Occurrence, Fate, and Effects of Current-Use Pesticides in the Aquatic Environment

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Pesticides are applied in a wide variety of pesticide-use settings, including agriculture, home and garden, industry, and vector control. Transported off-site, pesticides and their degradates are detected in all compartments of the hydrologic system and have the potential to adversely affect the health of humans and aquatic and terrestrial organisms. Continuing pesticide research by the USGS Toxics Program is focused on understanding the occurrence and fate of current-use pesticides and evaluating the potential health and ecosystem effects. Today's presentation will provide an overview of our California WSC laboratory capabilities and summarize the results of our studies on two major groups of pesticides: pyrethroid insecticides and fungicides. The knowledge gained from these studies is relevant to issues of concern in Oregon such as the Columbia River Estuary, Willamette River, and Senate Bill 737.

Pesticide use is not static – it changes with time. So our analytical methods are continually being updated to keep up with the new compounds. Our research laboratory in the California WSC has developed a series of analytical methods to measure nearly 100 current-use pesticides and degradates in water and sediments. The use of passive samplers (e.g. SPMDs and POCIS) to collect an integrative sample over time have been validated for a number of current-use pesticides. Since moderately-hydrophobic pesticides can bioconcentrate in organisms, methods have been developed to analyze pesticides in the tissues of organisms.

Pyrethroid insecticides are of increasing environmental concern because of their widespread use and high aquatic toxicity. Although pyrethroids have been frequently detected in California streams in both agricultural and urban areas, only limited data are available on their nationwide occurrence. Pyrethroid insecticides are highly hydrophobic compounds (log K_{oc} >5) and tend to bind tightly to sediments. A summary of pyrethroid occurrence is presented which includes both urban and agricultural streams from a series of nationwide reconnaissance surveys and locally-focused studies in twenty-three states. A total of 260 bed sediment samples from representative stream reaches were analyzed for fourteen pyrethroids. Bifenthrin was detected the most frequently in all samples followed by cyhalothrin and permethrin. In general, urban areas tend to have higher concentrations while agricultural areas tend to have a greater variety of detected pyrethroids.

Fungicides are pesticides designed to control fungal diseases, and tend to be understudied or even ignored during routine monitoring of contaminants in aquatic environments. Used on a wide variety of crops, fungicides are typically applied repetitively throughout the growing season. Chlorothalonil, a broad spectrum fungicide, has been applied for over 50 years, but recently the use of other new classes of fungicides has been increasing. Fungicides are moderately hydrophobic (log K_{oc} 3-4) and are considered to be relatively persistent in water and sediments. Three studies in the western USA examined the occurrence of fungicides in watersheds with potatoes, stonefruit orchards, or lettuce. Overall, twelve fungicides were detected in water and sediments. In water, boscalid was detected most frequently and at the highest concentration. In sediment, chlorothalonil was detected frequently and at the highest concentration. Three other fungicides (azoxystrobin, myclobutanil, and pyraclostrobin) were detected frequently in both water and sediment. Mixtures were common, with more than half of the water and sediment samples containing three or more fungicides.

This comprehensive analytical approach can be used to characterize the occurrence and fate of current-use pesticides and degradates in the environment and to eventually link observed tissue pesticide concentrations to aquatic ecosystem health.