TRENDS IN CHEMICAL CONTAMINATION, TOXICITY AND LAND USE IN CALIFORNIA WATERSHEDS:

Stream Pollution Trends (SPoT) Monitoring Program Third Report – Five-Year Trends 2008-2012

Overview

The State Water Resources Control Board's Surface Water Ambient Monitoring Program (SWAMP) has released the third report on results from a continuing statewide program that measures trends in pollution levels and toxicity in major California watersheds. The program is the Stream Pollution Trends monitoring program (SPoT) and is one of three statewide projects funded by SWAMP. The report, *Trends in Chemical Contamination, Toxicity and Land Use in California Watersheds*, summarizes results from the first five years of annual SPoT surveys which assess large watersheds across California to determine how stream pollutant concentrations are affected by land use, with an emphasis on urban and agricultural development. SPoT is improving our understanding of the long-term trends of watershed contamination and associated toxicity. This program investigates the impacts of land development on water quality, helps prioritize water bodies in need of water quality management, and evaluates the effectiveness of management programs designed to improve stream health. SPoT data provide a statewide perspective on the impact of pollution on stream health and allows local and regional water quality managers to evaluate how conditions in their streams compare to those in other California watersheds.

About the Survey

To most efficiently detect pollutant trends in California streams, the SPoT program measures contaminant concentrations and toxicity in sediments that accumulate in the lower reaches of large watersheds. In 2012, samples were collected from 100 of the nearly 200 major hydrologic units in California. Sediment samples are collected once per year when streams return to base flow conditions after the high flows that carry pollutants washed from watershed surfaces during storms. Sediments are monitored because the majority of contaminants entering streams accumulate in sediments, and this environmental compartment integrates pollution signals over time. Each sample is analyzed for industrial compounds, pesticides, and metals, and is tested for toxicity to a resident aquatic crustacean, the amphipod *Hyalella azteca*. Results are compared across watersheds throughout the state, and pollutant concentrations are compared to land use and other human activities.

Findings

Statewide Trends

Of the general classes of organic chemicals measured, pyrethroid pesticides demonstrated an increasing trend in all watersheds, but most significantly in urban watersheds. Bifenthrin continues to be the most commonly detected pyrethroid in SPoT samples. One possible explanation is that of all the pyrethroids, bifenthrin is the most stable in aquatic environments. Bifenthrin use is also increasing. The chlorinated compounds (DDTs and PCBs) saw a significant decline over the five years, whereas detections and concentrations of hydrocarbons (PAHs), flame retardants (PBDEs) and selected metals remained relatively constant. Detections and concentrations of organophosphate pesticides in sediment also decreased between 2008 and 2012.

Variable	Statewide	Urban	Agriculture	Open	Individual Sites
Pyrethroids	Increase	Increase	Equal	Equal	3 Increased; 1 Decreased
DDTs	Decrease	Decrease	Decrease	Decrease	10 Decreased
PCBs	Decrease	Decrease	Decrease	Decrease	1 Increased
PAHs	Equal	Equal	Equal	Decrease	1 Increased; 2 Decreased
PBDEs	Equal	Equal	Equal	Equal	1 Increased
Cd, Cu Pb, Zn	Equal	Equal	Equal	Equal	1 Increased; 1 Decreased
Survival	Equal	Equal	Equal	Increase	4 Increased

Table 1. Summary of trends at a statewide level, trends related to land use, and trends at individual sites.

The incidence of toxicity to amphipods remained relatively stable during this period with significant toxicity being observed in an average of 19% of sediment samples per year. An average of 8% of the samples was identified as highly toxic. Highly toxic samples were collected from agricultural watersheds in the Central Valley and in the Central Coast, and in urban areas of Southern California.

There was a significant relationship between pyrethroid pesticides and urban land use, and sediment toxicity was significantly associated with these parameters. Pyrethroid toxicity thresholds were exceeded annually in an average of 17% of the samples. Two-thirds of these samples were significantly toxic, and pyrethroid toxicity thresholds were exceeded in 83% of the samples where high toxicity was observed.

Because pyrethroids are more toxic at colder temperatures, the relationship between pyrethroids and sediment toxicity was further investigated by assessing sediment toxicity at 15°C, in addition to the standard test temperature, 23°C. The colder temperature represents the average ambient temperature in California watersheds. Sixty-four percent of the samples tested at 15°C were significantly toxic, whereas only 27% of these samples were significantly toxic when tested at 23°C.

SPoT Indicators in Relation to Stream Ecology

The relationship between laboratory sediment toxicity test results, chemical contamination and macroinvertebrate community structure in SPoT watersheds was investigated to develop connections between the indicators of water quality impairment measured by SPoT and indicators of ecological impairment measured by the various programs conducting bioassessment monitoring in these watersheds. Index of Biological Integrity (IBI) scores were calculated from field bioassessment data from 66 sites assessed in other monitoring projects conducted between 2008 and 2012. These sites corresponded to SPoT amphipod sediment toxicity tests conducted in samples from the same or proximate stations during the same calendar years.

Correlation analyses were conducted between toxicity and chemistry results and individual IBI scores, as well as several measures of habitat quality conducted as part of the benthic bioassessments. The results showed a significant correlation between amphipod survival in laboratory toxicity tests and the IBI calculated from the bioassessments. This analysis also revealed a significant negative correlation with contaminant concentrations, particularly pyrethroid pesticides. The IBI was also negatively correlated with some habitat parameters reflecting stream sedimentation. As more bioassessment data are incorporated into the state databases, a more detailed assessment of these relationships will be investigated. These statistical relationships provide a basis for developing hypotheses for assessing causal relationships between in-stream ecological degradation measured in bioassessment monitoring and toxicity and chemical stressors measured by SPoT. For example, a key question concerns the degree to which pyrethroids and other pesticides are impacting stream macroinvertebrates in California watersheds.

New for the Next Reporting Cycle

Given the evidence that pesticides are associated with ambient toxicity in California waters, certain emerging pesticides are being prioritized as SPoT monitoring proceeds. In 2013, fipronil was added to the SPoT analyte list due to increasing use and the potential for surface water toxicity.

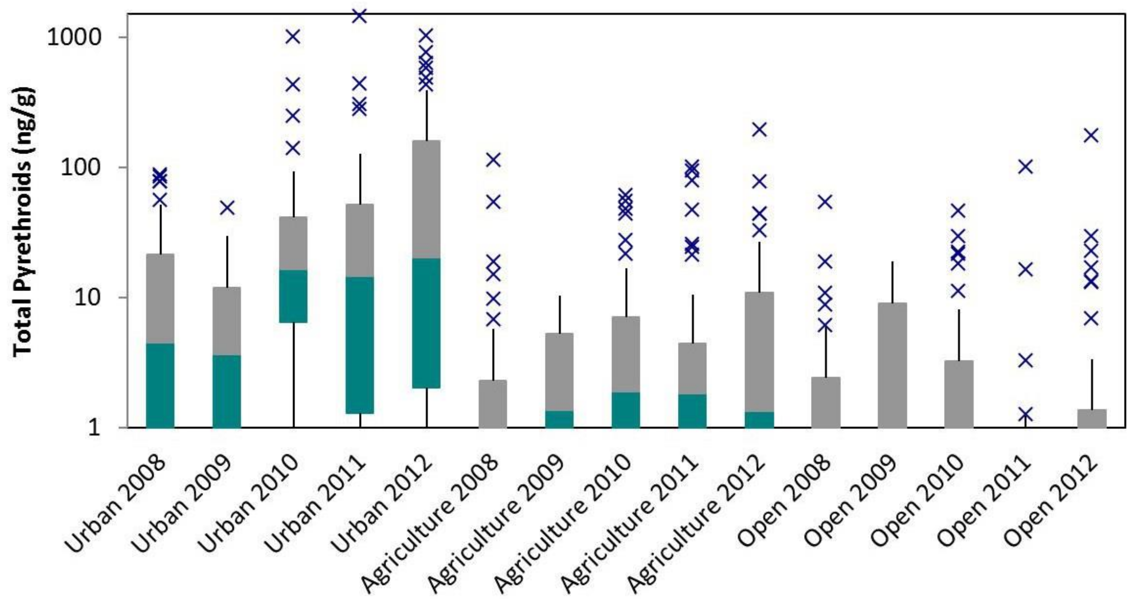

Figure 1. Total pyrethroid pesticide concentrations measured in sediments in relation to watershed land use in SPoT watersheds. *Concentrations of pyrethroids increased between in all watersheds between 2008 and 2012, but most significantly in urban watersheds.*

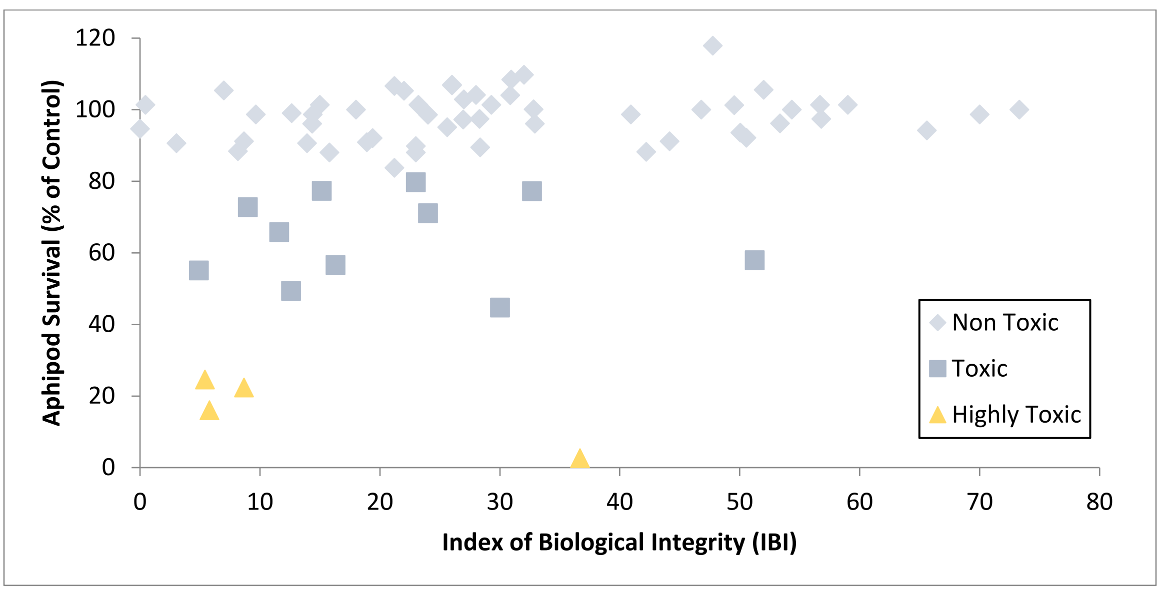

Figure 2. Relationship between amphipod survival in sediment toxicity tests and benthic macroinvertebrate Index of Biological Integrity scores. *Amphipod survival is presented as a percentage of the respective control sample survival value.*

In 2013, SPoT also began collaborating with the California Department of Pesticide Regulation to evaluate the effectiveness of new restrictions on the use of pyrethroid pesticides in urban applications. Four “intensive” monitoring sites were jointly sampled by SPoT and CDPR to determine whether new regulations result in reduced pyrethroid concentrations and associated effects.

Algal toxins have recently been found in polluted waterbodies throughout California and certain cyanotoxins have been associated with liver toxicity in marine mammals. In a new collaboration with California State University Monterey Bay, SPoT measured microcystin-LR in stream sediments statewide beginning in 2013.

Next Steps

SPoT will continue to focus on chemicals of emerging concern. In 2015 SPoT will be adding an additional indicator organism to assess the effects of fipronil and its degradates. *Chironomus dilutus* will be tested in sediments from urban stations. SPoT is also exploring the possibility of incorporating water column monitoring for imidacloprid and other neonicotinoid pesticides beginning in 2016. In collaboration with DPR and SWAMP, a pilot monitoring project is measuring these pesticides in agricultural streams in 2014 and assessing their effect using *C. dilutus*. Legacy pesticides (DDT), PCBs, organophosphate pesticides and metals will be monitored every other year.

Sampling the Navarro River in Mendocino County.

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