Sagehen Project
Purpose of and Need for Action
and Proposed Action

Pacific Southwest Research Station – Sagehen Experimental Forest
Tahoe National Forest – Truckee Ranger District
Nevada and Sierra Counties, California

Introduction
Planning for the proposed Sagehen Project has been a highly unique undertaking, combining collaboration, science, and forest management in an interactive and novel way. The proposal put forth in this document is the result of an extensive, yearlong collaborative effort to design an integrated, innovative approach for applying the most recent science to enhance marten habitat, restore forest stand ecological conditions, and manage fire and fuels on national forest lands within the Sagehen Experimental Forest and adjacent Tahoe National Forest. This collaborative effort has included countless hours of fieldwork, analyses, meetings, and document reviews by all involved. The extensive efforts by all stakeholders to work hard and work together have resulted in the Sagehen Project proposal presented in this document.

Most of the proposed Sagehen Project is located within the Sagehen Experimental Forest, which is under the management and direction of a partnership between the Forest Service’s Pacific Southwest Research Station (PSW) and the Tahoe National Forest (TNF), in strong collaboration with the University of California (UC) at Berkeley, which manages the Sagehen Creek Field Station in the center of the Basin under a Special Use Authorization. Experimental forests and ranges are intended to be living laboratories where Forest Service scientists and collaborators conduct research and demonstrate research results through experimental approaches that examine various land management and conservation strategies. These lands offer one of the few opportunities to conduct manipulative, innovative research that will produce scientific knowledge required for the stewardship of the Nation’s natural resources.

The Sagehen Basin has been a managed forest for many decades. The contemporary condition of the forest in this area is a result of past forest management practices that are typical of conditions found throughout much of the Sierra Nevada. As such, the Sagehen Experimental Forest, with the wealth of scientific data that has been generated by researchers over the past several decades, provides rich opportunities for examining key relationships between stand density, risk of drought-related stress and mortality, and forest resiliency to disturbance.

Experimental forests and ranges are also some of the few places where ecological research can be maintained over the long term. These areas are particularly important to study ecological processes that can only be revealed over long time periods. For example, climate change in recent decades and
anticipated changes in the coming decades is expected to result in shifts in the precipitation regime for the Sierra Nevada Range. Snow pack, total precipitation, and the ratio of rain to snow are all expected to shift, resulting in possible greater moisture stress for vegetation during the summer drought period. Competition for available soil moisture will likely increase, particularly among the smaller trees that are now typically found in the Basin’s dense stands. Such ecological processes and conditions present a variety of management and concurrent research challenges and that can be addressed in the Sagehen Experimental Forest.

**Background of the Sagehen Basin**

The Sagehen Basin is an approximate 9,000 acre watershed at the headwaters of Sagehen Creek, a tributary of the Little Truckee River, just on the east side of the Sierra Nevada Range. The Basin lies about 10 miles north of Truckee, California, on the west side of Highway 89. In November 2005, almost the entire Basin was designated an Experimental Forest, with the exception of two private timber company holdings in the southwest area of the Basin and a small remainder in National Forest System (NFS) lands of the Truckee Ranger District, TNF.

UC Berkeley has operated the Sagehen Creek Field Station, in the center of this Basin, since 1951. It has hosted hundreds of scientific studies over the last 60 years. The earliest studies were begun by W.E. Needham and A. Starker Leopold with groundbreaking fisheries and wildlife studies. The Field Station was incorporated into the UC Natural Reserve System in 2004. The Sagehen Creek Field Station has accumulated massive amounts of data, which contributes to its value for research. For example, daily weather records date back to 1953 for a weather station established near the main Field Station. Snow telemetry (SNOTEL) records dating from 1978 are also available. In addition, the United States Geology Survey (USGS) has measured stream flow since 1953 and water quality since 1968. Water temperature is measured in several sites along Sagehen Creek and its tributaries. Groundwater depth and temperature are also measured. Other routinely collected data include daily satellite imagery, seismic activity, and transects of tree sap flow data.

Numerous fauna and flora studies have been conducted, many of which help to inform management strategies for the Basin and the Sierra Nevada Range. The biodiversity in the Basin is high with a total of 686 plant and 212 vertebrate species documented to occur there. There is a very diverse riparian zone associated with the perennially-flowing Sagehen Creek, which includes meadows, fens and a headwater area. The fens in the Sagehen Experimental Forest are well-known for their scientific value and the largest, Mason Fen, has been the subject of research since 1957 and is a designated Special Interest Area. Sagehen Creek has been recommended for National Wild and Scenic River designation (Record of Decision for Eight Eastside Rivers Wild and Scenic River Study Report and FEIS, 1999) because of its ecosystem values in the form of fens, unique plants, special geologic formations that support the fens, unique water chemistry that supports rare caddis flies, an assemblage of native fisheries, unique wildlife values, and historical logging values eligible to the National Register of Historic Places. Many studies have been conducted on macroinvertebrates, many of which were discovered and taxonomically defined from specimens collected in springs within the Basin. Long running and repeated studies include native fisheries and introduced trout research, songbird and cavity nesting bird monitoring in relation to areas unburned and burned in wildfires, small mammal/rodent trapping and monitoring associated with
the Calhoun Lines that ran approximately 30 years, and studies on beaver populations that began in the 1960s, just to name a few.

Since 1978, the Sagehen Basin has been host to a number of crucial research studies on marten distribution, habitat use and preferences, and prey selection. Some notable theses and dissertations completed on marten in or adjacent to the Sagehen Basin include: An Ecological Study of the Marten in the Tahoe National Forest, California (Simon, 1980), Food Habits, Activity Patterns and Ectoparasites of the Pine Marten at Sagehen Creek, California (Zielinski, 1981), Pine Marten Habitat Preferences at Sagehen Creek, California (Spencer, 1981), The Ecology of the Pine Marten (Martes americana) at Sagehen Creek, California (Martin, 1987), and American Marten Distributions over a 28 Year Period: Relationships with Landscape Change in Sagehen Creek Experimental Forest, California, USA (Moriarty, 2009). Many other subsequent publications were produced based on data presented in the above theses and dissertations.

As in many places of the Sierra Nevada, the Sagehen Basin has also been subjected to numerous disturbances over time. For example, from the 1870s through the 1930s, the Sagehen Basin was heavily logged. From the 1870s through 1890s, the Banner Mill, a sawmill, was located within the Basin. During this time, sawtimber was cut and milled within the Basin, after which contractors came in and removed most of the remaining trees in cut areas for cordwood. After the Banner Mill closed, another private timber company, the Sierra Nevada Wood and Lumber Company, began removing sawtimber from the remaining sections in the Basin. A mainline railroad grade was pushed north through the Sagehen Basin. Harvesting by this company extended up in elevation to much of the red fir sawtimber in Section 10, Township 18N, Range 15E. By 1931, the Company had begun to harvest the sawtimber within the Basin with early tractor based logging systems. From the 1890s through 1936, most if not all of the remaining saw (merchantable) timber was removed from the Basin. What remained was a scattering of second growth trees that grew in after the 1870s-1890s logging and the non-merchantable trees left after sawtimber removal from the 1890s-1936 (Knowles, 1942, Myrick, 1992, Wilson, 1992). The Forest Service purchased the land in 1936. Trees remaining in 1936 became some of the legacy trees seen in the Basin today. Since 1936, there have been some logging and salvage operations conducted by the Forest Service, most notably post-fire salvage logging in the 1960s, the Golden Timber Sale in 1988, the Sagehen Salvage Sale in 1990, and the Sagehen and Spring Chicken Fuel Breaks in 1998 and 2002 respectively.

Other disturbances include grazing and wildfire. Sheep, and occasionally cattle, actively grazed the area from the Gold Rush era, through the early 1990s. The Sagehen Basin was removed from the TNF grazing program in 2008. Portions of this area have been subject to high-severity fire in the past, such as the 1928 Independence Fire, and most notably the Donner Ridge Fire that occurred in the fall of 1960 which burned approximately ½ of the Basin.

Even with these activities and disturbances, there are portions of the Basin that have not seen active timber management since the Forest Service acquired the land. Fires have been actively suppressed, and dense forest conditions have developed in many places.
Need for the Sagehen Project
This section describes why the Forest Service is proposing to take actions now in the Sagehen Basin to:

- reduce hazardous fuel loadings and modify landscape-scale wildland fire behavior;
- maintain and enhance habitat for the marten and other wildlife species associated with late seral forest habitat;
- create heterogeneous forest stand conditions that would be expected to develop under an active fire regime;
- enhance the ecological role of fire; and
- restore declining aspen stands.

Reducing hazardous fuel loadings and modifying landscape-scale wildland fire behavior

A large wildfire in the Sagehen Basin would likely have severe adverse effects on natural and cultural resources as well as human property and life. Large, uncharacteristically severe wildfires have occurred in and around the Sagehen Basin in the past, most notably the 1960 Donner Ridge Fire, which burned a total of approximately 44,000 acres under high fire intensities, including the southeastern one-third of the Basin. In addition, the 1926 Independence Fire burned approximately 3,900 acres along the northwestern area of the Basin. The majority of the Sagehen Basin has not burned for decades, resulting in high fuel loadings throughout the area. The southeastern portion of the Basin is extensively occupied by post-fire plantations, which are now nearly 50 years old, while much of the remaining area is occupied by densely stocked, primarily second growth conifer forest stands, which emerged after logging done from the 1870s through the 1930s, followed by decades of fire exclusion. The accumulation of forest fuels over time has created the potential for a large, severe wildland fire in the Sagehen Basin.

There is substantial risk that a wildfire could start in the more populated areas located to the south of the Sagehen Basin during a period of low fuel moistures and be driven into the Basin by winds from the south or southwest. Under such a scenario, the fire entering the Basin would likely be characterized by extreme fire behavior, with long flame lengths and high rates of spread. Such a fire would be expected to spread in a manner similar to the historic Donner Ridge Fire or other more recent large fires in the Truckee/Tahoe area. There is also the possibility of a fuel-driven wildfire from the south and southwest in which fire would move through the even-aged plantations in the southeastern portion of the Basin. The high vegetation densities in these plantations, combined with the short distance from the ground to the live crowns of the trees, would cause the fire to spread rapidly. A secondary threat is a wildfire starting along Highway 89, which could be driven into the Basin by winds from the north/northeast.

A rapidly spreading wildfire in the Sagehen Basin would adversely affect numerous ecological values, including high quality late seral habitat for the marten, California spotted owl, and northern goshawk as well as unique habitats, including aspen stands and fens. A severe wildland fire could have substantial adverse effects on riparian habitats and water quality in Sagehen Creek and its tributaries, the waters of which enter the Little Truckee and Truckee Rivers. The State of California has listed the Truckee River as being “water quality limited” under Section 303 (d) of the Clean Water Act, and Sagehen Creek has been
recommended for designation as a Scenic River under the Wild and Scenic River Act (USDA, 1999). Finally, the Sagehen Basin is eligible for listing as a National Historic District; a severe wildland fire would likely adversely affect the numerous cultural resources present in the Basin.

**Maintaining and enhancing habitat for the marten and other wildlife species associated with late seral forest habitat**

The Sagehen Basin currently provides habitat for Forest Service designated sensitive species associated with late seral forest conditions, most notably the American marten (*Martes americana*), northern goshawk (*Accipiter gentilis*), and California spotted owl (*Strix occidentalis occidentalis*) The Basin contains one spotted owl and four goshawk designated protected activity centers (PACs) as well as one designated spotted owl home range core area (HRCA) associated with the spotted owl PAC. These areas provide for suitable nesting and foraging habitat for these species.

While there are no formally designated marten use areas as there are for goshawk and spotted owls, the Sagehen Basin’s well documented history of marten research points to habitats and areas within the Basin that are particularly important to martens. These areas can be adversely affected by management activities, especially if marten needs are not considered in the design of the activities. In addition, the most recent study (Moriarty, 2009) documents a dramatic decrease in marten occurrence as compared to results from earlier studies. This information accentuates the need to maintain and enhance marten habitat within the Basin over both the short and long term. Where marten habitat falls within proposed treatment areas, the need to specifically consider marten requirements and habitat needs in the development of potential project prescriptions becomes critical.

Because high value marten habitat (defined below in Table 1) is representative of habitat components and conditions that are important to other late seral species such as goshawk and spotted owl, maintaining and enhancing conditions for marten, along with protecting PACs, would also maintain and enhance habitat conditions for goshawks and spotted owls.

A landscape configuration of areas of high value habitats (such as reproductive, resting, foraging, and nesting habitats), combined with other habitat types (such as more open areas that may provide habitat for prey species), is critical in maintaining and enhancing habitat conditions capable of supporting martens and other wildlife species that rely on late seral habitats. Action is needed to maintain existing high quality habitats by reducing the potential for uncharacteristically severe wildfire effects while enhancing both stand and landscape habitat conditions by (1) retaining and/or enhancing the Basin’s high value habitats for marten, goshawk, and spotted owl; (2) retaining and recruiting large trees and crown cover; (3) retaining and recruiting areas called dense cover areas (DCAs) that currently have dense, multilayered tree and vegetation conditions, and areas that provide early seral conditions suitable for prey species; (4) maintaining or restoring connectivity across or around areas of unsuitable habitat; (5) retaining and recruiting trees with decay and/or “defect” structures to support cavity development or platforms for denning, nesting, and resting sites; and (6) retaining and recruiting large and small dead wood features such as snags, high stumps/short snags, and down logs in various configurations.
Creating heterogeneous forest stand conditions that would be expected to develop under an active fire regime
Past large uncharacteristically severe wildfires (specifically the Donner Ridge and Independence), combined with reforestation efforts 50 years ago, have resulted in the extensive Jeffrey and ponderosa pine plantations that currently occupy the southeastern, northeastern, and northwestern areas of the Sagehen Basin. Dense second growth conifer stands occupy much of the remainder of the Basin and fire has been excluded from these natural stands for decades. Past fires, reforestation, timber harvesting, and fire exclusion have combined to create today’s simplified, relatively homogenous structure of the plantations and many of the Basin’s forest stands.

The structure and tree species composition of the plantations and many of the Basin’s forest stands have made them vulnerable to a host of mortality factors, including drought stress, bark beetle outbreaks, disease, and the over-arching ramifications of climate change. Excessive tree mortality can have significant and long-term effects on forest structure and composition, and these conditions can exacerbate the threat of severe fire. Action is needed to develop forest stands that can be more resilient to this array of threats. Enhancing forest heterogeneity at both the stand- and landscape-scale; reducing stand densities in certain locations; and modifying tree species composition, for example, favoring more fire resilient pines on south facing slopes, could address these potential sources of mortality. Reducing stand densities would result in less competition for soil moisture resources and light, which would help accelerate the development of stands comprised of larger trees. By creating a more heterogeneous landscape, remaining trees and stands would be better able to cope with drought stress, insect infestation, and disease outbreaks. Climate change is anticipated to aggravate these stressors; hence, action is needed to enable stands in the Sagehen Basin to be more resilient under expected future conditions.

Enhancing the ecological role of fire
Fire plays a pivotal role in reshaping and maintaining forest ecosystems; however, fire has been excluded from the Sagehen Basin for many decades. Action is needed to jumpstart ecosystem processes that have been stalled by accumulating surface fuels and the absence of frequent burning (North 2006). Fire adapted ecosystems, like the Sagehen Basin, need fire as an active ecosystem process in order to improve or maintain fire resilient attributes. Low intensity surface fire would achieve many objectives intended for fire resilient forests, such as reducing surface and ladder fuels, increasing canopy base height (pruning lower limbs), and increasing the proportion of fire resistant tree species. A long-term goal is to return more frequent, low intensity fire to this Basin. This cannot be achieved without some initial management action to reduce the excessive fuel loading that currently exists.

Restoring Declining Aspen Stands
Due to fire exclusion, some aspen stands in the Sagehen Basin have been overtopped by conifers. Thus these stands have a higher percentage of conifers compared to aspen, and have very little regeneration of aspens due to over-shading. Aspen habitat is particularly important for biological diversity and is limited across the landscape. Actions to restore aspen stands would help to enhance and perpetuate these highly diverse habitats over the long term.
Purpose of the Sagehen Project
The primary purpose of an Experimental Forest is to provide opportunities for research to address a wide variety of ecological questions in forest settings including response of forest systems to land management practices. A carefully designed research project, funded by a Joint Fire Science Program grant, was initiated by researchers from UC Berkeley in 2007 to examine the effects of a pattern of strategically placed area treatments (SPLATs) laid out across the Sagehen Basin. The concept of establishing a pattern of SPLATs across a landscape in order to modify landscape-level wildfire behavior has been developed through extensive computer simulations, and a number of scientific publications describe the prospects that this approach offers. However, little field testing of this concept has been executed. This study was designed to investigate how a SPLAT approach performs in the field, using carefully quantified conditions of fuels, canopy cover, and tree size distribution with field data and airborne LiDAR data.

A key objective in meeting the need for action is to develop a landscape pattern of fuels treatments that would implement the conceptual fuels treatment strategy delineated in the UC Berkeley study. Forest management in the Sagehen Basin presents an ideal opportunity to field test, based on extensive pre- and post-treatment field data and more advanced computer modeling, the likely effects of such fuel treatments. Implementation of the treatments in the field would take this research a large step forward by allowing researchers to examine how an actual treatment regime performs.

Notwithstanding the overarching SPLAT design, the setting of a vegetation and fuels management project within the Sagehen Experimental Forest further presents an unprecedented opportunity to test innovative ideas related to forest management, particularly in eastside forest stands. A key objective for this project is to design, test, and apply vegetation and fuels management approaches that are congruent with principles put forth in An Ecosystem Management Strategy for Sierran Mixed-Conifer Forests (North et al. 2009), also referred to as General Technical Report (GTR) 220. This Report presents a comprehensive overview of the recent scientific literature regarding mixed conifer stands in the Sierra Nevada and its bearing on forest management approaches. The Report’s recommendations are aimed at enhancing forest resiliency, increasing stand and landscape scale heterogeneity, restoring the ecological role of fire to the landscape, and maintaining habitat for sensitive wildlife species in Sierra Nevada mixed conifer forests. Specifically for the Sagehen Project, objectives for sensitive species management focused on providing high quality martens habitat; providing protection for northern goshawk and California spotted owl protected activity centers (PACs); retaining and recruiting large trees and crown cover; maintaining and recruiting areas that currently have dense, multilayered tree and vegetation conditions, and areas that can represent early seral conditions suitable for prey species; maintaining and recruiting trees with structure to support cavity development or platforms for denning, nesting, and resting sites; and maintaining and recruiting large dead wood features such as snags and down logs.
Proposed Action

History of the Project
The Truckee Ranger District staff recognized the risk of another large wildfire and as a result began to actively pursue options to reduce the risk in 2003. The “Sagehen Project” began with the overall goal of reducing the potential of uncharacteristically severe wildfire effects through the implementation of fuels reduction treatments and management direction as laid out in the Sierra Nevada Forest Plan Amendment Record of Decision (SNFPA ROD 2004). The initial strategy proposed to reduce the risk of large scale wildfire was to designate SPLATs. SPLATs are intended to slow the spread and reduce the size and severity of a wildfire across a planning landscape as well as to modify fire behavior within the treatment areas. The assumption with SPLATs is that, given an effective treatment area shape and pattern, only a portion of the landscape needs to be treated and maintained to produce desired modifications in wildfire behavior over the entire landscape.

To designate initial SPLATs, the Truckee Ranger District worked closely with the UC Berkeley Sagehen Creek Field Station beginning in 2004. Areas of low fire risk such as high elevation areas and known sensitive areas such as California spotted owl and northern goshawk Protected Activity Centers (PACs), sensitive plant sites, and cultural resource sites were generally avoided when designating SPLATs. In conjunction with this, opportunities to improve forest health and resiliency were also considered, typically tied in with reducing stand densities. Scientists from the University of California (John Battles and Scott Stephens) developed a research approach and collected vegetation and fuels data to examine the effects of SPLATs. From 2004-2008, the focus of the Project planning was to design fuels and forest health treatments within SPLAT treatment units. Upon the designation of the Sagehen Experimental Forest, the Truckee Ranger District also began to work closely with PSW to incorporate experimental forest objectives into project planning.

Early in 2010, the Truckee Ranger District and PSW agreed to take a step back from the internal project planning that had been done to date. An expanded collaborative planning process was begun to engage all interested parties and stakeholders (public, private, and agency) to thoroughly examine the issues that pertain to fuels reduction management in light of new information in GTR 220, as well as information put forth in a master’s thesis titled American Marten Distributions over a 28 Year Period: Relationships with Landscape Change in Sagehen Creek Experimental Forest, California, USA (Moriarty, 2009). The thesis documented surveys and inventories to determine American marten distributions within the Sagehen Basin, and how those distributions changed as compared to similar studies in the 1980s. Management implications were put forth to preserve and restore habitat and to increase the likelihood of marten persistence within the Basin. A grant was obtained from the Sierra Nevada Conservancy to support an independent facilitator and the collaborative effort was launched in May of 2010.
How the Proposed Action was Developed through Collaboration

Collaborative Process
In May 2010, a collaborative planning process was begun to engage all interested parties and stakeholders (public, private, and agency) to examine issues that pertain to fuels reduction management and to consider new information. Approximately 140 potentially interested and affected parties were initially invited to participate in the process. Since May 2010, approximately 20-60 people (average of 25), representing local city, county, and state agencies, other federal agencies, environmental groups, private companies, universities and research, Forest Service research, and interested citizens have routinely and actively been participants in the collaborative process.

One constraint was placed on the collaborative effort: proposed activities would be limited to the areas covered by the prior (2004-2008) planning effort and data collection areas, where a suite of survey activities had already been completed. The primary reason for this limitation was to avoid the need for and costs of additional surveys and inventories. Opening up the planning process to the entire Sagehen Basin would have added significant costs and time to the process and the Forest Service (PSW and Truckee Ranger District) did not have the funds or timelines that would allow additional surveys at that time. With that one caveat, the Collaborative Planning process began to explore all the issues that the collective body considered meaningful and necessary to address as part of a forest or fuels management project.

The Collaborative Planning process for the Sagehen Project was intended to generate comprehensive stakeholder participation and input. This was used in defining approaches for implementing vegetation and fuels management and ecological restoration activities and methods. In general, the goal of a collaborative process is to reach a decision everyone can accept. In this case, the end goal was to use input, review, and ideas from the collaborative group to generate a Proposed Action and Purpose and Need (PA/PN) document that could be used to begin the National Environmental Policy Act (NEPA) process. Through the collaborative process, PSW and the Truckee Ranger District wanted to provide ample opportunity for satisfying the concerns of involved parties. By discussing and exploring issues in advance of any official NEPA action, the group could collectively reveal and deal with many issues prior to crafting and putting forth a PA/PN.

Steps Used to Craft the Proposal
Collaboration took place primarily through a series of meetings, with an independent facilitator, with information shared through email, web postings, conference calls, and live web meetings. The initial stages were designed to inform stakeholders of the existing conditions and natural resource data that existed regarding the Sagehen Basin and to identify any and all questions, concerns, and issues stakeholders had in relation to a proposed project in the area. Less complex issues and questions were addressed during the meetings and/or through modifications or additions to the proposal. Committees or subgroups of particularly interested stakeholders were formed to address the more complex and specific questions and issues. Four issues drove much of the proposed action development. One general issue was stakeholders were unsure of what a treatment would look like that incorporated concepts from the GTR 220. The other main issues were concepts of ecological restoration and increased forest
resiliency to change, habitat protection and enhancement for the American marten, and how proposed treatments affect fire behavior.

**GTR 220 Treatment Example – Sagehen Test Plots**
To address the question of what a GTR 220 project looked like, two test plots of approximately three acres each were selected, one in the northeast portion and one in the southwest portion of the Basin. The test plots were designed to be representative of the larger project landscape. Each plot was inventoried, marked (in conjunction with the GTR 220 authors), harvested, and in the case of one plot, underburned during the summer/fall of 2010. Post treatment, the plots were re-inventoried to provide metrics of sizes, species, and numbers of trees removed, basal area removed and retained, and before and after crown cover. Post treatment photo point monitoring was also conducted. The plots helped to illustrate and test the prescriptions and methods described below under the *Prescriptions and Treatments* section. Specifically the plots demonstrated variable thinning, legacy tree treatment, suppressed cut, dense cover area (DCA), and early seral opening (ESO) prescriptions. See below for more detail.

The test plots proved to be very important to the larger collaborative process. The collaborative group was able to view the resulting stand composition and structure as well as two small adjacent areas that were sample marked to represent a before treatment condition. Data collected proved very effective in communicating the anticipated outcomes of treatments and helped further refine prescriptions for the larger Sagehen Project Area. Lessons learned helped to define operating procedures and to fine tune expectations on the logistics of implementation. The test plots provided a visual confirmation of the concepts expressed in GTR 220. Overall they helped provide common understanding of the concepts, opportunities, and challenges in using the GTR 220.

**Ecological Restoration and Habitat Protection/Enhancement for the Marten**
One particular subgroup was formed to deal specifically with two of the main issues raised. This subgroup dealt with: (1) how concepts of ecological restoration and increased forest resiliency to change from the GTR 220 could be incorporated into project design while (2) also addressing habitat protection and enhancement for the American marten.

A formal definition of ecological restoration is “The process of assisting the recovery of resilience and adaptive capacity of ecosystems that have been degraded, damaged, or destroyed. Restoration focuses on establishing the composition, structure, pattern, and ecological processes necessary to make terrestrial and aquatic ecosystems sustainable, resilient, and healthy under current and future conditions”(USDA Forest Service Manual 2020.5). For the Sagehen Project, the concept of stand level ecological restoration focuses on creating a heterogeneous forest stand that would be representative of a forest stand under a more active fire regime. Therefore, it would be expected that forest stand species mixes, structures, and densities would vary dependent upon topographic variables, such as slope aspect and position.

This subgroup helped to define draft prescriptions and objectives which were brought for review and input to the larger collaborative group at multiple times through the process. In order to do this, the
subgroup reviewed all American marten research conducted in the Sagehen Basin. Recommendations, habitat metrics important to marten (such as snag and down log sizes and densities), and habitat definitions were pulled directly from research studies. In particular, Spencer (1981), Martin (1987), and Moriarty (2009) provided a wealth of information that allowed the subgroup to define high quality marten habitat and designate habitat components and metrics important to marten. Table 1 below describes the habitat definitions (Moriarty, 2009, as slightly modified with input from Katie Moriarty and Bill Zielinski) that the subgroup used to identify high and moderate quality marten habitat within the Basin.

Table 1: Definitions of High and Moderate Quality Marten Habitat within the Sagehen Basin (Moriarty 2009, modified)

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Forest Type</th>
<th>Size Class*</th>
<th>Canopy Closure**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Quality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lodgepole Pine (LPN)</td>
<td>4, 5</td>
<td>M, D</td>
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</tr>
<tr>
<td>Montane Riparian (MRI)</td>
<td>5, 6</td>
<td>M, D</td>
<td></td>
</tr>
<tr>
<td>Red Fir (RFR)</td>
<td>4, 5</td>
<td>M, D</td>
<td></td>
</tr>
<tr>
<td>Subalpine Conifer (SCN)</td>
<td>4, 5</td>
<td>M, D</td>
<td></td>
</tr>
<tr>
<td>Sierran Mixed Conifer (SMC) – Fir dominated stands only</td>
<td>5, 6</td>
<td>M, D</td>
<td></td>
</tr>
<tr>
<td>White Fir (WFR)</td>
<td>4, 5, 6</td>
<td>M, D</td>
<td></td>
</tr>
<tr>
<td><strong>Moderate Quality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastside Pine (EPN) – Higher lodgepole pine component only</td>
<td>4, 5, 6</td>
<td>P, M, D</td>
<td></td>
</tr>
<tr>
<td>Eastside Pine (EPN)</td>
<td>5, 6</td>
<td>M, D</td>
<td></td>
</tr>
<tr>
<td>Jeffrey Pine (JPN)</td>
<td>5, 6</td>
<td>M, D</td>
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<tr>
<td>Lodgepole Pine (LPN)</td>
<td>4, 5</td>
<td>P</td>
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<td>4</td>
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<tr>
<td>Sierran Mixed Conifer (SMC) – Fir dominated stands only</td>
<td>4</td>
<td>M, D</td>
<td></td>
</tr>
<tr>
<td>Sierran Mixed Conifer (SMC) – Pine dominated stands only</td>
<td>5, 6</td>
<td>M, D</td>
<td></td>
</tr>
</tbody>
</table>

* Size class in diameter at breast height (dbh) inches: 4 = 11”-24”, 5 = >24”, 6 = >24” with multi-layered canopy.
** Canopy closure in percent: P = 25-39%, M = 40-59%, D = 60-100%

One of the key principles in GTR 220, the concept of topographic variability as a determining factor in forest composition and structure, was used in combination with other key sources of spatially explicit information (e.g. locations of high quality marten habitat and vegetation types) to partition the landscape into subunits which were termed as emphasis areas. Objectives were then developed for each emphasis area type. Not all the emphasis areas have equal value (as habitat) or have equal ecological potential (for one kind of forest stand or another based on topography or site condition), or generate equal concern (for fire behavior). A benefit of the emphasis area approach was that it provided a way to deal with issues that some in the collaborative group perceived as mutually exclusive. The perceived problem that fuels could not be reduced while still maintaining habitat for late seral species was addressed by explicitly designating where in the potential treatment areas one objective had a greater priority than the other. For example, ridges and drier south facing slopes are areas that typically experience more severe wildfire effects as compared to north facing mid slopes, whereas typically north facing mid slopes tend to have more of the preferred habitats for late seral species. By partitioning the
landscape, objectives could be specifically tied to existing and potential conditions that explicitly address landscape heterogeneity and/or habitat quality. Based on these objectives, tailored silvicultural and fuels management strategies were crafted to meet the needs for each of the emphasis areas considering the habitat needs of marten, stand level ecological restoration as described in GTR 220, and fuels reduction to effectively modify fire behavior.

**How Proposed Treatments Affect Fire Behavior**

To address a third main issue, a Forest Service Enterprise Team was hired to model how proposed treatments might affect post treatment fire behavior. Modified fire behavior combined with increased resiliency would result in less severe wildfire effects. For this treatment strategy to be considered a credible approach, the Forest Service sought evidence that the treatments, addressing multiple objectives, resulted in effective reduction of potential large, uncharacteristically severe wildfire effects. The collaboration group reviewed and provided input to the fire behavior modeling.

**Areas Identified for Management Emphasis**

**Overall Goals and Treatment Objectives**

As stated above, one of the main outcomes of the collaborative process was the designation of a number of emphasis areas within the boundaries of the proposed treatment units (original SPLAT boundaries). These emphasis areas became subunits within the treatment units where management would be focused and modified depending on the intent of each emphasis area. Three primary objectives are all reflected in all of the emphasis areas, albeit in different orders of priority. These included: (1) American marten habitat protection and/or enhancement, (2) stand level ecological restoration, and (3) fuels reduction.

For all emphasis areas, a common set of metrics were identified to assess different post-treatment stand conditions, which would reflect the primary treatment objectives of that area. The metrics used include: (a) basal area retention, especially in trees greater than 20 inches diameter at breast height (dbh), (b) crown cover, (c) snag density, (d) large and small down woody material, (e) high stumps/short snag densities, (f) tree species composition, (g) dense cover areas (DCAs) with multiple tree ages, and early seral openings (ESOs), and (h) fire behavior modeled values under 90th percentile weather conditions, including flame lengths and predicted crown fire and associated larger tree mortality.

While it is preferred that prescribed and natural fire become two primary management tools over the long term in all the emphasis areas, interim steps are needed so that fuels may be reduced to a more natural level, allowing fire to occur as it would have if fuels had not built up to unnatural levels. In order to facilitate that, near term management goals include the use of silvicultural and fire/fuels prescriptions and treatment methods that can, to a certain extent, mimic the effects of natural fire. Once these treatments have been applied it is hoped that prescribed or natural fire could occur without heavy mortality and uncharacteristically severe effects. These prescriptions and treatment methods and how they apply to emphasis areas (subunits), are detailed in the sections below beginning with “Prescriptions and Treatments”. Directly below are sections that explain the overall goals and treatment objectives for each emphasis area.
Sagehen Project Area Map 1

Each emphasis area is represented by a different color on the attached Map 1. These colors translate into subunits within the proposed treatment unit boundaries. For example, in treatment unit 38, the two discontinuous green areas are both emphasis area 1 and they are both designated subunit 38-1. In another example, treatment unit 213 is comprised of emphasis areas 1 (green), 2 (blue), 4 (fuchsia), 5 (gray), 6 (orange), and 7 (yellow). It therefore has subunits 213-1, 213-2, 213-4, 213-5, 213-6, and 213-7.

Emphasis Areas 1 and 3

Emphasis areas 1 and 3 represent some of the high quality marten habitat (defined in Table 1) currently existing within the Sagehen Basin. Emphasis area 1 (green areas on Map 1) includes high value habitats on north facing slopes, on ridges, and on higher elevation south facing slopes (above 6,725 feet). Emphasis area 3 includes high value habitats on lower elevation south facing slopes. High quality habitat for marten also exists outside the treatment unit emphasis areas, primarily along and south of Sagehen Creek and west of unit 46. There are also some scattered pockets of high value habitat north of Sagehen Creek. Because emphasis area 3 is very limited in total area, it was combined with either emphasis area 1 or emphasis area 2 (also high value marten habitat), whichever was closer. Therefore there is no mapped emphasis area 3 and there are no metrics assigned to it. Because numbers were already assigned to emphasis areas when emphasis area 3 was combined with others, re-numbering was not done. This discussion is intended to reduce confusion as to why emphasis area 3 is not shown on the map and why it will not be discussed further in this document. Within the treatment units, approximately 465 acres are identified as emphasis area 1 (see Table 3 below).

Emphasis area 1 values vary above and below 6,725 feet (2,050m), especially on north and east facing slopes in the southwest portion of the Basin (south of Sagehen Creek and west of the Donner Fire area). Areas above 6,725 feet in the southwest portion of the Basin are of relatively higher importance to marten than areas below 6,725 feet and to areas above 6,725 feet in the northeast portion of the Basin. As stated in Spencer (1981), “martens in the upper basin (>2,050m) preferred stands with larger trees than those in the lower basin, reflecting their affinity for old-growth red fir stands.” and that the change from lodgepole/white fir to red fir occurs at 2,050m in elevation on the north and east facing slopes in the southwest portion (south of Sagehen Creek and west of Donner Fire area) of the Basin. This generally occurs in treatment units 156 and 213 and parts of treatment unit 163, see Map 1.

The primary goal is to manage emphasis area 1 for both the conservation and restoration of marten habitat values both in the near term and long term. Secondary and tertiary goals include ecological restoration and fuels reduction, respectively. To manage habitats for marten, this emphasis area would maintain relatively higher basal areas, specifically of larger trees, as compared to all the other emphasis areas. Some trees would likely be removed but basal areas would be lowered only to the extent to facilitate the faster creation of a higher proportion of trees greater than 20 inches dbh while at the same time retaining enough basal area and crown closure to maintain the emphasis area as current high quality habitat. Of the designated emphasis areas, emphasis area 1 retains/recruits the highest number of snags, high stumps/short snags, and existing DCAs. This would maintain components and areas important for resting/denning martens and would ensure future recruitment of important habitat
elements and areas. High amounts of large down wood material and high stumps are also important to provide foraging areas and rest sites. In addition, as compared to the rest of emphasis area 1, relatively higher basal areas, more DCAs, and a higher percentage of red fir and white fir are afforded higher prominence in the portions of the emphasis area above 6,725 feet in the southwest portion of the Basin due to the relatively higher habitat values present in this area. Another goal for emphasis area 1 is to maintain reasonable connectivity (i.e. cover from predators and access to adjoining areas) across the area. Recent evidence (Moriarty, pers. comm.) suggests that marten are vulnerable to predation if sufficient cover between preferred resting and foraging sites is lacking.

Even though the primary goal for this emphasis area is to manage for marten use, it is also very important to manage for stand level ecological restoration and a heterogeneous forest which will be more resilient to fire and climate-induced stresses. Treatment objective ranges for basal area retention, crown cover, percentage of the subunit in DCAs and/or ESOs, and tree species compositions help to ensure that a heterogeneous condition would result post treatment. Also, in order to address fuels reduction and the need to reduce the potential of uncharacteristically severe wildfire effects, treatment objectives that address ladder fuel removal, the spatial arrangement of areas where ladder fuels would not be removed, and the horizontal arrangement of fuels to break up continuous fuel beds help to address these concerns.

**Emphasis Areas 2 and 4**

Emphasis areas 2 and 4 include the drainage bottoms that currently support high quality marten habitat (emphasis area 2, blue areas on Map 1) and the drainage bottoms that do not currently support high quality marten habitat, i.e. the habitat does not currently meet the criteria described in Table 1 (emphasis area 4, fuchsia areas on Map 1). As stated above, high quality habitat for marten also exists outside the treatment unit emphasis areas. Emphasis areas 2 and 4 include perennial stream courses and other intermittent and ephemeral drainages throughout the Basin. These locations tend to be relatively more mesic, retain moisture longer through the season and generally support more dense and diverse vegetation conditions than the surrounding stands. Stream courses and other mesic drainage bottom areas are known to be preferable habitat for many wildlife species. They tend to have more herbaceous vegetation cover and microhabitats, provide more escape cover, are accessible to permanent water sources, and support a larger volume and diversity of vertebrates and invertebrates. Thus emphasis areas 2 and 4 intend to maintain and enhance these conditions. In cases where trees are encroaching on meadows or open herbaceous areas, the basal area/crown cover of trees would be reduced to maintain and/or restore meadow habitat as well as encourage herbaceous cover. By contrast, some drainages tend to be relatively more xeric and have fewer to no adjoining wet meadows or similar features. Under these conditions these areas still retain moisture for a longer period of the year than surrounding stands and tend to support denser vegetation and often larger trees. Under these circumstances the objective is to maintain higher basal areas and crown cover and a higher proportion of dense vegetation and structural diversity that these areas tend to provide. Within the treatment units, approximately 108 acres are identified as emphasis area 2 and 189 acres are identified as emphasis area 4 (see Table 3 below).
The primary distinction between emphasis area 2 and emphasis area 4 is the consistent presence of greater than 11 inches dbh lodgepole pine as the dominant tree species in most of emphasis area 2 with an average crown cover of 40% or more. Emphasis area 4 can include perennial and intermittent streams, as well as mesic and relatively xeric ephemeral drainages with a variety of tree cover types. Overall, emphasis areas 2 and 4 are intended to provide higher basal areas of larger trees than the areas surrounding them except for emphasis area 1. They would provide relatively high canopy closures within the treed areas but would also allow enough light for well developed herbaceous ground cover where sufficient water exists. In addition they would also have higher proportions of snags and high stumps/short snags which would provide resting sites, foraging features, and prey cover for martens. Because of their preferential use for foraging habitat, treatment objectives include the highest retention of large/small down wood components. The differences arise in emphasis area 4 because it includes not only perennial stream courses, but also many intermittent and ephemeral drainages which are highly variable in moisture conditions, vegetation types, position on slope, and aspect. More variation occurs in this emphasis area, thus treatment objectives are also more variable. Relatively more mesic conditions would have more downed logs and high stumps and would be composed of more lodgepole pine; while more xeric conditions would have less dead wood components and would trend on a scale more towards white and red fir and/or ponderosa or Jeffrey pine (depending on slope/aspect).

Even though the primary goal for these emphasis areas is to manage for marten use, especially foraging habitat, it is also very important to manage for stand level ecological restoration and a heterogeneous forest which will be more resilient to fire and climate-induced stresses. Treatment objective ranges for basal area retention, crown cover, snag, down wood, and high stumps densities, percentage of the subunit in DCAs and/or ESOs, and tree species compositions help to ensure that a heterogeneous condition would result post treatment. Also, in order to address fuels reduction and the need to reduce the potential of uncharacteristically severe wildfire effects, treatment objectives that address ladder fuel removal, the spatial arrangement of areas where ladder fuels would not be removed, and the horizontal arrangement of fuels to break up continuous fuel beds help to address these concerns.

**Emphasis Area 5**

Emphasis area 5 (gray areas on Map 1) represents north facing slopes that are not currently high quality marten habitat. The primary goal in emphasis area 5 is to work towards stand level ecological restoration, followed by marten habitat enhancement and fuels reduction. In general the treatment objectives would move the area towards a more heterogeneous forest that would improve resilience to fire and climate induced stresses, while at the same time still providing habitat elements for old forest associated sensitive wildlife species, such as the marten, northern goshawk, and California spotted owl. This emphasis area is also present in some plantations (units 46, 76, 87, and 99). For the Sagehen Project, the objectives in these plantations would be focused on the first steps of achieving a resilient heterogeneous forest. Some examples of this are retaining some young porcupine damaged trees that could grow into trees with split tops and other defects suitable for nesting/resting structures, and retaining residual or legacy trees and areas that are sparsely treed – for plantations, these areas would become similar features to DCAs and ESOs. See the “Prescriptions and Treatments” section below for more detail.
For the remainder of emphasis area 5, outside of plantations, objectives include retaining individual trees, small groups of trees, retaining existing DCAs, and creating ESOs that can support younger cohorts of a variety of species. Due to the more northerly exposure, emphasis area 5 would support more basal area and crown cover as compared to ridges and south facing slopes. However it would support less basal area and crown cover than drainages, because of the more xeric conditions, and less than emphasis area 1 because of the objectives to maintain higher basal areas and crown cover for high quality marten habitat. Overall however, treatment objectives specify that enough basal area, crown cover, and habitat components such as snags, down wood, high stumps, and DCAs would be retained to ensure that the emphasis area retains, or in plantations, facilitates the creation of, important habitat structures for wildlife and provides suitable habitat or moves the habitat towards suitability for old forest species. Also, as in emphasis areas 1, 2, and 4, to address fuels reduction and the need to reduce the potential of uncharacteristically severe wildfire effects, treatment objectives are designed that address ladder fuel removal, the spatial arrangement of areas where ladder fuels would not be removed, and the horizontal arrangement of fuels to break up continuous fuel beds. Within the treatment units, approximately 1,048 acres are identified as emphasis area 5 (see Table 3 below).

**Emphasis Areas 6 and 7**

Emphasis area 6 (orange areas on Map 1) represents vegetation types not identified as high value marten habitat on south facing slopes and emphasis area 7 (yellow areas on Map 1) represents vegetation types not identified as high value marten habitat on ridges. In emphasis areas 6 and 7 where fuels reduction is the highest priority, treatments are designed to substantially modify wildfire behavior and reduce the potential of uncharacteristically severe wildfire effects. Although important in all the other emphasis areas, in emphasis areas 6 and 7 especially, the post treatment fire behavior is targeted to meet conditions for SPLATs. SPLATs are designed to achieve, under 90th percentile fire weather conditions, an average of a four foot flame length, that surface and ladder fuels would be removed as needed to meet less than 20 percent fire mortality in dominant and co-dominant trees, and that tree crowns would be thinned to meet less than 20 percent probability of initiation of crown fire (SNFPA ROD 2004, Standard and Guideline #5, pg 50). The secondary priority of stand level ecological restoration in these areas is focused on facilitating conditions that would result under an active fire regime, which includes a more heterogeneous forest that is resilient to fire and climate induced stresses. Within the treatment units, approximately 759 acres are identified as emphasis area 6 and 171 acres are identified as emphasis area 7 (see Table 3 below).

Overall, in emphasis areas 6 and 7, basal area and crown cover would be lower than in emphasis areas 1-5. In emphasis area 6, basal area would be reduced to a level that would help increase the pace of tree growth so that a higher percentage of the basal area is in larger (greater than or equal to 20 inches dbh) trees in a shorter amount of time. In emphasis areas 6 and 7, the intent is produce stand conditions that are more similar to those that would have been produced under an active fire regime. A more heterogeneous forest would be created by retaining individual trees, with particular emphasis on tree species more suited to xeric environments, retaining small groups of trees, retaining DCAs, and creating ESOs that can support younger cohorts of a variety of species.
Emphasis areas 6 and 7 are also present in some plantations (units 46, 76, and 87, and emphasis area 6 in unit 99). In plantations, fuels reduction objectives to modify wildfire behavior and reduce severe wildfire effects can usually be achieved in a relatively short timeframe. For the Sagehen Project, the secondary objectives in these plantations would be focused on the first steps of achieving heterogeneous forest. Some examples of this are retaining some young porcupine damaged trees that could grow into trees with split tops and other defects suitable for nesting/resting structures, and retaining residual or legacy trees and areas that are sparsely treed – for plantations, these areas would become similar features to DCAs and ESOs. See the “Prescriptions and Treatments” section below for more detail.

In addition, the third priority of these areas is marten habitat. Because of their topographic position on drier south facing slopes and ridges, usually with shallower soils, it is unlikely these emphasis areas would develop high quality marten denning/resting habitat over the long term. The exposures and soils would likely preclude the development of dense, large treed fir stands. However these areas could provide for marten movement. Therefore the objectives include to avoid the creation of barriers to marten movement (i.e. large openings). Therefore enough basal area, crown cover, and habitat components such as snags, down wood, and existing DCAs would be retained to allow marten movement in/through these emphasis areas.

**Emphasis Area 8**

Emphasis area 8 (purple areas on Map 1) is unique in that its only goal is stand level ecological restoration of aspen stands. However this goal is solely focused on a small forest stand scale. This does not represent all aspen stands within the Basin. Where small aspen stands exist within the potential treatment units, the goal is to improve/restore the aspen stands. Under a more active fire regime, conifer encroachment into aspen stands would be minimized and the aspens would be able to reproduce through suckering. However, with a lack of fire disturbances, conifers are able to shade out aspens and impede successful reproduction. The only objectives considered in this emphasis area are minimizing direct conifer competition to existing aspens and to remove conifers to the extent that the aspen stand could expand appropriately to the extent site conditions would allow. Within the treatment units, approximately 8 acres are identified as emphasis area 8 (see Table 3 below).

**Forest Plan Direction**

Most of the Sagehen Project Area is encompassed within the Sagehen Experimental Forest. A small portion of the area along the northeastern portion of the Project Area lies on the Truckee Ranger District of the Tahoe National Forest. The *Establishment Record for Sagehen Experimental Forest* (November 28, 2005) specifies that management direction for the Sagehen Experimental Forest will follow the *Tahoe National Forest Land and Resource Management Plan* (1990) as amended by the Sierra Nevada Forest Plan Amendment (2004) (referred to as the Forest Plan) for Management Areas 036 (Sagehen Basin) and 043 (Sagehen Station). Management direction for the portion of the Project Area on the Truckee Ranger District is provided by the Forest Plan.

A wildland urban intermix (WUI) defense zone surrounds the immediate vicinity of the Sagehen Creek Field Station, and the defense zone is buffered by a WUI threat zone. Most of the Project Area lies within
the old forest emphasis area land allocation, although the eastern portions of treatment units 46, 76, 98, and 100 and all of unit 99 lie within the general forest land allocation. Overlapping these land allocations are four northern goshawk and one California spotted owl protected activity centers (PACs) as well as one spotted owl home range core area (HRCA). Finally, Sagehen Creek has been recommended for Wild and Scenic River designation (Record of Decision for Eight Eastside Rivers Wild and Scenic River Study Report and FEIS, 1999), and is currently managed under interim management standards as a Scenic river. The emphasis area objectives for the Sagehen Project are consistent with Forest Plan desired conditions, management intents, and management objectives for these land allocations. Proposed activities would adhere to Forest Plan standards and guidelines.

Prescriptions and Treatments

The proposed action would apply a suite of integrated silvicultural and fire/fuels prescriptions within each treatment unit. Application of the prescriptions (via various treatment methods) would set the stage for achieving emphasis area treatment objectives, described in the preceding section. The sections below describe the prescriptions and treatment methods proposed for the Sagehen Project.

Order of Prescription Application

Implementing the following silvicultural prescriptions involves careful consideration of fire: both the follow-up application of fire/fuels prescriptions as well as the stand structure conditions that would likely develop under an active fire regime. On-the-ground decisions about which individual trees and groups of trees to retain are made in light of (1) ensuring overall stand structure will remain intact following application of prescribed fire and (2) mimicking stand structures that would develop under an active fire regime.

The prescriptions can be highly variable and site-specific, and are set within the context of the existing stand’s structure and tree species composition. For most units within the Sagehen Project, implementing the following silvicultural prescriptions involves applying each of the first four prescriptions in a step-wise fashion. The first step involves identifying both the dense cover areas (DCAs) and early seral openings (ESOs), and laying out their boundaries out on the ground. Next, the trees suitable for legacy tree treatments are identified and the surrounding trees proposed for removal are marked. After this is done, the variable thinning mark is anchored to DCAs, ESOs, and legacy tree treatments. In addition, the suppressed cut prescription is applied to remove suppressed trees contributing to ladder fuels outside of DCAs. All four of these prescriptions would be applied, in a step-wise fashion, for each identified unit (see Table 2). If there are no trees suitable for legacy tree treatment in a given unit, that prescription would be dropped during marking. The remaining two prescriptions, plantation thinning and aspen restoration are applied specifically to plantations and aspen stands, respectively.

Silvicultural Prescriptions

Dense Cover Areas (DCAs) and Early Seral Openings (ESOs)

Dense cover areas (DCAs) are small areas distributed within treatment units that provide continuous vertical and horizontal cover with a mixture of shrubs and trees along with large and small down wood,
snags, and high stumps. DCAs would typically contain clumps of trees of various size classes as well as a variety of snag and down wood sizes. These existing DCAs, ranging in size from 0.25-1 acre, would contribute to/enhance within-stand horizontal and vertical structural diversity and provide important old forest and/or mid seral habitat elements. For example existing DCAs can be representative of multiple layered late seral conditions with high levels of decadence and dead wood. They can also represent a more mid seral condition with brush and a medium sized tree overstory that provide important hiding and resting cover for wildlife and provide foraging and/or movement cover for martens and other late seral species. ESOs would be comprised of dense young regenerating trees and/or shrubs to provide early successional habitat within larger stands managed for late successional or old forest habitat. ESOs, from 0.25-0.50 acre, would enhance within-stand age and species diversity as well as provide prey and foraging habitat for old forest associated wildlife species. In some cases, there can actually be a mix of DCAs and ESOs such as around fens. For example, some DCAs are planned around small fens in units 46, 85, and 98. The area would encompass not only the fen but also some of the surrounding forest stand. Both vertical structural diversity and an early seral stage would be represented.

Two primary methods would be used to retain and create DCAs or ESOs: For DSAs, an area would be designated that has multiple wildlife habitat elements, such as large down woody material, a mixture of tree age classes (including solitary and groups of large trees), large snags, multiple tree canopy layers; and/or trees with features associated with wildlife use (for example, platforms, mistletoe brooms, forked tops, and cavities). No mechanical tree removal would be conducted in these “existing DCAs”. For ESOs, by taking advantage of existing conditions, such as areas of sparse tree cover, thinner soils, or pockets of extensive tree mortality, openings would be created by removing most or all of the existing trees and either planting or allowing natural shrub and/or tree regeneration to create an ESO of early successional habitat.

Prescribed fire would be an important management tool within DCAs and ESOs. For DCAs comprised of multiple sizes of trees, snags, and down wood, prescribed fire would be carefully applied to maintain key habitat elements, particularly snags and down wood. While underburning in DCAs would likely result in some mortality of suppressed and subdominant trees, burning prescriptions would be designed to ensure the overall structure of the DCA would remain intact. For ESOs (regeneration areas), prescribed fire would be applied to regenerate shrubs and create suitable areas for shade-intolerant tree species to regenerate.
Legacy trees are the largest and/or oldest trees within a stand. A legacy tree is a large tree (typically greater than 24 inches dbh) that has remained on site while most of the original surrounding trees have been removed by either by timber harvest or mortality due to fire, insects, drought, or disease. Hence, a legacy tree tends to be at least a generation older than the trees in the surrounding stand. Legacy trees can occur singly or in groups, and often represent tree species that would occur under an active fire regime. Legacy trees are not present within every stand, and, as a general rule, are somewhat rare in the Sagehen Project Area’s forest stands, typically occurring at a density of 1-2 legacy trees per 5 acres. As
with many other forest structural features, this value varies considerably depending on site history and conditions.

In some of the Project Area plantations, there are trees that survived the wildfires and subsequent salvage harvest, in these cases the trees are referred to as “residual” trees. While they do meet the definition of legacy trees, they occur in large enough groups that they would be treated differently than individual or small groups of legacy trees, see the Plantation Thinning prescription below.

Legacy tree treatment would involve removing trees up to 30 inches dbh around the legacy tree, however, existing stand structure would dictate the sizes of trees (up to a 30 inch dbh limit) to be removed. For example if the legacy tree was 28 inches dbh, trees up to 28 inches dbh could be removed, or if the legacy tree was 40 inches dbh and it was surrounded by 34 inches dbh trees, the largest tree that would be removed is 29.9 inches dbh. In no cases would trees be removed that are larger than 30 inches dbh, and trees larger than the legacy tree would not be removed. This treatment is designed to increase the resiliency of large legacy trees from the effects of fire, drought, pathogens, and disease. Removing trees from around the legacy tree(s) accelerates tree root and diameter growth, thereby improving overall legacy tree health and resiliency. In addition, the removal of smaller, understory trees, particularly the shade tolerant, less fire-resistant white fir, removes ladder fuels, which could carry fire into the canopy of the legacy tree(s).

The distance of the tree removal around legacy tree(s) would be variable, based on site-specific conditions (such as extent of the drip line, aspect, and topography). For example, legacy tree(s) on slopes greater than 25 percent could have a treatment distance that extended approximately one and one-half tree lengths. In flatter areas, treatment distances could be shorter as flame lengths would be lower compared to those occurring on steeper slopes. In addition, treatment distance could be longer on the south side of the legacy tree versus the north side of the tree, based on expected topographic effects of the sun. Although varying conditions would dictate a range of proposed tree removal under and around legacy trees, the majority of legacy tree treatments would not extend beyond a half a tree length from the drip line of the tree and would rarely hold a consistent distance from the tree. For example the north side of a legacy tree may only be cleared to the drip line (removal of ladder fuels), while the south side of the tree may extend a half a tree length further. On the rare occurrences where topographic conditions could increase flame lengths from surrounding trees (i.e. a legacy tree at the high end of a 35% slope) treatments may extend as much, but no further, than a tree and half length only on the downhill side from the bole of the legacy tree. If this situation does occur and the acreage of that treatment exceeds 0.25 of an acre, then this treatment will also be accounted for as early seral opening (ESO) acreage.
Variable Thinning

The variable thinning prescription is highly site-specific, set within the context of the existing stand’s structure and tree species composition. In general, variable thinning involves selective removal and retention of individual codominant and subdominant trees and/or small groups of codominant and subdominant trees. Variable thinning would occur throughout the areas outside of dense cover areas, early seral openings, and legacy tree treatment areas, varying by the prescriptions designed for each emphasis area. Thinning would be conducted to meet treatment subunit level objectives of basal area,
crown cover, tree species composition, and fire behavior (as described under “Prescription Metrics” below), and to increase stand level structural heterogeneity. As stated above, and especially for a variable thinning prescription, implementation involves careful consideration of fire: both the follow-up application of prescribed fire, as well as the stand structure conditions that would likely develop under an active fire regime. On-the-ground decisions about which individual trees and groups of trees to retain would be made in light of (1) ensuring overall stand structure would remain intact following application of prescribed fire and (2) mimicking stand structures that would develop under an active fire regime.

Variable thinning objectives include: (a) enhancing stand heterogeneity (by retaining groups of larger trees that can provide valuable wildlife habitat and creating subtle openings by thinning around these groups), (b) reducing fuels, and (c) work towards stand level ecological restoration. The variable thinning approach is based on the GTR 220 principle that varying stem density according to potential fire intensity effects on stand structure can create horizontal heterogeneity inherent to these landscapes. As such, the variable thinning primarily focuses on removing ladder fuels, subdominant and codominant shade-tolerant trees (such as white fir), and some subdominant and codominant shade-intolerant trees (such as Jeffrey or ponderosa pine). It is not based on spacing guidelines but rather works within the context of the existing stand to emphasize retaining desired tree species compositions, basal areas, and desired stand structure elements (such as trees with some level of decadence or “defect”).

Variable thinning would be applied using the following guidelines:

- Generally favor retention of pines over firs, especially in southerly facing areas and on ridges. In areas of more fir dominance, give retention preference to red fir over white fir. Retained groups of larger trees (described under the bullet below) may include fir trees. Overall the emphasis for retained groups of trees is preserving or enhancing desirable stand structure rather managing for any particular species composition.
- Retain groups of larger trees, generally comprised of five to ten (or more) trees of roughly similar size. Ideally, some of the retained trees should have desirable habitat features, such as forked or broken tops. Remove trees adjacent to these retained groups to improve the overall health and resiliency of the group to drought, insects and disease.
- Where a few (less than five) trees occur together, or where trees are scattered, retain the more vigorous trees by removing subdominant and, in some cases, codominant trees around them to reduce ladder fuels and competition for light, water, and nutrients.
- In areas of greater fir dominance where large trees tend to grow in more of a clumped nature, emphasize retaining clumps, or groups, of generally five to ten trees, and removing trees adjacent to these retained clumps to create small, variably shaped gaps.
- When making site-specific determinations on individual tree removal/retention preferences, vary the choices made so as to increase the variability at the micro-site scale.
Suppressed Cut
A suppressed tree is typically no larger than ten inches dbh (usually ranging between one and five inches dbh) and is a component of a stand’s understory, where there is an overstory of dominant, codominant, and subdominant trees. Suppressed trees, in general, have little capacity to release (initiate increased growth rates), even if the overstory is removed. These trees often make up the lower levels of ladder fuels, and the suppressed tree layer combined with subdominant trees helps connect the forest floor
into the crowns of dominant/codominant trees, which can increase fire severity and the potential for crown fire.

The suppressed cut would remove suppressed trees (down to one inch dbh for hand thinning and down to three inches dbh for mechanical thinning), as described above, within treatment units outside of dense cover areas. The suppressed cut prescription would not be applied within dense cover areas. This would retain a percentage of the suppressed tree size class within the treatment units, enhancing within-stand variability from a tree size standpoint. Suppressed tree removal outside dense cover areas would facilitate use of prescribed fire while helping to minimize the risks of crown fire by removing some ladder fuels.

**Plantation Thinning**

Plantations in the Sagehen Project Area were established in the 1960s and 1970s following the Independence and Donner Ridge wildfires. The plantations are largely comprised of planted Jeffrey and ponderosa pines; however, they also contain young trees that grew in naturally. The plantation thinning prescription is designed to facilitate and accelerate the continued growth of these young trees. The plantations currently contain some trees that survived wildfire and subsequent salvage harvest: these “residual” trees would not be removed. While they do meet the definition of legacy trees, residual trees in plantations would be treated differently than individual or small groups of legacy trees with a focus on removing ladder fuels to protect them during prescribed burning treatments. There also would be an emphasis on removing ladder fuels on the downhill sides of the residual trees where steep slopes may contribute to flame lengths reaching the residual trees.

Plantation thinning would involve mechanical thinning and/or mastication (mechanical grinding and crushing that rearranges material on site) of plantation trees and mastication of brush. Mastication changes a vertical large piece of fuel (i.e. a standing tree) into many smaller pieces of horizontal fuel. This is termed “rearranging” the fuels to a condition that allows the material to decompose more rapidly and/or burn more quickly with less intensity (small pieces). It would also be more difficult to ignite this material (horizontal, on the ground with less air flow). The plantation thinning prescription would primarily focus on removing and/or rearranging trees between one and 12 inches dbh. An occasional tree between 12 and 18 inches dbh could be removed; however, this would occur only where mechanical cutting and removal systems were used. The majority of trees between 12 and 18 inches dbh would be retained. Because of the nature of plantations and the logistics of marking trees in extremely dense brush, trees would be thinned by description and a spacing guideline would be applied. Typically, retained trees would be spaced roughly 14 to 22 feet apart; however, where logistically possible, existing variable stand structure would be used to increase within-stand horizontal heterogeneity such that there would be some more dense and more open areas.

Plantation thinning would retain at least 120 trees per acre. Sufficient tree canopy cover would be maintained to suppress shrub growth under groups of trees; however, retarding shrub growth over the entire treatment unit would not be a specific objective. Although the primary objective of plantation thinning is to accelerate the growth of retained trees, a secondary objective is to foster some within-
stand defect trees. To meet this secondary objective, plantation thinning would retain an average of ten to 12 trees per acre with injuries, split tops, and/or porcupine damage.

Shrubs growing under the drip line of retained trees would be masticated. Other areas of snow brush, manzanita, and white thorn outside the drip lines would also be masticated to decrease the fire hazard and provide opportunities for brush regeneration. Further, patches of bitterbrush and Ribes outside of tree drip lines would not be masticated unless they posed a fire hazard (ladder fuels) to retained trees/groups of trees. Bitterbrush is a preferred browse species for mule deer and it occurs in some homogeneous small patches in the plantations. These patches provide valuable foraging habitat. Because bitterbrush and Ribes do not regenerate (stump sprout) very well after mastication, unless posing a direct ladder fuels hazard, these species would not be masticated.

In addition to spacing guideline ranges, other measures would be implemented to increase within-stand horizontal heterogeneity. Where less than ten trees per acre are present, no trees would be thinned and shrubs would not be masticated; however, these areas could be underburned. Because the plantations are largely composed of Jeffrey and ponderosa pines, species preference for retention would focus on other species, if they are present. This could mean that a larger pine would be proposed for removal/mastication if it is in close proximity to a tree of another species, such as red fir.

Areas containing “residual” trees as well as areas that currently have less than ten trees per acre, which would not be mechanically thinned or masticated, would serve functions similar to DCAs and ESOs in the treated plantations. In addition, identified drainage bottoms within plantations would not be treated, providing additional areas like DCAs. Based on existing conditions in the plantation treatment units, it is estimated that at least ten percent of the overall plantation acreage would be included in these residual tree zones, sparsely treed areas, and drainages. These areas would enhance heterogeneity in the treated plantations.

Picture 7:

Example of typical plantation thinning area, showing brush that would be masticated and trees that would be thinned.
(photo of unit 46, see Map 1)
Aspen Restoration

An aspen restoration prescription involves selectively removing conifers from stands of aspen that are at risk of loss because they are being crowded and shaded by thickets of small lodgepole pine or they are being overtopped by conifers. These stands typically have a much higher percentage of conifers than aspen, and have little aspen regeneration. Conifer removal would occur by hand cutting or mechanical cutting methods. When treated by hand, typically most conifers from one to 16 inches dbh would be cut and removed from site and larger conifers girdled to create snags. When treated by mechanical means, conifers greater than three inches dbh that are overtopping and/or crowding aspens would be removed.

Picture 8:

*Example of typical aspen restoration area, showing conifers that would be removed and/or girdled. (photo of unit 80, see Map 1)*

Silvicultural Treatment Methods

Silvicultural prescriptions would be implemented using ground-based mechanized equipment or by hand, as described below.

Mechanical Thinning

Mechanical thinning is a harvest activity, which, under the Sagehen Project would utilize ground-based equipment (tractors, feller bunchers and some chainsaw work) to fell and remove identified trees while retaining and protecting desirable trees to accomplish fuels reduction, marten habitat enhancement and restoration, and stand level ecological restoration objectives set within each treatment unit. A network of skid trails (in the case of ground-based thinning operations), landings, and, in some cases, temporary roads (which are removed following project activities) would be used to transport and collect harvested material.
Hand Thinning
Hand thinning is an activity that utilizes crews with chainsaws or handsaws that cut understory conifers less than 16 inches dbh to accomplish fuels reduction, marten habitat enhancement and restoration, and stand-level ecological restoration objectives set for the treatment unit. If hand felled material contributes to unacceptable fuel loading, this material may be hand piled outside the drip lines of desirable trees and burned when conditions permit a minimum amount of mortality.

Mastication
A masticator is a low ground pressure piece of equipment that “chews” up brush and small understory trees to reduce competition. The machine mechanically grinds and crushes this material and down woody fuels and distributes the resulting small pieces around the site. Mastication is also a Fire/Fuels Treatment Method – see below.

Fire/Fuels Prescriptions
Fire/fuels prescriptions would be aimed at reducing hazardous surface and ladder fuels within the treatment units and providing conditions that would enable subsequent use of prescribed fire to maintain suitable fuels conditions. Fire/fuels prescriptions include prescribed surface fire as well as pile burning and lop and scatter prescriptions.

Surface Fire Prescription
A surface fire is a fire that burns live and dead fuels at or near the surface of the ground, mostly by flaming combustion. A surface fire prescription is usually implemented by an underburn. Surface fire prescriptions are typically designed to consume surface and ladder fuels and to mimic fire that would occur in an active fire regime. Surface fire prescriptions can be applied under spring-like and fall-like conditions. Spring-like conditions are defined by relatively high live fuel moistures, high 1000 hour size (“coarse woody debris”, three inches diameter and greater) fuel moistures, and soils that are relatively moist beneath the surface fuels. Under spring-like conditions, it is expected that surface fires would have moderate to high consumption of 1-100 hour size fuels (“fine woody debris”, ranging from 0.00-2.99 inches diameter) and minimal consumption of 1000+ hour fuels with mortality primarily expected in subdominant tree size classes. Fall-like conditions are defined by relatively low live fuel moistures, lower 1000 hour fuel moistures, and drier soils with dry organic layers beneath the litter layer. Under fall-like conditions, it is expected that burning would be primarily surface fires with higher flame lengths, and faster burn times as compared to burning under spring-like conditions. It would have high consumption of 1-100 hour size fuels and moderate to high consumption of 1000+ hour fuels, and with mortality expected in subdominant and some codominant tree size classes. Depending on cycles of drought and wet weather, spring-like and fall-like conditions can occur throughout the year. For the Sagehen Project, spring-like condition surface fire prescriptions would be emphasized, however due to limited suitable burning conditions, surface fire prescriptions under fall-like conditions would be implemented in some cases. In these cases, extra measures to protect large dead wood, such as creating firelines around large logs/snags, would be implemented.
Pile Burn Prescription
A pile burn prescription is designed to remove surface fuels, both fuels generated from silvicultural treatments (activity fuels) and existing fuels on the ground. A pile burn prescription can be implemented by hand or by machinery (typically a grapple piler – see below). In general, small down wood is placed in piles for future burning. Pile location and size is dictated by existing conditions, however piles would be preferentially placed outside of sensitive areas such as riparian conservation areas and cultural resource sites. Piles of fuels typically are burned under fall-like conditions, in winter months, or during periods of low fire danger. This prescription removes surface fuels in the treatment units and is used to mimic underburning where sensitive areas prevent unit-wide application of underburning.

Lop and Scatter
A lop and scatter prescription does not remove fuels from treated areas. It prescribes changing the size and arrangement of the fuels. Lop and scatter prescriptions usually deal with activity generated fuels as a result of tree removal (tree tops and branches), however it can also apply to brush and standing ladder fuels. The purpose of a lop and scatter prescription, by changing the arrangement and size of fuels, is to take the fuels to a condition that allows the material to break down more rapidly and/or burn more quickly with less intensity.

Fire/Fuels Treatment Methods
Often, the silvicultural treatment would partially achieve hazardous fuels reduction objectives, and, in the case of mastication, could fully achieve fuels reduction objectives. Most of the silvicultural treatments however would be followed by a fire/fuels treatment, aimed at reducing surface fuels and residual ladder fuels.

Prescribed fire constitutes much of the proposed follow-up fuels treatments for the Sagehen Project treatment units. Prescribed fire refers to any fire ignited by management actions to meet specific objectives. Prescribed fire can include underburning (intentionally set surface and ground fire) and burning of hand and machine constructed piles. Associated activities include creating firelines to prevent fire spread from treatment units as well as prevent the site-specific ignition of key habitat components, such as snags and down logs.

Underburning
Underburning is a generalized term used when applying prescribed fire to large areas and is typically the treatment method for a surface fire prescription. Underburning targets surface fuels, some understory, and, in rare cases, larger trees. Surface fuels are the primary agent of fire spread. The objective is to apply controlled fire under optimum conditions where the treatment can modify fuel conditions to effectively reduce fire behavior and the corresponding intensity of a future wildfire. Within some areas proposed for burning, the goal of the treatment may be to consume a significant portion of the existing surface fuels that could cause high wildfire intensities, and/or the consume understory vegetation (ladder fuels) in order to reduce future fire severity and to create conditions that allow for future prescribed underburning opportunities. In other areas, underburning is used to create new growth of native shrub species and forage opportunities for wildlife. Underburning most closely mimics low-intensity fire that would occur in an active fire regime. Underburning, especially on south and west
facing slopes, is typically conducted under spring-like conditions. A more mosaic burn pattern is created by underburning in spring-like conditions as compared to fall-like conditions; with some areas minimally burned and overall less fuel consumption. For the Sagehen Project proposal, underburning would be applied on a unit-wide basis, in other words, where underburning is proposed it would be conducted across the entire treatment unit and across all subunits (emphasis areas) within that treatment unit.

Picture 9:
Example of underburning under fall-like conditions, post tree harvest. (photo from Sagehen Test Plots 2010)

Picture 10:
Example of underburning under fall-like conditions, post tree harvest. (photo from Sagehen Test Plots 2010)
Hand Piling and Burning
After a hand or mechanical thin, residual activity fuels and some naturally occurring fuels are piled by hand into burn piles. Hand piles of fuels typically are burned under fall-like conditions, in winter months, or during periods of low fire danger.

Grapple Piling and Burning
After a mechanical thin, residual activity fuels and some naturally occurring fuels are piled by a grapple piler into burn piles. A grapple piler is typically an excavator that can pick up fuels from the ground surface, carry the material suspended from the ground, and place it in a pile for burning. Grapple piles of fuels typically are burned under fall-like conditions, in winter months, or during periods of low fire danger.

Mastication
As stated above, a masticator is a low ground pressure piece of equipment that “chews” up brush, small understory trees and downed woody fuels. Mastication does not actually remove wildland fuels from the treated area, but changes the size, continuity, and arrangement of the fuels, leading to an acceleration of decomposition rates of processed material and producing a desired change in fire behavior. Mastication changes a vertical large piece of fuel (i.e. a standing tree) into many smaller pieces of horizontal fuel. This is termed “rearranging” the fuels to a condition that allows the material to decompose more rapidly and/or burn more quickly with less intensity (small pieces). It would also be more difficult to ignite this material (horizontal, on the ground with less air flow). Mastication can be a mechanized method of implementing a lop and scatter fire/fuels prescription. Mastication is also a Silvicultural Treatment Method – see above.

Unit-Specific Prescriptions and Treatments
Silvicultural and fire/fuels prescriptions and methods proposed for each treatment unit are displayed in Table 2 below.

Table 2: Prescription and Method Summary

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<td>1</td>
<td>7</td>
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<td>Hand</td>
<td>Pile Burn Rx</td>
<td>Hand Pile Pile Burn</td>
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<td>Mechanical</td>
<td>Lop &amp; Scatter</td>
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<td>112</td>
<td>1</td>
<td>14</td>
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<td>Hand</td>
<td>Pile Burn Rx</td>
<td>Hand Pile Pile Burn Underburn</td>
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<td>156</td>
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<td>81</td>
<td>Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening</td>
<td>Mechanical</td>
<td>Pile Burn Rx</td>
<td>Grapple Pile Pile Burn</td>
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Table 3: Summary of Treatment Unit and Emphasis Area Acres within Sagehen Project Area

<table>
<thead>
<tr>
<th>Total Area within Project Boundary Acres</th>
<th>NFS Lands within Project Boundary Acres</th>
<th>Total Acres within Treatment Units Acres</th>
<th>Emphasis 1</th>
<th>Emphasis 2</th>
<th>Emphasis 3</th>
<th>Emphasis 4</th>
<th>Emphasis 5</th>
<th>Emphasis 6</th>
<th>Emphasis 7</th>
<th>Emphasis 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>9,478</td>
<td>8,541</td>
<td>2,748 (29%) (32%)</td>
<td>465 (17%)</td>
<td>108 (4%)</td>
<td>189 (7%)</td>
<td>1,048 (38%)</td>
<td>759 (27%)</td>
<td>171 (6%)</td>
<td></td>
<td>8 (&lt;1%)</td>
</tr>
</tbody>
</table>

Prescription Metrics
As shown in Table 2 above, each treatment unit includes one or more of the seven identified management emphasis areas. Application of the silvicultural and fire/fuels prescriptions described in the preceding section within a given treatment unit would be aligned with the treatment objectives previously described for each emphasis area within the unit. (Each emphasis area within a treatment unit is referred to as a subunit).
Metrics for post-treatment stand structure elements and tree species composition have been developed to guide application of the silvicultural and fire/fuels prescriptions within each emphasis area. Post-treatment stand structure elements include: (a) basal area, particularly in trees greater than 20 inches dbh, (b) crown cover, (c) snag density, (d) large and small down woody material, (e) high stumps/short snag densities, (f) dense cover areas (DCAs) and early seral openings (ESOs), and (g) prescribed surface fire behavior, as indicated by spatial extent and intensity (tree mortality). The site-specifically defined values for the metrics for each subunit are grounded in the scientific literature as well as Forest Plan direction related to emphasis area objectives. The Sagehen Project record provides detailed citations for each defined metric, and this information is available from the Truckee Ranger District.

Post-treatment metric values for each emphasis area represent a range of outcomes that would vary by subunit as prescriptions were applied within the context of the existing stand’s structure and tree species composition. For example, although silvicultural and fire/fuels prescriptions for subunits 213-1 and 38-1 are designed to meet emphasis area 1 objectives, post-treatment stand conditions for subunit 213-1, which is occupied by a higher elevation mature red fir stand on a northwest-facing slope, would be different than those for subunit 38-1, which is occupied by a lower elevation mixed conifer stand on an east-facing slope.

The stand structure and species composition metrics apply at the subunit-scale. While these metrics can play out at other spatial scales (for example, microsite or landscape scales), they are meant to be applied at the subunit-scale. The silvicultural prescriptions would be applied in the step-wise fashion (as described in the “Order of Prescription Application” section above), with variable thinning decisions regarding which trees to retain made at generally a microsite scale by field marking crews. The stand structure and species composition subunit-scale metrics would serve to limit and define the tree marking decision space. Data on the defined metrics would be gathered and assessed during the layout and tree marking phase of the project, with adjustments made to tree marking as necessary to align with emphasis area treatment objectives. This information would also be available to stakeholders and other interested individuals and groups, allowing feedback during the ongoing scoping process, with possibility of making incremental changes to the proposed action, as needed.

Detailed descriptions of each subunit’s silvicultural and fire/fuels prescriptions and associated post-treatment stand structure and tree species composition metric values are included in the Sagehen Project record. These detailed descriptions in the project record provide the site-specific information that would be used to guide application of the silvicultural and fire/fuels prescriptions on the ground. The sections below summarize key similarities and differences between the metrics for each emphasis area.

**Basal Area**

Existing subunit-scale basal areas are quite variable, both within and between emphasis areas, ranging between 100 and 280 square feet per acre across all subunits. Emphasis area treatment objectives would be expected to result in a 20 to 25 percent reduction in existing basal area levels at the subunit scale, with the lower end of the range (20 percent reduction) in emphasis area 1 subunits and the higher end (25 percent reduction) in emphasis area 7 subunits. Residual basal areas in emphasis areas 1
through 4 would typically range between 165 and 190 square feet per acre while emphasis areas 5, 6, and 7 would typically range between 100 and 170 square feet per acre. Mechanical thinning treatments would meet Forest Plan standards and guidelines for basal area retention (SNFPA ROD, pg. 50).

Reductions in basal area would not be evenly distributed across tree size classes (trees less than ten inches dbh, trees between ten and 19.9 inches dbh, and trees between 20 and 29.9 inches dbh), however. All trees 30 inches dbh and larger would be retained within all treatment units. For all emphasis areas, silvicultural prescriptions focus on removing selected trees less than 20 inches dbh, guided by the emphasis area’s treatment objectives. The majority of the retained basal area would be in the largest trees within each subunit, and most trees 20 inches dbh and larger would be retained following application of the silvicultural and fire/fuels prescriptions. Data from the Sagehen Test Plots show that between 89 and 93 percent of trees between 20.0 and 29.9 inches dbh were retained following application of variable thinning, legacy tree treatment, dense cover area, and early seral opening prescriptions and, in the case one unit, a low intensity surface fire prescription. Similar outcomes would be expected for the Sagehen Project subunits.

**Crown Cover**

Tree crown cover retention would result from retaining basal area as described above. Crown cover is a stand level average that indicates roughly the percentage of the forest floor that is vertically overtopped with tree canopy. The silvicultural and fire/fuels prescriptions are expected to result in varying crown cover levels within each subunit. For emphasis area 1 through 5 subunits, crown cover following application of silvicultural and fire/fuels prescriptions would be greater than 50 percent, with reductions of existing crown cover ranging between 10 and 15 percent. For emphasis area 6 and 7 subunits, crown cover following application of prescriptions would generally range between 40 and 50 percent. Mechanical thinning treatments would meet (and, in many cases, exceed) Forest Plan standards and guidelines for canopy cover retention (SNFPA ROD, pp. 50 – 51).

Note that “crown closure” values (a measure of the canopy hemisphere within an angle of view, i.e., a cone, over the sample point) within DCAs and other areas retaining clumps of trees would be in the 70 to 90 percent range, an objective for the microsite conditions desired for nesting, resting, and denning sites used by late seral associated wildlife species.

**Snag Density**

Snag density levels would be higher within emphasis areas 1 through 5 compared to emphasis areas 6 and 7. Large snags (greater than 15 inches dbh) would be retained within all subunits, regardless of emphasis area. Where currently available within emphasis area 1, 2 and 5 subunits, some decadent firs with declining crown characteristics would be retained for future snag recruitment. Where existing snag levels are low, particularly within the plantations, silvicultural prescriptions retain all snags greater than three inches dbh. Snag retention would meet (and, in many cases, exceed) Forest Plan standards and guidelines (SNFPA ROD, pg. 51).
Silvicultural prescriptions for subunits 33-1, 33-5, 35-1, 35-5, 36-5, 85-5, 213-1, 213-2, 213-4, and 213-5 call for creating (via stem girdling) two snags (each between 15 and 30 inches dbh) per acre outside DCAs and one snag (greater than 15 inches dbh) per acre within DCAs.

Hand-constructed fire lines would be placed around large snags before applying low intensity surface fire prescriptions. Each subunit’s low intensity surface fire prescription (available in the project record) specifies the numbers of snags to be lined, based on existing numbers of large snags within the subunit. In emphasis area 1 and 2 subunits proposed for underburning, between 10 and 18 large snags per acre would be lined while in emphasis area 4, 5, 6, and 7 subunits, between 2 and 10 large snags per acre would be lined.

In treatment units where hand or grapple piling of fuels would be conducted, piles would be located a sufficient distance from large snags (greater than 15 inches dbh) to ensure the snags did not ignite during pile burning operations.

**Down Woody Material**

In all subunits, regardless of emphasis area, large down logs (larger than 15 inches diameter and ten feet long) would be retained during implementation of silvicultural treatments (mechanical thinning or mastication). Crushing of large down logs with machinery would be avoided.

Fire/fuels prescriptions are designed to retain specified levels of down woody material, commensurate with emphasis area management objectives. In units proposed for application of low intensity surface fire following silvicultural treatments, the largest down logs per acre would be lined to protect them during underburning operations. Emphasis area 1 and 2 subunits to be underburned have the greatest quantities of large down logs to be lined prior to underburning, ranging from 15 to 20 large down logs to be lined per acre. In emphasis area 4, 5, 6, and 7 subunits generally three to seven large down logs per acre would be lined, with the exception of subunits 163-5, 163-7, and 213-4. In these subunits, approximately 15 to 20 large logs per acre would be lined prior to application of low intensity surface fire.

In treatment units proposed for grapple or hand piling, piles would be located a sufficient distance from large down logs to ensure the logs did not ignite during pile burning operations. In addition, piling would not be conducted on approximately 30 percent of the unit, allowing for retention of small down woody material.

In treatment units proposed for surface fire prescriptions (Table 2 above), approximately 30 percent of each unit’s area would not be underburned. Small woody material would be retained in these unburned areas of the treatment units.

**High Stumps/Short Snags**

High stumps would be created in emphasis area 1 through 6 subunits with silvicultural prescriptions that include existing DCAs. These subunits are located outside the Sagehen Project’s plantations. To create high stumps, one to two live trees greater than 15 inches dbh would be cut at a height of four feet.
within each late seral DCA following implementation of silvicultural treatments. White fir would be the preferred cut species. Felled portions of these cut trees would be retained on site.

**Dense Cover Areas and Early Seral Openings**

Silvicultural prescriptions call for varying acreages of DCAs and/or ESOs within each subunit, based on emphasis area. (Note that DCAs and ESOs are not included in the plantation thinning prescription.) DCA/ESO acreages are calculated as a portion of each subunit’s area, with the highest proportion in emphasis area 1 subunits. In emphasis area 1 subunits, DCAs and ESOs would occupy an average of 15 to 20 percent of the subunit area; in emphasis areas 2 and 6, DCAs and ESOs would occupy an average of five to ten percent of the overall subunit area; in emphasis areas 4 and 5, DCAs and ESOs would occupy an average of ten to 15 percent of the subunit area; and in emphasis area 7, DCAs and ESOs would occupy an average of one to five percent of the subunit area. Subunits 38-1, 73-5, and 213-1 would have the highest acreages of DCAs, ten, eight, and 15 total acres, respectively.

**Tree Species Composition**

Site-specific objectives for tree species composition are based on existing species composition within the subunits. Relative percentages of tree species to be removed vary by crown class (dominant, codominant, subdominant, and suppressed) within each subunit, as described in detail in the Project Record. Silvicultural prescriptions for all subunits outside plantations, regardless of emphasis area, would be primarily focused on removing suppressed trees (ranging from 50 to 90 percent removal of existing suppressed trees) and some removal of subdominant trees (ranging from ten to 30 percent removal of existing subdominant trees), depending on the existing species composition within the subunit. In general, most dominant and codominant trees of all species would be retained, with some limited site-specific exceptions to provide for removal of three to ten percent of dominant/codominant white fir.

Because the plantations are predominantly comprised of ponderosa and Jeffrey pine, plantation thinning prescriptions are focused on retaining existing white fir and red fir as well as sugar pine and western white pines not infected with blister rust.

**Prescribed Surface Fire Behavior**

Two metrics are used to define targets for surface fire prescriptions: spatial extent of surface fire and intensity as indicated by the amount of tree mortality caused by surface fire. To facilitate application of surface fire prescriptions, underburning is proposed for entire treatment units (rather than individual subunits within treatment units). Hence, values for the prescribed surface fire metrics are applied at the treatment unit scale, and are the same for all emphasis areas.

The spatial extent for application of low intensity surface fire is approximately 70 percent of the area in a mosaic pattern within each treatment unit. (Table 2 above displays the treatment units proposed for surface fire prescriptions.) Approximately 30 percent of the unit’s area would remain in an unburned condition. Surface fire prescriptions would be designed to result in mortality of approximately 70 percent of trees less than three inches dbh and approximately five to 15 percent of trees greater than
three inches dbh. Mortality in trees greater than three inches dbh would be primarily comprised of trees in subdominant crown classes, with occasional mortality of trees in the codominant crown class.

**Resource Protection Measures**
Resource Protection Measures (RPMs) are Best Management Practices (BMPs), mitigations, standard management requirements, standard contract provisions, and special operating provisions designed to minimize or negate any potential adverse effects associated with planned activities. The complete list of RPMs is included in Appendix A. General practices, types, or categories of RPMs are listed below. This general list is intended to provide an overview of the RPMs listed in detail in Appendix A, it is not all inclusive.

**Air Quality**
Requirements such as obtaining burning permits from the Northern Sierra Air Quality Management District, and conditions under which burning would/would not occur are typically listed.

**Aquatic Resources**
Consistent with Forest Plan direction, a Riparian Conservation Objective (RCO) analysis will occur as part of the project design. The analysis identifies Riparian Conservation Areas (RCAs) and restrictions and mitigations for RCAs, a summary of which is usually placed in the RPM table. The RCO analysis is typically tied in with Best Management Practices (BMPs) as well. In addition, species specific mitigation is listed in the table.

**Cultural Resources**
Typical protection measures for cultural resources usually involve avoidance of sites by machinery, restrictions on ground disturbing activities, and depending on site type, restrictions on types of prescribed fire.

**Hydrology**
As with Aquatic Resources, the RCO analysis mitigations and BMPs are typically detailed for hydrology resources in the table. Equipment avoidance areas, erosion control measures, limits on operations based on slope, stream crossing requirements, and timing of operations are detailed.

**Noxious Weeds**
Standard noxious weed mitigations involve the requirements for equipment cleaning when coming from or moving between known weed sites, and the use of weed-free erosion control or road materials.

**Prescribed Fire**
Conditions under which burning would occur, requirements for residual ground cover and down logs, snag protection measures, measures to protect desirable large down wood components, and measures to protect other resources are detailed.
Sensitive Plants
Standard mitigations for sensitive plants involve a “flag and avoid” strategy to prevent ground disturbance. In the case of fens and/or fen-like wet areas that either have known sensitive plants or have the potential to, avoidance of sites by machinery, restrictions on ground disturbing activities, and depending on site type, restrictions on types of prescribed fire are called for.

Soils
As with Aquatic and Hydrology Resources, the RCO analysis mitigations and BMPs are typically detailed for soils resources in the table. Limitations for soil dryness, equipment avoidance areas, erosion control measures, ground cover requirements, limits on operations based on soil type, measures to maintain soil productivity are detailed.

Transportation
Specifying pre and post project road maintenance, wet weather restrictions, reconstruction and/or decommissioning requirements, and erosion control measures are typical requirements relating to transportation management.

Vegetation Management
Operating procedures including skid trail and landing layout and requirements, erosion control measures, operations avoidance areas, contract provisions, and limitations on equipment operations are listed in the RPM table.

Wildlife
Requirements for the retention of habitat features such as large trees, down logs, or snags, limitations on operating seasons/locations, and species specific mitigations are detailed.

Responsible Officials
Because the Sagehen Project falls within the Sagehen Experimental Forest managed by PSW and NFS lands managed by the Truckee Ranger District, both the PSW Station Director and the Truckee District Ranger have responsibilities for this project and are both Decision Makers or Responsible Officials.

Literature Cited
Knowles, Constance. 1942. Lumbering history of the Truckee Basin: 1856-1936. Division of Forest Survey, California Forest and Range Experiment Station, Berkeley, CA.


Moriarty, Katie M. 2011. Personal communication as part of the Sagehen Collaborative Planning process.
**Moriarty, Katie M. 2009.** American marten distributions over a 28 year period: relationships with landscape change in Sagehen Creek Experimental Forest, California, USA. M.S. Thesis, Oregon State University, Corvallis, OR. 108 p.


