Musser and Jarvis Watershed Restoration
2023 Monitoring Report

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Prepared by: Kaitlyn Garber and Isabella Kurtz

Headwaters Coordinator: Rachel Kieffer

Alpine Watershed Group
P.O. Box 296
Markleeville, CA 96120
(530) 694-2327
www.alpinewatershedgroup.org

Summary

In November 2021, Alpine Watershed Group (AWG), Markleeville Water Company, CAL FIRE, and community volunteers completed a restoration project in the Musser and Jarvis watershed to prevent erosion into Markleeville Water Company's intake infrastructure. Starting in 2022, AWG completed post-restoration monitoring as outlined in the *Musser and Jarvis Watershed Restoration Monitoring Plan* (Appendix A). A second year of monitoring was completed in 2023, and post-project monitoring is expected to continue through at least 2024. Photo points and vegetation data are taken at 24 locations around the watershed.

The number of native species present continued to increase over time, while nonnative species present diminished. In July of 2023, a total of 25 native species were identified, compared to only two nonnative species. Average percent cover has steadily increased between December 2021 and September 2023, peaking in July of 2023 at approximately 20%. Visually, the hillsides show little erosion. The monitoring indicates that the restoration project has served an important role in maintaining watershed health, and the area will continue to be monitored for another year to determine success and next steps for recovery.

Introduction

Musser and Jarvis Creek is located in the Humboldt-Toiyabe National Forest and flows into Markleeville Creek. This area was impacted by the Tamarack Fire in July of 2021 by both medium-intensity burns and high-intensity crown burns (see Appendix C). The Musser and Jarvis watershed supplies 70% of Markleeville's water through an intake on the downstream side of the burn scar. Because of the fire, the banks became unstable and the hillsides were susceptible to erosion. This negatively impacted water quality, and Markleeville Water Company's intake infrastructure has clogged repeatedly, leading to complications that could impact Markleeville's access to clean water.

This restoration project, spearheaded by Markleeville Water Company President Mary Young and her husband Bill Young, worked to stabilize the hillsides to prevent further erosion. Two types of physical barriers to slow runoff and store sediment on the hillsides were used: wattles and felled and chinked trees. Seeds from seven native grass species were spread along the flatter areas near the creek banks, on both sides of the wattles, and on the upslope side of the felled trees. See below for the species list.

Over November 19–21, 2021, 115–135 trees were felled and chinked, 900 feet of wattles were installed, and 7–8 acres were seeded over an area of 15 acres. Two CAL FIRE California Conservation Corps (CCC) crews of 15 and a total of 49 volunteers worked over the weekend, totaling 284 volunteer work hours.

Native Grass Seed Species List

- Mountain brome
- "Pryor" slender wheatgrass
- "Elkton" blue wildrye
- High Plains Sandberg bluegrass
- "Sherman" big bluegrass
- "Sodar" streambank wheatgrass
- "Joseph" Idaho fescue

Data and Methods

Baseline photo monitoring was conducted the day before the project started (November 18, 2021). Twenty-four points were chosen within the 15-acre worksite to best represent the various conditions of the watershed and the range of treatments. See Figure 1 for a map of the photo points. Each vegetation monitoring site, which measures species, type, and percent cover, corresponds to the photo point monitoring sites. The photos and vegetation surveys are taken two times per year in early July and late September. This allows the data to represent the entire growing season without impacting early growth. Note that the Monitoring Plan called for the first round of monitoring to take place in June, but it was determined that early July would have fewer impacts on post-winter growth.

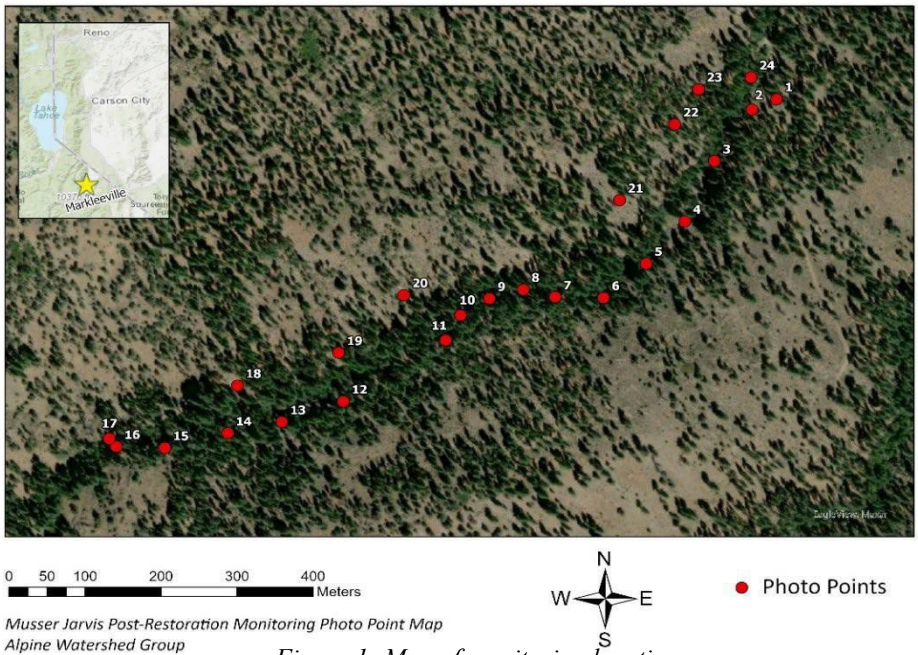


Figure 1: Map of monitoring locations

For this report, photo points 1, 3, 8, 10.1, 12, 13.2, 14, 17, 19, and 20 have been selected for side-by-side comparison because they each represent a different method of treatment. For the vegetation data, the native and nonnative species are compared, and the percent cover of all plots over time is average.

Results and Discussion

Photo Monitoring

Photo point monitoring can be used to visually detect changes in the slope of the hillside and the degree of erosion that occurs, as well as provide a visual reference for post-fire revegetation over time. See Appendix B for the selected photo points' side-by-side comparison.

Noticeable growth is detectable in both the seeded and non-seeded areas, with graminoids (herbaceous plants with grass-like features) being the prominent vegetation type in seeded areas and forbs in the non-seeded areas. Comparing the selected photo points demonstrates the most notable difference between September of 2022 and July of 2023, with September of 2023 seeing a slight regression of the graminoids as is typical in fall months (see Appendix B). Average percent cover reflects this same increase. The planted trees have persisted well to date, despite a significant growth of graminoids in the surrounding area as of September 2023, and growth is visible (for example, see MJPP 14 [July and September] in Appendix B). Soil has continued to settle behind the felled trees, encouraging graminoid growth between September of 2022 and 2023, and significant bank erosion has not been observed even with a significant storm event in August 2022 (see MJPP 12 in Appendix B) and the high-water year in winter 2022-2023. The south slope, despite little treatment, is recovering with few invasive species (see MJPP 19 and MJPP 20 in Appendix B).

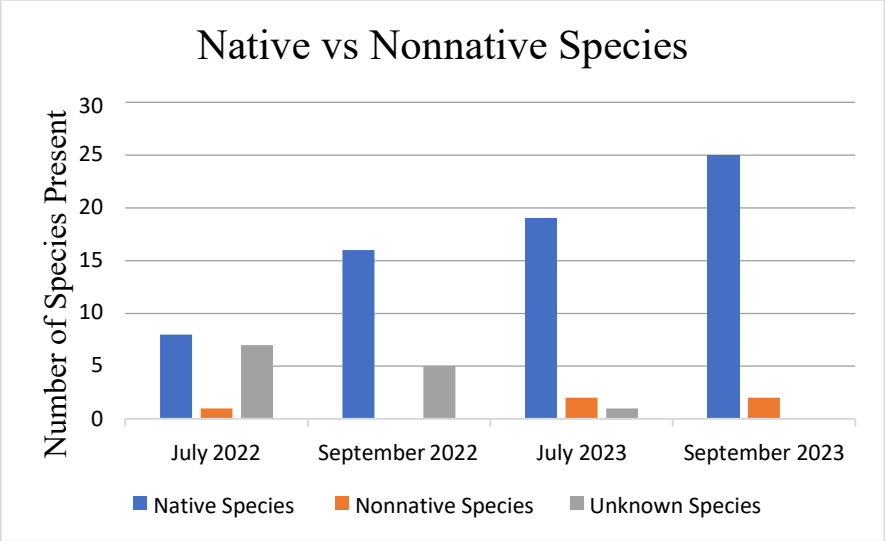


Figure 2: Native, nonnative, and unknown species present in 2022 and 2023

Vegetation Monitoring

Vegetation monitoring can determine what seeded species were successful at germinating and reproducing and whether seeding is effective at preventing nonnative species from inhabiting a disturbed area.

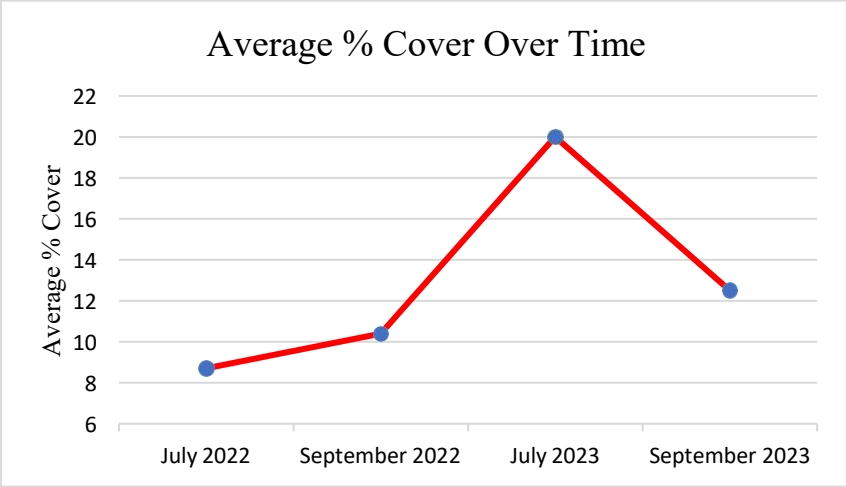


Figure 3: Average percent cover over time in 2022 and 2023

On July 5, 2023, 19 native species, 2 nonnative species, and 1 unknown species were found within the vegetation monitoring plots. September 27, 2023, had increased numbers of native species, decreased numbers of unknown species, and an unchanged number of nonnative species, with 25, 0, and 2 species respectively (see Figure 2). The average percent cover data between 2022 and 2023 reflects the changes seen in the photo points with an overall increase in average percent cover from 8.7% in July 2022 to 12.5% in September 2023 (see Figure 3). Out of the seeded native grass species, 5 were present. The two species of native grass that were not observed during the 2023 surveys were "Sodar" streambank wheatgrass *(Elymus lanceolatus)* and High Plains Sandberg bluegrass *(Poa secunda)*.

Conclusion

The restoration project was successful in accomplishing the objective of preventing erosion and maintaining improved watershed health. Most of the species observed were native, and ground cover is steadily increasing. Visual comparisons of key points along the watershed indicate that the hillsides are remaining stable. This area experienced a high flow/volume event in August of 2022, showing little to no impact after. Monitoring continued for a second year in 2023, after a record-high snow year, to observe the species present and percent cover. The same data collections will occur in 2024 to record data three years post project.

Acknowledgements

Thank you to all of the volunteers that helped with restoration and monitoring; Alpine County Chamber of Commerce, who funded the restoration project through the Tamarack Fire GoFundMe effort, and the many people who donated to the fund; Brian Hansen of the U.S. Forest Service, who obtained approval for this project; Andy Lovell and Alpine Trails Association, who donated their time and tools; Debbi Waldear and Friends of Hope Valley, who volunteered and helped recruit additional volunteers; Jed Gains of CAL FIRE, who organized and led the CCC efforts; Richard Burchell of Markleevillage, who helped to organize the work and brought in CAL FIRE CCC; and Mary and Bill Young, who obtained the funding, planned the project, and have worked tirelessly to help heal this landscape. We are grateful to Sierra

Nevada Conservancy for providing funding through the Regional Forest and Fire Capacity Program to assess post-fire Musser and Jarvis restoration activities to inform additional post-fire restoration needs. Finally AWG is grateful to past AWG staff for their work on this project: Sierra Nevada AmeriCorps Partnership (SNAP) Member Sierra Riker for assisting with restoration project implementation, development of the monitoring plan, the initial rounds of monitoring, and the 2022 Monitoring Report; and AWG's first Forest Health Coordinator Wes Mosley for finalizing the 2022 Monitoring Report and leading 2023 data collection.

Musser and Jarvis Watershed Restoration Monitoring Plan

Comments received from Mary and Bill Young on February 16, 2022; incorporated into next draft; and recirculated to Mary Young for Markleeville Water Company Board of Directors on May 12, 2022
Reviewed and Approved by Carson Ranger District, Humboldt-Toiyabe National Forest on June 16, 2022
Finalized by Alpine Watershed Group on August 12, 2022
Updated by Alpine Watershed Group on January 23, 2024, to reflect July monitoring

Introduction

Project Background

Musser and Jarvis Creek is in the Humboldt-Toiyabe National Forest and flows into Markleeville Creek, which flows into the East Fork Carson River north of Markleeville. This area was impacted by the Tamarack Fire in July of 2021 by both medium-intensity burns and high-intensity crown burns. The Musser and Jarvis watershed supplies 70% of Markleeville's water through an intake on the downstream side of the burn scar, which is leased from the U.S. Forest Service by Markleeville Water Company (MWC). Because of the fire, the banks have become unstable and the hillsides are eroding into the stream. This is negatively impacting water quality, and the intake infrastructure has clogged repeatedly. This restoration project, spearheaded by Markleeville Water Company President Mary Young and her husband Bill Young, aims to stabilize the hillsides to prevent further erosion. The work described in the Project Description took place on November 19–21, 2021.

Location

The Musser and Jarvis watershed can be accessed through Markleevillage. The access road is located at the end of Sawmill Road, and is locally known as the access route for Thornburg Canyon Trail. The dirt road goes through private property and over Spratt Creek. Shortly after crossing the creek, the road forks, with one fork continuing straight up Thornburg Canyon while the other turns sharply to the right and goes up a steep hill to a gate, beyond which is U.S. Forest Service land. There is a gate with a U.S. Forest Service lock, which restricts access. Access will be coordinated with Markleeville Water Company. After approximately a mile, the road enters the forest and widens out. This is where vehicles should park. See the reference binder for a map of the access area.

If parking at the intake is necessary, prior to going to the intake, phone Mary Young, Kris Hartnett, or another MWC Board Member to let MWC know when you will be parked at the intake. Keep vehicles on existing gravel and dirt roadways. Parking at the MWC intake requires driving along the existing road through a section of private property, which should be respected

and used for access only. Park the vehicle in a position where other vehicles can access and turn around at the intake site. Place a note on the vehicle identifying AWG so MWC personnel will know why the vehicle is parked at the intake. The creek should not be entered near or within 100 yards upstream of the intake structure and MWC facilities or equipment at the intake should not be disturbed.

The restoration work initially did not include the area immediately around the intake structure, but began about 100 yards upstream, moving upstream on both the north and south slopes. The first photo point is near two large boulders upstream of the water intake infrastructure. The restoration area begins about 100 yards upstream of the intake and extends upstream to shortly before the "narrows," which is the approximate border of Mokelumne Wilderness Area. The photo locations were created by traversing a loop starting on the downstream, south side of the creek and proceeding upstream on the south side of the creek. At the westernmost edge of the restoration area (near the wilderness boundary), the numbering transferred to the north side of the creek and returned downstream. The creek will need to crossed at least twice when completing monitoring.

Project Description

Seeding

Seed from seven native grass species was spread along the flatter areas near the creek banks, on both sides of the wattles, and on the upslope side of the felled trees. These grasses should help to slow surface runoff, allowing water to infiltrate into the ground and nutrients, pollutants, and sediment to settle. These nutrients and pollutants then can be taken up by plants, decay, get metabolized by microbes, or absorbed into soil particles, thereby preventing sediment from flowing into the stream and negatively impacting water quality. The roots from the grasses will stabilize the soil and hold the banks and hillsides in place.

The species list includes mountain brome (*Bromus marginatus*), "Pryor" slender wheatgrass (*Elymus trachycaulus*), "Elkton" blue wildrye (*Elymus glaucus*), High Plains Sandberg bluegrass (*Poa secunda*), "Sherman" big bluegrass (*Poa ampla*), "Sodar" streambank wheatgrass (*Elymus lanceolatus*), and "Joseph" Idaho fescue (*Festuca idahoensis*).

Physical Erosion Control Barriers

The two types of physical barriers used were focused on slowing runoff and storing sediment on the hillsides. The first barrier type was wattles, which are 25-foot burlap tubes filled with straw. Wattles were staked into the ground to block the passage of runoff, and they were placed at the foot of the hill for the highest effectiveness. The other barriers were felled and chinked trees. The trees were felled perpendicular to the slope. Chinking is when the soil upslope from a felled tree is packed against the log to create a barrier. Both barriers serve to block and slow high-velocity

surface runoff.

Accomplishments

Over three days, 115–135 trees were felled and chinked, 900 feet of wattles were installed, and 7–8 acres were seeded over an area of 15 acres. Thirty volunteers assisted on Saturday, November 20, 2022 and nineteen volunteers assisted on Sunday, November 21, 2022, totaling 284 volunteer work hours. Two CAL FIRE California Conservation Corps (CCC) crews of 15 worked Friday, November 19, 2022 through Sunday, November 21, 2022. The volunteer crews seeded around the wattles, behind the felled trees, and on the flat areas near the stream; they also helped with chinking. The CCC crews installed the wattles, felled the trees, and chinked trees.

Goals

Research Questions

- How effective were seeding, tree felling/chinking, and wattle treatments in preventing erosion?
- How does seeding impact the ratio of native/nonnative species that grow post-fire?
- What species were most successful for post-fire seeding? (if monitors can identify individual species)

Purpose of Monitoring

Ongoing monitoring will record the effectiveness of the treatments in the post-fire burn area. Photo point monitoring can be used to visually detect changes in the slope of the hillside and the degree of erosion that occurs, as well as provide a visual reference for post-fire revegetation over time. The vegetation monitoring will determine what seeded species were successful at germinating and reproducing. The monitoring may also suggest whether seeding is effective at preventing nonnative species from inhabiting a disturbed area. Through vegetation monitoring, the spread of invasive species after native seeding can be identified and compared to other restoration sites. Success of revegetation in the different treatment areas as shown by photo point monitoring and vegetation monitoring might suggest the success of a specific treatment type at preventing erosion.

Limitations

- As described above, vehicle access to the project site depends on having the key to unlock the gate.
- The area is remote and steep.
- The lack of human presence makes the relatively pristine area ideal as a drinking water source. Therefore, aside from necessary crossings, the stream should be disturbed as little

as possible. No analytical water quality sampling/monitoring should occur, however visual records of the stream should be recorded in the observation box on the data sheet.

- Due to the area's remote and pristine nature, replicability or project application in other areas may be difficult.
- Identification of grass species is very challenging, especially in their early stages of development, however native vs. nonnative will be identified.
- Relocating photo point locations can be very difficult due to the nature of thelandscape, as we are not able to place permanent markers for the points. Alpine Watershed Group (AWG) does not have a high-end GPS. The GPS device AWG owns and GPS-enabled smartphones can be off by several meters, making locating by GPS not alwaysaccurate.

Additional restoration projects or correctional actions to the current project could be difficult because of these limitations.

To assist with consistent, high-quality monitoring, AWG staff has created a reference binder.

Methods

Plot Selection Rationale

The project was brought to AWG's attention one week before the restoration project commenced. No pre-fire photos exist. Baseline photo monitoring was conducted the day before the project started (November 18, 2021). Twenty-four points were chosen within the 15-acre worksite. Photo points were chosen to best represent the various conditions of the watershed (e.g., medium and high burn severity) and the range of treatments, including:

- lack of any alterations (as a control)
- just tree felling and chinking (including seeding the chinked area)
- just seeding
- both tree felling and chinking and seeding

Monitoring Descriptions

Photo Monitoring

Each location was marked with a neon orange flag; locations were also noted with GPS in case flags disappear. Locations will be marked with a stake at a later date. The first flag starts at the top of the hill overlooking the second flat section upstream of the water intake on the south side of the creek. The rest of the photo points occur along the flat areas next to the stream. After photo point 16, photo point 17 is across the steam on the north side. Remaining photo points continue downstream until reaching photo point 23. Photo point 24 is across the stream looking toward the water intake. GPS coordinates for all photo points are included in the reference

binder. The reference binder also includes maps and direction guides for photos points. Each photo point should have two portrait and two landscape photos taken.

The photos should be taken two times per year: July and September. For the best quality photos, the survey should be performed in the late morning to mid-afternoon (around 11 a.m. - 2 p.m.). Much earlier or later than that, the sun may decrease the quality of the photos. Avoid sun glare, shadows, and presence of people in photos as much as possible.

If something of interest is seen, such as alterations in stream flow, wildlife sightings, animal tracks, etc., a photo should be taken for documentation. The data sheet also includes a box for observations.

Vegetation Monitoring

Each vegetation monitoring site corresponds to the photo point monitoring sites. A 1-meter by 1-meter square made from PVC pipe will determine where to monitor around the photo point. From the flag, throw the PVC square in an upstream/downstream direction or away from stream/toward stream direction. The direction the PVC square is thrown should be the same between each point during the monitoring day and alternated between each monitoring session.

Species name, type, and abundance should be measured. Use the identification sheet to determine the species present. Notate if the species is a forb, grass, shrub, etc. Lastly, determine percent cover first by species, then by type. Use the Visual % Cover Comparison Chart, Plant Reference sheet, and USFS Life Form Definitions documents in the reference binder. If you cannot identify a species, notate the species as unknown.

Identify the species using the Plant Reference sheet, which includes all the grass species that were seeded during restoration, as well as native and nonnative grasses, forbs, shrubs, and trees common to the area. If the species is unknown, mark it as such on the sheet.

Notations should be done using standard U.S. Forest Service acronyms. This includes:

- TR - Woody Tree
- SH - Woody Shrub
- FB - Herbaceous forb/herb
- GR - Herbaceous graminoid
- HB - Herbs
- AL - Algae
- LC - Lichen
- SS - Woody subshrub/half shrub
- NP - Nonvascular plant
- UN - Unknown

- VP - All vascular plants

See the Life Form Definitions Memo in the reference binder for more information about each type and how to classify plants.

Vegetation should be monitored in July and September. This allows the data to represent the entire growing season without impacting early growth.

Gear List

- 4WD vehicle
- GPS and extra batteries
- Camera (AWG's camera or a phone) and extra battery
- 1-meter x 1-meter PVC Square
- Work gloves
- Close-toed (preferably waterproof) shoes
- Long pants and long sleeves
- Hard hat
- Sunscreen
- Binder with data sheets and guides
- Pencils
- Water and snacks
- Tape measure
- WAG bags – All waste needs to be packed out of the watershed.

Reporting

Stakeholders of the project, specifically Markleeville Water Company and the U.S. Forest Service, should be kept informed of developments. No official report is required by any agency, however, a report should be completed at the end of each monitoring season as AWG staffing allows. This would serve as a reference for other similar projects after a large-scale wildfire.

References

Lee, K.H., Isenhart, T.M., Schultz, R.C. *et al.* Nutrient and sediment removal by switchgrass and cool-season grass filter strips in Central Iowa, USA. *Agroforestry Systems* 44, 121–132 (1998). https://doi.org/10.1023/A:1006201302242

Robichaud, P.R., Pierson, F.B., Brown, R.E., & Wagenbrenner, J.W. (2008). Measuring effectiveness of three postfire hillslope erosion barrier treatments, western Montana, USA. *Hydrological Processes: An International Journal*, *22*(2), 159-170.

	11/19/2021 (before treatment)	12/3/2021 (after treatment)	7/5/2022
MJPP1 (seeding with wattles)			
	9/22/2022	7/5/2023	9/27/2023
			

	11/19/2021 (before treatment)	12/3/2021 (after treatment)	7/5/2022
MJPP3 (seeding with wattles)			
	9/22/2022	7/5/2023	9/27/2023
			

MJPP8 (seeding without wattles)

11/19/2021 (before treatment)	12/3/2021 (after treatment)	7/5/2022
		
9/22/2022	**7/5/2023**	**9/27/2023**
		

	11/19/2021 (before treatment)	12/3/2021 (after treatment)	7/5/2022
MJPP10.1 (seeding without wattles)			
	9/22/2022	7/5/2023	9/27/2023
			

	11/19/2021 (before treatment)	12/3/2021 (after treatment)	7/5/2022
MJPP12 (tree felling)			
	9/22/2022	7/5/2023	9/27/2023
			

MJPP13.2 (tree felling)	11/19/2021 (before treatment)	12/3/2021 (after treatment)	7/5/2022
	No photo taken		
	9/22/2022	7/5/2023	9/27/2023
		No photo taken	

	11/19/2021 (before treatment)	12/3/2021 (after treatment)	7/5/2022
MJPP14 (tree planting and felling)	No photo taken		
	9/22/2022	7/5/2023	9/27/2023
			

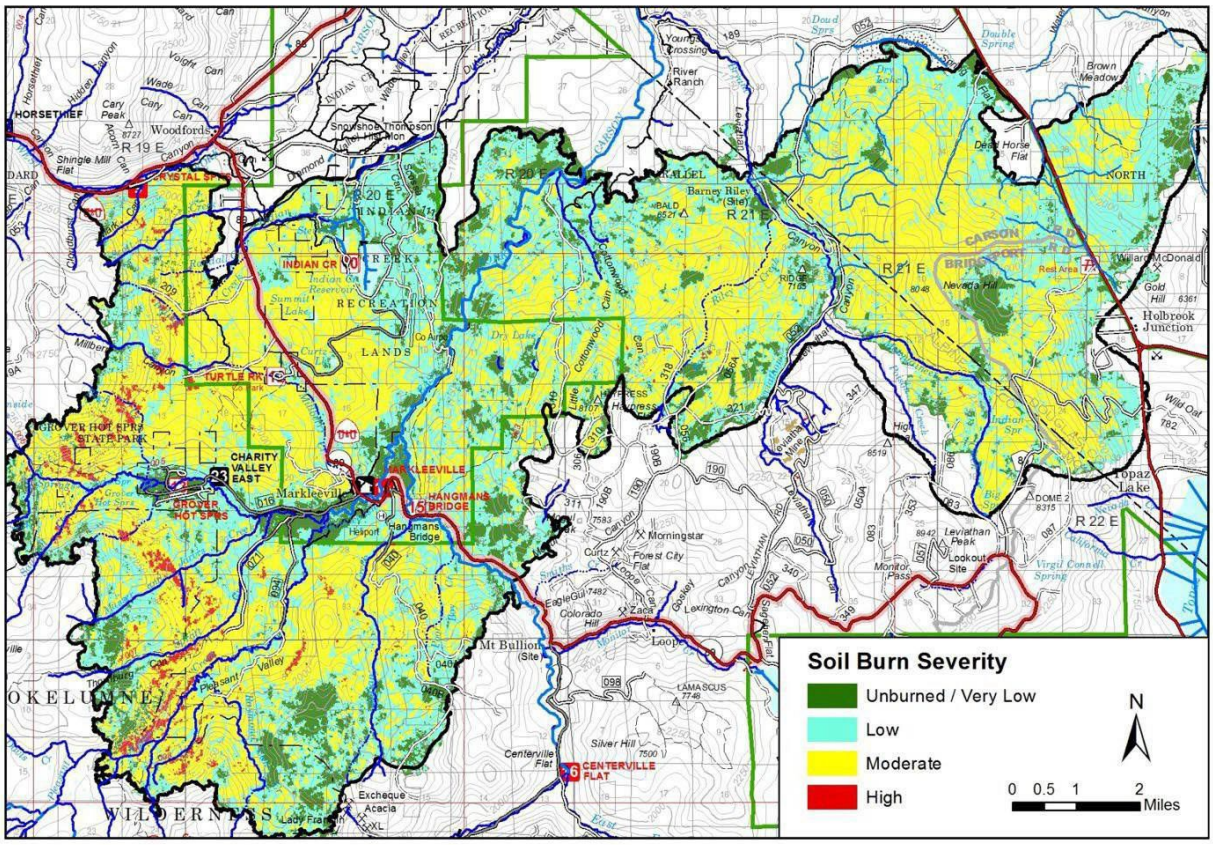
	11/19/2021 (before treatment)	12/3/2021 (after treatment)	7/5/2022
MJPP17 (tree planting)	No photo taken		
	9/22/2022	7/5/2023	9/27/2023
			

	11/19/2021 (before treatment)	12/3/2021 (after treatment)	7/5/2022
MJPP19 (no treatment)			
	9/22/2022	7/5/2023	9/27/2023
			

	11/19/2021 (before treatment)	12/3/2021 (after treatment)	7/5/2022
MJPP20 (no treatment)			
	9/22/2022	7/5/2023	9/27/2023
			

Appendix C: Tamarack Fire Soil Burn Severity Map

Tamarack Fire Soil Burn Severity



Tamarack Fire – Burned Area Emergency Response Soil Resource Report
Eric Nicita, Forest Soil Scientist, Eldorado NF, eric.nicita@usda.gov,
USDA Forest Service, August 11, 2021