Have agricultural management practices (AMPs) improved water quality?: A case study in Sugar Creek

Jeff Frey
U.S. Geological Survey

U.S. Department of the Interior
U.S. Geological Survey

National Water-Quality Assessment Program (NAWQA)
Understanding trends

- **Hydrology** – How does the water (and chemicals) move to streams and groundwater
- **Chemical properties** – Does the chemical dissolve in water or attach to sediment
- **Wet vs Dry years** – Do changes in water quality reflect changing streamflow instead of changing management practices?
Sugar Creek: Extensively Studied Since 1992 (17 years)

- Streamflow monitored since 1967
- Nutrients (1992-2010) – 354 samples
- Sediment (1992-2010) – 325 samples
- Pesticides (1992-2010) – 325 samples
- Ecological community sampling – 12 years
  - Algae, fish, invertebrates
  - Habitat

USGS
Sugar Creek is a Heavily Agricultural Basin

- 95 mi² basin
- Corn/ Soybeans
- Till plain
- Heavily tiled
Transport and fate of agricultural chemicals in Leary Weber Ditch
Ground Water and Precipitation
Overland Flow
Figure 3. Nutrient transport pathways in Leary Weber Ditch Watershed, Hancock County, Ind. Numbers in parenthesis are approximate transport amounts for a typical rain-fed watershed (Schnepf and Cox, 2006). Arrow is dashed and queried where pathway is uncertain.
How Do Nutrients Get Into Streams?

**NITRATE PLUS NITRITE (N)**

- **Concentration in Milligrams per Liter**
  - Variability across different sources:
    - Rain
    - Unsaturated Soil
    - Saturated Soil
    - Groundwater
    - Tile
    - Overland Flow
    - Leary Weber Ditch

**ORTHOPHOSPHATE (P)**

- Variability across different sources:
  - Unsaturated Soil
  - Saturated Soil
  - Groundwater
  - Tile
  - Overland Flow
  - Leary Weber Ditch

**Explanation**
- Upper adjacent
- 75th percentile
- Median
- 25th percentile
- Lower adjacent
Has Water Quality Improved with the Implementation of Agricultural Management Practices?
What are agricultural management practices?

- Conventional tillage
- Conservation tillage
No Till Conservation Tillage Increased Through the 1990’s

From Evans and others, 2000

Soybeans
1990 – 2%
1998 – 72%
2000 – 74%

Corn
1990 – 2%
1998 – 5%
2000 – 8%

Hancock County
Sediment Concentrations over Time

Discharge (ft³/sec)

Suspended Sediment (mg/L)

May-92 May-93 May-94 May-95 May-96 May-97 May-98 May-99 May-00 May-01 May-02 May-03 May-04 May-05 May-06

Sugar Creek
Sediment Concentrations over Time

Log Median Suspended sediment concentrations

Year

Sediment Concentrations over Time

1992-2006: No significant change

1992-1999: 30.6% decrease

p-value = 0.036

Sugar Creek
What are agricultural management practices?

Riparian buffers

Tile drains
Nitrate Concentrations over Time

Discharge ▲ Nitrate

Sugar Creek
Tile Drain Variability

The type of tile drain system within the watershed greatly affects the transport and type of nutrient and sediment in the stream, specifically:

- **Surface connected**
  - Cloudy
  - Contains sediment, total forms

- **sub-surface inlets**
  - Usually clear
  - Contains mostly dissolved forms
NAWQA Program

Nitrate Concentrations over Time

1992-2006: No significant change
1992-1999: 14.3% decrease
p-value = 0.363

Sugar Creek
Population in Hancock County Has Increased

Hancock County, Indiana

Year
Annual change in population (%)
Sensitive fish species have increased in Sugar Creek

Percent relative abundance of Bigeye Chub and Bigeye Shiner at Sugar Creek, Indiana, 1993-2008

Sensitive fish species have increased in Sugar Creek 1993-2008
Sensitive fish species have increased in Sugar Creek.

Percent relative abundance of Bigeye Chub and Bigeye Shiner at Sugar Creek, Indiana, 1993-2008.

Sensitive fish species have increased in Sugar Creek, 1993-2008.
Sensitive fish species have increased in Sugar Creek

Abundance of the Northern Studfish at Sugar Creek, Indiana, 1993-2008

Number of Northern Studfish

Percent of No-till

Sugar Creek 1993-2008
Sensitive fish species have increased in Sugar Creek.

Abundance of the Northern Studfish at Sugar Creek, Indiana, 1993-2008

Sugar Creek 1993-2008
Long term water quality and biological monitoring can help show improvements in water quality.

Implementation of Best Management Practices has improved water quality ... depending upon the BMP and the compound.

Multiple stressors (ag and urban) can influence trends.

Sugar Creek, Indiana
Indiana Water Science Center
Web Page:

http://in.water.usgs.gov/

Jeff Frey
317-600-2751
jwfrey@usgs.gov