NWQEP NOTES

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IN THIS ISSUE

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PROJECT SPOTLIGHT

Changes in Herbicide Use and Occurrence in Iowa

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Introduction

Since 1991, the U.S. Environmental Protection Agency (EPA) has provided for states to take primary responsibility in developing management programs to deal with agricultural chemicals. Guidance on this program is spelled out in EPA's guidance policy, *Pesticides and Ground-Water Strategy* (EPA, 1991). Because of variations in geology, soil, and landscape features among the states, the strategy allows states to implement their pesticide-specific state management plans (SMPs) to best protect their water resources. Since that time, the Iowa Department of Natural Resources, Geological Survey Bureau has been developing a database of pesticide analyses to coordinate existing data and make the results more readily available for review as part of the SMP process. Development of the database was initiated through the financial support of the Iowa Department of Agriculture and Land Stewardship (Pesticide Bureau) and EPA Region VII, Water, Wetlands and Pesticide Division. The Iowa Pesticide Water Resources Database (IAPEST) was designed to improve access to pesticide contaminant information and facilitate integration of this data with other natural resource information. Through the integration of various databases, regulatory decision-making efforts such as the SMP and TMDL (Total Maximum Daily Load) programs could be conducted in a timely and knowledgeable manner.

The IAPEST database is a collection of water-quality data from a variety of sources including federal, state, and local monitoring programs and research activities. The data has been extracted from numerous electronic databases, such as WATSTORE (U.S. Geological Survey's water quality database), STORET (EPA's water quality database) and various Iowa Department of Natural Resources water-quality datasets from Section 319 (Clean Water Act) projects including the Sny Magill National Monitoring Program project. It also includes published and unpublished Iowa data not available in electronic form. All information in IAPEST is currently stored within a Visual dBase framework, but plans are to eventually migrate all the data to the State's STORET system. Currently, there are more than 60,000 records for 118 different pesticide analytes including degradate products of several pesticides. The length of record for pesticides in surface water spans nearly forty years from 1963 through 2000. However, the record for pesticide analyses from groundwater does not begin until 1982. Prior to 1980, most of the compounds analyzed were chlorinated or carbamate insecticides, while since 1980, most of the analyses have focused on the nitrogen herbicides (corn and soybean herbicides in the triazine and chloroacetanilide families). In Iowa, more than 90% of the corn and soybean acres are treated with at least one herbicide, therefore, the focus of this article will be on the changing occurrence patterns in those compounds during the past two decades.

EDITOR'S NOTE

Pesticides are widely used in the United States for crop production. Their movement into water resources is a form of nonpoint source pollution and their potential persistence has been an environmental concern. The regulation of pesticides by the U.S. EPA has lead to changes in both the type and amount of pesticides applied. In this issue of *NWQEP NOTES*, our feature article discusses trends over time in pesticide use and occurrence in surface and groundwater resources of Iowa. The analysis was made possible due to the development of the *Iowa Pesticide Water Resources Database,* a conglomerate of pesticide water quality data collected in Iowa from various government agencies over the past several decades. The database is a valuable tool for state-level environmental planning and regulatory programs.

As always, please feel free to contact me regarding your ideas, suggestions, and possible contributions to this newsletter.

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Methodology

The analysis of data originating from multiple sources with varying laboratory methods and reporting levels presents several challenges. However, the use of disparate project-level data is valuable when attempting to determine temporal trends in pesticide concentrations because the state did not collect pesticide data from its state-wide ambient water monitoring network until 1995. This project-level data is the only basis from which to determine a historical context for understanding the impacts of management changes in pesticide use. For the purposes of this analysis, five of the most commonly used herbicides (during the period of record) were selected, and only those results obtained by EPA Method 507 were included. The data were then standardized to a common method quantitation limit; quantified results lower than the "new," standardized limit (0.1 ug/l) were reclassified to "Below Quantitation Limit." While the standardization process helped to remove biases introduced by laboratory method or reporting limits, the sites as well as sampling frequencies at each site are not uniformly distributed across the state or for various water resources units, such as surface water and groundwater.

Influence of Landforms

Figure 1 illustrates the major landform regions of the state of Iowa and the seven major drainage basins. The landform regions define areas of similar geology and can be used to help predict the soil types, vegetation, biological, and landuse characteristics that may occur in various areas. In Iowa, the Des Moines Lobe (DML) landform region represents the most recently glaciated portion of the state and is typified by poor drainage. The DML also tends to have calcareous soils that present carry-over problems for triazine herbicides (residual herbicide lingers in the soil and may damage the next year's crop rotation). Therefore, the DML region uses more chloroacetanilide herbicides such as alachlor and metolachlor. The Iowan Surface and Paleozoic landform regions are older landscapes with more intensive weathering of soils. In many cases, the bedrock is close to the ground surface and karst topography has developed. The surface water and groundwater are intricately tied and the groundwater is very vulnerable to activities on the landscape. This area of the state has been intensively studied for herbicide impacts on groundwater. Figures 2 and 3 indicate the number of surface water and groundwater sites monitored throughout the state. The clustering of sites illustrates the level of monitoring effort in these landform regions. The Southern Iowa Drift Plain is characterized by rolling topography with thick deposits of weathered glacial till covering bedrock. The landuse in the southern por-

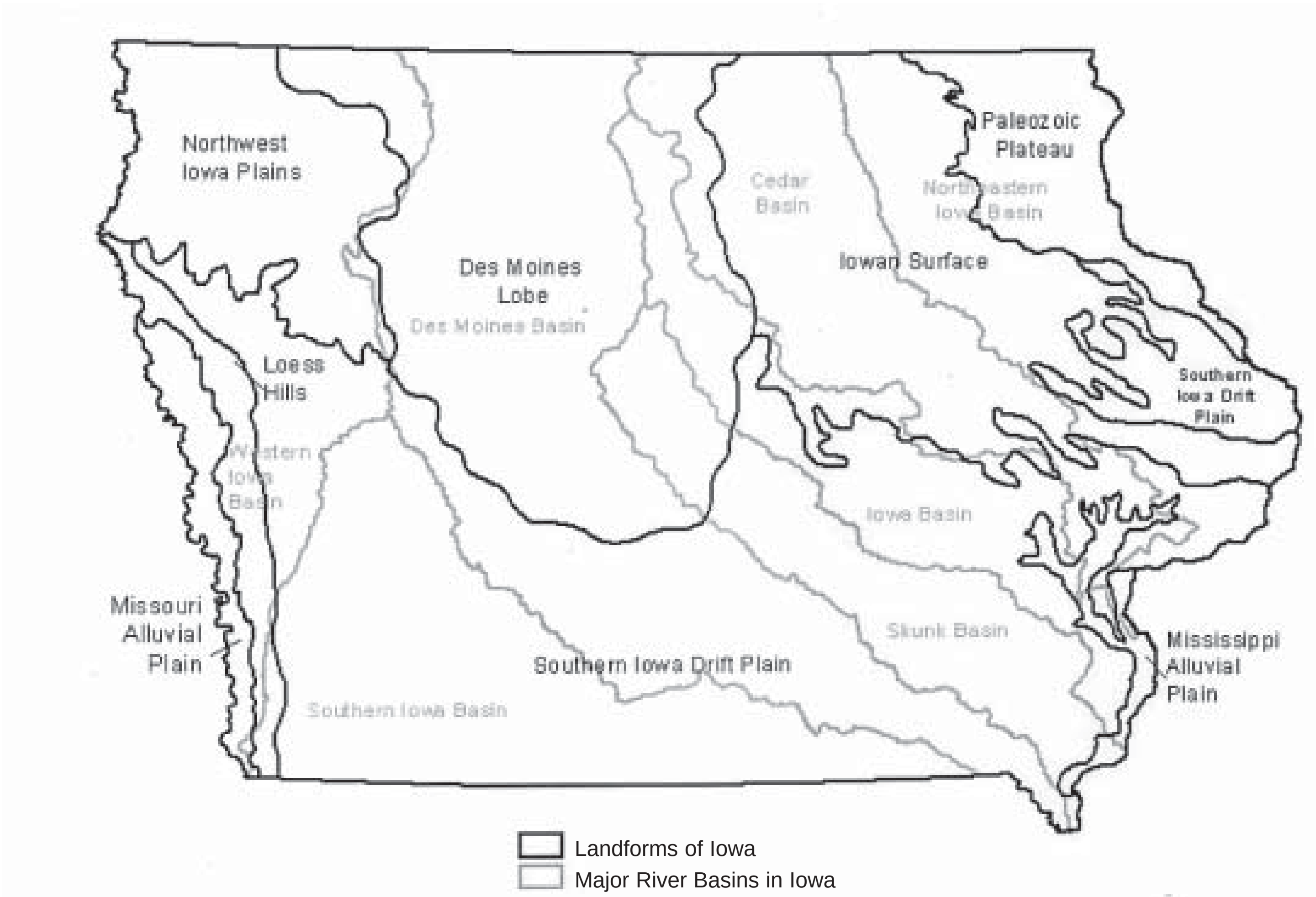

Figure 1. Major Landform Regions of Iowa and Seven Major Drainage Basins.

tion of the state is less-intensively row-cropped and more pasture or land enrolled in the Conservation Reserve Program is found. In this area, groundwater drinking sources are deeply buried and of poor natural quality. Therefore, reservoirs are used extensively for drinking water and the lack of groundwater sites reflects the decreased level of concern about groundwater contamination from pesticides. The western portion of the state is dominated by deposits of thick, windblown loess soils and row crop also dominates. Fewer samples reflect the naturally drier conditions and lack of water quality projects in this area.

Data Distribution

The database can be divided into five different site types: groundwater, surface water, tile drainage, springs, and rain collectors. Table 1 provides the distribution of sites and water-quality analyses among the five site categories since 1980. It is apparent from this table that the data is not evenly distributed among the different site types. The majority of the sites (3,850) and water quality analyses (12,375) fall within the groundwater category and include sites such as domestic wells, municipal wells, and monitoring wells.

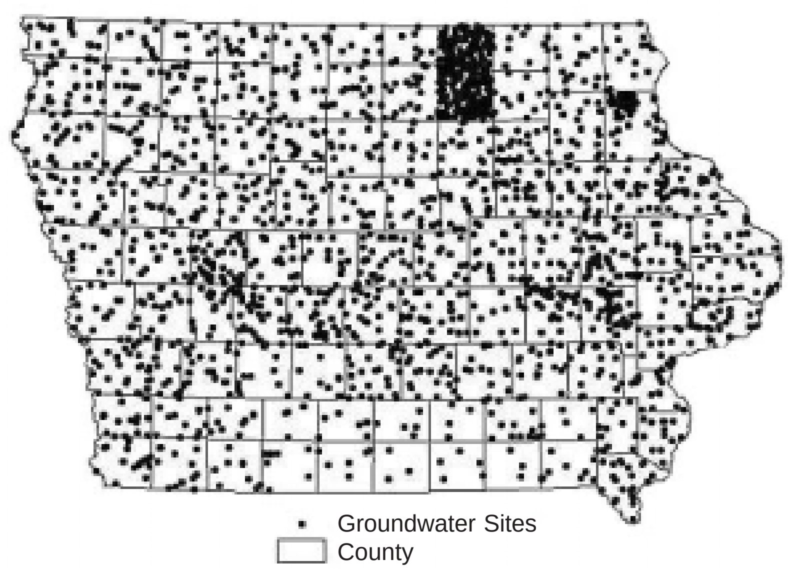

Figure 2. Distribution of Groundwater Monitoring Sites in Iowa.

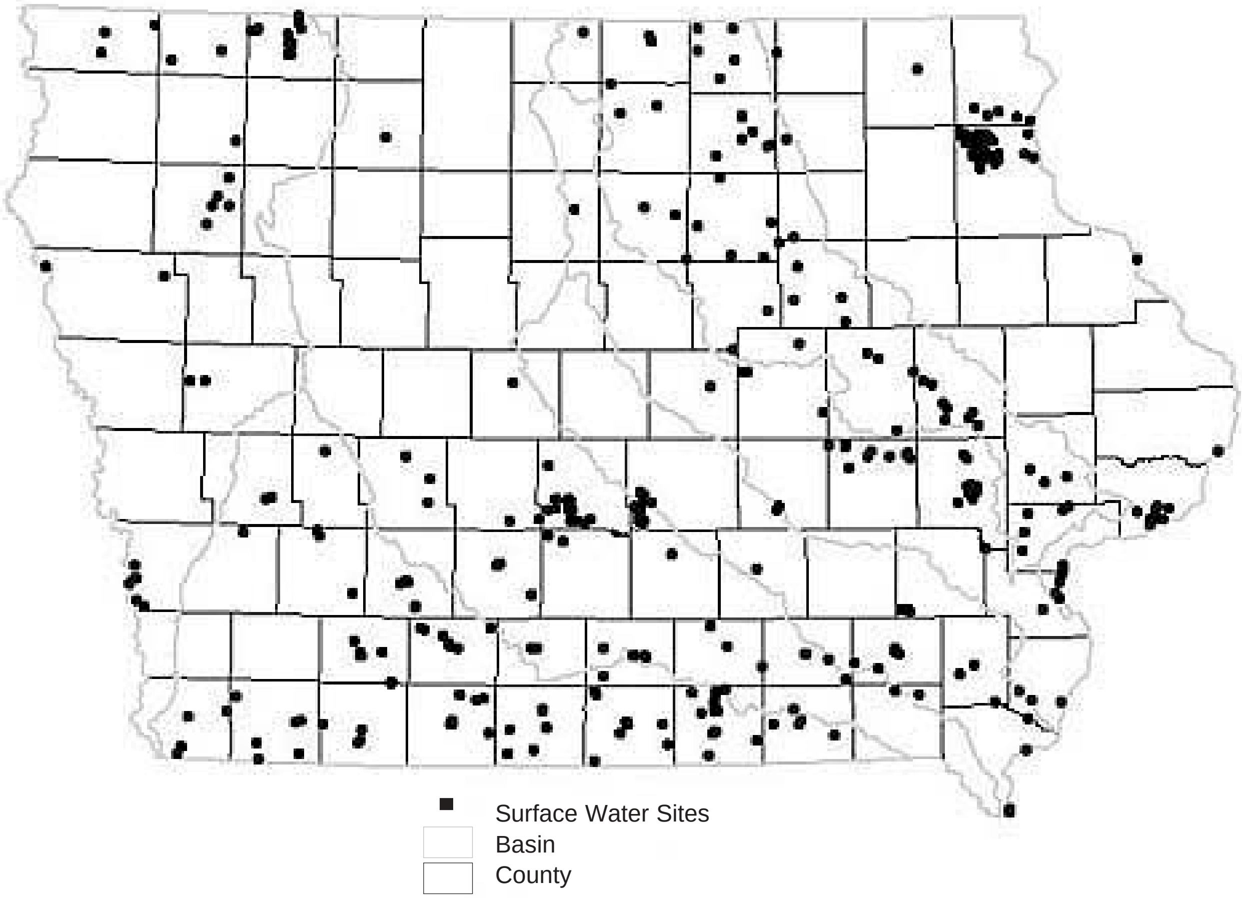

Figure 3. Distribution of Surface Water Monitoring Sites in Iowa.

Table 1. Number of sites and water quality analyses for the five site categories.

	No. of Sites	No. of Analyses
Groundwater	3,850	12,375
Surface Water	530	5,766
Springs	2	916
Rain Collectors	6	118
Tiles	50	2,225
Total	4,438	21,400

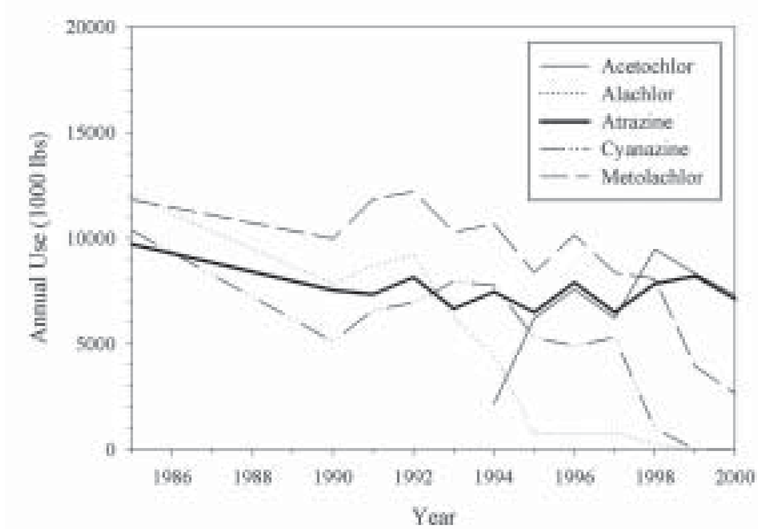

Figure 4. Temporal changes in herbicide use during the period 1985 – 2000. Data from Iowa Agricultural Statistics and the National Agricultural Statistical Service.

Changing Patterns in Herbicide Use

Despite the weaknesses of the existing dataset, interesting patterns have emerged in the water quality of the state with respect to herbicides. Figure 4 shows changes in herbicide use during the period 1985 through 2000 for the five most commonly used herbicides: Acetochlor (Harness), Alachlor (Lasso), Atrazine (Aatrex), Cynazine (Bladex), and Metolachlor (Dual). While herbicide use remained fairly stable during the first ten years (1985 – 1995), the second half of the 1990s has experienced substantial change. Prior to 1995, alachlor was the second most commonly used herbicide in the state. Beginning in 1992, the use of alachlor began to decline dramatically and it was quickly replaced by acetochlor, which was first registered for use in the state in 1994. Within four years, acetochlor had become the most widely used herbicide (as determined by bulk weight). Cyanazine, which had been slowly declining in the 1980s and early 1990s, was voluntarily phased-out of production and had nearly disappeared from use by 1999. Metolachlor maintained its status as the number one herbicide until acetochlor replaced it in 1998. Since then, metolachlor use has dropped to less than one half of its previous high levels. In comparison, atrazine has not experienced substantial changes in use during the period 1985 – 2000 and has maintained levels similar to that found in the early 1980s. Many of the declines in traditional herbicide use can be attributed to efforts by EPA to reduce the use of herbicides with longer soil half-lives and greater persistence in soil and water. The appearance of low-use rate herbicides, such as the sulfonylurea, sulfonamide, and imidializone herbicides in the 1990s, and later the development of Roundup ready soybeans and corn, hastened the decline of these traditional herbicides. Despite the decreases in use, questions remained regarding the potential lag-time for these compounds in the environment.

Patterns in Water Quality Changes

Water quality trends as exhibited by the IAPEST database mirror the patterns shown with herbicide use, but are not as dramatic as the declines in herbicide use. Figures 5 and 6 show the changes in mean concentrations for atrazine, alachlor, acetochlor, cyanazine, and metolachlor during the period 1990 – 2000. In general, mean concentrations are less than 1 ug/l for the majority of the pesticides. The mean concentration of alachlor has declined in both surface and groundwater resources since 1990. The mean concentration spiked in 1993, which was a year of widespread flooding in the Upper Midwest. Similarly, the mean concentration of cyanazine has slowly declined during the past decade in both surface water and groundwater. The mean cyanazine concentration spiked in groundwater in 1994 and does not correlate with any known natural or management phenomenon. Since 1995, acetochlor mean concentrations have remained low in both surface and groundwater and do not show an increase since monitoring began. Likewise, mean atrazine concentrations showed a decreasing trend in the early 1990s, but more variability and generally increasing mean concentrations in the second half of the decade. Metolachlor concentrations have also shown substantial year-to-year variation, but ended the decade with much lower mean concentrations for both surface and groundwater.

Pesticide Degradates

One of the lingering questions with the occurrence of these traditional herbicide compounds was related to the fate of breakdown products. Prior to 1995, only the degradate products of atrazine were routinely monitored in the state. New analytical techniques and equipment allowed the state to incorporate testing for the ethane sulfonic acid (ESA) and

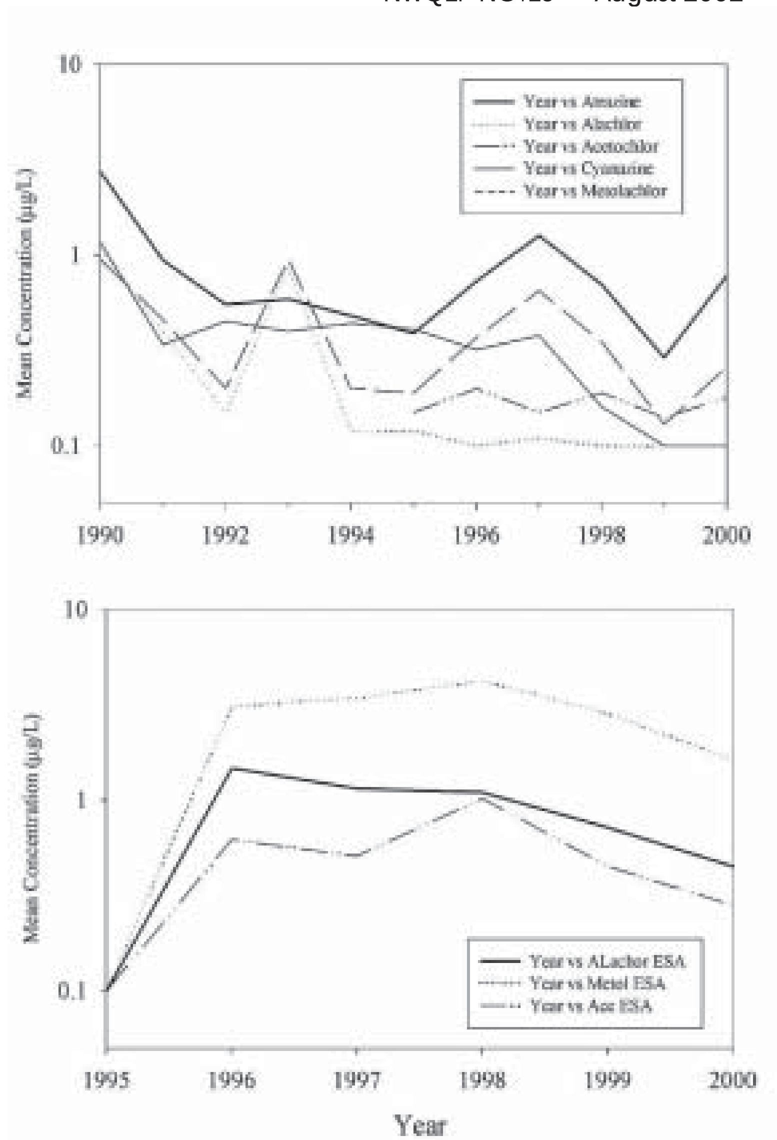

Figure 5. Mean Annual Concentrations of Common Herbicides in Surface Water (1990– 2000).

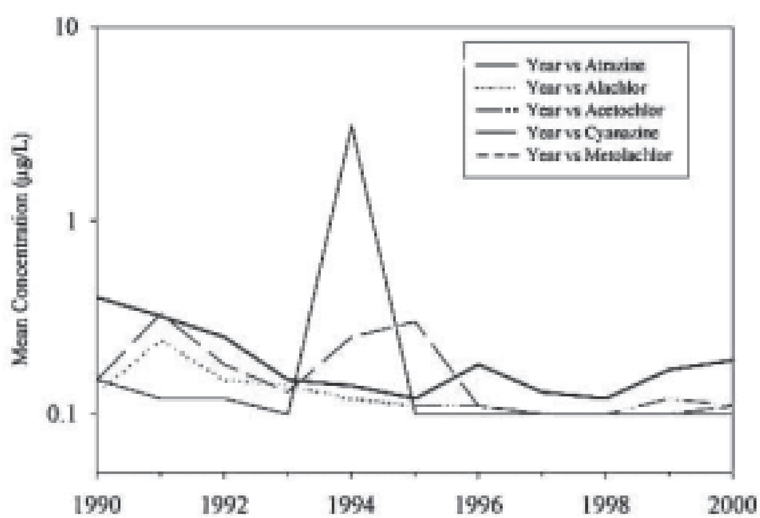

Figure 6. Mean Annual Concentrations of Common Herbicides in Groundwater (1990 – 2000).

oxanilic acid (OXA) degradates of compounds such as acetochlor, alachlor, and metolachlor. Figure 5 shows changes in the mean concentrations of these compounds since 1995. Testing revealed that the mean concentrations of these degradates are generally above the levels measured for the parent compounds and show only slight decreases in concentration during the period where substantial decreases in product use occurred. Alachlor ESA in particular shows a mean concentration between 1 ug/l and 0.5 ug/L since 1996. This suggests persistence in the environment that exceeds that of the parent compound. Acetochlor ESA levels increased rapidly following the appearance of acetochlor in the marketplace, but have declined since 1998. Metolachlor ESA levels have sustained levels well above 1 ug/L, but declines since 1998 may be indicative of the dramatic decrease in the use and occurrence of the parent compound in the environment. To date, groundwater analyses for these pesticide degradates have been very limited and is not presented in this article.

Summary

It is necessary to be cautious when making conclusions based on non-uniformly collected data. As previously indicated, the data housed within IAPEST is not the product of a well-designed monitoring program, but represents the amalgam of data from many different studies and research projects. However, the lack of any consistently collected pesticide data in the state during the period where dramatic changes in pesticide use were occurring makes this database extremely valuable and important in attempting to understand the changes in Iowa's water quality. All conclusions or observations should consider these caveats.

The trend analysis for pesticide data from 1990 through 2000 suggests gradual declines in alachlor, cyanazine, and metolachlor concentrations in surface water. Atrazine and acetochlor do not appear to have significant trends in concentrations found in surface waters. The degradate products of both acetochlor and alachlor do appear to be responding to changes in inputs with respect to the parent compounds, but also seem to incorporate significant lag times for this response. Similar trends exist for groundwater data. There is little evidence of a significant downward or upward trend in atrazine and acetochlor concentrations. However, alachlor, cyanazine, and metolachlor mean concentrations do appear to be decreasing in groundwater.

For More Information

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Reference

Pesticides and Ground-Water Strategy. October 1991. EPA Publication 21T-1022. Environmental Protection Agency. Office of Pesticide Programs.Washington D.C. USA.

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Testing Iowa's Water from Two Wheels

Lynette Seigley, Iowa Department of Natural Resources

And how did you spend your summer vacation? For several water quality specialists from Vermont, North Carolina, and Iowa, vacation was spent pedaling bikes 480 miles across Iowa and dipping test tubes in streams as part of the Des Moines Register newspaper's Annual Great Bike Ride Across Iowa (RAGBRAI). In its 30th year, RAGBRAI is a seven-day bike ride festival across Iowa during the last week of July, with more than 10,000 bicyclists from all over the United States and numerous foreign countries participating.

TEAM IOWATER (from left to right): Becky Ohrtman, Mary Skopec, Bill Schwarz, Don Meals, Susan Warlick, Jean Spooner, Susan Merrit, Pat Boddy, and Lynette Seigley. (Lisa Swenson not pictured). Photo by Tracy Thompson.

Each year's ride traverses Iowa from west to east, with bicyclists traditionally dipping their back tires in the Missouri River at the beginning of the week and their front tires in the Mississippi River at the end of seven days later. The bike route varies from year to year, rolling along miles of cornfields and through dozens of small towns, traversing varying topography, and experiencing Iowa hospitality at its best. By the end of the week, even Don Meals from Vermont had to admit that Iowa **does** have hills. This year's route traveled from Sioux Center to Bellevue, Iowa.

Collection of aquatic insects at a stream in north-central Iowa. Photo by Lynette Seigley.

While others just rode, TEAM IOWATER also tested the water quality of streams along the bike route. (IOWATER is Iowa's volunteer water monitoring program.) TEAM IOWATER members on this year's ride included Don Meals (Vermont); Jean Spooner, Susan Merritt, and Susan Warlick (North Carolina); and Becky Ohrtman, Mary Skopec, Bill Schwarz, Pat Boddy, Lisa Swenson, and Lynette Seigley (Iowa). TEAM IOWATER, with testing equipment in tow, dipped nets and test tubes in 20 streams during the week in an effort to evaluate stream quality and increase awareness about water quality.

Field test kits and meters were used to measure nitrate, pH, dissolved oxygen, orthophosphate, water temperature and transparency, specific conductance, total dissolved solids, chloride, and ammonia. Many of the field tests and sampling protocols employed by TEAM IOWATER are the same used by more than 1,000 IOWATER trained volunteers monitoring Iowa streams statewide. Benthic macroinvertebrates (aquatic insects) were also sampled to assess water quality. At each stream, observations were recorded about stream habitat type, streambed substrate, microhabitats, stream banks, canopy cover, riparian zone width and plant cover type, and adjacent land use. All of the data collected, along with digital images of the streams, are available at **www.IOWATER.net** (see Online Database; View Data; select RAGBRAI IOWATER sites).

Identifying the aquatic insects collected from a stream in north-central Iowa (Lisa Swenson and Pat Boddy). Photo by Lynette Seigley.

So what were the results from TEAM IOWATER's efforts? Besides some sore saddles, sunburned skin, and a few flat tires, water quality results from the streams sampled were typical for Iowa streams during the month of July. TEAM IOWATER even sampled a few unscheduled sites. At the request of a northwest Iowa resident,TEAM IOWATER tested a tile line, wetland, and stream on the resident's property. We found that his wetland was effectively functioning to remove nitrate-N, since nitrate-N concentrations were 10 mg/L in the tile line discharging into the wetland and 0 mg/L in the wetland itself.

During RAGBRAI, TEAM IOWATER discovered a fun way to test Iowa's waters and increase public awareness of our volunteer water monitoring program.

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Information

New Book on Watershed Project Management

The Watershed Project Management Guide presents an approach to watershed management based on a collaborative process that responds to common needs and goals. This recommended process consists of a series of four basic phases: Assessment, Planning, Implementation, and Evaluation. This four-phase approach helps watershed practitioners develop a plan consistent with the recently released USDA-EPA Watershed Management Planning and Implementation Process guidance. The process can be used to implement a management strategy to meet the load allocations required by an approved Total Maximum Daily Load (TMDL), the goals of a Source Water Protection Plan, USDA programs such as EQIP, or Section 319 Projects.

The Watershed Project Management Guide by Thomas E. Davenport. Published by Lewis Publishers/CRC Press, Catalog No. TX927, August 2002, Hardcover, ISBN: 1-5871-6092-7, $119.95/£83.00. To order, see website www.crcpress.com or call (toll free) 1-800-272-7737.

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Web Resources

New Environmental Policy Web Site Available

The Texas Institute for Applied Environmental Research (TIAER) announces its new website: **http://www.tiaer.org/.**

TIAER, housed at Tarleton State University, has a ten-year history of working with industry to shape workable solutions to nationwide environmental problems in nonpoint source pollution. The TIAER Web site features:

- Inside TIAER - explaining who TIAER is, what they do, and how to contact them;
- News - presenting executive briefings and press releases;
- Research Library - offering over 100 documents written by TIAER; and
- Projects - presenting TIAER watershed studies, computer modeling, and scientific efforts.

The TIAER web site targets legislators, legislative staff, policy analysts, and industry leaders attempting to shape agricultural or environmental policy, as well as economists, scientists, citizens, and students.

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Meetings

Call For Papers

The Fourth National Workshop on Constructed Wetlands/BMPs for Nutrient Reduction and Coastal Water Protection: June 23-25, 2003, Wilmington, North Carolina. Contact Dr. Frank Humenik, Waste Management Programs, College of Agriculture and Life Sciences, Campus Box 7927, North Carolina State University, Raleigh, NC 27695-7927. Tel: 919-515-6767; Fax: 919-513-1023; e-mail: frank_humenik @ncsu.edu.

The workshop will feature technical and poster sessions on:

- Constructed Wetland Treatment Systems
- Nutrient Management for Livestock and Crop Systems
- BMPs for Water Quality Protection
- Pollutant and Source Transport Reduction
- Animal Waste Management
- Watershed Management

The workshop will also include virtual and field tours of the Smithfield Foods and Premium Standard Farms swine waste management projects (including a solids separation-constructed wetland and reciprocating wetland for swine waste management); a cooperative study of a constructed wetland to treat runoff from 2,000 acres of a 44,000-acre row crop operation; and a constructed wetland to treat leachate from the New Hanover County landfill in Wilmington. **Abstracts due November 1, 2002**.

6th National Mitigation Banking Conference: Practice and Policy: April 23-25, 2003, San Diego, CA. For more information on submissions and participation in the conference, visit http://www.mitigationbankingconference.com, or contact Carlene Bahler at cbahler@erols.com or 703-548-5473. **Abstracts due September 4, 2002.**

Restore America's Estuaries Inaugural National Conference on Coastal and Estuarine Habitat Restoration: April 13-16, 2003, Baltimore, MD. Contact Heather Bradley, Conference Coordinator, at 703-524-0248, or hbradley @estuaries.org. Website http://www.estuaries.org/. Program focus will include restoration best practices, information and resource needs, community outreach, national and regional policy strategies, funding opportunities, partnerships, and restoration science and practice - including monitoring, evaluation and adaptive management. The conference will address habitat restoration in coastal and estuarine areas of the United States, including the Great Lakes region, as well as transboundary initiatives and issues. **Abstracts due September 13, 2002**.

Meeting Announcements - 2002

September

10th National Nonpoint Source Monitoring Workshop:
Monitoring and Modeling from the Peaks to the Prairies

September 9-12, 2002
Beaver Run Resort, Breckenridge, CO

This year's Workshop offers a great opportunity to share accomplishments and ideas in NPS monitoring and modeling in a beautiful setting, autumn in the Rockies. The focus will be on the outcomes of Section 319 National Monitoring Program projects and similar innovative efforts. The agenda includes three days of workshop sessions and presentations. A one-day field trip will feature stream restoration and legacy mines along with other local technical tours.

Session topics are stream restoration, inactive mine remediation, NPS modeling, BMP implementation and evaluation in agriculture, silviculture, and urban/construction, TMDL development, and, public information/education. Contact Tammy Taylor at taylor@ctic.purdue.edu or call 765-494-9555; Fax: 765-494-5969. Website: http://www.ctic.purdue .edu/NPSWorkshop/NPSWorkshop.html.

6th International Conference on Diffuse Pollution: September 30-October 4, 2002, Amsterdam, Netherlands. Contact Conference Secretariat, Buerweg 51, 1861 CH Bergen, Netherlands. Tel: +31-20-4602466; Fax +31-20-4602475; Email: r.r.kruize@inter.nl.net.

October

5th National North Carolina Stream Restoration Conference: Restoration in the Coastal Plain: Stream and Wetland Processes. October 7-10, 2002, Wilmington, NC. Website: www.ncsu.edu/sri/.

Wetlands 2002: Restoring Impaired Wetlands and Other Waters: October 7-9, 2002, Indianapolis, IN. Website: www.Core4.org/Wetlands.

Hydrologic Extremes: Challenges for Science and Management. American Institute of Hydrology 2002 Annual Meeting and Conference: October 13-17, 2002, Portland, OR. Visit the website: www.aihydro.org/call_2002.htm/.

22nd NALMS International Symposium: October 29 - November 2, 2002, Anchorage, Alaska. Visit the website at: www.nalms.org.

November

AWRA's 2002 Annual Water Resources Conference: November 3-7, 2002, Philadelphia, PA. Website: http://www.awra.org/meetings/Philadelphia2002/.

2002 Brownfields Conference: Investing in the Future: November 13-15, 2002, Charlotte, NC. Web site: www.brownfields2002.org.

Meeting Announcements - 2003

February

Urban Stormwater: Enhancing Programs at the Local Level: February 17-20, 2003, Chicago, Illinois. Contact conference coordinator Bob Kirschner, Chicago Botanic Garden, 1000 Lake Cook Road, Glencoe, Illinois, 60022; email: bkirschn@chicagobotanic.org.

April

2003 Symposium on the Application of Geophysics to Environmental and Engineering Problems (SAGEEP 2003): April 6-10, San Antonio, Texas.See website at www.eegs.org.

Bureau of Reclamation's International Workshop on Integrated Water Resource Management: April 7 - 11, 2003, Denver, Colorado. Contact Ms. Leanna Principe, International Affairs, D-1520, U.S. Bureau of Reclamation, P.O. Box 25007, Denver, CO, 80225. Tel: (303) 445-2127; Fax: (303) 445-6322; E-mail: lprincipe@do.usbr.gov. Web Site: http://www.usbr.gov/international/trn_integrated.htm.

July

Coastal Zone 03: Coastal Zone Management Through Time: July 13-17, 2003, Baltimore, MD. For more details, visit website: http://www.csc.noaa.gov/cz2003/.

October

Delaware Erosion, Sediment and Stormwater "Race for Clean Water" Conference 2002: October 21-23, 2002, Dover, Delaware. For more information visit website: http://www.dnrec.state.de.us/dnrec2000/Divisions/Soil/Stormwater/Conf/E_Reg_ Index.htm.

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