



COTTONWOOD CREEK FIRE BURNED AREA REHABILITATION PLAN



September 11, 2020

ON THE COVER

Cottonwood Creek Fire burned riparian zone (02/20/2020)

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PURPOSE AND NEED

This Burned Area Rehabilitation Plan documents post-fire impacts and potential impacts to natural resources, cultural resources, and visitor experiences and safety resulting from the Cottonwood Creek Fire in Grand Canyon National Park (GRCA). In addition, this Plan recommends actions designed to repair lands that were damaged directly by the Cottonwood Creek Fire. Recommended post-fire actions include stabilization and rehabilitation actions designed to promote public safety, protection of property and values at risk, and the long-term health of critical ecosystems.

FIRE BACKGROUND

The Cottonwood Creek Fire was reported by a Wildland Trekking guide at 1000 AM on 10/27/2019. The burn area is located on the east side of GRCA, approximately three miles north of Grandview Point and one mile south of the Colorado River in the Cottonwood Creek drainage. The fire occurred within the Eastern Park wilderness unit which provides picturesque plateaus and summits, habitat for threatened wildlife species, and solitude to adventurous visitors. The wilderness unit harbors 82.1 miles of the Colorado River (Nickel 2018) which enables visitors to experience wilderness through solitude and naturalness. Due to direct fire impacts, the USGS Gaging Station along Cottonwood Creek was lost.

TABLE 1. Fire Background

Cottonwood Creek Fire	
Agency Units	Grand Canyon National Park
Region	Intermountain
State	Arizona
Ignition Date	10/27/2019
Point of Origin	31 degrees, 1' 28.7, -111 degrees 59' 13.2
Date Contained	11/02/2019
Date Extinguished	01/06/2020
Acres Burned	64
Fire Number	AZGCP-000081
Fire Code	PF.FSMWV6020.00.1
NPS Case Number	NP19183320

The fire was human-caused due to park visitors (2) burning toilet paper after relieving themselves. The point of origin was adjacent to the Grandview Trail within the Cottonwood Creek Use Area. On 10/27/2019, strong winds and dry conditions resulted in rapid growth of the fire. Significant portions of the Cottonwood Creek riparian zone and adjacent upland shrublands and woodlands were significantly impacted. By the evening of 10/27/19, all forward progress in fine flashy fuels had ceased (M. Engbring, pers. comm., 06/02/2020). The fire was naturally suppressed as relative humidity increased to meet the moisture of extinction threshold. On 10/28/19 and 10/29/2019, the GRCA Flight Crew monitored and mapped the fire from the air. On 10/28/2019, the GRCA Flight Crew reported there was little smoke in the interior, no smoke around the perimeter, and the fire was left in monitor status. On 11/02/2019, the fire was contained, and on 01/06/2020 the fire was called out by GRCA Fire Managers. Burn severity is characterized in the Burned Area Reflectance Classification (BARC) section below.

References

Nickel, T. 2018. Grand Canyon wilderness character narrative and baseline monitoring assessment: Building blocks for wilderness stewardship. Natural Resource Report NPS/GRCA/NRR—2018/XXX. National Park Service, Fort Collins, Colorado.

BURNED AREA RESPONSE

Grand Canyon National Park began assessing post-fire impacts to resources, infrastructure, visitor experiences, and visitor safety shortly after the fire was called out. The team was comprised of specialists (see Table 2) from the National Park Service (NPS), United States Geological Survey (USGS), Northern Arizona University (NAU), and American Conservation Experience (ACE). Post-fire impacts were assessed on the following dates: 11/25/2019 - 11/26/2019, 02/18/2020 – 02/21/2020, 03/31/2020, 04/22/2020 – 04/23/2020, 04/27/2020 – 04/28/2020, and 07/23/2020. To date, staff has assessed impacts to natural and cultural resources, infrastructure, visitor experiences, and visitor safety. On 03/24/2020, GRCA reached out to the NPS National Post-Fire Programs Coordinator and requested assistance. On 03/25/2020, GRCA, NPS National Post-Fire Programs Coordinator, and the NPS Intermountain Region (IMR) Fire Ecologist discussed emergency stabilization, burned area rehabilitation treatments, and potential fund sources. Prior to discussions on 03/25/2020, GRCA staff were unaware of the Burned Area Emergency Response (BAER) Emergency Stabilization (ES) and Burned Area Rehabilitation (BAR) fund sources and associated proposal deadlines. Once aware, GRCA began assembling information to prepare a proposal to seek BAR funding for stabilization and rehabilitation actions. On 04/06/2020, a Burned Area Reflectance Classification (BARC) image was requested to assist with determining burn severity. Maps showing the perimeter of the burn and photos were provided as supportive documentation.

On 05/20/2020, GRCA submitted a Resource Damage Assessment to the NPS Special Agent assigned to this case. On 09/08/2020, the Cottonwood Creek Fire defendant plead guilty in federal court and restitution funds were earmarked for GRCA (see Budget Section).

TABLE 2. Burned Area Rehabilitation Plan Team

Role	Name	Affiliation
Chief of Science and Resource Management	Jeanne Calhoun	NPS, GRCA
Vegetation Program Manager	Lonnie Pilkington	NPS, GRCA
Wilderness Coordinator, Visitor Use Management and Wilderness	Mike Kearsley	NPS, GRCA
Vegetation Biologist	Dan Boughter	NPS, GRCA
Biological Science Technician	Cam Prophet	NPS, GRCA
Biologist	Ahsa Jensen	NPS, GRCA
Biological Science Technician	Meagan Dreher	NPS, GRCA
Archaeologist/Resource Advisor	Jason Nez	NPS, GRCA
GIS Program Manager	Mark Nebel	NPS, GRCA
GIS Specialist	Jered Hansen	NPS, GRCA
Recreation Technician	Claire Morris	NPS, GRCA
Permits Program Manager	Steve Sullivan	NPS, GRCA
Special Agent	Philip Oakes	NPS Investigative Services Branch
Paleontologist	Anne Miller	American Conservation Experience
Professor	Abe Springer	Northern Arizona University
Graduate Student	Sara Birch	Northern Arizona University
Hydrology Research Technician	Hannah Chambless	Northern Arizona University
Physical Scientist - Wildland Fire Science Team	Kurtis Nelson	USGS

BURNED AREA REFLECTANCE CLASSIFICATION (BARC)

Submitted by:

Kurtis Nelson¹ and Jered Hansen². ¹United States Geological Survey and ²National Park Service, Grand Canyon National Park

Background

A BARC is a satellite-derived data layer of post-fire vegetation condition. The BARC has four classes: high, moderate, low, and unburned.

Assessment

On 04/06/2020, BARC imagery was obtained to help determine soil burn severity. The BARC revealed a mixed severity burn that impacted a diverse set of vegetation associations (see Table 3 and Figure 1). The fire resulted in impacts to the *Pinus edulis* – *Juniperus osteosperma*/Cercocarpus – *Quercus* Woodland Alliance which provides foraging habitat for the declining Pinyon Jay (*Gymnorhinus cyanocephalus*). The fire impacted the highly biodiverse *Populus fremontii* – *Salix gooddingii* Woodland Alliance which is currently declining across the southwestern U.S. This vegetation association provides critical habitat for the federally listed threatened Mexican Spotted Owl (*Strix occidentalis lucida*) (MSO) since MSOs use vegetated creek beds to roost during hot months and to hunt for their preferred prey, the wood rat (*Neotoma* spp.).

Table 3 . BARC and Vegetation Association Data

Vegetation Association	Code	Burn Severity	Acres Burned
<i>Acacia greggii</i> Shrublands	AcGr	Low	3.90641
<i>Acacia greggii</i> Shrublands	AcGr	Moderate	0.215728
<i>Baccharis</i> spp. - <i>Salix exigua</i> - <i>Pluchea sericea</i> Shrubland Alliance	BaSa	Low	0.36954
<i>Baccharis</i> spp. - <i>Salix exigua</i> - <i>Pluchea sericea</i> Shrubland Alliance	BaSa	Moderate	1.255177
<i>Brickellia longifolia</i> - <i>Fallugia paradoxa</i> - <i>Isocoma acradenia</i> Shrubland	BlFp	Low	1.314073
<i>Brickellia longifolia</i> - <i>Fallugia paradoxa</i> - <i>Isocoma acradenia</i> Shrubland	BlFp	Moderate	0.00158
<i>Cercocarpus montanus</i> - <i>Amelanchier utahensis</i> Shrubland Alliance	CmAu	Low	0.407497
<i>Cercocarpus montanus</i> - <i>Amelanchier utahensis</i> Shrubland Alliance	CmAu	Moderate	0.19069
Colorado Plateau Hanging Garden Seep Group	CpHg	Low	0.199147
Colorado Plateau Hanging Garden Seep Group	CpHg	Moderate	0.329068
<i>Ephedra</i> (<i>torreyana</i> , <i>viridis</i>) / Mixed Semi-desert Grasses Shrubland	EpSp	Low	18.00101

<i>Fraxinus anomala</i> - <i>Rhus trilobata</i> - <i>Fendlera rupicola</i> Talus Shrubland Alliance	FaRt	Low	10.0917
<i>Fraxinus anomala</i> - <i>Rhus trilobata</i> - <i>Fendlera rupicola</i> Talus Shrubland Alliance	FaRt	Moderate	2.300419
<i>Gutierrezia (sarothrae, microcephala)</i> - <i>Ephedra (torreyana, viridis)</i> Mojave Desert Shrubland Alliance	GuEp	Low	5.032644
<i>Gutierrezia (sarothrae, microcephala)</i> - <i>Ephedra (torreyana, viridis)</i> Mojave Desert Shrubland Alliance	GuEp	Moderate	1.66543
<i>Pinus edulis</i> - <i>Juniperus osteosperma</i> / <i>Cercocarpus</i> - <i>Quercus</i> Woodland Alliance	PeJo	Low	0.458384
<i>Pinus edulis</i> - <i>Juniperus osteosperma</i> / <i>Cercocarpus</i> - <i>Quercus</i> Woodland Alliance	PeJo	Moderate	0.228987
<i>Populus fremontii</i> - <i>Salix gooddingii</i> Woodland Alliance	PfSg	Low	0.989335
<i>Populus fremontii</i> - <i>Salix gooddingii</i> Woodland Alliance	PfSg	Moderate	0.435344

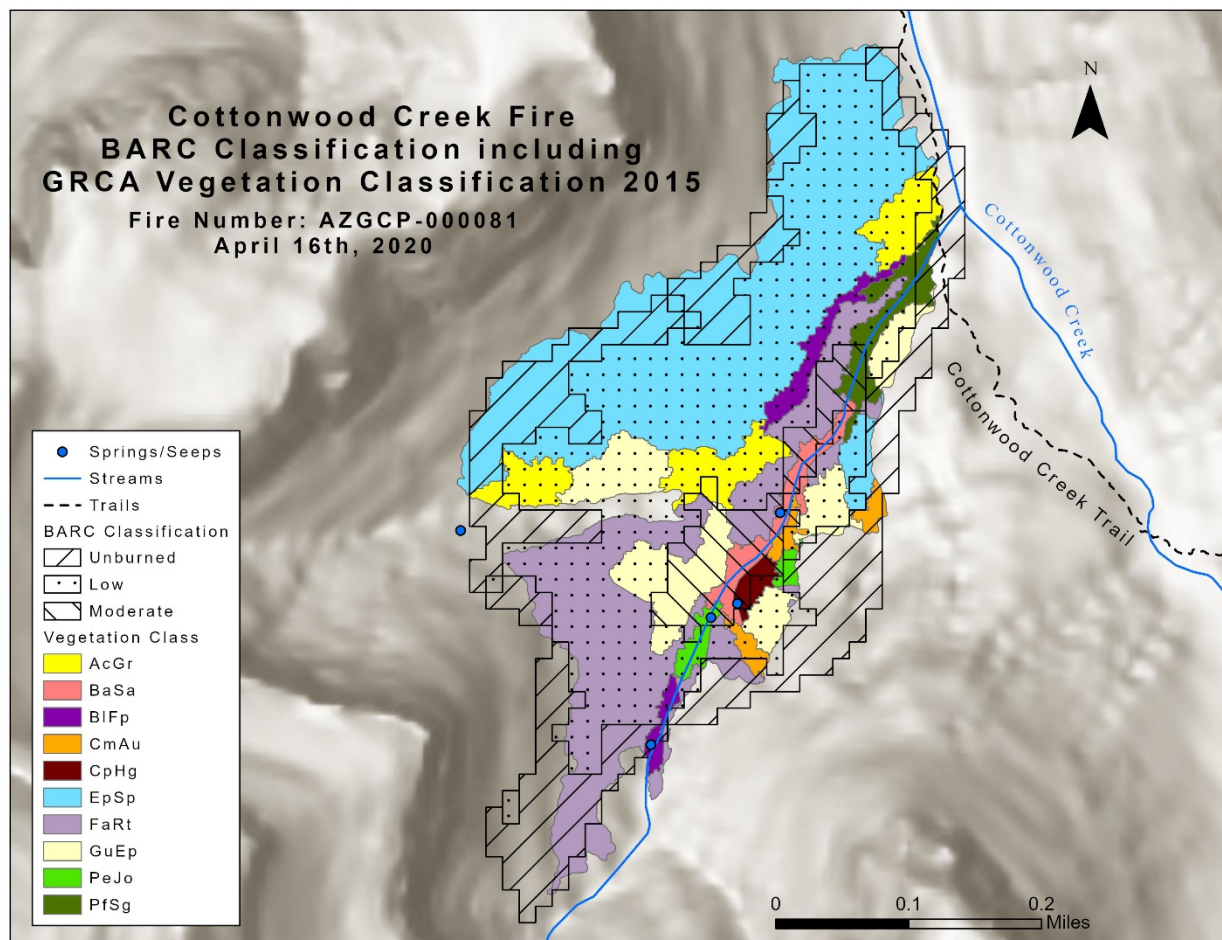


Figure 1. BARC and Vegetation Association Map

References

Kearsley, M.J.C., K. Green, M. Tukman, M. Reid, M. Hall, T.J. Ayers, and K. Christie. 2015. Grand Canyon National Park-Grand Canyon / Parashant National Monument vegetation classification and mapping project. Natural Resource Report NPS/GRCA/NRR---2015/913. National Park Service, Fort Collins, CO.

Parson, Annette; Robichaud, Peter R.; Lewis, Sarah A.; Napper, Carolyn; Clark, Jess T. 2010. Field guide for mapping post-fire soil burn severity. Gen. Tech. Rep. RMRS-GTR-243. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 49 p

POST-FIRE ASSESSMENT FOR HYDROLOGY AND WATERSHED

Submitted by:

Abe Springer and Sara Birch, Northern Arizona University



Site Description

This report summarizes the hydrologic assessment of the Cottonwood Creek Fire in Grand Canyon National Park. The fire occurred entirely within lands managed by the National Park Service. The Cottonwood Creek Fire took place on the east side of the park in an area that received an average precipitation of 17.48 inches throughout 2019, with roughly 12.14 inches as snow, and 5.34 inches as monsoonal rainfall (<http://prism.oregonstate.edu>) (Fig. 2a). Flows in Cottonwood Creek and its associated springs are highest in late spring, with the peak 2019 gauge discharge measured at ~0.07 cubic feet per second (cfs) (Figure 2b). The largest flow

rates are assumed to be associated with snowmelt runoff during late spring, usually around March-April with seasonal variability.

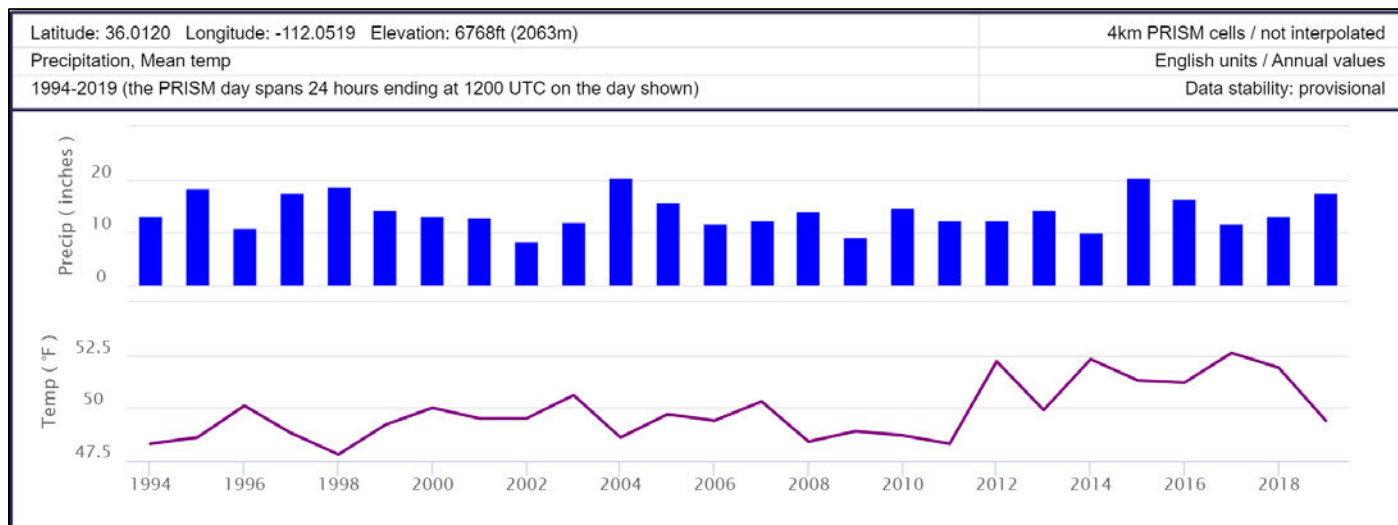


Figure 2a. Mean annual precipitation and temperature values from 1994-2019 in the Cottonwood Creek watershed. Values were obtained from the PRISM Climate Group at Oregon State University.

Annual and monthly mean precipitation and temperature data were obtained from the PRISM Climate Group database (<http://prism.oregonstate.edu>) (Fig. 2b). Precipitation in northern Arizona primarily falls in the form of snow during the winter season, typically October-March with yearly variability. Summer monsoons (July-August) contribute spikes in precipitation; however, these spikes undergo variability depending on the intensity and timing of the monsoon season. Prior to the Cottonwood Creek fire, summer precipitation was recorded at approximately 1.52 inches from July-August 2019, and 4.70 inches from October-December.

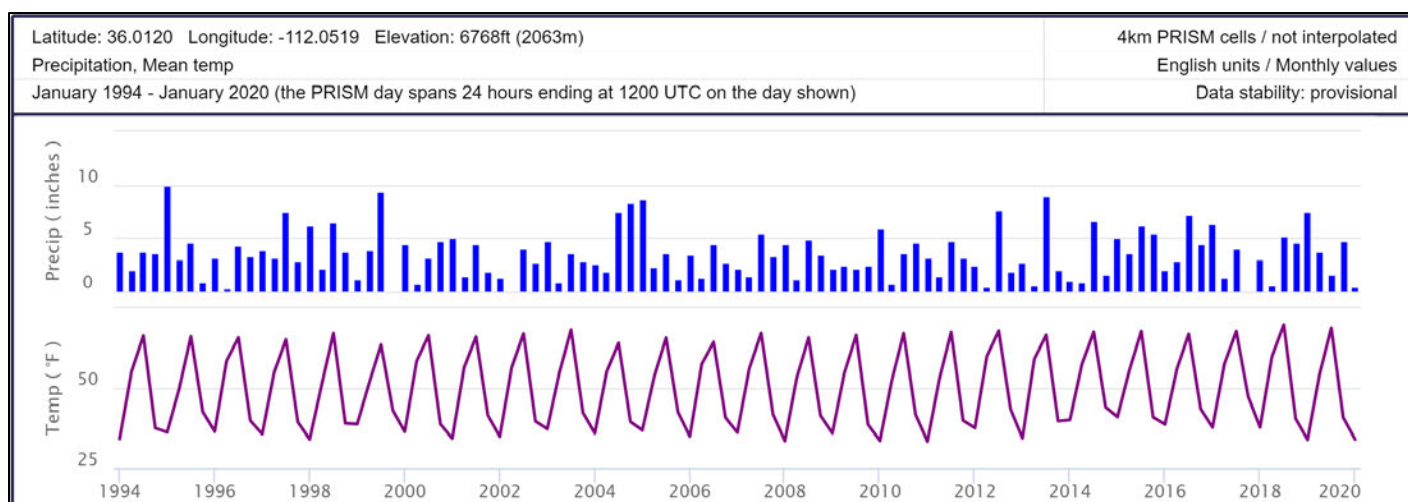


Figure 2b. Monthly mean precipitation and temperature data in the Cottonwood Creek watershed from 1994-2020. Values were obtained from the PRISM Climate Group at Oregon State University.

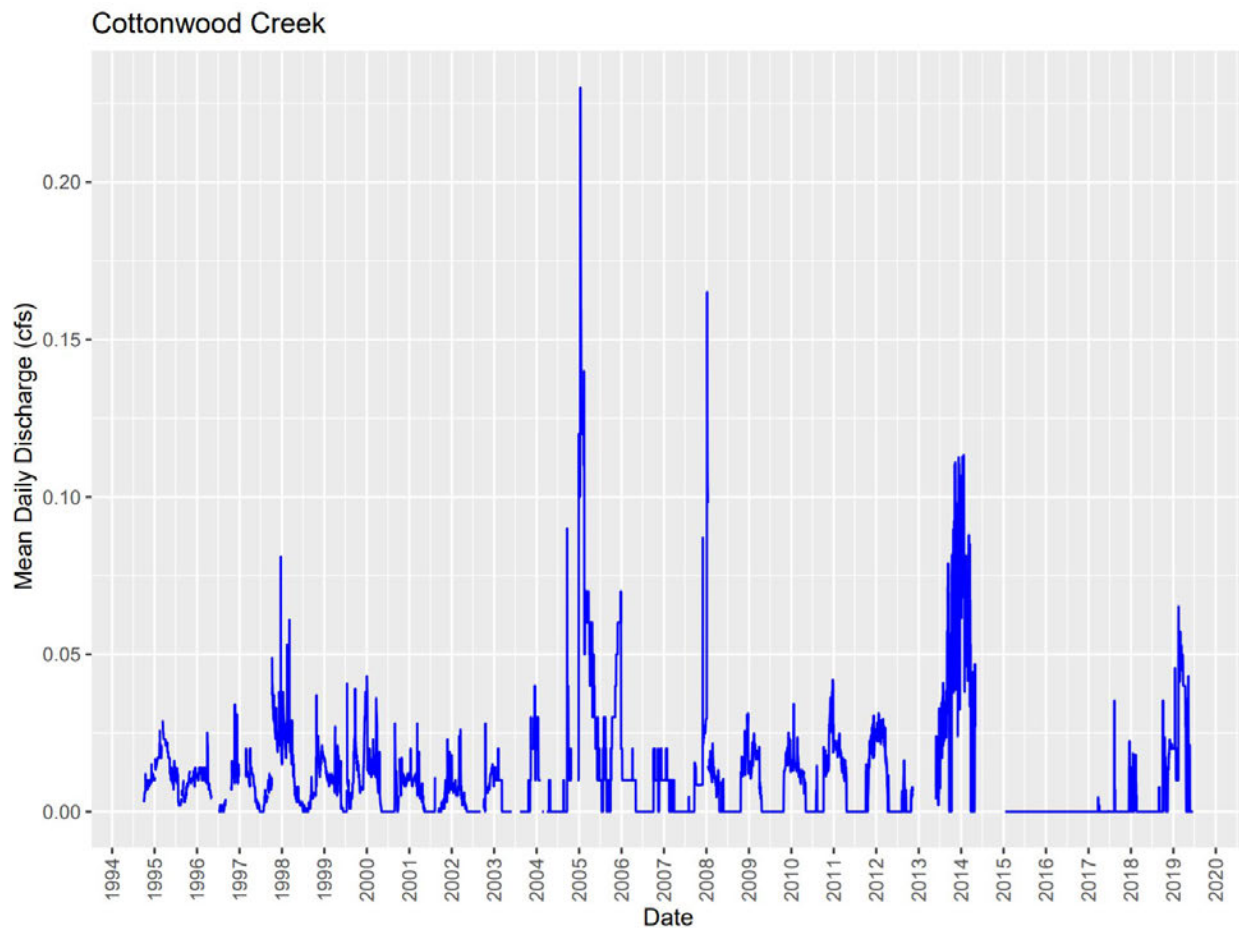


Figure 3. Monthly mean discharge (cfs) at the Cottonwood Creek gauge from 1994-2020. Discharge values were collected from the Aquarius database, and the USGS stream gaging website (<https://waterdata.usgs.gov/nwis/rt>).

A composite hydrograph for the Cottonwood Creek gauge was prepared from disparate sources to display recorded discharge measurements from 1994-2019 (Fig. 3). Peak discharge events correlate with snowmelt from winter precipitation events and occur during late spring (Jones et al. 2018). Discharge values at the Cottonwood Creek gauge indicate peak flows February-April and decrease into summer months. Summer monsoon events generally provide a spike in discharge, and gradually decline throughout late summer through early spring.

Management of the Cottonwood Creek gauge was under the USGS from 1994-2003. The NPS continued monitoring from 2003-2017. Little to no continuous discharge measurements were collected between 2014-2017, accounting for the gap in data on the hydrograph (personal communication with Steven Rice). The USGS began monitoring efforts again in 2017 and reinstated continuous discharge measurements at the Cottonwood Creek gauge. The

Cottonwood Creek fire destroyed the gaging device; this gage will soon be replaced to begin discharge measurement collection.

Prior to the Cottonwood Creek fire, peak discharge was recorded at ~0.07 cfs during snowmelt season (March-April). Discharge at the gaging station generally decreased following snowmelt, with a minor spike during monsoon season (July-September). The monsoon season in the southwestern US did not produce frequent or intense storms in 2019 compared to average years. The gage generally records no flow about half of the days of the year.

Table 4. MODEL RESULTS FOR ANTICIPATED CHANGES TO PEAK FLOWS AND SEDIMENT YIELD INCREASES

WATERSHED	PRE-FIRE PEAK FLOW (cfs)	POST-FIRE PEAK FLOW (cfs)	PEAK FLOW INCREASE (%)	MAGNITUDE PEAK FLOW INCREASE	SEDIMENT YIELD INCREASE (%)	MAGNITUDE SEDIMENT YIELD INCREASE
Cottonwood Creek	~0.07	~ 0.00032*	N/A Post-fire peak flow not recorded	N/A	N/A	N/A

***A post-fire peak flow has not yet been recorded. The USGS gauge in Cottonwood Creek is inoperable due to fire damage. A pressure transducer was installed February 18th, 2020; however, measurements from the instrument have not yet been collected. The value for post-fire peak flow is a measured discharge below the USGS gaging station and was measured with a 30 degree steel plate weir on February 19th, 2020.**

Debris Flow Modeling

Most debris flows in a burned area occur within the first 12 months following exposure to wildfire. Factors which increase the possibility of a debris flow include the burn severity, gradient, seasonal occurrence, and rainfall regime (DeGraff et al., 2015). Predicting the possibility of a debris flow in the Cottonwood Creek watershed requires analysis of monsoon recurrence intervals and magnitudes.

Figure 2a displays historic precipitation data for the Cottonwood Creek watershed. Analysis of the plot indicate summer monsoon events provide roughly 4 inches of precipitation from July-September (<http://prism.oregonstate.edu>). El Nino climate conditions are predicted to remain neutral throughout summer months of 2020, indicating an average amount of rainfall to occur during monsoon events. In this event, it is unlikely for a debris flow to occur, so long as the intensity of the monsoons are average.

Summary

The Cottonwood Creek watershed is displaying general warming in temperature conditions and increasingly erratic behavior of precipitation events in recent years (2010-present) (Fig. 2a). In

response, flows in Cottonwood Creek peak with high snowmelt and monsoon events, and are typically dry between these seasonal events (Fig. 3). It is difficult to predict the possibility of a monsoon event in the Cottonwood Creek watershed due to recent erratic behavior in climate conditions near the site. If average precipitation values are observed by the 2020 summer monsoon, a debris flow is less likely.

Mitigations/Recommendations

It is recommended that quarterly hydrological and geomorphological monitoring continue in the Cottonwood Creek watershed over the course of 1 year, with continued efforts spanning throughout watershed recovery. Changes to discharge events, sedimentation transport, and hydrologic function will be better understood as monitoring continues throughout the year in the Cottonwood Creek watershed.

Replanting of native riparian plant species, such as the coyote willow (*Salix exigua*), would allow for some bank stabilization to occur. Native plant restoration actions may mitigate future issues, such as sediment yield increase during summer storm events.

References

- DeGraff, J.V., Cannon, S.H., Gartner, J.E., 2015, The Timing of Susceptibility to Post-Fire Debris Flows in the Western United States: Environmental & Engineering Geoscience, vol. XXI, no. 4, p. 277-292.
- Jones, J.C., Springer, E.A., Tobin, W.B., Zappitello, J.S., Jones, A.N., 2017, Characterization and hydraulic behavior of the complex karst of the Kaibab Plateau and Grand Canyon National Park, USA: Geological Society, London, Special Publications, 466. <https://doi.org/10.1144/SP466.5>.
- PRISM Climate Group, Oregon State University, <http://prism.oregonstate.edu>, created 4 Feb 2004.

POST-FIRE ASSESSMENT FOR VEGETATION MANAGEMENT

Submitted by:

Lonnie Pilkington, Dan Boughter, Cam Prophet, Ahsa Jensen, and Meagan Dreher,
National Park Service, Grand Canyon National Park



Figure 4. Burned riparian area (02/20/2020)



Figure 5. Adjacent unburned riparian area (02/20/2020)

Initial Concerns

- Potential for soil erosion (i.e., rills, gullies, debris flows) inside and outside of the burn area.
- Invasive non-native plant establishment and spread inside and outside of the burn area.
- Impact of cheatgrass (*Bromus tectorum*) and red brome (*Bromus rubens*) on fire frequency and intensity.
- Fire weakened timber (e.g., burned Fremont cottonwood [*Populus fremontii*] trees) within and adjacent to the Cottonwood Creek Use Area.
- Impacts to the ecological integrity of burned riparian and upland plant communities and dependent species.

Assessments

Post-fire impacts were assessed during on-site visits on the following dates: 11/25/2019 - 11/26/2019, 02/18/2020 – 02/21/2020, 03/31/2020, 04/27/2020 – 04/28/2020, and 07/23/2020. On 02/19/2020, quantitative data describing ground cover (moss, lichen, litter, biological soil crusts [BSC], rocks, bare ground) and foliar cover of vascular plants (differentiated by species and functional group, live or standing dead) were collected along ten 50-meter (m) transects (i.e., five transects inside the burned upland area and five transects in adjacent unburned upland areas [reference sites]) using the line-point intercept method (Canfield 1941). On 02/20/2020, quantitative data describing ground cover (moss, lichen, litter, biological soil crusts [BSC], rocks, bare ground) and foliar cover of vascular plants (differentiated by species and functional group, live or standing dead) were collected along ten transects (i.e. five transects inside the burned riparian area and five transects in adjacent unburned riparian areas [reference sites]) using the cross-channel point-count transect method (Spence and Wheeler 2011). Photos were taken at each transect start and end point to assist with monitoring vegetation and ecosystem change over time (Hunt et al. 2005).

Preliminary vegetation monitoring data revealed significant differences in total vegetation cover between burned and unburned riparian and upland areas. Total vegetation cover was 65.74 % in adjacent unburned upland areas, while total vegetation cover in burned upland areas was 14.78 %. Total vegetation cover was 49.99 % in adjacent unburned riparian areas, while total vegetation cover in burned riparian areas was 00.00 %. Upland and riparian plant communities in the area appear to be very diverse based on vegetation transect data collected in adjacent unburned areas. The dominant species in unburned upland areas include: catclaw acacia (*Acacia greggii* var. *arizonica*), netleaf hackberry (*Celtis laevigata* var. *reticulata*) three-leaved snakeweed (*Gutierrezia microcephala*), Mormon tea (*Ephedra* spp.), threeawn grass (*Aristida* spp.), scratchgrass (*Muhlenbergia asperifolia*), sand dropseed (*Sporobolus cryptandrus*), spike dropseed (*Sporobolus contractus*), cheatgrass, and red brome. The dominant species in unburned riparian areas include: Fremont cottonwood, singleleaf ash (*Fraxinus anomala*), willow baccharis (*Baccharis* spp.), and skunkbush (*Rhus trilobata*). Based on the BARC, burn severity was low to moderate and impacted a diverse set of vegetation associations (Kearsley et al 2015).

Vegetative resources in the burn area provide habitat for a number of species including small mammals, aquatic and terrestrial invertebrates, and birds, including the federally listed threatened Mexican Spotted Owl. In addition, these vegetative resources and ground cover (moss, lichen, litter, biological soil crusts [BSC], rocks, bare ground) provide soil stability as well as aesthetic values.

Findings

General Vegetation Impacts and Expected Recovery

Preliminary post-fire vegetation monitoring data revealed that vegetative mortality was significant in burned upland (14.78 % total vegetation cover) and riparian areas (00.00 % total vegetation cover) when compared to unburned upland (65.74 % total vegetation cover) and riparian areas (49.99 % total vegetation cover). Based on the BARC, the impacted upland area contains a mosaic of low to moderate burn severity. In late April of 2020, vegetative regeneration (native and non-native species) was documented in portions of the burned upland and riparian areas; however, cheatgrass and red brome were invading some areas. White sagebrush (*Artemisia ludoviciana*), sanddune cryptantha (*Cryptantha fendleri*), gooseberry globemallow (*Sphaeralcea grossulariifolia*), sticky brittlebush (*Encelia resinifera*) and cliffrose (*Purshia stansburiana*) were noted re-sprouting in areas where the burn was less severe; however, cheatgrass and red brome were invading many areas. Soils in burned areas varied from unstable to moderately stable. In the upland area, hundreds of trees, thousands of shrubs, and an unknown number of forbs and grasses were killed or damaged by the fire. The likelihood of recovery of many impacted upland native plant species is unknown and will be closely monitored.

Based on the BARC, the impacted riparian area experienced low to moderate burn severity. In the riparian zone, 100+ Fremont cottonwood (diameter at breast height (DBH) ranged from 14 cm – 44 cm and tree height ranged from 7.62 m or 25 ft. to 10.36 m or 34 ft.), numerous seep willow, and an unknown number of shrubs, grasses and forbs were killed or damaged by the fire. In late April of 2020, minimal to moderate vegetative regeneration and unstable soils were documented in the impacted riparian zone. Coyote willow (*Salix exigua*), seep willow (*Baccharis emoryii*), dogbane (*Apocynum cannibum*), cattail (*Typha angustifolia*), and sedges (*Carex* spp.) were noted re-sprouting in areas where the burn was less severe; however, cheatgrass and red brome were invading the edge of riparian zone in some areas. On 07/23/2020, rushes (*Juncus* spp.), sedges, reeds, willow (*Salix* spp.) and California redbud (*Cercis orbiculata*) were re-sprouting in the stream reaches with shallow to flowing water (A. Springer, pers. comm., 07/24/2020). In reaches with no flowing water or wet soil, no re-sprouting had occurred and only 5 Fremont cottonwood seedling re-sprouts were documented in the burned riparian zone (A. Springer, pers. comm., 07/24/2020).



Figure 6. Dense red brome colonization along burned upland area transect # 3 (04/27/2020)

Values at Risk: Invasive Plants

In many areas of the western United States, it is common for fire disturbance to facilitate invasion and expansion of invasive non-native plant species such as cheatgrass and red brome. Cheatgrass and red brome are cool season grasses that have a competitive advantage over many native species and commonly thrive in disturbed areas resulting from fire, roads, and trails. Cheatgrass and red brome cause significant environmental impacts through altering wildfire regimes, impacting species diversity, and reducing wildlife habitat (Mealor et al. 2013, Reid et al. 2008, Fusco et al. 2019).

The Cottonwood Creek Fire burn area and adjacent undisturbed lands are at risk of rapid invasion and expansion of cheatgrass, red brome, and other invasive non-native plants. Vegetation monitoring efforts in February, March, and April of 2020 revealed that cheatgrass and red brome were rapidly colonizing the burned upland area, and both species were also detected in the burned riparian zone. On 04/27/2020 and 04/28/2020, red brome (see Figure 6) was observed every 25 cm to 45 cm along burned upland area vegetation transects. Recent data collections confirm that conditions are favorable for rapid invasion and expansion of invasive non-native plants inside and directly adjacent to the burn area. Additional invasive non-native species documented within 0.75 miles of the fire perimeter that are considered medium to high priorities include common sowthistle (*Sonchus oleraceus*) and horehound

(*Marrubium vulgare*) (NPS 2009, SEINet 2020). Invasive non-native plant monitoring and treatments are planned for the burn area and adjacent unburned areas.

Management Recommendations

The following stabilization, rehabilitation, and restoration actions are proposed to mitigate post-fire threats to natural resources.

Invasive Non-Native Plant Management

Mechanical, chemical, and/or cultural (e.g. seeding grasses that are highly competitive with annual brome species) control methods will be used to treat high priority invasive non-native plant species (NPS 2009) within and directly adjacent to the burn area. Treatments will be implemented in the spring, summer, and/or fall. Treatment will begin in the summer of 2021 and occur annually through 2023. An estimated three to five acres will be treated annually.

Restoration

To repair and improve lands impacted by the fire, the following stabilization and rehabilitation actions will be implemented in the burned riparian zone: installation of 300 Coyote willow stakes (FY 2021), out-planting of 200 Fremont cottonwood trees (FY 2023), installation of temporary fencing around cottonwood plantings to discourage herbivory by mule deer (*Odocoileus hemionus*) (FY 2023), and invasive non-native plant control (FYs 2021 – 2023). Between 2021 and 2023, the following stabilization and rehabilitation actions will be implemented in the burned upland area: reseeding areas that are prone to erosion or lack natural regeneration (as needed), reseeding species critical to monarch butterfly (*Danaus plexippus*) conservation efforts installation of log erosion barriers on highly erodible slopes (if needed), and invasive non-native plant management focused primarily on annual non-native bromes (e.g. red brome and cheatgrass). Plant materials for rehabilitation and stabilization actions will be collected at nearby source populations containing equivalent habitat types (Mijnsbrugge et al. 2009). Target species for seed collection and reseeding will include species known to compete well with annual non-native bromes such as squirreltail (*Elymus elymoides*) (Stevens et al. 2014), species relatively tolerant to Imazapic such as sideoats grama (*Bouteloua curtipendula*) (Mealor et al. 2013), and species critical to monarch butterfly conservation efforts such as antelope horns milkweed (*Asclepias asperula*) (Nabhan et al. 2015). In addition, reseeding efforts will include shrub species such as fourwing saltbush (*Atriplex canescens*) that can effectively establish through direct seeding.

Monitoring

Vegetation Monitoring

Following active restoration, evaluation of riparian restoration success will occur on an annual basis for five years and include monitoring of planted tree (e.g. Fremont cottonwood) survivability, growth, and repeat photography. At the time of planting, data collections will include: tree height, canopy cover, diameter at breast height, planting method, and overall tree

health. Each planted tree will be tagged (½" x 2" aluminum tag) with a unique number and GPS coordinates will be recorded. Eight permanent photo points will be established throughout the riparian restoration site. Photo point monitoring will be conducted on an annual basis. If restoration is not progressing towards a later successional stage, additional restoration treatments (i.e. seeding, planting, erosion control, invasive non-native plant control, etc.) may be implemented. Restoration success monitoring will continue through 2024.

Invasive Plant Monitoring

Qualitative data collection will occur on an annual basis and include mapping infestations inside and directly adjacent to the burn area.

References

Canfield, R.H. 1941. Application of the line interception method in sampling range vegetation. *Journal of Forestry* 39:399-394.

Huisinga, K., L. Makarick, and K. Watters. 2006. *River and desert plants of the Grand Canyon*. Mountain Press Publishing Company.

Hunt, E., J.H. Everitt, and R. Hamilton. 2005. *A weed manager's guide to remote sensing and GIS-mapping and monitoring*, remote sensing applications center, USDA Forest Service, Salt Lake City, Utah. USDA Forest Service Resource Notes.

Kearsley, M.J.C., K. Green, M. Tukman, M. Reid, M. Hall, T.J. Ayers, and K. Christie. 2015. Grand Canyon National Park-Grand Canyon / Parashant National Monument vegetation classification and mapping project. Natural Resource Report NPS/GRCA/NRR---2015/913. National Park Service, Fort Collins, CO.

Mealor, B.A., R.D. Mealor, W.K. Kelley, D.L. Bergman, S.A. Burnett, T.W. Decker, B. Fowers, M.E. Herget, C.E. Noseworthy, J.L. Richards, C.S. and Brown. 2013. *Cheatgrass management handbook: managing an invasive annual grass in the Rocky Mountain region*. B (Laramie, Wyo.); no. 1246.

Nabhan, G., S. Buckley, and H. Dial. 2015. *Pollinator Plants of the Desert Southwest: Native Milkweeds (Asclepias spp.)*. USDA-Natural Resources Conservation Service, Tucson Plant Materials Center, Tucson, AZ. TN-PM-16-1-AZ.

Vander Mijnsbrugge, K., A. Bischoff, and B. Smith. 2010. A question of origin: where and how to collect seed for ecological restoration. *Basic and Applied Ecology*, 11(4), 300-311.

National Park Service (NPS). 2017. *Burned Area Emergency Response Plan*. Glacier National Park, West Glacier, Montana.

National Park Service (NPS). 2009. Grand Canyon National Park Exotic Plant Management Plan, Environmental Assessment/Assessment of Effect.

Phillips, B. G., A. M. Phillips III, and M.A.S. Bernzott. 1987. Annotated checklist of vascular plants of Grand Canyon National Park: 1987, Vol. 7. Grand Canyon Natural History Association.

Reid, C. R., S. Goodrich, and J.E. Bowns. 2008. Cheatgrass and red brome; the history and biology of two invaders. In: Kitchen, Stanley G.; Pendleton, Rosemary L.; Monaco, Thomas A.; Vernon, Jason, comps. 2008. Proceedings-Shrublands under fire: disturbance and recovery in a changing world; 2006 June 6-8; Cedar City, UT. Proc. RMRS-P-52. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 27-32, 52.

SEINet. 2019. Website: <http://swbiodiversity.org/seinet/> (accessed 08 April 2020)

Spence, J. R. and M. Wheeler. 2011. Monitoring following woody invasive species removal in the Escalante River Watershed.

POST-FIRE ASSESSMENT FOR CULTURAL RESOURCES

Submitted by:

Jason Nez and Ellen Brennan, National Park Service, Grand Canyon National Park

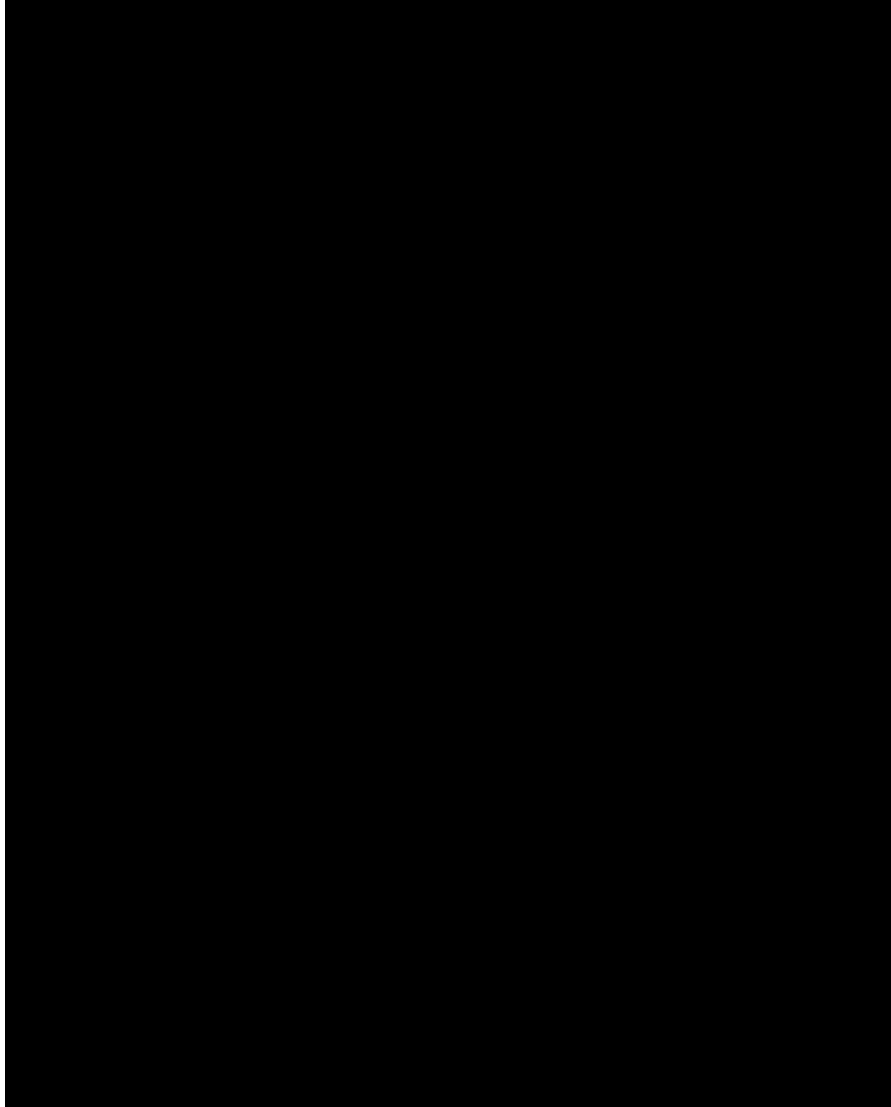


Figure 7. Cultural site locations

Initial Concerns

- Potential fire damage to cultural resources.
- Potential for short term and/or long term impacts to cultural resources due to soil erosion (i.e., rills, gullies, debris flows) and/or debris flows.
- Assess the need for stabilization actions within and adjacent to cultural sites.

Observations

Background

Within a few days of ignition, J. Nez accessed park data [REDACTED]
[REDACTED]

Site Description

[REDACTED]

Assessment and Findings

On 3/31/2020, J. Nez visited the site to assess post-fire related damage to cultural resources and potential erosion issues. Accompanied by GRCA Vegetation Program staff, the Fire Archaeologist [REDACTED]

[REDACTED]

[REDACTED] these grasses, although invasive non-natives, may help stabilize the site in the short term. As of 03/31/2020, no native plant species had begun to colonize the cultural site. [REDACTED]

[REDACTED]
The site was monitored using the Grand Canyon Cultural Resources Department Monitoring Form (GRCA Monitoring Form v2018.1) and [REDACTED]

[REDACTED] The monitoring form evaluates site disturbance, data potential, depositional integrity, site condition, management action, threat from fire, and national register evaluation as defined in the Cultural Resource Management Programs Protocols Document (2016). In addition, a Grand Canyon Cultural Resources Department Post Fire Monitoring form was completed.

Compliance for Stabilization and/or Rehabilitation Treatments

Burned area stabilization, rehabilitation, and monitoring actions will be assessed to determine their potential effect on cultural resources. Compliance tasks may include cultural resource surveys and evaluations, Tribal Historic Preservation Office consultation and State Historic Preservation Office consultation (NPS 2017). Whenever possible, stabilization, rehabilitation, and monitoring activities should result in a finding of “no historic properties affected” (NPS 2017).

Proposed Treatments

At this time, we do not recommend stabilization or rehabilitation actions [REDACTED]

[REDACTED]

If impacts to cultural resources are identified, cultural resources and vegetation program staff may stabilize and rehabilitate the site by installing erosion control structures (e.g., log erosion barriers), seeding, and/or mulching.

Monitoring

An additional cultural resource monitoring trip will occur following the 2020 monsoon season. It is very doubtful that future erosion events will negatively impact [REDACTED] however, if the monsoonal floods are more intense than normal, there is a possibility of significant erosion and negative impacts to cultural resources.

References

Grand Canyon National Park, Science and Resource Management. (2016). Cultural Resource Management, Protocols Document, Grand Canyon National Park. Report 2016-01-GRCA.

National Park Service (NPS). 2017. Burned Area Emergency Response Plan. Glacier National Park, West Glacier, Montana.

POST-FIRE ASSESSMENT FOR PALEONTOLOGICAL RESOURCES

Submitted by:

Mark Nebel¹ and Anne Miller²

¹Grand Canyon National Park (GRCA) and ²American Conservation Experience (ACE)

Initial Concerns

- Potential fire damage to paleontological resources.
- Potential for short term and/or long-term impacts to paleontological resources due to soil erosion (i.e., rills, gullies, debris flows) and/or debris flow impacts.
- Potential collection of significant and vulnerable paleontological resources.
- Assess the need for stabilization and monitoring actions for paleontological localities.

Observations

Background

The burned area has not been previously surveyed for paleontological resources. Potentially fossiliferous geologic formations mapped in the burned area include the Cambrian Bright Angel Shale and Muav Limestone.

[REDACTED]

[REDACTED]

Site Description

The Bright Angel Shale consists of mostly continuous layers of interbedded sandstone, siltstone, and shale that most often forms a slope with few exposed cliffs. Many of these layers are weak and can be easily eroded. The Bright Angel Shale contains the highest density of Cambrian trace fossils across Grand Canyon National Park and provides important information on Cambrian paleoecology to scientists around the world.

[REDACTED]

[REDACTED] The burned area needed to be surveyed to assess any potential damage to significant paleontological resources that may exist there.

The Muav Limestone is a cliff-forming unit composed of limestone, dolomite, thin shale and siltstone, and conglomerate (Connors et al., 2020). Due to its cliff-forming nature and difficult access, it is not well studied in Grand Canyon for paleontological resources, but potentially contains diverse, primarily marine, paleontological resources.

Assessment and Findings

On April 27 and 28, 2020, several paleontology survey lines were conducted within the perimeter of the Cottonwood Creek burn area. The geology within the burned area mostly consists of Redwall talus, cover, and creek cobbles; however, there are two major outcrops of Bright Angel Shale on the east side of the main Cottonwood Creek area where the fire appeared to cause the most damage (Figures 11 and 12). These outcrops contain several layers of sandstone, siltstone, and shale that gradually form a slope down towards the creek. There are thousands of fallen out pieces from the outcrop that rest precariously on the slope. [REDACTED]

[REDACTED]

[REDACTED]

The slopes that come out of the outcrops are unstable, but this is a common characteristic for the Bright Angel Shale. Most of the instability of the slope appears to occur nearest to the creek bed where the sediment has been charred. This area was surveyed most thoroughly for significant fossil specimens. Collection of these specimens was the only mitigation needed. These outcrops could be more thoroughly surveyed on a future monitoring trip for continued exposure and weathered out material, especially for significant fossils like trilobites or other more unique trace fossils.



Figure 11. First Bright Angel Shale outcrop next to creek



Figure 12. Second Bright Angel Shale outcrop next to creek.

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]



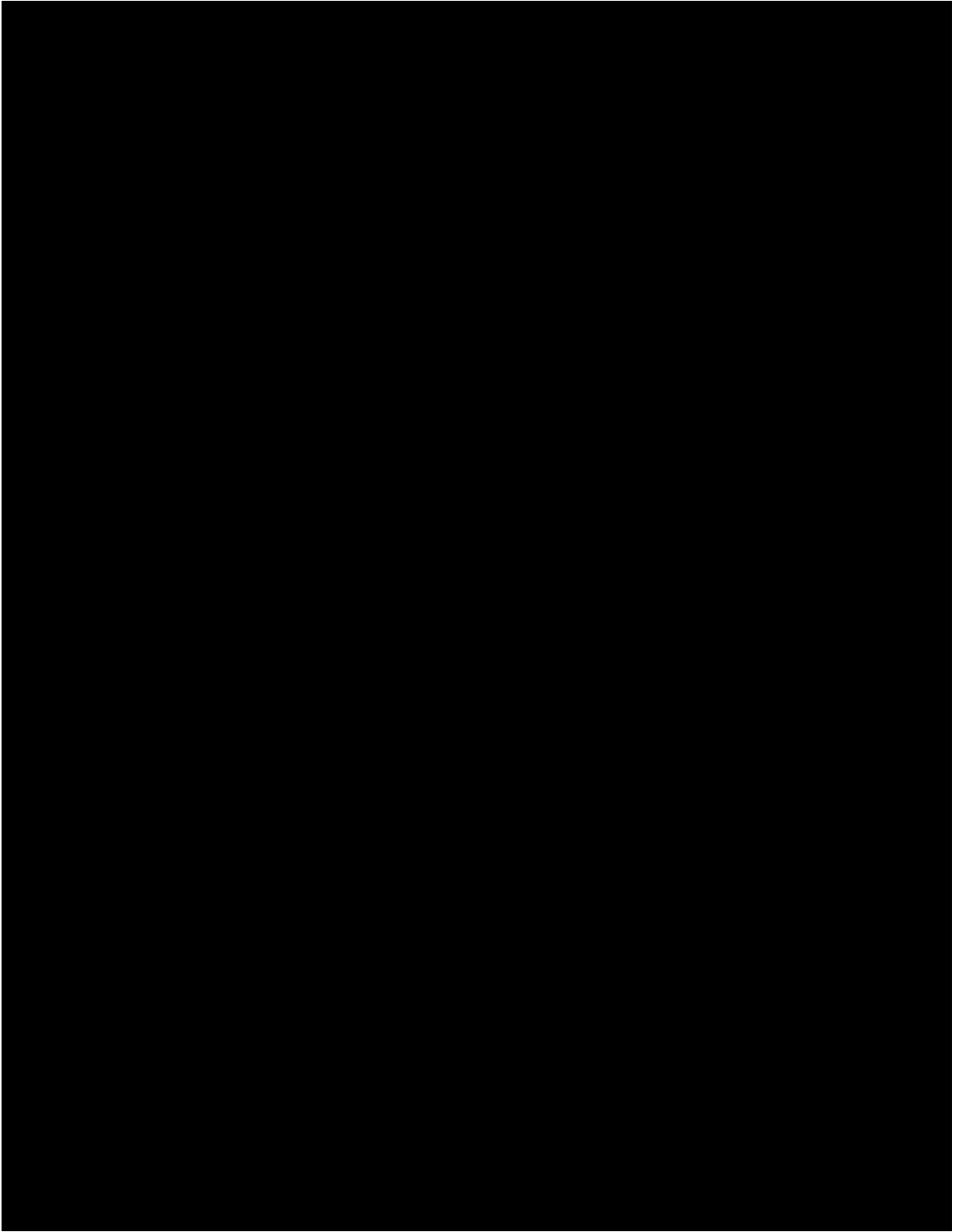


Figure 16. Map of Cottonwood Canyon area showing the fire perimeter, paleontology survey [REDACTED]

Proposed Treatments

The Bright Angel Shale is particularly vulnerable to erosion, and this would be exacerbated by a lack of vegetation on burned slopes [REDACTED]

Monitoring

Additional monitoring of the site would be provisional, and only necessary if a significant erosion event occurs. These types of events would most likely occur during the Arizona monsoon season (June - September). Monitoring of vegetation and soil resources by other GRCA programs will alert the GRCA Paleontology Program to any such event. In the case of a major erosion event, the GRCA Paleontology Program will conduct a follow-up evaluation [REDACTED]

[REDACTED] most, this would entail one annual trip in September or October of 2020, 2021, and 2022, under similar guidelines and workplan as the initial survey and condition assessment.

References

Connors, T.B, Tweet, J.S., and Santucci, V.L, 2020, Stratigraphy of Grand Canyon National Park, in Santucci, V.L. and J.S. Tweet, (editors), Grand Canyon National Park: Centennial paleontological resource inventory (non-sensitive version). Natural Resource Report NPS/GRCA/NRR—2020/2103. National Park Service, Fort Collins, Colorado, p. 45-74.

Lassiter, L.S., J.S. Tweet, F.A. Sundberg, J.R. Foster, and P.J. Bergman, 2020. Paleozoic Invertebrate Paleontology of Grand Canyon National Park. in Santucci, V.L. and J.S. Tweet, (editors), Grand Canyon National Park: Centennial paleontological resource inventory (non-sensitive version). Natural Resource Report NPS/GRCA/NRR—2020/2103. National Park Service, Fort Collins, Colorado, p. 109-236.

Miller, A.E., L. Marchetti, H. Francischini, and S.G. Lucas, 2020. Paleozoic Invertebrate Ichnology of Grand Canyon National Park. in Santucci, V.L. and J.S. Tweet, (editors), Grand Canyon National Park: Centennial paleontological resource inventory (non-sensitive version). Natural Resource Report NPS/GRCA/NRR—2020/2103. National Park Service, Fort Collins, Colorado, p. 277-331

Nebel, M.L., Miller, A.E., and Garcia, S., 2020, GRCA Paleontology Geodatabase Documentation and Protocols, version PaleontologyGDB_20200108.docx, unpublished GRCA, 10 pp.

POST-FIRE ASSESSMENT FOR VISITOR SERVICES AND SAFETY

Submitted by:

Mike Kearsley, Claire Morris, Steve Sullivan, and Dan Boughter, National Park Service, Grand Canyon National Park



Fig. 17. Cottonwood Creek Use Area BG9_12 Fig. 18. Cottonwood Creek Use Area BG9_24

Initial Questions and Concerns

- How has the Cottonwood Creek Fire negatively impacted Cottonwood Creek Use Area visitor services and safety?
- How has the Cottonwood Creek Fire impacted Use Area camper behavior?
- Fire damaged and weakened hazard trees located within and adjacent to the Use Area.
- Potential for short term and/or long term impacts to Use Area due to soil erosion (i.e., rills, gullies, debris flows) and/or debris flow impacts.
- Potential need for stabilization actions within or adjacent to the Use Area.

Observations

Background

The Cottonwood Creek Use Area is one of the more popular use areas in the park. The Use Area contains at-large camping and does not have designated sites. The Use Area receives around 1,500 user-nights/500 group-nights each year (a group of 3 staying 2 nights there would be 2 group-nights and 6 user nights). In addition, Cottonwood Creek and its

associated springs provide a reliable water source for Cottonwood Creek Use Area visitors and for many of the groups staying overnight on nearby Horseshoe Mesa (another 500 group-nights and 1900 user-nights).

Site Description

Pre-fire, the Cottonwood Creek Use Area contained a vibrant riparian area with mature Fremont cottonwood trees that provided respite from brutally hot inner canyon temperatures. The fire severely impacted the riparian area where plant mortality included 100+ Fremont cottonwood (diameter at breast height (DBH) ranged from 14 cm – 44 cm and tree height ranged from 25 ft. to 34 ft.),, numerous seep willow, and an unknown number of shrubs, grasses and forbs. Unfortunately, the fire weakened most cottonwood trees, and they are now considered hazard trees. Post-fire, Cottonwood Creek is more prone to flash floods and debris flows which could have a negative impact on visitors.

Assessment and Findings

The Use Area was monitored on April 22nd and 23rd of 2020, where it was found that cores BG9_12 and BG9_24 were impacted by this fire. Both are primarily impacted by hazard trees, shown in the photographs (Figures 17 and 18). BG9_12 is a large core on the west side of the creek and trail. It is partially covered on the south side by a large Utah juniper that appears to be drying out and dying. The north side of the core is framed by a tree and a bush that could easily snap and could be removed. BG9_24 is a small core approximately 15 meters upstream from BG9_12. It is directly beneath a dead cottonwood that would pose serious risk to campers. Neither site seems to be impacted by soil stability and would be otherwise be unimpacted if not for the hazard trees and vegetation.

Mitigations

The GRCA Backcountry Information Center will include links to the following information when issuing backcountry permits for the Cottonwood Creek Use Area: hazard tree information, condition of the springs, soil stability, and overall site condition.

Proposed Treatments

The identified hazard trees near BG9_12 and BG9_24 will be assessed and treated as necessary.

Monitoring

The Use Area will be monitored in 2021 and 2022.

Budget

On 05/20/2020, GRCA submitted a Resource Damage Assessment to the NPS Special Agent assigned to this case. On 09/08/2020, the Cottonwood Creek Fire defendant plead guilty in federal court. The defendant plead guilty to: Count 1: Leaving a Fire Unextinguished, in violation of 18 U.S.C. § 1856, a Class B misdemeanor; and Count 2: False Information, in violation of 36 C.F.R. § 2.32(a)(3), a Class B Misdemeanor. GRCA will receive a restitution payment totaling \$53,520.03. Between FY 2020 and FY 2024, restitution funding will be utilized for stabilization and rehabilitation actions (e.g. mulch application, invasive plant treatment, seed collection and reseeding, direct transplanting, and hazard tree assessment and treatment) (\$45,808.03), replacement of the USGS gaging station (\$3,000.00), paleontology assessment and stabilization (2,712.00), and GRCA public service announcements in coordination with the defendant (\$2,000.00).

Through this Burned Area Rehabilitation proposal (FYs 2021 – 2023), GRCA is seeking an additional \$34,669.93 to implement riparian restoration actions that exceed the restitution funding allotment. The amount of funding needed to implement riparian restoration efforts was underestimated in the Resource Damage Assessment submitted on 05/20/2020. The fire impacted the highly biodiverse Fremont cottonwood – Goodding's willow Woodland Alliance which provides critical habitat for the federally listed threatened Mexican Spotted Owl. On 07/24/2020, only five Fremont cottonwood seedling re-sprouts were documented in the burned riparian zone. Burned Area Rehabilitation funding will be used on riparian restoration treatments proven to have a high probability of success (i.e. Fremont cottonwood planting and Coyote willow staking). Thank you for considering this funding proposal.

Table 5. BAR Budget

DESCRIPTION	FY 2021	FY 2022	FY 2023	TOTAL COSTS
Personnel Services – Cottonwood Cuttings Collection	\$2,183.43			\$2,183.43
Travel – Backcountry Per Diem for Cuttings Collection	\$160.00			\$160.00
Personnel Services for Fremont	\$1,676.50	\$1,676.50		\$3,353.00

Cottonwood Propagation				
Personnel Services – Planting Fremont Cottonwood			\$3,940.00	\$3,940.00
Travel – Backcountry Per Diem for Planting Fremont Cottonwood			\$480.00	\$480.00
Personnel Services for Collecting and Staking Willows	\$7,293.00			\$7,293.00
Travel – Backcountry Per Diem for Collecting and Staking Willows	\$480.00			\$480.00
Helicopter Support for Fremont Cottonwood Planting			\$16,780.50	\$16,780.50
Totals	\$11,792.93	\$1,676.50	\$21,200.50	\$34,669.93

Grand Canyon National Park
National Park Service
U.S. Department of the Interior



Division of Science and Resource Management
