Summary and interpretation of monitoring data for synthetic pyrethroids in U.S. surface water and sediment

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Introduction
Synthetic pyrethroids have been used for decades in North America and throughout the world for agricultural and non-agricultural insect control. Among the synthetic pyrethroids registered for use in the United States (U.S.) are bifenthrin, cyfluthrin, cypheprin, deltamethrin, lepidoperem, allethrin, permethrin, and their congeners. This poster summarizes the data and provides an initial evaluation on approximately 35000 analyses in approximately 13000 samples. The PWG continues to add data to the database as new reports are published.

Objectives
• Compile available pyrethroid analytical results for surface waters and sediments from U.S. and other countries.
• Characterize concentration distributions.
• Identify trends by:
  - Land use categories (urban, agricultural, mixed, undeveloped)
  - Water body types (e.g., main stem, tributary, urban)
  - Location (California, rest of U.S.)
• Pyrethroid active ingredients

Materials and Methods
Data Sources
• Sources include open literature publications, public reports, and the California Department of Pesticide Regulation (CDPR) Surface Water Database. Other general databases (e.g., STORET) were evaluated but data were not included because they overlapped with the other data sources, offered insufficient detail about sampling methods and results, or used alternative analytical methods.

Data Evaluation and Compilation
Data were evaluated following USGS Office of Pesticide Programs guidance (USEPA 2007). The database included the following supporting information:
• Sampling station type (e.g., drainage canal, storm drain outfall, etc.)
• Characteristic concentration distributions
• Identify trends by:
  - Land use categories (urban, agricultural, mixed, undeveloped)
  - Water body types (e.g., main stem, tributary, urban)
  - Location (California, rest of U.S.)
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Statistical Characterization
For each combination of pyrethroid and sample type, the following descriptive statistics were generated:
- 90th, 95th, and 99th percentiles
- Maximum observed value
- Number of reported values
- Number of detections
- Percent detections

These calculations were performed for subgroups of water body types (flowing and static) and land use categories (agricultural and urban). Data distributions for sediments were also analyzed by location (California vs other states). Concentrations that were repeatedly in ranges of means or medians in the source documents (rather than as individual sample results) were excluded from the distributional analysis, though they were retained in the database for future reference. Sediment concentrations that occurred in storms that occurred due to absence of OC data (i.e., very small percentage of the data) were also excluded from the distributional analysis.

Scope of the Database
• Most samples were from sites receiving agricultural or urban drainage.
• Most samples were from flowing water. Most samples were sediment or whole water.
• Most samples were from waters in California. Some data were available for filtered water and suspended sediment.
• Most pyrethroids were analyzed in approximately 2000 sediment and 2000 water samples.
• Nearly 90% of samples were from California.

Results

Sediment Samples
• The highest pyrethroid concentrations in sediments were for bifenthrin and permethrin.
• Sediment concentrations of pyrethroids were generally greater in water bodies receiving urban or agricultural drainage.
• Most sediment concentrations of pyrethroids ranged from approximately 1 to 100 ng/g.
• Sediment sampling protocols (e.g., 500mM, Pesqout 2001) target depositional areas, which are typically a small portion of the streambed (Hall et al. 2012). Pyrethroid concentrations in fine-grained sediments than in coarser sediments which are preferred habitat for many benthic species (Pensom et al. 1998). Sediment monitoring data therefore reflects under-represent pyrethroid exposure to many invertebrates.

Whole Water Samples
• Pyrethroids were detected in 12% of the whole water samples.
• Detection frequencies and concentrations of most pyrethroids were higher in urban streams than in agricultural streams.
• Percent detections and concentrations were higher for inflow samples (see table below). None of the other pyrethroids were detected in more than 3% of the samples in which they were analyzed.
• Distributions of measured concentrations were strongly skewed – a small number samples had concentrations more than an order of magnitude greater than the other samples (see table below for bifenthrin). The highest concentrations were found in urban storm sewer inlets and irrigation drain injection points.

Pyrethroid Concentrations in Whole (Unfiltered) Water Samples

Pyrethroid

Percentage Detections

Concentrations (%)

Detection Distributions (%)

Percentile

Bifenthrin

2141

39

733

20

-<RL

-<RL

-<RL

-<RL

0.5

-RL

-RL

Cyfluthrin

2109

84

-<RL

19

4

-<RL

-<RL

-<RL

<RL

<RL

Cypermethrin

2388

48

13

5

-RL

-RL

<RL

<RL

<RL

Fenpropathrin

2612

62

9

2

-<RL

-<RL

<RL

<RL

<RL

Fenvalerate

2419

63

5

-<RL

<RL

-RL

<RL

<RL

<RL

<RL

Lindane

4403

62

2

-RL

<RL

-<RL

-<RL

<RL

<RL

<RL

<RL

<RL

<RL

Tetraethylthallium

2510

20

-<RL

-RL

<RL