Upper Rapid Creek
Water Quality Monitoring Report

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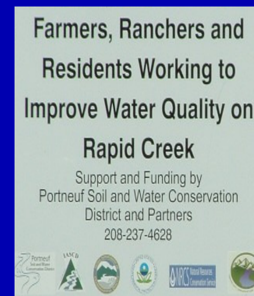

Technical Report Summary
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Introduction

The Idaho Association of Soil Conservation Districts (IASCD) recently completed a water quality monitoring project in the Upper Rapid Creek watershed in southeastern Idaho. This monitoring was conducted to measure the impacts of Best Management Practice (BMPs) that have been implemented in the watershed.

Rapid Creek is included on the State of Idaho §303(d) list of water quality impaired streams. Sediment was identified as the major pollutant of concern in Rapid Creek (IDEQ, 1999). Additional pollutants were recognized for the greater Portneuf subbasin (Table 1). The Upper Rapid Creek watershed includes the West and North Forks of Rapid Creek, tributaries to Rapid Creek and ultimately the Portneuf River. Seventy-two percent of the 16,195 acres in the Upper Rapid Creek watershed are privately owned and rangeland is the dominant land use in the watershed. The beneficial uses designated for Rapid Creek are cold water aquatic life, salmonid spawning, secondary contact recreation, and agricultural water supply.

Recent conservation efforts in the Upper Rapid Creek watershed have largely been guided by the Agricultural Implementation Plan that was developed by the Idaho Soil Conservation Commission (ISCC) in 2002. This plan details recommendations that were based on visual assessments and water quality monitoring data (Fischer, 2002). Stream assessments showed that livestock grazing, streambank erosion, sheet and rill erosion, roads, and animal feed operations negatively impacted water quality in the watershed.

Table 1. Pollutant targets for streams in the Portneuf River subbasin (IDEQ, 1999).

Pollutant of Concern	Pollutant Targets for the Portneuf River Subbasin
Total Suspended Sediment (TSS)	Not to exceed 50 mg/L (low flow) or 80 mg/L (high flow)
Total Phosphorus (TP)	Not to exceed 0.075 mg/L
Nitrate + Nitrite	Not to exceed 0.3 mg/L
Escherichia coli	Not to exceed 576 cfu/100 mL

The Portneuf Soil and Water Conservation District (SWCD) has worked extensively with private landowners in the Upper Rapid Creek watershed to improve water quality. The Portneuf SWCD obtained State Agriculture Water Quality Project (SAWQP) and Idaho Nonpoint Source §319 (1,085 acres treated) funds to implement BMPs in the watershed. Additionally, Conservation Reserve Program (CRP, 1251 acres), Environmental Quality Incentives Program (EQIP, 506 acres), and Conservation Improvement Grants (CIG) were used to support conservation efforts in the watershed. Of the 4,800 acres that were considered to be in critical condition (ISCC, 2002), 2,842 (59%) have been treated. Typical projects included: livestock exclusion fencing, offsite watering, grazing management, and berms to contain animal waste.

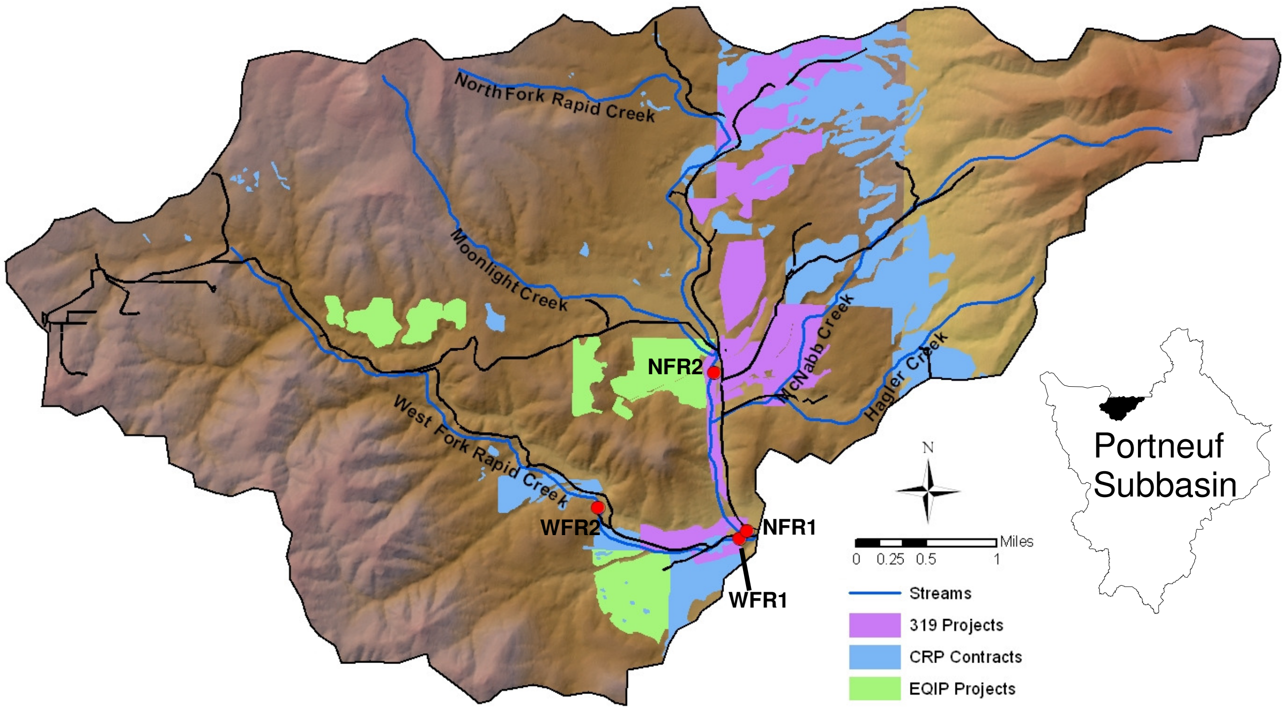

Figure 1. IASCD monitoring locations in the Upper Rapid Creek watershed (red circles).

The Upper Rapid Creek monitoring project was initiated with the support of the Portneuf SWCD. The project goal was to evaluate the effectiveness of BMPs that have been implemented on the West and North forks of Rapid Creek. Water quality monitoring was originally conducted in the Upper Rapid Creek watershed by IASCD from 2001-2003 (Jenkins, 2005) to measure baseline conditions. This report quantifies how water quality has changed since BMPs have been implemented in the watershed. IASCD has worked cooperatively with Idaho State Department of Agriculture (ISDA), and the Portneuf SWCD to implement this monitoring project.

Monitoring Schedule and Site Descriptions

Water quality monitoring began at two sites on the West Fork and two on the North Fork of Rapid Creek in March 2006 (Figure 1). On each stream, sites were selected both above and below the §319 project area to allow for upstream-downstream comparisons of water quality. Sites that had previously been monitored by IASCD (NFR1, WFR1) were revisited to allow for direct comparison of water quality before and after BMP implementation. Monitoring stations on the North Fork of Rapid Creek were located immediately upstream of Hoot Owl Road (NFR1), and below Buckskin Road (NFR2). On the West Fork of Rapid Creek sampling was conducted 0.1 miles upstream of the confluence with the North Fork Rapid Creek (WFR1), and upstream of the project area, approximately 1.5 miles above North Rapid Creek Road (WFR2).

IASCD monitored twice a month from March through September and once a month during winter months. During each visit, samples were collected and analyzed for Total Suspended Sediment (TSS), total phosphorous (TP), orthophosphorus, nitrate + nitrite, ammonia, and *E. coli*. Stream discharge, temperature, dissolved oxygen, pH, and conductivity were measured in the field.

Results

Discharge

Discharge rates in both streams fluctuated seasonally as is common in systems that are largely influenced by snow melt (Figure 2). Stream flow peaked during spring months and declined to base flows for the remainder of the year. The spring runoff was unusually high in 2006, with stream flows in April and May approximately double the 110 year average (USGS). Conversely, the watershed experienced a low water year in 2007 and during summer months stream flows were significantly reduced from 2006 levels ($p \leq 0.025$).

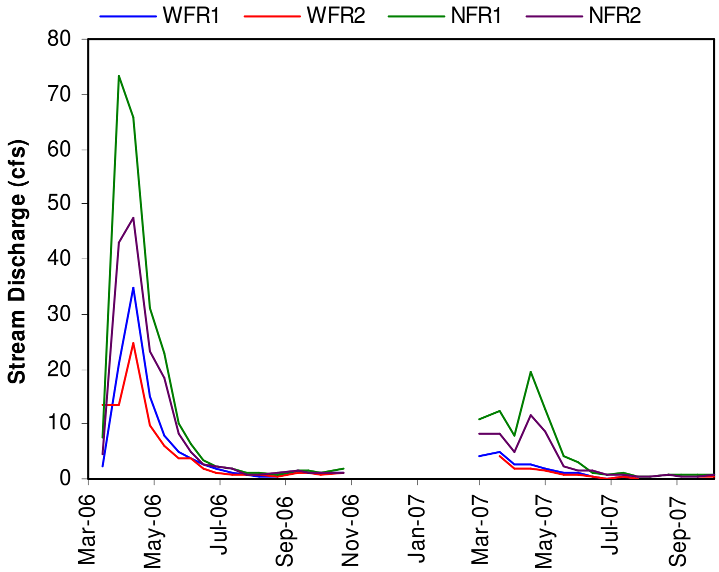

Figure 2. Stream discharge (cfs) from March 2006 to October 2007.

Average stream discharge rates were lower during pre-implementation sampling than in the current monitoring period ($p \leq 0.031$, Figure 3). This was due to reduced relatively low precipitation levels from 2001-2003.

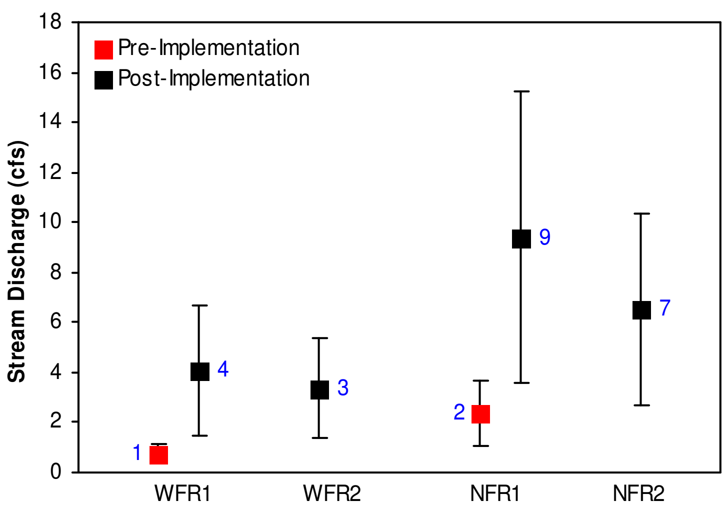

Figure 3. Mean stream discharge (± 95% CI) in the North and West forks of Rapid Creek.

Total Suspended Sediment

Total suspended sediment (TSS) concentrations at the four sites fluctuated on a seasonal basis. As is typical of snowmelt dependent systems, TSS levels increased during spring runoff events and declined to low levels throughout the rest of the year (Figure 4). TSS concentrations in the West Fork of Rapid Creek were typically low and never exceeded the water quality targets of 50 mg/L (low flow) and 80 mg/L (high flow). During low flow periods (June-February), the North Fork did not exceed the 50 mg/L target. However, NFR1 and NFR2 exceeded the high flow target (March-May) 36% and 55% of the time, respectively.

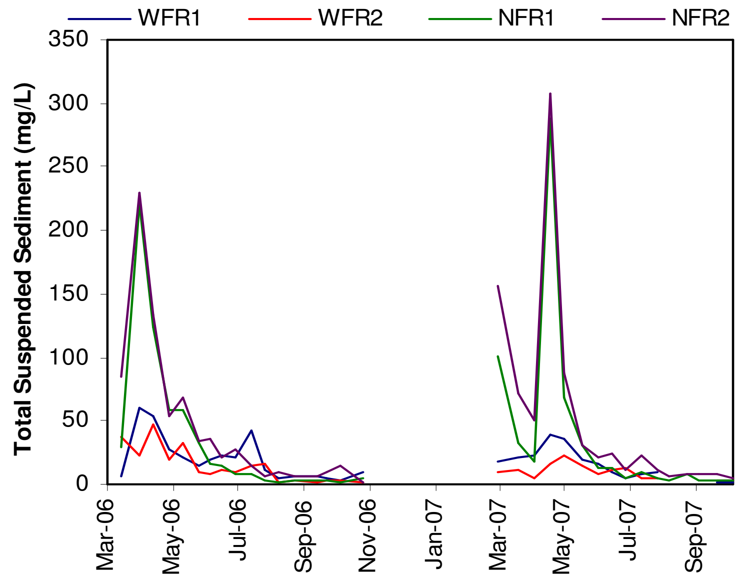

Figure 4. Total suspended sediment levels (mg/L) from March 2006-October 2007.

Mean TSS concentrations at the four sites were low and on average did not exceed the 50 mg/L target (Figure 5). Longitudinal differences in TSS were not detected on either stream. TSS levels were significantly reduced after implementation of BMPs in the West Fork Rapid Creek subwatershed ($p = 0.039$). No difference was detected before and after implementation on the North Fork of Rapid Creek.

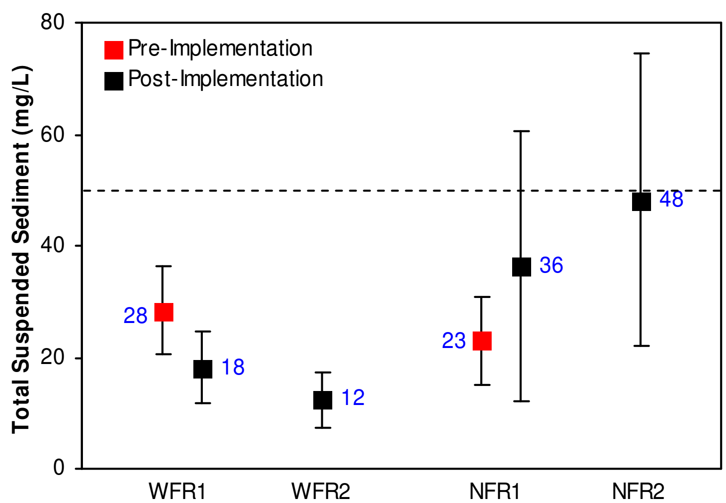

Figure 5. Mean suspended sediment concentrations (± 95% CI) measured before and after implementation in the Upper Rapid Creek watershed.

Sediment was identified as the pollutant of concern in the Rapid Creek watershed (IDEQ, 1999). However, the data presented here suggest that sediment concentrations are typically low and elevated concentrations are limited to high flow periods on the North Fork of Rapid Creek. Sediment does not appear to impact beneficial uses on the West Fork of Rapid Creek and likely has limited seasonal impacts on the North Fork of Rapid Creek.

Total Phosphorus

Phosphorus is the major nutrient of concern in the Portneuf Subbasin. Both total phosphorus (TP) and orthophosphorus (OP, dissolved phosphorus) inputs to the system were measured. Orthophosphorus represents the portion of total phosphorus that is directly available to plants.

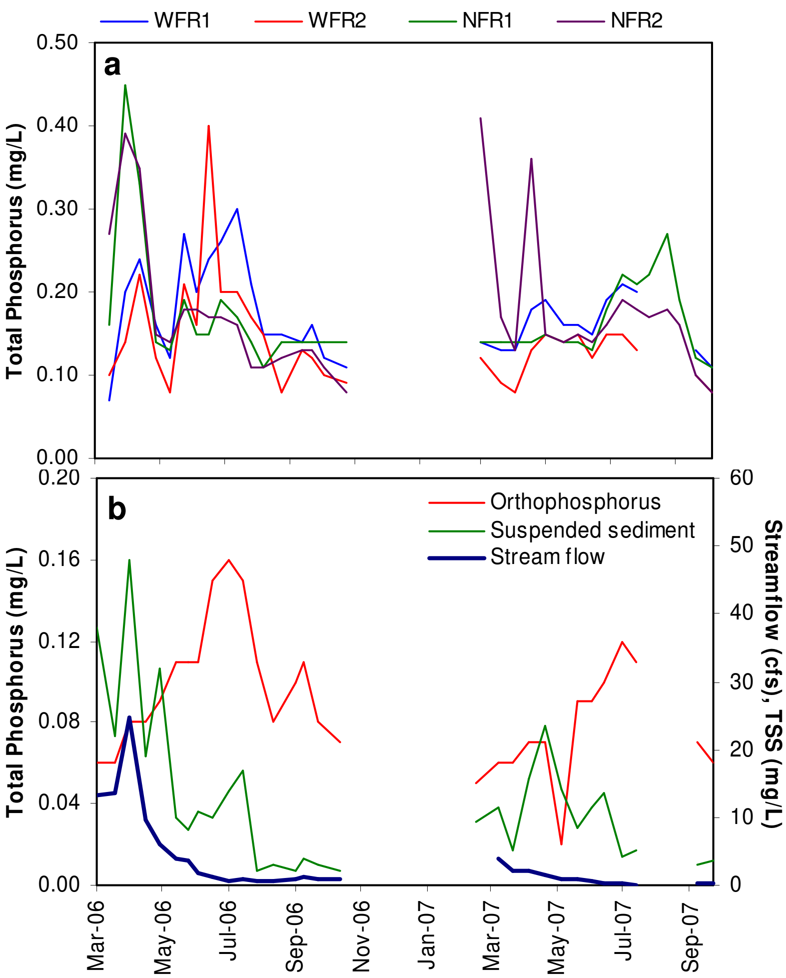

Figure 6. a) Total phosphorus concentrations at the four sites. b) Orthophosphorus levels at WFR2 increased 1-2 months after peaks in stream flow and suspended sediment at the four sites. This pattern was observed at all four sites.

TP concentrations in the Upper Rapid Creek watershed fluctuated throughout the year (Figure 6a). TP concentrations were typically highest during the late spring and summer months. Phosphorus may be adsorbed to sediment particles and therefore TP and TSS inputs to surface waters are often correlated. At the four sites we monitored in Upper Rapid Creek, TP was correlated with TSS concentrations ($p \leq 0.012$), although it did not match the TSS pattern exactly. The variability was due to the large OP inputs that were detected 1-2 months after peak flow (Figure 6b).

The time lag between spring runoff and OP may indicate that the Upper Rapid Creek watershed is impacted by landuse practices such as non-irrigated cropland. Until the 1980s, wheat was grown in parts of the watershed and alfalfa is still grown in the North Fork subwatershed. Current OP levels may be the result of leaching from retired and active crop fields. Also, it is possible that phosphorus is being leached into the groundwater supply from septic systems. There are approximately 35 homes in the Upper Rapid Creek watershed, primarily on the North Fork of Rapid Creek.

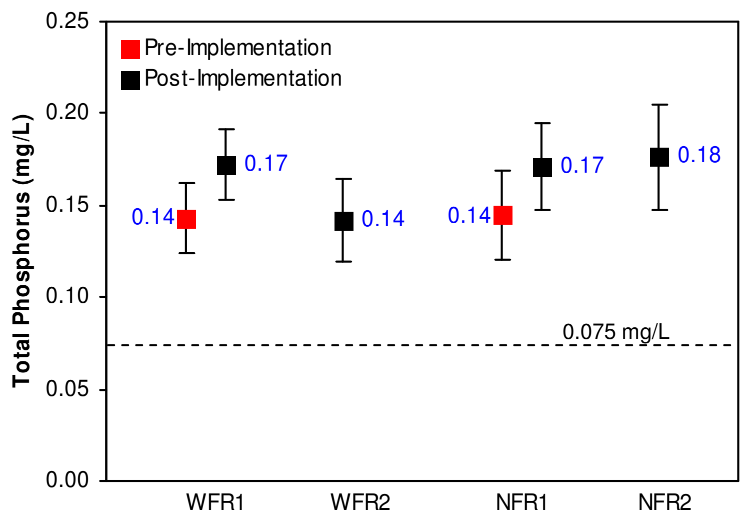

Figure 7. Mean phosphorus concentrations (± 95% CI) before and after BMP implementation. The dashed line represents the DEQ target of 0.075 mg/L.

Every TP sample we collected exceeded the phosphorus target of 0.075 mg/L. TP concentrations remained high after BMPs were implemented and did not differ significantly between sites on each stream (Figure 7). On average, 33-42% of phosphorus entered these streams attached to sediment particles and efforts to decrease sediment inputs may reduce TP levels in these systems. After natural background concentrations are assessed, septic system performance should be investigated to determine if they are having an impact on water quality in the watershed. Current and historic farming practices may also be influencing water quality. It would be impractical to treat retired cropland, but fertilizer application on active cropland should be investigated.

Nitrogen

The original Portneuf TMDL (DEQ, 1999) cited nitrogen as a pollutant of concern in the watershed and set a target of 0.3 mg/L. The Portneuf TMDL is currently being revised and it has been proposed that the nitrogen target be significantly increased.

Distinct patterns of variability in nitrogen concentrations were observed at the four sites (Figure 8). On both streams, concentrations at the downstream site mirrored the upstream site. On the North Fork, peaks in nitrate + nitrite levels were correlated with increases in ammonia concentrations. On the West Fork of Rapid Creek ammonia was rarely detected. Instead, nitrate + nitrite concentrations varied seasonally; concentrations declined steadily from March to November both years.

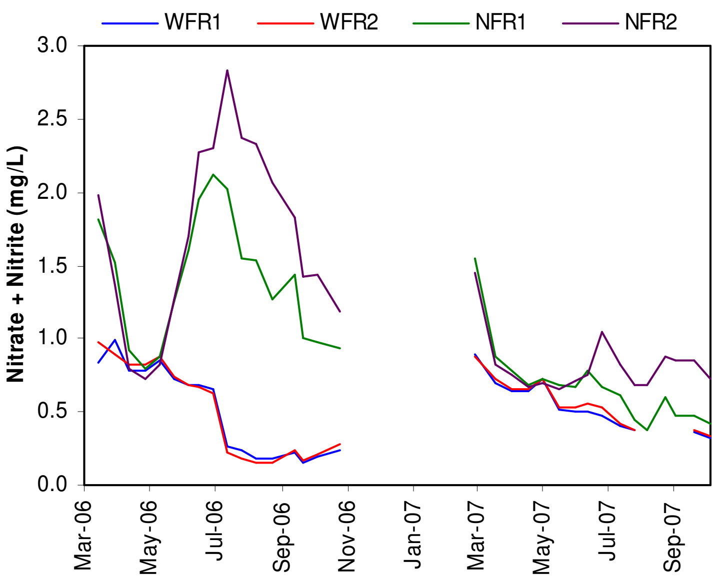

Figure 8. Nitrogen levels (nitrate + nitrite, mg/L) measured in Upper Rapid Creek from 2006-2007.

Average nitrogen (nitrate + nitrite) concentrations in the West Fork were significantly lower than in the North Fork of Rapid Creek ($p < 0.0001$, Figure 9). In the West Fork, nitrogen levels were significantly reduced from pre-implementation levels ($p < 0.0001$). No upstream-downstream differences were detected on the West Fork of Rapid Creek. Nitrogen concentrations in the North Fork did not differ significantly before and after BMP implementation. Additionally, there was no difference between the upstream and downstream sites on the North Fork of Rapid Creek.

The significant reductions in nitrogen concentrations on the West Fork were likely due to the exclusion of livestock from the stream. On the North Fork of Rapid Creek livestock have been excluded from the lower reaches of the North Fork, but the upper reaches are largely untreated. The upstream reaches significantly degrade water quality in the stream and appear to mask the benefits of BMPs on the lower reaches. Implementation of BMPs on the upstream reaches of the North Fork of Rapid Creek would likely reduce nitrogen inputs to the stream. Faulty septic systems could also be responsible for elevated nitrogen concentrations in the North Fork of Rapid Creek.

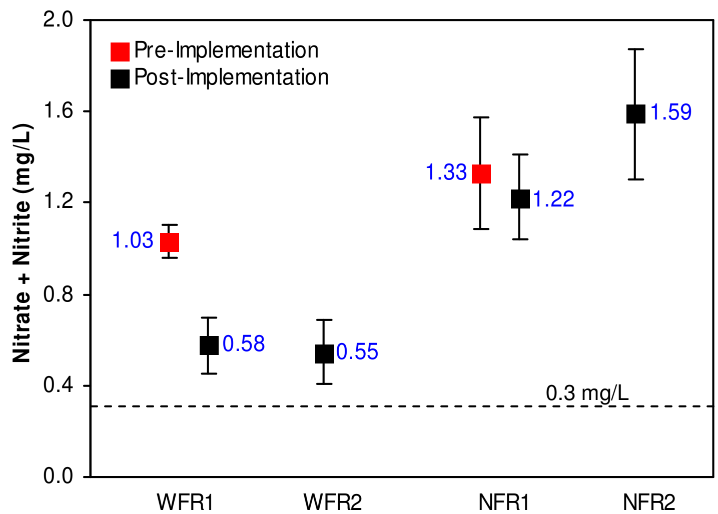

Figure 9. Mean nitrate + nitrite (± 95% CI) at the four monitoring sites. The dashed line represents the 1999 target of 0.3 mg/L; this target is currently being revised.

Escherichia coli

Escherichia coli (*E. coli*) concentrations were highly variable, but did not follow an obvious spatial or temporal pattern (Figure 10). Sites on the West Fork rarely exceeded the state standard of 576 cfu/100 ml. In contrast, the North Fork sites exceeded the standard 27-52% of the time.

Average *E. coli* concentrations in the West Fork of Rapid Creek and at the North Fork 1 site were below the state standard (Figure 11). On average, *E. coli* levels at the North Fork 2 were significantly higher than the other monitoring sites (p = 0.0004) and exceeded the state standard. A significant reduction in *E. coli* concentrations (p = 0.042) was observed on the West Fork after implementation of BMPs. No change in *E.coli* levels were detected on the North Fork of Rapid Creek. Livestock exclusion on the West Fork of Rapid Creek was likely responsible for reductions in *E. coli* concentrations. As mentioned earlier, North Fork sites were highly influenced by untreated reaches upstream and did not experience reductions in *E. coli*.

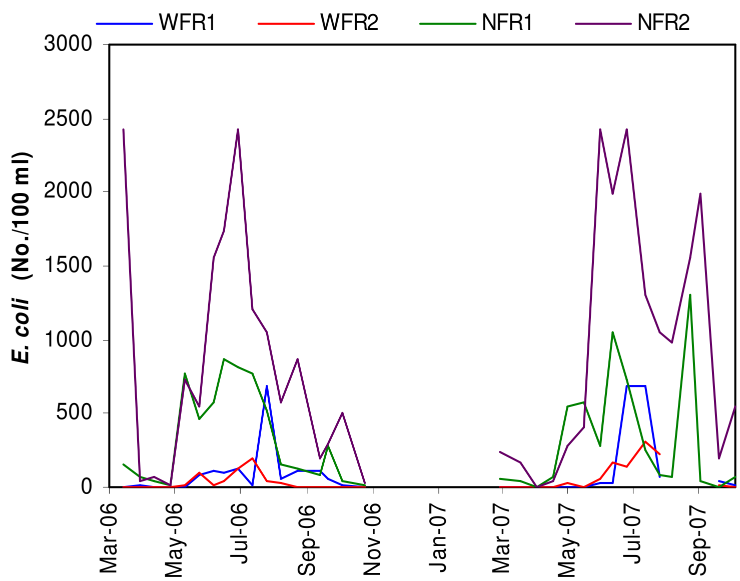

Figure 10. *E.coli* concentrations at the four sites from March 2006 to October 2007.

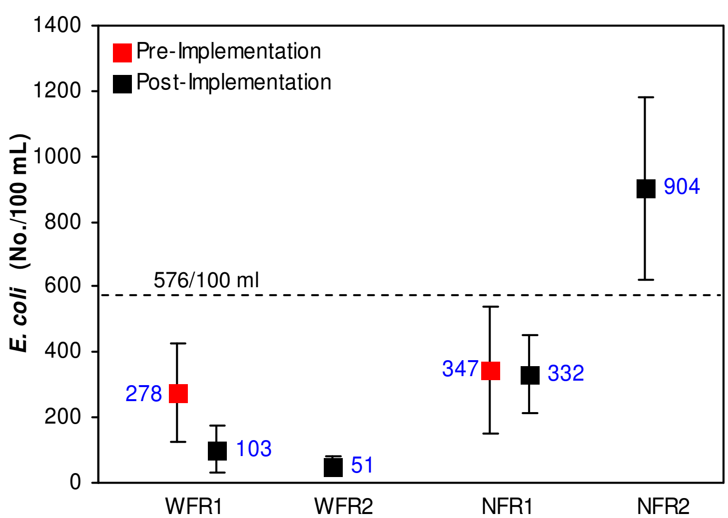

Figure 11. Mean *E. coli* concentrations (± 95% CI) at the Upper Rapid Creek sites.

Conclusions

Best Management Practices were successful at improving water quality in the West Fork of Rapid Creek. Reductions in pollutant concentrations were detected despite elevated precipitation levels and more substantial runoff events during the post-implementation period. Significant decreases in suspended sediment, nitrogen, and *E. coli* concentrations were measured. However, phosphorus remains a concern in the West Fork. This monitoring effort commenced as the projects on the West Fork were being completed. It is encouraging that significant improvements in water quality were detected in such a short timeframe.

No significant changes in water quality were observed in the North Fork of Rapid Creek. As previously stated, landuse activities such as livestock grazing and animal feeding operations, significantly degrade the upper reaches of the stream. These activities contribute significant amounts of TSS, TP, nitrogen, and *E. coli* to the North Fork of Rapid Creek and appear to obscure the benefits of BMPs that have been implemented further downstream. Additionally, the conservation practices that have been implemented (ie: grazing management) may need to be implemented for a number of years before their benefits are fully realized. Septic systems and fertilizer application may also contribute to pollutant loads in the stream.

Recommendations

It appears that conservation efforts on the West Fork have largely been successful at reducing the impacts of landuse activities. The one water quality parameter that remains a concern in the West Fork is phosphorus. It is recommended that pristine springs within the watershed be tested to determine is phosphorus concentrations are naturally elevated. Additionally, anthropogenic sources of phosphorus to the system should be investigated and may include faulty septic systems and/or leaching of phosphorus from farm fields. As streambanks continue to stabilize due to livestock exclusion and grazing management, sediment inputs may continue to decline and consequently may result in lower TP concentrations in the stream.

The North Fork of Rapid Creek continues to be impacted by landuse activities. Livestock exclusion and grazing management practices appear to be providing benefits to the stream. However, the upper reaches of the North Fork of Rapid Creek are largely untreated and these upstream landuse activities are likely masking the benefits of BMPs on the lower reaches. It is recommended that focus be placed on the upper reaches of the stream. Efforts to reduce pollutant loading to the stream should be focused on excluding livestock from riparian areas; reducing erosion from cropland, rangeland, and streambanks; nutrient management; and trapping pollutants before they enter the stream. Additionally, a watershed-scale assessment of septic system performance is recommended to determine if private homes have an impact on nutrient loading to the stream.

The benefits of BMPs to water quality may not be fully detectable for a number of years. Therefore, it is recommended that water quality monitoring be conducted in the Upper Rapid Creek watershed in future years to fully quantify the impacts of the BMPs that have been installed. It is also important that BMPs be maintained to provide long-term benefits to the watershed.

Acknowledgements

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