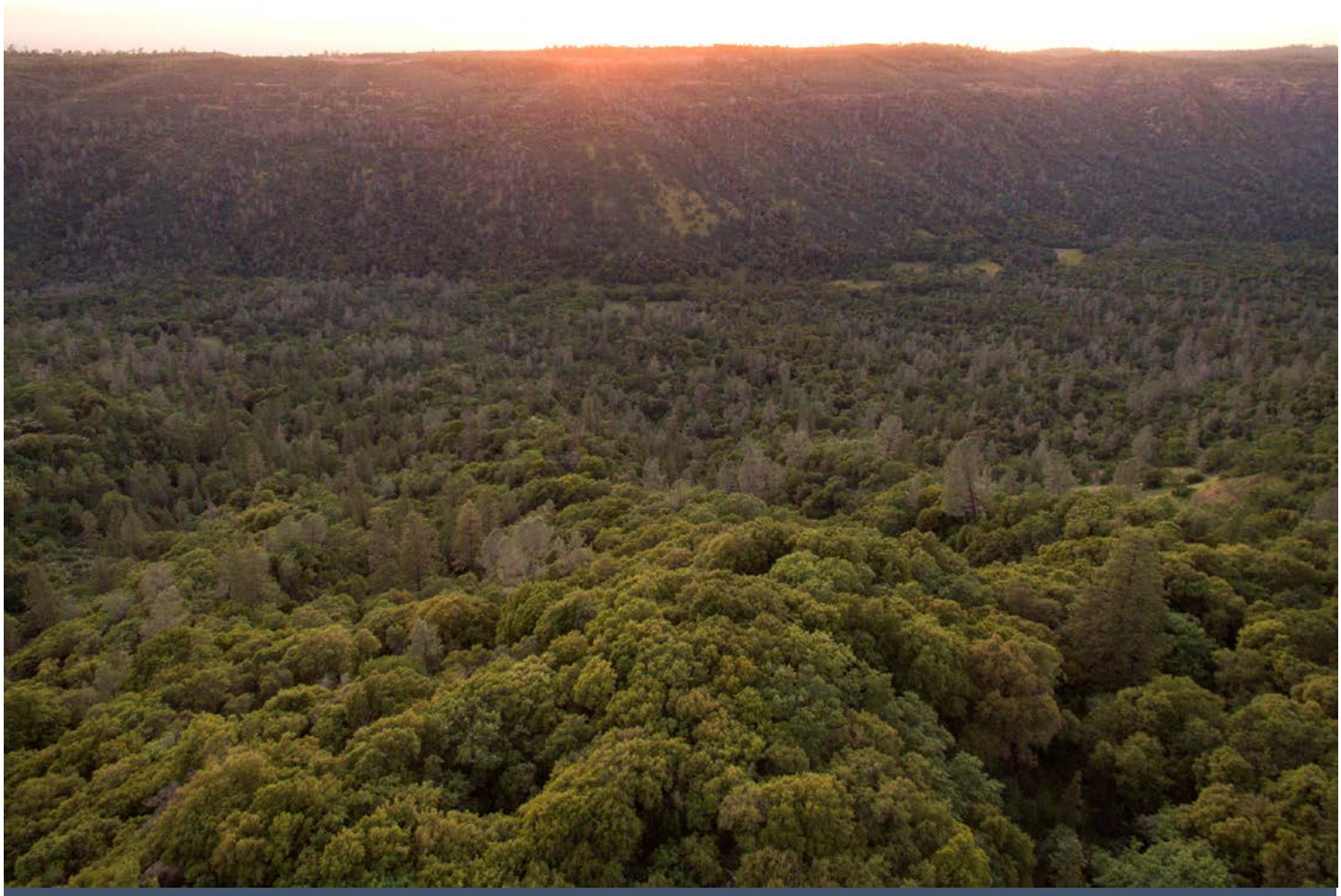

Big Chico Creek Forest Health Plan

Big Chico Creek Forest Health Plan

Developed for:

And the landowners in the Big Chico Creek Watershed.

By:

The Butte County RCD and the CSU, Chico Ecological Reserves.
Spring 2022

Funding provided by the Sierra Nevada Conservancy.

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Introduction and Purpose

The purpose of this document is to provide guidance for landowners and land managers within the Big Chico Creek Canyon. Priorities, techniques, and recommendations may be applicable to landowners adjacent to the Big Chico Creek Watershed, or to those that steward lands with similar ecosystems. The plan is focused toward the private landowners and the Big Chico Creek Ecological Reserve who steward these lands. This plan includes:

- A history of management within Big Chico Creek Canyon.
- Identification of ecological priorities.
- Best practices and recommendations surrounding land stewardship specifically for the canyon.
- Overview of current projects and landowner resources.

The hope is that this plan will provide private landowners within the Big Chico Creek Canyon and similar ecosystems a guide for best practices in land stewardship. The plan is not meant to be comprehensive or academically focused. Best practices and priorities were identified based on landowner feedback on their land stewardship goals. Note that all recommendations and practices put forth in this digestible guide should be completed within compliance of all local, state, and federal laws and regulations.

History of Management in the Canyon

Precolonial Management

Since time immemorial, the Northwestern Maidu have resided along the drainages that make up the foothills of the Cascades and Sierra Nevada ranges. The Mechoopda are a tribe of the Maidu that traditionally inhabited and continue to occupy watersheds within western Butte County, including Big Chico Creek. The Mechoopda Tribe thrived in Butte County, utilizing a mixture of technologies, strategies, and land stewardship practices associated with a "hunting and gathering" economy. Once abundant fauna such as elk, pronghorn antelope, deer, waterfowl, salmonids, and rabbits were harvested for sustenance. Flora and landscapes were actively managed to increase biodiversity, which in turn increased the amount of food, fiber, and medicine produced by the land.

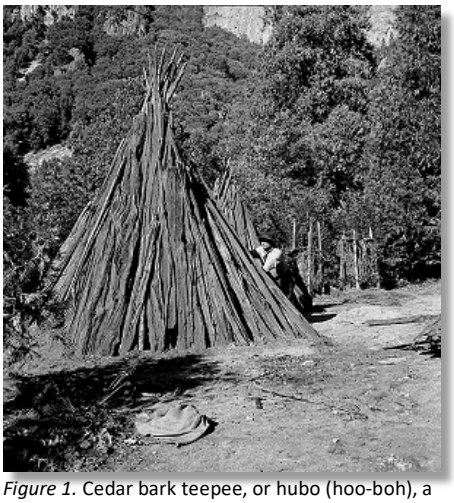

Figure 1. Cedar bark teepee, or hubo (hoo-boh), a dwelling of the Mechoopda.

This land management/stewardship was executed by the implementation of coppicing, pruning, and burning practices to achieve a mosaic of habitat types that were easily accessible. Cultural fire was their primary practice in maintaining healthy ecosystems. This was achieved by applying fire at varying frequencies and intensities at the landscape scale-level, with the explicit

intention of maintaining specific vegetation types and habitats. This mosaic pattern achieved through pyro-diversity not only increased biodiversity, but also created a heterogeneous landscape with low fuel loads and discontinuity, which made habitation more pleasant.

Figure 2. Depressions in the boulder where the milling of acorns took place.

The historic plant community was more heterogeneous than that of today. In contrast to today's dense, homogenous conifer forests dominating the foothills of Butte County, the historic plant community was more oak-dominant, with a mixture of meadow/grasslands, shrubs, and conifers. Evidence of a plethora of grinding stones, found throughout the Camp Fire footprint in the Paradise area, supports the historic, predominantly oak woodland habitat of the past. Acorns are a staple food source for a majority of California Indians, and pre-colonization oaks were one of the most, if not the most, important source of food. Grinding stones were used for processing acorns into flour and are found throughout oak woodland habitat. With so many located in one area, it is indicative of large oak woodlands.

These oak woodlands would have been maintained annually with fire to reduce pest populations, increase oak health, and reduce fuel loading. One incentive for this land management was that oaks in an open oak woodland produce more acorns per tree than oaks in crowded, dense woodlands.

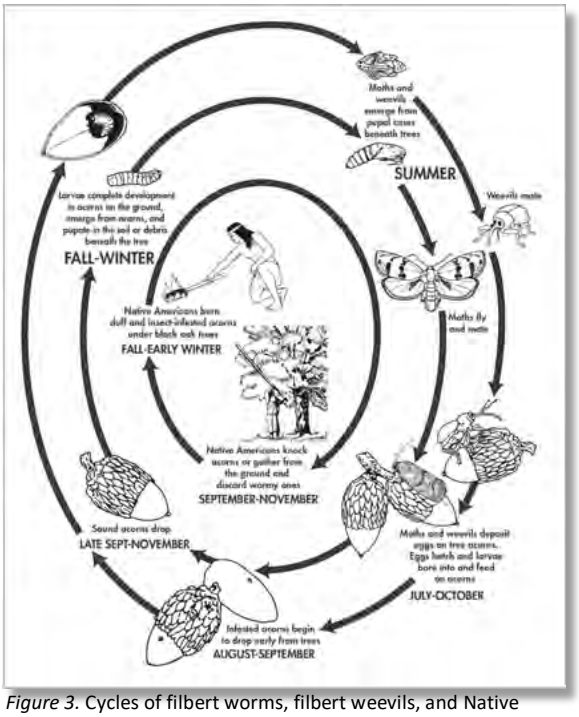

Figure 3. Cycles of filbert worms, filbert weevils, and Native American tending practices to manage these two pests of black oak acorns. (Anderson 2007).

Meadows/grasslands were also maintained with fire to discourage the encroachment of conifers while also promoting the growth of desirable grasses and forbs, such as the edible geophyte colloquially known as "Indian potato/onion". Chaparral habitats were maintained with fire and pruning/coppicing techniques to increase accessibility to chaparral products, such as the fruits of manzanitas and chokecherries. By creating trails through the chaparral and intermixing grasslands within the habitat, a mosaic of shrubs, grasses, and forbs were formed. This prevented dense, homogenous walls of chaparral from forming, which decreased fuel-loading and fuel continuity, while making desirable plant products accessible for humans and other wildlife.

Historic Management

By 1850 persons of European ancestry began to settle the area. They cut timber for their own use and for sale to the developing community of Chico and turned loose cattle, pigs, and sheep to graze. Native wildlife was hunted and trapped for food or sale and to prevent predation on livestock. As more people homesteaded the area, fences were built to separate herds. In the later part of the 18th century, timber in the upper watershed of Big Chico Creek began to be extensively exploited. The Homestead Act of 1862 turned this open landscape into ownable property. Land in the Big Chico Creek Canyon was inhabited by gold mining prospectors, which quickly gave way to logging for lumber production. Logging left a greater legacy on the canyon, as the geology was not suitable for finding gold.

Figure 4. Looking NW across Chico Creek from a point about one-mile NE of 10-Mile House. November 17, 1933.

In 1874 a flume was completed from near Chico Creek headwaters to the town of Chico, passing through the area of the Big Chico Creek Ecological Reserve (BCCER). This flume included flume tender's cabins and a telegraph line. The flume operated until about 1910. Vast changes in the ecosystem followed the homesteaders and their livestock. Much of the timberland was replaced by brush and the perennial native grasses were replaced by exotic annual grasses and weeds. Gradually the early homestead families sold out to owners of large cattle ranches and left the area. Cattle were generally driven to high country in summer and back to the home ranch in fall. As pastures deteriorated, the ranches were no longer profitable and speculators began to buy up the land for potential development (BCCER).

To make the land profitable from grazing cattle and/or logging, the families brought in farm equipment, from horse drawn equipment to dozers. These tools were able to manipulate the ground to create the roads that are still in use today. They also quickly disseminated invasive species across the landscape. Today, anywhere earth was moved with a piece of equipment there is likely to be the invasive Klamath weed and/or yellow star thistle present.

Historic fire regime.

As people began to settle in the California foothills and beyond, fire suppression practices increased. This resulted in a decrease of low-intensity wildfires. Historically, fire ran through the northern California foothills on a 5–7-year return interval. In the 1800s indigenous people were prohibited from starting fires that would have been beneficial to the native vegetation. There was a misunderstanding between Mechoopda tribal members and settlers of European decent on the purpose and benefit of wildfires. The settlers only saw wildfire as a threat to their new homes and livelihoods; the settlers were there for timber and grazing, and these were fuel for wildfire.

As populations increased and expanded into the rural foothills, the demand for fire suppression continued. However, the rate of unintentional human-caused wildfires increased. During the 1970s many environmental regulations came into play, such as the Z'Berg-Nejedly Forest Practice Act (1974), The Endangered Species Act (1973), the Clean Air Act (1970 & 1977), and the Clean Water Act (1972). These acts made it more difficult to freely graze and log the foothills, which led to further unchecked vegetation growth.

This then led to the beginning of the mega fires. After an additional 20 years of unchecked growth coming into the '90s, and the addition of more people into the Wildland Urban Interface (WUI), wildfires became more frequent, and with greater intensity, than historically before. This is due to the increased vegetation, or fuel, for the fire.

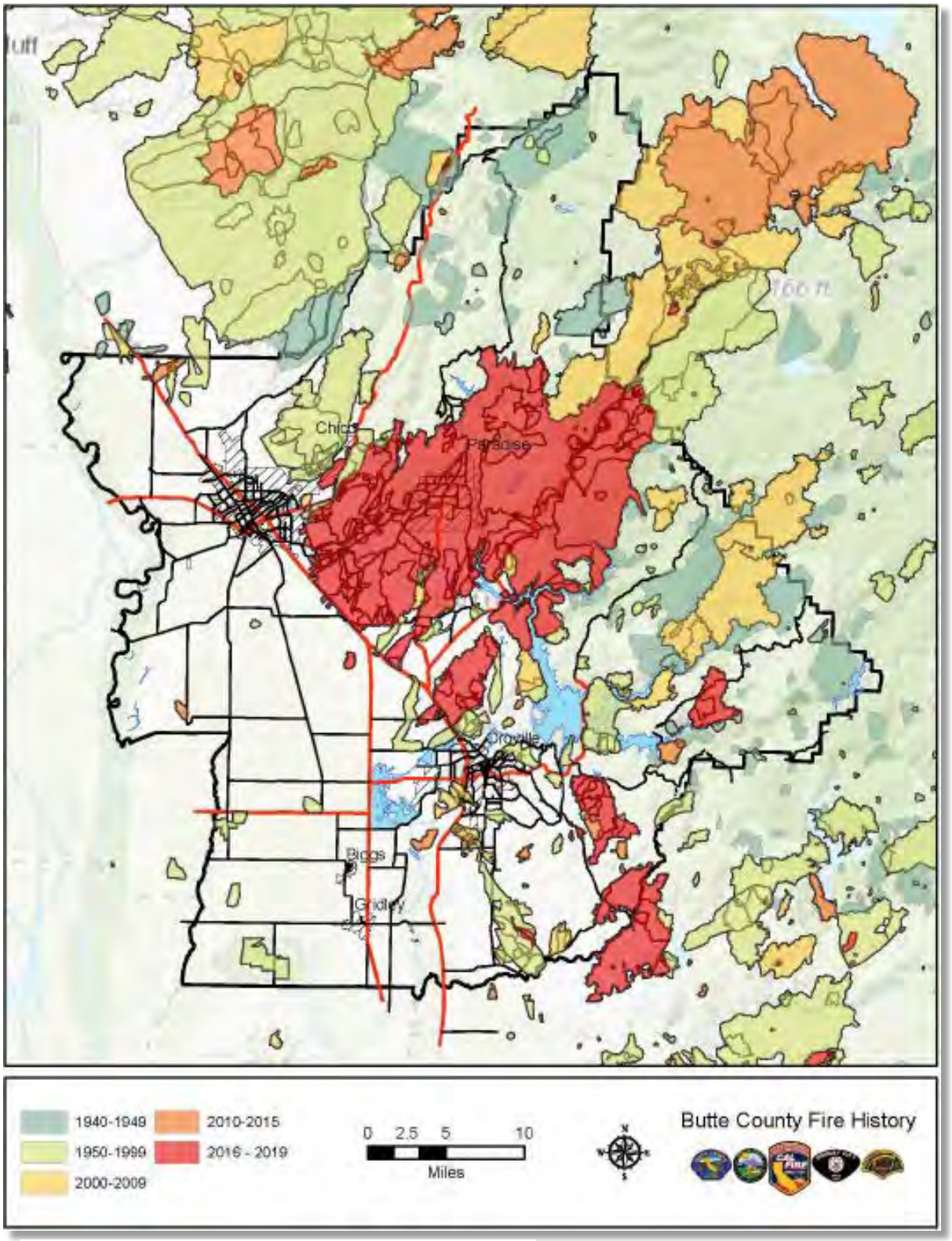

Figure 5. Map of wildfires in Butte County from 1940 – 2019 (Butte County).

Results of a changed fire regime.

Currently the Big Chico Creek watershed is overgrown in every vegetation class. Overgrown doesn't necessarily just mean that the plant species are larger than they otherwise would be, but that there are simply more of them. The vegetation in the foothills and the Sierra Nevada range grew in mosaic and scattered groups and clumps. It was once uncommon for vegetation to grow in thick bands as it does now. As mostly evergreen species like toyon, manzanita, buck brush, and deer brush grow larger and more abundant, they shade out many other disturbance-loving species. A disturbance-loving species is one that benefits from a disturbed ecosystem. A disturbance is an event or force that changes the ecosystem, usually by increasing mortality and changing the spatial arrangement. For the Big Chico Creek watershed that disturbance is wildfire.

The ecosystem in the canyon has evolved and adapted to include wildfire. Below is an image that shows the succesion after a fire. In stage 7 and 8 it shows what happens if fire continues to be excluded. There are no more wildflowers or diversity of tree species by stage 8. This is due to a dominant tree species has shaded out the other vegetation. Naturally occuring, low-intensity wildfire would likey burn again at stages 6 and 7. That low-intensity fire would only set plant succession back by one stage.

Did You Know?

Some plants thrive because of disturbance and will die out without regularly occurring disturbance. Most of the species native to the Big Chico Creek canyon are adapted to seasonal flooding along the creek and low intensity fires every 3-5 years. Without flooding, willows will no longer thrive. Without regular low intensity fire, many native bunch grasses will eventually be shaded out by other species.

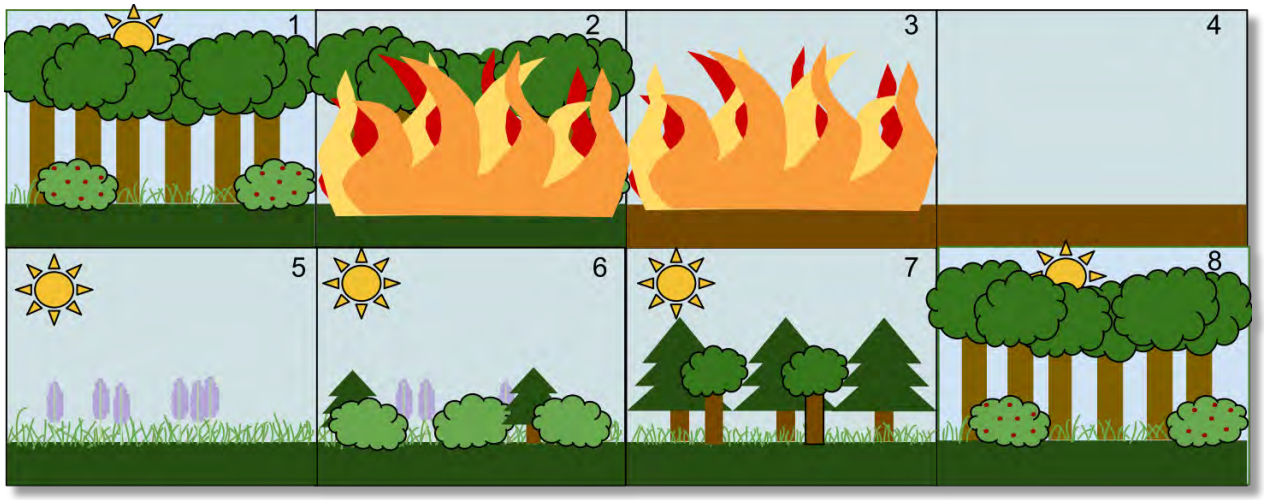

Figure 6. Secondary succession (Murphy 2012).

This scenario can be observed in the canyon currently. As fires were excluded, the evergreen oaks (canyon live oaks and interior live oaks) have grown unchecked and have shaded out the deciduous oaks (valley oaks and black oaks). The unchecked growth is a result of evergreen oaks photosynthesizing and grow year-round, while deciduous oaks have a dormant period.

Figure 7. One valley oak fighting for canopy space under the closing canyon live oak canopy (Photo taken post intervention).

Deciduous oaks are fire resilient with thick bark that can withstand low intensity fires. Evergreen oaks are fire resilient through vigorous stump sprouting. The live oak canopy blocks sunlight from reaching the understory, resulting in a reduction in diversity. In contrast, the

deciduous oak canopy allows for sunlight to penetrate the forest floor in the early spring, allowing native grass and wildflower populations to grow.

Figure 8. Manzanita regrowth after initial entry.

Evergreen shrubs like manzanita, buck brush, and toyon have also followed the same principles. However, these shrubs also have massive growth rates in addition to vigorous sprouting after a fire disturbance. A history of fire and other natural disturbance suppression has led to predicted high fire behavior based on current conditions.

Present Management

The Big Chico Creek upper watershed is currently divided between private landowners' parcels and the Big Chico Creek Ecological Reserve. The property runs north to south with the BCCER in the southern end. For the past 20 years, the CSU, Chico Ecological Reserves has attempted a number of different techniques to manage its acres. Management began at the entrance road and headquarters infrastructure. This was done through systematic vegetation thinning and maintenance. The neighboring landowners have also been doing work beyond their defensible space.

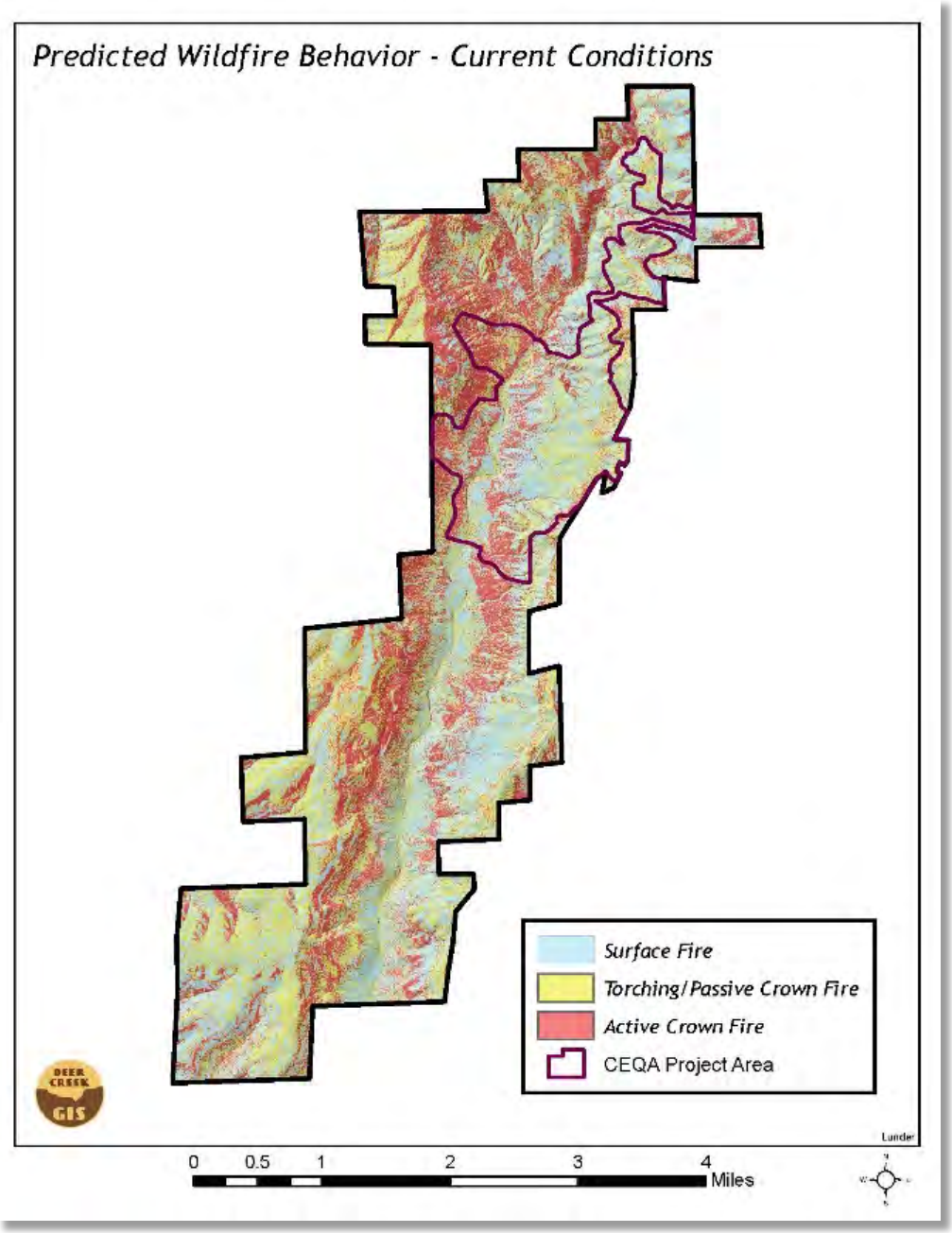

Figure 9. Predicted wildfire behavior – current conditions.

On the north end of the project area are six privately owned properties of varying parcel sizes, with the smallest property being 160 acres. Each landowner has historically managed their property as they saw fit, with a focus on access and wildfire mitigation. A few landowners have spent significant time and resources on invasive species management and forest health. They have worked both together and independently to keep the shared roads maintained.

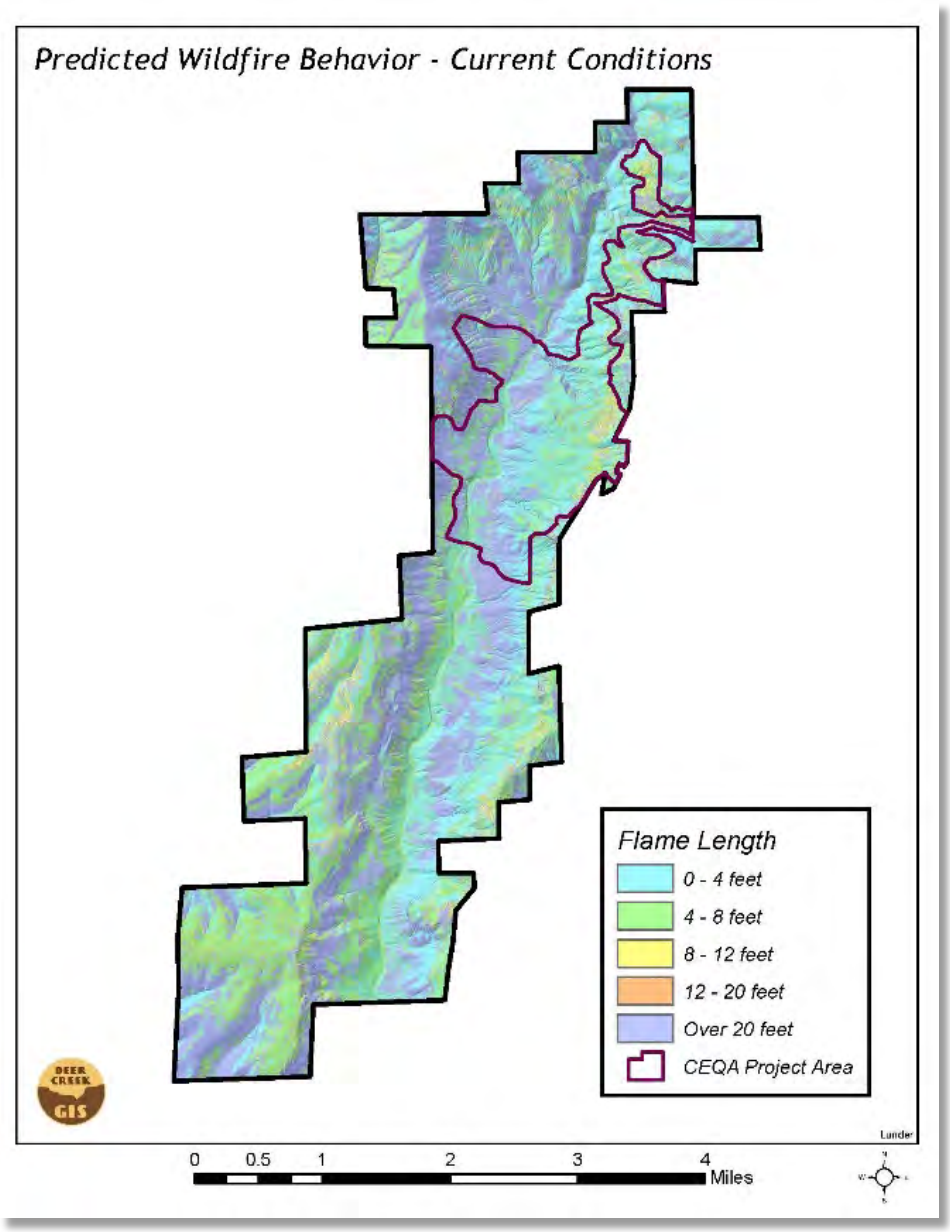

Figure 10. Predicted wildfire behavior – current conditions.

Below is a table of vegetation classes within the upper watershed of Big Chico Creek. The area is dominated by oak and grey pine. The oak and grey pine vegetation class is characterized by multiple oak species including black oak, canyon live oak, interior live oak, blue oak, valley oak, and dispersed grey pines above the oak canopy.

Table 1. Vegetation classes within the upper watershed of Big Chico Creek.

Vegetation Classes	Acres
Ponderosa Pine	393
Black Oak	1390
Oak and Gray Pine	1653
Herbaceous	518
Mixed Conifer/Tall Hardwoods	204
Live Oak	789
Blue Oak or Valley Oak	1160
Tall Brush/Scrub Oak	1210
Herbaceous/Star Thistle	98
Riparian/Mixed Hardwoods	686
Medium Brush	34
Low Brush	87
Total	8221

Current Projects

As of spring 2022, there are 1,292 acres of funded project implementation occurring within this plan's boundary. The projects are mapped and described in the section below. Note that, while important, this project summary does not include hundreds of acres being stewarded by private landowners.

Sierra Nevada Conservancy Grant #1126.

This landscape-level project located in the rural northern Sierra Nevada mountains is in a mixed-conifer forest in the Big Chico Creek watershed. The project will develop a Forest Health Management Plan for 7,939 acres and will complete CEQA on 1,500 acres.

The California Environmental Quality Act (CEQA) requires state and local agencies disclose and evaluate the significant environmental impacts of proposed projects and adopt all feasible mitigation measures to reduce or eliminate those impacts (CA Justice Dept.).

The purpose of the project is to:

- Protect water quality and improve water quantity.
- Prevent catastrophic wildfire.
- Restore forest ecosystems from overstocked conditions through forest thinning and prescribed fire.
- Reduce greenhouse gas emissions and improve air quality and carbon storage.

Project partners include public and private landowners, local, state, and federal land managers, non-profit organizations, and local fire safe councils.

The project is located in Butte County. The project area is in the Big Chico Creek watershed and will encompasses over seven miles of Big Chico Creek. The project is adjacent to public lands managed by the Bureau of Land Management (BLM) and is located between three community areas: Forest Ranch to the east, Cohasset to the west, and the City of Chico to the south.

Downstream beneficiaries of the project include habitat and public recreation in the City of Chico's Bidwell Park, CSU Chico Campus, California Water Service Company (Cal Water), as well as agricultural and municipal users throughout the Sacramento River region and beyond. The watershed is home to significant diversity of both plant and animal life. This plant and animal life, along with the watershed's considerable resources of water, farmland, timber, and recreational opportunity, enriches the lives of both those living in the watershed and downstream users.

The Forest Management Plan project will take place on a total 7,939 acres of forested lands in the watershed and produce CEQA documents for 1,500 acres within that project. These properties are all critical areas which support the flow of Big Chico Creek. Wildfires in the area have devastated many thousands of acres of land, including the 15,647 acres burned in 1999 from the Musty Buck Fires. The potential for a large, fuel-driven fire to occur in these watersheds is very real. This project spatially contributes to large scale forest health efforts by the BLM.

The fire adapted landscape of the watershed would have burned every 10-15 years but has missed many of the natural fire return intervals. The mixed-conifer forest stands in the project area have been threatened by brush regrowth, a result from historic logging and the Musty Buck fire. The density of fuels needs to be reduced to protect the mixed-conifer forest from wildfires ravaging the remaining stands. The stands are in the 80 – 100-year age category and need to be protected to retain adequate seed bank for future growing stock.

Multiple benefits from this project include protecting the wildlife/plant habitat and historic/cultural resources.

1. Protect water quality and improve water quantity –The project will improve quantity and quality of water throughout the year by increasing ground water recharge.
2. Prevent catastrophic wildfire –The project is located within a Cal Fire "Very High Fire Hazard Severity Zone". The presence of homes and high use recreational areas in the lower watershed in Chico increases the ignition potential and threat to Big Chico Creek. Reducing the risk of wildfires is essential to providing clean and abundant water to California.
3. Restore forest ecosystems from overstocked conditions with forest thinning – The project will lay the foundation for implementing watershed adaptation to reduce the impacts of climate changes on the ecosystems. Future forest thinning will reduce overstocked conifers and improve forest health.
4. Reduce Greenhouse Gas Emissions/ Improve Air Quality and Carbon Storage - The project will reduce potential greenhouse gas emissions and air quality impacts by

reducing the threat of high intensity fire and its impacts including soil erosion and carbon release.

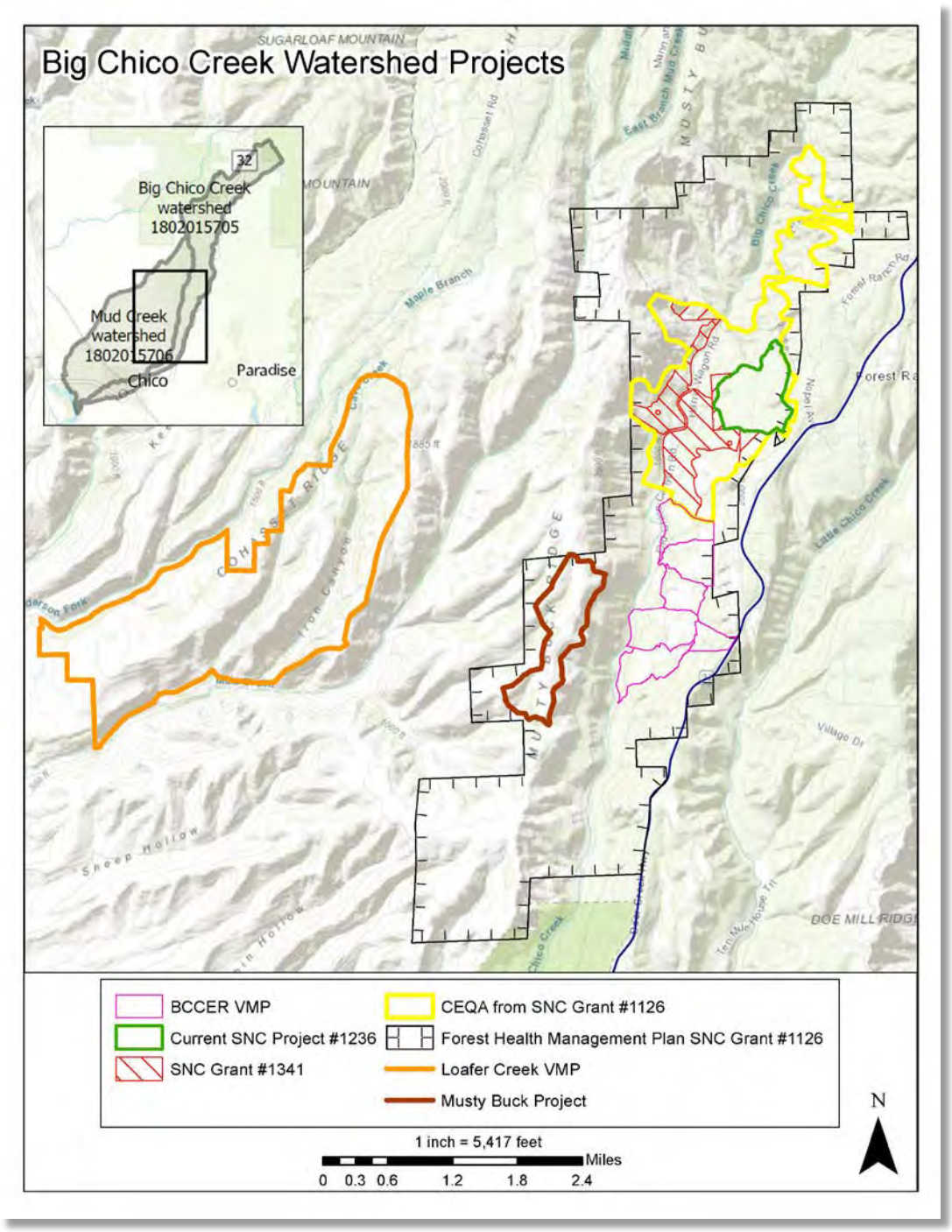

Figure 11. Current Big Chico Creek watershed projects.

Sierra Nevada Conservancy Grant #1236.

This is a watershed improvement project that aims to improve water quality through fuels reduction and to reduce the chances of catastrophic stand-replacing wildfire. A stand-replacing fire kills all or most of the living overstory trees in a forest and initiates forest succession or regrowth (NWCG). Also, it explicitly describes the nature of fire in grasslands and some shrublands. This grant covers 250 acres of the Big Chico Creek watershed on the adjacent privately-owned lands, in cooperation with the CSU, Chico Ecological Reserves and the Butte County Fire Safe Council. The 250 acres chosen for implementation was the area modeled to have the highest probability of stand-replacing fire. A third of the project area has had stand-thinning fuel reduction completed. Concurrent with the treatment of the 250 acres, the CSU, Chico Ecological reserves is developing the much-needed labor force through its ecological stewardship training program.

The project, which builds on SNC grant 835 and 1126 (Category II projects), will protect and improve water quality, increase water quantity, and restore forest ecosystems from overstocked conditions with forest thinning to prevent catastrophic wildfire.

Whereas introducing fire to the project area today would be disastrous, site conditions post-project will be open enough to allow for permanent maintenance with regular prescribed fire, a stated management goal of the BCCER and local landowners within the watershed.

Project partners include multiple local, state, and federal partners, which notably include CAL FIRE, Terra Fuego, the Mechoopda Indian Tribe of Chico Rancheria, the City of Chico, Forest Ranch Fire Safe Council, and the U.S. Forest Service.

Problem and solution - Water quantity and quality enhancement needed.

Wildfires in Butte County have burned over 265,000 acres in the last 15 years. However, prior to 1950, there had been no fire activity in the project area. This has led to an unhealthy density of trees and shrubs, and an accumulation of surface fuels. The watershed is at greater risk to catastrophic wildfire than ever before. There is currently the potential for a large, fuel-driven fire to occur in these watersheds and negatively impact forest health, water quality, water quantity, and community safety.

Many of California's ecosystems are fire-adapted. Fire adapted ecosystems need management to avoid the excessive fuels buildup that can result in mega fires. Fire exclusion has created an unhealthy ecosystem which places excessive hydrological demands on our watersheds, amplifies the effects of a changing climate, and creates favorable conditions for disease, insects and, mega fires.

A project with a purpose.

This project provides a solution: reduce overstocked forest stands to protect watershed values, enhance water quantity and quality, and increase forest resilience.

- Improve water quantity and protect water quality – The project will improve quantity and quality of water throughout the year by increasing ground water recharge.
- Develop the next generation's labor force for wildland management and forest health through the CSU, Chico Ecological Reserves ecological stewardship training program.
- Prevent catastrophic wildfire –The project will be completed in areas identified in the FMP as most susceptible to crown fire and those with extreme fuel load conditions.
- Restore forest ecosystems from overstocked conditions with forest thinning – The project will buffer the watershed from the impacts of climate change by transforming overstocked stands to a moderate stand density.
- Preserving and enhancing habitat – The project will protect the rich and complex diversity of animal and plant species in the Big Chico Creek watershed.
- Reduce greenhouse gas emissions and improve air quality and carbon storage - The project will reduce potential greenhouse gas emissions and air quality impacts by reducing the threat of high intensity fire and its impacts including soil erosion and carbon release.

Goals of the project.

This project, which builds on prior water quality protection and forest health projects undertaken with the SNC, has the following goals:

- Enhance water quantity and quality in the Big Chico Creek watershed.
- Protect drinking water and agricultural water supply for the City of Chico and surrounding areas.
- Increase forest health by reducing risk of catastrophic wildfire.
- Conduct a collaborative landscape-level forest health improvement project on 250 acres.
- Train a labor force to manage and/or implement forest health projects throughout the Sierra Nevada Mountain Range.
- Provide watershed, forest health, Native cultural, and wildfire safety education to youth and forest residents to increase knowledge of protection, restoration, and enhancement.
- Improved forest health through the reduction of ladder fuels and the thinning of overstocked stands.
- Habitat protection by enhancing ecosystem functions by increasing water availability for a variety of wildlife types including the Tehama deer herd, spring run Chinook salmon, migratory waterfowl, and other animal and plant species.
- Partnership development through improved collaborations with multiple landowners for forest health.
- Maintain the project area for 10 years through agreements with participating landowners on providing ongoing project maintenance.

Sierra Nevada Conservancy Grant #1341.

The project, which builds on SNC grants 1126 and 1236, has the purpose of preventing catastrophic wildfire by restoring healthy forest ecosystems by thinning overstocked forests, while protecting and improving water quality and increasing water quantity through fuels and invasive species management.

Purpose of the project:

- Improve water quantity and protect water quality – The project will improve quantity and quality of water throughout the year by increasing ground water recharge.
- Develop the next generation's labor force for wildland management and forest health through the CSU, Chico Ecological Reserves ecological stewardship training program.
- Prevent catastrophic wildfire –The project will be completed in areas identified in the FMP as most susceptible to crown fire and those with extreme fuel load conditions.
- Restore forest ecosystems from overstocked conditions with forest thinning – The project will buffer the watershed from the impacts of climate change by transforming overstocked stands to a moderate stand density.
- Reduce invasive meadow species (star thistle and medusahead) to reduce wildfire spread and intensity while increase groundwater recharge and reducing erosion.
- Preserving and enhancing habitat – The project will protect the rich and complex diversity of animal and plant species in the Big Chico Creek watershed.
- Reduce greenhouse gas emissions and improve air quality and carbon storage - The project will reduce potential greenhouse gas emissions and air quality impacts by reducing the threat of high intensity fire and its impacts including soil erosion and carbon release. Further carbon storage will be accomplished through the reduction of invasive annual species (with shallow roots and annual carbon release) allowing for the restoration of perennial native grasses (with extensive below ground root systems) to allow for the long-term storage of carbon in the soil.

Goals of the project.

This project, which builds on prior water quality protection and forest health projects undertaken with the SNC, has the following goals:

- Enhance water quantity and quality in the Big Chico Creek watershed.
- Protect drinking water and agricultural water supply for the City of Chico and surrounding areas.
- Increase forest health by reducing risk of catastrophic wildfire.
- Conduct a collaborative landscape-level forest health improvement project on 441 acres.
- Increase carbon storage through the transition from invasive annual species to perennial native plants.
- Train a labor force to manage and/or implement forest health projects throughout the Sierra Nevada Mountain Range.

- Provide watershed, forest health, Native cultural, and wildfire safety education to youth and forest residents.

Expected outcomes.

- 441 acres of forest health enhanced through thinning of overstocked stands and reduction of invasive species.
- Monitoring of the project with pre- and post-treatment photos and GPS.
- Six-month progress reports as well as final progress reports.
- Community education: Youth and adult watershed, forest health, Native Cultural and wildfire safety.
- Water Quantity and Quality - Water quantity and quality will be increased. The upper watershed receives an average of 70-80 inches of precipitation each year, whereas the valley average is only about 20 inches.
- Improved Forest Health – Overstocked stands will be thinned and ladder fuels will be reduced.
- Watershed Resilience- The project area will be more resilient to the impacts of wildfire.
- Drinking Water Protection - With the reduction of overstocked trees, water supply will be enhanced for downstream users and for the regeneration of the Tuscan aquifer.
- Workforce Development - Provide paid forest health training opportunities for interdisciplinary students through the Big Chico Creek Ecological Reserves ecological stewardship training program.
- Habitat Protection – Enhance ecosystem functions by improving habitat and increasing water availability for a variety of wildlife types including the Tehama deer herd, spring run Chinook salmon, migratory waterfowl, and other animal and plant species.
- Partnership Development – Improved partnerships with multiple landowners for forest health.
- Watershed, Forest, Cultural and Wildfire Education – Improve youth and forest residents' knowledge of protection, restoration and enhancement of the Sierra Nevada.

Forest Health and Upper Watershed Resilience, Butte County 20-FH-BTU-084.

Wildfires in Butte County have been significant and devastating, burning over 400,000 acres in the last 20 years, with 21% of the county burning within the last three years. The proposed project sites are located within a Cal Fire "Very High Fire Hazard Severity Zone" and are proposed for locations where (1) a lack of fire activity has led to an unhealthy density in trees and shrubs and an accumulation of surface fuels or (2) areas have survived wildfire and need additional enhancement to protect forest values (Coutolenc/Dean Rd./West Branch). The watersheds in the project area are at greater risk to catastrophic wildfire than ever before. Fire exclusion has created an unhealthy ecosystem which places excessive hydrological demands on watersheds, amplifying the effects of a changing climate, and creating favorable conditions for disease, insects and mega fire.

Table 2. CA Program Goals. Crosswalk of CA's program goals with the project.

FOREST HEALTH PROGRAM	
Restore forest health and disaster resilience to California's forests	1. Thinning and prescribed fire will create uneven aged stands, reduced understory, favor large tree species and larger diameter individuals
Protect upper watersheds where California's water supply originates	2. Thinning will reduce evapotranspiration and risk of runoff impacts after large high severity fires and prescribed fire reduces sediment and nutrient runoff risk as compared to large high severity fires.
Promote long-term storage of carbon in forest trees and soils	3. Thinning will shift tree carbon storage from smaller to larger trees with stronger growth and carbon capture potential and resilience under hotter conditions. Reforestation will capture carbon in appropriate species.
Minimize the loss of forest carbon from unnaturally large high severity wildfires	4. Thinning and prescribed fire can reduce fire intensity and the potential for large high severity wildfires.
CALIFORNIA FOREST CARBON PLAN	
Expand and improve forest management to enhance forest health and resilience, resulting in enhanced long-term carbon sequestration and storage potential	See 1. Above.
Pursue innovations in wood products and biomass utilization in a manner that reduces or offsets GHG emissions; promotes land stewardship; and strengthens rural economies and communities	A biomass feedstock feasibility study will determine if technology that produces hydrogen from fuels management waste can be combined with ag waste to create a facility with good jobs.
NATURAL AND WORKING LANDS IMPLEMENTATION PLAN	
Provide long-term climate benefits through protecting carbon stocks, increasing carbon sequestration, or reducing GHG emissions from California's natural and working lands, while enhancing their resilience to threats including worsening climate change impacts	Thinning and prescribed fire reduce the risk of carbon losses and GHG emissions due to high severity fires, especially in soils and large diameter trees. Associated shifts to larger diameter trees will sequester carbon and provide resilience to climate change.
GLOBAL WARMING SOLUTIONS ACT (as identified in scoping plan)	
Support vulnerable communities	Forest health management is proposed in the Wildland Urban Interface designated as low-income areas with high fire danger.
Create jobs	BCFSC employees 15 staff and contracts for implementation with dozens of contractors, providing good jobs in the local economy. A successful biomass effort can result in high paying technical jobs.
Give consumers clean energy choices	The biomass feedstock study, technical evaluation and potential engineering work can lead to facility producing hydrogen for transportation.
Make California more resilient	The actions described above will lead to healthier forests and protect important water supply and anadromous fish habitat.
Save water	Hydrologic changes from fuels management will increase watershed resiliency for Lake Oroville, a statewide water resource.

BCCER's Vegetation Management Plan.

The Big Chico Creek Ecological Reserve has entered into a Vegetation Management Plan (VMP) and will be extending this plan along the entirety of the eastern side of Big Chico Creek.

A VMP is a cost-sharing program that focuses on the use of prescribed fire, and some mechanical means, to address wildland fire fuel hazards and other resource management issues on State Responsibility Area (SRA) lands. The use of prescribed fire mimics natural processes, restores fire to its historic role in wildland ecosystems, and provides significant fire hazard reduction benefits that enhance public and firefighter safety (CAL FIRE).

Figure 12. CAL FIRE representative at the BCCER prior to a broadcast burn event.

CAL FIRE completed the vast majority of the California Environmental Quality Act (CEQA) compliance at the BCCER. CAL FIRE can now bring in trained fire personnel when it comes time to do a prescribed burn. This greatly reduces the costs and risks involved with the preparation and implementation of prescribed fire.

Ecological Priorities

Catastrophic Wildfire Mitigation

In the last 10 years mega fires have become the norm each summer, with each year the number of acres increases. The largest wildfire to date is the August Complex in 2020 with more than 1,000,000 acres consumed by wildfire (CAL FIRE). Wildfire is part of the natural ecosystem in California. While we should not try to stop every wildfire, it is imperative to protect communities and steward our landscapes to mitigate catastrophic wildfires that can negatively impact the natural and built environments. Landowners play a critical role in mitigating future impacts of wildfires.

Many best practices and information regarding landowner fire readiness can be found at the Butte County Fire Safe website (www.buttefiresafe.net).

Landowner defensible space.

Each landowner within the canyon has been responsible for their own defensible space.

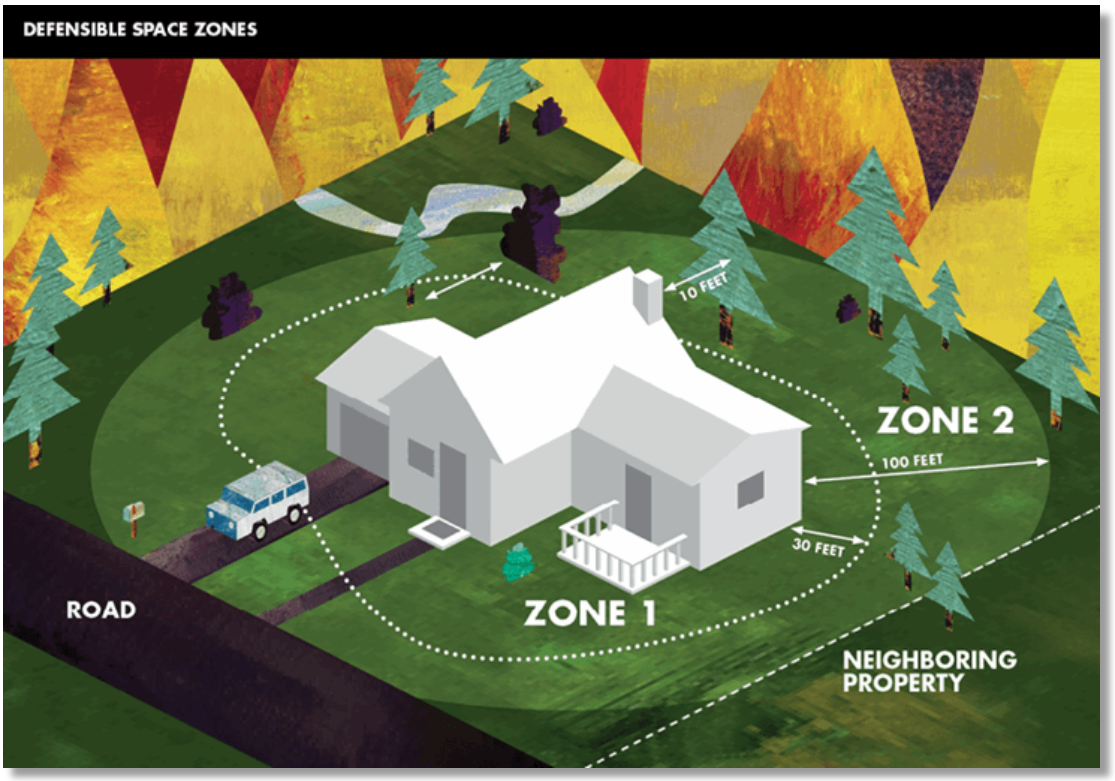

Figure 13. Defensible space zone diagram (CAL FIRE).

Defensible space, coupled with home hardening, is essential to improve your home's chance of surviving a wildfire. Defensible space is the buffer you create between a building on your property and the grass, trees, shrubs, or any wildland area that surround it. This space is needed to slow or stop the spread of wildfire and it helps protect your home from catching fire—either from embers, direct flame contact or radiant heat. Proper defensible space also provides firefighters a safe area to work in, to defend your home (CAL FIRE).

With the overwhelming and daunting task of managing all of the acreage under a single ownership, starting around the house one zone at a time is a good starting place.

Vegetation thinning.

Thinning is the practice of cutting vegetation to reduce its volume. At the Big Chico Creek Ecological Reserve, thinning has been done by pruning limbs from the ground up, and cutting down shrubs and trees that were growing close together. The areas that are prioritized each year are the ones that have been worked on in the past, followed by initial entry for fuel breaks and habitat restoration. Prioritizing the maintenance of acres treated in the past is the most efficient use of time and resources.

Biodiversity and habitat needs should be greatly considered when conducting vegetation thinning. Illustrated in the graphic below, certain plants and trees of each species should be left (excluding invasive or diseased plants). Doing this ensures a variety of conifers, broad leaf trees, shrubs, and forbs. See the Species Specific Vegetation Reduction section for species specific recommendations.

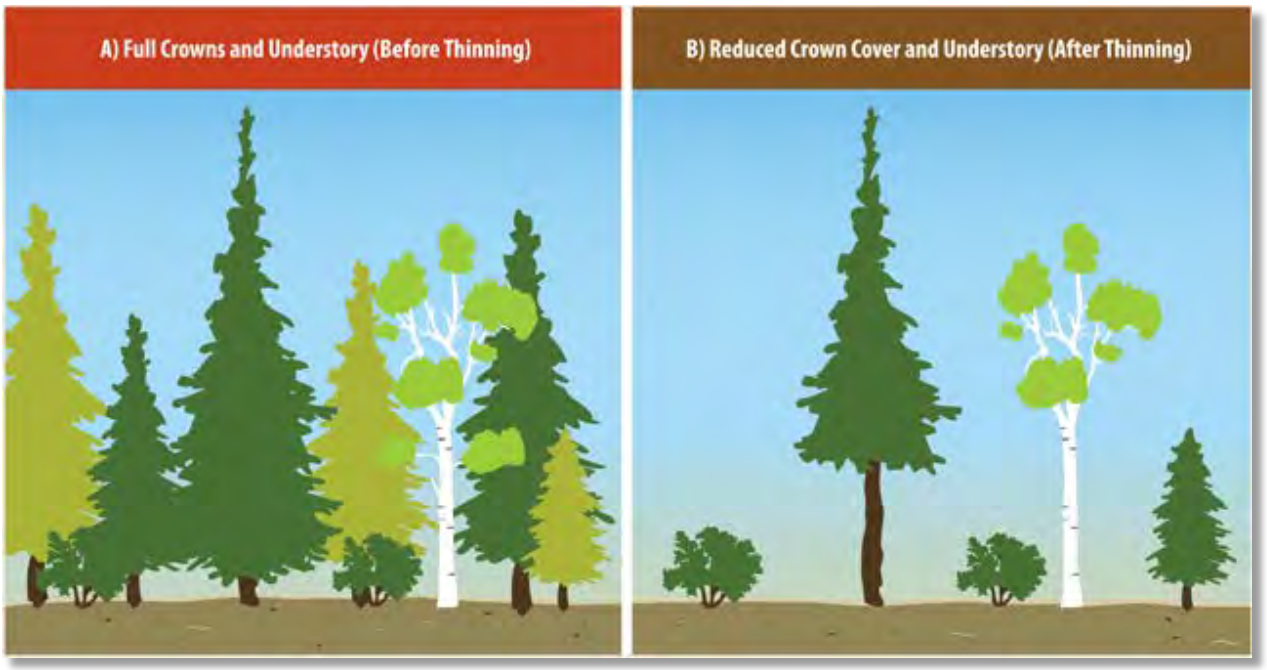

Figure 14. Graphic showing a before and after affect from vegetation thinning (Ontario MNRFC).

Figure 15. Illustration of fire and ladder fuel (Ontario MNRFC).

Did you know?

Ladder Fuels are living and/or dead vegetation that allows a fire to climb from the ground up into the tree canopy. Ladder fuels can include tall grasses, shrubs, and tree branches that make close contact with trees above. Once fire is in the canopy it is much harder to control or stop.

Shaded fuel break.

Fuel breaks built in timbered areas where the trees on the break are thinned and pruned to reduce the fire potential yet retain enough crown canopy to make a less favorable microclimate for surface fires (NWCG).

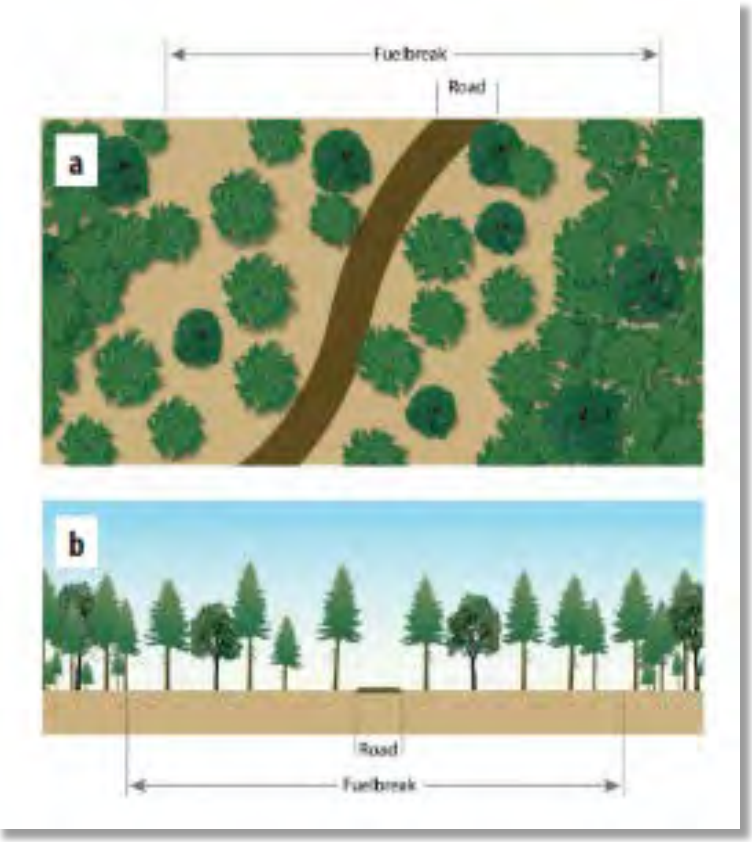

Figure 16. Graphic depicting vegetation discontinuity of a shaded fuel break (Ontario MNRFC).

Create shaded fuel breaks along roads by removing shrubs, surface, and ladder fuels, selectively leaving trees that will eventually be large enough to suppress shrub growth. Fuel breaks will require maintenance, but the amount should decrease as the trees grow. Fuel breaks don't stop a fire but create an area of reduced fire intensity, providing a starting line for firefighters and reducing the heat that sweeps into an adjacent habitat. Drainage divides are natural places for a fuel breaks since fire burns rapidly uphill but slowly downhill and vegetation is generally sparse on ridge tops (BCCER).

Species specific vegetation reduction.

It is critical to consider and prioritize long term goals and ecological objectives as landowners manage their land for wildfire mitigation. While this section does not cover every species of vegetation found in the Big Chico Creek Canyon, it provides treatment recommendations for some of the most prevalent and important.

Deer brush (Ceanothus integerrimus).

This is an always-cut species within a fuel break and a frequent-cut species in any thinning project. Compared to most other brush species, deer brush doesn't grow as large or live as long. It will die back before too long and leave dead fuel in your break. It stump sprouts readily, as do many other species on this list. Stump sprouting can bring fuels down lower and make them more available to fire, possibly creating ladder fuels if not retreated. However, most species stump sprout, so this isn't a reason not to cut something. Another byproduct of stump sprouting is creating browse at a height that deer can easily reach. As the name suggests deer brush is the top choice browse for deer. So, by cutting deer brush you're reducing fuel and creating deer habitat.

Figure 17. Close up of the flowers and leaf pattern of deer brush, *Ceanothus integerrimus* (Barry Breckling).

Toyon (Heteromeles arbutifolia).

Figure 18. Close up of the berries and leaf pattern of toyon, *Heteromeles arbutifolia* (George W. Hartwell).

This is a very common species in the watershed and will stump sprout. Toyon is not browsed by deer heavily and provides the best use for wildlife as a large mature bush that produces berries for birds to eat. The larger the brush, the more berries present, the better the habitat. This means smaller ones should be cut and larger ones saved and limbed up.

Manzanita (Arctostaphylos sp).

This plant does not stump sprout when cut. It can be cut without fear for producing a brushy understory of sprouts. Since this plant does not stump sprout, leaving one or two in an area to produce seeds for future generations is important. Again, larger ones should be selected for since they produce more seeds and can be limbed up higher away from the flames. There are two nearly identical species of manzanita in the area that will often grow side by side. Common manzanita (*Arctostaphylos manzanita ssp. manzanita*) has slightly larger and greener leaves, while white leaf manzanita (*Arctostaphylos viscida ssp. viscida*) has blue-green leaves that are often (but not always) smaller. The white leaf manzanita usually doesn't get as large as the common, so when selecting for larger manzanita proper identification of the plants is important. Leaving a variety of species in any given project area is a good idea to maximize habitat and ecological diversity.

Depending on the species, manzanita can grow anywhere from 4ft. – 20ft. tall (Softschool).

Figure 19. Common manzanita, *Arctostaphylos manzanita ssp. manzanita*.

The manzanita plant is named after its berries, being the Spanish word for "little apple."

Figure 20. White leaf manzanita, *Arctostaphylos viscida ssp. viscida*.

California bay (Umbellularia californica).

California bay can become a full-sized tree, so saving larger individuals and limbing them up is good practice. Bays stump sprout. One concern with bay is that it's extremely flammable. It is best to limb them up high to insure vertical discontinuity. Many bays have stump sprouted after the 1999 Musty Buck Fire within the Big Chico Creek Canyon and are now over 20 years old. Many of these are large enough to limb up and turn into canopy trees. However, they will often have numerous trunks coming up from where the original tree burned down from the fire. Select the largest/healthiest 2-4 trunks, cut down the rest and limb them up. Don't leave them too close to other higher priority species since they can ignite and scorch nearby trees, even in a cool prescribed burn.

Figure 21. Close up of leave and fruit of the California bay, *Umbellularia californica* (David Popp).

Western Red bud (Cercis occidentalis).

This is not a very common shrub, but it's a "do not cut" species whenever possible. This is objectively one of the prettiest shrubs with pink flowers in the spring and leaves that turn color in the fall. It also stumps sprouts, and like the bay, you can select the 2-4 best stems and cut the rest as needed. The western red bud is also considered a culturally significant plant for the Mechoopda tribe.

Figure 22. Western redbud in bloom (*Cercis occidentalis*).

The western redbud is part of the legume family, Fabaceae, making it related to beans, soybeans, and peas.

California coffeeberry (Frangula californica).

This plant is more common in sunnier areas and less common in shade or north-facing slopes. If there is an abundance of this plant in an area, cut most and leave a couple. They don't get very big in most areas except in sunny meadows, so they won't be able to make for good shade canopy. They do stump sprout, but do not make good deer browse. They don't seem to re-sprout too aggressively in the shade. Keep a few individuals for biodiversity purposes.

Figure 23. California coffeeberry, *Frangula californica*.

Gray pine (Pinus sabiniana).

The gray pines are a bluish grey in color. Remove smaller gray pines while leaving the larger, more-full trees. Large gray pines can be identified by their multiple branches. Any gray pine under eight inches in diameter can be removed. They're adapted to this area and can live in rough, harsher terrain than other pines. Gray pines are an important species for the wildlife, as many are dependent on the pine seeds. It is considered a culturally significant species to the Mechoopda tribe as well.

Figure 24. Crowns of two grey pine, *Pinus sabiniana*.

Gray pines provide pine nuts that are packed with protein and calories (UCANR).

Ponderosa pine (Pinus ponderosa).

Ponderosa pines are very bright green in color. The bark of ponderosa pines have the unique characteristic of resembling puzzle pieces. These large trees require a lot of space and a lot of sunshine. The larger the tree, the more space that is necessary. In a young stand of ponderosa pines, it is best to identify the best looking and thin out the stand around them.

Figure 25. Ponderosa pine, *Pinus ponderosa*.

Canyon live oak and interior live oak (Quercus chrysolepis and Quercus wislizeni var. wislizeni)

There are primarily two species of live oak within the project area. Canyon live oak, which grows in shadier areas, and interior live oak, which grow in sunnier, more open areas. The canyon live oak will produce many baby oaks underneath, and the interior live oak does not grow quite as large. They can be treated in the same fashion.

Figure 26. Canyon live oak stand, *Quercus chrysolepis*.

While live oak trees can grow to be large and useful, there are some drawbacks. Their leaves are very flammable and their bark is not very fire resistant. They also produce large quantities of acorns that are not regularly foraged by wildlife. This results in a many saplings around the base of the large tree, which can carry fire toward the tree. These trees stump sprout, more so than other oak species. This brings those flammable leaves down into the path of the fire and can create a lot of heat. It is best to remove the saplings that are under 6' tall by pulling them out, roots and all. A slow creeping fire in the winter can also kill them. The large trees should not be cut down. Like the bay, many of these intermediate size live oak trees are stump sprouts from the 1999 fire. The best course of action is to select the best 2-4 leaders of the stump sprout and cut the rest. They won't stump sprout, at least not as much, when you do this, since they still have a few trunks to continue to grow from. Then limb them up and clear all other fuels away from them.

Figure 27. Interior live oak leaves and acorns, *Quercus wislenzi var. wislenzi*.

The large trees just need to be cleared underneath and limbed so as not to allow fire into those flammable leaves. To fully kill and remove a larger live oak, you should girdle the trunk of the tree. Girdling requires concentration. Any tiny bridge of cambium left between root and stem will produce a bridge of phloem to keep the roots alive. All stems must be either girdled or cut and repeat visits made to remove stump sprouts to continuously deprive roots of energy. The tree will eventually die (in a year or two) and can then be cut down without stump sprouting.

Evergreen oaks retain their foliage all year. This can prohibit understory flora from growing and establishing themselves.

Deciduous oaks: California black, blue, and valley (Quercus kelloggii, Quercus douglasii, and Quercus lobata)

The deciduous oaks are extremely valuable to shaded fuel breaks. This includes anything from a foot-tall sapling to a 100-foot-tall tree. The trinity of oaks are the blue oaks, the black oaks, and the valley oaks.

Figure 28. Leaves of the California black oak, *Quercus kelloggii* (Rebecca Shoenenberger).

They are "deciduous" oaks, meaning they lose their leaves in the winter. This can complicate distinguishing between oak species. They can be distinguished by their acorns and their bark pattern.

Figure 29. Leaves of the blue oak, *Quercus douglasii* (Jay Chamberlain).

Figure 30. Leaves and acorn of the valley oak, *Quercus lobata* (Neal Kramer).

The majestic "Hooker Oak" of Chico was one of the largest valley oaks known to man. It fell on May 1st, 1977, revealing that in fact it was two valley oak trees growing together instead of a single tree (Bristol).

Buck Brush (Ceanothus cuneatus var. cuneatus)

This is a dense and thorny plant species. It burns very hot but doesn't stump sprout much. Buck brush provides habitat for birds, therefore the removal of all in an area is not suggested.

Figure 31. Buck brush, *Ceanothus cuneatus var. cuneatus*.

Thinning out dense areas of buck brush and leaving some for habitat and biodiversity purposes is preferred.

The Miwok Indians of the Sierra Nevada region of California used the young, straight shoots of buckbrush for basketry material (USFS).

California buckeye (Aesculus californica).

This species is classified as a tree, but can sometimes be better characterized as a bush. In general, prune surrounding vegetation to provide adequate space for the buckeye to grow. Like the redbud, it is one of the showier species and creates a more scenic landscape. It can grow large enough to provide shaded canopy to make an effective shaded fuel break.

Figure 32. New leaves of a California buckeye, *Aesculus californica* (Suzanne Weakley).

Big leaf maple (Acer macrophyllum).

This is a full-sized tree, and a great overstory species for a shaded fuel break. It's not quite as hardy or fire resistant as a deciduous oak. Clear around them to protect them from fire and provide space to grow.

Figure 33. Leaves of a big leaf maple, *Acer macrophyllum* (Kim Cabrera).

Blue elderberry (Sambucus nigra ssp. caerulea)

While the elderberry plant itself is not a listed species, the valley elderberry longhorn beetle (VELB) that inhabits the plant is. The VELB is endemic to riparian systems and in adjacent grassy savannas in California's Central Valley. The VELB feed exclusively on two species of elderberry, including the blue elderberry (*Sambucus nigra ssp. caerulea*) and the red elderberry (*Sambucus racemosa*). The adult female beetle deposits eggs in the crevices of the bark of living elderberry plants. The larvae bore into the pith of the larger elderberry stems where the majority of the animal's life span is spent. Following pupation in the spring, the adult beetle emerges, creating a hole in the bark of the stem or branch. Adults feed on foliage and are present from March through early June (USFWS). Elderberry plants can only be trimmed specific times of the year, therefore becoming familiar with all laws and regulations prior to treatment is necessary.

Figure 34. Leaves, flowers, and fruit of a blue elderberry, *Sambucus nigra ssp. caerulea*.

Hierarchy of Cutting

This is a general hierarchy to help aid in deciding what to cut back. This can change based on specific location, condition, and objectives.

Table 3. Hierarchy of cutting.

Never cut	Almost never cut	Cut Most & Leave Few	Cut small ones	Keep largest & cut the rest
Deciduous oaks Maple Unknown plants	Buckeye Cedar Douglas fir Elderberry Ponderosa pine Redbud	Buck brush Coffeeberry Deer brush Live oak tress	Grey pine	Bay Manzanita Toyon

It is a best practice to skip over plants that aren't identifiable. Certain species of plants are protected by state and federal laws.

Ridding (Disposal) of Cut Vegetation

The removal of limbs and whole plants from an area is only half of the restoration process; more work is to be done. The downed woody debris will need to be addressed. Retaining this material can be good for nutrient cycling and wildlife habitat, but in some cases, it can be a fire hazard and a barrier to reforestation (Oregon Dept. of Forestry).

Oftentimes known as “slash,” this debris can be mitigated in a variety of ways. The various ways of disposing of the cut vegetation include pile burning, chipping, and broadcast (prescribed) burning.

Pile burning.

Pile burning is one of the best methods for removing vegetation after it has been cut. Piles can be massive, pushed together by machinery, or small and piled by hand. Pile burning is an art and there are many different techniques. Large machinery-constructed piles are efficient but can only be done in flatter areas that are accessible by that machinery. The creation of these piles must also be done in areas that are open enough to not kill nearby trees with the intense heat of the fire.

Figure 35. Hand-made pile of cut woody debris for pile burning.

Hand-made piles can be done in more rugged and heavily forested areas. If built small enough, hand-made piles can burn under a closed canopy without damaging it (weather conditions permitting). These piles can either be built ahead of time or piled while burning. The premade piles are considered more efficient since they can be made when burning, or even cutting, is not possible (e.g., red flag days). The premade pile can also be burned efficiently if the weather conditions are just right. However, conditions can sometimes be too dry or too wet to burn the premade piles safely and effectively.

Piling while burning allows one to control the heat of the pile and burn in a wider range of conditions. All burns carry a risk of escape, so all necessary precautions need to be taken and to

treat pile burns seriously. Also, pile burning is subject to all local laws and regulations and requires all necessary permits and notifications in place before lighting any fires.

Pile burning methods.

"Top lighting" of a slash pile is a method of controlling the rate of fire on these piles and a way to create biochar. Biochar is a charcoal-like material that is produced from burning plant material. It is used to enhance soil fertility and sequester carbon by preventing CO2 from atmospheric cycling. A quick step-by-step video of this process has been shared on the Ecological Reserves' social media pages (BCCER's Biochar short video).

Figure 36. BCCER volunteer Dr. Paul Maslin creating biochar by drenching coals in water.

"Bottom lighting" of a slash pile will cause the pile to burn at a much faster rate compared to top lighting. This method is used when wanting to burn down piles with no plan of creating biochar. Generally, this method creates less smoke than top lighting, as chemicals released from the pile are typically burned off quickly before smoke is able to significantly form.

Chipping.

Chipping is a great method for processing cut slash, especially if conditions are not favorable for pile burning. Note that chipping can still cause a fire, as rocks or other hard materials accidentally fed into a chipper can create sparks. Chipping does have its drawbacks, the main one being that it does not actually get rid of the fuels, but just redistributes them. Placing the fuels in a chip bed close to the soil surface does increase their rate of decay and will break down those fuels faster than if they were left as whole slash. The proximity to the ground means that the fuels now do not have as much air between them as they would have had as

slash or standing brush, so it will burn slower in a fire, therein decreasing the rate of spread of that fire.

Figure 37. California Conservation Corps members hauling branches and logs from debris piles to a wood chipper (CCC).

A fire through chips still produces a lot of heat, and the lack of air means the fire will slowly smolder for a very long time and can be very difficult to put out. Chips can make pile burning and especially broadcast burning very challenging. When chipping, it is best to spread out chips as much as possible to reduce to depth of the chip bed. It is also best to avoid putting chips near trees, as burning chips can kill a tree by heating the trunk or the roots.

Broadcast burning.

Broadcast burning is a prescribed fire ignited in areas with little or no forest canopy present (BLM). Broadcast burns are one of the most cost-effective ways to treat a forest, barring all the conditions are correct. Broadcast burning is used in grasslands, shrublands, and oak woodlands for habitat restoration and fuels reduction purposes (BLM). Regular broadcast burning functions great to inexpensively maintain a forest that is already in a healthy state.

These burns can be conducted at different scales, ranging from small burns that are less than an acre to burns that cover hundreds of acres. The resources to execute these burns at different scales adjust with the sizing, too. A handful of people can conduct a small burn, while it can take large crews from different agencies and organizations partnering together to accomplish the larger burns.

Any type of broadcast burn requires a large amount of training and experience to do safely. Anyone interested in doing these types of burns should explore all opportunities to gain knowledge and experience in prescribed burning. This can be done through earning a Wildland Firefighter Type 2 certification, joining your local Prescribed Burn Association (PBA), and participating in Training Exchange (TREX) events. Like with pile burns, broadcast burning is

subject to all local laws, regulations, permits, and notifications that would need to be in place before lighting. Liability is another important factor to keep in mind when burning.

Figure 38. BCCER staff and partner organizations conducting a prescribed burn on a meadow in November 2021.

Sediment/Water Retention

Water should be kept on the land as long as possible. Since surface water flows 100,000 times faster than groundwater, an important management goal is to retain as much rain water to allow it to soak into the ground. This will allow for the groundwater to recharge. Minimizing compaction of the soil and maintaining ground cover are vital. Any modification of small tributaries to raise stream surface level will increase hydraulic pressure forcing water into the adjacent soil. It is best to work with the local geology of the land. In a bedrock reach of the stream, a dam can only store water in the resultant pool. In a reach through soil or alluvium, large quantities of water can also soak into the bank.

When using rocks to stymie the flow, you can have two problems: Keeping the rocks from dislodging and keeping the water from eroding the embankment around them. It is best to ensure the rocks are wedged against embedded rocks and each other and that adjacent banks are armored. If needed, create a splash apron.

Cut brush packed into small tributaries can be even more effective than rock dams at slowing flow. Brush usage isn't without its share of potential problems. It may move and plug downstream culverts, it may form a bridge allowing erosion to continue underneath the brush, and it will eventually decompose. The use long pieces, placed with branches upstream, starting from downstream and working up, is a best practice for using brush in tributaries. The brush can be packed down by trampling the brush and adding rocks and logs to keep them in place. If there is a downstream culvert, it is best to place large logs just upstream of it to catch any

branches that get dislodged (Bigger streams can move bigger pieces of wood so choose materials appropriate to the stream). Kick, rake, or blow leaves and rotten wood into the streambed to help seal the brush dams.

As soon as the brush captures enough debris and alluvium, introduce hydrophytes. The extensive root systems of water-loving plants will tie the deposits and decomposing brush together, while their tops will continue to slow the flow and trap sediment. Note that all stream or tributary modifications must meet all local, state, and federal laws/regulations.

Meadow Restoration

Meadow restoration is a priority for land stewardship and forest management in California. California forest meadows are in ecological decline due to lack of disturbance. Historic disturbances were caused by a consistent fire regime, spring flooding, and native large mammal grazing.

Without the regular disturbance interval, trees and shrubs have begun encroaching on the meadow areas. When trees encroach and shrubs encroach and begin absorbing the water available in the area, they lower the meadow's water table. This then reduces the water availability in the creek meadows, thus changing the type of vegetation possible in meadow areas.

Without the regular disturbance from burning, flooding and native large mammal grazing, invasive species can more readily taken root.

Meadows infestation with star thistle, medusahead, and barbed goat grass are the highest priority for management. Ideally, these areas would be burned in July or August for several consecutive years to reduce the seedbed of these invasive species. If burned consistently, native grasses and forbs would be given the opportunity to outcompete invasive grasses, as natives are fire-adapted and most invasive species are not. However, due to funding availability, restrictions, and small windows for prescribed burning (which is not in July or August), it is more likely that opportune mowing will be applied. As funding becomes available, invasive grasses (such as barbed goat grass, medusahead, and wild oats) should be mowed prior to drying and seed setting in order to reduce the population spread on an annual basis.

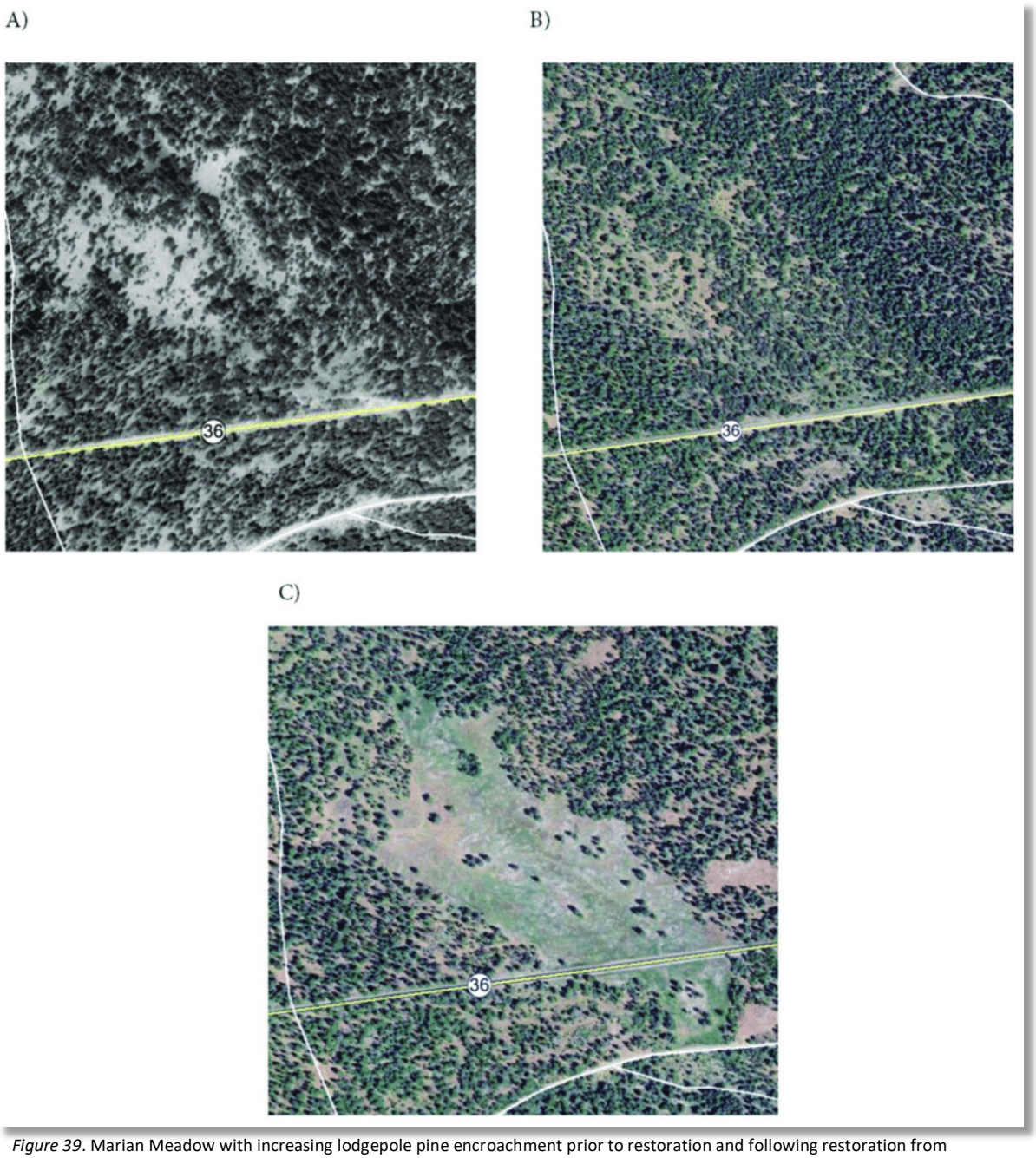

Figure 39. Marian Meadow with increasing lodgepole pine encroachment prior to restoration and following restoration from removal of encroached lodgepole pine (Imagery from Google Earth). California State Route 36 in image provides the spatial reference of the location (see Figure 1) (A) Marian Meadow at July, 1993; 12 years prior to restoration. (B) Marian Meadow May, 2014; 1 year prior to restoration. (C) Marian Meadow July, 2017; 2 years after restoration. (Marian Meadow).

Many of the invasive species are not palatable to grazing animals and can even hurt grazers. Grazing can be beneficial to reduce herbaceous fuel loads in areas of native grass species, as native grasses can lose vigor over time if their thatch is not being reduced by fire. Invasive forbs such as yellow star thistle and Klamath weed are a threat to native grasslands. These invasive forbs can also be managed through direct herbicide applications, grazing, or mowing.

Figure 40. Broadcast burn in a meadow at the Big Chico Creek Ecological Reserve.

Broadcast burns have also been used to restore meadows. Burning has been utilized within Big Chico Creek Canyon for time immemorial. First by indigenous tribes, followed by settlers, private, and public land owners. These broadcast burns have been as small as a tenth of an acre to as large as 80 acres. The smaller burns look a little more like the photo above and primarily consist of meadows and blue oak savanna habitat.

The BCCER has worked hard for years to restore meadows to native grasses by reducing yellow star thistle and planting native grass seeds. This was accomplished through mowing, burning, and seed collecting. See specific invasive species management techniques below.

Invasive Species Management

When it comes to managing invasive species, the different plant species require different techniques, methods, and timing in order to effectively eradicate them from the landscape.

Broom.

There are multiple types of broom that exist in the canyon and the surrounding community. Spanish (*Spartium junceum*), Scotch (*Cytisus scoparius*), and French (*Genista monspessulana*) broom are all invasive species that can disperse millions of seeds annually if left alone. They are also very good at inhabiting disturbed places. Broom also takes hold along the creeks.

Figure 41. Spanish broom growing along a creek bank (Julie A. Kierstead).

It is best to pull broom in early spring with a weed wrench. It is imperative that broom is pulled out before they go to seed. Broom can also be sprayed with herbicide depending on location and objectives.

Figure 42. Scotch broom flowers (Jim Moore).

Figure 43. French broom flowers (Joseph DiTomaso).

Yellow star thistle (Centaurea solstitialis).

Yellow star thistle (*Centaurea solstitialis*) is an invasive species from Eurasia. It was introduced to California in 1850. It is now common throughout California's meadows, fields, and roadsides. It is poisonous to horses and unpalatable to most ungulates, with the exception of goats. It matures after all the grass in the meadows has died out and set seed.

Figure 44. Close up of flower head with spikes of a yellow star thistle plant (Carol Witham).

Yellow star thistle cannot be contained or managed with one treatment or even within a single year. The BCCER has been managing star thistle since 1999 without the use of herbicide. Yellow star thistle can be controlled by mowing after it starts to flower but before any seeds are ripe. At this stage (usually in July) the basal leaves drop and the lower stem turns brown. Cutting the thistle below any green, even if you have dig a little, will kill the plant and prevent it from re-sprouting. This will deprive the plant of photosynthesis.

Triangle blade trimmers and sickle bar mowers are some of the best tools to treat yellow star thistle. They cut best through the herbaceous stems and cut lowest to the ground. Star thistle that has not yet matured can pulled out either by hand or with a pick. Star thistle plants should be pulled out below the rosette. It is recommended that you run fire through star thistle meadows in the fall. This will release the stored seed bank and allow the above treatment methods to be much more effective.

Note on mowing yellow star thistle.

It is recommended that a sickle bar mower is used instead of a conventional mower because it cuts low to the ground and rides right along the surface. Sickle bar mowers are able to cut the star thistle low enough so that is does not sprout back. Sickle bar mowers are generally safer to

use during fire season as they are less likely to create sparks from rock strikes, but abundant caution and preparedness must still be used. A conventional mower may also be used but the possibility of causing a fire is increased dramatically. A trimmer with a metal triangle or polymer blade can be used for spot treatments which usually happens after at least two years of mowing and burning. Hand pulling or cutting with picks or hoes can also be effective for small areas.

Figure 45. Milk thistle (Ralph Boniello).

Milk thistle (*Silybum marianum*).

Originating from the Mediterranean area, milk thistle (*Silybum marianum*) has established itself here in California and all around the world. This species is an annual or biennial plant of the family Asteraceae. This fairly typical thistle has red to purple flowers and shiny pale green leaves with white veins (Wikipedia).

Milk thistle is extremely good at re-sprouting. Treating it similar to yellow star thistle will help in removing the plant.

Italian plumeless thistle (*Carduus pycnocephalus*).

The Italian plumeless thistle is an annual herb that is invasive in California. Italian thistle can grow densely, crowding out other vegetation with dense rosette 'colonies' in the winter, thereby preventing establishment of native plants (Wikipedia).

Control methods include mowing before the seeds ripen or after a fall burn after seeds have sprouted following a rain.

According to the Mayo Clinic, research on milk thistle use for specific conditions shows:

Diabetes: Milk thistle might lower blood sugar in people who have type 2 diabetes, but more studies are needed to confirm its benefits.

Indigestion (dyspepsia): Milk thistle, in combination with other supplements, might improve the symptoms of indigestion.

Liver disease: Research on the effects of milk thistle on liver disease, such as cirrhosis and hepatitis C, has shown mixed results.

Figure 46. Italian plumeless thistle (Southwest Desert Flora).

Common fig (*Ficus carica*).

While tasty, the common fig is a non-native to California and can invade a habitat quickly. The management plan for figs calls for *opportunistic abuse*: girdle, pull, cut, build fire on top of, etc. Figs are easy to girdle in spring and early summer. Cut the bark loose several feet up then peel it off in strips to ground level. Desiccation over such a wide area will kill the cambium.

Figure 47. Young fruit and leaves of a common fig (Julie Kierstead).

Klamath weed (*Hypericum perforatum*).

Klamath weed, also known as St. John's wort, is a flowering shrub that is native to Europe. It is an aggressive invasive plant that can take over areas. Klamath weed should be grubbed out in early June when it is visible and the ground is still soft. Small patches should be identified and treated immediately upon detection. Once established in large areas, herbicide may need to be used to control.

Did you know?

The name St. John's wort apparently refers to John the Baptist, as the plant blooms around the time of the feast of St. John the Baptist in late June.

(National Center for Complementary & Integrative Health)

Figure 48. Klamath weed growing amongst rocks (Bob Sweatt).

Himalayan blackberry.

Not all blackberries are invasive. Invasive blackberries, such as the Himalayan blackberry, have long thorns and much larger leaves than that of the native blackberries. Native blackberries can be left alone unless they are taking over, which is highly unlikely. Blackberries are an important food source for many critters at the reserve.

Blackberries spread by tip layering. Long stems develop during summer, then branch out into multiple branchlets, each of which sends down roots. Cutting off these stems will prevent the spread. If they have already started to root, pull the new roots out. Blackberries tend grow near water sources.

A Woodsman's Pal, a type of machete, is a great tool for having out in the field because it is light weight and can easily be carried over changing terrain. A weed wrench and loppers are great tools for taking down Himalayan blackberry.

Reseeding/Planting

Native seed collection can be done every summer from the main grass species. Blue wild rye, purple needle grass, and woodland brome are the main bunch grasses. Broad leaf lupine and California poppy seeds can also be collected and dispersed. For the best success establishing populations of native species, scatter wildflower and grass seeds in areas post-fire (in the hottest burned areas) and pre-rainfall. Just before and during the rainy season (winter), this window is 1 – 5 days after a pile or broadcast burn and right before it rains. The rain helps to drive the seeds into the fresh, nutrient-rich ash.

Implementation Equipment

Tools and Equipment

There are a variety of tools that can be used in land management. These tools range in size and capabilities, from residential to commercial, from hand to power, and from simple to complex. Having the appropriate tools for the job can make the project run smoothly.

Pruners/Loppers.

Loppers are a non-motorized hand tool that are best used for precise small-scale work. Loppers are most useful around sensitive areas and plant species that require more care than a motorized tool would allow, but also are useful during periods of elevated fire danger when other types of tools could potentially cause an accidental ignition.

Figure 49. Pruning shears (NY Times).

Loppers come in a range of sizes, from small hand shears to long-handled, super-duty loppers, capable of cutting stems up to three inches in diameter. Loppers, even the super-duty types, are light-weight and require no special training or skills. They are a tool that anyone can used quite easily.

Figure 50. BCCER staff member using loppers to remove overgrown vegetation.

Mowing.

Mowing can be utilized in areas that are on less than a 10% slope and do not have woody vegetation. It is generally implemented in meadows and the periphery. Traditional mowers should be used with caution as they can easily spark a fire by hitting a rock.

Figure 51. Sickle bar mower (Daily's Farm & Walk-behind Tractors).

The sickle bar mower, as mentioned earlier, reduces the chance of sparks and cuts vegetation at the base, close to the ground.

Power saws.

There are three types of power saws that are predominantly used in forest management. These are the trimmer, pole saw, and chainsaw.

Trimmer.

A trimmer is one of the most multifunctional tools available. Many people will know a trimmer by other names, such as a "Weed Wacker" but there are higher-powered trimmers available that can use many other attachments aside from a string head for cutting grass. They can run everything from polymer blades (good for work in high fire danger seasons) to a metal circular

Figure 52. Gas-powered trimmer (Stihl).

saw blade, which, with the appropriate training, is one of the most effective tools for removing a large area of short-to-medium brush.

Pole saw.

A Pole saw is essentially a small chainsaw on a stick. There are a variety of powers and lengths of pole saws available, but the standard pole saw is a great entry-level tool.

Figure 53. Gas-powered pole saw (Stihl).

It can be used to clear brush and limb up trees. More safe and easier to use than a chainsaw, it can do most of the work a chainsaw can, and then some. Tree felling and bucking are not tasks that a pole saw can accomplish, but in many areas, those are not essential parts of forest management.

Chainsaw.

A chainsaw is the most powerful and efficient hand tool that can be used for forest management. A single well-trained sawyer with a good professional-grade chainsaw can clear nearly half an acre of brush on a good day. That said, chainsaws require the most training to safely and effectively run, but once trained, their power and ability make the chainsaw one of the most productive management tools.

Figure 54. Gas-powered chainsaw (Stihl).

Skid steer.

A skid steer is a tracked or wheeled (tracks are best for forestry purposes) piece of machinery with a forward set of hydraulic powered lifting arms, on to which a wide variety of tools can be attached. The type of tool that can be attached depends on the size and power of the skid steer, as they come in a variety of sizes and capabilities. Some more basic tools, such as a bucket, log forks, or dozer blade, are available for even the smallest of skid steers. Some other attachments require more hydraulic power that is only available with higher-end pieces of

Figure 55. Skid steer used to create large slash piles at the BCCER.

equipment. The number of different types of attachments that can be used on a skid steer make it one of the most versatile pieces of equipment a land manger can own.

There are three specific attachments suited to forest management work that are worth noting. The first is some manner of grapple that can be used to move materials around in a project area. The next is a chipper, and while available as a towable trailer as well, a skid steer-mounted chipper provides more accessibility and prevents you from having chipper operations limited to roads only. The third is a masticator; essentially a giant rotating drum with teeth that will mow through brush. Mastication won't leave as neat and tidy of a project site as chainsaws will, but there isn't much that can match the productivity of mastication. The latter two attachments generally will require high-flow hydraulics that can only be found on the larger machines.

While initial costs of these machines are substantial, a skid steer is a piece of equipment that should be considered for land managers due to their versatility and efficiency. Transportation and cost of maintenance are important factors to consider when purchasing a skid steer or any other piece of large machinery.

Excavator.

An excavator is another piece of large machinery that can be used for many things, including forest management. The excavator was originally designed for digging and trenching, and, like the skid steer, comes with a wide variety of different attachments. The grapple and masticator are the two main attachments for forest management work that are available for an excavator, and they are both like the version that go on a skid steer. The main benefit of the excavator is the extended reach and dexterity of the long boom arm and the elevated position of the cab, which provides a better view of your work area. These benefits do make it a more effective tool in many situations, but it does not have the versatility of a skid steer. The excavator also requires much more training and experience to operate and is generally more expensive to operate and maintain than a skid steer.

Figure 56. Excavator with masticator attachment.

Crews.

Hand crews are often a complement to the heavy equipment and can enhance production when resources are available. Crews often prep units for prescribed fire, work alongside (at a safe distance) equipment on projects, and prep units for grazing to ensure intended ecological outcomes are met. An individual landowner can do a lot of this work themselves, but in most cases a hired crew is needed to implement larger projects. Crews can vary widely, from the

Figure 57. California Conservation Corps crew members clearing vegetation.

highly trained, ecologically-minded crews of the Ecological Reserves, to productive, but less-specialized private or public hand crews.

Whatever the make-up of the crew, working with others on forest management is important for many reasons. Safety, efficiency, and just the idea that you're not at it alone makes crews a useful tool. Crews also provide multiple perspectives on ideas to solve the challenges of doing this type of work. Maybe the most important benefit of a having a crew help with the work is to provide more opportunities for experience to people, who can then take what they learn about forest management and utilize that knowledge on other projects throughout the state.

Avenues for Funding

Much of this work, and the costs surrounding it, fall on the landowner. There are a number of different options for funding that a landowner can look into in order to accomplish the goals and objectives of land management. Funding can come from the federal level, state level, county level, and even from private and public organizations. All with goal of aiding landowners into becoming stewards of the land.

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) provides financial and technical assistance to agricultural producers and non-industrial forest managers to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, increased soil health and reduced soil erosion and sedimentation, improved or created wildlife habitat, and mitigation against drought and increasing weather volatility (NRCS).

The Environmental Quality Incentives Program (EQIP) is a voluntary cost share program through the federal government with the Natural Resource Conservation Service (NRCS). It is a fairly straightforward process to release federal funds to private landowners. EQIP can only be utilized once for the ownership of the property number (farm number).

The majority of the land in the canyon would fall under forest stand improvement projects. Timber cannot be commercially harvested while the land is under EQIP dollars. Timber can be fallen just not sold for commercial gain. Non-timbered acres could still benefit from cost share dollars through soil improvements, meadow restoration, or other improvement projects. Partial CEQA has been completed on most properties in the canyon, which could expedite the process to release EQIP dollars.

California Forest Improvement Program

The purpose of the California Forest Improvement Program (CFIP) is to encourage private and public investment in, and improved management of, California forest lands and resources. This focus is to ensure adequate high-quality timber supplies, related employment and other economic benefits, and the protection, maintenance, and enhancement of a productive and stable forest resource system for the benefit of present and future generations.

The program scope includes the improvement of all forest resources including fish and wildlife habitat, and soil and water quality. Cost-share assistance is provided to private and public ownerships containing 20 to 5,000 acres of forest land (CAL FIRE). The California Forest Improvement Program (CFIP) is a voluntary state cost share program to encourage private landowners to improve their forest lands by subsidizing the work and preparation. A forest management plan would have to be completed for individual landowners.

Vegetation Management Plan

The Vegetation Management Program (VMP) is a cost-sharing program that focuses on the use of prescribed fire, and some mechanical means, for addressing wildland fire fuel hazards and other resource management issues on State Responsibility Area (SRA) lands. The use of prescribed fire mimics natural processes, restores fire to its historic role in wildland ecosystems, and provides significant fire hazard reduction benefits that enhance public and firefighter safety (CAL FIRE).

VMP allows private landowners to enter into a contract with CAL FIRE to use prescribed fire to accomplish a combination of fire protection and resource management goals. Implementation of VMP projects is by CAL FIRE Units. The projects which fit within a unit's priority areas (e.g., those identified through the Fire Plan) and are considered to be of most value to the unit are those that will be completed. The Vegetation Management Program has been in existence since 1982 and has averaged approximately 25,000 acres per year since its inception.

Landowners may choose to apply for participation in the Vegetation Management Program. The Unit VMP Coordinator will make the determination as to the suitability of a project for funding through the Vegetation Management Program. When approved as a VMP project, CAL FIRE assumes the liability for conducting the prescribed burn.

California Vegetation Treatment Program

The California Vegetation Treatment Program (CalVTP), developed by the Board of Forestry and Fire Protection, is a critical component of the State's multi-faceted strategy to address California's wildfire crisis. The CalVTP includes the use of prescribed burning, mechanical treatments, manual treatments, herbicides, and prescribed herbivory as tools to reduce hazardous vegetation around communities in the Wildland-Urban Interface (WUI), to construct fuel breaks, and to restore healthy ecological fire regimes. The CalVTP Program Environmental Impact Report (Program EIR) provides a powerful tool to expedite the implementation of vegetation treatments to reduce wildfire risk while conserving natural resources (CAL FIRE Board).

Additional Resources for Landowners

Butte County Specific

It is recommended that all landowners in Butte County explore the different agencies and organizations for resources.

Butte County Fire Safe Council.

The Butte County Fire Safe Council (BCFSC) formed in 1998 and is Butte County's largest ally in educating and assisting the public with wildfire preparedness. The BCFSC is a non-profit community organization funded by grants and community donations. The organization operates in cooperation with local, state and federal fire agencies throughout Butte County.

www.buttefiresafe.net

Butte County Resource Conservation District.

The mission of the Butte County Resource Conservation District is to protect, enhance, and support Butte County natural resources and agriculture by working with willing land owners and citizens through education, land management, and on-the-ground projects.

www.bcrcd.org

Natural Resources Conservation Service's Conservation Stewardship Program.

The Conservation Stewardship Program is a natural resources protection program, administered by the Natural Resources Conservation Service (NRCS), that's geared toward working farmers.

Chico Specific

2021 City of Chico Vegetative Fuels Management Plan (VFMP)

2021 Program Environmental Impact Report: City of Chico Vegetative Fuels Management Plan

Cohasset Specific

2021 Cohasset Forest Management Plan

Paradise Specific

2021 Paradise Forest Management Plan

Plan for the Canyon

This area encompasses almost 8,000 acres of land which includes the Big Chico Creek Ecological Reserve and the adjacent private landowners. 8,000 acres of needed treatment area is a rather daunting task when each year there is a constant threat of catastrophic wildfire. There is a plan for breaking down the areas and taking it one step at a time and then to follow that break down through the future.

Step 1: Define Boundaries

Outlining the boundaries of the project site is one of the first steps in managing the area. These boundaries follow the outline of the incorporated lands, the various parcels owned by the private landowners and the parcels that make up the Big Chico Creek Ecological Reserve. The other factors that influence the boundaries are the vegetation type, the roads (paved and dirt) within the canyon, the creeks and tributaries, the various ridges of the canyon, and the overall watershed.

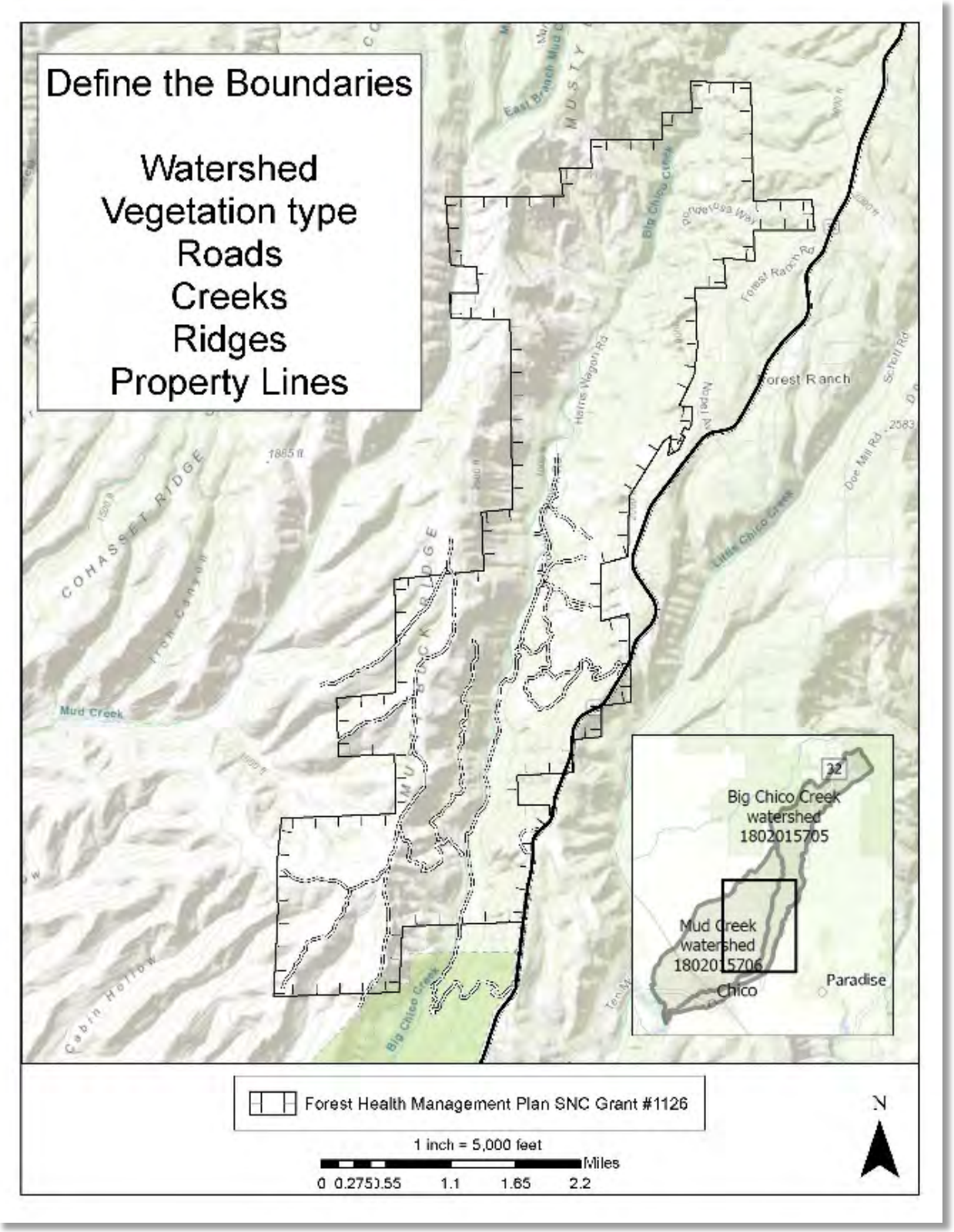

Figure 58. Forest Health Management map indicating the boundaries of the entire project.

Step 2: Complete Environmental Compliance and Further Define Boundaries

After completing the environmental compliance (CEQA), the next step would be to further delineate the work that will need to be done. In the diagram below, the boundary outlined in yellow is the area where CEQA was completed. This area is ready for treatment implementation.

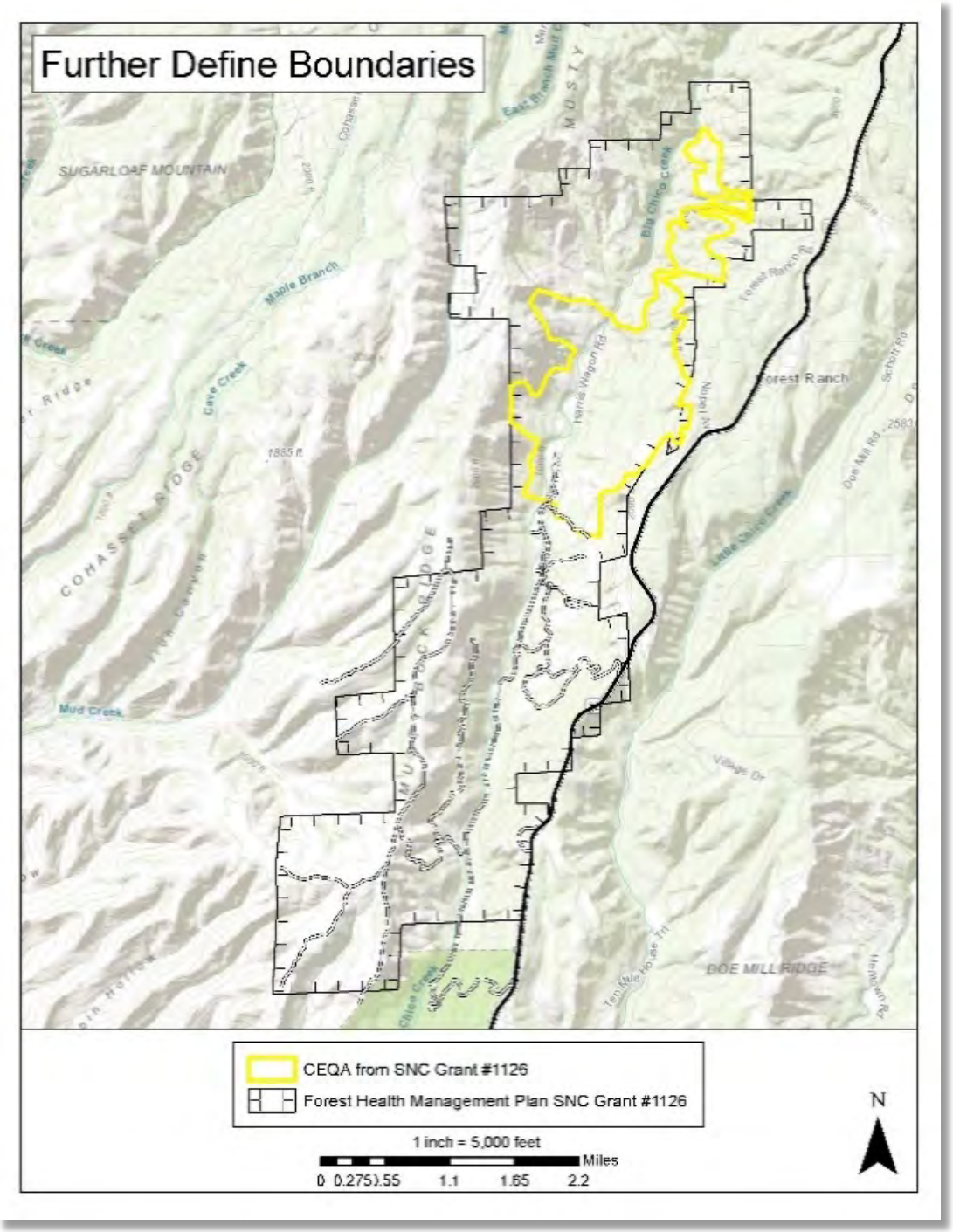

Figure 59. Forest Health Management map with boundaries outlined indicating where environmental compliance has been completed (CEQA).

Within the boundary of the area that had environmental compliance completed, further delineation could be used to identify the area that has been identified for the prescribed treatment methods.

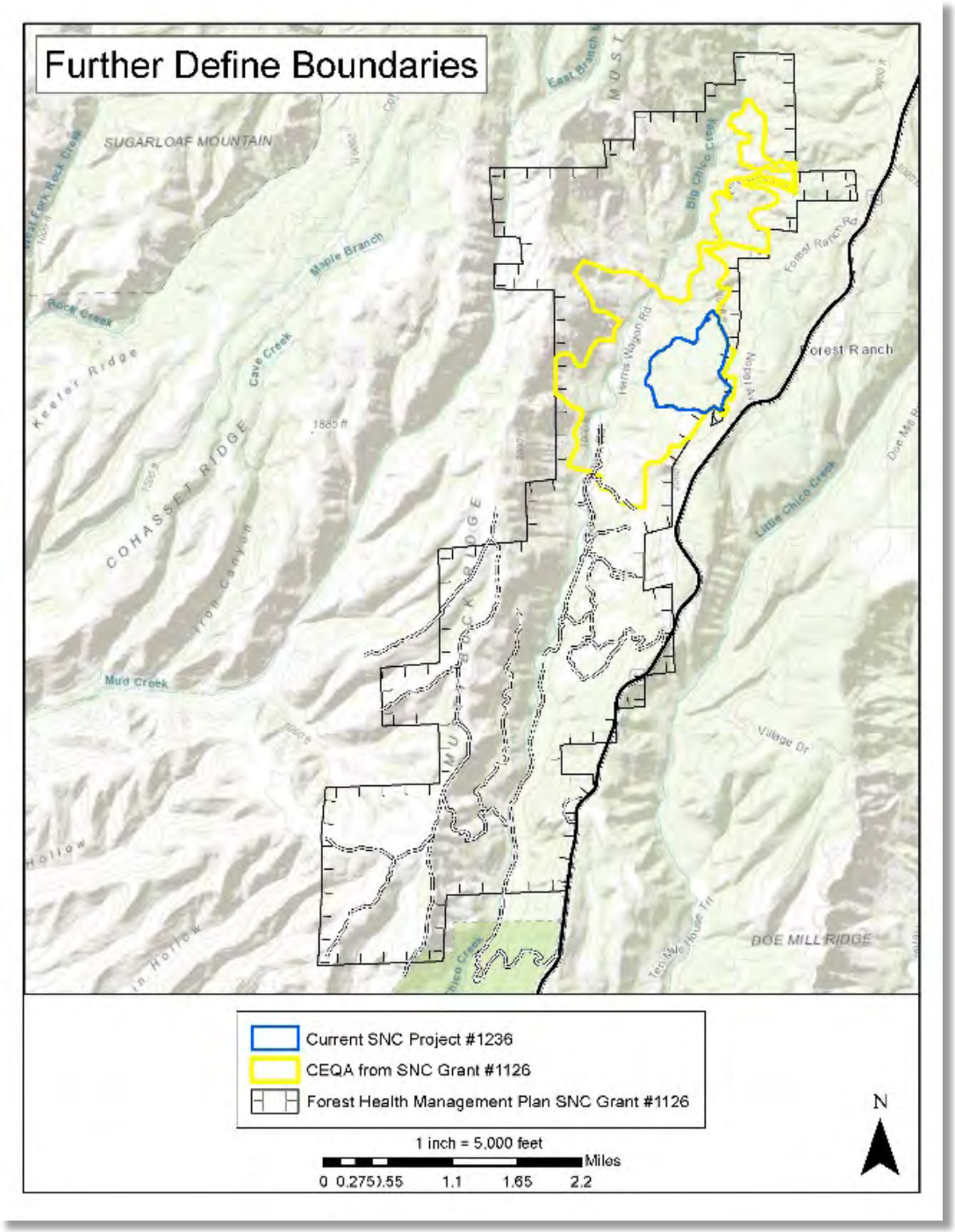

Figure 60. Forest Health Management map with prescribed fire treatment area identified within the boundaries of the completed environmental compliance (CEQA).

Step 3: Boundaries Based on Geography of Area

The various roads within the project boundary are great starting points for further breaking down the project area into sizeable sections. While the roads provide easy starting points for boundaries of a section, treatment of the boundaries are necessary. Shaded fuel breaks are built in timbered areas where the trees on the break are thinned and pruned to reduce the fire potential yet retain enough crown canopy to make a less favorable microclimate for surface fires (NWCG).

These shaded fuel breaks stretch to 150 feet on both sides of the road. This is to ensure the slow of any potential wildfire that may run through the area. This treated corridor, or buffer, is to be maintained throughout the duration of the project and on an annual basis.

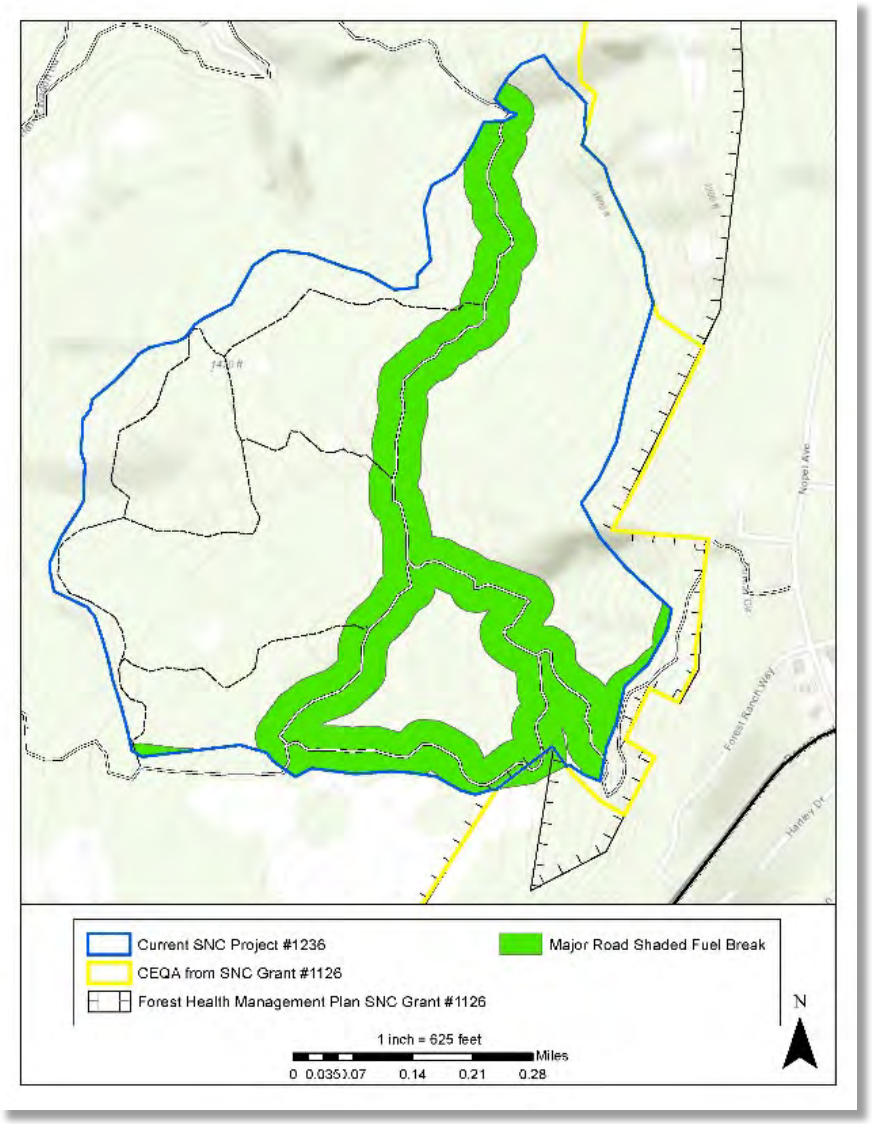

Figure 61. Forest Health Management map with outline of shaded fuel break along a road.

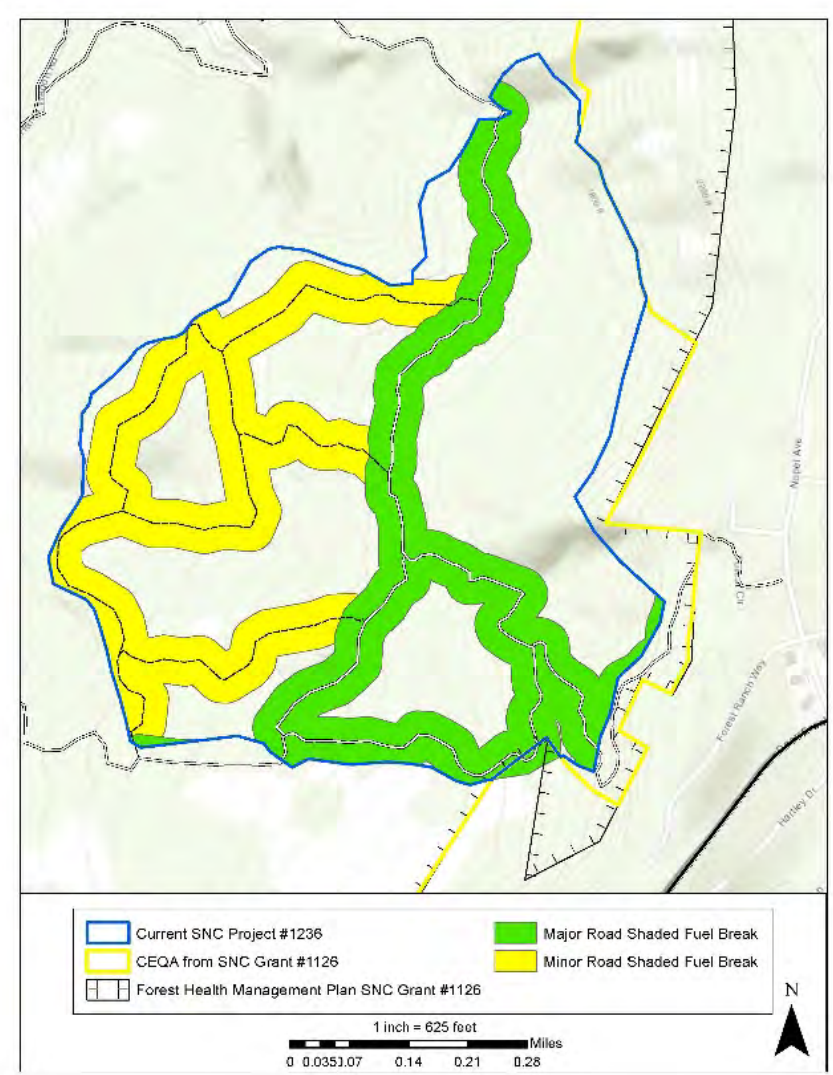

Figure 62. Forest Health Management map with continued outline of shaded fuel breaks along the roads within the project area.

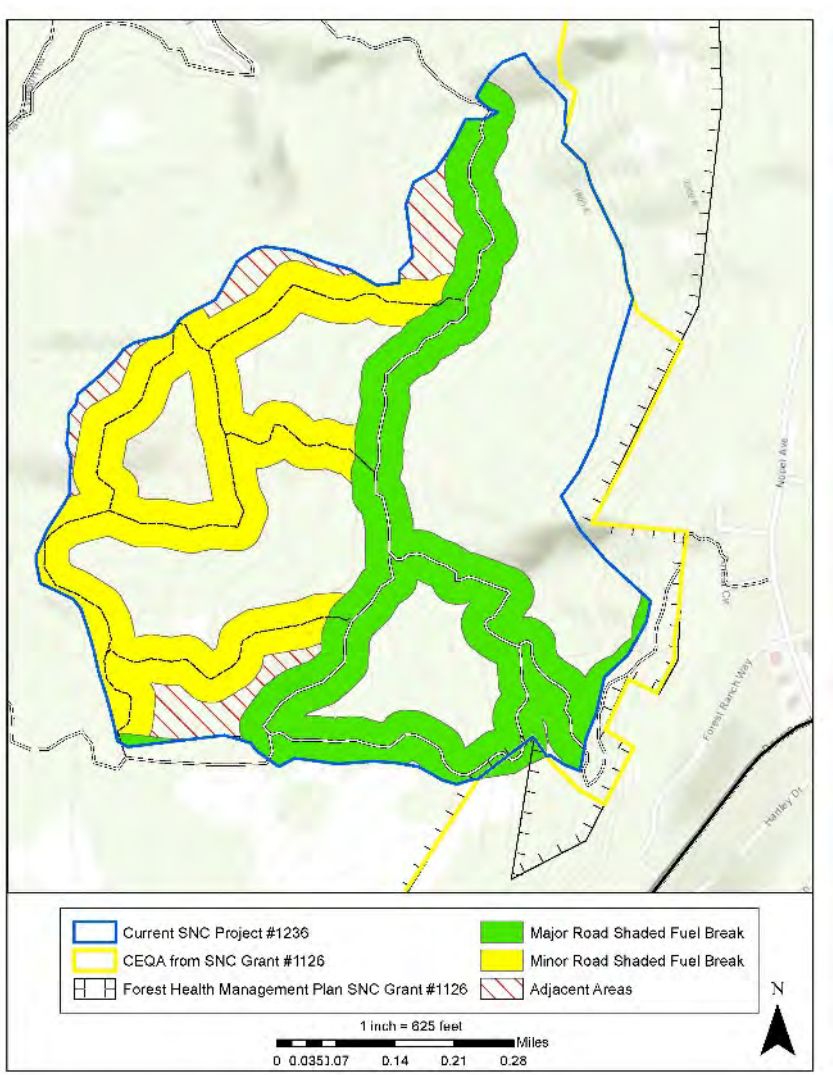

Figure 63. Forest Health Management map with identified adjacent areas not encompassed completely with a shaded fuel break. These areas are to be thinned.

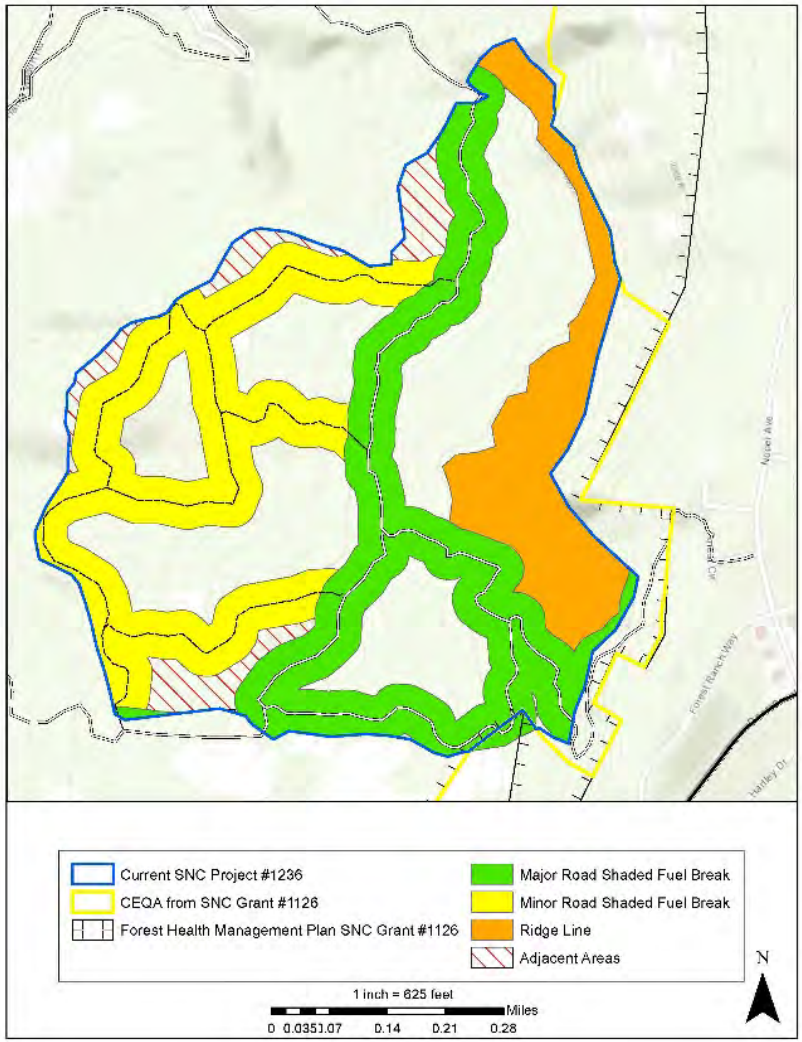

Figure 64. Forest Health Management map with continued outline of shaded fuel breaks along the roads, adjacent areas identified, and the ridge line outlined as another section. The ridge top section is to be thinned, similar to the identified adjacent areas.

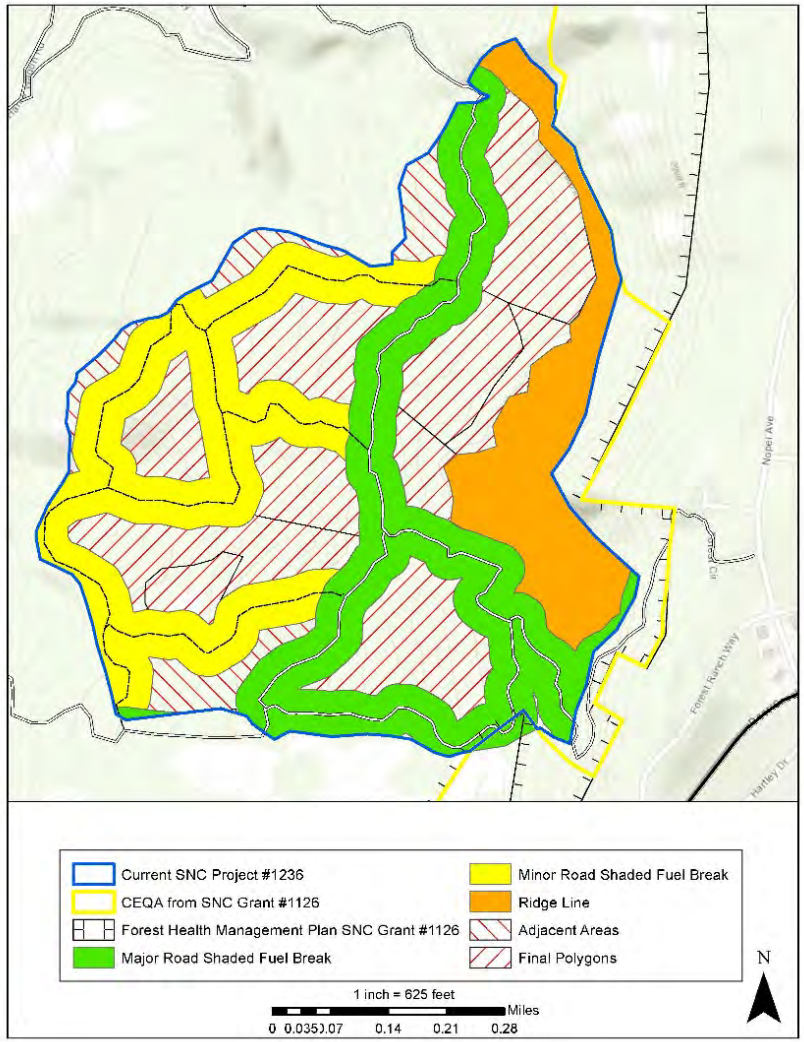

Figure 65. Forest Health Management map indicating the different project sections to be treated and maintained.

Planning for Future

Breaking down the project area into different sections, or units, will provide managers with the ability to tackle the project strategically. Each unit can be assessed and an outline of project implementation can be made based on strategic goals identified for the properties in Big Chico Creek:

- Accessibility
    - Prioritize projects adjacent to roads
    - Topographic features allow work to be completed
- Methodology
    - Work on units adjacent to one another when possible
    - Treat ridge tops
- Manageability
    - Goal of treating 200 acres per year by 2024 and 1,00 acres per year by 2030
    - Prioritize maintenance of treated acres with appropriately spaced disturbances

In addition, the project identification and implementation should support the larger strategic priorities for the canyon :

- Develop and expand innovative sustainable land management activities for devastating wildfire mitigation, forest health, academic goals, cultural practices, and wildlife habitat conservation supported through:
    - Identify and secure sustainable funding for forest health and habitat improvement projects
    - Creation of wildlife corridors
    - Reintroduction of native flora and fauna
    - Use of cultural methodology
    - Establish and increase research, scholarship and inquiry consistent with regional Indigenous and traditional knowledge
- Influencing/Impact lands outside of the Ecological Reserves and Big Chico Creek Canyon
- Prioritize workforce development and training to prepare the next generation of land stewards and conservationists
- Every project should have ecological benefit, be a learning opportunity, and provide a public benefit

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