Spavinaw Creek Watershed Implementation Project Final Report

FY 2003 319(h) Task 4

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Introduction

Lakes Eucha and Spavinaw are the result of impoundment of Spavinaw Creek and provide water for a combined population of nearly 1 million people in northeastern Oklahoma. Lake Eucha is one of three "Category I" watersheds in Oklahoma that were recognized in 1997 as significantly impaired and in need of immediate federal and state funding to target restoration activities. The excessive nutrient loading in the watershed, particularly phosphorus loading, and the resulting eutrophication of the lakes has impacted 10 municipalities, including Tulsa, and 11 Rural Water Districts which depend on the lakes to supply their populations with drinking water and recreation. Significant taste and odor problems have been linked to eutrophication in the lakes, and complaints from water users have led to increased treatment costs and increased water quality monitoring. Low dissolved oxygen has resulted in both lakes, and some streams in the watershed are impaired by pathogens.

The Spavinaw Creek Watershed Implementation Project expanded the efforts which were initiated in the 1990s on a smaller scale in the Beaty Creek subwatershed and in other, later projects in the area. This project focused on the implementation of Best Management Practices (BMPs), as well as education and demonstration, in order to further reduce NPS loading, with the ultimate goal of eliminating the impairments in the watershed and improving the water quality of the lakes. This project involved the collaboration of numerous agencies as well as Oklahoma State University and local landowners, and nearly three million dollars were spent overall. Data was collected from Oklahoma Conservation Commission (OCC) stream monitoring sites in order to determine the effects of the implementation project on water quality. This report will detail the education and implementation efforts which occurred in the watershed as well as the results of the monitoring. Several distinct components were included in the Spavinaw Creek Watershed Implementation Project: 1) Targeting NPS Pollution, 2) Implementation of Best Management Practices (BMPs), 3) Watershed Education through OCC, Oklahoma Cooperative Extension, and Oklahoma Water Watch, 4) Soil Sampling Technique and Nutrient Variability Demonstration, and 5) Measurement of Success. Components 1, 2, and 5 will be summarized here; components 3 and 4 are described in separate reports, as required in the project workplan.

Project Location

The Spavinaw Creek watershed is located in Mayes and Delaware Counties in northeastern Oklahoma and in Benton County in northwestern Arkansas (Figure 1). The watershed includes Hydrologic Unit Codes 11070209050, 11070209040, and 11070209060. The principal stream in the Lake Eucha Watershed is Spavinaw Creek, which drains approximately 230,000 acres in Arkansas and Oklahoma (60% in Oklahoma). Spavinaw Creek is a tributary to the Neosho River, which is a tributary to the Arkansas River. Spavinaw Creek drains Lake Eucha and is impounded downstream to form Lake Spavinaw located approximately four stream miles downstream of the Eucha dam. Other major tributaries to Lake Eucha include Beaty Creek, Brush Creek, and Dry Creek.

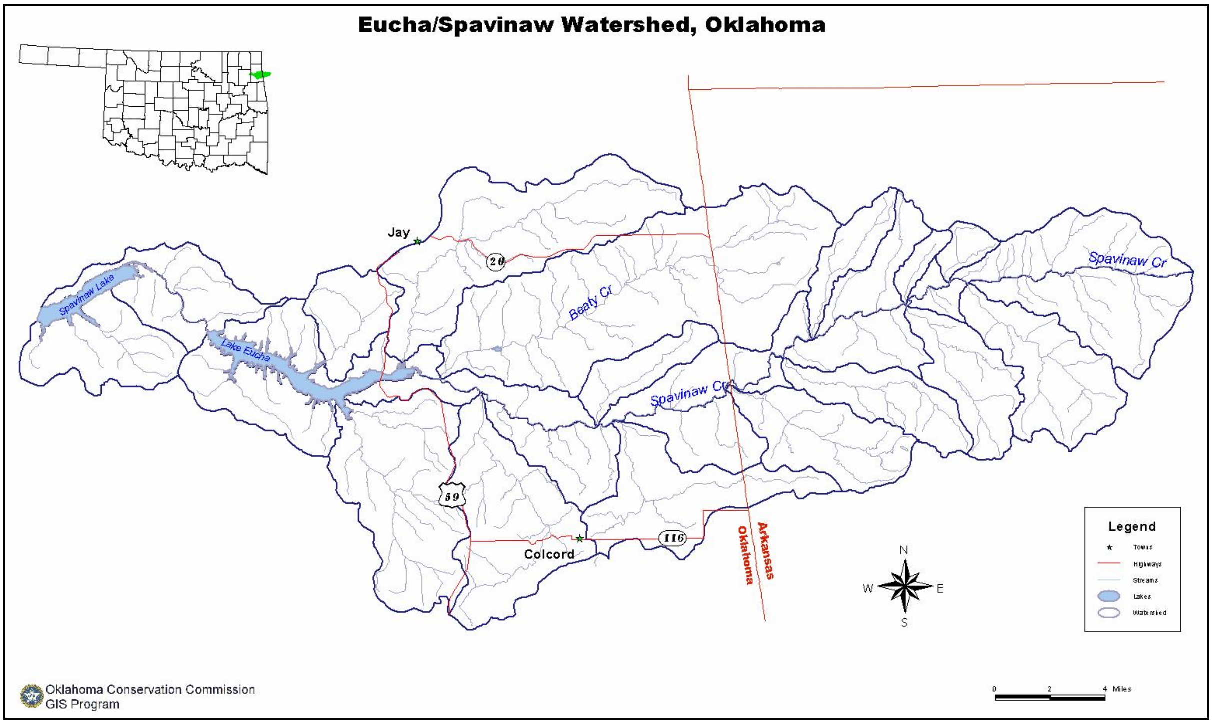


Figure 1. Location of Spavinaw Creek Watershed.

Spavinaw Creek is located in the Ozark Highlands and Central Irregular Plains Ecoregions in Oklahoma. Land use in the watershed can be described as:

51.3% forested	23.1% well managed pastures
13.3% hayed pastures	6.5% poorly managed pastures
2.6% row crop	1.3% urban
1.7% water	0.1% brushy rangeland

(Storm et al. 2002)

The designated beneficial uses for Lake Eucha, Lake Spavinaw, and Beaty Creek include public and private water supply (PPWS), fish and wildlife propagation--cool water aquatic community (CWAC), agriculture, primary body contact recreation (PBCR), and aesthetics. Both lakes have also been designated “sensitive public and private water supply” (SWS) and “nutrient limited watershed” (NLW). In addition, Beaty Creek has a “high quality water” (HQW) designation, which indicates water quality that exceeds that necessary to support the propagation of fish and other aquatic life. This designation prohibits any new point source discharge or increased load or concentration from an existing point source which would lower water quality.

Problem Statement

The Spavinaw Creek Watershed is located in the poultry and cattle producing area of northeastern Oklahoma. Both Lake Eucha and Lake Spavinaw were listed on the state's 2006 303(d) list for nutrients (phosphorus) and low dissolved oxygen values, and both are on the draft 2008 303(d) list for chlorophyll-*a* in addition to those parameters. Beaty Creek has been listed for "pathogens" impairment since 2000. Beaty Creek was delisted for *E. coli* bacteria impairment in 2006 but remains impaired for *Enterococcus* bacteria. Agricultural activities appear to be the major NPS source of impact. Riparian areas in this region are frequently compromised, either through removal of protective vegetation or through uncontrolled livestock access. The result is streambank erosion, habitat loss, and increased sediment and nutrient transport into streams.

It is estimated that Beaty Creek and Spavinaw Creek supply approximately 85% of the phosphorus entering Lake Eucha. The phosphorus in Beaty Creek likely originates from nonpoint source pollution due to agricultural practices associated with the poultry industry, while the phosphorus in Spavinaw Creek likely originates from a combination of both point source pollution (from the Decatur, AR WWTP) and nonpoint source pollution (from agricultural practices associated with the poultry industry). Another indication of possible nonpoint source contamination and impacts from animal waste is suggested by the elevated levels of bacteria found in the tributaries to Lake Eucha.

The major agricultural industry in the Oklahoma portion of the watershed includes cattle and poultry. According to 2006 state permits from the Oklahoma Department of Agriculture, Food, and Forestry (ODAFF) and the Arkansas Soil and Water Conservation Commission (ASWCC), the Eucha / Spavinaw Watershed supports a poultry industry with the capacity to produce approximately 77 million birds annually. Along with these birds, more than 73,000 tons of litter are produced annually, containing over 1,300 tons of waste phosphorus (based on estimates by Everett 2004). There are also a number of dairy and hog operations in the watershed.

The OCC began a Watershed Implementation Project in the Beaty Creek Watershed, a watershed of nearly 38,000 acres, in 1998 that was designed to demonstrate the benefits of proper animal waste application in the Lake Eucha watershed. A significant reduction in the expected loading of phosphorus was observed after implementation in the Beaty Creek subwatershed, indicating that the BMP implementation combined with education was improving water quality.

The objective of this 2003 Spavinaw Creek Watershed project was to continue and expand to a larger watershed scale the practices and programs, identified by previous projects and the Watershed Based Plan, necessary to reduce NPS loading to Spavinaw Creek. In accomplishing this goal, threats to water quality will be decreased, and Oklahoma Water Quality Standards will eventually be met.

Program Partners and Management

Considerable efforts have been made to identify the causes, extent, and sources of water quality threats and impairments in the basin, and extensive remedial efforts have been carried out and will continue into the future. The Oklahoma Conservation Commission (OCC), as the state's technical lead nonpoint source agency, managed the project, providing administrative support and technical guidance. A local project coordinator was hired to set cost-share rates and oversee the implementation of best management practices. The OCC worked with local partners to accomplish this task and to educate the residents of the watershed to reduce nonpoint source pollution. Most of these partner agencies have submitted final reports, which will be referenced, on their efforts. The primary partner agencies in the Spavinaw Creek Watershed Project include:

- **Delaware County Conservation District and Natural Resources Conservation Service (NRCS)**

  These agencies were critical in ensuring participation of local landowners in water quality improvement programs and in accounting for local cost-share funds. The Delaware County Conservation District and local NRCS offices tracked program progress and promoted local education events and demonstrations. The district, the NRCS, and the project coordinator worked one-on-one with citizens of the watershed to reduce pollution and educate about the importance of protecting water resources. The district and NRCS also organized or participated in seminars, training sessions, and BMP tours to interact with local people and provide technical assistance and information. The summary and description of all of these activities are detailed in the OCC education report.

- **Oklahoma State University Cooperative Extension Service (OCES)**

  The OCES worked closely with the Delaware County Conservation District and the NRCS to promote water quality awareness through numerous educational programs in the watershed. OCES provided technical assistance to landowners and developed a demonstration farm to educate producers about the effectiveness of certain best management practices. The OCES also held public meetings and workshops to educate landowners on topics such as soil testing, riparian area management, forage management, and others (described in detail in the OCES final report).

Youth education was another significant effort pursued by OCES, NRCS, and the conservation district. Most youth education activities focused on general water quality maintenance and improvement. A youth water camp was offered several times during the project period (see OCES final report). The OCC's volunteer stream monitoring program, **Blue Thumb**, coordinated with the OCES to provide five trainings in the area over the project period, as well as numerous educational tours at the demonstration farm and natural resource day events. Again, these are summarized in the OCES final report.

- **Oklahoma Water Resources Board (OWRB) Water Watch Program**

The OWRB's volunteer lake monitoring program, Oklahoma Water Watch (OWW), worked cooperatively with the Blue Thumb program to develop a watershed education program in the Spavinaw Creek Watershed. This program focused on a local middle school where a chemistry teacher expressed interest in monitoring the lake. In addition to the normal volunteer sampling protocol, OWW initiated the collection of chlorophyll-*a* samples from Lake Eucha to attempt to monitor any changes in the eutrophication of the lake. The final report on the OWW's project provides more details on this.

- **Oklahoma State University, Division of Agricultural Sciences and Natural Resources**

OSU provided modeling of the land use in the basin and targeting data necessary for optimal implementation of best management practices. In addition, OSU designed and implemented a study on soil sampling and nutrient variability. The details of each of these projects can be found in the final reports produced as part of these specific projects.

- **Oklahoma Department of Wildlife Conservation and Oklahoma Department of Agriculture, Food and Forestry**

These agencies assisted in installing BMPs on the demonstration farm and also provided personnel and expertise at some of the trainings. The details of this cooperation are found in the OCC and OCES final reports.

Targeting NPS Pollution

Past studies in the Spavinaw watershed had identified causes of impairment and suggested possible sources, but the relative contribution of certain land uses and potential sources to the impairments in the watershed was unknown. To accurately target and reduce the sources of pollution in the watershed, a land use database was developed for the watershed based on satellite-imagery data. The SWAT (Soil and Water Assessment Tool) model was then used to predict how phosphorus loads varied across the Spavinaw watershed. Areas contributing a disproportionate amount of phosphorus per unit area were identified, and these areas were targeted as the best places to implement practices to maximally reduce phosphorus loss.

Detailed maps of the watershed were produced and verified by ground-truthing. Specifics of the SWAT modeling are found in a report by Dr. Dan Storm in the Department of Biosystems and Agricultural Engineering at OSU (Storm et al. 2003). The model showed that between 40% and 65% of the total phosphorus load from upland sources comes from just 10% of the basin. Thus, it was advantageous to target areas where BMP implementation was most likely to reduce loading in the watershed in order to maximize project resources, as shown in Figure 2, below.

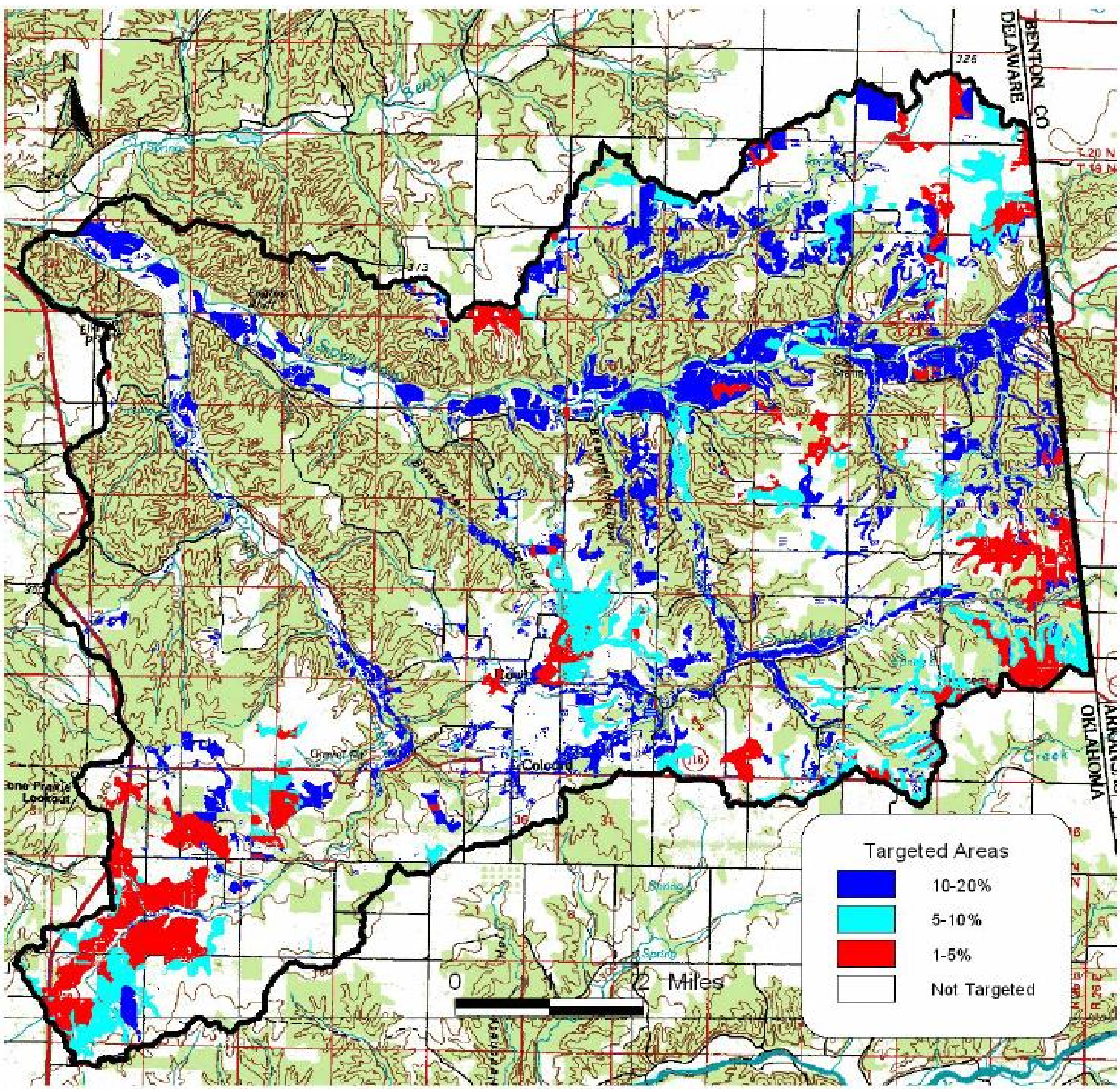


Figure 2. Targeted areas in the Spavinaw Creek Basin as predicted by SWAT (Storm et al. 2005).

Storm's targeting study indicated that the most significant limiting factor to load reduction was current soil phosphorus concentrations in the watershed. Many soils in the watershed are supersaturated with phosphorus and will require many years (perhaps even decades) of depletion through leaching, crop harvest/export, and runoff to reach levels that do not contribute significantly to water quality problems. Possible management measures are listed in Table 1, along with the expected total NPS load reduction associated with that practice, based on simulations in the SWAT model. Riparian fencing, converting row crops to pasture, ceasing litter/fertilizer application, and improving pastureland are suggested to provide the greatest potential for load reduction.

Table 1. Suggested NPS Best Management Practices and expected load reductions (from Storm et al. 2005).

Practice	Expected NPS Load Reduction (from SWAT)
Cease poultry litter application	20%
Row crop BMPs	6%
Convert row crops to pasture and cease fertilizer use	50%
Fencing of riparian areas	60-78%
Strip cropping / contour farming	up to 40%
Nutrient management plan / decreased litter application	10-15%
Pastureland BMPs (no litter, rotational grazing, pasture planting, terrace installation)	44%
Vegetated strips around urban streams	0.5%
Conservation easements around Lake Eucha (erosion control)	0.5-0.7%
Streambank stabilization	15%

Demonstration of Best Management Practices

Based in part on the results from the SWAT model and also on the practices that were successfully adopted in previous projects, a suite of BMPs were promoted throughout the Spavinaw Creek watershed. The Spavinaw Creek workplan states that the primary intent of the project is "to demonstrate the benefits of NPS implementation on the water resources." Objectives listed in the workplan include:

- promote protection and re-establishment of buffer zones and riparian areas,
- demonstrate practices necessary to achieve nutrient control to protect Spavinaw Creek,
- implement practices and programs to improve water quality.

Demonstration of BMPs occurred in two ways in this project. One mechanism for demonstrating BMPs was the establishment of a demonstration farm which allowed viewing of all of the regional BMPs on one property. The owner of this 196 acre farm, Cody Bill Smith, allowed access to his property for data collection and public tours.

Additional information about the demonstration farm is in the Oklahoma Cooperative Extension Service education report.

To facilitate the demonstration of BMPs throughout the watershed, the OCC partnered with the Delaware County Conservation District and local NRCS. The OCC employed a local project coordinator, who was responsible for working with the individual landowners to develop conservation plans and agreements to participate in the program, then verifying whether the practices had been implemented and maintained. The specific practices and cost-share rates offered to individual producers through the Spavinaw project were based on the BMPs that the Beaty Creek Watershed Advisory Group (WAG) had established. The Delaware County Conservation District Board changed the percentage rates for cost-share reimbursement, but the rest remained the same (with annual increases in unit costs per NRCS cost lists).

Using the targeting results discussed above, individuals who lived in a critical area were contacted by the project coordinator and the conservation district and strongly encouraged to participate in the program. The coordinator then developed a conservation plan and assigned a ranking index based on the practices that would need to be implemented, the cost for implementation, and the expected impact on water quality improvement. Landowners with the highest rankings were funded first to ensure that the greatest water quality benefit was derived for each dollar spent.

Planning efforts were coordinated with the NRCS and the Delaware Conservation District to allow leveraging of funds for mutual benefit. For example, EQIP provides funding for some practices that 319 does not. If a landowner could not participate in the 319 program, they were informed about EQIP possibilities so that both agencies benefited from the relationship and worked toward mutual goals.

The main BMPs that were implemented in the demonstration area focused on reduction of nutrient loads and included the following broad categories, prioritized in this order:
(1) riparian management / establishment; (2) buffer zone / filter strip establishment; (3) streambank stabilization; (4) animal waste storage facilities; (5) pasture establishment / management; (6) proper waste utilization for poultry producers (litter transport); (7) heavy use areas; and (8) rural waste systems.

All residents of the Spavinaw Creek Watershed were eligible for cost-share assistance regardless of size of land ownership. Applicants were assigned a priority rank based on the proximity of their property to streams, whether the property was in the targeted area, and the practices that would be implemented. The maximum cost-share assistance to any one participant in Spavinaw Creek was $20,000, and cost share rates were generally set at 60-80%, requiring a 20-40% match from the landowner (see below).

Detailed breakdowns of each component can be found in the *Spavinaw Implementation Plan* (**Appendix A**).

Cost Share Practices			***Cost Share Rate***
Riparian Area Establishment/Management			
	Components:	(1) Use Exclusion	100%
		(2) Off Site Watering	80%
		(3) Fencing	80%
Buffer Zone / Filter Strip Establishment			
	Components:	(1) Use Exclusion	100%
		(2) Vegetative Establishment	80%
		(3) Fencing	80%
Streambank Stabilization			
	Components:	(1) Fencing	80%
		(2) Vegetative Establishment	80%
Animal Waste Storage			
	Components:	(1) Composter	60%
		(2) Cake-out house	60%
		(3) Full clean out house	60%
		(4) Cattle feeding / waste storage	60%
Pasture Establishment / Management			
	Components:	(1) Vegetation Plantings	60%
		(2) Fencing	60%
		(3) Off-Site Watering	60%
Waste Utilization for Poultry			
	8¢-15¢ per lb. of phosphorus produced and properly utilized		
Heavy Use Areas			60%
Rural Waste Systems			
	Components:	(1) Septic System	80%
		(2) Percolation test	80%

One hundred and sixty landowners installed BMPs through this 2003 Spavinaw Creek Watershed project, resulting in about 26% of the land in the Oklahoma portion of the watershed having some sort of BMP. A total of **$2,337,441** was spent on BMP implementation, of which landowners provided $1,007,428 (approximately 43% of the total) and the rest was a combination of federal and state funding. $180,000 of the federal funding was used to specifically target the transport of poultry litter out of the Spavinaw watershed with the assistance of BMPs, Inc., a nonprofit company formed by poultry integrators to facilitate litter transport out of nutrient limited watersheds. The

BMP implementation and funding reported here also includes some practices/funding from the 2000 and 2001 Spavinaw supplemental projects.

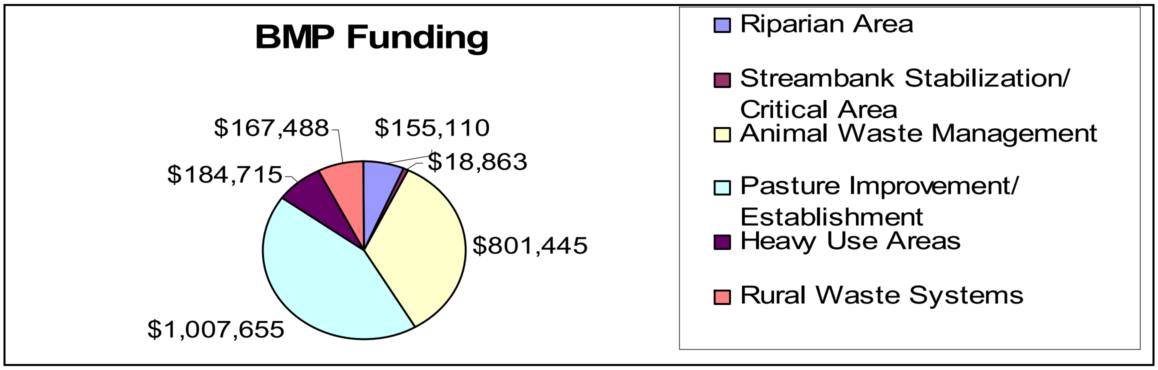


Figure 3. Summary of funds spent on implementation for each BMP category.

As shown in Figure 3, approximately 43% of the funding was for pasture improvement, while 34% was for animal waste management. The practices implemented as part of each of these categories are described in the following sections, and the locations of BMP implementation across the watershed are shown in Figure 4.

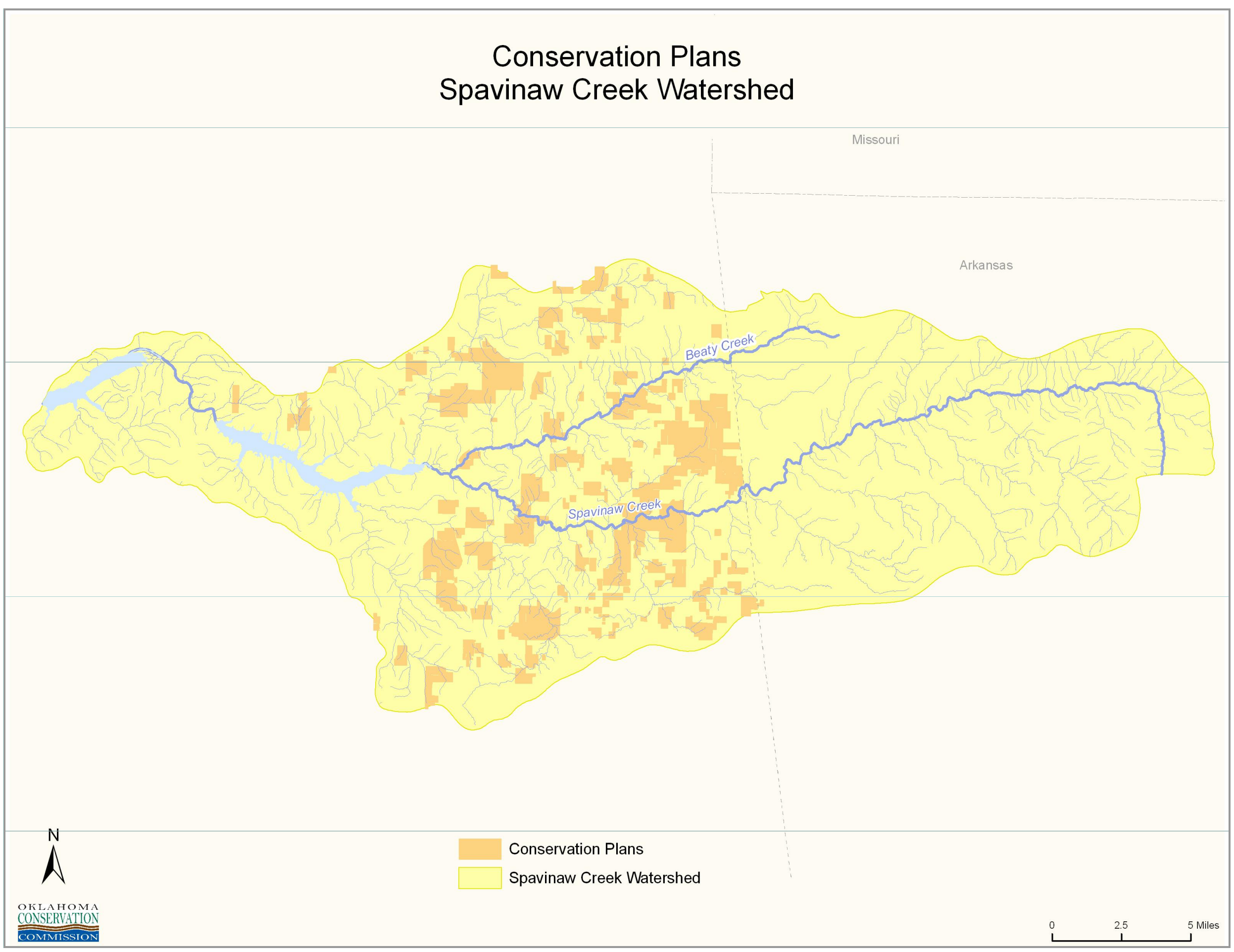


Figure 4. Spavinaw Creek Project Cooperators.

Riparian Establishment and Management and Buffer Zone / Filter Strip Establishment

Cultivated fields, pastures, and / or farmsteads have the potential to contribute large amounts of nutrients and sediment that pollute the waters of Lake Eucha during runoff events. The establishment of vegetated riparian zones and buffer zones / filter strips around these areas helps to reduce the nonpoint source pollution from these sources. The demonstration of the cumulative benefit of comprehensive buffer and riparian management incentives was a top priority. The following practices were implemented in order to reduce the nutrient and sediment load:

1) Fencing for Riparian Management

Landowners look upon the riparian areas as critically needed, highly productive pasture. However, heavily grazed riparian areas function poorly as nutrient traps, and cattle trails become channels for direct transport of nutrients to the stream. Fencing to exclude cattle from a certain area along a stream was recommended to control these problems. Incentives were offered to establish a buffer of 150 feet, maximum, on each side of the stream (average width). In order to take advantage of existing fences, the buffer widths occasionally varied slightly. Fences were built above the flood prone area elevation to lower maintenance costs.

Landowners were given the option of riparian protection with total livestock exclusion for a $50/acre incentive payment, riparian protection with limited hay production (with haying allowed only in vegetative zone of the buffer and only during a time of the year to allow sufficient regrowth prior to the end of the growing season) for a $45/acre incentive payment, or riparian protection with limited grazing for a $40/acre incentive payment. Limited grazing or flash grazing would allow landowners to grant livestock access to the riparian zone for a brief period in summer when streambanks were most stable (due to lack of rain) and with sufficient time for regrowth before the end of the growing season. In addition, during limited grazing, landowners agreed to pull livestock out of the area prior to the point where it became overgrazed.

The acreage that was converted to riparian buffer zones or filter strips is given in Table 2, below, along with the other riparian protection BMPs. Three landowners (total of 30.3 acres) used the limited grazing option, while the rest of the riparian area was total exclusion. As shown in the photos on this page, the riparian area (side of the fence with trees in photos 1 and 2) can be quite wide, and vegetation will quickly grow to the height of the fence or more once cattle are excluded (photo 3, right side is riparian area).

Table 2. Riparian buffer and filter strip establishment/management BMPs implemented.

Best Management Practice	Number of Landowners	Amount	Unit
Riparian area/filter strip total exclusion/limited grazing	13	155	acres
Riparian fence	14	36,030	feet
Pond	4	4	ponds
Water tank	6	11	tanks
Well	7	8	wells

2) Off Stream Watering

Pastures where the stream is the primary or sole source of water for livestock were provided with an alternate water source to allow riparian management. Studies have shown that off-stream water sources can substantially reduce the impact of cattle even without fencing the stream. Off-stream watering was budgeted only for the perennial sections of the stream because the landowners already had provided water supplies for livestock where the stream does not supply permanent water. Watering options included pond excavation and freeze-proof water tanks. Wells were drilled to supply the alternative water in some cases. Some of the ponds were fenced to prevent cattle from loafing in them. Again, Table 2, above, indicates the number of alternative water supplies installed through this project.

3) Permanent Vegetative Establishment

The planting of grasses and/or trees within the riparian zone or in a filter strip was encouraged by providing cost share funds for seed, seedbed preparation, lime, and fertilizer (if necessary). Permanent vegetation in these areas should help to reduce runoff of both sediment and nutrients from cropland and pasture adjacent to a stream. No landowners planted grasses as part of this BMP category due to adequate vegetation already being present, as seen previously in photos 1-3.

Figure 10 shows the locations of the riparian buffers and filter strips which were implemented as well as the alternative water supplies that were established. Four ponds and six water tanks were installed as part of the riparian management practices. In addition, 36,030 feet of fencing was built along riparian areas and around ponds.

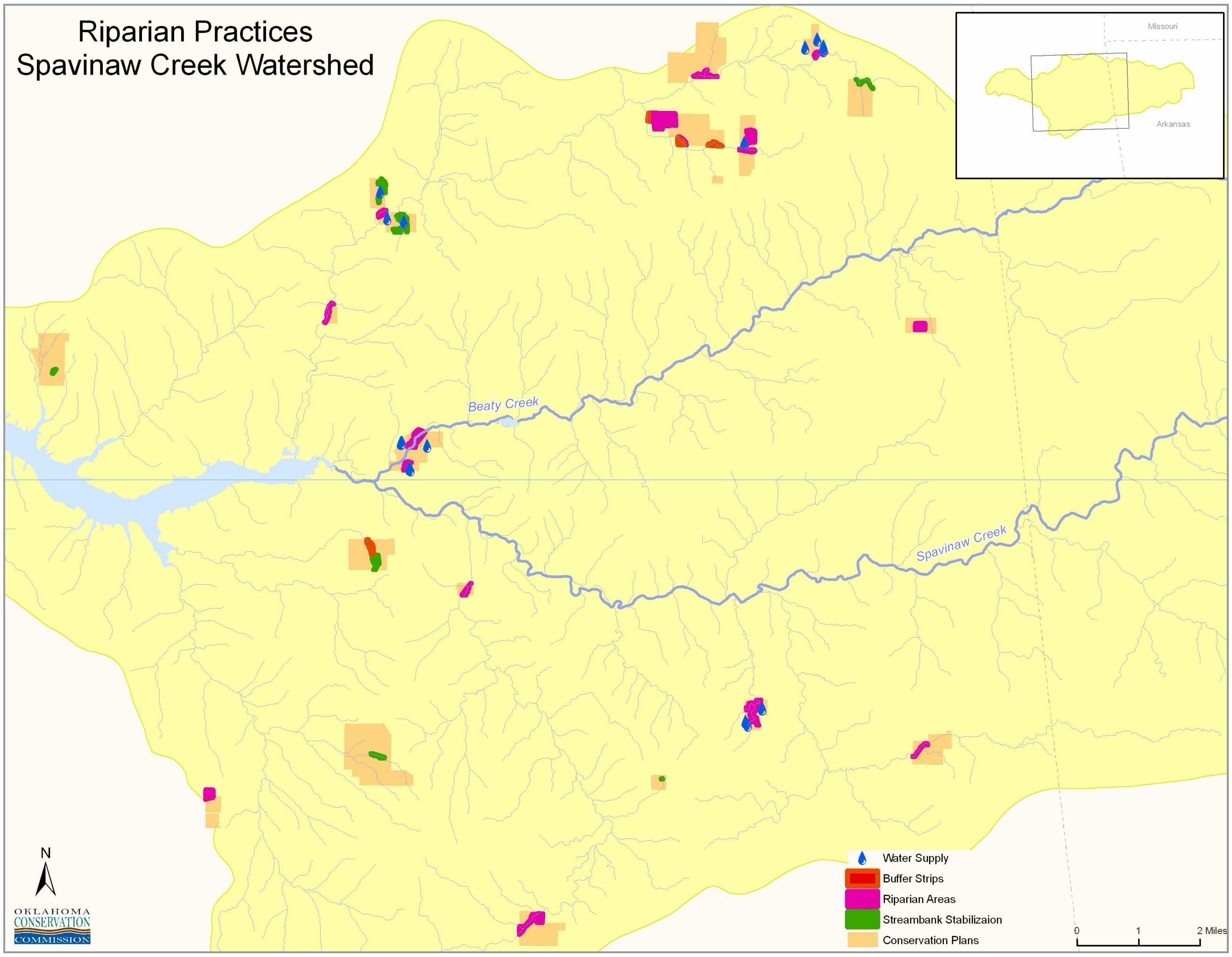


Figure 5. Location of riparian management and streambank stabilization practices implemented.

Streambank Stabilization

Some areas in the watershed required more than just fencing off a riparian zone and replanting vegetation. Where erosion was severe and the riparian zone was depleted, the area was reshaped and planted with grasses. Two landowners required this type of BMP, and four planted grass in critical areas (Table 3). One grade stabilization structure was installed, and one stream crossing was installed in order to allow the landowner to access property across a stream without further eroding the area (photos 4 and 5, before and after). The location of stabilization BMPs is shown in Figure 5.

Table 3. Streambank stabilization BMPs implemented.

Best Management Practice	Number of Landowners	Amount	Unit
Stream crossing	1	1	crossing
Critical area - shape and fill	2	8	acres
Barrel Riser	1	1	unit
Critical Area Planting	4	55	acres
Fertilizer	1	50	acres

Animal Waste Storage

1) Poultry Composters / Cake-out Houses


Photo 6

There are many poultry operations in the Spavinaw Creek watershed. Many producers did not have a means of properly disposing of dead birds, so they often just put them on their fields. Additionally, many producers are forced to clean out their poultry houses when weather and soil conditions are not acceptable for application of animal waste as fertilizer. Cost-sharing was used to provide composting and waste storage facilities to producers (photo 6). This enabled the producers to clean out their houses regardless of weather and time of year and store the waste out of the elements until it could be transported off of the farm or applied properly. Table 4, below, indicates the number of participants in this BMP.

Table 4. Animal Waste Storage Facilities installed.

Best Management Practice	Number of Landowners	Amount	Unit
Cakeout house/Composter and full cleanout	7	10	houses
Waste storage/Animal feeding facility/Windbreak (1)	32	35	facilities

2) Cattle Feeding / Waste Storage Facilities

Cattle feeding / waste storage facilities (photos 7 and 8) are elaborate structures which are designed to reduce runoff of nutrients, bacteria, and sediment from cattle supplemental feeding areas. Landowners typically overwinter and often feed cattle in the same areas of a pasture, areas that are chosen because they are easy to get to and provide a reliable source of shelter and water for overwintering stock. This often means they are close to the creek or a ravine or dry channel where shelter from the wind is available, and the running water in the creek generally insures that it does not freeze often. Unfortunately, these areas become trampled, overgrazed, and laden with waste, and, hence, are susceptible to runoff. By providing a sheltered feeding area away from the stream, feeding facilities reduce this problem. The structure has a concrete floor with a lip all around to contain waste. In addition, the back 1/3 of the structure is devoted to dry manure storage, sized sufficiently to store up to 3 months worth of manure until such a time it can be properly land applied. This was a very popular BMP, with 35 facilities constructed during the project period.

In addition to storage facilities, windbreak/shade panels were installed on one property. This was the first time that this BMP had been used in an OCC project. These panels can be converted to provide protection from both sun and wind, depending on the orientation (see photos 9 and 10 below). Gravel and geotextile material was installed around the wind shades (photo 10) to lessen the soil erosion due to loafing in the area (photo 9).

Wind shades before installation of "heavy use area" protection (left) and after (right).

Pasture Establishment / Management

1) Vegetative Plantings

Over-grazed and poorly grassed fields and pastures can be significant sources of erosion in the watershed. Since the phosphorus levels in the soil in this watershed are very high, soil entering streams could be contributing to the high phosphorus load in the watershed. Fertilization of 602 acres of poor pastureland and cropland in the watershed allowed for the establishment of better quality and quantity of vegetative cover. As indicated in Table 5, over 1,000 acres of grass was planted to create healthy pastures which will reduce the amounts of nutrients and sediment which enter streams due to runoff. Figure 6 shows the locations of pasture BMPs in the watershed.

2) Cross-Fencing

In order to keep pastures in optimal condition, as seen in photo 11, overgrazing must be avoided. Landowners may use cross-fencing to rotate cattle to various pastures and, thus, prevent overgrazing. Additionally, rotating herds to various fields lessens the bare soil, erodible areas associated with loafing in certain spots of a pasture (as seen on the right in photo 12). 234,034 linear feet of fence was erected to allow rotation of livestock across pastures at certain times.


Photo 11

Photo 12

Table 5. Pasture establishment/management BMPs implemented.

Best Management Practice	Number of Landowners	Amount	Unit
Cross-fence	59	234,034	feet
Pasture planting (bermuda, fescue, forbs)	15	1,014	acres
Watering facilities and pipeline	38	84	tanks
Ponds	16	19	ponds
Wells	42	45	wells
Lime	6	988	tons
Fertilizer	12	602	acres
Seedbed preparation (drill and tractor)	12	600	acres

3) Water Facilities

To successfully cross-fence livestock, water must be available in each pasture. As part of the pasture management BMPs, 84 water tanks (photo 13) and 19 ponds (photo 14) were installed in the watershed. The water source for some of these tanks was supplied by new wells.


Photo 13


Photo 14

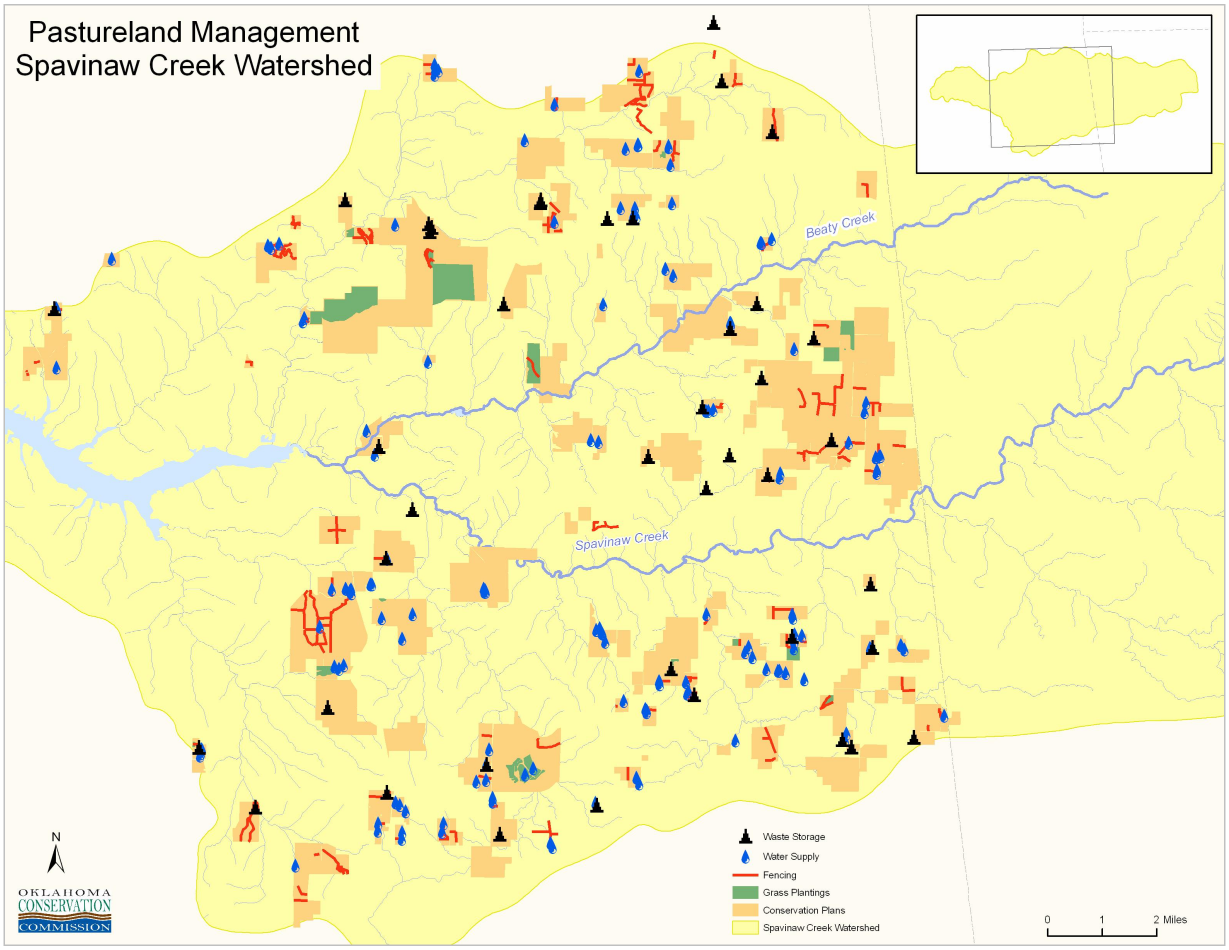


Figure 6. Location of pasture establishment/management BMPs implemented.

Waste Utilization for Poultry

Poultry litter is a mixture of manure and bedding material which is cleaned out of poultry houses periodically and then used as fertilizer on fields. The timing of litter application as well as the amount applied can have a large impact on water quality in the area. In the Spavinaw Creek watershed, soils are already very high in nutrients, particularly phosphorus, due to years of litter application.

To target producers who have excess litter or cannot spread litter at all based on a soil test, an incentive was given for litter movement to areas outside the Spavinaw Watershed that could utilize it properly. BMPs, Inc., was the contractor that organized the litter transport for this project. Approximately 28,000 tons of litter was moved out of the watershed to a non-nutrient limited area (yellow areas, Figure 7). $180,000 in federal funds was used to implement this BMP, with a subsidy of up to $8/ton going to the hauler and a minimum of $2/ton going to the grower. The subsidy for haulers was based on a value of $0.05/mile/ton.

Due to the high cost of fertilizer, the demand for poultry litter has risen a great deal. As a result of this, the allotted funding for litter transfer was spent very quickly. The OCC has supplemented the litter transfer program twice, both times obligating all of the available funding within just a few days.

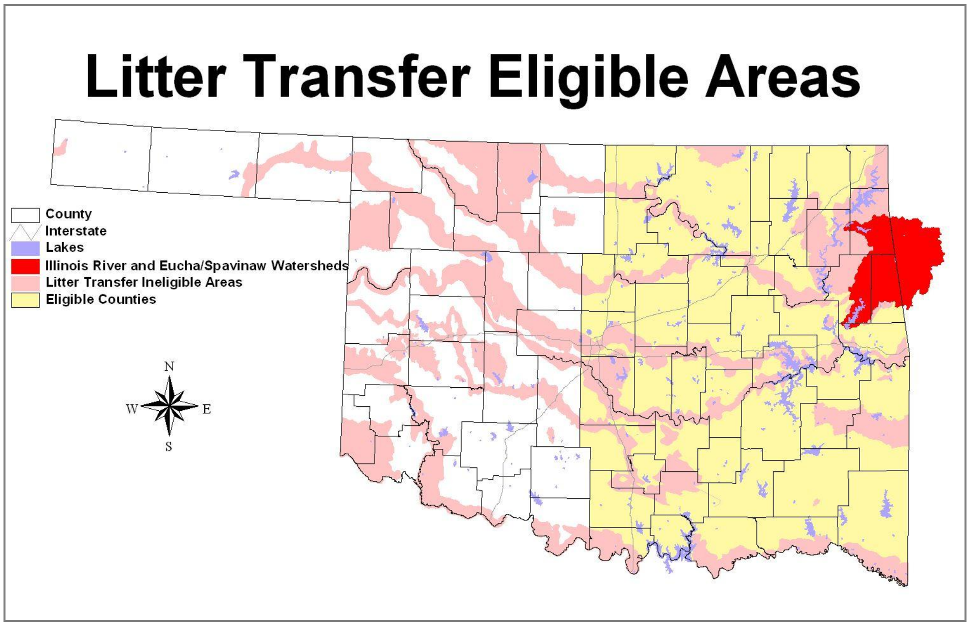


Figure 7. Areas in Oklahoma eligible for subsidized purchases of poultry waste (litter).

Heavy Use Areas

As large animals, cattle can severely impact areas around feeding or watering facilities where heavy traffic compacts soil and destroys stabilizing vegetative cover, increasing soil erosion from the area. In addition, heavy traffic is usually accompanied by increased waste deposition, which can lead to increased nutrients and bacteria in runoff from these areas. Installation of concrete feeding pads for round hay bale feeding or gravel and grading in loafing areas are modifications that can reduce runoff of soil, nutrients, and bacteria from these heavy use areas. In some instances, only geotextile and gravel are necessary to prevent degradation around feeding/watering areas. Sixty-one landowners installed 83 heavy use areas as part of this project. Most areas consisted of a combination of concrete surrounded by geotextile and gravel, but a few opted for the geotextile/gravel area only. Photos 15 and 16 show the improvement in the area around a water tank after installation of geotextile and gravel. Similar improvement is observed in other heavy use areas such as travel paths (photos 17 and 18) and feeding areas.

Freeze-proof water tank before and after geotextile and gravel protection.

Cattle travel path before and after geotextile and gravel protection.

Rural Waste Systems

Rural residents within the Spavinaw Creek watershed may not have septic tanks, or they may be in bad repair. To decrease the amount of residential sewer pollution entering the streams and lakes in the watershed, septic tanks and lateral lines were installed after a percolation test was performed. Table 6, below, indicates the number of septic systems improved or installed, as well as the number of perc tests performed, and Figure 8 shows the locations of the septic systems installed.

Table 6. Septic system BMPs installed.

Best Management Practice	Number of Landowners	Amount	Unit
Pump out existing tanks	22	23	pump outs
Install new septic systems	60	62	systems
Perc test	57	59	tests

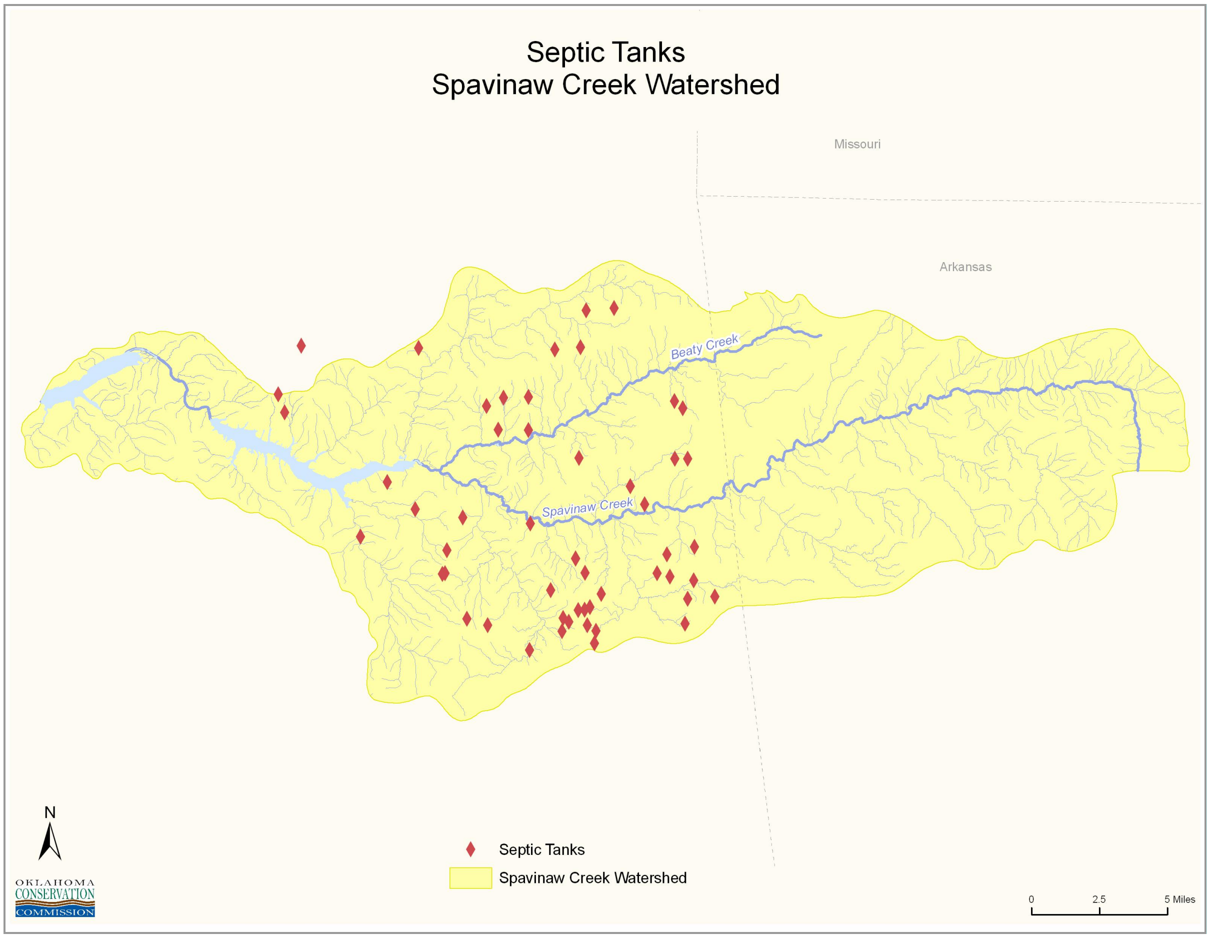


Figure 8. Location of septic systems installed.

In addition to BMPs implemented through the OCC's 319 program, the NRCS has provided cost-share funding for landowners through the Environmental Quality Incentives Program (EQIP). The EQIP program spent over $350,000 in BMP installation in Delaware County, where most of the Oklahoma portion of the watershed is located, from 2004-2006. This included installation of approximately 44,648 linear feet of fencing, 15 ponds, 419 acres of pasture / hay planting, 645 acres of nutrient management, 26 watering facilities and associated pipelines and wells, 30 heavy use protection areas (about 80 acres), brush and pest management, 3 composting facilities, and 7 waste storage facilities.

OCC's previous Beaty Creek project, which was begun in 1998, resulted in protection of 330 acres of riparian area by installing 34 off-site watering facilities and 9.4 miles of fencing. Also, 7,135 acres of pasture were improved in the watershed through prescribed grazing strategies, and 1,683 acres of cropland or poorly vegetated pasture was converted to pasture or improved by planting grass. The water quality improvements discussed in the next section are the result of the combined efforts of all of these programs.

Water Quality Assessment

Water quality monitoring is critical to the project for purposes of determining the causes and sources of NPS derived pollution in the watershed and ascertaining whether or not project efforts have had an effect on water quality. A considerable amount of water quality monitoring has occurred since 1999 in the Beaty Creek watershed and since September 2005 in the larger Spavinaw Creek Watershed as part of this project. All monitoring followed the protocols detailed in the project QAPP, with data collected at the locations indicated in Table 7 and Figure 9.

Table 7. OCC monitoring sites.

SiteName	WBID	Lat	Long	County
Beaty Creek: Lower	OK121600-05-0160G	36.3554	-94.7760	Delaware
Beaty Creek: Upper	OK121600-05-0160F	36.3704	-94.7191	Delaware
Cloud Creek	OK121600-05-0180C	36.3372	-94.7562	Delaware
Flint Creek	OK121700-06-0010G	36.1961	-94.7078	Delaware
Spavinaw Creek	OK121600-05-0150G	36.3418	-94.7550	Delaware
Little Saline Creek	OK121600-02-0070F	36.2796	-95.0710	Mayes
Saline Creek	OK121600-02-0030D	36.2820	-95.0929	Mayes

The Spavinaw Creek Watershed Project was set up using a paired watershed design, developed in accordance with requirements outlined in Clausen and Spooner (1993). The basic method requires a minimum of two watersheds, a control and a treatment, and two definable periods of study, calibration and treatment. The control watershed is chosen to account for environmental variability, which may otherwise mask the overall effect of BMPs on NPS pollutant loads in the treatment watershed, over the periods of study. The control watershed must be located near the treatment watershed in order to experience the same weather and seasonally induced changes. The difference in quality of runoff between the control and treatment watersheds is not the issue of concern; rather, it is most important that the relationship between paired observations between the two remains the same through time, except for the effects of the BMPs (EPA 1993). Differences in water quality between the two watersheds are expected, but it is the predictable response of the two watersheds together that is the foundation of the paired watershed method.

This project allowed analysis of two sets of paired watersheds: Beaty / Little Saline and Spavinaw / Flint-Saline. Monitoring was conducted at each watershed outlet in an identical fashion for both the treated (Beaty and Spavinaw) and the control (Little Saline, Flint, Saline) watersheds, and through the calibration and treatment periods, as required in the paired watershed design. A total of seven automated samplers were established (see Figure 9) to obtain continuous, flow-weighted samples from the different streams. These samples were collected at least weekly (more often if rain had occurred). If the autosampler had malfunctioned, a grab sample was obtained and submitted to the lab.

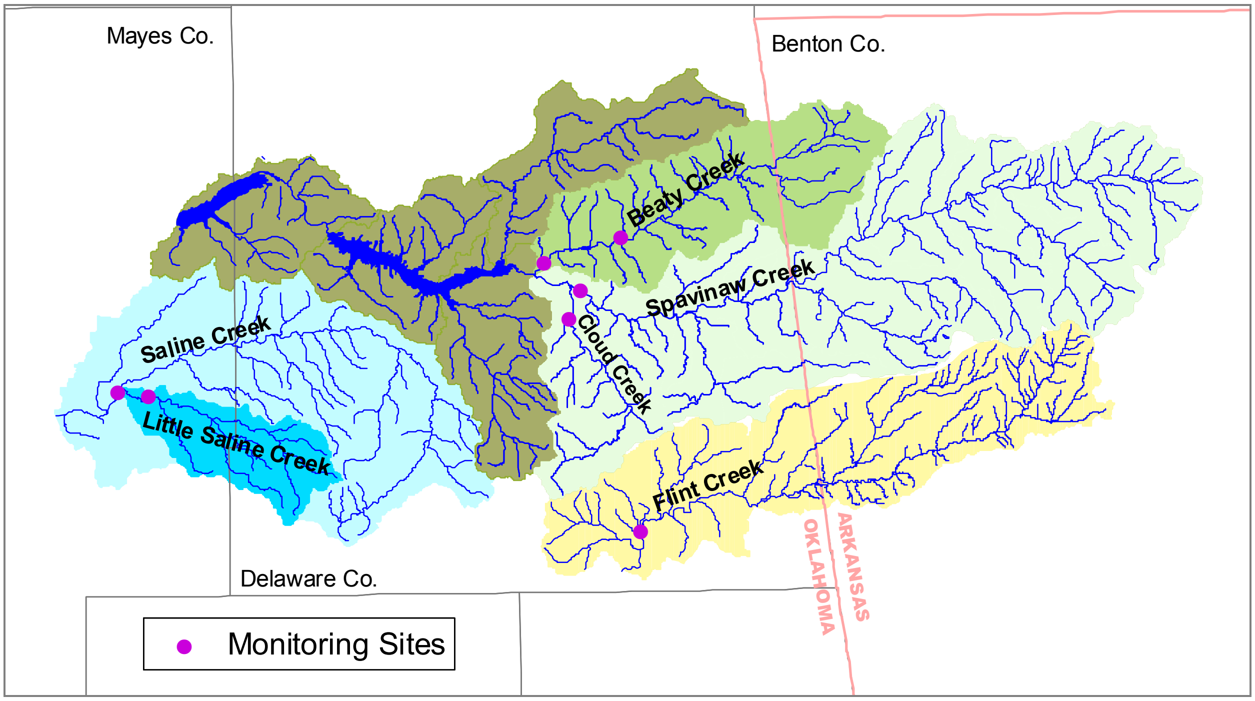


Figure 9. Map of the project watersheds with monitoring sites indicated by the purple dots.

Water quality samples were analyzed for ortho-phosphorus, total phosphorus, nitrate-nitrogen, ammonium nitrogen, and total Kjeldahl nitrogen (TKN). *Escherichia coli* and *Enterococcus* bacteria were assessed weekly during the recreation season only (May 1-September 30). The OCC also conducted routine physico-chemical monitoring at each site on a weekly basis throughout the length of the project. This included the following field parameters: dissolved oxygen, pH, temperature, turbidity, conductivity, instantaneous discharge, and alkalinity. Monthly grab samples were analyzed for total suspended solids (TSS), chloride, and sulfate. Additionally, benthic macroinvertebrates were collected twice a year throughout the project, and fish and habitat data was collected twice for each site.

Beaty / Little Saline Watershed Analysis

Little Saline Creek was used as the control watershed for Beaty Creek. Although two autosamplers were deployed along Beaty Creek, the autosampler at the lower station on the creek was not functional during the calibration period. Therefore, the comparison between the treatment and control watersheds is based on data collected at the upper Beaty Creek site only. Although this station does not represent the entire watershed, it represents a subwatershed more similar in size to the Little Saline Watershed. Monitoring at the lower Beaty site will cease at the end of 2008 due to continued problems with the sampler location.

For the Beaty Creek subwatershed, calibration monitoring began in August 1999 and continued until August 2001, when BMP implementation began in Beaty. This data provided a baseline relationship between Beaty Creek (the treatment watershed) and

Little Saline Creek (the control watershed) and allowed calibration of the paired watershed model used to assess implementation effectiveness. Post-implementation monitoring began in September 2003 and is ongoing.

Nutrient Load Reduction Analyses

Data analysis was conducted according to procedures outlined in Clausen and Spooner (1993). The relationship between water quality variables from the two watersheds during the calibration phase was described by simple linear regression. For purposes of calibration, the relationship between Beaty and Little Saline Creeks was evaluated using autosampler data collected between August 1999 and August 2001. This has already been described in detail in the "Lake Eucha Watershed Implementation Project: Beaty Creek Watershed" Final Report (OCC 2006). The most recent two years of post-implementation data will be presented here in order to track the continuing effect of BMPs several years after implementation.

All load reduction analyses were conducted on log-transformed data to satisfy assumptions of parametric statistical analyses. The significance of the regression between paired observations was tested using analysis of variance (ANOVA). The probability (p) value associated with the resulting F statistic indicates whether the regression explained a significant amount of the variation in the paired data ($p \leq 0.05$). The coefficient of determination (r^2) indicates the quality of the regression (i.e., its utility in predicting y from x).

At the end of the treatment period, the significance of the effect of the BMPs was determined using analysis of covariance (ANCOVA). Specifically, the analysis determined:

1. the significance of the treatment regression equation,
2. the significance of the overall regression which combines the calibration and treatment period data,
3. the difference between the slopes of the calibration and treatment regressions, and
4. the difference between the intercepts of the calibration and treatment regressions.

Item 1 was determined through an ANCOVA for the treatment period regression. Items 2 – 4 were determined through an ANCOVA comparing the treatment and calibration period regressions.

A preliminary comparison of total phosphorus loading compiled in a thesis by Andrew Lyon from OSU compared total phosphorus loading in Beaty Creek and Little Saline Creek between the calibration period of the program (1999-2001) and the post-implementation period of 2003-2005. This analysis indicated a 31% reduction in total phosphorus load as compared to expected results based on the relationship between the paired watersheds (Lyon 2006).

This analysis has been repeated here using data from 2003-2007 for the post-calibration period and keeping the calibration period the same. As described in the 2006 report, weekly total phosphorus (T-P) loads were determined by multiplying T-P concentrations from weekly, integrated samples by the total flow for the sampling period. The first step in the analysis was to determine the relationship, if any, between the watersheds for both the calibration and treatment phases. To meet assumptions necessary to utilize certain statistical methods, weekly T-P loads were converted to log base ten values before analysis. These log T-P load values were paired between the watersheds by date of collection and analyzed by linear regression to determine relationship. Figure 10 indicates strong, statistically significant (P<0.000) linear relationships between the two watersheds for both the calibration and post-implementation periods.

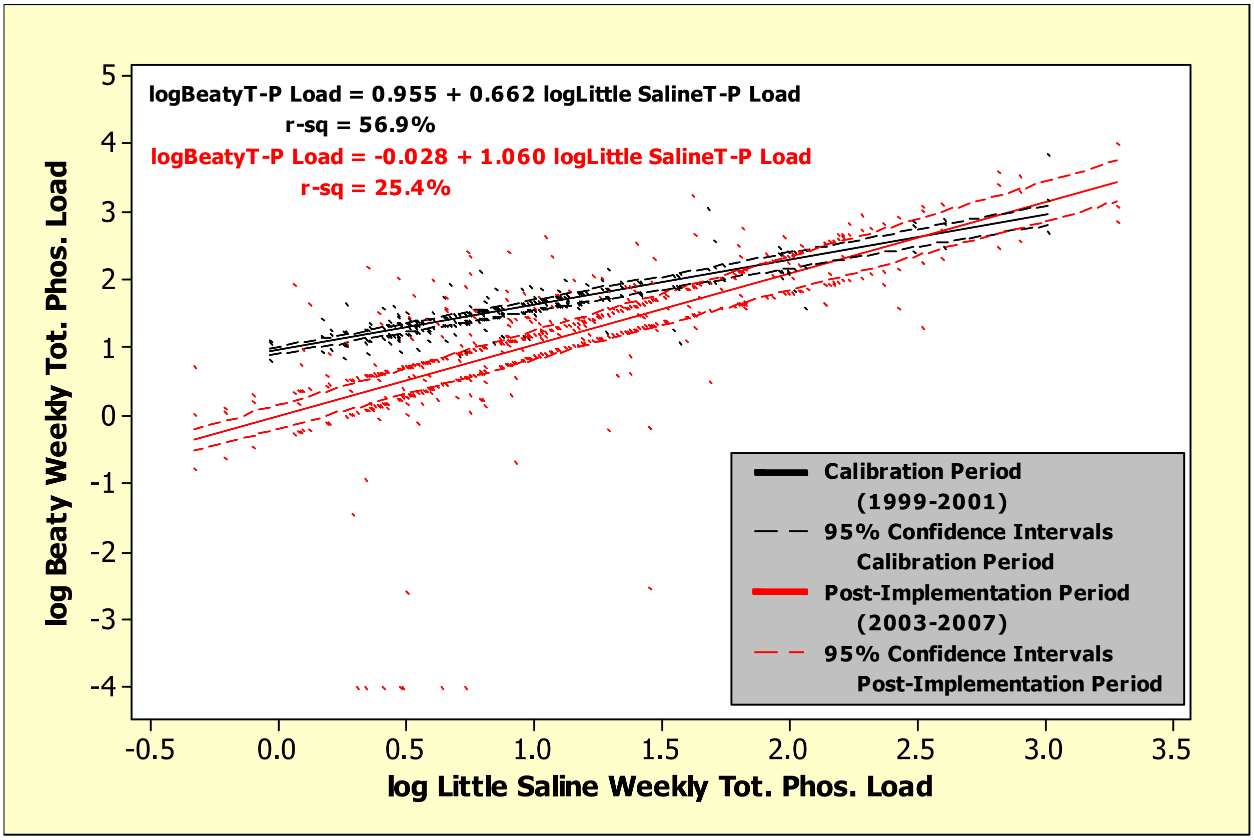


Figure 10. Regressions of log-transformed total phosphorus data. 95% confidence intervals for each regression line are indicated by dashed lines. The equations for the regression lines are given at the top of the graph, with black lines and font representing the calibration period and red lines and font depicting post-implementation.

An analysis of covariance (ANCOVA) was performed to determine the effect of the BMP implementation on weekly T-P load in Beaty Creek. This type of analysis allows the determination of difference between the calibration and treatment periods despite whatever difference might have occurred because of environmental variability (e.g., wet year vs. dry year). The statistical software package Minitab, V. 14 was employed to conduct the analysis. The results of the ANCOVA analysis are shown in Table 8 (below). The p values of 0.000 indicate that the regression equations are significantly different and that there is a significant effect of both treatment (BMP implementation) and time period.

Table 8. Minitab results of the ANCOVA for the combined calibration and post-implementation T-P data (log transformed) for Beaty and Little Saline Creeks.

Factor:	**Type:**	**Levels:**	**Values:**
Period	Fixed	2	Calibration, Post-implementation

Analysis of Variance for logBeatyT-P Load, using Adjusted SS for Tests:

Source	DF	Seq SS	Adj SS	Adj MS	F	P
logLSalineT-P Load	1	91.820	102.228	102.228	109.62	0.000
period	1	23.933	23.933	23.933	25.66	0.000
Error	306	285.357	285.357	0.933		
Total	308	401.109				

The significance of the regression lines was also evaluated using a regression analysis to examine both slope and intercept together (whole regression equation), slope only, and intercept only. Both the slopes (represented by the interaction term) and the intercepts (indicated by the "period" term) of the regression lines were significantly different ($p \leq 0.05$), as shown in Table 9.

Table 9. Minitab results of the regression analysis for the combined calibration and post-implementation T-P data (log transformed) for Beaty and Little Saline Creeks.

The regression equation is:
logBeatyT-P Load = 0.955 + 0.662 logLittleSalineT-P Load - 0.982 period + 0.396 TP interaction

Predictor	Coef	SE Coef	T	P
Constant	0.9545	0.1913	4.99	0.000
logLST-P Load	0.6615	0.1771	3.74	0.000
period	-0.9821	0.2336	-4.20	0.000
TP interaction	0.3959	0.2062	1.92	0.056
r^2 = 29.7%	r^2 (adj) = 29.0%			

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	119.161	39.720	42.97	0.000
Residual Error	305	281.948	0.924		
Total	308	401.109			

In order to quantify the reduction in total phosphorus load, expected loads are calculated for Beaty Creek using the calibration and post-implementation regression equations and the observed post-implementation loads in Little Saline. Then, the percent reduction was calculated in terms of the average of the difference between the calibration and post-implementation weekly loads relative to the calibration load:

*% reduction = (calibration – postimplementation) / calibration * 100*

Using this method, it was calculated that a **66% reduction in total phosphorus loading** has been achieved in Beaty Creek during the post-implementation period.

Reductions in average total phosphorus loading and total phosphorus concentration were observed for Beaty Creek as well, as shown in Table 10, below. Analysis of variance showed that the reduction in loading is statistically significant (p=0.001), although the slight reduction in concentration is not significant.

Table 10. Average nutrient concentrations and loads for the calibration period (1999-2001) and the post-implementation period (2003-2007).

	Parameter	Beaty Calib	Beaty Post-Impl	Beaty Change	L. Saline Calib	L. Saline Post-Impl	L. Saline Change
Concentration (mg/L)	TotPhosphorus	0.1029	0.0936	⇓	0.0345	0.0455	⇑
	Ortho-Phosphorus	0.0443	0.0437	⇓	0.0111	0.0146	⇑
	Ammonia	0.0621	0.0392	⇓	0.0320	0.0200	⇓
	Nitrate	2.2345	2.5657	⇑	0.5956	0.5161	⇓
	TKN	0.5863	0.1977	⇓	0.1700	0.1223	⇓
Load (lbs)	TotPhosphorus	138.99	116.85	⇓	30.77	48.48	⇑
	Ortho-Phosphorus	76.33	57.44	⇓	12.35	17.88	⇑
	Ammonia	12.91	6.53	⇓	21.64	18.56	⇓
	Nitrate	344.15	534.08	⇑	467.40	508.08	⇑
	TKN	814.54	217.69	⇓	141.99	99.57	⇓

Another way to view this reduction in Beaty Creek over what has been observed in Little Saline is shown in Figure 11. Again, since these are paired watersheds experiencing approximately the same environmental conditions, the observed differences are due to the high amount of BMP implementation in the Beaty watershed versus relatively no implementation in the Little Saline watershed (a small amount may have been implemented through the NRCS EQIP program).

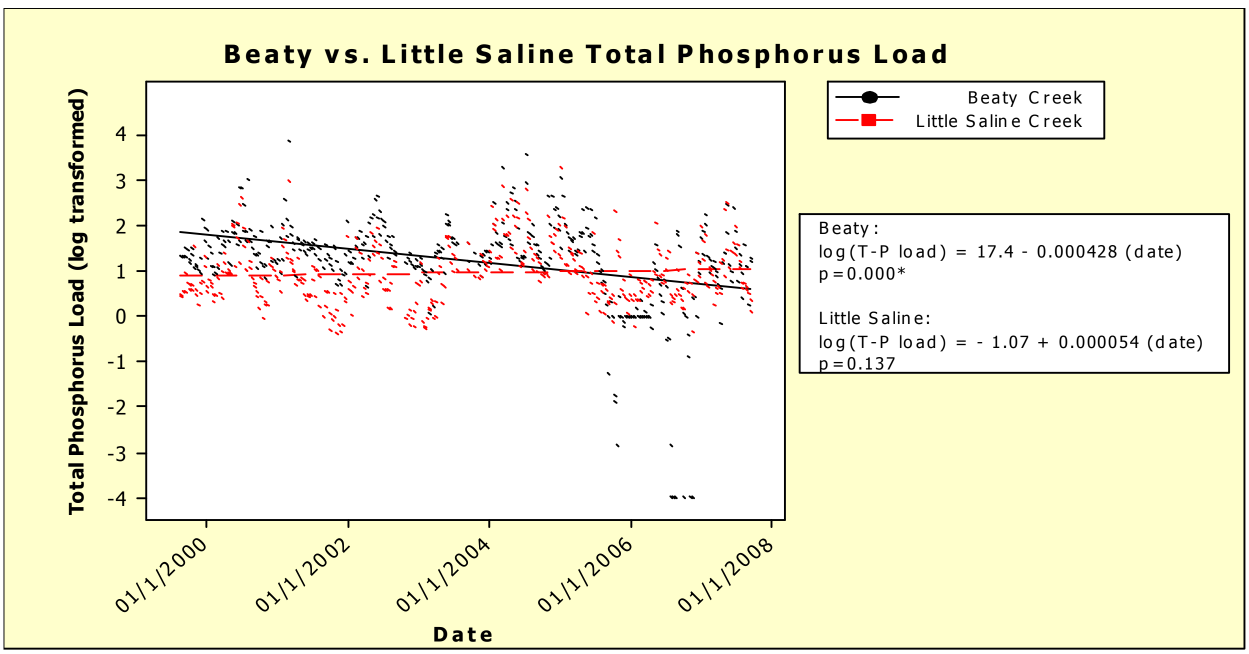


Figure 11. Comparison of total phosphorus load over time. Beaty Creek (black line) shows a significant (p=0.000) *reduction* in TP over time, while Little Saline (red line) shows no significant change over time (p=0.137).

All other nutrient parameters were analyzed in this same way. As shown below, there was a significant effect of both treatment and time period, and both the slopes and the intercepts of the lines were significantly different (Tables 11 and 12; Figure 12) for TKN. There was a **80% reduction in total Kjeldahl nitrogen loading** in Beaty Creek during the post-implementation period.

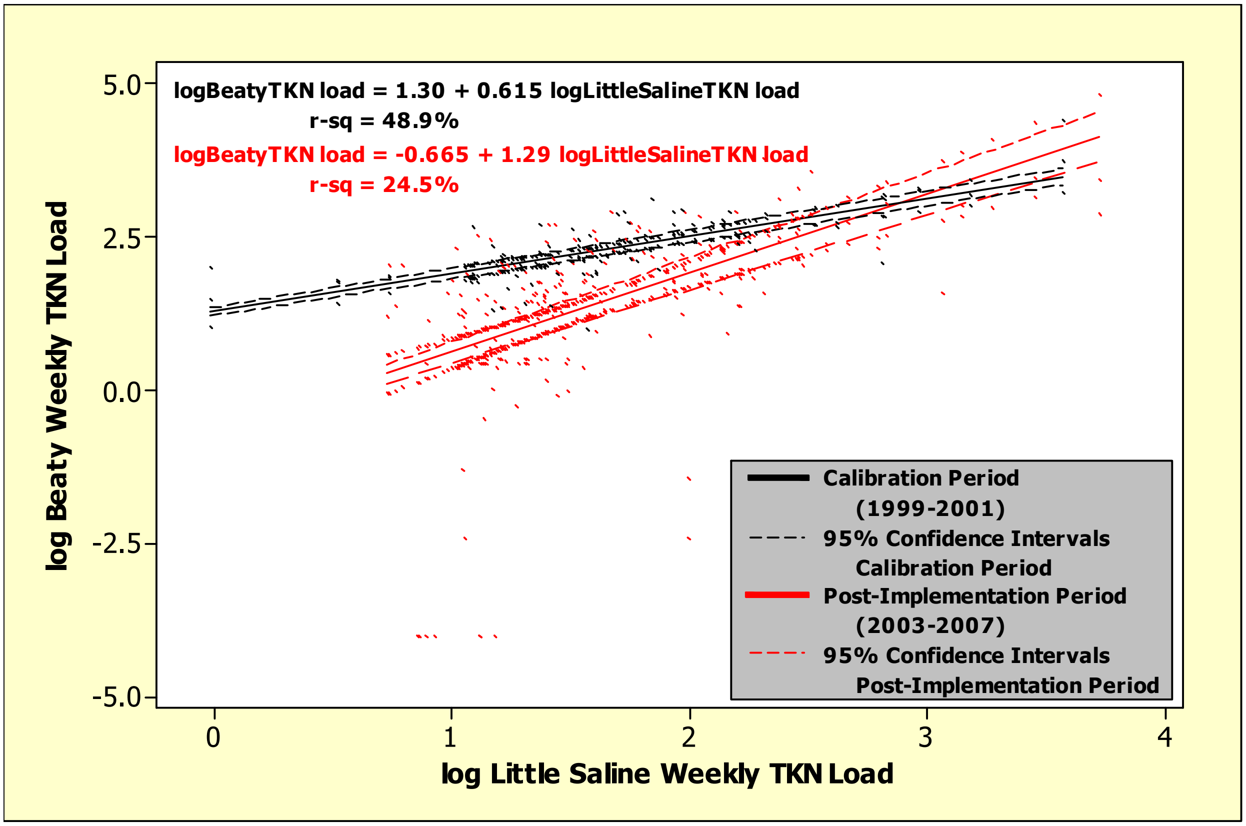


Figure 12. Regressions of log-transformed total Kjeldahl nitrogen (TKN) data. 95% confidence intervals for each regression line are indicated by dashed lines. The equations for the regression lines are given at the top of the graph, with black lines and font representing the calibration period and red lines and font depicting post-implementation.

Table 11. Minitab results of the ANCOVA for the combined calibration and post-implementation TKN data (log transformed) for Beaty and Little Saline Creeks.

Factor:	**Type:**	**Levels:**	**Values:**
Period	Fixed	2	Calibration, Post-implementation

Analysis of Variance for logBeatyTKN Load, using Adjusted SS for Tests:

Source	**DF**	**Seq SS**	**Adj SS**	**Adj MS**	**F**	**P**
logLSalineTKN Load	1	108.735	95.695	95.695	90.61	0.000
period	1	45.152	45.152	45.152	42.76	0.000
Error	292	308.371	308.371	1.056		
Total	294	462.258				

Table 12. Minitab results of the regression analysis for the combined calibration and post-implementation TKN data (log transformed) for Beaty and Little Saline Creeks.

The regression equation is:
logBeatyTKN Load = 1.41 + 0.546 logLittleSalineTKN Load – 1.61 period + 0.642 TKN interaction

Predictor	Coef	SE Coef	T	P
Constant	1.4135	0.2629	5.38	0.000
logLSTKN Load	0.5457	0.1442	3.78	0.000
period	-1.6124	0.1886	-8.55	0.000
TKN interaction	0.6417	0.1194	5.37	0.000

r^2 = 66.4% r^2 (adj) = 66.1%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	181.718	60.573	62.83	0.000
Residual Error	291	280.540	0.964		
Total	294	462.258			

Again, this greater reduction in Beaty Creek versus in Little Saline can be seen in a different way in Figure 13.

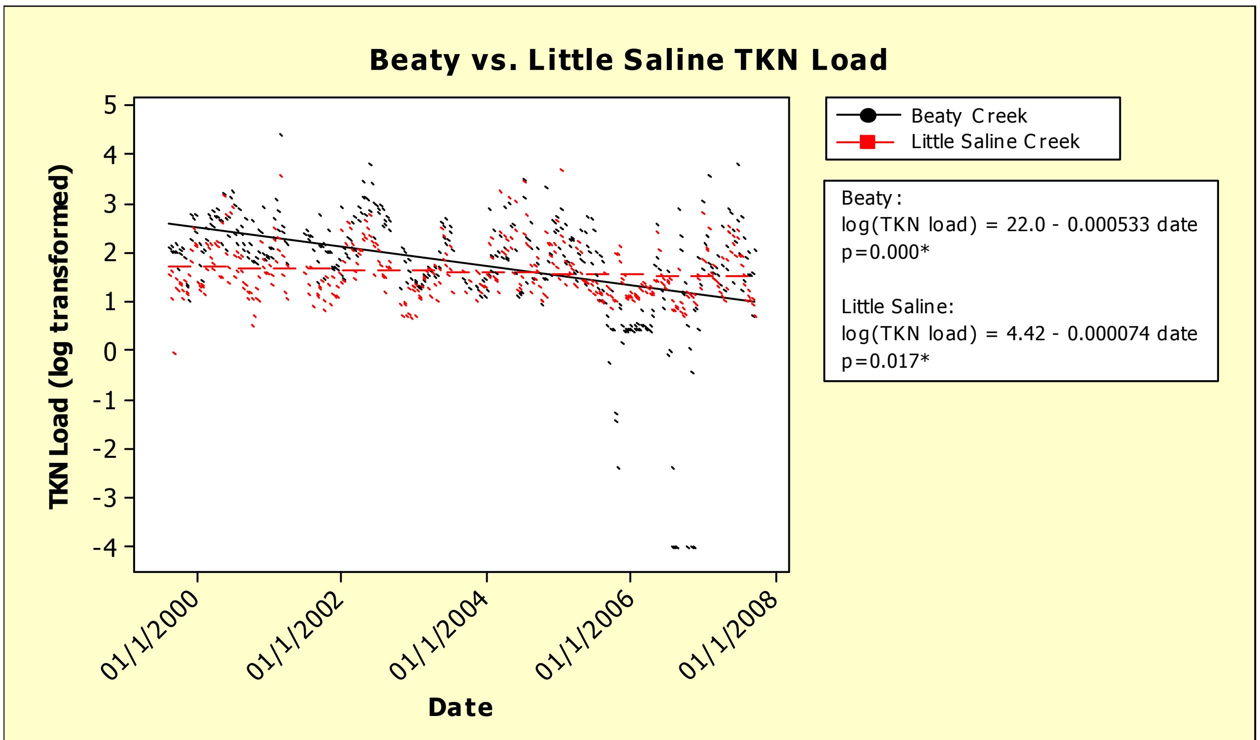


Figure 13. Comparison of TKN load over time. Both Beaty Creek (black line) and Little Saline Creek (red line) show a significant (p=0.000 and p=0.017) decrease over time, with the decrease being sharper in Beaty Creek.

For ortho-phosphorus, there was a 53% reduction in total loading in the post-implementation period relative to the calibration period. As shown below, there was a significant effect of both treatment and time period, and the intercepts of the lines were significantly different (Tables 13 and 14). The slopes of the calibration and post-implementation lines were not significantly different (Table 14).

Table 13. Minitab results of the ANCOVA for the combined calibration and post-implementation orthoPhosphorus data (log transformed) for Beaty and Little Saline Creeks.

Factor:	Type:	Levels:	Values:
Period	Fixed	2	Calibration, Post-implementation

Analysis of Variance for logBeaty orthoPhos Load, using Adjusted SS for Tests:

Source	DF	Seq SS	Adj SS	Adj MS	F	P
logLSaline orthoPhos Load	1	77.753	83.144	83.144	86.61	0.000
period	1	9.321	9.321	9.321	9.71	0.000
Error	305	292.783	292.783	0.960		
Total	307	379.857				

Table 14. Minitab results of the regression analysis for the combined calibration and post-implementation orthoPhosphorus data (log transformed) for Beaty and Little Saline Creeks.

The regression equation is:

logBeatyOrthoPhos Load = 0.734 + 0.702 logLittleSalineOrthoPhos Load – 0.463 period + 0.194 OrthoPhos interaction

Predictor	Coef	SE Coef	T	P
Constant	0.7338	0.1175	6.25	0.000
logLSoPhos Load	0. 7022	0.1589	4.42	0.000
period	-0.4629	0.1498	-3.09	0.002
TKN interaction	0.1940	0.1924	1.01	0.314

r^2 = 23.2% r^2 (adj) = 22.4%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	88.050	29.350	30.58	0.000
Residual Error	304	291.808	0.960		
Total	307	379.857			

As seen in Figures 14 and 15, ortho-phosphorus loads were significantly decreased in Beaty and were significantly increased in Little Saline.

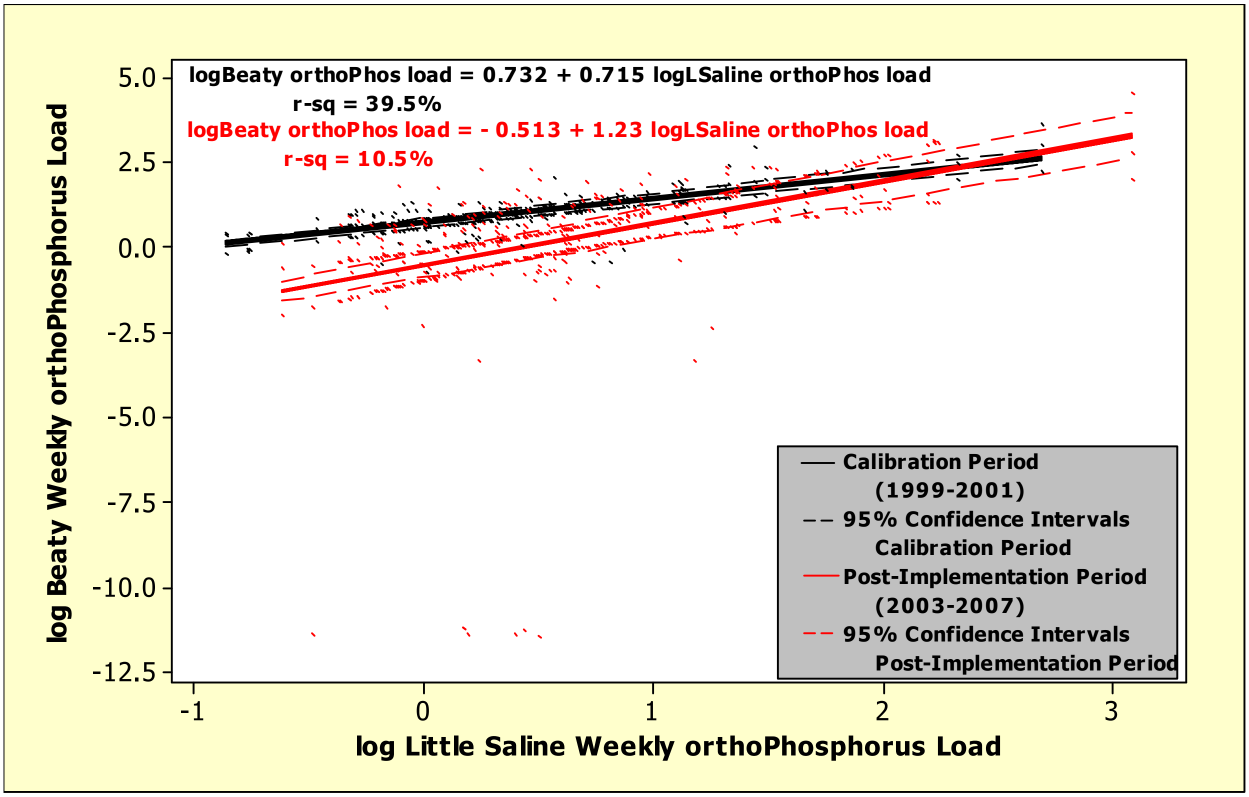


Figure 14. Regressions of log-transformed ortho-phosphorus data. 95% confidence intervals for each regression line are indicated by dashed lines. The equations for the regression lines are given at the top of the graph, with black lines and font representing the calibration period and red lines and font depicting post-implementation.

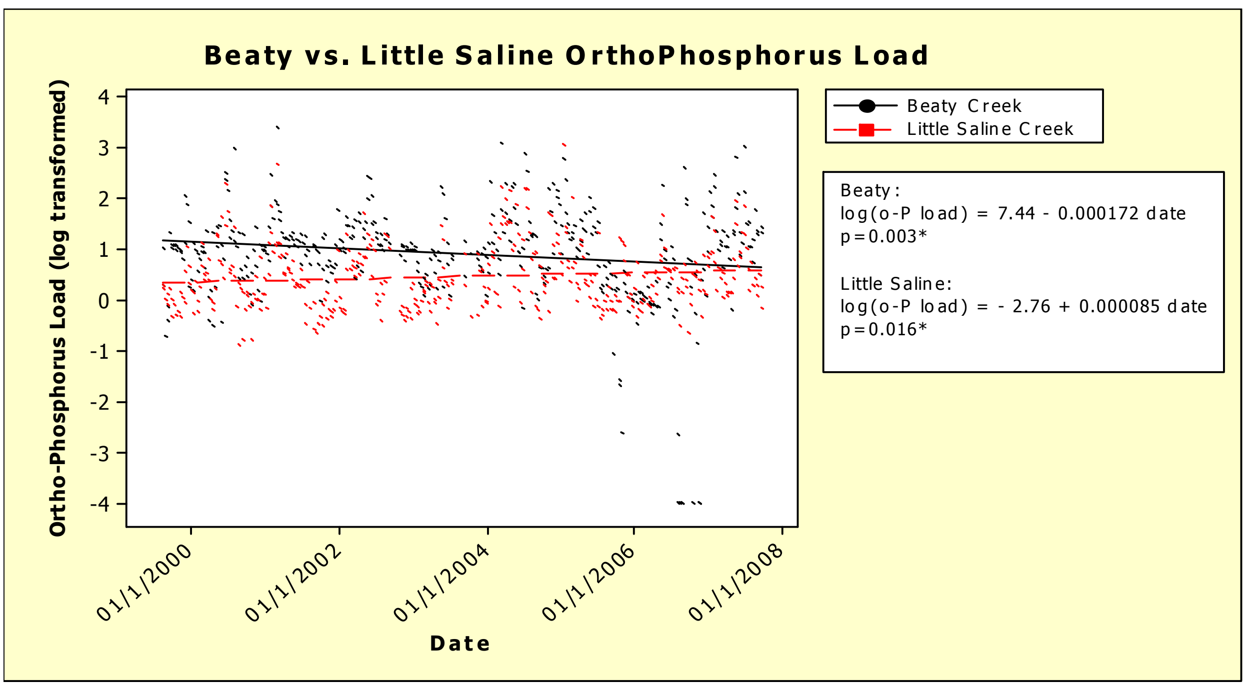


Figure 15. Comparison of ortho-phosphorus load over time. Beaty Creek (black line) shows a significant (p=0.003) decrease in ortho-phosphorus over time, while Little Saline (red line) shows a significant (p=0.016) increase over time.

There was an 87% reduction in ammonia loading in the post-implementation period relative to the calibration period. As shown below, there was a significant effect of both treatment and time period (Table 15), and the slopes of the lines were significantly different (Table 16; Figure 16). The intercepts of the calibration and post-implementation lines were not significantly different (Table 16).

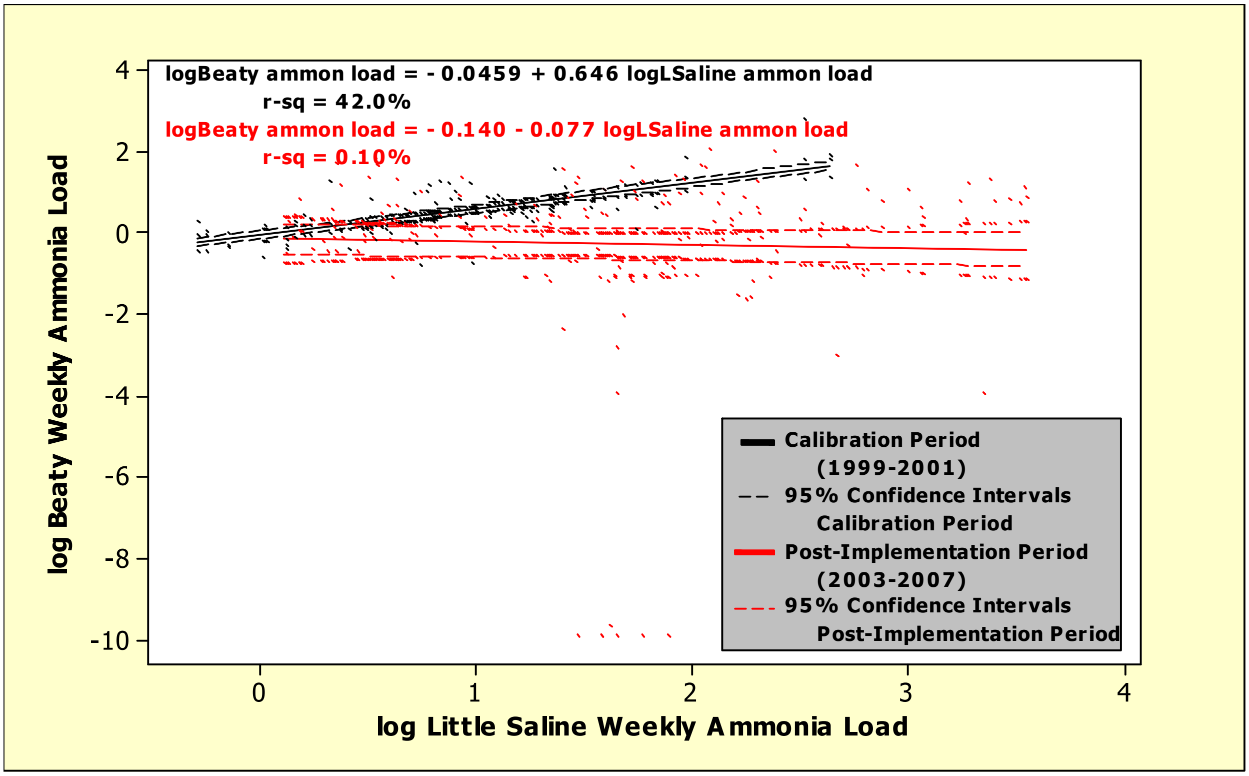


Figure 16. Regressions of log-transformed ammonia data. 95% confidence intervals for each regression line are indicated by dashed lines. The equations for the regression lines are given at the top of the graph, with black lines and font representing the calibration period and red lines and font depicting post-implementation.

Table 15. Minitab results of the ANCOVA for the combined calibration and post-implementation ammonia data (log transformed) for Beaty and Little Saline Creeks.

Factor:	**Type:**	**Levels:**	**Values:**
Period	Fixed	2	Calibration, Post-implementation

Analysis of Variance for logBeaty Ammonia Load, using Adjusted SS for Tests:

Source	**DF**	**Seq SS**	**Adj SS**	**Adj MS**	**F**	**P**
logLS Ammon Load	1	4.034	0.309	0.309	0.11	0.743
period	1	44.332	44.332	44.332	15.41	0.000
Error	306	880.278	880.278	2.877		
Total	308	928.645				

Table 16. Minitab results of the regression analysis for the combined calibration and post-implementation ammonia data (log transformed) for Beaty and Little Saline Creeks.

The regression equation is:

logBeatyAmmonia Load = -0.044 + 0.644 logLSAmmonia Load – 0.097 period - 0.720 Ammonia interaction

Predictor	Coef	SE Coef	T	P
Constant	-0.0437	0.3441	-0.13	0.899
logLSAmmon Load	0. 6437	0.3150	2.04	0.042
period	-0.0972	0.4256	-0.23	0.819
Ammon interaction	-0.7201	0.3447	-2.09	0.038

r^2 = 6.5% r^2 (adj) = 5.6%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	60.785	20.262	7.12	0.000
Residual Error	305	867.859	2.845		
Total	308	928.645			

In contrast to the other results, there was a 37% ***increase*** in nitrate loading in the post-implementation period relative to the calibration period, indicated by the upward shift in the post-implementation line relative to the calibration line in Figure 17, below.

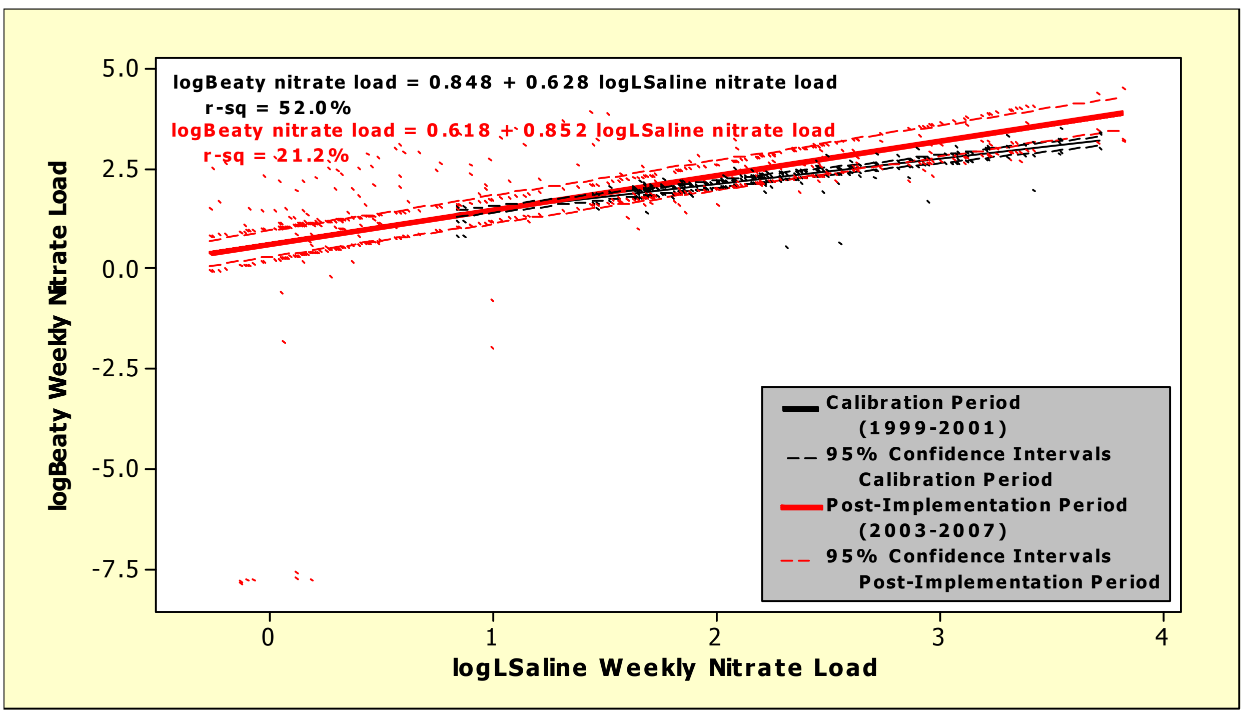


Figure 16. Regressions of log-transformed nitrate data. 95% confidence intervals for each regression line are indicated by dashed lines. The equations for the regression lines are given at the top of the graph, with black lines and font representing the calibration period and red lines and font depicting post-implementation.

As shown below, there was no significant effect of time period (Table 17). Neither the slopes nor the intercepts of the calibration and post-implementation lines were significantly different (Table 18). This indicates that, although the nitrate load increased in Beaty Creek, it increased similarly in Little Saline Creek. This suggests that the BMPs implemented did not have an effect on nitrate loading in the watershed.

Table 17. Minitab results of the ANCOVA for the combined calibration and post-implementation nitrate data (log transformed) for Beaty and Little Saline Creeks.

Factor:	**Type:**	**Levels:**	**Values:**
Period	Fixed	2	Calibration, Post-implementation

Analysis of Variance for logBeaty Nitrate Load, using Adjusted SS for Tests:

Source	**DF**	**Seq SS**	**Adj SS**	**Adj MS**	**F**	**P**
logLS Nitrate Load	1	203.140	187.290	187.290	83.74	0.000
period	1	3.450	3.450	3.450	1.54	0.215
Error	297	664.290	664.290	2.240		
Total	299	870.880				

Table 18. Minitab results of the regression analysis for the combined calibration and post-implementation nitrate data (log transformed) for Beaty and Little Saline Creeks.

The regression equation is:

logBeatyNitrate Load = 0.851 + 0.627 logLSNitrate Load – 0.233 period + 0.225 Nitrate interaction

Predictor	**Coef**	**SE Coef**	**T**	**P**
Constant	0.8505	0.5905	1.44	0.151
logLSNitrate Load	0. 6271	0.2532	2.48	0.014
period	-0.2328	0.6132	-0.28	0.704
Nitrate interaction	0.2253	0.2709	0.83	0.406

r^2 = 23.9% r^2 (adj) = 23.1%

Analysis of Variance

Source	**DF**	**SS**	**MS**	**F**	**P**
Regression	3	208.143	69.381	30.99	0.000
Residual Error	296	662.738	2.239		
Total	299	870.881			

In-situ Data

Figure 18, below, shows the *in-situ* and grab sample data that was collected for the two Beaty Creek sites and Little Saline Creek. The data has been divided into pre-implementation (1999-2002) and post-implementation (2003-2007) periods.

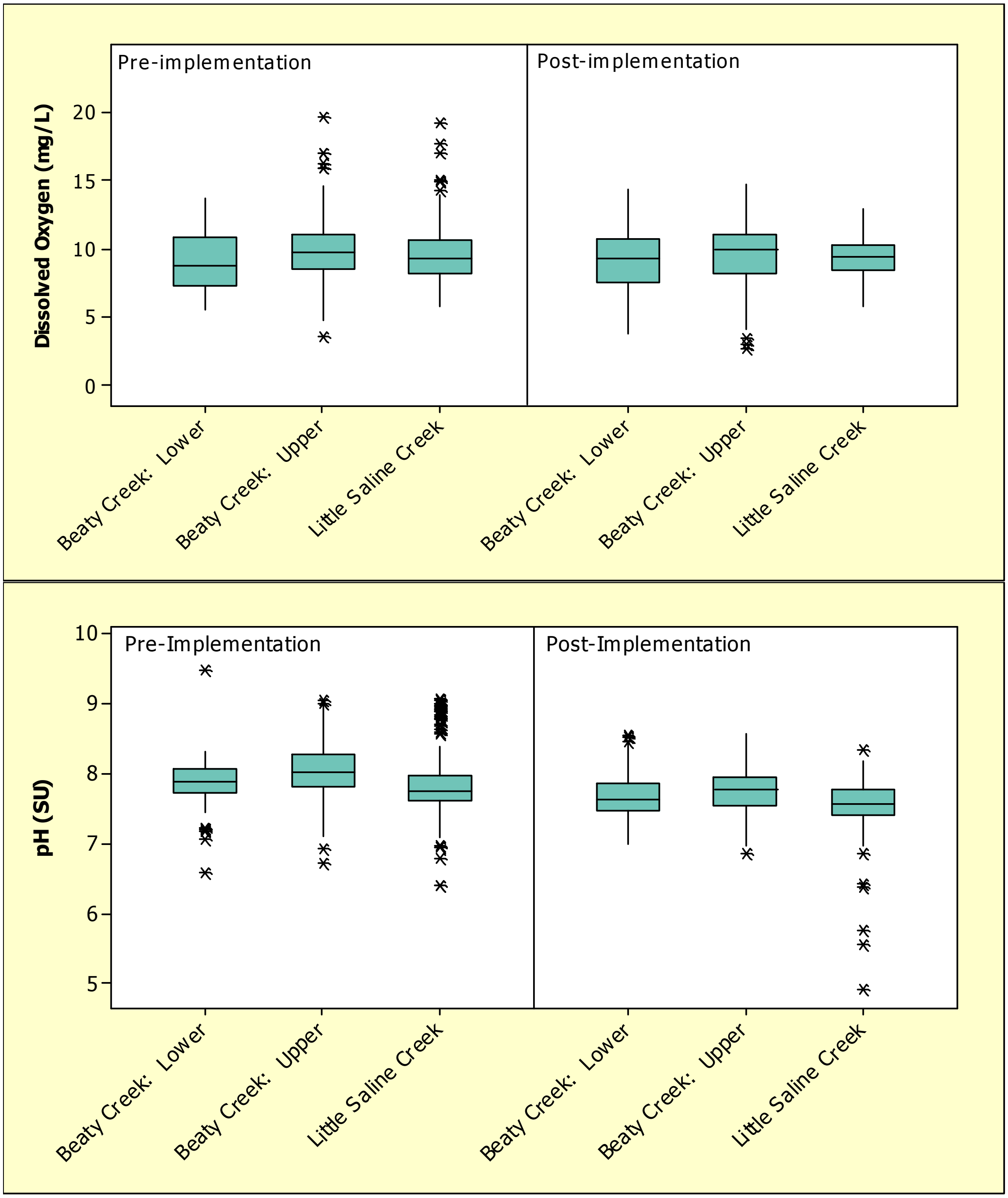


Figure 18. Boxplots of *in-situ* or grab sample data collected during pre-implementation (1999-2002) and post-implementation (2003-2007) periods. The solid line within each box is the median value, and the box represents the interquartile range (25th -75th quartile) of the data. Asterisks indicate outliers, with red asterisks showing extreme outliers whose values correspond to the altered scale above the red slash marks on the y-axis.

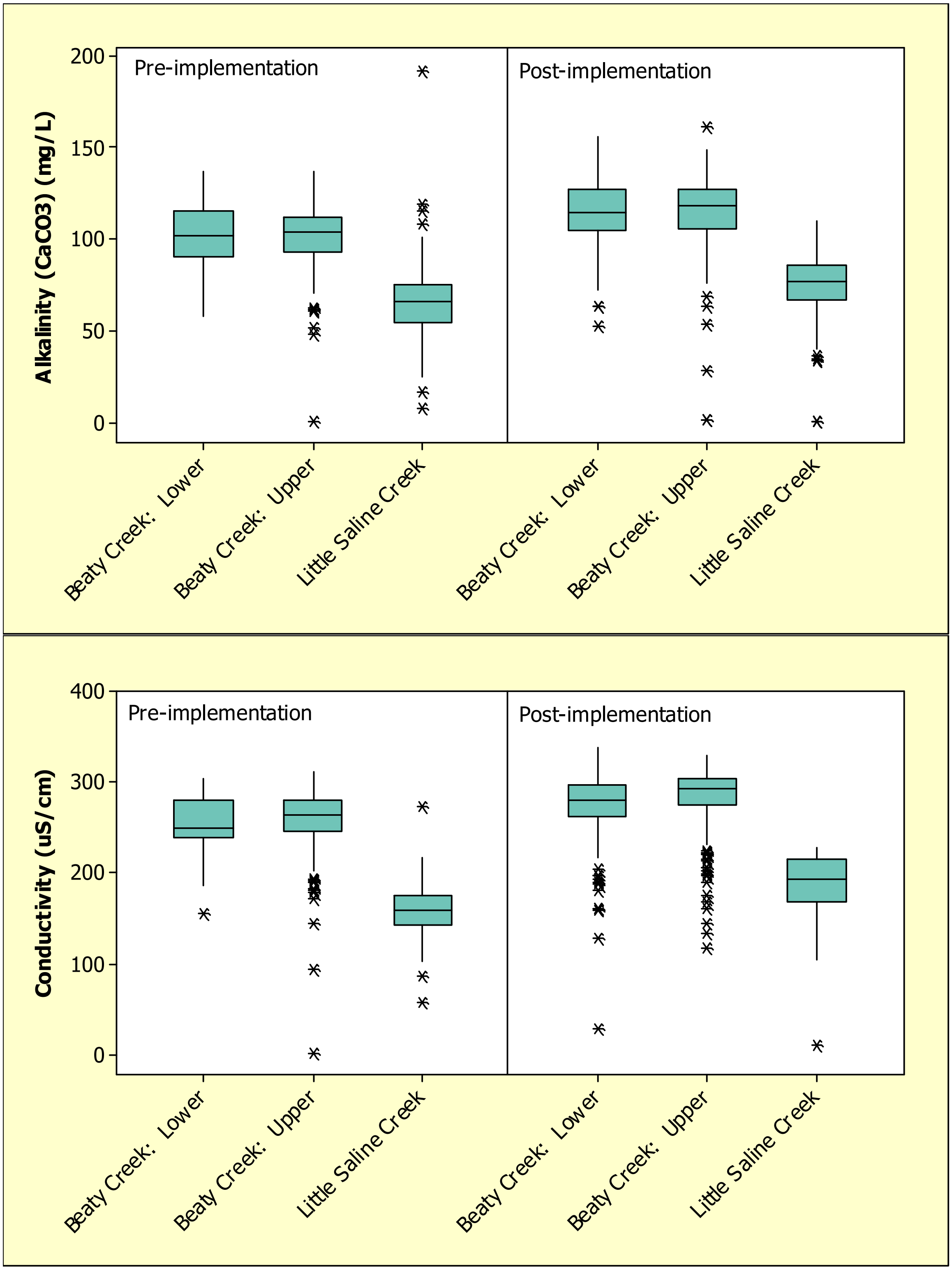


Figure 18, continued.

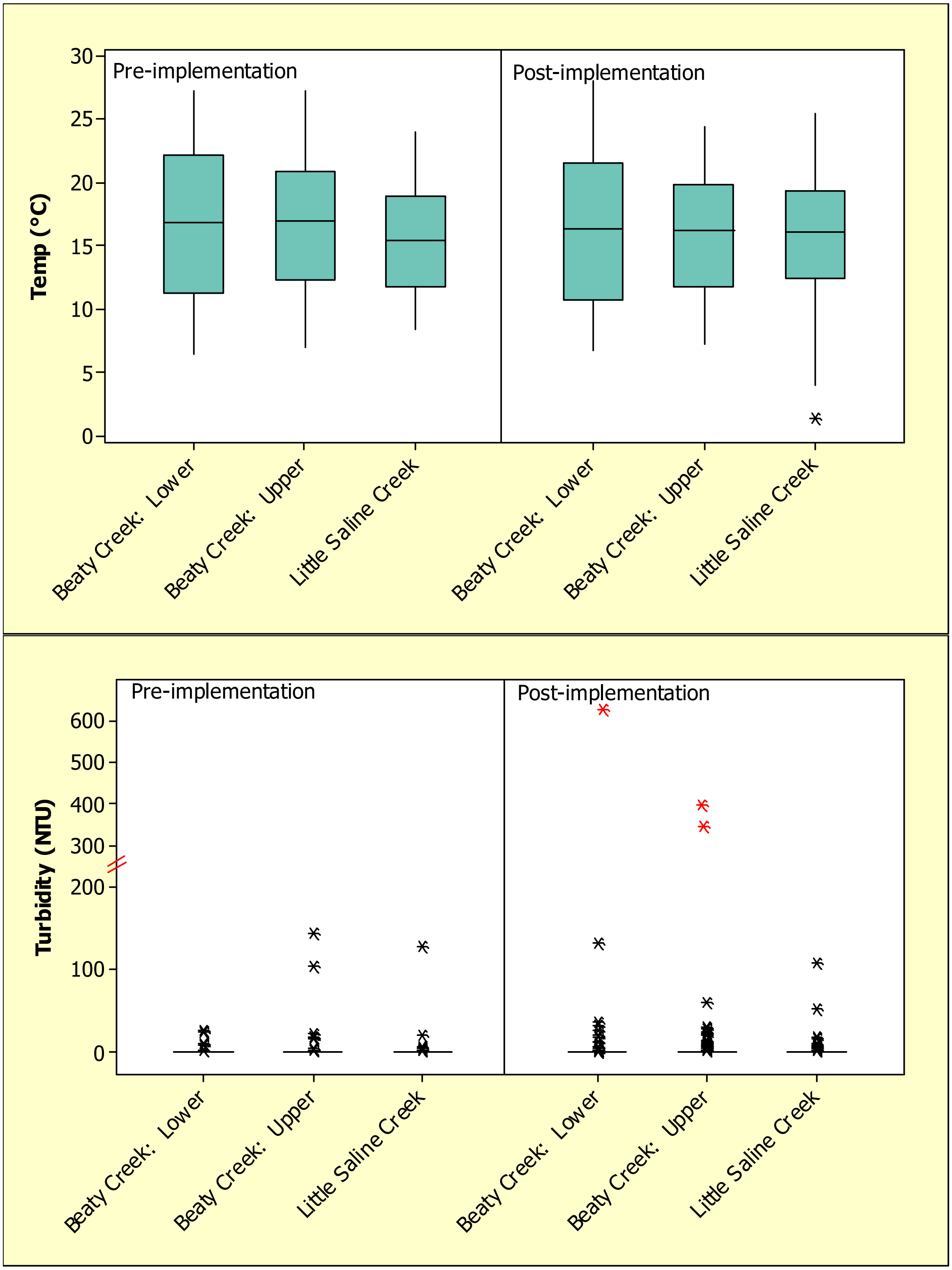
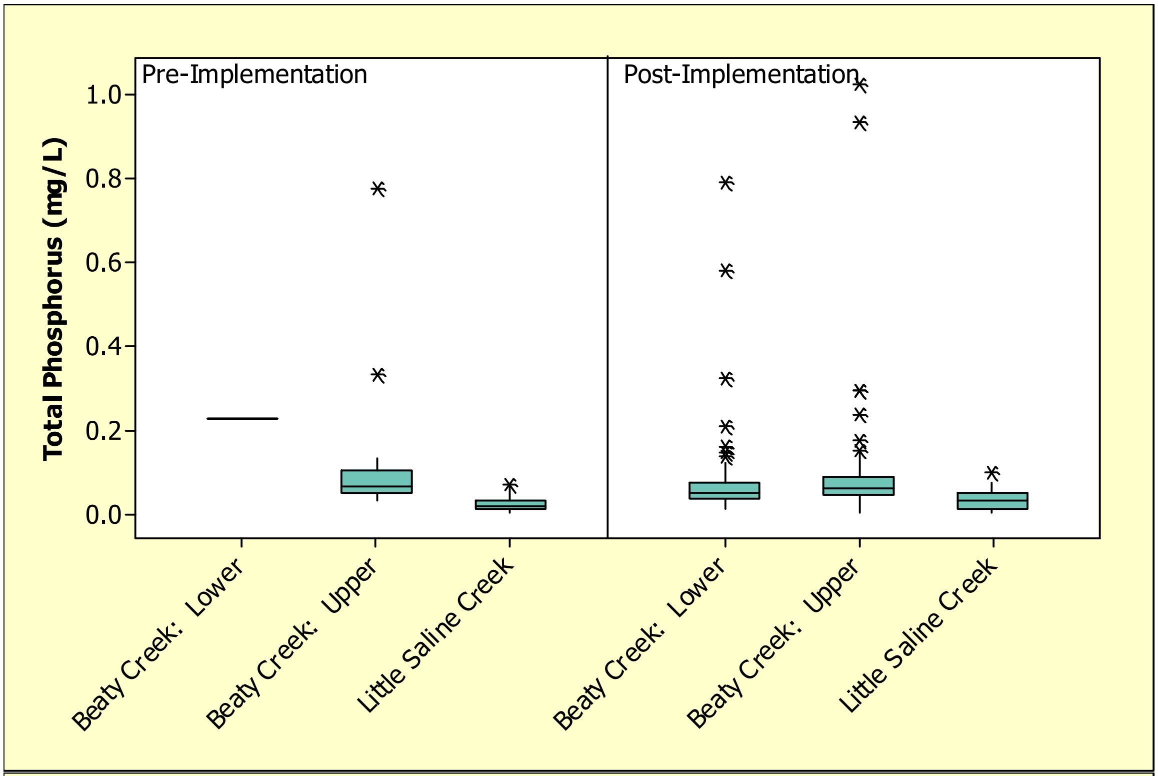


Figure 18, continued.



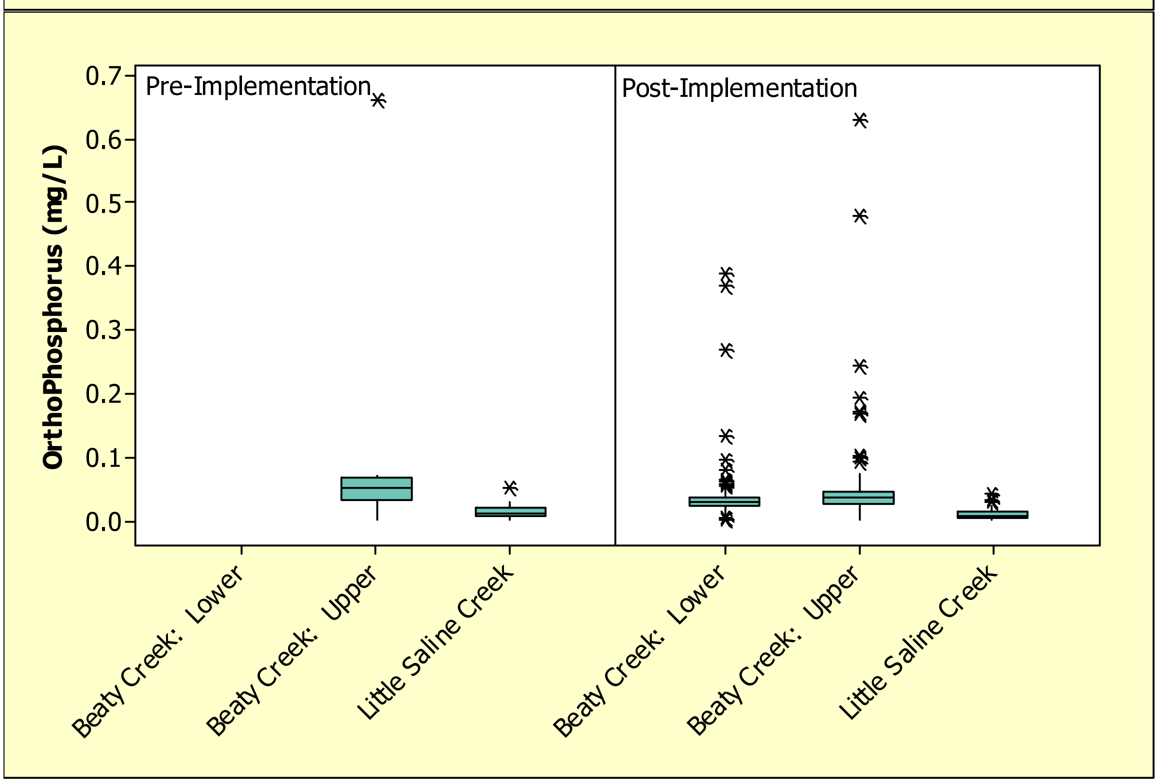
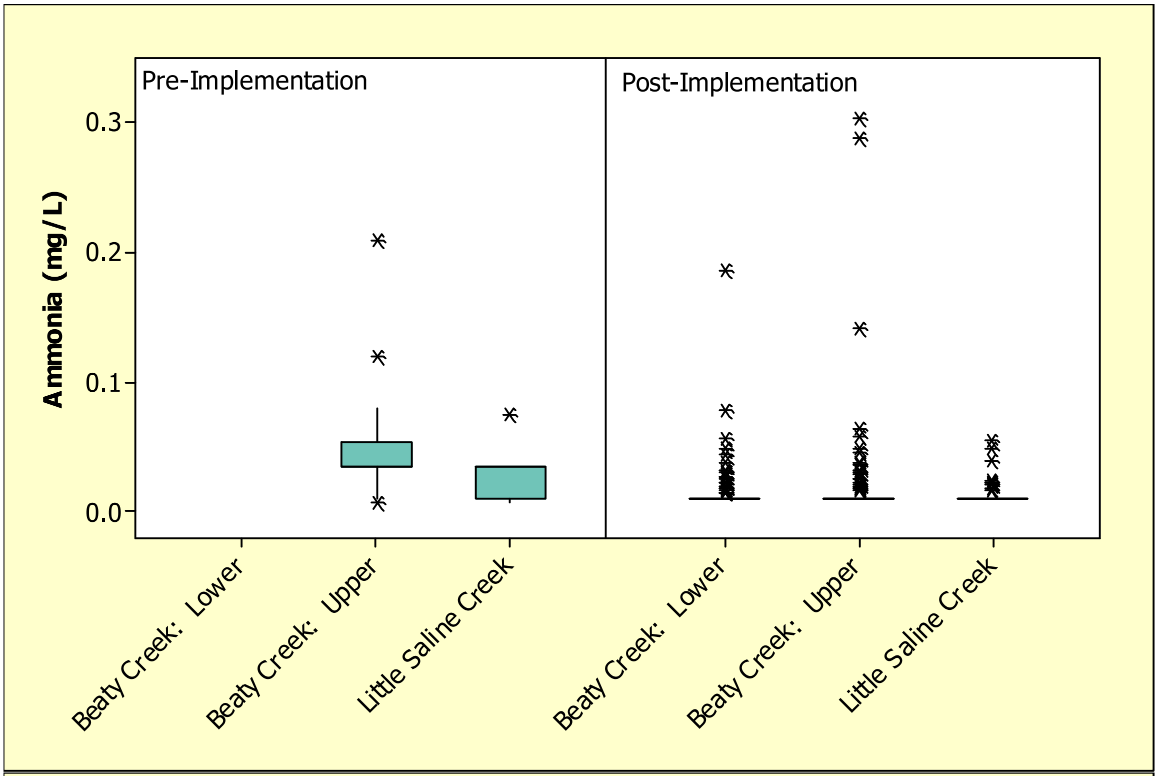


Figure 18, continued.



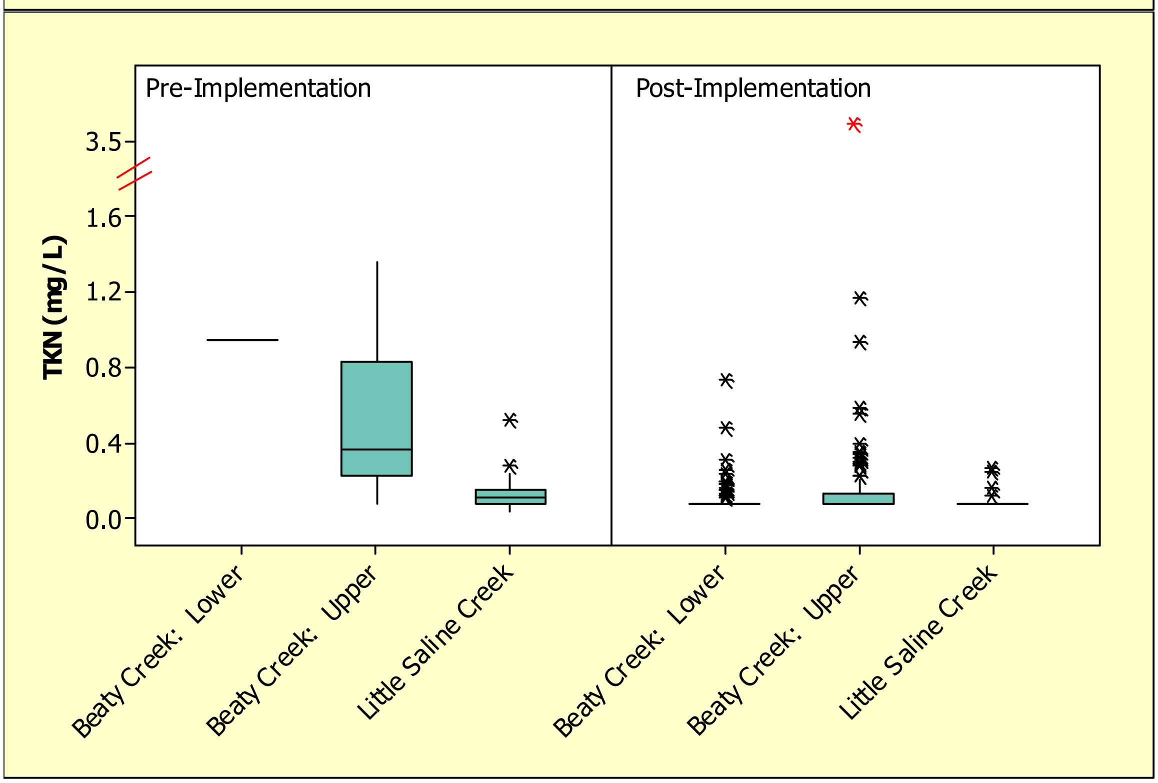


Figure 18, continued.

There was no discernible change between the two monitoring periods for the physico-chemical parameters. For the nutrient parameters, there tended to be decreases in concentration; however, these graphs depict *all* data, regardless of stream stage/flow and, thus, do not necessarily represent the typical water quality under baseflow conditions or account for variable environmental conditions like the regression/ANCOVA analyses do.

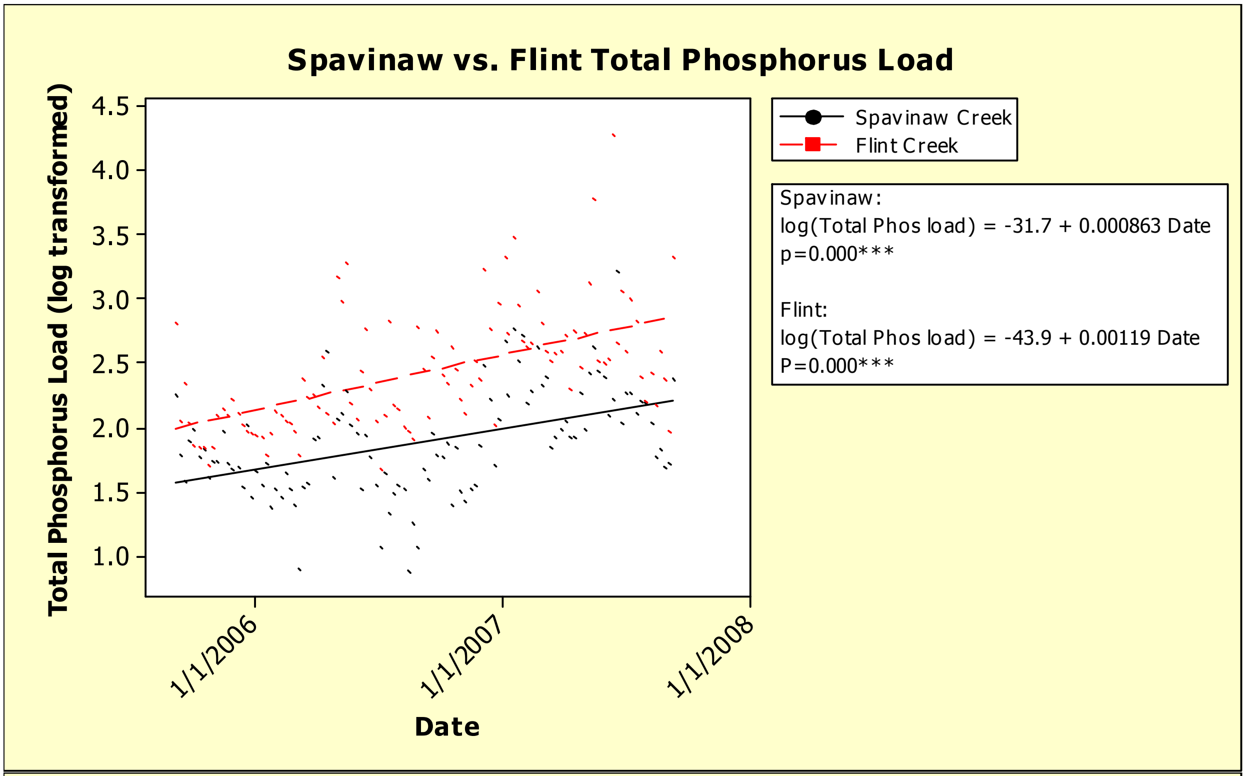
Spavinaw / Flint-Saline Watershed Analysis

Both Flint Creek and Saline Creek are control watersheds for the Spavinaw Creek watershed where implementation occurred. Flint and Spavinaw are adjacent watersheds, with each having about 50% of the area in Arkansas; however, Flint Creek receives effluent from the city of Siloam Springs, AR, and thus, is not the best control watershed for comparison to Spavinaw, which receives no discharges. At the start of this project, it was not possible to obtain access to a sampling location on Saline Creek, which is the watershed most similar to Spavinaw, so Flint was the next best site to use as a control. Currently, access to a site on Saline Creek has been obtained, so Saline can now be used as the control watershed for Spavinaw; however, there has been limited data collected so far at this site. Flint Creek will continue to be monitored since it is now part of the CREP program that the OCC is overseeing in the Illinois River watershed.

Again due to lack of land access to a preferred site, the autosampler on Spavinaw Creek was installed upstream of the confluence of Cloud Creek instead of just downstream of this tributary as planned. Since this stream has the potential to receive overflow from the city of Colcord WWTP lagoons, Cloud Creek was monitored to account for any potential impact of the WWTP on Spavinaw Creek.

The current data set for Spavinaw Creek and its controls only represents the calibration period for the paired watershed design since much of the BMP implementation occurred near the end of the project (September 2008). Therefore, it will be necessary to assess the improvements in water quality due to this project in a couple of years, at the end of the 2008 Spavinaw project. Figure 19, below, shows the data collected during this calibration period, beginning in 2005, for Spavinaw and Flint Creeks. Monitoring for Saline Creek did not begin until April 2007, so trend data for Saline was not compared to the Spavinaw site in this report. Saline will be used as a comparison to Spavinaw in future reports.

There was a significant ($p<0.05$) increase in total phosphorus, ortho-phosphorus, TKN, and nitrate loads in both the Spavinaw and Flint watersheds, and a significant increase in ammonia load in Spavinaw but not Flint. It is expected that Spavinaw will show reduced nutrient loading in the next several years, similar to that observed in the Beaty Creek watershed, once the BMPs have been installed for a longer period of time.



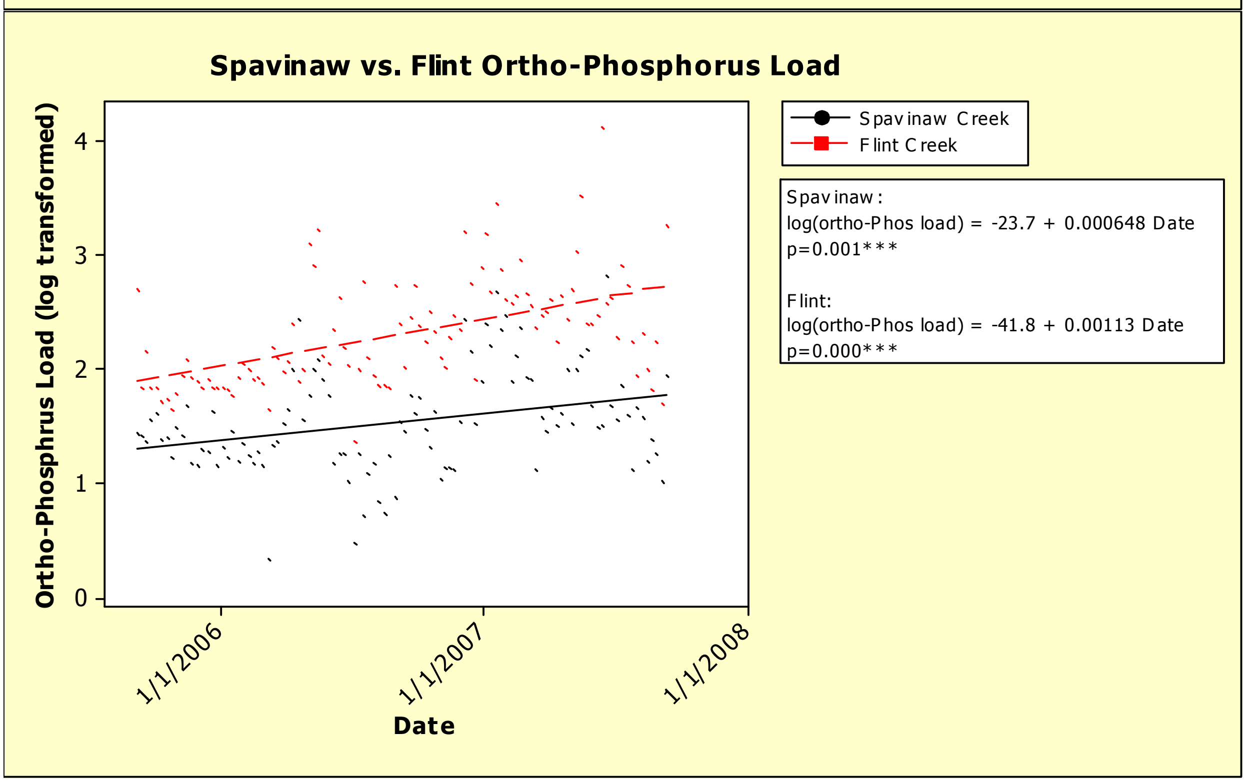
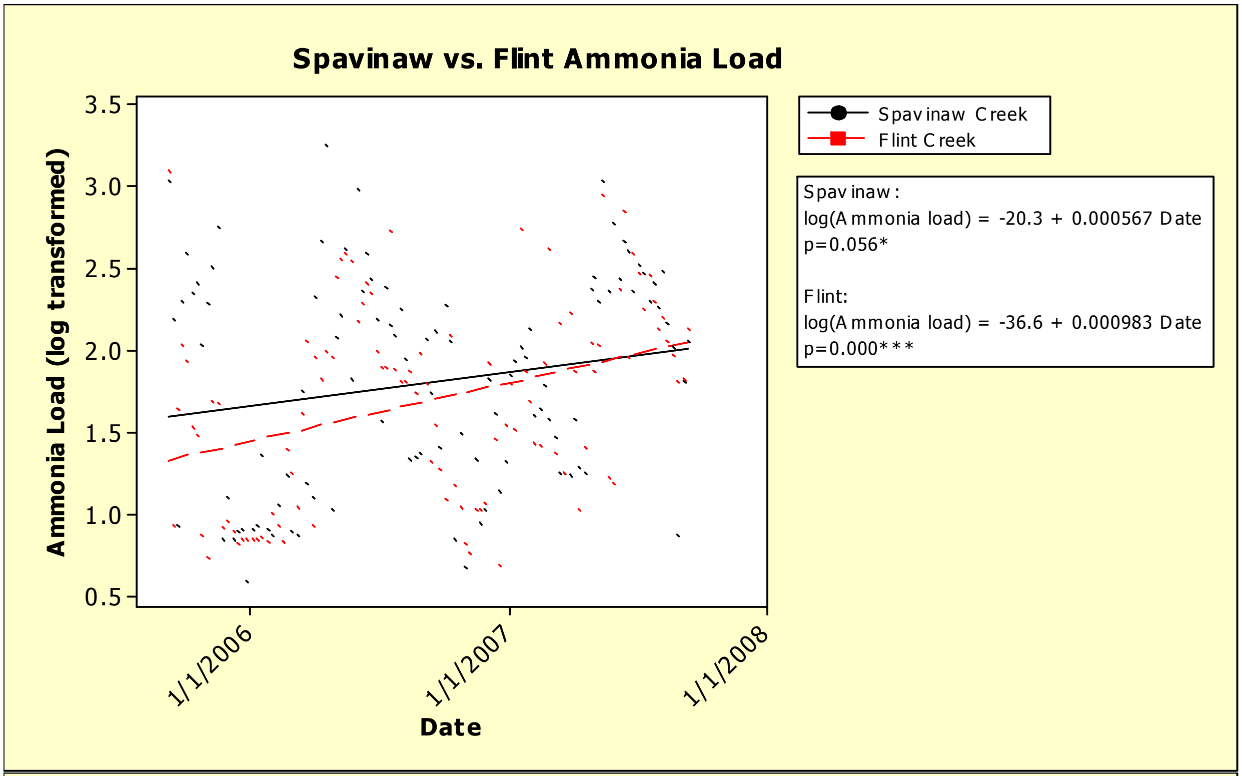


Figure 19. Comparison of nutrient loads over time.



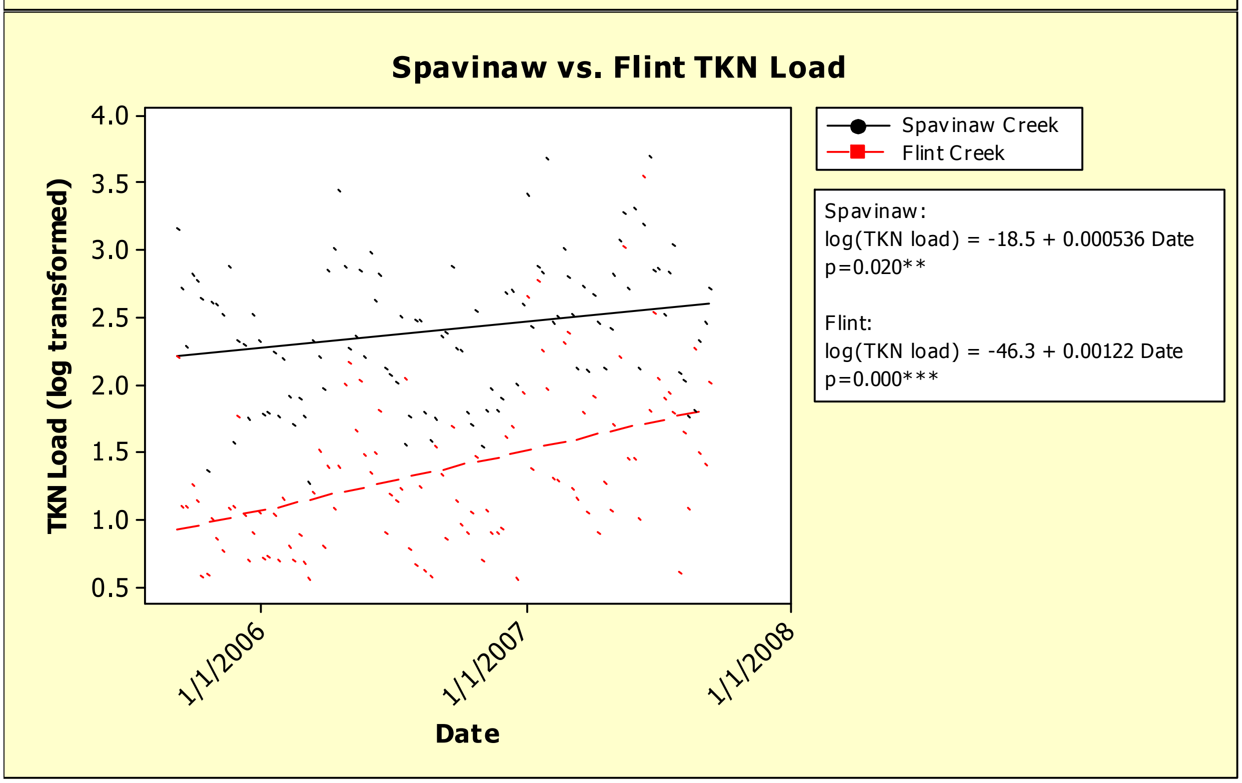


Figure 19, continued.

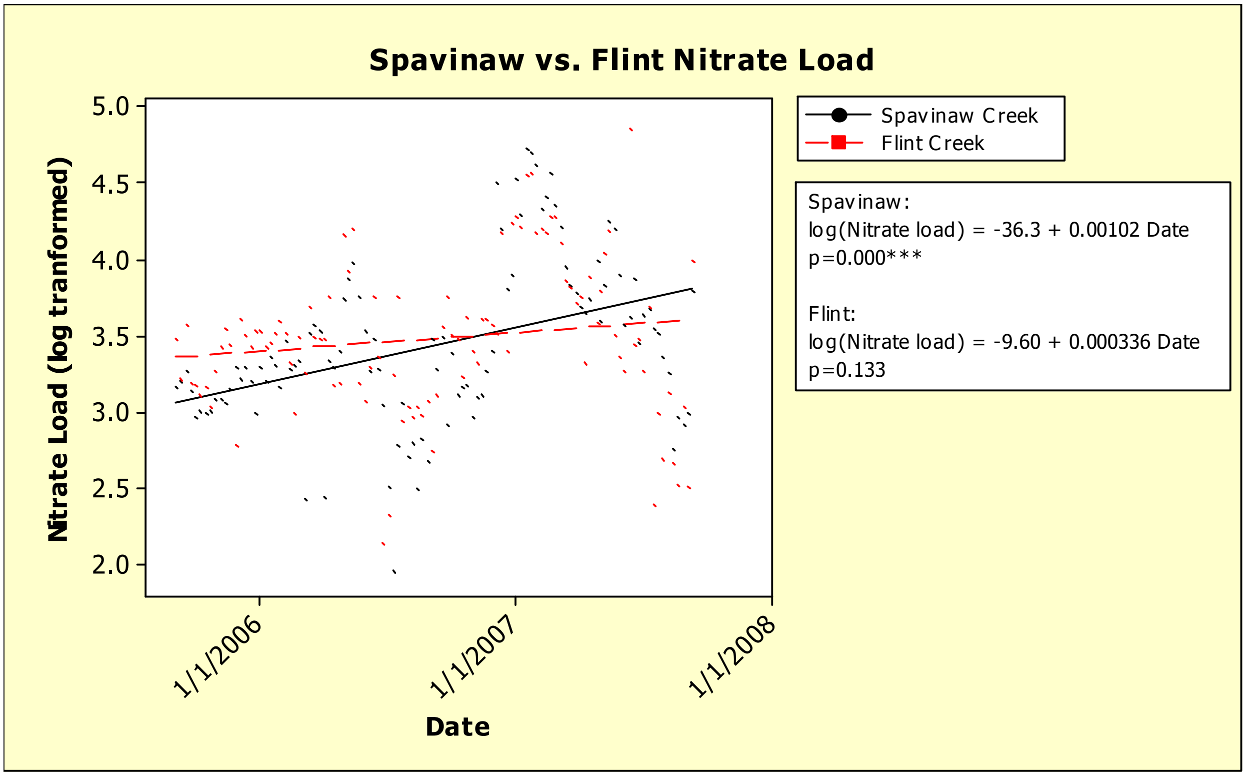


Figure 19, continued.

In-situ and grab sample data is shown in Figure 20, below, for Spavinaw, Flint, Saline, and Cloud Creek. Again, this data represents *all* data, regardless of stream stage/flow and, thus, does not necessarily represent the typical water quality under baseflow conditions or account for any environmental variability. In addition, this is only calibration period data, and it will be compared with data collected over the next 2-3 years in order to assess the effects of BMPs in the Spavinaw watershed. In general, Flint and Spavinaw have higher nutrient concentrations than Saline or Cloud.

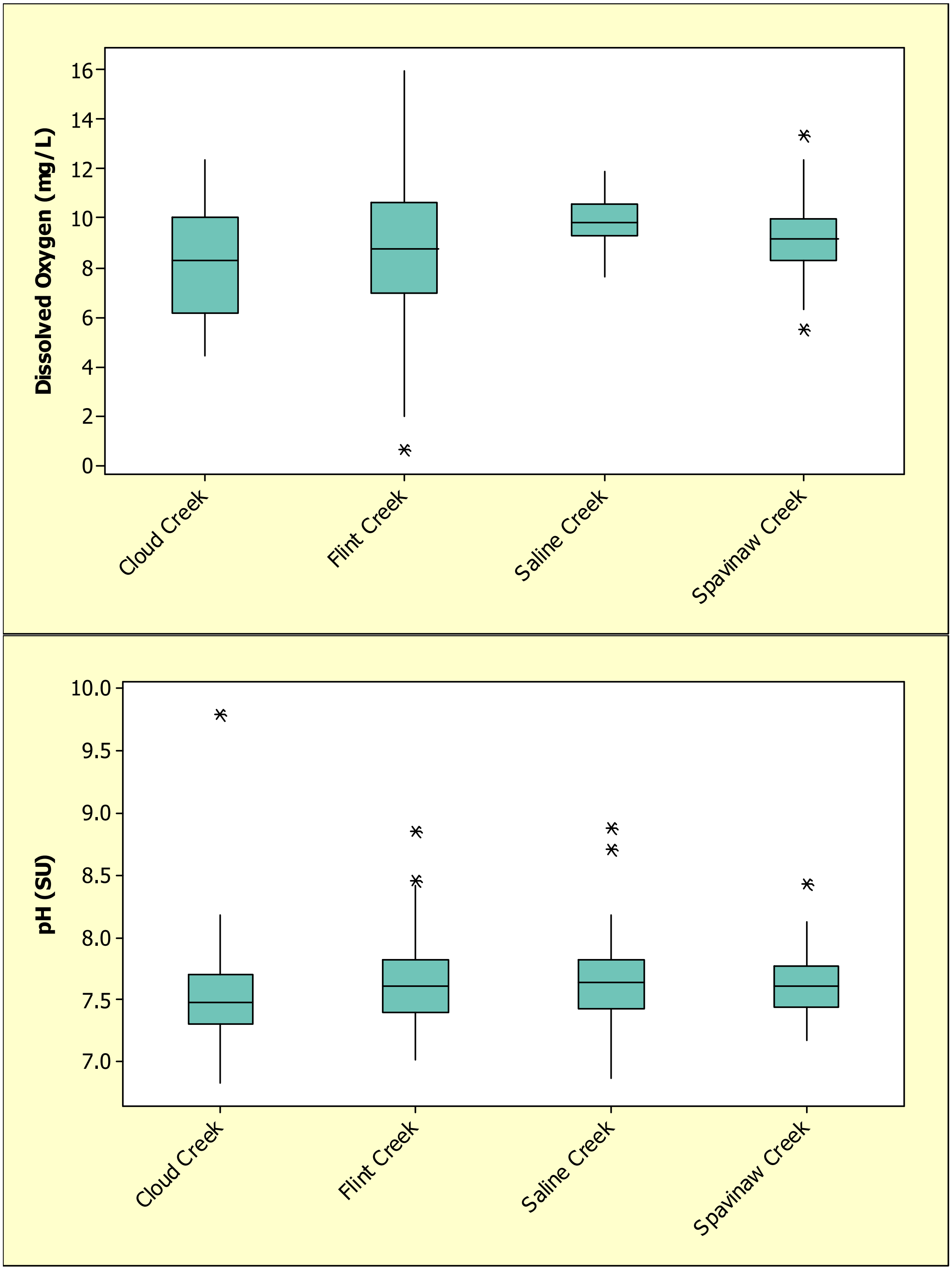
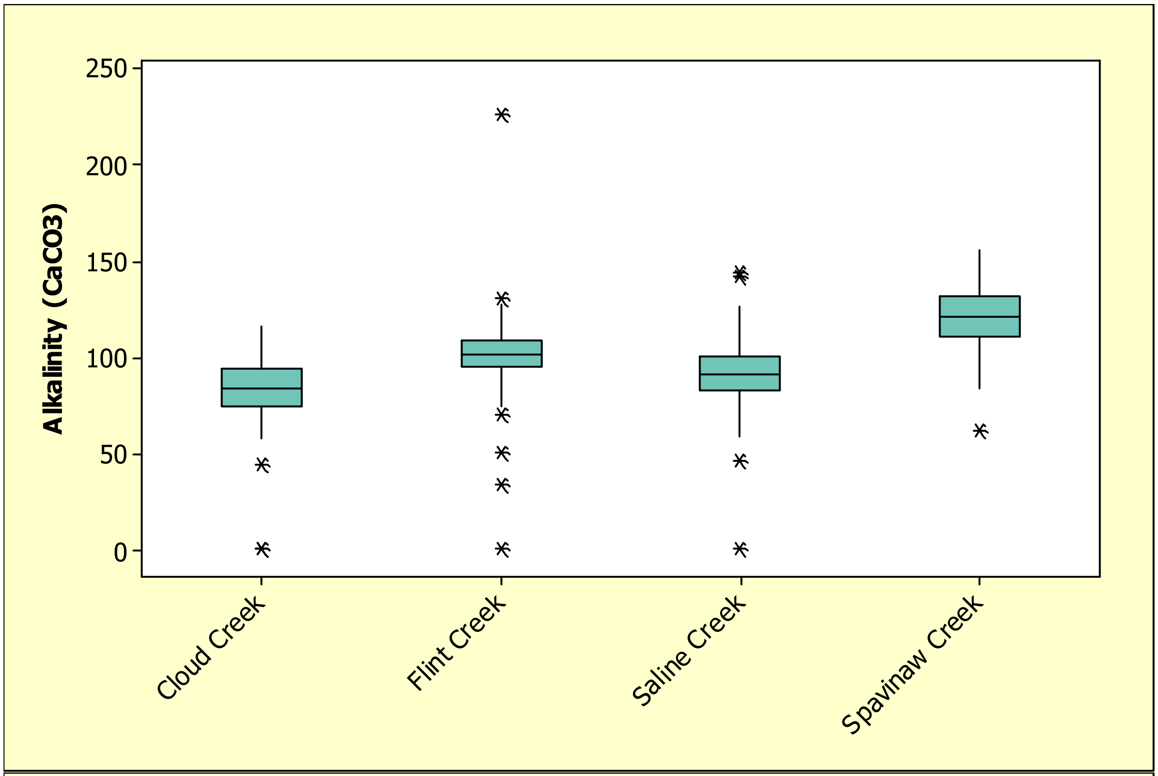


Figure 20. Boxplots of *in-situ* or grab sample data collected during the pre-implementation/calibration period (2005-2007). The solid line within each box is the median value, and the box represents the interquartile range (25th -75th quartile) of the data. Asterisks indicate outliers, with red asterisks showing extreme outliers whose values correspond to the altered scale above the red slash marks on the y-axis.



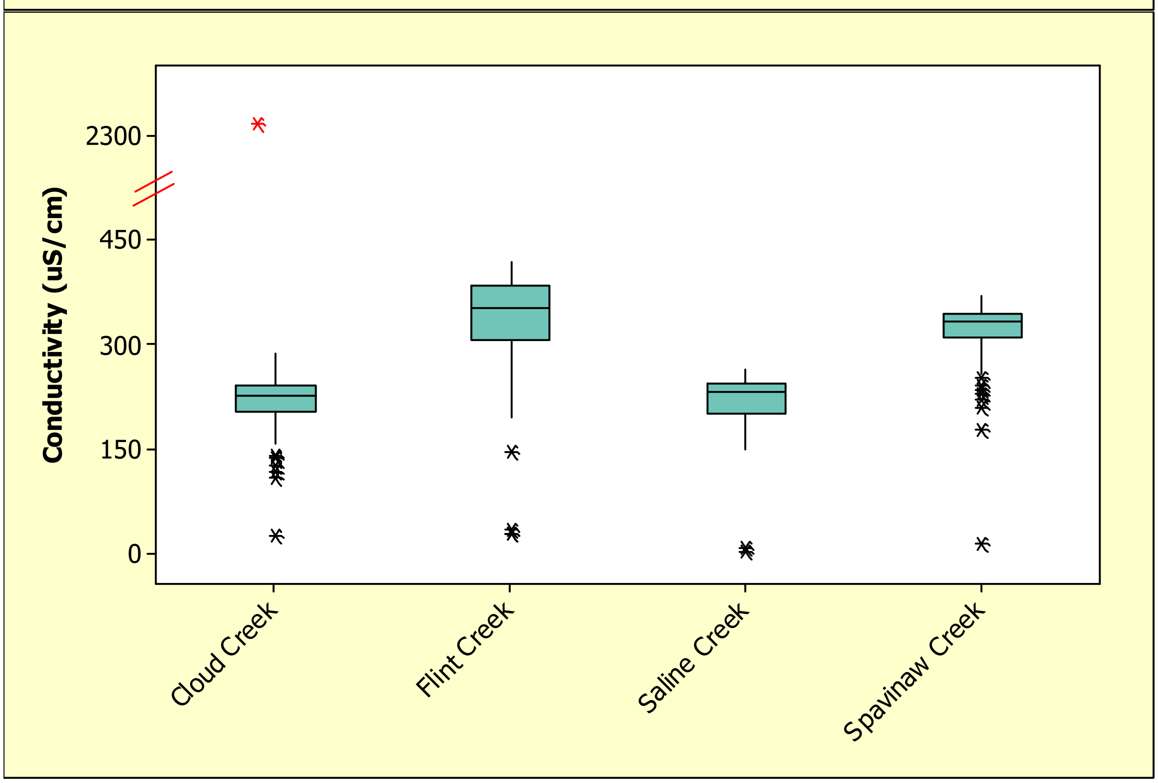


Figure 20, continued.

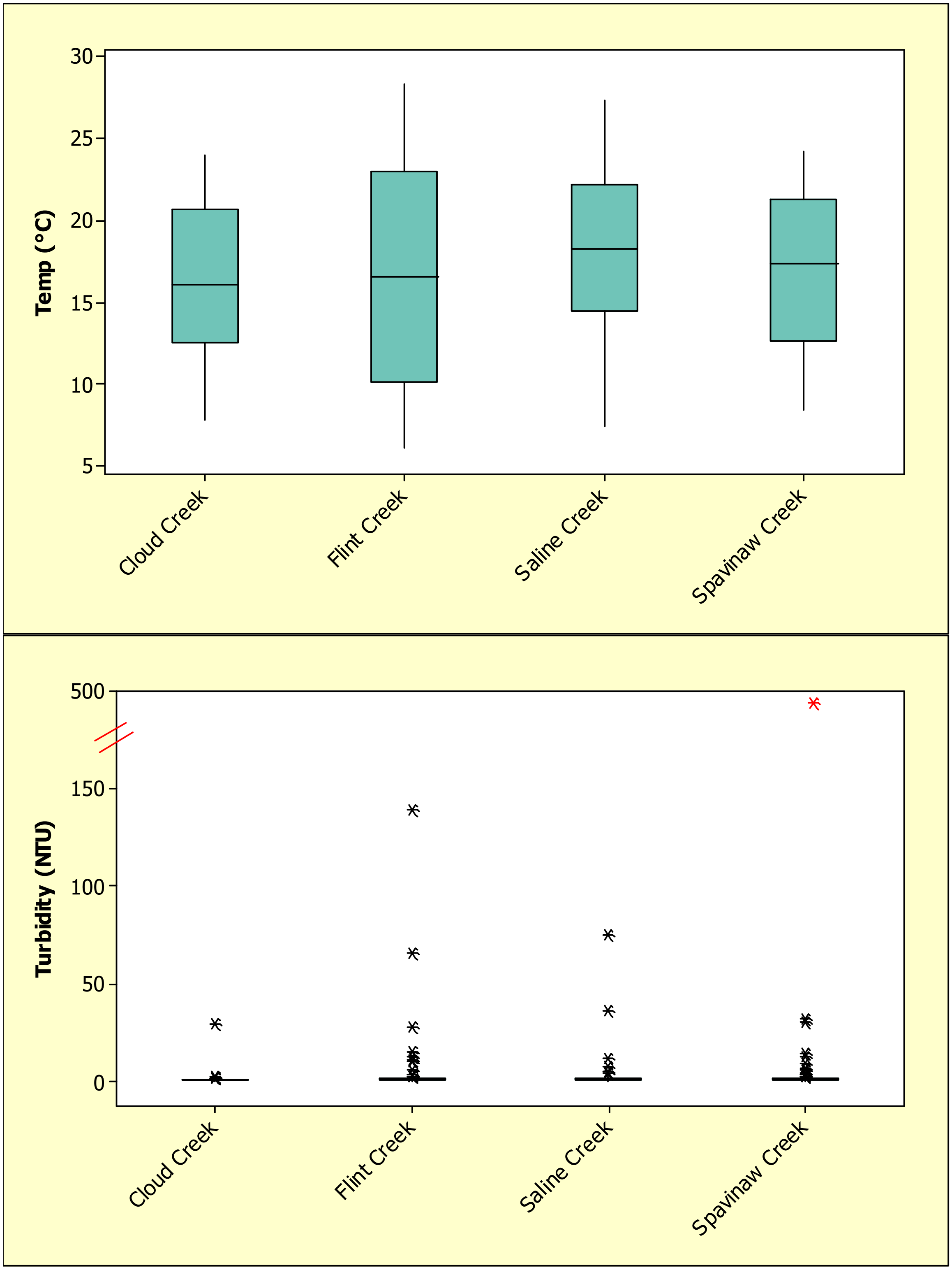


Figure 20, continued.

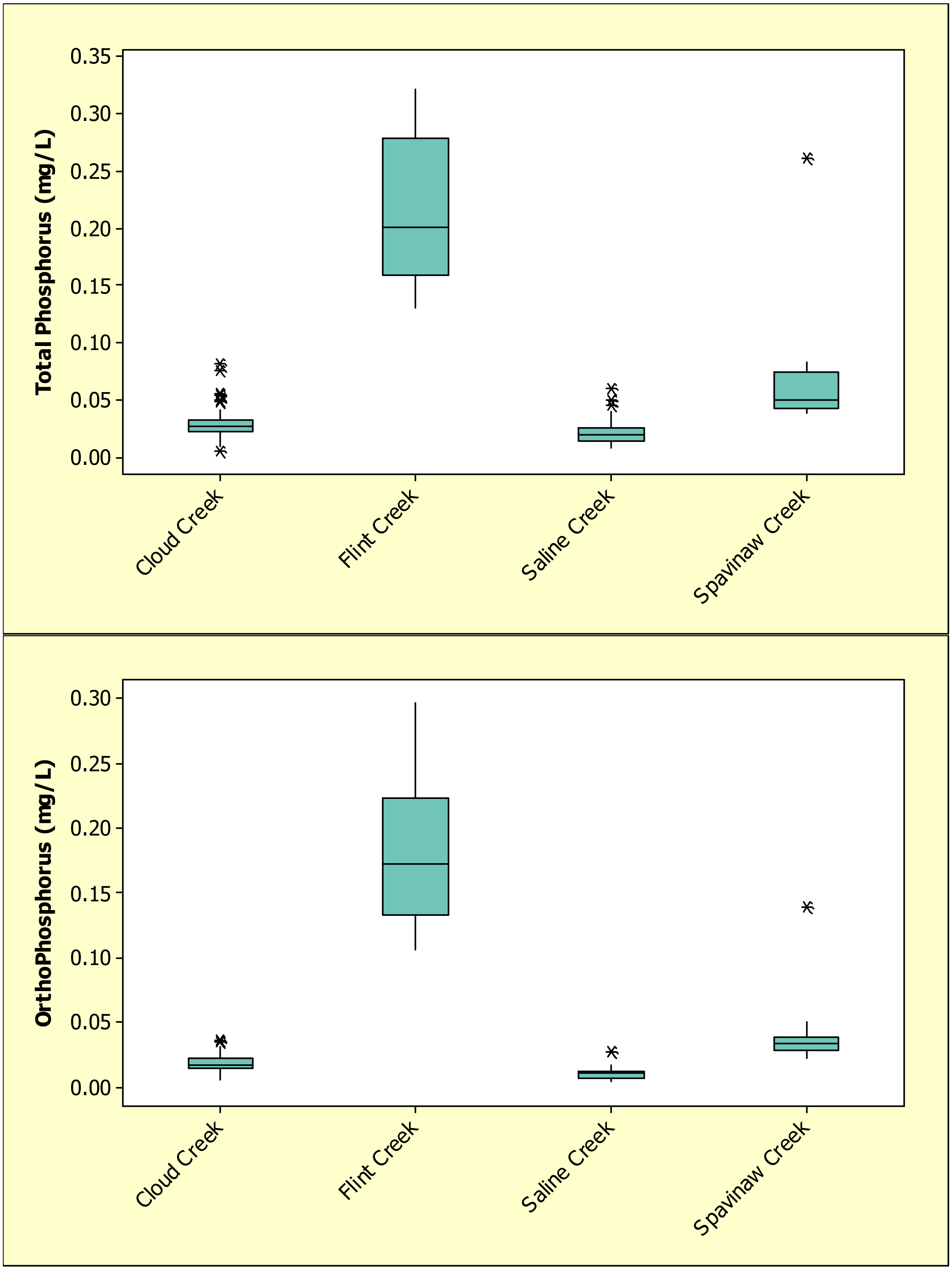
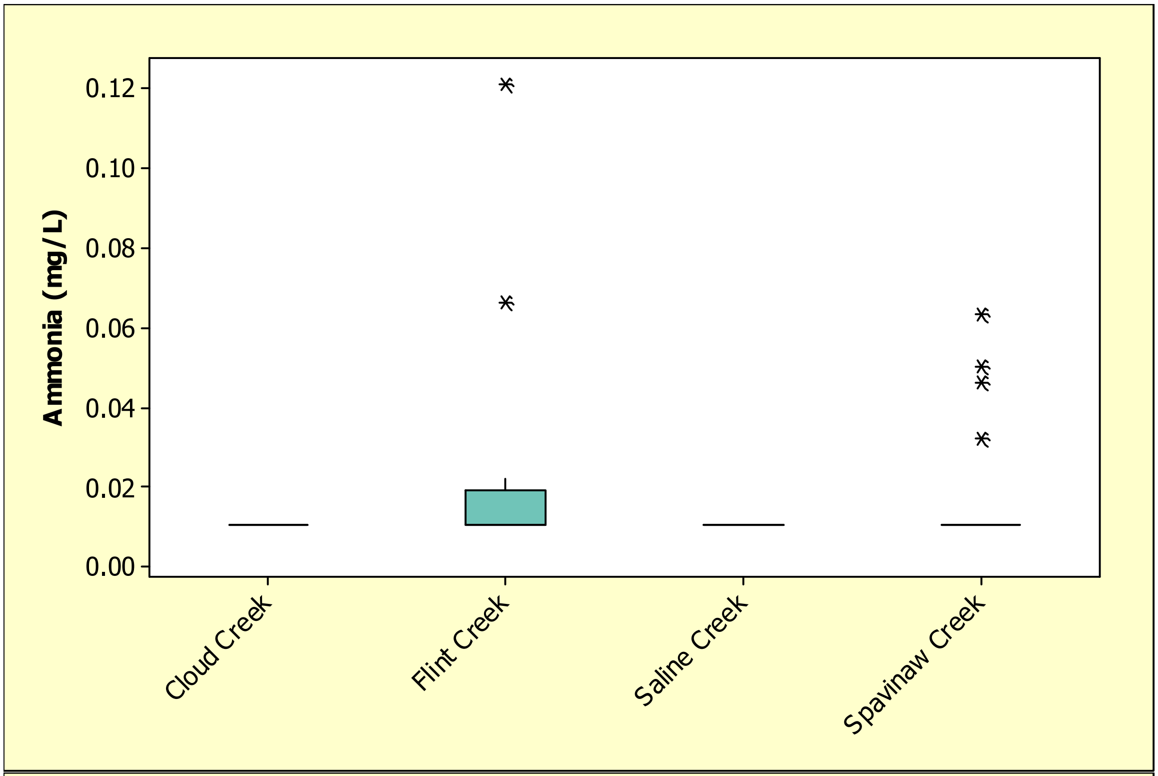


Figure 20, continued.



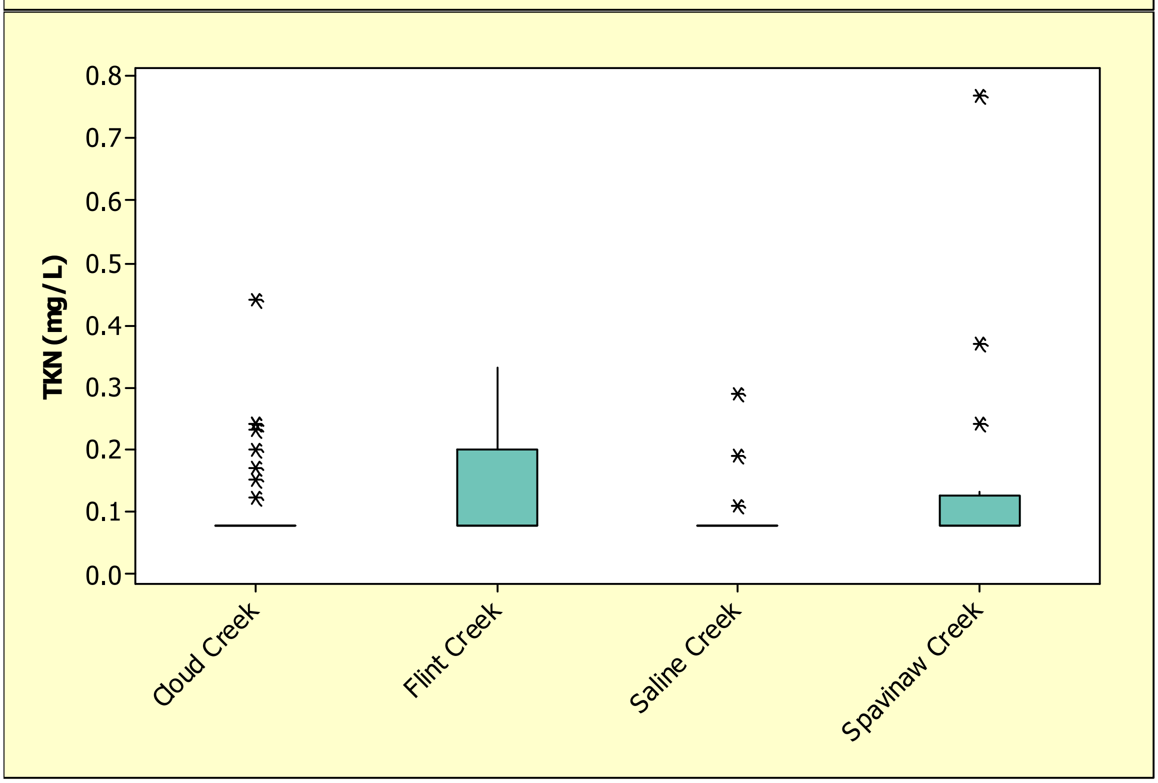


Figure 20, continued.

Biological Data Analysis

Fish

Fish collections were obtained in 1999, 2001, 2003, and 2007 for both Beaty Creek sites and the Little Saline site. In addition, fish data was assessed once during the project period for Cloud Creek and twice each for Flint and Spavinaw Creeks. Saline Creek was sampled once in 2001 and once in 2006. The fish data was analyzed using two slightly different methods to calculate an "Index of Biological Integrity" (IBI) score. Tables 19 and 20, below, show the metrics used to calculate the scores. Details of the OCC method and the USAP method for calculating IBIs are found in the latest OCC Rotating Basin report (OCC 2008) and the Oklahoma USAP (OWRB 2007), respectively.

All streams in this watershed are designated as "Cool Water Aquatic Communities." Analysis of fish collection data resulted in "excellent" fish community scores for most collections relative to cool water aquatic community (CWAC) high quality sites in the ecoregion. As seen in Table19, below, both Beaty sites and the Little Saline site had improvement in the fish community in 2001 relative to 1999; however, the 2007 Little Saline collection indicated a lower IBI score again. In addition, using the USAP method, all of the Little Saline collections gave lower scores than either Beaty site. Spavinaw and Flint both resulting in "supporting" scores with the USAP method, but the 2007 Spavinaw collection gave a lower score under the OCC method of analysis. Cloud Creek had the lowest IBI score using the OCC method and was "undetermined" in its status with the USAP method.

Table 19. Fish metrics used for calculation of IBI score using OCC method and resulting IBI, percent of reference, and condition.

Site	Date	Total Species	# Darters	# Sunfish Spp	# Intolerant Spp	% Tolerant Spp	% Insectivorous Cyprinids	% Lithophilic Spawners	OCC IBI	OCC %ref	OCC condition
Beaty Creek: Lower	9/15/1999	17	3	5	9	6.30	17.78	92.59	31	0.89	good
	8/16/2001	17	4	4	10	1.70	51.70	98.16	35	1.00	excellent
	7/29/2003	22	4	5	14	5.45	20.07	92.07	33	0.94	excellent
	7/19/2007	23	4	4	12	4.02	30.36	94.64	33	0.94	excellent
Beaty Creek: Upper	8/26/1999	20	4	6	12	1.92	13.46	98.08	31	0.89	good
	8/16/2001	22	3	6	14	3.22	61.37	96.78	35	1.00	excellent
	7/29/2003	19	3	5	13	0.35	64.71	99.65	35	1.00	excellent
	8/16/2007	18	3	4	12	0.38	40.15	99.62	33	0.94	excellent
Little Saline Creek	9/15/1999	11	2	2	7	0.65	38.06	99.35	29	0.83	good
	8/28/2001	14	3	1	8	8.78	57.98	71.28	33	0.94	excellent
	7/24/2003	12	3	1	8	0.53	47.47	99.47	33	0.94	excellent
	7/30/2007	12	3	1	8	1.28	28.26	98.72	29	0.83	Good

Site	Date	Total Species	# Darters	# Sunfish Spp	# Intolerant Spp	% Tolerant Spp	% Insectivorous Cyprinids	% Lithophilic Spawners	OCC IBI	OCC %ref	OCC condition
Saline Creek	8/2/2001	21	5	6	12	0.73	29.04	99.09	33	0.94	excellent
	7/13/2006	19	5	5	12	2.22	23.33	96.11	33	0.94	excellent
Cloud Creek	7/11/2007	9	3	0	6	0.00	21.54	100.00	25	0.71	fair
Flint Creek	9/13/2005	21	3	4	14	0.89	40.02	98.95	33	0.94	excellent
	8/29/2007	17	3	5	11	2.27	41.29	97.73	33	0.94	excellent
Spavinaw Creek	9/20/2005	20	5	3	14	0.23	37.63	98.63	33	0.94	excellent
	8/10/2007	23	4	5	12	1.63	15.63	97.14	31	0.89	good

Table 20. Fish metrics used for calculation of IBI score using Oklahoma USAP method and resulting score/condition.

Site	Date	Total Species	Total Number	# Sunfish Spp	# Intolerant Spp	% Tolerant Spp	% lithophils	# Spp Comprising 75%	Shannon Diversity	% Delt Anomalies	IBI (USAP)	IBI Condition (USAP)
Beaty Creek: Lower	9/15/1999	17	270	5	9	6.30	92.59	3	1.8555	0	39	Supporting
	8/16/2001	17	706	4	10	1.70	98.16	3	1.6899	0	39	Supporting
	7/29/2003	22	807	5	14	5.45	92.07	6	2.3698	0	43	Supporting
	7/19/2007	23	448	4	12	4.02	94.64	5	2.1581	0	43	Supporting
Beaty Creek: Upper	8/26/1999	20	624	6	12	1.92	98.08	4	1.8524	0	41	Supporting
	8/16/2001	22	963	6	14	3.22	96.78	3	1.6350	0	41	Supporting
	7/29/2003	19	1139	5	13	0.35	99.65	4	1.5549	0	39	Supporting
	8/16/2007	18	787	4	12	0.38	99.62	3	1.7675	0	41	Supporting
Little Saline Creek	9/15/1999	11	155	2	7	0.65	99.35	4	1.8071	0	35	Undetermined
	8/28/2001	14	376	1	8	8.78	71.28	3	1.7492	0	35	Undetermined
	7/24/2003	12	375	1	8	0.53	99.47	4	1.8807	0	35	Undetermined
	7/30/2007	12	545	1	8	1.28	98.72	4	1.9716	0	35	Undetermined
Saline Creek	8/2/2001	21	1095	6	12	0.73	99.09	3	1.6027	0	39	Supporting
	7/13/2006	19	360	5	12	2.22	96.11	4	2.0326	0	39	Supporting
Cloud Creek	7/11/2007	9	984	0	6	0.00	100.00	4	1.7998	0	35	Undetermined
Flint Creek	9/13/2005	21	1237	4	14	0.89	98.95	3	1.6384	0	39	Supporting
	8/29/2007	17	528	5	11	2.27	97.73	3	1.7449	0	39	Supporting
Spavinaw Creek	9/20/2005	20	877	3	14	0.23	98.63	4	1.9330	0	37	Supporting
	8/10/2007	23	1292	5	12	1.63	97.14	4	2.1478	0	41	Supporting

Instream and riparian habitat assessments were conducted at sites concurrent with fish collections. All assessments were conducted in accordance with procedures outlined in the OCC Habitat Assessment SOP (OCC SOP 2006). The OCC's habitat assessment adheres to a modified version of the EPA Rapid Bioassessment Protocols (RBP) (as described in the SOP) and is designed to assess habitat quality in relation to its ability to support biological communities in the stream. Figures 21 and 22 and Table 21, below, show the results of the habitat assessments.

The Beaty Upper site showed the largest increase in the average post-implementation habitat score relative to the pre-implementation score (Figure 21), although the Beaty Lower site had a large improvement in 2007 relative to 2003 (Table 21). BMPs implemented throughout the earlier and current projects were expected to improve instream and riparian habitat, and the high scores in 2007 indicate success in this area. Improvement in habitat quality is similarly expected in the Spavinaw watershed once the recently installed BMPs have been in place for a while.

Cloud Creek had a high habitat score yet a low fish score. This is most likely due to streambed disturbance caused by gravel harvest downstream of the collection site which creates relatively long reaches of interstitial flow. Since the receiving stream (Spavinaw Creek) is approximately 2.3 kilometers from the collection site, the large expanse of stream with interstitial flow inhibits the migration of fish from the receiving stream up to the collection area at normal flow. In addition, fish populations need areas of refuge, especially during dry periods; refuge areas for fish downstream of the collection area do not exist, thereby reducing numbers of fish that can move freely in and out of the target reach. Although the habitat score on the collection reach is relatively high, that reach of Cloud Creek is actually often isolated from much of the rest of the stream system by the interstitial or intermittent flow. This “island effect” can and probably has significantly reduced both numbers of fish and diversity. Since the Cloud Creek site has this specific disturbance, only Flint and Saline will be used as comparator sites for fish communities.

Table 21. Habitat assessment values, total habitat score, and site total score relative to reference site score for this ecoregion.

SiteName	Date	Instream Cover	Pool Bottom Substrate	Pool Variability	Canopy Cover Shading	Presence of Rocky Runs or Riffles	Flow	Channel Alteration	Channel Sinuosity	Bank Stability	Bank Vegetation Stability	Streamside Cover	Total Points	% of Reference
Beaty Creek: Upper	8/26/1999	17	18.1	14	14.9	12.4	20	1.8	1.1	8	2.8	7.6	118	1.03
	8/16/2001	15	14.4	19	11.5	0	20	2.3	1.1	9	5.5	9.2	107	0.94
	7/29/2003	14	18.8	20	14.5	0	20	1.4	1	9	4.5	10	114	1.00
	8/16/2007	19	18.8	19	18	7.5	20	1.8	1.1	10	6.5	10	131	1.16
Beaty Creek: Lower	9/15/1999	18	18	9.9	8.3	16.3	20	1.8	2.7	9	2.4	9.2	115	1.01
	8/16/2001	16	18.1	19	9.8	14.1	9.9	0.4	3.1	9	5	10	114	1.00
	7/29/2003	16	19.3	9.9	9.6	10.3	8.9	0.4	1.1	8	5.6	10	99	0.87
	7/19/2007	20	18.5	20	7.2	14.7	17	0.4	0.5	8	6	10	121	1.07
Little Saline Creek	9/15/1999	18	18.2	17	18.2	16.3	17	5.8	0.8	9	5.6	9.9	136	1.19
	8/28/2001	18	15.7	14	20	16.2	7.6	5	0.8	9	5.8	9.7	122	1.07

SiteName	Date	Instream Cover	Pool Bottom Substrate	Pool Variability	Canopy Cover Shading	Presence of Rocky Runs or Riffles	Flow	Channel Alteration	Channel Sinuosity	Bank Stability	Bank Vegetation Stability	Streamside Cover	Total Points	% of Reference
Little Saline, cont.	7/24/2003	19	16.7	15	20	15.6	12	5.8	0.4	9	3.9	9.6	127	1.12
	7/30/2007	19	17.9	19	19.7	16.1	14	4.2	0.5	9	3.8	10	134	1.18
Saline Creek	8/2/2001	18	16.2	17	7.7	15.2	15	0.4	0.1	5	1.6	8.4	105	0.92
	7/13/2006	13	17.2	0	2.7	16.3	17	1.4	0.1	3	1.8	8.9	81.3	0.72
Cloud Creek	7/11/2007	20	18.9	20	10.6	14.7	14	1.8	9.6	9	5.9	8.7	132	1.16
Flint Creek	9/13/2005	19	16.8	18	9.3	14.1	18	0.4	0.2	8	4.9	10	119	1.05
	8/29/2007	20	18.4	13	13.6	16.1	20	0.4	2	9	5.9	10	128	1.12
Spavinaw Creek	9/20/2005	19	16.4	13	1.4	15.2	20	0.4	0.9	7	4.5	9.7	109	0.96
	8/10/2007	20	17.5	14	0.6	15.6	19	7.7	1.1	8	4.5	3.2	110	0.97

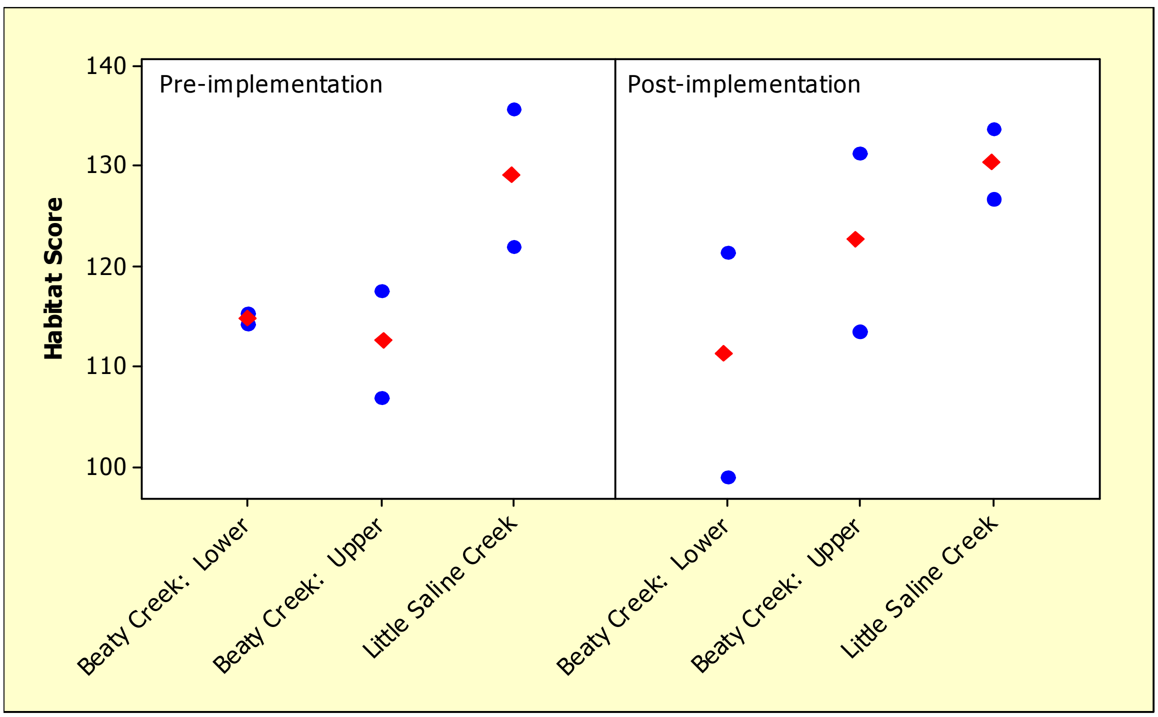


Figure 21. Total habitat score for each site during the pre-implementation period (1999-2001) and the post-implementation period (2003-2007). Blue dots indicate the score of a single assessment, while red diamonds represent the average habitat score of the assessments for that site within that period.

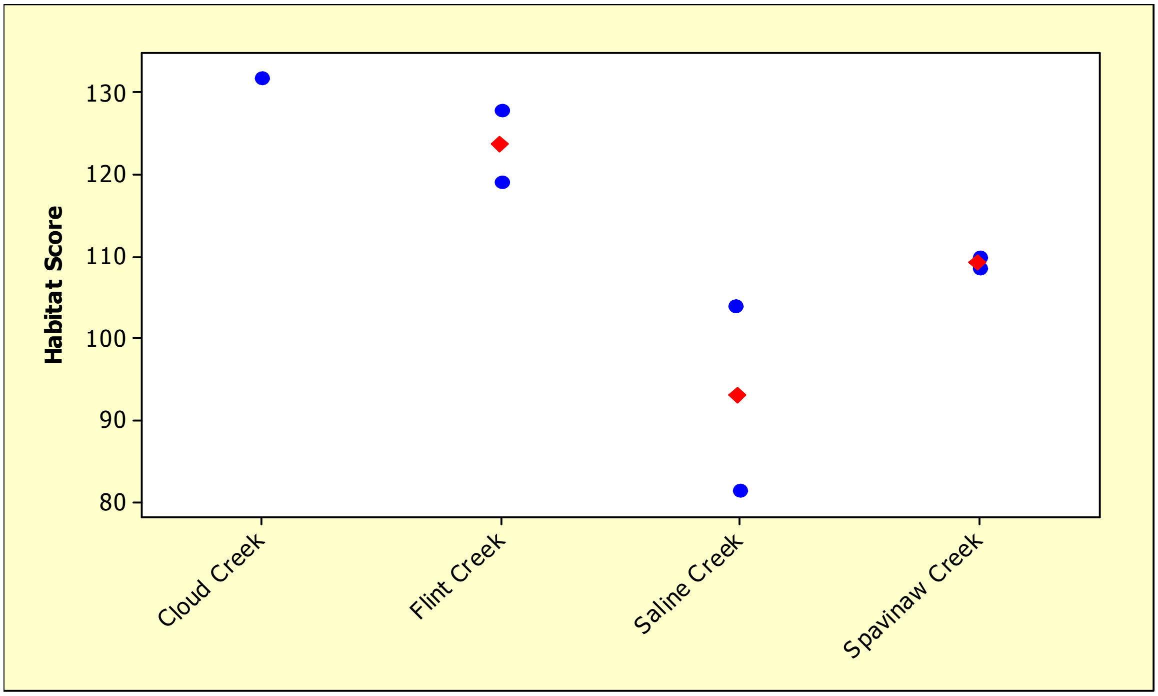


Figure 22. Total habitat score for each site during the pre-implementation period (1999-2001) and the post-implementation period (2003-2007). Blue dots indicate the score of a single assessment, while red diamonds represent the average habitat score of the assessments for that site.

Macroinvertebrates

Macroinvertebrate collections were attempted at all sites twice a year, once in the winter period (January 1 to March 15) and once in the summer period (July 1 to September 15). Macroinvertebrates were only collected if there was flowing water, so in dry periods, no samples were obtained. Sampling efforts included attempts to procure animals from all available habitats at a site; thus, total effort at a site may have entailed up to three total samples with one from each of the following habitats: rocky riffles, streamside vegetation, and woody debris. Table 22 shows summarized results.

Table 22. Average macroinvertebrate metrics used to calculate an IBI score, score percent of reference, and biological condition of sites. In the "Season" column, "S" denotes the summer index period and "W" indicates the winter period. "Pre" and "Post" represent the time periods of 1999-2002 or 2003-2007, respectively. For condition, "NI" represents nonimpaired relative to high quality sites in the ecoregion, "SI" indicates slightly impaired.

Season	Collection type	Site name	Period	# collections	Total Species	Percent EPT taxa	Shannon Diversity	HBI	Percent dominant 2 taxa	% HBI	total pts	%ref total pts	condition
S	riffle	Beaty Creek: Lower	pre	4	23.5	0.53	2.37	4.29	0.49	1.01	32.00	1.17	NI
			post	5	17.0	0.59	1.86	4.40	0.60	0.99	26.40	0.97	NI
S	riffle	Beaty Creek: Upper	pre	4	19.3	0.72	2.30	4.32	0.49	1.01	31.50	1.15	NI
			post	5	19.4	0.66	2.06	4.24	0.55	1.02	29.20	1.07	NI
S	riffle	Little Saline Creek	pre	4	19.3	0.51	2.30	4.28	0.47	1.02	30.50	1.12	NI
			post	5	20.0	0.42	2.28	4.18	0.47	1.05	31.20	1.14	NI
S	riffle	Cloud Creek		2	13.0	0.60	1.58	4.39	0.70	0.99	23.00	0.84	NI
S	riffle	Flint Creek		3	19.7	0.69	2.35	4.58	0.43	0.95	32.67	1.20	NI
S	riffle	Saline Creek		4	18.5	0.68	2.21	4.36	0.51	1.00	32.00	1.17	NI
S	riffle	Spavinaw Creek		4	18.3	0.64	2.44	4.21	0.37	1.04	32.67	1.20	NI
W	riffle	Beaty Creek: Lower	pre	3	18.0	0.56	2.27	3.92	0.45	1.04	27.33	0.89	SI
			post	5	15.4	0.31	1.54	4.86	0.74	0.85	16.80	0.55	SI
W	riffle	Beaty Creek: Upper	pre	3	18.7	0.40	2.05	4.86	0.60	0.84	27.33	0.89	NI
			post	5	16.4	0.33	1.69	4.88	0.66	0.89	18.00	0.59	SI
W	riffle	Little Saline Creek	pre	4	20.3	0.53	2.46	4.19	0.40	0.98	29.50	0.96	NI
			post	5	18.8	0.42	2.29	4.91	0.47	0.84	23.60	0.77	SI
W	riffle	Cloud Creek		2	11.0	0.58	1.75	4.97	0.60	0.83	18.00	0.59	SI
W	riffle	Flint Creek		2	16.0	0.33	1.93	5.91	0.59	0.69	21.00	0.68	SI
W	riffle	Saline Creek		5	21.0	0.48	2.14	4.68	0.52	0.93	25.60	0.83	NI
W	riffle	Spavinaw Creek		2	22.5	0.67	2.64	4.40	0.33	0.93	30.00	0.98	NI
S	veg	Beaty Creek: Lower	pre	1	25.0	0.68	2.21	4.63	0.58	1.23	32.00	1.28	NI
S	veg	Little Saline Creek	pre	3	16.3	0.13	1.95	6.06	0.61	0.95	22.00	0.88	NI
W	veg	Little Saline Creek	pre	3	14.7	0.54	1.94	4.10	0.57	1.05	24.00	0.88	NI
W	veg	Saline Creek		1	17.0	0.88	1.95	2.45	0.62	1.65	30.00	1.10	NI
S	wood	Beaty Creek: Upper	pre	2	18.0	0.51	2.24	5.16	0.46	0.91	29.00	1.12	NI
S	wood	Little Saline Creek	pre	4	15.8	0.13	1.57	3.73	0.70	1.69	20.00	0.77	SI
W	wood	Beaty Creek: Lower	pre	2	13.5	0.33	1.64	4.79	0.69	0.95	28.00	1.24	NI
W	wood	Beaty Creek: Upper	pre	2	15.5	0.50	1.98	4.44	0.57	1.03	28.00	1.24	NI
W	wood	Little Saline Creek	pre	2	21.5	0.46	2.27	4.03	0.52	1.13	32.00	1.41	NI
W	wood	Saline Creek		1	11.0	0.31	1.65	4.91	0.64	0.92	24.00	1.06	NI

The method used to determine the condition of the biological communities at each site is based on and modified from methods outlined in the EPA Rapid Bioassessment Protocols (Plafkin et al. 1989). The biological data was compared relative to data from high quality cool water aquatic community (CWAC) sites in the Ozark Highlands ecoregion following the method described in the latest Rotating Basin report (OCC 2008).

For the Beaty sites and Little Saline site, four pre-implementation and five post-implementation summer riffle collections were obtained for each site (Table 22). All collections were "non-impaired" relative to high quality sites in the ecoregion with the exception of the 2005 Beaty Lower sample, which was "moderately impaired"; however, the average condition of all sites was non-impaired over both periods (Table 22). Figure 23, below, shows the median and range of IBI scores of summer and winter riffle collections and compares these values over the pre- vs. post-implementation periods.

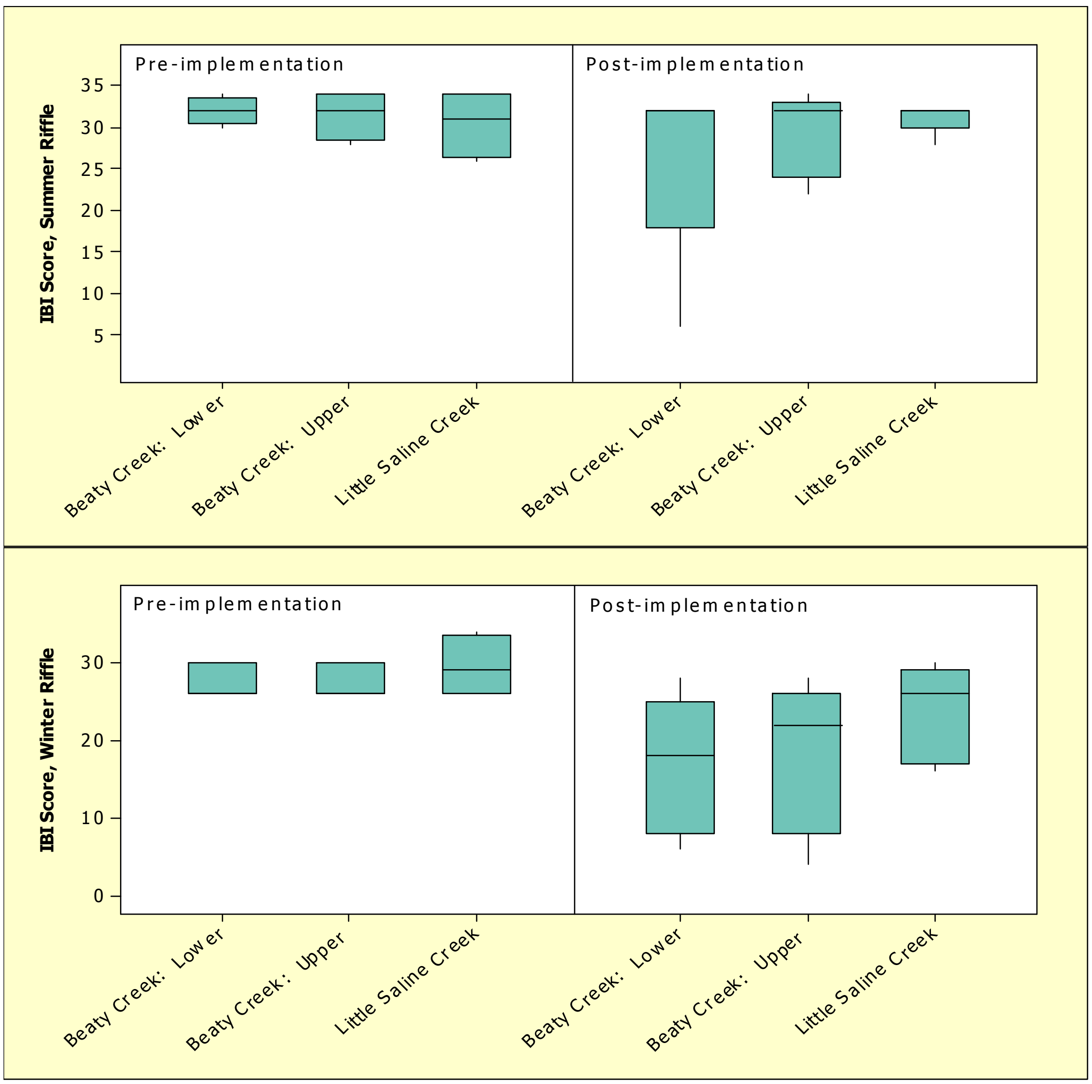


Figure 23. Macroinvertebrate IBI scores for summer and winter riffle collections for the pre-implementation period (1999-2001) compared to the post-implementation period (2003-2007). The solid line within each box is the median value, and the box represents the interquartile range (25th -75th quartile) of the data.

The two Beaty sites had three pre-implementation and five post-implementation winter riffle macroinvertebrate collections, while Little Saline had four pre- and five post-implementation winter riffle collections. The last two post-implementation collections (2006 and 2007) for Little Saline were "slightly impaired." The first 2 post-implementation collections (2003 and 2004) for Beaty Upper were "slightly impaired," the 2005 collection was "severely impaired," and the 2006 collection was "moderately impaired." At the Beaty Lower site, the 2004 and 2005 collections were slightly impaired while the 2006 and 2007 were moderately impaired. When all winter riffle collections were averaged for each site, the post-implementation period resulted in a "slightly impaired" condition for all three sites, a decrease in condition from the average pre-implementation condition (Table 22, above).

The general trend toward more impaired macroinvertebrate samples is likely the result of two years of drought (2005-2006). The reference samples to which all collections were compared were taken during more normal climatic conditions, which would accentuate the stress of the communities that resulted from lack of normal water conditions. Due to the design of the paired watershed method, the data is valuable for comparison between treatment watersheds and the control watershed, regardless of environmental stresses, since all watersheds in the area experienced the same climatic conditions. There is not a significant difference in macroinvertebrate IBI score between the treatment and control watersheds.

During the project period (2005-2007), two summer riffle collections were obtained for Cloud and Saline Creeks, and three were obtained for Flint and Spavinaw Creeks. All collections were "nonimpaired" except for one of the Cloud Creek collections. Figure 24, below, shows the median and range of IBI scores for these four sites. Flint and Spavinaw had significantly higher average IBI scores than the other two sites.

For the winter index period, two collections were obtained for each site, with the exception of Saline Creek, which only had one collection. Cloud Creek and Flint Creek had average IBI scores which were "slightly impaired," while Saline and Spavinaw were "nonimpaired." Spavinaw Creek had the highest winter riffle macroinvertebrate score.

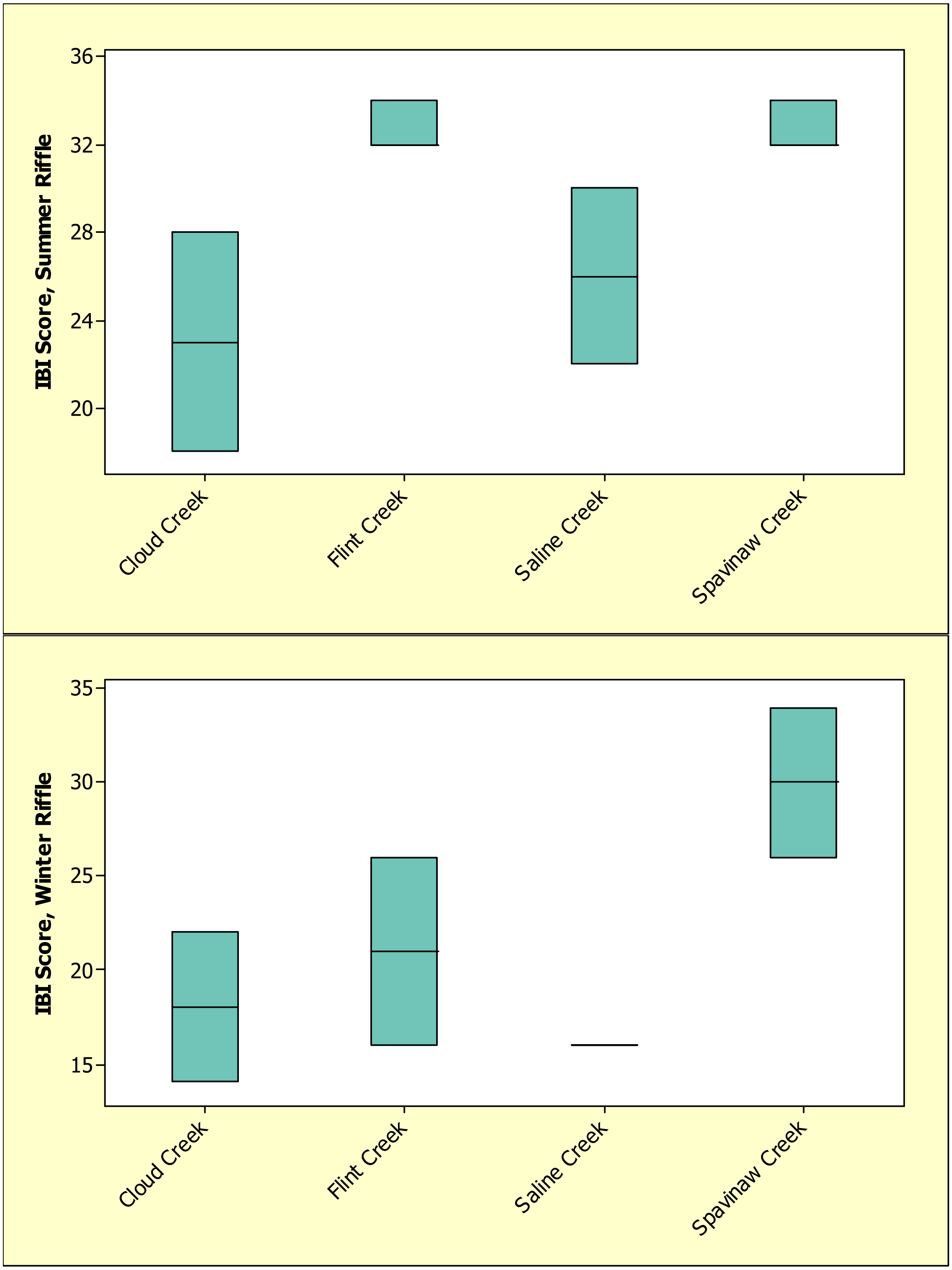


Figure 24. IBI scores for summer and winter riffle collections. The solid line within each box is the median value, and the box represents the interquartile range (25^{th} -75^{th} quartile) of the data.

Bacteria

Of the sites sampled for this project, Beaty Creek, Little Saline Creek, and Flint Creek are listed on the state's 2008 303(d) list as not attaining the designated Primary Body Contact Recreation (PBCR) use due to impairment by *Enterococcus* bacteria. The criteria for being placed on the 303(d) list of impaired waters are described in the Oklahoma State Standards (OWRB 2007).

Beaty Creek was removed from the 303(d) list for *E. coli* bacteria impairment in 2006, and the stream has had a significant reduction in the geometric mean of *Enterococcus* during the post-implementation period relative to the pre-implementation period (Figure 25, below). In contrast, Little Saline has exhibited no significant change in bacteria concentration. This suggests that the implementation of BMPs in the Beaty watershed has helped to ameliorate the pathogen load, and it is hoped that this improvement will continue to the point that the stream is delisted for *Enterococcus* as well. It is expected that a similar trend will be observed in the Spavinaw Creek watershed over time. Figure 26 shows the geometric means for bacteria for the Spavinaw, Flint, Saline, and Cloud Creek sites.

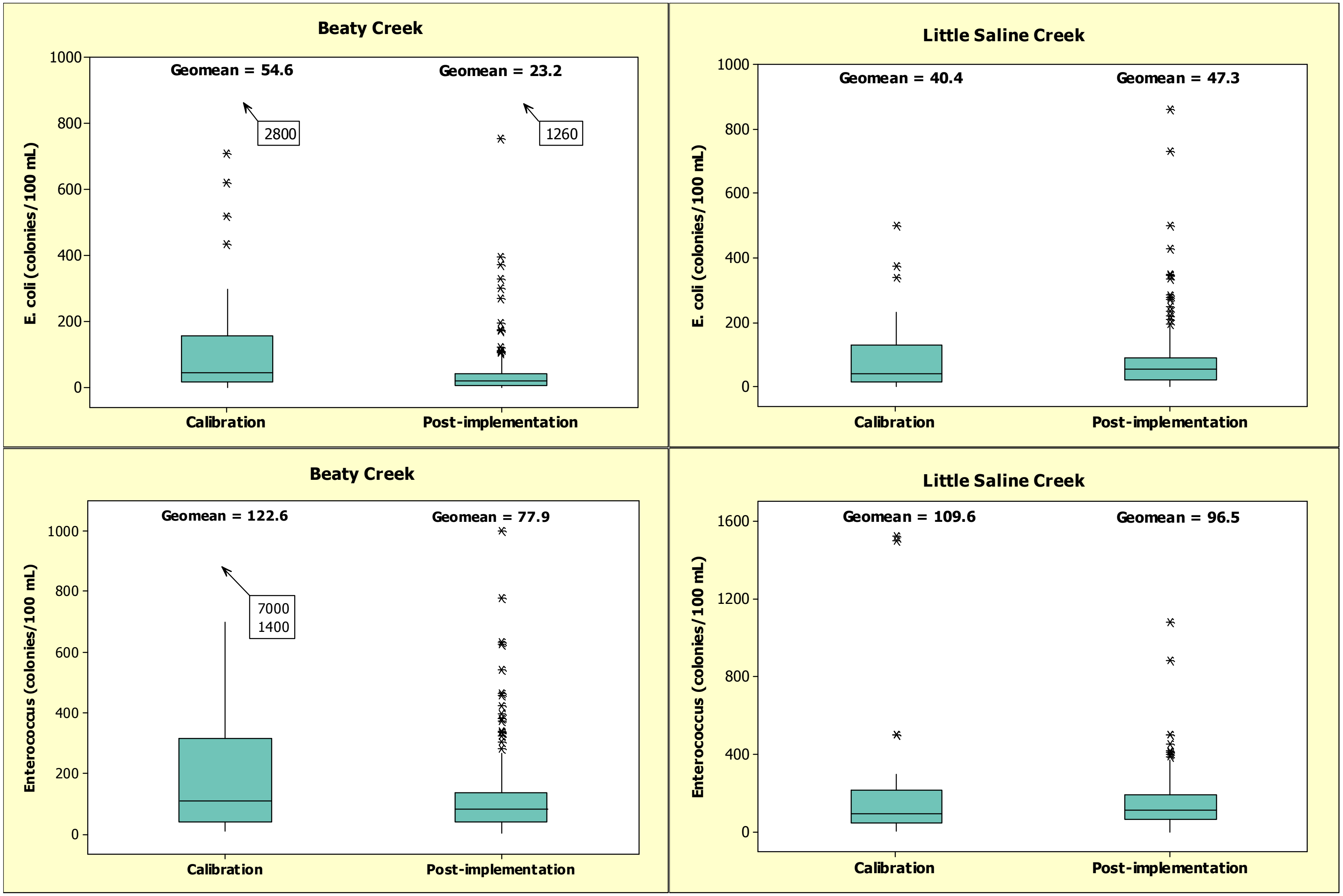


Figure 25. Boxplots of the bacteria data for Beaty Creek (Lower and Upper sites averaged) and Little Saline Creek. There was significant reduction (p<0.01) in the mean bacteria concentration (both *E. coli* and *Enterococcus*) between the calibration period, 1999-2001, and the post-implementation period, 2003-2007, for Beaty Creek. However, there was no significant difference between periods for Little Saline Creek.

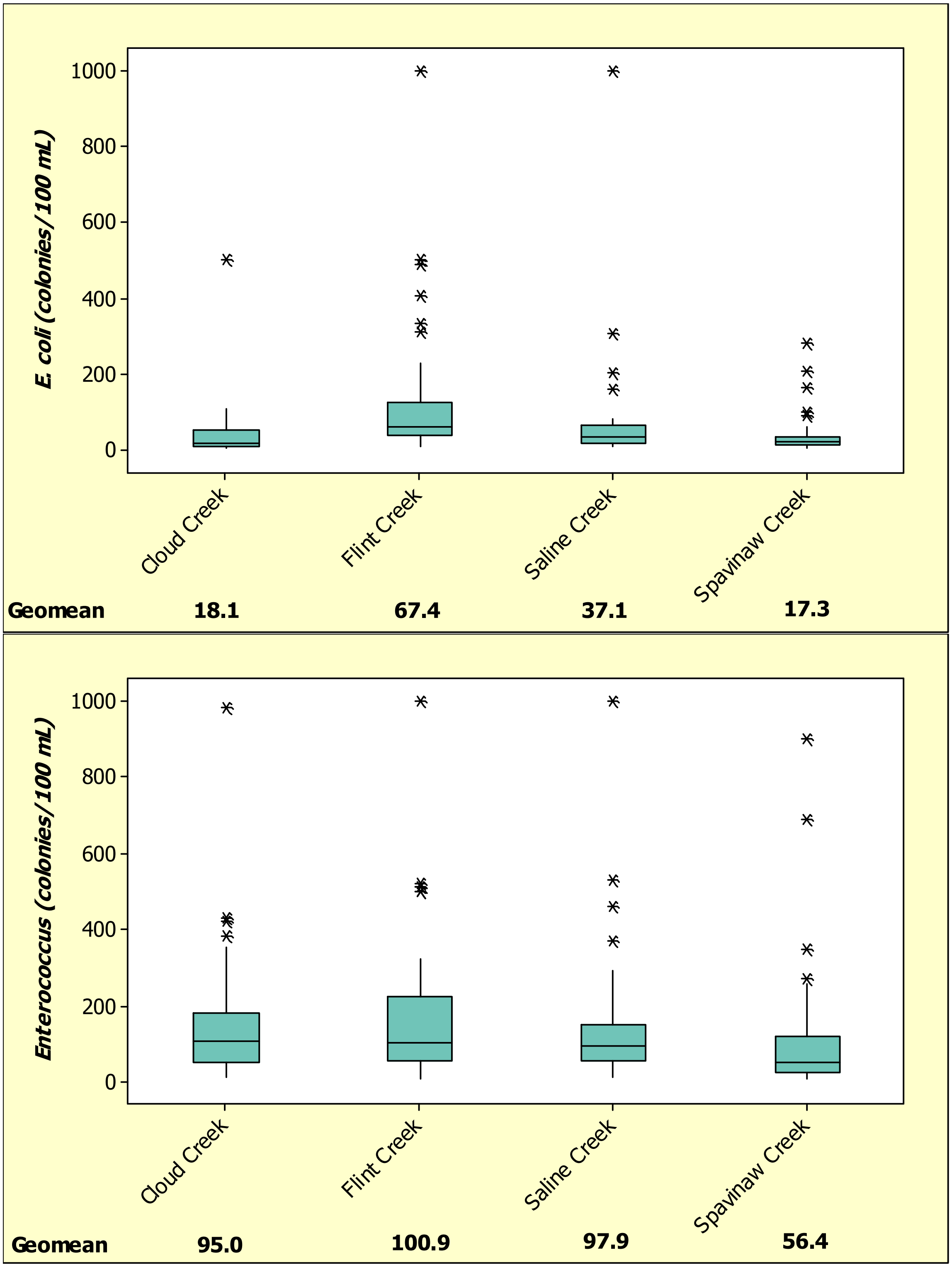


Figure 26. Boxplots of the bacteria data collected from September 2005-September 2007. The geometric mean of the data at each site is given below each site name.

Conclusion

The Spavinaw Creek Watershed Implementation Project expanded the successful efforts that have been ongoing in the Beaty Creek watershed since the 1990s. This project brought together numerous groups, with the ultimate goal of restoring and protecting all designated beneficial uses in the watershed through education, BMP demonstration, and implementation. Sources of phosphorus were assessed with a SWAT model, and areas were targeted for BMP implementation in order to maximize the potential for improvement of water quality.

Over two million dollars was spent on implementation, which allowed BMPs to be installed in an additional 26% of the watershed. Significant decreasing trends in nutrients, especially phosphorus, are evident in the Beaty Creek watershed relative to the Little Saline watershed. In the last two years, the total phosphorus loading has improved from the 14% reduction reported after one year of implementation in the Beaty project to a 66% reduction over what was expected based on pre-implementation conditions. Average phosphorus loading has been significantly decreased in the post-implementation period relative to the calibration period. In addition, TKN loading has been reduced by 80% in the Beaty watershed, ortho-phosphorus loading is down by 53%, and ammonia loading in Beaty Creek has been reduced by 87% over what was expected without BMP implementation. Bacteria levels have significantly decreased in the Beaty watershed while there has been no significant change in Little Saline. The fish community has remained “excellent” in Beaty Creek while decreasing in Little Saline Creek, and the habitat has improved in Beaty Creek.

It is expected that similar water quality improvements, not yet evident, will be observed in Spavinaw Creek in the next couple of years since some practices have just recently been implemented, and significant improvement is rarely, if ever, evident in a short timeframe. The data collected in the last two years on Spavinaw Creek and the control sites will provide baseline, calibration data so that improvements can be accurately detected in the next few years. Importantly, educational efforts should be long-lasting and wide-reaching. The litter transport project has been very popular and is expected to continue, perhaps despite limited funding for cost-share assistance.

Lakes Eucha and Spavinaw and several watershed streams remain on the state’s 303(d) list for NPS related impairments, but efforts to delist these waterbodies are continuing. The OCC has an ongoing project in the watershed which will enable continued BMP implementation, the NRCS will continue to focus available EQIP funding in the watershed, and additional riparian buffer areas are expected to be established in the watershed through the Conservation Reserve Enhancement Program (CREP). The cooperative, cumulative efforts of all of these programs are expected to allow attainment of the ultimate goal of the work in this watershed: the full attainment of all beneficial uses in the waterbodies of the Spavinaw Creek watershed.

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Appendix A:
Spavinaw Implementation Plan

FY 2003 319 Project 4:

Spavinaw Creek Watershed Implementation Project

Final Targeting Mechanism

Output 4.1.4

Oklahoma Conservation Commission
Water Quality Division

August 31, 2006

OKLAHOMA CONSERVATION COMMISSION

STATE GUIDELINES
FOR THE
LAKE EUCHA STATE PRIORITY PROGRAM
AND 319 NON POINT COST SHARE PROGRAM
PROJECT 4 SPAVINAW CREEK WATERSHED

PROGRAM YEARS 1-5 AND APPROVED PRACTICES

I. GENERAL

The Oklahoma Conservation Commission hereby declares that the following problems are having a detrimental affect on the state's water resources in the Lake Eucha Watershed:

Oklahoma's water resource is an important foundation of the state's economic infrastructure. Natural climatic events as well as human activity are impacting the state's water resources. As long as farmers and ranchers produce food from the land to feed the world and rain falls, we will continue to see impacts on the state's water. Our task, as stewards of the natural resources, is to minimize these impacts. Protecting these vital natural resources is paramount in preserving the state's economic future. In order to accomplish this goal, the Commission hereby establishes the following goals and objectives to address these problems affecting our renewable natural resources:

Make cost-share funds available to conservation districts so that they can implement cost-share practices which will protect our natural resource of water.

The Conservation Commission herein establishes the complete list and description of the Conservation Cost-Share Program policies and conservation practices approved by the Delaware County Conservation District for use during this five (5) year program. (See Section II for the approved list of conservation practices.) Cost-share rates (unit cost) will be based on Oklahoma Natural Resources Conservation Service (NRCS) unit cost, effective date April 19, 2004, and subsequent revisions. These unit costs will be updated each year based on the data gathered from participants of this program. Any variances in the best management practices or unit cost rates must be approved by the Delaware County Conservation District and the Oklahoma Conservation Commission. These variances must be approved prior to performance agreements being signed.

ALLOCATION OF FUNDS

The Commission, on the recommendation of the Delaware County Conservation District and the Commission's Water Quality staff, has designated Spavinaw Creek in the Lake Eucha Watershed as the demonstration area to allocate the following funds for the purpose of providing cost-share payments to eligible applicants for implementing approved cost-share water quality conservation practices.

NOTE:	State funds and land user contribution:	$1,101,093.00
	EPA 319 funds	$1,651,640.00
		$2,752,733.00

The allocation period for these funds is 5 years. The allocation period will start October 1, 2003 and end September 30, 2008. Funds not allocated by the ending date will divert back to the Commission.

All residents of the Spavinaw Creek Watershed are eligible for cost-share assistance regardless of size of land ownership. There will be no minimum cost-share payment to any applicant. The maximum cost-share assistance to any one participant in Spavinaw Creek will be $20,000.00 for the first sign-up period. If this is deemed too small to meet the water quality needs for the watershed, the Delaware County Conservation District will review and revise the cap.

POLICIES

- The Lake Eucha Watershed Advisory Group, the Delaware County Conservation District and the Oklahoma Conservation Commission have approved eight (8) best management practices (see Section II) that will be offered to the residents of Spavinaw Creek for cost-share assistance.

- Cost-share practices shall be implemented according to NRCS standards and specifications. Best Management Practice No. 8 – Rural Waste Systems will be implemented by Department of Environmental Quality standards and specifications Bulletin 641 and subsequent revisions.

- Conservation Commissioners, Conservation Commission staff, conservation district employees or the spouses of any of these people shall not be eligible to participate in the Conservation Cost-Share Program.

Conservation district directors are eligible and encouraged to participate in the Spavinaw Creek Watershed Cost-Share Program. If district directors choose to participate, the following OCC policy will apply: In order to provide for an impartial legal majority, no more than two district directors shall participate in the cost-share program for the Spavinaw Creek Priority Watershed and 319 Non Point Source Pollution Program. In addition, the directors who desire to apply for the cost-share program shall refrain from discussing or voting on any items or issues pertaining to the cost-share program. This includes: rates, practices, maximum payment, and applicants for the program.

The Oklahoma Conservation Commission Water Quality staff, with the concurrence of the Delaware County Conservation District and the Oklahoma Conservation Commission, have developed special forms for the following: (1) CC Project Cost-Share Assistance Application Form; (2) CC Project Priority Ranking System; (3) CC Project Performance Agreement (see attached forms).

SIGN UP

A three week sign-up period will be established by OCC, with concurrence of the participating conservation district, for taking applications for cost-share assistance. Applications will be taken at the Delaware County Conservation District and the Lake Eucha Water Quality Project offices, using the CC Cost-Share Application Form. After the prospective cooperator signs up, the conservation planners will contact each applicant and: (1) determine eligibility; (2) develop a conservation plan to determine needs; (3) set priority ranking (using the priority ranking form); (4) with applicants' concurrence, a project agreement will be developed in accordance with the Oklahoma Conservation Commission Cost-Share Program (refer to OCC State Guidelines for Program Year 7); (5) the completed conservation plan and project agreement will be presented for approval to the Delaware County Conservation District; (6) the final approval will be authorized by the designated OCC representative.

NOTE: Absolutely no work will begin on any project until the OCC staff and representative have approved the plan and project agreement.

As funds become available after the initial sign-up period and planning have been completed, a second sign-up period can be conducted as determined by the conservation district and the OCC staff representative. At regular intervals a review/audit of the program will be made by the OCC water quality representative. This will be used to determine compliance with the program objectives and to determine if modifications are necessary.

ELIGIBILITY CRITERIA

The following criteria must be satisfied for an applicant to participate in the Cost-share program: (1) must own or operate land in the Spavinaw Creek Watershed in Delaware County, Oklahoma; (2) must have a need for one of the Priority Best Management Practices; (3) if it is determined that the applicant requires a priority practice, he/she must be willing – with cost-share assistance – to install the needed BMPs; (4) the applicant will be required to maintain the BMP for the life of the practice.

CONTRACT COMPLIANCE

The cooperator will be required to sign a project agreement with the Delaware County Conservation District and follow a specified schedule of operations. The schedule of operations form details a year by year plan of the Best Management Practices (BMPs) to be installed and a time frame within which to install them. Each Fall, the project coordinator will conduct annual status reviews. If a cooperator is found to be out of compliance with the schedule of operations due to circumstances beyond his/her control, a revision schedule can be discussed and completed. These revisions will require conservation district board approval. In the event a cooperator is not in compliance due to lack of interest, the district board has the discretion to terminate the contract. The idle funds can then be utilized by another cooperator. The importance of the cooperators keeping on schedule must be stressed by the planner. The four-year lifespan of the project dictates the need for schedule compliance. All funds for BMP installation must be expended by September 30, 2008.

II. LIST OF APPROVED CONSERVATION PRACTICES FOR THE SPAVINAW CREEK PRIORITY WATERSHED AND 319 NON-POINT PROGRAM

Contained in this section is a master list of Best Management Practices (BMPs) and cost-share levels that were approved for implementation in the Beaty Creek Demonstration Area. The Lake Eucha Watershed Advisory Group approved the majority of these BMPs at their regularly scheduled meeting on Thursday, December 17, 1998 (BMP 4d was added late in the program). The Delaware County Conservation District approved the BMP list at their regularly scheduled board meeting on January 14, 1999 and the Oklahoma Conservation Commission gave their approval at their meeting on February 8,

1999. Those BMPs are incorporated into the Spavinaw Creek Demonstration Area, using the USDA/NRCS Environmental Quality Incentive Program cost list effective April 19, 2004, and any supplemental cost lists as they become effective.

High potential phosphorus loss on targeted riparian area and grazing lands, based on OSU targeting results, will be used on a ranking sheet as follows:

- Poor condition pastures – 20 points
- High potential phosphorus loss (red on targeting maps) – 20 points
- High potential phosphorus loss (blue on targeting maps) – 15 points
- High potential phosphorus loss (purple on targeting maps) - 10 points
- Filter strip development next to riparian areas - 15 points

Funds will be expended based on a ranking sheet using the above system, plus rural waste concerns and plant condition. The fields receiving the highest score on the ranking sheet will be given first priority for available funds.

PRACTICES
Riparian Area Management/Establishment
Buffer/Filter Strip Establishment
Stream Bank Stabilization
Animal Waste Storage Facilities
Pasture Establishment/Management
Proper Waste Utilization
Heavy Use Area
Rural Waste Systems

APPROVED BEST MANAGEMENT PRACTICES
To include the following conservation practices, components, units, cost-share rates and costs.

Best Management Practices (BMPs)
Spavinaw Creek 319 Project

Incentive Percentage

1. Riparian Area Management Establishment — 100%
   Components:
   1a. Incentive Payments:
      1a-1. Total exclusion — $50.00/ac/year for up to 4 years
      1a-2. Total exclusion with hay production of riparian area in Zone 3 only — $45.00/ac/year for up to 4 years
      1a-3. Limited grazing — $40.00/ac/year for up to 4 years

      These incentive payments will be limited to no more than an average of 150 feet on each side of the stream bank. To qualify for these incentive payments, one or more practices to improve water quality must be completed and certified by the Project Coordinator.

   1b. Off-site Watering Facilities — 80%
      1b-1. Pond
      1b-2. Trickle pipe
      1b-3. Well Drilling

1b-4. Watering facilities
1b-5. PVC Pipeline
1b-6-9. Watering lane to creek

1c. Vegetative Establishment 80%
1c-1- 1c-5. Pasture (grass planting)
1c-6. Lime
1c-7. Fertilizer
1c-8. Seedbed preparation
1c-9. Drill & Tractor
1c-10 – 1c-11. Forestry plantings

1d. Fencing 80%
1d-1. 4-wire fence
1d-2. Woven wire fence

1. PURPOSE
To establish riparian areas along Spavinaw Creek and all tributaries draining into Lake Eucha. To control and filter runoff water from pastures and fields and to stabilize the creek banks to stop erosion.
2. APPLICABILITY
To target areas where the stream banks are eroded, over grazed and over used by cattle having access to the water. These targeted areas have deteriorated because of the lack of vegetation or the proper vegetation to hold them in place.

3. POLICIES
A. Cost-sharing is authorized for:
(1) Incentive payment for
(a) Total exclusion
(b) Total exclusion with hay production
(c) Limited grazing
(2) Off-site watering
(3) Vegetative establishment
(4) Fencing
(5) To receive cost-share assistance, the following criteria must be met:
(a) The livestock producer must be willing to fence the riparian area as established by the Natural Resources Conservation Service/Oklahoma Conservation Commission Water Quality staff technicians.
(b) The livestock producer will be required to maintain the riparian area and all component parts for the life of the practice.
(c) To receive Incentive Payments, the cooperator must enter into an agreement with the Delaware County Conservation District.

B. Cost-share is not authorized for:
(1) Individuals receiving cost-share funds from any other state or federal agencies on the same Best Management Practices.

(2) Producers who do not enter into a total farm or water quality plan with the Delaware County Conservation District.

C. Design, layout and inspection:
   (1) Technical assistance will be accomplished by the Conservation Commission Water Quality staff representatives or Natural Resources Conservation Service personnel.
   (2) Natural Resources Conservation Service standards and specifications will be used in all designs.

D. Best Management Practice approval:
   (1) The Oklahoma Conservation Commission Water Quality staff representatives will be responsible for the initial approval of this Best Management Plan.
   (2) The Delaware County Conservation District will be the official approving authority.

Best Management Practices (BMPs)
Spavinaw Creek 319 Project

			Incentive Percentage
2.	Buffer-Filter Strip Establishment		80%
	Components:		
2a.	Incentive Payments:	$45.00/ac	
2b.	Vegetative Establishment (same as 1c)		
2c.	Fencing		
	2c-1. 4-wire fence		
	2c-2. Woven wire		

1. <u>PURPOSE</u>
To establish buffer/filter strip around cultivated fields and/or farmsteads where the runoff water has the potential to contain large amounts of nutrients that pollute the waters of Lake Eucha.

2. <u>APPLICABILITY</u>
To target areas where the stream banks are eroded, over grazed and over used by cattle having access to the water. These targeted areas have deteriorated because of the lack of vegetation or the proper vegetation to hold them in place.

3. <u>POLICIES</u>
A. Cost-sharing is authorized for:
   (1) Incentive payments
   (2) Vegetative establishment
   (3) Fencing, if necessary
   (4) To receive cost-share assistance, the following criteria must be met:
      (a) Have a whole farm conservation plan to include Animal Waste Plan, if applicable.
      (b) Must agree to maintain all component parts of the Best

Management Practices for the entire life of the practices.

B. Cost-share is not authorized for:
   (1) Individuals receiving cost-share funds from any other state or federal agencies on the same Best Management Practices.
   (2) Producers who do not enter into a total farm or water quality plan with the Delaware County Conservation District.

C. Design, layout and inspection:
   (1) Technical assistance will be accomplished by the Conservation Commission Water Quality staff representatives or Natural Resources Conservation Service personnel.
   (2) Natural Resources Conservation Service standards and specifications will be used when available.

D. Best Management Practice approval:
   (1) The Oklahoma Conservation Commission Water Quality staff representatives will be responsible for the initial approval of this Best Management Plan.
   (2) The Delaware County Conservation District will be the official approving authority.

Best Management Practices (BMPs)
Spavinaw Creek 319 Project

	Incentive Percentage
3. Streambank Stabilization	80%

Components:

3a. Fencing
   3a-1. 4-wire fence
   3a-2. Woven wire

3b. Vegetative Plantings
   3b-1 – 3b-9: Grass establishment
   3b-10 – 3b-11: Forestry plantings

3c. Special Best Management Practices
   Note: this will only be used when a BMP is needed that is not covered under the list of approved BMPs.

1. PURPOSE
This BMP is designed to correct/protect stream banks in the Spavinaw watershed. Stopping erosion will stop sediment build up in the waters of Lake Eucha.

2. APPLICABILITY
To target high use areas where the riparian area is depleted.

3. POLICIES
A. Cost-sharing is authorized for:

(1) Areas determined in need of erosion control.
(2) Areas where vegetative cover is lacking.
(4) To receive cost-share assistance, the following criteria must be met:
  (a) Have a whole farm conservation plan to include Animal Waste Plan, if applicable.
  (b) Must agree to maintain all component parts of the Best Management Practices for the entire life of the practices.

B. Cost-share is not authorized for:
  (1) Individuals receiving cost-share funds from any other state or federal agencies on the same Best Management Practices.
  (2) Projects that will require large amounts of work, materials and labor to complete. (The objective for this BMP is to correct small on-the-farm stream bank erosion.)

C. Design, layout and inspection:
  (1) Technical assistance will be accomplished by the Conservation Commission Water Quality staff representatives or Natural Resources Conservation Service personnel.
  (2) Natural Resources Conservation Service standards and specifications will be used when available.

D. Best Management Practice approval:
  (1) The Oklahoma Conservation Commission Water Quality staff representatives will be responsible for the initial approval of this Best Management Plan.
  (2) The Delaware County Conservation District will be the official approving authority.

Best Management Practices (BMPs)
Spavinaw Creek 319 Project

	Incentive Percentage
4. Composters (dead bird) Animal Waste Storage Facilities	75%

Components:
- 4a: Composter
- 4b. Cake out house
- 4c. Full clean out house
- 4d. Cattle feeding/waste storage facility

1. <u>PURPOSE</u>
This BMP has been developed to address the proper disposal of dead animals and proper storage of animal waste.

2. <u>APPLICABILITY</u>
To target producers who do not have available proper disposal of dead birds and those producers who are required to dispose of animal waste when weather and soil conditions are not acceptable.

3. POLICIES

A. Cost-sharing is authorized for:

(1) Producers who have no other way to dispose of their dead birds.

(2) Producers who need to clean animal waste out of their poultry houses and need a place to store the waste until such time as it can be transported off the farm.

(3) Producers who need an animal waste storage and feeding facility to store animal waste until weather permits proper application.

B. Cost-share is not authorized for:

(1) Individuals receiving cost-share funds from any other state or federal agencies on the same Best Management Practices.

(2) Producers who have adequate means for proper disposal of dead birds.

C. Design, layout and inspection:

(1) Technical assistance will be accomplished by the Conservation Commission Water Quality staff representatives or Natural Resources Conservation Service personnel.

(2) Natural Resources Conservation Service standards and specifications will be used when available.

D. Best Management Practice approval:

(1) The Oklahoma Conservation Commission Water Quality staff representatives will be responsible for the initial approval of this Best Management Plan.

(2) The Delaware County Conservation District will be the official approving authority.

Best Management Practices (BMPs)
Spavinaw Creek 319 Project

		Incentive Percentage
5.	Pasture Establishment/Management	Components:
5a.	Pasture Establishment	75%
	Components	
	5a-1. Sprigging	
	5a-2 – 5a-5. Seeding	
	5a-6. Lime (Soil Test)	
	5a-7. Fertilizer (Soil Test)	
	5a-8. Seedbed Preparation	
	5a-9. Drill & Tractor	
5b.	Pasture Management	75%
	Components:	
	5b-1. Fencing (for rotational grazing systems)	
	Off-site Watering	
	5b-2. Pond	
	5b-3. Watering facilities	
	5b-4. Pipeline (PVC)	

5b-5. Well drilling

1. <u>PURPOSE</u>
This BMP is to be used to correct erosion problems that contribute to the movement of nutrients from pastures into the waters of Lake Eucha.

2. <u>APPLICABILITY</u>
To encourage producers to manage pastures so as not to overgraze, causing erosion problems. Also, to establish vegetative cover on areas where inadequate cover is causing nutrients to move from pastures into the waterways of Lake Eucha.

3. <u>POLICIES</u>
A. Cost-sharing is authorized for:
   (1) Pasture establishment
   (2) Pasture management with components:
      (a) Fencing
      (b) Watering facilities

Cost-share is not authorized for:
   (1) Pasture establishment where an adequate cover is present
   (2) Where a producer wants to change species of vegetation. Example: from fescue to Bermuda
   (3) Producers who do not want to develop a total pasture rotational system
   (4) Individuals receiving cost-share funds from any other state or federal agencies on the same Best Management Practices.

.

C. Design, layout and inspection:
   (1) Technical assistance will be accomplished by the Conservation Commission Water Quality staff representatives or Natural Resources Conservation Service personnel.
   (2) Natural Resources Conservation Service standards and specifications will be used when available.

D. Best Management Practice approval:
   (1) The Oklahoma Conservation Commission Water Quality staff representatives will be responsible for the initial approval of this Best Management Plan.
   (2) The Delaware County Conservation District will be the official approving authority.

Best Management Practices (BMPs)
Spavinaw Creek 319 Project

Incentive Percentage

6. Proper Waste Utilization (For Poultry Waste Producers)
(This BMP will require a waste management plan)

6a. *8¢ per lb. of phosphorus produced and properly utilized on producer's farm according to Oklahoma State guidelines and USDA-NRCS waste utilization standard 633. Must have soil/litter tests and application plan developed by Eucha/Spavinaw Watershed Management Team.*

6b. **10¢ per lb. of phosphorus moved from producer's farm and applied in Lake Eucha Watershed according to Oklahoma State guidelines and USDA-NRCS waste utilization standard 633. Must have soil/litter tests and application plan developed by Eucha/Spavinaw Watershed Management Team.*

6c. **15¢ per lb. of phosphorus moved from producer's farm to an alternative use waste project or moved out of Spavinaw Creek watershed into a non-phosphorus threatened watershed and applied according to Oklahoma State guidelines and USDA-NRCS waste utilization standard 633. Cannot be moved into Grand Lake, Illinois, Wister or Illinois watersheds. Must have soil/litter tests.*

*Must show movement location.

1. <u>PURPOSE</u>
To insure proper application of animal waste and not to exceed the phosphorus level as established by the Natural Resources Conservation Service and application plan developed by the Eucha/Spavinaw Watershed Management Team.

2. <u>APPLICABILITY</u>
To target producers who have excess litter or cannot spread and give an incentive for movement to areas within the Eucha Watershed that can utilize it and also to encourage movement of litter out of the Eucha/Spavinaw Creek watershed or to an alternative use waste project.

3. <u>POLICIES</u>
   A. Cost-share is authorized for:
      (1) Proper use of litter
      (2) Movement of litter

   B. Cost-share assistance is not authorized for:
      (1) When like funds are being received from any other state or federal agency. (Note: NRCS funds being paid to a purchaser of producer's litter does not constitute funds being received.)
      (2) Where producer cannot or will not show proof of movement and provide a soil test at receiving location.

   C. Best Management Practice Structure:
      (1) Producer/Cooperator **must have** an Animal Waste Management Plan and Conservation Plan.
      (2) The structure of movement will be by the producer and concurred by the Oklahoma Conservation Commission Water Quality Staff

representatives.

D. Best Management Practice approval
   (1) The Oklahoma Conservation Commission Water Quality staff representatives will be responsible for the initial approval of this Best Management Plan.
   (2) The Delaware County Conservation District will be the official approving authority.

Best Management Practices (BMPs)
Spavinaw Creek 319 Project

		Incentive Percentage
7.	Heavy Use Areas	75%

7a. Establish permanent feeding areas away from water sources (creeks, drainageways, etc.)
Components:
7a-1. Concrete pads for round bale feeding.
7a-2. Gravel for heavy traffic areas (cattle).
7a-3: Geotextile fabric and terracells for use under gravel
7a-4. Concrete or gravel pads around watering facilities.
7a-5. 6” Terracell – erosive areas.

1. PURPOSE
To reduce pollution entering the stream from pasture feeding of hay to livestock.

2. APPLICABILITY
To target livestock producers who feed hay in areas too close to streams.

3. POLICIES
A. Cost-sharing is authorized for:
   (1) Construction of feeding areas away from creeks.
   (2) Diversion of winter runoff feeding areas to proper disposal areas.

B. Cost-share is not authorized for:
   (1) Producers who do not have a full farm conservation plan to include an Animal Waste Management Plan.
   (2) Producers who are not involved with Best Management Practice #5 (Pasture Management).

C. Design, layout and inspection:
   (1) Technical assistance will be accomplished by the Conservation Commission Water Quality staff representatives or Natural Resources Conservation Service personnel.
   (2) Natural Resources Conservation Service standards and specifications will be used when available.

D. Best Management Practice approval:

(1) This Best Management Plan will be written into the whole farm plan developed and approved by the he Oklahoma Conservation Commission Water Quality staff representatives and the Delaware County Conservation District.

Best Management Practices (BMPs)
Spavinaw Creek 319 Project

Incentive Percentage

8. Rural Waste Systems — 75%

Install residential septic system in the rural areas of the Spavinaw Creek watershed

Components:

8a-1. Septic Tank – 1000 gallon

8a-2. Installation of tank.

8a-3. Percolation test and certification (one allowed)

8b. Installation of lateral lines
Includes materials, machinery, cost and labor

1. PURPOSE

To reduce residential sewer pollution entering the waters of Lake Eucha.

2. APPLICABILITY

To target problems within the watershed where septic tanks are not in place, or systems which are not adequate to function as needed to prevent water pollution in Lake Eucha.

3. POLICIES

A. Cost-sharing is authorized for:

(1) Installation of septic systems to include:

(a) Septic tank

(b) Lateral lines

(c) Labor for installation

(d) Percolation test and certification.

(2) To receive cost-share assistance, the following criteria must be met:

(a) If the applicant is an agriculture livestock producer (dairy, poultry, swine or beef), a water quality conservation plan must be developed with the Delaware County Conservation District.

(b) If the Water Quality Conservation Plan addresses other Best Management Practice needs, the applicant will be required to correct them along with the septic system. These other BMP needs may also receive cost share assistance, if they are in the system.

(c) If the applicant is a non-agriculture producer and lives within 1000 feet of a tributary of the Lake Eucha reservoir, cost-share assistance is available. They must meet all criteria of the program and have no other water quality problems on the property.

B. Cost-share assistance is not authorized for:

(1) Trailer type homes not permanently attached to the ground.
(2) Recreational trailer
(3) Seasonal homes
(4) New home construction

C. Design, layout and inspection:
(1) A local representative of the Department of Environmental Quality for the State of Oklahoma or a certified percolation tester and septic system installer will design and make final approval of the installation.
(2) The septic system will be designed within the guidelines of Oklahoma Departmental Quality Bulletin No. 641.

D. Best Management Practice approval:
(1) The Oklahoma Conservation Commission Water Quality staff representatives will be responsible for the initial approval of this Best Management Plan.
(2) The Delaware County Conservation District will be the official approving authority.

SPAVINAW CREEK WATERSHED
CONSERVATION COST-SHARE PROGRAM
PRE-APPLICATION

Delaware County Conservation

Name			
Address	City	State	Zip
Phone Number			
I heard about this program □ from a friend/neighbor □ from a newspaper or newsletter article or radio broadcast □ from NRCS or Conservation District personnel			
Legal description where the conservation practice(s) is to be constructed. Sec. ____ T ____ R ____ Number of Acres____________			
Do you own, lease, or rent this land? Own Lease Rent If not the landowner, provide a properly executed consent form from the owner(s) of the land and file it with the application.			
For which conservation practice(s) are you applying?			

I understand this application does not obligate the applicant or the Conservation District to enter into a contract. I am not an Oklahoma Conservation Commission commissioner or employee, conservation district employee or the spouse of any of these people mentioned above.

____

Applicant Signature Date

Failure to provide correct, complete information will result in the withholding or withdrawal of financial assistance.

STATE OF OKLAHOMA
CONSERVATION COST-SHARE PROGRAM
PERFORMANCE AGREEMENT

This agreement, made and entered into by and between the Delaware County Conservation District, hereinafter referred to as District, and ____ hereinafter referred to as participant.

Part I - Conservation Practice(s) To Be Completed
See attached Schedule for the conservation practice(s) to be implemented as set forth in the participant's Conservation Plan.

Part II - Stipulations

1. The participant agrees:
    1. To perform or have performed all work described in Part I in accordance with conservation practice standards and specifications furnished by the District or the Natural Resources Conservation Service (NRCS).
    2. To submit to the District a detailed, itemized statement of costs and copies of contractor's invoices when conservation practice(s) are constructed by a contractor.
    3. To submit to the District detailed invoices for participant in-kind contributions.
    4. To complete or have completed all work described in Part I on or before ______________________
    5. To obtain required permits and approvals prior to the construction of the conservation practice(s).
    6. To permit free access to the participant's land for District and NRCS representatives to inspect the conservation practice(s) upon completion.
    7. To maintain the conservation practice(s) as outlined in the cost-share Maintenance Agreement for the specified life of the conservation practice(s) at no cost to the District.
    8. To accept the District's method of calculating the cost-share payment(s) for completed work.

2. The District agrees:
    1. To provide assistance to the participant to develop a new or revised Conservation Plan that reflects the conservation practice(s) outlined in Part I.
    2. To provide conservation practice standards and specifications and technical assistance for work described in Part I.
    3. To provide and pay a cost-share level, as shown on the attached Schedule, of the lesser of the established District average cost or actual cost to construct the conservation practice(s). Cost share reimbursement will not exceed the amount on the attached Schedule.
    4. To accept in-kind contributions from the participant for work performed by the participant on approved cost-share conservation practice(s) constructed.

Part III B Signatures
This agreement shall be effective from the last date of signature below. Work cannot begin until an effective agreement is signed and dated by the participant and the conservation district.

PARTICIPANT:

___________________________________ ___________ ____ ___________

Participant Signature   Date   Project Coordinator   Date
Lake Eucha Water Quality Project

____
Social Security Number or
Federal Employee Identification Number

_________________________________ ___________
District Representative   Date
Delaware County Conservation District

____
Participant Signature

____
Social Security Number

	SPAVINAW CREEK 319 NON-POINT PRIORITY WATERSHED		
	PRIORITY RANKING SYSTEM 2004		
Producer:		Total Acres:	
Telephone		Farm No(s):	
Legal Description:	Section ___ Township ___ Range ___	Total Points:	
	Conservation Priorities:		**Evaluation Score**
	Water Quality- High Potential Phosphorus Loss		
	Plant Condition- Productivity, Health and Vigor - and Inadequate Stock Water		
		Total Evaluation Points:	

	Water Quality- High Potential Phosphorus Loss on Targeted Riparian Area and Grazing Lands (Total: 100 pts)		
	Poor Condition Pastures as identified on Target Maps (20 pts)		
	High Potential Phosphorus Loss areas identified in **red** on Target Maps (20 pts)		
	High Potential Phosphorus Loss areas identified in **blue** on Target Maps (15 pts)		
	High Potential Phosphorus Loss areas identified in purple on Target Maps (10 pts)		
	Land offered will apply a Comprehensive Nutrient Management Plan if applying poultry litter according to a plan prepared by the Eucha/Spavinaw Management Team. (20 pts)		
	Distance from confined livestock facility to USGS Blue Line Stream or other water body. Adjacent (15 pts) <1/4 mile (10pts) 1/4-1/2 mile (5pts) >1/2 mile (0pts)		-
	General topography between confined livestock facility and USGS Blue line or Water Body. >8% slope (10pts) 3% - 8% slope (5pts) 0% - 3% slope (0pts)		
	319 Project application will develop filter strips for the entire length of land that is adjacent to streams and lakes in offered land units (15pts)		
	Plant Condition- Productivity, Health and Vigor - and Inadequate Stock Water (Total: 43 pts)		
	Offer includes implementation of Prescribed Grazing (528A) system that balances forage production with livestock numbers for the period of the contract.		-
	% of the grazing lands in the operating unit planned for implementation of Prescribed Grazing according to the (528A) standard during the contract period. 100% (25pts) 50%-99% (15pts) 49%-25% (5pts) <25% (0pts)		
	Practice(s) will facilitate improved grazing distribution. (382, 614, 642, 378)(10pts)		-
	Grazing system rotates through 3 or more pastures per grazing season. 3-5 (6pts); 6/7 (7pts); 8 or more (8pts)		

319 Project Evaluation Worksheet Page 2

*******TO BE USED ONLY IN THE CASE OF A TIE FOR FUNDING*******	
Cost: Benefit ratio based on $/acre score	-
Lowest $/acre wins the tie-break	
	-
Designated Conservation Planner	
______________________________________ __________ *(Signature)* *Date*	
Applicant	
______________________________________ __________ *(Signature)* *Date*	