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Evaluation of Urban Riverscape Aesthetics in the Canadian Prairies

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Despite the large amount of literature on landscape assessment, methodologies developed are unsuitable for the planning and management of the non-spectacular regional landscapes where human populations and development are concentrated. Methodologies are uncorrelated to actual landscape perception, use improper techniques to elicit responses to landscape, or are too coarse and inflexible to use in the complex landscape of a partially developed region.

This study measures perception of an urban riverscape, using unbiased differentiation of riverscape photographs by 30 University of Saskatchewan students from various backgrounds and disciplines. Multidimensional scaling of the resultant similarity matrix revealed three cognitive constructs (dimensions) used to evaluate the riverscape. Cluster analysis of the matrix developed clusters of photographs which were plotted on the three dimensions. Common attributes of the photographs in each cluster were determined and the dimensions characterized in terms of the attributes. The dimensions were identified as (1) Natural *vs.* Man-made, (2) Blighted *vs.* Enhanced, (3) Barren and Brown *vs.* Lush and Green.

The common attributes of the photographs in the clusters are those significant to landscape evaluation, their effect assessed in the context of the regional landscape. Attributes eliciting strong responses are colour, vegetation, soil exposure, land use, blight and cultural features.

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The methodology developed is not directed towards preferred landscapes, but towards evaluation of landscapes in a specific regional context. It analyses hybrid landscapes, evaluates particular views against the regional landscape, and identifies perceived attributes of a landscape in terms of cognitive constructs. Because of this theoretical base, it is suitable for planning and management. Potential use of the methodology in aesthetic impact assessments and landscape manipulation is discussed.

Keywords: Landscape assessment, riverscape evaluation, South Saskatchewan River, repertory grid, multidimensional scaling, planning, management of landscapes, urban aesthetics, Saskatoon Canada.

1. Introduction

Landscapes are receiving increased attention from society as haphazard development conflicts with environmental awareness, recreational demands and quality of life expectations. River-edge lands support much of the most intense development and dense populations on earth. Developers often do not consider the aesthetic resource of the riverscape in their plans. However, there is evidence that riverscapes are under heavy demand for their aesthetic value. A basic human attraction to and fascination with rivers is noted by historians, philosophers and planners (McHarg, 1969; James, 1973; Tuan, 1968; Wittrogal, 1957).

Planning and management of landscapes require an understanding of landscape perception. The purpose of this study is to determine the cognitive constructs used in evaluating a non-spectacular riverscape, and, in terms of the constructs, to determine the riverscape attributes eliciting the evaluation. Cognitive constructs of landscapes are the ideas used by individuals to discriminate among attributes of the environment (Harrison and Sarre, 1976). The perceived differences in a regional landscape, and the attributes of the landscape causing those differences are useful in the planning of management regions.

2. Development of landscape assessments

Perception and evaluation studies have been undertaken by a diverse body of researchers in the past 15 years, with varying success. The methodologies and theories developed are applicable to riverscapes and merit a cursory review.

2.1. DESCRIPTIVE ASSESSMENTS

Descriptive landscape assessments involve the selection, measurement and analysis of various biophysical parameters of the land which are then related, by various methods, to preference. The parameters are not tested on their significance to landscape perception or aesthetic value, but follow intuitive assumptions of what constitutes a scenic landscape. Basic assumptions made by early research workers are referred to without validation by subsequent studies. The pioneer studies of Linton (1968) and Leopold (1969) have been refined and applied by Blacksell and Gilg (1975), Dearden (1980*a*), Gilg (1974), Morisawa (1971) and others. Linton's (1968) methodology alone has spawned a large number of county council planning studies in Great Britain, with only slight modification of his assumptions on scenic parameters of the landscape (Appleton, 1975). Such studies are based on a belief in a standard for "British" landscapes, definable by a landscape profession and in concurrence with the wishes of the British people (Lowenthal and Prince, 1965). Leopold's (1969) methodology has been applied uncritically a number of times in North America, particularly by the United States Forest Service (Hamill, 1975).

A weakness in applications of descriptive landscape assessments is that they do not correlate physical landscape parameters with the perceived attributes of perceptual constructs of the landscape. The result is a physical inventory of land features, not an evaluation of landscape.

2.2. EVALUATIVE ASSESSMENTS

Evaluative landscape assessments predict societal evaluation of landscapes by measuring the reactions of individuals. Reactions can be preferential or cognitive, depending on the assessment methodology and purpose. The more complex and rigorous approaches use photographs or slides as surrogates for landscapes.

2.2.1. *Use of surrogate landscapes*

Use of surrogates has received some criticism (Dearden, 1980*b*), but continues to be the only feasible method, in terms of time and expense, to elicit a sufficient number of responses to a landscape.

Fines (1968) pioneered the use of photographs, and the technique is validated by Brush and Shafer (1975), Buhyoff and Wellmann (1980), Calvin *et al.* (1972), Dunn (1976) and Zube *et al.* (1975). Dunn (1976) compares landscape preference of sites in the West Midlands, England, using photographs and on-site testing, and concludes that photographs may accurately represent landscapes if strict controls are maintained on photographic quality and the representativeness of composition. This concurs with Zube *et al.* (1975), who conclude that colour photographs offer the most realistic off-site simulation of landscapes.

2.2.2. *Composition-preference approaches*

The composition-preference approach was initiated by Shafer *et al.* (1969), with more sophisticated use by Buhyoff and Wellmann (1980) and others. The regressions of various factors of photograph composition were calculated on ranked preference ratings. Factors such as vegetation, water and non-vegetation at various distances are found to explain some variation in landscape preference. Thayer *et al.* (1976) criticizes this method, claiming that it predicts beauty but not ugliness, and works only for natural landscapes. The method works best where the landscapes are unfamiliar to the respondants, are drawn from an extremely wide range of scenery, and are undeveloped. It does not apply well to regional management problems.

2.2.3. *Semantic differential technique*

Calvin *et al.* (1972), Craik (1972, 1975) and Zube (1974), among others, have used colour slides, photographs and on-site surveys in attempts to extract aesthetic responses to landscape. These studies suffer technical and methodological deficiencies, a common technical problem being the use of the semantic differential to evaluate landscapes. This technique measures the evaluation of landscapes by bipolar adjective scales, each landscape being rated numerically on scales composed of two descriptive terms. Thus, two types of perception are involved, descriptive terminology and landscape. As there is wide variance among individuals in the comprehension and application of descriptive terminology, use of adjective scales adds an unnecessary degree of imprecision to the interpretation of landscape evaluations. The semantic differential also sacrifices much information on the cognitive constructs used to evaluate landscapes. The bipolar adjective scales function as supplied constructs, so may at best only approximate the actual cognitive constructs of an individual. Because of varied individual interpretations

of terminology, the supplied constructs do not aggregate well, and group results may be unrepresentative of the actual personal constructs used in cognition of the landscape (Harrison and Sarre, 1976).

2.2.4. *Repertory grid methodology*

Repertory grid methodology utilizes multidimensional scaling and is based on personal construct theory, which assumes that idiosyncratic ideas are used by individuals to discriminate between environmental elements. Personal constructs are the ideas used in this discrimination of environmental stimuli and are used to create the repertory grid. The repertory grid is a binary matrix showing the similarity of environmental stimuli, and is defined by dimensions which represent personal constructs. The repertory grids are assembled into a supergrid, composed of aggregated personal constructs (Bannister and Fransella, 1971). Use of the repertory supergrid as an accurate and sensitive representation of mass environmental cognition is supported by Harrison and Sarre (1976).

Garling (1976) compares the semantic differential technique with the repertory grid methodology, using perceptions of sketches of urban views. His repertory grid was assembled from sorting the sketches. The results do not apply to landscape evaluation, however, because urban sketches are a biased representation of the landscape. The sorting procedure was done on the basis of preference, and thus was a directed evaluation and not a full cognitive evaluation. Results showed that analysis of the repertory supergrid by multidimensional scaling and cluster analysis reveals the cognitive basis for the semantic differential analysis, and is therefore preferable.

Ward and Russel (1981) examined cognition of physical environments using the repertory grid and multidimensional scaling, and showed that constructs elicited from the repertory grid are salient.

3. Study area

The riverscape of the South Saskatchewan River in and adjacent to Saskatoon, Canada, was selected for this study of landscape aesthetics. Saskatoon is a city of population 150 000, located in a sparsely populated region dominated by dry-land prairie agriculture. Local terrain is flat to moderately rolling, except for the river valley, which is incised sharply in the north of the study area, opening to a broad floodplain in the south. The river valley is of interest to local people and planning authorities as it displays water, forest and topographically diverse terrain in a region of typically monotonous, semi-arid prairie.

4. Methodology

4.1. PHOTOGRAPHIC REPRESENTATION OF THE RIVERSCAPE

The South Saskatchewan River at Saskatoon was divided into 13 reaches, each 0·5–1·25 km in length. A reach was defined by a line of sight unobstructed by meanders in the river, bridges or excessive distance. Two to four 35 mm colour photographs were taken in each reach, a total of 40 in the study area. Photograph composition was strictly standardized to reduce the "clutter" and "noise" inherent in representing a landscape on a photograph, to ensure that all views were representative and could be compared on their permanent attributes.

Photographs were taken during periods of high sun, on clear, cloudless days in late summer. These conditions characterize those usually found from late May to mid-

September, when highest recreational use is made of the urban riverbank. The photographs were taken from accessible, well-travelled viewpoints along bridges, riverbank drives and trails. Photograph composition includes the immediate bank and far-shore as one looks along the river, with the sky to land ratio constant at 1:5. Views were chosen for two main objectives: best representation of the riverscape in a reach, and greatest likelihood of being seen by a riverbank user. It is recognized that the views chosen are insufficient in number for accurate mapping of riverscape aesthetics, but they can provide pilot indicators of riverscape perception.

4.2. TESTING PROCEDURE

The participation of 30 University of Saskatchewan students, from a broad range of disciplines and backgrounds, was obtained. Forty 9×13 cm colour prints of the riverscape were used as stimuli. The participants appraised the stimuli by creating a repertory grid, based on personal constructs. They were given a randomly mixed stack of the 40 colour prints and informed that this was a "landscape study". The participants were then instructed to sort the photographs into as many piles as they wished, based on any criteria they chose. The produced piles are similarity groupings of the photographs, similarity derived from unbiased evaluation of landscapes. The procedure was repeated twice to insure a standard cognitive set in construction of the repertory grid, but repetitions did not alter the similarity groupings. The number of piles and the photographs in each pile were tallied by the experiment supervisor.

5. Analysis

5.1. REPERTORY GRID ANALYSIS

For each subject, a binary matrix was created, with the rows and corresponding columns representing the photographs. Each cell has a value of one if the photographs were placed in the same pile, zero if they were not. These similarity matrices were added together to form a single similarity matrix, whose cell values represent the degree to which a pair of photographs was considered similar by the participants. This matrix is the aggregate repertory supergrid.

5.1.1. *Multidimensional scaling*

The repertory supergrid was analysed by classical non-metric multidimensional scaling (Young *et al.*, 1979). The repertory supergrid is assumed to be a multidimensional perceptual representation of the riverscape. A three-dimensional, multidimensional scaling solution (stress = 0·141) was found to be the most suitable derivation from the supergrid. Stress values do not improve sufficiently to warrant a four-dimensional solution (stress = 0·100), while a two-dimensional solution exhibits an unacceptably high stress value (stress = 0·262). The three dimensions represent criteria used by study participants to evaluate the photographs, and are the personal constructs used in riverscape cognition.

Dunn (1976) concludes that landscape photograph cognition approximates non-contemplative landscape cognition in the field. The perceptual constructs derived from surrogate landscapes should approximate those used in on-site riverscape perception, given standard field conditions, familiarity with the area, and non-contemplative observation. The supergrid elicited from photographs is therefore a sufficiently good representation of the Saskatoon riverscape.

5.1.2. *Cluster analysis*

Johnson's hierarchical clustering algorithm was applied to the photographs, the derived clusters being plotted on the three dimensions. Six clearly defined clusters emerge, the centroids of which determine in which dimensions particular clusters have diagnostic values for use in interpreting the identity of the dimensions. Values of the centroids range from $\pm 0{\cdot}04$ to $\pm 1{\cdot}66$ in the various dimensions (see Table 1). Values greater than $|0{\cdot}50|$ were considered diagnostic, those less than $|0{\cdot}50|$ were non-determinate. Each cluster was rated as non-determinate, or given a positive or negative magnitude on each dimension. Magnitudes were assigned on the following basis: magnitude $1 = \pm 0{\cdot}5$ to $\pm 1{\cdot}0$; magnitude $2 = \pm 1{\cdot}01$ to $\pm 1{\cdot}5$; magnitude $3 > |\pm 1{\cdot}5|$ (see Table 2).

Photographs with extreme values on a particular dimension were assembled into "extreme value groups". Such a group only characterizes a positive or negative range of a dimension and has no relation to other dimensions or clusters. Extreme value groups were used only when there was no diagnostic cluster for that range of a dimension.

5.2. ATTRIBUTE ANALYSIS

The photographs in the clusters and extreme value groups were visually inspected for selected attributes: colour, angle of view, vegetation, clarity, land use, valley slope, soil exposure, blight, river exposure and cultural features. These attributes are selected from the range of "aesthetic factors" postulated by Leopold (1969), Linton (1968) and Litton *et al.* (1974), based upon their prominence in the photographs, similarity within the clusters, and range among the clusters of photographs.

TABLE 1. Centroid values of clusters on the three dimensions

	Dimension		
Cluster	1	2	3
1	−0·14	0·22	−1·22
2	0·04	1·6	−0·36
3	−1·26	−1·14	0·57
4	−1·36	0·67	0·49
5	1·42	0·39	−0·05
6	1·66	0·16	1·14

TABLE 2. Integral magnitudes of the cluster centroids for the three dimensions (0 = non-determinate centroid)

	Dimension		
Cluster	1	2	3
1	0	0	2
2	0	−3	0
3	−2	−2	+1
4	−2	+1	0
5	+2	0	0
6	+3	0	+2

Riverscape attributes were determined qualitatively for each photograph, and gradations of attributes within the universe of the riverscape were observed. To aid in analysis of the attributes, labels of positive and negative were arbitrarily assigned to extremes of gradation. The label, non-determinate, was assigned to the centre of the gradations and where attributes did not apply.

If the photographs in a cluster or extreme value group were relatively consistent in an attribute rating, then that cluster or group received that rating (e.g. positive, negative). If riverscape attributes were inconsistent, the cluster or group received a non-determinate rating for that attribute (see Table 3).

6. Results

6.1. DIMENSION 1

In dimension 1, clusters 3 and 4 have strong negative ratings, while clusters 5 and 6 have strong positive ratings. Clusters with negative dimension 1 ratings have consistent man-made and urban attributes, while clusters with positive dimension 1 ratings have natural riverscapes with no apparent anthropogenic modifications. It is suggested that the dimension 1 construct be labeled *Natural–Man-made* (see Figure 1 and Appendix).

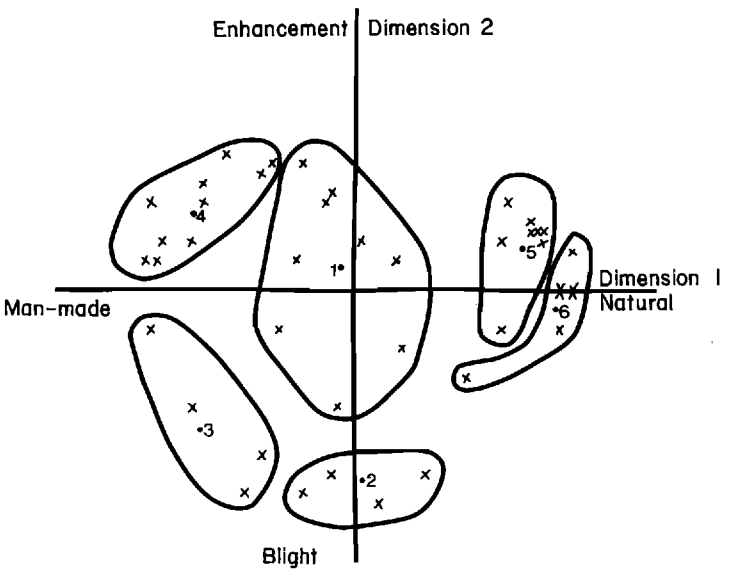

Figure 1. Dimension 1 (Natural–Man-made) *vs.* dimension 2 (Blighted–Enhanced) with clusters and photographs plotted. ×, Photographs, ·, centroids of clusters.

6.2. DIMENSION 2

In dimension 2, clusters 2 and 3 have strong negative ratings, while cluster 4 has a moderate positive rating. To confirm characterization of the dimension, a "positive" extreme value group of photographs was assembled and analysed for attributes. Thus, groups or clusters of photographs with high ratings on both ranges of dimension 2 could be used in the analysis. All clusters and extreme value groups with strong positive or

TABLE 3. Consistent riverscape attributes of the clusters (0 = non-determinate rating)

Cluster no.	Colour Brown + Green	Angle of view High + Low	Vegetation Lush + Barren	Clarity Clear + Hazy	Land use Rural + Urban	Valley slope Steep + Level −	Soil exposure Great + Minor −	Blight Predominant + None −	River exposure Great + Minor −	Cultural features Positive + Negative −
1	+	0	−	+	0	0	+	0	0	0
2	0	0	−	+	0	0	+	+	0	−
3	0	−	−	−	−	0	+	+	0	−
4	0	0	0	0	−	0	−		0	+
5	0	0	+	+	+	+			0	0
6	−	−	+	−	+	0	−	−	+	0

negative ratings in dimension 2 are anthropogenic riverscapes. Clusters 2 and 3 contain consistent views of trash, bulldozed sites, vandalism and other disturbing anthropogenic modifications. The positive extreme value group contains city centre riverscapes with arching bridges, the city skyline and urban parks as prominent features. There is no trash or any other feature with definite cultural connotations in this group. It is suggested the dimension 2 construct be labeled *Blighted–Enhanced* (see Figure 2 and the Appendix).

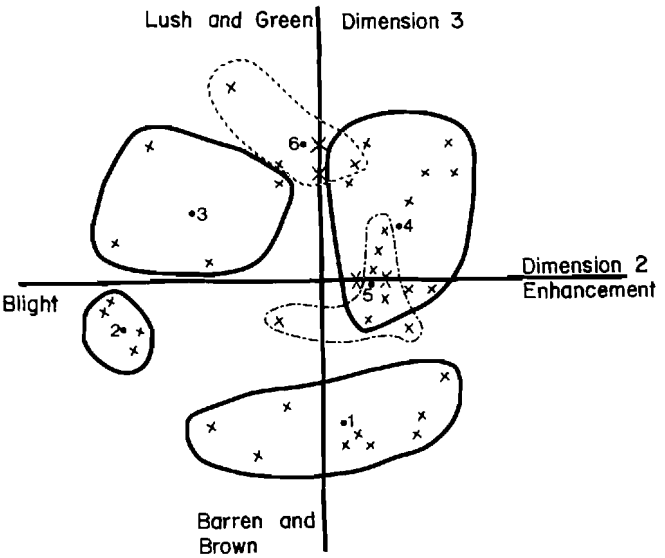

Figure 2. Dimension 2 (Blighted–Enhanced) *vs.* dimension 3 (Lush and Green Barren and Brown) with clusters and photographs plotted. ×, Photographs, ·, centroids of clusters.

6.3. DIMENSION 3

In dimension 3, cluster 1 has strong negative ratings, while cluster 3 has moderate positive ratings and cluster 6 strong positive ratings. Cluster 1 has consistently brown coloured land, barren vegetation and often disturbed soils. Cluster 6 has a green coloured landscape, lush vegetative cover and no bare soil. It is suggested the dimension 3 construct be labeled *Barren and Brown–Lush and Green* (see Figure 3 and the Appendix).

7. Conclusions

The identity of the dimensions shows that only riverscape attributes elicit perceptual constructs from surrogate riverscapes as used in this study. Variations in photographic quality and composition are minimal, but the variation present has no coincidence with either clusters or dimensions. The cognitive response to photographic quality was completely overshadowed by the response to the landscapes in the photographs. This result lends additional support to the conclusions of Brush and Shafer (1975), Dunn (1976) and Zube *et al.* (1975), that photographs are valid representations of landscapes.

Multidimensional scaling of repertory supergrids is found to be a flexible, precise and

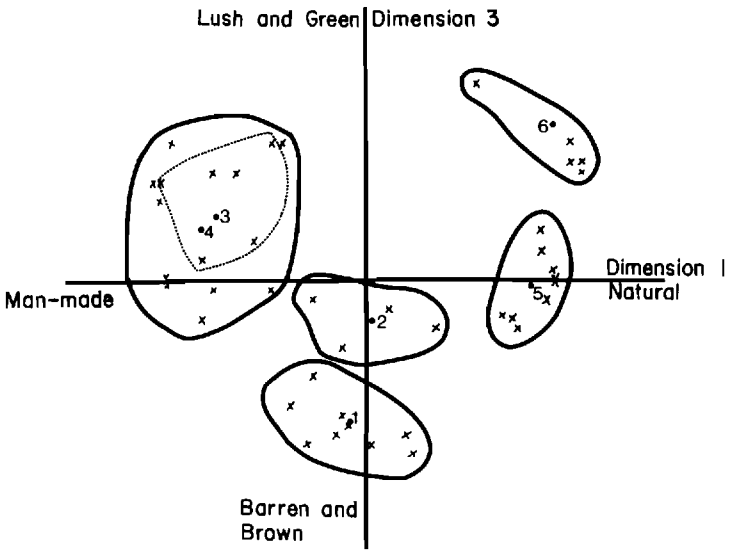

Figure 3. Dimension 1 (Natural–Man-made) *vs.* dimension 3 (Lush and Green–Barren and Brown) with clusters and photographs plotted. ×, Photographs, ·, centroids of clusters.

sensitive method of measuring landscape evaluations. Derived configurations deal with hybrid landscapes and represent effectively the complex relationships between perceptual constructs, yet acknowledge the subtle differences in perception of similar landscapes. The perceptual constructs used in landscape evaluation function within the cognitive set of the regional landscape. Thus, the universe of landscape attributes and their synthesis into the regional landscape are the sets within which a particular landscape is evaluated and the attributes of that landscape weighted.

Dimension 1 indicates that an important criteria in evaluating a hybrid riverscape is whether it appears natural or man-made. The distinction between natural and man-made landscapes is recognized in dimension 2 also, as that dimension evaluates only anthropogenic attributes of the riverscape.

The Natural–Man-made construct has great potential as a tool to determine the apparent "naturalness" of a landscape and the attributes that result in the perception. Landscapes perceived as natural may often differ greatly from truly natural landscapes. The distinction is important in land management, particularly where there is public pressure for a "natural environment" in an area where establishment of such a zone is impractical or impossible because of land use conflicts. A landscape perceived as being natural but less difficult to maintain may be devised in such areas.

The emphasis on perceptions of anthropogenic modifications is expected, given the urban riverscape evaluated and despite alternative dimensions found by other studies. The Vertical–Horizontal and Land–Water dimensions found by Ward and Russel (1981) would not appear in this analysis, as all scenes were prairie riverscapes, landscapes homogeneous in those qualities.

By restricting the study area to an urban to peri-urban riverscape, perceptual constructs useful in regional planning are emphasized. Dimension 2, Blighted–Enhanced, could be useful in urban planning, as it directly evaluates riverbank development in the context of the regional riverscape. With a greater density of photographs and more

precise techniques of riverscape attribute analysis, specific anthropogenic modifications of the riverbank can be evaluated.

Dimension 3, Barren and Brown–Lush and Green relates strongly to land use, park development and the moisture regime of riparian lands. It does not evaluate human structures, but does repond to non-natural vegetation and soil disturbances. This construct does not evaluate the magnitude of natural components of the landscape, but qualifies them on a perceived moisture–colour scale. The construct has potential for evaluation of the aesthetic impact of riverbank erosion, construction projects and over-use of parks. Specific vegetation patterns and types can be evaluated and suggestions for effective manipulation made.

Perceptual constructs derived in this study are very useful in a planning and management context. They delineate the perceived similarity of landscapes, but are not directed towards a "preferred" landscape, if one exists.

Doubts have been raised as to whether there is sufficient agreement on preferred landscapes in non-spectacular regions. A river-edge use questionnaire, administered to 170 Saskatoon residents, found large numbers desiring an undeveloped riverbank, yet similar numbers wanted tea gardens, trail developments, swimming pools and other structural developments. Results indicate considerable confusion on the types of development preferred; frequently, a "natural" riverbank containing sufficient structural development to preclude its existence was desired (FitzGibbon *et al.*, 1982). This conflict indicates contradiction and disparity on preferred landscapes, and contrasts with the unanimity of perceived landscape constructs from the repertory grid.

Intensive study using this application of multidimensional scaling and the repertory supergrid methodology will allow land managers to make sound decisions on the manipulation of landscapes towards a perceived "identity", chosen from their own objectives or determination of preference. Specific attributes significant in the evaluation of a landscape are identified and their effect assessed in the context of the regional landscape. The aesthetic impact of changes in landscape attributes can be measured quantitatively in a theoretically sound manner that takes into account present attributes of the region (cognitive set). This is an applicability and reliability not found in other methodologies of landscape evaluation, and will make scientific landscape evaluation viable in the land management practice.

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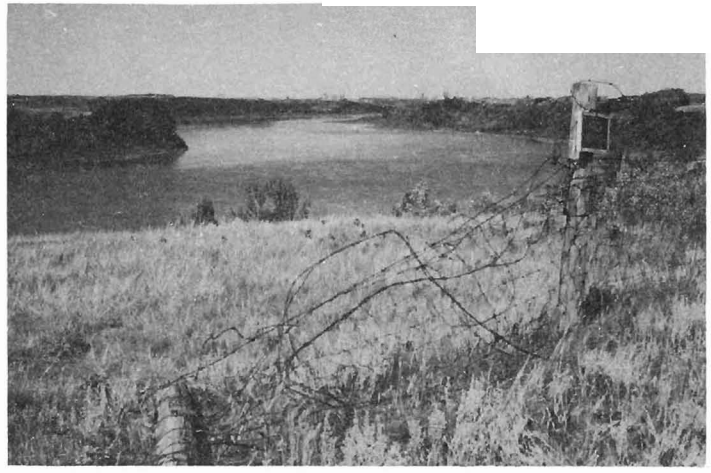
Appendix

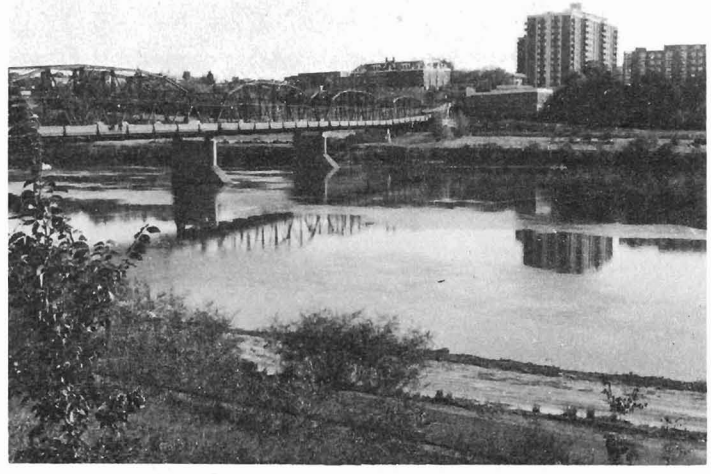
Examples of riverscapes from each cluster and from the dimension 2 positive extreme value group are shown on the two following pages.

Cluster 1.



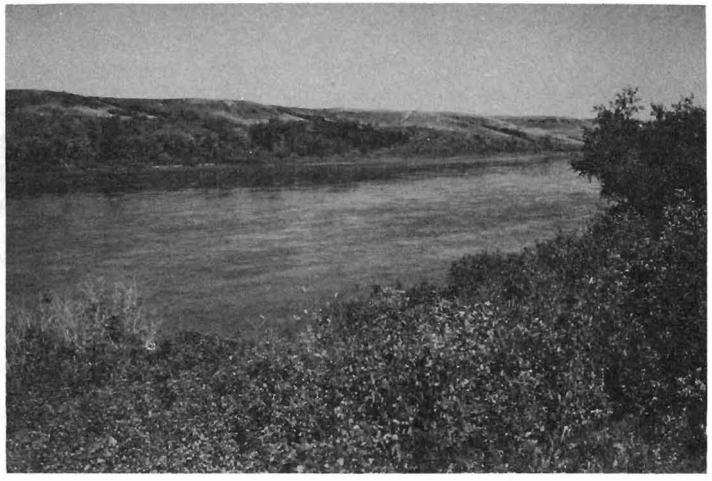
Cluster 2.

Cluster 3.

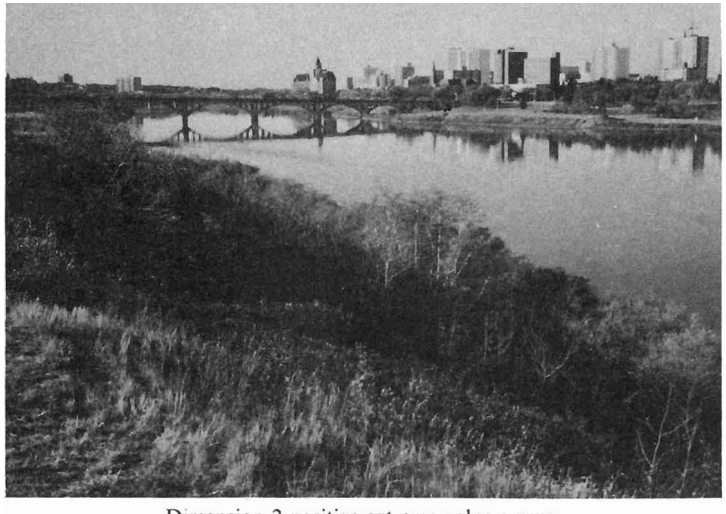


Cluster 4.

Cluster 5.



Cluster 6.



Dimension 2 positive extreme value group.