A METHOD FOR ASSESSING RIVER RECREATION POTENTIAL

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ABSTRACT

A METHOD FOR ASSESSING RIVER
RECREATION POTENTIAL

By

Eric Hans Bauman

Rivers and adjacent lands often offer excellent opportunities for recreational activities. The potentials for such activities as canoeing, powerboating, swimming, camping, nature study, driving for pleasure, fishing, and hunting vary according to the land and water characteristics of each river. With increasing pressures on rivers (such as subdivision and second home development, increasing recreational uses, flood control and power generation projects, and logging road construction) the need appears to exist for the development of planning tools which will enable the resource manager, for example, national forest staff, to comprehensively evaluate the recreational potential of river corridors and to inventory existing river characteristics. This information would then be available to decision-makers and the public.

A technique for inventorying characteristics of river corridors and for evaluating their recreational potentials was developed in the course of this research.

Sixty-seven variables were evaluated along river segments. These variables were divided into eight groups: basic physical features, special physical features, water quality, general soils limitations for dry land recreational uses, biological features, land uses, aesthetics, and accessibility. Each segment was one river-mile long and extended for one-quarter mile inland from each river bank. Using a five-point scale, values were assigned to each variable based on field observations, interpretation of available aerial photography, and other documentation from government agencies.

The next phase consisted of the evaluation process involving calculation of recreational potential scores for each river segment for sixteen recreational activities (wilderness canoeing, general canoeing, small craft boating, powerboating, swimming, waterskiing, nature study, hiking, picnicking, canoe camping, trail camping, vehicle camping, driving for pleasure, bank fishing, boat fishing, and hunting). Raw scores for the significant variables were recorded on worksheets for each activity. Values for certain variables were then "transformed" depending on whether or not a variable had a positive or negative correlation with the particular activity concerned. Either the raw values or the appropriate transformed values were multiplied by weights which reflected the relative importance of each variable in determining the feasibility of each activity. Finally, the weighted scores for each variable were summed and the recreational activity potential scores were expressed as a percentage of the maximum possible total.

Four reaches on three rivers in Michigan were used to test the technique. One ten mile test reach was on the Pine River (Wexford County). Two eleven mile reaches were on the Manistee River (Manistee County). One ten mile reach was on the Looking Glass River (Clinton County). In the past the Pine and Manistee Rivers have been well known throughout the state for the high-quality recreational experiences they have provided. Both are located within the Manistee National Forest in the northern portion of Michigan's lower peninsula. The Looking Glass contrasts with the two northern rivers in that it flows through agricultural lands with some streambank housing development, and is within ten miles of the Lansing-East Lansing metropolitan area.

Sixteen recreational activity scores were calculated for each of the forty-two test segments. Mean recreational potential scores were computed for each test reach. All scores were interpreted by taking into consideration the known activities occurring on the reaches and the physical landscape limitations imposed on recreational activities.

The results of testing the technique are indicative of the responsiveness of the procedure components to changes in the environment. The technique is presently capable of identifying general patterns in recreational activity potentials. However, refinements in the inventory and analysis procedures are needed, as are additional tests on a greater variety of rivers. Recommendations were also formulated to guide future application of the technique and future research.

The technique described in this thesis, with the recommended improvements, should be immediately useful for national forest river and watershed planning, and for planning by other federal and state land management agencies.

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CHAPTER I

INTRODUCTION

Much of the summertime recreation in the United States is water-oriented. Swimming, fishing, boating, canoeing, waterskiing, nature study, picnicking, and camping revolve around recreation sites along the nation's coastlines, shorelines, and riverbanks. This thesis describes the development and testing of a method for identifying and assessing the potential for such recreational activities along rivers.

Rivers and Recreation

Rivers and adjacent lands offer excellent opportunities for recreation, and individual rivers are highly variable in the types of recreation which are best suited for enjoyment. These variations between and within rivers and river systems are ultimately due to variations in climate, geology, physiography, soils and land use. These interacting factors manifest themselves as differences in stream bed materials, width and depth, temperature, water pattern (e.g., presence or absence of riffles), and vegetative cover. While one river may be able to support trout populations, another may be able to support northern pike, but not trout. While an individual could use a powerboat on one river, perhaps another is navigable only by canoe.

Numerous factors influence an individual's selection of leisure time activities in which one chooses to participate. These factors include amount of available leisure time, mobility, income, education, culture, age, and geographic location.[1] Whatever the influences are at any given time, a larger number of people are attracted to certain activities. For instance, the Bureau of Outdoor Recreation estimated that in the summer quarter of 1972, 487.1 million activity days were devoted to outdoor swimming (not in pools), while 54.1 million activity days were estimated for waterskiing.[2]

Among those individuals who prefer rivers for recreation, some may be able to purchase rights to do so by means of buying river frontage and thereby acquiring riparian rights. For many, however, public lands must be used. Which lands they use may depend on distance,

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[1]Clayne R. Jensen, Outdoor Recreation in America (Minneapolis: Burgess Publishing Co., 1970), pp. 202-204; and, William R. Catton, Jr., "The Recreation Visitor: Motivation, Behavior and Impact," in Recreational Use of Wildlands, ed. C. Frank Brockman and Lawrence C. Merriam, Jr. (New York: McGraw-Hill Book Company, 1973), pp. 71-92.

[2]U.S. Department of the Interior, Bureau of Outdoor Recreation, Outdoor Recreation: A Legacy for America (Washington, D.C.: U.S. Government Printing Office, 1973), p. 23.

attraction to the river and its adjacent lands, and an individual's knowledge of the area. Attractive rivers and park lands near urban areas now and in the future will have to cope with substantial numbers of recreationists desiring fulfillment of their leisure time needs.

Paramount recreation problems are those of increased recreation participation, the potential for conflicts between users, and degradation of scenic landscapes due to increased use. Cooper and Vlasin have observed:

> Recreation in our society is heavily water oriented. The available shoreline of freshwater lakes and streams represents a fixed stock of resources now under rapidly increasing demand resulting from our affluence and mobility.[3]

The Northern Environmental Council has observed that certain pressures on remaining streams can be classified into two categories: shoreland and watershed-based activities (farming, subdivisions, logging roads, utility lines and pipelines, etc.), and, consumptive and recreational water uses (commercial boating, unlimited canoe use, innertube rafting, over-fishing, septic tank effluent and solid waste litter). The Council also states:

> The rapid expansion of "second homes," recreational uses of all types, and greater mobility of people . . . forces us to search for ways and means of making these

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[3]William E. Cooper and Raymond D. Vlasin, "Ecological Concepts and Applications to Planning," in Environment: A New Focus for Land-Use Planning, ed. Donald M. McAllister (Washington, D.C.: RANN--Research Applied to National Needs, National Science Foundation, 1973), p. 204.

scarce natural values available without "loving them to death."[4]

With regard to the increased values of recreational lands, including water recreation areas, Nelson and Butler have observed,

> In recent years there has been a dramatic increase in demand for outdoor recreation facilities. This, together with increasing pressure on land resources resulting from population growth and sub-urbanization, has created new values for reservoirs, scenic areas and wilderness and stimulated attempts to identify areas with high value for recreation and related conservation uses.[5]

In reference to national forest lands, Chubb notes that backcountry rivers do not appear to be receiving the comprehensive resource planning which they deserve considering the increased pressures of urbanization and growing recreation participation rates, unless the rivers have been designated as federal or state wild and scenic rivers.[6]

The needs for identification of river recreation opportunities and for comprehensive river planning are certainly not restricted to non-urban areas. For example,

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[4]Northern Environmental Council, Preservation of Wild and Scenic Rivers From Overuse and Deterioration, Policy Research Paper 14 (Ashland, Wisc.: Northern Environmental Council, 1973), pp. 4-5.

[5]J. G. Nelson and R. W. Butler, "Recreation and the Environment," in Perspectives on Environment, ed. Ian R. Manners and Marvin W. Mikesell (Washington, D.C.: Commission on College Geography, Association of American Geographers, 1974), p. 291.

[6]Michael Chubb, "Backcountry River Recreation Potential Assessment: An Interim Outline," Department of Geography, Michigan State University, East Lansing, Mich., 10 July 1975. (Photo-Copied.)

anticipated secondary benefits of this country's wastewater treatment program, administered by the U.S. Environmental Protection Agency, are increasing property values along waterways downstream from treatment plants.[7] A concern raised, however, by Train is that of "assuring public access and public use of shorelands along cleaned-up waterways."[8] He further states:

> The creation and supervision of multiple use demands very careful advance planning, particularly in the case of newly cleaned water. . . . Unless such planning precedes the development of cleaned-up shorelines, the result will be zoning disaster.[9]

The foremost beneficiary of a policy of maximizing public benefit from public investments, Train stresses, is the ordinary, local citizen and his family who desire and need recreation facilities close to home.

Purpose of Study

The need appears to exist for the development of planning tools which will enable the resource manager to comprehensively evaluate the recreational potential of river corridors and to make this information available to decision-makers and the public. Further, these evaluation procedures should permit resource managers, planners, and

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[7]Russell E. Train, Administrator, U.S. Environmental Protection Agency, "The Uses of Clean Rivers: Securing Full Value on Public Investment," speech before the Conference on Water Cleanup and the Land, Boston, Mass., 5 November 1975.

[8]Ibid.

[9]Ibid.

others to quickly evaluate numerous rivers. As a part of this need, such a technique must minimize field work which is costly in terms of equipment, personnel, and associated expenses as well as time. With the reduced budgets of agencies in recent years and associated "employment freezes," man-hours per assignment become crucial considering burgeoning agency workloads. Considering these pressures, it becomes more important to develop approaches which substitute as much "desk-top analysis" as possible for field work, yet allow personnel to collect reasonably accurate and useful information.

In response to the needs and problems outlined above, the present study attempted to accomplish two major closely interwoven but separable goals; (1) development of a better approach for inventorying landscape characteristics of river corridors, and (2) development of a technique capable of identifying the recreational potential for a number of activities within these corridors and to rank the suitabilities for each recreational activity for segments of rivers.

The remainder of this chapter provides the reader with additional background material on problems of river recreation potential identification, a discussion of the research goals, objectives and hypotheses, a justification for this study, and a brief introduction to subsequent chapters of this thesis.

Background

In this thesis, I attempted to classify or delineate landscape[10] areas in which certain human activities could occur. Such activities--in this case recreation--may be characterized as generally occurring under sets of physical and cultural limitations. For example, criteria have been identified which give detailed physical requirements (soils, slope, orientation to prevailing winds), for an ideal camping area. Similarly, recreation researchers have identified at least general trends in user preferences for camping sites depending on the desired experience sought by individuals.[11] These preferences are reflections of cultural limitations or criteria. For instance, desired experiences may vary from wilderness or "primitive" camping to "developed" camp sites with showers, electric outlets, and other amenities. Other factors are important in considering potentials for recreation activities; these include, but are not limited to, accessibility, land

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[10]"Landscape" is used here in the same way that Sauer used it in his writings. He defines it "as an area made up of a distinct association of forms, both physical and cultural." Carl Sauer, "The Morphology of Landscape," in Introduction to Geography: Selected Readings, ed. Fred E. Dohrs and Lawrence M. Sommers (New York: Thomas Y. Crowell Co., 1967), p. 97.

[11]David W. Lime, "Behavioral Research in Outdoor Recreation Management: An Example of How Visitors Select Campgrounds," in Environment and the Social Sciences (Washington, D.C.: American Psychological Association, 1972), pp. 198-206; and Alan J. Wagar, Campgrounds for Many Tastes, Research Paper INT-6 (Ogden: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, 1963).

ownership, and government restrictions. Recreation planners and decision-makers generally look first at the physical components of the landscape for restrictions on design, and then search for desirable areas based on a consideration of cultural or perceptual restrictions.

Intangible Values

One of the problems in recreation planning is that of incorporating intangible values into the planning process, e.g., scenery, landscape "misfits."[12] These values transcend traditional physical and social criteria or preferences. Researchers have sought to measure these values, and have attempted to integrate such measurements into the traditional planning process.[13]

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[12]Leopold's "misfits" are features of the landscape which are "out of character with natural surroundings." (From, Luna B. Leopold, "Landscape Esthetics," Natural History 8 (October 1969):38.) Dearinger defines "disvalues" as: "Aspects of the watershed considered detrimental to the selected recreational activities and the preservation of natural, scenic, and historic resources." The following is a sample of his examples: dumps, excessive littering, feed lot near stream, channelization, highway along stream, and detrimental industrial and commercial development. (From, John A. Dearinger, Esthetic and Recreational Potential of Small Naturalistic Streams Near Urban Areas, Research Report No. 13 (Lexington, Kent.: University of Kentucky Water Resources Research Institute, 1968), pp. 41-42.) Leopold's examples are similar to Dearinger's "disvalues," hence we may safely assume that these two terms are synonymous.

[13]Shafer has focused on techniques of measuring values, and in particular, on attempting to determine if such measurements can be made through use of photographs to substitute for viewing landscapes in the field. His research includes: Elwood L. Shafer, Jr., The Photo-Choice Method for Recreation Research, Research Paper NE-29

Selection Methodology

In order to improve the recreation planning process, recreation planners need to perfect approaches to observing landscape characteristics, recording these characteristics, and evaluating them as the planners attempt to delineate desirable recreation activity areas (Figure 1). One problem encountered in the process is that of identifying the necessary requirements for recreation activities and the specific criteria for "screening" suitable areas and sites. Figure 2 illustrates another way of looking at the problem in that all segments of a river can be considered for an

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(Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeast Forest Experiment Station, 1964); Elwood L. Shafer, Jr. and James Mietz, "Aesthetic and Emotional Experiences Rate High with Northeast Wilderness Hikers," in Environment and the Social Sciences (Washington, D.C.: American Psychological Association, 1972), pp. 207-216; Elwood L. Shafer, Jr. and James Mietz, It Seems Possible to Quantify Scenic Beauty in Photographs, Research Paper NE-162 (Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeast Forest Experiment Station, 1970); Elwood L. Shafer, Jr. and James Mietz et al., "Natural Landscape Preferences: A Predictive Model," Journal of Leisure Research 1 (Winter 1969):1-19; Elwood L. Shafer, Jr. and Thomas A. Richards, A Comparison of Viewer Reactions to Outdoor Scenes and Photographs of Those Scenes, Research Paper NE-302 (Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeast Forest Experiment Station, 1974). Some of R. Burton Litton's work has focused on mapping approaches and identification of aesthetic resources and attempts to integrate aesthetic considerations into national forest resource management. His research publications include: R. Burton Litton, Jr., Forest Landscape Description and Inventories, Research Paper PSW-49 (Berkeley: U.S. Department of Agriculture, Forest Service, Southwest Forest Experiment Station, 1968); R. Burton Litton, Jr., "Visual Vulnerability of Forest Landscapes," Journal of Forestry 72 (July 1974); R. Burton Litton, Jr., "Aesthetic Dimensions of the Landscape," in Natural Environments, ed. John Krutilla (Baltimore: Resources for the Future by Johns Hopkins University Press, 1972).

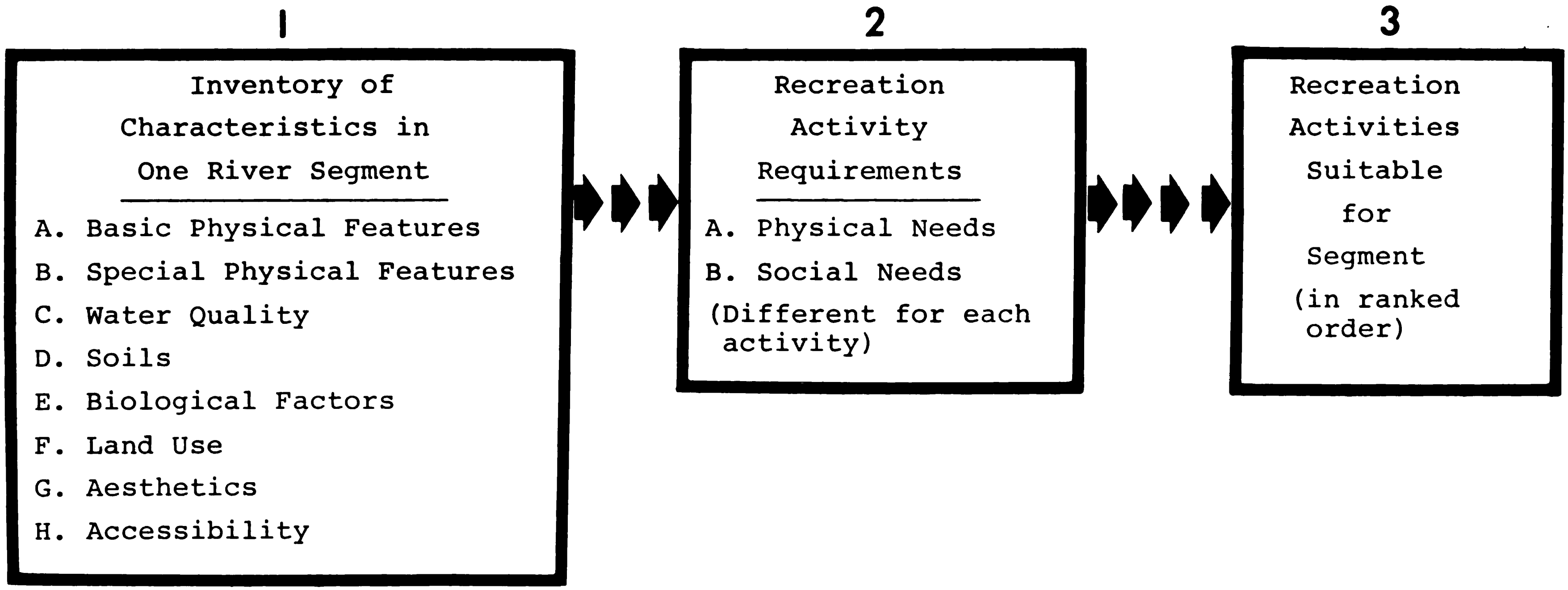

Fig. 1.--Model of the Basic River Recreation Evaluation Process: Identifying Suitable Potential Activities in One Segment.

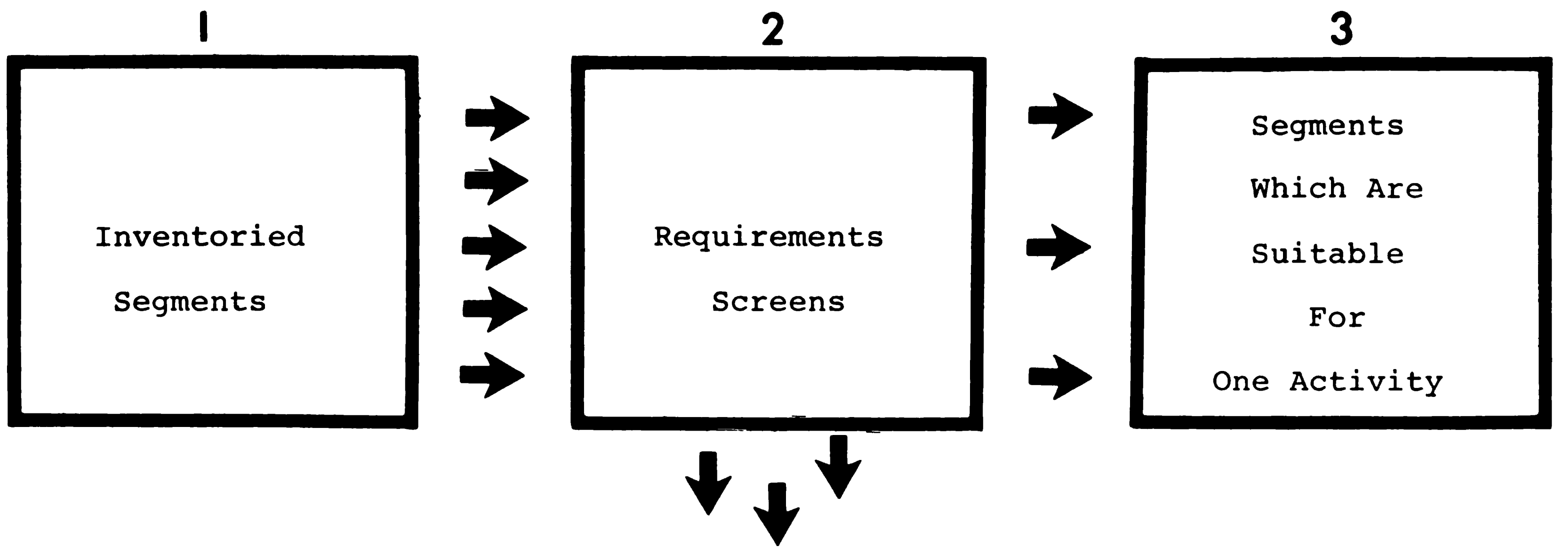

Fig. 2.--Model of the Basic River Recreation Evaluation Process: Identifying Segments Suitable for An Activity.

activity. Only those that meet the selection criteria are judged suitable. Each line going from Box 1 to the screen represents one segment with its particular set of characteristics. Segments are then "screened" out until only those suitable for the particular activity remain. The actual components of these screens are discussed in Chapter III and Appendix A.

Once sites have been identified which possess recreational potential, decisions must be made to determine what management action, if any, will be taken. This final management decision is not simply made by utilizing this procedure. The results however of this technique will assist the policy makers in their deliberations as information is provided about the area subject to a decision.

Goal One: Inventory of Landscape Characteristics

The first goal of this thesis research was to develop a methodology to observe, classify, and record data on river landscape characteristics. This information is used to calculate recreational potential scores, which in turn, also provides the user with another method of classifying landscape areas.

Classification of a landscape as spatially diverse and complex as rivers presents a real challenge to the geographer. One could describe the landscape through use of fractional codes, similar to that done by Finch, or

Sauer and Lovejoy.[14] With a fractional code, numerous landscape characteristics can be recorded onto one map, instead of mapping only one phenomenon at a time. In the case of Finch, six features were mapped in the study area. Division of the area would occur when one of the six features changed, in comparing one parcel of land with another. Digits, which represented categories of three features (land use, type of crop or other use, condition of crop), were marked above a line within a defined area. Likewise, digits were marked below the line for three other features (soil types, slope, drainage condition).[15] Mapping a large area in the field with this method also be difficult due to its complexity, though separate maps can be constructed for each feature, as read from the fractional-coded base map.

As reviewed by James, land classification studies (land quality and land use) have deep roots in the history of geography.[16] Notably, early land classification is

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[14] Robert S. Platt, ed., Field Study in American Geography (Chicago: Department of Geography, University of Chicago, 1959), pp. 96-114; and Charles M. Davis, "Field Techniques," in American Geography: Inventory and Prospect, ed. Preston E. James and Clarence F. Jones (Syracuse: Syracuse University Press for Association of American Geographers, 1954), pp. 507-516.

[15] Davis, "Field Techniques," p. 514.

[16] Preston E. James, All Possible Worlds (Indianapolis: Odyssey Press, 1972), pp. 303-309, 435-446.

exemplified by the "Great Surveys" of the nineteenth century; those "expeditions specifically organized to map and make inventories of the western territories" led by Hayden, King, Wheeler, and Powell.[17] Land classification studies were improved with Finch's development of the fractional code system (1933), Michigan Land Economic Survey (Sauer and Lovejoy between 1922-1933), Tennessee Valley Authority (Hudson, 1934), and the Puerto Rico Rural Land Classification Program (1949-1951).[18]

Evaluation of the landscape for recreation appears to be very similar to that of evaluating an area for agricultural purposes, i.e., agricultural land-capability classification.[19] However, certain aspects of the landscape which are important to the outdoor recreation planner are difficult to quantify, for example, aesthetic values.

This research is an attempt to further develop techniques for recording the characteristics of river corridor landscapes through field observations, and through use of remote imagery, topographic maps, soil surveys, and other documentation. Not all river characteristics were classified, but only those of importance in considering the

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[17]Ibid., pp. 204-205.

[18]Ibid., pp. 413, 436-446; and Davis, "Field Techniques," pp. 507-516.

[19]See, for example: U.S. Department of Agriculture, Soil Conservation Service, Land-Capability Classification, Agriculture Handbook No. 210 (Washington, D.C.: U.S. Government Printing Office, 1961).

use of rivers and adjacent lands for specific human activities of a recreational nature.

Goal Two: Identification of River Recreation Opportunities

With increased pressures on recreational facilities and areas in the United States such as national forest lands, (particularly those forests within close proximity to urbanized areas such as the White Mountains National Forest, or the Manistee National Forest) it seems important to evaluate recreation resource areas. In this case, rivers are the type of recreation resource area under consideration. This study involved a review of techniques used in previous studies for evaluation of river landscapes, development of an improved approach to estimating the recreational opportunities, field testing of the approach, and an assessment of the usefulness of such a procedure.

Objectives

Four study objectives were identified for this thesis. First, investigation of past and present river and recreation landscape assessment techniques was necessary. This task included a review of how states and the federal government have responded to increased attention paid to rivers in the form of legislation establishing natural, wild, or scenic river programs. This objective addresses the traditional step in scientific research of identifying

and assessing previous research findings in order to build upon them.

The second objective was to develop a draft objective resource inventory and evaluation procedure for subsequent testing. As previously mentioned, this approach had certain requirements: field work was to be minimized, simplicity of operation, objectivity in resource evaluation to reduce subjective decisions and to allow the procedure to be used by other researchers, and separation of inventory from planning considerations. The approach further required that evaluations be attempted for numerous components of the landscape, not just aesthetics, physical stream characteristics, land use, or other individual components alone, but all integrated.

Third, field testing on one or more rivers was deemed requisite to determine the overall usefulness of the evaluation approach.

Four, upon successful or meaningful completion of objectives one, two, and three, an evaluation was necessary. Concurrent was the need to summarize project activities and to recommend changes in the approach for further testing by agencies, university researchers, and others.

Hypotheses

Despite the lack of complete user-preference and behavior studies, an attempt was made to objectively evaluate river recreation opportunities. Resource decisions continue to be made, consciously or by default, which includes river recreation management decisions. While user-preference and behavior studies are lacking which can be universally applied in developing the river recreation potential evaluation procedure, development of such a procedure should continue.

The basic hypothesis of this thesis is as follows: It is feasible to develop and to implement an objective technique for evaluating river recreation opportunities, which will assist in river recreation planning and in guiding associated land management practices,[20] and, further, will accommodate the operational constraints of land management agencies.[21]

This hypothesis generates seven sub-hypotheses which are enumerated below:

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[20]Associated land management practices refers to other activities which may occur in a watershed and/or along a river corridor, and which could effect a change in the physical appearance of a river and adjacent lands. These activities could include timber cutting, stream management practices (e.g., erosion prevention structures), fish management practices, and new road construction.

[21]Accommodation of the operational constraints of land management agencies within the methodology of this procedure indicates that an agency may complete evaluation of a river corridor with minimal manpower, and with only one trip down the river corridor, depending on use of aerial photography and other data sources to minimize costs of field work to an agency. Further, the time requirements of this technique's application are minimal, thereby allowing hundreds of river miles to be evaluated within a summer season or equivalent length of time.

Sub-Hypothesis 1. No existing recreation potential assessment system fulfills the project needs namely, objective calculation of recreational opportunity potential scores for specific activities within a narrow, linear river corridor, subdivided into smaller segments.

Sub-Hypothesis 2. The most accurate river recreation opportunity evaluation process is one that obtains data, for a quantitative inventory of river characteristics, through an integration of field research and interpretations of aerial photographs, and processes this inventory data through a quantitative evaluation procedure.

Sub-hypothesis 3. Data gathering and analysis using a continuous and relatively narrow river corridor[22] is the most satisfactory approach to evaluating the recreational potentials of rivers, and is more satisfactory than using data from designated sampling points[23] distributed along the river, or methods which involve data for watersheds.

Sub-Hypothesis 4. Because of the complexity of recreational activities, a large number of different variables must be inventoried in order to comprehensively evaluate the

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[22]In this case, the corridor extends from the river banks to one-quarter mile inland. The total width of the corridor is one-half mile plus the width of the river itself.

[23]An alternative to evaluating the entire length of study river and adjacent lands is to strictly evaluate the river at specific points, for example, a transect or sample area every two miles.

potentials for diverse land and water based recreational activities.

Sub-Hypothesis 5. Special aerial photography[24] will generally be unnecessary for use in this evaluation procedure.

Sub-Hypothesis 6. The process of conducting an inventory of a river landscape and evaluating recreational potentials can be accomplished through wholly objective measurements and techniques.[25]

Sub-Hypothesis 7. One application that a river recreation potential assessment procedure will have is to identify possible recreational activity conflicts within river segments.

Relevance of Study

A basic requirement for effective and responsible land use planning is knowing how land is presently being utilized, and the capabilities of the land resource for supporting certain other activities. This then is part of the supply function in a recreation research "supply and

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[24] Special aerial photography are those types other than black and white or color infrared imagery which are commonly available through the Soil Conservation Service, Agricultural Stabilization and Conservation Service, highway departments, planning commissions, national forest supervisors' offices, and other agencies.

[25] "Wholly objective measurements and techniques" means that all variables should be measured using instruments or systematized observations (for example, "keys" for identifying plant or animal species).

demand" equation. As Twiss states, "Inventory is a basic part of virtually all considerations in supply."[26] Twiss also identifies classification as a component of supply. He states that classification concepts are "no doubt useful as a guide, but no one concept [of a classification approach] should be interpreted too strictly, as is often the case."[27] Even yet, Twiss urges that objective and subjective aspects of supply evaluation should be candidly reported:

> For example, a broad survey and mapping of environmental and landscape attributes may be of more use to planners than calculations based on tabular data about gross acreage and standards. Comprehensive inventories can serve as a continuing basis for supply decisions even though recreation activities and tastes change somewhat over time.[28]

Sanford, in a Forest Service publication states,

> Inventory is a fact-finding operation designed to take stock of the recreation resource. . . . Any effort to combine inventory and planning into a simultaneous procedure will seriously depreciate the value of both. . . . Recreation opportunities and attributes should be recognized simply because they exist, irrespective of current or anticipated demand for recreation or compelling demands for other products and services of the land.[29]

Sanford goes on to identify three functional distinctions in recreation resource management: inventory (locate,

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[26] Robert H. Twiss, "Supply of Outdoor Recreation," in Elements of Outdoor Recreation Planning, ed. B. L. Driver (Ann Arbor: University of Michigan Press, 1970), p. 137.

[27] Ibid., p. 139.

[28] Ibid., p. 142.

[29] U.S. Department of Agriculture, Forest Service, Recreation Inventory Instructions, Forest Service Handbook--Preliminary Draft (Washington, D.C.: U.S. Department of Agriculture, Forest Service, August 1972), p. 111.

quantify, describe), planning (projected needs, program goals, long range objectives), and management (develop, utilize, operate, maintain, administer, acquire). One must take inventory within the context of planning and management information needs.

The need for river inventories and classification, similar to the type described in this thesis, was expressed in 1962 by the Outdoor Recreation Resources Review Commission in their Study Report 10.[30] The study, prepared for the Commission by hydrologists in the U.S. Geological Survey, note that classifications would help to delineate rivers which should be: (1) preserved, (2) used for transportation of waste, (3) set aside for research, and (4) classified according to the recreational opportunities they could provide.

Given that inventories and classification appear to be important components in recreation planning, the question may be asked as to how this research fits into identified needs of recreation research in this country. One list of research priorities has been compiled by an inter-disciplinary group, including a geographer, under the auspices of the National Academy of Sciences for the Bureau

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[30] Outdoor Recreation Resources Review Commission, Water for Recreation--Values and Opportunities, ORRRC Study Report 10 (Washington, D.C.: U.S. Government Printing Office, 1962), pp. 12, 50-56.

of Outdoor Recreation, U.S. Department of the Interior.[31] The study undertaken by the Academy sought to identify relevant problems amenable to research, establish realistic research objectives and programs, provide the conceptual frameworks for such programs, and recommend implementation arrangements.

This thesis appears to fit into certain categories of priority research needs as identified by this interdisciplinary group. First, in calling for standards of resource quality, in order to quantify costs of supplying resource-based recreation,[32] this study could contribute to quantifying the baseline; recording that which currently exists for comparison with future surveys. More importantly, the present study will contribute to research needs in the operation of recreation service systems. To this need, the river recreation potential assessment technique has applications to resource allocation and activities in relation to user preferences, estimating potentials for expanding the supply of recreational opportunities, assisting in the recognition of quality factors, and in helping to develop outdoor recreation data bases and information analysis.[33] In considering research regarding

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[31] National Academy of Sciences, A Program for Outdoor Recreation Research (Washington, D.C.: National Academy of Sciences, 1969).

[32] Ibid., p. 39.

[33] Ibid., pp. 49-53, 59.

"Quality Factors," the National Academy of Sciences study states:

> The accelerating tendency to assign land to recreation --particularly in areas where pressures for its commitment to alternative uses are intense--suggests that high priority should be assigned to research on the different characteristics of land resources and on comprehensive indices of recreation-site quality.[34]

Another justification for this study is its possible usefulness for assessing recreational potentials of rivers in and under study for the national Wild and Scenic Rivers Act (PL 90-542) and the twenty-four states with some type of natural rivers program.[35]

Finally, river recreation research has seen increasing work done in the quantification of landscapes, quantitative assessment of river recreation potential, and development of screening procedures to identify quality rivers which can be included in a natural, wild, or scenic rivers program. Some of the more important research efforts are reviewed in Chapter II.

Study Location

Portions of three Michigan rivers were selected for development and testing purposes in this study: the Pine

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[34]Ibid., p. 51.

[35]The twenty-four states, as of March 1975, were: Alabama, California, Florida, Georgia, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia, and Wisconsin. (Source: U.S. Department of the Interior, Bureau of Outdoor Recreation, "Summary of State Actions to Establish State Scenic Rivers Programs, 5 March, 1975. (Photo-copy.))

River (also known as the South Branch of the Manistee River) (Lake, Wexford, and Manistee counties), the Manistee River (Wexford and Manistee counties), and the Looking Glass River (Clinton County) (Figure 3).

The Pine and Manistee rivers are well known throughout the state for high-quality recreational activities and are located within the Manistee National Forest in the northern portion of Michigan's lower peninsula. They are also high-use rivers within a few hours drive of major population centers in the state. The Looking Glass River contrasts with the two northern rivers in that it is narrower, flows through agricultural lands with some streambank housing development, and is within ten miles of the Lansing-East Lansing metropolitan area.

Conclusion

In following chapters, I have outlined the stages of development leading to successful completion of this project. Chapter II discusses the primary studies and research efforts which preceded the present study and were particularly important in the development of this approach. A description and discussion of this evaluation method is found in Chapter III. Chapter IV outlines and illustrates evaluation scores and preferred recreational activities for each river and individual segments that were actually used to test the evaluation procedure. Finally, Chapter V reviews the findings in light of the overall study

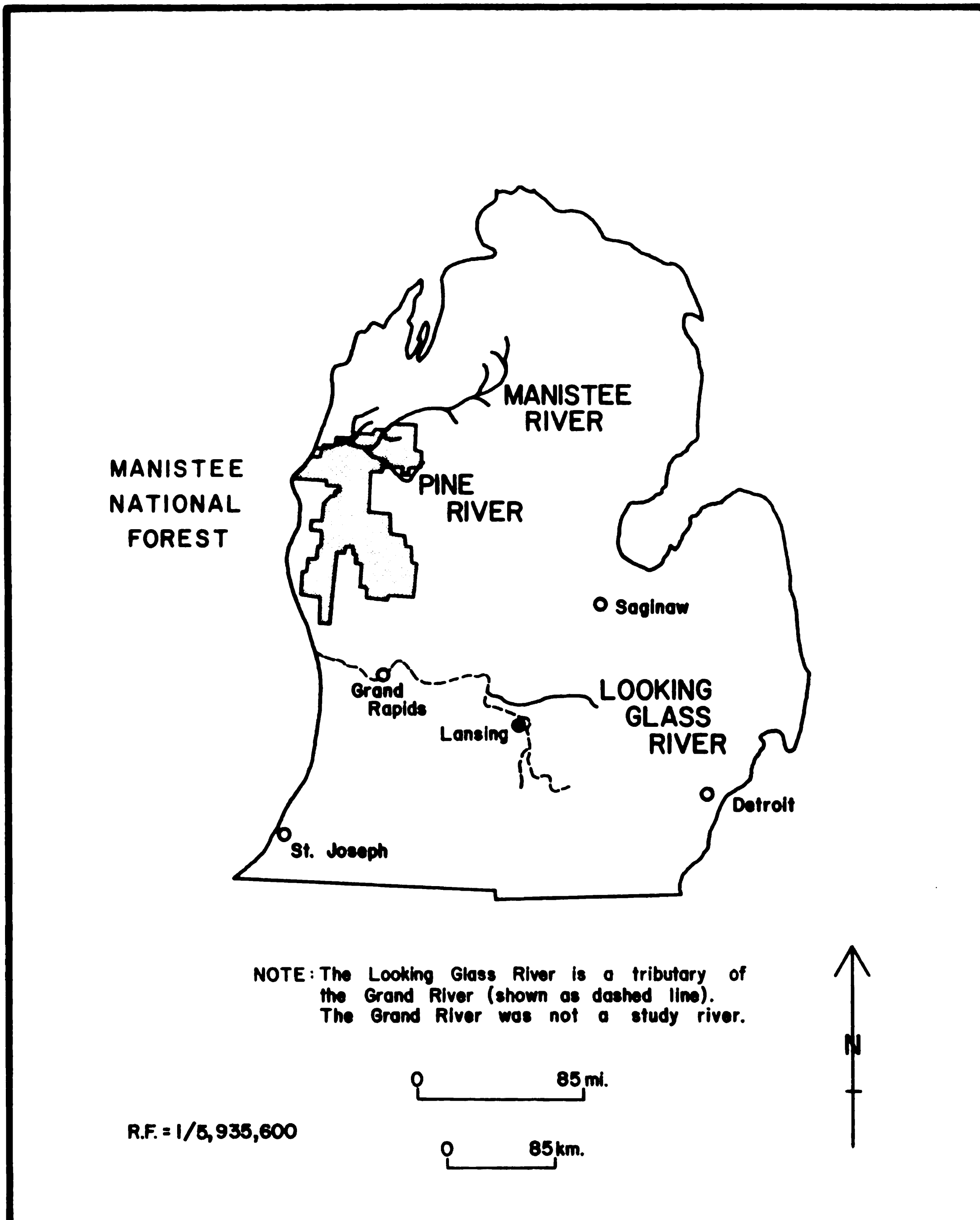

Fig. 3.--Map showing location of three study rivers.

objectives and hypotheses, and offers recommendations for improvements to this approach and for analyzing other rivers.

CHAPTER II

RELATED RESEARCH

Introduction

Previous research efforts in this area of river recreation potential assessment are rather limited. Major works cited herein are listed and briefly described under the following broad subject headings: river aesthetic studies, river recreation inventories, remotely-sensed river recreation inventories, wild and scenic river classifications, and non-river recreation inventories.

The results of three computer literature searches were used as part of the literature review for this project. They were as follows: Water Resources Scientific Information Center (WRSIC), Cooperative Research Information System (CRIS), River Recreation Bibliography-North Central Forest Experiment Station. In addition, a punch-card, needle-sort retrieval search was done for this study by the Washington, D.C. office of the Bureau of Outdoor Recreation.

Previous Approaches

River Aesthetic Studies

Leopold.--Easily the most cited series of studies are those by Leopold.[36] He used measurements of river characteristics to develop river uniqueness values or indicies, valley character analysis, and river character analysis. Inventoried parameters were broken down into three classes: physical, biological, and human use or interest. As examples, under "physical factors," width, velocity, stream order and others were measured. For "biological factors," land flora type and fauna were two variables. Under "human use and interest," land use, accessibility and trash were three variables listed.

Based on the premise that unique landscapes (either negatively or positively unique) have more significance to society than do common landscapes, Leopold developed the uniqueness ratio. He described the procedure as follows:

> If the site factor is, for example, one among 12 of the same category, the site shares this characteristic with 11 others. It is unique in the ratio of 1 to 12 or its uniqueness ratio is 1:12 (.08). If no other site shares the same category position, then the site

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[36]Luna B. Leopold and M. O. Marchand, "On the Quantitative Inventory of the Riverscape," Water Resources Research 4 (August 1968):709-717; Luna B. Leopold, "Landscape Aesthetics," Natural History 8 (October 1969):36-45; Luna B. Leopold, Quantitative Comparison of Some Aesthetic Factors Among Rivers, U.S. Geological Survey Circular 620 (Washington, D.C.: U.S. Government Printing Office, 1969).

> has a uniqueness ratio of 1:1 (1.0). The uniqueness is then defined on a scale of 0 to 1.0.[37]

A major problem with the uniqueness value is that it does not differentiate between superlative areas or the most aesthetically unpleasant areas.[38,39] For example, Hamill writes:

> The ranking test indicates that uniqueness ratios are poorly correlated with consistent evaluation ratings for physical measures of streams and valley and for water quality factors. . . . I conclude that this use of the uniqueness ratio is inefficient.[40]

Leopold's analysis of river character and valley character has also been criticized as being too complex in terms of their method of calculation, using too few variables, and being an inadequate approximation of the whole landscape.[41]

Others have also used Leopolds' basic concepts, with some modification, in river studies.[42]

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[37]Leopold, Quantitative Comparison, p. 5.

[38]Nicolas Coomber and Asit Biswas, Evaluation of Environmental Intangibles (Bronxville: Genera Press, 1973), p. 40.

[39]Louis Hamill, "Analysis of Leopold's Quantitative Comparisons of Landscape Aesthetics," Journal of Leisure Research 7 (Winter 1975):18.

[40]Louis Hamill, "Statistical Tests of Leopold's System for Quantifying Aesthetic Factors Among Rivers," Water Resources Research 10 (June 1974):401.

[41]Hamill, "Analysis," p. 23.

[42]David Libby, The Recreational Potential of Selected Rivers in New Brunswick (Fredericton: Department of Tourism, Province of New Brunswick, 1975); Priidu Juurand, Wild Rivers Survey 1971 (Ottawa: Indian and

River Recreation Inventories

Craighead and Craighead.--The widely cited approach by Frank Craighead and John Craighead was the earliest river recreation inventory method I detected.[43] Searth points out that this inventory seems to be developed from the National Forest Outdoor Recreation Survey approach.[44,45] The potentials for three recreational activities were inventoried and evaluated. These were: boating, fishing, and hunting. For boating and hunting, twelve variables were scored, while fishing had thirteen. A rating of zero to three, four, or five (the maximum depending on the variable) was assigned to each variable. These scores were summed. This approach, which could be used to rate an entire stream, or segments thereof, was an early attempt to meet perceived

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Northern Affairs, 1972); John A. Dearinger and George M. Woolwine, Measuring the Intangible Values of Natural Streams, Part 1: Application of the Uniqueness Concept (Lexington: University of Kentucky, Water Resources Research Institute, 1971); Wilton N. Melhorn, Edward A. Keller, and Richard A. McBane, Landscape Aesthetics Numerically Defined (LAND System): Application to Fluvial Environments, Studies in Fluvial Geomorphology No. 1 (West Lafayette: Purdue University, Water Resources Research Center, 1975).

[43]Frank C. Craighhead, Jr. and John J. Craighead, "River Systems: Recreational Classification, Inventory and Evaluation," Naturalist--Journal of the Natural History Society of Minnesota 13 (Summer 1962):2-19.

[44]Thomas S. Searth, "Land Classification for Outdoor Recreation" (M.A. thesis, The University of Calgary, 1970).

[45]U.S. Department of Agriculture, Forest Service, Work Plan for the National Forest Outdoor Recreation Survey (Washington, D.C., 1959).

needs of knowing that river resources were available, the rates of development, and the need for classification and evaluation.

Ditton criticized the Craigheads' use of the maximum values for the variables in that these values constituted arbitrary weights reflecting the relative importance of the variables. He writes:

> The fixed maximum values of the criteria reflect the relative importance of each criterion and provide a common denominator upon which comparisons can be made within and between resource areas. Since weighting of the criteria by the Craigheads is arbitrary, there is a need to quantitatively establish the relative magnitude of these weights on the basis of recreation participants attitudes and behavior. To ignore the individual and his quality framework is to remain an arbitrary and unreliable quality framework.[46]

Dearinger.--Recognized as one of the most comprehensive methods of river recreation potential assessment, a 1968 study by John Dearinger at the University of Kentucky[47] was based, in part, on techniques used by the U.S. Department of Agriculture-Soil Conservation Service.[48] The

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[46]Robert B. Ditton, The Identification and Critical Analysis of Selected Literature Dealing with the Recreational Aspects of Water Resources Use, Planning, and Development, Research Report No. 23 (Urbana: University of Illinois, Water Resources Center, 1969), p. 113.

[47]John A. Dearinger, Esthetic and Recreational Potential of Small Naturalistic Streams Near Urban Areas, Research Report No. 13 (Lexington: University of Kentucky Water Resources Institute, 1968).

[48]U.S. Department of Agriculture, Soil Conservation Service, Guide to Making Appraisals for Potentials for Outdoor Recreation Development (Washington, D.C.: U.S. Government Printing Office, 1966).

method was rather conventional in that a system of assigning arbitrary weights to key elements in recreation activities was used. Thus a value, between one and five, was placed on ninety-two natural and cultural elements. Depending on the recreational activity--there were sixteen--the element value was multiplied by the appropriate weight to yield an element score. A percentage score was calculated, for each river for each activity, from the sum of scores divided by the total possible score. Further, Dearinger calculated an attractivity assessment using step-wise regression, and estimated economic benefits of each of the two creeks tested in this research effort.

Morisawa.--Morisawa concentrated on "developing methods for objectively identifying and assessing values of rivers in their natural, free-flowing states, including cultural, geological, hydrological, aesthetic and recreational values."[49] This is accomplished through detailed, time-consuming transects of the main stream and the major tributaries, as well as a field reconnaissance over the complete watershed and the length of the main river under study.[50] The recreation and aesthetics classifications are limited, however. For the former, recreation activities

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[49]Marie Morisawa, Evaluation of Natural Rivers, Final Report, Project C-1779 (Binghamton: State University of New York, 1971), p. 3.

[50]Ibid., p. 89.

are divided into three categories, namely "active outdoor recreation" (camping, hiking, hunting, horseback riding, backpacking), "active water recreation" (swimming, canoeing, fishing, motor boating, sailing), and "nature observation and interpretation" (wildlife, wildflowers, birds, geology). Then the observers matched activity groups with one of the following four time categories of possible use: most or all activities (year-around), most or all activities (seasonal), some activities (year-around), and some activities (seasonal). For aesthetics, observers rated vistas, color, vegetation, relief, serenity, naturalness, accessibility, water appearance (clean-turbid), water appearance (ripple-calm), and, pollution and litter. All ratings were done on a one to five scale for each transect. Morisawa notes that, "It must be admitted, however, that these rankings are probably biased."[51]

The study also attempted to quantify the natural beauty of rivers. This was done by asking five hundred individuals to rate beauty of forty-five colored slides depicting river scenery. A scale of one (extremely beautiful) to six (very unattractive, eyesore) was used by the participants to rate the beauty of the scenery. Subjects were also requested to identify a characteristic considered most important in evaluating the beauty of a landscape. Color, relief, naturalness, solation, white

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[51] Ibid., p. 82.

water, mountains, vista, variation, and wildlife were ranked by the number of times mentioned. Morisawa concluded from her study that "we can agree more on extreme unpleasantness than we can differentiate among scales of pleasantness."[52] This appears to agree with the Dearinger et al. findings that "different groups of people agree on what constitutes a very beautiful or very ugly scene, but disagree about scenes that are neither one or the other."[53]

Nighswonger.--A different approach to river recreation potential assessment was developed by James J. Nighswonger in 1970 for the Kansas Department of Economic Development.[54] Points were given whenever one of the following landscape features occurred in a study segment on one of the four rivers: access, riffles, rapids, waterfalls, dam, bluffs, spring, bridge, natural campsite, improved campsite, unique specimen plants, cave, pipe line, scenic sites, historic sites, rock/fossil area, wetlands, and scenic sites. While these received positive points, bank

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[52] Ibid., p. 85.

[53] John A. Dearinger et al., Measuring the Intangible Values of Natural Streams, Part II: Preference Studies and Completion Report, Research Report No. 66 (Lexington: University of Kentucky, Water Resources Research Institute, 1973), p. 114.

[54] James J. Nighswonger, A Methodology for Inventorying and Evaluating the Scenic Quality and Related Recreational Value of Kansas Streams, Report No. R32 (Topeka: Kansas Department of Economic Development, 1970).

and water pollution necessitated deduction of points. In comparison of one river's total score with that of another river, that river with the higher score represented an estimate of greater scenic quality and related recreational value.

In addition to his discussion of measurement of scenery and recreational value, Nighswonger also reviewed the issue of public accessibility to the state's privately owned streams.

Methods Using Remotely-Sensed Data

MacConnell and Stoll.--MacConnell and Stoll demonstrated the feasibility of analyzing the Connecticut River for its recreational potential utilizing aerial photo analysis.[55,56] Two sets of photographs were used: earlier imagery (1951, 1952, 1953, 1955), at a scale of 1:20,000, and new imagery (1965) at 1:12,000. Maps were compiled of adjacent land uses. The classes used were, agricultural or open space land (nine types), mining (exposed rock, or waste disposal areas) (six types), urban areas (twelve types), outdoor recreational facilities (fourteen types),

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[55]William P. MacConnell and G. Peter Stoll, "Time Lapse Aerial Photo Analysis of the Connecticut River from 1952 to 1965," Water Resources Bulletin 5 (June 1969): 37-50.

[56]William P. MacConnell and G. Peter Stoll, "Evaluating Recreational Resources of the Connecticut River," Photogrammetric Engineering 35 (July 1969):686-692.

and riverbank and edge-of-river bed (twenty-six types). The 1:12,000 scale photographs were preferred due to larger scale, and, since the imagery was taken in spring with no leaves on trees, the photographs permitted easy identification of roads, buildings, shorelines and other features. The 1:20,000 scale imagery taken in the summer enabled the photo interpreters to delineate vegetation, forest, farms, and wetlands more easily. The data compiled by their study included not only land use information, but also evaluations of accessibility, picnic-camping areas, scenic overlooks, aquatic vegetation, physical obstacles in the water and others.

Dill.--Dill concluded that airphotos could be used for three different levels of recreational analysis, namely, to estimate numbers of overall site potentials for a large area using random sub-samples, to identify and locate possible recreation sites, and to assist in final site selection, technical planning, and final presentation.[57]

Olson.--Olson et al. estimated the boating, swimming, and camping potential of five "township-size" areas in Michigan using 1:20,000 panchromatic aerial photographs. In one case, 1:15,840 infrared imagery was used.[58] After

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[57]Henry W. Dill Jr., "Airphoto Analysis in Outdoor Recreation: Site Inventory and Planning," Photogrammetric Engineering 29 (January 1963):67-70.

[58]Charles Olson, Jr., "Inventory of Recreation Sites," Photogrammetric Engineering 35 (1969):561-568.

two months experience, they found it possible to complete photo-inventory at the rate of thirty-six square miles in two to three hours. Field checking was carried out at the rate of forty to eighty square miles per day. The time requirement for photo interpretation and field checking combined, meant that thirty to fifty square miles could be assessed per man-day. The study identified three types of interpretation problems; they were unrealistic or ambiguous classification standards, inexperience of the photo interpreter, and failure to separate clearly the inventory and management decision-making functions.

Other Studies.--Besides the specific uses of aerial photography mentioned above, many of the other studies previously cited or footnoted used aerial photographs on a more limited scale.

In general, it appears that remotely-sensed imagery was helpful in recreational potential studies. Since field work time can be reduced through its use, the present study incorporated interpretations of black and white modified infrared, and color infrared imagery into the data gathering procedure.

Recreation Opportunity Evaluation Methods

Two significant recreation inventory approaches have been developed by the U.S. Department of Agriculture Forest Service. While neither excludes river corridor recreation resource evaluation, the application is to larger, more diverse areas, such as entire national forests or river and mountain valleys.

U.S.F.S. Recreation Inventory Method.--This Forest Service approach entails locating and delineating areas which combine to provide environments suitable for recreational experiences. It also estimates the potential of land for future recreation opportunities.[59]

The Handbook divides recreation into two broad classes: intensive and dispersed. Dispersed recreation refers to low density use (wilderness, special interests, etc.) where developments to support use are usually only roads, trails, parking places, and simple facilities. Intensive recreation takes place where developed recreation sites have been built or could be built; for example, picnic grounds, swimming beaches, hotels, and others.

Five major characteristics of land and water for low density recreational use are quantified and qualified in the inventory. These characteristics are: the land environment, landscape and scenery, wildlife habitat, cultural features (archeological, botanical, geological, historical, zoological, and memorial), and the water environment (boating and fishing opportunities). For intensive

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[59] U.S. Department of Agriculture, Forest Service, Recreation Inventory Instructions: Forest Service Handbook--Preliminary Draft (Washington, D.C.: U.S. Department of Agriculture, Forest Service, 1972).

use, such factors as terrain, soil, slope, shelter, water availability, water temperature, depth-of-snow, wind, ice, and shoreline frontage, are considered for three groups of activities, namely, group 1, composed of campgrounds, picnic grounds, organizational camps, lodges, group 2--swimming and boating sites, and group 3--skiing and other winter sports activities. Then to evaluate quality:

> Each scope of land and water having one or more important characteristics or attributes differing significantly from those of surrounding or adjacent places is treated as a quality evaluation unit.[60]

These quality units are combined on map overlays forming, in essence, fractional code land classifications. For dispersed recreation, the quality evaluation values are summed to yield a quality profile value. For intensive phases, composites of a quality unit receive a value of outstanding, good, or fair, as opposed to numbers by "mechanical synthesis."

This new approach, as outlined in the draft handbook, appears to be a revision of the 1959 National Forest Recreation Survey (NFRS) which "produced a large volume of organized information which formed the basis for a recreational management plan covering each National Forest."[61]

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[60]Gordon Sanford, U.S. Department of Agriculture, Forest Service," Understanding the Inventory." Presentation outline, no date, p. 12. (Photo-copied.).

[61]USDA Forest Service, Draft Handbook, pp. 811-812.

The new draft revision attempts to rectify certain conceptual and practical problems encountered with the NFRS.

Northern Region Method.--Recreation opportunity indexes and classes of five recreation preference types are calculated for individual recreation experience units (R.E.U.s)[62] in the method developed by the Northern Region of the U.S. Forest Service. The five preference types were: active-appreciative, active-extractive, passive-appreciative, sociable-learning, and active-expressive. The R.E.U.s were inventoried for various factors: attractive features, accessibility and remoteness, visual resource characteristics, discord elements, and visitation capacity. These factors were then used to calculate recreation opportunity scores. All data and scores were then tabulated in summary matricies. Also, by assuming changes in the environmental characteristics of an R.E.U. (such as timber cutting), the impact on future recreation use by visitors could be estimated.

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[62]Recreation experience units were defined as: "discrete portions of the Forest land to which people relate while engaging in Forest outdoor recreation. . . . Delineations . . . that represent more or less distinct separations between spaces are drawn by visualizing how recreationists may relate to these spaces when within them. Such delineations usually follow major wall plane elements as valley ridgelines, terrain characteristics, and other geological portals, vegetation, directional changes, etc." U.S. Department of Agriculture, Forest Service, Northern Region, Recreation Opportunity Inventory and Evaluation (Washington, D.C.: U.S. Government Printing Office, 1974), p. 17.

It appears that this approach is oriented to western topography and, as previously mentioned, to large areas rather than small units such as the river corridors investigated in this thesis. Further, it includes inventorying of existing recreational facilities, while the emphasis of this thesis is on inventorying the river landscape exclusive of existing recreational facilities.

Wild and Scenic Rivers Classifications

State River Classification Systems.--As mentioned in previous discussions, twenty-four states have some form of natural, or wild and scenic rivers program. Each state, except Michigan (where relevant information already was available), received a letter requesting information on classification approaches. All but two states replied, in some form, with only two indicating that they were not involved in any work which would be applicable to the investigation. Included in many replies were copies of state river program enabling legislation, eligibility guidelines, and general discussions of programs. Other replies consisted of specific river studies such as a report on the Allagash River in Maine.

Some type of numerical scoring system was in use in seven states.[63] The emphasis of these systems was one

[63]These states are Kentucky, Massachusetts, Pennsylvania, Florida, Tennessee, Georgia, and Indiana.

of determining whether or not surveyed rivers qualified for inclusion in the state's program, and if so, in what category.[64] Also, their usefulness was limited in contributing to the design of this present study's inventory and weighting approaches because their emphases were not on overall recreational opportunities for a wide range of river landscapes. They were focused on wilder, more pristine environments with a narrower range of recreation opportunities.[65]

Bureau of Outdoor Recreation.--The Bureau of Outdoor Recreation (U.S. Department of the Interior) is presently establishing procedures for identifying "a balanced representation of the most outstanding river segments in the Nation."[66] The evaluation's purpose is to focus on directly measuring "the quality of the resource rather than the quality of the activities that may occur on it."[67]

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[64]From replies received from the twenty-two states, the following general continuum of classes is derived: wilderness (apparent lack of man's influence, remote, etc.), wild (in some cases, synonymous with wilderness, in other cases, something less than wilderness values), scenic, recreational, and modified. The sequence represents increasing degrees of human influence and modification to the river and adjacent lands, but each contains some recreational values.

[65]All replies from the twenty-one states to the information request letter are gratefully appreciated.

[66]U.S. Department of the Interior, Bureau of Outdoor Recreation, "Identifying a Minimum Wild and Scenic Rivers System, Draft" (1975), p. 1.

[67]Ibid., p. 5.

Under the draft approach, an initial screening would occur to eliminate river segments under twenty-five miles in length (unless a shorter length possesses high qualities), to eliminate segments where water quality could not be brought up to contact recreation standards within ten years, and to eliminate any segments on which heavy industrial or urban development is visible on 25 percent or more of the river. After the initial screening, "pre-study" evaluations by physiographic section will take place. The goals at this "pre-study" stage would be two-fold. First, a resource survey would utilize an evaluation form covering hydrology, water quality, land-use characteristics, cultural and historic resources, recreation resources, zoological resources, botanical resources, and physiographic resources. Following completion of this inventory, Bureau personnel will determine what river types are significant to each physiographic section and if there is a balanced representation of river type within the section.

Finally, the Bureau will develop a proposed "full-study" program which it will take to Congress for approval prior to initiating more detailed studies.

Other Studies

Milligan et al.--A classification system for recreation water was developed by Milligan et al. which focused on calculating a "factor profile of lake and reservoir attributes."[68] Thirty-six factors were graphically displayed utilizing a histograph. The values of the various factors were reflected in the length of the horizontal bars measured on a ten point scale. The width of the bars were used to indicate the weights assigned to each factor.

Milligan's study was primarily conceptual in its discussion of relating the factor profile to carrying capacity. Also, data collected for ten lakes or reservoirs were incomplete, but profile values were estimated for factors where data was available.

Libby.--In a New Brunswick river study, Libby calculated, for eighteen rivers, Leopold's uniqueness ratios and ranked the rivers on river quality, aesthetic appeal and human interest, and total attractiveness.[69] Further, he identified user conflicts related to recreational canoeing and associated activities (salmon angling, poor summer canoe-ability, and urbanization). Crown ownership of river frontage was also inventoried, as were waterway and shoreland recreation capabilities extracted from the Canada Land Inventory. As a summary table, Libby considered each river's natural attractions, scope of significance, average

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[68] J. H. Milligan et al., Recreation Water Classification System and Carrying Capacity (Moscow: University of Idaho, Water Resources Research Institute, 1973), p. 14.

[69] David Libby, The Recreational Potential of Selected Rivers in New Brunswick (Fredericton: Department of Tourism, Province of New Brunswick, 1975).

summer canoeability, and the apparent imminence of misuse. Each of the four factors received a rating of one (greatest), two (moderate), or three (least) which were then summed. The higher the number, the less desirable was the river. This evaluation of recreational potential was on a more general level of analysis than was the case in Dearinger's study.

Conclusion

Other studies were reviewed during this investigation of related research. Those summarized above are the ones which contributed most significantly to the development of the method of river recreation potential assessment described in this thesis.

The major objectives of past studies appear to be grouped as follows: aesthetic evaluation of one or more rivers, quantification of physical characteristics of one or more rivers, recreation opportunity evaluation for watersheds, recreation opportunity inventory for large and diverse land and water areas (such as entire national forests or major subdivisions), and evaluation of high quality rivers as part of state wild and scenic river programs. The most influential recreation inventory approaches which "set the stage" for subsequent studies were Leopold and Marchand's study of river aesthetics, the Craighead and Craighead approach, the National Forest Outdoor Recreation Survey, and Dearinger's initial report (1968).

The following chapter of this thesis describes the method which this author developed for assessing the recreational potential of rivers.

CHAPTER III

INVENTORY AND ASSESSMENT METHODS

Introduction

Initial attempts were made during early phases of the literature review to further define the problem, develop initial drafts of the inventory list and weightings, collect river data, and prepare for field work. From these early attempts, the technique evolved throughout the development period.[70] Constantly evolving components were the inventory list and associated forms, transformation tables, weightings table, and the procedure for subdividing a river corridor into smaller observation units. Other facets of the technique remained fairly stable throughout the development period. These facets were: the recreational activities for which evaluations should be produced, data sources, and the width of the river study zone or river corridor.

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[70]Literature review occurred primarily between March 1975 and July 1975. The primary field period extended from August 1, 1975 to August 29, 1975, with some day and overnight trips to the study areas occurring from May to October, 1975.

The next section discusses the activities around which the procedure was built, and the nature of the river study zone. The second and third sections outline the specific procedure developed for inventorying the river corridor and for analyzing the data.

Outline of Method: Fundamentals

River Study Zone

Overall Width.--For this study, the river study zone (hereinafter called the river corridor) extends one-quarter mile inland from each river bank.

River corridors in previous studies have varied from the immediate banks, as in Leopold (1969),[71] to an entire watershed (Dearinger, 1968).[72] Other possibilities which were considered were the visual corridor, some other arbitrary distance (for example, one-half mile on each side), recreation experience units (R.E.U.), or, a visual corridor plus additional land up to a convenient and legally definable boundary.[73]

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[71]Leopold, Quantitative Comparison, p. 3.

[72]Dearinger, Esthetic and Recreational Potential, p. 8.

[73]The visual corridor was inspired, in part, by: U.S. Department of Agriculture, Forest Service, Northern Region, Forest Landscape Management, Volume One, Revised (Washington, D.C.: U.S. Government Printing Office, February 1972). The R.E.U. was reviewed in the previously cited

The impact of the river or river-oriented activity extends beyond the immediate banks of a river. Beyond some point, however, the land itself strongly influences the recreation activities and limitations in the vicinity. For example, in an uplands area, hiking may occur not necessarily because of the relative close-proximity of the river, but because of the topography or vegetation. Individuals may camp with the objective of enjoying the land area, not because a river is in the vicinity.

Finally, in addressing this issue, the selection of a one-quarter-mile width on both sides of the river was arbitrary, but it also represents a convenient boundary to which one can easily relate.

Subdivision of Zone.--For certain variables (corridor soils, land flora characteristics, and land uses), the river corridor was divided into two sections. From the river bank to three hundred feet inland, the primary zone was delineated. The secondary zone began three hundred feet from the river and extended to the one-quarter mile limit.

Recreation Opportunity Inventory and Evaluation, also by the Forest Service-Northern Region.

The R.E.U. was not selected here since this unit, as conceptualized by the Northern Region, appears to be more applicable to Western states.

The last alternative--visual corridor plus additional land up to a convenient and legal boundary--was suggested by David Foster, Recreation Staff Officer, Huron-Manistee National Forest, 7 May 1975.

This subdivision of the corridor appeared necessary since soils, land flora, and land uses may vary significantly beyond land areas adjacent to the river. For instance, wooded areas along portion of the Looking Glass River exhibit a narrow, linear pattern close to the river. Further back from the trees and the river, farm land is often the predominant land use. These linear patterns in the primary zone may also exist for wetlands and muck soils due to periodic flooding of rivers and streams.

Other studies or approaches have used the one-quarter mile, or one-half mile total, corridor. For example, the Pacific Northwest Region of the Forest Service used such a corridor in its study of the Skagit River in Washington under the National Wild and Scenic Rivers Act (PL 90-542).[74] In addition, the Bureau of Outdoor Recreation is considering use of this approach in their program to identify qualified wild and scenic rivers in each physiographic region of the United States.[75] In these cases of federal agency use of the one-quarter or approximately one-half mile wide corridor, such use may have originated in the joint U.S. Departments of Agriculture and Interior

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[74]U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, The Skagit, Draft Environmental Statement, A Proposal for River Classification under the Wild and Scenic Rivers Act (Washington, D.C.: U.S. Government Printing Office, 1975), p. 8.

[75]Bureau of Outdoor Recreation, "Identifying a Minimum Wild and Scenic Rivers System," p. 6.

booklet outlining evaluation guidelines for proposed river inclusions in the National Wild and Scenic Rivers System.[76] Under "Criteria for River Designation" the booklet stated that wild river areas should possess the attribute of being "generally inaccessible except by trail."[77] This is interpreted, by the booklet to mean that:

> there are no roads or other provisions for overland motorized travel within a narrow, incised river valley, or if the river valley is broad, with 1/4 mile of the riverbank.[78]

Three hundred feet appeared to represent a reasonable limit for the first zone, based on observations made while in the field and through reviewing soils maps and aerial photography. Obviously, the one-quarter mile limit of the secondary zone corresponded with the one-quarter mile river corridor limit.

Recreational Activity Definitions

The activities included below reflect a desire to reduce to a minimum number the actual activities considered in the evaluation process. That is, it appeared desirable to avoid subdividing of the activities. These activities then may be considered "activity packages," for instance,

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[76]U.S. Departments of Interior and Agriculture, Guidelines for Evaluating Wild, Scenic, and Recreational River Areas Proposed for Inclusion in the National Wild and Scenic Rivers System Under Section 2, Public Law 90-542 (Washington, D.C.: U.S. Government Printing Office, 1970).

[77]Ibid., p. 5.

[78]Ibid., p. 6.

nature study could be further divided into birdwatching, wildflower study, and others.

Wilderness Canoeing.--This activity involves canoeing on rivers which are minimally affected by man's activities, and generally by those canoeists seeking pristine environments with minimum contact with other people.[79]

General/Social Canoeing.--The primary objectives of general canoeing are to engage in sightseeing from the river, and, often, to spend time with friends, family, or groups while engaging in relaxing boating on a river. Scenic variety and attractive natural areas are important. Greater accessibility to the river does not disturb the general canoeist in comparison with the wilderness canoeist. Likewise, more human structures are acceptable to the general canoeist than for wilderness canoeists.

While some easily negotiable white water or riffles are acceptable, they must not be too rough since beginners and novices are included in this category.

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[79]The reference here to "wilderness" should not be interpreted to mean that this type of canoeing can only occur in formally designated wilderness areas under the National Wilderness Preservation System, established by the Wilderness Act (PL 88-577) or similar state systems, or on rivers formally designated under the National Wild and Scenic Rivers Act (PL 90-542) or similar state program. This term is intended to mean wilder areas which are more remote, where man's influence is minimal.

Small Craft Boating (under 10 horsepower).--The primary objective is in using the boat and/or sightseeing. Row boats, jon boats, and light outboard motor powered fitted watercraft are used in this category.

Powerboating (10 horsepower or more).--Using the boat and/or sightseeing are the primary objectives for this activity. Operating speeds are higher than with small craft boating, and depth requirements are greater.

The number of homes and human structures along the banks are generally not of much concern to the powerboater.

Swimming.--Objectives for swimming are often to engage in exercise, to relax by one's self or with a group, or to lower the body's surface temperature ("cooling off"). The water may be used for wading, vigorous swimming, or for diving, if the depth permits.

Sandy beaches are preferred sites along river banks with moving, clean water. The water velocity must not be too high in order that safe swimming may occur.

Waterskiing.--This activity entails using a powerboat to tow an individual wearing waterskis, with some speed. Therefore, the water must be free of submerged, emergent, or floating objects.

Nature Study.--Participants desire to observe, photograph, or conduct research on wild animals or plants. Depending on an individual's preference, nature study may or may not include study with other people or groups, and could occur in swamps and marshes, upland areas, river banks, bayous, and other areas.

Hiking (Walking).--Activity may range from simple walking for pleasure (casual stroll to day-long explorative jaunts) to walking done with a pack carried by the hiker. Hiking may often be done in conjunction with picnicking and camping, and may extend overnight or longer. Scenic variety and attractive natural settings are usually important to the hiker or walker.

Picnicking.--The desired experience is primarily that eating outdoors or preparing food in a pleasantly-situated area. Such an area may or may not be developed with picnic tables, rest room facilities, grills, etc., and could include roadside picnic areas.

Canoe Camping.--Living in a small tent or other temporary shelter, which is often transported in the camper's canoe. Access to the camping area may or may not be only by canoe. The area should, however, be situated close to the river since camping gear must usually be carried by hand.

Trail Camping.--Living in a small tent or other temporary shelter or trailside shelter in a remote or semi-remote area for some period of time. Usually this type of camping is associated with transient hikers. Accessibility to the sites could be by foot travel only, by trail vehicle, or on horseback.

Vehicle Camping.--Living in a tent, trailer, tent-trailer, motor home, pickup camper, etc., which is transported by motorized vehicle. Areas for this type of camping may or may not be remote, and may be located along tourist routes and designed primarily for transient camping.

Driving for Pleasure.--This activity involves sightseeing from a motor vehicle along a river corridor. Preferably, the river should be frequently observable, with specific points of interest. The quality of the road must be such to allow a standard, two-wheel drive automobile safe and easy passage without danger of damage to the undercarriage of the automobile, to the tires, or of the car becoming mired in mud, slush, or dirt. Variety in the scenery is important.

Bank Fishing.--The taking of fish for non-commercial purposes from the immediate river banks, or wading or walking in the river channel itself. Such fishing may include, but is not limited to, flycasting, or bait casting.

Boat Fishing.--The taking of fish for non-commercial purposes from canoes or small boats (jon boats, row boats, light outboard motor equipped watercraft). This fishing may include, but is not limited to, flycasting, or bait casting.

Hunting.--The taking of game animals (deer, grouse, ducks, squirrels, etc.) for non-commercial purposes with shotguns, rifles, bow and arrow, and other devices.

Outline of Method: Inventory

The purpose of this section is to comprehensively outline the procedure which was developed to collect data for evaluating the recreational potential of rivers. The approach discussed below was developed over a period of time from March to November 1975. The development process was very dynamic in that procedure components were constantly modified and improved.

Subdividing the River Corridor

A basic decision in collecting data is to establish the size of the observation units. In the case of this project, the basic decision was to determine the length of river units to be used throughout the evaluation process. The question was one of how to subdivide the river corridor into meaningful segments.

Final Approach.--Observation units used for recording river variable data were river segments of one river-mile in length. Subdividing of the river began at the upstream limit of the portion to be studied. From this point, sequential numbering was applied to all of the one river-mile segments as subdividing proceded downstream from the initial point. This delineation was accomplished through use of a map measuring wheel or string on topographic maps, aerial photography, or other larger scale map sources.

Rejected Approaches.--Initially the river was divided into three mile segments. Because of the potential problem, however, of locating oneself while actually on the river, another approach was considered, namely that of segmenting the river at significant landmarks such as bridges, dominant river bends, campgrounds, canoe access points, and other features.[80] Since this approach appeared reasonable, it was used in delineating segments on canoe trips on the Pine, Manistee, and Looking Glass rivers (August 1, and August 12 to September 7, 1975).

Concurrent with the field research, the Project for the Use of Remote Sensing in Resource and Land Use Policy (hereinafter called the Remote Sensing Project) interpreted certain characteristics in one-quarter mile, straight line segments.[81] While the one-quarter mile segments appeared

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[80]Interview with Ronald Shelton, Associate Professor, Department of Resource Development, Michigan State University, East Lansing, Michigan, 24 July 1975.

[81]The Project for the Use of Remote Sensing for Resource and Land Use Policy, funded in large part by the National Aeronautics and Space Administration, agreed on

too small for the level of analysis for which this evaluation technique was designed, three-mile segments required too much generalization and would not be an efficient use of aerial photography interpretation.[82]

Considering the capabilities of remote sensing interpretation and its usefulness in data collection on larger scales, the level of generalization required in using three mile segments, and the marginal success the author had with the technique of subdividing the river at significant landmarks, the author adopted the one river-mile segment as the compromise observation unit.

Other studies have used alternative methods for delineating observation units. For instance, Morisawa

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July 23, 1975, to demonstrate the use and applicability of aerial photographs, from the U.S. Forest Service and Michigan Department of State Highways and Transportation, for river recreation studies. Specifically it was agreed that the Project would

> "test the feasibility of identifying and/or measuring quantitatively the various parameters we are using in our experimental river evaluation process. . . . In addition there is a possibility you will be able to do some light plane 35mm color photography . . . for near vertical photographs."

This latter procedure, using a procedure developed by Wayne Meyers, Associate Professor, Department of Forestry, Michigan State University, is briefly discussed in Chapter IV. (Source: Michael Chubb, Associate Professor, Department of Geography, Michigan State University, to Ronald Shelton, Associate Professor, Department of Resource Development, Michigan State University, 5 August 1975.)

[82]Interview with Salleh Nor, Interpreter, Project for the Use of Remote Sensing in Resource and Land Use Policy, Michigan State University, East Lansing, Michigan, August 1975.

based her study unit on transects every three miles down a river.[83] Leopold's approach was similar in that information was collected at specific points.[84] Libby delineated segments whenever the river changed character, e.g., fast to slow water, different significant land uses.[85] In this case the data collected was representative of the entire section of river, not just of a point.

Inventory Form

Variables.--River characteristics data were collected for the variables grouped below. The inventory form (Appendix B) contains spaces for data on these eight groups of factors: (1) basic physical features (width of river, site development potential, apparent stream velocity, floatability, flow fluctuation, months of water flow, stream bed materials, dominant river pattern, water surface pattern, and bank erosion; (2) special physical features (area of ponds, sandy beaches, oxbow lakes and bayous, islands, navigational obstructions, immediate bank height); (3) water quality (turbidity, temperature, solids on the bottom, floating liquids, floating solids, bacteriological

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[83] Morisawa, Evaluation of Natural Rivers, p. 3.

[84] Leopold, "Quantitative Inventory," p. 709.

[85] Libby, The Recreational Potential of Selected Rivers in New Brunswick, p. 29.

condition, pesticides, chemical pollutants, odor); (4) general soils limitations for camping, picnicking and other dry land recreational use; (5) biological features (algae, water plants, small game, large game, non-game species, waterfowl, other birds, warm-water fish, cold-water fish, land flora, wild flowers); (6) land use (general land use, historic sites, public land ownership); (7) aesthetics (artificial controls, detrimental values of buildings, trash and litter, utility crossings, other detrimental values, scenic variety, view confinement, beauty, unique features, remoteness), and (8) accessibility.

These variables obviously do not represent all the variables which one could measure along a river corridor. Selection of the included variables was based on the nature of the activities for which recreational potentials are evaluated, on previous research which gave at least general indications of the more significant variables, and on the intuitive perceptions of the author. More specific explanations of these variables and support for their inclusion on the inventory form are contained in Appendix A.

Scaling.--The scale which was used in this technique to measure the river variables was a five-point scale. While a five-point scale or a ten-point scale have both been used in previously cited studies, the selection of the five-point scale for my technique largely resulted from a consideration of simplicity. In addition, it appeared that a ten-point scale would convey the idea of greater accuracy in measurement then would actually be the case.

The second issue in scaling was whether a five (on the five-point scale) would represent the more positive values or the more negative values. Based on the assumption that most people generally associate the high numbers in a scoring system with maximum positive values, the lowest values on the five-point scales were designated as the least desirable conditions and the highest values as the most desirable conditions. This was not possible where the preferred or optimum rating for a variable fell in the middle of the five-point scale.[86]

Other Variable Considerations.--When variables were evaluated for their impact upon, or significance to recreational activities, certain variables appeared to have different relative influences on activities. For this reason, some variables were evaluated for their influence on each of the sixteen activities or some major groupings of activities. For example, all boats may not be able to be operated if the river is shallow due to size, weight, and other design considerations. A canoe may pass without

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[86]This necessitated development and use of transformation tables to compensate for this factor. See "Data Transformation" later in this chapter for more information.

difficulty while a sixteen-foot outboard motor-powered watercraft may be unable to operate.

Also, separate evaluations of certain individual variables and their relation with each activity were required because of the widely varying physical arrangement of certain natural features within a segment. For example, along the Pine River, an individual may encounter stream bed materials of rocks and cobbles, gravel, clay, and sand within one segment. While these were noted on the inventory sheet, the author was called upon to determine the degree of compatibility that these features had with each activity. To attempt to numerically express the presence or absence of each type of stream bed material, in proportion to the length of the segment, was not feasible for this evaluation approach.

Accessibility Form

Accessibility was rated separately for two types of recreational activities: (1) those in which the recreation participant can readily move from one segment to another or those where the participant is sensitive to the presence of other recreationists,[87] and (2) those in which the participant's movements are restricted within a given segment or are site-oriented. In the case

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[87]The sensitivity mentioned above is applicable to the wilderness canoeist, hiker, canoe camper, and trail camper.

of the former activity-type, accessibility was rated on Form #2 (see Appendix B). Subsequently, values for wilderness canoeing, general canoeing, small craft boating, powerboating, waterskiing, hiking, canoe camping, trail camping, and bank fishing which were actually rated on Form #2, were transferred to Form #1. For the more site-oriented activities (such as picnicking), accessibility was rated directly on Form #1.

Data Collection

Data Sources.--Data, which were used to inventory the study rivers, came from four main sources. These sources were field observation, remote imagery interpretations, topographic and other maps, and other documentation acquired from government agencies. Agencies which either supplied information, or would be possible sources in the future, are listed on Table 1.

Aerial Photography.--Recent remote sensing imagery was used extensively in data gathering. Imagery types used were: black and white modified infrared at a scale of 1:15,840 provided by the Huron-Manistee National Forest, color infrared at a scale of 1:36,000 provided by the Michigan Department of State Highways and Transportation, black and white panchromatic at approximately 1:7920 from the Agricultural Stabilization and Conservation Service, and color infrared at scales of 1:60,000 and 1:120,000

Table 1.--Government Agency Suppliers or Potential Suppliers of Information for River Recreation Potential Assessment Inventory.

Agencies	Contacted	Potential Contacts
Federal		
USDI, Geological Survey	X	
USDI, Bureau of Outdoor Recreation	X	
USDA, Soil Conservation Service	X	
USDA, Forest Service	X	
USDA, Agricultural Stabilization and Conservation Service	X	
USDoD, Army Corps of Engineers		X
USDI, Bureau of Sport Fisheries and Wildlife		X
State of Michigan		
Dept. of State Highway & Transportation	X	
Dept. of Natural Resources	X	
Other		
Regional Planning Agencies		X
County Health Departments		X

provided by the Remote Sensing Project. While all of this imagery was useful, the preferred type for overall use was the 1:36,000 color infrared photographs.[88]

Aerial photographs were very useful for collecting data for those variables listed on Table 2. Also some form of the photographs (original or copy) should be taken into the field and on the rivers for field-checking of interpretations and to assist the user in orienting himself while conducting field surveys on a study river. Photos were not taken on the rivers during my field research because of the possibility of damaging the borrowed imagery.

Field Work.--Field work served two main purposes in this procedure, namely, field checking of air photo interpretations, and in gathering data concerning the remaining variables on the inventory sheet. Experience in testing this technique indicated that evaluation of each segment by floating down the river in a boat or canoe was important. First, a boat or canoe can travel a stretch of river much faster than walking the banks, which is important since the time element may be crucial to land management agencies. Second, in some areas along rivers, walking may be difficult (for example, swamps). Third, complete road access along segment lengths is unlikely, and even if roads

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[88] Interview with Salleh Nor, Interpreter, Project for the Use of Remote Sensing for Resource and Land Use Policy, Michigan State University, East Lansing, Michigan, September 1975.

Table 2.--River Characteristics Data Collected From Aerial Photographs for Pine River.

Variable Number	Variable Name
1	River Width
*	River Valley Width
8	Dominant River Pattern
10	Bank Erosion
11	Acreage of Ponds
12	Sandy Beaches (Number)
13	Oxbow Lakes (Number)
14	Islands (Number, Acreage)
15	Navigational Obstructions (Number Only)
38-49	Land Flora (Type, Density, Diversity)
51-54	Land Use
57	Artifical Controls
58	Detrimental Values of Buildings
60	Utilities
*	Vistas
*	View Confinement
66	Remoteness
*	Number of Structures (Residential, Mobile Homes, Farmsteads, Institutions, Commercial, Industrial, Other)
*	Number of Access Points (Trails, 2-wheel drive vehicle roads, 4-wheel drive vehicle roads, county roads, major tourist routes)
*	Number of Bridges (Same as above)
*	Existence of Parallel Roads within 300 feet of river banks (Same as above)
*	Existence of Parallel Roads between 300 feet and 1320 feet of river banks (same as above)

*Denotes that this variable was not directly incorporated into the final inventory sheet as a separate variable, but the information was used.

were available, it appeared important during my experience that the observer must be on the river to accurately assess such variables as immediate bank height, stream bed material, and impacts of buildings on recreational activities.

For much of the field research conducted on the rivers in this study, the author was seated in the bow of the canoe with a partner in the stern. This largely freed me from navigational and paddling responsibilities and allowed me to concentrate on landscape observation. If segments of the river were fast-flowing or contained numerous navigational obstructions, my attention had to be given to paddling which detracted from observation of the surrounding environment. In the future, a two-man crew, in addition to the observer who would sit in the middle, would be preferable for faster, rougher waterways.

Recording of river variables was done directly onto inventory sheets and into a tape recorder while on the river. Both approaches were workable, however, problems were encountered with both systems if either notes or recorder became wet.

Outline of Method: Analysis

As previously noted, this recreation opportunity potential assessment method has two distinct parts: inventory, and analysis. Inventory discussion has preceded this section. A description of the analysis follows.

This second step of the evaluation procedure involves processing the collected inventory data to determine the recreational activity potentials for each segment of river. Inventory data, which can be useful in its own right, was used then to estimate activity potential values.

Data Transformation

Not all of the data collected on the inventory sheet could be used directly when considering the potential for a recreational activity. This is because the one to five scales on the inventory sheet did not necessarily reflect the continuum from less desirable to desirable values for each activity. For instance, in the case of variable number three (apparent stream velocity) a torrential flow in a river may be desirable from a sightseer's viewpoint, but such flow may be dangerous for the swimmer or canoeist.[89]

For this reason, the optimum rating for a variable, depending on the activity, may be a value other than five. To return to the example above, the optimum flow velocity for swimming may vary from one to three (stagnant or minimal flow, to moderate flow). In this case, if a river segment received an apparent stream velocity rating of one,

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[89]Hendrickson and Doonan have stated that:

> "A general rule for safe wading is that depth in feet, multiplied by velocity in feet, should not exceed 10. This assumes a vigorous fisherman and a stream having a firm sand or gravel bottom. If bottom materials are slippery rock or clay the safe depth and velocity would be considerably reduced."

G. E. Henrickson and C. J. Doonan, Hydrology and Recreation on the Cold-Water Rivers of Michigan's Southern Peninsula, Water Information Series Report 3 (Lansing: U.S. Geological Survey in Cooperation with the Michigan Geological Survey, Department of Natural Resources, 1972), p. 24.

two or three, it received a revised rating of five for swimming, indicating the general optimum for that variable in the context of swimming.

These "transformations" are indicated in the Table of Weightings and Data Transformation Index, Form #4 (Appendix B). If a variable needed to be transformed, a number indicated which transformation pattern was appropriate (Form #5, Appendix B). This transformed value, was then substituted for the raw value on the inventory sheet, when later multiplied by a weight.

In some cases, if a variable received a transformed value of one, an activity was not considered further because the segment was deemed totally unsuitable for participation in a particular activity. This was shown by the instruction "CANCEL" in appropriate locations in the transformation pattern tables (Form #5, Appendix B).

Weightings

Background.--If, in the process of calculating scores for recreational activity potentials, variable values (raw or transformed) were merely summed, with subsequent division of the sum by the total possible score to yield a percentage, this would assume that each variable was equally important for all activities. For instance, under this assumption, the amount of wildflowers present in a river segment would be as important as floatability in considering any type of canoeing or boating.

The author, feeling that this assumption was not acceptable, developed a Table of Weights (Form #4, Appendix B) where each variable was assigned a weight reflecting the relative importance of that variable for each recreational activity.[90] That is, each variable score was weighted for each activity, excluding those variables which were deemed not significant in determining the potential for a recreational activity.

Form #4 includes weightings and an index to the transformation patterns. If a transformation was required, the cell indicated the pattern which was appropriate for that variable in the context of a particular activity and a weight. One number in the cell indicated that no transformation was required. That lone number represented the assigned weight. If the variable was not significant to the activity, and therefore not included in the calculations, the cell contained an "X".

Support.--These weightings have little empirical support, i.e., research studies to back up each relative weight. These weightings have, however, been developed considering general preferences and behavior trends for recreational participation and with some degree of informed, subjective judgments.

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[90] Weightings were also used in other studies cited in Chapter II. These studies include those conducted by Melhorn et al., Craighead and Craighead, Dearinger (1968), and Milligan et al.

Calculations of Segment-Activity Scores

The basic score in this evaluation technique was the segment-activity score. This score was calculated for each activity for each segment of river using Form #3 (Appendix B), which has columns for: the significant variables, raw variable values, transformed values (if necessary), weight, segment-variable score, and variable group sub-totals. Each activity had a sheet with numbers indicating the significant variables, transformation pattern number and weights, which were taken from Form #4.

The process of calculation was relatively simple. First, the raw variable values were transferred from the inventory sheet for the significant variables. Second, the Table of Weightings and Data Transformation Index (Form #4) was consulted to determine if a transformation was required. If a transformation was required, the transformation pattern number referred to those patterns on Form #5 (Appendix B). This form contains twenty-seven patterns for transformation.) Third, using the reference number from Form #4, the raw variable value, was located in the appropriate transformation pattern, and the transformed value recorded on Form #3. This new value was then substituted for the raw variable value in further calculations. (If the appropriate transformation pattern indicated a "CANCEL" order, no further calculations were done and a segment-activity score of zero was recorded at the bottom of Form #3). Four, the raw, or transformed value, was then multiplied by the weight. This yielded a segment-variable score. Five, after all segment-variable scores were calculated, variable group subtotals were recorded. Six, these subtotals were summed and recorded under "Total Segments Points" at the bottom of Form #3. Seven, this value was divided by the total possible score. The recorded percentage calculation then became the segment-activity score.

Application of the Technique

The objective of this chapter has been to outline the method of this recreational activity potential evaluation approach. Three rivers (Pine, Manistee, and Looking Glass) were used in various stages of technique development to test components of the approach. The practical application of this technique is described in Chapter IV, as applied to four stretches of river, one on the Pine River, two on the Manistee River, and one on the Looking Glass River.

CHAPTER IV

RESULTS

Introduction

The development of this recreational activity potential assessment technique involved constant modifications of the inventory sheet, weightings, and other components. Throughout this development process, draft materials were frequently revised based on the results of field testing and other research activities. This field period is discussed in this chapter, following a brief description of the study areas. The third section describes the actual application of the procedure to four test stretches of river.

Study Areas

On the Pine River (also known as South Branch of Manistee River) (Wexford County) (Figure 4), the final technique was applied to a ten mile reach[91] which stretches

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[91] A reach is defined as a "length of stream or valley, selected for convenience in a study." U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook-Hydrology, NEH-4 (Washington, D.C.: U.S. Government Printing Office, 1972), pp. 22-7.

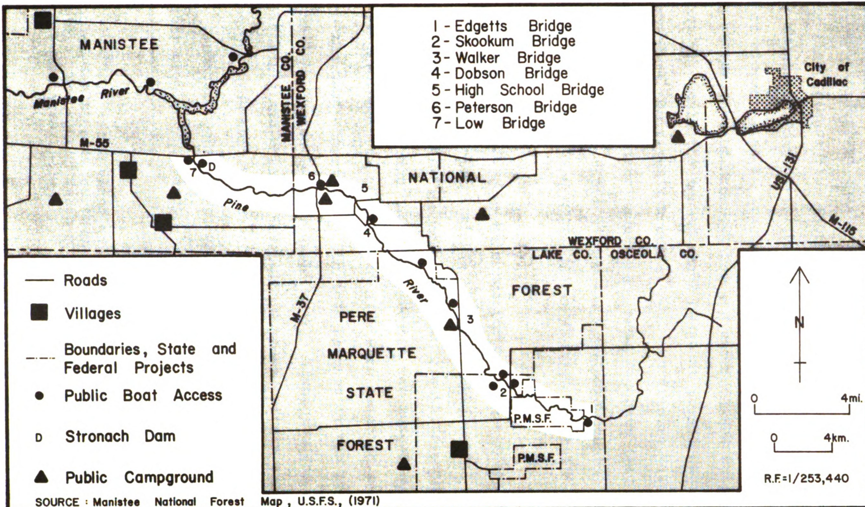

Fig. 4.--Locational Map of Pine River Study Area.

from the Lake-Wexford county line to the Wexford-Manistee county line (Figure 5). In the case of the Manistee River (Manistee County) (Figure 6), two test reaches, both of eleven miles in length, were used. The first began at the foot of Hodenpyl Dam and ended at Red Bridge (Figure 7), while the second reach began at Borski Bayou and ended at the river's mouth at Manistee (Figure 8).[92] A ten mile stretch from Bauer Road, near Wacousta (Eagle Township, Clinton County) to the Clinton-Ionia county line was used on the Looking Glass River (Clinton County) (Figure 9).

These rivers were selected for four main reasons. First, all of the rivers within the Manistee National Forest were considered as possible test rivers, due in large part to the fact that this project was funded by the Forest Service. The two rivers which were selected seemed to be the best compromise. The test reaches of the Pine and Manistee were close to each other. Also, the Forest provided a field headquarters with a phone, within twenty miles of three test reaches on these rivers. This was very important considering the time and budget constraints of this project. Second, a wide range of landscapes were

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[92]The first reach will be referred to as the "middle" Manistee in subsequent discussions in this chapter. The second reach may be referred to as the "lower" Manistee.

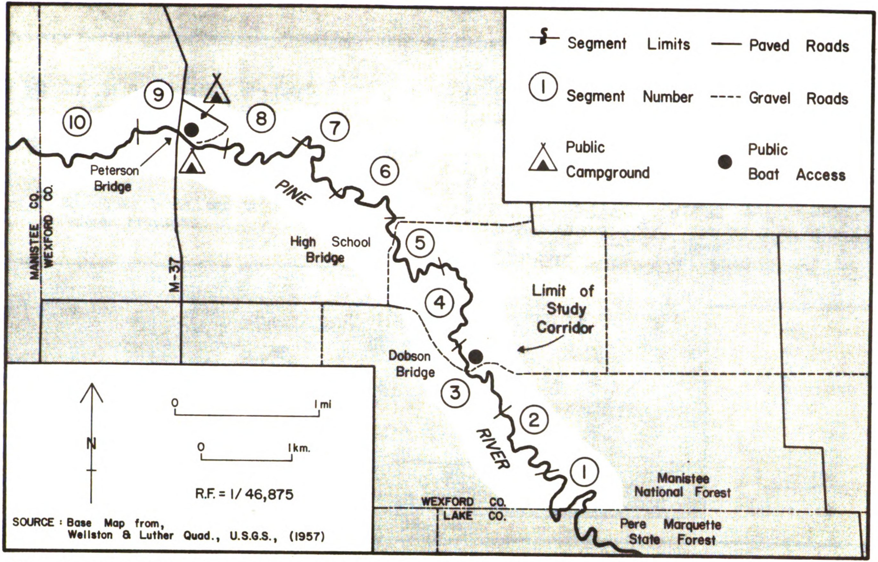
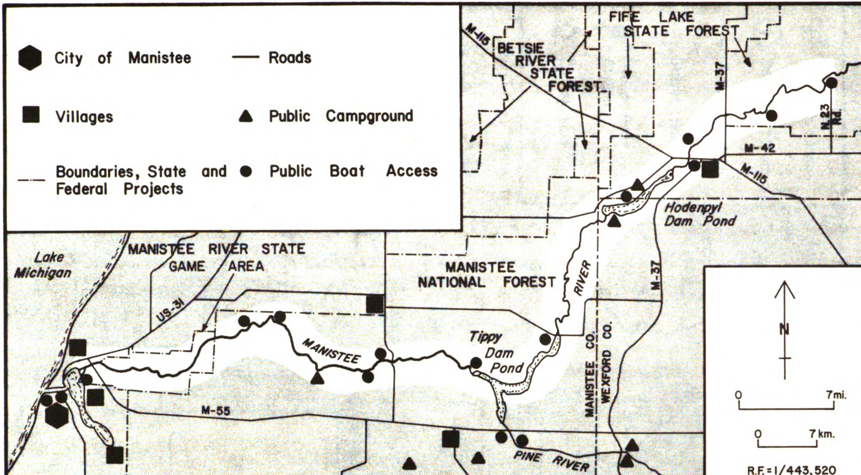


Fig. 5.--Map of Pine River Test Reach Showing Study Corridor and River Segments.



SOURCE : Manistee & Wexford County Maps, D.N.R., (1968, 1969)

Fig. 6.--Locational Map of Manistee River Study Area.

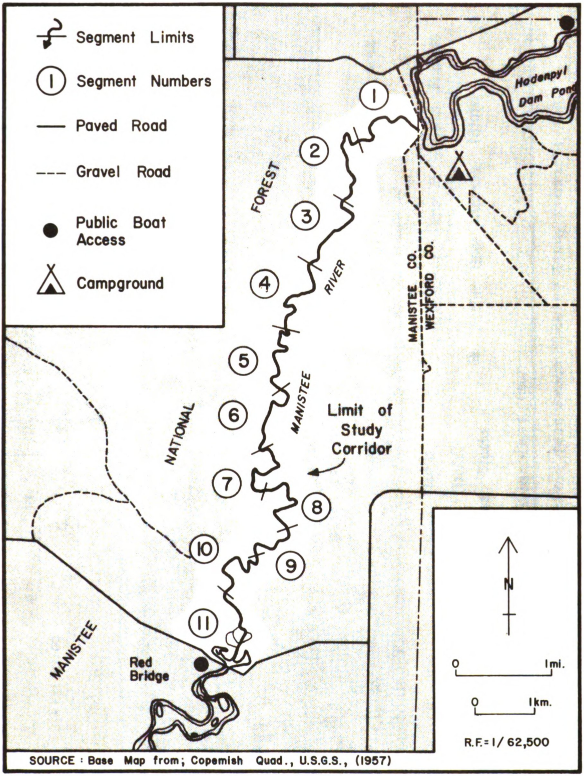


Fig. 7.--Map of "Middle" Manistee River Test Reach Showing Study Corridor and River Segments.

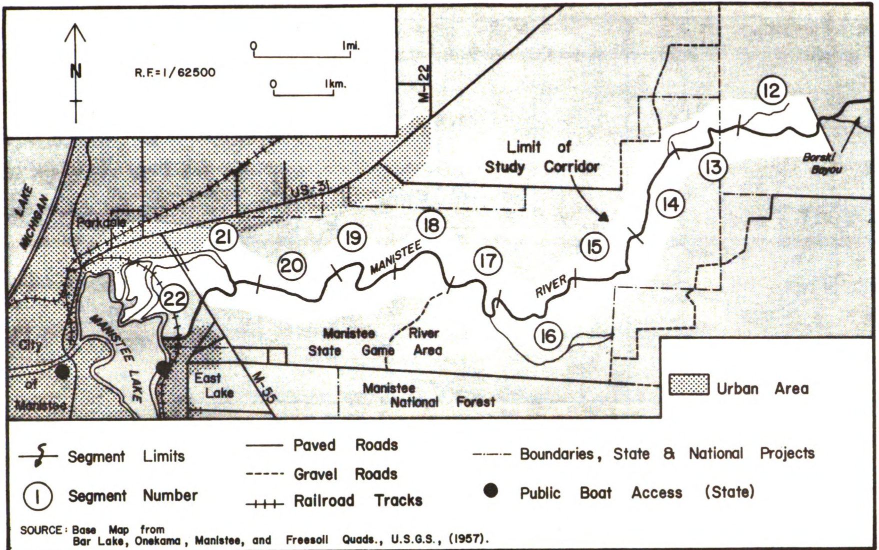


Fig. 8.--Map of "Lower" Manistee River Test Reach Showing Study Corridor and River Segments.

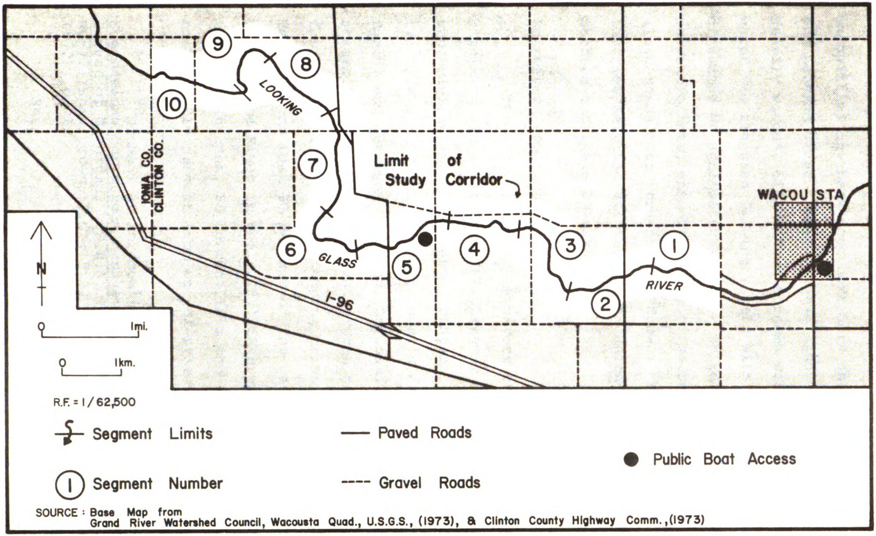


Fig. 9.--Map of Looking Glass River Test Reach Showing Study Corridor and River Segments.

exemplified in these test corridors on the Pine, Manistee, and Looking Glass rivers. These landscapes varied from heavily wooded, high-banked streams with riffles and fast water, to sluggish flowing rivers with adjacent land uses of swamps or agricultural land. Third, conflicts between recreationists, and the nature of recreational activities along these test streams were known. Fourth, canoe liveries serviced all test areas which simplified conducting the field research.

Recreation Opportunity

The Pine and Manistee rivers are two of Michigan's highest quality recreational streams, with relatively easy accessibility from population centers. For example, these two rivers are within a three hour's drive from Grand Rapids and Muskegon, Lansing, Saginaw, and are relatively accessible to some 10 percent of the nation's population for weekend canoeing and camping trips.[93] Solomon and Hansen found that 20 percent of the canoeists interviewed on the Pine River in their 1971 interview season came from the Detroit area, 28 percent from the Grand Rapids-Muskegon area, and 14 percent from out-of-state.[94]

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[93]Michael J. Solomon and Edward A. Hansen, Canoeist Suggestions for Stream Management in the Manistee National Forest of Michigan, U.S.D.A. Forest Service Research Paper NC-77 (Washington, D.C.: U.S. Government Printing Office, 1972), p. 1.

[94]Ibid., p. 3.

The Pine River is well known throughout the state of Michigan for its faster waters, attractive high banks, white water, and attractive scenery. Further, the Pine is a top-quality trout stream. This has been in the past and continues to remain a source of user conflicts between canoeists and fishermen.

The lower portion of the Manistee River (below Hodenpyl Dam) is also an attractive stream for canoeing, trout-fishing, warm water and anadronomous fishing (e.g., coho and chinnok salmon, steelhead) and hunting. The relative importance of each activity, however, varies somewhat from stretch to stretch.

The Looking Glass River represents a recreational opportunity within the Lansing metropolitan area. The river corridor is suited for limited recreational activities because of its physical characteristics and adjacent land uses. It is used primarily for warm-water species fishing, hunting, and canoeing. The flow during the summer months is usually low making the Looking Glass a "bottom-scraper" for canoes, during these low-flow months, over much of its length.

In general, unless otherwise specified, subsequent references to these rivers will concern the ten and eleven mile reaches which have been subjected to the final assessment method.

Physiography and Land Uses

The Looking Glass River contrasts significantly with the Pine and Manistee rivers. These two rivers flow through rolling glacial hills composed primarily of sand and gravels covered with pine, aspen, low land hardwoods, and oak forests with relatively few residential structures on the banks.[95] According to Martin, the stream channels of the Pine and "middle" Manistee test segments flow on outwash or glacial channel deposits.[96] The surface formation of the "lower" Manistee is sandy, lake bed from an inundation of Glacial Lake Nippissing.[97] This latter area is characterized by its extensive swamp land, bayous, and wide flood plain.

The Looking Glass River occupies a glacial drainage spillway between moraines or ground moraines in the test segment.[98] The course of this spillway, the Looking Glass Channel, is "well marked by gravelly terraces and a widened valley 20 to 40 feet above the floodplains of the rivers."[99]

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[95]Exceptions from this general statement on the Manistee River are in Segment 14 where numerous structures are seen concentrated on one large parcel, and in the last segment which flows through an urbanized area near Manistee. On the Pine, homes and cabins may be seen adjacent to bridge crossings.

[96]Helen M. Martin, Map of the Surface Formations of the Southern Peninsula of Michigan (Lansing: Michigan Department of Conservation, 1955).

[97]Ibid.

[98]Ibid.

[99]Frank Leverett and Frank B. Taylor, The Pleistocene of Indiana and Michigan and the History of the Great

The river flows through predominately agricultural land with most wooded areas exhibiting a narrow, linear pattern along the river. In addition, many residential structures are clearly visible from the river.

Administrative Considerations

It is interesting to note that the Pine and the Manistee rivers are split between two ranger districts within the Manistee National Forest. The district ranger is a resource manager[100] providing administrative direction and land management decisions.[101] It would appear important that river recreation planning be coordinated between these types of administrative units.

Land Ownership

Land ownership patterns vary considerably on the three test rivers. The Pine is predominately in public ownership with small private holdings along the test reach, while most of the lands adjacent to the Manistee River are privately owned by Consumers Power Company of Jackson, Michigan, though many of the "lower" Manistee

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Lakes, Monographs of the United States Geological Survey, Volume LIII (Washington, D.C.: U.S. Government Printing Office, 1915), p. 252.

[100] Robert K. Holz, "The Area Organization of National Forests: A Case Study of the Manistee National Forest, Michigan" (Ph.D. dissertation, Michigan State University, 1963), p. 138.

[101] Ibid., p. 148.

segments lie within the Manistee River State Game Area under the control of the Michigan Department of Natural Resources. Because of Consumers Power Company ownership, little land along the river has been developed except for some leased lands with older cabins, road crossings, and utility structures (two dams, and transmission lines). The Looking Glass River is almost entirely in private ownership.

Field Testing and Aerial Photograph Interpretations

Initial Field Work

While data collection from agency contacts, letters, and telephone conservations was a continual process throughout the study, actual time in the field was limited. The first field work took place in early May, 1975, when I approximately fifteen miles of the Pine River was canoed from Elm Flats to Peterson Bridge in an attempt to begin developing sensitivities for river corridor characteristics.

The next field period was spent on the Pine River on July 31, 1975, with another canoe trip from Elm Flats to Peterson Bridge. At this time, data was collected utilizing a draft of the inventory sheet. The segments were delineated by significant landmarks or when the river changed character.

As the result of these two field experiences, particularly the latter trip, and from other research done up to this time, the necessary components of the inventory procedure were identified. Also these experiences enabled me to refine the inventory which was used in the next field period.

Two-Week Field Period

Between August 12 and August 29, 1975, field work was conducted on the Pine and Manistee rivers. This period included canoe trips, and local agency contacts. The Pine River was canoed from Skookum Bridge to Low Bridge. The Manistee was canoed from North 23 Road, about twenty miles east of M-37 in Wexford County, to Manistee Lake, except for the two dam impoundments at Hodenpyl and Tippy Dams. From these trips, test reaches were later identified. Also, in September 7, 1975, a ten mile stretch of the Looking Glass River was canoed.

Throughout the canoe trips, river characteristics were recorded onto draft editions of the inventory sheet. Since the sheet was subject to modifications, weightings which had been previously drafted were not used. Therefore, the collected data were not processed through the total evaluation procedure until December, 1975. The experiences in working with the inventory sheets, U.S. Geological Survey topographic maps, and the practical aspects of canoeing the rivers, benefited the study in that the inventory sheet and other procedure components underwent significant improvement as the study progressed.

Aerial Photograph Interpretations

Data Collection.--Concurrent with field work, color infrared aerial photography was interpreted for the Pine River by the Remote Sensing Project. Information was collected in observation units which were one-half mile wide (centered on the river) by one-quarter mile long. The variables for which information was collected are shown in Table 2 in Chapter III.

As mentioned earlier in Chapter III, color infrared aerial photography (1:36,000) was also used to collect data for the Manistee River. In addition to the use of color infrared photography at scales of 1:60,000 and 1:120,000, conventional black and white aerial photography was used for the Looking Glass River. Interpretations for these two rivers were done by the author.

Low Altitude Photography

Color and color infrared photography was taken over part of the Pine River from Poplar Creek to Peterson Bridge in a broken flightline by personnel from the Remote Sensing Project and the author. This was flown on September 27, 1975, in order to make an assessment of the feasibility of using low altitude imagery for data collection in the river recreation potential assessment procedure. The plane was flown at approximately 2,500 feet above sea level. The river in this reach is at an elevation of approximately 780 feet above mean sea level at Peterson Bridge, and about

850 feet at Dobson Bridge. The scale of the resulting imagery was approximately 1:5000, or one inch equals 400 feet.

Procedures and Equipment.--The plane used was a four-seat Cessna Skyhawk, single-engined aircraft. Camera equipment consisted of a Nikon, 35 millimeter, single-lens reflex camera with motor-drive unit and an intervelometer. The camera and motor-drive unit were mounted on a bracket attached to a pipe which when the aircraft was airborn, was extended out of the right window of the aircraft. The pipe itself was mounted on a gun stock. One person was required to hold the gun stock while the camera was extended out of the window. Another person changed film, put the camera out of the window, helped support the unit while extended and taking pictures, and pulled the unit inside the plane.

Actual flight time was approximately one hour which included time for two sweeps around Tippy Dam Pond, and passing over the entire length of the Pine River from Tippy Dam Pond to Edgetts Bridge. Further, this time included three passes over the Peterson Bridge-Poplar Creek segments (two for ordinary color pictures and one for color infrared) (Figure 10).

Results.--Utilizing this low-level imagery, it appears that very accurate interpretations are possible for many factors: width of river, site development potential, river pattern, water surface pattern, bank erosion,

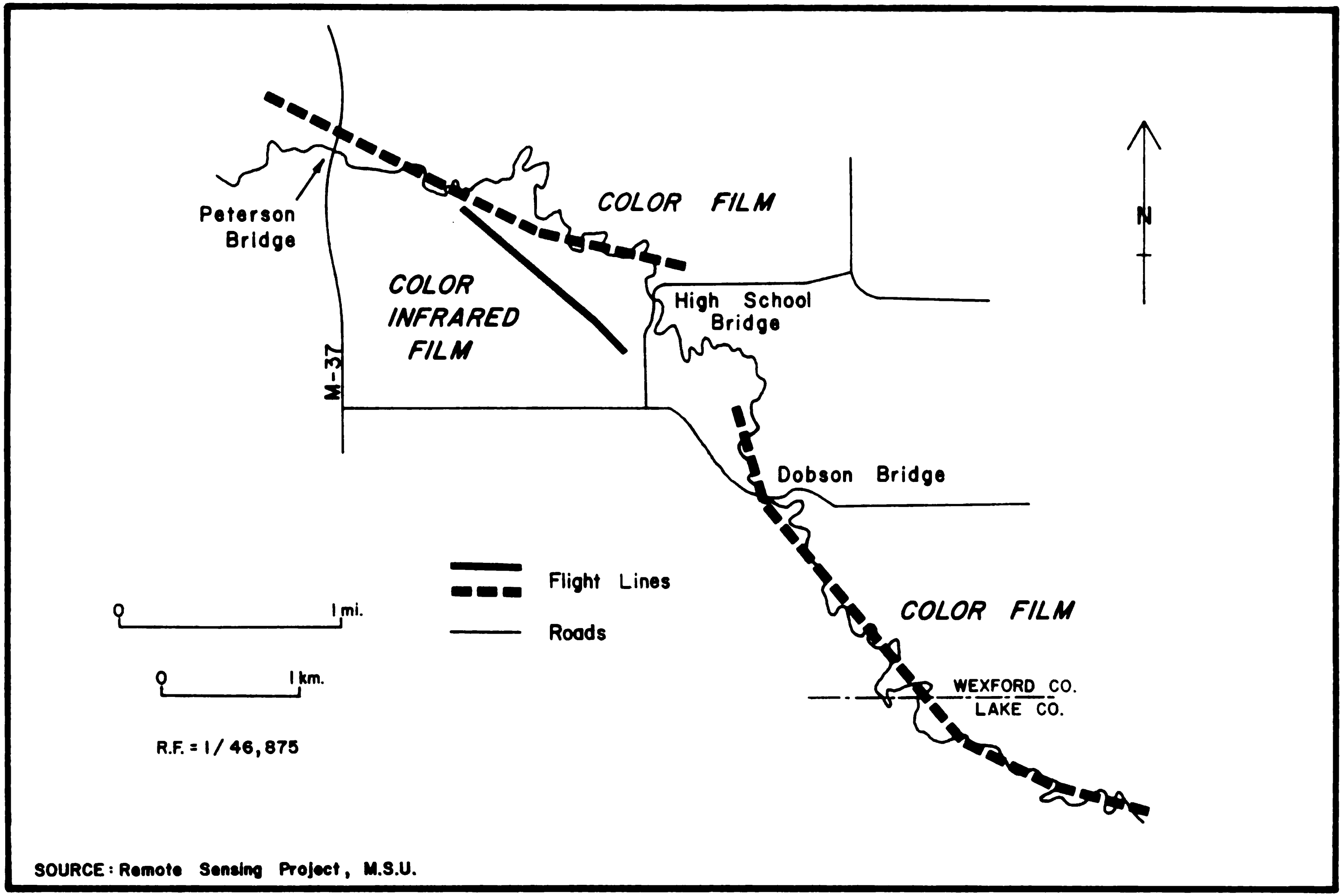

Fig. 10.--Map of Pine River from Poplar Creek to Peterson Bridge Showing Flight Lines from Low Altitude Imagery Test, September 27, 1975.

immediate bank height, acreage of ponds, sandy beaches, oxbow lakes and bayous, islands (all sizes), navigational obstructions, water plants (floating/emergent), land flora (type, density, diversity), artifical controls, buildings, trash and litter, utilities' crossings, other detrimental values, land use, view confinement, and remoteness.

One immediately apparent drawback of this system was the small size of individual slides and the many slides which would be necessary to cover a river. These drawbacks, however, might be mitigated by experimentation with camera lens, camera type, flight lines, and flight altitudes.

Another consideration here is the cost for flying, and perhaps the cost of acquiring the necessary equipment. Would the benefits derived from interpretation of this detailed imagery outweigh the costs of acquiring the imagery since the river corridor should be observed from the river as part of the developed technique and given the general availability of some type of aerial photography to cover a study area? This question was not answered by this test, but it is one which should receive further attention in future tests of the assessment technique.

Recreation Potential Scores

Anticipated High-Scoring Activities

In the case of each test river reach, scores of certain activities were anticipated to be higher scoring than others. These reflected the author's intuitive perceptions of which activities had the greatest potential and what activities occurred in the rivers' corridors. For the Pine River, anticipated high-scoring activities were general and wilderness canoeing, canoe camping, and bank fishing.

On the "middle" Manistee, between Hodenpyl Dam and Red Bridge, wilderness and general canoeing, hiking, nature study, canoe and trail camping, bank fishing, and hunting were thought to have the greatest potentials. For the Manistee River between Borski Bayou and the river's mouth near Manistee, expected high scoring activities included wilderness canoeing, nature study, boat fishing, hunting, and small craft boating. The potentials for land-based recreation were thought to be low due to extensive swamp land and bayous along the river corridor.

The Looking Glass River, flowing through predominately agricultural and rural lands, was thought to possess significantly less recreational opportunities than the three previous reaches. High-rated activities' scores were anticipated to be below those scores of high rated activities for the other rivers. These identified activities for the Looking Glass River were picnicking, nature study, bank fishing, hunting, and general canoeing.

Calculated Scores

Utilizing the methodology outlined in Chapter III, recreation potential assessment scores for a total of forty-two river segments were calculated.[102] These scores are illustrated in Tables 3, 4, 5, and 6 (Pine, "Middle" Manistee, "Lower" Manistee, and Looking Glass rivers, respectively).

These initial scores appeared to be somewhat inflated and suffered from a limited range of scores. Since no score was below fifty-five or higher than ninety-one, the range was only thirty-six. Most scores appeared to fall between the mid-60s and the mid-80s. Two possible explanations are possible. First, not enough poorer quality river segments were evaluated which would yield a better range of scores. This could also mean that the surveyed rivers have significant recreational potential and the system simply reflected this fact. Second, the scoring system may not be capable of discriminating sufficiently among differences in the landscape from one segment to another and in translating those differences into impacts on recreational activities to yield more accurate activity potential scores.

Highest Scoring Activities

Throughout the months of this technique's development, an anticipated use of scores was to identify the recreation activities with the greatest potentials for each

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[102] Manual calculations consumed approximately one full week of work. A computer program is being developed for our project report to the North Central Forest Experiment Station, U.S. Department of Agriculture.

Table 3.--River Recreation Potential Assessment Scores[a] for Pine River Test Reach.

Activity	Pine River Test Reach Segments									
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Wilderness Canoeing	87	85	81	80	80	82	82	84	82	84
General Canoeing	86	84	84	83	85	85	86	85	86	86
Small Craft Boating	77	76	76	75	77	77	78	78	79	78
Powerboating	0[b]	0	0	0	0	0	0	0	0	0
Swimming	80	79	78	79	80	81	80	83	80	82
Waterskiing	0	0	0	0	0	0	0	0	0	0
Nature Study	81	78	80	79	81	81	81	82	82	81
Hiking	88	81	81	81	84	84	85	87	86	86
Picnicking	80	76	77	76	79	79	78	81	80	79
Canoe Camping	83	80	77	80	80	80	81	83	82	81
Trail Camping	82	78	75	77	79	78	80	82	82	80
Vehicle Camping	82	79	79	77	79	80	80	83	82	81
Driving for Pleasure	80	77	80	78	80	82	81	82	82	80
Bank Fishing	82	79	81	83	82	83	82	83	82	82
Boat Fishing	80	79	80	80	81	80	81	81	81	80
Hunting	82	78	78	77	79	78	78	80	80	79

Note: Scores were calculated from data collected from field observation, aerial photography interpretations, and government agency contacts and documentation.

[a]Possible scores are 0-100.

[b]0 indicates that the activity was considered impossible or improbable.

Table 4.--River Recreation Potential Assessment Scores[a] for "Middle" Manistee River Test Reach.

Activity	"Middle" Manistee River Test Reach Segments										
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
Wilderness Canoeing	81	81	86	82	83	85	84	80	83	83	83
General Canoeing	82	80	84	83	83	84	83	81	82	82	81
Small Craft Boating	74	74	76	76	75	76	75	73	74	75	76
Powerboating	0[b]	0	0	0	0	0	0	0	0	0	0
Swimming	78	77	77	73	79	77	76	76	75	74	70
Waterskiing	0	0	0	0	0	0	0	0	0	0	0
Nature Study	81	81	84	83	82	83	83	81	82	83	83
Hiking	82	85	86	85	84	85	86	86	86	84	80
Picnicking	77	75	76	76	76	75	76	75	73	71	66
Canoe Camping	79	78	80	80	78	80	80	78	77	76	73
Trail Camping	79	79	81	80	79	80	81	78	77	77	73
Vehicle Camping	81	79	80	80	79	79	80	78	77	81	72
Driving for Pleasure	81	80	80	80	80	79	79	76	78	78	74
Bank Fishing	77	80	80	77	77	77	77	76	75	74	74
Boat Fishing	77	77	78	77	78	78	78	76	76	76	76
Hunting	78	77	80	83	77	80	79	78	78	79	78

Note: Scores were calculated from data collected from field observation, aerial photography interpretations, and government agency contacts and documentation.

[a]Possible scores are 0-100.

[b]0 indicates that the activity was considered impossible or improbable.

Table 5.--River Recreation Potential Assessment Scores[a] for "Lower" Manistee River Test Reach.

Activity	"Lower" Manistee River Test Reach Segments										
	#12	#13	#14	#15	#16	#17	#18	#19	#20	#21	#22
Wilderness Canoeing	79	87	0	85	87	87	91	87	84	0	0
General Canoeing	84	86	81	84	87	86	87	90	85	82	74
Small Craft Boating	82	86	79	83	85	84	85	88	85	82	73
Powerboating	82	84	81	83	85	84	86	86	83	83	73
Swimming	72	73	72	74	74	74	75	75	74	72	70
Waterskiing	85	86	88	86	87	86	88	88	87	82	81
Nature Study	86	88	79	86	90	89	88	89	85	81	62
Hiking	75	78	71	75	80	79	80	79	78	67	60
Picnicking	65	66	67	67	68	65	69	67	68	65	58
Canoe Camping	71	74	70	74	76	73	75	75	74	67	61
Trail Camping	70	72	67	72	74	72	73	73	73	66	59
Vehicle Camping	70	73	71	72	73	70	73	72	72	69	61
Driving for Pleasure	72	73	70	73	75	65	77	76	75	76	61
Bank Fishing	75	75	74	78	77	77	78	76	76	75	72
Boat Fishing	82	84	80	84	84	86	84	82	79	82	78
Hunting	82	85	76	81	86	84	84	85	83	78	55

Note: Scores were calculated from data collected from field observation, aerial photography interpretations, and government agency contacts and documentation.

[a]Possible scores are 0-100.

[b]0 indicates that the activity was considered impossible or improbable.

Table 6.--River Recreation Potential Assessment Scores[a] for Looking Glass River Test Reach.

Activity	Looking Glass River Test Reach Segments									
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Wilderness Canoeing	72	0	0	0	68	67	67	72	67	64
General Canoeing	76	76	73	78	74	75	75	76	73	72
Small Craft Boating	72	72	69	73	69	68	68	70	67	67
Powerboating	0[b]	0	0	0	0	0	0	0	0	0
Swimming	69	66	70	71	69	65	68	68	67	68
Waterskiing	0	0	0	0	0	0	0	0	0	0
Nature Study	79	73	69	70	74	69	70	74	70	68
Hiking	72	67	64	70	69	63	63	68	65	64
Picnicking	69	69	66	72	67	64	65	64	63	66
Canoe Camping	72	69	67	69	69	66	66	68	64	67
Trail Camping	69	64	64	71	66	63	63	65	63	65
Vehicle Camping	70	73	70	75	68	66	66	68	65	69
Driving for Pleasure	66	65	62	70	64	63	62	63	59	61
Bank Fishing	66	65	63	68	64	63	64	65	62	62
Boat Fishing	69	68	67	70	67	67	66	67	65	65
Hunting	71	68	67	75	72	70	77	72	71	70

Note: Scores were calculated from data collected from field observation, aerial photography interpretations, and government agency contacts and documentation.

[a]Possible scores are 0-100.

[b]0 indicates that the activity was considered impossible or improbable.

segment. These scores could then be plotted on overlay maps of the appropriate river allowing the user to visually examine the spatial distribution of these high scoring activities and to compare such scores with other important conditions in and out of the river corridor, for example, access points, land ownership, distance from major tourist routes, isochrones to major tourist routes and population centers. Therefore, an initial approach to analysis was that of identifying the highest scoring activities in each segment. Table 7 summarizes this work.

Upon perusing the table, certain general patterns were apparent. For the Pine River and "middle" Manistee, hiking and canoeing seemed to have the greatest potentials. For the "lower" Manistee, nature study and boating (canoe, power, and waterskiing) are rated high. On the Looking Glass River, general canoeing, nature study, and hunting would appear to have high potentials. Similar trends may be identified for the second and third highest ratings, however, the actual range in numbers is minimal between the first and third highest series. Further, the differences between the third category and the fourth or fifth highest scores are often very small, i.e., within one or two points. For instance, on the sixth segment of the Pine River, bank fishing is rated at eighty-three (83) and vehicle camping is rated eighty (80).

Table 7.--Three Highest-Scoring Potential Recreation Activities for Each River Segment.

River	Segment	First	Second	Third
Pine	1	Hiking (88)	Wild. Canoeing (87)	General Canoeing (86)
	2	Wild. Canoeing (85)	General Canoeing (84)	Hiking (81)
	3	General Canoeing (84)	Hiking (81) Wild. Canoeing (81) Bank Fishing (81)	Driving for Pleas. (80) Bank Fishing (80) Nature Study (80)
	4	General Canoeing (83) Bank Fishing (83)	Hiking (81)	Wild. Canoeing (80) Canoe Camping (80) Boat Fishing (80)
	5	General Canoeing (85)	Hiking (84)	Bank Fishing (82)
	6	General Canoeing (85)	Hiking (84)	Bank Fishing (83)
	7	General Canoeing (86)	Hiking (85)	Wild. Canoeing (82) Bank Fishing (82)
	8	Hiking (87)	General Canoeing (85)	Wild. Canoeing (84)
	9	General Canoeing (86) Hiking (86)	Wild. Canoeing (82) Canoe Camping (82) Trail Camping (82) Vehicle Camping (82) Bank Fishing (82) Nature Study (82) Driving for Pleas. (82)	Boat Fishing (81)

Table 7.--Continued.

River	Segment	First	Second	Third
Pine (cont.)	10	General Canoeing (86) Hiking (86)	Wild. Canoeing (84)	Swimming (82) Bank Fishing (82)
Manistee	1	Hiking (82) General Canoeing (82)	Wild. Canoeing (81) Nature Study (81) Vehicle Camping (81) Driving for Pleas. (81)	Canoe Camping (79) Trail Camping (79)
	2	Hiking (85)	Wild. Canoeing (81) Nature Study (81)	General Canoeing (80) Bank Fishing (80) Driving for Pleas. (80)
	3	Hiking (86) Wild. Canoeing (86)	General Canoeing (84) Nature Study (84)	Trail Camping (81)
	4	Hiking(84)	Hunting (83) General Canoeing (83) Nature Study (83)	Wild. Canoeing (82)
	5	Hiking (84)	Wild. Canoeing (83) General Canoeing (83)	Nature Study (82)
	6	Hiking (85) Wild. Canoeing (85)	General Canoeing (84)	Nature Study (83)
	7	Hiking (86)	Wild. Canoeing (84)	General Canoeing (83) Nature Study (83)

Table 7.--Continued.

River	Segment	First	Second	Third
Manistee (cont.)	8	Hiking (86)	General Canoeing (81) Nature Study (81)	Wild. Canoeing (80)
	9	Hiking (86)	Wild. Canoeing (83)	General Canoeing (82) Nature Study (82)
	10	Hiking (84)	Wild. Canoeing (83) Nature Study (83)	General Canoeing (82)
	11	Wild. Canoeing (83) Nature Study (83)	General Canoeing (81)	Hiking (80)
	12	Nature Study (86)	Waterskiing (85)	General Canoeing (84)
	13	Nature Study (88)	Wild. Canoeing (87)	General Canoeing (86) Small Craft Boat. (86) Waterskiing (86)
	14	Waterskiing (88)	General Canoeing (81) Powerboating (81)	Boat Fishing (80)
	15	Waterskiing (86) Nature Study (86)	Wild. Canoeing (85)	General Canoeing (84) Boat Fishing (84)
	16	Nature Study (90)	Waterskiing (87) General Canoeing (87) Wild. Canoeing (87)	Hunting (86)
	17	Nature Study (89)	Wild. Canoeing (87)	General Canoeing (86) Waterskiing (86)

Table 7.--Continued.

River	Segment	First	Second	Third
Manistee (cont.)	18	Wild. Canoeing (91)	Nature Study (88) Waterskiing (88)	General Canoeing (87)
	19	General Canoeing (90)	Nature Study (89)	Small Craft Boat. (88) Waterskiing (88)
	20	Waterskiing (87)	General Canoeing (85) Small Craft Boat. (85) Nature Study (85)	Wild. Canoeing (84)
	21	Powerboating (83)	General Canoeing (82) Small Craft Boat. (82) Waterskiing (82) Boat Fishing (82)	Nature Study (81)
	22	Waterskiing (81)	Boat Fishing (78)	General Canoeing (74)
Looking Glass	1	Nature Study (79)	General Canoeing (76)	Canoe Camping (72) Hiking (72) Wild. Canoeing (72) Small Craft Boat. (72)
	2	General Canoeing (76)	Vehicle Camping (73) Nature Study (73)	Small Craft Boat. (72)
	3	General Canoeing (73)	Swimming (70) Vehicle Camping (70)	Small Craft Boat. (69) Nature Study (69)

Table 7.--Continued.

River	Segment	First	Second	Third
Looking Glass (cont.)	4	General Canoeing (78)	Vehicle Camping (75) Hunting (75)	Small Craft Boat. (73)
	5	General Canoeing (74) Nature Study (74)	Hunting (72)	Small Craft Boat. (69) Swimming (69) Hiking (69) Canoe Camping (69)
	6	General Canoeing (75)	Hunting (70)	Nature Study (69)
	7	Hunting(77)	General Canoeing (75)	Nature Study (70)
	8	General Canoeing (76)	Nature Study (74)	Hunting (72) Wild. Canoeing (72)
	9	General Canoeing (73)	Hunting (71)	Nature Study (70)
	10	General Canoeing (72)	Hunting (70)	Vehicle Camping (69)

Note: Numbers in parentheses are recreation potential scores taken from Tables 3, 4, 5, and 6. The total possible score for each activity per segment varies from 0 to 100.

Are these significant differences so that ranks one, two, and three are meaningful, or must it be said that all activities have good recreational potentials with some appearing to be slightly, but perhaps only insignificantly better? This analysis cannot answer the question. Such an answer may be possible after further testing of the technique on a wider variety of river types.

Mean Activity Scores

Another possible approach in determining the significance of the scores, was through calculation of mean activity scores for each activity for each river and comparing these scores to known physical landscape characteristics of the test reaches and the activities which presently occur in them. An average score for each activity from all ten or eleven segments was calculated for each river. These means are depicted on Table 8, and are more revealing than the previous analysis, though the observation units were expanded to entire river reaches.

Reviewing these mean river activity scores indicated that some scores were higher than would be expected or warranted considering physical limitations to activities imposed by the landscape. This point is illustrated on Table 9.

Table 8.--Mean Activity Scores by Test River.

Activity	Pine	"Middle" Manistee	"Lower" Manistee	Looking Glass
Wilderness Canoeing	82.7	82.8	62.5	47.7
General Canoeing	85.0	82.3	84.2	74.8
Small Craft Boating	77.1	74.9	82.9	69.5
Powerboating	*	*	82.7	*
Swimming	80.2	75.6	73.2	68.1
Waterskiing	*	*	85.8	*
Nature Study	80.6	82.4	83.9	71.6
Hiking	84.3	84.5	74.7	66.5
Picnicking	78.5	74.2	65.9	66.5
Canoe Camping	80.7	78.1	71.8	67.7
Trail Camping	79.3	78.5	70.1	65.3
Vehicle Camping	80.2	78.7	70.5	69.0
Driving for Pleasure	80.2	78.6	72.1	63.5
Bank Fishing	81.9	76.7	75.7	64.2
Boat Fishing	80.3	77.0	82.3	67.1
Hunting	78.9	78.8	79.9	71.3

*Indicates that the activity was considered impossible or improbable.

Table 9.--Assessment of Mean Activity Scores in Relation to Physical Landscape Limitations.[a]

Activity	Pine	"Middle" Manistee	"Lower" Manistee	Looking Glass
Wilderness Canoeing	*	*	*	*
General Canoeing	*	*	(1,6)	(6)
Small Craft Boating	(5)	(5)	*	(5)
Powerboating	NA	NA	*	NA
Swimming	*	*	(1,8,3)	(8)
Waterskiing	NA	NA	(1,8,3)	NA
Nature Study	*	*	*	*
Hiking	*	*	(1,6)	(2,4,6)
Picnicking	(3)	(3)	(1,3,7)	*
Canoe Camping	*	*	(1,7)	(2,7)
Trail Camping	*	*	(1,7)	(2,4,7)
Vehicle Camping	(3)	(3)	(1,3,7)	(1,4,7)
Driving for Pleasure	(3)	(3)	(3,6)	*
Bank Fishing	*	*	(1,3)	*
Boat Fishing	(5)	(5)	*	(5)
Hunting	*	*	*	*

[a]If asterisk is present, the mean score in Table 8 appeared appropriate. If numbers are present, mean score was too high. Numbers refer to physical limitations which should have lowered the score.

(1) Poor soils; swampy
(2) Too much access
(3) Too little access
(4) Houses; human structures
(5) Shallow water; poor navigation
(6) Scenery is monotonous
(7) Less desirable surroundings
(8) Less desirable, visual water quality

NA indicates that the activity was considered impossible or improbable.

The following conclusions were drawn from Table 9:

(1) The mean scores in Table 8 do not appear to adequately reflect the negative impact of poor soils on the recreational potentials of such dry-land activities as hiking, camping, bank fishing, and picnicking. (This is a particularly appropriate observation for the "lower" Manistee below Borski Bayou.)

(2) Insufficient weight was given to accessibility, if there was either too much accessibility or insufficient accessibility for any given activity. (Two examples illustrate this problem well. First, the scores for driving for pleasure appear inappropriately high for segments along the Pine and Manistee rivers since parallel road accessibility and road surface quality is poor. Second, the score for trail camping along the Looking Glass River appeared to be too high considering the many access points, parallel roads and homes along the river which reduces the feeling of remoteness. This indicated to me that the procedure failed to adequately consider the negative effect of adjacent roads and access points for some activities, such as trail camping, wilderness canoeing, and hiking. Further, the procedure failed to adequately consider the positive effects of adjacent roads

for other activities, such as picnicking, vehicle camping, and driving for pleasure.)

(3) The weights assigned for floatability appears insufficient. (For example, boating with small craft is possible only on a limited basis on the Pine, Looking Glass, and "middle" Manistee due to the shallow waters. While the scores somewhat reflect this limitation to the activity by lower scores in comparison with those scores of canoeing, the degree of response does not appear sufficient. The potential scores for this activity should be lower.)

(4) Despite the limitations noted above, the system does appear to represent general trends for these test reaches. Except as noted above, lower scores for certain activities are evident when comparing scores for the Pine River and "middle" Manistee River with those for the Looking Glass River and "lower" Manistee River. Further, the mean scores of the rivers generally agree with the expectations noted earlier in this chapter.

Conclusion

While certain problems with the evaluation system have been identified above, the overall approach appears to have worked in identifying the recreational potentials along test reaches and in individual segments of the three rivers. Further, the approach, with some notable exceptions, seemed to be responsive to changes in the landscape from one segment to another segment. Modifications will be needed to improve the technique's sensitivities towards variations in the recreation environment. Suggested modifications are offered in the following chapter.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Introduction

This investigation attempted to achieve two goals which were set forth in Chapter I. First, in response to an apparent need for improvement in comprehensive river recreation planning, it sought to develop a system for evaluating recreational potentials along river corridors. Second, it attempted to further develop techniques for recording the characteristics of river corridor landscapes. This study, while meeting a specific need for national forest river planning, also represented efforts to extend the past and present research in the United States directed at quantifying river landscapes.

The remainder of this chapter summarizes the principal findings of this investigation and offers recommendations for improvements and for future testing of the system. Included in the following section is an analysis of this research through discussion of the hypotheses which were first offered in Chapter I.

Conclusions Concerning Hypotheses

Basic Hypothesis

Hypothesis.--It is feasible to develop and to implement an objective technique for evaluating river recreation opportunities, which will assist in river recreation planning and in guiding associated land management practices,[103] and, further, will accommodate the operational constraints of land management agencies.[104]

Discussion.--It is important to understand the possible uses of this technique to the land manager before directly commenting on the hypothesis.

The resource manager may, through use of this technique, inventory the existing physical conditions of the river corridor landscape and the existing recreational

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[103]Associated land management practices refers to other activities which may occur in a watershed and/or along a river corridor, and which could effect a change in the physical appearance of a river and adjacent lands. These activities could include timber cutting, stream management practices (e.g., erosion prevention structures), fish management practices, and new road construction.

[104]Accommodation of the operational constraints of land management agencies within the methodology of this procedure indicates that an agency may complete evaluation of a river corridor with minimal manpower, and with only one trip down the river corridor, depending on use of aerial photography and other data sources to minimize costs of field work to an agency. Further, the time requirements of this technique's application are minimal, thereby allowing hundreds of river miles to be evaluated within a summer season or equivalent length of time.

potentials of the river. The manager may, however, also use this technique to identify the consequences to recreational opportunities of a land management decision resulting in a change in the landscape or quality of the river. The existing inventory becomes the baseline, or benchmark against which predicted changes are compared.

This approach would function as follows. The resource manager predicts the new appearance of the landscape, or change in the river's water quality, stemming from a possible land or water management decision. These predictions are simply substituted for the existing data where appropriate. The "new" data is processed through the system. Comparison of the recreational potential scores, from the landscape before and "after" decisions are implemented, will enable the manager to see the impact of the decision on recreational opportunities in the river corridor. In this sense, the technique becomes a method of socio-environmental impact assessment.

The second major use is that once the procedure is completed for a river corridor, recreational potential areas may be identified, and in doing so, may enable the manager or planner to better inform citizens of recreational opportunities in a given area.

Based on these research efforts, this basic hypothesis should largely be accepted for the following reasons. First, the technique appears to effectively evaluate the recreational potentials for sixteen activities in a reasonably objective fashion.[105] Second, while some modifications will definitely be necessary, and the list of activities may be changed, the author believes the feasibility of development of the method was proven with the results discussed in Chapter IV. With training, the technique's users should be capable of uniform application, though obviously this must be subjected to formal testing. The third point is that the logic behind the potential uses of this technique, as discussed in the paragraphs above, appears to support the clause in the hypothesis referring to assistance which the procedure will give to resource and land managers.

While the implementation and operational constraint clauses of the basic hypothesis are presently untested, I believe that with subsequent testing and use, these too will be supported.

Sub-Hypothesis One

Hypothesis.--No existing recreation potential assessment system fulfills the project needs; namely, objective calculation of relative recreational opportunity

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[105]The reader is referred to the discussion under Sub-Hypothesis Six.

potential for specific activities within a narrow, linear river corridor, subdivided into smaller segments.

Discussion.--Under the assumptions embodied in the hypothesis, the author believes that a cautious acceptance of the hypothesis is possible. Caution is indicated since a change in any of these specific assumptions may produce reason for rejection of the hypothesis.

In terms of using any of the past methods to meet the needs of this project, there are seven reasons for not applying the techniques in this approach.

First, some methods involved evaluation of a very large area. In Dearinger's approach,[106] the entire watershed was evaluated, which I feel is not appropriate.

Second, previous methods evaluated the potential for a limited number of activities or used activity categories which were too broad. For example, Craighead and Craighead only evaluated boating, hunting, and fishing.[107] Morisawa, at the other extreme, classified recreational activities into three broad groupings, namely, active outdoor recreation (camping, hiking, hunting, horseback riding, backpacking), active water recreation (swimming, canoeing, fishing, motor boating, sailing), and nature

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[106]Dearinger, Esthetic and Recreational Potential.

[107]Craighead and Craighead, "River Systems," pp. 14-19.

observation and interpretation (wildlife, wildflowers, birds, and geology).[108]

Third, some studies emphasized aesthetic quantification.[109] These studies focused on methods of quantifying only the aesthetics or uniqueness of a river. The objective was not to assess recreational potentials, per se. Fourth, the emphasis of some other studies was on classification of rivers into categories for potential designations in wild, scenic, or natural river programs.[110] Here the method focused on classifying the surroundings of, and eliminating from further consideration, those river environments which did not meet a given set of standards for remoteness and pristine qualities as mandated by a legislative or an administrative order. Fifth, the approaches of the U.S. Forest Service which were reviewed did not focus on the assessment of recreational potentials of rivers and river corridors, but larger geographic areas and included assessments of activities which were not necessarily oriented towards rivers. Sixth, other studies did not integrate aerial photography interpretation with recreational potential evaluation for a broad range of

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[108] Morisawa, Evaluation, p. 79.

[109] See "Previous Approaches" in Chapter II.

[110] See "State River Classification Systems" in Chapter II.

activities.[111] Seventh, those studies which did generate overall study river scores of recreational potential, did so for either a limited number of activities[112] or for overall recreational potential.[113] None did so for a reasonably broad spectrum of activities on a segment by segment basis.

Sub-Hypothesis Two

Hypothesis.--The most accurate river recreation opportunity evaluation process is one that obtains data, for a quantitative inventory of river characteristics, through an integration of field research and interpretations of aerial photographs, and processes this inventory data through a quantitative evaluation procedure.

Discussion.--In order to quantify the aesthetics of a landscape, it is important to be on the river to enable one to gain an appreciation for the landscape which is subject to the evaluation process. Second, field research is important to check the interpretations from aerial photography of the variables noted on Table 2, Chapter III. Third, use of a boat is father than attempting

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[111]See "Methods Using Remotely-Sensed Data" in Chapter II.

[112]Dearinger, Esthetic and Recreational Potentials.

[113]Nighswonger, Kansas Streams.

to hike entire lengths of river reaches. In some cases, hiking may not be possible due to swampy land, heavy brush, restrictions in river access, or other limitations. Fourth, roads and trails do not always follow a river for its entire length or for major reaches.

Field research for this procedure is not limited to observations from boats on the water. Information on variables, such as water quality or months of water flow, may also be obtained from government agency personnel, local canoe livery and marina operators, riparians, and others.

Use of aerial photographs for gathering data reduces field time. Variables for which aerial photographic interpretations are well-suited are land use, location of oxbow lakes, vegetation (types, densities, diversity), river pattern, acreage of ponds and islands, identification of roads, trails, bridges, and human structures for remoteness and accessibility.

Approaching the evaluation of recreational potentials through quantitative procedures provides greater uniformity in applying an evaluation procedure. Second, it reduces the amount of subjective judgement required. Third, it provides the opportunity to substitute electronic data processing techniques for manual calculations.

Sub-Hypothesis Three

Hypothesis.--Data gathering and analysis using a continuous and relatively narrow river corridor[114] is the most satisfactory approach to evaluating the recreational potentials of rivers, and is more satisfactory than using data from designated sampling points[115] distributed along the river, or methods which involve data for an entire watershed.

Discussion.--Supporting arguments for the use of a relatively narrow river corridor have been outlined in Chapter III.[116]

Regarding the issue of whether the spatial unit used in the inventory and analysis should be a continuous length of river or widely spaced transects or plots, the author feels that data should be generalized for a continuous segment of river rather than collected for limited areas every x miles. The primary reason for this opinion is that important values, both positive and negative, may

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[114]In this case, the corridor extends from the river banks to one-quarter mile inland. The total width of the corridor is one-half mile plus the width of the river itself.

[115]An alternative to evaluating the entire length of study river and adjacent lands is to strictly evaluate the river at specific points, for example, a transect or sample area every two miles.

[116]See Chapter III, "Outline of Method: Fundamentals."

be missed if the limited area or transect sampling approach is used. For instance, a housing subdivision, dam and impoundment, or rapids may be missed if it falls between sampling points and only one such intrusion on a natural landscape may profoundly affect an activity such as wilderness canoeing.

Sub-Hypothesis Four

Hypothesis.--Due to the complexity of recreational activities, a large number of different variables must be inventoried in order to comprehensively evaluate the potentials for diverse land and water based recreational activities.

Discussion.--If the potentials for only a few recreational activities were to be evaluated and these few activities were very similar, it would probably be possible to identify a limited number of variables from which potentials for those activities could be estimated. Due to the diversity, however, of recreational activities, more variables need to be considered in estimating the recreational potential for many activities. These activities, for example, may be classified by their relationship to the river. Participation in wilderness and general canoeing, and in small craft and power boating primarily involves watercraft contact with the water. Swimming and waterskiing involves total body contact, while the remaining activities generally involve only visual and/or olfactory contact with the river.

If more rivers are evaluated using this procedure in the future, perhaps a smaller number of key variables will be identified from the large number used here, or significant new variables will be found, which prove satisfactory in estimating potential. Hopefully revision will be based on empirical research. Lacking this basis, and depending on intuition in the selection of variables, it appears that all of the current sixty-seven variables are needed.

Sub-Hypothesis Five

Hypothesis.--Special aerial photography[117] will generally be unnecessary for use in this evaluation procedure.

Discussion.--Satisfactory interpretation results were obtained using conventional black and white aerial photography, and color infrared photography. As noted in Chapter IV, low altitude, light plane aerial photography was tested along a portion of the Pine River. While certain problems were encountered during the test (air

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[117] "Special aerial photography" is photography other than black and white or color infrared imagery which is commonly available through the Soil Conservation Service, Agricultural Stabilization and Conservation Service, highway departments, planning commissions, national forest supervisors' offices, and other agencies.

sickness), the developed photographs were reviewed and a greater amount of detail can be seen in comparison with generally-available photography. However, since this imagery is not necessary to complete an inventory, the hypothesis may be accepted.

Sub-Hypothesis Six

Hypothesis.--The process of conducting an inventory of a river landscape and evaluating recreational potentials can be accomplished through wholly objective measurements and techniques.

Discussion.--"Wholly objective measurements and techniques" means that all variables should be measured using instruments or systematized observations (for example, "keys" for identifying plant or animal species). This is not true for this procedure. Some subjective judgments were necessary in the application of this technique. In future applications, subjectivity may be minimized through training.

Some of the variables incorporated into this procedure could be objectively measured. These include: width, stream velocity, stream bed material, bank erosion, turbidity, bacteriological quality, pesticides, chemical pollutants, odor, algae, plants, trash and litter, sandy beaches, and oxbow lakes. Other variables simply cannot be objectively measured in this technique, though other researchers have attempted to do so in their own studies. These variables include view confinement, scenic beauty, impacts of artificial river controls (e.g., dams, channelization) on recreational activities, impacts of buildings on recreational activities, impacts of trash and litter, and the appropriateness of accessibility. In some cases, objectivity is sacrificed for guided subjectivity in order to save time and money when collecting data. Potentially, this could mean the difference between numerous rivers being inventoried and evaluated, and no rivers, or just a few, being studied. If rivers are not evaluated, decisions will continue to be made which may adversely affect river recreation quality and the number of opportunities available.

While the selection of variables and weights should ideally be based upon empirical evidence, thoughtful subjective selections will have to suffice until such evidence is available to guide the selection and weights-assignment processes. Decisions affecting the rivers are often made without the benefits of even rudimentary systematic recreation potential assessment.

Sub-Hypothesis Seven

Hypothesis.--One application that a river recreation potential assessment procedure will have is to identify possible recreational activity conflicts within river segments.

Discussion.--At the present time, the possible significance of differences in, and magnitudes of, recreational activity potential scores for different segments is not clear, but this evaluation procedure should logically identify recreational conflicts when, for example, swimming and waterskiing both receive high scores.

The specific judgement on this hypothesis then is that these scores may be used to identify conflicts but not with the specificity implied in the hypothesis. Once, however, more diverse rivers are evaluated, and the meanings of the scores become clearer, more specific potential conflict identification by segment should be possible.

Additional Conclusions

Many of the basic conclusions which can be drawn from the development and application of this river recreation potential assessment technique are embodied in the discussions of the hypotheses. The following additional conclusions also emerged.

Conclusion One.--The results of the technique are indicative of the responsiveness of the procedure components to changes in the environment, and is presently capable of identifying general trends in recreational activity potentials. Refinements in the inventory and analysis procedures are needed, however, as are additional tests on diverse rivers.

Conclusion Two.--Insufficient weighting was applied in the case of the following variables: soils, accessibility, and floatability. The effects of these factors were not adequately reflected in the potential scores as reported in Chapter IV.

Conclusion Three.--Manual calculations of the recreational potential scores are extremely time-consuming, due to the number of variables, weightings, and transformation procedures. Processing the inventory data through a computer program appears necessary.

Recommendations

The following recommendations are offered to: (1) help those who wish to apply the technique to actual river corridors, and, (2) guide future research oriented towards improving the procedure, testing of the hypotheses, and selecting test rivers.

Recommendation One

Instead of assessing the recreation potentials of bank fishing and boat fishing, it appears more useful to separate cold-water species fishing from warm-water species fishing.

Recommendation Two

A wide range of additional rivers should be subject to evaluation. These additional evaluations will serve to identify further modifications which may be needed on the inventory form, weightings, and other technique elements. Additional rivers should represent a cross-section of river types. In Michigan, for example, currently poorer quality rivers such as the Rouge River in Detroit and portions of the Grand River should be evaluated. Other potential rivers throughout the state which represent a variety of river types include: Kalamazoo, St. Joseph, Raisin, Huron, Shiawassee, Flint, Thornapple, White, Pine (Gratiot County), Betsie, Rifle, Jordan, Pigeon, Muskegon, Carp (Mackinac County), Indian, Ontonagon, and Net.

Rivers finally selected for additional testing should represent regions of agricultural lands, urbanized areas, wilderness areas, rivers cutting through bedrock in the Upper Peninsula, rivers in the Saginaw River Basin, and other natural regions in Michigan.

Recommendation Three

Personnel from various government agencies should be involved in tests for uniformity in application of the procedure. After an appropriate training period, personnel would individually apply all steps of the procedure as outlined in Chapter III, including aerial photograph interpretation and data collection on the river. Each individual's inventory data could then be processed through the analysis component to yield recreational activity potential scores. The scores of all personnel would then be compared and contrasted. In this fashion, needs for further modifications to increase objectivity in the procedure may be identified.

Recommendation Four

Due to the extremely time-consuming nature of manual processing of the inventory data through the evaluation phase, a computer program should be developed to quickly process the data. The program might also be designed to handle an interactive mode, i.e., have the capability of receiving data and producing scores through remote terminals. These terminals could potentially be located in, for example, national forest supervisors' offices or regional headquarters of the U.S. Forest Service.

An additional benefit of utilizing a computer program for processing is that given the correct program design, variables, weights, and transformations may be easily manipulated. Easy substitution would make it possible to experiment with new formats and values in attempts to develop more accurate weights, transformations, and selection of variables.

Recommendation Five

In Chapter IV, the problem of insufficient weights assigned to soils, accessibility, and floatability was discussed. Correction of this deficiency may be approached in three ways. First, the weights may be increased from five (for accessibility) to, perhaps, ten. Second, negative numbers may be introduced to reflect detrimental situations. This solution may correct the probable existing situation of apparent inflated scores due to the lack of these negative numbers. The third possibility is altering the variable and/or scale parameters.

Recommendation Six

In the later stages of subsequent refinement, attention should be given to the possibility for use of this technique for rivers in arid and semi-arid regions of the United States. This may require extensive modification of the present approach, and could result in two systems, though it would be desirable to retain one format and procedure.

Recommendation Seven

Further testing of the usefulness of low-altitude aerial photography in this evaluation procedure would be desirable, though not an inexpensive proposition.

Recommendation Eight

Additional empirical evidence should be sought to support variable selection and weighting as initially attempted here in Appendix A. Through this process, potentially useful modifications to the variables and scale parameters may be identified.

This empirical data may be forthcoming from planned U.S. Forest Service research by George L. Peterson and B. L. Driver,[118] or the findings of other studies, such as those of the U.S. Geological Survey's on-going project, "River-Quality Assessment of the Williamette River Basin, Oregon."[119]

Recommendation Nine

For gathering information for the inventory phase of this evaluation procedure, the following suggestions are offered:

(1) Interpretation of aerial photographs should precede field data collection. This would allow the user to field check the photo-interpretations, and to complete the inventory sheet for those variables not completed with interpretation data.

(2) Users may desire to take systematic photographs or slides of river segments while on the river for future reference and reporting purposes, and to "fill-in-the-gaps" if field observers fail to rate a variable.

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[118] Interview with George L. Peterson, Northwestern University, and David W. Lime, North Central Forest Experiment Station, U.S. Forest Service, East Lansing, Michigan, 2 December 1975.

[119] David A. Rickert and Walter G. Hines, A Practical Framework for River-Quality Assessment (River Quality Assessment of the Williamette River Basin, Oregon), Geological Survey Circular 715-A (Washington, D.C.: U.S. Government Printing Office, 1975).

(3) Users should always plan on making an automobile or jeep reconnaisance trip within the river corridor if time and road access permits. Such trips should assist in field checking of the aerial photograph interpretations and would help in increasing the users familiarity with the river corridor.

Recommendation Ten

Consideration should be given to the possible inclusion on the inventory sheet of one or more variables which, when rated, would reflect the presence of existing recreational facilities, if they occur within a segment. This should be considered since facilities may increase the recreational potential of a segment. With such an inclusion, however, one segment's higher score (assuming that facilities exist within it) could obscure identification of other segments with as much natural potential (for a given activity), but whose score would be lower because it was undeveloped. This trade-off should be investigated.

The Need Continues

In 1962, Craighead and Craighead stated:

> The nation is rapidly developing and utilizing its tremendous outdoor recreational resource, especially that portion of the resource that is water-oriented without knowing the total scope of the resource, the

> rate at which it is being developed, the characteristics of the resource and how it can be classified, rated and evaluated, preserved and improved.[120]

The development pressures that Craighead and Craighead saw in 1962 continue today for homes, flood control projects, power generation needs, and other uses. The need for classifying and inventorying river landscapes and their recreational opportunities is great, and the need for the integration of river recreation and aesthetic values into the planning processes is logical. As Tippy stated:

> Planning should illuminate all values involved--so that decisions to develop are made after consideration of the preservation values which will be lost, and so that decisions to preserve are made with awareness of development values foregone.[121]

Recreation may be one of these preservation values.

Recognizing its limitations and the need for further development and refinement, it is hoped that this technique will eventually be of some use in the recreation and watershed planning processes to meet this need for equal consideration of aesthetic and recreational values, while not forgetting, however, that identification of existing recreational opportunities has immediate application for federal and state land management agencies.

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[120] Craighead and Craighead, "River Systems," p. 2.

[121] Roger Tippy, "Preservation Values in River Basin Planning," Natural Resources Journal 8 (April 1968): 259.

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APPENDIX A

EXPLANATIONS OF RIVER RECREATION POTENTIAL ASSESSMENT VARIABLES

APPENDIX A

EXPLANATIONS OF RIVER RECREATION POTENTIAL ASSESSMENT VARIABLES

This appendix defines and explains the variables contained in the inventory sheet, Form #1 in Appendix B. As outlined in the main text of the thesis, values were assigned to all of these variables in each segment of the test rivers, where appropriate, based on the assumptions and definitions contained here and in the main text.

A. Basic Physical Features

1. Width of River.--In order to set some lower limit to the size of river which would generally be evaluated, a minimum of fifteen feet was established in the scale for this variable. This could be easily modified for subsequent use of the evaluation procedure. It seems, however, that the recreational potential of rivers less than fifteen feet would often be limited to wading, fishing, nature study, and limited canoeing.

The scale for this variable was developed with the intent that values in the field could be measured by either approximating the width or through some type of measurement. For the latter, this could be done on high-quality aerial photography using precision measuring instruments.

2. Site Development Potential.--Relatively speaking, the development potential along a very narrow river valley was thought to be limited, while if the immediate valley is flatter, the site development potential could be greater.

Slope and soils are often major limitations to development. Soils are covered, however, under variables twenty-six (26) and twenty-seven (27). Slope then was the primary concern of this variable. For example, a value of three on the scale could reflect a situation where either small scale development could occur due to only a limited area of flat topography, or where larger scale development could occur but extensive land modification would be necessary.

3. Apparent Stream Velocity.--In lieu of recording actual velocity with a water flow meter, a time consuming process relative to the processes required for assigning a value to each of the other inventory variables, the stream flow was estimated visually using the scale of "stagnant" or a barely perceptible flow (1 on the scale) to a torrential flow (5 on the scale). A fast current may be treacherous to negotiate while canoeing,

particularly if obstacles occur in the stream channel.[1] On the other hand, high velocities may result in greater aesthetic appeal. If these higher velocities are present, however, swimming may be dangerous.[2]

4. Floatability.--Five activities received a score for this factor, namely, wilderness and general canoeing, small craft boating, powerboating, and water-skiing. This variable was used in lieu of stream depth since numerous streams in Michigan are of the pool-and-riffle stream profile type where streams have widely varying depths even within a one mile segment.

While the categories are somewhat self-explanatory, a few explanations are important. "Long Pools" refers to substantial sections of river where navigation is possible for watercraft, but is broken by short stretches where the water is so shallow it creates difficulties, or a portage is required. The scale parameter "with difficulty" may indicate constant bottom-scraping, or portage.

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[1]This concern is reflected in American Whitewater Affiliations' "River Rating Scale, Factors Related to Difficulty in Negotiating and Safety" appearing in Scott Arighi and Margaret S. Arighi, Wildwater Touring: Techniques and Tours (New York: MacMillan Publishing Co., Inc., 1974), pp. 5-8.

[2]G. E. Hendrickson and C. J. Doonan, Hydrology and Recreation on the Cold-Waters of Michigan's Southern Peninsula, Water Information Series Report 3 (Lansing: U.S. Geological Survey in cooperation with Michigan Geological Survey, Department of Natural Resources, 1972), pp. 41, 43, 46.

5. Flow Fluctuation (natural or man-induced).--This variable addressed the issue of seasonal variations or daily variations in stream discharges, such as daily releases from power dam impoundments. This fluctuation may effect, not only human recreation activities, but also botanic communities and animal behavior. For instance, sand pipers were observed to have problems in locating and remaining on perching spots and feeding areas during periods of high water along the Manistee River below the Tippy Dam caused by release of water. Moreover, fluctuations lead to deposition of trash on river banks, stranding of floating craft, and the need for caution with rising water. As was reported in Study Report 10 of the Outdoor Recreation Resources Review Commission:

> Although the available data show that recreationists are using bodies of water despite large fluctuations in water surface, it can hardly be doubted that the quality if not the quantity of recreation is impaired by water surface fluctuation.[3]

Evidence of flow fluctuation may be observed along a river by vegetation lines which are, for example, three feet higher on the river banks during low flow periods. Also, lines of moisture on the banks which are higher than the low flow are possible evidence of fluctuation.

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[3]Outdoor Recreation Resources Review Commission, Water for Recreation--Values and Opportunities, ORRRC Study Report 10 (Washington, D.C.: U.S. Government Printing Office, 1962), p. 21.

Other local sources could be consulted to discover, or to affirm field observations of such fluctuations.

A normal spring-runoff situation with somewhat higher water levels than during July-August periods would not necessarily warrant a low score. However, if after the spring runoff the stream flow drops significantly to minimal flow, then fluctuation could receive a one (1) or two (2) score. For example, there is considerable fluctuation in the flow in the Looking Glass River, north of Lansing, Michigan (Clinton and Ionia counties), which drains substantial agricultural and suburban land areas. Spring run-off is high, but in the summer months, the river is a "canoe bottom-scraper," seriously decreasing the capacity of the stream to support some recreation activities.

6. Months of Water Flow.--This factor obviously contributes to floatability and flow fluctuation, however, it is still important to identify separately. The focus here was on the months of any stream flow. Stream flow may cease due to insufficient rainfall or ground water supplies. A stream may have intermittent flow, or cessation may be due to winter freezing.

Total months of flow obviously will vary year-to-year; however, through various sources, some estimate should be available.

7. Stream Bed Material.--This factor is important from the perspectives of aesthetics, fisheries, boating (including canoeing), and swimming though it is rather difficult to completely separate this factor from river pattern and water surface pattern and profile.

Just as floatability must be rated for different activities, so too must bed material. In this case, all sixteen activities received a score varying from excellent suitability (five) to very poor (one).

Stream bed material has impact on four recreation activity groups. For aesthetics, the impact is obviously visual: gravel and boulders are usually considered to be most aesthetically attractive, with sand, clay, and mud bottoms following in order of attractiveness.[4] Second, for fishing, stream bed materials are very important. For example, "trout, in order to reproduce, need gravels ranging in size from pea to hen's egg size in which to deposit their eggs."[5] Further, for fishermen who wade along and in streams, firm sand or gravel is preferable to slippery rocks or clay.[6]

In the case of boating, not only are aesthetics of the stream bed material important, if one can see the bottom, but sand and gravel bottoms are preferable over

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[4]Ibid., p. 21.

[5]Ibid., p. 24.

[6]Ibid.

boulders or cobbles, if one considers possible damage to watercraft.

Four, most people prefer sand bottoms to gravel or clay in swimming activities. Boulders may add interest to swimming in an area, but can also be dangerous, particularly in relation to stream velocity. Silt and muck bottoms are the least desirable.[7]

8. Dominant River Pattern.--An important function of river pattern is that it determines, in large part, the carrying capacity of the stream. Meanders, for example, with associated bends, keep people more out-of-sight from each other than gently curving rivers or channels. Meandering rivers are usually more scenic than straighter-channelled rivers since views along the corridor change more frequently. For example, canoeists or boaters may cause a blue heron to take flight down a river. This may be repeated as the watercraft comes around successive bends causing the bird to move downstream further, to the delight of those individuals thrilled with the view of such a bird.

With braided rivers, boaters may have problems as channels are often narrow, with obstructions, and may be shallower than one main channel.[8]

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[7]Ibid., p. 28.

[8]Ibid., p. 14.

"Channels," as used in this variable scale, referred to rivers which have little sinuosity. These may be man-modified or natural.

A stream segment was inventoried as "Pond(s) and Stream" if a pond was connected to the main stream, that is, actually part of the stream channel. Also, it must have been at least twice the river-width to be classified as a pond. These "ponds" may be natural, man-made, or beaver dam impoundments.

9. Water Surface Pattern and Profile.--While this variable is an obvious function of velocity, width of river, stream bed material, and seasonality, the type of water surface pattern may have profound influences on the type of recreation possible in a river channel.

Aesthetically, a stream with riffles, pools, chutes, rapids, and waterfalls is more attractive. Consider the numbers of scenic sites at areas where these features exist.

For canoeing and boating, the water surface pattern will definitely affect activities.

10. Bank Erosion.--Along a river channel, two types of geomorphic processes are at work: deposition (constructional surfaces) and erosion. Erosion is a normal function of flowing rivers, though rates of erosion

vary widely depending on the size of the drainage area, ground cover, soil types, bedrock types and rainfall.

Normal erosion was not considered in the variable unless it was of such severity that it effected recreational activity, for example, if slopes of the immediate river channel were very unstable, or erosion of clay banks caused a great deal of turbidity in the water.

B. Special Physical Variables

11. Acreage of Ponds.--Ponded water areas may be a good resource for various recreational activities including swimming, boating, hunting, waterskiing, and sightseeing. Each activity, however, requires varying amounts of space. For instance, space requirements for swimming have been estimated at 100-200 square feet of swimmable water per swimmer or fifty to 100 square feet of beach per person. Space requirements for boat fishing are estimated at 3.6 acres per person; for waterskiing--forty acres per boat, for small boating--five acres per boat, and powerboating--twenty acres per boat.[9]

12. Sandy Beaches.--People engaged in swimming, as a recreational activity, appear to be concerned with water quality and the quality of land in adjacent

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[9]U.S. Department of the Interior, Bureau of Outdoor Recreation, Outdoor Recreation Space Standards (Washington, D.C.: U.S. Government Printing Office, 1967), pp. 31, 34.

areas.[10] Sandy beaches seem to attract people as is evident at many swimming beaches in parks and resorts. To identify beaches then is an important component of a river recreation inventory.

For the purposes of this inventory, a sandy beach should be of such dimensions to support a small group of swimmers with an approximate size of 100 feet in length.[11]

13. Oxbow Lakes and Bayous.--Oxbow lakes, which often occur in river valleys, may provide interesting areas for nature study, as these water bodies are usually subject to rather rapid natural succession. Further, these may attract waterfowl for hunting.

14. Islands. Islands play a dual role in considering recreation along river corridors. First, they add variety to the river landscape. Second, islands, depending on their size and characteristics such as soils, height above river, and nature of vegetative cover, may represent areas with high recreational potential for developed-site recreation. For these reasons, the inventory procedure included the counting of islands with

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[10]Ralph L. Levine and Gary K. Higgs, "Environmental Influence on Tourism and Recreational Behavior," unpublished paper, 1975(?). (Mimeographed)

[11]Bureau of Outdoor Recreation, Space Standards, p. 34.

suitability for camping, picnicking or other dry-land recreational use, in various size categories.

15. Navigational Obstructions.--Navigational obstructions may include, but are not limited to, such hazards to safe watercraft operations as log jams, tree-falls, large boulders, low bridges, and dams.

This variable was rated for four watercraft activities: canoeing, small craft boating, powerboating, and waterskiing. If, however, one of these four have received scores of "1" (Never) under variable 4, float-ability, then this variable was not assigned a value for that activity.

16. Immediate Bank Height.--Reference here is made to the ease with which a canoe or other watercraft could be run ashore for emergency purposes, portaging, eating, and other purposes.

C. Water Quality

A few brief remarks are necessary to preface this discussion of water quality variables concerning recre-ation.

There appears to be little agreement on specific water quality criteria in Water Quality Criteria 1972[12]

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[12]National Academy of Science - National Academy of Engineering, Environmental Studies Board, Committee on Water Quality Criteria, Water Quality Criteria 1972 (Washington, D.C.: U.S. Government Printing Office, 1972).

and of discussions the author had with numerous individuals.[13] Even if specific criteria were identified, data collection in the context of this evaluation procedure would be a major problem. Complete and frequent water quality sampling information is generally lacking except at some stations on rivers in or near urban areas. Moreover, if it is not available, even one-day grab samples collected when a float trip is taken on the river, and subsequent analysis, would be grossly inadequate for obvious reasons, for example, heavy rainfall on the preceeding day could cause abnormally high turbidity readings and other parameter readings.

Therefore, as a result of discussions and a limited investigation of related research literature, the variables discussed below appear on the inventory list. These variables are general but appear to be sufficient for this level of analysis.

Information to be used to determine values for these variables could come from such sources as: state

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[13]Dennis Kirchoff, National Sanitation Foundation, Ann Arbor, MI (26 September 1975); Darrell King, Institute of Water Research, Michigan State University, East Lansing, MI (1 October 1975); Karl Zollner, Bureau of Water Management, Michigan Department of Natural Resources, Lansing, MI (7 October 1975); Ronald Willson, Bureau of Water Management, Michigan Department of Natural Resources, Lansing, MI (7, 9 October 1975); Thomas Doyle, Fisheries Division, Michigan Department of Natural Resources, Lansing, MI (8 October 1975); Steve Buda, Bureau of Water Management, Michigan Department of Natural Resources, Lansing, MI (September 1975).

water pollution control agencies, local watershed organizations, colleges and university researchers (e.g., institutes for water research, fisheries, and biology departments), regional offices of the U.S. Environmental Protection Agency, regional planning agencies, and designated 208 planning agencies.[14]

17. Turbidity.--Turbidity, a measure of the amount of light intercepted by suspended sediment in water, is an important water quality indicator. Generally, a clear stream is preferred for recreation over one which is highly turbid, though the relative importance of this variable varies from activity to activity. A report on rivers in Michigan's upper peninsula notes that "turbidity can lower the productivity of a trout stream by reducing the amount of sunlight that reaches the stream bed and, subsequently, the amount of fish food organisms that are produced."[15] Also, turbidity inhibits fish in seeing their food or a fisherman's lure.[16]

[14] Section 208 (Public Law 92-500, commonly referred to as the Federal Water Quality amendments of 1972) agencies are designated by the Governor of each state to develop areawide waste treatment management plans.

[15] G. E. Hendrickson, R. L. Knutilla, and C. J. Doonan, Hydrology and Recreation on the Cold-Waters of Michigan's Upper Peninsula, Water Information Series Report 4 (Lansing: U.S. Geological Survey in cooperation with Michigan Geological Survey, Department of Natural Resources, 1973), p. 29.

[16] N.A.S.-N.A.E., Water Quality Criteria 1972, p. 16; and Interview with Thomas Doyle, Fisheries Division, Michigan Department of Natural Resources, Lansing, MI, 8 October 1975.

For swimming, it is important to be able to estimate the water depth, see hazards on the bottom, and see the bodies of submerged swimmers and divers in trouble. For this reason, clear water is preferable.[17] Further, clear water allows boaters to see obstructions which may lie just below the water surface.

While turbidity can be measured objectively, it appeared more appropriate for purposes of this study to classify river turbidity, on the scale listed on the inventory sheet, by means of personal observations while making the inventory trip down the river and then to check on turbidity fluctuation through discussions with knowledgeable individuals in the area, such as fisheries biologists.

18. Temperature.--Temperature is important for two major activities: fishing and water contact recreation, primarily swimming.

Certain fish species, of which trout are the best known, are cold-water species and are intolerant of warm-water. In Michigan, cold water species streams are defined as those with July-August temperatures of 68°F or less.[18] Rivers capable of supporting warm water fisheries must not exceed 83°F in the northern lower peninsula, or

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[17] N.A.S.-N.A.E., Water Quality Criteria 1972, p. 33.

[18] Michigan, Part 4, Water Quality Standards, General Rules, Water Resources Commission, Department of Natural Resources (1973), Rule 1075 (1) (b).

85°F in the southern lower peninsula.[19] Also, "cooler water normally retains a higher-dissolved oxygen content"[20]; dissolved oxygen being a good indicator of water quality and important to maintaining intolerant fish species.

The second type of activities center on water contact recreation, primarily swimming and waterskiing, where temperature is important for comfortable and safe water contact.

The parameters in the scale for this variable have been derived largely from the Michigan Water Quality Standards, and from general discussions in Water Quality Standards 1972.[21] In considering temperature for swimming, segments with temperatures below 60°F will receive lower scores due primarily to discomfort.

19. Man-Produced Solids on Bottom.--Solids of interest here are such items as: cement slabs and fragments, bedsprings, oil drums, cars, appliances, and boats. These can represent hazards to walking on the bottom, if shallow enough, and can be an eyesore. Further, these can

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[19] Ibid., Rule 1075 (3) (a), (b).

[20] Hendrickson, Knutilla, and Doonan, Upper Peninsula, p. 16.

[21] N.A.S.-N.A.E., Water Quality Standards 1972.

be a hazard to navigation, and fisherman may find that their tackle becomes tangled.[22]

20. Man-Produced Floating Liquids.--Oils, scums, industrial processed wastes, and other materials are floating liquids for purposes of this evaluation.

Aesthetically, these materials should not be present on the water surface.[23] Also for personal health and safety reasons, and for survival of normal aquatic systems, these materials should not be present.

21. Man-Produced Floating Solids.--Such items as industrial waste products, trash, litter were considered to be floating solids. In like manner to floating liquids, floating solids should not be present on the water surface for health and safety, survival of normal aquatic systems, and aesthetic reasons.

22. Bacteriological Quality.--The notes presented at the beginning of this discussion of water quality variables regarding disagreements on criteria are particularly applicable to assessing the bacteriological quality of water. Not only is there disagreement over which

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[22]This variable was brought to the author's attention by Ronald Willson, Aquatic Biologist, Water Quality Appraisal Division, Bureau of Water Management, Michigan Department of Natural Resources.

[23]N.A.S.-N.A.E., Water Quality Criteria 1972, p. 12.

parameter accurately assesses this variable, but also disagreement exists over measurement techniques.

In Water Quality Criteria 1972, the conclusion reached over microbiological considerations regarding swimming and bathing waters was that:

> No specific recommendation is made concerning the presence or concentrations of micro-organisms in bathing waters because of the paucity of valid epidemiological data.[24]

The situation does not appear to have changed since 1972.

The problems with the parameters are largely concerning which parameter is most indicative of unsafe water. A total coliform count is a broad spectrum indicator but is not directly related to sewage. It appears to be less useful than a fecal coliform count. Fecals are presently thought to be present only in the intestines of warm-blooded animals, including man. Water Quality Criteria 1972 states:

> Tests using fecal coliform bacteria are more indicative of the possible presence of enteric pathogenic micro-organisms from man and other warm-blooded animals than for the coliform group of organisms.[25]

The report further states that the use of fecal coliform counts to determine the acceptability of water for bathing or swimming should be undertaken cautiously, and only in

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[24] Ibid., p. 32.

[25] N.A.S.-N.A.E., Water Quality Criteria 1972, p. 31.

association with other water quality parameters to measure water's "sanitary cleanliness." It concludes:

> To use the fecal coliform index as the sole measure of "sanitary cleanliness," it would be necessary to know the maximum "acceptable" concentrations of organisms; but there is no agreed upon value that divided "acceptability" from "unacceptability."[26]

Further, other ailments casually related to swimming in polluted water are not enteric (intestinal inflammation) diseases or not caused by enteric organisms. While alternative indicators have been proposed, e.g., Pseudomonas aeruginosa (a common organism implicted in ear infection) "none of the alternative microbiological indicators have been supported by epidemiological evidence."[27]

Considering the lack of agreement on indicators of sanitary cleanliness, the parameters used for this variable in the river evaluation procedure were not tied to specific measurement units. Five (5) represents excellent water quality while one (1) represents unacceptable quality, that is, swimming should not be permitted. On the basis of health or water quality authorities' judgements, a value can be assigned.

Nutrients in the Water.--While this water quality variable was initially considered for inclusion on the inventory list, the author decided that this variable was better reflected by variables twenty-nine (29), thirty (30),

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[26]Ibid., p. 32. [27]Ibid.

and thirty-one (31), which concern algae, submergent water plants, and floating/emergent water plants respectively. This position is taken since "all the factors causing nuisance plant growths and the level of each which should not be exceeded are not known."[28]

23. Pesticides.--Potential toxic substances classified as herbicides, insecticides, piscicides, fungicides, rodenticides, and mollusicides were considered in this variable. Such substances reach rivers through sewage and industrial wastes, runoff from land used for agriculture and forestry, and chemicals used to control aquatic vegetation.

Obviously large quantities of such materials may be directly detrimental to human health resulting from direct contact, or ingestion such as occurs in swimming or waterskiing. Also, some materials such as chlorinated hydrocarbons are concentrated in aquatic organisms and in the case of shellfish and fish may create a potential health hazard to human consumption.

24. Chemical Pollutants.--Due to the broad spectrum of possible pollutants other than those mentioned above, this category was included to enable the evaluation to consider polychlorinated biphenyls (P.C.B.'s), mercury,

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[28]N.A.S.-N.A.E., Water Quality Criteria 1972, p. 23.

mining acids, chlorides, and other such materials. These are evaluated on the same scale as variables nineteen (19), twenty (20), twenty-one (21), and twenty-three (23).

25. Odor.--Odor is definitely an aesthetic consideration of water quality, recognized in Water Quality Criteria 1972. The author believes that there would be little argument that a foul-smelling river's recreational potential is lower than one in which no odor is present.

Odors in water bodies primarily come from odor-producing microorganisms in raw water supplies, and from human and industrial wastes.[29]

The scale used for this variable reflected the preference that little or no odor be present in rivers in order to maximize the recreational potential of the river.

D. Soils

26. Corridor Soils: Primary.--Soils were considered in this variable and in variable twenty-seven (27) because of their relationships to camping, picnicking, and other dry land recreational use. The "primary" zone was defined as that area which extends from the river bank to a point 300 feet inland.

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[29] N.A.S.-N.A.E., Water Quality Criteria 1972, p. 74.

The most appropriate way in which to judge the severity of restrictions imposed by soils and frequency with which such limitations occur was to estimate the percentage of the segment corridor which has restrictive soils classes. Another approach used was that five (5) was considered "slight restrictions" to dry land recreational use, four (4) was "slight to moderate restrictions," three (3) was "moderate restrictions," two (2) was "moderate to severe restrictions," and one (1) was "severe restrictions."

Due to the sporadic availability of detailed soils surveys, more specific parameters than those included in this procedure are difficult to specify. In testing this approach, the author had to depend on reconnaissance soil surveys, general soil associations maps, and land resource inventory maps, which were available from such agencies as the USDA Soil Conservation Service or Agricultural Stabilization and Conservation Service.

27. Corridor Soils: Secondary.--The same notes as related above in variable twenty-six (26) are applicable to this variable, except the "secondary" zone extends from 300 feet (the upper limit of the "primary" zone) to one-quarter mile inland.[30]

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[30] See "Outline of Method: Fundamentals" in Chapter III for a discussion of the zones within the river corridor.

E. Biological Factors

28. Algae; 29. Water Plants: Submergent; 30. Water Plants: Floating/Emergent.--Water Quality Criteria 1972 states that "dense growth of aquatic macrophytes are generally objectionable to the swimmer, diver, water skiier, and scuba enthusiast," and "sport fisherman have mixed feelings about aquatic macrophytes."[31] The plants may directly or indirectly inhibit recreational activity by tangling propellers, catching waterskis, producing objectionable odor when decomposing, or simply detracting from the aesthetic quality of the water by sheer numbers of plants.

For fishing, plants may provide food and cover for fish, making these areas attractive fishing sites. However, if growth is too dense, tackle and lures may get tangled or dense growth may limit fishing potential.

31-37. Fauna: Small Game, Large Game, Non-Game, Waterfowl, Other Birds, Fish (Cold-Water), Fish (Warm-Water).--The inclusion of these variables is generally self-explanatory as the presence or absence of each group contributes significantly to certain recreational activities.

Some species of small game (squirrels, grouse, woodcock, fox, bobcat, rabbits), or large game (principally

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[31]Ibid., pp. 25-26.

deer, elk, bear), or waterfowl (ducks, geese, snipe) must be present for hunting. These also contribute, along with non-game species and birds, to nature study activities.

Fish were separated into two classes, warm-water species and cold-water species. Both classes are important for fishing.

Cold-water fish are less tolerant of higher temperatures and pollution than are warmer-water species; in general. Prime examples of cold-water fish are trout (brook, rainbow) while warm-water fish include catfish, crappie, bluegill, perch, carp, pike, and bass.

38-49. Land Flora.--Consideration of land flora is essential for two principle reasons: from an aesthetic viewpoint and for site-development. There are also three components of land flora: type, density, and diversity. These were observed and recorded for both sides of test rivers.

Preferences in land flora type will obviously vary from activity to activity. In general, the scale represented the assumption that wooded areas are preferred over grass or barren areas. This scale, for example, does not apply, however, when nature study is considered, since a marsh may provide as much, or more opportunities than wooded areas. The selected categories seemed to present most of the land flora encountered.

Density varies in its influence on various recreational activities. For camping, one might not prefer an area to be too dense so as to restrict the pitching of a tent. A canoeist seeking solitude and "getting away from it all," however, may prefer dense vegetation without exception.

In the case of diversity, more diversity is generally preferable over a vegetative monotone.

50. Wildflowers.--Wildflowers are a recreational asset in terms of their impact on aesthetic values, and their role in nature study. For this reason, the presence or absence of wildflowers was included as a special variable.

F. Land Use

51-54. Adjacent Land Use.--Land uses along and on both sides of a river corridor obviously influence the quality of recreational experiences. For instance, one seeking pristine experiences will be unable to do so if the corridor is significantly modified. Also, certain uses of the land may pre-empt development of some recreation sites. For example, hiking, camping, and nature study will be less possible if the river corridor is largely urbanized or suburbanized, or in agricultural uses.

The scale parameters appear to cover most of the land uses expected along a river and are generally self-explanatory. If industrial land uses had been present, they would have been classified under urban/suburban (human activities). "Natural area" (5) could possess pristine values, or wooded areas, or natural marshes, for example. In value (4), agricultural and/or vacant lands are mixed with natural areas. "Extractive resources" (2) refers to some type of mining operation, for example, gravel, sand, oil. Values were assigned to land use variables for both sides of segments and for both the primary (streambank to 300 feet inland) and secondary (300 feet to one-quarter mile inland) zones.

55. Historic Sites or Features.--It is not unusual to have historic sites become popular areas for tourism. Examples are numerous at the national, state, regional, or municipal levels. These areas may serve as the goal for a recreational trip, or just a "stop-over" point on the route of a longer trip.

Historic sites are important components of driving for pleasure and, sometimes for hiking, canoeing, and boating. As the current nationwide recreation plan explains: "appreciation of our historic and archeological heritage is a special and significant aspect of public outdoor recreation."[32]

56. Public Land Ownership.--(Federal, regional, state, local). Greater participation in recreational activities and freedom can be achieved through recreation resources held in public ownership in comparison to private ownership. For example, consider that eighty-two percent of the U.S. Great Lakes shoreline is held in private ownership.[33] The recreational potential of much of the shoreline is therefore precluded by private land rights. Assuming then that the land manager desires control over as much of the recreational resources as possible to expedite planning, then the scale used for variable fifty-six (56) seems appropriate.

G. Aesthetics

57. Artificial Controls.--Modifications to the river landscape may affect certain recreational activities and to varying degrees. In addition, the type of modification may also vary the impacts. Because of the large variations, one value would not be satisfactory as applied to all recreational activities of concern in this

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[32]U.S. Department of the Interior, Bureau of Outdoor Recreation, Outdoor Recreation: A Legacy for America (Washington, D.C.: U.S. Government Printing Office, 1973), p. 46.

[33]Ibid., p. 34.

evaluation procedure. For example, while a dam may not bother individuals on a picnic, the presence of a dam would most likely have a negative impact on a canoer seeking recreational experiences in an environment with little apparent influence of man.

The types of artificial controls were noted along river segments if they occurred. Then, considering these notes, a determination was later made as to the impacts on each of the sixteen activities.

Limited empirical data was available to support these interpretations. However, the author believes that the greatest impact of artificial controls would occur with a "pristine" canoeist described above. Of course, there are individual fishermen, rowboaters, and sight-seers who may object to even small amounts of modification. The author believes that, in general, larger amounts of modification would be necessary to score three (3) or higher for this variable for all activities except wilderness canoeing, nature study, and hiking.

58. Detrimental Values of Buildings.--Scoring was done on the basis of the degree of interference in recreational activities caused by the existence of buildings in the river corridor. How may the presence of buildings negatively affect recreational activities? The following examples should answer this rhetorical question.

The canoeist described in variable 57 above would probably seek to avoid seeing man-modifications, so more than a few buildings (depending on the type) may seriously detract from the desired experience. Buildings may also interfere with camping (particularly canoe and trail), hunting, nature study, and hiking. In a different manner, residential buildings too close to a stream may necessitate legal provisions calling for "no wake" speeds for motorized watercraft.

In considering the impact of buildings on recreational experiences, the crucial question should be: can this activity still be enjoyed in a largely unimpaired manner by the recreationist. Using this guiding question, a river segment which had six residential buildings scattered throughout the one-mile segment in a wooded setting would probably have minimal or no impact on activities such as general canoeing, small craft boating, powerboating, swimming, waterskiing, picnicking, driving for pleasure, bank fishing, and boat fishing.

This variable represents one where the judgement of the person using the inventory must be depended upon, though in the future, it would be desirable to have numerous examples to illustrate various values.

59. Trash and Litter (on river banks).--This variable is self-explanatory.

60. Utility Crossings.--Features which are included under this broad category include electric transmission lines, gas pipelines, and telephone lines. The visual impacts of these lines vary according to the numbers of crossings, specific manner of crossing, and appearances of any structures used. For example, an electric transmission line may be suspended from steel towers or wooden poles. The latter would probably have somewhat less impact on the visual experience than steel.

61. Other Detrimental Values.--This variable allows some flexibility in the inventory in order that other negative landscape characteristics may be included in the evaluation of recreational opportunity. Space is allocated on the inventory form to indicate these additional negative values.

62. Scenic Variety, 63. View Confinements, 64. Beauty.--The inclusion of these three variables represented an attempt to describe the views and feeling one perceives along a river segment.

"Local scene" describes the diversity of the views along the segment on a scale from one (monotonous) to five (diverse). Diverse views rate higher with individuals than do monotonous views.

"View confinement" is more self-evident as it pertains to the degree which views along the river corridor are confined, i.e., closed in by the surroundings. The scale here ranges from one (closed in by hills, cliffs, or trees) to five (open, no confinement).

"Beauty" reflects an attempt to allow the researcher to consider all of the surroundings within a corridor. Obviously, one would prefer outstanding beauty over dull monotone.

65. Unique Features.--Along rivers, certain features (scenes, structures, memorials, etc.) may be unique to the river, state, North America, or be one-of-a-kind. An example of such a feature might be Tahquamenon Falls in Michigan's Upper Peninsula. These spectacular falls are unique to Michigan, so the segment containing them would rate a three (unique to state).

66. Remoteness.--Remoteness was important for six activities in this evaluation process: wilderness canoeing, hiking, nature study, canoe camping, trail camping, and hunting. Full enjoyment of these activities, in varying degrees, often depend on experiencing an area with less of man's influences than would be the case for other activities, for example, swimming. For hiking, camping, hunting, and wilderness canoeing, the experiences sought are often those of solitude and "getting away from it all."

The use of a quarter-mile as the critical area is arbitrary except that it corresponds to the river corridor. It is not necessarily the best distance, since noise can travel well over a quarter-mile.

H. Accessibility

67. Accessibility.--Realistic evaluation of accessibility is exceedingly difficult, for in considering this variable, the question of carrying capacity is raised.

Annual recreational carrying capacity has been defined as:

> The number of user-unit periods that the recreation site can provide each year without permanent biological or physical deterioration of the site's ability to support recreation or appreciable impairment of the recreational experience.[34]

This is an important concept in considering accessibility and these questions: when can the individual get to an area adequately and when can he reach an area too easily thereby impairing the land itself and the experience for other individuals participating in other activities.

To make an accurate judgement on the accessibility to one segment of river and its corridor would necessitate thorough study of the areas' characteristics in relation to the nature of the recreational activities which will occur in the corridor. Chubb and Ashton note that: "the

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[34] Michael Chubb and Peter G. Ashton, Park and Recreation Standards Research: The Creation of Environmental Quality Controls for Recreation, Technical Report No. 5 (East Lansing: Recreation Research and Planning Unit, Department of Park and Recreation Resources, Michigan State University, 1969), p. Appendix C.

second group of factors affecting recreation land capacity are those factors associated with the psychology and social behavior of the users."[35]

Assuming that a judgement must be made for input in this evaluation system regarding accessibility, acceptance that such a judgement will merely be an approximation is inevitable. Such a judgement will be made after all other variables are scored. This scoring then represents a look at waterbody and river corridor resources. Consideration of social factors is incorporated into some of the variables raw scores and in the weightings assigned to individual variables for individual activities. Incorporation of these considerations is required to assign accessibility scores for river segments.

Another important question is whether accessibility is best judged on a segment by segment basis or whether it is best to group segments together, for example, five segments per group. Should accessibility for segment six (6) in Figure 9 be judged on this segment alone, or should accessibility be considered for segments four (4) through eight (8) as a whole?

It is the contention of the author that for certain activities, accessibility must be considered for larger units than one mile segments. For other activities, segments can be judged alone.

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[35]Ibid., p. 12.

For dispersed activities (hiking, nature study, wilderness canoeing, general canoeing, small craft boating, powerboating, waterskiing, canoe camping, trail camping, and boat fishing) accessibility was rated for five segments with that value being used in individual segment evaluation.

Placement of the "to-be-rated" segment in the middle of a five segment sequence, or accessibility unit, sets the individual segment in the perspective that it is only one part of a larger unit. Access is not limited to just that one area. For example, a feeling of remoteness can probably not be achieved by the desirous recreationist in a one-mile or two-mile stretch of river for two reasons. First, he is in and out of "civilization" too quickly. Second, the stretch of river is too accessible so that canoeists seeking, perhaps, more social experiences may also use the segment with the goal of "having a good time." Also, if the physical character of the river permits, a boater could easily travel up and downstream into adjacent segments.

To assess the accessibility of segment seven (7), adjacent segments five (5), six (6), eight (8), and nine (9) were included in the accessibility unit. If a recreation opportunity assessment was desired on the stretch of the Looking Glass for segments one (1), two (2), eight

(8) and nine (9), accessibility units extended beyond the ends of the desired reach.

For developed-site activities where mobility is less within a segment (swimming, picnicking, vehicle camping, bank fishing, and driving for pleasure) accessibility was rated by individual segments irrespective of the evaluation for adjacent segments.

Therefore, on the inventory sheet (Form #1), seven (7) activities were rated. For the nine (9) other activities, accessibility ratings were transferred from Form #2.

APPENDIX B

EVALUATION FORMS

Form # 1

RIVER RECREATION POTENTIAL ASSESSMENT PROJECT: FIELD INVENTORY

River Name:_______________ River Number:________ Segment Number:________

State:_______________ County:_______________ Township:_______________

Location of Initial Point:______________________________

Field Work Date(s):_______________ Surveyors:_______________

Photographs: Roll Number:________ Frame Number(s):________ Recording Tape Number:________

(NOTE: In factors 26, 38-49, and 51-54, "Primary" refers to land adjacent to the river which constitutes an inventory zone extending from the banks to 300 feet inland. "Secondary" refers to the inventory zone extending from 300 feet to one-quarter mile inland.)

A. BASIC PHYSICAL FACTORS

(NOTE: River should be at least fifteen feet wide.)

1.	WIDTH OF RIVER	5. Very Broad (over 200')	4. Broad (120-200')	3. (80-120')	2. (40-80')	1. Narrow (15-40')
2.	SITE DEVELOPMENT POTENTIAL (considering width of river valley flat)	5. Suitable for developed sites	4.	3.	2.	1. Unsuitable for developed sites
3.	APPARENT STREAM VELOCITY	5. Very Swift (torrential)	4. Swift	3. Moderate	2. Sluggish	1. Stagnant or minimal flow
4.	FLOATABILITY (rate each activity below according to this scale)	5. Always	4. Long Pools (normal flow)	3. During High Water	2. With Difficulty	1. Never

a) Canoeing ______ c) Powerboating ______

b) S. Craft Boat. ______ d) Waterskiing ______

5.	FLOW FLUCTUATION	5. Infrequent & negligible	4. Seldom occuring & of little impact	3. More frequent & moderate, or infrequent & Serious	2.	1. Frequent & Serious
6.	MONTHS OF WATER FLOW	5. 11-12 mths.	4. 8-10 mths.	3. 5-7 mths.	2. 3-4 mths.	1. less than 3 mths.
7.	STREAM BED MATERIAL (suitability of material for activities rated below according to this scale)*	5. Excellent	4. Very Good	3. Good	2. Poor	1. Very Poor

a) Wild. Canoeing _____
b) General Canoeing _____
c) Small Craft Boat. _____
d) Powerboating _____
e) Swimming _____
f) Waterskiing _____
g) Nature Study _____
h) Hiking _____
i) Picnicking _____
j) Canoe Camping _____
k) Trail Camping _____
l) Vehicle Camping _____
m) Driving for Pleasure _____
n) Bank Fishing _____
o) Boat Fishing _____
p) Hunting _____

*SPACE FOR NOTES:

Rocks & Boulders ____________ Sand ____________
Cobbles ____________ Clay or Silt ____________
Gravel ____________ Muck ____________

Fig. 11.--Field Inventory, Form #1.

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8.	DOMINANT RIVER PATTERN	5. Pond(s) & Stream	4. Braided	3. Meanders	2. Gentle Curves	1. Channel
9.	WATER SURFACE PATTERN AND PROFILE (suitability for each activity rated below according to this scale)*	5. Excellent	4. Very Good	3. Good	2. Poor	1. Very Poor

a) Wild. Canoeing ____ g) Nature Study ____ m) Driving for Pleasure ____
b) General Canoeing ____ h) Hiking ____ n) Bank Fishing ____
c) Small Craft Boat. ____ i) Picnicking ____ o) Boat Fishing ____
d) Powerboating ____ j) Canoe Camping ____ p) Hunting ____
e) Swimming ____ k) Trail Camping ____
f) Waterskiing ____ l) Vehicle Camping ____

*SPACE FOR NOTES:

Smooth ____________ Rapids ____________
Ripples ____________ Chutes ____________
Pools ____________ Waterfalls ____________

10.	BANK EROSION (beyond normal river action which may negatively affect recreational activities)	5. Infrequent & negligible	4. Seldom occuring & of little impact	3. More frequent & moderate, or infrequent & serious	2.	1. Frequent & Serious

B. SPECIAL PHYSICAL FEATURES

11.	ACREAGE OF PONDS (natural, or man-made impoundments; pond must be equal to or greater than twice the width of the river)	5. over 250	4. 200-250	3. 150-200	2. 100-150	1. less than 100
12.	SANDY BEACHES (capable of supporting small groups of swimmers)	5. 5 & over	4. 4	3. 3	2. 2	1. 1
13.	OXBOW LAKES AND BAYOUS	5. 5 & over	4. 4.	3. 3	2. 2	1. 1
14.	ISLANDS (suitable for camping, picnicking, or other dry-land recreational use)					
a)	ISLANDS UNDER ½ ACRE	5. 5 & over	4. 4	3. 3	2. 2	1. 1
b)	ISLANDS ½ - 2 ACRES	5. 5 & over	4. 4	3. 3	2. 2	1. 1
c)	ISLANDS 2 - 5 ACRES	5. 5 & over	4. 4	3. 3	2. 2	1. 1
d)	ISLANDS 5 - 10 ACRES	5. 5 & over	4. 4	3. 3	2. 2	1. 1
e)	ISLANDS OVER 10 ACRES	5. 5 & over	4. 4	3. 3	2. 2	1. 1

Fig. 11.--Continued.

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(NOTE: If the segment has received a value of "1" under Variable 4, do not rate Variable 15 for that activity.)

15.	NAVIGATIONAL OBSTRUCTIONS	5. None	4. Minimal	3. Infrequent obstructions not requiring portages	2. Infrequent obstructions requiring portages	1. Frequent portages

a) Canoeing ______ c) Powerboating ______

b) S. Craft Boat. ______ d) Waterskiing ______

16.	IMMEDIATE BANK HEIGHT	5. Easy exiting throughout segment	4.	3.	2.	1. Absence of reasonable exiting locations

a) Canoeing ______ c) Powerboating ______

b) S. Craft Boat. ______

C. WATER QUALITY

17.	TURBIDITY	5. Clear	4. Cloudy	3. Turbid	2. Very Turbid	1. Muddy
18.	TEMPERATURE (average July daytime)	5. $< 60^{o}$	4. $60 - 68^{o}$	3. $68 - 78^{o}$	2. $78 - 85^{o}$	1. $> 85^{o}$
19.	MAN-PRODUCED SOLIDS ON BOTTOM (rate impact on the recreational activity groups below)	5. None of significance	4. Seldom & of little impact	3. More frequent & moderate, or infrequent & serious	2.	1. Frequent & Serious

a) Water-Contact (Total) ______ c) Aesthetics ______

b) Watercraft Contact ______

20.	MAN-PRODUCED FLOATING LIQUIDS (rate impact on the recreational activity groups below)	5. None of significance	4. Seldom & of little impact	3. More frequent & moderate, or infrequent & serious	2.	1. Frequent & Serious

a) Water-Contact (Total) ______ c) Aesthetics ______

b) Watercraft Contact ______

21.	MAN-PRODUCED FLOATING SOLIDS (rate impact on the recreational activity groups below)	5. None of significance	4. Seldom & of little impact	3. More frequent & moderate, or infrequent & serious	2.	1. Frequent & Serious

a) Water-Contact (Total) ______ c) Aesthetics ______

b) Watercraft Contact ______

22.	BACTERIOLOGICAL QUALITY (fecal coliforms)	5. Excellent Quality	4.	3.	2. Minimally acceptable	1. Unacceptable

Fig. 11.--Continued.

p. 4

		5	4	3	2	1
23.	PESTICIDES (rate impact on the recreational activity groups below)	5. None of significance	4. Seldom & of little impact	3. More frequent & moderate, or infrequent & serious	2.	1. Frequent & Serious

a) Water-Contact (Total) _______ c) Aesthetics _______

b) Watercraft Contact _______

		5	4	3	2	1
24.	CHEMICAL POLLUTANTS (rate impact on the recreational activity groups below)	5. None of significance	4. Seldom & of little impact	3. More frequent & moderate, or infrequent & serious	2.	1. Frequent & Serious

a) Water-Contact (Total) _______ c) Aesthetics _______

b) Watercraft Contact _______

		5	4	3	2	1
25.	ODOR (rate impact on the recreational activity groups below)	5. None of significance	4. Seldom & of little impact	3. More frequent & moderate, or infrequent & serious	2.	1. Frequent & Serious

a) Water-Contact (Total) _______

b) Watercraft Contact _______

c) Aesthetics _______

D. SOILS

(NOTE: In Variables 26 and 27, consider the general limitations for camping, picnicking, and other dry land recreational uses.)

		5	4	3	2	1
26.	CORRIDOR SOILS: PRIMARY	5. Negligible restrictions	4. Infrequent & minor restrictions	3. More frequent & moderate, or infrequent & serious restrictions	2.	1. Frequent & Serious restriction
27.	CORRIDOR SOILS: SECONDARY	5. Negligible restrictions	4. Infrequent & minor restrictions	3. More frequent & moderate, or infrequent & serious restrictions	2.	1. Frequent & serious restriction

E. BIOLOGICAL FACTORS

(NOTE: For Variables 28, 29, and 30, the underlying assumption is that ratings will reflect amounts of algae and waterplants which affect recreational activities.)

		5	4	3	2	1
28.	ALGAE	5. Absent	4.	3. Moderate	2.	1. Infested
29.	WATER PLANTS: SUBMERGENT	5. Absent	4.	3. Moderate	2.	1. Infested
30.	WATER PLANTS: FLOATING AND/OR EMERGENT	5. Absent	4.	3. Moderate	2.	1. Infested
31.	FAUNA: SMALL GAME	5. Abundant	4.	3.	2.	1. Absent
32.	FAUNA: LARGE GAME	5. Abundant	4.	3.	2.	1. Absent

Fig. 11.--Continued.

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33.	FAUNA: NON- GAME	5. Abundant	4.	3.	2.	1. Absent
34.	FAUNA: WATERFOWL	5. Abundant	4.	3.	2.	1. Absent
35.	FAUNA: OTHER BIRDS	5. Abundant	4.	3.	2.	1. Absent
36.	FAUNA: FISH (Warm)	5. Abundant	4.	3.	2.	1. Absent
37.	FAUNA: FISH (Cold)	5. Abundant	4.	3.	2.	1. Absent

(NOTE: Variables 38 through 43 represent the RIGHT BANK.
Variables 44 through 49 represent the LEFT BANK.)

38.	LAND FLORA: TYPE (PRIMARY)	5. Wooded	4. Trees & Brush	3. Open Grass & Trees	2. Bog, Marsh, Swamp, Brushy	1. Lawns, or Barren
39.	LAND FLORA: DENSITY (PRIMARY)	5. Dense	4.	3. Moderate	2.	1. Thin
40.	LAND FLORA: DIVERSITY (PRIMARY)	5. Great	4.	3. Moderate	2.	1. Small
41.	LAND FLORA: TYPE (SECONDARY)	5. Wooded	4. Trees & Brush	3. Open Grass & Trees	2. Bog, Marsh, Swamp, Brushy	1. Lawns, or Barren
42.	LAND FLORA: DENSITY (SECONDARY)	5. Dense	4.	3. Moderate	2.	1. Thin
43.	LAND FLORA: DIVERSITY (SECONDARY)	5. Great	4.	3. Moderate	2.	1. Small
44.	LEFT BANK ~~LAND FLORA~~: TYPE (PRIMARY)	5. Wooded	4. Trees & Brush	3. Open Grass & Trees	2. Bog, Marsh, Swamp, Brushy	1. Lawns, or Barren
45.	LEFT BANK ~~LAND FLORA~~: DENSITY (PRIMARY)	5. Dense	4.	3. Moderate	2.	1. Thin
46.	LEFT BANK ~~LAND FLORA~~: DIVERSITY (PRIMARY)	5. Great	4.	3. Moderate	2.	1. Small
47.	LEFT BANK ~~LAND FLORA~~: TYPE (SECONDARY)	5. Wooded	4. Trees & Brush	3. Open Grass & Trees	2. Bog, Marsh, Swamp, Brushy	1. Lawns, or Barren
48.	LEFT BANK ~~LAND FLORA~~: DENSITY (SECONDARY)	5. Dense	4.	3. Moderate	2.	1. Thin
49.	LEFT BANK ~~LAND FLORA~~: DIVERSITY (SECONDARY)	5. Great	4.	3. Moderate	2.	1. Small
50.	WILDFLOWERS	5. Abundant	4.	3. Moderate	2.	1. Absent

Fig. 11.--Continued.

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F. LAND USE

(NOTE: Variables 51 and 52 represent the RIGHT BANK.
Variables 53 and 54 represent the LEFT BANK.)

51.	ADJACENT LAND USE: PRIMARY	5. Natural Area	4. Mixed natural area and agriculture, or vacant	3. Primarily agriculture	2. Extractive Resources	1. Urban/ Suburban (Human structures)
52.	ADJACENT LAND USE: SECONDARY	5. Natural Area	4. Mixed natural area and agriculture, or vacant	3. Primarily agriculture	2. Extractive Resources	1. Urban/ Suburban (Human structures)
53.	LEFT BANK ~~ADJACENT~~ LAND USE (PRIMARY)	5. Natural Area	4. Mixed natural area and agriculture, or vacant	3. Primarily Agriculture	2. Extractive Resources	1. Urban/ Suburban (Human structures)
54.	LEFT BANK ~~ADJACENT~~ LAND USE (SECONDARY)	5. Natural Area	4. Mixed natural area and agriculture, or vacant	3. Primarily agriculture	2. Extractive Resources	1. Urban/ Suburban (Human structures)
55.	HISTORIC SITES OR FEATURES	5. Many	4.	3. Few	2.	1. None
56.	PUBLIC LAND OWNERSHIP	5. 90-100%	4. 75-90%	3. 50-75%	2. 25-50%	1. 0-25%

G. AESTHETICS

57.	ARTIFICAL CONTROLS (impact on recreation activities rated below according to this scale)*	5. None	4. Minimal	3.	2.	1. Substantial

a) Wild. Canoeing	____	g) Nature Study	____	m) Driving for Pleasure	____
b) General Canoeing	____	h) Hiking	____	n) Bank Fishing	____
c) Small Craft Boat.	____	i) Picnicking	____	o) Boat Fishing	____
d) Powerboating	____	j) Canoe Camping	____	p) Hunting	____
e) Swimming	____	k) Trail Camping	____		
f) Waterskiing	____	l) Vehicle Camping	____		

*SPACE FOR NOTES:

Rip-Rap	________	Walls	________
Channelization	________	Dams	________
Groins	________	Other	________

Fig. 11.--Continued.

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		5	4	3	2	1
58.	DETRIMENTAL VALUES OF BUILDINGS (impact on recreation activities rated according to this scale)*	5. None	4. Minimal	3.	2.	1. Substantial

a) Wild. Canoeing ____
b) General Canoeing ____
c) Small Craft Boat. ____
d) Powerboating ____
e) Swimming ____
f) Waterskiing ____
g) Nature Study ____
h) Hiking ____
i) Picnicking ____
j) Canoe Camping ____
k) Trail Camping ____
l) Vehicle Camping ____
m) Driving for Pleasure ____
n) Bank Fishing ____
o) Boat Fishing ____
p) Hunting ____

*SPACE FOR NOTES:

	# of	Impact on River Environment
Residential	____	____
Trailers	____	____
Farmsteads	____	____
Schools(Instit.)	____	____
Commercial	____	____
Industrial	____	____
____	____	____
____	____	____

		5	4	3	2	1
59.	TRASH & LITTER (river bank & flat)	5. Infrequent & negligible	4. Seldom occuring & of little impact	3. More frequent & moderate, or infrequent & serious	2.	1. Frequent & Serious
60.	UTILITIES' CROSSINGS (e.g. electric transmission, telephone)	5. None	4. Seldom occuring	3. Infrequent	2. Moderately occuring	1. Frequent
61.	OTHER DETRIMENTAL VALUES* (not covered in above)	5. None	4. Seldom & of little impact	3. More frequent & moderate, or infrequent & serious	2.	1. Frequent & Serious

*Indicate type(s) of detrimental values rated above:

____

____

		5	4	3	2	1
62.	SCENIC VARIETY	5. Diverse Views	4.	3. Limited Views	2.	1. Monotonous
63.	VIEW CONFINEMENT	5. Open, no confinement	4.	3. Occasional Confinement	2.	1. Closed by hills, cliffs, or trees
64.	APPARENT BEAUTY	5. Outstanding	4.	3. Pleasant	2.	1. Monotone, Dull
65.	UNIQUE FEATURES (scenes, structures, geologic formations, etc.)	5. One of a Kind	4. Unique to North America	3. Unique to state	2. Unique to this river	1. None

Fig. 11.--Continued.

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66.	REMOTENESS (% of total length of main channel greater than one-quarter mile from a road or human habitation)	5. 80-100%	4. 60-80%	3. 40-60%	2. 20-40%	1. 0-20%

H. ACCESSIBILITY

67.	ACCESSIBILITY (rate, considering the information below and from Form #2, according to this scale)	5. Accessibility is appropriate	4.	3. Accessibility is difficult or inadequate	2.	1. Accessibility is excessive

a)	Wild. Canoeing	____*	g)	Nature Study	____	m)	Driving for Pleasure	____
b)	General Canoeing	____*	h)	Hiking	____*	n)	Bank Fishing	____
c)	Small Craft Boat.	____*	i)	Picnicking	____	o)	Boat Fishing	____*
d)	Powerboating	____*	j)	Canoe Camping	____*	p)	Hunting	____
e)	Swimming	____	k)	Trail Camping	____*			
f)	Waterskiing	____*	l)	Vehicle Camping	____			

(NOTE: * denotes that accessibility rating for recreational activity has been derived from Form #2 which considers the segment within a larger five segment unit. Unmarked activities' accessibilities are rated for the present segment alone.)

	# of Bridges	Presence of Parellel Roads 0-300'	300'-1/4 mi.	# of Access Points
Trails	____	____	____	____
4WD	____	____	____	____
2WD	____	____	____	____
CTY	____	____	____	____
MTR	____	____	____	____
RR	____	____	____	

(4WD- roads passable only with four-wheel drive equipped vehicles.
2WD- roads passable with standard automobile; usually good dirt, gravel.
CTY- very good gravel surface and paved surface roads; generally well used; county type roads.
MTR- major tourist road; freeways, divided four lanes, state highways, U.S. routes.)

Fig. 11.--Continued.

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FAUNA OBSERVED OR SIGNS OF:

		# Observed	Signs
WATERFOWL		____	____
BIRDS OF PREY		____	____
KINGFISHER		____	____
PERCHING BIRDS		____	____
OTTER		____	____
OTHER MAMMALS (specify)	____________	____	____
	____________	____	____
	____________	____	____
	____________	____	____
FISH (type)	____________	____	____
	____________	____	____
	____________	____	____
	____________	____	____

FLORA OBSERVED (Most Abundant Species)

TREES ____________________________

____

SHRUBS ____________________________

____

HERBS ____________________________

____

ADDITIONAL COMMENTS:

Fig. 11.--Continued.

Form # 2

RIVER RECREATION POTENTIAL ASSESSMENT PROJECT:
ACCESSIBILITY RATINGS

River Name:______________ River Number:__________ Segment Number:______

State:______________ County:______________ Township:______________

Evaluator(s):____

INSTRUCTIONS: (1) Accessibility data is collected for each segment or river. This data is recorded on page eight (8) of Field Inventory Form #1 and in part two (2) of this form. This data is then used for estimating the appropriateness of access for each of the sixteen recreational activities in each segment.

(2) This form is to be used only for certain activities: hiking, wilderness canoeing, general canoeing, small craft boating, powerboating, waterskiing, canoe camping, trail camping, and boat fishing. For other activities, only use Variable 67 on Form #1.

(3) Accessibility, for the activities listed in (2) above, is considered for larger units than individual one mile segments. Here accessibility is rated for five segments, an accessibility unit. An accessibility unit is composed of two segments upstream from the "to-be-rated" segment, and two segments downstream, creating a total of five segments. Accessibility data is also required for two segments upstream from the upstream terminus of the length of river subject to evaluation, and two segments downstream from the downstream terminus of the length of river. This data is recorded in part two of this form.

(4) With placement of the "to-be-rated" segment in the middle of a five segment sequence, accessibility can be rated more accurately for these activities which involve movement along the river corridor, i.e. sets the individual segment in the perspective that it is only one part of a larger unit since access is not limited to just the one mile segment. The rating for each segment within its five mile accessibility unit is transferred to Form #1 Variable 67.

I. ACCESSIBILITY UNIT ASSIGNMENTS

(NOTE: Record segments assigned to the accessibility unit in which the present segment is being rated.)

Accessibility Unit Sequence Number:________ Segments:____ ____ ____ ____ ____

II. SUPPLEMENTARY ACCESSIBILITY EVALUATION SEGMENTS

(NOTE: As stated in Inst. 3 , these tables should be used to record information for supplementary upstream or downstream segments. The furthest upstream segment shall be referred to as "A", while the segment adjacent to the upstream terminus will be "B". The adjacent downstream supplementary segment shall be referred to as "C", with the furthest downstream being "D". Circle the appropriate labels.)

1. UPSTREAM/DOWNSTREAM SEGMENT A/B/C/D:

	# of Bridges	Presence of Parellel Routes 0-300'	Presence of Parellel Routes 300'-1 mi.	# of Access Points
Trails				
4WD				
2WD				
CTY				
MTR				
RR				

Fig. 12.--Accessibility Ratings, Form #2.

p. 2

2. UPSTREAM/DOWNSTREAM SEGMENT A/B/C/D:

	# of Bridges	Presence of Parellel Routes 0-300'	Presence of Parellel Routes 300'-½ mi.	# of Access Points
Trails				
4WD				
2WD				
CTY				
MTR				
RR				

(NOTE: 4WD - roads passable only with four-wheel drive equipped vehicles.
2WD - roads passable with standard automobile; usually good dirt, gravel.
CTY - very good gravel surface and paved surface roads; generally well used; county type roads.
MTR - major tourist road; freeways, divided four lanes, state highways, U.S. routes.)

III. ACCESSIBILITY RATINGS

(NOTE: Rate accessibility for each activity designated according to the following scale:)

67. ACCESSIBILITY	5. Accessibility is appropriate	4.	3. Accessibility is difficult or inadequate	2.	1. Accessibility is excessive

a) Wilderness Canoeing	______	h) Hiking	______
b) General Canoeing	______	j) Canoe Camping	______
c) Small Craft Boat.	______	k) Trail Camping	______
d) Powerboating	______	o) Boat Fishing	______
f) Waterskiing	______		

ADDITIONAL COMMENTS:

Fig. 12.--Continued.

RIVER RECREATION POTENTIAL ASSESSMENT PROJECT: SEGMENT-ACTIVITY SCORE WORKSHEET Form # 3

ACTIVITY: ____________________

River Name [ ] River Number [ ] Segment Number [ ]

SIGNIFICANT VARIABLES	RAW VARIABLE VALUES	TRANSFORMATION TABLE NUMBER	TRANSFORMED VALUE	WEIGHT	SEGMENT-VARIABLE SCORE	VARIABLE GROUP SUBTOTALS
						Basic Physical
						Special Physical
						Water Quality
						Soils
						Biolog-ical

SIGNIFICANT VARIABLES	RAW VARIABLE VALUES	TRANSFORMATION TABLE NUMBER	TRANSFORMED VALUE	WEIGHT	SEGMENT-VARIABLE SCORE	VARIABLE GROUP SUBTOTALS
						Land Use
						Aesthetic
						Accessi-bility

TOTAL SEGMENT POINTS (A) [ ] TOTAL POSSIBLE POINTS (B) [ ] SEGMENT-ACTIVITY SCORE (A / B) [ ]

Fig. 13.--Segment-Activity Score Worksheet, Form #3.

FORM # 4

TABLE OF WEIGHTS AND TRANSFORMATION INDEX

X = Not Significant; Weight 5/11 = Weight / Transformation Table (See Form # 5); 3 = Weight without Transformation Table

VARIABLES \ ACTIVITIES	WILD. CANOEING	GENERAL CANOEING	SM. CRAFT BOAT	POWER-BOATING	SWIMMING	WATER-SKIING	NATURE STUDY	HIKING	PICNICKING	CANOE CAMPING	TRAIL CAMPING	VEHICLE CAMPING	DRIVING PLEASURE	BANK FISHING	BOAT FISHING	HUNTING
1. WIDTH OF RIVER	X	1	2	3	2	3	X	1	1	X	1	2	2	2	2	X
2. SITE DEVELOP. POTEN.	X	X	X	1	2	2	X	X	3	3	3	3	X	X	X	X
3. APP. STREAM VELOCITY	2/13	3/15	3/7	3/7	4/25	4/7	X	2	2	3/15	2	2	2	3/20	3/7	X
4. FLOATABILITY	5/2	5/2	5/2	5/2	X	5/2	X	X	X	5/2	X	X	X	X	5/2	X
5. FLOW FLUCTUATION	3	3	3	3	3	3	X	1	3	3	1	1	1	3	3	X
6. MONTHS OF WATER FLOW	2	2	2	2	2	2	1	2	1	2	2	2	1	2	2	X
7. STREAM BED MATERIAL	2	2	2	1	2	2	1	2	2	2	2	2	2	3	3	1
8. DOMINANT RIVER PATTERN	3/12	3/12	X	X	X	X	X	X	X	X	X	X	X	X	X	X
9. WATER SURFACE PATTERN	3	3	2	1	2	2	1	3	3	3	3	3	3	3	3	1
10. BANK EROSION	1	1	1	1	1	1	1	2	2	2	2	1	X	3	3	1
11. ACREAGE OF PONDS	1	1	3	3	2	3	X	X	X	1	X	X	X	3	3	X
12. SANDY BEACHES	X	X	X	X	3	1	X	X	X	1	1	1	X	X	X	X
13. OXBOW LAKES AND BAY.	X	X	1	X	X	X	2	X	X	X	X	X	X	X	2	2
14.a. ISLANDS un. ½ ac.	1	1	1	1	1	X	1	X	1	1	1	X	1	1	1	1
14.b. ISLANDS ½ - 2 ac.	1	1	1	1	1	X	1	X	1	2	1	X	1	1	1	1
14.c. ISLANDS 2 - 5 ac.	1	1	1	1	2	X	1	X	2	2	2	1	1	1	1	1
14.d. ISLANDS 5 - 10 ac.	1	1	1	1	2	X	1	X	2	2	2	1	1	1	1	1
14.e. ISLANDS ov. 10 ac.	1	1	1	1	2	X	1	X	2	2	2	2	1	1	1	1
15. NAVIGAT. OBSTRUCT.	2	4	4	4	X	4	X	X	X	2	X	X	X	X	3	X
16. IMMED. BANK HEIGHT	2	2	2	2	3	3	1	X	X	2	X	X	X	2	2	X
17. TURBIDITY	3	3	3	2	5	5	2	2	2	3	2	2	2	5	5	X
18. TEMPERATURE	X	X	X	X	5/16	5/16	X	X	X	X	X	X	X	5/22	5/22	X
19. SOLIDS ON BOTTOM	2	2	2	2	5/11	5/11	2	2	1	1	2	1	1	5	5	X
20. FLOATING LIQUIDS	4	5	5	5	5/11	5/11	4	4	3	5	4	4	4	5	5	3
21. FLOATING SOLIDS	4	5	5	5	5/11	5/11	4	4	3	5	4	4	4	5	5	3
22. BACTER. QUALITY	1	1	1	1	5/2	5/2	1	X	1	1	X	X	X	5	5	1
23. PESTICIDES	4	4	4	4	5/11	5/11	5	3	3	4	3	4	X	5	5	5
24. CHEMICAL POLLUT.	4	4	4	4	5/11	5/11	5	3	3	4	3	4	X	5	5	5
25. ODOR	5	5	5	5	5/11	5/11	5	5	5	5	5	5	5	5	5	5
26. SOILS: PRIMARY	X	X	X	X	3	X	X	4	5	5	5	5	X	4	X	5
27. SOILS: SECONDARY	X	X	X	X	3	X	X	4	5	5	5	5	X	4	X	5

Fig. 14.--Table of Weights and Transformation Index, Form #4.

VARIABLES \ ACTIVITIES	WILD. CANOEING	GENERAL CANOEING	SM. CRAFT BOAT	POWER-BOATING	SWIMMING	WATER-SKIING	NATURE STUDY	HIKING	PICNICKING	CANOE CAMPING	TRAIL CAMPING	VEHICLE CAMPING	DRIVING PLEASURE	BANK FISHING	BOAT FISHING	HUNTING
28. ALGAE	1/1	1/1	1/1	1/1	5/3	5/3	1	1	1	1/1	1	1	1	3	3	X
29. WATER PLANTS: Sub.	2/1	2/1	2/1	2/1	5/3	5/3	1	1	1	2/1	1	1	1	3	3	X
30. WATER PLANTS: F/E	2/1	2/1	2/1	2/1	5/3	5/3	1	1	2	2/1	1	2	1	3	3	2
31. SMALL GAME	1	1	1	1	X	X	3	2	X	1	1	1	1	X	X	9
32. LARGE GAME	1	1	1	1	X	X	3	2	X	1	1	1	1	X	X	9
33. NON-GAME	1	1	1	1	X	X	3	2	X	1	1	1	1	X	X	5
34. WATERFOWL	1	1	1	1	X	X	3	2	X	1	1	1	1	1	1	9
35. OTHER BIRDS	1	1	1	1	X	X	3	2	X	1	1	1	1	1	1	5
36. FISH (Warm Water)	1	1	1	1	X	X	3	1	X	1	1	1	1	9	9	X
37. FISH (Cold Water)	1	1	1	1	X	X	3	1	X	1	1	1	1	9	9	X
38. LAND FLORA: TYPE PRIMARY	3/4	3/8	3/8	3/8	2/9	2/18	3/4	5	3/10	3/10	3/10	3/10	3	3	3	3/22
39. LAND FLORA: DENSITY (P)	1/13	X	X	X	X	X	X	2/5	1/5	1/5	1/5	1/5	X	1	X	X
40. LAND FLORA: DIVER. (P)	2	2	2	1	1	X	2	2	2	2	2	2	2	X	X	2
41. LAND FLORA: TYPE SECONDARY	3/4	3/8	3/8	3/8	2/9	2/18	3/4	5	3/10	3/10	3/10	3/10	3	3	3	3/22
42. LAND FLORA: DENSITY (S)	1/13	X	X	X	X	X	X	1	1/5	1/5	1/20	1/20	X	1	X	X
43. LAND FLORA: DIVER. (S)	2	2	2	1	1	X	2	2	2	2	2	2	2	X	X	2
44. LEFT BANK: PRIMARY LAND FLORA: TYPE	3/4	3/8	3/8	3/8	2/9	2/18	3/4	5	3/10	3/10	3/10	3/10	3	3	3	3/22
45. LEFT BANK: PRIMARY LAND FLORA: DENSITY	1/13	X	X	X	X	X	X	2/5	1/5	1/5	1/5	1/5	X	1	X	X
46. LEFT BANK: PRIMARY LAND FLORA: DIVER.	2	2	2	1	1	X	2	2	2	2	2	2	2	X	X	2
47. LEFT BANK: SECONDARY LAND FLORA: TYPE	3/4	3/8	3/8	3/8	2/9	2/18	3/4	5	3/10	3/10	3/10	3/10	3	3	3	3/22
48. LEFT BANK: SECONDARY LAND FLORA: DENSITY	1/13	X	X	X	X	X	X	1	1/5	1/5	1/20	1/20	X	1	X	X
49. LEFT BANK: SECONDARY LAND FLORA: DIVER.	2	2	2	1	1	X	2	2	2	2	2	2	2	X	X	2
50. WILDFLOWERS	2	2	2	1	X	X	3	2	2	2	2	2	1	X	X	X
51. LAND USE: PRIMARY	5/3	4	4	3	2/26	2/9	5/19	5/27	4/10	5/6	5/6	5/6	4	4	3	5/23
52. LAND USE: SECONDARY	5/3	4	4	2	1	1	5/19	5/27	4/10	5/6	5/6	5/6	4	3	2	5/23
53. (LEFT BANK) LAND USE: PRIMARY	5/3	4	4	3	2/26	2/9	5/19	5/27	4/10	5/6	5/6	5/6	4	4	3	5/23
54. (LEFT BANK) LAND USE: SECONDARY	5/3	4	4	2	1	1	5/19	5/27	4/10	5/6	5/6	5/6	4	3	2	5/23
55. HISTORIC SITES	1	2	2	2	X	X	X	1	2	1	1	2	2	X	X	X
56. PUBLIC LAND OWNER.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
57. ARTIFICAL CONTROLS	4	2	2	1	1	1	1	1	1	3	2	1	1	1	1	1
58. DETRIMENTAL VALUES OF BUILDINGS	3	2	2	1	1	1	2	2	2	3	3	2	2	2	2	3
59. TRASH & LITTER	3/2	2	2	2	1	1	2	2	2	3	3	2	2	2	2	2
60. UTILITY CROSSINGS	3/2	2	2	1	1	1	1	2	2	3	3	2	1	1	1	1
61. OTHER DETRIMENTAL VALUES	3	2	2	1	1	1	1	2	2	3	3	2	2	2	2	2

Fig. 14.--Continued.

VARIABLES \ ACTIVITIES	WILD. CANOEING	GENERAL CANOEING	SM. CRAFT BOAT.	POWER-BOATING	SWIMMING	WATER-SKIING	NATURE STUDY	HIKING	PICNICKING	CANOE CAMPING	TRAIL CAMPING	VEHICLE CAMPING	DRIVING PLEASURE	BANK FISHING	BOAT FISHING	HUNTING
62. SCENIC VARIETY	3	3	3	2	2	1	2	3	3	3	3	3	3	3	3	X
63. VIEW CONFINEMENT	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
64. APPARENT BEAUTY	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
65. UNIQUE FEATURES	1	2	2	1	1	X	1	1	2	1	1	2	2	X	X	X
66. REMOTENESS	5	2	2	1	X	X	4	3	X	3	3	X	X	X	X	5
67. ACCESSIBILITY	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Fig. 14.--Continued.

RIVER RECREATION POTENTIAL ASSESSMENT PROJECT : TRANSFORMATION TABLES

Form # 5

NOTE: (1) These tables are used in conjunction with the segment-activity worksheet, or the table of weights and transformation table index.

(2) The user takes the raw variable value (RAW VALUE), locates that value on the appropriate table (as indicated on the worksheet, or index sheet), and reads the transformed value (TRANSF. VALUE). This new value is then used in subsequent calculations.

(3) If a note appears on the table which reads CANCEL, this indicates that the activity automatically receives a score of zero (0), and that no further calculations should be undertaken.

1

RAW VALUE	TRANSF. VALUE	NOTE
4 5	5	
	4	
3	3	
2	2	
1	1	

2

RAW VALUE	TRANSF. VALUE	NOTE
5	5	
4	4	
3	3	
2	2	
1	1	CANCEL

3

RAW VALUE	TRANSF. VALUE	NOTE
5	5	
4	4	
	3	
3	2	
1 2	1	CANCEL

4

RAW VALUE	TRANSF. VALUE	NOTE
2 3 4 5	5	
	4	
	3	
	2	
1	1	

5

RAW VALUE	TRANSF. VALUE	NOTE
1	5	
2	4	
3	3	
4	2	
5	1	

6

RAW VALUE	TRANSF. VALUE	NOTE
4 5	5	
	4	
3	3	
1	2	
2	1	

7

RAW VALUE	TRANSF. VALUE	NOTE
1 2 3	5	
	4	
4	3	
	2	
5	1	CANCEL

8

RAW VALUE	TRANSF. VALUE	NOTE
3 4 5	5	
2	4	
1	3	
	2	
	1	

9

RAW VALUE	TRANSF. VALUE	NOTE
1 3 4 5	5	
	4	
2	3	
	2	
	1	

10

RAW VALUE	TRANSF. VALUE	NOTE
4 5	5	
3	4	
	3	
1	2	
2	1	

11

RAW VALUE	TRANSF. VALUE	NOTE
5	5	
	4	
4	3	
	2	
1 2 3	1	CANCEL

12

RAW VALUE	TRANSF. VALUE	NOTE
2 3 4 5	5	
1	4	
	3	
	2	
	1	

13

RAW VALUE	TRANSF. VALUE	NOTE
2 3 4	5	
1	4	
	3	
	2	
5	1	CANCEL

14

RAW VALUE	TRANSF. VALUE	NOTE
5	5	
1 2 3 4	4	
	3	
	2	
	1	

15

RAW VALUE	TRANSF. VALUE	NOTE
2 3	5	
1 4	4	
	3	
	2	
5	1	CANCEL

16

RAW VALUE	TRANSF. VALUE	NOTE
2 3	5	
1 4	4	
	3	
	2	
5	1	

17

RAW VALUE	TRANSF. VALUE	NOTE
2	5	
1 3	4	
4	3	
5	2	
	1	

18

RAW VALUE	TRANSF. VALUE	NOTE
1 3 4 5	5	
2	4	
	3	
	2	
	1	

19

RAW VALUE	TRANSF. VALUE	NOTE
4 5	5	
3	4	
	3	
2	2	
1	1•	CANCEL

20

RAW VALUE	TRANSF. VALUE	NOTE
2 3 4	5	
1 5	4	
	3	
	2	
	1	

21

RAW VALUE	TRANSF. VALUE	NOTE
1 2 3	5	
	4	
4	3	
	2	
5	1	

22

RAW VALUE	TRANSF. VALUE	NOTE
2 3 4 5	5	
	4	
	3	
	2	
1	1	CANCEL

23

RAW VALUE	TRANSF. VALUE	NOTE
3 4 5	5	
	4	
2	3	
	2	
1	1•	CANCEL

24

RAW VALUE	TRANSF. VALUE	NOTE
5	5	
4	4	
3	3	
	2	
1 2	1	

25

RAW VALUE	TRANSF. VALUE	NOTE
2 3	5	
1	4	
4	3	
	2	
5	1	CANCEL

26

RAW VALUE	TRANSF. VALUE	NOTE
1 3 4 5	5	
	4	
	3	
2	2	
	1	

27

RAW VALUE	TRANSF. VALUE	NOTE
4 5	5	
	4	
3	3	
2	2	
1	1•	CANCEL

• For variables 51-54 under hiking, nature study, and hunting, ALL four variables in a segment must read CANCEL in order to score the segment zero (0) for these activities.

Fig. 15.--Transformation Tables, Form #5.