Stevensville West Central Study

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Abstract—This paper reports on an application of two modeling systems in the assessment and planning effort for a 58,038-acre area on the Bitterroot National Forest: **SIM**ulating Vegetative **P**atterns and **P**rocesses at **L**andscape Sca**LE**s (SIMPPLLE), and **M**ulti-resource **A**nalysis and **G**eographic **I**nformation **S**ystem (MAGIS). SIMPPLLE was a useful model for tracking and analyzing an abundance of spatial data and processes, providing a good depiction of landscape patterns over time. Concerns were raised by Forest specialists about the predicted levels for a few of the fire and insect processes. MAGIS was an effective model for calculating watershed effects and some wildlife effects and was used to select some of the harvest treatments in the selected alternative. Problems in the application of MAGIS included the time needed for data cleaning and preparation, and the information projected for future stands provided a weak basis for estimating some wildlife effects.

Implementing ecosystem management requires managers to face a number of questions. What are the current conditions on the landscape and, in view of the important natural processes, how are they expected to change in the future? What are the desired conditions for the landscape? If the projected future differs from the desired conditions, what alternatives for treatment should be developed? Then, what effects are expected from the proposed treatments regarding extent and location of future natural processes, various resource values, environmental concerns, and economic and social interests?

Models and decision support systems can provide information and analyses to aid managers in addressing these questions (Mowrer 1997). The Landscape Analysis Group of the Bitterroot Ecosystem Management Research Project has participated in developing two landscape-level modeling systems: (1) **SIM**ulating Vegetative **P**atterns and **P**rocesses at **L**andscape Sca**LE**s (SIMPPLLE), a stochastic simulation model for projecting vegetative change as it is influenced by natural processes (Chew 1995), and (2) the **M**ulti-resource **A**nalysis and **G**eographic **I**nformation **S**ystem (MAGIS) for scheduling activities both spatially and temporally, given alternative management objectives and constraints (Zuuring and others 1995).

This paper reports on an application of these two modeling systems in the assessment and planning effort for the 58,038-acre Stevensville West Central (SWC) area on the Bitterroot National Forest. This study was a cooperative effort among the Rocky Mountain Research Station, Bitterroot National Forest, and The University of Montana. The objective was to test the use of these models with Forest data in an interdisciplinary team environment. Specifically, we were interested in learning about the capabilities of these models for addressing key analytical support needs:

1. Defining the range of variability for the analysis area, including capabilities, restoration goals and desired conditions.
2. Describing a sustainable landscape, what site-specific ecological characteristics and processes must be present to meet restoration goals.
3. Designing cost effective management practices that meet restoration goals and provide for people's needs for wood fiber, visual quality, recreation, etc., within the capabilities of the ecosystem.
4. Quickly examining the trade-offs among and between important ecological components and human desires and needs.
5. Assessing the ways to implement management practices while meeting forest plan goals and standards and other identified constraints.

The Planning Process

The planning process for the Bitterroot National Forest, like all National Forests, is directed by the National Forest Management Act (NFMA, 36 CFR part 219, 9/30/82) and the National Environmental Policy Act (NEPA) of 1969 (40 CFR 1500-1508). This specifies a two-level decision process. The first level involves decisions already made in the Forest Plan environmental impact statement and the next level involves decisions to be made in the site-specific NEPA analysis. Project planning involves two separate but linked planning processes, the NFMA Analysis and the NEPA Analysis. The steps in these processes are summarized in table 1. The NFMA analysis is not a decisionmaking process, but helps the responsible official review the decisions made in the Forest Plan and determine the purpose and need for action. This six-step analysis is completed to determine forest plan compliance, to identify opportunities

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Table 1—Summary of steps in the NFMA (or EAWS) and NEPA processes.

Step	Description
NFMA and EAWS process	
1. Monitoring	Mid- and larger scale monitoring at the Forest or Regional level identifies needs for further study. Monitoring may also determine that there is a purpose and need for action, and a proposed action is developed, thus condensing or eliminating the NFMA analysis.
2. Location	The Bitterroot National Forest is divided into 32 study areas for forest plan implementation, with an average size of 65,000 acres. This is considered the fine scale assessment. Highest priority study areas are addressed first, with priorities determined by inventories, monitoring, and evaluations.
3. Existing conditions and characterization	Field data collection is used to document the existing conditions of resources. An assessment of private land conditions adjacent to National Forest land is also made.
4. Forest plan consistency, issues, and key questions	Existing resource conditions are compared to the Forest Plan standards and guidelines. Resource issues and resource sustainability questions are developed.
5. Desired conditions or reference conditions	Interdisciplinary team develops goals and objectives for the resources in the study area that are consistent with meeting Forest Plan goals and that are compatible with mid- and larger-hierarchical monitoring and evaluations. If desired conditions are not compatible with Forest Plan goals and objectives, an amendment may be proposed. The desired conditions or reference conditions can provide the framework for determining the purpose and need for action.
6. Opportunities and recommendations	Site-specific opportunities are identified for achieving the desired conditions. Short-term needs (1 to 5 years) are established, and the highest priority projects are taken into the NEPA process.
NEPA process	
7. Purpose and need for action	NEPA analysis is directly linked to the desired conditions or reference conditions described during the NFMA analysis or EAWS.
8. Proposed action	From the opportunities/recommendations developed in step 6, the highest priority site-specific project or set of projects will be evaluated for issues, effects and alternatives.
9. Scoping and issue identification	The formal process of informing the public of the proposed actions and the purpose and need for action, as well as requesting comments to determine the social, economic, and environmental issues is initiated.
10. Alternatives	Alternatives to the proposed action are suggested by the public and developed by the interdisciplinary team. They are responsive to the significant issues identified during scoping.
12. Environmental effects	The environmental effects of the proposed actions and the alternatives are determined and disclosed in the environmental document.
13. Decision	An alternative is selected. If the interdisciplinary team determines a finding of “no significant impact,” an Environmental Assessment is used and Decision Notice is published. If the selected alternative is found to have a significant impact on the human environment, an environmental impact statement is required and a Record of Decision is published.

for implementing the forest plan, and to identify areas where forest plan amendments are needed. Opportunities identified during this assessment that are high priority for short-term implementation become the proposed actions that are taken through the NEPA analysis (steps 7 to 12). The NEPA analysis is an effects analysis and is used to assist responsible officials in making good resource decisions. An interdisciplinary team of resource specialists interacts to assist in the decision process.

The Ecosystem Assessment at the Watershed Scale (EAWS) is an assessment similar to the NFMA analysis that is required by the Forest Plan Inland Native Fisheries Amendment of 1995 (INFISH) where actions may take place in watersheds that contain threatened or endangered fish species. Where an EAWS is required, it replaces the NFMA analysis and meets the same objectives, with an emphasis on watershed conditions. An EAWS was not completed for Stevensville West Central because there were no actions proposed within any Riparian Habitat Conservation Areas.

Public involvement is optional during the NFMA or EAWS process. It becomes a formal part of the process once proposed actions and the purpose and need for action have been identified and the NEPA process has begun. Then, a public scoping period begins and the issues that frame the analysis and the alternatives are identified.

The Stevensville West Central Area Analysis

The Planning Process for the Stevensville West Central analysis was guided by the Bitterroot Land and Resource Management (Forest) Plan and environmental impact statement, dated September 1987. The area analyzed was a section of the east slope of the Bitterroot Range, bordered on the west by the Montana/Idaho border and the east by the Bitterroot River (fig. 1). The major Management Areas and summary of their goals are:

Bitterroot National Forest	
Management Area 7—Selway-Bitterroot Wilderness	25,283 acres
Management Area 5—Emphasize motorized and nonmotorized semi primitive recreation and elk security	3,720 acres
Management Area 3a—Maintain “partial retention” visual quality objectives while managing timber	9,077 acres
Management Area 3c—Maintain “retention” visual quality objectives while managing timber	1,358 acres
Private lands	18,600 acres
Total area	58,038 acres

The private land was included for assessment purposes only; no management decisions were made for land in private ownerships.

Public participation, although optional during the NFMA or EAWS process, was a key component of the Stevensville West Central analysis. The public was involved in refining the goals and desired future conditions for the area. This involvement was formed around a collaborative working group that included interested publics, Bitterroot National Forest, Rocky Mountain Research Station, and The University of Montana. Over 20 public meetings and 3 public field reviews were completed. The group was able to agree on goals and develop desired conditions for all issue areas except for scenery management and roadless areas.

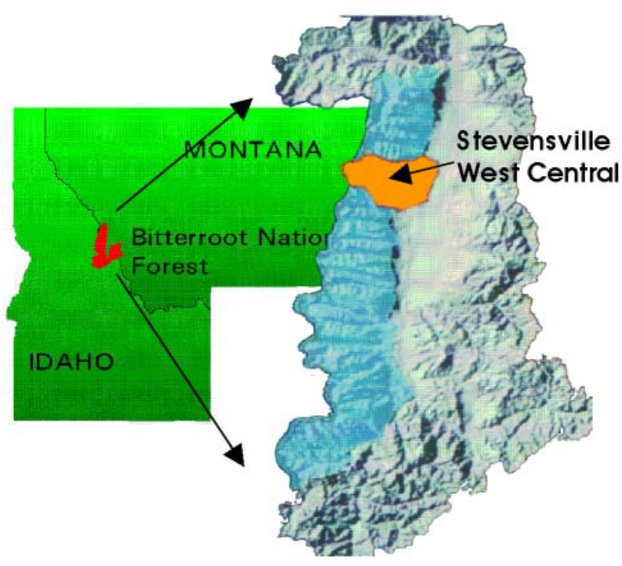


Figure 1—The Stevensville West Central Area.

The environmental issues associated with the proposed actions as well as those identified by the public centered around vegetation and fuels, wildlife, roadless lands, watershed and fisheries restoration, visual quality, recreation, and economic efficiency. Vegetation and fuels issues included the need to (1) restore and sustain historic structures and age classes; (2) restore species diversity; (3) restore fire; (3) alleviate forest health problems, including mountain pine beetle (*Dendroctonus ponderosae*), western spruce budworm (*Choristoneura occidentalis*), dwarf mistletoe (*Arceuthobium* spp.); and (5) the need to reduce intense wildfire risk. Wildlife issues included the need to restore vegetative conditions for elk (*Cervus elaphus*) habitat and old growth.

Five alternatives, including the Proposed action, were considered in detail:

1. No action.
2. Achieve desired conditions (proposed action).
3. Achieve desired conditions with wildlife corridors/distribution.
4. Achieve desired conditions in roaded lands.
5. Achieve desired conditions without commercial harvest.

The public suggested four more alternatives. These were considered, but not in detail:

6. Selection harvest only, no new roads.
7. Improve watersheds and fisheries without vegetation management.
8. Eliminate fire suppression.
9. Change visual quality objectives.

The NFMA analysis and ecosystem assessment was completed in September 1995, and the Environmental Analysis was completed in November 1996 (U.S. Department of Agriculture, Forest Service 1996). The decision was a modification of the Proposed Action alternative made to reduce harvest actions within the roadless areas and to improve the economic efficiency of the commercial timber harvests. The decision contained a comprehensive watershed and fisheries restoration program that included permanent road closures, road drainage improvements, and erosion prevention measures to reduce sediment; improvements for three trailheads; and the following vegetation treatments:

Precommercial thinning	1,160 acres
Commercial thinning	180 acres
Shelterwood harvest	20 acres
Sanitation/Salvage harvest	715 acres
Group Selection harvest	200 acres
Understory burning	4,615 acres
Whitebark pine burning	850 acres

The Friends of the Bitterroot, The Ecology Center, Alliance for the Wild Rockies, and American Wildlands filed appeals to the decision. The Regional Deciding Officer affirmed the decision. To date, a timber sale implementing the harvesting activities has been sold; understory burning has been accomplished on 2,879 acres; whitebark pine burning has occurred on 50 acres; and pre-commercial thinning has been completed on 117 acres.

Applications of SIMPPLLE

One of the models used in the Stevensville West Central analysis was SIMPPLLE, a stochastic simulation model that projects changes in vegetation over time and space by using a vegetative state/pathway approach (Chew 1995). A vegetative state is defined by dominant tree species, size class/structure, and density. These states are grouped by an ecological stratification of habitat type groups (Pfister and others 1977). Change between vegetative states is a function of disturbance processes. The probability of a process occurring in a given plant community is determined by both attributes of the state it is in and the vegetative pattern as identified by its neighboring communities in a unique landscape. The probabilities determined for each plant community in a landscape are used in a classical Monte Carlo method to simulate the location and timing of process occurrence. Once a disturbance process occurs for a plant community, logic is used to model its spread to neighboring plant communities. The application of SIMPPLLE in the Stevensville West Central area included the processes of western spruce budworm and mountain pine beetle in both lodgepole pine (*Pinus contorta*) and ponderosa pine (*Pinus ponderosa*), root disease, and three intensities of wildfire: light severity fire, mixed severity fire, and stand replacing fire.

The first application of SIMPPLLE in the Stevensville West Central analysis was to assist in quantifying the range of variability in processes and vegetative conditions. Multiple stochastic simulations with and without fire suppression, but with no management treatments, provided the basis for identifying averages and ranges in processes and vegetative conditions. Eight simulations were made with no fire suppression, and 30 simulations were made with fire suppression. The difference in number of solutions reflects differing estimates of the number of runs needed to quantify range of variability.

There are various ways to present and compare the results from these simulations to assist in quantifying the concept of range of variability. Figure 2 is a line plot of stand replacing fire. The output from the eight, five-decade simulations can be used to identify the range of occurrence for this process. However, a longer simulation for ten decades shows a possible different range of variation. In using SIMPPLLE, one has to consider the question of what time span is sufficiently long to address the concept of range of variability. Figure 3 displays the process of light western spruce budworm taken from the same eight simulations. There is less variability in this process, but a more definitive upward trend through about 7 decades in the future.

To evaluate the effect of fire suppression on this landscape, the average amounts of disturbance per decade for the processes were compared between the simulations with and without fire suppression. As expected, the average number of disturbed acres for the fire processes is notably higher without fire suppression (fig. 4). For acres disturbed by the insect and disease processes, the cumulative levels are compared. In contrast, the occurrence of insect and disease processes was higher in the simulations with fire suppression (fig. 5).

In addition to processes, the attributes of species, size-class/structure and density can be compared. Figure 6 compares the distribution of existing stand structure classes

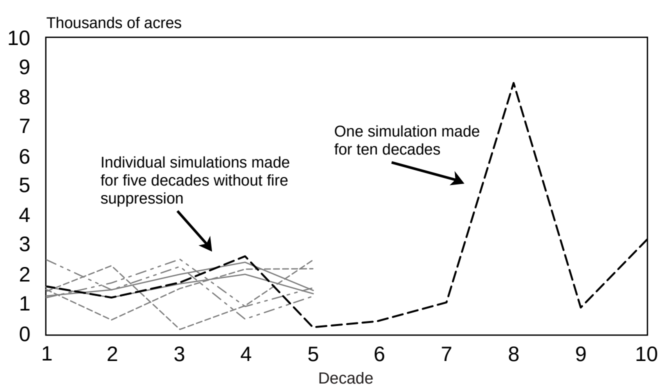


Figure 2—Acres of stand-replacing fire predicted in eight simulations with SIMPPLLE assuming no fire suppression and no management treatments.

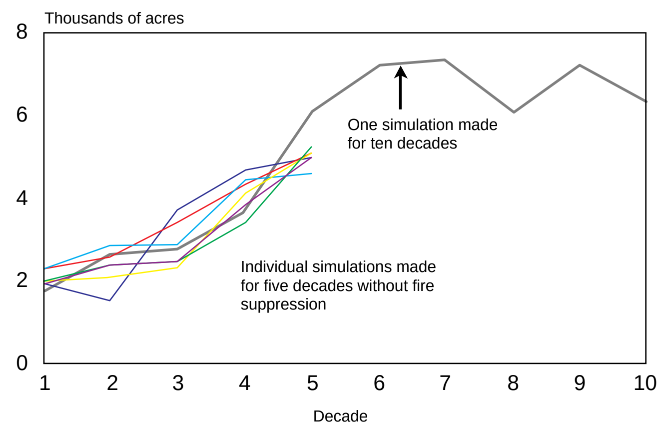


Figure 3—Acres of light infestations of western spruce budworm predicted in eight simultions with SIMPPLLE assuming no fire suppression and no management treatments.

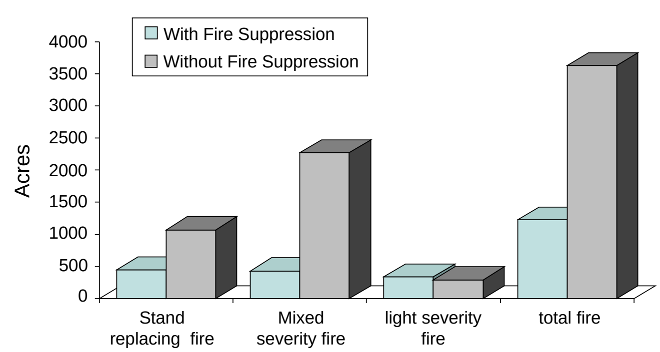


Figure 4—Average acres of disturbance per decade from SIMPPLLE simulations for "no action" with and without fire suppression for three fire intensities.

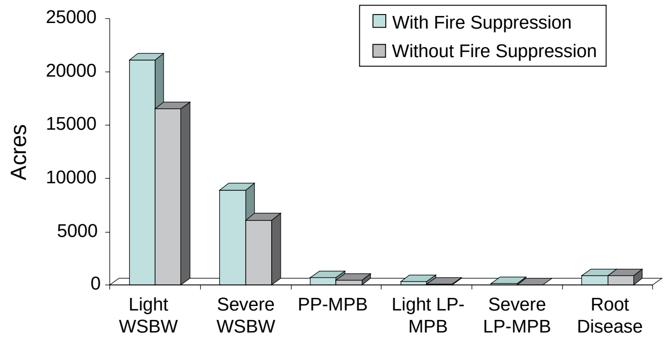
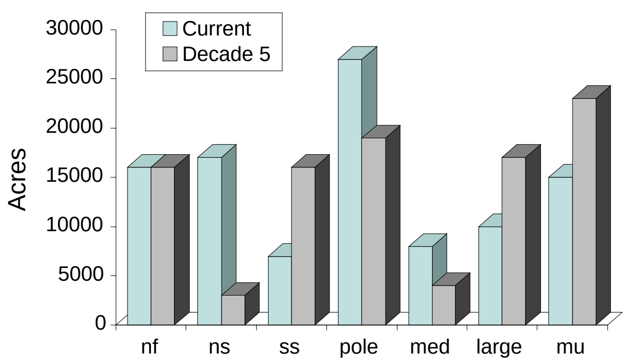


Figure 5—Cumulative acres of disturbance over five decades from SIMPPLLE simulations for "no action" with and without fire suppression for light western spruce budworm (light WSBW), severe western spruce budworm (severe WSBW), mountain pine beetle in ponderosa pine (PP-MPB), light mountain pine beetle in lodgepole pine (light LP-MPB), severe mountain pine beetle in lodgepole pine (severe LP-MBP), and root disease.



nf = nonforest
ns = non stocked
ss = seedlings & saplings
pole = 5" - 8.9"
med = 9" - 14.9" dbh
large = 15" - 20.9" dbh
mu = multi-story

Figure 6—Distribution of existing stand structure classes compared with the distribution projected for the fifth decade from SIMPPLLE simulations with fire suppression but no management treatments.

with the distribution projected for the fifth decade as a result of only fire suppression and no other management activities. A significant percentage of the area is projected to move from the pole- and medium-size classes into the large- and multi-story-size classes. The increase in the multi-story class is of particular concern because of the increased probability for insect and disease processes associated with the shade tolerant species in the understory and because of the ladder fuels created by the understory species. The location of these multi-story stands, plus the location of the projected natural processes, can provide direction for designing treatment alternatives.

Once management alternatives were developed, SIMPPLLE was used to quantify possible amounts and locations of natural processes associated with those alternatives. Five simulations were made for each alternative that included the proposed treatments with fire suppression. Comparisons among the alternatives were made for the projected vegetation (species, stand structure, and density), and levels of disturbances processes. These projections can be presented as map displays showing spatial locations, as nonspatial frequencies for the disturbance processes, or compared numerically as acres disturbed, as in figure 7. The average level of occurrence of severe western spruce budworm for each alternative is compared to the range of variability from no management simulations (shown by the dots for each decade). The SIMPPLLE simulations display that the amount of severe western spruce budworm predicted for each of the alternatives exceeds the range of variability for the amount of budworm associated with no action and no fire suppression. The reason is these alternatives include fire suppression that prevents the fire processes from converting the high budworm hazard, multistory stands to other stand structures that are less susceptible to budworm.

Applications of MAGIS

MAGIS is a microcomputer-based spatial decision-support system. It is used for planning land management and transportation-related activities on a geographic and temporal basis in the presence of multiple and sometimes conflicting objectives (Zuuring and others 1995). MAGIS can be used in either optimization or simulation mode. In optimization mode, managers specify an objective to maximize or minimize and other objectives as constraints that must be achieved, and the solver selects the location and timing of activities that best meets these specifications and calculates the effects. In simulation mode, managers choose the location and timing of activities and use MAGIS to calculate the effects. Management Relationships within MAGIS are used to tabulate output quantities, acres with specified characteristics, and miles with specified characteristics, costs, and net revenues. Any of these can be calculated for an entire planning area or specific portions such as individual watersheds. Key Management Relationships developed in cooperation with District resource specialists were acres of hiding cover, acres of thermal cover,

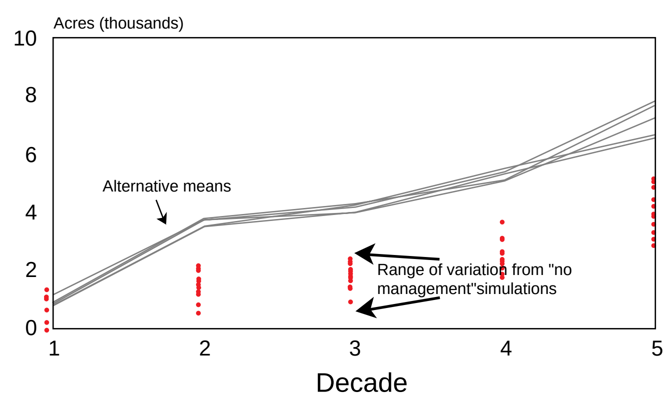


Figure 7—Average levels per decade of severe western spruce budworm from five SIMPPLLE simulations for each management alternative, compared with the dots showing the range of disturbance predicted for "no management."

a pine marten (*Martes americana*) habitat index, a pileated woodpecker (*Dryocopus pileatus*) habitat index, sediment yield, water yield, equivalent clear cut acres, and road impact factor. Ten year time periods were used.

In the plan for the Stevensville West Central study, MAGIS was to be applied in the process of developing the proposed action and management alternatives. Unfortunately, delays in completing the computer code prevented using MAGIS in this step of the analysis. As a result, the first application of MAGIS was to run it in simulation mode to compute the effects of the proposed action and each of the management alternatives developed by the interdisciplinary team. These effects were displayed numerically, as illustrated by the acres of hiding cover for the selected third order drainages presented in figure 8, and spatially, as illustrated by the big game habitat map displayed in figure 9.

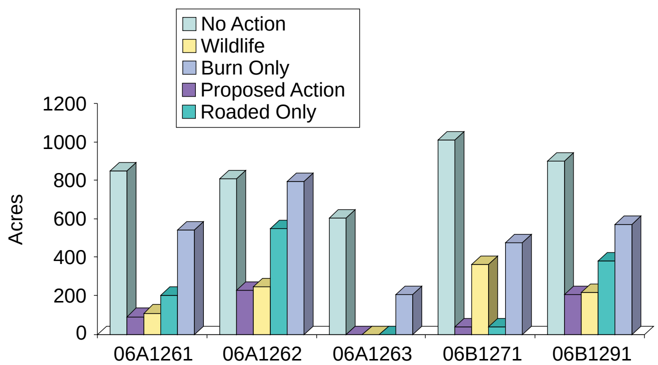


Figure 8—Acres of hiding cover by alternative for elected third order drainages calculated by MAGIS for the management alternatives.

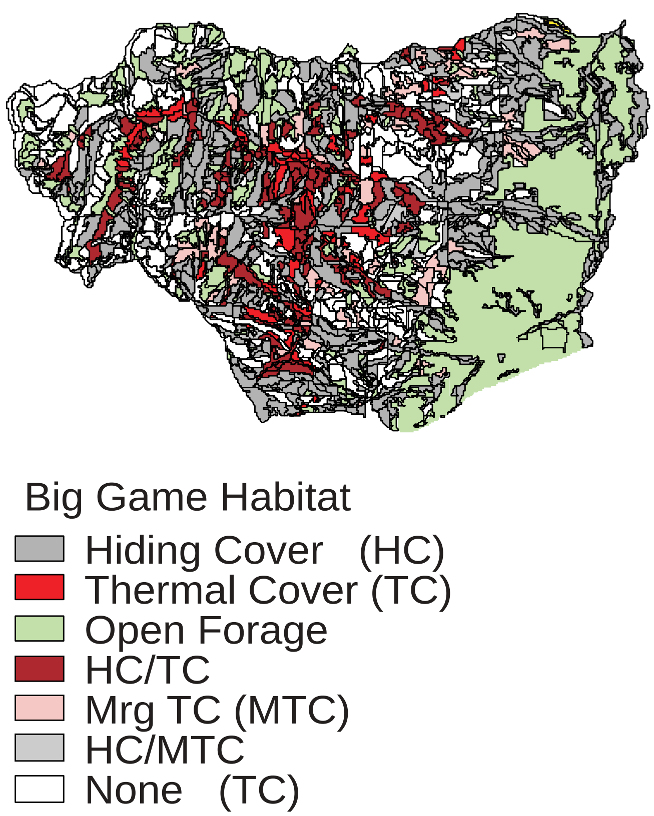


Figure 9—Location of various types o big game habitat computed by MAGIS for decade 1 of the “no action” alternative.

Later in the process, MAGIS was applied in optimization mode to determine if the model could develop one or more management scenarios that improve on the previously developed alternatives. Four additional management scenarios were developed with the following specifications:

10. MAGIS proposed action.
    - Maximize present net value.
    - Harvest volume ≤ proposed action.
    - Wildlife habitat indexes and acreages ≥ proposed action.
    - Watershed impacts ≤ proposed action.
    - Maintain the underburn and precommercial thinning treatments specified for the proposed action.
    - No new roads or even-aged management harvest treatments.

11. No Helicopter yarding.
    - Specifications same as 1, except no helicopter yarding.

12. Minimize risk index.
    - Specifications same as 1, except minimize a composite risk index based on the frequency and type of disturbance predicted for the individual stands in the “no action” simulations made using SIMPPLLE.
    - Two MAGIS solutions were used to develop this scenario; the first minimized the risk index, and the second maximized present net value while holding the risk index to the value achieved in the previous solution.

13. Modified minimize risk index.
    - Specifications same as 3, except allow even-aged management harvest treatments.

Figure 10 compares the treatments selected in the Proposed Action with those selected in each of the four MAGIS scenarios. In general, fewer acres would be harvested in the each of the MAGIS scenarios than the Proposed Action. The other noteworthy trend was that the Minimize Risk Index

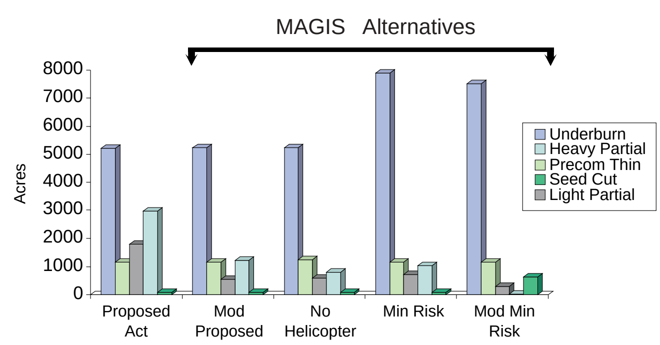


Figure 10—Acres by treatment type for the proposed action alternative compared with the scenarios developed using the MAGIS optimizer.

and Modified Minimize Risk Index scenarios would conduct underburning on approximately 2,000 more acres than the Proposed Action or the first two MAGIS scenarios.

The composite risk index multiplies the index assigned to a stand (from the SIMPPLLE simulations) times the stand acres and sums this product across all the stands. If a treatment is selected in a MAGIS scenario that addresses the risk for a stand, the post-treatment risk index is lowered accordingly. The composite risk index is approximately half that of "no action" for the Proposed Action, as well as the MAGIS Proposed Action and No Helicopter Yarding scenarios (fig. 11). The Minimize Risk Index and Modified Minimize Risk Index scenarios further brought the index value down to approximately 15 percent of "no action."

Present net value was negative for the Proposed Action and each of the MAGIS scenarios, although the Modified Minimize Risk Index scenario did show a positive return after the first decade (fig. 12). These negative present net values, or net costs, are due to the emphasis on ecosystem restoration. The MAGIS Proposed Action and No Helicopter Yarding scenarios had net costs approximately half those computed for the Proposed Action, while the net cost of the Minimize Risk Index scenario approximated the Proposed Action.

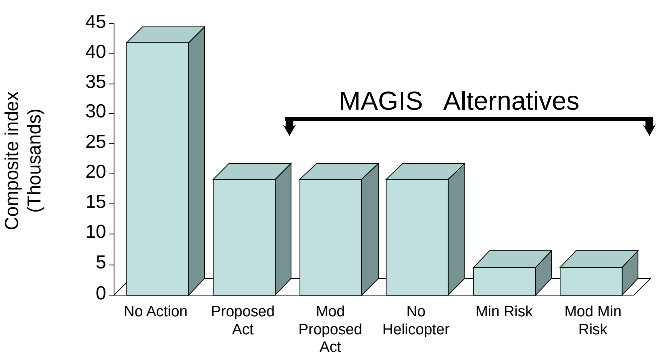


Figure 11—Risk index values for the "no action" and proposed action alternatives compared with the scenarios developed using the MAGIS optimizer.

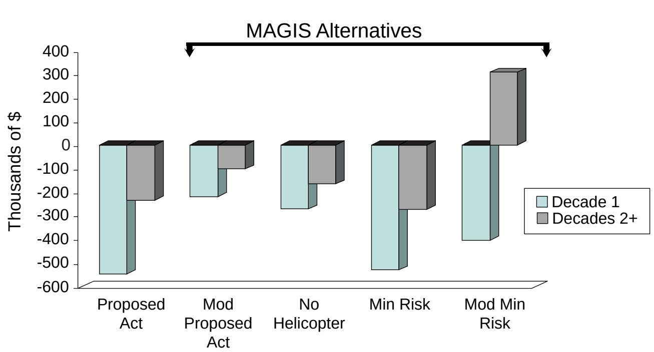


Figure 12—Present net value for the proposed action alternative compared with the scenarios developed using the MAGIS optimizer.

Discussion

Overall, the interdisciplinary team that developed the Stevensville West Central plan found SIMPPLLE to be a useful model for tracking and analyzing lots of spatial data and processes at one time. It provides the big picture of the interaction of natural processes working on a landscape over time and produces maps of landscape patterns over time. Past processes and adjacent processes and conditions are considered; it includes specific pest hazards, and it identifies problem areas. The processes involved in the model can be modified to reflect local conditions and knowledge. Data needs are simple and basic and are likely inexpensive. In addition, it provides a good public involvement tool to display various conditions and the effects of different management alternatives on the processes present on a landscape. The user interface/window system is easy to use and is being constantly improved.

Members of the interdisciplinary team identified several problems with regard to the fire and insect modeling included in the application of SIMPPLLE on Stevensville West Central area. Several members felt that the fire occurrence and intensity predicted for future decades was probably high in some instances, and the fire probabilities were higher than the fire occurrence data for large stands. They also believed adjustments were needed because the amount of mountain pine beetle activity predicted was probably low in mixed conifer stands, and the mortality of pole-sized trees is probably low during an epidemic.

Other problems were associated with data. Out-of-date stand data, a common condition, needs to be updated prior to modeling use. Also, stand exam data were not available for all stands, particularly those in the higher elevations and in the designated Wilderness. Data for these stands were based on air photo interpretation. In particular, this presented a problem in assigning these stands to a stand structure (size) class, which can be difficult to obtain from air photos.

Interdisciplinary team members expressed concerns that the current version of SIMPPLLE is polygon-based. That means that the logic for assigning processes is applied to the entire polygon. Either a polygon is assigned a process (the process is assumed to be present on the entire polygon) or it is not (the process is assumed to be totally absent from the polygon). It is likely that some processes operate on a scale smaller than an entire stand polygon.

Several system-related problems were also identified. Pathways and vegetation descriptions were not available at the time of the analysis, and the online help was not fully developed. SIMPPLE is currently only available on an IBM UNIX platform, while some would prefer a Windows version. Also, depending on the size of the IBM UNIX computer and use load placed on that machine, some significant computational time can be required to run SIMPPLE. The average time per time step (decade of analysis) in the Stevensville West Central analysis was five seconds, but this increases with number of polygons. For example, a model for another area containing 54,600 polygons required seven minutes per time step.

Many of the above problems have been addressed as of this writing. First, the fire process within SIMPPLLE has been redesigned to separate fire starts from the size or class of the fire. The fire probability data are designed to come from the National Fire Management Analysis System (NFMAS). Second, reprogramming key modules in SIMPPLLE has greatly increased its processing speed. Third, SIMPPLLE can now be run for either average or extreme fire conditions. Fourth, a raster-based version of SIMPPLLE is planned to address the potential problems of a polygon-based system.

The MAGIS model was used to predict water and sediment yield by watershed for the alternatives. This proved to be faster and more efficient than manually loading and running WATSED, a computer program commonly used in the Northern Region to compute watershed effects. The model also worked well for calculating equivalent clearcut area and road impact factors. A problem with the stand and compartment boundaries was they do not follow watershed boundaries, so stands had to be divided to stay consistent.

The model also calculated the wildlife effects for the alternatives including measures of big game habitat and indicator species habitat. This saved time and effort for the wildlife biologist's analysis. However, the lack of accurate stand data on snags and down woody material data hampered some of the wildlife effects calculations. This was particularly a problem when classifying stands as old growth, and the use of MAGIS to calculate old-growth acres had to be abandoned. Acceptable approximations were found for computing the other wildlife indicators.

The alternative eventually selected in the decision notice for the Stevensville West Central area was a modification of the original proposed action. The chosen alternative included some of the harvest treatments in the MAGIS Proposed Action scenario while others that were not selected in that MAGIS scenario were dropped.

The MAGIS Proposed Action scenario, as well as the other scenarios built via the MAGIS optimizer, could not be implemented in their entirety. The problem was that some unacceptable treatment and yarding options were included as candidate options for the polygons. Some of these unacceptable candidates were selected in the MAGIS scenarios. In future analyses, entering more precise rules for assigning the candidate options for the polygons could solve this problem. In particular, the assignment rules need to include cover type and ecology as criteria for selecting treatment options and need to integrate silvicultural logic to apply systems for specific habitats.

The use of MAGIS did result in time delays for completing the project analysis. As mentioned earlier, the cause of some of the delay was the program was not ready for production use when the analysis was begun. Some of the delay was caused by data preparation, a part of which was correcting and updating stand data. During the analysis, additional delays were caused by lack of communication regarding data needs. More modeling and computer applications help on the interdisciplinary team and closer communications with the research group would have helped the project stay within the NEPA schedule. Much of this was part of the learning process.

The vegetation projection method used in MAGIS was to apply growth rates to stand parameters: basal area per acre, volume per acre, average height, and average diameter. This caused several problems. First, these parameters were not available for all stands, and some had to be estimated by strata averaging methods. It became apparent in the latter stages of the analysis that not all members of the interdisciplinary team placed sufficient faith in these strata estimates. In particular, this was a problem in the MAGIS optimization scenarios, because the solver selected stands for harvest for which stratum averaging was used. This illustrates the importance of the interdisciplinary team having confidence in all the data and prediction methods.

Second, these projected stand parameters did not provide a good basis for predicting many of the wildlife effects associated with stands in the future. Information was lacking about the understory, down woody debris, and snags.

Third, this vegetation projection method differed from the vegetative state/pathway approach used by SIMPPLLE. As a result the two models provided somewhat different vegetation predictions.

Subsequent to this analysis, a vegetative state/pathway option for projecting vegetation has been added to MAGIS. This provides the advantage of using the same pathway relationships as SIMPPLLE, as well as the same stand information. Also, because vegetative states describe various aspects of vegetation, it is anticipated that this method will provide a better basis for predicting wildlife effects for future stands.

Recommendations for future applications include:

1. Applying MAGIS to landscapes where existing data are adequate, or allowing for time in the process for improving data to a level of acceptance by the interdisciplinary team.
2. Spending time at the beginning of the analysis for all team members to understand and agree on how the model will be applied.
3. Designating a member of the team the responsibility of running MAGIS in the analysis.
4. Using the vegetative state/pathway approach to minimize data requirements for projecting vegetation and enhance the potential for handling wildlife effects.
5. To the extent possible, minimizing data requirements for computing wildlife effects, by basing the effects calculations on vegetative states, as opposed to other stand attributes that must be supplied.

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