

because of the high annual use of nitrogen fertilizer in the Midwest (more than 6 million metric tons per year; Battaglin and others, 1993), a large reservoir of nitrate probably remains in the hydrologic system.

PLAN OF STUDY

The following material is a plan for a study to determine if changes in herbicide usage since 1990 have resulted in changes in herbicide concentrations in Midwestern streams. The proposed study also provides a plan to determine if the abnormally high rainfall and flooding in 1993 had an effect on nitrate concentrations in 1994 in the streams that flooded in 1993. In addition, the proposed study will provide an opportunity to further examine the distribution of the alachlor soil metabolite ESA (alachlor ethane sulfonic acid) and the cyanazine metabolites deethylcyanazine and cyanazine amide. ESA is one of the most abundant herbicide compounds found in Midwestern reservoirs and shows relatively little seasonal variation (Goolsby, Battaglin, Fallon, and others, 1993). These results suggest that ESA is very persistent and is transported in a manner more similar to nitrate than to the other herbicide compounds being studied. Analyses for deethylcyanazine and cyanazine amide in sample extracts from the 1989-90 studies indicate that the abundance and distribution of these compounds is similar to cyanazine (Mike Meyer, USGS, Lawrence, Kansas, unpublished data, 1994).

Objectives and Hypotheses

The principal objective of the proposed study is to determine if changes in the application rate recommended by the manufacturers of atrazine have resulted in an overall reduction in atrazine concentrations in Midwestern streams since 1990. Secondary objectives are to: (1) determine if overall changes since 1990 in the concentrations of cyanazine, metolachlor, and nitrate can be detected in these streams, (2) determine the seasonal and geographic distribution of the alachlor soil metabolite ESA, and (3) compare the seasonal and geographic distribution of the cyanazine metabolites cyanazine amide and deethylcyanazine with 1990 results. Specific hypotheses to be tested are:

1. The overall concentrations of atrazine and desethylatrazine in Midwestern streams during runoff following application will be lower in 1994 than in 1989 and 1990.
2. The concentrations of cyanazine, cyanazine amide, and deethylcyanazine during runoff following application will be higher in 1994 than in 1990.
3. ESA will be detected at a frequency and in concentrations similar to that of atrazine.
4. ESA will show much less seasonal variation (pre-application compared to post-application) in concentrations than the other herbicides and metabolites studied.
5. Nitrate concentrations in the stream basins affected by the 1993 flood will be higher in 1994 than in 1989 and 1990.

Sampling Sites

Fifty three (53) stream sites will be sampled in this study. Of these, 50 will be the same sites sampled for the 1990 study. These sites were selected from the 1989 reconnaissance as described