TN 27: PERCEPTION OF QUALITY OF WILD RIVERS

By P. Juurand, V. Guzelimian, and J. Beaman

ABSTRACT

A group that was in the organization that was the Planning Division of -Parks Canada in 1972 carried out Wild Rivers Surveys to develop a technique for designating rivers with National wild river potential. The surveys had the objective of developing an input to the systematic selection of National Wild Rivers. However, this project also resulted in the possibility of learning something about how expert canoeists' ratings of sites on wild rivers relate to the "resources" at those sites.

Understanding how "resource" variables are related to the perceived quality of a given segment of a river, a site, was pursued by determining how well an average site score for the 4 persons who rated each site was explained by each of three models. The simplest model considered a multivariate regression model in which only interval variables were used. The second model was the more general ANOVA, analysis of variance model, which allowed for nominal variables and non–linear relations between each resource variable and the dependent variable, site quality (note that regression analysis did not assume a designed experiment-see text). Finally, the most general model used was the Michigan AID, Automatic Interaction Detection model (the computer program produces a "model"). The three analysis explained 38%, 64%, and 84% of the variance in average site quality scores respectively.

Statistical tests are presented to show that the improved results based on the different analyses of 212 Wild River sites on which data were collected in 1972 did not occur by chance. The conclusion is that the improvement from model to model is unquestionably real!

Two types of implications of the analysis are pointed out. The first type of conclusions is methodological. The other has to do with the planning use of models. The conclusions suggest very limited value in using "perceived" site quality models for planning because of problems of site use for what, by whom, under what conditions, etc. The paper makes it clear that the comments do not refer to the merits of developing and using "engineering" and "biological" land capability models but to using models of human perception.

PURPOSE

This paper addresses basic questions relating to the use of models in order to show how resource variables are related to the qualities assigned by a jury of expert canoeists to specific sites on a number of Canada's Wild Rivers.

From a social-psychological perspective the concern is with, for a given type of site and user: (1) what variables influence the decision that a site has a given quality, and (2) how a person's decision on the quality of a site is influenced by the ranked importance of physical, historical and biological variables and in what manner do the combination of the judgments on each variable produce an overall judgment of a site's quality.

From a mathematical point of view the question is whether a simple linear model or a more elaborate model is required to explain the Wild River Site quality ratings.

From a parks planning viewpoint, the concern is: (1) to demonstrate how to determine which resource variables are important in the site quality rating, (2) to comment on whether or not resource information (natural, historical and biological) can be used in defining the quality of an area that will be perceived by a given type of user, and (3) to shed some light on whether or not site quality estimates can be obtained with enough social-psychological and statistical confidence that they can reasonably be used in planning.

THE PROBLEM

Any discussion of the attractiveness of landscapes raises the problem of how a person reacts to resource variables when judging the quality of a site. To pursue but one example, the Shafer et al (1969) study indicates that people do not react to resource variables in a linear way. Shafer's models, by their structure, imply that they react independently to different resource variables and that their responses to different variables combine additively.

Do people in the real world react to situations by mentally adding up the effect of each resource variable to get a "composite" quality rating? Obviously, they do not do it consciously, so it is necessary to consider the possibility that when an individual reacts to a site, that reaction is (firstly) not necessarily linear or curvilinear and (secondly) not necessarily defined by independent reactions to each of several resource variables.

From a mathematical perspective, the preceding ideas can be dealt with by accepting that the perceived "quality" of a site on a wild river (in relation to the use of the river for a given purpose) is determined by an individual in a rational, predictable and statistically reproducible way. Accepting this statement acknowledges that the following type of equation may be used to define the quality of a site:

$$a(s) = F(X(1), X(2), X(3), \cdots, X(n)) + E(p)$$

WHERE

$a(s)$ = Quality of a particular site, s, as perceived by a given type of person, for a given purpose;

$F(\,)$ = some function;

$X(i)$ = the score of site s on resource variable i; and

$E(p)$ = a unique "error" related to variability in perception, with (p) being a subscript that refers to a particular rating by a given person on a given occasion.

Whether or not the rating of a site is made in a linear way is then a matter of determining whether F( ) is a linear function of X(1), X(2), etc. and, if decisions are made in other ways, by determining if F( ) is a different kind of function of the resource variables.

THE DATA

As shown in Figure 1, the rivers for which data were collected in the 1972 Parks Canada Wild Rivers Survey were those flowing through the Mackenzie Mountain section of the Western Cordillera, the Barrenlands and Tundra Hills of the Canadian Shield, the Boreal Uplands of Saskatchewan, the Laurentian and east coast regions, and the rivers in the Appalachian mountain system of Newfoundland. They were studied by crews of two 2-man canoe teams. Four crews were in the field in 1972.

The data were collected from sites on the rivers where major or minor changes in the river and the river valley environs were observed to take place. Major changes were considered to be those where a lasting change took place (e.g. from a V-shaped straight valley to a broad flood plain with a meandering channel); minor changes were defined as spot locations of scenic, historic or cultural interest. (in the original document there were references to the survey reports. These are not available so they are not referenced.)

A survey site was a 200-to 500-yard reach, or two to three stream-widths of a river that best illustrated one of the following:

- Upstream starting point
- Change in water pattern: rapids to slow moving water Change in water pattern: slow moving water to rapids Change in valley: from flats to canyons
- Change in valley: from canyons to flats
- Change in river or valley caused by intersection with major river
- Mouth of river
- Points of historic interest
- Major resource developments or townsites
- Spectacular or scenic sites that do not fall into the above categories (e.g. waterfalls, a particularly attractive bend in a canyon, etc.)

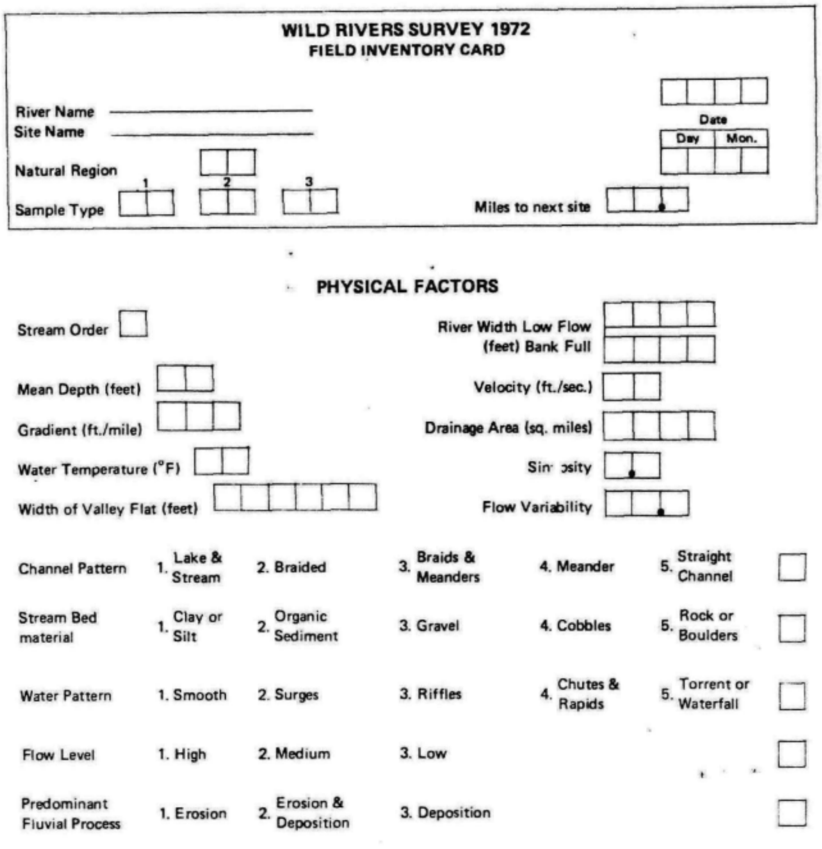
Figure I

RIVERS STUDIED IN THE 1972 WILD RIVERS SURVEY

When collecting data, crews were instructed not only to note the reason for choosing an area as a sample site but also to record the type of sample. Secondary and tertiary reasons for choosing a site were also to be recorded. Crews were also required to record the number of miles between sites as an indication of the frequency of changes along the course of the river.

The variables chosen to describe site characteristics are shown in Figure 2. The codes for some of them are given in the Appendix but other variable values are not shown there because they can be read from the Inventory Coding Form also given in Figure 2. Of all the variables listed on the Inventory Coding Form, only stream order and sinuosity were found to be interpreted inconsistently. They were not coded and therefore do not appear in the Appendix.

One change between the 1971 Wild River Survey and the 1972 survey was the recording of site ratings. Each crew member rated each site subjectively on a 10-point scale. The average measure for a site is the dependent variable describing site quality used in the analysis. Although individual crew members had varying backgrounds and tastes, all were expert canoeists with extensive experience in wilderness and river environments. Thus their ratings, while varying according to personal preference, can be expected to reflect homogeneity of judgment due to similar to, and interest in, extensive wilderness travel.



WILD RIVERS SURVEY 1972
FIELD INVENTORY CARD

River Name ____________
Site Name ____________
Date ☐☐☐☐
Day ☐☐ Mon. ☐☐
Natural Region ☐☐
Sample Type 1 ☐☐ 2 ☐☐ 3 ☐☐
Miles to next site ☐☐.☐

PHYSICAL FACTORS

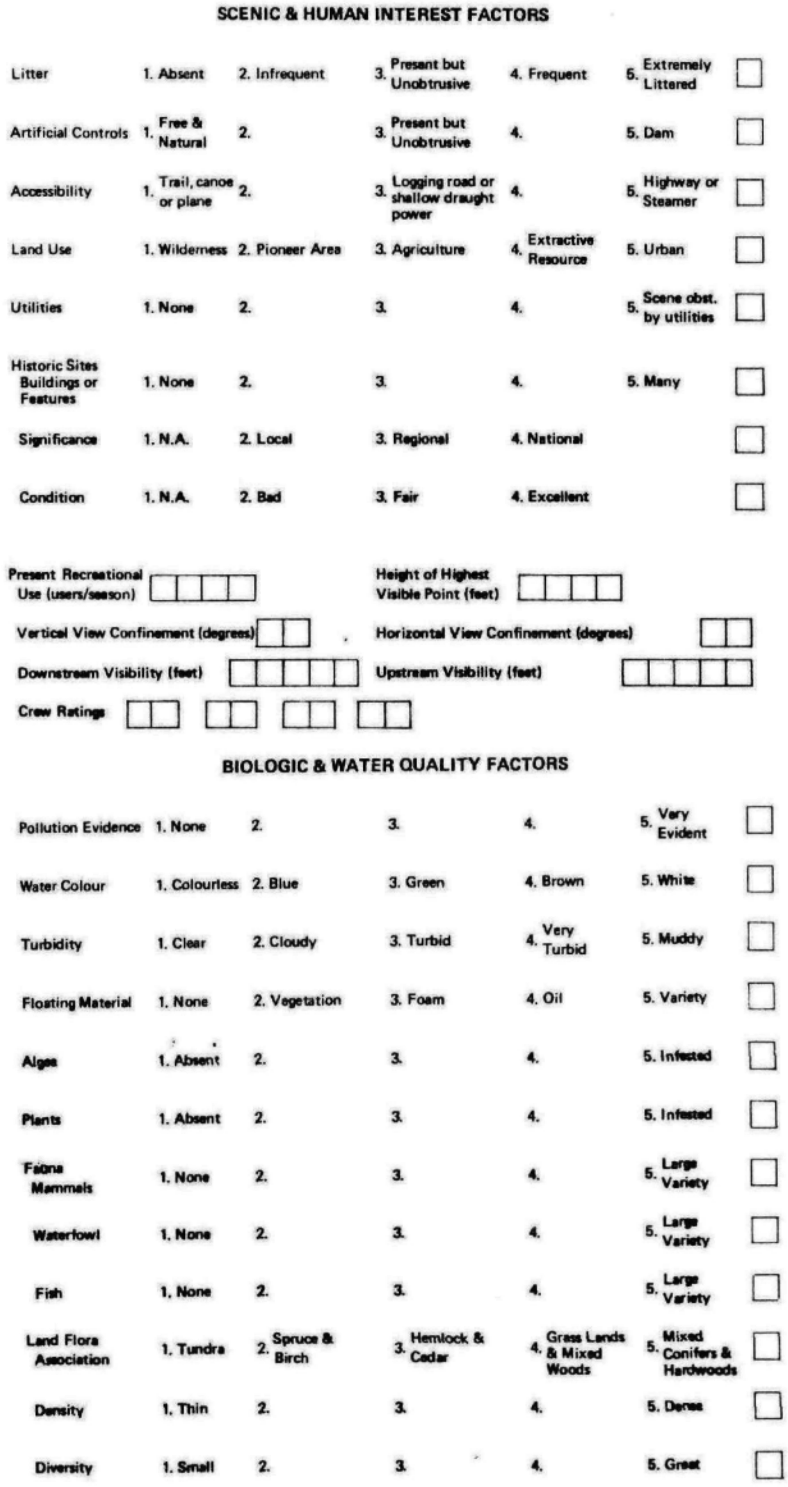
Stream Order ☐
River Width (feet) Low Flow ☐☐☐☐
Bank Full ☐☐☐☐
Mean Depth (feet) ☐☐
Velocity (ft./sec.) ☐☐
Gradient (ft./mile) ☐☐☐
Drainage Area (sq. miles) ☐☐☐☐
Water Temperature (°F) ☐☐
Sinuosity ☐.☐
Width of Valley Flat (feet) ☐☐☐☐☐☐
Flow Variability ☐☐.☐

Channel Pattern	1. Lake & Stream	2. Braided	3. Braids & Meanders	4. Meander	5. Straight Channel	☐
Stream Bed material	1. Clay or Silt	2. Organic Sediment	3. Gravel	4. Cobbles	5. Rock or Boulders	☐
Water Pattern	1. Smooth	2. Surges	3. Riffles	4. Chutes & Rapids	5. Torrent or Waterfall	☐
Flow Level	1. High	2. Medium	3. Low			☐
Predominant Fluvial Process	1. Erosion	2. Erosion & Deposition	3. Deposition			☐

ANALYSIS

In the following, three terms are used to describe data analysis approaches. 'Simple regression' refers to a "standard" regression analysis in which both the independent and dependent variables are continuous (interval) and the dependent variable is explained by a mean plus a sum of regression coefficients times their respective variables. 'ANOVA' (analysis of variance) is used in a fairly welt accepted way to refer to an analysis where the independent variables are nominal, having values such as married, single, divorced, rather than being intervals. (Scheffe 1970) In this analysis, "effects" for each value of each variable are calculated (see Figure 2). A very simple illustration of the kind of results obtained, using this analysis method, is available in the CORD Study TNs No. 12 and 15. Finally, 'AID' (Sonquist and Morgan 1964) is based on a computer program that performs a search for a structure in data in a more general way, using less restrictive assumptions, than does

ANOVA. (For an example of the use of



SCENIC & HUMAN INTEREST FACTORS

Litter	1. Absent	2. Infrequent	3. Present but Unobtrusive	4. Frequent	5. Extremely Littered	☐
Artificial Controls	1. Free & Natural	2.	3. Present but Unobtrusive	4.	5. Dam	☐
Accessibility	1. Trail, canoe or plane	2.	3. Logging road or shallow draught power	4.	5. Highway or Steamer	☐
Land Use	1. Wilderness	2. Pioneer Area	3. Agriculture	4. Extractive Resource	5. Urban	☐
Utilities	1. None	2.	3.	4.	5. Scene obst. by utilities	☐
Historic Sites Buildings or Features	1. None	2.	3.	4.	5. Many	☐
Significance	1. N.A.	2. Local	3. Regional	4. National		☐
Condition	1. N.A.	2. Bad	3. Fair	4. Excellent		☐

Present Recreational Use (users/season) ☐☐☐☐

Height of Highest Visible Point (feet) ☐☐☐☐

Vertical View Confinement (degrees) ☐☐

Horizontal View Confinement (degrees) ☐☐

Downstream Visibility (feet) ☐☐☐☐☐

Upstream Visibility (feet) ☐☐☐☐☐

Crew Ratings ☐☐ ☐☐ ☐☐ ☐☐

BIOLOGIC & WATER QUALITY FACTORS

Pollution Evidence	1. None	2.	3.	4.	5. Very Evident	☐
Water Colour	1. Colourless	2. Blue	3. Green	4. Brown	5. White	☐
Turbidity	1. Clear	2. Cloudy	3. Turbid	4. Very Turbid	5. Muddy	☐
Floating Material	1. None	2. Vegetation	3. Foam	4. Oil	5. Variety	☐
Algae	1. Absent	2.	3.	4.	5. Infested	☐
Plants	1. Absent	2.	3.	4.	5. Infested	☐
Fauna Mammals	1. None	2.	3.	4.	5. Large Variety	☐
Waterfowl	1. None	2.	3.	4.	5. Large Variety	☐
Fish	1. None	2.	3.	4.	5. Large Variety	☐
Land Flora Association	1. Tundra	2. Spruce & Birch	3. Hemlock & Cedar	4. Grass Lands & Mixed Woods	5. Mixed Conifers & Hardwoods	☐
Density	1. Thin	2.	3.	4.	5. Dense	☐
Diversity	1. Small	2.	3.	4.	5. Great	☐

AID, see TN 4.) The authors are not concerned with the fact that regression analysis can be employed to carry out an analysis of variance by what is often called the dummy variable approach. By ‘simple regression' they mean that no nominal variables or interaction effects are built into a model. Similarly, by analysis of variance they mean analysis of variance in the sense that regression was run to estimate a model without any assumption that data constituted a designed experiment (*e.g., experiments for which special ANOVA estimation programs are used because effects are e.g. orthogonal*).

Since use of linear regression analysis of variables with more than two values requires that variables be interval, only interval variables having a logical bearing on landscape preference were selected for analysis. The variables that could be used were correlated, and some of those exhibiting high correlations with other variables (r=.8) were eliminated by keeping only one variable of a set of highly intercorrelated variables. After such screening a multiple regression analysis was carried out. Using the average crew ratings as the dependent variable and the "dimensions" of the environment listed below, it was possible to determine relationships between the quality measure and the selected environmental variables. The regression model derived is given by the following equation, for which standard errors in the regression coefficients are shown in parentheses:

$$\begin{aligned}(1)\quad Y = 2.686 &- \underset{(.17)}{0.19\,X10} - \underset{(.08)}{0.18\,X12} - \underset{(.15)}{0.05\,X22} - \underset{(.08)}{0.08\,X24}\\ &- \underset{(.11)}{0.03\,X25} - \underset{(.14)}{0.51\,X29} - \underset{(.20)}{0.52\,X33} - \underset{(.01)}{0.02\,X37} - \underset{(.07)}{0.17\,X39}\\ &- \underset{(.16)}{0.32\,X54} - \underset{(.10)}{0.05\,X56} - \underset{(.14)}{0.35\,X58} - \underset{(.11)}{0.46\,X60} - \underset{(.14)}{0.25\,X61}\end{aligned}$$

WHERE: X10 is the mean depth of the river;
X12 is the gradient of the river at the site; X22 is the velocity of the river;
X24 is the coarseness of the stream bed material;
X25 is the degree of turbulence on water's surface;
X29 is the degree of artificial channel control (recognized as a questionable variable to be considered as Interval);
X33 is the angle between horizontal and highest visible point;
X37 is the height above the river of the highest visible point;
X39 is angle between highest visible point;
X54 is the amount algae (recognized as a questionable variable to be considered as interval);
X56 is the number of mammals;
X58 is the number of fish;
X60 is the density of land flora; and 161 is the diversity of land flora.

The analysis of variance presented in Table 1 shows that the regression resulted in a significant relationship with a F = 10.22, which has a probability of less than .005 of occurring by chance. The R^2 value obtained was .38. The F-test clearly indicates that the null hypothesis of no relation must be rejected. But the R^2, while acceptable mathematically, hardly suggests that the model is usable for planning purposes. In descriptive terms, the low value of R2 means that a prediction of site quality has a high probability of being very much in error (being high when it should be low and vice versa).

TABLE 1: ANALYSIS OF VARIANCE TABLE FOR THE SIMPLE LINEAR REGRESSION

Source of Variation	Degrees of Freedom	Sum of Square	Mean Square
Regression	14	415.667	26.69
Residual	225	653.6	2.90

F-Ratio = 10.22*

*** Significant at .005 level.**

Turning to analysis of the data using analysis of variance, it should be noted that the following equation was assumed to be appropriate to explain site quality ratings:

> (Quality of a River Site i) =
> General mean + gradient effect at site i + valley width effect appropriate to site i + bank width effect + velocity effect + stream bed material effect + water pattern effect + fluvial process effect + artificial control effect + access effect + land use effect + utilities effect + historic sites effect + height of highest point effect + vertical view confinement effect + horizontal view confinement effect + downstream view effect + upstream view effect + pollution effect + water colour effect + turbidity effect + floating material effect + algae effect + plants effect + flora effect + flora density effect + flora diversity effect + mean depth effect.

Expressed differently, Equation 2 shows that the effect for each level of the variables that apply to a given site is added to give a predicted quality as follows:

(2) $Y(i) = U + B(1,i) + B(2,J) + B(3,k) + \ldots$
$+ B(L,m) + \ldots + B(n,61)$

WHERE $Y(i)$ = the quality rating of site i
U = the general level of site quality
$B(1, i)$ = the effect of level i of variable 1
$B(2,J)$ = the effect of level $_{j}$ of variable 2
$B(3,k)$ = the effect of level k of variable 3
$B(L,m)$ = the effect of level m of variable L,
$B(n,61)$ = the effect of level n of variable 61.

A computer program was used to perform the generalized analysis of variance. The R^2 value for the analysis was .594. The B's for Equation 2 are listed in the Appendix, which gives the names of all variables and the values that they were allowed to take along with the constant U, the general mean. The coefficients listed in the table are often called the beta coefficients of a particular level.

Figures 3 through 5 were prepared by plotting the beta values for each level value of the variables used to explain site quality. For example, looking at the turbidity variable, one sees that the bar showing its value is close to 0 for level 1, extends above 0 for level 2, and drops below 0 for level 3. These results show that for higher turbidity levels (2 rather than 1) the turbidity effect is higher. However, when turbidity is 3, the turbidity effect is lower than for a turbidity of 2. The respective effects are .052, .320, and -.372 as indicated in the Appendix.

When the largest (positive) value for turbidity, .320, is added to the general mean for quality, 6.167, the perceived site quality score is 6.487. When the lowest beta value for turbidity -

.372 is added, the score is 6.795. Thus, recognizing that the mean quality score can vary from 1 to 10, it is apparent that little change in this score results from considering the turbidity effect. So it is reasonable to say that the variable has a small effect on site quality scores, a point which becomes more meaningful in a comparative sense. A relatively large change in the general mean is associated with the variable "highest point". A flat terrain should have a low beta value. Level 1 of highest point, has a beta value of -.926 associated with it; level 4 of highest point (the level indicates at least one feature projecting high above the water level) has a beta value of .412. When each of these scores is added to the general mean, the two values obtained are 5.241 and 6.167 respectively. Thus it is seen that the highest point variable has a much larger effect on site quality scores than the turbidity variable.

In contrast to the foregoing analysis techniques (in which regression coefficients or effects are calculated), the AID technique is a multivariate method of analysis used to classify data into homogeneous groups, called terminal clusters, on the basis of the value of a dependent variable. Given an interval value dependent variable and a specific set of nominal (possibly ordinal) independent variables, an AID analysis indicates (i) which independent variables may be considered to explain most of the variance in the dependent variable, and (2) which levels of independent variables account for the variance explained.

Two AID analyses were performed on the Wild Rivers data. The first run provided an analysis for the purpose of illustration only. The second, with the same number of degrees of freedom as ANOVA, was then performed to obtain AID results which are comparable to ANOVA results because both had the same number of degrees of freedom. (On comparing AID and ANOVA, see TN 20.) The R^2's were respectively .74 and .85. The former analysis produced fifteen terminal groups, the latter produced forty-five.

Figure 6 presents the results of the AID run which produced fifteen groups. The various steps of the analysis resulted in the tree diagram shown. The first step was to compute the mean site quality score of all 240 sites, in this case M = 6.17. This parent group, Group 1, is indicated by 1,240 at 6.i7 on the site quality axis. The independent variable that accounts for the most variance in the dependent variable (site quality score) was then chosen.

Whenever AID is used, the independent variable that accounts for the most variance is chosen on the basis of variance explained in a dichotomous split. In this case the original 240 observations in Group 1 were divided into Groups 2 and 3 in such a way that there was the greatest possible difference between their site quality scores in terms of between-group variance. At the right-hand side of Figure 6, at splitting level 1, the independent variable "flora density" is shown because it accounts for the largest amount of variance in site quality scores. When Group 1 was divided on the basis of the flora density values, Groups 2 and 3 were formed. Group 2 contains observations with levels 2, 3, 4 and 5, of flora density and Group 3 contains level 1 (as indicated in the right-hand column of the Figure). The tree diagram is read from top to bottom. The brackets notation (X,Y) gives the variable on which a split has taken place to form Group I, which contains Y observations. By reading the X's, one may determine the order of splitting and thus, in some sense, the independent variables' relative power to explain variance. The position of the (X,Y) for a group on the site quality scale indicates the mean value of the dependent variable for the Group X. For example, as the Figure shows, Group 2 with a mean of 6.6 is made up of 187 of the original 240 observations.

Figure 3:

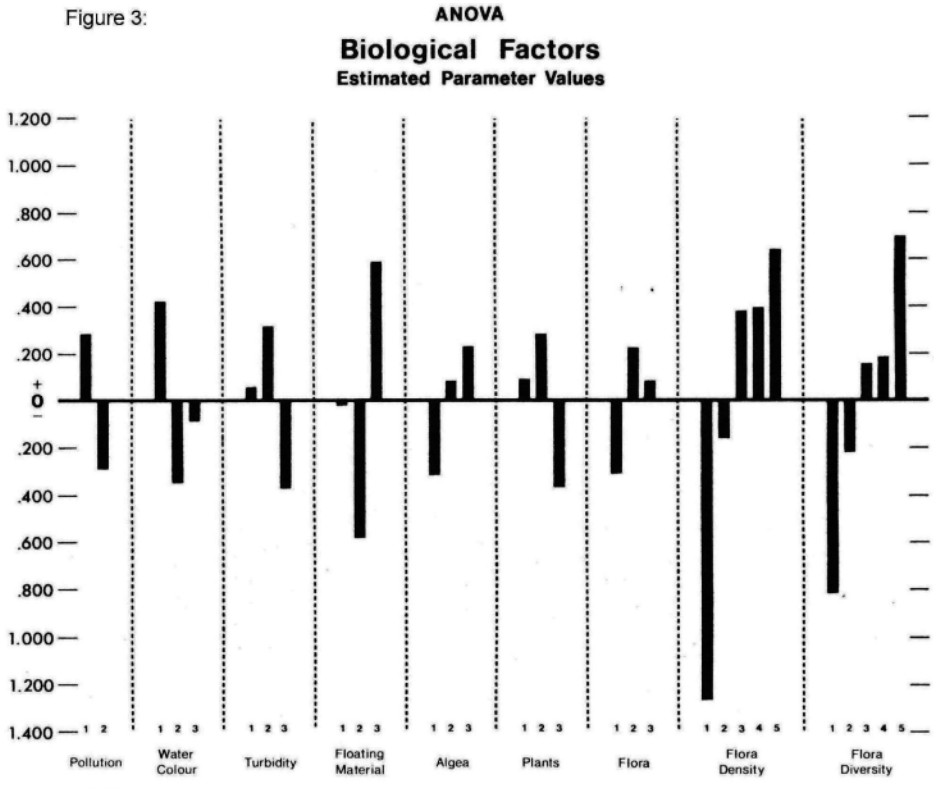


Figure 4

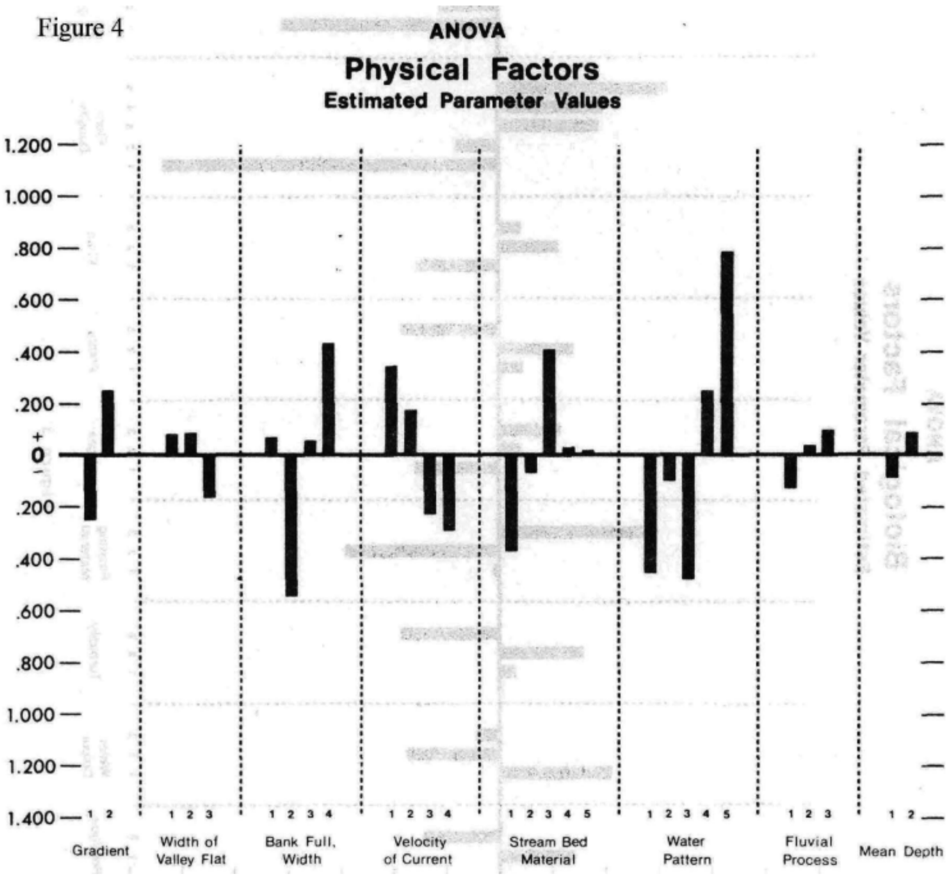
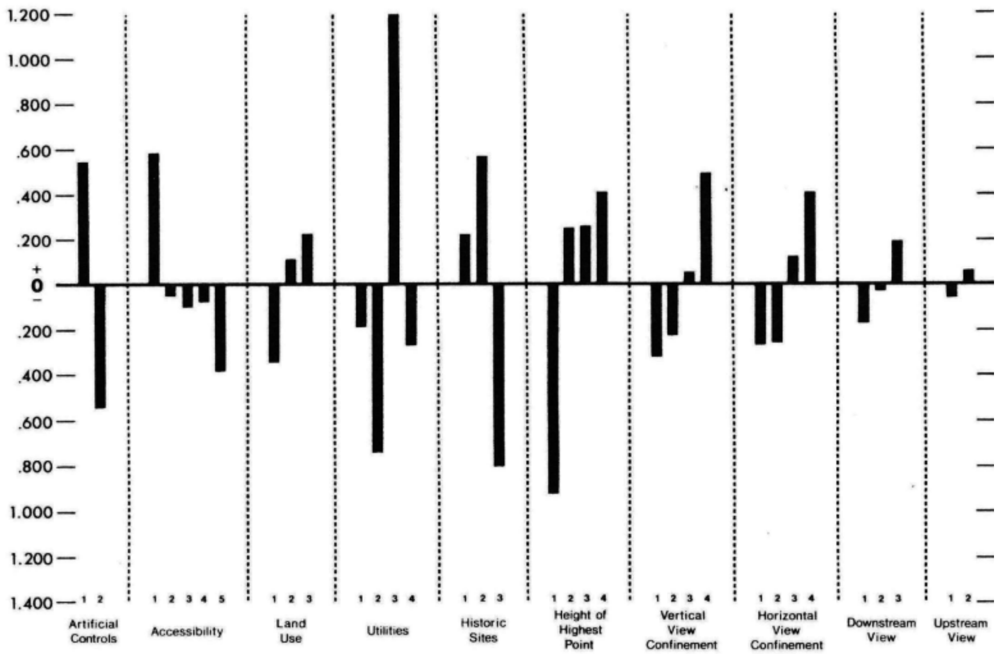


Figure 5:

ANOVA

Human Use and Interest Factors

Estimated Parameter Values



When a further step of splitting is considered, the largest amount of variance within groups that may be split is taken as the criterion for selecting that group: the AID program computes the amount of variance (within each group that may be split) about the group mean. Referring again to Figure 6, since Group 2 has more variance to be explained than Group 3 (Groups 2 and 3 are the only candidates for splitting at step two), it is divided to form Groups 4 and 5 on the variable "water pattern". This splitting is done the same way as for Group 1: water pattern was the variable that would explain the most variance in Group 2 based on dividing the Group into two parts. Groups 3, 4 and 5 are now candidates for further splitting. Group 5, having the most variance to be explained, is split to form Groups 6 and 7 using the variable "water colour".

This process of splitting continues until a cut-off point is reached. These points are predetermined criteria that indicate that a particular Group available for splitting should not be split. Termination of splitting results in terminal groups. Group 4 underwent no further splitting because of the cut-off rule, and thus it is a terminal group. Other terminal groups are Groups 9, 10, 19, 22, etc. appearing at the ends of the branches of the AID tree. (For details, see TN 4.)

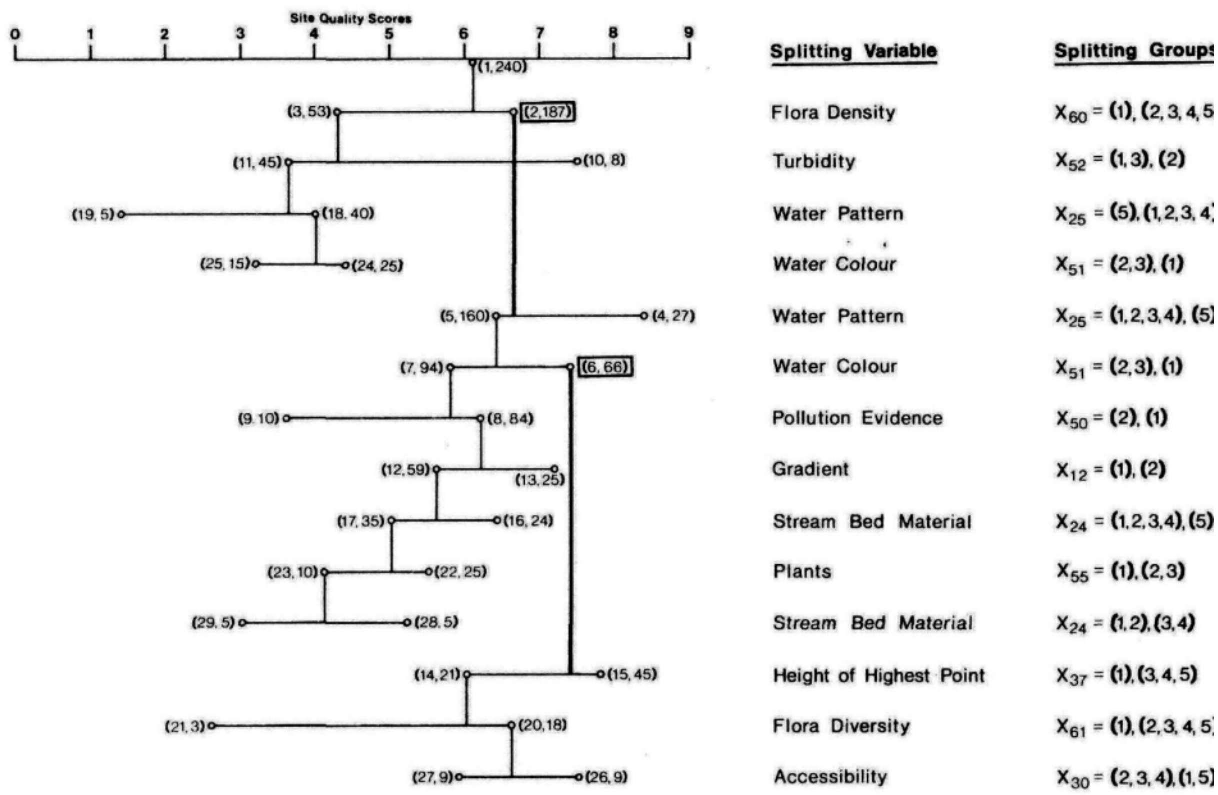
An AID analysis of the Wild Rivers data produced Group 19, which has the lowest site quality score (i.4) in the AID tree, and Group 4 which has the highest score (8.3). These two sites had a similar water pattern of torrent or waterfall (X25 = 5) but the variable "flora density" made the difference of scores of 1.4 and 8.3 on the site quality scale. Group 19 has a thin flora density while Group 4 has denser flora. Otherwise the sites in clusters 4 and 19 are similar.

Figure 6 also indicates that fourteen of the twenty-seven independent variables were significant in the assessment of site quality in that they were used in forming the AID tree. Furthermore, because of its position on the tree, flora density may be considered a more prominent variable than turbidity. To the extent that the canoeists' aesthetic judgment is simulated by the AID trees, an understanding of the elements of the decision-making process is achieved and the AID tree lays out the logic behind the canoeists' definition of site quality. For this reason, the AID computer analysis may be said to replicate the tree of logic that a canoeist follows in defining site quality on wild rivers.

Figure 6:

ANOVA

A. I. D. Tree Structure



Splitting Variable	Splitting Groups
Flora Density	X_{60} = (1), (2, 3, 4, 5
Turbidity	X_{52} = (1, 3), (2)
Water Pattern	X_{25} = (5), (1, 2, 3, 4
Water Colour	X_{51} = (2,3), (1)
Water Pattern	X_{25} = (1, 2, 3, 4), (5
Water Colour	X_{51} = (2,3), (1)
Pollution Evidence	X_{50} = (2), (1)
Gradient	X_{12} = (1), (2)
Stream Bed Material	X_{24} = (1, 2, 3, 4), (5)
Plants	X_{55} = (1), (2, 3)
Stream Bed Material	X_{24} = (1, 2), (3, 4)
Height of Highest Point	X_{37} = (1), (3, 4, 5)
Flora Diversity	X_{61} = (1), (2, 3, 4, 5
Accessibility	X_{30} = (2, 3, 4), (1, 5

DISCUSSION

Earlier, it was pointed out that only interval variables having a logical bearing on landscape preference were used in the simple linear regression analysis. It was found that the interval variable of the linear regression model could be used to describe a linear relationship significant at the .005 level and explaining 38 percent of the variance in the Wild River data. On the other hand, with the ANOVA model, it was found that allowing for a curvilinear relationship and for the inclusion of nominal variables explained 59 percent of the variance in the site ratings.

In both models, the fourteen and twenty-nine parameters were estimated from 241 observations. Since the simple linear model has an R^2 of .38 and ANOVA is a generalization of the linear model, the ANOVA analysis has a larger R^2, as expected. This R^2 of .59 indicates that by introducing fifteen new parameters, 34 percent of the residual variance was accounted for:
$(R^2(\text{ANOVA}) - R^2(\text{LINEAR}))/(1 - R^2(\text{LINEAR}))$ 100% = (.58 - .38)/(1 - .38) X 100% = 34%

But, is the increase in R^2 only due to increasing the number of parameters estimated? The percent of the remaining variance that can be expected to be explained by chance is 15/(241-i4) = .066 (about 7%), which is:

$$\text{\% of variance expected to be explained by chance} = \frac{\text{No. of degrees of freedom introduced to explain remaining variance}}{\text{No. of degrees of freedom of variance that remains to be explained}}$$

Therefore, the inclusion of an additional fifteen parameters would be expected to explain approximately 7 percent of the remaining variance by chance rather than the 34 percent actually explained. But this could still occur by chance, and so an F-test is useful to determine whether the increase in variance explained is statistically significant. An appropriate F-ratio to test the significance of the increased variance explained is:

$F = (1/(B - A)(SSE(ANOVA) - SSE(LINEAR)))/((1/(241 - B)) RSS(ANOVA)) = 7.12$

WHERE

A = degrees of freedom in a linear regression model

B = degrees of freedom in an ANOVA model

SSE = the sum of the squared deviations around the mean of the site quality score explained by a model

RSS = the sum of the squared deviations around the mean not explained by a model.

The F-value 7.21 is significant at the .01 level. Thus one has proof that allowing for nonlinearity by the inclusion of the fifteen nominal variables in the analysis results in an explanatory power significantly higher than chance would produce.

To summarize the preceding discussion shows that one model may appear to be better than another because (1) it has more freedom to fit the same data, or (2) the better fit has occurred only by chance. The first condition is caused when a large number of parameters are estimated: the second is the result of random error. But, the 34 percent increase in explanation when more parameters were introduced is (statistically) significantly higher than the 7 percent increase that would be expected by chance, and so both (1) and (2) can be rejected as explanation and the ANOVA model must be accepted as better (more structurally appropriate to the data) than the simple regression model.

Similar consideration must be introduced in comparing AID and ANOVA, but one interesting difference exists. The AID model can be (and was) set up in such a way that it had the same number of parameters as the ANOVA model. Using the equation for increased variance explained, it is evident that the AID model explained the 63 percent that was not explained using the ANOVA model:

$(R^2(AID) - R^2(ANOVA))/(1 - R^2(ANOVA) X 100\% = (.85 - .59)/(1 - .59) X 100\% = 63\%$

If, as before, one performs an F-test using the equation

$F = (1/(B - A) SSE(AID) - SSE(ANOVA))/ (1/(241 - B) RSS(ANOVA))$

a problem is encountered: the number of parameters in the AID model is equal to the number of parameters in the ANOVA model. Therefore 1/B-A involves division by zero. To avoid this problem B - A can be arbitrarily set to 1 (or even 2 or 3 if there is a desire to make the test very conservative). When this is done, the F-ratio is found to be 375.93, which is significant at the .001 level with 1 and 212 degrees of freedom. (For other comparisons of AID and ANOVA results, refer to TN 20.) Thus the AID model fits the Wild River data better than do either the ANOVA or Linear models. And this is true in a statistically highly significant way, predicting a given site's attractiveness for a certain purpose with more confidence than can be done with either of the other two models.

The results not only show that AID is the best model, ANOVA next and the simple linear poorest, but they confirm the conclusions of previous investigations and add a number of new dimensions. For example, the importance of vegetative cover in the evaluation of landscape photographs is also implied by the results obtained by Shafer (Reference 19), Rabinowitz and Coughlin (Reference 17), and Calvin et al (Reference 2). Further comparisons involve too elaborate a commentary to include here since the factors used in describing landscapes-differ from one study to another.

Probably more important than confirmation of past findings is the fact that these studies allow researchers to say something about the structure of the decision made when a site is rated highly by a given individual. That the AID model (which puts the reaction of a site in the context of a collection of variables) is the most accurate model for describing the perceiver's decision-making process is proof that people do not react to individual resource variables and then build some total score for a site. Acknowledging the superiority of the AID model in explaining site attractions adds a meaningful dimension to the study of site attractivity. (Cesario used it to study park attractions in TN 4.)

To elaborate on the methodological complications of the preceding, there is often not enough care taken in distinguishing different uses of general programs such as the AID Program or regression programs. For example, it is perfectly valid to use a linear regression program to obtain the coefficients (parameters) that define a linear function, regardless of the number of data points, as long as that function is truly linear. Similarly, examination of the clusters determined by the AID Program tells us something about how the decisions that ranked various sites were made by the canoeists, even though only 240 observations were used. Group 11, for example, consisting of forty-five observations, was split to form two groups with means i.4 and 4.0. In this case it is claimed that the groups formed are relatively homogeneous clusters having truly different site quality scores. Some may argue that is not statistically sound to use AID analysis to split a group containing forty-five out of 240 observations. However, further statistical examination indicates that a real structure has been found in the data: there is a difference of almost three units between the means of the two newly formed groups and there is a very low probability that this occurred by chance.

Some of the final splits presented in the paper make it questionable whether anything new was learned about the rankings of sites. It is felt here that researchers need not be bound by criteria that suggest that either information must be available on 2,000 sites or AID must not be used. The important point is that it a researcher decides not to use AID simply because of a relatively small sample size, and uses some linear technique such as ANOVA to look for structure, he may find it with an R^2 of .64 which looks good. But suppose that the reason for obtaining the model is to use it in making predictions in a planning exercise? Even an R^2 of .84 is not particularly good if one is to put much faith in predictions. What is worse is that if the structure of a model is not really appropriate to the data (as would be the case with the ANOVA) predictions will be systematically in error so that some types of good locations may be regularly underrated and bad ones overrated. Even if an analysis is used for strictly academic ends (except for teaching purposes) it is futile to derive a simple regression of an ANOVA model to explain data when these models are not appropriate.

In sum, the superiority of the AID analysis means that interactions between resources must be taken into account when formulating models to explain the ratings of the Wild River Sites considered.

CONCLUSION

Accepting the straightforward conclusion reached (that the AID model is superior to the other models considered for explaining perceived quality of sites) and if other research supports these findings, then interaction must be considered in developing meaningful models of how people react to their environment in terms of assessing the attractiveness of a given setting. But even the preceding statement fails to emphasize the importance of quality or attractiveness "to whom and for what purpose." It is unlikely that a wild river canoeist will rate a site highly if the river has little gradient: he will prefer the excitement of changing water conditions. A fisherman who uses a motorboat, on the other hand, may prefer a river without barriers. Thus there may be homogeneity of response among wild river canoeists and large variations across different river users. An individual's reasons for being at a certain site determine to some extent the rating of the site in terms of scenic value and there is no suggestion here that the ratings by the canoeists are generalizable to a population of river users.

This has clear implications for park planners. Within a parks planning framework, concern is with whether a site quality measure defined by field survey crews can be explained by resource variables for the sites studied (e.g. natural, cultural, etc.). If site quality can be explained with a high enough degree of accuracy by a function of a number of resource variables, it is possible to predict the quality of various areas by using only resource information. The AID model can be used for predictions (see TN 4) and an R^2 of .84 suggests that they would be quite good. Thus at first sight it appears that there are planning applications of the AID model worth investigating, particularly so in an era when remote recording techniques can be used to produce relatively inexpensive resource data that can be readily processed by computers.

The "catch" is that the model derived gives quality estimates for a particular type of user at a site for a particular purpose. Quality values for a number of types of users could, of course, be computed but unless there is almost total agreement between quality measures there is the problem of how to get an overall intangible assessment. (See TN 25.) Unfortunately a compromise quality may not satisfy any of the users of a site. So, it must seriously be asked if it is only engineering type assessments (for example, impact on land due to use) that are worth generating using computers.

Certainly some of the modelling techniques now in vogue for capacity and impact analysis (ones which involve people stating their model for the social capacity of an area) are brought into serious question by the quantitative results presented here. An ANOVA model has been shown to be inappropriate to explain expert canoeists' perceptions of site qualities on wild rivers. Even if an ANOVA model were appropriate to assessing composite quality to a party that is at the site for purpose X, why should it be appropriate to explain the quality of day—use or camping areas? Why should one suppose that Mr. or Mrs. Average Citizen or park planners or managers are able to state the parameters of the model they are using to assess quality?

It is the policy—maker's responsibility to decide whether or not an agency's plans and policies for the management of a specific resource should reflect only current popular values and tastes or if (for example) they should focus on conservation or be used to mould future values by providing new environments, experiences, programs and facilities. Perceptual studies can be useful for marketing purposes, and can provide a basis for interpretive programs but they are not appropriate as the exclusive vehicle for planning analysis. In an age of increasing automation, it is important to realize that just because a model can be developed that explains 84 percent of the variance in site quality rating for one type of site for one type of user, that is no reason to suggest that a planner attuned to the objectives for a park is not a better "vehicle" to use in planning the park. The planner who sees merit in having the way he judges site qualities automated should exercise great care that (1) different models are developed in relation to sites having different purposes, and (2) that sophisticated models like the AID model are used to reinforce planners' judgments in preference to ad hoc model formulations in which he specifies the importance of variables and their values and these are "plugged into" a preconstructed equation that may be entirely inappropriate

APPENDIX: ANALYSIS OF VARIANCE, VARIABLES, VALUES AND ESTIMATED ANOVA PARAMETER VALUES FOR ATTRACTIVITY

General Mean = 6.167

VARIABLE	LEVEL	BETA
Gradient(Rate of drop)	1. 0 - 7	-0.252
Feet per Mile	2. 8-132	0.252
Width of Valley Flat	1. 1 - 1,295	0.081
Feet	2. 1,296 - 9,599	0.002
	3. 10,000 - 31,999	-0.163
Bank, Full River	1. 35 - 322	0.064
Width - feet	2. 323 - 2,302	-0.547
	3. 2,303 - 8,834	0.048
	4. 8,835 - 9,999	0.435
Velocity of Current	1. 0 - 2	0.349
Feet per Second	2. 3 - 7	0.173
	3. 8 - 14	-0.231
	4. 15 - 80	-0.292
Stream Bed Material	1. Clay or silt	-0.372
at Edge of River	2. Organic sediment	-0.065
	3. Gravel	0.408
	4. Cobbles	0.020
	5. Rocks or Boulders	0.009
Water Pattern	1. Smooth	-0.459
of River at Site	2. Surges	-0.098
	3. Rip^{p}les	-0.480
	4. Chutes and rapids	0.248
	5. Torrent or waterfall	0.788
Fluvial Process	1. Erosion	-0.126
at Site	2. Erosion & Deposition	0.029
	3. Deposition	0.097
Artificial Controls	1. Free and Natural	0.545
	2. Present but unobtrusive	
or dam	-0.545	
Accessibility	1. Trail, canoe, or plane	0.586
	2. *	-0.044
	3. Logging Road	
or shallow draught	-0.099	
	4. *	-0.071
	5. Highway or Steamer	-0.381

VARIABLE	LEVEL	BETA
Land Use	1. Wilderness	-0.348
	2. Pioneer Area	0.111
	3. Resource & Urban	0.221
Utilities	1. None	-0.19:
(graded as to	2. Infrequent	-0.73'
frequency)	3. unobtrusive	1.201
	4. Obstructed by utility	-0.27:
Historic Sites	1. None or Many	0.221
(Buildings or	2. Infrequent	0.57'
Features)	3. Unobtrusive or Many	-0.80:
Height of Highest	1. 0 - 254	-0.921
Point in Feet	2. 255 - 898	0.251
	3. 899 - 2,498	0.26:
	4. 2,499 - 9,950	0.41:
Vertical View	1. 0 - 2	-0.311
Confinement - Degrees	2. 3 - 7	-0.225
	3. 8 - 23	0.041
	4. 24 - 90	0.411
Horizontal View	1. 0 - 14	-0.271
Confinement - Degrees	2. 15 - 79	-0.26:
	3. 80 - 254	0.12:
	4. 255 - 360	0.411
Downstream Visibility	1. 0 - 3,599	-0.17
- Feet	2. 3,600 - 29,583	-0.023
	3. 29,854 - 31,999	0.19:
Upstream Visibility	1. 0 - 3,843	-0.055
- Feet	2. 3,844 - 31,999	0.055
Pollution (Evidence	1. None	0.28'
Perceived by Senses)	2. Very Evident	-0.28'
Water Colour	1. Colourless or White	0.42
of River Site	2. Blue or Brown	-0.34
	3. Green	-0.08:
Turbidity of River	1. Clear	0.05
at Site	2. Cloudy	0.32
	3. Turbid or Muddy	-0.37
Floating Material	1. None	-0.01
on River at Site	2. Vegetation and/or Oil	-0.58
	3. Foam	0.59
Algae at Site	1. Absent	-0.31
of River	2. *	0.08
	3. Infested	0.23
Plants at Site	1. Absent	0.086
of River	2. *	0.282
	3. Infested	-0.368

VARIABLE	LEVEL	BETA
Flora	1. Tundra or Mix Woods	-0.310
Type of Woods	2. Spruce and Birch	0.228
	3. Conifers and Hardwood	0.082
Flora Density	1. Thin	-1.265
at Site	2. *	-0.160
	3. *	0.383
	4. *	0.398
	5. Dense	0.644
Flora Diversity	1. Small	-0.819
at Site	2. *	-0.222
	3. *	0.154
	- 4. *	0.185
	5. Great	0.701
Mean Depth at River	1. 1 - 7	-0.084
Site - Feet	2. 8 - 50	0.084

[*] **Note: Some of the levels appear to be missing - these levels fall between the upper and lower level and are the read on an intuitive level.**