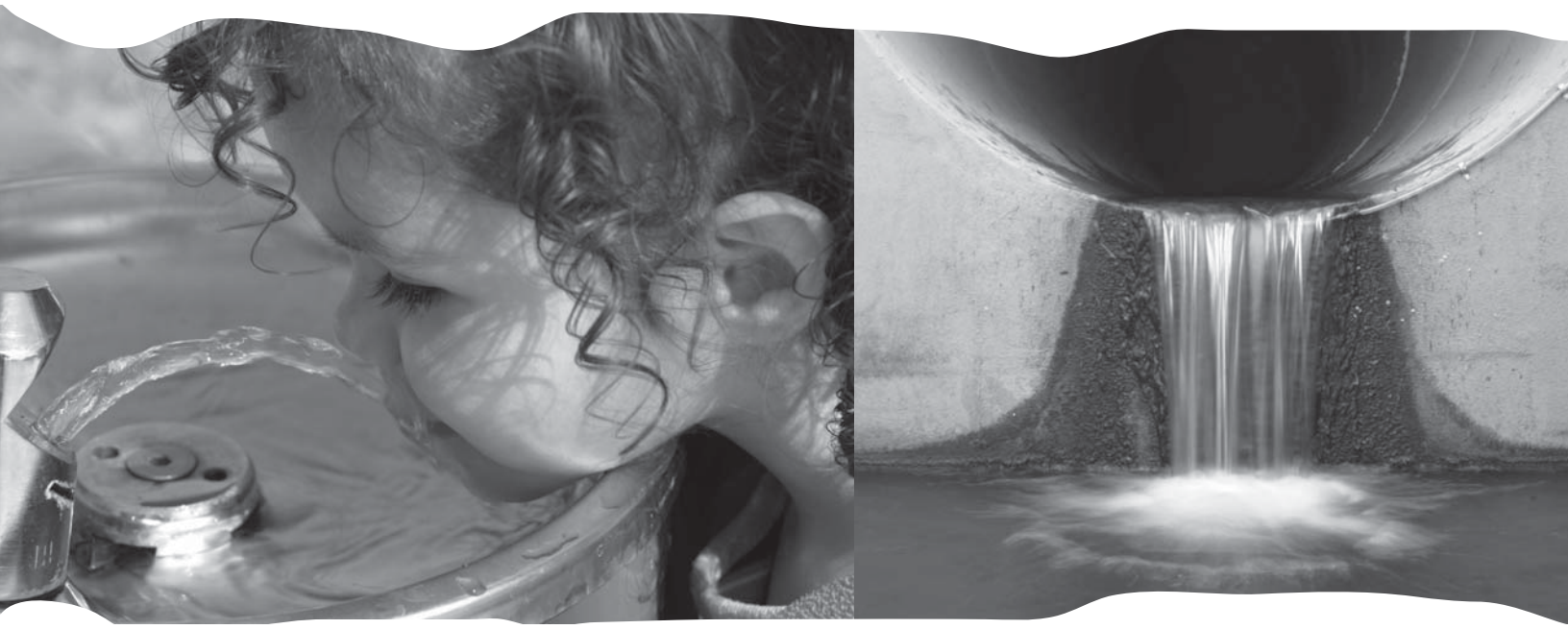

Threatened Waters

Turning the tide on pesticide contamination

By Aviva Glaser

Eds. Note. *With mounting data documenting the increasing problem of water contamination and an inadequate federal regulatory response, it is urgent that policy makers (especially at the local level) and community members refocus on the threat that pesticides pose to the nation's waterways and community health.*

This literature and regulatory review identifies serious threats from pesticides that cannot be ignored:

- Frogs exhibit hermaphrodism when exposed to below below-legal allowable levels of the herbicide atrazine in waterways;
- Human health effects, including low birth weights, increased numbers of breast cancer cases, and low sperm counts are linked to herbicide-contaminated water;
- Dozens of pesticides and their degradation products contaminate waterways and escape regulatory oversight;
- Runoff from urban lawn pesticide use contaminates local watersheds and stresses municipal water treatment plants; and,
- Children are not adequately protected by federal allowances of pesticides in water.

This review brings together the current state of knowledge, while documenting the critical deficiencies in understanding the implications for human health and the environment. The data shows that concern is warranted, and that an urgent response is demanded. With a crisis in safety looming, steps can and must be taken to curtail pesticide uses and adopt alternative practices and products that do not end up in the nation's waterways.

Water is the most basic building block of life. Clean water is essential for human health, wildlife protection, and a balanced environment. Yet, water is being polluted at unprecedented rates, with chemicals, nutrients metals, pesticides, and other contaminants. The U.S. Environmental Protection Agency (EPA) states that, "By their very nature, most pesticides create some risk of harm to humans, animals, or the environment because they are designed to kill or otherwise adversely affect living organisms." Studies of major rivers and streams document that 96% of all fish, 100% of all surface water samples and 33% of major aquifers contain one or more pesticides at detectable levels.

How do pesticides get into water?

Around one billion pounds of pesticides are used each year in the U.S. alone. When pesticides are applied to fields, gardens, parks, and other places, a percentage of the chemicals end up as runoff. This runoff moves in streams, rivers, and lakes. Similarly, when pesticides are applied to lawns in urban and suburban areas, rain washes some of the pesticides into street gutters, where the pesticide-contaminated water goes through storm drains and pipes and eventually flows into nearby creeks and rivers. Some of the pesticides also end up in groundwater systems by leaching down through the soil. Small amounts also volatize into

the atmosphere, and then later fall back to land as precipitation. As a result of all these pathways, pesticides are widely found in rivers, streams, lakes, and even in drinking water.

Pesticide contamination of water

Results of the United States Geological Survey's (USGS) National Water-Quality Assessment (NAWQA) studies show that pesticides are widespread in streams and groundwater sampled throughout the country. USGS found that 90% of water and fish samples from all streams sampled in the U.S. contain at least one pesticide. Not surprisingly, USGS also found that the most heavily used pesticides are the ones found most often in streams and groundwater. The top 15 pesticides found in water are among those with the highest current usage today.

The amount of pesticides in water varies both geographically and seasonally, based on land use and pesticide use patterns. Pesticide concentrations also vary yearly, based on variations in rainfall, and seasonally, based on agricultural practices. A 1991 study of watersheds in the cornbelt region found that concentrations of herbicides in May and June, the planting period, were 10 times higher than levels before planting (March and April) and after harvest (October and November).

Surface water

Surface water, which is water that sits above the surface of the earth, includes lakes, rivers, streams, ponds, and wetlands. Surface water supplies drinking water to around 47% of the U.S. population. Low levels of pesticides have been widespread in the nation's surface waters for several decades. In a large sampling of streams throughout the country, USGS found 46 pesticides and pesticide degradation products in one or more samples. In the Midwest especially, seasonal variations account for strong differences in amount of pesticide residues in surface water—in the summer, pesticides have been detected in concentrations above allowable levels set by EPA.

A number of studies show that pesticides applied to lawns and gardens contaminate local streams. In a King County, Washington study, USGS compared types of pesticides found in urban streams during rainstorms (times of high runoff) to sales data from nearby home and garden stores. The three most frequently purchased pesticides—diazinon, 2,4-D, and MCPP—were detected in water samples from all study sites. USGS also found that four of the five pesticides that exceeded recommended maximum concentrations were purchased by residents and applied in homes and gardens. A recent Canadian study reveals that the most frequently detected pesticides in Toronto streams are also diazinon, 2,4-D, and MCPP, prompting the authors to conclude, "…Stormwater drainage systems may be conveying nutrients and pesticides used on lawns in urban areas to the Don River and Humber River watersheds and ultimately, into Lake Ontario."

Groundwater

Over 50% of the U.S. population draws its drinking water supply from groundwater, which includes sources below the earth's surface, including springs, wells, and aquifers. In general, groundwater has a lower incidence of pesticide contamination than streams because the water gets filtered slowly through soil and rock, allowing for degradation and sorption of the chemicals out of the water and into soil. However, once groundwater has been contaminated, it takes many years or even decades to recover, while streams and shallow water sources can recover much more rapidly. Herbicides are found more often in groundwater than insecticides, but insecticides in groundwater exceed drinking water standards more often than herbicides. A 1989 study found residues of 39 pesticides and their degradation products in the groundwater of 34 states and Canadian provinces. The pesticides were mainly herbicides used in agriculture and insecticides and nematicides used in soil treatments.

Wells

Privately or publicly owned wells draw their water from groundwater sources. USGS found that around 50% of well samples contain one or more pesticides. Those wells that tap shallow groundwater beneath agricultural and urban areas have the highest detection frequencies of pesticides. A study in the mid-1980s of well water by Monsanto, a chemical manufacturer, found the chemical alachor in wells affecting 100,000 people in the sample area, some of whom were exposed to levels above maximum contaminant levels set by the EPA. It also found that 12.95% of the wells sampled contained detectable residues of herbicides. The herbicide atrazine was found in the highest percentage of wells and in the highest amounts, often over the EPA allowable level. A 1990 EPA survey found that over 10% of community water system wells and almost 5% of rural domestic wells contain more than one pesticide.

Human exposure through water

More water is consumed per kilogram of body weight than any other item in the diet. Drinking water comes from a variety of water sources, including surface water and groundwater, as well as public water and private well systems. There are also vast geographic and seasonal variations in quality of drinking water and amount of pesticide residues. Because of these factors and a limited amount of available information, risk estimates on exposure to pesticides from water intake and the health effects of that exposure are currently unavailable. Despite unknown information about exposure and hazards, the National Academy of Sciences (NAS), in its 1993 review *Pesticides in the Diets of Infants and Children,* noted that since pesticide residues in water generally tend to be low, the contribution in ingested food prepared by using water is expected to be low, except in areas where the water is contaminated at above-average levels. A number of pesticides have been found in drinking water sources at concentrations above EPA limits and of potential concern to human health. In that same report, NAS recommended that pesticide exposure through drinking water be evaluated along with other dietary exposures to determine exposure risks.

According to USGS, insecticides in urban streams are a concern for downstream water suppliers and possibly for recreational users. Similarly, the high levels of herbicides in

water in agricultural areas are of concern to residents drinking the contaminated water, and have already caused health problems for some communities. For example, in Kentucky, researchers discovered that in counties where drinking water is contaminated with triazine herbicides, such as atrazine, there are increased numbers of breast cancer cases. In southern Iowa, researchers found that the number of babies with low birth weights is linked to herbicide-contaminated drinking water. Additionally, a study in Missouri found that men in rural areas have lower sperm counts and quality than men in urban areas. The men with lower sperm counts and quality have higher concentrations of pesticide metabolites in their urine, and the researchers believe that "…it is likely that men are ingesting these chemicals through their drinking water."

Environmental problems

In addition to threatening human health, the widespread contamination of the nation's waterways with pesticides has pervasive environmental effects, some of which are only beginning to be understood. The following are a sampling of some of the documented detrimental effects that pesticides are having on aquatic ecosystems.

Aquatic Microorganisms: Herbicides have been shown to be especially toxic to certain aquatic microorganisms, disrupting the photosynthesis process. Microorganisms are very important in aquatic ecosystems, as they are primary producers, they cycle nutrients, and aid in decomposition. By negatively affecting microorganisms, pesticides in aquatic systems may have detrimental effects on higher trophic levels and disrupt the balance and the ecosystem.

Pyrethroids and Stream Sediments: A recent study of pesticides in bodies of water in the agriculture-dominated Central Valley in California found high levels of synthetic pyrethroids in stream sediments—levels high enough that they are toxic to freshwater bottom dwellers in almost 50% of the sampled locations. A follow-up study found that high levels of pyrethroids are also in stream sediments in urban areas in California, resulting from residential use of pyrethroids. In the residential study, pyrethroids are found in every sediment sample. In half of the samples, they caused total or near-total mortality to *Hyalella azteca*, a small bottom-dwelling crustacean that is generally regarded a sensitive "warning" species.

Fish and Endocrine Disruption: A study of sex hormones in carp indicates that pesticides may be affecting the ratio of estrogen to testosterone in both male and female fish. At stream sites with the highest concentrations of pesticides, the hormone ratio in the carp is significantly lower, indicating potential abnormalities in the endocrine system. The authors of the study conclude, "Reconnaissance assessment of sex steroid hormones in carp from United States streams indicates that fish in some streams within all regions studied may be experiencing some degree of endocrine disruption." According to the U.S. Fish and Wildlife Service (FWS), "Endocrine disruption has the potential to compromise proper development in organisms, leading to reproductive, behavioral, immune system, and neurological problems, as well as the development of cancer. Effects often do not show up until later in life."

Decline of Amphibians: In an alarming trend worldwide, frog and salamander numbers are declining at a rapid pace, and many species are becoming endangered or going extinct. In the U.S. alone, there are currently 21 amphibian species classified as endangered or threatened and 11 species waiting to be listed. Although the causes of the decline are not fully understood, pesticides are believed to play a role in the decline.

One hypothesis for how pesticides are causing this decline in amphibian populations is the possibility that endocrine disruptors have altered reproductive and endocrine systems. Studies by researchers at UC Berkeley on atrazine, the most commonly used herbicide in the U.S., show that exposure to atrazine at levels found in the environment, even at levels far below EPA's drinking water limits, demasculinizes tadpoles

and turns developing frogs into hermaphrodites – having both male and female sexual characteristics.

Another hypothesis is that pesticides reduce the food supply of the amphibians. A 2005 study on pesticides and salamanders finds that the addition of carbaryl, a commonly used insecticide, to water caused reduced survival and affected metamorphosis in two species of salamanders. The effect is likely due to pesticide-induced reductions of food resources such as zooplankton. In the study, zooplankton abundance decreased by up to 97% following carbaryl application.

Fish Kills: Sizeable fish kills have resulted from pesticide use, and have often made sensational news headlines, including the 1991 death of over one million fish in Louisiana after aerial spraying of the insecticide azinphos-methyl (Guthion) on sugarcane fields. In 1995, toxic concentrations of endosulfan and methyl parathion along a 16-mile stretch of the Tennessee River in Alabama resulted in 240,000 fish killed. Most recently, 100,000 to 300,000 black crappie fish died suddenly in Minnesota. Water samples show the presence of permethrin, the pesticide that had been used two days prior for mosquito control.

Failures in the regulatory system

EPA has developed water quality standards and guidelines for pesticides that have been the subject of much criticism. Under the *Safe Drinking Water Act*, EPA establishes maximum contaminant levels (MCLs) for water pollutants. MCLs are the maximum permissible level of a contaminant in water delivered to users of a public water system. In addition to MCLs, EPA also establishes Secondary Maximum Contaminant Levels (SMCLs), Risk-Specific Doses (RSD), and Lifetime Health Advisories (HA-L), all of which are other guidelines for how much of a contaminant is acceptable in water, based on health and environmental data. However, there are many uncertainties and complexities. The following failures in the regulatory system threaten both public health and environmental integrity:

- EPA has not established drinking water standards for all the pesticides found in water. EPA has established MCLs for only 24 pesticides, 10 of which are no longer approved for use. Of 76 pesticides analyzed in NAWQA water samples, human-health criteria (MCLs, RSDs, or HA-Ls) are available for 42 pesticides and four degradation products. Similarly, in USGS's study of pesticides in shallow groundwater, only 25 of the 46 pesticides detected had water quality standards established for them.
- Mixtures, synergisms, and breakdown products are not considered or being studied. Yet, pesticides in water usually occur in mixtures of several compounds rather than individually. More than 50% of all stream samples reviewed by the USGS contained five or more pesticides, and nearly 25% of all groundwater samples contained two or more pesticides. Although unregulated, some studies indicate that combinations of pesticides may exhibit additive or in some cases, synergistic effects, making the combined effect worse than the effect of a single compound.
- Certain effects, such as endocrine disruption and responses of sensitive individuals, have not been considered in the guidelines.
- The effects of seasonally high concentrations have not been evaluated.
- Breakdown products, which are the same as or more toxic than parent compounds, are not regularly factored into safety reviews. Breakdown products are compounds that result from pesticides undergoing changes while in the environment.
- Recent research suggests that some pesticides may cause health and environmental effects at levels considered safe by current standards. For example, when exposed to atrazine at concentrations considered acceptable by EPA, hamster ovary cells exhibit chromosome damage, including at levels commonly found in public water supplies. Additionally, tadpoles exposed to below-allowable levels of atrazine develop sexual abnormalities. EPA testing has failed to detect the significance of sublethal doses and has downplayed and in some cases dismissed studies that look at these impacts.

Conclusion and recommendations

There are a plethora of studies documenting known contamination of waterways with hazardous pesticides linked to serious immediate and chronic health and environmental effects. At the same time, a review of the current situation related to water contamination finds that there is a regulatory failure to account for the *full* environmental and health impact of pesticide use patterns. Finally, as government focuses on mitigation measures that allow uses based on false assumptions, no real effort is being put into curtailing pesticide use and assisting with the adoption of practices that do not pollute.

Key to effecting change in response to water contamination are community-based programs that replace toxic pesticides with alternative non-chemical practices and products.

Communities should adopt no-pesticide policies and launch community education programs. Communities should pass policies and adopt practices that stop toxic pesticide use and outline approaches to land management that are safe for the environment and public health. While government regulatory agencies tinker with acceptable levels of pesticides in water, based on inadequate information, communities can lead the nation in rejecting the ongoing contamination and support environmental and public health protection. Institutions in the community, such as schools, hospitals, and office parks, should adopt similar policies and practices. In addition, local communities should develop outreach and educate community members on the adoption of practices that eliminate toxic chemical use on their property.

For a fully cited version of this article, visit www.beyondpesticides.org/documents/water.pdf *or call 202-543-5450. This spring, look for the publication of an in-depth brochure on water and pesticides.*