Developing a Comprehensive Pesticide Monitoring Program

Through Interagency Cooperation

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Biographical Sketches

Larry Rosenmann is an Engineering Geologist with the New York State Department of Environmental Conservation, Division of Solid & Hazardous Materials since 1984. For the past 5 years he has been in charge of the Department's Water Quality Monitoring for Pesticides Program. In addition, Mr. Rosenmann is a past representative for the Northeastern States on the SFIREG Working Group on Water Quality and Pesticides Disposal, and has served as an instructor for the USEPA Pesticide Regulatory Education Program's Water Quality course at the University of California, Davis. Mr. Rosenmann holds a Masters Degree in Engineering Geology from Rensselaer Polytechnic Institute in Troy New York.

Patrick Phillips has been with the U.S. Geological Survey since 1986, and has been in the Troy, New York office since 1992. He has investigated pesticide occurrence and water quality issues as a member of both the is Hudson River Basin National Water Quality Assessment project and the cooperative Statewide Pesticide Monitoring project with the New York State Department of Environmental Conservation.

David Eckhardt has U.S. Geological Survey in 1974, and began in the Harrisburg U.S. Geological Survey Office. Between 1982 and 1988 he worked on ground water quality assessments in the Long Island office of the USGS. Since 1988 he has worked in the Ithaca, NY office on pesticide transport and regional assessment of pesticides. Mr. Eckhardt has a PhD in Cornell in Soil Science, and an MS from West Virginia University in Forestry/Geology.

Martin Trent is Chief of the Bureau of Groundwater Resources for the Suffolk County Department of Health Services. A graduate of SUNY at Stony Brook in 1973, he has over 20 years of experience conducting groundwater investigations in a sole-source aquifer that provides drinking water for Long Island's 2.8 million residents. Martin has been involved in numerous studies of pesticide impacts to groundwater supplies since the 1979 discovery of aldicarb (Temik)contamination in many Long Island wells by his department.

Abstract

In recent years many states have initiated monitoring programs to understand the occurrence and fate of pesticides in their ground and surface water resources. Monitoring work in New York State has shown that creation of a meaningful monitoring program requires an understanding of: pesticide use; pesticide migration and fate; statewide hydrogeologic conditions, and a clear definition of the regulatory and environmental concerns the monitoring program is seeking to address. This paper is intended to demonstrate how New York State has relied on strong interagency cooperation to develop this understanding and how we will be using it to create a meaningful, long-term, statewide pesticide monitoring program.

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Introduction

New York State is blessed with abundant groundwater and surface water resources that are important for drinking water supply and for recreation.

The state has several major river systems and thousands of man made or natural lakes, most of which are used for public or private water supply. The state also contains many important public water supply reservoir systems; the largest is the New York City Water supply system that provides 1.4 billion gallons of high quality drinking water to almost nine million New Yorkers every day. New York is bordered by two of the Great Lakes (Erie and Ontario), the Saint Lawrence Seaway, Lake Champlain, and the Atlantic Ocean.

Our largest groundwater resource is a highly permeable glacial moraine aquifer of Long Island, which is the sole source of drinking water for nearly 3 million New Yorkers. Unconsolidated aquifers in upstate New York are smaller and most lie in the lowlands adjacent to rivers and streams. The 18 largest and most heavily used are designated as primary aquifers. Less developed high yield aquifers are designated principal aquifers. Much of the non-aquifer area is covered with glacial till. New York also has several different bedrock aquifers of varying yield and water quality.

Pesticide use in New York State varies widely depending primarily on land use. Corn and soybeans heavily dominate some areas, like the agricultural western part of the state. Other agricultural areas include vineyards and orchards. Still other areas vary from mixed urban and agricultural to highly developed urban areas, most notably around New York City.

Until recently, there has been only a limited amount of pesticide monitoring in the waters of New York State. Those monitoring studies have shown that pesticide concentrations, in most of the upstate areas studied, do not exceed relevant health based water quality standards. (Walker and Porter, 1990) (Wall and Phillips, 1996) (Wall and Phillips, 1998b.) On Long Island, State and federal maximum contaminant levels (MCLs) for pesticides have frequently been exceeded (Suffolk County, 1989). Even here, however, problem areas can be reasonably predicted based upon pesticide use and hydrogeologic conditions.

This paper focuses primarily on the activities of the New York State Water Quality Monitoring for Pesticides Program. Other complimentary programs are also discussed when appropriate.

Mandate for Monitoring / Involved Agencies

Because New York State values clean water, there are many different agencies involved in water quality monitoring and protection. Each brings unique monitoring needs based upon the mandate they are charged with. Wherever possible, these agencies have been partners in developing and implementing the program so that their specific information needs are met.

These agencies include:

- The New York State Department of Environmental Conservation (NYSDEC)

NYSDEC has a general mandate for water quality protection and for regulation of pesticide use. In addition, NYSDEC has a specific mandate to monitor state waters for pesticide residues to “provide an adequate

understanding of the health and environmental impacts of pesticide use in the State." (ECL§33-0714) This mandate has been the major driving force in development of this comprehensive program. In the future, monitoring by NYSDEC will also be required for the State's federally mandated pesticide management plans (40 CFR Parts 152 and 156) to demonstrate the efficacy of statewide management of several important corn herbicides.

- The United States Geological Survey (USGS)

USGS has a mandate for gathering hydrogeologic information on and assessing the quality (including pesticides) of the nation's aquifers through the National Water Quality Assessment Program (NAWQA). USGS also has a mandate to work cooperatively with state and local government agencies in scientific and technical investigations.

- The New York State Department of Health (NYSDOH)

NYSDOH has a mandate to monitor and protect the State's public and private water supplies outlined in NYS Public Health Law Article 11 and Article 2. The mandate is shared with county Department's of Health and by public water suppliers who are regulated by NYSDOH. NYSDOH also has a responsibility for evaluating human health risks from pesticides and for establishing drinking water standards for pesticide residues in drinking water.

- The Suffolk County Department of Health Services (SCDHS) and the Nassau County Department of Public Works (NCDPW)

Monitoring for pesticides in groundwater has been an important program for these two local agencies ever since the widespread discovery of aldicarb residues in Long Island groundwater in 1979. Collectively, these two agencies have analyzed tens of thousands of water samples for pesticide residues and have been responsible for developing and refining several nationally recognized pesticide analytical methods.

- Cornell University

Cornell University's mandates related to water quality protection and pesticide management shared primarily by two branches of the university, the Cooperative Extension Service (CES) and the Center for the Environment (CFE). CES provides statewide pesticide management information through a network of CES agents, who advise agricultural, residential and commercial pesticide applicators on the most environmentally sound pesticide management practices and integrated pest management. Responsibilities regarding the environmental and health risks of pesticides are shared by several groups within CFE. The group most heavily involved in this program is the New York State Water Resources Institute (WRI) which promotes research and education throughout NYS and provides technical assistance to communities and others concerned with understanding and managing the state's water resources.

- New York State Department of Agriculture and Markets (Ag & Markets)

Ag & Markets is responsible for support activities to the agricultural community through their Agricultural Environmental Management program, administered in conjunction with the New York State Soil and Water Conservation Districts, and the New York State Soil and Water Conservation Committee.

- Public Water Purveyors, including the New York City Department of Environmental Protection - Bureau of Water Supply, Quality & Protection (NYCDEP-BWSQP)

Local water purveyors have a mandate to protect the quality of drinking water they provide. The largest of these is NYCDEP-BWSQP, which manages, operates and protects New York City's upstate water supply system.

Water purveyors routinely monitor water quality. They also typically have responsibility for enforcement of watershed regulations and, in conjunction with NYSDEC and NYSDOH, they are responsible for source water protection under the federal Safe Drinking Water Act.

Problem Definition

The mandate for pesticide monitoring in New York State is extremely broad. Ultimately, the monitoring program must provide information that will: support registration decisions; protect public and private drinking water supplies and the environment; provide continued protection; and define any trends in pesticide concentrations in the waters of New York. But there are many complicating factors that affect the specific monitoring strategy and techniques to be employed:

- There are thousands of registered pesticides in New York State and their use in any one area often changes in relation to land use and changes in response to the introduction of new products.
- There are a tremendous number of ground and surface water bodies that can be monitored.
- Varied hydrogeologic conditions often require widely different monitoring tools and timeframes.
- There are many pesticides that were used in the past but are now banned in New York State.
- Pesticides are generally introduced into the environment from a widespread, non-point source resulting in extremely low concentrations, often below the minimum detection levels of the most commonly used analytical methods. Even with adequate methods, pesticide residues at these low concentrations can be hard to find, especially in groundwater.
- Many pesticide products break down quickly forming metabolites that need to be monitored.
- Analytical capabilities are not always available to detect compounds of interest at low concentrations, especially the metabolites.
- As new methods become available, the cost to include them can be prohibitive.
- The many involved agencies often have vastly different data needs that require different monitoring strategies, which cannot always be incorporated into one study.

Monitoring Strategy

The statewide strategy being used in the NYSDEC program is to identify and characterize pesticide concentrations in various situations and to use these characterizations to build a comprehensive, statewide understanding of pesticide migration and impacts.

With all of the complexities, a broad-brush approach to understand "average" or typical conditions will not provide the meaningful information required. Instead, the monitoring sites, compounds to be sought, monitoring methods and monitoring time frames need to be precisely targeted in studies designed to meet clearly defined objectives. Some will be short-term studies lasting one year or less and others will be long-term studies lasting years or even decades before objectives are met. Ultimately, the information gained in these studies will be used to build a comprehensive, statewide understanding of pesticide migration and fate.

The strategy employed in the NYSDEC program starts by investigating pesticides in hydrologic settings where they are most likely to be found and in areas of high pesticide use. The program also emphasizes monitoring sites that are representative of large areas. For example, the mouth of a stream will be monitored rather than a small upstream segment. These investigations help us understand pesticide residue patterns that help target monitoring in more difficult situations.

The following priorities have been developed to help sort through the many potential monitoring options and to plan specific monitoring studies:

- Monitoring will not only seek to document the concentrations of pesticides present, but it will also seek to understand the migration and fate of pesticides in the environment.
- Monitoring will place a high priority on ensuring that waters used as a drinking water source are acceptable for human consumption.
- Monitoring will place a high priority on the most heavily used, most toxic and most mobile pesticide products and areas that are expected to be the most vulnerable to pesticide contamination.
- Monitoring will seek to assess ambient concentrations and long-term trends of currently used pesticides in the environment. These will include atrazine, alachlor, simazine, cyanazine and metolachlor; the chemicals that will be the focus of the federally mandated Pesticide Management Plan (40 CFR Parts 152 and 156).
- Monitoring will seek to develop information necessary to confirm registration decisions and foster responsible pesticide management practices.
- Wherever appropriate permanent monitoring sites (fixed sites) will be developed to help understand long-term trends.
- Monitoring of older, discontinued pesticides will primarily target those situations where there is a known human or environmental exposure pathway.
- Wherever practical, based upon stated priorities, monitoring will incorporate new analytical tools to expand the compounds sought and reduce minimum detection levels.
- Wherever possible monitoring will combine the efforts of the many involved agencies.

Monitoring Studies / Summary of Key Findings

As stated earlier, our statewide strategy is to identify and characterize pesticide concentrations in various situations and to use these characterizations to build a comprehensive, statewide understanding of pesticide migration and impacts. The following is a review of the studies implemented so far to accomplish this:

1. USGS National Water Quality Assessment Program (NAWQA) Hudson River Basin study

The USGS NAWQA Hudson River Basin study is part of a continuing, national USGS effort to understand the factors that affect water-quality conditions by gathering information about the status and trends of a variety of water-quality parameters. The study investigated a wide suite of commonly used pesticides in surface and ground waters of the basin between 1992 and 1996. All analyses are conducted with extremely low detection levels, typically measured in parts per trillion (ppt.). (Wall and Phillips, 1996) (Wall and Phillips, 1998b)

Using a variety of investigative methods developed for the national NAWQA effort, the study found that:

- In synoptic studies, low-level pesticide residues (0.002-0.005 :g/l) were very common (85%) in surface water samples but less common (25%) in private drinking water wells.
- Even with extremely low detection levels, many pesticides were not detected at all.
- Fixed site studies in surface waters showed similarly low pesticide residue concentrations throughout most of the year with dramatic spikes (1.6 :g/l for carbaryl) in response to spring floods especially those immediately after pesticide application.
- Only two samples taken during high spring flow exceeded State or federal MCLs for drinking water.
- 18 different pesticides residues were detected in surface waters. Often, as many as eight different compounds were found in the same sample. Groundwater samples had much less variety with no more than two different compounds detected in any one well.
- Pesticide detections were closely related to land use with insecticides being more frequently found in urban streams and herbicides, most notably atrazine, in agricultural streams.

- Fish tissue and sediment studies found persistent, bio-accumulative pesticides like DDT in fish tissue samples, especially in large rivers and in small urban watersheds.

2. Statewide Synoptic and Fixed Site Surface Water Monitoring

In 1997 the USGS, in cooperation with NYSDEC, (USGS/DEC) expanded parts of the Hudson River Basin monitoring network to gain a preliminary understanding of pesticide concentrations in surface waters throughout the state. Four additional fixed sites were added and a 64 site, statewide synoptic study was undertaken with a concentration in the highly agricultural areas of western New York. (Phillips and others, 1998)

Some key findings from these studies include:

- Synoptic and the fixed sites continue to show low concentrations (typically less than 0.01 :g/l) of 34 different pesticides or pesticide breakdown products that rarely exceeded 1 microgram per liter (:g/l).
- Pesticide residues that are most frequently detected in stream-water in western New York are agricultural herbicides and their metabolites, which include atrazine, de-ethylatrazine, metolachlor, metolachlor-ESA, cyanazine, simazine, and alachlor.
- Synoptic sampling further defined the relationship between pesticide residues and land use. Residues found in areas of row crop agriculture (mostly corn and soybeans) included atrazine, metolachlor, deethylatrazine alachlor and cyanazine. These are fairly common in all areas of the state. Residues near urban areas also commonly include prometon, carbaryl and diazinon. Residues near orchards and vineyards often include simazine and carbaryl.
- Three insecticides, diazinon, azinphos-methyl and dieldrin, (an insecticide that is no longer registered for use in New York) were found to exceed aquatic surface water standards or NYS Class GA standards in samples collected near orchards and vineyards.
- The most commonly detected corn herbicides, atrazine, metolachlor and deethylatrazine, (a breakdown product of Atrazine) were found in 100% of the fixed site samples and more than 88% of the synoptic samples. Typical concentrations were between 0.001 and 0.3 :g/l.
- The sulfonic acid metabolite of metolachlor (metolachlor ESA) was found to constitute a significant portion of the total pesticide load in the fixed site studies; often exceeding the concentration of any other pesticide residue including parent metolachlor.
- Thirteen pesticides that are registered in New York State or their metabolites were analyzed for in the study but were not detected in any sample.

3. Pesticide transport at the Genesee and Seneca River fixed sites in western New York

Pesticide residues in two major tributaries to Lake Ontario - the Genesee River (drainage area 4333 km^2) and the Seneca River (drainage area 8127 km^2) - are being studied to provide seasonal and annual assessments of pesticide loadings to the lake.

Some key findings of this study include:

- Maximum concentrations of pesticides in the Genesee River are typically greater than those in the Seneca River, but median concentrations are typically greater in the Seneca River. This pattern is believed to be because (1) the Seneca River basin contains more agricultural land than the Genesee River basin and (2) the Seneca River's flow is more highly regulated and it drains deep lakes that have water-retention times exceeding 15 years.

- Metolaclor-ESA, the sulfonic-acid metabolite of metolachlor, represents the greatest fraction of the total pesticide residue load in the two rivers; concentrations were typically more than 4 times that of the parent compound.
- Annual pesticide loads for both rivers were estimated through regression methods. The three largest annual pesticide loads for the 1997-98 water years - metolachlor-ESA, metolachlor, and atrazine – were 1200, 290, and 220 kg/yr for the Genesee River, and 1500, 350, and 490 kg/yr for the Seneca River, respectively.

4. Toxicity testing.

The NYSDEC Division of Fish, Wildlife and Marine Resources has been conducting chronic aquatic toxicity tests on split USGS samples from the Genesee River and Canaseraga Creek fixed sites to evaluate the potential adverse effects of agricultural pesticide runoff on aquatic ecosystems in western New York. To date the results are inconclusive.

5. Pesticide Transport Modeling in the Canajoharie Creek Watershed

The Canajoharie Creek Watershed is typical of many small agricultural watersheds in upstate New York. The USGS has been sampling water quality in this watershed since 1994. While the intensity and nature of the sampling has changed over the years, sites within the watershed are still being sampled. Projects include sampling the creek and tile drains that underlie fields in a corn-soybean rotation. In addition, WRI used the watershed to evaluate a possible a watershed scale pesticide migration model for use in pesticide registration decisions. (Wall and Phillips, 1998a) (DeGloria and others, 1999)

- Because the study focused solely on a small agricultural watershed, concentrations of the more common pesticides were typically slightly higher than reported for the entire Hudson River basin or statewide data. This was most evident in the storm sampling that had a maximum atrazine concentration of 20 :g/l and a median concentration of 3.2 :g/l. Both exceed the federal atrazine MCL of 3 :g/l.
- Diazinon was absent in the June 1996 samples and 73% of the diazinon detections were in 1994. The reason for this is not clear.
- The calculated atrazine load during the 14 hour storm flow period on June 19, 1996 was 1 kilogram, far in excess of the load of 0.028 kilograms during a 60 day low-flow period of the previous year.
- Metolachlor metabolites, metolachlor ESA (ethanesulfonic acid) and metolachlor OA (oxanilic acid), represent the major residue of metolachlor in shallow ground water intercepted by tile drains. (Phillips and others, 1999a) These metabolites were observed in tile drain samples almost immediately after application and persisted for 3 years after the last application.
- Development of a watershed scale pesticide migration model was possible, but due to the vast data requirements to properly construct this model and the high level of modeling skill required to use it, the model was deemed inappropriate as a tool for routine pesticide registration decisions on a state level. (DeGloria and others, 1999)

6. Monitoring Long Island Ground Water

SCDHS, in conjunction with the NCDPW and NYSDEC, analyzed 2,306 samples for a variety of pesticides commonly found in Long Island groundwater. Samples were taken from public water supply wells, homeowner wells and monitoring wells in areas with known or suspected pesticide residues. (Suffolk County, 1999)In a subsequent investigation requested by SCDHS, the USGS/NYSDEC sampled 50 shallow wells in areas with known or suspected pesticide residues. (Phillips and others, 1999b) Because the samples were targeted at areas with known pesticide residues, they are not necessarily representative of groundwater quality in all areas of Long Island. However, they demonstrate the aquifer's sensitivity to pesticide migration, especially in areas where pesticides are used.

Key findings include:

- Much of the sampling for the project was targeted at high-risk areas including old agricultural lands, utility rights-of-way, and golf courses. In the SCDHS study pesticides were found in 9% of the 405 wells tested in Nassau County, and in 27% of the 1,901 locations sampled in Suffolk.
- In highly agricultural areas of eastern Suffolk County 50.5% of 642 private wells tested had low level detections of pesticides. The vast majority of these were shallow wells screened in the upper glacial aquifer. Even in these areas, however, impacts are often very localized, appearing in one well but not in neighboring wells.
- In the SCDHS study, 32 pesticide and metabolite compounds were detected. Of these, 10 were found in concentrations exceeding drinking water MCLs. 6 of those compounds exceeding MCLs were removed from the market between 10 and 20 years ago.
- Extremely high concentrations of certain pesticides (sometimes more than 500 :g/l) were detected in some samples. These are believed to be the result of pesticide spills, improper disposal or inappropriate use.
- In the USGS follow-up study, 25 of the 60 compounds sought were detected.
- The seven compounds detected at the highest frequency and concentration in the USGS study were the herbicides atrazine, metolachlor, simazine, tebuthiuron, the metolachlor metabolites metolachlor OA and ESA and the simazine metabolite deisopropylatrazine. Maximum concentrations of these ranged from 1 to 30 :g/l. The concentration of the metolachlor metabolites was typically higher than that of the parent metolachlor and often represented the bulk of the pesticide load in any sample.
- Insecticide residues dieldrin, p,p-DDE (a DDT metabolite) and carbofuran were detected in more than 20% of the USGS samples. Their concentrations were generally below 0.05 :g/l.
- 44 of the 50 USGS samples contained at least one pesticide or metabolite (breakdown product as a pesticide degrades in the environment). Of these, 24 samples had concentrations greater than 1 :g/L for one or more pesticide. Some samples contained as many as 11 different pesticides or pesticide metabolites.
- Concentrations of metolachlor and its metabolites were generally highest in samples from agricultural areas. Concentrations of simazine, deisopropylatrazine and tebuthiuron were highest in residential and mixed land use areas, and were particularly high in areas near utility rights-of-way.

7. Finger Lakes Monitoring with emphasis on Cayuga Lake

A synoptic investigation conducted in 1997 by the USGS determined that concentrations of pesticides seen in several of the Finger Lakes (including Cayuga Lake) were higher than the typical concentrations seen in New York rivers and streams during baseflow. In 1998 the USGS/NYSDEC studied the distribution of pesticide residues in the Cayuga Lake basin. The work included collection of stormflow samples in three major tributaries to the lake during June of 1998 and collection of water samples from Cayuga Lake at 12 cross sections on 2 consecutive weeks one month later in July 1998 (Eckhardt and others, 1999.)

Findings of these investigations include:

X Concentrations of herbicides in Cayuga Lake were fairly uniform throughout the lake, from 0.2 to 0.6 :g/l for atrazine and from 0.05 to 0.3 :g/l for metolachlor. These concentrations appear to represent a long-term mixing of stream pesticides loads that are delivered to the lake.

X Seasonally, higher concentrations of the herbicides were seen in the epilimnion (surface layer) in the northern end of the lake where tributary streams drain predominantly agricultural lands. Deeper waters of the hypolimnion are apparently well mixed by annual turnovers of the lake and wind action. (This is corroborated by ongoing USGS monitoring of a public water supply intake in the hypolimnion that has shown relatively non-variable concentrations of pesticides for several years.)

X The highest metolachlor and atrazine concentrations in the three tributaries occurred during the peak of stormflow.

X Significantly more of the metolachlor ESA metabolite was transported in the tributaries than any other herbicide residue. As stormflow receded, the concentrations of metolachlor metabolites in the tributaries began to exceed the concentrations of the parent metolachlor, suggesting that the metabolites are transported to the lake primarily in ground-water discharge to the lake and streams.

X The ratios of metolachlor metabolite concentrations to parent concentrations were significantly higher in lake-water than in tributary streamflow. The differences may be due in part to the inflow of metabolite enriched groundwater that enters the lake directly from adjacent agricultural land and the transformation of the parent compounds during their residence in the lake.

8. Monitoring Public-Water Supply Reservoirs

Building on the USGS/DEC synoptic survey, NYSDOH conducted a survey of pesticide residues in public water supply reservoirs that were considered vulnerable to pesticide contamination. This preliminary screening identified three public-water-supply systems Village of LeRoy, Village of Perry and the City of Hornell) as the most highly impacted.

The USGS/NYSDEC conducted a study to assess the concentrations of pesticides in the reservoirs and their tributary streams using a broader set of analytes including metabolite products of commonly used herbicides. (Phillips and others, 1999c) Between May 1998 and January 1999, samples were collected from the public water supply intake and several tributaries at each reservoir in this study. Some significant findings include:

- Only three of the samples taken exceeded State or federal drinking water quality standards. All of these were in tributaries on June 26 under stormflow conditions. None of the samples collected from the water supply intakes exceeded these standards.
- Due to the small size of these reservoirs pesticide concentrations can change rapidly with precipitation and on a seasonal basis. This response is very different from the much larger Lake Cayuga where concentrations change little throughout the year. Concentrations of pesticides in the small reservoirs also appear to be heavily influenced by differences in land use.

Work at the village of Le Roy water supply has been continued by a joint USGS/USEPA program designed to understand the concentrations of pesticides in public water supplies throughout the nation.

In addition, the USGS has sampled public water supply reservoir working cooperatively with several public water suppliers around the state. This work has been added to the USGS/NYSDEC program to provide a continuing data base on the concentrations of pesticides in upstate groundwater.

9. Monitoring Drinking-Water Sources in NYC Watersheds

Intensive pesticide monitoring in the New York City Watershed will be accomplished as part of the New York City watershed filtration avoidance agreement under the federal Safe Drinking Water Act. Much of this work is slated to begin in the next federal fiscal year. In anticipation of this program, the NYSDEC and the USGS have conducted some preliminary pesticide monitoring that can help focus future efforts. Some of these efforts include: Flood Stage Monitoring in the Cannonsville watershed; sampling at ten reservoir sites throughout the watershed; and macro-invertebrate testing of the Croton Reservoir to determine the impacts of pesticides on the ecology of tributary streams within the watershed. In the future, we hope to complete studies, modeled after the Cayuga Lake study to evaluate pesticide loads, distribution and fate for the entire system.

10. Community Water Supply Wells of Western New York, August 1999

Water samples from 32 community water systems (CWS) were collected from upstate aquifers in in August 1999 by the USGS in cooperation with NYSDEC. The CWS sites included 31 wells that ranged in depth from 23 to 120 feet, and one spring. All wells tapped water-table aquifers in sand or gravel deposits, except one well that was finished in karstic limestone bedrock. Laboratory analytical methods that produced low detection limits - from 0.001 to 0.2 mg/L (micrograms per liter) – were used to analyze the samples for 60 pesticide residues.

This sampling program was intentionally conducted in highly vulnerable areas with a high percentage of agricultural land or residential use and extremely permeable soils. The results are not expected to be representative of CWS wells in the state. Instead they are intended to evaluate a "worst case" scenario.

Key findings include:

- Eight pesticide residues were detected, and 24 of the 32 CWS samples contained at least one pesticide residue; one sample contained eight different pesticides or pesticide metabolites. However, no New York State or federal water-quality standards were exceeded in any CWS samples collected in this study.
- The four most common pesticide residues detected were the herbicides atrazine and metolachlor and their metabolites, deethylatrazine and metolachlor ESA, respectively. The maximum concentrations of these four pesticide residues ranged from 0.088 mg/L for deethylatrazine to 3.58 mg/L for metolachlor ESA.
- The pesticides found are commonly used in row-crop agriculture. Their frequent occurrence in the CWS well samples reflects the agricultural land use near many of the wells.
- No insecticides were detected and the impacts from residential and industrial (right of way) pesticides that were seen on Long Island were not detected in this in this preliminary sampling effort.

Conclusions:

An integral focus of New York's pesticide monitoring program has been to develop information that meets the needs of the various State and federal agencies involved in pesticide management and of the citizens of New York State. This focus on agencies sharing information and resources has enabled us to develop a wide-ranging and comprehensive program in a very short period of time. In addition, sharing resources has enabled us to accomplish many tasks that would have been impossible by any one agency acting alone.

Major findings of the pesticide monitoring effort include:

1. Low concentrations of pesticides are ubiquitous in New York's surface waters. With few exceptions, these concentrations are all well below state and federal maximum drinking water MCLs. The relevant monitoring question, therefore, is not whether pesticide residues are present, but are the concentrations seen acceptable to protect public health and the environment under current regulatory standards? A second relevant question is how are these concentrations changing over time?
2. While some modern herbicides including atrazine, metolachlor and their breakdown products are detected in nearly every sample, many other registered pesticides have never been detected in State surface waters. It is just as important to document products that are not migrating into the environment as it is to identify those that are. This is a strong argument in favor of the use of analytical methods with extremely low minimum levels of detection.
3. In watersheds where they are heavily used, certain insecticides have consistently been detected at concentrations above State surface water protection standards during base-flow conditions. This requires further investigation.
4. Mixtures of pesticides can often be directly correlated to land use. Knowledge of these mixtures in specifically studied areas may be useful in the future to evaluate health impacts of mixed pesticide residues in other areas of the State.

5. High concentrations of pesticide residues are found in rivers and streams during seasonal high flow periods, especially those right after pesticide application. While these transient concentrations infrequently exceed drinking water standards, their real significance is that they represent the bulk of the total pesticide load moving in the environment. The environmental significance of these high concentrations is still being investigated.
6. Calculations of total pesticide loading showed more than 4,000 kg/yr of metolachlor-ESA, metolachlor and atrazine passed through the Genesee and Seneca Rivers (two major tributaries to Lake Ontario in highly agricultural areas of western New York) in the 1997-98 water years.
7. Concentrations of pesticides in large lakes and reservoirs do not vary much seasonally, making them a useful monitoring target for understanding long-term changes to pesticide concentrations in the environment.
8. Pesticide concentrations in streams under base-flow conditions are also fairly steady and may prove to be a useful surrogate for long-term groundwater monitoring.
9. Groundwater on Long Island has been shown to be extremely susceptible to pesticide contamination. Most of the impacts above drinking water standards are related to older pesticides that are no longer allowed for use in New York State.
10. The highest pesticide concentrations found on Long Island appear to be related to improper disposal or spills rather than use. Prevention efforts aimed at avoiding these in the future can have a significant impact on reducing total pesticide concentrations in the environment and can avoid the most potentially dangerous threats to public health and the environment.
11. Groundwater impacts on Long Island can be correlated to certain areas of high pesticide use. Within these areas, however, impacts are often very local, appearing in one well but not in neighboring wells. This suggests that monitoring for public health protection may require monitoring of every drinking water supply well in an impacted area.
12. Pesticide metabolite residues such as metolachlor ESA and metolachlor OA can be more common than the parent compound in both surface water and ground water. They also can persist in the environment. Unfortunately, analytical methods and health based standards are not often available for the metabolites. Continued work in this area is absolutely necessary if we are to understand the total impact of pesticides on human health and the environment.
13. Preliminary studies of groundwater in highly vulnerable upstate aquifers suggest that some upstate aquifers are vulnerable to pesticide impacts in areas of high pesticide use. However, no pesticides were detected at levels exceeding federal MCLs in this "worst case," preliminary study.

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