Comparing Two Methods of Identifying Ecological Restoration Opportunities

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Abstract—*Two methods for identifying ecological restoration opportunities in the Northern Region of the Forest Service are compared. Different analysis methods are often used to address issues at different planning scales. The first method is a nonspatial characterization of current vegetation conditions using Forest Inventory and Analysis (FIA) plot data grouped by potential vegetation for both the state of Montana and smaller landscape areas. The second method uses a spatially explicit model on two landscapes of one-half million and 1 million acres. Similar rule sets are used in both methods to compare current vegetation condition to historic vegetation conditions. This analysis indicates that spatially explicit modeling for determining restoration opportunities would not always support the same decisions made through a nonspatial analysis. For both types of land on the Pintler District area, suitable and unsuitable, the spatially explicit modeling indicates a greater need for more costly restoration and conversion treatments and less maintenance treatments compared to FIA plots for the entire state and just those within the area. For the three land classes on the Bitterroot Face area, only the suitable land had a similar mixture of treatment needs compared to the FIA plots for the entire state and those within the area. The differences in the levels of the treatment opportunities between the methods and scales can have a significant impact on the level of treatment needs and associated budgets identified for programs.*

Introduction

The departure of current vegetation from the conditions maintained by historic fire regimes has had an impact on our ability to meet many management objectives. Increases in the activity of bark beetles, root diseases, and defoliators are examples of insects and pathogens capitalizing on a large food base of susceptible host trees. Increases in fire severity and fire sizes are considered a result of the lack of fire disturbance across landscapes (Monnig and Byler 1992).

Identifying the level of treatment opportunities and the types of land that they occur on is an essential step in identifying funding to meet management objectives. To identify the level of management opportunities that would be needed to restore historic vegetation conditions, the Northern Region of the US Forest Service developed a procedure to analyze the Montana portion of Forest Inventory and Analysis (FIA) data (working paper on file with Region Office, Region One). This approach is based on a set of rules for comparing current vegetation conditions on plots with historic fire regimes. The second approach also uses similar rules to make a comparison, but it utilizes a spatially explicit landscape scale model, developed at the Rocky Mountain Research Station. The model is used to project the trend of current inventoried vegetation and to create a representation of historic vegetation. This paper compares the results of these two approaches.

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Treatment opportunities used for both methods were categorized in three condition classes: maintenance, restoration, and conversion.

- **Maintenance** opportunities are identified when there is little or no change required in forest cover type or density. Maintenance treatments are relatively low cost operations such as deferring treatment for greater than two decades or using wildland prescription fire for resource benefit with no pre-treatment of fuels.
- **Restoration** opportunities are identified when there is little need to change the forest cover type but the density needs to be changed. When the associated vegetative conditions are compared to management objectives, pre-treatment such as thinning is required prior to the use of wildland prescription fire.
- **Conversion** opportunities are identified when the current cover type is substantially different from historic conditions. Conversion opportunities have higher investment costs such as replacing a current cover type due to its relative departure from historical conditions. Treatments of regeneration harvests or stand replacing fire followed by reforestation of intolerant species such as ponderosa pine, western larch rust resistant western white pine, whitebark pine, or aspen are needed to return to historical conditions.

FIA Plot Analysis Method

The Forest Inventory and Analysis is a national, strategic scale program conducted on a state by state basis with a set of field sample locations distributed with approximately one sample location (FIA plot) every 6,000 acres (Gillespie 1999). Treatment condition classes were assigned to the set of Montana plots based on the potential vegetation setting with an inferred historical fire regime from the literature (Hardy et.al. 1998). Table 1 is an example of the condition class rule sets or assignments given by historic fire regimes. The current cover type existing on a potential vegetation group (PVG) setting was determined by species with a plurality of basal area. A current structure class was determined: seedlings/saplings are <5 inches dbh; poles are 5-8.9 inches dbh; medium is 9-14.9 inches dbh; large is 15-20.9 inches dbh; and very large is >21 inches dbh. S is single story, 2S is two stories, and multi is three or more stories. A current density class was assigned: L is 10-39%, M is 40-69%, H is ≥70%. Finally, a treatment class was determined: A maintenance class (M) is assigned if the current cover type was consistent with the historical fire regime within the PVG setting, indicating relatively low departure from historical conditions. A condition class of restoration (R) was assigned if departure was not great (density or layering increased, but cover type had not changed). A conversion class (C) was assigned if a greater departure from historical conditions was indicated by an increase in density and a change of cover type. All three classes are treatment opportunities with different tools and costs associated as in the descriptions above.

Plots were stratified into land classes. The three land classes used for this comparison are suitable, non-suitable, and wilderness. The suitable and unsuitable classes refer to the suitability of National Forest land for the production of commercial timber products. Only forested FIA plots on National Forest System Lands were used in this analysis. A total of 2,343 plots were used for all of Montana, 94 for the Pintler District, and 43 for the Bitterroot Face.

Table 1—Treatment class for historical fire regimes of 35-100+ years, mixed severity. See test for explanation of abbreviations.

Existing cover type/group/a	Structure class/b	Density class/c	Treatment class
Limber pine (*Pinus flexis*)	single, two story	L	M
Limber pine	multi	M-H	R
	seedling/sapling	M-H	R
	pole	M-H	R
	medium	M-H	R
	large	M-H	R
	very large	M-H	R
Ponderosa pine (*Pinus ponderosa*)	S,2S	L	M
Ponderosa pine	S,2S,multi	M-H	R
	seedling/sapling	M-H	R
	pole	M-H	R
	medium	M-H	R
	large	M-H	R
	very large	M-H	R
Eastside Region One DF (*Pseudotsuga menziesii*):			
Eastside Region One DF (xeric)	S,2S	L	M
Eastside Region One DF (xeric) <25%	S,2S,multi	M-H	R
Eastside Region One DF (xeric) >25%	S,2S,multi	M-H	M
	seedling/sapling	M-H	R
	pole	M-H	R
	medium	M-H	R
	large	M-H	R
	very large	M-H	R
Lodgepole pine (*Pinus contorta*) <80 years	all	All	M
Lodgepole pine (upper subalpine) >80 years	all	All	M

Landscape Modeling Approach

The modeling system used is SIMPPLLE (Simulating Pattern and Process at Landscape Scales) (Chew 1995, 1997). SIMPPLLE uses stochastic disturbance processes to model vegetation change. Vegetation is described by cover type, size and structure class, and density classes. Long-term simulations (300-500 years) that start with the current vegetation conditions are made without fire suppression to re-create a representation of historic conditions for a specific landscape. Multiple simulations are used to create the frequency of occurrence for the cover type attributes. Multiple short-term simulations (50 years) with fire suppression are also made on the inventoried current vegetations conditions to generate frequency of future vegetation conditions. Similar rules sets are used to compare the simulated historic vegetation conditions with the simulated current vegetation conditions trends.

If there is no difference between these simulated vegetation conditions, the treatment class of maintenance is assigned. If the two most frequently occurring cover types from the simulated current trends are consistent with modeled historic cover types, but either density or size class differs, the restoration class is assigned. If the cover type does not match between the two sets of simulations, regardless of the other two attributes, the conversion class is assigned.

Comparison

The comparison is made using the percents of the condition classes for all of the Montana FIA plots, percents for the FIA plots within the two landscapes, and the percents from the SIMPPLLE modeling of two landscapes. Existing vegetation conditions on the Bitterroot Face on the Bitterroot National Forest is described by field inventories. The Pintler Ranger District from the Deerlodge Forest is described by satellite imagery. The comparison of the percent of treatment opportunity class on suitable land for the Pintler District is in figure 1. The comparison for the suitable land on the Bitterroot Face is in figure 2. For the nonsuitable land, figure 3 describes the Pintler District landscape and figure 4 describes the Bitterroot Face. For the wilderness land, figure 5, only the wilderness portion of the Bitterroot Face landscape was used.

For all except the suitable land class on the Bitterroot Face, there is less maintenance treatment opportunity class identified by the modeling approach. To gain insight into what accounts for the difference, individual plant communities from the Pintler District landscape are examined. These communities were selected from one type to use for the comparison because of the simplicity

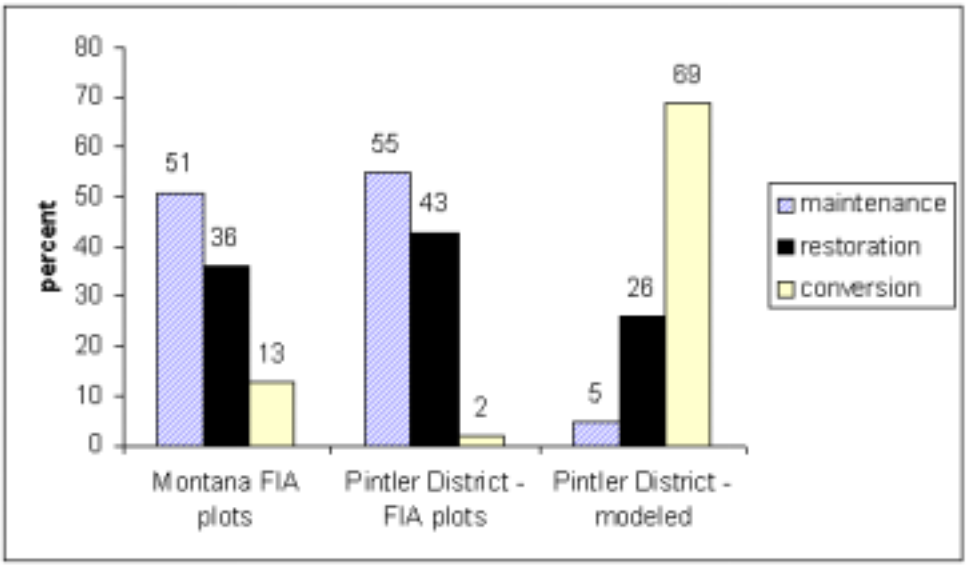

Figure 1—Comparison of percent of suitable land by treatment opportunity for the Pintler District.

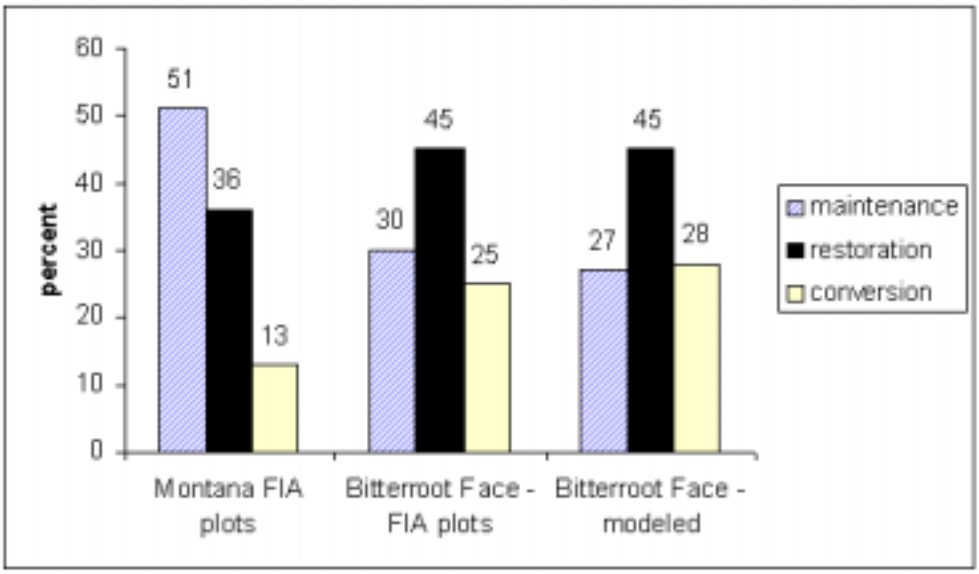

Figure 2—Comparison of percent of suitable land by treatment opportunity for the Bitterroot Face landscape.

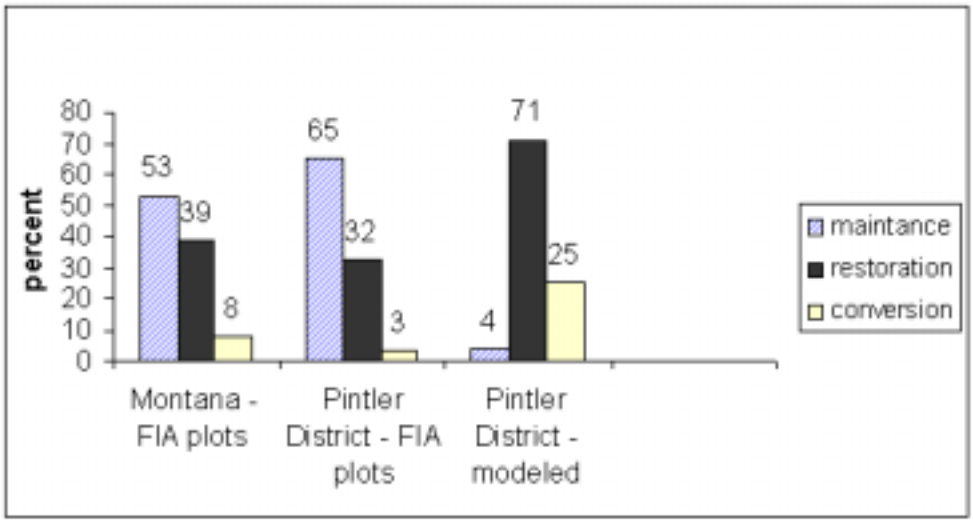

Figure 3—Comparison of percent of nonsuitable land by treatment opportunity for the Pintler District.

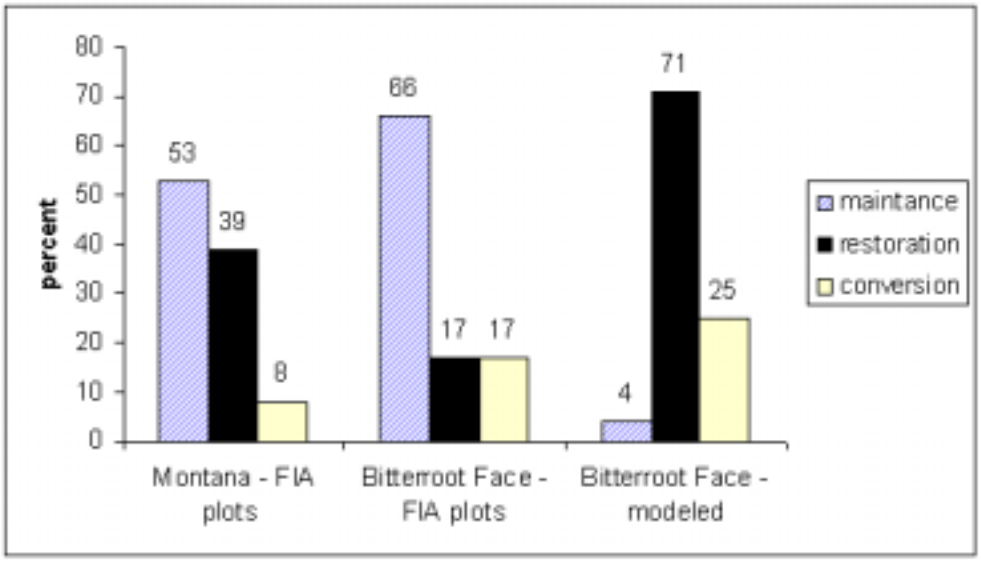

Figure 4—Comparison of percent of nonsuitable land by treatment opportunity for the Bitterroot Face landscape.

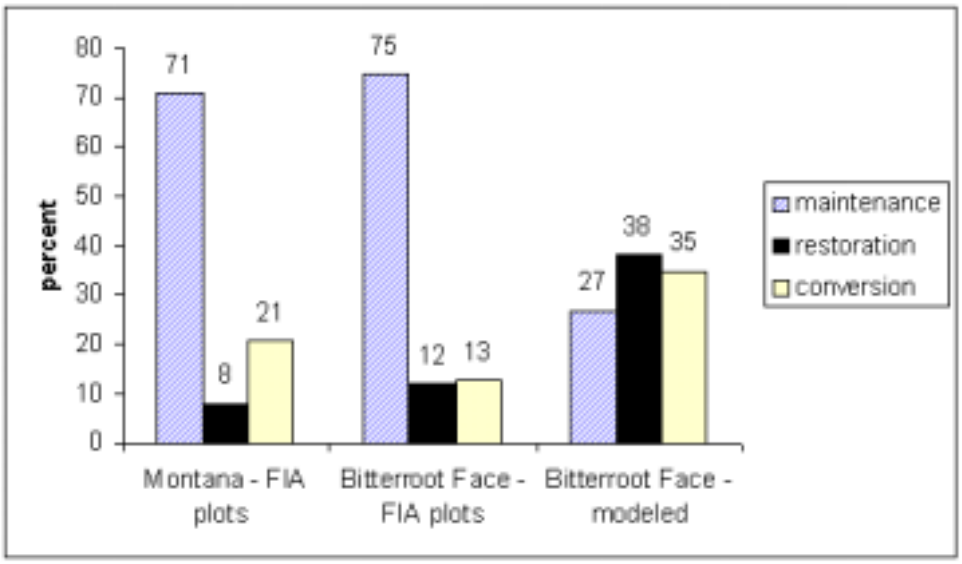

Figure 5—Comparison of percent of wilderness land by treatment opportunity for the Bitterroot Face landscape.

within the Rule Sets (table 1). Xeric Douglas-fir, on slopes greater than 25%, all medium size class, and medium to high density are always put in the restoration condition class. This means that the cover type does not need to be changed but some change in density and structure may need to be made.

Within the Pintler District, using the modeling approach, the Douglas-fir cover type, medium size class, and density 3 on xeric sites have only 2% classified as restoration. The conversion treatment class was assigned to 98%. The difference in results from the SIMPPLLE modeling approach are from being spatially explicit. The arrangement of different cover types present in the current landscape has an impact in the multiple simulations that are made to represent both current trends and possible historic conditions. Different plant communities can be in the same PVG and be assigned the same historic fire regime, but be surrounded by different cover types. The timing of fire events with the size class development of the different cover types and the presence or absence of seed sources all play a part in determining how cover types can vary from one fire event to another.

Figure 6 is taken from a portion of the Pintler District and displays a gradient of Douglas-fir stands intermixed with nonforest communities, to solid Douglas-fir, to Douglas-fir adjacent to lodgepole pine. Three plant communities are selected for a comparison.

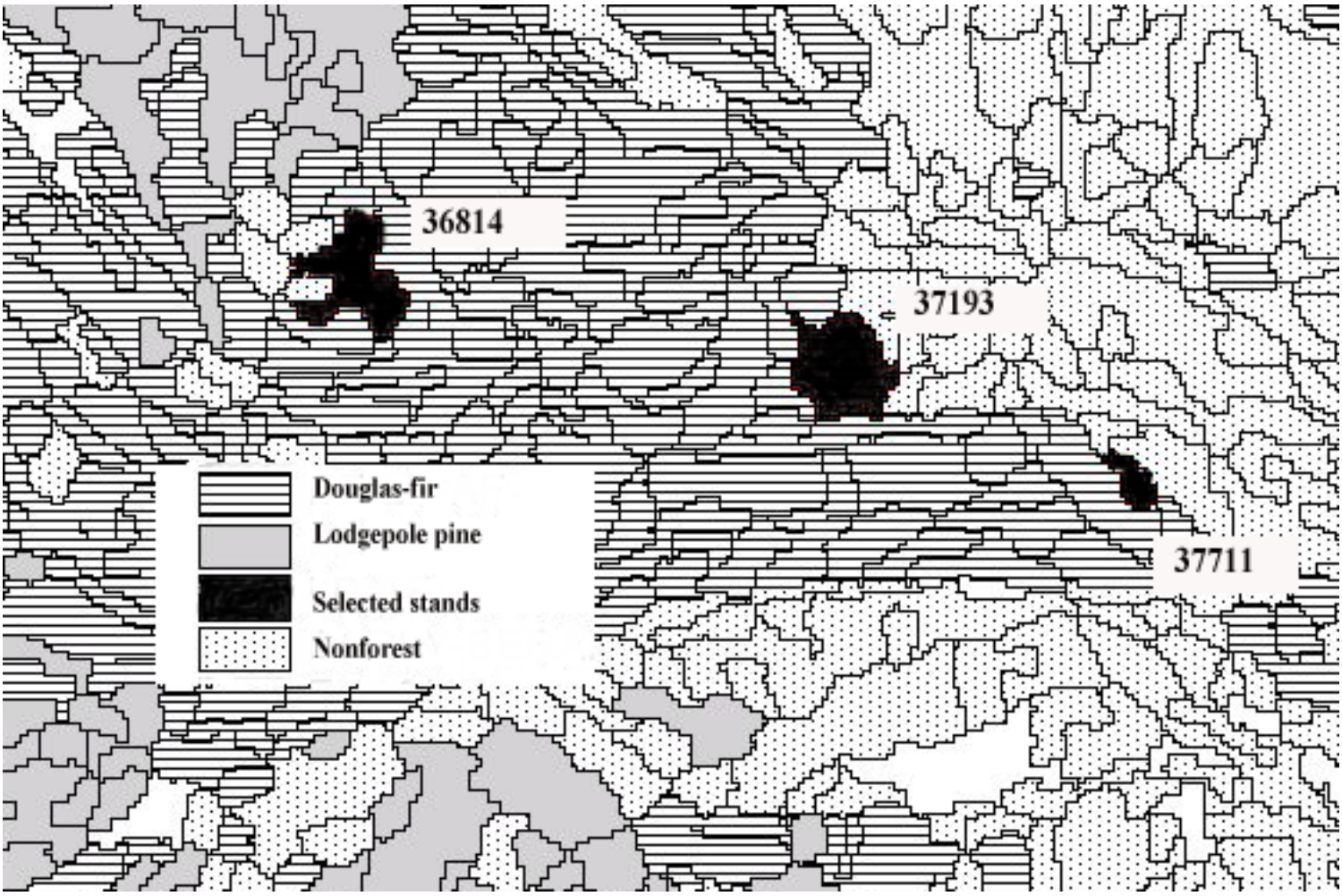

Figure 6—Map showing three plant communities selected for detailed examination of modeled results.

From the modeling method, plant community 37193 is assigned a conversion treatment need. In the modeled current trend, the plant community stays the same type and size class over the next five decades, but increases in density. Historic conditions have the two most dominant cover types being upland-grasses and lodgepole pine. With lodgepole pine it did not grow out of the seedling sapling stage before it burned again. The high level of fire in historic simulations minimizes the acres of the Douglas-fir cover type. Acres of both upland-grasses and lodgepole pine are expanded.

The modeling method resulted in plant community 37711 also being assigned a conversion need. The current trend simulations have the plant community staying the same cover type and size class but increasing in density over the next five decades. Historic conditions have the plant community always in shrub cover type. The level of simulated historic fire has the nonforest communities occurring in areas that have been invaded by Douglas-fir.

Plant community 36814 is assigned a restoration need. The simulated current trend has the plant community staying Douglas-fir and size class medium but increasing in density. The simulated historic conditions are always a Douglas-fir cover type but the size class is predominately pole with frequently becoming pole two-story. The density stays class 3 ninety percent of the time.

Discussion

The FIA process for the entire state was intended to be a broad, nonspatial classification of treatment opportunities appropriate for a Regional assessment. The method of using a spatially explicit model such as SIMPPLLE is often considered more appropriate at the landscape scale for Forest or District planning. Planning processes are often considered hierarchical, with the results of finer level, more detailed planning expected to fall within the context of the decisions made at broader assessment scales. The types of decisions made using a broad scale analysis would continue to be supported as more detailed analysis and planning are conducted. However, this comparison indicates that spatially explicit modeling for determining restoration opportunities would not always support the same decisions made through a nonspatial analysis. For both types of land on the Pintler District area, suitable and unsuitable, the spatially explicit modeling indicates a greater need for more costly restoration and conversion treatments and less maintenance treatments compared to both the FIA plots for the entire state, or those within the area. For the three land classes on the Bitterroot Face, only one, the suitable land, had a similar mixture of treatment needs compared to either the FIA plots for the entire state or those within the area. Would budgets and programs developed for restoration treatments needs from the broad nonspatial analysis underestimate the needs for restoration and conversion? Or are the needs for restoration and conversion overestimated from the spatial analysis that may be completed at other planning levels?

The answer to these questions depends on the confidence in the analysis method used. Does the spatially explicit modeling system overestimate how fast current conditions may change? Does the modeling method overestimate the variability that existed historically? Or does the use of historic fire regimes by PVG's underestimate the historic variability? The differences we see in this comparison can raise additional questions about differences in assessment methods used at different planning scales. Where broad, nonspatial analyses are made, should they be adjusted by using "sample areas" that are modeled

spatially? Or should broad scale assessments be composed of spatially explicit analyses on a size of areas that can be added to represent the total area of interest?

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