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Landscape Aesthetics Numerically Defined (Land System): Application To Fluvial Environments, Studies In Fluvial Geomorphology No. 1

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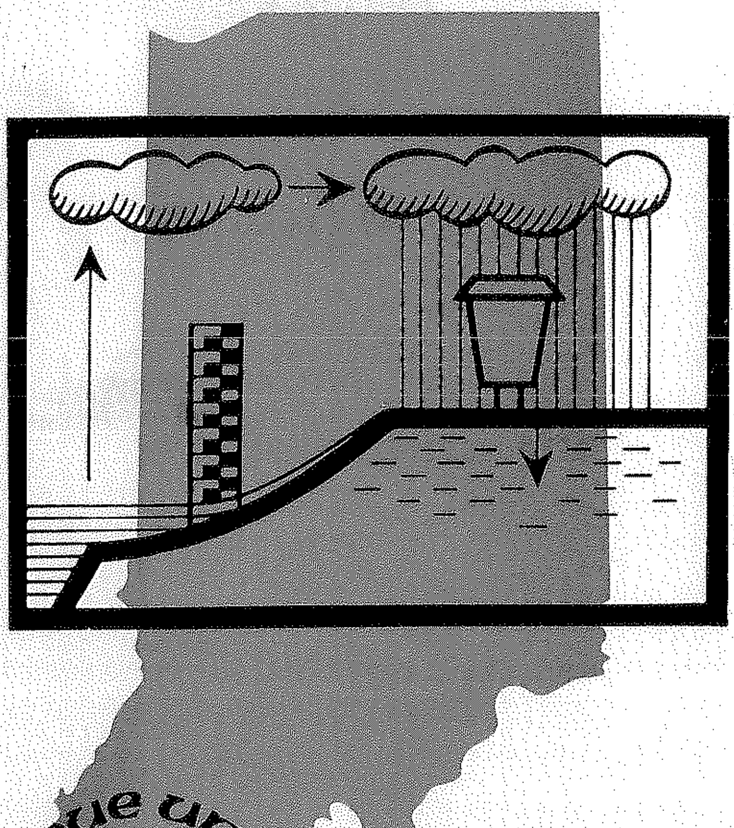

by

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APRIL 1975

PURDUE UNIVERSITY
WATER RESOURCES RESEARCH CENTER
WEST LAFAYETTE, INDIANA

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This is a completion report for OWRR Project No. A-018-IND (Agreement No. 14-31-0001-4014 entitled "A Quantitative Analysis of Landscape Aesthetics, With Special Reference to Stream and Valley Systems and Related Land and Water Resources"

Purdue University

Department of Geosciences

West Lafayette, Indiana

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FRONTISPIECE

Big Pine Creek, an aesthetic and scenic stream in west-central Indiana.

ABSTRACT

Passage of several Federal laws in recent years has clearly indicated that the national policy is to foster preservation and protection of certain aspects of the natural landscape for the benefit and enjoyment of present and future generations. Because of controversies about land use, polarization of individual and group interests has resulted in points of conflict which have not been resolved. The potential impact of human modification on natural landscapes, and the possible aesthetic degradation of the natural heritage, has shown the need to develop a quantitative method to assess the operational aesthetic values of landscape as objectively as possible. Any such method developed should separate facts from emotions and subjective feelings by providing a means to objectively rank landscapes in terms of planning of alternatives for development or use.

Historical viewpoints of landscape values differ from those of today. Originally, land and nature was to be conquered and there was little interest in preservation of aesthetic qualities. The modern trend is toward diminution of this developmental ethic and a corresponding increase of interest in a preservation ethic. Research techniques for recognizing and analyzing significant landscape parameters have been proposed and tested by geographers, sociologists, psychologists and others. Their methodologies, which employ graphic, interview, viewing, or matrix techniques lead to vicarious presentations, are liable to much subjective bias, and arrive at non-quantitative conclusions. The problem is complicated by incomplete understanding of geographic spatial relationships, the psychology of perception processes among individuals, and absence of an adequate methodology

for assessing perceived aesthetic inputs by a sound decision-making process.

Numerical results are more desired, inasmuch as any benefits-cost study requires quantifiable ranking of natural landscapes in considering trade-off values in a decision-making context. The LAND (Landscape Aesthetics Numerically Defined) system as outlined in this report is an extension of the best matrix technique (Leopold, 1969b). A parametric, computerized data-sorting process provides an easy-to-use and understood method to objectively evaluate natural fluvial landscapes. Landscape evaluation indices, e.g. Uniqueness, Aesthetic, Scenic, Recreational, and Wild, are arbitrarily defined or taken verbatim from statutory definitions.

Preliminary testing suggests that personnel doing evaluation tend to arrive at essentially the same evaluation numbers regardless of education, background, etc. Specific subjective views tend to be suppressed by the total air-water-land interplay, and as all personal assessments are reduced to discrete ordinal numbers it is difficult for an individual to maintain significant subjective bias. Comparative results are determined only after the LAND program gives unweighted linear or graphic results. For specific user requirements, weighted results can be achieved by assigning weighting factors to one or more evaluation categories, by changing boundaries between descriptive evaluation numbers, or by modifying evaluation factors used in the basic matrix.

The LAND system has been used only to evaluate fluvial systems in terms of physical, biological, water quality, and human use factors. However, the system can be changed to produce a different set of evaluation indices to rank non-fluvial landscapes. Preliminary work suggests that the system is applicable to highway routing and urban landscape evaluations. Theoretically, it is possible to achieve "total landscape evaluation" of any arbitrarily defined geographic area.

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This report describes work performed as part of OWRR research project A-018-IND entitled "A Quantitative Analysis of Landscape Esthetics, with Special Reference to Stream and Valley Systems and Related Water and Land Resources." The project was sponsored by the Purdue Water Resources Research Center, directed by Dr. Dan Wiersma.

The project title is inordinately long and exhaustive, but no more so than some difficulties encountered in the project inself. The basic research objectives were completed on schedule. A matrix or model for assessment of landscape parameters was devised, field tested, and improved enough to satisfy our standards. A simple computer program for rapid handling and visual display of the parametric measurements and landscape rankings was also completed with only the ordinary problems attendant to programming. However, in preparing a report to detail our findings, we became concerned with the need of some examination of the fundamentally deeper and more complex problems of spatial theory, perceptional psychology, present and historical attitudes towards landscapes, and the merits of other landscape assessment methodologies. No adequate review or summary exists in the literature that discusses psychological theory and also considers historical, geographical, and management outlooks in relation to assessment of landscape values.

It would be simple merely to present our results without reference to the supportive background described above. However, we deemed it important to provide the reader with some information which, if nothing else, demonstrates the awesome complexity of the problem of objective evaluation of landscape. The result is the first three chapters of this report, written by the senior author, who must accept responsibility for their success or failure. This review of the subject matter, obtained from initial examination of more than 125 articles, is admittedly largely beyond our training and expertise, and any distortions or errors in interpretation or evaluation should be considered as honest and inadvertent transgressions.

Chapters IV and V describe the methodology used and results of our study. These chapters are a compilation of various versions prepared and presented as illustrated talks during the past two years before university groups from California to Alberta to New York. It is a joint product of Dr. Melhorn and Dr. Keller.

The basic computer program was written by Mr. McBane, with improvement and modification by Mr. Michael Ruark. Mr. Ruark was in charge of most of the field measurements on 32 Indiana streams, and was assisted at times by the authors. Able field assistance was also provided at various intervals by Dr. Dan M. Coffman and Messrs. Steve Jones and Joe Payne, Jr.

Special thanks are owing to Dr. Dan Wiersma for his infinite patience, enthusiasm, and general support of our investigation.

CHAPTER I

ENVIRONMENTAL PERCEPTION AND LANDSCAPE AESTHETICS: PHILOSOPHY AND PROBLEMS

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During recent years, there has been a great deal of public and private debate and discussion about environmental quality. Examples include such things as cleanliness of air and water, use of pesticides, mining of public lands, beauty of the countryside, optimal use of recreational areas, preservation of wilderness, and the effects of urban living on the human mind and body. Not the least of these is the problem of measuring aesthetic appeal and amenities. This growing concern about environmental quality clearly incorporates positive aims, yet at the same time tends toward a blind reaction to the generally inadvertent negative effects of man's alterations of the natural environment. No longer is concern about these inadvertent alterations limited to a few lonely voices crying in the wilderness, as typified by the protests of Thoreau, Muir and especially Marsh (1882). The majority of Americans are now aware of at least a sampling of environmental problems, and recognize that improvement of our surroundings is a matter of universal interest and concern; the matter is no longer limited to the conscience of a few individuals.

One of the thorniest problems of all lies in the way in which man views spatially his environment. The character of the problem becomes readily apparent by reference to the encompassing and rather futile way in which Webster defines environment -- "the aggregate of all the external conditions and influences affecting the life and development of an organism" -- in this case, man. Every day, men are making decisions that lead to transformation of Earth's environment. The cumulative effect of a number of small decisions is rather great, and inadvertent side effects of primary decisions are producing environmental problems of increasing number and complexity (Saarinen, 1974). One theme, which seems to occupy the thinking of geographers and psychologists in dealing with environmental perception, is that environmental decisions and behavior are based on individual or group images of the real world as they perceive it, not on the world as it is. Thus, decision makers operating in an environment base a decision on environment as perceived, not as it really is. The action resulting from decision, however, is played out in a real world environment where the consequences of action must either be endured or further changed.

Thus, an interaction of technology and science overlaps into the behavioral sciences, *i.e.* a recognition that human decisions with locational implications are affected by the way in which individual or group decision-makers perceive the physical and human environment. Behavioral geographers have thus tended to view the problem as theirs. Concurrently, environmental perception forms an overlapping area with certain aspects of psychology, a field where studies of individual or group rationalizations of certain natural events that effect human behavior has received some attention, particularly in connection with "hazard" problems such as climate, floods, and seashores (Kates, 1962).

Historically, the thoughts about the philosophy of perception certainly reach back as far as the 5th Century B.C., to the Greek scientist Empedocles (Encyclopedia Brittanica). There appear also certain roots for problems of landscape perception in the body of Gestalt psychology, as framed by von Ehresman. This is particularly true in terms of concepts of "visual shapes", dealing as Gestalt does with mental facts which are ignored when merely analytical procedures are used in psychology. This theme seems to either permeate or be at least tangential to many discussions of conceptual schemes dealing with research into geographical space perception. For example, Downs (1970) suggests that different people view the segments of the real world differently, as through a set of filters. The physical filters are the same for all people, but any constant input of information, such as spatial geography, is also screened through a set of psychological filters such as language, social class, personal values, ideas of need and value, group culture, education, and other forms of Gestalt or pattern seeking functions. Lowenthal (1961) has stated this concept particularly well:

> "The surface of the earth is shaped for each person by refraction through cultural and personal lenses of custom and fancy. We are all artists and in accordance with our apperceptions and predilictions. The geography of the world is unified only by human logic and optics, by the light and colour of artifice, by decorative arrangement, and by ideas of the good, and the true and the beautiful."

And subsequently, Lowenthal (1968) noted:

> "Landscapes are formed by landscape tastes. People see their surroundings through preferred and accustomed glasses and tend to make the world over as they see it. Such preferences long outlast geographic reality."

The psychology of spatial meaning and experimental bases for aesthetic decisions about landscapes has received attention from other sources in the fields of psychology and physiology. This theme is particularly well developed by Fitch (1965):

> "A fundamental weakness in most discussions of aesthetics is the failure to relate it to experiential reality. Most literature on aesthetics tends to isolate it from this matrix of experience, to discuss the aesthetics process as though it were an abstract problem in logic.
>
> ....A change in one aspect of quality of the environment inevitably affects our response to, and perception of, all the rest....aesthetics actually derives from the body's total response to, and perception of, its external physical environment....the natural environment is anything but constant in either time or space....Every experience has built-in time limits....constant exposure to steady stimulation at some fixed level will ultimately deaden perception.
>
> ....while all human standards of beauty and ugliness stand ultimately upon a bedrock of material existence, the standards themselves vary astonishingly. All men have always been submerged in the environment....the same sensory apparatus for perceiving changes in its qualities and dimensions....the same central nervous system for analyzing and responding to the stimuli thus perceived....Ultimately, it is physiology, and not culture, which establishes the levels at which sensory stimuli become traumatic."

And Beck (1967) extends this theme as to spatial meaning and environmental properties:

> "Perception of the environment requires man to interpret the physical and social components of his stimulus field....These transactions further lead to the establishment of group attitudes, beliefs, and values associated with various domains of the environmental field. The physical and interpersonal properties of the environment are distributed in space.... personal systems of spatial meaning may yield important insights into individual perceptions of the environment."

Beck further defines 3 basic kinds of space. Objective space is the dimensions of distance, size, shape, and volume. Ego space is defined essentially as an individual adaptation of observed to objective space to present a coherent and logically consistent view of shape, size, and distance. Immanent space is basically psychological space of the unconscious, fantasy and dreams, and includes the spatial styles and orientations of the individual and the ingrained biases of his whole culture. Beck further notes that an individual's styles are ingrained, and are the result of prolonged and complex exchanges between the individual and his environment; thus, by implication, his view of environment is a result of physical and social experiences and his cultural stereotypes.

This theme of cultural and experiential factors, and the role they play in determining individual or group response to landscape stimuli, thus seems firmly entrenched in theory. However, allusions to social, educational, and physical experience, which permeate the literature, seldom are specifically exemplified. Saarinen (1974) has attacked the matter as a historical function by describing how perception of environment, at the broadest level, involves such factors as national stereotypes, ethnocentrism, national attitudes, and national character. Whittlesey (1945) has traced the change in geographic horizons as seen by groups through historic time, and describes the mental myopia, weight of tradition, and parochial viewpoints which have dominated men's political systems as well as their geographic outlook. Whittlesey notes that until a few centuries ago, local or regional senses of space dominated human settlements everywhere; and, even in the present United States, where society is considered very mobile, relatively few people move beyond their native region so that only a limited number are exposed to cultural, climatic, physical, or thought patterns different from their own. Thus, although we should expect that the number of people who have a worldwide geographic horizon is the greatest in planetary history, there is reason to question the quality of this knowledge horizon. These limitations are described by Saarinen (1969), who defines the whole environment external to man as the <u>objective</u> geographic environment. Within this larger sphere is the <u>operational</u> environment in which individuals operate;

it consists only of the portion of the world which impinges on him, influencing behavior in one way or another, whether or not he is aware of it. Only that portion of the operational environment of which man is aware is the perceptual environment.

Therefore, despite a body of geographical, psychological, and physiological theory, there seems to be a general realization that as yet there is not general agreement on what "perception" means, what is being metricated when we try to subjectively or objectively measure it, or exactly what influence or bias is exerted on any individual through mass culture, group values, or personal social status or experience. Hall (1969) doubts the validity of the long-held idea that "experience" is what all men share universally, and suggests that different people inhabit different sensory worlds. He further suggests that space perception is not only a matter of what can be perceived but what can be screened out.

Schiff (1971) also has noted this level of disagreement, and in terms of perception of environment, has stated that an individual's perception is a function of his past history and his state of mind at the moment he is viewing a stimulus. Schiff also concludes that perception of any stimulus may also be a function of (1) value of the object to the individual, (2) previous experience with any given stimulus, (3) habituation, *i.e.*, repeated presentation of the same stimulus leads to a decrease or total disappearance of response, and (4) to perceive something, one must first be aware of it. For these reasons, Schiff concludes that 2 individuals with different past experience may look at the same physical stimulus, receive the same image, have the same image transmitted to the brain, and yet perceive the image differently.

Moeller, et al., (1974) have stated:

> "The scientific investigation of how people perceive natural environments, other people who use those environments, and resource managers is important to the resource-management process....But the human perceptual process is not yet understood."

And Saarinen (1969) has somewhat gloomily declared:

> "The stage of research in perception of environment is such that no real body of theory has developed. It would be premature to try to generalize as to the main findings, since not even a name has yet been agreed upon....Perception is an extremely complex concept....Social perception is generally concerned with the effects of social and cultural factors on man's cognitive structuring of physical and social environment. Perception then depends on more than the stimulus present and the capabilities of the sense organs. It also varies with an individual's past history and the present "set" or attitude acting through values, needs, memories, moods, social circumstances, and expectations.... In many cases, perception must be inferred from behavior or otherwise sought in indirect ways...."

Yet Newby (1971), speaking as a recreational resource manager and not as a theoretician, has exuded somewhat greater optimism:

> "Perceptual experience involves intricate relationships between what is seen and the individual doing the seeing. The standard cliche for these relationships is that "Beauty is in the Eye of the beholder." There is little argument when dealing with superlative examples of visual landscapes, nor is there any great disparity when identifying what is chaotic and ugly.... The real problems exist within the ambiguous middle range of the natural beauty continuum. Within this range are found the majority of landscapes to which man is exposed throughout his life--landscapes that support or destroy the movement of imagery from here to there.
>
> ....Each individual has his own level or degree of complexity tolerance, which is dynamic in the sense that it shifts upward as perceptual grasp is refined. Some familiarity must be present to retard stress; but a degree of the unusual, the unknown, or the unperceived must exist to prevent boredom. Accordingly, simplicity in an environment can be a deterrent to visual pleasure, particularly if flow experience or movement is restricted....

> ....At present, there is no cookbook approach to understanding the visual response resource, nor are there definite procedures for insuring that scenic amenities become harvestable commodities. However, the fact that resource managers are becoming sensitive and responsive to environmental interactions opens new avenues for developing a positive approach to the assessment of the aesthetic response potential inherent in all visual resources."

The authors of this report take comfort in the preceding citation, and further comfort from Sonnenfeld (1969) who, in presenting a model of environmental personality and behavior, has rather boldly stated:

> "I am willing to predict that constant environmental personality types will be found among all populations, regardless of the contrast in cultural values otherwise distinguishing between them, and regardless of the contrast in environments they occupy."

The purpose, then, of this introductory chapter has been to deal with the disorganized philosophical background of perception processes, inherent problems of bias in aesthetic perception of landscapes, and the resultant obvious difficulties in developing a methodology for landscape assessment that retains appropriate elements of both subjective and objective factors which bear on decision-making in resource management. In a sense, we are addressing the problem outlined by Newby, and with the same degree of optimism. Concurrently, this review of the theoretic and philosophic leaves an appropriate residual degree of humility. We realize that the results of our studies of stream and valley aesthetics, as presented subsequently in this paper, are subject to criticism on many grounds. We take refuge in this final quotation (Brookfield, 1969):

> "In all this work, descriptive and analytical, the mutual interrelation of real environment, perceived environment and human activity emerges in only a shadowy, or at best halting manner. It becomes evident that this is an extremely difficult field to handle in behavioural research, and that while the significance of perception emerges equally positively from quantified and non-quantified research, the manner in which the system operates fails to emerge sharply except in quite restricted contexts."

CHAPTER II

HISTORICAL VIEWS OF LANDSCAPE: CHANGES IN VIEWPOINTS AND ATTITUDES.

****

More than a century ago, Alexander von Humboldt (1852) asserted that "....in order to comprehend nature in all its vast sublimity, it would be necessary to present it under a twofold aspect, first objectively, as an actual phenomenon, and next subjectively, as it is reflected in the feelings of mankind." He thought that real or simulated exposure to selected environments would exercise powerful and lasting effects on the human mind. Such exposure could result from the opening of educational displays in large cities where, through literary descriptions, landscape paintings, and collections of exotic plants and other natural forms, a marked influence would result affecting the feelings and experience level of students observing the displays.

A similar concern with expansion of geographic horizons was examined some years ago by Whittlesey (1945). His essay explored the way in which man's horizons have expanded with time, commencing with primitive people whose landscape perspective was literally confined to the physical horizon. This primal period was succeeded some 2,000 years ago by regional or sub-continental views of geographic space as political entities became more centralized and communications improved. The worldwide horizon did not appear until the 15th Century, when voyages of discovery by Columbus, de Gama, Magellan and others gave rise to the first conceptualization of world-wide space. However, the slowly decreasing tendency toward parochialization of geographic and landscape precepts has lasted until the present time, as described in Chapter I.

Of more importance, however, is the matter of real or imagined mastery of man over his own environment. The drive to development of land, of taming the wilderness, undoubtedly commenced when man first ceased his total reliance for support on hunting and nut-gathering, and made a shallow furrow in the ground with a forked stick for planting seeds. For some hundreds, if not thousands of years a constant drive has been toward developing and altering landscapes to satisfy the immediate human needs - food, clothing, and shelter. This developmental mode - some modern critics would refer to it as the rape, pillage, and burn the landscape pattern - still persists and will be discussed subsequently in this chapter. The surge toward development, and thereby total alteration of much of our landscape, was speeded exponentially within the last 100 years by a world-wide population explosion and the concurrent development of advanced technology that has culminated in the modern level of communications, mechanization, and transport of goods.

In substance, for most of historic time emphasis has been placed totally on economic utilization of renewable and non-renewable natural resources - plow the land, mine the ore, cut down the forests, and use the water freely. Most of this has been done without thought about inevitable waste, future societal needs, and most certainly without much regard for the presumedly uneconomic, intangible aesthetic or scenic values of the natural landscape. However, in fairness of retrospect, this outlook could hardly have been different.

Lowenthal (1962) has noted that as recently as a century ago concepts of wilderness and scenery were nearly the opposite of today's concepts. By the middle of the 19th Century, western Europe was "civilized" and land use was a neatly compartmented, de facto thing. Already, populations were large relative to the available area, and the inhabitants were assured enough about their mastery of the elements, terrain, and other life forms to assume that a certain amount of land could be left undeveloped for sheer enjoyment. Lowenthal notes that although these people enjoyed panoramic views and primitive vistas, they greatly preferred landscapes more as set pieces than as real pieces. Neat, formal gardens and parks were the norm, although in creating them artificial husbandry substituted for the natural landscapes they pretended to admire; the "controlled environment" of the Versailles Gardens was widely acclaimed. Elsewhere parks, woodlands, open fields, and glades were sometimes left in a more or less pristine condition, although generally for use as gaming preserves or "summer retreats" by the social and economic elite rather than for enjoyment as purely aesthetic natural collections of terrain, vegetation, and wildlife. Only such regions as the Alps, the Caledonides, and perhaps a few other sections were considered so remote, foreboding, and rugged as to not be worth exploiting.

The view that landscape was to be attacked and subdued rather than enjoyed carried over into the settlement and development of North America. Here, distances were vaster, the rivers wider, the mountains higher, the woods thicker and more abundant, and climates more extreme than in western Europe. Lowenthal (1968) has suggested that even the quality of light was unaccustomed, and lushness and alien character of the vegetation repelled rather than attracted the newcomers - an example perhaps of the effects of inherited group culture and ethnocentrism described in Chapter I. Thus, a certain repulsion towards and fear of landscape possessed these people. The supposed starkness and hazards of a limitless frontier did appeal to a few people, perhaps including a female progenitor of the senior author of this report; she homesteaded in wilderness west of the Appalachian Mountains in 1763. However, major territorial expansion came after 1820, and culminated with the opening of the American West between about 1870 and 1910. This was the period when sod had to be turned, mines must be opened, water resources were developed for irrigation, and cattle were placed to roam the grassland ranges.

There is little to record that ordinary people of this period paused in their labors to enjoy the aesthetic qualities of their everyday landscape surroundings. The landscape was still to be combatted, not enjoyed. Only poets and artists were advocates of the natural setting. Lucas (1964) and particularly Nelson and Butler (1974) have touched lightly on the attitudes toward scenic landscape as shown in paintings of the 19th and early 20th centuries. The works of Ayres, Moran, and particularly Albert Bierstadt come immediately to mind. Anyone who has contemplated the western paintings of Bierstadt, and contrasted the scale of man in the grandeur of mountain landscapes (Wind River), the great California redwoods (Eden Before They Fell), or the pastoral, idyllic vistas of Sacramento Valley in the Spring cannot but sense the mid-Victorian outlook of the artistic elite towards natural landscape. It appears that much is yet to be learned about former attitudes toward scenic appreciation as shown in landscape art of past periods.

Geologists, too, extolled the values of scenery in the early reports of the Powell, Hayden, and Wheeler geographical and geological surveys. Dutton's (1882) discussion of the Vermillion Cliffs in Arizona, and Russell's (1885) description of the Nevada desert are classic but romantic versions, in the 19th Century tradition, of the insignificance of man, the vastness of scenery, and the interplay of elements of cloud, land, and water as they effect the viewer of landscape.

As the frontier contracted, and eventually closed, the view of landscape or wilderness in its own right, rather than as land to be developed, came into existence. True, there were some early appeals for public action to set aside certain areas for future use and enjoyment. George Catlin made an appeal in 1841 (Nelson and Butler, 1974); another by Thoreau followed shortly. George P. Marsh's books (1864, 1882) perhaps had an impact that helped result in the first park reservations, Yosemite and Yellowstone. Lowenthal (1968) rather caustically suggests that the National Parks were originally founded to enshrine the freaks and wonders of nature; if they were typical, who would bother to go and see them? However, it is more likely that these preserves were defined to stockpile them for future use, not for perpetual non-development or simple aesthetic enjoyment. Yosemite, established as a California state park in 1864, seems to be the first example or scenery being managed as a natural resource, and as such was to be managed by public policy and subsequent enactment of Federal legislation (Zube, 1973). Of course, Yosemite valley was too deep to plow, and the original cover on the valley floor was mostly savanna, not trees, so there was little to cut! Shortly afterwards, in 1872, Yellowstone was established as the first National Park, but the enabling act does not appear to specifically consider scenery as the most important natural resource to be managed. Establishment of the Adirondack Forest Preserve in New York in 1885 seems to have been with the same general intent (Lucas, 1964). By and large, transfer of public lands to park systems appears to have been dictated by uniqueness or size of a single physical feature, remoteness from settlement, the then general inhospitability and inaccessibility of terrain, or apparent lack of tangible agricultural, mineral, or economically recoverable timber resources.

The subsequent progress in allocation of natural areas to parks, forests, scenic vistas, and fish or game reserves is abundantly documented in the literature but is too detailed to review here. With a few exceptions, however, only in the last two decades has there been a general tendency to preserve landscape purely for scenic or wilderness values.

Three basic causes have led traditionally to the establishment of parks and scenic reserves. As already noted, the first of these was a trend toward stockpiling of areas for protection of natural resources. Next came planning for recreational and scenic needs. The last cause to come was increased local demand for business income generated by tourism, but this cause was scarcely foreseen by the earlier planners. Another governing factor that undoubtedly affected early thinking was the seemingly inexhaustible abundance of raw land; there was at worst only limited conflict of interest between individuals or groups over the programmed use of terrane. Even as recently as 20 years ago the large, national scenic preserves and the generally smaller state preserves were extensive enough to meet the needs of what has now become a major national industry, i.e. tourism and recreation. There was little apparent need to examine regional or local areas of lesser "uniqueness", determine their respective intangible values, and take steps towards either preserving these areas from development or at least subjecting them to the recently developed concept of "multiple use." Now, pressure from overcrowding in recreational or scenic areas has led to group dissatisfaction, introduction of restricted access and use permits, and increasing limitations on actual terrane use even within areas long dedicated to the public welfare and enjoyment. This pressure now leads to the need to identify, assess, and hierarchically rank more commonplace terrane in terms of its relative value as scenic or aesthetically desirable domain. This new trend, from preservation of the unique to critical examination of the ubiquitous, correspondingly increases the need for a system of comparative evaluation of landscapes. The objectives of such examination are, of course, to aid in the decision-making context wherein a choice of land use alternatives exists. In this vein, we note again the quotation from Newby (see Chapter I, page 7) that the greatest problems exist in assessment of the great span of that ambiguous general majority of landscapes, i.e., what is locally or regionally conceived of as the commonplace.

The increasing level of direct conflicts of interest between individuals, groups, or even government agencies (for example, the current disagreement between different federal government programs concerned with management of land and water resources of the Charles Sheldon Antelope Refuge in northern Nevada) has emphasized the equal increase in need for political decision-making. Cook (1973) has seriously examined the problems of environmental politics, and states:

> "A modern nation has no ethical arm and its political leaders move cautiously, trying to develop new devices for sensing what its people consider good and what they consider bad. They move cautiously because they face sustained and growing questioning of goals and values--because opinions differ and conflict--because many people are uncertain or unclear about their values and goals--because values seem to be changing rapidly....because there is great difficulty in determining what the people want...."

There is no better illustration of determining the ethical attitudes and value sense of the public than on the environmental scene. This chapter has tried to synoptically chart something about the qualitative historical attitudes of people about their environment, but directly or quantitatively measuring these attitudes is not as easy. The recently implemented requirement for environmental impact statements, as outlined in the Environmental Protection Act of 1970, is perhaps really an expression of the cautious way in which political action programs are forced to move. Impact statements, regardless of their values or disvalues, have and are leading toward a more deliberate, systematic, and open framework in which, in theory, expert opinion can be employed, secondary consequences of any action examined, alternate planning can be considered, and arguments of the advocacy position between conflicting interests heard before final political and economic decisions are reached. In any case, there is realization that we do need new ways which will allow opposing positions to compare alternative plans for developing any common resource--in this case, let us assume a scenic or aesthetic resource, such as a river valley--in terms of all the costs and benefits, both market and nonmarket, or the so-called intangible values. Cook, for example, has noted that before any technologic intrusion is made, all aspects of physical, economic, and social costs, benefits, and disbenefits of any project should be summed before being placed in the political decision making area where, in theory, appropriate value weights can be attached and decisions reached on a purely best-alternative basis.

Cook (1973) seems to combine the above requirements into a concept known as the equilibrium ethic, essentially defined as a constraint which requires examination of all consequences of a proposed environmental change. Demonstration of a positive benefit-cost ratio, with non-market costs and benefits included in the assessment, are required before proceeding. It appears that Cook is suggesting that this ethic should supercede the other two major ethical positions, which are:

1) The development ethic.

This subdivides into two parts:

a) Dominion or conquest. Man has dominion over nature; good comes from the management and mastery of his environment, from dynamic action and change by man and not from contemplation or aesthetic sensitivity.

b) Work. Work and change are good; rest, stasis or contemplation are bad.

This ethical complex, as a result of theological training and cultural outlook has in the past and still tends to be the dominant force in American society.

2) The preservation ethic.

This subdivides into several categories:

a) Moral. Nature is good in and of itself.

b) Nature-therapy. Nature is good for its own sake, and is good for man.

c) Aesthetic. Natural areas are good for man because of aesthetic values and satisfactions which are derived from contemplating and visiting them, i.e. as constructs of the mind, not of the tactile senses.

d) Scientific. Requires no disturbance or change in systems, because man can learn more from natural than altered natural assemblages, and more from variety than from sameness.

e) Recreational. Preservation of natural, though not necessarily pristine, areas for hunting, fishing, hiking, canoeing, etc. This has become a relatively powerful political force in recent years.

All of us are probably personally acquainted with individuals or groups who fit neatly into each of these categories of subcategories. In recent years, members of the second category apparently have increased in numbers, in influence, and in vocal expression. It is indeed rather clear that some accomodation approaching Cook's equilibrium ethic is needed. This resolution between advocacy positions is not to be easily achieved.

This chapter has traced the thread of some historical attitudes towards development, preservation, management, and use of obviously desirable, scenic, aesthetic, and seemingly non-quantifiable visual resources of segments of our landscape. The final portions of the chapter have examined briefly the disparate outlooks existing today, variant views about management of natural and scenic terrain, and the apparent continuing flow of changes in ethical and political attitudes and social values. We have also tried to provide as an undercurrent the need for providing some methodology, however restrictive, that will establish more absolute values in measurement of landscape variables. This methodology then can be applied in the decision-making process of the political and economic arenas.

CHAPTER III

MEASUREMENT AND RANKING OF LANDSCAPE VALUES: METHODS AND PROBLEMS

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General Statement

This chapter reviews and analyzes some systems that were proposed or tested during the last decade for measurement of environmental quality and attitudes towards landscapes. A previous review and analysis of various types of measurement and ranking systems is available in an excellent article by Fabos (1971), and anyone seriously interested in landscape assessment methodology should avail themselves of his article. Of particular note is the way in which he collected all ranking systems into 3 major categories; the basic criteria for categorization are scale and size of the area surveyed and the scope or purpose of the investigation, _i.e._ national, regional, intrastate, local, etc. We emphasize that reasons for selection of particular criteria to meet objectives of any given study must be appreciated; otherwise, it is tempting to unduly criticize the methods used or underrate the caliber of past evaluations of particular landscape groupings.

Some additional studies have been consummated and tested since the appearance of Fabos' paper. Discussion of these receives primary emphasis in the following pages, but results of earlier works are interjected wherever warranted.

Graphic Techniques

Fabos suggests that variables used in conventional landscape evaluations by landscape architects and land planners are the basis for most of the quality ranking systems that have been proposed. These variables are largely abstract, and deal with such things as the observer's position, quality of light, distance of view, canopy or coverage, and other criteria. Impressions received by different viewers are influenced by the factors described in previous chapters: cultural, historical, and psychological. It is extremely difficult to reduce such variables to meaningful mathematical terms. Recently, there has been a trend toward developing computer graphic techniques for regional landscape analysis. This provides an at least statistical tool that gives some numeric component to natural resource inventories. A recent example of a functional application of computer graphics techniques is that used for land use planning in Iowa by Sinatra, et al., (1972). In this interdisciplinary study, a data matrix is developed for storage of 14 raw data inputs (mostly physical factors) for land "cells" of various acreage sizes. In a single test area of Story County, Iowa, weights were placed on the data variables in order to select cells with optimal conditions for certain land uses. This study further notes that the state of Iowa has been divided into 10 resource regions established on the bases of physical, social, hydrologic, etc. patterns. It is probably safe to assume that the variations in scale or importance of raw data or their special characteristics will result in modifications of the data matrix for each of the 10 resource regions. Each computer printout contains a map and a frequency distribution graph, giving a type of quantitative ranking function to the product. The graphic technique is reinforced by a back-up collection of color slides depicting data sources. From these, it would be possible to establish aesthetic appreciation as another data input if desired.

A similar and pragmatic approach to measurement of landscape variables is typified by some current assessments by engineering consultants in land use. An example is a landscape resources inventory of Madison County, Indiana (Schellie Associates, 1969). In this study, field inventory was made of variables which were placed in 11 major categories and 44 minor categories. The categories follow the same general range of physical, hydrologic, vegetation, etc. patterns used in Iowa; however, a category of "Perceptual Qualities" receives equal weighting along with such categories as "Historic Sites" and "Cultural Sites", demonstrating that aesthetic and cultural variables are important factors in land use decision processes. The products in this study are not computer-derived, but consist of a series of inventory or "landscape personality" maps, on a conventional base and scale, which graphically delineate the nature and extent of each inventory item. Somewhat similar environmental maps are currently published by the U.S. Geological Survey, though none have considered purely scenic or aesthetical qualities in their presentation. These are primarily natural hazards maps and inventory maps of physical parameters. Graphic presentations in map form are simple and likely to be best understood and appreciated by the lay public, by planners, and by political decision-makers.

Interview Techniques

A common method of approach has been the personnel interview, wherein a random sampling of users of a resource are asked a series of questions about their preferences and their reactions to moving experience. This methodology has long usage in the social and political sciences, where statistically treated sampling procedures appear commonly successful, and even have a certain predictive capability. In environmental preference studies, predictive models based on the interview technique have centered mostly around evaluation of user attitudes toward wilderness. An instructive example in perceptional ranking is by Lucas (1964), who interviewed users of the Boundary Waters Canoe Area in the Superior National Forest. Analysis of response from 300 groups of visitors of all types was used. He concluded that differences in attitudes and values suggested that the area should be zoned into 2 different "perceived" wildernesses to meet the general desires of the disparate user groups. A similar questionnaire was developed by the University of Idaho Water Resources Research Center (Herbst and Michalson, 1970), and implemented in modified interview form in studies by Christopherson (1973a, 1973b), where attitudes and opinions of recreationists and landowners on the St. Joe River were measured with the expectable conflict of attitudes. Peckfelder (1973), in a corollary study of users and managers of the Salmon River suggests that, if complete information is available, resource managers and users achieve the same perception levels and arrive at the same basic conclusions about the natural environment.

Viewing Techniques

Another landscape preference system evaluation method is to expose randomly or non-randomly selected groups to visual stimuli, usually in the form of color slides, photo-montages, line drawings, or art. In some cases this viewing technique has been combined with the interview or questionnaire device previously discussed. This methodology seems totally removed spatially from a truly experiential setting, and therefore represents reaction to a vicarious experience only. Zube (1971) and his students testing the hypothesis that the quality of land form, water, contrast and variety of variables of the permanent landscape, and environmental diversity are the essential components and determinants of overall landscape quality. One part of this study employed responses of university students to color slides. Another part used photo-montage patterns in testing a random sample of an adult population. A third part of this study used line drawings in place of photo products. Results of all segments of the study showed that great variety of pattern and changes are preferred over little variety of pattern and flatter landscapes.

Craik (1972) developed a method for descriptive assessment of landscapes, based on what he called Landscape Rating Scales and Graphic Landscape Typology. This method draws on definitional studies by Litton (1968, 1972), and is basically an environmental psychology approach to determining the level of human observer objectivity of classification within a comprehensive system of landscape dimensions. The Landscape Rating Scales consist of 10 rating factors and 34 specific elements of landscape dimensions. A test set of 100 colored slides was selected from a large collection. These were compared with a 10 category schematic Graphic Landscape Typology set of line drawings, which contained holistically the basic composition of frequently occurring landscape associations. The test set then was reduced to 50 slides. Five different panels of students and faculty were tested, consisting in total of 250 people. Aesthetic appeal levels were then determined by statistically massaging the combined landscape ratings and typological judgements of the panels. Subsequently, a check list was compiled of 1,196 adjectives and descriptive phrases employed by the observers in describing any scene from the color slides. This is the Landscape Adjective Check List (LACL). Craik contends that by reducing the list to include only those adjectives or terms used 6 or more times by the respondents, a LACL is available which has the advantages of everyday language, brevity and ease of making judgments and recording them, a breadth of coverage, and wide and flexible application and analysis. Presumably LACL is also envisioned as a quick method of gathering descriptive impressions and of reaching substantial concensus by large samples of observers in the field.

Morisawa (1970, 1971?, and 1972) and Morisawa and Murie (1970), in an interesting sequence of studies, used photographic and interview techniques. However, this work also includes field measurements of geologic, hydrographic, cultural, biotic, and recreational attributes of 8 major drainage basins. These stream basins range in geographic setting from Wyoming to New Jersey, and provided a wide variety of natural environments for assessment. Field data were gathered at appointed stations or by transects across the valleys at determined intervals. A ranking system based on field observation was developed for the following group of "interest inventories": Geologic, 5 categories and 15 ranking levels; hydrologic, 6 categories, 18 ranking levels; historical, 3 categories, 9 ranking levels; and recreational, 3 categories. Almost 500 individuals were asked to rate 45 color slides on a rating scale of 6. A 15 part questionnaire of user opinions for Green River was also developed, but the reports do not clearly indicate how this was coordinated with the other measurement techniques.

In some ways these studies are an ideal assemblage of methods. They permit comparison of quantitative measurements of landscape variables taken directly in the field with indirect and partly vicarious perceptual evaluation gathered by interview and slide rating methods. Most significantly, the field measurements, assessment categories, and ranking levels for some streams were the result of interdisciplinary effort by specialists in various disciplines; thus geology, hydrology, vegetation, birds, and mammals received directed attention. The stated goals of the study--development of methods for objectively identifying and assessing values of rivers in a natural, free-flowing state--appear to be generally met. The inventory system devised is simple but not very quantitative or specific in terms of a specially stated objective of use in watershed planning.

Matrix Techniques

Dearinger (1968) used an appraisal system for recreation potentials developed by the USDA Soil Conservation Service, with the stated objective of finding a way to evaluate the aesthetic and recreational potential of small streams and their watersheds. His study concentrated on 2 small basins of about 40 mi^2 each in the Lexington, Kentucky vicinity. The original SCS (1966) plan recognized 12 types of recreational development and 10 "key elements" that affect to some degree the limiting potential of each area considered. Weighting factors or "multipliers" were assigned for all row and column positions of the 10 by 12 development-key element matrix. Each key element is rated on a 1 to 10 scale for each development mode. The total score is obtained by summing the product of the weight factors and the rating numbers; the system requires a rather extensive data inventory for proper use. Dearinger modified the SCS system to accomodate tangible and intangible natural and aesthetic values peculiar to small streams in non-urbanized areas. His development-key element matrix is reduced to 7 rows and 10 columns from the original 10 by 12. Assigned multipliers of weights range from a low of 1 to a high of 5, and are presumed to be an objective consideration of actual conditions observed on the watersheds studied. Of interest is his use of "disvalues" in a row-column position. This defines a key element which, under certain circumstances, becomes a factor that precludes a given activity or obviates the designation of an area as natural, scenic, etc. Disvalues thus provide a negative rating value in the summation process. This study was further enhanced by preparation of graphic presentations, for example slope, geologic, soils, vegetation, and development maps. A user questionnaire form was also devised. The study admits to a lack of adequate key element data, the problem of subjectivity, and concludes there is a need for a better way of simplifying and expediting the inventory process.

Leopold and Marchand (1968) and Leopold (1969a, 1969b) have provided a method for quantitative comparison of some aesthetic factors among rivers. Fabos (1971) gives these studies high marks, and cites them as the finest examples of quality-ranking systems yet devised for the purpose of evaluating landscape for a single use. Such site evaluation discriminates mainly those which are most appropriate for development and identifies those best left undisturbed. Fabos notes that Leopold's is the only study to recognize the time continuum of landscape, and provides also the most uncomplicated method to evaluate the uniqueness quality and negative components in terrane. No sophisticated tools or techniques are needed; determinations of parameters can be made quickly in the field or from maps and airphotos. The specified purpose of Leopold's study is to reduce or eliminate conflicts in the decision-making process. By quantifying non-monetary values of landscapes which may have long-range social values, a trade-off is available for use in contemporary economic evaluation techniques such as benefit-cost ratios.

The 1968 paper is a preliminary approach to a numerical description of a riverscape (river landscape). Test sites were observed at a point on 24 streams in northern California. These sites were evaluated using a 28 factor inventory combined into 3 descriptive categories: (1) physical and chemical, (2) biological and water quality, and (3) human use and interest. Each factor for every stream studied was assigned a category rating ranging from 1 to 5 on an arbitrary scale. The rating depended on measurement or evaluation at observation points. A "uniqueness ratio" for each stream factor was computed by taking the reciprocal of the number of stream sites sharing the same category rating. Adding "uniqueness ratios" for all factors for a given stream site yielded a "total uniqueness ratio". Compution of this ratio for all 24 streams permitted their relative hierarchical ranking. Sites with the highest "total uniqueness ratio" were considered the "most unique". No value judgment was placed on the relative good or bad of uniqueness. The "uniqueness ratio" has the advantage of quantifying uniqueness simply without regard to the merits of its values or disvalues in a societal context.

The 1969 studies examined 12 sites on "wild" rivers in Idaho, and comparisons were made with some of the streams studied in California. The number of factors was increased to 46 and the factor groupings rearranged. At-a-site observations were again used, the 46 factors evaluated at each of the 12 stream sites, and total "uniqueness ratios" computed. Some semi-graphical procedures were also developed to pictorially show rating scales of "valley character", "scenic outlook", etc. This procedure isolates those streams that were "unique" either in a good or bad sense. Leopold (1969b) concluded that:

> "The result of the data collection and analysis indicates that it is possible to set up a list of factors that influence the aesthetic nature of a given location. The factors can be considered all together....by the computation of a total uniqueness ratio, or they can be selected and used in various combinations to express certain aspects of a landscape's characteristics."

Dearinger and Woolwine (1971) used Leopold's philosophy and methodology, and reexamined the application, development, and analytical value of the uniqueness ratio procedure. They also made a modest attempt to point out the relationship of uniqueness to real value in economic terms. A total of 58 streams in Kentucky were evaluated. All had drainage areas less than 250 mi^2. The number of category factors was increased to 54, to compensate for geographical and "fluviological" differences between Kentucky and Idaho or California. Measurements were by stream transect at preselected sites. Voluminous data tables were organized and stream rankings assigned. The tables would be difficult to use in practice. Dearinger did suggest computer sorting of data as a valuable analytical aid. It would also have been useful to sort the 58 streams by ranking under physiographic subprovinces to facilitate comparison and perhaps establish physiographic subprovincial norms. This would easily identify the most unique streams, either good or bad in each subprovince. The report does, however, have the largest statistical assemblage of basic data yet collected for any applied study.

Leopold _et_ _al_., (1971) developed the most comprehensive information matrix system yet devised. This report was prepared specifically as a preliminary draft, subject to improvement and change, for use in obtaining and summarizing environmental factors in connection with legal requirements for impact statements. The matrix provides a method for analysis and numerical weighting of probable impacts. The overall rating is not totally quantitative as it includes the possbility for many value judgments. An expanded row-column format allows for 8,800 possible environmental interactions. The basic matrix can be expanded or contracted as desired, depending on the stated objectives of a particular action program and the geographic area studied. Numerical weighting of the magnitude and importance of given actions are based on factual data rather than personal preference insofar as possible. The rating scheme is intended to discourage purely subjective opinion and requires a reasonable attempt to quantify any judgment of the results of probable impacts.

Although it is designed for different purposes than the previous matrix for evaluating aesthetics of fluvial systems, this new matrix retains vestiges of the earlier one. The descriptive factor categories have increased in number, are divided into subcategories, and the total number of factors considered is greatly expanded. Evaluation numbers for descriptive categories now become many rows of "impact actions", each of which can be rated on a scale ranging from zero to 10. The field evaluation matrix for aesthetic factors previously used can still be extracted by judiciously selecting the appropriate row and column designators from this more complex matrix.

Leopold includes an important flow diagram with this study. This is reproduced herein as Figure 1. The most significant item in this idealized flow of action programs is "D" in the figure. There is universal need for introduction at this point in any decision-making procedure of something about the intangible and scenic values of landscape. The fundamental or basic raw data thus introduced should be numerically expressed if feasible, and with the highest possible degree of objectivity. Such input should enter action flow as much in a study which concerns only the scenic and aesthetic values

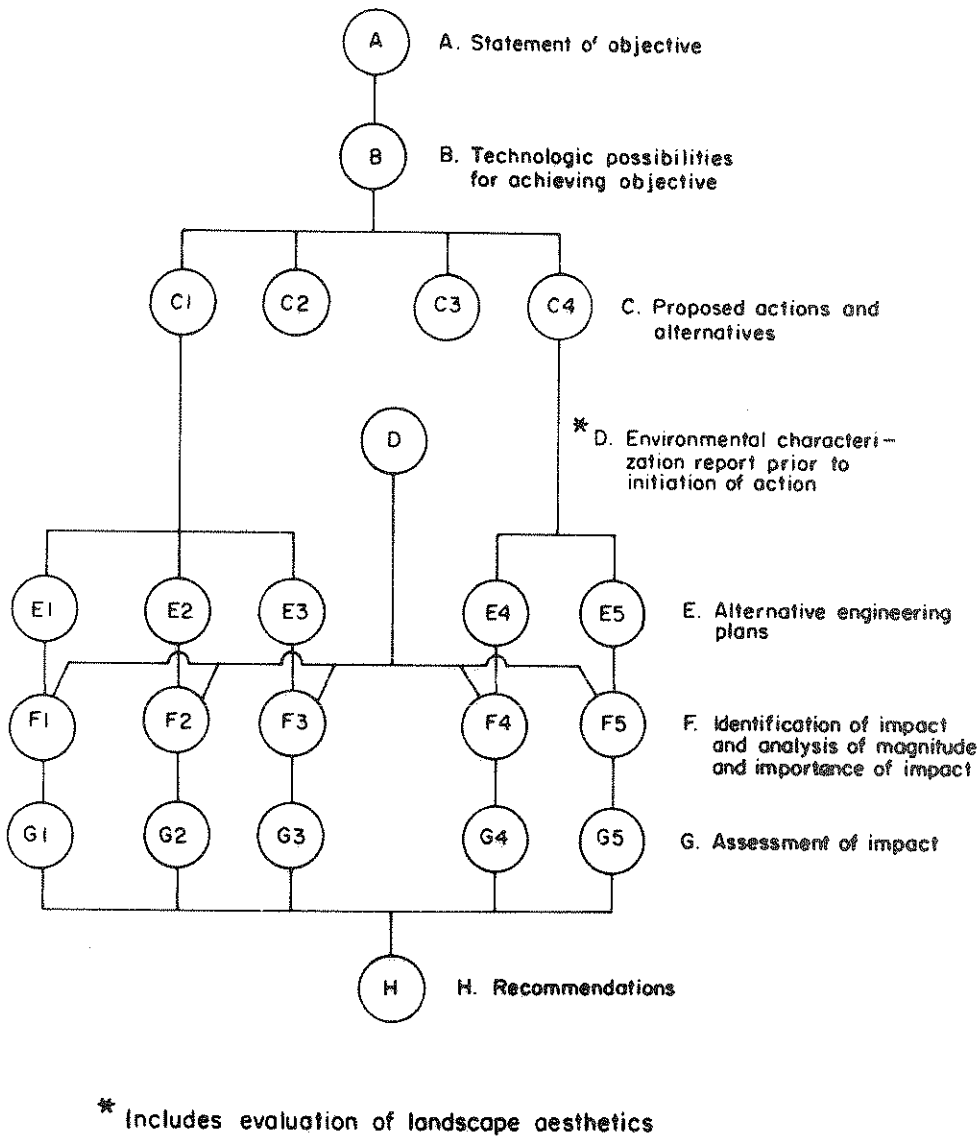

Figure 1. Flow chart for development of action programs (slightly modified from Leopold et al., 1971).

of a single river valley as in a more generalized and complex environmental impact analysis of a large geographic region.

Fabos (1973) made an extensive study to develop a landscape resource assessment model for the metropolitan Boston area. General objectives focused on development of a model for rating landscape resource values and defining measurements and rating techniques. These then could be used to measure and rate the affects of urbanization on landscape resource value change. After refinement, the basic model was tested on selected subareas within the metropolitan region. Hypothetical reallocations of land use were assumed. An attempt then was made to define institutional changes that would be needed to improve metropolitan landscape planning processes, which would maximize benefits of landscape resource values while minimizing effects of the impact. A "visual land use comparability" matrix was developed but is non-numerical. Graphic techniques included hand-drawn geographical distribution isopleth maps of composite resource value change for several suburban communities near Boston. The interview technique was used to obtain input from land use managers and public officials. The author admits that the study has only limited utility, and suggests that any application of the model should be oriented to take advantages of computer processing and computer graphics.

One other study merits brief mention. Knudson *et al*., (1973) embarked on a short-term project commissioned by the Indiana Department of Natural Resources, to determine methods and criteria for ranking the natural values of free-flowing streams. Another objective was to then identify those streams which are worthy of inclusion in an Indiana Natural Streams System. A simple matrix called a "stream classification tally" consists of only 8 factors, each assigned a rating value of zero to 5. Criteria evaluation is limited geographically to values or parameters that can be seen from a canoe floating on a creek. This confines assessment to a very narrow spectrum of the total aesthetic or scenic potential of a stream valley. This closely circumscribed measurement and rating system of recreational values considerably limits a broader application of the study.

Summary and Critique of Methods

Study of landscape resources, parameters and intangible values generally has followed one of 4 procedural methods. These are the graphic, interview, viewing, and matrix techniques. Research investigations using these techniques, either singly or in combination have varied in objectives, scale, or spatial extent. Therefore, there is no sound basis for declaring that any single study has definite advantages or achieves better results than any other study. Investigation methods also range from purely qualitative, through semi-quantitative, to some matrix techniques wherein numerical rating values are objectively assigned if at all possible. No totally numerical evaluative system for landscape assessment has been devised, except for Leopold's environmental input matrix.

Techniques used seem a direct reflection of the training and background of the investigators. Social scientists, resource managers, and planners appear to rely principally on one or more of the graphic, interview, and viewing techniques in looking for results. Somewhat strangely, landscape architects and geographers tend to also confine themselves to this mode. The matrix technique has been used chiefly by geologists and engineers. Models or techniques that result in some kind of ordination procedure are best. Measurements can be made quickly and cheaply, and provide firm values or rankings useful in the decision-action program shown in Figure 1.

Several investigators whose work has been reviewed in this chapter cite the need for computer processing of raw data. The principal objective of our study has been to take the best of the matrix methods and adapt it for programming by computer techniques.

CHAPTER IV

LANDSCAPE AESTHETICS NUMERICALLY DEFINED: THE LAND SYSTEM (PRELIMINARY MODEL)

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General Statement

All of the surface of the solid Earth has been sculptured to some degree by the action of running water. Every geologist knows that fluvial processes stand at the front of the pantheon of natural agencies that form landscapes. It follows logically that most of our parks and preserved scenic areas derive from fluvial action. Waterfalls, deep gorges, rugged peaks, and many other major irregularities of scenic landscape have resulted from erosion by water, liquid or solid, on soil and rocks. Running water plays a significant role even in arid zone landscapes, such as the Sahara Desert or the Great Sand Dunes of Colorado. Because of this universality, it is easiest and perhaps most informative to attempt measurement and comparison of water-carved landscapes. The measurement technique can be graphic, interview, photographic, semi-quantitative, or quantitative determinations of something about physical and biological variables associated with the fluvial process. Some previous attempts to measure and rank landscape values are reviewed in Chapter III of this report.

The LAND system (Landscape Aesthetics Numerically Defined) is a modeling method which quantifies aesthetic factors and hierarchically ranks different landscapes in terms of numerically derived indices. Only river valleys have been evaluated to date, but the system can be easily modified to evaluate any part of the landscape of interest.

Leopold (1969b), stated that any scheme for comparing landscapes must rest on some philosophical framework. The concept basic to our philosophy, as with Leopold, is that any landscape that is unique, either in a positive or negative way, is more significant to society on a local, regional, or national scale than a landscape that is commonplace. The evaluation of a landscape initially requires an evaluation of its "relative" uniqueness. Landscapes shown as relatively unique must then be analyzed to determine why they are unique. This is accomplished by defining what is to be evaluated, and then numerically determining what part of this uniqueness is owing to characteristics which are antithetical to the definition of what is being evaluated. For example if we define an "Aesthetic River" as those rivers or sections of rivers which are clear running, unpolluted, and unlittered, then a stream which is polluted and cluttered with garbage dumps along the banks would be ranked very low as an Aesthetic River even though it may be a relatively unique river for the region. In a similar manner definitions can be formulated to help define recreational potential, geological hazard potential, industrial land-use potential, or any other aspect of environmental planning of interest to people or organizations charged with evaluation of alternative uses.

The LAND Model

Assessment factors to be evaluated are grouped into three categories: 1) Physical, 2) Biologic and Water Quality, and 3) Human Use and Interest. The number of factors used within each evaluation category depends on what is to be measured and the detail of the evaluation. Our preliminary model evaluates 31 factors as shown in Table 1. This model, which evaluates an entire stream reach in terms of numerical indices, is an extension of Leopold's (1969a, 1969b) method which evaluates the relative uniqueness at a site. Each given factor is assigned a series of evaluation numbers ranging from 1 to 5. Evaluation determinations are arrived at from measurements and observations obtained from topographic maps, aerial photography, and field work. Each evaluation number has no rank in value relative to the other evaluation numbers. Thus, it should be emphasized that the evaluation numbers serve a descriptive function only. For example, evaluation number 1 should not be interpreted as "better" or "worse" than any other evaluation number. What is important is how many of the evaluated landscapes have a common evaluation number for the same factor. Thus, if all streams in a group of river valleys being evaluated are polluted by oily water (see Factor 16, Table 1), then this indicates a common occurrence. However, if one of these streams is clear-running, this is a unique situation for this factor for the example chosen; however, this does not negate the commonness of oil pollution in this set of fluvial landscapes.

After evaluation numbers are assigned for every factor and for all streams, a comparison of streams may commence. Although we recognize that there is no degree of the state of being unique, a "relative" uniqueness value for a factor may be computed.

The uniqueness value for each factor is determined from its Uniqueness Ratio (UR), defined by Leopold (1969b) as the reciprocal of the number of sites sharing the same evaluation number. This Uniqueness Ratio

TABLE 1. Matrix for input data in the LAND system.

Factor No.	Descriptive Categories	EVALUATION 1	NUMBER OF DESCRIPTIVE 2	3	4	CATEGORIES 5
Physical Factors						
1	Channel width (ft)	< 10	10 to 30	30 to 100	100 to 300	> 300
2	Low flow discharge (cfs)	< 10	10 to 50	50 to 100	100 to 200	> 200
3	Average discharge (cfs)	< 10	10 to 100	100 to 500	500 to 1000	> 1000
4	Basin area (sq. mi.)	< 10	10 to 100	100 to 500	500 to 1000	> 1000
5	Channel pattern	sinuous (pool & riffles)	meandering (pool & riffles)	sinuous (without riffles)	meandering (without pool & riffles)	braided
6	Ratio valley width to height	< 5	5 to 12.5	12.5 to 25	25 to 50	> 50
7	Bed material	alluvium (A) 100%	A(75)R(25)	A(50)R(50)	A(25)R(75)	Rock (R)100%
8	Bank and valley material	uncon. (U) 100%	U(75)R(25)	U(50)R(50)	U(25)R(75)	Rock (R)100%
9	Bedslope (ft/ft)	< .0005	.0005 to .001	.001 to .005	.005 to .01	> .01
10	Width of valley flat (ft)	< 100	100 to 500	500 to 1000	1000 to 5000	> 5000
11	Erosion of banks	stable	——	slumping	——	eroding
12	Valley slope (x^{o})	0 to 10	10 to 30	30 to 50	50 to 70	70 to 90
13	Sinuosity	< 1.25	1.25-1.5	1.5-1.75	1.75-2.0	> 2.0
14	No. of tributaries	none	1 to 3	4 to 5	6 to 7	> 7
Biologic and Water Quality						
15	Water color	clear & colorless	——	green tints	——	brown
16	Floating material	none	vegetation	foamy	oily	variety
17	Algae	none	bed & bank partly covered	——	bed & banks mostly covered	everything covered
18	Landplants - flood plain	open	wooded with brush	wooded	cultivated	mixture cultivated and other
19	Landplants - hillslope	open	wooded with brush	wooded	cultivated	mixture cultivated and other
20	Water plants	absent	——	——	——	abundant
Human Use and Interest						
21	Trash per 100'	<2	2 to 5	6 to 10	11 to 50	>50
22	Variability of trash	equally distributed	——	——	——	predominantly in localized areas
23	Artificial control	free & natural	partially controlled	partially channelized	completely channelized	dammed
24	Utilities, bridges, roads	none	< 4	5 to 10	11 to 20	> 20
25	Urbanization	no buildings	cabins trailors campsites few farm houses	farm houses	mixture 2,3 & urban	predominantly urban
26	Historical features	none	1	2	3	> 3
27	Local scene	pleasing	——	——	——	nauseating
28	View confinement	open	——	——	——	closed by hills, cliffs
29	Rapid & falls	none	——	——	——	abundant
30	Land use	agriculture	recreation	urbanization	recreation & urban	agriculture & urban
31	Misfits	none	1	2	3	> 3

is a value which indicates how closely a stream approaches the state of being unique for a given factor. For example, if 5 river valleys are being evaluated and if all have oily streams, the Uniqueness Ratio is 1 divided by 5, or 0.20. If one stream is clear-running, than that stream will have a UR of 1 divided by 1, or 1.00; the 4 remaining streams, all oily, have a UR of 1 divided by 4, or 0.25 for that factor. If 10 streams have the same evaluation number, the ratio is 1/10 or 0.10; for 5, the ratio is 0.20, and for one stream, the ratio is 1.00. The maximum value any landscape can have is 1.00 for each factor, so for 2 factors the maximum total value is 2.00, etc. This computation procedure for UR is repeated for all evaluation factors for each fluvial landscape. The total uniqueness is computed as the sum of all uniqueness ratios for each river valley, within each category.

We define the Uniqueness Index (UI) as the percentage of total possible uniqueness; or, stated another way, the UI is only a measure of the relative differences between stream valleys. To equate an unequal number of factors in the three groups of evaluation factor categories, each subtotal is divided by the total number of factors in each category (see Table 1). The total for all categories is placed on the convenient base of 1,000 by multiplying by 1,000, and then dividing by the number of factors for each category grouping. This gives the UI for each category, and the sum is the total uniqueness index for each stream. For example, if for the group of ten (10) physical factors the total uniqueness is 5.0 out of a possible 10.0, the Uniqueness Index for physical factors on a 333.3 point scale is $\frac{333.3 \times 5.0}{10} = 167.0$. The 333.3 scale is used so that the entire Uniqueness Index for the 3 categories of factors will be on a 1,000 point scale.

All groups of factors are thus equally weighted, regardless of the number of factors used. Also, a basis is allowed for comparison between different landscapes from geographically disjunct areas, because it is not necessary to consider only the highest value; it is also possible to determine a "breaking point" for separating commonplace from unique streams. Furthermore, the method of ranking has no connotation of "good" or "bad", and because certain evaluation numbers in some factors are definitely "bad" (such as large amounts of trash or obvious pollutants) it is possible for a stream or valley to be either "uniquely good" or "uniquely bad." Thus the matter of preferential weighting is left in the hands of the user of the LAND system; the computer data handling technique is easily amended to accomodate elimination or change in evaluation number boundaries for any of the input variables (i.e., the factors).

The next procedure is to evaluate what part of the uniqueness is contrary to a predetermined definition. We presently evaluate four additional indices: Wild River, Scenic River, Recreational River and Aesthetic River. The first three indices are defined by the WILD AND SCENIC RIVER ACT, PUBLIC LAW 90-542, 1968:

Wild river areas - Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

Scenic river areas - Those rivers or sections of rivers that are free of impoundments with shorelines and watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

Recreational river areas - Those rivers or sections of rivers that are readily accessible by road or railroad, that may have undergone some impoundments or diversion in the past.

We define Aesthetic river areas as: Those rivers or sections of rivers that are clear running, unpolluted and unlittered. Admittedly, this definition is broad and general. What is aesthetically pleasing will vary from person to person. One individual may prefer a high mountain stream such as Yellowstone River, whereas another may like a lazy, meandering stream such as the Wabash River, or even a stream in a swampy area because it provides habitat for game and other wildlife. However, we believe that what is really unpleasing or nauseous to one will be unpleasing to nearly all. Most people would agree that greatly polluted, industrialized streams such as the Mahoning River in eastern Ohio or the Calumet River in northwestern Indiana are disagreeable. Thus, a polluted, littered stream is considered unpleasing to most people, and would have little aesthetic appeal. We realize this assumption has many limitations and may reflect our lack of total understanding of how different individuals perceive the environment. However, it seems a satisfactory working definition for the present stage of our model.

Given definitions of what is to be evaluated, we can derive indices to hierarchically rank landscapes in terms of how well they fit the predetermined definitions. The following section on calculation of indices shows examples of how two of the indices, Uniqueness Index and

Aesthetic Index, may be computed.

Calculation of Indices

In quantifying landscape unit values for fluvial systems, we have used a matrix of 31 rows (descriptive category factors) and columns (evaluation numbers). This forms a $x_{i,j}$ matrix and is shown in Table 1. An example, as used in calculation of Uniqueness Index (UI), is shown by the following format:

$$
\begin{matrix}
x_{1,1} & x_{1,2} & x_{1,3} & x_{1,4} & x_{1,5} \\
x_{2,1} & x_{2,2} & x_{2,3} & \ldots\text{etc}\ldots & \\
x_{3,1} & x_{3,2} & \ldots & \ldots\text{etc}\ldots & \\
x_{31,1}^{\downarrow} & x_{31,2}^{\downarrow} & x_{31,3}^{\downarrow} & x_{31,4}^{\downarrow} & x_{31,5}^{\downarrow}
\end{matrix}
$$

where:

i = factor number (1 to 31)

j = evaluation number (1 to 5), and

$x_{i,j}$ = number of streams having equal values of evaluation numbers (j) for a given factor (i)

And to obtain the UI, proceed as follows:

1. Sum the number of streams having the same evaluation number for each factor under consideration (i.e., the number of streams in each $x_{i,j}$ matrix location).
2. The Uniqueness Ratio (UR) for each matrix location is merely the reciprocal of the number obtained for $x_{i,j}$ in step 1; thus, UR = $\frac{1}{x_{i,j}}$. An example: if for factor 1, a given stream has $j = 4$, and if the total number of all streams with $j = 4$ for factor 1 is 5, then the value for that factor is .200 (maximum value is $\frac{1}{1} = 1$).

3. Sum the UR values for all factors within a given category to obtain 5 UR subtotals representative of each evaluation number column. Thus:

$$\text{Category 1 UR subtotals} = \sum_{i=1}^{i=14} \frac{1}{x_{i,j}} \qquad (j = 1,2...5)$$

$$\text{Category 2 UR subtotals} = \sum_{i=15}^{i=20} \frac{1}{x_{i,j}}$$

$$\text{Category 3 UR subtotals} = \sum_{i=21}^{i=31} \frac{1}{x_{i,j}}$$

4. Uniqueness Index (UI) for each evaluation number in each category is given by:

$$UI = \frac{\text{UR subtotal}}{\text{number of factors in category}} \times 333.3$$

5. Obtain a total UI value by summing individual UI values over all 3 categories:

$$\text{Total UI} = UI_1 + UI_2 + UI_3$$

Although this procedure may seem complex, in reality it is quite simple when the output is handled by machine processing. Examples of calculations and printout for real streams are found in Appendix A.

The Aesthetic River Index (ARI) may be derived from the Uniqueness Index (UI) by the equation:

$$ARI = UI\ (1 - \frac{x}{y})$$

assigning a zero value to any factor antithetical to the definition of an

Aesthetic River, and where:

ARI = Aesthetic River Index

UI = Uniqueness Index

x = total value of uniqueness ratio zeroed

y = total value of uniqueness that could have been zeroed.

Shown somewhat differently, AI is calculated by first determining the total amount the index can be lowered if all detrimental factors are given zero value, and using the ratio of actual lowering (AL) to total possible lowering (TPL). This is then multiplied by the uniqueness index (UI) for each category to arrive at the Aesthetic Index (AI). For each category:

$$AI = UI\ (1.0 - \frac{AL}{TPL})$$

This method of calculating the aesthetic index is required because the total amount the index can be lowered depends upon the values of the factors that can be assigned zero value relative to the values of the factors which cannot be eliminated.

The hypothetical examples that follow illustrate extreme cases for the computing of any indices other than uniqueness index.

<u>Case I</u>. Index is calculated by summing ratios and dividing by the total number of factors. Starred factors indicate those which may be zeroed. In this case, calculation of AI is assumed for two streams with equal UI.

Factor	Stream 1	Stream 2		Stream 1	Stream 2
1	1.0	.1		1.0	.1
2	1.0	.1		1.0	.1
3	1.0	.1		1.0	.1
4	1.0	.1		1.0	.1
5	1.0	.1		1.0	.1
*6	.1	1.0		0	0
*7	.1	1.0		0	0
*8	.1	1.0		0	0
*9	.1	1.0		0	0
*10	.1	1.0		0	0
Subtotal	5.5	5.5		5.0	.5
$\left(UI = 5.5 \times \frac{1,000}{10}\right)$	550	550	AI	500	50

For Stream 1, the total amount of lowering is only 50, whereas for Stream 2 the total decrease is 500, even though the streams have numerically equal UI values.

Case II. A hypothetical calculation, yielding identical AI values, from 2 streams with greatly different UI values.

Factor	Stream 1	Stream 2
1	1.0	.1
2	1.0	.1
3	1.0	.1
4	1.0	.1
5	1.0	.1
*6	0	0
*7	.1	1.0
*8	0	0
*9	.1	1.0
*10	0	0
Subtotal	5.2	2.5
$\left(UI \frac{5.2 \times 1000}{10}\right)$	520	250

$$AI\ (Stream\ 1) = 550\ (1 - \frac{550-520}{550-500}) = 220$$

$$AI\ (Stream\ 2) = 550\ (1 - \frac{550-250}{550-50}) = 220$$

These two cases illustrate essentially converse relationships, but show quite well how the various indices are computed and results compared. Based on definitions in Public Law 90-542, 1968, we have also developed matrices for calculations of Wild River, Scenic River, and Recreational River indices. The methodology used is similar to examples shown for calculation of Aesthetic River index. Appendix A gives examples of such calculations for natural streams.

In summary, calculations of indices within our proposed model are based on the concept of uniqueness. Indices are defined by statute or our own arbitrary definitions. Input data are compared to the constructed definitions. Data contrary to a given definition are zeroed; indices are then computed and fluvial landscapes hierarchically ranked. In essence, we quantitatively determine how well a given landscape fits a definition of an idealized landscape. In this way stream valleys can be ranked in terms of how closely they approach the idealized predetermined definition of a Scenic, Recreational, etc., river. Therefore the indices are only as good as the original definitions. We therefore consider the LAND system as purely a preliminary model. It is offered only as a start in the evolution of a system to quantitatively evaluate landscapes in terms of factors which are easily measured or observed.

Methodology and Data Requirements

Information concerning physical, biological and water quality, and human use and interest factors are obtained from topographic maps, aerial photography, and field observations.

Leopold's (1969b) study used 46 factors divided among these three groupings of descriptive categories. We have maintained the descriptive category group subdivision, but have modified the number and type of factors by eliminating, or combining them to better fit the natural fluvial environments characteristic of the urban-rural setting of Indiana. The result is a reduction from 46 to 31 in the number of factors used (Table 1).

Most of the evaluation factors are self-explanation. Physical factors include those easily measured parameters of the valley and stream, for example channel width and valley slope. Factors such bank and valley material (Plate 1, 2, 3) are also easily classified. Biologic and water quality factors are somewhat more subjective and absolute numbers are more difficult to obtain (Plates 4 and 5). We also recognize that other factors could be added to this category; as geomorphologists, we included only factors which we thought could be readily observed and evaluated in the field. Addition of an aquatic biologist and other disciplinarians during the assessment stage of future studies would obviously aid in refining this category of the preliminary model.

Human use and interest factors are those pertaining to local land use patterns, historic development, or the local level of "throw-away" psychology. In Plate 6 the old grist mill is an example of a structural feature of historic interest. The covered bridge (Plate 7) or cabin and sea-wall (Plate 8) also are indicators of human use and interest. Misfits, defined as objects which are out of place in the natural landscape, may also be an evidence of human use. Manmade "eye sores" such as a large, neon-lighted billboard in Yosemite National Park would be an extreme example of an obvious misfit. On a smaller, local scale the abandoned washing machine in Wildcat Creek (Plate 9) and auto body (Plate 10) are misfits.

PLATE 1

Erosion of bank and valley-fill alluvium along Whitewater River. An eroding cut bank is in the middle distance and cobbles are concentrated in a point bar in the foreground. The valley fill material of the stream is glacially derived. Uplands in background are bedrock covered by a thin mantle of till.

PLATE 2

Limestone outcroppings and dense growth of water plants in the channel of Laughery Creek, Dearborn County, southeastern Indiana. Pool and riffle sequence in the stream shows clearly. Compare the scenic characteristics of this part of the stream reach evaluated with those shown in Plates 4 and 5.

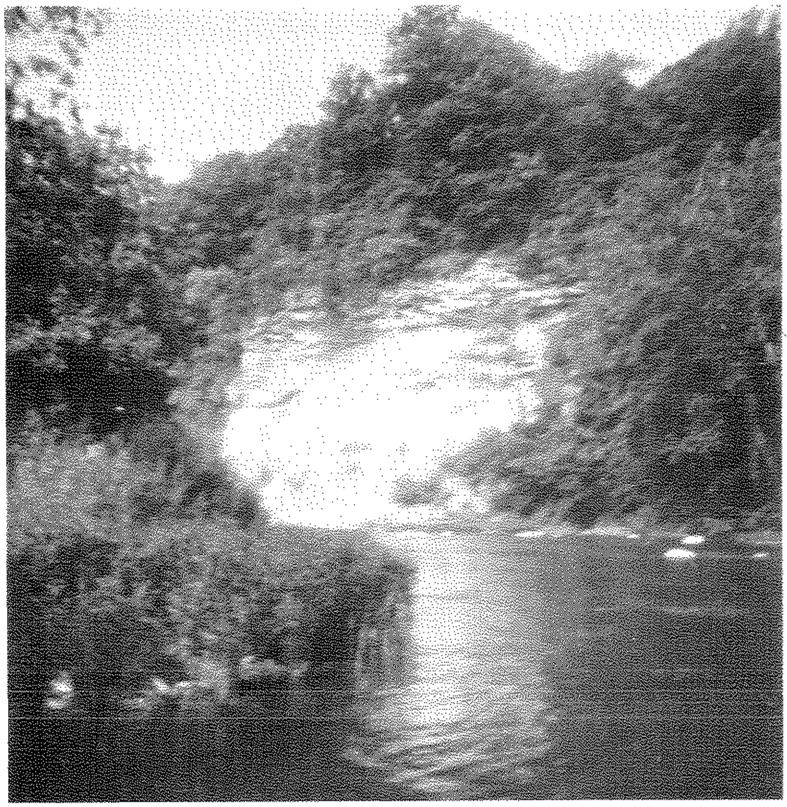


PLATE 3

Bluff of outcropping bedrock along Sugar Creek, Montgomery County, west-central Indiana. Pennsylvanian (?) sandstone rests on Borden shale and siltstone in the face of the bluff. An old point bar, surmounted by an alluvial flat, is at the left side of the picture. Adjacent uplands are covered by a thin mantle of glacial till. This particularly scenic area is already partly in the State Park system.

PLATE 4

Aquatic plants nearly fill the channel of Laughery Creek, Ripley County. Vegetational clogging decreases stream flow and acts as a sediment trap for fine-grained, suspended sediment, as seen in the foreground. (See Plate 5).

PLATE 5

Channel of Laughery Creek a short distance downstream from point shown in Plate 4. Aquatic vegetation totally fills the channel. This stream reach may be "relatively unique" for the region; aesthetic, scenic, or recreational values compared to other streams depends on data inputs used in the LAND model.

PLATE 6

Old grist mill and flume on Big Raccoon Creek, Parke County, west-central Indiana. The mill dates from the mid-19th Century and is an example of a structure of historical interest. The stream reach is characterized by bedrock outcroppings in the channel (see middle ground of photo), pool and riffle sequences, clear water, and a great diversity of seasonally colorful valley wall and valley flat vegetation.

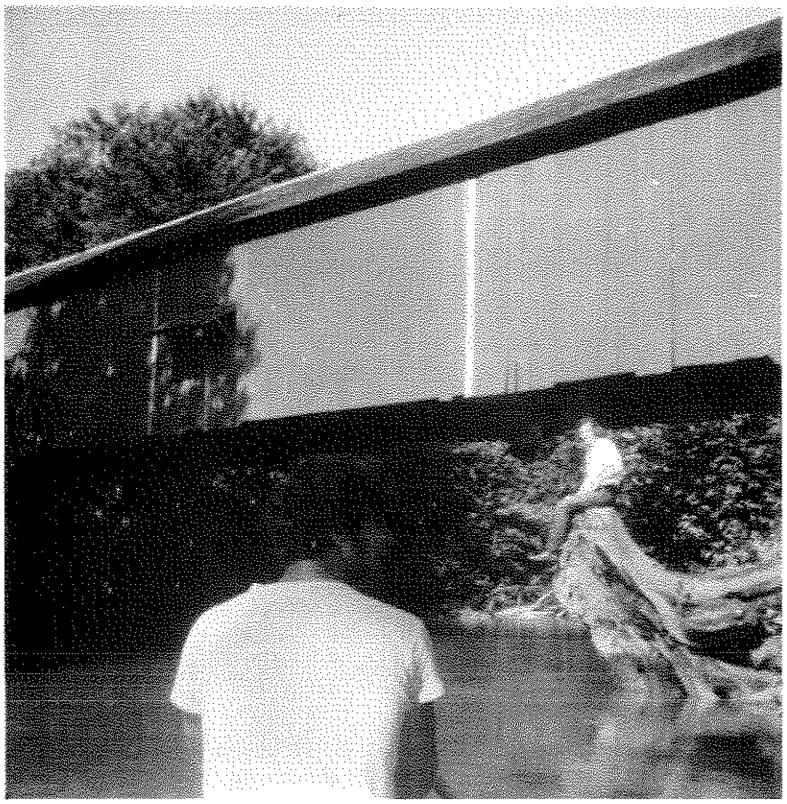


PLATE 7

Covered bridge across Sugar Creek on Indiana Highway 234 south of Alamo, Montegomery County, west-central Indiana. Some covered bridges are more than 150 years old and are considered historic structures.

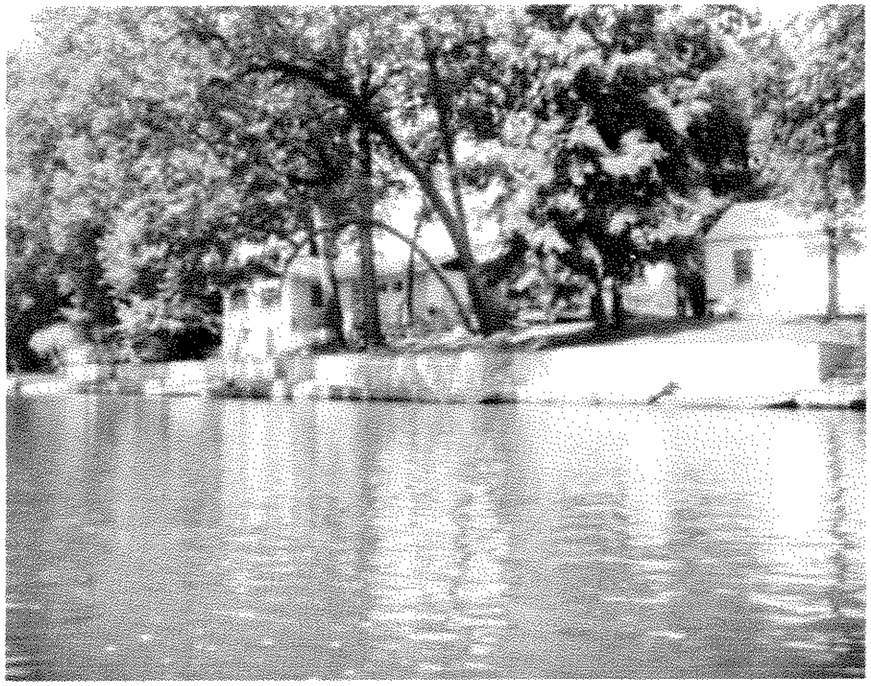


PLATE 8

Sea-wall on Tippecanoe River, Carroll County. The wall permits stabilization of grass-covered alluvial flats. Tippecanoe River is already substantially utilized for recreational purposes, and numerous summer homes as shown here give part of the study reach an almost suburban evaluation rating. However, the stream has a high aesthetic index.

PLATE 9

Abandoned washing machine in Wildcat Creek, Tippecanoe County. Such misfits tend to degrade evaluation ratings of otherwise scenically or aesthetically pleasing stream reaches.

PLATE 10

A scenic vista spoiled by junk -- abandoned automobile in an otherwise pleasing rural setting along Whitewater River in southeastern Indiana.

We have differentiated misfits of this type from trash by the criterion that a misfit cannot be easily removed manually by one individual.

Leopold (1969b) used an "at-a-point" scheme in determining evaluation numbers for each factor of his descriptive categories. The points used were commonly bridges or other places of crossing. We believe that the at-a-point method introduces bias and artificiality of conditions. Bridges constrict flow and over time alter the regimen and bank and channel conditions immediately upstream and downstream. There is a tendency towards greater accumulation of trash and misfits at these crossings. Other examples of distortion could be cited but these suffice as illustrations. Furthermore, because any form of development, such as a dam and reservoir, channelization, or recreational improvements for fishing and canoeing involves a longer stretch of a stream valley, we believed it absolutely necessary to consider a stream reach rather than confine observations to a single location. Therefore, the preliminary LAND model evaluates a length of stream valley five hundred (500) times the stream channel width, normally extending upstream from a gaging station which is used as a control on stream discharge. For example, a stream 100 feet wide is evaluated for a distance of about 9.5 miles. This decision to evaluate a valley reach 500 times channel width is completely arbitrary. What we wanted to accomplish in choosing a study reach was to base a length of valley on some standard parameter that varies directly with the length of reach; in this case, the parameter is stream discharge. Thus we evaluate a short reach of valley for small streams and a longer reach as channel width increases. The only other qualification is that there is sufficient stream gage data (generally 10 years of record) to determine flow duration and average discharge.

The procedure in evaluating a given river valley is;

1. Measure channel width, from a topographic map or aerial photograph, to determine the length of valley to be evaluated.
2. Divide the study reach into ten equally spaced increments, and mark the 10 stations on the field map. Field observations and measurements are recorded at these stations. Photographic and other documention may also be obtained.
3. Record measurements (office or field) and field observations in terms of evaluation numbers for each of the descriptive factors shown in Table 1.
4. Evaluate and hierarchically rank the evaluated fluvial landscape with other river valleys similarly analyzed.

U.S. Geological Survey 1:24,000 (7½' series) topographic maps are the best current source to use as a base for this type of analysis. Un-dodged, black and white aerial photographs at a 1:20,000 scale were also used for obtaining data. These photos are readily available from various agencies.

Field observations of study reaches are best obtained by canoe traverses. Landings are made at most of the 10 field stations to complete the check list for all factors obtained from field measurement, for example the count of trash and litter (factors 21 and 22, Table 1) or landplants (factor 18). Most predetermined field station points normally are not accessible by road, and "walking the bank" is commonly impossible and tedious at best. Although Indiana presumably has no "wild rivers", the authors (not being Olympic calibre canoeists) tend to dispute this contention. More than one wetting of body and clothing and dents in a 17 ft length canoe are adequate testimony of the field experience.

All data are processed by computer. Output includes tables and graphs which list and hierarchically rank the evaluated landscapes in terms of desired indices. The computer program is Appendix A of this report and examples of output not discussed in the text are in Appendix B. It is emphasized that although data analysis is facilitated by use of the computer, the indices, tables, and graphs can also be produced manually.

Weighting

All evaluation factors were given equal weight, in determination of UR and UI. It is possible, of course, to assign various levels of weighting in the data input function. Zeroing of certain factors in determination of AI or other indices is a function of index definition rather than weighting. Weight levels could be assigned as desired to factors used in determination of these indices. Slight changes in the data processing program would accomodate these changes.

Bias

Because only streams with gaging stations were used in this study, we have an overweighted sampling of larger streams, because very few small streams have gages. This emphasis is partly justified, however, by the reasoning that most streams undergoing pressure, i.e. being considered for "improvements" or development are large ones. By adjusting the range of values in the evaluation number columns of the Physical Factors category, it is possible to eliminate or "mask-out" smaller streams and simplify a hierarchical ranking of only the larger streams. Even so, it is desirable or perhaps necessary to include a diversity of stream size in a given study area or region in order to maintain a good sampling; otherwise, all streams in an area tend to fall into the same evaluation numbers and thus would tend to determination as "extremely common."

It should be noted that because a longer reach is used for a wider, *i.e.*, larger stream, it would seem that there should be a greater number of highway bridges, railroad bridges, and utility crossings in a given reach. This tendency is not evident, however; except in largely urban areas, the most likely reason is that a small stream is relatively easy to cross, and small bridges are cheap; therefore, wherever a road intersects a stream a bridge is built. As a stream increases in size expense increases until only major highway crossings have bridges. Because of this, access to small streams is as great or greater than to large streams, and therefore other factors such as incidence of trash, misfits, and water quality tend to even out for an entire reach.

Observational and measurement bias are another matter. A reasonable objection to the LAND system is that "human bias" is involved and therefore the numerical determinations are also biased, *i.e.*, the system is subjective, not truly objective. Other semi-quantitative or quantitative aesthetic measurement schemes, reviewed in Chapter III, have been roundly criticized by Coomber and Biswas (1972); procedures used by Morisawa and Murie (1966) and Dearinger (1968) are summarily dismissed as conventional or as of little use. The Leopold methods (both uniqueness and matrix) are more vigorously attacked by Coomber and Biswas (1972, p. 39-40), principally on the grounds of presumed arithmetic invalidity, relative credibility, lack of scientific sampling, relevancy of original input of variables, etc.

Because the present study is a variant of the Leopold method, it can be attacked for at least some of the same "failings." We agree that it is impossible to identify all "relevant unput variables", to assume that equal weighting should be assigned invariably to all factors, or that subjectivity is entirely removed from the process of field observation and measurement. However, we believe that subjectivity of this last category is at the lowest level possible. Although we are not sociologists, we conducted some casual experiments during the process of measurement and observation. Teams of high school students, college-level non-science majors, and adult outdoorsmen went through the same procedures of office measurement and field observation and measurement as the teams conducting the study. In some instances, as little as 30 minutes of briefing was given these other teams prior to entering the field. In each case, assignment of evaluation category values varied little from that of the experienced field teams. There are no assertions or claims as to the statistical or other validity of these casual experiments, but we believe a controlled study by appropriate professionals would reach similar conclusions.

We do believe, however, that questions of bias or subjectivity aside, the numerical assessment scheme used is better than the questionnaire or viewing techniques reviewed in Chapter III. The field approach is at least first-hand, rather than a second-hand vicarious experience. Furthermore, with teams evaluating several streams during a short time period, and with all output handled by machine, it is very difficult for a single operator to deliberately or unconsciously prejudice the results.

Measurement of Descriptive Category Factors

Table 2 shows four ways in which the descriptive category factors are measured or evaluated. It is readily apparent that most factors are evaluation by a combination of field, map, and aerial photographic measurements. A few are measured solely from topographic maps or obtained from stream flow records.

Some additional commentary on the measurement procedure follows; this may be useful to the reader.

Channel Width. This is measured from aerial photos of appropriate scale, but is checked in the field, at bankfull stage, to correct any error. Gaging station records establish an initial control to determine size (width) of streams. Figures given in the evaluation number columns were arbitrarily chosen after experimentation, to fit the general size range of Indiana streams, and in consideration of the fact that otherwise, because of a lack of gaging stations, very small streams would rarely be evaluated.

Low Flow Discharge. This is taken from the 90% point on the published flow duration curve.

Average Discharge. Taken from gaging station flow records. No attempt was made to consider changes in drainage basin size or average discharge throughout a stream reach. However, all streams were treated in precisely the same manner, and these changes should not influence or bias the evaluation.

Basin Area. Determined in same manner as average discharge. For large streams, the gaging station is always in the furthest downstream measurement station.

Table 2. List Of How The Factors May Be Evaluated* For The Preliminary LAND System

Factor	Field Measurement & Observation	Factor	Air Photo Measurement & Observation	Factor	Map Measurements & Observation	Factor	Gaging Station Records
5	Channel Pattern[c]	1	Channel Width[a]	1	Channel Width[a]	2	Low Flow Discharge (90% flow duration)
7	Bed Material[b]	13	Sinuosity	6	Ratio Valley Width to Height[a]	3	Average Discharge
8	Bank and Valley Material[b]	14	Number of Tributaries[d]	9	Bed Slope[a]	4	Basin Area
11	Erosion of Banks[b]	18	Land Plants on Flood Plain[c]	10	Width of Valley Flat[a]		
15	Water Color[b]	19	Land Plants on Hillslope[c]	12	Valley Slope[a]		
16	Floating Material[b]	23	Artificial Controls[c]	13	Sinuosity		
17	Algae[a]	24	Utilities, Bridges, Roads[d]	14	Number of Tributaries[d]		
18	Land Plants on Flood Plain[c]	25	Urbanization[c]	23	Artificial Controls[c]		
19	Land Plants on Hillslope[c]	29	Rapids and Falls[d]	25	Urbanization[c]		
20	Water Plants[b]	30	Land Use[c]	26	Historical Features[d]		
21	Trash per 100'[a]			30	Land Use[c]		
22	Variability of Trash[b]						
23	Artificial Controls[c]						
24	Utilities, Bridges, Roads[d]						
25	Urbanization[c]						
26	Historical Features[d]						
27	Local Scene[a]						
28	View Confinement[a]						
29	Rapids and Falls[d]						
30	Land Use[c]						
31	Misfits[d]						

a Evaluation numbers for these factors are an average of the ten (10) stations.

b Evaluation numbers for these factors are based on the closest fit as determined from field observations at the ten (10) stations.

c Evaluation numbers for these factors are a general observation for the entire study reach.

d Evaluation numbers for these factors are based on counting the occurrences over the entire study reach.

* Many factors listed as obtained from field or map observations might easier be obtained from aerial photographs. This table represents how we are obtaining data in our preliminary model.

Channel Pattern. Evaluation columns follow Leopold's scheme and standard geological classification of stream patterns and is purely a field determination, although maps or aerial photos can be used in part. Most streams evaluated in our study developed pool-riffle patterns, regardless of whether they were straight or meandering. Braided patterns or torrential flow did not occur on any streams studied.

Valley width-height ratio. The topographic break at the top of the valley can be determined from air photos; the corresponding height above the stream can be obtained from the topographic map. An appropriate number of measurements along the reach evaluated provides an average for the valley.

Figures shown in the evaluation number columns are really quite arbitrary, and boundaries were drawn after experimentation with the general range of valley width-height ratios for Indiana streams. The distribution finally chosen tends to distribute natural stream data across the evaluation number columns. In a situation where all streams of a grouping would fall in the same evaluation number column, column values can be modified to remove borderline cases, changed to effect a redistribution between columns, or simply nulled from the evaluation process. Obviously, it is also possible to set boundary conditions so that everything falls into one column or into separate columns. The only requirement is that when decisions are made they are done without bias to any particular stream and that divisions between columns are systematic.

Bedslope. Measure channel length between contours over the reach.

Width of Valley Flat. Measured as width of flood plain, or distance from point of bankfull stage to break in slope at base of valley wall.

Valley Slope. Horizontal distance (h) measured normal to contours, from upper topographic break to break at contact with valley flat. Vertical distance (v) is determined from the topographic map. The slope is then equal to $\tan^{-1} \frac{v}{h}$.

Sinuosity. Equal to $\frac{\text{length of stream}}{\text{length of valley}}$. Both values may be obtained from the topographic map.

Number of tributaries. All perennial and intermittent streams for the entire reach are counted on the topographic map. It should be remembered that in Indiana most maps rarely show intermittent tributaries smaller than third-order.

Water Color. Sampling with a clear glass (Mason jar) container is better than direct observation of color from the stream.

Floating Material. Evaluation category columns could be rearranged to identify and separate different types of water surface vegetation. The "variety" column indicates that two or more of the other four categories are present. The class "foamy" may indicate either natural turbidity or presence of soap and detergents. The investigator must decide if enough foam, oil, etc. is present to note it as important; subjectivity is minimized if all streams are treated equally.

Algae. Abundance and type (floating or attached) varies according to season of year and stage of flow in the stream. If all streams of a sample group are measured within a short time span, these variations should be insignificant.

Landplants. Determinable to some extent from air photos, but only field observation will show if unusual, endangered, or relict forms are present.

Water Plants. No species identification was attempted. Each investigator can determine appropriate column assignments on the basis of abundance or species.

Trash. The number of pieces of visible trash are counted for a 100 ft interval at each station along the reach. Variability is computed by first determining the average amount of trash for all stations on the reach, and then subtracting this average amount from the actual amount at each station. If a large trash dump is at one station, whereas other stations are relatively clear, the average for the reach would be erroneous and misleading if the variability factor is not included.

Artificial Control. Free and natural means the stream is free of any bank controls designed to prevent slumping or erosion. Partially controlled implies that channel bends have blocks (brush, crushed stone, etc.) to decrease erosion. Partial channelization includes straightened sections of the stream or walls erected to confine the stream to its natural channel. A complete channelization extends these controls over the entire reach. If a dam exists anywhere within a reach, the entire reach is considered dammed because of control the dam exerts over flow regime and pattern both upstream and downstream.

Urbanization. Column 2 (Table 2) includes a mixture of open ground, weekend cabins, campsites, trailers, and a few farm outbuildings. Column 3 includes tilled fields and farm structures dominating the scenic vista. Column 4 is suburbia -- a mixture of small towns interspersed with farms.

Historical Features. Collectively the total number of points of historic interest -- covered bridges, water wheels, old forts, battle grounds, pioneer structures, etc.

Factors not included in the foregoing discussion are self-explanatory.

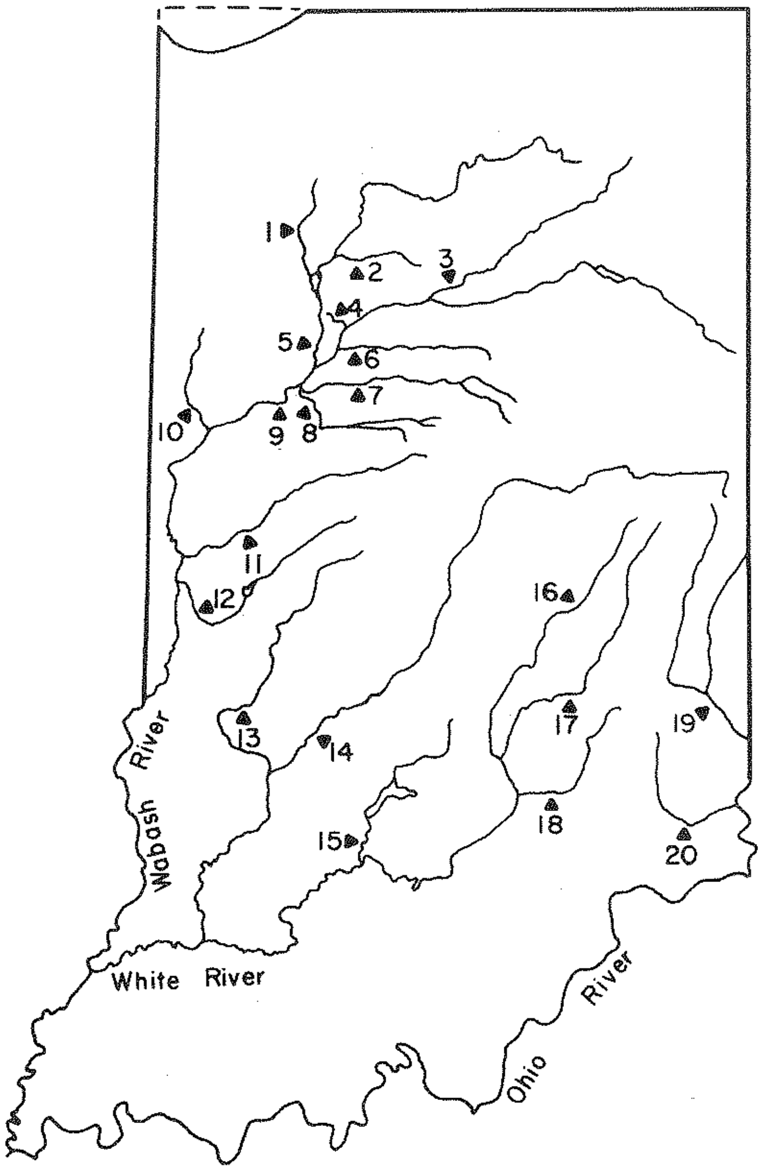
CHAPTER V

EVALUATION OF NATURAL STREAM VALLEYS

****

General Statement

Twenty stream valley reaches (Fig. 2 and Table 3) from various physiographic subprovinces in Indiana (Fig. 3) are used as illustrations of the preliminary LAND system. Basic data measurements and observations were made for other stream reaches, but the 20 streams used suffice as applications of the model. No streams were studied in areas of predominantly bedrock controlled channels in southwestern Indiana nor in the Northern Moraine and Lake sector of the state. We realize that additional factors can be added to the basic model to increase applicability and creditability of the results; examples might be better listings in the biologic and human use and interest categories. More specific legislative definition of riverine types would also be helpful. We elected only to select factors and evaluation levels which we considered ourselves competent to evaluate. This necessitated not including numerous factors that perhaps could be included in a refined model or a model designed for other evaluation purposes (see Chapter VI). This also emphasizes the need for more broadly based, multidiciplinary participation in this type of research. The present version of the LAND system is primarily a method to quantify various factors of a fluvial landscape such that different areas may be hierarchically ranked in terms of a set of selected indices.



1. Big Monon Ditch
2. Little Indian Creek
3. Eel River
4. Rattlesnake Creek
5. Tippecanoe River
6. Deer Creek
7. Wildcat Creek
8. South Fork Wildcat Creek
9. Wabash River
10. Big Pine Creek
11. Sugar Creek
12. Big Raccoon Creek
13. Eel River
14. West Fork White River
15. Salt Creek
16. Big Blue River
17. Flatrock River
18. Sand Creek
19. Whitewater River
20. Laughery Creek

Figure 2. Location of reaches evaluated by the LAND system on 20 Indiana streams.

TABLE 3. General Characteristics of the Evaluated Stream Valleys (Data in part from U.S. Geological Survey, 1972).

River	Channel Width (ft)	Ave. Discharge (cfs)	Basin Area (sq. mi.)	Sinuosity	Predominant Bank Material
Big Monon Ditch near Francesville	75	138	152	nearly 1.00	glacial till
Big Pine Creek near Williamsport	65	240	323	1.57	alluvium, bedrock, glacial till
Deer Creek near Delphi	95	231	274	1.67	glacial till, alluvium, bedrock
Eel River near Logansport	110	707	789	1.27	glacial till, alluvium, bedrock in lower reaches
Little Indian Creek near Royal Center	30	26	35	nearly 1.00	glacial till
Rattlesnake Creek near Patton	10	9	7	1.70	glacial till, alluvium
South Fork Wildcat Creek	50	229	243	2.50	glacial till, alluvium
Tippecanoe River near Delphi	285	1,585	1,865	1.61	glacial till, alluvium
Wabash River at Lafayette	430	6,242	7,267	1.07	glacial till, alluvium, bedrock
Wildcat Creek at Owasco	60	333	396	1.70	glacial till, alluvium
Big Blue River at Carthage	55	189	184	1.17	glacial till
Big Raccoon Creek at Coxville	61	438	440	1.22	glacial till, alluvium, bedrock
Eel River at Bowling Green	99	823	830	1.42	alluvium
Flatrock River near St. Paul	82	308	303	1.18	glacial till, alluvium, bedrock
Laughery Creek near Farmers Retreat	86	266	248	1.36	alluvium, bedrock
Salt Creek near Peerless	85	653	573	1.20	alluvium, bedrock
Sand Creek near Brewersville	67	163	155	1.34	glacial till, alluvium, bedrock
Sugar Creek near Byron	111	628	668	1.15	glacial till, alluvium, bedrock
White River at Spencer	207	2,981	2,988	1.23	glacial till, alluvium, bedrock
Whitewater River at Brookville	191	1,247	1,224	1.30	alluvium, bedrock

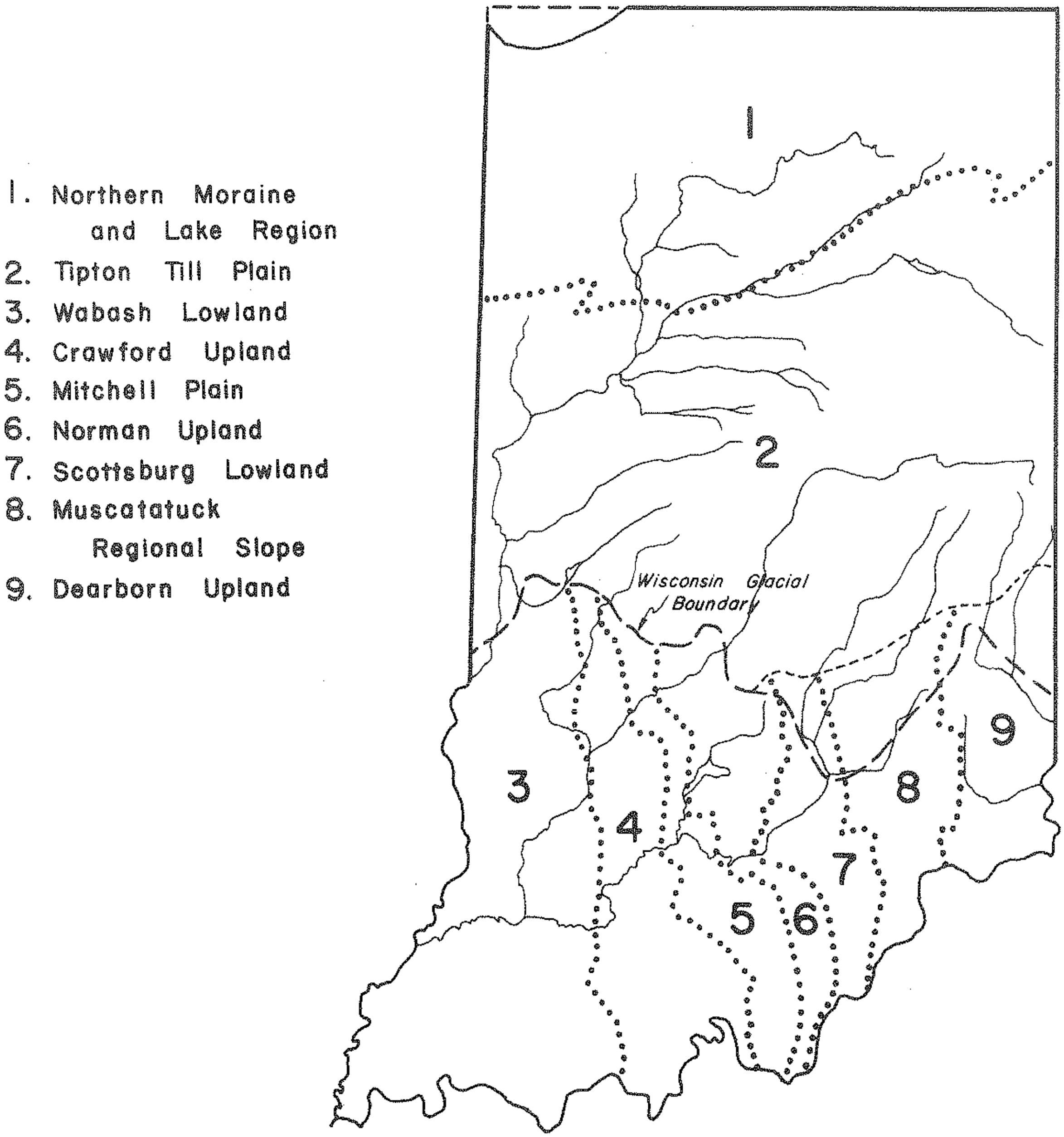


Figure 3. Physiographic units (subprovinces) in Indiana.

In discussion of the evaluation listings in subsequent sections of this text, the authors with minor exceptions have deliberately refrained from adding lengthy gratuitous comments about the results which are presented in graphic or tabular form. This eliminates any inadvertent chance of bias that might result from descriptive analysis or discussion. The reader may therefore draw his own opinions or conclusions about the relative ranking or merits of individual streams.

Evaluation of Uniqueness Index

Evaluation numbers for the 20 stream valleys are shown in Table 4. The Uniqueness Indices were derived from these numbers. The Uniqueness Index (UI) for each stream has a possible maximum of 1,000 points (333.3 for each of the three main categories of factors).

The results of the uniqueness analysis for the first 10 valleys listed on Figure 2 are shown in Table 5 and Figure 4. It is interesting to note that the largest and smallest streams, Wabash River and Rattlesnake Creek respectively, are the "most unique." It is also interesting that for all 10 streams the contribution of each of the three descriptive factor categories to the Uniqueness Indices is fairly evenly distributed.

We believe that to make the LAND system of greatest practical value and relatively easy to use, the population of 10 streams is too many to evaluate. We therefore experimented by varying the number of streams used in a single grouping, and concluded that at least five streams of more comparable size should be analyzed for realistic results. Table 6 and Figure 5 are examples of results from evaluation of a grouping of five streams; Big Pine Creek, Deer Creek, Eel River, Tippecanoe River, and Wildcat Creek at Owasco. These are the same five evaluated streams

Table 4. Landscape Evaluation Numbers

FACTOR	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
	LANDSCAPE LOCATION																			
1 CHANNEL WIDTH	3	2	1	3	5	3	3	4	4	3	3	3	3	3	4	3	3	3	4	4
2 LOW FLOW DISCHARGE	2	1	1	2	5	2	2	4	5	2	2	2	1	1	4	3	2	2	3	5
3 AVERAGE DISCHARGE	3	2	1	3	5	3	3	4	5	3	3	3	3	3	5	3	4	4	4	5
4 BASIN AREA (SQ.MI.)	3	2	1	3	5	3	3	4	5	3	3	3	3	3	5	3	4	4	4.	5
5 CHANNEL PATTERN	3	4	2	2	4	2	2	1	2	2	1	1	1	1	1	1	1	3	1	1
6 VALLEY WIDTH/HEIGHT	1	2	4	4	5	2	4	5	4	5	5	5	3	4	3	4	5	4	3	4
7 BED MATERIAL	1	1	1	1	1	1	2	1	1	1	1	3	3	2	1	1	1	2	3	1
8 BANK AND VALLEY MATERIAL	1	1	1	1	1	3	2	1	1	1	1	2	2	2	1	2	1	4	4	1
9 BED SLOPE	2	1	1	3	3	2	3	2	2	1	3	2	3	2	3	2	1	1	3	1
10 WIDTH OF VALLEY FLAT	1	1	2	4	5	3	3	5	4	4	5	4	4	3	4	4	5	4	2	4
11 EROSION OF BANKS	1	3	1	3	1	2	2	1	2	2	2	2	4	2	3	3	3	3	1	3
12 VALLEY SLOPE	3	2	1	2	2	3	2	1	2	1	1	1	2	1	2	2	1	3	2	2
13 SINUOSITY	1	1	3	5	1	3	3	2	3	3	1	1	2	2	2	1	2	1	1	1
14 NO. OF TRIBUTARIES	5	1	1	2	5	5	5	5	5	5	4	3	5	2	5.	2	3	3	5	5
15 WATER COLOR	4	2	1	2	4	2	5	2	2	4	2	3	2	5	4	2	3	4	3	3
16 FLOATING MATERIAL	2	1	1	1	3	1	5	2	5	1	1	3	3	3	3	3	3	4	3	1
17 ALGAE	1	1	1	3	1	2	2	1	1	2	4	4	3	3	4	4	4	4	4	4
18 LAND PLANTS-FLOOD PLAIN	2	1	2	5	5	4	5	5	5	5	5	5	4	4	5	4	4	4	5	4
19 LAND PLANTS-HILLSLOPE	2	2	3	3	5	3	2	5	2	2	2	3	3	3	3	2	2	3	3	3
20 WATER PLANTS	1	2	3	1	2	1	1	3	1	2	1	3	4	4	2	1	1	1	3	1
21 TRASH/100 FT.	1	1	1	2	3	2	3	2	3	3	4	2	2	1	3	2	2	2	2	3
22 VARIABILITY OF TRASH	1	1	1	5	3	5	3	4	2	3	3	3	4	1	3	3	3	2	2	3
23 ARTIFICIAL CONTROL	4	4	1	1	2	1	1	1	5	1	1	2	2	1	2	2	2	1	1	2
24 UTILITIES, BRIDGES, ROAD	3	1	2	2	5	2	3	3	4	3	3	3	3	2	3	2	3	4	2	3
25 URBANIZATION	3	3	3	3	4	2	1	4	4	1	4	4	2	2	4	4	3	4	2	4
26 HISTORICAL FEATURES	1	1	1	1	3	1	1	1	1	2	2	2	2	3	1	3	1	1	2	1
27 LOCAL SCENE	3	2	1	3	3	2	3	3	2	3	3	2	3	2	2	2	2	2	1	2
28 VIEW CONFINEMENT	2	2	2	3	2	3	3	2	2	3	2	3	3	3	2	2	2	3	3	1
29 RAPID AND FALLS	1	1	1	1	1	2	1	1	1	1	2	2	1	1	4	1	1	1	1	1
30 LAND USE	1	1	1	1	5	2	1	1	2	1	5	5	1	1	5	5	1	5	2	5
31 MISFITS	2	1	1	5	5	1	4	2	2	3	5	2	4	1	5	4	5	4	1	1

LOCATION OF LANDSCAPE

A BIG MONON DITCH NEAR FRANCESVILLE, IND.
B LITTLE INDIAN CREEK NEAR ROYAL CENTER, IND.
C RATTLESNAKE CREEK NEAR PATTON, IND.
D S FORK WILDCAT CREEK NEAR LAFAYETTE, IND.
E WABASH RIVER AT LAFAYETTE, IND.
F BIG PINE CREEK NEAR LOGANSPORT, IND.
G DEER CREEK NEAR DELPHI, IND.
H EEL RIVER NEAR LOGANSPORT, IND.
I TIPPECANOE RIVER NEAR DELPHI, IND.
J WILDCAT CREEK AT OWASCO, IND.
K BIG BLUE RIVER NEAR KNIGHTSTOWN, IND.
L FLATROCK RIVER NEAR ST PAUL, IND.
M LAUGHERY CREEK NEAR FARMERS RETREAT, IND.
N SAND CREEK NEAR BREWERSVILLE, IND.
O WHITEWATER RIVER AT BROOKVILLE, IND.
P BIG RACCOON CREEK AT COXVILLE, IND.
Q EEL RIVER AT BOWLING GREEN, IND.
R SALT CREEK NEAR PEERLESS, IND.
S SUGAR CREEK NEAR BYRON, IND.
T WHITE RIVER AT SPENCER, IND.

TABLE 5. UNIQUENESS MATRIX

		LANDSCAPE LOCATION A	B	C	D	E	F	G	H	I	J
	PHYSICAL FACTORS										
1	CHANNEL WIDTH	.200	.200	.500	.500	.200	.200	1.000	1.000	.200	1.000
2	LOW FLOW DISCHARGE	.200	.200	1.000	.500	.200	.250	.500	.500	.200	.500
3	AVERAGE DISCHARGE	.200	.200	1.000	.500	.250	.200	1.000	1.000	.200	.500
4	BASIN AREA(SQ. MI.)	.200	.200	1.000	.500	.200	.200	1.000	1.000	.200	.500
5	CHANNEL PATTERN	.167	.167	1.000	.167	.167	1.000	.500	.167	.167	.500
6	VALLEY WIDTH/HEIGHT	.500	.250	.333	.250	.333	1.000	.500	.250	.250	.333
7	BED MATERIAL	.111	1.000	.111	.111	.111	.111	.111	.111	.111	.111
8	BANK AND VALLEY MATERIAL	1.000	1.000	.125	.125	.125	.125	.125	.125	.125	.125
9	BEDSLOPE	.250	.333	.250	.250	.333	.250	.333	.333	.333	.333
10	WIDTH OF VALLEY FLAT	.500	.500	.500	.333	.333	.500	.500	1.000	.333	.500
11	EROSION OF BANKS	.250	.250	.250	.250	.250	.250	.500	.250	.500	.250
12	VALLEY SLOPE	.500	.200	.333	.200	.333	.500	.200	.333	.200	.200
13	SINUOSITY	.200	.200	1.000	.200	.200	.333	.333	.200	1.000	.333
14	NO. OF TRIBUTARIES	.143	.143	.143	.143	.143	.143	.500	.500	1.000	.143
	SUBTOTAL	4.42	4.84	7.55	4.03	3.13	5.01	7.10	6.77	4.82	5.33
	PHYSICAL UNIQUENESS INDICES	105	115	180	96	74	119	169	161	115	127
	BIOLOGIC + WATER QUALITY FACTORS										
15	WATER COLOR	.200	1.000	.200	.200	.333	.333	.200	1.000	.200	.333
16	FLOATING MATERIAL	.200	.500	.500	.500	.200	.500	.200	.200	.200	1.000
17	ALGAE	.333	.333	.167	.167	.333	.167	.167	.167	1.000	.167
18	LANDPLANTS-FLOOD PLAIN	1.000	.167	.167	.167	.167	.500	1.000	.500	.167	.167
19	LANDPLANTS-HILLSLOPE	.333	.200	.500	.200	.200	.200	.200	.333	.333	.500
20	WATER PLANTS	.200	.200	.500	.200	.333	.200	.333	.500	.200	.333
	SUBTOTAL	2.27	2.40	2.03	1.43	1.57	1.90	2.10	2.70	2.10	2.50
	BIOLOGIC + WATER QUALITY UNIQUENESS INDICES	126	133	113	80	87	106	117	150	117	139
	HUMAN USE AND INTEREST FACTORS										
21	TRASH / 100 FT.	.333	.250	.333	.250	.250	.333	.333	.333	.333	.250
22	VARIABILITY OF TRASH	.500	.333	1.000	1.000	.333	.333	.333	.333	.500	.333
23	ARTIFICIAL CONTROL	.167	.167	.167	1.000	.167	.500	.500	.167	.167	1.000
24	UTILITIES, BRIDGES, ROAD	.333	.250	.250	1.000	.250	.250	1.000	.333	.333	1.000
25	URBANIZATION	1.000	.500	.333	.333	.500	.250	.250	.250	.250	.333
26	HISTORICAL FEATURES	.125	.125	.125	.125	1.000	.125	.125	.125	.125	1.000
27	LOCAL SCENE	.333	.167	.167	.333	.167	.167	.333	1.000	.167	.167
28	VIEW CONFINEMENT	.250	.250	.167	.167	.250	.167	.167	.167	.250	.167
29	RAPID AND FALLS	1.000	.111	.111	.111	.111	.111	.111	.111	.111	.111
30	LAND USE	.500	.143	.143	.500	.143	.143	.143	.143	.143	1.000
31	MISFITS	.333	1.000	.333	.333	1.000	.333	.333	.333	.500	.500
	SUBTOTAL	4.87	3.30	3.13	5.15	4.17	2.71	3.63	3.30	2.88	5.86
	HUMAN USE AND INTEREST UNIQUENESS INDICES	148	139	35	156	126	82	110	100	87	178
	TOTAL	11.56	10.54	12.71	10.62	8.87	9.62	12.83	12.77	9.80	13.69
	TOTAL UNIQUENESS INDICES	379	349	387	332	288	307	396	411	319	443

LANDSCAPE LOCATION

A BIG PINE CREEK — C EEL RIVER — E WILDCAT CREEK — G LITTLE INDIAN CREEK — I SOUTH FORK WILDCAT CREEK

B DEER CREEK — D TIPPECANOE RIVER — F BIG MONON DITCH — H RATTLESNAKE CREEK — J WABASH RIVER

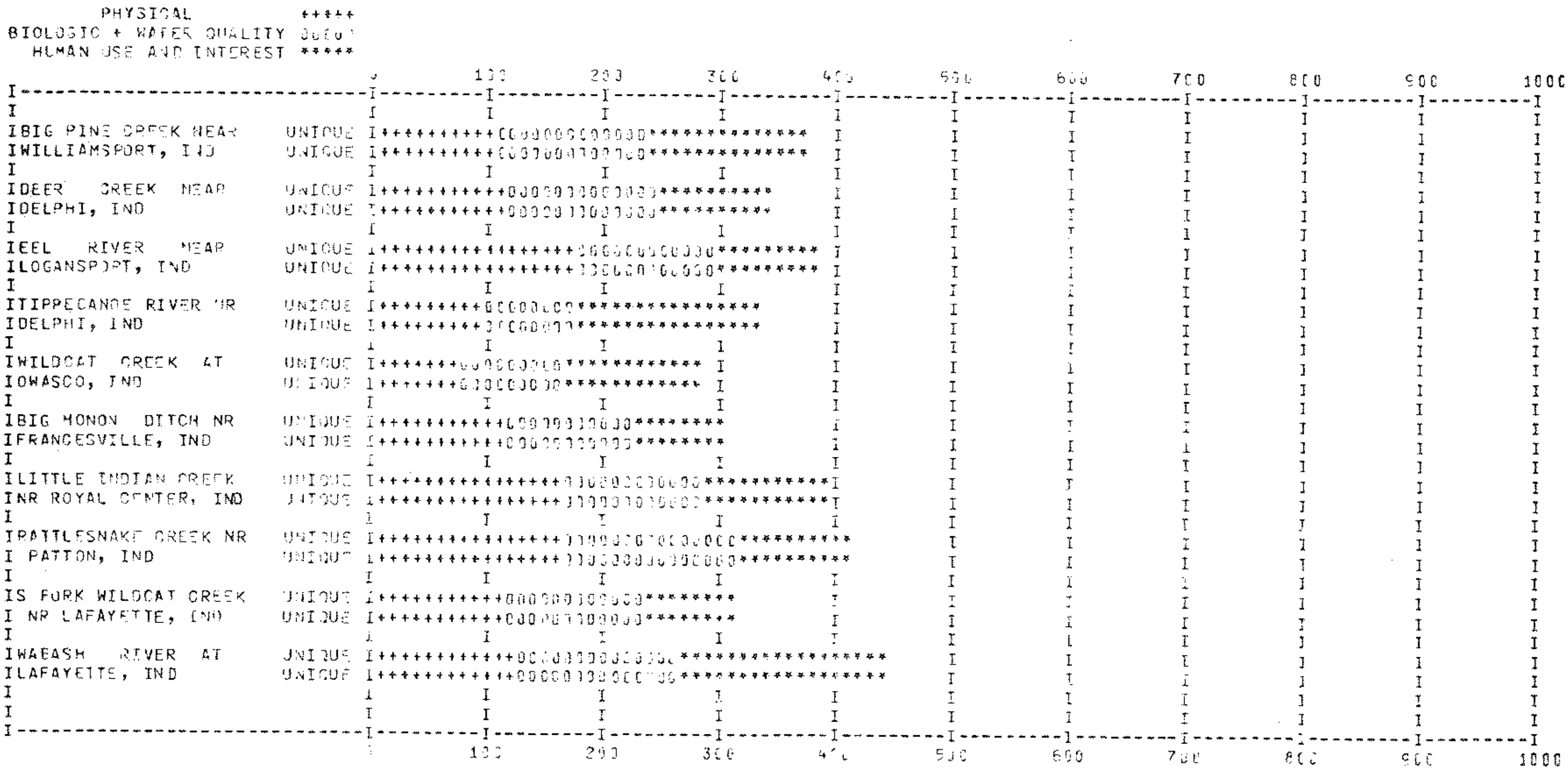


Figure 4. Bar graph of uniqueness indices as calculated for the first 10 stream valleys shown in Figure 2. These streams have a wide range of size in terms of basin area, discharge, and other physical factors.

TABLE 6. UNIQUENESS MATRIX

		LANDSCAPE LOCATION A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.333	.333	.500	.500	.333
2	LOW FLOW DISCHARGE	.333	.333	1.000	1.000	.333
3	AVERAGE DISCHARGE	.333	.333	1.000	1.000	.333
4	BASIN AREA(SQ. MI.)	.333	.333	1.000	1.000	.333
5	CHANNEL PATTERN	.250	.250	1.000	.250	.250
6	VALLEY WIDTH/HEIGHT	1.000	.500	.500	.500	.500
7	BED MATERIAL	.250	1.000	.250	.250	.250
8	BANK AND VALLEY MATERIAL	1.000	1.000	.333	.333	.333
9	BEDSLOPE	.333	1.000	.333	.333	1.000
10	WIDTH OF VALLEY FLAT	.500	.500	1.000	.500	.500
11	EROSION OF BANKS	.250	.250	1.000	.250	.250
12	VALLEY SLOPE	1.000	.500	.500	.500	.500
13	SINUOSITY	.250	.250	1.000	.250	.250
14	NO. OF TRIBUTARIES	.200	.200	.200	.200	.200
	SUBTOTAL	6.37	6.78	9.62	6.87	5.37
PHYSICAL	UNIQUENESS INDICES	152	162	229	163	128
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	.333	1.000	.333	.333	1.000
16	FLOATING MATERIAL	.500	.500	1.000	.500	.500
17	ALGAE	.333	.333	.500	.500	.333
18	LANDPLANTS-FLOOD PLAIN	1.000	.250	.250	.250	.250
19	LANDPLANTS-HILLSLOPE	1.000	.333	1.000	.333	.333
20	WATER PLANTS	.333	.333	1.000	.333	1.000
	SUBTOTAL	3.50	2.75	4.08	2.25	3.42
BIOLOGIC + WATER QUALITY	UNIQUENESS INDICES	194	153	227	125	190
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	.500	.333	.500	.333	.333
22	VARIABILITY OF TRASH	1.000	.500	1.000	1.000	.500
23	ARTIFICIAL CONTROL	.250	.250	.250	1.000	.250
24	UTILITIES, BRIDGES, ROAD	1.000	.333	.333	1.000	.333
25	URBANIZATION	1.000	.500	.500	.500	.500
26	HISTORICAL FEATURES	.250	.250	.250	.250	1.000
27	LOCAL SCENE	.500	.333	.333	.500	.333
28	VIEW CONFINEMENT	.333	.333	.500	.500	.333
29	RAPID AND FALLS	1.000	.250	.250	.250	.250
30	LAND USE	.500	.333	.333	.500	.333
31	MISFITS	1.000	1.000	.500	.500	1.000
	SUBTOTAL	7.33	4.42	4.75	6.33	5.17
HUMAN USE AND INTEREST	UNIQUENESS INDICES	222	134	144	192	157
	TOTAL	17.20	13.95	18.45	15.45	13.95
TOTAL	UNIQUENESS INDICES	568	448	600	480	474

LANDSCAPE LOCATION

A BIG PINE CREEK NEAR WILLIAMSPORT, IND

B DEER CREEK NEAR DELPHI, IND

C EEL RIVER NEAR LOGANSPORT, IND

D TIPPECANOE RIVER NEAR DELPHI, IND

E WILDCAT CREEK AT OWASCO, IND

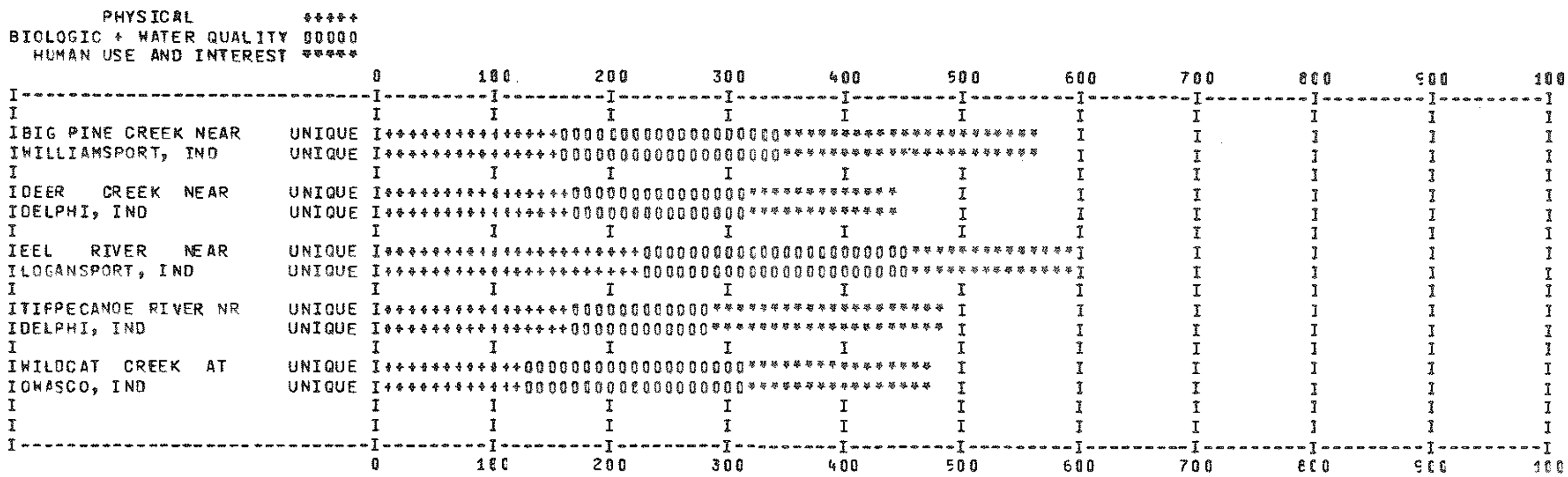


Figure 5. Bar graph of uniqueness indices for five streams. These streams, though not of the same size, have less range in the physical factors category than the 10 stream grouping in Figure 4.

referenced in the discussion of how various indices are derived. Evaluation of two additional groups of five streams each are included in Appendix B.

The model is sensitive to changes in the number of streams evaluated. This owes to how much the added stream is similar or dissimilar to the other streams. It appears to be especially sensitive in terms of physical factors. Figure 6 shows one example of the variation of uniqueness as the number of streams evaluated increases from four (4) to ten (10). The top line y = 1000, where y is Uniqueness Index, is the maximum uniqueness. The bottom line $y = \frac{1}{x} 1000$, where y is Uniqueness Index, and x is the number of streams evaluated, is the minimum uniqueness. It is our opinion that the magnitude of change of the indices will decrease as improvements in the model are achieved.

Evaluation of Aesthetic River Index

The Aesthetic River Index (ARI) is derived from the equation:

$$ARI = UI\ (1 - \frac{x}{y})$$ where

ARI = Aesthetic River Index

UI = Uniqueness Index

x = the total value of uniqueness ratio zeroed

y = the total value of uniqueness ratio that could have been zeroed.

This equation is used to compute an ARI for each of the three categories; the sum is then the final index. Table 7 shows the factors and evaluation numbers zeroed for the Aesthetic River Index. Table 8 shows how the ARI is computed for biologic and water quality indices. Aesthetic River Indices for five (5) evaluated Indiana river valleys are shown in Table 9 and

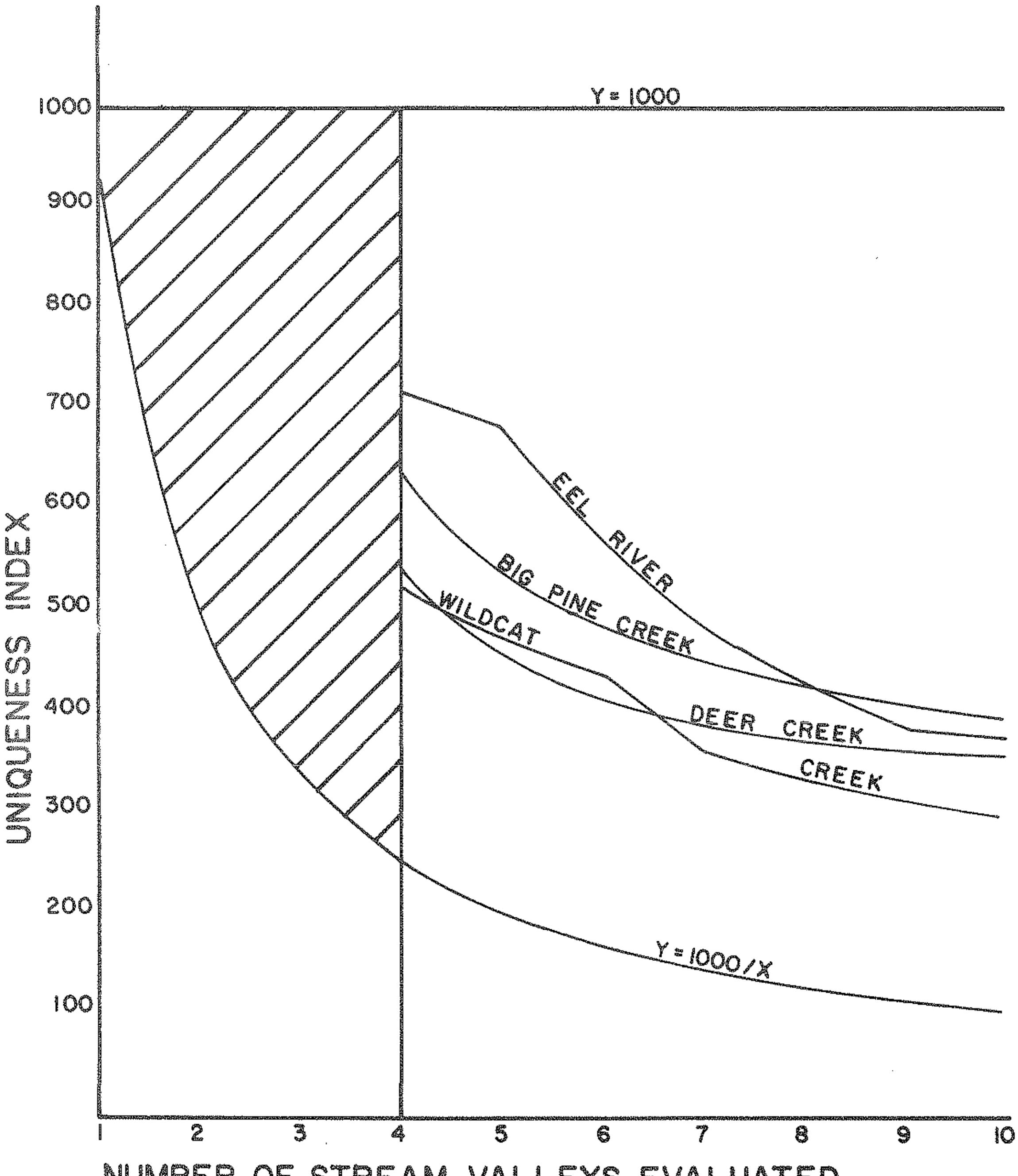


Figure 6. Example of the possible variability of uniqueness as the number of river valleys evaluated is changed.

Table 7. Factors and Evaluation Numbers That May Be Zeroed For Various Indices

	Factors (F) and Evaluation Number (E) - Zeroed
Aesthetic River Index	F 15, E 3,4,5; F 16, E 3,4,5; F 17, E 4,5; F 21, E 3,4,5; F 22, E 1,2,3; F 27, E 4,5; F 31, E 3,4,5
Wild River Index	F 16, E 3,4,5; F 18, E 4,5; F 19, E 4,5; F 21, E 3,4,5; F 22, E 1,2,3; F 23, E 2,3,4,5; F 24, E 2,3,4,5; F 30, E 1,3,4,5; F 31, E 2,3,4,5
Scenic River Index	F 16, E 3,4,5; F 17, E 4,5; F 21, E 4,5; F 22, E 1,2; F 23, E 4,5; F 24, E 3,4,5; F 25, E 4,5; F 27, E 3,4,5; F 30, E 3,4,5; F 31, E 4,5
Recreational River Index	F 16, E 3,4,5; F 17, E 5; F 24, E 1; F 25, E 1; F 27, E 4,5

Table 8: Example of Uniqueness Index (UI)
and Aesthetic Index (AI) Computation

Assuming: 1. Computed for biologic factors only, Deer Creek, Tables 6 and 9.

2. Factors 15, 16, 17 can be contrary to the definition of an Aesthetic River and so may be zeroed.

Uniqueness (UI) Index

Factor	Uniqueness Ratio	
15	1.000	
16	0.500	UI = 2.75/6 (333.3)
17	0.333	
18	0.250	UI = 153
19	0.333	
20	0.333	
Total	2.75	

Aesthetic River (ARI) Index

Factor	Uniqueness Ratio	
15	0.000	
16	0.000	Amount zeroed from factors
17	0.333	15,16,17 is 1.500
18	0.250	
19	0.333	Amount that could have been
20	0.333	zeroed is 1.833
Total	1.25	

$ARI = UI\ (1 - \frac{x}{y})$ x is amount zeroed

y is amount that could be zeroed

$ARI = 153\ (1 - \frac{1.500}{1.833})$

ARI = 28

TABLE 9. AESTHETIC MATRIX

	Factor	A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.333	.333	.500	.500	.333
2	LOW FLOW DISCHARGE	.333	.333	1.000	1.000	.333
3	AVERAGE DISCHARGE	.333	.333	1.000	1.000	.333
4	BASIN AREA(SQ. MI.)	.333	.333	1.000	1.000	.333
5	CHANNEL PATTERN	.250	.250	1.000	.250	.250
6	VALLEY WIDTH/HEIGHT	1.000	.500	.500	.500	.500
7	BED MATERIAL	.250	1.000	.250	.250	.250
8	BANK AND VALLEY MATERIAL	1.000	1.000	.333	.333	.333
9	BEDSLOPE	.333	1.000	.333	.333	1.000
10	WIDTH OF VALLEY FLAT	.500	.500	1.000	.500	.500
11	EROSION OF BANKS	.250	.250	1.000	.250	.250
12	VALLEY SLOPE	1.000	.500	.500	.500	.500
13	SINUOSITY	.250	.250	1.000	.250	.250
14	NO. OF TRIBUTARIES	.200	.200	.200	.200	.200
	SUBTOTAL	6.37	6.78	9.62	6.87	5.37
	PHYSICAL AESTHETIC INDICES	152	162	229	163	128
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	.333	0.000	.333	.333	0.000
16	FLOATING MATERIAL	.500	0.000	1.000	0.000	.500
17	ALGAE	.333	.333	.500	.500	.333
18	LANDPLANTS-FLOOD PLAIN	1.000	.250	.250	.250	.250
19	LANDPLANTS-HILLSLOPE	1.000	.333	1.000	.333	.333
20	WATER PLANTS	.333	.333	1.000	.333	1.000
	SUBTOTAL	3.50	1.25	4.08	1.75	2.42
	BIOLOGIC + WATER QUALITY AESTHETIC INDICES	194	28	227	78	86
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	.500	0.000	.500	0.000	0.000
22	VARIABILITY OF TRASH	1.000	0.000	1.000	0.000	0.000
23	ARTIFICIAL CONTROL	.250	.250	.250	1.000	.250
24	UTILITIES, BRIDGES, ROAD	1.000	.333	.333	1.000	.333
25	URBANIZATION	1.000	.500	.500	.500	.500
26	HISTORICAL FEATURES	.250	.250	.250	.250	1.000
27	LOCAL SCENE	.500	.333	.333	.500	.333
28	VIEW CONFINEMENT	.333	.333	.500	.500	.333
29	RAPID AND FALLS	1.000	.250	.250	.250	.250
30	LAND USE	.500	.333	.333	.500	.333
31	MISFITS	1.000	0.000	.500	.500	0.000
	SUBTOTAL	7.33	2.58	4.75	5.00	3.33
	HUMAN USE AND INTEREST AESTHETIC INDICES	222	21	144	82	24
	TOTAL	17.20	10.62	18.45	13.62	11.12
	TOTAL AESTHETIC INDICES	568	210	600	324	238

LANDSCAPE LOCATION

A BIG PINE CREEK NEAR WILLIAMSPORT, IND

B DEER CREEK NEAR DELPHI, IND

C EEL RIVER NEAR LOGANSPORT, IND

D TIPPECANOE RIVER NEAR DELPHI, IND

E WILDCAT CREEK AT OWASCO, IND

Figure 7. All graphs showing the various indices allow for comparison of the Uniqueness Index in the top row for each stream with the appropriate new index in the bottom row. This allows for easy determination of the amount the Uniqueness Index was lowered for each stream by zeroing factors antithetical to the definition of the new index being derived.

Wild, Scenic, and Recreational River Indices

These indices are computed from the same general equation used to calculate ARI. The data are compared to the definition of what is to be evaluated and evaluation numbers contrary to the definition are zeroed. Table 7 shows the factors and evaluation numbers zeroed for the Wild River Index (WRI), Scenic River Index (SRI), and Recreational River Index (RRI).

By statutory definition there are no wild river areas in Indiana. The analysis merely ranks the streams hierarchically in terms of the definition for a wild river, i.e. to what degree a stream approaches "wildness." Table 10 and Figure 8 show the Wild River Indices for five (5) of the evaluated streams.

Indiana does have scenic river areas, and therefore, the LAND analysis has some real application. The Scenic River Index (SRI) is derived from the Uniqueness Index in the same manner the Wild River Index was computed. The results for five (5) streams are shown in Table 11 and Figure 9.

Indiana also has recreational river areas, and the analysis for Recreational River Index (RRI) should have application. Table 12 and Figure 10 show the results of the RRI evaluation for five (5) streams.

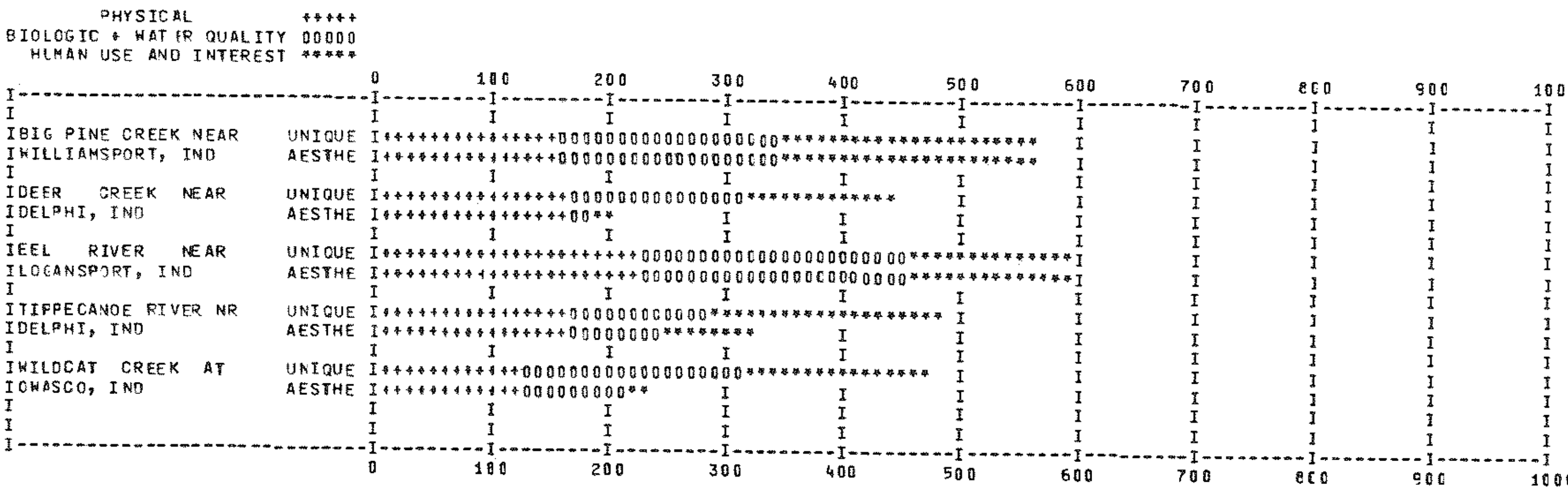


Figure 7. Bar graph of aesthetic indices for the same five stream grouping shown in Figure 5. The graph is constructed to allow comparison of Uniqueness Index (top row) with Aesthetic Index (bottom row) for each stream. This permits visual inspection of the amount of lowering owing to zeroing of factors antithetical to the definition of an aesthetic stream.

TABLE 10. WILD RIVER MATRIX

No.	Factors	A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.333	.333	.500	.500	.333
2	LOW FLOW DISCHARGE	.333	.333	1.000	1.000	.333
3	AVERAGE DISCHARGE	.333	.333	1.000	1.000	.333
4	BASIN AREA(SQ. MI.)	.333	.333	1.000	1.000	.333
5	CHANNEL PATTERN	.250	.250	1.000	.250	.250
6	VALLEY WIDTH/HEIGHT	1.000	.500	.500	.500	.500
7	BED MATERIAL	.250	1.000	.250	.250	.250
8	BANK AND VALLEY MATERIAL	1.000	1.000	.333	.333	.333
9	BEDSLOPE	.333	1.000	.333	.333	1.000
10	WIDTH OF VALLEY FLAT	.500	.500	1.000	.500	.500
11	EROSION OF BANKS	.250	.250	1.000	.250	.250
12	VALLEY SLOPE	1.000	.500	.500	.500	.500
13	SINUOSITY	.250	.250	1.000	.250	.250
14	NO. OF TRIBUTARIES	.200	.200	.200	.200	.200
	SUBTOTAL	6.37	6.78	9.62	6.87	5.37
	PHYSICAL WILD RIVER INDICES	152	162	229	163	128
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	.333	1.000	.333	.333	1.000
16	FLOATING MATERIAL	.500	0.000	1.000	0.000	.500
17	ALGAE	.333	.333	.500	.500	.333
18	LANDPLANTS-FLOOD PLAIN	0.000	0.000	0.000	0.000	0.000
19	LANDPLANTS-HILLSLOPE	1.000	.333	0.000	.333	.333
20	WATER PLANTS	.333	.333	1.000	.333	1.000
	SUBTOTAL	2.50	2.00	2.83	1.50	3.17
	BIOLOGIC + WATER QUALITY WILD RIVER INDICES	117	47	101	38	146
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	.500	0.000	.500	0.000	0.000
22	VARIABILITY OF TRASH	1.000	0.000	1.000	0.000	0.000
23	ARTIFICIAL CONTROL	.250	.250	.250	0.000	.250
24	UTILITIES, BRIDGES, ROAD	0.000	0.000	0.000	0.000	0.000
25	URBANIZATION	0.000	.500	0.000	0.000	.500
26	HISTORICAL FEATURES	.250	.250	.250	.250	1.000
27	LOCAL SCENE	.500	.333	.333	.500	.333
28	VIEW CONFINEMENT	.333	.333	.500	.500	.333
29	RAPID AND FALLS	1.000	.250	.250	.250	.250
30	LAND USE	.500	0.000	0.000	.500	0.000
31	MISFITS	1.000	0.000	0.000	0.000	0.000
	SUBTOTAL	5.33	1.92	3.08	2.00	2.67
	HUMAN USE AND INTEREST WILD RIVER INDICES	138	31	74	20	36
	TOTAL	14.20	10.70	15.53	10.37	11.20
	TOTAL WILD RIVER INDICES	406	239	404	222	310

LANDSCAPE LOCATION

A BIG PINE CREEK NEAR WILLIAMSPORT, IND

B DEER CREEK NEAR DELPHI, IND

C EEL RIVER NEAR LOGANSPORT, IND

D TIPPECANOE RIVER NEAR DELPHI, IND

E WILDCAT CREEK AT OWASCO, IND

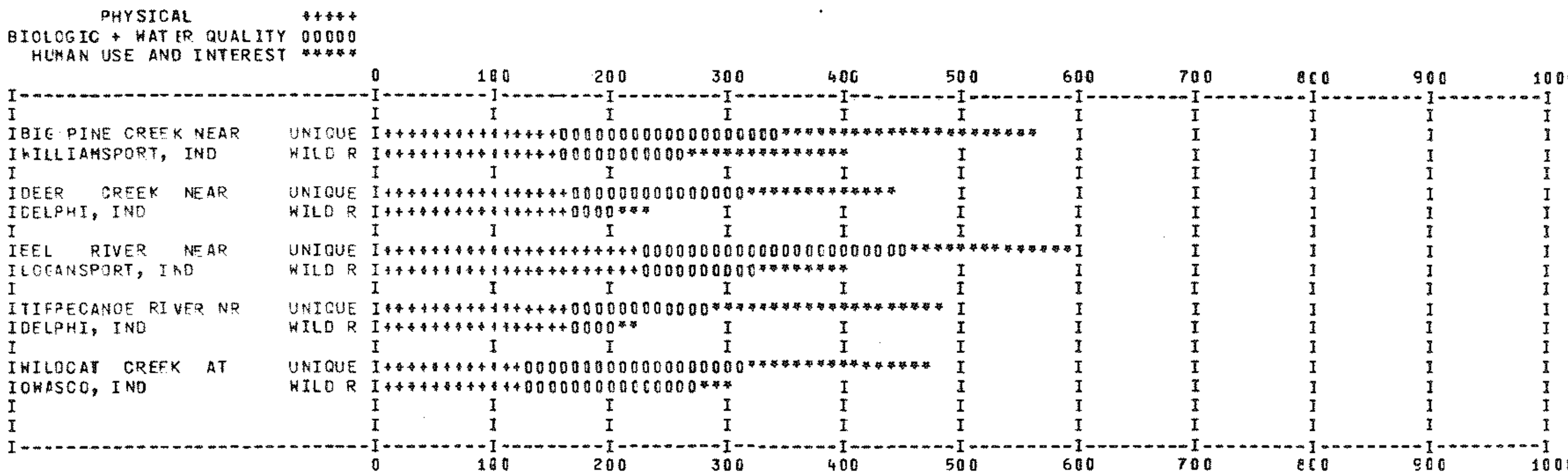


Figure 8. Bar graph of wild river indices for the same grouping of five streams. The graph permits comparison of Uniqueness Index (top row) with Wild River Index (bottom row) for each stream, and shows the lowering resulting from application of the definition of a wild river.

TABLE 11. SCENIC RIVER MATRIX

		LANDSCAPE LOCATION A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.333	.333	.500	.500	.333
2	LOW FLOW DISCHARGE	.333	.333	1.000	1.000	.333
3	AVERAGE DISCHARGE	.333	.333	1.000	1.000	.333
4	BASIN AREA(SQ. MI.)	.333	.333	1.000	1.000	.333
5	CHANNEL PATTERN	.250	.250	1.000	.250	.250
6	VALLEY WIDTH/HEIGHT	1.000	.500	.500	.500	.500
7	BED MATERIAL	.250	1.000	.250	.250	.250
8	BANK AND VALLEY MATERIAL	1.000	1.000	.333	.333	.333
9	BEDSLOPE	.333	1.000	.333	.333	1.000
10	WIDTH OF VALLEY FLAT	.500	.500	1.000	.500	.500
11	ERCSION OF BANKS	.250	.250	1.000	.250	.250
12	VALLEY SLOPE	1.000	.500	.500	.500	.500
13	SINUCSITY	.250	.250	1.000	.250	.250
14	NO. OF TRIBUTARIES	.200	.200	.200	.200	.200
	SUBTOTAL	6.37	6.78	9.62	6.87	5.37
PHYSICAL	SCENIC RIVER INDICES	152	162	229	163	128
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	.333	1.000	.333	.333	1.000
16	FLOATING MATERIAL	.500	0.000	1.000	0.000	.500
17	ALGAE	.333	.333	.500	.500	.333
18	LANDFLANTS-FLOOD PLAIN	1.000	.250	.250	.250	.250
19	LANDPLANTS-HILLSLOPE	1.000	.333	1.000	.333	.333
20	WATER PLANTS	.333	.333	1.000	.333	1.000
	SUBTOTAL	3.50	2.25	4.08	1.75	3.42
BICLOGIC + WATER QUALITY	SCENIC RIVER INDICES	194	61	227	62	190
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	.500	.333	.500	.333	.333
22	VARIABILITY OF TRASH	1.000	.500	1.000	0.000	.500
23	ARTIFICIAL CONTROL	.250	.250	.250	0.000	.250
24	UTILITIES, BRIDGES, ROAD	1.000	0.000	0.000	0.000	0.000
25	URBANIZATION	1.000	.500	0.000	0.000	.500
26	HISTORICAL FEATURES	.250	.250	.250	.250	1.000
27	LOCAL SCENE	.500	0.000	0.000	.500	0.000
28	VIEW CONFINEMENT	.333	.333	.500	.500	.333
29	RAPID AND FALLS	1.000	.250	.250	.250	.250
30	LAND USE	.500	.333	.333	.500	.333
31	MISFITS	1.000	0.000	.500	.500	1.000
	SUBTOTAL	7.33	2.75	3.58	2.83	4.50
HUMAN USE AND INTEREST	SCENIC RIVER INDICES	222	72	99	66	127
	TOTAL	17.20	11.78	17.28	11.45	13.28
TOTAL SCENIC RIVER	INDICES	568	294	555	292	445

LANDSCAPE LOCATION

A BIG PINE CREEK NEAR WILLIAMSPORT, ING

B DEER CREEK NEAR DELPHI, IND

C EEL RIVER NEAR LOGANSPORT, IND

D TIPPECANOE RIVER NEAR DELPHI, IND

E WILDCAT CREEK AT OWASCO, IND

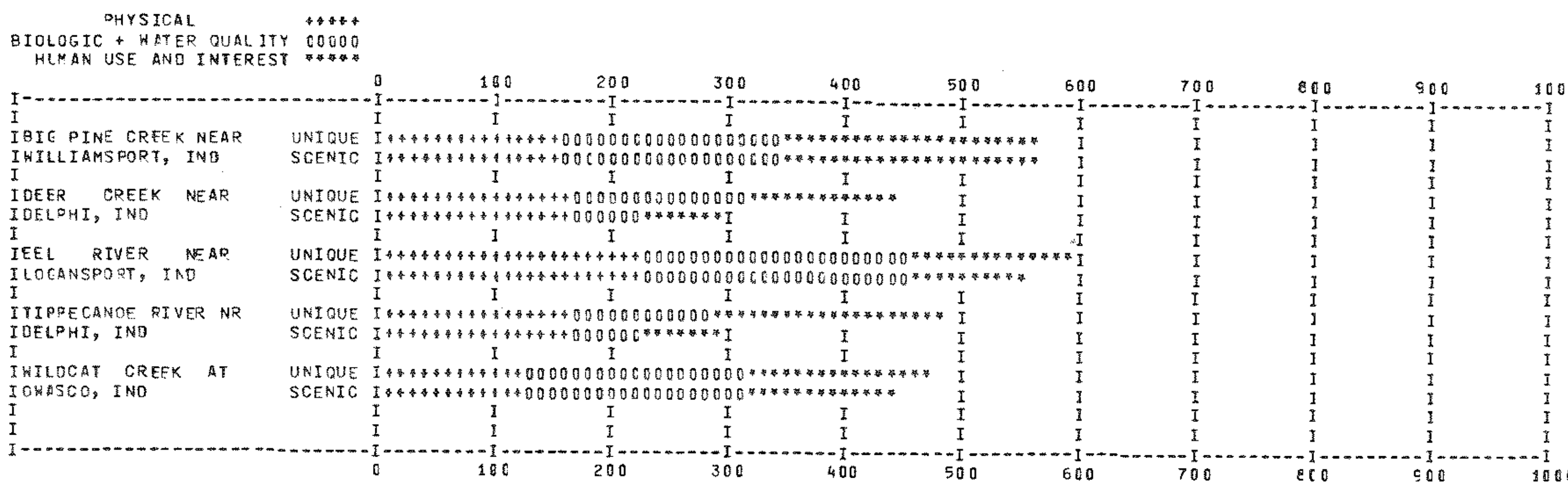


Figure 9. Bar graph of scenic river indices for the same five stream grouping. The graph allows visual comparison of the Scenic River Index and Uniqueness Index.

TABLE 12. RECREATIONAL RIVER MATRIX

		LANDSCAPE LOCATION A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.333	.333	.500	.500	.333
2	LOW FLOW DISCHARGE	.333	.333	1.000	1.000	.333
3	AVERAGE DISCHARGE	.333	.333	1.000	1.000	.333
4	BASIN AREA(SQ. MI.)	.333	.333	1.000	1.000	.333
5	CHANNEL PATTERN	.250	.250	1.000	.250	.250
6	VALLEY WIDTH/HEIGHT	1.000	.500	.500	.500	.500
7	BED MATERIAL	.250	1.000	.250	.250	.250
8	BANK AND VALLEY MATERIAL	1.000	1.000	.333	.333	.333
9	BEDSLOPE	.333	1.000	.333	.333	1.000
10	WIDTH OF VALLEY FLAT	.500	.500	1.000	.500	.500
11	EROSION OF BANKS	.250	.250	1.000	.250	.250
12	VALLEY SLOPE	1.000	.500	.500	.500	.500
13	SINUOSITY	.250	.250	1.000	.250	.250
14	NO. OF TRIBUTARIES	.200	.200	.200	.200	.200
	SUBTOTAL	6.37	6.78	9.62	6.87	5.37
	PHYSICAL RECREATIONAL RIVER INDICES	152	162	229	163	128
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	.333	1.000	.333	.333	1.000
16	FLOATING MATERIAL	.500	0.000	1.000	0.000	.500
17	ALGAE	.333	.333	.500	.500	.333
18	LANDPLANTS-FLOOD PLAIN	1.000	.250	.250	.250	.850
19	LANDPLANTS-HILLSLOPE	1.000	.333	1.000	.333	.333
20	WATER PLANTS	.333	.333	1.000	.333	1.000
	SUBTOTAL	3.50	2.25	4.08	1.75	3.42
	BIOLOGIC + WATER QUALITY RECREATIONAL RIVER INDICES	194	61	227	62	190
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	.500	.333	.500	.333	.333
22	VARIABILITY OF TRASH	1.000	.500	1.000	1.000	.500
23	ARTIFICIAL CONTROL	.250	.250	.250	1.000	.250
24	UTILITIES, BRIDGES, ROAD	1.000	.333	.333	1.000	.333
25	URBANIZATION	1.000	0.000	.500	.500	0.000
26	HISTORICAL FEATURES	.250	.250	.250	.250	1.000
27	LOCAL SCENE	.500	.333	.333	.500	.333
28	VIEW CONFINEMENT	.333	.333	.500	.500	.333
29	RAPID AND FALLS	1.000	.250	.250	.250	.250
30	LAND USE	.500	.333	.333	.500	.333
31	MISFITS	1.000	1.000	.500	.500	1.000
	SUBTOTAL	7.33	3.92	4.75	6.33	4.67
	HUMAN USE AND INTEREST RECREATIONAL RIVER INDICES	222	76	144	192	89
	TOTAL	17.20	12.95	18.45	14.95	13.45
	TOTAL RECREATIONAL RIVER INDICES	568	299	600	418	407

LANDSCAPE LOCATION

A BIG PINE CREEK NEAR WILLIAMSPORT, IND

B DEER CREEK NEAR DELPHI, IND

C EEL RIVER NEAR LOGANSPORT, IND

D TIPPECANOE RIVER NEAR DELPHI, IND

E WILDCAT CREEK AT OWASCO, IND

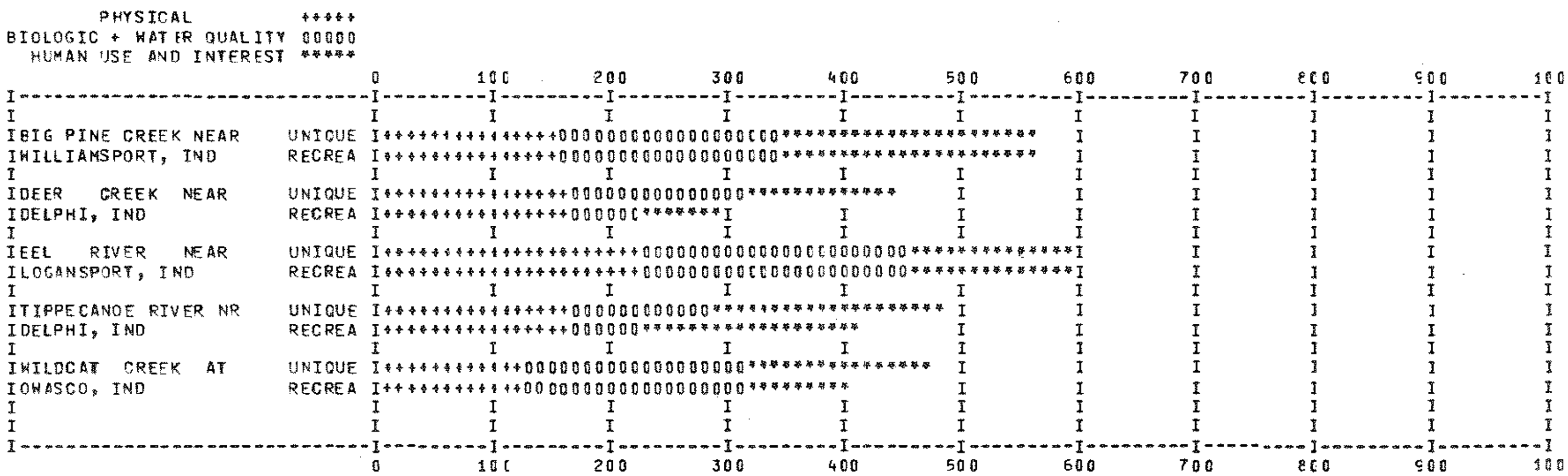


Figure 10. Bar graph of recreational river indices for the same five streams. The graph permits visual comparison of the Recreational River Index and Uniqueness Index.

Discussion of Results

It is difficult to analyze the results or to determine their significance. There is little doubt that the concept of uniqueness and Uniqueness Index can be used to hierarchically rank landscapes. However, uniqueness is very sensitive to the number of streams evaluated and adding an additional stream or streams to a grouping may considerably change the results. It is hoped that future modifications of the system can be devised to minimize these changes.

In quantifying landscape aesthetics we have tried to separate emotion from facts, and to some extent this has been accomplished. However, we have not removed all subjectivity. In fact a new type of subjectivity may have been introduced: that of the trained observer. This subjectivity may persist although it is more subtle and is masked by the numbers. The initial choice of categories, factors and boundaries for evaluation numbers are all subjective decisions. However, the data analysis is not subjective. Once parameters are chosen, observed, and recorded the influence of the operator is removed. This is distinctly different from a purely qualitative verbal report by a trained or untrained observer. It is our expressed hope, however, that the general perceptive impressions one gets in the field as to which streams have aesthetic value will be consistent with the numerical analysis. For example, after studying the 10 streams (Fig. 4) we agreed that, on the basis of impressions garnered in the field, Big Pine Creek was a relatively unique and scenic stream with considerable aesthetic value. Our analytical results, using various combinations for Uniqueness Index and Scenic River Index, consistently rated Big Pine Creek as relatively high. Other areas of agreement were that Wildcat Creek, though beautiful, is relatively commonplace for the region, and that Tippecanoe River, already heavily used and somewhat despoiled through long-term recreational pressures, would rank relatively high in an aesthetic sense if it were returned to a pristine state. In both cases, analytical results tend to support our original perceptive assessment as reached in the field. This is encouraging and is an indication that the LAND system is consistent with more basic perceptive mechanisms. The values presented in the graphs and tables appear quite realistic if compared to non-numeric field assessments. This coincidence of relative levels of agreement between the two approaches to aesthetic evaluation therefore suggests that the LAND system of analysis does have operational value.

CHAPTER VI

GENERAL SUMMARY AND RECOMMENDATIONS

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Geomorphology has been defined as the study of landscape and the geologic forces that produce it. Our scientific studies of the constantly acting dynamic processes that change the "face of the Earth" have tended to ignore the fact that mankind has the power to create aesthetic disruption or destroy the natural landscape. There is a moral burden, then, for those who know something about the natural processes that produce the Earth's scenery and physical environments to use the fundamental constructs of geomorphology and related sciences to 1) find a way to rationally assess the impact of potential human action on the scenic environment, 2) to help protect and preserve the national landscape heritage, and 3) to propose ways to predict and monitor the probable effects of any number of alternative future developments. These responsibilities are sufficient justification for conducting studies of the type described in this report.

Passage of several Federal laws, such as the Wilderness Act of 1964, the National Wild and Scenic Rivers Act of 1968, and the National Environmental Policy Act of 1969 has clearly indicated that the policy of the Federal Government is to foster the preservation and protection of certain aspects of the natural landscape, so that their values shall be retained for the benefit and enjoyment of present and future generations. However, it is a far cry from the decree to the deed. Because of polarization of individual, agricultural, communal, industrial, recreational, and agency interests many arguments have arisen and the solution of many points of conflict has not been forthcoming. One reason for the failure to resolve these arguments has been that very little methodology existed or has been developed with which to attack particular controversial issues. Methodology is only a means to an end, but it is nevertheless the key to developing techniques and criteria which provide sound inputs into decision-making processes. Even after decisions are reached, sound methodologies and criteria are useful in planning implementation procedures as they pertain to alteration of natural landscapes and the use and management of natural resources. Preparation of inventories, identification, measurement and analysis of appropriate input parameters, and recommendations for alternative management schemes should also be used to refine methods of economic modeling and play a role in understanding the social ramifications of each alternative course of action.

The purpose of this paper is to introduce the LAND system, which is a practical, quantitative method to hierarchically rank landscapes in terms of some predetermined definition, for use in alternative land use planning studies. The parametric, dating-sorting procedure employed is designed to provide an easy-to-use and understand method for landscape evaluation. We believe that planners, landscape architects, engineers and agencies who are considering proposals for landscape modification will use a method that allows various alternatives to be quantitatively evaluated so that facts can be separated from emotions. This is especially important if a balance between economic considerations and less tangible variables such as beauty, aesthetics, and human satisfaction and mental pleasure is attempted. Furthermore, such a relatively objective evaluation should certainly be considered as a necessary part of environmental impact statements, where it is desirable to have as an unbiased evaluation as possible of "what really is there" prior to consideration of alternative proposals for landscape modification.

The basic concept of uniqueness (Leopold, 1969b) is retained in modified form and various indices are computed using the LAND system of analyses. The use of descriptive category factors and evaluation numbers to derive a set of indices for landscape measurement appears to be a valid procedure. The primary objective is to affect comparisons of existing situations with a hypothetical or ideal land use as outlined by a statutory or some arbitrary definition. Therefore, construction of initial definitions is crucial and results are only as good as the definitions, i.e., how well an index as defined really depicts what is being evaluated. A poor or incomplete definition of an index cannot be expected to provide significant results.

For any further testing of fluvial systems, the LAND system can easily be modified to evaluate different types of landscapes in various geologic, physiographic, and biologic settings. In fact, we anticipate that the evaluation factors and the boundaries between evaluation numbers must change as the LAND model is tested on diverse landscapes of other physiographic provinces. Establishment of evaluation factors and boundary conditions for evaluation numbers is the most subjective part of the operational procedure and therefore is the most controversial. However, once all concerned parties agree on a definition of what is to be evaluated, then the factors, evaluation numbers, and the results will be consistent and can be duplicated by other workers.

The LAND system can just as easily produce a different set of indices to evaluate non-fluvial landscapes. The number and designations of descriptive category factors, and the evaluation levels and their boundaries will obviously differ from those used to show ranking of stream valleys, but the analytical procedure will not change. This type of parametric analysis may find application in refining the process of site selection for engineering projects such as dams, highways, and building complexes; location of parks and recreational areas; and in defining a comparative level of uniqueness characteristics of political subdivisions. Melhorn and Keller (1973) have suggested the possible applications of the LAND system to highway routing or transportation corridor selection. In theory, it should be possible to modify the LAND system to permit "total landscape evaluation" of a topographic quadrangle, political subdivision, or other arbitrarily defined unit area. A preliminary example of a possible total landscape assessment concludes this report. This example is not presented as a formally numbered table; rather, it is presented only as a springboard from which the interested reader can build an evaluation matrix, to suit his own needs.

TOTAL LANDSCAPE EVALUATION FACTORS

(Preliminary)

A. <u>Physical</u>

1. <u>Water-Erosion related</u>

   Total relief (maximum relief)
   Height of valley walls (local relief)
   Character of valley walls (slope)
   Amount & type of dissection (hysometry)
   Drainage patterns
   Drainage density (blue-line only, or V-construct)
   Drainage Frequency (number/sq. mile)
   Lakes: natural, artificial: size (area), number, percent of total area
   Swamps and marshes: size (area), number, percent of total area
   Rapids and waterfalls

2. <u>Materials</u>

   Alluvial material: percent and type
   Glacial material: percent and type; glaciofluvial vs. till
   Bedrock: percent of area in outcrop; rock type, classes and percent
   - a. Volcanic
   - b. Glacial
   - c. Bedrock
   - d. Aeolian
   - e. Lacustrine and unconsolidated marine

   Soils

3. Morphologic (Form Families)
   Plains, hills, plateaus, mountains, valleys, etc.

B. <u>Biologic</u>

1. Vegetation: type and percent for each type; timber, brush, aquatic, agricultural plants, grassland or pasture spatial relations

2. Unusual or relict plant assemblages

3. Unusual or relict faunal assemblages

4. Water quality and color; algal growth

C. <u>Human Use and Interest</u>

1. Transportation: bridges, roads, railroads, airports; percent of area
2. Land Use: Urban, Surburban, rural (agricultural), recreation, diverted acreage (parks, cemeteries, etc.)
3. Population density: uninhabited, sparse, medium, heavy
4. Power sources: Pipelines, transmission, power stations, dams
5. Mineral resources: Quarries, pits, mines, smelters, oil wells
6. Industry: none, light, heavy; total percent of area in structures
7. Historical & Archeological features
8. Misfits: junkyards, dumps, sanitary landfills, spoil areas
9. Trash, billboards
10. View confinement: owing to vegetation, topography, human development
11. Local scene: nauseating, neutral, mildly pleasing, pleasing, extremely pleasing

REFERENCES CITED

______, 1960, Perception; in Encyclopedia Brittanica, v. 18, p. 708, 714-716.

Beck, Robert, 1967, Spatial meaning and the properties of the environment; in Lowenthal, D. (ed.), Environmental Perception and Behavior, Univ. Chicago Dept. Geog., Research Paper 109, p. 18-41.

Brookfield, H.C., 1969, On the environment as perceived; in Progress in Geography, v. 1, p. 50-80, St. Martin's Press, New York.

Christopherson, K.A., 1973a, Attitudes and opinions of recreationists toward wild and scenic rivers: Univ. Idaho Water Resources Res. Center, Scenic Rivers Study Rept. 9, 66 p.

______, 1973b, An analysis of attitudes and opinions of St. Joe River basin landowners toward wild and scenic rivers; Univ. Idaho Water Resources Res. Center, Scenic Rivers Study Rept. 2, 74 p.

Cook, Earl, 1973, Ecoethics and environmental politics: Exxon USA, v. 12, no. 2, p. 16-19.

Coomber, N.H., and A.K. Biswas, 1972, Evaluation of environmental intangibles: review of techniques; Ecological Systems Branch, Environment Canada, 74 p.

Craik, K.H., 1972, Appraising the objectivity of landscape dimensions; in Krutilla, J.V. (ed.), Natural Environment: Studies in Theoretical and Applied Analysis, Johns Hopkins Univ. Press, Baltimore, p. 292-346.

Dearinger, J.A., 1968, Esthetic and recreational potential of small naturalistic streams near urban areas: Univ. Kentucky Water Res. Inst., Research Rept. 13, 260 p.

______, and G.M. Woolwine, 1971, Measuring the intangible values of natural streams, Part I: Application of the uniqueness concept; Univ. Kentucky Water Res. Inst., Research Rept. 40, 86 p.

Downs, R.M., 1970, Geographic space perception, past approaches and future prospects; in Progress in Geography, v. 2, p. 65-108. St. Martin's Press, New York.

Dutton, C.E., 1882, Tertiary history of the Grand Canyon region: U.S. Geol. Survey, Mon. 2, 264 p.

Fabos, J.G., 1971, An analysis of environmental quality ranking systems; in Recreation Symposium Proc., U.S. Dept. Agr., Northeastern Forest Expt. Sta., Upper Darby, Pennsylvania, p. 40-55.

Fabos, J.G., 1973, Model for landscape resource assessment: Part I of the Metropolitan Landscape Planning Model (METLAND); Univ. Massachusetts Agr. Expt. Sta., Research Bull. 602, 141 p.

Fitch, J.M., 1965, Experimental bases for aesthetic decision; Annals New York Acad. Sci., v. 128, p. 706-714.

Hall, E.T., 1969, The Hidden Dimension; Doubleday & Co., Inc., Garden City, 217 p.

Herbst, J., and E.L. Michalson, 1970, A wild and scenic rivers symposium; Univ. Idaho Water Resources Res. Center, Inf. Bull. 6, 41 p.

Kates, R.F., 1962, Hazard and choice perception in flood plain management; Univ. Chicago Dept. Geog., Research Paper 78, 157 p.

Knudson, D.M., C.F. Gerlach, and P.R. Saunders, 1973, Indiana natural, scenic and recreational stream system; Indiana Agr. Expt. Sta., Bull. 2, 60 p.

Leopold, L.B., 1969a, Landscape esthetics; Nat. History, v. 78, no. 8, p. 36-45.

______, 1969b, Quantitative comparison of some aesthetic factors among rivers: U.S. Geol. Survey Circ. 620, 16 p.

______ and M.O. Marchand, 1968, On the quantitative inventory of the riverscape; Water Resources Res., v. 4, no. 4, p. 709-717.

______, F.E. Clarke, B.B. Hanshaw, and J.R. Balsley, 1971, A procedure for evaluating environmental impact: U.S. Geol. Survey Circ. 645, 13 p.

Litton, R.B., Jr., 1968, Forest landscape description and inventories: a basis for land planning and design: U.S. Dept. Agr., Forest Service Res. Paper PSW-49, Pacific Southwest Forest and Range Expt. Sta., Berkeley, California.

______, 1972, Aesthetic dimensions of the landscape: in Krutilla, J.V. (ed.), Natural Environments: Studies in Theoretical and Applied Analysis, Johns Hopkins Univ. Press, Baltimore, p. 262-291.

Lowenthal, David, 1961, Geography, experience, and imagination: toward a geographical epistemology: Annals Assoc. Am. Geog., v. 51, p. 241-260.

Lowenthal, David, 1962, Not every prospect pleases: what is our criterion for scenic beauty?; Landscape, v. 12, no. 1, p. 19-23.

______, 1968, The American scene; Geog. Rev., v. 58, p. 61-88.

Lucas, R.C., 1964, User concepts of wilderness and their implication for resource management; in Western Resources Conference Book--New Horizons for Resources Research: Issues and Methodology, Univ. Colorado Press, Boulder, 340 p.

Marsh, G.P., 1864, Man and Nature: the Earth as modified by man; Scribner and Welford, New York, 472 p.

______, 1871, Man and Nature: or, physical geography as modified by human action; Scribner and Welford, New York, 577 p.

______, 1882, The Earth as Modified by Human Action; revision of 1871 ed. of Man and Nature, Chas. Scribner and Sons, New York, 629 p.

Melhorn, W.N., and E.A. Keller, 1973, Landscape aesthetics numerically determined: applications to highway corridor selection; in Highway Res. Rec., no. 452 (Photogrammetric Analysis of Urban and Rural Environments), p. 1-9.

Moeller, G.H., R. MacLachlan, and D.A. Morrison, 1974, Measuring perception of elements in outdoor environments: U.S. Dept. Agr., Forest Service Res. Paper NE-289, Northeastern Forest Expt. Sta., Upper Darby, Pennsylvanian, 9 p.

Morisawa, Marie, 1970, A hydrologic inventory system; Water Resources Bull., v. 6, no. 5, p. 794-801.

______, 1971?, Evaluation of natural rivers: Final Report of Phase II; Office of Water Resources Res., Project C-1779, 114 p.

______, 1972, A methodology for watershed evaluation; in Csallany, S.C., et al. (eds.), Watersheds in Transition: National Symposium for the International Hydrological Decade, Colorado State Univ., Ft. Collins, p. 153-158.

______ and Martin Murie, 1970, Evaluation of natural rivers: Final Report; Office of Water Resources Res., Project C-1314, 143 p.

Nelson, J.G., and R.W. Butler, 1974, Recreation and the environment; in Mikesell, M.W. and I.R. Manners (eds.), Perspectives on Environment, Assoc. Am. Geog., Pub. 13, p. 290-310.

Newby, F.L., 1971, Understanding the visual resource: in Recreation Symposium Proc., U.S. Dept. Agr., Northeastern Forest Expt. Sta., Upper Darby, Pennsylvania, p. 68-72.

Peckfelder, R.L., 1973, Wild river perception and management, a study of users and managers of the Middle Fork of Salmon River; Univ. Idaho Water Resources Res. Center, Scenic Rivers Study Rept. 8, 108 p.

Russell, I.C., 1885, Geological history of Lake Lahontan, a Quaternary lake of northwestern Nevada; U.S. Geol. Survey, Mon. 11, 288 p.

Saarinen, T.F., 1969, Perception of environment; Assoc. Am. Geog., Resources Paper 5, 37 p.

______, 1974, Environmental perception; in Mikesell, M.W. and I.R. Manners (eds.), Perspectives on Environment, Assoc. Am. Geog., Pub. 13, p. 252-289.

Schellie Assoicates, Inc., 1969, Landscape resources inventory, Madison County, Indiana: pilot study for Indiana Dept. Nat. Resources, 25 p.

Schiff, M.R., 1971, The definition of perception and attitudes: in Sewell, W.R.D., and I. Burton (eds.), Perceptions and Attitudes in Resource Management, Resource Paper 2, Policy Research and Coordination Branch, Dept. Energy, Mines and Resources, Ottawa, Canada, p. 7-12.

Sinatra, J.B., et al. (eds.), 1972, Iowa Awareness Newsletter, v. 1, no. 3, 15 p.

Sonnenfeld, J., 1969, Equivalence and distortion of the perceptual environment; Environment and Behavior, v. 1, p. 83-99.

Thoreau, H.D., 1817, The Selected Journals of Henry David Thoreau; Carl Bode (ed.), New American Library, New York (1967), 327 p.

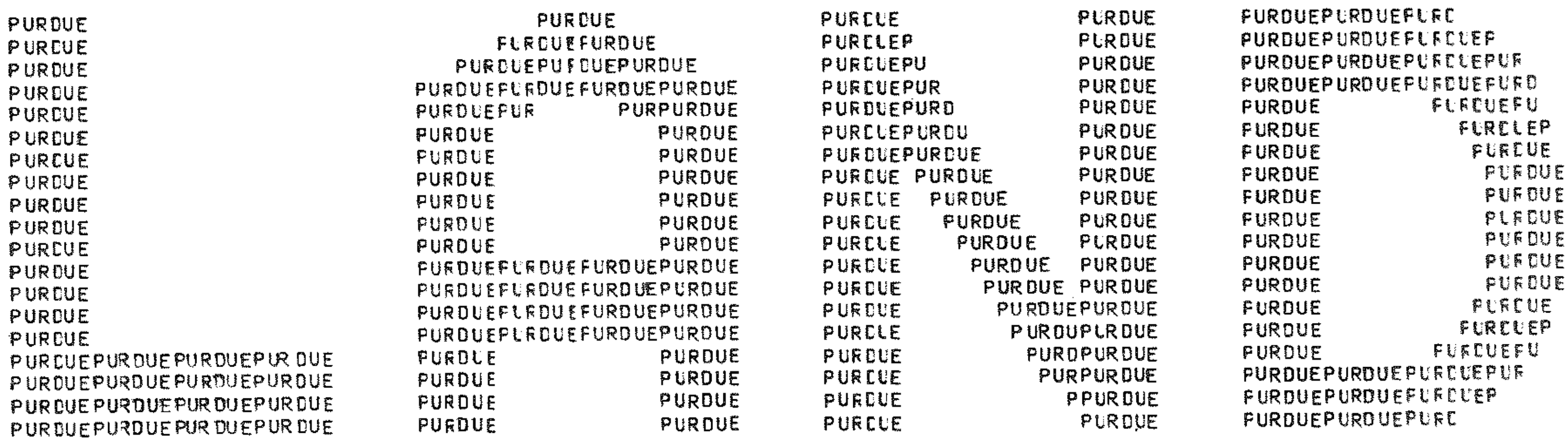
U.S. Dept. of Agriculture, 1966, Guide to making appraisals of potentials for outdoor recreation developments: in National Handbook for Updating the Conservation Needs Inventory, Soil Conserv. Service, Washington.

Von Humboldt, Alexander, 1852, Cosmos: A Sketch of a Physical Description of the Universe; reprint by Harper, New York, v. 1, p. 62.

Whittlesey, D., 1945, Horizon of geography; Annals Assoc. Am. Geog., v. 35, p. 1-36.

Zube, E.H., 1971, The visual landscape: policies, problems, and practices; Univ. Massachusetts, Dept. Landscape Architect., 28 p.

______, 1973, Scenery as a natural resource; Landscape Architect., v. 63, no. 2, p. 126-132.



LANDSCAPE AESTHETICS NUMERICALLY DETERMINED

Note: The LAND program is designed to run on a CDC 6500 computer; other FORTRAN systems may not accept all the statements as written in this program.

```
      PROGRAM LAND (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
C
C        PROGRAM LAND COMPUTES THE RELATIVE UNIQUENESS INDICES
C     AND OTHER SUBSEQUENT INDICES AS THE USER DEFINES.
C
C     USER INPUT IS AS FOLLOWS
C
C     JOB FILE
C     7/8/9 CARD ( END OF FILE )
C                 SOURCE PROGRAM
C      7/8/9 CARD  ( END OF FILE )
C        DATA AS FOLLOWS
C             CARD 1
C        CARD 1 CONTAINS FIVE INTEGERS WHICH DETERMINE
C     THE NUMBER OF UNITS BEING EVALUATED ( I ),
C     THE MODE OF THE PROGRAM ( ICODE ),
C     THE NUMBER OF DIFFERENT MATRICES WHICH ARE EVALUATED ( ICT )
C     THE NUMBER OF FACTORS BEING EVALUATED ( MM )
C     THE NUMBER OF DIVISIONS OF FACTORS  ( N )
C     THESE INTEGERS ARE PUNCHED ON THE DATA CARD USING A 5I5 FORMAT
C
C             CARD 2
C     CARD 2 CONTAINS THE BREAKING POINT FOR EACH DIVISION,
C     IN OTHER WORDS THE NUMBER OF THE LAST FACTOR IN EACH DIVISION.
C     THIS CARD IS PUNCHED USING A 5I5 FORMAT
C     THE USER NEEDS TO FILL ONLY AS MANY OF THE  FIVE DATA
C     LOCATIONS AS THE NUMBER OF DIVISIONS HE IS USING.
C
C             CARDS 3A, 3B, 3C, ETC.
C        THE NEXT DATA CARDS CONTAIN THE NAMES OF THE
C     DIVISIONS OF FACTORS.  THE NAMES ARE PUNCHED IN
C     THE FIRST  TWENTY-FOUR COLUMNS OF THE CARD AND
C     MAY BE SHIFTED IN THE FIELD TO GIVE A MORE PLEASING OUTPUT.
C     ONE CARD IS USED FOR EACH NAME TO AID THE USER IN MODIFYING
C     THE DIVISION NAMES AT SOME LATER TIME.
C
C             CARDS 4A, 4B, ETC.
C        THE NEXT SET OF CARDS CONTAINS THE NAMES OF EACH OF THE FACTORS
C     EACH FACTOR NAME IS PUNCHED IN THE FIRST TWENTY-FOUR COLUMNS.
C     AGAIN A SEPARATE CARD IS USED FOR EACH FACTOR NAME TO AID
C     THE USER IN MODIFICATION OF THE FACTORS AT SOME LATER TIME.
C
C             CARD 5
C        CARD 5 CONTAINS THE LETTERS OR NUMBERS USED TO REFERENCE EACH
C     OF THE STREAM LOCATIONS, PUNCHED IN A 2 COLUMN FORMAT.
C     IF THE COLUMN HEADING IS FOR A SINGLE LETTER OR NUMBER,
C     THEN THE LETTERS OR NUMBERS ARE PLACED IN COLUMNS 2, 4, 6,
C     ETC. ON THE DATA CARD.  FOR DOUBLE LETTER OR TWO DIGIT HEADINGS,
C     THE COLUMNS 1 AND 2, 3 AND 4, 5 AND 6, ETC. WOULD BE USED.
C
C             CARDS 6A, 6B, ETC. FOR ICODE= 1
C        FOR USE WHERE THE LANDSCAPES ARE MEASURED AT STATIONS.
C     CARD 6A1 CONTAINS THE NAME OF THE LANDSCAPE IN COLUMNS
C     ONE TO FORTY WITH THE NUMBER OF STATIONS PUNCHED IN
C     COLUMNS 41 TO 45, VALUES RIGHT JUSTIFIED.
C     CARDS 6A2, 6A3, ETC. CONTAIN THE STATION NAME IN COLUMNS
C     1 TO 40 WITH THE DATA FOR THAT STATION PUNCHED IN COLUMN
C     41 ON, FILLING ONE COLUMN PER FACTOR.
```

```
C     CARDS 6B1, 6B2, 6B3, ETC. 6C1, 6C2, 6C3, ETC. FOLLOW
C     THE SAME FORMAT AS CARDS 6A1, 6A2, ETC. CONTAINING
C     THE NAMES AND DATA FOR ALL THE LANDSCAPES TO BE COMPARED.
C
C             CARDS 6A, 6B, ETC. FOR ICODE = 2
C        FOR USE WHERE THE LANDSCAPE IS MEASURED AS A UNIT.
C     CARDS 6A, 6B, ETC. CONTAIN THE LANDSCAPE LOCATIONS PUNCHED
C     IN THE FIRST FORTY CARD COLUMNS WITH THE EVALUATION NUMBERS
C     FOR EACH FACTOR STARTING IN CARD COLUMN 41.
C
C             CARD 7
C        CARD 7 CONTAINS THE NAME OF THE FIRST MATRIX PUNCHED IN THE
C     FIRST TWENTY-ONE COLUMNS.  THE NUMBER OF CHANGES IN THE MATRIX
C     ( ICH ) IS PUNCHED IN CARD COLUMNS TWENTY-TWO TO TWENTY-FIVE.
C
C             CARDS 8A, 8B, ETC.
C        THESE CARDS CONTAIN THE NUMBER OF THE FACTOR WHICH
C     CAN BE MODIFIED IN COLUMNS ONE TO FIVE AND THE VALUES FOR
C     WHICH FACTOR WILL BE ZEROED IN EVERY SUBSEQUENT FIFTH
C     COLUMN.
C
C     DATA CARDS FOR ALL SUBSEQUENT MATRICES, CARDS 9, 10A, 10B,
C     ETC., FOLLOW THE SAME PATTERN AS CARDS 7 AND 8A, 8B, ETC.
C
C
      DIMENSION SUM(5,100), JDATA(10,100), TCTIND(10,5,20), LCC(10,8)
      COMMON LINE(134),LOCAT(20,8),IS(20),IDATA(20,100),DATA(2,20,112),F
     1ACTOR(3,100),MATRIX(3,10),MCD(100,6),IDIV(5),DIV(3,5),XLOW(6,20),C
     2OL(21),XCOL(20)
      LINE(1)=(6HPURDUE)
      WRITE (6,600) (LINE(1),I=1,190)
      DO 110 J=1,10
  110 COL(J)=(1H )
      JCT=1
C
C     I = NUMBER OF STREAMS
C     ICODE = NUMBER 1 IF EVALUATING STATIONS, 2 IF EVALUATING REACH
C     ICT = NUMBER OF MATRIX
C     MM = NUMBER OF FACTORS
C     N = NUMBER OF DIVISIONS
C     IDIV(J) = BREAKING POINTS FOR EACH DIVISION
C     DIV(J,K) = DIVISION NAMES
C     FACTOR(J,K) = FACTOR NAMES
C
      READ (5,610) I,ICODE,ICT,MM,N,(IDIV(J),J=1,5),((DIV(J,K),J=1,3),K=
     11,N),((FACTOR(J,K),J=1,3),K=1,MM)
      READ (5,630) (XCOL(J),J=1,20)
      IF (ICODE.EQ.1) GO TO 260
  120 IF (I-10) 140,140,130
  130 LSW=I/2
      GO TO 150
  140 LSW=I
  150 DO 160 K=1,5
      DO 160 J=1,MM
  160 SUM(K,J)=0.0
      WRITE (6,620)
      LB=1
      LE=LSW
```

```
      DO 200 J=1,I
         IF (ICODE.EQ.1) GO TO 170
         READ (5,640) (LOCAT(J,K),K=1,8),(IDATA(J,L),L=1,MM)
  170    WRITE (6,650) XCOL(J),(LOCAT(J,K),K=1,8)
         DO 190 L=1,MM
            DO 180 II=1,5
               IF (IDATA(J,L).EQ.II) SUM(II,L)=SUM(II,L)+1.
  180       CONTINUE
  190    CONTINUE
  200 CONTINUE
      LM=LSW+10
      DO 210 J=1,4
  210 LINE(J)=(6H      )
      DO 220 J=5,20
  220 LINE(J)=(6H******)
  230 COL(LF)=(1H*)
      WRITE (6,660) (XCOL(J),COL(J),J=LS,LF)
      WRITE (6,670) (LINE(J),J=1,LM)
      DO 240 L=1,MM
  240 WRITE (6,690) L,(FACTOR(J,L),J=1,3),(IDATA(J,L),COL(J),J=LS,LF)
      WRITE (6,670) (LINE(J),J=1,LM)
      IF (LF-I) 250,320,320
  250 LS=LF+1
      LF=I
      LM=I-LSW+10
      GO TO 230
  260 DO 310 IJ=1,I
         READ (5,700) (LOCAT(IJ,K),K=1,8),JJ
         DO 270 L=1,JJ
  270    READ (5,640) (LOC(L,K),K=1,8),(JDATA(L,K),K=1,MM)
         COL(JJ+1)=(5HREACH)
         COL(JJ)=(5H  *  )
         LM=JJ+6
         WRITE (6,710) (LOCAT(IJ,K),K=1,8),((LOC(L,K),K=1,8),L=1,JJ),(J,
     1   COL(J),J=1,JJ),COL(JJ+1)
         DO 280 J=1,LM
  280    LINE(J)=(7H*******)
         WRITE (6,680) (LINE(J),J=1,LM)
         DO 300 L=1,MM
            AVE=0.0
            DO 290 J=1,JJ
  290       AVE=AVE+FLOAT(JDATA(J,L))
            AVE=AVE/FLOAT(JJ)
C
C
C        IF THE VALUES OF THE FACTORS ARE 5,7, OR 8 CALL CHANGE TO
C        COMPUTE A DIFFERENT VALUE.  CHANGE IS A DIFFERENT METHOD OF
C        DETERMINING THE TOTAL VALUE.
C
C
            IF (L.EQ.5.OR.L.EQ.7.OR.L.EQ.8) CALL CHANGE (L,I,AVE,JDATA)
            IDATA(IJ,L)=AVE
            AVE=AVE-FLOAT(IDATA(IJ,L))
            IF (AVE.GT.0.5) IDATA(IJ,L)=IDATA(IJ,L)+1
  300    WRITE (6,720) L,(FACTOR(J,L),J=1,3),(JDATA(J,L),COL(J),J=1,JJ),
     1   IDATA(IJ,L)
         WRITE (6,680) (LINE(J),J=1,LM)
  310 CONTINUE
```

```
      GO TO 120
  320 WRITE (6,890)
      DO 330 J=1,LM
  330 LINE(J)=(6H      )
      DO 340 J=5,16
  340 LINE(J)=(6H******)
      WRITE (6,670) (LINE(J),J=1,16)
      DO 350 L=1,MM
  350 WRITE (6,730) L,(FACTOR(J,L),J=1,3),(SUM(J,L),J=1,5)
      WRITE (6,670) (LINE(J),J=1,16)
      DO 360 J=1,I
      DO 360 L=1,MM
      DO 360 II=1,5
         IF (IDATA(J,L).EQ.II) DATA(1,J,L)=1.0/SUM(II,L)
         DATA (2,J,L)= DATA(1,J,L)
  360 CONTINUE
      CALL RAM (1,I,MM,N)
  370 READ (5,740) (MATRIX(J,JCT),J=1,3),ICH
      IF (ICH.EQ.0) GO TO 390
      READ (5,750) ((MOD(J,K),K=1,6),J=1,ICH)
      DO 380 J=1,I
      DO 380 K=1,ICH
         LLL=MOD(K,1)
  380 DATA (2,J,LLL)=0.0
  390 CALL RAM (2,I,MM,N)
      NN=N+1
      DO 400 J=1,I
      DO 400 K=1,NN
  400 XLOW(K,J)=DATA(2,J,MM+K)
      IF (ICH.EQ.0) GO TO 420
      DO 410 J=1,I
      DO 410 K=1,ICH
         LLL=MOD(K,1)
         DATA (2,J,LLL)= DATA(1,J,LLL)
      DO 410 L=2,6
  410 IF (IDATA(J,LLL).EQ.MOD(K,L)) DATA(2,J,LLL)=0.0
      CALL RAM (2,I,MM,N)
  420 DO 440 J=1,I
         DO 430 K=1,N
            LLL=MM+NN+K
            A=DATA(1,J,MM+K)-XLOW(K,J)
            IF (A.EQ.0.0) A=1.0
            B=DATA(1,J,MM+K)-DATA(2,J,MM+K)
            DATA (2,J,LLL)= DATA(1,J,LLL)* (1.0-(B/A))
  430    CONTINUE
      DO 440 K=1,N
         DATA (2,J,MM+NN+NN)= DATA(2,J,MM+NN+NN)+ DATA(2,J,MM+NN+K)
  440 CONTINUE
      LS=1
      LF=LSW
      LN=-1+(LSW+6)/2
      LM=LSW+8
      DO 450 J=1,I
  450 COL(J)=(1H )
  460 COL(LF)=(1H*)
      DO 470 K=1,LN
  470 LINE(K)=(7H       )
      DO 480 K=1,3
```

```
480 LINE(LN+K)=MATRIX(K,JCT)
    LINE(LN+4)=(7H MATRIX)
    LN=LN+4
    WRITE (6,760) (LINE(K),K=1,LN)
    WRITE (6,880) (XCOL(J),COL(J),J=LS,LF)
    DO 490 K=1,LM
490 LINE(K)=(7H*******)
    LL=1
    DO 510 K=1,N
       WRITE (6,830) (LINE(L),L=1,LM)
       WRITE (6,770) (DIV(L,K),L=1,3),(COL(L),L=LS,LF)
       NN=JDIV(K)
       DO 500 L=LL,NN
500    WRITE (6,780) L,(FACTOR(J,L),J=1,3),(DATA(2,J,L),COL(J),J=LS,LF
   1   )
       WRITE (6,830) (LINE(L),L=1,LM)
       WRITE (6,790) (DATA(2,J,MM+K),COL(J),J=LS,LF)
       WRITE (6,800) (DIV(J,K),J=1,3),(MATRIX(J,JCT),J=1,3),(DATA(2,J,
   1   MM+N+1+K),COL(J),J=LS,LF)
       WRITE (6,830) (LINE(L),L=1,LM)
       LL=NN+1
510 CONTINUE
    NN=N+1
    LL=MM+2*NN
    LLL=MM+N+1
    WRITE (6,830) (LINE(L),L=1,LM)
    WRITE (6,810) (DATA(2,J,LLL),COL(J),J=LS,LF)
    WRITE (6,820) (MATRIX(J,JCT),J=1,3),(DATA(2,J,LL),COL(J),J=LS,LF)
    WRITE (6,830) (LINE(L),L=1,LM)
    IF (LF-I) 520,530,530
520 LS=LF+1
    LM=I-LSW+8
    LF=I
    GO TO 460
530 DO 540 J=1,I
    DO 540 K=1,NN
       TOTIND(JCT,K,J)=DATA(2,J,MM+NN+K)
540 CONTINUE
    WRITE (6,840) (MATRIX(J,JCT),J=1,3)
    CALL SORTAB (I,MM,N)
    CALL GRAF (I,MM,JCT,N)
    IF (ICH.EQ.0) GO TO 560
    DO 550 J=1,I
    DO 550 K=1,ICH
       LLL=MOD(K,1)
       DATA (2,J,LLL)= DATA(1,J,LLL)
550 CONTINUE
560 JCT=JCT+1
    IF (JCT.LE.ICT) GO TO 370
    K=1
570 L=I
    M=L-K
    IF (M.GT.4) L=K+4
    WRITE (6,860)
    TOT=(8H  TOTAL )
    DO 580 LN=1,3
       WRITE (6,850) (DIV(LN,M),M=1,3),TOT
580 TOT=(8H        )
```

```
      DO 590 J=K,L
  590 WRITE (6,870) (LOCAT(J,M),M=1,8),((MATRIX(M,LL),M=1,3),(TOTIND(LL,
     1KK,J),KK=1,4),LL=1,5)
      K=L+1
      IF (L.LT.I) GO TO 570
C
      STOP
C
C
  600 FORMAT (1H3,A6,33X,A6,15X,A6,13X,A6,6X,2A6,A4/1H ,A6,30X,2A6,12X,A
     16,A1,12X,A6,6X,3A6,A1/1X,A6,27X,3A6,9X,A6,A2,11X,A6,6X,3A6,A3/1X,A
     26,24X,4A6,6X,A6,A3,10X,A6,6X,3A6,A4/1X,A6,24X,A6,A3,6X,A3,A6,6X,A6
     3,A4,9X,A6,6X,A6,8X,A6,A2/1X,A6,24X,A6,12X,A6,6X,A6,A5,8X,A6,6X,A6,
     410X,A6,A1/1X,A6,24X,A6,12),A6,6X,2A6,7X,A6,6X,A6,11X,A6/1X,A6,24X,
     5A6,12X,A6,6X,A6,1X,A6,6X,A6,6X,A6,12X,A6/1X,A6,24X,A6,12X,A6,6X,A6
     6,2X,A6,5X,A6,6X,A6,12X,A6/1X,A6,24X,A6,12X,A6,6X,A6,3X,A6,4X,A6,6X
     7,A6,12X,A6/1X,A6,24X,A6,12X,A6,6X,A6,4X,A6,3X,A6,6X,A6,12X,A6/1X,A
     86,24X,4A6,6X,A6,5X,A6,2X,A6,6X,A6,12X,A6/1X,A6,24X,4A6,6X,A6,6X,A6
     9,1X,A6,6X,A6,12X,A6/1X,A6,24X,4A6,6X,A6,7X,2A6,6X,A6,11X,A6/1X,A6,
     *24X,4A6,6X,A6,8X,A5,A6,6X,A6,10X,A6,A1/1X,4A6,6X,A6,12X,A6,6X,A6,9
     *X,A4,A6,6X,A6,8X,A6,A2/1X,4A6,6X,A6,12X,A6,6X,A6,10X,A3,A6,6X,3A6,
     *A4/1X,4A6,6X,A6,12X,A6,6X,A6,12X,A1,A6,6X,3A6,A1/1X,4A6,6X,A6,12X,
     *A6,6X,A6,13X,A6,6X,2A6,A4////7X,9HLANDSCAPE,22X,10HAESTHETICS,20X,
     *11HNUMERICALLY,21X,10HDETERMINED)
  610 FORMAT (5I5/5I5/(3A8))
  620 FORMAT (1H1,59X,20HLANDSCAPE AESTETICS,/61X,14HDEPT. OF GEOS.,/60X
     1,17HPURDUE UNIVERSITY,///59X,22H LOCATION OF LANDSCAPE)
  630 FORMAT (20A2)
  640 FORMAT (8A5,40I1/60I1)
  650 FORMAT (1H0,47X,A2,5X,8A5)
  660 FORMAT (1H1,55X,28HLANDSCAPE EVALUATION NUMBERS,//63X,18HLANDSCAPE
     1 LOCATION,/1X,30X,6HFACTOR,20X,1H*,4X,10(A2,2X,1A1,1X))
  670 FORMAT (1H ,22A6)
  680 FORMAT (1H ,19A7)
  690 FORMAT (25X,1H*,I4,1X,3A8,3H  *,4X,10(I2,2X,A1,1X))
  700 FORMAT (8A5,I5)
  710 FORMAT (1H1,55X,28HLANDSCAPE EVALUATION NUMBERS,//60X,18HLANDSCAPE
     1 LOCATION,//50X,8A5//60X,17HSTATION LOCATIONS,//10(50X,8A5/)//1X,2
     25X,8HFACTOR *,4X,10(I2,A5),2X,A5)
  720 FORMAT (1H ,1H*,I3,1X,3A8,4H   *,4X,11(I2,A5))
  730 FORMAT (1H ,24X,3H*  ,I2,2X,3A8,4X,1H*,5(3X,F3.0),5X,1H*)
  740 FORMAT (3A7,I4)
  750 FORMAT (6I5)
  760 FORMAT (1H1,18A7/)
  770 FORMAT (2H *,17X,3A8,8H FACTORS,4X,2H* ,10(6X,A1))
  780 FORMAT (2H *,17X,I5,5X,3A8,4H   * ,10(F5.3,1X,A1))
  790 FORMAT (2H *,43X,12HSUBTOTAL   * ,10(F5.2,1X,A1))
  800 FORMAT (2H *,3A8,3A7,10HINDICES * ,10(F5.0,1X,A1))
  810 FORMAT (2H *,46X,9HTOTAL   * ,10(F5.2,1X,A1))
  820 FORMAT (2H *,10X,5HTOTAL,3A7,7HINDICES,10X,2H* ,10(F5.0,1X,A1))
  830 FORMAT (1H ,18A7)
  840 FORMAT (1H1,48X,11HSUMMARY OF ,3A7,7HINDICES,//)
  850 FORMAT (1H ,44X,6(A8,4X))
  860 FORMAT (1H1,55X,22HSUMMARY OF ALL INDICES//)
  870 FORMAT (1H0,8A5//(1H ,11X,3A7,5HINDEX,7X,4(F6.0,6X)))
  880 FORMAT (/60X, 18HLANDSCAPE LOCATION,/55X,1H*,3X,10(A2,2X,A1, 2X))7X
     1,8HFACTOR *,5X,10(I2,2X,A1,2X))
  890 FORMAT (1H1,50X, 37HNUMBER OF LANDSCAPES IN EACH CATAGORY,//66X,
     18HCATAGORY,/32X,6HFACTOR,22X,1H*,5X,1H1,5X,1H2,5X,1H3,5X,1H4,5X,1H
     25,5X,1H*)
C
      END
```

```
      SUBROUTINE GRAF (I,MM,JCT,N)
C
C      SUBROUTINE GRAF PLOTS A BAR GRAPH OF THE COMPUTED INDICES.
C
      DIMENSION XNUM(5), III(5), MARK(5)
      COMMON LINE(134),LOCAT(20,8),IS(20),IDATA(20,100),DATA(2,20,112),F
     1ACTOR(3,100),MATRIX(3,10),WCD(100,6),IDIV(5),DIV(3,5),XLOW(6,20),C
     2OL(21)
      NN=N+1
      MARK(1)=(1H+)
      MARK(2)=(1HO)
      MARK(3)=(1H*)
      MARK(4)=(1H$)
      MARK(5)=(1HX)
      WRITE (6,210) (MATRIX(J,JCT),J=1,3),((DIV(J,K),J=1,3),(MARK(K),L=1
     1,5),K=1,N)
      WRITE (6,250) (J,J=0,1000,100)
      DO 110 J=1,132
  110 LINE(J)=(1H-)
      LINE(1)=(1HI)
      DO 120 J=32,132,10
  120 LINE(J)=(1HI)
      WRITE (6,220) (LINE(J),J=1,132)
      WRITE (6,230)
      DO 130 J=1,132
  130 LINE(J)=(1H )
      DO 180 J=1,I
         LS=1
         LF=4
         LM=1
         DO 170 M=1,2
            DO 140 K=1,100
  140       LINE(K)=(1H )
            DO 150 K=10,100,10
  150       LINE(K)=(1HI)
            X=0.0
            JJ=0
            DO 160 K=1,N
               X=X+DATA(M,J,MM+NN+K)
               II=JJ+1
               JJ=X/10.0
            DO 160 KK=II,JJ
  160       LINE(KK)=MARK(K)
            WRITE (6,240) (LOCAT(J,K),K=LS,LF),MATRIX(1,LM),(LINE(K),K=1
     1      ,100)
            LS=5
            LF=8
            LM=JCT
  170    CONTINUE
         WRITE (6,230)
  180 CONTINUE
      WRITE (6,230)
      DO 190 J=1,132
  190 LINE(J)=(1H-)
      LINE(1)=(1HI)
      DO 200 J=32,132,10
  200 LINE(J)=(1HI)
      WRITE (6,220) (LINE(J),J=1,132)
      WRITE (6,250) (J,J=0,1000,100)
      RETURN
```

```
C
  210 FORMAT (1H1,45X,12HBAR GRAPH OF,1X,3A7,7HINDICES,//(1H ,3A8,1X,5A1
     1))
  220 FORMAT (1H ,132A1)
  230 FORMAT (1H ,1HI,30X,1HI,10(9X,1HI))
  240 FORMAT (1H ,1HI,4A5,2X,A8,1HI,100A1)
  250 FORMAT (1H ,30X,I2,8X,9(I3,7X),I4)
C
      END
```

```
      SUBROUTINE SORTAB (I,MM,N)
C
C       SORTAB IS A ROUTINE THAT CALLS ANOTHER SUBROUTINE TO RANK
C       THE LANDSCAPE VALUES FROM THE GREATEST TO THE LEAST
C       CONCLUSIVELY AND PRINTS THE RESULTS AS A TABLE.
C
      COMMON LINE(134),LOCAT(20,8),IS(20),IDATA(20,100),DATA(2,20,112),F
     1ACTOR(3,100),MATRIX(3,10),MCD(100,6),IDIV(5),DIV(3,5),XLOW(6,20),C
     2OL(21)
      STR=(6HSTREAM)
      TOT=(5HTOTAL)
      DO 110 J=1,3
         WRITE (6,130) STR,(DIV(J,K),K=1,N),TOT
         TOT=(5H     )
  110 STR=(6H      )
      NN=N+1
      CALL SORT (I,NN,MM)
      DO 120 J=1,I
         K=IS(J)
  120 WRITE (6,140) (LOCAT(K,L),L=1,8),(DATA(2,K,MM+L+N),L=1,NN)
      RETURN
C
  130 FORMAT (1H ,14X,A6,25X,5(A8,4X),A5)
  140 FORMAT (1H0,8A5,3X,6(F8.0,4X))
C
      END
```

```
      SUBROUTINE CHANGE (L,I,AVE,JDATA)
C
C      IN THE CASE OF SCME FACTORS, THE AVERAGE VALUE
C      MAY NOT BE THE MOST DESIRABLE METHOD OF OBTAINING THE TOTAL
C      VALUE.   CHANGE IS A RCUTINE WHICH ALLCWS THE USER TO
C      RECOMPUTE THE VALUE FCR THE STATIONS WHEN THE PRCGRAM IS IN MODE
C      1 OTHER THAN AVERAGING THE VALUES OF THE STATICNS.
C
C      EACH FACTOR NUMBER AND METHOD OF CHANGE MUST BE SPECIFIED
C      IN THE PRCGRAM AND SUBROUTINE.
C
      DIMENSION NUM(5), JDATA(10,100)
      COMMON LINE(134),LOCAT(20,8),IS(20),IDATA(20,100),DATA(2,20,112),F
     1ACTOR(3,100),MATRIX(3,10),MCD(100,6),IDIV(5),DIV(3,5),XLOW(6,20),C
     2OL(21)
      A=0.0
      LL=0
      ISW=0
      K=0
      IF (L.NE.5) GO TO 160
      DO 110 J=1,5
  110 NUM(J)=0
      DO 120 J=1,I
         K=JDATA(J,L)
  120 NUM(K)=NUM(K)+1
      DO 130 K=1,5
         IF (NUM(K).LE.LL) GC TO 130
         LL=NUM(K)
         J=K
  130 CONTINUE
      DO 140 K=1,5
         IF (NUM(K).NE.LL) GC TO 140
         IF (K.NE.J) ISW=1
  140 CONTINUE
      IF (ISW) 180,150,180
  150 AVE=J
      GO TO 180
  160 DO 170 J=1,I
         IF (JDATA(J,L).LE.3) A=A+1.
         IF (JDATA(J,L).EC.4) A=A+3.
         IF (JDATA(J,L).EC.5) A=A+5.
  170 CONTINUE
      AVE=A/FLCAT(I)
  180 RETURN
C
      END
```

```
      SUBROUTINE RAM (L,I,MM,N)
C
C       RAM IS A SUBROUTINE WHICH COMPUTES THE VALUES OF ALL
C       INDICES AND RETURNS THOSE VALUES TO THE MAIN PROGRAM.
C
      COMMON LINE(134),LOCAT(20,8),IS(20),IDATA(20,100),DATA(2,20,112),F
     1ACTOR(3,100),MATRIX(3,10),MCD(100,6),IDIV(5),DIV(3,5),XLOW(6,20),C
     2OL(21)
      DO 110 J=1,I
      DO 110 K=1,12
  110 DATA (L,J,MM+K)=0.0
      NN=N+1
      LLL=MM+NN
      JJ=0
      DO 120 K=1,N
         II=JJ+1
         JJ=IDIV(K)
      DO 120 J=1,I
      DO 120 KK=II,JJ
         DATA (L,J,MM+K)= DATA(L,J,MM+K)+ DATA(L,J,KK)
         IF (L.EQ.2) GO TO 120
         ID=(JJ+1-II)*N
         DATA (L,J,LLL+K)= CATA(L,J,MM+K)* 1000.0/FLOAT(ID)
  120 CONTINUE
      DO 130 J=1,I
      DO 130 K=1,N
         DATA (L,J,LLL+NN)= CATA(L,J,LLL+NN)+ DATA(L,J,MM+NN+K)
         DATA (L,J,LLL)= DATA(L,J,LLL)+ DATA(L,J,MM+K)
  130 CONTINUE
      RETURN
C
      END
```

```
      SUBROUTINE SORT (I,NN,MM)
C
C       SORT IS A SUBROUTINE TC SCRT THE INDICES AND RETURN THOSE
C       VALUES TO ANOTHER SLBRCUTINE SORTAL.
C
      COMMON LINE(134),LOCAT(20,8),IS(20),IDATA(20,100),DATA(2,20,112),F
     1ACTOR(3,100),MATRIX(3,10),MCD(100,6),IDIV(5),DIV(3,5),XLOW(6,20),C
     2OL(21)
      IM=MM+2*NN
      DO 110 J=1,I
  110 IS(J)=J
  120 ISW=0
      DO 130 J=2,I
         L=IS(J-1)
         K=IS(J)
         IF (DATA(2,L,IM).GE.CATA(2,K,IM)) GO TO 130
         IS(J)=L
         IS(J-1)=K
         ISW=1
  130 CONTINLE
      IF (ISW.EQ.1) GO TO 120
      RETURN

      END
```

APPENDIX B

INPUT FOR THE LAND SYSTEM

General Statement

The computer program for the LAND system is designed to evaluate various aspects of landscapes. The choice of factors, categories and matrices varies with the type of landscape being evaluated, and the system can be modified to accomodate these variations by changing appropriate data cards.

Input

The correct sequence and format for the data cards is necessary to use the LAND program. A summary of the proper sequence of cards is printed at the beginning of the program in Appendix A and an example is shown in Table B1 (see page B7).

A more specific example of cards 1-10b etc. necessary to evaluate five landscapes in terms of several indices is shown in Figures B1 and B2. A more detailed discussion on how to prepare these cards is as follows:

Card 1 (Fig. B1) contains five integers punched in a 5I5 format, *i.e.*, the computer reads values for five integers; each integer is five digits, one digit per column. The first integer on card 1 refers to the number of landscapes being evaluated; in the example, the integer 5 represents the number of river valleys being evaluated and corresponds to the rivers on cards 6a, 6b, 6c, 6d and 6e. The second integer on card 1 refers to the mode of evaluation that has been selected. This number will always be either 1 or 2 and will occur in column

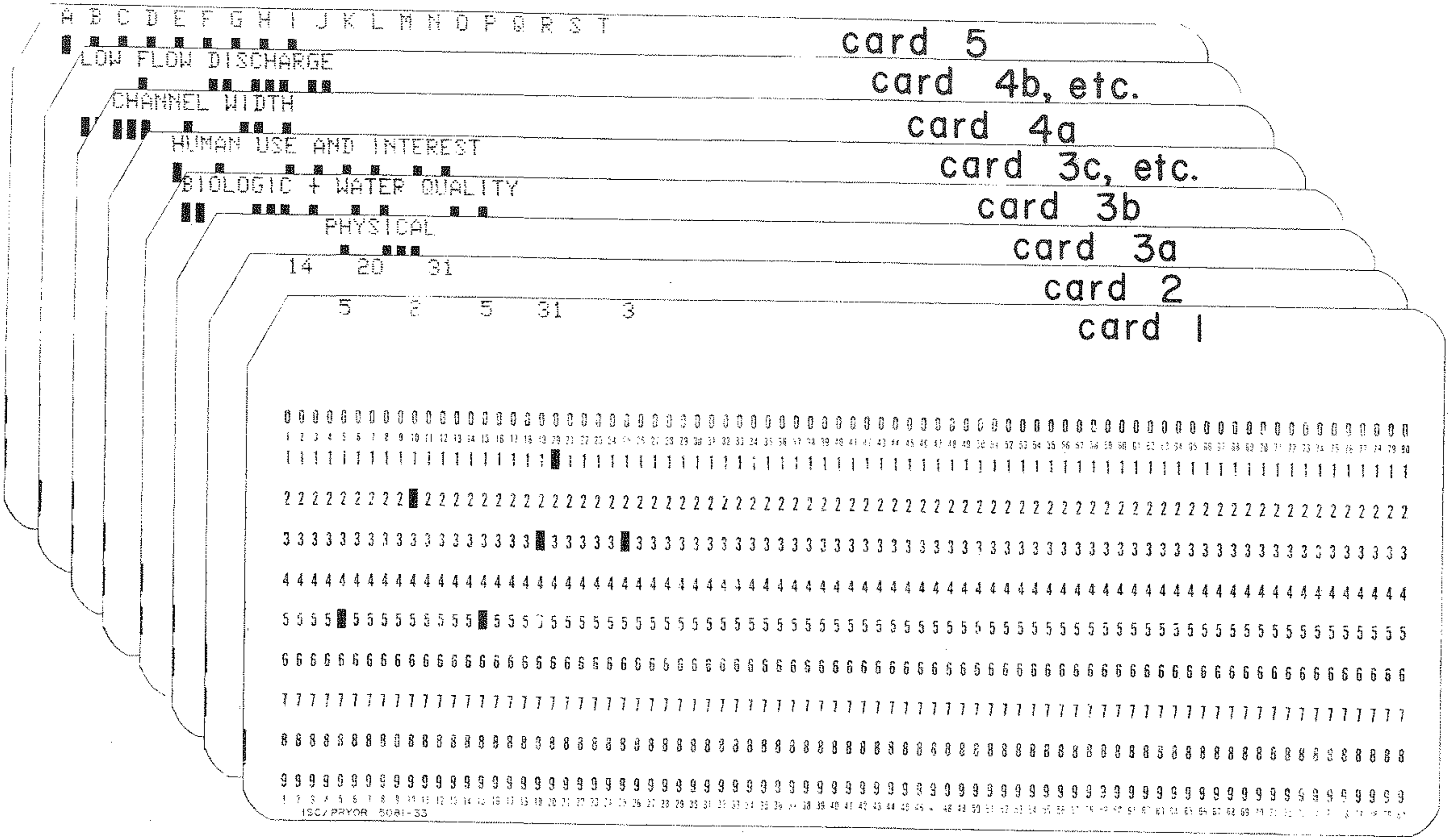


Figure B1. Arrangement of data input cards 1 through 5.

ten on the card. Mode selection is explained on card 6. The third integer on card 1 occurs in column fifteen (fourteen and fifteen for two digit numbers), and indicates the number of matrices or indices as listed on cards 7, 9, 11, 13 and 15. Additional matrices may be added as desired. The fourth integer, columns 19 and 20, shows the total number of descriptive factors used. The fifth integer on card 1, column twenty-five, refers to the number of descriptive categories or divisions into which each matrix is divided, and corresponds to the headings on card 3a, 3b, etc., i.e., physical, biological and water quality, etc.

Card 2 contains the breaking point for each of the categories, and is also printed in a 515 format. The number 14 in columns four and five specifies that factors one through fourteen belong under the physical factors category on card 3a; the number 20 in columns nine and ten specifies that factors fifteen through twenty belong under the biologic and water quality category on card 3b, etc.

Cards 3a, 3b, etc. contain the names of the categories (physical, biologic and water quality, etc.). They are punched in columns one through twenty-four and the spacing can be varied to give a pleasing output.

Cards 4a, 4b, etc. contain the names of the factors, i.e., channel width, low flow discharge, etc., punched in columns one through twenty-four.

Card 5 contains the letters or numbers used to reference each of the landscape locations. In our model, letters were used for the stream locations to avoid confusion with the numbers that appear in the computer print-out. An I2 format is used.

Cards 6a, 6b, etc. (Fig. B2). The LAND program was designed with two modes of evaluation. Mode 1 is used to evaluate landscapes by measurements at individual stations; mode 2 is used to evaluate a landscape as a unit over an entire area. In evaluating reaches of river valleys, mode 2 is appropriate; therefore the number 2 appears in column ten of card 1. For mode 2, cards 6a, 6b, etc. have the stream locations punched in columns one through forty, with the evaluation number for each factor beginning in column forty-one.

Card 7 contains the name of the first matrix (index to be computed) punched in columns one through twenty-one. The number of changes in the matrix resulting from "zeroed" factors is punched in columns twenty-two through twenty-five. For the Uniqueness Index, no factors are zeroed.

Cards 8a, 8b, etc. contain the number of the factor that is to be zeroed, punched in columns one to five. The evaluation numbers which may be zeroed for each factor are punched in every subsequent fifth column. In our exemplary model, cards 8a, 8b, etc. are not included because no factors are zeroed in the uniqueness matrix (see card 7).

Card 9 contains the name of a second matrix (index to be computed) and follows the same punch procedure as outlined for

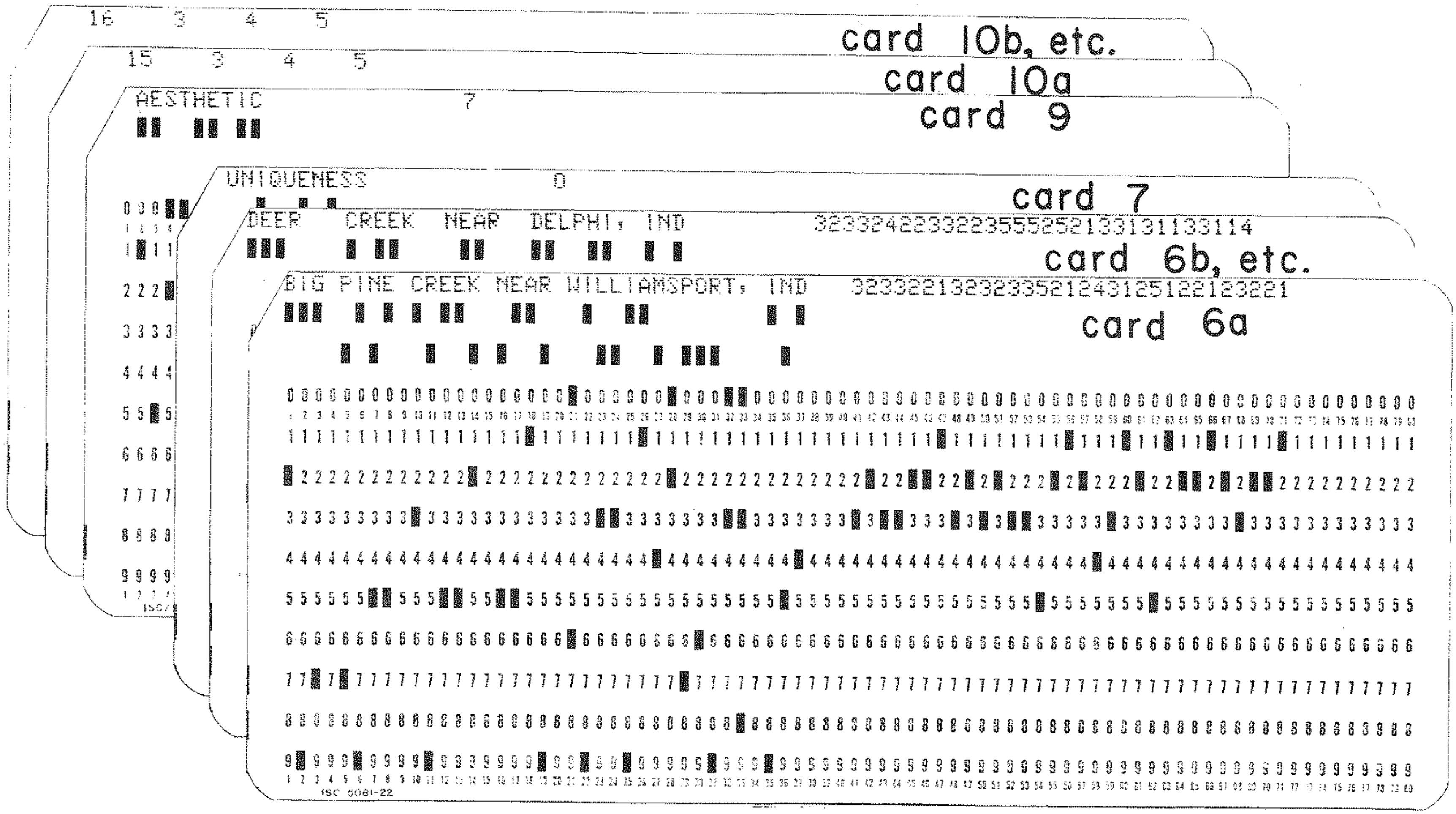


Figure B2. Arrangement of data input cards 6a through 10b.

card 7. Cards 11, 13, 15 etc. may be continued in a similar fashion for all remaining matrices.

Cards 10a, 10b, etc., as well as cards 12a, 12b, etc., follow the same procedure given for cards 8a, 8b, etc. (see Table B1).

OUTPUT FOR THE LAND SYSTEM

General Statement

Two examples of output from the LAND program illustrate the tables and graphs used to display the data and computed indices. The locations of the river valleys analyzed are shown on Figure 2 of the text.

Example 1 is output of individual and summary data for five streams located in west-central Indiana. Example 2 provides similar data output for five streams in southeastern Indiana. The clustering used permits comparison of quality values for streams in an areally limited and rather uniform biological, geological, and physiographical setting. For large scale areal or regional comparison, it is possible to further cluster the ten streams into a single tabular or graphic printout. Data input and output for additional streams is possible; with machine processing the quantity of landscape assessment information which can be accomodated is virtually unlimited.

TABLE B1. Example of correct sequence and format for input of data cards in the LAND program.

```
                 D A T A

CARD
 1        5     2     5    31     3
 2       14    20    31
 3a            PHYSICAL
  b     BICLOGIC + WATER CUALITY
  c       HUMAN USE AND INTEREST
 4a     CHANNEL WIDTH
  b     LOW FLOW DISCHARGE
  c     AVERAGE DISCHARGE
  d     BASIN AREA(SG. MI.)
  e     CHANNEL PATTERN
  f     VALLEY WIDTH/HEIGHT
  g     BED MATERIAL
  h     BANK AND VALLEY MATERIAL
  i     BEDSLOPE
  j     WIDTH OF VALLEY FLAT
  k     EROSION OF BANKS
  l     VALLEY SLOPE
  m     SINUOSITY
  n     NO. OF TRIBUTARIES
  o     WATER COLOR
  p     FLOATING MATERIAL
  q     ALGAE
  r     LANDPLANTS-FLCOD PLAIN
  s     LANCPLANTS-HILLSLOPE
  t     WATER PLANTS
  u     TRASH / 100 FT.
  v     VARIABILITY CF TRASH
  w     ARTIFICIAL CONTROL
  x     UTILITIES, BRIDGES, ROACS
  y     URBANIZATION
  z     HISTORICAL FEATURES
 aa     LOCAL SCENE
 bb     VIEW CONFINEMENT
 cc     RAPID AND FALLS
 dd     LAND USE
 ee     MISFITS
 5        A B C D E F G H I J K L M N O P Q R S T
 6a     BIG PINE CREEK NEAR WILLIAMSPORT, IND    3233221323233521243125122123221
  b     DEER    CREEK   NEAR   DELPHI, IND       3233242233223555252133131133114
  c     EEL     RIVER   NEAR   LOGANSPORT, IND   4444151125112522155324134132112
  d     TIPPECANOE RIVER NR DELPHI, IND          4555241124223525152132544122122
  e     WILDCAT  CREEK   AT   OWASCO, IND        3233251114213541252233131233113
*7        UNIQUENESS                0
 9        AESTHETIC                 7
10a      15     3     4     5
  b      16     3     4     5
  c      17     4     5
  d      21     3     4     5
  e      22     1     2     3
  f      27     4     5
  g      31     3     4     5
11        WILD RIVER               10
12a      16     3     4     5
  b      18     4     5
  c      19     4     5
  d      21     3     4     5
  e      22     1     2     3
  f      23     2     3     4     5
  g      24     2     3     4     5
  h      25     2     3     4     5
  i      30     1     3     4     5
  j      31     2     3     4     5
13        SCENIC RIVER             10
14a      16     3     4     5
  b      17     4     5
  c      21     4     5
  d      22     1     2
  e      23     4     5
  f      24     3     4     5
  g      25     4     5
  h      27     3     4     5
  i      30     3     4     5
  j      31     4     5
15        RECREATIONAL RIVER        5
16a      16     3     4     5
  b      17     5
  c      24     1
  d      25     1
  e      27     4     5
```

* Card 8a,8b, etc.are not present because the number of changes in the uniqueness matrix is zero.

Example 1

LOCATION OF LANDSCAPE

A	BIG RACCOON CREEK AT COXVILLE, IND
B	EEL RIVER AT BOWLING GREEN, IND
C	SALT CREEK NEAR PEERLESS, IND
D	SUGAR CREEK NEAR BYRON, IND
E	WHITE RIVER AT SPENCER, IND

LANDSCAPE EVALUATION NUMBERS

	FACTOR	LANDSCAPE LOCATION A	B	C	D	E
1	CHANNEL WIDTH	3	3	3	4	4
2	LOW FLOW DISCHARGE	3	2	2	3	5
3	AVERAGE DISCHARGE	3	4	4	4	5
4	BASIN AREA(SQ. MI.)	3	4	4	4	5
5	CHANNEL PATTERN	1	1	3	1	1
6	VALLEY WIDTH/HEIGHT	4	5	4	3	4
7	BED MATERIAL	1	1	2	3	1
8	BANK AND VALLEY MATERIAL	2	1	4	4	1
9	BEDSLOPE	2	1	1	3	1
10	WIDTH OF VALLEY FLAT	4	5	4	2	4
11	EROSION OF BANKS	3	3	3	1	3
12	VALLEY SLOPE	2	1	3	2	2
13	SINUOSITY	1	2	1	1	1
14	NO. OF TRIBUTARIES	2	3	3	5	5
15	WATER COLOR	2	3	4	3	3
16	FLOATING MATERIAL	3	3	4	3	1
17	ALGAE	4	4	4	4	4
18	LANDPLANTS-FLOOD PLAIN	4	4	4	5	4
19	LANDPLANTS-HILLSLOPE	2	2	3	3	3
20	WATER PLANTS	1	1	1	3	1
21	TRASH / 100 FT.	2	2	2	2	3
22	VARIABILITY OF TRASH	3	3	2	2	3
23	ARTIFICIAL CONTROL	2	2	1	1	2
24	UTILITIES, BRIDGES, ROAD	2	3	4	2	3
25	URBANIZATION	4	3	4	2	4
26	HISTORICAL FEATURES	3	1	1	2	1
27	LOCAL SCENE	2	2	2	1	2
28	VIEW CONFINEMENT	2	2	3	3	1
29	RAPID AND FALLS	1	1	1	1	1
30	LAND USE	5	1	5	2	5
31	MISFITS	4	5	4	1	1

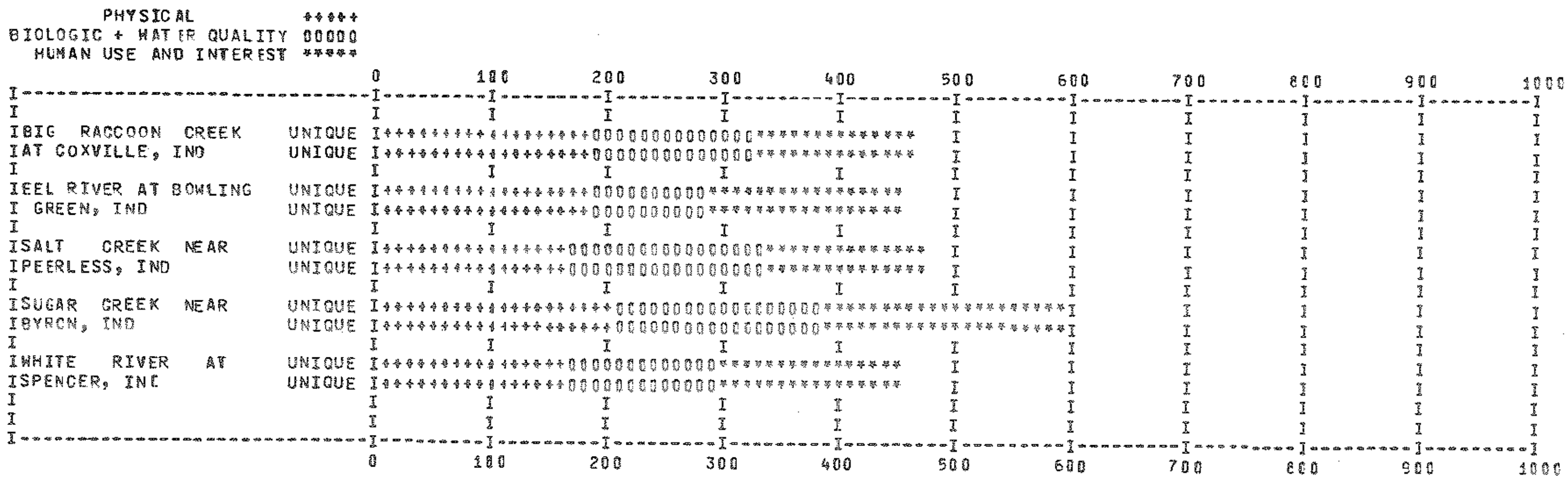
UNIQUENESS MATRIX

		LANDSCAPE LOCATION A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.333	.333	.333	.500	.500
2	LOW FLOW DISCHARGE	.500	.500	.500	.500	1.000
3	AVERAGE DISCHARGE	1.000	.333	.333	.333	1.000
4	BASIN AREA(SQ. MI.)	1.000	.333	.333	.333	1.000
5	CHANNEL PATTERN	.250	.250	1.000	.250	.250
6	VALLEY WIDTH/HEIGHT	.333	1.000	.333	1.000	.333
7	BED MATERIAL	.333	.333	1.000	1.000	.333
8	BANK AND VALLEY MATERIAL	1.000	.500	.500	.500	.500
9	BEDSLOPE	1.000	.333	.333	1.000	.333
10	WIDTH OF VALLEY FLAT	.333	1.000	.333	1.000	.333
11	EROSION OF BANKS	.250	.250	.250	1.000	.250
12	VALLEY SLOPE	.333	1.000	1.000	.333	.333
13	SINUOSITY	.250	1.000	.250	.250	.250
14	NO. OF TRIBUTARIES	1.000	.500	.500	.500	.500
	SUBTOTAL	7.92	7.67	7.00	8.50	6.92
	PHYSICAL UNIQUENESS INDICES	188	183	167	202	165
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	1.000	.333	1.000	.333	.333
16	FLOATING MATERIAL	.333	.333	1.000	.333	1.000
17	ALGAE	.200	.200	.200	.200	.200
18	LANDPLANTS-FLOOD PLAIN	.250	.250	.250	1.000	.250
19	LANDPLANTS-HILLSLOPE	.500	.500	.333	.333	.333
20	WATER PLANTS	.250	.250	.250	1.000	.250
	SUBTOTAL	2.53	1.87	3.03	3.20	2.37
	BIOLOGIC + WATER QUALITY UNIQUENESS INDICES	141	104	169	178	131
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	.250	.250	.250	.250	1.000
22	VARIABILITY OF TRASH	.333	.333	.500	.500	.333
23	ARTIFICIAL CONTROL	.333	.333	.500	.500	.333
24	UTILITIES, BRIDGES, ROAD	.500	.500	1.000	.500	.500
25	URBANIZATION	.333	1.000	.333	1.000	.333
26	HISTORICAL FEATURES	1.000	.333	.333	1.000	.333
27	LOCAL SCENE	.250	.250	.250	1.000	.250
28	VIEW CONFINEMENT	.500	.500	.500	.500	1.000
29	RAPID AND FALLS	.200	.200	.200	.200	.200
30	LAND USE	.333	1.000	.333	1.000	.333
31	MISFITS	.500	1.000	.500	.500	.500
	SUBTOTAL	4.53	5.70	4.70	6.95	5.12
	HUMAN USE AND INTEREST UNIQUENESS INDICES	137	173	142	211	155
	TOTAL	14.98	15.23	14.73	18.65	14.40
	TOTAL UNIQUENESS INDICES	467	459	478	591	451

SUMMARY OF UNICLENESS INDICES

STREAM	PHYSICAL	BIOLOGIC + WATER QUALITY	HUMAN USE AND INTEREST	TOTAL
SUGAR CREEK NEAR BYRON, IND	202	178	211	591
SALT CREEK NEAR PEERLESS, IND	167	169	142	478
BIG RACCOON CREEK AT COXVILLE, IND	188	141	137	467
EEL RIVER AT BOWLING GREEN, IND	183	104	173	459
WHITE RIVER AT SPENCER, IND	165	131	155	451

BAR GRAPH OF UNIQUENESS INDICES



AESTHETIC MATRIX

		LANDSCAPE LOCATION A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.333	.333	.333	.500	.500
2	LOW FLOW DISCHARGE	.500	.500	.500	.500	1.000
3	AVERAGE DISCHARGE	1.000	.333	.333	.333	1.000
4	BASIN AREA(SQ. MI.)	1.000	.333	.333	.333	1.000
5	CHANNEL PATTERN	.250	.250	1.000	.250	.250
6	VALLEY WIDTH/HEIGHT	.333	1.000	.333	1.000	.333
7	BED MATERIAL	.333	.333	1.000	1.000	.333
8	BANK AND VALLEY MATERIAL	1.000	.500	.500	.500	.500
9	BEDSLOPE	1.000	.333	.333	1.000	.333
10	WIDTH OF VALLEY FLAT	.333	1.000	.333	1.000	.333
11	EROSION OF BANKS	.250	.250	.250	1.000	.250
12	VALLEY SLOPE	.333	1.000	1.000	.333	.333
13	SINUOSITY	.250	1.000	.250	.250	.250
14	NO. OF TRIBUTARIES	1.000	.500	.500	.500	.500
	SUBTOTAL	7.92	7.67	7.00	8.50	6.92
	PHYSICAL AESTHETIC INDICES	188	183	167	202	165
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	1.000	0.000	0.000	0.000	0.000
16	FLOATING MATERIAL	0.000	0.000	0.000	0.000	1.000
17	ALGAE	0.000	0.000	0.000	0.000	0.000
18	LANDPLANTS-FLOOD PLAIN	.250	.250	.250	1.000	.250
19	LANDPLANTS-HILLSLOPE	.500	.500	.333	.333	.333
20	WATER PLANTS	.250	.250	.250	1.000	.250
	SUBTOTAL	2.00	1.00	.83	2.33	1.83
	BIOLOGIC + WATER QUALITY AESTHETIC INDICES	92	0	0	0	86
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	.250	.250	.250	.250	0.000
22	VARIABILITY OF TRASH	0.000	0.000	0.000	0.000	0.000
23	ARTIFICIAL CONTROL	.333	.333	.500	.500	.533
24	UTILITIES, BRIDGES, ROAD	.500	.500	1.000	.500	.500
25	URBANIZATION	.333	1.000	.333	1.000	.333
26	HISTORICAL FEATURES	1.000	.333	.333	1.000	.333
27	LOCAL SCENE	.250	.250	.250	1.000	.250
28	VIEW CONFINEMENT	.500	.500	.500	.500	1.000
29	RAPID AND FALLS	.200	.200	.200	.200	.200
30	LAND USE	.333	1.000	.333	1.000	.333
31	MISFITS	0.000	0.000	0.000	.500	.500
	SUBTOTAL	3.70	4.37	3.70	6.45	3.78
	HUMAN USE AND INTEREST AESTHETIC INDICES	52	47	47	164	56
	TOTAL	13.62	13.03	11.53	17.28	12.53
	TOTAL AESTHETIC INDICES	332	230	214	366	306

SUMMARY OF AESTHETIC INDICES

STREAM	PHYSICAL	BIOLOGIC + WATER QUALITY	HUMAN USE AND INTEREST	TOTAL
SUGAR CREEK NEAR BYRON, IND	202	0	164	366
BIG RACCOON CREEK AT COXVILLE, IND	188	92	52	332
WHITE RIVER AT SPENCER, IND	165	86	56	306
EEL RIVER AT BOWLING GREEN, IND	183	0	47	230
SALT CREEK NEAR PEERLESS, IND	167	0	47	214

```
                                        BAR GRAPH OF  AESTHETIC          INDICES

       PHYSICAL         +++++
BIOLOGIC + WATER QUALITY 00000
  HUMAN USE AND INTEREST *****
                                0        100       200       300       400       500       600       700       800       900       1000
I-------------------------------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
I                               I         I         I         I         I         I         I         I         I         I         I
IBIG  RACCOON  CREEK     UNIQUE I+++++++++++++++++++00000000000000**************  I         I         I         I         I         I
IAT COXVILLE, IND        AESTHE I+++++++++++++++++++0000000000*****     I         I         I         I         I         I         I
I                               I         I         I         I         I         I         I         I         I         I         I
IEEL RIVER AT BOWLING    UNIQUE I+++++++++++++++++++0000000000*****************   I         I         I         I         I         I
I GREEN, IND             AESTHE I++++++++++++++++++++****     I         I         I         I         I         I         I         I
I                               I         I         I         I         I         I         I         I         I         I         I
ISALT   CREEK  NEAR      UNIQUE I+++++++++++++++++00000000000000000************** I         I         I         I         I         I
IPEERLESS, IND           AESTHE I++++++++++++++++++*****      I         I         I         I         I         I         I         I
I                               I         I         I         I         I         I         I         I         I         I         I
ISUGAR  CREEK  NEAR      UNIQUE I+++++++++++++++++++++00000000000000000*********************I         I         I         I         I
IBYRON, IND              AESTHE I+++++++++++++++++++++****************  I         I         I         I         I         I         I
I                               I         I         I         I         I         I         I         I         I         I         I
IWHITE   RIVER   AT      UNIQUE I+++++++++++++++++0000000000000****************   I         I         I         I         I         I
ISPENCER, IND            AESTHE I+++++++++++++++++000000000*****        I         I         I         I         I         I         I
I                               I         I         I         I         I         I         I         I         I         I         I
I                               I         I         I         I         I         I         I         I         I         I         I
I-------------------------------I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                                0        100       200       300       400       500       600       700       800       900       1000
```

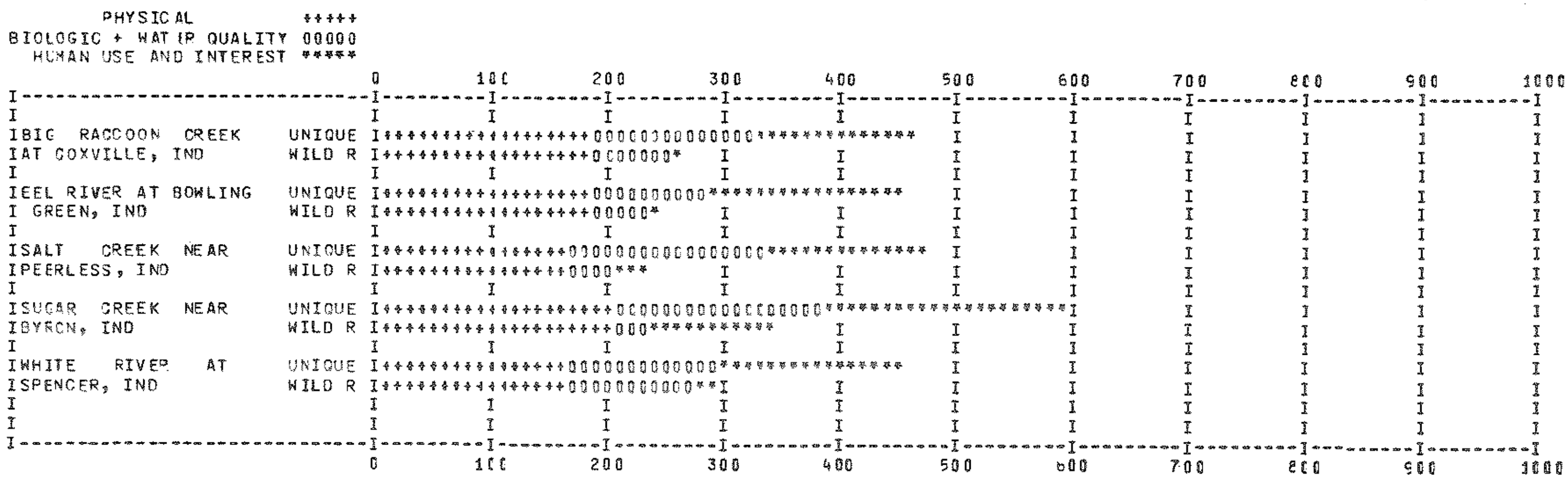
WILD RIVER MATRIX

		LANDSCAPE LOCATION A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.333	.333	.333	.500	.500
2	LOW FLOW DISCHARGE	.500	.500	.500	.500	1.000
3	AVERAGE DISCHARGE	1.000	.333	.333	.333	1.000
4	BASIN AREA(SQ. MI.)	1.000	.333	.333	.333	1.000
5	CHANNEL PATTERN	.250	.250	1.000	.250	.250
6	VALLEY WIDTH/HEIGHT	.333	1.000	.333	1.000	.333
7	BED MATERIAL	.333	.333	1.000	1.000	.333
8	BANK AND VALLEY MATERIAL	1.000	.500	.500	.500	.500
9	BEDSLOPE	1.000	.333	.333	1.000	.333
10	WIDTH OF VALLEY FLAT	.333	1.000	.333	1.000	.333
11	EROSION OF BANKS	.250	.250	.250	1.000	.250
12	VALLEY SLOPE	.333	1.000	1.000	.333	.333
13	SINUOSITY	.250	1.000	.250	.250	.250
14	NO. OF TRIBUTARIES	1.000	.500	.500	.500	.500
	SUBTOTAL	7.92	7.67	7.00	8.50	6.92
	PHYSICAL WILD RIVER INDICES	168	183	167	202	165
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	1.000	.333	1.000	.333	.333
16	FLOATING MATERIAL	0.000	0.000	0.000	0.000	1.000
17	ALGAE	.200	.200	.200	.200	.200
18	LANDPLANTS-FLOOD PLAIN	0.000	0.000	0.000	0.000	0.000
19	LANDPLANTS-HILLSLOPE	.500	.500	.333	.333	.333
20	WATER PLANTS	.250	.250	.250	1.000	.250
	SUBTOTAL	1.95	1.28	1.78	1.87	2.12
	BIOLOGIC + WATER QUALITY WILD RIVER INDICES	65	48	35	36	111
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	.250	.250	.250	.250	0.000
22	VARIABILITY OF TRASH	0.000	0.000	0.000	0.000	0.000
23	ARTIFICIAL CONTROL	0.000	0.000	.500	.500	0.000
24	UTILITIES, BRIDGES, ROAD	0.000	0.000	0.000	0.000	0.000
25	URBANIZATION	0.000	0.000	0.000	0.000	0.000
26	HISTORICAL FEATURES	1.000	.333	.333	1.000	.333
27	LOCAL SCENE	.250	.250	.250	1.000	.250
28	VIEW CONFINEMENT	.500	.500	.500	.500	1.000
29	RAPID AND FALLS	.200	.200	.200	.200	.200
30	LAND USE	0.000	0.000	0.000	1.000	0.000
31	MISFITS	0.000	0.000	0.000	.500	.500
	SUBTOTAL	2.20	1.53	2.03	4.95	2.28
	HUMAN USE AND INTEREST WILD RIVER INDICES	13	10	31	111	23
	TOTAL	12.07	10.48	10.82	15.32	11.32
	TOTAL WILD RIVER INDICES	267	240	233	349	299

SUMMARY OF WILD RIVER INDICES

STREAM	PHYSICAL	BIOLOGIC + WATER QUALITY	HUMAN USE AND INTEREST	TOTAL
SUGAR CREEK NEAR BYRON, IND	202	36	111	349
WHITE RIVER AT SPENCER, IND	165	111	23	299
BIG RACCOON CREEK AT COXVILLE, IND	188	65	13	267
EEL RIVER AT BOWLING GREEN, IND	183	48	10	240
SALT CREEK NEAR PEERLESS, IND	167	35	31	233

BAR GRAPH OF WILD RIVER INDICES



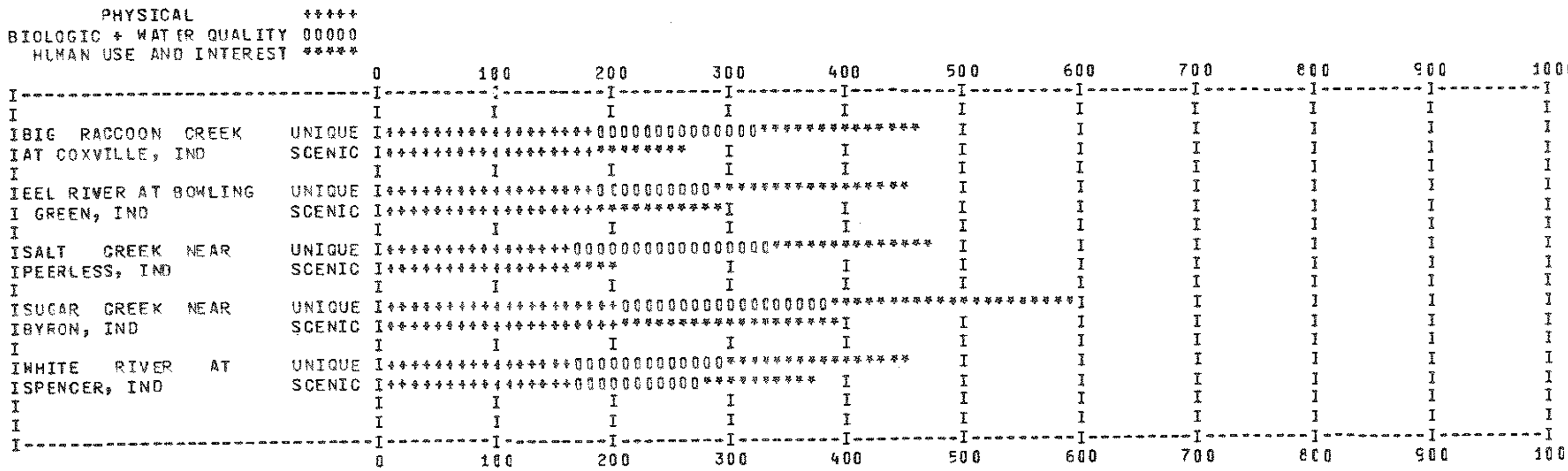
SCENIC RIVER MATRIX

		LANDSCAPE LOCATION A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.333	.333	.333	.500	.500
2	LOW FLOW DISCHARGE	.500	.500	.500	.500	1.000
3	AVERAGE DISCHARGE	1.000	.333	.333	.333	1.000
4	BASIN AREA(SQ. MI.)	1.000	.333	.333	.333	1.000
5	CHANNEL PATTERN	.250	.250	1.000	.250	.250
6	VALLEY WIDTH/HEIGHT	.333	1.000	.333	1.000	.333
7	BED MATERIAL	.333	.333	1.000	1.000	.333
8	BANK AND VALLEY MATERIAL	1.000	.500	.500	.500	.500
9	BEDSLOPE	1.000	.333	.333	1.000	.333
10	WIDTH OF VALLEY FLAT	.333	1.000	.333	1.000	.333
11	EROSION OF BANKS	.250	.250	.250	1.000	.250
12	VALLEY SLOPE	.333	1.000	1.000	.333	.333
13	SINUOSITY	.250	1.000	.250	.250	.250
14	NO. OF TRIBUTARIES	1.000	.500	.500	.500	.500
	SUBTOTAL	7.92	7.67	7.00	8.50	6.92
	PHYSICAL SCENIC RIVER INDICES	188	183	167	202	165
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	1.000	.333	1.000	.333	.333
16	FLOATING MATERIAL	0.000	0.000	0.000	0.000	1.000
17	ALGAE	0.000	0.000	0.000	0.000	0.000
18	LANDPLANTS-FLOOD PLAIN	.250	.250	.250	1.000	.250
19	LANDPLANTS-HILLSLOPE	.500	.500	.333	.333	.333
20	WATER PLANTS	.250	.250	.250	1.000	.250
	SUBTOTAL	2.00	1.33	1.83	2.67	2.17
	BIOLOGIC + WATER QUALITY SCENIC RIVER INDICES	0	0	0	0	110
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	.250	.250	.250	.250	1.000
22	VARIABILITY OF TRASH	.333	.333	0.000	0.000	.333
23	ARTIFICIAL CONTROL	.333	.333	.500	.500	.333
24	UTILITIES, BRIDGES, ROAD	.500	0.000	0.000	.500	0.000
25	URBANIZATION	0.000	1.000	0.000	1.000	0.000
26	HISTORICAL FEATURES	1.000	.333	.333	1.000	.333
27	LOCAL SCENE	.250	.250	.250	1.000	.250
28	VIEW CONFINEMENT	.500	.500	.500	.500	1.000
29	RAPID AND FALLS	.200	.200	.200	.200	.200
30	LAND USE	0.000	1.000	0.000	1.000	0.000
31	MISFITS	0.000	0.000	0.000	.500	.500
	SUBTOTAL	3.37	4.20	2.03	6.45	3.95
	HUMAN USE AND INTEREST SCENIC RIVER INDICES	81	117	39	191	105
	TOTAL	13.28	13.20	10.87	17.62	13.03
	TOTAL SCENIC RIVER INDICES	269	300	206	393	379

SUMMARY OF SCENIC RIVER INDICES

STREAM	PHYSICAL	BIOLOGIC + WATER QUALITY	HUMAN USE AND INTEREST	TOTAL
SUGAR CREEK NEAR BYRON, IND	202	0	191	393
WHITE RIVER AT SPENCER, IND	165	110	105	379
EEL RIVER AT BOWLING GREEN, IND	183	0	117	300
BIG RACCOON CREEK AT COXVILLE, IND	188	0	81	269
SALT CREEK NEAR PEERLESS, IND	167	0	39	206

BAR GRAPH OF SCENIC RIVER INDICES



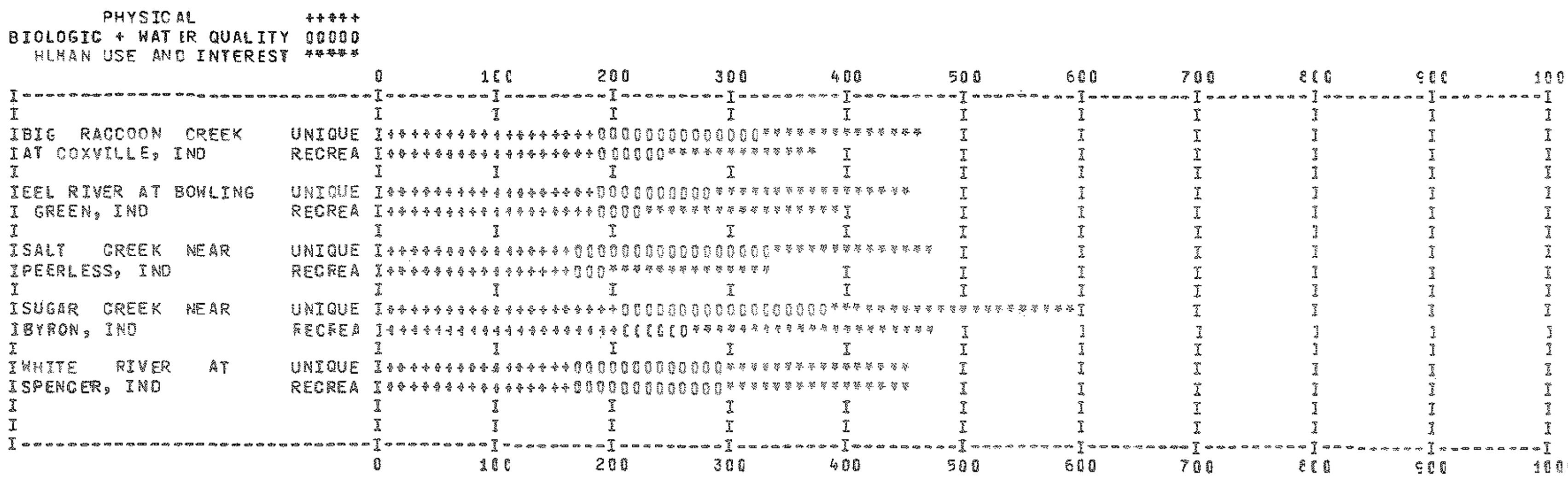
RECREATIONAL RIVER MATRIX

		LANDSCAPE LOCATION A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.333	.333	.333	.500	.500
2	LOW FLOW DISCHARGE	.500	.500	.500	.500	1.000
3	AVERAGE DISCHARGE	1.000	.333	.333	.333	1.000
4	BASIN AREA(SQ. MI.)	1.000	.333	.333	.333	1.000
5	CHANNEL PATTERN	.250	.250	1.000	.250	.250
6	VALLEY WIDTH/HEIGHT	.333	1.000	.333	1.000	.333
7	BED MATERIAL	.333	.333	1.000	1.000	.333
8	BANK AND VALLEY MATERIAL	1.000	.500	.500	.500	.500
9	BEDSLOPE	1.000	.333	.333	1.000	.333
10	WIDTH OF VALLEY FLAT	.333	1.000	.333	1.000	.333
11	EROSION OF BANKS	.250	.250	.250	1.000	.250
12	VALLEY SLOPE	.333	1.000	1.000	.333	.333
13	SINUOSITY	.250	1.000	.250	.250	.250
14	NO. OF TRIBUTARIES	1.000	.500	.500	.500	.500
	SUBTOTAL	7.92	7.67	7.00	8.50	6.92
	PHYSICAL RECREATIONAL RIVER INDICES	188	183	167	202	165
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	1.000	.333	1.000	.333	.333
16	FLOATING MATERIAL	0.000	0.000	0.000	0.000	1.000
17	ALGAE	.200	.200	.200	.200	.200
18	LANDPLANTS-FLOOD PLAIN	.250	.250	.250	1.000	.250
19	LANDPLANTS-HILLSLOPE	.500	.500	.333	.333	.333
20	WATER PLANTS	.250	.250	.250	1.000	.250
	SUBTOTAL	2.20	1.53	2.03	2.87	2.37
	BIOLOGIC + WATER QUALITY RECREATIONAL RIVER INDICES	53	39	28	67	131
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	.250	.250	.250	.250	1.000
22	VARIABILITY OF TRASH	.333	.333	.500	.500	.333
23	ARTIFICIAL CONTROL	.333	.333	.500	.500	.333
24	UTILITIES, BRIDGES, ROAD	.500	.500	1.000	.500	.500
25	URBANIZATION	.333	1.000	.333	1.000	.333
26	HISTORICAL FEATURES	1.000	.333	.333	1.000	.333
27	LOCAL SCENE	.250	.250	.250	1.000	.250
28	VIEW CONFINEMENT	.500	.500	.500	.500	1.000
29	RAPID AND FALLS	.200	.200	.200	.200	.200
30	LAND USE	.333	1.000	.333	1.000	.333
31	MISFITS	.500	1.000	.500	.500	.500
	SUBTOTAL	4.53	5.70	4.70	6.95	5.12
	HUMAN USE AND INTEREST RECREATIONAL RIVER INDICES	137	173	142	211	155
	TOTAL	14.65	14.90	13.73	18.32	14.40
	TOTAL RECREATIONAL RIVER INDICES	379	394	337	480	451

SUMMARY OF RECREATIONAL RIVER INDICES

STREAM	PHYSICAL	BIOLOGIC + WATER QUALITY	HUMAN USE AND INTEREST	TOTAL
SUGAR CREEK NEAR BYRON, IND	202	67	211	480
WHITE RIVER AT SPENCER, IND	165	131	155	451
EEL RIVER AT BOWLING GREEN, IND	183	39	173	394
BIG RACCOON CREEK AT COXVILLE, IND	188	53	137	379
SALT CREEK NEAR PEERLESS, IND	167	28	142	337

BAR GRAPH OF RECREATIONAL RIVER INDICES



SUMMARY OF ALL INDICES

		PHYSICAL	BIOLOGIC + WATER QUALITY	HUMAN USE AND INTEREST	TOTAL
BIG RACCOON CREEK AT COXVILLE, IND					
UNIQUENESS	INDEX	188	141	137	467
AESTHETIC	INDEX	188	92	52	332
WILD RIVER	INDEX	188	65	13	267
SCENIC RIVER	INDEX	188	0	81	269
RECREATIONAL RIVER	INDEX	189	53	137	379
EEL RIVER AT BOWLING GREEN, IND					
UNIQUENESS	INDEX	183	104	173	459
AESTHETIC	INDEX	183	0	47	230
WILD RIVER	INDEX	183	48	10	240
SCENIC RIVER	INDEX	183	0	117	300
RECREATIONAL RIVER	INDEX	183	39	173	394
SALT CREEK NEAR PEERLESS, IND					
UNIQUENESS	INDEX	167	169	142	478
AESTHETIC	INDEX	167	0	47	214
WILD RIVER	INDEX	167	35	31	233
SCENIC RIVER	INDEX	167	0	39	206
RECREATIONAL RIVER	INDEX	167	28	142	337
SUGAR CREEK NEAR BYRON, IND					
UNIQUENESS	INDEX	202	178	211	591
AESTHETIC	INDEX	202	0	164	366
WILD RIVER	INDEX	202	36	111	349
SCENIC RIVER	INDEX	202	0	191	393
RECREATIONAL RIVER	INDEX	202	67	211	480
WHITE RIVER AT SPENCER, IND					
UNIQUENESS	INDEX	165	131	155	451
AESTHETIC	INDEX	165	86	56	306
WILD RIVER	INDEX	165	111	23	299
SCENIC RIVER	INDEX	165	110	105	379
RECREATIONAL RIVER	INDEX	165	131	155	451

Example 2

	LOCATION OF LANDSCAPE
A	BIG BLUE RIVER NEAR KNIGHTSTOWN, IND
B	FLATROCK RIVER NEAR ST PAUL, IND
C	LAUGHERY CREEK NEAR FARMERS RETREAT, IND
D	SAND CREEK NEAR BREWERSVILLE, IND
E	WHITEWATER RIVER AT BROOKVILLE, IND

LANDSCAPE EVALUATION NUMBERS

		LANDSCAPE LOCATION				
	FACTOR	A	B	C	D	E
1	CHANNEL WIDTH	3	3	3	3	4
2	LOW FLOW DISCHARGE	2	2	1	1	4
3	AVERAGE DISCHARGE	3	3	3	3	5
4	BASIN AREA(SG. MI.)	3	3	3	3	5
5	CHANNEL PATTERN	1	1	1	1	1
6	VALLEY WIDTH/HEIGHT	5	5	3	4	3
7	BED MATERIAL	1	3	3	2	1
8	BANK AND VALLEY MATERIAL	1	2	2	2	1
9	BEDSLOPE	3	2	3	2	3
10	WIDTH OF VALLEY FLAT	5	4	4	3	4
11	EROSION OF BANKS	2	2	4	2	3
12	VALLEY SLOPE	1	1	2	1	2
13	SINUOSITY	1	1	2	2	2
14	NO. OF TRIBUTARIES	4	3	5	2	5
15	WATER COLOR	2	3	2	5	4
16	FLOATING MATERIAL	1	3	3	3	3
17	ALGAE	4	4	3	3	4
18	LANDPLANTS-FLOOD PLAIN	5	5	4	4	5
19	LANDPLANTS-HILLSLOPE	2	3	3	3	3
20	WATER PLANTS	1	3	4	4	2
21	TRASH / 100 FT.	4	2	2	1	3
22	VARIABILITY OF TRASH	3	3	4	1	3
23	ARTIFICIAL CONTROL	1	2	2	1	2
24	UTILITIES, BRIDGES, ROAD	3	3	3	2	3
25	URBANIZATION	4	4	2	2	4
26	HISTORICAL FEATURES	2	2	2	3	1
27	LOCAL SCENE	3	2	3	2	2
28	VIEW CONFINEMENT	2	3	3	3	2
29	RAPID AND FALLS	2	2	1	1	4
30	LAND USE	5	5	1	1	5
31	MISFITS	5	2	4	1	5

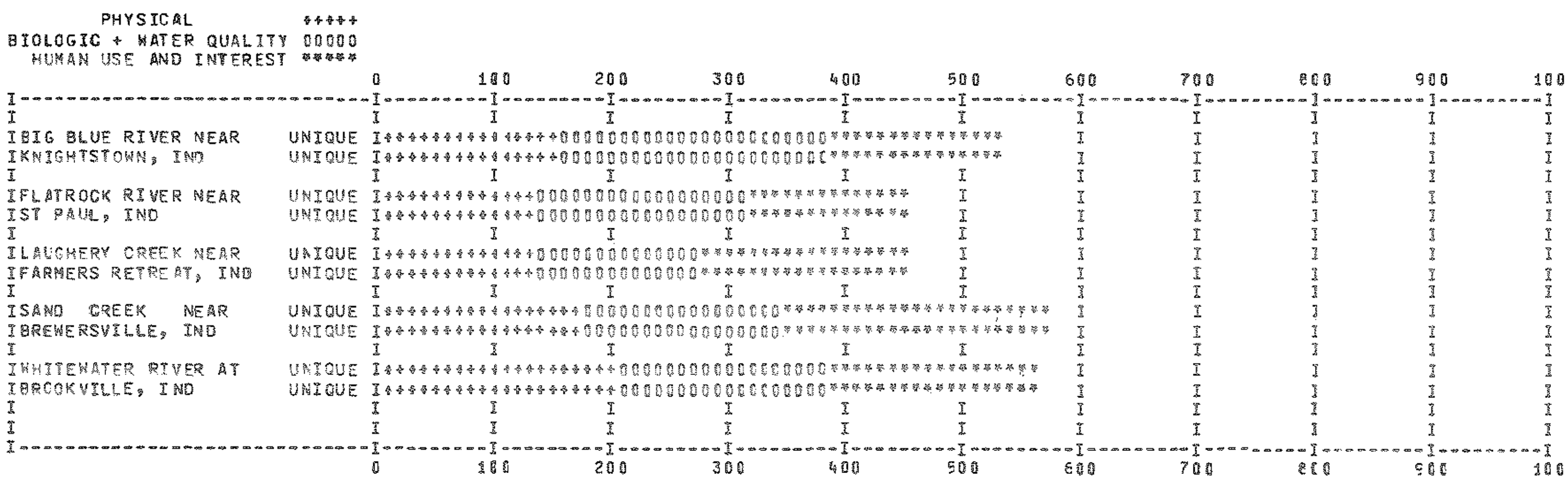
UNIQUENESS MATRIX

		LANDSCAPE LOCATION A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.250	.250	.250	.250	1.000
2	LOW FLOW DISCHARGE	.500	.500	.500	.500	1.000
3	AVERAGE DISCHARGE	.250	.250	.250	.250	1.000
4	BASIN AREA(SQ. MI.)	.250	.250	.250	.250	1.000
5	CHANNEL PATTERN	.200	.200	.200	.200	.200
6	VALLEY WIDTH/WEIGHT	.500	.500	.500	1.000	.500
7	BED MATERIAL	.500	.500	.500	1.000	.500
8	BANK AND VALLEY MATERIAL	.500	.333	.333	.333	.500
9	BEDSLOPE	.333	.500	.333	.500	.333
10	WIDTH OF VALLEY FLAT	1.000	.333	.333	1.000	.333
11	EROSION OF BANKS	.333	.333	1.000	.333	1.000
12	VALLEY SLOPE	.333	.333	.500	.333	.500
13	SINUOSITY	.500	.500	.333	.333	.333
14	NO. OF TRIBUTARIES	1.000	1.000	.500	1.000	.500
	SUBTOTAL	6.45	5.78	5.78	7.28	8.70
	PHYSICAL UNIQUENESS INDICES	154	138	138	173	207
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	.500	1.000	.500	1.000	1.000
16	FLOATING MATERIAL	1.000	.250	.250	.250	.250
17	ALGAE	.333	.333	.500	.500	.333
18	LANDPLANTS-FLOOD PLAIN	.333	.333	.500	.500	.333
19	LANDPLANTS-HILLSLOPE	1.000	.250	.250	.250	.250
20	WATER PLANTS	1.000	1.000	.500	.500	1.000
	SUBTOTAL	4.17	3.17	2.50	3.00	3.17
	BIOLOGIC + WATER QUALITY UNIQUENESS INDICES	231	176	139	167	176
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	1.000	.500	.500	1.000	1.000
22	VARIABILITY OF TRASH	.333	.333	1.000	1.000	.333
23	ARTIFICIAL CONTROL	.500	.333	.333	.500	.333
24	UTILITIES, BRIDGES, ROAD	.250	.250	.250	1.000	.250
25	URBANIZATION	.333	.333	.500	.500	.333
26	HISTORICAL FEATURES	.333	.333	.333	1.000	1.000
27	LOCAL SCENE	.500	.333	.500	.333	.333
28	VIEW CONFINEMENT	.500	.333	.333	.333	.500
29	RAPID AND FALLS	.500	.500	.500	.500	1.000
30	LAND USE	.333	.333	.500	.500	.333
31	MISFITS	.500	1.000	1.000	1.000	.500
	SUBTOTAL	5.08	4.58	5.75	7.67	5.92
	HUMAN USE AND INTEREST UNIQUENESS INDICES	154	139	174	232	179
	TOTAL	15.70	13.53	14.03	17.95	17.78
	TOTAL UNIQUENESS INDICES	539	453	451	572	562

SUMMARY OF UNICLENESS INDICES

STREAM	PHYSICAL	BIOLOGIC + WATER QUALITY	HUMAN USE AND INTEREST	TOTAL
SAND CREEK NEAR BREWERSVILLE, IND	173	167	232	572
WHITEWATER RIVER AT BROOKVILLE, IND	207	176	179	562
BIG BLUE RIVER NEAR KNIGHTSTOWN, IND	154	231	154	539
FLATROCK RIVER NEAR ST PAUL, IND	138	176	139	453
LAUGHERY CREEK NEAR FARMERS RETREAT, IND	138	139	174	451

BAR GRAPH OF UNIQUENESS INDICES



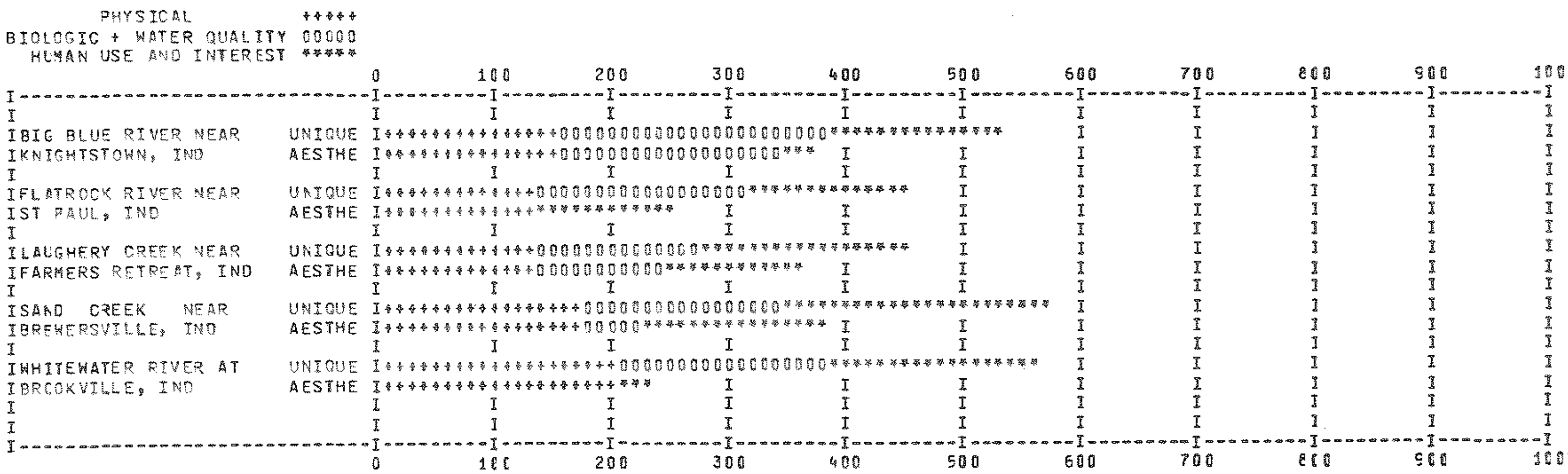
AESTHETIC MATRIX

		LANDSCAPE LOCATION A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.250	.250	.250	.250	1.000
2	LOW FLOW DISCHARGE	.500	.500	.500	.500	1.000
3	AVERAGE DISCHARGE	.250	.250	.250	.250	1.000
4	BASIN AREA(SQ. MI.)	.250	.250	.250	.250	1.000
5	CHANNEL PATTERN	.200	.200	.200	.200	.200
6	VALLEY WIDTH/HEIGHT	.500	.500	.500	1.000	.500
7	BED MATERIAL	.500	.500	.500	1.000	.500
8	BANK AND VALLEY MATERIAL	.500	.333	.333	.333	.500
9	BEDSLOPE	.333	.500	.333	.500	.333
10	WIDTH OF VALLEY FLAT	1.000	.333	.333	1.000	.333
11	EROSION OF BANKS	.333	.333	1.000	.333	1.000
12	VALLEY SLOPE	.333	.333	.500	.333	.500
13	SINUOSITY	.500	.500	.333	.333	.333
14	NO. OF TRIBUTARIES	1.000	1.000	.500	1.000	.500
	SUBTOTAL	6.45	5.78	5.78	7.28	8.70
PHYSICAL	AESTHETIC INDICES	154	138	138	173	207
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	.500	0.000	.500	0.000	0.000
16	FLOATING MATERIAL	1.000	0.000	0.000	0.000	0.000
17	ALGAE	0.000	0.000	.500	.500	0.000
18	LANDPLANTS-FLOOD PLAIN	.333	.333	.500	.500	.333
19	LANDPLANTS-HILLSLOPE	1.000	.250	.250	.250	.250
20	WATER PLANTS	1.000	1.000	.500	.500	1.000
	SUBTOTAL	3.83	1.58	2.25	1.75	1.58
BIOLOGIC + WATER QUALITY	AESTHETIC INDICES	189	0	111	48	0
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	0.000	.500	.500	1.000	0.000
22	VARIABILITY OF TRASH	0.000	0.000	1.000	0.000	0.000
23	ARTIFICIAL CONTROL	.500	.333	.333	.500	.333
24	UTILITIES, BRIDGES, ROAD	.250	.250	.250	1.000	.250
25	URBANIZATION	.333	.333	.500	.500	.333
26	HISTORICAL FEATURES	.333	.333	.333	1.000	1.000
27	LOCAL SCENE	.500	.333	.500	.333	.333
28	VIEW CONFINEMENT	.500	.333	.333	.333	.500
29	RAPIC AND FALLS	.500	.500	.500	.500	1.000
30	LAND USE	.333	.333	.500	.500	.333
31	MISFITS	0.000	1.000	0.000	1.000	0.000
	SUBTOTAL	3.25	4.25	4.75	6.67	4.08
HUMAN USE AND INTEREST	AESTHETIC INDICES	33	118	116	163	28
	TOTAL	13.53	11.62	12.78	15.70	14.37
TOTAL AESTHETIC	INDICES	376	255	365	384	235

SUMMARY OF AESTHETIC INDICES

STREAM	PHYSICAL	BIOLOGIC + WATER QUALITY	HUMAN USE AND INTEREST	TOTAL
SAND CREEK NEAR BREWERSVILLE, IND	173	48	163	384
BIG BLUE RIVER NEAR KNIGHTSTOWN, IND	154	189	33	376
LAUGHERY CREEK NEAR FARMERS RETREAT, IND	138	111	116	365
FLATROCK RIVER NEAR ST PAUL, IND	138	0	118	255
WHITEWATER RIVER AT BROOKVILLE, IND	207	0	28	235

BAR GRAPH OF AESTHETIC INDICES



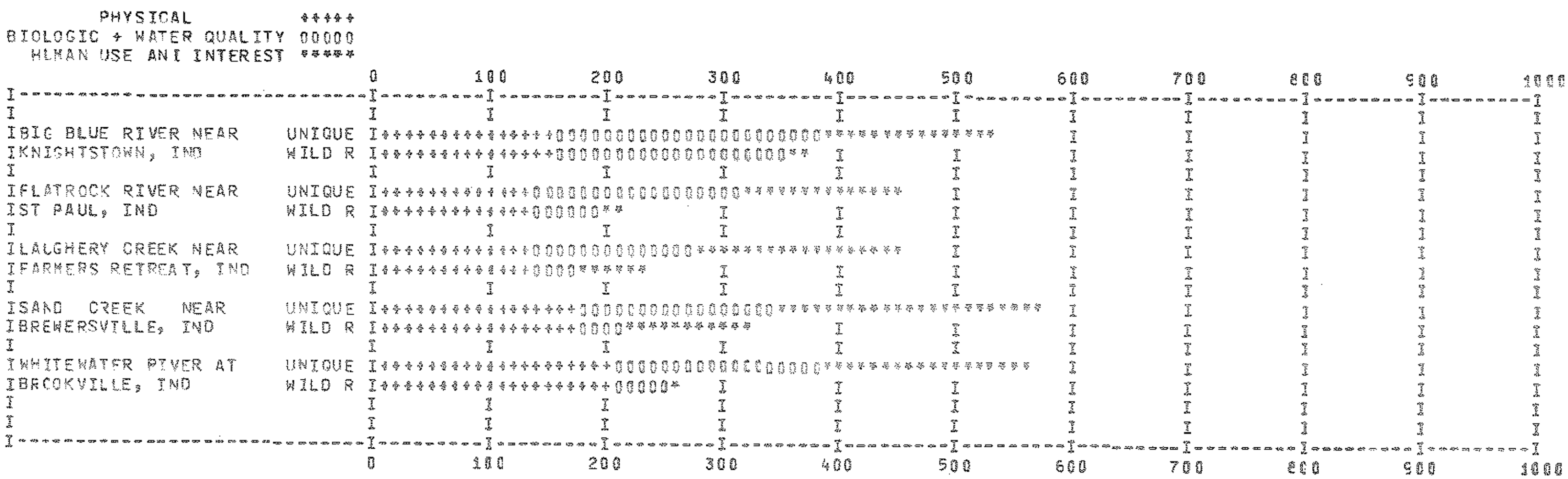
WILD RIVER MATRIX

		LANDSCAPE LOCATION A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.250	.250	.250	.250	1.000
2	LOW FLOW DISCHARGE	.500	.500	.500	.500	1.000
3	AVERAGE DISCHARGE	.250	.250	.250	.250	1.000
4	BASIN AREA(SQ. MI.)	.250	.250	.250	.250	1.000
5	CHANNEL PATTERN	.200	.200	.200	.200	.200
6	VALLEY WIDTH/HEIGHT	.500	.500	.500	1.000	.500
7	BED MATERIAL	.500	.500	.500	1.000	.500
8	BANK AND VALLEY MATERIAL	.500	.333	.333	.333	.500
9	BEDSLOPE	.333	.500	.333	.500	.333
10	WIDTH OF VALLEY FLAT	1.000	.333	.333	1.000	.333
11	EROSION OF BANKS	.333	.333	1.000	.333	1.000
12	VALLEY SLOPE	.333	.333	.500	.333	.500
13	SINUOSITY	.500	.500	.333	.333	.333
14	NO. OF TRIBUTARIES	1.000	1.000	.500	1.000	.500
	SUBTOTAL	6.45	5.78	5.78	7.28	8.70
	PHYSICAL WILD RIVER INDICES	154	138	138	173	207
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	.500	1.000	.500	1.000	1.000
16	FLOATING MATERIAL	1.000	0.000	0.000	0.000	0.000
17	ALGAE	.333	.333	.500	.500	.333
18	LANDPLANTS-FLOOD PLAIN	0.000	0.000	0.000	0.000	0.000
19	LANDPLANTS-HILLSLOPE	1.000	.250	.250	.250	.250
20	WATER PLANTS	1.000	1.000	.500	.500	1.000
	SUBTOTAL	3.83	2.58	1.75	2.25	2.58
	BIOLOGIC + WATER QUALITY WILD RIVER INDICES	198	53	35	42	53
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	0.000	.500	.500	1.000	0.000
22	VARIABILITY OF TRASH	0.000	0.000	1.000	0.000	0.000
23	ARTIFICIAL CONTROL	.500	0.000	0.000	.500	0.000
24	UTILITIES, BRIDGES, ROAD	0.000	0.000	0.000	0.000	0.000
25	URBANIZATION	0.000	0.000	0.000	0.000	0.000
26	HISTORICAL FEATURES	.333	.333	.333	1.000	1.000
27	LOCAL SCENE	.500	.333	.500	.333	.333
28	VIEW CONFINEMENT	.500	.333	.333	.333	.500
29	RAPID AND FALLS	.500	.500	.500	.500	1.000
30	LAND USE	0.000	0.000	0.000	0.000	0.000
31	MISFITS	0.000	0.000	0.000	1.000	0.000
	SUBTOTAL	2.33	2.00	3.17	4.67	2.83
	HUMAN USE AND INTEREST WILD RIVER INDICES	24	23	64	106	0
	TOTAL	12.62	10.37	10.70	14.20	14.12
	TOTAL WILD RIVER INDICES	376	213	236	321	260

SUMMARY OF WILD RIVER INDICES

STREAM	PHYSICAL	BIOLOGIC + WATER QUALITY	HUMAN USE AND INTEREST	TOTAL
BIG BLUE RIVER NEAR KNIGHTSTOWN, IND	154	198	24	376
SAND CREEK NEAR BREWERSVILLE, IND	173	42	106	321
WHITEWATER RIVER AT BROOKVILLE, IND	207	53	0	260
LAUGHERY CREEK NEAR FARMERS RETREAT, IND	138	35	64	236
FLATROCK RIVER NEAR ST PAUL, IND	138	53	23	213

BAR GRAPH OF WILD RIVER INDICES



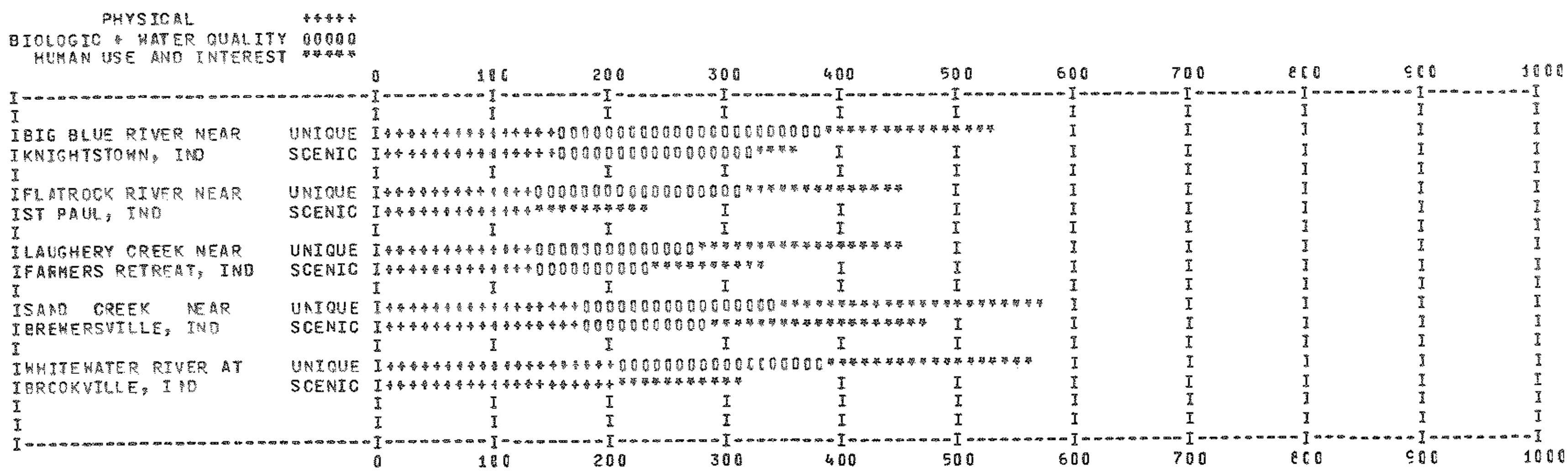
SCENIC RIVER MATRIX

		Landscape Location A	B	C	D	E
PHYSICAL FACTORS						
1	CHANNEL WIDTH	.250	.250	.250	.250	1.000
2	LOW FLOW DISCHARGE	.500	.500	.500	.500	1.000
3	AVERAGE DISCHARGE	.250	.250	.250	.250	1.000
4	BASIN AREA(SQ. MI.)	.250	.250	.250	.250	1.000
5	CHANNEL PATTERN	.200	.200	.200	.200	.200
6	VALLEY WIDTH/HEIGHT	.500	.500	.500	1.000	.500
7	BED MATERIAL	.500	.500	.500	1.000	.500
8	BANK AND VALLEY MATERIAL	.500	.333	.333	.333	.500
9	BEDSLOPE	.333	.500	.333	.500	.333
10	WIDTH OF VALLEY FLAT	1.000	.333	.333	1.000	.333
11	EROSION OF BANKS	.333	.333	1.000	.333	1.000
12	VALLEY SLOPE	.333	.333	.500	.333	.500
13	SINUOSITY	.500	.500	.333	.333	.333
14	NO. OF TRIBUTARIES	1.000	1.000	.500	1.000	.500
	SUBTOTAL	6.45	5.78	5.78	7.28	8.70
PHYSICAL	SCENIC RIVER INDICES	154	138	138	173	207
BIOLOGIC + WATER QUALITY FACTORS						
15	WATER COLOR	.500	1.000	.500	1.000	1.000
16	FLOATING MATERIAL	1.000	0.000	0.000	0.000	0.000
17	ALGAE	0.000	0.000	.500	.500	0.000
18	LANDPLANTS-FLOOD PLAIN	.333	.333	.500	.500	.333
19	LANDPLANTS-HILLSLOPE	1.000	.250	.250	.250	.250
20	WATER PLANTS	1.000	1.000	.500	.500	1.000
	SUBTOTAL	3.83	2.58	2.25	2.75	2.58
BIOLOGIC + WATER QUALITY	SCENIC RIVER INDICES	174	0	93	111	0
HUMAN USE AND INTEREST FACTORS						
21	TRASH / 100 FT.	0.000	.500	.500	1.000	1.000
22	VARIABILITY OF TRASH	.333	.333	1.000	0.000	.333
23	ARTIFICIAL CONTROL	.500	.333	.333	.500	.333
24	UTILITIES, BRIDGES, ROAD	0.000	0.000	0.000	1.000	0.000
25	URBANIZATION	0.000	0.000	.500	.500	0.000
26	HISTORICAL FEATURES	.333	.333	.333	1.000	1.000
27	LOCAL SCENE	0.000	.333	0.000	.333	.333
28	VIEW CONFINEMENT	.500	.333	.333	.333	.500
29	RAPID AND FALLS	.500	.500	.500	.500	1.000
30	LAND USE	0.000	0.000	.500	.500	0.000
31	MISFITS	0.000	1.000	0.000	1.000	0.000
	SUBTOTAL	2.17	3.67	4.00	6.67	4.50
HUMAN USE AND INTEREST	SCENIC RIVER INDICES	34	102	108	192	105
	TOTAL	12.45	12.03	12.03	16.70	15.78
TOTAL	SCENIC RIVER INDICES	361	239	338	477	312

SUMMARY OF SCENIC RIVER INDICES

STREAM	PHYSICAL	BIOLOGIC + WATER QUALITY	HUMAN USE AND INTEREST	TOTAL
SAND CREEK NEAR BREWERSVILLE, IND	173	111	192	477
BIG BLUE RIVER NEAR KNIGHTSTOWN, IND	154	174	34	361
LAUGHERY CREEK NEAR FARMERS RETREAT, IND	138	93	108	338
WHITEWATER RIVER AT BROOKVILLE, IND	207	0	105	312
FLATROCK RIVER NEAR ST PAUL, IND	138	0	102	239

BAR GRAPH OF SCENIC RIVER INDICES



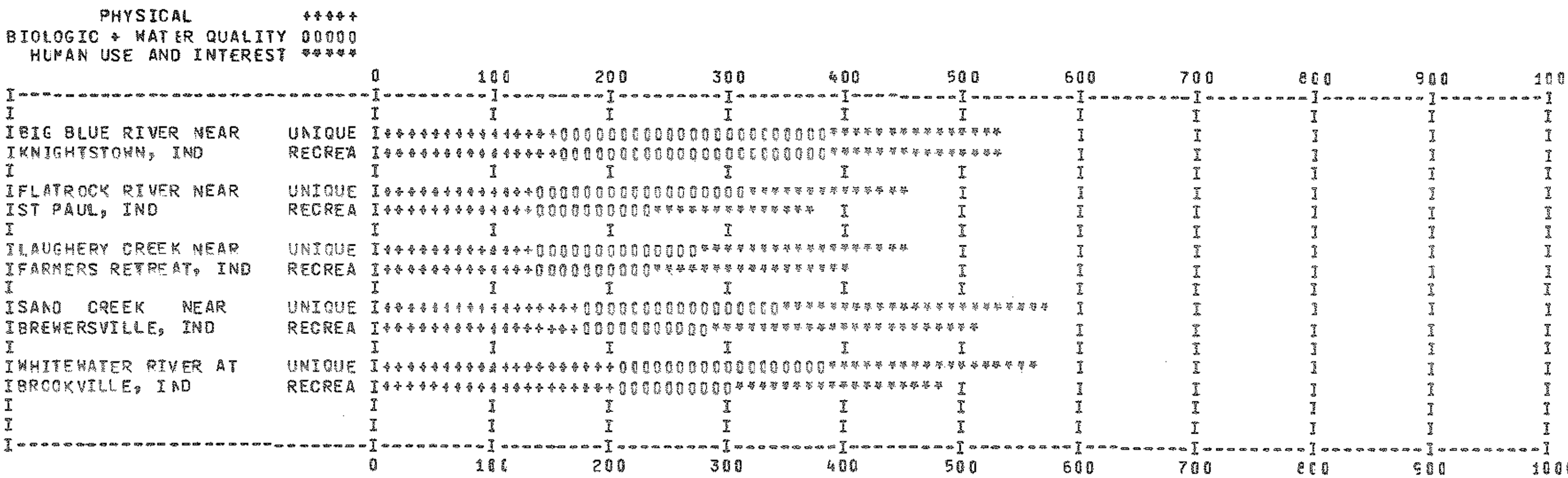
RECREATIONAL RIVER MATRIX

		LANDSCAPE LOCATION A	B	C	D	E
	PHYSICAL FACTORS					
1	CHANNEL WIDTH	.250	.250	.250	.250	1.000
2	LOW FLOW DISCHARGE	.500	.500	.500	.500	1.000
3	AVERAGE DISCHARGE	.250	.250	.250	.250	1.000
4	BASIN AREA(SQ. MI.)	.250	.250	.250	.250	1.000
5	CHANNEL PATTERN	.200	.200	.200	.200	.200
6	VALLEY WIDTH/HEIGHT	.500	.500	.500	1.000	.500
7	BED MATERIAL	.500	.500	.500	1.000	.500
8	BANK AND VALLEY MATERIAL	.500	.333	.333	.333	.500
9	BEDSLOPE	.333	.500	.333	.500	.333
10	WIDTH OF VALLEY FLAT	1.000	.333	.333	1.000	.333
11	EROSION OF BANKS	.333	.333	1.000	.333	1.000
12	VALLEY SLOPE	.333	.333	.500	.333	.500
13	SINUOSITY	.500	.500	.333	.333	.333
14	NO. OF TRIBUTARIES	1.000	1.000	.500	1.000	.500
	SUBTOTAL	6.45	5.78	5.78	7.28	8.70
	PHYSICAL RECREATIONAL RIVER INDICES	154	138	138	173	207
	BIOLOGIC + WATER QUALITY FACTORS					
15	WATER COLOR	.500	1.000	.500	1.000	1.000
16	FLOATING MATERIAL	1.000	0.000	0.000	0.000	0.000
17	ALGAE	.333	.333	.500	.500	.333
18	LANDPLANTS-FLOOD PLAIN	.333	.333	.500	.500	.333
19	LANDPLANTS-HILLSLOPE	1.000	.250	.250	.250	.250
20	WATER PLANTS	1.000	1.000	.500	.500	1.000
	SUBTOTAL	4.17	2.92	2.25	2.75	2.92
	BIOLOGIC + WATER QUALITY RECREATIONAL RIVER INDICES	231	101	93	111	101
	HUMAN USE AND INTEREST FACTORS					
21	TRASH / 100 FT.	1.000	.500	.500	1.000	1.000
22	VARIABILITY OF TRASH	.333	.333	1.000	1.000	.333
23	ARTIFICIAL CONTROL	.500	.333	.333	.500	.333
24	UTILITIES, BRIDGES, ROAD	.250	.250	.250	1.000	.250
25	URBANIZATION	.333	.333	.500	.500	.333
26	HISTORICAL FEATURES	.333	.333	.333	1.000	1.000
27	LOCAL SCENE	.500	.333	.500	.333	.333
28	VIEW CONFINEMENT	.500	.333	.333	.333	.500
29	RAPID AND FALLS	.500	.500	.500	.500	1.000
30	LAND USE	.333	.333	.500	.500	.333
31	MISFITS	.500	1.000	1.000	1.000	.500
	SUBTOTAL	5.08	4.58	5.75	7.67	5.92
	HUMAN USE AND INTEREST RECREATIONAL RIVER INDICES	154	139	174	232	179
	TOTAL	15.70	13.28	13.78	17.70	17.53
	TOTAL RECREATIONAL RIVER INDICES	539	377	405	517	487

SUMMARY OF RECREATIONAL RIVER INDICES

STREAM	PHYSICAL	BIOLOGIC + WATER QUALITY	HUMAN USE AND INTEREST	TOTAL
BIG BLUE RIVER NEAR KNIGHTSTOWN, IND	154	231	154	539
SAND CREEK NEAR BREWERSVILLE, IND	173	111	232	517
WHITEWATER RIVER AT BROCKVILLE, IND	207	101	179	487
LAUGHERY CREEK NEAR FARMERS RETREAT, IND	138	93	174	405
FLATROCK RIVER NEAR ST PAUL, IND	138	101	139	377

BAR GRAPH OF RECREATIONAL RIVER INDICES



SUMMARY OF ALL INDICES

		PHYSICAL	BIOLOGIC + WATER QUALITY	HUMAN USE AND INTEREST	TOTAL
BIG BLUE RIVER NEAR KNIGHTSTOWN, IND					
UNIQUENESS	INDEX	154	231	154	539
AESTHETIC	INDEX	154	189	33	376
WILD RIVER	INDEX	154	198	24	376
SCENIC RIVER	INDEX	154	174	34	361
RECREATIONAL RIVER	INDEX	154	231	154	539
FLATROCK RIVER NEAR ST PAUL, IND					
UNIQUENESS	INDEX	138	176	139	453
AESTHETIC	INDEX	138	0	118	255
WILD RIVER	INDEX	138	53	23	213
SCENIC RIVER	INDEX	138	0	102	239
RECREATIONAL RIVER	INDEX	138	101	139	377
LAUGHERY CREEK NEAR FARMERS RETREAT, IND					
UNIQUENESS	INDEX	138	139	174	451
AESTHETIC	INDEX	138	111	116	365
WILD RIVER	INDEX	138	35	64	236
SCENIC RIVER	INDEX	138	93	108	338
RECREATIONAL RIVER	INDEX	138	93	174	405
SAND CREEK NEAR BREWERSVILLE, IND					
UNIQUENESS	INDEX	173	167	232	572
AESTHETIC	INDEX	173	48	163	384
WILD RIVER	INDEX	173	42	106	321
SCENIC RIVER	INDEX	173	111	192	477
RECREATIONAL RIVER	INDEX	173	111	232	517
WHITEWATER RIVER AT BROOKVILLE, IND					
UNIQUENESS	INDEX	207	176	179	562
AESTHETIC	INDEX	207	0	28	235
WILD RIVER	INDEX	207	53	0	260
SCENIC RIVER	INDEX	207	0	105	312
RECREATIONAL RIVER	INDEX	207	101	179	487