A Comparison of Residential Pyrethroid Exposure Predictions Based on EPA Tier 2 Standard Scenarios and SWMM/AGRO Scenarios Based on Residential Use Survey Data

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Presented by Michael Winchell on Behalf of Pyrethroid Working Group member companies: AMVAC, BASF, Bayer, DuPont, FMC, Syngenta, Valent

Background

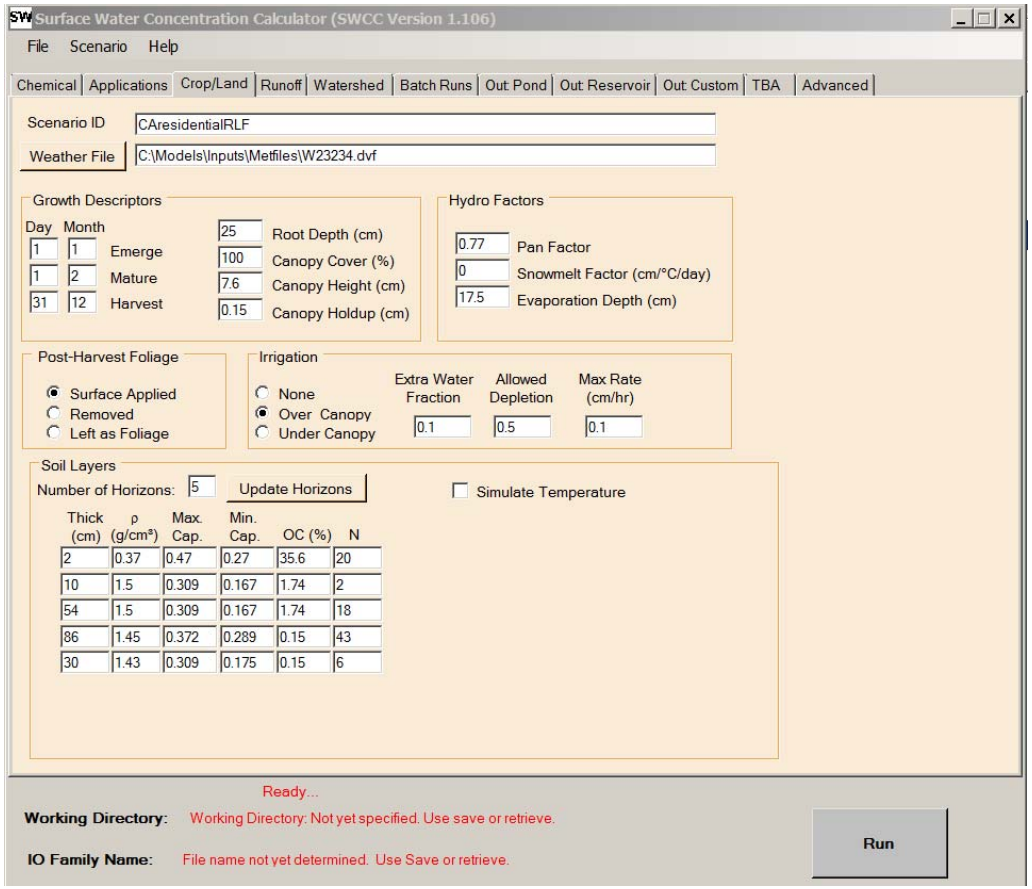
- Estimation of pesticide concentrations in urban and residential water bodies is necessary for some ecological risk assessments
- The US EPA has developed PRZM/EXAMS and SWCC screening level scenarios to predict potential exposure from non-agricultural uses of pesticides
- The Pyrethroid Working Group (PWG) has developed a residential exposure modeling approach and scenarios that uses the SWMM-AGRO model parameterized based on residential pesticide use survey data
- With equivalent parameterizations, predictions from the PRZM and the SWMM modeling approaches may be similar

Outline

- Tools for residential exposure modeling
- Conceptual models for EPA and PWG methods
- Comparison of predicted residential pesticide loads with monitoring data
- Implications for simulation of residential EECs for ecological risk assessment

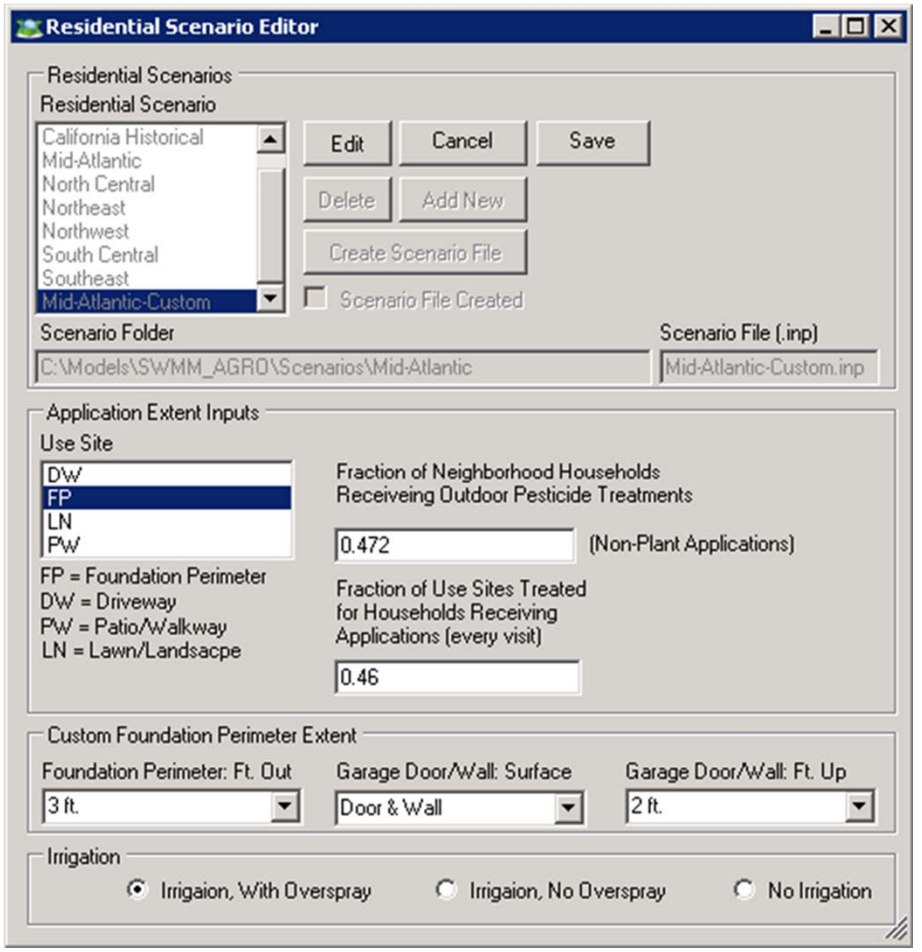
Tools for Residential Aquatic Exposure Modeling: PRZM/EXAMS and SWCC

- Developed by US EPA, originally for agricultural use assessments
- Includes 2 standard residential lawn and residential impervious scenarios (Barton Springs Salamander (BSS) and California Red-Legged Frog (CRLF))
- Requires that independent simulations for lawn and impervious scenarios be combined at appropriate proportions in a post-processing step



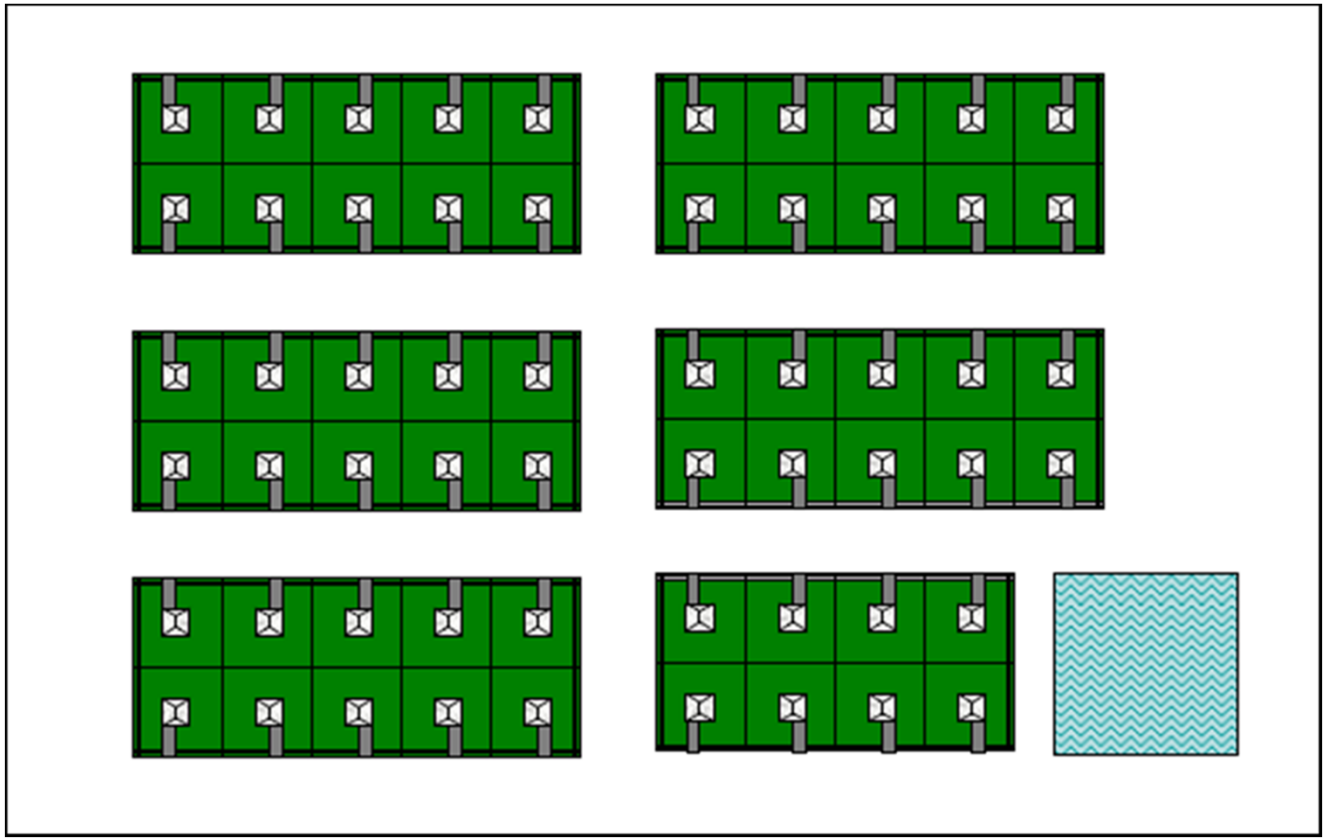
Tools for Residential Aquatic Exposure Modeling: SWMM/AGRO

- Developed by the Pyrethroid Working Group (PWG)
- Couples US EPA's SWMM model with the Canadian Center for Environmental Modeling (CEMC) AGRO model (Mackay, 2001; Padilla and Winchell, 2014)
- Simulates multiple types of use sites simultaneously in a single simulation (e.g. perimeter, driveway, lawn, patio/walkway)
- Includes scenarios for 7 different regions with use data from a recent regional survey (Winchell, 2013)



Conceptual Model for PRZM/EXAMS Residential Scenarios, Watershed

- A 10 ha. watershed consisting of 58 ¼ acre lots
- 50% of the watershed is pervious (lawn)
- 50% of the watershed is impervious (roofs, driveways etc.)
- All areas drain directly to a 1 ha, 2 m. deep pond

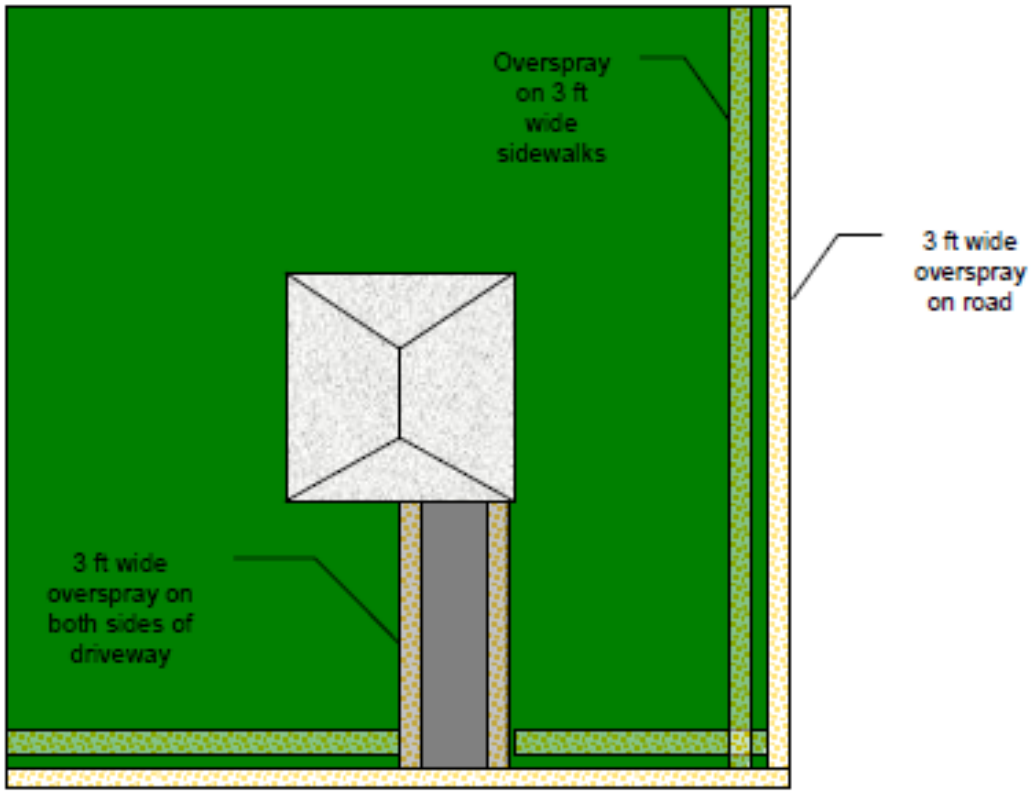


Conceptual Model for PRZM/EXAMS Residential Scenarios, House Lot

- Direct applications to the pervious (lawn) portion of the lot result in off-target application to adjacent impervious surfaces

- Off-target impervious surfaces include:
  - Driveway edge
  - Sidewalk
  - Road edge
  - 5.68% of total impervious area

- Corner lots have different pervious/ impervious fractions than mid-block lots



Conceptual Model for SWMM/AGRO Residential Scenarios, Watershed

- Aliso Viejo, Orange County, CA
- Part of CA DPR / UC Riverside monitoring program (Oki and Haver, 2011)
- Drainage area: 27.2 ha (67.2 acres)
  - 307 homes
  - Dwelling unit density: 4.6 units/acre
- Drains to same 1 ha., 2 m. deep pond

Conceptual Model for SWMM/AGRO Residential Scenarios, House Lot

- Aliso Viejo neighborhood was spatially delineated
- Particular attention to impervious use sites
  - Lower driveway
  - Upper driveway (within 5 ft)
  - Garage door
  - Impervious within 5-ft foundation perimeter
  - Patios/walkways away from building
- Impervious areas near lawns (1.5 ft) receive irrigation
- A fraction of impervious surfaces (other than driveway) flow into adjacent lawns

Conceptual Model for SWMM/AGRO: Residential Use Data

- Pyrethroid use characteristics for California were derived primarily from a 2009 survey of urban pesticide use (PWG, 2010) with additional support from an earlier survey (Wilen, 2001)
- Bifenthrin was selected for the initial assessment
- Key assumptions include:
  - 75.9% of households use outdoor insecticides
  - Some households are treated every 6 weeks, and some every 12 weeks
  - Fraction of use sites treated with bifenthrin (of households using insecticides) at these intervals was estimated from survey data and were set as follows:

Use Site	Estimated Total Percent Treated (%)	Estimated Percent Treated Every 6 Weeks (%)	Estimated Percent Treated Every 12 Weeks (%)
Foundation Perimeter	25.7	13.1	12.6
Patios/Walkways	24.9	12.7	12.2
Driveways	24.1	10.6	13.5
Lawns	24.4	5.4	18.9

Conceptual Model for SWMM/AGRO: Residential Use Data, Cont.

- The fraction of each use site surface area treated was assumed to be the following (estimated from survey data):
  - Foundation Perimeter: 100%
  - Patios/Walkways (away from foundation perimeter): 10%
  - Driveways (away from foundation perimeter): 10%
  - Lawns/Landscape areas (house lot): 100%

- Application rate was set at the maximum label rate (rate information was not collected in surveys).

- Target application dates were set at the following:

Cycle	App1	App2	App3	App4	App5	App6	App7	App8
6-week	01/01	02/15	04/01	05/15	07/01	08/15	10/01	11/15
12-week	01/01	04/01	07/01	10/01				

Comparison of Load Predictions: Scenario Background

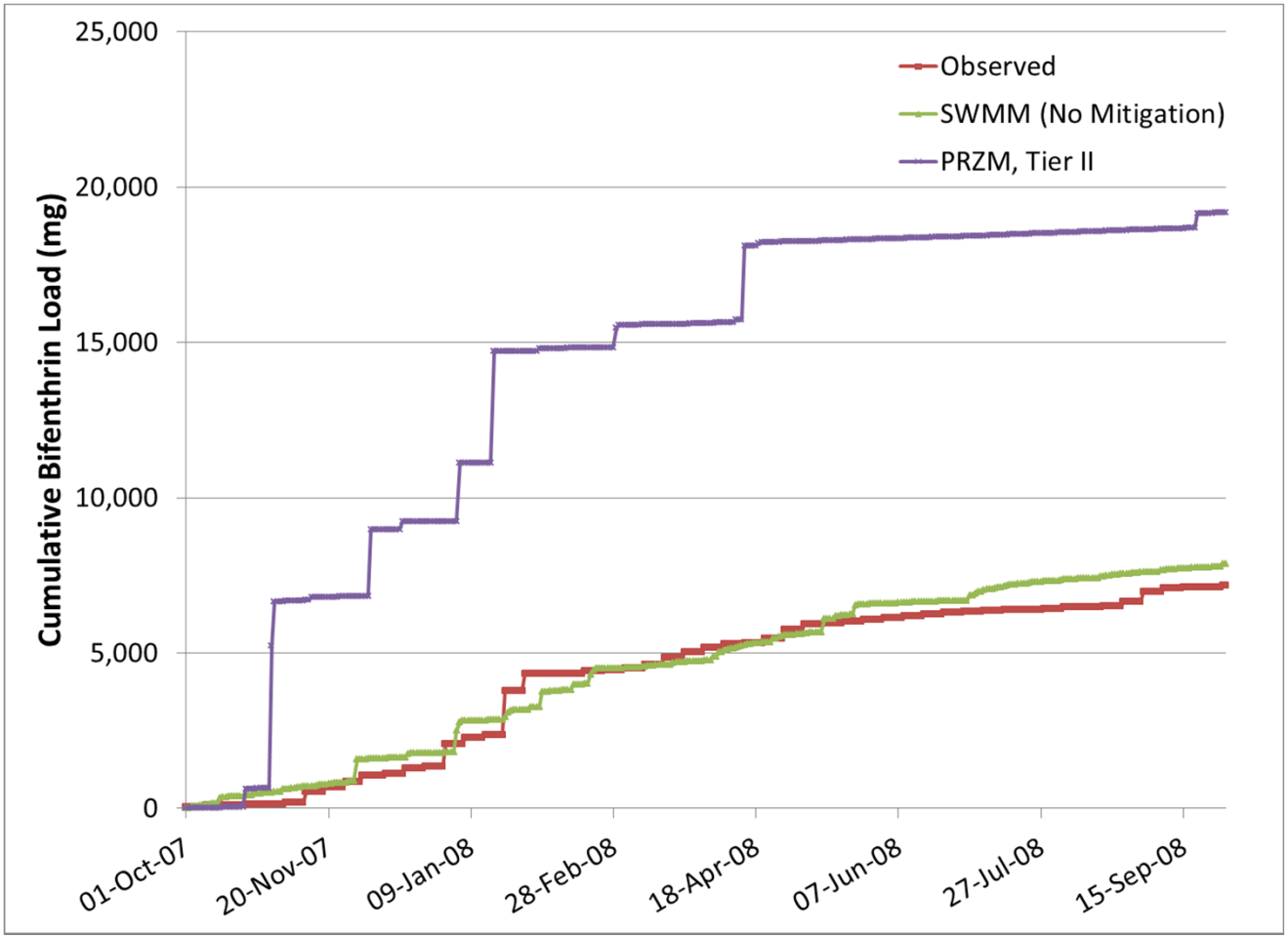
- Bifenthrin applications 8 times per year (4 at half rate to account for 50% of homes with less frequent use)

- PRZM/EXAMS scenario
  - California residential (CAresidentialRLF) 50% of area
  - California impervious (CAImperviousRLF) 50% of area
  - Weather station: Irvine CA, from SWMM model CA scenario
  - Application to lawn with overspray to impervious
  - 5.68% of impervious area receives application, modeled as reduced application rate over impervious fraction
  - Assume entire neighborhood is treated

- SWMM/AGRO scenario
  - CA historical scenario (application practices pre-label mitigation)
  - Applications are made to multiple use sites directly (lawn, perimeter, driveway, patio/walkway)
  - Percent Treated Area (PTA) based on use survey data

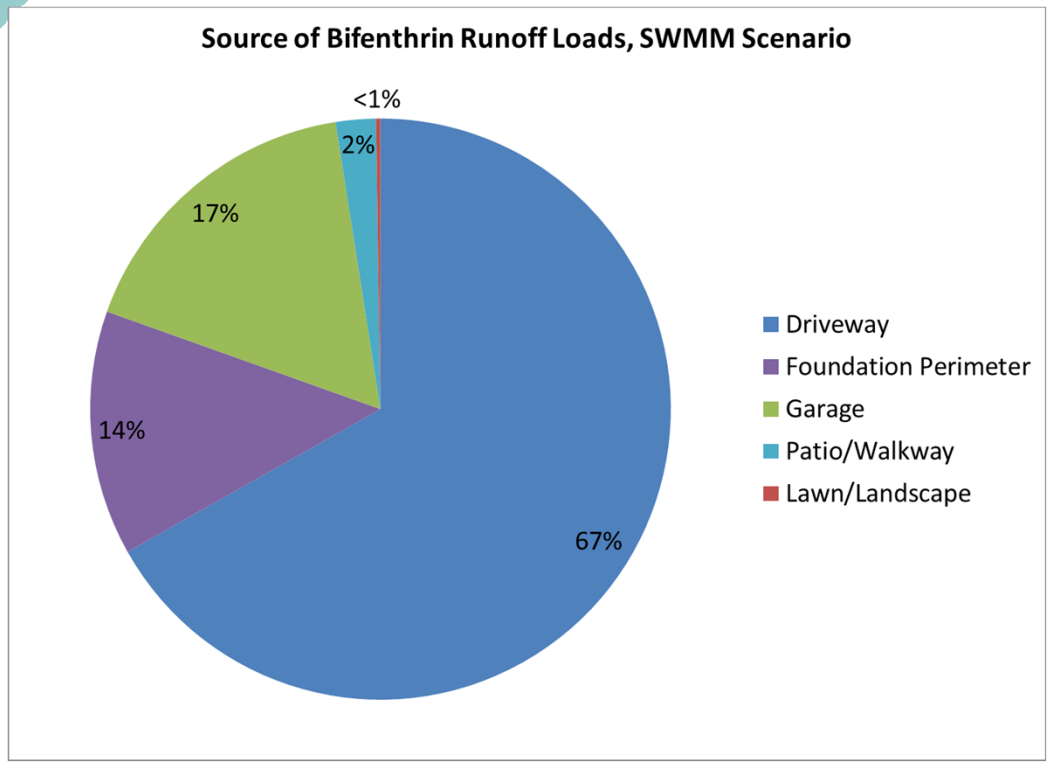
Comparison of Load Predictions: Cumulative Loads

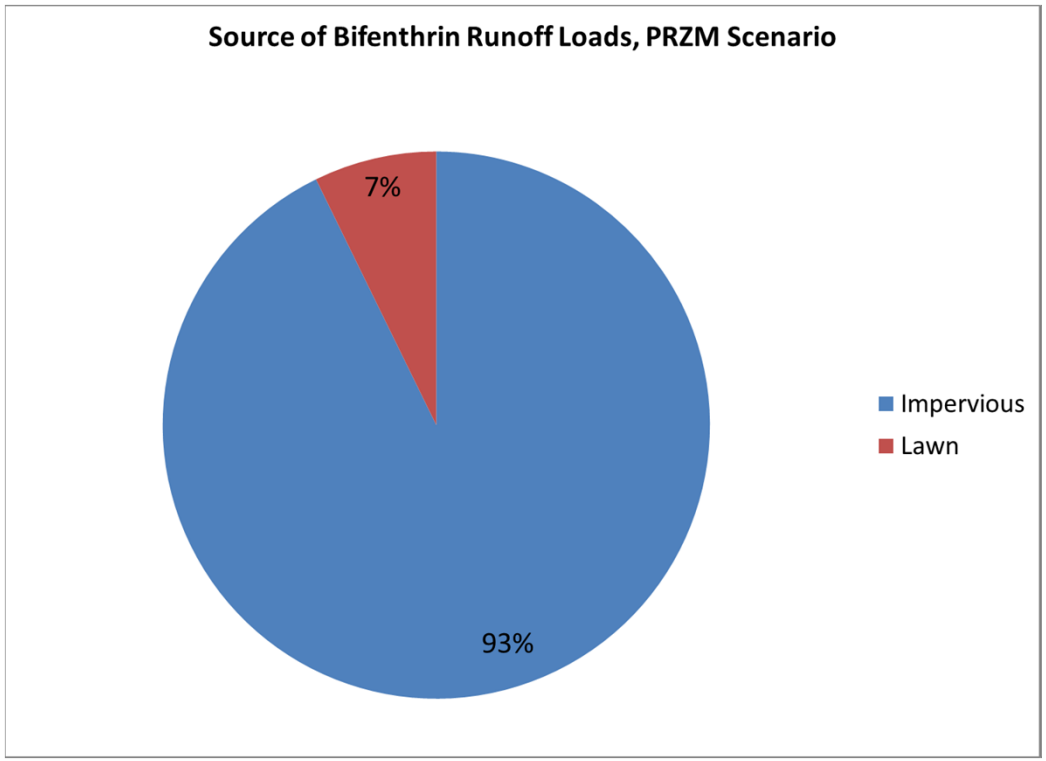
- SWMM Bifenthrin load in runoff closely follows observations
- Load from PRZM scenario is 2.7x times higher than observations and occurs in larger pulses



Comparison of Load Predictions: Load Distribution Comparison

- Over the 30-yr simulation, total load is dominated by impervious sources (93% PRZM, 99% SWMM)
- SWMM scenario allows a more specific breakdown of sources
  - Driveway dominates, with 67% of total
  - Garage and foundation perimeter (impervious portions) account for 31%
  - Breakdown consistent with PWG Pathway ID field study findings





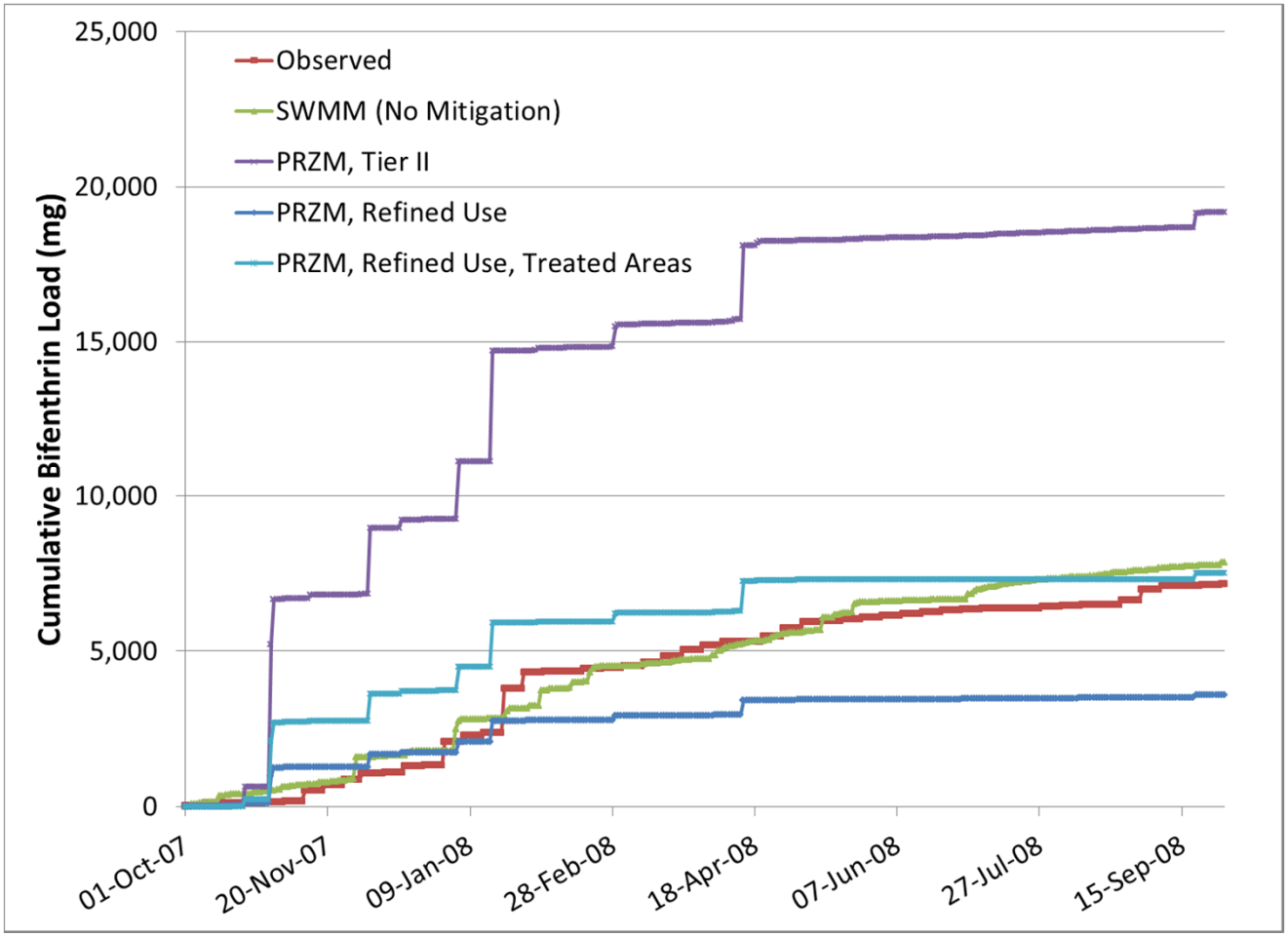
Comparison of Load Predictions: PRZM Scenario Refinement

- Use Refinement: Adjust the fraction of the neighborhood treated based on the use survey data used to develop SWMM parameterization
  - Percent of neighborhood with outdoor insecticide use: 75.9%
  - Market share of bifenthrin: ~25%
  - Percent of neighborhood households treated with bifenthrin: 19%

- Use Refinement & Treated Area Refinement: Add adjustment to the fraction of impervious and pervious (turf) areas treated based on the use survey data and the SWMM conceptual model
  - Watershed fraction of pervious area use sites (lawn): 31%
  - Total faction of pervious area treated: 5.8%
  - Watershed fraction of impervious area use sites: 12%
  - Total fraction of impervious area treated: 2.3%
  - Residential and impervious fractions remained at 50%/50%

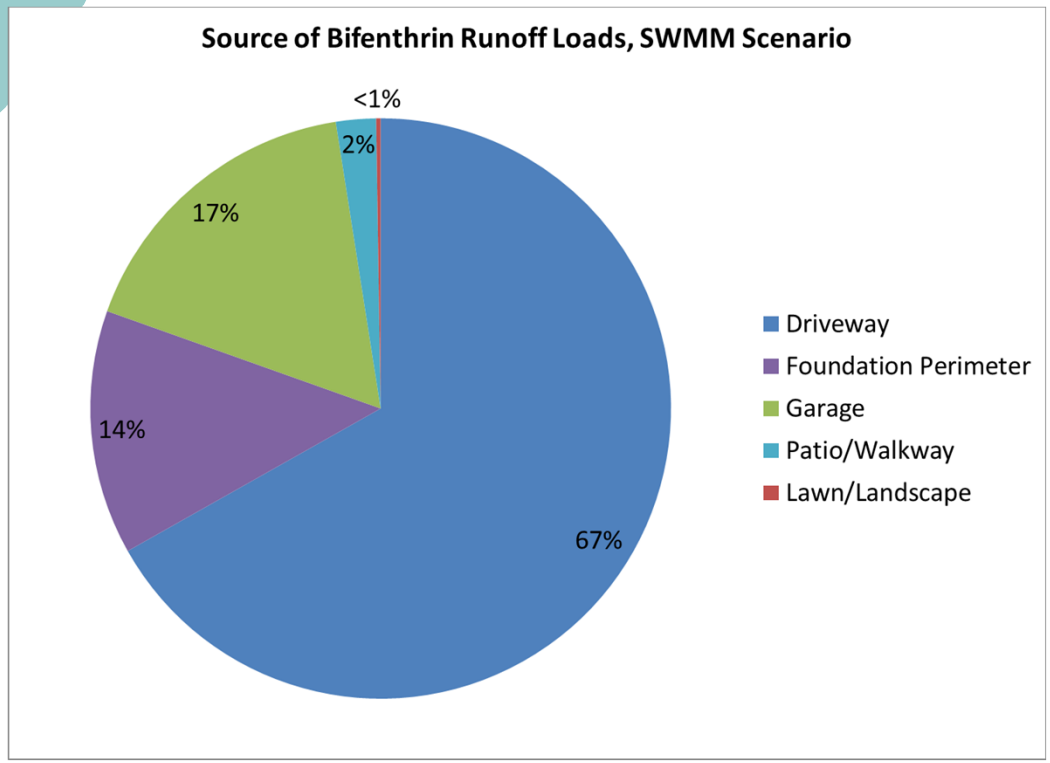
Comparison of Load Predictions: Cumulative Loads, Refined PRZM

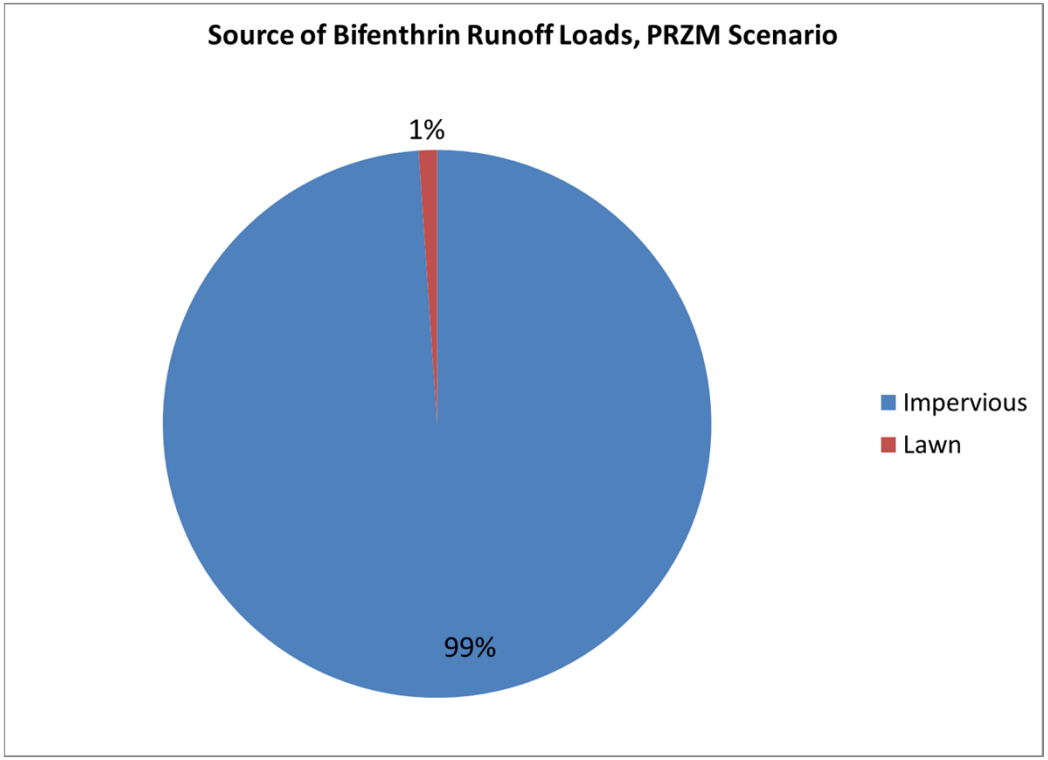
- PRZM use only refinement results in lower loads than SWMM
- PRZM with use and treated area refinement results in nearly the same total bifenthrin load as the SWMM scenario



Comparison of Load Predictions: Load Distribution Comparison

- The PRZM scenario with the use refinement & treated area refinement results in an impervious load fraction closer to the SWMM scenario



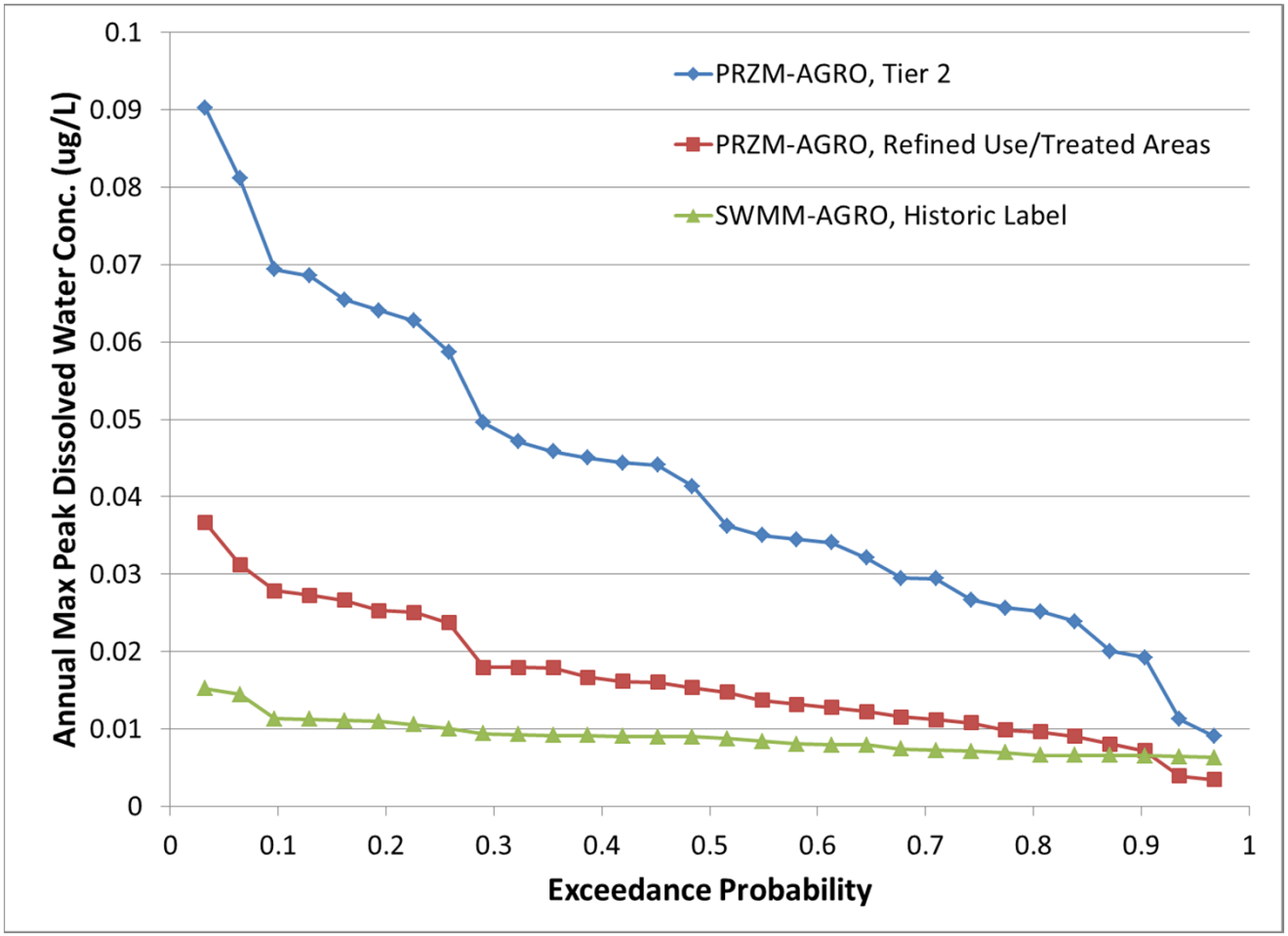


Implications for Simulation of Residential EECs: Historical Practices

- 30-year PRZM-AGRO and SWMM-AGRO simulations were run based on Tier 2 and refined input assumptions

- Peak EECs for the refined PRZM-AGRO scenario were ~2.5x higher than the SWMM-AGRO scenario at the 90th percentile

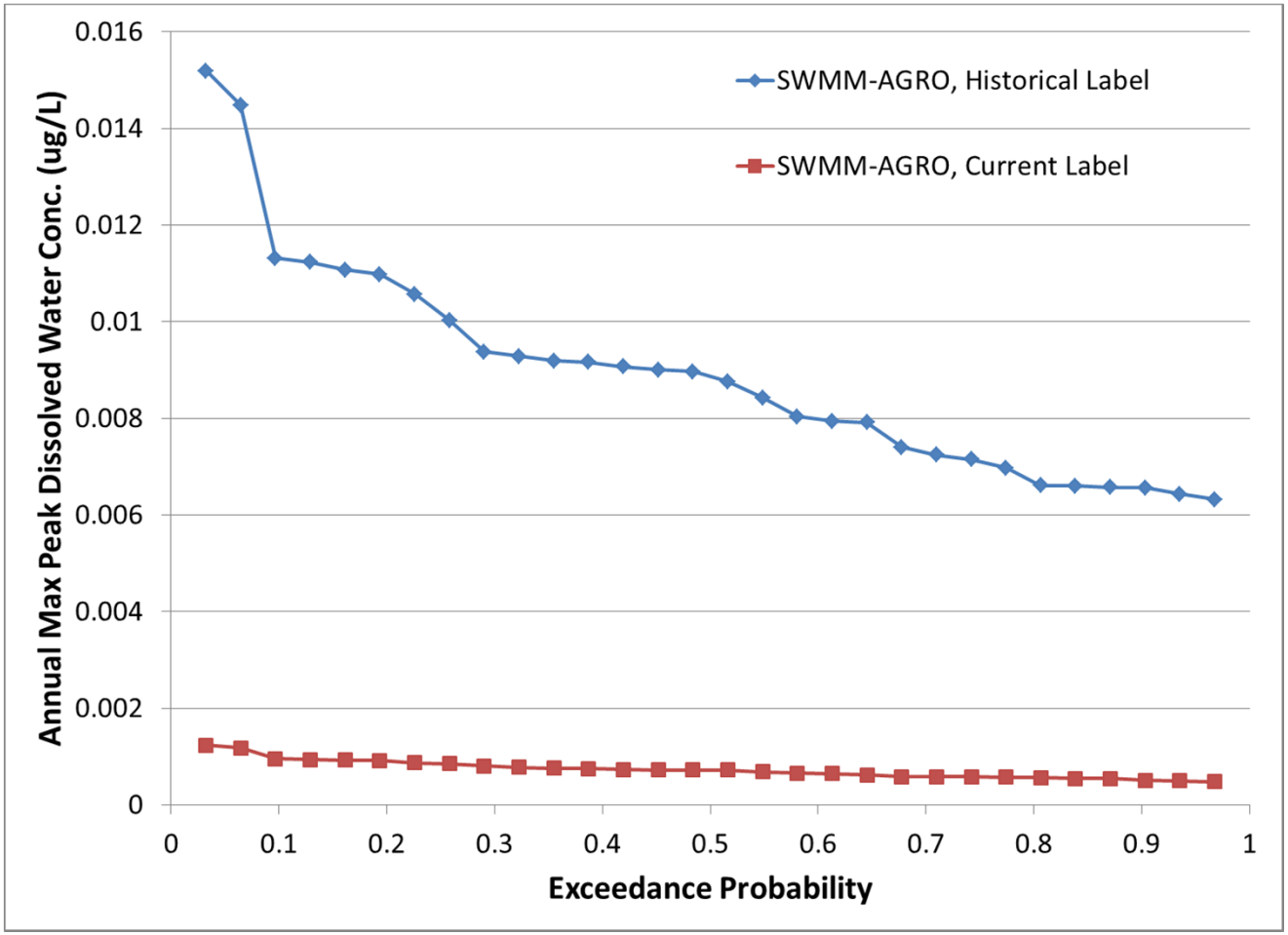
- Tier 2 PRZM-AGRO EECs were highest due to very conservative use assumptions



Implications for Simulation of Residential EECs: Label Mitigation

- Current pyrethroid labels (as of ~2010) limit applications on hard surfaces to crack and crevice applications, and reduce the portion of the garage door that can be treated

- Mitigation resulted in an ~12x reduction in EECs



Summary and Conclusions

- The differences in the predictions of aquatic EECs between a PRZM-based approach and a SWMM-based approach are partly attributable to the parameterization of pesticide use
- When similar pesticide use assumptions were made, total pesticide loads were within 10%, and annual maximum EECs were within a factor of 2.5x
- Both modeling approaches predicted that the vast majority (99%) of pesticide residues in urban runoff from a CA scenario originate from impervious surfaces
- The SWMM conceptual model allows for a more refined diagnosis of pesticide runoff sources and provides flexible options for parameterizing label mitigations

Acknowledgements and References

- Acknowledgements:
  - Funding provided by the Pyrethroid Working Group

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