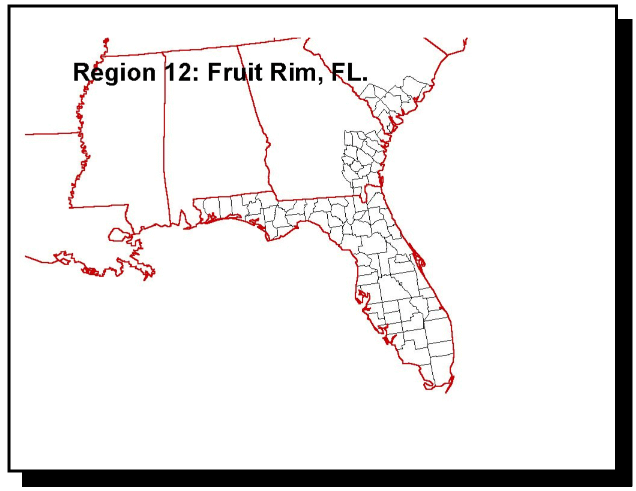
II. Regional Assessments

M. Region 12 - Fruitful Rim – FL

1. Executive Summary

This module of the Organophosphate (OP) cumulative risk assessment focuses on risks from OP uses in the Fruitful Rim – FL (area shown to the right). Information is included in this module only if it is specific to the Fruitful Rim – FL, or is necessary for clarifying the results of the Fruitful Rim–FL 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 exposure 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.M.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.M.1. Pesticides and Use Sites/Scenarios Considered in Fruitful Rim – FL Residential/Non-Occupational and Drinking Water Assessment

Pesticide	Residential Use Scenarios	OP Drinking Water Scenarios
Acephate	Ornamentals, Golf Courses	Peppers (Bell)
Azinphos Methyl	None	None
Bensulide	Golf Courses	None
Chlorpyrifos	None	Oranges, Tangelos, Tangerines, Grapefruit, Sweet Corn
DDVP	Pest Strips, Crack/Crevice	None
Diazinon	None	Lettuce, Tomatoes
Disulfoton	Ornamentals	None
Ethoprop	None	Sugarcane
Fenamiphos	Golf Courses	None
Fenthion	Public Health	None
Malathion	Lawns, Public Health, Vegetable Gardens	None
Methamidophos	None	Tomatoes
Naled	Public Health	None
Phorate	None	Sugarcane, Sweet Corn
Trichlorfon	Lawns	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 – FL 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.

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

In general, the risks estimated for the Fruitful Rim – FL 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 and (at the higher percentiles for children) oral hand to mouth. 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 – FL Region

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, public health uses, and indoor uses. These scenarios were selected because they are expected to be the most prominent contributors to exposure in this region. 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.

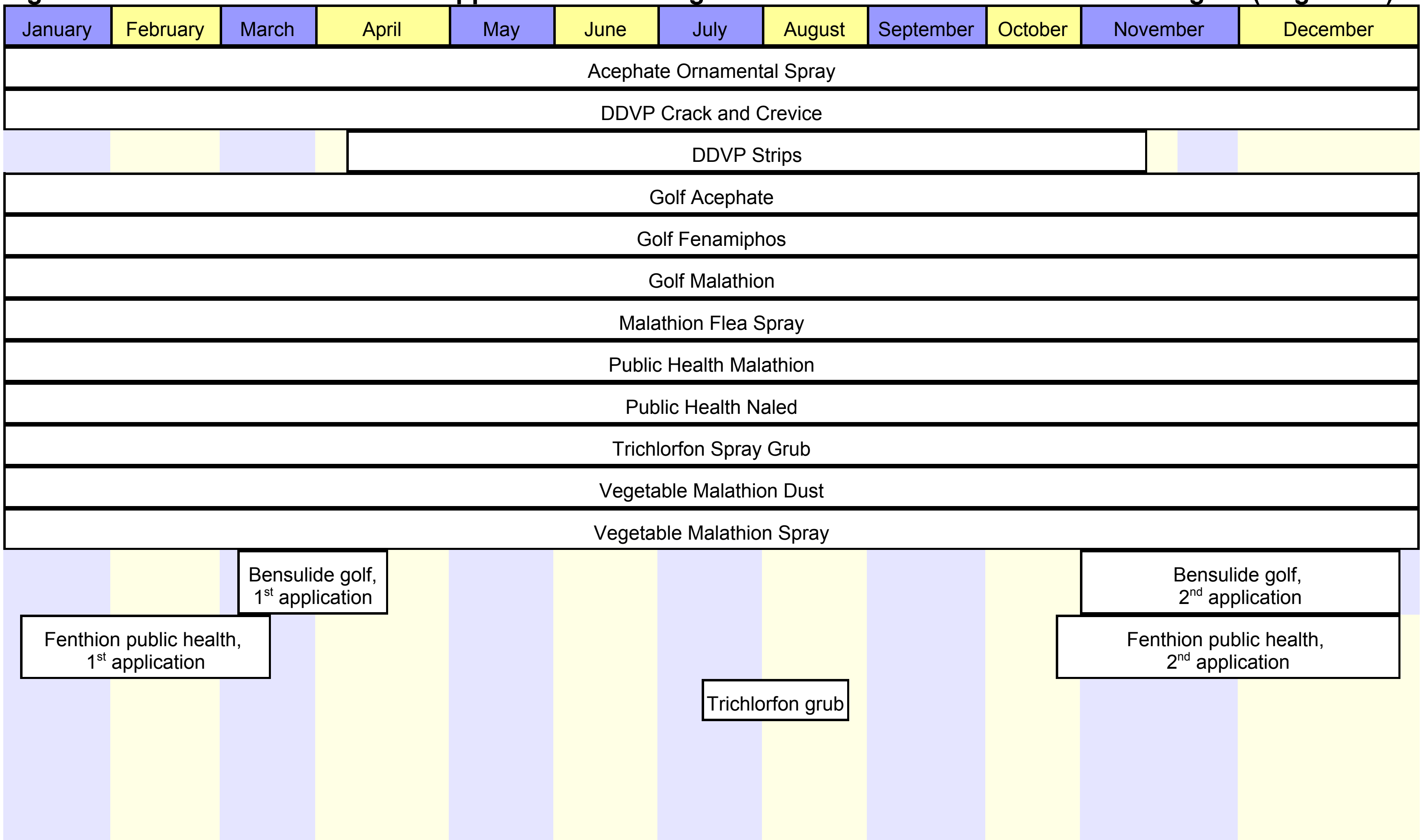
The data inputs to the residential exposure assessment come from a variety of sources including the published, peer reviewed literature and data submitted to the Agency to support registration and re-registration of pesticides. Generic scenario issues and data sources are discussed in Part I of this report. However, a variety of additional region-specific ancillary data was required for this assessment of the Fruitful Rim – FL region. 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.M.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 is presented in Table II.M.2 which summarizes all relevant region-specific scenarios.

Table II.M.2. Use Scenarios and Calendex Input Parameters for Fruitful Rim – FL 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	Jan-Dec.	--	100	6	1	dermal, inhalation
	Golf Courses	NA	5	2/yr	Jan-Dec.	100	--	10.37	10	dermal
Bensulide	Golf Courses	NA	12.5	2/yr	March-April Nov-Dec.	100	--	1.22	14	dermal
DDVP	Pest Strips	strip	NA	2/yr	April-Nov.	NA	100	2.5	90	inhalation
	Crack/Crevice	spray can	0.72-2.5 mg	1/mth	Jan-Dec.	--	100	8	1	inhalation
Disulfoton	Ornamentals	granular	8.7	5/yr	Jan-Dec.	--	100	6	1	dermal, inhalation
Fenamiphos	Golf Courses	NA	116	1/yr	Jan-Dec.	100	--	1	2	dermal
Fenthion	Public Health	aerial and ground	NA	18/yr	Jan-March Oct-Dec.	100	--	6.37	2	dermal, oral
Malathion	Lawns Fleas	hose end spray	5 lb ai	2/yr	Jan-Dec.	13	87	3	4 1	dermal, oral inhalation
	Public Health Mosquitoes	aerial and ground	NA	23/yr	July-Sept	100	--	42	2	dermal, oral
	Vegetable Gardens	hand duster	1.5 lb/A	5/yr	Jan-Dec.	--	100	1.1	7 1	dermal, inhalation
		hand pump sprayer	1.5 lb/A	5/yr	Jan-Dec.	--	100	1.1	7 1	dermal inhalation
Naled	Public Health	aerial and ground	NA	5/yr	Jan-Dec.	100	–	1.1	1 7	inhalation, dermal

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
Trichlorfon	Lawns Granular	rotary spreader	8 lb ai	1/yr	July-Aug.	13	87	1	1 2	inhalation dermal, oral
	Lawns Spray	hose end sprayer	8 lb ai	1/yr	Jan-Dec.	13	87	1	1 2	inhalation dermal, oral

Figure II.M.1 Residential Scenario Application and Usage Schedules for the Fruitful Rim FL Region (Region 12)



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 current assessment based instead on the time-series distribution or actual residue measurements. The uniform distribution reflects a range of spray and granular measurements.

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

A residue degradation study was based on a 3-day study conducted on a cool-season grass in Missouri, North Carolina, and Pennsylvania (application rate 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, 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 assessing non-dietary ingestion for children.

For vegetables in eastern regions, a residue dissipation study was conducted in Pennsylvania with multiple residue measurements collected up to 7 days after treatment. A uniform distribution bounded by the high and low 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. 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.

v. 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.

3. Development of Water Exposure Aspects of Fruitful Rim-FL Region

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 --FL. 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-FL 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 location in Palm Beach County, Florida, used for the drinking water assessment for the Fruitful Rim-FL, (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-FL 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 Palm Beach County for Drinking Water Assessment

The Fruitful Rim --FL encompasses all of Florida, and extends through coastal Georgia into southernmost South Carolina. The great majority of people living in this region derive their drinking water from ground-water sources. Sandy, coastal plain sediments and shallow, unconfined aquifers make portions of the Fruitful Rim, SE particularly vulnerable to pesticide contamination. The drinking-water supply of a significant number of people in Florida might be vulnerable to contamination with OP insecticides, although there is little evidence of ground-water contamination in Florida available except for fenamiphos.

Available monitoring from Florida and around the nation does not provide evidence that parent OP insecticides co-occur in ground water. Few data are available to determine if OP transformation products might co-occur in ground water, although concentrations of total fenamiphos residues can be quite high under vulnerable conditions, as described below. The Agency currently does not have a tool to predict a multiple year distribution of possible daily exposures to pesticides in ground water. For these reasons, possible exposure to OPs in drinking water from surface-water sources was estimated to represent the Fruitful Rim-FL. The high-use regions in southern Florida, around Palm Beach County to the east and Manatee County to the west represent the most vulnerable areas where OP use coincides with surface water intakes. The Agency selected Palm Beach County because the combination of OP-use crops represented the greatest potential for co-occurrence in the region. While a surface water assessment using the index reservoir may be less representative of actual drinking water sources in this region than in other regions, it is likely to be health-protective for the region.

Total OP usage is relatively low in the Fruitful Rim-FL, where less than a million pounds (ai) of OPs were applied in on agricultural crops in this region in 1997. OP use on vegetables (32% of total OP use), corn (22%), cotton (16%), tobacco (10%), and citrus (9%) account for approximately 90 percent of the total use (Table II.J.3). Additional OP use crops in the region include alfalfa, pecans, and sugarcane.

Table II.M.3. General Overview of OP Usage in the Fruitful Rim-FL

Crops	Primary Production Areas	Total Pounds Applied	Percent of Total OP Use
Vegetables	Southern FL	229,000	32
Corn (field, sweet)	Northern end of region	161,000	22
Cotton	GA, SC coastal plain; northern panhandle of FL	116,000	16
Tobacco	Southern GA, northern FL	70,000	10
Citrus	FL	68,000	9
Alfalfa/Hay		35,000	5
Pecans	GA coastal plain	17,000	2
Sugarcane	Southeast FL (Palm Beach Co)	na	na
		724,000	96

(1) Source: NCFAP, 1997.

Figure II.M.2 shows the highest OP-use areas in the coastal plain of Georgia and South Carolina. Within Florida, the highest use areas are in southern Florida, focused on specialized crops.

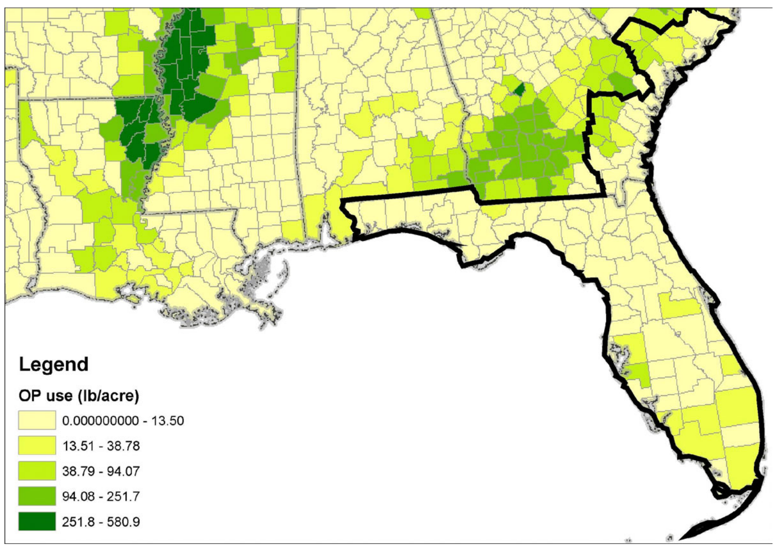


Figure II.M.2. Total OP usage (pounds per area) in the Fruitful Rim-FL (source: NCFAP, 1997)

In the high-use counties in Georgia and Florida, cotton, corn, tobacco, and pecans were the dominant OP-use crops. In southern Florida, vegetables, citrus, sugarcane, and sweet corn were the dominant use crops. As described below, the only area in the Fruitful Rim-FL where surface water sources of drinking water coincided with significant OP usage was in southern Florida. OP uses on vegetables, citrus, sugarcane, and sweet corn accounted for more than 95 percent of agricultural usage of OP pesticides in Palm Beach County, FL, where the drinking water assessment was based, with sugarcane being the dominant use-crop (Table II.M.4).

Table II.M.4. OP Usage on Agricultural Crops in Palm Beach County, FL.

OP Usage/ Agricultural Crops				Cropland Acreage, Assessment Area	
Crop Group	Crops	OP Usage (lb)	Percent of Total OP Use	Acres	Pct of total Cropland
Sugarcane	Sugarcane	263,000	88	431,000	81
Corn	Sweet corn	31,000	11	22,000	4
Vegetables	Lettuce, tomato, pepper	2,000	<1	10,000	2
Citrus	Orange, tangelo, tangerine, grapefruit	500	<1	10,000	2
				474,000	92

Pesticide use based latest data collected by USDA National Agricultural Statistics Service (NASS). Acreage estimates based on FL Agricultural Statistics Service and FL Cooperative Extension Service. Details on the sources of usage information are found in Appendix III.E.8.

Few surface water sources of drinking water occur in this region. The database with locations of surface water intakes of drinking water is still preliminary and may not capture every intake. However, it does indicate that only those intakes in southern Florida are located in the more vulnerable runoff areas (Figure II.M.3).

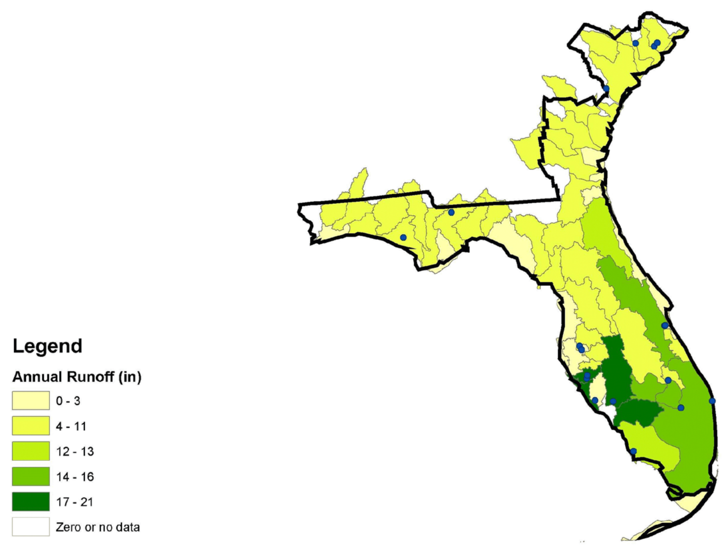


Figure II.M.3. Locations of surface water intakes of drinking water (shown as dots) in relation to average annual runoff (color gradation) in the Fruitful Rim-FL Region

Florida is served by five main aquifer systems. The vulnerability of drinking water derived from these aquifers to pesticide contamination varies.

The **Floridan Aquifer** is "one of the most productive aquifers in the world." The Floridan aquifer system provides water for the cities of Savannah and Brunswick in Georgia; and Jacksonville, Tallahassee, Orlando, and St. Petersburg in Florida. In addition, "the aquifer system provides water for hundreds of thousands of people in smaller communities and rural areas." It is the principal source of water supply for most of the state of Florida (USGS

Hydrologic Investigations Atlas 730-G).

The Floridan aquifer is a carbonate aquifer (limestone and dolomite rock). In areas where the Florida outcrops, or where confining layers above the Floridan are thin or breached, dissolution of these carbonate rocks allows much more rapid recharge and discharge of the aquifer http://capp.water.usgs.gov/gwa/ch_g/jpeg/G055.jpeg . In some regions, dissolution is sufficient to form karst topography, which is most vulnerable to contamination from the surface. Where the confining layer is missing or thin, hydraulic connection with surface drainage, or the unconsolidated surficial aquifer, is substantial.

However, the Floridan is confined by thick clay layers over much of its area. In areas of thick confinement, there is little or no hydraulic connection with the surface. The confining layer is particularly thick in southern Florida http://capp.water.usgs.gov/gwa/ch_g/jpeg/G050.jpeg . The Floridan and the confining unit above underlie most of the other aquifers in the Fruitful Rim, which are mentioned below http://capp.water.usgs.gov/gwa/ch_g/jpeg/G008.jpeg . The Floridan is underlain by the Southeastern Coastal Plain aquifer in the Panhandle of Florida, Georgia and South Carolina. This aquifer is described in the Southern Seaboard appendix.

The USGS describes the **surficial aquifer system** as “a thin, widespread layer of unconsolidated sand beds that commonly contains a few beds of shell and limestone. This aquifer system generally yields small volumes of water, and primarily is used for domestic supplies” (USGS Hydrologic Investigations Atlas 730-G). This aquifer is present at the surface along the entire South Carolina and Georgia coasts, and the eastern Florida coast south to where the Biscayne aquifer overlies it, south of West Palm Beach.

The surficial aquifer is typically less than 50 feet deep, although it is as thick as 400 feet in places. The surficial aquifer is unconfined almost everywhere, except for where thin clay beds cause local confined or semi-confined conditions. Water moves quickly in and out of the surficial aquifer, moving laterally to surface water or the ocean. Some leaks through the confining unit below to the Floridan or intermediate aquifer.

People deriving drinking water from the surficial aquifer are most likely to encounter pesticide contamination in their domestic wells. Frequent contamination of shallow ground water in Florida with pesticides has been detected in many monitoring studies. However, with the exception of fenamiphos, ground-water contamination with OPs is much less common.

An **“intermediate” aquifer** is present in the subsurface between the surficial aquifer and the Floridan below in southwestern Florida. It is separated by confining layers above and below, and seepage from above provides recharge. It is an important “municipal supply in Sarasota, Charlotte, and Glades Counties, Fla.; elsewhere, it primarily is used for domestic supplies” (USGS Hydrologic Investigations Atlas 730-G). The confinement of the intermediate aquifer makes it less vulnerable to contamination than the surficial aquifer, except where breaches in the confining layer allow recharge from the surficial aquifer above.

The **Biscayne aquifer** serves the Miami Dade area, and is a sole-source drinking water supply for about three million people (USGS Circular 1207). This aquifer is unconfined, and particularly vulnerable to contamination. It consists of highly permeable carbonate rocks that were deposited in a marine environment. It is separated from the underlying Floridan below, which contains saltwater in this region, by 1000 feet of clay. The two aquifers are not hydraulically connected.

Three-quarters of withdrawal from the Biscayne aquifer were for public supply. “Major population centers that depend on the Biscayne aquifer for water supply include Boca Raton, Pompano Beach, Fort Lauderdale, Hollywood, Hialeah, Miami, Miami Beach, and Homestead. The Florida Keys also are supplied primarily by water from the Biscayne aquifer that is transported from the mainland by pipeline” (USGS Hydrologic Investigations Atlas 730-G).

South Florida Water Management District uses methods such as canals, levees, pumping to manage surface water flow and prevent flooding. Rapid interchange between canals and the Biscayne is possible almost everywhere because the high permeability. As a result, “aquifer contamination by any pollutants in the canal water can be both rapid and widespread” (USGS Hydrologic Investigations Atlas 730-G).

The **surficial “sand and gravel” aquifer** occurs in the Fruitful Rim – FL only in the western-most panhandle of Florida. It is a sand and gravel aquifer which provides moderate amounts of water. Eighty percent of withdrawal from this aquifer is in the Pensacola area. Although it can be locally confined by interbedded clay layers, it is generally unconfined, and susceptible to contamination.

b. Cumulative OP Concentration Distribution in Surface Water

The Agency estimated drinking water concentrations in the Fruitful Rim-FL cumulative assessment using PRZM-EXAMS output with various input parameters that are specific, where possible, to southern Florida. Table II.M.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. Sources of usage information can be found in Appendix III.E.8.

Table II.M.5. OP-Crop Combinations Included in the Fruitful Rim-FL Assessment, With Application Information Used in the Assessment

Chemical	Crop/ Use	Pct. Acres Treated	App. Rate, lb ai/A	App Meth/ Timing	Application Date(s)	Range in Dates
Chlorpyrifos	Corn, Sweet	80	0.66	Aerial; Foliar	Oct 1, Feb 15	Oct1-Dec1, Feb15-May15
Phorate	Corn, Sweet	69	1.3	Ground; At Planting	Sep. 1	Sep1-Feb1
Chlorpyrifos	Grapefruit	5	1.88	Ground; Foliar	Jan 1, Feb 15	Jan1-Mar31
Diazinon	Lettuce	51	0.69	Ground; Foliar	Oct 15, Jan 22	Oct15-Apr30
Chlorpyrifos	Oranges	5	0.57	Ground; Foliar	Jan 1, Feb 15	Jan1-Mar31
Acephate	Peppers (Bell)	28	0.76	Ground; Foliar	Oct 15, Dec 5, Jan 25	Oct15-Mar15
Ethoprop	Sugarcane	6	3.5	Ground; At Planting	Sep 1	Sep1-Jan15
Phorate	Sugarcane	10(9.5)	4	Ground; At Planting	Sep 1	Sep1-Jan15
Chlorpyrifos	Tangelos	5	1.01	Ground; At Planting	Jan 1	Jan1-Mar31
Chlorpyrifos	Tangerines	10	0.72	Ground; Foliar	Jan 1, Feb 15	Jan1-Mar31
Diazinon	Tomatoes	7	0.58	Ground; Foliar	Nov 1, Jan 23	Nov1-Apr15
Methamidophos	Tomatoes	14	0.47	Ground; Foliar	Nov 1, Dec 26, Feb 19	Nov1-Apr15

Figure II.M.4 displays 35 years of predicted OP cumulative concentrations for the Fruitful Rim-FL drinking water assessment. This chart depicts peaks during the years 18 and 29 of concentrations exceeding 3 ppb in methamidophos equivalents.

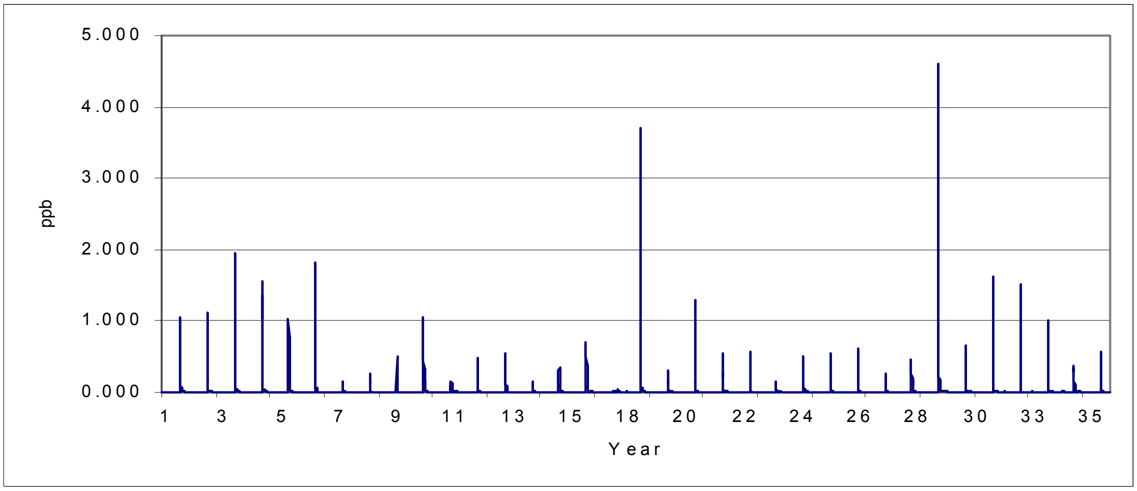


Figure II.M.4. Cumulative OP Distribution in Water in the Fruitful Rim-FL (Methamidophos equivalents)

Figure II.M.5 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 follow a recurring pattern each year, with a sharp peak occurring about day 240 and rapidly dissipating soon thereafter.

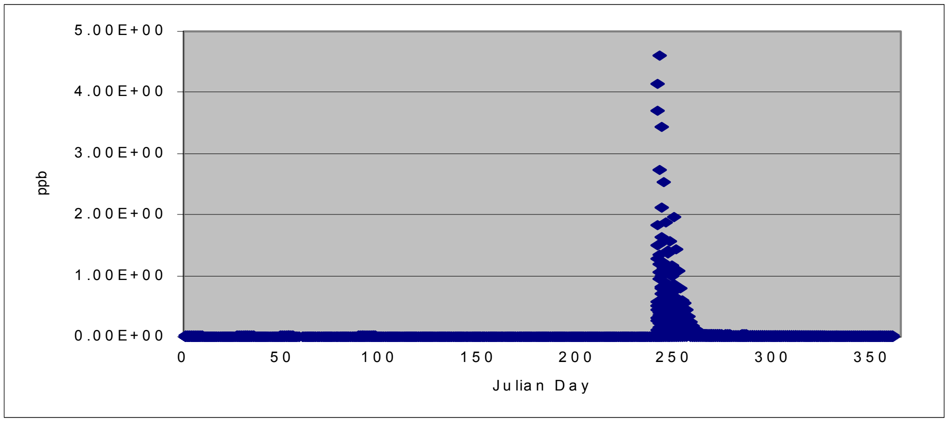


Figure II.M.5. Cumulative OP Distribution in Water (Methamidophos Equivalents) in the Fruitful Rim-FL, summarized on a weekly basis over 35 years

Figure II.M.6 depicts the predicted OP cumulative concentration for uses that made significant contributions during Year 29, the year in which the highest modeled concentration occurred. Phorate use on sugarcane accounted for much of that OP cumulative concentration; phorate is applied to sugarcane during the first week of September. 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.

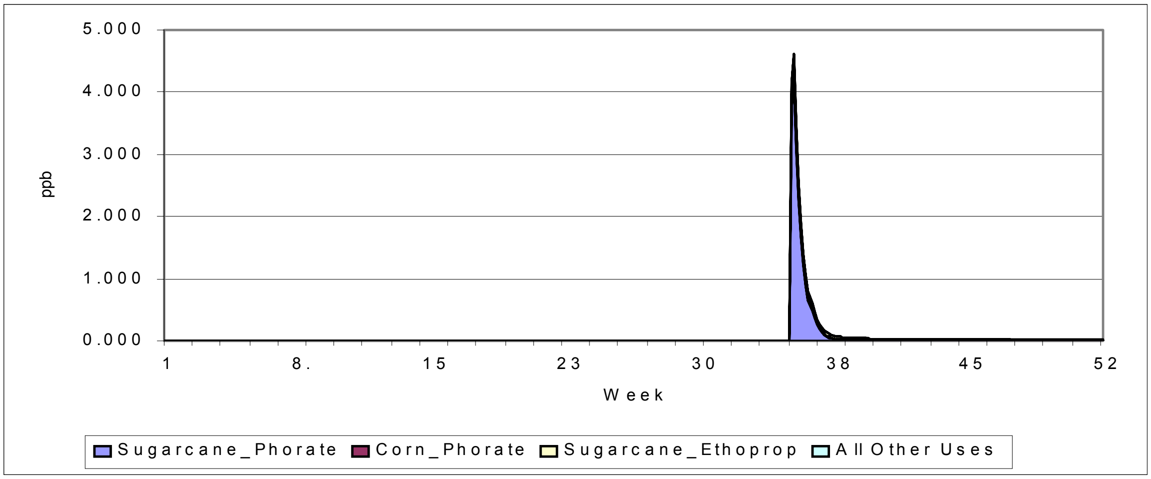


Figure II.M.6. Cumulative OP Distribution for an Example Year (Year 29) in the Fruitful Rim-FL Region Showing Relative Contributions of the Individual OPs in Methamidophos Equivalents

c. A Comparison of Monitoring Data versus Modeling Results

The maximum detections from the USGS NAWQA studies in the region (summarized below and in Appendix III.E.1) for chlorpyrifos, ethoprop, and phorate were an order of magnitude less than the maximum estimated concentration (Table II.M.6). The estimated maximum concentration for diazinon is similar to the maximum reported concentration in the monitoring data.

Table II.M.6. Percentile Concentrations of Individual OP Pesticides and of the Cumulative OP Distribution, 35 Years of Weather

Chemical	Crop/Use	Concentration in ug/L (ppb)						
		Max	99th	95th	90th	80th	75th	50th
Acephate	Peppers	7.7e-02	6.8e-03	8.5e-04	2.8e-04	8.7e-05	5.7e-05	4.3e-06
Chlorpyrifos	Corn, Citrus	2.0e-01	9.6e-02	4.9e-02	3.3e-02	2.1e-02	1.8e-02	9.1e-03
Diazinon	Lettuce, Tomato	2.9e-02	1.5e-02	9.1e-03	6.4e-03	4.0e-03	3.3e-03	1.1e-03
Ethoprop	Sugarcane	1.5e+00	5.1e-01	2.5e-01	1.7e-01	9.8e-02	8.0e-02	3.8e-02
Methamidophos	Peppers, Tomato	9.3e-03	1.7e-03	2.6e-04	8.4e-05	1.6e-05	9.9e-06	1.8e-07
Phorate(ttl)	Corn, Sugarcane	1.2e+01	7.2e-01	1.8e-02	1.1e-04	5.4e-09	8.5e-11	4.4e-12
OP Cumulative Concentrations (in Methamiiophos Equivalents, ppb)		4.6e+00	3.0e-01	2.5e-02	1.4e-02	8.0e-03	6.6e-03	3.4e-03

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 levees along the Mississippi River and by a system of drainage 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-FL

The **Southern Florida (SOFL) NAWQA** study unit includes the Biscayne aquifer, the Everglades, and portions of the Flatwoods and highly vulnerable Central Ridge regions of Florida. The Floridan, surficial and intermediate aquifers are also important sources of drinking water in this study unit. Ground water supplied 94% of water used in the study unit in 1990 (USGS Circular 1207).

Intensive surface water sampling in the SOFL study unit included canals draining mixed use (vegetables), citrus and sugar cane fields. Diazinon and chlorpyrifos were detected at low concentrations in the mixed use canal. Chlorpyrifos(max 0.023ug/l) and malathion (max 0.084 µg/l) were detected in 25% and 20% of samples from the citrus canal, with fewer detections of azinphos-methyl, methyl-parathion and ethoprop. Ethoprop was extensively (32%) detected in the sugarcane canal, with a maximum concentration of 0.279 µg/l. Chlorpyrifos, methyl parathion, diazinon and malathion were detected less frequently, and at lower concentrations. Sugarcane is the most important use for ethoprop. Although the sugarcane canal is not used for drinking water, this targeted monitoring indicates transport of ethoprop from the fields can be expected to occur.

Pesticides were detected in 85% of the wells included in this monitoring program. However, OPs were not among pesticides detected. This is in spite of rapid recharge in shallow, unconfined aquifers. Three ground-water studies (two agricultural and one urban) were performed:

Thirty one wells were installed within the row in the tree drip line of citrus groves in the Flatwoods region of Florida. Almost all the wells were less than 15 feet deep in an area where depth to ground water ranges from two to four feet. All of the wells were sampled once in early summer, 1998 and ten wells were sampled again that fall. The NAWQA SOFL report does not indicate if OP insecticides were applied to the citrus trees before sampling http://srv3sfltpa.er.usgs.gov/gw/cbkbyparm.html .

Thirty public supply wells in the Biscayne aquifer were sampled, with depths ranging from 40 to 150 feet. Each was sampled a single time in 1998. While almost all of the wells had some kind of pesticide contamination, no OP was detected http://srv3sfltpa.er.usgs.gov/gw/psbyparm.html .

Thirty-two wells were sampled once each in the SOFL urban land-use study. Wells were shallow (10 to 50 feet deep). In addition to residential areas, wells at areas such as parks, golf courses and parking lots were included. No OPs, including urban-use pesticides like diazinon and chlorpyrifos, were detected http://srv3sfltpa.er.usgs.gov/gw/urbbyparm.html .

The **Georgia-Florida Coastal Plain (GAFL) NAWQA** study unit extends from central Florida south of Tampa to just north of Atlanta, Georgia. The USGS reports that 80% of the population in this area derives its drinking water from ground water, and that 94% of that ground water is drawn from the Upper Floridan aquifer. About 25% of this region is devoted to agriculture, and more than half to forestry. Most of the Georgia portion of the study unit is located within the Coastal Inlands Farm resource Region.

No OP was detected in ground-water monitoring in this study unit in three studies:

The agricultural ground-water study is on the edge of the Fruitful Rim – FL and the Coastal Inlands Farm Resource Regions. Twenty-three shallow monitoring wells were installed in an area of intensive row-crop agriculture in Georgia. Crops in this area to which OPs are applied include peanuts, corn, and cotton. The study was designed to sample recently recharged ground water in the surficial aquifers. All wells were sampled once in spring 1994, and half of these wells were resampled that summer. Herbicides were detected in 11 wells, but OPs in none.

The GAFL program included 37 domestic wells in surficial deposits. Eighteen of these were in the Coastal Flatwoods and 19 were in the Southern Coastal Plain physiographic region. Only herbicides were detected in these wells. Previously, from 1985 to 1989, the Florida Department of Environmental Protection sampled 27 GAFL region wells in the Central Ridge region. OPs were not detected in these wells, either.

A third ground-water study included 32 monitoring wells in urban areas. These wells, which tap the surficial and Upper Floridan aquifers, were sampled once each in 1995.

Surface-water monitoring in the GAFL study unit were located in Georgia, outside of the Fruitful Rim, SE Farm resource Region. Sampling in Florida included intensive sampling from an urban stream in Tallahassee, and a number of fixed stream-sampling stations. Diazinon and chlorpyrifos were detected frequently (54% and 45%) in urban and mixed land-use samples. Malathion was detected in 35% of urban stream samples, but not in mixed land-use samples, with a maximum concentration of 0.2 µg/l. Ethoprop, phorate, azinphos-methyl and diazinon were detected in 3 or fewer agricultural samples each, at concentrations <0.1 µg/l.

Doug Jones of the Department of Agriculture indicated that GDA has a Pesticide Monitoring Network in conjunction with the Georgia Geological Survey. This ground-water monitoring program includes annual sampling of a wide number of pesticides, including OPs included in EPA method 507. Before 1999, NAWQA monitoring wells were included in the program. Recently, GDA has limited sampling to domestic wells, and excluded monitoring wells. Sampling has been mostly in southern, agricultural portion of state, which includes recharge areas for the Floridan aquifer. Wells in the program are located where the water table is shallower than 100 feet.

Reports from the last three years indicate that no OPs were detected in samples from this network. Previous studies indicate that no pesticides were detected above MCLs; OP insecticides have not yet been assigned MCLs. Keith Parmer of the Florida Department of Agriculture and Consumer Services provided results of three ground-water monitoring programs (plus data from an additional background well network) which included OPs as analytes. Seventeen OPs and transformation products are included as analytes among these three studies:

azinphos-methyl, chlorpyrifos, diazinon, dichlorvos, disulfoton, ethion, ethoprop, fenamiphos, fenamiphos sulfone, fenamiphos sulfoxide, malathion, methamidophos, methyl parathion, methyl paraoxon, naled, phorate and terbufos.

The three studies include both monitoring and drinking water-supply wells:

The Florida Department of Environmental Protection and the Florida Department of Health in which “up to 50 private drinking water wells were selected from each of Florida's 67 counties, to be sampled for a fairly comprehensive list of ground water contaminants. As of 1998, wells from approximately 26 counties had been sampled. The extent to which the selected wells represent either the private drinking water resource or the ground water resource is unknown” (Keith Parmer, personal communication).

This data set includes 7016 “determinations” for OP insecticides. “Determinations” are the total number of analyses made for OPs, including duplicates and split samples. No OPs were detected in these samples “without qualifiers.”

The second dataset included results from the "Very Intense Study Area Network." There have been 22 VISA studies to date, "with 7-45 well/spring stations located in each VISA. VISA sample stations were deliberately located to fall within particular land use/vulnerability domains; the water quality in these areas may very likely be impacted by human activities" (Keith Parmer, personal communication). No OP was detected in 12,136 determinations for OPs in this data set.

A follow-up monitoring program to that performed by the FDEP and the FDEH include private and public drinking water supply wells. This dataset includes 7411 determinations for OPs. Fenamiphos sulfoxide was detected in five samples in 2 wells from this study in 1992 and 1993. The maximum concentration detected in both wells was 1 ug/l.

Mr. Parmer reported that a "Lake Wells Ridge monitoring network" included shallow ground-water samples analyzed for OPs. He related that other compounds have been detected in this study, but not OPs.

Fenamiphos in Ground Water

The studies described above provide useful information on the general likelihood of pesticide contamination in Florida wells. However, the studies were not specifically targeted to OP insecticides. Limited targeted monitoring data indicate that concentrations of fenamiphos and its transformation products in ground water can exceed those of most other OPs detected in surface water or ground water. A1989 retrospective ground-water monitoring study in the Central Ridge of Florida detected maximum concentrations of total fenamiphos in a citrus grove of up to 252.8 µg/l. The detections were a result of fenamiphos applied at a rate of 9.9 lb a.i./A in three separate applications from 1990 to 1992.

Total fenamiphos residues were detected in a subsequent prospective ground-water monitoring study on sandy soils in the Central Ridge at concentrations up to 87.2 µg/l. Fenamiphos sulfoxide accounted for 83.3 µg/l of this total concentration, which was detected 183 days after a 4.1 lb ai/acre application to citrus. The results of this study led to the voluntary cessation of fenamphos use on citrus in the Central Ridge. Fenamiphos can still be applied in that region for other uses, such as turf.

Fenamiphos residues have also been detected in groundwater elsewhere in Florida. Maximum concentrations in groundwater of 0.71, 0.75, and 0.10 µg/l for fenamiphos, fenamiphos sulfoxide, and fenamiphos sulfone, respectively were detected in a golf course study conducted by the USGS. Fenamiphos and its transformation products were found at five out of seven golf courses sampled, which were located on soils varying from fine sands with good drainage (citrus-growing soils) to Flatwoods soils with poor drainage.

The detections of total fenamiphos residues in these three studies were all from samples in shallow wells installed in unconsolidated surficial aquifers. As detailed above, shallow surficial aquifers are an important source of drinking water in Florida. **Available data generally do not indicate that OPs will co-occur in ground water. Therefore, the potential for unacceptable exposure to fenamiphos in ground water used as drinking water is not best considered in the cumulative risk assessment, but in the current risk management phase of the fenamiphos reregistration process.**

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 (i.e., distribution of exposures for each of the 365 days of the year) 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 95^{th} percentile values can be plotted, with 95^{th} 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 levels 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 at various total exposure levels for different subgroups of the Fruitful Rim – FL population (e.g, those at the 95th percentile vs. 99th percentiles of exposure).

Figures III.U.2-1 through III.U.2-5 in Appendix U present the results of this cumulative risk analysis for Children, 1-2 years for a variety of percentiles of the Fruitful Rim – FL population (95 th , 97.5 th , 99 th , 99.5 th , and 99.9 th). Figure III.U.2-6 through Figure III.U.2-10, Figure III.U.2-11 through III.U.2-15, and Figure III.U.2-16 through III.U.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 courses 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 for children 1-2 years old, the 95 th percentile (total) exposure for children 1-2 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 – FL population at the 95th percentile exposures throughout the year. Each "component" of this 95th percentile total exposure for children 1-2 (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.U.2-1 through Figure III.U.2-5): At the 95th percentile, a variety of exposures from the various pathways (food, water, residential) are observed. There are increases in drinking water concentrations near Julian day 240 which arise from phorate application to sugarcane in September, but drinking water at this percentile does not contribute to substantial exposure. At the higher percentiles, the exposure profile and relative contributions begin to change. The residential exposures become an increasingly important component portion of the total exposure profile, with hand to mouth exposures via the oral route dominating. This corresponds to use of malathion, fenthion, naled, and trichlorfon in this region. Inhalation exposures become increasingly important at still higher percentiles but remain secondary to the oral hand to mouth route. Drinking water exposures continue to be low and do not contribute in any significant manner to the overall risk picture. Dermal exposures appear throughout all percentiles examined, but remain a small fraction (<1%) of total exposure.

b. Children 3-5 years old

(Figure III.U.2-6 through Figure III.U.2-10). As with children 1-2, a variety of exposures from the various pathways (food, water, residential) are observed at the 95th percentile. There are increases in drinking water concentrations near Julian day 240 which arise from phorate application to sugarcane in September, but drinking water at this percentile does not contribute to substantial exposures. At the higher percentiles, the exposure profile and relative contributions begin to change. The residential exposures become an increasingly important component of the total exposure profile, with hand to mouth exposures via the oral route dominating. This corresponds to use of malathion, fenthion, naled, and trichlorfon in this region. Inhalation exposures become increasingly important at still higher percentiles but remain secondary to the oral hand to mouth route. Drinking water exposures continue to be low and do not contribute in any significant manner to the overall risk picture. Dermal exposures appear throughout all percentiles examined, but remain a small fraction (<1%) of total exposure.

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

(Figure III.U.2-11 through Figure III.U.2-15 and Figure III. U.2-16 through III.U.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. Exposure from drinking water at this percentile also does not contribute to substantial exposure. At the higher percentiles the exposure profile and relative contributions begin to change. The residential inhalation exposures become an increasingly dominant portion of the total exposure profile. Drinking water exposures continue to remain low and do not contribute in any significant manner to the overall risk picture. Dermal exposures appear throughout all percentiles examined, but are consistently only a small fraction (< ca. 1%) of total exposure.