A TOOL FOR ASSESSING THE IMPACTS OF MOUNTAIN PINE BEETLE AND RELATED MANAGEMENT STRATEGIES

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ABSTRACT: The Forest Pest Management Methods Application Group of the U.S. Forest Service has developed an automated, menu-driven, Decision Support System that operates on Data General minicomputers and utilizes spatial data from a geographic information system, and information from tabular data bases, to run various resource simulation models. Developed to analyze and display the impacts of mountain pine beetle on resource values, this system has the potential for broad application in the analysis of impacts of most management practices on resource values.

INTRODUCTION

Natural Resource Management entails varied and complex problems which the resource manager must solve. Demands on resources come from many sources. These demands often involve an open and direct conflict of values. It is the unique job of the resource manager to evaluate and implement management strategies over time that protect long term resource values, while providing a mix of opportunities to meet resource demands.

Declining budgets and personnel ceilings complicate the job of the resource manager at a time when more informed publics and user groups are raising issues that require detailed analysis and assessment of cummulative effects. As more analysis and study are undertaken, additional constraints surface which require further evaluation and impose new considerations in the formulation of management alternatives.

Just when managers feel they have identified the best management strategy, along comes a destructive agent, such as mountain pine beetle, that affects resource conditions to the extent that management plans must be reevaluated.

Paper presented at the Symposium on the Management of Lodgepole Pine to Minimize Losses to the Mountain Pine Beetle, Kalispell, MT, July 12-14, 1988.

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Faced with budgetary and time constraints, and required by policy, Congress, and the courts to do a more thorough job of analysis, resource managers must become more efficient and timely in their ability to plan and execute management strategies that are responsive to changing resource conditions and changing public values.

One solution to the resource managers dilemma is better use of analytical capabilities and application of new and emerging technologies. There is a recently developed tool that can enable resource analysis to be completed more timely and efficiently and be displayed in a manner that will greatly aid the decisionmaker in choosing the best management alternative. This tool is a user friendly flexible system framework or shell that links a geographic information system and independent data bases with resource or impact models to estimate the effects of alternative courses of action. This system is known as INFORMS (Integrated Forest Resource Management System).

INFORMS displays the effects of a management activity on a resource value in tabular or graphic form. The structure of INFORMS is modular; this results in flexibility in application because only those models and data which are appropriate for a specific analysis are linked and used. The modular structure also allows model updates or models specific for a certain geographic location to be inserted without major programming changes to the basic INFORMS shell.

BACKGROUND

In 1984, the Nez Perce National Forest entered into a cooperative agreement with the Forest Pest Management Methods Application Group to develop and evaluate an automated decision dupport system to analyze the impacts of mountain pine beetle on resources on the Red River Ranger District. The primary role of the Forest in this project was to describe the current environmental analysis process, identify the resource models commonly used, and provide the spatial and tabular resource data needed for the analysis. Forest Pest Management's primary role was to provide the system design and programming expertise necessary to link the data bases and models together in a single, menu-driven system. In addition to FPM, several other groups cooperated in the development of INFORMS, including the Western Energy Land Use Team of the U.S. Fish

and Wildlife Service, and the University of Arizona. However, FPM has been the primary coordinator throughout the project. The Red River Ranger District is currently in their fifth year of the program and are in the process of writing a user's guide and written evaluation of the system.

In 1987, the Butte Ranger District of the Deerlodge National Forest was given the charter of testing the transferability of the INFORMS Decision Support System. The Butte Ranger District's responsibility is to test the transferability of INFORMS to another geographical location, refine existing resource models to fit their condition, and to test new models as they become available. The Butte District is evaluating the performance of INFORMS by using the system to develop an area analysis on 23,000 acres of National Forest. This analysis will prescribe management practices to be implemented within the analysis area over the next ten years. This analysis unit contains a Congressionally designated recreation area administered by City/County government, a municipal watershed, and a private inholding of 1,100 acres on which 45 families reside. The area is bordered by the interstate highway system and transected by a state highway system. There is an active infestation of mountain pine beetle that has moved into one corner of the analysis unit and is predicted to spread over most of the area. In addition, the analysis unit is in the background viewing area for the City of Butte. When INFORMS was under development on the Red River District of the Nez Perce National Forest, it was known as the Integrated Pest Management Assessment System (IPMAS). However, it became readily apparent that this decision support system had potential far beyond the original charter of assessing the impacts of mountain pine beetle on Forest resource values.

THE TOOL - INFORMS

The Integrated Forest Resource Management System (INFORMS) is a Decision Support System (DSS), aimed at improving the efficiency of resource data and simplifying the use of new technologies in natural resource management. INFORMS combines new and conventional information science technologies into an adaptable computer system environment or shell. Technologies such as advanced computers, spatial analysis functions, data bases (spatial and nonspatial), and simulation models are used.

INFORMS is written in FORTRAN 77 and runs on a Data General MV Series machine. In its present form the software is made up of four major system components (fig. 1). These are: Central Control Module, Model Library, Spatial and Non-spatial Components.

Central Control Module

The Central Control Module (CCM) is the primary component of INFORMS and operates as the logic engine of the system. CCM is the control panel of the user through which all components are linked. User requests are transformed into system commands to define the problem, perform analysis, and present results. The user interface to CCM is menu-driven, providing both text and high resolution graphic capabilities.

Model Library

The Model Library is a collection of programs (models) in files that simulate dynamics of various resources. These include:

PROGNOSIS - A stand growth and yield model that simulates the size and structure of Forest stands over time.

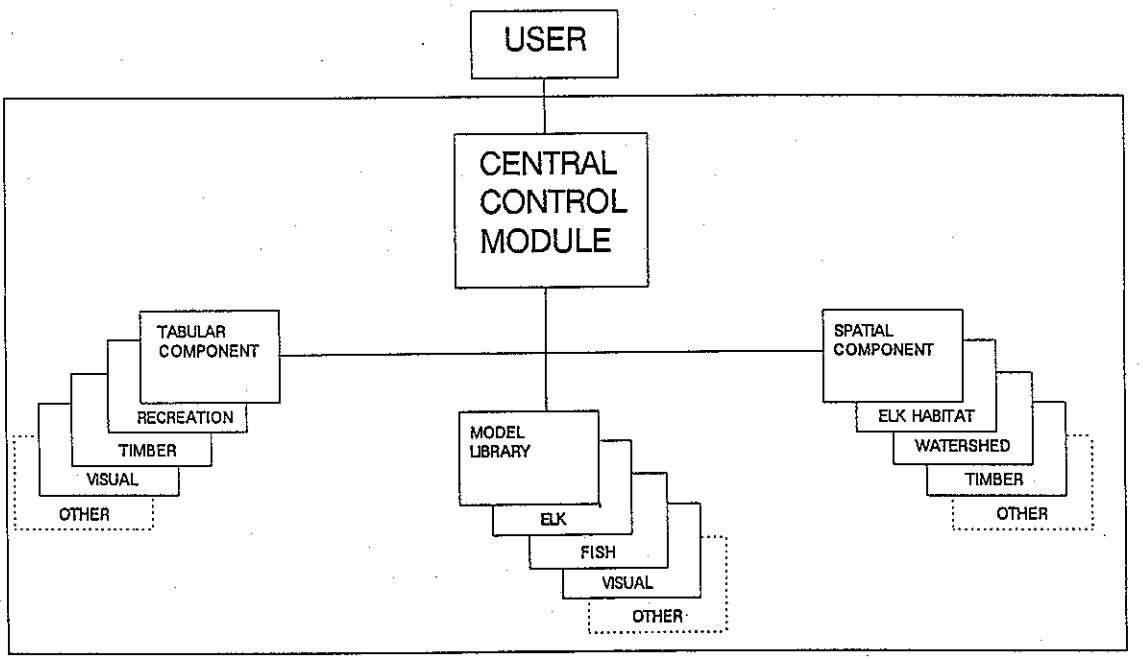

Figure 1.--Informs system diagram showing major components.

NEZSED - A sedimentation model that computes the amount of sediment delivered to critical stream reaches in response to fire occurence, logging, and road building.

FISH - A fisheries model that simulates the response of Brook and Cutthroat Trout to sediment loading in streams.

ELK - An elk dynamics model that identifies the effective security cover based on road use, and attributes of cover.

COVER - A cover model that simulates the growth and structure of wildlife cover over time.

CONTAGION - A dispersion model that projects the rate of spread and extent of mountain pine beetle caused damage.

DLOGPRICE - An econometric model that evaluates the viability of proposed timber sales.

VISUAL - A visual sensitivity model for evaluating aesthetic changes relative to management actions.

WATER YIELD - A water yield model that simulates water run-off in response to road building, logging, and fire occurance.

SBW HAZARD - An insect risk rating model that rates forest stand susceptibility to spruce budworm damage.

Spatial Component

This component contains the spatial functions for manipulating and displaying spatial data. These data are in the form of maps organized into various data themes, such as timber, watersheds, soil types, and roads. The number and type of themes are a function of the problem universal INFORMS is configured to solve. This map information is stored in the polygonal format utilized by the geographic information system - MOSS (Map Overlay and Statistical System). The spatial component also provides a direct link to MOSS so that the user may access the full functions of a general purpose GIS.

Nonspatial Component

Nongeographic data such as timber inventory data and economic data are retrieved from various data bases (local or remote) for input into the various models.

INFORMS resides on the U. S. Forest Service Data General minicomputer on site at the Butte Ranger District, Deerlodge National Forest, Butte, Montana. A high resolution graphics terminal is needed to take advantage of all INFORMS functions. Though not absolutely necessary, all the individual components of INFORMS are on the same computer.

APPLICATION

INFORMS aids the resource manager in the decisionmaking process on the timing, extent, and type of management strategies to be employed to minimize the loss from mortality associated with mountain pine beetle outbreaks.

Predictive Model

INFORMS embodies a predictive model (contagion) that uses stand data to project the rate of spread and the extent of mountain pine beetle damage. Resource managers can use this information to prioritize which analysis units should be analyzed first to prioritize when and where harvest activity should take place.

Scoping

Scoping is the process used to determine the extent of analysis necessary for an informed decision on any proposed activity.

INFORMS aids the scoping process by providing good displays of available resource information; maps of allocation areas, graphs and tabular data on present resource values, and maps and tabular data on predictive models. This professionally displayed information is very useful in informing publics of proposed activities, what resource values are present, and what course of action the mountain pine beetle is expected to take.

Having good information on the resource values within an area to be analyzed and being able to professionally display this information internally, with other agencies, and with interested publics, materially aids in the quality of the scoping process, and reduces the time required to complete this aspect of the process. Many potential or emerging issues can be defused.

Data Collection

Based on the issues and concerns, resource response or impact models are selected for use in the analysis. Model selection determines the amount and kind of data needed to conduct the analysis. Models indicate when data required is not in place and needs to be collected to complete the analysis.

Alternative Development

Alternatives can be developed on the terminal screen over any data theme or combination of data themes that may be useful in developing an alternative.

For example, you may wish to develop an alternative with the following criteria to address an issue or combination of issues: 1) harvest will only take place in Management Area E1, 2) harvest will be restricted to tractor logging, 3) harvest will only take place in stands of high risk lodgepole pine, and 4) areas of critical elk security cover will be avoided by a two sight distance.

To develop this alternative on the terminal with INFORMS to meet the above criteria, we would do the following: 1) call up the management area theme and shade all management areas except E1, 2) call up the digital elevation (contour) theme

and shade all slopes over 40 percent, 3) call up the lodgepole risk theme and shade all areas but high risk lodgepole, and 4) call up the elk cover theme and shade areas of critical elk security including a two sight distance buffer. The remaining unshaded area is ground meeting the criteria for harvest on which this alternative can be developed.

The next step would be to overlay the existing and proposed road systems from the transportation theme. Other themes may be employed, such as soils, etc., if there is a concern or a need for their use in the development of an alternative. Once an alternative is developed on the terminal, you may wish to run it through the visual model if there are concerns on how it will appear from a given location. Modifications are easy to make and run back through the model. Other data, such as volume, acreage, etc., are easy to generate. Using INFORMS, a wide range of alternatives can be developed that are specific to criteria designed to address issues and concerns.

Estimating Effects

Based on the issues and concerns identified in the scoping process, selected resource response or impact models are used for each alternative to display the effects on a particular resource by the alternative being evaluated. The effects of an alternative on a resource are displayed in map or graphic and tabular form.

Evaluating Alternatives

Quantified graphic and tabular display of the effects of an alternative on a resource value that may be an issue or concern makes the job of the Interdisciplinary Team who must recommend an alternative a lot easier. Alternatives can easily be compared for their effect on a particular resource value. This in turn simplifies the job of weighing the benefits and impacts of the alternative being evaluated.

Identification of Preferred Alternatives

INFORMS aids the line officer or resource manager in the selection process by providing data on the effects of each alternative on resource values in map or graphic and tabular form that is displayed in common format.

The data displayed are generated by a common process that is repeatable, and information used to generate the data is of the same quality standards.

The deciding official can play "what if" if not completely satisfied with a recommended alternative and modify or refine an alternative and see what changes in effects on resource values are caused by the modification. Also, if an issue arises that is not addressed by an alternative, it is easy to develop a new alternative that addresses that issue. The data on effects make the process of documenting the rationale for a decision in a Decision Notice much easier.

Monitoring

INFORMS aids the resource manager in monitoring of a project because the process used to estimate effects is repeatable and the intermediate steps are visible and documented. If monitoring shows predicted effects are off from what is actually experienced, then the parameters of the model can be changed to more accurately reflect actual response.

SUMMARY

INFORMS can be used to help resolve complex natural resource problems more easily and efficiently, without requiring resource managers to become tool experts. By integrating models that simulate ecosystem interactions, managers were able to gain a better understanding of the interrelationships of the resources. With the increased speed and repeatability of INFORMS, managers "fine tuned" their decisionmaking. Designed primarily as an integrating shell, INFORMS assumes technology will continue to evolve, and allows for adaptation - an important feature.

REFERENCE

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