SAN MIGUEL RIVER

RESTORATION STUDY

SAN MIGUEL WATERSHED COALITON

Table Of Contents

SAN MIGUEL WATERSHED COALITION

"Our mission is to protect the San Miguel watershed."

https://sanmiguelwatershed.org

San Miguel Restoration Study

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SECTION
ONE

INTRODUCTION

"The San Miguel Watershed Coalition (SMWC) 2021 River Restoration Study aims to develop a list of restoration projects in the watershed to be pursued by SMWC and its partners."

The River Restoration Study took place simultaneously while the Colorado Water Conservation Board (CWCB) organized San Miguel Partnership identified large-scale environmental and recreational restoration objectives. The San Miguel Partnership (SMP) is a basin-wide stakeholder group that serves to pilot a large, inclusive basin-wide stakeholder process. The objective of the SMP is to identify environmental and recreational needs of the San Miguel to be included on the Southwest Basin Roundtable Basin Implementation Plan (BIP), Identified Projects and Processes (IPP) list, and connect partners to work on the identified projects. As a partner of the SMP, SMWC provided local insight and connected stakeholders. To avoid redundancy in these parallel restoration studies, SMWC aimed to identify restoration objectives within the scope of projects a small watershed group can complete over the next five years that will also fill gaps in the restoration objectives identified by the SMP. Projects identified will serve as outlines to develop funding proposals in the near future. The River Restoration Study includes restoration objectives identified by stakeholders and partners of the San Miguel Watershed Coalition (SMWC) including the BLM, USFS, Montrose County, Town of Norwood, Town of Naturita, Colorado Cooperative Ditch Company, Telluride Institute, CO Parks and Wildlife, CO Division of Reclamation Mining and Safety, The Nature Conservancy, Backcountry Hunters and Anglers, Trout Unlimited, The Colorado Cooperative Company, U.S. Fish and Wildlife and others. These restoration objectives were identified over a two year period of outreach with stakeholders, including surveys, interviews and meetings. The River Restoration Study serves as an update to the 2001 River Restoration Plan.

The 2021 River Restoration Study was made possible by funding from the Bureau of Reclamation WaterSMART program, Colorado Watershed Assembly Colorado Healthy Rivers Fund, with additional support from San Miguel County, Town of Mountain Village, Southwestern Water Conservation District, Town of Telluride and the Telluride Foundation.

The San Miguel Watershed encompasses: **1,000,000 ACRES**

The San Miguel River stretches over: **80 MILES**

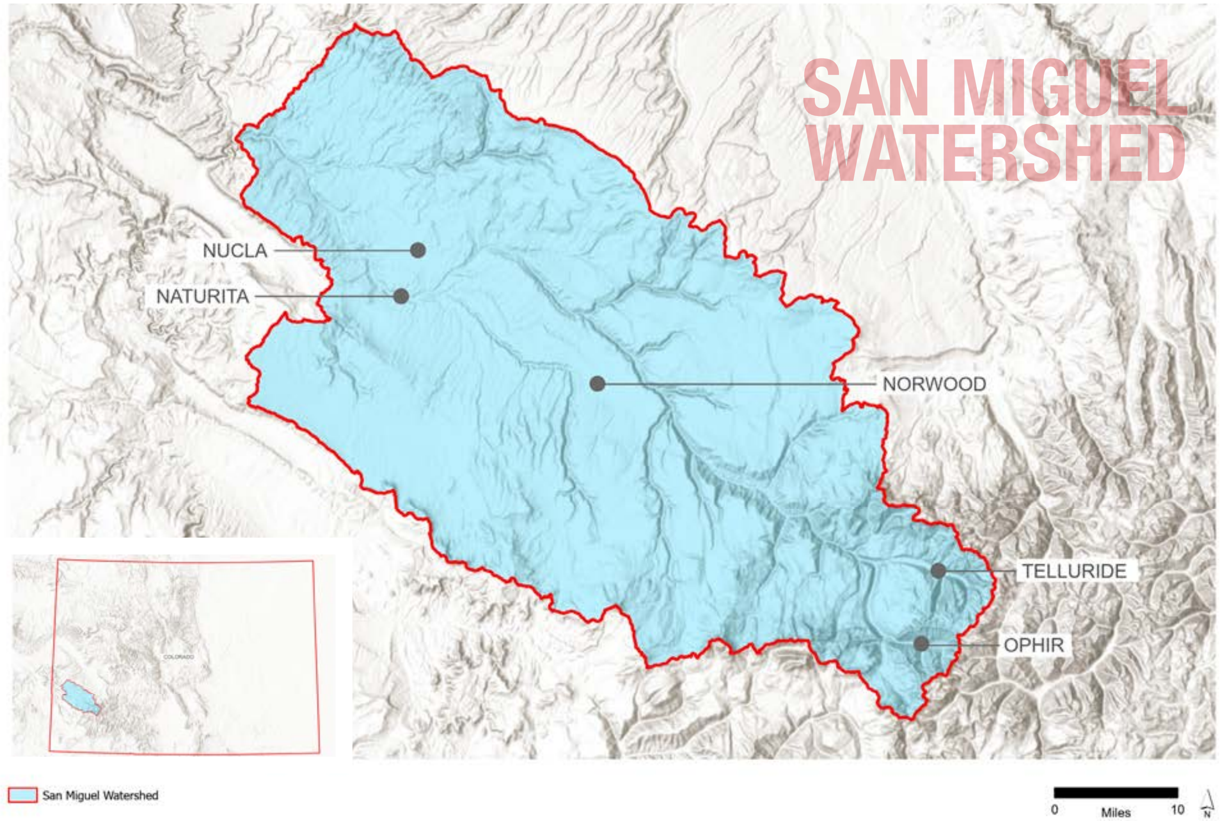

Figure 1. Map of the San Miguel River Watershed

The million-acre San Miguel Watershed in southwest Colorado lies within one of the largest relatively undisturbed areas that remains in North America. At its heart, the free-flowing San Miguel River extends for 80 miles from high-alpine headwaters above Telluride, Ophir and Trout Lake through scenic canyons to a desert confluence with the Dolores River in red rock country near the Utah border. The San Miguel is one of the few remaining ecologically and hydrologically intact river systems in Colorado. The USDA Forest Service and the Bureau of Land Management manage a majority of the land in the watershed, and within its boundaries are the towns of Nucla, Naturita, Norwood, Telluride, Mountain Village, Ophir, Placerville and Sawpit.

Historically, the area's economy has been based on mining, ranching, logging, power production and agricultural activities. More recently, there has been significant residential and commercial development in the upper basin because of the Telluride Ski Resort, summer festivals, and recreational activities. Roughly 6,000 people live and work in the watershed with many more commuting into the area daily for employment and enjoyment.

The San Miguel Basin is changing. The upper basin shift to a resort economy, coupled with a decline of traditional industries, has altered social and economic patterns. Residents are concerned about a host of environmental issues, such as decreasing water supplies, degrading riparian communities, the spread of noxious weeds, impacts to water quality, and unstable river channels. Basin communities are challenged with finding ways to enhance their long-term economic and cultural interests while preserving the environment.

The 2021 River Restoration Study aims to address these challenges moving forward with sustainable solutions to preserve the environmental and economic vitality of the San Miguel Watershed.

SECTION

TWO

BEAVER DAM ANALOGS

Figure 2. An example of beaver dam analogues (BDAs) mimicing beaver dam activity, and then the maintenance and expansion of beaver dam activity is taken over by actual beaver, and then they maintain a complex system state (Wheaton et al. 2019).

Historically, Across the American West, North American beavers (Castor canadensis) built dams across stream channels which created positive watershed-scale effects on hydrology, sediment dynamics, resilience to disturbance, and animal and plant community composition and diversity (Pollock et al. 2014; Wright, Jones, & Flecker 2002). Though a single beaver dam is a small geomorphic feature on the landscape they impact ecosystem processes at larger spatial scales across the landscape. Beaver dams often result in the development of wetlands and floodplains and promote a more complex channel network. Streams where beavers have been extirpated experience incision of the channel, disconnection from the floodplain, and degradation of the riparian corridor (Polvi & Wohl 2012). In many of these degraded streams the channels are oftentimes too narrow resulting in a powerful stream power that does not allow for the establishment and maintenance of natural beaver dams (Pollock et al. 2014).

Furthermore, Fairfax and Whittle (2020) found that beaver-dammed riparian corridors spread water into the surrounding landscapes making the soil and vegetation more resiliant to drought. As a result, these areas were shown to be more resilient to the impacts wildfire when compared to similar riparian corridors without dams.

Within degraded streams, where beavers are absent and the reestablishment of beavers is not practical, restoration practitioners are increasingly using beaver dam analogues (BDAs) as a low-tech and low-cost solution to mimic the hydrologic, ecologic, and geomorphic processes that a natural beaver dam would provide to the stream (Pillord et al. 2018). Utilization of BDAs are also seen as a more socially acceptable solution than the reintroduction of beavers themselves, especially within streams that flow through agricultural and ranching landscapes (Charnley 2018).

In terms of ecological function, BDAs mimic natural beaver dams by creating an area of slow-moving water upstream of the structure. Impounded water raises the local water table and reconnects the stream to its natural floodplain (Pollock et al. 2014). Though the main goal of installing BDAs is to induce aggradation and limit incision of the stream, there are other ancillary benefits that include increased hyporheic flow and subsurface biogeochemical cycling (Wade et al. 2020). Pollock et al. (2014) note that a series of BDAs constructed within a degraded stream system can have the potential to restore streams to a semi-pre-disturbed state.

Pillord et al. (2018) conducted a survey of projects in the Western United States that involved translocation of beavers or the installation of instream structures that mimic beaver dam effects. Of the 97 projects surveyed, 14 involved the construction of BDAs. A key conclusion of the study was that there is a lack of necessary decision-making tools for landowners and managers that limits adoption of best practices sing the given conditions and desired outcomes are determined on the specific site- and landscape-level scales. However, the authors note that the development of tools such as the Beaver Restoration Assessment Tool (BRAT) (Mcfarlane et al. 2014) may have the capacity to fill this void. In addition, Pillord et al. (2018) note that legal and regulatory issues for artificial structures can be spread across multiple jurisdictions and/or agencies depending on the spatial spread of the projects. Multiple regulatory agencies may have different permitting, planning, and construction requirements.

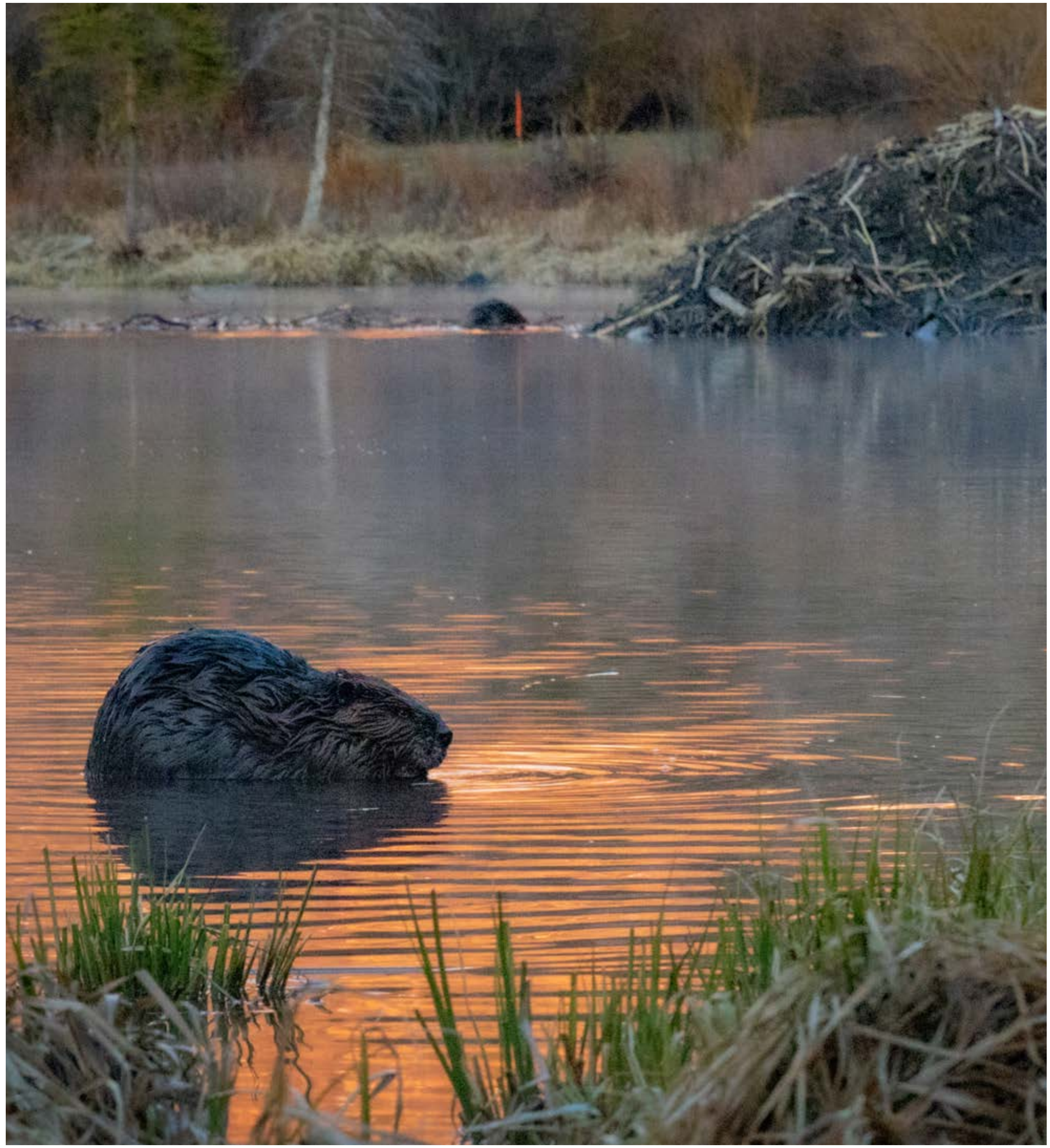

Figure 3. Beaver and beaver lodge in the Telluride beaver pond. Photo courtesy of Michael Mowery

The San Miguel Watershed Coalition is pursuing a program to institute Process Based Restoration (PBR) within the watershed. PBR is the term applied to restorative practices that allow riverine processes to naturally restore full functionality of a river system. Instead of using heavy machinery and complex engineering to mimic a healthy riparian corridor, the river is given a small helping hand to restore these processes on its own. Because the majority of the restoration happens completely naturally from the energy of the river and it's eco-systems these PBR approaches are extremely cost effective and self-sustaining in the long run. Many river systems across the American west have become incised and separated from their floodplain. These impairments lead to poor aquifer recharge, small wetlands, fast runoff and dry soils. Much of this impairment is due to lack of woody debris in the river that slow the flow of water – creating wetland complexes and augmenting water supply.

The two main tools in the PBR toolbox are beaver dam analogs (BDA) and post-assisted log structures (PALS). BDA's and PALS are both low-tech structures installed by pounding posts into the riverbed to anchor woody structure thereby mimicking naturally occurring beaver dams or log jams. This structure in the river slows the flow of water, widens wetlands and creates fish and wildlife habitat.

The San Miguel Watershed tributaries and headwaters are ideal for this work. There are many headwaters tributaries with perennial flow and springs that have historically been home to beaver habitat. Due to anthropogenic impacts beaver are no longer present on the landscape. The upper watershed community embraces conservation efforts and is ready to pursue PBR work. Partnerships with conservation-minded private landowners are being developed and the GMUG USFS is partnering with SMWC to pursue restoration projects on public lands. The aesthetic and wildlife values of beaver ponds bolster the worth of these restoration projects to private landowners and the public. Individuals who have already pursued this type of work show increased presence of big game, waterfowl and fish on their properties.

BEAVER DAM ANALOG EXAMPLES

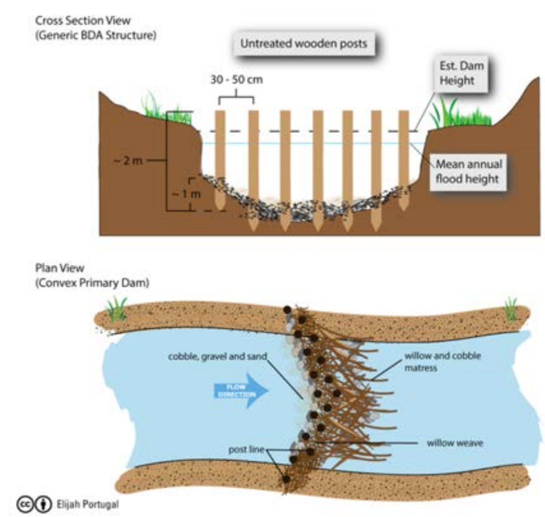

Figure 4. Conceptual illustration of BDAs using a downstream mattress and double poste line (Wheaton et al. 2019).

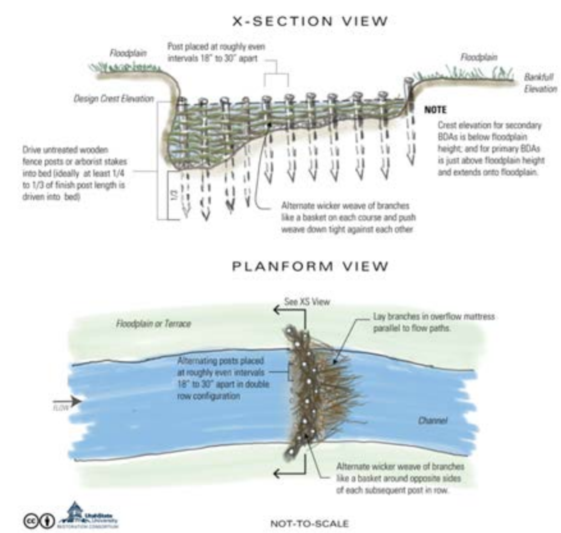

Figure 5. Conceptual illustration of a post-line wicker weave BDA (Wheaton et al. 2019).

Figure 6. Map of modeled beaver dam capacity density within the San Miguel Watershed.

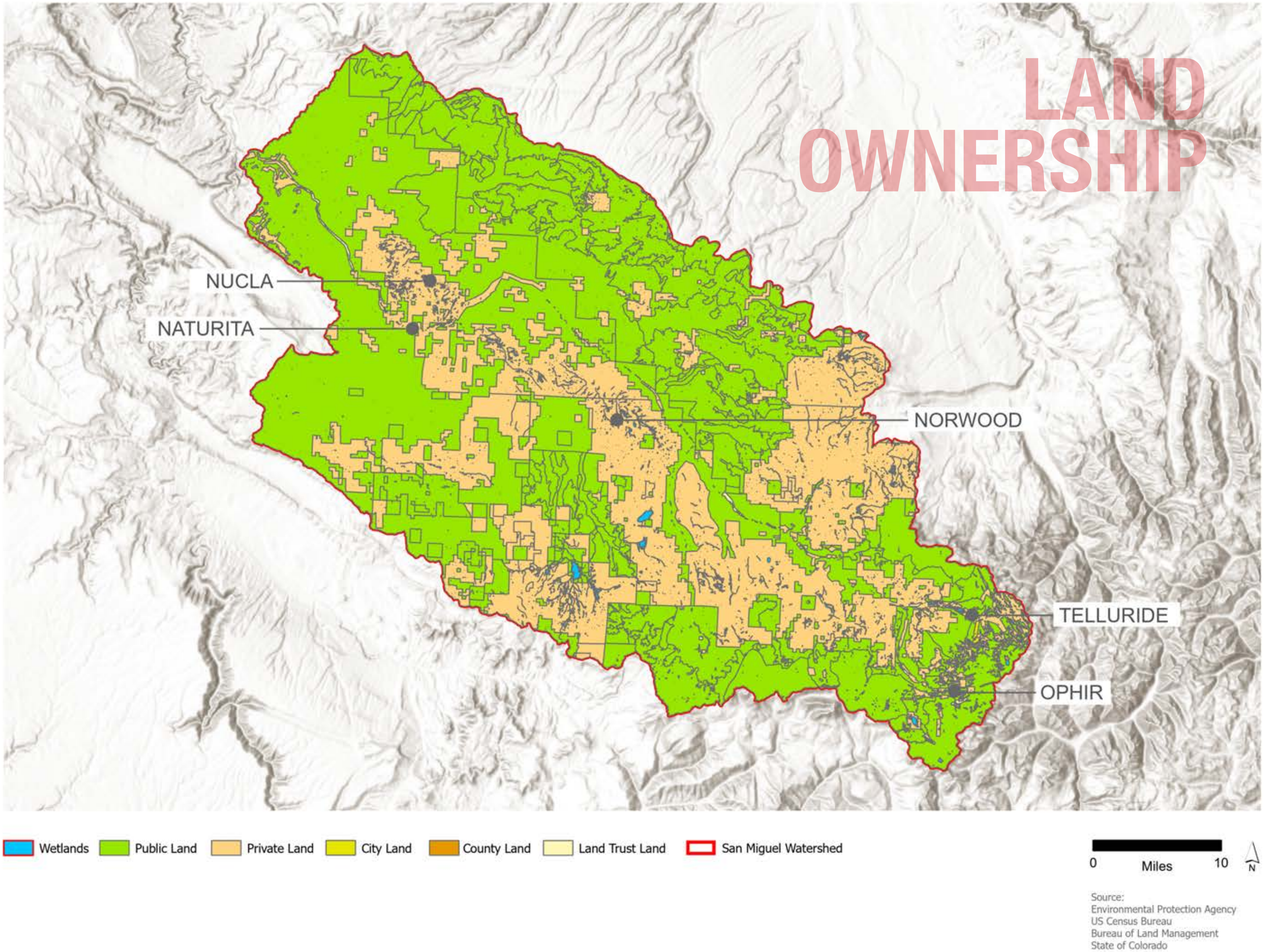

Figure 7. Map of land management within the San Miguel Watershed.

SECTION
THREE

BOATING

WHITEWATER PARKS

American Whitewater (2005) defines a whitewater park as a watercourse within a city or town that has been artificially modified to create whitewater activities for canoeists and kayakers. In recent years this definition can be expanded to also include stand up paddle boarding (SUP) and rafting.

Whitewater parks are created by installing obstacles like rocks or boulders or through the pinching in of stream banks or the building up of stream bottoms to create artificial drops. Walls installed on the sides of the river channel banks create lateral constrictions and create chutes of water near the mid-channel and create plunge pools and lateral eddies immediately downstream. Whitewater parks can also be created by diverting water from the main river channel and creating side channels with pre-placed obstacles. In addition to boaters, whitewater parks are an attraction for fishermen, walkers, bikers, and spectators if the park is built adjacent to a greenway or trail system (Kincaid 2005). Furthermore, whitewater parks can act as an economic development and quality of life enhancers for the communities in which they are located (American Whitewater 2005).

An in-channel whitewater park can improve the ecological health of the river and the surrounding riparian area. Ecological health can be restored through riverbank restoration that coincides with the construction of the park, dam removal, increased riverbed permeability, and water aeration all of which can lead to the restoration and promotion of natural riparian life (Podolak 2012). Whitewater parks also change the hydraulic conditions of a river channel by altering flow patterns, depth, velocity, and flow complexity. With an increase in pool area, it has been assumed that whitewater parks structures will have a positive impact on habitat quality since increasing pool area is oftentimes a key component in aquatic habitat-improvement projects in the United States (Roni et al. 2008). However, this assumption has yet to be empirically demonstrated or tested.

Colorado currently has the most whitewater parks of any state and the Colorado Parks and Wildlife (CPW) initiated a research project with Colorado State University (CSU) to study a whitewater park in Lyons, Colorado. The results of the initial study indicated that whitewater parks can impair upstream migration of fish and create unfavorable habitat conditions for fish (Fox et al. 2016). As a result of this study, CPW has begun to develop design guidelines for whitewater parks that can optimize both recreational and ecological benefits and has also begun to expand their research to other whitewater parks in the state to begin to understand how different design characteristics of structures impact fish, benthic macroinvertebrates, and habitat.

Figure 8. Rafting in Placerville, Photo courtesy of Cole Macasko

WHITEWATER RAFTING

Whitewater kayaking, rafting, and stand-up paddle boarding (hereafter referred to as whitewater paddlers) are a distinct recreational activity in that they require specific distinctive river features, water flows, and access to make them feasible and enjoyable (Loomis and McTernan 2014). Non-commercial whitewater paddling recreation is one of the fastest growing activities in the United States, however as a nonmarket good, it has proven difficult to measure its direct value to communities in which it exists. To determine the indirect measures of a recreational users' value the Water Recourse Council (1977) recognizes three methods of recreational valuation: (1) the travel cost method (TCM), (2) the contingent valuation method (CVM), and (3) unit day values. Bishop, Heberlein, and Kealy (1999) noted in a review of studies that utilized the three methods outlined above that they tend to produce meaningful though inaccurate economic information and that things with unknown economic value are given little or no value when compared to market goods. They also pointed out that the different valuation methods should be evaluated based on the specific situation.

Most of the academic literature on the economic valuation of whitewater paddling on surrounding communities relies on the relationship between river flows and recreationalists' preference (see Branden and Kolstad 1991; Haab and McConnell 2002; Hanley et al. 2003; and Loomis and McTernan 2014). These studies focus on the tradeoffs between water diversions for agricultural and municipal purposes and instream flows for recreational purposes. There have been few studies conducted specifically to address the estimation of demand for and economic benefits for whitewater paddling. Therefore, it is hard to estimate the economic impact of whitewater paddling generally and more specifically how to quantify economic impact to a specific river without a dedicated study to that specific location using the one or multiple of the three methods of recreational valuation outlined above.

The section of river between Ledges Campground in Pinon and the town of Naturita is currently the only non boatable section of river between the CDOT boat ramp downstream of Illium on HWY 145 and Lake Powell. The section has numerous dangerous obstacles that prevent the connection of wonderfully scenic and engaging sections of whitewater. Creating safe boat passage in this section opens many doors for length and style of boating trip on the Miguel. The local boating community is relatively small compared to similar communities and watersheds across the state. Growth in the boating community creates advocates for the entire watershed that are engaged in the conversations surrounding our water resources.

Figure 9. Map of non boatable section of the San Miguel River between Ledges Campground and the town of Naturita.

Figure 10. Reed-Chatfield diversion dam.

Figure 11. Mitigated CC Ditch Diversion.

The communities of Nucla and Naturita are engaging in activities to diversify their economies with recreational opportunities by expanding trail networks and increasing ecotourism opportunities. The section of river being discussed is one of the most family friendly sections on the Miguel and fits into the vision of a diversified economy for the lower watershed. SMWC proposes to work with landowners, local and state governments, agencies and stakeholders in this section of river to increase signage regarding public and private properties, work with landowners to reduce risks from water infrastructure to recreationists. The Colorado Department of Natural Resources (DNR) in partnership with American Whitewater and other partners has a successful initiative called Dam Safety to promote awareness of lowhead dams through a statewide marketing campaign and on-river signage. The initiative also funds mitigation efforts of lowhead dams to increase habitat connectivity and reduce risk to recreational users when possible.

The second type of human obstacle in this stretch of river are pallet cattle fences. Pallet fences across the river pose a threat to river runners. They come up quickly and can ensnare gear, oars, frames and the boaters themselves. The solution is simple - replace existing pallet fences with floating PVC fences. The fences serve the same purpose as pallet fences but pose no risk to boaters. As boats pass the PVC fences the hanging pipes part or slide around and over the boat and its passengers. The Telluride Mountain Club and Boating Community have stated they would be willing to provide volunteer labor and resources to accomplish this goal. SMWC's intent is not to injure or inconvenience ranching or agricultural operations but to advocate for a San Miguel River that works for all users and economies.

The boating community and Telluride Mountain Club have a desire for a white-water park or play wave for boaters to develop their skills. The San Miguel River has a very consistent, steep gradient and a short boating season. These conditions make for a shallow, fast-moving river with little opportunity to eddy out or develop skills necessary to safely kayak the river. The idea to create a safe whitewater park on the San Miguel is not a new idea. Originally this idea was proposed with the location being the San Miguel County Down Valley Park in Placerville. An engineered whitewater park does not fit especially well with the conservation values of the easement placed on the Down Valley Park and it is the opinion of SMWC and its stakeholders that this project would be better completed elsewhere on the river.

The nearby Montrose whitewater park has been a great success. It has re-vitalized the river corridor in town and has bolstered and created economic opportunities. The park serves as an example of how passionate recreational users are about these opportunities to grow their sports and hone their skills. The wave provides opportunities for kayakers to learn to roll, surf and develop technical strokes. The wave is also very popular for river surfing. People travel from as far as Dolores and Grand Junction to use the Montrose whitewater park. It is logical that a whitewater park or play wave in the lower watershed would have the same draw to the communities of San Miguel, Montrose and Montezuma Counties. The boating community in the San Miguel Watershed has made it very clear they are willing to drive to use these amenities.

SMWC is aware of the complexity of developing a whitewater park and advo-cates that a further feasibility study needs to take place to weigh the political, economic, cultural and environmental impacts of such an attraction.

Figure 12. Boats along the banks of the San Miguel River.

SECTION FOUR

MIKE SHE MODEL

Within a hydrologic system groundwater and surface water interact in a variety of physiographic and climatic landscapes. An understanding of the interactions between ground water and surface water (GW-SW) is required for effective water resource management (Sophocleous 2001). Winter (1995) noted that GW-SW studies are prevalent in headwater streams, lakes, wetlands, and estuaries and in recent years there have been a focus on the exchanges between near- and in-channel water (Sophocleous 2001). Understanding these exchanges are key to the evaluation of the ecological structures of streams and are critically needed for stream-restoration and riparian-management efforts. A more comprehensive understanding of GW-SW interactions has been accomplished through the teaming of geologists, hydrologists, and ecologists and their work has led to a broader multidisciplinary perspective of GW-SW interactions with a recognition that these interactions are part of a large and complex environmental system.

Tóth (1970) defined the hydrologic environment of groundwater flow systems as the effects of topography, geology, and climate. Groundwater flow patterns are determined by the configuration of the water table, the conductivity in the rocks, and the climate (precipitation being the source of recharge). Flow paths are organized into flow systems and in regions with irregular topography multiple flow systems exist. Surface and subsurface hydrologic interactions are a result of substrate lateral flow through unsaturated soil and infiltration into or exfiltration from saturated zones. Individual water input events such as rain or snowmelt enter water bodies promptly and are known as event flows, direct flows, storm flows, or quick flows. Alternatively, baseflow is water that enters a stream from persistent, slowly varying sources, though it has been demonstrated that the main source of baseflow is supplied from groundwater flow (Morel-Seytoux 2012).

Stream, lake, and wetland interactions with groundwater are based on the position of the water bodies along the flow systems, the geologic characteristics of their beds, and their climatic settings (Winter 1999). All three factors should be considered when trying to understand specific water bodies' GW-SW interactions.

MIKE SHE MODEL

SMWC is pursuing the development of a MIKESHE integrated climate and hydrological model of the watershed to better understand base flows and groundwater movement. Currently there is no model available in the San Miguel basin that considers groundwater. SMWC will build on the surface water model created by Lotic Hydrological for the San Miguel Partnership's Nonconsumptive Needs Assessment. Lotic used Statemod hydrologic modeling to complete the model which does not take groundwater into account. The Southwest Basin Roundtable notes "there are significant gaps in the data and understanding of flows and other conditions necessary to sustain the Southwest Basin's environmental and recreational uses." MIKESHE is the most comprehensive modeling tool available to understand these conditions. The tool is a product of DHI and the construction and calibration of the tool will be completed by Integrated Hydro Systems, LLC with support from SMWC and Mountain Studies Institute. SMWC is currently developing a proposal for a CWCB Colorado Water Plan grant.

MIKESHE models are especially useful at determining climate-based water availability and post-fire hazards to water quality and infrastructure. These will be the primary goals of the initial regional model. Higher resolution forest health and wildfire risk modeling is another restoration objective of the study. These data can be input into the MIKESHE model to increase accuracy of post-fire hazard modeling. Once the regional model is built, the tool will be made available to SMWC stakeholders and partners to request specific modeling scenarios such as: restoration, agricultural efficiency, municipal water supply, advection of dissolved solids, draining mine adit water quality impairments and others.

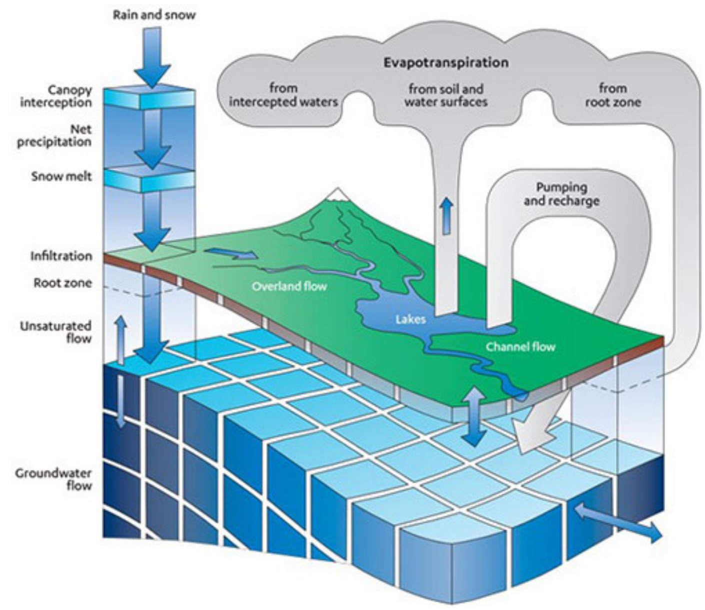

Figure 13. Example of hydrological processes simulated in the MIKE SHE model. Source: MIKE

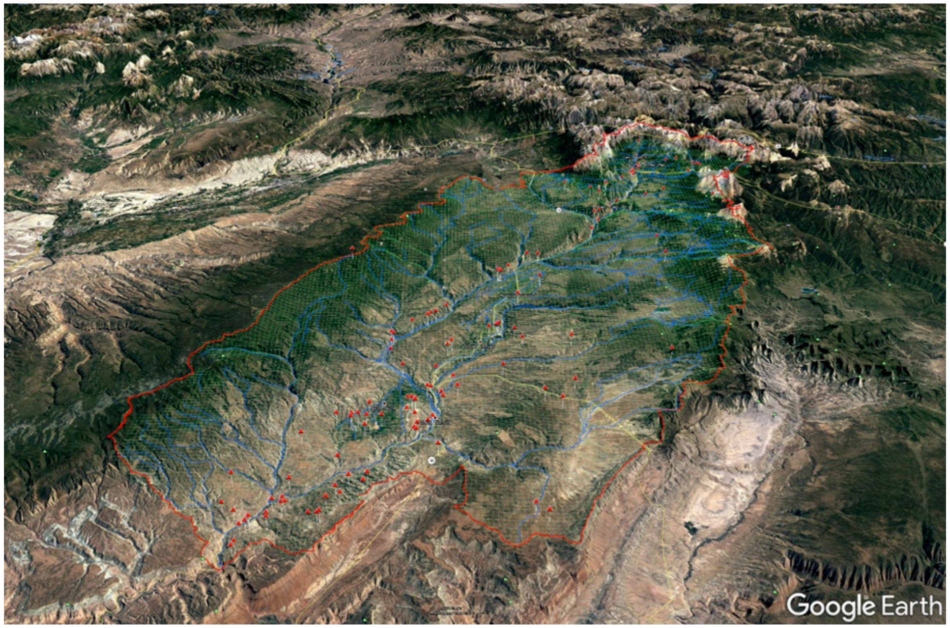

Figure 14. Example of 3D MIKE SHE output of San Miguel Watershed. Source: Integrated Hydro Systems, LLC

SECTION
FIVE

FOREST HEALTH

Forest and aquatic ecosystem health within a watershed coincide with one another. Most forests in the Western United States have changed in their structure, composition, and patterns due to human impact. Fragmentation and simplification of forests have arisen due to timber harvesting, road construction, domestic livestock grazing, and fire suppression. Vegetative pattern changes, insect infestations and pathogen disturbances impact conditions for fuels and fire behavior that may lead to more frequent stand replacement wildfires (Hann et al. 1998). Rieman et al. (2000) note that an ecosystem approach that recognizes the linkages between terrestrial and aquatic environments is needed to assess watershed health. A terrestrial landscape's natural patterns of vegetation have an influence on erosion, hydrology, and geomorphology processes which influence the complexity, diversity, and productivity of aquatic environments (Naiman et al. 1992). As a result, a healthy watershed is supported by a healthy forest (Franklin 1992).

Whole watershed ecosystem health analyses revolve around the impacts of natural and human activities and are based on the interrelated physical, chemical, and biological processes. Researchers use watershed ecosystem analysis to determine how individual uses or disturbances affect nutrient cycles, the health and productivity of forest ecosystems, and the chemistry and biodiversity of forest streams (Hornbeck and Swank 1991). Using a watershed as a study boundary ensures that impacts across different forest types are represented over a sizable landscape and therefore generalizations can be made with greater confidence and can ensure that cause-and-effect relationships are established at a landscape level (Hornbeck 1987).

Figure 15. Example of steep slopes with beetle kill at the confluence of the South Fork of the San Miguel and the San Miguel River.

In 2017 SMWC worked in partnership with Mountain Studies Institute, Colorado State University and San Miguel County to complete the Upper Basin Forest Health Landscape Assessment of the San Miguel Watershed. The objective of the project was to inform the local community of current and projected forest impacts due to changing climate to help inform on current wildfire hazards, future land use decisions and forest health projects on the landscape. The baseline information from this project is currently being used to inform wildfire mitigation efforts within the watershed.

The study area of the Upper Basin Forest Health Landscape Assessment covered the upper extent of the watershed surrounding the towns of Telluride, Ophir and Mountain Village and extending to Norwood to the northwest following the gradient of the watershed. Downstream of the confluence between Specie Creek and the San Miguel the assessment is restricted to headwaters areas on the northern side of the basin. The assessment does not include the river and HWY-145 corridor downstream of Specie Creek between Placerville and Norwood and does not include the headwaters areas to the south of Norwood or any of the lower watershed.

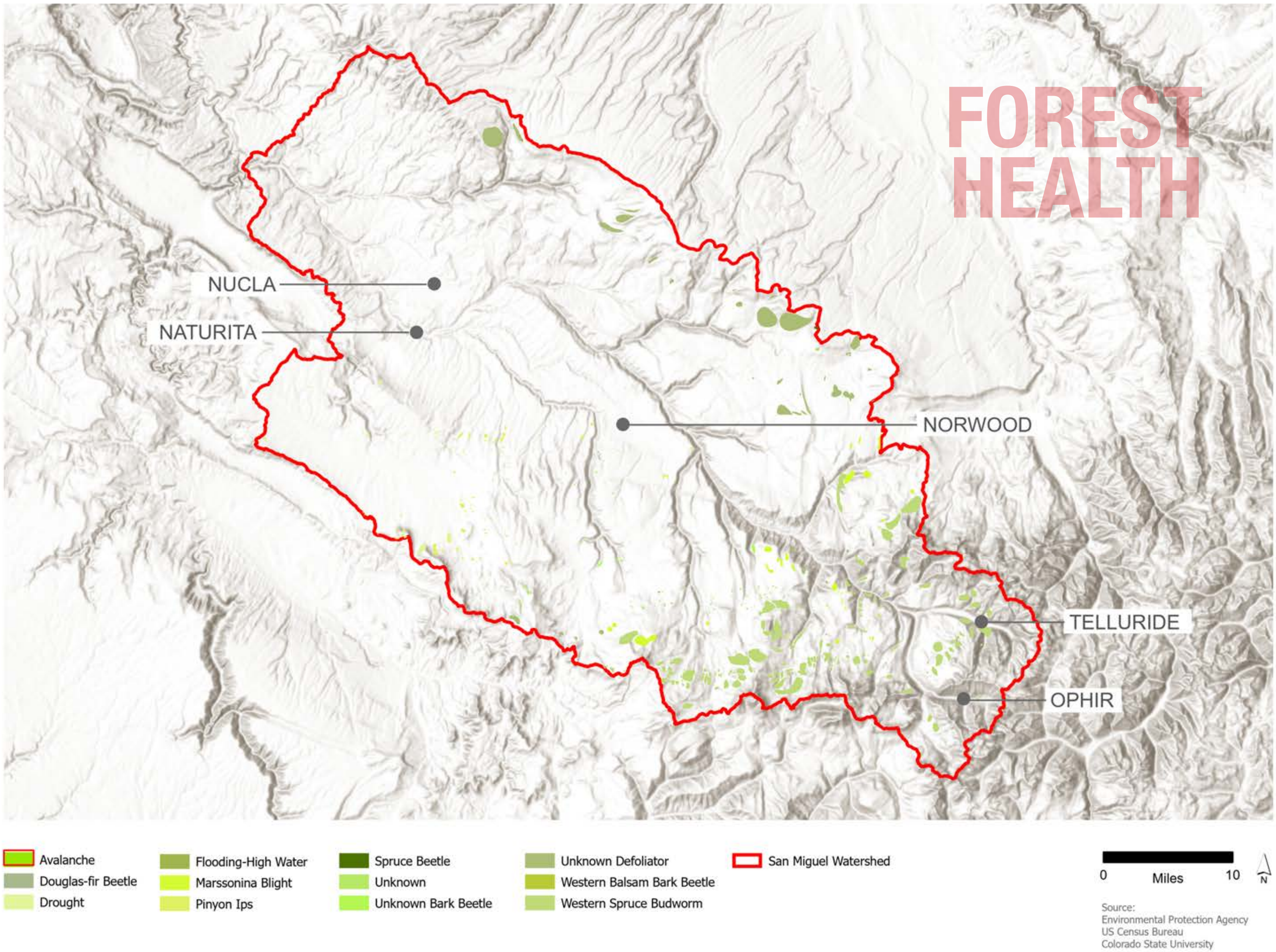

Figure 16. Map of the results from the 2007 Forest Health Assessment report for the San Miguel Watershed.

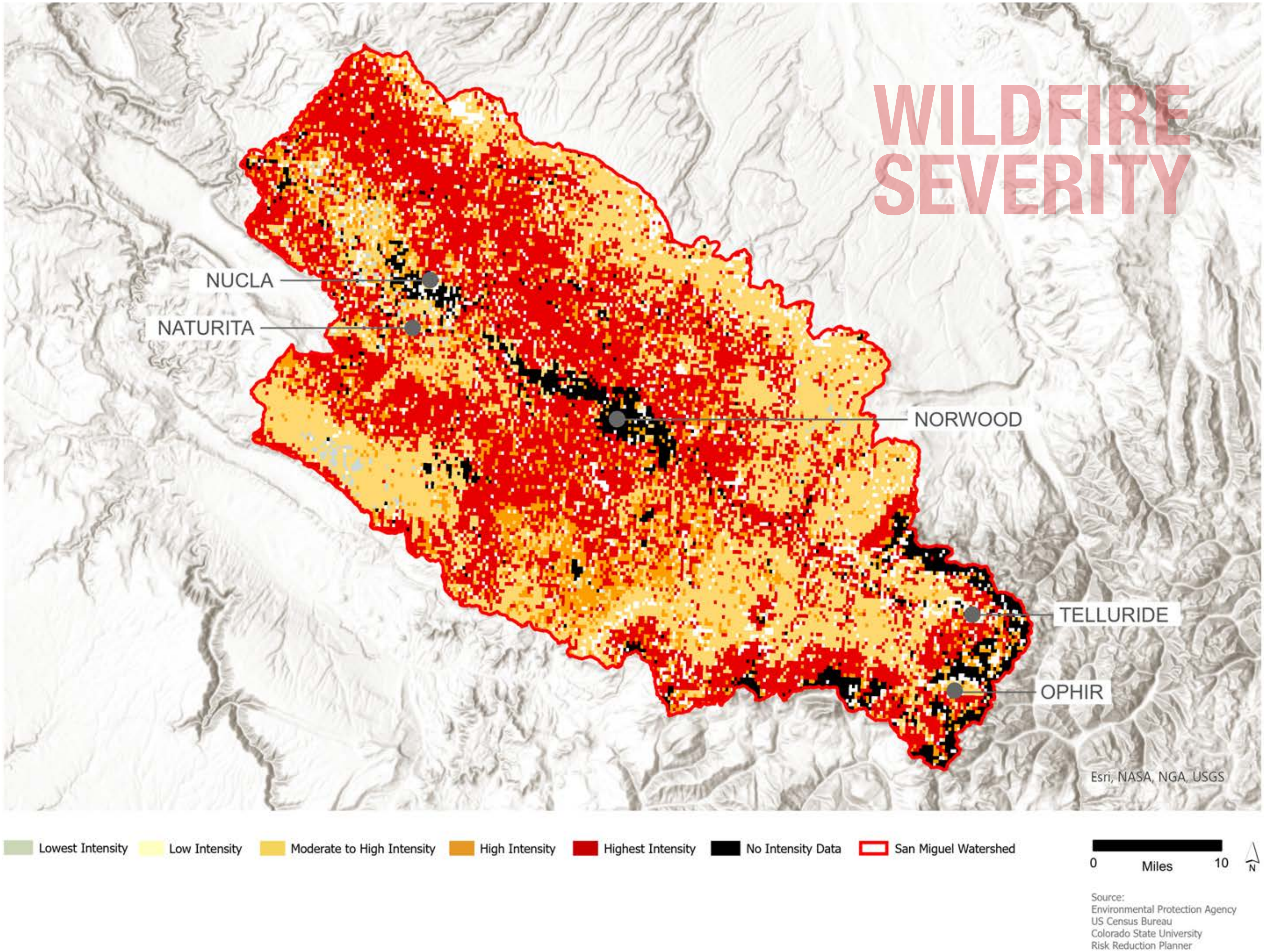

Figure 17. Map of different levels of wildfire severity within the San Miguel Watershed.

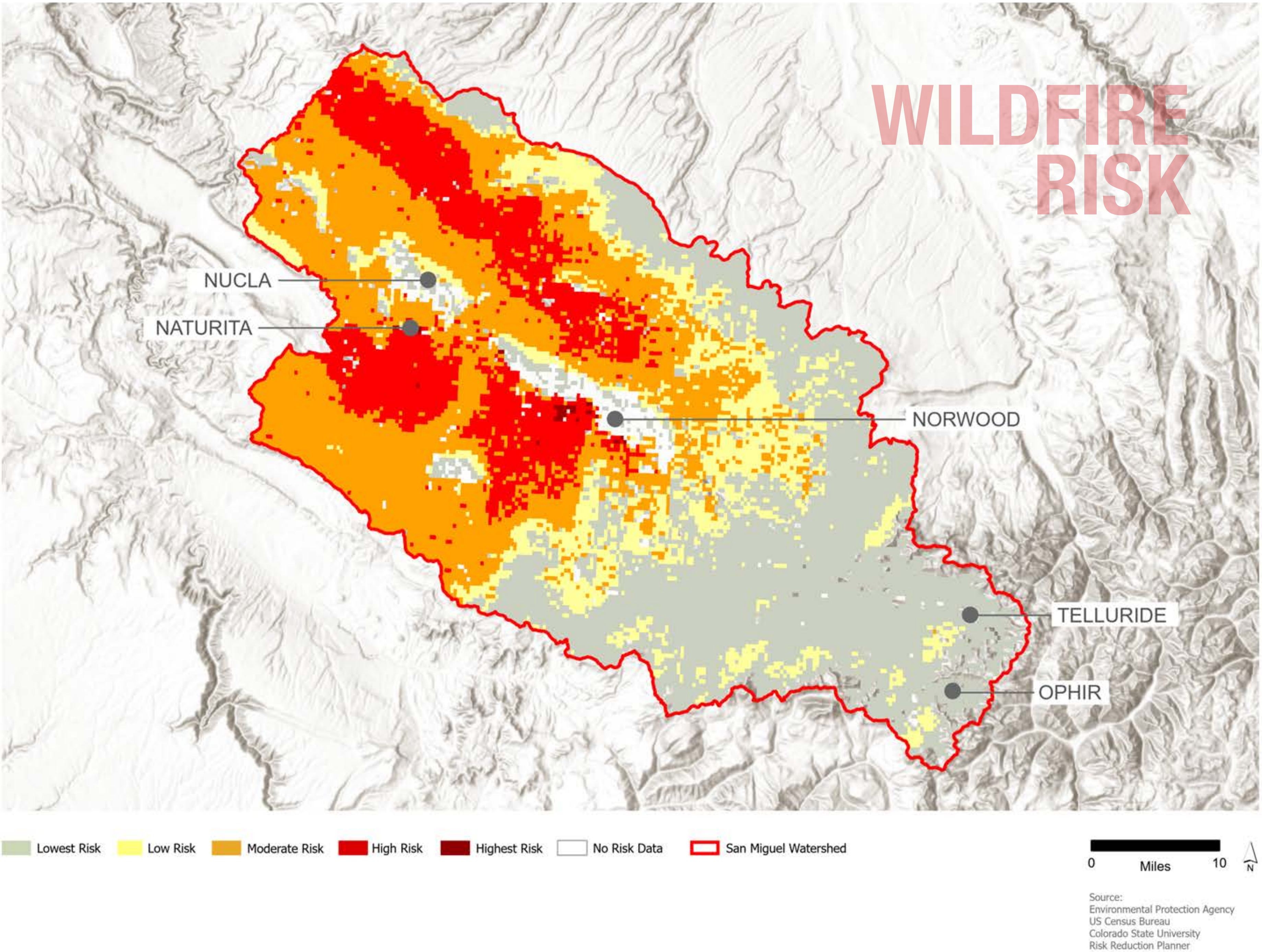

Figure 18. Map of different levels of wildfire risk within the San Miguel Watershed.

During the River Restoration Study the need for an expanded forest health assessment area became apparent. The Colorado Forest Atlas Wildfire Risk Assessment indicates the aforementioned areas are at risk for moderate to high severity wildfire. A warmer, drier climate is promoting the upslope movement of species better adapted to these climate conditions at higher elevations within the watershed. These warming conditions combined with insect and disease are leaving behind many dead trees as the forest adapts. Between the late 19th middle 20th centuries mining development clear-cut much of the San Miguel River corridor between Society Turn and Leopard Creek. When mining operations ceased, the Douglas Fir forest in the river corridor grew back, resulting in extremely limited age class diversity, lack of understory and a cramped forest. These forest health issues allow beetles to easily traverse from tree to tree and create a tinderbox in the river corridor. The Grizzly Creek fire outside of Glenwood Springs illustrates the effects post-fire hazards can have on infrastructure and watersheds. SMWC's goal is to promote understanding of fire risks to the water supply of the basin and highway infrastructure by expanding upon the work of the Upper Basin Forest Health Landscape assessment into the middle and lower watersheds with a focus on the HWY-145 corridor.

Expanded forest health assessment of the San Miguel Watershed will aid in prioritizing wildfire mitigation efforts with the greatest impact. SMWC's goals are to protect the watershed, infrastructure and property at localized high-risk areas and mitigate post-fire water impairments for downstream water users and communities.

SECTION
SIX

CONCLUSION

The 2021 River Restoration Study serves to provide a framework for restoration activities in the San Miguel Watershed. The document will serve as a tool for SMWC to develop projects, partnerships and to pursue funding opportunities. SMWC urges stakeholders and partners to come forward with restoration objectives not mentioned in the study in the continued effort to develop a comprehensive list of potential projects and partnerships within the basin.

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