ENVIRONMENTAL PREFERENCE
A Comparison of Four Domains of Predictors

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ABSTRACT: This article examines four domains of variables to assess their relative merit in explaining environmental preference. Within each of the domains, between three and seven specific attributes were measured, for a total of 20 predictor variables. The study site includes small forested areas, agricultural land, and fields, with little topographic variation. Preference ratings of 59 scenes representing the area serve as the dependent variable. Taken together, the 20 attributes accounted for 83 percent of the preference variance. Taken separately, the Physical Attributes lacked predictive power. Of the Informational variables, Mystery was the only significant contributor. The Land Cover types proved effective, with Weedy Fields, Scrubland, and Agriculture all significant negative predictors. Finally, the Perception-based variables were most powerful, with Openness and Smoothness particularly useful predictors. The results point to the importance of using different predictor domains, rather than relying exclusively on any one, since their role in different environmental contexts is likely to vary.

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Visual resource management depends on the recognition of environmental attributes that are salient to scenic quality. The decision about which environmental attributes to examine depends on a great variety of factors. There are pragmatic considerations that lead to the selection of environmental features that are readily obtainable (for example, in geographical data bases). The choice can also be based on professional wisdom, on prior empirical research, or on theoretical grounds. Given these options, the number and kinds of environmental attributes to pursue can be overwhelming.

The purpose of the present study is to compare the effectiveness of four domains of environmental attributes, based on different kinds of rationales, in the context of a particular setting. The four domains—Physical Attributes, Land Cover types, Informational variables, and Perception-based variables—are drawn from various sources. Among these are prior research, theoretical considerations, and expert judgment. The particular concern of the research reported here is on the relative ability of the variables within each of these domains to predict scenic quality or preference.

Research on environmental preference has generally relied on the use of slides or photographs as the basis for the outcome rating or dependent variable, for example, scenic quality. In many cases the scenes themselves also provide the basis for the prediction of environmental qualities that contribute to the outcome. In other words, the scenes can be assessed in terms of a great variety of characteristics that may contribute to how much they are preferred. Thus, past studies have included variables such

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as the amount of sky, the density of tree cover, and the complexity of the scene. The present study involves the comparisons of different domains that can be ascertained from such examination of pictures of settings.

While all derived from the information in the scene, the domains differ with respect to the degree of inference made by the observer. Attributes that involve the physical properties of the scene entail less inference, while those that require examination of the scene as a three-dimensional space may involve a greater amount of interpretation. If preference were as readily explained on the basis of the more objective characteristics, there would be advantages for the ease of managing the visual resource. On the other hand, the experience of the landscape involves more than the enumeration of the physical objects in the environment (Kaplan and Kaplan, 1989).

The four domains under study here include two that constitute relatively direct measurements of the physical environment, with one of these (Physical Attributes) based on environmental elements and the other (Land Cover types) on broader-based patterns. The other two domains depend to a greater degree on the information provided by the spatial organization of the setting. Both of these latter domains (Informational and Perception-based variables) are based on empirical research on environmental preference, but draw on different approaches to such research.

PHYSICAL ATTRIBUTES

Physical dimensions have been used extensively in research in this area. For example, the approach Shafer et al., (1969) used in their original effort to derive a predictive model started with 26 variables. These entailed vegetation, nonvegetation, sky, and water, examined in terms of different distance zones within the scene and with respect to both "perimeter" and "area" of the grid-cell overlayed on photographs of scenes. The final regression equation included 6 of these 26 variables, in various combinations.

Zube and his colleagues (for example, Zube et al., 1975) included 23 physical dimensions, or attributes, in their study, drawn from a variety of sources. While here again six variables were found to be most salient, they were different from the ones Shafer included in his regression model. Many other examples of research based on physical dimensions are reviewed by Daniel and Vining (1983) in what they call the "psychophysical" category.

Physical dimensions typically involve an assessment of some specific elements in the environment or of the relationship between two aspects (as is implied by a "contrast" rating). The present study included seven such physical attributes, based on the work of Brown and Itami (1982). Their initial work in this area, carried out in the context of a forested region in Australia, was an attempt to link Zube's work and the theoretical framework proposed by Kaplan et al., (1972), using information that can be derived from maps. Table 1 provides an abbreviated description of each of these Physical Attributes that had also been part of the Brown and Itami work.

Versions of many of these attributes, defined in the context of each particular study, have been used by other researchers as well. Their effectiveness as predictors has been mixed. Naturalism, for example, accounted for an astounding 64 percent of the variance in an extensive study carried out in Victoria, Australia (Williamson and Chalmers, 1982) and emerged as one of the strong predictors (although accounting for only 3 percent of the variance) in the Zube et al., (1975) study.

TABLE 1
Physical Attributes

Landform:	
Slope/relief	The prominence of the landform (both steepness & change in elevation)
Edge contrast	Contrast between adjacent landforms
Spatial diversity	Variety of spaces created by landforms
Landcover:	
Naturalism	Absence of direct human influence
Compatibility	Fit between adjacent landcover types
Height contrast	Height variation among adjacent elements
Variety	Diversity of landcover types or patterns within a type

LAND COVER TYPES

A different way to consider physical aspects is to focus not on the elements but on broad patterns, such as land cover designations. While definitions for these are common across large regions, finer distinctions often need to be made within a specific context. Thus, for example, agricultural land covers will vary from region to region.

There is reason to suspect that scenic quality or preference is closely related to some land cover types. While we are not aware of research in this area that has focused on this type of predictor domain, the preference for some land cover types (for example, water) is widely recognized.

As our study focused on vegetated areas with no built elements, six land cover types were identified as most pertinent (Table 2). In our instance, Agriculture involved crops rather than orchards or farm animals. Three of the categories could be grouped together as representing "Fields." However, in the context of the study it was useful to differentiate these in terms of issues such as plant types, their height and color. On the other hand, there was not as much variation in forest types, so Forests constituted a single category. Each scene could represent several land types; the Forest scenes, in particular, often included other types as well.

INFORMATIONAL VARIABLES

Numerous studies on environmental preference have focused on factors that are quite distinct from the physical setting itself. Daniel and Vining (1983) include these under their "Psychological Model," which refers to the "feelings and perceptions" of the viewer. Zube et al. (1982) refer to this category as "Cognitive" and characterize it as relating to "psychological dimensions manifest in or attached to the landscape" (Pitt and Zube, 1987). Here again, as was true with the Physical Attributes, there is a vast array of potential predictor variables. Their effectiveness is difficult to assess as each study relies on different variables, and variables by the same name may be based on different definitions.

Our research in this area has focused on factors that are best described as depending on both the environment and the perceiver. The underlying theoretical perspective is based on the notion that the perceptual process involves extracting information from one's environment. Thus, rather

TABLE 2
Land Cover Types

Agriculture	Under active crop cultivation
Cut Grassland	Short, predominantly green, even textures maintained by mowing or grazing
Weedy Field	Longer, predominantly brown, uneven with no evidence of mowing or grazing
Scrubland	Early succession of woody plants, >10% density, <30' height
Forests	Native tree cover of climax or late successional species, >30' high
Woodlawn	Forests with understory removed, or lawn planted with trees

than focusing on specific elements in the physical setting, this framework is concerned with the organization of the space. The way the space is organized provides the observer with a great deal of information about how one could function in it (Kaplan and Kaplan, 1982).

Two major categories structure this informational model: Some aspects of the organization of space help in one's ability to *understand* what is going on, while other aspects

TABLE 3
Informational Variables

	Understanding	Exploration
Immediate	Coherence Orderly, "hangs together," Repeated elements, regions	Complexity Richness, intricate, no. different elements
Inferred	Legibility Finding one's way there & back, distinctiveness	Mystery Promise of new but related information

encourage one to *explore* the setting further. For each of these two categories, two specific variables were included in the study, differing in terms of the degree of inference involved in the perceptual process. Table 3 provides abbreviated descriptions of these predictors.

Within the framework of this table, the four predictor variables appear to be of comparable status; however, this is far from the case. The informational model both has a history and is still evolving (Kaplan, 1987). In the context of this historical development, each of the predictors assumes a unique place. Early theories of environmental aesthetics focused on the optimal complexity hypothesis that asserts that complexity is the primary factor in aesthetic judgment and, further, that some intermediate value of complexity will be the most preferred (Wohlwill, 1976). This position, either in its original form, or recast in terms of "variety" or "diversity," remains popular. The informational model arose from an effort to demonstrate that complexity plays at best a limited role in preference.

Mystery, by contrast, has been a key element in the informational model. As shown in the table, Mystery emphasizes an inferential process on the part of the observer and points to the importance of a search for information. It has turned out to be a remarkably reliable and effective predictor, consistently outperforming complexity. (Kaplan and Kaplan [1989] provide a more extensive description of this framework and summarize results of several studies where ratings of the Informational variables were related to preference.)

PERCEPTION-BASED VARIABLES

The final domain of predictor variables used in the present study is based on results of previous studies using a particular analytic tool. Empirical studies of environmental preference have relied on three distinct statistical approaches. One of these, as already mentioned, is based on regression analyses, where preference or scenic quality is the dependent variable and the independent variables consist of ratings of various environmental attributes, such as the Physical dimensions. A second approach involves examination of the magnitude of the preference ratings, with particular emphasis on the most and least preferred scenes. The researcher attempts to interpret these results by inferring environmental qualities that are different as a function of preference.

A third approach involves an effort to understand common patterns in people's reactions to scenes. In this approach, the preference scenes are used as a tool to examine perception or themes that show similar reactions. R.Kaplan (1985) provides a summary of the kinds of perceptual categories that have emerged across many studies using this approach. Repeatedly, such studies have yielded categories that differentiate the relative openness of the setting as well as the smoothness of the ground plane (Figure 1). Openness and smoothness, in turn, presumably

TABLE 4
Perception-Based Variables

Openness	Amount of space perceivable to viewer
Smoothness	Uniformity of and shortness of ground texture
Locomotion	Ease of traversing without undue effort

affect a rapid, unconscious decision about how easily one could move about in the space suggested by the scene (Kaplan, 1987). Given this consistent pattern of results across a diversity of environmental settings, it was decided to include these Perception-based variables in the present study (Table 4).

While we are not aware of studies that have used ratings of Openness, Smoothness, and Ease of Locomotion, three previous studies have included predictor variables that are closely related. "Spaciousness" (defined as "visible availability of options for locomotion; how much room to wander in") was reported by Gallagher (1977) as a negative contributor to preference. In Anderson's (1978) study, Spaciousness was defined somewhat differently ("Perceived or experienced depth"), but also was a negative aspect of preference. Herzog's (1987) definition was closer to Gallagher's, but he reported a positive relationship between Spaciousness and preference. Our use of Openness differed from these ratings of Spaciousness, both in avoiding mention of locomotion (a separate variable) and in not explicitly considering the perceived depth of the scene.

Both Gallagher (1977) and Herzog (1987) also included "Texture" (defined as "how fine-grained the surface is"), which did not significantly account for variations in preference. Their definition of Texture is quite similar to our use

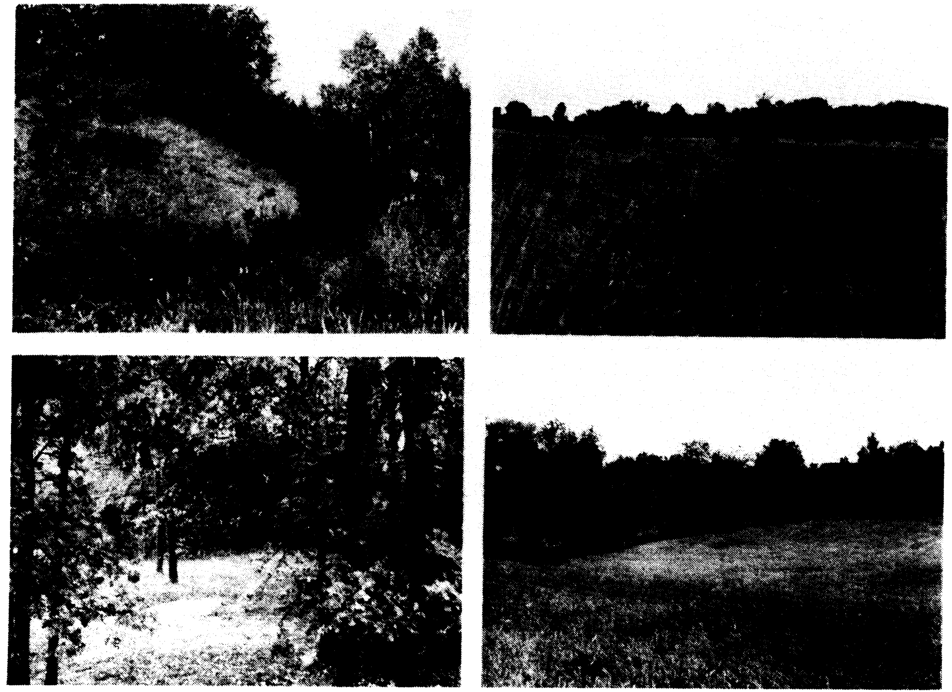

Figure 1: These four scenes, included in the study, vary with respect to Openness and Smoothness. Both scenes in the top row were rated low (2 on a 5-point scale) in Smoothness, while scenes in bottom row received high (4 or 5) ratings on this attribute. Scenes in the left column were rated low with respect to Openness, while those in the right column were rated "5" on this quality.

of Smoothness. We have opted to use the latter term, however, as it more clearly communicates the direction of the variable.

METHODS

The purpose of the present study, then, was to compare the effectiveness of the four domains of predictors as well as the particular variables that had been selected within each of the domains.

The study area, Scio Township, Washtenaw County, Michigan, was selected because it met three criteria: An extensive data base was already available for this six-by-six mile area; the area is relatively nearby, making the logistics of taking photographs convenient; and there is considerable diversity in land cover types. As is characteristic of much of the Great Lakes region, the area offers relatively little variation in land form.

The study reported here is based on photographs. While various residential, commercial, and industrial land uses are present in the study area, these were not included in our research. Similarly, scenes of rivers and lakes were excluded. The initial set of 243 slides was taken at predetermined locations selected to provide a representative range of the land form and land cover diversity within the study area.

Each scene was rated by two research assistants (both then students in the Master's program in Landscape Architecture) in terms of the Physical Attributes and Land Cover types. For each of the seven Physical Attributes, a five-point rating scale was used to reflect the degree to which the quality or the contrast was present. For the Land Cover types the rating was binary, based simply on the presence or absence of the specific category. These ratings were used in selecting a subset of 59 slides, which are the basis of the research reported here.[1]

Ratings of each of the 59 scenes with respect to the four Informational variables, as well as Ease of Locomotion, were carried out by a panel of five individuals, including the three authors and two research assistants. For each of these, a five-point rating scale was used. To avoid biasing effects of other ratings, all slides were rated on a single predictor variable before proceeding to another predictor. Openness and Smoothness ratings, also based on five-point scales, were performed by the two research assistants.[2]

Once all the predictor variable ratings were completed, the slides were rated in terms of Preference. Participants for these ratings were students enrolled in introductory psychology courses. (These courses are often the only courses in psychology that these students take.) About equal numbers of students were enrolled at the University of Michigan (UM, n = 88) and at Grand Valley State College (GV, n = 92). While the study area is closer to the UM campus, the GV students are more likely to see the kinds of scenes included in the study since their campus is in a less urban area.

Following the procedure we have used in the past, a five-point rating scale was used, and participants were asked to indicate how much they like "the kinds of places that are shown in the slides." Before the preference rating was begun, the first ten slides were shown for two to three seconds each to provide a context. This was followed by three practice slides. The 59 slides were then shown for 15 seconds each. The rating sheet was marked for 60 slides to avoid an end effect. The slides were presented in two different orders to control for order effects.

RESULTS AND DISCUSSION

As the main purpose of this study is the comparison of the four domains of predictor variables, the major approach to data analysis involved four regression analyses using the variables within each domain as the independent variables. The dependent variable for each analysis is the mean scene preference rating, based on a combination of both samples. (The correlation between the two sets of ratings was .95.) When the overall multiple regression is significant (at $p < .05$), individual predictors with significant partial correlations are reported.

PHYSICAL ATTRIBUTES

Three of the four domains of predictors yielded significant results. The Physical Attributes were the exception. Several factors may help explain this result. The study area had very little topographic variation, thus providing little opportunity to test the effectiveness of the land form predictors. Similarly, Compatibility and Naturalism could not get a fair test in this context since very few scenes included anything but vegetation. Given this pattern, it is less surprising that the overall regression was not significant. Of the remaining two variables, however, Variety had a low but significant partial correlation, suggesting that in the present context scenes showing more variation were somewhat preferred.

It is difficult to compare these results to other studies. In the case of the Brown and Itami research in Australia, preference measures were not obtained. Herbert (1981), studying a setting similar to this study's, found the combination of these variables to be useful, but the presence of water in many of his scenes was an important factor in the results. As already mentioned, Zube et al. (1975) and Williamson and Chalmers (1982), among others, have used similar variables, but in totally different environmental settings.

LAND COVER TYPES

The six Land Cover types provided a highly significant basis for preference prediction (R^2 = .47), with Weedy Fields, Scrubland, and Agriculture each showing significant negative aspects in the participants' preferences (Table 5). These three Land Cover types were the least preferred, with means between 2.8 and 3.0.

The most preferred Land Cover type, Woodlawn (mean 3.75), did not contribute significantly to the regression equation. This is likely due to the small number of instances included (n = 7). The Grassland and Forest types (preference means of 3.3 and 3.2, respectively) also played a neutral role.

INFORMATIONAL VARIABLES

Of the predictor domains with significant regression results, the analysis based on the Informational variables was by far the lowest in the variance explained (R^2 = .19), with Mystery a significant predictor (Table 5). While there have been numerous studies that have included these informational variables, the reported results have not been based on a regression analysis of the entire set of slides. Herzog (1984), for example, studied "field and forest" settings, which would have some similarity to the present scenes, but reported regression analyses only within empirically-based categories. It is thus difficult to assess whether the present results are different or similar to previous work in this area. In any event, the finding that Mystery is a positive predictor of preference in natural settings has been found many times over (Kaplan, 1987).

TABLE 5
Multiple-Regression Analysis Summary Results

	partial r	reg. coef.	stand. error	F	p	r[a]	
Landcover:							
Agriculture	-.35	-.46	.17	-2.71	.01	-.18	
Cut Grassland	-.08	-.09	.16	-.59	.56	.15	
Weedy Field	-.53	-.64	.14	-4.49	.00	-.43	*
Scrubland	-.39	-.49	.16	3.07	.00	-.24	*
Forests	.04	.03	.11	.30	.77	.08	
Woodlawn	.16	.23	.20	1.16	.25	.42	
R^2 = .47	[R^2(adj.) = .42]		p=.001				
Informational							
Coherence	.11	.08	.09	.80	.43	-.11	
Complexity	.18	.16	.12	1.34	.19	.25	
Legibility	-.26	-.18	.09	-1.97	.06	-.12	
Mystery	.31	.17	.07	2.39	.02	.32	*
R^2 = .19	[R^2(adj.) = .15]		p=.02				
Perceptual							
Openness	.72	-.37	.05	-7.65	.00	-.43	*
Smoothness	.57	.26	.05	5.15	.00	.33	*
Locomotion	.27	.13	.06	2.09	.04	.01	
R^2 = .62	[R^2(adj.) = .60]		p=.001				
Physical							
Slope/relief	.20	.16	.11	1.46	.15	-.22	
Edge Contrast	.06	.00	.12	.04	.97	.10	
Spatial Diversity	-.04	.03	.11	-.28	.77	-.07	
Naturalism	.11	.06	.08	-.76	.45	-.14	
Compatibility	-.22	.30	.19	-1.59	.12	.21	
Height Contrast	.00	.00	.08	.00	.99	.12	
Variety	.29	.25	.11	2.19	.04	.17	
R^2 = .18	[R^2(adj.) = .08]		p=.17				

NOTES: a = first-order correlation of preference and attribute.
* = significant predictor in stepwise regression using all variables.

PERCEPTION-BASED VARIABLES

These proved to be the most powerful domain of predictors (R^2 = .62). While each of the three predictors was significant, Openness was by far the strongest and Smoothness was also very high (Table 5). It is important to note the negative contribution of Openness in the regression equation. These results suggest that Ease of Locomotion, Smoothness, and *Non*openness are each important attributes in the prediction of preference for these scenes.

The role of smooth ground texture in enhancing preference has been evident in numerous studies, with "park land" scenes serving as good examples (Kaplan, 1985). The fact that Openness was a negative predictor may come as a surprise. (Recall, however, that Spaciousness, a similar concept, also was a negative predictor in Gallagher and Anderson's studies.) In the present study, Openness and Smoothness are, in fact, positively correlated (r = .51), but there are nonetheless numerous instances where they are not both present. Most of the "open" scenes in this study were scenes of agricultural areas (which were relatively smooth) and of weedy fields (which were not). In either case, these scenes had plenty of sky, but little on which to focus attention.

ALL PREDICTORS

The separate regression analyses are useful to provide an assessment of the role played by specific attributes, as well as the effectiveness of each of the four domains. It is also useful to enter all 20 independent variables in a single regression analysis to see the relative contribution of the different attributes sampled. Before discussing the results of such an analysis, however, it must be emphasized that they be viewed with due caution, given that the ratio of scenes (59) to predictors (20) is quite small. Furthermore, the Land Cover types are based on binary ratings, while the other variables used five-point scales. It should also be noted that some of the variables are highly interrelated. Specifically, the three Perception-based variables and two of the Informational variables (Coherence and Legibility) are all interrelated (with correlations between .51 and .76).

Regression analysis based on all 20 independent variables (combining across the four domains) accounted for a substantial amount of variance (R^2 = .83; adjusted R^2 = .75). Five of the predictors were selected in stepwise regression (Table 5), and these account for 69 percent of the variance. It is interesting that these five predictors—Weedy Fields, Mystery, Openness, Smoothness, and Scrubland—are drawn from three of the four domains. Smoothness, with the highest partial correlation (.61) and Mystery (partial r = .41) are positive, while the other three, as seen in previous analyses, are negative predictors. In other words, in the cases of Weedy Fields (partial r = −.43), Scrubland (−.35) and Openness (−.39), preference is enhanced by the relative absence of the attribute.

What is particularly striking about this finding is that, with the exception of the "Agriculture" Land Cover type, these are the same predictors that were significant in the separate analyses. One might have expected that correlations among the variables from the separate domains would lead to substantial redundancy and thus alter the pattern of results. Instead, the results suggest independent predictive power for the different domains.

CONCLUSIONS

These results are in some respects surprising. Given the heavy emphasis on physical dimensions in the scenic assessment literature, it would have been expected that at least some of these attributes would have accounted for preference judgments. While the environment under study was not particularly rich in topographic variation, this hardly makes it an unusual setting. Much of the land managed by federal agencies, however, is characterized by substantial elevation differences. It would seem to be of considerable importance to determine whether the application of scenic assessment models that are based on physical dimensions is limited to areas of dramatic topographic variation.

Mystery continued to be the flagship Informational variable. Also consistent with previous findings, Complexity did not play a significant role. Assessing the implications for Coherence and Legibility is more difficult. Coherence has predicted successfully in a number of previous studies (e.g., Gallagher, 1977; Anderson, 1978), and its failure to reach significance in the present study remains unexplained. Of the four Informational variables, Legibility is the most recently developed; its conceptualization is still not completely satisfactory (Kaplan, 1987).

Two domains of predictors that have received little systematic attention in the past were found to be strong factors in this environmental context. The relative absence of Openness and the presence of Smooth ground texture were powerful preference predictors. Physical characteristics viewed in terms of Land Cover type, as opposed to separate physical elements, also showed promise.

The results of this study are important both for the positive findings and the absence of positive findings. Perhaps the most striking positive finding is the usefulness of predictors of very different kinds, predictors that are rarely found in the same study. Both their relative independence and their cumulative, substantial predictive effectiveness suggest that future studies could benefit from sampling predictors more widely.

The most noteworthy finding in the negative column is the lack of effectiveness of the separate Physical Attributes. While this set of predictors did not show striking variation in the study area, It must be remembered that preference varied from scene to scene nonetheless. Thus, at the very least this finding suggests that certain types of predictors may only be effective in certain types of environments.

This possibility, in turn, points to other fascinating, and as yet unsettled, questions. First, might it be the case that predictors in general vary in their effectiveness in different kinds of environments? Second, are some predictors more robust than others across different environments? Research to unravel these issues will have to be concerned both with environmental sampling and with environmental categorization. While some traditional land cover typologies may be helpful here, there may also be merit in looking at the empirically-based environmental categories that draw on preference ratings (Kaplan, 1985).

The quest for appropriate domains of environmental attributes is both important and challenging. The ease of measuring a characteristic is important in visual resource management. However, environmental attributes that are most readily measurable and most easily obtained from spatial data banks are not necessarily the most useful in achieving one's purposes. On the other hand, it is not yet clear whether characterisitics that are most useful in understanding scenic quality can be readily derived from such data sources. Addressing this vital pragmatic consideration as well as identifying effective predictor domains are interesting challenges for the researcher. They are also necessary steps before the implications of these tentative results can find their way into an enhanced policy for managing the landscape.

NOTES

1. It is characteristic in research of this kind that one takes many more pictures than are used. Scene elimination is based on considerations such as picture quality (for example, too dark, too light, focus on a particular feature) and

redundancy. In addition the 59 scenes used in the final study were selected to reflect the range of land forms and land covers in the study area.

2. Unfortunately, inter-rater reliabilities were not computed for the various predictor variables, and the data sheets with the separate ratings by each team member have been misplaced. For the ratings made by two individuals there were detailed coding instructions and virtually no discrepancies in their ratings. For the ratings made by the panel of five judges, in a few instances the ratings spanned three scale points; in all other instances the independent ratings were either unanimous or at adjacent scale positions. Here again, detailed definitions were used and the panel members had extensive experience with these concepts. While the Informational variables might be considered less objective than ratings of Land Cover types, for example, Herzog's (1987, 1989) research has consistently shown very high reliability coefficients for these variables with ratings performed by individuals with no particular training and with brief definitions for the concepts.

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