

## Executive Summary

The Peaks to People Water Fund is working to improve watershed health and protect water resources on the northern Colorado Front Range by using active forest management in areas of high wildfire risk and potential impact to water resources. Peaks to People Water Fund completed a selection process to establish forest restoration projects demonstrating the benefits of forest management in moderating wildfire behavior and protecting water resources from negative impacts associated with postfire soil erosion and sedimentation. The goals of establishing demonstration sites were to enhance communication of connections between forest and watershed health, attract investors, promote water resource protection, and serve as a learning lab to enhance effectiveness of forest management. The two sites selected were Ramsay-Shockey in the Big Thompson watershed and the Ben Delatour Scout Ranch (Scout Ranch) in the Cache la Poudre watershed.

Peaks to People aims to manage forests such that wildfires are less severe, post-fire erosion is minimized, and valuable ecosystem services are preserved. Historically, lower elevation ponderosa pine forests burned primarily at low and moderate severity with scattered patches of high severity effects, which maintained open, low density forests that were resilient to fire disturbances. However, fire suppression and other land management practices over the past century have led to increased tree density that reduces forest resiliency under current and future climates. Forest restoration goals in lower elevation ponderosa pine forests aim to restore and maintain long-term low-density forests, openings, and complex, varied forest spatial patterns. Such structures can support characteristic low- to mixed-severity fire and create and maintain conditions that support resilience and resistance to disturbances such as wildfire and insect and disease outbreaks.

The Colorado Forest Restoration Institute at Colorado State University worked closely with the Colorado Chapter of The Nature Conservancy and other partners to lead monitoring at the demonstration sites to assess how projects aligned with Peaks to People program goals and objectives. Restoration effectiveness monitoring incorporates a comprehensive, multi-scale approach that enhances our understanding of current treatment effects on wildfire behavior and improves future forest management. In this report, we combine field-based measurements of forest and fuel structure,



Figure 1: Before and after photos from Ramsay-Shockey

remote sensing techniques, and stand- and landscape-scale fire behavior modeling to measure cumulative ecological effects of forest restoration treatments on fire behavior and watershed health. Additional goals of the monitoring program include peer-to-peer learning and collaboration among forest and fire managers, which will improve future project outcomes.

During summer 2016, Ramsay-Shockey and Scout Ranch were targeted for forest restoration treatments consisting of mechanical tree harvesting. By spring 2017, nearly 100 acres of tree cutting was accomplished across both sites. In fall 2017, a 100 acre broadcast prescribed



Figure 2: An old-growth ponderosa pine at Ramsay-Shockey.

burn at Scout Ranch reintroduced fire to further reduce risk of high intensity wildfires and restore ecological processes. At both Scout Ranch and Ramsay-Shockey, fire behavior modeling informed by field surveys suggests that forest restoration activities contributed to desired forest structural conditions, though enhanced forest resilience to wildfire was most evident in stands at Scout Ranch that included prescribed broadcast burning. Prescribed fire at Scout Ranch in areas that weren't thinned reduced key metrics of effective fuel reduction projects. Average tree crown base height (CBH) was raised by 26 ft. and there was a 46% reduction in fine woody surface fuel loading. Mechanical thinning followed by prescribed fire raised average tree CBH by 5 ft. and reduced surface fuel loading by 2%; if precipitation had not occurred during the burn, effects of the prescribed fire likely would have been greater. Regardless, these changes promoted fuel conditions that can support a more characteristic low- to mixed-severity fire regime dominated by surface fire. When thinning treatments reduced tree density near historical reference condi-

tions, the likelihood of high severity crown fire also decreased. However, at Ramsay-Shockey, mechanical thinning with modest overstory removal that did not remove residual slash had limited effects one year after treatment on reducing potential fire intensity and post-fire tree mortality.

While tree density remained high in some areas of Ramsay-Shockey following thinning, decreased forest cover and increased frequency of large gaps in forest cover indicate the treatment made incremental progress towards fuels reduction and other forest health objectives. At Ramsay-Shockey, we found that forest restoration treatment decreased tree canopy cover (44% to 35%) and increased coverage of gaps from 25% to 40%. Gap size distributions show that Ramsay-Shockey restoration treatments generally shifted gap cover from many small gaps ( $\leq 2$  acres) to fewer, larger gaps ( $> 2$  acres). At Scout Ranch, gap coverage increased from 41% to

46% following thinning treatments as many small gaps combined to form larger gaps. Restoration treatments at both sites decreased overall tree density, and increased the size, size variability, and aggregation of gaps towards desired complex forest structure.

The Peaks to People Watershed Investment Tool models fire behavior in FlamMap using fuels data from the LANDFIRE program to estimate the impact of forest restoration treatments on fire behavior and effects. We compared fire behavior predictions from the Watershed Investment Tool to fire modeling using field survey data collected at each demonstration site. We found that the Watershed Investment Tool predicted more intensive fire behavior, including more passive and active crown fire. Most of this difference can be explained by differences in fire behavior fuel models and tree canopy base height. If LANDFIRE consistently under-predicts canopy base height, future analyses may need to adjust fuel structure inputs used by the Watershed Investment Tool to more accurately estimate benefits of forest fuel reduction for watershed protection.

Peaks to People stakeholders participated in field data collection as part of the monitoring process and provided valuable insights into the application of monitoring data. In turn, fire and forestry professionals learned ecological measurement techniques that will improve outcomes on other projects, expanding the impact of the demonstration sites. Participants from over 10 agencies collaborated and assisted Colorado Forest Restoration Institute in the data collection. Ramsay-Shockey and Ben Delatour Scout Ranch now serve as demonstration sites that show the effectiveness of cooperation and peer-to-peer learning. Both sites have hosted multiple visits from potential water fund investors, and serve to demonstrate connections of forest and watershed health to new audiences. They provide an open-air forum for managers, researchers, and stakeholders to engage in collaborative discussion about forest ecology and management.