



Upper Columbia Basin Network Integrated Water Quality Annual Report 2009

City of Rocks National Reserve (CIRO)
Castle Rocks State Park (CRSP)

Natural Resource Technical Report NPS/UCBN/NRTR—2010/279



ON THE COVER

Almo Creek, June 2008 Castle Rocks State Park
Photograph courtesy of Eric Starkey

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Castle Rocks State Park (CRSP)



Natural Resource Technical Report NPS/UCBN/NRTR—2010/279

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Executive Summary

The mission of the National Park Service is “to conserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment of this and future generations” (NPS 1999). To uphold this goal, the Director of the NPS approved the Natural Resource Challenge to encourage national parks to focus on the preservation of the nation’s natural heritage through science, natural resource inventories, and expanded resource monitoring (NPS 1999). Through the Challenge, 270 parks in the national park system were organized into 32 inventory and monitoring networks.

The Upper Columbia Basin Network (UCBN) has identified 14 priority park vital signs, indicators of ecosystem health, which represent a broad suite of ecological phenomena operating across multiple temporal and spatial scales. Our intent is to monitor a balanced and integrated “package” of vital signs that meets the needs of current park management, but will also be able to accommodate unanticipated environmental conditions in the future. Water quality is a particularly high priority vital sign for six of the nine UCBN parks. The UCBN contains more than 34 rivers, streams, ponds and reservoirs located in nine park units spread over four large western states. Unlike many National Parks that are large and often encompass entire watersheds, most UCBN parks and water bodies are small and embedded in large watersheds with diverse land use.

This annual report details the status of key indicators of water quality obtained from the first season of monitoring in City of Rocks National Reserve (CIRO) and Castle Rock’s State Park (CRSP) 2009. Note that several of the appendices in this report are primarily intended for UCBN internal reference. Data from the 2009 field sampling effort was collected following methods detailed in the UCBN integrated water quality monitoring protocol (Starkey et al. 2009). The UCBN integrated water quality monitoring protocol was formally peer-reviewed and approved for implementation in August 2009.

Water chemistry and macroinvertebrate results indicate that the primary concern in the Circle Creek drainage (CIRO) is turbidity caused primarily by stream bank erosion. Data collected during a 24-hour period in 2009 suggest that the main stem of Circle Creek may encounter dissolved oxygen levels below the regulatory threshold (6.0 mg/L) on a regular basis during base flow. Water chemistry and macroinvertebrate results suggest that the “wetland mitigation” areas along Almo Creek (CRSP) may be having a positive effect on stream biota. Wide fluctuations in water levels due to irrigation needs should be a concern to park managers as it is likely adding to bank instability issues along Almo Creek. In both Almo Creek and the Circle Creek drainage there is much evidence that stream bank erosion is being caused by the use of the riparian area and stream channel by livestock. Stream bank erosion is discussed in more detail in this report. The status of water quality for Circle Creek (CIRO) and Almo Creek (CRSP) relative to state regulatory thresholds, is given in the summary tables on the following page.

UCBN water quality monitoring is conducted on a 3 year rotating panel. Water quality conditions in Almo, North Fork Circle, South Fork Circle, and Main Circle Creeks will be evaluated again in 2012.

North Fork Circle Creek Water Chemistry Summary for 24 Hour Period 14-15 June, 2009

Measure	Condition	State DEQ Thresholds
Temperature (*MDMT, **MDAT)	* MDMT= 12.22°C ** MDAT=12.22 °C	*MDMT<22 °C **MDAT<19 °C
Specific Conductance (mean)	Unavailable due to data quality issues (see description below)	N/A
Dissolved Oxygen (mean daily min)	8.42 mg/L	> 6.0 mg/L
pH (mean daily max)	7.54 pH Units	9.5 pH Units, Max
pH (mean daily min)	7.37 pH Units	6.0 pH Units, Min
Turbidity (mean daily max)	80.9 NTU	< 50 NTU (instantaneous) < 25 for 10 consecutive days

*MDMT – Maximum Daily Maximum Temperature **MDAT – Maximum Daily Average Temperature

South Fork Circle Creek Water Chemistry Summary for 24 Hour Period 13-14 June, 2009

Measure	Condition	State DEQ Thresholds
Temperature (*MDMT, **MDAT)	* MDMT= 10.07 °C ** MDAT= 10.07°C	*MDMT<22 °C **MDAT<19 °C
Specific Conductance (mean)	Unavailable due to data quality issues (see description below)	N/A
Dissolved Oxygen (mean daily min)	8.84 mg/L	> 6.0 mg/L
pH (mean daily max)	7.6 pH Units	9.5 pH Units, Max
pH (mean daily min)	7.4 pH Units	6.0 pH Units, Min
Turbidity (mean daily max)	176 NTU	< 50 NTU (instantaneous) < 25 for 10 consecutive days

*MDMT – Maximum Daily Maximum Temperature **MDAT – Maximum Daily Average Temperature

Main Stem Circle Creek Water Chemistry Summary for 24 Hour Period 11-12 June, 2009

Measure	Condition	State DEQ Thresholds
Temperature (*MDMT, **MDAT)	* MDMT= 15.62 °C ** MDAT= 15.62 °C	*MDMT<22 °C **MDAT<19 °C
Specific Conductance (mean)	305 µS/cm	N/A
Dissolved Oxygen (mean daily min)	5.66 mg/L	> 6.0 mg/L
pH (mean daily max)	7.87 pH Units	9.5 pH Units, Max
pH (mean daily min)	7.75 pH Units	6.0 pH Units, Min
Turbidity (mean daily max)	252 NTU	< 50 NTU (instantaneous) < 25 for 10 consecutive days

*MDMT – Maximum Daily Maximum Temperature **MDAT – Maximum Daily Average Temperature

Almo Creek Water Chemistry Summary for 24 Hour Period 12-13 June, 2009

Measure	Condition	State DEQ Thresholds
Temperature (*MDMT, **MDAT)	* MDMT= 9.89 °C ** MDAT= 9.89 °C	*MDMT<22 °C **MDAT<19 °C
Specific Conductance (mean)	Unavailable due to data quality issues (see description below)	N/A
Dissolved Oxygen (mean daily min)	8.67 mg/L	> 6.0 mg/L
pH (mean daily max)	7.11 pH Units	9.5 pH Units, Max
pH (mean daily min)	6.95 pH Units	6.0 pH Units, Min
Turbidity (mean daily max)	Unavailable due to data quality issues (see description below)	< 50 NTU (instantaneous) < 25 for 10 consecutive days

*MDMT – Maximum Daily Maximum Temperature **MDAT – Maximum Daily Average Temperature

Acknowledgments

Funding for this project was provided through the National Park Service Natural Resource Challenge and the Servicewide Inventory and Monitoring Program. I thank Wallace Keck and the park staff at CIRO for arranging accommodations at Smoky Mountain Campground for the field crew. In addition, thanks to the UCBN staff who provided review of the content and formatting of this report.

Introduction and Background

Water resources have been identified as a high priority vital sign for the UCBN. Water resources and riparian habitats are used by many aquatic, migratory, and terrestrial organisms, and the intrinsic value of water as natural resources (Garrett et al. 2007) are all compelling reasons to monitor these resources in UCBN parks. Reflecting this priority, the Water Resources Division (WRD) of the NPS provides a separate source of funding each fiscal year to the Upper Columbia Basin Network (UCBN) to accomplish water quality monitoring. In June 2009 the UCBN began its first year of integrated water quality monitoring in Almo, North Fork Circle, South Fork Circle, and Main Circle Creeks at City of Rocks National Reserve (CIRO). Note that Almo Creek is within Castle Rocks State Park (CRSP).

Water resources in the semi-arid west have been strongly affected by human activity, and all UCBN streams and rivers are listed by states as impaired for one or more parameters. Most UCBN water bodies and many aquatic resources such as migratory fish are strongly influenced by activities in the larger watersheds outside park boundaries. Understanding the current status of freshwater ecosystems will help guide management and restoration efforts, and provide insight into ecosystem change in a landscape with a shifting climate and dynamic human influences.

During the process of prioritizing vital signs to monitor in UCBN parks in 2005, water quality was identified as a high priority vital sign (Garrett et al. 2007). When asked what aspects of water quality were important to monitor, resource managers identified the sampling of macroinvertebrate communities within UCBN water bodies as the top water quality monitoring priority. Secondary priorities included baseline sampling of water chemistry parameters, characterization of channel morphology, and information on water quantity. Channel morphology will be addressed in a separate stream channel characteristics monitoring protocol which is under development and will be available in 2010.

The foci of the UCBN Integrated Water Quality Monitoring Protocol are aquatic macroinvertebrate community composition and water chemistry. Aquatic macroinvertebrate communities have strong effects on freshwater ecosystem processes and represent an important trophic linkage between primary producers and fishes. Measures of macroinvertebrate community composition and structure have been frequently used as water quality indicators because these communities integrate the effects of point and non-point source pollutants over spatial-temporal scales and can be used to answer many management questions. Also, macroinvertebrates are more cost-effective to sample than other biota or many water chemistry parameters.

Water chemistry and temperature have strong effects on aquatic biota. Consequently, direct and indirect human alteration of stream water quality is associated with altered biotic communities and ecosystem processes. Because of the direct relationship between water chemistry and biota, water chemistry is typically a central component of any water quality monitoring program. More recently, monitoring of stream water temperatures has increased in the Pacific Northwest, because of concerns over cold-water fish habitat (primarily salmonid fishes), the recognized influence of land- and water-use on stream temperature regime, and the need for baseline temperature information to monitor the effects of climate change. The NPS WRD has identified

a suite of four “core water quality parameters”, temperature, specific conductance, pH, and dissolved oxygen that are critical to understanding baseline conditions in aquatic habitats. The UCBN added turbidity as a parameter to measure because turbidity is listed as a source of impairment in several UCBN park streams.

Well articulated desired future condition statements have not yet been developed for water quality in UCBN parks. However, the mission statements for the NPS as a whole and for the individual parks clearly state the intent “to conserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment of this and future generations” (NPS 1999). Water quality is a particularly important resource with nationally recognized merit. It is assumed that desired future conditions for all UCBN parks will include clean streams, rivers, and lakes free of human health concerns that provide visitors with recreational and scenic experiences. Monitoring macroinvertebrate assemblage composition and structure, and core water quality parameters, will directly measure the water characteristics most important to park mission, visitor experience, and desired future conditions.

Objectives

The overarching programmatic goal of the UCBN integrated water quality monitoring program is to obtain information that will aid in informed management decisions pertaining to improved water quality within UCBN parks. Park managers have committed to improving the water quality of impaired waters by adopting the NPS Government Performance Results Act (GPRA) goal that 99.3% of streams and rivers managed by NPS will meet State and Federal water quality standards. Most UCBN waters do not meet standards and are listed on EPA 303(d) lists.

Given the lack of available data on water quality in UCBN parks, the following fundamental questions drive much of the UCBN’s inquiry into water quality:

- Are the core water quality parameters of streams in the UCBN with established Total Maximum Daily Loads (TMDLs) selected for sampling improving over time?
- What is the status and long-term trend of core water quality parameters (temperature, pH, conductivity, dissolved oxygen, and turbidity) in UCBN streams selected for sampling?
- What is the status and long term trend in aquatic macroinvertebrate abundance and assemblage composition in selected UCBN streams?
- Do aquatic macroinvertebrate assemblages sampled within UCBN streams indicate polluted or otherwise impaired water quality?
- Do aquatic macroinvertebrate assemblages sampled within UCBN streams indicate “pristine” or “reference” conditions according to regional criteria established by EPA and the states of Idaho, Oregon, Montana, and Washington?

In light of these questions and the broader goals outlined above, water quality monitoring in the UCBN addresses the following specific measurable monitoring objectives:

- Determine status and long term trend in key water quality parameters for selected streams within UCBN park units.
- Determine status and trend in aquatic macroinvertebrate abundance, assemblage composition, and functional feeding group composition in wadeable streams within the UCBN.

Methods

Water Chemistry

A continuous water quality monitor (Hydrolab) was deployed for 24 hours in each of the selected streams within CRSP/CIRO (Almo Creek, North Fork Circle Creek, South Fork Circle Creek, and Main Circle Creek). The deployment interval was 24 hours instead of six months due to the ephemeral nature of streams within the park. The core parameters measured were water temperature, dissolved oxygen, pH, specific conductance, and turbidity. These core parameters were measured hourly and the instruments retrieved/serviced at the end of each deployment period. Recalibration of the Hydrolab occurred after deployment in all four streams. As a result, the degree of sensor fouling was not assessed for each individual deployment; instead, sensor drift was determined for the entire time period. Data quality ratings were determined by the degree of sensor drift and other factors discussed in the results section. For more information on the UCBN water chemistry sampling design see Starkey et al. (2009).

Cross Section Survey

Given the short deployment interval (24hours) and lack of water deep enough to permanently deploy the Hydrolab, no cross section surveys were conducted.

Quality Assurance/Quality Control (QA/QC)

Quality assurance and quality control for multiprobe data collection are covered in detail in SOP #12 (Starkey et al. 2009). Basic procedures adhere to the guidelines established in Part B lite QA/QC Review Checklist for Aquatic Vital Sign Monitoring Protocols and SOPs (Irwin 2008); the National Coastal Assessment Quality Assurance Project Plan 2001-2004 (U.S. EPA 2001); the Laboratory Methods Manual-Estuaries, Volume 1: Biological and Physical Analyses (U.S. EPA 1995); and Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (Barbour et al. 1999). Note that the multiprobe (Hydrolab) was calibrated prior to deployment at CIRO and CRSP.

General quality assurance and quality control methods for UCBN water quality multiprobe calibration and data downloads include the following:

- Representative multiprobe sample locations are determined by using a cross-section and stream segment survey. Each site is re-assessed for representativeness at the start and end of each sample year. Note that cross section surveys are conducted for long term (>1 month) deployments.
- The UCBN follows pre-established maximum acceptable differences for field instrument calibration and QC checks. If the multiprobe readings are outside of the maximum acceptable differences the multiprobe will likely need to be removed for non-routine maintenance.
- When calibrating the multiprobe, values of known standard solutions will be determined pre and post calibration, to help determine if the instrument's measurements have "drifted." In addition, repeated measures of these solutions will help determine the repeatability of multiprobe measures.

- All multiprobe data will be visually checked for outliers and QC issues immediately following the download of data.
- Quantitative and qualitative terms that describe how good data need to be in order to meet project objectives are discussed in detail in SOP #12 Starkey et al. 2009 and Appendix E in this report. NPS WRD lists the following data quality objectives as necessary for water chemistry data: target population, representativeness, completeness, data comparability, measurement sensitivity and detection limits, measurement precision as repeatability, and measurement systematic error/bias.

More detailed QA/QC for water quality multiprobes is contained in SOP #6 and 12 of Starkey et al. 2009.

Discharge

Currently no United States Geological Survey (USGS) real time gauging sites are present on the selected streams within or downstream of CIRO. The closest gage to the park is Raft River above Onemile Creek near Malta ID # 13078000. This data was used to determine general conditions within the Raft River drainage which includes Almo Creek, North Fork Circle Creek, South Fork Circle Creek, and the main stem of Circle Creek.

Macroinvertebrates

Macroinvertebrates were sampled using protocols established by the Environmental Protection Agency (EPA) Environmental Monitoring and Assessment Program (EMAP) (Peck et al. 2006). The EMAP protocol specifies that sample reach length is determined by the wetted width of the stream. Thereby the number of sample reaches in a park was a function of reach length. Almo Creek (CRSP) contained three EMAP style reaches. While the North Fork, South Fork and Main Circle Creeks (CIRO) each accommodated two EMAP reaches. Each sample reach included 11 transects that were permanently marked on the left bank. Macroinvertebrate samples were taken at each transect and composited as a single sample for each reach. Macroinvertebrates were collected several weeks before the preferred index period July-October due to the ephemeral nature of streams within the park. In a “typical” water year, streams are almost dry by July 1st. For more information on the UCBN macroinvertebrate sampling design see Starkey et al. (2009).

Study Area

City of Rocks National Reserve (CIRO)

North Fork, South Fork, and Main Stem Circle Creeks

The North Fork, South Fork, and main stem of Circle Creeks are in the Raft River drainage in Hydrologic Unit 170402100207, south and west of Almo, Idaho. The headwaters for the Circle Creek drainage are within CIRO. The North Fork of Circle Creek merges with the South and Middle forks on private property before re-entering the park as the main stem Circle Creek.

The 4 primary land cover types for CIRO as determined from the National Land Cover Dataset and the National Park Service digital park unit layer include shrubland (71%), grasslands/herbaceous (23%), evergreen forest (4%), and agriculture (3%). This is an accurate reflection of land cover types in the Circle Creek drainage. One land use not accounted for in the above list is ranching. Ranching is present throughout the Circle Creek drainage and is extensive on both public and private lands. The North Fork of Circle Creek is within a different grazing allotment than the South Fork and main stem Circle Creeks.

Threats to water resources in CIRO have been listed as: cattle grazing, residential development, gas, oil and mining operations, and recreational use. The Circle Creek drainage has not been assessed relative to state DEQ 303(d) thresholds (Garrett et al. 2007). In addition, state beneficial uses are currently undesignated.

Two macroinvertebrate sample reaches were established on the North Fork, South Fork and Main Circle Creeks (Appendix A) (Figures 1, 2, 3 and 5). The Hydrolab was deployed in locations with adequate water depth and locations that facilitated relatively easy equipment transfer from one stream to another (i.e. near trails).



Figure 1. North Fork Circle Creek looking downstream from transect F, sample reach 001, during macroinvertebrate sampling on June 14th 2009.



Figure 2. South Fork Circle Creek looking upstream from transect F, sample reach 002, during macroinvertebrate sampling on June 13th 2009.



Figure 3. Main stem Circle Creek looking upstream from transect F, sample reach 001, during macroinvertebrate sampling on June 12th 2009.

Castle Rocks State Park (CRSP)

Almo Creek

Almo Creek is in the Raft River drainage in Hydrologic Unit 170402100203, northwest of Almo, Idaho (Appendix B). Almo Creek originates in and flows through the Sawtooth National Forest prior to entering Castle Rocks State Park. Water from Almo Creek is used extensively for downstream irrigation; consequently there are several diversions within the park. Adjustments to headgates are made by CRSP managers according to a set schedule.

The four primary land cover types for CIRO as determined from the National Land Cover Dataset and the NPS digital park unit layer include shrubland (71%), grasslands/herbaceous (23%), evergreen forest (4%), and agriculture (3%). This is an accurate reflection of land cover types in CRSP and the Almo Creek drainage. One land use not accounted for in the above list is ranching, which occurs extensively on CRSP public lands and downstream on private land. In 2008 two sections of Almo Creek were fenced off to exclude cattle and create wetland mitigation areas.

Threats to water resources in CRSP have been listed as: cattle grazing; residential development; gas, oil and mining operations; and recreational use. Almo Creek has not been assessed relative to state DEQ 303(d) thresholds (Garrett et al. 2007). In addition, state beneficial uses are currently undesignated. Although a variety of water quality information exists for the Raft River and several sub-basins there is a lack of existing information on Almo Creek.

Three macroinvertebrate sample reaches were established on Almo Creek. One of which (002) is within the lower wetland mitigation area (Figures 4 and 5). The Hydrolab was deployed just upstream of the “Ranch House” where there is adequate water depth and relatively easy access (Appendix A).



Figure 4. Almo Creek looking upstream from transect F, sample reach 002, during macroinvertebrate sampling on June 11th 2009.

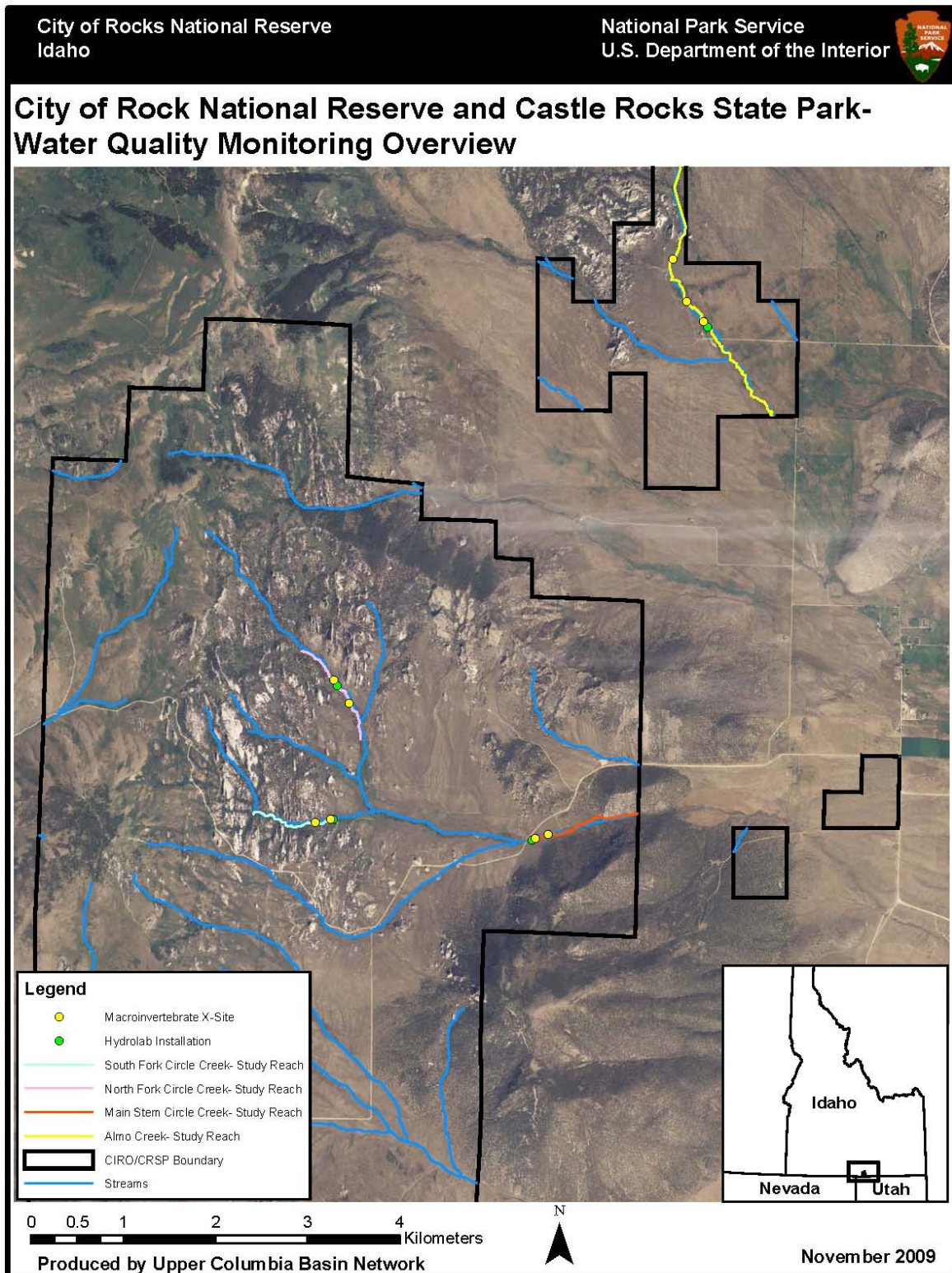


Figure 5. Overview of water quality monitoring locations in CIRO and CRSP, 2009.

Results and Discussion

City of Rocks National Reserve (CIRO): North Fork Circle Creek

Water Chemistry:

Status:

Twenty-four hour summary statistics of core water quality parameters along with the corresponding state Department of Environmental Quality (DEQ) regulatory threshold are given in Table 1. All results from water chemistry monitoring in North Fork Circle Creek should be viewed against the backdrop of unseasonably wet weather in southern Idaho in 2009. The rainfall total from June 1st to June 15th 2009 in Burley ID was 2.36 in. The average monthly rainfall in the same location for the entire month of June is 0.87 in (<http://www.wunderground.com/cgi-bin/findweather/getForecast?query=83318>). The data suggest that the primary concern in the North Fork of Circle Creek is turbidity caused by stream bank erosion.

Table 1. Vital sign summary table for water chemistry in North Fork Circle Creek 2009.

North Fork Circle Creek Water Chemistry Summary for 24 Hour Period 14-15 June, 2009		
Measure	Condition	State DEQ Thresholds
Temperature (*MDMT, **MDAT)	* MDMT= 12.22°C ** MDAT=12.22 °C	*MDMT<22 °C **MDAT<19 °C
Specific Conductance (mean)	Unavailable due to data quality issues (see description below)	N/A
Dissolved Oxygen (mean daily min)	8.42 mg/L	> 6.0 mg/L
pH (mean daily max)	7.54 pH Units	9.5 pH Units, Max
pH (mean daily min)	7.37 pH Units	6.0 pH Units, Min
Turbidity (mean daily max)	80.9 NTU	< 50 NTU (instantaneous) < 25 for 10 consecutive days

*MDMT – Maximum Daily Maximum Temperature **MDAT – Maximum Daily Average Temperature

- *Temperature:*

The maximum daily maximum temperature (MDMT) (12.22 °C) was well below the regulatory threshold of 22 °C. Figure 6 shows the hourly temperatures in North Fork Circle Creek June 14-15th 2009. The temperature data received a grade of “excellent” due to lack of drift during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the temperature data are listed in Appendix F.

Water temperature was influenced to a large extent by rainfall during and prior to the deployment period. Given the unseasonably wet weather in June water temperatures were likely lower than average.

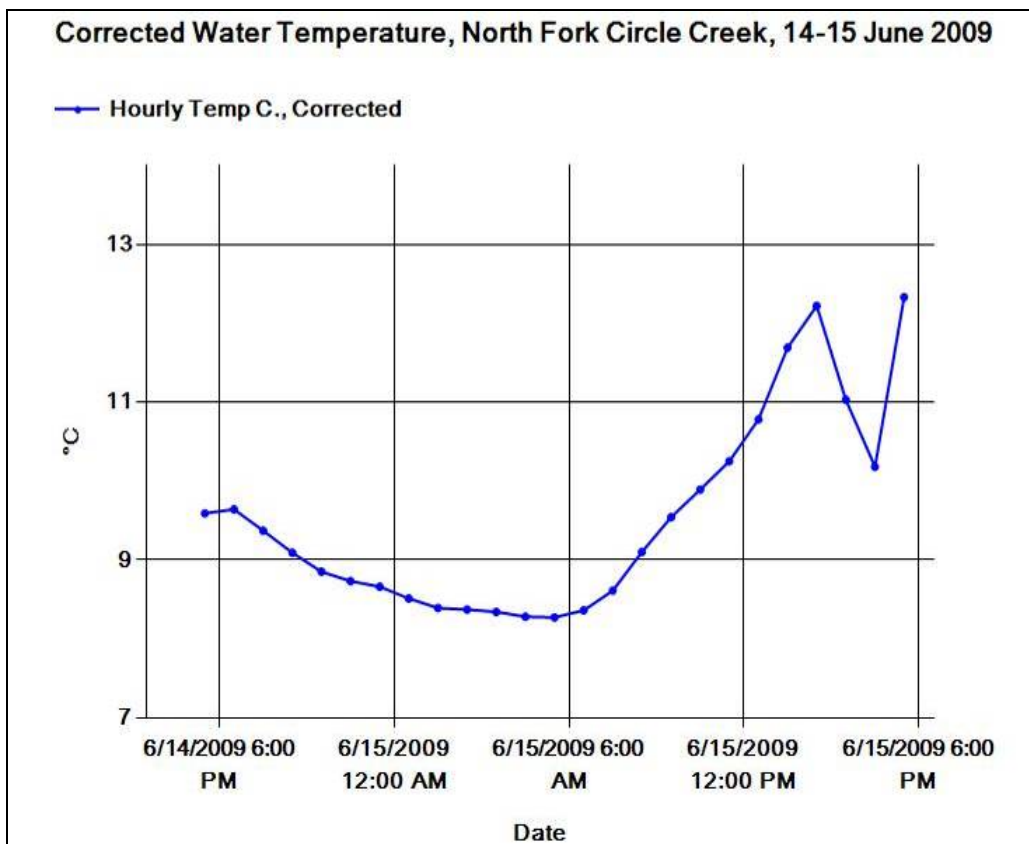


Figure 6. Corrected hourly temperature in North Fork Circle Creek, CIRO, 2009. The State DEQ regulatory threshold for maximum daily maximum temperature (MDMT) is 22°C.

- *Specific Conductance:*

Specific conductance data ranged from 0 to 29 $\mu\text{S}/\text{cm}$, with an average specific conductance of 4.91 $\mu\text{S}/\text{cm}$. These values are not likely to be representative of stream conditions and appear to have been influenced by debris or air bubbles trapped in the specific conductance sensor. Despite minimal sensor drift during the deployment, data quality should be viewed as very poor or unusable. This standard USGS rating was applied due to the high degree of sensor fouling encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Figure 7 shows hourly readings for specific conductance June 14th-15th. There is no regulatory threshold for specific conductance as it varies widely depending on the geology of the drainage basin and stream discharge.

Corrections that have been applied to the specific conductance data are listed in Appendix F.

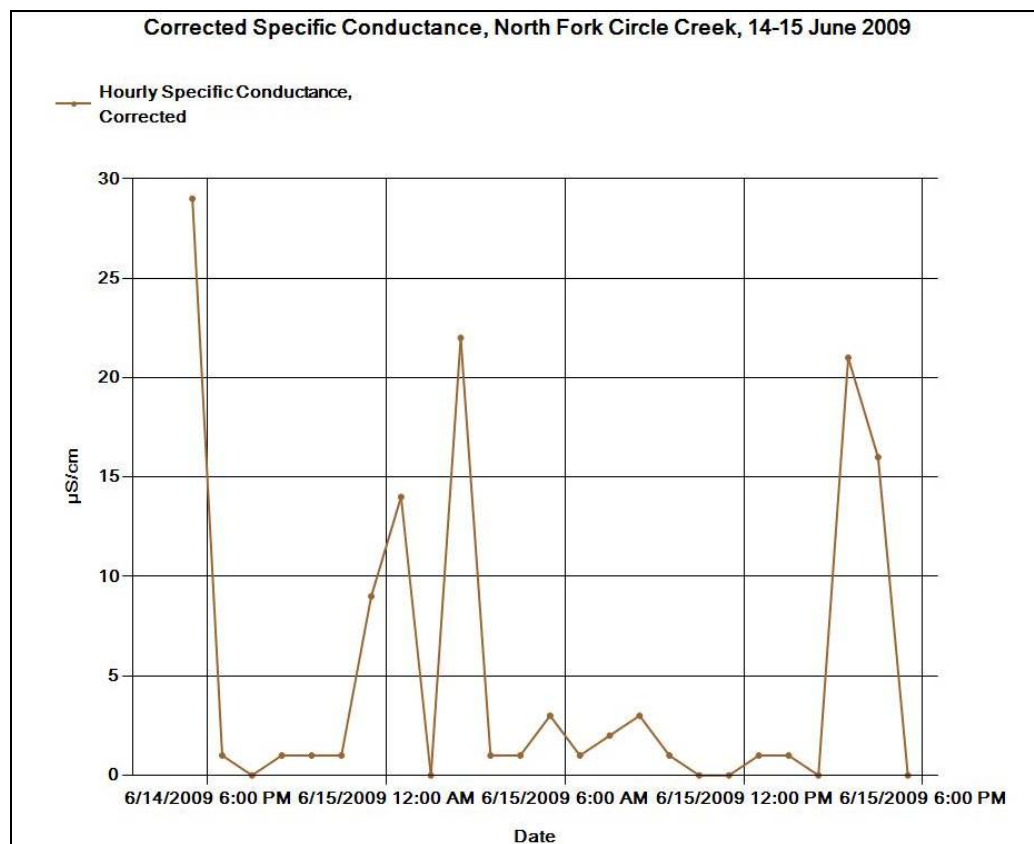


Figure 7. Corrected hourly specific conductance in North Fork Circle Creek, CIRO, 2009. There is no regulatory threshold for specific conductance.

- *Dissolved Oxygen:*

Daily minimum dissolved oxygen was 8.42 mg/L which is well above the regulatory threshold (6.0 mg/L). An unusual diel pattern of dissolved oxygen was observed in which the peak dissolved oxygen occurred at 5:30 am on June 15th and declined throughout the day (Figure 8). Typically dissolved oxygen should be at its lowest in the early morning hours and increase as photosynthesis increases during the day. This reverse pattern was likely due to high flows late in the day on June 14th creating elevated dissolved oxygen as water flowed more rapidly over an upstream riffle. Subsequently dissolved oxygen decreased and returned to a baseline level on June 15th. Dissolved oxygen data collected during this deployment has a data quality rating of “excellent”. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the dissolved oxygen data are listed in Appendix F.

The dissolved oxygen reading was influenced to a large extent by rainfall during and prior to the deployment period. Given the unseasonably high flows in June dissolved oxygen was likely higher in North Fork Circle Creek than average.

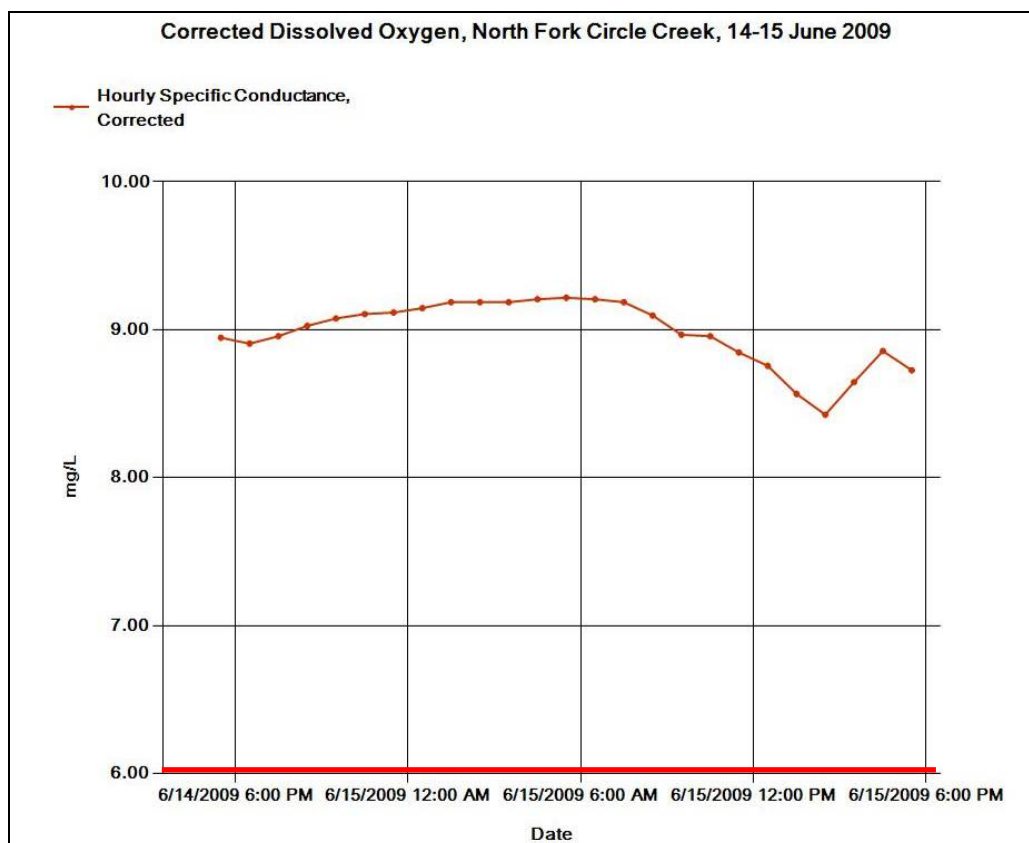


Figure 8. Corrected hourly dissolved oxygen in North Fork Circle Creek, CIRO, 2009. The red line denotes the state DEQ regulatory threshold for daily minimum dissolved oxygen (6.0 mg/L).

- *pH*:

The minimum, maximum and mean pH (7.37, 7.54 and 7.46 respectively) were never outside the acceptable regulatory thresholds of 6.0-9.5 pH units. Figure 9 shows the corrected hourly pH in North Fork Circle Creek June 14-15th 2009. Data quality ratings indicate this data is of “excellent” quality. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the pH data are listed in Appendix F.

The 24-hour data for pH reflect the rainfall events during and prior to the deployment period. It is likely that pH values would be somewhat different if stream water retention time was longer.

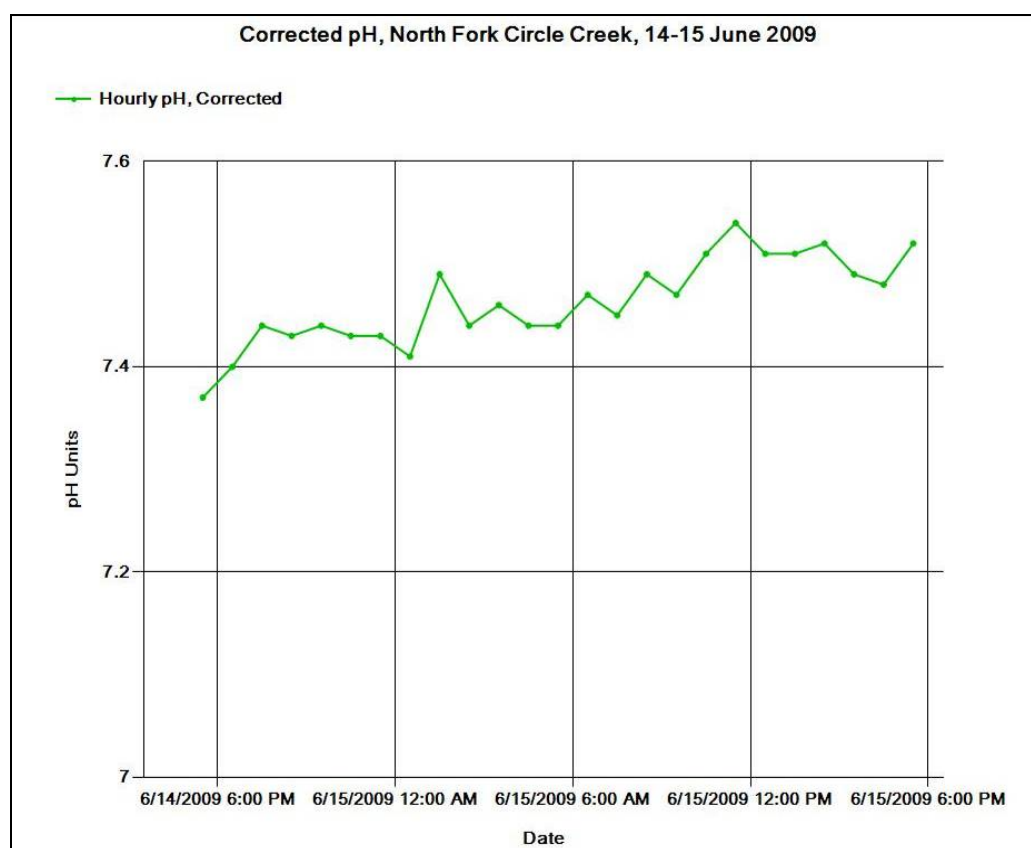


Figure 9. Corrected hourly pH in North Fork Circle Creek, CIRO, 2009. Note that the maximum and minimum regulatory thresholds were never exceeded (6.0, 9.5 pH units)

- *Turbidity:*

It should be noted that spikes in turbidity correspond to increased discharge from large rain events prior to and during the deployment period. During these rain events substantial bed load transport was noted as in other studies in the Raft River drainage basin (Dallon 2001; Lay et. al. 2004). Regulatory thresholds indicate that turbidity should be less than 50 NTU (instantaneous) and no more than 25 for 10 consecutive days. Our data indicates that turbidity values ranged from 0 NTU to 80.9 NTU. It is important to note that the method detection limit (MDL) for this sensor is 0.2 NTU and the minimum level of quantitation (ML) is 0.78 NTU (Appendix E). Figure 11 shows the hourly turbidity in North Fork Circle Creek on June 14th - 15th 2009. Turbidity data from this deployment received a quality rating of “good”. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to turbidity data are listed in Appendix F.

It is unlikely that North Fork Circle Creek experiences widespread elevated turbidity except during rain events. These event based spikes in turbidity are in large part due to sediment supplied to the stream via bank erosion. Several substantial headcuts were noted along macroinvertebrate sample reach 002 (Appendix A). Bank erosion is one of the primary concerns along the North Fork of Circle Creek. The primary source of erosion is due to the use of the riparian area and stream channel by livestock (Figure 10). As noted by Belsky et al. (1999), many publications indicate the detrimental effects of cattle on stream communities.



Figure 10. Evidence of livestock use of North Fork Circle Creek’s riparian area and stream channel.

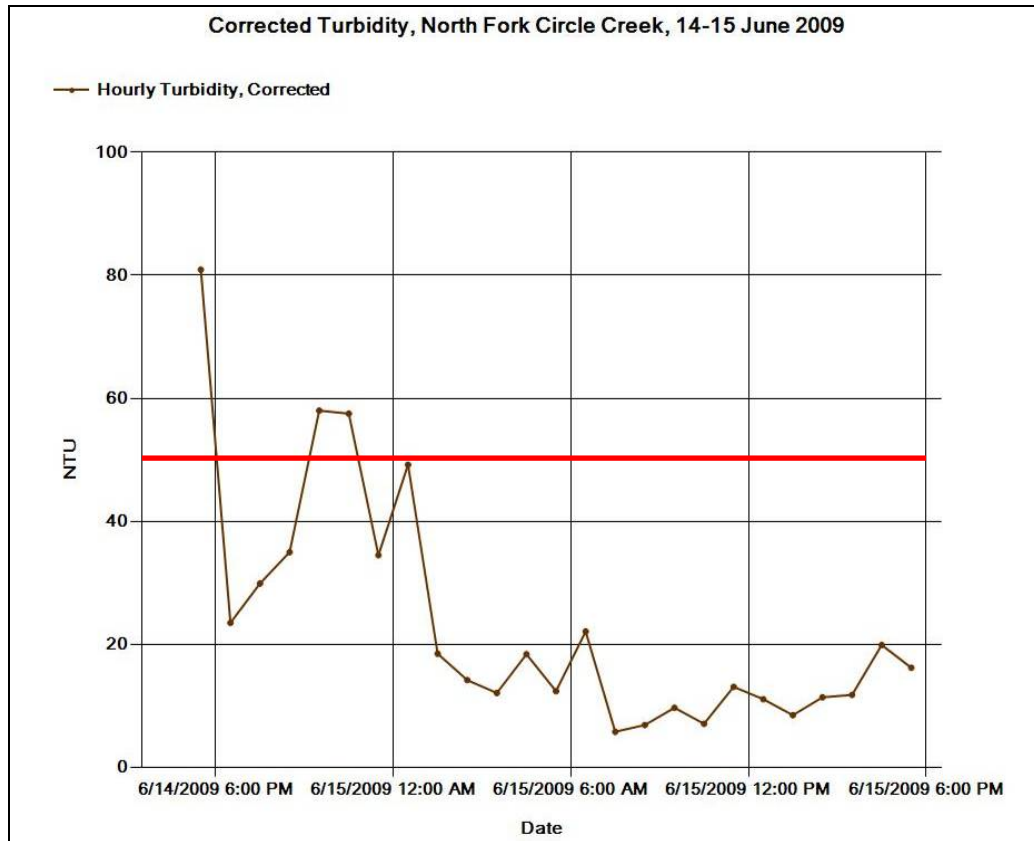


Figure 11. Corrected hourly turbidity in North Fork Circle Creek, CIRO, 2009. The red line denotes the state DEQ regulatory threshold of maximum instantaneous turbidity (50 NTU).

Macroinvertebrates:

Status:

Macroinvertebrate metrics support water chemistry results (Hilsenhoff 1987; Royer et.al. 2001; Wiesman 2003; Hayslip 2007). There is currently no clearly defined multimetric index for the Circle Creek basin or for other representative streams in this region. The condition of the North Fork of Circle Creek was determined based on comparisons to other streams Ephemeroptera, Plecoptera, Tricoptera (EPT) measures and the Hilsenhoff Biotic Index (HBI) (Table2). The HBI values for both reaches (3.49 and 3.68) indicate that water quality is “very good” to “excellent” for streams having an HBI between 0.00 and 4.50 (Hilsenhoff 1987). In addition, the HBI indicates that there may be “slight organic pollution” in North Fork Creek. It will be important to track both the HBI and %EPT/EPT over time. Other macroinvertebrate metrics can be found below in Table 2 or in Appendix I, and a taxa list in Appendix K. Figure 12 shows the percent community composition in the North Fork Circle Creek.

During sample collection, North Fork Circle Creek was flowing in sample reach 01 and 02, and had a high proportion of macroinvertebrate samples drawn from glides (18.2% and 27.3%) and riffles (63.6% and 63.6%) (Appendix G).

As suitable reference sites and multimetric indices become available, the UCBN intends to rate North Fork Circle Creek using these indices or compare it to reference or benchmark conditions. While statements on the status of North Fork Circle Creek macroinvertebrates are limited in 2009, these data establish an important baseline condition to which we will compare future samples.

Table 2. Vital sign summary table for benthic macroinvertebrates in North Fork Circle Creek, June 14th, 2009. Sample reach 001 and 002.

Measure	Current Condition	
	001	002
Dominance Measures		
% Top 3 dominant taxon	32.26	59.70
Richness Measures		
Species richness	51.00	37.00
EPT richness	19.00	19.00
Community Composition		
% EPT	74.73	79.47
Functional Group Composition		
% Filterers	4.48	1.90
% Gatherers	55.91	50.38
% Predators	12.54	14.26
% Scrapers	7.17	24.14
% Shredders	19.71	9.32
Biotic Indices		
Hilsenhoff Biotic Index [HBI]	3.49	3.68

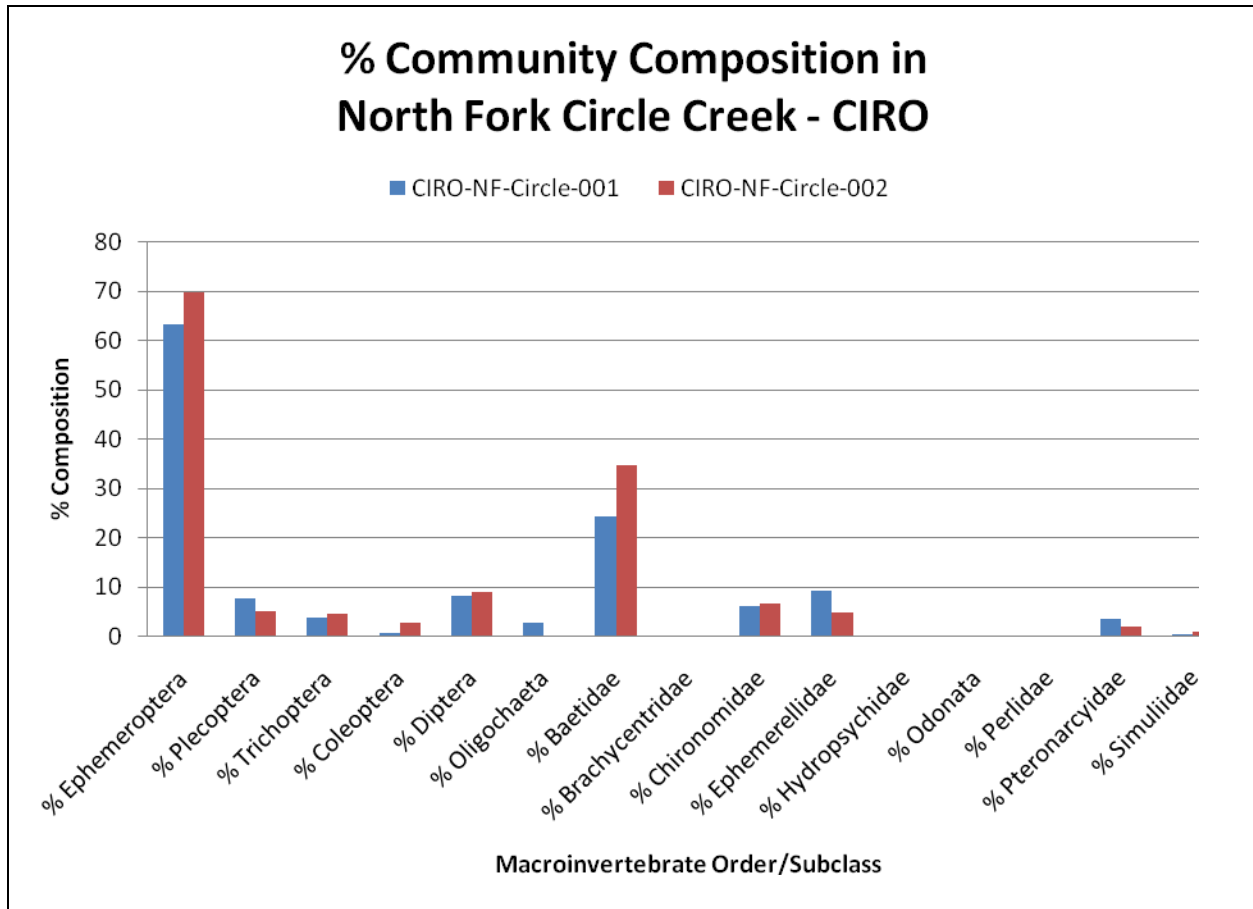


Figure 12. Percent Community Composition in North Fork Circle Creek, 2009.

Summary/Recommendations:

Turbidity levels due to bank erosion should be of primary concern for park managers. Consequences of pronounced bank erosion and increased turbidity include the filling of spaces in between the substrate (interstitial space) and subsequent shift in macroinvertebrate community (decrease of EPT and other sensitive species). Restriction of livestock from the riparian area and stream channel via fencing should be considered to reduce erosion and fecal input. Future assessments should include a determination of coliform and E-coli levels.

City of Rocks National Reserve (CIRO): South Fork Circle Creek

Water Chemistry:

Status:

Twenty-four hour data for core water quality parameters along with the corresponding state Department of Environmental Quality (DEQ) regulatory threshold are given in Table 3. All results from water chemistry monitoring in South Fork Circle Creek should be viewed against the backdrop of unseasonably wet weather in southern Idaho in 2009. The rainfall total from June 1st to June 15th 2009 in Burley ID was 2.36 in. The average monthly rainfall in the same location for the entire month of June is 0.87 in (<http://www.wunderground.com/cgi-bin/findweather/getForecast?query=83318>). The primary concern in the South Fork of Circle Creek is elevated levels of turbidity. Causes of turbidity in the South Fork of Circle Creek were stream bank erosion and surface flow from nearby trails. Each water chemistry parameter is discussed in further detail below.

Table 3. Vital sign summary table for water chemistry in South Fork Circle Creek 2009.

South Fork Circle Creek Water Chemistry Summary for 24 Hour Period 13-14 June, 2009		
Measure	Condition	State DEQ Thresholds
Temperature (*MDMT, **MDAT)	* MDMT= 10.07 °C ** MDAT= 10.07°C	*MDMT<22 °C **MDAT<19 °C
Specific Conductance (mean)	Unavailable due to data quality issues (see description below)	N/A
Dissolved Oxygen (mean daily min)	8.84 mg/L	> 6.0 mg/L
pH (mean daily max)	7.6 pH Units	9.5 pH Units, Max
pH (mean daily min)	7.4 pH Units	6.0 pH Units, Min
Turbidity (mean daily max)	176 NTU	< 50 NTU (instantaneous) < 25 for 10 consecutive days

*MDMT – Maximum Daily Maximum Temperature **MDAT – Maximum Daily Average Temperature

- *Temperature:*

The maximum daily maximum temperature (MDMT) (10.07 °C) was well below the regulatory threshold of 22 °C. Figure 13 shows the hourly temperatures in South Fork Circle Creek June 13-14th 2009. The temperature data received a grade of “excellent” due to lack of drift during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the temperature data are listed in Appendix F.

Water temperature was influenced to a large extent by rainfall during and prior to the deployment period. Given the unseasonably wet weather in June water temperatures were likely lower than average.

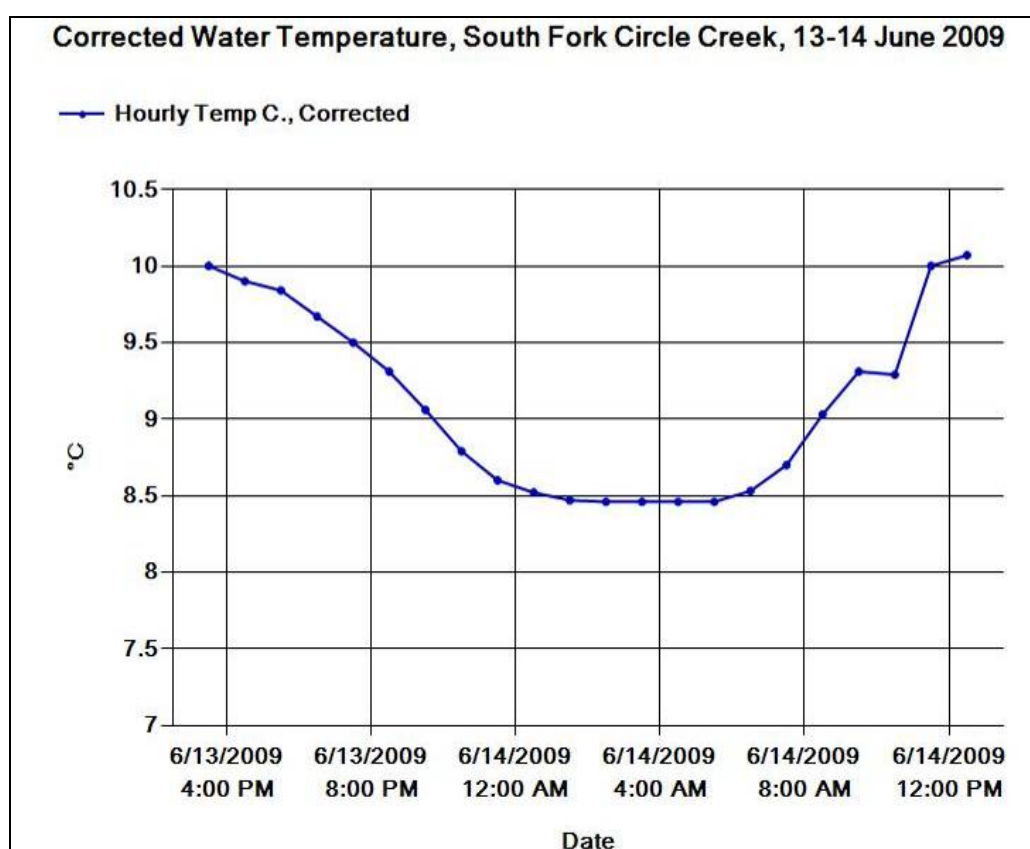


Figure 13. Corrected hourly temperature in South Fork Circle Creek, CIRO, 2009. The State DEQ regulatory threshold for maximum daily maximum temperature (MDMT) is 22°C.

- Specific Conductance:**
 Specific conductance data ranged from 1 to 128 $\mu\text{S}/\text{cm}$, with an average specific conductance of 29.6 $\mu\text{S}/\text{cm}$. These values are not likely to be representative of stream conditions and appear to have been influenced by debris or air bubbles trapped in the specific conductance sensor. Data quality should be viewed as “poor” due to outliers and data suggesting air bubbles were trapped in the sensor. Figure 14 shows hourly readings for specific conductance June 13th-14th. There is no regulatory threshold for specific conductance as it varies widely depending on the geology of the drainage basin and stream discharge. Corrections that have been applied to the specific conductance data are listed in Appendix F.

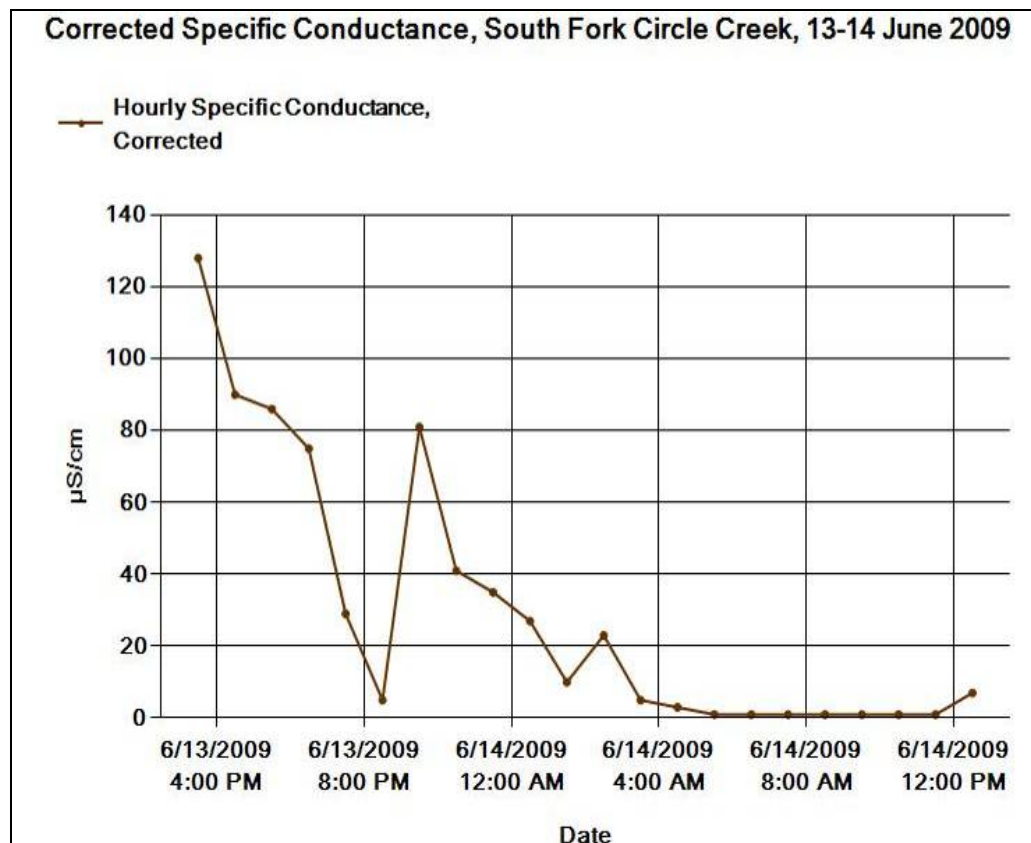


Figure 14. Corrected hourly specific conductance in South Fork Circle Creek, CIRO, 2009. There is no regulatory threshold for specific conductance.

- Dissolved Oxygen:**
 Daily minimum dissolved oxygen was 8.84 mg/L which is well above the regulatory threshold (6.0 mg/L). An unusual diel pattern of dissolved oxygen was observed in which the peak dissolved oxygen occurred at 4:30AM on June 14th and declined throughout the day (Figure 15). Typically dissolved oxygen should be at its lowest in the early morning hours and increase as photosynthesis increases during the day. This pattern was likely due to high flows late in the day on June 13th creating elevated dissolved oxygen as water flowed rapidly over upstream riffles and cascades. Subsequently, dissolved oxygen decreased and returned to a baseline level on June 14th. Dissolved oxygen data received a grade of “excellent” due to lack of drift during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the dissolved oxygen data are listed in Appendix F.

Dissolved oxygen was influenced to a large extent by rainfall during and prior to the deployment period. Given the unseasonably high flows in June dissolved oxygen was likely higher in South Fork Circle Creek than average.

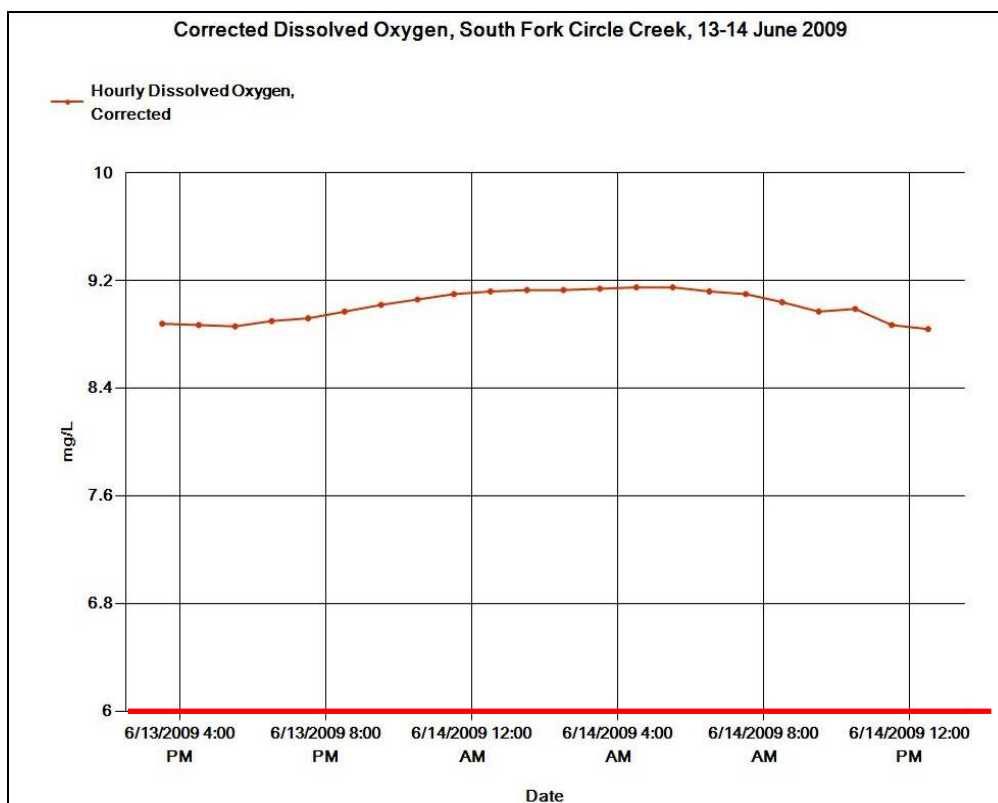


Figure 15. Corrected hourly dissolved oxygen in South Fork Circle Creek, CIRO, 2009. The red line denotes the state DEQ regulatory threshold for daily minimum dissolved oxygen (6.0 mg/L).

- pH:**

The minimum, maximum and mean pH (7.4, 7.6 and 7.5 respectively) were never outside the acceptable regulatory thresholds of 6.0-9.5 pH units. Figure 16 shows the corrected hourly pH in South Fork Circle Creek June 13-14th 2009. The pH data received a grade of “excellent” due to lack of drift during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the pH data are listed in Appendix F.

The 24-hour data for pH reflect the rainfall events during and prior to the deployment period. It is likely that pH values would be somewhat different if in-stream water retention time was longer.

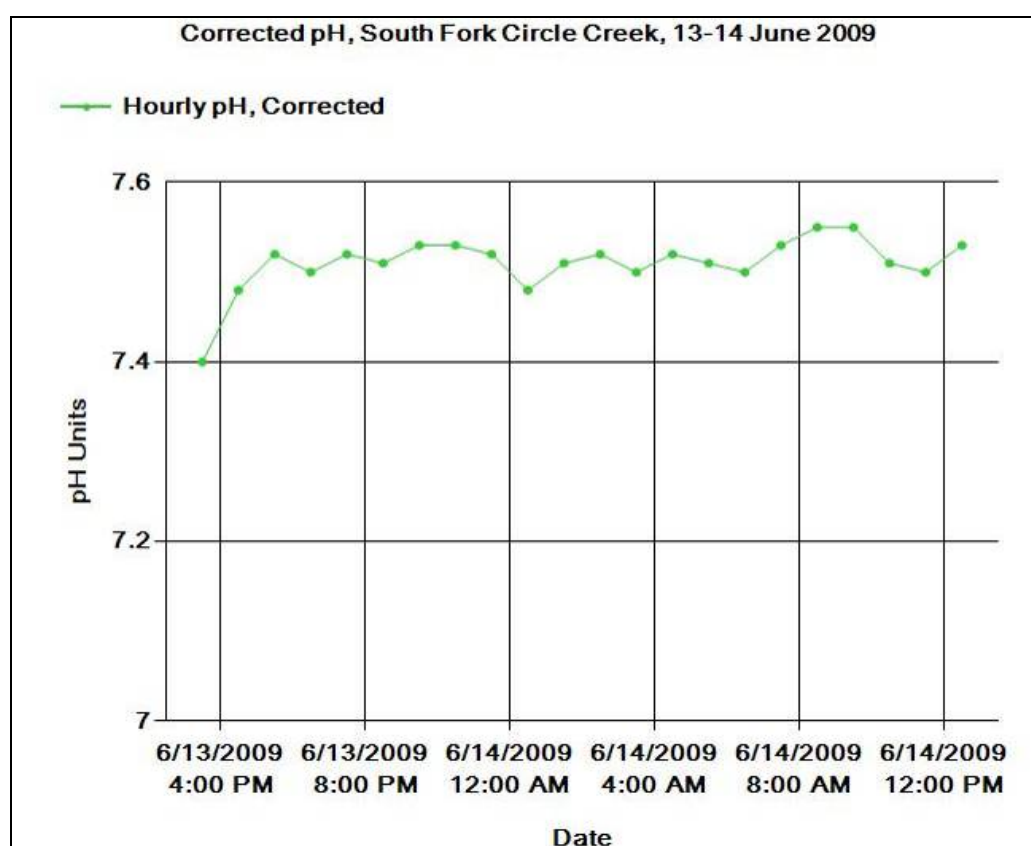


Figure 16. Corrected hourly pH in South Fork Circle Creek, CIRO, 2009. Note that the maximum and minimum regulatory thresholds were never exceeded (6.0, 9.5 pH units)

- *Turbidity:*

It should be noted that spikes in turbidity correspond to increased discharge from large rain events prior to and during the deployment period. During these rain events substantial bed load transport was noted as in other studies in the Raft River drainage basin (Dallon 2001; Lay et al. 2004). Regulatory thresholds indicate that turbidity should be less than 50 NTU (instantaneous) and no more than 25 for 10 consecutive days. Our data indicates that turbidity values ranged from 16 NTU to 176.1 NTU (only one observation fell above 50 NTU). It is important to note that the method detection limit (MDL) for this sensor is 0.2 NTU and the minimum level of quantitation (ML) is 0.78 NTU (Appendix E). Figure 18 shows the hourly turbidity in South Fork Circle Creek on June 13th -14th 2009. Turbidity data received a grade of “good” during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to turbidity data are listed in Appendix F.

It is unlikely that South Fork Circle Creek experiences widespread elevated turbidity except during rain events. These spikes in turbidity are in large part due to sediment supplied to the stream via bank erosion and surface flow from nearby trails, such as the Box Top trail (Figure 17). While bank erosion was much less severe than on North Fork Circle Creek several cut banks were observed. Added suspended materials were likely from banks affected by prior grazing practices. As of June 2009 livestock had been removed from this grazing allotment for several years.

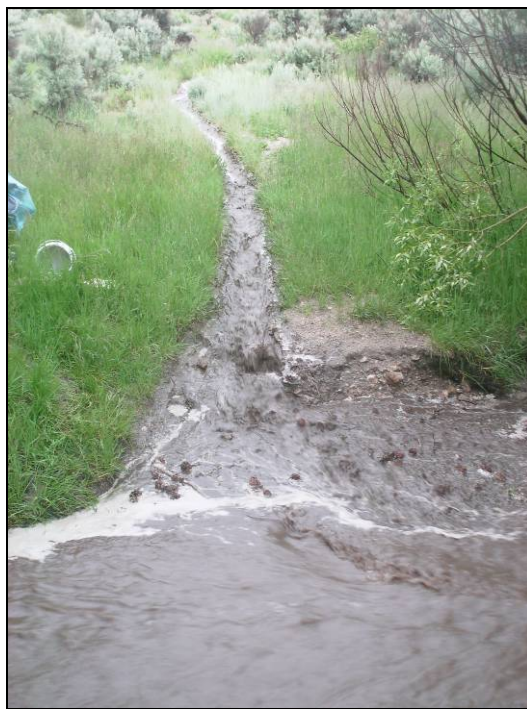


Figure 17. Surface flow from Boxtop Trail entering South Fork Circle Creek during a severe thunderstorm on June 13th 2009. Looking north from South Fork Circle Creek.

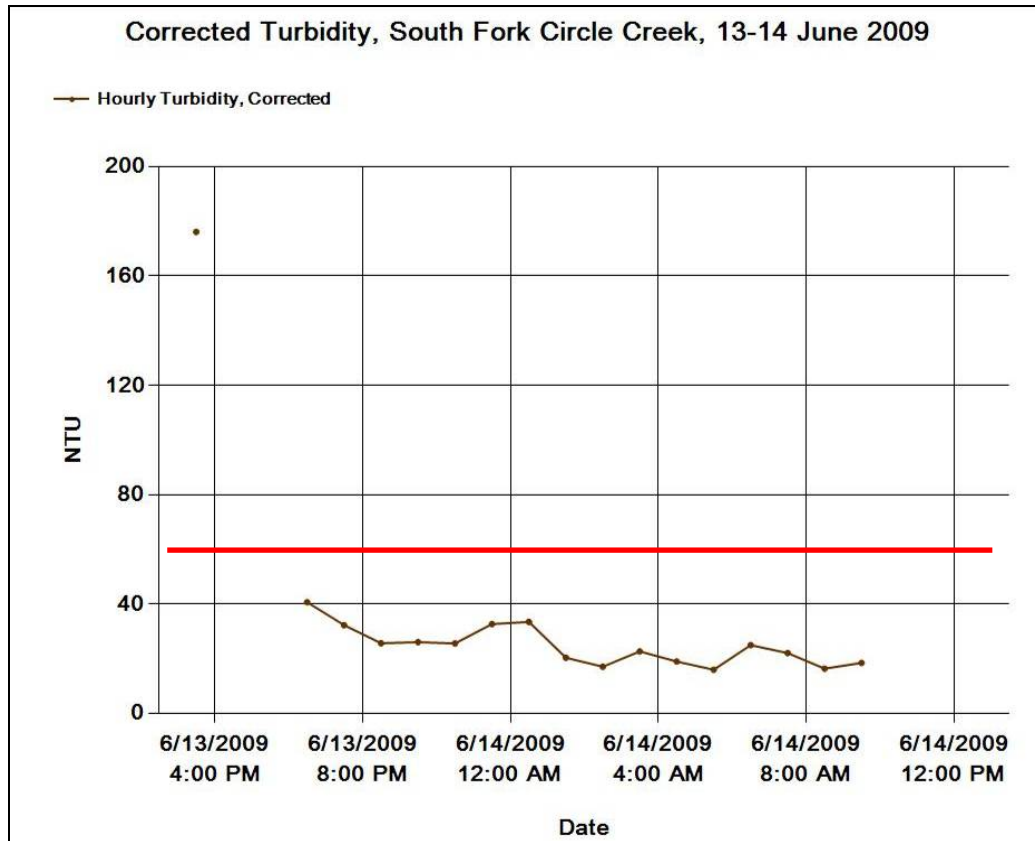


Figure 18. Corrected hourly turbidity in South Fork Circle Creek, CIRO, 2009. The red line denotes the state DEQ regulatory threshold of maximum instantaneous turbidity (50 NTU). Note that the gap in data during the first few hours of sampling is due to the removal of data collected when the wiper parked over the optic.

Macroinvertebrates:

Status:

Macroinvertebrate metrics support water chemistry results (Hilsenhoff 1987; Royer et.al. 2001; Wiesman 2003; Hayslip 2007). There is currently no clearly defined multimetric index for the Circle Creek basin or for other representative streams in this region. The condition of the South Fork of Circle Creek was determined based on comparisons to other streams Ephemeroptera, Plecoptera, Tricoptera (EPT) measures and the Hilsenhoff Biotic Index (HBI) (Table 4). The HBI in South Fork Circle Creek at sample reach 001 and 002 was 3.57 and 2.81 respectively. An HBI between 0.00 and 4.50 indicates that water quality is “very good” to “excellent” (Hilsenhoff 1987). In addition, the HBI indicates that there may be “slight organic pollution” in South Fork Circle Creek. It will be important to track both the HBI and %EPT/EPT over time. Other macroinvertebrate metrics can be found below in Table 4 or in Appendix I, and a taxa list in Appendix K. Figure 19 shows the percent community composition in South Fork Circle Creek.

During the time of sample collection, South Fork Circle Creek was flowing in sample reach 01 and 02, and had a high proportion of macroinvertebrate samples drawn from glides (54.5% and 18.2%) and riffles (36.4% and 72.7%) (Appendix G).

As suitable reference sites and multimetric indices become available, the UCBN intends to rate South Fork Circle Creek using these indices or compare it to reference or benchmark conditions. While statements on the status of South Fork Circle Creek are limited in 2009, these data establish an important baseline condition to which we will compare future samples.

Table 4. Vital sign summary table for benthic macroinvertebrates in South Fork Circle Creek June 13th, 2009. Sample reach 001 and 002.

Measure	Current Condition	
	Reach	
	001	002
Dominance Measures		
% Top 3 dominant taxon	52.78	52.31
Richness Measures		
Species richness	15.00	17.00
EPT richness	5.00	5.00
Community Composition		
% EPT	47.22	53.85
Functional Group Composition		
% Filterers	2.78	0.00
% Gatherers	55.56	47.69
% Predators	25.00	35.38
% Scrapers	5.56	4.62
% Shredders	8.33	9.23
Biotic Indices		
Hilsenhoff Biotic Index [HBI]	3.57	2.81

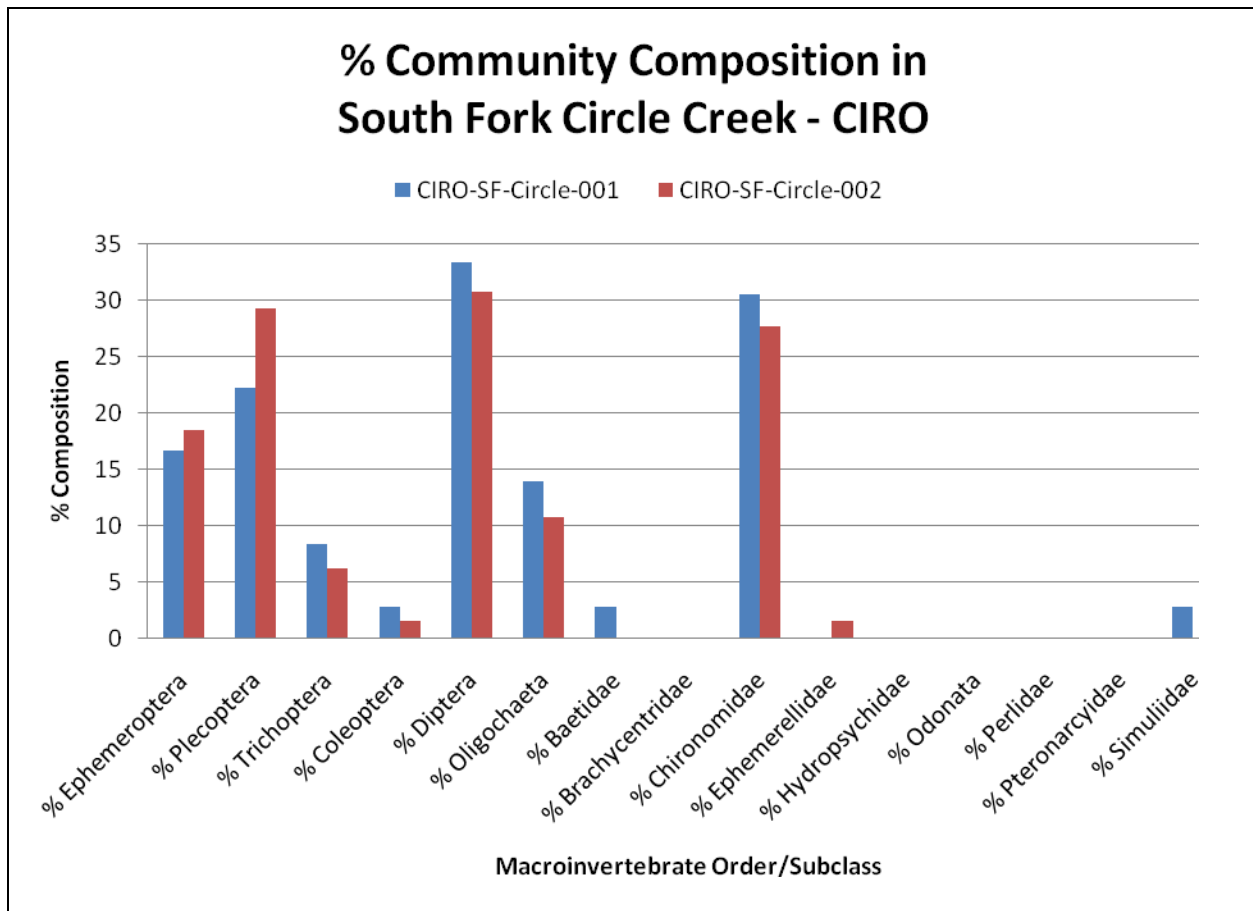


Figure 19. Percent Community Composition in South Fork Circle Creek, 2009.

Summary/Recommendations:

Turbidity levels due to bank erosion and surface runoff should be of primary concern for park managers. Consequences of pronounced bank erosion and increased turbidity include the filling of spaces in between the substrate (interstitial space) and subsequent shift in macroinvertebrate community (decrease of EPT and other sensitive species). Reduction of surface flow from Boxtop trail into South Fork Circle Creek would substantially reduce suspended loads during storm events. In addition, restriction of livestock from the riparian area and stream channel should continue. Future assessments should include the assessment of coliform and E-coli levels.

City of Rocks National Reserve (CIRO): Main Stem Circle Creek

Water Chemistry:

Status:

Twenty-four hour data for core water quality parameters along with the corresponding state Department of Environmental Quality (DEQ) regulatory threshold are given in Table 5. All results from water chemistry monitoring in the main stem of Circle Creek should be viewed against the backdrop of unseasonably wet weather in southern Idaho in 2009. The rainfall total from June 1st to June 15th 2009 in Burley ID was 2.36 in. The average monthly rainfall in the same location for the entire month of June is 0.87 in (<http://www.wunderground.com/cgi-bin/findweather/getForecast?query=83318>). The primary concerns in the main stem of Circle Creek are low dissolved oxygen levels and elevated turbidity. Each water chemistry parameter is discussed in further detail below.

Table 5. Vital sign summary table for water chemistry in the main stem of Circle Creek 2009.

Main Stem Circle Creek Water Chemistry Summary for 24 Hour Period 11-12 June, 2009		
Measure	Condition	State DEQ Thresholds
Temperature (*MDMT, **MDAT)	* MDMT= 15.62 °C ** MDAT= 15.62 °C	*MDMT<22 °C **MDAT<19 °C
Specific Conductance (mean)	305 µS/cm	N/A
Dissolved Oxygen (mean daily min)	5.66 mg/L	> 6.0 mg/L
pH (mean daily max)	7.87 pH Units	9.5 pH Units, Max
pH (mean daily min)	7.75 pH Units	6.0 pH Units, Min
Turbidity (mean daily max)	252 NTU	< 50 NTU (instantaneous) < 25 for 10 consecutive days

*MDMT – Maximum Daily Maximum Temperature **MDAT – Maximum Daily Average Temperature

- **Temperature:**

The maximum daily maximum temperature (MDMT) (15.62 °C) was well below the regulatory threshold of 22 °C. Figure 20 shows the hourly temperatures in the main stem of Circle Creek June 11-12th 2009. The temperature data received a grade of “excellent” due to lack of drift during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the temperature data are listed in Appendix F.

Water temperature was influenced to a large extent by rainfall during and prior to the deployment period. Given the unseasonably wet weather in June, water temperatures were likely lower than average.

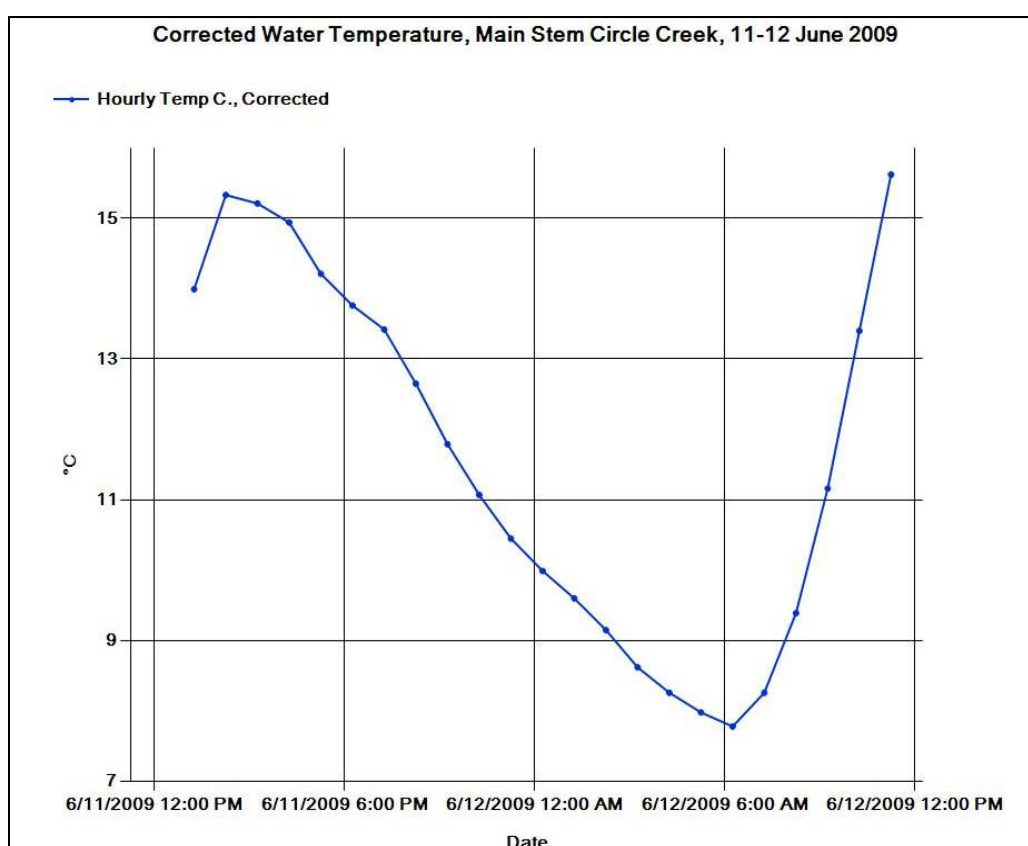


Figure 20. Corrected hourly temperature in main stem Circle Creek, CIRO, 2009. The State DEQ regulatory threshold for maximum daily maximum temperature (MDMT) is 22°C.

- Specific Conductance:**
 Specific conductance ranged from 235 to 322 $\mu\text{S}/\text{cm}$, with an average specific conductance of 305 $\mu\text{S}/\text{cm}$. Unlike data collected in the North and South Forks, specific conductance data for the main stem of Circle Creek was un-impacted by debris or air bubbles trapped in the specific conductance sensor. Specific conductance data received a grade of “excellent” due to lack of drift during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the specific conductance data are listed in Appendix F.

Figure 21 shows hourly readings for specific conductance June 11-12th. There is no regulatory threshold for specific conductance as it varies widely depending on the geology of the drainage basin and stream discharge.

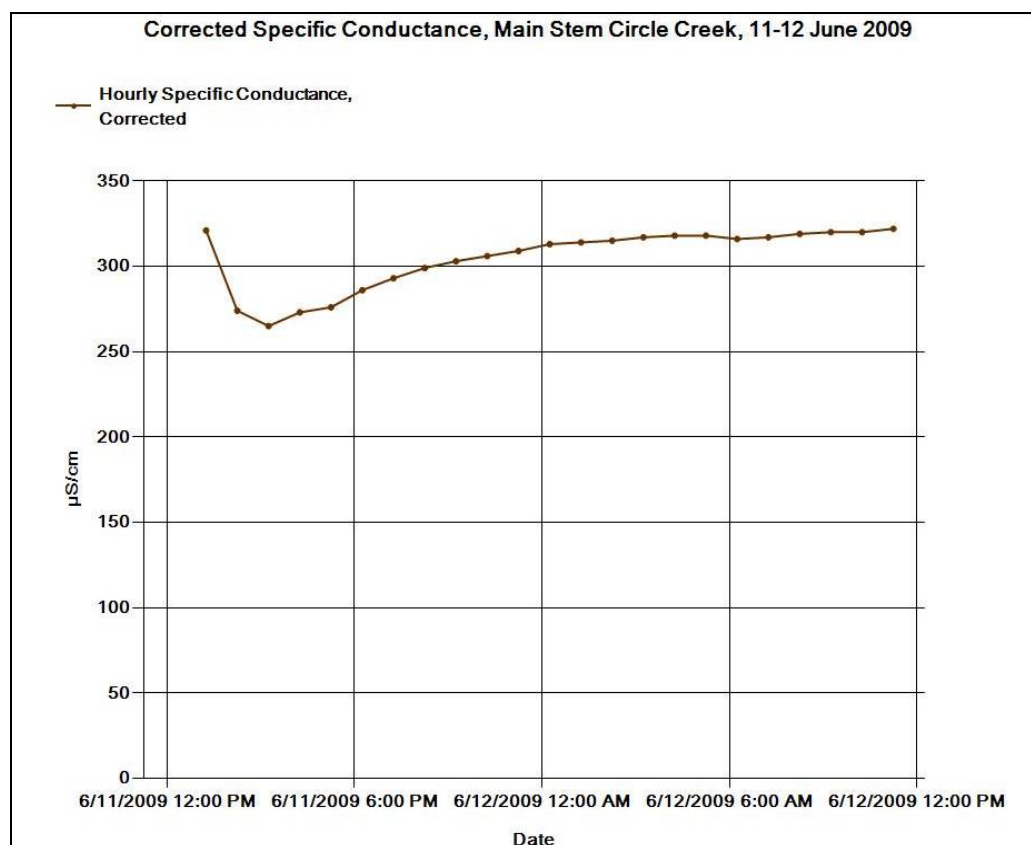


Figure 21. Corrected hourly specific conductance in main stem Circle Creek, CIRO, 2009. There is no regulatory threshold for specific conductance.

- *Dissolved Oxygen:*

Daily minimum dissolved oxygen was 5.66 mg/L which is below the regulatory threshold (6.0 mg/L). An unusual diel pattern of dissolved oxygen was observed in which the peak dissolved oxygen occurred at 6:15AM on June 12th and declined throughout the day (Figure 22). Typically dissolved oxygen should be at its lowest in the early morning hours and increase as photosynthesis increases during the day. This pattern was likely due to high flows late in the day on June 11th and cool water temperatures at night. Subsequently dissolved oxygen decreased and returned to a baseline level late in the day on June 12th. Dissolved oxygen data received a grade of “excellent” due to lack of drift during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the dissolved oxygen data are listed in Appendix F. Gaps in the time series data in Figure 22 are due to the removal of extreme outliers.

Dissolved oxygen was influenced to a large extent by rainfall during and prior to the deployment period. Given the unseasonably high flows in June dissolved oxygen was likely higher than average. Despite this, dissolved oxygen dipped below the regulatory threshold of 6.0 mg/L. This suggests that during warm water temperatures and low flow the dissolved oxygen in the main stem of Circle Creek likely dips below 6.0 mg/L on a regular basis.

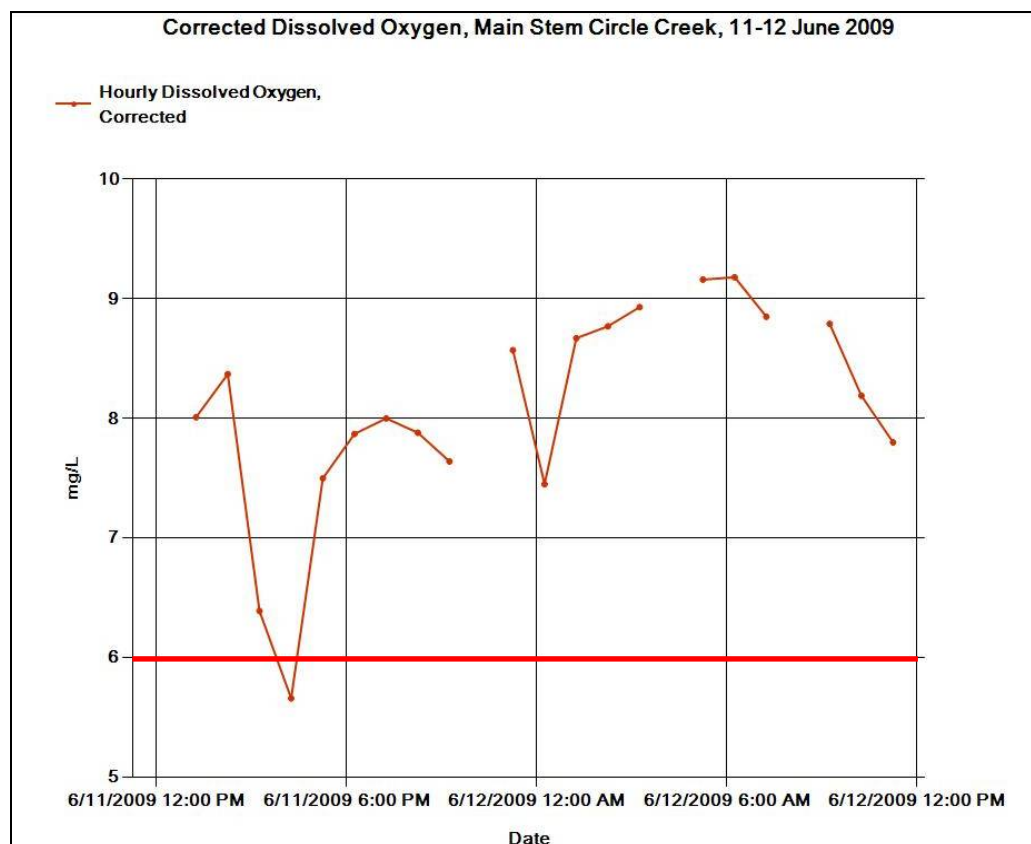


Figure 22. Corrected hourly dissolved oxygen in main stem Circle Creek, CIRO, 2009. The red line denotes the state DEQ regulatory threshold for daily minimum dissolved oxygen (6.0 mg/L).

- pH:**

The minimum, maximum and mean pH (7.75, 7.87 and 7.82 respectively) were never outside the acceptable regulatory thresholds of 6.0-9.5 pH units. Figure 23 shows the corrected hourly pH in the main stem Circle Creek June 11-12th 2009. The pH data received a grade of “excellent” due to lack of drift during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the pH data are listed in Appendix F.

The 24-hour data for pH reflect the rainfall events during and prior to the deployment period. It is likely that pH values would be somewhat different if in-stream water retention time was longer.

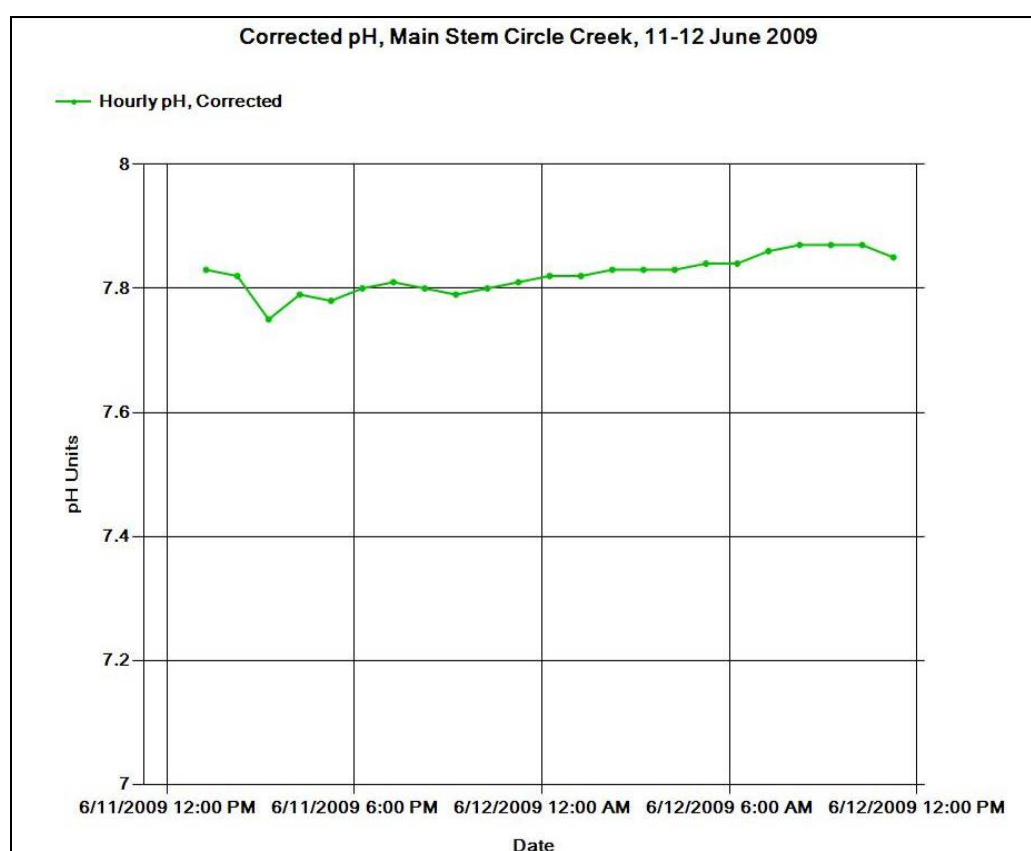


Figure 23. Corrected hourly pH in the main stem of Circle Creek, CIRO, 2009. Note that the maximum and minimum regulatory thresholds were never exceeded (6.0, 9.5 pH units)

- *Turbidity:*

It should be noted that spikes in turbidity correspond to increased discharge from large rain events prior to and during the deployment period. Regulatory thresholds indicate that turbidity should be less than 50 NTU (instantaneous) and no more than 25 for 10 consecutive days. Our data indicates that turbidity values ranged from 4.3 NTU to 252 NTU. It is important to note that the method detection limit (MDL) for this sensor is 0.2 NTU and the minimum level of quantitation (ML) is 0.78 NTU (Appendix E). Figure 25 shows the hourly turbidity in the main stem of Circle Creek on June 11th - 12th 2009. Turbidity data received a grade of “good” during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to turbidity data are listed in Appendix F.

The main stem of Circle Creek had turbidity levels that far exceeded the North Fork or South Forks of Circle Creek. The primary driver of elevated turbidity is extensive bank erosion (Figure 24). Most of the stream channel is entrenched 1-2 m. Causes of bank erosion likely come from two sources. The first and primary cause of erosion is the extensive use of the riparian area and stream channel by livestock. The entire length of both macroinvertebrate reaches (300 m) had widespread cattle trails with evidence of recent erosion. The second factor is the series of small impoundments upstream on private property. These impoundments prevent bed and suspended load transport that would otherwise aggrade downstream sections of Circle Creek. Currently only one of these factors can be controlled by CIRO, thereby it is advisable to restrict livestock from the stream to minimize continued erosion. Many publications indicate the detrimental effects of cattle on stream communities. Belsky et al. (1999) provides a summary of literature related to livestock’s influence on streams.



Figure 24. Bank erosion on the main stem of Circle Creek near macroinvertebrate reach 001 (looking upstream).

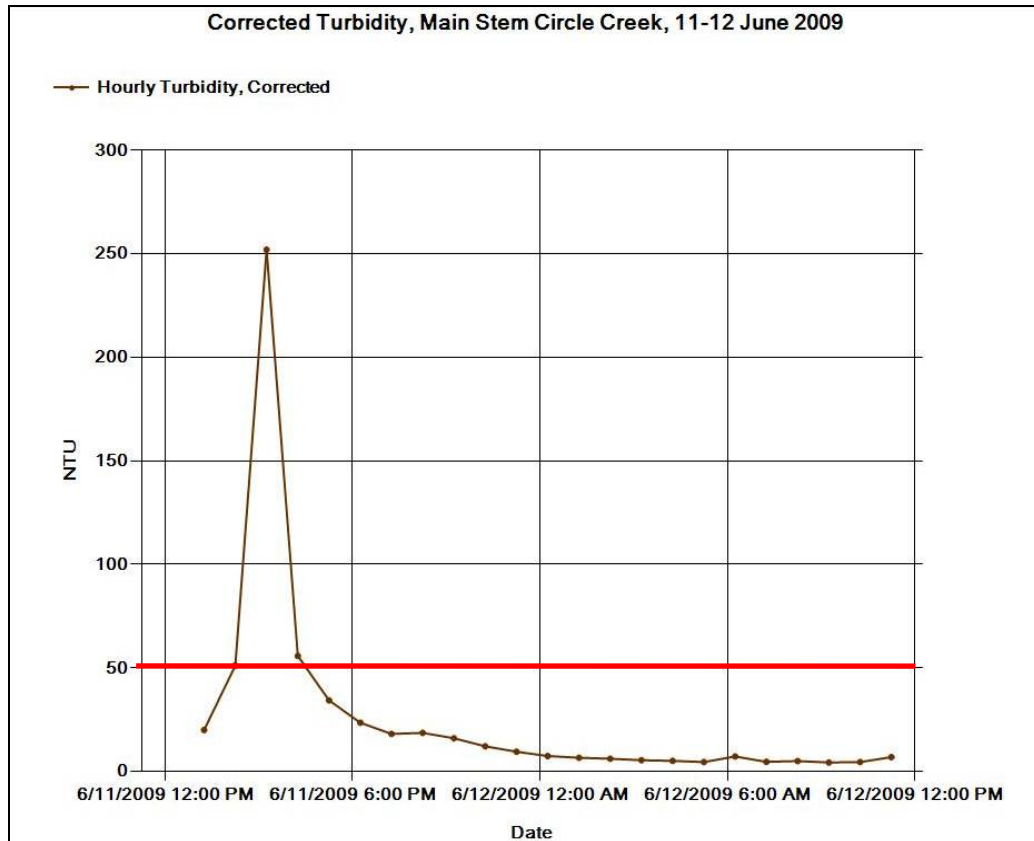


Figure 25. Corrected hourly turbidity in the main stem of Circle Creek, CIRO, 2009. The red line denotes the state DEQ regulatory threshold of maximum instantaneous turbidity (50 NTU).

Macroinvertebrates:

Status:

Macroinvertebrate metrics support water chemistry results in the main stem of Circle Creek (Hilsenhoff 1987; Royer et.al. 2001; Wiesman 2003; Hayslip 2007). There is currently no clearly defined multimetric index for the Circle Creek basin or for other representative streams in this region. The condition of the main stem of Circle Creek was determined based on comparisons to other streams Ephemeroptera, Plecoptera, Tricoptera (EPT) measures and the Hilsenhoff Biotic Index (HBI) (Table 6). The HBI in the main stem of Circle Creek at sample reach 001 and 002 was 5.26 and 5.11 respectively. An HBI between 4.51 and 5.50 indicates that water quality is “good” (Hilsenhoff 1987). In addition, the HBI indicates that there may be “some organic pollution” in the main stem of Circle Creek. It will be important to track both the HBI and %EPT/EPT over time. Other macroinvertebrate metrics can be found below in Table 6 or in Appendix I, and a taxa list in Appendix K. Figure 26 shows the percent community composition in the main stem of Circle Creek.

During the time of sample collection, the main stem of Circle Creek was flowing in sample reach 01 and 02, and had a high proportion of macroinvertebrate samples drawn from glides (72.7% and 36.4%) and riffles (9.1% and 54.5%). Reach 01 also had a high proportion of samples drawn from pools (18.2%) (Appendix G).

As suitable reference sites and multimetric indices become available, the UCBN intends to rate the main stem of Circle Creek using these indices or compare it to reference or benchmark conditions. While statements on the status of Circle Creek are limited in 2009, these data establish an important baseline condition to which we will compare future samples.

Table 6. Vital sign summary table for benthic macroinvertebrates in the main stem of Circle Creek June 12th, 2009. Sample reach 001 and 002.

Measure	Current Condition	
	001	002
Dominance Measures		
% Top 3 dominant taxon	30.32	31.45
Richness Measures		
Species richness	46.00	39.00
EPT richness	12.00	9.00
Community Composition		
% EPT	29.41	33.96
Functional Group Composition		
% Filterers	10.86	15.09
% Gatherers	59.73	58.49
% Predators	9.95	17.61
% Scrapers	4.52	2.52
% Shredders	11.76	3.77
Biotic Indices		
Hilsenhoff Biotic Index [HBI]	5.26	5.11

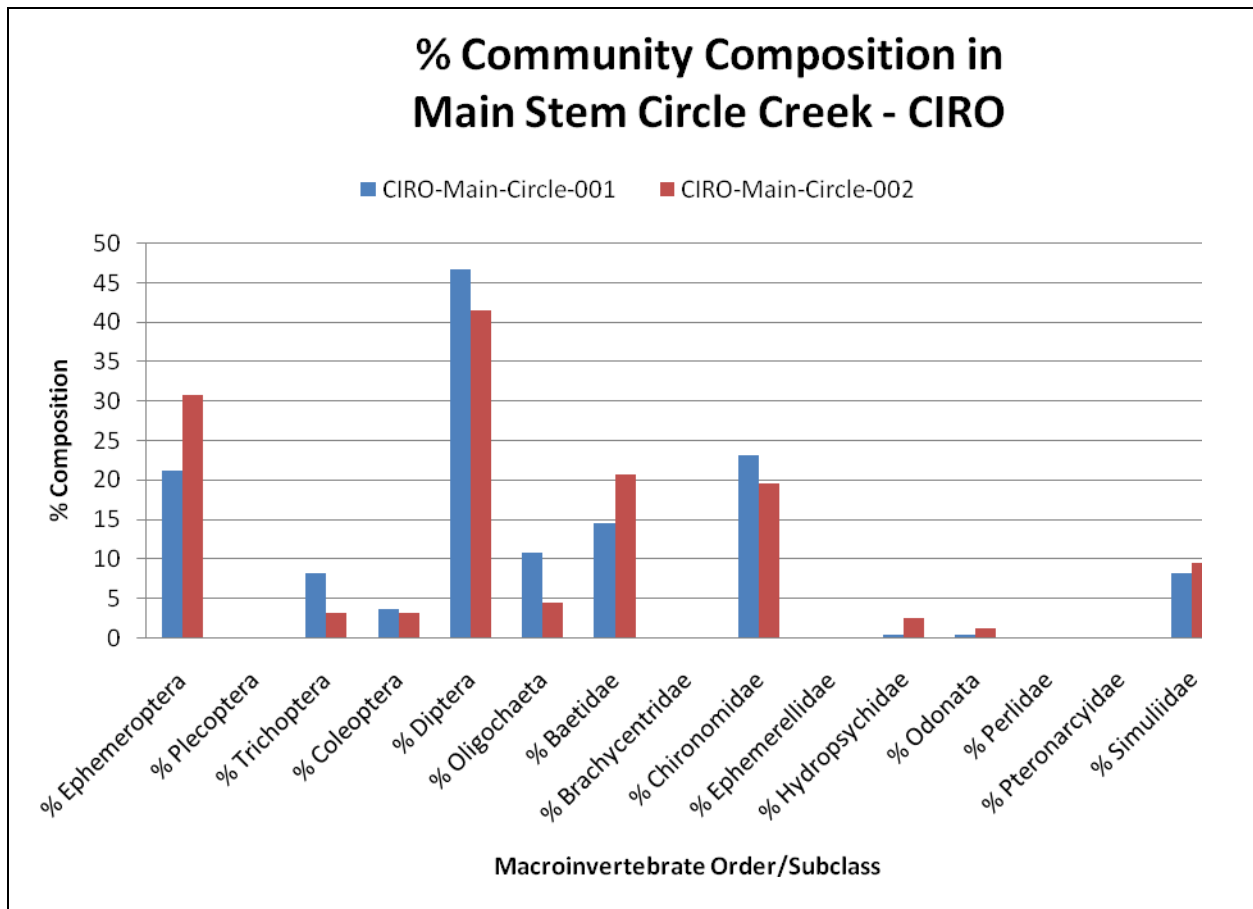


Figure 26. Percent Community Composition in the main stem of Circle Creek, 2009.

Summary/Recommendations:

Turbidity levels due to bank erosion should be of primary concern for park managers. Consequences of pronounced bank erosion and increased turbidity include the filling of spaces in between the substrate (interstitial space) and subsequent shift in macroinvertebrate community (decrease of EPT and other sensitive species). Reduction in livestock access to the riparian area and stream channel would substantially reduce erosion and turbidity resulting from NPS lands. Future assessments should include the determination of coliform and E-coli levels. This is especially important given the likelihood of visitor contact with Circle Creek near the Smoky Mountain Campground and Circle Creek trail.

Castle Rocks State Park (CRSP): Almo Creek

Water Chemistry:

Status:

Twenty-four hour data for core water quality parameters along with the corresponding state Department of Environmental Quality (DEQ) regulatory threshold are given in Table 7. All results from water chemistry monitoring in Almo Creek should be viewed against the backdrop of unseasonably wet weather in southern Idaho in 2009, and high flows during the deployment period. The rainfall total from June 1st to June 15th 2009 in Burley ID was 2.36 in. The average monthly rainfall in the same location for the entire month of June is 0.87 in (<http://www.wunderground.com/cgi-bin/findweather/getForecast?query=83318>). The primary concerns in Almo Creek are turbidity and dewatering. Each water chemistry parameter is discussed in further detail below.

Table 7. Vital sign summary table for water chemistry in Almo Creek 2009.

Almo Creek Water Chemistry Summary for 24 Hour Period 12-13 June, 2009		
Measure	Condition	State DEQ Thresholds
Temperature (*MDMT, **MDAT)	* MDMT= 9.89 °C ** MDAT= 9.89 °C	*MDMT<22 °C **MDAT<19 °C
Specific Conductance (mean)	Unavailable due to data quality issues (see description below)	N/A
Dissolved Oxygen (mean daily min)	8.67 mg/L	> 6.0 mg/L
pH (mean daily max)	7.11 pH Units	9.5 pH Units, Max
pH (mean daily min)	6.95 pH Units	6.0 pH Units, Min
Turbidity (mean daily max)	Unavailable due to data quality issues (see description below)	< 50 NTU (instantaneous) < 25 for 10 consecutive days

*MDMT – Maximum Daily Maximum Temperature **MDAT – Maximum Daily Average Temperature

- *Temperature:*

The maximum daily maximum temperature (MDMT) (9.89 °C) was well below the regulatory threshold of 22 °C. Figure 27 shows the hourly temperatures in Almo Creek June 12-13th 2009. The temperature data received a grade of “excellent” due to lack of drift during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the temperature data are listed in Appendix F.

Water temperature was influenced to a large extent by rainfall during and prior to the deployment period. Given the unseasonably wet weather in June water temperatures were likely lower than average.

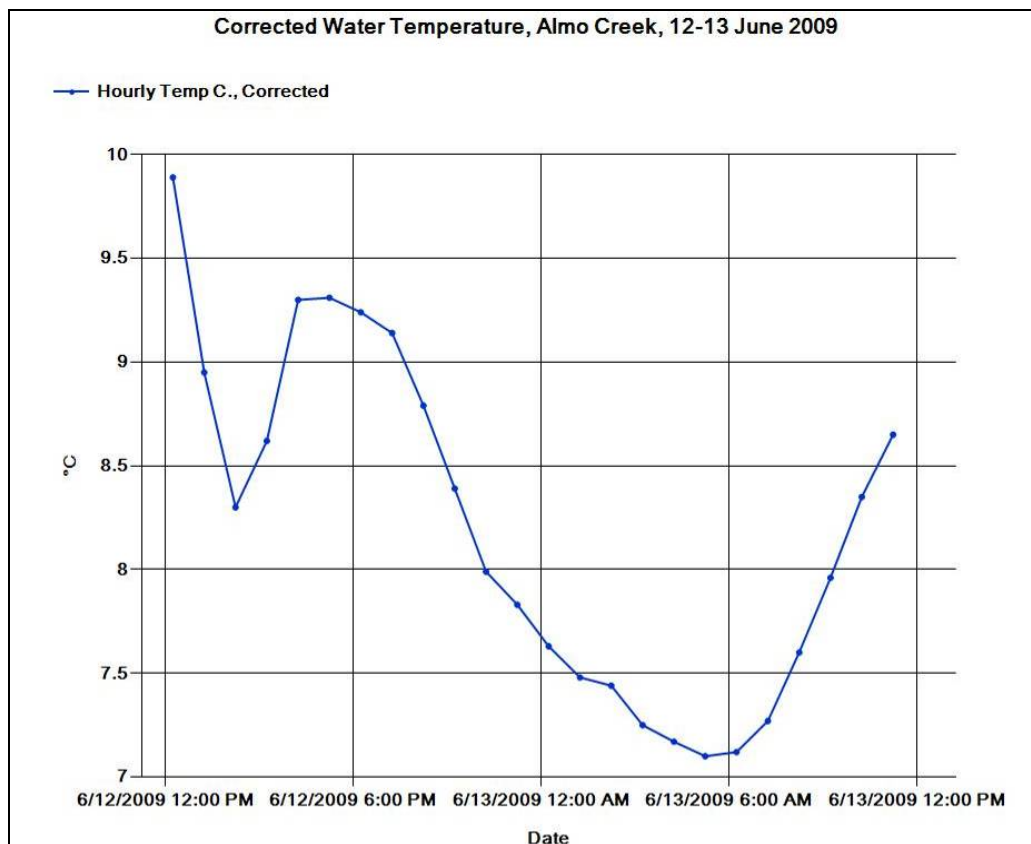


Figure 27. Corrected hourly temperature in Almo Creek, CRSP, 2009. The State DEQ regulatory threshold for maximum daily maximum temperature (MDMT) is 22°C.

- Specific Conductance:**
 Specific conductance data ranged from 18 to 46 $\mu\text{S}/\text{cm}$, with an average specific conductance of 21 $\mu\text{S}/\text{cm}$. These values are not likely to be representative of stream conditions and appear to have been influenced by debris trapped in the specific conductance sensor. When the Hydrolab was removed from the stream, the measurement cell of the specific conductance sensor was filled with sand and gravel. The accumulation of materials in the sensor was due to bed load transport during high flows. Data quality should be viewed as “very poor” or “unusable”. Corrections that have been applied to the specific conductance data are listed in Appendix F. Figure 28 shows hourly readings for specific conductance June 12-13th. There is no regulatory threshold for specific conductance as it varies widely depending on the geology of the drainage basin and stream discharge.

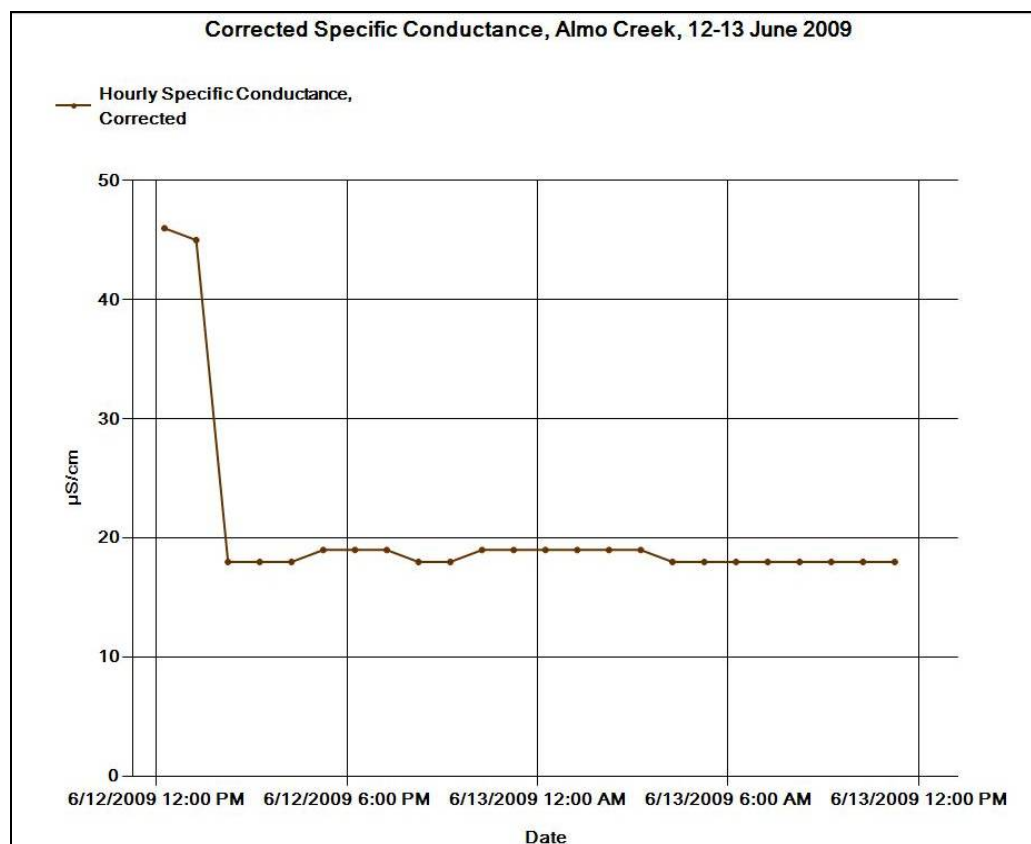


Figure 28. Corrected hourly specific conductance in Almo Creek, CRSP, 2009. Note data grade below. There is no regulatory threshold for specific conductance.

- Dissolved Oxygen:**
 Daily minimum dissolved oxygen was 8.67 mg/L which is above the regulatory threshold (6.0 mg/L). An unusual diel pattern of dissolved oxygen was observed in which the peak dissolved oxygen occurred between 5:15 AM and 6:15AM on June 13th and declined throughout the day (Figure 29). Typically dissolved oxygen should be at its lowest in the early morning hours and increase as photosynthesis increases during the day. This pattern was likely due to high flows late in the day on June 12th and cool water temperatures at night. Subsequently dissolved oxygen decreased and returned to a baseline level late in the day on June 13th. Dissolved oxygen data received a grade of “excellent” due to lack of drift during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the dissolved oxygen data are listed in Appendix F.

Dissolved oxygen was influenced to a large extent by rainfall during and prior to the deployment period. Given the unseasonably high flows in June dissolved oxygen was likely higher than average.

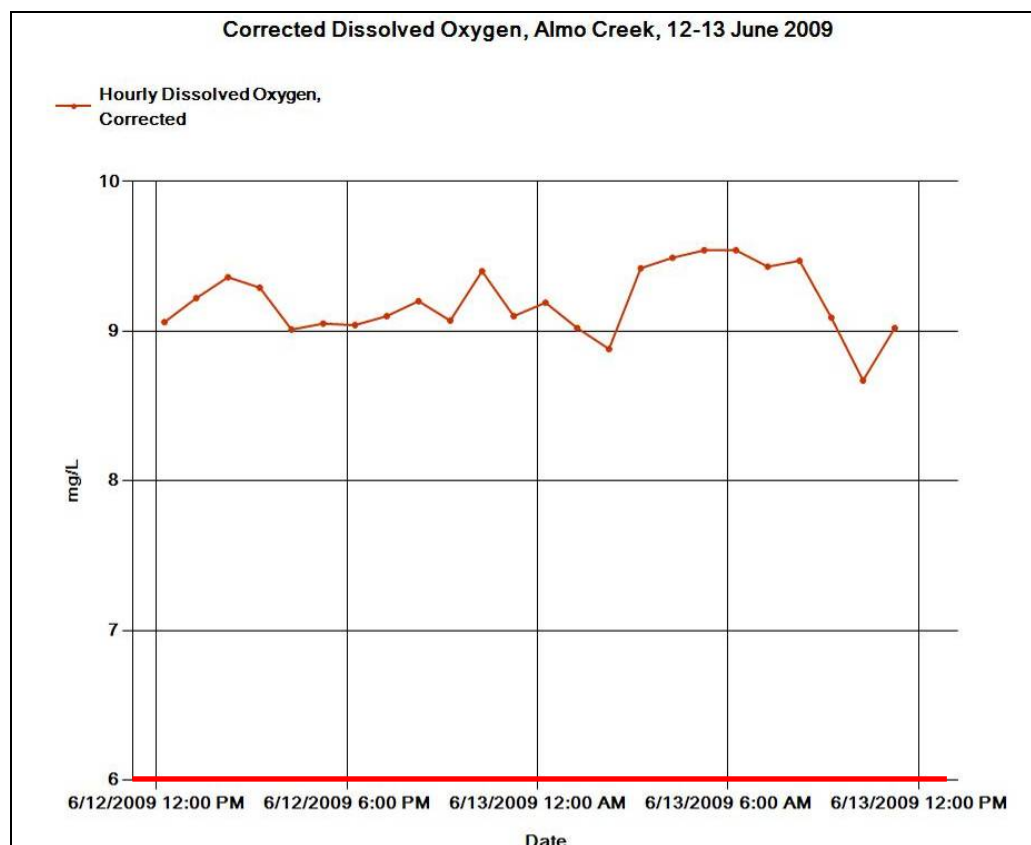


Figure 29. Corrected hourly dissolved oxygen in Almo Creek, CRSP, 2009. The red line denotes the state DEQ regulatory threshold for daily minimum dissolved oxygen (6.0 mg/L).

- pH:**

The minimum, maximum and mean pH (6.95, 7.11 and 7.02 respectively) were never outside the acceptable regulatory thresholds of 6.0-9.5 pH units. Figure 30 shows the corrected hourly pH in Almo Creek June 12-13th 2009. The pH data received a grade of “excellent” due to lack of drift during the deployment period. This standard USGS rating is based on the degree of sensor drift encountered during the deployment period (Wagner et al. 2006; Starkey et al. 2009). Note that fouling was not assessed due to the short deployment interval and sensor maintenance every 24 hours. Corrections that have been applied to the pH data are listed in Appendix F.

The 24-hour data for pH reflect the rainfall events during and prior to the deployment period. It is likely that pH values would be somewhat different if in-stream water retention time was longer.

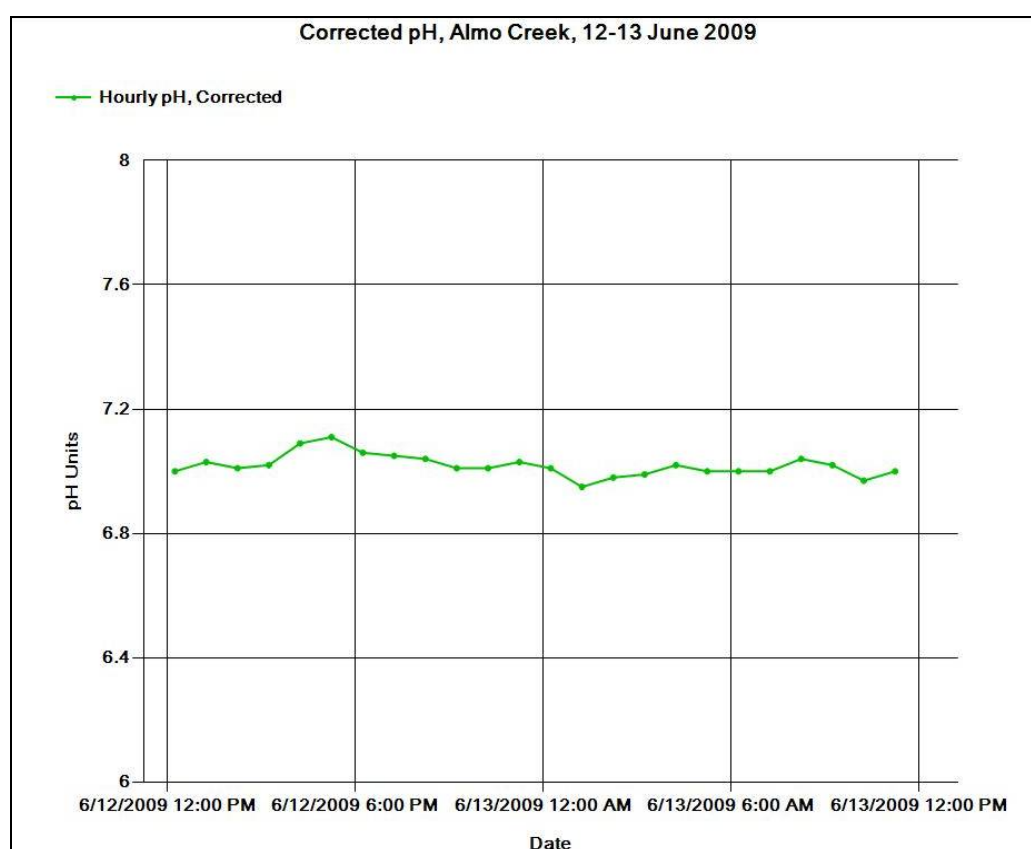


Figure 30. Corrected hourly pH in Almo Creek, CRSP, 2009. Note that the maximum and minimum regulatory thresholds were never exceeded (6.0, 9.5 pH units).

- *Turbidity:*

When the Hydrolab was removed from the stream on June 13th gravel had become trapped in the sensor guard and caused the self cleaning wiper to “park” over the turbidity sensor (Figure 31). As a result, assessment of turbidity in Almo Creek was unsuccessful. A graph of turbidity data from Almo Creek has been included in this report to illustrate what wiper “parking” looks like when the data is graphically displayed (Figure 32).

Relative to the Circle Creek drainage there were fewer cut banks along Almo Creek. However, erosion from frequent changes in water level caused by irrigation diversions should be considered a threat to bank stability (Dallon 2001).



Figure 31. Gravel and sand deposited in the Hydrolab housing and sensor guard by high flows in Almo Creek.

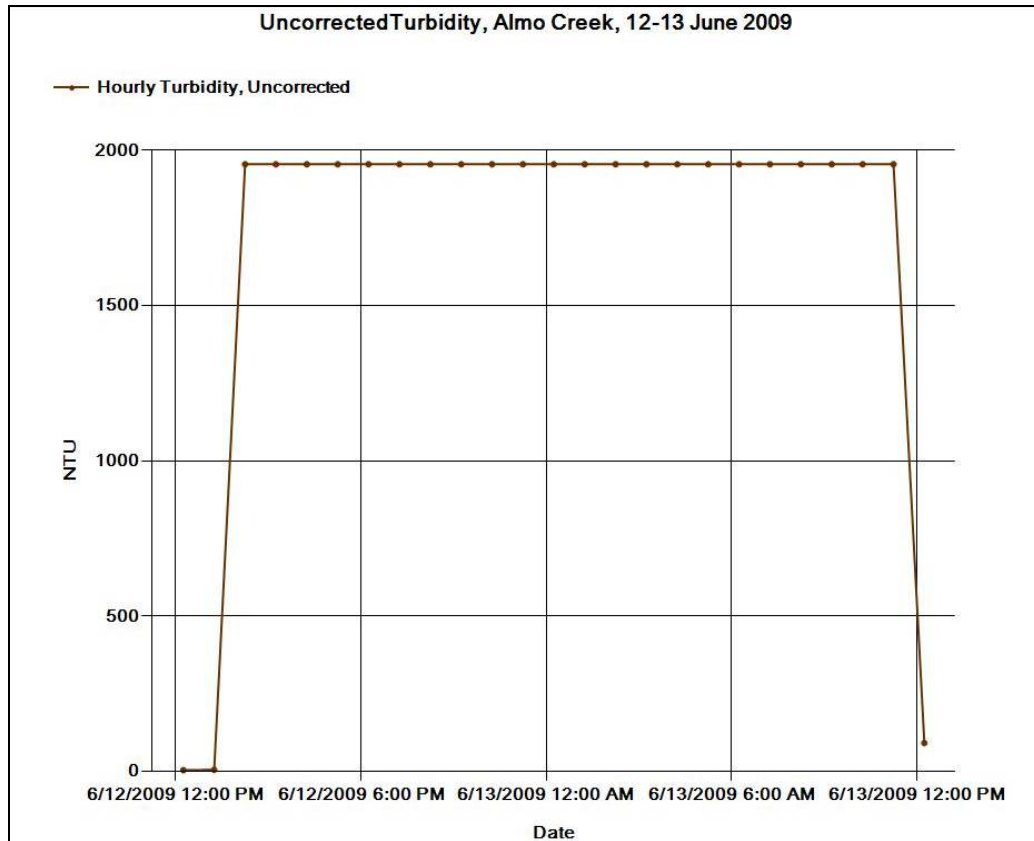


Figure 32. Un-corrected hourly turbidity in Almo Creek, CRSP, 2009. Note that wiper “parking” occurred shortly after deployment.

Macroinvertebrates:

Status:

Macroinvertebrate metrics support water chemistry results in Almo Creek (Hilsenhoff 1987; Royer et.al. 2001; Wiesman 2003; Hayslip 2007). There is currently no clearly defined multimetric index for the Almo Creek basin or for other representative streams in this region. The condition of the main stem of Almo Creek was determined based on comparisons to other streams Ephemeroptera, Plecoptera, Tricoptera (EPT) measures and the Hilsenhoff Biotic Index (HBI) (Table 8). HBI values indicate that water quality varies among the three sample reaches. Reach 01 and 02 are rated as “very good to excellent” (HBI between 0.00 and 4.50). Reach 003 is rated as “good” (HBI between 4.51 and 5.50). Reach 003 likely has “some organic pollution” while reach 01 and 03 were less impacted by organic input (Hilsenhoff 1987). These discrepancies may be related to differences in land use within and outside of the “wetland mitigation area.” It will be important to track both the HBI and %EPT/EPT over time to determine if the mitigation areas are having a positive influence on stream biota. Other macroinvertebrate metrics can be found below in Table 8 or in Appendix H, and a taxa list in Appendix J. Figure 33 shows the percent community composition in Almo Creek.

During the time of sample collection, the main stem of Circle Creek was flowing in sample reach 01 and 02, and had a high proportion of macroinvertebrate samples drawn from glides (72.7% and 36.4%) and riffles (9.1% and 54.5%). Reach 01 also had a high proportion of samples drawn from pools (18.2%) (Appendix G).

As suitable reference sites and multimetric indices become available, the UCBN intends to rate Almo Creek using these indices or compare it to reference or benchmark conditions. While statements on the status of Almo Creek are limited in 2009, these data establish an important baseline condition to which we will compare future samples.

Table 8. Vital sign summary table for benthic macroinvertebrates in Almo Creek June 12th, 2009. Sample reach 001, 002, and 003. Note that 001 was re-sampled as part of quality assessment/quality control procedures.

Measure	Current Condition			
	Reach			
	001	001 QA/QC	002	003
Dominance Measures				
% Top 3 dominant taxon	49.06	37.07	44.13	70.40
Richness Measures				
Species richness	27.00	46.00	33.00	26.00
EPT richness	18.00	27.00	19.00	18.00
Community Composition				
% EPT	87.92	86.05	81.38	52.65
Functional Group Composition				
% Filterers	6.79	5.10	3.24	0.93
% Gatherers	62.26	55.44	51.82	68.85
% Predators	6.04	9.18	11.74	2.49
% Scrapers	17.36	13.61	13.36	21.18
% Shredders	7.55	16.33	19.43	6.54
Biotic Indices				
Hilsenhoff Biotic Index [HBI]	3.46	3.33	3.67	5.39

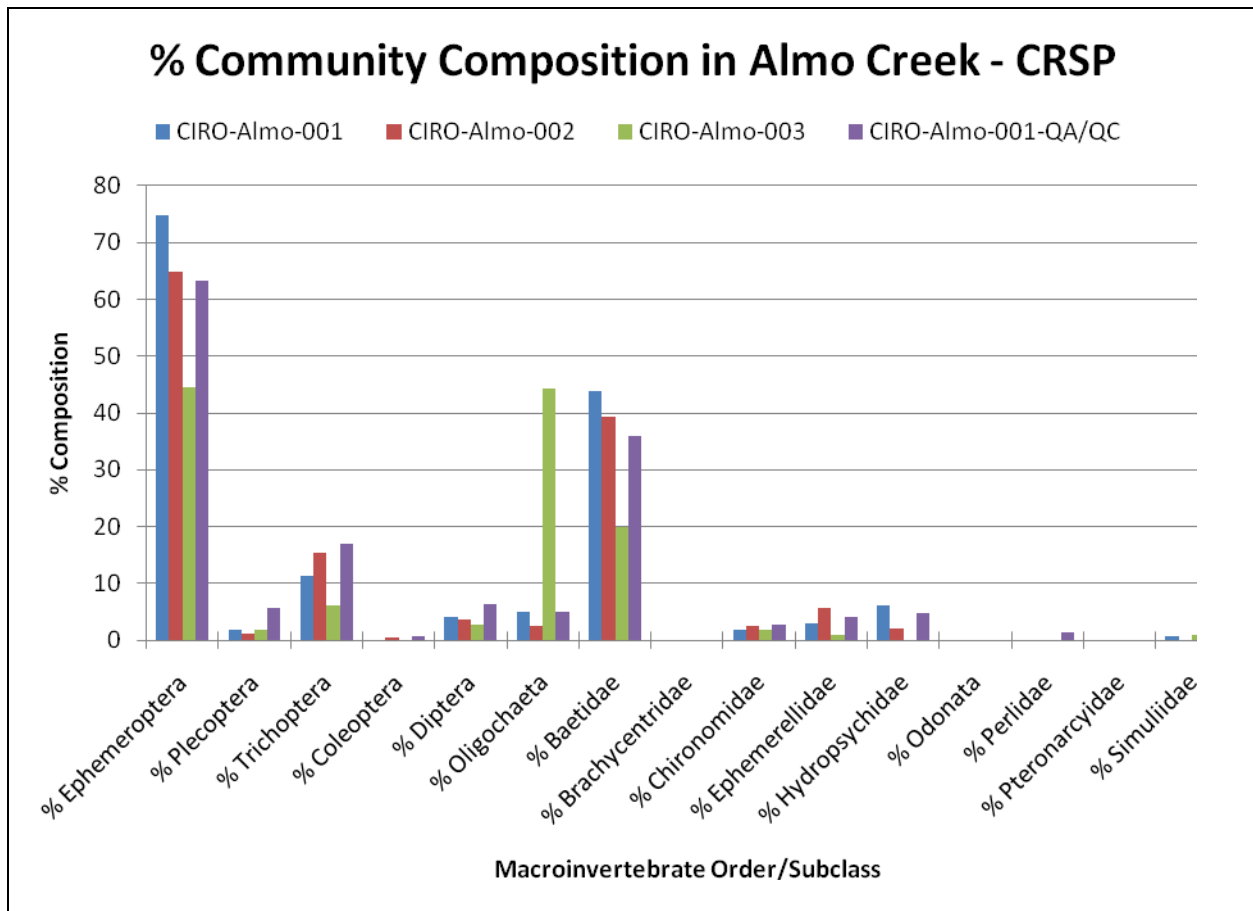


Figure 33. Percent Community Composition in Almo Creek, 2009.

Summary/Recommendations:

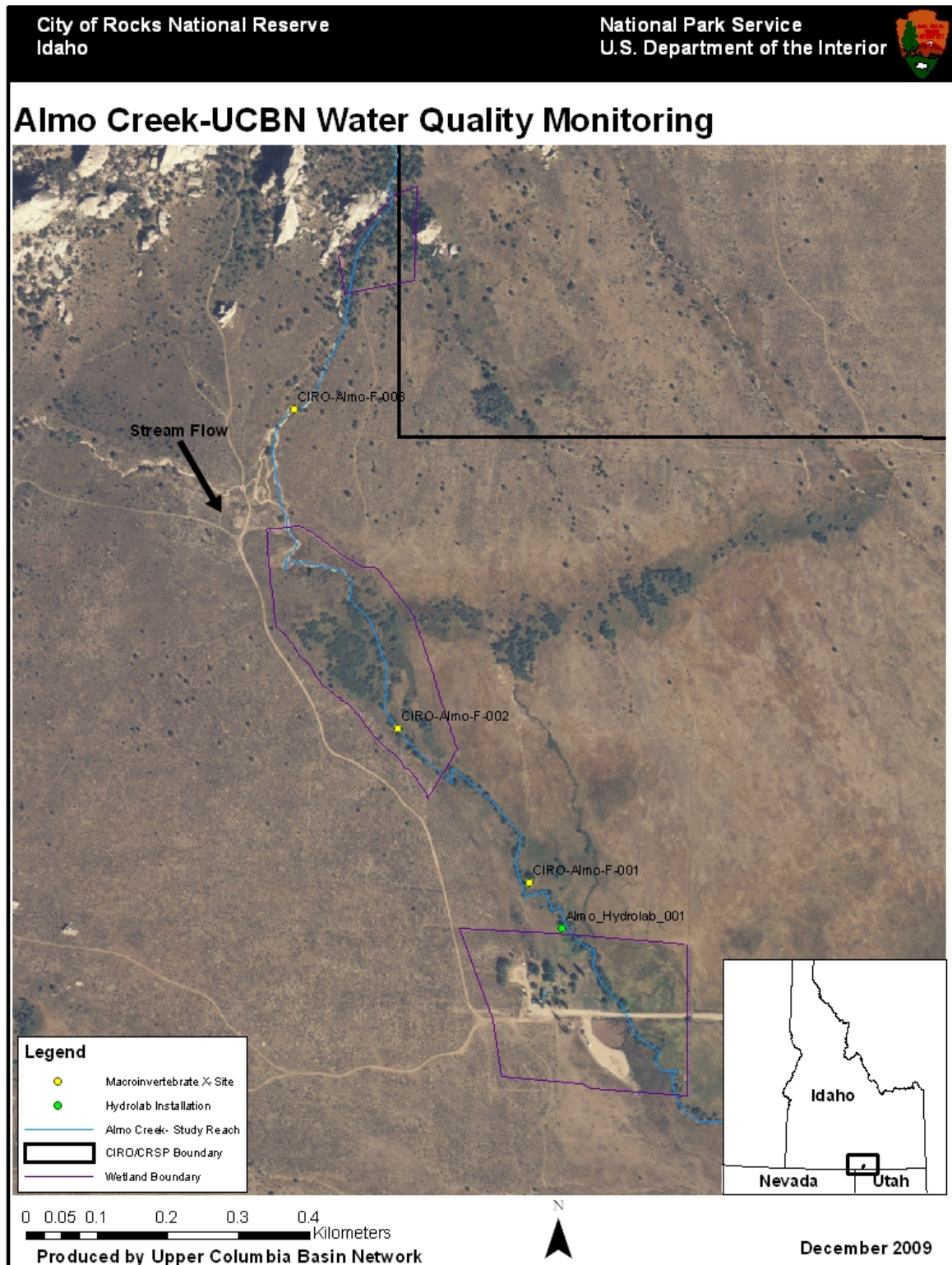
Subsequent sampling is necessary, but HBI and EPT data suggest the mitigation areas are having a positive influence on stream biota. Further reduction in livestock access to the riparian area and stream channel could help reduce bank erosion. Dewatering of and water fluctuations in Almo Creek are of concern due to the likelihood that these are having a negative impact on bank stability. Future assessments should include the determination of coliform and E-coli levels. Subsequent data collection in 2012 will help determine the difference between the macroinvertebrate community sampled within the wetland mitigation area and those sampled outside.

Literature Cited

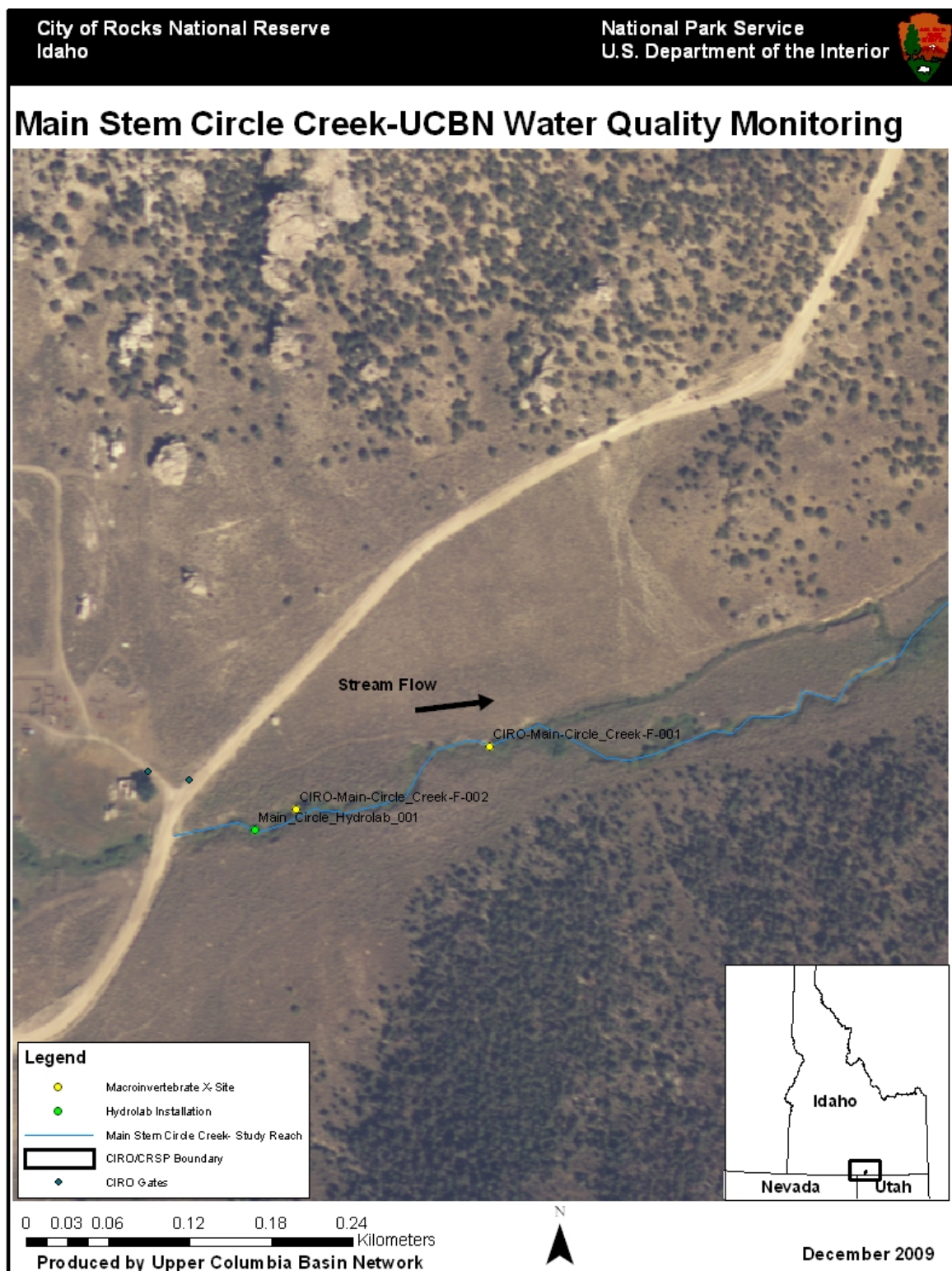
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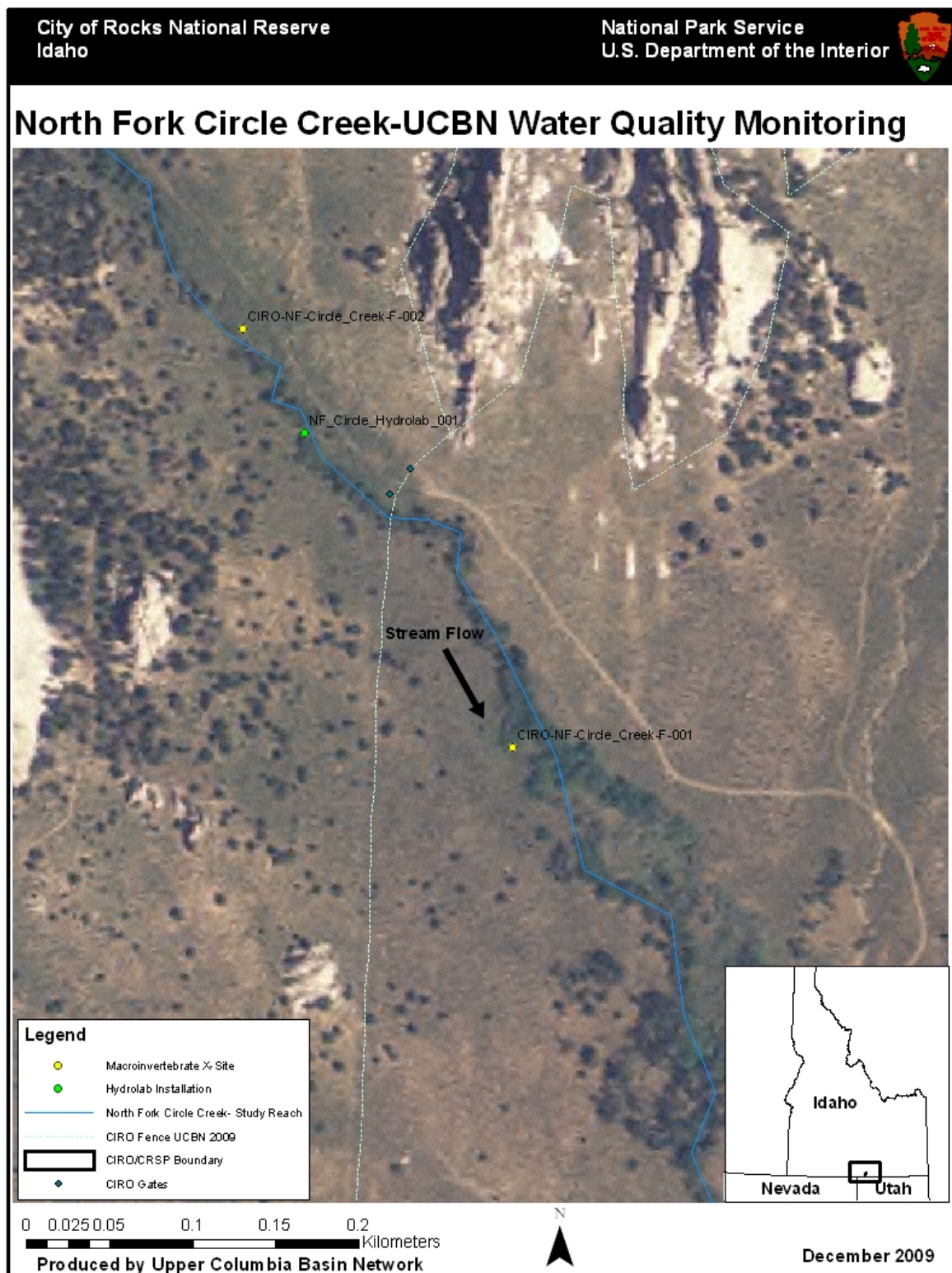
Appendix A. UCBN 2009 Water Quality Monitoring Locations



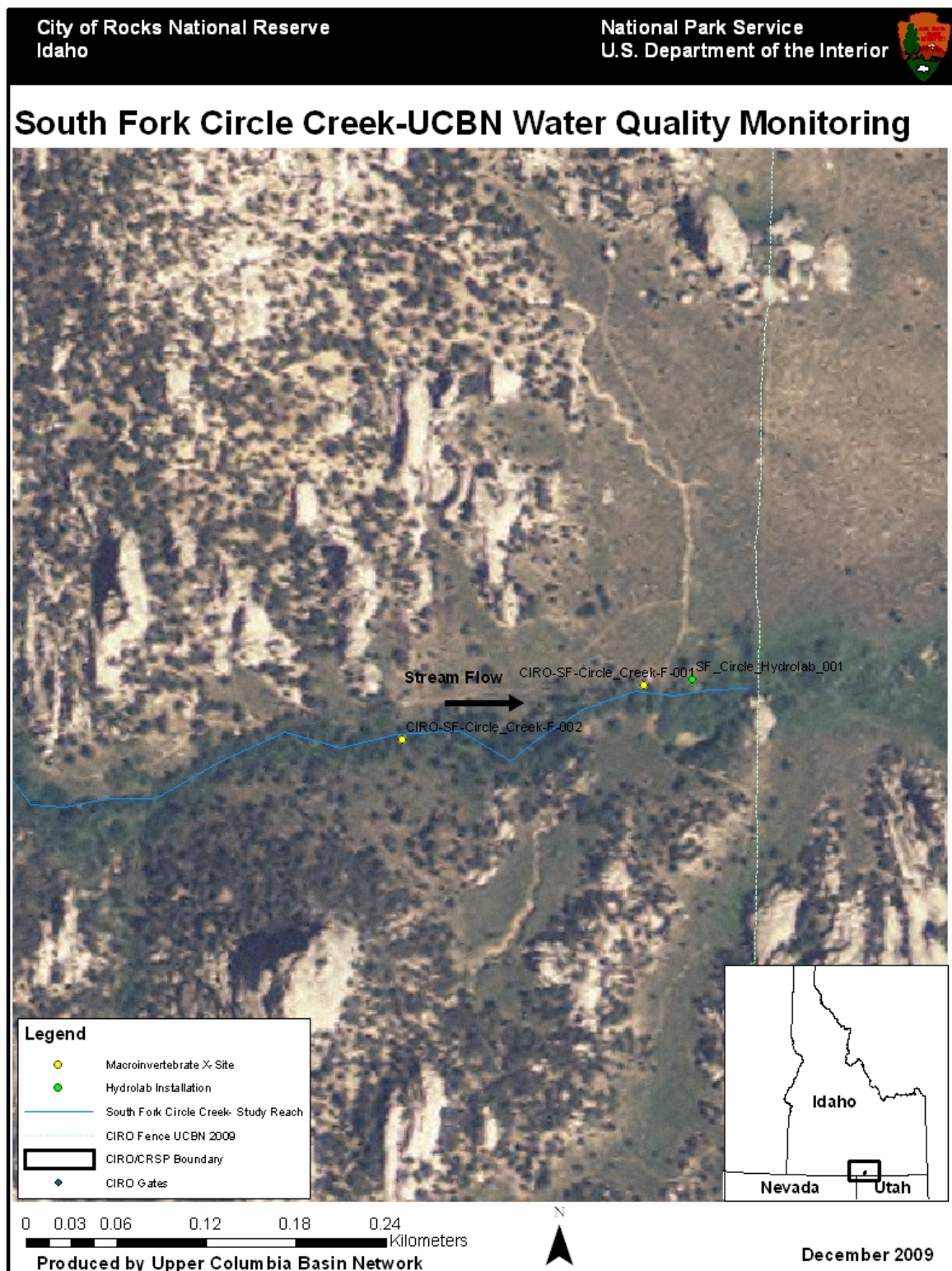
Appendix A. (continued). UCBN 2009 Water Quality Monitoring Locations



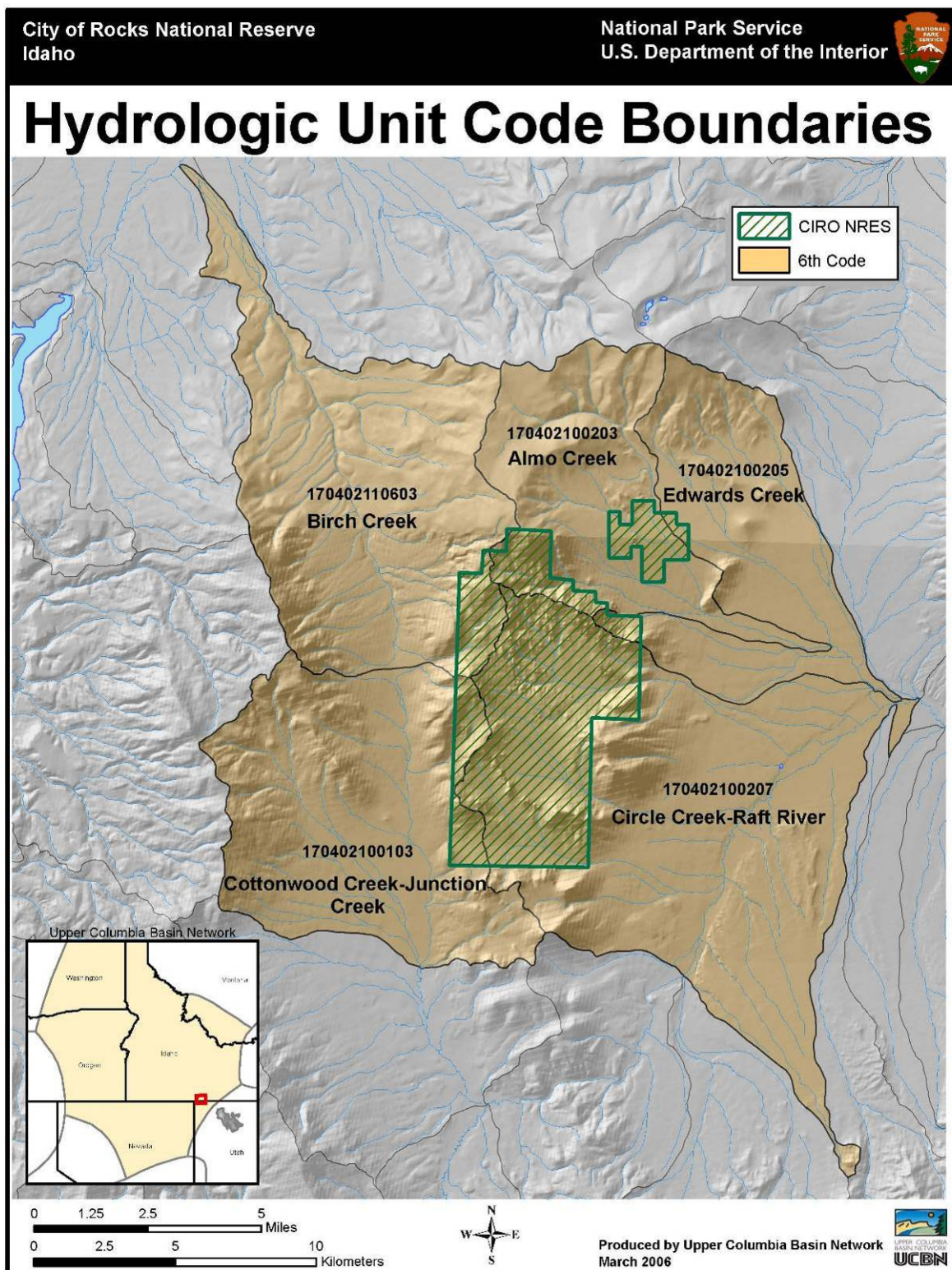
Appendix A. (continued). UCBN 2009 Water Quality Monitoring Locations



Appendix A. (continued). UCBN 2009 Water Quality Monitoring Locations



Appendix B. CIRO Hydrologic Unit Code Boundaries



Appendix C. GPS Locations for Water Quality Monitoring at CIRO

Park	Stream	Monitoring Type	Macroinvertebrate Site ID	Lat.	Long.	Y	X
CIRO	Almo Creek	Macroinvertebrate	001	42.12735968	-113.66044273	4669316.38383994	776037.89371556
CIRO	Almo Creek	Macroinvertebrate	002	42.12928207	-113.66277709	4669522.31537251	775836.56995156
CIRO	Almo Creek	Macroinvertebrate	003	42.13331326	-113.66473493	4669963.65204251	775657.22588584
CIRO	Almo Creek	Water Chemistry	-			4667279.22126	280145.31404
CIRO	Main Stem Circle Creek	Macroinvertebrate	001	42.07685553	-113.67875023	4663648.82728237	774742.69224206
CIRO	Main Stem Circle Creek	Macroinvertebrate	002	42.07639528	-113.68045125	4663592.24532359	774603.94969257
CIRO	Main Stem Circle Creek	Water Chemistry	-			4661720.21418	278238.00566
CIRO	North Fork Circle Creek	Macroinvertebrate	001	42.08902622	-113.70545170	4664914.81241526	772481.48048352
CIRO	North Fork Circle Creek	Macroinvertebrate	002	42.09124113	-113.70750837	4665154.21494742	772301.87600761
CIRO	North Fork Circle Creek	Water Chemistry	-			4663392.25359	276119.93333
CIRO	South Fork Circle Creek	Macroinvertebrate	001	42.07762549	-113.70740058	4663642.55072780	772369.09217875
CIRO	South Fork Circle Creek	Macroinvertebrate	002	42.07725132	-113.70934007	4663594.81516146	772210.23728199
CIRO	South Fork Circle Creek	Water Chemistry	-			4661946.25176	276076.14854

Note that macroinvertebrate X and Y have been projected in NAD 83, UTM Zone 11 and water chemistry X and Y are projected in NAD 83 UTM Zone 12.

Appendix D. 2009 Water Quality Photo Point Locations at CIRO

Park	Stream	Macroinvertebrate Site ID	Transect	Distance from Left Bank Permanent Marker (m)
CIRO	Almo Creek	001	F	2.35
CIRO	Almo Creek	002	F	2.03
CIRO	Almo Creek	003	F	4.1
CIRO	Main Stem Circle Creek	001	F	1.45
CIRO	Main Stem Circle Creek	002	F	1.1
CIRO	North Fork Circle Creek	001	F	1.9
CIRO	North Fork Circle Creek	002	F	1.4
CIRO	South Fork Circle Creek	001	F	1.55
CIRO	South Fork Circle Creek	002	F	1

Photos were taken facing upstream, downstream, and of the left and right banks.

Appendix E. Quality Control (QC) Indicators

QC data quality indicators for 2009 season at CIRO. Hydrolab Loaner*, Station # Almo 001, NF-Circle Creek 001, SF- Circle Creek 001, Main Circle Creek 001

STORET Name	Units	Detection Range Description from Manufacture	Method Detection Limit (MDL)	Minimum Level of Quantitation (ML)	Alternative Measurement Sensitivity Plus (AMS+) Beginning of Season	Alternative Measurement Sensitivity Plus (AMS+) End of Season	Precision+ (RPD) Beginning of Season	Precision+ (RPD) End of Season
Temperature, water	deg C	-5 to 50°C	N/A	N/A	0.01	*	0.00	*
Specific Conductance	µS/cm	0 to 100,000 µS/cm	N/A	N/A	0.4	*	0.38	*
Dissolved Oxygen	mg/L	0-20 mg/L	N/A	N/A	0.03	*	0.00	*
pH	pH units	0-14 Units	N/A	N/A	0.05	*	0.14	*
Turbidity	NTU	0-3000 NTU	0.2	0.78	N/A	N/A	0.00	*

* A loaner Hydrolab was used until UCBN Hydrolab #064 was repaired (not used at CIRO). End of the season QC indicators for instrument #064 can be found in the 2009 BIHO water quality monitoring annual report.

Appendix F. Corrections History

Correction history for Almo Creek, CIRO 2009 temperature data.

Correction #	From	To	Comment
1	6/13/2009 12:15	6/13/2009 12:15	Delete region -removed from water

Correction history for Almo Creek, CIRO 2009 specific conductance data.

Correction #	From	To	Comment
1	6/13/2009 12:15	6/13/2009 12:15	Delete region - removed from water

Correction history for Almo Creek, CIRO 2009 dissolved oxygen data.

Correction #	From	To	Comment
1	6/13/2009 12:15	6/13/2009 12:15	Delete region - removed from water

Correction history for Almo Creek, CIRO 2009 pH data.

Correction #	From	To	Comment
1	6/13/2009 12:15	6/13/2009 12:15	Delete region - removed from water

Correction history for Almo Creek, CIRO 2009 turbidity data.

Correction #	From	To	Comment
1	6/13/2009 12:15	6/13/2009 12:15	Delete region - Removed from water

Correction history for Main Stem Circle Creek, CIRO 2009 temperature data.

Correction #	From	To	Comment
1	6/11/2009 12:15	6/11/2009 12:15	Delete region - Hydrolab not installed

Correction history for Main Stem Circle Creek, CIRO 2009 specific conductance data.

Correction #	From	To	Comment
1	6/11/2009 12:15	6/11/2009 12:15	Delete region - Hydrolab not installed

Appendix F. Corrections History (continued)

Correction history for Main Stem Circle Creek, CIRO 2009 dissolved oxygen data.

Correction #	From	To	Comment
1	6/11/2009 12:15	6/11/2009 12:15	Delete region - Hydrolab not installed
2	6/11/2009 22:15	6/11/2009 22:15	Delete region due to outlier
3	6/12/2009 4:15	6/12/2009 4:15	Delete region due to outlier
4	6/12/2009 8:15	6/12/2009 8:15	Delete region

Correction history for Main Stem Circle Creek, CIRO 2009 pH data.

Correction #	From	To	Comment
1	6/11/2009 12:15	6/11/2009 12:15	Delete region Hydrolab not installed

Correction history for Main Stem Circle Creek, CIRO 2009 turbidity data.

Correction #	From	To	Comment
1	6/11/2009 12:15	6/11/2009 12:15	Delete region- Hydrolab not installed

Correction history for North Fork Circle Creek, CIRO 2009 temperature data.

Correction #	From	To	Comment
1	6/14/2009 16:30	6/14/2009 16:30	Delete region - Hydrolab not deployed

Correction history for North Fork Circle Creek, CIRO 2009 specific conductance data.

Correction #	From	To	Comment
1	6/14/2009 16:30	6/14/2009 16:30	Delete region- Hydrolab not installed

Correction history for North Fork Circle Creek, CIRO 2009 dissolved oxygen data.

Correction #	From	To	Comment
1	6/14/2009 16:30	6/14/2009 16:30	Delete region- Hydrolab not installed

Correction history for North Fork Circle Creek, CIRO 2009 pH data.

Correction #	From	To	Comment
1	6/14/2009 16:30	6/14/2009 16:30	Delete region- Hydrolab not installed

Appendix F. Corrections History (continued)

Correction history for North Fork Circle Creek, CIRO 2009 turbidity data.

Correction #	From	To	Comment
1	6/14/2009 16:30	6/14/2009 16:30	Delete region - Hydrolab not installed

Correction history for South Fork Circle Creek, CIRO 2009 temperature, specific conductance, and dissolved oxygen data.

Correction #	From	To	Comment
No Corrections Applied			

Correction history for South Fork Circle Creek, CIRO 2009 turbidity data.

Correction #	From	To	Comment
1	6/13/2009 16:30	6/13/2009 17:30	Delete region due to outlier
2	6/14/2009 10:30	6/14/2009 12:30	Delete region due to outlier

Appendix G. Summary Information for Each Macroinvertebrate Sample Reach

Park	Stream	Site	Date	Mean Wetted Width (m)	Sample Reach Length	*Total transects sampled	% of sample taken in each substrate category:					% of sample taken in each channel type:				
							Fine	Gravel	Coarse	Boulder	Bedrock	Pool	Glide	Riffle	Rapid	
CIRO	Almo Creek	001	6/12/2009	3.34	150	11	45.5	0.0	45.5	9.1	0.0	9.1	36.4	36.4	18.2	
CIRO	Almo Creek	QA/QC	6/12/2009	3.34	150	11	45.5	0.0	45.5	9.1	0.0	9.1	36.4	36.4	18.2	
CIRO	Almo Creek	002	6/12/2009	2.91	150	11	9.1	0.0	81.8	9.1	0.0	0.0	18.2	54.5	27.3	
CIRO	Almo Creek	003	6/12/2009	3.96	160	11	0.0	0.0	36.4	63.6	0.0	0.0	0.0	18.2	81.8	
CIRO	Main Stem Circle Creek	001	6/12/2009	1.47	150	11	100.0	0.0	0.0	0.0	18.2	72.7	9.1	0.0	18.2	
CIRO	Main Stem Circle Creek	002	6/12/2009	1.52	150	11	81.8	0.0	18.2	0.0	9.1	36.4	54.5	0.0	9.1	
CIRO	North Fork Circle Creek	001	6/14/2009	0.93	150	11	90.9	0.0	9.1	0.0	0.0	9.1	27.3	63.6	0.0	
CIRO	North Fork Circle Creek	002	6/14/2009	1.12	150	11	18.2	0.0	72.7	0.0	9.1	0.0	18.2	63.6	18.2	
CIRO	South Fork Circle Creek	001	6/13/2009	1.03	150	11	90.9	0.0	9.1	0.0	0.0	9.1	54.5	36.4	0	
CIRO	South Fork Circle Creek	002	6/13/2009	1.4	150	11	27.3	0.0	72.7	0.0	0.0	0.0	18.2	72.7	9.1	

*Note that macroinvertebrate samples were taken outside of the preferred index period July-October due to ephemeral nature of each stream.

Appendix H. Macroinvertebrate Metrics – Almo Creek

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Stream	Almo Creek	Almo Creek	Almo Creek	Almo Creek
Site	CIRO-Almo-001	CIRO-Almo-002	CIRO-Almo-003	CIRO-Almo-001-QA/QC
Date	06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled	100.00	100.00	100.00	100.00
EcoAnalysts Sample ID	5349.1-1	5349.1-2	5349.1-3	5349.1-4
Abundance Measures				
Corrected Abundance	265.00	247.00	321.00	294.00
EPT Abundance	233.00	201.00	169.00	253.00
Dominance Measures				
Dominant Taxon	Baetis tricaudatus	Baetis tricaudatus	Oligochaeta	Baetis tricaudatus
Dominant Abundance	85.00	53.00	142.00	66.00
2nd Dominant Taxon	Epeorus longimanus	Diphetor hageni	Baetis tricaudatus	Diphetor hageni
2nd Dominant Abundance	23.00	31.00	42.00	22.00
3rd Dominant Taxon	Baetis sp.	Hesperophylax sp.	Cinygmula sp.	Epeorus longimanus
3rd Dominant Abundance	22.00	25.00	42.00	21.00
% Dominant Taxon	32.08	21.46	44.24	22.45
% 2 Dominant Taxa	40.75	34.01	57.32	29.93
% 3 Dominant Taxa	49.06	44.13	70.40	37.07
Richness Measures				
Species Richness	27.00	33.00	26.00	46.00
EPT Richness	18.00	19.00	18.00	27.00
Ephemeroptera Richness	10.00	13.00	13.00	14.00
Plecoptera Richness	2.00	2.00	1.00	5.00
Trichoptera Richness	6.00	4.00	4.00	8.00
Chironomidae Richness	1.00	4.00	5.00	5.00
Oligochaeta Richness	1.00	1.00	1.00	1.00
Non-Chiro. Non-Olig. Richness	25.00	28.00	20.00	40.00

Appendix H. Macroinvertebrate Metrics – Almo Creek (continued)

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Site	CIRO-Almo-001	CIRO-Almo-002	CIRO-Almo-003	CIRO-Almo-001-QA/QC
Date	06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled	100.00	100.00	100.00	100.00
EcoAnalysts Sample ID	5349.1-1	5349.1-2	5349.1-3	5349.1-4
Community Composition				
% Ephemeroptera	74.72	64.78	44.55	63.27
% Plecoptera	1.89	1.21	1.87	5.78
% Trichoptera	11.32	15.38	6.23	17.01
% EPT	87.92	81.38	52.65	86.05
% Coleoptera	0.00	0.40	0.00	0.68
% Diptera	4.15	3.64	2.80	6.46
% Oligochaeta	4.91	2.43	44.24	5.10
% Baetidae	43.77	39.27	19.94	36.05
% Brachycentridae	0.00	0.00	0.00	0.00
% Chironomidae	1.89	2.43	1.87	2.72
% Ephemerellidae	3.02	5.67	0.93	4.08
% Hydropsychidae	6.04	2.02	0.00	4.76
% Odonata	0.00	0.00	0.00	0.00
% Perlidae	0.00	0.00	0.00	1.36
% Pteronarcyidae	0.00	0.00	0.00	0.00
% Simuliidae	0.75	0.00	0.93	0.00
Diversity/Evenness Measures				
Shannon-Weaver H' (log 10)	1.11	1.18	0.89	1.33
Shannon-Weaver H' (log 2)	3.68	3.93	2.96	4.43
Shannon-Weaver H' (log e)	2.55	2.73	2.05	3.07
Margalef's Richness	4.66	5.81	4.33	7.92
Pielou's J'	0.77	0.78	0.63	0.80
Simpson's Heterogeneity	0.87	0.90	0.76	0.92

Appendix H. Macroinvertebrate Metrics – Almo Creek (continued)

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Site	CIRO-Almo-001	CIRO-Almo-002	CIRO-Almo-003	CIRO-Almo-001-QA/QC
Date	06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled	100.00	100.00	100.00	100.00
EcoAnalysts Sample ID	5349.1-1	5349.1-2	5349.1-3	5349.1-4
Functional Group Composition				
% Filterers	6.79	3.24	0.93	5.10
% Gatherers	62.26	51.82	68.85	55.44
% Predators	6.04	11.74	2.49	9.18
% Scrapers	17.36	13.36	21.18	13.61
% Shredders	7.55	19.43	6.54	16.33
% Piercer-Herbivores	0.00	0.00	0.00	0.00
% Unclassified	0.00	0.40	0.00	0.34
Filterer Richness	2.00	3.00	1.00	2.00
Gatherer Richness	9.00	13.00	11.00	12.00
Predator Richness	7.00	5.00	3.00	12.00
Scraper Richness	4.00	4.00	6.00	10.00
Shredder Richness	5.00	7.00	5.00	9.00
Piercer-Herbivore Richness	0.00	0.00	0.00	0.00
Unclassified	0.00	1.00	0.00	1.00
Biotic Indices				
% Indiv. w/ HBI Value	96.98	99.19	99.69	98.64
Hilsenhoff Biotic Index	3.46	3.67	5.39	3.33
% Indiv. w/ MTI Value	82.64	72.87	45.48	71.43
Metals Tolerance Index	3.10	2.79	2.19	2.94
% Indiv. w/ FSBI Value	82.64	67.21	47.04	69.05
Fine Sediment Biotic Index	67.00	67.00	71.00	94.00
FSBI - average	2.48	2.03	2.73	2.04
FSBI - weighted average	4.76	4.72	5.13	4.70
% Indiv. w/ TPM Value	72.08	66.40	42.99	68.03
Temp. Pref. Metric - average	2.78	2.82	3.27	2.91
TPM - weighted average	5.36	5.18	6.33	5.16

Appendix H. Macroinvertebrate Metrics – Almo Creek (continued)

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Site	CIRO-Almo-001	CIRO-Almo-002	CIRO-Almo-003	CIRO-Almo-001-QA/QC
Date	06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled	100.00	100.00	100.00	100.00
EcoAnalysts Sample ID	5349.1-1	5349.1-2	5349.1-3	5349.1-4
Karr BIBI Metrics				
Long-Lived Taxa Richness	2.00	3.00	1.00	4.00
Clinger Richness	13.00	15.00	14.00	23.00
% Clingers	76.60	63.56	44.86	65.99
Intolerant Taxa Richness	11.00	13.00	13.00	20.00
% Tolerant Individuals	5.45	2.86	44.38	5.17
% Tolerant Taxa	7.41	6.06	3.85	2.17
Coleoptera Richness	0.00	1.00	0.00	2.00

Appendix I. Macroinvertebrate Metrics - Circle Creek Drainage

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Stream	Main Circle Creek CIRO-Main-Circle-001	Main Circle Creek CIRO-Main-Circle-002	South Fork Circle Creek CIRO-SF-Circle-001	South Fork Circle Creek CIRO-SF-Circle-002	North Fork Circle Creek CIRO-NF-Circle-001	North Fork Circle Creek CIRO-NF-Circle-002
Site						
Date	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled	100.00	100.00	100.00	100.00	100.00	68.97
EcoAnalysts Sample ID	5349.1-5	5349.1-6	5349.1-7	5349.1-8	5349.1-9	5349.1-10
Abundance Measures						
Corrected Abundance	221.00	159.00	36.00	65.00	558.00	762.70
EPT Abundance	65.00	54.00	17.00	35.00	417.00	606.10
Dominance Measures						
Dominant Taxon	Oligochaeta	Centropilum sp.	Sweltsa sp.	Sweltsa sp.	Baetis tricaudatus	Baetis tricaudatus
Dominant Abundance	24.00	20.00	8.00	19.00	67.00	230.55
2nd Dominant Taxon	Eukiefferiella sp.	Simulium sp.	Parametriocnemus sp.	Ameletus sp.	Leptophlebiidae	Cinygmula sp.
2nd Dominant Abundance	24.00	15.00	6.00	8.00	60.00	178.35
3rd Dominant Taxon	Diphetor hageni	Eukiefferiella sp.	Oligochaeta	Oligochaeta	Diphetor hageni	Polycelis sp.
3rd Dominant Abundance	19.00	15.00	5.00	7.00	53.00	46.40
% Dominant Taxon	10.86	12.58	22.22	29.23	12.01	30.23
% 2 Dominant Taxa	21.72	22.01	38.89	41.54	22.76	53.61
% 3 Dominant Taxa	30.32	31.45	52.78	52.31	32.26	59.70
Richness Measures						
Species Richness	46.00	39.00	15.00	17.00	51.00	37.00
EPT Richness	12.00	9.00	5.00	5.00	19.00	19.00
Ephemeroptera Richness	7.00	6.00	3.00	3.00	9.00	11.00
Plecoptera Richness	0.00	0.00	1.00	1.00	5.00	6.00
Trichoptera Richness	5.00	3.00	1.00	1.00	5.00	2.00
Chironomidae Richness	11.00	13.00	6.00	7.00	10.00	7.00
Oligochaeta Richness	1.00	1.00	1.00	1.00	1.00	0.00
Non-Chiro. Non-Olig. Richness	34.00	25.00	8.00	9.00	40.00	30.00

Appendix I. Macroinvertebrate Metrics - Circle Creek Drainage (continued)

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Site	CIRO-Main-Circle-001	CIRO-Main-Circle-002	CIRO-SF-Circle-001	CIRO-SF-Circle-002	CIRO-NF-Circle-001	CIRO-NF-Circle-002
Date	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled	100.00	100.00	100.00	100.00	100.00	68.97
EcoAnalysts Sample ID	5349.1-5	5349.1-6	5349.1-7	5349.1-8	5349.1-9	5349.1-10
Community Composition						
% Ephemeroptera	21.27	30.82	16.67	18.46	63.26	69.77
% Plecoptera	0.00	0.00	22.22	29.23	7.71	5.13
% Trichoptera	8.14	3.14	8.33	6.15	3.76	4.56
% EPT	29.41	33.96	47.22	53.85	74.73	79.47
% Coleoptera	3.62	3.14	2.78	1.54	0.54	2.85
% Diptera	46.61	41.51	33.33	30.77	8.06	8.94
% Oligochaeta	10.86	4.40	13.89	10.77	2.69	0.00
% Baetidae	14.48	20.75	2.78	0.00	24.37	34.60
% Brachycentridae	0.00	0.00	0.00	0.00	0.18	0.00
% Chironomidae	23.08	19.50	30.56	27.69	6.09	6.65
% Ephemerellidae	0.00	0.00	0.00	1.54	9.14	4.94
% Hydropsychidae	0.45	2.52	0.00	0.00	0.00	0.00
% Odonata	0.45	1.26	0.00	0.00	0.00	0.00
% Perlidae	0.00	0.00	0.00	0.00	0.18	0.19
% Pteronarcyidae	0.00	0.00	0.00	0.00	3.58	1.90
% Simuliidae	8.14	9.43	2.78	0.00	0.36	0.95
Diversity/Evenness Measures						
Shannon-Weaver H' (log 10)	1.43	1.38	1.03	1.02	1.34	1.06
Shannon-Weaver H' (log 2)	4.75	4.60	3.43	3.40	4.45	3.53
Shannon-Weaver H' (log e)	3.29	3.19	2.38	2.36	3.09	2.45
Margalef's Richness	8.34	7.50	3.91	3.83	7.91	5.42
Pielou's J'	0.86	0.87	0.88	0.83	0.78	0.68
Simpson's Heterogeneity	0.95	0.95	0.90	0.88	0.94	0.84

Appendix I. Macroinvertebrate Metrics - Circle Creek Drainage (continued)

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Site	CIRO-Main-Circle-001	CIRO-Main-Circle-002	CIRO-SF-Circle-001	CIRO-SF-Circle-002	CIRO-NF-Circle-001	CIRO-NF-Circle-002
Date	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled	100.00	100.00	100.00	100.00	100.00	68.97
EcoAnalysts Sample ID	5349.1-5	5349.1-6	5349.1-7	5349.1-8	5349.1-9	5349.1-10
Functional Group Composition						
% Filterers	10.86	15.09	2.78	0.00	4.48	1.90
% Gatherers	59.73	58.49	55.56	47.69	55.91	50.38
% Predators	9.95	17.61	25.00	35.38	12.54	14.26
% Scrapers	4.52	2.52	5.56	4.62	7.17	24.14
% Shredders	11.76	3.77	8.33	9.23	19.71	9.32
% Piercer-Herbivores	0.00	0.00	0.00	0.00	0.00	0.00
% Unclassified	3.17	2.52	2.78	3.08	0.18	0.00
Filterer Richness	3.00	4.00	1.00	0.00	4.00	2.00
Gatherer Richness	21.00	16.00	9.00	7.00	21.00	15.00
Predator Richness	7.00	9.00	2.00	4.00	14.00	11.00
Scraper Richness	4.00	2.00	1.00	1.00	1.00	2.00
Shredder Richness	7.00	4.00	1.00	3.00	10.00	7.00
Piercer-Herbivore Richness	0.00	0.00	0.00	0.00	0.00	0.00
Unclassified	4.00	4.00	1.00	2.00	1.00	0.00
Biotic Indices						
% Indiv. w/ HBI Value	94.12	94.34	97.22	96.92	97.13	99.24
Hilsenhoff Biotic Index	5.26	5.11	3.57	2.81	3.49	3.68
% Indiv. w/ MTI Value	66.97	66.67	44.44	38.46	65.95	87.07
Metals Tolerance Index	3.90	3.92	2.69	3.12	2.48	2.51
% Indiv. w/ FSBI Value	24.43	19.50	41.67	49.23	58.24	77.57
Fine Sediment Biotic Index	33.00	24.00	24.00	20.00	68.00	65.00
FSBI - average	0.72	0.62	1.60	1.18	1.33	1.76
FSBI - weighted average	3.52	3.61	4.40	4.13	4.21	5.01
% Indiv. w/ TPM Value	43.89	40.25	66.67	64.62	58.60	80.61
Temp. Pref. Metric - average	1.24	1.49	4.07	3.24	2.63	3.73
TPM - weighted average	4.57	4.30	6.88	6.74	5.57	6.31

Appendix I. Macroinvertebrate Metrics - Circle Creek Drainage (continued)

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Site	CIRO-Main-Circle-001	CIRO-Main-Circle-002	CIRO-SF-Circle-001	CIRO-SF-Circle-002	CIRO-NF-Circle-001	CIRO-NF-Circle-002
Date	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled	100.00	100.00	100.00	100.00	100.00	68.97
EcoAnalysts Sample ID	5349.1-5	5349.1-6	5349.1-7	5349.1-8	5349.1-9	5349.1-10
<i>Karr BIBI Metrics</i>	4.00	3.00	2.00	1.00	8.00	5.00
Long-Lived Taxa Richness	15.00	11.00	6.00	4.00	21.00	18.00
Clinger Richness	31.22	37.11	44.44	47.69	51.43	80.80
% Clingers	4.00	2.00	3.00	4.00	13.00	15.00
Intolerant Taxa Richness	17.79	14.67	14.29	11.11	3.32	0.00
% Tolerant Individuals	13.04	12.82	6.67	5.88	5.88	0.00
% Tolerant Taxa	5.00	3.00	1.00	1.00	2.00	2.00
Coleoptera Richness	4.00	3.00	2.00	1.00	8.00	5.00
	15.00	11.00	6.00	4.00	21.00	18.00

Appendix J. Macroinvertebrate Taxa List – Almo Creek

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Stream		Almo Creek	Almo Creek	Almo Creek	Almo Creek
Site		CIRO-Almo-001	CIRO-Almo-002	CIRO-Almo-003	CIRO-Almo-001-QA/QC
Date		06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat		Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled		100.00	100.00	100.00	100.00
EcoAnalysts Sample ID		5349.1-1	5349.1-2	5349.1-3	5349.1-4
Ephemeroptera	Ameletus sp.	14	14	2	11
	Baetis bicaudatus	0	2	8	1
	Baetis sp.	22	11	4	17
	Baetis tricaudatus	85	53	42	66
	Cinygmula sp.	20	6	42	8
	Diphetor hageni	9	31	10	22
	Drunella				
	coloradensis/flavilinea	0	0	2	0
	Drunella doddsi	0	1	0	2
	Ecdyonurus sp.	0	0	0	1
	Epeorus longimanus	23	20	14	21
	Epeorus sp.	0	0	4	1
	Ephemerella				
	inermis/infrequens	8	11	1	10
	Ephemerella sp.	0	2	0	0
	Leptophlebiidae	6	2	2	15
	Paraleptophlebia sp.	10	1	7	9
	Rhithrogena sp.	1	6	5	2
	Plecoptera				
	Chloroperlidae	2	1	0	3
	Hesperoperla pacifica	0	0	0	4
	Malenka sp.	0	2	0	2
	Nemouridae	0	0	0	1
	Sweltsa sp.	3	0	6	7

Appendix J. Macroinvertebrate Taxa List – Almo Creek (continued)

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Stream		Almo Creek	Almo Creek	Almo Creek	Almo Creek
Site		CIRO-Almo-001	CIRO-Almo-002	CIRO-Almo-003	CIRO-Almo-001-QA/QC
Date		06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat		Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled		100.00	100.00	100.00	100.00
EcoAnalysts Sample ID		5349.1-1	5349.1-2	5349.1-3	5349.1-4
Coleoptera	Optioservus sp.	0	0	0	1
	Oreodytes sp.	0	1	0	0
	Stictotarsus sp.	0	0	0	1
Diptera- Chironomidae	Eukiefferiella sp.	0	3	0	0
	Larsia sp.	0	0	1	0
	Micropsectra sp.	5	0	2	2
	Parametriocnemus sp.	0	0	1	0
	Phaenopsectra sp.	0	0	0	1
	Polypedilum sp.	0	1	1	3
	Pseudosmittia sp.	0	1	0	0
	Psilometriocnemus sp.	0	1	0	0
	Rheocricotopus sp.	0	0	1	0
	Stempellinella sp.	0	0	0	1
	Tvetenia bavarica gr.	0	0	0	1
Diptera	Atrichopogon sp.	0	1	0	0
	Dicranota sp.	3	0	0	0
	Diptera	0	0	0	1
	Dolichopodidae	0	1	0	2
	Erioptera sp.	0	0	0	3
	Hexatoma sp.	0	0	0	2
	Ptychoptera sp.	1	0	0	0
	Rhabdomastix fascigera gr.	0	0	0	2
	Simulium sp.	2	0	3	0
	Tipula sp.	0	1	0	0
	Tipulidae	0	0	0	1

Appendix J. Macroinvertebrate Taxa List – Almo Creek (continued)

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Stream		Almo Creek	Almo Creek	Almo Creek	Almo Creek
Site		CIRO-Almo-001	CIRO-Almo-002	CIRO-Almo-003	CIRO-Almo-001-QA/QC
Date		06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat		Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled		100.00	100.00	100.00	100.00
EcoAnalysts Sample ID		5349.1-1	5349.1-2	5349.1-3	5349.1-4
79	Trichoptera	Dicosmoecus atripes	1	0	0
		Hesperophylax sp.	2	25	17
		Hydropsyche sp.	16	5	0
		Lepidostoma sp.	6	6	1
		Limnephilidae	0	0	0
		Neophylax splendens	2	0	0
		Onocosmoecus sp.	3	2	1
		Rhyacophila angelita gr.	0	0	1
		Rhyacophila sp.	0	0	0
		Uenoidae	0	0	0
	Gastropoda	Vorticifex effusa	0	0	1
	Bivalvia	Pisidium sp.	0	2	0
		Sphaeriidae	0	1	0
	Annelida	Oligochaeta	13	6	142
	Acari	Acari	0	2	0
		Atractides sp.	3	0	0
		Lebertia sp.	2	0	0
		Sperchon sp.	1	0	0
		Torrenticola sp.	2	0	0
	Crustacea	Ostracoda	0	1	0
	Other				
	Organisms	Polycelis sp.	0	24	0
TOTAL		265	247	321	294

Appendix K. Macroinvertebrate Taxa List - Circle Creek Drainage

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Stream		Main Circle Creek CIRO-Main-Circle-001	Main Circle Creek CIRO-Main-Circle-002	South Fork Circle Creek CIRO-SF-Circle-001	South Fork Circle Creek CIRO-SF-Circle-002	North Fork Circle Creek CIRO-NF- Circle-001	North Fork Circle Creek CIRO-NF- Circle-002
Site		06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009
Date		Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Habitat		100.00	100.00	100.00	100.00	100.00	68.97
Percent Subsampled		5349.1-5	5349.1-6	5349.1-7	5349.1-8	5349.1-9	5349.1-10
EcoAnalysts Sample ID							
Ephemeroptera	Ameletus sp.	0	0	3	8	39	24
	Baetis sp.	1	2	0	0	16	9
	Baetis tricaudatus	5	2	1	0	67	159
	Centroptilum sp.	7	20	0	0	0	0
	Cinygmula sp.	0	0	0	0	40	123
	Diphetor hageni	19	9	0	0	53	14
	Ecdyonurus sp.	1	0	0	0	0	0
	Epeorus longimanus	0	0	2	3	0	4
	Ephemerella						
	inermis/infrequens	0	0	0	1	48	23
	Ephemerella sp.	0	0	0	0	3	2
	Ephemerellidae	0	0	0	0	0	1
	Leptophlebiidae	5	7	0	0	60	2
	Paraleptophlebia sp.	0	0	0	0	27	6
	Siphonurus sp.	9	9	0	0	0	0
Odonata	Aeshna sp.	0	1	0	0	0	0
	Amphiagrion sp.	0	1	0	0	0	0
	Argia sp.	1	0	0	0	0	0
Plecoptera	Chloroperlidae	0	0	0	0	0	8
	Hesperoperla						
	pacifica	0	0	0	0	1	1
	Kogotus sp.	0	0	0	0	0	1
	Malenka sp.	0	0	0	0	15	5
	Pteronarcella sp.	0	0	0	0	17	10
	Pteronarcyidae	0	0	0	0	3	0
	Sweltsa sp.	0	0	8	19	7	2

Appendix K. Macroinvertebrate Taxa List - Circle Creek Drainage (Continued)

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Stream		Main Circle Creek CIRO-Main-Circle- 001	Main Circle Creek CIRO-Main-Circle- 002	South Fork Circle Creek CIRO-SF-Circle- 001	South Fork Circle Creek CIRO-SF-Circle- 002	North Fork Circle Creek CIRO-NF- Circle-001	North Fork Circle Creek CIRO-NF- Circle-002
Site							
Date		06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat		Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled		100.00	100.00	100.00	100.00	100.00	68.97
EcoAnalysts Sample ID		5349.1-5	5349.1-6	5349.1-7	5349.1-8	5349.1-9	5349.1-10
Hemiptera	Aquarius sp.	0	1	0	0	0	0
Coleoptera	Agabus sp.	0	3	0	0	0	0
	Helochares sp.	1	1	0	0	0	0
	Helophorus sp.	1	0	0	0	0	0
	Heterlimnius sp.	0	0	0	0	2	14
	Hydraena sp.	0	0	0	1	1	0
	Hydrophilidae	1	0	0	0	0	0
	Laccobius sp.	1	0	0	0	0	1
	Narpus sp.	0	0	1	0	0	0
	Optioservus sp.	4	1	0	0	0	0
Megaloptera	Sialis sp.	1	0	0	0	0	0
Diptera-							
Chironomidae	Alotanypus sp.	3	0	0	0	0	0
	Apedilum sp.	0	1	0	0	0	0
	Brillia sp.	0	1	0	1	6	1
	Chaetocladius sp.	0	0	0	0	1	0
	Chironomus sp.	1	0	0	0	0	0
	Constempellina sp.	0	0	0	0	2	0
	Corynoneura sp.	4	1	0	0	0	0
	Diamesa sp.	0	0	0	1	0	0
	Eukiefferiella sp.	24	15	0	0	2	1
	Heterotrissocladius marcidus gr.	0	0	0	0	5	0
	Krenopelopia sp.	0	0	0	1	0	0

Appendix K. Macroinvertebrate Taxa List - Circle Creek Drainage (Continued)

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Stream	Main Circle Creek CIRO-Main-Circle- 001	Main Circle Creek CIRO-Main-Circle- 002	South Fork Circle Creek CIRO-SF-Circle- 001	South Fork Circle Creek CIRO-SF-Circle- 002	North Fork Circle Creek CIRO-NF- Circle-001	North Fork Circle Creek CIRO-NF- Circle-002
Site						
Date	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled	100.00	100.00	100.00	100.00	100.00	68.97
EcoAnalysts Sample ID	5349.1-5	5349.1-6	5349.1-7	5349.1-8	5349.1-9	5349.1-10
Diptera-						
Chironomidae						
(cont.) Krenosmittia sp.	0	0	0	0	0	2
Larsia sp.	0	0	0	0	0	1
Limnophyes sp.	0	2	0	0	0	0
Macropelopiini	0	1	0	0	0	0
Micropsectra sp.	4	2	0	0	11	27
Orthoclaadiinae	0	0	1	0	1	0
Orthocladus Complex	2	2	1	0	0	0
Pagastia sp.	0	0	0	2	0	0
Paramerina/Zavreliomyia sp.	2	1	1	0	0	0
Parametriocnemus sp.	2	0	6	6	2	0
Paraphaenocladus sp.	0	1	0	0	1	0
Polypedilum sp.	0	1	0	0	3	0
Pseudodiamesa sp.	1	0	0	5	0	2
Rheocricotopus sp.	0	0	0	2	0	1
Thienemanniella sp.	2	0	1	0	0	0
Thienemannimyia gr. sp.	0	1	0	0	0	0
Tvetenia bavarica gr.	6	2	1	0	0	0
Diptera Ceratopogonidae	3	7	0	0	1	0
Ceratopogoninae	13	10	0	0	1	0
Chelifera/Metachela sp.	0	0	0	1	0	0
Cryptolabis sp.	6	3	0	0	1	0
Dicranota sp.	2	0	0	1	1	5

Appendix K. Macroinvertebrate Taxa List - Circle Creek Drainage (Continued)

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Stream		Main Circle Creek CIRO-Main-Circle- 001	Main Circle Creek CIRO-Main-Circle- 002	South Fork Circle Creek CIRO-SF-Circle- 001	South Fork Circle Creek CIRO-SF-Circle- 002	North Fork Circle Creek CIRO-NF- Circle-001	North Fork Circle Creek CIRO-NF- Circle-002
Site							
Date		06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009	06-14-2009
Habitat		Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
Percent Subsampled		100.00	100.00	100.00	100.00	100.00	68.97
EcoAnalysts Sample ID		5349.1-5	5349.1-6	5349.1-7	5349.1-8	5349.1-9	5349.1-10
84	Diptera (cont.)						
	Dixa sp.	0	0	0	0	0	1
	Empididae	0	0	0	0	1	0
	Hexatoma sp.	0	0	0	0	1	0
	Ormosia sp.	6	0	0	0	1	0
	Prosimulium sp.	0	0	1	0	1	5
	Psychodidae	0	0	0	0	1	0
	Ptychopteridae	0	0	0	0	1	0
	Simulium sp.	18	15	0	0	1	0
	Stratiomyidae	1	0	0	0	0	0
	Tipula sp.	2	0	0	0	0	0
	Tipulidae	1	0	0	0	0	1
	Trichoptera						
	Amphicosmoecus canax	1	0	0	0	0	0
	Hesperophylax sp.	4	1	3	4	2	0
	Hydropsyche sp.	1	2	0	0	0	0
	Hydropsychidae	0	2	0	0	0	0
	Lepidostoma sp.	11	0	0	0	14	8
	Micrasema sp.	0	0	0	0	1	0
	Psychoglypha sp.	1	0	0	0	0	0
	Rhyacophila brunnea gr.	0	0	0	0	3	16
	Trichoptera	0	0	0	0	1	0
Gastropoda	Lymnaeidae	1	0	0	0	0	0
	Physa sp.	4	3	0	0	0	0

Appendix K. Macroinvertebrate Taxa List - Circle Creek Drainage (Continued)

NPS Upper Columbia Basin Benthos 2009

Data are adjusted for subsampling and do NOT include L/R taxa

Stream		Main Circle Creek	Main Circle Creek	South Fork Circle	South Fork Circle	North Fork	North Fork
Site		CIRO-Main-Circle-	CIRO-Main-Circle-	Creek	Creek	Circle Creek	Circle Creek
Date		001	002	CIRO-SF-Circle-	CIRO-SF-Circle-	CIRO-NF-	CIRO-NF-
Habitat		06-14-2009	06-14-2009	001	002	Circle-001	Circle-002
Percent Subsampled		Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide	Reach-Wide
EcoAnalysts Sample ID		100.00	100.00	100.00	100.00	100.00	68.97
		5349.1-5	5349.1-6	5349.1-7	5349.1-8	5349.1-9	5349.1-10
Bivalvia	Pisidium sp.	5	5	0	0	8	5
	Sphaeriidae	0	0	0	0	15	0
Annelida	Oligochaeta	24	7	5	7	15	0
Acari	Acari	0	0	0	0	1	0
	Atractides sp.	1	0	0	0	0	0
	Lebertia sp.	0	2	0	0	5	2
	Sperchon sp.	0	0	0	0	9	2
Crustacea	Hyaella sp.	6	9	0	0	0	0
	Ostracoda	2	3	0	0	2	0
Other							
Organisms	Nematoda	0	2	0	0	3	5
	Polycelis sp.	0	0	1	2	35	32
TOTAL		221	159	36	65	558	526

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