



Upper Columbia Basin Network Integrated Water Quality Annual Report 2015

City of Rocks National Reserve (CIRO)

Castle Rocks State Park (CRSP)

Natural Resource Report NPS/UCBN/NRR—2016/1272



ON THE COVER

Overview of the Circle Creek drainage, June 2015, City of Rocks National Reserve
Photograph courtesy of the National Park Service

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Castle Rocks State Park (CRSP)

Natural Resource Report NPS/UCBN/NRR—2016/1272

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August 2016

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Please cite this publication as:

Starkey, E. N. 2016. Upper Columbia Basin Network integrated water quality annual report 2015: City of Rocks National Reserve (CIRO), Castle Rocks State Park (CRSP). Natural Resource Report NPS/UCBN/NRR—2016/1272. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	v
Tables.....	vii
Appendices.....	viii
Executive Summary	ix
Acknowledgments.....	xii
Introduction and Background.....	1
Objectives	2
Study Area	5
City of Rocks National Reserve (CIRO).....	5
North, South and Main Circle Creeks	5
Castle Rocks State Park (CRSP)	12
Almo Creek	12
Methods.....	15
Water Chemistry.....	15
Quality Assurance/Quality Control (QA/QC):	15
Discharge.....	16
Macroinvertebrates.....	16
Results.....	17
City of Rocks National Reserve (CIRO): North Fork Circle Creek.....	17
Water Chemistry.....	17
Macroinvertebrates	23
City of Rocks National Reserve (CIRO): South Fork Circle Creek.....	25
Water Chemistry:.....	25
Macroinvertebrates	29
City of Rocks National Reserve (CIRO): Circle Creek.....	31
Water Chemistry:.....	31
Macroinvertebrates	35
Castle Rocks State Park (CRSP): Almo Creek.....	37

Contents (continued)

	Page
Water Chemistry:.....	37
Macroinvertebrates	42
Literature Cited	45

Figures

	Page
Figure 1. City of Rocks National Reserve regional map (NPS 1999b).	6
Figure 2. North Circle Creek water quality monitoring station #01	7
Figure 3. South Circle Creek water quality monitoring station #01	7
Figure 4. Main Circle Creek water quality monitoring station #01	8
Figure 5. Water quality monitoring locations in CIRO- North Fork Circle Creek 2015.	9
Figure 6. Water quality monitoring locations in CIRO- South Fork Circle Creek 2015.	10
Figure 7. Water quality monitoring locations in CIRO- Main Circle Creek 2015.....	11
Figure 8. Almo Creek looking upstream towards water quality monitoring station #01.....	13
Figure 9. Water quality monitoring locations in CRSP- Almo Creek 2015.	14
Figure 10. Water temperature in North Fork Circle Creek, 15-16 June 2015.....	19
Figure 11. Daily maximum and mean water temperature in North Fork Circle Creek, June-October 2015.	19
Figure 12. Specific conductance in North Fork Circle Creek, 15-16 June 2015.	20
Figure 13. Dissolved oxygen and water temperature in North Fork Circle Creek, 15-16 June 2015.	21
Figure 14. pH in North Fork Circle Creek, 15-16 June 2015.	22
Figure 15. Turbidity in North Fork Circle Creek, 15-16 June 2015.	22
Figure 16. Water temperature in South Fork Circle Creek, 15-16 June 2015.....	26
Figure 17. Specific conductance in South Fork Circle Creek, 15-16 June 2015.	27
Figure 18. Dissolved oxygen and water temperature in South Fork Circle Creek, 15-16 June 2015.	28
Figure 19. pH in South Fork Circle Creek, 15-16 June 2015.	28
Figure 20. Turbidity in South Fork Circle Creek, 15-16 June 2015.	29
Figure 21. Water temperature in Circle Creek, 14-15 June 2015.	32
Figure 22. Specific conductance in Circle Creek, 14-15 June 2015.	33
Figure 23. Dissolved oxygen and water temperature in Circle Creek, 14-15 June 2015.....	34
Figure 24. pH in Circle Creek, 14-15 June 2015.	34
Figure 25. Turbidity in Circle Creek, 14-15 June 2015.	35
Figure 26. Water temperature in Almo Creek, 14-15 June 2015.	39

Figures (continued)

	Page
Figure 27. Specific conductance in Almo Creek, 14-15 June 2015.	40
Figure 28. Dissolved oxygen and water temperature in Almo Creek, 14-15 June 2015.	40
Figure 29. pH in Circle Creek, 14-15 June 2015.	41
Figure 30. Turbidity in Almo Creek, 14-15 June 2015.	42

Tables

	Page
Table ES-1. North Fork Circle Creek Water Chemistry Summary for 24 hour period 15-16 June, 2015	x
Table ES-2. South Fork Circle Creek Water Chemistry Summary for 24 hour period 15-16 June 2015	x
Table ES-3. Circle Creek Water Chemistry Summary for 24 hour period 14-15 June 2015.....	xi
Table ES-4. Almo Creek Water Chemistry Summary for 24 hour period 14-15 June 2015	xi
Table 1. Deployment intervals of water quality monitors at CIRO and CRSP 2015.....	15
Table 2. North Fork Circle Creek Water Chemistry Summary for 24 hour period 15-16 June, 2015	17
Table 3. Vital sign summary table for water chemistry in North Fork Circle Creek June, 2012.	18
Table 4. Water temperature summary table for North Fork Circle Creek 2011-2015.	20
Table 5. Vital sign summary table for benthic macroinvertebrates in North Fork Circle Creek, 2015.	24
Table 6. Vital sign summary table for water chemistry in South Fork Circle Creek June, 2015.....	25
Table 7. Vital sign summary table for water chemistry in South Fork Circle Creek June, 2012.....	26
Table 8. Vital sign summary table for benthic macroinvertebrates in South Fork Circle Creek, 2015.	30
Table 9. Vital sign summary table for water chemistry in Circle Creek June, 2015.....	31
Table 10. Vital sign summary table for water chemistry in Circle Creek June, 2012.....	32
Table 11. Vital sign summary table for benthic macroinvertebrates in Circle Creek, 2015.	36
Table 12. Vital sign summary table for water chemistry in Almo Creek June, 2015.	37
Table 13. Vital sign summary table for water chemistry in Almo Creek June, 2012	38
Table 14. Water temperature summary table for Almo Creek 2011-2015.....	39
Table 15. Vital sign summary table for benthic macroinvertebrates in Almo Creek, 2015.....	43

Appendices

	Page
Appendix A. 2015 Water Quality Monitoring Locations	Appendix A-1
Appendix B. CIRO/CRSP Hydrologic Unit Code Boundaries	Appendix B-1
Appendix C. Sample Locations for Water Quality Monitoring at CIRO/CRSP	Appendix C-1
Appendix D. Quality Control (QC) Indicators.....	Appendix D-1
Appendix E. Macroinvertebrate Metrics.....	Appendix E-1
Appendix F. Macroinvertebrate Taxa List.....	Appendix F-1

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 1999a). 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 1999a). Through the Challenge, 270 parks in the national park system were organized into 32 inventory and monitoring networks. The Upper Columbia Basin Network (UCBN) is comprised of 8 national park sites located in Idaho, Montana, Oregon, and Washington.

The 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. The intent of the network 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. 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 monitoring in City of Rocks National Reserve (CIRO) and Castle Rocks State Park (CRSP). North Fork, South Fork and Main Stem Circle Creeks flow through CIRO and Almo Creek flows through CRSP. Creeks in both CIRO and CRSP were previously sampled by the UCBN in 2009 and 2012 (see Starkey 2010, Starkey 2013). Data from the 2015 field sampling effort was collected following methods detailed in the UCBN integrated water quality monitoring protocol (Starkey et al. 2008). The UCBN Integrated Water Quality Monitoring Protocol was formally peer-reviewed and approved for implementation in August 2009. A revised version has recently been published (Starkey et al. 2016a) and can be found on the UCBN website at: <http://science.nature.nps.gov/im/units/ucbn/publications.cfm?tab=3>. Benthic macroinvertebrates were collected by the United States Forest Service- PACFISH/INFISH Biological Opinion (PIBO) according to their peer reviewed protocol during the UCBN’s monitoring of stream channel characteristics and riparian condition in 2015. The UCBN’s peer reviewed stream channel characteristics and riparian condition protocols can also be found on the UCBN’s website listed above.

Water chemistry and macroinvertebrate results indicate that Circle and Almo Creeks are in fair to good condition. Water chemistry data indicate that conditions were within established thresholds. Benthic macroinvertebrate results generally indicated good water quality but give cause for continued monitoring. The status of water quality for North Fork, South Fork and Main Stem Circle Creeks and Almo Creek relative to state regulatory thresholds is given in the Table ES-1, ES-2, ES-3, and ES-4. UCBN water quality monitoring is conducted on a 3 year rotating panel. As a result, conditions in these streams will be re-evaluated in 2018.

Note that several of the appendices in this report are primarily intended for UCBN internal reference. In addition, some appendices serve as hard copies of quality assurance/quality control procedures performed during data processing.

Table ES-1. North Fork Circle Creek Water Chemistry Summary for 24 hour period 15-16 June, 2015

Measure	Current Condition (15-16 June, 2015)	State DEQ Thresholds ^c	% Exceedance ^d
Temperature (MDMT ^a , MDAT ^b)	MDMT ^a = 14.05 °C	<22 °C	0%
	MDAT ^b = 11.99 °C	MDAT ^b <19 °C	0%
Specific conductance (mean)	152.27 µS/cm	N/A	N/A
Dissolved oxygen (mean daily min)	8.29 mg/l	> 6.0 mg/l	0%
pH (mean daily max)	7.84 pH Units	9.0 pH Units, Max	0%
pH (mean daily min)	7.77 pH Units	6.5 pH Units, Min	0%
Turbidity (mean daily max)	<0.44 NTU	< 50 NTU over background (instantaneous) < 25 for 10 consecutive days	Insufficient data

^a MDMT – Maximum Daily Maximum Temperature

^b MDAT – Maximum Daily Average Temperature

^c Criteria for cold water life designation

^d Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). Exceedance values 0% - 5% indicates good water quality (also highlighted in green), 5% - 25% indicates fair water quality (also highlighted in yellow), and > 25% indicates poor water quality (also highlighted in red).

Table ES-2. South Fork Circle Creek Water Chemistry Summary for 24 hour period 15-16 June 2015

Measure	Current Condition (15-16 June, 2015)	State DEQ Thresholds ^c	% Exceedance ^d
Temperature (MDMT ^a , MDAT ^b)	MDMT ^a = 14.39	<22 °C	0%
	MDAT ^b = 12.69 °C	MDAT ^b <19 °C	0%
Specific conductance (mean)	185.65 µS/cm	N/A	N/A
Dissolved oxygen (mean daily min)	7.92 mg/L	> 6.0 mg/L	0%
pH (mean daily max)	7.64 pH Units	9.0 pH Units, Max	0%
pH (mean daily min)	7.56 pH Units	6.5 pH Units, Min	0%
Turbidity (mean daily max)	<0.17 NTU	< 50 NTU over background (instantaneous) < 25 for 10 consecutive days	Insufficient data

^a MDMT – Maximum Daily Maximum Temperature

^b MDAT – Maximum Daily Average Temperature

^c Criteria for cold water life designation

^d Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). 0% - 5% exceedance indicates good water quality (also highlighted in green), 5% through 25% exceedance indicates fair water quality (also highlighted in yellow), and exceedance greater than 25% indicates poor water quality (also highlighted in red).

Table ES-3. Circle Creek Water Chemistry Summary for 24 hour period 14-15 June 2015

Measure	Current Condition (15-16 June, 2015)	State DEQ Thresholds ^c	% Exceedance ^d
Temperature (MDMT ^a , MDAT ^b)	MDMT ^a = 20.55 °C	<22 °C	0%
	MDAT ^b = 16.81 °C	MDAT ^b <19 °C	0%
Specific conductance (mean)	458.52 µS/cm	N/A	N/A
Dissolved oxygen (mean daily min)	7.27 mg/L	> 6.0 mg/L	0%
pH (mean daily max)	8.25 pH Units	9.0 pH Units, Max	0%
pH (mean daily min)	8.19 pH Units	6.5 pH Units, Min	0%
Turbidity (mean daily max)	<0.17 NTU	< 50 NTU over background (instantaneous) < 25 for 10 consecutive days	Insufficient data

^a MDMT – Maximum Daily Maximum Temperature

^b MDAT – Maximum Daily Average Temperature

^c Criteria for cold water life designation

^d Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). 0% - 5% exceedance indicates good water quality (also highlighted in green), 5% through 25% exceedance indicates fair water quality (also highlighted in yellow), and exceedance greater than 25% indicates poor water quality (also highlighted in red).

Table ES-4. Almo Creek Water Chemistry Summary for 24 hour period 14-15 June 2015

Measure	Current Condition (15-16 June, 2015)	State DEQ Thresholds ^c	% Exceedance ^d
Temperature (MDMT ^a , MDAT ^b)	MDMT ^a = 15.96 °C	<22 °C	0%
	MDAT ^b = 13.31 °C	MDAT ^b <19 °C	0%
Specific conductance (mean)	46.67 µS/cm	N/A	N/A
Dissolved oxygen (mean daily min)	8.41 mg/L	> 6.0 mg/L	0%
pH (mean daily max)	7.49 pH Units	9.0 pH Units, Max	0%
pH (mean daily min)	7.38 pH Units	6.5 pH Units, Min	0%
Turbidity (mean daily max)	14.05 NTU	< 50 NTU over background (instantaneous) < 25 for 10 consecutive days	Insufficient data

^a MDMT – Maximum Daily Maximum Temperature

^b MDAT – Maximum Daily Average Temperature

^c Criteria for cold water life designation

^d Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). 0% - 5% exceedance indicates good water quality (also highlighted in green), 5% through 25% exceedance indicates fair water quality (also highlighted in yellow), and exceedance greater than 25% indicates poor water quality (also highlighted in red).

Acknowledgments

Funding for this project was provided through the National Park Service Natural Resource Challenge and the Servicewide Inventory and Monitoring Program. The UCBN would also like to thank CIRO park staff for their review of this report and for accommodations during fieldwork.

Introduction and Background

Water resources have been identified as a high priority vital sign for the Upper Columbia Basin Network (UCBN). These resources are used by many riparian, migratory, and terrestrial organisms in the Network, and have intrinsic value as places of natural beauty and recreation (Garrett et al. 2007). Reflecting this priority, the Water Resources Division (WRD) of the NPS provides a separate source of funding each fiscal year to the UCBN to accomplish water quality monitoring. In June 2015 the UCBN began its third year of integrated water quality monitoring in North Fork Circle, South Fork Circle, and Main Circle Creeks at City of Rocks National Reserve (CIRO) and Almo Creek at Castle Rocks State Park (CRSP).

Water resources in the semi-arid West have been strongly affected by human activity, and many 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 assemblages 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 and riparian vegetation are addressed in separate monitoring protocols which were also implemented at CIRO and CRSP in 2015.

The objectives of the UCBN Integrated Water Quality Monitoring Protocol are documenting the aquatic macroinvertebrate assemblage composition and baseline water chemistry parameters. Aquatic macroinvertebrate assemblages have strong effects on freshwater ecosystem processes and represent an important trophic linkage between primary producers and fishes. Measures of macroinvertebrate assemblage composition and structure have been frequently used as water quality indicators because these assemblages 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. National Park Service (NPS) Water Resource Division (WRD) has

identified a suite of four “core water quality parameters”: temperature, specific conductance, pH, and dissolved oxygen, which 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 1999a). 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 (Ia4) that streams and rivers managed by NPS will meet State and Federal water quality standards (NPS 2000).

Given this goal, it should be noted that Almo, North, South and Circle Creeks are considered “undesignated surface waters,” meaning that they have not been assigned a beneficial use. In Idaho undesignated streams are assumed to support cold water aquatic life and primary or secondary contact recreation (ID Admin Code 2015, 58.01.02.101.01a [through 4/5/00]). Circle Creek has been listed as an assessment unit that is intermittent (i.e. “has zero flow for at least 1 week during most years”) and as a result, Idaho Department of Environmental Quality (ID DEQ) was unable to determine attainment relative to presumed beneficial uses (ID DEQ 2014). The segment of Almo Creek within the park is part of the Edwards Creek assessment unit and has been listed as a category 2 stream, meaning that it is a water of concern but currently supports presumed beneficial uses (ID DEQ 2014). For information specific to this assessment unit see http://mapcase.deq.idaho.gov/wq2012/js/adb2012.aspx?WBIDSEGID=ID17040210SK012_02 and <http://mapcase.deq.idaho.gov/wq2012/> (accessed 19 November 2015).

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 the (Environmental Protection Agency (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.

Study Area

City of Rocks National Reserve (CIRO)

North, South and Main Circle Creeks

The North Fork, South Fork, and main stem of Circle Creeks are in the Raft River drainage in Hydrologic Unit Code (HUC 6) 170402100207 (United States Geologic Survey [USGS]), Circle Creek-Raft River subwatershed, in Cassia County, Idaho (Figure 1, Appendix A and B). The headwaters of 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. It should be noted that, on some maps and in state reports North Fork and South Fork Circle Creeks are referred to as North Creek and South Creek.

As noted by Erixson and Corrao (2012) in the natural resource condition assessment, the vegetation of CIRO has been separated into five primary categories (percent of area covered); shrublands (33%), herbaceous-shrub steppe (26%), open and closed canopy evergreen (24%), grassland/herbaceous (14%), and other (including sparsely vegetated areas and agriculture) (3%).

This is an accurate reflection of land cover types in the Circle Creek drainage above monitoring locations. One land use not explicitly 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 (Garrett et al. 2007). As mentioned above, North, South and Circle Creeks are considered “undesignated surface waters,” meaning that they have not been assigned a beneficial use. In Idaho undesignated streams are assumed to support cold water aquatic life and primary or secondary contact recreation (ID Admin Code 2015, 58.01.02.101.01a [through 4/5/00]). Circle Creek has been listed as an assessment unit that is intermittent (i.e. “has zero flow at some time during most years”) and as a result, Idaho Department of Environmental Quality (ID DEQ) was unable to determine attainment relative to presumed uses (ID DEQ 2014).

Additional information about the Circle Creek and Raft River watersheds can be found in Baseline Water Quality Data Inventory and Analysis- City of Rocks National Reserve (NPS 1999b). Natural Resource Condition Assessment: City of Rocks National Reserve (Erixson and Corrao 2012), Raft River Watershed Total Maximum Daily Load-Implementation Plan for Agriculture (Firth et.al. 2006).

Continuous water quality monitors (Hydrolabs) were deployed in North, South and Main Circle Creeks in locations that provided adequate water depth and surface flow in mid-June. Monitoring locations are noted in Figures 2-7, and Appendix A. These locations were the same as in 2012. The macroinvertebrate sample reaches along North, South and Circle Creeks coincide with the stream channel characteristics and riparian condition monitoring reaches (see Appendix C for GPS waypoints).

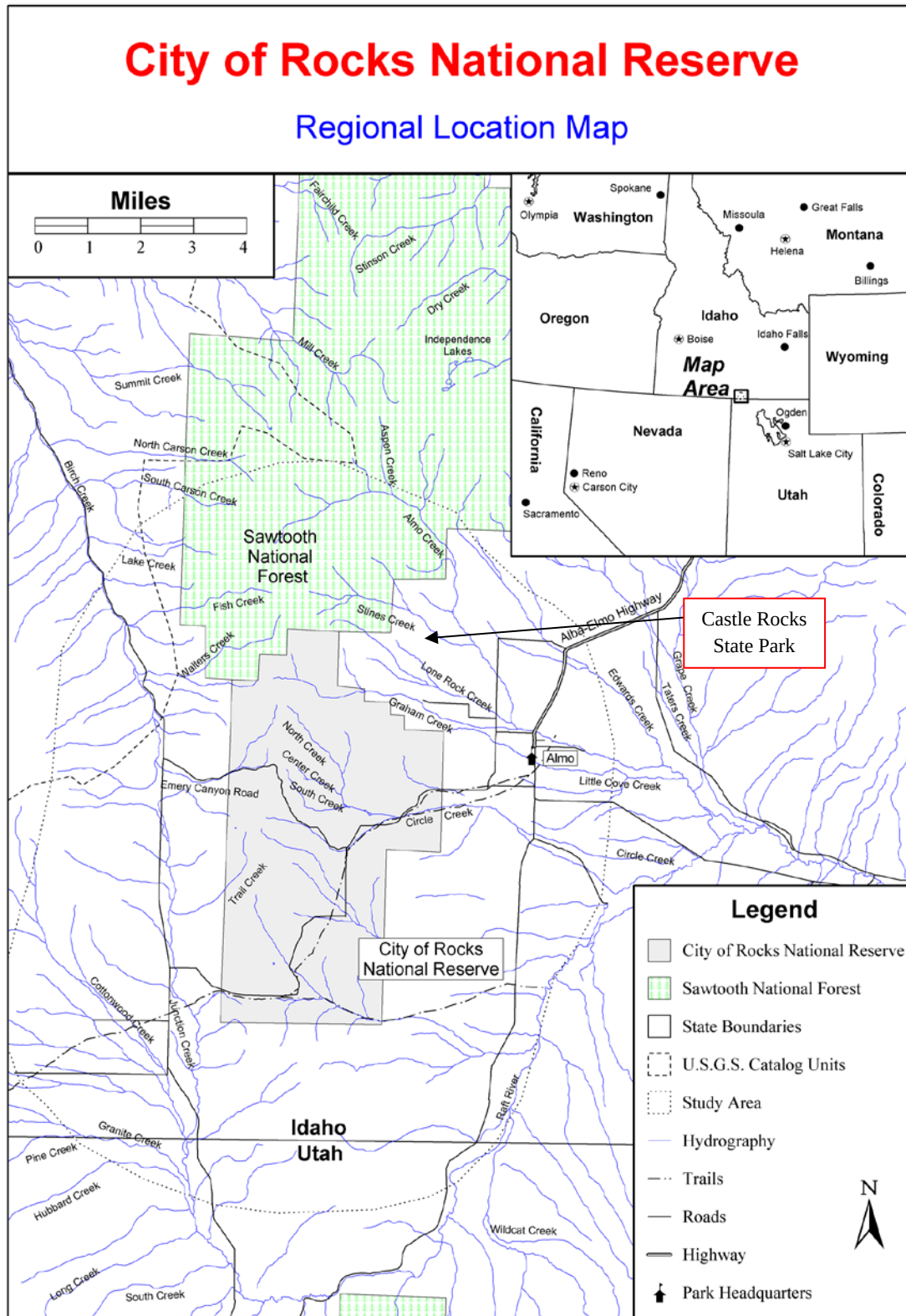


Figure 1. City of Rocks National Reserve regional map (NPS 1999b). Note that monitoring occurred in both City of Rocks National Reserve and Castle Rocks State Park (CRSP) (CRSP location noted in red, boundary not shown).



Figure 2. North Circle Creek water quality monitoring station #01, approximately 15 m upstream from the intersection of Stripe Rock trail with North Fork Circle Creek trail.



Figure 3. South Circle Creek water quality monitoring station #01, approximately 15 m downstream of Box Top trail.



Figure 4. Main Circle Creek water quality monitoring station #01, approximately 150 m downstream of City of Rocks road.

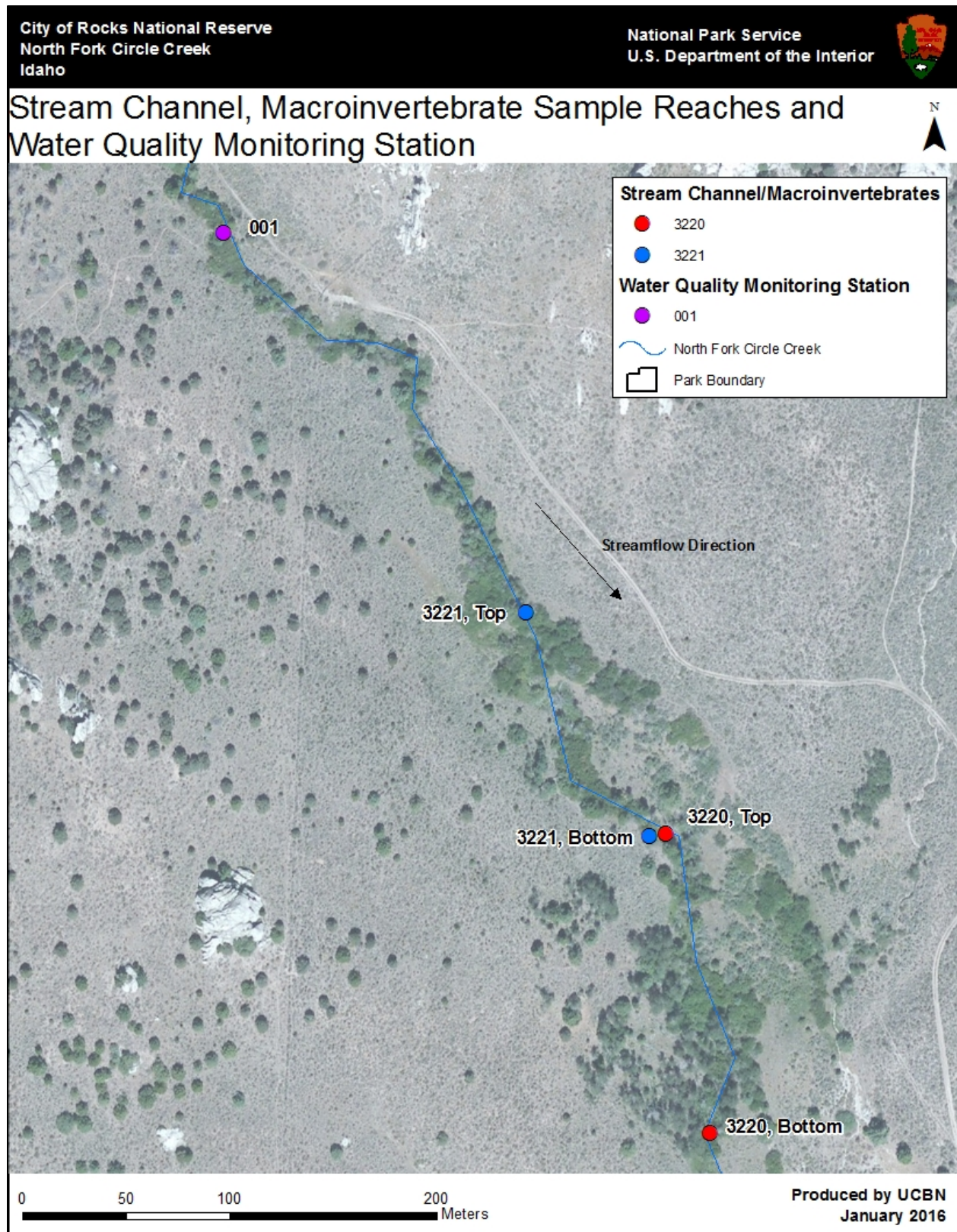


Figure 5. Water quality monitoring locations in CIRO- North Fork Circle Creek 2015.



Stream Channel, Macroinvertebrate Sample Reaches and Water Quality Monitoring Station

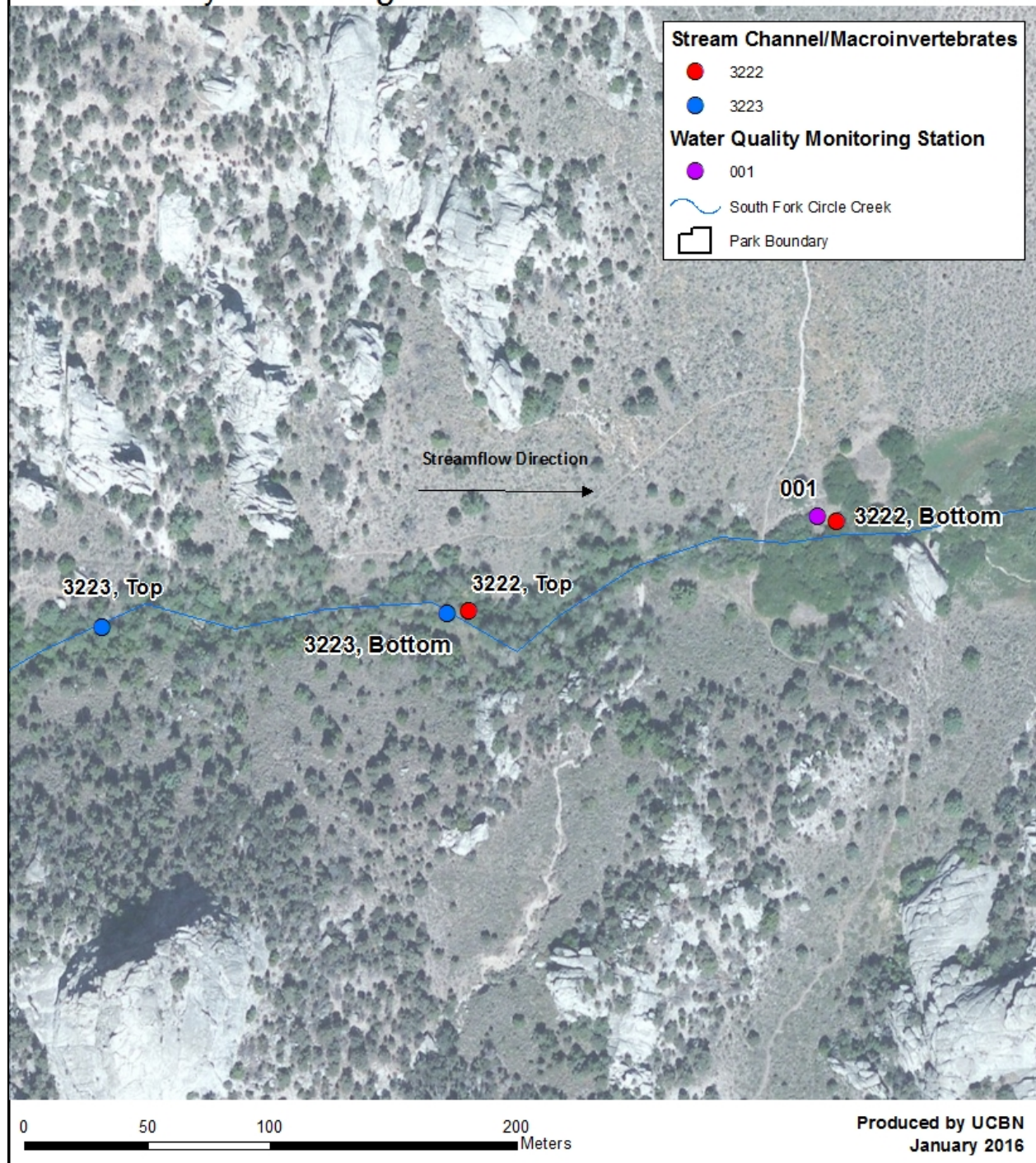


Figure 6. Water quality monitoring locations in CIRO- South Fork Circle Creek 2015.

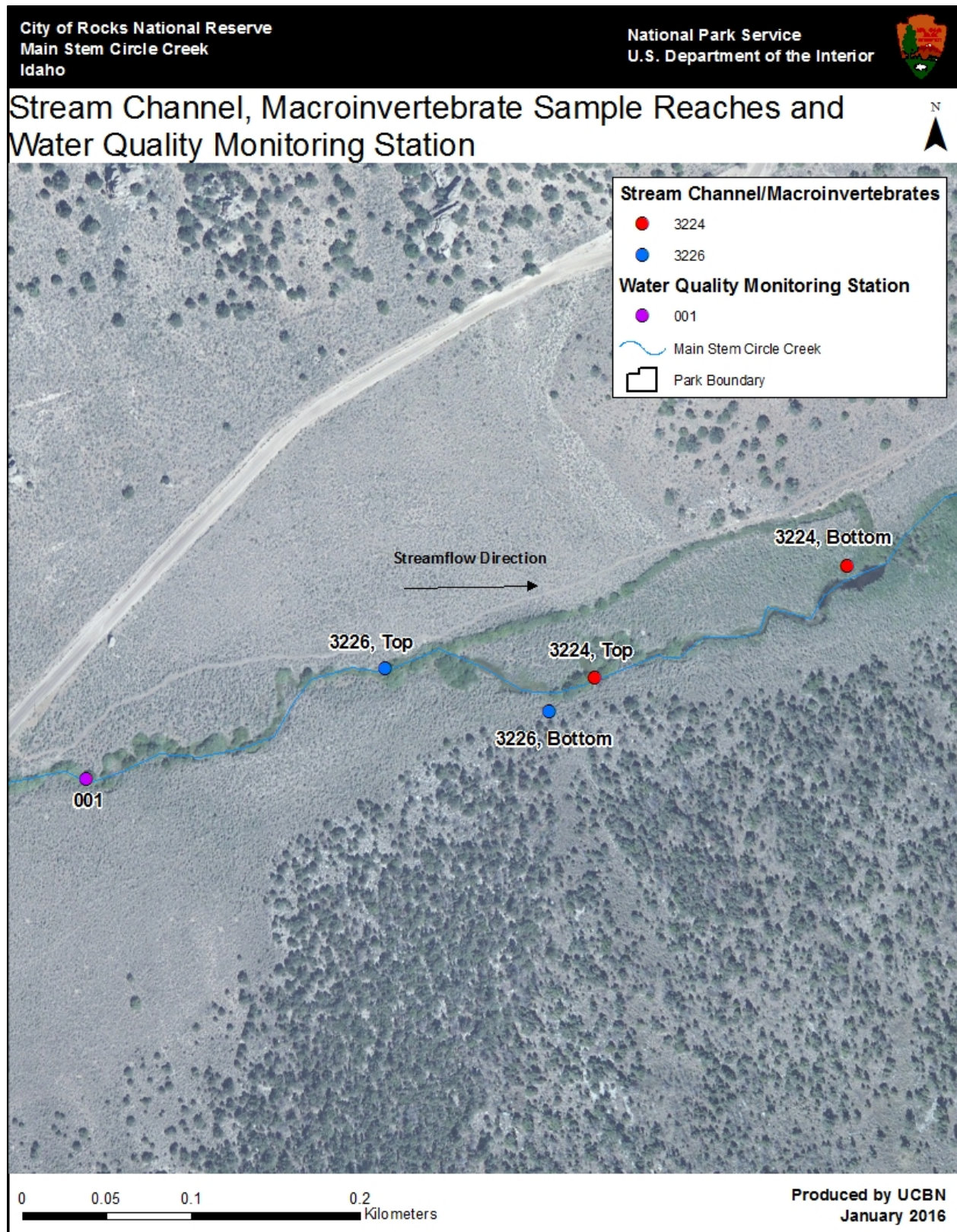


Figure 7. Water quality monitoring locations in CIRO- Main Circle Creek 2015.

Castle Rocks State Park (CRSP)

Almo Creek

Almo Creek is in the Raft River drainage in Hydrologic Unit Code (HUC 6) 170402100203 (United States Geologic Survey [USGS]), Almo Creek subwatershed, in Cassia County, Idaho (Figure 1, Appendix A and 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 diversion headgates are made by CRSP managers according to a set schedule.

As noted by Erixson and Corrao (2012) in the natural resource condition assessment, the vegetation of CIRO has been separated into five primary categories (percent of area covered); shrublands (33%), herbaceous-shrub steppe (26%), open and closed canopy evergreen (24%), grassland/herbaceous (14%), and other (including sparsely vegetated areas and agriculture) (3%).

This is an accurate reflection of land cover types in the Almo Creek drainage above the monitoring location. One land use not explicitly accounted for in the above list is ranching, which occurs on CRSP public lands and downstream on private land. However, in 2015 the Castle Rocks State Park grazing allotment was rested. 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 (Garrett et al. 2007). As mentioned above, Almo Creek is considered “undesignated surface water,” meaning that it has not been assigned a beneficial use. In Idaho undesignated streams are assumed to support cold water aquatic life and primary or secondary contact recreation (ID Admin Code 2015, 58.01.02.101.01a [through 4/5/00]). The segment of Almo Creek within the park is part of the Edwards Creek assessment unit and has been listed as a category 2 stream, meaning that it is a water of concern but currently supports presumed beneficial uses (ID DEQ 2014).

Additional information about the Almo Creek and Raft River watersheds can be found in Baseline Water Quality Data Inventory and Analysis- City of Rocks National Reserve (NPS 1999b), Natural Resource Condition Assessment: City of Rocks National Reserve (Erixson and Corrao 2012), Raft River Watershed Total Maximum Daily Load-Implementation Plan for Agriculture (Firth et.al. 2006), Management Plan for Conservation of Yellowstone Cutthroat Trout in Idaho (ID DFG 2007).

The Hydrolab was deployed in Almo Creek in a location that provided adequate water depth and surface flow in mid-June. The monitoring location is noted in Figures 8 and 9, and Appendix A. The location was the same as in 2012. The macroinvertebrate sample reaches along Almo Creek coincide with the stream channel characteristics and riparian condition monitoring reaches (see Appendix C for GPS waypoints).



Figure 8. Almo Creek looking upstream towards water quality monitoring station #01.



Stream Channel, Macroinvertebrate Sample Reaches and Water Quality Monitoring Station

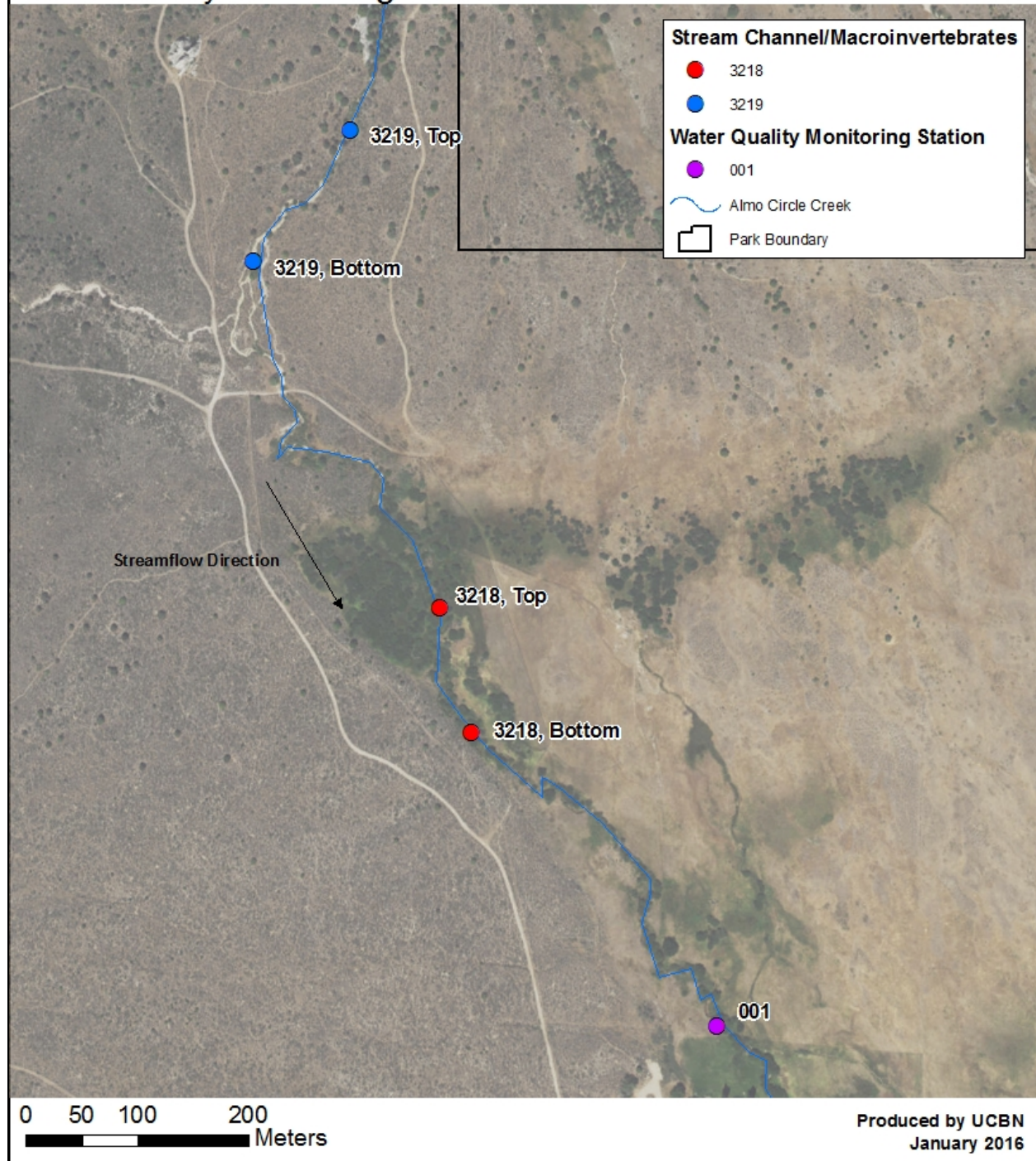


Figure 9. Water quality monitoring locations in CRSP- Almo Creek 2015.

Methods

Water Chemistry

Continuous water quality monitors (HACH, MS5 Hydrolabs) were deployed for 24 hours in each of the selected streams within CIRO/CRSP (North Fork Circle Creek, South Fork Circle Creek, Circle Creek, and Almo Creek). The deployment interval was 24 hours instead of six months due to the streams intermittent flow (see deployment periods in Table 1). Deployments occurred at index sites to estimate the status, variability, and long-term trends in core parameters. The core parameters measured were water temperature, dissolved oxygen, pH, specific conductance, and turbidity. These core parameters were measured every half hour and the instruments were retrieved and 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. Note that no visible fouling occurred on any of the sensors during deployments. Data quality ratings were determined by the degree of sensor drift and other factors discussed in the results section. Any corrections to the data, including outlier removal and drift corrections are documented in AQUARIUS Time-Series software/database. For more information on the UCBN water chemistry sampling design and data quality ratings see Starkey et al. (2016a) and Wagner et al. (2006).

Table 1. Deployment intervals of water quality monitors at CIRO and CRSP 2015.

UCBN Property Number	Hydrolab Serial Number	Stream	Deployment Start	Deployment End
064	0710C0045801	North Fork Circle Creek	06/15/2015 10:00:00 MDT	06/16/2015 10:00:00 MDT
054	070300045028	South Fork Circle Creek	06/15/2015 10:30:00 MDT	06/16/2015 10:30:00 MDT
054	070300045028	Circle Creek	06/14/2015 08:00:00 MDT	06/15/2015 08:00:00 MDT
064	0710C0045801	Almo Creek	06/14/2015 08:30:00 MDT	06/15/2015 08:30:00 MDT

Quality Assurance/Quality Control (QA/QC):

Quality assurance and quality control for multiprobe data collection are covered in detail in SOP #10 (Starkey et al. 2016b). Basic procedures adhere to the guidelines established in Part B lite (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).

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

- 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 is removed for non-routine maintenance.
- When calibrating the multiprobe, values of known standard solutions are measured pre and post calibration, to help determine if the instrument's measurements have "drifted." In addition, repeated measures of these solutions are used to determine the repeatability of multiprobe measures.
- All multiprobe data is visually checked for outliers and QC issues immediately following the download of data. QC issues indicated by the data may include: wiper parking, defective sensors, power supply problems, and other anomalies affecting data quality.
- Quantitative and qualitative terms that describe how accurate data need to be in order to meet project objectives are discussed in detail in SOP #10 Starkey et al. 2016b and Appendix D 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 #10, Starkey et al. 2016b.

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

On North Fork Circle Creek and Almo Creek macroinvertebrates were collected at designated sample reaches (2 reaches in each stream) by the United States Forest Service- PACFISH/INFISH Biological Opinion (PIBO) Effectiveness Monitoring Program during the assessment of stream channel characteristics. This assessment was completed as part of the UCBN stream channel characteristics monitoring protocol. Macroinvertebrates were collected from 8 fast water habitats (riffles, runs) in each sample reach. These 8 samples were combined for a single composite sample per reach. For more information on the PIBO macroinvertebrate sampling design, see Heitke et al. (2008).

Results

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

Water Chemistry

Status:

Condition of core water quality parameters (2015) along with the corresponding Idaho DEQ regulatory threshold are given in Table 2. For comparison, the condition of core water quality parameters as observed in 2012 are given in Table 3. Data indicate that conditions were well within acceptable ranges relative to criteria for cold water aquatic life. Individual parameters are discussed below.

Table 2. North Fork Circle Creek Water Chemistry Summary for 24 hour period 15-16 June, 2015

Measure	Current Condition (15-16 June, 2015)	State DEQ Thresholds ^c	% Exceedance ^d
Temperature (MDMT ^a , MDAT ^b)	MDMT ^a = 14.05 °C	<22 °C	0%
	MDAT ^b = 11.99 °C	MDAT ^b <19 °C	0%
Specific conductance (mean)	152.27 µS/cm	N/A	N/A
Dissolved oxygen (mean daily min)	8.29 mg/l	> 6.0 mg/l	0%
pH (mean daily max)	7.84 pH Units	9.0 pH Units, Max	0%
pH (mean daily min)	7.77 pH Units	6.5 pH Units, Min	0%
Turbidity (mean daily max)	<0.44 NTU	< 50 NTU over background (instantaneous) < 25 for 10 consecutive days	Insufficient data

^a MDMT – Maximum Daily Maximum Temperature

^b MDAT – Maximum Daily Average Temperature

^c Criteria for cold water life designation

^d Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). Exceedance values 0% - 5% indicates good water quality (also highlighted in green), 5% - 25% indicates fair water quality (also highlighted in yellow), and > 25% indicates poor water quality (also highlighted in red).

Table 3. Vital sign summary table for water chemistry in in North Fork Circle Creek June, 2012.

Measure	Current Condition (15-16 June, 2015)	State DEQ Thresholds ^c	% Exceedance ^d
Temperature (MDMT ^a , MDAT ^b)	MDMT ^a = 14.30 °C	<22 °C	0%
	MDAT ^b = 12.36 °C	MDAT ^b <19 °C	0%
Specific conductance (mean)	144.30 µS/cm	N/A	N/A
Dissolved oxygen (mean daily min)	8.33 mg/l	> 6.0 mg/l	0%
pH (mean daily max)	8.13 pH Units	9.0 pH Units, Max	0%
pH (mean daily min)	8.03 pH Units	6.5 pH Units, Min	0%
Turbidity (mean daily max)	-- ^e	< 50 NTU over background (instantaneous) < 25 for 10 consecutive days	Insufficient data

^a MDMT – Maximum Daily Maximum Temperature

^b MDAT – Maximum Daily Average Temperature

^c Criteria for cold water life designation

^d Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). Exceedance values 0% - 5% indicates good water quality (also highlighted in green), 5% - 25% indicates fair water quality (also highlighted in yellow), and > 25% indicates poor water quality (also highlighted in red).

^e Poor data quality precludes reporting

Temperature:

June 15-16th 2015, the maximum daily maximum temperature (MDMT) was 14.05 °C and the maximum daily average temperature (MDAT) was 11.99 °C (Figure 10). Neither the MDMT nor MDAT exceeded the cold water aquatic life criteria of 22.0 °C and 19.0 °C respectively. Data quality was rated as “excellent” due to minimal sensor drift.

In addition, continuous temperature loggers (HOBO Pro v2) have been deployed at this location since 2011 (June-October) (Figure 11). Results for temperature monitoring are shown in Table 4. No exceedances of the cold water aquatic life designation were observed and data indicates that cool water temperatures persist throughout the summer.

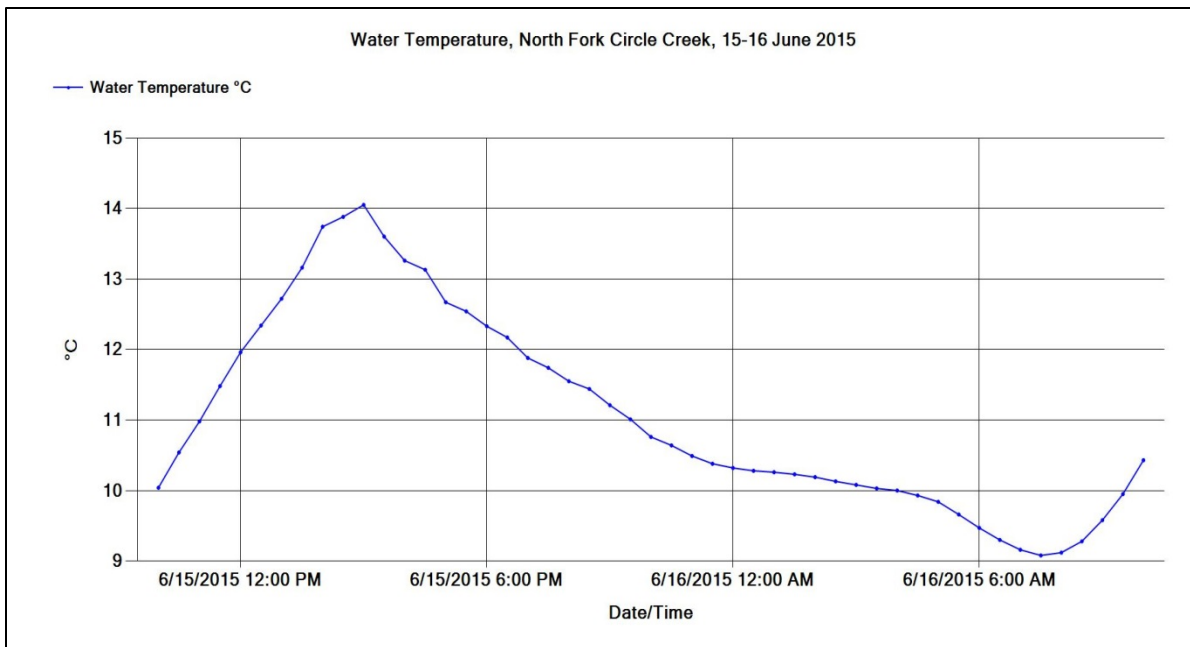


Figure 10. Water temperature in North Fork Circle Creek, 15-16 June 2015.

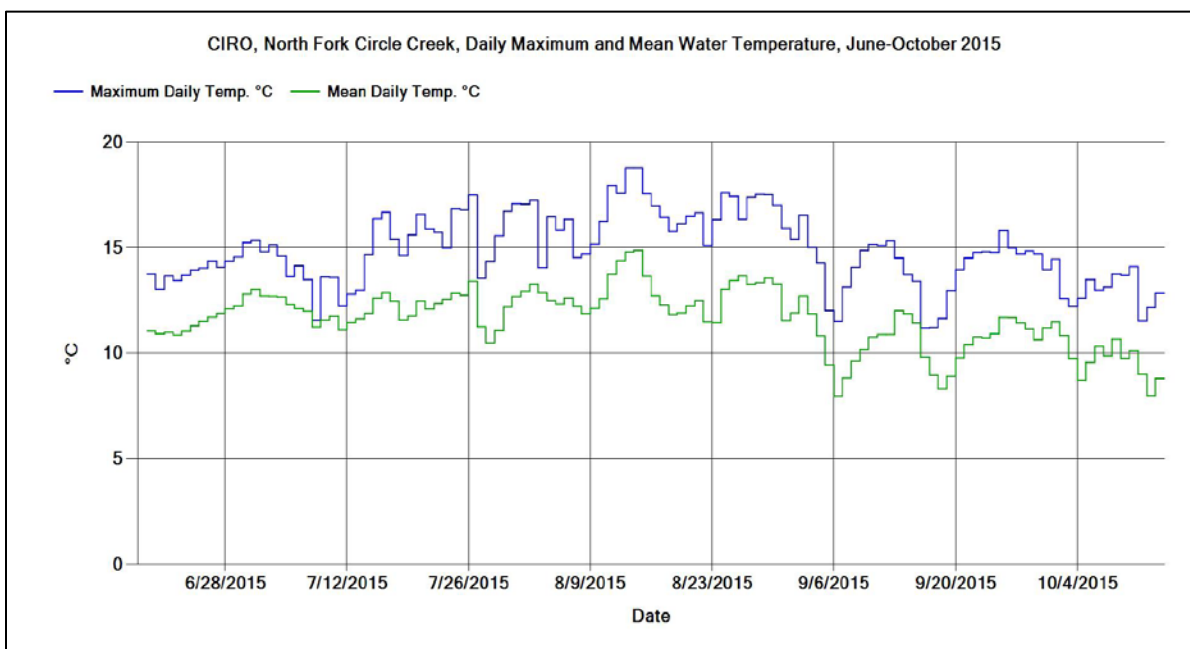


Figure 11. Daily maximum and mean water temperature in North Fork Circle Creek, June-October 2015.

Table 4. Water temperature summary table for North Fork Circle Creek 2011-2015.

Monitoring Dates	State DEQ Threshold	% Exceedance ^b	MDMT °C	MDAT °C
06/18/2015-10/14/2015 ^a	>22 °C	0	18.77	n/a
	MDAT >19 °C	0	n/a	14.86
06/01/2014-11/17/2014 ^a	>22 °C	0	18.44	n/a
	MDAT >19 °C	0	n/a	14.46
06/01/2013-09/19/2013 ^a	>22 °C	0	16.75	n/a
	MDAT >19 °C	0	n/a	14.00
06/20/2012-10/24/2012 ^a	>22 °C	0	18.77	n/a
	MDAT >19 °C	0	n/a	14.56
06/01/2011-10/02/2011 ^a	>22 °C	0	15.72	n/a
	MDAT >19 °C	0	n/a	12.88

^a Collected with HOBO Pro v2.0 temperature logger, MDMT – Maximum Daily Maximum Temperature, MDAT – Maximum Daily Average Temperature

^b Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). Exceedance values 0% - 5% indicates good water quality (also highlighted in green), 5% - 25% indicates fair water quality (also highlighted in yellow), and > 25% indicates poor water quality (also highlighted in red).

Specific Conductance:

Specific conductance ranged from 151.0 to 153.0 $\mu\text{S}/\text{cm}$, with an average specific conductance of 152.25 $\mu\text{S}/\text{cm}$ (Figure 12). Note that there is no state threshold for specific conductance as it varies widely depending on the geology of the drainage basin and stream discharge. Data quality was rated as “excellent” due to the lack of sensor drift encountered during the deployment.

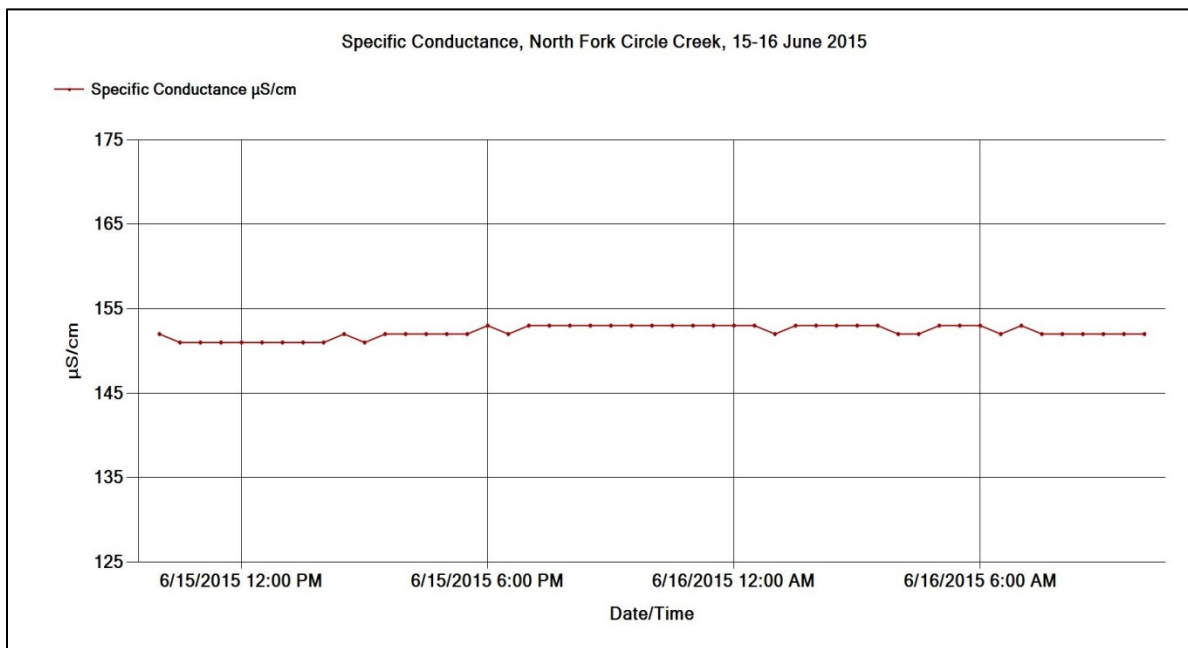


Figure 12. Specific conductance in North Fork Circle Creek, 15-16 June 2015.

Dissolved Oxygen:

Mean daily minimum dissolved oxygen was 8.29 mg/L and was never below the cold water aquatic life criteria of 6.0 mg/L. Minimum dissolved oxygen levels corresponded to maximum water temperatures. Figure 13 shows dissolved oxygen and temperature in North Fork Circle Creek from June 15th and 16th 2015. Data quality was rated as “excellent” due to the lack of sensor drift encountered during the deployment.

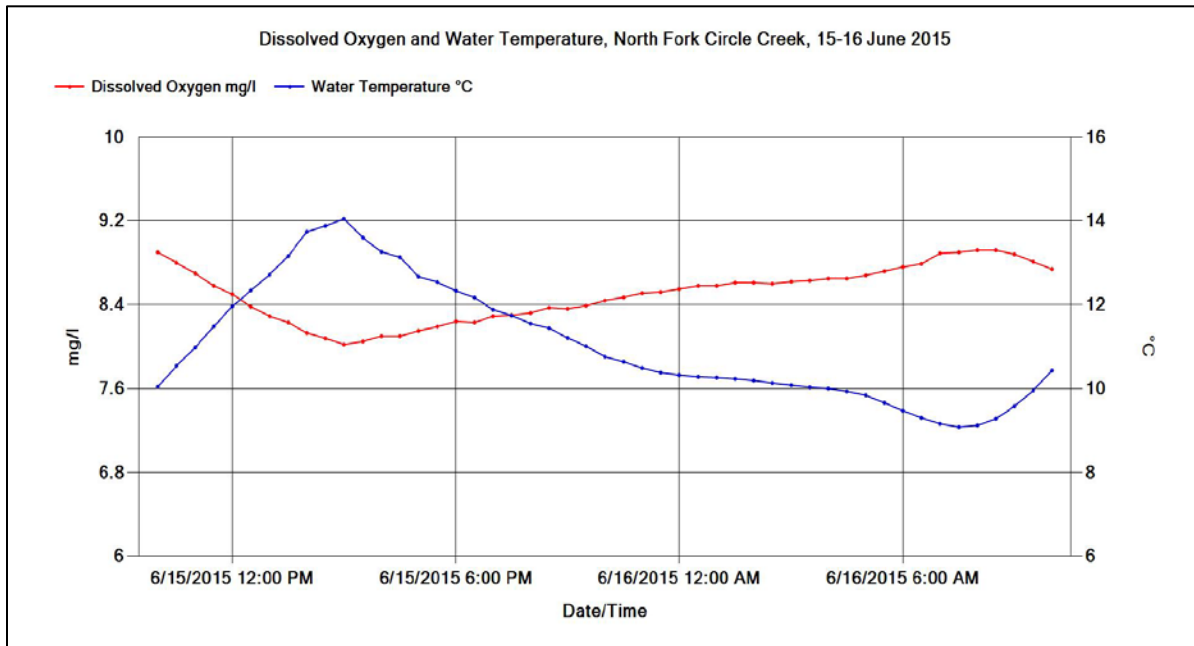


Figure 13. Dissolved oxygen and water temperature in North Fork Circle Creek, 15-16 June 2015.

pH:

The minimum and maximum pH (7.76 and 7.84 respectively) were never outside the acceptable regulatory thresholds of 6.5-9.0 pH units and the median (7.8 pH units) was well within this range. Figure 14 shows pH levels in North Fork Circle Creek on June 15th and 16th 2015. Data quality was rated as “excellent” due to the lack of sensor drift encountered during the deployment.

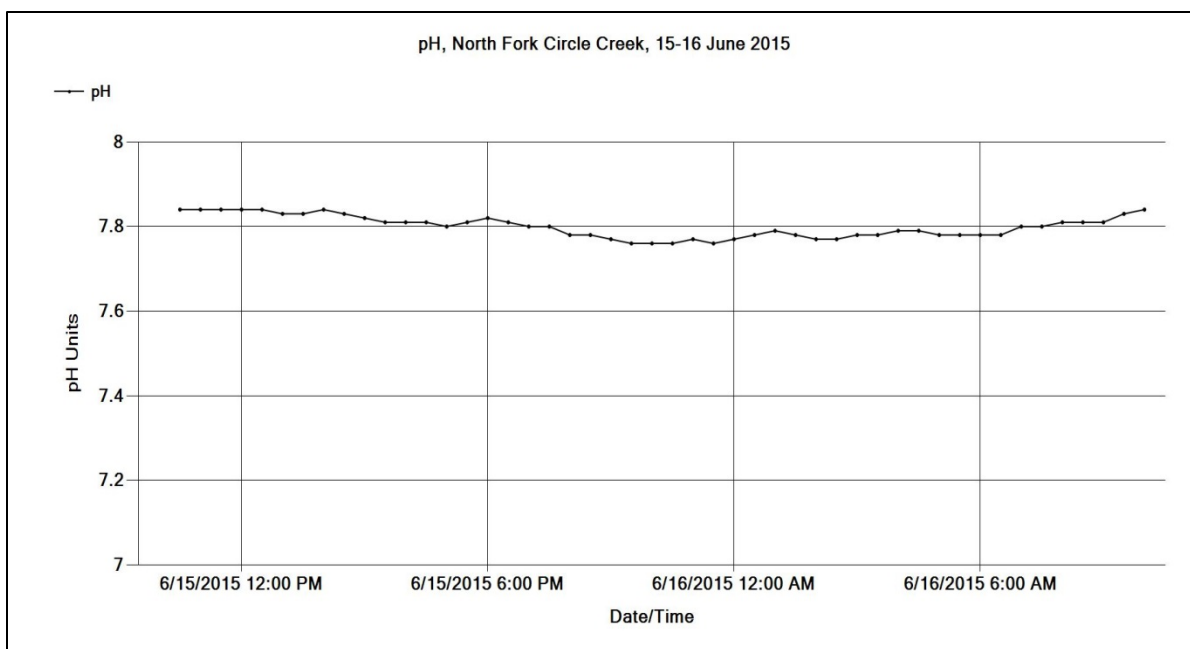


Figure 14. pH in North Fork Circle Creek, 15-16 June 2015.

Turbidity:

Prior to discussion about turbidity, it is important to note that the method detection limit (MDL) for this sensor was 0.44 NTU and the minimum level of quantitation (ML) was 1.39 NTU (Appendix D). As a result, turbidity data shown in Figure 15 reflects turbidity less than the method detection limit (0.44 NTU). Data quality was rated as “fair” due to the degree of sensor drift over the deployment period.

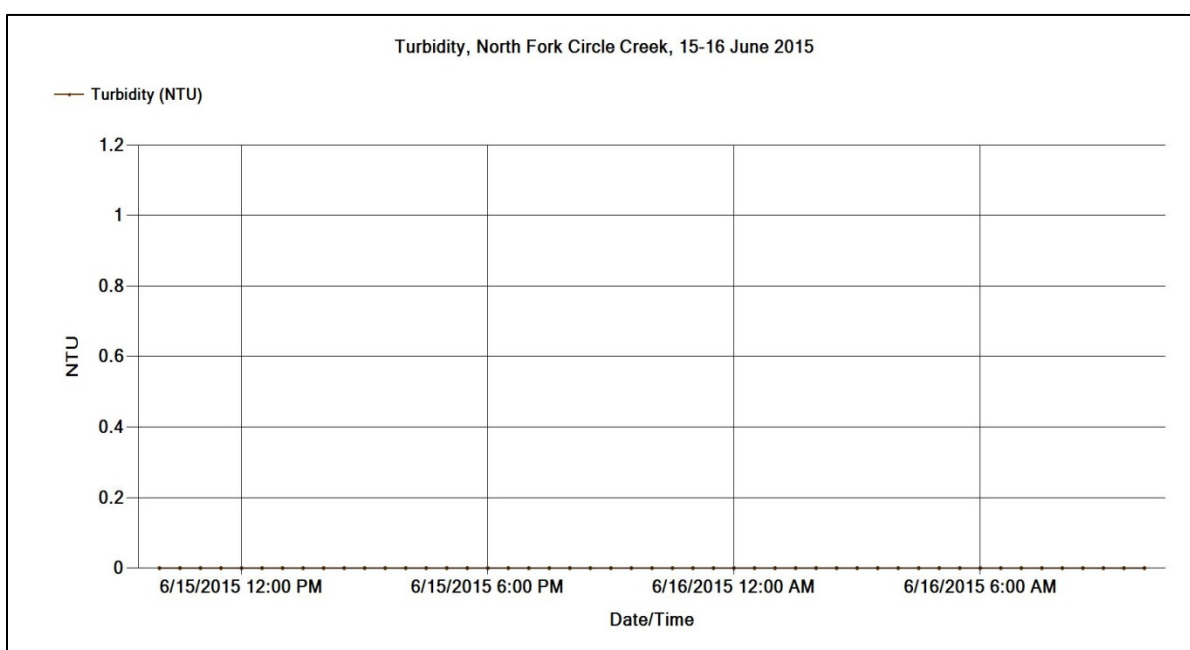


Figure 15. Turbidity in North Fork Circle Creek, 15-16 June 2015.

Data indicates that mean daily turbidity was <0.44 NTU. Regulatory thresholds for turbidity state that it should be “< 50 NTU over background (instantaneous) and < 25 NTU for 10 consecutive days.” As indicated in previous reports, (Starkey 2010, Starkey 2013) this stream appears to meet these criteria during normal stream flow conditions.

Macroinvertebrates

Status:

The Hilsenhoff Biotic Index (HBI), which summarizes pollution tolerances of the macroinvertebrate taxa within the sample, was 3.14 in station #3220 and 3.67 in station #3221. Values indicate that water quality is “excellent” with “organic pollution unlikely” (Hilsenhoff 1988). HBI values generally increase (HBI ranges from 0.0 to 10.0) as nutrient enrichment increases. While HBI is most sensitive to organic pollution, it may also respond to sediment loading, low dissolved oxygen and elevated water temperatures. Note that the 2012 HBI values were 2.85 and 3.90 and indicated that water quality was “very good” to “excellent” with “possible slight organic pollution” in one reach (#3221) and “organic pollution unlikely” in the other (#3220).

The US Forest Service (USFS) community tolerance quotient was 74 and 90. Community tolerance quotient values vary from 20 to just over 100, with lower values indicating better water quality. As with the HBI, the tolerance quotient indicated that station #3221 had lower water quality. In a single sample reach, the maximum number of Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa was 9; and there were a maximum of 3 long lived taxa. In one reach (#3220), the dominate family was Baetidae (small minnow mayflies) and in the other (#3221) Simuliidae (black flies).

The observed to expected ratio (OE) or River Invertebrate Prediction and Classification System (RIVPACS) scores were 0.65 and 0.47 and indicated “poor” habitat quality (<0.78). Note that a condition of poor indicates additional sampling should be conducted prior to designating the site “impaired.” Although observed to expected ratio results were lower than anticipated, the intermittent nature of this stream, may in part, be influencing the results of the predictive model. It is important to note that, as above, station #3221 rated as having poorer condition than #3220. See Table 5 and Appendix E and F for additional summary metrics and a taxa list.

These data suggest that the macroinvertebrate assemblage in North Fork Circle Creek may be suboptimal. Suboptimal does not necessarily imply “impaired” but rather indicates cause for some concern and continued monitoring. Low stream flow, fine sediments, bank stability, and other factors may be contributing to these results.

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Table 5. Vital sign summary table for benthic macroinvertebrates in North Fork Circle Creek, 2015.

Parameter	PIBO Abbreviation ^a	PIBO Station (Sample ID)	
		3220 (155513)	3221 (155514)
Richness*	RICH	21	16
Shannon's Diversity*	SHDIVER	2.12	1.84
Simpson's Diversity*	SIDIVER	0.84	0.79
Evenness*	Evenness	0.70	0.66
# of EPT Taxa*	EPTT	9	4
Dominant Family	DFAMILY	Baetidae	Simuliidae
Dominant Taxa	dtaxonomy	Baetis	Simulium
Hilsenhoff Biotic Index*	tv1	3.14	3.67
# of Intolerant Taxa*	HBIINT1	7	2
# of Tolerant Taxa*	HBITOL1	0	0
USFS Community Tolerance Quotient (d)*	ctqd	74	90
# of shredder taxa*	sht	2	1
# of scraper taxa*	sct	1	0
# of collector-filterer taxa*	cft	2	2
# of collector-gatherer taxa*	cgt	4	5
# of predator taxa*	prt	8	4
# of clinger taxa*	clinger	6	3
Long-lived Taxa*	LLTaxa	3	2
RIVPACS	--	0.65	0.47

^aThe abbreviations are those found in the PIBO MS-Access database.

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

Water Chemistry:

Status:

Condition of core water quality parameters (2015) along with the corresponding Idaho DEQ regulatory threshold are given in Table 6. For comparison, the condition of core water quality parameters as observed in 2012 are given in Table 7. Data indicate that conditions were well within acceptable ranges relative to criteria for cold water aquatic life. Individual parameters are discussed below.

Table 6. Vital sign summary table for water chemistry in South Fork Circle Creek June, 2015.

Measure	Current Condition (15-16 June, 2015)	State DEQ Thresholds ^c	% Exceedance ^d
Temperature (MDMT ^a , MDAT ^b)	MDMT ^a = 14.39	<22 °C	0%
	MDAT ^b = 12.69 °C	MDAT ^b <19 °C	0%
Specific conductance (mean)	185.65 µS/cm	N/A	N/A
Dissolved oxygen (mean daily min)	7.92 mg/L	> 6.0 mg/L	0%
pH (mean daily max)	7.64 pH Units	9.0 pH Units, Max	0%
pH (mean daily min)	7.56 pH Units	6.5 pH Units, Min	0%
Turbidity (mean daily max)	<0.17 NTU	< 50 NTU over background (instantaneous) < 25 for 10 consecutive days	Insufficient data

^a MDMT – Maximum Daily Maximum Temperature

^b MDAT – Maximum Daily Average Temperature

^c Criteria for cold water life designation

^d Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). 0% - 5% exceedance indicates good water quality (also highlighted in green), 5% through 25% exceedance indicates fair water quality (also highlighted in yellow), and exceedance greater than 25% indicates poor water quality (also highlighted in red).

Table 7. Vital sign summary table for water chemistry in South Fork Circle Creek June, 2012.

Measure	Current Condition (15-16 June, 2015)	State DEQ Thresholds ^c	% Exceedance ^d
Temperature (MDMT ^a , MDAT ^b)	MDMT ^a = 16.66	<22 °C	0%
	MDAT ^b = 13.93 °C	MDAT ^b <19 °C	0%
Specific conductance (mean)	175.78 µS/cm	N/A	N/A
Dissolved oxygen (mean daily min)	7.89 mg/L	> 6.0 mg/L	0%
pH (mean daily max)	8.1 pH Units	9.0 pH Units, Max	0%
pH (mean daily min)	7.87 pH Units	6.5 pH Units, Min	0%
Turbidity (mean daily max)	11.55 NTU	< 50 NTU over background (instantaneous) < 25 for 10 consecutive days	Insufficient data

^a MDMT – Maximum Daily Maximum Temperature

^b MDAT – Maximum Daily Average Temperature

^c Criteria for cold water life designation

^d Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). 0% - 5% exceedance indicates good water quality (also highlighted in green), 5% through 25% exceedance indicates fair water quality (also highlighted in yellow), and exceedance greater than 25% indicates poor water quality (also highlighted in red).

Temperature:

June 15-16th 2015, the maximum daily maximum temperature (MDMT) was 14.39 °C and the maximum daily average temperature (MDAT) was 12.69 °C (Figure 16). Neither the MDMT nor MDAT exceeded the cold water aquatic life criteria of 22.0 °C and 19.0 °C respectively. Data quality was rated as “excellent” due to minimal sensor drift.

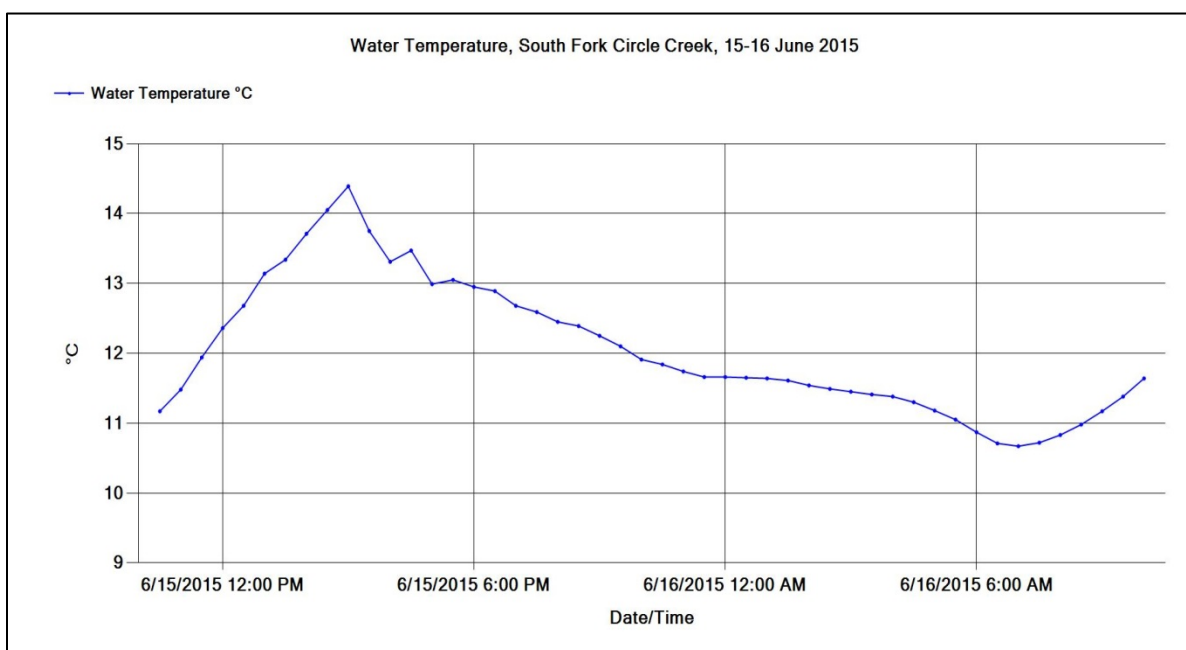


Figure 16. Water temperature in South Fork Circle Creek, 15-16 June 2015.

No additional temperature monitoring occurred at this site.

Specific Conductance:

Specific conductance ranged from 185.0 to 187.0 $\mu\text{S}/\text{cm}$, with an average specific conductance of 185.54 $\mu\text{S}/\text{cm}$ (Figure 17). Note that there is no state threshold for specific conductance as it varies widely depending on the geology of the drainage basin and stream discharge. Data quality was rated as “excellent” due to the lack of sensor drift encountered during the deployment.

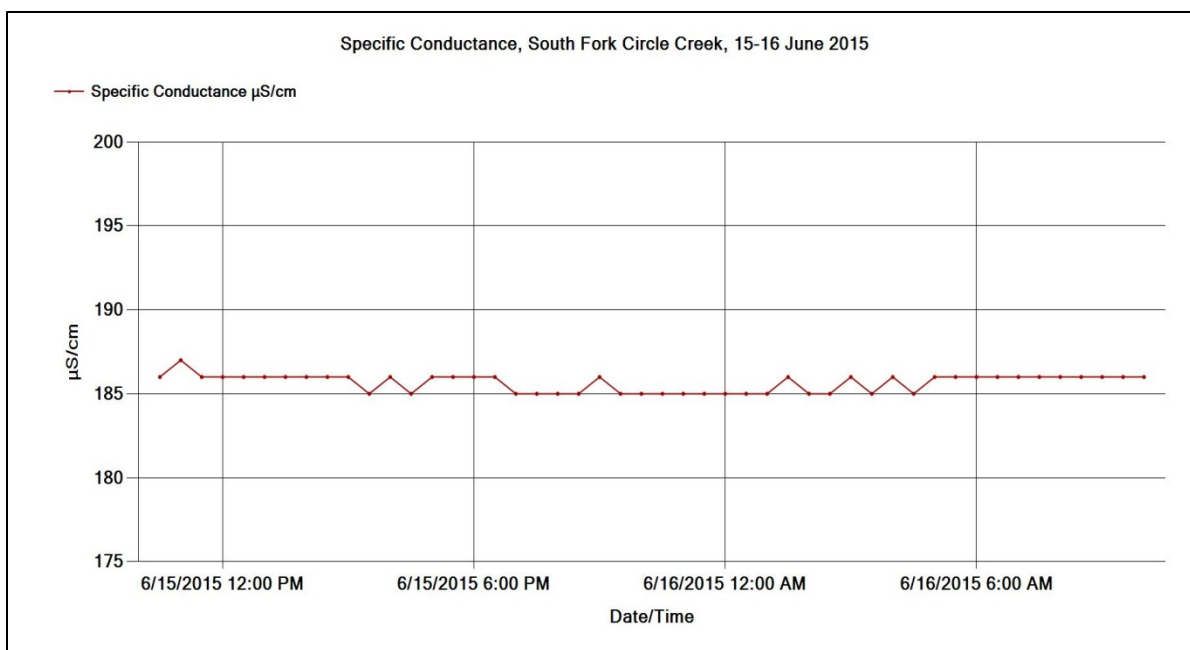


Figure 17. Specific conductance in South Fork Circle Creek, 15-16 June 2015.

Dissolved Oxygen:

Mean daily minimum dissolved oxygen was 7.92 mg/L and was never below the cold water aquatic life criteria of 6.0 mg/L. Minimum dissolved oxygen levels corresponded to maximum water temperatures. Figure 18 shows dissolved oxygen and temperature in South Fork Circle Creek from June 15th and 16th 2015. Data quality was rated as “excellent” due to the lack of sensor drift encountered during the deployment.

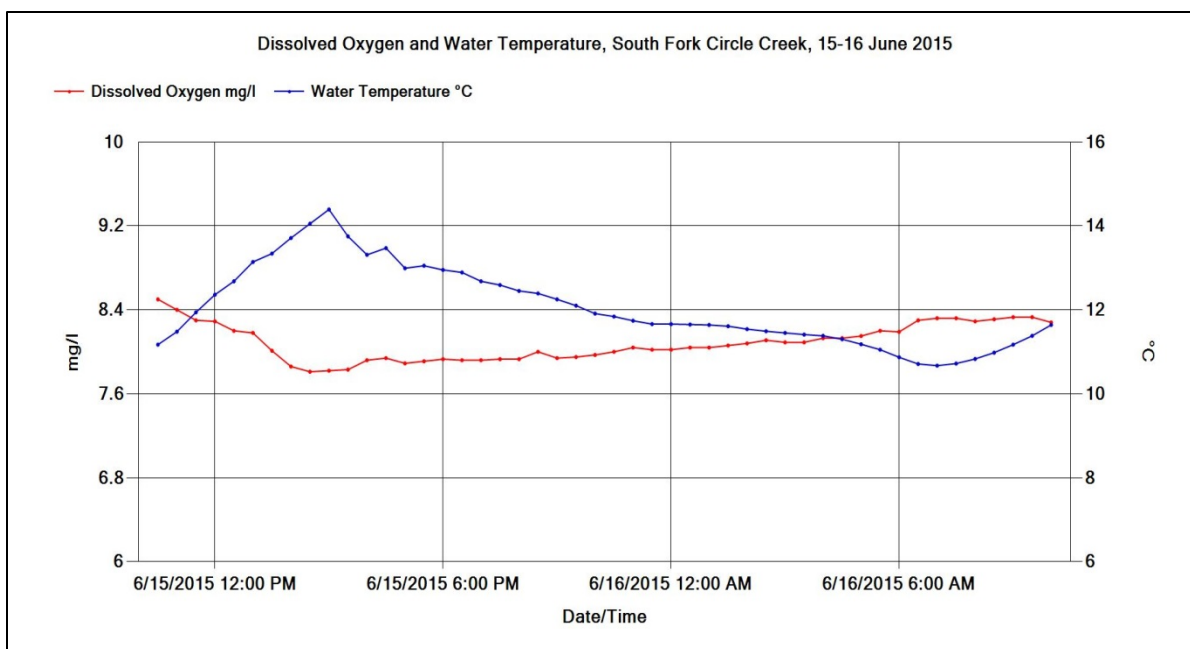


Figure 18. Dissolved oxygen and water temperature in South Fork Circle Creek, 15-16 June 2015.

pH:

The minimum and maximum pH (7.55 and 7.66 respectively) were never outside the acceptable regulatory thresholds of 6.5-9.0 pH units and the median (7.58 pH units) was well within this range. Figure 19 shows pH levels in South Fork Circle Creek on June 15th and 16th 2015. Data quality was rated as “excellent” due to the lack of sensor drift encountered during the deployment.

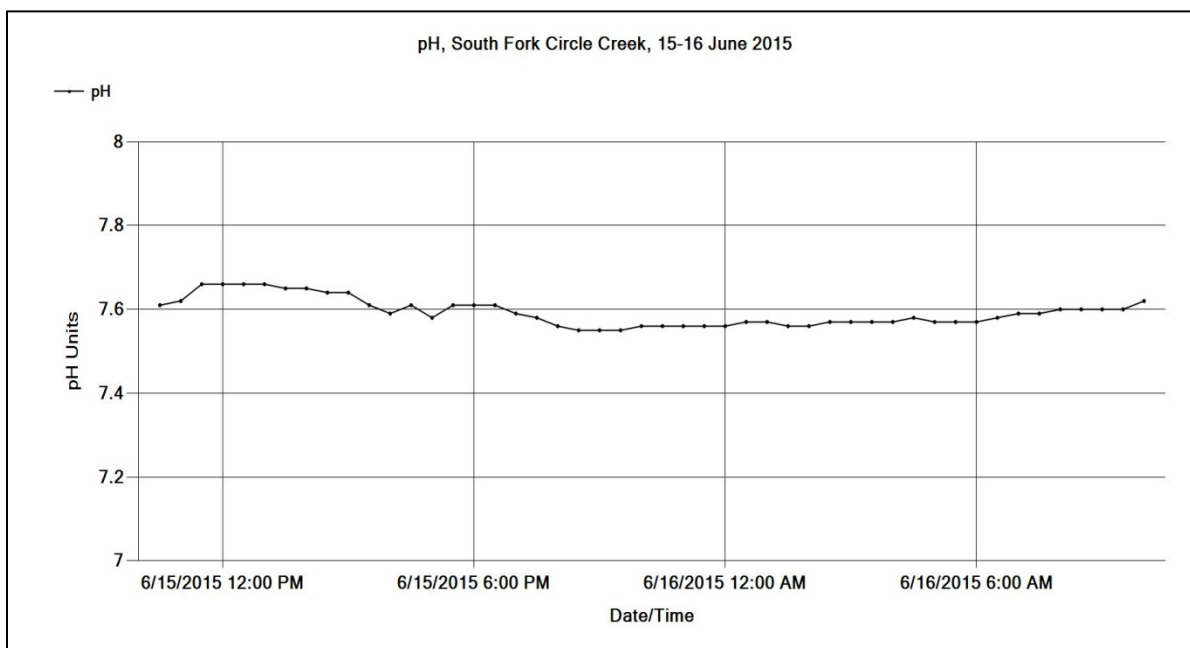


Figure 19. pH in South Fork Circle Creek, 15-16 June 2015.

Turbidity:

Prior to discussion about turbidity, it is important to note that the method detection limit (MDL) for this sensor was 0.17 NTU and the minimum level of quantitation (ML) was 0.53 NTU (Appendix D). As a result, turbidity data shown in Figure 20 reflects turbidity less than the method detection limit (0.17 NTU). Data quality was rated as “Excellent” due to lack of sensor drift over the deployment period.

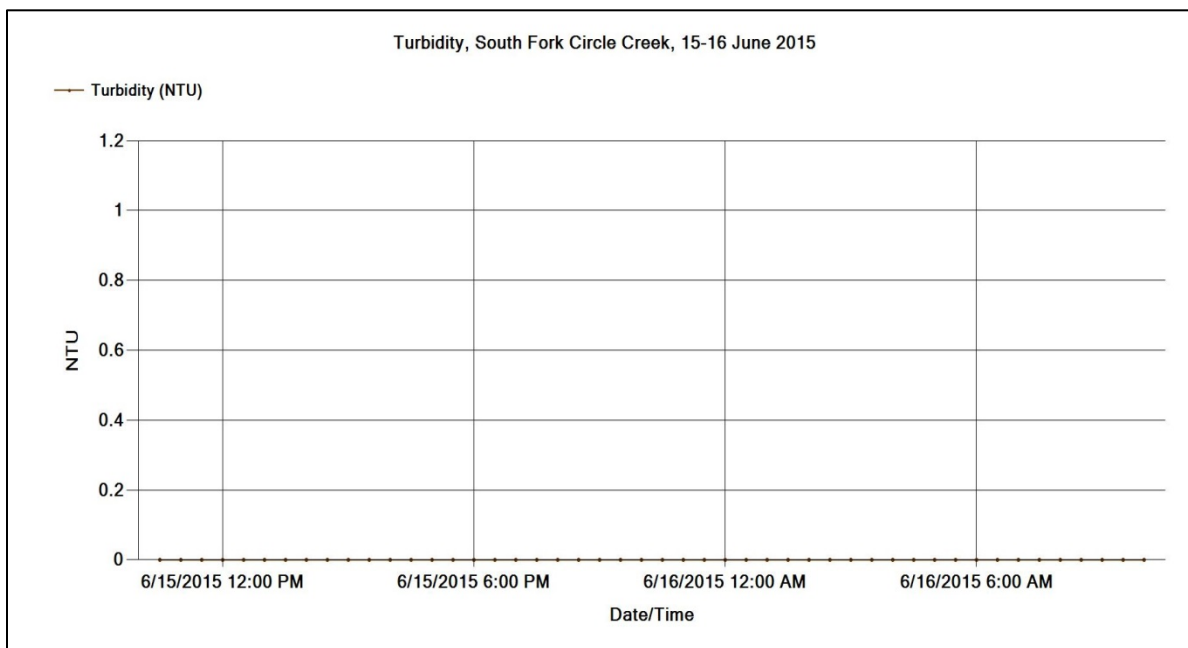


Figure 20. Turbidity in South Fork Circle Creek, 15-16 June 2015.

Data indicates that mean daily turbidity was <0.17 NTU. Regulatory thresholds for turbidity state that it should be “< 50 NTU over background (instantaneous) and < 25 NTU for 10 consecutive days.” As indicated in previous reports, (Starkey 2010, Starkey 2013) this stream appears to meet these criteria during normal stream flow conditions.

Macroinvertebrates

Status:

The Hilsenhoff Biotic Index (HBI), which summarizes pollution tolerances of the macroinvertebrate taxa within the sample, was 3.85 and 3.61. Values indicate that water quality is “very good” to “excellent” with “possible slight organic pollution” in one station (#3222) and “organic pollution unlikely” in the other (#3223) (Hilsenhoff 1988). HBI values generally increase (HBI ranges from 0.0 to 10.0) as nutrient enrichment increases. While HBI is most sensitive to organic pollution, it may also respond to sediment loading, low dissolved oxygen and elevated water temperatures.

The US Forest Service (USFS) community tolerance quotient was 60 and 64. Community tolerance quotient values vary from 20 to just over 100, with lower values indicating better water quality. In a single sample station, the maximum number of Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa

was 8; and there were a maximum of 2 long lived taxa. In both stations (#3222 and #3223), the dominate family was Chironomidae (non-biting midges).

The observed to expected ratio (OE) or River Invertebrate Prediction and Classification System (RIVPACS) scores were 0.59 and 0.64 and indicated “poor” habitat quality(<0.78). Note that a condition of poor indicates additional sampling should be conducted prior to designating the site “impaired.” Although observed to expected ratio results were lower than anticipated, the intermittent nature of this stream, may in part, be influencing the results of the predictive model. See Table 8 and Appendix E and F for additional summary metrics and a taxa list.

Table 8. Vital sign summary table for benthic macroinvertebrates in South Fork Circle Creek, 2015.

Parameter	PIBO Abbreviation ^a	PIBO Station (Sample ID)	
		3222 (155515)	3223 (155516)
Richness*	RICH	15	16
Shannon's Diversity*	SHDIVER	1.91	1.92
Simpson's Diversity*	SIDIVER	0.79	0.79
Evenness*	Evenness	0.71	0.69
# of EPT Taxa*	EPTT	8	7
Dominant Family	DFAMILY	Chironomidae	Chironomidae
Dominant Taxa	dtaxonomy	Orthocladiinae	Orthocladiinae
Hilsenhoff Biotic Index*	tv1	3.86	3.61
# of Intolerant Taxa*	HBIINT1	5	4
# of Tolerant Taxa*	HBITOL1	0	0
USFS Community Tolerance Quotient (d)*	ctqd	60	64
# of shredder taxa*	sht	2	2
# of scraper taxa*	sct	1	2
# of collector-filterer taxa*	cft	0	2
# of collector-gatherer taxa*	cgt	4	4
# of predator taxa*	prt	6	4
# of clinger taxa*	clinger	3	7
Long-lived Taxa*	LLTaxa	0	2
RIVPACS	--	0.59	0.64

^a The abbreviations are those found in the PIBO MS-Access database

These data suggest that the macroinvertebrate assemblage in South Fork Circle Creek may be suboptimal. Suboptimal does not necessarily imply “impaired” but rather indicates cause for some concern and continued monitoring. Low stream flow, fine sediments, bank stability, and other factors may be contributing to these results.

City of Rocks National Reserve (CIRO): Circle Creek

Water Chemistry:

Status:

Condition of core water quality parameters (2015) along with the corresponding Idaho DEQ regulatory threshold are given in Table 9. For comparison, the condition of core water quality parameters as observed in 2012 are given in Table 10. Data indicate that conditions were well within acceptable ranges relative to criteria for cold water aquatic life. Individual parameters are discussed below.

Table 9. Vital sign summary table for water chemistry in Circle Creek June, 2015.

Measure	Current Condition (15-16 June, 2015)	State DEQ Thresholds ^c	% Exceedance ^d
Temperature (MDMT ^a , MDAT ^b)	MDMT ^a = 20.55 °C	<22 °C	0%
	MDAT ^b = 16.81 °C	MDAT ^b <19 °C	0%
Specific conductance (mean)	458.51 µS/cm	N/A	N/A
Dissolved oxygen (mean daily min)	7.27 mg/L	> 6.0 mg/L	0%
pH (mean daily max)	8.25 pH Units	9.0 pH Units, Max	0%
pH (mean daily min)	8.19 pH Units	6.5 pH Units, Min	0%
Turbidity (mean daily max)	<0.17 NTU	< 50 NTU over background (instantaneous) < 25 for 10 consecutive days	Insufficient data

^a MDMT – Maximum Daily Maximum Temperature

^b MDAT – Maximum Daily Average Temperature

^c Criteria for cold water life designation

^d Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). 0% - 5% exceedance indicates good water quality (also highlighted in green), 5% through 25% exceedance indicates fair water quality (also highlighted in yellow), and exceedance greater than 25% indicates poor water quality (also highlighted in red).

Table 10. Vital sign summary table for water chemistry in Circle Creek June, 2012.

Measure	Current Condition (15-16 June, 2015)	State DEQ Thresholds ^c	% Exceedance ^d
Temperature (MDMT ^a , MDAT ^b)	MDMT ^a = 20.34 °C	<22 °C	0%
	MDAT ^b = 16.14 °C	MDAT ^b <19 °C	0%
Specific conductance (mean)	432.14 µS/cm	N/A	N/A
Dissolved oxygen (mean daily min)	7.52 mg/L	> 6.0 mg/L	0%
pH (mean daily max)	8.32 pH Units	9.0 pH Units, Max	0%
pH (mean daily min)	8.25 pH Units	6.5 pH Units, Min	0%
Turbidity (mean daily max)	<0.17 NTU	< 50 NTU over background (instantaneous) < 25 for 10 consecutive days	Insufficient data

^a MDMT – Maximum Daily Maximum Temperature

^b MDAT – Maximum Daily Average Temperature

^c Criteria for cold water life designation

^d Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). 0% - 5% exceedance indicates good water quality (also highlighted in green), 5% through 25% exceedance indicates fair water quality (also highlighted in yellow), and exceedance greater than 25% indicates poor water quality (also highlighted in red).

Temperature:

June 14-15th 2015, the maximum daily maximum temperature (MDMT) was 20.55 °C and the maximum daily average temperature (MDAT) was 16.81 °C (Figure 21). Neither the MDMT nor MDAT exceeded the cold water aquatic life criteria of 22.0 °C and 19.0 °C respectively. Data quality was rated as “excellent” due to minimal sensor drift.

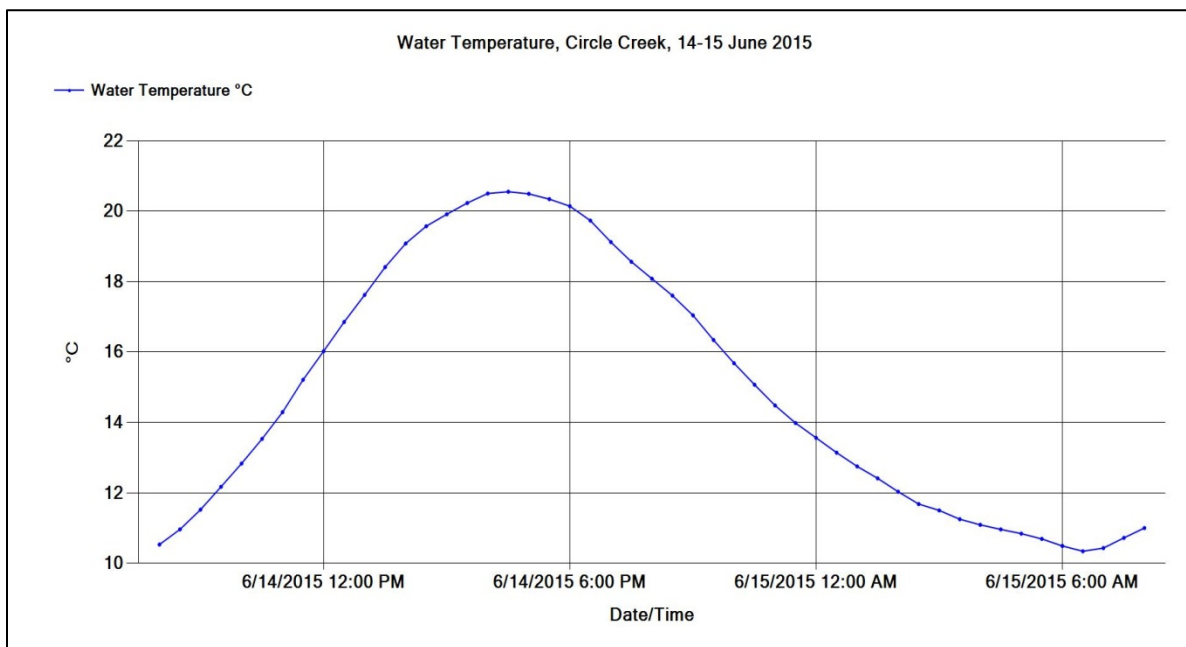


Figure 21. Water temperature in Circle Creek, 14-15 June 2015.

No additional temperature monitoring occurred at this site.

Specific Conductance:

Specific conductance ranged from 455.0 to 463.0 $\mu\text{S}/\text{cm}$, with an average specific conductance of 458.51 $\mu\text{S}/\text{cm}$ (Figure 22). Note that there is no state threshold for specific conductance as it varies widely depending on the geology of the drainage basin and stream discharge. Data quality was rated as “excellent” due to the lack of sensor drift encountered during the deployment.

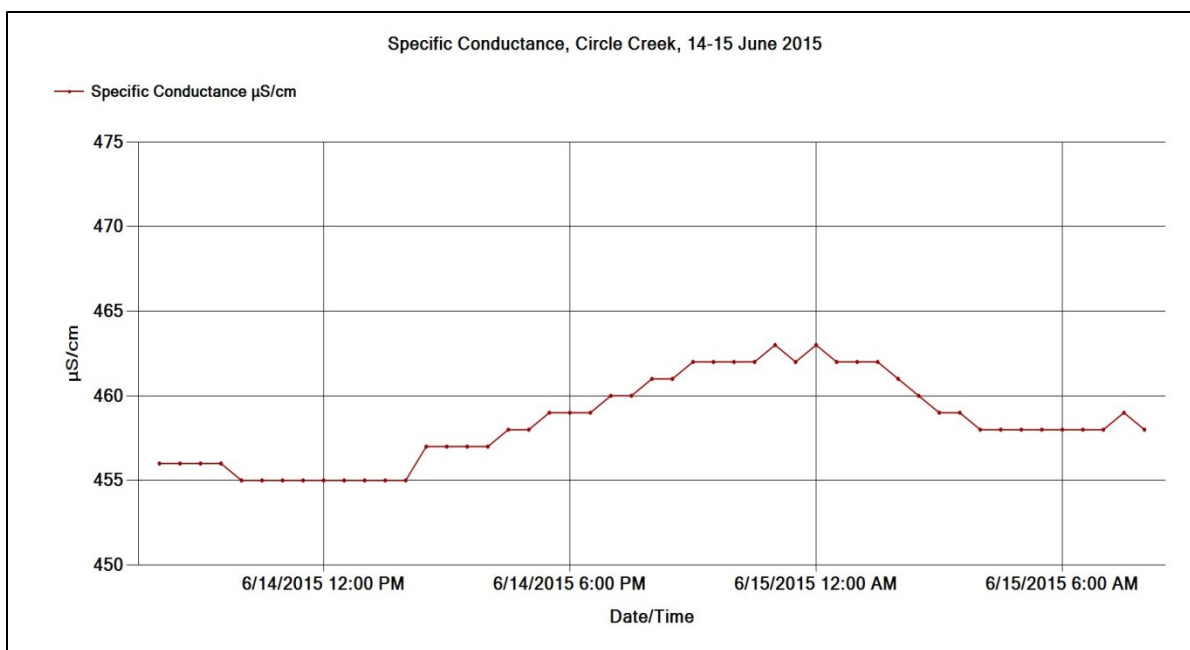


Figure 22. Specific conductance in Circle Creek, 14-15 June 2015.

Dissolved Oxygen:

Mean daily minimum dissolved oxygen was 7.27 mg/L and was never below the cold water aquatic life criteria of 6.0 mg/L. Minimum dissolved oxygen levels corresponded to maximum water temperatures. Figure 23 shows dissolved oxygen and temperature in Circle Creek from June 14th and 14th 2015. Data quality was rated as “excellent” due to the lack of sensor drift encountered during the deployment.

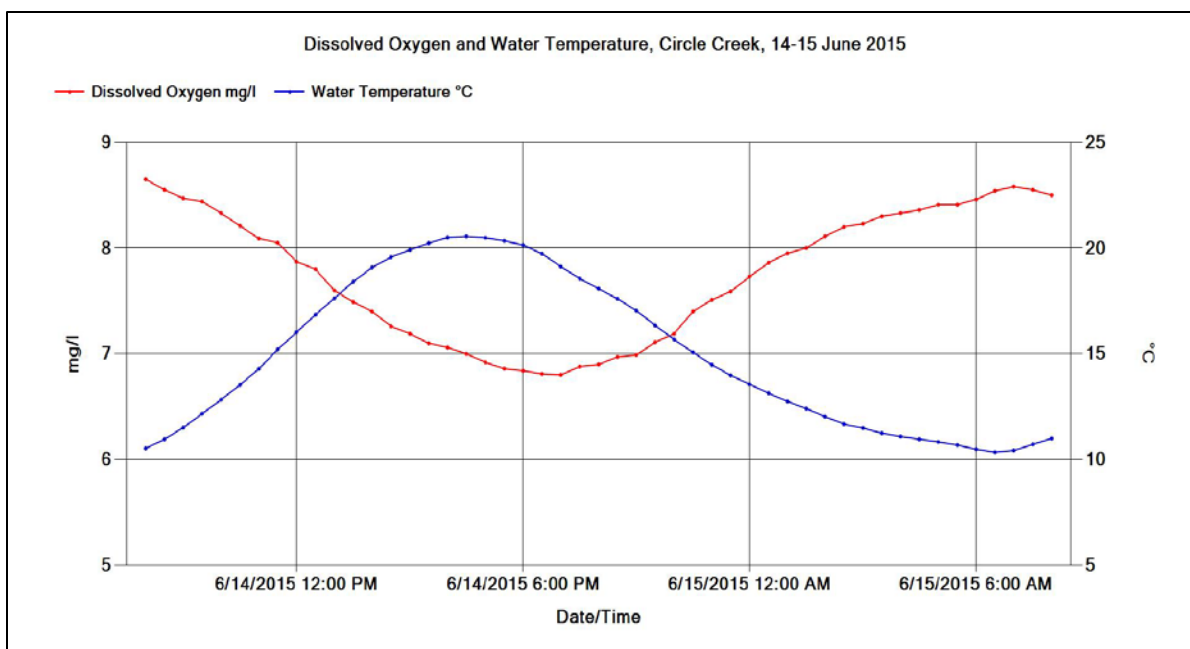


Figure 23. Dissolved oxygen and water temperature in Circle Creek, 14-15 June 2015.

pH:

The minimum and maximum pH (8.17 and 8.28 respectively) were never outside the acceptable regulatory thresholds of 6.5-9.0 pH units and the median (8.23 pH units) was within this range. Despite currently being within acceptable levels, pH should be monitored closely for exceedances of the upper threshold. Figure 24 shows pH levels in Circle Creek on June 14th and 15th 2015. Data quality was rated as “excellent” due to the lack of sensor drift encountered during the deployment.

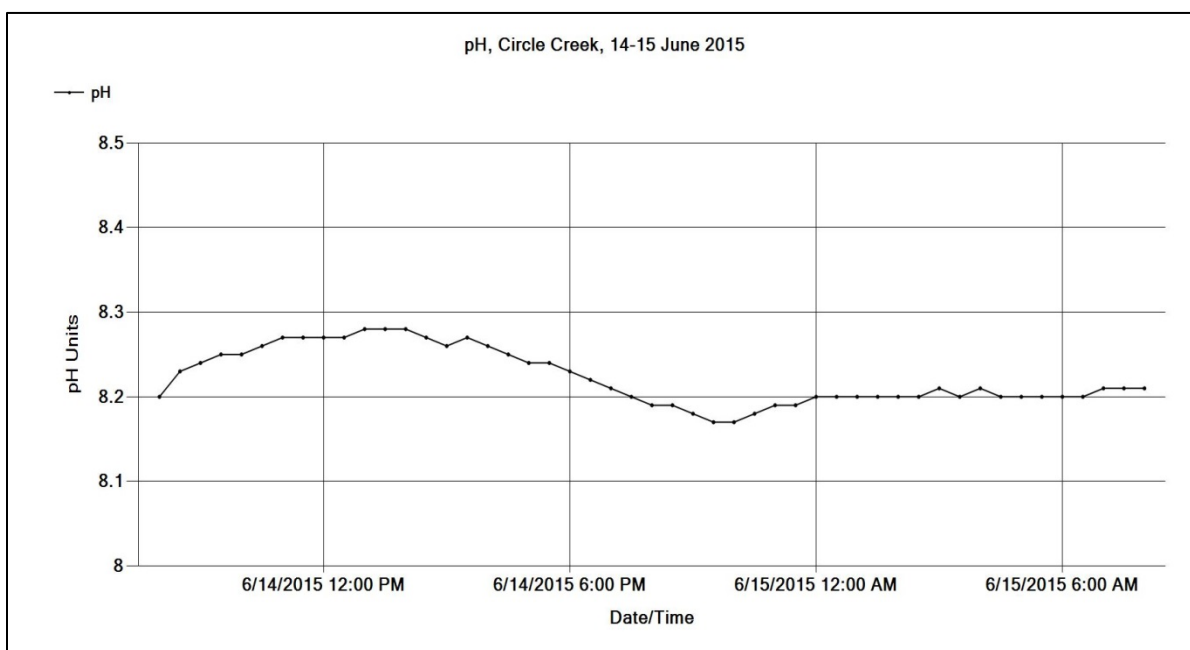


Figure 24. pH in Circle Creek, 14-15 June 2015.

Turbidity:

Prior to discussion about turbidity, it is important to note that the method detection limit (MDL) for this sensor was 0.17 NTU and the minimum level of quantitation (ML) was 0.53 NTU (Appendix D). As a result, turbidity data shown in Figure 25 reflects turbidity less than the method detection limit (0.17 NTU). Data quality was rated as “Excellent” due to lack of sensor drift over the deployment period.

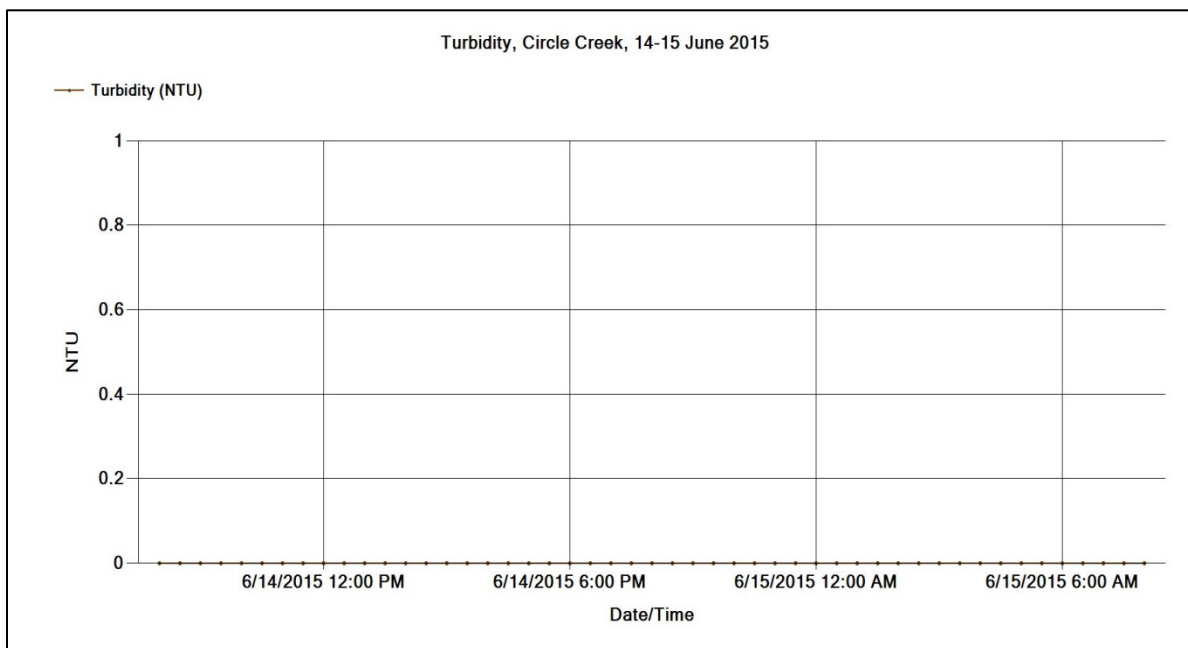


Figure 25. Turbidity in Circle Creek, 14-15 June 2015.

Data indicates that mean daily turbidity was <0.17 NTU. Regulatory thresholds for turbidity state that it should be “< 50 NTU over background (instantaneous) and < 25 NTU for 10 consecutive days.” As indicated in previous reports, (Starkey 2010, Starkey 2013) this stream appears to meet these criteria during normal stream flow conditions.

Macroinvertebrates

Status:

The Hilsenhoff Biotic Index (HBI), which summarizes pollution tolerances of the macroinvertebrate taxa within the sample, was 3.20 and 3.05. Values indicate that water quality is “excellent” with “organic pollution unlikely (Hilsenhoff 1988). HBI values generally increase (HBI ranges from 0.0 to 10.0) as nutrient enrichment increases. While HBI is most sensitive to organic pollution, it may also respond to sediment loading, low dissolved oxygen and elevated water temperatures.

The US Forest Service (USFS) community tolerance quotient was 75 and 77. Community tolerance quotient values vary from 20 to just over 100, with lower values indicating better water quality. In a single sample reach, the maximum number of Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa was 2; and there were a maximum of 1 long lived taxa. In one station (#3224), the dominate family

was Dytiscidae (predaceous diving beetles) and in the other (#3226) Baetidae (small minnow mayflies).

The observed to expected ratio (OE) or River Invertebrate Prediction and Classification System (RIVPACS) score for station #3226 was 0.08 and indicated “poor” habitat quality(<0.78). Note that a condition of poor indicates additional sampling should be conducted prior to designating the site “impaired.” Although observed to expected ratio results were lower than anticipated, the intermittent nature of this stream, may in part, be influencing the results of the predictive model. The observed to expected ratio (OE) was not calculated for station #3224 due to complications caused by low flow and beaver pools. See Table 11 and Appendix E and F for additional summary metrics and a taxa list.

Table 11. Vital sign summary table for benthic macroinvertebrates in Circle Creek, 2015.

Parameter	PIBO Abbreviation ^a	PIBO Station (Sample ID)	
		3224 (155517)	3226 (155518)
Richness*	RICH	3	5
Shannon's Diversity*	SHDIVER	1.05	1.41
Simpson's Diversity*	SIDIVER	0.80	0.74
Evenness*	Evenness	0.96	0.88
# of EPT Taxa*	EPTT	1	2
Dominant Family	DFAMILY	Dytiscidae	Baetidae
Dominant Taxa	dtaxonomy	Callibaetis	Callibaetis
Hilsenhoff Biotic Index*	tv1	3.20	3.05
# of Intolerant Taxa*	HBIINT1	0	0
# of Tolerant Taxa*	HBITOL1	1	0
USFS Community Tolerance Quotient (d)*	ctqd	75	77
# of shredder taxa*	sht	0	0
# of scraper taxa*	sct	0	0
# of collector-filterer taxa*	cft	0	0
# of collector-gatherer taxa*	cgt	2	3
# of predator taxa*	prt	1	1
# of clinger taxa*	clinger	0	0
Long-lived Taxa*	LLTaxa	1	1
RIVPACS			0.08

^a The abbreviations are those found in the PIBO MS-Access database

These data suggest that the macroinvertebrate assemblage in Circle Creek may be suboptimal. Suboptimal does not necessarily imply “impaired” but rather indicates cause for some concern and continued monitoring. Low stream flow, fine sediments, bank stability, and other factors may be contributing to these results.

Castle Rocks State Park (CRSP): Almo Creek

Water Chemistry:

Status:

Condition of core water quality parameters (2015) along with the corresponding Idaho DEQ regulatory threshold are given in Table 12. For comparison, the condition of core water quality parameters as observed in 2012 are given in Table 13. Data indicate that conditions were well within acceptable ranges relative to criteria for cold water aquatic life. Individual parameters are discussed below.

Table 12. Vital sign summary table for water chemistry in Almo Creek June, 2015.

Measure	Current Condition (15-16 June, 2015)	State DEQ Thresholds ^c	% Exceedance ^d
Temperature (MDMT ^a , MDAT ^b)	MDMT ^a = 15.96 °C	<22 °C	0%
	MDAT ^b = 13.31°C	MDAT ^b <19 °C	0%
Specific conductance (mean)	47.53 µS/cm	N/A	N/A
Dissolved oxygen (mean daily min)	8.41 mg/L	> 6.0 mg/L	0%
pH (mean daily max)	7.49 pH Units	9.0 pH Units, Max	0%
pH (mean daily min)	7.38 pH Units	6.5 pH Units, Min	0%
Turbidity (mean daily max)	14.05 NTU	< 50 NTU over background (instantaneous) < 25 for 10 consecutive days	Insufficient data

^a MDMT – Maximum Daily Maximum Temperature

^b MDAT – Maximum Daily Average Temperature

^c Criteria for cold water life designation

^d Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). 0% - 5% exceedance indicates good water quality (also highlighted in green), 5% through 25% exceedance indicates fair water quality (also highlighted in yellow), and exceedance greater than 25% indicates poor water quality (also highlighted in red).

Table 13. Vital sign summary table for water chemistry in Almo Creek June, 2012

Measure	Current Condition (15-16 June, 2015)	State DEQ Thresholds ^c	% Exceedance ^d
Temperature (MDMT ^a , MDAT ^b)	MDMT ^a = 18.94 °C	<22 °C	0%
	MDAT ^b = 14.64°C	MDAT ^b <19 °C	0%
Specific conductance (mean)	68.55 µS/cm	N/A	N/A
Dissolved oxygen (mean daily min)	7.88 mg/L	> 6.0 mg/L	0%
pH (mean daily max)	7.67 pH Units	9.0 pH Units, Max	0%
pH (mean daily min)	7.56 pH Units	6.5 pH Units, Min	0%
Turbidity (mean daily max)	-- ^e	< 50 NTU over background (instantaneous) < 25 for 10 consecutive days	Insufficient data

^a MDMT – Maximum Daily Maximum Temperature

^b MDAT – Maximum Daily Average Temperature

^c Criteria for cold water life designation

^d Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). 0% - 5% exceedance indicates good water quality (also highlighted in green), 5% through 25% exceedance indicates fair water quality (also highlighted in yellow), and exceedance greater than 25% indicates poor water quality (also highlighted in red).

^e Poor data quality precludes reporting

Temperature:

June 14-15th 2015, the maximum daily maximum temperature (MDMT) was 15.96 °C and the maximum daily average temperature (MDAT) was 13.31 °C (Figure 26). Neither the MDMT nor MDAT exceeded the cold water aquatic life criteria of 22.0 °C and 19.0 °C respectively. Data quality was rated as “excellent” due to minimal sensor drift.

In addition, continuous temperature loggers (HOBO Pro v2) have been deployed at this location since 2011 (June-October). Results for temperature monitoring are shown in Table 14; however, 2013, 2014, and 2015 data have been omitted due to data quality concerns (i.e. data logger out of water due to tampering). No exceedances of the cold water aquatic life designation were observed and data indicates that cool water temperatures persist throughout the summer.

Given the consistent issues with temperature loggers being tampered with, it is suggested that the logger be permanently affixed to a rock or the upstream side of the nearby headgate. Permanent placement would help prevent removal from the stream by passersby. The ideal location for placement should be determined during low water (July-August). A paired specific conductance logger could assist in determination of dewatering.

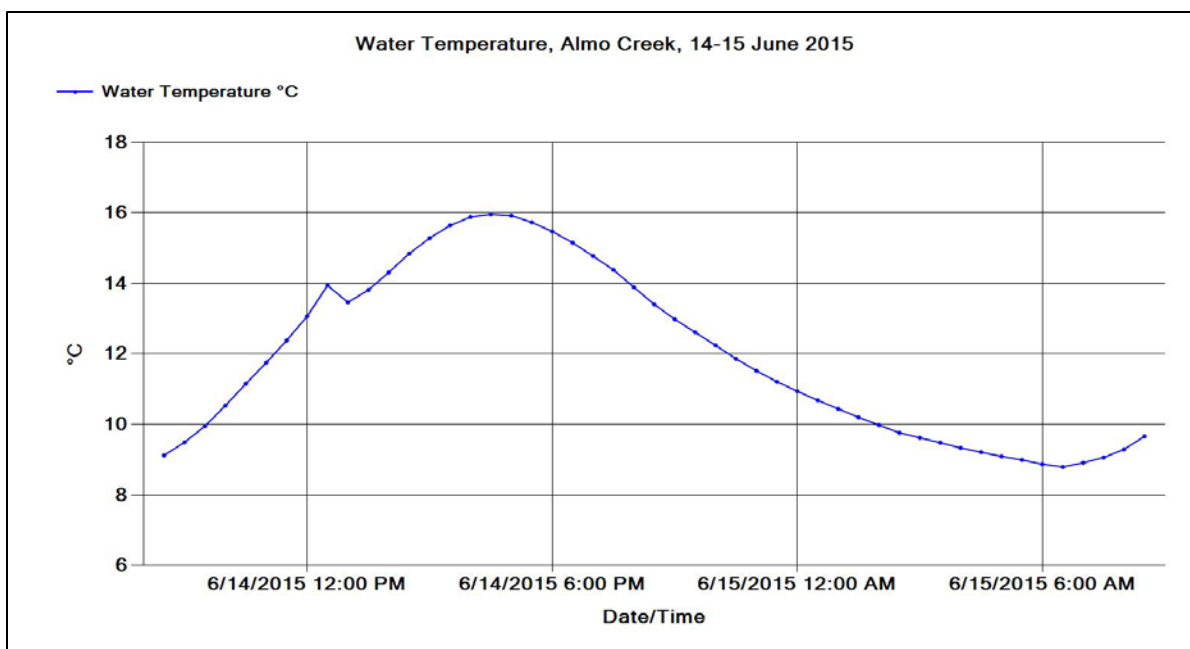


Figure 26. Water temperature in Almo Creek, 14-15 June 2015.

Table 14. Water temperature summary table for Almo Creek 2011-2015.

Monitoring Dates	State DEQ Threshold	% Exceedance	MDMT °C	MDAT °C
06/20/2012-10/24/2012 ^a	>22 °C	0	19.98	N/A
	MDAT >19 °C	0	N/A	16.34
06/01/2011-08/31/2011 ^a	>22 °C	0	20.82	N/A
	MDAT >19 °C	0	N/A	16.84

^a Collected with HOBO Pro v2.0 temperature logger, MDMT – Maximum Daily Maximum Temperature, MDAT – Maximum Daily Average Temperature

^b Proportion of samples above water quality standard (Note that the % exceedance indicated is based on 24 hours of data). Exceedance values 0% - 5% indicates good water quality (also highlighted in green), 5% - 25% indicates fair water quality (also highlighted in yellow), and > 25% indicates poor water quality (also highlighted in red).

Specific Conductance:

Specific conductance ranged from 35.0 to 85.0 $\mu\text{S}/\text{cm}$, with an average specific conductance of 47.53 $\mu\text{S}/\text{cm}$ (Figure 27). Data may have indicated a change to one of the upstream headgates at about noon on the 14th of June and about 06:00 on the 15th of June. Note that there is no state threshold for specific conductance as it varies widely depending on the geology of the drainage basin and stream discharge. Data quality was rated as “excellent” due to the lack of sensor drift encountered during the deployment.

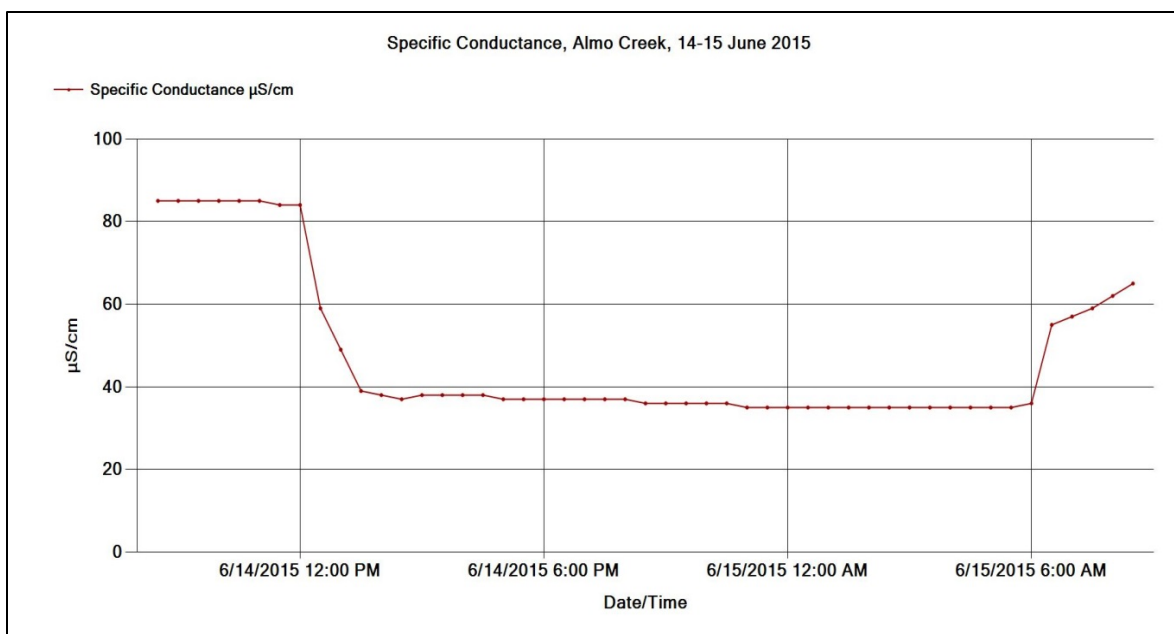


Figure 27. Specific conductance in Almo Creek, 14-15 June 2015.

Dissolved Oxygen:

Mean daily minimum dissolved oxygen was 8.41 mg/L and was never below the cold water aquatic life criteria of 6.0 mg/L. Minimum dissolved oxygen levels corresponded to maximum water temperatures. Figure 28 shows dissolved oxygen and temperature in Almo Creek from June 14th and 14th 2015. Data quality was rated as “excellent” due to the lack of sensor drift encountered during the deployment.

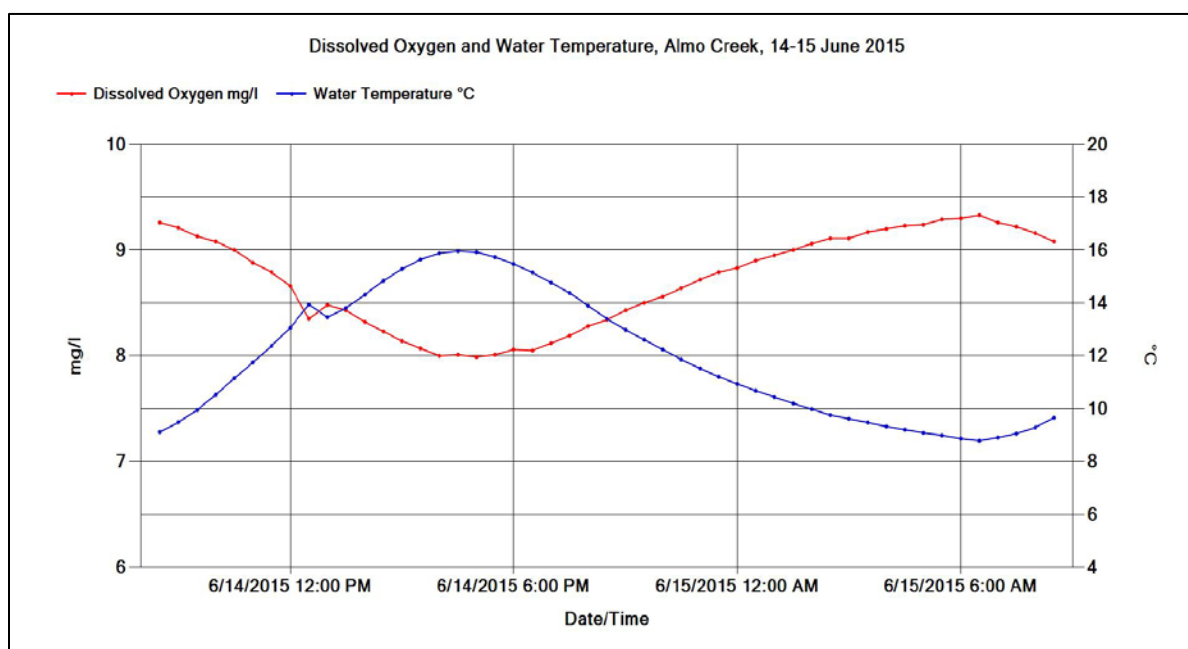


Figure 28. Dissolved oxygen and water temperature in Almo Creek, 14-15 June 2015.

pH:

The minimum and maximum pH (7.42 and 7.55 respectively) were never outside the acceptable regulatory thresholds of 6.5-9.0 pH units and the median (7.47 pH units) was within this range. Figure 29 shows pH levels in Almo Creek on June 14th and 15th 2015. Data quality was rated as “excellent” due to the lack of sensor drift encountered during the deployment.

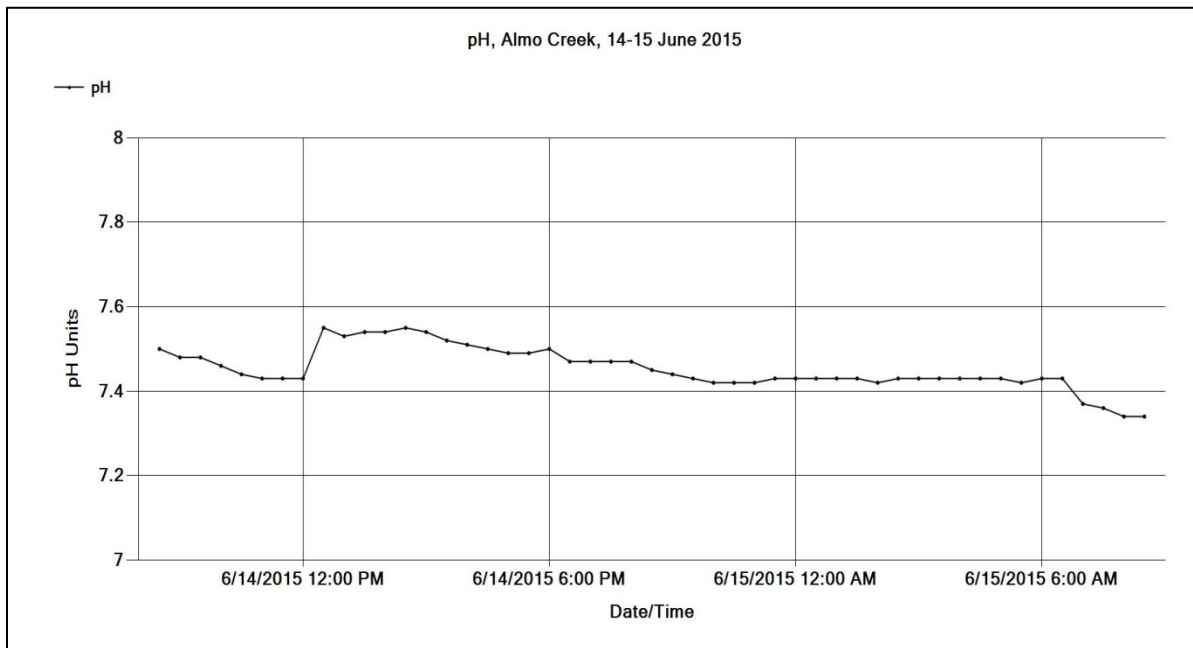


Figure 29. pH in Circle Creek, 14-15 June 2015.

Turbidity:

Prior to discussion about turbidity, it is important to note that the method detection limit (MDL) for this sensor was 0.44 NTU and the minimum level of quantitation (ML) was 1.39 NTU (Appendix D). Data quality was rated as “fair” due to sensor drift over the deployment period. Data indicates that mean daily maximum turbidity was 14.05 NTU (Figure 30). Regulatory thresholds for turbidity state that it should be “< 50 NTU over background (instantaneous) and < 25 NTU for 10 consecutive days.”

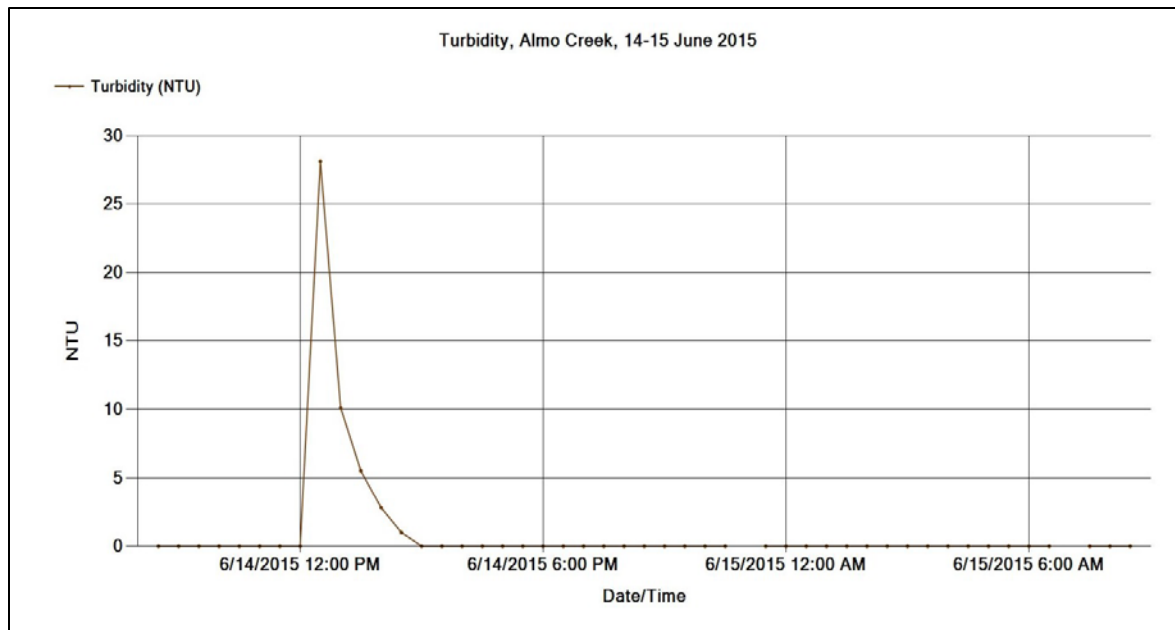


Figure 30. Turbidity in Almo Creek, 14-15 June 2015.

Macroinvertebrates

Status:

The Hilsenhoff Biotic Index (HBI), which summarizes pollution tolerances of the macroinvertebrate taxa within the sample, was 3.69 and 4.03. Values indicate that water quality is “very good” to “excellent” with “possible slight organic pollution” in one site (#3219) and “organic pollution unlikely” in the other (#3218) (Hilsenhoff 1988). HBI values generally increase (HBI ranges from 0.0 to 10.0) as nutrient enrichment increases. While HBI is most sensitive to organic pollution, it may also respond to sediment loading, low dissolved oxygen and elevated water temperatures.

The US Forest Service (USFS) community tolerance quotient was 59 and 61. Community tolerance quotient values vary from 20 to just over 100, with lower values indicating better water quality. As with the HBI, the tolerance quotient indicated that site #3219 had lower water quality. In a single sample reach, the maximum number of Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa was 12; and there were a maximum of 4 long lived taxa. In both sites, the dominate family was Baetidae (small minnow mayflies).

The observed to expected ratio (OE) or River Invertebrate Prediction and Classification System (RIVPACS) scores were 0.75 and 0.45 and indicated “poor” quality habitat (<0.78). Note that a condition of poor indicates additional sampling should be conducted prior to designating the site “impaired.” Although observed to expected ratio results were lower than anticipated, the intermittent nature of this stream, may in part, be influencing the results of the predictive model. It is important to note that, as above, reach #3219 rated as having poorer condition than site #3218. See Table 15 and Appendix E and F for additional summary metrics and a taxa list.

Table 15. Vital sign summary table for benthic macroinvertebrates in Almo Creek, 2015.

Parameter	PIBO Abbreviation ^a	PIBO Station (Sample ID)	
		3218 (155511)	3219 (155512)
Richness*	RICH	25	9
Shannon's Diversity*	SHDIVER	1.85	1.63
Simpson's Diversity*	SIDIVER	0.66	0.74
Evenness*	Evenness	0.57	0.74
# of EPT Taxa*	EPTT	12	6
Dominant Family	DFAMILY	Baetidae	Baetidae
Dominant Taxa	dtaxonomy	Baetis	Baetis
Hilsenhoff Biotic Index*	tv1	3.69	4.03
# of Intolerant Taxa*	HBIINT1	6	2
# of Tolerant Taxa*	HBITOL1	0	0
USFS Community Tolerance Quotient (d)*	ctqd	59	61
# of shredder taxa*	sht	2	0
# of scraper taxa*	sct	3	2
# of collector-filterer taxa*	cft	3	1
# of collector-gatherer taxa*	cgt	6	4
# of predator taxa*	prt	7	0
# of clinger taxa*	clinger	9	5
Long-lived Taxa*	LLTaxa	4	1
RIVPACS		0.75	0.45

^a The abbreviations are those found in the PIBO MS-Access database

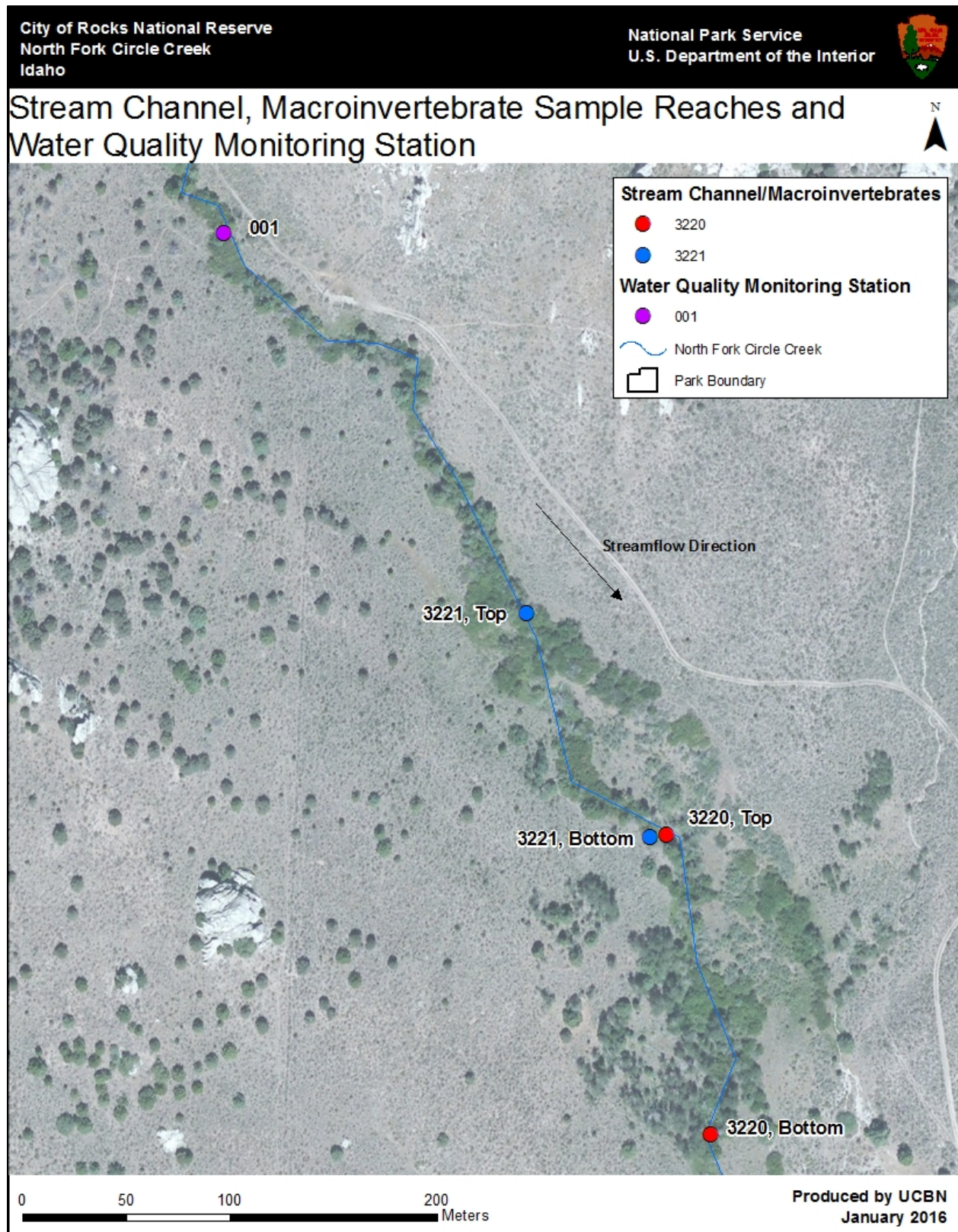
These data suggest that the macroinvertebrate assemblage in Almo Creek may be suboptimal. Suboptimal does not necessarily imply “impaired” but rather indicates cause for some concern and continued monitoring. Low stream flow, fine sediments, bank stability, and other factors may be contributing to these results.

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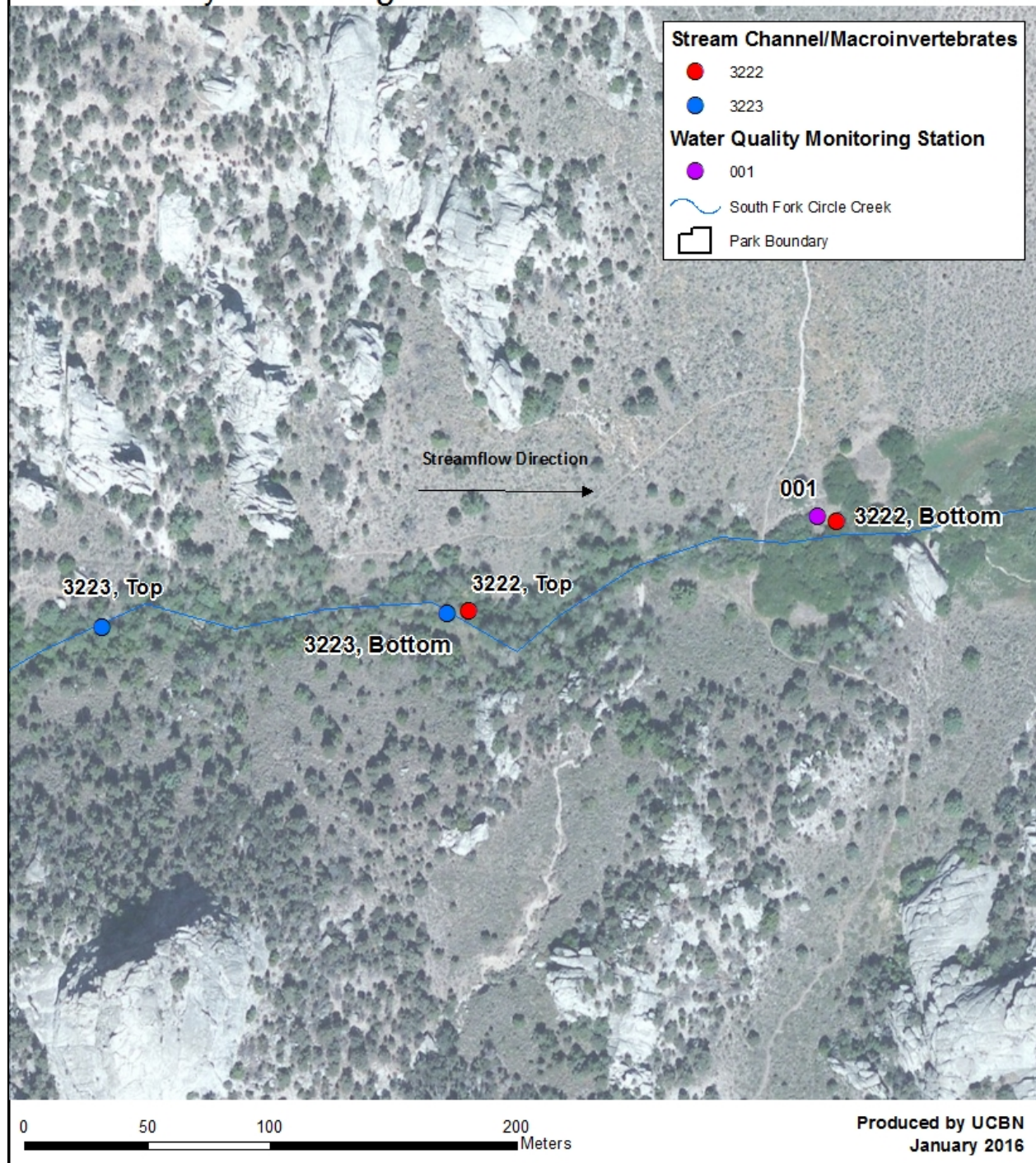
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Appendix A. 2015 Water Quality Monitoring Locations



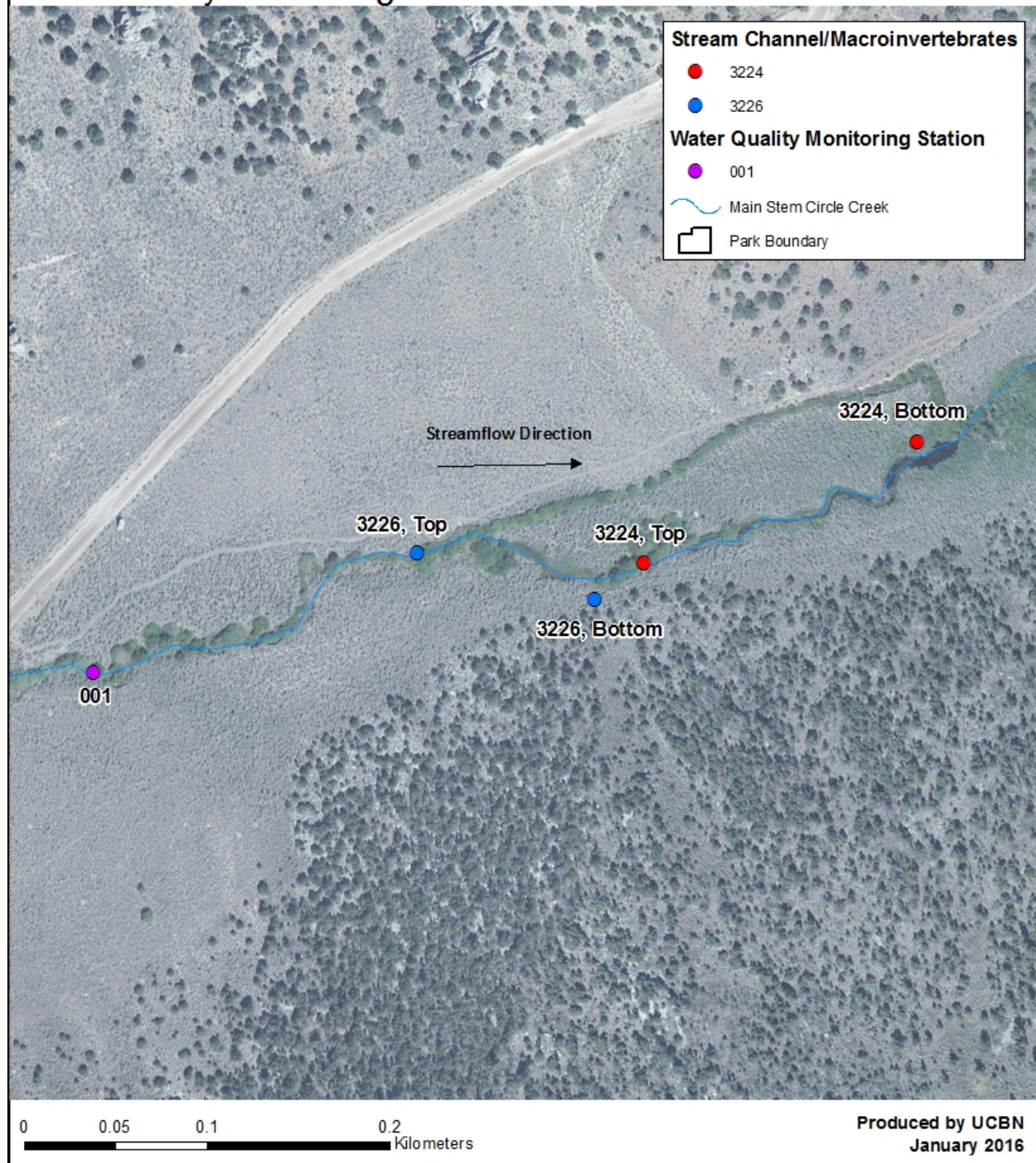


Stream Channel, Macroinvertebrate Sample Reaches and Water Quality Monitoring Station



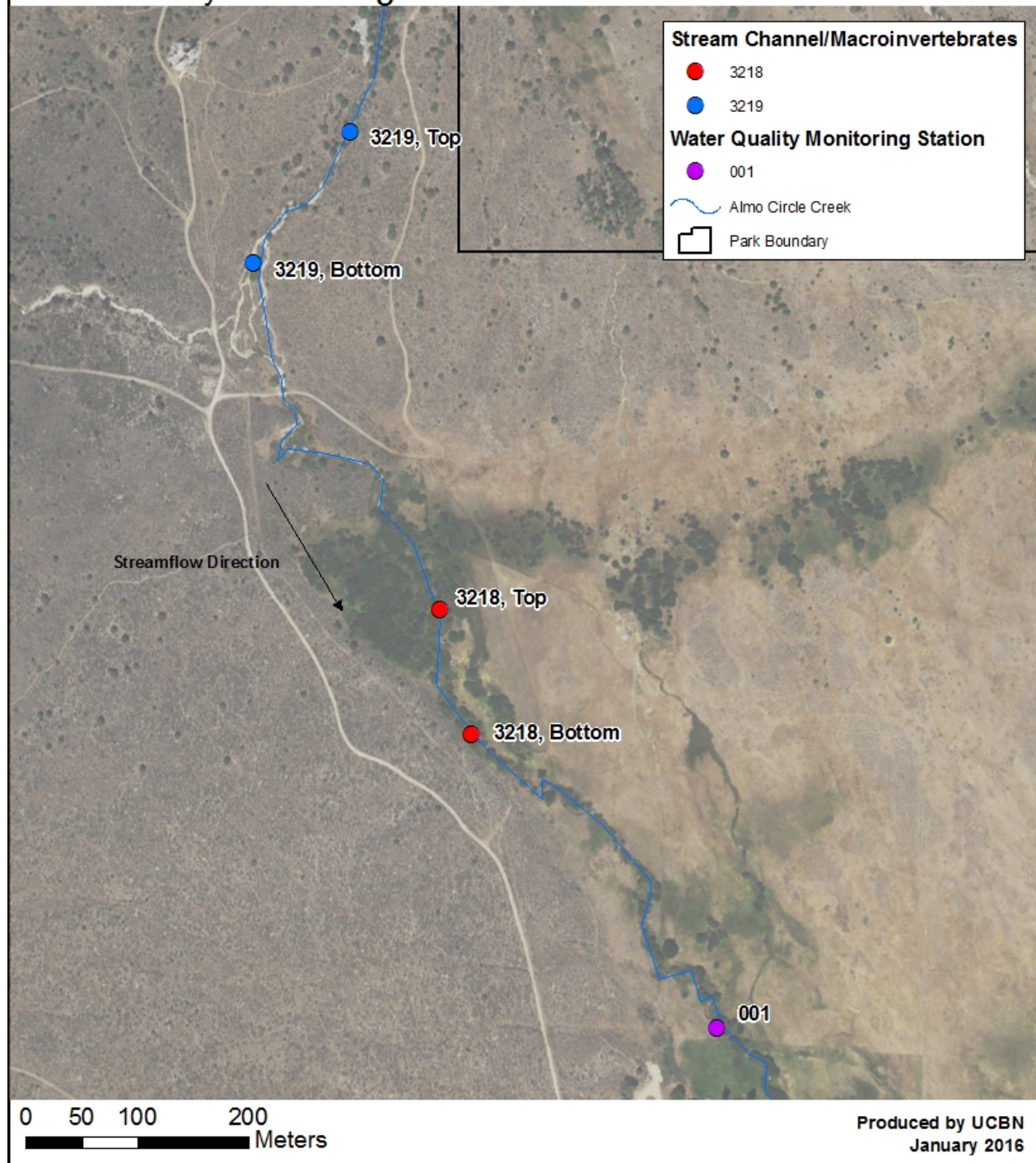


Stream Channel, Macroinvertebrate Sample Reaches and Water Quality Monitoring Station



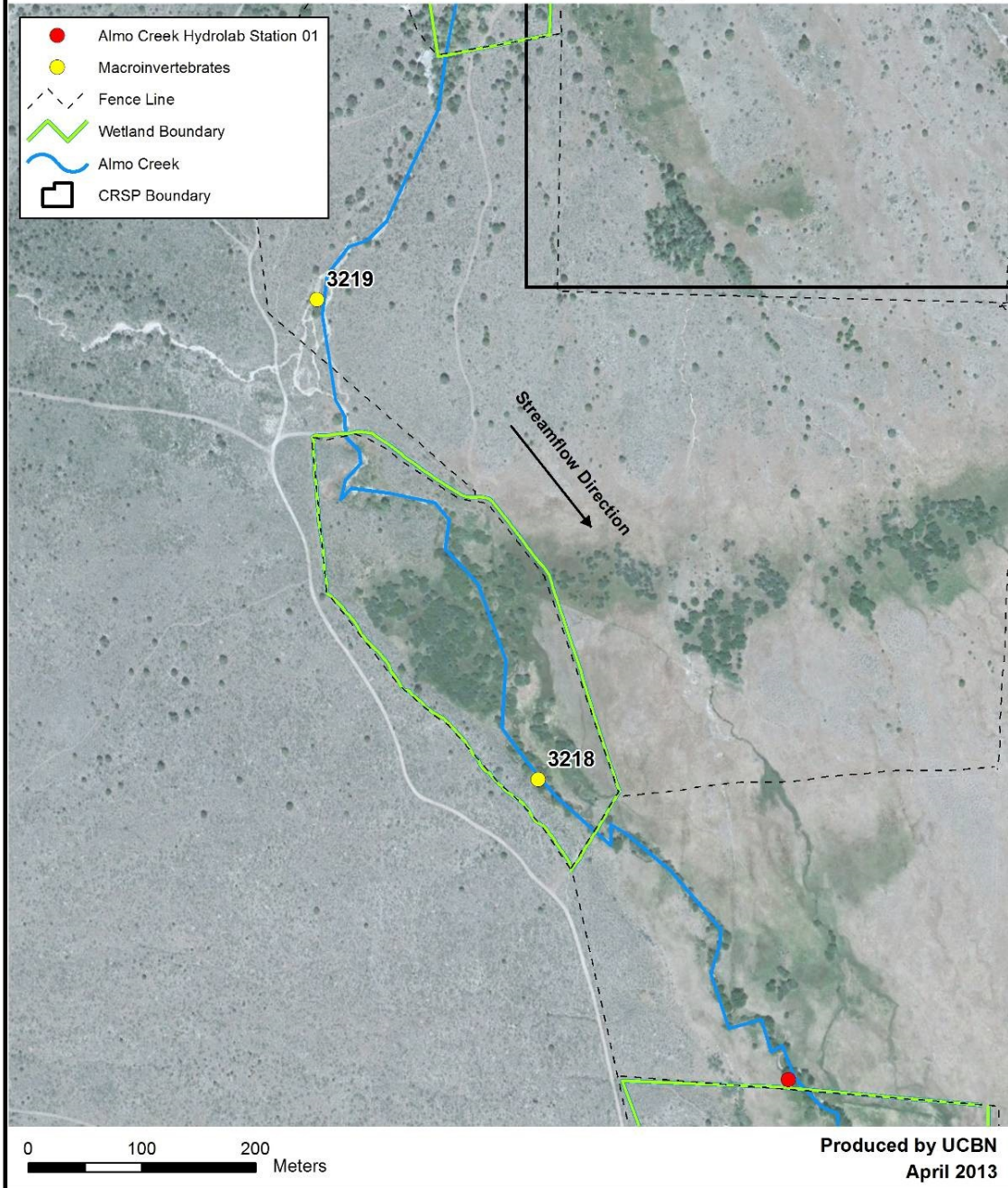


Stream Channel, Macroinvertebrate Sample Reaches and Water Quality Monitoring Station



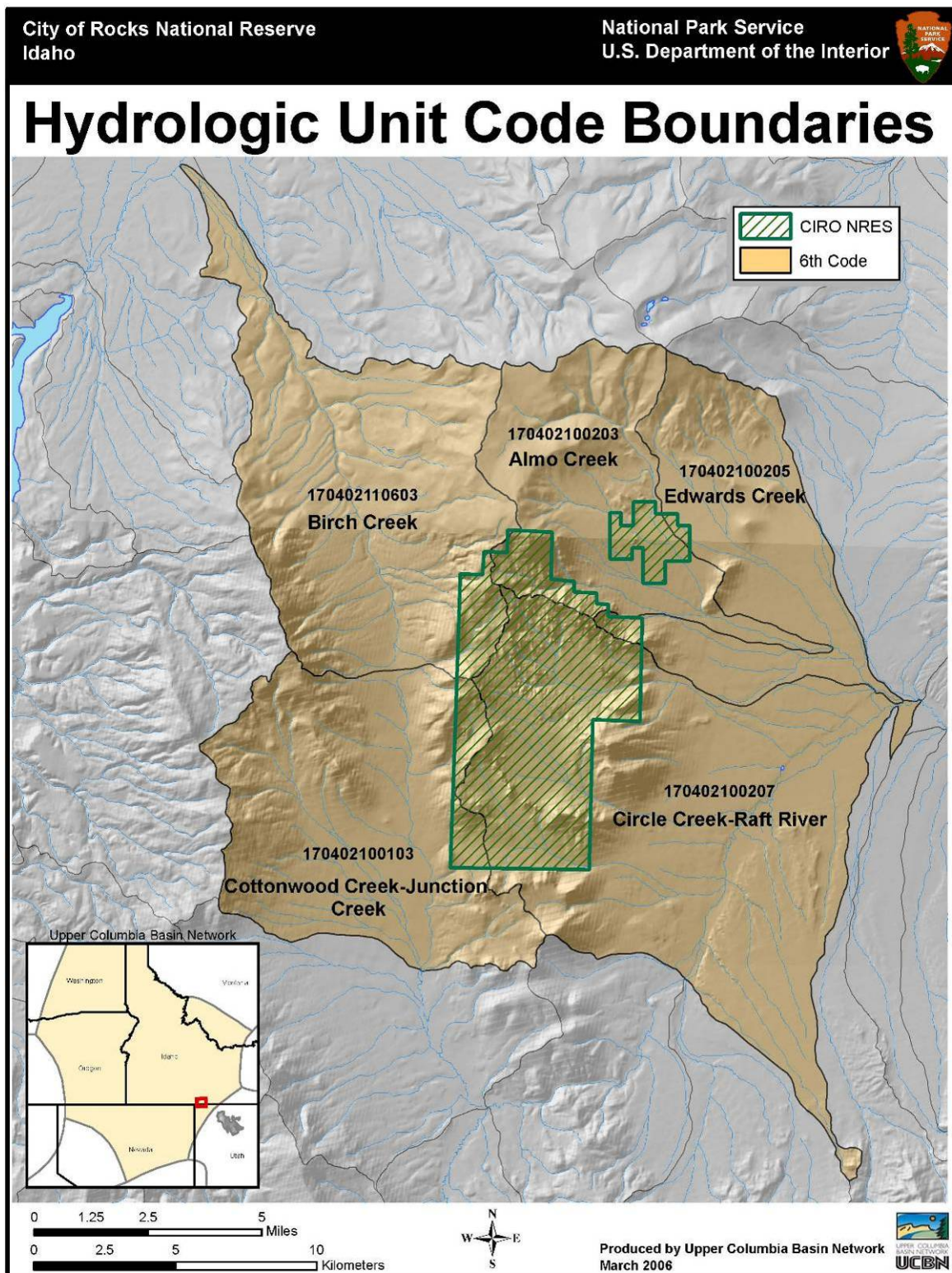


Water Quality Monitoring 2012



2012 Almo Creek map included to show fence lines and wetland boundaries.

Appendix B. CIRO/CRSP Hydrologic Unit Code Boundaries



Appendix C. Sample Locations for Water Quality Monitoring at CIRO/CRSP

Park	Stream	Monitoring Type	Station #/ Site ID	Lat.	Long.	Y ^a	X ^a
CIRO	North Fork Circle Creek	Water Chemistry	001	42.090693	-113.707035	4663392.25359	276119.93333
CIRO	South Fork Circle Creek	Water Chemistry	001	42.077681	-113.707022	4661946.25176	276076.14854
CIRO	Circle Creek	Water Chemistry	001	42.076254	-113.680830	4661720.21418	278238.00566
CRSP	Almo Creek	Water Chemistry	001	42.126794	-113.659879	4667279.22126	280145.31404
CIRO	North Fork Circle Creek	Macroinvertebrates	3220	42.0868722	-113.703967	4662960	276360
CIRO	North Fork Circle Creek	Macroinvertebrates	3221	42.0881861	-113.7044	4663107	276329
CIRO	South Fork Circle Creek	Macroinvertebrates	3222	42.0774917	-113.706889	4661926	276085
CIRO	South Fork Circle Creek	Macroinvertebrates	3223	42.0772472	-113.708811	4661904	275926
CIRO	Circle Creek	Macroinvertebrates	3224	42.0773806	-113.675389	4661832	278691
CIRO	Circle Creek	Macroinvertebrates	3226	42.0768028	-113.677481	4661773	278516
CRSP	Almo Creek	Macroinvertebrates	3218	42.1292361	-113.662408	4667556	279944
CRSP	Almo Creek	Macroinvertebrates	3219	42.1328139	-113.664922	4667960	279749

^a Note that X and Y have been projected in WGS84, UTM Zone 12. These locations were recorded by the field crew with a handheld GPS unit.

Appendix D. Quality Control (QC) Indicators

Table D-1. QC data quality indicators for 2015 season at CIRO, North Fork Circle Creek, Hydrolab #064, Station ID: CIRO #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	0.04	N/A	0.1	N/A
Specific Conductance	µS/cm	0 to 100,000 µS/cm	N/A	N/A	0.42	N/A	0.03	N/A
Dissolved Oxygen	mg/L	0-20 mg/L	N/A	N/A	0.05	N/A	0	N/A
pH	pH units	0-14 Units	N/A	N/A	0.02	N/A	0	N/A
Turbidity	NTU	0-3000 NTU	0.44	1.39	1.45	N/A	0	N/A

Table D-2. QC data quality indicators for 2015 season at CIRO, South Fork Circle Creek, Hydrolab #054, Station ID: CIRO #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	0.05	N/A	0.1	N/A
Specific Conductance	µS/cm	0 to 100,000 µS/cm	N/A	N/A	0.89	N/A	0.06	N/A
Dissolved Oxygen	mg/L	0-20 mg/L	N/A	N/A	0.04	N/A	0.45	N/A
pH	pH units	0-14 Units	N/A	N/A	0	N/A	0	N/A
Turbidity	NTU	0-3000 NTU	0.17	0.53	0.64	N/A	0	N/A

Table D-3. QC data quality indicators for 2015 season at CIRO, Circle Creek, Hydrolab #054, Station ID: CIRO #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	0.05	N/A	0.1	N/A
Specific Conductance	µS/cm	0 to 100,000 µS/cm	N/A	N/A	0.89	N/A	0.06	N/A
Dissolved Oxygen	mg/L	0-20 mg/L	N/A	N/A	0.04	N/A	0.45	N/A
pH	pH units	0-14 Units	N/A	N/A	0	N/A	0	N/A
Turbidity	NTU	0-3000 NTU	0.17	0.53	0.64	N/A	0	N/A

Table D-4. QC data quality indicators for 2015 season at CRSP, Almo Creek, Hydrolab #064, Station ID: CRSP #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	0.04	N/A	0.1	N/A
Specific Conductance	µS/cm	0 to 100,000 µS/cm	N/A	N/A	0.42	N/A	0.03	N/A
Dissolved Oxygen	mg/L	0-20 mg/L	N/A	N/A	0.05	N/A	0	N/A
pH	pH units	0-14 Units	N/A	N/A	0.04	N/A	0.28	N/A
Turbidity	NTU	0-3000 NTU	0.44	1.39	1.45	N/A	0	N/A

Appendix E. Macroinvertebrate Metrics

Table E-1. NPS Upper Columbia Benthos 2015—CIRO

Parameter	Sample ID					
	155513	155514	155515	155516	155517	155518
Station	PIBO:3220	PIBO:3221	PIBO:3222	PIBO:3223	PIBO:3224	PIBO:3226
ReachID	8842	8843	8844	8845	8846	8847
Waterbody	N.F. Circle 1	N.F. Circle 2	S.F. Circle 1	S.F. Circle 2	Circle 1	Circle 2
County	Cassia	Cassia	Cassia	Cassia	Cassia	Cassia
State	ID	ID	ID	ID	ID	ID
Latitude	42.08687	42.08819	42.07749167	42.07724722	42.07738	42.0768
Longitude	-113.704	-113.704	-113.706889	-113.708811	-113.675	-113.677
Collection Date	6/19/2015	6/21/2015	6/16/2015	6/18/2015	6/20/2015	6/20/2015
Habitat Sampled	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle
Collection Method	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net
Field Notes	NULL	NULL	NULL	NULL	NULL	NULL
Lab Notes	NULL	NULL	NULL	NULL	NULL	NULL
Area sampled (m^2)	0.74	0.74	0.74	0.74	0.74	0.74
Field Split	100	100	100	100	100	100
Lab Split	62.5	62.5	62.5	100	100	100
Split Count	610	483	640	568	6	21
Fixed Count	300	300	300	300	5	21
Big Rare Count	10	5	33	0	0	0
Richness*	21	16	15	16	3	5
Abundance	1332	1051	1428	768	8	28
Shannon's Diversity*	2.120861	1.83526	1.910325774	1.916144838	1.05492	1.411205
Simpson's Diversity*	0.840178	0.785574	0.790992196	0.787759197	0.8	0.738095
Evenness*	0.696615	0.66193	0.705424801	0.691103164	0.96023	0.876831

*Standardized to OTU and fixed count

Table E-1 (continued). NPS Upper Columbia Benthos 2015—CIRO

Parameter	Sample ID					
	155513	155514	155515	155516	155517	155518
# of EPT Taxa*	9	4	8	7	1	2
EPT Taxa Abundance	486	91	776	462	3	18
Dominant Family	Baetidae	Simuliidae	Chironomidae	Chironomidae	Dytiscidae	Baetidae
Abundance of Dominant Family	359	320	548	265	3	18
Dominant Taxa	Baetis	Simulium	Orthoclaadiinae	Orthoclaadiinae	Callibaetis	Callibaetis
Abundance of Dominant Taxa	359	320	504	232	3	14
Hilsenhoff Biotic Index*	3.143333	3.67	3.856666667	3.61	3.2	3.047619
# of Intolerant Taxa*	7	2	5	4	0	0
Intolerant Taxa abundance	117	26	459	223	0	0
# of Tolerant Taxa*	0	0	0	0	1	0
Tolerant Taxa abundance	0	0	0	0	0	0
USFS Community Tolerance Quotient (d)*	74	90	60	64	75	77
# of shredder taxa*	2	1	2	2	0	0
Shredder Abundance	4	27	324	24	0	0
# of scraper taxa*	1	0	1	2	0	0
Scraper abundance	6	6	120	78	0	0
# of collector-filterer taxa*	2	2	0	2	0	0
Collector-filterer abundance	465	618	0	5	0	0
# of collector-gatherer taxa*	4	5	4	4	2	3
Collector-gatherer abundance	526	242	708	358	4	20
# of predator taxa*	8	4	6	4	1	1
Predator abundance	245	140	221	203	4	4
# of clinger taxa*	6	3	3	7	0	0
Long-lived Taxa*	3	2	0	2	1	1
# of Ephemeroptera taxa*	3	3	4	4	1	2

*Standardized to OTU and fixed count

Table E-1 (continued). NPS Upper Columbia Benthos 2015—CIRO

Parameter	Sample ID					
	155513	155514	155515	155516	155517	155518
Ephemeroptera abundance	369	55	291	193	3	18
# of Plecoptera taxa*	3	0	3	2	0	0
Plecoptera abundance	86	4	475	264	0	0
# of Trichoptera taxa*	3	1	1	1	0	0
Trichoptera abundance	30	32	11	5	0	0
# of Coleoptera taxa*	3	2	0	2	1	1
Coleoptera abundance	17	6	17	23	4	4
# of Elmidae Taxa*	1	2	0	2	0	0
Elmidae abundance	2	4	0	9	0	0
# of Megaloptera taxa*	0	0	0	0	0	0
Megaloptera abundance	0	0	0	0	0	0
# of Diptera taxa*	7	7	5	6	0	1
Diptera abundance	492	609	605	278	0	3
# of Chironomidae taxa*	3	3	3	3	0	1
Chironomidae abundance	167	212	548	265	0	3
# of Crustacea taxa*	0	0	0	0	1	0
Crustacea abundance	0	0	0	0	1	0
# of Oligochaete taxa*	0	0	0	0	0	0
Oligochaete abundance	0	2	15	3	0	0
# of Mollusca taxa*	1	1	0	0	0	0
Mollusca abundance	253	298	0	0	0	0
# of Insect taxa*	19	13	13	15	2	5
Insect abundance	995	707	1398	764	7	28
# of Non-insect taxa*	2	3	2	1	1	0
Non-insect abundance	337	344	30	4	1	0

*Standardized to OTU and fixed count

Table E-2. NPS Upper Columbia Benthos 2015—CIRO

Parameter	Sample ID	
	155511	155512
Station	PIBO:3218	PIBO:3219
ReachID	8840	8841
Waterbody	Almo 1	Almo 2
County	Cassia	Cassia
State	ID	ID
Latitude	42.12924	42.13281
Longitude	-113.662	-113.665
Collection Date	6/17/2015	6/18/2015
Habitat Sampled	Targeted Riffle	Targeted Riffle
Collection Method	Surber net	Surber net
Field Notes	NULL	NULL
Lab Notes	NULL	NULL
Area sampled (m^2)	0.74	0.74
Field Split	100	100
Lab Split	100	100
Split Count	226	36
Fixed Count	226	36
Big Rare Count	0	0
Richness*	25	9
Abundance	305	49
Shannon's Diversity*	1.848608	1.631902
Simpson's Diversity*	0.656323	0.739683
Evenness*	0.574302	0.742711
# of EPT Taxa*	12	6
EPT Taxa Abundance	251	38

*Standardized to OTU and fixed count

Table E-2 (continued). NPS Upper Columbia Benthos 2015—CIRO

Parameter	Sample ID	
	155511	155512
Dominant Family	Baetidae	Baetidae
Abundance of Dominant Family	191	23
Dominant Taxa	Baetis	Baetis
Abundance of Dominant Taxa	176	23
Hilsenhoff Biotic Index*	3.685841	4.027778
# of Intolerant Taxa*	6	2
Intolerant Taxa abundance	36	3
# of Tolerant Taxa*	0	0
Tolerant Taxa abundance	0	0
USFS Community Tolerance Quotient (d)*	59	61
# of shredder taxa*	2	0
Shredder Abundance	7	0
# of scraper taxa*	3	2
Scraper abundance	18	7
# of collector-filterer taxa*	3	1
Collector-filterer abundance	5	1
# of collector-gatherer taxa*	6	4
Collector-gatherer abundance	242	39
# of predator taxa*	7	0
Predator abundance	28	0
# of clinger taxa*	9	5
Long-lived Taxa*	4	1
# of Ephemeroptera taxa*	7	6
Ephemeroptera abundance	232	38
# of Plecoptera taxa*	1	0

*Standardized to OTU and fixed count

Table E-2 (continued). NPS Upper Columbia Benthos 2015—CIRO

Parameter	Sample ID	
	155511	155512
Plecoptera abundance	1	0
# of Trichoptera taxa*	4	0
Trichoptera abundance	18	0
# of Coleoptera taxa*	4	1
Coleoptera abundance	11	1
# of Elmidae Taxa*	2	1
Elmidae abundance	5	1
# of Megaloptera taxa*	1	0
Megaloptera abundance	3	0
# of Diptera taxa*	6	1
Diptera abundance	38	8
# of Chironomidae taxa*	2	1
Chironomidae abundance	26	8
# of Crustacea taxa*	0	0
Crustacea abundance	0	0
# of Oligochaete taxa*	0	0
Oligochaete abundance	0	0
# of Mollusca taxa*	1	1
Mollusca abundance	1	1
# of Insect taxa*	23	8
Insect abundance	303	47
# of Non-insect taxa*	2	1
Non-insect abundance	3	1

Appendix F. Macroinvertebrate Taxa List

Table F-1. NPS Upper Columbia Basin Benthos 2015 – CIRO/CRSP.*

Sample ID	Reach ID	Name	Sample Date	Lab Split	Field Split	Area	Code	Taxon	Split Count	Big Rare Count
155511	8840	Almo 1	6/17/2015	100	100	0.74	63	Lebertia	1	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	118	Oreodytes	3	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	184	Orthocladiinae	18	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	223	Simulium	1	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	241	Hexatoma	5	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	250	Baetis	130	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	222	Prosimulium	2	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	233	Tabanus	1	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	187	Tanypodinae	1	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	279	Cinygmula	10	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	280	Epeorus	4	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	359	Sialis	2	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	519	Lepidostoma	3	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	292	Paraleptophlebia	8	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	303	Ameletus	1	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	412	Chloroperlidae	1	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	647	Pisidium	1	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	834	Diphetor hageni	11	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	1076	Optioservus quadrimaculatus	3	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	1743	Cleptelmis addenda	1	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	1538	Stictotarsus	1	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	549	Neophylax	2	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	1206	Rhyacophila brunnea/vemna group	6	0

* Note that all samples were from targeted riffles and sampled using Surber nets.

Table F-1 (continued). NPS Upper Columbia Basin Benthos 2015 – CIRO/CRSP.*

Sample ID	Reach ID	Name	Sample Date	Lab Split	Field Split	Area	Code	Taxon	Split Count	Big Rare Count
155511	8840	Almo 1	6/17/2015	100	100	0.74	1282	Ephemerella inermis/infrequens	8	0
155511	8840	Almo 1	6/17/2015	100	100	0.74	1488	Onocosmoecus unicolor	2	0
155512	8841	Almo 2	6/18/2015	100	100	0.74	1743	Cleptelmis addenda	1	0
155512	8841	Almo 2	6/18/2015	100	100	0.74	1180	Drunella coloradensis/flavilinea	1	0
155512	8841	Almo 2	6/18/2015	100	100	0.74	647	Pisidium	1	0
155512	8841	Almo 2	6/18/2015	100	100	0.74	303	Ameletus	1	0
155512	8841	Almo 2	6/18/2015	100	100	0.74	285	Rhithrogena	1	0
155512	8841	Almo 2	6/18/2015	100	100	0.74	279	Cinygmula	3	0
155512	8841	Almo 2	6/18/2015	100	100	0.74	280	Epeorus	5	0
155512	8841	Almo 2	6/18/2015	100	100	0.74	250	Baetis	17	0
155512	8841	Almo 2	6/18/2015	100	100	0.74	184	Orthocladiinae	6	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	184	Orthocladiinae	67	2
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	63	Lebertia	3	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	58	Trombidiformes	5	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	108	Agabus	1	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	133	Narpus	2	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	182	Chironominae	5	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	241	Hexatoma	6	1
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	223	Simulium	96	3
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	201	Chelifera	3	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	66	Sperchonidae	29	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	237	Dicranota	35	1
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	250	Baetis	165	2
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	280	Epeorus	3	1

* Note that all samples were from targeted riffles and sampled using Surber nets.

Table F-1 (continued). NPS Upper Columbia Basin Benthos 2015 – CIRO/CRSP.*

Sample ID	Reach ID	Name	Sample Date	Lab Split	Field Split	Area	Code	Taxon	Split Count	Big Rare Count
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	135	Optioservus	2	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	153	Hydrophilidae	1	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	179	Ceratopogonidae	7	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	187	Tanypodinae	4	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	419	Sweltsa	4	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	480	Trichoptera	1	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	519	Lepidostoma	1	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	303	Ameletus	1	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	431	Malenka	35	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	439	Zapada	1	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	647	Pisidium	117	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	2115	Arrenurus	2	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	1505	Rhyacophila vofixa group	8	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	1219	Hydraena	2	0
155513	8842	N.F. Circle 1	6/19/2015	62.5	100	0.74	1206	Rhyacophila brunnea/vemna group	4	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	1488	Onocosmoecus unicolor	0	1
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	2172	Torrenticola	1	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	834	Diphetor hageni	3	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	2150	Mideopsis	1	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	2154	Oxus	1	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	647	Pisidium	138	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	403	Plecoptera	2	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	303	Ameletus	2	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	519	Lepidostoma	10	0

* Note that all samples were from targeted riffles and sampled using Surber nets.

Table F-1 (continued). NPS Upper Columbia Basin Benthos 2015 – CIRO/CRSP.*

Sample ID	Reach ID	Name	Sample Date	Lab Split	Field Split	Area	Code	Taxon	Split Count	Big Rare Count
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	480	Trichoptera	4	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	179	Ceratopogonidae	10	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	187	Tanypodinae	12	2
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	279	Cinygmula	0	1
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	250	Baetis	20	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	237	Dicranota	16	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	234	Tipulidae	2	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	66	Sperchonidae	14	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	121	Elmidae	1	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	198	Dixa	2	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	201	Chelifera	5	1
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	223	Simulium	148	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	182	Chironominae	2	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	133	Narpus	1	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	128	Heterlimnius	1	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	63	Lebertia	3	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	19	Oligochaeta	1	0
155514	8843	N.F. Circle 2	6/21/2015	62.5	100	0.74	184	Orthoclaadiinae	83	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	19	Oligochaeta	7	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	58	Trombidiformes	3	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	105	Dytiscidae	3	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	182	Chironominae	7	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	121	Elmidae	1	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	134	Narpus concolor	1	0

* Note that all samples were from targeted riffles and sampled using Surber nets.

Table F-1 (continued). NPS Upper Columbia Basin Benthos 2015 – CIRO/CRSP.*

Sample ID	Reach ID	Name	Sample Date	Lab Split	Field Split	Area	Code	Taxon	Split Count	Big Rare Count
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	184	Orthoclaadiinae	233	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	63	Lebertia	2	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	67	Sperchon	2	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	234	Tipulidae	2	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	237	Dicranota	4	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	250	Baetis	42	12
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	279	Cinygmula	46	6
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	280	Epeorus	26	6
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	187	Tanypodinae	13	1
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	153	Hydrophilidae	1	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	173	Diptera	2	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	179	Ceratopogonidae	11	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	419	Sweltsa	53	4
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	404	Capniidae	3	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	303	Ameletus	5	1
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	403	Plecoptera	5	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	439	Zapada	144	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	667	Rhabdomastix	4	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	2253	Neoplasta	3	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	1076	Optioservus quadrimaculatus	2	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	5757	Chloroperlinae	12	0
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	1488	Onocosmoecus unicolor	0	1
155515	8844	S.F. Circle 1	6/16/2015	62.5	100	0.74	1206	Rhyacophila brunnea/vemna group	3	2
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	1206	Rhyacophila brunnea/vemna group	3	0

* Note that all samples were from targeted riffles and sampled using Surber nets.

Table F-1 (continued). NPS Upper Columbia Basin Benthos 2015 – CIRO/CRSP.*

Sample ID	Reach ID	Name	Sample Date	Lab Split	Field Split	Area	Code	Taxon	Split Count	Big Rare Count
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	5757	Chloroperlinae	59	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	5845	Ephemerella dorothea/excrucians	3	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	439	Zapada	11	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	303	Ameletus	23	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	419	Sweltsa	125	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	542	Hesperophylax	1	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	187	Tanypodinae	21	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	280	Epeorus	44	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	279	Cinygmula	34	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	250	Baetis	39	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	222	Prosimulium	2	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	67	Sperchon	1	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	134	Narpus concolor	14	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	135	Optioservus	1	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	121	Elmidae	2	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	223	Simulium	2	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	247	Tipula	6	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	182	Chironominae	3	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	19	Oligochaeta	2	0
155516	8845	S.F. Circle 2	6/18/2015	100	100	0.74	184	Orthocladiinae	172	0
155517	8846	Circle Creek 1	6/20/2015	100	100	0.74	75	Hyalella	1	0
155517	8846	Circle Creek 1	6/20/2015	100	100	0.74	251	Callibaetis	2	0
155517	8846	Circle Creek 1	6/20/2015	100	100	0.74	153	Hydrophilidae	1	0
155517	8846	Circle Creek 1	6/20/2015	100	100	0.74	1770	Acilius abbreviatus	2	0

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Table F-1 (continued). NPS Upper Columbia Basin Benthos 2015 – CIRO/CRSP.*

Sample ID	Reach ID	Name	Sample Date	Lab Split	Field Split	Area	Code	Taxon	Split Count	Big Rare Count
155518	8847	Circle Creek 2	6/20/2015	100	100	0.74	314	Corixidae	3	0
155518	8847	Circle Creek 2	6/20/2015	100	100	0.74	1538	Stictotarsus	3	0
155518	8847	Circle Creek 2	6/20/2015	100	100	0.74	252	Centroptilum	3	0
155518	8847	Circle Creek 2	6/20/2015	100	100	0.74	251	Callibaetis	10	0
155518	8847	Circle Creek 2	6/20/2015	100	100	0.74	182	Chironominae	2	0

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NPS 003/133780, August 2016

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