WATER QUALITY MONITORING REPORT

North Fork of the Colorado River

PREPARED FOR

Upper Colorado River Watershed Group

PREPARED BY

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Summer 2022

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ABSTRACT

In October 2020, the second largest wildfire (193,812 acres) in Colorado history swept through the East Troublesome Valley in northern Grand County, Colorado. The burn area of the East Troublesome Fire destroyed Lodge Pole Pine and mixed forests including all understory and ground cover growth. Due to the lack of vegetation cover, summer storms have increased overland runoff and has contributed large amounts of sediment into the streams of the watershed that eventually flows into drinking water reservoirs for the Front Range of Colorado. This project has provided a baseline assessment of water quality that is needed to guide post-fire stream and watershed restoration efforts in the North Fork of the Colorado River (NFCR) watershed with the end goal to reduce non-point source pollution. Environmental geochemical parameters of concern were analyzed (NO_3^-, NO_2, NH_3, PO_4^{-3}, TDS, TSS, Sp. Cond.,, temperature, turbidity, alkalinity, Ca^{+2}, Mg^{+2}, SO_4^{-2}, pH, Fe total, K^+) and compared to local discharge data. Due to limited sample collection during major runoff events (i.e. storm influenced peak flows), geochemical water quality data collected provided a poor baseline for stream restoration efforts. The turbidity, TDS, and TSS data collected was minimal and did not show influence of high sedimentation due to storm runoff on fire affected lands, therefore, sediment loads were not able to be calculated. However, results did show that phosphate, pH, TDS, and TSS were increased in highly burned drainages compared to drainages that were not completely destroyed by the fire. The drainage of concern is the Supply Creek drainage that flows into the NFCR before entering Shadow Mountain Reservoir. Since the Supply Creek geochemical data appeared to be more influenced by fire burn scar runoff pollution than by the less destroyed NFCR, it is recommended to focus watershed and stream restoration efforts on the Supply Creek Drainage.

INTRODUCTION

With increase of climate change and weather severity, wildfires have become more abundant and severe (Hall and Lombardozzi, 2008) in the Western United States. There has been an increase in number and size of wildfires since the 1990s (Smith et al., 2011) and a change in wildfire behavior such as speed, heat, and severity (Hall and Lombardozzi, 2008; Smith et al., 2011; Sherson et al., 2015). There are numerous hydrologic divers (precipitation events, high snow melt, etc.) in fire affected watershed systems that affect stream responses to water quality and sediment load (Sherson et al., 2015). Precipitation transports ash and sediment quickly to stream systems, thus, altering the water geochemistry (Rhoades et al., 2011; Smith et al., 2011). These events also increase erosion and sedimentation loads into the stream ecosystems and can alter biogeochemical parameters and macroinvertebrate populations (Hall and Lombardozzi, 2008; Smith et al., 2011; Sherson et al., 2015). Changes in stream geochemistry by wildfire induced runoff from loss of forested vegetation and altered soil processes can last weeks to up to 5 years after the burn (Hall and Lombardozzi, 2008; Rhoads et al., 2011; Smith et al., 2011; Sherson et al., 2015).

The second largest wildfire in Colorado history swept through the East Troublesome Valley in northern Grand County, Colorado in October 2022 (Figure 1; Gabbert, 2022). The East Troublesome Fire (ETF) burned 193,812 acres and was fueled by beetle killed lodge pole pine trees, drought, and high, abnormal winds (red flag weather conditions; Meldrum et al., 2022). The fire destroyed lodge pole pine and mixed forests including understory and ground cover growth. The following summer's rain storms (2021 and 2022) have caused large amounts of overland runoff and mud and rock slides contributing to non-point pollution to surface streams that eventually flow into drinking water reservoirs for Colorado-Big Thompson Project (Shadow Mountain Reservoir, Lake Granby, Willow Creek Reservoir, Windy Gap Reservoir), This project seeks to provide an assessment of water quality that is needed to guide post-fire stream and watershed restoration efforts in the North Fork of the Colorado River (NFCR) watershed with the end goal to reduce non-point source pollution. The watershed of the North Fork of the Colorado River was heavily affected by the East Troublesome Fire in 2020. Ecological functions provided by the burned landscape have the potential to cause significant non-point source pollution (including excess sediment and nutrient transport) to the Colorado River and its intended reservoirs. The purpose of the water quality monitoring is to develop a water quality baseline that will guide monitoring effectiveness of the river's recovery following the implementation of restoration projects.

To create a post-fire baseline of hydrogeochemical parameters of the North Fork of the Colorado River in regards to watershed restoration, environmental geochemical parameters of concern were analyzed (NO_3^-, NO_2, NH_3, PO_4^{-3}, TDS, TSS, Sp. Cond.,, temperature, turbidity, alkalinity, Ca^{+2}, Mg^{+2}, SO_4^{-2}, pH, Fe total, K^+) from grab samples of the North Fork of the Colorado River and a tributary that was completely burned by the fire. The 2022 water quality data sample set will create a baseline understanding of the NFCR prior to watershed and stream restoration.

METHODS

Sampling Area Description

North Fork of the Colorado River sampling area occupies approximately 24 miles of stream in a National Park Service area and private lands that includes the head waters of the North Fork of the Colorado River to the mouth with Shadow Mountain Reservoir (Figure 1). The sampling area is bordered on the north by National Park Service (Rocky Mountain National Park), on the west by National Forest Service on the south by private land and National Forest Service, and on the east by National Park Service.

The headwaters of the river are dominated by sub-alpine spruce and pine forest and followed willows and beaver dams at lower elevations. The river transitions into the private lands and meanders to the Shadow Mountain Reservoir. Approximately the last half of the sample area was heavily affected by the Troublesome Fire in 2020 (Figure 1). Sample sites are in the upper, middle, and mouth of the river as well as a tributary, Supply Creek, that was highly affected by the Troublesome Fire (Figure 1; Table 1).

Regional geology consists of large lateral moraines from glaciers originating in the Rocky Mountain National Park area and the Continental Divide. The mountains surrounding the NFCR watershed are topped with Tertiary volcanic rocks, high river terraces, upturned strata, and glacial deposits. The Never Summer Mountain Range to the North-West of the watershed contains Precambrian rocks over Mesozoic rocks due to a thrust fault being pushed westward. To the East are deposits of metasedimentary Early Proterozoic Rocks. To the west are primarily tertiary

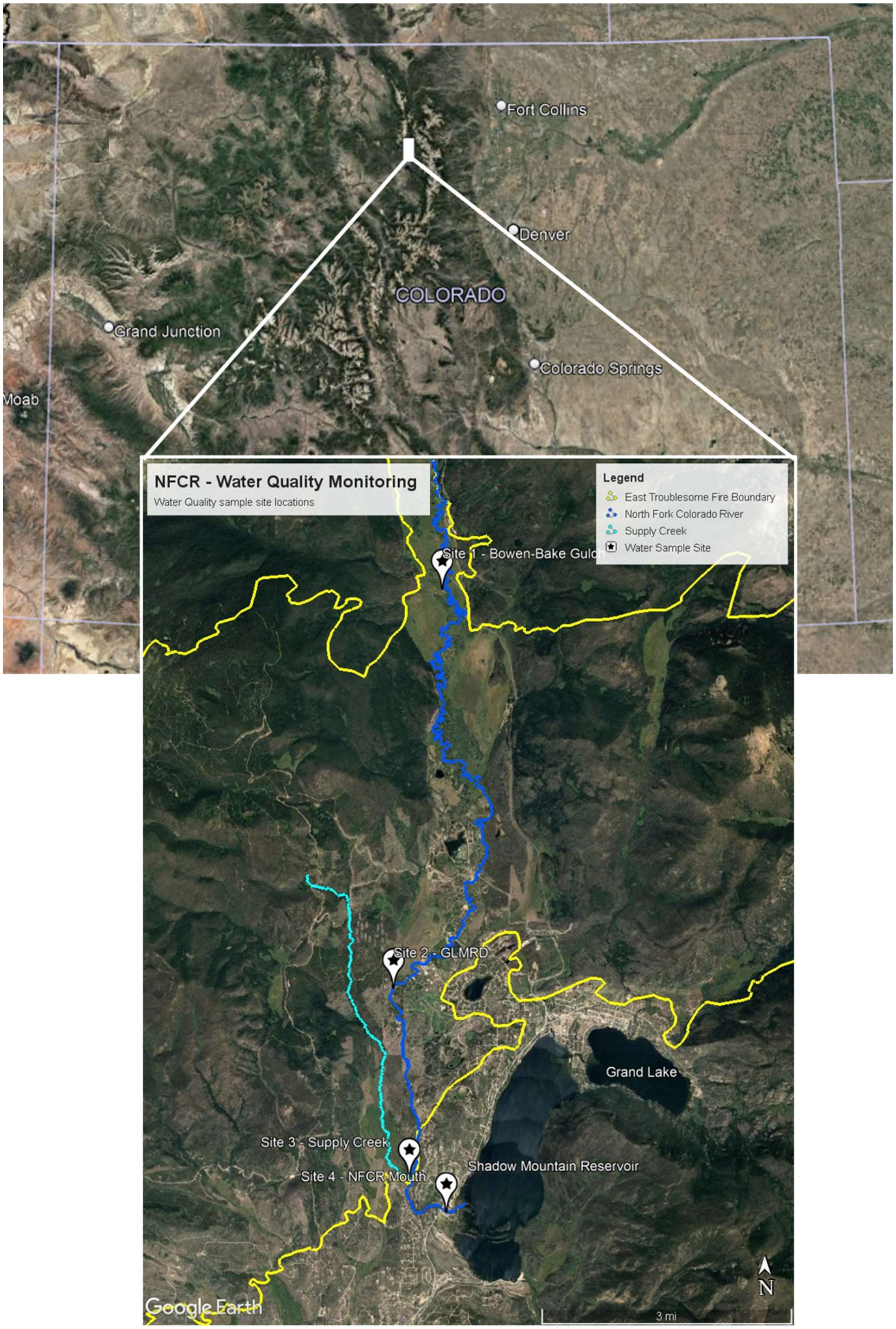

Figure 1. *Sample Site Locations on the North Fork of the Colorado River and Supply Creek. Map shows fire boundary burn line in yellow (Grand County, 2022).*

__Table 1.__ Sample site locations and descriptions.

Sample Site Name	Northing	Easting	Land Ownership	Comments
Site 1 – near Discharge Gauge @ Baker Gulch	4464329.00 m N	427092.00 m E	Private; MCLAREN, SHIRLEY RAE	USGS Gauge
Site 2 - Grand Lake Metropolitan Recreation District (GLMRD)	4456702.00 m N	426063.00 m E	Private; GLMRD	-
Site 3 - Supply Creek	4453077.11 m N	426324.05 m E	Private; ROUNDS, EDWARD & CALLAE WALCOTT	-
Site 4 - Discharge Gauge @ NFCR Mouth	4452414.81 m N	427027.84 m E	Private; LORENS, LYNDA TRACEE	North Water Gauge

sediments (Chronic, 1980). Local Geology consists of Tertiary sediments that originated from Tertiary flows and intrusions. The lower portion of NFCR and Supply Creek flow through a Tertiary Intrusion that is surrounded by tertiary sediments. East of the NFCR are Quaternary gravels (Chronic, 1980). The watersheds geology contains floodplain influenced by meandering streams and glacial outwash. There are multiple depositional lateral moraines and benches consisting of glacier fines and boulders.

The headwaters of the NFCR area have historical agricultural, logging, and mining use, however, the land has been owned by the National Park Service since 1915. The section of the river that meanders through private lands are dominated by single family residences. The lower portion of the river was influenced by the East Troublesome Fire in 2020 where most of the land and infrastructures were burned. There are multiple water irrigation ditches in the sample area. The fire affected land and irrigation ditches inside the burn area pose the highest risk of contamination due to ash and sediment runoff. The Supply Creek watershed is dominated by public Forest Service lands with the lower reaches near the confluence with NFCR is private land.

Sampling and Analysis

Water quality parameters have been analyzed in relation to seasonality, stream distance, and stream discharge. Water quality samples were collected every 2-4 weeks throughout the thaw season (May-September) on the North Fork of the Colorado River (NFCR). Samples were not collected during daily peak flows due to time and work constraints; peak flows were recorded to be 11pm – 2 pm daily. Similarly, there were no storm runoff events collected. Water quality samples were collected in field in clean 125 mL polyethylene terephthalate (PET) bottles and properly labeled with site location name, date, time, and noted as unfiltered. Samples were grab collected from flowing, not stagnant water, closest to the stream thalweg. Select parameters (Sp. Cond. Temperature, turbidity) were analyzed in situ with Apera PC60-Z Smart Multi-Parameter Tester (APERA Instruments, Columbus, OH) and Apera TN500 Turbidity Meter (APERA Instruments, Columbus, OH). All sample bottles were chilled and transported to Gatesman Environmental Consulting and Engineering LLC laboratory/office and then frozen until laboratory analysis. Chemical parameters (NO_3^-, NO_2, NH_3, PO_4^{-3}, alkalinity, Ca^{+2}, Mg^{+2}, SO_4^{-2}, pH, Fe total, K^+) were analyzed via RETEGO® TTR-2 (RETEGO Labs LLC, Bountiful, UT). Total dissolved solids (TDS) and total suspended solids (TSS) analysis were completed in the GECE lab following Environmental Protection Agency (EPA) methodologies. Stream geochemical data was compared to documented stream discharge. Stream discharge data was used from a United States Geological Survey (USGS) stream gauge site (location # 09010500 , USGS, 2022) and Norther Water stream gauge site (station #M-0009, Northern Water, 2022).

For more information regarding sample and analysis procedures, Field Equipment/Instrument Calibration, Maintenance, Testing, and Inspection and Contaminants of Concern with Instrumental Minimum Reporting Limit, Precision, and NELAC Proficiency Testing Reporting Limit (PTRL), see "*Sampling and Analysis Plan*" documented with the Colorado Department of Public Health and Environment (CDPHE).

RESULTS

Seasonal Variation

The North Fork of the Colorado River seasonal hydrograph shows a distinct snow melt runoff during June of 2022 (Figure 2). This large peak in discharge does not coincide with any high monsoon rain events. Individual monsoon storm events recorded at the NOAA station in nearby Grand Lake, CO are observed on the seasonal discharge hydrograph for the NFCR for both Site 1 and Site 4; however, Site 4 shows a larger response in discharge to the storm events than Site 1 (Figure 2).

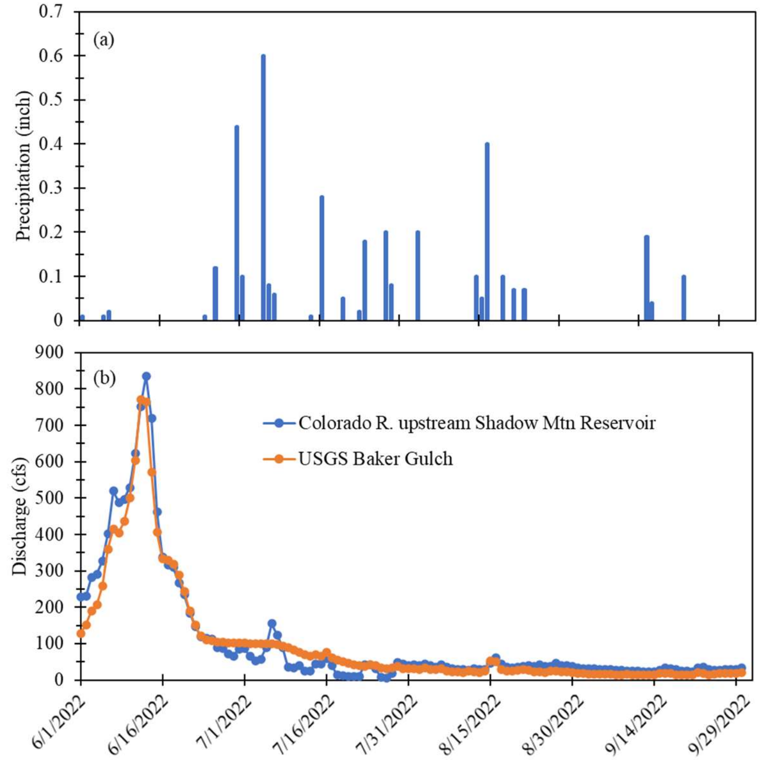

Figure 2. *(a) precipitation recorded at town of Grand Lake (NOAA, 2022); (b) discharge of NFCR at Site 1, Bowen-Baker Gulch (USGS, 2022), and Site 4, NFCR mouth (Northern Water, 2022).*

Most chemical parameters tested for do not follow any trends with stream discharge, however, it appears that phosphate and turbidity may be related to stream discharge as there are peaks in concentrations during the snow melt peak discharge in June (Figure 4; Table 2). There is insufficient continuous data to observe any relationships with chemical parameters and monsoon storm events.

Select chemical parameters have seasonal trends in composition. Alkalinity and specific conductivity increase from June to September (Figure 3). There is a slight drop in temperature as the peak in snow melt diminishes followed by an increase in temperature during the warm season of July and August (Figure 3). Once the season cools with cooler nights and shorter day in September, stream temperature drops to temperatures near spring values. It appears that turbidity has the opposite trend as temperature and is high during peak snow melt with a sharp decrease at the end of the snow melt in the beginning of July (Figure 4). It appears that turbidity slowly increase temporally, however, there are no statistical values to support this conclusion.

Spatial Variation

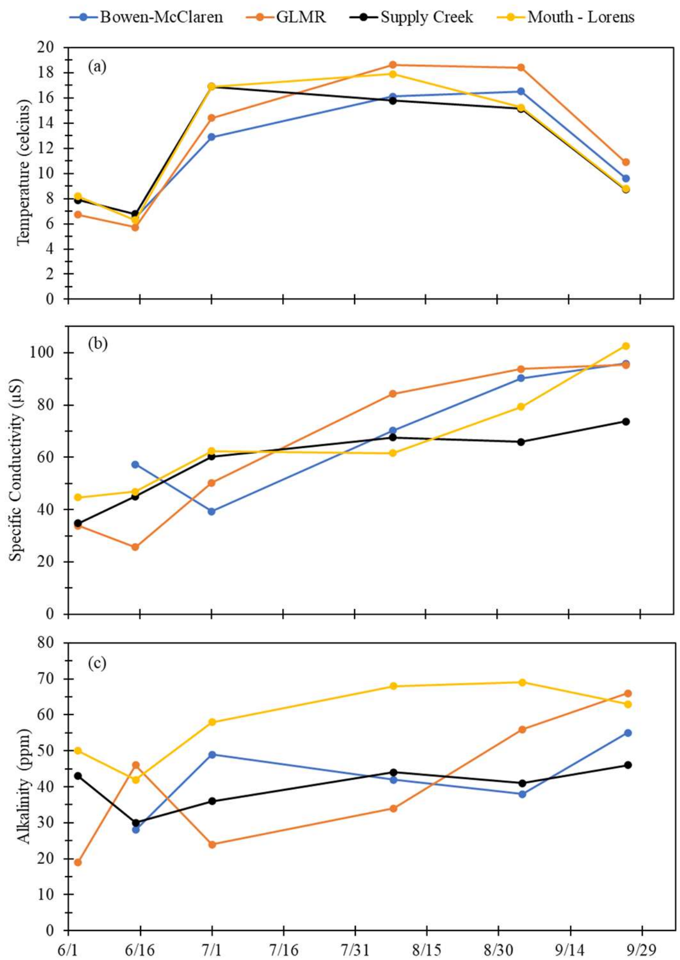

Figure 3. *Seasonal trends in temperature (a), specific conductivity (b), and alkalinity (c) of the NFCR and Supply Creek.*

Iron is significantly lower in Supply Creek than the Site 1 and 4 of the NFCR (t-test 0.04 and 0.008, respectively; Table 2). Similarly, pH is statistically lower in Supply Creek and the mouth (site 4) than Site 1 and 2 (t-test 0.0065 and 0.05, respectively; Table 2). Supply Creek has the highest detected chloride compared to NFCR. Site 1 has sulfate detected throughout the season (5-17 ppm), however, the other sample sites do not have any sulfate above detection limit (5 ppm; Table 2). Similarly, ammonia is detected in Sites 1 and 2 but not detected in Supply Creek or at the Mouth of NFCR. There are no concentrations of nitrate and nitrite above detection limit (0.05 ppm) for any site (Table 2). There is little phosphate above detection limit at Site 1 of NFCR; concentrations appear to increase downstream (Figure 3). Phosphate is significantly higher in Supply Creek than NFCR (t-test values: 0.03 - Site 1; 0.004 - Site 2; 0.02 - Site 4). There does not appear to be any temporal trends of phosphate through the season of 2022 (Figure 4). There is ammonia detected in the upstream sections (Site 1 and 2), however, concentrations are below detection limit at the mouth and Supply Creek (Table 2). TSS and TDS show similar trends through the season. Supply Creek has the highest solids in solution and appear to mimic monsoon events.

Instrumentation Precision

Most water quality parameters tested were analyzed on RETEGO® TTR-2 in laboratory environment (NO_3^-, NO_2, NH_3, PO_4^{-3}, alkalinity, Ca^{+2}, Mg^{+2}, SO_4^{-2}, pH, Fe total, K^{+}). Samples were collected in field, chilled, and transported to lab and then frozen until analysis. Duplicate tests (laboratory

Table 2. *Water quality data for Sites 1-4 of the NFCR and Supply Creek. Any dashes indicate parameter not tested for.*

Site Number	Date	Discharge (cfs)	Alkalinity (ppm)	Ca^{+2} (ppm)	Cl^- (ppm)	Fe tot (ppm)	Mg^{+2} (ppm)	pH	K^+ (ppm)	SO_4^{-2} (ppm)
1	6/15/2022	406	28	25	<10	0.4	22	5.6	20	5
1	7/1/2022	102	49	24	<10	0.6	19	5.9	21	9
1	8/8/2022	23	42	31	<10	0.6	13	6	17	13
1	9/4/2022	16	38	21	10	0.6	37	6	13	17
1	9/26/2022	17	55	51	49	0.3	0	5.1	26	0
2	6/3/2022	-	19	17	<10	0.2	31	5.5	6	<5
2	6/15/2022	-	46	54	33	0.2	17	4.5	28	<5
2	7/1/2022	-	24	16	<10	0.4	42	5.7	15	<5
2	8/8/2022	-	34	31	20	0.6	25	6	9	<5
2	9/4/2022	-	56	50	22	0.3	19	5.2	29	<5
2	9/26/2022	-	66	62	29	0.3	<5	4.9	27	<5
3	6/3/2022	-	43	39	26	0.2	<0.1	4.4	30	<5
3	6/15/2022	-	30	36	32	<10	12	4.7	30	5
3	7/1/2022	-	36	45	53	0.3	9	4.5	29	<5
3	8/8/2022	-	44	49	33	<10	<0.1	4.5	30	<5
3	9/4/2022	-	41	30	46	<10	<0.1	4.9	26	<5
3	9/26/2022	-	46	48	48	<10	<0.1	4.6	30	<5
4	5/5/2022	167	-	30	-	-	-	5.5	-	13
4	6/3/2022	283	50	45	28	0.2	<5	4.3	26	<5
4	6/15/2022	463	42	42	33	0.3	<5	4.2	29	<5
4	7/1/2022	87	58	60	34	0.5	9	4.5	28	<5
4	8/8/2022	32	68	32	33	0.4	<5	4.8	30	<5
4	9/4/2022	30	69	43	39	0.2	25	4.8	29	<5
4	9/26/2022	28	63	53	29	0.3	16	5.2	25	<5

Site Number	Date	NH_3 (ppm)	NO_3^- (ppm)	NO_2 (ppm)	PO_4^{-2} (ppm)	Sp. Cond. (μS)	Temp (°C)	TDS - dry weight (ppm)	TSS - dry weight (ppm)	Turbidity (NTU)
1	6/15/2022	0.78	<0.05	<0.05	<0.1	57.3	6.5	0.2	-	3.45
1	7/1/2022	0.85	<0.05	<0.05	<0.1	39.3	12.9	0.1	-	1.32
1	8/8/2022	1.12	<0.05	<0.05	<0.1	70.2	16.1	0.7	0.2	1.11
1	9/4/2022	1.29	<0.05	<0.05	<0.1	90.3	16.5	4.5	0.3	1.69
1	9/26/2022	0.11	<0.05	<0.05	0.45	95.9	9.6	0.2	0.05	2.43
2	6/3/2022	0.62	<0.05	<0.05	<0.1	33.9	6.7	1.5	0.5	10.09
2	6/15/2022	<0.05	<0.05	<0.05	0.11	25.6	5.7	7.6	1.5	8.74
2	7/1/2022	0.55	<0.05	<0.05	<0.1	50.2	14.4	1	0.04	1.47
2	8/8/2022	1.09	<0.05	<0.05	<0.1	84.3	18.6	2	0.2	2.11
2	9/4/2022	<0.05	<0.05	<0.05	0.22	93.7	18.4	4.4	0.3	2.1
2	9/26/2022	<0.05	<0.05	<0.05	<0.1	95.3	10.9	1.8	0.15	3.52
3	6/3/2022	<0.05	<0.05	<0.05	0.2	34.8	7.9	2.3	0.9	6.58
3	6/15/2022	<0.05	<0.05	<0.05	0.6	45	6.8	2.1	1.9	8.21
3	7/1/2022	<0.05	<0.05	<0.05	0.15	60.3	16.9	1.3	0.7	3.89
3	8/8/2022	<0.05	<0.05	<0.05	0.35	67.6	15.8	0.6	1.1	2.28
3	9/4/2022	<0.05	<0.05	<0.05	0.37	65.9	15.1	3.8	0.4	12.89
3	9/26/2022	<0.05	<0.05	<0.05	0.42	73.7	8.7	1.5	0.8	13.28
4	5/5/2022	<0.05	-	-	-	-	-	-	-	-
4	6/3/2022	<0.05	<0.05	<0.05	0.21	44.7	8.2	1.8	0.6	8.73
4	6/15/2022	<0.05	<0.05	<0.05	0.26	46.9	6.3	2.6	0.8	11.4
4	7/1/2022	<0.05	<0.05	<0.05	<0.1	62.4	16.9	1.6	0.2	1.86
4	8/8/2022	<0.05	<0.05	<0.05	0.19	61.6	17.9	2.2	0.2	5.78
4	9/4/2022	<0.05	<0.05	<0.05	<0.1	79.3	15.2	2.6	0.6	3.09
4	9/26/2022	<0.05	<0.05	<0.05	<0.1	102.6	8.8	1	0.1	4.17

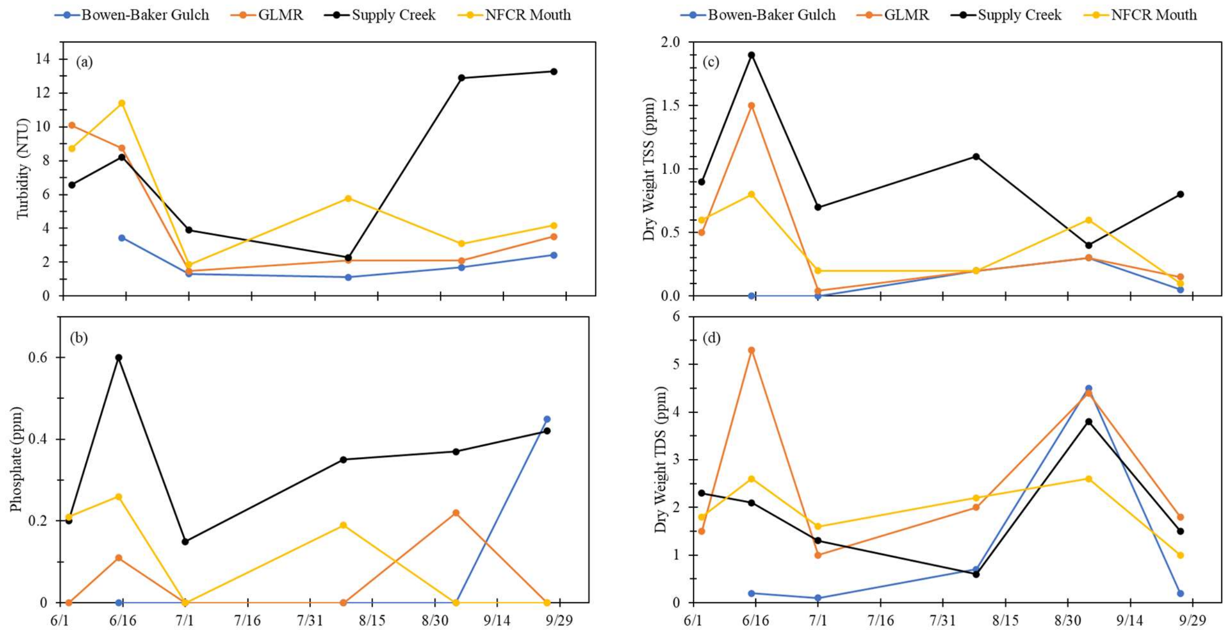

Figure 4. *Spatial trends in turbidity (a), phosphate (b), TSS (c), and TDS (d) of the NFCR and Supply Creek.*

and field) were analyzed in laboratory environmental up to 2 weeks after the original sample wer analyzed. Samples were chilled in refrigerator until duplicate analysis. Out of the 25 duplicate samples for the season, precision error was calculated at 30%. The high error is most likely due to the storage time between original sample analysis and duplicate sample analysis as the samples were not preserved with acid, only preserved via being chilled. Alkalinity, calcium, and phosphate had the highest precision error whereas pH, ammonia, potassium, iron, and sulfate are all below 20%. Since the deviations of the duplicate samples were low, the precision error may be high due to the naturally low concentrations of analytes; any deviation in concentrations below 1 ppm will calculate high precision error. Duplicates that were conducted on the same day as sample analysis show precision errors below 15%. Other causes of high precision errors can be attributed to instrument drift and common human technical errors during sampling and analysis.

DISCUSSION

Samples were not collected during daily peak flows nor during peak runoff events, therefore, there was little to no relationships found from chemical parameters and stream discharge, except for turbidity, TSS, and TDS. In general, for most chemical parameters there was an increase in concentrations with increase of time of season. Water temperature increases in mid-season and decreases in late season most likely due to decrease in air temperatures and an increase in baseflow contribution to streamflow. Supply creek had higher solids and dissolved ions compared to the North Fork of the Colorado River. This is most likely due to most of the Supply Creek drainage being burned from the Troublesome Fire compared to the North Fork of the Colorado River drainage and having more erosion and sediment runoff into surface water. There were little to no observations of increased sediment runoff in samples collected. Precipitation events on burn scars can influence overland flow, flushing, and sediment loads into streams (Sherson et al., 2015), therefore, it is important to collect stream flow samples during runoff events in order to capture sedimentation affects by storm runoff. Sedimentation load due to increased erosion in burn areas can last up to 5 years after the fire (Hall and Lombardozzi, 2008), so there should be high sediment loads observed. Total sediment load was not calculated for the season as ideal samples for TSS and TDS was not collected.

Typically, nitrates and turbidity can increase in streams after fires (Rhoades et al., 2011). There was no detectable nitrate or nitrite in any of the sites sampled. Since the burn in 2020, there has been high regrowth of ground cover consisting of grasses, willows, and aspens. High ground cover regrowth in burn areas can be a large sink of nutrient uptake for growth (Rhoades et al., 2011). Additionally, nitrogen can be lost in a watershed system by increased soil nitrification and sediment erosion (Rhoades et al., 2011). There was a slight increase in turbidity during the season, but the trend was not strong. Additionally, there was little seasonal trend observed with dry weight solids (TDS and TSS; Figure 4; Table 2). This may be due to un-opportune sample collection time that did not coincide with monsoon storm events to collect the overland runoff and erosion that occurred during the events.

Supply Creek showed high concentrations of phosphate than NFCR. Changes in phosphate are most likely due to storm events contributing to runoff and erosion. Increases in PO_4 have been observed in other Rocky Mountain wildfires up to 2 years after the burn (Rhoades et al., 2011). This suggests that Supply Creek water quality is affected more by burn scar ash and sediment runoff than the NFCR. Sherson and others (2015) have found that there can be changes in pH and DO due to ash accumulation in streams and photosynthesis by biota. Further research should include pH and DO analysis in conjunction with TDS, TSS, and turbidity to understand sedimentation loads into the stream system. DO was not collected during this sampling campaign, however, pH observations show that Supply Creek has significantly lower pH than Sites 1 and 2.

This low pH also affected the NFCR pH at the mouth of the watershed by lowering the pH; Site 4 pH was also statistically lower than Sites 1 and 2).

Supply Creek also had the highest concentrations of TSS compared to all site on the NFCR. The TDS does not match the same seasonal trend as TSS in Supply Creek (Figure 4). This may be attributed to higher overland runoff contributing to suspended solids from the burn scar. Since the Supply Creek drainage is not very large and long (in comparison to NRCR), the residence time of the solids in the water column is low, in comparison. Mixing of suspended solids in the water column contributes to chemical weathering and increases dissolved solids and chemical species into solution (Gatesman, 2017). The short residence time of suspended solids in Supply Creek reduces the post mixing chemical weathering. In contrast, suspended solids in the NFCR have a longer residence time, therefore, TDS appears to mimic the TSS throughout the 2022 season for all sites of the NFCR (Figure 5). The TDS and TSS data collected does not appropriately represent the suspended load occurring due erosion and runoff in the burn scar. Water samples were not collected during high runoff events, therefore, cannot be used to determine sediment load in the stream systems.

Temporal and spatial variation in alkalinity, calcium, chloride, magnesium, and potassium were not observed. Rhoades and others (2011) have stated previous research that shows that increase in select parameters (Ca^{+2}, SO_4^{-2}, K^+, P, NO_3^-) return to pre-fire levels 1-4 months after burn. There were lower concentrations of iron in Supply Creek than the NFCR, this is most likely due to geological impacts rather than fire influenced contamination. The Supply Creek drainage is dominated by tertiary sediments whereas the NFRC drainage is dominated by Precambrian granites (Chronic, 1980).

Generally, water quality samples collected were dilute with analytes and solids. This is most likely due to the select sampling schedule and no samples collected during peak monsoon storm runoff events. Continuous and multiple data sets are suggested in order to understand stream water quality functions (Sherson et al., 2015; Gatesman et al., 2017). It is recommended to utilize automated water collection systems, such as a Teledyne ISCO Automated Water Sample, to collect continuous water quality samples for analysis. In addition, these collection systems can be managed to collect at specific times, such as during peak daily flow events. This latter point was difficult to collect for during the 2022 season as the peak flow of the North Fork of the Colorado

River was 11 pm to 2 am at night. Newer collection systems can also be managed via telephone communication so water samples can be collected during intense storm events.

CONCLUSION

Due to the original sampling timeline plan of the 2022 field champagne, ideal water quality data was not collected. It is suggested that future sampling consist of automated sampling procedures (such as an ISCO water sampler) located near the mouth of the North Fork of the Colorado River. Sample collection time should be collected during the average daily peak flow determined by the Northern Water stream discharge gauge data located at the mouth of the NFCR. This will allow for a better snap shot of the sediment and geochemical load from peak runoff. Grab samples throughout the season should still be collected from upstream locations and the Supply Creek tributary. Additionally, grab samples should be collected at the mouth of the NFCR during storm flood events in order to collect reliable data on the sediment load during high runoff formed by storm flooding.

Determination of total suspended load of the NFCR and Supply Creek would be beneficial to understand the erosion of the East Troublesome Fire burn scar. Water samples collected during average daily runoff peaks and large monsoon storm events will allow for better collection and data of erosional solids in these water systems.

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