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Reports from the Ohio Tributary Monitoring Program

Time-weighted Mean Concentrations of Pesticides

This report presents information on the annual average pesticide concentrations in seven of the largest rivers within the state of Ohio. The report covers calendar years 1995 to 1998.

Stations

Basic information about the stations in the Ohio Tributary Monitoring Program is shown in Table 1. More detailed information about the location of the monitoring stations, the sampling approach, and the analysis of samples is provided in a companion report: Program Description.

Table 1. Characteristics of the seven major Ohio Tributary Monitoring Program stations

River	Drainage Area above Station (sq.mi.)	Land use above station, by percent*			
		Agri-culture**	Urban	Wooded	Other***
Maumee R. at Waterville USGS 04193500	6,330	89.9	1.2	7.3	1.6
Sandusky R. near Fremont USGS 04198000	1,253	84.1	0.9	13.0	2.0
Cuyahoga R. at Independence USGS 04208000	708	30.4	9.6	50.1	9.9
Grand R. at Painesville USGS 04212100	686	40.0	0.9	45.2	13.1
Muskingum R. at McConnelsville USGS 03150000	7,420	52.0	1.7	43.4	2.9
Scioto R. at Chillicothe USGS 03231500	3,854	80.2	4.6	12.9	2.3
Great Miami R. below Miamisburg USGS 03271601	2,685	82.1	4.7	10.3	2.9

* Source: ODNR Division of Real Estate and Land Management

** Includes open urban/suburban areas such as lawns

*** Includes shrub/scrub lands, open water, non-forested wetlands, barren ground

Background

Concern about pesticide concentrations in the environment centers about two issues: ecosystem effects and human health effects. In this fact sheet we concentrate on human health effects, which might occur if river water containing pesticides was used as a source of drinking water. Impacts might be due to high concentrations over a short period of time (acute effects) or lower concentrations over a long period of time (chronic effects). The U.S. EPA has set both long term and short term standards for many pesticides for human exposure through drinking water. These standards are set at levels EPA believes will protect the population from harm from exposure to pesticides. They generally include a large safety factor to protect infants, the elderly, and others who may be more sensitive to exposure. Standards that can legally be the basis for regulatory action are called Maximum Contaminant Levels (MCLs). Other standards, calculated the same way but considered advisory only, are referred to as Health Advisories. MCLs and Health Advisories for lifetime exposure (HALs) usually are set at the same concentration.

Concentrations at the WQL monitoring stations never exceed those required to produce acute effects, so our interest centers on long-term average concentrations which might produce chronic effects. Chronic standards are set to protect people against a lifetime exposure to pesticides, but the evaluation and regulation of these compounds is based on annual average concentrations.

Methods

The WQL pesticide sampling program focuses on periods of high flow in the summer months, when concentrations are at their highest. As a consequence, observations from these times are more frequently represented in our data sets than those from other periods of time when concentrations are generally lower. To avoid producing misleading results when calculating average concentrations from these data, each observation must be weighted by a time factor reflective of the time between samples. The resulting Time Weighted Mean Concentration (TWMC) is the most appropriate number to compare with EPA health standards, in order to evaluate the significance of pesticide concentrations for human health.

The TWMC is given by $$\text{TWMC} = \frac{\sum_i c_i t_i}{\sum_i t_i},$$

where c is a sample concentration and t is the time represented by that sample. t is set equal to half the time from the sample to the next sample, plus half the time from the sample to the preceding sample.

In this paper, we report annual TWMCs for calendar years 1995 through 1998 for the seven rivers in the Ohio Tributary Monitoring Program.

Results

The resulting TWMCs for five of Ohio's most extensively used pesticides (all herbicides) are given in Table 2.

Table 2. Time-weighted mean concentrations (TWMCs) of selected pesticides, 1995-1998. Concentrations are expressed in units of micrograms per liter (µg/L), or parts per billion (ppb). Lifetime health advisory concentrations (see Table 3) are listed below the pesticide names.

River and year		Acetochlor 2.0	Alachlor 2.0	Atrazine 3.0	Metolachlor 70.0	Simazine 4.0
Maumee	1995	0.24	0.35	1.34	1.28	0.19
	1996	0.15	0.19	1.31	1.02	0.11
	1997	0.39	0.30	2.28	1.97	0.13
	1998	0.35	0.18	1.86	2.13	0.17
Sandusky	1995	0.38	0.32	1.46	1.25	0.13
	1996	0.21	0.14	1.46	1.10	0.10
	1997	0.61	0.30	2.54	1.97	0.11
	1998	0.38	0.12	1.98	1.81	0.15
Cuyahoga	1995	0.025	0.012	0.101	0.08	0.10
	1996	0.005	0.000	0.079	0.08	0.01
	1997	0.019	0.003	0.127	0.12	0.01
	1998	0.004	0.002	0.073	0.07	0.04
Grand	1995	0.028	0.027	0.304	0.25	0.06
	1996	0.025	0.029	0.329	0.18	0.04
	1997	0.036	0.009	0.536	0.37	0.02
	1998	0.009	0.004	0.126	0.10	0.02
Muskingum	1995	0.070	0.048	0.457	0.35	0.11
	1996	0.053	0.045	0.471	0.32	0.09
	1997	0.143	0.015	0.766	0.52	0.07
	1998	0.062	0.028	0.397	0.38	0.08
Scioto	1995	—	—	—	—	—
	1996	0.21	0.10	1.68	1.39	0.25
	1997	0.38	0.04	2.80	2.06	0.27
	1998	0.10	0.02	1.08	1.48	0.19
Great Miami	1995	—	—	—	—	—
	1996	0.08	0.09	0.92	0.73	0.13
	1997	0.14	0.09	1.42	1.15	0.09
	1998	0.10	0.04	0.80	0.88	0.11

Discussion

Atrazine and metolachlor generally have the highest TWMCs. Acetochlor, alachlor, and simazine generally have TWMCs that are lower: one-fifth to one-tenth of those for atrazine and metolachlor. This pattern reflects differences in the amount of pesticide used annually, and differences in the rate at which the pesticide breaks down following application.

Among stations, the Maumee, Sandusky, Scioto, and Miami stations tend to have higher concentrations than the Cuyahoga, Grand, and Muskingum rivers. This pattern reflects the fact that agricultural land use, and particularly cultivation of corn and soybeans, is more intensive in the western half of Ohio than in the eastern half (Table 1).

Standards for chronic exposure to these compounds are presented in Table 3. No annual TWMC at any station exceeds the corresponding health standard, and most are only a fraction of the standard (Figure 1). Thus, all of these waters would be considered safe for use as drinking water from the standpoint of their pesticide concentrations. Of course, nobody drinks water right from the river. When these rivers are used as raw water supplies, the water is treated in various ways, often stored for a time in a reservoir before use, and often mixed with water from other sources such as wells. Many water treatment plants process the water using activated carbon filtration. These treatments all have the effect of lowering the pesticide concentrations in the finished drinking water, though often they are done for other reasons. Thus the TWMCs in a river are over-estimates of potential exposure to pesticides through drinking water taken from the river.

Table 3. Lifetime health advisory levels (HALs) for herbicides, established by the U.S. EPA. Source: http://www.epa.gov/OST/Tools/dwstds.html

Herbicide	MCL (ppb)	HAL (ppb)
Acetochlor	2.0*	2.0*
Alachlor	2.0	
Atrazine	3.0	3.0
Metolachlor		70.0
Simazine	4.0	4.0

* No standard has been set for acetochlor, but consensus is that it will be set equal to that of alachlor, 2.0 ppb.

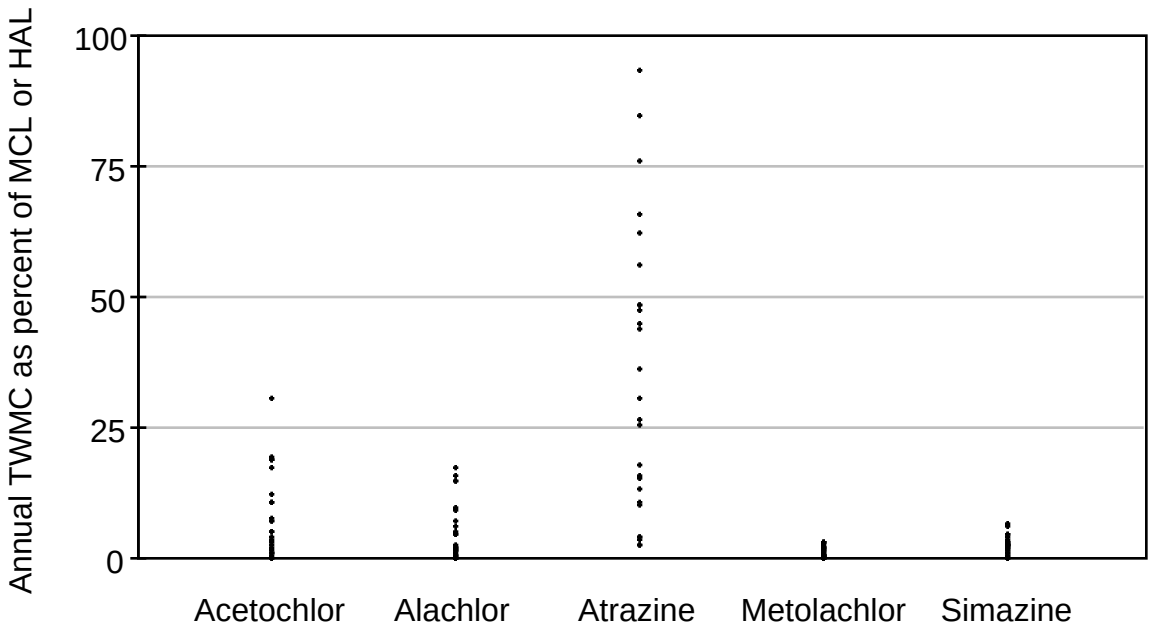

Figure 1. Annual time weighted mean concentrations (TWMCs) expressed as a percent of the HAL or MCL for the compound The HAL or MCL is a concentration that the U.S. EPA has judged acceptable for lifetime consumption through drinking water. Each symbol represents one of the TWMCs listed in Table 2.

Many people filter the water that comes from the tap, either from concern about chemicals in the water or because of taste issues. Most of the filters available on the market will reduce pesticide concentrations below the levels present in tap water, though doing so is thought to be unnecessary to protect human health. If you are considering using a home filter, it is comforting to know it will add still further to the margin of safety that already protects you from harm from pesticides. However, do not let an aggressive salesman sell you a filter to protect you from "toxic pesticides". If your drinking water comes from one of these rivers, you are already protected!

Concentration Trends

The relatively long data records (1983 to present) for the Maumee and Sandusky rivers have been examined to determine if there have been any systematic changes in concentrations over time. Atrazine, metolachlor, and simazine do not show any systematic changes over the last decade. Acetochlor came onto the market in 1994, and rapidly replaced alachlor for most uses. This change is clearly reflected in the data when 1994 and before are compared with post-1994. It is not reflected in the data in Table 2 because the transition was mostly complete by 1995, the first year covered by this report.

Further sources of information:

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