Visual Simulations of Forest Wildlife Habitat Structure, Change, and Landscape Context in New England

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ABSTRACT

Visualization is a powerful tool for depicting projections of forest structure and landscape conditions, for communicating habitat management practices, and for providing a landscape context to private landowners and to those concerned with public land management. Recent advances in visualization technology, especially in graphics quality, ease of use, and relative ease of learning, make it readily usable by natural resource managers. Concerns about the appearance of even-aged practices, which have the greatest potential to enhance wildlife diversity, have constrained forest management. We developed realistic visual simulations to display the outcomes of forest management practices used to create and maintain a range of wildlife habitat conditions in New England, and to project future landscape appearance for periods up to 100 years. We describe the simulation process so that it can be used elsewhere. Realistic visual images can be a useful tool to clearly display habitat management alternatives for landowners and participants in public land management and to improve communication about the long-term appearance of the landscape as periodic treatments are applied.

Keywords: forest wildlife habitat, habitat change, landscape, visualization

Realistic visual simulations of forest treatment options have utility for communicating wildlife habitat management on public and private lands. Stoltman et al. (2004) developed a system of visual simulations to demonstrate current forest conditions and various stand management scenarios for use by natural resource managers in Wisconsin. Visualization technology can also be used to display habitat conditions used by certain wildlife species or to show how treatments will look on the landscape. We developed visual simulations of forest management treatments for enhancing or maintaining wildlife diversity in heavily forested northern New England and forested/agricultural/suburban southern New England. We projected how these landscapes will generally look after 100 years of continuous management to maintain wildlife diversity. Of course, other management options would yield different projections. We developed these visual simulations primarily to demonstrate effective forest management for private landowners, who own the vast majority of forestland in the region. Many such landowners highly value wildlife (Echelberger et al. 1991, Birch 1996) but do not manage their lands as habitat for a variety of reasons, including uncertainties about the appearance of treated sites (Askins 2001).

In the eastern United States, even-aged management provides habitat for more species over time than does uneven-aged management (e.g., Gullion 1984, DeGraaf and Yamasaki 2001). Throughout this region, most forests are mature, and the reversion of rural agricultural lands to forest is nearly complete (Brooks 2003). The most critical habitat issue in New England, and the northeastern United States in general, is the decline of early successional and young forest habitats (Thompson and DeGraaf 2001, Brooks 2003). Most disturbance-dependent specialist species are in decline throughout the region (e.g., Askins 1993, 2000, Litvaitis 1993). Even-aged silvicultural treatments are more effective than uneven-aged ones in reversing these trends (DeGraaf and Yamasaki 2003) but are generally opposed on public lands due to perceived unsightliness, forest fragmentation, or other reasons. Early successional forest conditions are ephemeral; even-aged treatments need to be applied every 10–15 years to keep such habitats present in the landscape. Visual simulations can enhance public understanding of the likely long-term appearance of a continuously managed forested landscape.

Visual simulations of forest conditions or stand structure have been developed that range from highly representative to highly realistic. Representative simulations (e.g., McGaughey 1998) help foresters, ecologists, and other professionals understand the results of various treatments or natural events. Such images are usually not intended for public display. We used realistic visual simulations to convey effects of management to nonspecialists: private landowners and citizens participating in the management of public land. Realistic images of alternative management options can encourage landowners to manage their properties by showing effects of treatment through time and by placing their ownerships in a larger landscape context, therefore helping them understand the role their property plays in providing wildlife habitats in the surrounding landscape. Likewise, citizens participating in the management of public forest lands can be better informed if both managers and the public share

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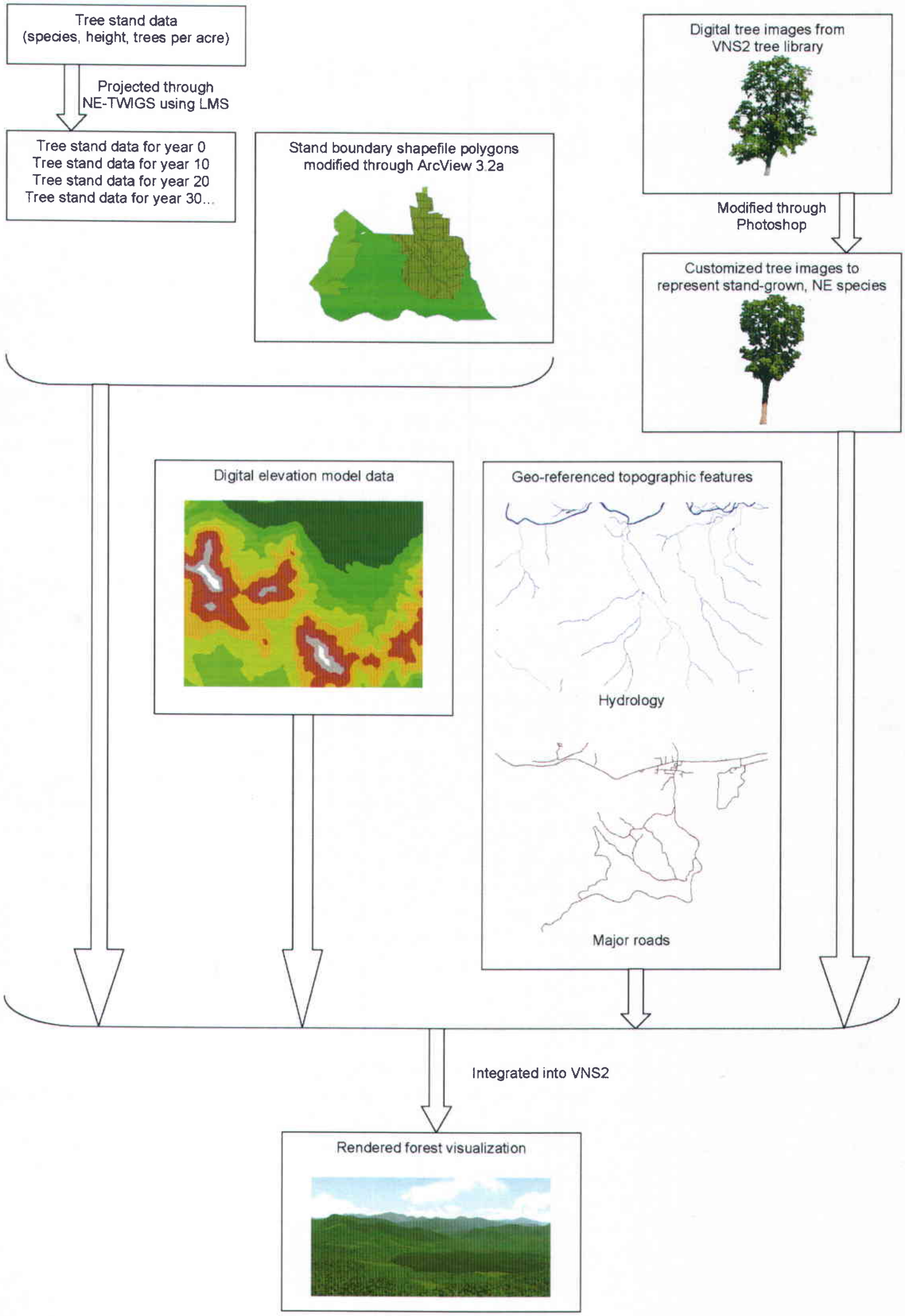

Figure 1. Type of data, software programs, and steps taken to create forest visualizations

a common understanding of the initial appearance of alternative treatments and how appearances are likely to change over time.

The appearance of a landscape plays a major role in how it is appreciated (Bell 2000). Visual simulations allow concerned parties from disparate backgrounds to evaluate proposed management in context and may improve communication about habitat options, for example, treatments needed to reverse the declines of early successional species. Visual simulations, therefore, can be extremely useful (1) in conveying information about vegetation management options and ecological relationships in a way that is easily understandable to people with different levels of knowledge and (2) in showing how a forest managed for a mix of successional stages, cover

Table 1. Links to program websites, information, or data sources used in creating the images and other useful sources.

Type of data	Website resources
Stand growth simulators	
NE-TWIGS	http://www.fs.fed.us/fmsc/fvs/variants/ne.php
Landscape Management System (LMS)	http://lms.cfr.washington.edu/lmsdownload.php
Forest Vegetation Simulator	
Digital elevation models	
GIS Data Depot, by the GeoCommunity	http://data.geocomm.com/dem/demdownload.html
Geo-referenced data layers	
GIS data fro Vermont	http://www.vcgi.org/
GIS data for New Hampshire	http://www.granit.sr.unh.edu/
GIS data for Maine	http://apollo.ogis.state.me.us/
GIS data for Massachusetts	http://www.state.ma.us/mgis/massgis.htm
GIS data for Connecticut	http://magic.lib.uconn.edu/
GIS data for Rhode Island	http://www.edc.uri.edu/rigis/
GIS links to all US states	http://www.columbia.edu/acis/eds/outside_data/stategis.html
GIS links for Canada	http://geodiscover.cgdi.ca
Software programs	
ArcView software by ESRI	http://www.esri.com/software/arcgis/arcview/index.html
Photoshop 5.0	http://www.adobe.com/products/photoshop/main.html
Visual Nature Studio 2 (VNS2) by 3DNature	http://www.3dnature.com/

types, and stand conditions to increase potential wildlife diversity will look in the future.

The key to producing high-quality visual simulations of forest wildlife habitat is to use software that creates stand and landscape images that landowners and managers can recognize and relate to their own experience. Over the last 10 to 15 years, several software programs have been developed to produce simulated forest images, including Integrated Forest Resource Management System (INFORMS) (White 1992), Forest Management Information System (FMIS) (Marshall et al. 1997), and the Stand Visualization System (McGaughey 1998). Although these simulators are all excellent quantitative tools in expressing stand growth and development under different silvicultural scenarios, the images are not as realistic as those produced by other commercially produced terrain-modeling software. LandForm, TruFlite for Windows, Virtual Forest, World Construction Set (WCS), and Visual Nature Studio (VNS) produce realistic images of forested landscapes by using digital photographs of trees and other objects (see Rowe [1997] for comparison of these software packages and respective references). Both WCS and VNS have the additional ability to integrate GIS data to produce visual simulations. Visualization technology creates three-dimensional color images that not only show location and structure of forest change but also place treatments in landscape context. When used with growth models, visualization also displays change through time as treated stands develop and others are cut. The result of these advances is the ability to integrate stand inventory data, GIS data layers, and growth models to create realistic images of various forest types and stand conditions.

Natural resource managers have only recently begun to use realistic visualization technology to display forest conditions, treatment options, and change over time for actual landscapes (Stoltman et al. 2004, DeGraaf et al. 2005). Simulating forest conditions using real tree composition and density, digital images of live trees, and terrain for specific locations produces realistic images that allow landowners to "see" how their lands are likely to look if they did no management or used uneven-aged silviculture or even-aged silviculture to manage their lands as wildlife habitat or for other forest commodities and amenities. Such images can communicate how projected forest management scenarios are likely to appear on the landscape and permit evaluation of their contributions to the mix of wildlife habitats present.

We simulated specific conditions for different landscape types because terrain, forest cover types, and land use patterns differ between northern New England, which is extensively forested, and southern New England, which has a mix of agriculture, forest, and suburban land uses. Our objective was to demonstrate an approach to visually simulate habitat management options and their effects on wildlife habitat distribution.

Methods

We created simulated forest images to represent two general forest cover types: (1) northern hardwood forests characteristic of northern New England, and (2) oak-pine forests commonly found in southern New England. The overall procedure we used to create the images involved a series of steps to integrate multiple sources of data with available software packages (Figure 1; Table 1). We obtained forest inventory data containing tree species composition, density, and dbh for multiple stands in the two regions. Simulated silvicultural treatments were applied, and stand data were then projected through a growth simulator to predict species composition, height, and density for each stand. The stand data were then integrated with elevational terrain data using a three-dimensional visualization system. Images were produced at two scales: stand scale (3–8 ha) and landscape scale (~800 ha). Finally, the images were placed in a time sequence at different intervals through a span of 100 years, and corresponding wildlife associations from DeGraaf and Yamasaki (2001) were made with the temporal projections of forest growth and prescribed silvicultural treatments that were applied.

Specifically, the first step in creating the images involved obtaining representative data for each forest type: northern hardwood–dominated stands in northern New England and oak-pine–dominated stands in southern New England. Stand data consisted of individual live tree (>5 in. dbh) records containing information on tree species, dbh in inches, and trees per acre. Both sets of data included spatial data with corresponding stand boundaries. For the northern New England region, we used data from New Hampshire provided by the US Forest Service. These included sample plots of stands dominated by northern hardwoods and stands dominated by softwoods and vegetation data from high-elevation stands (Table 2). For the northern New England landscape, each stand was approximately 8 ha in size. To optimize wildlife habitat values, we specified that one-fifth of the

Table 2. Tree heights and stocking densities representative of managed northern New England hardwood and softwood stands at time steps ranging from 5 years to 100 years.

	Stand age														
	Shelterwood			5 years			15 years			25 years			100 years		
Species	Max. height (m)	Min. height (m)	Trees per ha	Max. height (m)	Min. height (m)	Trees per ha	Max. height (m)	Min. height (m)	Trees per ha	Max. height (m)	Min. height (m)	Trees per ha	Max. height (m)	Min. height (m)	Trees per ha
Hardwood-dominated stands															
American breech				5	3	3020	9	6	1678	17	8	1387	22	9	940
Sugar maple				5	4	972	9	8	678	16	8	1597	23	9	356
Red maple				4	2	257	8	6	151	17	7	643	17	11	20
Yellow birch				4	2	1923	7	6	1350	15	7	668	19	13	60
Striped maple				4	2	1629	6	5	1481				16	7	169
White ash				3	2	339	7	5	220						
Paper birch				5	3	3551	9	6	3141	19	9	1154			
Quaking aspen				4	3	1367	8	6	846	19	7	986			
Pin cherry				4	2	3991	7	6	3759						
Red spruce				3	2	45	4	4	43				5	4	10
Eastern hemlock				4	3	75	7	4	70						
Softwood-dominated stands (after shelterwood removal)															
American beech													19	10	40
Sugar maple															
Red maple				4	2	257	7	5	159	18	8	28	23	20	109
Yellow birch				4	2	1923	7	5	1355	17	7	141	22	17	70
Striped maple				4	2	1629	6	4	1495	18	7	114			
White ash													10	10	10
Paper birch				5	3	3551	8	6	3186	18	9	282			
Quaking aspen				4	2	1607	7	5	1019	18	7	114			
Pin cherry				4	4	3991	6	6	3771	18	7	1209			
Red spruce	24	18	178	3	3	972	4	4	927	15	5	228	25	5	99
Balsam fir				3	3	339	4	3	314	16	6	28	9	6	60
Eastern hemlock	23	5	99	4	2	3020	7	4	2805	15	6	648	24	6	603

management unit of each forest type (northern hardwood–dominated and hemlock/red spruce–dominated stands) be managed/cut every 20 years, corresponding to a 100-year harvest rotation. Softwood-dominated stands were managed using shelterwood cutting, and hardwood-dominated stands were managed using clearcutting. Regenerated stands "grew" to a maturity over time until age 100, at which time another clearcut or shelterwood removal was applied.

For the southern New England region, the Massachusetts Division of Fisheries and Wildlife provided data from Wildlife Management Areas in Massachusetts, which included sample plots of hardwood, mixed-wood, and softwood stands (Table 3). For the southern New England landscape, each stand was approximately 3 ha, with one-fifth of the management unit of each forest type (oak-dominated and white pine–dominated stands) cut every 20 years. Hardwood stands in both regions were managed using clearcutting, and softwood and mixed-wood stands were managed using shelterwoods. Twenty-year cutting cycles provide early-successional habitat continuously through time.

To demonstrate the dynamic nature of the stands over time, we projected the regeneration, growth, and death of trees using the NE-TWIGS (Hilt and Teck 1989) stand growth simulator, which we used through Landscape Management System (LMS) version 2.0.45 (McCarter et al. 1998). NE-TWIGS, an individual-tree growth model for the Northeast, simulates changes in tree growth and stand density over time. LMS is a computer application that integrates several software tools to simulate forest growth and change at stand and landscape levels. We chose NE-TWIGS as the stand simulator because it is the growth model used by the US Forest Service for the Northeast in its Forest Vegetation Simulator (FVS) and included tree species found in New England. LMS was chosen because it incorporates various software packages with many options, and it simultaneously simulates change for multiple stands on a forest landscape. Tree growth was simulated for 100 years, the average silvicultural rotation age for northern hardwoods in New England, with output produced every 5 years. This stand level data represented a projected "snapshot" of the forest at selected time intervals.

The next step was obtaining the topographic data for the study sites. We used a digital elevation model (DEM) produced by the US Geological Survey consisting of a grid of elevation points that were measured on the ground at 30-m intervals. We obtained digital files of other geographic features such as streams, lakes, and roads from Massachusetts Geographic Information System (MassGIS) (for southern New England) and New Hampshire Geographically Referenced Analysis and Information Transfer System (NH-GRANIT) (for northern New England) websites (Table 1) and placed these features on the landscape at their actual locations. We used ArcView 3.2a (Environmental Systems Research Institute 2000) to analyze and manipulate the geographic information, to view the stand boundaries (represented by polygons) on the landscape, and to assign representative tree data and silvicultural prescriptions to each stand.

In the final step, we combined the tree data with the geographic data to produce realistic images of the landscape by using Visual Nature Studio 2 (VNS 2004, v.2; 3DNature, LLC, Arvada, CO). We chose VNS2 for its ability to handle large amounts of georeferenced data from multiple sources, to import data with different projections, and, most importantly, to render realistic forest landscapes and surrounding environments (such as sky, clouds, haze, etc.). The DEM and stand shapefiles were imported into VNS2 and used to create various viewpoints at the stand level and landscape level. For

Table 3. Tree heights and stocking densities representative of managed southern New England oak–pine, mixed-wood, and softwood stands at time steps ranging from 5 years to 100 years.

	Stand age														
	Shelterwood			5 years			25 years			45 years			100 years		
Species	Max. height (m)	Min. height (m)	Trees per ha	Max. height (m)	Min. height (m)	Trees per ha	Max. height (m)	Min. height (m)	Trees per ha	Max. height (m)	Min. height (m)	Trees per ha	Max. height (m)	Min. height (m)	Trees per ha
Hardwood-dominated, oak-pine stands															
American breech				5	3	371	9	9	55	9	9	15	21	9	574
Red maple				4	2	7661	14	8	2131	17	8	618			
Quaking aspen				4	2	1483	17	17	213	22	22	62			
Pin cherry				4	2	1483	16	16	213						
Black birch				4	2	6672	13	8	1439	16	8	418			
Gray birch				5	3	6178	15	14	853	21	18	248			
Hickory sp.													25	22	43
N. red oak				5	5	495	17	14	426	22	20	124	23	20	159
Eastern hemlock															
White pine															
Mixed-wood stands															
American beech															
Red maple				4	2	7661	14	8	2217	17	8	794	22	20	43
Quaking aspen				4	2	1483	17	17	223	22	21	109			
Pin cherry				4	2	1483	18	16	166						
Black birch	19	18	20	4	2	6672	8	8	1552	8	8	556	21	19	43
Gray birch				5	3	1483	15	15	223	20	18	80			
Hickory sp.													25	9	1229
N. red oak	21	18	43	5	5	495	14	14	443	21	19	159	23	21	43
Eastern hemlock				4	3	1483	7	7	223	7	7	85			
White pine	21	16	43	4	3	865	15	11	500	23	21	178	26	20	43
Softwood-dominated stands															
American beech															
Red maple				4	2	1483	8	8	230	8	8	82			
Quaking aspen				4	2	2719	17	17	401	22	21	144			
Pin cherry				4	2	692	17	16	114						
Black birch				4	2	3855	8	8	571	8	8	206			
Gray birch				5	3	5437	11	10	1028	15	10	369			
Hickory sp.															
N. red oak	22	19	43	5	3	742	9	9	114	14	9	43	23	21	43
Eastern hemlock	24	22	33	4	3	5239	7	7	858	7	7	307	24	7	1861
White pine	22	17	80	4	2	6870	15	11	2402	21	11	860	26	22	80

each forest type and age class, a VNS2 "foliage ecosystem" was developed. Each foliage ecosystem specified which forest species were included, how many trees per acre, and the height ranges of the species based on NE-TWIGS results from the LMS output. We assigned digital photographs of real trees to each species within the VNS2 foliage ecosystems. Since most of the tree images included with the VNS2 software were species found in the western United States, we used Photoshop 5.0 (Adobe Systems) to create tree images representative of New England species. Images of open-grown trees were "trimmed" to produce realistic shapes of stand-grown trees. Each species' density and height range were contained in the foliage ecosystems, which were then linked to the shapefile polygons depending on the stand type and rotation. Other aspects of the visual landscape images were also customized to create a more realistic illustration, such as adding atmospheric haze, cloud models, sky coloration, sun position, stream color and reflections, and road texture. Additional structures, such as power lines, buildings, and a cell phone tower, were added to the more residential, southern New England region, which also included the addition of agricultural fields. We added these features to explore their appearances in simulated images. Users simulating actual landscapes would use them as driven by data from the landscape in question. The images were then rendered from different viewpoints to depict stands and landscapes at various periods up to 100 years into the future.

Results

We displayed the digitized forest images in a time sequence that highlights the stand size classes needed for sustained provision of habitat diversity. Our visual simulations integrated information across multiple scales from stand to landscape. Using the forest habitat (cover type and size class) associations in DeGraaf and Yamasaki (2001), we displayed changes in four disparate wildlife species' habitat qualities over time at the stand scale; the habitat becomes more suitable for some and less so for others (Figure 2). At the landscape scale, the diversity of successional stages present in a shifting mosaic through time shows how the landscape will generally look if forest habitat is managed for a diversity of species over time (Figure 3). Both the northern New England (Figure 3) and southern New England (Figure 4) landscape images showed potential implications of forest management for wildlife habitat; however, the context of the surrounding landscape differs greatly: extensive forest in the northern part and a mosaic of forest, suburbs, and agriculture in the southern part of the region. The landscape scale also shows the extent to which management meets the habitat needs of species in relation to their home range sizes, that is, some species will likely be present and will only visit a given ownership size occasionally (Figure 5).

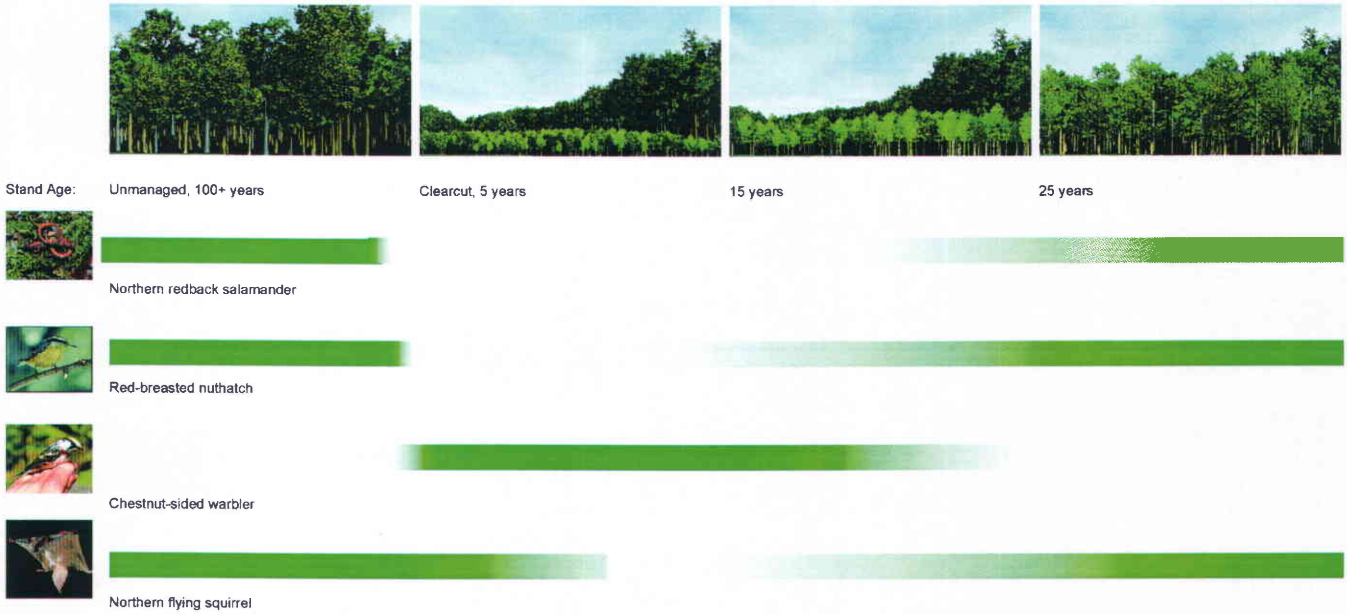

Figure 2. Communicating habitat change and wildlife response in New England northern hardwoods after a clearcut using visualization.

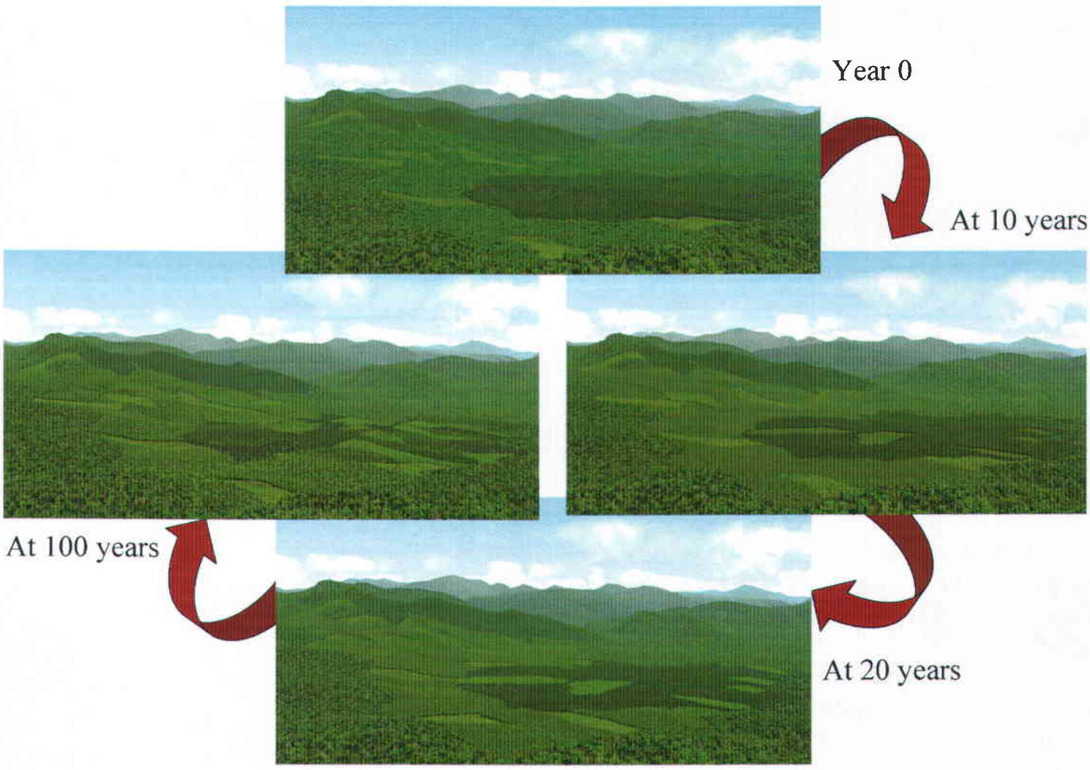

Figure 3. Communicating a progression of northern New England northern hardwood stands from year 0 to 100 using visualization. Using a 100-year rotation, various stand development stages are present across the landscape in a shifting mosaic.

Discussion

Visual forest simulations express ecological relationships in ways that realistically portray actual places under current and projected future forest conditions. Natural resource managers, consultants, wildlife biologists, and forest planners can use these "virtual forest habitats" as a valuable tool in communicating ideas and predictions to forest landowners, particularly when alternative visual representations can be related to the associated difference in wildlife habitat and other forest products and amenities. Public participation in forest and wildlife habitat management planning makes the clear expression of alternative conditions an important component of discussions about land management.

There are several issues to consider when developing visual simulations of a landscape. It is critical to use real inventory data that describe every stand in the managed landscape and stand polygons that accurately represent the spatial arrangement of nonforested areas on the landscape. Also, a fundamental component of creating close-up visual simulations that are appropriately realistic to a given

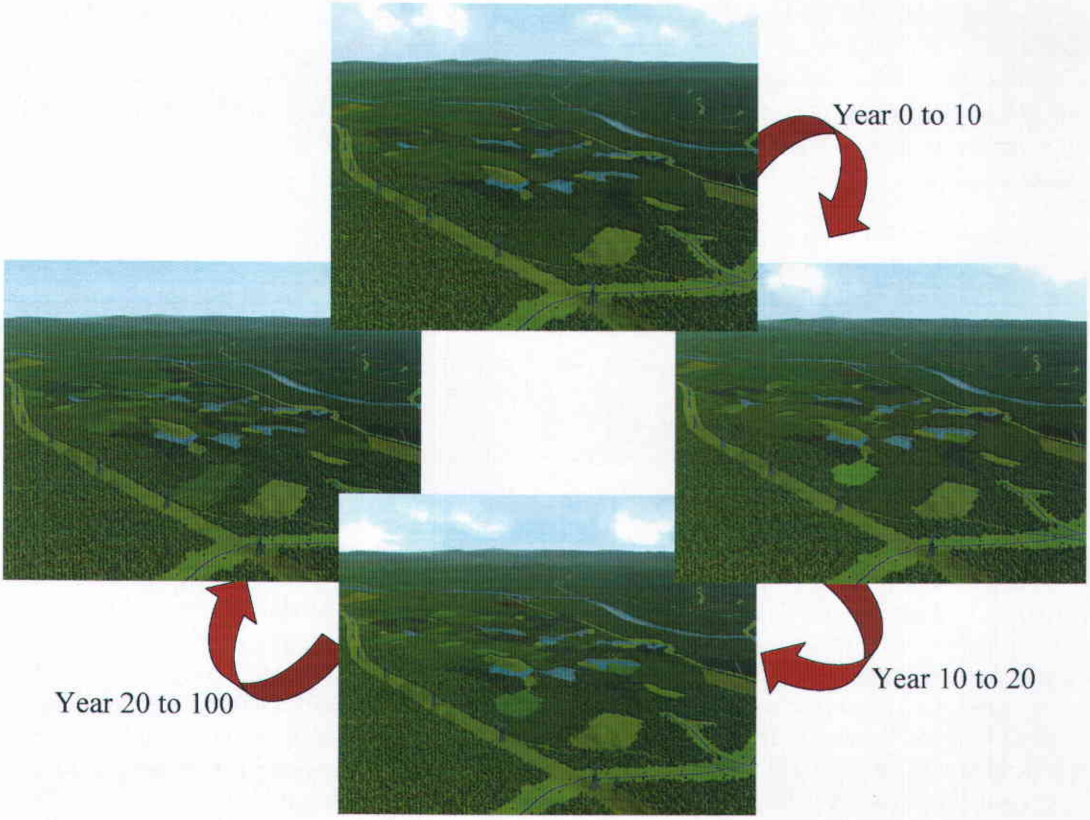

Figure 4. Communicating a progression of southern New England oak–pine stands from year 0 to 100 using visualization.

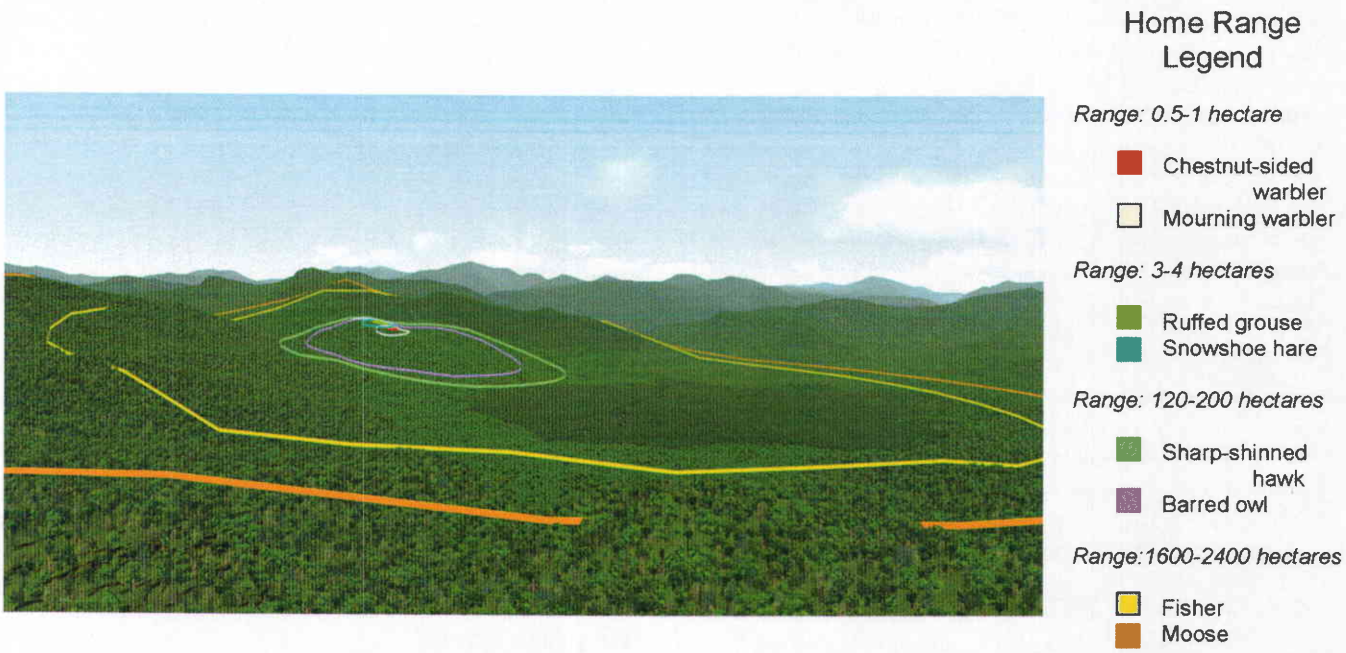

Figure 5. Examples of home ranges in the New England northern hardwood landscape.

application is using digital images of real trees that occur within the region of interest. Taking photographs of trees oneself would yield the best results; however, this process can pose difficulties and be time-consuming, especially where forests have a diversity of species. It is easiest to work with images of trees in which there is a consistent background color (e.g., sky) as opposed to branches of other trees, which can interfere and be difficult to distinguish from the subject tree once it is a two-dimensional photograph. Open-grown trees are often easy to locate with a sky background, but rendering images of a partial or fully to closed overstory canopy requires images of forest-grown trees. Forest-grown trees might be more difficult to find because they are not often isolated in this way unless a harvest or thinning has recently occurred. If possible, using multiple images of each species is also recommended as it increases the visual variability and increases the realism of the final rendered images (Bieging 2003, Stoltman et al. 2004). The need for such realism likely increases as the scale of the image decreases. The realism of a projected image of a stand interior would be improved by a high level of detail regarding tree species composition. In exploring the potential of visualization to show stand conditions, we strove for realistic images of the major species involved.

The use of VNS2 also enhanced the effectiveness of the images as a communication tool for private landowners by rendering images with increased realism compared with other systems that use geometrically shaped, computer-generated trees rather than digital images of real trees, or that display trees on a plane, regardless of the scale chosen, rather than on contoured terrain.

For visual simulations to be effective, they need to be appropriately realistic. To help assure users that forest conditions and structure are adequately displayed, inclusion of region-specific forest elements (e.g., snags, stumps, slash, streams, and roads) should be included when appropriate. Visualizations also need to be useful representations of projected habitat conditions. Forest visualizations are useful as a tool only if the data used to create them are empirically correct and based on strong science; only accurate, reliable sources of data should be used (Stoltman et al. 2004). It may be counterproductive, however, to strive for too much detail or highly realistic visualizations. It should be kept in mind that visualization techniques that approach the realism of photography can arouse a high level of expectation about what future conditions will be like (McQuillan 1998). In time, the actual conditions will differ in detail from the projected image.

The size of the unit depicted influences the degree of detail needed to simulate forest structure. The structure of the wildlife habitats probably could have been rendered just as usefully and much more efficiently by using images of the dominant or codominant hardwoods and softwoods. It has long been recognized that habitat selection is more a function of vegetation structure than plant species composition (e.g., Lack 1933, Bond 1957, MacArthur and MacArthur 1961). We maintained a high level of detail to create images that look realistic to explore visualization as a forest habitat communication tool. Visualizations created with less tree species detail may be adequate to show habitat conditions because even when viewing actual forest stands, most tree species, especially hardwoods, cannot be distinguished in summer from 200–300 meters away. Finally, the point of view can be chosen based on the management objective being simulated. For example, if the concern is how clearcuts over time will look on the landscape, then a point of view from various viewpoints, both high and low, might be appropriate. If, however, the concern is based on the spread of habitat types throughout the landscape, then an aerial point of view would be more useful.

Simulations of the New England forest landscapes demonstrate how forest visualizations can be used to communicate changes in wildlife habitat conditions associated with temporal projections of forest growth and future silvicultural management options. Visualization in both northern and southern New England illustrates how rapidly the forest regenerates following an overstory removal (e.g., Marquis 1967) and the relatively short time that early successional habitat is available (Thompson and DeGraaf 2001). Both are critical concerns of many forest landowners and biologists; in New England, harvested sites quickly "green over," but the newly created early successional wildlife habitat goes by quickly as the stand enters the sapling stage (DeGraaf et al. 2005, p. 24). Many New England wildlife species are disturbance-dependent specialists that need frequent periodic management (DeGraaf and Yamasaki 2001). The effects of such management are readily shown in visualizations because the rapidity with which harvested sites regenerate to forest is clearly communicated.

Long-term projections are readily applicable to public lands because they will likely be intact far into the future. Long-term projections can also give landowners perspective on their actions and the impacts of their management decisions, and they may also encourage long-term ecological and estate planning. Thus, visualizations may be important in encouraging landowners to view their property as an integral part of the larger landscape, with important habitat components.

Unforeseen disturbances such as wind, tree diseases, or insects will change the forest in ways that cannot be anticipated, although recent advances in FVS have included insect and disease effects on tree dynamics. Creating visualizations that are representative of management actions (i.e., that show how the forest distribution in the landscape will look over time) is the real objective. Using realistic elements enhances that representation. Furthermore, people relate to forest landscapes in ways that are as diverse as the landscapes themselves (Gobster 2001). Maps, tables, and even artists' depictions of future forest conditions are limited in their abilities to convey how the landscape will look in the future. In many ways, visualization is an improvement on these methods to communicate future forest conditions, especially if images are shown in the field, because the topography and overall forest landscape is as seen in the images. People looking at the actual landscape can then compare images showing different options and evaluate them.

A major obstacle to maintaining a distribution of forest size classes, especially early successional habitat conditions, is the common perception that such habitats are unsightly, uninteresting, or even threatening (e.g., Herzog 1984). They are generally closed or monotonous, without open views and coherent patterns that people find aesthetic in landscapes. Also, barring natural disturbances, early successional habitats and regenerating forests are produced by cutting trees or otherwise disturbing vegetation, activities that many people oppose (Askins 2001). Visualization is a technique to place the creation and maintenance of critically needed early successional habitats, indeed all stand sizes, in a realistic landscape context, project vegetation change over time, and communicate the ecological values of habitat management such that people develop a better understanding of proposed land management outcomes. We urge managers to use it to communicate the wildlife values of various management options, especially even-aged methods, which yield the greatest wildlife diversity, and the maintenance of forest landscape integrity that results from their proper use.

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