Providing service and support to watershed improvement projects across Iowa

Jamie Benning, extension watershed specialist, Sociology, Iowa State University; Chad Ingels, extension watershed specialist, Agronomy, Iowa State University

Water quality

Nonpoint source nutrient pollution from agriculture entering Iowa's surface water bodies (Figure 1) is a problem for impaired local watersheds throughout the Corn Belt, and as far away as the Gulf of Mexico. The Mississippi River drains 40 percent of the continental US and carries almost 140 cubic miles of water yearly (Libra 1998). The U.S. Geological Survey estimated an average of 1.65 million tons/year of nitrogen (N) were exported into the Gulf of Mexico from 1987-1996 causing a condition called hypoxia (Libra 1998). Hypoxia, also known as a dead zone, is an area where water has no or very little oxygen necessary for fish and other marine life. Nitrogen accelerates the production of marine phytoplankton whose life cycle consumes oxygen previously available for fish and shrimp (Libra 1998). Estimates in 1996 suggested that Iowa supplied on average almost 25 percent of the nitrate-N to the Gulf of Mexico via the Mississippi River; much of it from agricultural land-use practices (Libra 1998). More than ten years later scientists continue to document hypoxia issues, increased nitrogen fluxes and transport of phosphorus (P) into the Gulf from mid-western farmlands (Alexander et al. 2008). Further, improved simulation models reveal that agricultural sources contribute 70 percent of N and P with corn and soybean cultivation accounting for 52% N and animal manure on pasture and rangelands (37%) and corn and soybeans (25%) as key sources of excess P (Alexander et al. 2008). More than 80 percent of Iowa's land mass is managed for agriculture; and the state is the number one and two sources of excess N and P respectively in the Mississippi. Iowa has 439 impaired water bodies (303d listed figure 2) that the U.S. Environmental Protection Agency (EPA) requires targeting for watershed planning and remediation action through the Total Maximum Daily Load (TMDL) process (Sabatier et al. 2005).

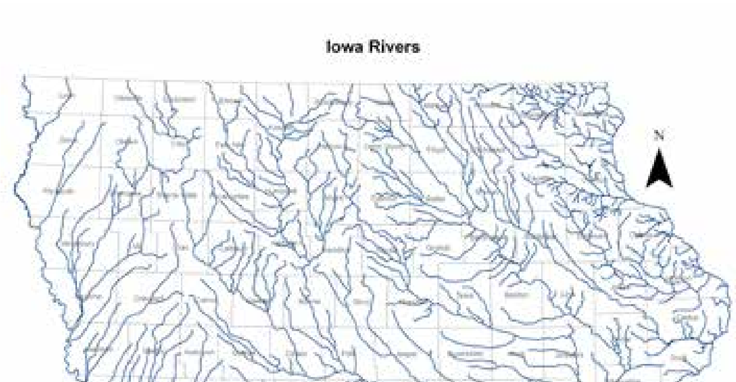

Figure 1. Iowa rivers

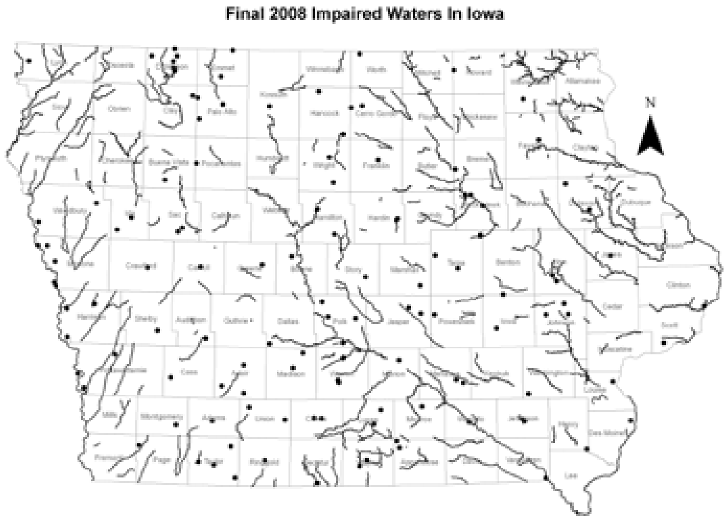

Figure 2. 2009 Iowa impaired waters

Although it has been scientifically documented for more than two decades that agricultural practices are major sources of non-point source pollution in the Mississippi River Basin, success in solving the problem has been limited. Decision support systems have been available to farmers since the late 1970s (McCown 2005), soil conservation efforts date back to the 1930s, farm bills of 1996, 2002, 2006 had substantial economic incentives for conservation practices; yet farm management as currently practiced continues to be an inadequate response to the serious issues of non-point source pollution from agriculture. McCown (2005:11) evaluated 14 decision support systems and reports “None of the fourteen decision support systems had become a routine tool that farmers used in their management year-in and year-out.”

Part of the problem is the disconnect between scientific knowledge and the subjective local knowledge farmers bring to their management decisions. The normative system of knowledge transfer from scientists and technical experts to farmers has failed to account for how farmers learn and “construct personal, subjective knowledge that is relevant to practical action” (McCown 2005:11). This shortcoming of the expert model is an underlying reason “why” farmers have neither acknowledged a water quality problem nor changed their management practices to significantly respond to excessive N and P leaching into their local water bodies.

Up to now, nonpoint source management programs have been based on a “soil conservation” model that involves cost-share of expert-prescribed practices to landowners willing to accept the contracts. Farm operators are not asked to organize and collectively address their impacts on water quality. Nor do they have performance tools and feedback that would allow them to apply their knowledge and skills to environmental goals through flexible, adaptive management processes. Lack of performance feedback also leaves producers unable to confirm the success of their environmental management efforts for themselves, their neighbors and communities.

What is a watershed?

A watershed is an area of land that drains into a water body. A watershed can be as small as an area that drains into a small stream or creek, or a very large area that drains into the Mississippi or Missouri Rivers. Management of the land within a watershed can have a great impact on water quality. Watersheds are identified by Hydrologic Unit Codes (HUC), as the HUC number increases, the size of the watershed decreases.

Many HUC 8 watersheds (Figure 3.) exceed a million acres in size while HUC 12 watersheds are generally between 20,000 to 30,000 acres. Most watershed improvement projects in Iowa are focused on these HUC 12 (Figure 4.) watersheds because topography, soils, and land management practices are similar across the smaller watersheds. With such large scale, HUC 8 watersheds are spread across several counties with HUC 12 watersheds usually draining parts of one or two counties. Fifty to eighty farms are typically located in each HUC 12 watershed.

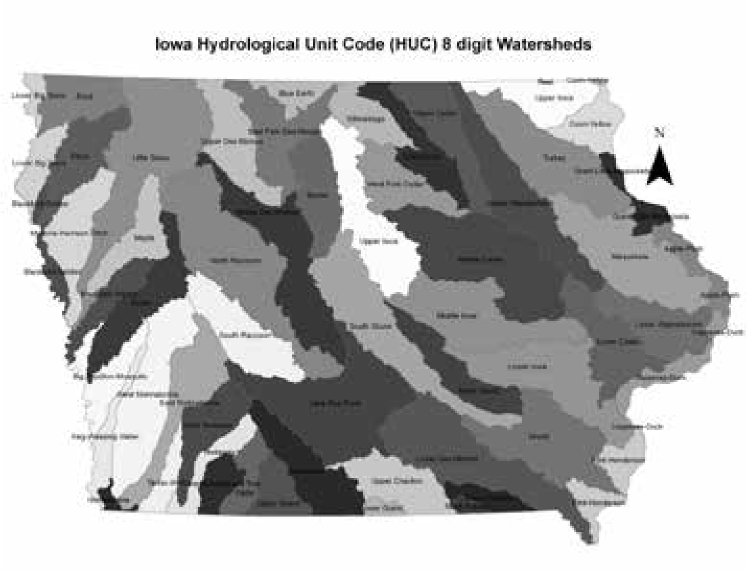

Figure 3. Iowa HUC 8 watersheds

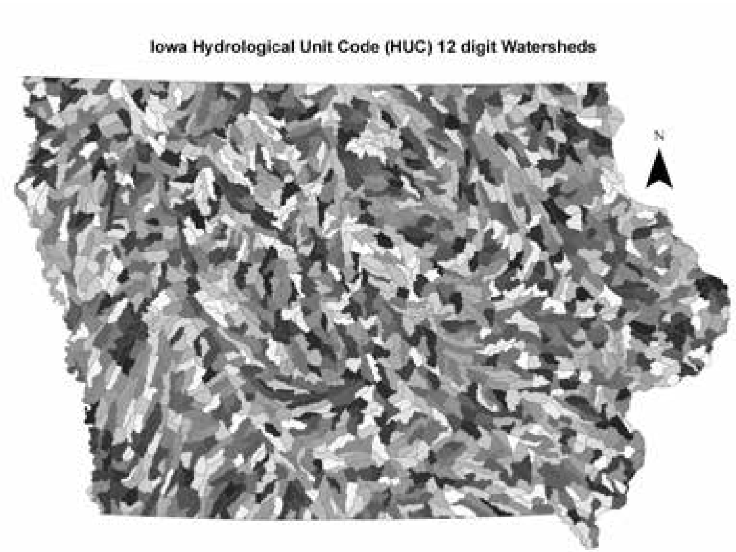

Figure 4. Iowa HUC 12 watersheds

Performance-based watershed management

In the past 8 years, the concept of on-farm performance driven environmental management has been developed through a series of northeast Iowa projects. ISU Extension began providing both community development and educational assistance that enabled watershed residents to establish councils. In the Upper Maquoketa watershed, scientists from the Texas Institute of Agricultural and Economic Research and Iowa State University conducted research monitoring and modeling to generate scenarios predicting the environmental (nonpoint source) impact and economic costs/returns of numerous alternative BMPs to address the watershed's known problems. The watershed councils who received education to interpret these model scenarios were empowered by their ability to understand the performance of alternative practices and the flexibility this gave them to make progressive improvements. Based on these scenarios and education about their watershed's impairments they made a formal recommendation/request for practices to be included in a watershed proposal. Another council in the Mineral Creek watershed was brought into a BMP modeling effort and producers were similarly engaged and energized by their ability to understand the potential environmental and economic performance of various practices. A subsequent watershed conservation program in Mineral Creek has been lauded as one of Iowa's most successful. Key features in that success were the recruitment of cooperators by their neighbors and strong community support.

In the Hewitt Creek Watershed, a model of farmer watershed councils coached by extension educators was piloted. The councils had the goal of reducing the impairment status of their watersheds. Performance evaluation was no longer solely the responsibility of experts, but also included tools (agronomic tests and indexes) that were useable at the farm level and linked to accountable management decisions. Currently in four priority watersheds, councils are allowed to set goals and determine their own watershed program based on their knowledge of local contaminant sources. Over a four-year period these locally-managed performance-based environmental management programs have successfully demonstrated that farmers will set and act voluntarily on personal environmental goals when they are convinced there is a problem and can measure their progress in solving the problem.

Agronomic and environmental performance tools

Environmental performance measures are used to monitor improvements or anticipated improvements in water quality due to changes made on the landscape. Farmer-useable, science-based performance measurements such as the late-season Cornstalk Nitrate Test, the Soil Conditioning Index, the Iowa Phosphorus Index, and residue measurement are being used in watersheds to assess environmental performance and monitor improvements in water and soil quality over time. Reductions of phosphorous and nitrogen delivery to surface waters, improvement in soil condition, and reduced erosion can be estimated using these performance measures.

Phosphorus index

The phosphorus index was developed as a measure of phosphorus loss risk for applying manure and commercial fertilizer for regulatory purposes. In Iowa the phosphorus index is used in manure management planning by regulated animal feeding operations. However, it can be used by any farmer interested in tracking the risk of phosphorus loss, or environmental performance, of his or her operation. The phosphorus index considers erosion estimate, conservation practices, landform region, residue management, soil type and slope, soil test phosphorus, manure and commercial phosphorus fertilizer application, fertilizer application method, and subsurface drainage in the calculation of phosphorus loss risk.

Soil conditioning index

The Soil Conditioning Index (SCI) is an assessment tool created by the NRCS to estimate whether tillage and cropping systems will result in maintained or increased levels of soil organic matter. The SCI is a product of the RUSLE2 soil erosion calculation and was a significant component of the Conservation Security Program. Values for SCI fall within a range of -1 to 1.1, where values less than zero predict depletion of soil organic matter and values greater than zero predict long term building of organic matter. Soil organic matter is an indicator of overall soil health and productivity.

Fall cornstalk nitrate test

The late season or fall cornstalk nitrate test was developed to monitor nitrogen (N) fertilizer and manure application programs. Corn plants suffering from inadequate N availability remove N from the lower cornstalks and leaves during the grain-filling period. Corn plants that have more N than needed to attain maximum yields, however, accumulate nitrate in their lower stalks at the end of the season. Stalk nitrate concentrations can be divided into four categories; ***low*** (less than 250 ppm N), ***marginal*** (250 to 700) ***optimal*** (700 to 2000 ppm N), and ***excess*** (greater than 2000 ppm N). Seasonal variation in rainfall and crop growing conditions do make comparing results year-to-year challenging.

Residue measurement

Increased residue cover can minimize sheet erosion from the soil surface. Changing tillage practices to those that leave higher amounts of residue or modifying current practices to increase residue after tillage are encouraged. Residue cover can be measured using the line transect method. A study by the Iowa Learning Farm is underway to study the impact of residue measurement as a performance tool.

Watershed project performance results

The performance programs have resulted in extensive, voluntary adoption of improved soil and nutrient management practices and targeting. The average stalk nitrate test in the longest-running watershed project, Hewitt Creek was reduced 33% in the first year and an additional 29% in the second. At the same time producers reduced sediment delivery by over 4000 tons per year by targeting fields with high phosphorus index and low soil conditioning index values. Strong local leadership and peer recruitment have emerged. Performance results shared neighbor-to-neighbor build local pride in watershed improvement and peer pressure for new participation. Enrollment has grown to 65-70% of farm operators in the watersheds and new cooperators continue to join. In a survey of participants, over 90% were confident that the program rewards a conservation systems approach, encourages farmers to change their management - including neighbors who are not participants, has a positive effect on the environment and is also profitable. Further, farmer-to-farmer knowledge exchanges and leadership opportunities encouraged producer experimentation and acceptance of performance-based management tools. Cooperators continue to be engaged in progressively modifying their day-to-day management practices to further protect water quality.

Overall the performance-based management projects have been found to effectively address some important unmet needs that increase producer engagement and adoption of water quality practices, including:

- continuing education on nonpoint source BMPs for cooperators to refine their methods;
- targeting the program's education and incentives to land managers, who make the daily management decisions, as opposed to landowners;
- a primary focus on adaptive management processes rather than structures;
- providing incentives, including local recognition, for continuing improvement - with improvement indicated by tests that cooperators can understand to track their own progress (performance);
- accessibility to livestock producers with high-environmental impact operations who may not participate in existing conservation programs because of their small land base;
- mechanisms to establish widespread adoption, peer pressure and community support for changes on the landscape to address nonpoint source management improvement;
- encouraging producers to go beyond their concerns about regulation and environmental 'finger pointing' and actively target their own problem lands and practices for improvement.

A critical component of the performance-based process is developing a system where performance is continually measured and is the basis of future decisions. Producers involved in the performance-based projects typically are not able to allocate the time or may not have the desire to collect the data necessary for the performance measurements. To facilitate data collection, the watershed groups currently involved in testing the performance incentive process often work with local agronomists and independent consultants to provide agronomic services. Soil testing is essential to calculate the phosphorus index so producers rely on their agronomist to update soil test results. Some groups have hired an individual or group to complete corn stalk samples for nitrate testing while other groups have coordinated with local agronomists to collect samples and report the results to the group uniformly. In each watershed, data collection funded by the group produces information that is owned by the individuals and also summarized and reported anonymously to all watershed participants. This locally produced information allows cooperators to compare and contrast their management to other operators in the watershed. The need for local data also creates an opportunity for agronomists to provide new services to a group of clients in a watershed.

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