Visual Quality Assessment of Alternative Silvicultural Practices in Upland Hardwood Management

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Abstract: Visual impacts of forest operations are of increasing concern to forest managers. Tools are available for evaluating, **and potentially avoiding, problems in visual quality resulting from poorly designed harvest unit boundaries. One of these** visualization tools is applied **in comparing various harvest unit shape alternatives in an upland hardwood stand on steeply sloping ground. Visualization tools were found to be most suited to placing small leave strips within larger clearcuts for obscuring** some **areas from view and giving the impression of a series of smaller cutting units.**

Key Words: visualization rendering, visual impacts, quality aesthetics

INTRODUCTION

Forest management in the South has not historically been constrained by visual quality concerns. Although management practices are routinely employed to mitigate visual impacts of harvesting, greater care in design and layout of forest harvest units may become necessary if public sensitivity to appearance increases as it has in other parts of the country.

Visual simulation is one technique available to managers for estimatingthe severity of, and perhaps avoiding, negative visual impacts of forest harvesting. These techniques have not been used widely in the South, but could be of great benefit to forest managers if applied in highly visually sensitive areas. This paper reports on an application of visual simulation in evaluating the change in appearance of a hillslope when harvested using different cut unit boundaries. Various types of design recommendations have been published giving managers some guidance in how to alter a particular harvest block to minimize visual impacts. This paper will report on a particular application of some of these recommendations, report on how they changed cut unit size, and show how effective they were in altering the visual impact of harvesting.

METHODS

There are two main approaches to implementing visual simulation: retouching photos (e.g. Orland 1988; Johnson and others 1994; Palmer and others 1993) and a 'virtual reality' method where the scene is constructed using computer rendering techniques based on a model of landscape features (e.g. Bergen and others 1992; Fridley and others 1991). Both methods have their advantages. Photo retouching tends to be the most realistic, but is constrained by the quality and view point of the original image. It also requires at least a minimal level of artistic skill to perform, and considerable ground work to collect a photo library of appropriate textures and colors for use in retouching the images. It has been used successfully in developing a strategy for harvests in visually sensitive areas (Palmer and others 1993), and seems to be used quite effectively, and often, in the Pacific Northwest region (Taylor 1994). The 'virtual reality', or computer modelling, approach has been used less frequently in practice. This seems mainly related to issues of quality of the images produced and the computer power necessary to generate them. This approach requires generating a 3-dimensional model of the landscape, complete with trees and other features, and then simulating computationally how light would interact with it. It requires large amounts of data and a sophisticated rendering system to implement. Because of the intensity of the computations required, it can also take a long time to generate an image. The advantages of the approach, however, make it a viable option. Although costs of computer hardware might be higher up front, costs per picture will probably be lower because no field work is needed to generate an image. There is also considerable flexibility with the approach. Any forest type at any stage of development can be simulated on the same landscape, making it possible to see changes over time, something very difficult to do with photo editing. Another disadvantage of the photo editing method is locating a particular spot on the ground within a photo. In the modelling approach, any location can be specified exactly within the image. This is especially easy if the rendering system is coupled with a GIS.

Either of these tools would be useful in evaluating visual impacts typical of southern silvicultural practices and landscape conditions. Our particular application was to examine the suitability of strip clearcutting in upland hardwood management. At least two studies (Schweitzer and others 1976; Daniel and Boster 1976) have shown that leave strips can increase the scenic acceptability of large clearcuts. Strip clearcutting of hardwoods on steeply sloping sites could also potentially decrease soil losses by providing filter strips within the stand. Despite these potential advantages, a number of concerns persist over costs and silvicultural effects of implementing strip clearcutting in upland hardwoods.

In 1996 our research unit, along with Champion International, National Forests of Alabama, Alabama A&M University, and Auburn University, installed a study to investigate three harvest systems in upland hardwoods: clearcut, strip clearcut, and deferment cut. Variables measured included estimates of harvest costs and productivity, site impact, soil movement, and regeneration, for each alternative.

Also of interest was the perceived scenic beauty of each harvest alternative. However, because of the study design, it was not possible to implement each treatment on an operational scale. The study was installed on a hillslope in northern Alabama, near the confluence of Thompson and West Flint creeks in Lawrence County. The area available for the study totaled about 20 ha (50 acres), and to have a minimum number of replicates, treatment blocks were limited to 4 acres in size. It was possible to satisfactorily measure economic, silvicultural, and environmental effects on blocks this size, but visual quality was another matter. As an alternative, a computer visualization system was developed to produce images of the treatments implemented aross the entire hillslopee. This paper reports on the use of that system in evaluating the silvicultural treatments installed in the upland hardwood management study, as well as some observations on the validity of images produced, the drawbacks/problems associated with this type of approach, and some observations on the use of harvest unit boundaries and leave patches to mitigate visual impact.

A number of simulations were made using the visualization system. Presented in this paper are views of the uncut hillslope. plus a clearcut and strip ciearcut version, and a larger clearcut on the same hill with SMZs and visual screens. All images were made using topography data obtained from USGS and imported into a GIS. The GIS was used to create fictitious cut unit boundaries, as well as to measure areas of treated blocks.

Figure l shows a topographic map with the strip clearcut boundaries superimposed. Scale is not shown, but is approximately 8mm per km (1/2 inch per mile). Strips were approximately 46 m (1 50') wide, with 46 m intervals between. Total area was 18.2 ha (45 ac) for the three strip cuts. These boundaries in figure l served as the basis for simulating the strip clearcut, and the outer boundary of the three strips was used for the clearcut. Total area of the clearcut polygon was 3 l ha (76 ac).

A view point is also indicated on the map. This view point was about 600 m (2000 ft) from the middle of the hillslope across a narrow valley. It was higher than the surrounding ground and both cleared of trees and accessible. Photos were taken from the view point for comparison with simulated images. This point was also used as the viewer location for all simulated images.

Figure 2a shows topography of the same area with a somewhat larger clearcut boundary superimposed. Within the clearcut are three buffer zones covering the bottom of drains running downhill. This area was used as a potential realization of a large-scale clear-cut that might be applied on the hill. Total area of the clearcut was 48 ha (119 ac) excluding the buffer zones. Figure 2b is the same clearcut plus a series of small screens and patches used to both obscure parts of the clearcut and give the appearance of the larger area being composed of several smaller areas. These are standard options for mitigating visual impact of clearcuts.

Figure 3 is a scanned image of a photo of the hillslope taken from the view point in figure 1. The photo was taken using a standard 50 mm lens and recorded on slide film.

Simulated images were made using the system described in McDonald (In Press). This visualization system is built around a general-purpose ray tracing renderer. The renderer provides very flexible control over the ' camera' used to create the images. The simulated images were made using a wide-angle exposure in order to show a greater length of the hillslope for comparison among trcatmenr options. This is in contrast to the photo in figure 3 and should be kept in mind in making comparisons to the actual view.

RESULTS AND DISCUSSION

Figure 4 shows simulated versions of the hillslope in an uncut state, and with the clearcut and strip clearcut treatments imposed. Comparison of the uncut simulated image with the photo from figure 3 shows that there were some obvious differences between the two. The most striking was the amount of relief seen in the simulated ridgetop compared to the real one. The photo from figure 3 shows only a small section of the simulated hill slope in figure 4 and could, therefore, not be truly comparable. But, based on experience with other simulations, it was likely that the use of the USGS digital elevation model (DEM) to generate the topography led to errors. There is variability inherent in the DEM itself, as well as in the conversion from the 30 m grid used in the DEM to the triangular irregular network that serves as the ground surface in the simulated images.

Another obvious difference between the images in figures 3 and 4 were the textural characteristics of the vegetation. The simulated trees seemed somewhat 'smoother' in appearance than the real. The difference was more pronounced in the color versions of the images. The simulated trees were modeled using images of trees painted onto transparent boxes. The tree images used in this process were drawings instead of actual tree photos. The use of photos might have led to more realistic simulations. Although no direct comparison is possible from figure 3, it is likely that the cutover areas of figure4 would have shown qualitative differences with actual photos of slash and bare ground.

Despite some inconsistencies with reality, the images produced using the system were useful for comparison between treatments. There was a dramatic difference in the amount of visible ground surface between the two cutting patterns. It appeared from these results that the use of strip clearcutting should reduce the potential for negative public reaction to the harvest. No data are available, however, that might indicate the degree of benefit from implementing this silvicultural practice. Without this type of information it would be difficult to determine whether a 40 percent reduction in harvested volume, plus the added expense for marking, would be justified.

Strip clearcutting is a screening technique used to obscure the view of a harvested area. Some have charged (Wood 1988 for example) that this deceives the public concerning the nature of forest management and is counterproductive in the long term. Mitigating the visual impact of a harvest, on the other hand, is considered a prudent approach to gaining, or at least maintaining, public acceptance for the practice of forestry.

Mitigation techniques are more difficult to implement than simple screening. Calculating an average strip width to screen a harvest as in the above example could easily be done given data on slope and tree height. A rendering system for this situation is probably not necessary.

Placing cut unit boundaries for reducing visual impacts, however, is a more subtle process that benefits from the use of a design tool. Relatively small shifts in placement of screens, for example, or small patches of leave trees, can have fairly dramatic effects on the appearance of a harvest.

Figure 5 shows the hillslope of the previous examples with a 42.5 ha (105 ac) clearcut (46.1 ha bounded by cut unit, 3.6 ha in buffer strips). Although the buffer strips help break up the size of the unit visually, the clearcut still dominates the hillside visually. Adding two small, thinned strips and a couple of leave patches (see figure 2), however, seems to reduce the apparent size of the clearcut. Areas of the visual screens totaled 3.8 ha (9.5 ac) (2.6 in strips, 1.2 in patches), reducing total clearcut size to 38.6 ha (95.5 ac). Leave strips and patches had been 'thinned' to 75 simulated trees per ha (30 per ac) (down from about 125 per ha for the uncut areas).

It is also likely in this situation that an adequate job of mitigating visual impacts could have been done without first checking how it might appear using simulation - only a very few simple design principles were being applied on a limited basis. But because the consequences can be great, in some instances simulation can be justified. Also, from a design standpoint, it makes sense economically to retain as little of the harvested area as possible in leave strips. Use of visual simulations allows a designer to use a minimal amount of leave strip area while still doing an acceptable job of mitigating negative visual impacts.

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View Point

Figure 1. Map of the topography of the study area (low-high elevation is dark-light in color). Polygons show the outline of 18 ha (45 ac) strip clearcut. For comparison, a clearcut consisting of the outer boundary of the strips was also simulated. The view point used in all images is shown circled.

a)

b)

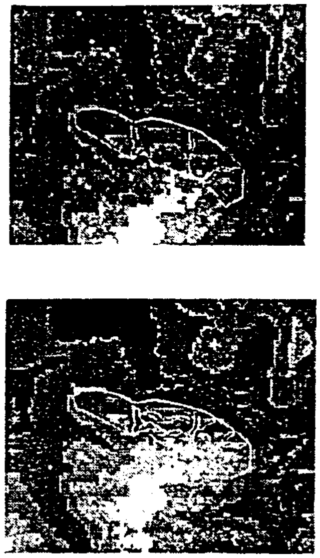

Figure 2. Two elevation maps showing the hillside with a large clearcut boundary. Streamside buffers are included in 2a. The addition of some small patches of leave trees is shown in 2b.

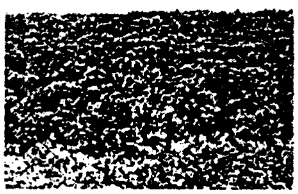

Figure 3. A photo showing how the hillside actually appeared from the view point.

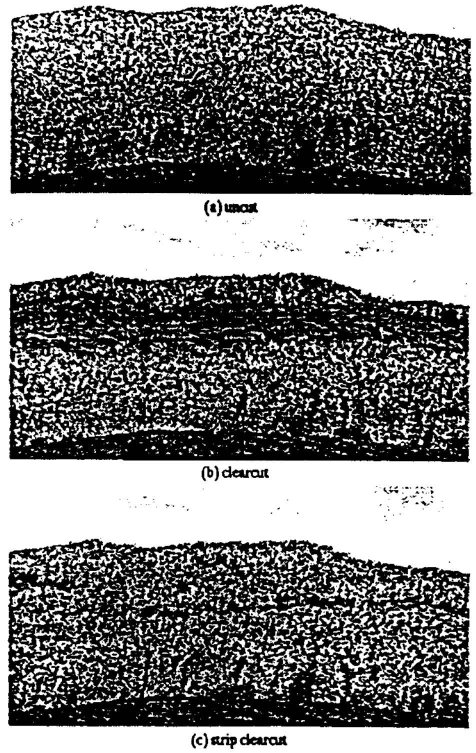

Figure 4. Simulated image as seen from the view point that compares the hillslope in an uncut, clearcut, and strip clearcut state.

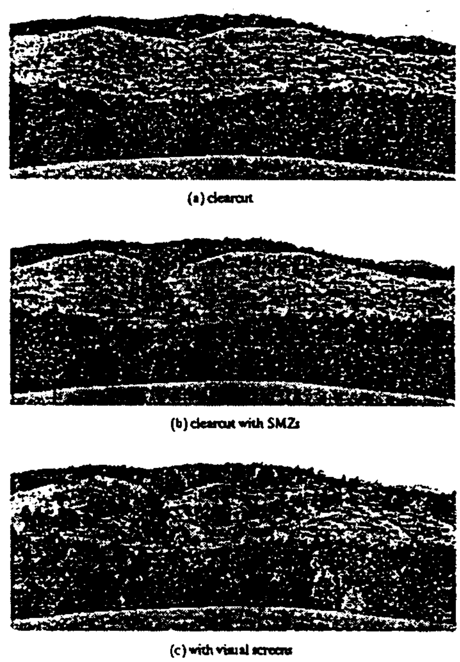

Figure 5. The same hillside with a larger clearcut, with SMZs added, and with additional visual screening patches.