WRC RESEARCH REPORT NO. 23

THE IDENTIFICATION AND CRITICAL ANALYSIS OF SELECTED LITERATURE DEALING WITH THE RECREATIONAL ASPECTS OF WATER RESOURCES USE, PLANNING, AND DEVELOPMENT

Robert B. Ditton
Department of Recreation and Park Administration
University of Illinois

F I N A L   R E P O R T

Project No. A-025-ILL

Principal Investigator - Edward H. Storey
Professor of Recreation and Park Administration
University of Illinois

The work upon which this publication is based was supported by funds provided by the U.S. Department of the Interior as authorized under the Water Resources Research Act of 1964, P.L. 88-379
Agreement No. 14-01-0001-1081 and 1632

UNIVERSITY OF ILLINOIS
WATER RESOURCES CENTER
3220 Civil Engineering Building
Urbana, Illinois 61801

ABSTRACT

THE IDENTIFICATION AND CRITICAL ANALYSIS OF SELECTED LITERATURE
DEALING WITH THE RECREATIONAL ASPECTS OF WATER RESOURCES
USE, PLANNING AND DEVELOPMENT

The literature dealing with the recreational aspects of water is fragmented to such a degree that it presents a weak foundation for future research. Therefore, this study integrates and summarizes the existing interdisciplinary body of knowledge dealing with recreation and water. Over one thousand pertinent articles and publications were identified, fully documented, and classified according to keyword descriptors. A computerized bibliographic retrieval routine was developed to enable an investigator to receive, automatically, using keyword inputs, those bibliographic notations that are pertinent to his request. Bibliographic retrieval was accomplished through the IBM System/360. Using this retrieval system to assemble bibliographies by topic, this research project surveyed and critically analyzed research findings and their implications for water recreation planning and development. The narrative critical analysis of pertinent literature is organized within five broad areas: (1) The water resource, (2) Water resource recreation planning, (3) User-resource planning considerations, (4) Factors inhibiting the recreational use of water resources, and (5) Maintaining water quality for recreational use. In citing gaps in existing methods and knowledge, this critical analysis forms the bibliographic foundation for a programatic identification of interdisciplinary recreation-water resources research needs. These research needs are grouped according to: (1) The water resource, (2) User-resource planning, (3) Water quality maintenance for recreational use. An extensive interdisciplinary water recreation planning and development bibliography is included in this report.

Ditton, Robert B.
THE IDENTIFICATION AND CRITICAL ANALYSIS OF SELECTED LITERATURE DEALING WITH THE RECREATIONAL ASPECTS OF WATER RESOURCES USE, PLANNING AND DEVELOPMENT
Research Report to Office of Water Resources Research, Department of the Interior, July 1969, Washington, D.C., 292 p.
KEYWORDS--recreation/recreation demand/water quality/ attitudes/behavior/planning/hydrology/legal aspects/water quality control/water pollution effects/research and development/reviews/bibliographies/documentation/information retrieval

ACKNOWLEDGMENT

Appreciation is expressed to the several graduate students who helped identify, review, and classify the one thousand publications included in the bibliographic retrieval system. They include: Bruce Rogers, Elizabeth Stradley, Robert Ivins, and Robert Aukerman. Tony Nestor deserves special recognition for his loyalty and hardwork.

Special thanks are extended to the members of my doctoral committee for their ideas and critical evaluation: Dr. A. W. Booth, Department of Geography; Prof. L. F. Blair, Department of Urban Planning; Dr. B. W. Carss, Department of Secondary and Continuing Education; Dr. H. E. Weaver, Department of Recreation and Park Administration; Dr. E. H. Storey, Department of Recreation and Park Administration; and Dr. A. V. Sapora, Department of Recreation and Park Administration.

This writer is deeply indebted to Dr. E. H. Storey, presently with the University of Wisconsin at Green Bay, for his ability to secure funds for this two-year research project from the University of Illinois Water Resources Center. His inspiration and guidance during my doctoral program is greatly appreciated.

The work upon which this publication is based was supported in part by funds provided by the United States Department of the Interior as authorized under the Water Resources Research Act of 1964, Public Law 88-379.

A very special thank you to my wife, Penny, for her continuous love, confidence, and support. And McGuffy, too.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

CHAPTER I

INTRODUCTION

Water and life are inseparable. More than three quarters of the earth's surface is water. Seventy percent of the human body is water, and a loss of just fifteen percent of this body fluid means death. Water and the outdoor recreation experience are almost as inseparable. The Outdoor Recreation Resources Review Commission's National Recreation Survey reported that "44 percent of the population prefer water-based recreation activities over any others."[1]

Water is used generally in two non-consumptive ways for recreation. First, it is the medium in which or on which recreation experiences such as swimming, boating, water skiing, and fishing take place. Second, water is an esthetic complement to land-based recreation activities such as camping, picnicking, walking for pleasure, and the like.

These resource uses were quantified by the Bureau of Outdoor Recreation (B.O.R.) in Outdoor Recreation Trends, 1965.[2] Swimming is currently the second most popular summer outdoor recreation activity in America. This report also predicts that swimming occasions will increase 149 percent by 1980 and will rank as the number one outdoor recreation activity.[3] Fishing occasions numbered 322 million in 1965 for persons twelve years and older and a 78 percent increase in

---

[1]U.S., Outdoor Recreation Resources Review Commission, Outdoor Recreation for America (Washington, D.C.: U.S. Government Printing Office, 1962), p. 173.

[2]U.S., Bureau of Outdoor Recreation, Outdoor Recreation Trends (Washington, D.C.: U.S. Government Printing Office, 1965).

[3]Ibid., p. 14.

fishing occasions is predicted.[4] Boating activity ranked as the tenth most popular summer outdoor recreation activity in 1965. Boating occasions are expected to increase 215 percent by the year 2000.[5]

Satisfaction of this potential demand for water-based recreation will rely heavily on the quantity, quality, and accessibility of all water resources. Projected swimming, boating, and fishing occasions cannot continue to increase independently of the following constraints: (1) impairment of water quality, (2) lack of accessibility to the water resource, and (3) conflicts of both use and economic interest. These constraints as well as the following questions are related to the recreational use and development of water, and they all need to be examined and analyzed:

1) How is the hydrologic cycle (exchange of water between the earth and the atmosphere) related to the recreational use of water?
2) What is the geographical distribution and current availability of our water resources for recreational use?
3) Can resource-user groups be identified and their recreation requirements related to the potential water resource base?
4) What are the basic ecological considerations involved in the user-water resource relationship?

If potential demand is to be realized, questions such as these must be examined, and the answers must be integrated within a body of knowledge pertaining to the recreational aspects of water resources use, planning, and development.

The major policy issues facing outdoor recreation in the future will be more complex than the ones we experience at present. The current focus on land and water acquisition for recreational use will be enlarged to one of making

---

[4] _Ibid._, p. 16.

[5] _Ibid._, p. 17.

wiser use of our resource base and the maintenance of the quality of outdoor experiences. Ecological considerations will be a vital concern in resource planning and management. Human attitudes and behavior patterns will receive more attention in relating users and resources. Marion Clawson speaks of the solution of future policy issues:

> These policy issues are primarily economic, social, governmental not technological nor concerning resource availability. Some of the latter kinds of problems do indeed exist, but in our judgment they are not the critical ones. These human problems grow partly out of the changing volume and nature of the outdoor recreation demand; they also arise in part because they have had little attention in the past. Such issues, when they have arisen, have tended to be debated on an emotional and preconceptual basis; social science research has generally not been brought to bear upon their solution.[6]

The solution of these higher order problems requires objective and logical study based on the pertinent knowledge currently available. Before further research can be brought to bear, our present body of knowledge must be identified, summarized and analyzed. This three-part process is a prerequisite to the development of a comprehensive research program dealing with the recreational aspects of water resources.

This writer's collaborative study is based on the belief that knowledge within a discipline will only progress to the degree that investigators build on the work already done by other people.

The development of a selected literature survey and partial bibliography was a preliminary step to the planning of the overall design of the Outdoor Recreation Resources Review Commission (O.R.R.R.C.) study reports.

> . . . it was decided that such a survey would provide an outline of the subject areas pertinent to outdoor recreation, would indicate those which have been treated and would describe the types of material available. An agreement was developed with the Library of Congress for this purpose.[7]

---

[6] M. Clawson, Land and Water for Recreation (Chicago: Rand McNally and Company, 1963), p. 144.

[7] U.S., Outdoor Recreation Resources Review Commission, Outdoor Recreation Literature: A Survey (Washington, D.C.: U.S. Government Printing Office, 1962), p. 2.

> . . . the three goals of this survey were to (1) assess and describe the amount and quality of the available literature, showing areas of strength or weakness; (2) point out or indicate, from available evidence, the most apparently useful writings; and (3) identify, if possible, those writings, types, or categories of literature concerned with special or significant problems in outdoor recreation.[8]

Since the 1962 Report of the Outdoor Recreation Resources Review Commission, there has been a veritable "explosion" of outdoor recreation literature and research. Identification, classification, summarization, and analysis are required if this literary production is to continue to be meaningful. While this requirement pertains to all aspects and specializations within the recreation field, this writer will deal only with literature pertaining to the recreational aspects of water resources use, planning, and development.

Statement of the Problem

It is the purpose of this study to critically analyze in a narrative form the body of knowledge dealing with the recreational aspects of water resources use, planning, and development. For clarification purposes, the tasks involved in this problem have been divided into divisional parts or sub-problems to represent the homogeneous components of the problem and to illuminate the task of primary focus. These sub-problems are:

1) to identify, locate, manually retrieve, document, and classify according to keywords selected literature pertaining to the recreational aspects of water resources use, planning, and development;
2) to adapt an existing IBM/360 computerized document processing system to permit bibliographical retrieval according to assigned keyword descriptors; and
3) to develop a topical outline model of the body of knowledge dealing with the recreational aspects of water resources use, planning, and

---

[8] Ibid., p. 1.

development to provide a framework for the critical analysis of the selected literature.

Narrative analysis will be organized according to the model described in number 3 above. Sub-problems 1, 2, and 3 are steps leading to the realization of the critical analysis of the body of knowledge.

Need for the Study

There have been numerous writing and research efforts by professionals outside the recreation field. These make up a substantial part of the existing body of knowledge that must be analyzed. The development of water resources depends on an interdisciplinary approach. Future resource policy decisions will rely heavily on the comprehensive nature of this knowledge. To assemble a body of knowledge on recreational aspects of water resources, it is imperative that the literature of all related disciplines be reviewed, analyzed, and summarized. The interdisciplinary nature of water resources research reveals that scientific, legal, economic, sociological, psychological, technological, ethical, and ecological considerations are involved in problems of natural resources management.

One cannot write about the recreational aspects of water resources if he intends to remain within the confines of a single discipline. The field of outdoor recreation is an amorphous, heterogeneous entity that is more problem- than discipline-oriented. It is extremely broad in scope and cuts across many disciplines better recognized than that of outdoor recreation. The problem-orientation is responsible for attracting professionals and stimulating scholarly writings from numerous disciplines.

There is considerable evidence in current water resources- and outdoor recreation research bibliographies as well as references found in current books, periodicals, and research studies to support the hypothesis that there is an unidentified body of knowledge on the recreational aspects of water resources existing in a fragmentary state. The O.R.R.R.C.'s Water for Recreation--Values and Opportunities is the only completed study of this body of knowledge.

At present the literature is fragmented to such a degree that it presents a weak foundation for future research efforts dealing with the recreational aspects of water resources. To fill the gaps in our body of knowledge, we must know what the gaps are. This study is intended to integrate and summarize the existing interdisciplinary body of knowledge, thus providing a stable and realistic foundation for future research efforts.

Scope and Limitations

Goals

The three goals of this collaborative study are to:

1) identify, classify, summarize, and analyze the literature pertaining to the recreational aspects of water resources use, planning, and development;
2) reveal areas of weakness and strength in the body of knowledge;
3) identify research needs within the body of knowledge pertaining to the recreational aspects of water resources in order to fulfill content and methodology deficiencies.

Inclusion-Exclusion Criteria for Literature Review

Content Criteria

1) Each piece of literature must specifically mention both the terms "outdoor recreation" or "recreation" and "water" or "water resources" to be termed pertinent and be included. Selected literature may be included which does not meet this criterion but which may have implication value in developing this body of knowledge. When such literature is reviewed

and included, it will be noted that such literature does not meet the criterion for inclusion but has implications for recreational use, planning, and development.

2) All studies pertaining to water fowl, game fish, animals, and birds could be included as water resource-oriented recreation literature because their primary use ultimately would presumably be for outdoor recreation. These will not be reviewed, except to the degree that they pertain to recreational use, planning, and development.

3) There is an enormous body of information, both basic and applied, that deals with water as a natural resource. Most of this literature has come from the biological and physical sciences. Only that knowledge pertinent to the recreational use and development of water resources will be reviewed. For example, the formulation and pure study of water quality standards will be reviewed only to the degree that they pertain to recreational use and development. Hydrologic factors will only be reviewed if they apply directly to and affect outdoor recreation.

4) Publications and studies dealing with the administration, organization, and staffing requirements of water resources agencies, such as river basin commissions, interstate compacts, or water pollution districts, will not be included or reviewed.

5) The vastness and geographical variance involved in water-use law place such an investigation beyond the scope of this study. Only those publications dealing with water-use law as it is directly related to the recreational use and development of water resources will be identified, summarized and analyzed. Legal implications are beyond the scope of this study.

6) Pieces of literature dealing expressly with water-based activities (e.g., swimming techniques, boating tips, sport fishing rates, etc.),

programs, or supervision will be systematically excluded. Literature which involves the relationship between the recreation activity and the resource base will be included.

7) Pieces of literature must have been written after January 1, 1960, for inclusion. Selected writings which do not meet this writing date criterion will be reviewed and included because of their definitive nature.

8) State outdoor recreation plans will generally be excluded unless viewed as innovative in content and approach by a consensus of project staff members. This criterion has been established because of the repetitive nature of these state outdoor recreation plans. The concept of state-wide planning can be illustrated with limited review and inclusion of state outdoor recreation plans (up to 10 plans).

9) Local site development plans will likewise be included on a limited basis (up to 10 plans) to illustrate the methods and techniques involved in site planning.

Quality Criteria

1) Pieces of literature will not be excluded on the basis of methodology and/or techniques used. Decisions to exclude because of methodology and/or techniques used would be based strictly on the opinion, biases, and/or educational background of the reviewer, and hence such an inclusion-exclusion criterion will be avoided. Between study variations in results, methodologies, and techniques will be illustrated but not evaluated.

2) Summaries, abstracts of discussions of research projects found in annual reports will not be reviewed in lieu of retrieving the full research work.

3) Articles found in professional and/or technical journals will be reviewed for inclusion-exclusion purposes while articles found in both non-technical and popular magazines will be systematically excluded.
4) Pieces of literature will not be systematically included or excluded on the basis of the status of the author or place of authorship.
5) Pieces of literature judged by a consensus of project staff members as being "too general" or "non-specific" will be systematically excluded from this system even if pertinent in content.

CHAPTER II

REVIEW OF RELATED LITERATURE

This review of related literature deals with the collaborative methodology to be used in establishing a basic body of knowledge pertaining to the recreational use, planning, and development of water resources.

In 1962, a Bibliography of Research Related to Recreation was compiled and published by the National Recreation Association. This 1962 bibliography and a 1965 supplement list more than thirteen hundred theses and dissertations dealing with all aspects of recreation. Neither of these bibliographic efforts attempt to classify, summarize, and analyze the existing body of knowledge.

The only previously completed study pertaining to the body of knowledge to be analyzed is Water for Recreation - Values and Opportunities.[1] Because of the current literature "explosion" and focus upon water resources and outdoor recreation, this volume has become dated and ineffective as a base for research efforts.

The Index for the Literature of Leisure, Recreation, Parks and Other Recreation Resources authored by Sapora and Vance[2] in 1965 sought to obtain bibliographical control of the literature pertaining to leisure, recreation, and parks, as well as the literature contributed by a vast number of related disciplines. Sapora and Vance state:

---

[1] U.S., Outdoor Recreation Resources Review Commission, Water for Recreation--Values and Opportunities (Washington, D.C.: U.S. Government Printing Office, 1962).

[2] A. V. Sapora and M. Vance, Index to the Literature of Leisure, Recreation, Parks, and Other Recreation Resources (New York: National Recreation Association, 1965).

> Bibliographical control in this instance means systematic identification and listing of literature, organized in a manner harmonious to the field of leisure, recreation and parks. Since one of the basic procedures of the scientist is to build upon work previously done, knowing what information is available thus contributes immeasurably to progress in any discipline. The need is now urgent to (1) develop a systematic way to recover from related fields information which has significant implications for leisure, parks, and recreation, and (2) develop techniques to organize this information so that it may be effectively used by and disseminated to interested individuals and groups.[3]

This index classified books, parts of books, magazine articles, government publications, pamphlets, serials, and other special publications according to Library of Congress headings, so the researcher can build upon work previously done. The Index to the Literature of Leisure, Recreation, Parks, and Other Recreation Resources was strictly a tool for classification, and it did not include any analysis of the content of the literature. It was intended as a model for a proposed quarterly index to the literature.

In an article entitled "Research in the Recreation Resource Field in the Universities and State Experiment Stations," Graves[4] used seven subject categories within which resource recreation research could be catalogued. They are as follows:

1) Technological research within the resource subject fields
2) Research concerning resource use and activity
3) Research into durability and carrying capacity
4) Research concerned with integration and allocation of resource use
5) Studies in resource operation and development
6) Studies relating to public-private resource relationship
7) Case studies and wilderness research.

---

[3] Ibid., p. 5.

[4] P. F. Graves, "Research in the Resource Recreation Field in the Universities and State Experiment Stations," Proceedings of National Conference on Outdoor Recreation Research (Ann Arbor, Michigan: School of Natural Resources, University of Michigan and Bureau of Outdoor Recreation, Department of the Interior, 1963), pp. 57-69.

Current and completed research studies dealing with the recreational use of the resource base were discussed in regard to status and methodologies used. Graves does not present a survey or summary of existing or recently completed works but rather a status report of research activity on university campuses.

> The approach taken here to this topic of research in the resource-recreation field is that of identifying and evaluating where we are and what is going on, at the universities and state experiment stations, in terms of relatively broad subject categories or kinds of research actively being pursued.[5]

The focus of this classification in so far as subject matter is consistent with that of this writer:

> Resource recreation is interpreted here as including those aspects of outdoor recreation where the natural resource is a primary or dominant consideration of recreational use. Such outdoor recreation is resource-based or resource-oriented. Research in resource recreation includes those projects aimed primarily at adjustments of the resource to serve outdoor recreational use and also those projects aimed at new knowledge in natural resource subject fields where a part of the objective relates to recreational use or impact.[6]

To the best knowledge of this writer, this fragmented body of knowledge pertaining to the recreational aspects of water resource use, planning, and development has nowhere been completely assembled, classified, critically analyzed, and used as a logical basis for the direction of future research efforts.

---

[5] Ibid., p. 58.

[6] Ibid., p. 57.

CHAPTER III

METHODOLOGY

During the academic year 1967-68 an intensive manual retrieval of literature pertinent to the recreational aspects of water resources was accomplished. Pertinent pieces of literature were identified, examined, and thoroughly documented. Using a modified version of the Thesaurus of Outdoor Recreation Terms originally prepared by the Bureau of Outdoor Recreation, these bibliographic documentations were assigned keyword descriptors. This keyword assignment process establishes a framework or order to the literature.

A computerized bibliographic retrieval process has been utilized through which this investigator receives automatically, using keyword inputs, those bibliographic notations that are pertinent to his request. This bibliographic retrieval process is accomplished through the IBM System/360 Document Processing System. For a comprehensive explanation of the computerized bibliographic retrieval system, refer to Appendix A, pp. 253-257. With a bibliography available by keyword, the investigator is then required to retrieve manually the actual pieces of literature prior to his collaborative summarization and critical analyses of the literature.

In this document the collaborative method[1] is used to summarize and analyze the literature classified automatically according to particular keyword subject areas. This method assembles by topic pieces of literature providing insight into philosophical concepts and scientific results of research by investigators

---

[1]T. K. Cureton, "Perspective on Methodology Related to Selecting a Problem and Planning Its Solution," Research Methods Applied to Health, Physical Education and Recreation (Washington, D.C.: American Association of Health, Physical Education, and Recreation, 1952), p. 45.

in allied research-based fields. Because of the vast nature of interrelationships involved in the study of recreational aspects of water resources, a survey and narrative analysis of the most apparent relationships involved would be a valuable contribution to establishing the interdisciplinary foundations of water-recreation planning and development.

An outline model or framework of the body of knowledge dealing with the recreational aspects of water resources planning and development was constructed prior to analysis to insure meaningful and concise analysis. This outline model is as follows:

CHAPTER IV. The Water Resource

A. Introduction

B. The Hydrologic Cycle and Recreational Use

1. The hydrologic cycle

a) components

2. The land surface

a) percolation

b) runoff

c) watershed concept

3. Man--a new geologic force

a) affects of human activities on water quantity and quality

C. Uses of Water

1. Withdrawal, non-withdrawal, and consumptive water uses.

D. Water Requirements for Recreational Use

1. Introduction to water quality criteria

2. Water quantity requirements

E. Water-Use Law

1. Introduction

a) prediction for a given population

b) prediction of site consumption

c) prediction of area-wide participation

(1) regression analysis

3. Variables affecting recreation participation and site consumption

a) socio-economic variables

b) environmental variables

C. The Recreation Resource Supply

1. Resource inventory

2. Relating supply and demand

3. Supply in terms of carrying capacity

a) carrying capacity defined

b) carrying capacity standards

c) carrying capacity inconsistencies

4. Recreation potential and regional analyses

a) introduction

b) appraisal methods to determine recreation potential (rating systems)

c) regional analysis techniques

D. Summary

CHAPTER VII. Factors Inhibiting the Recreational Use of Water Resources

A. Introduction

B. Conflicting Project Purposes

1. Water level fluctuation and recreational use

2. Domestic water supply and recreational use

C. Pollutants and Their Inhibiting Effects on Recreation

1. Pollution defined

2. Pollution classified

   a) municipal

   b) industrial

   c) other

3. Municipal wastes: implications for recreation

   a) increased amounts of nutrients

   b) oxygen-consuming organic matter

   c) suspended solids

   d) pathogenic bacteria

4. Industrial wastes: implications for recreation

   a) chemical pollution

   b) thermal pollution

   c) acid mine drainage

   d) oil discharges

   e) commercial watercraft wastes

   f) radioactive wastes

   g) agricultural runoff

   h) pesticides

5. Other wastes

D. Summary

CHAPTER VIII. Maintaining Water Quality for Recreational Use

A. Introduction

B. Water Quality Requirements for Recreational Use

1. Criteria and standards defined

2. Indicator organisms and pathogenic bacteria

3. Water quality criteria

C. Methods of Maintaining Water Quality

1. Introduction

CHAPTER IV

THE WATER RESOURCE

Introduction

It is the intention of this chapter to discuss within the framework of existing literature, hydrologic phenomena, multiple-uses of water, water quality and quantity requirements, and public and private rights to use water. Each of these topics will be considered in developing the body of knowledge pertaining to the recreational aspects of water resource use, planning, and development. Documentary support will be included for this body of knowledge. For example, the hydrologic cycle will be broken down into its component parts. Those parts which affect the availability of sufficient amounts of quality water for recreational use will be discussed. The critical task is to identify the principal water cycle components and to determine the degree of affect each component has on the provision of recreation opportunities. Man is recognized as a force capable of controlling and/or affecting the availability and quality of water with both positive and negative results. This control requires that there are or should be quantitative water quality and quantity requirements for recreational use. While the use of water quality requirements has already been sanctioned by the Federal government, water quantity requirements for each water-based recreation experience have received little, if any, attention. To demonstrate a need for such requirements within a multi-purpose planning framework, it is necessary to identify the existing literature and review the problems involved.

The legal aspects of water use are discussed in this chapter. Public and private water-use rights will be compared within both the riparian rights and prior appropriation doctrines. This comparison is intended to illustrate the origin, nature, and extent of public and private water-use rights in selected regions of the United States.

The Hydrologic Cycle and Recreational Use

The Hydrologic Cycle

The hydrologic cycle involves the continuous circulation of water from earth to atmosphere. Thus hydrology[1] is the study or knowledge of water. The basic elements of the hydrologic cycle are illustrated by Leopold and Langbein,[2] King,[3] Osborne and Harrison,[4] and Bates[5] while Rechard and McQuisten[6] provide a multidisciplinary glossary of selected hydrologic terms. Our discussion of the hydrologic cycle is presented in layman's terms to promote understanding of the water quality and quantity problems facing recreational development and use of water. No attempt is made to present a definitive work on the technical aspects of hydrology due to a primary concern with the establishment of ecological relationships affecting recreational use.

---

[1]"The applied science concerned with the waters of the earth--their occurrences, distribution, and circulation through the unending hydrologic cycle of: precipitation, consequent runoff, infiltration and storage; eventual evaporation; and reprecipitation. It is concerned with the physical and chemical reaction of water with the rest of the earth, and its relation to the life of the earth." P. A. Rechard and R. McQuisten, Glossary of Selected Hydrologic Terms (Laramie, Wyoming: Water Resources Research Institute, University of Wyoming, 1968), p. 22.

[2]U.S., Geological Survey, A Primer on Water (Washington, D.C.: Department of the Interior, 1960), pp. 3-29.

[3]T. King, Water: Miracle of Nature (New York: The Macmillan Company, 1953).

[4]B. Osborn and P. O. Harrison, "Water...and the Land" (Washington, D.C.: Soil Conservation Service, United States Department of Agriculture, 1965).

[5]M. Bates, The Forest and the Sea (New York: Random House, 1960), pp. 77-82.

[6]Rechard and McQuisten, p. 22.

It is apparent after a thorough examination of the literature that the natural relationship between the hydrologic cycle and the recreational use of water is virtually undocumented. The relationship has apparently received little attention because: (1) the post-World War II recreation boom was primarily related to socio-economic determinants such as available leisure time, more disposable income, and an increasing population with higher mobility;[7] and (2) arbitrary discipline designations have assigned hydrological activities to the domain of the hydrologist and the engineer.

The continual exchange of water between the earth and the atmosphere is accomplished by the heat of the sun and gravitational force. With the energy provided by the sun, water evaporates from the wet ground, from the leaves of plants, and from the existing open water bodies and is carried into the atmosphere as water vapor. "Transpiration from plants is one of the important sources of water vapor in the air and often produces more vapor than does evaporation from land surface, lakes and streams."[8]

Since the water stored in the lakes and rivers tends to evaporate in direct proportion to the size of the water body, there is considerable concern for minimizing the increased evaporation caused by impoundment. The Utah Water Research Laboratory[9] has undertaken research on the aerial application of evaporation-reducing, monolayer-forming materials to large lakes and reservoirs. They make recommendations concerning equipment design, application rates, altitude of flight, and the like but fail to deal with the effects of

---

[7]M. Clawson, Land and Water for Recreation (Chicago, Illinois: Rand McNally and Company, 1963), pp. 1-12.

[8]U.S., Geological Survey, A Primer on Water, p. 5.

[9]Utah, Water Research Laboratory, Equipment and Techniques for Aerial Application of Evaporation--Reducing Monolayer--Forming Materials to Lakes and Reservoirs (Logan, Utah: Water Research Laboratory, Utah State University, 1964).

recreational use on the evaporation-retarding film or vice versa. Badger[10] notes that wind, as well as boats and other water-oriented recreation activities may break up the evaporation retarding film. Also, the film causes the water to become warmer and this may be detrimental to some species of fish.

The oceans, however, are still the most important source of moisture in the air. After being carried into the atmosphere, the water vapor is heated and caused to rise, cooling as it rises to levels where condensation of moisture occurs. If cooling is sufficient and enough nuclei are available, the vapor condenses and falls as rain.

To efficiently use water for recreation as well as other beneficial uses, man is dependent upon his knowledge of the hydrologic cycle and further, his ability to capture and/or regulate the movements of water. Water is migratory in that it moves from one location to another when acted upon by gravitational forces and temperature gradients. Without this knowledge and ability to capture and/or regulate water, recreation resource planning has little control over quantity and quality, thereby greatly diminishing recreation potential.

The Land Surface

Water which fails to evaporate or percolate into the ground runs off the land, eroding and transporting materials into the streams and rivers. Several environmental factors influenced by man determine the extent of both groundwater infiltration and surfacewater runoff. While large amounts of surface runoff increase the amount of water available in the stream, it is doubtful that much of the water is of sufficient quality to be usable for recreational use due to

---

[10] D. D. Badger, "Recreational Aspects of Upstream Reservoirs," Agricultural Engineering Paper No. AE6620, Paper presented at the 16th Annual Meeting of the Oklahoma Section, American Society of Agricultural Engineers, October 28, 1966.

turbidity. Gleason[11] describes some indicators for determining whether or not soil erosion has been accelerated, but he notes that sedimentation surveys of reservoirs are probably the most accurate means of measuring erosion activity of an entire watershed over a period of years. While part of the groundwater is held in the soil and used by vegetation or evaporated, the rest percolates downward into aquifers. This groundwater emerges as springs or seepages to augment the flowing surface systems of streams and rivers. Often the flow of these streams is blocked by contours of the land, to create ponds and lakes, where water is held until it overflows.[12]

The importance of the land and its use or misuse is implicit in a discussion of hydrological implications for recreation's water quality and quantity requirements. Up to now water has been considered separate from its environment. Water, however, is only one element in a complex environment which encompasses soil, animals, vegetation, and humans. Storer[13] relates the interdependance of man and his environment in his book entitled The Web of Life. The effects of windstorms, overpopulations of pests, forest fires, open agricultural land, improper lumbering and farming methods, and waste discharges are all endured by humans downstream since they depend upon the water for drinking, recreation, and navigation. In dealing with the recreational aspects of water resources use, an understanding of the hydrologic cycle and the ecological relationships involved is vital. These interdependent relationships include: (1) man's effects on and use of the physical environment, (2) environmental effects on man, and (3) effects of human populations on humans. To plan for the recreational use of

---

[11] C. H. Gleason, "Indicators of Erosion on Watershed Land in California," Transactions, American Geophysical Union, 34(3) (1953), 419-426.

[12] Bates, pp. 77-82.

[13] J. H. Storer, The Web of Life (New York: Devin-Adair Company, 1953).

water without considering the interdependencies of the physical environment and man is not to plan at all. Current environmental conditions dictate that recreation resource planners must look beyond the mere surface storage and flow stages of water. The implications of ecological relationships are pertinent in light of the current water resource development policy of the U.S. Army Corps of Engineers and the Department of Agriculture's Soil Conservation Service (S.C.S.). While the S.C.S. is concerned with conservation of small watersheds together with the development of detention reservoirs, the Corps of Engineers is not authorized to deal with watershed problems on its water development projects. The Corps of Engineers considers water as an individual resource and while taking measures to control floods and sedimentation, it fails to deal with the watershed sources of these problems. Such a lack of authorization may provide water quality and quantity of limited usefulness in creating opportunities for water-based outdoor recreation.

The character of the soil and the growth it supports have a marked influence on the quality and quantity of water contributed by a watershed. These two influences determine if precipitation is to be absorbed as groundwater capable of sustaining high quality waterbodies in the watershed, or to rapidly run off the surface of the land causing soil erosion, sedimentation, flooding, and turbidity. While surface runoff contributes the greater portion of the water in waterbodies, this runoff is rapidly leaving waterbodies unsustained during drought conditions.

Land area is divided up into drainage area units in which water resources can be described, measured, controlled, or developed. Previously, considerable confusion has resulted from the interchangeable use of the terms "watershed" and "river basin," but such interchangeable use is nevertheless correct. Each stream or river receives water from an area of land that slopes downward toward the channel or body of that water resource. Divides or ridges surround each watershed and act to separate one drainage area from another. The total character of the water resource at any specific location is a product of the interaction of all factors affecting it.

Man--A New Geologic Force

The water resource is not only a result of the underlying geologic structure but, moreover, an outcome of the human activities which modify the quality, quantity, or the movement of water.[14] In discussing the damage which man has inflicted upon his environmental life sources, Osborn[15] considers him to be a new geologic force. In a review of related literature, Newhall and Smith[16] show that watershed management activities have a significant influence upon timing of water delivery, upon sedimentation, and total water yield.

Human activities such as lumbering,[17] agriculture, and roadbuilding,[18] affect the hydrologic cycle negatively. In contrast, degradation of water quality or decreases in water quantity may occur as a result of environmental imbalance as described by Storer.[19] Precipitation may fall on virgin forests, clear-cut or selectively-cut lumber areas, grazing lands, or cultivated fields

---

[14] S. O. Denslow, "Spatial Aspects of Water Resource Problems in the Saginaw River Basin: A Case Study" (unpublished Ph.D. dissertation, Michigan State University, East Lansing, Michigan, 1966), p. 58.

[15] F. Osborn, Our Plundered Planet (New York: Little, Brown, and Company, 1948), pp. 37-48.

[16] G. N. Newhall and J. L. Smith, Watershed Management: Effects on Basin Development, presented at ASCE Billings Conference of Irrigation and Drainage Division, October 7, 1965 (Washington, D.C.: U.S. Forest Service, Department of Agriculture, 1965), pp. 47-65.

[17] J. Rothacher, "Influence of Forest Management Practices," reprinted from Water and Environmental Quality (Corvallis, Oregon: Water Resources Research Institute Seminar, Oregon State University, 1967).

[18] P. E. Packer and H. F. Haupt, "The Influence of Roads on Water Quality Characteristics," reprinted from The Proceedings, Society of American Foresters (Washington, D.C.: U.S. Forest Service, 1965).

[19] Storer, pp. 65-67.

with varying results. When rain falls upon a woodland forest's canopy, much of the water evaporates before reaching the soil; the remainder is absorbed into the soil to supply the roots and leaves of the trees and to be stored as groundwater. There is very little surfacewater runoff from a forest watershed, and there are restrictions on groundwater infiltration because of the excessive water demands of the forest vegetation. Grassland areas respond in a similar fashion although canopy interception and transpiration are not as great as in a forest watershed. When a forest is cut-over or burned or grassland is overgrazed by herbivores, optimum conditions are disturbed. When the vegetative cover is destroyed, the soil is bared to hydrologic forces causing soil compaction which results in minimum groundwater infiltration and excessive surface runoff, more frequent flooding, and sustained low-flow periods during the dry weather.[20] Recently foresters have again begun to recommend clearcutting of timber even though this practice has always been associated with increased erosion and turbid streamflow. The following demonstrates the deleterious nature of clearcutting:

> A maximum turbidity of 56,000 ppm was measured after a commercial clearcutting on one of the watersheds while progressively lighter cuts yielded less and less turbidity. Before the logging of these watersheds, streamflow was pure and clear; turbidities were less than 5 ppm (the drinking water standard is less than 11 ppm) except during a few severe storms.[21]

Hornbeck states that erosion is not only due to the amount of timber cut but is also affected by the care taken and methods used in logging. The cultivation of the land involves the removal of grass and other vegetation followed by seasonal plantings and harvests leaving the soil open to the beating impact of precipitation. The result is accelerated surface runoff characterized by movement of

---

[20] Storer, pp. 64-65.

[21] J. Hornbeck, "Clear Cutting and the Erosion Hazard," reprinted from the Northern Logger and Timber Processer (October, 1967), n.p.

topsoil, depletion of soil fertility, and the clogging of streams with silt. Agricultural activities likewise contribute to water quality reduction through the transport of inorganic pesticides, nutrient-rich fertilizers, and animal fecal material in the runoff waters. These pollutants and the manner in which they inhibit the recreational use of water will be discussed more fully in Chapter VII. When a stream is filled with silt and other debris carried by surfacewater, its storage capacity is diminished, creating the likelihood of flooding conditions. These flood conditions further perpetuate erosion and sedimentation downstream.

The effects of various land uses on two extremes of the hydrologic cycle, peak flows during storms and low flows during dry periods, are investigated by Johnson.[22] His paper does not present detailed information on the effect of each land use because this information is as yet not comprehensive.

> Excessive use by domestic livestock, big game, and people may cause compaction and thereby decrease soil permeability, increase erosion, create gullies, and adversely alter the timing of local storm peaks. However, we lack adequate knowledge on the impact of properly managed grazing on storm peaks by kind of vegetation, topography and soil type.[23]

As a geographer, Denslow focuses on man's use of a water resource within the confines of a watershed region and examines their interrelationships as they exist in space. He concludes that each identifiable subregion within the watershed has a distinctive relationship to existing water resource problems as a result of land utilization. For example, recreation uses are concentrated in upstream areas of the basin which would indicate that downstream land uses are incompatible with and act to restrict water recreation use and development.

---

[22] E. A. Johnson, "Effects of Multiple Use on Peak Flows and Low Flows," reprinted from the International Symposium on Forest Hydrology, Proceedings of a National Science Foundation Advanced Science Seminar held at Pennsylvania State University, August 29-September 10, 1965.

[23] Ibid., p. 548.

> . . . the geographic method provides an effective means to approach the total spatial relationships of a water resource which is an important component of the geography of a region. The correlation between physical and cultural factors under the examination of a phenomenon such as water also provides a means of identifying areas where future conflicts in resource utilization can be anticipated.[24]

Many of these future conflicts in water resource utilization will result from man's continuing misuse of watershed lands and/or his subsequent failure to employ watershed management or conservation concepts. While all vegetation and soil resources cannot be fully preserved, watershed management programs based upon multiple-use can provide for the optimum yield of water of desired quality with the control of erosion, pollution, and floods.[25]

Uses of Water

Water has economic values which both require it to be withdrawn as well as non-withdrawn from a water resource. Among the non-withdrawal uses are navigation, waste disposal, power generation, recreation, flood control, and wildlife conservation. Municipal and industrial water supply and irrigation are the most demanding withdrawal uses of water. While the potential supply of water after evapo-transpiration remains virtually constant, needs for human use pyramid with the rapidly growing population:

> From 1900 to 1950, while our population doubled, total water use, other than for power increased fourfold. Average daily use for all purposes increased from 600 gallons per capita in 1900 to 1,100 in 1950. By 1960 per capita water use had increased to 1,500 gallons.[26]

Unfortunately, many of the increasing uses are withdrawal or consumptive, making them incompatible with recreational use. While withdrawal uses may

---

[24] Denslow, p. 5.

[25] U.S., Department of Health, Education, and Welfare, Environmental Health Practice in Recreational Areas (Washington, D.C.: U.S. Government Printing Office, 1966), p. 10.

[26] Osborn and Harrison, p. 2.

degrade the quality of the water, consumptive use decreases the quantity of water available for recreational use.

Recreational use of water has been well documented by the O.R.R.R.C.[27] The Commission's National Recreation Survey reports that 44 percent of the population prefer water-based recreation activities over any others.[28] According to the B.O.R., swimming is currently the second most popular summer outdoor recreation activity in America.[29] Outdoor Recreation Trends, 1965[30] predicts future demand for each of the water-based recreation activities.

In its use, water can also be consumed or lost to the atmosphere as vapor restricting further immediate use by man. The main consumptive use of water is irrigation where some 40 percent of the water delivered is returned to surface streams by runoff or to the groundwater supply by percolation. The remainder is taken up by crops or lost to the atmosphere by evapo-transpiration.[31]

The generation of hydro-electric power and reservoir recreation are generally thought of as non-consumptive uses of water. However, this is not strictly true as water is lost through increased evaporation from the impounded water area. The use of water for cooling is also considered consumptive due to evaporation losses. A significant form of consumptive use occurs when "water is discharged

---

[27] U.S., Outdoor Recreation Resources Review Commission, Water for Recreation-Values and Opportunities (Washington, D.C.: U.S. Government Printing Office, 1962).

[28] U.S., Outdoor Recreation Resources Review Commission, Outdoor Recreation for America (Washington, D.C.: U.S. Government Printing Office, 1962), p. 173.

[29] U.S., Bureau of Outdoor Recreation, Outdoor Recreation Trends (Washington, D.C.: U.S. Government Printing Office, 1965), p. 14.

[30] Ibid.

[31] U.S., Department of Agriculture, Water--The Yearbook of Agriculture--1955 (Washington, D.C.: U.S. Government Printing Office, 1955), p. 344.

into brackish estuaries where re-use is generally not feasible."[32] The latter "consumptive use" deals with consumption of water quality rather than consumption of quantity. It is further based on the idea that any significant degradation of water quality reduces the amount of usable water available, much like the process of evaporation.

The multiple-purpose uses of water impose varying non-withdrawal, withdrawal, and consumptive pressures on recreational use which may be restrictive, if the water requirements for recreational use are unknown or not sanctioned.

Water Requirements for Recreational Use

The recreational use of water demands certain levels of water quantity and water quality. Unfortunately, the need for these levels has not made a substantial impact on the water resource planning process. Except for establishing chemical, physical, and biological water quality requirements, very little has been accomplished in quantifying any water requirements for recreational use. Research is imperative in order to establish standards which can be implemented and enforced by the appropriate governmental agencies. Water quality requirements have received far more attention than water quantity requirements for recreation because of the Federal government's major concern with pollution control. The Federal Water Pollution Control Administration[33] (F.W.P.C.A.) has established quantitative biological, turbidity, pH, and temperature criteria for direct body contact and indirect body contact recreational uses. They have also established general esthetic criteria with limited value.

---

[32]Maryland University, Water Resources Study Committee, Water Resources Management in Maryland (College Park, Maryland: University of Maryland, 1966), p. 5.

[33]U.S., Federal Water Pollution Control Administration, Report of the National Technical Advisory Committee on Water Quality Criteria to the Secretary of the Interior (Washington, D.C.: U.S. Government Printing Office, 1968), pp. 7-14.

Except for biological criteria established to restrict water-borne diseases of epidemic proportions, no quality requirements have been established to minimize eye, ear, nose, and throat infections and gastrointestinal illness resulting from body contact activities. These individual health conditions related to recreational use have largely gone unnoticed because of their seeming minor nature and the inconclusive research designs that were used by investigators. Therefore, there are three different kinds of water quality requirements for recreational use that exist in varying degrees: (1) established biological, turbidity, pH, and temperature criteria, (2) criteria to minimize individual health conditions are suggested in the literature but are currently non-existent, and (3) esthetic criteria have been established by the National Technical Advisory Committee on Water Quality, but their value is in doubt because they have not been quantified. Without numerical indexes related to levels of human acceptance of specific esthetic conditions, these criteria cannot be implemented. The different kinds of criteria together with the problems and existing gaps in information will be discussed in detail in Chapter VIII.

It has been suggested that the reason why we have relatively weak and arbitrary standards established for recreational use is that if it were otherwise, the number of existing and potential water recreation sites available for water-based recreation use would be greatly minimized. This obvious misuse of the multiple-use concept is used conversely to illustrate the fact that in decreasing the quality of water, the quantity of water usable for recreational use is also diminished. However, in using the minimum quality critiera currently established, it is generally impossible to say that water degradation will diminish the quantity of water available for recreational use. Besides impoundment, the quantity of water available for recreation can be increased by more adequate wastewater treatment permitting re-use. Wastewater treatment involves the reduction of harmful and unstable elements in wastewater, allowing it to be discharged into a receiving water without impairing water uses such as recreation. Water re-use has undergone considerable investigation as a means of balancing the demand for water with the available supply.[34] Wastewater treatment processes have been designed to provide increased high quality water for downstream users and more specifically, high quality water for swimming use.

Since a wide variety of water resources are needed to support recreation activities, the quantity and timing of water available must meet specific requirements to support a particular activity. While the existence of water quantity requirements for recreation activities has been acknowledged in the literature,[35] they have neither been developed nor officially sanctioned by any particular planning agency. Irrigationists use the term "duty of water" to describe the amount of water withdrawn to support a certain amount of agricultural activity. The O.R.R.R.C. extends the usual connotation of the term beyond irrigation to recreational use.[36] However, unlike irrigation, recreation is not a withdrawal or consumptive use and is required to share water with other uses. The term "duty of water" acknowledges the existence of water quantity requirements based on the amount, extent, distribution, and quality needed for producing a selected recreation opportunity:

> The duty of water for recreational purposes has more than one aspect. For certain kinds of uses (i.e. sailboating), the

---

[34] Los Angeles, Department of County Engineer, Final Report, Waste Water Reclamation Project for Antelope Valley Area (Los Angeles, California: County of Los Angeles, 1968), pp. 85-89.

U.S., Federal Pollution Control Administration, Santee Recreation Project, Final Report, WP-20-7 (Cincinnati, Ohio: Federal Water Pollution Control Administration, 1967).

[35] U.S., Outdoor Recreation Resources Review Commission, Water for Recreation--Values and Opportunities, pp. 11-12.

[36] Ibid., p. 11.

> principal requirement is one of distribution in space of the water resource; for another type of use it may be distribution in time which is most important (e.g. white water canoeing). In still a third type of use, (e.g. swimming) the principal requirement may be one of water quality.[37]

Previous investigations focus on methods for determining the recreational potential of a particular site on watershed area.[38] In determining potential, one must be aware of water quantity and quality requirements necessary for supporting certain activities. Without such criteria, potential is vague and divorced from recreation behavior patterns. Particular sites, by nature of the quantity or quality of water available, are better suited to one recreational use over another. The propriety of a recreational use is one aspect which many users may consider in assessing the quality of their recreation experience. Specific quantity requirements for water-oriented recreation activities require further investigation and identification to insure indigenous water recreation planning. To date they have received little attention aside from the casual discussion in the O.R.R.R.C.'s Water for Recreation--Values and Opportunities.

Water-Use Law

Introduction

Many of the complexities associated with recreational use of water arise from the fact that this use is often shared with other uses. If the recreational aspects of water use were confined simply to the accommodation of activities such as swimming, boating, and fishing, problems to be solved by planning would be easily reconciled. Unfortunately, the problems of water

---

[37] Ibid., p. 11.

[38] U.S., Soil Conservation Service, "Guide to Making Appraisals of Potentials for Outdoor Recreation Developments" (Washington, D.C.: U.S. Department of Agriculture, 1966).

J. A. Dearinger, Esthetic and Recreational Potential of Small Naturalistic Streams Near Urban Areas (Lexington, Kentucky: Water Resources Institute, University of Kentucky, 1968).

resource availability are compounded by the riparian rights of the adjacent land owner and other legal requirements prerequisite to public use. Many water resources are not available for recreational use because shorelines are privately owned and public access is lacking. Legality of access and use is therefore of major concern when reviewing the number of waterbodies usable for recreation. As an increased amount of shoreline becomes private property, the need arises to give the public power over the use of riparian property to the extent of allowing access to the water. This would provide the public with an opportunity to use the water as the law permits them to do. This access must be accomplished by fee simple purchase, condemnation, or access easements since each riparian has exclusive control over his own shorelands for access purposes, even to public water.

There is an incompatibility between recreation and other multiple-purpose uses,[39] which is sustained by current water quality criteria. Dilution and disposal of wastes severely restrict the chemical, physical, biological, and esthetic acceptability of waters for recreation; yet these are legitimate uses of water when kept within reasonable limits. The test of "reasonable use" is employed to control these uses.

Further, laws pertaining to water are principally concerned with three factors: (1) power to control the use of water, (2) the locus of this power within the hierarchy of government, and (3) the uses to be allowed. Water-use law recognizes the interests and rights of non-riparians as well as riparians. In response to traditional restrictions on public water-use rights, Waite feels that equity in the law is achieved:

---

[39] F. O. Sargent, "Multiple Use and Water Law," Proceedings of the Water Rights Law Conference (Boston, Massachusetts: New England Council of Water Center Directors, 1966), pp. 87-96.

> By forcing individual claimants of water to press their claims on the merits of the particular uses desired to be made, rather than by reliance on tradition, custom, or precedent . . . .[40]

To restrict recreational use of water to shoreline ownership would be an inequity in the law.

Public Water Rights

Uses of water allowed non-riparians and persons generally are usually referred to as public rights[41] to use water. When waters are navigable and hence public or have been declared public by statutory law, non-riparians may use the entire surface of these waters for recreation. In a four-state (Minnesota, Wisconsin, Indiana, and Ohio) comparative analysis, Waite[42] focuses on uses generally included within public rights, namely, navigation and fishing, either commercial or recreational, and other recreational activities such as swimming, waterskiing, ice fishing, and ice boating. In some states this group includes hunting, trapping, and esthetic enjoyment.

While there is considerable variation among states in protecting non-riparian uses of watercourses, the traditional method employed by the courts is to declare these uses to be non-riparian property rights. Similarly, legislatures may use their police power to declare watercourses within state control and open to non-riparian uses.

Waite points out that the law has been slow in imposing limitations on individual water uses available to non-riparians:

---

[40] G. G. Waite, A Four State Comparative Analysis of Public Rights in Water (Madison, Wisconsin: Department of Law, University Extension, University of Wisconsin, 1967), p. 3.

[41] O. E. Delogu, "Comments on Public Water Use Rights," Proceeding of the Water Rights Law Conference (Boston, Massachusetts: New England Council of Water Center Directors, 1966), pp. 34-43.

[42] Waite, A Four State Comparative Analysis of Public Rights in Water, pp. 1-21.

> This is true largely because, until recently, the inherent conflicts existing between these uses had not come to light. But with rising intensity of use, the need for limitation becomes apparent, since real conflicts do exist among them.[43]

These conflicts occur between recreation and other water uses, as well as among the various recreation activities. With increasing pressure of recreationists on waterbodies, it is apparent that for safety reasons, some restraints must be placed on the common right of water use. Two general approaches to this problem are practical: (1) governmental restraints through activity zoning, speed zones, and similar regulations and (2) common law restraints imposed through the law of trespass, riparian rights, and nuisance. It is unfortunate that historically neither county or state government have accepted responsibility for regulating public use. Common law, therefore, provides the principal alternative. Research is lacking on how best to legally control excessive or abusive public use of waterbodies.

Non-local demands to make certain uses of water may also interfere with the rights of people living at the site of proposed use:

> For example, residents of Portland may desire to canoe the Allagash River in its wilderness state, while owners of Allagash shorelands may desire to engage in logging operations, which would impair the wilderness environment of the river, and persons residing in northeastern Maine may desire to have the river dammed for power generation, which damming might eliminate both competing uses by inundating the river and its shores.[44]

Accommodation of these conflicting demands from different regions of a state would seem to be most effectively handled at the state government level by planning and implementation of a plan through appropriate use of police power. The concept of multiple-use requires a river basin approach to water resource law. "Nothing rational and nothing productive can come from studying sectors

---

[43] Ibid., p. 6.

[44] G. G. Waite, "Public Rights in Maine Waters," reprinted from Maine Law Review (1965), 201.

of streams and disregarding other sectors."[45]

Generally, public rights may be exercised on navigable waters, even though this cannot be assumed. Several states fail to agree on what waters can be considered navigable. The test of navigability takes two alternative forms based on interpretation: (1) navigability means actual use or susceptibility to use for navigation for commercial purposes and (2) navigability means the ability to float any boat, skiff, or canoe of the shallowest draft used for recreational purposes. The former interpretation greatly restricts non-riparian recreational use of many streams or lakes, even though waterbodies are entirely suitable for recreational activities; while the latter test permits public use even where the public cannot or may not wish to exercise their rights, for example, a lake completely surrounded by private land or a heavily polluted stream.

The broad definition of navigability and consequential public rights lay the basis for a state's interest in pollution abatement or in providing access[46] to recreational waters. When a stream is navigable, regardless of the interpretation of "navigable" that is used, the stream bed is usually held in trust for the public. The fact that more bodies of water are subject to public water-use rights today than in the past is not due to any change in the criteria of what is public and what is private, but is instead due to a simple expansion of what is navigable, to a point where an increasing number of waterbodies fit the definitional framework and are subject to public water-use rights. States

---

[45] Sargent, "Multiple Use and Water Law," in Proceedings of the Water Rights Law Conference, p. 93.

[46] New Hampshire, State Planning Project, Land Water Recreation, The Water Resources of New Hampshire (Concord, New Hampshire: State of New Hampshire, 1963), pp. 125-130.

New Hampshire, State Planning Project, Land Water Recreation, New Hampshire Public Water Bodies and Public Access Points, Part II (Concord, New Hampshire: State of New Hampshire, 1965).

employing the commercial navigation interpretation to determine common law public rights usually favor riparians because of economic, political, and historical factors. These states fail to lay a foundation for providing recreation access or pollution abatement because of restrictions on public use of water. In Illinois, for example, a stream is considered navigable if "in its natural state or with reasonable improvements, it is or can be used as a highway for commerce over which trade or travel may be conducted in the customary modes on water."[47] The riparian holds title to the bed of a navigable stream; and while he may use the water for recreation, he may exclude others from doing so. Illinois holds to the strict interpretation of navigability and, therefore, severely restricts the number of public waters and consequential public water rights.

A balance between public and private rights has been reached in Maine. Public rights exist where the tide ebbs and flows, in lakes having a surface of at least ten acres, and in waterways which are "sufficiently large to bear boats or barges or to be of public use in the transportation of property."[48] Recognizing that recreation is becoming more valuable to the public as an industry, the Maine court has indicated that pleasure boating is equally entitled to the protection of the law as is navigation for any other purpose.[49] In referring to the lack of decisions pertaining to other recreation activities besides pleasure boating, Waite notes:

> However, the great popularity of these activities and the revenue they produce both for individual residents of Maine and for the State itself, suggest the Maine court would include the

---

[47] N. G. P. Krausz and L. G. Lemon, Laws and Regulations Concerning Recreation in Rural Areas of Illinois, Circular 889 (Urbana, Illinois: Cooperative Extension Service, University of Illinois, 1964), p. 9.

[48] Waite, "Public Rights in Maine Waters," reprinted from Maine Law Review, p. 162.

[49] Ibid., p. 166.

> activities within the public rights should the question be presented for decision in the future.[50]

Lakes in the New England states with a surface area of ten acres or more are called Great Ponds,[51] from the terminology of the Colonial Ordinance of 1641-7 enacted by the Massachusetts Bay Colony and now a part of common law. Recreational uses such as fishing, swimming, and boating are recognized as public rights on Great Ponds. These public rights exist regardless of their navigability, the critical point being simply that the pond have at least ten acres of water surface. In establishing these ponds as public property, the state government is then responsible for providing basic facilities to allow public access to these waters.[52] Waite also enumerates the possible public recreation rights for the ocean area adjoining the Maine coast.[53] There appears to be no restrictions on recreational use of these tidal areas except that the public does not have the right to cross the upland to reach the water surface.

In all of the western states surveyed by Johnson and Austin,[54] except Colorado, the courts have held that the public has a right to use those waters where the bed is state-owned for fishing, commercial travel, recreation, and otherwise. The concern, therefore, lies with the public right of use where the beds are privately owned. On waterbodies that are non-navigable and possibly privately owned, the public has no right to use under pure interpretation of the prior appropriation doctrine.

---

[50] Ibid., p. 166.

[51] Ibid., p. 167.

[52] New Hampshire, State Planning Project, New Hampshire Public Water Bodies and Public Access Points, Part II.

[53] Waite, "Public Rights in Maine Waters," reprinted from Maine Law Review, pp. 170-172.

[54] R. W. Johnson and R. A. Austin, "Recreational Rights and Titles to Beds on Western Lakes and Streams," Natural Resources Journal, 7 (January, 1967), 1-52.

> Nine states West of the Mississippi now recognize a right of the public, or at least other than the owner of the bed, to use the surface of lakes and streams where the beds are privately owned. Six other states west of the Mississippi have spoken against a public right of use of waters where the beds are privately owned . . . . Further, one of the six applied an erroneous "pleasure boat" test for determining title which renders virtually all its river and lake beds state-owned.[55]

In states where recreational uses are regarded as an important economic benefit, public water-use rights are well established. Alternately, those states with orientations other than recreation such as agriculture and industry focus on private water-use rights and usually tie the test of public waters to the most restrictive interpretation. If water-use law is a reflection of social, economic, political, and historical factors, growing awareness of an abundant leisure should be the basis for changes in water-use law--changes which firmly establish the rights of the public to use waterbodies for recreation along with the riparian. In states where public rights are already vigorously championed, greater effort must be made to accommodating public rights to one another, to private rights, and to the rights of riparian recreation interests.

Private Water Rights

There are two distinctly different regional-oriented water rights doctrines commonly held today: the riparian rights doctrine[56] prevails generally in the

---

[55] Ibid., p. 8.

[56] U.S., President's Water Resources Policy Commission, Report of the Commission (Washington, D.C.: 1950, III), p. 35.

H. E. Alexander, "Water Policy and Wildlife," reprinted from Proceedings of the Fourteenth Annual Conference, Southeastern Association of Game and Fish Commissioners, October 23-27, 1960, pp. 17-23.

H. H. Ellis, "Water Law in the Eastern United States," Journal of Soil and Water Conservation, 18(1) (1963), 19-27.

eastern United States while the prior appropriation doctrine[57] is followed in the West. The vastness and geographical variance involved in water-use law places a comprehensive investigation beyond the scope of this study. Specific legal implications of court decisions relating to these two doctrines are likewise beyond the scope of this study and the reader requiring this information is directed to the bibliographic notations cited.

Waite makes a distinction between public and private rights pointing out fallacies and detrimental effects involved in using such labels. Normally, water uses permitted riparians are private rights while those permitted both riparians and non-riparians are public rights. Using court decisions to justify his point, Waite concludes that no flat statement can be made about the supremacy of public rights over private rights or vice versa:

> The supremacy question is controlled by the circumstances of each case. Just as the private rights are modified to accommodate the public ones, so the public rights are altered to allow recognition of private ones.[58]

This section will focus on private water rights--those property rights of the riparian and the appropriator.

In 31 eastern states, the riparian rights doctrine applies to an exclusive right to use water from non-navigable surface streams and waters. This doctrine has also been applied together with the prior appropriation doctrine in nine of seventeen western states. Using historical examples, Galbreath[59] traces the

---

[57]Alexander, "Water Policy and Wildlife," reprinted from Proceedings of the Fourteenth Annual Conference, Southeastern Association of Game and Fish Commissioners, pp. 17-23.

P. M. Galbreath, Maryland Water Law (College Park, Maryland: Water Resources Study Committee, University of Maryland, 1965), pp. 42-46.

W. Ellis, "Recreational Uses of Water Under Prior Appropriation Law: Colorado Water Conservation District-Rocky Mountain Power Company," Natural Resources Journal, 6(2) (1966), 181-185.

Johnson and Austin, "Recreational Rights and Titles to Beds on Western Lakes and Streams," Natural Resources Journal, pp. 1-52.

[58]Waite, A Four State Comparative Analysis of Public Rights in Water, p. 12.

[59]Galbreath, pp. 7-14.

early development of common law doctrine in both England and the United States.

The riparian rights doctrine defines rights of landowners adjacent to a waterbody in terms of the following: (1) it is a right of use that exists and not ownership of the water itself, (2) it is a right annexed by operation of law to land bordering on a waterbody, (3) it is a right in common among all riparian owners on the waterbody, (4) each riparian owner can make a reasonable use of the water so long as he does not unreasonably interfere with the equal right of other riparians, and (5) prior use by one riparian confers no exclusive right.

On non-public watercourses, each riparian owns an adjacent portion of the bed. If the watercourse is a stream, each riparian has exclusive use of the riparian rights on the portion of the bed he owns and the water over this bed area. If this riparian wishes to use other portions of the bed or overlying water, he must get the permission of the appropriate riparian. If the watercourse is a lake, each riparian generally may use its entire surface, although technically the use of the bed remains exclusive to each riparian within his own segment of bed property.

On streams or lakes open to public uses, property rights of riparians continue but are modified to accommodate the uses allowed to the non-riparians. While the owner of land bordering on navigable waters always has the advantage of having immediate access to the water, no one can cross his property to get to water without the landowner's permission. In most states riparians do not own the beds of navigable watercourses; but regardless of ownership, they cannot prevent use of water by non-riparians or other riparians under either riparian rights or prior appropriation doctrines.

Since riparian uses of water are generally afforded the status and protections of property rights and private rights as well, every riparian owner has the right to the enjoyment of a water body in its natural state, in flow quantity, and quality. This would seem to indicate that there can be no increase or decrease of quantity or quality whatsoever. However, the law allows for reasonable use:

> Of course, we are not be understood as meaning there can be no diminuation or increase of the flow whatever, for that would be to deny any valuable use of it. There may be, and there must be, allowed to all of that which is common a reasonable use, and such a use, although it may to some extent diminish the quantity, or affect in a measure the flow of the stream, is perfectly consistent with the common right.[60]

Since recreational use can be severely restricted by upstream riparians who diminish water quality and water quantity, it is necessary to clearly understand the concept of reasonable use.[61] This concept is central to multiple-use management. What constitutes reasonable use? Galbreath notes that "it is entirely a question of degree, the true test being whether the use is of such a character as to affect materially the equal beneficial uses of the stream by others."[62] Each riparian is entitled to reasonable use of the water for domestic, agricultural, and industrial purposes. The nature of what is reasonable with respect to the rights of others depends upon the circumstances, such as the character and size of the stream, and the intended uses. It should be kept in mind that when a lawyer speaks of a test of "reasonableness," he contemplates a jury question.[63]

With the public demanding more waterbodies, more access, and higher water quality for recreation, the concepts of reasonable and beneficial use that

---

[60] Galbreath, p. 16.

[61] F. J. Trelease, "The Concept of Reasonable Beneficial Use in the Law of Surface Streams," Economics and Public Policy in Water Resource Development, Stephen Smith (ed.) (Ames, Iowa: Iowa State University Press, 1964), pp. 276-282.

[62] Galbreath, p. 16.

[63] J. H. Kendall and R. E. Whiting, "Basic Concepts of Private Water Rights," Proceedings of Water Rights Law Conference (Boston, Massachusetts: New England Council of Water Center Directors, 1966), p. 11.

underlie private water-use rights are beginning to narrow and become more specific. A recent common law development has implications for insuring suitable water for recreation. In some states, riparians are permitted unlimited use of water as long as no downstream owner suffers actual loss as a result of this use.[64] At a time when increases or decreases in recreational use can be related to varying levels of water quality, it may be possible to evaluate the economic losses due to stream degradation by upstream riparians. Currently, methods for determining economic losses related to diminished recreational use are extremely crude. With more quantitative water quality criteria to narrow the concept of reasonable use, demand estimation methods that acknowledge peoples' attitudes and behavior patterns, and improved economic analysis techniques, recreational use may achieve increased status as a multiple-purpose use of water.

The prior appropriation doctrine is followed exclusively in eight western states. Under this doctrine, a title to land does not include the right to use an adjacent waterbody. Under the prior appropriation doctrine, diversion and use of water for beneficial purposes[65] constitute an appropriation and entitle the appropriator to the continuing right to use the water to the extent of the appropriation but not exceeding that reasonably required and actually used. The term "prior appropriation" refers to the legal fact that the appropriator first in time to use the water for some beneficial use is prior in right over others upon the same stream so long as he continues to make beneficial use of the water. The prior appropriation doctrine is tied to the unique historical factors of Federal and state ownership of waters in the West. The Federal

---

[64] Galbreath, p. 20.

[65] In many western states, water-oriented recreation is not regarded as a beneficial use of water.

government was originally the proprietor of water resources in the West, and right of use was acquired under the state law rather than conferred upon the owner of the adjacent land.[66]

Some major differences between riparian rights and prior appropriation are readily apparent. In the West, a state must issue a permit to use unappropriated waters, and these permits constitute a right to the use of the water. Where riparian rights prevail, a state uses its police power to regulate rights already in existence. In other words, proprietorship of water rests with the owners of the land while the state is in the position of a sovereign rather than a proprietor.

Many of the western states recognize certain uses as being preferred over other uses. Since agriculture has historically been important to the economy of western states, the use of water for irrigation has always been given high preference along with domestic, municipal, industrial, and water power uses. In some western states, appropriation of water for irrigation purposes has denied the significance of recreation or any other use. Therefore, Alexander[67] feels that the doctrine of prior appropriation has frozen water into inflexible patterns that impose limitations on water use and fail to reflect the more recent values that water has for people. These water policies are generally based on narrow foundations which fail to recognize the full range of water uses with their particular water quality and quantity requirements. In doing so, other uses are excluded. Recreation together with other evolving water uses must receive consideration equivalent to traditional and previously declared priorities if waterbodies are to sustain optimum ecological and economic use.

---

[66]U.S., President's Water Resources Policy Commission, p. 34.

[67]Alexander, "Water Policy and Wildlife," reprinted from <u>Proceedings of the Fourteenth Annual Conference, Southeastern Association of Game and Fish Commissioners</u>, p. 19.

Summary

The recreational use of water partially depends upon several factors reviewed in this chapter: (1) existence of required amounts of water at a specific point in time, (2) physical, chemical, biological, and esthetic qualities of the water, (3) the extent of compatibility between recreation and other multiple-purpose uses, and (4) legal implications involved in determining public rights and access to use available water.

Leibig's law of the minimum, a basic law of ecology, is used to find a common denominator for the above factors. This law states that the functioning or occurrence of an organism is limited by that essential environmental factor or combination of factors present to the least favorable extent.[68] In applying this law, we find that the provision of water resources for recreational use is limited to the extent that one of the above four factors occurs to the least favorable extent. For example, a particular waterbody may meet established water quality and water quantity requirements for body contact recreational use, but public use rights are lacking because of a state's strict interpretation of navigability. Hence, legal requirements restrict the public from using this waterbody which may meet all other established requirements. The application of the law of the minimum demonstrates that recreation resource development, planning, and use involve a system of interdependent physical, ecological, chemical, biological, hydrological, esthetic, social, psychological, economic, historic, and political inputs. Optimum use, planning, and development depends upon an understanding of this interrelated system of knowledge.

---

[68] E. P. Odum, Fundamentals of Ecology (Philadelphia, Pennsylvania: W. B. Saunders Company, 1959), pp. 88-89.

CHAPTER V

WATER RESOURCE RECREATION PLANNING

Introduction

It is the intention of this chapter to provide a social and environmental rationale for outdoor recreation resource planning and to relate planning objectives to current planning methods and policies. Water resource recreation planning will be critically analyzed and documented on four major levels: (1) nationwide planning; (2) statewide planning; (3) regional planning; and (4) project planning and evaluation.

Planning Rationale

Human Ecological Considerations

It has been virtually taken for granted that water quality and quantity will be sufficient to meet the increasing water-oriented recreation needs of this nation's burgeoning population. Several critical factors illustrate an urgent concern for not taking recreation's quality and quantity requirements for granted: (1) the nation's need for water will continue to increase as the population and standard of living increase, (2) with an increasing population using more water in more ways, water uses will further conflict with each other, (3) pollutants decrease the amount of water available because they render water unfit for recreation, and (4) current and anticipated land-misuses of watershed lands will deleteriously affect water quality and hence quantity of available water.[1]

---

[1]Ohio, Division of Water, Principles of Water--Its Uses, Behavior, Problems and Conservation (Columbus, Ohio: Department of Natural Resources, 1960), pp. 11-14.

Since the quantity of water involved in the hydrologic cycle is relatively constant, we are more concerned about water distribution. There is nothing we can do about a relatively constant quantity. Increased amounts of usable water can be obtained by: (1) manipulating components of the hydrologic cycle to produce increased high-quality runoff. These components can be controlled in time and space for recreational use by impoundment, evaporation retardation, and low-flow augmentation, (2) using sustained-yield management practices to insure re-use by downstream users. Preventing the total degradation of withdrawn water by implementing wastewater treatment that returns high quality water for multiple-use downstream, and (3) increasing the number of water bodies available to the public through gradual modification of the water-use common law.

It is recognized that the relative constancy of the ultimate source of water supply, precipitation, may impose a ceiling on the economic development of a region as well as its population growth.[2] Fortunately changes in supply and availability of water can be made at several points in the hydrologic cycle by impounding water to store surface runoff from periods of excess supply to periods of excess demand. The availability of water or man's ability to control it, is linked to many sectors of the regional economy and ultimately results in increased personal incomes. In attracting recreation users from areas outside the basin, water recreation resource development promotes recreation consumption within the region. "Economically this represents both a tangible and intangible regional export of recreational services."[3] Likewise,

[2]D. Bradwell, "The Timing of Development of the Saskatchewan River Basin" (unpublished Ph.D. dissertation, University of Oregon, Corvallis, Oregon, 1964), p. 5.

[3]*Ibid.*, p. 5.

Hamilton et al.[4] relate water recreation resource development to the employment sub-sector of a dynamic economic model of the Susquehanna River Basin:

> The one feed back from the water sector to the economy involves recreation at reservoirs in the various subregions. Regression analysis has been used to relate attendance at reservoirs to such factors as their location and physical attributes. The attendance is then related to employment.[5]

In 1962, the O.R.R.R.C. documented the existence of a diminishing recreation demand-supply ratio, namely, increasing demand and a dwindling recreation resource supply. This situation is reiterated by Clawson[6] who indicates that use of public recreation areas is increasing at the rate of 8 to 10 percent yearly. Such use predictions cannot be met with existing designated recreation resources. Through planning, however, demand and supply can be identified, measured, and projected into the future to quantitatively demonstrate long-range resource development needs.

The O.R.R.R.C. points out another reason for recreation resource planning, namely, the lack of balance in distribution of outdoor recreation land resources in the United States. For example, the highly populated industrial northeast U.S. "where one-quarter of the people live, has only 4 percent of the recreation acreage of the 48 contiguous states."[7] Conversely, one-sixth of the total recreation acreage is in sparsely populated Alaska. The number of acres alone is not an adequate measure of recreation supply since most of the seeming abundance of recreation acreage is in large units:

---

[4]H. R. Hamilton et al., Final Report on a Dynamic Model of the Economy of the Susquehanna River Basin to the Susquehanna River Basin Utility Group (Columbus, Ohio: Battelle Memorial Institute, 1966), p. 12.

[5]Ibid., p. 12.

[6]M. Clawson, "Crisis in Outdoor Recreation," American Forests (March, 1959), n.p.

[7]U.S., Outdoor Recreation Resources Review Commission, Outdoor Recreation for America (Washington, D.C.: U.S. Government Printing Office, 1962), p. 51.

> Only 1 percent of the areas are over 100,000 acres in size but they make up 88 percent of the total recreation acreage. Conversely, over two-thirds of the areas are under 40 acres in size, but they contain less than 0.1 percent of the total acreage.[8]

Water resource recreation planning is further complicated because water recreation is a shared water use. Alternative withdrawal and consumptive uses often reduce the supply or diminish the value of water through degradation. Since man congregates where climate, water supply, economy, and other conditions favor his existence, the most populated areas of the world are contained in a strip of land 250 miles around the Pacific, Atlantic, and Indian Oceans.[9] It is estimated that nearly one-third of the population of the United States lives within a 50-mile range of our coastlines. Such population pressures on estuarine and other water resources are increasing, but industry continues to develop around these water-oriented population centers to sustain inexpensive water supplies and waste disposal, an adequate work force, and access to transportation routes. Industrial growth and development places increasing pressures on adjacent waters rendering them unfit for both immediate and downstream recreational use. Such degradation has created a demand for development of intermediate recreation resources[10] and upstream watershed areas.[11] These sites are intended to fill the gap between the water-deficient user-oriented

---

[8] Ibid., p. 52.

[9] W. S. Woytinsky and E. S. Woytinsky, World Population and Production (Report of the Seventieth Century Fund, 1953), pp. 620-644.

[10] These intermediate outdoor recreation areas are usually readily available for all-day use in that they are within two hours' travel distance from the population area. The most popular intermediate outdoor recreation areas are usually water-oriented (i.e., artificial lakes or U.S. Corps of Engineers impoundments), M. Clawson, Land and Water for Recreation (Chicago: Rand McNally and Company, 1963), p. 15.

[11] D. D. Badger, "Recreational Aspects of Upstream Reservoirs," Paper presented at the Sixteenth Annual Meeting of the Oklahoma Section, American Society of Agricultural Engineers, October 28, 1966.

recreation areas of the urban center and the resource-oriented areas found primarily in the western United States that require increased time and money to use. Unfortunately, there are many urban residents with neither the income nor the mobility to use the resource-oriented areas. These restricting factors are creating an increased demand for intermediate areas. Rapid development of intermediate recreation areas together with completion of the Federal Interstate Highway System and more advanced modes of transportation will create a more balanced national distribution of water available for recreational use.

In comparison to land resources available for public recreational use, water resources are generally well-distributed with respect to population centers. However, effective water acreage available for recreation cannot possibly meet the demand in many areas. Because of imbalances and deficiencies in effective water acreage, recreation resource planning focuses on relating demand for outdoor recreation opportunities and effective resource supply within a nationwide, statewide, and regional context. A summation of statewide and other area-wide planning efforts will provide the B.O.R. with data necessary to formulate a nationwide outdoor recreation plan. This nationwide plan will be a guide to funding, development, and policy for Federal recreation agencies, just as statewide planning provides direction to regional recreation resource development within state boundaries.

Planning Considerations

Initially, the area-wide planning process involves production of gross future demand for recreation within a certain geographical area and relates this demand quantitatively to recreation resource supply to ascertain future recreation resource needs. Several planning methods have been established for relating supply to demand, but these methods are still in need of refinement:

> The lack of adequate methods of determining demand and relating it to supply in order to predict needs has meant that most agencies

are still using demand curve projections or gross participation rates coupled with socio-economic multipliers in order to establish estimates of future recreation demand. In many cases, the participation rates that are used are those contained in the 1962 National Recreation Survey of the Outdoor Recreation Resources Review Commission which is based on data for the period between September 1960 and June 1961.[12]

One of the basic objectives of planning is to provide for the best use of water and related land resources to meet both short- and long-term needs. U.S. Senate Document No. 97[13] calls for full consideration of three broad objectives during the planning process: (1) the well-being of the people, (2) preservation of water and related land resources, and (3) national economic development based on regional development. In compliance with these objectives, water recreation resource planning is accomplished on four major levels with varying perspectives: nationwide, statewide, regional, and project planning. Within each of these levels the process is carried out by agencies with varying foci, namely, single-purpose recreation planning agencies or water-oriented agencies with a responsibility for including recreation in a multi-purpose planning framework. Examples of these level and organizational differences are illustrated. The planning approach of relating supply and demand is generally used on all four planning levels with varying degrees of sophistication.

Planning Levels

Nationwide Planning

The B.O.R. is charged with formulation and maintenance of a comprehensive nationwide outdoor recreation plan which takes into consideration the plans of

---

[12]M. Chubb, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part III (East Lansing, Michigan: Michigan State University, 1968), pp. 3-4.

[13]U.S., Senate, Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources, Senate Document No. 97 (Washington, D.C.: U.S. Government Printing Office, 1962), pp. 1-2.

various Federal agencies, states, and their political subdivisions.[14] It is anticipated that the Nationwide Plan will be an assemblage of key data from state comprehensive plans. The Nationwide Plan is intended to coordinate Federal, regional, state, local, and private planning, acquisition, and development. The first Nationwide Outdoor Recreation Plan was to be completed by July 1, 1967, but as of May 1, 1969, this plan had not been completed.

The plan is intended to be an overall statement of: (1) present and potential supply of outdoor recreation resources, classified according to an established uniform system, (2) present and future demand for outdoor recreation opportunities, (3) present and future needs for outdoor recreation areas, facilities, and opportunities, (4) critical outdoor recreation problems, and (5) recommendations and programs for meeting identified outdoor recreation needs. Nationwide planning is concerned with projecting regional recreation resource development and acquisition needs through a complete understanding of present and projected participation within each region. The B.O.R. is therefore authorized to determine statistical indicators which relate the imbalance between supply and demand for each region. Besides establishment of indices of imbalance, nationwide planning is concerned with an analysis of the factors underlying the supply-demand relationship and establishment of action proposals to remedy recreation resource imbalances.

The <u>National Recreation Survey</u>[15] and other studies conducted by the O.R.R.R.C.[16] are both based on four regional samples of the national population

---

[14]U.S., Bureau of Outdoor Recreation, <u>Planning and Surveys Series Manual</u> (Washington, D.C.: Bureau of Outdoor Recreation, 1964), pp. 241.9.3-241.9.4.

[15]U.S., Outdoor Recreation Resources Review Commission, <u>National Recreation Survey</u> (Washington, D.C.: U.S. Government Printing Office, 1962).

[16]U.S., Outdoor Recreation Resources Review Commission, <u>Participation in Outdoor Recreation: Factors Affecting Demand Among American Adults</u> (Washington, D.C.: U.S. Government Printing Office, 1962).

(1960) to determine rates of participation in concert with socio-economic characteristics for prediction purposes. These participation rates provide considerable information on collective national outdoor recreation consumer behavior patterns, but these rates should not be overgeneralized to local or state conditions because of the regional sample used. Unfortunately, National Recreation Survey participation rates by region are often used in place of surveying a state or local population to determine recreation behavior patterns.

The B.O.R. is authorized to conduct demand surveys and studies on a regional and local basis in connection with river basin planning and project feasibility studies. It is required that output from these regional demand studies be compatible with the demand procedures, data, and information used for the Nationwide Plan but not to the point of discouraging experimentation and innovation of new demand estimation methods and techniques.[17] It is unfortunate that such a narrow policy regarding demand estimation procedures has acted to restrain the conduct of research dealing with demand and acceptance of research findings not compatible with the existing system.

In order to provide a common framework for outdoor recreation planning and management, the B.O.R. has adopted a uniform system for classifying recreation resource supply. It was felt that in the past a lack of consistent systems or standards for the management of recreation resources constituted a major obstacle to a balanced national resource development program. This classification scheme includes a range of physical resources needed for outdoor recreation and type of management best suited to each kind of area. These resource classifications include: (1) high-density recreation areas, (2) general outdoor recreation areas, (3) natural environment areas, (4) outstanding natural areas,

[17] U.S., Bureau of Outdoor Recreation, Planning and Surveys Series Manual, pp. 241.9.3-241.9.4.

(5) primitive areas, and (6) historical and cultural sites.[18]

While nationwide outdoor recreation planning will provide the framework for funding to state organizations necessary to maintain a spatial balance of outdoor recreation resources, it is highly unlikely that water resource development will be accurately reflected or coordinated by such a plan. Unlike park development which is largely single-purpose, multi-purpose water resource developments may be planned in specific locations regardless of any deficiencies in regional recreation resource supply. This is because the recreational use of water is shared with other uses, which have their own supply and demand justifications. The need for the water recreation resource development will be reflected, however, in project economic justification.

Statewide Planning

Statewide comprehensive recreation planning, as we commonly know it today, began in 1960 with the California Public Outdoor Recreation Plan.[19] Outdoor recreation planning existed prior to 1960, but it was generally not of a comprehensive nature. This has changed as a result of the Land and Water Conservation Fund Act.

The major purpose of the Land and Water Conservation Fund Act (P.L. 88-578), passed by the 88th Congress in 1965, was to create a fund from which Congress could appropriate money for the preservation, planning, and development of outdoor recreation resources. Sixty percent of the annual appropriations from this fund is designated for grants-in-aid to states on an equal matching basis. Since a statewide comprehensive outdoor recreation plan is a prerequisite for

---

[18] U.S., Outdoor Recreation Resources Review Commission, Outdoor Recreation for America, pp. 92-120.

[19] California, Public Outdoor Recreation Plan Committee, California Public Outdoor Recreation Plan (Sacramento, California: Public Outdoor Recreation Plan Committee, 1960).

obtaining matching funds for planning or land acquisition, this Fund has been instrumental in establishing and regulating statewide planning.

Comprehensive statewide outdoor recreation planning is generally designed to:

1) gather and assess information describing a region's potential to provide recreation for residents and nonresidents.
2) analyze present and potential supply of outdoor recreation resources.
3) assess impact of outdoor recreation on the region's economy.
4) analyze present use of existing recreation resources and future implications of this use.
5) analyze and evaluate future demand for recreation resources by activities.
6) develop guides or standards for relating supply in terms of carrying capacity to requirements in acreage and facilities.
7) determine net needs (difference between demand and total required needs minus existing resources and facilities) using carrying capacity planning guides.
8) develop action programs and recommendations to meet resource needs.
9) establish general priorities for types of acquisition and development.
10) appraise selected resource sites to determine their potential and ability to meet the needs of a particular region.
11) provide general guidelines for the division of responsibility and coordination among units of government.
12) provide the framework for future comprehensive planning on various levels, including the identification of areas requiring more study.[20]

---

[20]Wisconsin, Department of Resource Development, The Outdoor Recreation Plan (Madison, Wisconsin: Wisconsin Department of Resource Development, 1968), pp. A1-A2.

While covering these major points, comprehensive outdoor recreation plans vary considerably in depth of analysis and sophistication. Some plans quantitatively evaluate and relate supply and demand while others discuss demand and/or supply in general qualitative terms. The Texas Statewide Outdoor Recreation Plan completely disregarded user-resource relationships and used gross acreage standards per 1,000 population in 1963.[21] While some plans are based on county or regional surveys of leisure attitudes and behavior coupled with socio-economic multipliers to obtain estimates of future recreation demand, other plans use the gross participation rates established by the O.R.R.R.C. to estimate future population demand. For example, the authors of Outdoor Recreation in Illinois recognize that they do not have the necessary data to reliably estimate population demand for outdoor recreation:

> In the absence of exhaustive surveys it is not possible to specify in detail the special recreation desires or goals of the people of Illinois. Assuming that they have tastes and aspirations similar to those of people in other parts of the country, some general statements can be made about their recreation goals.[22]

Similarly, outdoor recreation resource supply data is evaluated differently in various statewide plans. The User Resource Recreation Planning Method,[23] the California Outdoor Recreation Plan,[24] and the Wisconsin Outdoor Recreation Plan[25] quantify supply in terms of user-day units based on use potential or

---

[21]Texas Technological College, Department of Park Administration, Horticulture, and Entomology, Texas State Parks (Lubbock, Texas: Texas Technological College, 1963), p. 13.

[22]Illinois, Department of Business and Economic Development, Outdoor Recreation in Illinois (Springfield, Illinois: Illinois Department of Business and Economic Development, 1965), p. 25.

[23]National Advisory Council on Regional Recreation Planning, A User-Resource Recreation Planning Method (Loomis, California: National Advisory Council on Regional Recreation Planning, 1959), p. 41.

[24]California, Public Outdoor Recreation Plan Committee, California Public Outdoor Recreation Plan, p. 28.

[25]Wisconsin, Department of Resource Development, The Outdoor Recreation Plan, p. 359.

carrying capacity. In Indiana, however, supply data was only quantified in terms of total acres for broad classifications providing no indication of actual resource capacity to support recreational use.[26]

Chubb[27] makes several observations following his review of statewide planning approaches: (1) there is a significant amount of public time and money going into statewide planning efforts, (2) there is little uniformity of approach, (3) not all states are convinced that statewide comprehensive plans which attempt to quantify and relate supply and demand are either necessary or feasible, and (4) several doubtful planning procedures may have been perpetuated because of previous use and the ease of use. Based on these observations he concludes that "a new, more adequate approach to recreation planning is desperately needed"[28] and hence proceeded to develop and apply a systems analysis planning approach.

There appears to be little difference in the approach used in the User-Resource Recreation Planning Method and the California Public Outdoor Recreation Plan - 1960; however, varying techniques were used to quantitatively relate supply and demand. The User-Resource Recreation Planning Method divides recreation users into a limited number of user groups according to the type and quality of recreation experience that each user desires. Since each user group can be identified by certain collective social and economic determinants, it was considered possible to predict behavioral patterns from these characteristics. Planning guides are used in the analysis of supply and demand to

---

[26]Indiana, Department of Conservation, 1965-1975 A Pivotal Decade in Indiana, An Expansion Program to Meet Indiana's Growing Need for Conservation and Recreation (Indianapolis, Indiana: Indiana Department of Conservation, 1964).

[27]M. Chubb, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part III, pp. 60-61.

[28]Ibid., p. 61.

determine user group needs for acreage in five broad resource classes. Outdoor recreation demand and supply are calculated in user-days in both the User-Resource Planning Method and the California Public Outdoor Recreation Plan - 1960.

The California Plan assembles use data by county for eight basic recreation activities. The two primary factors used to determine the magnitude of recreation needs are the population increase and the TIM factor (amount of leisure time, income, and mobility). Base year (1958) use data is multiplied by the TIM factor multiplier to represent "the estimated outdoor recreation demand that may be expected in each county in 1980 if facilities and resources are reasonably adequate."[29] Then demand in user-day units is related to supply in user-day units. Based on spatial planning standards, existing supply is evaluated according to the number of user-days it can support. While "it is mathematically simple to divide the number of anticipated activity-days by the recommended level of use to determine the quantity of facilities needed at this standards,"[30] the relative lack of reliable carrying capacities based on biological and human acceptance capabilities weakens this approach's effectiveness.

Several basic components and relationships are imperative in developing more sophisticated comprehensive statewide outdoor recreation plans. Firstly, estimation and quantification of total demand for recreation activities within the state by surveying component regions must be accomplished. All too often statewide planning becomes preoccupied with either (1) generalizing non-localized rates of recreation behavior to all persons within the state, or (2) using facility-use figures as a reflection of total demand. Both of these

---

[29]California, Public Outdoor Recreation Plan Committee, California Public Outdoor Recreation Plan, p. 195.

[30]Ibid., p. 84.

planning procedures are weak, but have been perpetuated because of the low costs involved and ease of use. Secondly, a state must be concerned with the amount of recreation consumed by its residents within and outside the state as well as the total amount of recreation consumed within the state by residents and non-residents. Thirdly, the resource supply must be inventoried in terms of recreation potential, namely, the optimum number of user-days by activity that the resource base can support. Carrying capacity standards need to be developed which reflect both biological and human acceptance limits. Fourthly, to determine resource deficiencies within a region, demand by activity (in user-days) must be compared to supply (number of user-days the resource base can best support). Fifthly, plans must appraise the potential of recreation sites capable of making up the difference between existing resource supply and required resource supply. Lastly, action programs for resource development must be included. There is a considerable lag in what is considered imperative and the short cuts in logic currently followed in a majority of statewide planning efforts. Just as the Land and Water Conservation Fund Act stimulated regional and statewide planning, the Act must also sanction higher levels of planning quality.

Regional Planning

The problems involved in delineating a planning region are of considerable concern in regional planning. Possibilities include regional definition by landform and watershed characteristics or along political boundaries. While U.S. Senate Document No. 97 encourages regional definition by landform or watershed, such physiographically-defined areas may not coincide with census regions, greatly reducing the amount of socio-economic data available for demand prediction equations. Planning carried out within physiographic regions often crosses political boundaries causing difficulties in planning implementation.

Weaknesses involved in using political boundaries to delineate a planning region are evident in most statewide outdoor recreation plans. There is a tendency to plan for a static population and to ignore human populations in nearby regions.[31]

The Department of the Interior, through the Water Resources Council, has adopted a coordinated interdepartmental program to develop comprehensive plans for all major river basins in the United States. In this program, the B.O.R. is responsible for formulating and evaluating the recreation component of these regional water resource development plans. To insure comprehensive resource development, the Bureau provides planning assistance to the U.S. Army Corps of Engineers,[32] Bureau of Reclamation, Federal Water Pollution Control Administration,[33] National Park Service,[34] and other Federal agencies with development authority.

There are two major types of river basin studies under the authorization of the Water Resources Council: (1) Type I studies are general in nature, deal with the major river basins as regions, and are usually referred to as framework studies; and (2) Type II studies are more detailed and deal with river basins and sub-basins. Type I studies are described as follows:

---

[31]An example of regional planning within political boundaries is evident in an Illinois regional water resources study in which the river is ignored when it enters Indiana. Illinois, Department of Public Works and Buildings, Kankakee River Basin Study: A Comprehensive Plan for Water Resource Development (Springfield, Illinois: State of Illinois, 1967).

[32]U.S., Bureau of Outdoor Recreation, The Middle Missouri, A Rediscovery: A Study of the Outdoor Recreation Potential (Washington, D.C.: U.S. Government Printing Office, 1968).

[33]U.S., Bureau of Outdoor Recreation, Water-Oriented Recreation in the Lake Michigan Basin (Ann Arbor, Michigan: Bureau of Outdoor Recreation, 1965).
U.S. Bureau of Outdoor Recreation, Water-Oriented Recreation in the Lake Ontario Basin (Ann Arbor, Michigan: Bureau of Outdoor Recreation, 1967).

[34]U.S., Bureau of Outdoor Recreation, New England Heritage, The Connecticut River National Recreation Area Study (Washington, D.C.: Bureau of Outdoor Recreation, 1968).

> . . . we contemplate comprehensive plans which would provide "economic projections of economic development, translation of such projections into demands for water and related land resource uses, hydrologic projections of water availability both as to quantity and quality, and projections of related land resource availability, so as to outline the characteristics of projected water and related land resources problems and the general approaches that appear appropriate for their solution." Such framework studies would provide general guides to future water resource development. In addition to indicating which regions, or sub-basins within them have water problems calling for prompt detailed planning efforts as well as those where no such problems are current or looming, such studies will provide a substantial contribution of fact and analysis to subsequent detailed plan formulation.[35]

Framework studies once completed will provide the Water Resources Council with a general appraisal of overall water and related land resource development needs. They are also intended to accelerate the formulation of detailed plans for sub-basins of each region. Type I Comprehensive Framework Studies are currently in progress in the following river regions: the Missouri, Upper Mississippi, Ohio, and the Wabash. None of these studies were completed as of January 1, 1969.

Type II studies are usually coordinated by a river basin commission or other Federal interagency-state coordinating organization and focus on defining projects in sufficient detail to enable development authorization.

Project Planning and Evaluation

U.S. Senate Document No. 97[36] firmly establishes that where feasible, plans for individual water resource development projects shall be formulated as a part of a comprehensive plan for a region, river basin, or other planning

---

[35] U.S., Water Resources Council, Guidelines for Framework Studies, 1967 (Washington, D.C.: Water Resources Council, 1967), p. 1.

[36] U.S., Senate, Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources, Senate Document No. 97, p. 3.

area. This requirement was established because project plans can be better evaluated when viewed within a regional framework. Since the B.O.R. formulates and evaluates the recreation component of selected water and related land resources projects, the water resource plans of development agencies along with Federal power project applications are reviewed to ascertain whether full consideration has been given by the development agency to outdoor recreation development and that the action proposed is justifiable and consistent with national, regional, and local outdoor recreation development objectives.[37]

Water resource planning must be carried out on a fully comprehensive basis, namely, all significant resource uses and purposes of development should be considered in the planning process:

> . . . including, but not limited to domestic, municipal, agricultural, and industrial uses of water; water quality control; navigation in relation to the Nation's transportation system; hydroelectric power; flood protection control or prevention; land and beach stabilization; drainage, including salinity control; watershed protection and management; forest and mineral production; grazing and cropland improvement; outdoor recreation, as well as sport and commercial fish and wildlife protection and enhancement; preservation of unique areas of natural beauty, historical and scientific interest . . . .[38]

U.S. Senate Document No. 97 authorizes all of these project purposes singly, in combination, or in alternative combinations. Planning efforts are therefore intended to reconcile competitive project uses by choosing the best combination of project uses. This is accomplished through a benefit-cost evaluation to determine the economic feasibility of the proposed project purposes.

---

[37]U.S., Bureau of Outdoor Recreation, Planning and Surveys Series Manual, p. 260.2.2.

[38]U.S., Senate, Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources, Senate Document No. 97, pp. 3-4.

The extent and nature of both water resource development and water recreation resource development depends entirely on economic feasibility. To determine feasibility, a quantitative measure of demand[39] for water-oriented recreation must be determined. The total economic benefit generated by a projected demand is calculated by assigning the arbitrary user-day values established in U.S. Senate Document No. 97, Supplement No. 1.[40] The methods for estimating demand in visitor-day units and for assigning arbitrarily-assigned monetary values to these visitor-day units have been severely criticized for their deficiencies in logic and accuracy, but at the present time these methods are the best available and are sanctioned for use in Federal water resource development project planning. It has been suggested in the literature that the use of arbitrary values fails to discriminate between different levels of resource quality and the regional nature of recreation supply and demand. The necessity to assign arbitrary values to visitor-days will diminish with refinement of demand estimation and benefit measurement methods that are tied with quality levels. Economic feasibility plays an important role in water resource project planning where the benefits-to-costs ratio of one particular development purpose is compared with that of another project purpose to reconcile competition among various project uses.

For recreation resource development to compete with other project purposes, it is imperative that a realistic monetary value be placed on each unit of recreational use. It is just as important that methods of demand estimation

---

[39] Demand is established through an estimation of recreation participation expected at a particular project or in a subregion surrounding the site. The Bureau of Outdoor Recreation is concerned with projecting recreational use of the water resource on the bases of participation rates of an entire area, not on the basis of only those who participate in outdoor recreation at the water resource under consideration.

[40] U.S., Senate, Evaluation Standards for Primary Outdoor Recreation Benefits, Senate Document No. 97, Supplement No. 1 (Washington, D.C.: U.S. Government Printing Office, 1964), p. 4.

be improved if recreational use is to receive an accurate total valuation.

Summary

Effective water acreage available for recreation is insufficient to meet the demand for recreation in many regions. Because of imbalances and deficiencies in effective water acreage with subsequent social and economic implications, recreation resource planning focuses on relating demand for outdoor recreation opportunities and effective resource supply on a nationwide, statewide, and regional and project level. The Outdoor Recreation Resources Review Commission oversimplifies the recreation planning process in regard to water resource development. The relating of water resource supply to future demand for water recreation is not enough to justify development of water recreation resources because recreation is a shared use of water. Therefore, development of water resources may not be tied to an increasing demand for water recreation opportunities.

Planning efforts of the Bureau of Outdoor Recreation are more effective when dealing with land resources allocated for recreational use. Park areas are intended for a single-purpose use, recreation. Planning for recreational use of water resources is more effective when it is a responsibility of a water resources planning agency. In this manner, requirements of all water uses can be integrated to allow for optimum water resource use. This process encourages the recreation-oriented planning organization to provide demand-supply-needs data for integration into a regional comprehensive water resources plan. The Bureau of Outdoor Recreation is authorized to carry out this task in Federal water resource planning.

CHAPTER VI

USER-RESOURCE PLANNING CONSIDERATIONS

Introduction

It is the intention of this chapter to discuss recreation resource planning in terms of its interrelated demand and supply compenents. There is a need to clarify the various concepts of demand as they are presently used or as they may be used in the future. Without a working knowledge of the influence of individual preferences and how to incorporate this data into planning, the prediction of participation as a reflection of demand has received the most attention in the literature. This prediction process is discussed for: (1) a given population, (2) a specific location or project, and (3) a given area and/or census region. Methods used in statewide planning to determine participation are compared with the complex, but more sensitive, regression methods. Since the improvement of regression prediction equations rests on further understanding, identification, and quantification of socio-economic and environmental variables affecting participation and use, these variables are reviewed together with their weight of influence, if known.

The supply component is first discussed in terms of inventories. When inventories are converted into capacity data that recognize physical and attitudinal considerations, demand and supply components can be compared to determine the extent of resource needs. This comparison process is discussed together with the carrying capacity concept as used and misused in the literature. Planning standards that meet the accepted conceptual definition of carrying capacity are documented. Several regional analysis methods of varying complexity and degrees of objectivity are compared and contrasted to illustrate the present state of knowledge. These methods are used to supplement the planning process by providing vehicles for incorporating environmental qualities considered to be of value to a wide range of recreation user groups.

Throughout the discussion of demand and use prediction, recreation resource potential, and carrying capacity, a common theme that recognizes the close interrelationships of man and his environment is emerging in the literature. Peoples' preferences, tastes, and satisfactions together with consequential behavior patterns are becoming more important in the planning process. Therefore, the role of human attitudes and the degree to which attitudes are presently considered in resource planning will be assessed.

Prediction of Total Recreation Demand or Participation

Introduction

Prediction of recreation demand for a population or within a region is critical information for balancing resource supply and user requirements in any plan regardless of scope. Likewise, prediction of demand at existing or proposed water resource developments is essential to determining economic feasibility of development. What do we mean when we use the term "demand"?

Firstly, there is a limited concept of demand that is commonly used in planning, namely, that manifest or effective demand equals the population's expressed desire to participate in an activity or use a particular site, Manifest or effective demand is referred to as participation,[1] consumption,[2]

---

[1] This writer prefers to use the term participation because of its wide application to a population, region, or site.

[2] L. W. Gahan, "A Regional Analysis of Factors Affecting the Demand for and Participation in Water-Oriented Recreation Activities" (unpublished research paper, Department of Recreation and Park Administration, University of Illinois, Urbana, Illinois, 1968), p. 8.

or utilization.[3] This concept of demand eliminates from planning consideration those people who may desire to participate but who for lack of leisure time or money do not participate.

Secondly, there exists some additional desire to participate in water-oriented recreation activity or use a particular site which is constrained for various reasons. Such unexpressed or unfulfilled desire to participate is termed latent or dormant demand for recreation. It is assumed that this demand is reflected in a person's preferences for activity even though he may not participate.

Thirdly, there is a broad definition of demand that includes peoples' expressed or fulfilled desire to participate in outdoor recreation or use a particular site and their unexpressed or unfulfilled desire to participate or use a particular site. This is considered total or aggregate demand and includes both participation and preferred recreation activity.[4]

Demand, regardless of conceptual definition used, can be theoretically identified and measured for various points in time. For example, Tomazinis and Gabbour have constructed a projection model which allows present manifest and latent demand for a given activity along with the variables affecting this present demand to be projected into the future.

> . . . by using the proper relationships (sub-models) one can reach an estimate of the <u>total demand</u> for an activity in a specified region at a given time (p. 15).[5]

---

[3]E. W. McCoy, "Analysis of the Utilization of Outdoor Recreation in Tennessee" (unpublished Ph.D. dissertation, University of Tennessee, Knoxville, Tennessee, 1966), p. 24.

[4]U.S., Federal Water Pollution Control Administration, <u>Water-Oriented Recreation Benefits--A Study of the Recreation Benefits Derivable from Various Levels of Water Quality of the Delaware River</u> (Philadelphia, Pennsylvania: Institute of Environmental Studies, University of Pennsylvania, 1966), pp. 9-14.

[5]<u>Ibid.</u>, p. 15.

The current academic approach to determining demand is to identify, weight, and use the underlying determinants or shifters[6] in a linear regression model. Demand prediction is therefore based on what a given set of shifter variables are expected to produce.

There is considerable divergence in the scope, purposes, and methods of economists and recreation resource planners in demand estimation. While the economist's demand is a measure of the volume of total demand (fulfilled or unfulfilled desire to participate) in dollars and cents, the recreation resource planner's concept of demand is usually a measure of consumption in user-days.

The economist generally believes that the recreation resource planner is misusing the terms "demand" and "demand analysis" because he is using non-monetary measures of demand to avoid problems of pricing. However, in order to balance recreation resource supply and demand, there is no need to determine the amount of a particular good or service purchased in a given time period at specified prices per unit. The concern for a priced volume is more related to benefit valuation.

The economist's concept of demand is usually restricted to resource development feasibility studies where a demand schedule is used to reveal the number of persons engaging in or preferring recreation at specified prices per unit of use to establish benefit values. Contrived studies are carried out with the intention of pragmatically measuring benefits accruing to recreation participants, regions, or society; developing means of simulating these measures; and determining a schedule of total benefits.[7] Alternately, recreation resource planners focus on practical calculation of total recreation

---

[6] In economics literature, shifter variables are independent variables that affect and determine recreation behavior or preferences.

[7] U.S., Senate Document No. 97, Supplement No. 1 establishes attributed benefit values which are said to represent what participants are willing to pay for the recreation experience.

benefits by determining the amount of participation expected in a particular region or from a regional population and attributing arbitrarily-established benefit values to this consumption.

The recreation resource planner's concept of demand is usually concerned with predicting recreation behavior patterns of a population for a particular region, or a site. He uses participation as a planning indicator for demand because he is usually incapable of probing human attitudes of participants and non-participants to determine the extent of dormant demand by activity. Several approaches using non-monetary measurement of demand focus entirely on extent of participation:

> Such measures include number of visits to recreation areas, percent of persons participating in a particular activity during a specified time period as well as degree of participation, and time spent away from home and distance traveled in connection with various types of outdoor recreation occasions.[8]

These approaches appear logical for determining the amount and rate of consumption, but danger lies in overgeneralization with intent to simplify the concept of demand. Studies purporting to project demand on the basis of participation or use data do so subject to the general criticism of economists because they equate consumption with total demand. Knetsch[9] makes this point in the following statement:

> Projections which are made to substantiate these claims (that of increasing demand), are not really projections of demand, but rather they are projections of consumption. The data which are used in support of them are invariably use data, i.e., they are attendance figures for existing facilities, or the number of activity days engaged in by the population concerned . . . .

---

[8]U.S., Outdoor Recreation Resources Review Commission, Prospective Demand for Outdoor Recreation (Washington, D.C.: U.S. Government Printing Office, 1962), p. 1.

[9]J. L. Knetsch, "Problems of Appraised Demand," Water Resources and Economic Development of the West, Report 13 (Berkeley, California: Committee on the Economics of Water Resources Development of the Western Agricultural Economics Research Council, 1964).

> These attendance figures or use figures are the net effect of the existing supply. The result, then, is not an estimate of the demand but again an estimate of the consumption which consequently occurs.[10]

These criticisms point out that recreation resource planners are too preoccupied with projecting consumption and ignore the other aspect of demand--preferred behavior--for lack of conceptualization and quantification means.

Efforts must be made to move closer to investigating and measuring total demand for water recreation. This is supported by Tomazinis and Gabbour who cite an advantage to predicting both consumed and preferred recreation behavior.

> Estimating recreation demand in this way would permit the planning analyst to specify the demand which may occur under a certain set of circumstances, and also the demand which may be left unexpressed and consequently go unsatisfied.[11]

The more that can be learned about participation or consumption brings the investigator closer to determining total demand, further reducing the magnitude of the unknown latent demand. It is total demand rather than participation alone that must be predicted to insure optimum allocation of outdoor recreation resources.

The O.R.R.R.C.'s National Recreation Survey[12] elicited respondent activity preferences as a measure of dormant demand to supplement participation data.

> . . . we proposed to examine the pattern of preferences for outdoor activities as expressed by the population, both in terms of the activities generally preferred (1st, 2d, and 3d choices combined, and preferences expressed in terms of particular outdoor occasions. The latter are a vacation, a trip, a day's outing, and an occasion of only 2 to 3 hours duration. For the summer season only, some of the socioeconomic characteristics of the population may be examined in relation to their preferences.[13]

---

[10] Ibid., p. 49.

[11] U.S., Federal Water Pollution Control Administration, Water-Oriented Recreation--A Study of the Recreation Benefits Derivable from Various Levels of Water Quality of the Delaware River, p. 11.

[12] U.S., Outdoor Recreation Resources Review Commission, National Recreation Survey (Washington, D.C.: U.S. Government Printing Office, 1962).

[13] Ibid., p. 4.

Reid[14] hypothesizes that human preferences might be a better criterion for decision making than use of attendance or other consumption data. Since preference studies seek to identify human wants and desires, it is possible to reveal that people do in fact prefer recreation opportunities other than are in existence. Studies based on consumption data are insensitive in that they equate consumption with human satisfaction. By introducing the wants and desires of both participants and non-participants, the researcher adds a dimension to demand analysis that may improve the accuracy of prediction. In revealing a weakness in his nationwide study[15] of user desires, Reid underscores the belief that individual preferences are based on varying normative value schemes due to differences in background, experience, and motvations. Rather than assume a homogeneity in experience and background among all users, he suggests the formation of identifiable groups based on similar values, attitudes and/or beliefs as illustrated by Anderson[16] in the User-Resource Recreation Planning Method.

> . . . studies which deal with preferences based upon more or less homogeneous groups displaying specified behavioral or motivational characteristics are equally applicable to origin (home) as to on-site (recreation area) study.[17]

Preference data cannot be solely equated with demand data because what people verbalize as their recreation wants and what they choose to participate in are

---

[14] L. M. Reid, "Utilizing User Preferences in Predicting Outdoor Recreation Demand," Recreation Research (Washington, D.C.: American Association of Health, Physical Education and Recreation, 1966), pp. 86-93.

[15] L. M. Reid, "Outdoor Recreation Preferences. A Nationwide Study of User Desires" (unpublished Ph.D. dissertation, Michigan State University, East Lansing, Michigan, 1963).

[16] National Advisory Council on Regional Recreation Planning, A User-Resource Recreation Planning Method (Hidden Valley, Loomis, California: National Advisory Council on Regional Recreation, 1959), pp. 27-32.

[17] Reid, "Utilizing User Preferences in Predicting Outdoor Recreation Demand," Recreation Research, p. 88.

often not the same. Preferences can be elicited from survey respondents with varying degrees of sophistication, but the question remaining is how can this variable be measured and weighted for use in a regression prediction equation. Human preferences are considered a critical component of demand, but the value of such a consideration is seriously diminished by lack of quantitative means to measure and weigh the magnitude of this variable.

Both social scientists and economists seek to measure the extent to which socio-economic and environmental variables influence total demand, participation or preferences. The identification, examination, measurement, and/or use of these variables has received considerable attention in the literature. With continued data refinement and variable definition, it will be possible to weight these independent variables and predict the total demand for any population or region using a regression equation. At present, we are only able to predict gross participation because of lack of agreement on shifter variables and their degree of influence on participation.[18]

On the site or project level, U.S. Senate Document No. 97, Supplement No. 1 provides the recreation resource planner with a range of values which can be assigned to predicted participation data and summed to determine total project recreation benefits. Herein lies a great challenge to economists. Through their work can these imputed values be substantiated and/or authenticated.

Approaches for Predicting Water Recreation Participation

Prediction of a Population's Participation

The O.R.R.R.C. was to "determine the amount, kind, quality, and location of such outdoor recreation resources and opportunities that will be required by

---

[18] U.S., Bureau of Outdoor Recreation, An Interim Method for Projecting Recreation Use of Outdoor Recreation Resources and Facilities in a Sub-Region (Washington, D.C.: Bureau of Outdoor Recreation, Department of the Interior, n.d.), p. 12.

the year 1976 and the year 2000."[19] The Commission "designed its fact-gathering to provide information about an array of outdoor recreation activities which could be projected into the future for the Nation, for large census regions, and for places of residence of various size."[20] Projections in this form could be readily related to data on the number and capacity of facilities available and could indicate the areas under greatest pressure. The O.R.R.R.C. thus provides a workable example of participation prediction for the many statewide planning efforts funded under the Land and Water Conservation Fund Act.

The common method of predicting participation by a given population is to multiply 1960 participation rates developed by the O.R.R.R.C. by projected population levels to arrive at the number of projected user-days of activity expected. Projections must then be adjusted by socio-economic multipliers. This method, however, will produce gross predictions which are inadequate because: (1) a relative constance in social and environmental factors is assumed, (2) the amount of recreation consumed within the state by out-of-state populations is ignored, and (3) the established participation rates are a reflection of a unique opportunity level. The use of socio-economic and environmental variables in a linear regression equation to predict participation is used least in statewide and regional planning because of the mathematical complexities involved.

The procedures used in compiling demand data in the Wisconsin Outdoor Recreation Plan are representative of most statewide planning procedures:

1) Projections of county populations and non-resident visitors, by five age groups (12-17, 18-24, 25-44, 45-64, and 65 and over) for the years 1980 and 2000 based on 1960 census data.

---

[19] U.S., Outdoor Recreation Resources Review Commission, Prospective Demand for Outdoor Recreation, p. 1.

[20] Ibid., p. 2.

2) Application of activity participation rates, most of which were derived from O.R.R.R.C. data for the U.S. North-central Region. "These were adjusted for the situation in Wisconsin where evidence from past surveys showed slightly different rates for some activities."[21]

3) Conversion of the data to average summer Sunday figures, in order to determine peak demand. "This method provides projections by activities of participation rates for the years 1980 and 2000 including both resident and non-resident demand, at peak periods."[22]

4) Determination of the distribution of projected demand by counties using the distance factor.

In the Wisconsin Plan, demand data for the years 1967 and 1972 were determined by linear projections between the 1960 and 1980 data.

Prediction of Site Consumption

The outdoor recreation experience must be consumed at the site where produced. This is the justification put forward for "site demand analysis" studies. These studies are usually concerned with consumption as a reflection of available resource supply.

> Projections of consumption figures are really then projections of demand with some implied relation of demand and supply. What is implied is that recreation consumption will increase, and that this increase is based on a shift or increase in demand and expanding levels of supply. As long as these relationships are understood there is considerable merit, for planning and policy guidance, in examining the likely trends of future recreation participation. In so doing we are principally interested in projecting the use rate expected to prevail in the future, given some assumption about the availability of facilities relative to the growing population and to other circumstances and characteristics of this population.[23]

---

[21] Wisconsin, Department of Natural Resources, Wisconsin's Outdoor Recreation Plan (Madison, Wisconsin: Department of Natural Resources, 1968), p. 358.

[22] Ibid., p. 359.

[23] M. Clawson and J. L. Knetsch, Economics of Outdoor Recreation (Baltimore, Maryland: The Johns Hopkins Press, 1966), pp. 115-116.

Lee hypothesizes that market demands for outdoor recreation confronting sites "are open to the same conceptual interpretation in assessing consumer preferences as market demands for other goods and services."[24] His discussion of consumption and product differentiation is based on the facts that outdoor recreation experiences are far from homogeneous from a demand standpoint "and in an important sense the product produced is identifiable with site of production."[25]

Having established that consumption is something less than demand, present use or attendance data are used to project future consumption. There is considerable disagreement whether site use or market area data are proper inputs for making projections of on-site consumption. The B.O.R. projects water use on the basis of regional participation rates, not on the basis of only those who participate in outdoor recreation at the water resource. The B.O.R. used one-half the market area radius to delineate the participating population because they assume participation on the site diminishes with distance from the site.[26] Alternately, Crane[27] is concerned with projecting potential use for a project rather than projecting demand from a market area.

Several studies investigate methods commonly employed for projecting recreation consumption at existing and proposed recreation sites. First of all, there is uncertainty in what is being measured and projected. Cesario

---

[24]I. M. Lee, "Economic Analysis Bearing on Outdoor Recreation Development," Economic Studies of Outdoor Recreation, O.R.R.R.C. Study Report 24 (Washington, D.C.: U.S. Government Printing Office, 1962), p. 8.

[25]Ibid., p. 8.

[26]U.S., Bureau of Outdoor Recreation, An Interim Method for Projecting Recreation Use of Outdoor Recreation Resources and Facilities in a Sub-Region, pp. 5-6.

[27]D. A. Crane, Progress Report, Corps of Engineers Recreation Data Collection and Research Program (Sacramento, California: U.S. Army Corps of Engineers, 1967), p. 13.

notes that "the visitor day is often specified as a measure of use of a recreation site, but there is surprisingly little agreement on what a visitor-day is, or how to go about measuring one."[28] Such lack of consistency in use measurement is the topic of a remedial report prepared by the U.S. Recreation Advisory Council entitled A Uniform Method for Measuring and Reporting Recreation Use on Public Lands and Waters of the United States.[29] Crane describes the efforts of the U.S. Army Corps of Engineers in standardizing the units of recreation use measurement, definitions of recreation activity, and methods of data collection.[30]

Projections of recreation consumption at a site are accomplished by (1) predicting use on the basis of use trends at similar sites, (2) using a regression model calibrated with regression weights from past use data, (3) projecting present use data gathered by attendance and origin-destination studies, and (4) using 1960 recreation participation rates for a region in a step-down analysis to approximate future water project use. Advantages and weaknesses of these methods will be discussed.

The seemingly-logical and often used method for predicting visitor-days at proposed water recreation sites involves comparison of the proposed project's physical features with those of water projects in existence. When similar projects are discovered, use patterns can be determined from the existing project. The underlying assumptions of this method are: (1) physical facilities are the primary determinants of attendance levels and (2) water projects

---

[28] F. J. Cesario, Jr., "Appendix Q . . . Recreation," Final Report on Dynamic Model of the Economy of the Susquehanna River Basin, H. R. Hamilton, et al. (Columbus, Ohio: Battelle Memorial Institute, 1966), p. Q-2.

[29] U.S., Recreation Advisory Council, A Uniform Method for Measuring and Reporting Recreation Use on the Public Lands and Waters of the United States (Washington, D.C.: Recreation Advisory Council, 1965), p. 3.

[30] Crane, pp. 5-8.

with similar features will attract the same number of visitors. Although physical features of the site will certainly affect attendance levels, other interacting factors must also be considered in predicting use. This method ignores demand and spatial aspects of participation prediction.

Cesario focuses on the problem of estimating visitations to existing and proposed recreation sites in the Susquehanna River Basin using a regression equation calibrated with 1960 data from Pennsylvania and Ohio.[31] Entire sites were examined rather than individual activities at these sites. Cesario did not attempt to estimate the value of this predicted use. The refinement of regression models to predict site use is of highest priority.

Prediction of Area-Wide Participation

Anderson reviews planning techniques used to provide more adequate recreation opportunities. These methods include: (1) inventories of recreation resource developments to establish a ratio between the present service population and total acreage, (2) surveys to ascertain present recreation behavior of people, and (3) budget analyses to justify larger public expenditures for outdoor recreation resource development.[32] These planning methods are based mainly on planners' professional experience, gross estimates of participation and acreage needed, and planning standards. While these planning methods have proved adequate in the past, improved techniques must be developed if recreation development is to compete equally with other duly authorized project purposes of resource development.[33] This disenchantment with current planning practices is verbalized by Sessoms:

---

[31] Cesario, Jr., "Appendix Q . . . Recreation," Final Report on Dynamic Model of the Economy of the Susquehanna River Basin, p. Q-41.

[32] National Advisory Council on Regional Recreation Planning, p. 33.

[33] Ibid., p. 33.

> Planners and recreation specialists have for the past two decades relied primarily on standards which stress the relationship of the size of the area served with the number of people residing therein. This concept is no longer functional: increased mobility, leisure, and family income are bringing about rapid changes in our recreational patterns. A study of social variables which condition recreation pursuits is basic for the sound planning of recreation areas.[34]

In 1959 Anderson foresaw possibilities of demand estimation using census data. He stratified a service population in terms of variables defined with available census data. Using a random sample of the population, a relationship between selected variables and user groups could be determined. The recreation requirements of each user-group could be estimated with regular census projections.[35] The first comprehensive quantitative measurement and analysis of outdoor recreation behavior patterns was undertaken by the O.R.R.R.C. in 1962.[36] Their recommendations concerning stratification of a service population in terms of variables are in general agreement with Anderson.

> That recreation behavior is predictable only within wide ranges when persons are taken one at a time is no serious problem. The need is not to be able to say what any individual will do, but rather to estimate what individual behaviors will add up to when all persons are combined. The studies . . . have determined levels of activity within narrow margins for persons generally and have analyzed the underlying factors which seem to shape and structure demand for outdoor recreation in the time periods to which they apply.[37]

---

[34] H. D. Sessoms, "New Bases for Recreational Planning," Parks and Recreation, 48(1) (January, 1965), 12.

[35] National Advisory Council on Regional Recreation Planning, p. 34.

[36] U.S., Outdoor Recreation Resources Review Commission, National Recreation Survey.
U.S., Outdoor Recreation Resources Review Commission, Participation in Outdoor Recreation: Factors Affecting Demand Among American Adults (Washington, D.C.: U.S. Government Printing Office, 1962).
U.S., Outdoor Recreation Resources Review Commission, Prospective Demand for Outdoor Recreation.

[37] U.S., Outdoor Recreation Resources Review Commission, Prospective Demand for Outdoor Recreation, p. 2.

Clawson explains some of the underlying assumptions involved in stratifying a service population by independent variables to determine levels of activity:

> . . . any single individual may have a demand curve that is extreme in some form or other, but a large number of people will have a predictable and measurable reaction to an outdoor recreation opportunity. If we can measure the demand curve for a large group of people, then it is probable that another large group, chosen more or less at random but with similar characteristics to the first group, will respond in similar fashion to costs and other characteristics of the recreation experience. This assumption as to predictability or stability of reaction to similar factors of cost and value is basic to all demand curve analysis and, in fact, to all studies of human action. It is an assumption of rationality, not of irrationality, of response.[38]

Alternately, Crane suggests an overemphasis in the relative importance of socio-economic factors in the planning process:

> . . . socio-economic factors are certainly important elements in recreation use. However, it appears they are relatively constant, at least within geographic regions. If the socio-economic factors are considered within the context of mean disposable income rather than total income and the cancelling effects of regional social constraints are also considered, these factors may be relatively constant nation-wide and subject to objective analysis based on measurable use of available recreation supply. There are, of course, notable exceptions where these factors are far from normal but they can also be measured objectively and correlated with the socio-economic norm.[39]

The O.R.R.R.C. focused on socio-economic factors related to recreation participation. Although some socio-economic factors were found to be significantly related to participation, these analyses did not account for a large proportion of variance.[40] This suggests that additional factors remain to be determined and measured prior to accurate prediction of recreation participation using regression equations.

---

[38] M. Clawson, Methods of Measuring the Demand for Outdoor Recreation, Reprint No. 10 (Washington, D.C.: Resources for the Future, Inc., 1959), p. 15.

[39] Crane, pp. 13-14.

[40] The Outdoor Recreation Resources Review Commission established quantitative relationships between participation and the variables age, race, sex, and place of residence. U.S. Outdoor Recreation Resources Review Commission, Prospective Demand for Outdoor Recreation, p. 2.

Prediction of area-wide participation requires identification and quantification of all factors influencing participation. The most promising technique for quantification of variables influencing behavior appears to be multiple regression. When all variables are weighted, they can be manipulated in linear regression equations and other probability techniques to predict area-wide recreation participation.

Using a linear regression model, Storey[41] refines the process of predicting area-wide participation[42] by using physiographic and climatic variables along with established socio-economic variables. In demonstrating the usefulness of his method, he concludes that geographic region and climate are important factors in predicting participation in all water recreation activities.

> Since correlation is highest for coefficients for those activities which are the most popular (picnics, swimming, hunting, fishing, automobile riding, boating and canoeing, and camping), the model describes the data most accurately for these activities. This indicates the usefulness of the method of demand estimation for these activities for use in benefit allocation for resource development planning.[43]

Storey[44] demonstrates the practical use of a linear regression model by estimating present participation in outdoor recreation for the population of Christian County, Illinois. He uses 1963 participation data gathered by Abramson[45] for comparative purposes. Storey explains disparity between his predicted estimate and Abramson's data:

---

[41]E. H. Storey, "A Method of Estimating the Demand for Outdoor Recreation" (unpublished Ph.D. dissertation, University of Illinois, Urbana, Illinois, 1964), pp. 1-2.

[42]Storey defines demand as follows: A schedule of the quantities [expressed in units of visitor-days] that would be taken at various prices, when the determinants of demand--buyers' incomes, buyers' taste and preferences and the prices of closely related goods--remain constant.

[43]Storey, p. 74.

[44]_Ibid._, p. 65.

[45]M. P. Abramson, "Participation in Outdoor Recreation: Factors Affecting Demand in Christian County, Illinois" (unpublished Master's thesis, University of Illinois, Urbana, Illinois, 1964).

> The use of five-year-old data from one study does not, therefore provide sufficient information on which to base current demand estimates using current census data in a linear model. While it is possible to project census data with reasonable accuracy, there is no basis upon which to project changes in the behavior patterns of people. It will be necessary to conduct similar studies at, for example, five-year intervals to provide a basis for the projection of changing outdoor recreation behavior patterns.[46]

Storey therefore recommends that future research efforts predicting participation: (1) focus on collection of accurate and recent data for use in regression models, (2) use regional stratification in collecting and assembling data on outdoor recreation behavior, (3) use standard census classifications in collecting and assembling data, and (4) secure data on changing outdoor recreation behavior patterns at five-year intervals.[47]

Variables Affecting Recreation Participation and Site Consumption

Socio-economic Variables

Two groups of determinants or shifters have been demonstrated as affecting outdoor recreation behavior. These groups are user-oriented socio-economic variables and environmental variables. It is imperative that these variables be identified and their influence on behavior determined.

> We know all too little about why different persons seek outdoor recreation, or what they hope to gain from it. And too often we have thought of recreation administration and management in terms of physical area, and not enough in terms of demand, and the user public. Just as modern marketing is turning to a study of what the consumer wants, expects, and is willing to pay for, so must modern recreation administration turn to a study of its consumers.[48]

The first group of variables are interrelated and act similarly[49] in inducing

---

[46] Storey, p. 70.

[47] Ibid., pp. 74-75.

[48] Clawson and Knetsch, Economics of Outdoor Recreation, p. 45.

[49] These variables are interrelated in several ways, e.g., people with higher incomes tend to have a high education, a skilled or professional occupation, and live in suburban areas.

increases in recreation behavior. User-oriented variables include income, amount of leisure time, education, occupation, age, race, and place of residence. The most universally accepted factors related to increased participation in water-oriented recreation are (1) increasing size of the population, (2) increasing mobility of the population, (3) increasing amount of leisure time resulting from the shorter work week and retirement at 65 or earlier, and (4) increasing per capita disposable income.[50] However, Moore notes that these accepted factors do not fully explain this pattern of increasing recreation behavior:

> The same trends might have led to rapid expansion along hundreds of quite different lines, all of which are equally open to consumers. Why water recreation? The social psychologists, the anthropologists, or the sociologists may someday explain it. Perhaps it is an adaptation of our frontier traditions to the conditions of modern life. It may be a reflection of a deep-seated desire for some activity in which the whole family can join. To some extent it may be a flight from urban living, or even from the new suburbs, to a more direct contact with nature. Water-centered recreation is often associated with less congestion and regimentation. Perhaps the tactile sensations-direct immersion in air, water, and sunshine with less screening from clothing-explain its appeal to many.[51]

According to Owens'[52] study of outdoor recreation behavior in a fifty-two county study region in Ohio, the most important quantitative variables in approximate order of their effect on participation are:

1) family income

2) length of workweek

3) number of family members

4) education of head of household

---

[50]M. Clawson refers to these basic factors as the "TIM" factor + P, that is, time, income, mobility plus population.

[51]A. L. Moore, "The Rise of Reservoir Recreation," Economic Studies of Outdoor Recreation, O.R.R.R.C. Study Report 24 (Washington, D.C.: U.S. Government Printing Office, 1962), p. 24.

[52]G. P. Owens, "Factors Affecting Demand for Outdoor Recreation" (unpublished Ph.D. dissertation, Ohio State University, Columbus, Ohio, 1965).

5) leisure committed to social activities, by head of household

6) age of participant

7) time spent by head traveling to and from work[53]

Beyond partially confirming Clawson's TIM factor + P, he agrees that participation is a function of age while also stating that participation was not necessarily a function of mobility factors he studied.

Several O.R.R.R.C. study reports focus on socio-economic variables thought to condition or determine outdoor recreation behavior. In the National Recreation Survey,[54] each water recreation activity is examined in terms of the socio-economic characteristics of its participants or people preferring the activity. This study assumes that unfulfilled demand for an outdoor recreation activity is reflected in preferences for an activity, even though the person may not so participate.[55] The National Recreation Survey expresses a concern for dealing with total demand; yet, their analysis did in fact focus on participation.

The O.R.R.R.C. revealed (1) which factors are most relevant in projecting future participation in outdoor recreation and which factors may be disregarded and (2) the approximate magnitude of influence of factors on participation.

Using a regression technique called multiple classification analysis, income, education, occupation, length of paid vacation, race, age, life cycle station, region, and place of residence only explain:

> about 28 percent of the variance in the activity scale for men and 29 percent for women. Probably a somewhat greater proportion of the variance in outdoor recreational activity would have been

---

[53] Ibid., p. 34.

[54] U.S., Outdoor Recreation Resources Review Commission, National Recreation Survey, pp. 20-30.

[55] Ibid., p. 4.

> explained if a more refined measure of participation could have been devised. In any case, it is clear that factors other than socioeconomic characteristics are major determinants of outdoor recreation activity.[56]

While considerable variance is unaccounted for, there is research value in determining the statistical significance of the relationship between outdoor recreation participation and each of the nine socio-economic variables. The results of future multivariate analyses can be compared with these results. Table 1 lists F-ratios separately for males and females.

TABLE 1

SIGNIFICANCE OF THE RELATIONSHIP BETWEEN OUTDOOR RECREATION AND SOCIO-ECONOMIC FACTORS[57]

Factor	F ratio: Males	F ratio: Females	5-percent level of significance	1-percent level of significance
Age of head	14.81**	18.19**	$F^{7}_{\infty} = 2.00$	$F^{7}_{\infty} = 2.64$
Race of respondent	13.65**	3.13*	$F^{3}_{\infty} = 2.60$	$F^{3}_{\infty} = 3.78$
Region	5.88**	3.44**	$F^{4}_{\infty} = 2.37$	$F^{4}_{\infty} = 3.32$
Place of residence	4.75**	4.01**	$F^{4}_{\infty} = 2.37$	$F^{4}_{\infty} = 3.32$
Education of head	4.20**	9.63**	$F^{8}_{\infty} = 1.94$	$F^{8}_{\infty} = 2.51$
Paid vacation	3.31**	0.66	$F^{8}_{\infty} = 1.94$	$F^{8}_{\infty} = 2.51$
Income	3.05**	6.98**	$F^{6}_{\infty} = 2.09$	$F^{6}_{\infty} = 2.80$
Life cycle	2.90**	3.21**	$F^{10}_{\infty} = 1.83$	$F^{10}_{\infty} = 2.32$
Occupation of head	2.34**	1.48	$F^{10}_{\infty} = 1.83$	$F^{10}_{\infty} = 2.32$

**Significant at the 1-percent level.

*Significant at the 5-percent level.

---

[56] U.S., Outdoor Recreation Resources Review Commission, Participation in Outdoor Recreation: Factors Affecting Demand Among American Adults, p. 27.

[57] Ibid., p. 29.

Age has the largest and most significant influence on participation for both sexes. For males, F-ratios for all nine variables were significant at the .01 level. For women, the variables occupation of head and paid vacation were not significant. While race was significant only at the .05 level, all other variables were statistically significant at the .01 level.

The O.R.R.R.C. reports variations in participation rates of individuals in relation to their ages, namely, the rate of participation decreases as the age of the individual increases. The rate of decline for fishing and boating is almost identical, while for swimming and picnicking it is much sharper. Tomazinis and Gabbour arrive at the following conclusions concerning age:

> in general, age is inversely proportional to the amount and intensity of participation. For an activity such as boating, the correlation between age and participation is independent of income. It is more likely due to health factors and interest in physical activity.[58]

Closely related to education as a determinant of recreation participation is occupation. Higher education implies better job opportunities and higher incomes which are highly correlated with boating activity and participation in other water recreation activities except fishing.

Using data from the National Recreation Survey to ascertain the relationship between socio-economic variables and water recreation behavior, the O.R.R.R.C. reveals that an increase in income (up to $10,000 annual mean income) is correlated with an increase in use of public outdoor recreation facilities.[59] Beyond this income level, individuals prefer activities usually found in the private sector.

---

[58] U.S., Federal Water Pollution Control Administration, Water-Oriented Recreation Benefits--A Study of the Recreation Benefits Derivable from Various Levels of Water Quality of the Delaware River, p. 53.

[59] U.S., Outdoor Recreation Resources Review Commission, Participation in Outdoor Recreation: Factors Affecting Demand Among American Adults, p. 10.

> water-oriented recreation activities retain their appeal to high income groups and, in fact, become increasingly popular when the annual income of the family is on the high side. These activities require relatively greater investment in time and money . . . and require more extensive and particular facilities . . . . In particular, income is at present the most important factor affecting boat ownership and indirectly affecting participation in boating recreation activities.[60]

Owens[61] investigates the effects of price and income upon participation. Respondents were asked about their participation in hypothetical cases where cost[62] is increased or decreased 25 percent from the actual cost. Means in these contrived situations were tested with the t-test against actual participation data previously determined. Further, means of actual participation, participation at higher cost, and participation at lower cost were plotted on demand curves. These contrived situations illustrate price elasticity[63] which represents consumer reaction to changes in cost to participate. Owens finds that powerboating and fishing are relatively unresponsive to cost decreases probably because of the participant's high financial investment in the activity in terms of equipment and time. Alternately, participation in swimming is considerably responsive to a cost increase but much less responsive to a cost decrease.[64]

---

[60] U.S., Federal Water Pollution Control Administration, Water-Oriented Recreation Benefits--A Study of the Recreation Benefits Derivable from Various Levels of Water Quality of the Delaware River, pp. 42-43.

[61] Owens, pp. 24-25.

[62] Cost is defined as user fees, license fees, transportation cost, food and lodging costs over and above costs normally accruing while at home and cost of recreation equipment purchased or rented.

[63] Price elasticity refers to the responsiveness of quantity purchased of commodity to change in price. A reduction in price usually results in an increase in the amount consumed. "If the increase in quantity taken is greater, percentagewise, than the decrease in price, demand is said to be elastic." Owens, p. 24.

[64] Ibid., p. 74.

Sex is considered a critical determinant of recreation participation. Men engage in outdoor recreational activities more than women.[65] However, this generalization cannot be made in regard to every specific activity. Owens concludes that sex is a significant determinant in such water recreation experiences as powerboating, canoeing-rowing-sailing, hunting, and fishing.[66]

Several reasons explain differential participation rates in water-oriented activities between white and non-white populations. These include a variance in attitudes toward water recreation, a differential availability of facilities, and variations in disposable income. In the northeast U.S. region, the O.R.R.R.C. found the percent of whites 12 years and older participating was higher than for non-whites in boating, swimming, and fishing. The opposite relationship exists with picnicking.[67]

The O.R.R.R.C.[68] determined the percentage of persons 12 years and older participating and their degree of participation in water recreation activities by area of residence.[69] The National Recreation Survey data revealed that an urban population not in a standard metropolitan area (SMA) demonstrated a greater percent of participation than residents of SMA's. However, in the highly urbanized northeast U.S. region, "the percent of persons 12 years and over participating in swimming appears to be higher where residents are within

---

[65] U.S., Outdoor Recreation Resources Review Commission, Participation in Outdoor Recreation: Factors Affecting Demand Among American Adults, p. 14.

[66] Owens, p. 34.

[67] U.S., Federal Water Pollution Control Administration, Water-Oriented Recreation Benefits--A Study of Recreation Benefits from Various Levels of Water Quality of the Delaware River, p. 55.

[68] U.S., Outdoor Recreation Resources Review Commission, National Recreation Survey, pp. 113-156.

[69] Residence is classified according to the following: (1) urban, SMA, over 1 million; (2) urban, SMA, under 1 million; (3) rural, SMA; (4) urban, not in SMA; (5) rural, farm, not in SMA; and (6) rural, non-farm, not in SMA.

an SMA rather than the contrary."[70] The intensity of participation (activity days per person) varies in a reverse manner. For all water-oriented recreation activities, the intensity of participation is higher in suburban and ex-urban areas than it was in cities. In the northeast U.S. region, the highest rate and intensity of participation among all residential locations occur in rural non-farm areas for swimming, boating, fishing, and picnicking.[71] The use of place of residence to predict participation is a good example of why participation should not be equated with demand for an activity. An insufficient supply of usable water may be hypothesized to exist in urban areas because of pollution and conflicting multiple-uses. These factors severely restrict opportunities for swimming and other water recreation opportunities. While participation is low, demand may be high. The O.R.R.R.C.'s participation data by place of residence reflects demand within the context of available resource supply. Therefore, while participation may be substantially higher in rural areas, existing swimming participation data together with the unexpressed demand for swimming in the urban area may make the urban area more deserving for recreation water resource development. In determining the percentage of persons 12 years and older participating and their rate of participation by place of residence, the O.R.R.R.C. leads the reader to assume that opportunity to participate in recreational activities is the same throughout each of the four survey regions. The weakness of such an assumption is apparent.

The O.R.R.R.C. uses a recreational opportunity rating to estimate the effect of existing recreation resource development on recreation participation. Such an instrument is imperative to place participation data within a proper

---

[70] U.S., Federal Water Pollution Control Administration, Water-Oriented Recreation Benefits--A Study of the Recreation Benefits Derivable from Various Levels of Water Quality of the Delaware River, pp. 56-57.

[71] Ibid., pp. 56-57.

perspective. However, the subjective nature of this kind of rating scale makes its use prohibitive:

> . . . in order to reduce the effect of rater bias, ORRRC attempted to get five independent ratings for each area. Recreational opportunity was rated for nine activities at each of the sixty-six sampling points on a five-point scale ranging from no facilities to very good recreational facilities. The rater was instructed to consider 1) the quantity and quality of physical resources, 2) the accessibility and development of these resources, 3) the relative degree of use made of such resources (crowding), and to rate present opportunities for the people of this area rather than potential opportunities.[72]

High opportunity ratings were determined for the western U.S.; yet complaints by survey respondents about lack of recreation resources were most frequent in the West. It is possible to conclude, therefore, that in areas with high opportunity for outdoor recreation participation people are stimulated to desire more development.

An interim method for projecting recreational use of outdoor recreation resources within a subregion has been developed by the B.O.R.[73] This method relies entirely on income, education, and age as the major factors influencing participation. "The gross influence on participation rates of the other factors included in ORRRC Study Report 19 was too erratic to be useful."[74] Regression weights are included that represent the relative importance of population characteristics to participation rates for selected activities by region.[75]

---

[72] U.S., Outdoor Recreation Resources Review Commission, Prospective Demand for Outdoor Recreation, p. 49.

[73] U.S., Bureau of Outdoor Recreation, An Interim Method for Projecting Recreation Use of Outdoor Recreation Resources and Facilities in a Sub-Region.

[74] Ibid., p. 12.

[75] Ibid., p. 10.

In developing use prediction models for U.S. Army Corps of Engineers Reservoirs in California, Johnston and Pankey[76] evaluate income, age, education, urbanization, and population of the zones (counties) from which recreationists come.

Others focusing on examination, identification, measurement, and/or use of socio-economic determinants as shifters of demand, participation, or use include McCoy, Gillespie,[77] Gahan, Stoevener and Guedry,[78] Goodale,[79] and Storey.

Environmental Variables

Environmental variables are less related to one another than socio-economic variables and appear to affect demand in independent and particular directions. Environmental variables relate the recreation participant and the environment. They include availability or accessibility of recreation resources in terms of distance, time, and cost of travel, attractibility in physical and attitudinal terms, transportation facilities, regional physiography and climate, existing opportunity, and saturation and competing opportunities. Storey observes the vital nature of the relationship between recreation behavior and environmental characteristics:

---

[76] W. E. Johnston and V. S. Pankey, "Use Prediction Models for Corps of Engineers, Reservoirs in California," An Economic Study of the Demand for Outdoor Recreation (San Francisco, California: Cooperative Regional Research Technical Committee, 1968), pp. 15-47.

[77] G. A. Gillespie, "An Evaluation of the Factors Affecting the Demand for Water-oriented Outdoor Recreation" (unpublished Ph.D. dissertation, University of Missouri, Columbia, Missouri, 1966).

[78] H. H. Stoevener and L. J. Guedry, "Sociological Characteristics of the Demand for Outdoor Recreation," An Economic Study of the Demand for Outdoor Recreation (San Francisco, California: Cooperative Regional Research Technical Committee, 1968), pp. 65-74.

[79] T. L. Goodale, "An Analysis of Leisure Behavior and Attitudes in Selected Minneapolis Census Tracts" (unpublished Ph.D. dissertation, University of Illinois, Urbana, Illinois, 1965).

> Just as the continuing satisfaction of outdoor demand depends upon the understanding and application of ecological principals, so does the future of mankind.[80]

Lee notes three important variables in outdoor recreation product differentiation: (1) the particular collection of activities accommodated at the site, (2) the quality of the recreation product associated with natural endowment of the site, and (3) accessibility to concentrations of population.[81] He further elaborates on the relationship between these variables and participation:

> . . . considering two sites on each of which it is technically possible to accommodate the same collection of recreation activities, the level and/or form of the demand relation confronting these sites may depend in an important way on both endowment and accessibility of the site.[82]

A variation in these determinants may also involve a corresponding variation in resource development costs.

> Physical features may set limits to capacity for certain activities at given sites, limits that could be altered only at very substantial resource costs. Similarly, accessibility of recreation facilities would usually not be independent of costs . . . .[83]

The prediction of demand is the primary reason for study and quantification of environmental variables. When the effects of socio-economic and environmental variables on participation are identified and weighted so as to account for a large proportion of total variance (R^2), linear regression techniques can be used to predict participation on a population, regional, or project basis. At the present time, there is general agreement on what the variables are but divergence on what to measure for each variable.

---

[80] Storey, p. 37.

[81] Lee, "Economic Analysis Bearing on Outdoor Recreation Development," Economic Studies of Outdoor Recreation, p. 7.

[82] Ibid., p. 7.

[83] Ibid., p. 8.

Since the O.R.R.R.C. did not analyze environmental factors affecting outdoor recreation participation, Lee theorizes that an appropriate regional breakdown of recreation resources would result in more within-class homogeneity in participation.[84] Storey tests Lee's theory to determine the effect of environmental factors and also to correlate these environmental factors to other socio-economic variables affecting recreational participation.

> . . . it seems obvious that the land-surface form of an area plays a significant role in the provision of many forms of outdoor recreation and that climate influences both provision of recreational opportunity and as a comfort or discomfort factor, may have significant effect on the rate of participation.[85]

Storey explores the influence of geographic factors by redefining regional classifications on the basis of land-surface form and climate.[86] Upon determining the influence and magnitude of these geographic factors, he uses environmental factors along with the O.R.R.R.C.'s regression weights for socio-economic factors in a linear regression model to estimate regional participation. Storey concludes that the geographical variable is significant as a shifter of demand or participation.

In an investigation of environmental factors affecting outdoor recreation participation in Christian County, Illinois, Abramson concludes that ease of access to outdoor recreation resources along with increased recreation resource development influenced participation.[87] As a result of recent water resource development, Abramson notes that: (1) participation in outdoor recreation was

---

[84] Ibid., p. 29.

[85] Storey, p. 16.

[86] The O.R.R.R.C. data was based on sampling within four regional classifications while Storey defines 17 geographic regions. "All but two of these regions contained at least one of the primary sampling units used by the Survey Research Center in obtaining the data used in this study. This enabled an analysis of the relationship of the two geographic factors, land form and climate, with participation in outdoor recreation."

[87] Abramson, p. 78.

strongly affected by driving distance to the impoundment, (2) recreation habits of people in the county have been affected by recreation resource development, and (3) purchase of recreational goods and services had been stimulated.[88]

For predicting consumption at a specific location or site, Owens discusses complementarity, competition, and distance factors:

> The enterprise's competitive position with regard to attractiveness of facilities, price, proximity to patrons . . . . Differences in fees and other costs to participate are probably much more important on the enterprise level than on an area or regional level.[89]

Cesario investigates the influence of the variables attractibility and accessibility.[90] Without origin-destination data available for the Susquehanna River Basin, he uses data gathered at state parks in Pennsylvania and Ohio. Using multiple regression analysis Cesario concludes that the proportion of variance in attendance levels can be attributed to environmental variables and upon weighting the variables, site attendance can be predicted.

The first environmental variable to be discussed is attractibility. Two attractiveness components, namely, the size of the recreation site in acres and the quantity of water available were found to be significant factors affecting use. However, interpretation difficulties arise because these two variables are highly correlated making it difficult to separate their effects. In Ohio, Cesario demonstrated the importance of the accessibility variable and, depending upon interpretation, the attractiveness variable. Alternately, attendance at Pennsylvania parks was found to be more related to attractiveness factors rather than to accessibility. Amount of water available for recreational use clearly demonstrated as a major use factor accounting for about 60 percent of

---

[88] Ibid., p. 79.

[89] Owens, p. 105.

[90] Cesario, Jr., "Appendix Q . . . Recreation," Final Report on a Dynamic Model of the Economy of the Susquehanna River Basin, pp. Q1-Q45.

variance compared to only 30 percent in Ohio.[91] The variety of recreation activities available and number of total acres were found to be critical components of attractability. With 78 percent of the variance accounted for, Cesario could not trace the magnitude and direction of the residual variance to any one factor.[92] A planning evaluation model, based on knowledge of physical constraints and behavioral assumptions regarding the propensity to visit a particular recreation facility has been developed by Ellis.[93] This model, called "RECSYS" is designed to deal individually with any recreation experience on a regional basis. Ellis assumes that on-site participation is positively related to attractiveness of that facility. Johnston and Pankey[94] view the attractibility determinant in terms of: (1) natural site attributes, e.g., size of the reservoir in land and water acres and seasonal changes in water area and pool level; and (2) man-made facilities, e.g., capital investment in recreation facilities, number of camp sites, and number of boat launching ramps.

Attractability as operationalized by Cesario, Johnston and Pankey, and Ellis does not include site quality as evaluated by site users. Instead they all evaluate site quality in an arbitrary manner. Munson[95] examines the opinions of providers and users about site quality for water recreation on eight small lakes in Arkansas, but he fails to relate peoples' evaluations to their recreation behavior. Did users rating a particular site low in quality

---

[91] Ibid., p. Q-40.

[92] Ibid., p. Q-40.

[93] Michigan Department of Conservation, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach (Lansing, Michigan: Department of Commerce, 1966).

[94] Johnston and Pankey, "Use of Prediction Models for Corps of Engineers Reservoirs in California," An Economic Study of the Demand for Outdoor Recreation, pp. 15-47.

[95] K. F. Munson, "Opinions of Providers and Users about Site Quality for Water-Oriented Recreation on Eight Small Lakes in Arkansas" (unpublished Ph.D. dissertation, University of Illinois, Urbana, Illinois, 1968).

return to that site and if so, how often? This question is unanswered. There is a critical need to redefine attractability because it can be logically hypothesized that physical quality of a recreation site as seen and evaluated by users is a determinant of site use. This view is shared and substantiated by Jones:[96]

> The "commodity" recreation comes into being because someone chooses to do something which he expects will give him an enjoyable experience. These expectations are not always realized. But if we accept the principle of consumer sovereignty, the decision to recreate, (and to pay the price in terms of time, distance travelled, and other costs)--this decision is based on his expectation of receiving an experience which will provide the recreator with a certain amount of pleasure or satisfaction. What amount we cannot say and it is not important to the argument.[97]

In seeing the recreation experience either as good or bad, Jones suggests specifying the quality differential as high or low in order to evaluate the role of quality as a demand, participation, or use shifter. Jones' suggestion rules out a range of quality levels.

Besides attractability, distance to the recreation site is an independent variable in calculating a demand function because travel to a particular site is inversely related to time and monetary expense required to make the trip. Cesario found that attendance at Ohio sites was more related to site location in relation to population centers. The population residing within a 60-mile radius of the sites accounted for 29 percent of the variance in attendance levels.[98] Johnston and Pankey conclude that an increase in an adjacent population will result in a nearly proportional increase in water-based recreational

---

[96] D. M. Jones, "Intensity of User Participation as a Basis for Differentiating the Recreation Project," An Economic Study of the Demand for Outdoor Recreation (San Francisco, California: Cooperative Regional Research Technical Committee, 1968), pp. 85-95.

[97] Ibid., p. 89.

[98] Cesario, Jr., "Appendix Q . . . Recreation," Final Report of a Dynamic Model of the Economy of the Susquehanna River Basin, p. Q-31.

use.[99] In findings of the U.S. Army Corps of Engineers Recreation Data Collection and Research Program, Crane[100] clarifies the accessibility variable:

> However, distance traveled was the only practical way found to treat this factor with data of such magnitude. Analysis based on airline miles relative to use has shown very low correlation, while studies of road-distance traveled has consistently provided high correlations for day-use recreation activities . . . .[101]

Cesario agrees that air distance is an impractical measure of accessibility and suggests that travel time be used.[102]

In examining current collective water-oriented behavior patterns of the population residing within a twenty-four county region in East Central Illinois, Gahan hypothesizes that consumption is a function of population density and distance from opportunities.[103] He also investigates a second group of variables, namely, age, income, education, and others to determine if they moderate the influence of the hypothesized major environmental predictors of water recreation consumption.

> . . . it is suspected that age has a moderating effect upon the predictor variable distance, that is, people who are older would be less likely to drive longer distances to participate in water recreation activities than people who are younger.[104]

The results of Gahan's research are forthcoming.

Besides accessibility and attractability, Cesario investigates competing opportunities (what are the effects of alternative sites?) and saturation (what

---

[99] Johnston and Pankey, "Use of Prediction Models for Corps of Engineers Reservoirs in California," An Economic Study of the Demand for Outdoor Recreation, p. 36.

[100] Crane, pp. 14-16.

[101] Ibid., p. 15.

[102] Cesario, Jr., "Appendix Q . . . Recreation," Final Report on a Dynamic Model of the Economy of the Susquehanna River Basin, p. Q-40.

[103] Gahan, "A Regional Analysis of Factors Affecting the Demand for and Participation in Water-Oriented Recreation Activities," pp. 21-22.

[104] Ibid., p. 22.

are the effects of overcrowding?). The effects of these two variables were not clearly demonstrated by Cesario but this should not be taken to mean that they do not exist.[105] These variables must receive intensive research attention if we are to determine their affects on attendance levels.

While not identifying environmental variables related to recreation participation, the O.R.R.R.C. did identify variables which restricted participation in recreation activities. These variables included: (1) facilities overcrowded, inadequate, or distant; (2) lack of money, equipment, or transportation; (3) lack of available leisure time; (4) physical condition, age, or fear; and (5) other externally imposed restrictions.[106] The lack of available leisure time was the most restrictive factor upon participation in swimming, fishing, and picnicking; while in boating and water skiing the importance of a lack of leisure time was superseded only by financial restrictions. The lack of adequate or conveniently located facilities was the second major restrictive factor with regard to swimming, and the third with regard to boating and fishing.

In conclusion, the environmental variables, accessibility (distance, time, costs) and attractability, have received considerably more attention than any of the other environmental variables even though the operational definitions of these variables have varied widely. These two variables together are accepted as predictors of participation for short-term projections. The two environmental variables, competing opportunities and saturation, have received the least amount of research attention; yet this data is necessary to making accurate long-range projections of demand. To understand and identify dormant demand for outdoor recreation, there is a need to better quantify the relationship

---

[105] Cesario, Jr., "Appendix Q . . . Recreation," Final Report on a Dynamic Model of the Economy of the Susquehanna River Basin, p. Q-40.

[106] U.S., Outdoor Recreation Resources Review Commission, National Recreation Survey, p. 177.

between levels of resource opportunity and recreation behavior. Others focusing on the examination, identification, use, and/or measurement of environmental determinants as shifters of demand, participation, preferences, or use include McCoy and Stoevener and Guedry.

Recreation Resource Supply

The Resource Inventory

An inventory and classification of water resources is essential to knowing the total scope of the resource, the rate at which it is being developed, and its characteristics. A quantitative evaluation of a resource's potential to support high quality recreation should be a part of the inventory process but this is usually ignored. The determination of a resource's physical potential and ability to satisfy members of various user groups is imperative if projected user group recreation requirements are to be quantitatively related to the resource base. Several forms of water recreation resources have been inventoried on national, regional, statewide, and local levels. Some notable inventories or classification schemes for inventories on the national level deal with shorelines,[107] estuaries,[108] reservoirs,[109] and water supply.[110] Statewide and regional inventories survey public and private outdoor recreation

---

[107] U.S., Outdoor Recreation Resources Review Commission, Shoreline Recreation Resources of the United States (Washington, D.C.: U.S. Government Printing Office, 1962).

[108] U.S., Federal Water Pollution Control Administration, National Estuarine Inventory Handbook of Descriptors (Washington, D.C.: U.S. Government Printing Office, 1968).

[109] U.S., Geological Survey, Reservoirs in the United States (Washington, D.C.: U.S. Government Printing Office, 1966).

[110] U.S., Geological Survey, Has the United States Enough Water? (Washington, D.C.: U.S. Government Printing Office, 1965).

areas,[111] boating facilities,[112] artificial surfacewaters,[113] rivers,[114] public waterbodies,[115] shoreline land use,[116] islands,[117] and lakes and ponds,[118]

The B.O.R. considers the inventory process a critical aspect of nationwide, statewide, and regional planning.[119] Therefore, all of the statewide comprehensive outdoor recreation plans contain an inventory of existing recreation resources.

---

[111]New Hampshire, State Planning Project, Land-Water-Recreation, Inventory of Public and Private Outdoor Recreation Areas (Concord, New Hampshire: State of New Hampshire State Planning Project, 1965).

U.S., Bureau of Outdoor Recreation, Water-Oriented Outdoor Recreation, Lake Michigan Basin (Ann Arbor, Michigan: Bureau of Outdoor Recreation, Department of the Interior, 1965).

[112]California, Department of Harbors and Watercraft, Inventory of Boating Facilities (Sacramento, California: Department of Harbors and Watercraft, 1966).

[113]Michigan State University, Preliminary Inventory of Michigan's Artificial Surface Water, Bulletin Number 12 (East Lansing, Michigan: Department of Resource Development, Michigan State University, 1962).

[114]Midwest Planning and Research, Inc., A Survey and Analysis of 24 Rivers in Minnesota (St. Paul, Minnesota: Midwest Planning and Research, Inc., 1966).

Minnesota, Outdoor Recreation Resources Commission, Recreational Use of Rivers and Streams in Minnesota, Staff Report Number 9 (St. Paul, Minnesota: Minnesota Outdoor Recreation Resources Commission, 1965).

[115]New Hampshire, State Planning Project, Land-Water-Recreation, New Hampshire Public Water Bodies and Public Access Points, Part 1, Report Number 4 (Concord, New Hampshire: State of New Hampshire State Planning Project, 1965).

[116]New Jersey, Division of State and Regional Planning, New Jersey's Delaware Bay Shore: An Inventory of Land Use (Trenton, New Jersey: New Jersey Division of State and Regional Planning, 1964).

[117]New Hampshire, State Planning Project, Land-Water-Recreation, Islands of New Hampshire, Report Number 15 (Concord, New Hampshire: State of New Hampshire State Planning Project, 1965).

[118]Vermont, Department of Water Resources, Inventory of Small Ponds in Vermont by Counties--Less than 20 Acres (Montpelier, Vermont: Vermont Department of Water Resources, 1966).

Vermont, Department of Water Resources, Inventory of Lakes and Ponds in Vermont by Counties--20 Acres or More in Area (Montpelier, Vermont: Vermont Department of Water Resources, 1966).

[119]U.S., Bureau of Outdoor Recreation, Planning and Surveys Series Manual (Washington, D.C.: Bureau of Outdoor Recreation, Department of the Interior, 1965), p. 260.4.3.

> The supply function of the recreation plan consists of an inventory of available outdoor recreation areas, both public and private, and determination of their capacities to accommodate people and provide them with recreation opportunities.[120]

There is, however, considerable variance in the usability and reliability of the supply data reported in these plans. Some of the plans merely quantify supply in terms of frequency, others talk in qualitative or descriptive terms, and others seek to transform existing resource frequency data into capacity data. To do the latter requires an understanding and implementation of concepts and methods that have received little research attention in the literature. The capacity aspects of the inventory process are often approximated for lack of carrying capacity standards or simplified through the use of invalid and arbitrary spatial standards. Most state outdoor recreation plans transpose supply data into capacity data, but the results are suspect because of methods used. An inspection of cited inventories reveal that they contain frequency counts of available resources rather than any mention of capacity. Descriptively they deal with physical measurement, e.g., number of adjacent land acres, number of water acres, miles of shoreline, number of campsites, number of beaches, etc. If demand and supply are to be meaningfully related to determine resource needs, inventory data must go beyond frequency counts of physical measures.

Relating Supply and Demand

The process of relating user requirements to recreation resource potential was conceptualized in the User Resource Recreation Planning Method and acknowledged by Chubb and Ashton[121] but practical use of this process depends heavily

---

[120] Midwest Research Institute, Missouri State Comprehensive Outdoor Recreation Plan (Kansas City, Missouri: Midwest Research Institute, 1967), p. 2.

[121] M. Chubb and P. Ashton, Park and Recreation Research: The Creation of Environmental Quality Controls for Recreation (East Lansing, Michigan: Department of Park and Recreation Resources, Michigan State University, 1969), pp. 4-5.

on quantification of physical and attitudinal considerations involved in determining carrying capacity. Planning guides are needed which convert frequency measures into capacity data to relate supply and demand. Instead of narrowly-conceived spatial planning standards, Anderson suggests planning guides that include criteria for locating recreation areas, environmental characteristics of recreation areas, and carrying capacities.[122] Without planning guides, the recreation resource planner is faced with the dilemma of knowing how much recreation has to be provided but not knowing how much land and water is necessary to support it. It is understandable why these planning guides will be crude after a review of the literature dealing with carrying capacity.

To identify the recreational potential of various resource types, Anderson suggests the random point method for determining the amount (in acres) of each major resource type that is present in a specific planning region.

> The random point method makes use of the fact that any point truly selected at random (according to the theory of random numbers) can be assumed to represent an area surrounding that point . . . . The amount of area that each random point represents is determined by the number of random points that are selected per unit area.[123]

Secondly, he estimates the extent of recreation opportunities in user-days per season that these resources can provide based on the quality of recreation experiences desired by users and based on an evaluation of site characteristics by activity.[124] This is the carrying capacity concept.

The recreation potential of a resource area (in number of user-days per season) is determined by multiplying effective acreage by its annual user carrying capacity.[125] Since the recreation potential of the resource area and the

---

[122] National Advisory Council on Regional Recreation Planning, p. 44.

[123] Ibid., p. 41.

[124] Ibid., p. 14.

[125] Ibid., p. 41.

demand for recreation are expressed in the same units of measure, it is possible to compare the two to determine the status of the demand-supply ratio and resource needs. Demand and supply can be compared for the present, 1980, 2000, and 2020 to provide the number of activity occasions or user-days not satisfied by existing or projected supply (need) or the excess capacity (idle supply).[126] Unfortunately, the User-Resource Recreation Planning Method involves a number of unknowns that must be investigated to make the method operational. Areas of study pointed out by Anderson that require more investigation are: identification of user groups on the basis of socio-economic determinants, resource types, and the development of planning guides based on resource carrying capacities that recognize both physical and attitudinal considerations.[127] This method must be made operational if recreation resource planning is to be effective.

Supply in Terms of Carrying Capacity

Carrying Capacity Defined

In a state-of-the-knowledge publication, Chubb and Ashton[128] provide the most definitive explanation and clarification of the carrying capacity concept. A review of other literature reveals agreement between Chubb and Ashton, Anderson,[129] Lucas,[130] and Wagar[131] concerning the scope of the carrying

---

[126] Midwest Research Institute, Missouri State Comprehensive Outdoor Recreation Plan, Vol. II, p. 104.

[127] National Advisory Council on Regional Recreation Planning, p. 14.

[128] Chubb and Ashton, Park and Recreation Standards Research: The Creation of Environmental Quality Controls for Recreation, pp. 58-62.

[129] National Advisory Council on Regional Recreation Planning, pp. 47-48.

[130] R. C. Lucas, The Recreational Capacity of the Quetico-Superior Area (St. Paul, Minnesota: U.S. Forest Service, 1964), pp. 5-22.

[131] J. A. Wagar, "The Carrying Capacity of Wildlands for Recreation," Forest Science Monograph (Washington, D.C.: Society of American Foresters, 1964), pp. 20-21.

capacity concept, namely, that physical, social, attitudinal, and behavioral factors are involved in establishing optimum-use limits.

> Outdoor Recreation Annual Carrying Capacity is the number of user-unit use-periods that the recreation site can provide in an average year without permanent biological or physical deterioration of the site's ability to support recreation or appreciable impairment of the recreational experience.[132]

While there is general agreement on the definition of carrying capacity, there is a further need to operationalize the phrase "appreciable impairment of the recreation experience." What level of dissatisfaction must exist among users for an appreciable impairment of the recreation experience to occur? This must be determined.

Chubb's definition of carrying capacity indicates that resource planning recognizes a carrying capacity that is partly dependent on what the user considers desirable in the recreation experience. Wagar concurs with the attitudinal aspects of carrying capacity:

> Whether land is used for recreation or for other purposes, the ultimate measure of proper use must be its provision for the fulfillment of human needs and desires. Thus even severe abuse of land and other resources is not wrong from the standpoint of the resources themselves, but because of the impact that deteriorating resources have on the fulfillment of human needs and on the sustained welfare of society. For evaluating recreational carrying capacity, comparing alternative uses of land, or for making other land-use decisions, human needs and desires provide the primary criteria for judgment.[133]

However, the use of attitudinal data elicited from various individuals in user groups is not precise because it has been determined that threshold levels of satisfaction vary within and between user groups.[134] In fact there is little reason to believe that the same experience will provide the same satisfaction

---

[132] Chubb and Ashton, Park and Recreation Standards Research: The Creation of Environmental Quality Controls for Recreation, p. 59.

[133] J. A. Wagar, The Carrying Capacity of Wild Lands for Recreation, p. 12.

[134] Lucas, The Recreational Capacity of the Quetico-Superior Area, pp. 22-23.

for another person or for the same person at another time. This fact would virtually eliminate the possibility of establishing any fixed carrying capacity standard to eliminate any "appreciable impairment of the recreation experience." Even if a satisfaction level is not precisely measurable, Wagar contends that its relation to numbers of people can be reasoned and roughly described from consideration of eleven basic human needs. Logically, Wagar draws a curve for each need plotting satisfaction against the degree of crowding. These two variables need to be related scientifically on the basis of actual attitudinal data.

Since a carrying capacity is primarily a management concept, the level of capacity can be manipulated to achieve optimum user satisfaction. Therefore, carrying capacity considerations have received more attention on the management level because of a dual concern for high-quality recreation and intensive use. After a careful study of user attitudes such as the one done by Lucas in the Quetico-Superior, the carrying capacity of the area as it is now managed can be determined. With such a capacity established, management policies can be established that increase capacity by redistribution of use and zoning without any appreciable decrease in satisfaction to users or change in management goals.

Within a planning or developmental framework, however, a potential recreation resource should be evaluated both in terms of the particular recreation experiences it is best suited physically to support and in terms of what "proxy" user groups consider desirable in their specific recreation experiences. The latter indicates a need to investigate the collective attitudes of water-oriented recreation user groups to establish some gross carrying capacity standards for their particular recreation experiences. The standards would be gross because: (1) attitudinal studies may not be indigenous to the site or region in question and (2) the recreation experience as evaluated by users is, in fact, closely related to the quality of a particular site.

Carrying Capacity Standards

Two user groups were investigated by Lucas in the Quetico-Superior wilderness area on the basis of their attitudes toward the importance of wilderness and other environmental qualities, the area considered wilderness, and the characteristics of the wilderness. He found that their attitudes toward overuse were polarized according to craft used--motor boat or canoe. Boating and canoeing carrying capacity standards based largely on user attitudes are developed by Lucas as a prerequisite to management manipulations:

TABLE 2

WILDERNESS CARRYING CAPACITY STANDARDS[135]

Area classification	Type of use: Canoes	Type of use: Boats and canoes	Level of wilderness
Underused	less than 300	none	"Full wilderness"
Transitional	300-600	1-200	"Half wilderness"
Overused	over 600	over 200	Not wilderness

It is not documented why there has been considerably more research on attitudes of wilderness recreation users in contrast to intensive use water recreation users. Activities indigenous to wilderness involve considerably less people than water recreation activities. Have wilderness user groups received more study because of an ability to control more factors in the simplified wilderness setting? Is wilderness use more dependent upon physical quality and the quality of the experience than other water recreation experiences? Is the wilderness user more discriminating or perceptive? Questions such as these can only be answered through intensive attitudinal studies of all

[135] Lucas, The Recreational Capacity of the Quetico-Superior, p. 23.

water-oriented recreation user groups regardless of whether an area is managed as a wilderness or intensive-use area.

In the Michigan Outdoor Recreation Plan, water recreation standards are based upon the carrying capacity concept that includes both physical and attitudinal aspects of capacity. These standards further recognize a daily "turnover factor" and three levels of use intensity in managing activity areas.[136]

Motor Boating

10 acres per boat--Intensive use.
20 acres per boat--Moderate use.
40 acres per boat--Light use.

Average boat contains 3 people

Water Skiing

20 acres per boat--Intensive use.
40 acres per boat--Moderate use.
60 acres per boat--Light use.

Average boat contains 3 people

Canoeing

10 canoes per linear mile--Intensive use.
5 canoes per linear mile--Moderate use.
2 canoes per linear mile--Light use.

Average of 2 people per canoe

Boat Launching Access

50 car/trailer per acre--Intensive use.
25 car/trailer per acre--Moderate use.
10 car/trailer per acre--Light use.

Average of 3 persons per boat[137]

---

[136]Michigan, Department of Conservation, Michigan Outdoor Recreation Plan (Lansing, Michigan: Michigan Department of Conservation, 1967).

[137]Ibid., p. 4.

While spatial or design standards[138] have been developed for swimming and fishing,[139] no management classifications or carrying capacity standards based on both physical and attitudinal considerations have been developed for these activities. This must be accomplished.

Carrying Capacity Inconsistencies

Unlike land-based activities that can be segregated by careful design, many incompatible water-based activities take place simultaneously on a waterbody. This fact makes carrying capacities by activity even more difficult to establish and utilize in the planning process. After studying cycles and fluctuations in recreation activity on selected Iowa lakes to analyze areas of present and future conflict between users, Haugen and Sohn[140] establish capacity standards for entire waterbodies together with zoning procedures[141] to minimize conflicts between user groups. In recognition of the multiple-use of waterbodies, it would appear more logical to develop standards based on the total use of the waterbody rather than by activity. This added complexity, however, has not received any substantial attention in the literature which is just now beginning to accept the carrying capacity concept based on physical and attitudinal considerations.

---

[138] Spatial standards establish how many uses-units can occupy a site at any one time with little concern with the effect of this use on the site's physical attributes.

[139] Wisconsin, Department of Natural Resources, Wisconsin's Outdoor Recreation Plan (Madison, Wisconsin: Department of Natural Resources, 1968), p. G-230.
U.S., Bureau of Outdoor Recreation, Outdoor Recreation Space Standards (Washington, D.C.: U.S. Government Printing Office, 1967), pp. 29-36.

[140] A. O. Haugen and A. J. Sohn, Competitive Recreational Uses of Selected Iowa Lakes, Completion Report of Project No. A-005-1A (Ames, Iowa: Iowa State Water Resources Research Institute, 1968).

[141] Guidelines for developing lake zoning regulations that regulate the quality of recreational use have been developed by G. T. Wilson, Lake Zoning for Recreation (Wheeling, West Virginia: American Institute of Park Executives, Inc., 1964).

Chubb and Ashton illustrate the lack of continuity in terminology pertaining to capacity and/or potential.[142]

> Some refer to merely spatial concepts; others involve site durability, user satisfaction, social considerations, and management improvements. Some include the time element.[143]

There is considerable difference between spatial or design standards and carrying capacity standards. Spatial capacity standards are seen by Chubb and Ashton as "the ability of an area of recreation land to provide recreation opportunities judged solely on the space available and the space required to make the activity concerned a satisfactory experience."[144] Spatial standards are usually developed from personal views and experience rather than on scientific study of site quality or human attitudes. Examples of spatial capacity standards used are reviewed in Outdoor Recreation Space Standards.[145] While heavily relied upon by recreation resource planners, these spatial capacity standards fail to consider the amount of use that can take place without significant physical deterioration of the site. The term "carrying capacity" as conceived by Chubb, Lucas and Wagar is highly misused in the literature. For example, the Missouri State Comprehensive Outdoor Recreation Plan mistakenly refers to spatial standards as measures of carrying capacity.[146] Their standards are only concerned with how many people can use a particular facility rather than any regard

---

[142]Chubb and Ashton, Park and Recreation Standards Research: The Creation of Environmental Quality Controls for Recreation, p. 53.

[143]Ibid., p. 53.

[144]Ibid., p. 57.

[145]U.S., Bureau of Outdoor Recreation, Outdoor Recreation Space Standards, pp. 24-36.

[146]Midwest Research Institute, Missouri State Comprehensive Outdoor Recreation Plan, Vol. II, pp. 17-19.

for either deterioration of site quality or the quality of the experience afforded. Similarly, the North Carolina Recreation Commission has developed a method for determining the annual carrying capacity for selected outdoor recreation areas and facilities which is based on a limited view of carrying capacity.[147] Their concept of carrying capacity similarly only reflects physical and layout considerations.

Recreation Potential and Regional Analysis

Introduction

Anderson's output values of recreation potential are stated in user days to which economic values can be easily attributed. Alternately, several appraisals have been developed which evaluate recreation potential of a region or watershed area on a numerical rating scale to enable a comparison with appraisals from other regions. These appraisal methods are more related to project or regional development than any area-wide planning process that balances demand and recreation resource supply to determine relative recreation resource needs. Furthermore, these methods are for the most part not concerned with physical or psychological carrying capacity or quantifiable user-resource relationships but focus entirely on evaluating an area in terms of those recreational uses for which it is best physically or esthetically (as determined by the rater) suited as opposed to other recreation uses or other uses in general. This singular focus on the physical characteristics of the environment is of limited value as it ignores all the socio-economic and environmental determinants of demand.

[147] North Carolina, Recreation Commission, A Method for Determining the Annual Carrying Capacity of Selected Types of Outdoor Recreation Areas and Facilities in North Carolina, Draft Copy (Raleigh, North Carolina: North Carolina Recreation Commission, 1968).

On a regional analysis scale Lewis,[148] MacConnell,[149] Dearinger,[150] U.S. Soil Conservation Service,[151] and the Craigheads[152] feel that there is a need to evaluate a site or a region to decide which recreation activities or resource uses are indigenous in terms of water quality, soil, landscape, and other indicators. The criteria for evaluation are almost entirely related to physical qualities. There is usually little attempt to identify, measure, or appraise factors related to the quality of the experience as reflected in human attitudinal or behavioral responses. Current factors, which are evaluated, are taken at face value as reliable measures of absolute site quality. Site quality as viewed by individuals and user groups, however, may be based on entirely different factors. Therefore, reliable measures of resource quality remain to be demonstrated in future research efforts.

---

[148] P. H. Lewis, Jr., "Quality Corridors for Wisconsin," Landscape Architecture, 54(2) (1964), 100-108.

P. H. Lewis, Jr. and Associates, Regional Design for Human Impact (Kaukoma, Wisconsin: Thomas Publishers, 1968).

Wisconsin, Department of Resource Development, Recreation Potential of the Lake Superior South Shore Area (Madison, Wisconsin: Department of Resource Development, 1963-64).

Wisconsin, Departmen of Resource Development, Recreation in Wisconsin (Madison, Wisconsin: Department of Resource Development, State of Wisconsin, 1962).

P. H. Lewis, Jr., Recreation and Open Space in Illinois (Urbana, Illinois: Illinois State Housing Board, 1961).

[149] W. P. MacConnell and G. P. Stoll, The Use of Aerial Photographs to Evaluate the Recreation Resources of the Connecticut River (Amherst, Massachusetts: College of Agriculture Experiment Station, University of Massachusetts, 1968).

[150] J. Dearinger, Esthetic and Recreational Potential of Small Naturalistic Streams Near Urban Areas (Lexington, Kentucky: Water Resources Institute, University of Kentucky, 1968).

[151] U.S., Soil Conservation Service, "Guide to Making Appraisals of Potentials for Outdoor Recreation Developments" (Washington, D.C.: U.S. Department of Agriculture, 1966).

[152] F. C. Craighead, Jr. and J. J. Craighead, "River Systems--Recreational Classification, Inventory and Evaluation," Naturalist, 13(2) (Summer, 1962), 3-19.

Appraisal Methods

Dearinger modifies an existing appraisal method developed by the Soil Conservation Service to evaluate esthetic and recreation potential of small streams and their watersheds adjacent to urban areas. The modified method is based on the principles of terrain analysis and land use planning, quantitative geomorphology, airphoto interpretation, the philosophy and psychology of value judgments, and economics of land use and outdoor recreation. Further, Dearinger's appraisal method:

> . . . recognizes twelve types of developments (recreation) and ten "key elements" that affect activities to a greater or lesser degree the potential of each type. Weighting factors or "multipliers" are assigned for all appropriate row and column positions of the ten by twelve development-key element matrix.[153]

The only water recreation activities studied by Dearinger include camping, fishing, and esthetic use. Using qualitative criteria value, judgments made by specialists are used to evaluate each of the key elements of a specific watershed area for the various twelve recreation activities. Once the ratings (value judgments) have been determined for each key element (physical and cultural factors) and activity, they are then multiplied by the weights. The sum of these products produces a value which expresses the esthetic and recreation potential for each selected activity in the watershed under study. This final output figure is then converted to a percentage so that comparisons of potential data within each watershed can be made. Dearinger applies his methodology to two similar watersheds in Kentucky to evaluate their recreation potential.

A comprehensive inventory and recreation evaluation of the nation's rivers was recommended in 1962 by Frank and John Craighead.[154] They developed a set

---

[153] Dearinger, pp. 13-14.

[154] Craighead, Jr. and Craighead, "River Systems, Recreational Classification, Inventory and Evaluation," pp. 32-43.

of criteria and rating forms to evaluate the fishing, boating, and hunting resources of each classified waterway. Their criteria deal with the following: environmental effect, populations, success or satisfaction, accessibility, crowding, research and management, seasons, conflicts, size, habitat, pollution or littering, hazards and barriers. It is worthwhile to note that some of their criteria, namely, success and satisfaction, conflicts, and crowding, deal with an individual's preferences and satisfactions. Gathering this data would require a survey of a regional population's collective attitudes toward a particular water resource. In their article, however, the Craigheads avoid this complexity and rely on arbitrary evaluation. Their methods of weighting these criteria differ slightly from Dearinger's methods in that they indirectly assign weights when they assign differing maximum values for criteria. The evaluator scores the various criteria separately and the sum of these numerical scores is a measure of quality of the particular recreation resource.[155] 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 or 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 participant's attitudes and behavior. To ignore the individual and his quality framework is to remain with an arbitrary and unreliable quality framework.

Greater intensity of use leads to an increasing economic value while the quality of recreational activities may diminish with increasing use intensity. This is an essential reason why recreational resource quality must be recognized, evaluated, and measured. There are numerous recreational resources such as

---

[155] Recreation resource refers to an interaction of people and environment which creates hunting, fishing, boating, and other recreation opportunities. Ibid., pp. 36-37.

wilderness areas and wild rivers where economic value must be determined on the basis of quality rather than intensity of use.

> The classification, evaluation and rating system we have proposed emphasizes the qualitative aspect of the water resource and its esthetic role, yet properly recognizes that use statistics and total quantity of the resource are also important considerations in a nation where mass recreation is well established and provides stimulation to the national economy, and important financial returns to regional and local economies.[156]

Several writers question whether numerical point evaluation techniques are accurate since they are relatively indiscriminating.

> Determination of the values is often an arbitrary decision, and it provides no real basis for the best use of limited funds for land acquisition or management. Poorly rated sites might be a better buy than highly rated ones when price and accessibility are considered.[157]

Regional Analysis Techniques

MacConnell and Stoll[158] investigate aerial photogrametric techniques for identifying and classifying river-based recreation sites on the Connecticut River. They prepare maps, catalog suitable sites for recreational use, and make recommendations concerning development. Their method does not deal with site use or carrying capacity nor does it appraise using a numerical rating scale to enable comparisons with other sites or regions. In many ways, the work of MacConnell and Stoll closely resembles that of Lewis and is subject to many of the same shortcomings.

Lewis utilizes a set of two hundred twenty map symbols, each representing an esthetic or recreation resource. Natural and man-made resources were found to occur in linear patterns across Wisconsin, i.e., along streams, ridges,

---

[156] Ibid., p. 43.

[157] Harvard University, Graduate School of Design, Three Approaches to Environmental Resource Analysis (Washington, D.C.: The Conservation Foundation, 1967), p. 90.

[158] MacConnell and Stoll, Use of Aerial Photographs to Evaluate the Recreational Resources of the Connecticut River in Massachusetts, pp. 1-17.

floodplains, and the like. The delineation and evaluation of these patterns by Lewis has led to a plan for a network of "heritage trails" in Wisconsin. Lewis focuses on the significant resource patterns that serve as form determinants of future impact within the region. He identifies corridors of environmental diversity as well as areas likely to be destroyed by future development. Lewis, McHarg, and Hills ignore the demand and locational aspects of planning and make development recommendations solely on the basis of physical characteristics of the environment. Such an approach is unrealistic. Data on environmental characteristics must be combined with regional demand data that reflects the participation and preferences of user groups.

In a visual survey of the Lake Superior shoreline in Wisconsin, Lewis and Fine[159] assign weights to values of various intrinsic and extrinsic recreation resources. The scale of weights is based on the authors' "best judgment of the relative weights that should be assigned to the different resources, bearing in mind the basic goals of public policy in the fields of conservation and recreation."[160] In Recreation in Wisconsin, Lewis identifies and maps patterns of water, wetland, significant topography, and all natural recreation resources capable of meeting recreation needs.[161] This data is broken down into a description of resource types, mileage involved, and judgments.

In a working document Three Approaches to Environmental Resource Analysis,[162] an interdisciplinary research team explored the environmental analysis approaches of P. H. Lewis, Jr., G. A. Hills, and I. L. McHarg to determine how they differ,

---

[159] Wisconsin, Department of Resource Development, Recreation Potential of the Lake Superior South Shore Area, pp. 8-10.

[160] Ibid., p. 9.

[161] Wisconsin, Department of Resource Development, Recreation in Wisconsin, pp. 20-44.

[162] Harvard University, Graduate School of Design, Three Approaches to Environmental Resource Analysis, pp. 7-74.

where they were both effective and ineffective, and make suggestions for additional research. In assessing the contributions of Lewis, Hills, and McHarg, the interdisciplinary research team makes the following statement:

> None of the three approaches provides for the adequate assessment of human needs, desires and environmental values; the authors did not intend to address this task. It is the responsibility of social and ecological scientists to develop adequate supplementary methods for incorporation into environmental resource inventories.[163]

While noting the importance of user preferences in recreation resource development, Lewis does not relate the weighting of various intrinsic and extrinsic recreation resources to human satisfactions as revealed through intensive attitudinal studies. To leave the realm of subjective judgment, Lewis' regional analysis methods must be combined with data concerning population's and/or user groups' attitudes, beliefs, and consequential recreation behaviors as related to specific resource types. The literature indicates that efforts are being made to relate peoples' attitudes and beliefs to their recreation behavior patterns and to investigate behavioral responses to various landscape forms.[164] If it is found that peoples' participation in water recreation is related to their attitudes and beliefs toward the quality of a particular waterbody, this must be included in a resource appraisal process together with demand prediction equations. Such a finding would also have important implication value for clarifying the value of carrying capacity, understanding latent or dormant demand for water recreation, and participation prediction on a site basis. Litton and Craik[165] are identifying visual landscape elements on the basis of interviews with recreation users and recreation resource planners. Their findings are awaited.

---

[163] Ibid., p. 89.

[164] Resources for the Future, Inc., Annual Report 1968 (Washington, D.C.: Resources for the Future, Inc., 1968), p. 52.

[165] Ibid., p. 52.

In the past it has been easy to plan recreation resources for people solely on the basis of arbitrarily-established planning standards or "rules of thumb." These "rules of thumb" were rarely concerned with peoples' attitudes because the relationship between attitudes and beliefs and consequential behavioral responses was not clearly established. When this relationship is established, however, economic and ecological implications will be evident in non-use or unbalanced use. While quantification of human behavior has long been a concern of the economist in his task of making resource allocation decisions, human attitudes and beliefs have not undergone the same scientific investigation. Due to difficulties involved in measuring attitudes, summarizing attitudinal data, and using this data in the planning process, human attitudes and beliefs have been largely ignored when analyzing a site or region. The work of Litton and Craik, Lucas, Louenthal and Fife,[166] and Shafer *et al.*[167] are growing indications that human attitudes will receive considerably more attention throughout the entire planning process in lieu of complete reliance on planning "rules of thumb" or the planners' framework of values.

Summary

Should demand and recreation resource supply be integrated or isolated? Are we more concerned with physical planning or human environmental planning? In the past planning done within a single discipline has isolated supply and demand components causing considerable inaccuracy and questionable results. Natural and physical scientists have developed their resource planning and development methods in a vacuum that fails to consider human ecological relationships. Their ability to predict use or attribute quality is diminished by

---

[166] Resources for the Future, Inc., p. 52.

[167] E. L. Shafer, Jr., J. E. Hamilton, Jr. and E. A. Schmidt, "Natural Landscape Preferences: A Predictive Model," *Journal of Leisure Research*, 1(1) (1969), 1-20.

a lack of attitudinal and behavioral data. This data is the responsibility of the social scientist. Alternately, planners, sociologists, psychologists, and economists have developed comprehensive methods of analyzing and allocating resources which reflect a minimum of environmental understanding.

Human-environmental planning requires an integrated and interdisciplinary approach as illustrated by the literature reviewed. Water resource recreation planning is not totally within the realm of the engineer, economist, ecologist, or social scientist but an effort of a combination of disciplines. Until all disciplines focus on problems of leisure and water resource recreation development using their own tools and methods, resource planning methods will continue to be insensitive to ecological complexities.

The extent of literature from the natural and physical sciences is far greater than from social science research but this must be reconciled if contributions from the natural sciences are to be meaningful. We cannot discuss water recreation or plan for it unless we consider man, his requirements, and the physical environment. Besides the relative consequences and costs of human behavior patterns upon the environment, we must comprehend and evaluate the effects of the environment upon the human condition.

CHAPTER VII

FACTORS INHIBITING THE RECREATIONAL USE OF WATER

Introduction

It is the intention of this chapter to specifically discuss the impairment of recreational uses of water by conflicting water uses. Since water-use conflicts are historically related to single-purpose and multi-purpose water development concepts, these two concepts will be discussed in terms of specific conflicting-use examples. Conflicts with water level fluctuation, domestic water supply, and waste disposal will be documented or logically developed in lieu of documentary support.

The term "pollution" will be defined in terms of user-resource relationships. After classifying pollutants by source (municipal, industrial, and other), the critical task will be to document physiological and psychological effects of pollution on man. Gaps or uncertainties in knowledge will be cited. This writer will go beyond the traditional substances said to affect recreational use to establish basic relationships requiring further investigation.

In addition to existing public health and safety concerns, emphasis will be placed on a need to assess peoples' attitudes toward conditions caused by interaction of conflicting water uses. It is felt that recreation-use requirements should be based on attitudinal and behavioral responses as well as physical, chemical, and biological conditions.

Conflicting Project Purposes

Conflicts between such uses as recreation and water supply, flood control, power generation, irrigation, and waste disposal uses are documented in the literature.[1] Prior to the 1962 U.S. Senate Document No. 97, which established recreation and fish and wildlife propagation as primary Federal water project purposes, few project development costs were attributed to recreation benefits. This change in allocation policy has generally permeated all other water planning levels. Regardless of recreation's new status as a primary project purpose, a single use can restrict or eliminate recreational use by making the waterbody physically inaccessible and esthetically displeasing.

There is a clear distinction between multiple-use coordination and multiple inclusion of project purposes. In the latter, there is no guarantee that recreation will be coordinated with other project purposes to maximize values besides those currently reflected in economic valuation. Multiple-use requires that uses be planned and coordinated to achieve a predetermined objective of providing the greatest benefits for the greatest number of people. Implementation of multiple-use as a planning and management concept is complicated by lack of: (1) accurate water quality and quantity criteria for recreation based

---

[1]U.S., Outdoor Recreation Resources Review Commission, Water for Recreation --Values and Opportunities (Washington, D.C.: U.S. Government Printing Office, 1962), pp. 21-40.

E. T. Van Nierop, A Framework for the Multiple Use of Municipal Water Supply Areas (Ithaca, New York: Water Resources Center, Cornell University, 1966).

F. Strenge, "Recreational Uses of Hydroelectric Reservoirs," Civil Engineering, 33(8) (August, 1963), 38-41.

R. Tocher, "Municipal Watersheds and Recreation: Conditions for Compatibility," Western Resources Conference, 1963 (Boulder, Colorado: University of Colorado Press, 1964), pp. 47-51.

American Water Works Association, "Recreational Use of Domestic Water Supply Reservoirs," American Water Works Association Statements of Policy (New York: American Water Works Association, 1967), pp. 15-16.

U.S., Federal Water Pollution Control Administration, Problems of Combined Sewer Facilities and Overflows, 1967 (Washington, D.C.: U.S. Government Printing Office, 1967).

J. K. Carswell, J. M. Symans, and G. G. Robeck, Status of Research on the Recreational Use of Public Water Supply Sources (Cincinnati, Ohio: U.S. Public Health Service, 1968).

U.S., Federal Water Pollution Control Administration, Biological Associated Problems in Freshwater Environments: Their Identification, Investigation, and Control (Washington, D.C.: U.S. Government Printing Office, 1967).

on physical, biological, chemical, attitudinal, and behavioral considerations and (2) an established relationship between recreation benefit values and varying water quality levels. While Federal water development agencies are authorized to implement multiple-use, this does not indicate that multiple-use is being practiced and coordinated. For example, a reservoir designed for flood control loses its effectiveness unless water held during flood flow is released to maintain storage capacity necessary for subsequent flood waters. Water that is released cannot be used efficiently for hydro-electric generation, irrigation, low-flow augmentation, or recreation. Likewise, reservoirs developed for producing hydroelectric power often result in intermittent storage and release of entire streamflow with implications for fish propagation, water supply, and waste disposal. Use of a stream for municipal or industrial waste disposal and agricultural return flows may conflict with almost all other uses. Residual nutrients in treated municipal wastes stimulate aquatic plant growth to the particular detriment of recreational use and water supply.

Water Level Fluctuation and Recreational Use

Water level fluctuation created by flood control, irrigation, and low-flow augmentation is incompatible with recreational use. During summer months when recreation participation is highest, water is released from reservoirs for these other project purposes. As water is withdrawn, silt and mud are exposed leaving boat docks, launching ramps, fishing piers, and other facilities non-operational. Also, fewer recreation users can be safely accommodated as water surface decreases and turbidity increases.

The O.R.R.R.C. related reservoir fluctuation to extent of recreation participation.[2] Fluctuation was found to have no apparent effect on recreation

[2]U.S., Outdoor Recreation Resources Review Commission, Water for Recreation --Values and Opportunities, pp. 21-32.

attendance. In fact, the O.R.R.R.C. suggested that recreation participation may even increase regardless of conditions caused by conflicting uses:

> But the available data say nothing about the quality of the recreation which they enjoy. Because people accept something less than the highest quality of experience does not mean that no cognizance need be taken of the quality of the recreational experience available. It is this quality aspect, however, that is difficult to characterize quantitatively, and because it is elusive it tends, therefore, to be awarded no value.[3]

It is suggested that an analysis of participant satisfaction supplement attendance as a determinant of recreation resource adequacy. Attitudinal effects on particular user groups must be determined. Water level fluctuations may eliminate some water recreation uses entirely or make them unacceptable to participants. In considering attitudes, the following questions need to be answered: Are people satisfied with their reservoir recreation experiences? Have experiences fallen short of expectations and/or has recreation behavior been modified as a result of diminished quality? An analysis of user group attitudes and behavioral responses to conditions precipitated by conflicting water uses could provide the insight needed for establishing optimum use-interaction requirements. These requirements could be established by an equitable combination of singular water-use requirements.

Some conflicts in water use can be lessened through integrated coordination and planning of multiple-uses of water. Without comprehensive quality and quantity requirements that reflect humanly acceptable conditions, recreation is regarded as a "very tolerant" water use when integrated with other uses. The psychological, physiological, and physical interdependencies of these comprehensive requirements justify interdisciplinary study. Recreation facilities can be developed that avoid problems of water inaccessibility. With research focusing on development of grasses that can survive inundation, unsightly conditions

---

[3] Ibid., p. 22.

associated with water level fluctuation can also be eliminated.[4]

Domestic Water Supply and Recreational Use

With growing awareness that effective water acreage is limited, there is a need for more efficient use of existing projects, originally designed and operated for a single purpose. While existing policy provides authorization for recreation as a primary Federal water development project purpose, municipal water supply purveyors oppose recreational use of domestic water supply on the basis of conflicting interests. However, water should be able to provide additional benefits without jeopardizing its original-use value. To ascertain if this is possible, research has focused on water recreation's impact on the quality of public water supply.

A review of literature reveals that the controversial multiple-use of public water supply reservoirs is more related to traditional agency policy than any specific research findings:

> . . . the differences are in interpretation: the California people are not concerned with a moderate contamination of their water supply because they filter it, whereas the New England purveyors wish to keep their supplies as pure as possible so that they may continue their present policies of no treatment or light treatment.[5]

The water supply industry considers recreational access to or use of public water supply reservoirs incompatible with supplying potable water because such reservoir policy would increase the risk of disease transmission. Legal liability and economic considerations are also cited. If recreational use of water supply is suspected or shown to be a cause of pollution, water supply agencies have either provided complete treatment or enforced regulations to

---

[4] D. D. Badger, "Recreational Aspects of Upstream Reservoirs," Paper presented at Sixteenth Annual Meeting of the Oklahoma Section, American Society of Agricultural Engineers, October 28, 1966.

[5] I. C. Reigner, Effect of Recreation on Water Quality, Report by the U.S. Department of Agriculture (Upper Darby, Pennsylvania: Northeastern Forest Experiment Station, n.d.), p. 50.

insure potable water with disinfection only. The latter precaution usually involves considerable restriction of recreational use.

Regardless of research findings, the American Water Works Association (A.W.W.A.) registered its opposition to legislation permitting or requiring recreational access and use of domestic water supply reservoirs and adjacent lands.[6]

> The determination of the kind and extent of recreational use shall be the sole responsibility of the water works executive of the system involved, whose primary obligation it is to provide a safe and potable water and subject only to existing police powers.[7]

After classifying[8] reservoirs, the A.W.W.A. established the following single-use policy:

> It is considered generally that recreational use of equalizing and terminal reservoirs and the adjacent marginal lands is inimical to the basic function of furnishing a safe and potable water supply to the system's customers and should be prohibited.[9]

Recreation is permitted only on multi-purpose reservoirs, but the A.W.W.A. notes that water withdrawn from these multi-purpose reservoirs for domestic water supply will be given the same complete treatment as those waters derived from polluted sources.

Several articles discussing arguments for or against recreational use of domestic water supplies appear in the technical literature. Considerable

---

[6] American Water Works Association, "Recreational Use of Domestic Water Supply Reservoirs," American Water Works Association Statements of Policy, p. 16.

[7] Ibid., p. 16.

[8] Four classifications of water supply reservoirs have been developed by the A.W.W.A.: (1) Equalizing reservoirs - reservoirs within an area served that deliver finished water ready for consumption to the distribution system; (2) Terminal reservoirs - areas providing end storage of water prior to treatment; (3) Upstream reservoirs - reservoirs providing storage of untreated water at various points in the watershed to provide or supplement the supply at the terminal; (4) Multi-purpose reservoirs - reservoirs constructed for purposes in addition to the supply of domestic water, over which the water purveyor does not have complete control. Ibid., p. 15.

[9] Ibid., p. 15.

variance between the public health,[10] Federal,[11] and operator[12] viewpoints is also documented. Articles or publications opposing the recreational use of water supply reservoirs are contributed by Van Nierop, Reigner, Karalekas and Lynch,[13] and Minkus.[14] After an investigation of public health considerations, Van Nierop recommends that direct body contact activities not be permitted under any conditions. He writes:

> For this reason, the use of canoes or sail boats has generally been discouraged due to the allegedly greater danger of these craft dumping their occupants. If boating on reservoirs is considered, it should be limited to row boats which present no particular problem. Motor boats may cause damage to the reservoir shore line as a result of wave action. Furthermore, oil deposited in the water is difficult to remove by treatment processes. Only in the largest of reservoirs could their use be given consideration.[15]

After Reigner notes that recreation on New England reservoirs has been detrimental to water quality, he enumerates actions enabling the water supply purveyor to resist pressures for recreational use.

Articles or publications supporting recreational use of water supply

---

[10] T. D. McKewan, "Recreational Use of Watersheds, State Health View," American Water Works Association Journal, 58 (October, 1966), 1270-1272.

[11] F. B. Taylor, "Recreational Use of Watersheds, Federal View," American Water Works Association Journal, 58 (October, 1966), 1272-1274.

[12] A. P. Brigham, "Recreational Use of Watersheds, Operator's View," American Water Works Association Journal, 58 (October, 1966), 1260-1263.

[13] P. C. Karalekas and J. P. Lynch, "Recreational Activities of Springfield, Mass. Water Reservoirs, Past and Present," New England Water Works Association Journal, 79 (1965), 18.

[14] A. J. Minkus, "Recreational Use of Reservoirs," New England Water Works Association Journal, 79 (1965), 32.

[15] Van Nierop, p. 70.

reservoirs are contributed by Ongerth,[16] Dodson,[17] Beattie,[18] and Tocher.[19] Bacterial increases were generally associated with increased recreational use, but these increases were not large enough for Ongerth to conclude that water quality degradation was due to recreational use. Roseberry[20] attained similar results at Forrest Lake in Kirksville, Missouri. While no evidence of contamination due to recreational use was detected by Dodson in the San Diego water supply, their water supply was subject to filtration and complete treatment. Tocher observed that recreational use pressure exerted on a specific water supply reservoir depends on whether alternative opportunities for recreation exist nearby. His remarks reflect an understanding of demand determination not found in other water supply impact studies. Several convincing arguments in favor of multiple-use of water supply reservoirs are offered by Beattie: (1) most raw surface water used for drinking and household purposes is contaminated and is or should be treated anyway, (2) most objections to recreational use of water supply are based on esthetic arguments, (3) technology is available to provide the necessary treatment safeguards required for multiple-use, and (4) regulation and supervision of all uses permitted on a reservoir and adjoining lands together with proper water treatment procedures are better than unregulated recreational use of a closed water supply.

---

[16] H. J. Ongerth, "Watershed Management and Reservoir Use--Public Viewpoint," American Water Works Association Journal, 56(2) (February, 1964), 149-158.

[17] R. E. Dodson, "Recreational Use of Reservoirs in San Diego," American Water Works Association Journal, 55 (September, 1963), 1115-1119.

[18] B. Beattie, "Municipal Watersheds and Recreation Can Be Compatible," Western Resources Conference, 1963 (Boulder, Colorado: University of Colorado Press, 1963), pp. 37-46.

[19] Tocher, "Municipal Watersheds and Recreation; Conditions for Compatibility," Western Resources Conference, 1963, pp. 47-51.

[20] D. A. Roseberry, "Relationship of Recreational Use to Bacterial Densities of Forrest Lake," American Water Works Association Journal, 56(1) (January, 1964), 43.

While most of previous arguments cited are based on a priori judgments and a minimum of scientific investigations, a review of literature reveals six major studies[21] that scientifically investigate the impact of water-based recreation on water quality. These field studies demonstrate the inadequate state of knowledge in this area. Conclusions from these studies range from little or no deterioration of water quality based on indicator organism densities to a moderate rise in indicator organism counts in high-density recreation areas. Natural dilution, bacterial die-off, and disinfection together with complete water treatment should provide the protection necessary to produce potable water from a source in which water recreation is permitted. Such protection, however, cannot be provided by disinfection alone. While investigation of impact was relatively inconclusive, it is still suggested in the literature that without adequate controls and water treatment recreational use is a potential health hazard,[22] capable of disease transmission.

The impact studies all generally suffered from the same weaknesses: (1) no

---

[21]California, Department of Public Health, Proceedings of the Conference on Recreational Use of Impounded Water (Berkeley, California: Committee on Research in Water Resources, 1957).

J. A. Little, Pearl River Shallow Water Reservoir Water Quality--Recreation Project (Atlanta, Georgia: Public Health Service, U.S. Department of Health, Education, and Welfare, 1963).

Roseberry, "Relationship of Recreational Use to Bacterial Densities of Forrest Lake," American Water Works Association Journal, p. 43.

Karalekas and Lynch, "Recreational Activities of Springfield, Mass. Water Reservoirs: Past and Present," New England Water Works Association Journal, p. 18.

Minkus, "Recreational Use of Reservoirs," New England Water Works Association Journal, p. 32.

U.S., Federal Water Pollution Control Administration, Indiana Water Quality --Recreation Project--Geist Reservoir--Indianapolis, Indiana (Washington, D.C.: Federal Water Pollution Control Administration, U.S. Department of Health, Education, and Welfare, 1966).

[22]For example, Van Nierop indicates that while available evidence indicates that recreation activities have been combined with the provision of water supply without apparent ill-effect, he could find no direct data to prove the case either way. "A potential hazard remains and the notion that water treatment processes are sufficient for providing 'safe' water is debatable." Van Nierop, p. 5.

control groups were included in research designs, (2) most field studies were done when measurement of total coliform density was the only bacteriological pollution indicator system available, and (3) studies were done before adequate methods for measuring bacterial and viral-pathogen water content were available.

Together with public health concerns, there are economic considerations[23] involved in permitting collateral use of municipal water supply reservoirs. The costs involved in attaining established public health criteria in comparison to monetary benefits derived from recreational use are critical determinants of multiple-use economic feasibility. Recreation-related water treatment, development, and regulation costs must be borne by either the municipality or reservoir recreation users.

To justify their arguments against recreational use, municipal water supply interests have demonstrated a lack of "demand" for public access to water supply reservoirs. This situation, if true, would seriously diminish the economic feasibility of multiple-use. However, their concept of demand is extremely limited. For example, Van Nierop investigated pressures to use water supply areas by surveying municipal leaders to determine the number of "requests from local people."[24] Application of area-wide demand analysis techniques by a regional planning agency is an imperative prerequisite to any analysis of economic feasibility. In addition, a survey of water consumer attitudes toward treatment precautions and esthetic effects caused by recreational use will provide necessary attitudinal data for predicting total demand. If recreation user requirements can be satisfied with existing regional recreation resource supply, the need for an open reservoir policy is diminished.

Regardless of economic or policy complications, present trends are toward

---

[23] Ibid., pp. 71-109.

[24] Ibid., pp. 104-105.

increased recreational use of municipal watersheds, especially where water supply is already receiving complete treatment. While many direct and indirect effects of recreational use are difficult to determine and/or unknown, potential hazards of disease transmission can be minimized by complete treatment and stringent control measures. These facts together with the previously cited research conclusions still do not make multiple-use any more acceptable to municipal water supply agencies.

Single-use management is closely related to the development policy and extent of authorization of a water supply agency. This is reflected in the questions: Why is a reservoir built and who paid for it? Many supply agencies suggest that when reservoirs were constructed to supply potable water, it is unfair to the public to authorize a multiple-use policy that may conflict with the primary project purpose. Therefore, the solution is to develop impoundments that are intended and financed for multiple-use with all necessary health safeguards.

While improvements can be readily made in research designs that determine the impact of recreational use on existing water supplies, much can also be accomplished by: (1) scientific examination of water consumer attitudes toward recreational use with adequate public health precautions, (2) accurate assessment of regional demand for water recreation together with assigned benefits expected to accrue from reservoir recreational use, and (3) development of coordinated multiple-use municipal water supply impoundments that optimize all purposes included.

Pollutants and Their Inhibiting Effects on Recreation

Pollution Defined

The A.W.W.A. defines polluted water as "an otherwise inoffensive water fouled by sewage or other liquids or suspensions rendering it offensive to sight and smell and unsatisfactory for potable, culinary, or industrial purposes."[25] Their definition, however, is not comprehensive enough because it recognizes only selected water uses. Bramer[26] provides a definition of pollution within a multiple-use framework: "The discharge of material that unreasonably impairs the quality of water for maximum beneficial use in the over-all public interest."[27] Bramer's definition implies that the extent to which materials discharged into water affects its beneficial use is the proper measure of pollution rather than the mere presence of offensive substances.

> Use of such a definition requires that an investigation of a water pollution problem include the determination of sources of discharged materials, the measurement of the kinds and quantities of such qualities, the evaluation of the effects on water quality as related to the impairment of beneficial uses and consideration of all of the consequences of abating (or not abating) pollution in one matter or another.[28]

It is not realistic to discuss "pollution" in general terms since determination of whether a substance creates a nuisance, impairs the usefulness of water, or interferes with ecological balance depends upon the subsequent use of water. Each water use should have comprehensive water quality requirements that identify pollutants and set acceptable pollution levels. Without these comprehensive requirements, many substances that logically affect recreational use and satisfaction may not be considered pollutants and, as such, receive a minimum of further investigation.

While the F.W.P.C.A. and other agencies are concerned with effects of various pollutants on water quality, there has been limited study of the

---

[25] American Water Works Association, Water Quality and Treatment (New York: American Water Works Association, 1960)., p. 29.

[26] H. C. Bramer, "The Economic Aspects of the Water Pollution Abatement Program in the Ohio River Valley," (unpublished Ph.D. dissertation, University of Pittsburgh, Pittsburgh, Pennsylvania, 1960).

[27] Ibid., p. 4.

[28] Ibid., p. 4.

quantitative relationship between water quality and physical and psychological impairment of recreational use. Reports studying the effects of pollutants on water quality and on the environment exclude man as a part of the environment. The concept that substances are pollutants when they affect man's recreational use of water has only been accepted within a public health and safety framework. Attitudinal effects and behavioral responses to potential pollutants have gone unnoticed. The implications of pollution are considered broad enough to require an interdisciplinary effort to establish water quality criteria. This dissertation will logically identify potential pollutants that may psychologically and physicologically affect man engaging in water recreation.

McKee and Wolf[29] consider any substance entering surface waters a potential pollutant--potential in the sense that, if in sufficient concentration, it can adversely affect waters for one or more beneficial uses.[30] Therefore, they review every known physical, inorganic, organic, and biological substance and note their effects on specific water uses.[31] Few relationships are established that relate polluting substances to recreational use of water because McKee and Wolf rely entirely on the existing water quality criteria for recreation. Other established recreation-water quality relationships are in qualitative terms and hence vague. While the effects of polluting substances on other water uses have been more accurately documented, no new recreation-water quality relationships were determined by McKee and Wolf. The effects of pollution on flatworms, trout fingerlings, and other aquatic life are studied as indicator organisms of man. For example, "water pollution specialists believe that when insecticides

---

[29] J. E. McKee and H. W. Wolf (eds.), Water Quality Criteria (Sacramento, California: State Water Quality Control Board, 1963).

[30] Ibid., p. 123.

[31] Ibid., pp. 123-392.

are not present in sufficient quantities to kill fish, they will not constitute a public health hazard in drinking water."[32] They contend that the effects of pollutants on man are largely unstudied because of a lack of investigation and measurement techniques for determining impact on aquatic life:

> It is an expensive, time consuming project to predict with confidence a new waste's probable impact on certain downstream water uses. Toxicological studies for determining the effect of repeated exposure to low concentrations of waste over various periods of time may take as long as two years.[33]

Regardless of the complexities involved, efforts to determine toxicological effects of pollutants must continue with man as the ultimate focus.

Pollution effects on recreation can be reviewed in several ways. These include: (1) effects on water quality, (2) effects on fish and other aquatic life, (3) effects on man's health and safety, and (4) effects on man's attitudinal and behavioral patterns. Porterfield lists some documented and undocumented effects on man from severe water pollution:

1) transmission of enteric diseases by water inadequately treated,
2) transmission of diseases by insects from polluted streams,
3) harmful reduction of individual water intake due to lack of water potability,
4) possible toxicity of chemical and metallic wastes,
5) neuroses caused by noxious odors from polluted streams,
6) spread of diseases by cattle and other animals having access to polluted streams,

---

[32] C. H. Hoffman, "How Should Agricultural Products be Controlled," Biological Problems in Water Pollution (Cincinnati, Ohio: U.S. Department of Health, Education, and Welfare, 1965), p. 255.

[33] B. B. Berger, "Research Needs in Water Quality Conservation," Algae and Metropolitan Wastes Seminar (Cincinnati, Ohio: Robert A. Taft Sanitary Engineering Center, 1961), p. 156.

7) loss of extensive recreational areas, and

8) economic changes.[34]

There are considerable gaps in information dealing with pollutional effects on man's physiological and psychological condition. These effects should be a legitimate research concern because recreation users must know in advance the effects of potential pollutants on direct body contact and indirect body contact with water. Therefore, this writer will review potential pollutants by source and will decide if their physiological and psychological effects on man engaged in recreation have been analyzed or discussed.

Pollution Classified

The Committee on Pollution of the National Academy of Sciences has broadly classified pollutants entering watercourses into eight categories: (1) domestic sewage and other oxygen-demanding wastes; (2) infectious agents; (3) plant nutrients; (4) organic chemicals such as insecticides, pesticides, and detergents that are highly tosic at very low concentrations; (5) other minerals and chemicals including chemical residues, petrochemicals, salts, acids, silts, and sludges; (6) sediments from land erosion; (7) radioactive substances, and (8) heat from power and industrial plants.[35]

It is more common, however, to classify wastes by source rather than specific nature because a particular waste may include a variety of pollutants. A convenient classification includes municipal, industrial, and other miscellaneous wastes. Since the waste problems of eutrophication and combined sewer overflows relate to more than one classification, efforts will be made to place problems in the more appropriate classification.

---

[34] J. D. Porterfield, Water Pollution, Its Effect on the Public Health, Proceedings, First Ohio Water Clinic Engineering Series Bulletin No. 147 (Columbus, Ohio: Ohio State University, 1952), pp. 34-39.

[35] U.S., Federal Water Pollution Control Administration, Biological Associated Problems in Freshwater Environments--Their Identification, Investigation, and Control, pp. 2-3.

Municipal Wastes: Implications for Recreation

Municipal wastes are derived from domestic sewage, industrial wastes discharged into municipal systems, surface runoff, and groundwater. The principal pollutional characteristics of these municipal wastes with implications for recreational use are: (1) increased amounts of nutrients, (2) oxygen-consuming organic matter, (3) suspended solids, and (4) pathogenic bacteria.

Many pollutants contribute to an overproduction of aquatic organisms that seriously affect man's health and welfare in a water recreation setting. Mackenthun and Ingram note that control of excess production of aquatic organisms is of prime importance to recreational water use. Overproduction is likely to remain an inhibiting factor unless basic causes are either reduced or eliminated through waste control.[36]

Wastes resulting from municipal, agricultural, and industrial sources contribute significant quantities of nutrient compounds that promote ecological imbalances leading to algal overproduction. An estimated 235 to 2,350 tons of phosphate are discharged daily into receiving waters from municipal waste sources in the United States.[37] Surface lakes and streams are becoming more densely populated by nuisance growths of aquatic organisms that multiply in response to specific changes in the aquatic ecological balance.

Four factors that influence this balance are: (1) concentration of suspended and dissolved organic and inorganic compounds, (2) availability of

---

[36]Eutrophication is a natural aging process of a water body, but through addition of wastes containing nutrients, the life cycle of the waterbody is accelerated and use is impaired. Accelerated eutrophication is defined by Martin and Weinberger as the state of a waterbody resulting from intentional or unintentional, natural or man-made modifications to the aquatic environment to the extent that the ecological system supports an imbalance in biological production and creates a nuisance or interference with water use.

E. J. Martin and L. W. Weinberger, "Eutrophication and Water Pollution," Publication No. 15 (Ann Arbor, Michigan: Great Lakes Research Division, University of Michigan, 1966), p. 451.

[37]<u>Ibid.</u>, p. 452.

these compounds as nutrient materials, (3) concentration of dissolved gases including oxygen, and (4) availability of sunlight. Overpopulation of aquatic organisms is highly related to man's activities that modify these four factors affecting aquatic balance.

Algae are individually microscopic, but they are visible when clustered in colonies. These organisms are vital because they form the base of the aquatic food pyramid. Inorganic elements required for algal cell growth include nitrogen, phosphorus, potassium, calcium, and iron as well as certain organic substances. Many of these required elements are contained in municipal waste discharges. Algal overproduction results in poor tasting water, odors, and unsightly conditions that inhibit recreational use of water. Gorham[38] considers the origin and development of toxic waterblooms of bluegreen algae and their effects upon water quality and man. Heavy concentrations of blue-green algae are cited as a possible factor in gastroenteritis epidemics. Effects of waterbloom ingestion can also be traced to nausea and allergic responses.

This overproduction can be controlled by waste treatment that reduces supply of one or more of the elements required for algal growth. Phosphorus is the most amenable to control.[39] This is significant because the F.W.P.C.A.'s laboratory and field experiments demonstrate that algal growth varies according to the quantity of soluable phosphates available.[40]

Besides taste, odor, and other esthetic conditions, accelerated eutrophication has several interrelated effects on recreation: (1) death and decay of

---

[38] P. R. Gorham, "Toxic Waterblooms of Blue-Green Algae," Biological Problems in Water Pollution (Cincinnati, Ohio: U.S. Department of Health, Education, and Welfare, 1965), pp. 37-44.

[39] U.S., Federal Water Pollution Control Administration, Great Lakes Region. Water Pollution Problems of Lake Michigan and Tributaries (Chicago, Illinois: Federal Water Pollution Control Administration, 1968), p. 22.

[40] Ibid., p. 22.

aquatic vegetation exerts an added dissolved oxygen demand on waterbodies. Dissolved oxygen (DO) is required for waste assimilation and sustaining aquatic life; (2) after degradation of organic materials, inorganic nutrients are released back into water, perpetuating the processes; and (3) since aquatic vegetation is essential in the aquatic food pyramid, imbalances in vegetation may induce imbalances in fish and other aquatic populations. It is therefore necessary to adopt criteria for nutrient concentrations and to apply nutrient control techniques to maintain an ecological balance that enables optimum recreational use of water.

The amount of Dissolved Oxygen (DO) desired in a waterbody varies according to use. "Many industrial users desire water with no DO to inhibit corrosion, but those who are concerned with control of water pollution strive to maintain maximum solubility of atmospheric oxygen in water."[41] DO is used as a primary indicator of pollution because oxygen levels in streams are directly dependent on the physical, chemical, biochemical, and biological activities occurring in water. Waterbodies get their oxygen supply from the atmosphere and to a lesser extent from photosynthesis of green aquatic plants.

Dissolved Oxygen in water can be exhausted by decay of algal overproduction and oxidation of excessive amounts of organic materials discharged in municipal wastes. Levels of DO are critically important to water's ability to support sport fish populations required for recreational use. While DO levels are high, bacterial populations have the ability to decompose organic materials discharged in municipal wastes. The water quality parameter Biochemical Oxygen Demand (BOD) is a measure of oxygen demand of sewage and industrial wastes determined by biochemical techniques. If the load of organic substances is sufficient to substantially reduce DO during decomposition, the bacterial population becomes

---

[41]U.S., Public Health Service, Analysis of Dissolved Oxygen in Natural and Waste Waters (Cincinnati, Ohio: U.S. Public Health Service, 1966), p. 1.

predominantly anaerobic:

> The decomposition of the organic material under anaerobic conditions results in the formation of organic acids, lower alcohols, methane, hydrogen sulfide, etc., which produce foul odors and the condition commonly known as putrefaction.[42]

Excessive amounts of sewage from municipalities are discharged into streams without adequate treatment because of combined storm and sanitary sewer systems.[43] Organic wastes must then be completely oxidized and assimilated in the receiving stream causing a depletion of DO. During storm periods, sewers and local treatment plants cannot cope with excessive combined flows. Therefore, much of this flow by-passes treatment and is discharged. Increased combined flow also flushes sludge deposits from sewers into streams. This discharge of solids is deposited as sludge banks on the bottom of the waterbody. Anaerobic decomposition occurs within sludge banks with detrimental effects on aquatic life and recreation potential.

At one time, sanitary engineers and public health officials felt that overflows were sufficiently small and diluted enough to not pose a water pollution problem. With increasing urban growth, this attitude and situation required investigation. The F. W. P. C. A. defined the number of combined sewer overflow points in every drainage basin, uses of waters receiving overflows, dilution rates, types of receiving waters, and frequency and duration of overflows.[44]

The type of recreational use near combined sewer overflows and resulting damages are noted. Major recreational uses occurring near overflows are indirect body contact activities (11.8 percent of total overflows) and fishing

---

[42] Bramer, p. 21.

[43] U.S., Federal Water Pollution Control Administration, Problems of Combined Sewer Facilities and Overflows, 1967 (Washington, D.C.: Federal Water Pollution Control Administration, 1967).

[44] U.S., Federal Water Pollution Control Administration, Problems of Combined Sewer Facilities and Overflows, 1967, p. 30.

(11.5 percent of total overflows). The use of separate sanitary and storm sewers is generally advocated by F.W.P.C.A. to prevent overflows. This system would separately convey domestic and industrial sewage to a treatment plant and would discharge storm runoff directly into a convenient body of water.

In addition to depleting DO and increasing amounts of suspended solids and inorganic nutrients, improperly treated sanitary wastes can also transmit water-borne diseases hazardous to man. While substantial amounts of pathogenic bacteria can be destroyed by disinfection, dangerous fecal coliform levels exist in waterbodies because of inadequate treatment and/or raw discharge. Excessive fecal coliform levels are considered a significant indicator of health hazards that accompany pathogenic bacteria and viruses. Many pathogenic bacteria live only a few days after being transferred in excreta of warm-blooded animals to a waterbody. Others having the ability to multiply through sporulation remain longer as potential health dangers because of an ability to adapt to extremes in environmental conditions.

> Associated with the municipal and industrial wastes resulting from the activities of man are pathogenic organisms including bacteria, viruses, toxic algae, leeches, worms, insect pests and parasites. All affect the use of waters for recreation.[45]

Harmful bacterial contamination levels and demand for recreational use often coincide near population centers making water quality regulation necessary to maintain public health. The critical task of controlling pathogenic bacteria is reflected in the water quality criteria and standards reported by McKee and Wolf[46] and the National Technical Advisory Committee of the F.W.P.C.A.[47] Water

---

[45]U.S., Federal Water Pollution Control Administration, Biological Associated Problems in Freshwater Environments--Their Identification, Investigation, and Control, p. 9.

[46]McKee and Wolf (eds.), Water Quality Criteria, Second Edition, pp. 118-122.

[47]U.S., Federal Water Pollution Control Administration, Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior (Washington, D.C.: U.S. Government Printing Office, 1968), pp. 3-16.

quality standards are most restrictive for direct body contact activities in which there is prolonged contact with water involving considerable risk of ingestion in quantities sufficient to pose a significant health hazard.

Fecal discharges from boats and other vessels are individually a minor contribution to contamination, but in waters with heavy boating use such discharges represent a direct health hazard that must be controlled in or near direct body contact recreation areas. Clark[48] studies wastewater characteristics together with methods and costs of treatment of sewage wastes from houseboats and other floating structures.

> Average daily houseboat wastewater quantities are similar to those for normal land residences with a daily per capita flow of 75 gpd. The average 16-hour flow is also similar with a per capita flow rate of 95 gpd.[49]

Since domestic waste discharges are of critical concern, numerous states require motor boats, houseboats, and other floating structures to treat their sewage before discharge or to retain wastes for complete removal to sanitary sewers on shore.

Industrial Wastes: Implications for Recreation

Unlike municipal wastes, industrial wastes cannot be characterized in general terms because they vary by industry and process used. Industrial chemical wastes may contain organic matter, suspended solids, toxic chemicals, and oily and acidic wastes. Several pollution problems will be reviewed as industrial wastes. These include thermal pollution, acid mine drainage, oil discharges, wastes from commercial watercraft, radioactive wastes, agricultural runoff, and pesticides.

---

[48] B. D. Clark, Houseboat Wastes--Methods for Collection and Treatment (Corvallis, Oregon: Pacific Northwest Laboratory, 1967).

[49] Ibid., p. 5.

Chemical Pollution

Industrial chemical pollution involves contamination due to oil, phenolic compounds, or other organic chemicals contributing to taste and odor problems; ammonia and other nitrogenous materials; phosphorus; suspended matter; and highly acidic or alkaline wastes. These chemicals can produce two effects: (1) local effects in the immediate vicinity of discharge and (2) progressive buildup of certain chemicals in an entire waterbody. Studies of various industrial processes by the F.W.P.C.A. focus on determining effects of pollutants on existing water quality.[50] Relying on established water quality criteria for recreation, they fail to investigate or define any new relationships between human use of water and levels of chemical pollutants.

Bodien[51] studied 158 plywood plants in the northwest United States that discharge an estimated 6.2 million gallons of waste per day from cleanup of glue mixing equipment and glue spreaders. The effluent is toxic and high in pollutional strength. ". . . Oregon rates this waste as their primary pollution problem based on number of complaints received."[52] Bodien determines the extent of problems created by glue waste disposal, analyzes the component makeup of glue wastes, and recommends treatment methods. While effects of glue wastes on stream ecology are examined, no quantification is made of their effects on direct body contact and indirect body contact recreation from either a health or human acceptance viewpoint.

---

[50] U.S., Federal Water Pollution Control Administration, The Beet Sugar Industry--the Water Pollution Problem and Status of Waste Abatement and Treatment (Denver, Colorado: Federal Water Pollution Control Administration, 1967).
U.S., Federal Water Pollution Control Administration, Plywood Plant Glue Wastes Disposal (Corvallis, Oregon: Federal Water Pollution Control Administration, 1968).
U.S., Federal Water Pollution Control Administration, Pollutional Effects of Pulp and Paper Mill Wastes in Puget Sound (Portland, Oregon: Federal Water Pollution Control Administration, 1967).

[51] U.S., Federal Water Pollution Control Administration, Plywood Plant Glue Wastes Disposal, p. 4.

[52] Ibid., p. 2.

The F.W.P.C.A. and the Washington State Pollution Board conducted investigations in four areas of Puget Sound that were concerned with pollutional effects of wastes discharged by seven pulp and paper mills. Since each of these mills discharges untreated or partially treated process wastes into estuarine waters, this study focuses on pollutional interferences with "legitimate" water uses. Pollution effects that occur in Puget Sound include: (1) toxic effects of pulp wastes on marine life, (2) disturbance of water quality (DO concentrations, pH values, etc.) near discharge, (3) sludge deposits formed by settled waste solids, and (4) esthetic impairment of water quality by colored, odorous, and turbid mill wastes.[53] The report focuses on effects of wastes on the marine environment, esthetics in qualitative terms, and sport fishing. The effects of industrial wastes on direct body contact and indirect body contact recreation pursuits are ignored, even though intensive recreational use with high economic value was noted.

The goal of high quality water should be more critical with regard to human use. The fact that maintenance of water quality is not an end in itself is demonstrated by the F.W.P.C.A.'s comprehensive water supply quality criteria. Future F.W.P.C.A. efforts must recognize that growing recreational use of water demands more comprehensive water quality requirements. These requirements must protect the participant's health and welfare, provide a satisfying recreation experience, and protect the important recreation values of water, as determined by study of participant attitudes and beliefs.

Thermal Pollution

Power plants that are not equipped with cooling towers for transfer of heat into the atmosphere usually discharge waste heat into water. Most steam-electric and atomic power plants use cooling water from waterbodies and return

---

[53] U.S., Federal Water Pollution Control Administration, Pollutional Effects of Pulp and Paper Mill Wastes in Puget Sound, p. 1.

it without temperature reduction. The electric power industry will continue to require substantial amounts of water for cooling in the future:

> This industry is increasing at the annual rate of 10 percent in the United States. A careful estimate of thermoelectricity production in the 1980's in the U.S.A. is 2,000 b.k.w.h. (billion killowatt hours). This will require 200 billion gallons of water per day of which about 6 percent will be used for boiler makeup water and 94 percent for cooling water. . . . in a quarter of a century about one-sixth of all runoff waters will be needed for cooling and makeup in steam-electric plants.[54]

Heat discharges produce two conditions with varying effects. These conditions include: (1) a local zone of water is created that is warmer than natural background water temperatures and (2) the temperature of an entire waterbody is raised slightly. In the former condition, where the local zone of water may be ten to fifteen degrees warmer than background lake temperatures, there are severe implications for the aquatic environment and recreational use. If the bottom of a waterbody has suitable attachment surfaces, overproduction of filamentous algae may result in accelerated eutrophication.[55]

These submerged aquatic plants and generally warm temperatures are two of the primary factors in promotion of schistosome cercariae. Mackenthun and Ingram document the effects of schistosome cercariae larval worms that originate from birds and mammals. The larval worms penetrate the skin of swimmers producing a dermatitis called schistosome dermatitis or swimmer's itch. The cercariae are free-swimming, colorless, 0.7 mm in length, and emerge from a snail host under optimum water quality conditions.[56]

---

[54]F. J. Trembley, "Effects of Cooling Water From Steam-Electric Power Plants on Stream Biota," Biological Problems in Water Pollution (Cincinnati, Ohio: U.S. Department of Health, Education, and Welfare, 1965), pp. 334-345.

[55]U.S., Federal Water Pollution Control Administration, Great Lakes Region. Water Pollution Problems of Lake Michigan and Tributaries, p. 32.

[56]U.S., Federal Water Pollution Control Administration, Biological Associated Problems in Freshwater Environments, Their Identification, Investigation, and Control, pp. 220-235.

Trembley studied the effects of heat discharge on the Delaware River biota and notes several findings with implications for recreational use and development. Most of the forty fish species in the discharge area under study were attracted to the heated water from September until June. He concluded that this "adds to the recreational value of these areas, since angling can be continued throughout the winter when there is little or no fishing in other areas."[57] However, since heat discharges are related to a loss in DO, it is very likely that game fish will be replaced by more tolerant rough species. No documentation was found in the literature that dealt with the physiologic and health effects of heat discharge on participants in direct body contact or indirect body contact recreational activities.

Acid Mine Drainage

In 1965, the 89th Congress enacted the Appalachian Regional Development Act of 1965 (Public Law 89-4) which authorized a study of strip and surface mining operations and their environmental effects.[58] Such a study was required because the U.S. Bureau of Sport Fisheries and Wildlife reported that 5,800 miles of streams and 29,000 surface acres of reservoirs were presently affected by surface coal mining operations.[59]

Following destruction of the soil's protective vegetative cover, the soil and rock overlaying mineral deposits are turned over and left in waste piles. These mining practices have led to landslides that block streams, pollution by acids and sediment, and serious impairment of esthetic and economic values. Pollution caused by surface mines involves acidity, alkalinity, or presence of

---

[57] Trembley, "Effects of Cooling Water from Steam-Electric Power Plants on Stream Biota," Biological Problems in Water Pollution, p. 336.

[58] U.S., Department of the Interior, Surface Mining and Our Environment (Washington, D.C.: U.S. Government Printing Office, 1967).

[59] Ibid., p. 67.

excessive concentrations of dissolved substances like iron, manganese, and copper. The effects of these concentrations on fish and other aquatic life include changes in physical condition, death, or suppression of reproduction. Surface mining wastes are also responsible for the following effects on water quality:

> Sulfur-bearing minerals are commonly associated with coal, and are a major cause of water pollution. When exposed to air and water, they oxidize to form sulfuric acid. This acid may enter streams in two ways: 1) soluable acid salts formed on the exposed spoil surfaces enter into solution during periods of surface run-off, and 2) groundwater, while moving to nearby streams, may be altered chemically as it percolates through spoil, or waste dumps.[60]
>
> Even in minute concentrations, salts of metals such as zinc, lead, arsenic, copper, and aluminum are toxic to fish, wildlife, plants, and aquatic insects. Indirectly associated with acid drainage are the undesirable slimy red or yellow iron precipitates ("yellow boy") in streams that drain sulfide-bearing coal or metal deposits.[61]

While the impairing effects of surface mining on water quality are reviewed, the relationship of inadequate or non-esthetic water quality to specific recreational uses is left to the reader to ascertain.

Oil Discharges

Oil discharges from industrial plants or commercial ships produce unsightly conditions at beaches and other water recreation areas, contribute to taste (taste of water and fish caught in water containing oil discharges) and odor problems, coat hulls of boats used for recreation, and are often toxic to desirable fish and aquatic life.[62] Health effects of oil concentrations in contact with man are as yet undetermined. The breaking-up of the ship Torry Canyon, which caused a major spill of oil off the coast of England in 1966,

---

[60] Ibid., p. 63.

[61] Ibid., p. 64.

[62] U.S., Federal Water Pollution Control Administration, Great Lakes Region. Water Pollution Problems of Lake Michigan and Tributaries, p. 34.

and the 1969 oil well leaks off the shore of southern California are bringing attention to the detrimental effects of oil contamination on recreation facilities, fish and wildlife, and associated economic values. These disasters establish the need to develop resources and techniques which could be brought to bear on further spills and leakage of this magnitude.

Commercial Watercraft Wastes

Commercial, recreational, and governmental vessels discharge quantities of untreated or inadequately treated wastes (sanitary, garbage, and oil wastes) in local harbors and in open waters that intensify problems of bacterial pollution and unsightly conditions. The F.W.P.C.A. has investigated the incidence of waste discharge from watercraft and made legislative recommendations for enforcement.[63]

Radioactive Wastes

The dilution, dispersion, and transport of liquid radioactive wastes in surfacewaters are considered critical factors in locating nuclear reactors.[64] However, effects of liquid radioactive wastes on humans engaged in direct body contact and indirect body contact recreational activities are undocumented. Using surfacewaters to dilute or transport radioactive wastes may be totally incompatible with recreational use or any human contact.

Agricultural Runoff

Pollution from agriculture includes: (1) soil erosion promoted by type and extent of agricultural development, (2) fertilizers contained in surface-water runoff, and (3) pathogenic bacteria carried in farm animal excreta.

---

[63] U.S., Federal Water Pollution Control Administration, Pollution of Navigable Waters of the United States by Wastes from Watercraft (Washington, D.C.: Federal Water Pollution Control Administration, 1967).

[64] U.S., Federal Water Pollution Control Administration, Great Lakes Region. Water Pollution Problems of Lake Michigan and Tributaries, p. 34.

In agricultural areas where soil is moderately productive, chemical fertilizers are applied and misapplied for high crop yields. Fertilizers contained in runoff provide waterbodies with an overabundance of nitrates, phosphates, and other nutrients. From samples taken in eight pilot watersheds in the Green Bay, Wisconsin area, the amount of total soluable phosphates annually reaching streams in runoff waters was about 1,167,000 pounds or about 0.1 pound per acre of watershed.[65] Based on findings such as these, the F.W.P.C.A. has established an acceptable phosphate level of 0.03 mg/l.[66] Nutrient values monitored above this standard stimulate algal blooms and other aquatic plant life.

Pesticides

The use of pesticides[67] in the United States has increased in recent years without substantial government controls:

> The total market value was over one billion dollars, for the first time, in 1964. Usage in the United States increased from 34 million pounds in 1953 to 119 million pounds in 1965. More than 58% of this usage was by agriculture.[68]

Pesticides have been so loosely controlled that much of man's environment has been infiltrated by these inorganic substances whose accumulative and toxic effects are relatively unknown. Investigation has not yet determined man's tolerance limits to these substances. Because the potential long-term effects of pesticides are virtually undocumented, pesticide levels must be established

---

[65] U.S., Federal Water Pollution Control Administration, A Comprehensive Water Pollution Control Program, Lake Michigan Basin, Green Bay Area (Chicago, Illinois: Federal Water Pollution Control Administration, 1966), p. 7.

[66] Ibid., p. 3.

[67] Hoffman, "How Should Agricultural Products Be Controlled?" Biological Problems in Water Pollution, pp. 255-261.

N. P. Nicholson, "Pesticide Pollution Studies in the Southeastern States," Biological Problems in Water Pollution (Cincinnati, Ohio: U.S. Department of Health, Education, and Welfare, 1965), pp. 262-265.

[68] U.S., Federal Water Pollution Control Administration, Great Lakes Region. Water Pollution Problems of Lake Michigan and Tributaries, p. 44.

for waters used for recreational and water supply uses until such data are available.

Other Wastes

Wastes from other than municipal and industrial sources include disposal of dredgings, sedimentation resulting from inappropriate land-use activities, and natural sources of pollution. Natural sources of pollution include soil eroded by rainfall or melting snow, soluble salts leached from soil by surfacewaters and groundwaters, organic material from animal excreta and decaying bodies of plants and animals, and microorganisms.

Carrying out delegated responsibilities for maintenance of authorized navigation depths, the U.S. Army Corps of Engineers dredges harbor areas and often disposes of dredgings in open surfacewaters.[69] Disposal of dredgings usually occurs in depths over 50 feet and these dredgings contain a range of materials from polluted sludge to clean sand. In addition to the unknown long-term effects of composite pollutants, the more visible effects of open water disposal are discoloration, increased turbidity, and oil slicks. Substances contained in dredged material may also contribute to increased concentrations of dissolved solids, nutrients, and toxic materials.

On Lake Michigan, the U.S. Army Corps of Engineers initiated a pilot program in 1967 to develop alternative disposal methods for dredged materials. These alternatives included disposal either on shore or within specially constructed diked-in areas.[70] Ewing, Storey _et al._[71] indicate the logical

---

[69] U.S., Federal Water Pollution Control Administration, _Great Lakes Region. Water Pollution Problems of Lake Michigan and Tributaries_, pp. 36-42.

[70] _Ibid._, p. 42.

[71] B. B. Ewing, E. H. Storey _et al._, _Feasibility of Evaluation of Benefits From Improved Great Lakes Water Quality_ (Urbana, Illinois: Water Resources Center, University of Illinois, 1968).

relationships between water quality parameters affected by dredging disposal and recreational use of water.[72] Several of these relationships cannot be established because of insufficient research investigation. They have also developed a practical methodology to determine economic benefits accruing from alternative disposal methods that increase water quality.

Silt from eroding agricultural lands, overgrazed rangelands, improperly-cut forests, and stream banks may be deposited in reservoirs, stream channels, or on flood plains. Another contributing factor has been the demolition of forested lands for housing, industrial development, and highway construction that expose open land to erosion.[73] In discussing consequences of sedimentation, Glymph and Storey[74] conclude that swimming, boating, and water skiing are directly affected by turbidity and the amount of sediment in water.

Sediment in water also has an adverse impact on aquatic organisms with implications for sport fishing. Settling on spawning beds, sediment suffocates incubating eggs and fills crevices reducing food supply. A reduction in light penetration caused by suspended sediment, also, has considerable effect on the aquatic environment.

Summary

Effective water acreage for recreation and satisfaction derived from recreation experiences are both diminished by three major inhibiting factors: (1) uncoordinated multiple-use that leaves water physically inaccessible and

---

[72] Ibid., pp. 57-59.

[73] J. B. Stoll, "Man's Role in Affecting the Sedimentation of Streams and Reservoirs," in Proceedings of the Second Annual American Water Resources Conference, November 20-22, 1966 (Urbana, Illinois: American Water Resources Association, 1966), pp. 79-95.

[74] L. M. Glymph and H. C. Storey, "Sediment--Its Consequences and Control," reprinted by the U.S. Department of Agriculture, Washington, D.C., n.d., pp. 205-220.

esthetically displeasing, (2) agency policy that protects a single water use over others, and (3) polluting substances that initiate an unfavorable series of physical, chemical, and biological events, each of which may induce a variety of psychological reactions.

Conflicts between recreational use and water supply, flood control, power generation, irrigation, and waste disposal have received limited documentation. With attendance levels as the sole determinant of adequacy, the literature reveals a minimum of conflict between water level fluctuation and recreational use. The O.R.R.R.C. found that attendance at reservoirs did not diminish in response to physical and biological consequences of water level fluctuation. To comprehend the full implications of water-use conflicts, an analysis of participant satisfactions must supplement attendance as determinants of recreation resource adequacy.

Recreation activities are generally restricted from domestic water supply reservoirs because they pose a potential hazard to public health. Swimming, boating, and other water recreation activities may cause pollution by contributing organic wastes, pathogens, inorganic wastes, trash, and toxic lead and other substances from motor exhausts. However, field studies investigating human impact on water supplies indicate findings that range from little or no water quality deterioration to a moderate rise in indicator organism counts at high density areas. While protection afforded by natural dilution, bacterial die-off, and disinfection together with complete treatment would insure recreation's compatibility with provision of potable water, water supply agencies continue their traditional opposition to multiple-use because the unknowns involved potentially conflict with interests of water consumers. Research efforts geared to overcoming this opposition must focus on: (1) more accurate recreation impact studies, (2) scientific examination of water consumer attitudes toward recreational use with adequate public health precautions, (3) accurate assessment of regional demand for water recreation together with benefits expected to accrue from reservoir recreational use, and (4) development of coordinated multiple-use municipal water supply impoundments.

Industrial and municipal wastes render water useless for leisure use because of toxicity, color, suspended and deposited solids, increased temperature, bacterial and viral concentrations, unsightly esthetic conditions, and human fear of unknown consequences. However, a review of current literature revealed that a minimum of pollutants are quantitatively related to recreational use. Past investigations of waste discharges have primarily studied effects of pollutants on water quality and the environment but excluded man from that environment. To understand their total consequences, pollutants must be studied in relation to all environmental components. An environmental study should involve interrelationships among the pollutants, water, man, aquatic life, bottom quality, plants, and other substances and conditions. Investigators must be encouraged to detect, measure, and determine physiological, attitudinal, and behavioral effects of water pollution on man. Without comprehensive knowledge of these effects, many substances that affect recreational use and satisfaction will not be considered polluting substances. These effects and implications of pollution are considered broad enough to require an interdisciplinary research effort.

CHAPTER VIII

MAINTAINING WATER QUALITY FOR RECREATIONAL USE

Introduction

It is the intention of this chapter to review the problems and methods of maintaining water quality for recreational use. Such maintenance requires establishment of Federal-state water quality standards based largely on scientifically-developed criteria. To reconcile a misuse of terms in the literature, the definitional dichotomy between "standards" and "criteria" will be documented.

Examination of pathogenic bacteria and their indicator organisms is critical to understanding public health requirements for direct body contact and indirect body contact recreation. Indicator organisms will be compared in their accuracy to detect recent and possibly dangerous contamination.

The primary task in this chapter, however, is to focus on the status and degree of comprehensiveness of the physical, chemical, biological, and psychological water quality criteria for recreational use. It is, therefore, essential that criteria oriented toward public health, safety, and human satisfaction be classified to ascertain areas of weakness. Requirements established by the F.W.P.C.A. for direct body contact, indirect body contact, and non-body contact recreation experiences will be cited and critically analyzed.

Since water quality standards are a collaborative reflection of arbitrary and scientifically-developed criteria, existing water quality conditions, and politically viable decisions, they are seen by this writer as subordinate in importance to the establishment of accurate and comprehensive water quality criteria.

Several methods for maintaining water quality will be discussed. These methods include: (1) sanitary waste treatment, (2) advanced waste treatment, (3) dilution of wastes and low-flow augmentation, (4) limited impoundment and filtration of polluted water, and (5) enforcement of water quality standards. To understand how water quality criteria and control methods are integrated with reality, water quality maintenance must be viewed within an economic framework. Evaluation of recreation benefits accruing from pollution abatement, or, conversely, the costs of pollution incurred by water recreational use, plays a major role in establishing the feasibility of increased water quality. A conceptual discussion will be presented as a prerequisite to understanding economic feasibility of pollution abatement.

Water Quality Requirements for Recreational Use

Criteria and Standards Defined

The Federal Water Pollution Control Act, as amended by the Water Quality Act of 1965 (P.L. 89-234) authorizes the states and Federal Government to establish water quality standards for interstate and coastal waters by June 30, 1967. Once submitted by a state, standards are subject to review and approval by the Secretary of the Interior. The standards are then evaluated according to compliance with established scientific and arbitrary water quality criteria.

In February, 1967, the Secretary of the Interior established the first National Technical Advisory Committee on Water Quality Criteria. The Committee's primary function was to collect into one volume a basic foundation of water quality criteria.[1] These criteria were intended as guidelines to be used with a thorough knowledge of local conditions in setting and evaluating water quality standards.

---

[1] U.S., Federal Water Pollution Control Administration, Report of the National Technical Advisory Committee on Water Quality Criteria to the Secretary of the Interior (Washington, D.C.: U.S. Government Printing Office, 1968).

Because the two terms "criteria" and "standards are used indiscriminantly, there is a need for definition. McKee and Wolf[2] delineate between standards and criteria by noting that a water quality standard is established by a government authority making it rigid, official, or quasi-legal. This status, however, does not necessarily mean that a standard is fair or based on scientific knowledge; it may be arbitrarily established on the basis of inadequate technical data or safety guidelines:

> Where health is involved and where scientific data are sparse, such arbitrary standards may be justified. There is a tendency, however, for regulatory authorities to promulgate standards of questionable scientific justification to serve as a crutch that facilitates administrative action and enforcement.[3]

Unlike a standard, a criterion carries no connotation of authority and is more concerned with fairness and equity.

The F.W.P.C.A. defines criterion as "a scientific requirement on which a decision or judgment may be based concerning the suitability of water quality to support a designated use."[4] Physical, chemical, or biological quality characteristics demanded by aquatic life and various water recreation experiences are requirements or criteria. Water pollution control authorities use the terms "criteria" and "requirements" interchangeably. The same is true with "standards" and "objectives."

There are two basic types of water quality standards. One type deals with the quality of receiving waters and is designated as stream standards or receiving water standards. Alternately, effluent standards refer to the quality of wastes to be discharged. Each type has its advantages and disadvantages, each

---

[2]J. E. McKee and H. W. Wolf (eds.), Water Quality Criteria (Sacramento, California: State Water Quality Control Board, State of California, 1963), p. 4.

[3]Ibid., p. 4.

[4]U.S., Federal Water Pollution Control Administration, Report of the National Technical Advisory Committee on Water Quality Criteria to the Secretary of the Interior, p. vii.

type has its advocates and opponents, and each type is in common use today.

Standards of receiving water quality are based on the setting of limits for specific substances in water and depend largely on the uses intended of water. This system of standards is frequently used with a system of stream classification, where standards are set for each stream or zone. McKee and Wolf note some of the advantages and disadvantages of this system of water quality standards:

> . . . they take into account dilution and the assimilative capacity of the receiving water and consequently lead generally to an economy of treatment works for pollution abatement . . . such standards are difficult to formulate and define, and more difficult to administer . . . the program may become extremely cumbersome.[5]

The New York water pollution abatement program uses standards based on receiving water quality.[6]

Effluent standards are divided into two general categories: (1) those that place restrictions on the strength and/or the amount of substance that can be discharged and (2) those that specify the degree of treatment or percentage removal of a specific pollutant that must be accomplished by treatment processes. Pennsylvania uses effluent standards that specify the amount of pollutant that may be discharged by industries and each process within these industries. McKee and Wolf note the following advantages and disadvantages of effluent standards:

> . . . effluent requirements favor good housekeeping and penalize the inefficient operator . . . . Effluent standards have the advantages of simplicity and ease of administration, for they are well defined and equitable among industries. Their primary disadvantage lies in their uneconomical use of the assimilative powers of receiving waters.[7]

It is not the intention of this writer to present a listing of water quality

---

[5]McKee and Wolf (eds.), Water Quality Criteria, p. 30.

[6]New York, State Department of Health, Rules and Classifications and Standards of Quality and Purity for Water's of New York State (Albany, New York: New York State Department of Health, 1961).

[7]McKee and Wolf (eds.), Water Quality Criteria, p. 30.

standards by state and/or agency in this chapter. Instead, McKee and Wolf are relied upon to present the most current water quality standards of each state or region.[8] Inadequacies in these water quality standards can be partially traced to weak or invalid water quality criteria. Therefore, this writer is mainly interested in investigating the status, adequacy, and relevancy of established water quality criteria.

Indicator Organisms and Pathogenic Bacteria

Since pathogenic organisms form the basis for dealing with health aspects of direct body contact and indirect body contact recreation, discussion should begin with detection and control of these organisms. Reliability and specificity in qualitative and quantitative detection of organisms are critical to determining the feasibility of future recreational use or safety of current use.

The National Technical Advisory Committee on Water Quality Criteria considered the presence of pathogenic bacteria to be the most useful indicator of contamination but:

> time factors, multiplicity and complexity of tests, economics of equipment and other materials, and manpower requirements rule out use of pathogens as criteria for general application. The optimum solution then becomes one of monitoring an indicator organism.[9]

The coliform group of bacteria is generally used as an indicator of sanitary quality in evaluating the disease-producing potential of water. Until recently, total coliforms was the indicator organism used for evaluation. The critical task, however, lies in quantification of coliforms being contributed from fecal matter.

Since feces and urine of warm-blooded animals are considered to be more significant sources of water-borne pathogens capable of infecting man, an

---

[8] Ibid., pp. 33-62, 405-466.

[9] U.S., Federal Water Pollution Control Administration, Report of the National Technical Advisory Committee on Water Quality Criteria to the Secretary of the Interior, p. 11.

appropriate indicator with numerical limits was selected to indicate contamination by excreta of warm-blooded animals: fecal coliforms. The National Technical Advisory Committee on Water Quality Criteria suggested that total coliforms was not an accurate indicator of pathogenic bacteria in recreation waters because only a portion of total coliforms may be of fecal origin.

> Approximately 95 percent of the coliform organisms in the feces of both birds and mammals yield positive fecal coliform tests . . . the use of fecal coliforms as an indicator does not add to the complexity or expense of monitoring.[10]

The presence of fecal coliform organisms indicates recent and possibly dangerous contamination.[11]

More research is required to determine the correlation of various indicator organism levels to specific water-borne diseases. For example, the F.W.P.C.A.'s Santee Recreation Project[12] correlated the prevalence of virus with fecal coliform concentrations following sewage treatment. Virus levels following secondary waste treatment were found to be one virus particle per 10,000 fecal coliforms. Based on these findings, bathing waters with 400 fecal coliforms per 100 ml. could be expected to have 0.02 virus particles per 100 ml. Increased knowledge of reliable indicator organisms and their correlation to pathogenic bacteria levels and viral concentrations is essential to insuring microbiologically safe water for body contact recreation.

Water Quality Criteria for Recreation

Currently, the public health and safety water quality criteria developed by the Federal Water Pollution Control Administration's National Technical Advisory

---

[10] Ibid., p. 12.

[11] Ibid., p. 22.

[12] U.S., Federal Water Pollution Control Administration, Santee Recreation Project, Final Report (Cincinnati, Ohio: Federal Water Pollution Control Administration, 1967), pp. 26-38.

Committee on Water Quality Criteria[13] and various state agencies[14] are the only established water criteria for recreation. Considerable effort has focused recently on both more precise quantitative measurement of water quality variables and determination of more relevant criteria by which water can be evaluated for recreational use. Recent studies by the F.W.P.C.A.[15] have clarified the techniques of measurement and interpretation of three indicator organisms, namely, total coliform, fecal coliform, and fecal strepotcocci concentrations. Their work serves as a basis for more rational decision making regarding potential health hazards of a particular body of water for direct body contact recreational use.

The F.W.P.C.A. has developed sanitary criteria for "de facto," as well as designated recreational water uses. In doing so, they recognize the undeniable attraction of water to human beings. Man will use water for recreation whether or not an area is managed or designated for such use. The sanitary criteria for "de facto" recreational use are as follows:

> Surface waters should be suitable for use in secondary contact recreation--activities not involving significant risks of ingestion--without reference to official designation of recreation as a water use . . . surface waters should be maintained in a condition to minimize potential health hazards by utilizing fecal coliform criteria. In the absence of local epidemiological experience, the Subcommittee recommends an average not exceeding 2,000 fecal coliforms per 100 ml and a maximum of 4,000 per 100 ml, except in specified mixing zones adjacent to outfalls.[16]

---

[13] U.S., Federal Water Pollution Control Administration, Report of the National Technical Advisory Committee on Water Quality Criteria to the Secretary of the Interior, pp. 3-16.

[14] McKee and Wolf (eds.), Water Quality Criteria, pp. 118-121.

[15] U.S., Federal Water Pollution Control Administration, Santee Recreation Project, Final Report, pp. 38-42.

[16] U.S., Federal Water Pollution Control Administration, Report of the National Technical Advisory Committee on Water Quality Criteria to the Secretary of the Interior, p. 9.

In contrast to criteria for general use of surfacewaters, water quality criteria have been established for direct and indirect body contact uses where recreation is designated for water quality management purposes:

> As determined by multiple-tube fermentation or membrane filter procedures and based on a minimum of not less than five samples taken over not more than a 30-day period, the fecal coliform content of primary contact recreation waters shall not exceed a log mean of 200/100 ml, nor shall more than 10 percent of total samples during any 30-day period exceed 400/100 ml.[17]
>
> In waters designated for recreation uses other than primary contact recreation, the Subcommittee recommends that the fecal coliform content as determined by either multiple-tube fermentation or membrane filter techniques, should not exceed a log mean of 1,000/100 ml, nor equal or exceed 2,000/100 ml in more than 10 percent of the samples.[18]

The Antelope Valley, California Wastewater Reclamation Project[19] established minimum water quality criteria for indirect body contact recreational water re-use. Their minimum criteria were:

1) Turbidity of less than 10 Jackson Candle Turbidity Units (JTU)
2) Phosphate concentration of less than .5 mg/l
3) pH of less than 8.0
4) Low concentration of chemical oxygen demand (COD) and biological oxygen demand (BOD)
5) Algae counts of less than 10,000/ml.
6) Treated water intended for recreational use shall contain not more than 2.2 coliform organisms per 100 ml. (MPN)[20]

---

[17] Ibid., p. 12.

[18] Ibid., p. 10.

[19] Los Angeles, Department of County Engineer, Final Report, Waste Water Reclamation Project for Antelope Valley Area (Los Angeles, California: County of Los Angeles, 1968).

[20] Ibid., p. 9.

This reclamation project report notes that the final product water was suitable for sport fishing and boating use, but direct body contact use of the reclaimed water required further study and testing.

Water microbiologically suitable for direct body contact recreation is a desirable goal for all waters designated for recreational use because health hazards are minimized. However, the quality levels required for direct body contact recreation are often lacking, and use must then be restricted to indirect body contact recreation.

In addition to microbiological requirements, the National Technical Advisory Subcommittee established safety-oriented water quality criteria for pH and clarity. The pH values were established for direct body contact recreational waters because of the resulting potentials for eye irritation. A deviation of 0.1 unit from the normal pH of the eye may result in discomfort, while appreciable deviation will cause severe pain.[21] In direct body contact recreational waters, pH should be within the range of 6.5-8.3 except when due to natural causes. In no case should pH be less than 5.0 or more than 9.0.

Clarity in recreational waters is highly desirable for visual appeal and safety, but variations according to local conditions makes it difficult to set absolute clarity criteria. The F.W.P.C.A. notes that for direct body contact recreational waters, "clarity should be such that a Secchi disc is visible at a minimum depth of 4 feet."[22]

Excessively high water temperatures may lessen the pleasure of some water contact activities, cause undesirable physiological effects after prolonged

---

[21] E. W. Mood, "The Role of Some Physico-chemical Properties of Water as Causative Agents of Eye Irritation of Swimmers," Report of the National Technical Advisory Committee to the Secretary of the Interior (Washington, D.C.: U.S. Federal Water Pollution Control Administration, 1968), pp. 15-16.

[22] U.S., Federal Water Pollution Control Administration, Report of the National Technical Advisory Committee on Water Quality Criteria to the Secretary of the Interior, p. 13.

immersion, and upset the aquatic biota causing conditions incompatible with recreational use. It has been determined that high water temperatures limit the dissipation of body heat, and through the elevation of the deep body temperature, serious physiological effects may be produced.[23] In direct body contact recreational waters, except where caused by natural conditions, maximum water temperature should not exceed 30C (85°F).[24]

Except for microbiological criteria established to restrict water-borne diseases, no quality requirements have been quantitatively established to minimize eye, ear, nose, throat, and skin infections and gastro-intestinal illness resulting from direct body contact recreation. These deleterious health effects have gone largely unnoticed because of their lack of epidemic proportions and the inadequacy of studies correlating epidemiological data on water-borne diseases with varying degrees of pollution. As a result of this inconclusive research, McKee and Wolf and others recommend that some of the strict bacterial requirements for waters used for direct body contact use be relaxed.[25]

While calling attention to the need for water temperature criteria and these other requirements, the National Technical Advisory Committee on Water Quality Criteria notes that it was faced with a dilemma--that of balancing reasonable safeguards for public health and physical well-being against possible undue restrictions on availability of waters for contact recreation.[26] In compromising water quality criteria for recreation with the reality of providing recreational opportunities, the Committee risks losing sight of the very essence

---

[23] Ibid., p. 13.

[24] Ibid., p. 14.

[25] McKee and Wolf (eds.), Water Quality Criteria, pp. 119-20.

[26] U.S., Federal Water Pollution Control Administration, Report of the National Technical Advisory Committee on Water Quality Criteria to the Secretary of the Interior, p. 11.

of recreational water quality criteria as well as the fact that recreation is a shared use of water along with industrial, municipal, and other uses. If inadequate quality requirements are established as standards, waters currently of high quality may be preserved only to the nature and level of these minimum standards, providing a quality of water that is microbiologically safe but of dubious value for producing recreation.

Some water deterioration unavoidably accompanies the growth of municipalities and the development of industrial and agricultural resources. Priorities of water use are largely a matter of regional concern influenced by historical, economic, and political factors. Usually it can be surmised that the higher the priority, the more comprehensive the water quality goals will be to insure this water use. While the increasing economic importance of the recreational use of water has been recognized with the adoption of U.S. Senate Document No. 97, this increasing economic importance has not been adequately reflected in the establishment of water quality goals necessary to support optimum recreational use. Perhaps this failure may be attributed to inabilities to adequately price the recreation experience and the secondary benefits of economic impact. But as Moore[27] points out, it is not the function of benefit-cost analysis to set water quality goals or to provide economic justification for one level of water quality against another. These requirements should be established by scientific investigation of the physical, chemical, biological, and consequential psychological factors involved. Effective water pollution control has been established as national policy, but this policy will not be implemented insofar as recreational use is concerned unless the water quality requirements for this use are both scientifically established and politically accepted. While a particular waterbody may meet the presently established criteria, it may still receive a minimum

---

[27] J. G. Moore, Jr., "Water Quality Management in Transition," reprinted from Civil Engineering Journal, (June, 1968), n.p.

of recreational use because the water is perceived by recreation users as being polluted, noxious, or otherwise unsatisfactory.

During his leisure, man views the quality of a specific waterbody in a much different manner than does a chemist responsible for biological and chemical water quality monitoring. This is perhaps an indication of an extremely weak relationship between water quality as measured by conventional criteria and actual recreational use of a waterbody at a particular point in time. Since 1961, the Santee Recreation Project has operated recreational lakes supplied with reclaimed wastewater processed from the effluent of the community's secondary sewage treatment plant. The project has demonstrated that public acceptance of reclaimed water is largely based on perception of such esthetic factors as visual and olfactory conditions.[28]

Stevenson[29] notes that the water used for direct body contact recreational activities must conform to three general conditions: (a) they must be esthetically enjoyable, i.e., free from obnoxious floating or suspended substances, objectionable color, and foul odors; (b) they must contain no substances that are toxic upon ingestion or irritating to the skin or eyes of human beings; and (c) they must be reasonably free from pathogenic organisms. Water quality standards have seldom defined the first two conditions in any but general qualitative terms. While noting that the esthetic values of water need to be recognized and protected, the National Technical Advisory Committee on Water Quality Criteria did not quantitatively relate these esthetic conditions to human requirements to establish levels of water quality acceptance. Persons have varying standards of esthetic acceptance which are met or not met depending upon their expectations for an experience. If a recreational experience fails

---

[28] U.S., Federal Water Pollution Control Administration, Santee Recreation Project, Final Report, pp. 1-13.

[29] A. H. Stevenson, "Studies of Bathing Water Quality and Health," reprinted from American Journal of Public Health, 43(5) (May, 1953), 2.

to meet a person's expectations due to objectionable water conditions, the individual has a variety of behavioral choices--he may not return, thereby diminishing the economic and social value of the site; or he may return because of time and cost limitations that restrict alternative behavior and, in doing so, lower his expectations for environmental quality and accept an inferior experience.

While a recreation experience involves a total human interaction with the environment which may or may not be satisfying, current physical, chemical, and biological water quality standards ignore human attitudes and their consequent behavioral responses that have considerable ecological and economic implications. Psychological requirements must therefore be acknowledged since recreational use accounts for a considerable amount of benefits in the economic justification of both project development and pollution control. Within an economic framework, any decrease in recreational use related to lack of human acceptance must be considered a cost of water pollution.

Willeke[30] sought to determine how many people refrain from participation in water-oriented recreation on San Francisco Bay because of their perceptions of selected aspects of water quality. These perceptions are based on an individual's esthetic acceptance standards which are in turn a product of his beliefs and attitudes. The difficulty in establishing psychological water quality criteria is apparent when it is realized that individuals have both varying standards of esthetic acceptance and varying perceptions of their environment. For example, the water that is considered "acceptable" for direct body contact recreation by the urban dweller may be considered as "noxious" or "grossly polluted" by a person of rural background or even another urban dweller who has been exposed to higher quality recreational waters.

---

[30] G. E. Willeke, Effects of Water Pollution in San Francisco Bay, Project on Engineering--Economic Planning, Report EEP-29 (Stanford, California: Stanford University, 1968).

To what degree do people's apprehensions (beliefs and attitudes) about a particular waterbody affect their recreational behavior? With a random sample of 914 adults, Willeke established the following responses to pollution in San Francisco Bay. "About 20 percent said that they refrain from swimming in the Bay because of pollution. The comparable figure for water skiing is about 5 percent; for fishing 2 percent; and for boating or sailing, about 2 percent." Unfortunately, analysis did not reveal the pollution characteristics to which individuals were responding. While Willeke probed only health apprehensions related to water-oriented recreation behavior, his study identifies a need to investigate the effects of dissatisfaction with specific water quality characteristics on participation. He found that people who believed contact with water would be harmful to health are much more likely to say that they do not participate in water-oriented recreation because of the unesthetic nature of the water.

It is abundantly clear that the unknown factors affecting water quality requirements for recreation outweigh the known factors. Procedures have not yet been developed to evaluate the quality of recreation in relation to water quality. Research effort must be accelerated and related to a conceptualization of recreation that places high priority on the quality of recreation, as determined by studies of user group attitudes and satisfactions.

Methods of Maintaining Water Quality

Introduction

Abatement of pollution through the construction of sewers and wastewater treatment facilities has traditionally been the responsibility of local government. Starting in 1956 with the enactment of the Federal Water Pollution Control Act, the Federal government assumed a degree of responsibility in this field through a program of grants to municipalities for construction of treatment works. Federal, state, and local governments are now all involved in maintaining water quality for recreation together with other water uses. Many of these other uses have conflicting requirements, making pollution control more complex. Their approaches to maintaining water quality required for recreation include: (1) sanitary waste treatment, (2) advanced waste treatment, (3) low-flow augmentation, (4) limited impoundment and treatment of polluted water, and (5) enforcement of water quality standards.

Sanitary Waste Treatment

Methods of sanitary waste treatment for altering characteristics of liquid wastes include the following: (1) preliminary treatment, (2) primary treatment, and (3) secondary treatment.[31] Preliminary treatment includes processes that do not significantly reduce pollutional strength of wastes but which serve to prepare waste for treatment by altering waste characteristics. These treatments include screening, grit removal, and preaeration.

Sewage and industrial wastes are given primary treatment to reduce solids that form sludge banks and unsightly conditions, to reduce food available to microorganisms and resultant depletion of DO, and to prepare sewage for additional treatment. Primary treatment involves screening and sedimentation tanks that separate raw sewage into a water component and a sludge component.[32] After primary treatment, the water component still contains significant amounts of dissolved and colloidal pollutants unaffected by primary treatment. The water component can be discharged after disinfection or given additional treatment to remove residual pollutants. The sludge component cannot be discharged and must

---

[31] T. L. Willrich and N. W. Hines (eds.), Water Pollution Control and Abatement (Ames, Iowa: Iowa State University Press, 1967), p. 25.

[32] National Association of Counties, Community Action Program for Water Pollution Control (Washington, D.C.: National Association of Counties, 1967), p. 69.

receive further treatment. Anaerobic digestion treatment maintains sludge under conditions enabling conversion of organic solids to organic acids and gas. Primary treatment generally removes 98-99 percent of the settleable solids, 60-80 percent of suspended solids, and 30-50 percent of oxygen demand from the domestic waste.[33]

Secondary treatment involves biological processes to stimulate growth of microorganisms which remove suspended and dissolved pollutants by converting them to energy and biological cells. The additional cells created can be removed from the liquid by sedimentation. Trickling filter and activated sludge processes are designed to provide removals of 90-95 percent of suspended solids and oxygen demand in raw wastes. Following chlorination, effluent can be discharged.[34] Wastes receiving both primary and secondary treatments are considered completely treated.

Advanced Waste Treatment[35]

It is evident that primary and secondary treatments are not adequate to produce effluent of required quality. Municipal and industrial wastes include many contaminants that are resistant to or totally unaffected by conventional wastewater treatment processes. These organic and inorganic contaminants are

---

[33] Willrich and Hines (eds.), Water Pollution Control and Abatement, p. 28.

[34] National Association of Counties, Community Action Program for Water Pollution Control, pp. 69-70.

[35] Although the term "tertiary" is often used as a synonym for advanced treatment methods, the two are not precisely the same. Tertiary suggests a single treatment to be applied only after conventional primary and secondary treatment. "Advanced treatment" actually means any process, technique, or system not now in common use. Advanced treatment techniques may be used after conventional treatment, as a tertiary treatment or they may modify or replace processes in conventional treatment. U.S., Federal Water Pollution Control Administration, Summary Report, Advanced Waste Treatment (Cincinnati, Ohio: Federal Water Pollution Control Administration, 1968), p. 1.

called refractory substances. Advanced waste treatment processes are required to remove refractory substances:

> . . . the engineer must bear in mind the fact that it is impossible to destroy any of the chemical elements present. They can, however, be changed to produce different chemical substances than those present in the original waste . . . . The design of a treatment plant, then, involves the provision of sufficient treatment processes for the economical conversion of waste constituents to forms which can be removed from the liquid portion by mechanical straining, sedimentation, gasification, or evaporation.[36]

The existence of refractory substances in water requires development and implementation of advanced waste treatment processes that can alleviate particular pollution problems or renovate wastewater for direct re-use. Economic evaluation plays a major role in determining the extent of refractory removal because often only one subsequent use is affected. The inhibitory effects of a refractory substance may not be quantitatively established or recognized in existing water quality criteria. Costs must be balanced against benefits derived to determine economic reasibility. Advanced waste treatment processes to remove refractory substances include:

> . . . adsorption, electrodialysis, emulsion separation, evaporation, extraction, foaming, freezing, hydration, ion exchange, and chemical or electrochemical oxidation.[37]

These processes seek to provide removals of 99.9 percent of suspended solids and oxygen demand.

Problems related to accelerated eutrophication require development of advanced waste treatment processes capable of nutrient-reduction. Thomas[38]

---

[36]Willrich and Hines (eds.), Water Pollution Control and Abatement, p. 26.

[37]Ibid., p. 32.

[38]E. A. Thomas, "The Eutrophication of Lakes and Rivers, Causes and Prevention," Biological Problems in Water Pollution (Cincinnati, Ohio: U.S. Department of Health, Education, and Welfare, 1965), pp. 299-305.

lists several conventional means by which accelerated eutrophication can be reduced:

1) prevention of raw sewage discharge,

2) nutrient removal during waste treatment,

3) intensive development of fishing,

4) physical removal and destruction of algae and higher plants,

5) chemical intervention,

6) aeration of deep water to increase dissolved oxygen content,

7) drawing-off deep water, and

8) transferring fresh water to depths where oxygen content is low.[39]

Since many of these means may prove undesirable to fish and aquatic habitat, water supply, and direct body contact recreational use, implementation of advanced waste treatment processes capable of nutrient-reduction is required. These processes include: (1) activated sludge, (2) algal removal, (3) chemical precipitation, (4) ion exchange, (5) ammonia stripping, (6) electrodialysis and other membrane processes, (7) effluent spraying on land, and (8) distillation.[40] Martin and Weinberger attempt to evaluate the nutrient-removal efficiencies of these processes, but they emphasize that their findings are inconclusive. Advanced waste treatment processes must continue to be developed and implemented if refractory substances and their consequences are to be minimized.

Development of advanced waste treatment processes has been stimulated by the F.W.P.C.A. They have sought to develop treatment processes that would allow wastewater to be reclaimed for indirect body contact and direct body contact recreational uses. What is learned in these highly-controlled prototype

---

[39] Ibid., pp. 302-304.

[40] E. J. Martin and L. W. Weinberger, "Eutrophication and Water Pollution," Publication No. 15 (Ann Arbor, Michigan: Great Lakes Research Division, University of Michigan, 1966), p. 451.

conditions can be applied to (1) mass production of reclaimed wastewater for recreational use, and (2) development of tertiary treatment processes that remove refractory substances inhibiting recreational use of multiple-use waters.

An economically feasible wastewater renovation process was developed by the Los Angeles Department of County Engineer and the F.W.P.C.A.[41] Renovation was considered critical since it was unlikely that potable water supplies would be allocated for recreational use.[42] A primary goal of this project was to develop an advancedwaste treatment process that would improve oxidation pond water quality by removing nutrients to permit recreational use. Initial water quality objectives were set for turbidity, phosphates, pH, algae, coliform bacteria, and virus.

> . . . the product water would be of reasonably high quality, low in dissolved salts and nutrients, while fully oxygenated. The water needed to be pleasing aesthetically, both in clarity and odor for full public acceptance. Pathogen removal was of course a primary concern for users' health. Finally the water was intended to be capable of sustaining fish life in the recreational facility.[43]

Water Quality characteristics of original oxidation pond water were compared with those of chemically clarified water. Prior to chemical clarification, oxidation ponds would not support fish life. Chemical clarification using appropriate amounts of lime and alum can substantially reduce suspended solids, phosphates, and nitrogen refractories. Product water will retain enough DO after treatment to propagate sport fish. The chemically clarified product water exceeded several minimum water quality requirements for recreational use.

---

[41]U.S., Federal Water Pollution Control Administration, Summary Report, Advanced Waste Treatment, pp. 71-75.

[42]Los Angeles, Department of County Engineer, Final Report, Waste Water Reclamation Project for Antelope Valley Area, p. 184.

[43]Ibid., p. 9.

TABLE 3

COMPARISON OF OXIDATION POND AND CHEMICALLY CLARIFIED WATER CHARACTERISTICS[44]

Water Characteristics	Oxidation Pond Water	Chemically Clarified Product Water
pH	8.3	6.7
Turbidity (JTU)	90	4
Total Alkalinity (mg/1 as $CaCO_3$)	260	95
Hardness (mg/1 as $CaCO_3$)	80	100
Suspended Solids (mg/1)	75	6
Dissolved Solids (mg/1)	575	575
Chemical Oxygen Demand (mg/1)	250	50
Biochemical Oxygen Demand (mg/1)	38	< 10
Dissolved Oxygen Demand (mg/1)	0.1 to 40	7 - 15
Ammonia-N (mg/1)	0.1 - 20	0.1 - 20
Organic - N (mg/1)	7 - 20	1 - 3
Nitrate - N (mg/1)	1 - 4	1 - 4
Nitrate - N (mg/1)	0.1 - 12	0.1 - 12
Total - Nitrogen (mg/1)	7 - 20	3 - 20
ABS mg/1	3	3
Phosphate (mg/1)	40	0.25
Algae (Counts/ml)	200,000	7,000
Confirmed Coliform (MPN/100ml)	7,900	< 1.8
Chlorine Residual mg/1	-	0.2 - 0.5

Average turbidity was 5 JTU while minimum requirement was less than 10 JTU.[45] E. coliform counts of 1.8 or less per 100 ml were attained while no more than 2.2 coliform organisms per 100 ml was required.[46] A 500,000 gpd (gallons per day) plant is being designed by Los Angeles County based on prototype processes to produce water for 19 acres of recreation lakes for boating, fishing, and picnicking. Estimated cost of water renovation for this plant size is 18.4 cents per 1,000 gallons. If the total output of the oxidation ponds is 3 mgd

[44] U.S., Federal Water Pollution Control Administration, Summary Report, Advanced Waste Treatment, p. 74.

[45] Los Angeles, Department of County Engineer, Final Report, Waste Water Reclamation Project for Antelope Valley Area, p. 10.

[46] Ibid., p. 10.

(million gallons per day), the estimated operating cost is 15 cents per 1,000 gallons.[47]

Similarly, the F.W.P.C.A. made a study of Santee, California artificial recreation lakes that were deliberately planned to use the communities' reclaimed sewage effluent.[48] Recreational use of the Santee lakes was gradually increased from boating in 1961 to fishing in 1964. In 1965, reclaimed water in a separate impoundment received additional treatment necessary for swimming use. Advanced waste treatment processes were effective in reductions of virus, nitrogen, alkalinity, and bacteria. Virology studies demonstrated the presence of virus in all sewage samples as well as complete absence of virus in all samples tested of the treated recreation waters. These studies were intended to provide the evidence necessary to gain approval from public health agencies and epidemiological specialists for swimming activities. Waste treatment and water reclamation procedures necessary to maintain water quality for direct body contact and indirect body contact recreation were determined.

The Santee Recreation Project demonstrates the feasibility and social acceptability of using water reclaimed from sewage for recreation lakes. All users of the lakes participated with full knowledge of the water's origin, and attendance rates at the lakes have increased steadily.

Dilution of Wastes and Low-Flow Augmentation

Upon determination of water quality standards, engineers design and construct treatment facilities that meet discharge or multiple-use stream standards. Disposal of liquid waste into waterbodies is commonly referred to as disposal by dilution. This process involves discharge of treated wastewater effluent

---

[47] U.S., Federal Water Pollution Control Administration, Summary Report, Advanced Waste Treatment, p. 74.

[48] U.S., Federal Water Pollution Control Administration, Santee Recreation Project, Final Report.

into a waterbody of sufficient size to prevent health, esthetic, and consequential economic nuisances. The degree of dilution required depends on established DO water quality standards and the volume and strength of residual effluent being discharged.

If water flow together with volume and strength of effluent are regulated, oxidation can slowly reduce soluable and suspended organic compounds with minimum effect on water quality and ecology of the waterbody. Primary and secondary waste treatment are prerequisite to regulating the volume and strength of effluent, thereby accelerating stabilization and minimizing modifications in the aquatic biota.

Low-flow augmentation is used to supplement the quantity of water available for dilution purposes. Since effects of polluting substances in streams are more proportional to their concentrations than their absolute quantities, pollution abatement that maximizes oxidation and assimilation opportunities must involve manipulation of streamflow. Multiple-purpose reservoirs are authorized for impoundment of waters that can be released at low-flow periods.

Section 2(b) of the amended Federal Water Pollution Control Act (P.L. 87-88) requires that consideration be given to the inclusion of water storage for regulation of streamflow in reservoirs being constructed by the U.S. Army Corps of Engineers, Bureau of Reclamation, and other Federal agencies. This provision established water quality control as a primary purpose of water resource planning and development.

Public Law 87-88 further provides that storage in Federal reservoirs is not to be provided as a substitute for adequate treatment or other methods of controlling wastes at the source. This provision is weakened by a lack of agreement on "adequate treatment." For domestic sewage and other wastes that can be treated with conventional treatment processes involving biological oxidation, an average reduction of 85 percent of component organic substances is considered adequate treatment. It is more difficult to determine "adequate treatment" for many industrial pollutants because of a minimum number of effective and economical means of control. Each type of industry must be evaluated to determine the degree of waste reduction possible with existing technology.

Low-flow augmentation is likewise unacceptable in lieu of required tertiary treatments. Natural purification by dilution cannot return water to its original state if refractory contaminants are present in wastewater discharges. Refractories that result in consequences inhibitory to recreational use and satisfaction must be extracted by tertiary treatments. While streamflow regulation is primarily a second line of defense against residual wastes of conventional treatment plants, it is recognized as the first line of defense against pollution resulting from various land-use practices, surfacewater runoff from urban areas, and other downstream pollution sources that elude collection and treatment.

Streamflow regulation as a pollution abatement approach has critical implications for reservoir use and development because the flow augmentation period usually coincides with the period of most intensive outdoor recreation participation. Treated waste disposal by dilution does not severely conflict with recreational use when volume and strength of effluent are regulated. Alternately, unregulated disposal or dilution requiring extensive augmentation is undesirable for public health and esthetic reasons. It is recognized by this writer that the use of stored water to maintain downstream water quality provides an effective water quality control measure until waste treatment technology develops more efficient methods of control.

Limited Impoundment and Treatment

Since all water areas are not scheduled to be of a quality suitable for all forms of water recreation, the <u>New Jersey Comprehensive Outdoor Recreation</u>

Plan[49] suggests enclosing and treating a section of urban river for swimming purposes. This concept is suggested to meet the demand for water recreation in large heavily industrialized urban areas:

> Certain beach and water areas along polluted rivers and bays could be enclosed by concrete structures. The polluted water would be filtered, purified, and then fed into such enclosures. Properly designed, these enclosures would provide a sense of swimming in a large natural area rather than in an enclosed artificial pool. Enclosed swimming areas using filtered water are entirely feasible from a construction and perhaps even an economic point of view.[50]

This enclosure and treatment technique is not regarded as a substitute for abatement of marginal or highly toxic waters, but it could prove useful until pollution abatement can be effected.

Enforcement of Water Quality Standards

The Water Quality Act of 1965 (P.L. 89-234) provided for the establishment of the Federal Water Pollution Control Administration in the Department of Health, Education, and Welfare (transferred to the Department of the Interior in 1966) to be the primary Federal agency concerned with water quality maintenance and improvement. Provisions for the establishment of water quality standards[51] were also included in this 1965 public law. Standards were authorized to facilitate Federal enforcement action in respect to pollution of interstate waters. After a state establishes its water quality standards, they are reviewed and either accepted or rejected by the F.W.P.C.A. and the Secretary of the

---

[49] New Jersey, Department of Conservation and Economic Development, New Jersey Comprehensive Outdoor Recreation Plan, Report 2, Water Resources for Recreation (Trenton, New Jersey: Department of Conservation and Economic Development, State of New Jersey, 1968).

[50] Ibid., p. 80.

[51] U.S., Federal Water Pollution Control Administration, "Water Quality Standards: Questions and Answers" (Washington, D.C.: Federal Water Pollution Control Administration, 1967).
Willrich and Hines, Water Pollution Control and Abatement, pp. 76-81.

Interior. If a state's standards are rejected, the Secretary of the Interior is empowered to establish standards for the interstate waters in question.

Standards submitted by a state and approved by the Secretary of the Interior are considered Federal-state standards. While these standards are subject to Federal enforcement action, this is considered a last line of defense. Initial responsibility for enforcement of standards rests with the states. The F.W.P.C.A. maintains a surveillance system to monitor water quality changes in interstate waters.[52] This system is complemented by state water quality monitoring systems. If the Secretary of the Interior receives surveillance data that indicate standards are being violated or state enforcement actions are inadequate, he is empowered to refer the matter to the U.S. Department of Justice.

> Although enforcement conferences and hearings are not required under the water quality standards provisions, the burden remains on the Government to prove that an industry or city is in violation of the standards. In other words, as in any other enforcement action, the Government must be prepared to cite specific kinds and amounts of pollutants and their effects on the interstate waters involved.[53]

Two types of enforcement proceedings for abating pollution are available to the Secretary of the Interior pursuant to the Federal Water Pollution Control Act:

1) Type I proceedings involve conferences to establish remedial action, public hearings, and, if remedial action is not taken, court action. Type I proceedings have been used by the Federal Government to initiate forty-four enforcement proceedings to abate pollution.[54]

---

[52] U.S., Federal Water Pollution Control Administration, The Storage and Retrieval of Data for Water Quality Control (Washington, D.C.: U.S. Government Printing Office, 1964).

[53] U.S., Federal Water Pollution Control Administration, "Water Quality Standards: Questions and Answers," p. 7.

[54] U.S., Department of the Interior, The Federal Water Pollution Control Program (Washington, D.C.: U.S. Government Printing Office, 1968), p. 12.

2) Type II enforcement proceedings involve enforcement of water quality standards once adopted as Federal standards. The Secretary issues a notice to the polluter, allowing 180 days for voluntary compliance; or a court action is directly initiated.

A publication entitled The Federal Water Pollution Control Program[55] elaborates on conditions prerequisite to these two types of enforcement.

Control and prevention of pollution under the water quality standards program has its greatest impact where sources of pollution are most easily identified. Major objectives of the standards program are control of pollution from both municipalities with inadequate waste treatment facilities and industries without instituted pollution control measures. The standards program coupled with expanded Federal grants will stimulate construction and/or expansion of municipal waste treatment facilities. Requirements of the standards program should result in action against industrial pollutants such as organic substances that can readily be treated, either in plants or in combination with municipal waste treatment, and chemical pollutants that can be eliminated through process changes and alternate disposal methods. Therefore, standards, surveillance, and enforcement act in concert to stimulate more efficient waste treatment and maintain water quality for present and future authorized uses.

Economic Evaluation of Water Pollution Abatement

Pristine water quality would be desirable from an esthetic, recreation, and water supply viewpoint, but the cost of returning streams to "trout stream" quality is generally prohibitive in cost, even though technically possible. This action would also be contrary to multiple-use philosophy and would probably be outweighed by benefits accruing from the use of degraded water. However,

---

[55] Ibid.

some degree of pollution abatement may be required to support a balanced optimum of water uses. Attainment of optimum use requires a systems approach where the water quality level required for each use is considered in light of increases or decreases in total economic benefit.

Water quality problems are viewed within an economic framework to maximize satisfactions of human wants from the use of water and to minimize the costs of producing these satisfactions:

> Investigation is made into the nature of and the growing demand for water; and the economic dimension of water quality problems in relation to physical and structural dimensions, supply and demand characteristics, use interrelationships, and costs and benefits associated with particular uses and use methods.[56]

Both water quality and water pollution are evaluated in terms of the uses to be made of water. With adequate data, economic evaluation can be implemented to determine what levels of quality are consistent with the maximization of man's satisfactions. The economic dimension is necessary in making decisions about levels of water quality and technological means for achieving particular water quality changes.

Besides economic considerations, water quality levels are manipulated on the basis of physical possibility and uses authorized for a waterbody by institutional controls, laws, and political decisions. These controls provide for public intervention in behalf of the public interest. They determine what is permissible under particular conditions as related to particular uses.[57]

---

[56] Willrich and Hines (eds.), Water Pollution Control and Abatement, p. 34.

[57] Examples of institutional controls include (1) no standards will be approved by the Secretary of the Interior that permit lowering the existing quality of any interstate waters and (2) the National Technical Advisory Committee on Water Quality Criteria established criteria for general recreational use of surfacewaters without reference to specific designation of recreation as a water use. These examples are taken from: U.S., Federal Water Pollution Control Administration, Report of the National Technical Advisory Committee on Water Quality Criteria to the Secretary of the Interior, pp. 8-10.

Therefore, water uses are authorized for a waterbody on the basis of technological, economic, and institutional control considerations. Once present uses are described and authorized, levels of water quality based on scientific criteria are established.

With indications of a growing demand for water recreation, there is vital concern for projecting and evaluating the increased value of recreational use resulting from increasing increments in water quality. Conversely, this concern deals with the extent to which the recreational use of water is deleteriously affected by existing pollution levels. These are both important concerns because it is generally understood that pollution abatement is considered when use of surfacewaters results in social costs in excess of the aggregate benefits realized. An analysis of recreation demand is essential to such an assessment. As reflected in water quality standards, economic evaluation is also used to reconcile present water uses and their corresponding water quality requirements with projected future water uses and their corresponding quality requirements.

Evaluation of Recreation Benefits Derived from Pollution Abatement

While evaluation of recreation benefits derived from pollution abatement measures has received considerable study,[58] this has only helped to illustrate

---

[58]B. B. Ewing, E. H. Storey, et al., Feasibility of Evaluation of Benefits from Improved Great Lakes Water Quality, Special Report No. 2 (Urbana, Illinois: Water Resources Center, University of Illinois, 1968), pp. 52-66.

H. C. Bramer, "The Economic Aspects of the Water Pollution Abatement Program in the Ohio River Valley" (unpublished Ph.D. dissertation, University of Pittsburgh, Pittsburgh, Pennsylvania, 1960).

Delaware River Basin Commission, The Measurement of Water Quality Benefits (New Brunswick, New Jersey: Bureau of Economic Research, Rutgers University, 1966).

J. B. Stevens, "A Study of Conflict in Natural Resource Use: Evaluation of Recreational Benefits as Related to Changes in Water Quality" (unpublished Ph.D. dissertation, Oregon State University, Corvallis, Oregon, 1966).

E. M. Castle, Economic and Administrative Problems of Water Pollution, Technical Report 2284 (Corvallis, Oregon: Agricultural Experiment Station, Oregon State University, n.d.).

H. H. Stoevener, An Economic Evaluation of Water Pollution Control the complexities and relationships involved. A usable methodology that relates measurable or allocated recreation benefits to specific increasing or decreasing increments in water quality is lacking.

Using benefit-cost analysis, Stevens seeks to achieve optimum water use between dilution of wastes and sport fishing. His basic strategy is to examine a number of waste disposal alternatives, their costs, and their impacts on fishing and the local community. The impacts involve both: (1) direct recreation benefits of pollution abatement; or, conversely, the averted loss of recreational values that would otherwise occur due to pollution loads and (2) secondary benefits induced by water recreation behavior as reflected in changing personal income levels in the community and region. Due to considerable disagreement among economists concerning composition and importance of secondary benefits and the difficulties involved in their identification and measurement, Ewing, Storey, et al. focus on direct water recreation benefits.

A monetary value for the increased number of recreation-days attributable to improved water quality is assigned by Ewing, Storey, et al. based on monetary values authorized in U.S. Senate Document No. 97, Supplement No. 1:

> Use of an approximate value is justified, however, since allocating a zero value, when a positive value is known to exist, would be a disservice to the public interest as it seeks satisfaction of recreation needs.[59]

Alternately, however, research economists are more concerned with developing demand schedules that will measure recreation benefits expected to accrue.

Alternatives, A Progress Report (Salt Lake City, Utah: Economics of Water Resource Development of the Western Agricultural Economics Research Council, 1963).

E. M. Castle, "Economics of Water Pollution Control," Journal of Water Pollution Control Federation (Washington, D.C.: May, 1966), pp. 789-793.

[59] Ewing, Storey, et al., Feasibility of Evaluation of Benefits from Improved Great Lakes Water Quality, Special Report No. 2, p. 66.

Dutta and Asch[60] construct two models that yield estimates of recreation benefit: one based on revealed preferences described from historical or household budget data, and the other based on user preferences as elicited by survey instruments. Simulation methods such as using distance or other variables as proxies for price are also used to determine benefits accruing from pollution abatement. According to Stevens, these simulation methods are still relatively undeveloped and will require further study. This lack of development explains the apparent concentration on benefit valuation methods and the minimum of concern for specific water quality requirements related to recreation behavior and satisfaction.

A critical aspect of evaluating recreation benefits accruing from pollution abatement is quality--the quality of the recreation experience as expressed in participants' behavior and satisfaction. Using gross annual recreation values rather than accurate regional demand data, Bramer considers only the quantity of participation. Since quality as expressed in participant satisfaction is hypothetically reflected in quantitative behavior, economic value should definitely be based on the quality of the water recreation experience. Researchers generally concur that variations in the quality of recreation experiences is an important determinant of water recreation demand, but they fail to investigate human satisfactions and behaviors related to varying increments in water quality. Stevens notes the importance of quality in water pollution abatement:

> It is important, however, that the quality of the recreation experience be specifically considered because this parameter may very likely be affected by the secular increases in income, population, and leisure which have been forecast for the United States.[61]

The methodology developed by Ewing, Storey, et al. best demonstrates the critical

---

[60]Delaware River Basin Commission, The Measurement of Water Quality Benefits, pp. 97-106.

[61]Stevens, p. 8.

importance of relating water quality levels to participation fluctuations by activity. Their intent in using an effective-affected range[62] continuum is: (1) to provide a tool for evaluating a water recreation site's potential for certain activities, (2) to relate participation levels to fluctuations in water quality parameters, and (3) to determine the costs associated with the behavioral response to existing pollution level.

> If the water quality level falls within the effective range for that activity, the pollutant has no effect on the activity, and the economic benefit attributable to water quality improvement for that activity would be zero . . . . If the water quality level falls within the affected range, it will be necessary to determine the extent to which participation is affected, as an economic benefit will likely accrue through water quality improvement.[63]

Polluted water can rarely be totally abated or returned to a pristine condition. Usually only a small increase in water quality is attempted. To justify this increase, we must know how much the anticipated abatement will increase water recreation participation in economic terms. There is general agreement between Ewing, Storey, *et al.* and Stevens that such an investigation must be done by activity and the benefits resulting from each activity totalled. Dutta and Asch use a similar approach based on three broad collective levels of water quality that correspond to three categories of water recreation uses, namely, direct body contact, indirect body contact, and non-body contact recreation. They then estimate demand for the three different levels of water quality.

---

[62] *Effective Range* - the range of water quality which is not polluted sufficiently to affect the suitability of the water for recreation use; *Threshold* - the minimum level of water quality necessary to support recreational use without affecting its suitability for such use; *Affected Range* - the range of water quality within which the suitability of the water for recreational use is deleteriously affected. These definitions are taken from: Ewing, Storey, *et al.*, p. 56.

[63] *Ibid.*, p. 60.

> Appropriate quality standards for different recreational uses have been prescribed . . . . It appears that successive levels of improvements in water quality allows many uses for recreation. For example, the quality level sufficient for boating may not render fishing impossible. Swimming and water-skiing demand still higher water quality. Graphically, the situation can be described by a step function.[64]

Regardless of complexities involved, it is generally accepted that increases in water quality will generate considerable direct economic benefits attributable to increased recreational use. Conversely, it is also realized that the costs of diminished water quality are borne most heavily by recreational use. The literature reflects general agreement that assessment of increased recreation benefits may prove decisive in justifying pollution abatement or control programs. The problem lies, however, in measuring the benefits purported to occur. Stevens is concerned with identifying and measuring the secondary benefits of increased recreational use related to pollution abatement because of their considerable local and regional economic impact. Alternatively, Ewing, Storey, et al. offer an approach to benefit valuation that avoids measurement problems and secondary benefits but requires prerequisite development of more adequate water quality criteria and carrying capacity standards. The latter conceptual approach has greater implications for further study because it requires prerequisite investigations of more critical questions in water recreation planning and development.

Summary

There is considerable difference between water quality criteria and standards. While a standard is usually sanctioned by a governmental authority, a criterion should be based on scientific investigation. Since inadequacies in water quality standards can be partially traced to weak or invalid water quality

---

[64] Delaware River Basin Commission, The Measurement of Water Quality Benefits, pp. 28-29.

criteria, this writer focused on investigating the status and adequacy of established water quality criteria.

To be acceptable to regulatory authorities, waters used for swimming and other direct body contact recreational activities must meet three conditions:

1) they must be esthetically enjoyable,
2) they must contain no substances that are toxic upon ingestion or irritating to the eyes or skin of humans, and
3) they must be reasonably free from pathogenic bacteria.

Water quality criteria fail to define the first two conditions in quantitative terms. Sanitary bacterial criteria have been the most definitively and quantitatively defined.

Water quality criteria literature is primarily concerned with biological, chemical, and physical events but not with the variety of attitudinal and behavioral reactions that these events may induce. A waterbody may meet established water quality criteria, but people may still not consider the waterbody to be of acceptable water quality and refrain from using it for recreation. While the recreation experience involves a total human interaction with the environment which may or may not be satisfying, current physical, chemical, and biological criteria ignore human attitudes and consequent behavioral responses that have considerable ecological and economic implications. Unless esthetic requirements based on levels of human acceptance are clearly quantified according to regional variances, these requirements will receive little attention in establishing state water quality standards prerequisite to justification of pollution abatement programs.

Several methods of maintaining water quality for recreation use were discussed. These included: (1) sanitary waste treatment, (2) advanced waste treatment, (3) low-flow augmentation and dilution of wastewater, (4) limited impoundment and treatment of polluted water, and (5) enforcement of water quality standards. Dilution of wastewater has been considered to be a bona-fide beneficial use of water when water flow together with volume and strength of effluent are regulated; however, with increasing advanced waste treatment technology, the need for dilution and consequential low-flow augmentation will soon be economically obsolete. Efforts to make dilution a permanent replacement for more complete waste treatment must therefore be resisted. The efforts of Federal agencies involved in developing dilution and low-flow augmentation capabilities must be redirected to instituting more complete waste treatment. Extensive efforts will be required, however, to implement these proposed changes in agency authorization.

Surveillance of water quality, and enforcement of standards coupled with expanded Federal grants for more adequate waste treatment facilities will stimulate more efficient waste treatment and will help to maintain water quality for present and future authorized recreational uses.

In this chapter, water quality problems are viewed within an economic framework intended to maximize satisfaction of human wants from the use of water and to minimize costs of producing these satisfactions. Economic evaluation can be an accurate tool for achieving optimum recreational use of water resources when the following three conditions are satisfied: (1) total regional demand for individual water recreation activities can be measured, (2) accurate direct and secondary benefit values for each unit of recreation demand can be measured and/or attributed, and (3) relevant and comprehensive water quality criteria for various water recreation activities are established. Since the literature reveals that none of these prerequisite conditions is adequately met, it is concluded that economic evaluation alone cannot deal fairly in allocating resources for water recreational use or in implementing water quality standards to reflect this allocated use. Presently, therefore, recreational use must depend upon institutional controls, laws, and political decisions. To avoid total dependence on the realm of public intervention, the three conditions prerequisite to economic evaluation must begin to be fulfilled through future scientific investigation.

CHAPTER IX

A PROGRAMATIC IDENTIFICATION OF INTERDISCIPLINARY RECREATION-WATER RESOURCES RESEARCH NEEDS

Introduction

In this chapter interdisciplinary recreation-water resource research needs are identified. These needs are based on the critical analysis of literature accomplished in the previous eight chapters. An important purpose of this critical analysis was to cite gaps in existing methods and knowledge. These gaps form the basis for the following statement of research needs.

Since a programatic identification of research needs must be based on a comprehensive investigation of the literature, such an investigation has been effected by this writer. Nine hundred pieces of literature out of fifteen hundred identified and retrieved were considered pertinent in this collaborative study. These nine hundred publications form the bibliographic foundation for this programatic listing of research needs which has been developed to guide individual and interrelated recreation-water resources research.

Research needs are broken down into three major classifications with specific research needs listed under each.

The Water Resource

1) Relationships between the components of the hydrological cycle and their quantitative and qualitative implications for water-based recreation should be studied through an interdisciplinary research effort.
2) Broad ecological studies of water use need to demonstrate human-environmental relationships that are beneficial or detrimental to recreational use.

3) Methods to control both quantitative and qualitative water consumption need to be determined. Remedial actions should recognize water recreation as an increasing water use.
4) Water quantity criteria should be established that reflect the amount of water and its distribution in time and space required for each water recreation activity.
5) More reviews, comparative analyses, and documentation of public water-use rights guaranteed by state common law are needed.
6) The need to quantify projected regional demand for water recreation is essential to effecting gradual modification of water-use law.

User-Resource Planning

1) Development of more accurate total recreation demand prediction methods based on regression analysis is seen as a high priority research need.
2) Recreation resource planning efforts should determine the extent of unexpressed recreation behavior through studies of user group behavior, preferences, aspirations, and satisfactions. Models for incorporating an assessment of dormant demand into area-wide planning are also required.
3) Identification and quantification of multivariate variables affecting recreation demand should be effected until a maximum proportion of variance is explained.
4) The environmental variables, attractability, competing opportunities, and saturation require further definition and investigation if variability in recreation site consumption is to be better explained.
5) Regional planning studies by watershed or other physiographic characteristics should be encouraged over regional definition based on political boundaries.

6) Research economists should continue to develop demand schedules that measure direct and secondary benefits accruing from recreation experiences. Through their work, the imputed values sanctioned in U.S. Senate Document No. 97 can be substantiated.
7) To effect more sensitive user-resource planning, existing and potential recreation resources should be inventoried in terms of their physical and attitudinal carrying capacities.
8) Studies of collective attitudes toward environmental and experience qualities, as accomplished by Lucas, should be effected with other water-oriented recreation user groups to establish needed carrying capacity standards for management and planning of more intensively used recreation areas.
9) Upon determination of valid carrying capacity standards for individual water recreation experiences, there is a resource management need to develop capacity standards for entire waterbodies that minimize the effects of conflicting recreational uses.
10) Regional analysis techniques should be broadened to detect environmental qualities of value to specific recreation user groups.

Water Quality Maintenance for Recreational Use

1) Identification of more precise and reliable indicator organisms to determine microbiological suitability of waters for direct body contact recreation is critical.
2) Water quality criteria that minimize eye, ear, nose, throat, and skin infections and gastro-intestinal illness resulting from direct body contact recreation should be quantitatively established.
3) Since current water quality criteria ignore human attitudes and consequent behavioral responses to physical, chemical, and biological

conditions, psychological water quality criteria based on levels of human acceptance need to be developed for individual water recreation experiences.

4) Toxicological and pathogenic effects of numerous organic, inorganic, and biological substances on man need to be investigated with findings being incorporated into water quality criteria for direct and indirect body contact recreation.

5) Empirical studies of "de facto" recreational use should be undertaken to strengthen the F.W.P.C.A.'s water quality criteria for undesignated recreational waters. Methods developed by such studies will also improve the accuracy of recreation resource inventories in area-wide planning.

6) Since implementation of coordinated multiple-use as a planning and management concept depends on development of optimum use-interaction requirements, these requirements should be established by an equitable combination of singular water-use requirements.

7) Besides improving research designs that determine physical, chemical, and biological impacts of recreational use on water supply, efforts to use water supplies can also be supported by: (1) scientific examination of water consumer attitudes toward recreational use of their water supply with adequate health precautions and (2) accurate assessment of regional demand for water recreation.

8) While there should be continued development of advanced waste treatment processes that remove refractory substances inhibitory to recreational use, this research and development need is contingent upon establishment of comprehensive water quality criteria for direct and indirect body contact recreation.

9) Survey procedures to evaluate the quality of water recreation in relation to particular levels of water quality as determined by user group attitudes, satisfactions, and consequential behavior need to be developed. Similarly, measurable or allocated recreation benefits need to be related to specific water quality increments with their corresponding behavioral responses.

BIBLIOGRAPHY

Public Documents

California Assembly Interim Committee on Water. Handbook of Federal and State Programs of Financial Assistance for Water Developments. Sacramento, California: State of California, 1967.

California Assembly Interim Committee on Water. Recreation Costs at Water Projects. Vol. XXVI, Number 15. Sacramento, California: State of California, December, 1966.

California Department of Harbors and Watercraft. Inventory of Boating Facilities. Sacramento, California: California Department of Harbors and Watercraft, 1966.

California Department of Parks and Recreation. Accelerated Development Program Projecting to 1980. Sacramento, California: Department of Parks and Recreation, November, 1965.

California Department of Parks and Recreation. County Regional Parks and Regional Recreation Areas; A Planning Guide. Sacramento, California: Division of Recreation, California Department of Parks and Recreation, 1965.

California Department of Parks and Recreation. Outdoor Recreation Outlook to 1980. San Diego Metropolitan Area. Planning Monograph Number 4. Sacramento, California: Department of Parks and Recreation, 1967.

California Department of Parks and Recreation. Park and Recreation Information System. Planning Monograph Number 2. Sacramento, California: Department of Parks and Recreation, 1966.

California Department of Parks and Recreation. Recreation Policy of the State of California. Sacramento, California: Department of Parks and Recreation, January 2, 1962.

California Department of Parks and Recreation. Review of the California Comprehensive Statewide Outdoor Recreation Plan. Sacramento, California: California Department of Parks and Recreation, Resources Agency, August, 1966.

California Department of Public Health. Proceedings of the Conference on Recreational Uses of Impounded Water. Berkeley, California: Committee on Research in Water Resources, 1957.

California Department of Public Health. A Study of Recreational Use and Water Quality of Reservoirs, 1959-1961. Berkeley, California: Department of Public Health, December, 1961.

California Department of Water Resources. Delta Water Facilities. Bulletin Number 76. Preliminary Edition. Sacramento, California: Department of Water Resources, Resources Agency, December, 1960.

California Department of Water Resources. Ingram Creek Aquatic Recreation Area. Bulletin No. 117-120. Sacramento, California: State of California, The Resources Agency, December, 1966, pp. 1-15.

California Department of Water Resources. Investigation of Upper Feather River Basin Development. Bulletin Number 59-2. Sacramento, California: Department of Water Resources, October, 1960.

California Department of Water Resources. Lake Davis Recreation Development Plan. Bulletin Number 117-3. Sacramento, California: Department of Water Resources, Resources Agency, July, 1965.

California Department of Water Resources. Northeastern Counties Investigation. Bulletin 58. Sacramento, California: Department of Water Resources, Division of Resource Planning, June, 1960.

California Department of Water Resources. A Plan for the Development and Operation of Recreation Facilities at Frenchman Reservoir, Upper Feather River Basin. Sacramento, California: Department of Water Resources, Division of Design and Construction, 1960.

California Department of Water Resources. Recreation Areas along the California Aqueduct in the San Joaquin Valley. Bulletin Number 156-66. Sacramento, California: California Department of Water Resources, Resources Agency, May, 1966.

California Department of Water Resources. San Luis Reservoir and Forebay Recreation Development Plan, Appendix C: Fish and Wildlife Development Plan. Bulletin 117-7. Sacramento, California: Department of Water Resources, Resources Agency, June, 1966.

California Division of Beaches and Parks. Camp Pendleton. San Onofre Beach Study. Sacramento, California: California Department of Parks and Recreation, Division of Beaches and Parks, 1965.

California Division of Beaches and Parks. Coyote River Valley Study. Sacramento, California: California Department of Parks and Recreation, Division of Beaches and Parks, 1965.

California Division of Beaches and Parks. Inland Marine Park Development Program Study. Sacramento, California: Division of Beaches and Parks, January, 1967.

California Division of Beaches and Parks. Sacramento - San Joaquin Delta Study. Sacramento, California: California Department of Parks and Recreation, Division of Beaches and Parks, May, 1965.

California Division of Beaches and Parks. Sacramento Valley River Study Feather River. Sacramento, California: California Department of Parks and Recreation, 1964.

California Division of Beaches and Parks. Sonoma-Mendocina Coastal Study: Fort Ross, MacKerricher, Gualala River, Ten-Mile Beach, Manchester, Salt Point-Kruse Rhododendron, Willow Creek. Sacramento, California: Department of Parks and Recreation, Division of Beaches and Parks, 1966.

California Division of Beaches and Parks. South Central Coastal Study: Montana de Oro, Gaviota Refuge, Villa Creek, Santa Maria Dunes, Point Sal, Point Conception, Holister Ranch, El Capitan. Sacramento, California: California Department of Parks and Recreation, Division of Beaches and Parks, February, 1966.

California Public Outdoor Recreation Plan Committee. California Public Outdoor Recreation Plan. Part I and II. Sacramento, California: Public Outdoor Recreation Plan Committee, 1960.

California State Water Control Board. "Microbiological Content of Domestic Waste Waters Used for Recreational Purposes," in California State Water Control Board Publications. Publication 32. Sacramento, California: State Water Control Board, 1965.

Cleveland, Ohio, Regional Planning Commission. Lakefront Study Summary: Inventory, Analysis and Suggestions. Cleveland, Ohio: Regional Planning Commission, July, 1962.

Colorado Game, Fish and Parks Department. Colorado Outdoor Recreation Comprehensive Plan, 1967. Index, Summary, Recommendations, Planning Methods. Vol. 0. Denver, Colorado: Colorado Game, Fish and Parks Department, 1967.

Columbia Basin Inter-Agency Committee. Recreation Survey of the Pacific Northwest Region. Part I: Existing Recreation Areas. Portland, Oregon: Columbia Basin Inter-Agency Committee, March, 1961.

Columbia Basin Inter-Agency Committee. Recreation Survey of the Pacific Northwest Region. Part II. Recreation Report. Portland, Oregon: Columbia Basin Inter-Agency Committee, October, 1964.

Delaware River Basin Commission. The Measurement of Water Quality Benefits. New Brunswick, New Jersey: Bureau of Economic Research, Rutgers University, May, 1966.

Florida Outdoor Recreational Planning Committee. Guidelines for Local Government Participation in the Land and Water Conservation Fund Program in Florida. Tallahassee, Florida: Outdoor Recreational Planning Committee, October, 1966.

Hillsborough County Florida Planning Commission. Hillsborough County's Need for Public Outdoor Recreation Areas--and Planning to Meet This Need. Tampa, Florida: The Planning Commission, 1964.

Huron River Watershed Intergovernmental Committee. The Importance of the Management of the Huron River Watershed. Ann Arbor, Michigan: Washtenaw County Metropolitan Planning Commission, 1964.

Illinois. Water for Illinois, A Plan for Action. Springfield, Illinois: State of Illinois, 1967.

Illinois Department of Business and Economic Development. Outdoor Recreation in Illinois. Springfield, Illinois: Illinois Department of Business and Economic Development, 1965.

Illinois Department of Public Works and Buildings. Kankakee River Basin Study: A Comprehensive Plan for Water Resources Development. Springfield, Illinois: Department of Public Works and Buildings, 1967.

Illinois Department of Public Works and Buildings. Little Wabash River Basin Study: A Comprehensive Plan for Water Resource Development. Springfield, Illinois: Department of Public Works and Buildings, 1967.

Illinois Department of Public Works and Buildings. Vermilion River Basin Study: A Comprehensive Plan for Water Resources Development. Springfield, Illinois: Department of Public Works and Buildings, 1967.

Illinois State Geological Survey. "Geologic Factors in Dam and Reservoir Planning." Environmental Geology Notes. Number 13. Urbana, Illinois: State Geological Survey, December, 1966.

Indiana Department of Conservation. 1965-1975, A Pivotal Decade in Indiana. An Expansion Program to Meet Indiana's Growing Need for Conservation and Recreation. Indianapolis, Indiana: Department of Conservation, 1964.

Indiana Department of Natural Resources. 1965-1975, A Pivotal Decade in Indiana, Local Needs and Responsibilities. Supplement Number 1. Indianapolis, Indiana: Vollmer Associates, 1965.

Indiana Department of Natural Resources. Site Selection Summary, New State Recreation Areas. Indianapolis, Indiana: Department of Natural Resources, 1966.

Interstate Advisory Committee on the Susquehanna River Basin. Resources - Responsibility and Coordination Related to the Comprehensive Study of the Susquehanna River Basin. Harrisburg, Pennsylvania: Interstate Advisory Committee on the Susquehanna River Basin, 1965.

Kansas Governor's Advisory Council on Outdoor Recreation. Kansas Recreation: Past, Present, Future. Topeka, Kansas: Governor's Advisory Council on Outdoor Recreation, 1962.

Los Angeles County, California Regional Planning Commission. Los Angeles County Regional Recreation Acres Plan. Los Angeles, California: Regional Planning Commission, July 29, 1965.

Los Angeles Department of County Engineer. Final Report: Waste Water Reclamation Project for Antelope Valley Area. Los Angeles, California: Department of County Engineer, 1968.

Lubbock, Texas, City Planning Department. An Expanding Lubbock....Reclaimed Water for a Growing City.... Lubbock, Texas: City Planning Department, n.d.

Maryland State Planning Department. Maryland Water Supply and Demand Study, A Computer Model of Stream Quality. Publication 132C. Baltimore, Maryland: State Planning Department, June, 1966.

Massachusetts Department of Natural Resources. The Outdoor Recreational Resources of Barnstable County, Massachusetts. Boston, Massachusetts: Department of Natural Resources, 1963.

Michigan Department of Conservation. Michigan Outdoor Recreation Plan. Lansing, Michigan: Michigan Department of Conservation, 1967.

Michigan Department of Conservation. Outdoor Recreation Planning in Michigan by a System Analysis Approach: Part I--A Manual for "Program Recsys." Technical Report Number 1. Lansing, Michigan: State Resource Planning Program, Department of Commerce, May, 1966.

Michigan Department of Conservation. Outdoor Recreation Planning in Michigan by a Systems Analysis Approach: Part II--Computer Mapping for Recreation Planning. Technical Report Number 7. Lansing, Michigan: State Resource Planning Program, Department of Commerce, August, 1966.

Michigan Waterways Division. Transportation Predictive Procedures--Recreational Boating and Commercial Shipping. Technical Report No. 9C. Lansing, Michigan: Department of Conservation, 1966.

Minnesota Outdoor Recreation Resources Commission. An Accelerated Program for Hydrologic Studies in Minnesota. Staff Report Number 8. St. Paul, Minnesota: Minnesota Outdoor Recreation Resources Commission, 1965.

Minnesota Outdoor Recreation Resources Commission. An Accelerated Water Resources Program for the Red River Basin. Report Number 10. St. Paul, Minnesota: Outdoor Recreation Resources Commission, 1964.

Minnesota Outdoor Recreation Resources Commission. Control of Aquatic Nuisance Organisms in Minnesota. Report Number 9. St. Paul, Minnesota: Minnesota Outdoor Recreation, Resources Commission, 1964.

Minnesota Outdoor Recreation Resources Commission. Grants-In-Aid for Outdoor Recreation. Staff Report Number 5. St. Paul, Minnesota: Minnesota Outdoor Recreation Resources Commission, 1965.

Minnesota Outdoor Recreation Resources Commission. The Great River Road in Minnesota. Staff Study Report Number 12. St. Paul, Minnesota: Minnesota Outdoor Recreation Resources Commission, 1965.

Minnesota Outdoor Recreation Resources Commission. Legislative and Appropriation Recommendations. Report Subject Number 16. St. Paul, Minnesota: Minnesota Outdoor Recreation Resources Commission, 1965.

Minnesota Outdoor Recreation Resources Commission. The Minnesota River Valley. Staff Study Report Number 7. St. Paul, Minnesota: Minnesota Outdoor Recreation Resources Commission, 1964.

Minnesota Outdoor Recreation Review Commission. Public Access in Minnesota. Report Number 3. St. Paul, Minnesota: Minnesota Outdoor Recreation Review Commission, 1965.

Minnesota Outdoor Recreation Resources Commission. Recreational Use of Rivers and Streams in Minnesota. Staff Report Number 9. St. Paul, Minnesota: Minnesota Outdoor Recreation Resources Commission, 1965.

Minnesota Outdoor Recreation Resources Commission. Recreational Use of the St. Croix River. Staff Report Number 11. St. Paul, Minnesota: Minnesota Outdoor Recreation Resources Commission, 1965.

Minnesota Outdoor Recreation Resources Commission. A Study of Private Enterprise in Outdoor Recreation. Staff Report Number 4. St. Paul, Minnesota: Minnesota Outdoor Recreation Resources Commission, 1965.

Minnesota Outdoor Recreation Resources Commission. A Study of Users Fees. Staff Report. St. Paul, Minnesota: Minnesota Outdoor Recreation Resources Commission, 1964.

New Hampshire State Planning Board. Land Water Recreation. Baker River Watershed, Development Potential. Report Number 1. Concord, New Hampshire: State Planning Project, March, 1964.

New Hampshire State Planning Board. Land Water Recreation. Islands of New Hampshire. Report Number 15. Concord, New Hampshire: State Planning Project, December, 1965.

New Hampshire State Planning Board. Land Water Recreation. New Hampshire Outdoor Recreation Plan. Report Number 13. Concord, New Hampshire: State Planning Project, August, 1966.

New Hampshire State Planning Project. Land Water Recreation. Inventory of Public and Private Outdoor Recreation Areas in New Hampshire. Report Number 14. Concord, New Hampshire: State Planning Project, November, 1965.

New Hampshire State Planning Project. Land Water Recreation. New Hampshire Public Water Bodies and Public Access Points. Part I. Report Number 4. Concord, New Hampshire: State Planning Project, August, 1964.

New Hampshire State Planning Project. Land Water Recreation. New Hampshire Public Water Bodies and Public Access Points. Part II. Report Number 12. Concord, New Hampshire: State Planning Project, September, 1965.

New Hampshire State Planning Project. Land Water Recreation. Water Resources of New Hampshire. Report Number 10. Concord, New Hampshire: State Planning Project, September, 1965.

New Jersey Department of Conservation and Economic Development. The Need for a State Recreational Land Acquisition and Development Program. Trenton, New Jersey: Department of Conservation and Economics Development, 1960.

New Jersey Department of Conservation and Economic Development. New Jersey Comprehensive Outdoor Recreation Plan. Report 2. Water Resources for Recreation 1968. Trenton, New Jersey: New Jersey Department of Conservation and Economic Development, 1968.

New Jersey Department of Conservation and Economic Development. New Jersey Open Space Recreation Plan. Trenton, New Jersey: Department of Conservation and Economic Development, May, 1967.

New Jersey Department of Conservation and Economic Development. Setting for the New Jersey State Development Plan. Trenton, New Jersey: Department of Conservation and Economic Development, 1966.

New Jersey Division of State and Regional Planning. New Jersey's Delaware Bay Shore: An Inventory of Land Use. Trenton, New Jersey: Department of Conservation and Economic Development, 1964.

New York State Council of Parks. The Next Step: Building for Outdoor Recreation. Albany, New York: New York State Council of Parks, 1965.

New York Hudson River Valley Commission. The Hudson: The Report of the Hudson River Valley Commission, 1966. Bear Mountain, New York: Hudson River Valley Commission, 1966.

North Carolina Division of Community Planning. Development Plan, Lake Gaston. Raleigh, North Carolina: Division of Community Planning, 1964.

North Carolina Recreation Commission. A Method for Determining the Annual Carrying Capacity of Selected Types of Outdoor Recreation Areas and Facilities in North Carolina. (Draft Copy) Raleigh, North Carolina: North Carolina Recreation Commission, 1968.

Northeastern Illinois Metropolitan Area Planning Commission. Open Space in Northeastern Illinois. Technical Report Number 2. Chicago, Illinois: Metropolitan Area Planning Commission, 1962.

Ohio Department of Natural Resources. A Statewide Plan for Outdoor Recreation in Ohio. Vol. I. Preliminary Plan and Addendum to Vol. I. Columbus, Ohio: Department of Natural Resources, 1966.

Ohio Division of Water. Some Principles of Water--Its Uses, Behavior, Problems and Conservation. Columbus, Ohio: Department of Natural Resources, 1960.

Ohio Division of Water. Water Inventory of the Scioto River Basin. Report 17. Columbus, Ohio: Department of Natural Resources, April, 1963.

Tennessee Department of Conservation and Commerce. Impoundment of the Harpeth River; A Research Study of the Upper Harpeth Watershed. Water Resources Series Number 2. Nashville, Tennessee: Department of Conservation and Commerce, Division of Water Resources, 1961.

Tennessee State Planning Commission. Beech River Watershed Development Plan and Program Proposals. Nashville, Tennessee: Beech River Watershed Development Authority, March, 1965.

Texas Water Development Board. The Texas Water Plan--Summary. Austin, Texas: The Texas Water Development Board, November, 1968.

U.S. Ad Hoc Water Resources Council. Policies, Standards, and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources. Supplement No. 1, Evaluation Standards for Primary Outdoor Recreation Benefits. Washington, D.C.: Ad Hoc Water Resources Council, June 4, 1964.

U.S. Agricultural Research Service. "Weed Control: Spraying Clears Canals," Agricultural Research. Vol. XV. Number 8. Washington, D.C.: Agricultural Research Service, 1967.

U.S. Area Redevelopment Administration. Recreation and Tourism Development through Federal Programs. Washington, D.C.: U.S. Department of Commerce, Area Redevelopment Administration, 1965.

U.S. Area Redevelopment Administration, U.S. Department of Commerce. Tourist and Recreational Potential - Western North Carolina. Washington, D.C.: U.S. Area Redevelopment Administration, 1964.

U.S. Army Corps of Engineers. Information Bulletin Delaware River Basin Study. Brief Summary of Water Needs and Recommended Plan of Development. Philadelphia, Pennsylvania: U.S. Army Corps of Engineers, Revised 1961.

U.S. Army Corps of Engineers. Potomac River Basin Report. Volume 1-2. Baltimore, Maryland: U.S. Government Printing Office, February, 1963.

U.S. Army Corps of Engineers. Potomac River Basin Report. Volumes 7-9. Washington, D.C.: U.S. Government Printing Office, 1962.

U.S. Army Corps of Engineers. Recreation. Washington, D.C.: U.S. Army Corps of Engineers, June, 1965.

U.S. Army Corps of Engineers. "Water Resources Development Functions and Programs of the Corps of Engineers." Washington, D.C.: May, 1967. (Mimeographed)

U.S. Army Corps of Engineers. Water Resources Development in California. San Francisco, California: Corps of Engineers South Pacific Division, January 1, 1967.

U.S. Army Corps of Engineers. Water Resources Development in Illinois. Chicago, Illinois: U.S. Army Corps of Engineers, North Central Division, 1967.

U.S. Bureau of Outdoor Recreation. A Directory of Private Organizations Providing Assistance in Outdoor Recreation to Individuals, Organizations, Public Groups. Washington, D.C.: U.S. Bureau of Outdoor Recreation, n.d.

U.S. Bureau of Outdoor Recreation. Federal Assistance in Outdoor Recreation. Publication Number 1. Washington, D.C.: U.S. Government Printing Office, 1964.

U.S. Bureau of Outdoor Recreation. Federal Focal Point in Outdoor Recreation. Washington, D.C.: Department of Interior, Bureau of Outdoor Recreation, 1966.

U.S. Bureau of Outdoor Recreation. Federal Outdoor Recreation Programs. Washington, D.C.: Department of the Interior, 1967.

U.S. Bureau of Outdoor Recreation. An Interim Method for Projecting Recreation Use of Outdoor Recreation Resources and Facilities in a Sub-Region. Washington, D.C.: Bureau of Outdoor Recreation, Department of the Interior, n.d.

U.S. Bureau of Outdoor Recreation. The Middle Missouri. A Rediscovery: A Study of the Outdoor Recreation Potential. Washington, D.C.: U.S. Department of Interior, Bureau of Outdoor Recreation, 1968.

U.S. Bureau of Outdoor Recreation. New England Heritage: The Connecticut River National Recreation Area Study. Washington, D.C.: U.S. Government Printing Office, 1968.

U.S. Bureau of Outdoor Recreation. Outdoor Recreation Grants-In-Aid Manual. Washington, D.C.: U.S. Government Printing Office, September, 1965.

U.S. Bureau of Outdoor Recreation. Outdoor Recreation Space Standards. Washington, D.C.: U.S. Government Printing Office, 1967.

U.S. Bureau of Outdoor Recreation. Outdoor Recreation Trends. Washington, D.C.: U.S. Government Printing Office, 1967.

U.S. Bureau of Outdoor Recreation. Planning and Surveys Series Manual. Washington, D.C.: Bureau of Outdoor Recreation, 1964.

U.S. Bureau of Outdoor Recreation. Private Assistance in Outdoor Recreation. Washington, D.C.: U.S. Government Printing Office, 1968.

U.S. Bureau of Outdoor Recreation. A Report on Recreation Land Price Escalation. Washington, D.C.: U.S. Department of Interior, Bureau of Outdoor Recreation, 1967.

U.S. Bureau of Outdoor Recreation. Tourist and Recreation Potential: Lafayette and Suwanee Counties, Suwanee River Area, Florida. Area Analysis Staff Report. Washington, D.C.: Bureau of Outdoor Recreation, Division of Planning and Surveys, 1964.

U.S. Bureau of Outdoor Recreation. Tourist and Recreation Potential: Upper Cumberland Lakes Area of Tennessee. Washington, D.C.: U.S. Bureau of Outdoor Recreation, 1965.

U.S. Bureau of Outdoor Recreation. Water-Oriented Outdoor Recreation in the Lake Ontario Basin. New York--Pennsylvania. Ann Arbor, Michigan: U.S. Department of the Interior, Bureau of Outdoor Recreation, Lake Central Region, October, 1967.

U.S. Bureau of Outdoor Recreation. Water-Oriented Recreation in the Lake Michigan Basin. Ann Arbor, Michigan: U.S. Department of the Interior, Bureau of Outdoor Recreation, 1965.

U.S. Bureau of Reclamation. Design of Small Dams. Washington, D.C.: U.S. Government Printing Office, 1960.

U.S. Bureau of Sport Fisheries and Wildlife. Estuarine Programs Interim Report. Washington, D.C.: U.S. Government Printing Office, January, 1967.

U.S. Bureau of Sport Fisheries and Wildlife. National Survey of Fishing and Hunting, 1965. Resource Publication 27. Washington, D.C.: U.S. Department of the Interior, 1965.

U.S. Congress. Clean Water Restoration Act of 1966. An Act to amend the Federal Water Pollution Control Act in order to improve and make more effective certain programs pursuant to such Act. Public Law 753, 89th Cong., 2nd Sess., 1966.

U.S. Congress. Estuaries--Inventory--Study. An Act to authorize the Secretary of the Interior, in cooperation with the States, to conduct an inventory and study of the Nation's estuaries and their natural resources, and for other purposes. Public Law 454, 90th Cong., 2nd Sess., 1968.

U.S. Congress. Federal Water Pollution Control Act Amendments of 1961. An Act to amend the Federal Water Pollution Control Act to provide for a more effective program of water pollution control, and for other purposes. Public Law 88, 87th Cong., 1st Sess., 1961.

U.S. Congress. Federal Water Project Recreation Act. An Act to provide uniform policies with respect to recreation and fish and wildlife benefits and costs of Federal multiple-purpose water resource projects, and for other purposes. Public Law 72, 89th Cong., 1st Sess., 1965.

U.S. Congress. Fish and Wildlife Conservation Areas. An Act to assure continued fish and wildlife benefits from the national fish and wildlife conservation areas by authorizing their appropriate incidental or secondary use for public recreation to the extent that such use is compatible with the primary purposes of such areas, and for other purposes. Public Law 714, 87th Cong., 2nd Sess., 1962.

U.S. Congress. Flood Control--Improvement. An Act to amend the Watershed Protection and Flood Prevention Act to permit certain new organizations to sponsor works of improvement there under. Public Law 170, 87th Congr., 1st Sess., 1961.

U.S. Congress. Flood Control--Land. An Act to amend Section 4 of the Watershed Protection and Flood Prevention Act. Public Law 545, 86th Cong., 2nd Sess., 1960.

U.S. Congress. Land and Water Conservation Fund. An Act to amend title 1 of the Land and Water Conservation Fund Act of 1965, and for other purposes. Public Law 401, 90th Cong., 2nd Sess., 1968.

U.S. Congress. Land and Water Conservation Fund Act of 1965. An Act to establish a land and water conservation fund to assist the States and Federal agencies in meeting present and future outdoor recreation demands and needs of the American people, and for other purposes. Public Law 578, 88th Cong., 2nd Sess., 1964.

U.S. Congress. National Water Commission Act. An Act to provide for a comprehensive review of national water resource problems and programs, and for other purposes. Public Law 515, 90th Cong., 2nd Sess., 1968.

U.S. Congress. National Wildlife Refuge System--Disposition of Lands. An Act to restrict the disposition of lands acquired as part of the National Wildlife Refuge System. Public Law 404, 90th Cong., 2nd Sess., 1968.

U.S. Congress. Outdoor Recreation--Federal State Programs. An Act to promote the coordination and development of effective programs relating to outdoor recreation, and for other purposes. Public Law 29, 88th Cong., 1st Sess., 1963.

U.S. Congress. Recreation Facilities in Reservoir Areas. An Act to authorize the Secretary of Agriculture to modify certain leases entered into for the provision of recreation facilities in reservoir areas. Public Law 411, 87th Cong., 2nd Sess., 1962.

U.S. Congress. Reservoir Areas--Forest Cover. An Act to provide for the protection of forest cover for reservoir areas under the jurisdiction of the Secretary of the Army and the Chief of Engineers. Public Law 717, 86th Cong., 2nd Sess., 1960.

U.S. Congress. Reservoir Areas--Recreation Facilities. An Act to authorize the Secretary of Army to modify certain leases entered into for the provision of recreation facilities in reservoir areas. Public Law 236, 87th Cong., 1st Sess., 1961.

U.S. Congress. Small Reclamation Projects Act--Amendments. An Act to amend the Small Reclamation Projects Act of 1956. Public Law 553, 89th Cong., 2nd Sess., 1966.

U.S. Congress. Water Quality Act of 1965. An Act to amend the Federal Water Pollution Control Act to establish a Federal Water Pollution Control Administration, to provide grants for research and development, to increase grants for construction of sewage treatment works, to require establishment of water quality criteria, and for other purposes. Public Law 234, 89th Cong., 1st Sess., 1965.

U.S. Congress. Water Research--Appropriations. An Act to promote a more adequate national program of water research. Public Law 404, 89th Cong., 2nd Sess., 1966.

U.S. Congress. Water Resources Planning Act. An Act to provide for the optimum development of the Nation's natural resources through the coordinated planning of water and related land resources, through the establishment of a water resources council and river basin commission, and by providing financial assistance to the States in order to increase State participation in such planning. Public Law 80, 89th Cong., 1st Sess., 1965.

U.S. Congress. Water Resources Planning Act--Administration. An Act to amend the Water Resources Planning Act to revise the authorization of appropriations for administering the provisions of the Act, and for other purposes. Public Law 547, 90th Cong., 2nd Sess., 1968.

U.S. Congress. Water Resources Research Act of 1964. An Act to establish water resources research centers, to promote a more adequate national program of water research, and for other purposes. Public Law 379, 88th Cong., 2nd Sess., 1964.

U.S. Congress. Watershed Improvement Programs--Loans. An Act to amend the Watershed Protection and Flood Prevention Act to provide that its loan provisions shall be applicable to certain other projects, and for other purposes. Public Law 468, 86th Cong., 2nd Sess., 1960.

U.S. Congress. Wild and Scenic Rivers Act. An Act to provide for a National Wild and Scenic Rivers System and for other purposes. Public Law 542, 90th Cong., 2nd Sess., 1968.

U.S. Congress. Wilderness Act. An Act to establish a National Wilderness Preservation System for the permanent good of the whole people, and for other purposes. Public Law 577, 88th Cong., 2nd Sess., 1964.

U.S. Department of Agriculture. Land and Water Resources: A Policy Guide. Washington, D.C.: U.S. Department of Agriculture, May, 1962.

U.S. Department of Agriculture. Outdoor Recreation in the Upper Great Lake Area: Proceedings of a Seminar in Research Needs. Station Paper 89. St. Paul, Minnesota: Lake States Forest Experiment Station, 1961.

U.S. Department of Agriculture. Resources and Recreation in the Northern Great Lakes Region: A Department of Agriculture Task Force Report. Washington, D.C.: U.S. Department of Agriculture, 1963.

U.S. Department of Agriculture. Rural Recreation, a New Family-Farm Business Report of Task Force on Income-Producing Recreation Enterprises on Farm Land. Washington, D.C.: U.S. Government Printing Office, September, 1962.

U.S. Department of Agriculture, River Basin Survey Party. Water and Related Land Resources, Hood Drainage Basin Oregon. Salem, Oregon: U.S. Department of Agriculture, Economic Research Service, February, 1964.

U.S. Department of Agriculture. Water-The Yearbook of Agriculture-1955. Washington, D.C.: U.S. Government Printing Office, 1955.

U.S. Department of Agriculture and U.S. Department of the Interior. Wild Rivers. Washington, D.C.: U.S. Department of Agriculture and U.S. Department of the Interior, May, 1965.

U.S. Department of Health, Education and Welfare. Comprehensive Water Pollution Control Planning. Proceedings of the Thirteenth Pacific Northwest Symposium on Water Pollution Research, April 14, 1965. Corvallis, Oregon: Pacific Northwest Water Laboratory, 1965.

U.S. Department of Interior. America's Department of Natural Resources. Conservation Bulletin Number 39. Washington, D.C.: Department of Interior, 1962.

U.S. Department of the Interior. Community Recreation in the Public Domain. Washington, D.C.: U.S. Department of Interior, May, 1963.

U.S. Department of the Interior. The Federal Water Pollution Control Program. Washington, D.C.: U.S. Department of the Interior, December 2, 1968.

U.S. Department of the Interior. The Lower Colorado River Land Use Plan: A Report of the Lower Colorado River Land-Use Advisory Committee. Washington, D.C.: U.S. Government Printing Office, 1964.

U.S. Department of the Interior. Surface Mining and Our Environment. Washington, D.C.: U.S. Government Printing Office, 1967.

U.S. Environmental Pollution Panel, President's Science Advisory Committee. Restoring the Quality of Our Environment. Washington, D.C.: U.S. Government Printing Office, The White House, November, 1965.

U.S. Federal Council for Science and Technology, Commission of Water Resources, Office of the President. A Ten Year Program of Federal Water Resources Research. Washington, D.C.: U.S. Government Printing Office, 1966, pp. 1-88.

U.S. Federal Water Pollution Control Administration. "The Beet Sugar Industry--The Water Pollution Problem and the Status of Waste Abatement and Treatment." Denver, Colorado: U.S. Department of the Interior, June, 1967. (Mimeographed)

U.S. Federal Water Pollution Control Administration. Biological Associated Problems in Freshwater Environments: Their Identification, Investigation and Control. Washington, D.C.: Federal Water Pollution Control Administration, 1967.

U.S. Federal Water Pollution Control Administration. Biology of Water Pollution --A Collection of Selected Papers on Stream Pollution, Waste Water and Water Treatment. Washington, D.C.: Federal Water Pollution Control Administration, U.S. Department of the Interior, 1967.

U.S. Federal Water Pollution Control Administration. Comprehensive Water Pollution Control Program for the Lake Michigan Basin. Green Bay Area, Michigan and Wisconsin. Chicago, Illinois: U.S. Department of the Interior, June, 1966.

U.S. Federal Water Pollution Control Administration. Comprehensive Water Pollution Control Program for the Lake Michigan Basin, Milwaukee Area, Wisconsin. Chicago, Illinois: U.S. Department of the Interior, June, 1966.

U.S. Federal Water Pollution Control Administration. Delaware Estuary Comprehensive Study--Preliminary Report and Findings. Philadelphia, Pennsylvania: Department of the Interior, 1966.

U.S. Federal Water Pollution Control Administration. Great Lakes Region. Water Pollution Problems of Lake Michigan and Tributaries--Actions for Clear Water. Chicago, Illinois: U.S. Department of the Interior, January, 1968.

U.S. Federal Water Pollution Control Administration. Indiana Water Quality--Recreation Project--Geist Reservoir--Indianapolis, Indiana. Washington, D.C.: Federal Water Pollution Control Administration, U.S. Department of Health, Education, and Welfare, 1966.

U.S. Federal Water Pollution Control Administration. National Estuarine Inventory, Handbook of Descriptors. Washington, D.C.: U.S. Department of the Interior, June, 1968.

U.S. Federal Water Pollution Control Administration. Pollution Caused Fish Kills--1967. Eighth Annual Report. Washington, D.C.: U.S. Federal Water Pollution Control Administration, U.S. Department of the Interior, 1968.

U.S. Federal Water Pollution Control Administration. Problems of Combined Sewer Facilities and Overflows, 1967. U.S. Department of the Interior, Water Pollution Control Research Series, 1967.

U.S. Federal Water Pollution Control Administration. Progress Report--Plywood Plant Glue Waste. Report Number PR-2. Corvallis, Oregon: Pacific Northwest Water Laboratory, 1968.

U.S. Federal Water Pollution Control Administration. Report of the National Technical Advisory Committee on Water Quality Criteria to the Secretary of the Interior. Washington, D.C.: U.S. Government Printing Office, 1968.

U.S. Federal Water Pollution Control Administration. The Santee Recreation Project, Santee, California. Final Report. Cincinnati, Ohio: U.S. Department of the Interior, 1967.

U.S. Federal Water Pollution Control Administration. The Storage and Retrieval of Data for Water Quality Control. Washington, D.C.: U.S. Government Printing Office, 1964.

U.S. Federal Water Pollution Control Administration. Summary Report, Advanced Waste Treatment, July, 1964--July, 1967, WP-20-AWTR-19. Cincinnati, Ohio, 1968.

U.S. Federal Water Pollution Control Administration. Water-Oriented Recreation Benefits. A Study of the Recreation Benefits Derivable from Various Levels of Water Quality of the Delaware River. Phase I. Philadelphia, Pennsylvania: University of Pennsylvania, Institute for Environmental Studies, July, 1966.

U.S. Federal Water Pollution Control Administration. Water Quality Standards: Questions and Answers. Washington, D.C.: U.S. Federal Water Pollution Control Administration, 1967.

U.S. Federal Water Pollution Control Administration. Water Temperature Influences, Effects, and Control. Proceedings of the Twelfth Pacific Northwest Symposium on Water Pollution Research. Portland, Oregon: U.S. Department of the Interior, 1967.

U.S. Federal Water Pollution Control Administration and New York State Department of Health. Water Pollution Problems and Improvement Needs, Lake Ontario and St. Lawrence River Basins. Chicago, Illinois: U.S. Department of the Interior, June, 1968.

U.S. Federal Water Pollution Control Administration and Washington State Pollution Control Commission. Pollution Effects of Pulp and Paper Mill Wastes in Puget Sound. Portland, Oregon: U.S. Department of the Interior, 1967.

U.S. Forest Service. Changing Recreational Use of the Boundary Waters Canoe Area. Research Note N C - 42. St. Paul, Minnesota: U.S. Forest Service, Department of Agriculture, North Central Forest Experiment Station, October, 1967.

U.S. Forest Service. Multiple Use Management Plan for National Forest Lands: Lake Tahoe Basin. San Francisco, California: U.S. Forest Service Region 4 and 5, 1962.

U.S. Forest Service. Outdoor Recreation in the National Forest. Agricultural Information Bulletin 301. Washington, D.C.: U.S. Government Printing Office, 1965.

U.S. Forest Service. Use of Water-Meter Records to Estimate Recreation Visits and Use on Developed Sites. Research Note SE - 73. Ashville, North Carolina: U.S. Forest Service Southeastern Forest Experiment Station, April, 1967.

U.S. Forest Service. Waterline Erosion Control Essential to Streambank Rehabilitation. Research Note NC - 29. St. Paul, Minnesota: North Central Forest Experiment Station, U.S. Department of Agriculture, April, 1967.

U.S. Geological Survey. Has the United States Enough Water? Geological Survey Water Supply Paper 1797. Washington, D.C.: U.S. Department of the Interior, 1965.

U.S. Geological Survey. A Primer on Ground Water. Washington, D.C.: U.S. Government Printing Office, 1963.

U.S. Geological Survey. A Primer on Water. Washington, D.C.: U.S. Government Printing Office, 1960.

U.S. Geological Survey. A Primer on Water Quality. Washington, D.C.: U.S. Government Printing Office, 1965.

U.S. Geological Survey. Reservoirs in the United States. Geological Survey Water Supply Paper 1838. Washington, D.C.: U.S. Government Printing Office, 1966.

U.S. Mission. Natural Resources Mission to Germany. Washington, D.C.: U.S. Government Printing Office, 1966.

U.S. National Park Services. Assateague Island National Seashore: A Proposal. Washington, D.C.: National Park Service, 1965.

U.S. National Park Service. Channel Islands--A Sea Dominated National Park: Its Prospects and Proposals. Washington, D.C.: National Park Service,

U.S. National Park Service. Everglades National Park Natural Sciences Research Plan. Washington, D.C.: U.S. Department of the Interior, National Park Service, 1966.

U.S. National Park Service. Field Investigation Report for the Proposed Between the Rivers National Recreation Area in Kentucky and Tennessee. Richmond, Virginia: National Park Service, April, 1961.

U.S. National Park Service. Great Salt Lake, Utah. A Preliminary Survey of the Park and Recreation Potential. Washington, D.C.: National Park Service, 1960.

U.S. National Park Service. Handbook for Reservoir Recreation Planning. Washington, D.C.: Department of the Interior, National Park Service, 1960.

U.S. National Park Service. Project Report on the Recreation Resources of the Auburn - Folsom South Unit American River Division, Central Valley Project, California. San Francisco, California: U.S. Department of the Interior, National Park Service, March 1963.

U.S. National Park Service. Proposed Voyageurs National Park, Minnesota. Omaha, Nebraska: National Park Service--Midwest Region, July, 1964.

U.S. National Technical Advisory Committee on Water Quality. Research Needs. Washington, D.C.: U.S. Department of the Interior, 1968.

U.S. Outdoor Recreation Resources Review Commission. Alaska Outdoor Recreation Potential--Study Report No. 9. Washington, D.C.: U.S. Government Printing Office, 1962.

U.S. Outdoor Recreation Resources Review Commission. Multiple Use of Land and Water Areas. Study Report No. 17. Washington, D.C.: U.S. Government Printing Office, 1962.

U.S. Outdoor Recreation Resources Review Commission. National Recreation Survey. Study Report Number 19. Washington, D.C.: U.S. Government Printing Office, 1962.

U.S. Outdoor Recreation Resources Review Commission. Outdoor Recreation for America. Washington, D.C.: U.S. Government Printing Office, January, 1962.

U.S. Outdoor Recreation Resources Review Commission. Participation in Outdoor Recreation: Factors Affecting Demand Among American Adults--Study Report No. 20. Washington, D.C.: U.S. Government Printing Office, 1962.

U.S. Outdoor Recreation Resources Review Commission. Prospective Demand for Outdoor Recreation--Study Report No. 26. Washington, D.C.: U.S. Government Printing Office, 1962.

U.S. Outdoor Recreation Resources Review Commission. Shoreline Recreation Resources of the U.S.--Study Report No. 4. Washington, D.C.: U.S. Government Printing Office, 1962.

U.S. Outdoor Recreation Resources Review Commission. Water for Recreation--Values and Opportunities--Study Report No. 10. Washington, D.C.: U.S. Government Printing Office.

U.S. President's Council on Recreation and Natural Beauty. From Sea to Shining Sea. A Report on the American Environment--Our Natural Heritage. Washington, D.C.: U.S. Government Printing Office, 1968.

U.S. President's Water Resources Policy Commission. Report of the Commission. Washington, D.C.: U.S. Government Printing Office, 1950.

U.S. Public Health Service. Environmental Health Practice in Recreational Areas. Public Health Service Publication 1195. Washington, D.C.: U.S. Department of Health, Education and Welfare, 1966.

U.S. Recreation Advisory Council. Federal Executive Policy Governing the Reporting of Recreation Use of Federal Recreation Areas. Circular No. 6. Washington, D.C.: U.S. Government Printing Office, October 20, 1965.

U.S. Recreation Advisory Council. General Policy Guidelines for Outdoor Recreation. Circular No. 2. Washington, D.C.: U.S. Government Printing Office, April 9, 1964.

U.S. Recreation Advisory Council. Non-Federal Management of Recreational Facilities on Federal Lands and Waters. Circular Number 7. Washington, D.C.: U.S. Government Printing Office, October 20, 1965.

U.S. Recreation Advisory Council. Policy Governing the Water Pollution and Public Health Aspects of Outdoor Recreation. Circular Number 3. Washington, D.C.: U.S. Government Printing Office, 1964.

U.S. Recreation Advisory Council. A Uniform Method for Measuring and Reporting Recreation Use on the Public Lands and Waters of the United States. Washington, D.C.: Recreation Advisory Council, 1965.

U.S. Senate. Policies, Standards and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources. 87th Congress 2nd, Senate Document No. 97. Washington, D.C.: U.S. Government Printing Office, May, 1962.

U.S. Senate Committee on Commerce. Compilation of Federal Laws Relating to the Conservation and Development of Our Nation's Fish and Wildlife Resources. Washington, D.C.: U.S. Government Printing Office, 1965.

U.S. Senate Committee on Interior and Insular Affairs. Hearings Before the Subcommittee on Public Lands-Shoreline Recreation Area. 87th Congress, 1st Session, S543, 1961.

U.S. Senate Committee on Interior and Insular Affairs. Land and Water Conservation Fund: Hearings Before the Committee. 88th Congress, 1st Session, 1964.

U.S. Senate Committee on Interior and Insular Affairs. Land and Water Conservation Fund: Hearings Before the Committee. 88th Congress, 2nd Session, July, 1964.

U.S. Senate Committee on Interior and Insular Affairs. Water Project Recreation Act: Hearings Before the Committee. 89th Congress, 1st Session, 1965.

U.S. Senate Commission on Public Works. Western Water Development: A Summary of Water Resources Projects, Plans and Studies Relating to the Western and Midwestern U.S. Washington, D.C.: U.S. Government Printing Office, 1966.

U.S. Senate Select Committee on Natural Water Resources. Hearings Before the Select Committee on Natural Water Resources. 86th Congress, 2nd Session, S. Res. 48, Part II, 1960.

U.S. Senate Select Committee on Natural Resources. "Views and Comments of the States," Water Resources Activities in the United States. Committee Print Number 6. Washington, D.C.: U.S. Government Printing Office, 1960.

U.S. Senate Select Committee on Natural Water Resources. "Water Recreation Needs in the U.S. 1960-2000," Water Resources Activities in the U.S. Committee Print 17. Washington, D.C.: U.S. Government Printing Office, May, 1960.

U.S. Senate Select Committee on Natural Water Resources. "Water Resources of Alaska," Water Resources Activities in the United States. Committee Print 19. Washington, D.C.: U.S. Government Printing Office, January, 1960.

U.S. Senate Subcommittee on Air and Water Pollution. Steps Toward Clean Water. Report to the Senate Committee on Public Works, 89th Congress, 2d. Session, 1966.

U.S. Soil Conservation Service. Economics Guide for Watershed Protection and Flood Prevention. Washington, D.C.: U.S. Government Printing Office, 1964.

U.S. Soil Conservation Service. "Guide to Making Appraisals of Potentials for Outdoor Recreation Developments." Washington, D.C.: U.S. Department of Agriculture, 1966.

U.S. Study Commission Southeast River Basins. Plan for Development of the Land and Water Resources of the Southeast River Basins. Atlanta, Georgia: U.S. Study Commission for the Southeast River Basin, 1963.

U.S. Task Force on Environmental Health and Related Problems. A Strategy for a Livable Environment. Washington, D.C.: U.S. Government Printing Office, June, 1967.

U.S. Tennessee Valley Authority. Nature's Constant Gift, A Report on the Water Resource of the Tennessee Valley. Knoxville, Tennessee: Tennessee Valley Authority, June, 1966.

U.S. Tennessee Valley Authority. Outdoor Recreation for a Growing Nation. Knoxville, Tennessee: Tennessee Valley Authority, September, 1961.

U.S. Water Resources Council. Guidelines for Framework Studies, 1967. Washington, D.C.: Water Resources Council, 1967.

Vermont Department of Water Resources. Inventory of Lakes and Ponds in Vermont by Counties, 20 Acres or More in Area. Montpelier, Vermont: Department of Water Resources, August, 1966.

Vermont Department of Water Resources. Inventory of Small Ponds in Vermont by Counties, Less than 20 Acres. Montpelier, Vermont: Department of Water Resources, July, 1966.

Vermont Department of Water Resources. "Status of Outlets and Control Structures of Lakes and Ponds over Twenty Acres in Vermont." Montpelier, Vermont: Department of Water Resources, September, 1964. (Mimeographed)

Vermont Water Resources Board. "Proposed Classification for the Upper Connecticut River and Its Tributaries." Montpelier, Vermont: Water Resources Board, n.d. (Mimeographed)

Wabash Valley Interstate Commission. The Embarrass Basin. Mt. Carmel, Illinois: Wabash Valley Interstate Commission, 1963.

Washington Parks and Recreation Commission. Statewide Plan for State Parks. Olympia, Washington: Parks and Recreation Commission, October, 1965.

West Virginia Department of Natural Resources. Design of Water Resources Plan for West Virginia. Ann Arbor, Minnesota: Technology Planning Center, Inc., 1967.

West Virginia Water Research Institute. West Virginia Water Research Symposium Proceedings 1963. Morgantown, West Virginia: West Virginia University, 1964.

Wisconsin Department of Natural Resources. Wisconsin's Outdoor Recreation Plan. Madison, Wisconsin: Department of Natural Resources, 1968.

Wisconsin Department of Resource Development. The Outdoor Recreation Plan. Wisconsin Development Series. Madison, Wisconsin: Department of Resource Development, 1966.

Wisconsin Department of Resource Development. Recreation in Wisconsin. Madison, Wisconsin: Department of Resource Development, 1962.

Wisconsin Department of Resource Development. Recreation Potential of the Lake Superior South Shore Area. Volume 4. Madison, Wisconsin: Department of Resource Development, 1963-64.

Wisconsin Department of Resource Development. Wisconsin Ten Year Program--Resource Development and Outdoor Recreation. Madison, Wisconsin: Department of Resource Development, 1961.

Youngstown, Ohio, City Plan Commission. Recreation Development Plan for Lake Milton Reservoir. CPC Report 62-6. Youngstown, Ohio: City Planning Commission, 1962.

Books

Aguar, Jyring and Whiteman. Carey Lake Area Recreation Development; A Feasibility Study. Duluth, Minnesota: Aguar, Jyring and Whiteman, 1965.

American Association for Health, Physical Education, and Recreation. Recreation Research. Collected papers from the National Conference on Recreation Research, November 7-10, 1965, Pennsylvania State University, University Park, Pennsylvania, 1966.

American Enterprise Institute for Public Policy Research. Legislative Analysis: The Water Pollution Control Bill. Washington, D.C.: American Enterprise Institute for Public Research, 1966.

Anderson, Kenneth R. and Company. Recreation Potential: Upper Klamath River Basin. Roseville, California: California Oregon Power Co., 1960.

Associated Planners, Inc. Arkansas River Region Comprehensive Development Plan, 1980. Little Rock, Arkansas: Arkansas Planning Commission, December, 1966.

Batelle Memorial Institute. Alternative Long Range Water Use Plans for the Tri-County Region, Michigan: A Technical Economic Report to Tri-County Regional Planning Commission. Columbus, Ohio: Battelle Memorial Institute, 1963.

Bates, Marston. The Forest and The Sea. New York: Random House, 1960.

Battelle Memorial Institute. Development Potential of U.S. Continental Shelves. Washington, D.C.: Department of Commerce, 1966.

Behan, R. W. and Gratzer, Midlos J. Recreation at Libby Reservoir--An International Opportunity for Regional Development. Special Publication Number 2. Montana Forest and Conservation Experiment Station. Missoula, Montana: University of Montana, September, 1966.

Bennett, George W. Management of Artificial Lakes and Ponds. New York: Reinhold Publishing Corporation, 1962.

Bowdoin College, Center for Resource Studies. The Maine Coast, Time of Decision. Brunswick, Maine: Bowdoin College, Center for Resource Studies, 1967.

Bowen, A. Temple, Jr. A Plan for the Development of the Machias Lakes Region in Washington County, Maine. Bulletin 614. Augusta, Maine: University of Maine, Maine Agricultural Experiment Station, May, 1963.

Brauer and Associates. Feasibility Study: Hayes Lake State Park. Eding, Minnesota: Brauer and Associates, Inc., 1966.

Bury, Richard L. Information on Campground Use and Visitor Characteristics. U.S. Forest Service Resources Note PSW-43. Berkeley, California: U.S. Forest Service, Pacific Southwest Forest Range Experiment State, 1964.

Carr, Donald E. Death of the Sweet Waters. New York: W. W. Norton, 1966.

Carswell, J. Keith, Symons, J. M. and Robeck, Gordon G. Status of Research on the Recreational Use of Public Water Supply Sources. Cincinnati, Ohio: U.S. Public Health Service, Department of Health, Education and Welfare, July, 1968.

Checchi and Company. The Economic Potentials of Tourism and Recreation in Southern Illinois. Washington, D.C.: U.S. Department of Commerce, Economic Development Administration, 1966.

Chubb, Michael. Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part III. East Lansing, Michigan: Department of Resource Development, Michigan State University, 1968.

Clark, B. D. Houseboat Wastes--Methods for Collection and Treatment. Corvallis, Oregon: Pacific Northwest Water Laboratory, 1967.

Clark, John. Fish and Man--Conflict in the Atlantic Estuaries. Special Publication No. 5. Highlands, New Jersey: American Littoral Society, 1967.

Clawson, Marion. The Federal Lands Since 1965: Recent Trends in Use and Management. Washington, D.C.: Resources for the Future, 1967.

Clawson, Marion. Land and Water for Recreation: Opportunities, Problems and Policies. Chicago, Illinois: Rand McNally and Co., 1963.

Clawson, Marion. Methods of Meauring the Demand for Outdoor Recreation, Reprint No. 10. Washington, D.C.: Resources for the Future, Inc., 1959.

Clawson, M. and Knetsch, J. L. Economics of Outdoor Recreation. Baltimore, Maryland: The Johns Hopkins Press, 1966.

Cleary, Edward J. The ORSANCO Story: Water Quality Management in the Ohio Valley under an Interstate Compact. Baltimore, Maryland: Johns Hopkins Press for Resources for the Future, 1967.

Columbia University, School of Architecture. Break-through to the Hudson River: A Plan for Yonkers to Peekskill. New York: Columbia University, 1964.

Cornell, Howland, Hayes, and Merryfield. Developing Small Boat Harbors in Six Oregon Counties. Washington, D.C.: U.S. Department of Commerce Area Redevelopment Administration, February, 1965.

Cornell University Water Resources Center. Profile of a Watershed: Flint Creek. Ithaca, New York: Cornell University Water Resources Center, n.d.

Craine, Lyle E. Maryland's Role in Water Resources Development. College Park, Maryland: University of Maryland, Water Resources Study Committee, 1966.

Crites, Robert S. Handbook of Outdoor Recreation Enterprises in Rural Areas. Washington, D.C.: Farmers Home Administration, 1966.

Darling, F. Fraser and Eichhorn, Noel D. Man and Nature in the National Parks. Washington, D.C.: Conservation Foundation, 1967.

Darling, F. Fraser and Milton, John P. Future Environments of North America. Garden City, New York: Natural History Press, 1966.

Douglas, William O. A Wilderness Bill of Rights. Boston, Massachusetts: Little, Brown, and Company, 1965.

Eckstein, Otto. Water Resource Development: The Economics of Project Evaluation. Cambridge, Massachusetts: Harvard University Press, 1961.

Edwards and Kelcey. Outdoor Recreation and Open Space Inventory, 1966. Boston, Massachusetts: Massachusetts Department of Commerce and Development, January, 1967.

Fine, I. V. and Werner, E. E. Wisconsin Vacation--Recreation Papers. Vol. I. Madison, Wisconsin: University of Wisconsin Bureau of Business Research and Service, 1960.

Fine, Morton S. and Associates. Buff Point Master Plan Study; Design Principles for a Shoreline State Park, Groton, Connecticut. Hartford, Connecticut: Connecticut Park and Forest Commission, 1965.

Galbreath, Paul M. Maryland Water Law, Water Laws and Legal Principles Affecting the Use of Water in Maryland. College Park, Maryland: University of Maryland, Water Resources Study Committee, 1965.

Gamble, Hays B. The Economic Structure of Sullivan County, Pennsylvania. Bulletin 743. University Park, Pennsylvania: Pennsylvania State University, College of Agriculture, Agriculture Experiment Station, July, 1967.

Hall, Norville L. Manual and Survey on Small Lake Management; Recreation That Pays Its Way. Management Aids Bulletin Number 8. Wheeling, West Virginia: American Institute of Park Executives, Inc., October, 1961.

Hammond, R. J. Benefit Cost Analysis and Water Pollution Control. Stanford, California: Stanford University Food Research Institute, 1960.

Hare and Hare. Blue River Parkway; Master Plan. Kansas City, Missouri: Hare and Hare, 1964.

Harvard University, Graduate School of Design. Three Approaches to Environmental Resource Analysis. Washington, D.C.: The Conservation Foundation, 1967.

Heath, Edward I. Comparison of Recreational Development Plans for a Northern Maine Wilderness Tract. Bulletin 628. Augusta, Maine: University of Maine, Maine Agricultural Experiment Station, October, 1964.

Hector, Fred L. Master Plan--Laguna Lake Park San Luis Obispo California. Los Gatos, California: 1961.

Helfman, Elizabeth S. Rivers and Watersheds in America's Future. New York: David McKay, 1965.

Hendee, J. C., Catton, W. R., Jr., Marlow, L. D. and Brockman, C. F. Wilderness Users in the Pacific Northwest--Their Characteristics, Values, and Management Preferences. Portland, Oregon: Pacific Northwest Forest and Range Experiment Station, U.S. Department of Agriculture, 1968.

Herfindahl, Orris C. and Kneese, Allen V. Quality of the Environment: An Economic Approach to Some Problems in Using Land, Water and Air. Washington, D.C.: Resources for the Future, Inc., 1965.

Herrington, Roscoe B. and Dunham, Donald K. A Technique for Sampling General Fish Habitat Characteristics of Streams. Research Paper INT-41. Ogden, Utah: U.S. Forest Service Intermountain Forest and Range Experiment Station, 1967.

Herrington, Roscoe B. and Tocher, S. Ross. Aerial Photo Techniques for a Recreation Inventory of Mountain Lakes and Streams. Research Paper INT-37. Logan, Utah: U.S. Forest Service Intermountain Forest and Range Experiment Station, 1967.

Highsmith, Richard M. Jr. Conservation in the United States. Chicago, Illinois: Rand McNally Company, 1962.

Hitchcock, Lauren B. The Fresh Water of New York: Its Conservation and Use. Dubuque, Iowa: Wm. C. Brown Book Co., 1967.

Holden, Matthew Jr. Pollution Control as a Bargaining Process: An Essay on Regulatory Decision Making. Cornell University Water Resources Center, Publication Number 9. Ithaca, New York: Cornell University, October, 1966.

Huddleston, Sam L. Master Plan for Lake Pleasant Regional Park. Denver, Colorado: Sam L. Huddleston ASLA-Association, 1960.

Huddleston, Sam L. and Associates. Nancy Lake, Plan Program, Budget. Juneau, Alaska: Alaska Department of Natural Resource, 1967.

Hufschmidt, Maynard M. and Fiering, Myron B. Simulation Techniques for Design of Water-Resource Systems. Cambridge, Massachusetts: Harvard University Press, 1966.

Hull, William J. and Hull, Robert W. The Origin and Development of the Waterways Policy of the United States. Washington, D.C.: National Waterways Conference, Inc., 1967.

Humphrys, C. R. Inland Lake Development and Management Problems. East Lansing, Michigan: Michigan State University, Agricultural Experiment Station, n.d.

Humphrys, C. R. Lake Development Problems. Presented at Meeting of Michigan Society of Registered Land Surveyors, Caberfae Lodge, February 21-24, 1967. East Lansing, Michigan: Michigan State University, 1967.

Humphrys, C. R., Schafer, C. and Schafer, R. Antrim County, Michigan Lake Property Value Study. East Lansing, Michigan State Agricultural Experiment Station, Michigan State University, 1967.

Humphrys, C. R., Schafer, Carolyn and Schafer, Robert. Kent County, Michigan Lake Property Value Study. East Lansing, Michigan: Michigan State Agricultural Experiment Station, Michigan State University, 1967.

Illinois University Bureau of Community Planning and Department of Urban Planning. The Implementation of Public Programs of Open Space. Urbana, Illinois: University of Illinois, August, 1965.

Illinois University College of Agriculture. Farm Ponds. Circular 872. Urbana, Illinois: University of Illinois, College of Agriculture Cooperative Extension Service, July, 1963.

International Business Machines Corporation. IBM System 360 Document Processing System Application Description, No. H20-0315-0. White Plains, New York: International Business Machines Corporation, 1967.

International Business Machines Corporation. IBM System/360 Document Processing System [360A-CX-12X] Program Description and Operations Manual, No. H20-0477-0. White Plains, New York: International Business Machines Corporation, 1967.

Jansma, J. Jean. Local Secondary Effects of Watershed Projects: A Case Study of Roger Mills County, Oklahoma, Economic Research Service. Number 178. Washington, D.C.: U.S. Government Printing Office, May, 1964.

Keyes, Scott. A Guide to Federal Programs for Illinois Communities. Urbana, Illinois: University of Illinois, Bureau of Community Planning, 1967.

King, Thomson. Water: Miracle of Nature. New York: Collier Books, 1953.

Kirk, Ruth. The Olympic Seashore. Port Angeles, Washington: Olympic Natural History Association, 1962.

Kneese, Allen V. The Economics of Regional Water Quality Management. Baltimore, Maryland: Johns Hopkins Press for Resources for the Future, 1964.

Kneese, Allen V. Water Pollution--Economic Aspects and Research Needs. Baltimore, Maryland: Resources for the Future, 1962.

Kneese, Allen and Smith, Stephen (ed.) Water Research. Baltimore, Maryland: Johns Hopkins Press, 1966.

Krutilla, John V. and Eckstein, Otto. Multiple Purpose River Development. Baltimore, Maryland: Johns Hopkins Press for Resources for the Future, 1958.

Laas, William and Beicos, S. S. The Water in Your Life. New York: Popular Library, 1967.

Land Planning Associates. Master Plan Report Pawtuckaway State Park. Syracuse, New York: Land Planning Associates, 1963.

Landsberg, Hans H. Natural Resources for U.S. Growth. Baltimore, Maryland: Johns Hopkins Press, 1964.

Landsberg, Hans H., Fischman, Leonard L. and Fisher, Joseph L. Resources in America's Future: Patterns of Requirements and Availabilities 1960-2000. Baltimore, Maryland: Johns Hopkins Press, 1963.

League of Women Voters of the United States. The Big Water Fight. Brattleboro, Vermont: Stephen Greene Press, 1966.

League of Women Voters of the United States. Current Review of Water Resources, A Consideration of Federal Financial Incentives. Number 3. Washington, D.C.: League of Women Voters, August, 1966.

League of Women Voters of the United States. Current Review of Water Resources, the 89th Congress Acts in 1965...on Water Management. Number 2. Washington, D.C.: League of Women Voters, November, 1965.

League of Women Voters of the United States. Current Review of Water Resources, Federal Departments, Agencies and Commissions Which Offer Assistance in Planning, Development, Administration and Use of Water and Related Land Resources. Number 1. Washington, D.C.: League of Women Voters, March, 1965.

League of Women Voters of the United States. Current Review of Water Resources, Out of the 89th into the 90th Congress. Number 4. Washington, D.C.: League of Women Voters, May, 1967.

Leeds, Hill and Jewett, Inc. California Boating Plan. Sacramento, California: Leeds, Hill and Jewett, Inc., 1964.

Leeds, Hill and Jewett, Inc. California Small Craft Harbors and Facilities Plan; Comprehensive Report. Sacramento, California: California Department of Parks and Recreation, Division of Small Craft Harbors, 1964.

Leeds, Hill and Jewett, Inc. Interim Report on Coastal Harbors of Refuge. California Small Craft Harbors and Facilities Plan. Sacramento, California: California Department of Parks and Recreation, Division of Small Craft Harbors, January, 1963.

Leopold, Luna B. The Challenge of Water Management. Geological Survey Circular 414, Part B. Washington, D.C.: U.S. Geological Survey, 1960, pp. 7-13.

Leopold, Luna B. Conservation and Protection. Geological Survey Circular 414, Part A. Washington, D.C.: U.S. Geological Survey, 1960, pp. 1-5.

Leopold, Luna B. The Conservation Attitude. Geological Survey Circular 414, Part C. Washington, D.C.: U.S. Geological Survey, 1960, pp. 15-19.

Lewis, Philip H., Jr. Recreation and Open Space in Illinois. Urbana, Illinois: Illinois State Housing Board, 1961.

Lewis, Philip H., Jr. Upper Mississippi River Comprehensive Basin Study (Appendix B: Aesthetic and Cultural Values). Kaukoma, Wisconsin: National Park Service, Northeast Region, 1968.

Lewis, P. H., Jr. and Associates. Regional Design for Human Impact. Kaukoma, Wisconsin: Thomas Publishers, 1968.

Little, J. A. Pearl River Shallow Water Reservoir Water Quality--Recreation Project. Atlanta, Georgia: Public Health Service, U.S. Department of Health, Education, and Welfare, 1963.

Lucas, Robert C. Recreational Capacity of Quetico-Superior Area. Research Paper LS-15. Washington, D.C.: U.S. Department of Agriculture, 1964.

Lucas, Robert C. Recreational Use of the Quetico-Superior Area. Research Paper LS-8. Washington, D.C.: U.S. Department of Agriculture, Forest Service, April, 1964.

MacConnell, William P. and Stall, G. Peter. Use of Aerial Photographs to Evaluate the Recreational Resources of the Connecticut River in Massachusetts. Planning and Resource Development Series No. 8, Holdsworth Natural Resources Center, Bulletin 573, Agricultural Experiment Station, University of Massachusetts, October, 1968.

McConnen, R. J. Efficient Development and Use of Forest Lands: An Outline of a Prototype Computer--Oriented System for Operational Planning. Forest Record Number 59. Berkeley, California: Pacific Southwest Forest and Range Experiment Station, 1965.

McKee, Jack Edward and Wolf, Harold W. (ed.). Water Quality Criteria. Sacramento, California: State Water Quality Control Board, State of California, 1963.

MacKenthum, Kenneth. Limnological Aspects of Recreational Lakes. Washington, D.C.: U.S. Government Office, 1964.

Maine University Outdoor Recreation Study Team. Outdoor Recreation in Maine, A Study of the Supply and the Demand for Outdoor Recreation. Augusta, Maine: University of Maine, 1965.

Mann, Dean E. The Politics of Water in Arizona. Tucson, Arizona: University of Arizona Press, 1963.

Mann, Fred. Water Use Law in Illinois. Agricultural Experiment Station Bulletin 703. U.S. Department of Agriculture, Economic Research Service, 1964.

Martin, Edward and Weinberger, Leon. Eutrophication and Water Pollution. Publication 15. Ann Arbor, Michigan: University of Michigan, Great Lakes Research Division, 1966, pp. 451-469.

Maryland University Water Resources Study Committee. Water Resources Management in Maryland. College Park, Maryland: University of Maryland, 1967.

Maryland University Water Resources Study Committee. Water Resources Management in Maryland, Appendices, A Report to Maryland Department of Water Resources. College Park, Maryland: University of Maryland, 1966.

Massachusetts University Water Resources Center. Massachusetts Water Resources Research. Publication No. 2. Amherst, Massachusetts: University of Massachusetts, 1967.

Matson, Arthur. An Analysis of Economic Factors and Institutions Affecting the Productivity of South Dakota Land and Water Resources for Upland Game Birds and Migratory Waterfowl. Agricultural Economics Pamphlet 123. Brooking, South Dakota: South Dakota State University, 1964.

Metropolitan Planning Commission Portland, Oregon. Recreation Outlook 1962-1975. Portland, Oregon: Metropolitan Planning Commission, September, 1962.

Michigan State University. Water Management Information. East Lansing, Michigan: Co-op Extension Service and Department of Natural Resources, 1967.

Michigan State University Department of Resource Development. Preliminary Inventory of Michigan's Artificial Surface Water. Bulletin Number 12. East Lansing, Michigan: Department of Resource Development, 1962.

Midwest Planning and Research, Inc. A Survey and Analysis of 24 Rivers in Minnesota. St. Paul, Minnesota: Midwest Planning and Research, Inc., September, 1966.

Midwest Research Institute. Colorado Outdoor Recreation Comprehensive Plan. Statistical Summary, Vol. 4. Kansas City, Missouri: Colorado Game, Fish and Parks Department, March, 1968.

Midwest Research Institute. Missouri State Comprehensive Outdoor Recreation Plan. MRI Project Number 2962-D, BOR. Number S.C.O. R.P. 24-000-77. Vol. 1-3. Kansas City, Missouri: Midwest Research Institute, April, 1967.

Midwest Research Institute. Statistical Summary of the Missouri Recreation Survey. MRI Project Number 2962-D, BOR Number S.C.O.R.P. 27-000-77. Vol. 1-3. Kansas City, Missouri: Midwest Research Institute, April, 1967.

Miller, Arthur P. Water and Man's Health. Community Water Supply Technical Series Number 5. Washington, D.C.: Office of Human Resources and Social Development Agency for International Development, April, 1962.

Miller, David. Water Atlas of the U.S. Port Washington, Long Island, New York: Water Information Center, Inc., 1963.

Missouri University Meramec Basin Study Committee. The Meramec Basin Water Development Plans, Needs and Problems, Alternative Solutions. Columbia, Missouri: University of Missouri Extension Division, 1966.

Moeller, John. Standards for Outdoor Recreation Areas. Report 194. Chicago, Illinois: American Society of Planning Officials, 1965.

Monteith, Douglas B. and Corcoran, Thomas J. Some Aspects of Recreational Usage and Policy on Municipal Water Supply Areas in Maine. Bulletin 649. Augusta, Maine: University of Maine, Maine Agricultural Experiment Station, August, 1967.

Murphree, Clyde E. Resource Use and Income Implications of Outdoor Recreation. Bulletin 69. Gainesville, Florida: University of Florida, Agricultural Experiment Station, March, 1965.

Myles, George A. Water Based Recreation in Nevada - B13 Mead and Mohave; B10 Tahoe; B14 Western Desert and Northern Lakes. Reno, Nevada: University of Nevada, Agricultural Information Service, 1966.

Nath, Deba Prasad. Limitations of the Recreational Use of Landscape Development of the Flood Plain. Urbana, Illinois: University of Illinois, 1962.

Nathan, Robert R. and Associates, Inc. The Potential Impact of the Delaware Water Gap National Recreation Area on Its Surrounding Communities. Washington, D.C.: Robert R. Nathan Associates, Inc., April, 1966.

National Academy of Sciences, National Research Council. Alternatives in Water Management. Publication 1408. Washington, D.C.: National Academy of Sciences, National Research Council, 1966.

National Advisory Council on Regional Recreation Planning. A User-Resource Recreation Planning Method. Hidden Valley. Loomis, California: National Advisory Council on Regional Recreation, 1959.

National Association of Counties, Research Foundations. Community Action Program for Water Pollution Control. Washington, D.C.: National Association of Counties, Research Foundation, Revised July, 1967.

National Association of Counties Research Foundation. County Parks and Recreation; a Basis for Action. Washington, D.C.: National Association of Counties Research Foundation and National Recreation Association, 1964.

National Research Council. Agricultural Board Committee on Soil and Water Conservation. Principles of Resource Conservation Policy With Some Applications to Soil and Water Resources. Publication 885. Washington, D.C.: National Research Council, 1961.

Newhall, George N. and Smith, James L. Watershed Management: Effects on Basin Development. Presented at ASCE Billings Conference of Irrigation and Drainage Division, October 7, 1965. Washington, D.C.: U.S. Department of Agriculture, Forest Service, 1965, pp. 47-65.

Niering, William A. Nature in the Metropolis. Conservation in the Tri-State New York Metropolitan Region. New York: Regional Plan Association, Inc., June, 1960.

Odum, E. P. Fundamentals of Ecology. Philadelphia, Pennsylvania: W. B. Saunders Company, 1959.

O'Riordan, Timothy. Small River Basin Development in Eastern North America. Ithaca, New York: Cornell University Water Resources Center, 1966.

Osborn, Fairfield. Our Plundered Planet. New York: Little, Brown, and Company, 1948.

Outboard Boating Club of America. Boating Facilities, Facilities File. Chicago, Illinois: Outboard Boating Club of America, 1961.

Parson, Ruben L. Conserving American Resources. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964.

Potomac Planning Task Force. The Potomac--A Report on Its Imperiled Future and Guide for Its Orderly Development. Washington, D.C.: U.S. Government Printing Office, 1967.

Rechard, P. A. and McQuisten, R. Glossary of Selected Hydrologic Terms. Laramie, Wyoming: University of Wyoming, Water Resources Research Institute, May, 1966.

Richardson, Reed C. Recreation in Utah: A Profile of the Demand for Outdoor Recreation by Utah Residents. Salt Lake City, Utah: Utah State Planning Program, Economic and Population Studies, January, 1966.

Rick, William. Planning and Developing Waterfront Property. Technical Bulletin 49. Washington, D.C.: Urban Land Institute, June, 1964.

Rickert, John E. Urban Thesaurus: A Vocabulary for Indexing and Retrieving Urban Literature. Kent, Ohio: Center for Urban Regionalism, Kent State University, 1968.

Rothacher, Jack, Dyrness, C. T. and Fredriksen, Richard. Hydrologic and Related Characteristics of Three Small Watersheds in the Oregon Cascades. U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, 1967.

Schellie Associates. McCormick's Creek State Park: Master Plan. Indianapolis, Indiana: Schellic Associates, 1966.

Schellie Associates. Master Plan Shades State Park. Indianapolis, Indiana: Indiana Department of Natural Resources, May, 1966.

Schmid, A. Allan. Michigan Water Use and Development Problems. Circular Bulletin 230. East Lansing, Michigan: Michigan State University, Agricultural Experiment Station, 1961.

Scrugs and Hammond. A Park Feasibility Study for Boonesborough Beach on the Kentucky River. Lexington, Kentucky: Scrugs and Hammond, 1961.

Simonds and Simonds. The Allegheny Reservoir, Recreation in Warren County. Pittsburgh, Pennsylvania: Simonds and Simonds, 1963.

Smith, Clodus, Partain, Loyd E. and Champlin, James R. Rural Recreation for Profit. Danville, Illinois: Interstate Printers & Publishers, 1966.

Smith, Russell S., Woolsey, T. D. and Stevenson, A. H. Bathing Water Quality and Health, I--Great Lakes. A Study of Bathing Water Quality on the Chicago Lake Front and Its Relation to Health of Bathers. Cincinnati, Ohio: Federal Security Agency, 1951.

Smith, Russell S. and Woolsey, T. D. Bathing Water Quality and Health, II--Inland River. A Study of Bathing Water Quality in the Ohio River at Dayton, Kentucky and Its Relation to Health of Bathers. Cincinnati, Ohio: Federal Security Agency, 1952.

South Dakota State University. Recreational Survey of Lewis and Clark Lake and Randall Reservoir. Bulletin Number 68. Vermillion, South Dakota: State University of South Dakota, March, 1961.

Storer, John H. The Web of Life. New York: Devin-Adair Company, 1953.

Stott, Charles C. Evaluating Water Based Recreation Facilities and Areas. Management Aids Bulletin Number 70. Washington, D.C.: National Recreation and Park Association, 1967.

Texas A. & M. University. Outdoor Recreation Potential in East Texas. Agricultural Experiment Station Bulletin 1013. College Station, Texas: Texas A. & M. University, July, 1964.

Texas Technological College, Department of Park Administration, Horticulture, and Entomology. Texas State Parks. Lubbock, Texas: Texas Technological College, 1963.

Udall, Stewart L. The Quiet Crisis. New York: Rinehart and Winston, 1963.

Ullman, Edward, Boyce, Ronald R., and Volk, Donald. The Meramec Basin: Water and Economic Development. Vol. I. St. Louis, Missouri: Washington University Press, 1962.

Utah State University, College of Natural Resources and Bureau of Outdoor Recreation, Department of the Interior. National Conference on Policy Issues in Outdoor Recreation. Logan, Utah: Department of the Interior, 1966.

Utah State University and Utah Water and Power Board. Developing a State Water Plan; Utah's Water Resources--Problems and Needs; A Challenge. Logan, Utah: Utah State University and Utah Water and Power Board, 1963.

Utah Water Research Laboratory. Equipment and Techniques for Aerial Application of Evaporation--Reducing Monolayer--Forming Materials to Lake and Reservoirs. Logan, Utah: Water Research Laboratory, Utah State University, 1964.

Van Nierop, Emannuel Theodorus. A Framework for the Multiple Use of Municipal Water Supply Areas. Ithaca, New York: Cornell University Water Resources Center, July, 1966.

Vollmer Associates. Connecticut Comprehensive Statewide Outdoor Recreation Plan 1965-1970. Hartford, Connecticut: Connecticut Department of Agriculture and Natural Resources, 1965.

Wabash Valley Association. The Wabash Valley Program for Research and Planning. Mt. Carmel, Illinois: Wabash Valley Association, January, 1960.

Waite, G. Graham. A Four-State Comparative Analysis of Public Rights in Water. Madison, Wisconsin: Department of Law, University Extension, University of Wisconsin, 1967.

Wells, Donald T. The Tennessee Valley Tributary Area Development Program. Tuscaloosa, Alabama: University of Alabama, Bureau of Public Administration, 1964.

Wennergren, E. Boyd. Value of Water for Boating Recreation. Bulletin 453. Logan, Utah: Agricultural Experiment Station, Utah State Library, 1965.

Whyte, William H. Connecticut's Natural Resources--A Proposal for Action. Hartford, Connecticut: Department of Agriculture and Natural Resources, June, 1962.

Willrich, Ted L. and Hines, N. William, eds. Water Pollution Control and Abatement. Ames, Iowa: Iowa State University Press, 1967.

Wilsey, Ham, and Blair. A New Aquatic Park for the Region: Alameda Creek--Coyote Hills Aquatic Park Joint Agency. Milbrae, California: Wilsey, Ham and Blair, 1964.

Wilson, George T. Lake Zoning for Recreation: How to Improve Recreational Use of Lakes through Regulations. Management Aids Bulletin Number 44. Wheeling, West Virginia: American Institute of Park Executives, 1964.

Wollman, Nathaniel. Value of Water in Alternative Uses--With Special Application to Water Use in the San Juan and Rio Grande Basins of New Mexico. Albuquerque, New Mexico: University of New Mexico, 1963.

Woytinsky, W. S. and Woytinsky, E. S. World Population and Production. Report of the Seventieth Century Fund, New York: Seventieth Century Fund, 1953.

Wyoming University Water Resources Research Institute. State Water Planning Recommendations. Laramie, Wyoming: University of Wyoming Water Resources Research Institute, n.d.

Articles and Periodicals

Alexander, Harold E. "Problems and Progress in Stream Preservation." Reprinted from Transactions of the Thirtieth North American Wildlife and Natural Resources Conference, March 8-10, 1965. Washington, D.C.: Wildlife Management Institute, 1965, pp. 76-88.

Alexander, Harold E. "Stream Values, Recreational Use and Preservation." Reprinted from Transactions of the Twenty-Fifth North American Wildlife Conference, May 7-9, 1960. Washington, D.C.: Wildlife Management Institute, 1960, pp. 192-201.

"The Allagash--Maine's Counter Proposal," American Forests, 71 (February, 1965), 26-28.

American Water Works Association. "Recreational Use of Domestic Water Supply Reservoirs," American Water Works Association Statements of Policy. New York: American Water Works Association, 1967, pp. 15-16.

Amidon, Elliot L. "MIADS2, An Alphanumeric Map Information Assembly and Display System for a Large Computer." Research Paper PSW-38. Berkeley, California: Pacific Southwest Forest and Range Experiment Station, 1966.

Anderson, Henry W. "Erosion and Sedimentation," American Geophysical Union Transactions, 48 (2) (June, 1967), 697-700.

Anderson, James. "Recreational Uses of Lands and Water and Associated Bioenvironmental Problems," Urban Environmental Problems, 21 (6) (June, 1967), 60-65.

Anderson, Jerome E. "Recreation and Fish and Wildlife Studies," in Organization and Methodology for River Basin Planning. Atlanta, Georgia: Water Resources Center, Georgia Institute of Technology, 1964, pp. 261-300.

Anderson, Raymond L. "Wild Rivers: An Added Dimension in Water Resources Use," in Water Resources and Economic Development of the West, Report Number 13. San Francisco, California: Western Agricultural Economic Research Council, December, 1964, pp. 33-37.

Andrews, Elton R., and Lipman, William F. "Open Space for Recreation," State Government, 33 (4) (Autumn, 1960), 222-226.

Arnold, Maurice D. "Present Status and Research Needs on Relationships Between Recreation and Water Quality," Water for Texas, Proceedings of the 12th Annual Conference, November 20-21, 1967. College Station, Texas: Water Resources Conference, Texas A & M University, 1967, pp. 39-41.

Arnold, R. Keith and Hopkins, Walter S. "Scope of Recreation Research," IUFRO-Kongress-Munchen, 1967, 7 (26) (1967).

Badger, Daniel D. "Recreational Aspects of Upstream Reservoirs." Agricultural Engineering Paper No. AE 6620. (Paper presented at the 16th Annual Meeting of the Oklahoma Section, American Society of Agricultural Engineers, October 28, 1966.)

Badger, Daniel D. "Recreational Considerations in Water Planning," Proceedings of the 10th Annual Conference on Water for Texas. College Station, Texas: Water Resources Institute, Texas A & M University, November 22-23, 1965, pp. 43-48.

Baldwin, Fletcher N. "Role of the Federal Government," Urban Environmental Problems, 21 (6) (June, 1967), 19-51.

Banks, Harvey O. "The Bases of an Adequate State Water Program," State Government, 33 (2) (Spring, 1960), 133-139.

Barlowe, Raleigh. "Planning for Water Resource Development," in Modern Land Policy. Urbana, Illinois: Land Economics Institute, University of Illinois Press, 1960, pp. 223-333.

Barnhill, John T. and Levenson, Samuel. "The Water Quality Act of 1965 (P.L. 89-234)." Reprint from Health Education and Welfare Indicators, November 1965, Washington, D.C.: U.S. Government Printing Office, 1965.

Bartholic, John F. "Evaporation Control Research," Water for Texas. Proceedings of the 11th Annual Conference, November 21-22, 1966. College Station, Texas: Texas A & M University, 1966, pp. 21-27.

Beattie, Byron. "Municipal Watersheds and Recreation can be Compatible," Western Resources Conference, 1963. Boulder, Colorado: University of Colorado Press, 1964, pp. 37-46.

Beckman, Norman. "New Views on Public Responsibility for Resources Development-Jurisdictions, Consequences, and Remedies," New Horizons for Resources Research Western Resource Paper, 1964. Boulder, Colorado: University of Colorado Press, 1965, pp. 101-119.

Benedetti, A. J. "Watersheds and Recreational Land Use in the Pacific Northwest," American Water Works Association Journal, 56 (11) (November, 1964), 1467-1473.

Bird, Ronald. "Income Opportunities for Rural Families from Outdoor Recreation Enterprises." Reprint Number 68. Washington, D.C.: U.S. Department of Agriculture, Economic Research Service, 1965.

Bird, Ronald. "Water--Its Recreational Use as an Economic Factor in Regional Development," Public Policies Relating to Water. Papers Presented at a Conference at Purdue University, November 2-5, 1965. University of Missouri Extension Division, 1966, pp. 118-125.

Bishop, Doyle W. "Some Multivariate Data Analysis Techniques and Their Application to Recreation Research," Recreation Research--AAHPER. Washington, D.C.: AAHPER, 1966, pp. 177-193.

Blakey, Harold L. "Recreation Program of the Corps of Engineers," Water for Texas, Proceedings of the 12th Annual Conference, November 20-21, 1967. College Station, Texas: Water Resources Conference, Texas A & M University, 1967, pp. 36-38.

Bollman, Frank H. "The Role of Economic Analysis in Fish and Wildlife Management: Summary of a Symposium Panel." University of California at Berkeley, Division of Agricultural Sciences, April, 1968. (Mimeographed)

Booth, Alfred W. "Recreation and Wabash Basin Development," in Boyce, Roland R. (ed.), Regional Development and the Wabash Basin. Urbana, Illinois: University of Illinois Press, 1964, pp. 79-88.

Bower, Blair T. "Some Physical, Technological and Economic Characteristics of Water Resources Systems: Implications for Administration," Natural Resources Journal, 3 (2) (October, 1963), 215-237.

Boyet, Wayne E. and Tolley, G. S. "Recreation Projects Based on Demand Analysis," Journal of Farm Economics, 48 (4) (November, 1966), 984.

Brewer, M. F. "Incorporating Recreational Values into Benefit-Cost Analysis," in Western Farm Economics Association Proceedings (August, 1962), 22-29.

Brewer, Michael and Bordner, Betty. "Organizational Alternatives for Recreation Resources Management: An Analysis of State Agencies," Natural Resources Journal, 6 (4) (October, 1966), 560-579.

Brigham, Arthur P. "Recreational Use of Watersheds, Operator's View," American Water Works Association Journal, 58 (October, 1966), 1260-1263.

Bristow, Bud. "Colorado River Studies." Abstract, Project FW-16-R-6, Work Plan 3, Job 4. Phoenix, Arizona: Arizona Game and Fish Department, 1967.

Brockman, C. Frank. "Recreation and Water in the West," Western Resources Conference, 2 (1960), 201-210.

Brown, Carl B. "Role of Small Watersheds in River Basin Planning," Journal of Soil and Water Conservation, 18 (1) (1963), 14-18.

Brown, William G., Singh, A. and Castle, E. N. "An Economic Evaluation of the Oregon Salmon and Steelhead Sport Fishery." Oregon Agricultural Experiment Station, Technical Bulletin 78. Corvallis, Oregon: Oregon State University, September, 1964.

Burm, R. J., Krowczyk, D. F. and Harlow, G. H. "Chemical and Physical Comparison of Combined and Separate Sewer Discharges," Journal of Water Pollution Control Federation, No. 40 (January, 1968), 112-126.

Burton, T. L. and Fulcher, Margaret N. "Measurement of Recreation Benefits--A Survey." (Source Unknown) University of Birmingham, Birmingham, England, 1968.

Bury, Richard L. "A Method for Estimating Current Attendance on Sets of Campgrounds - A Pilot Study." No. 42. Berkeley, California: Pacific Southwest Forest and Range Experiment Station, 1964.

Cain, Stanley A. "Biotope and Habitat," Darling F. Fraser and Milton, John P. (ed.), Future Environments of North America. Garden City, New York: Natural History Press, 1966, pp. 38-54.

Cain, Stanley A. "Coordination of Fish and Wildlife Values with Water Resources Development Goals," in Proceedings of the Second Annual American Water Resources Conference, November 20-22, 1966. Proceedings Series Number 2. Urbana, Illinois: American Water Resources Association, 1966, pp. 213-220.

Cain, Stanley A. "Statement of Dr. Stanley A. Cain, Assistant Secretary of the Interior for Fish and Wildlife and Parks," Estuarine Areas. (Hearings before the Subcommittee on Fisheries and Wildlife Conservation, House of Representatives, Nineteenth Congress, March 6, 8, 9, 1967.) Serial No. 90-3. Washington, D.C.: U.S. Government Printing Office, 1967, pp. 28-76.

Castle, Emery N. "Economics of Water Pollution Control," Journal of Water Pollution Control Federation (May, 1966), pp. 789-793.

Castle, Emery N. "Multiple Use as a Concept for Water and Range Policy," Western Agriculture Economics Research Council: Proceedings (January 23-24, 1961), 13-14.

Castle, Emery and Kelso, Gardner. "Water Resources Development: A Review of the New Federal Evaluation Procedures," Farm Economics, 45 (4) (November, 1963), 693.

Cesario, Frank J., Jr. "Appendix Q, Recreation," Final Report on a Dynamic Model of the Economy of the Susquehanna River Basin. Columbus, Ohio: Battelle Memorial Institute, August 1, 1966, pp. Q1-Q45.

Cesario, Frank J., Jr. "Operations Research in Outdoor Recreation," Journal of Leisure Research, 1 (1) (Winter, 1969), 33-51.

Ciriacy-Wantrup, S. V. "Benefit-Cost Analysis and Public Resource Development," in Economics and Public Policy in Water Resource Development. Ames, Iowa: Iowa State University Press, 1964, pp. 9-21.

Ciriacy-Wantrup, S. V. "Multiple Use as a Concept for Water and Range Policy," Western Agricultural Economics Research Council: Proceedings. (January 23-24, 1961), 1-12, 19-20.

Clarke, F. E. "What Do We Really Know About Stream Quality Criteria and Standards?" Water Quality Criteria. STP Number 416. Philadelphia, Pennsylvania: American Society for Testing and Materials, 1967, pp. 100-120.

Clawson, M. "Crisis in Outdoor Recreation," American Forests (reprinted from), March, 1959, n.p.

Clawson, Marion. "Dynamics of Park Demand," in Regional Plan Association, Inc., Number 94. New York: Regional Plan Association, Inc., 1960, pp. 1-39.

Clawson, Marion. "Measuring Outcomes in Terms of Economic Implications for Society," Recreation Research--AAHPER. Washington, D.C.: AAHPER, 1966, pp. 54-61.

Clawson, Marion. "Recreation as a Competitive Segment of Multiple Use," in Thorne, Wynne (ed.), Land and Water Use. Number 73. Washington, D.C.: American Association for the Advancement of Science, 1963, pp. 169-183.

Clawson, Marion and Knetsch, Jack L. "Outdoor Recreational Research." Reprinted from Natural Resources Journal, October 1963, by Resources for the Future, Inc., Reprint Number 43, Washington, D.C.: November, 1963.

Clawson, Marion and Knetsch, Jack. "Outdoor Recreation Research: Some Concepts and Suggested Areas of Study," Natural Resources Journal, 3 (1) (May, 1963), 250-275.

Cope, O. B. "Pesticide--Wildlife Relations," Biological Problems in Water Pollution. Third Seminar, August 13-17, 1962. Cincinnati, Ohio: U.S. Department of Health, Education and Welfare, pp. 245-246.

Coppedge, Robert O. and Bray, James R. "Recreational Use and Value of Water at Elephant Butte and Navajo Reservoirs." Agricultural Experiment Station Bulletin 535. Las Cruces, New Mexico: New Mexico State University, 1968.

Craighead, Frank C., Jr. and Craighead, John J. "River Systems-Recreational Classification, Inventory and Evaluation," Naturalist, 13 (2) (Summer, 1962), 3-19.

Crutchfield, James H. "Valuation of Fishery Resources," Land Economics Journal, 37 (2) (May, 1962), 145-154.

Cureton, T. K. "Perspective on Methodology Related to Selecting a Problem and Planning Its Solution," Research Methods Applied to Health, Physical Education, and Recreation. Washington, D.C.: American Association of Health, Physical Education and Recreation, 1952, p. 45.

Curtis, Willie R. "Simple Practices Along Forest Edge Reduce Upland Runoff." Reprinted from Journal of Soil and Water Conservation, 22 (1) (January-February, 1967), by U.S. Forest Service, Washington, D.C.: 1967.

David, Elizabeth L. "Lakeshore Property Values: A Guide to Public Investment in Recreation." Reprinted from Water Resources Research, 4 (4) (August, 1968), 697-707.

David, Elizabeth L. "The Use of Assessed Data to Approximate Sales Values of Recreational Property," Land Economics, February, 1968, 127-129.

David, Elizabeth L. and Lord, William B. "Determinants of Property Value on Artificial Lakes." (Xerox draft obtained from author) Madison, Wisconsin: University of Wisconsin, College of Agriculture, n.d.

Davidson, Paul and Others. "The Social Value of Water Recreational Facilities Resulting from an Improvement in Water Quality, the Delaware Estuary," in Kneese, Allen V. and Smith, Stephen C. (ed.) Water Research. Baltimore, Maryland: Johns Hopkins Press, 1966, pp. 271-290.

Davis, Robert K. "Recreation Planning as an Economic Problem," Natural Resources Journal, 3 (2) (October, 1963), 239-249.

Delaney, John. "Muncie Dedicates Its Resources for Public Recreation Purposes," Water Works Engineering, 115 (10) (October, 1962), 810-813.

Delogu, O. E. "Comments on Public Water Use Rights," Proceeding of the Water Rights Law Conference. Boston, Massachusetts: New England Council of Water Center Directors, 1966.

Densmore, Jack, and Dahlstrand, Nils P. "Erosion Control on Recreational Land," Journal of Soil and Water Conservation, 19-20 (November-December, 1965), 261-262.

Devine, E. J. "The Treatment of Incommensurables in Cost-Benefit Analysis," Land Economics, 42 (3) (August, 1966), 383-387.

Dodson, Roy E. "Recreational Use of Reservoirs in San Diego," American Water Work Association Journal, 55 (September, 1963), 1115-1119.

Dominy, F. E. "Federal and State Cooperation in the Development of the Water Resources of California," American Water Works Association Journal, 55 (April, 1963), 461-466.

Dominy, Floyd E. "Water and Resource Development in the Lower Colorado River Basin," in Proceedings of the Second Annual American Water Resources Conference, November 20-22, 1966. Proceedings Series Number 2. Urbana, Illinois: American Water Resources Association, 1966, pp. 182-186.

Donahue, Julian P. and Humphrys, C. R. "Ponds for Work and Fun." Extension Bulletin E-374. East Lansing, Michigan: Cooperative Extension Service, Michigan State University, 1961.

Dressler, Frank W. "Outdoor Recreation and the Delaware River Basin," Recreation, 55 (6) (June, 1962), 299-301.

Duck, Lester G. "Recreation Needs," in Seminar on River Basin Planning, Ft. Belvoir, Virginia, May 27-37, 1963. Washington, D.C.: U.S. Department of Army Corps of Engineers, 1963, pp. 252-264.

Dunford, E. G. "Forests--Users of Water." Reprinted from Proceedings, Society of American Foresters, 1966. Washington, D.C.: U.S. Department of Agriculture, Forest Service, 1966, pp. 146-150.

Dworsky, Leonard B. "Analysis of Federal Water Pollution Control Legislation, 1948-1966," American Water Works Association Journal, 59 (6) (June, 1967), 651-668.

Eaton, E. D. "Water Resources Research," Western Resources Conference, 1963. Boulder, Colorado: University of Colorado Press, 1964.

Edwards, John A. "Multiple Use as a Concept for Water and Range Policy," Western Agriculture Economics Research Council: Proceedings, (January 23-24, 1961), 15-19.

Elkins, Winston and Sharp, Robert. "Recreational Fishing in the National Wildlife Refuges," Circular 152. Washington, D.C.: U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, August, 1962. (Mimeographed)

Ellis, Harold H. "Water Law in Eastern United States," Journal of Soil and Water Conservation, 18 (1) (1963), 19-27.

Ellis, J. B. and Van Doren, C. S. "A Comparative Evaluation of Gravity and System Theory Models for Statewide Recreational Travel Flow," Journal of Regional Science, 6 (2) (1966), 57-70.

Ellis, Willis. "Recreational Uses of Water Under Prior Appropriation Law: Colorado River Water Conservation District-Rocky Mountain Power Company, 406 P. 2nd. 798 (Colorado, 1965)," Natural Resources Journal, 6 (2) (April, 1966), 181-185.

Erlich, Harry, and McGouhey, P. H. "Economic Evaluation of Water, Jurisdictional Considerations in Water Resources Management," Economic Evaluation of Water, Part II, June, 1964.

Evans, John and Van Doren, Carlton S. "A Measurement of the Demand for Recreational Facilities at Lewis and Clark Lake," Business Review Supplement (February, 1960).

Failer, William R. "Trends in Outdoor Recreation and the Bureau of Outdoor Recreation," Proceedings of the Ohio University Interdepartmental Natural Resources Seminars. Columbus, Ohio: Ohio State University Natural Resources Institute, 1962-63, pp. 268-284.

"Flood-Plain Zoning Provides Recreation Areas," Recreation, 55 (6) (June, 1962), 307-308.

Forste, Robert H. "Multiple-Use Problems of Water Law in New Hampshire," Proceedings of Water Rights Law Conference. Sponsored by the New England Council of Water Center Directors, Boston, Massachusetts, November 10, 1966, pp. 97-106.

Foster, C. H. W. "Recreation Demands on Public Water Supplies," Recreation, 15 (6) (June, 1962), 292, 306 ff.

Fox, Irving K. "New Horizons in Water Resources Administration." Reprinted from Public Administrative Review, Journal of the American Society for Public Administration, March 1965, by Resources for the Future, Inc., Reprint Number 51, Washington, D.C.: April, 1965.

Fox, Irving K. "Policy Problems in the Field of Water Resources," in Kneese, Allen V. and Smith, Stephen C. (ed.), Water Research. Baltimore, Maryland: Johns Hopkins Press, 1966, pp. 271-290.

Fox, Irving K. "Trends in River Basin Development." Reprinted from Proceedings of the Ninth National Watershed Congress held at Columbus, Ohio, May 7-9, 1962, by Resources for the Future, Reprint Number 37, Washington, D.C.: November, 1965.

Fox, Irving K. and Herfindahl, Orris C. "Attainment of Efficiency in Satisfying Demands for Water Resources," American Economic Review, 54 (May, 1964), 198-206.

Galantowicz, Richard E. "The Potential Demand for Recreation Along the Maine Coast," Maine Coast Prospects and Perspectives, (A Symposium, Center for Resource Studies, Bowdoin College, Brunswick, Maine, October 20-22, 1966), pp. 18-21.

Gaudet, Joseph B. "Water Recreation-Public Use of Private Waters," California Law Review (March, 1964), 171-184.

Gessel, Stanley P. and Cole, Dale W. "Influence of Removal of Forest Cover on Movement of Water and Associated Elements Through Soil." Reprinted from Journal American Water Works Association, 57 (10) (October, 1965), 1301-1310.

Gleason, Clark H. "Indicators of Erosion on Watershed Land in California." Reprinted by American Geophysical Union, Transactions, 34 (3) (June, 1953), 419-426.

Glymph, Louis M. and Storey, Herbert C. "Sediment--Its Consequences and Control." Reprinted from U.S. Department of Agriculture Publications. Washington, D.C.: pp. 205-220.

Goddard, Maurice K. "Action in Developing Our Outdoor Recreation Resources," State Government, 37 (Summer, 1964), 198-202.

Gorham, P. R. "Toxic Waterblooms of Blue-Green Algae," Biological Problems in Water Pollution. Third Seminar, August 13-17, 1962. Cincinnati, Ohio: U.S. Department of Health, Education and Welfare, pp. 37-44.

Graham, Ralph E. "Municipal Water Supply and Recreation: Are They Compatible?" Western Resources Conference, 1963. Boulder, Colorado: University of Colorado Press, 1964, pp. 31-36.

Graves, Paul F. "Research in the Resource Recreation Field in the Universities and State Experiment Stations," Proceedings of the National Conference on Outdoor Recreation Research. Co-sponsored by the School of Natural Resources, The University of Michigan and the U.S. Bureau of Outdoor Recreation, Department of the Interior, Ann Arbor, Michigan, 1963, pp. 57-69.

Gray, James R. "Survey Problems and Techniques in Multi-Recreational Demand Areas," An Economic Study of the Demand for Outdoor Recreation. A collection of papers presented at the Annual Meeting of the Cooperative Regional Research Technical Committee for Project No. WM-59. Report Number 1. San Francisco, California, Cooperative Regional Research Committee WM-59, March 25-26, 1968, pp. 56-64A.

Greathouse, L. R. "Meeting Water Requirements for Outdoor Resource Recreation," in Water Research Symposium Proceedings 1963. Morgantown, West Virginia: West Virginia University, 1964, pp. 63-67.

Griffith, Richard E. "Ecological Considerations: Wildlife--," in Maine Coast Prospects Perspectives: A Symposium. Brunswick, Maine: Center for Resource Studies, 1966, pp. 34-36.

Hague, A. Bartlett, Jr. "Resolving Conflicts in Natural Resource Allocation," Journal of Soil and Water Conservation, 19-20 (November-December, 1964), 241-244.

Hanson, Edward A. "Stabilizing Eroding Streambanks in Sand Drift Areas of the Lake States." U.S. Forest Service Research Paper NC-21. St. Paul, Minnesota: North Central Forest Experiment Station, 1968.

Harper, George L. "Recreational Use of Reservoirs," American Water Works Association Journal, 56 (8) (August, 1964), 1083-1086.

Hatch, Richard W. "Ecological Considerations; Sea and Shore," in Maine Coast Prospects and Perspectives: A Symposium. Brunswick, Maine: Center for Resource Studies, 1966, pp. 29-34.

Henley, Robert J. "Water Quality Influences on Outdoor Recreation in the Lake Ontario Basin," Proceedings, Tenth Conference on Great Lakes Research, 1967, pp. 427-440.

Herfindahl, Orris C. "What is Conservation?" Reprinted from Three Studies in Minerals Economics by Resources for the Future, Reprint Number 30, Washington, D.C.: August, 1961.

Hewes, Laurence I., Jr. "The Demand for Outdoor Recreation-Implications for Natural Resource Allocation," Western Resource Conference, 2 (1960), 189-200.

Hewlett, John D. and Couglass, James E. "Blending Forest Uses," U.S.D.A. Forest Service Research Paper SE-37. Ashville, North Carolina: Forest Service, U.S. Department of Agriculture, Southeastern Forest Exp. Station, 1968.

Hilmon, J. B. and Douglass, J. E. "Potential Impact of Forest Fertilization on Range, Wildlife and Watershed Management." Proceedings of Symposium on Forest Fertilization, April 1967 at Gainesville, Florida. Muscle Shoals, Alabama: TVA National Fertilizer Development Center, 1968.

Hoffman, C. H. "How Should Agricultural Pollutants be Controlled?" Biological Problems in Water Pollution. Third Seminar, August 13-17, 1962. Cincinnati, Ohio: U.S. Department of Health, Education and Welfare, pp. 253-260.

Holmes, Robert. "Problems in Acquiring Public Lands for Conservation Purposes," Proceedings of the Ohio State University Interdepartmental Natural Resources Seminars. Columbus, Ohio: Ohio State University Natural Resources Institute, 1962-63, pp. 233-249.

Hood, William M. "Appraising Public Recreational Projects," The Appraisal Journal, 20 (1) (January 1952), 45-50.

Hopkins, Walter S., Jr. "Impacts of Recreation on Competition for Use of Water," Western Resources Conference, 1963. Boulder, Colorado: University of Colorado Press, 1964, pp. 151-162.

Hornbeck, James. "Clear Cutting and the Erosion Hazard." Reprinted from Northern Logger and Timber Processor for October, 1967.

Howe, Sydnew. "U.S. Rivers: Can Their Natural Values Be Restored and Their Economic Values Retained? If So, How?" Vital Issues, 16 (2) (October, 1966).

Howes, Robert M. "Land Between the Lakes--Vast Recreation Project," Journal of Water and Soil Conservation, 19-20 (November, 1964), 245-246.

Humphrys, C. R. "Beach Design for Ponds." East Lansing, Michigan: Michigan State University, Department of Resource Development, 1963.

Humphrys, C. R. "A New Great Lakes Park Concept--The Teach-Park Marina." East Lansing, Michigan: Michigan State University, 1967. (Mimeographed)

Humphreys, C. R. and Guice, R. L. "Michigan's Artificial Ponds." Reprinted from Quarterly Bulletin, 44 (2) (November, 1961), 361-374. Article 44-36. East Lansing, Michigan: Michigan State University, Agricultural Experiment Station, 1961.

Hutchings, Robert. "Water for Recreation," Recreation, 55 (6) (June, 1962), 280-281.

"Hydro-Licensing Hinges on Recreational Facilities," Electrical World, 166 (August, 1966), 65-66.

Ingram, William and Mae Kenthun, Kenneth. "The Pollution Environment," in Proceedings of the Second Annual American Water Resources Conference, November 20-22, 1966. Proceedings Series Number 2. Urbana, Illinois: American Water Resources Association, 1966, pp. 115-133.

Ise, John. "Can Wilderness Areas Be Economically Justified?" Western Agricultural Research Council: Proceedings, (August 6-8, 1962), 1-14.

James, George A. "Instructions for Using Traffic Counters to Estimate Recreation Visits and Use on Developed Sites." U.S. Forest Service Research Paper SE-3. Ashville, North Carolina: Southeastern Forest Experiment Station, U.S. Department of Agriculture, April, 1966.

James, George A. and Harper, Robert A. "Recreation Use of the Ocala National Forest in Florida." U.S. Forest Research Paper SE-18. Ashville, North Carolina: Southeastern Forest Experiment Station, 1965.

James, George A. and Rich, John L. "Estimating Recreation Use on a Complex of Developed Sites." U.S. Forest Service Research Note SE-64. Ashville, North Carolina: Southeastern Forest Experiment Station, U.S. Department of Agriculture, September, 1966.

James, George A. and Taylor, Gordon. "Recreation Use Estimation in the United States and Canada," IUFRO Kongr, Proceedings, 7 (26) (1967), 14-29.

Jemison, George. "Impacts of Recreation of the Ecology of Temperate North American Forests." Reprinted from Proceedings and Papers of the International Union for Conservation of Nature, June 1966, by IUCN Publications, New Series No. 7, 1967.

Johnson, Edward A. "Effects of Multiple Use on Peak Flows and Low Flows." Reprinted from International Symposium on Forest Hydrology. Proceedings of a National Science Foundation Advanced Science Seminar held at the Pennsylvania State University, Pennsylvania, August 29-September 10, 1965.

Johnson, Ralph W. and Austin, Russel A. "Recreational Rights and Titles to Beds on Western Lakes and Streams," Natural Resources, 7 (January, 1967), 1-52.

Johnson, Reuben J. "Small Boat Harbor Development on the Pacific Coast," American Society of Civil Engineers, Waterways Division Journal, 87 (February, 1961), 1-14.

Johnston, W. E. and Pankey, V. S. "Use Prediction Models for Corps of Engineers, Reservoirs in California," An Economic Study of the Demand for Outdoor Recreation. A collection of papers presented at the Annual Meeting of the Cooperative Regional Research Technical Committee for Project No. WM-59. Report Number 1. San Francisco, California: Cooperative Regional Research Committee WM-59, March 25-26, 1968, pp. 15-38.

Jones, Douglass M. "Intensity of User Participation as a Basis for Differentiating the Recreation Project," An Economic Study of the Demand for Outdoor Recreation. A collection of papers presented at the Annual Meeting of the Cooperative Regional Research Technical Committee for Project Number WM-59. Report Number 1. San Francisco, California: Cooperative Regional Research Committee WM-59, March 1968, pp. 85-94.

Jordahl, Harold C., Jr. "Conservation and Scenic Easements, An Experience Resume," Land Economics, 39 (4) (November, 1963), 343.

Kalinske, A. J. "The Law Relating to Access to Public Waters in New Hampshire," Proceedings of Water Rights Law Conference. Sponsored by the New England Council of Water Center Directors, Boston, Massachusetts, November 10, 1966, pp. 67-86.

Karalekas, P. C. and Lynch, J. P. "Recreational Activities of Springfield, Massachusetts Water Reservoirs, Past and Present," New England Water Works Association Journal, 79 (1965), 18.

Kaufert, F. H. "Controversy in Canoeland," American Forests, 70 (October, 1964), 24-71.

Kendall, J. H. and Whiting, R. E. "Basic Concepts of Private Water Rights," Proceedings of Water Rights Law Conference. Boston, Massachusetts: New England Council of Water Center Directors, 1966.

Kimball, Thomas L. "The Value and Use of Water Quality Criteria in Conservation Programs." A Speech Presented at the Third Seminar of Biological Problems in Water Solution, Cincinnati, Ohio, August 13-17, 1962.

King, James S. "Comprehensive 1965 River Basin Planning," in Proceedings of the First Annual Meeting of the American Water Resources Association, December 1-3, 1965, Proceedings Series Number 1. Urbana, Illinois: American Water Resources Association, 1965, pp. 128-134.

Kite, Rodney C. and Schutz, Willard D. "Economic Impact on Southwestern Wyoming of Recreationists Visiting Flaming Gorge Reservoir," Research Journal 11. Laramie, Wyoming: University of Wyoming, Agricultural Experiment Station, August, 1967.

Kneese, Allen V. "Approaches to Regional Water Quality Management." Reprint 64. Washington, D.C.: Resources for the Future, June, 1967.

Kneese, Allen V. "Economic and Related Problems in Contemporary Water Resources Management." Reprinted in Natural Resources Journal, October, 1965, by Resources for the Future, Inc., Reprint Number 55, Washington, D.C.: November, 1965.

Kneese, Allen V. "National Water Policies and Problems." (Paper presented at the River Basin Planning Seminar, University of Wisconsin, October 27, 1965.) Occasional Paper No. 1, Madison, Wisconsin: University of Wisconsin, Water Resources Center, April, 1966.

Kneese, Allen V. "Some Economic Effects of Alternative Water Use Pattern in New Mexico," Western Resources Conference, 2 (1960), 147-156.

Kneese, Allen V. "Water Quality Management by Regional Authorities in the Ruhr Area with Special Emphasis on the Role of Cost Assessment." Reprinted from Papers and Proceedings of the Regional Science Association, Volume 11, 1963, by Resources for the Future, Inc., Reprint Number 52, Washington, D.C.: April, 1965.

Kendall, James H. "Basic Concepts of Private Water Rights," Proceedings Water Rights Law Conference. Sponsored by the New England Council of Water Center Directors, Boston, Massachusetts, November 10, 1966, pp. 5-33.

Knetsch, Jack L. "Communications: Assessing the Demand for Outdoor Recreation," Journal of Leisure Research, 1 (1) (Winter, 1969), 85-87.

Knetsch, Jack L. "Economics of Including Recreation as a Purpose of Eastern Water Projects," Journal of Farm Economics, 46 (December, 1964), 1148-1157.

Knetsch, Jack L. "Estimating the Influence of Large Reservoirs on Land Values," Appraisal Journal, (October, 1964), 537-546.

Knetsch, Jack L. "Influence of Reservoir Projects on Land Values," Journal of Farm Economics, 46 (February, 1964), 231-243.

Knetsch, Jack L. "Outdoor Recreation Demands and Benefits," Land Economics, 39 (November, 1963), 387-396.

Knetsch, Jack L. "Problems of Appraised Recreation Demand," in Water Resources and Economic Development of the West. Report Number 13. San Francisco, California: Western Agricultural Economic Research Council, December, 1946, pp. 41-50.

Knetsch, Jack L. and Davis, Robert K. "Comparisons of Methods for Recreation Evaluation," in Kneese, Allen V. and Smith, Stephen C. (ed.), Water Research. Baltimore, Maryland: Johns Hopkins Press, 1966, pp. 125-142.

Koelzer, Victor. "Trends in Planning Water Resources Projects," in Proceedings of the First Annual Meeting of the American Water Resources Association, December 1-3, 1965. Proceedings Series Number 1. Urbana, Illinois: American Water Resources Association, 1965, pp. 135-145.

Krausz, N. G. P. and Lemon, L. G. "Laws and Regulations Concerning Recreation in Rural Areas of Illinois." Circular 889. Urbana, Illinois: University of Illinois, Cooperative Extension Service, 1964.

Krausz, N. G. P. and Meyer, Glendon S. "Recent Amendments to the Water Resources Act of 1964." Urbana, Illinois: University of Illinois, College of Agriculture, 1967.

Krutilla, John U. "Conservation Reconsidered." Reprinted from American Economic Review, September, 1967, by Resources for the Future, Inc., Reprint Number 67, Washington, D.C.: October, 1967.

Kuehn, Jerome H. "Research on Lakes and Water-Based Recreation," Water Resources Research and Educational Needs in Minnesota. A report of a task group of the consulting council. Bulletin 5. Minneapolis, Minnesota: University of Minnesota, Water Resources Research Center, March, 1967, pp. 56-74.

Lee, Ivan M. "Economic Analysis Bearing on Outdoor Recreation Development," Economic Studies of Outdoor Recreation, ORRRC Study Report 24. Washington, D.C.: U.S. Government Printing Office, 1962.

Leedy, Daniel L. "Effect of Water Development on Estuarine Areas," Water for Texas. Proceedings of the 11th Annual Conference, November 12-22, 1966. College Station, Texas: Texas A & M University, 1966, pp. 34-39.

Lerner, Lionel J. "Development of Recreational Facilities," in Water Resources and Economic Development of the West. Report Number 13. San Francisco, California: Western Agricultural Economic Research Council, December, 1964, pp. 53-58.

Lerner, Lionel. "Quantative Indices of Recreational Values," in Water Resources and Economic Development of the West. Report #11. Reno, Nevada, 1962, pp. 55-80.

Leven, Andrew A. and Williams, John A. "Hydrologic Soil Surveys for Wildland Watersheds," Journal of Soil and Water Conservation (November-December, 1967), pp. 239-241.

Lewis, Phillip H., Jr. "The Landscape Resources of Wisconsin," Natural Resources of Wisconsin. Reprinted from Main Article of the 1964 Wisconsin Blue Book by Natural Resources Committee of State Agencies, Madison, Wisconsin: 1964, pp. 130-142.

Lewis, P. H., Jr. "Quality Corridors for Wisconsin," Landscape Architecture, Vol. 54, No. 2, pp. 100-108.

Lifton, Fred B. "Trends in Small Boating and Its Impact on Water Resources Development," in Proceedings of the Second Annual American Water Resources Conference, November 20-22, 1966. Proceedings Series Number 2. Urbana, Illinois: American Water Resources Association, 1966, pp. 182-186.

"Local Lakes," Current Municipal Problems, 6 (February, 1965), 361-363.

Long, E. John. "America's National Seashores," American Forests, 68 (11) (November, 1962), 8-10, 56.

Lucas, Robert C. "The Contributions of Environmental Research to Wilderness Policy." Reprinted from The Journal of Social Issues, 22 (4), Washington, D.C.: U.S. Forest Service, pp. 116-126.

Lucas, Robert C. "Research Needs Generated by New Directions in Forest Policy," Reprinted from Proceedings, Society of American Foresters, 1965. Washington, D.C.: U.S. Forest Service, 1965, pp. 73-75.

Lucas, Robert C. "Wilderness Perception and Use: The Example of the Boundary Waters Canoe Area," Natural Resources Journal, 3 (3) (January, 1964), 394-411.

Lucas, Robert C. and Schweitzer, Dennis L. "Outdoor Recreation Surveys: Length-of-Stay Bias and Its Correction by Computer." Research Note LS-68. St. Paul, Minnesota: Lake States Forest Experiment Station, U.S.D.A., 1965.

Maass, Arthur. "Benefit-Cost Analyses: Its Relevance to Public Investment Decisions," in Kneese, Allen V. and Smith, Stephen C. (ed.), Water Research. Baltimore, Maryland: Johns Hopkins Press, 1966, pp. 311-327.

McCann, James A. "A Survey and Evaluation of Small Artificial Recreational Ponds in Central Massachusetts (WR-1)," Proceedings of the Water Resources Research Symposium, June 2, 1967. Publication Number 3. Amherst, Massachusetts: University of Massachusetts, Water Resources Research Center, 1967, pp. 13-21.

McComb, A. L. "Multiple Use--Interactions and Problems of Measurement," Western Agriculture Economics Research Council: Proceedings (January 23-24, 1961), 117-122.

McCulloch, Clay. "Identifying and Measuring the Inputs and Outputs of Watershed Treatment as Related to Wildlife and Recreation," in Water and Range Resources and Economic Development of the West. Report Number 9. Tucson, Arizona, 1961, pp. 111-116.

Mack, Ruth P. and Myers, Sumner. "Outdoor Recreation," Measuring Benefits of Government Investments. Edited by Robert Dorfman. Washington, D.C.: Brookings Institution, 1965, pp. 71-116.

McKewen, Thomas D. "Recreational Use of Watersheds, State Health View," American Water Works Association Journal, 58 (October, 1966), 1270-1272.

McNeely, John G., Jr. "Estimation of Demand for Water-Based Outdoor Recreation Activities," An Economic Study of the Demand for Outdoor Recreation. A collection of papers presented at the Annual Meeting of the Cooperative Regional Research Technical Committee for Project No. WM-59. Report Number 1. San Francisco, California: Cooperative Regional Research Committee WM-59, March 25-26, 1968, pp. 48-55A.

Magill, Arthur W. "Evaluating Ecological Trends on Campgrounds." Research Note PSW-N16. Berkeley, California: Pacific Southwest Forest and Range Experiment Station, U.S.D.A., 1963.

Mann, Fred L. and Krausz, N. G. P. "Water in Illinois--Your Right to Use It." Circular 783. Urbana, Illinois: College of Agriculture, University of Illinois, 1964.

Marcus, Leslie F., Gould, E. M. and Bury, R. L. "Measuring the Recreation Use of National Forests." Technical Paper 59. Berkeley, California: Pacific Southwest Forest and Range Experiment Station, 1961.

Marshall, Hubert. "Politics and Efficiency in Water Development," in Kneese, Allen V. and Smith, Stephen C. (ed.), Water Research. Baltimore, Maryland: Johns Hopkins Press, 1966, pp. 291-310.

Merewitz, Leonard. "Recreational Benefits of Water Resource Development," Water Resources Research, 2 (4) (1966), 625-639.

Michigan State University. "Artificial Lakes." Reprinted from Michigan Economic Record, 4 (3) (March, 1962). East Lansing, Michigan: Michigan State University Bureau of Business and Economic Research, Graduate School of Business Administration.

Middleton, F. M. "Complete Reuse of Water," Water for Texas, Proceedings of the 11th Annual Conference, November 21-22, 1966, College Station, Texas: Texas A & M University, 1966, pp. 28-33.

Milliman, J. W. "Economic Considerations in Allocating Water Resources," Public Policies Relating to Water. Missouri: University of Missouri, Extension Division, 1965, 86-98. (Papers presented at a conference at Purdue University, November 2-5, 1965.)

Milliman, J. W. "Policy Horizons for Future Urban Water Supply." Reprinted from Land Economics, May, 1963, by Resources for the Future, Reprint Number 40. Washington, D.C.: July, 1963, pp. 109-132.

Minkus, A. J. "Recreational Use of Reservoirs," New England Water Works Association Journal, 79 (1965), 32.

Mood, Eric W. "The Role of Some Physico-Chemical Properties of Water as Causative Agents of Eye Irritation of Swimmers," Report of National Technical Advisory Committee on Water Quality Criteria. Washington, D.C.: FWPCA, U.S. Government Printing Office, 1968.

Moore, Arthur L. "The Rise of Reservoir Recreation," Economic Studies of Outdoor Recreation, ORRRC Study Report 24. Washington, D.C.: U.S. Government Printing Office, 1962.

Moore, Joe G., Jr. "Water Quality Management in Transition." Reprinted from Civil Engineering--ASCE, June 1968, by Department of the Interior, Federal Water Pollution Control Administration, 1968.

Mulholland, Joseph. "The Objectives of Government Water Resource Policy." Working Paper CWR 14, St. Louis, Missouri: Institute for Urban and Regional Studies, Washington University, 1967.

Nichols, J. M. "Ozark River-Economic Development and Single Use Preservation?" Journal of Forestry, 62 (March, 1964), 147-153.

Nichols, Robert. "How a Waterway Improvement Changed Environment," American Society of Civil Engineers, Waterways Division Journal, 89 (November, 1963), 1-12.

Nicholson, H. P. "Pesticide Pollution Studies in the Southeastern States," Biological Problems in Water Pollution. Third Seminar, August 13-17, 1962. Cincinnati, Ohio: U.S. Department of Health, Education and Welfare, pp. 261-263.

Nobe, Kenneth C. "Emerging Natural Policies Governing Outdoor Recreation in Federal Water Development Projects," Journal of Soil and Water Conservation, 19-20 (March-April, 1964), 61-66.

Noyes, John H. and Mader, Donald L. Proceedings, Municipal Watershed Management Symposium. Publication 446. Amherst, Massachusetts: University of Massachusetts, Cooperative Extension Service, 1965.

Ongerth, Henry, Allen, E. Jerry and LaDue, Wendell. "Watershed Management and Reservoir Use," American Water Works Association Journal, 56 (2) (February, 1964), 149-168.

Osborn, Ben and Harrison, Phoebe O'N. "Water...and the Land." Washington, D.C.: U.S. Soil Conservation Service, Department of Agriculture, July, 1965.

Packer, Paul E. and Haupt, Harold F. "The Influence of Roads on Water Quality Characteristics." Reprinted from Proceedings, Society of American Foresters, 1965. Washington, D.C.: U.S. Forest Service, 1965, pp. 112-115.

Patrick, Ruth. "Algae as Indicators of Pollution," Biological Problems in Water Pollution. Third Seminar, August 13-17, 1962. Cincinnati, Ohio: U.S. Department of Health, Education and Welfare, pp. 225-231.

Pearse, Peter H. "A New Approach to the Evaluation of Non-Priced Recreational Resources," Land Economics, 44 (1) (February, 1968), 87-99.

Pearson, John E. "Economic Impact of Water Impoundment," Water for Texas, Proceedings of the 12th Annual Conference, November 20-21, 1967. College Station, Texas: Water Resources Institute, Texas A & M University, 1967, pp. 24-30.

Price, Reginald. "The Increasing Impact of Recreation on Water Resources Planning," in Proceedings of the Second Annual American Water Resources Conference, November 20-22, 1966. Proceedings Series Number 2. Urbana, Illinois: American Water Resources Association, 1966, pp. 187-192.

Public Health Activities Committee. "Coliform Standards for Recreational Waters," American Society of Civil Engineers-Sanitary Engineering Division Journal, 89 (August, 1963), 57-94.

Rainwater, Frank H. "Role of the Federal Water Pollution Control Administration in Water Resources," in Proceedings of the Second Annual American Water Resources Conference, November 20-22, 1966. Proceedings Series Number 2. Urbana, Illinois: American Water Resources Association, 1966, pp. 454-459.

Reid, Leslie M. "Utilizing User Preferences in Predicting Outdoor Recreation Demand," Recreation Research--AAHPER. Washington, D.C.: AAHPER, 1966.

Reigner, I. C. and Ningard, L. G. "Baltimore's Watersheds: An Example of Integrated Land Use," American Water Works Association Journal, 59 (11) (November, 1967), 1469-1477.

Reis, Robert I. "Policy and Planning for Recreational Use of Inland Waters." Reprint from Temple Law Quarterly. Philadelphia, Pennsylvania: Temple University, 1967, pp. 155-193.

Rose, Robert H. "Public Seashores--Their Preservation and Use." Reprinted from Proceedings and Papers of the I.U.C.N. 10th Technical Meeting (Lucerne, June, 1966). Part I, Section 2A, I.U.C.N. Publications New Series Number 7, 1967, pp. 146-152.

Roseberry, Dean A. "Relationship of Recreational Use to Bacterial Densities of Forrest Lake," American Water Works Association Journal, 56 (1) (January, 1964), 43-59.

Roseberry, John and Klimstra, W. "Recreational Activities on Illinois Strip-Mined Lands," Journal of Soil and Water Conservation, 19-20 (1964), 107-110.

Rothacher, Jack. "Experimental Watersheds Used as a Research Tool by the Forest Service." Reprinted from "Notes on Unit Source Watershed Conference." Paper presented at Unit Source Watershed Conference, February 16-19, 1965, by Soil and Water Conservation Research Division, Agricultural Research Service, Beltsville, Maryland, 1965.

Rothacher, Jack. "Influence of Forest Management Practices." Reprinted from Water and Environmental Quality. Oregon State University, Water Resources Research Institute, Seminar (WR 008. 67), by U.S. Forest Service, 1967, pp. 25-31.

Rudbeck, James P. "Economic Impact of Outdoor Recreation--A Case Study in Washington County," Maine Farm Research, 13 (4) (January, 1966), 33-36.

Sapora, Allen V. "Interdisciplinary Research," Recreation Research. Washington, D.C.: American Association for Health, Physical Education, and Recreation, 1965, p. 196.

Sargent, F. O. "Multiple Use and Water Law," Proceedings of Water Rights Law Conference. Sponsored by the New England Council of Water Center Directors. Boston, Massachusetts, November 10, 1966, pp. 87-96.

Schad, T. M. "Perspective on National Water Resources Planning," Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, 88 (HY4,318) (July, 1962), 17-41.

Schick, Harold. "Water Based Recreation," in Water Resources Planning and Development. Corvallis, Oregon: Oregon State University, Water Resources Research Institute, 1964, pp. 20-26.

Schiff, Ashley. "Outdoor Recreational Values in the Public Decision Process," Natural Resources Journal, 6 (4) (October, 1966), 542-559.

Schmedemann, Ivan W. "The Consumer and Water Based Outdoor Recreation," Water for Texas, Proceedings of the 11th Annual Conference, November 21-22, 1966. College Station, Texas: Texas A & M University, 1966, pp. 51-53.

Schulz, Paul. "Public Use of Underwater Resources." Reprinted from Proceedings and Papers of the I.U.C.N. 10th Technical Meeting (Lucerne, June, 1966), Part I, Section 2A. I.U.C.N. Publications New Series Number 7, 1967, pp. 153-159.

Seckler, D. W. "On the Uses and Abuses of Economic Science in Evaluating Public Outdoor Recreation," Land Economics, 42 (4) (November, 1966), 485-494.

Sessoms, H. D. "Analysis of Selected Variables Affecting Outdoor Recreation," Social Forces, 42 (1) (October, 1963), 112-115.

Sessoms, H. D. "New Bases for Recreational Planning," Journal of the American Institute of Planners, 30 (1) (February, 1964), 26-33.

Shafer, Elwood L., Jr. "Forest Aesthetics--A Focal Point in Multiple-Use Management and Research." Reprinted from 14th IUFRO Congress Papers 7, Section 26, Munich: September 4-9, 1967.

Shafer, Elwood L., Jr. "The Photo-Choice Method for Recreation Research." U.S. Forest Service Research Paper NE-29. Upper Darby, Pennsylvania: Northeast Forest Experiment Station, 1964.

Shafer, Elwood L., Hamilton, John F. and Schmidt, Elizabeth A. "Natural Landscape Preferences: A Predictive Model," Journal of Leisure Research, 1 (1) (Winter, 1969), 1-19.

Shank, William T. "Gifford Pinchot State Park: Water for Play and the Players," Water Works and Wastes Engineering, 2 (February, 1965), 38-40.

Smith, Anthony Wayne. "The Need for a New Water Policy," National Parks Magazine, 41 (240) (September, 1967), 2,20.

Smith, Charles E. "Public Health Limitations on Recreational Use of Reservoirs," Proceedings Conference on Recreational Use of Impounded Water, Richmond, California, December 13-14, 1965. University of California, Committee on Research in Water Resources, 1956, 44-49.

Sport Fishing Institute and Outboard Boating Club of America. "Proceedings: Fourth National Conference on Access to Recreational Waters." San Diego, California: Sport Fishing Institute and Outboard Boating Club of America, 1965. (Mimeographed)

Stall, John B. "Man's Role in Affecting the Sedimentation of Streams and Reservoirs," in Proceedings of the Second Annual American Water Resources Conference, November 20-22, 1966. Proceedings Series Number 2. Urbana, Illinois: American Water Resources Association, 1966, pp. 79-95.

Starr, Warren A. "Multiple Land Use Management," Natural Resources Journal, 1 (2) (November, 1961), 288-301.

Stead, Frank M. "Water Recreation and the Public Water Supply," Civil Engineering, 36 (November, 1966), 54-56.

Steele, Harry A. "Activities of the Water Resources Council," Water for Texas, Proceedings of the 12th Annual Conference, November 20-21, 1967. College Station, Texas: Water Resources Institute, Texas A & M University, 1967, pp. 6-10.

Stevens, Joe B. "Angler Success as a Quality Determinant of Sport Fishery Recreational Values." Reprinted from Transactions of the American Fisheries Society, 95 (4) (October, 1966), pp. 357-362.

Stevens, Joe B. "Economic Analysis of Outdoor Recreation as a Guide to Public Policy." A Paper Presented to Coast Land Use Symposium. Bowdoin College, Brunswick, Maine, October 20-22, 1966.

Stevens, Joe B. "Recreation Benefits from Water Pollution Control," Water Resources Research, 2 (2) (Second Quarter, 1966), 167-182.

Stevens, Joe B. "Recreation Benefits from Water Pollution Control: A Further Note on Benefit Evaluation," Water Resources Research, 3 (1) (First Quarter, 1967), 63-64.

Stevens, Joe and Bollman, Frank. "Quantitative Measurement of the Demand for and Use of Public Outdoor Recreation Resources." A paper presented at a meeting at the Committee on the Economics of Range Use and Development of the Western Agricultural Economics Research Council, San Francisco, California, August 2, 1966.

Stevenson, Albert H. "Studies of Bathing Water Quality and Health," American Journal of Public Health, 43 (5) (May 1953), 529-538.

Stewart, Bruce. "The Growing Use of Private Land for Recreation in Maine," Maine Farm Research, 9 (2) (July, 1961), 11-13.

Stoevener, Herbert H. "Water Use Relationships as Affected by Water Quality on the Yaquina Bay," New Horizons for Resources Research Western Resources Papers, 1964. Boulder, Colorado: University of Colorado Press, 1965, pp. 87-99.

Stoevener, H. H. and Castle, E. N. "Impact-Output Models and Benefit-Cost Analysis in Water Resources Research," Journal of Farm Economics, 47 (5) (December, 1965), 1572-1579.

Stoevener, H. H. and Guedry, L. J. "Sociological Characteristics of the Demand for Outdoor Recreation," An Economic Study of the Demand for Outdoor Recreation. San Francisco, California: Cooperative Regional Research Technical Committee, 1968.

Stoevener, H. H. and Sokoloski, A. A. "Estimation of the Magnitude and Distribution of Benefits from Recreational Resource Management in the Economy of a Small Area." Agricultural Experiment Station. Corvallis, Oregon: Oregon State University, n.d.

Stone, R. "Planning for Urban Multi-Purpose Parks," Public Works, 98 (May, 1967), 78-80.

Storey, Herbert C. and Reigner, Irvin C. "Forests-National Supplies and Demands for Water." Reprinted from Proceedings. Society of American Foresters, Seattle, Washington, 1966, pp. 143-146.

Strenge, F. "Recreational Uses of Hydroelectric Reservoirs," Civil Engineering, 33 (8) (August, 1963), 38-41.

Strong, Ann Louise. "Open Space through Water Resource Protection." Proceedings of Conference by Academy of Natural Sciences. Pittsburgh, Pennsylvania: University of Pennsylvania, 1965.

Strong, Benton J. "Concept, Legislative History, and Implementation of the Anderson Water Resources Research Act," New Horizons for Resources Research. Western Resources Paper 1964. Boulder, Colorado: University of Colorado Press, 1965, pp. 205-217.

Stroud, Richard H. "Recreational Use of Watersheds, Conservationist's View," American Water Works Association Journal, 58 (October, 1966), 1263-1270.

Struyk, Raymond J. "Summary of Present Practices in Evaluation of Water Resource Projects." Working Paper CWR 13, St. Louis, Missouri: Institute for Urban and Regional Studies, Washington University, 1967.

Swank, W. T. "The Influence of Rainfall Interception on Streamflow." Conference Proceedings, Hydrology in Water Resources Management. Water Resources Research Institute, Clemson University, South Carolina, March, 1968.

Swenson, Norman P. "Recreation Visits and Retail Trade Outside of Standard Metropolitan Statistical Areas." Working Paper CWR 11. St. Louis, Missouri: Washington University, Institute for Urban and Regional Studies, 1966.

Tarrant, Robert F. "Influence of Introduced Chemicals." Reprinted from Water and Environmental Quality. Oregon State University, Water Resources Research Institute Seminar (WR-008.-67), by U.S. Forest Service, 1967, pp. 33-45.

Taylor, Floyd B. "Recreational Use of Watersheds, Federal View," American Water Works Association Journal, 58 (October, 1966), 1272-1274.

Thomas, E. A. "The Eutrophication of Lakes and Rivers, Cause and Prevention," Biological Problems in Water Pollution. Third Seminar, August 13-17, 1962. Cincinnati, Ohio: U.S. Department of Health, Education and Welfare, pp. 299-305.

Threinen, C. W. "An Analysis of Space Demands for Water and Shore." Reprinted from Transactions of the 29th North American Wildlife and Natural Resources Conference, March 9-11, 1964. Washington, D.C.: Wildlife Management Institute, 1964, pp. 353-372.

Tippy, Roger. "Preservation Values in River Basin Planning," Natural Resources Journal, 8 (2) (April, 1968), 259-278.

Tocher, Ross. "Municipal Watersheds and Recreation: Conditions for Compatibility," Western Resources Conference, 1963. Boulder, Colorado: University of Colorado Press, 1964, pp. 47-51.

Trelease, Frank J. "The Concept of Reasonable Beneficial Use in the Law of Surface Streams," in Smith, Stephen (ed.), Economics and Public Policy in Water Resource Development. Ames, Iowa: Iowa State University Press, 1964.

Trelease, Frank J. "Policies for Water Law: Property Rights, Economic Forces and Public Regulation," Natural Resources Journal, 5 (May, 1965), 1-48.

Trembley, F. J. "Effects of Cooling Water from Steam-Electric Power Plants on Stream Biota," Biological Problems in Water Pollution. Third Seminar, August 13-17, 1962. Cincinnati, Ohio: U.S. Department of Health, Education and Welfare, pp. 335-345.

Trembley, F. J. "Recreational Uses of Reservoirs," Engineering, 192 (September, 1961), 339-340.

Trice, Andrew H. and Wood, Samuel E. "Measurement of Recreation Benefits," Land Economics, 34 (8) (August, 1958), 195-207.

Twiss, Robert A. "An Interdisciplinary Approach to Outdoor Recreation Research," Journal of Forestry, 61 (8) (August, 1963), 580-582.

Twiss, Robert H. "Information and Outdoor Recreation Research." Research Note PSW-3. Berkeley, California: Pacific Southwest Forest and Range Experiment Station, 1963.

U.S. Department of the Interior, Missouri River Basin Field Committee. "Facing Reality in Recreation," Progress, 61 (January-March, 1960), 63-68.

U.S. Department of the Interior, Missouri River Basin Field Committee. "Reclamation Lakes Attract Recreation Industry to Southwest Nebraska," Progress (October-December, 1961), 45-52.

U.S. National Park Service. "Sleeping Bear National Seashore: A Proposal," Planning and Civic Comment, 30 (June, 1964), 29-34.

U.S. National Park Service. "Tocks Island National Recreation Area: A Proposal," Planning and Civic Comment, 30 (March, 1964), 29-34, 54-55.

Waelti, John J. "Some Effects of Reservoir Based Recreation on Local Government Finance." Paper presented at the Western Farm Economics Association Annual Meeting, Los Angeles, California, August 15, 1966.

Wagar, John Alan. "The Carrying Capacity of Wild Lands for Recreation," Forest Service Monograph. Monograph Number 7. Washington, D.C.: U.S. Government Printing Office, 1964.

Wagar, J. Alan. "Estimating Numbers of Campers on Unsupervised Campgrounds." U.S. Forest Service Research Paper NE-18. Upper Darby, Pennsylvania: Northeast Forest Experiment Station, 1964.

Wagar, J. Alan. "Relationships Between Visitor Characteristics and Recreation Activities on Two National Forest Areas." U.S. Forest Service Research Paper NE-7. Upper Darby, Pennsylvania: Northeast Forest Experiment Station, 1963.

Wagar, J. V. K. "Some Fundamental Characteristics of Outdoor Recreation," Journal of Forestry, 64 (October, 1966), 667-673.

Waite, G. Graham. "Public Rights in Maine Waters." Reprint from Maine Law Review, 1965.

Weder, Eugene W. "Recreation--A Purpose of Water Resource Development," Civil Engineering, 32 (September, 1962), 57-59.

Wells, Dan M. "A Plan for Development of a Management Program for Galveston Bay," Water for Texas. Proceedings of the 11th Annual Conference, November 21-22, 1966. College Station, Texas: Texas A & M University, 1966, pp. 40-44.

Wennergren, E. Boyd. "Surrogate Pricing of Outdoor Recreation," Land Economics, 43 (February, 1967), 112-116.

Wennergren, E. Boyd. "Valuing Non-Market Priced Recreational Resources," Land Economics, 40 (3) (August, 1964), 303-314.

White, James P. "Recreational Use of Private Land: Legal Implications in Contract and Tort," Illinois University College of Agriculture Special Publication Number 7, 1964, pp. 37-61.

White, William M. "Evaluation of Recreation in Water Developments," American Society of Civil Engineers. Proceedings, Power Division Journal, 91 (No. PO1) (May, 1965), 1-9.

Whyte, William H. "Easements and Other Approaches," in Maine Coast Prospects and Perspectives: A Symposium. Brunswick, Maine: Center for Resource Studies, 1966, pp. 68-74.

Williams, Hallis R. "Small Watershed Projects," Recreation, 57 (June, 1964), 276-278.

Wilson, George T. "Lake Zoning for Recreation," American Institute of Park Executives, 44 (December, 1964), 1-30.

Wilson, Peter M. "Designing a Public Marina," Public Works, 95 (March, 1964), 111-113.

Wilson, Peter M. "Managing a Public Marina," Public Works, 95 (April, 1964), 118-120.

Wilson, Peter M. "Planning a Public Marina," Public Works, 95 (February, 1964), 109-111.

Wilson, Ralph. "Small Watershed Projects Help Fill the Need for Outdoor Recreation," in Make No Little Plans. A Collection of Selected Papers Presented at the 47th National Recreation Congress, Minneapolis, Minnesota, 1965. New York: National Recreation and Park Association, 1966, pp. 30-32.

Wirth, Donald E. "4 Million Earmarked for Recreation in 1,000 - MW Pumped Storage Project; Northfield Mt. Massachusetts," Electrical World, 166 (August, 1966), 62-64.

Wood, Donald F. and Trice, Andrew. "The Distances-Traveled Technique for Measuring Value of Recreation Areas: An Application," Land Economics, 37 (1961), 363-369.

Wooldridge, David D. "Water Transport in Soils and Streams." Reprinted from Transport Phenomena in Atmospheric and Ecological Systems. New York: American Society of Mechanical Engineers, n.d.

Wooldridge, David D. and Gessel, Stanley P. "Forests and the Nation's Water," Water Resources Bulletin, 2 (December, 1966), 7-12. Urbana, Illinois: American Water Resources Association.

Worley, David P. "Objectives and Methods of Economic Evaluation on the Beaver Creek Watershed Project," in Water and Range Resources and Economic Development of the West. Report Number 9. Tucson, Arizona, 1961, pp. 123-129.

Wurtz, C. B. "Water Use for Aquatic Life," Water Quality Criteria, STP Number 416. Philadelphia, Pennsylvania: American Society for Testing and Materials, 1967, pp. 81-89.

Yanggen, Douglass A. "A Suggested Shoreline Protection Approach," A Resource Paper on Wisconsin Water Issues. Prepared for Conference on Environmental Quality, Green Bay, Wisconsin, March 28-29, 1968. (Mimeographed)

Yanggen, Douglas A. and Kusler, John A. "Natural Resources Protection through Shoreland Regulation: Wisconsin," Land Economics, 44 (1) (February, 1968), 73-86.

Unpublished Material

Abramson, Marlin P. "Participation in Outdoor Recreation: Factors Influencing Demand in Christian County, Illinois." Unpublished Master's Thesis, University of Illinois, Urbana, Illinois, 1964.

Alsamarrai, Hashim Alwan. "Methods of Assessing Beneficiaries for a Share of the Cost of Public Water Control Projects that Enhance Agricultural Land Values." Unpublished Ph.D. Dissertation, University of Florida, Gainesville, Florida, 1964.

Barkley, Paul Weston. "The Economic Effects of Reservoir Development on Individual Farms Lying Partially Within the Site." Unpublished Ph.D. Dissertation, Kansas State University, Manhattan, Kansas, 1963.

Black, Peter Elliot. "Timber and Water Resource Management: A Physical and Economic Approach to Multiple Use on Denver's Municipal Watershed." Unpublished Ph.D. Dissertation, Colorado State University, Fort Collins, Colorado, 1961.

Bradwell, David. "The Timing of Development of the Saskatchewan River System." Unpublished Ph.D. Dissertation, University of Oregon, Eugene, Oregon, 1964.

Bramer, Henry Conrad. "The Economic Aspects of the Water Pollution Abatement Program in the Ohio River Valley." Unpublished Ph.D. Dissertation, University of Pittsburgh, Pittsburgh, Pennsylvania, 1960.

Brown, Gardner Mallard, Jr. "Distribution of Benefits and Costs from Water Development: A Case Study of the San Joaquin Valley--Southern California Aqueduct." Unpublished Ph.D. Dissertation, University of California, Berkeley, California, 1964.

Collins, Bernard Charles. "Land Use Conflict in the North Cascades Wilderness of Washington State." Unpublished Master's Thesis, University of Michigan, Ann Arbor, Michigan, 1962.

Cutler, Richard Oscar. "Amelia Island Florida: A Geographic Study of Recreation Development." Unpublished Ph.D. Dissertation, University of Florida, Gainesville, Florida, 1965.

Dalia, Frank John. "An Economic Examination of Federal Water Resource Developments in the Ovachita-Black River Basin." Unpublished Ph.D. Dissertation, Tulane University, New Orleans, Louisiana, 1964.

Davis, Robert Kenneth. "The Value of Outdoor Recreation: An Economic Study of the Marine Woods." Unpublished Ph.D. Dissertation, Harvard University, Cambridge, Massachusetts, 1963.

Denslow, Stuart Otis. "Spatial Aspects of Water Resource Problems in the Saginaw River Basin: A Case Study." Unpublished Ph.D. Dissertation, Michigan State University, East Lansing, Michigan, 1966.

Doty, Don Darrel. "The Justification for Including Recreational Benefits in Federal Water Project Benefit-Cost Analysis: An Empirical Test." Unpublished Ph.D. Dissertation, University of Arkansas, Fayetteville, Arkansas, 1963.

Emerson, Frederick, Beauregard, Jr. "Some Aspects of the Ecology and Management of Wildlife Marshes in New York State." Unpublished Ph.D. Dissertation, Cornell University, Ithaca, New York, 1961.

Fulcher, Glen Dale. "Methods of Economic Evaluation of Outdoor Recreational Use of Water and a Case Study of Their Application." Unpublished Ph.D. Dissertation, University of Wisconsin, Madison, Wisconsin, 1961.

Gahan, L. W. "A Regional Analysis of Factors Affecting the Demand for and Participation in Water-Oriented Recreation Activities." Unpublished Research Paper, Department of Recreation and Park Administration, University of Illinois, Urbana, Illinois, 1968.

Gillespie, Glenn Alton. "An Evaluation of the Factors Affecting the Demand for Water-Oriented Outdoor Recreation." Unpublished Ph.D. Dissertation, University of Missouri, Columbia, Missouri, 1966.

Goodale, T. L. "An Analysis of Leisure Behavior and Attitudes in Selected Minneapolis Census Tracts." Unpublished Ph.D. Dissertation, University of Illinois, Urbana, Illinois, 1965.

Goodin, Julius A., Jr. "Man-Made Lakes and Waterways Within Residential Developments." Unpublished Master's Thesis, Georgia Institute of Technology, Atlanta, Georgia, 1961.

Hellman, Allen David. "A Recreational Inventory and Analysis of School Craft County, Michigan: A Study in Recreational Land Use." Unpublished Ph.D. Dissertation, University of Michigan, Ann Arbor, Michigan, 1962.

Hinman, Robert Charles. "The Economic Impact of Reservoir Recreation on the Whitney Point Microregion of New York State." Unpublished Master's Thesis, Cornell University, Ithaca, New York, 1967.

Hubbard, Fred Harvey. "Planning and Control of Recreation Use on Public Inland Lakes." Unpublished Ph.D. Dissertation, University of Michigan, Ann Arbor, Michigan, 1962.

Kerpel, Frederick. "Riverfront Land--Use Planning in Urban Areas." Unpublished Master's Thesis, Georgia Institute of Technology, Atlanta, Georgia, May, 1960.

Lucas, Robert Charles. "The Quetico-Superior Area: Recreational Use in Relation to Capacity." Unpublished Ph.D. Dissertation, University of Michigan, Ann Arbor, Michigan, 1962.

McCoy, Edward Wayne. "Analysis of the Utilization of Outdoor Recreation in Tennessee." Unpublished Ph.D. Dissertation, University of Tennessee, Knoxville, Tennessee, 1966.

Matthews, Gerald H. "Island Lake Waterfront Development." Unpublished Master's Thesis, Michigan State University, East Lansing, Michigan, 1964.

Miller, Maurice Lee. "Control of Land Contiguous to Federal Reservoirs." Unpublished Master's Thesis, Kansas State University, Manhattan, Kansas, 1964.

Munson, Karl Franklin. "Opinions of Providers and Users About Site Quality for Water-Oriented Recreation on Eight Small Lakes in Arkansas." Unpublished Ph.D. Dissertation, University of Illinois, Urbana, Illinois, April, 1968.

Olson, George T. "Preservation of Reservoir Sites." Unpublished Master's Thesis, University of North Carolina, Chapel Hill, North Carolina, 1963.

Owens, Gerald Phillip. "Factors Affecting Demand for Outdoor Recreation." Unpublished Ph.D. Dissertation, Ohio State University, Columbus, Ohio, 1965.

Palmer, Edgar Z. "Recreational Aspects of Three Nebraska Lakes." Community Study Number Three. Lincoln, Nebraska: University of Nebraska, December, 1960. (Mimeographed)

Ramirez, Ruben D. "Boating in the Puget Sound Region--1985." Unpublished Master's Thesis, University of Washington, Seattle, Washington, 1964.

Reid, Leslie M. "Outdoor Recreation Preferences: A Nationwide Study of User Desires." Unpublished Ph.D. Dissertation, Department of Resource Development, Michigan State University, East Lansing, Michigan, 1963.

Romm, Jeffery Mel. "Benefit Estimation for Water-Based Recreation Facilities." Unpublished Master's Thesis, Cornell University, Ithaca, New York, January, 1968.

Ryland, Michael Trivitt. "Expressways and Urban Shorelines: Considerations for Their Visual Design." Unpublished Master's Thesis, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1962.

Schaaf, Gene P. "Factors Influencing Campground and Campsite Selection by Campers at Golden Lake Campground, Ottawa National Forest, Michigan." Unpublished Master's Thesis, University of Michigan, Ann Arbor, Michigan, 1965.

Stephens, Eeanor Belknap. "Conflicts in Recreation." Unpublished Master's Thesis, University of North Carolina, Chapel Hill, North Carolina, 1962.

Stevens, J. B. "A Study of Conflict in Natural Resource Use: Evaluation of Recreational Benefits as Related to Changes in Water Quality." Unpublished Ph.D. Dissertation, Oregon State University, Corvallis, Oregon, 1966.

Storey, Edward H. "A Method of Estimating the Demand for Outdoor Recreation." Unpublished Ph.D. Dissertation, University of Illinois, Urbana, Illinois, 1964.

Street, Donald. "Recreation Economics--Fee Fishing in Pennsylvania." University Park, Pennsylvania: Pennsylvania State University, Agricultural Experiment Station, June, 1967. (Mimeographed)

Thompson, Norman H., Jr. "Planning for the Creation and Utilization of Shoreline Fills." Unpublished Master's Thesis, Georgia Institute of Technology, Atlanta, Georgia, 1961.

Tokar, Paul. "The Recreational Program of the Muskingum Watershed Conservancy District." Unpublished Master's Thesis, University of Michigan, Ann Arbor, Michigan, 1964.

Van Ness, Albert Ward, Jr. "Social and Economic Factors Affecting Household Expenditures for Outdoor Recreation in Northeastern South Dakota." Unpublished Master's Thesis, South Dakota State University, Brookings, South Dakota, 1968.

Warne, William E. "Water-Oriented Recreation Planning and Management for Central California." Paper read before the Assembly Committee on Natural Resources, Planning and Public Works, Fresno, California, June 21, 1966.

Werner, Robert Rehm. "An Investigation of the Employment of Multiple Objectives in Water Resources Planning." Unpublished Ph.D. Dissertation, South Dakota State University, Brookings, South Dakota, 1968.

Reports

American Forest Products Industries, Inc. Water and Watersheds--A Report to the Forest Industries on the Watershed Situation in the United States. Washington, D.C.: American Forest Products Industries, Inc., 1960.

Bollman, Frank H. "Economic Evaluation of Primary Benefits from Fishing and Hunting Based on the National Surveys of Fishing and Hunting--A Progress Report." Paper prepared for the Conference on the Demand for Fishing, Hunting, and Other Outdoor Recreation Activities. Sponsored by the Bureau of Sport Fisheries and Wildlife, Washington, D.C., February 27-28, 1967.

Bourguard, E. H. and Associates. Report on Water Resources Study of Neshaminy Creek Basin and Vicinity Bucks and Montgomery Counties, Pennsylvania. Bulletin Number 2. Harrisburg, Pennsylvania: E. H. Bourguard and Associates, May, 1966.

Bourquard, Geil, and Associates. Report on the Water Resources Study of Cordorus Creek Basin and Vicinity. Harrisburg, Pennsylvania: Bourquard, Geil and Associates, June, 1962.

Brown, Gardner, Jr. Selection of the Optimum Method for Estimating the Demand for Non-Market Water Resources with Incomplete Information. Final Report of Project 161-34-10E-3996-3005 under Agreement A-015-WASH for the period January 1, 1966-June 30, 1967. Seattle, Washington: University of Washington, August 18, 1968.

California University Water Resources Center. Proceedings, Conference on Water Decisions in the Critical 60's, January 11-13, 1961. Report 3. Davis, California: University of California at Davis, 1961.

California University Water Resources Center. Proceedings, Water Resources Economic Conference. Report Number 4. Davis, California: University of California at Davis, 1964.

California University Water Resources Center. Proceedings, Water Resources Economics Conference, September 30-October 2, 1963. Held at California Alumni Center, Lake Tahoe, California: University of California, 1963.

California University Water Resources Center. Water: A Classification Scheme. Archives Series Report Number 19. Berkeley, California: Water Resources Center Archives, University of California, October, 1967.

California University Water Resources Center. Water: A Subject Heading List. Archives Series Report 18. Berkeley, California: Water Resources Center Archives, University of California, July, 1967.

Castle, Emery N. Economic and Administrative Problems of Water Pollution. Technical Report 2284. Oregon Agricultural Experiment Station. Corvallis, Oregon: Oregon State University, n.d.

Castle, Emory N. and Brown, William G. "The Economic Value of a Recreational Resource: A Case Study of the Oregon Salmon. Steelhead Sport Fishery," in Water Resources and Economic Development of the West. Report Number 13. San Francisco, California: Western Agricultural Economic Research Council, December, 1964, pp. 1-12.

Chubb, Michael and Ashton, Peter. Park and Recreation Standards Research: The Creation of Environmental Quality Controls for Recreation. A Report to the National Recreation and Park Association. Technical Report Number 5. East Lansing, Michigan: Department of Park and Recreation Resources, Michigan State University, January, 1969.

Crane, Dale A. Progress Report, Corp of Engineers Recreation Data Collection and Research Program. Presented at Conference on Methods and Demand Analysis for Fishing, Hunting and Other Outdoor Recreation Activities, Washington, D.C., February 27-28, 1967. Sacramento, California: Corp of Engineers, Recreation Planning Section, 1967.

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

Edwards and Kelcey, Inc. New Jersey Comprehensive Outdoor Recreation Plan, Water Resources for Recreation, 1968. Report 2. Trenton, New Jersey: New Jersey Department of Conservation and Economic Development, 1968.

Ewing, B. et al. "Feasibility of Evaluation of Benefits from Improved Great Lakes Water Quality." WRC Special Report Number 2. Urbana, Illinois: University of Illinois, Water Resources Center, May, 1968. (Mimeographed)

Hamilton, H. R. et al. Final Report on a Dynamic Model of the Economy of the Susquehanna River Basin to the Susquehanna River Basin Utility Group. Columbus, Ohio: Battelle Memorial Institute, August 1, 1966.

Haugen, Arnold O. and Sohn, Arnold J. Competitive Recreational Uses of Selected Iowa Lakes. Completion of Report of Project No. A-005-IA. Iowa State Water Resources Research Institute, June 30, 1968.

Humphrys, C. R. Water--Water Supply 1960--Water Demand 1980. A Personal Report to the Senate Select Committee on National Water Resources. East Lansing, Michigan: Michigan State University, Department of Resource Development, Agricultural Experiment Station, October 29, 1959.

Illinois University Water Resources Center. Intergovernmental Relationships in the Administration of Water Resources. Research Report No. 18. Urbana, Illinois: University of Illinois, September, 1968.

McCurdy, Dwight R. and Miller B. Hene. The Recreationist at the Crab Orchard National Wildlife Refuge and His Opinions of User-Fees. A Report Prepared by the Department of Forestry. Publication Number 1. Carbondale, Illinois: Southern Illinois University, February, 1968.

Michigan University School of Natural Resources and U.S. Bureau of Outdoor Recreation. Proceedings of the National Conference on Outdoor Recreation Research. Ann Arbor, Michigan: U.S. Department of the Interior, 1963.

Milstein, O. N. and Reid, L. M. Michigan Outdoor Recreation Demand Study. Technical Report Number 6. Vol. I and II. East Lansing, Michigan: Michigan State University, Department of Resource Development, 1966.

Moeller, John. Standards for Outdoor Recreation Areas. Report Number 194. Idaho: American Society of Planning Officials, 1965.

Nathan, Robert R. Recreation as an Industry (Field Study Summary Reports) in Appalachia. Washington, D.C.: Robert R. Nathan Associates, Inc., 1966.

National Conference on Outdoor Recreation Research. Proceedings of the National Conference on Outdoor Recreation Research. Ann Arbor, Michigan: Ann Arbor Publishers, 1963.

Ohio State University Natural Resources Institute and Office of Community Development. Meeting Outdoor Recreation Needs for the 60's. Conference Report. Columbus, Ohio: Ohio State University, July, 1961.

Pearson, John E. A Study of the Economic Impact of Water Impoundment Through the Development of a Comparative-Projection Model. Technical Report Number 8. College Station, Texas: Texas A & M University, Water Resources Institute, 1968.

Pennsylvania State University. Estimates of the Annual Expenditure Pattern and Its Economic Impact Within Tioga County from the Proposed Federal Tioga-Hammond Dam and Reservoir Project. A Report Prepared by the Center for Regional Analysis of the Pennsylvania State University. University Park, Pennsylvania: Pennsylvania State University, n.d.

Rechard, Paul A. and Lane, John E. The Effects of Varying Land and Water Use on Streamflow Regimen--A Report by Water Resources Research Institute. Water Resources Series Number 10, Laramie, Wyoming: University of Wyoming, June, 1968.

Reigner, Irvin C. Effect of Recreation on Water Quality. A Report by the United States Department of Agriculture, Northeastern Forest Experiment Station, Upper Darby, Pennsylvania, n.d.

Stoevener, Herbert H. An Economic Evaluation of Water Pollution Control Alternatives. A Progress Report. Salt Lake City: Economics of Water Resources Development of the Western Agricultural Economics Research Council, December 18, 1963.

Stott, Charles C. Criteria for Evaluating the Quality of Water Based Recreation Facilities. Report Number 1. Raleigh, North Carolina: Water Resources Research Institute of the University of North Carolina, 1967.

Taves, M., Hathaway, William and Bultena, Gordon. Canoe Country Vacationers. Miscellaneous Report 39. St. Paul, Minnesota: University of Minnesota, Agricultural Experiment Station, June, 1960.

Threinen, C. W. "Some Spatial Aspects of Aquatic Recreation." Miscellaneous Report No. 6. Wisconsin Conservation Department, Fish Management Division, 1961. (Mimeographed)

Threinen, C. W. and Poff, Ronald J. "Supply and Demand, Surface Water Resources, Southeastern Wisconsin." Miscellaneous Report No. 12. Wisconsin Conservation Department, Fish Management Division. (Mimeographed)

Water Conditioning Association International. Highlights Second International Water Quality Symposium. Wheaton, Illinois: Water Conditioning Association International, 1966.

Water Conditioning Association International and Water Conditioning Foundation. Highlights of the First International Water Quality Symposium. Washington, D.C.: Water Conditioning Association International and Water Conditioning Foundation, 1965.

Willeke, Gene E. Effects of Water Pollution in San Francisco Bay. Project on Engineering--Economic Planning, Report EEP-29. Stanford, California: Stanford University, October, 1968.

Wolman, Abel. Water Resources Report. Publication 1000-B. Washington, D.C.: National Academy of Sciences--National Research Council, 1962.

APPENDIX A

COMPUTERIZED BIBLIOGRAPHIC RETRIEVAL

Water Resources recreation bibliographic retrieval is accomplished through the IBM System/360 Document Processing System. This system processes bibliographic data into a file of interrelated data sets. The necessary hardware and programs for the IBM/360 Document Processing System are available at the University of Illinois Digital Computer Laboratory.

The System/360 Document Processing System program capabilities are described more specifically by the International Business Machines Corporation.[1]

This computerized literature retrieval system at present stores approximately 1,000 documents[2] on an IBM 1316 portable disc pack that can be searched automatically by the IBM System/360 Document Processing System. Graduate research assistants have assigned up to five keywords to each document. These keyword descriptors reveal the information and data contained in the document. Prior to storage, each document needs to be coded and key-punched on IBM cards.

Prerequisite to any use of the IBM/360 Document Processing System to determine sources of pertinent information and their location, the investigator must outline a search control statement or task specification, which spells out what information is desired. This search control statement activates the document processing system's search capability. It names the data sets to be searched.

---

[1] International Business Machines Corporation, IBM System/360 Document Processing System Application Description, No. H20-0315-0 (White Plains, N.Y.: International Business Machines Corporation, 1967), p. 1.

[2] Each document in this system consists of an assigned document number, title of the publication, author of the publication, publication date, library location, and the assigned keywords.

The search control statement is outlined in terms of the keywords listed in the Thesaurus of Outdoor Recreation Terms, developed by the B.O.R. and later modified by our project staff. Every search control statement must contain at least one keyword statement.

The following have been developed as lead-up steps to the development of a search control statement and the computerized retrieval of bibliographic notations:

A. An investigator formulates a question on paper that reflects the subject area about which information is desired. For example, one section of the collaborative study deals with determining, analyzing, and summarizing knowledge and deficiencies involved in forecasting the demand for water-based recreation (see outline model in the methodology section of this study). The question that relates to this section is as follows: What techniques and methodologies have been developed to forecast the demand for water recreation based on the social and economic characteristics of specified user groups?

B. Select the important terms within the question. These are considered user terms. The important user terms within our sample question are techniques, methodologies, forecast, demand, social and economic characteristics, and user groups.

C. Using the Thesaurus of Outdoor Recreation Terms, determine if there are keyword descriptors that match user terms selected.

   1. If there is a match, record the keywords and enter them in a computer search control statement.

   2. If a term is not in the Thesaurus, then an alternate term should be chosen and located in the Thesaurus of Outdoor Recreation Terms. In the following example required keyword descriptors have been found in the Thesaurus or else they have been approximated.

A	B
user terms	thesaurus keyword descriptors
techniques	research, surveys, statistics
methodologies	methodology
forecast	forecasting
demand	demand
social characteristics	user characteristics
economic characteristics	user characteristics, economic
user groups	studies
	users

The investigator then includes the selected thesaurus keyword descriptors in an input search control statement. Thus cued, routines within the search module react to the user's search statements by interrogating the data base. Finally, the search module causes a printout of documents whose keyword attributes match the investigator's specifications. The search control statement may be intended to cause all documents assigned one of the keyword descriptors listed in column B to be printed-out, or the statement may be constructed to search for and print documents assigned a particular combination of keyword descriptors, e.g., those documents assigned the keywords <u>users</u>, <u>demand</u>, and <u>forecasting</u>.

With a complete bibliography (pertinent to the specified topic of forecasting demand) available to the investigator, he must manually retrieve the actual pieces of literature prior to beginning his critical analyses of the literature.

APPENDIX B

DEFINITION OF TERMS

Bibliographic retrieval - In this study, bibliographic retrieval is an automatic process whereby a user is provided with a complete bibliography (each bibliographical notation is accompanied by assigned keywords and library location of the piece of literature) for each keyword he has designated in his search control statement.

Collaboration method - This method uses and reworks research conclusions and secondary data to develop new generalizations. The collaboration method in this study will be used to produce a narrative analysis and review of the selected literature relating to the recreational aspects of water resources use, planning, and development. This method is also called the integration method.

Data base - A data base is a major information category of stored input data. In this study the data base consists of data (bibliographic notations, library locations, and assigned keywords) dealing with the recreational aspects of water resources use, planning, and development.

Data set - A data set is a sub-set of the data base.

Document - Each document in this system consists of an assigned document number, title of the publication, author of the publication, publication date, library location, and the assigned keywords.

File of documents - A file of documents is the equivalent of one data base or major information category of stored input data.

Information retrieval - Information retrieval is an automatic process whereby a user is provided with the complete text of pieces of literature relating to specific keywords he has designated. Because of the extensive funding that is required to establish such a system, information retrieval is not a current goal of this research study.

Interdisciplinary research - Interdisciplinary research investigates concepts and methods transcending one discipline. Interdisciplinary implies problem orientation rather than discipline orientation. "Interdisciplinary research involves an integration of concepts during the various stages of a research project. Interdisciplinary research is needed when, after careful consideration of a problem, there is a feeling of need from outside one's own discipline or profession."[1]

Keyword descriptor - Keyword descriptors are alphameric terms that are assigned to pieces of literature suggesting the contextual meaning of the author. Members of the project staff have sought to use keywords which best anticipate the wording of a researcher's search query. Keyword descriptors may be either a single word or several words in length. The terms keyword descriptor and keyword are used interchangeably in this study.

Literature retrieval - In this study, literature retrieval is a manual process of identifying and gathering literature pertinent to the recreational aspects of water resources use, planning, and development.

---

[1] A. V. Sapora, "Interdisciplinary Research," Recreation Research (Washington, D.C.: American Association for Health, Physical Education, and Recreation, 1965), p. 196.

Search control statement - The control statement activates the document processing search capability. It names the data base to be searched and the optional data sets (of that base) that will be involved in the search process. These statements cause the system to yield data relating to selected keywords.

Thesaurus - A thesaurus is a specialized vocabulary that is used for a control over a certain body of information. In this study, the Thesaurus of Outdoor Recreation Terms developed by the Bureau of Outdoor Recreation was used.[2] This thesaurus has been extensively modified by the project staff.

---

[2] U.S. Bureau of Outdoor Recreation, U.S. Department of the Interior, Thesaurus of Outdoor Recreation Terms (Washington, D.C.: U.S. Government Printing Office, 1967), n.p.

APPENDIX C

LITERATURE AND INFORMATION SOURCES

Each of the following sources contributed or revealed two or more pieces of literature to this retrieval project. They are therefore worthy of solicitation or systematic monitoring by investigators concerned with recreation aspects of water resources planning and development.

I. PERIODICALS AND PROCEEDINGS

<u>American Water Works Association Journal</u>. New York: American Water Works Association.

<u>American Economic Review</u>. Evanston, Illinois: American Economic Association.

<u>American Forests</u>. Washington, D.C.: American Forestry Association.

<u>American Water Resources</u>. Urbana, Illinois: American Water Resources Association.

<u>Civil Engineering</u>. New York: American Society of Civil Engineers.

<u>Conference on Water for Texas, Proceedings</u>. College Station, Texas: Water Resources Institute, Texas A & M University.

<u>Journal of Farm Economics</u>. Ithaca, New York: American Farm Economic Association, Department of Agricultural Economics, Cornell University.

<u>Journal of Forestry</u>. Washington, D.C.: Society of American Foresters.

<u>Journal of Leisure Research</u>. Washington, D.C.: National Park and Recreation Association.

<u>Journal of Regional Science</u>. Philadelphia, Pennsylvania: Regional Science Research Institute and the Department of Regional Science, Wharton School, University of Pennsylvania.

<u>Journal of Soil and Water Conservation</u>. Ankeny, Iowa: Soil Conservation Society of America.

<u>Land Economics</u>. Madison, Wisconsin: Journals Department, University of Wisconsin Press.

Monthly Catalog, U.S. Government Publications. Washington, D.C.: Superintendent of Documents, Government Printing Office.

Monthly Checklist of State Publications. Washington, D.C.: Superintendent of Documents, Government Printing Office.

Natural Resources Journal. Alberquerque, New Mexico: The University of New Mexico School of Law.

Public Works. Ridgewood, New Jersey: Public Works Journal Corporation.

Research Digest. Urbana, Illinois: Bureau of Community Planning, University of Illinois.

Resources for the Future, Annual Reports. Washington, D.C.: Resources for the Future, Inc.

United States Code, Congressional and Administrative News. St. Paul, Minnesota: West Publishing Company, and Brooklyn, New York: Edward Thompson Company.

Water Pollution Control Federation Journal. Washington, D.C.: Water Pollution Control Federation.

Water Resources Research. Washington, D.C.: American Geophysical Union.

Western Resources Conference Papers. Boulder, Colorado: Colorado School of Mines, Colorado State University, and University of Colorado.

II. BIBLIOGRAPHIES

American Institute of Planners. Abstracts of Student Theses in City and Regional Planning. Washington, D.C.: American Institute of Planners.

Applied Science and Technology Index. New York: H. W. Wilson Company.

Bibliographical Index. New York: H. W. Wilson Company.

Burdge, R. J. Outdoor Recreation: An Annotated Bibliography. University Park, Pennsylvania: Department of Agricultural Economics and Rural Sociology, Pennsylvania State University, 1967.

Carroll, M. A. Open Space Planning: An Annotated Bibliography. Urbana, Illinois, University of Illinois, 1966.

Carswell, J. Keith, Symons, J. M. and Robeck, Gordon G. Status of Research on the Recreational Use of Public Water Supply Sources. Cincinnati, Ohio: U.S. Public Health Service, Department of Health, Education and Welfare, 1968 (contains bibliography).

Dissertation Abstracts. Ann Arbor, Michigan: University Microfilms.

Illinois University Water Resources Center. Feasibility of Evaluation of Benefits from Improved Great Lakes Water Quality. Special Report No. 2. Urbana, Illinois: Water Resources Center, Illinois University, May, 1968 (contains bibliography).

Rickert, John E. Open Space Land, Planning, and Taxation: A Selected Bibliography. Washington, D.C.: Urbana Renewal Administration, 1965.

Sapora, Allen V. and Vance, Mary. Index to the Literature of Leisure, Recreation, Parks and Other Recreation Resources. New York: National Recreation Association, 1965.

Smithsonian Institution, Science Information Exchange. Outdoor Recreation Research; A Reference Catalog. Washington, D.C.: U.S. Bureau of Outdoor Recreation, Department of the Interior, 1966.

U.S. Bureau of Outdoor Recreation. Directory of Federal and State Agencies Concerned with Outdoor Recreation. Washington, D.C.: U.S. Department of the Interior, 1963.

U.S. Bureau of Outdoor Recreation. Index of Selected Outdoor Recreation Literature. Volume I (1967), Volume II (1968), Volume III (1969). Washington, D.C.: U.S. Government Printing Office.

U.S. Bureau of Outdoor Recreation. Outdoor Recreation Research, A Reference Catalog, 1966 and 1967. Washington, D.C.: Department of the Interior.

U.S. Federal Water Pollution Control Administration. Water and Water Pollution Control, a Selected List of Publications. Washington, D.C.: U.S. Department of the Interior, March, 1968.

U.S. Federal Water Pollution Control Administration. Water Pollution Control Research and Training Grants. Washington, D.C.: Division of Grants Management, Office of Research and Development.

U.S. Forest Service. Forest Recreation Research, Bibliography of Forest Service Outdoor Recreation Research Publications, 1942 through 1966. Washington, D.C.: U.S. Department of Agriculture, 1967.

U.S. Government-Wide Index to Federal Research and Development Reports. Washington, D.C.: Division of Public Documents, U.S. Government Printing Office.

U.S.--Library of Congress--National Referral Center for Science and Technology. A Directory of Information Resource in the United States: Social Sciences. Washington, D.C.: National Referral Center for Science and Technology, 1965.

U.S. Office of Economic Opportunity. Catalog of Federal Assistance Programs. Washington, D.C.: Office of Economic Opportunity, 1967.

U.S. Office of Water Resources Research. Bibliography on Socio-Economic Aspects of Water Resources. Washington, D.C.: U.S. Government Printing Office, 1966.

U.S. Office of Water Resources Research. Water Resources Research Catalog. Volumes 1, 2 (1965), Volume 3 (1967). Washington, D.C.: U.S. Government Printing Office.

U.S. Office of Water Resources Research. Water Resources Thesaurus. Washington, D.C.: U.S. Government Printing Office, 1966.

U.S. Outdoor Recreation Resources Review Commission. Outdoor Recreation Literature: A Survey--Study Report 27. Washington, D.C.: U.S. Government Printing Office, 1962.

U.S. Public Health Service. Influence of Impoundments on Water Quality, a Review of Literature and Statement of Research Needs. Cincinnati, Ohio: U.S. Department of Health, Education and Welfare, 1966.

U.S. Tennessee Valley Authority. Benefit-Cost Analysis for Water Resource Projects: A Selected Annotated Bibliography. Knoxville, Tennessee: Tennessee Valley Authority, 1967.

U.S. Tennessee Valley Authority. A Bibliography for the TVA Program. Knoxville, Tennessee: TVA Technical Library, 1964.

Van der Smissen, Margaret Elisabeth. Research in Recreation, 1965. Supplement to the 1962 edition. New York: National Recreation Association, 1965.

Wolfe, R. I. "Perspective on Outdoor Recreation: A Bibliographic Survey," Geographical Review, 54 (April, 1964), 203-238.

III. AGENCIES AND ORGANIZATIONS

American Forest Products Industries, Inc., 1816 N Street, N.W., Washington, D.C.

American Water Resources Association, 103 North Race Street, Urbana, Illinois.

American Water Works Association, 2 Park Avenue, New York, New York.

Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.

Bowdoin College, Center for Resource Studies, Brunswick, Maine.

Bureau of Land Management, U.S. Department of the Interior, Washington, D.C.

Bureau of Outdoor Recreation, U.S. Department of the Interior, Washington, D.C.

Bureau of Reclamation, U.S. Department of the Interior, Washington, D.C.

Bureau of Sport Fisheries and Wildlife, U.S. Department of the Interior, Washington, D.C.

California Department of Public Health, Bureau of Sanitary Engineering, 2151 Berkeley Way, Berkeley, California.

California Department of Water Resources, Sacramento, California.

California State Water Quality Control Board, Sacramento, California.

California University, College of Engineering and School of Public Health, Berkeley, California.

California University, Giannini Foundation of Agricultural Economics, Berkeley, California.

California University, Water Resources Center, Los Angeles, California.

California University, Western Agricultural Economics Research Council, Berkeley, California.

Central States Forest Experiment Station, Columbus, Ohio.

The Conservation Foundation, 1250 Connecticut Avenue, N.W., Washington, D.C.

Cooperative State Research Service, U.S. Department of Agriculture, Washington, D.C.

Cornell University, Department of Agricultural Economics, Ithaca, New York.

Cornell University, State College of Agriculture, Ithaca, New York.

Cornell University, Water Resources and Marine Sciences Center, 468 Hollister Hall, Ithaca, New York.

Delaware Estuary Comprehensive Study, 321 Chestnut Street, Philadelphia, Pennsylvania.

E. H. Bourguard and Associates, 1822 N. 2nd, Harrisburg, Pennsylvania.

Environmental Economics Branch, Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, D.C.

Federal Water Pollution Control Administration, U.S. Department of the Interior, Washington, D.C.

Florida University, Florida Agricultural Experiment Station, Gainesville, Florida.

Florida University, Florida Engineering and Industrial Experiment Station, Gainesville, Florida.

Florida University, Water Resources Research Center, 220 Environmental Engineering Building, Gainesville, Florida.

Geological Survey, U.S. Department of the Interior, Washington, D.C.

Harvard University, Harvard Water Program, Cambridge, Massachusetts.

Hudson River Valley Commission, Tarrytown, New York.

Illinois Department of Public Works and Buildings, Division of Waterways, 201 West Monroe Street, Springfield, Illinois.

Illinois University, Cooperative Extension Service, College of Agriculture, Urbana, Illinois.

Illinois University, Department of Recreation and Park Administration, Urbana, Illinois.

Illinois University, Urban Planning and Landscape Architecture Library, Urbana, Illinois.

Illinois University, Water Resources Center, Urbana, Illinois.

Intermountain Forest and Range Experiment Station, 507 25th Street, Ogden, Utah.

International Commission on National Parks, 2000 P Street N.W., Washington, D.C.

Iowa State University of Science and Technology, Department of Zoology and Entomology, Ames, Iowa.

Kentucky University, Water Resources Institute, Lexington, Kentucky.

Maine University, Maine Agricultural Experiment Station, Orono, Maine.

Massachusetts University, Agricultural Experiment Station, Amherst, Massachusetts.

Massachusetts University, Water Resources Research Center, Amherst, Massachusetts.

Michigan Department of Conservation, Recreation Resource Planning Division, Lansing, Michigan.

Michigan Department of Conservation, Water Resources Commission, Lansing, Michigan.

Michigan State University, Department of Resource Development, Natural Resources Building, East Lansing, Michigan.

Michigan State University, Institute for Community Development, East Lansing, Michigan.

Midwest Research Institute, 425 Volker Boulevard, Kansas City, Missouri.

Minnesota University, Water Resources Research Center, Minneapolis, Minnesota.

Missouri University, Extension Division, Columbia, Missouri.

Montana University, Montana Cooperative Wildlife Research Unit, Missoula, Montana.

National Association of Counties, 1001 Connecticut Avenue, N.W., Washington, D.C.

National Parks Association, 1300 New Hampshire Avenue, N.W., Washington, D.C.

National Waterways Conference, Inc., 1130 Seventeenth Street, N.W., Washington, D.C.

National Wildlife Federation, 1412 Sixteenth Street N.W., Washington, D.C.

Nebraska University, Bureau of Business Research, Lincoln, Nebraska.

Nevada University, Agricultural Information Service, Max Fleischmann College of Agriculture, Reno, Nevada.

New Hampshire Department of Resources and Economic Development, State House Annex, Concord, New Hampshire.

New Hampshire State Planning Project, Concord, New Hampshire.

New Jersey Division of State and Regional Planning, P.O. Box 1978, Trenton, New Jersey.

New Mexico State University, College of Agriculture and Home Economics, Department of Agricultural Economics and Agricultural Business, Las Cruces, New Mexico.

New York State Water Resources Commission, Albany, New York.

North Carolina State University, Department of Recreation and Park Administration, School of Forestry, Raleigh, North Carolina.

North Central Forest Experiment Station, Folwell Avenue, St. Paul, Minnesota.

Northeastern Forest Experiment Station, 6816 Market Street, Upper Darby, Pennsylvania.

Office of Science and Technology, Executive Office of the President, Washington, D.C.

Ohio Department of Natural Resources, Columbus, Ohio.

Pacific Northwest Forest and Range Experiment Station, P.O. Box 3141, Portland, Oregon.

Pennsylvania State University, Institute for Environmental Studies, College Park, Pennsylvania.

Public Health Service, U.S. Department of Health, Education and Welfare, Washington, D.C.

Resources for the Future, Inc., 1755 Massachusetts Avenue, Washington, D.C.

Rhode Island University, Agricultural Experiment Station, Kingston, Rhode Island.

Robert A. Taft Sanitary Engineering Center, Library, 4676 Columbia Parkway, Cincinnati, Ohio.

Rocky Mountain Forest and Range Experiment Station, 221 Forestry Building, Colorado State University, Fort Collins, Colorado.

Rutgers University, Bureau of Economic Research, New Brunswick, New Jersey.

Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C.

South Dakota State University, Department of Agricultural Economics, Brookings, South Dakota.

Southeastern Forest Experiment Station, Asheville, North Carolina.

Sport Fishing Institute, Washington, D.C.

Tennessee Valley Authority, Knoxville, Tennessee.

Texas A & M University, Water Resources Institute, College Station, Texas.

Texas Water Development Board, P.O. Box 12386, Austin, Texas.

U.S. Department of the Army, Office of the Chief of Engineers, Washington, D.C.

U.S. Department of Health, Education and Welfare, Washington, D.C.

U.S. Department of the Interior, Office of the Secretary, Washington, D.C.

U.S. Forest Service, Department of Agriculture, Washington, D.C.

U.S. Recreation Advisory Council, Washington, D.C.

U.S. Water Resources Council, Washington, D.C.

Urban Land Institute, Washington, D.C.

Utah State University, Agricultural Experiment Station, Logan, Utah.

Wabash Valley Interstate Commission, 414-416 REA Building, Eighth and Wabash, Terre Haute, Indiana.

Washington State University, State of Washington Water Research Center, Pullman, Washington.

Washington University, Institute for Urban and Regional Studies, St. Louis, Missouri.

Wisconsin Department of Natural Resources, Madison, Wisconsin.

Wisconsin University, College of Agriculture, Madison, Wisconsin.

Wisconsin University, Department of Landscape Architecture, Madison, Wisconsin.

Wisconsin University, Department of Recreation Resource Management, Green Bay, Wisconsin.

Wisconsin University, Water Resources Center, Madison, Wisconsin.

Wyoming University, Water Resources Research Institute, P.O. Box 3038, University Station, Laramie, Wyoming.

Yale University, Environmental Health Section, Department of Epidemiology and Public Health, New Haven, Connecticut.

APPENDIX D

PUBLIC LAW ANALYSIS: WATER AND RECREATION

by Bruce Rogers[1]

Introduction

This paper brings together major provisions of public laws enacted since 1960 which affect planning, development, and use of the Nation's water resources for recreational purposes.

Public laws which bear upon the recreational use of water are not easily separated from public water laws in general. The relationship is often an implicit one. Therefore, no strict inclusion-exclusion criteria have been adhered to as to which laws are cited herein. Qualitative judgments have been made and only those laws which most directly effect the recreational use of water have been included. An exception to this concerns fish and wildlife conservation laws. It is felt that this legislation forms a category that can be distinguished from the present concern, even though several of the fish and wildlife conservation laws state that one reason for conservation practices is to enhance the recreational value inherent in fish and wildlife resources.

In many instances the laws referred to are amendments to legislation enacted prior to 1960. For these cases the general thrust of the previous law is explained before citing the amendment's provisions.

Two factors must be kept in mind. Firstly, public laws approved prior to

---

[1]Bruce Rogers, M. S., is a research assistant in the Department of Recreation and Park Administration, University of Illinois. This paper was completed as a part of project A-025-ill. for the Water Resources Center, University of Illinois.

1960, and not amended since, are not included although they may have a bearing upon the planning, development, and use of water for recreation. Secondly only the provisions of the laws are explained. Specific programs which have as their authorization one of these laws are not mentioned. The paper is not intended for use as a reference manual for Federal programs which assist in development of water resources for recreational purposes. For this other sources must be sought.

Several terms are used that have particular meanings which must be understood for the Acts' purposes to be clear. These follow.

Separable costs - As applied to any project purpose, means the difference between the capital cost of the entire multiple-purpose project and the capital cost of the project with the purpose omitted.

Joint costs - The difference between the capital cost of the entire multiple-purpose project and the sum of the separable costs for all project purposes.

Capital cost - Includes interests during construction, where appropriate.

Non-reimbursable - Shall not be construed to prohibit the imposition of entrance, admission, and other user fees and charges.

The Laws

When approved in 1954 the Watershed Protection and Flood Prevention Act was primarily intended to provide a means by which the Department of Agriculture could cooperate with state and local agencies for the purposes of soil conservation.[2] Amendments in 1956,[3] 1958,[4] 1960,[5] and 1961[6] have broadened the Act's scope. One of the 1961 amendments (PL 89-703) was particularly applicable to recreational development.

In general the Act authorizes the Secretary of Agriculture to financially and otherwise assist with the planning and development of "works and improvement" for flood prevention or conservation, development, utilization, and disposal of water in watershed areas not exceeding 250,000 acres. The Secretary is authorized to assist in preparing and carrying out plans provided there has been prior approval by the appropriate supervisory state agency. As a condition of Federal assistance the local organization must acquire its own land, with the following exception. When a local organization agrees to operate and maintain a reservoir or other area for public recreation or fish and wildlife development, the Secretary is authorized to bear a portion of the costs of the land, easements, or rights-of-way to be acquired. The Secretary's authorization to participate in recreation development is only to the extent that the need for such development has been demonstrated and then he may not participate in more than three recreation projects in any one watershed area. Also, the local organization

---

[2] U.S., Congress, An Act to Authorize the Secretary of Agriculture to cooperate with States and Local Agencies in the Planning and Carrying Out of Works of Improvement for Soil Conservation, and for Other Purposes, Public Law 566, 83rd. Cong., 2nd Sess., 1954.

[3] U.S., Congress, An Act to Amend the Watershed Protection and Flood Prevention Act, Public Law 1018, 84th Cong., 2nd Sess., 1956.

[4] U.S., Congress, An Act to Amend the Watershed Protection and Flood Prevention Act, Public Law 865, 85th Cong., 2nd Sess., 1958.

[5] U.S., Congress, An Act to Amend the Watershed Protection and Flood Prevention Act to Provide that Its Loan Provisions Shall Be Applicable to Certain Other Projects, and for Other Purposes, Public Law 468, 86th Cong., 2nd Sess., 1960.
U.S., Congress, An Act to Amend Section 4 of the Watershed Protection and Flood Prevention Act, Public Law 545, 86th Cong., 2nd Sess., 1960.

[6] U.S., Congress, An Act to Amend the Watershed Protection and Flood Prevention Act to Permit Certain New Organizations to Sponsor Works of Improvement

must assume a proportionate share of the cost of installing the works of improvement. The Secretary determines this share after consideration of national needs and assistance authorized for similar purposes under other Federal programs.

As was the case with the original Watershed Protection and Flood Prevention Act, the Small Reclamation Projects Act of 1956[7] was not intended to benefit recreational development at Federal water projects. A 1966 amendment,[8] however, expanded the Act's original focus. As amended, the Act is intended to encourage state and local participation in project development under Federal reclamation laws. Project is defined as: (1) "any complete irrigation undertaking, including incidental features thereof, or a distinct unit of such an undertaking or a rehabilitation and betterment program for an existing irrigation project . . ., and (2) any similar undertaking proposed to be constructed by an organization."[9]

A provision in the 1966 amendment specifically provided that public recreation may be one purpose of a project being funded by a grant under this Act.

Any proposals for construction of a project must include a proposed allocation of capital costs. Facilities used for single purposes must be allocated to that purpose and costs for multiple-purpose facilities must be allocated among

---

Thereunder, Public Law 170, 87th Cong., 1st. Sess., 1961.

U.S., Congress, An Act to Improve and Protect Farm Income to Reduce Costs of Farm Programs to the Federal Government, to Reduce the Federal Government's Excessive Stocks of Agricultural Commodities, to Maintain Reasonable and Stable Prices of Agricultural Commodities and Products of Consumers, to Provide Adequate Supplies of Agricultural Commodities for Domestic and Foreign Needs, to Conserve Natural Resources, and for Other Purposes, Public Law 703, 87th Cong., 2nd Sess., 1962.

[7]U.S., Congress, An Act to Supplement the Federal Reclamation Laws by Providing for Federal Cooperation in Non-Federal Projects and for Participation by Non-Federal Agencies in Federal Projects, Public Law 984, 84th Cong., 2nd Sess., 1956.

[8]U.S., Congress, An Act to Amend the Small Reclamation Projects Act of 1956, Public Law 553, 89th Cong., 2nd Sess., 1966.

[9]Public Law 84-984, sec. 2.

these purposes such that each purpose will share equitably in the costs of joint facilities. The grant must not exceed the sum of the following: (1) the costs of services necessary to the preparation of proposals and plans for the project allocable to fish and wildlife enhancement or public recreation; (2) one-half the costs of lands for an area to be operated for fish and wildlife enhancement or public recreation purposes; (3) one-half the costs of basic outdoor recreation facilities or facilities serving fish and wildlife enhancement purposes exclusively; (4) one-half the costs of construction of joint-use facilities properly allocable to fish and wildlife or recreation; and (5) "that portion of the estimated cost of constructing the project which, if it were constructed as a Federal reclamation project, would be properly allocable to functions, other than recreation and fish and wildlife enhancement, which are non-reimbursable under general provisions of law applicable to such projects."[10]

Further provisions of the Act deal with procedural matters.

Unlike most others, users of water for recreational purposes do not have an opportunity to "clean up" water before using it. To them water pollution is a severe deterrent because they must use the water as they find it. For this reason any water pollution control legislation has a bearing upon recreational use of water.

The first Water Pollution Control Act,[11] approved June 30, 1948, provided for pollution control activities in the Public Health Service and the Federal Works Agency. The Surgeon General, in cooperation with Federal, state, and other agencies, was charged with the responsibility of preparing and adopting comprehensive programs for pollution abatement in interstate waters. The Act

---

[10] Public Law 89-553, sec. 1.

[11] U.S., Congress, An Act to Provide for Water Pollution Control Activities in the Public Health Service of the Federal Security Agency and in The Federal Works Agency, and for Other Purposes, Public Law 845, 80th Cong., 2nd Sess., 1948.

stated, in part, that "due regard shall be given to the improvements which are necessary to conserve such [interstate] waters for . . . recreational purposes . . .," and others.[12] The 1948 Act had an expiration date of five years, but was extended for three years by a 1953 Act.[13] Since then four Acts have amended the original.

The 1956 amendment extended and strengthened the 1948 law, especially in the areas of enforcement and research.[14] It also established a Water Pollution Control Advisory Board whose chairman is the Secretary of the Interior, or his designee, and whose members are appointed by the President. The Board's duties are to advise and make recommendations on matters of policy relating to the activities and functions carried out under the Water Pollution Control Act.

The 1961 amendments further strengthened the enforcement authority and increased support for construction of waste treatment works and research.[15]

In addition to amending the original Act, the Water Quality Act of 1965 established the Federal Water Pollution Control Administration.[16] This administration was first housed in the Department of Health, Education and Welfare, but was transferred to the Department of the Interior in 1966 by the President's Reorganization Plan No. 2. This 1965 law required establishment of water quality standards for all interstate and coastal waters.

---

[12] _Ibid._, sec. 2.

[13] U.S., Congress, _An Act to Extend the Duration of the Water Pollution Control Act_, Public Law 579, 82nd Cong., 2nd Sess., 1952.

[14] U.S., Congress, _An Act to Extend and Strengthen the Water Pollution Control Act_, Public Law 660, 84th Cong., 2nd Sess., 1956.

[15] U.S., Congress, _An Act to Amend the Federal Water Pollution Control Act to Provide for a More Effective Program of Water Pollution Control, and for Other Purposes_, Public Law 88, 87th Cong., 1st Sess., 1961.

[16] U.S., Congress, _An Act to Amend the Federal Water Pollution Control Act to Establish a Federal Water Pollution Control Administration, to Provide Grants for Research and Development, to Increase Grants for Construction of Sewage Treatment Works, to Require Establishment of Water Quality Criteria, and for Other Purposes_, Public Law 234, 89th Cong., 1st Sess., 1965.

The Clean Water Restoration Act of 1966 increased authorizations for grants and research and generally made more effective certain programs.[17]

As currently stated the Water Pollution Control Act's purposes are to enhance the quality and value of the Nation's water and "to establish a national policy for the preservation, control, and abatement of water pollution."[18] As a matter of policy Congress recognizes, preserves, and protects the primary responsibilities and rights of the states in preventing and controlling water pollution. Although "primary responsibility" remains with the states, Federal technical and financial aid is made available to states and interstate agencies and to municipalities for the purposes of the Act.

The Act's comprehensive nature has been retained with the provision that all legitimate water uses are to be given "due regard" during the development of programs for water conservation.

Under the Secretary of the Interior's direction the Federal Water Pollution Control Administration is the agency which discharges the Administration's functions under this Act. The Secretary has the authority and responsibility to cooperate with other agencies in conducting and promoting work relating to the causes, control, and prevention of water pollution. Another of the Secretary's responsibilities under this Act is to make a comprehensive study of the effects of pollution in the Nation's estuaries on recreation and other uses of them. (The focus on estuaries and estuarine areas was further sharpened in 1968 by Public Law 90-454 which is referred to herein.)[19]

Authorization is given to the Secretary to make grants to any state,

---

[17] U.S., Congress, An Act to Amend the Federal Water Pollution Control Act in Order to Improve and Make More Effective Certain Programs Pursuant to Such Act, Public Law 753, 89th Cong., 2nd Sess., 1966.

[18] Public Law 89-234, sec. 1.

[19] U.S., Congress, An Act to Authorize the Secretary of the Interior, in Cooperation with the States, to Conduct an Inventory and Study of the Nation's Estuaries and their Natural Resources, and for Other Purposes, Public Law 454, 90th Cong., 2nd Sess., 1968.

municipality, or intermunicipal or interstate agency for the construction of treatment works to prevent the discharge of untreated or inadequately treated sewage or other wastes in any waters.

The Water Quality Act of 1965 required states to establish water quality standards, subject to approval by the Secretary of the Interior. The purpose of these standards are "to protect the public health or welfare, enhance the quality of the water and serve the purposes of this Act."[20] If the state does not establish and have such standards approved, the Secretary must promulgate standards consistent with this Act's intent. These standards are subject to appeal by the state. The procedures for appeal are contained in the Act.

Abatement of pollution in interstate and navigable waters is another of the Act's purposes. In order to accomplish this the Secretary of the Interior has the authority to request the Attorney General to bring suit on behalf of the United States. In instances where the pollution is endangering the health or welfare of persons only in the state in which the pollution originates, the Secretary must have the consent of the state's governor before taking such action. This is the Secretary's ultimate recourse and less severe measures to secure abatement are provided.

As previously noted, the Water Pollution Control Act contained provisions for the study of estuarine areas. Public Law 90-454 expands these and notes that the Nation's estuaries are rich in natural, commercial, and other resources of immediate and potential value. The latter law's purpose is to provide a means for considering the need to protect, conserve, and restore these estuaries to maintain a balance between the need to conserve the natural resources and natural beauty and the need to develop them to further the growth and development of the Nation.

---

[20] Public Law 89-234, sec. 5.

The Secretary of the Interior, in cooperation with other Federal agencies and the states, is instructed to conduct an inventory and study of estuaries. The Secretary shall consider, among other matters, their wildlife and recreational potential and their esthetic value. This study is to be carried out in conjunction with the estuarine pollution study authorized by the Federal Water Pollution Control Act, as amended, and other applicable studies.

The study is to focus attention on whether or not it is necessary for an estuary to be acquired and administered by the Federal government so as to adequately protect it, or can protection be furnished through local, state or Federal laws or other methods.

By January 30, 1970 the Secretary is to submit to Congress through the President a report on the study. Included is to be legislative recommendations, and recommendations on the feasibility and desirability of establishing a nationwide system of estuarine areas, and others as enumerated in the Act.

The Secretary is to encourage states and their sub-divisions to consider needs and opportunities for protecting and restoring estuaries when developing their comprehensive plans and proposals for financial assistance under the Land and Water Conservation Fund Act of 1965, and other acts.

The purposes of the Land and Water Conservation Fund Act,[21] as amended,[22] are to assist in preserving, developing, and assuring accessibility to citizens and visitors such quality and quantity of outdoor recreation resources as may be

---

[21] U.S., Congress, An Act to Establish a Land and Water Conservation Fund to Assist the States and Federal Agencies in Meeting Present and Future Outdoor Recreation Demands and Needs of the American People, and for Other Purposes, Public Law 578, 88th Cong., 2nd Sess., 1964.

[22] U.S., Congress, An Act to Provide Uniform Policies with Respect to Recreation and Fish and Wildlife Benefits and Costs of Federal Multiple-Purpose Water Resource Projects, and for Other Purposes, Public Law 72, 89th Cong., 1st Sess., 1965.

U.S., Congress, An Act to Amend Title I of the Land and Water Conservation Fund Act of 1965, and for Other Purposes, Public Law 401, 90th Cong., 2nd Sess., 1968.

available and are necessary and desirable for individual active participation in such recreation. These extensive purposes are to be realized by: "(1) providing funds for and authorizing Federal assistance to the states in planning, acquisition and development of needed land and water areas and facilities, and (2) providing funds for the Federal acquisition and development of certain lands and other areas."[23]

The Act established a land and water conservation fund in the Treasury of the United States. Into this fund are to be paid the following revenues and collections: (1) all proceeds received after the date of this Act from any disposal of surplus real property and related personal property under the Federal Property and Administrative Services Act of 1949, as amended (there are exceptions to this which are noted in the Act); (2) amounts specified in the Highway Revenue Act of 1956 relating to special motor fuels and gasolines used in motorboats; and (3) in addition to revenues and collections from the above sources, there are authorized to be appropriated annually to the fund out of any money in the Treasury not otherwise appropriated such amounts as are necessary to make the fund's income not less than $200,000,000 for each of the five fiscal years beginning July 1, 1968. To the extent that monies so appropriated are not sufficient to make the total annual income of the fund $200,000,000, the remainder is to be credited to the fund from revenues due and payable to the Treasury under the Outer Continental Shelf Lands Act.

The July 15, 1968 amendment (PL 90-401) repealed the section of the original Act dealing with entrance and user fees and their coverage into the land and water conservation funds. The intent of this repealer was <u>not</u> to prevent Federal agencies from making charges for furnishing outdoor recreation facilities and services. To make clear its intent the repealer provided that, except where revenues collected shall be credited to specific purposes, "all fees so charged

---

[23]Public Law 88-578, sec. 1.

shall be covered into a special account under the land and water conservation fund and shall be available for appropriation, without prejudice to appropriations from other sources for the same purposes, for any authorized outdoor recreation function of the agency by which the fees were collected."[24]

A statement regarding estimated requirements for appropriations from the fund must be submitted with the annual budget of the United States. Appropriations are to be in the ratio of 60 percentum for state purposes and 40 percentum for Federal purposes, with exceptions as noted in the Act. Provisions are made for advance appropriations from the fund.

The Secretary of the Interior is authorized to provide financial assistance to the states for planning, acquisition of land, water, or interests in land and waters, or development for outdoor recreation purposes. Amounts which may be appropriated to the states both equally, and to individual states, are stipulated in the Act. Payments are not to cover more than 50 percentum of the cost of planning, acquisition, or development of projects.

A state is required to have a comprehensive outdoor recreation plan prior to consideration by the Secretary for financial assistance. The plan's adequacy shall be judged in terms of its ability to promote the purposes of this Act. It must take into account Federal resources and programs and be correlated with other state and local plans.

In addition to assistance for planning projects, financial assistance may be provided for acquisition of land and waters and their development. Projects must have the approval of the Secretary before any payments can be made to the state.

Monies appropriated from the fund for Federal purposes are allotted by the President for acquisition of land, waters, or interests in land or waters as

---

[24] Public Law 90-401.

follows: recreation areas within the national park system, inholdings within national forests, national areas for the preservation of threatened species, and for incidental recreation purposes as provided for in Public Law 87-714, an Act dealing with fish and wildlife conservation areas.

A national commitment to research in the area of water resources was made with the approval of the Water Resources Research Act of 1964.[25] To assist in assuring the Nation of a water supply sufficient in quantity and quality to meet all requirements, this Act, as amended,[26] provides for research and the training of scientists in the field of water and related resources.

Water resources research centers were established at colleges and universities. These centers have the responsibility of conducting, or arranging to have conducted, "competent" research in relation to water resources and of training scientists. Recreational use of water is specifically mentioned as an area of research with which these centers are to be concerned.

The Secretary of the Interior is charged with the responsibility of administering the Act. From the monies authorized to be appropriated the Secretary is to make grants, on matching bases or other arrangements, for the conduct of research projects. Money may be made available to organizations other than the centers established by this Act. The Secretary has the responsibility of seeing that programs authorized do not duplicate established programs in other agencies (regardless of where), but rather supplement, stimulate research in otherwise neglected areas, and contribute to a comprehensive nationwide program of water and related resources research.

---

[25] U.S., Congress, <u>An Act to Establish Water Resources Research Centers, to Promote a More Adequate National Program of Water Research, and for Other Purposes</u>, Public Law 379, 88th Cong., 2nd Sess., 1964.

[26] U.S., Congress, <u>An Act to Promote a More Adequate National Program of Water Research</u>, Public Law 404, 89th Cong., 2nd Sess., 1966.

Planning, development, and operation of Federal water resources projects have been guided by the concept of multiple-purpose use for many years. Only recently, though, has recreation been recognized as a project purpose for allocating costs and benefits.

With the passage of the Federal Water Project Recreation Act in 1965,[27] Congress established as policy that: (1) in investigating water resource projects full consideration shall be given to the opportunities for outdoor recreation and fish and wildlife enhancement which are afforded; (2) planning with respect to recreation at the project shall be coordinated with other recreation developments; and (3) non-Federal public bodies shall, where possible, be encouraged to administer project land and water areas.

If, before authorization of a project, non-Federal public bodies agree to administer project areas and bear not less than one-half the separable costs allocated to either recreation or fish and wildlife enhancement, or both, and all the costs of operation incurred therefor, then: (1) the project's benefits to established purposes must be taken into account in determining the economic benefits of the project; (2) costs must be allocated to these purposes to insure that all project purposes share equitably in the advantages of multiple-purpose construction; and (3) not more than one-half the separable costs and all the joint costs allocated to recreation and fish and wildlife enhancement shall be borne by the United States and be non-reimbursable.

No facilities which will furnish recreation or fish and wildlife enhancement benefits can be provided in the absence of the indication of intent by a non-Federal public body to administer the facilities, unless the facilities would be justified to some other purposes or they are minimum facilities

---

[27]Public Law 89-72.

required for public health and safety. Calculation of "benefits in any such case shall be based on the number of visitor-days anticipated in the absence of recreation and fish and wildlife enhancement facilities . . . and on the value per visitor-day of the project without such facilities or modifications. Projects costs allocated to recreation and fish and wildlife enhancement on this basis shall be non-reimbursable."[28]

In the absence of a non-Federal body's indication of intent to operate a project, "lands may be provided in connection with project construction to preserve the recreation and fish and wildlife enhancement potential of the project."[29]

Nothing in the Act prevents post-authorization developments of any project for recreation or fish and wildlife enhancement by non-Federal public bodies pursuant to agreement with the appropriate Federal agency. However, "such development shall not be the basis for any allocation or reallocation of project costs to recreation or fish and wildlife enhancement."[30]

The Secretary of the Interior is authorized, in conjunction with reclamation or other reservoirs under his control, except those within national wildlife refuges, to provide for public outdoor recreation and fish and wildlife enhancement facilities.

The Act applies to neither the Tennessee Valley Authority nor to projects constructed under the authority of the Small Reclamation Projects Act or the Watershed Protection and Flood Prevention Act.

Provision of commercial recreation facilities in Federal reservoir areas

---

[28] Ibid., sec. 3.

[29] Ibid.

[30] Ibid., sec. 5.

was effected with the approval of laws in 1961[31] and 1962.[32] These authorized the Secretaries of Army and Agriculture, respectively, to amend any leases entered into providing for the construction, maintenance, and operation of commercial recreation facilities in reservoir areas under their jurisdiction. Both Acts provided for the adjustment, either by increase or decrease, of the amount of rental or other considerations payable to the United States.

Two public laws enacted since 1960 are especially concerned with the comprehensive planning, development, and utilization of water resources on a nationwide basis. Both are comprehensive water laws and the recreational use of water is but one concern.

The Water Resources Planning Act,[33] as amended,[34] declares it to be the policy of the Congress to encourage the conservation, development, and utilization of water and related land resources on a comprehensive and coordinated basis by all levels of government and private enterprise. The Act is not to be construed to either expand or diminish the responsibility or authority of Federal or state agencies except as required to carry out the Act's provisions.

A Water Resources Council, composed of high-ranking administration officials, was established and their duties fixed. The Council is to: (1) maintain

---

[31] U.S., Congress, An Act to Authorize the Secretary of Army to Modify Certain Leases Entered into for the Provision of Recreation Facilities in Reservoir Areas, Public Law 236, 87th Cong., 1st Sess., 1961.

[32] U.S., Congress, An Act to Authorize the Secretary of Agriculture to Modify Certain Leases Entered into for the Provision of Recreation Facilities in Reservoir Areas, Public Law 411, 87th Cong., 2nd Sess., 1962.

[33] U.S., Congress, An Act to Provide for the Optimum Development of the Nation's Natural Resources Through the Coordinated Planning of Water and Related Land Resources, Through the Establishment of a Water Resources Council and River Basin Commissions, and by Providing Financial Assistance to the States in Order to Increase State Participation in Such Planning, Public Law 80, 89th Cong., 1st Sess., 1965.

[34] U.S., Congress, An Act to Amend the Water Resources Planning Act to Revise the Authorization of Appropriations for Administering the Provisions of the Act, and for Other Purposes, Public Law 547, 90th Cong., 2nd Sess., 1968.

a continuing study and prepare an assessment of the adequacy of water supplies to meet the Nation's requirements, both regionally and nationally; (2) maintain a continuing study of the relation of regional plans and programs to the requirements of larger regions; (3) study the adequacy of administrative and statutory means for the coordination of the water and related land resources policies and programs of Federal agencies; (4) appraise the adequacy of existing and proposed policies and programs to meet requirements; and (5) make recommendations to the President with respect to Federal policies and programs. The Council is empowered to establish principles, standards, and procedures for Federal agencies to follow in the preparation of comprehensive regional or river basin plans and for the formulation and evaluation of Federal water resources projects.

Plans are reviewed by the Council with special regard to their effect on the achievement of other programs for the development of recreational resources, among others.

Title II of the Act authorizes the President to establish a river basin water and related land resources commission upon request by the Council. These commissions are to: (1) serve as the principal coordination agency for plans relating to the area's water resources, and (2) prepare and update a comprehensive plan, provided "that the plan shall include an evaluation of all reasonable alternative means of achieving optimum development of water and related land resources of the basin . . . ."[35]

Provisions for financial assistance to the states for comprehensive planning are contained in Title III. Recognition of the need for increased state participation in water planning brought about the authorization of appropriations for that purpose. The Council was given the authority to prescribe such rules as necessary to assure coordination with other Federally-assisted programs.

---

[35]Public Law 89-80, sec. 201.

For the Council to approve a state's plan, the plan must meet the requirements described in this Act. In general these relate to its taking into account prospective demands on the water for all purposes and coordination with other statewide planning programs, and other procedural matters. If after reviewing a plan the Council finds that it no longer complies with the requirements of this Act, no further payments can be made to the state until the Council is satisfied that there will no longer by any such failure.

The second of the comprehensive public water laws created the National Water Commission in 1968.[36] This Commission is appointed by the President to carry out the following duties: (1) review national water resource problems, make projections of water requirements, and identify alternative ways of meeting these requirements; (2) consider the economic and social consequences of water resources development, including the impact of development on "esthetic values affecting the quality of life of the American people";[37] and (3) advise on specific matters referred to it by the President and the Water Resources Council. The Commission is to consult with the Water Resources Council and furnish to the Council its reports and recommendations for review and comment. Reports of the Commission are to be accompanied by the Council's views when submitted to the President and to the Congress.

The National Wilderness Preservation System and the National Wild and Scenic River System are both additions to the Nation's resources for providing water-oriented outdoor recreation opportunities. The first of these was established in 1968 by the Wilderness Act;[38] the latter, in 1968 by the Wild and

---

[36] U.S., Congress, An Act to Provide for a Comprehensive Review of National Water Resource Problems and Programs, and for Other Purposes, Public Law 515, 90th Cong., 2nd Sess., 1968.

[37] Ibid., sec. 3.

[38] U.S., Congress, An Act to Establish a National Wilderness Preservation System for the Permanent Good of the Whole People, and for Other Purposes, Public Law 577, 88th Cong., 2nd Sess., 1964.

Scenic River Act.[39]

Through the Wilderness Act Congress established a policy that some areas were to be designated for preservation and protection in their natural condition. To this end the National Wilderness Preservation System was established. The System is composed of Federally-owned lands which Congress has designated as wilderness. These wilderness areas are devoted to the public purposes of recreation, scenic, scientific, education, conservation, and historical use, except as otherwise provided in the Act. No monies were authorized for the administration of the System as a separate unit; therefore, areas included continue to be managed by the same agency as before their inclusion.

The Act defines wilderness and established criteria which land must meet for inclusion in the System. Provisions are made for the periodic review of Federally-owned land to determine its suitability for preservation as wilderness. The purposes of this Act are within and supplemental to the purposes of the agencies administering the land. It is the administering agencies' responsibility to preserve the character of the lands while also administering it for purposes for which it was first established. No motorboats, structures, installations, or commercial enterprises are permitted on lands in the System except as provided for under the Act's special provisions. These include: (1) motorboats may be permitted when their use had already become established; (2) the President may authorize prospecting for water resources, the establishment and maintenance of reservoirs, water conservation works, and other facilities needed in the public interest; and (3) commercial services may be performed so that the recreational and other wilderness purposes may be realized.

Nothing in this Act exempts the Federal government from state water law or effects the states' jurisdiction or responsiblities with respect to wildlife and fish in the National Forests.

---

[39] U.S., Congress, An Act to Provide for a National Wild and Scenic Rivers Systems, and for Other Purposes, Public Law 542, 90th Cong., 2nd Sess., 1968.

The Wild and Scenic Rivers Act declares it to be the policy of the United States that certain rivers, which, with their immediate environments, "possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition . . . ."[40] Such rivers "shall be protected for the benefit and enjoyment of present and future generation."[41] The Act goes on to state that the national policy of dam and other construction on rivers needs to be complemented by a policy which preserves other rivers in their natural conditions to protect their water quality and "to fulfill other vital national conservation purposes."[42]

The National Wild and Scenic Rivers System was established in order to implement the Act's purposes. Areas eligible for inclusion must include a free-flowing stream and its related land and possess at least one of the aforementioned values. A river need only be capable of restoration to a free-flowing state in order to be considered for inclusion. A threefold classification of rivers is provided: (1) wild river areas - free of impoundments and generally inaccessible; (2) scenic river areas - free of impoundments and generally accessible by roads; and (3) recreational river areas - readily accessible with some development along the shoreline and may have been impounded or diverted in the past.

The Secretary of the Interior or of Agriculture, or both, are to study and from time to time submit to the President and the Congress proposals for additions to the System. Every such study and plan must be coordinated with other water resources planning involving the same river which is being conducted

---

[40] Public Law 90-542, sec. 1.

[41] Ibid.

[42] Ibid.

pursuant to the Water Resources Planning Act. The studies are to be done with close cooperation among Federal agencies and the effected states and "include a determination of the degree to which the state or its political subdivisions might participate in the preservation and administration of the river should it be proposed for inclusion in the national wild and scenic rivers system."[43] Planning by Federal agencies of any water development projects must give consideration to the project's potential as an element of this System.

The Act authorizes the Secretary of the Interior and the Secretary of Agriculture to use various means to acquire lands within the boundaries of any component of the System. It specifically authorizes land and water conservation fund money to be available for the acquisition of property.

The Federal Power Commission is prohibited from licensing the construction of project works under the Federal Power Act when these would directly effect any river in the System. Furthermore, no Federal agency may assist any water resource project that would have a direct and adverse effect on the values for which the river was established. Development above or below the area, or on the river's tributaries, may take place providing it does not "unreasonably diminish" the values present in the area when this Act was approved (Oct. 2, 1968).

Nothing in the Act effects the applicability of the United States' mining and mineral leasing laws within components of the System, except that mining and other operations may be regulated to effectuate the purposes of this Act. Regulations are to provide safeguards against pollution of the river and unnecessary impairment of the scenery. An exception arises when minerals are within one-quarter mile of the river bank. Subject to valid existing rights, when this occurs, the minerals are withdrawn from appropriation under the mining laws and from operation of the mineral leasing laws.

---

[43] Ibid., sec. 5.

The System's components are to be administered so as to protect and enhance their values without limiting other uses that do not interfere with the enjoyment of those values. Primary emphasis is on protecting esthetic, scenic, historic, archeologic, and scientific features. Areas administered through the National Park Service become a part of the national park system; those administered through the Fish and Wildlife Service become a part of the national wildlife refuge system. In the case of conflict the more restrictive provisions apply.

The Federal agency charged with the administration of an area in the System is to cooperate with the Secretary of the Interior and with the appropriate state water pollution control agency for the purpose of eliminating or diminishing water pollution.

The Secretary of the Interior is instructed to encourage and assist states to consider needs and opportunities for establishing state and local wild, scenic and recreational river areas. Such considerations by states are especially important in formulating and carrying out statewide outdoor recreation plans and in porposals for financial assistance for state and local projects submitted pursuant to the Land and Water Conservation Fund Act of 1965.

In general the jurisdiction and responsibilities of states in the System are uneffected, to the extent that they may be exercised without impairing the Act's purposes.

The responsibility for carrying out the purposes of the Acts cited herein rests with many Federal agencies. Coordination among these agencies is difficult at best. For the purpose of coordinating efforts at providing outdoor recreation opportunities among Federal agencies and between the Federal government and states, the Bureau of Outdoor Recreation was established by a 1963

Act.[44]

This Act outlines the general administrative responsibilities and functions which are to be exercised by the Department of the Interior through the Bureau of Outdoor Recreation. As a matter of policy, the Congress has found and declared it to be desirable that adequate outdoor recreation resources be assured to the American people, presently and in the future. Furthermore, to this end Congress finds it desirable for all levels of government and private interests to take prompt and coordinated action.

To carry out the Act's purposes the Bureau is authorized to perform these functions: (1) conduct a continuing inventory and evaluation of outdoor recreation needs and resources; (2) prepare a system for classification of outdoor recreation resources; and (3) formulate and maintain a comprehensive, nationwide outdoor recreation plan. The nationwide plan is to take into consideration governmental agencies at all levels. In addition to setting forth the needs and demands for outdoor recreation, and its availability, the plan is to identify problems and recommend solutions to be taken by both governments and private interests.

To accomplish its coordination responsibilities, the Bureau is authorized to provide technical assistance, sponsor, engage in or assist in research, and accept donations for the purposes of this Act.

Summary

Public laws since 1960 have greatly enhanced the position of recreation as a water use. Recreation is now considered a legitimate purpose along with such others as power, navigation, and water supply at Federal multiple-purpose projects.

---

[44]U.S., Congress, An Act to Promote the Coordination and Development of Effective Programs Relating to Outdoor Recreation, and for Other Purposes, Public Law 29, 88th Cong., 1st Sess., 1963.

The effects of pollution upon the recreational use of water have been considered in pollution control and abatement legislation. The recreational values of wild rivers and wilderness areas have been recognized to the extent that Congress has declared it to be the policy of the United States that certain areas must be preserved and protected in their natural condition. Recreation is consistently mentioned as a concern of those responsible for planning water resources developments, both regionally and nationally. Federal funds are now available to finance water resources research dealing primarily with recreation.

These are but a few examples of the impact public laws have had upon the planning, development and use of water for recreation. Legislation in force prior to 1960 has been amended to benefit recreation. Laws enacted since then have expanded the role of the Federal government to include greater responsibility for the provision of water-oriented outdoor recreation opportunities. Primary responsibility, though, remains at the state and local level.

Bibliography

U.S. Congress. An Act to Provide for Water Pollution Control Activities in the Public Health Service of the Federal Security Agency and in the Federal Works Agency, and for Other Purposes. Public Law 845, 80th Cong., 2nd Sess., 1948.

U.S. Congress. An Act to Extend the Duration of the Water Pollution Control Act. Public Law 579, 82nd Cong., 2nd Sess., 1952.

U.S. Congress. An Act to Authorize the Secretary of Agriculture to Cooperate With States and Local Agencies in the Planning and Carrying Out of Works of Improvement for Soil Conservation, and for Other Purposes. Public Law 566, 83rd Cong., 2nd Sess., 1954.

U.S. Congress. An Act to Extend and Strengthen the Water Pollution Control Act. Public Law 660, 84th Cong., 2nd Sess., 1956.

U.S. Congress. An Act to Supplement the Federal Reclamation Laws by Providing for Federal Cooperation in Non-Federal Projects and for Participation by Non-Federal Agencies in Federal Projects. Public Law 984, 84th Cong., 2nd Sess., 1956.

U.S. Congress. An Act to Amend the Watershed Protection and Flood Prevention Act. Public Law 1018, 84th Cong., 2nd Sess., 1956.

U.S. Congress. An Act to Amend the Watershed Protection and Flood Prevention Act. Public Law 865, 85th Cong., 2nd Sess., 1958.

U.S. Congress. An Act to amend the Watershed Protection and Flood Prevention Act to provide that its loan provisions shall be applicable to certain other projects, and for other purposes. Public Law 468, 86th Cong., 2nd Sess., 1960.

U.S. Congress. An Act to amend Section 4 of the Watershed Protection and Flood Prevention Act. Public Law 545, 86th Cong., 2nd Sess., 1960.

U.S. Congress. An Act to amend the Federal Water Pollution Control Act to provide for a more effective program of water pollution control, and for other purposes. Public Law 88, 87th Cong., 1st Sess., 1961.

U.S. Congress. An Act to amend the Watershed Protection and Flood Prevention Act to permit certain new organizations to sponsor works of improvement thereunder. Public Law 170, 87th Cong., 1st Sess., 1961.

U.S. Congress. An Act to authorize the Secretary of Army to modify certain leases entered into for the provision of recreation facilities in reservoir areas. Public Law 236, 87th Cong., 1st Sess., 1961.

U.S. Congress. An Act to authorize the Secretary of Agriculture to modify certain leases entered into for the provision of recreation facilities in reservoir areas. Public Law 411, 87th Cong., 2nd Sess., 1962.

U.S. Congress. _An Act to Improve and Protect Farm Income to Reduce Costs of Farm Programs to the Federal Government, to Reduce the Federal Government's Excessive Stocks of Agricultural Commodities, to Maintain Reasonable and Stable Prices of Agricultural Commodities and Products of Consumers, to Provide Adequate Supplies of Agricultural Commodities for Domestic and Foreign Needs to Conserve Natural Resources, and for other purposes_. Public Law 703, 87th Cong., 2nd Sess., 1962.

U.S. Congress. _An Act to promote the coordination and development of effective programs relating to outdoor recreation, and for other purposes_. Public Law 29, 88th Cong., 1st Sess., 1963.

U.S. Congress. _An Act to establish water resources research centers, to promote a more adequate national program of water research, and for other purposes_. Public Law 379, 88th Cong., 2nd Sess., 1964.

U.S. Congress. _An Act to establish a National Wilderness Preservation System for the permanent good of the whole people, and for other purposes._ Public Law 577, 88th Cong., 2nd Sess., 1964.

U.S. Congress. _An Act to establish a land and water conservation fund to assist the States and Federal agencies in meeting present and future outdoor recreation demands and needs of the American people, and for other purposes_. Public Law 578, 88th Cong., 2nd Sess., 1964.

U.S. Congress. _An Act to provide uniform policies with respect to recreation and fish and wildlife benefits and costs of Federal multiple-purpose water resource projects, and for other purposes_. Public Law 72, 89th Cong., 1st Sess., 1965.

U.S. Congress. _An Act to provide for the optimum development of the Nation's natural resources through the coordinated planning of water and related land resources, through the establishment of a water resources council and river basin commission, and by providing financial assistance to the States in order to increase State participation in such planning_. Public Law 80, 89th Cong., 1st Sess., 1965.

U.S. Congress. _An Act to amend the Federal Water Pollution Control Act to establish a Federal Water Pollution Control Administration, to provide grants for research and development, to increase grants for construction of sewage treatment works, to require establishment of water quality criteria, and for other purposes_. Public Law 234, 89th Cong., 1st Sess., 1965.

U.S. Congress. _An Act to promote a more adequate national program of water research_. Public Law 404, 89th Cong., 2nd Sess., 1966.

U.S. Congress. _An Act to amend the Small Reclamation Projects Act of 1956._ Public Law 553, 89th Cong., 2nd Sess., 1966.

U.S. Congress. _An Act to amend the Federal Water Pollution Control Act in order to improve and make more effective certain programs pursuant to such Act._ Public Law 753, 89th Cong., 2nd Sess., 1966.

U.S. Congress. An Act to amend title 1 of the Land and Water Conservation Fund Act of 1965, and for other purposes. Public Law 401, 90th Cong., 2nd Sess., 1968.

U.S. Congress. An Act to authorize the Secretary of the Interior, in cooperation with the States, to conduct an inventory and study of the Nation's estuaries and their natural resources, and for other purposes. Public Law 454, 90th Cong., 2nd Sess., 1968.

U.S. Congress. An Act to provide for a comprehensive review of national water resource problems and programs, and for other purposes. Public Law 515, 90th Cong., 2nd Sess., 1968.

U.S. Congress. An Act to provide for a National Wild and Scenic Rivers System and for other purposes. Public Law 542, 90th Cong., 2nd Sess., 1968.

U.S. Congress. An Act to amend the Water Resources Planning Act to revise the authorization of appropriations for administering the provisions of the Act, and for other purposes. Public Law 547, 90th Cong., 2nd Sess., 1968.

VITA

Robert Browning Ditton was born in New York, New York on January 22, 1943. He received his secondary education in Highland Falls, New York and graduated from Highland Falls High in 1960. He received his B.S. degree in Recreation Education from the State University of New York, College at Cortland in 1964 and his M.S. degree in Recreation from the University of Illinois in 1966.

Mr. Ditton has had professional recreation leadership, supervisory and administrative experiences with both the Palisades Interstate Park Commission, Bear Mountain, New York and the Special Services Division, United States Military Academy, West Point, New York.

While doing graduate work at Illinois, he served as Assistant Program Director at the Illini Union for two years and spent one year as a Research Assistant with the Children's Research Center's Lincoln School Behavior Modification Project. In the spring semester of 1967, Mr. Ditton served as an instructor within the Department of Recreation and Park Administration. In July, 1967 he was appointed as Project Coordinator for water resources research project #A-025-ill. granted to Dr. E. H. Storey, Professor of Recreation and Park Administration, by the U.S. Department of the Interior and the Water Resources Center, University of Illinois. This grant provided the funds for Mr. Ditton's dissertation.

Mr. Ditton is a member of the National Recreation and Park Association and the American Park and Recreation Society. In 1964 he was named to Who's Who Among Students in American Colleges and Universities and was also honored as the 1968 recipient of the Charles K. Brightbill Award by the Department of Recreation and Park Administration, University of Illinois. His wife is the former Penelope Wheeler of Monticello, Illinois.