LITERATURE REVIEW

SCENIC LANDSCAPE ASSESSMENT AND ARCHIVE PROJECT

Scenic VIRGINIA

Literature Review

Scenic Landscape Assessment and Archive Project

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Introduction

In this report, theory and techniques related to scenic assessment were reviewed. The purpose of this review is to determine appropriate variables and measures to use when assessing the scenic quality of viewsheds. A literature search was conducted resulting in two databases. These databases are stored as Excel files titled "Literature Review Data Bases I and II" and can be accessed with the following link.
(https://drive.google.com/file/d/1umd8pPV_inCnUBYSDs3aQ0OyAxBu6xmV/view?usp=sharing)

Sheet 1 is titled "Literature Review Data Base Derived from Keyword Search of Journals and Books." The researcher selected keywords to identify journal articles and books related to the purpose of this review. The nine keywords used in this search include the following or phrases: Scenic value, scenic beauty, visual assessment, landscape preference, visual quality, scenic quality, visual resource management, landscape quality, and landscape assessment. The search garnered 853 citations from the years 1969 to 2018. Included in the database are the abstract and URL for each article or book. The URLs can be used to access the journal articles online.

Sheet 2 is titled "Scenic Solutions Website" and is a database created by Dr. Andrew Lothian, the owner of the Scenic Solutions website. Dr. Lothian identified citations for 1,854 publications, including journal articles, books, and reports published during the period 1936 to 2014. The publications contained in these two databases provide the basis for the theories, models, and tools used in this study. This literature review first examines the different ways in which various authors have classified landscape assessment methods. There are overlapping areas in these classifications. It is necessary to understand, however, that there are different ways of thinking about the how to assess the scenic value. This review then follows one of the categorization assessment methods more closely -- that proposed by Daniel and Vining (1983). This categorization includes four categories (see below) and is clear, comprehensive, and potentially helpful in developing an appropriate method for assessing scenic viewsheds in Virginia and other places as well. The basic components of each category are described in detail.

Numerous landscape assessment tools have been developed and in use for a long time, particularly over the last 50 years. Landscape assessment models have been classified in various ways by different researchers. Among them, classical models were reviewed. Arthur, Daniel, and Boster (1977) split tools into descriptive inventories and public preference models. Zube, Sell, and Taylor (1982) divide the models into four landscape perception paradigms: The expert, psychophysical, cognitive, and experimental. Briggs and France (1980) use direct and indirect methods to divide scenic assessment into classificatory and non-classificatory methods. This literature review follows Daniel and Vining's classification (1983). Daniel and Vining split landscape assessment into four categories: Formal aesthetic, psychophysical, psychological, and ecological models. Their classification includes methods focused on the individual's experience of the landscape and resulting perceptions of their experience, as well as those that are based on evaluation of the landscape. This literature review is organized according to Daniel and Vining's four models: Formal aesthetic, psychophysical, psychological, and ecological (see Table 1 - Scenic landscape assessment classification).

Table 1. Scenic landscape assessment classification

	Evaluation	Preference
Theoretical	Ecological model	Psychological model
Empirical	Formal aesthetic model	Psychophysical model

Revised by authors based on Peng and Han's study (Peng & Han, 2018)

1. Formal Aesthetic Models

The formal aesthetic model is based on formal aesthetic principles expressed in the landscape. Landscape elements, such as form, line, color, and texture are evaluated for their contribution to intrinsic aesthetic quality of the landscape. In assessing aesthetic value landscape architects analyze the composition of these elements in terms of aesthetic properties such as harmony, unity, contrast, and variety (T. C. Daniel & Vining, 1983). This model requires understanding landscape elements and aesthetic principles and is applied experts. Some call this expert approach. Application requires some knowledge or training. Four examples of this approach are described below. The first, Forest Landscape Description and Inventories (Litton, 1968), describes the basic elements used in this approach. The next three examples, Visual Management

System, Scenery Management System, and Combined Landscape Value, describe how these basic elements can be used in assessing visual quality.

Forest Landscape Description and Inventories:

Litton (1968), a professor at the University of California at Berkeley and a researcher for the US Forest Service, studied the visual characteristics of the forest landscape as a visual resource. His work had four objectives: To recognize the impacts of landscape alterations on the landscape, to devise means of recording and expressing the visual character of the landscape, to understand the relationships between resource management and the visual resource, and to pose areas of future research concerned with better and more comprehensive use of the forest (Litton, 1968). As a description and inventory of the landscape, his study provides well-defined landscape units and an understandable method for documenting visual resources. This study assumes the landscape is a scenic resource that has an aesthetic value. With this assumption, the study offers identification of landscape features affecting visual quality, factors that affect visual perception and ways of categorizing scenic resources.

Litton pointed out six landscape factors that affect the observer experience of scenic quality: Distance, observer position, form, spatial definition, light, and sequence (Litton & Twiss, 1967). All of these variables have been used in scenic landscape assessments. Litton divided variables into essential features and the relationship of essential features to the observer. Three of these fundamental features are form, spatial definition, and light. They are properties of the landscape that cannot be altered easily. Three other factors, distance, observer position, and sequence depend on the relationship between the observer and the landscape (Litton, 1968). Viewer distance and observer position are important variables that offer promise in rating scenic viewsheds in Virginia and other places.

One of the fundamental features of the landscape is form. Topographic form refers to three-dimensional convex elements, such as mountains, ranges, hills, knolls, crests, ridges, cliffs, islands, mesas, escarpments, spits, and domes (see Table 2 - Form and spatial definition). Since Litton thought of the landscape form as a topographic form, the topographic map is the first step in understanding and finding forms in the landscape. To recognize dominant landforms, Litton recommends checking a topographic map and looking for abrupt changes in contours (Litton, 1968).

The second fundamental feature, spatial definition (see Table 2 - Form and spatial definition), refers to three-dimensional concave elements of the landscape, such as basin, valley, canyon, crater, pocket, meadow, glade and others (Litton, 1968).

Table 2. Form and spatial definition

Factors	Examples
Form (convex)	Range, mountain, cinder cone, hill, bald, butte (mesa), knoll, dome, crest, ridge, escarpment, crag, cliff, island, spit
Spatial definition (concave)	Basin, valley, canyon, crater, ravine, gorge, crique, pocket, dale, meadow, glade, swale

The last factor among these fundamental features is light. Litton thought that an understanding of light (Litton, 1968)is essential to predicting and understanding the visual consequences of land-use decisions. He considers color, distance, and direction as subsets of the light. For color as a basic manifestation of light, he mentions two features: hue and value. Hue is the difference in color -- what we call red, green and others. Value is what we call dark and light. The color, which includes hue and value, affects form, shape, and prominence. Directions of light are backlight, side light, and front light. Due to the direction of lighting, shadow sometimes accentuates landscape features, especially form. While these are important visual qualities, they are difficult to use in assessment and management as described in the next two sections.

More useful for Litton is the relationship between the observer and the landscape. Litton identifies three relationships: Distance, observer position, and sequence. Distance zones are divided into three types: Foreground, middle-ground, and background (Litton, 1968). The viewing experience is different when viewing the landscape from different distances. In the foreground, one sees details (colors, textures and etc.) but has difficulty seeing the larger patterns of vegetation and landforms. It is in the middle-ground that one can see the forms and shapes in the landscape. Variety or complexity in the landscape is easiest to assess in the middle-ground distance zone. In the background distance zone, visual elements are muted by distance and atmosphere.

Observer position refers to the location of the observer with respect to the landscape being viewed. Litton defines three observer positions: observer inferior, observer normal, and observer superior. Observer inferior is the position wherein the observer needs to look up to view the landscape. The observer experiences visual blockage by the landscape when in the observer inferior position. Observer normal is an eye-level position. Observer superior is looking down on the landscape from a ridge top or a mountain summit. The observer superior position is often a higher quality visual experience.

The last factor is a sequential visual experience that refers to the progressive inter-relationships of forms, distances, spatial definition, lighting, and observer position (Litton, 1968). Sequential visual experience is not applicable in assessing viewsheds. However, distance zones and observer position are very helpful in assessing viewsheds.

Based on analysis of these six factors, Litton suggests the technique applicable to forest management and landscape inventories. One of the interesting aspects of this model is the ephemeral landscape. He points out that ephemeral qualities the landscape depend on transitory effects, and ephemeral qualities may last for various time scales, from seconds to particular seasons of the year. Litton identifies five types of ephemeral landscapes: (1) Atmospheric and weather conditions, (2) projected and reflected images, (3) displacements, (4) signs, and (5) animal occupancy. For land managers and landscape architects, he accentuates the importance of ephemeral as reinforcing impacts of the complexity and sensitivity to the landscape (Litton, 1968). It would be helpful in assessing scenic value to understand the extent that ephemeral features are regularly part of a viewshed.

Litton's work summarizes how to identify and record the essential components of the landscape and the viewer experience that make up its visual character. So, rather than assess the scenic quality, this study identifies those concepts and ideas that are important in order to understand the visual character and visual experience of the landscape. In this regard, this work has been widely used by others (USDA Forest Service 1974 and USDI Bureau of Land Management 1980). Some of these ideas and concepts are relevant to evaluating the scenic quality of viewsheds as well. Observer position and distance zones are essential aspects of the visual experience of a viewshed. In addition, topographic form and spatial definition are contributing factors to variables used to evaluate the scenic quality of a viewshed.

Visual Management System:

Two examples of formal aesthetic model are the Visual Management System (VMS) developed by the US Forest Service (1974) and the Visual Resource Management Program (VRM) developed by the US Bureau of Land Management (1980). Increasing concerns about the quality of visual environments paired with the public demand for resources from the same land offer strong justification for creating an inventory of visual resources and providing measurable standards to manage them (Bacon, 1979). To protect visual resources, the VMS and (VRM) were developed as a management system that draw on the basic concepts, elements, principles, and variables of visual resource management. Based on Litton's system (1968), the VMS model considers landscape variety or visual complexity as the most dominant element indicating scenic quality. As with formal aesthetic models, VMS is also applied by landscape architects who are trained in the methodology (T. C. Daniel & Vining, 1983).

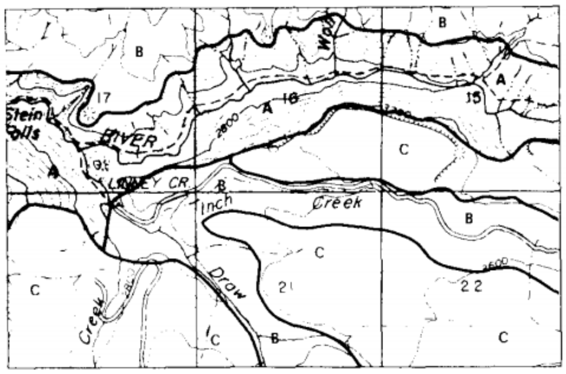
Variety or visual complexity classification is the most important classification of VMS. The variety or the visual complexity of landscape elements is divided into three classes in the VMS sustem: A, B or C. The classes are derived from the subtype features, such as landforms, water forms, and vegetation patterns. Class A refers to the area with features that are the most distinctive or unique. Class B is the ranking given to areas with moderate features. Class C features within the area have very little variety in form, line, color, and texture (Bacon, 1979). VMS assumes that variety and visual complexity in the landscape are positively related to the scenic quality of the landscape. Variety or visual complexity are potentially important attributes in evaluation the scenic quality of viwesheds.

The second classification of the VMS system is sensitivity level and refers to the public concern for the scenic resources. Each sensitivity level is determined for land areas based on how many people use each area. Three sensitivity levels-- 1, 2 or 3 -- correspond to high, average, or low sensitivity, respectively (Bacon, 1979).

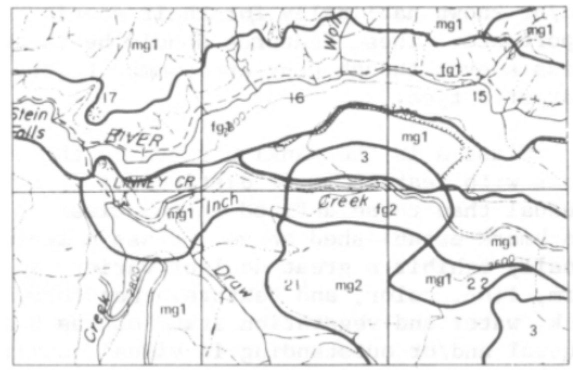
The last classification of the VMS model is the distance zone. Distance zones, or ranges of distance from the viewer, are also a measure of the size of a view and play a role in evaluating scenic quality (Anderson, Mosier, & Chandler, 1979; Antrop, 2000; Bacon, 1979; R. B. Litton, 1968). The distance zones in the literature are foreground (from 0 to between 1/4 and 1/2 mile), middle-ground (from between 1/4 and1/2 mile to between 3 and 5 miles) and background (beyond 3 to 5 miles). Views of the landscape in background distances tend not to contribute to scenic quality because they are muted or dulled by the atmosphere between the viewer and the landscape. Therefore, the visual characteristics of the view are less visible and visual characteristics, such as colors and textures, are not as visible and are not as vivid. The middle-ground often has higher visual quality, because the forms and patterns that of the landscape are more vivid at this distance. The viewer can get a sense of the lay of the land, and it is easier to "make sense" of the land; thus it is more legible and preferred by viewers (Kaplan & Kaplan, 1989a). The foreground is where details of the landscape are visible. Many ephemeral qualities are more apparent in the foreground, and if present, can contribute to scenic quality. However, in assessing their importance to the visual experience, distance zones may vary depending on atmospheric and topographic conditions of the regional location of the viewshed.

In Virginia, the closer distance of the viewing range of each distance zone would be more appropriate. Based on topography and atmospheric moisture, the following distance zones would be more appropriate: foreground (from 0 to 1/4 mile), middle-ground (from 1/4 to 3 miles) and background (beyond 3 miles).

Based on these three variables, landscape architects prepare a composite map which represents Visual Quality Objectives (VQO) (see Figure 1 - The VMS processes). VQOs are used to manage different levels of landscape alteration to protect scenic quality. The management levels are Preservation, retention, partial retention, modification or maximum modification. While VQOs are very helpful in managing public lands that are subject to the demands of multiple, natural resource use. However, VQOs are not very applicable tor viewshed management on lands that may be subject to multiple private ownership.



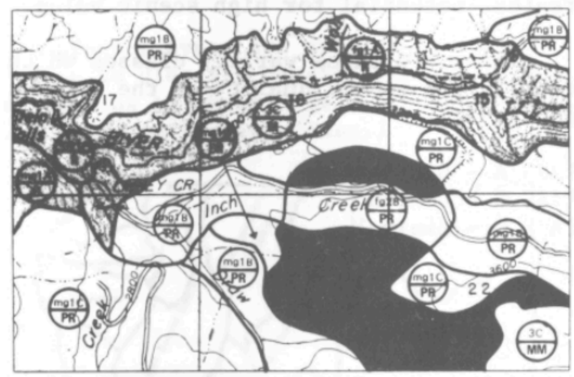
Visual Quality Classification



Sensitivity Levels

		Sensitivity level						
		fg1	mg1	bg1	fg2	mg2	bg2	3
Variety Class	Class A	R	R	R	PR	PR	PR	PR
	Class B	R	PR	PR	PR			MM
	Class C	PR	PR				MM	MM

Visual Quality Objectives



Management Objective Map

Figure 1. The VMS processes

<u>Scenery Management System:</u>

The Scenery Management System (SMS) has been used to manage scenic resources and determine the importance of scenery in National Forests (Forest Service, 1995). Lee Roger Anderson, along with National Forest resource managers, landscape architects, and others, prepared the original draft of the handbook, which was published by USDA Forest Service. The Scenery Management System (SMS) is an upgraded version of VMS. SMS uses the context of ecosystem management to inventory and analyze the landscape to develop overall resource goals and objectives that provide well-managed scenery for future generations (Forest Service, 1995) (see Figure 2 - The Scenery Management System process).

An ecological unit description is a mapping unit process that documents the basic elements of the landscape. The purpose of this step is to identify landscape character attributes based on the ecosystem that provide the basis for landscape character descriptions. Landscape Character is a combination of ecological unit descriptions and existing land use/themes to make each landscape unit identifiable. As a result, Landscape Character provides basis for identifying the Scenic Classes that represent the attractiveness and the scenic integrity of the landscape.

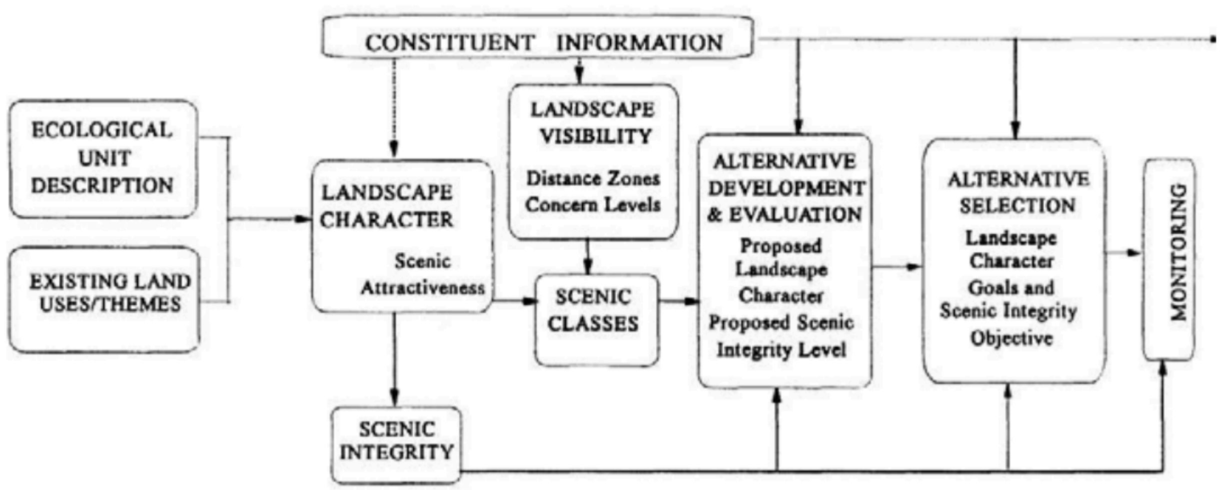


Figure 2. The Scenery Management System process

Scenic Classes are rated according to three scenic values. The three classes are: Class A, distinctive; Class B, typical; and Class C, indistinctive (see Table 3 - Scenic attractiveness classifications). Scenic Integrity represents the degree of intactness of the landscape in terms of, wholeness and visual disruption of the Landscape Character. Scenic integrity is evaluated in six classes: Very high, high, moderate, low, very low and unacceptably low (Forest Service, 1995) (see Table 4 - Scenic Integrity Level).

The focus of the SMS is management of the landscape in the context of resource harvesting and is more applicable to National Forests than to viewshed assessment and designation.

Landscape Visibility represents the interrelationships of an observer and various view situations in the landscape. This step is composed of distance zones and the level of levels of public concern that represent the visual sensitivity of the landscape. Landscape Visibility (what is seen and who is seeing the landscape) is the basis for sensitivity. Five considerations are used in assessing Visual Sensitivity: The context of the viewer (what the viewer is doing), duration of view, the degree of discernible detail, seasonal variations, and the number of viewers (Forest

Service, 1995). These considerations are used to determine the likely public concern for scenic resources.

Table 3. Scenic attractiveness classifications

Class	Description
A (Distinctive)	Areas where landform, vegetation patterns, water characteristics, and cultural features combine to provide unusual, unique, or outstanding scenic quality. These landscapes have strong positive attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, pattern and balance
B (Typical)	Areas where landform, vegetation patterns, water characteristics, and cultural features combine to provide ordinary or common scenic quality. These landscapes have generally positive, yet common, attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, pattern and balance. Normally they would form the basic matrix within the ecological unit.
C (Indistinctive)	Areas where landform, vegetation patterns, water characteristics, and cultural land use have low scenic quality. Often water and rockform of any consequence are missing in class C landscapes. These landscapes have weak or missing attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, pattern and balance.

Elements of Landscape Visibility draw upon three elements: Travel ways and use areas, concern levels, and distance zones. Travel ways are linear viewing positions including freeways, highways, roads, trails, rivers, canals and other linear pathways. Use areas include urban, suburban areas, towns and villages, subdivisions, parks, golf courses, or other public lands within national forests. Concern levels are a measure of the degree of likely public reaction to landscapes viewed from various travelways and use areas, and they are divided into three categories: High, moderate, and low. The SMS divides distance zones into four classes:

Table 4. Scenic Integrity Level

Criteria	Description
Very high	Very high scenic integrity refers to landscapes where the valued landscape character "is" intact with only minute if any deviations. The existing landscape character and sense of place are expressed at the highest possible level.
High	High scenic integrity refers to landscapes where the valued landscape character "appears" intact. Deviations may be present but must repeat the form, line, color, texture, and pattern common to the landscape character so completely and at such scale that they are not evident.
Moderate	Moderate scenic integrity refers to landscapes where the valued landscape character "appears slightly altered." Noticeable deviations must remain visually subordinate to the landscape character being viewed. See section below on meeting integrity levels.
Low	Low scenic integrity refers to landscapes where the valued landscape character "appears moderately altered." Deviations begin to dominate the valued landscape character being viewed but they borrow valued attributes, such as size, shape, edge effect and pattern of natural openings, vegetative type changes or architectural styles outside the landscape being viewed. They should not only appear as valued character outside the landscape being viewed but compatible or complementary to the character within.
Very low	Very low scenic integrity refers to landscapes where the valued landscape character "appears heavily altered." Deviations may strongly dominate the valued landscape character. They may not borrow from valued attributes, such as size, shape, edge effect and pattern of natural openings, vegetative type changes or architectural styles within or outside the landscape being viewed. However, deviations must be shaped and blended with the natural terrain (landforms) so that elements, such as unnatural edges, roads, landings, and structures do not dominate the composition.
Unacceptably low	Unacceptably low scenic integrity refers to landscapes where the valued landscape character being viewed appears extremely altered. Deviations are extremely dominant and borrow little if any form, line, color, texture, pattern or scale from the landscape character. Landscapes at this level of integrity need rehabilitation. This level should only be used to inventory existing integrity. It must not be used as a management objective.

Immediate foreground, foreground, middle-ground, and background. An immediate foreground represents areas from 0 to 300 feet from the observer, so people can see leaves, twigs, and textures. Foreground is the area from 300 feet to 1/2 miles in which people can notice the movement of a tree in moderate winds. Middle-ground is the predominant distance zone from the foreground to 4 miles. Background is the area from 4 miles to the horizon. The concept of public concern would be appropriate for scenic viewshed designation and management.

The final management classification is the Scenic Class and is composed of five factors: Scenic attractiveness, scenic class, scenic integrity, concern levels and distance zone (Forest Service, 1995) (see Figure 3 - Example of scenic class). Based on this information, landscape architects and forest managers propose overall scenery management planning in a national forest.

SCENIC CLASSES

Distance Zones & Concern Levels

		Fg1	Mg1	Bg1	Fg2	Mg2	Bg2	Fg3	Mg3	Bg3
Scenic	A	1	1	1	2	2	2	2	3	3
Attractiveness	B	1	2	2	2	3	4	3	5	5
	C	1	2	3	2	4	5	5	6	7

Figure 4 - 2

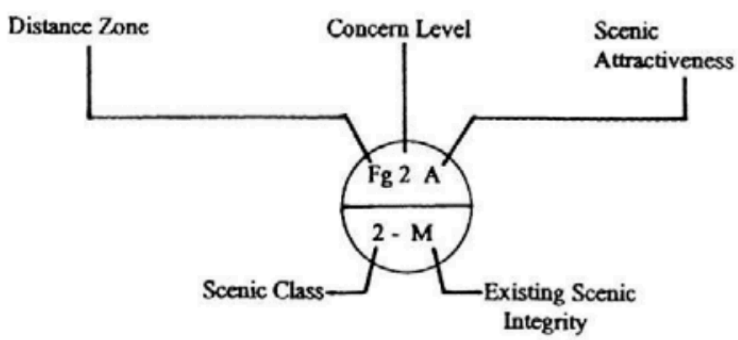


Figure 3. Example of scenic class

While the Scenery Management System used by the Forest Service is well developed and addresses a high level of detail, it is better suited to the management of public lands in a resource harvesting setting. However, SMS concepts, particularly as they relate to characteristics of the landscape that contribute to scenic attractiveness, distance zones and public concern for the landscape, are useful concepts for viewshed management.

Combined Landscape Value:

Zube (1970) used complexity as a core concept for landscape assessment. Variety and diversity were basic components to evaluate landscape value. He used 1:250,000 scale maps and aerial photography to understand landscape series and units. The landscape series for him included fundamental features of the landscape such as mountain, steep hill, rolling hill, and undulating hill. These were used to identify landscape units: Forest/wildland, forest/town, farm/forest, farm, and town/farm (Zube, 1970). The landscape units have a degree of homogamous visual character. The scenic quality is relatively similar within a landscape unit. The use of landform and spatial conditions to define landscape units is common in the literature (Bacon, 1979; Forest Service, 1995; Litton, 1968; Litton & Twiss, 1967). Zube also used different types of content (farm, town and etc) to define landscape units. Landscape units were based on features, use, and manmade elements present in the landscape.

Zube also developed a scoring system scoring scenic quality each landscape unity and weighting it relative to other units. He then developed a formula to calculate a "combined landscape value." The resulting value indicates high, medium, and low classes based on the total score. This model and the use of landscape units provide a way to assess and manage landscape value in a large landscape setting. There may be multiple viewsheds within a landscape unit. However, this approach is not suited for viewshed designation and assessment.

2. Psychophysical Model

Classical psychophysical model is the combination of two fields, the physical and the psychological. The theoretical background of this model is the relationships between physical features in the landscape and human perceptual responses (T. C. Daniel & Vining, 1983). The model seeks to identify mathematical relationships between the physical elements of the landscape and the psychological responses of human observers (E. L. Shafer Jr., 1969; Elwood L. Shafer & Brush, 1977). The physical elements are measured by experts and preferences are evaluated by empirical surveys. Psychophysical models have been used in many practical settings. For securing the validity of this model, many landscape scenes and multiple observers are employed. The purpose of this model is to develop research methods that provide and predict people’s perceptions of visual quality based on physical features of the landscape (T. C. Daniel & Vining, 1983).

Natural Landscape Preference Prediction:

Because of increasing development pressures, a natural resource manager needs to understand the inter-relationships between the landscape and the public’s visual preferences. To identify features of the landscape in photographs that were related to public preference for the landscape, Shafer and his colleagues developed the Natural Landscape Preference model in 1969 (E. L. Shafer Jr., 1969). The study of natural landscape preference can be divided into two parts: Measurement of landscape variables to predict the public’s preference, and the other interviews the public to confirm the former prediction model’s validity.

For the first part, measurement of landscape variables, Shafer *et al* used 8 x 10 inch, black and white photographs. Landscape variable measurement consists of two parts. One is identification of landscape zones. In this case the landscape was divided into ten zones (Appendix I – Shafer’s Landscape photograph zones). The second part is measuring several landscape zone dimensions. This was done by overlaying a 1/4-inch plastic grid over each photograph and using the grid to measure four properties of each zone: Perimeter, interior, area, and horizontal end-squares of each zone. These were summed for each photograph. By doing so, each photograph contained a given zone identification letter and several measurements such as: Perimeter, interior, area, and horizontal end-squares (Appendix II – Shafer’s landscape photograph zones applied) . These four variables were summed for each zone, providing a unique set of measures for each photograph (E. L. Shafer Jr., 1969).

Shafer et al the conducted six field tests to determine how well the model predicted the public’s landscape preference. They used 100 landscape slides taken in national forests and presented to 300 interviews. Each interviewee rated four sets of 20 slides with a scale of 1 to 5 in descending order of preference. Summation of each interviewee’s score of each slide represented each slide’s preference score (E. L. Shafer Jr., 1969). Using linear regression Shafer et al were able to develop an equation that predicted public preference for landscapes based on the quantified physical zones of the landscape. While Shafer’s work shows that landscape preference can be predicted, it is overly complex and lacks an intuitive basis for understanding preference. This does not hold much promise for viewshed identification and assessment.

Scenic Beauty Estimation:

The Scenic Beauty Estimation (SBE) was developed by Daniel and Boster (Daniel and Boster, 1976). This method measures the scenic quality of different landscapes and uses a panel to rate multiple scene. The SBE method is one of the psychophysical systems for quantitatively indexing the aesthetic quality of landscapes. The SBE method was an early attempt to relate the scenic beauty to features of the landscape.

Daniel and Schroeder (1979) conducted a study of applied techniques and management of visual resources to predict the perceived beauty of forest landscapes. The purpose of the study was to describe and quantitatively predict the effects of alternative vegetation management programs on scenic beauty (Daniel & Schroeder, 1979). They developed the SBE model as a surrogate for public aesthetic judgment. The goal of this model is to evaluate tradeoffs between scenic beauty and other objectives of forest management.

SBE method can be used by following three steps: (1) Representing landscapes on color slides, (2) presenting slides to observers and (3) evaluating observer judgment (T. C. Daniel & Boster, 1976). For implementing the SBE model, 1 to 30 color slides taken within several landscape areas are needed. In order to minimize biases, photos are taken in a stratified random sampling. Panels judge the scenic beauty in terms of a 10-point rating system: From 1, very low scenic beauty, to 10, very high scenic beauty. The individual results are adjusted statistically by using standardized Z scores. The scaling system of the SBE model was originated from Thurstone type scaling model (Thurstone, 1927). The results of the SBE model provide standardized relative indices of perceived scenic beauty that can be compared in spite of differences in the types of forest landscapes being evaluated (Terry C. Daniel & Schroeder, 1979).

Daniel & Schroeder (1979) conducted a study evaluating 90 ponderosa pine forests in Northern Arizona. Eight color slides were taken of eight randomly selected one-acre site. Selected panels evaluated each slide. Physical and biological features were selected according to the U.S. Forest Service management needs: the number of different species and sizes of the tree; volumes of grasses, forbs, and shrubs; and volumes of downed wood and slash per-acre average (Terry C.

Daniel & Schroeder, 1979). The SBE method provides a useful tool in relating the physical features of the forest to scenic quality. While this model is useful in a forest harvesting context on public lands, it is not useful in viewshed management on mixed ownership landscapes.

Predicting scenic beauty:

Arthur (1977) conducted a study to predict scenic beauty by using slides taken in ponderosa pine forest scenes with professionals and students. Arthur's study is partially supportive of the formal aesthetic model and partially supportive of the psychophysical model (Arthur, 1977). Daniel and Vining (1983) consider his study to be a formal aesthetic model. The study used preferences from three groups. Arthur's study can be included in the psychophysical model in this literature review. His study tests three landscape description techniques: Physical features, inventories of visual elements, and timber cruises for predicting scenic beauty of forests (Arthur, 1977). His study included three steps: (1) Quantifying scenic beauty evaluations, (2) regressing the three sets of quantitative landscape descriptors against scenic beauty estimates, and (3) relating the landscape descriptors to forest mensuration parameters. To evaluate the model's usefulness, two criteria are used: The effectiveness of each set of descriptors in explaining people's scenic beauty evaluations, and the strength of the relationships between scenic beauty descriptors and forest management descriptors (Arthur, 1977). Three groups of respondents participated in this study, and photographic slides of six sites were selected to represent various aesthetic conditions. Participants scored each slide with a 1 to 10 rating scale indicating low to high scenic quality.

To analyze the results, he calculated the mean standardized ratings by using standardized Z scores for each slide and landscape features. Next, physical features, timber cruise, and design inventory scores were calculated by using the SBE system. As a result, he found that the timber cruise model had the highest correlation with public preferences.

While the psychophysical models can predict public preference for different landscapes, at least in the forest setting, it is relatively complex and better suited for application in National Forest Environment. It would not be applicable for viewshed identification and management.

3. Psychological Model

The psychological model considers the perceptions and preferences of the public who see the landscape rather than understand landscape features as with the formal aesthetic model. In this model, the landscape scenic quality is rated based on the public preferences for the landscape. The basic concept behind the model is the judgment of the landscape in totality, instead of assessing landscape value by units or features. To figure out the public's preference, this model uses questionnaires or verbal surveys of individuals. According to Daniel and Vining (1983), in the psychological model, a high-quality landscape evokes positive feelings, and low-quality landscapes are related to negative feelings.

<u>Information-processing theory:</u>

S. Kaplan and R. Kaplan and their associates studied landscape preferences to develop the information-processing theory (R. Kaplan, 1973, 1975 and S, 1995). The information-processing theory is considered one of the most significant approaches in landscape preference research (Bourassa, 1990). Humans react to the landscape in two ways: 1) The content of the landscape and the positive or negative associations they have with that content (i.e. water, vegetation, built structures, and etc.) and 2) the spatial organization of the landscape. The model posits that one's preference for the landscape is dependent upon two basic human responses: The need to understand (make sense) and the desire to explore (be involved) (R. Kaplan & Kaplan, 1989). This model identifies relevant psychological features in photographs of landscapes. This method uses preference ratings from untrained observers and was designed to identify the psychological dimensions of the landscape and to predict landscape preferences (T. C. Daniel & Vining, 1983).

S. Kaplan (Kaplan, S.,1979) identified four key spatial organization variables important to peoples' preference for landscapes: Coherence, complexity, legibility and mystery. Coherence is a sense of order in the landscape. Legibility is similar to a concept that Kevin Lynch (1960) introduced, imageability, and refers to a space that is easy to understand and remember. Both coherence and imageability have to do with people's ability to makes sense of the landscape. Complexity is the number of different visual components that exist in a scene. The last factor is mystery, which is the promise of additional information if one could go further into the scene and has to do with how involving they find the landscape (R. Kaplan & Kaplan, 1989) (see *Table 6 - The Preference matrix).*

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Table 5. The Preference matrix

	Making Sense	Involvement
Immediate	Coherence	Complexity
Inferred, predicted	Legibility	Mystery

S. Kaplan, R. Kaplan and Wendt (1972) conducted a study to identify the relationship between complexity and preference for slides of the physical environment, and they tested the hypothesis that the content of slides will influence preference. In this study, slides taken from various scenes were selected by following four content categories: Pristine natural scenes, urban views, rural scenes, and natural scenes. Each slide shared the consistency of color, brightness, and picture clarity. Eighty-eight female college freshmen were asked to indicate the complexity of the scene or preference of the scene with a 4-point rating scale ranging from 'not at all' to 'a great deal.' Complexity and preference rating scores were then compared by each category. The researchers concluded that complexity did not explain or predict differences in preference for those categories. However, the rating of complexity may require some expert expertise.

Ulrich:

Ulrich's (1977) study of roadside scenes provides another example of the psychological model. Sequential photographs of rural roadsides were evaluated and rated by the public on the dimensions of complexity, coherence, and depth. An independent panel rated the focality, ground texture, and mystery (Ulrich, 1977). Ulrich examined the relationship between individual preference and complexity, focality, homogeneous ground texture, depth, and mystery. Subject ratings were correlated well with each other but not with complexity (T. C. Daniel & Vining, 1983).

Focality represents the degree to which a scene contains a focal point or area that attracts the observer's attention. It can be lines, textures, landform contours, and other patterns that direct the observer's attention to the scene. Variability in ground texture is important to people's perception of distance. A uniform texture presents the sense of continuity and can contribute to a sense of mystery, although rough and irregular textures disrupt a sense of continuous ground surface. Ulrich believes mystery contributes to uncertainty and has a negative effect on aesthetic preference (Ulrich, 1977). He predicted that preference would be positively related to complexity, focality, homogeneous ground texture, depth, and mystery. Ulrich concluded that ground texture, depth, and complexity were components of the legibility of a landscape.

The Psychological Model provided an empirical method for validation of public preference for different landscapes. It would be difficult to use in identifying and assessing scenic viewsheds. However, it could be used to verify the scenic quality of viewsheds once they have been identified.

4. Ecological Model

Ecological models originated from general concern for the protection of the natural environment. The environmental movement of the 1960s reinforced concern for pollution of the environment and warned about the harm of careless development. The ecological model places emphasis on naturalness as an important evaluation dimension. According to Daniel and Vining (1983), the ecological planning model addresses the landscape quality related to naturalness or ecosystem integrity and the assessment of scenic resources based on the degree of disturbance of or conflict with natural elements.

<u>Unique Ratio:</u>

Leopold was interested in inventorying a river valley to find an appropriate site for dam construction with minimum harm to visual quality. Leopold believed that unique landscapes hold more significance than common landscapes. His rationale is that a "landscape which is unique…has more significance to society" (Leopold, 1969 p.5), and those unique qualities enhance its value to society. He raised three questions to develop the model: (1) What criteria can be used to judge a given piece of the landscape, (2) what other landscapes or features can it be compared with, and (3) how can any set of landscapes be ranked by priority (Leopold, 1969). Based on these questions, he proposed a methodology to present a Unique Ratio.

To evaluate the uniqueness ratio of a river or site, he considered three factors: Physical features, biologic features, and human-interest factors (see Table 7 - Three factors of the unique ratio model). A river may have sites with different physical factors. Each factor has a descriptive category and its uniqueness can be evaluated numerically. The ranking system determines the relative uniqueness of sites within each factor. If more than one site is located in the same the factor its uniqueness is expressed as a ratio.   If there is only one site in a factor has a uniqueness ratio of 1:1. When comparing 12 sites, the minimum uniqueness ratio possible is 1:12 or 0.08, and the maximum uniqueness is 1:1 or 1. After the uniqueness ratio is calculated for each descriptive factor the three factors are summed for a total uniqueness score. Summation of the uniqueness ratios determines the relative uniqueness between sites.

Table 6. Three factors of the unique ratio model

Factors	Descriptive categories
Physical factors	River width at low flow, Depth at low flow, Bankfull depth, flow variability, river pattern, ratio of valley height to width, bed material, bed slope, basin area, stream order, erosion of banks, deposition, width of valley flat
Biologic and water quality	Water color, turbidity, floating material, water condition, algae, larger plants, river fauna, pollution evidence, land flora
Human use and interest	Number of occurrences of trash and litter per 100ft of river, material removable, artificial controls, accessibility, local scene, vista, view confinement, land use, utilities, degree of change, recovery potential, urbanization, special views, historic features, misfits

Leopold used this model to rank several sites on different rivers. One of the limitations recognized by Leopold and Marchand (1968) is the problem of sampling (L. B. Leopold & Marchand, 1968). Sampling sites can cause a flaw in comparison. On the other hand, this model assumes all characteristics of the landscape have equal value or weight. This limitation can be overcome by adding weight factors.

While uniqueness would seem to be a desirable attribute that could be applied to viewshed assessment, most viewsheds are evaluated individually and not relative to each other. Also, other visual characteristics need to be considered in viewshed designation. Leopold's uniqueness ratio also is numerically too complicated to be easily used in a viewshed designation program.

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Appendicies:

Appendix I – Shafer's Landscape photograph zones

Landscape zones	Descriptions
Sky zone	Includes only sky and clouds.
Immediate-vegetation zone	Where the characteristics of individual leaves, needles, bark, or stems of trees or shrubs are easily distinguishable.
Intermediate-vegetation zone	Where the outlines of individual trees or shrubs are recognizable, but not in the fine detail found in the immediate-vegetation zone
Distant-vegetation zone	Where trees or shrubs occupy the landscape, but the shape of individual crowns is not discernible.
Immediate-non-vegetation zone	Where soil or snow texture, blades of grass, or detailed characteristics of individual stones, boulders, or rock outcrops are distinguishable.
Intermediate-non-vegetation zone	Where the outlines of individual rocks, large crevices in rocks, prominent features of exposed soil, grass or snow-covered areas are recognizable but not in the fine detail found in the immediate non-vegetation zone.
Distant-non-vegetation zone	Soil, rocks, grass or snow occur, but no details of these features are recognizable
Stream zone	Includes only water and rocks in a stream
Waterfall zone	Includes only water and rocks in a waterfall
Lake zone	Includes water and rocks in a lake

Appendix II – Shafer's landscape photograph zones applied