Long-Term Post-Fire Hydrologic Impacts & Recovery Needs

river science


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Fire Water Nexus

Fire and the State of Colorado's water are inseparable. As wildfire becomes more prevalent and drought persists, our State must examine how post-fire impacted rivers and streams negatively influence our state's hydraulics, hydrology, water quantity, and water quality. Each year Colorado wildfires add several hundred (or more) miles of creeks that will experience post-fire flooding. Post-fire flooding creates long-term issues for our waterways including incised channels, disconnection from floodplains, loss of riparian habitat, and extreme sediment loading.

In 2020, 1% of our state's land burned in wildfires, which translates to over 1,000 miles of creeks located in burned watersheds. As fire & flooding are tied together, we must consider the long-term impacts on our waterways & how to help restore these systems to pre-fire conditions.

Initial Response

Each fire is unique, but as a general observation, large-scale destructive flooding persists for approximately five years following a wildfire. During this time, people living in and downstream of the burn face significant risks to their safety, homes, and water supplies. Hillsides stripped by fire can no longer absorb or catch rainfall. Burned trees fall and can be swept downstream with soil, ash, and other materials (known as debris). During this time, a focus on life & property is imperative.

Fires strip trees & vegetation from hillsides.

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Fire-scorched soils become hydrophobic soil (a temporarily impermeable soil layer), which cannot absorb rainwater.

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Without vegetation or stable soil, debris such as burned trees, soil and ash flow downhill during rain events.

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Communities downstream from these flows are at serious risk for flooding.

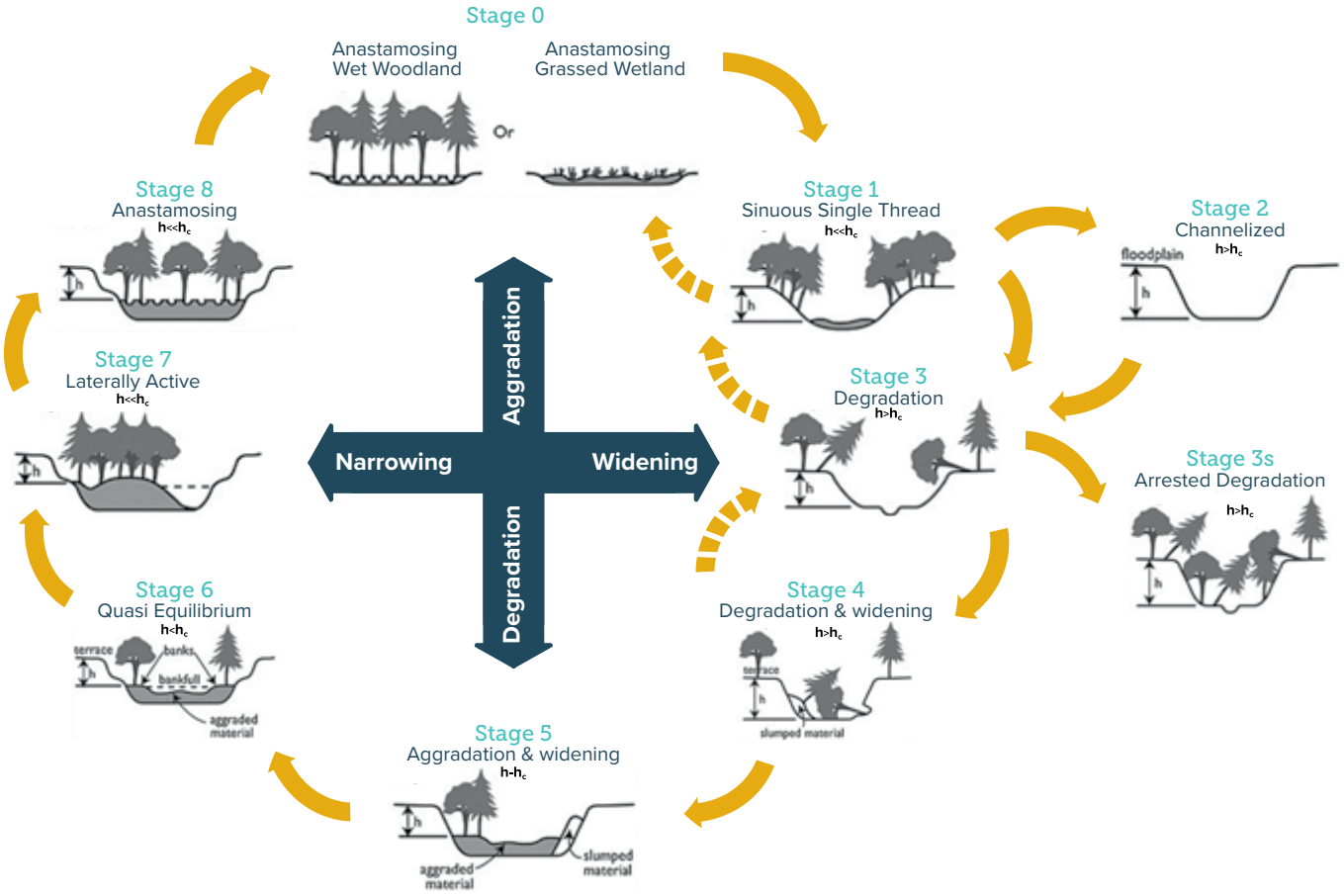
For example, the 2016 Hayden Pass Fire in Fremont County produced its most significant post-fire flood two years after the fire. Initial estimates (based on precipitation) calculated the event as a 3,500 CFS flood.

After analysis, River Science discovered that the flood was a 10,200 CFS flood due to increased sediment & debris loading.

Long-Term Recovery Needs & Opportunities

Big Cottonwood Creek

Following the Stream Evolution Model below, Big Cottonwood Creek, in various reaches, was a well-connected floodplain with a laterally active channel and beaver ponds. For the most part, reaches ranged from 6 to 7, with limited sections of 8 and 1. Post-fire flooding carved large incisions into the creek and quickly changed this creek to 2, 3, and narrow areas of 4s. While stream evolution from this current degraded stage may essentially return to pre-flood conditions, this may take hundreds, possibly thousands of years. During this time, post-fire degraded systems would continue to suffer from the impairments. However, targeted restoration techniques that aim to accelerate stream evolution could assist the recovery process with cost-effective, low-impact (i.e., no heavy equipment necessary) techniques. One such opportunity for restoration is Process-Based Restoration (PBR), as outlined in Wheaton et al. (2019).



Cluer, B. and Thorne, C., 2014. A stream evolution model integrating habitat and ecosystem benefits. River Research and Applications, 30(2): 135-154. DOI: 10.1002/rra.2631

Restoration techniques to trap sediment and slow the flow can amplify natural hydrologic processes. Using small, hand-built treatments designed to widen and lift channel bed elevations (or aggrade) can significantly improve the hydraulic, hydrologic, and habitat issues stemming from the deep incision over a significantly faster timeline than if neglected.

Long-Term Recovery Needs & Opportunities

Big Cottonwood Creek

Big Cottonwood Drainage in Fremont County is moving into its 6th-year post-fire, yet many issues remain. The pre-fire stream footprint for this creek was approximately 11 acres. Today, the stream footprint is about 6 acres, primarily due to incisions from post-fire flooding.

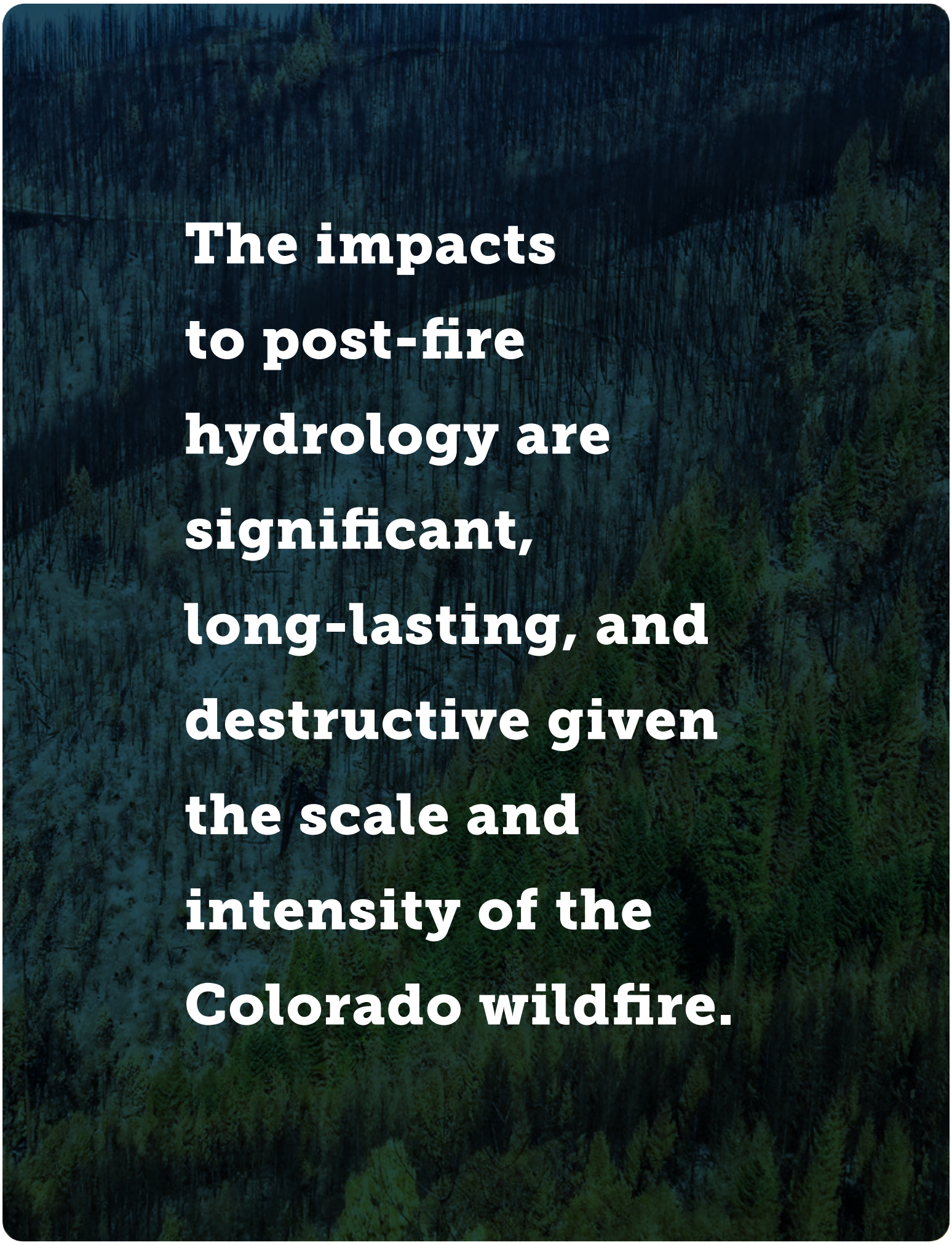
A typical degraded reach on Big Cottonwood Creek.

Long-Term Recovery Objectives

Although each fire & resulting flood are unique, we often find that long-term recovery objectives are similar across diverse landscapes.

Recovery objectives for impaired systems might include:

- Reconnecting the floodplain to spread and slow flood waters *(creating healthy systems for future post-fire landscape)*
- Return to pre-fire inundation extent
- Reducing frequent bank failures which introduce large amounts of fine sediment into the system
- Increasing structure and geomorphic diversity *(i.e., pools, slow moving water, ponded areas)*
- Slow the flow to create aquatic habitat
- Restoring deep incisions by trapping sediment to increase the elevation of the creek bed
- Mitigating steeper grades and faster flows which reduce water residence time and infiltration
- Increasing and restoring habitat for aquatic and terrestrial wildlife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The Opportunity

Every year we experience devastating fires. The impacts to post-fire hydrology are significant, long-lasting, and destructive given the scale and intensity of the Colorado wildfire.

Addressing the long-term recovery needs of post-fire landscapes is essential. Big Cottonwood Creek serves as an example of the compounding issues that exist many years after a fire. We hope to assist Big Cottonwood Creek in reaching pre-fire conditions by focusing on the recovery objectives listed above and documenting this process to serve as an example for other post-fire affected watersheds. We believe that incredible work is being accomplished in the 0-5-year post-fire phase, which focuses on protecting life and property. We hope to build on these efforts and include the next phase (5-20) post-fire period, which focuses on the health, rehabilitation, and restoration of the watersheds that sustain us all.

Learn more about
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Recovery Opportunities

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