Measuring Water Quality Improvement Due to BMP Implementation in Four Oklahoma Watersheds

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Key Points

- Description of projects and the BMP implementation in four high priority watersheds
- Comparison of water quality improvements observed using the paired watershed design and analysis procedures
- Discussion of how the results differed through time, and how much monitoring is necessary to detect water quality improvements over a long period
- General lessons learned from these projects that are applicable to other programs
By state statute, the OCC serves as the technical lead agency of Oklahoma’s Nonpoint Source (NPS) Program.

This responsibility means monitoring and assessing waterbodies for NPS impacts and implementing programs to reduce these NPS issues, with the ultimate goal of restoring full support of the designated uses of all waterbodies.
Implementation Projects

- **Spavinaw Creek** (Project Timeline = 2003-2015)
- **Honey Creek** (Project Timeline = 2006-2012)
- **Illinois River** (Project Timeline = 2007-2015)
- **North Canadian River** (Project Timeline = 2006-2015)
Data Analysis: Paired Watershed Method

- Two watersheds:
  Control (no BMPs) = upstream
  Treatment (BMPs installed) = downstream
- Watersheds should be similar size, slope, location, soils and land cover/use
- Must establish a relationship between the watersheds for each parameter; does not require same water quality
- Control accounts for year-to-year and seasonal climate variations

- Two periods of study:
  Calibration (pre-BMP installation)
  Treatment (during or post-implementation)

EPA method 841-F-93-009 developed by J.C. Clausen and J. Spooner 1993
Data Analysis: Paired Watershed Method

- Perform ANCOVA to analyze difference between periods while accounting for environmental effects.
- Determine load reductions by comparing “expected” loads to “monitored” loads during treatment period.

**Expected loads are modeled loads based upon the calibration period relationship**

(Indicates what the loads should be in the treatment watershed if nothing changed from calibration period)
Monitoring Design

- Continuous, flow-weighted composite sampling
  - Total Phosphorus, orthoPhosphorus, nitrate, ammonia, Total Kjeldahl Nitrogen (weekly and storm events)
- Field parameters
  - DO, pH, temperature, conductivity, hardness, alkalinity, turbidity & flow (weekly)
- Weekly grabs for bacteria (May-September)
- Monthly grabs for total suspended solids, chloride, sulfate
- Biological
  - Fish (biannually)
  - Habitat (biannually)
  - Macroinvertebrates (twice yearly)
Spavinaw Creek

- Watershed = 230,000 acres in Arkansas & Oklahoma (60% in Oklahoma)
- Lakes Eucha and Spavinaw provide water for a combined population of nearly one million people in northeastern Oklahoma
Landuse in Spavinaw Creek Watershed

- 52% forested
- 23% well managed pastures
- 13% hayed pastures
- 7% poorly managed pastures
- 3% row crop
- 1% urban
- 1% brushy rangeland
Agriculture Activities in Spavinaw Creek Watershed

- Significant poultry production
  - capacity to produce 77 million birds annually; > 73,000 tons of litter produced annually
- Strong beef cattle production; dairy and hog farms also present
- Poor/nonexistent riparian areas
  - Removal of vegetation and uncontrolled livestock access
  - Significant streambank erosion and habitat loss
Spavinaw Creek Monitoring Design

- 4 Autosamplers
- Little Saline Creek (control) vs. Beaty Creek (treatment)
- Saline Creek (control) vs. Spavinaw Creek (treatment)
Spavinaw Creek Monitoring Design

- Able to target BMP practices towards the most significant sources in “hotspot” areas based on SWAT (Soil & Watershed Assessment Tool) modeling.
Spavinaw Creek BMP Implementation

- Riparian area establishment/management & buffer zone/filter strip establishment
- Streambank stabilization
- Composter/animal waste storage facilities
- Proper waste/litter utilization
- Pasture establishment/improvement/management
- Heavy use areas
- Rural waste systems
Spavinaw Creek BMP Implementation

8319 Water Quality Implementation Project in the Lake Eucha-
Spavinaw Creek Watershed

Cost Share Available for the following Best Management Practices (BMPs):

- Cross Fence (80% of $1.80/ft)
- Replacement of Septic Systems (80% of Actual Cost)
- Well & Pump (80% of $19.04/ft)
- Watering Tanks (80% of $34.19/gallon)
- Heavy Use Area (75% of $41.69/cubic yard, gravel & fiber)
- Pipeline (80% of $1.46/ft)
- Riparian Fence (80% of $2.40/ft)
- Pasture Planting (80% depends on type)
- Pond (80% of $1.94/cubic ft)

Target Area for Implementation of BMPs:

For More Information, Contact:

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Responsible Care for Oklahoma’s Natural Resources
Spavinaw Creek Results

- **2008-2011**
  - Total Phosphorus load reduction = 37%
  - OrthoPhosphorus load reduction = 64%
  - Ammonia load reduction = 19%
  - Nitrate load reduction = 46%

- **2012-2015**
  - Results currently being analyzed
Honey Creek

- Honey Creek is a tributary to Grand Lake in northeastern Oklahoma
- 78,000 acre watershed in 3 states (70% in OK)
Landuse in Honey Creek Watershed

- 60% pastureland
- 33% forest
- 7% cropland

Approximately **1.5 million** chickens produced each year in Delaware County (2010 AG census)
Honey Creek Monitoring Design

- 2 Autosamplers
- Honey Creek: Upper (control) vs. Honey Creek: Lower (treatment)
Honey Creek BMP Implementation

- Pasture establishment and management (planting and cross fencing)
- Riparian area establishment and management
- Alternative water supplies
- Animal waste storage/feeding facilities
- Heavy use area protection
- Poultry litter transport
Honey Creek Results

- Total Phosphorus load reduction = 28%
- Nitrate load reduction = 35%
- *E. Coli* load reduction = 34%

**Special note:** Both segments of Honey Creek have now been delisted for *E. Coli*
Illinois River

- One of Oklahoma’s highest priority watersheds
- Watershed = 1,069,530 acres (54% in Oklahoma)
- The major tributaries of the Illinois River in Oklahoma are the Baron Fork River, Caney Creek, and Flint Creek. Lake Tenkiller is the major reservoir that receives the Illinois River. The Illinois River, Baron Fork, and Flint Creek are classified as state scenic rivers, and they support a very large recreational industry including canoeing, rafting, and camping
Landuse in Illinois River Watershed

- Land cover in the Oklahoma portion of the Illinois River Basin:
  - 46 % forest
  - 15 % hay
  - 24 % well-managed pasture
  - 8 % poorly managed pasture
  - 1 % rangeland
  - 3 % urban
  - 2 % water
  - 1 % row crops/small grains
Illinois River Monitoring Design

- 4 Autosamplers
- Baron Fork Creek: Upper (control) vs. Baron Fork Creek: Lower (treatment)
- Saline Creek (control) vs. Flint Creek (treatment)
Illinois River BMP Implementation

- Riparian area establishment and management
- Buffer strip establishment and streambank protection
- Animal waste management
- Proper waste utilization (poultry waste producers)
- Heavy use areas
- Rural waste septic systems
Illinois River Results

- **Flint Creek Watershed:**
  - Total Phosphorus load reduction = 30%
  - OrthoPhosphorus load reduction = 54%
  - Nitrate load reduction = 60%
  - E. coli load reduction = 41%

- **Baron Fork Creek Watershed:**
  - OrthoPhosphorus load reduction = 15%
  - Nitrate load reduction = 47%
  - Ammonia load reduction = 20%
North Canadian River

- Watershed = 48,4815 acres
- Landuse is primarily agricultural
- Erosion is significant factor
- Most soils in the watershed are highly erodible sandy, silty, or clay loams
Landuse in North Canadian River Watershed

- 42% small grains (wheat, rye, sorghum)
- 20% Grasslands
- 13% row crops (cotton, soybeans, peanuts)
- 11% pasture/hay
- 6% forest
- 3% residential
- 3% shrubland
- 2% open water
North Canadian River Monitoring Design

- 2 Autosamplers
- North Canadian River: Upper (control) vs. North Canadian River: Lower (treatment)
North Canadian River BMP Implementation

- Erosion control
- Conversion from conventional tillage to No-till farming
- Riparian area buffer zones
- Livestock management
- Septic systems
North Canadian River Results

- Total Phosphorus load reduction = 75%
- OrthoPhosphorus load reduction = 87%
- TKN load reduction = 66%
- Nitrate load reduction = 75%
- E. Coli load reduction = 44%
- Turbidity load reduction = 27%

Note: These results are preliminary; we are continuing to analyze for autocorrelation.
How results differed through time

- Shorter term data might tell you that you’re on the right track with your efforts, but not necessarily what the long-term impacts of those will be.
  - In Honey Creek, after 3 years we saw a statistically significant decrease in TP loading of 15%, after 6 years it was 28%
  - 10+ years is best
Lessons Learned

- BMP implementation success is vital for NPS programs
- You can never spend too much money on the monitoring component
- Talk about successes at every opportunity you have
- Continue to find opportunities for local groups to be involved in the process
Lessons Learned

- Autosamplers require more time & energy than one would expect from the word “autosampler”
High Flow & Miscellaneous

- Expect some problems with & anger towards the autosamplers

(Surprisingly, it was not OCC monitoring staff who shot this unit)
High Flow, continued...

AAAHHH! WHAT HAPPENED TO MY AUTO SAMPLER!!!???
Partnership!

United States Department of Agriculture
Natural Resources Conservation Service

Local citizens
Questions?

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