Pesticides in Streams in Central Nebraska

U.S. Department of the Interior–U.S. Geological Survey

Introduction

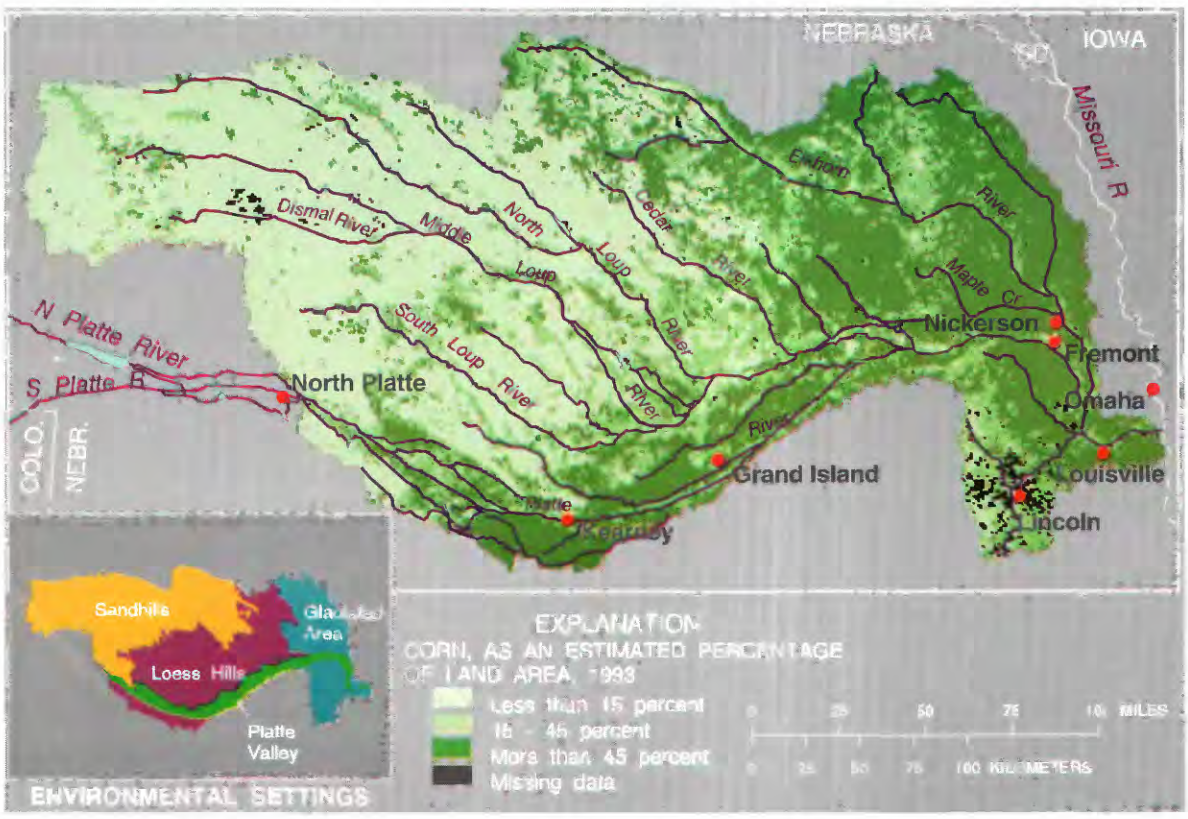
Contamination of surface and ground water from nonpoint sources is a national issue. Examples of nonpoint-source contaminants from agricultural activities are pesticides, which include fungicides, herbicides, and insecticides; sediment; nutrients (nitrogen and phosphorus); and fecal bacteria. Of these contaminants, pesticides receive the most attention because of the potential toxicity to aquatic life and to humans. Most farmers use pesticides to increase crop yields and values. Herbicides prevent or inhibit the growth of weeds that compete for nutrients and moisture needed by the crops. Herbicides are applied before, during, or following planting. In addition to agricultural use, herbicides are used in urban areas, often in larger rates of application, for weed control, such as along rights-of-way. Alachlor, atrazine, cyanazine, and metolachlor, which are referred to as organonitrogen herbicides, were the four most commonly applied herbicides (1991) in the Central Nebraska Basins (CNB), the area shown on the map. These herbicides are used for corn, sorghum, and soybean production. Atrazine was the most extensively applied pesticide (1991) in central Nebraska. Insecticides are used to protect the crop seeds in storage prior to planting and also to protect the plants from destruction once the seeds have germinated. Like herbicides, insecticides are also used in urban areas to protect lawns, trees, and ornamentals.

Atrazine was the most extensively applied pesticide (1991) in central Nebraska.

Many of the 46 pesticides shown in the table have either a Maximum Contaminant Level (MCL) or Health Advisory Level (HAL) established by the U.S. Environmental Protection Agency (USEPA) for public water supplies. The purposes of this Fact Sheet are (1) to provide water-utility managers, water-resource planners and managers, and State regulators an improved understanding of the distributions of concentrations of pesticides in streams and their relation to respective drinking-water regulations or criteria, and (2) to describe concentrations of pesticides in streams draining a selected small agricultural basin and a large agricultural area. This Fact Sheet is based on pesticide data collected from May 1992 through March 1994 at the Platte River at Louisville and Maple Creek near Nickerson sites (see map). Samples were collected monthly, with additional samples collected over a wide range of hydrologic conditions.

Study Area

The CNB lies entirely within Nebraska and includes the Platte River drainage between the confluence of the North and South Platte Rivers near North Platte in western Nebraska to its confluence with the Missouri River at the eastern boundary of Nebraska (see map). The two major tributaries to the Platte River are the Loup and Elkhorn Rivers. The Platte River at Louisville sampling site represents the outflow of the CNB, which encompasses approximately 30,000 square miles (mi^2) and is one of 60 study areas being assessed as part of the U.S. Geological Survey's (USGS) National Water-Quality Assessment (NAWQA) Program. The sampling site at Louisville on the Platte River is downstream from the confluence of the Platte and Elkhorn Rivers (see map), and the quality of water at this site is considered representative of the water that the cities of Lincoln and Omaha withdraw from the adjacent



The Central Nebraska Basins study area is predominately agricultural; most corn is produced in the eastern part and in the Platte Valley.

alluvial aquifer for public supplies. Mean daily streamflow of the Platte River is about 2,500 cubic feet per second (ft^3/s) at the western (upstream) boundary of the study area near North Platte and 6,735 ft^3/s at the eastern boundary at Louisville. Maple Creek drains 388 mi^2 and is a tributary to the Elkhorn River. The sampling site at Nickerson on Maple Creek is considered representative of surface-water quality in the eastern part of the study area. Mean daily streamflow of Maple Creek near Nickerson is 72.1 ft^3/s.

Land use in the study area is predominately agricultural. Rangeland and pastureland account for about 54 percent of the land use, and cropland accounts for about 37 percent. Rangeland characterizes most of the northern and western parts of the area, whereas cropland dominates the southern and eastern parts. Major crops are corn, soybeans, sorghum, and wheat. Most of the corn is produced in the eastern part of the study area and along the Platte Valley (see map) and is commonly irrigated. Urban areas occupy a small percentage of the land area (about 1 percent), with Lincoln being the largest city. Land use within the Maple Creek drainage basin is composed of about 45 percent corn, 20 percent soybeans, 2 percent pastureland, and less than 1 percent sorghum (Douglas Garrison, U.S. Soil Conservation Service, oral commun., 1994).

Rangeland and pastureland account for about 54 percent of the land use, and cropland accounts for about 37 percent.

Lincoln, Omaha (outside the study area), and smaller cities along the Platte River withdraw water for public supplies from the alluvium. The alluvium adjacent to the Platte River has a direct hydraulic connection to the river and thus is affected appreciably by the quantity and quality of water in the river.

Results

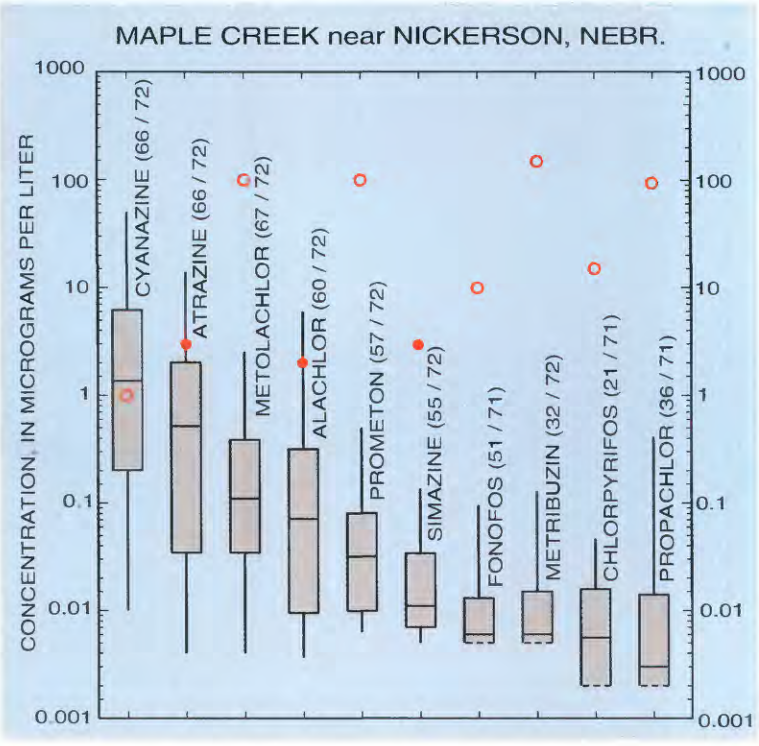
Distributions of concentrations are shown (see graphs) for pesticides that had 10 or more detections at the Maple

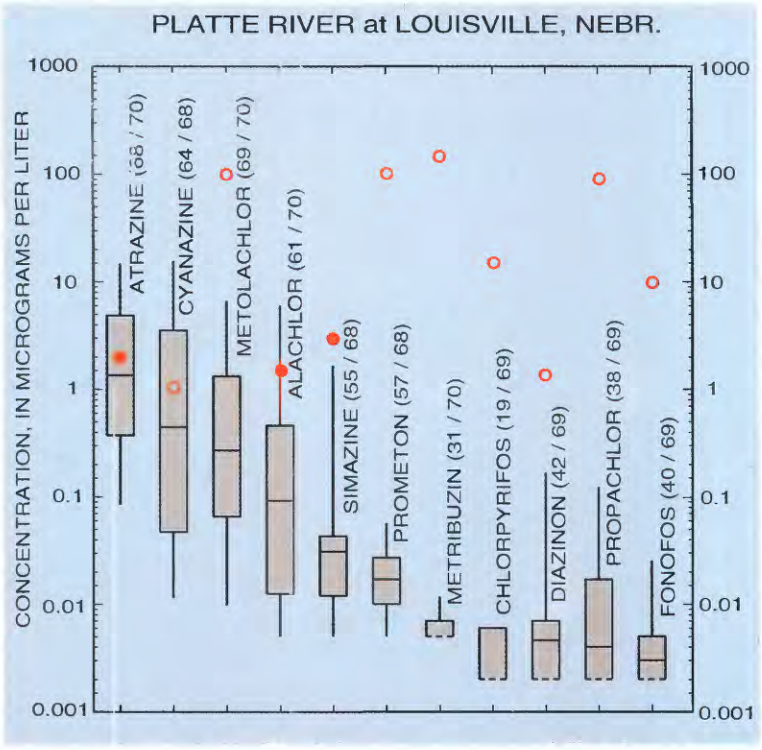
Differences in the distributions of concentrations of pesticides at the Maple Creek and Platte River sites partly reflect differences in land use and land-management practices.

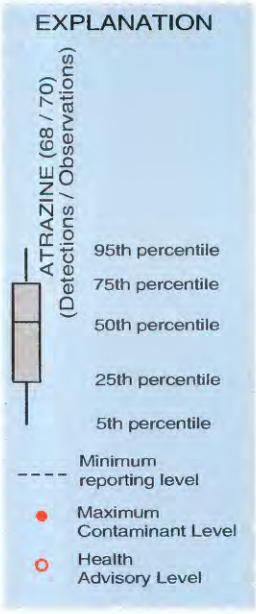
Forty-six pesticides in water were analyzed by solid-phase extraction followed by gas chromatography and mass spectrometry.

Name	Minimum reporting level, in micrograms per liter	Maximum Contaminant Level or Health Advisory Level, in micrograms per liter
Alachlor	0.005	[2]2.0
Atrazine	.002	[2]3.0
Azinphos, methyl-	.005	----
Benfluralin	.005	----
Butylate	.02	350
Carbaryl	.01	700
Carbofuran	.005	[2]40
Chlorpyrifos	.002	20
Cyanazine	.01	1.0
DCPA	.002	4000
DDE, p,p-	.005	----
Diazinon[1]	.002	0.6
Dieldrin	.005	----
Diethylanaline	.01	----
Dimethoate	.005	----
Disulfoton	.002	0.3
EPTC	.002	----
Ethalfluralin	.005	----
Ethoprop	.005	----
Fonofos	.002	10
HCH, alpha-	.007	[2]1.0
HCH, gamma-	.011	[2]0.2
Linuron	.039	----
Malathion	.014	200
Metolachlor	.005	100
Metribuzin	.005	200
Molinate	.007	----
Napropamide	.010	----
Parathion, ethyl-	.022	----
Parathion, methyl	.035	----
Pebulate	.009	----
Pendimethalin	.018	----
Permethrin, cis-	.016	----
Phorate	.011	----
Pronamide	.009	50
Prometon	.005	100
Propachlor	.002	90
Propanil	.016	----
Propargite	.006	----
Simazine	.005	[2]4.0
Tebuthiuron	.015	500
Terbacil	.030	90
Terbufos	.012	0.9
Thiobencarb	.008	----
Triallate	.008	----
Trifluralin	.006	5.0

[1] The use of trade names in this paper is for identification purposes only.
[2] Value is Maximum Contaminant Level; other values are Health Advisory Levels.







Distributions of concentrations of pesticides with 10 or more detections, and associated Maximum Contaminant Levels or Heath Advisory Levels, are plotted for the Maple Creek near Nickerson and the Platte River at Louisville sites.

Creek and Platte River sites. Differences in the distributions of concentrations of pesticides at the Maple Creek and Platte River sites partly reflect differences in land use and land-management practices. There is proportionately more cropland in Maple Creek Basin (about 66 percent) than in the entire study area upstream of Louisville (about 37 percent). The 25th, 50th (median), and 75th percentile concentrations of cyanazine in water were larger at the Nickerson site than the Louisville site. Cyanazine usage is apparently greater, relative to atrazine usage, in the Maple Creek Basin than in the area as a whole upstream of the Louisville site. Another difference between the two sites is the common presence of Diazinon at the Louisville site. Diazinon is an organophosphorus insecticide, which now is used primarily in urban environments to control insects in lawns and homes. Several urban areas such as Lincoln, Fremont, Grand Island, and Kearney are upstream of the Louisville site.

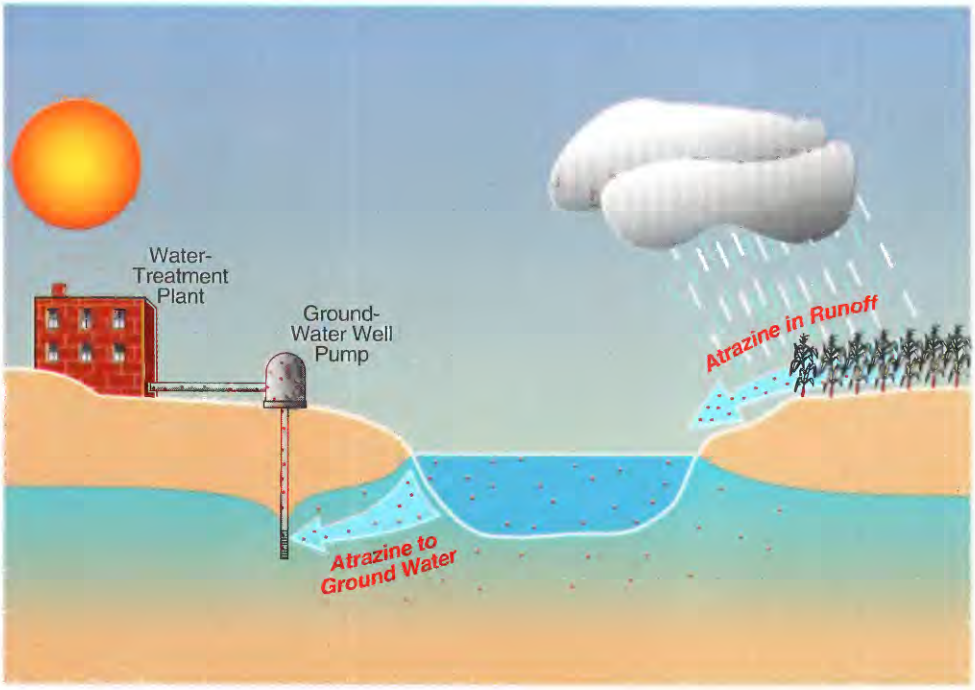
Implications

Of 46 pesticides analyzed, it appears that alachlor, atrazine, and cyanazine pose potential problems to public water supplies.

The distributions of concentrations of pesticides shown in the graph for the Platte River at Louisville site indicate which pesticides could affect the management of public (Lincoln and Omaha) water supplies withdrawn from the alluvium adjacent to the river because of possible exceedances of a regulation or criterion. During periods of considerable runoff, especially in May after the herbicides have been applied, herbicide concentrations in the Platte River can be quite large. For example, during a period of storm runoff from May 16-30, 1992, the maximum measured concentrations of alachlor, atrazine, cyanazine, and metolachlor were 10, 30, 30, and 8.0 micrograms per liter (µg/L), respectively, in water from the Platte River at Louisville.

When the river stage is high, water can move from the river into the adjacent alluvium, as shown in the schematic. Water soluble compounds, such as alachlor, atrazine, cyanazine, and metolachlor, move with the water. When supply wells are pumped, the water and compounds in solution move from the river's alluvium to the treatment plant; the water in the alluvium is replenished partly from the river by induced infiltration. In simplest terms, much of the ground water that is pumped by the municipalities is filtered river water. The concentrations of herbicides in the ground water in the adjacent alluvium may differ from the concentrations measured in the Platte River, depending on streamflow rates, distance traveled in the alluvium, amount of organic and clay materials in the alluvium, and hydraulic characteristics of the alluvium.

Of 46 pesticides analyzed, it appears that alachlor, atrazine, and cyanazine pose potential problems to public water supplies. Of the 70 samples collected at the Platte River at Louisville and analyzed for alachlor, 11 (about 16 percent) exceeded the MCL value of 2.0 µg/L. Of the 70 samples analyzed for atrazine, 23 (about 33 percent) exceeded the MCL value of 3.0 µg/L, and of the 68 samples analyzed for cyanazine, 18 (about 26 percent) exceeded the HAL value of the 1.0 µg/L. Presently, the USEPA has only established a HAL for cyanazine and not a MCL; a HAL is a



Herbicides, such as atrazine, can be washed from the land surface into the river and then move into the river's alluvium to the treatment plant.

criterion and a MCL is enforceable. Thus, based on current MCL's, atrazine is the herbicide most likely to exceed its MCL at the Platte River at Louisville. It is important to recognize that a MCL or HAL for a pesticide is based on an annual average and that one or more exceedances of the specified value does not necessarily indicate noncompliance. It is also important to recognize that the current MCL or HAL for a pesticide applies only to the parent compound and not to any of its degradation products.

Studies have shown that conventional water treatment is ineffective in removing organonitrogen herbicides such as alachlor, atrazine, cyanazine, and metolachlor from finished drinking water. These herbicides remain in solution, in contrast to many other contaminants that are more easily removed by conventional treatment processes such as coagulation, sand filtration, and chlorination.

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For information and selected readings about the Central Nebraska Basins study, write to:

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Additional information on NAWQA and other USGS programs can be found by accessing "http://wwwrvares.er.usgs.gov/nawqa/nawqa_home.html" on the World Wide Web.