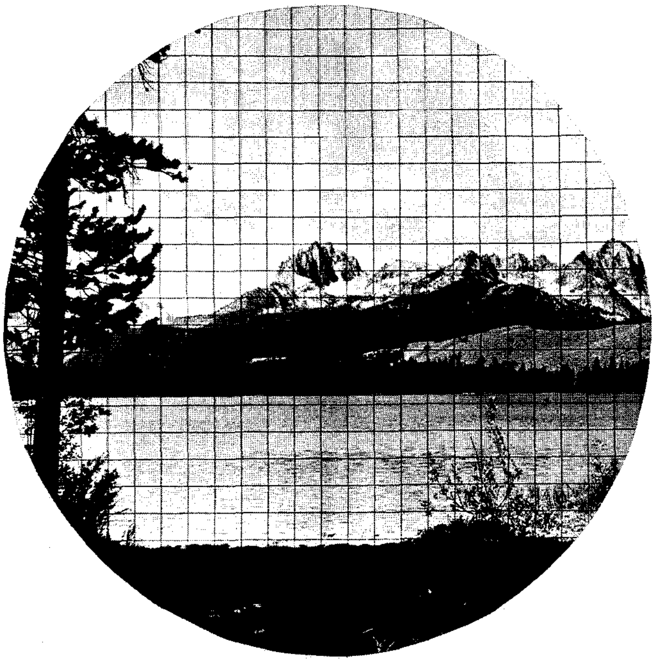
It Seems Possible to
Quantify Scenic Beauty
in Photographs



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TO PARAPHRASE KIPLING: East is West, and West is East—as far as a recent experiment in landscape preference is concerned. Our study indicated that recreationists in Utah and New York prefer the same kind of forest landscapes —when the landscapes are depicted by 8- by 10-inch black-and-white photographs.

A landscape-preference model that was developed and tested on recreationists in New York *(Shafer and others 1969)* predicted the overall landscape preference pattern of outdoor recreationists near Salt Lake City, Utah. Results of our experiment suggest that the model can be used by regional planners throughout the United States to help evaluate and compare quantitatively the aesthetic quality of different landscapes.

When it was developed, the model explained 66 percent of the variation in landscape preference scores of 250 Adirondack campers. Also, in independent field tests, the model predicted the overall landscape preferences of 300 other campers throughout New York State *(Shafer and others 1969)*. Thus, we knew the model worked in the Northeast. The next step was to test how well the model predicted preferences of western recreationists; that was the objective of this study. The study was conducted in cooperation with Utah State University.

THE MODEL

First, it is necessary to briefly describe how the model was developed and how it works.

Initially, we defined eight zones within a landscape photograph:

Zone A. *Sky and clouds:* All sky and cloud areas.

Zone B. *Immediate trees and shrubs:* Those parts of a photo where individual leaf and bark characteristics are visible if in full light.

Zone C. *Intermediate trees and shrubs:* Areas on a photo where outlines of individual trees and shrubs can be recognized but not in the fine detail found in zone B.

Zone D. *Distant trees and shrubs:* Areas where shapes of individual trees and shrubs cannot be distinguished.

Zone E. *Immediate other features:* Areas that contain rocks, grass, snow, or soil and where the texture, blades of grass, or detailed characteristics of the individual rocks and boulders can be distinguished if in full light.

Zone F. *Intermediate other features:* Places where the outlines of large rocks, large crevices, or prominent features of soil, grass, or snow are visible but not in the detail found in zone E.

Zone G. *Distant other features:* Areas where snow, rocks, grass, or soil occur, but no details of these features are visible.

Zone J. *Water:* All water areas, including streams, lakes, waterfalls, and rocks visible within the boundaries of those water areas.

For any 8- by 10-inch black-and-white photograph, the landscape preference model used measurements in six of the eight zones to predict a landscape's preference score (Y).

$$Y = 184.8 - .5436\,X_1 - .09298\,X_2 + .002069\,(X_1 \cdot X_3) + .0005538\,(X_1 \cdot X_4) - .002596\,(X_3 \cdot X_5) + .001634\,(X_2 \cdot X_6) - .008441\,(X_4 \cdot X_6) - .0004131\,(X_4 \cdot X_5) + .0006666\,X_1^2 + .0001327\,X_5^2$$

where:

X_1 = perimeter of the immediate tree-and-shrub zone.
X_2 = perimeter of intermediate other-features zone.
X_3 = perimeter of distant tree-and-shrub zone.
X_4 = area of intermediate tree-and-shrub zone.
X_5 = area of water zone.
X_6 = area of distant other-features zone.
The lower the Y value, the more preferred the landscape.

Values for the independent variables were obtained by placing a ¼-inch plastic grid over a photograph (fig. 1) and making landscape-zone area or perimeter measurements as follows:

- The eight landscape zones are outlined on a photograph by using the edges of the squares as boundary lines. All six zones will not necessarily occur on any one photograph.
- The perimeter measurement for variable X_1, X_2, or X_3 is the total number of ¼-inch edges of each square along the boundary of that particular zone. If a zone occurs at different locations on the photo, add that zone's perimeter measurements for all locations.
- The area measurement for variables X_4, X_5, or X_6 is the total number of ¼-inch squares within that specific zone. Again, if a given zone occurs at different locations, add that zone's area measurements for all locations.

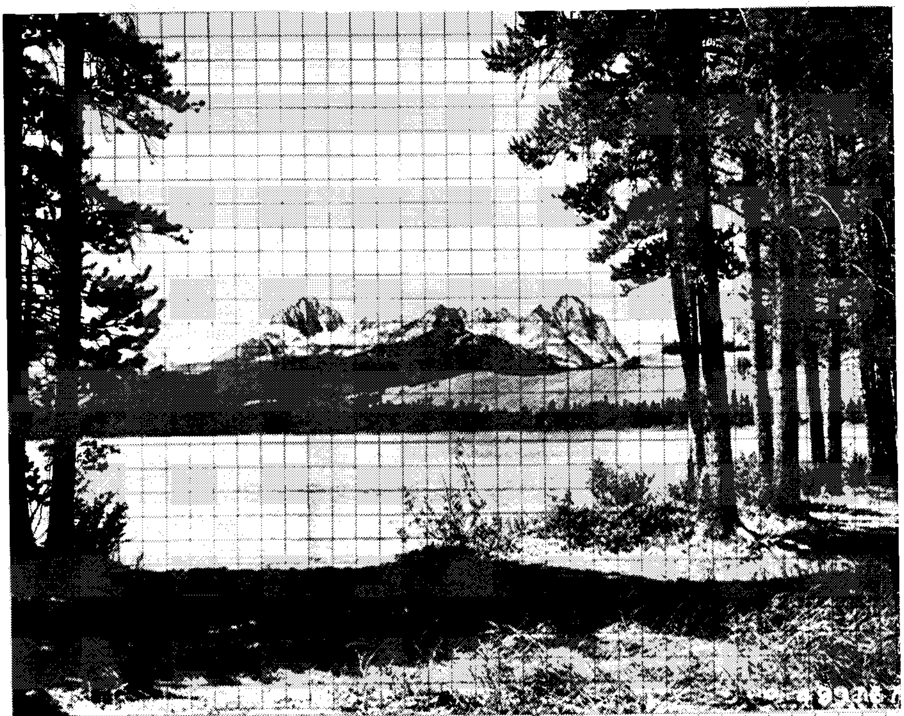
STUDY PROCEDURE

Initially, fourteen 8- by 10-inch photos were selected randomly from the original 100 photos used to develop the model. The 14 photos were sorted randomly into two sets—A and B—with seven photos in each set (figs. 2 and 3).

In August 1967, we randomly selected 50 day-users throughout the Big Cottonwood and Mill Creek Canyon recreation areas on the Wasatch National Forest—a half hour's drive from Salt Lake City, Utah. Each of the 50 respondents was asked to rank the seven landscapes in each set. The photo ranked first was the most preferred, and so on until the photos were ranked 1 through 7 per set. We restricted the interviews to people who lived in the Salt Lake City area. All respondents were 12 years of age or older. There were no non-respondents.

Thus, each photo received 50 rank values that could range from 1 to 7; the sum of these 50 values was a photo's overall observed preference score (Y'). Theoretically, a Y' value could range from 50 to 350. Observed scores for photos in set A ranged from 128 to 265; in set B, they ranged from 138 to 278.

Next, on each photo we measured the six perimeter or area variables required for the landscape preference model and computed the photo's predicted preference score (Y). Predicted



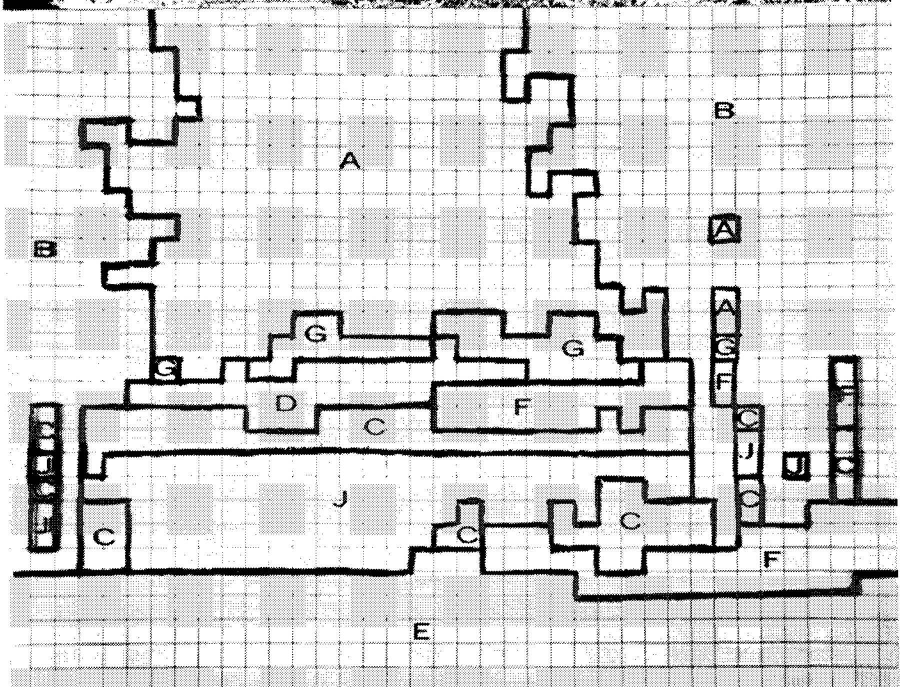

A
B
B
A
A
G
G
G
F
D
F
C
C
J
J
C
C
C
C
F
E

Figure 1.—A ¼-inch plastic grid is laid over a photo (top), and the edges of the squares are used to outline the various landscape zones (bottom).

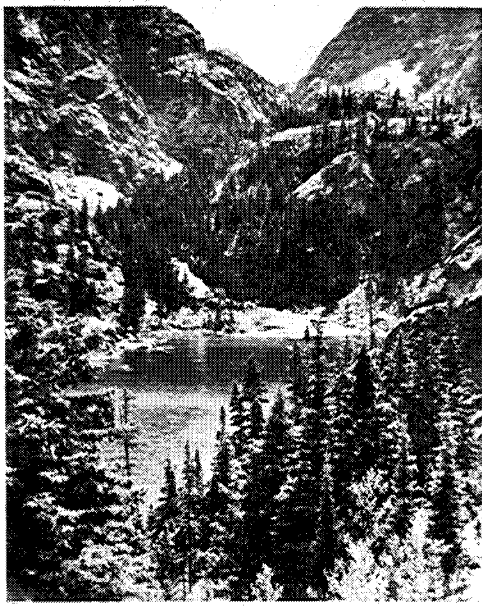
Measurement values for this example are:

Landscape Zone	*Measurement*	*Model variable*	*Value*
A.	Not required	—	—
B.	Perimeter	X_1	226
C.	Area	X_4	77
D.	Perimeter	X_3	44
E.	Not required	—	—
F.	Perimeter	X_2	92
G.	Area	X_6	30
J.	Area	X_5	98

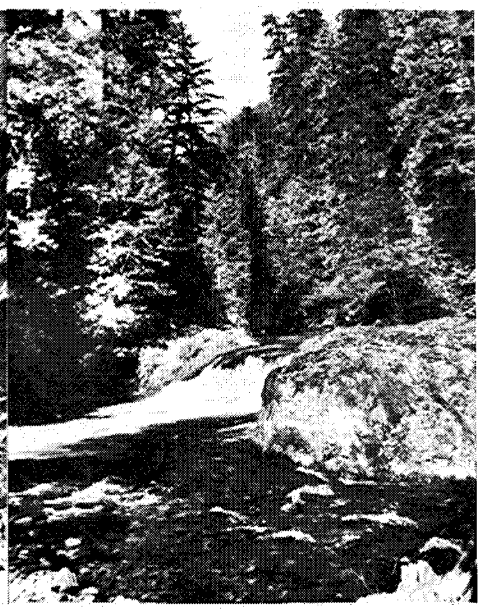
Solving for landscape's preference score:

$$
\begin{aligned}
Y = {} & 184.8 - .5436\ (226) - .09298\ (92) \\
& + .002069\ (226\,.\,44) + .0005538\ (226\,.\,77) \\
& - .002596\ (44\,.\,98) + .001634\ (92\,.\,30) \\
& - .008441\ (77\,.\,30) - .0004131\ (77\,.\,98) \\
& + .0006666\ (226)^2 + .0001327\ (98)^2 \\
Y = {} & 89
\end{aligned}
$$

Figure 2.—Landscape photos used in set A. The two numbers under each photo are its predicted and observed rankings, respectively. The coefficient of concordance = 0.851, and the F value = 5.71, which is significant at the 95-percent level.

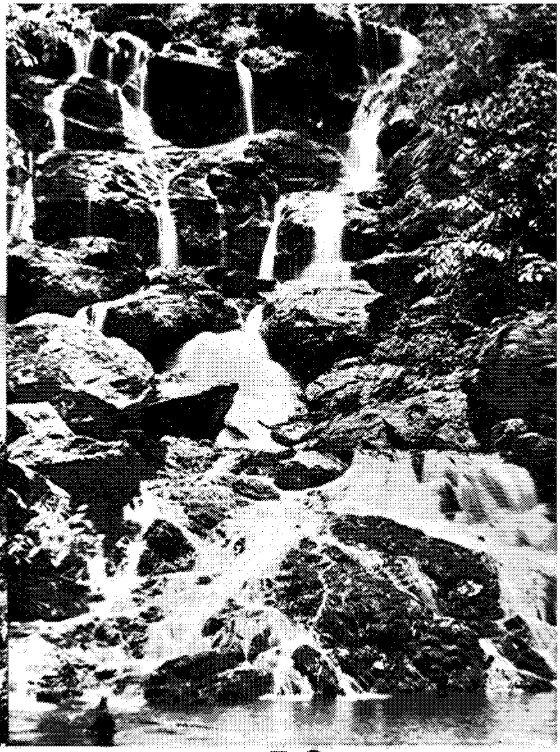


1:1



2:3

3:4



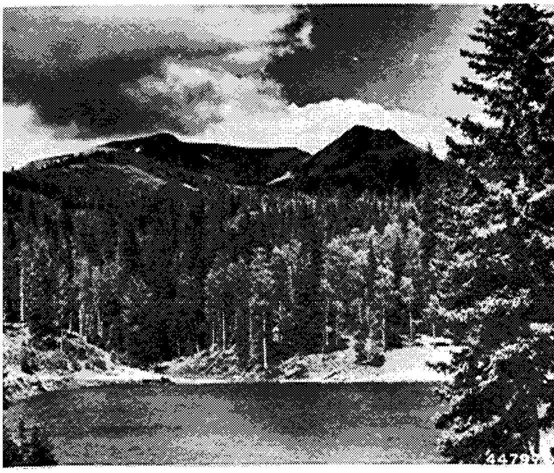
4:5

5:2

6:7

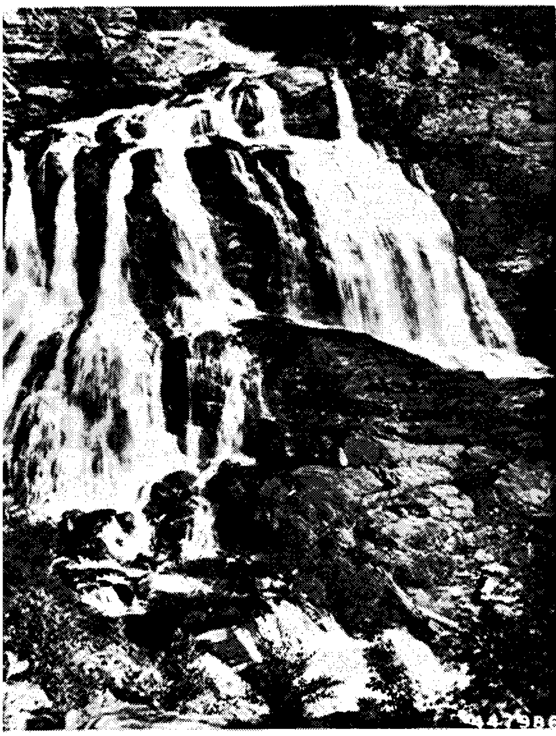
7:6

Figure 3.—Landscape photos used in set B. The two numbers under each photo are its predicted and observed ranking, respectively. The coefficient of concordance = 0.921, and the F value = 11.66, which is significant at the 95-percent level.



1:3

2:1



3:2

4:4

5:5

6:6

7:7

scores in set A ranged from 71 to 174; set B scores ranged from 99 to 212.

Finally, the observed and predicted preference scores were ranked separately from 1 to 7. The coefficient of concordance *(Walker and Lev 1953)* was used to test how well the observed and predicted ranks agreed. The coefficient was significant for both sets (fig. 2 and 3); this means that the predicted and observed ranks showed agreement far beyond what might be produced by sampling variance.

To understand why we compared rank values rather than numerical scores, consider the following possibility. Assume that a test with seven pictures contains one average — and six below-average-quality landscapes. The average picture will receive a much better score than it would if it were compared with six above-average quality landscapes. Thus, when only seven pictures are used in a test, biased scores could be obtained. To compare observed and predicted scores we would have had to conduct our survey with 100 different photographs as we did when we developed the model. We felt that a comparison between predicted and observed ranks was sufficient to test whether or not the model predicts landscape preferences of western recreationists.

DISCUSSION OF RESULTS

The landscape preference model worked fairly well in the West. Although the model predicts preferences for photos of landscapes—not for the landscapes themselves—the procedure seems realistic and practical. Advantages and disadvantages of using photographs in experiments of this kind are discussed elsewhere *(Shafer and Rutherford 1969)*.

In set A, the observed and predicted ranks never agreed exactly but usually differed by only one rank value (fig. 2). The largest difference between a predicted and observed rank occurred in set A: a watefall was predicted to be ranked fifth but actually ranked second (photo labeled 5:2 in fig. 2). This same photo shows a smaller area of the landscape than any of the other six in the set. Therefore, future surveys that use the model to evaluate landscapes might stratify photos first into macro and micro environments. However, stratification may not always be possible; it depends on the number and variety of landscapes to be evaluated.

All landscapes in set A have some water, but only four landscapes in set B contain water (figs. 2 and 3). Closer agreement between predicted and observed ranks in set B suggests that the model may more accurately predict preferences for landscapes that do not contain water. Perhaps the model could be improved if it included additional variables that describe water environments in more detail.

Such details might include the area and perimeter of dark and light shapes within the total water area and the height of a waterfall in relation to other features in the landscape. In addition, it may be helpful in future research to stratify water areas into lakes, streams, waterfalls, and rivers.

On the basis of observed preference scores in set A, our respondents preferred vaious types of water environments in this order:

Picture	*Observed rank*
Waterfall, stream, and lake combined	1
Mutliple waterfalls	2
Single waterfall and stream (rocky shoreline)	3 and 4
Stream (rocky shoreline)	5
Lake	6
Stream (swampy shoreline)	7

In set B, the observed and predicted ranks were the same for four pictures (fig. 3). However, three of the four photos that included water were ranked differently than predicted. Furthermore, one of these three water scenes was a close-up of a waterfall, while all other photos in set B included a much greater area of landscape.

By knowing that quantitative features in the photo of a landscape affect its aesthetic appeal, resource managers and planners can begin to have a factual basis, in addition to an intuitive one, for decisions about wildland aesthetics.

Results of our study provide several clues that may sharpen the model's predictive capabilities. The main point is that it seems possible to quantify certain aspects of the forest landscape, and furthermore, that our methodology presents a reliable approach. However, additional research is needed to test how well preferences for photos of landscapes compare with preferences for those same landscapes when viewed on the ground.

Granted, our procedure for quantifying aesthetics does not provide an economic value for aesthetic quality; this may never be possible. At the most, the model provides a quantitative index of how much one landscape is generally preferred over another, and therefore, may be used to assign weighted preference value to different natural landscapes.

Future research is needed to determine the relationship, if any, between preference value and the real-estate value of a given landscape. Additional research, using our methodology, is also necessary to predict preference for different elements within an environment—shapes, sizes, and colors of individual trees, for example.

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