Nutrient Dynamics in the Spoon River Watershed

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Background

- Tile drainage is the practice of removing excess water from agricultural fields through perforated subterranean pipes installed approximately 4 feet below the soil surface.
- Profitable agricultural production in Central Illinois relies on the practice of tile drainage.
- Located within the Upper Salt Fork watershed, our investigation focuses on the Spoon River, which is a small watershed (27,500 acres) chosen by the USDA for the Mississippi River Basin Healthy Watershed Initiative (an NRCS initiative to improve water quality).
- It is well established that tile drainage transports nitrate to streams in Central Illinois which ultimately flow to the Gulf of Mexico and contributes to the formation of a seasonal hypoxic zone.
- The Spoon River is a dredged and channelized ditch that drains approximately 27,500 acres of which more than 90% is row crop agriculture with extensive tile drainage.

photo taken by T.A. Royer

photo taken by M. Lewis

- The predominant cropping system is a corn-soybean rotation where 150 to 200 lbs/A of N fertilizer is applied to corn.
- The Spoon River watershed contains no livestock and only receives a small input of sewage effluent from Gifford, Illinois.
- The headwaters of the Spoon River originate from a glacial moraine in north-eastern Champaign County, but the remainder of the watershed is very flat.
- The Spoon River merges with the Salt Fork Ditch (which receives sewage effluent from Rantoul, IL) becoming the Salt Fork River where the USGS gauges the flow.
- The Upper Salt Fork Riverine is classified under the 303 d list of impaired watersheds by the United States EPA.
- Our overall objective is to investigate the nitrogen dynamics during and after the tile drainage season in an agricultural watershed that contains extensive networks of tile drainage systems.
- Our secondary objective is test and assess the newly installed real-time nitrate sensor in the Spoon River watershed outlet.

USGS field technician, Clayton Bosh, is installing a stage height recorder and nitrate sensor in the Spoon River. Stage height is measured with a radar sensor mounted beneath the bridge and a rating curve is being developed. The HACH nitrate sensor continuously measures real-time nitrate concentrations.

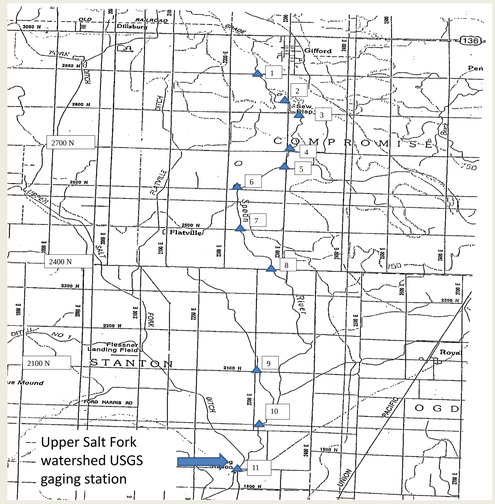
photo taken by L. E. Gentry

Methods

This shows the procedure taken in order to collect the river sample from each bridge.

Photos taken by T. LaVaire.

Along the Spoon River Watershed, we collected 10 samples, lowering a bucket from each bridge. Samples were collected on road 2900 N (site 1), above and below Gifford sewage effluent (sites 2 and 3), on 2700 N (site 4), 2300 E (located on the East Branch of the Spoon River (site 5), on 2600 N (site 6), on 2500 N (site 7), on 2400 N (site 8), and 2100 N (site 9), following to the Spoon River outlet on road 1950 N (site 10) above the confluence of the Spoon River and the Salt Fork Ditch, and finally an eleventh sample was collected at the USGS gauge on road 1850 N (site 11). See map below.



The Spoon River is approximately 11 miles long and its headwaters originate from tile drainage. This map shows the sampling locations along the river. The sewage effluent input from Gifford, IL is located in between sites 2 and 3. The USGS gauge on the Salt Fork River is located at site 11 (road 1850 N).

Water samples were collected when tiles were flowing on May 23 and June 4, 2013 and were filtered (0.45m) and preserved by freezing. Water samples were analyze the water for nitrate-N with an ion chromatograph (Dionex, Inc.).

Results & Discussion

Rainfall total from October 1, 2012 through June 30, 2013 was 35.7 inches which is about the 30 year average; however, April, May and June experienced above average precipitation. Tile drainage in the Spoon River watershed had already begun as of the start of the water year 2013 water year (Oct 2012 through Sept 2013) and has continued throughout the summer. Therefore, we will have to wait awhile until tile flow ceases to collect our last sample for this study.

On May 23 the nitrate concentration ranged from 4 to 11 mg/L across all eleven bridge sites with an average of 7.3 mg/L. On June 4 the nitrate ranged from 9 to 14 mg/L across all eleven bridge sites with an average of 11.3 mg/L (Figure 1).

Daily average temperature for the two sampling dates across all eleven sites was 61°F and 64°F for May 23 and June 4, respectively (data not shown).

There was a large precipitation and flow event between the two sampling dates that flushed more nitrate from agricultural fields, which increased nitrate concentrations on the second sampling date.

Results & Discussion continued

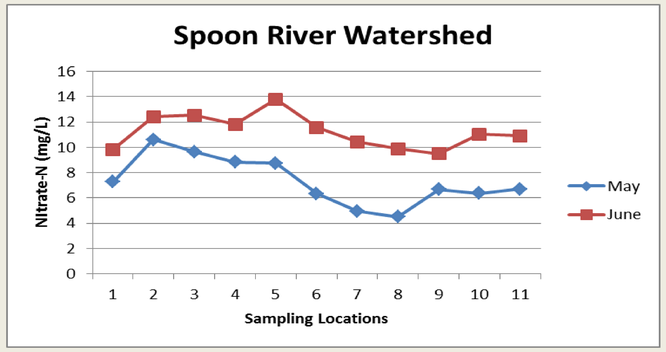


Figure 1. Nitrate concentrations when tiles were flowing at 10 sites collected on the Spoon River watershed in May 23, 2013 and June 4, 2013. Note: site 11 is the outlet for the entire Upper Salt Fork watershed.

The figure illustrates that as the river flows downstream the nitrate concentration generally decreased.

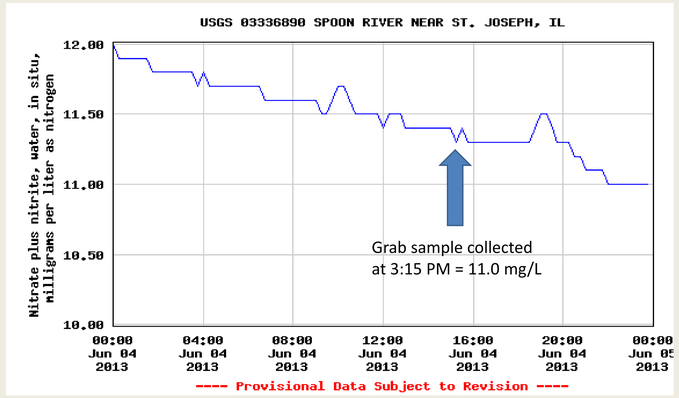


Figure 2. Nitrate concentration for the Spoon River outlet site (Site 10) for June 4, 2013 taken from the USGS website (USGS.GOV Spoon River near St Joseph, IL).

The figure illustrates the similarity in nitrate concentration between the real-time nitrate probe at the Spoon River outlet site and our laboratory results for June 4. The grab sample was collected at approximately 3:15 pm and contained 11 mg/L of nitrate-N, which indicated the nitrate probe was performing well. Daily average flow for the Spoon River on June 4 was 74 cfs and declining at the time. We calculated that the total nitrate-N load was approximately 4600 lbs in a 24 hour period.

Conclusions

- The different branches that connect to the Spoon River watershed appear to have an influence on nitrate concentration in the main channel.
- Generally, the nitrate concentration deceases as the water flows downstream for these sampling dates during the time that tiles were still flowing.
- We speculate that stream nitrate concentration decreased due to algal uptake and denitrification (filamentous green algae).
- The newly installed real-time nitrate sensor in the Spoon River outlet is very accurate in terms of comparison with our laboratory analysis.

Acknowledgements

Lowell Gentry, Dr. George Czapar, Dr. Mark B. David, Tito LaVaire, Tyler Groh, Morgan Davis, Cory Mitchell, Angelina Jaimes, Northeastern Illinois University, University of Illinois at Urbana-Champaign, NSF funding and the Department of NRES.