

FINAL FISHERIES SPECIALIST REPORT (ROUND 2, FINAL)

CAMERON PEAK FIRE: BURNED AREA EMERGENCY RESPONSE (BAER) ASSESSMENT

ARAPAHO & ROOSEVELT NATIONAL FORESTS

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The Interim BAER Assessment Report was revised to produce the final assessment report. Where additional and new information have been added, text has been italicized.

Incident Summary: *The Cameron Peak Fire started on from August 13th, 2020 near Chambers Lake, Larimer County, Colorado. The initial BAER Assessment for the Cameron Peak Fire was completed in October, 2020 and was based on an acreage of 99,209 (Burned area as of September 25, 2020). As of the November 1, 2020, final burned area perimeter encompassed by the fire was 208,760 acres across a spectrum of burn severity (Table 1). The nature of the Cameron Peak Fire resulted in two general types of soil burn severity, one being a mixed severity mosaic and the other being extensive moderate to high soil burn severity. Both types of soil burn severity are present in the burn areas with fisheries resource values.*

Table 1. Severity of areas Burned in cameron peak fire (Larimer Co., colo) used for final Burned Area emergency repair assessment.

Severity Class	High	Moderate	Low	Very Low/Unburned
Acres	12,200	63,869	91,143	41,547

The Cameron Peak Fire burned around and over significant amounts of aquatic habitat, including streams, lakes, and wetlands. Approximately 165 miles of perennial stream experienced fire nearby and the length of intermittent stream habitat feeding into perennial streams exceeded 340 miles (Figure 1).

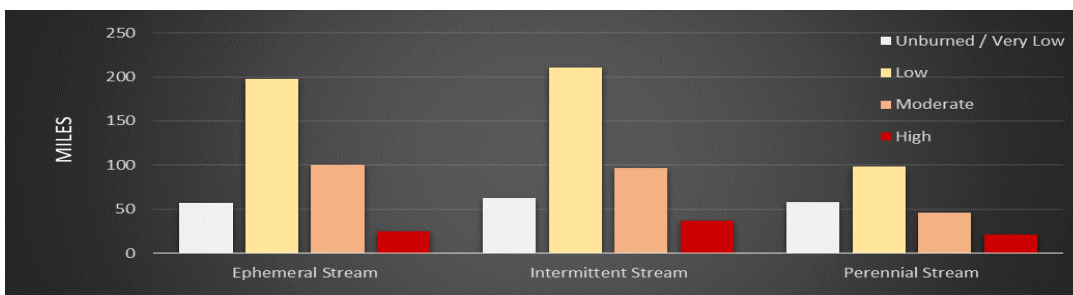


FIGURE 1. SUMMARY OF BURN SEVERITY FROM THE CAMERON PEAK FIRE ACROSS STREAM TYPE WITHIN THE CACHE LA POUDDRE, LARAMIE, AND BIG THOMPSON RIVERS.

OBJECTIVE

The objective of this report is to describe the results of BAER Assessment on fisheries resources, focusing on identified Critical Values, as affected by post-fire threats from the Cameron Peak Fire. *The purpose of this assessment is to determine whether or not there is an unacceptable post-fire risk to aquatic habitat and present the case for proposed treatments for reducing unacceptable risks.* In accordance with BAER procedures, there are several primary factors that should be considered to inform the probability of damage or loss and magnitude of consequences during the risk assessment. A summary of other important fisheries and aquatic resource values is also provided, including potential fire and post-fire effects on those important resource values.

CRITICAL VALUES

Two BAER - Critical Values for fisheries resources and aquatic habitat were identified in the Cameron Peak BAER Assessment: (1) The Cameron Peak Fire has occupied and suitable habitat for federally threatened greenback cutthroat trout *Oncorhynchus clarkii stomias* within portions of burned areas on NFS lands; (2) The Cameron Peak Fire also contains a timber constructed fish barrier on Black Hollow, which has protected suitable greenback cutthroat trout habitat from being invaded by non-native fish present in the mainstem of the Cache la Poudre River.

HISTORY OF LISTING STATUS FOR GREENBACK CUTTHROAT TROUT

Greenback cutthroat trout (GBCT) were listed as Endangered under the Endangered Species Act in 1973 and downlisted to Threatened status in 1978. The greenback cutthroat trout recovery plan was last revised in 1998 (USFWS 1998) and a status review of GBCT populations was completed in 2009 (USFWS 2009). At that time, all cutthroat trout populations and habitats within the BAER assessment perimeter were protected under ESA as threatened based on the listing definition and status of the species at that time.

For over 40 years, this native cutthroat trout has been managed as a “Threatened” species and recovery has been occurring on the Arapaho & Roosevelt National Forests. The genetic origins and purity of these recovery populations came into question in the past 15 years. Genetic and phenotypic studies (e.g., Metcalf et al. 2007, Metcalf et al. 2012, Bestgen et al. 2013, Rogers et al. 2018, Bestgen et al. 2019) have improved understanding of the origins and current distributions of native cutthroat trout on the east and west slopes of the Colorado Front Range mountains. The genetic findings of Metcalf and others (2007, 2012) upended the paradigm of recovery status for greenback cutthroat trout. Specifically, genetic distinctions for native cutthroat trout in Colorado characterized the native fish into 6 groups (Rio Grande, San Juan, Upper Colorado/Gunnison, Yampa/White/Green, Arkansas, and South Platte River basins) based on geographically-based genetic differences that both confirmed and cast doubt on the understanding of the 4 sub-species of cutthroat trout in Colorado (Rio Grande, Yellowfin [extinct], Colorado River, and Greenback). Due to the uncertainties for conservation status for these sub-species, in 2012 the U.S. Fish and Wildlife Service issued clarifying policy (USFWS 2012) on all of the listed GBCT populations that unequivocally continued protections as “threatened” under ESA. On April 17, 2020, the U.S. Fish and Wildlife Service revised that policy in a letter related to project-specific consultation (USFWS 2020), thus restricting the definition of GBCT to those fish genetically representative of the cutthroat trout native only to the South Platte River basin.

DISTRIBUTION OF GREENBACK CUTTHROAT TROUT

Throughout the range of greenback cutthroat trout, only 5 waterbodies are currently occupied with the ESA-listed status greenback cutthroat trout. Four of these populations occur on the Arapaho & Roosevelt National Forests. For the cutthroat trout populations within the Cameron Peak burn, only East Fork Roaring Creek has occupied habitat for federally-protected GBCT under ESA. As of April 2020, the populations in the other burned habitats (see Table 1) are no longer protected under ESA listing status based on a revised policy statement from U.S. Fish & Wildlife Service acknowledging that future listing

decisions may occur for the cutthroat trout native to the Upper Colorado/Gunnison and San Juan river basins (USFWS 2020). The habitats in question remain as a suitable, yet now “unoccupied” habitat and represent conservation values for potential reintroduction sites for greenback cutthroat trout in the future.

INVENTORY OF RESOURCE VALUES IN BURNED AREA

THREATENED AND ENDANGERED SPECIES

Specific to the Cameron Peak Fire, there are 6 cutthroat populations of various genetic origins within the burned area: Black Hollow, East Fork Sheep Creek, West Fork Sheep Creek, Roaring Creek, East Fork Roaring Creek, and Williams Gulch. A comprehensive summary of greenback cutthroat trout populations was completed in 2002 (Young et al. 2002 [<https://www.srs.fs.usda.gov/pubs/4591>]), which shows Black Hollow and Roaring Creek as populations that were “discovered” in the 1960’s and the remaining populations with distinct reintroduction and stocking efforts (i.e., more clear genetic origins). Within the burn perimeter of Cameron Peak Fire, a summary of the status of the GBCT populations provides baseline biological and physical attributes of each population (Table 2). The ARNF has managed the habitat for all of these populations as “threatened” since their discovery or reintroduction. *Habitats within the Poudre Headwaters Project area were included in the assessment as suitable habitat for greenback cutthroat trout that is in the process of being restored and reclaimed.*

TABLE 2. STREAMS WITH OCCUPIED OR SUITABLE HABITAT FOR THE FEDERALLY-THREATENED GREENBACK CUTTHROAT TROUT WITHIN CAMERON PEAK BURNED AREAS ON NFS LANDS.

Stream Name	Date of Discovery (D) or Reintroduction (R)	Species, Genetic Origin	Conservation Status	BAER Critical Value
East Fork Roaring Creek	2020 (R)	GBCT, South Platte	ESA Threatened; occupied GBCT habitat	Yes
Roaring Creek	1962 (D) ¹	CRCT, Yampa River	R2 Sensitive; suitable GBCT habitat	No
East Fork Sheep Creek	1982 (R) ¹	CRCT, Yampa River	R2 Sensitive; suitable GBCT habitat	No
West Fork Sheep Creek	1982 (R) ¹	CRCT, Yampa River	R2 Sensitive; suitable GBCT habitat	No
Williams Gulch	1996 (R) ¹	CRCT, Yampa River	R2 Sensitive; suitable GBCT habitat	No
Black Hollow	1963 (D) ¹ , 1969 (R) ¹ , 1982 (R) ¹	CRCT, Yampa River + Colorado River	R2 Sensitive; suitable GBCT habitat	Yes, on basis of property
<i>Poudre Headwaters (Corral & La Poudre Pass Creeks)</i>	<i>Prospective Habitat</i>	<i>None to date</i>	<i>Non-native; historic habitat</i>	<i>No</i>

1. Young et al. 2002 described the origin of GBCT populations as either discovered or reintroduced through stocking for recovery purposes.

BLACK HOLLOW FISH BARRIER AND HABITAT

Cutthroat trout present in Black Hollow are representative of cutthroat trout native to the Yampa River basin in western Colorado and are now managed as Region 2 Sensitive Species (see Table 1). Cutthroat have persisted in this stream due to a timber-frame wooden barrier constructed in the early 1980s (Figure 2). In 2019, Forest Service staff found the structural condition of the barrier sound, despite the intense flood flows this area experienced in September 2013. The barrier has protected the small, isolated habitat patch from invasion from non-native fish (USDA Forest Service 2019A). Assessments and surveys (Young and Guenther-Gloss 2004, Colorado Parks and Wildlife unpublished data, Forest Service unpublished data) since the 1980s have documented a low population size (< 500 adult fish) related to limited habitat patch size, limited pool habitat, and cold water temperatures that could limit long-term viability of the population.



FIGURE 2. PHOTOGRAPH OF BLACK HOLLOW FISH BARRIER DEPICTING CONDITION OF TIMBERS AND LOCAL BANK STABILITY FROM 2019 (FROM USDA FOREST SERVICE 2019).

OTHER RESOURCE VALUES

The Cameron Peak Fire also burned areas containing other Region 2 Aquatic Sensitive Species, Forest Service owned fishery habitat structures, and throughout extensive portions of the Wild and Scenic Cache la Poudre River, which represents an important recreational fishing value. While these values are important drivers of resource management, they do not meet definitions of BAER Critical Values and thus are not eligible for BAER funding sources.

- The Hudsonian Emerald Dragonfly *Somatochlora hudsonica* is an aquatic insect species with glacial relict populations in high elevation lakes along the crest of the northern Colorado Front Range (Packauskas 2005). The species occurs at Lost Lake, Laramie Lake, and Twin Lake within the burn area.
- The Colorado Water Quality Control Division designates Critical Resource Waters (Outstanding Waters) within the State of Colorado. Cache la Poudre River Basin is designated as a Critical Resource Water, which includes the mainstem of the Cache la Poudre River and the designation applies to all tributaries to the Cache La Poudre River, including lakes, reservoirs, and wetlands, located within Rocky Mountain National Park and the Rawah, Neota, Comanche Peak, and Cache La Poudre Wilderness Areas on National Forest System Lands. Portions of the mainstem Cache la Poudre River are prized wild trout fisheries with special fishing regulations to manage the use.
- *Cache la Poudre River is a Nationally-designated Wild and Scenic River with 46 miles designated as Recreational Segments and 30 miles (within Cache la Poudre and Comanche Peaks Wilderness Areas) designated as Wild Segments (USDA Forest Service 1990). Fishing and sustainable fishing access is a component of recreational management for the Wild and Scenic River Corridor in both Recreational and Wild Segments and a reserve water right is held by the Forest Service to maintain adequate quantity and high quality water and stream flows needed to support recreation, such as fishing. Fishing regulations are managed by Colorado Parks and Wildlife and management of fish populations within Wild Segments focuses on wild populations, without supplemental stocking programs.*
- Fish Habitat Improvement Structures along the South Fork Cache la Poudre River and Little Beaver Creek. Log drop habitat structures to increase fish densities and improve the recreational trout fishery were installed in the 1980s along the Fish Creek Day Use Recreation Site as well as dispersed recreation sites accessed from the Pingree Park Road, Larimer County Road 63 E.
- Poudre Headwaters Project – *Portions of the project area within the Roosevelt National Forest and Rocky Mountain National Park were burned by the Cameron Peak Fire. To date, the project has primarily been focused on acquiring data for designing fish barriers, evaluating natural waterfall barriers, and data needed for planning/designing piscicide applications. The only real infrastructure within the burn perimeter was the Radio Frequency Identification (RFID) Antennas and Hydrologic Monitoring Equipment. Equipment was deployed in 2018 to evaluate fish passage and hydraulic conditions at bedrock waterfalls in the Cache la Poudre River. This equipment is part of a 15-year interagency recovery project for greenback cutthroat trout on lands managed by Rocky Mountain National Park and the Arapaho & Roosevelt National Forests.*

RESOURCE CONDITION ASSESSMENT

RESOURCE SETTING

The Cameron Peak Fire began on August 13th, 2020 in spruce-fir-mixed conifer forest affect by spruce and pine beetle infestations west of Chambers Lake, a water supply reservoir and popular recreation destination. The cause of the fire remains under investigation. For the initial BAER Assessment period, the Cameron Peak Fire had burned 99,209 acres and

across 115 miles of perennial stream habitat and through portions of 6 cutthroat trout occupied watersheds. *The final BAER Assessment covers 208,760 acres across a range of soil burn severity within the burn scar perimeter (Table 3). Within the final burn scar perimeter, 165 miles of perennial stream had been burned over.*

TABLE 3. SUBWATERSEHD (HUC12) ACREAGE BY BURN SEVERITY (UNBURNED, LOW, MODERATE, AND HIGH) FOR CAMERON PEAK FIRE WITH IDENTIFIED FISHERIES AND AQUATIC RESOURCE VALUES. WATERSHEDS WITH CRITICAL BAER VALUES ARE NOTED AS CBV.

Subwatershed (HUC 12)	Total Acres	% Burned	Very Low Acres	%	Low Acres	%	Moderate Acres	%	High Acres	%
Beaver Creek	14,136	58.5%	2,400	17.0%	3,320	23.5%	2,414	17.1%	138	1.0%
Bennett Creek	9,210	82.3%	1,170	12.7%	2,945	32.0%	3,064	33.3%	397	4.3%
Big Thompson Canyon- Big Thompson River	17,695	0.0%	0	0.0%	0	0.0%		0.0%		0.0%
Black Hollow-Cache la Poudre River (CBV)	37,738	90.0%	5,044	13.4%	13,539	35.9%	12,973	34.4%	2,403	6.4%
Cedar Creek	12,100	46.2%	672	5.6%	4,656	38.5%	267	2.2%	0	0.0%
Elkhorn Creek	22,259	40.4%	2,122	9.5%	4,680	21.0%	2,039	9.2%	143	0.6%
Hague Creek (CBV)	8,685	46.5%	475	5.5%	870	10.0%	1,933	22.3%	765	8.8%
Headwaters Cache la Poudre River (CBV)	12,709	5.4%	113	0.9%	151	1.2%	372	2.9%	46	0.4%
Headwaters North Fork Big Thompson River	16,418	14.0%	435	2.6%	1,638	10.0%	223	1.4%	10	0.1%
Headwaters South Fork Cache la Poudre River	11,094	10.1%	524	4.7%	528	4.8%	66	0.6%	1	0.0%
Joe Wright Creek	24,469	45.4%	3,598	14.7%	3,222	13.2%	2,332	9.5%	1,948	8.0%
La Poudre Pass Creek (CBV)	14,066	7.9%	138	1.0%	555	3.9%	422	3.0%	3	0.0%
Little Beaver Creek	11,563	100.0%	1,595	13.8%	2,131	18.4%	5,904	51.1%	1,932	16.7%
Lower Buckhorn Creek	19,953	28.9%	348	1.7%	5,169	25.9%	249	1.2%	6	0.0%
Middle Buckhorn Creek	25,359	70.7%	3,333	13.1%	10,687	42.1%	3,842	15.1%	54	0.2%
Miller Fork	8,933	95.5%	1,440	16.1%	3,664	41.0%	3,248	36.4%	181	2.0%
Nunn Creek	19,035	0.0%	2	0.0%	2	0.0%	4	0.0%		0.0%
Outlet North Fork Big Thompson River	13,344	21.8%	154	1.2%	2,041	15.3%	710	5.3%	8	0.1%

Subwatershed (HUC 12)	Total		Very Low		Low		Moderate		High	
	Acres	% Burned	Acres	%	Acres	%	Acres	%	Acres	%
<i>Pendergrass Creek-South Fork Cache la Poudre River</i>	18,637	47.3%	1,632	8.8%	3,286	17.6%	3,343	17.9%	553	3.0%
<i>Pennock Creek</i>	11,068	23.5%	783	7.1%	1,726	15.6%	94	0.8%		0.0%
<i>Rawah Creek-Laramie River</i>	36,970	15.7%	772	2.1%	1,665	4.5%	1,863	5.0%	1,490	4.0%
<i>Redstone Creek</i>	19,832	9.8%	166	0.8%	1,693	8.5%	87	0.4%	0	0.0%
<i>Roaring Creek (CBV)</i>	9,938	44.4%	593	6.0%	1,427	14.4%	2,118	21.3%	279	2.8%
<i>Sevenmile Creek-Cache la Poudre River</i>	18,640	33.9%	1,601	8.6%	3,112	16.7%	1,503	8.1%	98	0.5%
<i>Sheep Creek (CBV)</i>	13,966	95.5%	3,661	26.2%	3,479	24.9%	5,349	38.3%	846	6.1%
<i>South Fork Lone Pine Creek</i>	16,306	13.5%	636	3.9%	784	4.8%	761	4.7%	18	0.1%
<i>Upper Buckhorn Creek</i>	27,370	74.0%	4,126	15.1%	10,619	38.8%	5,452	19.9%	50	0.2%
<i>Willow Creek-Cache la Poudre River</i>	21,936	53.0%	4,014	18.3%	3,553	16.2%	3,237	14.8%	831	3.8%
Grand Total	493,431	42.3%	41,547	8.4%	91,143	18.5%	63,869	12.9%	12,200	2.5%

METHODOLOGY

The BAER fisheries assessment is a rapid resource evaluation procedure and is based on existing data sources, site-specific field reviews within burned areas, and geospatial analyses of topography, mapped threatened and endangered species habitat, satellite-derived Burned Area Reflectance Classification (BARC) data, and soil burn severity classification data. BARC data is a satellite-derived data layer of post-fire vegetation condition, which yields four classes: high, moderate, low, and unburned areas. This product is used as an input along with field surveys to generate soil burn severity (see Soils and Hydrology BAER Reports). Soil burn severity is classified on the basis field surveys conducted among the high, moderate, and low burn severity class from BARC remote-sensing data. Areas of moderate to high soil burn severity have the greatest potential to trigger debris flows and transport sediment into stream systems and impact fisheries or other aquatic resources. To derive anticipated debris flow potential, hydrologists and soils scientists modelled both peak flow using WEPPcloud-Post-fire Erosion (PEP) model (USDA Forest Service 2019B) and debris flow probability using USGS models (Staley et al. 2016, 2017). *This same methodology was used for the Round 2 assessment. Please refer to the Initial and Final Hydrology BAER Reports for additional discussion and explanation of model parameters.* Assessment of fisheries and aquatic resource impacts were made on the basis of soil burn severity, peak flow changes, debris flow potential, documented effects from published literature, and professional judgement. *The BAER rapid assessment occurred from September 21st through September 29th, 2020 and again throughout October as conditions and weather allowed. As of November 1, 2020*

the Cameron Peak Fire had burned approximately 208,760 acres in the headwaters, numerous tributaries, the South Fork, and the mainstem of the Cache la Poudre River, the upper extents of the Laramie River, and portions of the North Fork Big Thompson River, Larimer County, Colorado. Efforts were made to visit all high priority fisheries and aquatic habitat sites in the field with a focus on areas with high to moderate burn severity; however, fire activity and time constraints limited access to some areas. Subsequent assessments may need to be resumed during spring prior to snow-melt runoff peaks and monsoonal thunderstorm seasons.

POST-FIRE RISKS TO CRITICAL FISHERIES RESOURCE VALUES

BAER TES Aquatic assessments evaluate the probability of damage or loss that would occur to designated habitat within one to three years of the fire. When evaluating the probability of damage or loss of the critical values, it is important to take into account the disturbance range of variability in the system due to natural cycles of wildfire and geomorphological conditions as well as the scale in which the TES habitat exists.

FINDINGS OF POST-FIRE ASSESSMENT AND MODELLED RESOURCE RESPONSES

The Cameron Peak Fire produced a mix of soil burn severity across 208,760 acres within the Cache la Poudre River, Laramie River, and Big Thompson River watersheds (Hydrology BAER Report). Watershed analyses of soil burn severity at the time of assessment presented a similar mixture of soil burn severity for the watersheds containing cutthroat trout habitat, natural fish barriers, and a FS-owned & constructed fish barrier (Table 4, Figure 3). The HUC 12 watersheds were larger than the scale at which cutthroat trout and their habitat occur on the landscape. Soil burn severity examined at a finer watershed scale for the available delineated HUC14 watersheds highlights a range of burn severity across the cutthroat trout habitats, with greatest potential for post-fire effects in the Sheep Creeks and Black Hollow (Figure 3).

TABLE 4. SUMMARY OF SOIL BURN SEVERITY FOR HUC12 WATERSHEDS CONTAINING CRITICAL FISHERIES RESOURCE VALUES. NOTE: ROARING CREEK AND SHEEP CREEK HUC12 CONTAIN 2 DISTINCT CUTTHROAT TROUT POPULATIONS AND HABITAT AREAS; Poudre HEADWATERS PROJECT AREA DOES CONTAINS SUITABLE HABITAT FOR GREENBACK CUTTHROAT TROUT.

Subwatershed Name	Total Subwatershed		Outside the Fire	Unburned or Very Low		Low		Moderate		High	
	Acres	% Burned		Acres	Acres	%	Acres	%	Acres	%	Acres
Black Hollow-Cache la Poudre River	37,738	90.0%	3,779	5,044	13.4%	13,539	35.9%	12,973	34.4%	2,403	6.4%
Roaring Creek	9,938	44.4%	5,522	593	6.0%	1,427	14.4%	2,118	21.3%	279	2.8%
Sheep Creek	13,966	95.5%	631	3,661	26.2%	3,479	24.9%	5,349	38.3%	846	6.1%
Hague Creek ^{1,2}	8,685	46.5%	4,643	475	5.5%	870	10.0%	1,933	22.3%	765	8.8%
Headwaters Cache la Poudre River ^{1,2}	12,709	5.4%	12,028	113	0.9%	151	1.2%	372	2.9%	46	0.4%

Subwatershed Name	Total Subwatershed		Outside the Fire	Unburned or Very Low		Low		Moderate		High	
	Acres	% Burned		Acres	Acres	%	Acres	%	Acres	%	Acres
La Poudre Pass Creek ^{1,2}	14,066	7.9%	12,948	138	1.0%	555	3.9%	422	3.0%	3	0.0%

1. Watershed is part of the Poudre Headwaters, Greenback Cutthroat Trout Restoration Project
2. The entire watershed occurs within Rocky Mountain National Park. Further information should be sought from the National Park Service, BAER Assessment and Report.
3. A portion of this watershed occurs within Rocky Mountain National Park. Further information should be sought from the National Park Service, BAER Assessment and Report.

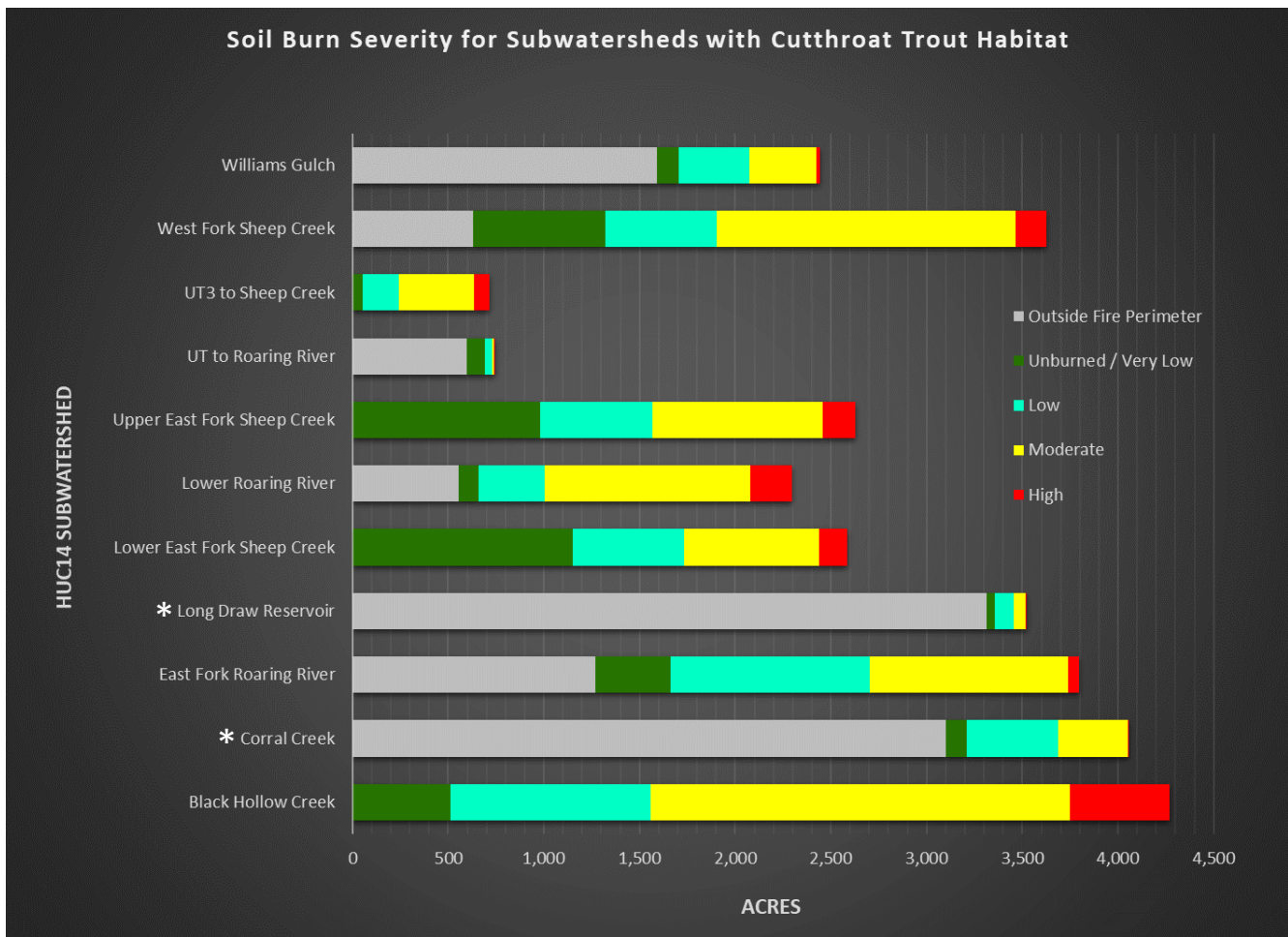


FIGURE 3. CUMULATIVE SOIL BURN SEVERITY ACROSS HIGH, MODERATE, LOW, AND UNBURNED CLASSES FOR HUC14 WATERSHEDS CONTAINING CUTTHROAT TROUT HABITAT VALUES. WATERSHEDS WITH AN ASTERISK (*) REPRESENT SUITABLE OR PROSPECTIVE HABITATS.

compared with those of unburned conditions (See Hydrology BAER Report). Additionally, the probability of severe erosion,

debris flows, and hillslope failure is substantially higher, and will remain so for at least the next few years. For watersheds containing critical fisheries resource values, peak streamflow is predicted to increase and there are slopes with moderate to high potential for debris flows. Each of the 6 identified cutthroat trout burned habitats are expected experience a range of increased peak flow (5 year storm; see Hydrology BAER Report) response from 0% increase to the lowest reaches of the Williams Gulch watershed to >1157% increase in a peak flow for the combination of East Fork and West Fork of Sheep Creeks (Table 5). During the initial assessment, the East Fork Roaring Creek had only experienced fire activity within the lowest portion of the watershed and 5-year peak flows were still predicted to increase by 145%. An additional 1,270 acres of the East Fork Roaring Creek watershed and habitat burned through November 1, 2020 and post-fire hydrologic responses are expected to increase an estimated a 445%. The Miller Fork watershed is under study and evaluation for potential greenback cutthroat trout habitat. Over 96% of the Miller Fork watershed was burned, with nearly 39% of the watershed with high and moderate soil burn severity and an estimated 637% increase in storm-related peak flow runoff (Callery and Krezelok 2020, Hydrology Report).

TABLE 5. SUMMARY OF CRITICAL THREATENED, ENDEANGERD, SENSITIVE FISHERIES RESOURCE VALUES DEPICTING GENERAL SOIL BURN SEVERITY, PROPORTION WITH LIMITED MANAGEMENT OPPORTUNITY (ROADLESS & WILDERNESS AREAS), AND PROPORTIONAL INCREASE IN 5-YEAR PEAK FLOW.

Cutthroat Trout Population	Habitat extent (Miles)	Subwatershed size (Acres)	General Soil Burn Severity	Roadless Area (% of watershed)	Wilderness Area (% of watershed)	Proportional Peak Flow Increase (%)
Black Hollow	1.4	4,267	Moderate to High	33 %	29 %	894 %
EF Sheep Creek	3.7	5,208	Moderate to High	35 %	11 %	1157 % ¹
WF Sheep Creek	4.1	3,624	Moderate to High	36 %	39 %	1157 % ¹
EF Roaring Creek	1.7	3,796	Moderate to High	71 %	0 %	445 % ²
Roaring Creek	4.1	5,397	Moderate to High	50 %	0 %	18 %
Williams Gulch	2.0	2,444	Low	80 %	0 %	Negligible, Not Modelled
Poudre Headwaters Project ³	37.0	54,838	Partial; Low to Moderate		>80%	9.6%

1. Relative increase of 5-year peak flow was only modelled for the entire Sheep Creek watershed. Actual proportional increase in high peak flow risk may be lower for East Fork and West Fork Sheep Creek.
2. Peak flows remodeled for East Fork Roaring Creek due to additional area burned following the initial assessment.
3. Poudre Headwaters Project Streams on NFS Lands include Corral Creek, Neota Creek, portions of La Poudre Pass Creek, and Long

Post-fire hydrologic responses will increase peak flow magnitude and coupled with high to moderate soil burn severity present increased risks of debris flow occurrence across the Cameron Peak burn scar and within the 7 cutthroat trout habitats identified as critical fisheries resource values (*Table 2*). Anticipated debris flows and impacts on cutthroat trout habitat will likely be most severe in Black Hollow, East Fork Sheep Creek, West Fork Sheep Creek, and East Fork Roaring Creek (*Figure 4*). Aquatic habitat in East Fork Roaring Creek is likely to experience elevated peak flows and debris flow events following heavy precipitation. Although the entire East Fork Roaring Creek drainage did not burn, the fire consumed vegetation surrounding all suitable habitat and the locations into which greenback cutthroat trout were and are planned for continued reintroduction and stocking. Debris flow risk modelling shows that aquatic habitat in lower Roaring Creek will also likely experience debris flow events following heavy precipitation (*Figure 4*). Upper portions of the Roaring Creek watershed did not burn and will likely serve as refugia habitat for cutthroat trout. The fire burned a smaller portion of the Williams Gulch catchment and the areas that did burn did so with less intensity. Post-fire hydrologic responses with potential to affect aquatic habitat in Williams Gulch are unlikely (*Figure 4*). Similarly, the area defined as the Poudre Headwaters Project that encompasses the three HUC12 watersheds of the upper Cache la Poudre River within Rocky Mountain National Park and the Roosevelt National Forest was partially burned. Portions of the project watersheds on both jurisdictions burned in the Cameron Peak Fire; however, the extent of moderate and high soil burn severity throughout the project area comprises a relatively small proportion of the overall project and the areas with elevated risks of debris flow effects on stream channels is not widespread (*Figure 5*). For the Forest Service managed areas of Corral Creek, La Poudre Pass Creek, and segments of the Cache la Poudre River, overall post-fire effects should be moderate. Within Rocky Mountain National Park, the Hague Creek watershed experienced the greatest extent of burn, with over 47% of the watershed within the burn perimeter, 31% of the watershed burned with high and moderate soil burn severity, and an estimated 24% increase in storm-related peak flow (see Callery and Krezelok 2020, Hydrology Report). Habitat segments affected by post-fire responses are likely to recover through natural processes over the next few years. The National Park Service has completed an independent BAER assessment of critical resource values, including post-fire responses to threatened and endangered species habitat on National Park Service Lands.

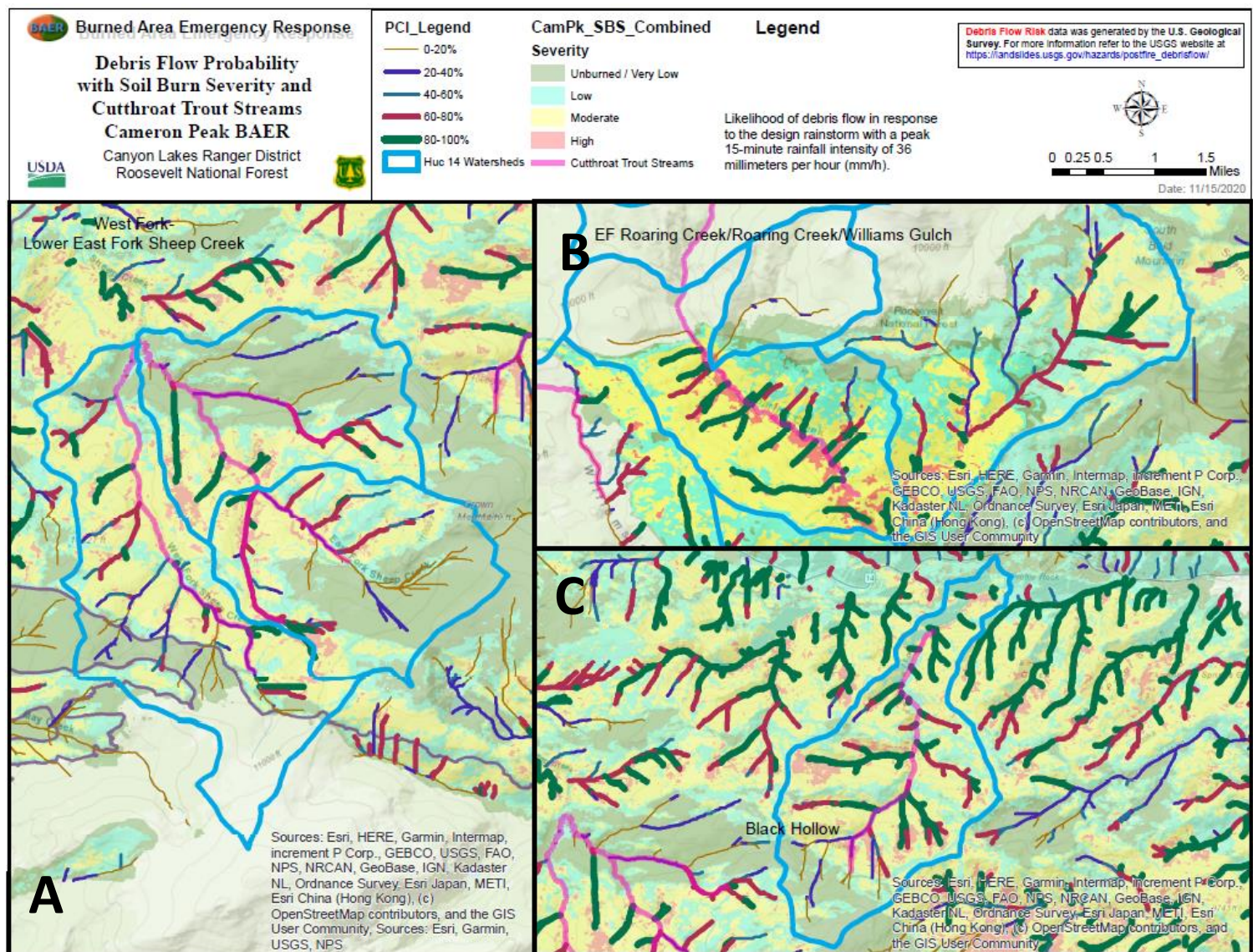


FIGURE 4. MAPPED SOIL BURN SEVERITY AND DEBRIS FLOW RISK FOR SIX CATCHMENTS OF THE CAMERON PEAK FIRE CONTAINING CUTTHROAT TROUT: (A) EAST FORK AND WEST FORK SHEEP CREEK CONTAINS COLORADO RIVER CUTTHROAT TROUT; (B) EAST FORK ROARING CREEK CONTAINS GREENBACK CUTTHROAT TROUT, ROARING CREEK AND WILLIAMS GULCH CONTAIN COLORADO RIVER CUTTHROAT TROUT; (C) BLACK HOLLOW CONTAINS COLORADO RIVER CUTTHROAT TROUT.

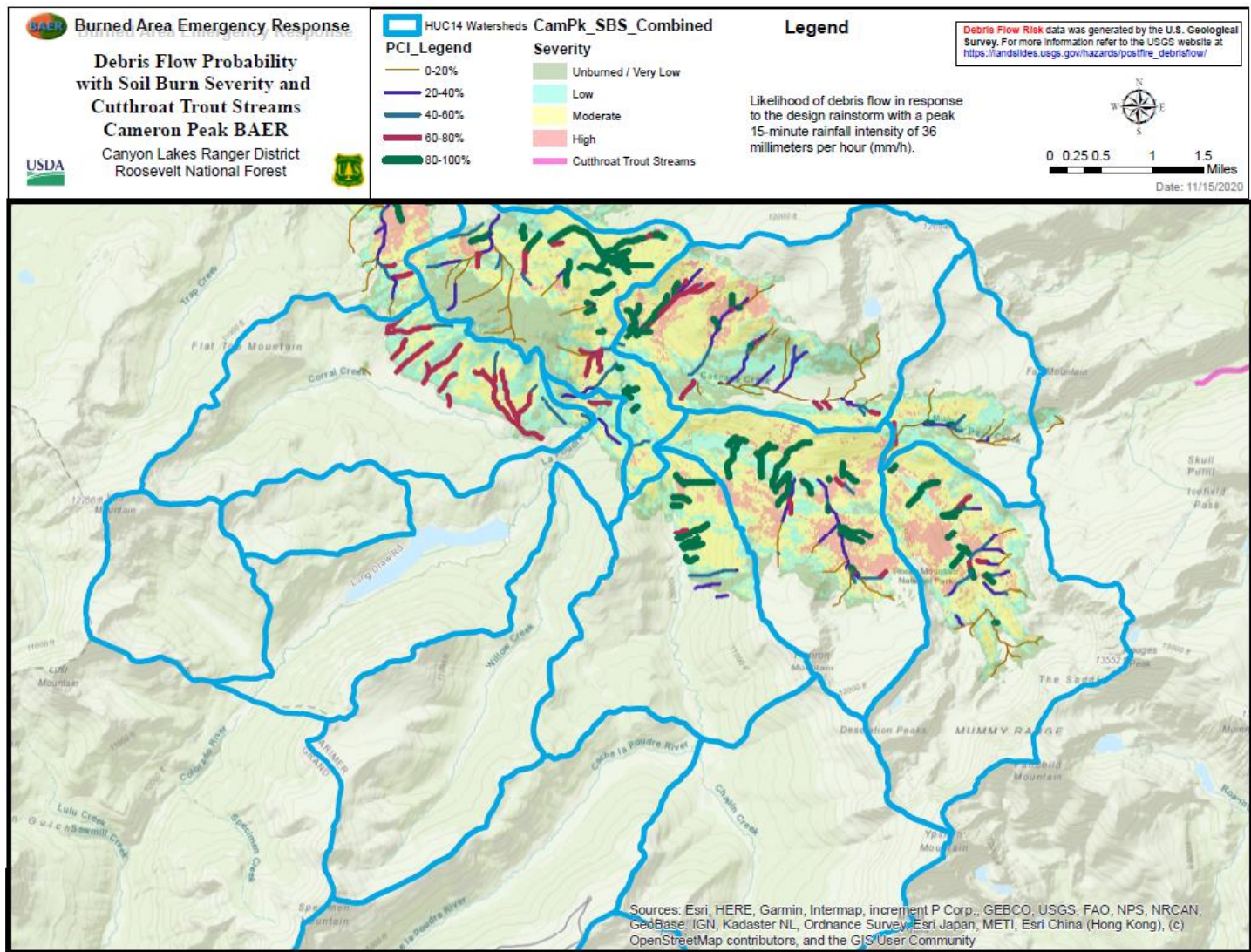


FIGURE 5. MAPPED SOIL BURN SEVERITY AND DEBRIS FLOW RISK FOR THE Poudre HEADWATERS PROJECT AREA, AN AREA WHERE GREENBACK CUTTHROAT TROUT ARE BEING RESTORED. THE CAMERON PEAK FIRE ONLY BURNED A SMALL PORTION OF THE TOTAL PROJECT AREA.

FINDINGS OF THE ON-THE-GROUND SURVEYS

Stream channels and burn severity were examined in the field for specific critical value aquatic habitats. Sites were assessed to determine potential for channel erosion, sediment movement, road drainage problems, alteration of stream morphology, and water quality changes. Results of field assessments follow. Streams containing the critical fisheries resource values Many of the tributaries within the Cougar Creek Fire have limited fish habitat miles due to steep slopes and natural barriers.

- **East Fork Roaring Creek** – Fire activity and aerial fire suppression activities persisted throughout the Round 1 BAER field assessment period. The stream assessed on October 22, 2020. The fire continued to burn into the upper reaches of the watershed including all reaches with habitat suitable for supporting fish. Based on intensity of suppression efforts, smoke plumes observed, and on-the-ground field assessment (Figure 6), this watershed burned with moderate to high intensity. Forest cover type along the valley bottom and channel margins are this stream differ little from adjacent upland vegetation. Habitat conditions were likely affected by the fire and are likely to experience post-fire effects with little to no remaining riparian vegetation capable of attenuating sedimentation from hillslope erosion. Further assessment was based on geospatial and modelled post-fire outcomes.

FIGURE 6. PHOTOGRAPHS OF POST-BURN CONDITIONS IN EAST FORK ROARING CREEK: (A) UPVALLEY VIEW OF LOWER WATERSHED, (B) CROSS-VALLEY VIEW OF LOWER WATERSHED, AND (C) VIEW OF BEDROCK CONTROLLED BARRIER REACH.



- **Roaring Creek** - Fire activity and aerial fire suppression activities persisted throughout the BAER field assessment period. Wildfire continued to burn into the upper reaches of the watershed beyond the assessment period. Based on intensity of suppression efforts and smoke plumes observed, this watershed burned with moderate to high intensity. Wide valley segments with meadow-type vegetation occur in Roaring Creek and these stream reaches are lined with pockets of wetland habitat,

where the fire either did not burn or burned less severely than upland areas. Further assessment was based on geospatial and modelled post-fire outcomes.

- **East Fork Sheep Creek** – Stream assessments were conducted from the Crown Point Road (FSR 169). Cameron Peak Fire burned through this watershed in a short period of time. Topographic alignment with prevailing high-speed winds carried a crown fire across this watershed. The upper reaches of the watershed burned with high and moderate intensity. Views into the burn area indicated widespread loss of forest, forest canopy, and living vegetation. Streambanks were still intact with most organic material adjacent to the channel being charred on the surface, but not within the soil. Moss patches on the surface of rocks out of the channel were consumed by the fire.
- **West Fork Sheep Creek** - Stream assessments were conducted from the Crown Point Road (FSR 169). Cameron Peak Fire burned through this watershed in a short period of time. Fire spread burned laterally across the upper watershed segments and indicated extensive areas of moderate to severe burn. Views into the burn area indicated widespread loss of forest, forest canopy, and living vegetation. Streambanks were still intact with most organic material adjacent to the channel being charred on the surface, but not within the soil.
- **Williams Gulch** - Fire activity and aerial fire suppression activities persisted throughout the BAER field assessment period. Wildfire only burned the east portion of this watershed. Only the steep, lower reaches of the stream were burned by the fire. Stream reaches containing existing cutthroat trout and suitable habitat for greenback cutthroat trout were not directly burned in the fire.
- **Black Hollow** – Stream assessments were conducted from the Crown Point Road (FSR 169) and the stream mouth upstream from the confluence with the Cache la Poudre River. Fire spread burned laterally across the upper watershed segments and indicated extensive areas of moderate to high severity burn. Views into the burn area indicated widespread loss of forest, forest canopy, and living vegetation. Streambanks were still intact with most organic material adjacent to the channel being charred on the surface, but not within the soil. Lower portions of this watershed where the primary cutthroat trout habitat occurs burned with high severity. The wooden barrier structure was partially consumed by the fire and likely accelerated the structure’s trajectory toward failure. Although still standing and functional, water seepage was occurring in the soils along the flanks of the wooden wingwalls embedded in the streambanks and the primary support timbers were severely charred (Figure 2). The local topography surrounding the structure indicates that even small increases in bedload transport are likely to deposit upstream of the structure causing the stream channel to avulse and bypass the structure.
- **Poudre Headwaters Project Streams** – *Portions of La Poudre Pass and Corral Creek were assessed on October 19, 2020. The wildfire and burnout operations produced mixed severity patches of burn intensity encountered along the Corral Creek Trailhead. Portions of forest were burned with low intensity while others burned very hot. While only portions of the watershed were burned, some areas along forested portion of lower Corral Creek did burn with high intensity.*
- **Miller Fork** – *A stream assessment was conducted from foot trail network of Miller Fork and Donner Pass Trails. This stream is one several stream habitats on the Arapaho and Roosevelt National Forest under evaluation as a prospective location for greenback cutthroat trout reintroduction. BARC imagery and data produced inaccurate classification due to snow interference encountered during image processing. Lower portions of the watershed contained mixed severity of canopy loss and burn severity to soils; however, upper portions of the watershed experienced near full consumption of the forest crown and understory, including intense fire along extensive portions of the valley bottom. Nearly 39% of the watershed had high to moderate soil burn severity.*

POST-FIRE EFFECTS TO STREAMS

Due to the large geographic footprint of the Cameron Peak Fire, several streams and rivers burned. These streams are likely to experience a periods of channel instability, some of which may create unfavorable or

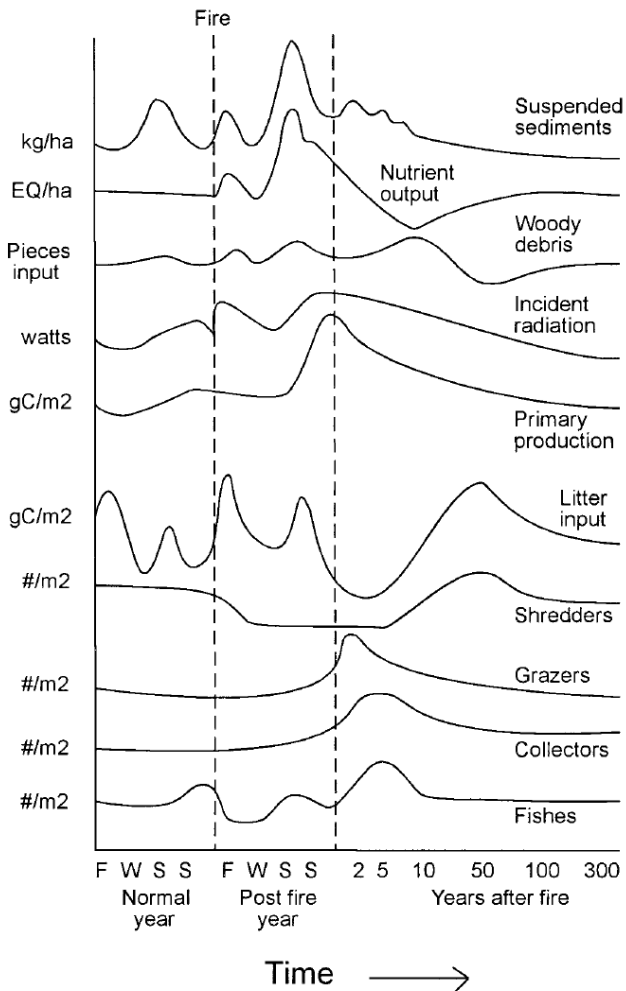


FIGURE 7. TIME-SERIES DIAGRAM OF POST-FIRE RESPONSES TO COMPONENTS OF AQUATIC ECOSYSTEMS. ADAPTED FROM MINSHALL AND OTHERS (1989).

even uninhabitable condition for aquatic life. Streams and rivers with the Laramie and Cache la Poudre river were burned under two distinct wildfire behavior

conditions: (1) mixed fire severity, moderate fire growth and (2) intense fire severity, rapid crown fire. The primary watershed responses of the Cameron Peak Fire on area streams and rivers within the burn perimeter are expected to include: 1) an initial flush of ash and sediment, 2) rill and gully erosion into drainages and on steep slopes within the burned area, 3) flash floods with increased peak flows and sediment delivery, transport, and deposition based on geomorphic valley type; 4) debris flows as result of unstable, eroding hillslopes and mass delivery of mixed sediment and organic material. The degree to which these watershed responses affect critical value habitats, depends upon the post-fire precipitation events, particularly the large events with the potential to increase channel bed scour within confined valley segments and streambed sedimentation and channel avulsions within less confined valley segments of streams and rivers. Such watershed responses are dependent on the occurrence of storm and melt events and will likely be greatest with initial storm events. Disturbance frequency and magnitude and thus geomorphic activity and habitat instability will likely subside as vegetation reestablishes, providing ground cover, increasing surface roughness, and increasing soil stability. Such events are most likely to occur within the first 2 to 3 years following the fire.

Post-fire impacts to aquatic ecosystems have been well-studied. Based on the burning conditions of the Cameron Peak Fire and the current state of resource conditions, there are a number of post-fire responses that can be reasonably expected to occur within 3-5 years after following the fire (see Figure 3). In the short-term of the

next 2-3 years, direct and indirect post-fire effects are likely to affect trout at all life stages including eggs, juveniles and adults (see Howell 2006). Direct effects to resident trout aquatic macroinvertebrates may include injury/mortality as a result of heavy ash loading to aquatic environments that can smother organisms, clog gills and fill in interstitial spaces important to many benthic aquatic species. In the short-term, post-fire effects can also result in lethal changes to water quality and water quantity (see Dunham et al. 2007).

Indirect effects from fire can be significant for native aquatic species residing in small, isolated habitats, such as cutthroat trout (e.g., Dunham et al. 2003). Post-fire conditions influencing species viability include modified shelter, foraging and breeding habitat, increased susceptibility to predation, introduction of non-native species and increased competition for limited resources. These types of aquatic and riparian ecosystem changes can result in stress and mortality for fish. Fire associated impacts to aquatic ecosystems include decreased stream channel stability, greater and more variable discharge, altered coarse wood delivery and storage, increased nutrient availability, and higher sediment delivery and transport (e.g., Miller et al. 2003, Eaton et al. 2010). Under severe fire conditions, where riparian forests are consumed, solar radiation can increase and water temperature regimes can be altered (e.g., Dunham et al. 2007). Due to loss and removal of hill slope and riparian vegetation, it is common for post-fire water flows and sediment transport to increase significantly. High water flows have the potential for flushing individuals out of stream stretches and into downstream areas. In other cases, sediment deposits or debris flows can occur and create conditions where pools and other stream habitats are filled in and organisms are smothered or crushed. Trout eggs are especially susceptible to smothering from excessive sedimentation in riffle-type spawning habitat.

While the extent to which these predicted effects manifest is largely based on the burn severity and interactions with precipitation events, the degree of impact on isolated habitat patches and cutthroat trout occupants is based on the size and configuration of the habitat. Within the upper portion of the Cache la Poudre River watershed area, the productivity, size, and drainage configuration of suitable greenback cutthroat trout habitat varies in disturbance vulnerability. Larger, dendritic habitat patches with a variety of broad reach types (e.g., meadow, woodland, canyons,) are less vulnerable to widespread wildfire disturbance. For example, Roaring Creek and the forks of Sheep Creek contain branched habitat networks with meadow and forested reaches where adequate refugia may buffer against post-fire effects. Whereas, smaller, linear habitat patches with uniform reach types (e.g., forested canyons) are extremely vulnerable to post-fire hydrologic disturbance. For example, Black Hollow is uniform and lacks unburned refugia in which cutthroat trout might survive. Despite the immediate negative consequences of fire and post-fire effects on trout, cutthroat trout and rainbow trout have exhibited relatively swift recovery within a few years (e.g., Howell 2006, Sestrich et al. 2011).

Despite the immediate and severe impacts to aquatic habitats, natural recovery of these aquatic systems will occur through time. Within 3-5 years post-fire, channels will become more stable and inputs of sediment will diminish. Within short recovery periods, riparian vegetation should recover to create stable streambanks and some overhead cover (Halofsky and Hibbs 2009). In areas of low burn severity or within stream segments of mixed severity fire, habitat conditions may only be minor and of short duration (< 1 year).

INVASION RISK TO TES SUITABLE HABITAT

Due to the well-understood, pervasive impacts of interspecific competition and predation from non-native trout, all occupied and suitable habitat for greenback cutthroat trout recovery occurs in isolated headwater habitats protected by some type of physical barrier that restricts invasion and colonization of wide-spread brook trout and brown trout. The upper portions of the Cache la Poudre River watershed contains geologic features on several tributary channels that have produced steep cascades and waterfalls through which non-native fish are unable to invade. These natural barriers protect 5 of the 6 identified cutthroat trout habitats within the Cameron Peak Fire. Steep, burned areas surrounding the reaches with natural cascades and waterfalls may experience localized debris flows. Although the occurrence, volume, and composition of predicted debris flows is unknown, debris flows are unlikely to alter the bedrock formations on which the

fish barriers occur. Debris flow accumulations may alter natural barrier configuration; however, alterations are likely to be so significant as to reduce the effectiveness of natural barriers to non-native trout. Black Hollow, however, has been protected by a wooden, FS-owned and constructed fish barrier structure since the early 1980's. The fire impacts and post-fire impacts are likely to cause failure, breach, or bypass of the vertical drop structure, which may facilitate invasion of non-native fish into the isolated habitat in Black Hollow.

POST-FIRE RISKS TO HUDSONIAN EMERALD DRAGONFLY

Mature mixed conifer forest surrounding three lakes (Laramie, Lost, and Twin Lakes) with known occurrences of the Hudsonian emerald dragonfly were burned during early period of the Cameron Peak Fire. Portions of forest surrounding these lake habitats were burned with high to moderate severity, yet some margins of forest surrounding the lakes either did not burn or burned with low intensity. Although specific responses of fire effects on dragonflies lacks study, the terrain surrounding these aquatic habitats is gentle and unlikely to experience considerable erosion. Likely the greatest impact to the species' habitat is the loss of mature forest adjacent to the lakes, which is understood to be important for adult roosting behavior (Packauskas 2007). Responses, positive or negative, of this dragonfly to fire and post-fire effects are unknown at this time. Future monitoring for continued persistence of the species at these sites is recommended.

RECOMMENDED BAER EMERGENCY TREATMENTS

Although there are many important critical aquatic habitat values within the Cameron Peak Fire perimeter, there were only two BAER Critical Values eligible for treatment: East Fork Roaring Creek as occupied habitat for the Threatened greenback cutthroat trout and the Black Hollow fish barrier, which isolates a small stream habitat that has supported a small cutthroat trout population (Table 5). Despite the high and very high risk ratings for these BAER Critical Values at Risk, available BAER treatments are unlikely prevent or effectively reduce impacts from occurring in East Fork Roaring Creek or Black Hollow subwatersheds within 1 to 3 years of the fire. BAER treatments will not prevent the severe post-fire hydrologic responses in these stream channels from occurring. In addition, the state of the fish barrier in Black Hollow prior to the fire was functional, but in need of maintenance or replacement as the age of the wooden structure was approaching 40 years, well beyond the intended design life. Structural damage to the timbers of the barrier caused by the fire accelerated the deterioration of the barrier. Given the expected change in peak flow runoff and potential for debris flows within Black Hollow, BAER treatments are unlikely to prevent further damage or destruction of the structure. In addition, the current location of the Black Hollow fish barrier restricts the available habitat to less than 1.4 miles, which is less habitat than the minimum 1.7 mile habitat patch recommended in the Recovery Outline for greenback cutthroat trout (USFWS 2019).

TABLE 6. SUMMARY OF BAER CRITICAL VALUES AT RISK FOR FISHERIES RESOURCES.

Critical Value	Threat to Value	Probability of Damage or Loss	Rationale for Probability	Magnitude of Consequence	Rationale for Magnitude	Risk
Black Hollow Fish Barrier	post-fire debris flow - destruction or local site avulsion	Likely	Structure burned in part, compromising timbers; Based on Debris Flow Modelling, structure likely to fail	Moderate	Structure failure would enable non-native fish invasion into Black Hollow habitat; altering the habitat for the long term; with management intervention (rebuild barrier+non-native fish removal), habitat would be "recoverable".	High
Greenback Cutthroat Trout Habitat (EF Roaring)	Debris flow and temporary loss of habitat; loss of fish	Very Likely	Intensity of burn; Based on debris flow modelling, small habitat patch likely to be considerably altered.	Moderate	TBD	Very High

RECOMMENDED NON-BAER TREATMENTS AND MONITORING

Post-fire recovery and rehabilitation treatments may be suitable for some critical fisheries and aquatic habitat resource values, provided that efforts will not be overwhelmed by post-fire hydrologic responses. Other sources of funding would need to be identified for the following types of rehabilitation.

- Occupied greenback cutthroat trout habitat in East Fork Roaring Creek. Habitat conditions in this stream should be monitored in the spring and summer of 2021 when safe access can be granted to determine the fate of recently introduced greenback cutthroat trout and suitability of the habitat to support aquatic life and greenback cutthroat trout. Routine population, occurrence, and habitat monitoring should be scheduled over the next 1-3 years to evaluate reintroduction efforts.*
- Black Hollow Fish Barrier. The condition and status of the existing wooden barrier should be monitored and evaluated for debris flow following post-fire precipitation. The isolated habitat should be evaluated to determine if the area should continue to be managed as suitable habitat for greenback cutthroat trout. Several habitat factors should be considered in light of the anticipated habitat changes resulting from the fire and post-fire effects, such as stream temperature regime, channel stability, presence of quality spawning habitat, quality and quantity of pool habitat, and overhead cover. In addition, an effective barrier to prevent non-native fish invasion would be needed. If habitat conditions are suitable, I recommend rebuilding the fish barrier lower in the drainage and closer to the stream mouth than the existing barrier. There are site options near the forest boundary and at road-stream crossings on private land near the stream mouth.

- *Suitable greenback cutthroat trout habitat. In addition to the suitable habitat in Black Hollow, other suitable greenback cutthroat trout habitat in Roaring Creek, Williams Gulch, East Fork Sheep Creek, West Fork Sheep Creek, Corral Creek, La Poudre Pass Creek, and other habitats in the Poudre Headwaters Project Area should be monitored to assess fate of current cutthroat trout populations and a full suite of habitat factors (e.g., stream temperature regime, pool quantity and quality, spawning habitat, etc.) from fire and post-fire effects. Occurrence of debris flows should be tracked and monitoring to determine fate, transport, and consequences on aquatic habitat conditions and naturally occurring waterfall/cascade barriers. Distribution of non-native trout within the natural barrier reaches should be monitored in connection with local debris flow events to confirm barrier effectiveness as streams undergo natural recovery.*
- The State of Colorado's Critical Resource Water of the Cache la Poudre River Basin. The Cache la Poudre River and its are prized wild trout fisheries. Colorado Parks and Wildlife (CPW) manages these trout populations and the associated recreational fisheries in the river. CPW should monitor these trout populations and determine appropriate management responses to post-fire habitat impacts.
- *Cache la Poudre River Wild and Scenic River, Recreational Fishing. Increases in turbidity, ash, and sediment loading could impact fisheries and recreational fishing within the Cache la Poudre River corridor over the next few years. These increases would not affect the designated Wild portion of the river, since these are natural processes associated with wildfires. The effects of the fire will recover to pre-fire conditions over time, with the greatest impacts occurring over the next three to five years. This may affect the use of the river for recreation at high risk locations.*
- Poudre Headwaters Project – *Downstream extents and eastern extents of the project area waters were burned in the fire, which includes portions of the Cache la Poudre River, Hague Creek, La Poudre Pass Creek, and Corral Creek. Although three of the fish barrier sites were burned, the severity of burn and debris flow potential for these sites was modelled as relatively low potential and post-fire effects are unlikely to dramatically change geomorphic conditions for the bedrock waterfall sites on the Cache la Poudre River. The cascade reach on Hague Creek may experience minor changes or shifts in channel configuration or alignment as result of post-fire erosion or runoff; however, the large meadow in Hague Creek upstream from the barrier reach will likely buffer against large pulses of sediment movement. Habitats in the Poudre Headwaters Project Area should be monitored to assess fate of current cutthroat trout populations and a full suite of habitat factors (e.g., stream temperature regime, pool quantity and quality, spawning habitat, etc.) from fire and post-fire effects. Occurrence of debris flows should be tracked and monitoring to determine fate, transport, and consequences on aquatic habitat conditions and naturally occurring waterfall/cascade barriers. The National Park Service has completed an independent BAER assessment of critical resource values, including post-fire responses to important habitats on National Park Service Lands. For more information, please refer to their assessment. Radio Frequency Identification (RFID) Antennas and Hydrologic Monitoring Equipment was deployed in 2018 to evaluate fish passage and hydraulic conditions at bedrock waterfalls in the Cache la Poudre River associated with the Poudre Headwaters Project. The equipment survived the fire and remains in place. Site conditions should be evaluated as the study proceeds in the future. Post-fire runoff could cause damage equipment and should monitored regularly to assess condition and need for replacement parts and repairs.*
- Fish Habitat Improvement Structures along the South Fork Cache la Poudre River, Little Beaver Creek. The Cameron Peak Fire burned along these reaches with mixed severity. Some riverbanks were burned at individual structure locations. These structures survived the High Park Fire of 2012 and weathered the high peak flow in the September 2013 flooding event. Although some individual structures are in need of repair, several are still functioning to provide recreationally-important trout habitat. Debris flow risks along the South Fork Cache la

Poudre river are low; however, Fish Creek and Little Beaver Creeks burned rapidly and with high intensity. Structures could be damaged, scoured, or buried in post-fire hydrologic responses. Structural integrity and stability should be monitored over the next 3-5 years to determine if structures should be replaced.

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