Seafoam Guard Station Vegetative Analysis and Fuels Treatment Plan
Technical Fire Management 16

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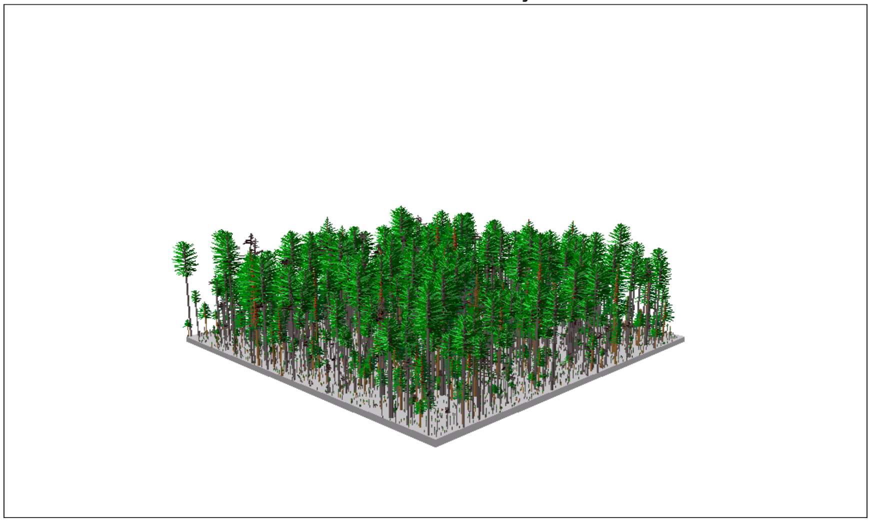

To This:

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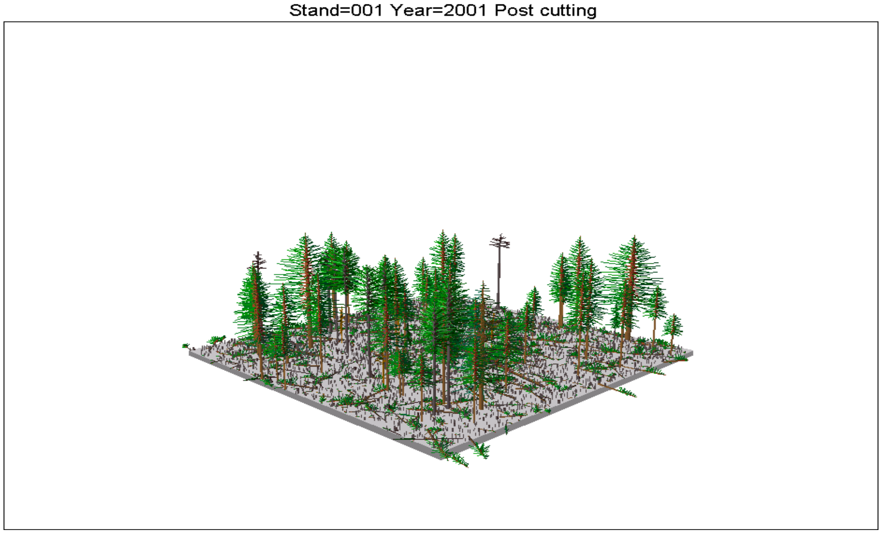

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<u>Presented April 15, 2002 in Albuquerque, N. M</u>.

EXECUTIVE SUMMARY

This vegetative analysis and fuels treatment plan analyzes the existing conditions that surround the historic Seafoam Guard Station Administrative Site and proposes alternatives that would treat the stand to lessen the existing fuel loadings and thus reduce the potential of future wildfires escaping initial attack suppression efforts and burning the buildings.

The scope of the paper is limited to the project area surrounding the Seafoam Administrative Site, but the process followed can be applied to any parcel of forested land in an efficient manner after collecting data pertinent to a particular location. Additionally, it is intended as a process whereby quantification of existing conditions and potential effects can be objectively incorporated into a Statement of Purpose and Need in the NEPA process.

Management determined a need for treatment through visual inspection and professional judgment based on experience. The task was to quantify the existing condition in order to devise a plan of attack to meet the objectives.

The problem is a continuous stand of six to twelve inch lodgepole pine with a dense understory of seedlings and saplings surrounding the Seafoam Administrative Site. A heavy stocking density of seedlings, saplings and pole size trees provide ladder fuels into the crowns of the overstory increasing the probability of a stand-replacing event. The District Ranger would like to treat the stand to reduce the density and keep potential wildfire out of the tree crowns. This would increase the likelihood of saving the historic buildings when a wildfire threatens the area.

The District Ranger, following direction in the Challis National Forest Resource Management Plan, set a goal to minimize the risk and hazard of loss due to wildfire of the Seafoam Guard Station and Administrative Site.

The objectives are to reduce stand density of overstory lodgepole pine greater than six inches to approximately 210 trees per acre and reduce understory stocking (trees less than five inches) by 60 to 80 percent, while maintaining down and dead fuels to less than four tons per acre.

I began the analysis by determining a boundary to the project, delineating aerial photos and then collecting inventory data for both the vegetation and the dead and down fuels. Once this data was established, percentile weather and fuel conditions were ascertained through FIREFAMILY PLUS and fire history was collected in the field and from GIS. Utilizing the gathered information, fire behavior was determined through Behave Plus and Fuels Management Analyst Suite (DDWOODY & CrownMass). Van Wagner's crown fire initiation model and CrownMass were used to determine the possibility of transitioning from surface to crown fire and First Order Fire Effects Model (FOFEM) was employed to understand mortality by two inch class under wildfire conditions. I formulated an economic analysis using fire probabilities and determined expected value of the risk and present net value for the two alternatives and if nothing was done over a 20-year planning horizon. Finally, I used Forest Vegetation Simulator (FVS) to visually

depict the stand pre-and post-treatment and determine amount of product that could be removed to offset costs.

The CrownMass modeling analysis determined that 50^{th}, 90^{th} and 97^{th} percentile seasonal fire behavior conditions will support transition of fire into the crowns. This was also looked at using Van Wagner's model and Fuel Management Analyst Suite's CrownMass model which indicated a transition to a crown fire under all scenario weather conditions. A springtime prescribed burn scenario-when foliar moisture content of the crowns is much lower-was also modeled with CrownMass and showed flame lengths would still be high enough to transition a fire into the crowns.

Although a prescribed fire across the landscape was considered, the two fire management officers who knew the area, and myself, felt that due to the crown fire probability, the landscape needed to be thinned before any fire could be introduced. Therefore, this was not one of the alternatives developed.

A recommended alternative is described that satisfies the objectives while maintaining the stand into the future in a condition that is closer to its natural range of variation. The recommended alternative has an associated discounted present net cost of $17,491and the highest present net value for the historic site. Furthermore this alternative will provide safer conditions for firefighters and the stand will be expected to survive unplanned ignitions (natural and person caused) with less chance of losing the Seafoam Guard Station and Administrative Site to wildland fire. Maintenance burns are planned in years 10 and 20 to thin the regenerating lodgepole pine and keep the stand open, and keep dead and downed fuels at a minimum, or the cycle will start all over again.

ACKNOWLEDGEMENTS

I would like to thank my wife Melissa. Her patience, support and understanding during the completion of this project were phenomenal. I would also like to thank the following individuals for their expertise and support towards the completion of this document.

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Andrea Reeder	Fire Clerk, SCF
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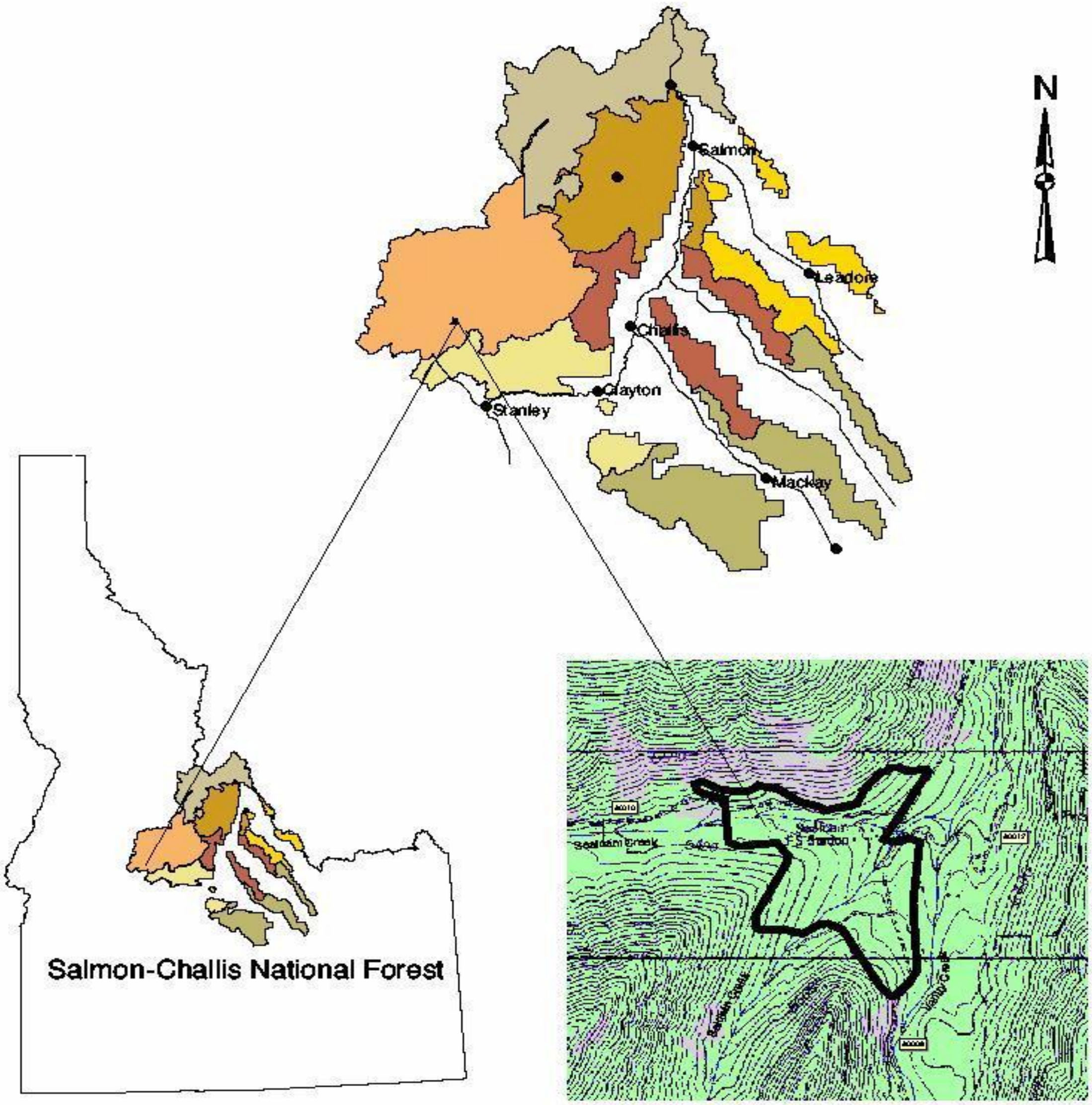

Location Map

BACKGROUND STATEMENT

This paper analyzes the hazard and risk of a wildfire threatening a Forest Service Administrative Guard Station at the mouth of Seafoam Creek on the Middle Fork Ranger District of the Salmon-Challis National Forest. Additionally this paper develops fuel treatment alternatives that would mitigate potential fire hazards and begin to return the area to the historic fire regime. These alternatives will be evaluated for costs and for their ability to mitigate the hazard and begin restoring historical conditions. The District Ranger is the line officer making the final decision on the treatment alternative to be used.

Historically, fire has been important in shaping the ecosystems of the Salmon-Challis National Forest. Plant species have adapted to survive with periodic fire. Pinus contorta (Lodgepole pine) have developed different types of cones, some of which require the heat from fires to open and release seeds.

Early fire suppression policies and successful implementation has allowed vegetative succession to progress beyond historical structural composition. The historic, presettlement fire history of the lodgepole pine stands was relatively frequent low to moderate intensity fires entering the stands every 25 to 40 years, and stand replacing fires consuming the entire stands every 200 to 300 years.

This is no longer the case on the Salmon-Challis National Forest. Fires have been suppressed in these stands for 75 to 100 years and the frequent low to moderate intensity fires have been aggressively put out with initial attack and not allowed to thin the stand (Crane and Fischer, 1986). Stands have become denser with additional ladder fuels. The lodgepole are of the perfect size class to perpetuate the Mountain Pine Beetle epidemic that is occurring nearby (within 20 miles), in the Stanley Basin Area.

The Seafoam Guard Station is an old Ranger Station built in the early 1930s by the Civilian Conservation Corps and is now an historic building on the National Register. There are eight other buildings associated with the guard station and they sit on an administrative site established in 1925. The Ranger wants to lessen the threat to the site from wildfire and determine the best means to achieve this request. After a large stand replacing fire in the late 1870's a thick stand of lodgepole pine regenerated.

PROBLEM STATEMENT

A continuous stand of six to twelve inch lodgepole pine with a dense understory of seedlings and saplings surround the Seafoam Administrative Site. Heavy stocking density of seedlings, saplings and pole size trees provide ladder fuels into the crown of the overstory increasing the probability of a stand replacing event. The District Ranger would like to treat the stand to reduce the density and keep potential wildfire out of the tree crowns. This would increase the likelihood of saving the historic buildings when a wildfire threatens the area.

GOAL STATEMENT

The District Ranger, following direction in the Challis National Forest Resource Management Plan, desires to minimize the hazard and risk of loss due to wildfire of the Seafoam Guard Station and Administrative Site.

SCOPE STATEMENT

The project will focus on vegetation analysis and fuels treatments on the landscape surrounding the Seafoam Administrative Site and its associated buildings in order to make the site more defensible from wildfire, and a safer place to reside. The area encompasses 130 acres and is on a relatively flat bench at the mouth of three drainages.

OBJECTIVES

Recommend a treatment; either mechanical thinning, prescribed fire, or a combination of thinning and prescribed burning that will result in the following:

A. Reduce stand density of overstory lodgepole pine to approximately 210 trees per acre.

B. Reduce understory stocking (trees 4.99 inches and less) by 60 – 80 percent.

C. Maintain down and dead fuels to an acceptable level (2 to 3 tons/acre), as described in the Forest Plan, typical of a Fuel Model eight stand.

METHODS

A study area boundary will be established and aerial photos delineated. Stand exams and fuel inventory will be conducted to establish baseline data. Weather data will be gathered from the nearest representative site to be used for analyzing fire behavior in untreated stands and treated stands. A fire history will be looked at from trees within the analysis area to determine a trend to past fire intervals.

EXISTING CONDITION

Soils

Soils in the Vanity-Seafoam basin are derived from Idaho Batholith parent material. Ridges and highlands of the leucicite have eroded into scree piles and deep local soils in the bottom and lower sideslopes of U-shaped glaciated valleys.

Elevation of the proposed project area is between 6,200 and 6,500 feet. Slopes have gradients that range from zero to 20 percent and averaging 13 percent. Soils are moderately deep to deep, have very dark gray to dark yellowish-brown loam surfaces and dark yellowish-brown loam to loamy-sand subsoils. They contain 35 to 80 percent gravel and cobbles. About 10 percent of the soils are shallow, but otherwise similar to the above. These soils exhibit moderate to moderately rapid permeability with medium to very rapid runoff, and therefore no flooding potential. Soil depth is very deep (up to 60 inches), with a fine-to-coarse extremely gravelly sandy loam texture. For the proposed actions analyzed in this document, expected soil loss would be less than soil-loss tolerance in the vicinity. Therefore there are no threats posed to soils that might generate management concerns.

Hydrology and Climate

The Seafoam Administrative Site is located near the confluence of three Second-order streams, within the Rapid River headwaters drainage. Within the Vanity-Seafoam subwatershed, Seafoam Creek flows into Baldwin Creek, Baldwin then flows into Vanity Creek, and then all merge with Rapid River, a Third-order stream, about three quarters mile downstream of the project area. Rapid River flows about 12 miles before it drains into the Middle Fork of the Salmon.

Local climate is principally a winter-precipitation regime, with most of the stream recharge occurring as snowmelt. Occasional intense summer thunderstorms contribute a lesser volume of water to the drainage. Both cycles contribute to area erosive forces, and average area stream gradients are steep (11percent and above). Seafoam, Baldwin and Vanity may be classified as source Rosgen-type stream channels although, in the project area gradients flatten to about eight percent.

Sediment size distribution includes a high percentage of sand, cobbles and boulders. No formal riparian inventories have been completed within this watershed but ocular estimates rate the Seafoam and Baldwin Creek channels as having 90% or greater bank stability, and healthy vegetative diversity and shading. Vanity Creek parallels the road, and may have associated sediment loading. Preliminary water quality data indicates that these streams are not impaired.

Fisheries

There are three perennial streams that flow through the project area. Seafoam, Baldwin and Vanity Creeks do have a historical use associated with them by steelhead and Chinook salmon but are presently not being utilized. Bull trout are suspected as currently occurring in Rapid River downstream from the project site. The current condition of these creeks is such that they are functioning properly yet have very little sunlight reaching the creek channels. Opening up the extremely dense stands of timber should move this trend in a positive direction. Any small increase in percentage of sunlight exposure to the channel bottom will help with algae growth and in turn macro-invertebrate composition, densities and production. Having visited the site and discussed the actions as proposed, as a fisheries biologist, it is my opinion that this project will have no adverse affects to any of the streams or the associated fisheries resource. I feel this project will help improve the condition of the watershed in this immediate area.

Wildlife

Threatened and Endangered species identified as potentially occurring on the Salmon-Challis National Forest and perhaps in the project area by the U.S. Fish and Wildlife Service include the gray wolf (experimental/nonessential population), grizzly bear, bald eagle, and Canada lynx. Viability for terrestrial wildlife species in the project area appears to be high. In general, viability of a species indicates the likelihood of a species' continued existence in an area for some specified period of time. Viability is generally higher in direct proportion to population size, width and geographical distribution, kinds, numbers, and connectiveness of locations occupied by the species, and overall species resistance and tolerance to environmental change or disturbance. No particular quantity or quality of disturbance by this project has been identified as limiting sustainable, viable wildlife populations.

Vegetation

The stand within the project area is primarily a Pinus contorta (lodgepole pine) cover type with an Abies lasiocarpa (subalpine fir) / Calamagrostis rubescens (pinegrass) habitat type. There are scattered older Pseudotsuga menziesii (Douglas-fir) throughout the stand although the stand has an eighty percent lodgepole overstory. Stand data collected in 2001 indicates the average DBH for trees greater than five inch is 10 inches with these same trees averaging 60 feet in height.

Insect and Disease

There is a presence of Arceuthobium americanum (dwarf mistletoe) and some Dendroctonus ponderosae (mountain pine beetle) attacked trees in the stand but overall no insect or disease problems were detected. There is a mountain pine beetle epidemic within 20 miles of the project area that has attacked and killed over 30,000 acres of lodgepole pine and the lodgepole on the Seafoam site are at the diameter size preferred by the beetle.

Fire Regime and History

The stand can be characterized as one of the two subgroups of Fire Group Seven, cool subalpine fir (Abies lasiocarpa) habitat types usually dominated by lodgepole pine. The even-aged lodgepole stand is characterized by dense, even-aged lodgepole, 85 to 140 years old, with closed or nearly closed canopies and evidence of some natural thinning in progress (Crane & Fischer, 1986). Decay has reduced the heavy loading of down material from the previous fire in the late 1870's.

Fire exclusion has changed the Seafoam project site vegetation composition and structure. Fowler in 2001 discovered the mixed severity fires historically returning every 30 to 40 years have been eliminated from the stand over the last 120 years. This fire history study reinforced past scientific studies by Robert Steele (1994) in similar stands in Fire Group Seven. He stated that this type of stand would get stand-replacing fires every 100 to 300 years, with mixed severity underburns occurring every 25 to 70 years. Currently the landscape is dominated by dense thickets and storied structures with many smaller diameter lodgepole pine and subalpine fir providing ladder fuels to the crowns of the overstory trees. All the Douglas-fir and older lodgepole pine sampled showed a fire scar in the late 1870s and then no fire scars since that event.

METHODS OF ANALYSIS

Stand Inventory

To better understand the stand conditions within the 130-acre project area, a stand exam was conducted in 2001 using standard Intermountain Region stand examination procedures. Thirty-eight plots were established using a systematic sampling technique. Trees five inches and greater were tallied using a 20 Basal-Area Factor (F) of 20 square feet per acre and trees and seedlings under five inches were tallied using a one-five-hundredth acre fixed plot (see Appendix 1).

A standard sampling error for planning purposes as described in Introduction to Forest Science, second Edition (Young, 1990) was set at 20 percent. The coefficient of variation was estimated to be 60 after conferring with the pre-sale forester. He felt this would allow for variance in the stand. To determine if the sample size was large enough to meet our allowable percentage of error, I used the following formula:

Figure 1. Statistical Formula to Determine Minimum # of Plots Required to Achieve a Specified Sampling Error.

$$n = \frac{CV^2 * t^2}{SE^2} \qquad 36 = \frac{60^2 * 2^2}{20^2}$$

Where:

n = Number of Samples
CV = Coefficient of Variation
t = Value obtained from a table of Student's t Distribution
SE = Standard Error

Solving this formula for n indicated that our 38 plots would meet our desired allowable error.

Fuel Inventory

A fuel inventory was conducted to determine the amount of dead and down woody debris that was present in the stand. Two fuel inventory transects were established at each of the 38 systematically placed plots across the project area to capture variability. Utilizing the fuels inventory technique developed by Brown in 1982, a 50-foot sampling plane was used for the three inch and greater material, a 12 foot sampling plane for 1-2.9 inches and a six foot sampling distance for less than one inch debris. Fuel loadings were calculated using Fire Programs Solutions "DDWoody PC", as part of the Fuel Management Analyst Suite software package (see Appendix 2). Sampling 76 transects utilizing the 50 foot sampling plane produced statistically sound sampling data for management planning (Young, 1990) with a less than 20 percent standard error of the mean.

Table 1. Present Dead and Down Fuel Loading and Percent Standard Error

Attribute	0" - .24"	.25"- .9"	1" – 2.9"	3"+	Needles	Total < 3"	Total
Tons/Acre	.48	.86	1.17	14.86	0	2.51	12.02
%SE	10.73	12.56	14.52	14.86	***	9.40	9.76

Where:

%SE = Percent Standard Error

Table 2. Fuelbed and Duff Layer Depth and Percent Standard Error

Attribute	Duff	Fuelbed
Average Depth (in)	8.53	5.73
%SE	6.90	10.61

Weather Analysis

Historic weather containing records from 1986 through 2001 (15 years), was collected from the Bonanza weather station (101801) via Kansas City. The station best represents the area's weather conditions being at a similar elevation, habitat type, and aspect.

Data was entered into FIREFAMILY PLUS (USDA Forest Service, 1999) and the typical fire season was defined on the project area as July 1 through August 31. Modeling was then run for 50^{th}, 90^{th} and 97^{th} percentile day weather observations (see Appendix 3). These percentiles can be approximated to seasonal fire behavior nomenclature where 50^{th} percentile equates to "normal condition", 90^{th} percentile equates to "drought condition", and 97^{th} percentile equates to "severe drought condition". Table 3 expresses the three percentile weather outputs from FIREFAMILY PLUS utilizing the climatology section and clicking on desired percentiles.

Table 3. Seasonal Fire Behavior Condition Weather for Bonanza Guard Station Representing Seafoam Admin Site (101801)

Attribute	Normal Condition	Drought Condition	Severe Drought Condition
Temperature, Degrees F	80	88	91
Relative Humidity (%)	15	9	6
1 hour	3.5	2.1	1.5
10 hour	5.4	3.4	2.9
100 hour	12.0	8.0	6.6
1000 hour	14.1	11.1	9.7
20' wind (mph)	5.5	9.0	10.0
Herbaceous Fuel Moisture	81.5	50.0	36.8
Live Woody	102.9	77.2	64.3

RESULTS AND DISCUSSION

Fire Behavior Modeling

Assessing the results using Aids to Determining Fuel Models For Estimating Fire Behavior (Anderson, 1982), talking to local Fire Management Officers (FMO), and inserting data into Van Wagner's crown fire initiation formula and then analyzing it, it was determined that the area was best characterized by a Fuel Model (FM) 10 in the 13 Fire Behavior Prediction System (FBPS) models. These Models are organized into four groups: grass (1-3), shrub (4-7), timber (8-10), and slash (11-13). They are further described by total fuel load < 3-inch, dead fuel load ¼ inch, live fuel load of foliage and fuel bed depth (Anderson, 1982). The appropriate selection of a fuel model from the 13 available can be considered something of an "art", where integration of knowledge, experience, and an underlying integrity of the actual ground conditions versus the models must be considered. The entire area contained high levels of understory regeneration. The total down and dead fuel loadings of materials under three inches is less than 3 tons per acre, typical of a fuel model eight, but with the live ladder fuels present and crown fires predicted, the data was analyzed using a FM-10 with lighter fuels. The results of running the data from Table 3 through FIREFAMILY PLUS are shown in table 4. Example runs are in Appendix 4.

Table 4. Outputs from Direct Model in Behave Plus for Summer Normal (50th percentile), Drought (90th percentile), and Severe Drought (97th percentile) Weather Data.

Direct Model Outputs For a Fuel Model 10 (low)	**Normal Weather Conditions**	**Drought Weather Conditions**	**Severe Drought Weather Conditions**
Rate of Spread, Ch/h	2.5	5.8	7.3
Heat per Unit Area Btu/Sqft	1371	1575	1604
Fireline Intensity, Btu/Ft/S	62	167	215
Flame Length, Ft	3.0	4.7	5.3
Scorch Height, Ft	16	35	44
Probability of Mortality, %	63	63	83

Assumptions:

1) A .3 wind reduction factor was used to model partially sheltered fuels (Fuel Management Analyst Suite (FMA), 2000).
2) Weather analysis was performed for dates July 1 – August 31, which define the fire season in that section of the Middle Fork Ranger District.
3) Input required variables for Behave Plus was determined by requesting frequency distribution reports from Firefamily Plus analyzing the historic weather data obtained from Kansas City.
4) The fire model describes fire behavior in the flaming front.
5) Primary carrier of the fire is the dead fuel less than one-quarter inch in diameter.
6) The fire model is primarily intended to describe fires advancing steadily, from a point, independent of the source of ignition.
7) The fire model describes fire spreading through surface fuels.
8) Fuel, moisture, wind and slope are assumed to be constant during the time that the predictions are to be applied.

I then wanted to look at the possibility of a crown fire developing in the project area. I utilized the English unit version of Van Wagner's Crown Fire Initiation Model (Alexander, 1988) to determine a threshold for transition from a surface to crown fire. This threshold is defined as the critical flame length (Fireline Intensity, $I_{Critical}$) based on the independent variables crown base height (CBH) and the crown foliar moisture content (M).

Figure 2. Van Wagner's Crown Fire Initiation Model

$$I_{Critical} = (0.003096*CBH*(197.50 + 11.186 * M))^{1.5}$$

Where:

$I_{Critical}$ = Fireline Intensity

CBH = Crown Base Height (ft)

M = Foliar Moisture Content (%)

CrownMass modeling in FMA Plus calculates an overall stand Crown Base Height of one foot across the project area. Using this CBH along with the foliar moisture content (Live Woody) from FIREFAMILY PLUS, critical fireline intensities ($I_{Critical}$) can be determined. These computations are as follows:

Normal Condition

$I_{Critical} = (0.003096 * CBH * (197.50 + 11.186 * M))^{1.5}$
$I_{Critical} = (0.003096 * 1 * (197.50 + 11.186 * 103.6))^{1.5}$
$I_{Critical} = 8.6$

Drought Condition

$I_{Critical} = (0.003096 * CBH * (197.50 + 11.186 * M))^{1.5}$
$I_{Critical} = (0.003096 * 1 * (197.50 + 11.186 * 76.7))^{1.5}$
$I_{Critical} = 5.9$

Severe Drought Condition

$I_{Critical} = (0.003096 * CBH * (197.50 + 11.186 * M))^{1.5}$
$I_{Critical} = (0.003096 * 1 * (197.50 + 11.186 * 64.1))^{1.5}$
$I_{Critical} = 4.8$

Fire transition into the crown can be determined if $I_{Surface} \geq I_{Critical}$. Table 5 compares $I_{Surface}$ fromTable 4 (FBPS Fuel Model 10 Behave Plus output) with the calculated $I_{Critical}$ values from above.

Table 5. Current Potential Surface Intensities vs. Critical Intensities

Attribute	**Normal Conditions**	**Drought Conditions**	**Severe Drought Conditions**
$I_{Surface}$	62	167	215
$I_{Critical}$	9	6	5

Where:
I = Fireline Intensity (Btu/ft/sec)
$I_{Surface}$ is derived from Behave Plus

It is shown in Table 5 that in all fire behavior seasonal conditions, $I_{Surface} \geq I_{Critical}$, therefore, transition of fire to the crowns is expected in all three seasonal fire behavior conditions. CrownMass modeling also indicated a passive crown fire under each of the above scenarios and was subsequently used during further analysis.

Crown Fire

This transition into the crown can be characterized as passive, active or independent crown fire and may transition rapidly from passive to active to independent, or may remain in the passive or active stages without ever reaching the independent stage. The stages can be described as follows:

Passive – characterized by a single or group tree "torching". This stage of a crown fire is small in scale and can reinforce or accelerate surface spread, but the main spread is dependent upon the surface spread rate.

Active – characterized by a "pulsing" fire that advances as a wall extending from the surface fuels to well above the involved crown fuel layer, fire carries in the crown and spread rate is greater than spread rate on the ground. However, these "runs" are relatively short lived and are dependent upon surface fire to support fire in the crown. When the surface fire catches up to where the pulse weakened, the process reinitiates.

Independent – characterized by fire "running through the crown without the support of surface fire intensities." These runs can greatly influence fire spread over short periods of time, but are often short lived. The continuity of fuels across the crowns will support any crown fire stage dependent upon a combination of favorable conditions. These conditions include: dry fuels, low humidity and high temperature, heavy accumulations of dead and downed litter, conifer reproduction and other ladder fuels, steep slope, strong winds, unstable atmosphere and a continuous forest of conifer trees (Rothermel, 1991). A combination of any or all of these conditions can lead to crown fire.

With a crown fire initiated under all situations looked at including spring under CrownMass modeling it was determined that prescribed burning across the landscape should not occur without thinning the stand first. Two treatment alternatives were considered using thinning to lessen the density of the stand and remove ladder fuels.

Fire Effects

Fire effects were determined for the normal, drought, and severe drought seasonal fire behavior conditions using FMA Suite's CrownMass models. First Order Fire Effects Model (FOFEM) was used to look at mortality by two-inch class under normal summer conditions. FOFEM is a model developed to display direct or immediate consequences of a fire such as tree mortality, fuel consumption and smoke (Reinhardt, 1997). Since the goal of the project is to propose a fuel and vegetation treatment strategy that would minimize the risk and hazard of loss due to wildfire of the Seafoam Administrative Site by reducing tree density, tree mortality was the focus in the application.

The fire effects indicated by the CrownMass models under each of the scenarios above indicated a crown fire was capable of developing (see Appendix 4). FOFEM and

CrownMass indicated mortality of the lodgepole pine exceeded that which would leave our desired 210 trees per acre of overstory trees (see Table 6). I used a flame length of 3 feet in the FOFEM model, which represented both the 50^{th} percentile summer weather conditions (normal) and the spring time conditions as outputted from the Behave Plus runs. This follows what Crane and Fischer (1986) stated in Fire Ecology of the Forest Habitat Types of Central Idaho where they say, "Opportunities for use of understory fire are limited in natural lodgepole pine stands because of the low resistance of lodgepole pine, spruce, and subalpine fir. The other side of this problem is that during safe fire weather, it is often difficult to sustain a fire in Group Seven stands."

Table 6. Percent Mortality Associated with FBPS Fuel Model 10 by 2 inch Class

	2 Inch Size Class											
Seasonal Fire Behavior Condition	2	4	6	8	10	12	14	16	18	20	22	24
Normal Summer or Spring Weather	.99	.85	.78	.75	.72	.69	.66	.63	.59	.56	.53	.50

Modeling the present vegetative structure, density, and loading for both wildfire and prescribed fire indicated that, without prior treatment, our first objective of leaving 210 of the larger trees per acre would not be met and our goal of not losing the Seafoam Guard Station and associated buildings would be in jeopardy.

The changing fuel profile in the crown layers must be recognized to understand historic fire analysis compared to future expected fire behavior and growth. It is reasonable to expect the same fire occurrence frequency based on historic analysis, but fire size and behavior is expected to increase with succession and as the current lodgepole stand begins to deteriorate from age, bugs, and self-pruning. Large fires over 5,000 acres on Salmon-Challis National Forest have increased from one per decade to over one per year in the last ten years.

The fire effects results led me, in conjunction with the Fire Management Officer, to look at alternatives to treat the stand by thinning rather than with just fire.

Commercial timber harvesting is not an alternative for the Seafoam fuels treatment project due to its location within a designated Roadless Area. Present Management direction does not allow for commercial timber harvesting in Roadless Areas.
Eighty acres of the project area is accessible without road building for removing the smaller materials in the 3 to 6 inch diameter classes, leaving what larger trees there are for our 210 trees per acre stocking level.

Probability of Fire

The analysis area used to determine historic fire input for PROBACRE was delineated from the Forest Geographic Information System (GIS) layer using surrounding topographic features such as ridges and drainages that would tend to use natural barriers and fuel type changes to check fire spread. Although the area encompasses 21,790 acres, it is conceivable that fire could move across these boundaries more readily than is indicated in the 20-year analysis period. The fire history analysis area boundary is also delineated as such to reasonably assume an ignition within the area would encompass the project area. This took into account fuel types, topography, general winds, prior experience and seasonal weather conditions. Table 7 shows the historic fire frequency for input into PROBACRE.

Table 7. Seafoam Administrative Site Analysis Area Fire Frequency (1961 – 1998)

Fire Size Class (Acres)	Number of Fires	Annual Frequency	Average Fire Size (acres)
A (<,25)	18	.486	.13
B (.25 – 9.9)	3	.081	3
C (10 – 99.9)	1	.027	55

Based on historic analysis, PROBACRE calculates the probability of having one class B fire within the Seafoam Administrative Site fire history analysis area as being 7 percent in year one and 37 percent by year eleven. The probability for one fire then begins to reduce as probabilities are increasingly distributed to more than one Class B ignition occurring in the same time span. The model was run for each of the twenty years in the planning horizon. The probabilities are shown in Table 8 and PROBACRE results are included in Appendix 4.

Table 8. Probability Distribution of Class B Fire Occurrence Within the Seafoam Fire History Analysis Area for Time Horizons Over the Twenty-Year Planning Cycle.

	Number of Fires					
Time Horizon (Years)	0	1	2	3	4	>4
1	.92	.07	.03	0	0	0
2	.85	.14	.01	0	0	0
3	.78	.19	.02	0	0	0
4	.72	.23	.04	0	0	0
5	.67	.27	.05	0	0	0
6	.62	.30	.07	.01	0	0
7	.57	.32	.09	.02	0	0
8	.52	.34	.11	.02	0	0
9	.48	.35	.13	.03	0	0
10	.44	.36	.15	.04	0	0

Table 8. Cont.						
	Number of Fires					
Time Horizon (Years)	**0**	**1**	**2**	**3**	**4**	**>4**
11	.41	.37	.16	.05	.01	0
12	.38	.37	.18	.06	.01	0
13	.35	.37	.19	.07	.02	0
14	.32	.36	.21	.08	.02	.01
15	.30	.36	.22	.09	.03	.01
16	.27	.35	.23	.10	.03	.01
17	.25	.35	.24	.11	.04	.01
18	.23	.34	.25	.12	.04	.02
19	.21	.33	.25	.13	.05	.02
20	.20	.32	.26	.14	.06	.02

Assumptions:

1) None of the fires from the analysis period were crown fires; therefore historic analysis does not reflect current expected fire behavior and size in the conditions now present on the site.
2) Ignitions are both natural and people caused and are assumed to remain constant.
3) .08 Class B fires historically occurred annually across the analysis area and are expected to continue at that frequency.

ECONOMIC ANALYSIS

An economic analysis of the alternatives was conducted by determining the value(s) at risk and costs associated with two treatment alternatives. To compare these costs and values against property values, I gathered estimated values from the Forest Service files for the nine buildings and other improvements at the Administrative Site as well as the private cabin in the project area. The value for the improvements on the project site was determined to be $144, 500. I then compounded the value over the 20-year planning horizon using the compounding formula in Figure 3 to get a present value in year 20 to be $316,617.

Figure 3. Compounding Formula

$$V_n = V_o (1+I)^n$$

Where:

V_n = value in year n
V_o = present value (time is now = 0)
I = discount rate (annual), (.04)

The costs associated with the treatment methods, thinning from below with prescribed burning piles and a personal use post and pole sales along with thinning from below each have a range of potential costs and values. To simplify the cost analysis, a single cost or benefit is assigned to each activity. The figures used have been obtained from Sharon Bradley and Roger Chilson, Salmon-Challis N.F. silverculturist and forested vegetation managers. Costs of burning were obtained from the Fire Management Officer (FMO). These costs are shown in Table 9.

Table 9. Treatment Costs/Acre

Treatment	Cost/Acre
Thinning	$220.00
Handpiling	$190.00
Handpile Burning	$40.00
Prescribed Maintenance Burning	$57.00
Monitoring	$5.00
Planning	$10.00

The cost per acre of maintenance burning and monitoring remained constant for alternatives A and B. They were understood by using the figures from the table above and multiplying that cost by the 130 acres. Carried over a planning horizon of 20 years, maintenance burning takes place in year 10 and 20 and monitoring takes place in years 0, 5, 10, 15 and 20. A terminable periodic annuity/cost formula (Figure 4), taken from "Principles of Forest & Environmental Economics" (Rideout & Hesseln, 1997), was applied to determine discounted present net cost.

Figure 4. Terminable Periodic Series

$$V_o = a\{1-(1+I)^{-n}\} / \{(1+I)^{t}-1\}$$

Where:

V_o = present value
a = periodic payment
i = discount rate = .04
n = number of years from beginning of the series to the end of the series.
t = the period (Number of years) that a repeats.

Discounted present net cost for maintenance burning is:

$$V_o = 7410\ \{1-(1.04)^{-20}\} / \{(1.04)^{10} - 1 \qquad V_o = \$8,387.76$$

Discounted present net cost for monitoring is:

$$V_o = 650\ \{1 - (1.04)^{-20}\} / \{(1.04)^{5} - 1 \qquad V_o = \$1,003.35$$

If the area was thinned from below to 210 trees per acre, modeling depicts only removing trees less than 5.4 inches in diameter. The larger trees would be left to make up the 210 trees per acre. Again the assumption is that trees are uniformly spaced across the landscape. Through extrapolation from the FVS output I determined there would be 40 trees/acre of post-sized trees (with a high limit of 5.4 inch DBH) available for removal and 320 trees/acre of pole sized trees for removal. This would amount to 25,600 poles and 3,200 posts on the 80 acres accessible for cutting. The Forest service charges $.50 per pole and $1.50 per post for personal use post and poles and the buyer has to pile the slash.

Treatment Alternatives

Alternative A: Alternative A would thin the entire 130 acres to a desired 210 trees per acre by thinning from below, piling the materials, and pile burning the resulting piles under proper weather conditions. Estimated cost for this treatment can be seen in Table 10. Thus this treatment alternative would cost the United States tax payers $67,891.

Alternative B: Alternative B would thin from below 50 acres and pile and burn while utilizing the usable materials in the other 80 acres by letting a series of contracts for personal use post and poles. Estimated cost for this treatment is shown in Table 10. Thus this treatment alternative would cost the taxpayers $17,491 and allow sought after post and poles to be put to good use.

Table 10. Comparison of Discounted Present Net Cost for Treatment Alternatives

	Thinning	**Piling**	**Pile Burning**	**Personal P&P Sales**	**Maint. Burns Yrs. 10 & 20**	**Monitoring Yrs. 0,5,10,15 & 20**	**Discounted Present Net Cost**
Alternative A	$220/a * 130 acres = $28,600	$190/a * 130 acres = $24,700	$40/a * 130 acres = $5,200	0	$8,388	$1,003	$67,891
Alternative B 50 acres Inaccessible 80 acres Accessible	$220/a * 50 acres = $11,000	$190/a * 50 acres = $9,500	$40/a * 130 acres = $5,200	25,600 poles * $.50 = ($12,800) 3,200 posts * $1.50 = ($4,800)	$8,388	$1,003	$17,491

Note: Numbers in Parenthesis are gains to offset costs.

Expected Value of the Risk

In order to complete the analysis, expected value of the risk must be determined. The expected value of the risk can be expressed as the probability of an event multiplied by the present value.

If no action was taken, fire behavior modeling, Van Wagner's crown fire initiation model, NEXUS and FOFEM provide evidence for me to make the assumption that even under normal summer conditions, a fire once initiated could become a crown fire and stand replace the project area including the Seafoam Administrative Site. In this case, the expected value of the risk is the probability of fire multiplied by the present value of improvements on the site. Alternatives A and B, mechanical treatment would prevent stand replacing fire behavior at the site and would therefore have an expected value of risk equaling zero. Table 11 expresses Present Net Value and associated input for no action and the two proposed alternatives. Present Net Value is shown in five-year intervals if no action is taken in an effort to describe risk over the twenty-year planning horizon.

Table 11. Present Net Value

	Year	**Present Value**	**Associated Probability**	**Expected $\textbf{Value}_{\textbf{risk}}$**	**Treatment Cost**	**Present Net Value**
No action	5	$175,806	.27	($47,468)	($650)	$127,688
	10	$213,895	.36	($77,002)	($650)	$136,243
	15	$260,236	.36	($93,685)	($650)	$165,901
	20	$316,617	.32	($101,317)	($650)	$214,650
Alternative A	20	$316,617	0	0	($67,891)	$248,726
Alternative B	20	$316,617	0	0	($17,491)	$299,126

Note: Values in parentheses are negative.

CONCLUSIONS AND RECOMMENDATIONS

Recommendations

From the economic analysis, both alternatives, A and B would result in a higher present net value than not doing anything and taking a chance on a wildfire. Both the alternatives treat the same amount of area but alternative B allows use of some of the removed fuels as a product highly desired in the area and shares the thinning work with someone not paid by the government.

The recommended alternative is alternative B: on 50 of the more inaccessible acres, hand thin from below and hand pile, followed by prescribed burning the piles when weather conditions permit; on the other 80 acres, let a series of small contracts for personal use post and pole cutting, requiring the purchasers to pile their created slash. The Forest Service would then burn the piles when appropriate.

This alternative meets the goal as measured by the criteria of the objectives. After treatment, in the event of an unplanned ignition, the fire will remain on the surface and can be initially attacked by ground forces helping to protect the Seafoam Administrative

Site. This alternative also has the highest present net value and lets the public help us move towards our goal.

Quantification of regeneration, growth and yield is beyond the scope of this particular paper, however relevant, and a silviculturist will be required to write a long term prescription for this project before any ground work is initiated. Light underburns will be initiated in the stand in years ten and twenty to thin the newly regenerated lodgepole pine seedlings and to more closely mimic natural disturbances.

Conclusions

Fuel conditions surrounding the Seafoam Administrative Site were assessed to quantify the existing vegetative conditions from the duff, litter, fuel loading and aerial vegetation. Thirty-eight stand exam plots and 76 fuel loading transects were sampled in the 130 acre project area. The less than three inch on-the-ground fuel loadings were less than 3 tons per acre, typical of a Fuel Model 8. After using Van Wagner's crown initiation model it became apparent that the live fuels present would add to the dead and down fuels to create a fire more typical of a Fire Behavior Prediction System (FBPS) Fuel Model 10. The two local Fire management Officers also felt the site would burn like a FM-10.

Weather records were analyzed using the Bonanza weather station for historic weather data. Historic weather information was collected since 1986 and 50th percentile, 90th percentile and 97th percentile weather for the period July 1 – August 31 was calculated. Modeling runs at the present stand conditions indicated a passive crown fire would exist under the 50th, 90th and 97th percentile weather conditions. A passive crown fire was also indicated under springtime burning conditions and with a 20-foot wind of 18 miles per hour the fire would become an active crown fire. This led me to conclude, with advice from other fire personnel, that prescribed burning without thinning first should not be attempted.

Scientific literature was researched where fire history and return intervals were indicated. A cursory fire history study was conducted by analyzing 26 tree slabs to look for trends in fire return intervals. My data mirrored that put forth by Steele (1994) that historically, mixed severity underburning occurred every 30 to 40 years.   My study also showed that larger fires have been eliminated in the stand for the last 120 years.

Thinning the stand from below utilizing the Forest Vegetation Simulator (FVS) tool indicated to leave 210 trees per acre of larger trees would mean removing over 5,000 trees 5.4 inches in DBH and below per acre. Ninety percent of those removed would be less than 1.5 inches in diameter and about 365 trees per acre would be of proper size to sell as post and poles.

Since a No Action alternative would not meet the goal of the project nor meet the objectives of the project, it was not considered beyond the fact that doing nothing was followed through the economic analysis to predict present net value for the improvements on the site.   Modeling indicated a wildfire under normal or worse weather conditions would transition into the crowns of the trees under present conditions. These conditions are worsening as the 120-year-old lodgepole pine stand continues to break down and add materials to the surface fuel loading. A mountain pine beetle epidemic is slowly moving towards the area as well. With a 37 percent chance of having one class B fire start in the area in the next 11 years and an 80 percent chance of one or more Class B fires start in the 20 year planning horizon, I feel it is time to take action to save the historic Seafoam Guard Station and Administrative Site.

Two alternatives were developed to treat the stand. Alternative A utilizes hand labor to thin from below to the recommended stocking of 210 trees per acre left of the larger trees. Materials would be piled for burning and burned under appropriate weather conditions. Maintenance burns would occur in year ten and twenty and monitoring would occur every five years.

Alternative B would thin from below, as in alternative A, but only on 50 acres that is inaccessible and allow private citizens to remove posts and poles under contract from the other 80 acres while piling their slash for burning. This alternative would cost the taxpayers less as some of the cost would be offset by income from sales of post and poles. This alternative also has the highest present net value for the Site over the 20-year planning horizon. Maintenance burns and monitoring would still occur as stated in alternative A.

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