On the Quantitative Inventory of the Riverscape[1]

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Abstract. In the vicinity of Berkeley, California, 24 minor valleys were described in terms of factors chosen to represent aspects of the river landscape. A total of 28 factors were evaluated at each site. Some were directly measurable, others were estimated, but each observation was assigned to one of five categories for that factor. Each factor for each site was then expressed as a uniqueness ratio, which depended on the number of sites being in the same category. The uniqueness ratio is believed to represent one way the scarcity of a given riverscape can be ranked quantitatively without bias based on notions of good or bad, and without assigning monetary value.

GENERAL STATEMENT

On property we grow pigs or peanuts. On land we grow suburbs or sunflowers. On landscape we grow feelings or frustrations. The quality of a landscape may be an asset to society, or it may be a 'scarlet letter' that should remind us of what we have thrown away. All attempts to preserve the environment must necessarily represent a compromise between the beauty of the natural world, minimally influenced by man, and the world in which we have to support ourselves. But we all realize that land can be used by man in such a way that it retains the essential elements of its aesthetic value, or it can be used in such a way that most of these values disappear.

Each one of us has a somewhat different idea about which aspects of the river landscape most contribute to its aesthetic worth. Even among those who are conscious of the fact that aesthetic values are worthy of preservation it is possible to have sincere and well meaning persons disagree as to what areas are more, or less, valuable, and for what purposes.

Many things are happening in the environment. Various groups give priority to preserving different parts of it, and as a result we are rather unsuccessful about preserving anything. The time has come when we should be able to speak objectively about the factors that contribute to aesthetic ranking and to realize that the relative importance of these factors is viewed differently, depending upon individual background, interest, desires, and thus one's objectives.

The present paper presents a tentative and modest attempt to record the presence or absence of chosen factors that contribute to aesthetic worth. Observations were made in a restricted range of examples in one locality, Alameda and Contra Costa counties near San Francisco Bay, California. Most of the sites are located along the channels of small streams draining these foothills. The sites chosen include streams originating in natural undeveloped areas, in parks, and in suburban and urban foothill areas.

THE INVENTORY

The factors contributing to the aesthetic or emotional reaction to a landscape are presumably capable of being identified. We constructed an inventory checklist that included both physical features of size and form and such subjective attributes as ecologic diversity and scenic views. The checklist was filled out at each site chosen, either measuring or subjectively evaluating the presence or level of each factor in the list.

Listing the qualities of various environments or sites, one might be able to rank the relative uniqueness of each attribute at various sites in relation to the population as a whole or to a particular part of it. Thus we conceive that in a planning program the computer read-out for each alternative for water development would include not only the usual pertinent data on

[1] A contraction of 'river landscape.'

sizes, benefits, and costs, but also the number of rankings that are violated or consumed. For example, one damsite might involve a river reach that contains several river properties that are unique and are found only at that site, whereas another may consume only usual or common types not at all unique.

The field inventory listing the items or parameters is presented in Table 1 with the range of categories assignable to each measured or estimated factor. As shown, each parameter in the list was assigned a category label using the numbers from 1 to 5. Those factors that could be measured have the measurement data classed in five ranges. Channel width, for example, was measured in feet. The ranges make up a geometric progression of size categories, as can be seen in the definition of ranges in Table 1.

Those factors that could not be measured in the usual sense were assessed in the field subjectively and assigned to a category 1 to 5 for that site factor as defined in Table 1. Some factors related to aesthetic impression could be expressed quantitatively, such as the number

TABLE 1. Definition of Class Categories

Physical and Chemical Character	Category Label 1	2	3	4	5
Width (ft)	<3	3–10	10–30	30–100	>100
Depth (ft)	<0.5	0.5–1	1–2	2–5	>5
Velocity (ft/sec)	<0.2	0.2–0.5	0.5–1	1–2.5	>2.5
Variability index	<0.1	0.1–0.25	0.25–0.75	0.75–2	>2
Width/height of valley	<4	4–10	10–25	25–50	>50
Bed sediment size (mm)	<0.01	0.01–0.2	0.2–2	2–20	>20
Bed slope (ft/mi)	<3	3–5	5–50	50–200	>200
Basin area (sq mi)	<0.5	0.5–1	1–5	5–10	>10
Stream order (Horton)	1	2	3	4	5
Bank height (ft)	<0.5	0.5–1	1–3	3–8	>8
Susceptibility to erosion (estim.)	stable				eroding
Width of flood plain	<5	5–10	10–100	100–300	>300
Turbidity (ppm)	<25	25–150	150–900	900–5000	>5000
Biological Character					
Algae	absent				infested
Filamentous slime (diatoms)	absent				infested
Fauna (estim.)	poor				excellent
Flora					
Character	bare	grassy	brush	wooded	forest
Exotic	exotic				natural
Diversity (estim.)	monotonous				diverse
General biologic condition	poor				excellent
Human Use and Interest					
Trash and litter					
Metal (no./100 ft)	<2	2–5	6–10	11–50	>50
Paper, plastic (no./100 ft)	<2	2–5	6–10	11–50	>50
Other (no./100 ft)	<2	2–5	6–10	11–50	>50
Artificial controls	controlled				none
Accessibility					
Individual	wilderness				urban—paved roads
Mass use	wilderness				urban—paved roads
Aesthetic impressions (estim.)					
Local scenery	unattractive				has beauty
Vistas	none				has scenic views
Degree of change					
Degradation	degraded				natural
Recovery potential	not recoverable				easily renovated
Urbanization	urban				wild
General aesthetic interest	unattractive				has beauty

of artifacts—beer cans, paper plates, or other rubbish.

FIELD DATA

The 24 sites listed below were chosen to represent a variety of small stream channels or valleys in northern California, primarily in the Berkeley area, including some that were primarily urbanized and other basins in relatively natural condition. With some changes the field inventory could be applied to channels and valleys of an entirely different sort, but it was our intention to take samples on basins of more or less comparable physical types.

The survey locations were chosen more or less at random and marked on a topographic map. There was no formal stratification or randomization; once the field technique is deemed satisfactory, a more formal method of choosing survey sites will be justified. Emphasis was directed primarily to the inclusion of sites representing a variety of conditions of urbanization and use rather than a variety of stream channel types. For this reason some streams were chosen in built-up urban areas, some in State and city parks, and some in areas not subject to intensive use.

On arrival at a location a specific site was chosen consisting of some 200 feet of channel length within which the observations were meant to apply. At each site the assignment of numbers to the factors was considered from the point of view of an observer standing near the stream and looking up and down the valley. Many of these small streams are incised in minor valleys, the sides of which stand 20 to 30 feet above the channel, and so the view was often restricted by the valley sides.

Many of the channels were so wooded that there was no vista out toward the bay or up the adjacent hills. We recorded whether such open vistas were common or absent.

A list of the 24 sites indicating location follows:

1. Couple Brook, adjacent to Lake Anza Tilden Regional Park, near Berkeley;
2. Family's Path Creek, tributary to Lake Anza, Tilden Regional Park, near Berkeley;
3. North Stream Picnic Area, Tilden Regional Park, near Berkeley;
4. Eucalyptus Creek, Indian Camp Area, near Summit Reservoir Junction, Berkeley;
5. Cobble Creek, Pony-Ride Playfield, near Summit Reservoir Junction, Berkeley;
6. Strawberry Creek, adjacent to Dwinelle Annex, University, California Campus, Berkeley;
7. Strawberry Creek, at bridge, between Haviland and Giovanni Halls, University of California, Berkeley;
8. Robbers Creek, at Ash Street crossover, Westwood;
9. Robbers Creek, at Highway 36 crossover, Westwood;
10. Feather River, at Tunnel Rest Stop;
11. Feather River, at Highway 70 exit north, near Oroville Dam;
12. Wildcat Creek, at Indian Camp Picnic area, Tilden Regional Park, Berkeley;
13. Kaler Creek, tributary to Wildcat Creek, near Alvarado Park, Richmond;
14. Kaler Creek, tributary to Wildcat Creek, ¼ mile downstream from site 13;
15. Horse trail crossing of Wildcat Creek, Alvarado Park, Richmond;
16. Wildcat Creek, picnic area in Alvarado Park, ¼ mile downstream from site 15, Richmond;
17. Judson Mead area, Strawberry Creek, west of Botanical Gardens, University of California, Berkeley;
18. Fern Grove area, Strawberry Creek, east of Palm Grove, Botanical Gardens, University of California, Berkeley;
19. Culvert zone of Strawberry Creek, between Botanical Gardens and tennis courts, University of California, Berkeley;
20. Land Slump Creek, South Highway, Siesta Valley;
21. Gully Creek, Siesta Valley;
22. Swamp Brook, Third Gully, Siesta Valley;
23. Cement Slab Creek at Orinda City Limits, Orinda;
24. Canyon Creek, tributary to San Leandro Creek, near San Leandro.

The measurements of physical size and characteristics were representative of the average condition in the 200-foot reach. A photograph taken at each site proved to be useful in the course of later data analysis.

Water velocity was measured by timed floats. Bed sediment size was taken as the *B*-axis diameter of the median size particle. To estimate the amount of green algae and filamentous diatoms, ten rocks were picked up from the bed and inspected; the average percentage of rock area covered by algae was estimated. The fauna and the diversity of flora were estimated from the general character of the area, in comparison with sites known to be generally representative of the valleys in the Coast Range.

Degree of channel control reflects the estimated degree to which the flow is controlled by reservoirs, the amount of bank revetment, and other channel alterations.

TABLE 2. Basic Data
(Value entered for each site is the number from 1 to 5 indicating range within which the measured or estimated quantity falls)

	Site Numbers																								No. of Each Category				
Parameters Measured or Estimated	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5
Physical and Chemical Character																													
Width (ft)	1	2	1	2	2	2	2	3	2	3	4	2	2	2	2	2	1	2	2	1	2	1	2	2	5	16	2	1	...
Depth (ft)	1	2	1	1	1	2	2	4	3	5	5	2	2	2	1	2	1	1	2	1	2	1	2	2	9	11	1	1	2
Velocity (ft/sec)	1	2	2	4	4	4	4	1	5	5	5	1	4	4	3	4	3	4	4	3	5	4	4	5	3	2	3	11	5
Variability Index 5 = ephemeral 1 = little variation	5	4	4	4	4	1	1	2	1	1	1	3	2	2	2	2	3	3	4	5	3	5	3	1	6	5	5	5	3
Width/height of valley	2	2	1	4	3	2	4	5	5	2	5	2	2	2	2	3	2	2	1	4	3	3	2	3	2	11	5	3	3
Bed sediment size (mm)	1	1	1	3	5	5	2	4	5	5	2	2	3	3	3	2	4	4	4	4	4	2	3	3	3	5	6	6	4
Bed slope (ft/mi)	5	5	5	4	4	4	4	5	5	1	1	4	4	4	4	4	5	5	5	5	5	5	5	4	2	...	...	10	12
Basin area (sq mi)																													
Stream order (Horton)	1	2	1	3	3	4	4	4	4	5	5	3	4	4	4	4	2	2	3	1	1	1	3	4	5	3	5	9	2
Bank height (ft)	2	4	4	3	3	4	3	4	3	5	5	3	4	4	3	4	2	2	4	4	4	1	4	4	1	3	6	12	2
Susceptibility to erosion (estim.)																													
Width of flood plain (ft)	1	2	2	3	3	2	2	4	5	5	3	3	2	2	3	3	1	2	2	1	3	3	3	3	3	8	10	1	2
Biological Character																													
Algae	1	2	1	2	1	1	1	3	2	1	3	3	1	1	1	1	2	1	1	1	1	2	1	3	15	5	4	...	...
Filamentous slime-diatoms	1	2	1	1	1	1	2	2	2	5	5	5	1	1	5	1	3	4	4	1	1	3	1	2	11	5	2	2	4
Fauna (estim.)	3	2	2	1	2	1	2	5	5	4	4	2	3	3	2	2	2	2	3	2	4	3	2	2	2	12	5	3	2
Flora																													
Character, bare to woods	4	1	3	5	3	3	3	4	4	2	4	3	4	3	3	3	3	5	4	2	3	3	4	4	1	2	11	8	2
Exotic[1]	3	4	...	4	3	1	1	...	...	...	...	3	...	...	4	3	2	3	4	5	4	4	4	4	2	1	5	8	1
Diversity (estim.)	4	2	5	1	3	5	5	5	5	2	1	3	2	2	3	3	5	5	4	4	5	5	3	4	2	4	5	4	9
Human Use and Interest																													
Trash and Litter																													
Metal	5	4	5	4	4	2	1	3	4	2	2	4	4	4	5	4	2	1	3	1	1	1	1	2	6	5	2	8	3
Paper, plastic	4	3	3	4	4	4	4	4	1	1	4	4	4	1	4	5	4	2	2	1	1	1	1	4	7	2	2	12	1
Other	3	3	2	3	4	3	2	4	4	2	3	4	4	2	4	4	2	4	4	1	2	1	5	2	2	7	5	9	1
Artificial controls	4	1	2	3	1	5	4	2	2	1	1	2	1	2	2	3	4	4	3	1	1	1	5	4	8	6	3	5	2
Accessibility																													
Individual	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	3	2	5	5	...	1	1	1	21
Mass use	4	5	5	5	5	5	5	5	5	5	5	5	1	1	5	5	5	5	5	2	2	2	5	5	2	3	...	1	18
Aesthetic impressions																													
Local scenery	4	2	4	1	2	5	5	2	5	5	2	4	3	2	3	2	5	5	4	2	3	1	3	5	2	7	4	4	7
Vistas	1	1	1	2	1	1	2	1	4	4	1	1	1	1	1	1	1	3	1	1	1	1	1	3	18	2	2	2	...
Degree of change																													
Degradation	2	3	2	4	3	3	1	4	3	2	4	5	4	2	3	4	2	3	3	2	1	2	4	2	2	8	7	6	1
Recovery potential	3	3	5	2	5	3	5	3	5	5	5	3	5	5	5	4	5	5	5	5	5	5	3	1	1	1	6	1	15
Urbanization	3	3	3	3	3	1	1	5	5	5	3	3	2	2	3	3	1	1	3	5	5	5	2	5	4	3	10	...	7
General aesthetic interest	2	1	4	1	2	4	5	2	5	5	3	2	2	4	4	3	5	5	3	3	5	3	1	5	3	5	5	4	7

[1] Missing data for 7 sites; used value of 1/7 = .14.

TABLE 3. Uniqueness Values by Parameter for Each Site
(The uniqueness ratio is equal to the reciprocal of the number of sites sharing the size class of the parameter.)

	Site Numbers																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Physical and Chemical Character																								
Width	.20	.06	.20	.06	.06	.06	.06	.50	.06	.50	1.00	.06	.06	.06	.06	.06	.20	.06	.06	.20	.06	.20	.06	.06
Depth	.11	.09	.11	.11	.11	.09	.09	1.00	1.00	.50	.50	.09	.09	.09	.11	.09	.11	.11	.09	.11	.09	.11	.09	.09
Velocity	.33	.50	.50	.09	.09	.09	.09	.33	.20	.20	.20	.33	.09	.09	.33	.09	.33	.09	.09	.33	.20	.09	.09	.20
Variability Index	.33	.20	.20	.20	.20	.17	.17	.20	.17	.17	.17	.20	.20	.20	.20	.20	.20	.20	.20	.33	.20	.33	.20	.17
Width/height valley	.09	.09	.50	.33	.20	.09	.33	.33	.33	.09	.33	.09	.09	.09	.09	.20	.09	.09	.50	.33	.20	.20	.09	.20
Bed sediment size	.33	.33	.33	.17	.25	.25	.20	.17	.25	.25	.20	.20	.17	.17	.17	.20	.17	.17	.17	.17	.17	.20	.17	.17
Bed slope	.08	.08	.08	.10	.10	.10	.10	.08	.08	.50	.50	.10	.10	.10	.10	.10	.08	.08	.08	.08	.08	.08	.08	.10
Stream order	.20	.33	.20	.20	.20	.11	.11	.11	.11	.50	.50	.20	.11	.11	.11	.11	.33	.33	.20	.20	.20	.20	.20	.11
Bank height	.33	.08	.08	.17	.17	.08	.17	.08	.17	.50	.50	.17	.08	.08	.17	.08	.33	.33	.08	.08	.08	1.00	.08	.08
Width flood plain	.33	.12	.12	.10	.10	.12	.12	1.00	.50	.50	.10	.10	.12	.12	.10	.10	.33	.12	.12	.33	.10	.10	.10	.10
Total	2.33	1.88	2.32	1.53	1.48	1.16	1.44	3.80	2.87	3.71	4.00	1.54	1.11	1.11	1.44	1.23	2.17	1.58	1.59	2.16	1.38	2.51	1.16	1.28
Biological Character																								
Algae	.07	.20	.07	.20	.07	.07	.07	.25	.20	.07	.25	.25	.07	.07	.07	.07	.20	.07	.07	.07	.07	.20	.07	.25
Filamentous slime	.09	.20	.09	.09	.09	.09	.20	.20	.20	.25	.25	.25	.09	.09	.25	.09	.50	.50	.50	.09	.09	.50	.09	.20
Fauna	.20	.08	.08	.50	.08	.50	.08	.50	.50	.33	.33	.08	.20	.20	.08	.08	.08	.08	.20	.08	.33	.20	.08	.08
Flora																								
Character	.12	1.00	.09	.50	.09	.09	.09	.12	.12	.50	.12	.09	.12	.09	.09	.09	.09	.50	.12	.50	.09	.09	.12	.12
Exotic	.20	.12	.14	.12	.20	.50	.50	.14	.14	.14	.14	.20	.14	.14	.12	.20	1.00	.20	.12	1.00	.12	.12	.12	.12
Diversity	.25	.25	.11	.50	.20	.11	.11	.11	.11	.25	.50	.20	.25	.25	.20	.20	.11	.11	.25	.25	.11	.11	.20	.25
Total	.93	1.85	.58	1.91	.73	1.36	1.05	1.32	1.27	1.54	1.59	1.07	.87	.84	.81	.73	1.98	1.46	1.26	1.99	.81	1.22	.68	1.02
Human Use and Interest																								
Trash and litter																								
Metal	.33	.12	.33	.12	.12	.20	.17	.50	.12	.20	.20	.12	.12	.12	.33	.12	.20	.17	.50	.17	.17	.17	.17	.20
Paper, plastic	.08	.50	.50	.08	.08	.08	.08	.08	.14	.14	.08	.08	.08	.14	.08	1.00	.08	.50	.50	.14	.14	.14	.14	.08
Other	.20	.20	.14	.20	.11	.20	.14	.11	.11	.14	.20	.11	.11	.14	.11	.11	.14	.11	.11	.50	.14	.50	1.00	.14
Artificial controls	.20	.12	.17	.33	.12	.50	.20	.17	.17	.12	.12	.17	.12	.17	.17	.33	.20	.20	.33	.12	.12	.12	.50	.20
Accessibility																								
Individual	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	1.00	1.00	1.00	.05	.05
Mass use	1.00	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.50	.50	.06	.06	.06	.06	.06	.33	.33	.33	.06	.06
Aesthetic Impression																								
Local scenery	.25	.14	.25	.50	.14	.14	.14	.14	.14	.14	.14	.25	.25	.14	.25	.14	.14	.14	.25	.14	.25	.50	.25	.14
Vistas	.06	.06	.06	.50	.06	.06	.50	.06	.50	.50	.06	.06	.06	.06	.06	.06	.06	.50	.06	.06	.06	.06	.06	.50
Degree of change																								
Degradation	.12	.14	.12	.17	.14	.14	.50	.17	.14	.12	.17	1.00	.17	.12	.14	.17	.12	.14	.14	.12	.50	.12	.17	.12
Recovery potential	.17	.17	.07	1.00	.07	.17	.07	.17	.07	.07	.07	.17	.07	.07	.07	1.00	.07	.07	.07	.07	.07	.07	.17	1.00
Urbanization	.10	.10	.10	.10	.10	.25	.25	.14	.14	.14	.10	.10	.33	.33	.10	.10	.25	.25	.10	.14	.14	.14	.33	.14
General aesthetic interest	.20	.33	.25	.33	.20	.25	.14	.20	.14	.14	.20	.20	.20	.25	.25	.20	.14	.14	.20	.20	.14	.20	.33	.14
Total	2.76	1.99	2.10	3.44	1.25	2.10	2.30	1.85	1.78	1.82	1.45	2.37	2.06	2.09	1.67	3.34	1.51	2.33	2.37	2.99	3.06	3.35	3.23	2.77

Human debris or artifacts were counted in the 200-foot reach and recorded as numbers counted. Scenic impressions and occurrence of vistas reflect what an observer sees when standing beside the stream.

Table 2 lists the basic data in terms of class categories as defined in Table 1. Note that the numbers in this table are only category labels and not measures of merit or value.

RELATIVE UNIQUENESS OF SITES

Unique is a word meaning without like or equal. For things society judges to be desirable, relative scarcity or uniqueness increases value to society, but for the present it appears to be more important to develop a method of determinging a scale of uniqueness than to assign any relative value. Therefore, we seek a hierarchical ranking of sites in terms of uniqueness based on the objective measurement or estimation of characteristics observed in the field.

If a site parameter is, for example, one among six of the same category, the site shares this characteristic with five others. It may be said then, that it is unique in the ratio of one to six, or its uniqueness is 1/6 (0.16). In this way uniqueness may be defined on a scale of 0 to 1.0.

In the present study there were 24 sites studied. If the numerical description of a certain characteristic is in the same class category at all sites, each site is described as having a uniqueness of 1/24 or .04. This is a minimum uniqueness in the sample. If, however, only one site has a certain class category among the possible class labels 1–5, then that site has a uniqueness of 1/1 or 1.0 for that parameter or attribute.

Table 3 presents the uniqueness ratios for each observed parameter at all 24 sites. The numerical value of this ratio depends on its scarcity of occurrence among all sites. For example, channel width at site 1 was 2 feet, and thus it falls in the category labeled 1, which includes a range of width from 0 to 3 feet. In this same class category are widths at sites 3, 17, 20, and 22. Thus each of these 5 sites has a uniqueness of 1/5 (.20) as its width characteristic (Table 3).

Average uniqueness scores can be calculated for all sites for any particular groups of characteristics and sites. These uniqueness scores, however, statistically measure one aspect of a mix of characteristics, even though they cannot tell of what the mix is composed.

The scheme of calculating uniqueness scores is indifferent whether the category class is in the middle of the range for that category or at one of the extremes. Although it would be possible to modify the scheme to consider the position in the range of categories, it does not seem necessary to do this, since class categories in the middle of the scale are the more common and, hence, the higher uniqueness values are usually associated with the extremes.

Note that the uniqueness scores are also indifferent to whether the class category labels go from 1 to 5 (in order of an implied increasing goodness) or in the reverse order.

Those items, whether 'good' or 'bad,' that are common among the sites are weighted low in the scoring. It happens that those factors that are usually considered 'good' tend to large values in the uniqueness score, because these factors are indeed less common in the modern riverscape. But it is entirely possible in a nearly natural river that the highest uniqueness score would be given to the site that is most turbid, most crowded, and generally worst in an aesthetic sense, because that site is indeed unique. Indeed, a crowded, littered site, together with a unique set of historical values, may outscore natural values in this scheme. Thus the uniqueness score is just a meaure of uniqueness and not necessarily a measure of goodness or badness.

Table 4 presents the rank order of sites on the basis of uniqueness scores for each of three groups of factors: physical, biological, and human interest. The ranking of sites based on the sum of all three is shown in column 5. Table 5 shows the average uniqueness score for each site.

Note that the uniqueness scores based on all factors have only a small range among the 24 sites. Presumably this is due in part to the intrinsic similarity of channels of a small range in size and within a small geographic compass.

However, included in the 24 sites are two, numbers 10 and 11, that represent larger rivers somewhat farther from the Berkeley area. These two, included in an otherwise restricted geographic area, should show a relatively high uniqueness score in the sample and, indeed, sites 10 and

TABLE 4. Rank Order for Each Site Based on Groups of Parameters and All Parameters

	Rank Based on			
Site No.	Physical	Biological	Interest	All
1	6	16	8	7
2	10	4	18	9
3	7	24	13	17
4	14	3	1	6
5	15	22	14	24
6	21	8	15	20
7	17	14	12	19
8	2	9	19	5
9	4	10	21	8
10	3	6	20	3
11	1	5	24	4
12	13	13	10	18
13	23	17	17	21
14	24	18	16	22
15	16	20	22	23
16	20	21	3	12
17	8	2	23	10
18	12	7	11	11
19	11	11	9	14
20	9	1	6	1
21	18	19	5	13
22	5	12	2	2
23	22	23	4	15
24	19	15	7	16

TABLE 5. Average Uniqueness Scores for Sites

Site	Average Uniqueness Score
1	.21
2	.20
3	.18
4	.25
5	.12
6	.16
7	.17
8	.25
9	.21
10	.25
11	.25
12	.18
13	.14
14	.14
15	.14
16	.19
17	.20
18	.19
19	.19
20	.26
21	.19
22	.25
23	.18
24	.18

11 stand in the third and fourth rank in the array (column 5, table 4).

Note that the sites in first and second rank order, numbers 20 and 22, also rank in the top 9 in the physical factors, in the top 6 in the human interest factors, and one of them, site 20, ranks first in the biological list.

NEEDS AND PROBLEMS IN RANKING METHODS

The imperfections, and drawbacks in this early attempt at ranking riverscape features are immediately admitted.

Krutilla [1967*a*] discussed the difficulties of traditional conservation economics under conditions created by technological advances. He points out elsewhere [*Krutilla*, 1967*b*] that

> . . . if a unique commodity is removed from the market, the social loss is not what the seller could have received, but the sum of the maximum each buyer would have been willing to pay rather than go without (p. 1046).

Krutilla's discussion emphasizes the need to evaluate relative uniqueness.

It is obvious that uniqueness is only one of the characteristics of an environment which is worthy of study. To the aspects of stimulation usually listed by the experimental psychologist —intensity, novelty, complexity, and variations —*Wohlwill* [1966] adds *incongruity*, 'the jarring effect of the juxtaposition of different structures lacking any relationship to one another (p. 33).' In our consideration of the problem of measurement we recognized this concept of the *misfit* or misplaced as a factor that should be recorded in the field but perhaps unfortunately chose to include that in our less specific term 'general aesthetic interest' in Table 1. The occurrence of misfits may be more than merely one factor in aesthetic evaluation. *Kates* [1966] goes so far as to say that 'we should not seek to measure beauty but rather ugliness (p. 24).'

Wohlwill continues

> . . . while it may be easy to illustrate the relevance of these 'collative' variables . . . to our response to the physical environment, systematic research in this area will have to come to grips with the problems of operational definition and measurement . . . (p. 33).

Perhaps our inventory should be altered to express more explicitly a numerical rating of misfit occurrences.

Another difficulty with the inventory checklist we used is that our three over-all categories—physical character, biological character, and human interest—are dissimilar. It is clearly easier to measure objectively some of the topographic or physical characteristics than most of those in the third category. Furthermore, it can be argued that these categories do not describe landscape aesthetics. It seems to us, however, that aesthetic reaction is made up of at least two aspects. The first is comprised to some extent of the factors in our checklist, although the present list may be incomplete and some factors need further definition and possibly further subdivision. The second aspect is the reaction of the viewer to these characteristics or attributes.

It was our intention to restrict our checklist and this paper to the description of the sites, uncomplicated by the weighting introduced by the attitudes or preferences of the viewer. In this we have not been entirely successful, primarily because of the inclusion of the three factors labeled local scenery, degradation, and general aesthetic interest. Each of these as defined reflects to some degree our own impression or preference, and in future work we suggest that these factors either be redefined or eliminated insofar as the purpose of objective description is concerned.

The list of factors included in the inventory may also be incomplete. Research should be undertaken to identify those features of the riverscape, both natural and man-induced, that influence individual reactions. At the moment we believe that attempts should be made to describe, keeping the assignment of rating numbers in the checklist as objective as possible and minimizing the effect of bias or preference in the quantitative rating procedure.

Separately, the matter of preference should be taken up. There are several approaches to the determination of preferences and thus to measuring both what various individuals see and what impact the factors have on their reactions. *Sonnenfeld* [1966] used a set of 50 pairs of photo slides in which four environmental elements—vegetation, topography, water features and temperature—were systematically varied.

Sargent [1967] took a somewhat different approach. Using factors chosen by him as diagnostic—distance, variety, depth of view, width of scene, and intermittency—he traveled extensively by automobile, filling out a scenery rating sheet every half-mile along the chosen routes. The rating quantities obtained were plotted on maps for planning purposes. Considerable attention was paid to eyesores analogous to our misfits. A somewhat similar form of mapping is used by *Research Planning and Design Associates* [1967], except that type examples of each category were selected, and the evaluation of a given site was made by matching as closely as possible one of the samples in the file of examples.

UTILIZING THE RANK VALUES

There is a difficulty involved in the mere process of adding the numerical ratings of all factors at a site or averaging them. Averaging makes the tacit assumption that each factor carries equal weight. Nevertheless, we ran totals on the columns in Table 3 to see how large a range in total uniqueness scores occurs in our sample. Further study should be given to the effect of averaging.

Adding unweighted uniqueness ratios of the several sites may tend to average out any significance among them. This tendency is the greater the larger the number of characteristics that are added together for each site. Thus, to test whether the differences among the several totals in Table 3 are significant, we constructed a set of random numbers 1 to 5 for 24 'sites' and 10 'characteristics,' thus, in effect, paralleling the data in Table 2 for the 10 'Physical and Chemical Characteristics.' The distribution of the total uniqueness ratios for such a set of random numbers does indeed occupy a narrow range as expected, between a maximum of 2.81 and a minimum of 1.74. In contrast, the totals for the data given in Table 3 range between a maximum of 4.00 and a minimum of 1.11.

It is our opinion that the uniqueness scores could be utilized to examine in depth the importance of bias or preference. The next stage should incorporate a consumer-demand analysis of what people seek in landscape, following the method used by *Shafer et al.* [1967]. These investigators showed photographs of each site to a sample of people, and each viewer was asked to rate or evaluate the sites.

In such a manner it may be possible to develop a set of weights to be applied to uniqueness values to develop a preference rank that incorporates both the objective site characteristics and a subjective preference weight.

SAMPLING PROBLEMS

A comparison of the quality of rivers on a statistical basis as described depends greatly on the radius of sampling in space and in time. The uniqueness scores of the several sites depend considerably on the geographical range of the sampling.

The time radius is important as well. Some of the factors, such as width or slope, are essentially fixed characteristics. Others, such as discharge or dissolved oxygen, are highly variable not only as between seasons but also diurnally. It would be desirable therefore either to make repeat surveys or to use continuously recorded data of those factors, such as discharge or dissolved oxygen, that change rapidly. To the extent that data at a site are themselves of major interest, then observations over time are needed; to the extent that comparison among sites is the dominant interest, then natural variations associated with seasons may be less significant. However, no judgment is possible at this time on the effect of time variations on such intersite comparisons or scores.

Besides sampling radius, the intensity of sampling, that is, the number of sampling points, is also a significant factor. The various sampling or access sites should not be so close that they are replicates of one another, nor so far apart that they are completely unrelated. If the sites are completely unrelated, then the category labels for each item (i.e., reading horizontally in Table 3) would be randomly distributed.

GROUP COMPARISONS

This technique does not consider the relative 'uniqueness' of groups or combinations of properties. There may be no particular theoretical difficulties, but an attack on the problem requires a larger sample size than now available.

Subject to the limitations of sampling, the procedure nevertheless represents one kind of analysis of the basic data contained in Table 2. Other kinds of applications may suggest other analyses. Indeed, upon appropriate evidence, it might be desirable to incorporate weighting functions to determine ranking of sites for various special purposes; as, for example, wilderness preservation, boating or canoeing, and interference of reservoir construction with alternate uses of the river.

GENERAL CONCLUSIONS

The study purports to be only a preliminary approach to a numerical description of factors comprising social or aesthetic rather than monetary value. But we have attempted to avoid consideration of relative desirability, that is, 'good' versus 'bad,' because it appears that the first need is for a method of description without the bias accompanying the assignment of measures of worth.

Data even for parameters not amenable to measurement by rule or meter can be classified to derive a relative ranking of uniqueness which, on further development, might be a usable approach to the problem of incommensurables in resource planning.

This preliminary effort suggests that some kind of classification of scarcity is feasible that can lead to a technique for river survey adaptable in a basic data program in addition to the usual hydraulic and hydrologic factors. If so, then the results of scarcity or uniqueness evaluation might be applied in evaluating choices among alternatives in river basin development.

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