An Internet-based decision support tool for non-industrial private forest landowners

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Received 2 March 2005; received in revised form 12 December 2005; accepted 21 August 2006
Available online 12 February 2007

Abstract

Landowners need a simple-to-use, readily available tool to contribute to sustainable management of family forests. We developed an Internet-based decision-support system, 4S Tool (Forest Stand Software Support System), which is designed to encourage informed forest management and to bridge the gap between a new generation of family forest owners (e.g., exurbanites) and natural resources professionals. We describe the technical and educational components of the 4S Tool and present several considerations for application to other geographic regions. The tool requires users to provide information on the species group, typical tree size, and density of trees in their forest. Users also select a forest management technique to apply to their “virtual forest.” The tool then estimates forest dynamics and wildlife habitat availability for up to 40 years into the future. The output provides projected changes in commercial timber, as well as changes in the diversity of berries, ferns, herbs, flowers, birds, and mammals as a consequence of the selected management option. Projected changes are based on primary and secondary data sources and modeled via the Forest Vegetation Simulator. 4S Tool provides a means of enhancing landowner awareness of options associated with management of forest property and provides users with access to additional resources and natural resource professionals to aid in future forest planning efforts.

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Keywords: Decision support; Family forest owners; Forest management; Internet-based modeling

1. Introduction

More than 10 million owners of family forests collectively account for nearly 50 percent of forestland in the United States and exhibit a wide array of values, attitudes, expectations, and behaviors pertinent to their ownerships (Butler and Leatherberry, 2004). Family forests produce considerable timber volume (Stier et al., 1999), offer many recreational opportunities (Wright and Fesenmaier, 1988), and provide invaluable ecosystem services (Wilcove et al., 2004). Despite their economic, social, and ecological importance, there are numerous threats to private forests, including an overall lack of interest in private forests from the general public (Best and Wayburn, 2001). Engagement of family forest landowners in conservation can take numerous forms, including enrollment in voluntary federal or state programs, participation in non-governmental programs, and development of a management plan. Although natural resources professionals consider forest management planning critical for forest conservation, this approach does not necessarily resonate with landowners; only 3% possess a written management plan and 16% have sought management advice from professionals (Butler and Leatherberry, 2004). Expanding the toolbox for private forest conservation to include new means of engaging diverse landowners is needed to attain sustainable management of private...
forests (Best and Wayburn, 2001; Cloughesy, 1997; Jackson et al., 2004; Kendra and Hull, 2005; Kilgore, 2004).

Due to population growth and the increasing feasibility of holding professional jobs while residing in rural areas, individuals and families are migrating from cities to rural environments in search of an improved quality of life (Egan and Luloff, 2000). This phenomenon, termed exurbanization or population deconcentration, is rapidly changing the social (Salamon, 2003) and physical (Theobald, 2005) fabric of the rural landscape. Exurbanites, those individuals who have moved from more urban areas to transitioning rural areas, often differ from traditional rural residents with respect to their attitudes, expectations, and values (Egan and Luloff, 2000). Generally, they place a higher value on landscape aesthetics, whereas traditional residents may demonstrate a more utilitarian view of the resource. In addition to the differences between new and traditional rural residents, there is enormous diversity among exurbanites. For example, in their study of new forest owners in Virginia, Kendra and Hull (2005) described six distinct classes of forest owners, based on ownership and socio-economic characteristics as well as management attitudes and intentions: (1) absentee investors; (2) professionals; (3) preservationists; (4) farmers; (5) forest planners; and (6) young families.

The increased diversity of attitudes and intentions of family forest owners results in altered constituent expectations for professional natural resources agencies and organizations. The nature of activities in which these professionals engage has evolved as a consequence. Hull et al. (2004) described how management prescriptions written by professional foresters have shifted in focus from timber production to aesthetics, largely due to a de-emphasis on profit from timber production and corresponding increase in importance of amenity values.

Given the importance of private forests, the magnitude of management activity in the absence of professional advice, and the increasing diversity of family forest owners, there is a growing need for simple-to-use, readily-available tools to aid in sustainable forest management. High transaction costs make it difficult for public foresters to continue to serve the increasing numbers of family forest owners via the traditional, one-on-one, expert-client approach. Nonetheless, it is essential that natural resource professionals continue to serve individuals who own smaller forest plots, despite the increased time and effort required (Bliss, 1999). Thus, novel approaches are necessary to overcome the transaction costs and engage these landowners in forest management. In response to this need, recent emphasis has been placed on delivering software to assist landowners, natural resource managers, and planners with forest management (Cloughesy, 1997; Jackson et al., 2004). In particular, the Internet may serve as a conduit through which to engage populations of landowners (e.g. absentee landowners) who currently are not involved in traditional consultation with natural resources professionals (Jackson et al., 2004).

According to a survey of landowners in north-central Indiana, 18% of forest landowners accessed the Internet for information regarding forest management (Ross-Davis, unpublished data) and almost all (89%) who accessed the Internet reported that it was a useful source of information.

A good description of the decision-support systems (DSS) in forestry as well as a presentation of some well-known approaches was recently published by Reynolds (2005). Probably the most frequently used decision-support system (DSS) in forestry is the Forest Vegetation Simulator (FVS), developed by the USDA Forest Service (Dixon, 2003). FVS is a growth and yield modeling system and often is used by government agencies and professional forest managers. Many software extensions permit the analysis of related processes, such as the risks of wildfires, insects, and economic analysis. The FVS learning curve and initial data requirements remain daunting for the majority of non-professional users, despite progress in developing the graphical interface, such as SupPose (Crookston, 1997), and post-processing tools, such as Stand Visualization System (SVSTM) (McGaughey, 1997) and EnVision (USDA Forest Service, 2004a) that greatly improved data manipulation and visualization. FVS is available for free download but can not be used over the Internet and must be installed on one’s computer; some pre-processing and post-processing tools have to be installed separately, which may be an additional hindrance. FVS can also be used by other applications as a stand growth engine, e.g. the Landscape Management System (McCarter et al., 1998; LMS, 2006).

Similarly, the Northeast Decision Model (NED, see Nute et al., 2003), available at http://www.fs.fed.us/ne/burlington/ned/product.htm, is a system of models for complex forest ecosystem management planning developed for the New England region of the USA. In NED, the user can designate several goals, including planning for aesthetic values (Alban et al., 1996). NED has an open architecture, making it easy to include new tools to the system without revising the whole structure; some components can be used as stand-alone applications. The NED can be run in a basic computer environment and is available for free download, but doing that can be challenging for users due to reliance on a comprehensive dataset for which input parameters may not be readily available.

The functionality of these models is complemented by stand-alone forest visualization tools, such as LMS and SVSTM (McGaughey, 1997). A region-specific, three-dimensional forest visualization tool that combines both photography and digital image processing is described by Stoltman et al. (2004). The software, developed for use in Wisconsin, uses Forest Inventory and Analysis (FIA) data and images of trees, forests, and management practices to allow the user to visualize a variety of management decisions at stand and landscape levels. DSD Dubroba is a tool designed to aid professional consultants in analyzing stand conditions, determining forest management objectives, and evaluating management alternatives based on long-term considerations for small forestland parcels in Austria Lexer et al. (2005).

As opposed to the software developed for professional use, a number of educational and decision support software geared specifically toward private forest owners is now available over the internet. One example of an educational tool is the National Web-Based Learning Center for Private Forest and
Range Landowners (Jackson et al., 2004) which allows users to engage in interactive educational processes related to land management. The Timberland Decision Support System (TDSS), developed by the Texas Forest Service, USA (Texas Forest Service, 2005), is an example of a DSS specifically oriented to private landowners. The tool can be run via the Internet and requires few input parameters. However, the scope of application is limited to commercial values, lessening its utility for landowners interested in other forest property attributes. A decision support system specifically designed to help private landowners residing in Florida in selecting tree species according to their management goals, SEADSS was suggested by Ellis et al. (2005). In SEADSS, the users select the location of their managed property using an online GIS interface and then query the SQL database. SEADSS then uses the stored spatially distributed data to return tree and shrub species that are bioclimatically suitable for the selected location and suit the users’ management goals. Private Woodland Planner (Enfor Consultants, 2005) is an example of software available to small private landowners interested in forest financial analysis. Similarly, extension professionals, in cooperation with Master Woodland Manager volunteers in Oregon, USA, have developed a series of three tools for private forest owners (i.e. TIMBER, ALLTREE, and TREEFARM) that accommodate various input parameters and generate estimates of volume and growth of timber stands and provide an economic analysis of forestry investments (Cloughesy, 1997).

While each of these DSS tools serves to assist forest owners and managers with a particular aspect of forest management, few online tools are designed for family forest landowners to consider multiple forest attributes in a user-friendly environment. An alternative approach to the tools described above is the Forestry Decision Tool for Non-industrial Private Landowners (Larson, 2004) which serves as the prototype for simulating stand dynamics described in this article. The model is housed in a Microsoft Access database and uses forecasts of forest dynamics specific to Missouri to estimate changes in both commercial and non-commercial values, e.g. the possibilities for wild berry growth. The Forest Stand Software Support System 4S Tool, which we present in this paper, provides output information for commercial and several non-commercial values, and was specifically developed to overcome the learning complexity and problems with data availability and accessibility associated with the comprehensive forest dynamics software. It offers easy-to-follow content, is situation-specific for each user, and is delivered over the Internet. The tool projects forest composition (e.g. commercial timber and vegetation, such as ferns, berries, flowers, and culinary herbs) and wildlife habitat conditions for up to 40 years, in 10-year increments. We position this software as a web-based educational tool designed to encourage informed forest management, rather than a tool for developing an actual forest management plan, because we believe that starting with a fully functional tool would require an overwhelming amount of data and knowledge and thus could discourage potential users. Rather, 4S Tool serves as a bridge between a new generation of forest owners and professional forest management. Given the need for such a tool, we: (1) describe tool components, both technical and educational; (2) describe how to use the tool as showcased by screen captures from the tool; and (3) propose a framework for extending applications to other areas.

2. 4S Tool

4S Tool projects the consequences of select management practices using a simple model of forest dynamics. The model and its data originally were acquired for Indiana, USA and later for Missouri, USA (Fig. 1). To aid users in making informed decisions about forest management, the projections are complemented by considerable information, either embedded in the tool itself or linked through the tool. Below we discuss four major components of 4S Tool, following Power’s (2002) classification, namely the architecture, the models and analytical tools, the database, and graphical user interface (GUI).

2.1. 4S Tool architecture

The principal intention governing 4S Tool architecture was to provide fast, interactive and intuitive access to the model, simulation results, and knowledge base. Indeed, 4S Tool is intended for private landowners who have limited experience in forestry and with computer software; thus it was developed as an educational, Internet-based DSS that is easy to learn and use. Internet access provides fast and cost-effective content delivery. Users can gain access to the DSS through dialup connections using de facto standard browsers; moreover, users need not purchase software (the cost of which can be prohibitive, e.g. Geographic Information System-enabled tools), download large databases, or risk compromising the security of their personal computer by installing downloaded code. Another advantage of using Internet-based models is that the latest version of the software is immediately available to all users when uploaded.

An obvious weakness of Internet-based models is the need to reduce model execution time dramatically, preferably to a few seconds per model scenario, including data retrieving, model run, and content delivery. Obviously, calls must be fast and code relatively short. With these considerations in mind, we decided on a two-step computation of model results. First, we used FVS to pre-compute forest dynamics for a predetermined set of forest attributes typical for Indiana. The results were then uploaded to a MySQL™ database. When a user requests predicted forest change for a specific forest site, simple and fast Java scripts are executed on the server side using the pre-processed data extracted from the database. A general outline of data flow in 4S Tool is shown in Fig. 2.

2.2. The models

During a model run, the user formulates a scenario by characterizing their forest and choosing a forest management scenario. The selected options are then used as input model parameters on the server side to predict likely forest-type
Fig. 1. Typical landscapes of two regions where 4S Tool has been applied. Dark color corresponds to forest.

### Technical Component

**Input Parameters**
- Forest type
- Tree size
- Tree density

**Management Scenarios**
- No Treatment
- Release Cut
- Commercial Harvest

**Output Parameters**
- Commercial Timber
- Berries
- Ferns
- Herbs
- Flowers
- Birds
- Mammals

### Educational Component

- Professional contacts
- Useful links
- Information on forest ecology & management
- Explanation of release cut & commercial harvest
- Trends in Indiana’s forest
- Forest attribute description
- How to manage for wildlife
- …commercial timber
- …game species

Fig. 2. 4S Tool scheme.
change for 40 years at 10-year intervals. Predictions of forest change in turn serve to estimate the change in commercial and non-commercial attributes. Finally, the simulation results are provided to the user.

To predict forest changes, we chose a simple definition of forest type for use by a landowner. Forest class \( t_i \) is defined by the dominant tree species group \( m \), the dominant tree size \( s \), and tree density \( d \): \( t_i = (m, s, d) \). For example, for Indiana we selected six dominant species groups: oak (Quercus spp.), hickory (Carya spp.), maple (Acer spp.), ash (Fraxinus spp.), black cherry (Prunus serotina), and black walnut (Juglans nigra). All other dominant species groups were combined into the group “other dominant hardwoods.” If no species dominated (i.e. no species comprised more than 40% of stand basal area), the stand was categorized as a “mixed forest.” To simplify the process of selecting forest type, we defined tree size categories as small (<15 cm diameter at breast height (DBH)), medium (15–30 cm DBH), and large (>30 cm DBH). Similarly, we defined three tree density categories as low (<400 trees/ha), medium (400–1200 trees/ha), and high (>1200 trees/ha\(^1\)). These definitions are accompanied by non-technical descriptions and photographs to aid the user in making the most appropriate selection (Figs. 3 and 4).

The combination of eight species groups, three tree sizes, and three tree density categories yielded 72 possible forest classes in Indiana’s model. The relatively small number of combinations provides a landowner with the opportunity to easily select the combination that approximates the described forest class.

Given an initial forest class \( t_i(0) \), \( (i = 1, 72) \), we determined the probabilities for future forest classes as a product: \( \mathbf{P}^t = \mathbf{P}^0 \mathbf{A}^t \). Here, \( \mathbf{A}^t \) is a transient probability matrix with an element \( a_{ij} \) representing the probability of transition from forest class \( i \) to forest class \( j \) within \( t \) years given management technique \( \mu \) applied in the initial year. The components of vector \( \mathbf{P}^0 \) represent the probabilities of different forest classes at decade \( t \). The initial probability vector \( \mathbf{P}^0 \) has all the components equal to 0, except for the component \( i \), which equals 1 (meaning that the initial forest class is defined exactly). The 12 transition probability matrices were defined for four time periods and three management techniques: no management, release cut, and commercial harvest. Although 72 possible transitions exist for each forest class and each model step, only a few of them actually have non-zero probability. When four or more transitions exhibit non-zero probabilities, only the three with the highest probabilities are presented to the user.

For each possible change in forest class we also assessed changes in one commercial and six non-commercial values, which we present as normalized indices. Commercial value (i.e. timber value) is the estimated potential for sawlog timber production, corrected for price fluctuations and species differences. Non-commercial values (i.e. non-timber values) include indices that estimate the change in diversity of vegetation cover (including herbs, berries, ferns, and flowers) and wildlife (including birds and mammals).

2.3. Database

2.3.1. Forest dynamics data

To support model simulations, we compiled a database containing the attributes of forest vegetation, soils, and wildlife in
the upper Wabash River basin of north-central Indiana using field data (n = 539 10 x 30 m plots) and FIA data (n = 143 plots; USDA Forest Service, 2004b). The FIA data are from a nationwide inventory of forests in the United States (Van Deusen et al., 1999). This database was incorporated into GIS and coupled with soil data from State Soil Geographic (STATSGO) (Natural Resources Conservation Service, 2004) to derive a site index layer to complement the field data. Based on this GIS, ArcFVS (Chivoiu, 2004) was used to generate input data for Suppose. We ran FVS simulations for all combinations of management practices and forest stand types for which data were available. In 4S Tool, release cut was defined as an understory thinning (i.e. thinning from below) until basal area was reduced to 12.5 m²/ha. Commercial harvest was implemented in the model as a diameter limit cut, with a minimum DBH of 90 cm for oak forest types and 50 cm DBH for the other forest types. FVS simulation output was further processed to classify each stand into one of the 72 species group-size-density combinations, for each time step and each management option, resulting in 824 pre-processed combinations of model parameters which were used in 4S Tool for predictions of future forest dynamics.

2.3.2. Commercial values

We generated indices to show the comparative change in forest commercial value by associating each possible forest class transition with a corresponding change in commercial value. All values were normalized from -1 to 1, such that 1 represents the maximum gain in commercial value, and 0 represents no change. Negative values correspond to decreasing commercial value. To compute the indices, we first estimated the average price of sawlog timber for each of the 72 forest classes, basing our estimate on the statistics for commercial timber price dynamics for the last two decades (Hoover and Preston, 2003). Average price for each of the trees simulated by FVS was found as a function of tree species and merchantable board volume. The calculated values for individual trees were combined, and the initial value was subtracted from the combined value for four simulated decades, giving commercial value gain. For each transition from forest class i to class j within t decades, the resulting commercial value gains were summarized and then divided by the corresponding number of transitions, producing the matrix of average price gain per decade for each forest class. Finally, the elements of the matrix were normalized. In total, the indices of change in commercial value were defined for four time periods and three management techniques.

2.3.3. Non-commercial values

Aside from commercial values, we also defined non-commercial forest values characterizing plant and wildlife diversity. For vegetation, we computed diversity indices for flowers, ferns, herbs, and berries. For wildlife, we computed diversity indices for mammals and birds. All the indices were normalized from 0 to 1. The user of the tool can view the difference between the initial and current index values for each time period, so that the displayed values are distributed between -1 and 1, similar to the commercial indices. A total of 248 forest herbaceous species were detected during field sampling. Of these species, 104 were selected as native species that were characteristic of forest ecosystems. Those species were further categorized into four classes of interest to landowners as showy flowers, edible herbs, ferns, and berry-producing plants.

A total of 32 species of mammals were detected, of which 20 were selected for inclusion in the model as native species that characterized forest ecosystems and occurred with enough frequency to permit analysis. Similarly, 47 of the 139 species of birds detected in the field were selected as native species that characterized forest ecosystems. Vegetation data were...
collected at all locations of wildlife surveys, enabling animal detection to be related to forest type. Using these data, we computed the following indices for vegetation and/or wildlife: Shannon diversity index (Shannon and Weaver, 1949), number of species, and relative area covered (the last index was used only for vegetation).

2.4. User interface

To deliver accessible and understandable information to private forest landowners requires the presentation of simplified information on complex forestry concepts such as basal area, forest density, succession and disturbance, as well as related topics such as wildlife management. For the more complex topics, written text and visual aids were used to describe these concepts (e.g., Fig. 5). As an example of use of visual aids, a non-technical description of the procedure to estimate basal area is accompanied by a graphic (Fig. 4) to assist landowners in determining the appropriate forest type. As an example of using written text to accompany technical definitions, to illustrate the tree density class definitions we used everyday examples to which users could relate: low density (you could drive a full-size pick-up truck through the forest without running into any trees), medium density (you could ride a mountain bike through it, but driving a truck through it would be difficult if not impossible), and high density (walking would be the only method of getting around, as truck driving and bike riding wouldn’t be possible).

Given the crude nature of the input data provided by landowners, as well as the inherent imprecision of this modeling approach, users are reminded that the tool simply provides a likely scenario of forest change. To communicate this uncertainty, we compare the output to a weather forecast. The presentation of the most likely predictions of forest change for 10, 20, 30, and 40 years (Fig. 6) also leads to educational information on forest change, wildlife diversity, commercial timber, and game species through hyperlinked content available by clicking on the prediction’s terms. For example, clicking on “birds” entry in the table will lead the used to explanation of wildlife diversity indices; clicking on the same term in the textual description of the output will lead to the web sites dedicated to information on wildlife and to pictures of typical for Indiana birds and mammals, used in the model.

4S Tool is intended to serve as a gateway between landowners and the plethora of resources and expert advice on forest management. Specifically, through useful links and contact

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**Step 2: What would you like to do with your forest?**

Please select your preferred management option. There are a variety of actions that you can take to achieve and maintain desired attributes of your forest. Again, we have provided you with three management options from which to choose. These three management options include: no treatment, release cut, and commercial harvest.

- No Treatment/Nothing
- Release Cut
- Commercial Harvest

**Release Cut**

4S Tool uses one variation of release cut – the thinning from below method. A thinning from below treatment reduces the density of trees in the forest by removing all trees below a certain diameter. This measure increases the availability of sunlight, water, and nutrients so that the remaining trees can grow faster. This is why it’s called release cut – it releases the remaining trees to grow. However, thinning from below can have negative ecological consequences as it can reduce the availability of habitat for many wildlife species. In addition to targeting size classes, a thinning from below treatment can also target particular species of trees for removal. This particular version of thinning from below can increase ecological and commercial viability, but requires consultation from a professional forester for proper implementation.

For example, Joe Jones owns 50 acres of oak-dominated forestland. He’d like to be able to harvest sawtimber in 20 years. However, Joe’s forest is currently overrun with undesirable species, including grapevines, bush honeysuckle, and autumn olive. These species can “take over” and hinder the growth of Joe’s oak trees, his potential sawtimber. The release cut is one option for eliminating such undesirable from his forest. By consulting with a professional forester, Joe will learn how to control these undesirables in his forest and identify lower-quality trees (from a timber perspective) whose removal would allow the higher-quality oaks to grow.

In our model, release cut is simulated as a treatment by which trees are harvested until the remaining basal area is 55 square feet per acre. The smallest trees are removed first and then increasingly larger trees are removed until the desired basal area is reached (this is called by foresters a Thinning From Below treatment). The treatment is applied in the first year of the simulated years time period.
information for natural resources professionals, the tool aims to increase users’ awareness of the professional assistance available to them. In the “useful links” page, informative websites are grouped according to major topics (i.e. forestry, wildlife, non-timber forest products, maps/publications/multi-media, tree identification and learning, government agencies, government assistance programs, and other groups and organizations) of interest to landowners. The tool opens with a reminder that such a web-based educational program cannot replace expert advice, but can facilitate communication with professionals. Throughout the tool, landowners are encouraged to seek consultation with natural resources professionals. By introducing users to the diversity of attributes for which their forests can be managed and the management techniques to achieve desired goals, and by using language that is common to natural resources professionals, 4S Tool serves to enhance communication between users and natural resources professionals.

2.5. Evaluation of 4S Tool

Due to limited availability of validation data, we could not check model performance against an independent dataset. Instead we used expert opinion acquired through surveys and a focus group to evaluate the tool. The model was built upon previously validated software products (see Section 2.1). Providing an explicit set of recommendations to potential users was not the primary goal of our efforts. Rather, we attempted to engage users in an active process of management while seeking professional advice. Thus, the emphasis in our model validation process was determining the success of 4S Tool in accomplishing its goals as assessed by experts.

Expert opinion was solicited at key stages during tool development. We conducted both an internal and external review of the tool. Internally, we used the expertise of the faculty and staff members of the Department of Forestry and Natural Resources at Purdue University to investigate the validity of information used and returned by the 4S Tool and to inquire on the tool’s integrity and visual appeal. First, a focus group was conducted; then, an invitation to participate in online testing of the prototype model was sent to a wider number of experts. Once the tool had been revised according to the recommendations received during the internal review, we contacted 75 natural resource professionals across Indiana requesting responses to particular questions with regard to the tool. The major concern expressed during this phase was about the users perceiving 4S Tool as a replacement for professional assistance. We received
other recommendations, such as strengthening the educational component of the tool, including additional management scenarios and changing the names of those currently provided to more accurately reflect the practice, providing more accurate outcomes and noting limitations of predictions, and improving the appeal of the tool by including photographs of practices and species of interest. Recommendations were evaluated and implemented accordingly; the original reviewers were invited to comment once again on the revised model available online at a temporary location.

3. Extending the model to other regions

While 4S Tool was originally developed for users in the state of Indiana, USA, our intention was to make the model available for other regions as well. Using the model structure, we have adapted the tool for Missouri, USA. Researchers and professionals who wish to adapt 4S Tool to other regions will need to consider three major issues: data requirements, model applicability, and the educational component.

3.1. Data requirements

Each forest region must be characterized using data specific to the conditions therein. In addition to forest stand data, knowing the values for which landowners may wish to manage their forest is important for model development, as these values affect model structure and data requirements. We have found that these values can differ over small geographic areas. For example, the commercial products available from forests differ between Indiana and Missouri, two states within the Central Hardwood Forest Region of the USA. Forest susceptibility to various factors, as well as the factors themselves, also differ between the regions. For example, in the Missouri application, an emphasis was made on demonstrating how forest management can affect susceptibility of the property to wildfires. This factor was not included in the Indiana tool, because wildfires are an uncommon disturbance factor in the fragmented forest landscapes typical of the state. Finally, forest management techniques also differ among regions. Some considerations include: the values for which landowners want to manage their forest, characteristics of the forest that drive changes in the output attributes of interest, and forest management techniques that are common to the region.

3.2. Data availability

Data availability will differ among regions in addition to data requirements. Availability of data characterizing the effects of forest management on various forest attributes in different types of forests is essential and will determine if certain effects can be included in the model, even if they are determined to be important from a landowner’s point of view (see Section 3.1). One possibility to overcome limited availability of empirical data is to use expert assessments to complement model-generated output. Another possibility is to use other models developed for the region for data pre-processing instead of the FVS modeling system used in 4S Tool.

3.3. Educational components

Finally, the decision to implement 4S Tool in other regions and the content and structure of the educational component of the tool will depend on the interests of the particular user groups. The background of the typical users, their major areas of interest, and the availability of resources pertaining to these interests are all important considerations. The familiarity of user groups with forest management will determine the level at which the information should be customized in the tool. The existing technical and financial resources available in the region also will affect the information included in the regionalized version of the tool. Some considerations include: identification of the user groups, the major areas of interest for the user groups, availability of resources pertaining to these interests, familiarity of the user groups with forest management, ability of user groups to provide requested input parameters, and the accompanying information necessary to help user groups estimate input parameters.

4. Results and discussion

The process of exurbanization over the past few decades has brought significant changes to the attitudes and values demonstrated by small forest landowners in the USA. The traditional domination of commercial values sought from privately owned forests is now accompanied by a wide diversity of services, including non-timber values, such as protection of biodiversity, aesthetic values, and stewardship. But not only the attitudes have changed, the types of communication channels used to effectively disseminate management information are also modified, with wider use and higher trust demonstrated towards the online information sources. Novel approaches based on the Internet technologies are required to assist with the management decisions of the 10.3 million family forest owners who own almost half of the 250 million ha of forestland in the USA.

Has the modeling community responded to the growing public demand for easy-to-use decision-support software? Indeed, a number of Internet sites offer convenient and simplified alternatives to professional forestry consultancy, providing software that could help compare different management actions. However, this software is heavily focused on traditional timber management goals and often does not consider non-timber forest values. The cumbersome or buggy installation process of some forest management software and steep learning curve required to use many other packages is an impediment in that a user must possess at least some prior professional knowledge to use such tools.

4S Tool is designed to encourage informed forest management by making expert information accessible to private landowners and by introducing users to forest management in an interactive environment. The tool aids in future forest-planning efforts by coupling predictions of forest change under
a given management scenario with links to additional resources and professionals and information pertaining to forest ecology. The open-source nature of the tool allows it to be adapted for use in any region where an increased awareness of forest management is warranted. We have already extended the model to Missouri from the initial Indiana site. However, any attempt to apply the modeling framework to other regions should carefully consider the ownership motivations of the intended users, educational resources that will aid with forest management, specific management scenarios appropriate for the given forest types that characterize the landscape of the region, and the data available for modeling forest change.

Our intention with 4S Tool is not to give users stand-alone model output to serve as a silvicultural prescription or a financial plan, but rather to add to the suite of tools currently available by facilitating information acquisition, learning, and stewardship. While we purposefully chose to use this format and distribution medium because it permits a user with limited knowledge in forestry or computer science to use the software effectively, we recognize the importance of professional consultation and encourage at numerous junctures in the tool users to seek professional assistance. We hope to provide landowners with an engaging opportunity to begin thinking about the planning possibilities for their forest with the help of professional foresters.

We employed two-phase review process to elicit feedback for improvement of 4S Tool. While many of the suggestions have been used to revise the current version, we are working to incorporate the more complex recommendations into a future release. These include making the tool spatially explicit and incorporating a risk assessment for forest insect damage. In doing so, we look forward to meeting the diverse and dynamic needs of tomorrow’s forest owners. Additional information and the current version of the tool are available at 4S Tool Internet site (4S Tool, 2005).

Acknowledgements

We thank Dave Larsen and Chad Larson of the University of Missouri for the generous permission to build on the framework of their forest dynamics model. This paper was supported with funds from the USDA CSREES Initiative for Future Agriculture and Food Systems.

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