Advances and Challenges in Reducing Nitrogen Export from Rural Watersheds
DRAFT Symposium Summary

This symposium was held at the USDA-CSREES National Water Conference in February of 2006, chaired by Dr. Art Gold (University of Rhode Island) and Ms. Lisa Duriancik (USDA-CSREES). Speakers included Dr. Bob Howarth (Cornell University), Dr. Michelle Wander (University of Illinois), Dr. Jane Frankenberger (Purdue University), Dr. Peter Groffman (Institute of Ecosystem Studies), and Dr. Mark David (University of Illinois).

Recent advances in understanding and managing nitrogen (N) losses from rural and agricultural lands were highlighted. Suggestions to meet the research and extension needs to reduce the risk of watershed N export were offered. Specific questions and challenges that speakers were asked to address were:

- Why are nitrate reductions important to estuaries?
- What types of landscape and stream features help identify watershed areas at high risk for nitrate delivery?
- What is the potential and applicability of new and improved best management practices (BMPs) for specific settings and cultural practices?
- How can we use a watershed approach to reduce N export from watersheds and how do we combine and promote acceptance of on-site and offsite strategies?

Dr. Bob Howarth focused on the first question by giving an overview of N pollution and coastal marine ecosystems (http://www.usawaterquality.org/conferences/2006/presentations/Howarth.pdf). Howarth stated that increased nutrient inputs over the last several decades have resulted in the degradation (e.g., hypoxia, anoxia, increased incidents of harmful algal blooms, degradation and alteration of habitat and food-web structure, and loss of biotic diversity) of 2/3rds of the nation's coastal rivers and bays. Howarth presented evidence for N being the major culprit in most coastal marine ecosystems. Because of regional variation in the sources of N pollution, Howarth indicated that management approaches need to be tailored to particular watersheds. Research needs to focus on identifying and understanding watershed "sinks" of N, especially considering climate change predictions.

Dr. Michelle Wander discussed soil and plant testing as a tool to reduce N losses from cropland (http://www.usawaterquality.org/conferences/2006/presentations/Wander.pdf). The variety of strategies to assess soil N supply was reviewed. Wander concluded that estimates of biologically active soil N that rely solely on estimates of N stock size will never be adequate because environmental losses and the availability of labile N stocks to plants, microbes, and soil fauna are highly context dependent. Wander suggested that BMPs should focus on soil N management to achieve environmental and production efficiencies. To improve N management, technical strategies must account for the plant, soil, and environmental factors that regulate N dynamics and account for the consequence of choices over long time frames.

Dr. Jane Frankenberger focused on new techniques to minimize N loss from the more than 60 million acres of drained, high-yielding crop lands in the United States (http://www.usawaterquality.org/conferences/2006/presentations/Frankenberger.pdf). In traditional drainage, water was removed from a field as quickly as possible leaving very little opportunity for nitrate transformations by plants or microbes before discharge into waterways. Frankenberger reviewed seven in-field, edge of field, and downstream technologies that in field scale studies have been shown to decrease N contributions from drained land. Frankenberger noted that the impact of these technologies on a watershed scale needs to be determined.

Dr. Peter Groffman expanded on the idea of the area between agricultural fields and streams (edge of field riparian areas) functioning as "sinks" for watershed N (http://www.usawaterquality.org/conferences/2006/presentations/Groffman.pdf). Groffman indicated that these areas are spatially variable, and in order to identify where conservation and restoration of these edge of field sinks are likely to produce significant water quality improvements, there is a great need to apply state-of-the-art spatial tools, especially ecohydrologic models to help assess the groundwater flowpaths connecting the field to the stream. Groffman also mentioned the possibility of identifying hotspots and simulating such N removal triggers in other edge of the field areas. Groffman cited a paper (Wagner 2005) showing that where education and outreach took place, farmers and land use managers better understood sources and sinks of N across the landscape.

Dr. Mark David discussed the role of headwater streams as sinks for N in dominantly tile drained regions (http://www.usawaterquality.org/conferences/2006/presentations/David.pdf). David found that although in-stream denitrification rates were generally high, hydraulic residence time limited the importance of denitrification in terms of export on an annual basis. However, in a reservoir with a longer hydraulic residence time, David found denitrification was effective at removing large amounts of N. David concluded that reservoir and in-field denitrification are likely to be more important N sinks than in-stream denitrification in tile drained agricultural areas and that hydrology is critically important in estimating N sinks on a watershed basis.

Discussion between the panel and the audience was facilitated by Dr. Dan Devlin (Kansas State University). Discussion focused on how the research results reported by the speakers could be best applied to reduce N loads to yield water quality improvements. Various regional models exist that target how much N loads need to be reduced in a watershed to improve water quality. A key component to reducing N loads may be increasing hydraulic residence times to foster greater N removal in sink areas, e.g., slowing down water flow by managed levees or managing drainage especially by allowing fields to flood in the off-season. One speaker also suggested that in managing on field N, we should change the yield target; only apply the amount of N to produce 70-80% yield rather than best yield. Speakers indicated that much of the science already exists – we need to determine what approach to take with the data at hand, e.g., are we going to change agricultural practices, are we going to take a cross-disciplinary approach that might consider atmospheric deposition, or are we going to work through social/economic mechanisms? On a closing note, all the speakers concluded that they are optimistic about their science – they know a lot about N processing and have made recommendations to improve water quality, but perhaps the greatest challenge is in getting the people who manage lands to actually implement those changes.

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