Interpretation of forest characteristics from computer-generated images

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Abstract
The need for effective communication in the management and planning of forested landscapes has led to a substantial increase in the use of visual information. Using forest plots from California, Oregon, and Washington, and a survey of 183 natural resource professionals in these states, we examined the use of computer-generated images to convey information about forest characteristics. Age and density (basal area (BA)) were underestimated for large, old, dense forest and overestimated for small, young, open forest. While accuracy of responses for density, tree size, and age of forest plot images was low, the ordering of such images by these attributes did correspond to the actual forest plot characteristics.

Alterations to the standard image were made for three of the forest plots, including alterations for the area depicted, the incorporation of understory vegetation and fallen trees, the addition of a truck, and regular and clumpy individual tree spacing. Image alterations did affect some mean responses for tree size, density, fire hazard, vertical stratification, and forest age. Results show managers and planners may need to exercise caution and supplement images with additional information to avoid miscommunication about the nature of current and projected forest landscapes.

Keywords: Computer visualization; Decision support systems; Vegetation modeling; Public communication

1. Introduction

More than a decade after the compromise Northwest Forest Plan was developed for 9.8 million ha of forest land in California, Oregon, and Washington, intense controversy over forest management in the region continues (Stokstad, 2005). The content of the conflict has broadened from protection of old growth (Thomas et al., 1993) to debate over the merits of salvage logging (Lindmayer et al., 2004) and fuels reduction (Stephens and Ruth, 2005). Because of the many disparate interests involved, effective communication is viewed as critical to addressing contentious issues in management of forest ecosystems (Yaffee and Wondolleck, 1997). Computer-based visualization is increasingly seen as an effective way of involving technical experts, decision makers, and public stakeholders in forest management (Lewis et al., 2004).

Frequently controversies over forest management are discussed in terms related to forest structural characteristics such as tree size, density, age, species composition, or relative fire risk. For example, the recent reevaluation of late-seral and old growth forests covered by the Northwest Forest Plan presents the status of the forests in terms of average tree size and vertical stratification (Moeur et al., 2005). Fuels reduction to lessen fire hazard is frequently discussed in terms of tree density and vertical stratification, with computer-generated graphic images used to portray patches of forest before and after silvicultural treatments (Johnson and Peterson, 2005).

Following the adage that “a picture is worth a thousand words” planners are increasingly using graphic images to convey the structural characteristics of forests. Whether for public or private forests, management plans now routinely include data-driven graphic images, as do many other publications and presentations. Researchers report positively on this development: visualizations can help managers communicate basic forest dynamics (Twery et al., 2005) or historical changes (Wang et al., 2006); visualizations help to involve the public in

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With the increase in use of images to communicate current and reflect the differences in the forests they portray, not just the sophisticated technology (McQuillan, 1998). Even when deception is not intended, images can provide a different impression of a forest than a field visit (Barrett et al., 2002). While designers of software for forest imaging strive for greater realism (e.g., Lim and Honjo, 2003; Kumsap et al., 2005), this may actually exacerbate the ability to create deceptive images (Orland and Uusitalo, 2001).

At the same time, researchers have also recognized that these data-driven images may have limitations. Stone and Porter (1998) advise that relative differences in visual images should reflect the differences in the forests they portray, not just the algorithm used to translate measurements into an image. Used in a biased manner, images can mislead the public or decision makers about the potential impacts of a management proposal (Lewis et al., 2004). Computer visualization of forests can be used to deceive by misrepresenting spatial patterns, portraying stochastic events through averages, presenting a single scale of perception, or simply through the “wow” effect of sophisticated technology (McQuillan, 1998). Even when deception is not intended, images can provide a different impression of a forest than a field visit (Barrett et al., 2002). While designers of software for forest imaging strive for greater realism (e.g., Lim and Honjo, 2003; Kumsap et al., 2005), this may actually exacerbate the ability to create deceptive images (Orland and Uusitalo, 2001).

Although there has been recognition that images could, in theory, create misperceptions, there is almost no information about whether and how this happens for typical visualizations. With the increase in use of images to communicate current and projected forest characteristics, it becomes important to understand more about perception of those forest characteristics. In this study, we used a web-based survey of natural resource professionals to understand more about interpretation of common forest characteristics from data-driven images. Comparisons are made both between perceptions of image and measured forest characteristics, and between different images generated from identical forest data. Specific objectives of the study are to: (1) increase understanding of the accuracy and bias of perceptions of tree size, age, and density from typical images, (2) examine the interaction between accuracy of perceptions and the nature of the forested areas depicted, and (3) test whether commonly used image alterations affect perception of tree size, layering, age, fire hazard, and density.

2. Methods

2.1. Forest data and image generation

The survey was designed to examine two aspects of visual interpretation. The first aspect, termed the “Image versus Forest” comparison, was the correspondence between peoples’ interpretation of forest attributes from the image and the matching attributes as calculated from field measurements of the trees. For example, did the perception of tree-age match with the field estimate of age? The second aspect of interest, described as the “Image versus Image” comparison, was the variation in response that occurred with different images generated from the same field measurements. For example, how did the presence of a truck affect a person’s tree-size estimate compared to the same image without a truck?

The data set from which the computer-generated images were created came from permanent field plots used to sample all forestland in Oregon, Washington, and California, in the year 2000 for the purposes of monitoring forest health (Alexander and Palmer, 1999). Field measurements included species, tree height, length of tree crown, and stem diameter at breast height (DBH—1.3 m above the ground) for individual trees within a fixed area plot (0.067 ha) of the forest (USDA Forest Service, 2006). From these data, the average DBH of tree stems was recorded in centimeters as a tree-size class attribute. Basal area (BA), the tree stem cross-sectional areas summed over a unit area, was calculated in square meters per hectare as a forest density attribute.

It was desirable to depict forested areas that were structurally diverse, yet keep the number of images small so that survey response time was limited to no more than 20 min. For this reason, the summary attributes were used to partition the forest samples into groups spanning the range of density and tree-size.

Table 1
Actual forest characteristics of eight plots representing unique combinations of size, density (BA), and forest type selected for standard 0.4 ha image used in ‘Image vs. Forest’ comparisons

<table>
<thead>
<tr>
<th>Plot</th>
<th>Combinations</th>
<th>Forest type</th>
<th>Age (years)</th>
<th>Trees (trees ha⁻¹)</th>
<th>Basal area (m² ha⁻¹)</th>
<th>Tree stem diameter (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Small</td>
<td>Low</td>
<td>Ponderosa pine</td>
<td>6</td>
<td>1512</td>
<td>7.1</td>
</tr>
<tr>
<td>2</td>
<td>Small</td>
<td>High</td>
<td>Lodgepole pine</td>
<td>55</td>
<td>2931</td>
<td>51.7</td>
</tr>
<tr>
<td>3</td>
<td>Medium</td>
<td>Low</td>
<td>Ponderosa pine</td>
<td>50</td>
<td>193</td>
<td>11.1</td>
</tr>
<tr>
<td>4b</td>
<td>Medium</td>
<td>Medium</td>
<td>White fir</td>
<td>95</td>
<td>772</td>
<td>35.1</td>
</tr>
<tr>
<td>5</td>
<td>Medium</td>
<td>High</td>
<td>Noble fir</td>
<td>70</td>
<td>1352</td>
<td>76.0</td>
</tr>
<tr>
<td>6</td>
<td>Large</td>
<td>Low</td>
<td>Douglas-fir</td>
<td>60</td>
<td>283</td>
<td>41.9</td>
</tr>
<tr>
<td>7</td>
<td>Large</td>
<td>Medium</td>
<td>Western hemlock</td>
<td>45</td>
<td>506</td>
<td>87.1</td>
</tr>
<tr>
<td>8c</td>
<td>Large</td>
<td>High</td>
<td>Western hemlock</td>
<td>250</td>
<td>1364</td>
<td>109.9</td>
</tr>
</tbody>
</table>

a Additional images: (i) 0.07 ha plot; (ii) truck in image; (iii) regular tree spacing; (iv) clumpy tree spacing.
b Additional images: (i) 0.07 ha plot; (ii) truck in image; (iii) regular tree spacing; (iv) with understory and fallen logs.
c Additional images: (i) 0.07 ha plot; (ii) truck in image; (iii) regular tree spacing; (iv) clumpy tree spacing.
conditions. The average diameter of tree stems was used to split the forest samples into three equal quantiles, representing forests of varying tree size. Within the size quantiles, the forest samples in the medium and large-size classes were split into three density quantiles, and the small-size class was split into two density quantiles. For the "Image versus Forest" analysis, one plot was chosen randomly from each of the resulting eight strata, to provide a range of forest types (Table 1). A visual image of each forest plot was created from the field measurements of tree species, diameter, and height using the Stand Visualization System (SVS) (McGaughey, 1998), the software most commonly used by forest managers and planners in the United States to depict a representative area of forest. SVS parameters were set to the standard defaults for the program, resulting in an image of 0.4 ha (1 acre) of forest with randomized tree positions (Fig. 1).

For the "Image versus Image" analysis, three of the plots had additional images created: an image of a 0.07 ha (0.17 acre) of forest (Fig. 2), an image including a truck in the foreground, and an image where trees had a more regular distribution. The three plots chosen for these additional images were the small-size low-density plot, the medium-size medium-density plot, and the large-size high-density plot. For this comparison, we looked at whether the choice of image affected perception of stand structure variables of: (1) size, (2) density (basal area), (3) layering, and (4) age. Two additional images with clumped tree distribution, and one image with a forest understory, were generated. This provided a total of 3 plots × 5 images/plot = 15 images used in the "Image versus Image" analysis (Table 1).

2.2. Survey and analysis procedures

A web-based questionnaire was built to show each of the images with accompanying questions as a single page. Initially the survey had been designed to show six images of all eight plots. However, pre-testing of the questionnaire with several university classes and a professional group indicated that this number of images would negatively affect the response rate. The number of images was therefore reduced from 48 to the 20 described above.

For each individual taking the survey, the order of images was selected randomly, without replacement, to avoid an ordering bias. Although a participant would have seen both altered and non-altered versions of the same image, the images would not have been visible at the same time. Participants for the project were identified from a list of 600 individuals in Oregon, California, and Washington, who belonged to the primary forestry professional organization for this region, the Society of American Foresters. Implementation was adapted from Dillman (2000) using a combination of email and regular mail initial contact and reminder letters.

A unique login and password for each participant controlled access to the web site. The number of completed responses...
for the 20 images ranged from 158 to 183. Communication with non-respondents indicated a variety of reasons for non-participation, with the most frequent reasons related to troubles with computers and web browsers and, for non-forestry resource professionals, unfamiliarity with terms like basal area. Each image was presented as a separate web page, with the following questions accompanying each image; English units were used in the survey instrument, although we show metric units below.

- Which of the following stand size classes best describes this image?
  - Seedling/saplings (most < 13 cm DBH);
  - small trees (most 13–23 cm DBH);
  - medium trees (most 23–51 cm DBH);
  - large trees (most 51–102 cm DBH);
  - very large trees (most > 102 cm DBH).

- Enter a number for basal area that best describes this image:
  - What is your best guess of the age of this stand?
  - Which of the following vertical stratifications best describes this stand?
    - Multi-story;
    - Single story.

- How would you rate the fire hazard of this image?
  - Fire hazard low;
  - Fire hazard med low;
  - Fire hazard med high;
  - Fire hazard high.

Responses were gathered electronically and analyzed using SAS 9.1 statistical procedures (SAS Institute, 2004). For the multiple category questions, tests for difference included chi-square tests for categorical variables, with use of exact tests for a few instances where more than 20% of the categories had expected values of less than five under the null hypothesis. For the real-valued questions about stand age and basal area, tests of difference used a two-sided one-sample t-test for comparison to field-measured attributes or a two-sided two-sample t-test for comparison of two images. Comparisons of vertical stratification responses used a two-sample t-test for a proportion. All comparison tests set the probability of a Type I error to 5%.

3. Results

3.1. Image versus Forest

This analysis focused on whether people have a tendency to perceive stand characteristics in a computer-generated image to be different than the actual forest characteristics. For basal area and stand age, the null hypothesis was that the mean value given by respondents was the same as the value from field measurements. For basal area (a measure of stand density), mean responses of estimated basal area were significantly different than actual basal area for seven out of eight images of stands (Table 2). For tree age, mean response of estimated stand age was significantly different than actual stand age for all eight stands (Table 2). There was a general pattern of overestimating the density and age of younger, less dense stands and underestimating density and age for older, more dense stands. For the forest stand having a basal area of 77 m² ha⁻¹, there was no significant difference with respondents’ estimated basal area. For the two stands with higher basal area than this, basal area was underestimated. For the five stands with lower basal area, basal area was overestimated. Similarly, stand age was underestimated for the 95 and 200-year-old stands, and overestimated for the six younger stands.

If a correct answer were to be defined as being within 20% of the actual value, only 18.6% of respondents’ replies would meet that criterion for basal area and 22.9% of replies would meet that criterion for stand age. For large tree stands, the lowest basal area accuracy by this criterion (9.2%) occurred with the high-density stand. For medium and small tree stands, lowest basal area accuracy occurred with the low-density stands (5.5 and 11.7% accuracy, respectively). Age class accuracy by this criterion was between 20 and 29% for each stand with the exception of the small size class low-density stand, for which respondents were 9.0% accurate.

Even with low accuracy, and bias in average responses, the overall ordering of average responses did correspond to the actual ordering of stand attributes such as stand size class (Fig. 3). For example, most respondents successfully classed large-tree stands as being larger than the medium-size class for both high-density and low-density stands, and they
3.2. Image versus Image

For the three stands, the mean basal area estimates were lower for the 0.07 ha plot. However, using a null hypothesis that the average basal area was the same for both types of images, there was a significant difference for the Large stand but not for the Medium and Small stands. Using regular tree spacing did not affect the proportion of respondents labeling the 0.07 ha image “multi-story” for the Large stand, but not for the Medium and Small stands (p-values = 0.0249, 0.1171, and 0.4035, respectively). A higher proportion of respondents labeled the 0.07 ha image “multi-story” for the Large stand, but no difference in proportions was observed for the Medium and Small stands (p-values = 0.0295, 0.9448, and 0.7103, respectively). There was no difference in mean age estimates for the three stands (p-values = 0.0848, 0.9545, and 0.6730, respectively). The average fire hazard rating was lower for the 0.07 ha image for the Large stand but not significantly different for the Medium and Small stands (p-values = 0.0479, 0.0581, and 0.2174, respectively).

3.2.2. Decreased stand area in an image

A second type of image alteration for the three stands was to display an image of a 0.07 ha (1/16th acre) stand instead of a 0.4 ha (1 acre) stand (Fig. 2). For all three stands, the mean basal area estimates were lower for the 0.07 ha plot. However, using a null hypothesis that the average basal area was the same for both types of images, there was a significant difference for the Large stand but not for the Medium and Small stands (p-values = 0.0127, 0.0630, 0.9549, d.f. = 327, 318, 355, respectively). Similarly a null hypothesis of equal tree-size class responses for both types of images yielded a significant difference for the Large stand but not for the Medium and Small stands (p-values = 0.0249, 0.1171, and 0.4035, respectively). A higher proportion of respondents labeled the 0.07 ha image “multi-story” for the Large stand, but no difference in proportions was observed for the Medium and Small stands (p-values = 0.0295, 0.9448, and 0.7103, respectively). There was no difference in mean age estimates for the three stands (p-values = 0.0848, 0.9545, and 0.6730, respectively). The average fire hazard rating was lower for the 0.07 ha image for the Large stand but not significantly different for the Medium and Small stands (p-values = 0.0479, 0.0581, and 0.2174, respectively).

3.2.3. Regular tree spacing in an image

A third image alteration was to create a more regular spacing of individual trees in the image. Using regular tree spacing did not affect the distribution of tree-size class responses for the Small (p-value = 0.3951), Medium (p-value = 0.0854), or Large stands (p-value = 0.1193). Likewise regular tree spacing did not affect the distribution of fire hazard categories for the Small (p-value = 0.4418) or Medium stands (p-value = 0.7111) but did affect the distribution of responses for the Large stand (p-value = 0.0238), with evenly spaced trees resulting in a decrease in the number of respondents classifying the stand as having a very high fire hazard. Using regular tree spacing did not affect mean stand basal area estimates (p-values = 0.4983, 0.5263, and 0.1983 for the Large, Medium, and Small stands, respectively) or mean stand age (p-values = 0.3419, 0.4582, and 0.1163 for the Large, Medium, and Small stands, respectively). Using even tree spacing in the image did not affect the proportion of responses concerning vertical stratification (multi-story or single-story) for the Small or Medium stands (p-values = 0.0621 and 0.6822, respectively), but there was an increase in the proportion of respondents labeling the Large stand single-story (p-value = 0.0076).
### Table 3
Summary of results for 'Image vs. Image' comparisons

<table>
<thead>
<tr>
<th>Plot type, response type</th>
<th>Image alterations</th>
<th>Decreased stand area</th>
<th>Regular tree spacing</th>
<th>Clumpy tree spacing</th>
<th>Understory veg and logs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small tree-size plot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tree-size class</td>
<td>NS</td>
<td>NS</td>
<td>NS'</td>
<td>NS'</td>
<td>n.a.</td>
</tr>
<tr>
<td>Basal area</td>
<td>NS</td>
<td>NS</td>
<td>NS'</td>
<td>NS'</td>
<td>n.a.</td>
</tr>
<tr>
<td>Stand age</td>
<td>NS</td>
<td>NS</td>
<td>NS'</td>
<td>NS'</td>
<td>n.a.</td>
</tr>
<tr>
<td>Vertical stratification</td>
<td>NS</td>
<td>NS</td>
<td>NS'</td>
<td>NS'</td>
<td>n.a.</td>
</tr>
<tr>
<td>Fire hazard</td>
<td>NS</td>
<td>NS</td>
<td>NS'</td>
<td>NS'</td>
<td>Dependence*</td>
</tr>
<tr>
<td>Medium tree-size plot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tree-size class</td>
<td>Dependence*</td>
<td>NS</td>
<td>NS'</td>
<td>NS'</td>
<td>Dependence*</td>
</tr>
<tr>
<td>Basal area</td>
<td>NS</td>
<td>NS'</td>
<td>NS'</td>
<td>NS'</td>
<td>n.a.</td>
</tr>
<tr>
<td>Stand age</td>
<td>NS</td>
<td>NS'</td>
<td>NS'</td>
<td>NS'</td>
<td>n.a.</td>
</tr>
<tr>
<td>Vertical stratification</td>
<td>NS</td>
<td>NS'</td>
<td>NS'</td>
<td>NS'</td>
<td>n.a.</td>
</tr>
<tr>
<td>Fire hazard</td>
<td>NS</td>
<td>NS'</td>
<td>NS'</td>
<td>Dependence*</td>
<td>Dependence*</td>
</tr>
<tr>
<td>Large tree-size plot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tree-size class</td>
<td>Dependence*</td>
<td>Dependence*</td>
<td>NS</td>
<td>NS'</td>
<td>n.a.</td>
</tr>
<tr>
<td>Basal area</td>
<td>NS</td>
<td>NS'</td>
<td>NS'</td>
<td>NS'</td>
<td>n.a.</td>
</tr>
<tr>
<td>Stand age</td>
<td>NS</td>
<td>NS'</td>
<td>NS'</td>
<td>NS'</td>
<td>n.a.</td>
</tr>
<tr>
<td>Vertical stratification</td>
<td>NS</td>
<td>Dependence*</td>
<td>NS'</td>
<td>NS'</td>
<td>n.a.</td>
</tr>
<tr>
<td>Fire hazard</td>
<td>NS</td>
<td>Dependence*</td>
<td>NS'</td>
<td>NS'</td>
<td>Dependence*</td>
</tr>
</tbody>
</table>

a Indicates response is dependent on default image.
b Indicates significant difference between mean response of this image and default image.
c Indicates test not significant.

#### 3.2.4. Clumpy tree spacing in an image

Images with very clumpy tree spacing were created for the Large and Small stands. This affected responses about fire hazard category for both stands, with an increase in the number of high hazard ratings for the clumped tree images. Test statistics for the interaction were $\chi^2 = 11.8$, $p$-value = 0.0182 for the Large stand, and $\chi^2 = 38.4$, $p$-value < 0.0001 for the Small stand. Clumpy tree spacing had no effect on responses about stand size class ($p$-values = 0.4789 and 0.2559 for the Large and Small stands, respectively), mean stand BA ($p$-values = 0.9688 and 0.4899), stand age ($p$-values = 0.7140 and 0.0511) or vertical stratification ($p$-values = 0.0968 and 0.7202).

#### 3.2.5. Including understory vegetation and fallen trees in an image

The final image alteration – including understory plants and fallen trees – was made only for the Medium stand. The image with an understory and fallen trees elicited higher ratings for fire hazard ($p$-value < 0.0001) compared to the standard image. There was no effect on mean responses about stand basal area ($p$-value = 0.8053 with d.f. = 317) or the proportion of participants placing the stand in an uneven age vertical stratification. It did increase the mean response for stand age ($p$-value = 0.0208). It also affected the distribution of size class responses ($p$-value < 0.0001) with more participants placing the stand in a larger tree-size class for the altered image.

Results for image alteration are summarized in Table 3. Although each of the image alterations resulted on a significant difference for at least one combination of forest characteristic and stand-type, image alteration affected responses most frequently for the large tree-size stand.

#### 4. Discussion

We began the study with three objectives: (1) to increase understanding of the accuracy and bias of perceptions of tree size, age and density from typical images; (2) to examine the interaction between accuracy of perceptions and the nature of the forested areas depicted; (3) to test whether commonly used image alterations affect perception of tree size, layering, age, fire hazard, and density.

No single study will conclusively meet these objectives. The eight stands used in this study are similar to only a tiny fraction of the diverse forest types in existence. Images are used to communicate to audiences more diverse than the forestry professionals who participated in this project; possibilities for image variations are vast. What image creators intend to communicate is typically much more complex and nuanced than the questions used in our survey.

Nonetheless, for the stands, images, participants, and questions used here, we can make some general observations. In relation to the first objective, we found that accuracy of tree size, age, and density perception was quite low, and bias was indicated by mean responses that differed significantly from field-measured values. However, viewers can perceive relative differences in tree size, density, and age from images when actual differences are great.

In examining the second objective, we found that the nature of the forest area depicted appeared to strongly influence the expected direction of bias in perception. Directions of the bias reversed as the real forests varied from small to large trees, and from low-density to high-density basal area. Responses were biased toward underestimating age, and density for large, old,
dense forest and overestimating age and density for young open forest. This suggests that interpretation of visual images follows the principal of regression toward the mean—images of young small trees appear larger than their actual size, and images of old large trees appear to be smaller. This is important for planners to know, because some of the most contentious issues for management of forest ecosystems are centered on the extremes of forest structure (e.g., clearcutting, stand-replacing fire, or conservation of old growth).

In relation to our third objective, we found that commonly used image alterations did affect perception of tree size, layering, age, fire hazard, and density. However, there were no clear patterns and in many cases image alterations had no discernable effect (Table 3). Image alterations for the depiction of the old, dense stand most frequently resulted in altered perception. Managers who use computer-generated images should think about the interaction of what they intend to convey and the choice of image style they use.

Collectively, the results that we found provide some corroboration of concerns raised by other researchers (Lewis et al., 2004; McQuillan, 1998; Orland and Uusitalo, 2001) about the use of computer-generated images within a forest planning context. The results also provide evidence for the general usefulness of images to convey differences in density, age, and tree size among forest structures when the actual differences are great.

A caveat is that we used forestry professionals as our target population, and framed survey questions in terms that would be unfamiliar or difficult for others. Although much of the use of computer-generated images in presentations and publications is directed toward other professionals, it is also common to use images for public communication. Indeed, graphic images are often appreciated precisely because they are more accessible to a general audience. It would be useful to confirm that these results hold true for a general population also. However, it seems likely that if professional foresters have difficulty in accurately perceiving forest characteristics from computer-generated images, that the general public would also.

A common base of understanding among individuals is critical to mitigating the contentious nature of disputes over management of forest ecosystems. Agreement on the current state of the forest, and on the potential state of the forest under different futures, allows discourse to move from arguments over facts to issues of substance. Like other models, algorithms for computer-generated images are typically judged on usefulness rather than accuracy. The frequency of appearance of computer-generated images of forests in recent professional communications is a strong argument in favor of their usefulness.

Yet if perception of forest characteristics from images differs from real forests, there is potential for miscommunication. These results suggest that managers and researchers need to exercise caution in using computer-generated images to communicate about current or projected forest characteristics. In some cases, accompanying images with summarized estimates may help in correcting misperceptions. Where possible, supplementing the use of computer-generated images with field visits and demonstration sites could prove useful in conveying realistic expectations.

References


