWQA sampling. The sampling frequency of the NAWQA study (sample intervals of 1 to 2 weeks apart or less frequent) was not designed to capture peak concentrations, so it is unlikely that the monitoring data will include true peak concentrations. As noted earlier, the surface-water hydrology in this region is complicated by irrigation and by a system of canals. The main document provides a characterization of what the water exposure estimates represent and includes an analysis of the factors that most influence these estimated concentrations.

d. Summary of Available Monitoring Data for the Fruitful Rim NCV

The **Sacramento River Basin (SACR) NAWQA** study site includes the Sacramento Valley in the Fruitful Rim, SW. The Sacramento River is the largest river in the State of California, and is a highly managed water body which meets the needs of the more than one million people in the Sacramento area. The USGS indicates that while the concentrations of OP insecticides in agricultural and urban streams in this region “sometimes exceed amounts that are toxic to zooplankton in laboratory tests, the toxicity is greatly reduced or eliminated when concentrations of these pesticides are diluted by the Sacramento River” (USGS Water Resources Circular 1215).

Surface-water monitoring included 3 intensive sampling sites, including the Colusa Basin Drain, which in the late 1980s had elevated concentrations of methyl parathion and malathion detected. Since that time, a program to reduce spray drift and increase paddy-water holding time has reduced detected concentrations dramatically. A description of this program is included in the State Monitoring Appendix. An urban intensive study site was also sampled.

In the SACR study, chlorpyrifos, diazinon, malathion and azinphos-methyl were detected in surface water. Diazinon was detected in 71% of agricultural samples, and 35% of mixed land-use samples, with a maximum concentration of slightly over 0.1 ug/l. Chlorpyrifos was detected in 29% of agiricultural samples, and a single mixed land-use sample, with a maximum concentration detected of about 0.05 ug/l. Malathion was detected in 53% of urban samples and 33% of agricultural samples, with a maximum detection of nearly 1 ug/l.

An aquifer study in the SACR included single samples of 31 domestic wells in the southeastern Sacramento Valley, where the Sacramento Valley aquifer is an important domestic and irrigation water source. Ground water in some other parts of the Sacramento Valley are not potable, due to elevated levels of fluoride and boron. A rice land-use study included single samples from 28 monitoring wells installed near the water table beneath or near rice fields. Finally, 19 urban monitoring wells were sampled once each from the surficial, unconfined aquifer. No OPs were detected in ground water from any of these studies.

The **San Joaquin-Tulare Basins (SANJ) NAWQA** study site includes the southern Central Valley of California. Surface water accounts for more overall water use than ground water, but ground water is the predominant source of drinking water in this region (USGS Water Resources Circular 1159). Irrigation accounts for the greatest amount of water use, and is also the greatest source of aquifer recharge, which can lead to contamination of ground water with agricultural chemicals.

Ground-water monitoring in the SANJ included single samples from 30 domestic wells around the eastern portion of the valley. Monitoring also included in single samples from 20 domestic wells and 10 monitoring wells each in almond, vineyard and row crop land-use ground-water studies. More than 50% of the monitoring wells in each of these studies was within a quarter-mile of cropped fields. Chlorpyrifos, malathion and diazinon were detected in one, two and three ground water samples, respectively. One detection of malathion at 0.1 ug/l was the highest OP concentration detected in ground water.

The SANJ report specifically mentions that “high concentrations of organophosphate insecticides, resulting from application to some orchards during the winter, are of particular concern” (USGS Water Resources Circular 1159). Surface-water monitoring included biweekly to monthly sampling at intensive agricultural, rangeland and urban sites in 1993. Another 23 sites were sampled once at low flow in urban and agricultural areas.

Diazinon was detected in 71% of samples taken, with a maximum concentration of 3.8 ug/l. Chlorpyrifos was detected in 52 % of samples, with a maximum concentration of about 0.5 ug/l. Azinphos methyl was also extensively (12%) detected, with a maximum concentration of about 1.0 ug/l. Malathion was detected in 8% of samples, with a maximum concentration between 0.5 and 1.0 ug/l. Ethoprop, disulfoton, methyl parathion and terbufos were detected in fewer than 1% of samples analyzed. The maximum concentrations of chlorpyrifos were detected in samples taken around the winter application season.

The USGS San Joaquin River Basin study included a study designed to determine sampling frequency needed to characterize the occurrence and distribution of pesticides in surface water in a semiarid agricultural region such as the SJRB. Results indicated that sampling three times per week is more likely to detect higher concentrations than once per week as indicated by the larger variance about the median for the more frequent sampling. Sampling once per week is sufficient if only the median concentration is important.

The **Central Arizona Basins (CAZB) NAWQA** study unit is located in southern and central Arizona. The dominant source of drinking water in central Arizona are deep basin aquifers, some of which may have been recharged thousands of years ago. At the very least, 55% of wells tested in the Central Arizona Basins NAWQA study area (CAZB) were recharged before 1953 (USGS Water Resources Circular 1213) .

The main aquifers in the Central Arizona region were formed by the sedimentary infilling of structural depressions typical of the Basin and Range physiographic province. These sediments, which range in thickness from a few thousand to as much as 10,000 feet, have led to a topography of broad, sloping plains interrupted by sharply rising mountains (USGS Professional Paper 1406-A). Natural recharge to these aquifers occurs mainly in the foothills of the mountain ranges, where rainfall is greater, and through infiltration from larger rivers. The USGS Regional Aquifer-System Analysis program identified 72 separate basin aquifers that are “virtually independent hydrologic entities that share common geologic and hydrologic characteristics.”

Alluvial deposits in the vicinity of major streams in Arizona range in thickness up to about 300 feet, and where locally saturated serve as aquifers. Chlorpyrifos was detected in a single sample from a shallow monitoring well in the CAZB study unit, but no OP was detected in samples from wells installed in the deeper aquifers. Although a single sampling of a well network is not definitive in determining the likelihood of pesticide contamination, the depth of the aquifers, combined with the very low rainfall for the region, result in very slow recharge rates which may delay contamination by OP residues for a long time.

In the CAZB report, the USGS notes that domestic wells drawing from below confining clay beds are protected to a large extent from surface contamination. However, the older water from below this layer could be contaminated in the future if large-scale water induces downward flow through the clay layer, or through breaches through the clay layer by well-drilling. For the present, however, the Arizona portion of the Fruitful Rim NCV should be conservatively represented by monitoring and modeling assessments for California.

Increased water withdrawal in Arizona that occurred with population growth from the middle 20th century has greatly exceeded recharge, and has led to depletion of aquifers. In addition to the loss of water that had been stored in the aquifer for hundreds of years, the withdrawal has led to compaction of pore spaces in some depleted portions of the aquifer. This has led to land subsidence in some places, and even to crevassing at the land surface.

In order to avoid permanent damage to the storage capacity of the aquifer, and to meet water needs for the long term, city and state water authorities have put in place plans to replace water taken from aquifer storage through artificial recharge.

Surface-water monitoring in this region included two intensive sampling sites from agricultural streams, and three other fixed sites which were sampled quarterly. Diazinon was detected in 97% of samples, and chlorpyrifos in 94%, all below 0.5 ug/l. malathion was detected in 26% of samples at similar concentrations. Disulfoton was detected once at nearly 1 ug/l. Azinphos methyl, methyl parathion and phorate are also reported to have been detected in surface water.

However, while these mixed agricultural/urban streams may be effected ecologically by this contamination, they are not used as drinking water sources. The two streams (Buckeye Canal and Hassayampa River) are typical of most in the region, in that flow is maintained through addition of treated wastewater effluent and irrigation return water.

The California Environmental Protection Agency Department of Pesticide Regulation (CDPR) performed a 10-year study of **rice pesticides in surface water**, which included methyl parathion and malathion. CDPR samples the Colusa Basin Drain, an agricultural discharge channel that collects outflow from rice fields from about 20 to 100 miles north of Sacramento, and west of the Sacramento River. This area is used for many continuous miles of rice monoculture on heavy clay soils.

According to the CDPR, methyl parathion was detected at concentrations of up to 6 ppb in 1989. CDPR was concerned with surface water contamination by a suite of rice pesticides. By the late 1980s, CDPR had instituted a control program to reduce the surface water impacts of rice herbicides. In the early 1990s, the CDPR expanded the program to include rice insecticides.

The program includes both irrigation and application controls to reduce direct input of pesticides to the Colusa Basin Drain, which drains to the Sacramento River. Rice farmers are required to hold water on flooded rice fields for prescribed periods of time before releasing it to the drainage system, periods which depend on the pesticides applied. The holding time for methyl parathion is 24 days, but it is held longer if applied concurrently with another pesticide that must be held longer. A voluntary holding time of 4 days is suggested for malathion. Application controls include requirements such as positive shutoff systems for aircraft nozzles, use of drift control agents, and a 300-foot buffer from water bodies for aerial applications.

CDPR has seen measurable improvements in the samples they have taken each year from early or mid-April to mid-June. For instance, the peak concentration of methyl parathion detected in 1996 was 0.12 ppb. A maximum concentration of 0.107 ppb of methyl parathion was detected in 32 samples taken in 1997. A single detection of <0.1 ug/l of malathion was detected in 1997. These data reflect successful mitigation, and also a reduction in methyl parathion use in the area over 15 years.

The California Department of Pesticide Regulation and the USGS have ongoing studies investigating OP contamination from winter use as a **dormant spray to tree fruits and tree nuts**. Since the series of CDPR dormant spray studies focus sampling on pesticides used in the area, coinciding with when they were applied, the frequency and concentrations of OP detections have both been relatively high. For instance, in sampling in the winters of 1991-1992 and 1992-1993, diazinon, methidathion and chlorpyrifos were detected in 72, 18 and 10% of 108 samples collected in the San Joaquin River Basin, respectively. Dimethoate was detected in 60% of samples taken in the watershed in the summer of 1992, at concentrations up to 2.4 ug/l. Azinphos-methyl, chlorpyrifos, diazinon and methidathion were also detected in summer sampling.

Sampling in the Sacramento River watershed has also led to detections of OPs from dormant spray use. Diazinon and methidathion, the two most importan tree fruit and tree nut dormant spray insecticides in the watershed, were detected at levels toxic to some aquatic invertebrates. Concentrations and frequency of detection of diazinon was greater than that of methidathion. Details of the detection of diazinon in studies performed by the State of California can be found in the diazinon Reregistration Eligibility Document, which is available on the internet at http://www.epa.gov/pesticides/op/status.htm .

Frank Spurlock of the CDEP has written a paper on the findings of chlorpyrifos and diazinon in surface water. This paper, which has not yet been published, is a summary of about 30 monitoring studies, including samples from the Sacramento and San Joaquin Rivers and their tributaries, as well as agricultural drains. The monitoring was predominantly from streams affected by agricultural runoff. Urban data is limited, but urban concentrations were much higher.

Agricultural loading was the most significant load of these chemicals in the Sacramento River. Small streams in the Sacramento basin had the highest agricultural detections. Of approximately 3900 individual samples for diazinon a very small percentage exceeded the lifetime Health Advisory of 0.6 ppb in rivers and tributaries. None of the 3700 samples for chlorpyrifos had concentrations that exceeded the lifetime Heath Advisory of 20 ppb. Overall, concentrations of chlorpyrifos were lower than those of diazinon. In general, based on analysis which will be available when the paper is published, overall concentrations in the winter application months have declined since a decade ago, corresponding with reductions in use (Frank Spurlock, personal communication.

A **prospective ground-water monitoring study for fenamiphos** use on grapes in California was begun in October, 1997, and preliminary information and monitoring results have been submitted in interim and progress reports. Interim reports indicate that fenamiphos and its sulfone and sulfoxide degradates were found in soil-pore water and ground water after one application of 6 lb A.I./acre. Fenamiphos and fenamiphos sulfone were detected in one ground-water sample, at concentrations of 0.05 and 0.53 ppb respectively, 216 days after treatment (DAT). Fenamiphos sulfoxide was detected in ground water samples from four of eight well clusters, at concentrations up to 2.13 ppb. These concentrations can be considered as a lower bound measure of the peak concentrations of total fenamiphos residues in ground water resulting from use of fenamiphos on HSG A soils. It is likely that application to similar soils in areas with higher rainfall or at higher applications rates will result in higher groundwater concentrations. A similar study on more vulnerable soils in the Florida Central Ridge resulted in significantly higher ground-water detections.

The California Department of Pesticide Regulation is currently sampling “about 40 **domestic wells for fenamiphos** in high use areas” (Robert Matzner, CDPR, written communication to EPA). Twenty-eight wells sampled in 2001 did not have detections of fenamiphos, fenamiphos sulfoxide, or fenamiphos sulfone. This sampling program is ongoing. These OPs were also not detected in 803 wells sampled in California from 1985 to 1994.

4. Results of Cumulative Assessment

Analyses and interpretation of the outputs of a cumulative distribution rely heavily upon examination of the results for changing patterns of exposure. To this end, graphical presentation of the data provides a useful method of examining the outputs for patterns and was selected here to be the most appropriate means of presenting the results of this cumulative assessment. Briefly, the cumulative assessment generates multiple potential exposures for each hypothetical individual in the assessment for each of the 365 days in a year. Because multiple calculations for each individual in the CSFII population panel are conducted for each day of the year, a distribution of daily exposures is available for each route and source of exposure throughout the entire year. Each of these generated exposures is internally consistent – that is, each generated exposure appropriately considers temporal, spatial, and demographic factors such that “mismatching” (such as combining a winter drinking water exposure with an exposure that would occur through a spring lawn application) is precluded. In addition, a simultaneous calculation of MOEs for the combined risk from all routes is performed, permitting the estimation of distributions of the various percentiles of total risk across the year. As demonstrated in the graphical presentations of analytical outputs for this section, results are displayed as MOEs with the various pathways, routes, and the total exposures arrayed across the year as a time series (or time profile). Any given percentile of these (daily) exposures can be selected and plotted as a function of time. That is, for example, a 365-day series of 95th percentile values can be plotted, with 95th percentile exposures for each day of the year (January 1, January 2, etc) shown. The result can be regarded as a "time-based exposure profile plot" in which periods of higher exposures (evidenced by low 'Margins of Exposure') and lower exposures (evidenced by high 'Margins of Exposure') can be discerned. Patterns can be observed and interpreted and exposures by different routes and pathways (e.g., dermal route through lawn application) seen and compared. Abrupt changes in the slope or level of such a profile may indicate some combination of exposure conditions resulting in an altered risk profile due to a variety of factors. Factors may include increased pest pressure and subsequent home pesticide use, or increased use in an agricultural setting that may result in increased concentrations in water. Alternatively, a relatively stable exposure profile indicates that exposure from a given source or combination of sources is stable across time and the sources of risk may be less obvious. Different percentiles can be compared to ascertain which routes or pathways tend to be more significant contributors to total exposure for different subgroups of the Fruitful Rim– North Central Valley population (e.g, those at the 95th percentile vs. 99th percentiles of exposure).

Figures III.O.2-1 through III.O.2-5 in Appendix O present the results of this cumulative risk analysis for Children, 1-2 years for a variety of percentiles of the Fruitful Rim – North Central Valley population (95 th , 97.5 th , 99 th , 99.5 th , and 99.9 th). Figure III.O.2-6 through Figure III.O.2-10, Figure III.O.2-11 through Figure III.O.2-15 and Figure III.O.2-16 through Figure III.O.2-20 present these same figures for Children 3-5, Adults 20-49, and Adults 50+, respectively. The following paragraphs describe, in additional detail, the exposure profiles for each of these population age groups for these percentiles (i.e., 95th, 97.5th, 99th, 99.5th, and 99.9th). Briefly, these figures present a series of time course of exposure (expressed as MOEs) for various age groups at various percentiles of exposure for the population comprising that age group. For example, for the 95th percentile graphs, the 95 th percentile (total) exposure is estimated for each of the 365 days of the year, with each of these (total) exposures – expressed in terms of MOE's – plotted as a function of time. The result is a "time course" (or "profile") of exposures representing that portion of the Fruitful Rim NCV population at the 95th percentile exposures throughout the year. Each "component" of this 95th percentile total exposure (i.e., the dermal, inhalation, non-dietary oral, food, and water, etc. "component" exposures which, together, make up the total exposure) can also be seen – each as its own individual time profile plot. This discussion represents the unmitigated exposures (i.e., exposures which have not been attempted to be reduced by discontinuing specific uses of pesticides) and no attempt is made in this assessment to evaluate potential mitigation options. The following paragraphs describe the findings and conclusions from each of the assessments performed.

a. Children 1-2 years old

(Figure III.O.2-1 through Figure III.O.2-5): At the 95th percentile, exposures from the residential applications of OP pesticides do not contribute to the overall exposure to these pesticides in this region. This is true for all of the routes of exposure examined: dermal and hand-to-mouth exposure from lawn treatment applications and inhalation exposure from crack and crevice and pest strip treatments. Drinking water exposures are also low and do not contribute to substantial exposure. At the higher percentiles the exposure profile and relative contributions begin to change. The residential exposures (via inhalation) become an increasingly dominant portion of the total exposure profile for an increasing fraction of the year. Drinking water exposures at these percentiles continue to be low and do not contribute in any significant manner to the overall risk picture. Dermal and/or hand-to-mouth exposures from lawn uses are apparent in the overall risk picture only at the 99.9th percentile, but remain a small fraction (generally <1 to 10%) of total exposure.

b. Children 3-5 years old

(Figure III.O.2-6 through Figure III.O.2-10): As with Children 1-2, exposures from the residential applications of OP pesticides do not contribute to the overall exposure at the 95th percentile in this region. This is true for all of the routes of exposure examined: dermal and hand-to-mouth exposure from lawn treatment applications and inhalation exposure from crack and crevice and pest strip treatments. Drinking water exposures are also low and do not contribute to substantial exposure. At the higher percentiles the exposure profile and relative contributions begin to change. The residential exposures (via inhalation) become an increasingly dominant portion of the total exposure profile for an increasing fraction of the year. Drinking water exposures at these percentiles continue to be low and do not contribute in any significant manner to the overall risk picture. Dermal and/or hand-to-mouth exposures from lawn uses are apparent in the overall risk picture only at the 99.9th percentile, but remain a small fraction (generally <1% to 10%) of total exposure.

c. Adults, 20-49 and Adults 50+ years old

(Figure III.O.2-11 through Figure III.O.2-15 and Figure III.O.2-16 through III.O.2-20) At the 95th percentile exposures from the residential applications of OP pesticides do not contribute to the overall exposure. This is true for all of the routes of exposure examined: dermal exposure from lawn and garden and golf course treatment applications and inhalation exposure from lawn and gardening activities and indoor crack and crevice and pest strip treatments. Drinking water exposures are also low and do not contribute to substantial exposure. At the higher percentiles the exposure profile and relative contributions begin to change. The residential exposures (via inhalation) become an increasingly dominant portion of the total exposure profile for an increasing fraction of the year. Drinking water exposures at these percentiles continue to be low and do not contribute in any significant manner to the overall risk picture. Dermal exposures begin to become apparent in the overall risk picture only at the 99th percentile, but remain a small fraction (generally <1 to 10%) of total exposure.