VRM Inventory for the New Millennium

From December 11th through 14th, Chris Horyza of the Phoenix Field Office, Russ Jackson of the Branch of Photogrammetric Applications, National Science and Technology Center (NSTC), with guidance from Rich Hagan Landscape Architect, WO, met to discuss how to use current GIS and Image processing technology to facilitate new Visual Resource Management (VRM) inventories, or improve on existing inventories. During this meeting, several assumptions guided the process:

First, we assumed that different offices possess differing levels of technical expertise, and the process needs to be flexible enough to allow for that.

Second, we assumed that regardless of the offices' level of GIS expertise, some minimum level exists and will be made available, since GIS has been decided on as a tool for storing, analyzing, and producing map products from geospatial information for all upcoming land use plans.

Third, that any process devised must address the inventory method in Handbook H-8410-1.

And finally, with 41 planning starts in the Bureau in Fiscal Year 2001, an acceptable procedure, data standards, and general guidance for them needs to be provided to the field as soon as possible.

To address all of these, we decided on a three-stage approach, what we referred to as a "three model approach."

Model "A" could be called the "Low Tech" model. This model represents a process guided primarily by a traditional VRM inventory, using GIS basically as a storage and map production medium. Some fairly simple overlay analysis and reporting may be done, but most would require only basic training in GIS applications and could even be provided by state office, NSTC, or contract experts on a periodic, or on a "as needed" basis. This model requires local inventory labor (may be labor intensive) and some local GIS support (possibly by resources specialist(s) with GIS ability or as-needed off-site support). Also, some data preparation would be necessary prior to any GIS analysis being performed. If these skills already exist, this too could be accomplished by existing field office staff. If not, it could be provided by state offices, NSTC, or by contract.

Examples of GIS analysis that may be conducted: buffers at various distances; view-shed analysis (for visible or not visible); conversion of polygon data to grids and adding multiple grids together; conversion of grids back to polygons (conversion to shape files;) overlay (intersection or clip) to assess acreage; and the production of some map products for field or office use.

Examples of data preparation that may be needed; digitizing or scanning of overlays; registration of those same overlays; acquisition of digital elevation models; and the projection or re-projection of data.

Model "B" could be described as the "GIS Based" model. In this model, collection of various components of the VRM inventory rely on GIS or image analysis techniques for initial data, and field verification to finalize the classifications. This model assumes a fairly high level of GIS expertise at the local office and the necessary hardware and software (ArcView and Arc Info) to support it. This model recognizes that some aspects of VRM inventory are very subjective and cannot be adequately represented by objective analysis, so must still involve simple mapping and digitizing of those factors. Use of the procedures in this model, when perfected, should reduce field time necessary to conduct a VRM inventory, reduce the overall cost of VRM inventory, produce a more "repeatable" product that is more "accurate" than traditional inventory.

Examples of GIS analysis that may be conducted: analysis described under model "A" and; view-shed analysis with a frequency option; neighborhood analysis on grids generating statistical products; some image processing and analysis.

Model "C" could be described as the "Developmental Model" or the "High Tech" model. In this model, most analysis techniques would mirror model "B" above, but additional techniques, which require expertise not commonly found in a local field office, would be required. This model takes further advantage of "state-of-the-art" geospatial and visualization technology to reduce field time, make landscapes that change seasonally or over many years more easily visualized, to demonstrate visually "What if?" scenarios, and to expand the audience for these to a larger "community." This model has a risk of seeming to reproduce a real world landscape in a "virtual" setting. It remains imperative that people with local knowledge be always involved and field verification of classified products be conducted to ground any results in the real world.

Examples of analysis for model "C": like model "A" and "B" and including 3D visualization of the project area like might be done in World Construction Set or similar 3D visualization software.

These models not only represent various technological levels, they also represent a staged approach to getting VRM Inventory guidance to the field. Since Model "A" is a slightly modified version of the traditional VRM inventory necessary guidance to support field data collection (data standards and support data requirements) could be provided in a fairly short time frame. It is our goal to provide documentation to the field to be able to begin inventories in this manner by February 15, 2001.

Model "B" incorporates some analysis techniques that have not been perfected. These should be tested in various landscapes and a prototype process developed. It is our goal to conduct these tests and have a field-available prototype within 18 months (or by about June 2002.) To accomplish this goal, we will need additional assistance from the GIS and Image Processing community, or a formalized project, which would allow shedding enough current workload to conduct the necessary tests unfettered.

Model "C" is based in the analysis of Model "B", and on developing expertise in the technology of 3Dimensional Landscape Visualization. Since this 3D visualization technology is maturing rapidly and only recently has become practical on computer systems found commonly in BLM, it will require extensive testing of its capabilities and to develop VRM inventory techniques that can take advantage of it. It is our hope that we can have a prototype process for early 2003. As in Model "B" above, additional assistance will be needed to achieve this goal.

As stated above, a basic assumption of these three models is that they address the VRM inventory as described in H-8410-1. It may be argued that some adjustments to the VRM inventory procedure are made with each model. Handbook H-8410-1, Section I, Implementation Options states that adaptations to the inventory method may be made if they "(1) provide a more cost-effective way to complete a quality inventory, and (2) keep the conceptual framework of the Visual Resource Management (VRM) system intact." We feel the inventory process models described here accomplish this. But in fact, if no savings in time or dollars is demonstrated, the model must be either discarded or modified. The following is a discussion of the components of the VRM inventory and how each model addresses it.

In all of the models, some decisions must be made before any major analysis or mapping is done. First, a decision must be made on what the management objectives of Visual Resource management will be, and these will be expressed by the selection of "Key Observation Points or Areas" (KOP.) Much of the analysis and mapping will be based on the locations of these KOPs and they should be selected at the beginning of the process. How this selection is made may vary from model to model. Second, a decision must be made as to the "minimum mapping unit size" which is a way to express what the smallest manageable VRM unit can be. This is important because GIS can generate a large number of very small areas (or polygons, or pixels) that, in a practical sense, are not manageable. By deciding at the beginning of the project what is the minimum size area that is practical to manage, techniques in GIS can be used to keep the product maps as simple as possible and to reflect realistic management objectives. Of course, these two decisions will be based on the unique characteristics of the inventory area and the objectives driving the management of the visual resources. Since these will vary from office to office, and possibly between inventories within offices, one would expect that, even with inventory and data standards, inventories conducted by different offices, or by different teams at different times, may not seamlessly fit together in a larger map if one attempted to do so.

SCENIC QUALITY RATING

For evaluating the Scenic Quality component of the VRM inventory, it was decided to evaluate each of the rating factors separately, allowing the combination of these factors to define the boundaries of differing "Scenic Quality Rating Areas." Though the handbook calls for defining Scenic Quality Rating Units before rating the evaluation factors, even in its most rudimentary application, GIS can assist with the complex overlay analysis required to allow the landscape to define the units. Each rating factor and the model solutions will be discussed.

Landform

The characteristics of landform that is quantified in this factor are described by the statement (from Handbook H-8410-1) "Topography becomes more interesting as it gets steeper or more massive, or more severely or universally sculptured."

Model "A"

The ID team evaluating the inventory area would map areas according to their landform rating as described on the "Scenic Quality Inventory and Evaluation Chart." Mapping would be done at 1:100,000 scale, or larger, as appropriate to the inventory area. These overlays would then be digitized or scanned and converted to grid (cell, or raster) data for later analysis.

Model "B"

In model "B", emphasis is placed on deriving topographical variety. Landform can be analyzed by conducting a statistical neighborhood analysis of digital terrain models. It is recommended that the 30 meter Digital Elevation Models, mosaiced together for the inventory area, be used for all analysis using terrain models. For landform, the analysis would be to use a large roving window (75x75 cell window up to as large as 125x125 cells) and create a new cell map of the variance of the roving window. If you cannot calculate the variance directly, the analysis can use the standard deviation, then square the resulting map to create a map with variance values. When the variance map is displayed in three standard deviation categories, the landscape is divided into three classes, which can be attributed as the three landform classes. The product will vary with changes in roving window dimensions and several attempts may need to be run to determine the best size for the particular landscape being classified.

An alternative analysis method may be to use the Terrain Ruggedness Index value as defined by Riley et. al. in their article titled "A Terrain Ruggedness Index that quantifies topographic heterogeneity" in the *Intermountain Journal of Science* (vol. 5, no. 1-4, 1999) and used by Jacek Blaszczynski (BLM National Science and Technology Center) for various landscape analysis techniques.

Model "C"

Analysis in Model "C" may be the same as in "B", but the reference data may be more precise and generated from sources other than USGS DEM. Other terrain data sources (ex. Radar, lidar, etc.) should be assessed and the affect on the roving window dimensions, or other analysis variables should be described. Further, Model "C" could include additional subjective input from people viewing 3-dimensional landscape representations in workshop settings.

Vegetation

Vegetation characteristics that are quantified in this factor are described in Handbook H-8410-1 as, "…consideration to the variety of patterns, forms, and textures created by plant life."

Model "A"

Vegetation is classified as described in the traditional inventory method on the "Scenic Quality Inventory and Evaluation Chart" and mapped on 1:100,000 scale overlays (or a scale appropriate to the inventory area.) The overlays are digitized and converted to grid for later analysis.

Model "B"

In model "B", emphasis is placed on methods to derive vegetation variety. Several possible analytical techniques could be tried, or possibly combined to derive this factor.

One possibility could involve using existing vegetation data, reclassified according to its visual characteristics and a roving window analysis similar to the landform discussion above to derive vegetation variety.

Another possibility is to use image processing on natural color, black and white, or false color infrared imagery to create textural communities. Electro-optical (E/O) imagery should be used to mimic as near as possible what is seen on the ground. This process might involve:

1) Unsupervised classification
2) Use of variance analysis on the product

Or

1) On original imagery (or vegetation maps) attempt to capture vegetation variety.

The technique developed in model "B" could increase the repeatability and reliability of mapping this factor, and reduce the time and people commitment to its compilation for final VRM inventory classification.

Model "C"

Analysis similar to model "B", except might be able to add analysis of vegetation relief. Model "C" could also incorporate 3 dimensional landscape visualization for simulating vegetation changes over seasons, or long-term as one might expect in various land treatments like timber harvests, range seedings, annual wildflower displays, prescribed burns or wildfires, etc.

Water

The characteristics of water to consider in the Scenic Quality rating are described in the H-8410-1 handbook as “That ingredient which adds movement or serenity to a scene. The degree to which water dominates the scene is the primary consideration in selecting the rating score.”

Model “A”

Manual mapping of areas rated for the dominance of visible water’s contribution to the scene as described above. This is mapped on 1:100,000 scale maps and digitized, then converted to grid for later analysis.

Model “B”

For purposes of deriving this factor, the elements of distance and visibility are emphasized in the analysis. Water bodies (streams, lakes, waterfalls, etc.) are mapped as points, lines or polygons as appropriate. The team defines distances from these waters that allow us to infer dominance i.e. The closer the observer is to the water body, the greater that feature dominates the scene. View-shed analysis is then conducted from these water bodies at the various dominance inferred distances and combined to derive an overlay reflecting the water factor.

Model “C”

Include and analyze visible motion of water bodies and infer a higher level of dominance in the landscape. Use 3 dimensional representations to assist with the classification of dominance. The 3D representations, if realistically rendered, can reduce field time and aid in viewing features that may be difficult to get to on the ground. Furthermore, they can allow us to share these features with a much wider audience than is usually possible in a normal field visit.

Color

The H-8410-1 handbook describes color as “…the overall color(s) of the basic components of the landscape (e.g., soil, rock, vegetation, etc.) as they appear during seasons or periods of high use.” Key factors to use when rating “color” are variety, contrast, and harmony.”

Model “A”

Based on knowledge of ID team and field visits as necessary, map areas of rich color contrasts, and variety and rate them as described on the Scenic Quality Inventory and Evaluation Chart. This mapping, at 1:100,000 scale will be digitized and converted to grid for later analysis.

Model “B”

Analysis techniques would emphasize the elements of color contrast and variety. By using natural color imagery, may be able to use a neighborhood analysis technique similar to that described for landform, to derive an index of color variety. Also, there may be ways to use image analysis to derive contrast and richness from the color values of hue, saturation, and intensity (or value) or the

Red-Green-Blue values, or the Cyan-Yellow-Magenta-Black values as plotted in a 3 dimensional color space. If analysis techniques fall short of deriving the inherently subjective key factors for color, mapping as described for model "A" may be required. Even if analysis techniques show promise in capturing some aspects of rating color, adjustments to the overlay boundaries based on local knowledge may be necessary to fully characterize this factor.

Model "C"

Analysis techniques like in model "B" may be done, but use of realistic 3 dimensional landscape renderings can help to view more areas in the inventory area, visualize those landscapes with more realistic colors, and share those landscapes with a much wider audience than the other two models. Inherently subjective characteristics of color and the temporal changes caused by seasons or vegetation aging after human or natural treatments can be better described and shared in a virtual environment.

<u>Scarcity</u>

The H-8410-1 handbook says that the scarcity factor "…provides an opportunity to give added importance to…scenic features that appear to be relatively unique or rare…" Rating scores are based on the degree of the feature's rarity and on the opportunity for consistent exceptional wildlife or wildflower viewing. This is the only key factor that allows a rating score higher than 5 with written justification.

Model "A"

Landscape features that are unique or rare in the physiographic region are mapped and rated according to the criteria in the Scenic Quality Inventory and Evaluation Chart. These overlay(s) are digitized and converted to grid for later analysis.

Model "B"

Scarcity may be difficult, if not impossible, to derive from GIS and Image processing analytical techniques. For now, model "B" is the same procedure as model "A".

Model "C"

Model "C" may not have any new analysis techniques, but using a realistic 3 dimensional landscape visualization tool, scarce features can be rendered and shared with a larger audience. This could help to build consensus on the contribution of scarce features to the aesthetic landscape, and therefore, to their management prescriptions.

<u>Cultural Modifications</u>

These are described in the H-8410-1 handbook as "Cultural modifications in the landform/water, vegetation, and addition of structures… may detract from the scenery…

or complement or improve the scenic quality of a…" landscape. This is the only Scenic Quality key factor that can receive a negative score, reducing the overall scenic rating.

Model "A"

A view-shed analysis could be run from the identified Key Observation Points/Areas. Existing cultural modifications can be mapped in the "visible" area and, based on local knowledge and field visits where considered necessary, landscapes can be mapped and rated according to the visual impact of those features. These overlays would be digitized and converted to grid for later analysis.

Model "B"

An analysis similar to the model "B" example for Water could be devised. In this analysis, all cultural modifications would be scored (or, the analysis could be simplified by using only the cultural modifications within the view-shed of the KOPs as in model "A") according to their potential affect on the scenic quality rating. These scores could be distance based, such as a range fence could score a –2 up to 30 meters away, -1 from 31 to 100 meters, and 0 beyond 100 meters. Or a rustic cabin may score a –2 up to 100 meters away, and +2 from 100 to 3000 meters and 0 over 3000 meters. View-shed analyses could be run from these features and controlled by the coded distances and ratings assigned to the results according to the coded rating scores. If conducted on all cultural modifications, this could reduce the dependence of the final VRM classifications on visibility from set Key Observation Areas.

Model "C"

An analysis process as described in model "B" may still be employed, but a realistic 3 dimensional landscape rendering tool could assist the ID team, and a larger audience as well, to visualize the cultural modifications being analyzed and reach a consensus on rating scores.

Adjacent Scenery

The H-8410-1 handbook describes adjacent scenery as "The degree to which scenery outside the scenery unit being rated enhances the overall impression of the scenery within the rating unit." It goes on to say that "This factor is generally applied to units which would normally rate very low in score, but the influence of the adjacent unit would enhance the visual quality and raise the score." In a practical sense, since the Adjacent Scenery key factor can add from 0 to 5 points to a scenic quality rating, a preliminary Scenic Quality Rating score must be between 7 and 11 for this factor to have an effect on the overall Scenic Quality Rating for a particular landscape. Regardless of the analysis model, the scores for the other Scenic Quality key factors should be added together first, and if the Scenic Quality total score is between 7 and 11, only then should the Adjacent Scenery Key Factor be analyzed, scored, and added to the Scenic Quality total score.

Model "A"

For those areas determined to have a preliminary Scenic Quality Rating of “C”, but close enough to the “B” rating to potentially benefit from an Adjacent Scenery score, the team can adjust the Scenic Quality rating based on consensus of the influence of adjacent scenery. This is a subjective rating and adjustments to the GIS database would be done manually.

(Note: Here’s a proposed methodology to get to this point. First, the grids that were created throughout the model “A” discussions above are mathematically added together. Second, the product grid can be reclassified into 3 categories based on the Scenic Quality Rating guidance in H-8410-1 where scores of 0 to 11 = C scenery, 12 to 18 = B scenery, and scores of 19 and above = A scenery. Third, areas with scores of 7 to 11 can be extracted separately for consideration of the Adjacent Scenery key factor. And finally, once a final Scenic Quality Rating grid is made, it can be vectorized and any polygons smaller than the agreed upon minimum mapping unit absorbed (eliminated) into the larger surrounding units. Or, the grid may be analyzed for clumps of cells of similar value which total less than the agreed upon minimum mapping unit size and those can be absorbed into the majority surrounding rating unit. This small area elimination process could wait until the final VRM Inventory classification is done but may keep the overall process “cleaner” if it is done here. At any rate, a grid should be the product of Scenic Quality for later analysis with the other major VRM components)

Model “B”

Analysis of Adjacent Scenery would be essentially the same for model “B” as in model “A”. The main difference is the way the previous six key factor “overlays” are derived. The Note under model “A” applies as well.

Model “C”

Overall analysis of Adjacent Scenery would be as in the previous two models, except a realistic 3 dimensional landscape visualization tool could improve the ability of the ID team, and a larger audience too if desired, to assess the influence of adjacent scenery to those units for which it may contribute to its overall Scenic Quality Rating.

(Note: It should be noted that a realistic 3 dimensional landscape visualization, or essentially a virtual reality rendering, of inventory landscapes is a common thread throughout this model. It should be stated that the degree of realism is a critical factor to the contribution of this technology to the VRM inventory process. Because these renderings will most likely be developed at a site remote to the field office conducting the VRM inventory, the realism of the product(s) must be assessed by people with extensive local knowledge and validated in the field. There exists a risk of biasing the computer generated landscapes to make them look better (or worse) than they really are. As with any influential technology, it MUST be applied with integrity and frequently validated and verified in the field by knowledgeable people.)

<u>SCENIC SENSITIVITY RATING</u>

For evaluating Scenic Sensitivity, we agreed the ratings were potentially very subjective. Because of the level of GIS expertise needed to characterize the landscape for this component of the VRM inventory, the differences between Models "A" and "B" are greater than with the Scenic Quality component. However, some offices may find an analysis methodology that is somewhere between the model "A" and model "B" suggested here.

Model "A"

Using traditional techniques to assess Visual Sensitivity, delineate Sensitivity Level Rating Units (as described in Handbook H-8410-1 at 1:100,000 scale) and score their sensitivity. Digitize these overlays and convert to grid for later analysis with the other two VRM inventory component overlays.

Model "B"

Design for model "B" is similar to that for Scenic Quality, i.e. constructing a separate overlay for each key factor to be rated, and then combining those overlays to create an overall Scenic Sensitivity Rating overlay. The following is a discussion of each of the key factors for rating Visual Sensitivity and how they could be addressed using GIS in a model "B" philosophy.

<u>Type of User</u>

Meetings would be held and informal contacts made with different user groups. At these meetings, maps would be made of the areas they use and discussions would be geared toward how they would react to various kinds of possible activities happening in the areas they use. In this way, we could map where the fisherman go, where hunters go, where OHV users go, where backpackers go, and, from the discussions on reactions to activities, gauge their sensitivity to activities we might entertain. It must be remembered that in the context of VRM, the area of use extends beyond the places people camp or the roads and trails they use to the landscape that is visible from those camps, roads, and trails. So, this being the case, once the areas people go to are mapped, view-shed analysis is conducted to derive the landscape that is being inventoried for sensitivity. The results of the various view-sheds can be added together to derive a map showing areas of high, moderate, and low use, (high given a score of 5, moderate a score of 3, and low a score of 1) which can then move forward for later analysis in derivation of a final Visual Sensitivity rating.

<u>Amount of Use</u>

This layer is mapped in the context of <u>visual use</u>. To begin this process, use data from various existing sources (car counters, visitor registers, etc.) to derive overlays of use levels for features in the inventory area, and distinguish them as High, Moderate, or Low using the visitation standards described in Handbook H-8410-1, Illustration 8, page 2, "Table for Classifying Amount of Use." View-shed analysis is then run from these features to define the visual landscapes that are represented. These are then coded as to the use category and combined so high, moderate and low use areas are all on the same Visual Use overlay.

One way to combine them would be to add them together and reclassify the cell values so values > 4 are assigned the value of 5, values of 2 and 3 are assigned 3, and the value of 1 remains 1. ***Chris*** -- ***QUESTION – Why break it here? How many cell values would/could there be? Can you clarify?***

Sensitivity Levels

Sensitivity Level is an attempt to map the publics' interest in the visual landscapes within the inventory area. Some of this will be done in conjunction with collection of Type of User information. Other ways to collect this information are:

1) Informal contact with land users in community gathering places. Take maps of the inventory area to these gathering places and have people show you (actually draw on the map) where they like to go and where their "special" places are. Get as many of these contacts as possible. If it would be useful, could show pictures of different kinds of possible activities to get peoples' reactions.

2) Have public workshops and invite locals who spend time in and around the inventory area to show on maps their "special" areas. As in 1) above, show pictures or slides of possible activities to get peoples' reactions.

3) Put maps on the internet along with pictures of possible activities. Have people delineated the areas that they consider "special" and get information similar to 1) and 2) above.

All the maps collected in the process above would be aggregated into a single layer of public interest and coded with 5 for high, 3 for moderate, and 1 for low.

Adjacent Land Uses

Identify land uses adjacent (or within five miles) of the inventory area that might have an effect on the visual sensitivity of the inventory area. For example, residential areas from which BLM lands are visible may have high sensitivity to visual changes on those lands. Parks or recreation areas adjacent to, or near, BLM lands may infer high sensitivity to visual changes on the lands visible from them. These possible sources of sensitivity should be identified and mapped. View-shed analysis would be run from them to identify the visible landscape affected. If several view-shed analyses are run, they should be aggregated and coded with 5 for high sensitivity, 3 for moderate sensitivity, and 1 for low sensitivity. ***Chris – another question – what criteria do you suggest to base the sensitivity on? Number of viewers? Density of homes? Number of visitors to adjacent parks?***

Special Areas

Special management areas such as wilderness, wilderness study areas, wild and scenic rivers, ***(Chris, do you know how the new monuments and NCAs are to be classed?)*** and others with special Visual Resource Management objectives are mapped and coded according to their visual sensitivity. Some special management areas, such as historic trails, may have visual objectives for the landscape visible from them as well as within the special management area. For these, view-shed analysis should be conducted from them to derive the affected landscape.

*Note: In most cases, the sensitivity ratings for this key factor will be high and will supercede any lower rating from other key factors. When the key factor overlays are combined, the other 4 or 5 should be done first, then the Special Areas overlay can be combined with the product for a final Visual Sensitivity overlay. Or, the Special Areas overlay can be added together with the others at the same time if a numeric value is assigned to the mapped Special Areas that will assure a high sensitivity rating. (For example, if all special management areas were coded with a "20," the sensitivity would automatically fall into the high range.) Or, especially in the case of Wilderness Areas, which are managerially mandated as VRM Class I, keep these as a separate overlay for combination at the end of the process.

Other Factors

If there are other factors that were not considered in the previous 5 key factors, that affect public sensitivity to changes in the visual landscape, they could be mapped and coded here. Assign values to the landscapes as in the other key factors with 5 for high sensitivity, 3 for moderate sensitivity, and 1 for low sensitivity. Be sure to identify and justify these additional factors. Care should be taken to not use this miscellaneous category to justify personal, or special interests to achieve a predetermined solution.

Model "C"

The common thread with model "C" throughout this discussion has been development of realistic 3 dimensional landscape representations. For sensitivity analysis, this could be used as a presentation tool to great advantage. This tool could be used by the inventory team to possibly reduce field time, but primarily as a presentation tool for the public and for management. "What If" scenarios can be viewed showing various management activities that may change the visual landscape. Temporal changes of season or of longer term can be portrayed so sensitivity portraying short and long term changes can be assessed. And, if done well, the cumulative effect of activities over the years could be assessed. Realistic 3 dimensional representations would make potential management activities more real to the public than the traditional slides and photographs. And the audience reached could be expanded beyond the Bureau's traditional constituents by placing these representations on Bureau websites for wider distribution.

In conclusion, each of the key factors for rating the Sensitivity Levels would be represented by a coded raster overlay. These overlays could be added together (see note under Special Areas) and sensitivity classes extracted from the product by reclassifying as:

Values greater than or equal to 19 = high,

Values 9 to 18 = moderate,

Values less than or equal to 8 = low.

Chris – suggest we use different numeric ranges than what is found on the Scenic Quality Inventory and Evaluation Chart. As this is an arbitrary numbering scheme, how about less than 5 = low, 6 – 10 = moderate, 11 - 15 = high? We can look at this closer as we get further into the Model B analysis. But right now, I'm concerned that having the same values as Scenic Quality, reviewers of this document will be confused about the scoring of Sensitivity as opposed to Quality.

DISTANCE ZONES

The basic assumption of distance analysis is that visual change is more significant the closer it is to the observer. In the traditional approach to this VRM component, key observation points or areas are defined at the beginning of the inventory and this component is analyzed from those. The question was asked if we could do analysis to account for future key observation areas? Though it is theoretically possible, this would result in one of two outcomes. First, analyzing for varying distance zones from any possible key observation area would result in a volume of data beyond the storage capacity of most computers. Or, the entire landscape would be treated as foreground/middle ground (the near-observer class) and the Visual Resource Management classes may not accurately reflect reasonable management prescriptions. In a sense, Scenic Quality and especially Visual Sensitivity are components of the VRM inventory that emphasize protection of landscapes from visual change. The distance zone analysis brings the inventory into context with the visual management objectives for the studied landscape and ameliorates the possibility of excessive restrictions.

Use of GIS technology, even in the model "A" concept can result in considerable timesavings and a more accurate representation of the visible landscapes from pre-mapped Key Observation Points and Areas. The result of this analysis, if documented, is also more repeatable than traditional methods of calculating this component.

Model "A"

> Key Observation Areas are defined and mapped. Distance buffers are run from these consistent with guidance in handbook H-8410-1. View-shed analysis would them be conducted using medium resolution terrain data (30 to 90 meter) to define the Seldom Seen class. The products of the distance buffers and the seldom seen analysis would be combined for a final Distance Zone overlay.

Model "B"

> Key Observation Areas defined and mapped as in model "A". Then, view-shed could be run from these using the frequency method and controlled distances for a

more detailed "visibility" analysis. The landscape could be divided further than in model "A" by defining a "not visible" class, a "seldom seen" class, and low, moderate, and high visibility within the various distance ranges based on the frequency value. (The frequency value product of this analysis is the number of Key Observation Points the particular cell in the product map is visible from. For example, if a cell has the value of 5, that place on the ground is visible from 5 Key Observation Points. View-shed analysis handles areas such as roads or the surface of a lake as a set of points, each of which would be considered a Key Observation Point for this analysis.) The product grid could be reclassified so that if the value of the cell is 0, it is considered "not visible." If the value is less than 5% of the total Key Observation Points defined, it could receive a classification of "seldom seen." Other visibility classes could be defined if they help to refine Visual Resource Management objectives, or they could be handled the same as the distance zones in the handbook guidance.

Model "B" could also incorporate varying Minimum Mapping Unit sizes into the process. (*Note: These minimum mapping units are a measure of our ability to manage VRM in potentially isolated islands. It characterizes the possibility that small areas of either high visual sensitivity, or low visibility (therefore low sensitivity) close to the observer may be important enough to warrant managing for very small land areas.) For example, from 0 to 1.5 miles away from the Key Observation Area, classifications as in the previous paragraph would be retained for areas over 2.5 acres. But, from 1.5 to 3 miles, the minimum area size would need to be more than 5 acres. From 3 to 5 miles away, the minimum mapping unit could be 25 acres, and in excess of 5 miles, 100 acres.

Model "C"

Model "C" could incorporate algorithms that account for varying distance zones based on observer viewing time. For example, if a Key Observation Area is an interstate freeway, travel speed narrows the distance zones of the viewer and reduces the time a particular point on the landscape is visible. However, if delays such as traffic bottlenecks commonly occur in some places, speed slows (or maybe even stops) and observers have more time, widening the distance zones and increasing viewing times. Distance zones could be fluid based on these kinds of inputs.

Model "C" might be able to address ridge top skylines also. Activities that may not be particularly visible on the face of a slope may stand out if conducted on a ridge top as viewed from a Key Observation Area or Point. At present, Model "B" has no good way to analyze this.

VRM INVENTORY CLASS DELINIATION

The process of defining the VRM Inventory classes is the same with models "A" and "B." Using raster processing capability, the overlays for the three components (and

Special Management Areas if there are any) are added together or re-combined for the final classes. Two possible methods are described here.

Method 1

1> Assign the value of 1000 to all features of the Special Management Areas (Wilderness) overlay.
2> Assign values to the Scenic Quality where “A” scenery = 500, “B” scenery = 300, and “C” scenery = 100.
3> Assign values to Visual Sensitivity where High = 50, moderate = 30, and Low = 10.
4> Assign values to the Distance Zones where foreground/middle ground = 5, Background = 3, and Seldom Seen = 1.

Then, add the reclassified raster maps together and reclassify the product as follows:

1> Values greater than or equal to 1000 = VRM Class I.
2> Values greater than or equal to 355 but less than 1000 = VRM Class II.
3> Values of 155, 335, and 353 = VRM Class III.
4> The value of 351 is VRM Class III if it is adjacent to VRM Class III, II, or I. If adjacent to Class IV, it is Class IV.
5> Values of 111, 131, 133, 135, 151, and 153 = VRM Class IV.

Method 2

If the GIS supports Boolean analysis, the cell values are not as important as in Method 1, as long as they can be defined by their appropriate class. A Boolean formula, such as follows, could be written to define the VRM Inventory classes from the separate overlays.

If Special Management Areas = yes, VRM Class I.

Or, if Scenic Quality is “A”, VRM Class II,

Or, if Scenic Quality is “B,” and Sensitivity is “high,” and Distance is “foreground/middle ground”, VRM Class II,

Or, if Scenic Quality is “B,” and Sensitivity is “high,” and Distance is “background,” VRM Class III,

Or, if Scenic Quality is “B,” and Sensitivity is “medium,” and Distance is “foreground/middle ground,” VRM Class III,

Or, if Scenic Quality is “B,” and Sensitivity is “high,” and Distance is “seldom seen,’ and adjacent to VRM Class I, II, or III, VRM Class III, Or, if Scenic Quality is “B,” and Sensitivity is “high,” and Distance is “seldom seen,’ and adjacent to VRM Class IV, VRM Class IV,

Or, if Scenic Quality is “C,” and Sensitivity is “high,” and Distance is “foreground/middle ground,” VRM Class III,

Or, if Scenic Quality is “C,” and Sensitivity is “high,” and Distance is “background” or “seldom seen,” VRM Class IV,

Or, if Scenic Quality is “C,” and Sensitivity is “medium” or “low,” VRM Class IV,

The previous classification methods are just two possibilities. Both were based on the table in Handbook H-8410-1 entitled “Illustration 11 (VA1),” and the tabular illustration under section A2 on that page. These analyses simply use the same products described in the VRM Inventory Handbook H-8410-1, but derived in various digital methods, and applies the classification criteria as defined in the referenced Illustration. The crosshatching patterns described in section B on the same page, though elegant in their simplicity as a method to derive VRM Classes, would be unnecessary.

CONCLUSION

The previous discussion attempts to “modernize” the VRM inventory process to take advantage of advancing technology to improve the quality of the results, (and therefore make better decisions) enhance the repeatability of the results, reduce the time needed to conduct an inventory, reduce the workload impacts of VRM inventory on the local office, and possibly to reduce the cost. The basic premise of the discussions leading up to this paper was to use technology available in the field to improve inventory procedures, without changing the basic concepts the VRM inventory is built on. Due to the large number of Planning starts scheduled for the BLM in fiscal year 2001, we also wanted to get a method to the field as soon as possible. The three-model structure decided on (and described throughout this paper,) addresses the need for an acceptable procedure quickly available to the field, as well as possibilities for further work to take greater advantage of technology.