Preface

OVERVIEW OF THE FOREST MANAGEMENT PLAN

The recently acquired Smuggler Mountain Open Space property is an iconic feature of the Roaring Fork Valley landscape, much beloved and actively used recreationally by residents and visitors alike. The need for the forest management plan described in this report was driven by the desire of the Open Space land managers to develop a comprehensive and integrated strategy to incrementally foster improvement in forest conditions based on analysis of reliable field data and ecologically sound management principles. A 10-year interval of annual management recommendations was chosen as the first step toward a goal of long term, sustainable forest management, and this notion provides the framework for the plan presented here.

The current forest conditions on the Smuggler Mountain property are the result of historical uses primarily for mining and timber. In the intervening time, little has been done to actively manage the property in terms of improving forest health. Lack of human caused disturbance and prevention of natural disturbance events such as fire has resulted over time in a forest that is generally over stocked and lacks age-class diversity. This plan addresses these issues and, moreover, outlines a balanced approach to provide the disturbance needed to regenerate forest tree age class diversity while creating collateral improvements in wildlife habitat, reducing fire risk and conserving the unique natural features of Smuggler Mountain.

The accompanying plan is organized around a series of integrated short-term and long-term management recommendations that stem from ecologically sound analysis of contemporarily acquired field data that is both robust and sufficiently comprehensive so as to properly inform the plan. The methods employed to analyze current forest conditions on Smuggler Mountain are presented first, followed by specific recommendations that form a series of tiered options for the property managers to consider that will yield a range of desired forest conditions over the operational life of the plan. Descriptive maps and

informative tables and figures augment the narrative of the plan. An appendix organizes supporting documentation and provides ancillary detail to certain issues raised during stand data analysis.

The over-arching goal of the plan is to restore age class diversity amongst the tree species present on Smuggler Mountain by mimicking natural disturbance events. The intended outcome of implementation of these recommendations is to provide a resilient, sustainable forest that meets the needs of the local community. The plan embodies silvicultural best practices and is an adaptable, forward thinking prescription for significant improvement in forest heath on Smuggler Mountain. It provides a foundation on which future management plans can be built that are properly informed by experience as a result of a built-in monitoring component.

A summary of each year's planned activities, a time-table for implementation and an estimated budget for each year is provided in the appendix of the document. The plan also addresses the socio-economic needs of the local community and provides some other intriguing options to consider in terms of educational opportunities and the potential for use of woody biomass as a collateral benefit of active management.

Due attention has been paid to the need to balance the recommended silvicultural methods with soil and watershed protection, wildlife habitat improvements, insect pest resistance and protection of infrastructure with the long-term objective to improve the health of all tree species on Smuggler Mountain. Lastly, the plan has been designed so as to facilitate cooperative interaction amongst other interested parties such as the local fire protection districts, adjacent private landowners and the U.S. Forest Service.

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1. Introduction

1.1. Background

Smuggler Mountain Open Space is a 234 acre tract of forest land bordering the City of Aspen in Pitkin County, Colorado. It was recently acquired by the City of Aspen and Pitkin County in an effort to conserve open space from further development. The acquisition of Smuggler Mountain conserves wildlife habitat, protects the local watershed and conserves forest resources while also providing unique recreational and educational opportunities for the citizens of Aspen and Pitkin County.

Several recent documents have assessed the various historical attributes and biological resources of the property. The history of land use was summarized by Smith Environmental and Engineering (2007). This assessment provided baseline data and management recommendations to ensure the preservation of cultural heritage sites on the property. A comprehensive biological resources report was prepared by Colorado Wildlife Science and WP Natural Resource Consulting (2008) which documented baseline data for wildlife, vegetation and ecological communities on Smuggler Mountain. Information and recommendations in these reports were the basis for the comprehensive Smuggler Mountain Open Space Management Plan (2008) which cited as major goals the need to manage Smuggler Mountain for natural resources, recreational use and educational opportunities.

Among the recommendations for natural resource management were calls for a baseline forest resource inventory and a comprehensive forest management plan, the latter to include action plans for insect and fire/fuel management.

This document describes a detailed 10-year forest management plan for Smuggler Mountain based on new inventory data and data from previous reports. In keeping with the overall goals of the 2008 plan, the proposed forest management plan will focus on how to maintain a diverse, healthy and sustainable forest while protecting and improving wildlife habitat, encouraging safe recreational use, minimizing fire potential and providing new educational opportunities for the public.

It should be recognized that a lot has been done on Smuggler Mountain from a forestry perspective. Significant efforts have occurred in the last two years to control the mountain pine beetle (MPB) outbreak in the lodgepole pine. This has included the removal of lodgepole pine infested with MPB and application of verbenone to repel the beetles and monitoring.

1.2. Goals of the forest management plan

A forest management plan, especially one that involves a forest/urban interface, must satisfy many stakeholders with varying priorities. However, a good management plan must have as its highest priority the health and sustainability of the forest. Without the attainment of that primary objective, all others goals are impossible to achieve or maintain on a long-term basis. The following are summaries of the key goals of the proposed 10-year forest management plan.

Manage for diverse, healthy and sustainable forest characteristics

Managing the forest for diversity and sustainability will require the presence of specific forest attributes. A diversity of tree species of many different ages and sizes, including sufficient regeneration of tree species within forest stands, will provide healthy sustainable forest characteristics. The current epidemic of mountain pine beetle (MPB) (*Dendroctonus ponderosae*) throughout the lodgepole pine (*Pinus contorta*) forests of the Rocky Mountains, exemplifies the need for species and age class diversity. Stands that have a high density of old, large lodgepole pines with a low diversity of tree species, age classes and size classes tend to be the most susceptible to serious MPB infestations. Stand conditions that have a high diversity of tree species, age classes and size classes can still be susceptible to infestations but are at a much lower risk of catastrophic tree mortality. A diverse and sustainable forest will ultimately be resistant to serious MPB infestations.

Sudden aspen decline (SAD) is also a threat at Smuggler Mountain. SAD is considered the abnormal dieback of aspen caused by a combination of accelerated abnormal insect and disease problems with predisposing factors being drought and low elevation south and west aspects. The rapidity of dieback, landscape scale and lack of regeneration are of grave concern. Healthy aspen (*Populus tremuloides*) stands have evolved by being dependent on disturbances such as fire, wind throw, avalanches, etc. Old aspen forests in Colorado that have not experienced such disturbances are at risk for SAD. Aspen stands managed for a diversity of characteristics will be more resistant to disease. The age class diversity of Gambel oak (*Quercus gambelii*), another major component on Smuggler Mountain, has also decreased due to fire suppression and is in need of management to return this species to a more natural state.

Manage for healthy wildlife habitat

Healthy wildlife habitat on Smuggler Mountain can be improved by active forest management. To achieve a wide range of wildlife habitats, the forest must be managed to include a full range of diverse forest structures such as species diversity, a wide distribution of tree sizes and ages and un-fragmented corridors of forest stands. Furthermore, the forest must be managed in a way that maintains standing dead trees (snags) and downed dead trees (coarse woody debris). The abundance of snags and coarse woody debris contribute to excellent habitat for wildlife by providing nesting, roosting and hiding cover.

Manage for a safe recreational setting

Smuggler Mountain receives heavy recreational use including hiking, jogging, mountain biking, snow shoeing, and cross country skiing. A safe recreational setting will consist of easily accessible areas that the public can enjoy without the threat of dead trees or limbs falling onto trails or roadways. The best way to manage for a safe recreational setting is to remove any defective live trees and dead trees in such areas and to continue monitoring for future safety. Since hazard trees are defined as dead trees and defective live trees near areas that people frequent, their removal will be minimal and most likely will have an insignificant impact on wildlife habitat. Keeping roads maintained, well marked and free from fuel build up along their edges will allow for quicker evacuation of recreational users in case of fire.

Implement a public educational program regarding forestry practices at Smuggler Mountain

In order to achieve the overall management objectives for Smuggler Mountain, active forest management is needed. Several forest management tools have been developed that are backed by sound forest science. An educational program needs to be implemented that informs the public of how this forest management plan is working toward achieving the overall goals of Smuggler Mountain. Components of an educational program may include informative kiosks near project sites and public presentations (both on and off site) from forest managers and scientists. Smuggler Mountain could also be available, with permission and guidance from City/County agencies, as a research or observation field site for high school and college biology courses. This could even include student and public participation in ongoing monitoring projects as outlined below.

Develop an effective monitoring program

Lastly, a monitoring program needs to be implemented in order to ascertain the efficacy of forest management recommendations. The dynamics of forest structures and wildlife habitat are typically obtained through field measurements. A design of measurement plots systematically placed on Smuggler Mountain should be implemented in order to repeat measurements over longer periods of time, typically decades. The installation of such plots would act as a very effective tool for forest managers to understand the forest growth dynamics at Smuggler Mountain and to ensure that the management goals are being properly met. And, of course, there would be a need to monitor MPB infestation on a regular basis.

1.3. Project area description

Smuggler Mountain Open Space is located in the heart of the Rocky Mountains just north of the City of Aspen in Pitkin County, Colorado (Fig. 1). It is embedded in a landscape at 8,129-9,698 feet above sea level that transitions from an urban environment to a rural national forest. The southern and eastern portions of the property border the White River National

Forest which is administered by the USDA Forest Service. The lands to the north and west border private properties. Smuggler Mountain is a combination of multiple properties acquired by the City of Aspen and Pitkin County. The purpose of the acquisitions was to conserve and protect open space, wildlife habitat, natural views and to provide outdoor recreational opportunities.

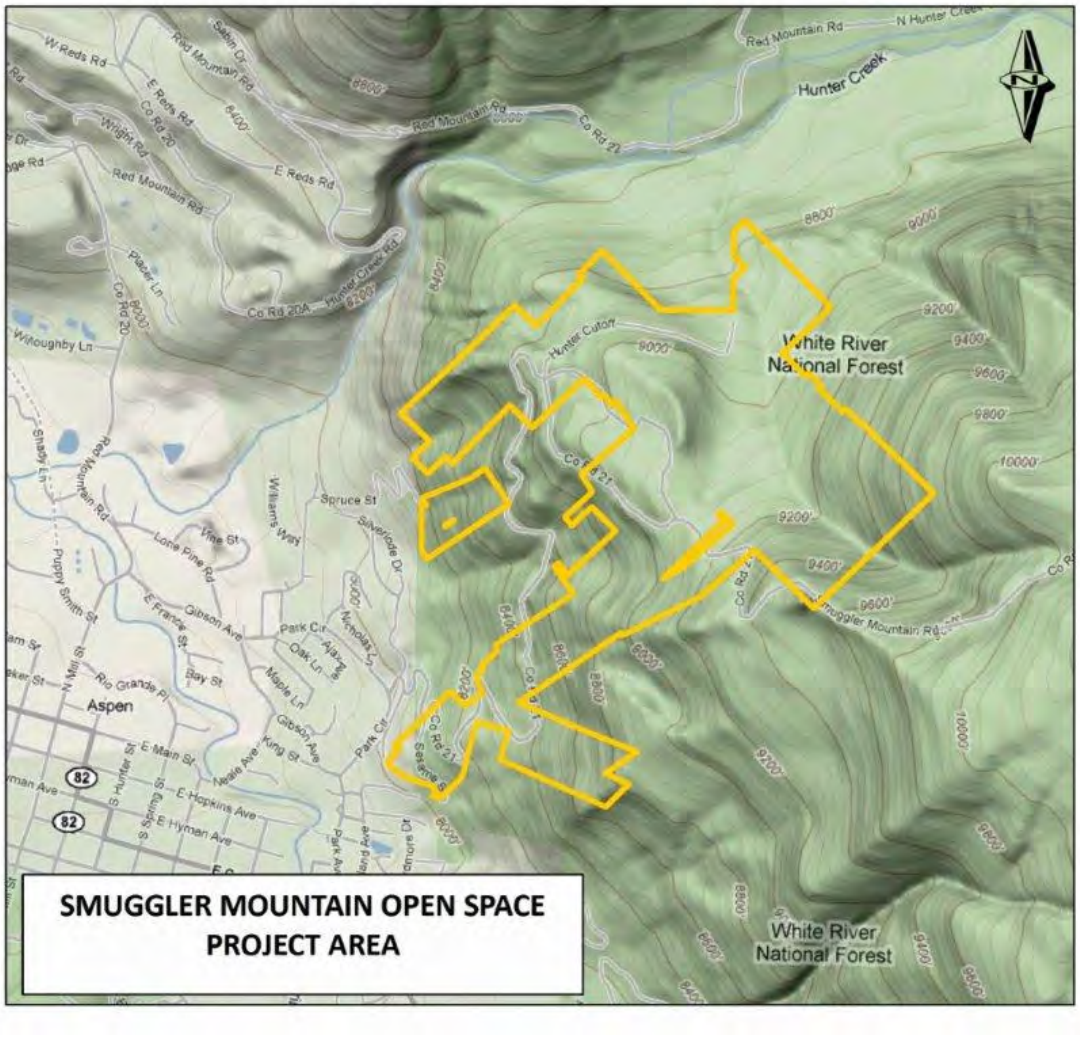


Figure 1. Vicinity map of Smuggler Mountain Open Space.

Climatic conditions at Smuggler Mountain can be highly variable and subject to sudden change. Generally, the climate is characterized as semi-arid with strong seasonal variations in temperatures, abundant sunshine and relatively low precipitation. Average daily maximum temperatures range from the mid 60's to low 70's (Fahrenheit) from April to September. July and August temperatures can reach up to 90 degrees. However, nights remain cool with average summer months reaching the low 40's. Winters are generally cold but are subject to sudden changes in temperature with daytime temperatures in the 30's and 40's not unusual. Average January lows are near 7 degrees with daytime averages in the 20's. Snowfall from October to April ranges from 150-200 inches. Average annual precipitation in the City of Aspen is 23 inches.

The topography of Smuggler Mountain ranges from relatively flat to extremely steep and rugged terrain. Dominant aspects are northerly and westerly in the upper forested areas with much of the lower, south-facing slopes covered in shrub. The lower part of the property is generally too steep and densely vegetated for recreational use. The varied topography of the Rocky Mountain region has been formed by numerous geologic events including ancient seas, glaciation and volcanic activity. The lower elevations of Smuggler Mountain contain relatively recent Pleistocene glacial deposits, but the higher elevations are built on Precambrian rock (0.5-4.6 billion years old). Erosion and primary succession have created a rich loamy topsoil covering layers of gravelly to cobbly sandy loam which allows vegetation to root up to 80 inches or more into the soil.

The primary vegetation types on Smuggler Mountain consist of mountain shrub, aspen and mixed conifer communities. Mountain shrub communities are mainly on the lower slopes of Smuggler Mountain and are dominated by Gambel oak (*Quercus gambelii*), Saskatoon serviceberry (*Amalanchier alnifolica*) and big sagebrush (*Artemisia tridentata*). Aspen communities contain aspen (*Populus tremuloides*), subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*). Mixed conifer communities consist of lodgepole pine (*Pinus contorta*), subalpine fir, Douglas-fir (*Pseudotsuga menziesii*), Engelmann spruce and a few ponderosa pines (*Pinus ponderosa*). The vegetation on Smuggler Mountain has historically evolved with numerous forms of disturbance. Historic fire regimes were prevalent throughout the landscape, creating diverse age classes of tree species and healthy stands of regenerating lodgepole, aspen and Gambel oak. In the past century fire suppression has been employed at Smuggler Mountain resulting in new vegetation dynamics. Past mining and logging have also changed the landscape from its original form (Fig. 2.)

Figure 2. Historical comparison of Red Mountain and Smuggler Mountain.

Wildlife is abundant at Smuggler Mountain. There are approximately 88 avian and 45 mammalian species using the habitat that Smuggler Mountain provides (Colorado Wildlife Science and WP Natural Resource Consulting, 2008). Small mammals, such as the American marten (*Martes americana*), weasels (*Mustela* spp.) and striped skunk (*Mephitis mephitis*), may spend their entire lives on the property while larger mammals will use the property occasionally for browsing, hunting, reproduction and/or migration. Common large mammals at Smuggler Mountain include Rocky Mountain elk (*Cervus elaphus nelsoni*), mule deer (*Odocoileus hemionus*), bobcat (*Felis rufus*), mountain lion (*Felis concolor*) , black bear (*Ursus americanus*), coyote (*Canis latrans*) and red fox (*Vulpes vulpes*). The federally threatened Canada lynx (*Felis lynx*) may be present as well. Some key bird species include the Virginia's warbler (*Virginia virginiae*), green-tailed towhee (*Pipilo chlorurus*), red-naped sapsucker (*Sphyrapicus nuchalis*), cordilleran flycatcher (*Empidonax oberholseri*), American three-toed woodpecker (*Picoides dorsalis*), olive sided flycatcher (*Contopus cooperi*) and northern goshawk (*Accipiter gentilis*).

2. Methods of Forest Analysis

2.1. Forest inventory procedure

In 2008 the Aspen-based non-profit organization *For the Forest*, in conjunction with the U.S. Forest Service, conducted "common stand exams" (CSE) throughout Smuggler Mountain. A CSE is performed by delineating a series of polygon-shaped areas (stands) within a forest from which data are collected. In this study, stands were delineated from aerial photography and ground observations.

With the CSE method several measurement plots were systematically placed in each stand. Within each plot detailed measurements were recorded. Species, diameter at breast height (DBH), total height, crown measurements, tree age and past ten-year growth increment, snag measurements and seedling quantities are typical kinds of data collected. With these data, detailed summary statistics are produced that assist forest managers in decision-making processes.

2.2. Analysis of forest inventory data

The inventory data were organized to be read by the Forest Vegetation Simulator (FVS) software (USFS, 2010). FVS produces summary statistics of forest stands that include descriptions of species composition, size class distribution, age class distribution, quantities of snags, quantities of seedlings and saplings, and stand densities. FVS relies on general models based on forest data from the Colorado Rocky Mountains that quantify coarse woody debris from standing tree data. This additional data analysis is necessary in order to make informed management decisions on insect and fire/fuel issues.

2.3. Temporal modeling of forest growth

FVS is a very powerful forest modelling tool. The program is designed to use forest inventory data in conjunction with a pool of numerous scientific studies that deal with forest growth dynamics. For this management plan the Colorado Rocky Mountain variant of FVS was used to project forest growth. From these projections, forest managers can obtain detailed descriptions of changes that will likely occur in a given stand over time.

Various management scenarios can be simulated with FVS. Such simulations are very useful in determining the best course of action to be taken to meet given objectives. For this management plan a no-action scenario was simulated over time along with other active management scenarios in order to determine the suggested actions needed in order to meet the forest management plan objectives.

3. Current forest conditions

3.1. Stand inventory and conditions

The CSE inventory was used to summarize current forest conditions. There were four stand types detected on Smuggler Mountain. A total of 17 stands were delineated within the boundaries of Smuggler Mountain, which were aspen, aspen/lodgepole pine, lodgepole pine and Gambel oak with lodgepole dominating the eastern part of the property, aspen the central region and Gambel oak the western section (Fig. 3).

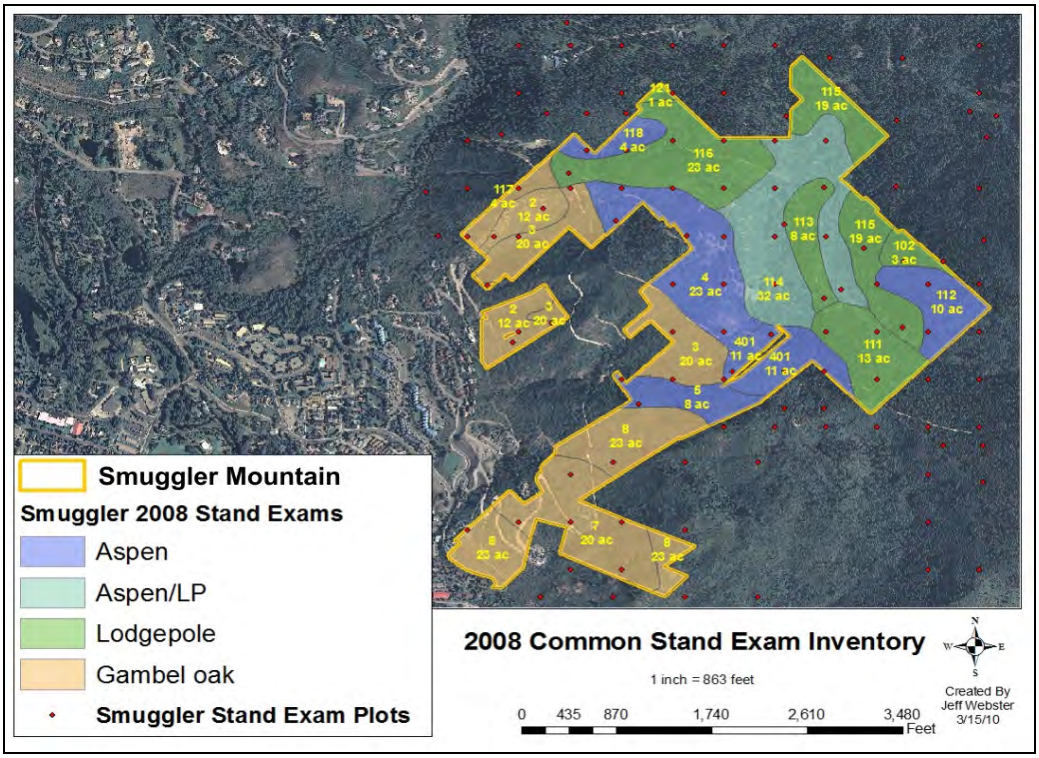


Figure 3. Common Stand Exam (CSE) stand types at Smuggler Mountain.

In terms of landscape cover, aspen is the most abundant species at Smuggler Mountain at 41% (Fig. 4). Most of the remaining cover is nearly equally divided between lodgepole pine and Gambel oak with each comprising slightly more than a quarter of the cover. Douglas-fir (1%) is a minor cover component while Engelmann spruce, ponderosa pine and subalpine fir (not shown in Fig. 4) are even less abundant. Disturbed areas and roads together comprise 4% of Smuggler Mountain cover.

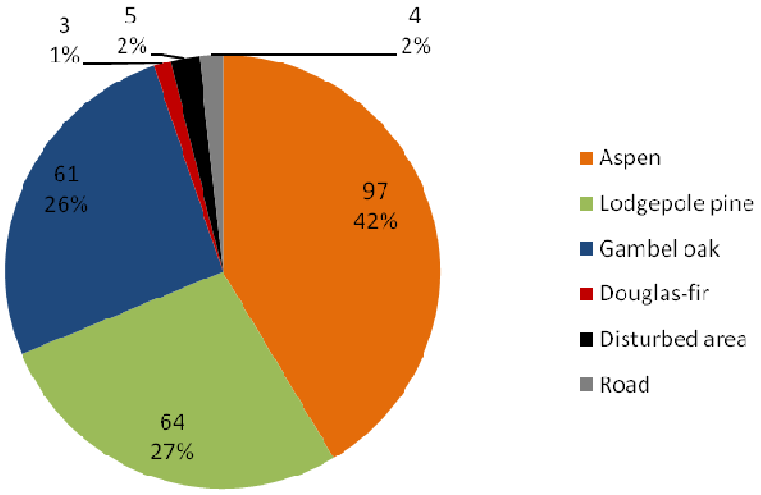


Figure 4. Abundance of combined vegetation types in 234 acres at Smuggler Mountain. This figure displays the acreage in each vegetation type and associated percentage of cover.

Tree species composition data is provided in Fig. 5. The most abundant species are aspen and lodgepole pine. Other minor species found are Douglas-fir, subalpine fir, ponderosa pine and Engelmann spruce. Blue spruce (*Picea pungens*) was rarely observed and not included in the analysis. It is important to point out that this analysis *excludes* the shrub-like Gambel oak found on a significant portion of the property. Although Gambel oak is the dominant cover in the western third of Smuggler Mountain, it is not included in this tree composition analysis due to its shrub-like characteristics. It does, however, provide further diversification of the Smuggler Mountain ecosystem. Tree and shrub species diversity is critical for maintaining healthy wildlife habitat and a sustainable forest as well as providing a wide variety of recreational settings.

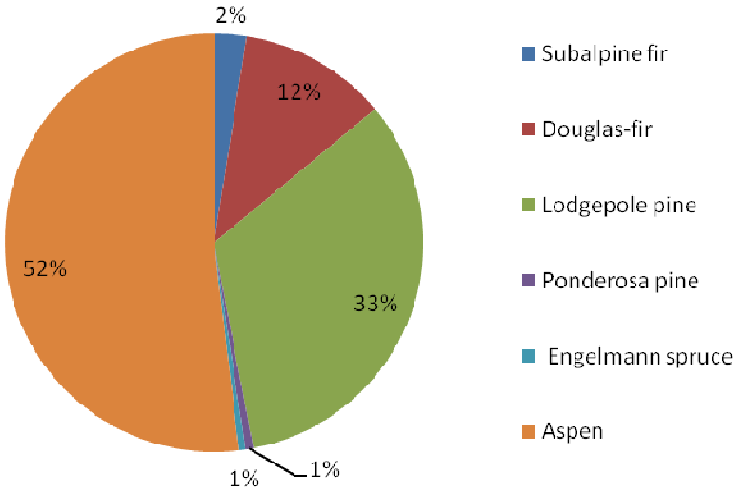


Figure 5. Tree species composition at Smuggler Mountain.

Analysis of tree species age class revealed a shortcoming of certain characteristics needed to meet the objectives for this forest management plan. The average age of the dominant tree species per stand ranges from roughly 90 to 120 years old. The current age distribution and ideal age distribution for lodgepole stands at Smuggler Mountain are shown in Fig. 6. The current distribution of lodgepole pine and aspen consists of old stands that are very susceptible to MPB infestation and SAD, respectively. The ideal age distribution for lodgepole would include trees from the ages of 0-150 years (trees older than 150 years are rare). For aspen a reasonable range is 0-100, for Gambel oak shrub 0-80 and Gambel oak tree 0-200. A forest with stands of wide age ranges will be more resilient to MPB infestation and SAD. Furthermore, increased age class diversity will provide better wildlife habitat.

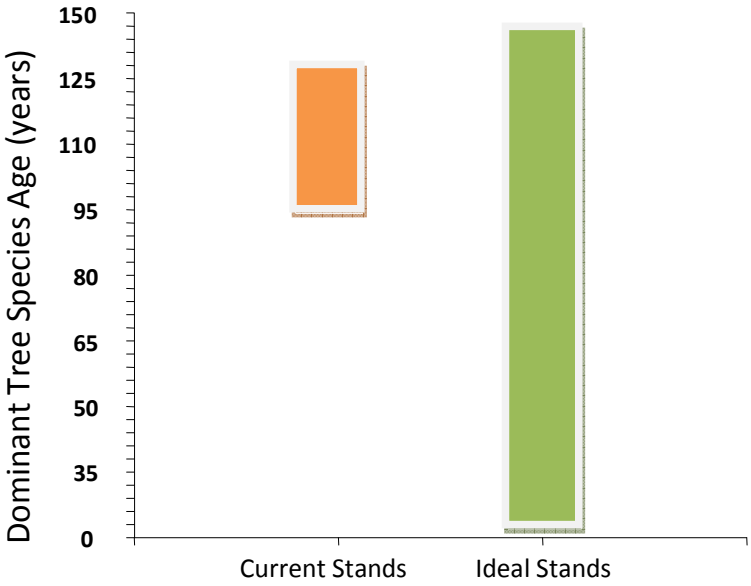


Figure 6. The box plot on the left represents the current age distribution of all stands at Smuggler Mountain. The box plot on the right represents an ideal age distribution for lodgepole.

One of the most important characteristics needed to understand growth dynamics of a forest stand is stand density. Stand density index (SDI) is a forest management tool created by Reineke (1933). SDI values are calculated from average trees per acre (TPA) and average DBH of a given stand. Each tree species has a unique biological maximum SDI. The maximum SDI for a given species is defined as the maximum number of trees of a given size that can occupy a site. Relative SDI is defined as "the number of trees actually in a stand divided by maximum number of trees of that average size that could exist" (Drew and Flewelling, 1977, 1979), i.e., how close the species in that stand is to its maximum density. Relative SDI can tell a forest manager many important characteristics of stand growth dynamics. For example, when the relative SDI reaches 15% the stand begins crown closure. When the relative SDI reaches 40%, trees begin to die, and at 55% extensive mortality is expected. At Smuggler Mountain, the ideal relative SDI for all stands should be below 40% (Peterson and Hibbs, 1989). Anything higher than this would be at high risk for tree mortality, MPB infestation (lodgepoles), SAD (aspens), and severe fire conditions.

Fig. 7 illustrates the current relative SDI for representative lodgepole and lodgepole/aspen stands at Smuggler Mountain. Most of the current stands are above or near the 40% relative SDI (assuming a maximum SDI = 650 for lodgepole pine), making them susceptible to poor forest health conditions. Fig. 7 also illustrates the projection of relative SDI after 50 years of growth. Note that the relative SDI for these stands would all be above the critical mortality initiation threshold of 55% by 2060.

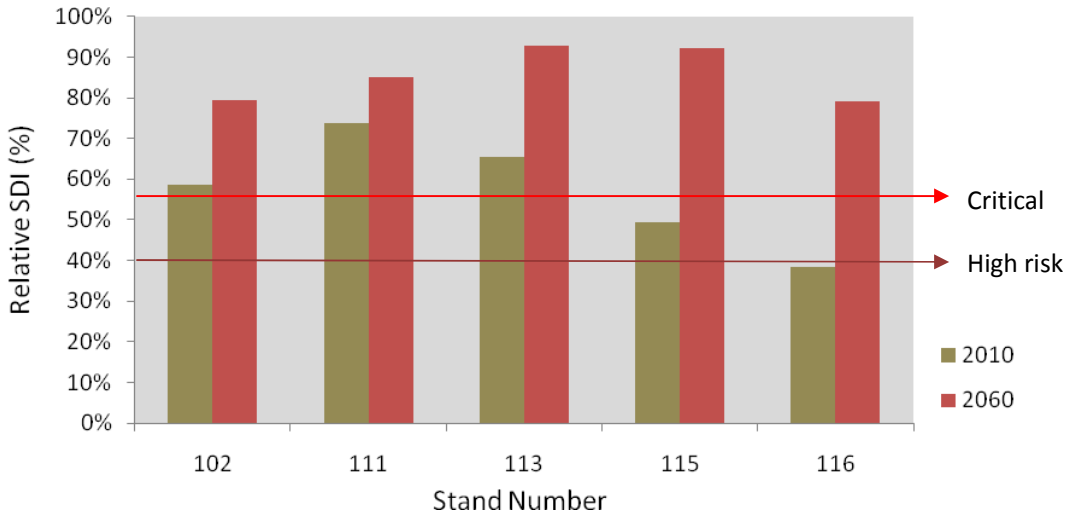


Figure 7. The relative SDI for representative lodgepole and lodgepole/aspen stands at Smuggler Mountain. The brown bars represent current relative SDI. The red bars represent relative SDI after 50 years of growth using FVS with a no-action management scenario.

The biological characteristics of aspen are different from lodgepole pine in regard to stand densities. Lodgepole pine has a maximum SDI of 650 whereas aspen has a maximum SDI of 725. This means that more aspen trees of a given size can occupy a site. However, the 40%

relative SDI rule is still true for aspen. The relative SDI for representative aspen stands on Smuggler Mountain is shown in Fig. 8. Currently, most stands are at or near the high risk relative SDI of 40%. Stand 401 is above the 40% high risk and stand 5 is currently above the 55% critical threshold. The FVS simulation after 50 years of growth, given a no-action scenario, shows that the relative SDI for each stand is far above the critical threshold of 55%. The aspen stands are at high risk to insect infestation and disease under this scenario. However, sufficient regeneration of aspen is present in every stand. This is a positive characteristic, suggesting that the aspen stands may be currently resistant to SAD. But high density stands like these will likely result in less regeneration in the future due to an increase in tree competition and subsequent mortality.

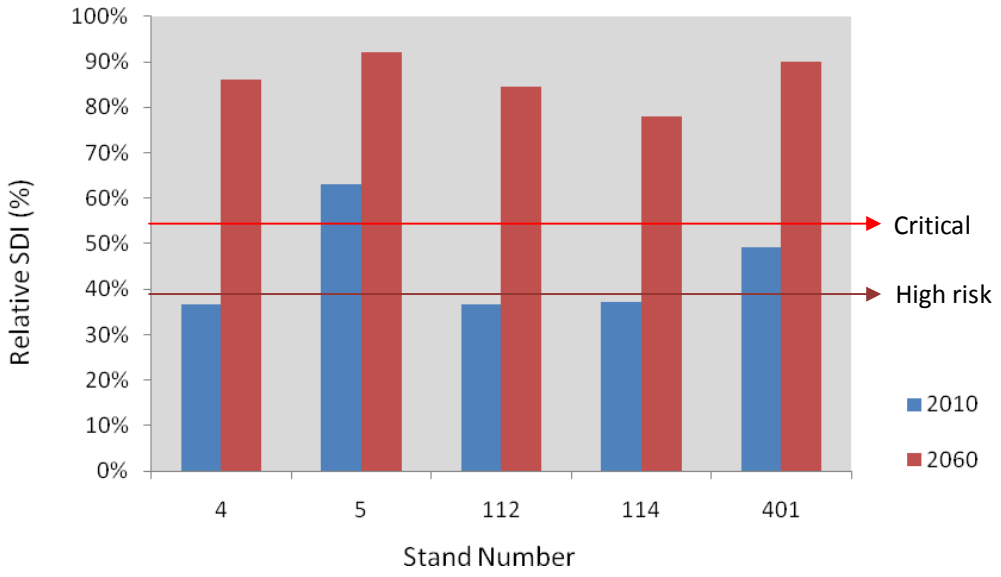


Figure 8. Relative SDI for aspens stands at Smuggler Mountain. The blue bars represent current conditions. The red bars represent relative SDI after 50 years of growth using FVS with a no action management scenario.

FVS has the option to produce visual images of stands that have been entered into the program using the Stand Visualization Simulator (SVS). SVS is unique because it has the ability to present a spatial effect within the images of the stands. This is a useful tool to represent the patchy nature of many stands at Smuggler Mountain. SVS analyses of current stands of lodgepole and aspen are shown in Figs. 9 and 10. The progression of images shows the current conditions and the conditions after 50 years of growth given a no-action scenario.

Fig. 9 illustrates several undesirable lodgepole forest conditions. Dense stands such as shown in Stand 111 do not allow for sufficient regeneration of lodgepole pine. Without regeneration, there is not a diversity of age classes within the stand. Again, a lack of age class diversity within lodgepole pine stands provides poor wildlife habitat and characteristics that are very susceptible to MPB infestation. Furthermore, the amount of fuel loading after 50 years of growth creates stands with extremely high fire risks. Under this scenario, a safe recreational setting also becomes increasingly difficult to obtain. Dense stands such as these produce many snags resulting in numerous hazard trees that would need to be removed in high use recreational areas to protect public safety.

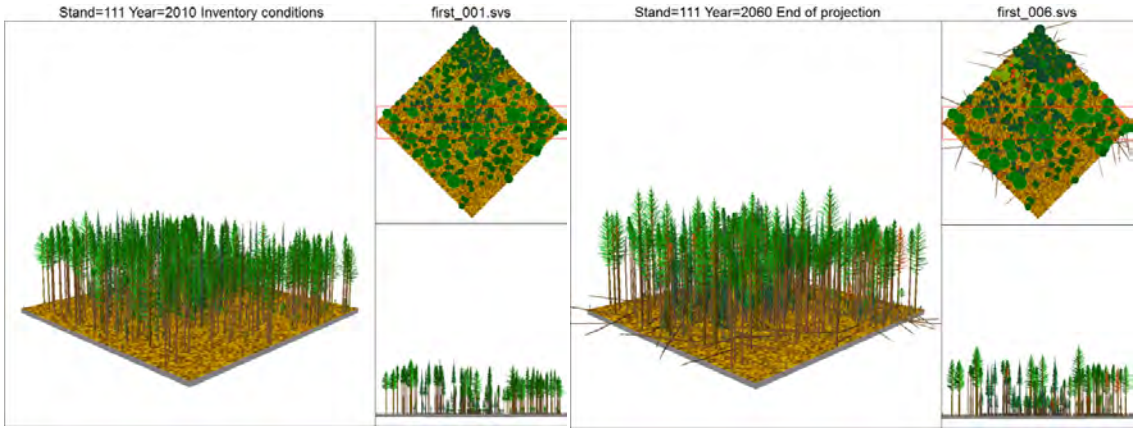


Figure 9. Stand Visualization Simulator (SVS) images of a representative lodgepole stand at Smuggler Mountain. The images on the left represent current conditions and the images on the right represent 50 years of growth projected by FVS. All images were produced with a spatial effect that illustrates the patchy nature of stands at Smuggler Mountain.

The aspen stands currently seem to be in decent condition. A typical aspen stand on Smuggler Mountain is shown in Fig. 10. There is a considerable amount of regeneration of aspen. This is a positive attribute that indicates the aspen stands are not currently experiencing SAD. However, the image of the aspen stand after 50 years of growth reveals conditions susceptible to SAD. Aspen require regular disturbance which keeps root structures vigorous and healthy by initiating regeneration through sprouting. Under a scenario without any active management such as prescribed fire, manual thinning, or root ripping, the aspen stands may be at severe risk to SAD.

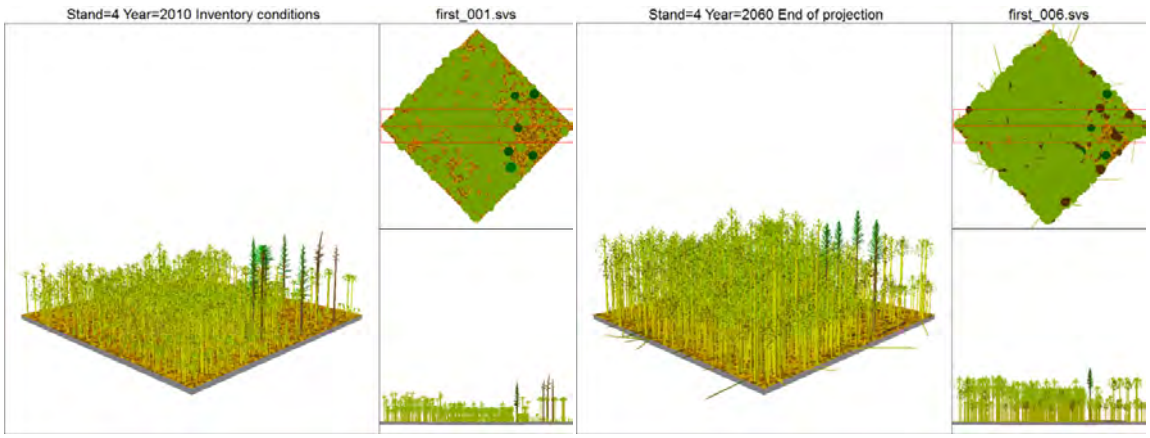


Figure 10. Stand Visualization Simulator (SVS) images of a representative aspen stand at Smuggler Mountain. The images on the left represent current conditions and the images on the right represent 50 years of growth projected by FVS. All images were produced with a spatial effect that illustrates the patchy nature of stands at Smuggler Mountain.

The above SVS images give a good representation of the unstable nature of many stands on Smuggler Mountain. Without any active management, many stands will remain in (or grow into) poor health conditions.

According to the Smuggler Mountain biological resources report (Colorado Wildlife Science and WP Natural Resource Consulting, 2008), the Gambel oak stands are in good to excellent condition. However, the report also states that Gambel oak communities are dependent on recurring fires to eliminate competing vegetation and initiate regeneration. Initial analysis from the CSE data reveals that the Gambel oak stands are very mature and are near the end of their life cycles (60-80 years). Without proper disturbance factors that mimic natural fire regimes, the condition of these stands will begin to degrade. A strategic management plan is needed to improve the condition of Gambel oak communities at Smuggler Mountain which, in turn, will improve wildlife habitat and overall forest sustainability.

3.2. Fuels condition

As one travels up the Roaring Fork Valley, the historical fire frequency gets longer because of lower temperatures and greater moisture levels at higher elevations. Fire frequency varies by fuel type (i.e., vegetation type), elevation and aspect. Historical fire frequencies for major vegetation types on Smuggler Mountain are 5-15 years for Gambel oak, 7-50 years for aspen, and about 100 years for lodgepole pine.

Fire suppression over the last 100 years or more has significantly altered the current fire behavior due to build up of fuels. Western fires are not as frequent but are burning with much greater intensity and creating more severe impacts on soils and watershed values. With increasing development in the Wildland Urban Interface (WUI), risk to infrastructure is increasing and making fire fighting more difficult and expensive. In the case of Smuggler Mountain and other forested areas around Aspen, the last major fire was probably associated with Indian activity and/or mining in the mid to late 1800's. As a result, the fuel load at Smuggler Mountain is high in all stands. Data gathered with the CSE inventory shows surface fuels ranging from 26-32 tons per acre and total fuel loading ranging from 62-128 tons per acre for aspen and lodgepole stands (see Appendix A for data). Combining these data with the Colorado Front Range Fuel Photo Series (Battaglia et. al, 2005) which verifies the aspen and lodgepole fuel loads, it is clear that all stands are in a high fire load condition. This also includes the Gambel oak stands.

From an ecological view, both aspen and gambel oak are considerably out of synchrony with historical fire disturbance frequencies. The lodgepole pine stands are at an age where fire can be expected, usually coinciding with mountain pine beetle mortality and associated fuels build up. With fuel loading high and property values high, it is important that dialogue continues with the appropriate fire protection district managers and local emergency services directors to develop specific plans for the protection of property and natural resources on Smuggler Mountain. Integration of the operational objectives of local fire protection plans and this forest management plan would be the desired goal. Primary guidance for this should be provided by those managers responsible for fire protection in the area after their review of the fuel loading data provided in this plan.

4. Short-term management recommendations

4.1. Lodgepole pine

The most important short-term priority is to create conditions that will lead to the eventual regeneration of a healthy, multi-aged forest ecosystem to replace the late seral trees that dominate existing lodgepole stands as they die. Considerable progress has been made over the past two years improving stand health with sanitation silviculture, using a combination of MPB brood tree removal and verbenone (MPB pheromone) treatments. Now that the local MPB population has been reduced by these treatments, it is time to improve the age class diversity of the landscape with small harvests designed for both wildlife habitat improvement and forest regeneration. Continuing these treatments in combination with strategic site-specific harvests will have a concomitant positive benefit to wildlife species that thrive in conditions that provide increased understory vegetation, such as deer, grouse and small mammals.

Mountain Pine Beetle Management

The first step is to remove lodgepole pines infested with MPB i.e., brood trees. In addition to reducing the risk of further MPB infestation and reducing fuel load, brood tree removal (BTR) can create openings within forest stands which will facilitate regeneration of lodgepole and other trees. The value of BTR is discussed in Gillette et al., (2010 and 2011). The 2011 final report from the 2010 Smuggler Mountain study is included as Appendix B to this report. Risk of attack by MPB is 40 times higher near brood trees (Gillette, et al. 2010).

The topography of Smuggler Mountain was analyzed in order to determine the appropriate logging methods needed to remove brood trees. Typically, on slopes less than 35%, ground-based logging operations are feasible. Slopes greater than 35% require more costly operations such as helicopter logging. The topography at Smuggler Mountain reveals that there are areas where both ground-based and helicopter logging are needed in order to remove known brood trees (Fig. 11). Brood trees in the "ground-based dependent" category could be logged by skidders downhill and transported off site via access from the adjacent landowner. If permission to access the adjacent property is denied, then helicopter logging is the only other feasible alternative.

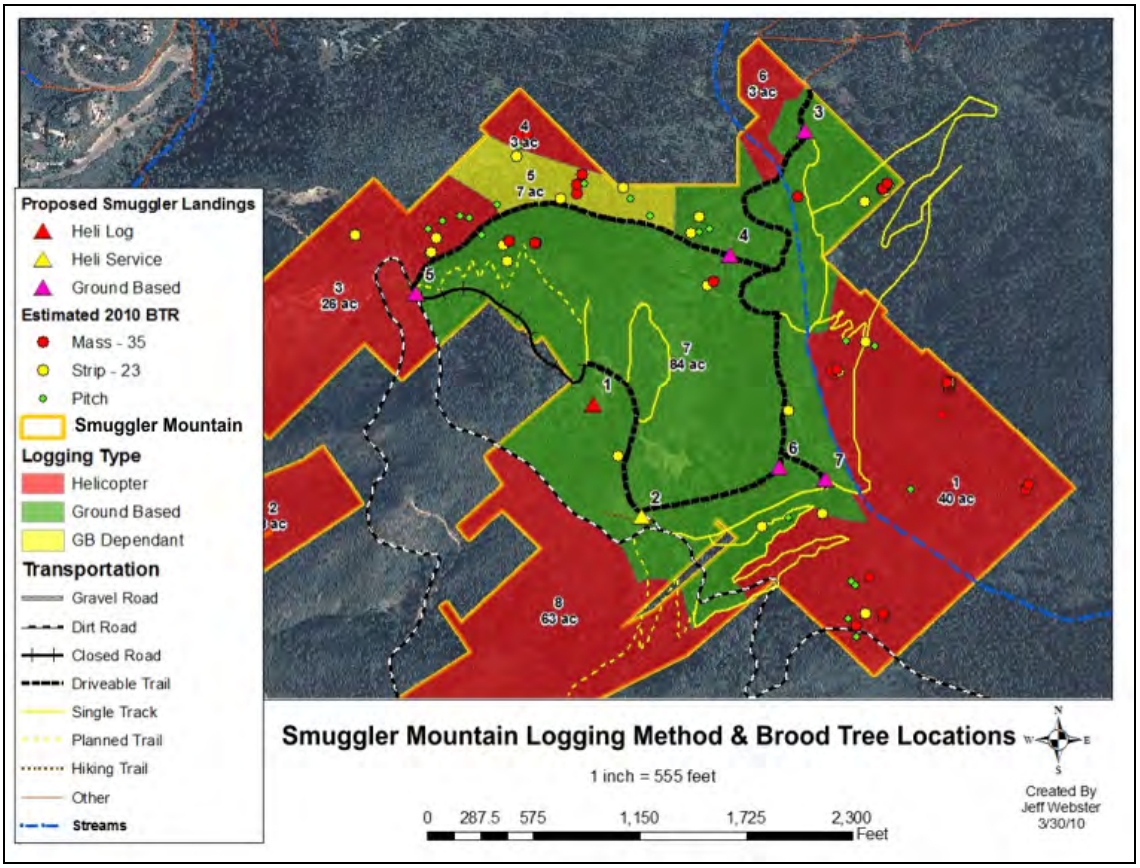


Figure 11. Potential logging methods and known brood tree locations at Smuggler Mountain

The second important step to facilitate control of MPB is the application of verbenone. Gillette et al. (2010), in their final report from the 2009 Smuggler Mountain study, reported that plots treated with brood tree removal and verbenone flakes applications had a 71% greater reduction in attack rates from the previous year, and the plots treated with verbenone pouches had a 59% greater reduction. This difference between the flakes and pouch treatments was not statistically significant. The results from this study suggest that both verbenone treatment methods in conjunction with brood tree removal provide significant protection from MPB attack, in the range of 60-80% over untreated stands.

Verbenone treatments should be applied along with brood tree removal in order to reduce lodgepole pine mortality when MPB populations are elevated (about 1% and increasing). The studies by Gillette et al., (2010 and 2011) recommend that verbenone pouches be installed evenly throughout the site in a grid-like fashion at a rate of 300 grams/acre. Use of bio-degradable verbenone flakes is another option. Due to the relatively low MPB infestation rate on Smuggler Mountain, and based on conversations with several entomologists, the recommended application rate is 210 grams/acre. Each pouch contains 7 grams, meaning that 30 pouches of verbenone need to be applied evenly to each acre at Smuggler Mountain. When MPB populations are very low and wet seasonal weather (above "normal" precipitation) conditions prevail increasing tree resistance to MPB attack, application may be eliminated or reduced. To minimize costs, lower rates of verbenone (to 140 grams per acre) and/or reduce acres treated to the immediate vicinity of host species. Applications of verbenone in 2009 and 2010 included a small “buffer zone” at the periphery of the verbenone treatment areas where the pheromone was also applied. Where possible, buffer zones are recommended as they increase the efficacy of the airborne pheromone by mimicking natural dispersal patterns. On Smuggler Mountain, many of these buffers were in aspen stands. Additionally, based on treatment experience in the area, it is possible that the buffer zone area could be reduced such that only about 80 acres would require verbenone (as compared to about 121 acres currently being treated). Rates of application could also reduced depending on MPB populations. Given fluctuations in the availability of economic resources on a yearly basis, these strategies could significantly reduce verbenone treatment costs.

The timing of the application of verbenone is critical. Pouches or flakes should be installed on the site as early as the third week of June, but should be in place no later than the second week of July, before the peak of MPB emergence. A map of verbenone application for 2010 (121 acres) is shown in Fig. 12.

The need for brood tree removal and verbenone application will be an annual decision based on yearly monitoring of beetle attacks each fall, along with antecedent winter weather in conjunction with landowner objectives and available economic resources. When the beetle pressure within and outside the Smuggler Mountain area falls to endemic levels then treatment may cease. Epidemic levels are considered when MPB caused mortality approaches 1% or more of host trees (Weatherby and Thier, 1993). With the age and density of trees on Smuggler Mountain, annual monitoring is recommended to catch any increases in activity due to drought or other stress and treat it before an infestation can get out of control. It is suggested by verbenone vendors that using verbenone with populations

over 15% will provide poor results, unless all infested trees are removed prior to application (Kegley & Gibson, 2009).

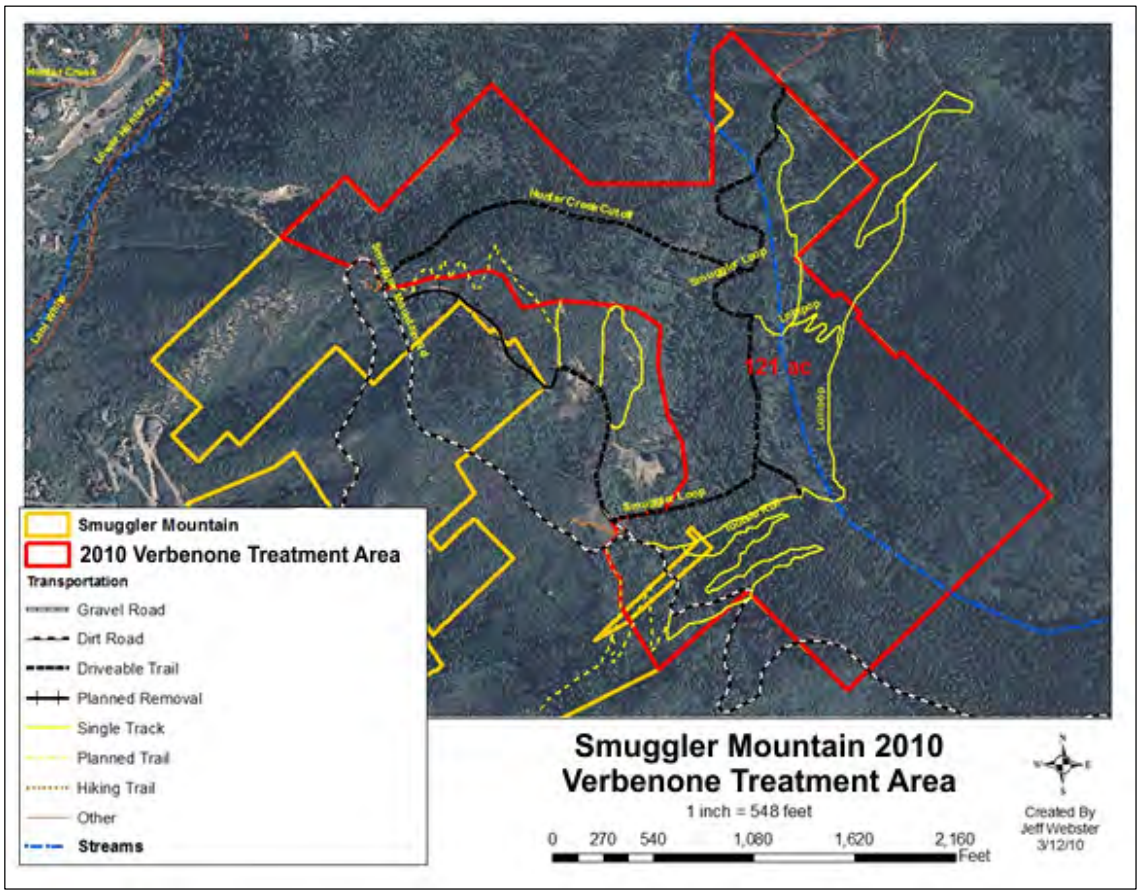


Figure 12. 2010 verbenone application area.

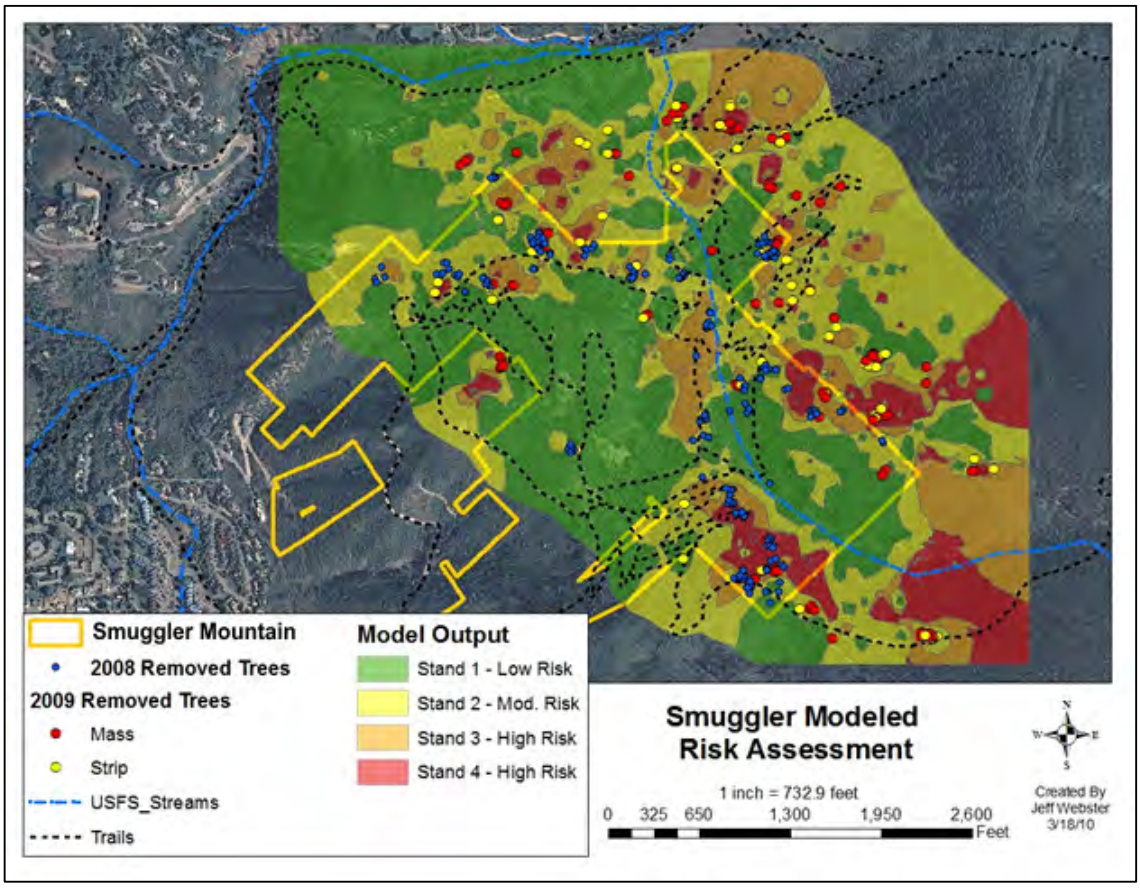
Initiation of lodgepole regeneration

The initiation of conifer regeneration is the next step in the short-term management plan. As discussed earlier, the age class distribution at Smuggler Mountain is poor (see Sec. 3.1, Fig. 6). The purpose of regeneration is to create new stands of conifers that will eventually replace old dying stands. Variable retention silviculture is recommended to facilitate regeneration and retain important structural elements for wildlife. With this method small openings are created to provide adequate sunlight for shade intolerant species (lodgepole, aspen and Douglas-fir) to grow properly while leaving snags and large woody debris for wildlife habitat. Increased age class diversity will increase wildlife diversity as a result of increased habitat diversity.

Lodgepole pine stands at Smuggler Mountain have been analyzed in conjunction with data from Gillette et al. (2010) using the USFS Westside Pine Beetle Model (Randall and

Tensmeyer, 2000) (Appendix C) to determine areas that are at the highest risk of MPB infestation (Fig. 13).

Figure 13. Risk assessment of MPB infestation based on 2009 data (Gillette et al., 2010).



Units have also been analyzed in regard to recent MPB activity, which has resulted in many dead lodgepole pines throughout Smuggler Mountain and adjacent properties. The combination of areas with high risk MPB infestation and recent MPB activity were the basis for prioritizing sites for regeneration efforts (Fig. 14).

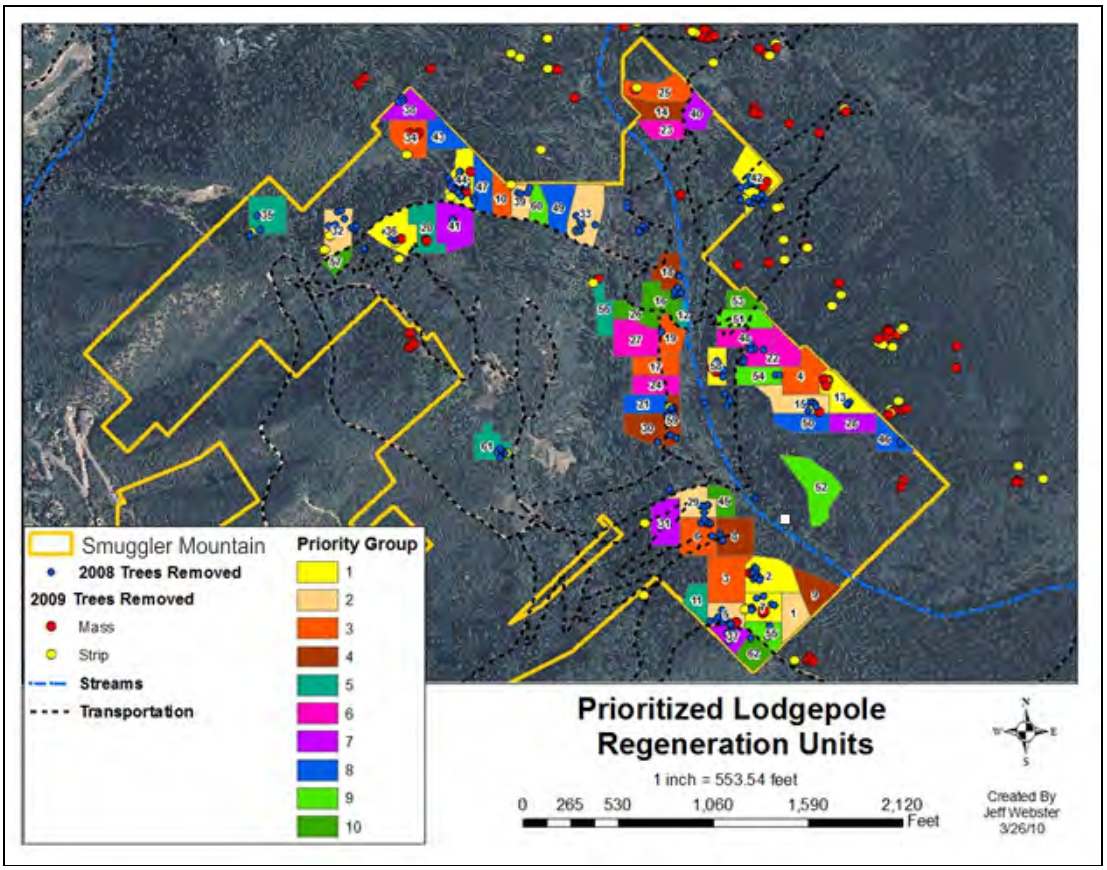


Figure 14. Suggested plan for conifer regeneration. Blue dots are brood trees removed in 2008. Red and yellow dots represent MPB attacks in 2009.

First, the regeneration efforts need to be aimed at the most recent areas of mortality. After regeneration efforts have been completed on sites with recent mortality, other sites need to be systematically regenerated over time. This can be accomplished either as mortality occurs or by scheduled harvest of green trees in high risk areas in order to consistently produce stands with a wide variety of age classes.

Ideally, each prioritized group should be regenerated with conifers each decade depending on site specific conditions. Specific prescriptions for each site should be made to take into consideration existing regeneration and brush competition while adhering to adaptive management principles. Depending on MPB activity, other units may need to be regenerated immediately following tree mortality from MPB. However, the combination of brood tree removal and the timely application of verbenone when MPB populations are elevated has reduced the threat of MPB infestation. In this case, the suggested prioritized regeneration units in Fig. 14 may be the best plan for regeneration, otherwise prioritization can be modified as mortality occurs. Appendix D contains a map and detailed list of suggested lodgepole pine units to be regenerated each decade.

Prior to regeneration of conifers in each unit, sufficient site-preparation activities need to occur to provide bare mineral soil. Traditional methods involve some form of mechanical,

fire or chemical treatment. For the first year of planting, a variety of site-preparation tactics should be tested to determine the best strategy for successful regeneration. The following is a sample of ideas for prescriptions for conifer regeneration at Smuggler Mountain.

1. Experiment with site scarification using a combination of methods. Potentially burning hand piles, under burning, grubbing only, mechanical scarification on flatter slopes, perhaps spraying only, and spraying and grubbing to determine the most effective methods. Knowing that spraying can be a highly controversial topic, it is suggested as experimentation to develop alternatives in the spirit of adaptive management. Burning may be controversial also due to concerns with liability and air quality. Grubbing should be done at least two months after spraying (spraying should ideally be done the year prior to fall planting). Bottom line is to have successful regeneration scarification (disturbance). Scarification needs to be done in time for seed fall by the end of August and planting in September.
2. Prepare (scarify) 200 planting spots per acre with 15' by 15' centers utilizing 4-foot radius circles.
3. Plant 2 to 4 species per planting area to increase species diversity. Lodgepole pine and Douglas-fir should be the primary species planted. Engelmann spruce and subalpine fir are prolific seeders and should regenerate naturally.
4. Conduct stocking surveys in August of the following year in order to examine which scarification method works best and which species survived the first year.
5. Conduct a pre-commercial thin between years 10 – 15 (tree heights 5 – 15 feet) leaving only one tree per planting area. There should be a total of 200 TPA following pre-commercial thin. Retained species depends on landowner goals, in this case to maximize diversity.

It must be recognized that the removal of brood trees may not create the proper conditions to initiate regeneration of young conifer stands. Additional trees may need to be removed to provide the biological conditions needed for proper conifer growth. A sample prescription of variable retention silviculture at Smuggler Mountain is presented below.

1. Remove a sufficient number of trees around pockets of recent mortality to create a minimum opening of 0.75 acre in size (York, et. al., 2007). This will allow sufficient sunlight for natural regeneration or newly planted seedlings.
2. Retain snags and coarse woody debris for wildlife habitat where appropriate.
3. Retain a sufficient number of tree species in order to improve species diversity.

An FVS analysis was run on two representative lodgepole stands with a potential MPB attack scenario to determine vegetation responses in the absence of management (Fig. 15). The analysis predicts that the two stands will experience mortality from MPB within the next ten years. The resulting vegetation response over the next 50 years provides poor wildlife habitat, unsustainable forest conditions, increased wildfire risks and numerous hazard trees which may impair recreational activities. It is clear that a no-action scenario with a MPB attack does not meet the management objectives.

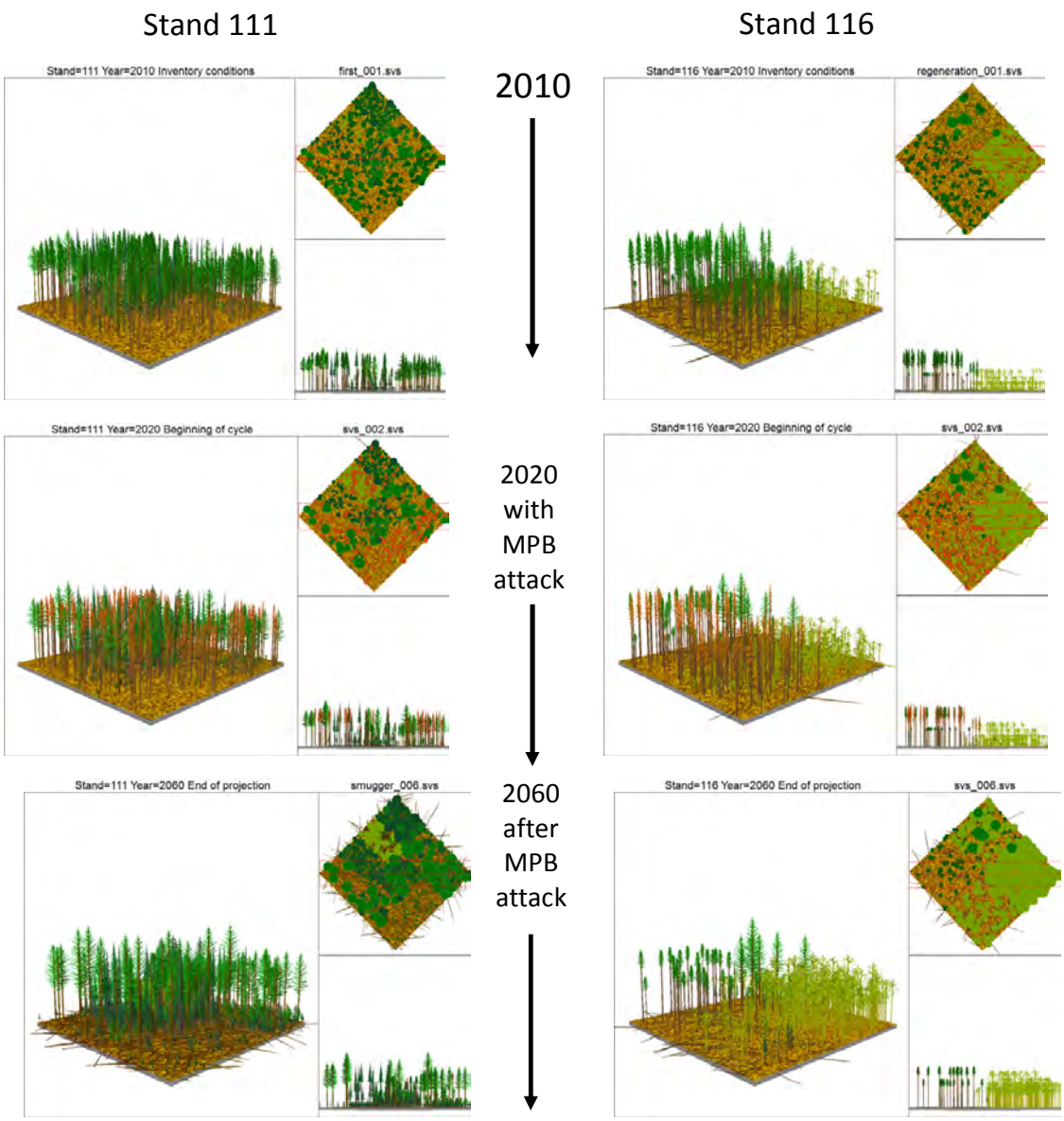


Figure 15. A MPB attack of two representative lodgepole stands at Smuggler Mountain are simulated over 50 years under a no-action management scenario. Note that each stand displays undesirable forest conditions after 50 years of growth. Remaining live trees are still in excessively dense stands and the fuel loading remains high, increasing the wildfire risk.

FVS simulations with active management described earlier show more desirable future forest conditions that will improve wildlife habitat, reduce MPB threats, remove excess fuel loading and replace older conifers with young vigorous conifers (Fig. 16). Active

management will also reduce the formation of hazard trees, providing a safer recreational setting.

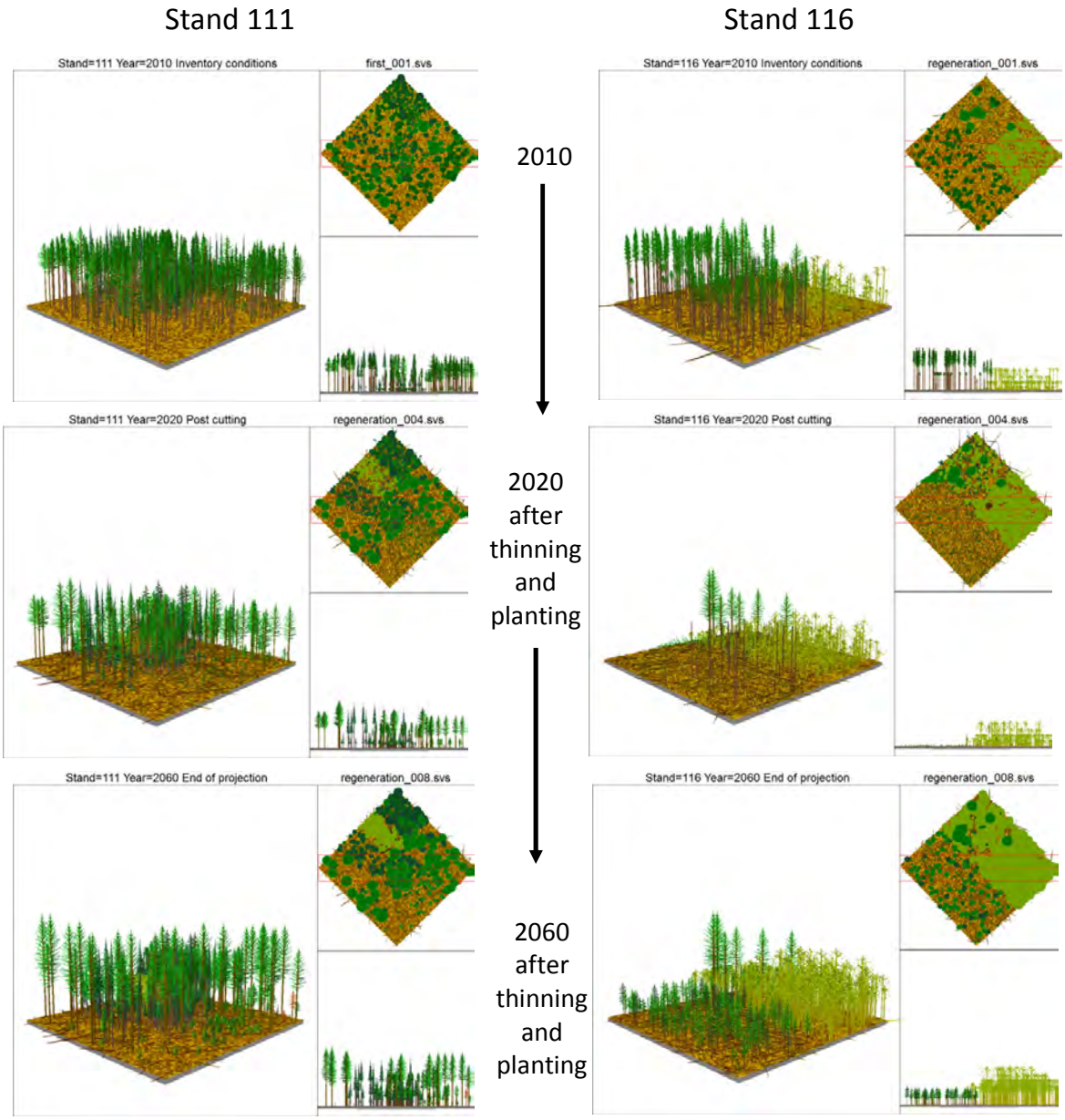


Figure 16. Two representative lodgepole stands with active management are simulated over 50 years. With this scenario, the objectives of creating a diverse age class of forest, improving wildlife habitat, reducing fuel loading and providing for a safer recreation area are met.

Along with initiating regeneration to provide a distribution of young stands of conifers, efforts need to be made to protect some old stands as well, thereby expanding age class diversity on both ends of the age class spectrum. There have been some areas identified that contain large old lodgepole pine. Units 16, 26, 27, and 45 contain old lodgepoles that

are at moderate to high risk for MPB. The areas north of unit 16, 26, and 29 also contain some old lodgepoles that are at low risk of MPB infestation. These trees are growing on sites where the soil is very deep and has the ability to retain sufficient moisture to promote a long life span. However, to maintain the life expectancy for these trees, other trees in the near vicinity may need to be removed to reduce density. A reduction in stand density has been shown to reduce the threat of MPB to trees that are larger than 16" DBH (personal communication, Nancy Gillette and Sylvia Mori, 2010). Efforts to protect and nurture old large trees will help create an age class distribution on Smuggler Mountain that meets the objectives of this management plan.

4.2. Aspen

Discussion so far has been focused on the lodgepole stands because of the current MPB infestation, but aspen is the dominant vegetation type on Smuggler Mountain as discussed in Section 3 (see Fig. 4). Aspen is the most widely distributed tree species in North America and a key indicator species for monitoring ecosystem health. With the exception of riparian areas, aspen communities are considered the most biologically diverse ecosystems in the Intermountain West (Kay, 1997). However, as aspen dominated stands convert to other cover types, tremendous biodiversity is lost (Bartos and Amacher, 1998).

Characteristics of "properly functioning" aspen stands usually include multi-aged stems in a stand, adequate regeneration to perpetuate the stand, age classes mostly less than 100 years old and good undergrowth beneath the canopy (Campbell and Bartos, 2001). Many aspen stands on Smuggler Mountain (based on inventory and observation) appear to be in good condition overall. But some stands are showing one or more of the risk factors cited by Campbell and Bartos (2001):

- Conifer cover (understory and overstory) greater than 25% (particularly subalpine fir and Engelmann spruce)
- Aspen cover less than 40%
- Dominant aspen trees greater than 100 years old
- Aspen regeneration less than 500 stems per acre (5-15 feet tall)
- Sagebrush cover greater than 10%

Risk factors for Sudden Aspen Decline (SAD) according to Worrall (2008) include:

- Predisposing factors - low elevation, south to southwest aspects, low density and stand maturity
- Inciting factors - warm drought conditions
- Contributing factors - insects and diseases, excessive browse

The major risk factors present in the Smuggler Mountain aspen stands are low elevation, southwest aspect, age greater than 100 years (mature stands) and browsing. Since there does not appear to be any current mortality occurring, the recommendation is to do further evaluation of the aspen stands to determine and then rank risk. The map in Fig. 17 presents

units for evaluation and the initial priority for treatment based on field observations of risk factors.

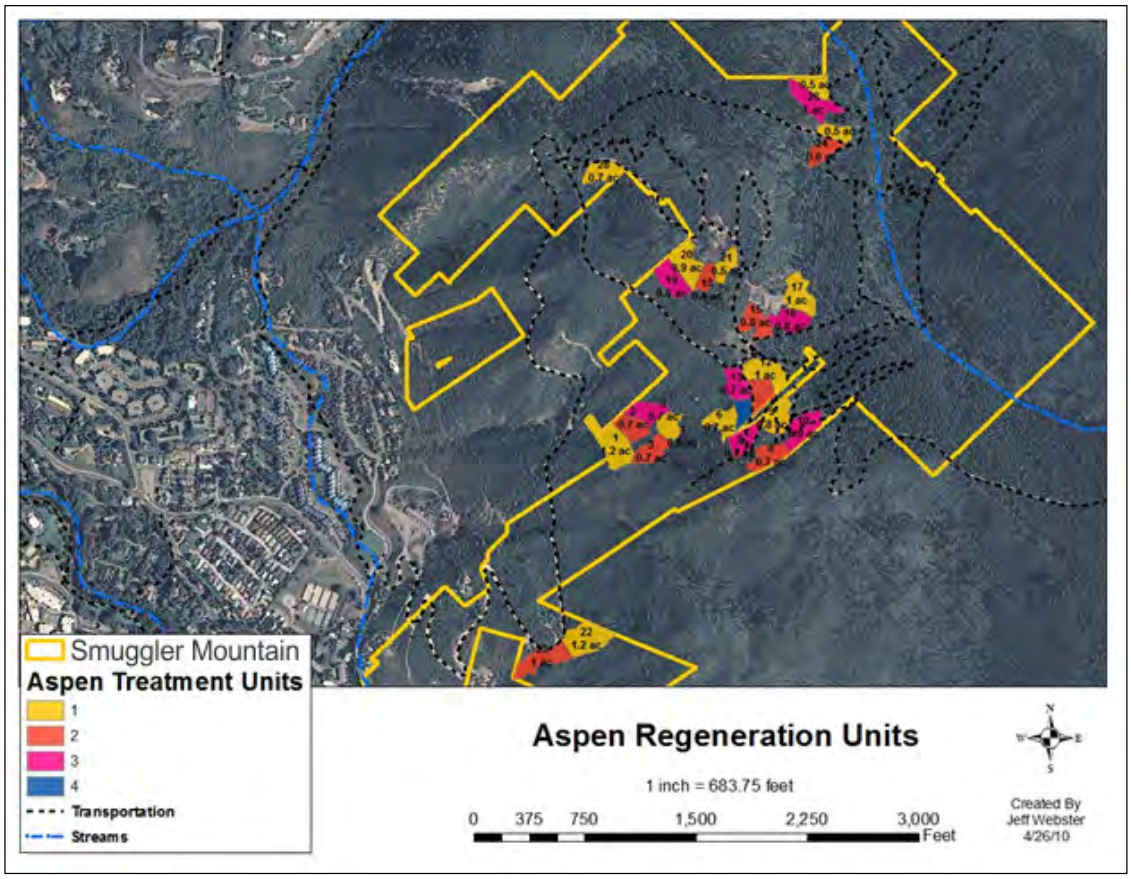


Figure 17. Aspen regeneration units on Smuggler Mountain color coded by proposed priority of treatment.

Once the stands are evaluated and ranked for risk, prescriptions need to be developed. Successful vegetative regeneration of aspen is dependent on three key components: hormonal stimulation, growth environment and protection of resulting suckers (Shepperd, 2001) as represented in the "aspen regeneration triangle" (Fig. 18).

Figure 18. The aspen regeneration triangle management decision model (Shepperd 2001).

To get the proper hormonal stimulation for sucker production, an aspen must be killed by burning or cutting to interrupt the auxin flow from stem to roots. The preferred environment for regeneration is achieved by the removal of competing vegetation to provide for warm soil conditions that will stimulate growth. Protection is guarding against over-browsing by livestock and wild ungulates.

In order to induce and support aspen regeneration, several manipulation techniques are available (Shepperd 2001):

- Doing nothing if aspen clones appear healthy
- Commercial harvest
- Prescribed fire
- Mechanical root stimulation
- Removal of vegetative competition
- Protection of regeneration from herbivory (fencing)
- Regeneration from seed
- Combination of techniques

To be successful, a manipulation technique must meet the three requirements of the aspen regeneration triangle, be cost effective and technically feasible. The most effective prescriptions usually involve a combination of the above techniques in conjunction with proper identification of stands to be treated, the risk factors, operational limitations and objectives. The most commonly used methods are fire and harvest. Exclusion of fire over the last century has had the effect of eliminating the disturbance aspen needs to regenerate. Air quality and liability issues are potential limiting factors on the use of fire. In some stands slope will limit harvest treatment options.

Aspen is an even shorter lived species than lodgepole pine. The stands on Smuggler Mountain are getting old, so regeneration of stands identified at risk needs to begin. Although the aspen stands are in good condition presently, the risk of SAD is on the horizon.

The recommendation is a monitoring program be designed to watch the stands and work with researchers to find solutions to the problem. Like with the lodgepole stands there are indications that more disturbance is needed to instigate regeneration in older aspen stands. With the lack of fire the aspen has not had the disturbance needed to regenerate.

The units identified in Fig. 17 represent 22% of the aspen stands on Smuggler Mountain. Knowing that maturity of aspen is about 100 years, a reasonable approach would be to treat 10% of the aspen stands on Smuggler Mountain each decade (Appendix E). The stands identified represent potential units for the first two decades.

Some sample treatments for aspen regeneration are listed below recognizing that each stand has different associated physical and biological circumstances:

- Lightly under-burn in the spring or fall (which is ecologically preferred). Hand piles are not an option since piles kill roots.
- Harvest and remove trees along with removal of competing vegetation.
- Stimulate roots around meadows.
- Remove conifers around the edge of aspen stands.

4.3. Gambel oak

Gambel oak is a significant vegetation type on Smuggler Mountain, representing 26% of the cover- nearly equivalent to the lodgepole cover (27%). Gambel oak is often just one component of what is considered the "Mountain Shrub Plant Community", for this document Gambel oak should be considered as "Mountain Shrub". Some other species often associated with the mountain shrub community include: serviceberry (*Amelanchier spp*.) and mountain big sage (*Artemisia tridentiata var vaseyana*). Treatment of these other species will be appropriate to their individual biology. Gambel oak provides important wildlife habitat throughout its central and southern Rocky Mountain range. Its importance stems from two things: the varied growth forms it exhibits and the different habitat values (brush and understory grasses and forbs) that are produced by the different growth forms (Druse 1992, Lesh 1999, Rosenstock 1998; as cited in Abella 2008). To understand how best to manage this hardwood species both of these factors must be considered (Abella 2008). Gambel oak adds valuable species diversity to the landscape by increasing soil fertility, understory species richness, wildlife diversity and watershed protection on steep slopes.

Prior to fire exclusion in the late 1800's, Gambel oak experienced frequent fire at less than 10 year intervals. Fire history studies have shown that prior to fire suppression, many Gambel oak stands burned on the average of every 4-17 years (Abella and Fule 2008). Similar to ponderosa pine forests, fire exclusion and the subsequent increase in small stems has resulted in declines in native plant abundance, ecosystem simplification, inferior wildlife habitat for some species and susceptibility to intense wildfire in Gambel oak communities (Abella, 2008). Even with natural cycles of burning, Gambel oak demonstrates only low to

moderate resistance to fire, being labelled both a resister (by survival of some large oaks) and an endurer (by re-sprouting) after fire.

Gambel oak is classified into three growth form categories based on various tree and clump characteristics. These classifications are generally recognized as shrubby thickets of small stems, clumps of intermediate-sized stems, and large mature trees (Abella 2008). These different life forms, diameters and heights of oak provide tremendous habitat diversity for wildlife species. But under the current conditions created by the exclusion of fire, the habitat is not nearly as diverse as it has been historically. Gambel oak now exists in an environment much different from the species' evolutionary environment of open stands and frequent fire. It would be of great benefit to the overall ecosystem at Smuggler Mountain to manage Gambel oak in order to achieve a wider range of variability that is more consistent with its natural history.

In summary, different ages and growth forms of the trees in Gambel oak stands produce different habitat values. No single oak stand condition provides optimal habitat for all wildlife species. Consequently, the key to maintaining a wide diversity of wildlife species is to manage the Gamble oak stands to maintain a diversity of oak age-classes and growth-forms.

For holistic ecosystem management of wildlife communities, oak management strategies may include the following:

1) Conserving all existing large, old oaks (Ganey and Vojta 2004).
2) Maintaining a variety of oak growth forms including shrub-thicket forms (Rosenstock 1998).
3) Cutting and burning small- and medium-sized oaks to promote growth form diversity where desired (Abella 2008).
4) Managing oaks within an ecosystem context that includes treatments promoting vigorous plant communities, healthy soil processes and overstory tree structures reasonably consistent with evolutionary environments of pine-oak forest wildlife communities (Neff et al. 1979).

The major management priorities for the Gambel oak communities on Smuggler Mountain are the improvement of wildlife habitat and the reduction of fire risk to the City of Aspen. Fortunately, managing for these two objectives is very compatible.

Manipulation of Gambel oak to improve wildlife habitat involves increasing diameter growth, changing density, increasing age class diversity and managing growth forms. Management prescriptions for promoting different oak growth forms include:

- Thinning clumps and protecting large trees.
- Allowing natural thinning in intermediate clumps.
- Thinning small clumps to promote pole size material.
- Cutting and burning brush thickets to facilitate sprouting.

On Smuggler Mountain Gambel oak is mostly in the shrub form, but on some of the northwest aspects it does exist in the tree form. Specific management prescriptions involve different treatments for the tree and shrub forms of the oak in addition to maintaining big sage habitat that is scattered within the Gambel oak stands on Smuggler Mountain. To incorporate the primary wildlife objectives with wildfire protection, these prescriptions should be applied within the context of "strategically placed area treatments" (SPLATS) on the landscape (Turner et al. 1989, Finney 2001, 2002 and 2004). The idea of SPLATS is to slow a fire down and thereby improving chances of control. A minimum of 20% of a landscape needs to be in this condition to be effective with the optimum being 50%. Using SPLATS to manage Gamble oak stands will perpetuate a diversity of age-classes (and growth-forms) to increase wildlife diversity. This approach will provide both acorns from older trees left and by sprouting from cut stumps. Any disturbance (e.g., cutting or burning) results in vigorous sprouting. This approach is very similar to what the USFS is proposing in the Aspen-Sopris Wildlife Habitat Improvement Project.

To accomplish this goal, landscapes with Gambel oak should be managed so that young, moderate-age, and older-age stands are perpetuated. This involves a regular program of stand disturbance, so that some patches re-sprout as shrub-growth forms. Other stands may be thinned, to help enhance stem growth and the rate they develop into small and large tree growth forms. Finally, older oaks should be protected from disturbance so as to retain their unique acorn- and cavity-production attributes. This active management strategy will result in a wide mix of habitats that provide cover, forage, and nesting opportunities for a large diversity of wildlife species, in a long-term sustainable manner.

Fig. 19 demonstrates the concept of SPLATS as applied to the Gambel oak vegetation type on Smuggler Mountain. The map shows the locations of permanent fuel breaks which will comprise 27% of the current Gambel oak landscape as illustrated. The balance will be implemented on an 80-year rotation, treating roughly 5 to 6 acres (9 to 10% of the oak type) per decade. With this plan, in any given decade, approximately 35% of the landscape would be in a relatively low fuel load condition. Fig. 19 can be seen in full in Appendix F

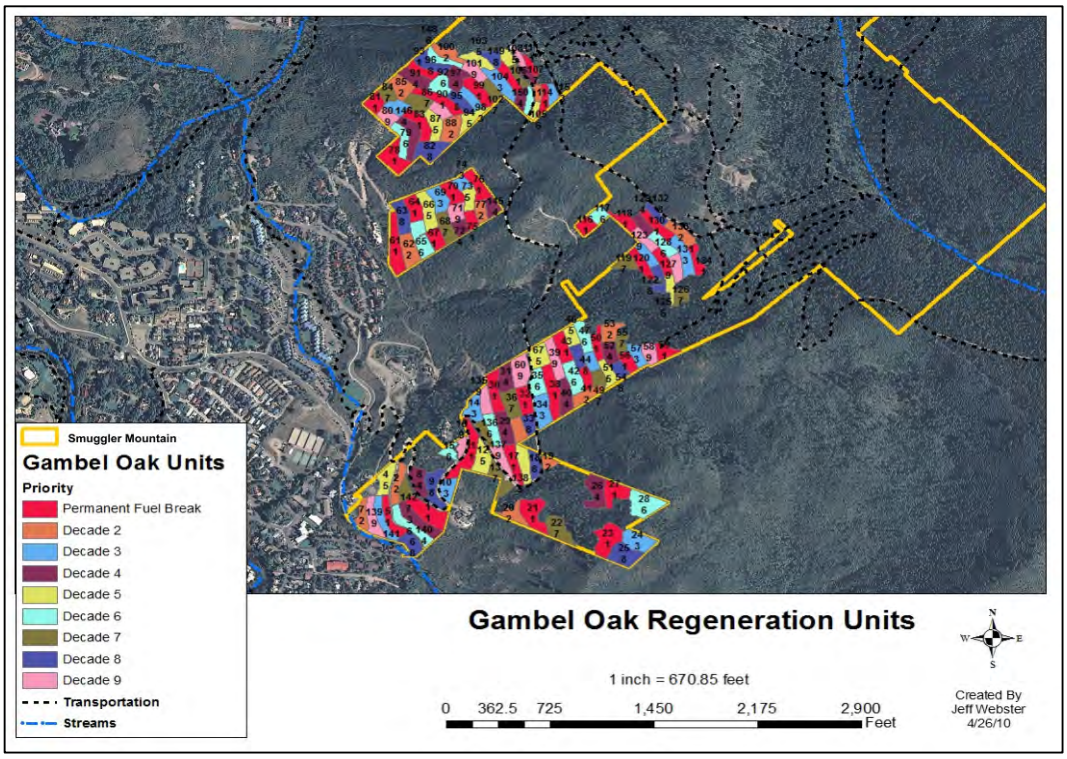


Figure 19.

Options for treatment are limited by ownership and topography. Three standard options are fire, mechanical and chemical. Broadcast prescribed burning, the ecologically preferred alternative, is limited by short burn condition windows, air quality, liability and ownership issues. Mechanical treatment is limited by the steep slopes on many of the units. Chemical treatment is very effective, but must be applied carefully and with regard to protecting water quality and public safety. Considering the physical limitations, the recommended combination of tools are manual cutting, herbicide treatment and burning of hand piles. Chipping of material is possible along roads where access is possible. Mechanical treatments should be considered where slopes allow.

Prescriptions for permanent fuel breaks are to focus on eliminating the majority of the brush component and converting the site to native grasses and forbs. Brush and overstory trees would be limited to 10-20% of cover. Some cover needs to be left for wildlife structure and visual mitigation purposes. Slightly different prescriptions would apply between scrub and tree oak (see Appendix G for areas of tree and shrub oak and big sage). For all prescriptions, following the variable retention philosophy, retaining any valuable wildlife structural elements such as large oaks, snags, large conifers, aspen or other features is critical to improving wildlife habitat. The general prescription would be to cut the oak and hand pile for burning or chip if close enough to roads (remove or leave chips on site). Piles should be covered to facilitate burning during the fall and winter after adequate rain or snow. In order to create permanent fuel breaks, reducing the Gambel oak density will be important. Accomplishing this will likely involve the use of herbicides, most likely as a stump treatment at time of cutting to reduce herbicide usage, exposure and visual effects. "Hack and squirt" is another low risk and cost effective method. This involves the use of a hatchet to chop into cambium and inject chemical with a syringe (usually about a millilitre per hack). Prior to any applications specific recommendations must come from a licensed applicator.

Herbicide applications must be done by a Certified Operator under the supervision of a Qualified Supervisor. Applications are regulated by the Colorado Department of Agriculture.

With this amount of disturbance the proliferation of non-native species, such as cheatgrass and yellow toadflax, will be of concern. After cutting of vegetation and burning of any piles, ash from piles should be incorporated into the soil with raking, and native seeds should be spread to capture the site before non-native species invade.

For the shrub form of Gambel oak, the primary focus is on creating young browse with increased nutrient value within browsing range of herbivores, especially on this important winter range for elk. The main prescription is to cut and burn the vegetation while at the same time leaving important structural elements and allowing the oak to re-sprout.

For the tree form, reducing the oak density will be important to facilitate improved growth of remaining oaks to produce larger trees. The general prescription will be to cut and burn a majority of the smaller stems focusing on retention of intermediate and larger oaks at a spacing that will prevent crown contact and reduce the risk of crown fire. To reduce density, selective use of herbicides will be essential. To protect the remaining larger oaks from fire, fuels should be raked away from the bottoms of the oaks prior to burning.

In summary, providing increased age class diversity and life form diversity has great proven benefits to wildlife. Moreover, the strategic placement of habitat improvement will also provide reduced risk to wildfire. Implementation of the SPLAT concept will be coordinated with the CWPP through the Aspen Fire Protection District.

4.4 Removal of hazard trees

Hazard trees are defined as standing trees, either live or dead, that are predisposed to mechanical failure due to defects present in the bole, butt, roots and/or limbs and are in an area in the forest where recreational activities occur frequently. To ensure the safety of the public on Smuggler Mountain, efforts should be made to locate, identify and remove hazard trees.

Tree defects can be the result of numerous factors. Biotic factors include weakening of the tree's structure due to insects and disease such as MPB, fungal root rots and wood borers. One of the most prevalent fungal infections for aspen on Smuggler Mountain is caused by several species of *Cytospora* fungi. *Cytospora* cankers (Fig. 20) are the result of the fungus infecting damaged or stressed parts of the tree. Ultimately, the canker can girdle the tree and kill it causing mechanical failure. The poplar borer beetle is an insect that can cause damage to aspen trees causing compromised structural integrity and mortality (Fig. 21).

Figure 20. An example of *Cytospora* canker on an aspen tree. The orange discoloration is a living fungus in the tree that weakens its structural integrity.

Figure 21. An example of the poplar borer beetle. Resin and dust are the result of the beetle boring

Abiotic factors that cause mechanical tree damage include lightning, avalanche, wind throw, logging operations and road construction. It is important that trees along trails and roadways be inspected for biotic and abiotic damaging factors. Although biotic factors that injure trees are part of a balanced and healthy ecosystem, they must be closely monitored to assess their damage potential followed by the immediate removal of hazard trees (or tree parts) in order to provide a safe recreational setting. Due to the high number of visitors on Smuggler Mountain each day, the removal of hazard trees should be an initial priority. The locations of the 24 known hazard trees identified last year are shown in Fig. 22. The City of Aspen and Pitkin County are planning to evaluate the rest of the trails this year for hazard trees. A rotation of every two years to cover all the trails is recommended.

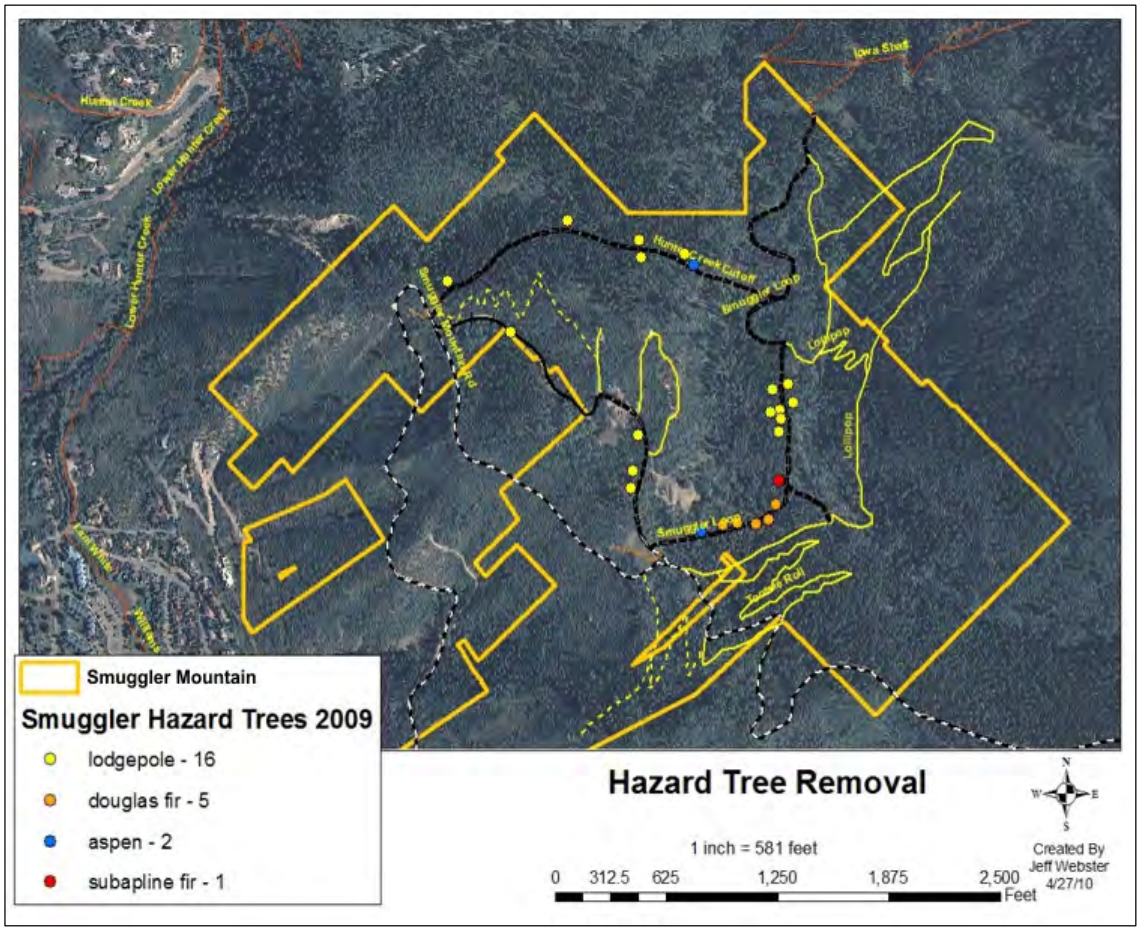


Figure 22. Location of known hazard trees on Smuggler Mountain slated for removal in 2010.

4.5 Wildlife implications

After the recommendations for forest management have been executed, the wildlife habitat will be altered at Smuggler Mountain. However, the changes to the forest ecosystem will add positive habitat characteristics for many wildlife species present. It is important to note that the habitat changes proposed will accrue habitat values to various species at various times and locations. Not all species will benefit equally at the same time. Groups of wildlife species that will be positively affected include birds, large mammals and small mammals. Within these groups, management indicator species (MIS) have been identified from the Smuggler Mountain biological resources report (Colorado Wildlife Science and WP Natural Resources Consulting, 2008). MIS species are important because they can indicate the quality of wildlife habitat for other species as well.

The American three-toed woodpecker is a MIS that will benefit from the forest management actions in this plan. This woodpecker relies on quality habitat provided by areas of late seral

stage lodgepole pine and subalpine fir stands. One of the main objectives of this forest management plan includes conserving the existing old lodgepole pine stands as long as possible and initiating the growth of new ones, i.e., increasing the tree age class diversity at Smuggler Mountain. Furthermore, the variable retention silviculture methods described earlier will leave many snags which also meet the habitat needs of the woodpecker. Since the woodpecker is a MIS, these forest management activities will improve not only the woodpecker's habitat, but the habitat of other species that are dependent on similar conditions.

The red-naped sapsucker is a MIS that requires quality conifer and aspen stands with sufficient snags for breeding grounds. Cavities that are created in snags by the red-naped sapsucker are also used extensively by secondary cavity nesters. Again, one of the main goals of this management plan is to retain snags for wildlife purposes. Although MPB brood trees and some hazard trees will form snags, it is in the overall interest of Smuggler Mountain forest health and safety to remove these trees in areas of high recreational use. However, due to the current late seral nature of the forest, there should be enough natural mortality occurring on a regular basis to produce a wide enough range of snag DBH and deterioration classes to support populations of snag dependent species on Smuggler Mountain.

The recommended management of the Gambel oak stands on Smuggler Mountain will improve the habitat quality for the Virginia's warbler and the green-tailed towhee, both of which are MIS. The Virginia's warbler requires dense shrub components of Gambel oak for nesting and foraging purposes. The green-tailed towhee requires sparse shrub components of Gambel oak for both nesting and foraging purposes. The management plan will create a variety of age classes and levels of density within the Gambel oak stands which will perpetuate habitat for both avian species. The installation of permanent fuel breaks within the Gambel oak stands will alter the vegetation from shrub to grass and forbs, creating a mosaic of structural characteristics that will also appeal to other bird species.

A good MIS species for large mammals is Rocky Mountain elk. According to the Smuggler Mountain biological resources report (Colorado Wildlife Science and WP Natural Resources Consulting, 2008), healthy elk habitat provides good habitat to a wide variety of species. Elk are migratory and therefore require large, diverse areas for foraging. Winter foraging is very important for elk on Smuggler Mountain. Some of the southern facing stands of Gambel oak provide winter foraging for elk. With the mosaic of age classes created by this management plan, the Gambel oak stands will be in continual stages of new growth resulting in improved foraging characteristics for elk. Smuggler Mountain also provides good elk calving habitat in the thick brush understory in aspen stands isolated from heavy recreational activity.

The MIS that will likely benefit the most from this management plan is the snowshoe hare. This species requires stands of early seral stage lodgepole pine and sub-alpine fir. One of the primary objectives of the management plan is to constantly initiate the growth of new stands of lodgepole pine. From these actions the snowshoe hare's habitat will be greatly improved. The snowshoe hare is a primary food source for the federally threatened Canada

lynx, so improvement of snowshoe hare habitat could increase the potential for Canada lynx on Smuggler Mountain.

Although the focus of much of the active management discussion has been on lodgepole and Gambel oak, aspen stands support the highest level of wildlife diversity. This plan is designed to perpetuate healthy stands of various seral conditions for all dominant tree species on site. This will perpetuate the wildlife that require the various seral conditions, such as elk that use the lush herbacious growth in younger and older stands to the red-naped sapsucker that builds and uses nesting holes on mature aspen trees.

All of the management actions in this plan that are designed to improve forest health and diversity will have positive effects on wildlife habitat over time. Wildlife recommendations were designed to be compatible with the wildlife recommendations in the Smuggler Mountain Biological Resources Report (Colorado Wildlife Science and WP Natural Resources Consulting, 2008). It needs to be reiterated that proposed habitat changes are going to provide different levels of values to different species of wildlife at different times, within the landscape. Without active forest management the quality and diversity of habitat for many of the MIS would likely deteriorate over time. A decline in the quality of wildlife habitat would be an unacceptable outcome based on the objectives of the Smuggler Mountain Open Space Management Plan (2008).

4.6 Education

Government agencies and non-profit environmental organizations in the Aspen area have a history of open communication, engagement and education with the public. This should continue in regard to the management activities at Smuggler Mountain. Not only does the greater Aspen community need to be continually kept abreast of management activities at Smuggler Mountain, the public also needs to be educated as to why certain treatments have been chosen and what their outcomes will be. Therefore, the agencies responsible for Smuggler Mountain are encouraged to continue developing a public education program designed around the activities and objectives of this forest management plan.

One common practice in city-owned forests throughout the U.S. is to post informative kiosks at parking areas, trailheads or near active management areas that define and describe the sustainable forestry practices that are being used to manage the forests. Smuggler Mountain should consider having constantly updated kiosks that describe ongoing resource management activities on the property in addition to supplying information on the area's natural and human history.

Some of the low-risk management activities such as the monitoring and removal of invasive plants could involve the public, thereby providing an activity that benefits Smuggler Mountain and at the same time creating a platform for the education of laypeople on the biology of invasive species and their effects on native ecosystems.

Public hikes held in Smuggler Mountain in 2009 (sponsored by the Aspen Center for Environmental Studies) were extremely popular. These educational walks were led by scientists and forest managers who were intimately familiar with the area and the issues involved in its conservation. Such hikes could be held on a monthly basis during the summer and fall. Snowshoe hikes could be held in the winter for the Aspen area public and for tourists looking for an alternative to skiing.

There is a unique opportunity to provide continuing forestry and wildlife research and education at Smuggler Mountain. A connection to research universities in Colorado would be useful for many purposes. First, field trips to Smuggler Mountain by students at various universities would help with public awareness of current forestry issues and practices such as MPB ecology and various silviculture techniques. The City and/or County could provide summer internships to Outdoor Recreation, Environmental Studies, or Forestry students from Colorado universities and colleges to specifically develop educational programs or assist with forest management activities at Smuggler Mountain.

Access to Smuggler Mountain may also provide graduate students or government agency scientists with a site to conduct research projects which, in turn, could be applied to future management practices. Any agreements made with researchers for access to the property could include a stipulation that the results of their studies eventually be presented at a public lecture.
These are but a few of many potential educational opportunities. Commitment, communication, collaboration and cooperation (Mrowka and Campbell, 1997) are the keys to success when managing public lands. Purchase of the open space demonstrates the community's commitment to conserving resources, and continuing educational efforts will foster an atmosphere of communication, collaboration and cooperation.

5. Long term recommendations

5.1. Lodgepole pine

The long term recommendation for lodgepole pine is to continue initiating regeneration. Each decade a regeneration schedule needs to be implemented within stands of decreasing priorities (Sec. 4.1, Fig. 14) This will ensure that there is a proper age class distribution of lodgepole pine and other conifers throughout Smuggler Mountain where the young, fast-growing trees will be less likely to be infested with MPB. Again, the best long term management plan to reduce the threat of serious MPB infestation is to promote a diversity of tree species and age classes.

Regeneration schedules and methods should be determined based upon past regeneration success. Variations on species planted, scarification techniques (e.g. burning vs. mechanical scarification), unit size and seedling growth rates should be monitored in order to determine future regeneration schedules and methods. Appendix D provides a general guideline of regeneration priorities, but adaptive management should still be the guiding principle, especially in decades beyond this 10 year plan when climate change could have a greater impact on the local ecosystem.

Each decade the condition of old large lodgepole pine trees should be monitored. The conditions of older lodgepole pines that were actively managed for protection should be closely monitored in order to determine future management techniques. An inventory of areas that contain large old conifers should be conducted each decade in order to assess areas of trees that need new protection. The combination of actively regenerating conifers and protecting old ones will ensure age class diversity at Smuggler Mountain.

5.2. Aspen

Long term recommendations for the aspen stands include monitoring for SAD with continued research regarding aspen regeneration. The risk for SAD increases when aspen experiences environmental stress such as by heat and/or drought. If predictions concerning climate change are accurate, then SAD might become a much larger problem in future decades for local aspen stands than it is at present. A recent study using three different climate models predicted that the aspen range in the western United States will decrease 40-75% by 2060 (Rehfeldt et al., 2009), so aspen decline at Smuggler Mountain should be expected to some degree in coming decades.

Further research needs to be performed in regard to various disturbance regimes within the aspen stands. Due to the proximity of Smuggler Mountain to the City of Aspen, prescribed burning may not be desirable. Since fire is the primary disturbance factor for aspen stands, other disturbance forms need to be studied for their efficacy of initiating aspen regeneration.

Systematically regenerating aspen on Smuggler Mountain will help meet the objectives of sustainable management by adding a diversity of aspen age classes. As discussed earlier in this document, the removal of overstory competition from conifers will be very important in ensuring the proper development of aspen at various stages of growth in certain stands. For other stands the removal of overstory aspen will be beneficial to stimulate sprouting. Each decade, a prescription for overstory removal of conifers and/or aspen combined with one or more disturbance factors should be implemented for aspen to ensure its future health and sustainability.

5.3. Gambel oak

As discussed earlier, the primary objectives of Gambel oak management are for this species to serve as wildlife habitat and natural fuel breaks between Smuggler Mountain and the City of Aspen. Fortunately, both objectives can be met simultaneously. Implementation of strategically placed fuel breaks, (see Sec. 4.3), created within the Gambel oak stands will significantly increase the age class diversity and life form diversity of the Gambel oak stands. This increased diversity will improve the wildlife habitat on Smuggler Mountain as well. Monitoring of wildlife habitat, noxious weed development and wildfire risks each decade will be crucial in determining success. Again, monitoring is the driving principle behind adaptive management.

5.4. Hazard tree removal

Efforts should continue for the removal of hazard trees. Each year an assessment of trees along trails and roadways should be conducted. Hazard tree removal could coincide with brood tree removal depending on the number of trees to be removed and their locations. One method to consider for removal is to have trees removed by a logger for commercial sale as firewood or by a non-profit for community use. Tops and breakage could be piled and burned or chipped and removed. Hazard tree removal will assure a safe recreational area for the public and must remain a high priority into the future.

5.5. Monitoring

In order to ensure that the objectives of this forest management plan are met over time, a monitoring program should be implemented. The three main elements that require a monitoring program are forest growth dynamics, wildlife habitat dynamics, and road and trail conditions. Other possible factors to consider are botanical data and water quality since both contribute to habitat diversity. Periodically, each of these elements needs to be assessed in order to determine their current state and how past management activities have affected them. Monitoring activities normally occur with 5 or 10 year re-measurement intervals.

Forest Cover

To assess the conditions of forest diversity over time, the most common method is to take periodic ground measurements. In this management plan, CSE's were used primarily to quantify vegetation dynamics. However, since this forest management plan is designed with conservation principles, it would be very useful to install what are known as "permanent measurement plots." Such plots are randomly distributed throughout each stand type. Each tree within the plot is tagged at the base of the tree for future relocation purposes. This type of forest inventory can provide very accurate forest statistics over time. Other standard types of forest inventory, such as the CSE's, provide accurate statistics of current forest conditions; however, they are not designed for re-measurement purposes. A permanent plot design will provide Smuggler Mountain with the most accurate data for each stand type in the future.

A suggested permanent plot design will consist of stratified sampling of each vegetation type. Roughly 2% of the acreage of each vegetation type is a suggested sampling intensity. Each plot installed should be a fixed-radius plot of 1/10th acre in size. Within the 1/10th acre plot, each tree over 3 inches DBH should be tagged in numerical order at the base of the tree. A nail should be placed in the tree at 4.5 feet above ground on the uphill side of the tree to ensure the proper location of future re-measurements. For each tree that is to be tagged, measurements such as species, DBH, height, crown ratio, height to crown base, various defects, snags (including DBH and deterioration class), and presence of disease and insects should all be recorded. Furthermore, a subset of one dominant tree per species in each plot should be bored to determine age and past 5 – 10 years' growth.

Within each 1/10th acre plot, a fixed radius sub-plot of 1/100th acre should be installed. The function of the sub-plot is to measure seedlings and saplings less than 3 inches DBH, list shrub, grass and forbs present and estimate cover by species. This will be very useful in determining the regeneration success and species diversity over time. Natural seedling survival rate is a very difficult variable to measure. The 1/100th acre sub-plots will serve as a very useful tool to help monitor this process. The presence of noxious weeds can also be quantified with the sub-plots. This will help evaluate management strategies to control noxious weeds as well.

Other measurements that could be taken at each permanent plot include coarse woody debris and/or fuel loading measurements. One of the easiest and most effective ways to quantify and monitor fuel loading is to use what are known as fuel loading photo series. The U.S. Forest Service has produced hundreds of photo series throughout Colorado Rocky Mountain forest types. Detailed measurements are taken on the ground, total fuel loading is quantified and a picture is taken of the area where the measurements were taken. This provides forest managers with a fast method to visually determine fuel loading quantities at each plot. For monitoring purposes at Smuggler Mountain, a digital photograph should be taken in each cardinal direction at each re-measurement period (Fig. 23). This will give the forest manager very specific visual representations of not only fuel loading but overall forest health. These visual aids will also be very useful when presenting management plans to the public. If geographic position system (GPS) points are taken with these photos, monitoring can be linked to GIS and aerial photography over time, too.

Lodgepole pine stand ***Aspen stand*** ***Gambel oak stand***

Figure 23. Examples of fuel loading photo series for common Colorado Rocky forest types. The surface fuel loading in each photo has been intensively sampled and quantified.

Wildlife

Implementation of the various vegetation management prescriptions described in this plan are designed to improve wildlife habitat and diversity, with goals in alignment with those in the proposed Aspen-Sopris Wildlife Habitat Improvement Project (2010). As stated in the proposed Aspen-Sopris Project report, "mountain shrub communities are treading outside their historical condition of age class diversity, variable shrub height, density of sprouting shoots and species composition. It is desirable to bring these communities back into their

historic conditions restoring plant health, vigor and regeneration. A variety of wildlife and plants, would benefit from this proposal due to enhanced forage quality, returning age class diversity to vegetation communities . . . . ". This forest management plan for the Smuggler Mountain Open Space property is designed to achieve similar goals, albeit at a smaller scale that conforms to the property acreage, and is in concordance with the recreational and aesthetic values held by the Aspen community.

Monitoring is essential and will provide important data to measure success of efforts to improve wildlife habitat. Wildlife monitoring on Smuggler Mountain should include seasonal surveys for MIS at time increments matching permanent plot remeasurements. Many of these species are birds that can be surveyed with a presence/absence method. Transects should be conducted through each habitat type to monitor the presence of MIS birds. Seasonal acoustic surveys can be conducted for goshawks and owls. Monitoring for mammals such as marten and lynx could be done in the winter with track surveys. Bait stations could be placed in remote areas where there is no visitor use. Bait stations should include cameras equipped with motion detectors. This will provide managers with useful data to assess wildlife populations.

The alternative to doing specific bird and animal surveys is to monitor habitat. Habitat is not nearly as mobile as wildlife and is easier to measure. Using forest cover monitoring as a surrogate for surveying wildife is common. Monitoring specific species can be very expensive and the results highly variable, especially on Smuggler Mountain which is too small to meet all of the habitat needs for some species. It is critical to monitor the habitat features that are important to many species of wildlife (i.e. snags and large course woody debris). The status of these habitat features can be easily plotted, thereby providing a metric for the health of wildlife that is dependent on them. For example, since it is known that Virginia's warbler likley nests in the dense Gambel oak and serviceberry dominated shrublands on Smuggler Mountain, we will have a good idea of how the warbler is faring based on the density trend in Gambel oak stands.

The suggested recommendation is to use a combination of methods based on goals and objectives for Smuggler Mountain. The first step is to clearly define objectives which is critical to understanding what data needs to be collected. Second, the data must be well organized and documented to allow for monitoring over long periods of time. There will be variability in results from year to year, but the important outcome is to be able to detect trends so changes in management can occur as needed, i.e. adaptive management.

Wildlife recommendations were designed to be compatible with the wildlife recommendations in the Smuggler Mountain Biological Resources Report (Colorado Wildlife Science and WP Natural Resources Consulting, 2008). It needs to be reiterated that proposed habitat changes are going to provide different levels of values to different species of wildlife at different times within the landscape. Successful implementation will require teamwork between wildlife and forestry personnel. Without active forest management, the quality and diversity of habitat will likely deteriorate over time.

Roads and Trails

Roads and trails throughout Smuggler Mountain should be annually surveyed for damages that result in erosion. Culverts, water bars and rolling dips should be monitored for effectiveness in diverting water off roads and trails while minimizing soil erosion. It is well documented that the majority of erosion in forests settings comes from roads and trails. Maintenance of road drainage structures to eliminate water concentration is vital to reducing erosion.

5.6. Fuel Management

Any fire prevention/fire fighting plans for Smuggler Mountain cannot be made without the guidance, advice and collaboration of the Aspen Fire Protection District and the U.S. Forest Service. The background and general recommendations provided in this section have no doubt already been considered by these agencies.

Current conditions of fuel loading at Smuggler Mountain were addressed in Sec. 3.2. As discussed earlier, a no-action scenario will result in most stands exceeding the critical relative SDI threshold of 55% (Figs. 7 and 8). With this scenario, stands begin to experience increased tree mortality and subsequent increased surface fuel loading, creating conditions that present higher risk of fire.

Historically, fires were a natural component of the ecosystem at Smuggler Mountain that improved the health of aspen stands, naturally reduced stand densities and created diverse age classes in each forest type. Currently, a wildfire occurrence under the no-action scenario could result in a stand-replacing fire event. A reduction in fuel loads at Smuggler Mountain will be achieved by the proposed management activities of this plan but preparation for a potential wildfire is still needed for the protection of life and property. The proximity of Smuggler Mountain to the urban interface of the City of Aspen suggests the need for a comprehensive fire management plan to be developed in collaboration with the appropriate agencies.

Although the protection of life and property are the primary objectives for this fuels reduction treatment, other objectives are met simultaneously. The overall objective for this management plan is to produce sustainable forest characteristics. Historically, the fuel loading at Smuggler Mountain was significantly lower due to natural fire regimes that occurred as frequent low intensity fires. However, past fire management policy suppressed all fires, resulting in unsustainable forest characteristics with excessive fuel loading. The purpose of this fuel reduction treatment is to attempt to restore Smuggler Mountain to historical fuel loading conditions. By doing this, not only will life and property be protected, but positive ecological benefits will be seen. The potential for wildfire will be reduced by creating fuel breaks, and reducing surface and ladder fuels. For fire protection at Smuggler Mountain, the following recommendations should be considered:

Communication & Coordination. Fire does not respect property boundaries. For fire protection efforts to be most effective, plans need to be developed with the appropriate agencies and personnel. In this case primarily coordinated efforts with the Aspen Fire Protection District and the USFS will be important.

Fuel load reduction. Fuel load reduction will occur if the recommendations proposed in Sec. 4 are implemented for the thinning of dense stands to promote regeneration and for the removal of hazard and brood trees.

Fuel breaks. Collaboration with Aspen Fire Protection District and USFS will determine the need for and placement of fuel breaks on Smuggler Mountain in conjunction with the Community Wildfire Protection Plan (CWPP). The primary purpose of fuel breaks is to provide fire fighters with a safe place to contain a fire. The objective is to reduce the fuel loading in strategic locations so that fire activity is reduced to a level where the fire slows down and can be more easily contained. The creation of strategically placed area treatments (SPLATS) in Gambel oak units (as recommended in Section 4.3) would contribute to a fuel break network at Smuggler Mountain.

Road maintenance. Annually inspect and maintain roads to ensure that fire fighting crews and equipment can take advantage of the entire Smuggler Mountain road network.

Identification and development of water sources. Local water sources for fighting fire are important.

For planning purposes, more detailed recommendations on potential fuel breaks, safety zone placement and water hole locations at Smuggler Mountain are offered in Appendix A.

5.7. Transportation

A properly functioning transportation infrastructure is the foundation of any management plan. The removal of brood trees, as discussed earlier, require sufficient road conditions for logging equipment to access the property and conduct operations. Management in the future will require easy access to the property for continued removal of brood trees. In addition, any fire suppression activities will require adequate road conditions. Along with accessibility issues, roads and trails that exist at Smuggler Mountain need to be maintained in order to meet the management objectives of this plan. Road and trails that are not properly maintained can cause significant erosion that impairs watersheds and degrades wildlife habitat. An erosion control plan should be implemented in order to achieve the management objectives of this plan. As mentioned in the Smuggler Mountain biological resources report (2008), best management practices (BMPs) of proper water bar construction and placement, check dams (if needed), slope drains or other needed erosion control techniques should be implemented as appropriate.

5.8. Seed bank

The development of a seed bank of locally adapted seeds will prove to be very useful for regeneration activities and insurance in the case of a stand replacing wildfire. Due to the fact that Smuggler Mountain exists within a WUI near the City of Aspen, the threat of human caused wildfire is high. The threat of climate change in combination with the fuel loading and proximity to Aspen may result in an increased chance of a stand replacing wildfire over the next several decades. In this scenario, it would be very helpful to have an accessible seed bank to help restore the area to native species in a timely manner.

Options to develop a seed bank include working with the Colorado State Forest Service and the USFS to determine seed availability. Other options may include collecting cones on site. This may be the best, and least expensive, method to ensure the availability of locally adapted seed.

5.9. Potential socio-economic benefits of Smuggler Mountain forest management

Plans for public open spaces generally call for an input of public monies to achieve management objectives, and this management plan is no different. However, because this plan calls for silivicultural practices aimed at reducing the fuel load of the Smuggler Mountain forests, there will be a relatively low, but constant, generation of woody biomass coming out of Smuggler Mountain on an annual or semi-annual basis. Because of the MPB infestation in Colorado, there is an overabundance of dead and dying pines which are currently going to waste – some even disposed of in landfills – so there is no available market for these kinds of forest products at present.

Biomass production as an alternative energy source to fossil fuels has made headway in other parts of the country, and some interest has been shown in using MPB-killed pines or pines selectively cut from overgrown forests as a means of renewable energy production in Colorado. Looking forward over the next several decades, as the supply of these “waste” wood products in the Roaring Fork Valley increase and the costs of fossil-based fuels increases, biomass utilization might become a more attractive investment with the potential to provide a source of income for private and public owners of local forestlands and become a source of jobs for Pitkin County citizens. However, investment will not materialize without some guarantee of a reliable supply of biomass and appropriate economic incentives.

It is recommended that governmental bodies in the City of Aspen and Pitkin County look for partners with whom they can initiate a study to determine the feasibility of conducting a valley wide supply analysis and developing local biomass facilities (matched to the reliable supply), that will, in the long term, help pay for the management of Smuggler Mountain, contribute to the local economy, and generate reasonably priced renewable power for the community.

6. Summary

The Smuggler Mountain Open Space property offers unique opportunities for the City of Aspen, Pitkin County and citizens of Roaring Fork Valley, Colorado. The vicinity of Smuggler Mountain to the City of Aspen makes it very accessible to a wide variety of daily recreation activities. In addition to promoting safe recreational use, this forest management plan is designed to achieve other important objectives. First and foremost, this plan aims to create a sustainable forest ecosystem at Smuggler Mountain. Sustainable forest management, as defined by the Food and Agriculture Organization (2010) is:

> *The stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems.*

The objectives of this forest management plan meet this definition. Biodiversity is a common thread that has been discussed throughout this document. Currently, the effects of climate change are being felt in Colorado, specifically with the MPB epidemic. In this plan, tree species diversity and age class diversity are the key forest characteristics that will be improved in order to combat MPB and retain a sustainable forest. Initial priorities of this plan include efforts to initiate regeneration of conifers to ensure healthy stands in the future.

The current state of Smuggler Mountain is a product of past land uses such as mining and logging. These historic land uses did not adhere to sustainable forest management practices, leaving some aspects of the forest in a somewhat unnatural state. This forest management plan is intended to re-direct the current state of the forest toward healthy and sustainable future. Healthy wildlife habitat and a safe recreational setting are concurrent priorities of this management plan. While adhering to adaptive management principles, the execution of this plan will create the appropriate environment for the desired future ecological, economic, and social functions.

In the 10-year forest management plan presented here, both short- and long-term management recommendations have been made. However, it should be noted that all management activities affect the long-term development of forests. With this in mind, so as to best cope with certain aspects of unpredictable future conditions, each recommendation described in this plan is designed with operational flexibility that in turn is based on the built-in monitoring and adaptive management components of the plan. It is recognized that a lack of markets combined with currently stressed economic conditions do contribute to the expense of the proposed actions in this plan. Thus, implementation of all or parts of the plan will depend on available funding. For detailed yearly recommendations, see Appendix H. Below is a summary of recommendations for Smuggler Mountain:

Short term recommendations

1. Continue brood tree removal activities and verbenone applications as long as the MPB populations remain elevated and seasonal weather conditions dictate.

Monitoring the populations of MPB each fall is essential for determining treatments in subsequent years.

2. Initiate regeneration of all tree species including conifers, aspen and Gambel oak. Age class diversity and species diversity will be the best way to deal with MPB, SAD, and a changing climate. Furthermore, it will protect wildlife habitat values.

3. Identify and remove hazard trees located by City and/or County staff to ensure a safe recreational setting. The City of Aspen and Pitkin County might consider the removal of hazard trees in conjunction with the removal of brood trees as a money-saving measure.

4. Maintain critical structural wildlife elements, such as snags, large woody debris and protection of riparian area, while implementing silivicultural prescriptions. Successful implementation will require teamwork between wildlife and forestry personnel.

5. Develop an educational plan that involves the public and increases public awareness of Smuggler Mountain history and forest management.

Long term recommendations

1. Continue with regeneration efforts each decade. This will ensure a wide variety of age classes and species diversity.

2. Work with Aspen Fire Protection District and federal lands fire managers to develop CWPP.

3. Maintain Smuggler Mountain Road and drivable trails to ensure that management operations can be executed. Properly maintained trails and roads will also reduce chances of erosion which can impair watershed and wildlife quality.

4. Develop monitoring plans to assess the attainment of management objectives and to determine management changes as needed relative to adaptive management as required due to changing conditions.

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7. Glossary

acre: an area of land containing 43,560 square feet or 10 square chains. A square acre would be about 209 feet by 209 feet. A circular acre would have a radius of 117.75 feet.

artificial regeneration: trees that are planted and not naturally reproduced in a particular location.

basal area: (a) the cross-sectional area of a single stem, including the bark, measured at breast height (4.5 feet above the ground). For example, the basal area of a tree 14 inches in diameter at breast height is about 1 square foot. Basal area = 0.005454 times diameter squared. (b) of an acre of forest: the sum of basal areas of the individual trees on the area. For example, a well stocked pine stand might contain 80 to 120 square feet of basal area per acre.

blowdown: trees or trees felled or broken off by wind.

canopy: the foliage formed by the crowns of trees in a stand.

coarse woody debris: fallen dead trees and the remains of large branches on the ground in forests.

coppice: the production of new stems from the stump or roots; to cut the main stem at the base or to injure the roots to simulate the production of new shoots for regeneration.

defensible space: an area around a structure where fuels and vegetation are treated, cleared or reduced to slow the spread of wildfire towards the structure.

diameter at breast height (DBH): the diameter of a stem of a tree at 4.5 feet above the ground

dominant: One of four crown classes recognized on the basis of relative position and condition of the stand. Specifically, trees with crowns extending above the general level of the crown cover, receiving full light from above and partly from the side; larger than the average trees in the stand, and with crowns well-developed but possibly somewhat crowded on the sides.

even-aged forest: a stand in which relatively small age differences exist between individual trees, the maximum difference in age permitted to consider a stand even-aged is usually 10-20years. For example, during a 100 year rotation, the age difference would not exceed 20 years. An even-aged forest may be a natural or an artificially regenerated stand.

fuel loading: the oven-dry weight of accumulated woody and vegetative material on the forest floor from leaf/needle fall, natural pruning and breakage that serves as fuel for wildfire.

fuelbreak: a strategically located strip or block of land (of varying width) depending on fuel and terrain, in which fuel density is reduced, thus improving fire control opportunities. The stand is thinned and remaining trees are pruned to remove ladder fuels. Most brush, heavy ground fuels, snags and dead trees are removed and an open park-like appearance established.

grubbing: manually removing all live and dead vegetation in a small area to expose mineral soil and facilitate artificial regeneration.

hazard tree: a standing tree, either live or dead, where defects are present in the bole, butt, roots and/or limbs and are predisposed to mechanical failure in an area in the forest where recreational activities occur frequently.

mountain pine beetle (MPB): *Dendroctonus ponderosae*, is a species of bark beetle native to the forests of western North America from Mexico to central British Columbia.

natural regeneration: trees or an age class of trees growing from natural seeding or natural vegetative reproduction (suckering, layering or sprouting).

no-action scenario: describes vegetation dynamics over time with the absence of any human management.

relative stand density index: the number of trees actually in a stand divided by maximum number of trees of that average size that could exist.

sapling: a usually young tree larger than a seedling but smaller than a pole.

seedling: (a) a tree, usually less than 2 inches in DBH, which has grown from a seed (in contrast to a sprout). (b) a nursery grown tree which has not been lifted and replanted in the nursery.

silviculture: the art, science, and practice of establishing, tending, and reproducing forest stands of desired characteristics. It is based on knowledge of species characteristics and environmental requirements.

snag: a standing, generally un-merchantable dead tree from which the leaves and most of the branches have fallen.

stand: a contiguous group of trees sufficiently uniform in age-class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit.

stand density index (SDI): a measure of the stocking of a stand of trees based on the number of trees per unit area and diameter at breast height of the tree of average basal area.

succession: a more or less predictable and orderly change in the composition and structure of an ecological community.

sudden aspen decline: aspen forests that have experienced widespread, severe, rapid dieback and mortality.

sustainable forestry: the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems.

thinning: a cultural treatment made to reduce stand density of trees primarily to improve growth, enhance forest health, or recover potential mortality.

uneven-aged forest: a stand with trees of three or more distinct age classes, either intimately mixed or in small groups.

Wildland Urban Interface (WUI): Zone where structures and other human developments meet, or intermingle with, undeveloped wildlands.

windbreak: a strip of trees or shrubs maintained mainly to alter wind flow and microclimates in the sheltered zone, usually farm buildings.

8. Literature Cited

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9. Appendix

Appendix A. **Fuels Data**

This section is intended to present data and ideas to facilitate discussions for the protection of life and property in the City of Aspen and valuable natural resources on Smuggler Mountain. This is not a substitute for proper planning discussions between the appropriate agencies and affected public.

The fuel loading was discussed in section 3.2, incorporating data from the common stand exams (CSE) and the Colorado Front Range Fuel Photo Series (Battagia et. al, 2005) to verify aspen and lodgepole fuel loads and include Gambel oak. It is clear that all stands are in a high fuel load condition. The data is presented in Table A.1 below.

Stand Number	Species	Surface Fuels Tons/Ac	Surface Fuel Loading Risk	Standing Fuels Tons/Ac	Total Fuels Tons/Ac
4	Aspen	32	High	30	62
5	Aspen		High		
7	Gambel oak/ Aspen		High		
112	Aspen	32	High	45	78
114	Lodgepole/ Aspen	30	High	45	75
118	Aspen		High		
401	Aspen		High		
117	Douglas-fir		High		
2	Gambel Oak		High		
3	Gambel Oak		High		
7	Gambel oak/ Aspen		High		
8	Gambel oak/ Aspen		High		
102	Lodgepole	27	High	90	117
111	Lodgepole	31	High	77	108
113	Lodgepole	32	High	96	128
115	Lodgepole	33	High	56	89
116	Lodgepole	26	High	46	72
121	Lodgepole		High		

Table A.1. Fuel loading from data gathered with CSE data and interpreted using Colorado Front Range Fuel Photo Series (Battaglia et. al, 2005).

The data confirms the need for continued discussions with the appropriate fire agencies to develop specific recommendations for the protection of life and property as well as watershed resources. The following potential actions are identified as ideas for discussion on the very important topic of fire protection.

Fuel load reduction. The concept of strategically placed area treatments (SPLATS) was discussed in detail within Section 4.3 with Gambel oak. This same concept could be applied to the rest of the landscape in conjunction with other planned treatments.

Fuel breaks. Fuel breaks located in key locations can provide for safe locations for containing fires.

Safety Zones. An important element to any fuel break is the location of safety zones.

Water Sources. Water is always in high demand during a fire. The unnamed creek on Smuggler Mountain provides potential for development of water holes for fire fighting.

Road Access. Rapid access to fires is critical to initial attack to keep fires small and preventing escape, in addition to safe ingress and egress of fire fighters and the public respectfully.

Fire protection is an important element to conserving resources on Smuggler Mountain. It will take commitment and cooperation by all interested parties to be successful. The preceding discussion is intended to present data, identify issues and potential solutions, but is no substitute for agency and public planning efforts.

Appendix B.

Final Report:
Bark Beetle Mitigation Treatments, Smuggler Mountain 2010

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William Murray, Project Manager, San Jose State University, San Jose, CA
Maggi Kelly, Geospatial Lead; **David Wood,** Pheromone Lead, Dept. Environmental Science, Policy, and Management, University of California, Berkeley, CA
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Sylvia Mori, Statistics Lead, USDA FS, PSW Research Station, Albany, CA

Summary: In 2010, a coalition of forest land managers initiated a 249-acre project to mitigate mountain pine beetle (MPB) risk in the Roaring Fork Valley near Aspen, CO (Fig. 1), with 171 acres treated using a combination of anti-aggregation pheromone applications and removal of infested brood trees, and the remaining 78 acres serving as untreated reference stands. These treatments followed upon successful applications of two formulations of verbenone (VBN) in 2009. Our objective in 2010 was to test efficacy of combining verbenone with two "green-leaf volatiles" ("GLVs"), which are six-carbon alcohols that represent a non-host signal for mountain pine beetle. The three treatments in 2010 were:

1. Verbenone pouches combined with brood tree removal ("VBN")
2. Verbenone and GLV pouches combined with brood tree removal ("VBN + GLV")
3. Untreated reference stands ("UNTR-REF")

Efficacy was assessed by conducting post-season timber cruises to measure stand structure and pre- and post-treatment MPB attack rates. Our key findings were:

- Mountain pine beetle attack rates were markedly lower in 2010 than in years immediately previous (Fig. 2).
- VBN and VBN + GLV treatments both resulted in significantly ($\alpha = 0.10$) lower MPB attack rates in 2010 when compared to untreated reference stands (Fig. 3), averaging more than 50% for each treatment.
- Two sequential years of verbenone and sanitation treatments resulted in a significant ($\alpha = 0.05$) reduction in MPB attack rates from 2008 levels, independent of the effect of declining beetle populations and differences in stand structure (Fig. 4). This reduction in attack averaged more than 70% for both treatments.

Introduction and Background.
Colorado, like many states in the Rocky Mountains, is experiencing record-breaking outbreaks of mountain pine beetle, *Dendroctonus ponderosae,* resulting in unprecedented mortality of lodgepole pine, *Pinus contorta.* It has been predicted that 80-90% of the mature lodgepole pines in Colorado will be killed by the end of this outbreak, and similar scenarios are playing out in British Columbia where forest stands that were once carbon sinks have become carbon sources. It is understood that MPB risk can be reduced at local scales through removal of infested trees, thinning of stands, and application of beetle anti-aggregation pheromones such as verbenone and non-host volatiles. Public land managers, however, need operational evidence of efficacy and guidelines for implementation of such large-scale treatments. To that end, we initiated a 240-acre demonstration project (the

Smuggler Mountain Project) to test two pheromone formulations, verbenone alone and verbenone with green leaf volatiles, combined with removal of infested brood trees (sanitation), for protecting stands from attack by MPB. Conditions did not permit a randomized, replicated and controlled study, so we implemented an unreplicated project on public and private lands using an adjacent forest stand on the US Forest Service's White River National Forest as an untreated reference stand; a parcel of privately owned land on the western boundary was also included in the reference stand.

Materials and Methods.

Site. The study site, referred to as Smuggler Mountain, is located east of the City of Aspen and consists of a patchwork of ownerships, including Smuggler Mountain Open Space, managed jointly by the City of Aspen and Pitkin County; a privately held property north of Smuggler Mountain Open Space; a portion of the Aspen Ranger District of the White River National Forest east of Smuggler Mountain Open Space; a parcel owned by the Aspen Valley Land Trust north of Smuggler Mountain Open Space; and privately held lands west of Smuggler Mountain Open Space managed by Investlink Corporation (Fig. 1).

Brood tree removal. Infested trees (mass and strip-attacked trees) were identified and removed using snowmobile logging and helicopter logging during winter/spring months of 2010.

Pheromone applications.

1. **Verbenone Pouches.** Verbenone-releasing pouches were supplied by AgBio Inc. (Westminster, Colorado), a subsidiary of ChemTica International SA, which is located in Heredia, Costa Rica. Each pouch contained 6.75 grams of verbenone, and they were applied over 121 acres in Smuggler Mountain Open Space at the rate of 30 pouches/acre (202.5 grams AI/acre) by stapling them at a height of six feet to individual host trees in a 38 X 38 foot grid throughout the plot. Applications were made during the week of June 28, 2010.
2. **Verbenone + GLV Pouches.** Verbenone + GLV pouches were provided by Synergy Semiochemicals Corporation, located in Burnaby, British Columbia, Canada. Each verbenone pouch contained 6.75 grams of verbenone, and they were applied over 50 acres of private and Aspen Valley Land Trust properties at the rate of 30 pouches/acre (202.5 grams AI/acre) by stapling them at a height of six feet to individual host trees in a grid throughout the plot. GLV pouches were applied over the same acreage at a rate of 30 pouches per acre (150 grams AI/acre). Grid spacing for the combined VBN/GLV pouches was 27 X 27 feet, with alternating VBN/GLV applications at each gridpoint. Applications were made during the week of June 28, 2010.

Reference Stands. Untreated reference stands comprising a total of 78 acres were demarcated on White River National Forest lands adjacent to the pouch-treated plots (east and south of the treated stands), and on Investlink properties adjacent to the Smuggler Mountain Open Space plots (immediately to the west).

Efficacy Assessment and Statistical Analysis. A preliminary survey was conducted to locate every single tree attacked in 2009 or 2010 in each treatment area, including the reference stands; these were GPS-ed and a variable plot cruise was conducted adjacent to each in order to characterize stand structure and the rates of MPB attack in 2009 and 2010. To develop a database for unattacked trees, we cruised three variable-radius plots per acre

over the entire project area, for a total of more than 700 plots. The response variable for the analysis was the rate of MPB beetle attack in 2010 (categorized by type of attack: mass or strip); explanatory variables were rate of MPB beetle attack in 2009, stand basal area, lodgepole pine basal area, total trees/acre, lodgepole pines/acre, mean lodgepole DBH, and UTM coordinates (a surrogate for treatment, because treatments were not replicated). Responses were analyzed using ANOVA models to estimate and compare stand conditions, and logistic regression (Case-Control Technique) to relate the risk of MPB attack in 2010 to the following covariates: spatial location, rate of beetle attack in 2009, stand basal area, lodgepole pine basal area, total trees/acre, lodgepole pines/acre, and mean lodgepole pine diameter (DBH). We have shown the MPB attack rates as the ratio of 2010 to 2008 attack rates (Fig. 4) because that response variable removes the effect of differing stand structures for the three types of plots, which would otherwise confound treatment effects.

Discussion and Conclusions. The proportion of lodgepole pine trees attacked by MPB was at least 50% lower in 2010 in stands treated with brood tree removal (sanitation) and either of the pheromone formulations, VBN alone or VBN + GLV, compared to untreated reference stands. Verbenone treatments and brood tree removal were shown to mitigate bark beetle damage at Smuggler Mountain in 2009, and other recent, unpublished research clearly demonstrates that timely brood tree removal lowers attack rates when combined with verbenone. There are many published reports of experimental studies demonstrating the efficacy of verbenone applications *without* brood tree removal for mitigating MPB damage, and results of forest modeling studies strongly support the efficacy of brood tree removal *without* verbenone applications. There is, however, no experimental evidence directly comparing the efficacy of each technique independently of the other, and this knowledge gap should be addressed by future research so that forest land managers will have the necessary information to make optimal use of limited funds for bark beetle mitigation. In this project at Smuggler Mountain, brood tree removal combined with anti-aggregation pheromone applications resulted in a significantly lower proportion of trees being attacked by mountain pine beetles, and the two pheromone formulations were not significantly different from one another.

Acknowledgements. We thank officials from For the Forest, the City of Aspen, Pitkin County, and the Aspen Ranger District of the White River National Forest for providing fiscal and in-kind support for this project. We thank the City of Aspen, Pitkin County, the Aspen Ranger District of the White River National Forest, the Aspen Valley Land Trust, and Investlink Property for access to lands.

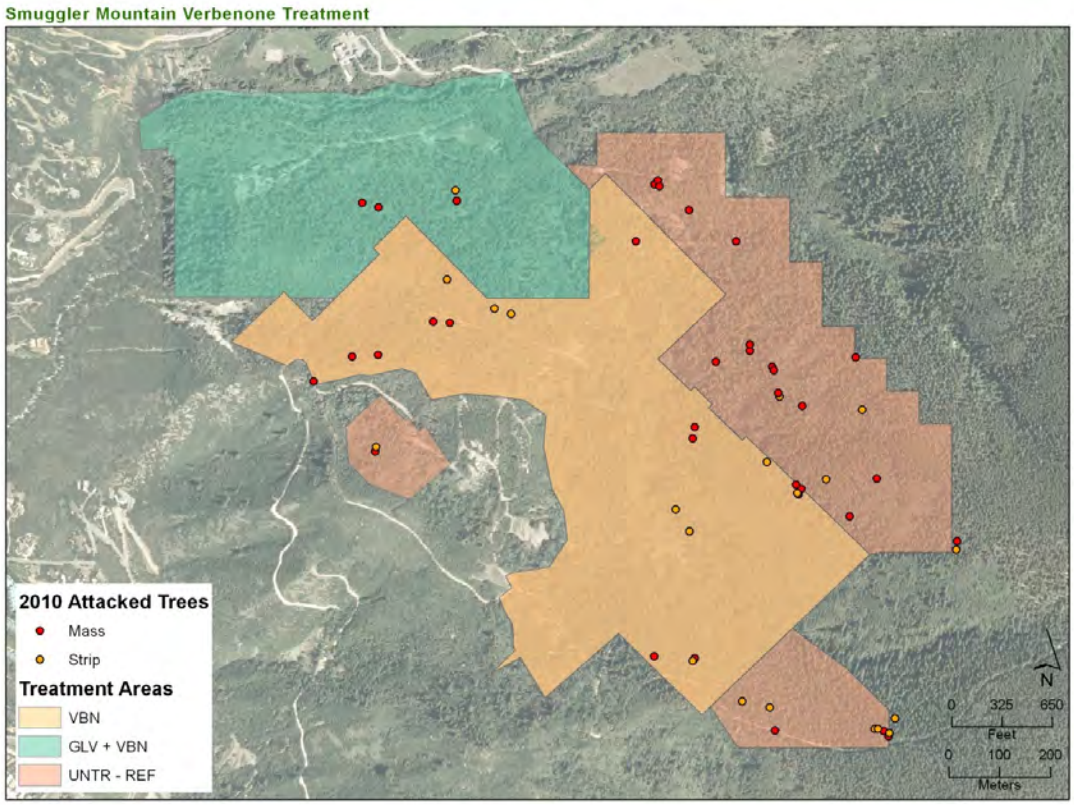


Fig. 1. Smuggler Mountain, 2010. Circles indicate trees attacked by MPB (red = mass-attack, orange = strip-attack).

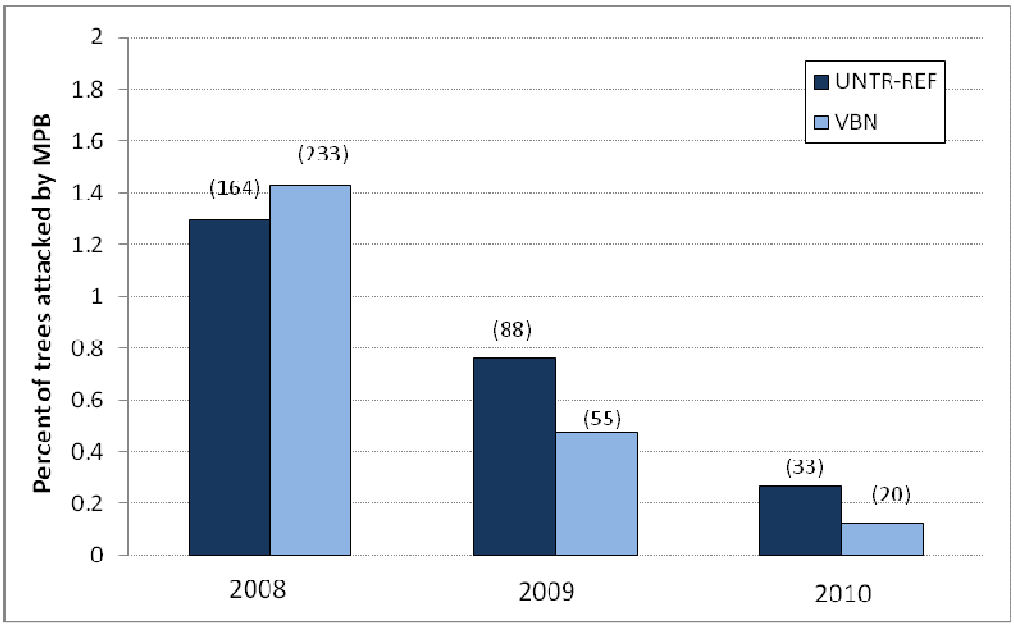


Fig. 2. Percent of trees mass- or strip-attacked by MPB in untreated and VBN-treated stands, 2008-2010. Numbers in parentheses indicate total number of trees attacked by MPB; acreages and stand densities were different in the two types of stand.

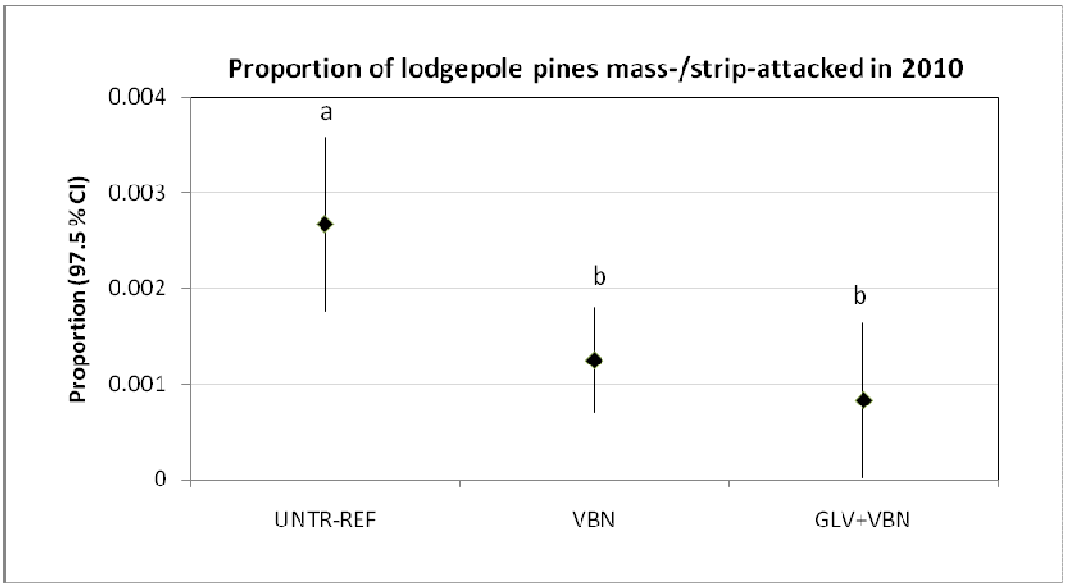


Fig. 3. Proportion of lodgepole pines mass- or strip-attacked by MPB, Aspen, CO, 2010. Means with same letter are not significantly different at an experiment-wise error rate of $\alpha = 0.10$ using the Bonferroni adjustment (i.e. the 97.5% confidence limits were used for multiple comparisons). UNTR-REF = untreated reference stands; VBN = Smuggler Mountain Open Space treated with verbenone pouches; VBN+GLV = private lands treated with verbenone pouches and GLV pouches.

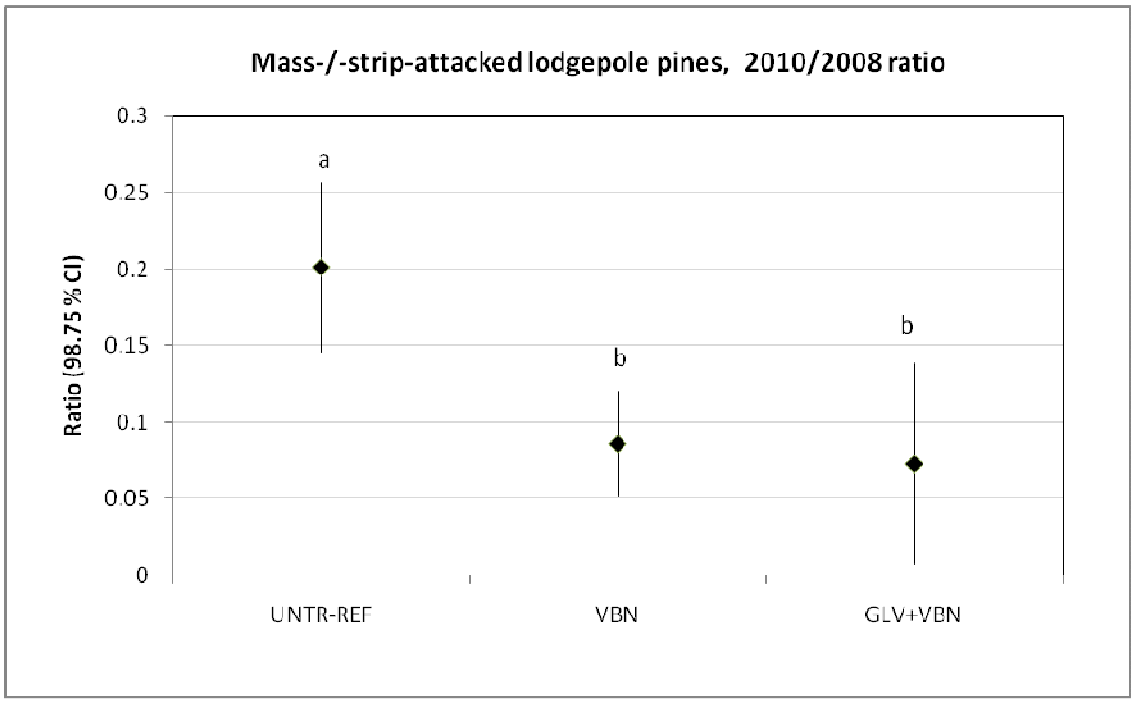


Fig. 4. Ratio of MPB attack rates (mass-attacked + strip-attacked) in 2010: 2080. This ratio provides a measure of the relative decline in attack rates with and without verbenone applications and brood tree removal, without the confounding effects of stand structure differences. Means with the same letter are not significantly different at an experiment-wise error rate of $\alpha = 0.05$ using the Bonferroni adjustment for multiple comparisons (i.e. the 98.75% confidence limits were used for multiple comparisons). UNTR-REF = untreated reference stands; VBN = Smuggler Mountain Open Space treated with verbenone pouches in 2010; VBN+GLV = private lands treated with verbenone pouches and GLV pouches in 2010.

Appendix C. Explanation of Risk Modelling

In order to assess susceptibility of the existing forest in the Smuggler Mountain Open Space project area, we integrated existing MPB hazard-rating systems with Geographical Information Systems (GIS) analysis to create an estimate of MPB hazard. This estimate of hazard is then utilized to target or prioritize areas of treatment immediately and into the 10-year planning future.

Geographical Information Systems (GIS) are an information technology that has been used in public policy-making for environmental and forest planning and decision-making over the past two decades (Bassole *et al.* 2001). GIS and related technologies provide foresters with powerful tools for record keeping, analysis and decision making.

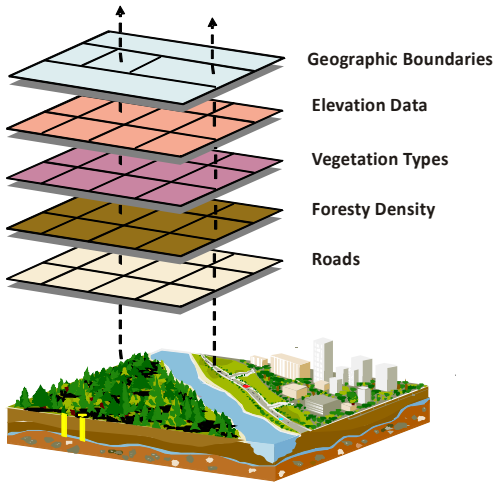
There are many reasons for the increasing trends towards GIS use by forestry professionals:

- Save time and money (computer time is less expensive than field time)
- Trustworthiness of technology (established data and models of analysis)
- Ease to update (forest is ever-changing)

Remove the "human" factor by evaluating data

A GIS can be used to organize and store information as a collection of thematic layers that can be linked by geography. Each layer contains features having similar attributes, like vegetation type and elevation that are located within the same geographic extent. This simple but extremely powerful and versatile concept (see example in Figure C.1) has made GIS an invaluable means of solving many real-world problems related to forestry and natural resources management.

Figure C.1.
Examples of layers in a GIS
for use in forest management



Methods

For our analysis of the Smuggler Mountain project area, we identified the US Forest Service Westwide Pine Beetle model as the best-fit model to suit our needs. The US Forest Service Westwide Pine Beetle model (WWPB; Beukema and others 1997;) utilizes the step-wise logic of the Randall and Tensmeyer risk rating system. For our purposes, a modified use of this model was utilized in performing analyses.

The WWPB model uses a set of sequential steps to determine a numerical hazard rating score. Factors considered in the hazard rating logic include:

- Percent of total basal area (BA) that is lodgepole pine
    - Basal area: the area of a given section of land that is occupied by the cross-section of tree trunks and stems at their base.
- Total stand basal area (BA)
- Total trees per acre (TPA)
- Average Diameter at breast height (DBH) of lodgepole pine
    - Diameter at breast height, or DBH: a standard method of expressing the diameter of the trunk or bole of a standing tree.

The data acquired for use in the WWPB model were created by Maggi Kelly at Kelly Geospatial Informatics as a contribution to the Smuggler Mountain analysis performed in 2009 by Dr. Nancy Gillette, with the Pacific Southwest Research Station in Albany, California to ascertain effectiveness of brood tree removal and verbenone treatment in June and July of 2009.

These data sets were plugged into a modified version of the Randall and Tensmeyer risk rating system (see Table C.1). The model was modified by removing steps that were not applicable to the project area.

Table C.1: Step-wise logic of the Randall and Tensmeyer risk rating system, as followed by the mpb_lpp_RT.kcp EM Addfile. Abbreviations used: BA = basal area; TPA = trees per acre; QMD = quadratic mean diameter.

Step	MPB in LPP Hazard Rating Logic (Performed stepwise)	Numerical Rating	Modified Rating	Hazard rating
1	If % BA LPP = 0	1	0	Ex. Low
2	If % of BA in LPP < 25%	2	1	Low
3	If stand BA <80 or >250 sq ft / acre	3	2	Low
4	If TPA > 3" is <100 or > 800	4	3	Low
5	If QMD of LPP > 5" DBH is < 6" DBH	5	4	Low
~~6~~	~~If elevation (in m) > Threshold A~~	~~6~~		~~Low~~
~~7~~	~~If stand age < 60 yrs~~	~~7~~		~~Low~~
8	If % of BA in LPP is 25-50%	8	5	Moderate
9	If stand BA is 80-120 sq ft / acre	9	6	Moderate
10	If TPA >3" is 100-300 or 600-800	10	7	Moderate
11	If QMD of LPP >5" DBH is < 8" DBH	11	8	Moderate
~~12~~	~~If elevation (in m) > Threshold B~~	~~12~~		~~Moderate~~
~~13~~	~~If stand age >= to 60 yrs and < 80 yrs~~	~~13~~		~~Moderate~~
14	Else	14	9	High

The decision to modify two of the model criteria was made for the following reasons:

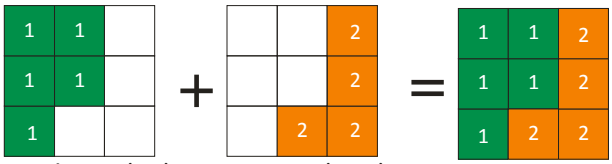
The elevation thresholds were not used because, according to the WWPB model; "These formulae come from relationships developed by Hopkins (1919), and used by Shore and Safranyik (1992). The relationship was developed from data primarily from the eastern U.S. and has not been validated for the western United States. The thresholds derived from these formulae thus ought to be considered only a first approximation. "

The other step removed from the model was the age of the stand. This was removed because the entire stand in our project area is over 80 years of age. This would automatically classify the entire stand as 'High' risk, and we would lose any variability in our model results. We already know that the entire area is highly susceptible to MPB attack,

which is why we are taking measures to treat the area in the first place. By removing the age criteria in the model, we are able to see variation across the stand that allows us to prioritize areas that would otherwise all be classified the same.

In order to understand the sequence of steps, we will look at a simple sample of our model. In our example, we have two of the steps in the model that help us determine vulnerability; basal area (BA) and tree diameter (DBH). (This example is simplified for the purpose of explanation.)

Once we have the necessary layers in the GIS (in this example, layers are basal area and tree diameter) they are combined to create a single hazard rating map. In order to do this we need a way to compare the values of classes between layers. An example of how we combine these data layers is shown below.



In the illustration, the two input layers have been reclassified according to the model. Each raster cell is assigned a number value. The cell values are combined together to create the output layer.

The results of the model are shown in the hazard rating map (Figure C.1). The results show areas of Low, Moderate, and High risk. The results of the model can be summarized according to the WWPB model: Hazard maps produced here are powerful tools for managers and planners at the geographic assessment level. Such maps help managers identify those areas that have the highest probability of significant mountain pine beetle mortality. Although hazard rating does not predict when mountain pine beetle will be active in a certain stand, experience has shown that beetles will eventually infest high-hazard stands (Randall and Tensmeyer, 2000).

In order to validate our use of the WWPB model we wanted to see how well our results reflected what our field knowledge and collected field data indicated. The foundation for most all MPB analyses are based on the criteria that; an increase in Basal Area (BA) and an increase in Diameter (DBH) lead to an increased risk of MPB attack. We took this simple assumption and re-ran our data model with only these two variables. Our results supported the use of the WWPB model in two ways. First, the areas identified as "Low" hazard in both models correlated very well, which means we aren't assessing any areas an "Low" that shouldn't be. Secondly, the areas identified as "Moderate" to "High" risk were similar, but more varied in the WWPB model, which means the WWPB model gives us a more refined set of locations to target for planning purposes.

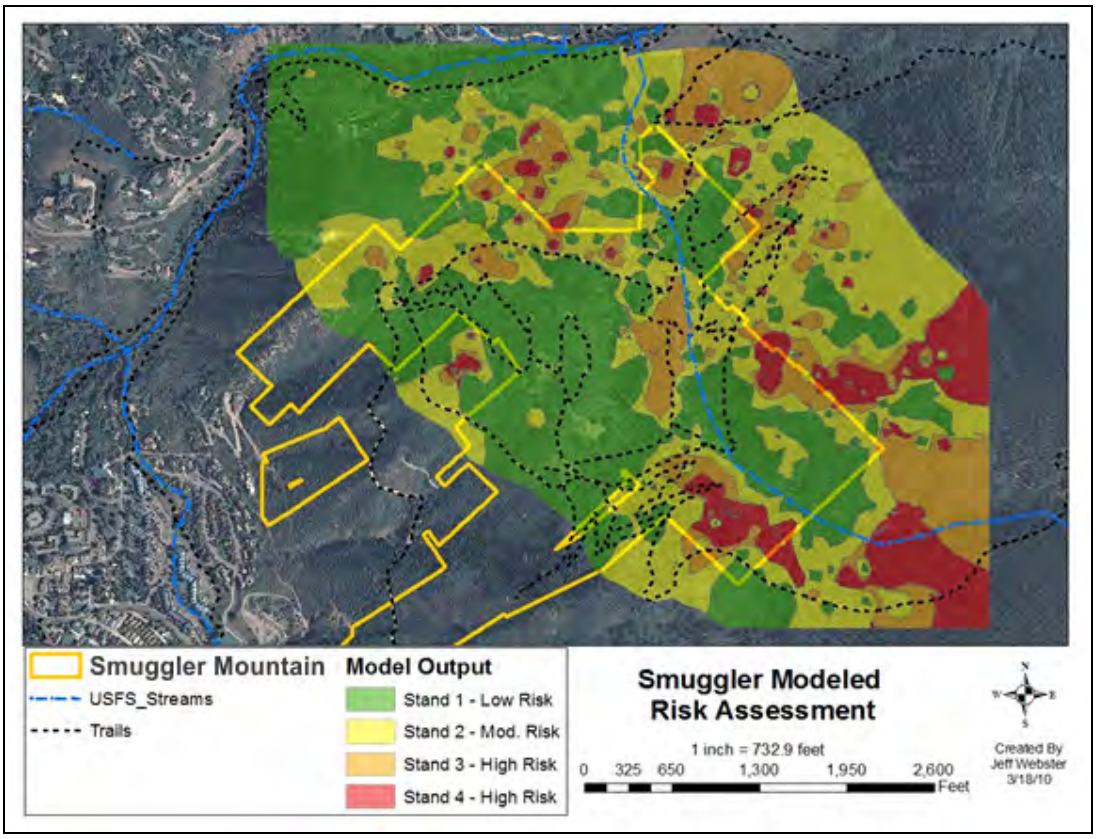


Figure C.1. Modeling results for the MPB risk rating assessment.

Next, the risk assessment data was intersected with existing field data including the 2008 attacked trees on Smuggler Mountain removed in June of 2008 and the 2009 attack trees on the entire Smuggler Mountain assessment area shown in Figure C.2. With the intersection of the data once can see how the activity coincides with the risk rating. The activity seems to be focused more in stand 3 as compared to stand 4. From analysis of inventory data this appears to be because the average stand DBH is higher in stand 3. The trees in stand 4 are smaller and less susceptible. Stand 4 has a higher ranking due to higher basal area.

These results were then used to develop specific regeneration unit recommendations.

One of the most important aspects of the model results is that it can be re-run if significant changes occur in the landscape. There is always the possibility that during the planning window any number of natural or human activities can drastically alter the landscape. These changes might necessitate a re-evaluation of the project area, which can easily be accomplished by re-running the model.

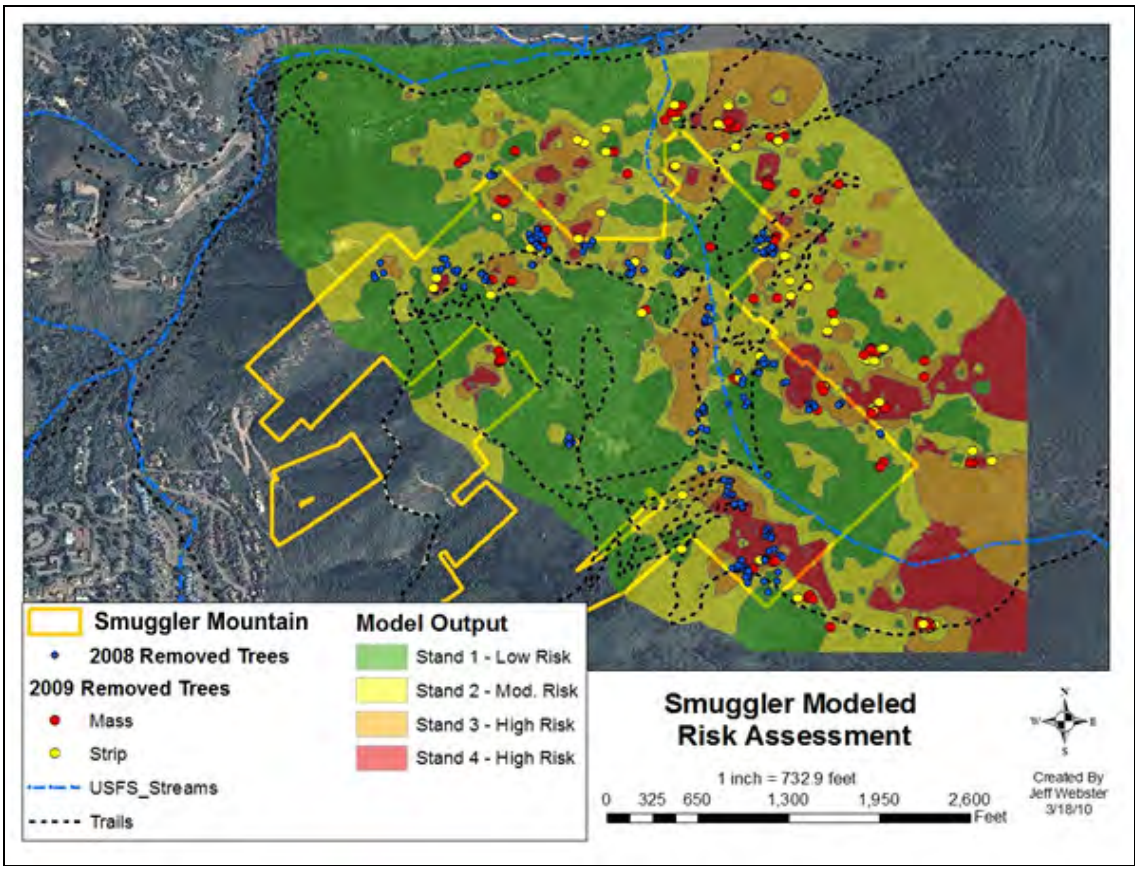


Figure C.2. Combination of risk rating model results and recent MPB activity.

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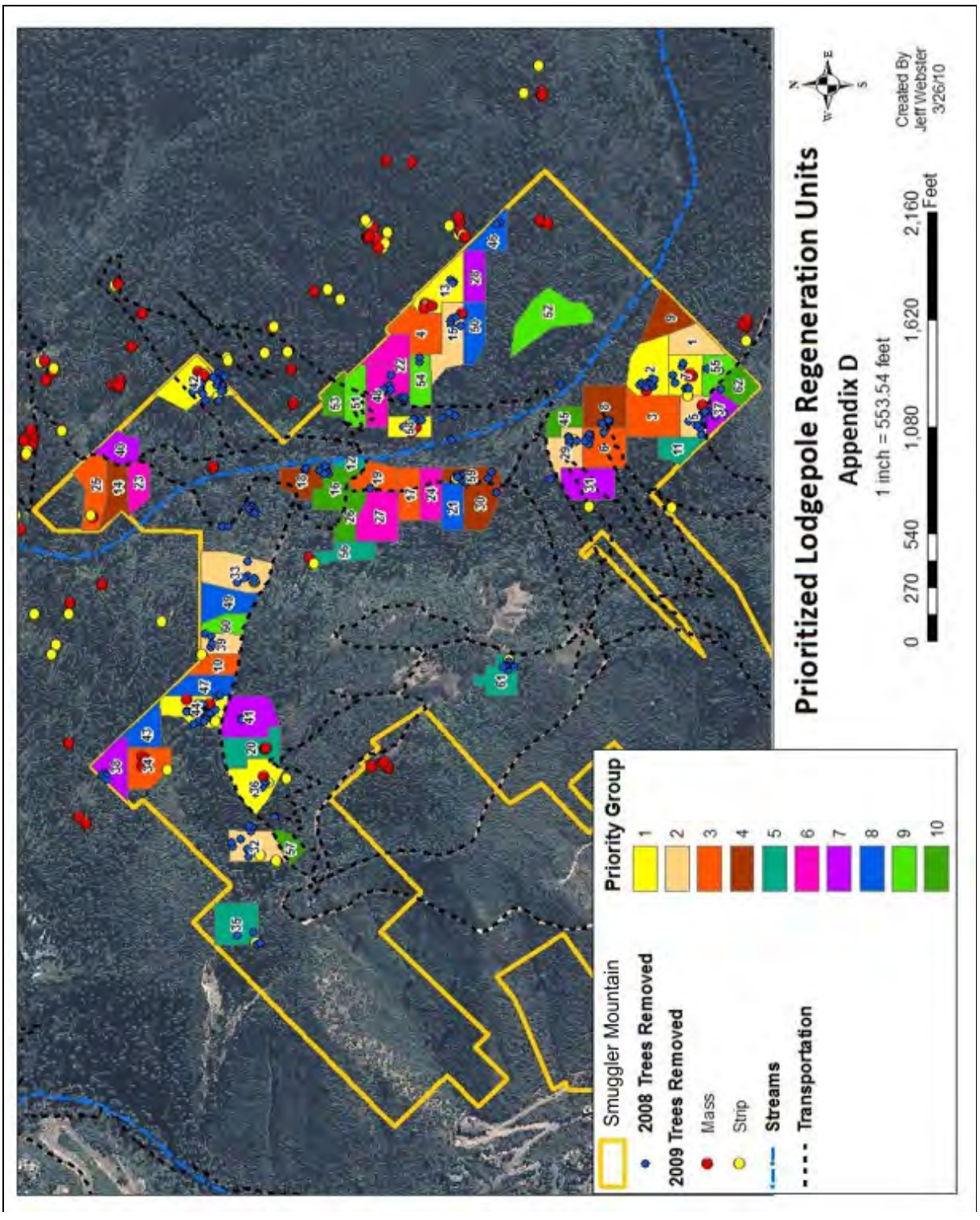
Appendix D. Proposed LP Regeneration Units by Treatment Group Priority

Unit	Acres	Priority	Entry Group	Risk Ranking	Comments
7	0.76	1	1	3.45	
2	1.21	2	1	3.63	
44	0.95	3	1	2.23	
42	1.15	4	1	2.25	
13	0.92	5	1	2.97	
36	1.01	6	1	2.44	
58	0.50	8	1	1.70	
	6.49				
5	0.62	10	2	3.52	
29	0.76	11	2	2.68	
39	0.47	12	2	2.29	
33	1.29	13	2	2.54	
1	0.66	14	2	3.74	
15	0.93	7	2	2.96	
32	0.87	9	2	2.56	
	5.61				
3	1.28	15	3	3.58	
34	0.87	16	3	2.53	
25	0.97	17	3	2.72	
19	0.62	18	3	2.87	
10	0.49	19	3	3.05	
4	0.98	20	3	3.53	
17	0.62	21	3	2.89	
6	1.00	21	3	3.51	
	6.83				
59	0.51	22	4	1.69	
14	0.68	23	4	2.97	
18	0.62	24	4	2.87	
30	0.83	25	4	2.66	
9	0.77	26	4	3.11	
8	1.00	27	4	3.23	
	4.41				
11	0.49	29	5	3.00	
12	0.18	30	5	2.99	
61	0.75	31	5	1.47	
56	0.68	32	5	1.75	
20	0.90	33	5	2.77	
35	1.00	34	5	2.45	
	4.00				
22	0.95	35	6	2.74	
48	0.75	36	6	2.03	
27	1.10	37	6	2.72	Thin, Big Trees?

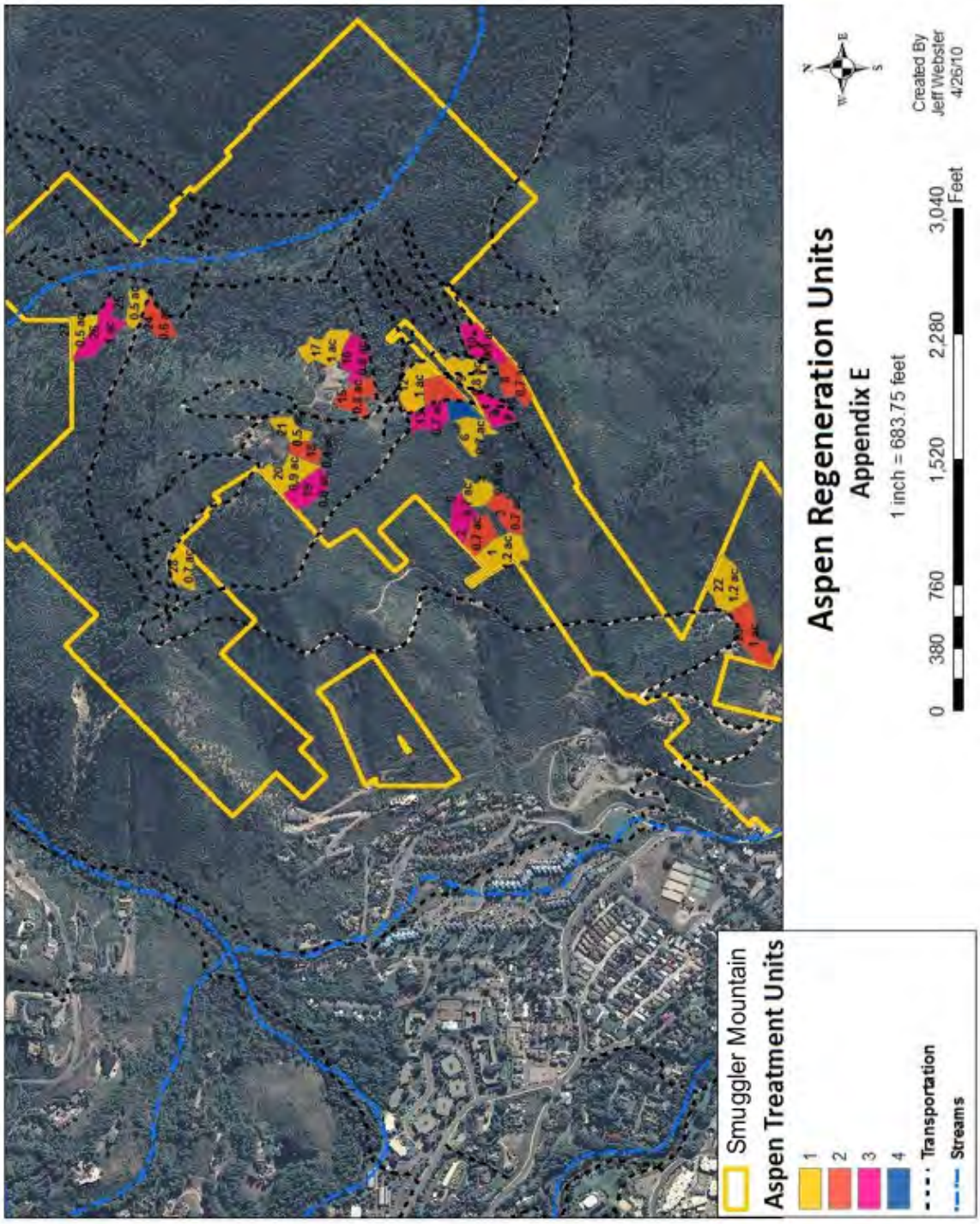
Unit	Acres	Priority	Entry Group	Risk Ranking	Comments
24	0.62	38	6	2.73	
23	0.54	39	6	2.74	
	3.96				
28	0.63	40	7	2.69	
31	0.90	41	7	2.64	
37	0.45	42	7	2.42	
38	0.73	43	7	2.34	
40	0.56	44	7	2.28	
41	1.15	45	7	2.26	
	4.42				
43	0.60	46	8	2.24	
21	0.58	46	8	2.75	
46	0.51	47	8	2.23	
47	0.66	48	8	2.07	
49	0.83	49	8	1.95	
50	0.69	50	8	1.93	
	3.88				
51	0.68	51	9	1.93	
52	1.43	52	9	1.90	
54	0.62	53	9	1.84	
55	0.51	54	9	1.76	
60	0.45	55	9	1.68	
	3.70				
53	0.42	57	10	1.88	
16	0.77	58	10	2.95	thin, Big Trees
45	0.47	59	10	2.23	Big Trees
26	0.54	60	10	2.72	Big Trees
57	0.34	61	10	1.73	
62	0.54	62	10	1.11	
	3.07				
Total Acres	**46.36**				
Average Unit	**0.75**				


Prioritized Lodgepole Regeneration Units
Appendix D
1 inch = 553.54 feet
0 270 540 1,080 1,620 2,160
Feet
Created By
Jeff Webster
3/26/10
Priority Group
1
2
3
4
5
6
7
8
9
10
Smuggler Mountain
2008 Trees Removed
2009 Trees Removed
Mass
Strip
Streams
Transportation

Appendix E.

Aspen Regeneration Units

Unit	Acres	Priority	Percent of Total Aspen	Comments
1	1.20	1		
6	0.72	1		
9	0.76	1		
12	0.98	1		
17	1.00	1		
20	0.94	1		
21	0.52	1		
28	0.73	1		
22	1.20	1		
25	0.52	1		
27	0.53	1		
4	0.57	1		
	9.67		**10%**	
2	0.68	2		
3	0.73	2		
8	0.74	2		
11	0.67	2		
15	0.80	2		
18	0.43	2		
23	0.99	2		
24	0.61	2		
	5.65		**6%**	
5	0.68	3		
7	0.69	3		
10	0.88	3		
13	0.74	3		
16	0.81	3		
19	0.83	3		
26	1.02	3		
	5.64		**6%**	
14	**0.41**	4	**0.4%**	
Total Proposed Regeneration Acres	**21.38**			
Total Aspen Acres	**97.00**			Need to determine stand type method to use to get these acres


Aspen Regeneration Units
Appendix E
1 inch = 683.75 feet
0 380 760 1,520 2,280 3,040
Feet
Created By
Jeff Webster
4/26/10
Smuggler Mountain
Aspen Treatment Units
1
2
3
4
Transportation
Streams

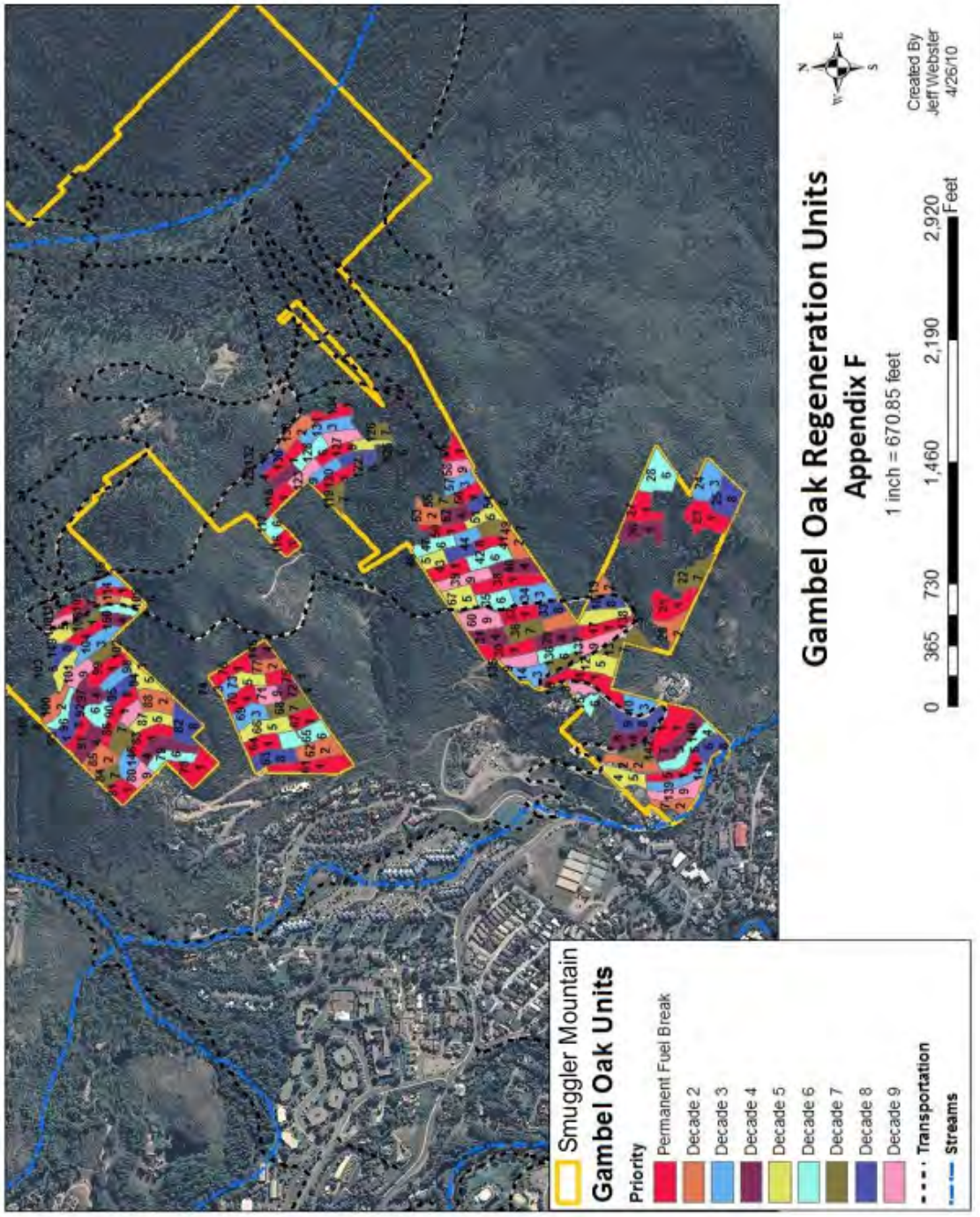
Appendix F. Gambel Oak Regeneration Units

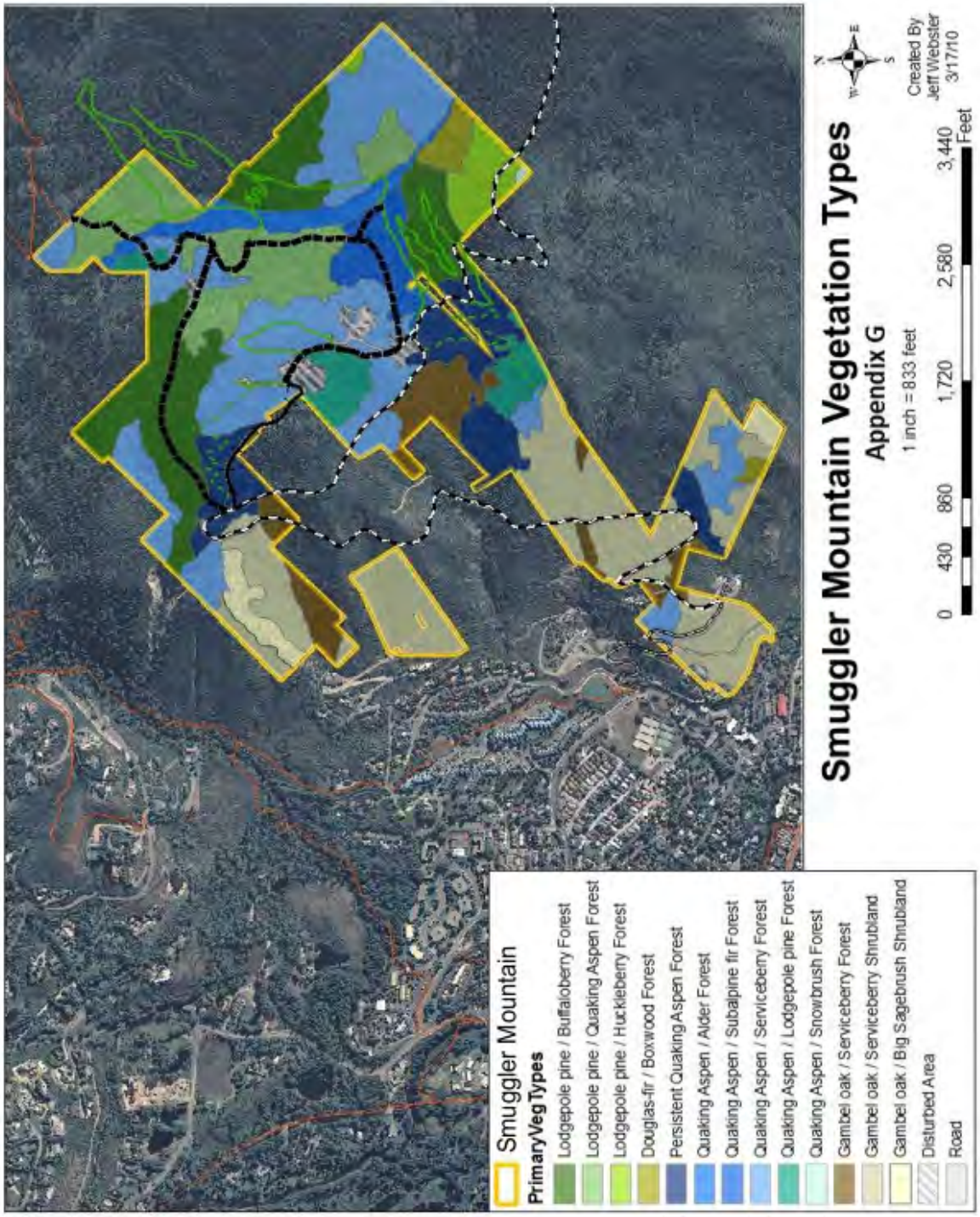
Unit	Acres	Decade	Percent of Gambel	Comments
1	0.82	1		
106	0.36	1		
11	0.79	1		
111	0.19	1		
114	0.25	1		
116	0.27	1		
118	0.32	1		
120	0.41	1		
124	0.35	1		
130	0.43	1		
134	0.32	1		
17	0.49	1		
21	0.77	1		
23	0.81	1		
27	0.56	1		
30	0.59	1		
32	0.45	1		
38	0.73	1		
43	0.47	1		
45	0.26	1		
5	0.45	1		
50	0.34	1		
56	0.29	1		
59	0.33	1		
61	0.76	1		
64	0.45	1		
67	0.34	1		
70	0.43	1		
75	0.25	1		
76	0.47	1		
78	0.63	1		
81	0.34	1		
83	0.54	1		
90	0.55	1		
93	0.32	1		
99	0.52	1		
	16.64		**27%**	
88	0.55	2		
85	0.49	2		
77	0.29	2		
7	0.30	2		
62	0.59	2		
53	0.39	2		
41	0.39	2		
20	0.37	2		
2	0.43	2		

Unit	Acres	Decade	Percent of Gambel	Comments
19	0.19	2		
144	0.35	2		
133	0.43	2		
113	0.16	2		
100	0.35	2		
	5.29		**9%**	
10	0.40	3		
104	0.55	3		
115	0.21	3		
121	0.32	3		
131	0.56	3		
14	0.43	3		
141	0.44	3		
147	0.33	3		
24	0.61	3		
34	0.60	3		
48	0.26	3		
57	0.35	3		
69	0.48	3		
74	0.23	3		
98	0.31	3		
	6.06		**10%**	
110	0.18	4		
129	0.29	4		
140	0.62	4		
145	0.27	4		
146	0.57	4		
150	0.27	4		
26	0.70	4		
29	0.57	4		
31	0.46	4		
40	0.51	4		
52	0.39	4		
72	0.26	4		
8	0.51	4		
91	0.47	4		
97	0.48	4		
	6.54		**11%**	
103	0.37	5		
108	0.24	5		
112	0.14	5		
12	0.55	5		
125	0.24	5		
138	0.46	5		
4	0.48	5		
46	0.30	5		

Unit	Acres	Decade	Percent of Gambel	Comments
51	0.32	5		
66	0.59	5		
67	0.50	5		
73	0.31	5		
87	0.45	5		
94	0.36	5		
	5.31		**9%**	
105	0.21	6		
117	0.26	6		
128	0.38	6		
136	0.41	6		
148	0.34	6		
15	0.21	6		
28	0.80	6		
3	0.55	6		
35	0.46	6		
42	0.55	6		
47	0.41	6		
65	0.65	6		
79	0.41	6		
92	0.42	6		
	6.06		**10%**	
102	0.30	7		
107	0.21	7		
119	0.30	7		
126	0.27	7		
13	0.43	7		
142	0.28	7		
143	0.25	7		
22	0.59	7		
36	0.50	7		
49	0.27	7		
55	0.25	7		
68	0.48	7		
84	0.29	7		
86	0.46	7		
	4.89		**8%**	
122	0.31	8		
132	0.24	8		
149	0.31	8		
18	0.33	8		
25	0.65	8		
33	0.29	8		
44	0.32	8		
54	0.26	8		
6	0.43	8		

Unit	Acres	Decade	Percent of Gambel	Comments
63	0.53	8		
82	0.59	8		
9	0.62	8		
95	0.35	8		
96	0.44	8		
	5.66		**9%**	
101	0.37	9		
109	0.16	9		
123	0.32	9		
127	0.36	9		
135	0.35	9		
137	0.42	9		
139	0.52	9		
16	0.18	9		
39	0.51	9		
58	0.33	9		
60	0.62	9		
71	0.34	9		
80	0.30	9		
89	0.28	9		
	5.05		**8%**	


Gambel Oak Regeneration Units
Appendix F
1 inch = 670.85 feet
0 365 730 1,460 2,190 2,920
Feet
Created By
Jeff Webster
4/26/10
Smuggler Mountain
Gambel Oak Units
Priority
Permanent Fuel Break
Decade 2
Decade 3
Decade 4
Decade 5
Decade 6
Decade 7
Decade 8
Decade 9
Transportation
Streams


Smuggler Mountain Vegetation Types
Appendix G
1 inch = 833 feet
0 430 860 1,720 2,580 3,440 Feet
Created By Jeff Webster 3/17/10
Smuggler Mountain
PrimaryVeg Types
Lodgepole pine / Buffaloberry Forest
Lodgepole pine / Quaking Aspen Forest
Lodgepole pine / Huckleberry Forest
Douglas-fir / Boxwood Forest
Persistent Quaking Aspen Forest
Quaking Aspen / Alder Forest
Quaking Aspen / Subalpine fir Forest
Quaking Aspen / Serviceberry Forest
Quaking Aspen / Lodgepole pine Forest
Quaking Aspen / Snowbrush Forest
Gambel oak / Serviceberry Forest
Gambel oak / Serviceberry Shrubland
Gambel oak / Big Sagebrush Shrubland
Disturbed Area
Road

SMOS Plan of Forest Activities: 2011

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Lodgepole Pine									
Brood Tree Removal (BTR)	Make Decision to do Brood Tree Removal (BTR)						Administrative	Oct or March	Should be done in Fall or Winter the previous year after fall evaluations going forward.
	Mark Brood Trees for Removal		120	ac			$1,200	May	Assumes finding location of GPS'd trees from fall 2010 monitoring v. covering entire property
	Layout Regeneration Units and mark any Green trees for removal to reach minimum opening size for species biological requirements (.75 acres)	36, 44, 32	3	ac			$600	May	See Appendix D for map table of unit priorities. OR other units as determined by current MPB activity
	Develop specific regeneration presriptions for each unit layed out						$600	May/June	
	Prospectus and Contracting for Tree Removal						Administrative	May	
	Removal of Brood Trees		20	tree	$250	$5,000	$5,000	May/June	Assumes only Tractor accessible trees removed
	Monitor Treatment, GPS attacked Trees, mark for Removal if possible		120	ac	$30	$3,600	$3,600	Sept/Oct	Same recommendation under Verbenone
	Evaluate GPS data and MPB activity, both on site and surrounding environment and make decision on BTR & Verbenone for 2012						Administrative	Oct-Feb	
	Ideally after data collection, make decision on BTR, if yes, it's best to do BTR in Fall/Winter						TBD	Oct-Dec	If BTR decided then Fall/Winter is best time to do BTR removal.
							$11,000		
Initiate Regeneration	Tree Removal (50 TPA) to create minimum size biological openings		150	ac	$250	$37,500	$37,500	June	Assumes about 50 trees per acre on 3 acres involving 3 units are being remove per regeneration unit to facilitate biological opening size
	Develop Prescriptions for Regeneration						$500	May/June	If no BTR or Verbenone, then Prescriptions need development here
	Implement Regeneration presriptions developed during BTR marking and unit layout	36, 44, 32					Administrative	June-Oct	Series of Steps to be layed out and applied during field season
	Do stocking surveys to monitor for regeneration						Administrative	Sept/Oct	
	Order Seedlings for 2012 Fall Plant? Ship Seed		1200	tree	$0.25	$300	TBD	Nov	Two species (LP & DF) minimum, 400 TPA on 3 acres
							$38,000		
Extend Life of Big Lodgepole	Identify and Delineate Stands to Protect Large Lodgepole pine	16, 26, 27					Administrative	Oct or June	
	Dispose of any Brood Trees each year within Stands no matter if done in other stands on SMOS		0	tree	$250	$0	$0	Oct/Nov or May/June	Cost dependant on Activity

SMOS Plan of Forest Activities: 2011

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
							$0		
Aspen									
Initiate Regeneration	Identify and create prescriptions for priority stands from proposed units list for implementation in 2012	Proposed Units 1-28	10	ac			Administrative	June-Aug	Look at all of suggested units for Aspen risk characteristics. Identify units needing treatment. See Appendix E for Map and list of units
	Develop detailed prescriptions for treatment		4	ac		$1,000	$1,000	Aug-Oct	Ideally different prescriptions for differernt conditions to design tests for first treatments to see what works best
	Investigate markets for any material developed						Administrative	Aug-Dec	Assuming some harvesting is done, having markets for material will reduce costs
							$1,000		
Gambel Oak									
Initiate Regeneration	Develop detailed prescriptions for treatment with Fire District personnel, Wildlife Biologist & Public	Permanent and 1st decade				$1,000	$1,000	Sept-Dec	
	Investigate markets for any material developed (chipping)						Administrative	Sept-Dec	
							$1,000		
Hazard Tree Removal									
	Remove 24 hazard trees identified in 2010		0	tree	$200	$0	$0	June-Sept	Was done in 2010, in house
	Evaluate half of the trail system for hazard trees						Administrative	June-Sept	Lollipop, Tootsie Roll and Smuggler Mountain Road
	Investigate markets and/or uses for the wood						Administrative	Sept-Dec	
							$0		
Monitoring									
	Work with Biologists and Foresters to develop objectives & methods for Monitoring					$2,000	$2,000	July-Dec	To implement a good monitoring program, defining objective is needed to determine methods of monitoring, quantitative v. qualitative
							$2,000		
Fire									
	Work on CWPP with Aspen Fire Protection District and USFS						Administrative	Jan-Dec	
							$0		
Transportation									
	Annual Road & Trail Inspection						Administrative	April-Oct	Assuming Brood Tree Removal, minimal repair will be needed for logging operations
							$0		

SMOS Plan of Forest Activities: 2011

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Socio Economic									
	Work with interested parties to contract for analysis of long-term fiber supply in Roaring Fork Valley						Administrative	Jan-Dec	Need markets for material to reduce costs
							$0		
Seed Bank									
	Collect Cones during Good Crop years		20	bushel	$75	$1,500	$1,500	Sept	Need local seed for LP, DF, subalpine fir and spruce. Good Crops do not occur every year.
	Get Cones Processed		20	bushel	$15	$300	$0	Sept-Dec	State willing to do
	Annual Storage Fee and Manage Inventory		100	lb	$1	$100	$0	Yearly	State willing to do
							$1,500		
Non Native Weeds									
	Control exotic weeds in regen areas						$1,000	Annual	
	Montitor known locations as needed						Administrative	Annual	
							$1,000		
					Total Cost		**$55,500**		

SMOS Plan of Forest Activities: 2012

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Lodgepole Pine									
Brood Tree Removal (BTR)	Make Decision to do Brood Tree Removal (BTR)						Administrative	April	Ideally should be done in Fall or Winter the previous year after fall evaluations going forward.
	Mark Brood Trees for Removal		120	ac			$1,200	May	Assumes finding location of GPS'd trees from fall 2011 monitoring v. covering entire property
	Layout Regeneration Units and mark any Green trees for removal to reach minimum opening size for species biological requirements (.75 acres)		3	ac			TBD	May	See Appendix D for map and table of unit priorities.
	Develop specific regeneration prespriptions for each unit layed out						TBD	May/June	
	Prospectus and Contracting for Tree Removal						Administrative	April/May	
	Removal of Brood Trees		20	tree	$250	$5,000	$5,000	May/June	Assumes only Tractor accessible trees removed. Estimated trees
	Evaluation of Treatment, GPS attacked Trees, mark for Removal if possible		120	ac	$30	$3,600	$3,600	Sept/Oct	Same recommendation under Verbenone
	Evaluate GPS data and MPB activity, both on site and surrounding environment and make decision on BTR & Verbenone for 2013						Administrative	Oct-Feb	Need to consider precipitation trend in decision is winter precipitation below or above "normal"? For how many years?
	Ideally after data collection, make decision on BTR, if yes, it's best to do BTR in Fall/Winter						Administrative	Oct-Dec	If BTR decided then Fall/Winter is best time.
							$9,800		
Verbenone Application	Make Decision to do Verbenone Application						Administrative	April	
	Determine acres of application and delineate on the ground						Administrative	April	Property boundaries need delineation on the ground
	Determine Material type, pouches or flakes						Administrative	April	
	Determine Application Method, aerial or ground						Administrative	April	
	Order Verbenone		3600	pouch	$7	$25,200	Administrative	April	120 acres at 30 pouches per acre for 210 grams of active ingredient per acre. Cheaper to go with Bio-flakes ($24,000)
	Prospectus and Contracting for Verbenone Application						Administrative	May	
	Flag Boundary of Verbenone application, especially property lines					$1,000	Administrative	May	Depends on Results of Fall Surveys

SMOS Plan of Forest Activities: 2012

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Application		120	ac	$75	$9,000	Administrative	June/July	Application of bioflakes may be cheaper $6,000
	Evaluation of Application, GPS attacked Trees, mark for Removal if possible						Administrative	Sept/Oct	Cost Accounted for under BTR
	Evaluate GPS data and MPB activity and make decision on BTR & Verbenone for 2012						Administrative	Oct-Feb	
								$0	
Initiate Regeneration	Tree Removal (50 TPA) to create minimum size biological openings		150	ac	$250	$37,500	TBD	June	Assumes about 50 trees per acre on 3 acres involving 3 units are being remove per regeneration unit to facilitate biological opening size
	Develop Prescriptions						Administrative	May/June	If no BTR or Verbenone, then Prescriptions need development here
	Implement Regeneration presriptions developed during BTR marking and unit layout		3	ac			Administrative	June-Oct	Series of Steps to be layed out and applied during field season
	Spray (4' radius circles 200 spots/ac)		3	ac	$300	$900	TBD	June/July	Assuming spraying is used as decided from tests then implement
	Scarification of Planting Spots (4' Radius, 200/ac)		3	ac	$1,500	$4,500	TBD	Aug.	
	Plant		3	ac	$150	$450	TBD	Sept	Before soil temps drop below 40 degrees
	Identify Nursery for Seedling Order						Administrative	June-Oct	Look for Container nursery to order stock
	Do stocking surveys to monitor for regeneration						Administrative	Sept/Oct	
	Order Seedlings for 2013 Fall Plant?		1200	tree	$0.25	$300	TBD	Nov/Dec	Two species (LP & DF) minimum, 400 TPA on 3 acres
								$0	
Extend Life of Big Lodgepole	Thin Stands identified with Big Lodgepole to reduce density		200	tree	$200	$40,000	DMPB	Oct or June	Assumes 5 acres and removal of 40 trees per acre
	Where ever any trees are removed Verbenone needs to be applied		5	ac			TBD	June/July	If thinning is done verbeone needs to be applied if SMOS as a whole is not treated
	Order & Apply Verbenone to Identified Large Lodgepole stands each year		5	ac	$350	$1,750	DMPB	June/July	Assumes 30 pouches per acre or flakes at 210 grams active ingredient per acre material and application, assuming MPB are elevated above 1% of hosts within stand and outside SMOS
	Dispose of any Brood Trees each year within Stands no matter if done in other stands on SMOS		5	ac			DMPB	Oct/Nor or May/June	Cost dependant on Activity
								$0	
Aspen									

SMOS Plan of Forest Activities: 2012

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Initiate Regeneration	Decide on Units for treatment in 2013	See Appendix E	4	ac			Administrative	June-Aug	Identify units needing treatment. See Appendix E for map and unit list. Need to treat 10 acres per decade.
	Layout units for Treatment in 2013		4	ac			TBD	May-June	Ideally done in 2012 ready for 2013
	Develop detailed prescriptions for treatment		4	ac		$500	TBD	May-June	Ideally different prescriptions for differernt conditions to design tests for first treatments to see what works best
	Update maps for treatment						Administrative		
	Investigate markets for any material developed						Administrative	Aug-Dec	Assuming some harvesting is done, having markets for material will reduce costs
	Develop prospectuses and contracts for implementation in 2013						Administrative	Jan-May	
							$0		
Gambel Oak									
Initiate Regeneration	Survey property lines to facilitate layout					$10,000	TBD	July-Sept	Lines need to be surveyed to avoid any liability & trespass issues
	Layout units to treat in 2012	Two 4 acre Units	8	ac	$250	$500	$500	July-Oct	assumes 4 units at .75 ac/unit average. Assumes that 21 acres need to be treated for the decade and 8 years remaining in decade to treat.
	Develop prospectuses and contracts for implementation in 2012						Administrative	Sept-Dec	
	Cut and Treat stumps, hand pile and cover piles for burning or chip.		8	ac	$2,000	$16,000	$16,000	June-July	Needs to be done no later that Mid August to allow for drying to facilitate burning.
	Burn piles		8	ac	$500	$4,000	$4,000	Nov-Dec	Burn after adequate rain or snow
	Rake piles to spread ash, apply native seeds		8	ac	$250	$2,000	$2,000	Nov or April	Spread seed in fall after burning or in spring
							$22,500		
Hazard Tree Removal									
	Remove hazard trees identified in 2011		20	tree	$200	$4,000	TBD	June-Sept	Tree Number is an estimate
	Evaluate half trail system for hazard trees						Administrative	June-Sept	
	Investigate markets and/or uses for the wood						Administrative	Sept-Dec	
							$0		
Monitoring									
	Implement Monitoring Plan, make decision on methods based on detailed objectives						Administrative	Jan-March	Need to decide if want to install all permanent plots in one year or distribute over 10 year. Recommend all at once. At least before treatment

SMOS Plan of Forest Activities: 2012

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Put out prospectuses for installation of permanent plots						Administrative	Jan-March	
	Install Permanent plots		23	plots	$500	$11,500	$11,500	Seasonal	Depending on objectives
	Install Wildlife Transects		30	transects	$500	$15,000	$15,000	Seasonal	Depending on objectives
	Evaluate effectiveness of Erosion control measures installed in 2010						TBD	Spring	Assumes road repair done in 2010
							$26,500		
Fire									
	Determine rate of implementation and units to treat, primarily Gambel oak						Administrative	July-Dec	
	Layout Gambel oak units to treat in 2012		4	acres			TBD	July-Oct	Cost covered in Gambel oak regeneration
	Decide on Fire protection measures for implementation, apply for grant funding						Administrative	July-Oct	Decisions and application timing driven by grant application timelines
							$0		
Transportation									
	Annual Road & Trail Inspection						Administrative	May-June	Assuming Brood Tree Removal, minimal repair will be needed for logging operations
							$0		
Socio Economic									
	Apply for Grant funding for Long-term Fiber supply analysis						Administrative	Jan-Dec	May need to contract
							$0		
Seed Bank									
	Collect Cones during Good Crop years		20	bushel	$75	TBD	TBD	Sept	Need local seed for LP, DF, subalpine fir and spruce. Good Crops do not occur every year.
	Get Cones Processed		20	bushel	$15	TBD	TBD	Sept-Dec	
	Annual Storage Fee and Manage Inventory		100	lb	$1	TBD	TBD	Yearly	
							$0		
Non Native Weeds									
	Control exotic weeds in regen areas						$1,000	Annual	
	Montitor known locations as needed						Administrative	Annual	
							$1,000		
					Total Cost		**$59,800**		

SMOS Plan of Forest Activities: 2013

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Lodgepole Pine									
Brood Tree Removal (BTR)	Make Decision to do Brood Tree Removal (BTR)						Administrative	April	Ideally should be done in Fall or Winter the previous year after fall evaluations going forward. Potentially do Brood Tree Removal in Fall/Winter
	Mark Brood Trees for Removal		120	ac			$1,200	May	
	Layout Regeneration Units and mark any Green trees for removal to reach minimum opening size for species biological requirements (.75 acres)		3	ac			TBD	May	See Appendix D for map table of unit priorities. OR other units as determined by current MPB activity
	Develop specific regeneration prespriptions for each unit layed out						TBD	May/June	
	Prospectus and Contracting for Tree Removal						Administrative	May	
	Removal of Brood Trees		20	tree	$250	$5,000	$5,000	May/June	Assumes only Tractor accessible trees removed. Trees estimated
	Evaluation of Application, OR monitor MPB Populations, GPS attacked Trees, mark for Removal if possible		120	ac	$30	$3,600	$3,600	Sept/Oct	Same recommendation under Verbenone
	Evaluate GPS data and MPB activity, both on site and surrounding environment and make decision on BTR & Verbenone for 2014						Administrative	Oct-Feb	
	Ideally after data collection, make decision on BTR, if yes, it's best to do BTR in Fall/Winter						Administrative	Oct-Dec	If BTR decided then Fall/Winter is best time.
							$9,800		
Verbenone Application	Make Decision to use Verbenone or not						Administrative	April	
	Determine acres of application and delineate on the ground & GIS/GPS						Administrative	April	Property boundaries need delineation on the ground
	Determine Material type, pouches or flakes						Administrative	April	
	Determine Application Method, aerial or ground						Administrative	April	
	Order Verbenone		TBD	TBD	TBD	TBD	Administrative	April	120 acres at 30 pouches per acre for 210 grams of active ingredient per acre
	Prospectus and Contracting for Verbenone Application						Administrative	May	
	Flag Boundary of Verbenone application, especially property lines					TBD	Administrative	May	Depends on Results of Fall Surveys
	Application		TBD	TBD	TBD	TBD	Administrative	June/July	

SMOS Plan of Forest Activities: 2013

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Evaluation of Application OR MPB population GPS attacked Trees, mark for Removal if possible						Administrative	Sept/Oct	Cost Accounted for under BTR
	Evaluate GPS data and MPB activity and make decision on BTR & Verbenone for 2014						Administrative	Oct-Feb	
						$0	**$0**		
Initiate Regeneration	Tree Removal (50 TPA) to create minimum size biological openings		150	ac	$250	$37,500	TBD	June	Assumes about 50 trees per acre on 3 acres involving 3 units are being remove per regeneration unit to facilitate biological opening size
	Develop Prescriptions						Administrative	May/June	If no BTR or Verbenone, then Prescriptions need development here
	Implement Regeneration presriptions developed during BTR marking and unit layout		3	ac			Administrative	June-Oct	Series of Steps to be layed out and applied during field season
	Spray (4' radius circles 200 spots/ac)		3	ac	$300	$900	TBD	June/July	Assuming spraying is used as decided from tests then implement
	Scarification of Planting Spots (4' Radius, 200/ac)		3	ac	$1,500	$4,500	TBD	Aug.	
	Plant		3	ac	$150	$450	TBD	Sept	Before soil temps drop below 40 degrees
	Identify Nursery for Seedling Order						Administrative	June-Oct	
	Do stocking surveys to monitor for regeneration						Administrative	Sept/Oct	
	Order Seedlings for 2014 Fall Plant?		1200	tree	$0.25	$300	TBD	Nov	Two species (LP & DF) minimum, 400 TPA on 6 acres
							$0		
Extend Life of Big Lodgepole	Thin Stands identified with Big Lodgepole to reduce density		200	tree	$200	$40,000	TBD	Oct or June	Assumes 5 acres and removal of 40 trees per acre, done in 2011?
	Where ever any trees are removed Verbenone needs to be applied		5	ac			TBD	June/July	If thinning is done verbeone needs to be applied if SMOS as a whole is not treated
	Order & Apply Verbenone to Identified Large Lodgepole stands each year		5	ac	$350	$1,750	TBD	June/July	Assumes 30 pouches per acre or flakes at 210 grams active ingredient per acre material and application, assuming MPB are elevated above .5-1% of hosts within stand and outside SMOS. Rate of application depends on MPB activity
	Dispose of any Brood Trees each year within Stands no matter if done in other stands on SMOS		5	ac			DMPB	Oct/Nor or May/June	Cost dependant on MPB Activity
							$0		
Aspen									

SMOS Plan of Forest Activities: 2013

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Initiate Regeneration	Decide on Units for treatment, assuming necessary	Treat one 5 acre unit	5	ac			Administrative	April	Identify units needing treatment. See Appendix E for map and unit list. Need to treat 10 acres per decade.
	Survey property lines to facilitate layout						TBD	July-Sept	Lines surveyed in 2012?
	Layout units for Treatment in 2013		5	ac		$500	$500	May	Ideally done in 2012
	Develop detailed prescriptions for treatment	See Appendix E for Units	5	ac		$500	$500	Aug-Oct	
	Update maps for treatment						Administrative	Nov-Dec	
	Investigate markets for any material developed						Administrative	Aug-Dec	Assuming some harvesting is done, having markets for material will reduce costs
	Develop prospectuses and contracts for implementation in 2013						Administrative	May-June	
	Cut and Dispose of Trees		250	trees	$200	$50,000	$50,000	June-Sept	
							$51,000		
Gambel Oak									
Initiate Regeneration	Survey property lines to facilitate layout						TBD	July-Sept	Lines surveyed in 2012?
	Layout units for Treatment in 2013	See Appendix F For Units	4	ac	$250	$1,000	TBD	July-Oct	assumes 4 units at .75 ac/unit average. Assumes that 21 acres need to be treated for the decade and 8 years remaining in decade to treat.
	Develop prospectuses and contracts for implementation in 2013						Administrative	Sept-Dec	
	Cut and Treat stumps, hand pile and cover piles for burning or chip.		4	ac	$2,000	$8,000	TBD	June-July	Needs to be done no later that Mid August to allow for drying to facilitate burning.
	Burn piles		4	ac	$500	$2,000	TBD	Nov-Dec	Burn after adequate rain or snow
	Rake piles to spread ash, apply native seeds		4	ac	$500	$2,000	TBD	Nov or April	Spread seed in fall after burning or in spring
	Monitor treatments						Administrative		
							$0		
Hazard Tree Removal									
	Remove hazard trees identified in 2012		20	tree	$200	$4,000	TBD	June-Sept	Tree Number is an estimate
	Evaluate half of the trail system for hazard trees						Administrative	June-Sept	
	Investigate markets and/or uses for the wood						Administrative	Sept-Dec	
							$0		
Monitoring									
	Implement Monitoring Plan						Administrative	Jan-Dec	Finish installation of plots if necessary
	Install Permanent plots		23	plots	$500	$11,500	TBD	Seasonal	Finish installation of plots if necessary

SMOS Plan of Forest Activities: 2013

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Install Wildlife Transects		30	transects	$500	$15,000	TBD	Seasonal	Finish installation of plots if necessary
	Evaluate effectiveness of Erosion control measures						TBD	Spring	Annual evaluation, schedule repair if needed
							$0		
Fire									
	Determine rate of implementation and units to treat, primarily Gambel oak	See Appendix F For Units					Administrative	July-Dec	See Gambel oak regeneration
	Layout Gambel oak units to treat in 2013		4	acres			TBD	July-Oct	Cost covered in Gambel oak regeneration
	Decide on Fire protection measures for implementation, apply for grant funding						Administrative	July-Oct	Decisions and application timing driven by grant application timelines
							$0		
Transportation									
	Annual Road & Trail Inspection						Administrative	May-June	Assuming Brood Tree Removal, minimal repair will be needed for logging operations
							$0		
Socio Economic									
	Assuming Grant funding found, initate Long term fiber supply analysis						Administrative	Jan-Dec	
	Develop prospectus and contract for supply analysis						Administrative	Jan-April	
	Contract for Supply Analysis					TBD	TBD	May-Dec	
	Administer supply analysis contract						Administrative	May-Dec	
							$0		
Seed Bank									
	Collect Cones during Good Crop years		20	bushel	$75	$1,500	TBD	Sept	Need local seed for LP, DF, subalpine fir and spruce. Good Crops do not occur every year.
	Get Cones Processed		20	bushel	$15	$300	TBD	Sept-Dec	
	Annual Storage Fee and Manage Inventory		100	lb	$1	$100	TBD	Yearly	
							$0		
Non Native Weeds									
	Control exotic weeds in regen areas						$1,000	Annual	
	Montitor known locations as needed						Administrative	Annual	
							$1,000		
					Total Cost		**$61,800**		

SMOS Plan of Forest Activities: 2014

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Lodgepole Pine									
Brood Tree Removal (BTR)	Make Decision to do Brood Tree Removal (BTR)						Administrative	April	Ideally should be done in Fall or Winter the previous year after fall evaluations going forward. Potentially do Brood Tree Removal in Fall/Winter
	Mark Brood Trees for Removal		120	ac			$1,200	May	
	Layout Regeneration Units and mark any Green trees for removal to reach minimum opening size for species biological requirements (.75 acres)	DMPB	3	ac			TBD	May	See Appendix D for map table of unit priorities. OR other units as determined by current MPB activity
	Develop specific regeneration prespriptions for each unit layed out	DMPB					TBD	May/June	
	Prospectus and Contracting for Tree Removal						Administrative	May	
	Removal of Brood Trees	DMPB	20	tree	$250	$5,000	$5,000	May/June	Assumes only Tractor accessible trees removed, trees estimated
	Evaluation of Application, OR monitor MPB Populations, GPS attacked Trees, mark for Removal if possible		120	ac	$30	$3,600	$3,600	Sept/Oct	Same recommendation under Verbenone
	Evaluate GPS data and MPB activity, both on site and surrounding environment and make decision on BTR & Verbenone for 2015						Administrative	Oct-Feb	
	Ideally after data collection, make decision on BTR, if yes, it's best to do BTR in Fall/Winter						Administrative	Oct-Dec	If BTR decided then Fall/Winter is best time.
							$9,800		
Verbenone Application	Make Decision to do Verbenone Application						Administrative	April	
	Determine acres of application and delineate on the ground & GIS/GPS						Administrative	April	Property boundaries need delineation on the ground
	Determine Material type, pouches or flakes						Administrative	April	

SMOS Plan of Forest Activities: 2014

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Determine Application Method, aerial or ground						Administrative	April	
	Order Verbenone		TBD	TBD	TBD	TBD	Administrative	April	Rate to be determined by MPB activity level
	Prospectus and Contracting for Verbenone Application						Administrative	May	
	Flag Boundary of Verbenone application, especially property lines					TBD	Administrative	May	Depends on Results of Fall Surveys
	Application		TBD	TBD	TBD	TBD	Administrative	June/July	
	Evaluation of Application OR MPB population GPS attacked Trees, mark for Removal if possible						Administrative	Sept/Oct	Cost Accounted for under BTR
	Evaluate GPS data and MPB activity and make decision on BTR & Verbenone for 2014						Administrative	Oct-Feb	
						$0	**$0**		
Initiate Regeneration	Tree Removal (50 TPA) to create minimum size biological openings	DMPB	150	ac	$250	$37,500	TBD	June	Removal of trees will depend on MPB activity
	Develop Prescriptions						Administrative	May/June	If no BTR or Verbenone, then Prescriptions need development here
	Implement Regeneration presriptions developed during BTR marking and unit layout	See Appendix D For Units	3	ac			Administrative	June-Oct	Series of Steps to be layed out and applied during field season
	Spray (4' radius circles 200 spots/ac)		3	ac	TBD	TBD	TBD	June/July	Assuming spraying is used as decided from tests then implement
	Scarification of Planting Spots (4' Radius, 200/ac)		3	ac	TBD	TBD	TBD	Aug.	
	Plant		3	ac	$150	$450	TBD	Sept	Before soil temps drop below 40 degrees
	Identify Nursery for Seedling Order						Administrative	June-Oct	
	Do stocking surveys to monitor for regeneration						Administrative	Sept/Oct	
	Order Seedlings for 2014 Fall Plant		$1,200	tree	$0.25	$300	$300	Nov	Two species (LP & DF) minimum, 400 TPA on 6 acres
							$300		

SMOS Plan of Forest Activities: 2014

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Extend Life of Big Lodgepole	Thin Stands identified with Big Lodgepole to reduce density		200	tree	$200	$40,000	$40,000	Sept/Oct or June	Assumes 5 acres and removal of 40 trees per acre
	Where ever any trees are removed Verbenone needs to be applied		5	ac			$500	June/July	Depends on MPB Activity
	Order & Apply Verbenone to Identified Large Lodgepole stands each year		5	ac	$350	$1,750	$1,750	June/July	Depends on MPB Activity
	Dispose of any Brood Trees each year within Stands no matter if done in other stands on SMOS		5	ac			DMPB	Oct/Nor or May/June	Cost dependant on MPB Activity
							$42,250		
Aspen									
Initiate Regeneration	Decide on Units for treatment, assuming necessary	2	2	ac			Administrative	April	Identify units needing treatment. See Appendix E for map and unit list. Need to treat 10 acres per decade.
	Layout units for Treatment in 2014		2	ac			TBD	May	Ideally done in 2012
	Develop detailed prescriptions for treatment		2	ac		$1,000	TBD	Aug-Oct	Develop prescriptions based on results of treatments in 2012
	Update maps for treatment						Administrative	Nov-Dec	
	Investigate markets for any material developed						Administrative	Aug-Dec	Assuming some harvesting is done, having markets for material will reduce costs
							$0		
Gambel Oak									
Initiate Regeneration	Survey property lines to facilitate layout						TBD	July-Sept	Lines surveyed in 2011
	Layout units for Treatment in 2014	See Appendix F For Units	4	ac	$250	$1,000	TBD	July-Oct	assumes 4 units at .75 ac/unit average. Assumes that 21 acres need to be treated for the decade and 8 years remaining in decade to treat.
	Evaluate 2013 Treatments						Administrative	July-Sept	
	Develop prospectuses and contracts for implementation in 2014						Administrative	Jan-March	

SMOS Plan of Forest Activities: 2014

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Cut and Treat stumps, hand pile and cover piles for burning or chip.		4	ac	$2,000	$8,000	TBD	June-July	Needs to be done no later that Mid August to allow for drying to facilitate burning.
	Burn piles		4	ac	$500	$2,000	TBD	Nov-Dec	Burn after adequate rain or snow
	Rake piles to spread ash, apply native seeds		4	ac	$500	$2,000	TBD	Nov or April	Spread seed in fall after burning or in spring
								$0	
Hazard Tree Removal									
	Remove hazard trees identified in 2013		20	tree	$200	$4,000	TBD	June-Sept	Tree Number is an estimate
	Evaluate half of the trail system for hazard trees						Administrative	June-Sept	
	Investigate markets and/or uses for the wood						Administrative	Sept-Dec	
								$0	
Monitoring									
	Implement Monitoring Plan						Administrative	Jan-Dec	Finish installation of plots if necessary
	Install Permanent plots						TBD	Seasonal	Finish installation of plots if necessary
	Install Wildlife Transects						TBD	Seasonal	Finish installation of plots if necessary
	Evaluate effectiveness of Erosion control measures						TBD	Spring	Annual evaluation, schedule repair if needed
								$0	
Fire									
	Determine rate of implementation and units to treat, primarily Gambel oak	See Appendix F For Units					Administrative	July-Dec	See Gambel oak regeneration
	Layout Gambel oak units to treat in 2014		3	acres			TBD	July-Oct	Cost covered in Gambel oak regeneration
	Implement grant funding for fuel breaks if funding received						Administrative	July-Oct	Funding available for fuel breaks?
								$0	
Transportation									

SMOS Plan of Forest Activities: 2014

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Annual Road & Trail Inspection						Administrative	May-June	Assuming Brood Tree Removal, minimal repair will be needed for logging operations
							$0		
Socio Economic									
	Analysis of Fiber Supply Analysis						Administrative	Jan-Dec	
	Based on Results of Fiber Supply Study work with Interested Investors to Build Infrastructure						Administrative	Jan-April	
							$0		
Seed Bank									
	Collect Cones during Good Crop years		20	bushel	$75	$1,500	TBD	Sept	Need local seed for LP, DF, subalpine fir and spruce. Good Crops do not occur every year.
	Get Cones Processed		20	bushel	$15	$300	TBD	Sept-Dec	
	Annual Storage Fee and Manage Inventory		100	lb	$1	$100	TBD	Yearly	
							$0		
Non Native Weeds									
	Control exotic weeds in regen areas						$1,000	Annual	
	Montitor known locations as needed						Administrative	Annual	
							$1,000		
					Total Cost		**$53,350**		

SMOS Plan of Forest Activities: 2015

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Lodgepole Pine									
Brood Tree Removal (BTR)	Make Decision to do Brood Tree Removal (BTR)						Administrative	April	Ideally should be done in Fall or Winter the previous year after fall evaluations going forward. Potentially do Brood Tree Removal in Fall/Winter
	Mark Brood Trees for Removal		120	ac			$1,200	May	Assumes finding location of GPS'd trees from fall 2014 monitoring v. covering entire property
	Layout Regeneration Units and mark any Green trees for removal to reach minimum opening size for species biological requirements (.75 acres)	33, 39, 42	3	ac			$600	May	See Appendix D for map table of unit priorities. OR other units as determined by current MPB activity
	Develop specific regeneration prespriptions for each unit layed out	33, 39, 42					$600	May/June	
	Prospectus and Contracting for Tree Removal						Administrative	May	
	Removal of Brood Trees	DMPB	20	tree	$250	$5,000	$5,000	May/June	Assumes only Tractor accessible trees removed, trees estimated
	Evaluation of Application, OR monitor MPB Populations, GPS attacked Trees, mark for Removal if possible		120	ac	$30	$3,600	$3,600	Sept/Oct	Same recommendation under Verbenone
	Evaluate GPS data and MPB activity, both on site and surrounding environment and make decision on BTR & Verbenone for 2016						Administrative	Oct-Feb	
	Ideally after data collection, make decision on BTR, if yes, it's best to do BTR in Fall/Winter						Administrative	Oct-Dec	If BTR decided then Fall/Winter is best time.
							$11,000		
Verbenone Application	Make Decision to do Verbenone Application						Administrative	April	
	Determine acres of application and delineate on the ground & GIS/GPS						Administrative	April	Property boundaries need delineation on the ground
	Determine Material type, pouches or flakes						Administrative	April	

SMOS Plan of Forest Activities: 2015

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Determine Application Method, aerial or ground						Administrative	April	
	Order Verbenone		TBD	TBD	TBD	TBD	Administrative	April	Rate to be determined by MPB activity level
	Prospectus and Contracting for Verbenone Application						Administrative	May	
	Flag Boundary of Verbenone application, especially property lines					TBD	Administrative	May	Depends on Results of Fall Surveys
	Application		TBD	TBD	TBD	TBD	Administrative	June/July	
	Evaluation of Application OR MPB population, GPS attacked Trees, mark for Removal if possible						Administrative	Sept/Oct	Cost Accounted for under BTR
	Evaluate GPS data and MPB activity and make decision on BTR & Verbenone for 2016						Administrative	Oct-Feb	
						$0	**$0**		
Initiate Regeneration	Tree Removal (50 TPA) to create minimum size biological openings		150	ac	$250	$37,500	$37,500	June	Removal of trees will depend on MPB activity
	Develop Prescriptions						$600	May/June	If no BTR or Verbenone, then Prescriptions need development here
	Implement Regeneration presriptions developed during BTR marking and unit layout	33, 39, 42	TBD	ac			Administrative	June-Oct	Series of Steps to be layed out and applied during field season
	Spray (4' radius circles 200 spots/ac)		3	ac	$300	$900	$900	June/July	Assuming spraying is used as decided from tests then implement
	Scarification of Planting Spots (4' Radius, 200/ac)		3	ac	$1,000	$3,000	$3,000	Aug.	
	Plant		3	ac	$150	$450	$450	Sept	Before soil temps drop below 40 degrees
	Identify Nursery for Seedling Order						Administrative	June-Oct	
	Do stocking surveys to monitor for regeneration						Administrative	Sept/Oct	
	Order Seedlings for 2016 Fall Plant?		1200	tree	$0.25	$300	TBD	Nov	Two species (LP & DF) minimum, 400 TPA on 6 acres
							$42,450		
Extend Life of Big Lodgepole	Thin Stands with Large Lodgepole?		DOR	tree	DOR	DOR	DOR	Oct or June	Assumes 5 acres and removal of 40 trees per acre, done previously?

SMOS Plan of Forest Activities: 2015

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Where ever any trees are removed Verbenone needs to be applied		5	ac			DMPB	June/July	Depends on MPB Activity
	Order & Apply Verbenone to Identified Large Lodgepole stands each year		5	ac	$350	$1,750	DMPB	June/July	Depends on MPB Activity
	Dispose of any Brood Trees each year within Stands no matter if done in other stands on SMOS		5	ac			DMPB	Oct/Nor or May/June	Cost dependant on MPB Activity
							$0		
Aspen									
Initiate Regeneration	Decide on Units for treatment, assuming necessary	TBD	TBD	ac			Administrative	April	Identify units needing treatment. See Appendix E for map and unit list. Need to treat 10 acres per decade.
	Layout units for Treatment in 2014, if needed		TBD	ac			TBD	May	Ideally done in 2014
	Develop detailed prescriptions for treatment		TBD	ac		TBD	TBD	Aug-Oct	Develop prescriptions based on results of previous treatments
	Update maps for treatment						Administrative	Nov-Dec	
	Investigate markets for any material developed						Administrative	Aug-Dec	Assuming some harvesting is done, having markets for material will reduce costs
							$0		
Gambel Oak									
Initiate Regeneration	Survey property lines to facilitate layout						TBD	July-Sept	Lines surveyed previously?
	Layout units for Treatment in 2015	See Appendix F For Units	4	ac	$250	$1,000	TBD	July-Oct	assumes 4 units at .75 ac/unit average. Assumes that 21 acres need to be treated for the decade and 8 years remaining in decade to treat.
	Evaluate Previous Treatments						Administrative	July-Sept	
	Develop prospectuses and contracts for implementation in 2015						Administrative	Jan-March	
	Cut and Treat stumps, hand pile and cover piles for burning or chip.		4	ac	$2,000	$8,000	TBD	June-July	Needs to be done no later that Mid August to allow for drying to facilitate burning.
	Burn piles		4	ac	$500	$2,000	TBD	Nov-Dec	Burn after adequate rain or snow

SMOS Plan of Forest Activities: 2015

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Rake piles to spread ash, apply native seeds		4	ac	$500	$2,000	TBD	Nov or April	Spread seed in fall after burning or in spring
								$0	
Hazard Tree Removal									
	Remove hazard trees identified in 2014		20	tree	$200	$4,000	TBD	June-Sept	Tree Number is an estimate
	Evaluate half of the trail system for hazard trees						Administrative	June-Sept	
	Investigate markets and/or uses for the wood						Administrative	Sept-Dec	
								$0	
Monitoring									
	Implement Monitoring Plan						Administrative	Jan-Dec	Finish installation of plots if necessary
	Install Permanent plots						TBD	Seasonal	Finish installation of plots if necessary
	Install Wildlife Transects						TBD	Seasonal	Finish installation of plots if necessary
	Evaluate effectiveness of Erosion control measures						TBD	Spring	Annual evaluation, schedule repair if needed
								$0	
Fire									
	Determine rate of implementation and units to treat, primarily Gambel oak	See Appendix F For Units					Administrative	July-Dec	See Gambel oak regeneration
	Layout Gambel oak units to treat in 2015		4	acres			TBD	July-Oct	Cost covered in Gambel oak regeneration
	Implement grant funding for fuel breaks and other fuels reduction activities if funding received						Administrative	July-Oct	Funding available for fuel breaks?
								$0	
Transportation									
	Annual Road & Trail Inspection						Administrative	May-June	Assuming Brood Tree Removal, minimal repair will be needed for
								$0	
Socio Economic									

SMOS Plan of Forest Activities: 2015

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Using Fiber Supply Analysis, facilitate development of markets						Administrative	Jan-Dec	
	Based on Results of Fiber Supply Study work with Interested Investors to Build Infrastructure						Administrative	Jan-Dec	
							$0		
Seed Bank									
	Collect Cones during Good Crop years		20	bushel	$75	$1,500	TBD	Sept	Need local seed for LP, DF, subalpine fir and spruce. Good Crops do not occur every year.
	Get Cones Processed		20	bushel	$15	$300	TBD	Sept-Dec	
	Annual Storage Fee and Manage Inventory		100	lb	$1	$100	TBD	Yearly	
							$0		
Non Native Weeds									
	Control exotic weeds in regen areas						$1,000	Annual	
	Montitor known locations as needed						Administrative	Annual	
							$1,000		
					Total Cost		**$54,450**		

SMOS Plan of Forest Activities: 2016

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Lodgepole Pine									
Brood Tree Removal (BTR)	Make Decision to do Brood Tree Removal (BTR)						Administrative	April	Fall/Winter BTR?
	Mark Brood Trees for Removal		120	ac			$1,200	May	
	Layout Regeneration Units and mark any Green trees for removal to reach minimum opening size for species biological requirements (.75 acres)	DMPB	3	ac			TBD	May	See Appendix D for map table of unit priorities. OR other units as determined by current MPB activity
	Develop specific regeneration prespriptions for each unit layed out	DMPB					TBD	May/June	
	Prospectus and Contracting for Tree Removal						Administrative	May	
	Removal of Brood Trees	DMPB	20	tree	$250	$5,000	$5,000		To be determined from Surveys in Fall of 2015
	Evaluation of Application, OR monitor MPB Populations, GPS attacked Trees, mark for Removal if possible		120	ac	$35	$4,200	$4,200	Sept/Oct	Same recommendation under Verbenone
	Evaluate GPS data and MPB activity, both on site and surrounding environment and make decision on BTR & Verbenone for 2017						Administrative	Oct-Feb	
	Ideally after data collection, make decision on BTR, if yes, it's best to do BTR in Fall/Winter						Administrative	Oct-Dec	If BTR decided then Fall/Winter is best time.
							$10,400		
Verbenone Application	Make Decision to do Verbenone Application						Administrative	April	
	Determine acres of application and delineate on the ground & GIS/GPS						Administrative	April	Property boundaries need delineation on the ground
	Determine Material type, pouches or flakes						Administrative	April	
	Determine Application Method, aerial or ground						Administrative	April	
	Order Verbenone		TBD	TBD	TBD	TBD	Administrative	April	Rate to be determined by MPB activity level
	Prospectus and Contracting for Verbenone Application						Administrative	May	
	Flag Boundary of Verbenone application, especially property lines					TBD	Administrative	May	Depends on Results of Fall Surveys
	Application		TBD	TBD	TBD	TBD	Administrative	June/July	

	Evaluation of Application OR MPB population, GPS attacked Trees, mark for Removal if possible						Administrative	Sept/Oct	Cost Accounted for under BTR
	Evaluate GPS data and MPB activity and make decision on BTR & Verbenone for 2016						Administrative	Oct-Feb	
						$0	**$0**		
Initiate Regeneration	Tree Removal to create minimum size biological openings	DMPB	TBD	ac	TBD	TBD	TBD	June	Removal of trees will depend on MPB activity
	Develop Prescriptions	DMPB					Administrative	May/June	If no BTR or Verbenone, then Prescriptions need development here
	Implement Regeneration presriptions developed during BTR marking and unit layout	See Appendix D For Units	TBD	ac			Administrative	June-Oct	Series of Steps to be layed out and applied during field season
	Spray (4' radius circles 200 spots/ac)		3	ac	TBD	TBD	TBD	June/July	Assuming spraying is used as decided from tests then implement
	Scarification of Planting Spots (4' Radius, 200/ac)		3	ac	TBD	TBD	TBD	Aug.	
	Plant		3	ac	$150	$450	TBD	Sept	Before soil temps drop below 40 degrees
	Identify Nursery for Seedling Order						Administrative	June-Oct	
	Do stocking surveys to monitor for regeneration						Administrative	Sept/Oct	
	Order Seedlings for 2017 Fall Plant?		TBD	tree	TBD	TBD	TBD	Nov	Two species (LP & DF) minimum, 400 TPA on 6 acres
							$0		
Extend Life of Big Lodgepole	Thin Stands with Large Lodgepole?		DOR	tree	DOR	DOR	DOR	Oct or June	Assumes 5 acres and removal of 40 trees per acre, done previously?
	Where ever any trees are removed Verbenone needs to be applied		5	ac			DMPB	June/July	Depends on MPB Activity
	Order & Apply Verbenone to Identified Large Lodgepole stands each year		5	ac	$350	$1,750	DMPB	June/July	Depends on MPB Activity
	Dispose of any Brood Trees each year within Stands no matter if done in other stands on SMOS		5	ac			DMPB	Oct/Nor or May/June	Cost dependant on MPB Activity
							$0		
Aspen									
Initiate Regeneration	Decide on Units for treatment, assuming necessary	TBD	TBD	ac			Administrative	April	Identify units needing treatment. See Appendix E for map and unit list. Need to treat 10 acres per decade.
	Layout units for Treatment in 2016, if needed		TBD	ac			TBD	May	Ideally done in 2015

	Develop detailed prescriptions for treatment		TBD	ac		TBD	TBD	Aug-Oct	Develop prescriptions based on results of previous treatments
	Update maps for treatment						Administrative	Nov-Dec	
	Investigate markets for any material developed						Administrative	Aug-Dec	Assuming some harvesting is done, having markets for material will reduce costs
	Layout units for Treatment in 2017	TBD	TBD			TBD	TBD	Sept-Oct	Depends on Results of previous years activities
	Develop prospectuses and contracts for implementation in 2017						Administrative	Oct-Dec	
							$0		
Gambel Oak									
Initiate Regeneration	Survey property lines to facilitate layout						TBD	July-Sept	Lines surveyed previously?
	Layout units for Treatment in 2016	Treat two 4 acre units	8	ac	$250	$500	$500	July-Oct	assumes 4 units at .75 ac/unit average. Assumes that 21 acres need to be treated for the decade and 8 years remaining in decade to treat.
	Evaluate Previous Treatments						Administrative	July-Sept	
	Develop prospectuses and contracts for implementation in 2016						Administrative	Jan-March	
	Cut and Treat stumps, hand pile and cover piles for burning or chip.		8	ac	$2,000	$16,000	$16,000	June-July	Needs to be done no later that Mid August to allow for drying to facilitate burning.
	Burn piles		8	ac	$500	$4,000	$4,000	Nov-Dec	Burn after adequate rain or snow
	Rake piles to spread ash, apply native seeds		8	ac	$250	$2,000	$2,000	Nov or April	Spread seed in fall after burning or in spring
							$22,500		
Hazard Tree Removal									
	Remove hazard trees identified in 2015		20	tree	$200	$4,000	TBD	June-Sept	Tree Number is an estimate
	Evaluate half of the trail system for hazard trees						Administrative	June-Sept	
	Investigate markets and/or uses for the wood						Administrative	Sept-Dec	
							$0		
Monitoring									
	Implement Monitoring Plan						Administrative	Jan-Dec	Finish installation of plots if necessary
	Install Permanent plots						TBD	Seasonal	Finish installation of plots if necessary
	Install Wildlife Transects						TBD	Seasonal	Finish installation of plots if necessary
	Evaluate effectiveness of Erosion control measures						TBD	Spring	Annual evaluation, schedule repair if needed

								$0	
Fire									
	Determine rate of implementation and units to treat, primarily Gambel oak	See Appendix F For Units					Administrative	July-Dec	See Gambel oak regeneration
	Layout Gambel oak units to treat in 2016		4	acres			TBD	July-Oct	Cost covered in Gambel oak regeneration
	Implement grant funding for fuel breaks and other fuels reduction activities if funding received						Administrative	July-Oct	Funding available for fuel modification efforts?
								$0	
Transportation									
	Annual Road & Trail Inspection						Administrative	May-June	Assuming Brood Tree Removal, minimal repair will be needed for logging operations
								$0	
Socio Economic									
	Using Fiber Supply Analysis, facilitate development of markets						Administrative	Jan-Dec	
	Based on Results of Fiber Supply Study work with Interested Investors to Build Infrastructure						Administrative	Jan-Dec	
								$0	
Seed Bank									
	Collect Cones during Good Crop years		20	bushel	$75	$1,500	TBD	Sept	Need local seed for LP, DF, subalpine fir and spruce. Good Crops do not occur every year.
	Get Cones Processed		20	bushel	$15	$300	TBD	Sept-Dec	
	Annual Storage Fee and Manage Inventory		100	lb	$1	$100	TBD	Yearly	
								$0	
Non Native Weeds									
	Control exotic weeds in regen areas						$1,000	Annual	
	Montitor known locations as needed						Administrative	Annual	
								$1,000	
					Total Cost		**$33,900**		

SMOS Plan of Forest Activities: 2017

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Lodgepole Pine									
Brood Tree Removal (BTR)	Make Decision to do Brood Tree Removal (BTR)						Administrative	April	Fall/Winter BTR?
	Mark Brood Trees for Removal		120	ac			$1,200	May	
	Layout Regeneration Units and mark any Green trees for removal to reach minimum opening size for species biological requirements (.75 acres)	DMPB	3	ac			TBD	May	See Appendix D for map table of unit priorities. OR other units as determined by current MPB activity
	Develop specific regeneration prespriptions for each unit layed out	DMPB					TBD	May/June	
	Prospectus and Contracting for Tree Removal						Administrative	May	
	Removal of Brood Trees	DMPB	20	tree	$250	$5,000	$5,000		To be determined from Surveys in Fall of 2016
	Evaluation of Application, OR monitor MPB Populations, GPS attacked Trees, mark for Removal if possible		120	ac	$35	$4,200	$4,200	Sept/Oct	Same recommendation under Verbenone
	Evaluate GPS data and MPB activity, both on site and surrounding environment and make decision on BTR & Verbenone for 2018						Administrative	Oct-Feb	
	Ideally after data collection, make decision on BTR, if yes, it's best to do BTR in Fall/Winter						Administrative	Oct-Dec	If BTR decided then Fall/Winter is best time.
							$10,400		
Verbenone Application	Make Decision to do Verbenone Application						Administrative	April	
	Determine acres of application and delineate on the ground & GIS/GPS						Administrative	April	Property boundaries need delineation on the ground
	Determine Material type, pouches or flakes						Administrative	April	
	Determine Application Method, aerial or ground						Administrative	April	
	Order Verbenone		TBD	TBD	TBD	TBD	Administrative	April	Rate to be determined by MPB activity level
	Prospectus and Contracting for Verbenone Application						Administrative	May	
	Application		TBD	TBD	TBD	TBD	Administrative	June/July	
	Evaluation of Application OR MPB population, GPS attacked Trees, mark for Removal if possible						Administrative	Sept/Oct	Cost Accounted for under BTR

SMOS Plan of Forest Activities: 2017

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Evaluate GPS data and MPB activity and make decision on BTR & Verbenone for 2017						Administrative	Oct-Feb	
						$0	$0		
Initiate Regeneration	Tree Removal to create minimum size biological openings	DMPB	TBD	ac	TBD	TBD	TBD	June	Removal of trees will depend on MPB activity
	Develop Prescriptions	DMPB					Administrative	May/June	If no BTR or Verbenone, then Prescriptions need development here
	Implement Regeneration presriptions developed during BTR marking and unit layout	See Appendix D For Units	TBD	ac			Administrative	June-Oct	Series of Steps to be layed out and applied during field season
	Spray (4' radius circles 200 spots/ac)		3	ac	TBD	TBD	TBD	June/July	Assuming spraying is used as decided from tests then implement
	Scarification of Planting Spots (4' Radius, 200/ac)		3	ac	TBD	TBD	TBD	Aug.	
	Plant		3	ac	$150	$450	TBD	Sept	Before soil temps drop below 40 degrees
	Identify Nursery for Seedling Order						Administrative	June-Oct	
	Do stocking surveys to monitor for regeneration						Administrative	Sept/Oct	
	Order Seedlings for 2018 Fall Plant?		TBD	tree	TBD	TBD	TBD	Nov	Two species (LP & DF) minimum, 400 TPA on 6 acres
							$0		
Extend Life of Big Lodgepole	Thin Stands with Large Lodgepole?		DOR	tree	DOR	DOR	DOR	Oct or June	Assumes 5 acres and removal of 40 trees per acre, done previously?
	Where ever any trees are removed Verbenone needs to be applied		5	ac			DMPB	June/July	Depends on MPB Activity
	Order & Apply Verbenone to Identified Large Lodgepole stands each year		5	ac	$350	$1,750	DMPB	June/July	Depends on MPB Activity
	Dispose of any Brood Trees each year within Stands no matter if done in other stands on SMOS		5	ac			DMPB	Oct/Nor or May/June	Cost dependant on MPB Activity
							$0		
Aspen									
Initiate Regeneration	Decide on Units for treatment, assuming necessary	Treat one 5 acre unit	5	ac			Administrative	April	Identify units needing treatment. See Appendix E for map and unit list. Need to treat 10 acres per decade.

SMOS Plan of Forest Activities: 2017

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Survey property lines to facilitate layout						TBD	July-Sept	Already done?
	Layout units for Treatment in 2017		5	ac		$500	$500	May	Develop prescriptions based on results of previous treatments
	Develop detailed prescriptions for treatment	See Appendix E for Units	5	ac		$500	$500	May	
	Cut and Dispose of Trees		250	trees	$200	$50,000	$50,000	June-Sept	
	Update maps for treatment						Administrative	Nov-Dec	Assuming some harvesting is done, having markets for material will reduce costs
	Investigate markets for any material developed						Administrative	Aug-Dec	Depends on Results of previous years activities
							$51,000		
Gambel Oak									
Initiate Regeneration	Survey property lines to facilitate layout						TBD	July-Sept	Lines surveyed previously?
	Layout units for Treatment in 2017	See Appendix F For Units	4	ac	$300	$1,200	TBD	July-Oct	assumes 4 units at .75 ac/unit average. Assumes that 21 acres need to be treated for the decade and 8 years remaining in decade to treat.
	Evaluate Previous Treatments						Administrative	July-Sept	
	Develop prospectuses and contracts for implementation in 2017						Administrative	Jan-March	
	Cut and Treat stumps, hand pile and cover piles for burning or chip.		4	ac	$2,000	$8,000	TBD	June-July	Needs to be done no later that Mid August to allow for drying to facilitate burning.
	Burn piles		4	ac	$500	$2,000	TBD	Nov-Dec	Burn after adequate rain or snow
	Rake piles to spread ash, apply native seeds		4	ac	$500	$2,000	TBD	Nov or April	Spread seed in fall after burning or in spring
							$0		
Hazard Tree Removal									
	Remove hazard trees identified in 2016		20	tree	$200	$4,000	TBD	June-Sept	Tree Number is an estimate
	Evaluate half of the trail system for hazard trees						Administrative	June-Sept	
	Investigate markets and/or uses for the wood						Administrative	Sept-Dec	
							$0		

SMOS Plan of Forest Activities: 2017

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Monitoring									
	Implement Monitoring Plan						Administrative	Jan-Dec	
	Consider 5 year Remeasurement of Permanent Growth Plots		23	plots	$600	$13,800	TBD	Seasonal	
	Consider 5 year remeasurement of Wildlife transects		30	transects	$600	$18,000	TBD	Seasonal	
	Evaluate effectiveness of Erosion control measures						TBD	Spring	Annual evaluation, schedule repair if needed
							$0		
Fire									
	Determine rate of implementation and units to treat, primarily Gambel oak	See Appendix F For Units					Administrative	July-Dec	See Gambel oak regeneration
	Layout Gambel oak units to treat in 2017		4	acres			TBD	July-Oct	Cost covered in Gambel oak regeneration
	Implement grant funding for fuel breaks and other fuels reduction activities if funding received						Administrative	July-Oct	Funding available for fuel breaks?
							$0		
Transportation									
	Annual Road & Trail Inspection						Administrative	May-June	Assuming Brood Tree Removal, minimal repair will be needed for logging operations
							$0		
Socio Economic									
	Using Fiber Supply Analysis, facilitate development of markets						Administrative	Jan-Dec	
	Based on Results of Fiber Supply Study work with Interested Investors to Build Infrastructure						Administrative	Jan-Dec	
							$0		
Seed Bank									
	Collect Cones during Good Crop years		20	bushel	$75	$1,500	TBD	Sept	Need local seed for LP, DF, subalpine fir and spruce. Good Crops do not occur every year.
	Get Cones Processed		20	bushel	$15	$300	TBD	Sept-Dec	

SMOS Plan of Forest Activities: 2017

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Annual Storage Fee and Manage Inventory		100	lb	$1	$100	TBD	Yearly	
							$0		
Non Native Weeds									
	Control exotic weeds in regen areas						$1,000	Annual	
	Montitor known locations as needed						Administrative	Annual	
							$1,000		
					Total Cost		**$62,400**		

SMOS Plan of Forest Activities: 2018

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Lodgepole Pine									
Brood Tree Removal (BTR)	Make Decision to do Brood Tree Removal (BTR)						Administrative	April	Fall/Winter BTR?
	Mark Brood Trees for Removal		120	ac			$1,200	May	
	Layout Regeneration Units and mark any Green trees for removal to reach minimum opening size for species biological requirements (.75 acres)	DMPB	3	ac			TBD	May	See Appendix D for map table of unit priorities. OR other units as determined by current MPB activity
	Develop specific regeneration prespriptions for each unit layed out	DMPB					TBD	May/June	
	Prospectus and Contracting for Tree Removal						Administrative	May	
	Removal of Brood Trees	DMPB	20	tree	$250	$5,000	$5,000		To be determined from Surveys in Fall of 2017
	Evaluation of Application, OR monitor MPB Populations, GPS attacked Trees, mark for Removal if possible		120	ac	$35	$4,200	$4,200	Sept/Oct	Same recommendation under Verbenone
	Evaluate GPS data and MPB activity, both on site and surrounding environment and make decision on BTR & Verbenone for 2019						Administrative	Oct-Feb	
	Ideally after data collection, make decision on BTR, if yes, it's best to do BTR in Fall/Winter						Administrative	Oct-Dec	If BTR decided then Fall/Winter is best time.
							$10,400		
Verbenone Application	Make Decision to do Verbenone Application						Administrative	April	
	Determine acres of application and delineate on the ground & GIS/GPS						Administrative	April	Property boundaries need delineation on the ground
	Determine Material type, pouches or flakes						Administrative	April	
	Determine Application Method, aerial or ground						Administrative	April	

SMOS Plan of Forest Activities: 2018

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Order Verbenone		TBD	TBD	TBD	TBD	Administrative	April	Rate to be determined by MPB activity level
	Prospectus and Contracting for Verbenone Application						Administrative	May	
	Flag Boundary of Verbenone application, especially property lines					TBD	Administrative	May	Depends on Results of Fall Surveys
	Application		TBD	TBD	TBD	TBD	Administrative	June/July	
	Evaluation of Application OR MPB population, GPS attacked Trees, mark for Removal if possible						Administrative	Sept/Oct	Cost Accounted for under BTR
	Evaluate GPS data and MPB activity and make decision on BTR & Verbenone for 2019						Administrative	Oct-Feb	
						$0	**$0**		
Initiate Regeneration	Tree Removal to create minimum size biological openings	DMPB	TBD	ac	TBD	TBD	TBD	June	Removal of trees will depend on MPB activity
	Develop Prescriptions	DMPB					Administrative	May/June	If no BTR or Verbenone, then Prescriptions need development here
	Implement Regeneration presriptions developed during BTR marking and unit layout	See Appendix D For Units	TBD	ac			Administrative	June-Oct	Series of Steps to be layed out and applied during field season
	Spray (4' radius circles 200 spots/ac)		3	ac	TBD	TBD	TBD	June/July	Assuming spraying is used as decided from tests then implement
	Scarification of Planting Spots (4' Radius, 200/ac)		3	ac	TBD	TBD	TBD	Aug.	
	Plant		3	ac	$150	$450	TBD	Sept	Before soil temps drop below 40 degrees
	Identify Nursery for Seedling Order						Administrative	June-Oct	
	Do stocking surveys to monitor for regeneration						Administrative	Sept/Oct	
	Order Seedlings for 2019 Fall Plant?		$1,200	tree	$0	$300	TBD	Nov	Two species (LP & DF) minimum, 400 TPA on 6 acres
							$0		
Extend Life of Big Lodgepole	Thin Stands with Large Lodgepole?		DOR	tree	DOR	DOR	DOR	Oct or June	Assumes 5 acres and removal of 40 trees per acre, done previously?
	Where ever any trees are removed Verbenone needs to be applied		5	ac			DMPB	June/July	Depends on MPB Activity

SMOS Plan of Forest Activities: 2018

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Order & Apply Verbenone to Identified Large Lodgepole stands each year		5	ac	$350	$1,750	DMPB	June/July	Depends on MPB Activity
	Dispose of any Brood Trees each year within Stands no matter if done in other stands on SMOS		5	ac			DMPB	Oct/Nor or May/June	Cost dependant on MPB Activity
							$0		
Aspen									
Initiate Regeneration	Decide on Units for treatment, assuming necessary	TBD	TBD	ac			Administrative	April	Identify units needing treatment. See Appendix E for map and unit list. Need to treat 10 acres per decade.
	Layout units for Treatment in 2018, if needed		TBD	ac			TBD	May	Ideally done in 2016
	Develop detailed prescriptions for treatment		TBD	ac		TBD	TBD	Aug-Oct	Develop prescriptions based on results of previous treatments
	Update maps for treatment						Administrative	Nov-Dec	
	Investigate markets for any material developed						Administrative	Aug-Dec	Assuming some harvesting is done, having markets for material will reduce costs
							$0		
Gambel Oak									
Initiate Regeneration	Survey property lines to facilitate layout						TBD	July-Sept	Lines surveyed previously?
	Layout units for Treatment in 2018	Treat one 5 acre unit	5	ac	$250	$250	$250	May-July	assumes 4 units at .75 ac/unit average. Assumes that 21 acres need to be treated for the decade and 8 years remaining in decade to treat.
	Evaluate Previous Treatments						Administrative	July-Sept	
	Develop prospectuses and contracts for implementation in 2018						Administrative	Jan-March	
	Cut and Treat stumps, hand pile and cover piles for burning or chip.		5	ac	$2,000	$10,000	$10,000	June-July	Needs to be done no later that Mid August to allow for drying to facilitate burning.
	Burn piles		5	ac	$500	$2,500	$2,500	Nov-Dec	Burn after adequate rain or snow
	Rake piles to spread ash, apply native seeds		5	ac	$250	$1,250	$1,250	Nov or April	Spread seed in fall after burning or in spring

SMOS Plan of Forest Activities: 2018

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
							$14,000		
Hazard Tree Removal									
	Remove hazard trees identified in 2017		20	tree	$200	$4,000	TBD	June-Sept	Tree Number is an estimate
	Evaluate half of the trail system for hazard trees						Administrative	June-Sept	
	Investigate markets and/or uses for the wood						Administrative	Sept-Dec	
							$0		
Monitoring									
	Implement Monitoring Plan						Administrative	Jan-Dec	
	Consider 5 year Remeasurement of Permanent Growth Plots		23	plots	$600	$13,800	TBD	Seasonal	Consider 5 year remeasurement of Plots 5 years after installation
	Consider 5 year remeasurement of Wildlife transects		30	transects	$600	$18,000	TBD	Seasonal	Consider 5 year remeasurement of Transects 5 years after installation
	Evaluate effectiveness of Erosion control measures						TBD	Spring	Annual evaluation, schedule repair if needed
							$0		
Fire									
	Determine rate of implementation and units to treat, primarily Gambel oak	See Appendix F For Units					Administrative	July-Dec	See Gambel oak regeneration
	Layout Gambel oak units to treat in 2018		4	acres			TBD	July-Oct	Cost covered in Gambel oak regeneration
	Implement grant funding for fuel breaks and other fuels reduction activities if funding received						Administrative	July-Oct	Funding available for fuel breaks?
							$0		
Transportation									
	Annual Road & Trail Inspection						Administrative	May-June	Assuming Brood Tree Removal, minimal repair will be needed for logging operations
							$0		
Socio Economic									

SMOS Plan of Forest Activities: 2018

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Using Fiber Supply Analysis, facilitate development of markets						Administrative	Jan-Dec	
	Based on Results of Fiber Supply Study work with Interested Investors to Build Infrastructure						Administrative	Jan-Dec	
							$0		
Seed Bank									
	Collect Cones during Good Crop years		20	bushel	$75	$1,500	TBD	Sept	Need local seed for LP, DF, subalpine fir and spruce. Good Crops do not occur every year.
	Get Cones Processed		20	bushel	$15	$300	TBD	Sept-Dec	
	Annual Storage Fee and Manage Inventory		100	lb	$1	$100	TBD	Yearly	
							$0		
Non Native Weeds									
	Control exotic weeds in regen areas						$1,000	Annual	
	Montitor known locations as needed						Administrative	Annual	
							$1,000		
					Total Cost		**$25,400**		

SMOS Plan of Forest Activities: 2019

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Lodgepole Pine									
Brood Tree Removal (BTR)	Make Decision to do Brood Tree Removal (BTR)						Administrative	April	Fall/Winter BTR?
	Mark Brood Trees for Removal		120	ac			$1,200	May	
	Layout Regeneration Units and mark any Green trees for removal to reach minimum opening size for species biological requirements (.75 acres)	DMPB	3	ac			TBD	May	See Appendix D for map table of unit priorities. OR other units as determined by current MPB activity
	Develop specific regeneration prespriptions for each unit layed out	DMPB					TBD	May/June	
	Prospectus and Contracting for Tree Removal						Administrative	May	
	Removal of Brood Trees	DMPB	20	tree	$250	$5,000	$5,000	June	To be determined from Surveys in Fall of 2018
	Evaluation of Application, OR monitor MPB Populations, GPS attacked Trees, mark for Removal if possible		120	ac	$35	$4,200	$4,200	Sept/Oct	Same recommendation under Verbenone
	Evaluate GPS data and MPB activity, both on site and surrounding environment and make decision on BTR & Verbenone for 2020						Administrative	Oct-Feb	
	Ideally after data collection, make decision on BTR, if yes, it's best to do BTR in Fall/Winter						Administrative	Oct-Dec	If BTR decided then Fall/Winter is best time.
							$10,400		
Verbenone Application	Make Decision to do Verbenone Application						Administrative	April	
	Determine acres of application and delineate on the ground & GIS/GPS						Administrative	April	Property boundaries need delineation on the ground
	Determine Material type, pouches or flakes						Administrative	April	
	Determine Application Method, aerial or ground						Administrative	April	
	Order Verbenone		TBD	TBD	TBD	TBD	Administrative	April	Rate to be determined by MPB activity level

SMOS Plan of Forest Activities: 2019

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Prospectus and Contracting for Verbenone Application						Administrative	May	
	Flag Boundary of Verbenone application, especially property lines					TBD	Administrative	May	Depends on Results of Fall Surveys
	Application		TBD	TBD	TBD	TBD	Administrative	June/July	
	Evaluation of Application OR MPB population, GPS attacked Trees, mark for Removal if possible						Administrative	Sept/Oct	Cost Accounted for under BTR
	Evaluate GPS data and MPB activity and make decision on BTR & Verbenone for 2019						Administrative	Oct-Feb	
						$0	**$0**		
Initiate Regeneration	Tree Removal to create minimum size biological openings	DMPB	150	ac	$250	$37,500	$37,500	June	Removal of trees will depend on MPB activity
	Develop Prescriptions	DMPB					$500	May/June	If no BTR or Verbenone, then Prescriptions need development here
	Implement Regeneration presriptions developed during BTR marking and unit layout	See Appendix D For Units					Administrative	June-Oct	Series of Steps to be layed out and applied during field season
	Spray (4' radius circles 200 spots/ac)		3	ac	$300	$900	TBD	June/July	Assuming spraying is used as decided from tests then implement
	Scarification of Planting Spots (4' Radius, 200/ac)		3	ac	$1,000	$3,000	TBD	Aug.	
	Plant		3	ac	$150	$450	TBD	Sept	Before soil temps drop below 40 degrees
	Do stocking surveys to monitor for regeneration						Administrative	Sept/Oct	
							$38,000		
Extend Life of Big Lodgepole	Thin Stands with Large Lodgepole?		DOR	tree	DOR	DOR	DOR	Oct or June	Assumes 5 acres and removal of 40 trees per acre, done previously?
	Where ever any trees are removed Verbenone needs to be applied		5	ac			DMPB	June/July	Depends on MPB Activity
	Order & Apply Verbenone to Identified Large Lodgepole stands each year		5	ac	$350	$1,750	DMPB	June/July	Depends on MPB Activity

SMOS Plan of Forest Activities: 2019

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Dispose of any Brood Trees each year within Stands no matter if done in other stands on SMOS		5	ac			DMPB	Oct/Nor or May/June	Cost dependant on MPB Activity
								$0	
Aspen									
Initiate Regeneration	Decide on Units for treatment, assuming necessary	TBD	TBD	ac			Administrative	April	Identify units needing treatment. See Appendix E for map and unit list. Need to treat 10 acres per decade.
	Layout units for Treatment in 2019, if needed		TBD	ac			TBD	May	Ideally done in 2018
	Develop detailed prescriptions for treatment		TBD	ac		TBD	TBD	Aug-Oct	Develop prescriptions based on results of previous treatments
	Update maps for treatment						Administrative	Nov-Dec	
	Investigate markets for any material developed						Administrative	Aug-Dec	Assuming some harvesting is done, having markets for material will reduce costs
								$0	
Gambel Oak									
Initiate Regeneration	Survey property lines to facilitate layout						TBD	July-Sept	Lines surveyed previously?
	Layout units for Treatment in 2019	See Appendix F For Units	4	ac	$200	$800	TBD	July-Oct	assumes 4 units at .75 ac/unit average. Assumes that 16 acres need to be treated.
	Evaluate Previous Treatments						Administrative	July-Sept	
	Develop prospectuses and contracts for implementation in 2019						Administrative	Jan-March	
	Cut and Treat stumps, hand pile and cover piles for burning or chip.		4	ac	$2,000	$8,000	TBD	June-July	Needs to be done no later that Mid August to allow for drying to facilitate burning.
	Burn piles		4	ac	$500	$2,000	TBD	Nov-Dec	Burn after adequate rain or snow
	Rake piles to spread ash, apply native seeds		4	ac	$500	$2,000	TBD	Nov or April	Spread seed in fall after burning or in spring
								$0	
Hazard Tree Removal									
	Remove hazard trees identified in 2018		20	tree	$200	$4,000	TBD	June-Sept	Tree Number is an estimate

SMOS Plan of Forest Activities: 2019

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Evaluate half of the trail system for hazard trees						Administrative	June-Sept	
	Investigate markets and/or uses for the wood						Administrative	Sept-Dec	
							$0		
Monitoring									
	Implement Monitoring Plan						Administrative	Jan-Dec	
	Maintenance of Growth Plots						TBD	Seasonal	Maintenance of Plots
	Maintenance of Transects						TBD	Seasonal	Maintenance of Plots
	Evaluate effectiveness of Erosion control measures						TBD	Spring	Annual evaluation, schedule repair if needed
							$0		
Fire									
	Determine rate of implementation and units to treat, primarily Gambel oak	See Appendix F For Units					Administrative	July-Dec	See Gambel oak regeneration
	Layout Gambel oak units to treat in 2019		4	acres			TBD	July-Oct	Cost covered in Gambel oak regeneration
	Implement grant funding for fuel breaks and other fuels reduction activities if funding received						Administrative	July-Oct	Funding available for fuel breaks?
							$0		
Transportation									
	Annual Road & Trail Inspection						Administrative	May-June	Assuming Brood Tree Removal, minimal repair will be needed for logging operations
							$0		
Socio Economic									
	Using Fiber Supply Analysis, facilitate development of markets						Administrative	Jan-Dec	
	Based on Results of Fiber Supply Study work with Interested Investors to Build Infrastructure						Administrative	Jan-Dec	
							$0		
Seed Bank									

SMOS Plan of Forest Activities: 2019

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Collect Cones during Good Crop years		20	bushel	$75	$1,500	TBD	Sept	Need local seed for LP, DF, subalpine fir and spruce. Good Crops do not occur every year.
	Get Cones Processed		20	bushel	$15	$300	TBD	Sept-Dec	
	Annual Storage Fee and Manage Inventory		100	lb	$1	$100	TBD	Yearly	
							$0		
Non Native Weeds									
	Control exotic weeds in regen areas						$1,000	Annual	
	Montitor known locations as needed						Administrative	Annual	
							$1,000		
					Total Cost		**$49,400**		

SMOS Plan of Forest Activities: 2020

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Lodgepole Pine									
Brood Tree Removal (BTR)	Make Decision to do Brood Tree Removal (BTR)						Administrative	April	Fall/Winter BTR?
	Mark Brood Trees for Removal		120	ac			$1,200	May	
	Layout Regeneration Units and mark any Green trees for removal to reach minimum opening size for species biological requirements (.75 acres)	DMPB	3	ac			TBD	May	See Appendix D for map table of unit priorities. OR other units as determined by current MPB activity
	Develop specific regeneration prespriptions for each unit layed out	DMPB					TBD	May/June	
	Prospectus and Contracting for Tree Removal						Administrative	May	
	Removal of Brood Trees	DMPB	4	tree	$250	$5,000	$5,000	June	To be determined from Surveys in Fall of 2019
	Evaluation of Application, OR monitor MPB Populations, GPS attacked Trees, mark for Removal if possible		120	ac	$35	$4,200	$4,200	Sept/Oct	Same recommendation under Verbenone
	Evaluate GPS data and MPB activity, both on site and surrounding environment and make decision on BTR & Verbenone for 2021						Administrative	Oct-Feb	
							$10,400		
Verbenone Application	Make Decision to do Verbenone Application						Administrative	April	
	Determine acres of application and delineate on the ground & GIS/GPS						Administrative	April	Property boundaries need delineation on the ground
	Determine Material type, pouches or flakes						Administrative	April	
	Determine Application Method, aerial or ground						Administrative	April	
	Order Verbenone		TBD	TBD	TBD	TBD	Administrative	April	Rate to be determined by MPB activity level
	Prospectus and Contracting for Verbenone Application						Administrative	May	

SMOS Plan of Forest Activities: 2020

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Flag Boundary of Verbenone application, especially property lines					TBD	Administrative	May	Depends on Results of Fall Surveys
	Application		TBD	TBD	TBD	TBD	Administrative	June/July	
	Evaluation of Application OR MPB population, GPS attacked Trees, mark for Removal if possible						Administrative	Sept/Oct	Cost Accounted for under BTR
	Evaluate GPS data and MPB activity and make decision on BTR & Verbenone for 2021						Administrative	Oct-Feb	
						$0	**$0**		
Initiate Regeneration	Tree Removal to create minimum size biological openings	DMPB	TBD	ac	TBD	TBD	TBD	June	Removal of trees will depend on MPB activity
	Develop Prescriptions	DMPB					Administrative	May/June	If no BTR or Verbenone, then Prescriptions need development here
	Implement Regeneration presriptions developed during BTR marking and unit layout	See Appendix D For Units	3	ac			Administrative	June-Oct	Series of Steps to be layed out and applied during field season
	Spray (4' radius circles 200 spots/ac)		3	ac	TBD	TBD	TBD	June/July	Assuming spraying is used as decided from tests then implement
	Scarification of Planting Spots (4' Radius, 200/ac)		3	ac	TBD	TBD	TBD	Aug.	
	Plant		3	ac	$150	$450	TBD	Sept	Before soil temps drop below 40 degrees
	Do stocking surveys to monitor for regeneration						Administrative	Sept/Oct	
	Order Seedlings for 2021 Fall Plant?		TBD	tree	TBD	TBD	TBD	Nov	Two species (LP & DF) minimum, 400 TPA on 6 acres
							$0		
Extend Life of Big Lodgepole	Thin Stands with Large Lodgepole?		DOR	tree	DOR	DOR	DOR	Oct or June	Assumes 5 acres and removal of 40 trees per acre, done previously?
	Where ever any trees are removed Verbenone needs to be applied		5	ac			DMPB	June/July	Depends on MPB Activity
	Order & Apply Verbenone to Identified Large Lodgepole stands each year		5	ac	$350	$1,750	DMPB	June/July	Depends on MPB Activity

SMOS Plan of Forest Activities: 2020

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Dispose of any Brood Trees each year within Stands no matter if done in other stands on SMOS		5	ac			DMPB	Oct/Nor or May/June	Cost dependant on MPB Activity
								$0	
Aspen									
Initiate Regeneration	Decide on Units for treatment, assuming necessary	TBD	TBD	ac			Administrative	April	Identify units needing treatment. See Appendix E for map and unit list. Need to treat 10 acres per decade.
	Layout units for Treatment in 2020, if needed		TBD	ac			TBD	May	Ideally done in 2018
	Develop detailed prescriptions for treatment		TBD	ac		TBD	TBD	Aug-Oct	Develop prescriptions based on results of previous treatments
	Update maps for treatment						Administrative	Nov-Dec	
	Investigate markets for any material developed						Administrative	Aug-Dec	Assuming some harvesting is done, having markets for material will reduce costs
	Layout units for Treatment in 2020, if needed	TBD	TBD			TBD	TBD	Sept-Oct	Depends on Results of previous years activities
								$0	
Gambel Oak									
Initiate Regeneration	Survey property lines to facilitate layout						TBD	July-Sept	Lines surveyed previously?
	Layout units for Treatment in 2020	See Appendix F For Units	4	ac	$200	$800	TBD	July-Oct	assumes 4 units at .75 ac/unit average. Assumes that 21 acres need to be treated for the decade and 8 years remaining in decade to treat.
	Evaluate Previous Treatments						Administrative	July-Sept	
	Develop prospectuses and contracts for implementation in 2020						Administrative	Jan-March	
	Cut and Treat stumps, hand pile and cover piles for burning or chip.		4	ac	$2,000	$8,000	TBD	June-July	Needs to be done no later that Mid August to allow for drying to facilitate burning.
	Burn piles		4	ac	$500	$2,000	TBD	Nov-Dec	Burn after adequate rain or snow
	Rake piles to spread ash, apply native seeds		4	ac	$500	$2,000	TBD	Nov or April	Spread seed in fall after burning or in spring
								$0	

SMOS Plan of Forest Activities: 2020

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Hazard Tree Removal									
	Remove hazard trees identified in 2019		20	tree	$200	$4,000	TBD	June-Sept	Tree Number is an estimate
	Evaluate half of the trail system for hazard trees						Administrative	June-Sept	
	Investigate markets and/or uses for the wood						Administrative	Sept-Dec	
						$0			
Monitoring									
	Implement Monitoring Plan						Administrative	Jan-Dec	
	Maintenance of Growth Plots						TBD	Seasonal	Maintenance of Plots
	Maintenance of Transects						TBD	Seasonal	Maintenance of Plots
	Evaluate effectiveness of Erosion control measures						TBD	Spring	Annual evaluation, schedule repair if needed
						$0			
Fire									
	Determine rate of implementation and units to treat, primarily Gambel oak	See Appendix F For Units					Administrative	July-Dec	See Gambel oak regeneration
	Layout Gambel oak units to treat in 2019		3	acres			TBD	July-Oct	Cost covered in Gambel oak regeneration
	Implement grant funding for fuel breaks and other fuels reduction activities if funding received						Administrative	July-Oct	Funding available for fuel breaks?
						$0			
Transportation									
	Annual Road & Trail Inspection						Administrative	May-June	Assuming Brood Tree Removal, minimal repair will be needed for logging
						$0			
Socio Economic									
	Using Fiber Supply Analysis, facilitate development of markets						Administrative	Jan-Dec	

SMOS Plan of Forest Activities: 2020

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Based on Results of Fiber Supply Study work with Interested Investors to Build Infrastructure						Administrative	Jan-Dec	
							$0		
Seed Bank									
	Collect Cones during Good Crop years		20	bushel	$75	$1,500	TBD	Sept	Need local seed for LP, DF, subalpine fir and spruce. Good Crops do not occur
	Get Cones Processed		20	bushel	$15	$300	TBD	Sept-Dec	
	Annual Storage Fee and Manage Inventory		100	lb	$1	$100	TBD	Yearly	
							$0		
Non Native Weeds									
	Control exotic weeds in regen areas						$1,000	Annual	
	Montitor known locations as needed						Administrative	Annual	
							$1,000		
					Total Cost		**$11,400**		

SMOS Plan of Forest Activities: 2021-2030

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Lodgepole Pine									
Brood Tree Removal (BTR)	Make Decision to do Brood Tree Removal (BTR), Yearly decision based on MPB activity						Administrative	April	Fall/Winter BTR?
	Mark Brood Trees for Removal		120	ac		$1,200	$12,000	May	
	Layout Regeneration units 10% of Lodgepole Cover Type per decade or 6 acres per decade. Based on MPB mortality and/or MPB risk	DMPB	6	ac	$200	$1,200	$1,200	May	See Appendix D for map table of unit priorities. OR other units as determined by current MPB activity
	Develop specific regeneration prespriptions for each unit layed out	DMPB	6			$500	$500	May/June	
	Prospectus and Contracting for Tree Removal						Administrative	May	
	Removal of Brood Trees	DMPB	20	tree	$300	$6,000	$60,000		To be determined from Surveys in Fall
	Evaluation of BTR & Verbenone Treatments OR just monitoring MPB activity is an annual functions		120	ac	$40	$4,800	$48,000	Sept/Oct	Same recommendation under Verbenone
	Evaluate GPS data and MPB activity, both on site and surrounding environment and make decision on BTR & Verbenone for 2020						Administrative	Oct-Feb	
	Ideally after data collection, make decision on BTR, if yes, it's best to do BTR in Fall/Winter						Administrative	Oct-Dec	If BTR decided then Fall/Winter is best time.
							$121,700		
Verbenone Application	Verbenone application along with BTR is a yearly decision based on MPB activity						Administrative	April	
	Determine acres of application and delineate on the ground & GIS/GPS						Administrative	April	Property boundaries need delineation on the ground
	Determine Material type, pouches or flakes						Administrative	April	
	Determine Application Method, aerial or ground						Administrative	April	
	Order Verbenone		TBD	TBD	TBD	TBD	Administrative	April	Rate to be determined by MPB activity level

SMOS Plan of Forest Activities: 2021-2030

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Prospectus and Contracting for Verbenone Application						Administrative	May	
	Flag Boundary of Verbenone application, especially property lines					TBD	Administrative	May	Depends on Results of Fall Surveys
	Application		TBD	TBD	TBD	TBD	Administrative	June/July	
	Evaluation of Application OR MPB population, GPS attacked Trees, mark for Removal if possible						Administrative	Sept/Oct	Cost Accounted for under BTR
	Evaluate GPS data and MPB activity and make decision on BTR & Verbenone for 2019						Administrative	Oct-Feb	
						$0	**$0**		
Initiate Regeneration	Tree Removal to create minimum size biological openings	DMPB	150	trees	$300	$45,000	$45,000	June	Removal of trees will depend on MPB activity
	Develop Prescriptions	DMPB				$500	$500	May/June	If no BTR or Verbenone, then Prescriptions need development here
	Ideally 7-10% of cover type should be regenerated each decade no matter the MPB activity to achieve age class diversity	See Appendix D For Units	TBD	ac			Administrative	June-Oct	Series of Steps to be layed out and applied during field season
	Spray (4' radius circles 200 spots/ac)		6	ac	TBD	TBD	TBD	June/July	Assuming spraying is used as decided from tests then implement
	Scarification of Planting Spots (4' Radius, 200/ac)		6	ac	TBD	TBD	TBD	Aug.	
	Identify Nursery for Seedling Order						Administrative	June-Oct	
	Order Seedlings for 2020 Fall Plant		TBD	tree	TBD	TBD	TBD	Nov	Two species (LP & DF) minimum, 400 TPA on 6 acres
							$45,500		
Extend Life of Big Lodgepole	Stands with Large Trees need monitoring yearly							June-Oct	Monitor for activity and stand density
	Harvest trees as needed during decade to maintain low risk density		DOR	tree	DOR	DOR	DOR	Oct or June	Assumes 5 acres and removal of 40 trees per acre, done previously?
	Where ever any trees are removed Verbenone needs to be applied		5	ac			DMPB	June/July	Depends on MPB Activity
	Order & Apply Verbenone to Identified Large Lodgepole stands each year		5	ac	$400	$2,000	TBD	June/July	Depends on MPB Activity

SMOS Plan of Forest Activities: 2021-2030

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Dispose of any Brood Trees each year within Stands no matter if done in other stands on SMOS		5	ac			DMPB	Oct/Nor or May/June	Cost dependant on MPB Activity
							$0		
Aspen									
Initiate Regeneration	10% of cover type acres should be regenerated each decade to achieve age class diversity	6 ac	300	trees	$250	$75,000	$75,000	April	Identify units needing treatment. See Appendix E for map and unit list. Need to treat 10 acres per decade.
	Laying out units is an annual activity as needed until 10% goal is achieved		6	ac	$500		$500	May	
	Develop detailed prescriptions for treatment as needed in year of activity		6	ac		$500	$500	Aug-Oct	Develop prescriptions based on results of previous treatments
	Maps should be updated yearly for accomplishment and priority, but at least once per decade.						Administrative	Nov-Dec	
	Investigate markets for any material developed,						Administrative	Aug-Dec	Markets change constantly this should be an annual task to keep up on markets for products
	Develop prospectuses and contracts for implementation in 2020, if needed						Administrative	Oct-Dec	Assuming layout is done in prior year contracts can be done during winter
							$76,000		
Gambel Oak									
Initiate Regeneration	Survey property lines to facilitate layout						TBD	July-Sept	Maintaining property lines is a constant periodic activity
	Layout is a yearly activity, assuming the SPLAT concept is used	5 ac	1	ac	$500	$500	$500	July-Oct	Goal is to have 25% of landscape in permanent fuel break. The remaining 75% rotated over 80 years. Roughly 5-6 acres per decade
	Evaluate Previous Treatments						Administrative	July-Sept	
	Develop prospectuses and contracts for implementation, an annual activity						Administrative	Jan-March	
	Cut and Treat stumps, hand pile and cover piles for burning or chip.		5	ac	$3,000	$15,000	$15,000	June-July	Needs to be done no later that Mid August to allow for drying to facilitate burning.
	Burn piles		5	ac	$1,000	$5,000	$5,000	Nov-Dec	Burn after adequate rain or snow

SMOS Plan of Forest Activities: 2021-2030

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
	Rake piles to spread ash, apply native seeds		5	ac	$250	$1,250	$1,250	Nov or April	Spread seed in fall after burning or in spring
							$21,750		
Hazard Tree Removal	Remove hazard trees identified in previous year on an annual basis		20	tree	$400	$8,000	$0	June-Sept	
	Evaluate half of the trail system for hazard trees						Administrative	June-Sept	
	Investigate markets and/or uses for the wood						Administrative	Sept-Dec	
							$0		
Monitoring	Implement Monitoring Plan						Administrative	Jan-Dec	
	Remeasure Growth plots at 10 years from Installation		23	plots	$750	$17,250	$17,250	Seasonal	Maintenance of Plots
	Remeasure Wildlife Transects 10 years from installation		30	transects	$750	$22,500	$22,500	Seasonal	Maintenance of Plots
	Evaluate effectiveness of Erosion control measures io annual activity						TBD	Spring	Annual evaluation, schedule repair if needed
							$39,750		
Fire	Application of area wide fuel reduction activities primarily focused on Gambel oak, needs decadal review and evaluation of adding other cover types	See Appendix F For Units					Administrative	July-Dec	See Gambel oak regeneration
	Layout Gambel oak units to treat in 2019		3	acres			TBD	July-Oct	Cost covered in Gambel oak regeneration
	At change of decade is good time to evaluate plans and accomplishments						Administrative	July-Oct	Funding available for fuel breaks?
							$0		
Transportation	Evaluate roads and trails each spring for erosion issues and safety issues						Administrative	May-June	Assuming Brood Tree Removal, minimal repair will be needed for logging operations
	Maintenance of Erosion Control Structures is and annual activity as needed						Administrative	Sept-Oct	Prior to winter period
							$0		
Socio Economic	Analyze development of markets and evaluate plans for development						Administrative	Jan-Dec	
							$0		

SMOS Plan of Forest Activities: 2021-2030

Recommendations	Itemized Treatments	Stands or Units	Est. Amounts (units)	Units	Total Cost/ Unit	Total Cost	Cost of Activity	Timing of Activity	Comments
Seed Bank	Review seed inventory and update collection needs		20	bushel	$75	$1,500	$1,500	Sept	Need local seed for LP, DF, subalpine fir and spruce. Good Crops do not occur every year.
	Get Cones Processed		20	bushel	$15	$300	$300	Sept-Dec	
	Annual Storage Fee and Manage Inventory		100	lb	$1	$100	$100	Yearly	
							$1,900		
Non Native Weeds	Continue efforts to control non-native weeds						Administrative	Annual	
	Montitor known locations annually						$1,000	Annual	Cost is estimate
	Spray annually until eradicated and then monitor						$5,000	Seasonal	Cost is estimate
	Monitor known new disturbance areas for potential new locations of non-native weeds						$1,000	Seasonal	Cost is estimate
							$7,000		
					Total Cost		**$313,600**		

SMOS Plan of Forest Activities
2010 - 2020

Recommendations	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Decade 2
Lodgepole Pine											
Brood Tree Removal (BTR)	$11,000	$9,800	$9,800	$9,800	$11,000	$10,400	$10,400	$10,400	$10,400	$10,400	TBD
Verbenone Application	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	TBD
Initiate Regeneration	$38,000	$0	$0	$300	$42,450	$0	$0	$0	$38,000	$0	X
Extend Life of Big Lodgepole	$0	$0	$0	$42,250	$0	$0	$0	$0	$0	$0	X
Aspen											
Initiate Regeneration	$1,000	$0	$51,000	$0	$0	$0	$51,000	$0	$0	$0	X
Gambel Oak											
Initiate Regeneration	$1,000	$22,500	$0	$0	$0	$22,500	$0	$14,000	$0	$0	X
Hazard Tree Removal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	X
Monitoring	$2,000	$26,500	$0	$0	$0	$0	$0	$0	$0	$0	X
Fire	$0	$0	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Transportation	$0	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Socio Economic	$0	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Seed Bank	$1,500	$0	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Non Native Weeds	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	X
TOTAL COSTS	$55,500	$59,800	$61,800	$53,350	$54,450	$33,900	$62,400	$25,400	$49,400	$11,400	